

LMSC-D420943
27 APRIL 1974
NASA CR-132455

STUDY OF EPHEMERIS ACCURACY OF THE MINOR PLANETS

(NASA-CR-132455) STUDY OF EPHEMERIS
ACCURACY OF THE MINOR PLANETS (Lockheed
Missiles and Space Co.) 173 p HC \$11.75

N74-32264

CSCL 03B

Unclas

G3/30 46739

STUDY PERFORMED UNDER CONTRACT NAS1-11609

For
NASA-LANGLEY RESEARCH CENTER
HAMPTON, VIRGINIA



Prepared by
SPACE SYSTEMS DIVISION
LOCKHEED MISSILES & SPACE COMPANY, INC.
(A SUBSIDIARY OF LOCKHEED AIRCRAFT CORPORATION)
SUNNYVALE, CALIFORNIA 94088

LMSC-D420943
27 April 1974
NASA CR-132455

STUDY OF EPHEMERIS ACCURACY
OF THE MINOR PLANETS

Study Performed Under Contract NAS1-11609

For

NASA-Langley Research Center
Hampton, Virginia

Prepared by

Space Systems Division
LOCKHEED MISSILES & SPACE COMPANY, INC.
(A Subsidiary of Lockheed Aircraft Corporation)
Sunnyvale, California 94088

FOREWORD

The study described in this report was conducted by Lockheed Missiles & Space Company, Inc. (LMSC) for Langley Research Center, National Aeronautics and Space Administration, Hampton, Virginia, under Contract NAS1-11609. The study was conducted under the direction of D. R. Brooks of the Space Technology Division.

L. E. Cunningham, Professor of Astronomy at the University of California, Berkeley, contributed significantly to the effort under a consulting agreement with LMSC.

CONTENTS

Section		Page
	FOREWORD	iii
1	INTRODUCTION AND SUMMARY	1-1
2	HISTORICAL PROCEDURES	2-1
	2.1 Astronomical Position Observations of Minor Planets	2-1
	2.2 Determination of Orbits of Minor Planets	2-3
3	SURVEY OF ACCURACY OF EXISTING MINOR PLANET EPHEMERIDES	3-1
	3.1 Objective of the Survey	3-1
	3.2 Minor Planet Identification	3-1
	3.3 Last Known Observation	3-1
	3.4 Opposition Viewing	3-2
	3.5 Basis for Orbital Elements	3-4
	3.6 Ephemeris Accuracy, A General Description	3-6
	3.7 Empirical Formula Development	3-6
	3.8 Discussion of Survey Results	3-8
4	NEW SYSTEM FOR DETERMINING MINOR PLANET EPHEMERIDES	4-1
	4.1 Need for More Data and Ephemerides	4-1
	4.2 The New System	4-2
	4.3 Data Furnished By the New System	4-4
	4.4 Use of Data Furnished by the New System	4-8
5	IMPROVED EPHEMERIS ACCURACY	5-1
	5.1 Improvement of Elements from Current Observations	5-1
	5.2 Improvement of Initial Elements from Published Ephemerides	5-3
	5.3 Theory of Orbit Improvement Method	5-3

Section		Page
6	COMPUTER PROGRAM	6-1
	6.1 General Program Layout	6-1
	6.2 Numerical Integration Techniques	6-7
	6.3 JPL Planetary Position Data Tape	6-8
	6.4 Minor Planet Observation Data Tape	6-8
7	CONCLUSIONS AND RECOMMENDATIONS	7-1
8	REFERENCES	8-1
Appendix		
A	RESULTS FROM ACCURACY SURVEY	A-1
B	OSCULATING ELEMENTS AT FUTURE DATES	B-1
C	RECTANGULAR COORDINATES AND PERTURBATIONS AT FUTURE DATES	C-1
D	PERTURBATIONS IN OSCULATING ELEMENTS AT FUTURE DATES	D-1
E	PERTURBATIONS IN RECTANGULAR COORDINATES AT FUTURE DATES	E-1
F	LIST OF COMPUTER PROGRAMS	F-1

ILLUSTRATIONS

Figure		Page
5-1	Minor Planet Accuracy Initial Improvement	5-2
6-1	General Program Layout	6-2
6-2	NMP 23 Flow Diagram	6-5

TABLES

Table		Page
3-1	Distribution of Predicted Uncertainties	3-9
4-1	Standard 400-Day Dates	4-4
4-2	Contents of ELM for One Minor Planet -- First Series of Data Tapes	4-6
4-3	Contents of Second Series of Data Tapes	4-8

Section 1

INTRODUCTION AND SUMMARY

The objective of this study has been to assess the current state of minor planet ephemerides and to develop the means for providing and updating these ephemerides for use by both the mission planner and the astronomer.

Mission modes for studying asteroids and comets proposed by mission analysts include flybys of single targets, multiflybys, and surface sample return missions. Of particular interest as a background to this study are the multiple asteroid flyby missions proposed by Brooks, Hampshire, and Drewry^{1,2} and others. These missions demonstrate the need for readily available estimates of ephemeris accuracies, inasmuch as their analysis involves a large number of constantly changing targets. Velocity increments to effect close flyby of several asteroids on a single mission are highly dependent on the relative positions of the asteroids. From a systems point of view, these ephemeris uncertainties impact spacecraft propulsion and acquisition and guidance subsystems and thus could tend to restrict the number of suitable targets. It is usually assumed that ephemeris accuracies for asteroids being approached at flyby velocities should be on the order of 1000 km, but a better estimate of the worst tolerable position uncertainty must await further design studies of possible spacecraft configurations. The resulting criteria for ephemeris accuracy, in conjunction with a great deal of recent work to define physical characteristics of asteroids from ground-based observations,³ will aid mission planners in more sharply defining desirable multiple flyby missions.

An immediate source of partial answers to questions about ephemeris accuracies for the numbered asteroids is contained in Ephemerides of the Minor Planets, published annually by the Institute for Theoretical Astronomy, Leningrad, U.S.S.R. In addition, current observations are published in astronomical journals and released from time to time by various observatories. While these and other sources contain the raw data

necessary for determining ephemeris accuracies, the mission analyst needs an easily accessible means of interpreting such data. Also, the computational means required to reduce the raw data to quantities suitable for use by the mission planner are not always available. Thus, the results of this study are needed to facilitate determination of ephemeris accuracies.

The study began with a consolidation of the data contained in the Ephemerides of Minor Planets. This is published in Appendix A in the form of a computer listing. Second, a thorough search of other available astronomical literature was made to establish a complete base of existing minor planet ephemeris accuracy data. Next, a new computerized method was developed for the systematic ephemeris determination of all numbered minor planets. Examples of how data generated by the new method can be used by the mission planner and astronomer are provided in Appendixes B, C, D, and E. It should be noted that the osculating element data presented in these appendixes are shown as examples of output only and are in most cases not as accurate as data provided by the Ephemerides of the Minor Planets. On the other hand, the perturbation data shown are sufficiently accurate to be used directly with current observational or other more recently published data. Appendix F is a short description of the main computer programs and subroutines developed during the contract period.

The accuracy of the existing ephemerides for all of the numbered minor planets was examined on the basis of data contained in the annual volumes of Ephemerides of Minor Planets and elsewhere. An empirical formula was developed and used to estimate the present ephemeris accuracy in terms of angular errors and distance errors in kilometers. These are listed in Appendix A and are summarized in Table 3-1. Discussion of the methods used and results obtained are given in Section 3. Results from this survey show accuracies ranging from 1.0 arc-sec (1,000 km) to 4,000 arc-sec (4,000,000 km) and thus indicate the need for developing a new system for keeping track of the minor planets.

A new system of providing data for all of the numbered minor planets was planned, and computer programs for its initial mechanization were developed. Essentially, this new system furnishes the osculating elements for all of the numbered minor planets

at an adopted date of 10 October 1972 (JD = 2441600.5 days) and at every 400-day date over the years of interest. It also furnishes the perturbations in the rectangular coordinates relative to these osculating elements at every 4-day date. The overall ephemeris accuracy depends on the accuracy of the adopted elements at the initial date, which must be improved in stages to meet future standards. Details are given in Section 4; samples of listings are contained in Appendixes B, C, D, and E.

A new computer program was designed and developed to integrate the perturbed motion of a group of 50 minor planets simultaneously. This mass production approach secures great economy in both machine time and supervision. On the CDC 6400 computer, the numerical integration of 50 minor planets at a step interval of 4 days over one 400-day interval requires about 100 seconds of central processor time. At this rate, more extensive integrations than originally planned become practical. Appendixes B, C, D, and E came directly from listings made by the program. Details are contained in Section 6.

The data furnished by this new system and program are so extensive that only samples are listed in this report. However, all data computed during the study by the new system for all the minor planets are available on magnetic tapes. The osculating elements at each 400-day date and the perturbations in these elements are listed in full whenever a run is made. However, the perturbations in the rectangular coordinates relative to these osculating elements at each 4-day step are listed for only one of the 50 minor planets in each group during any given run. Again, data for all 50 minor planets are placed on magnetic tape. Details are given in par. 4.3, and examples of some typical uses of the data are given in par. 4.4. The listings in Appendixes B, C, D, and E show that the perturbations in the position of a minor planet after 10 years can exceed 3 degrees (roughly 10,000,000 kilometers). This error, of course, is often small in comparison to the error resulting from the propagation of velocity errors in the initial conditions; that is, in the osculating elements at the adopted date. Thus, improving the initial elements is of paramount importance for obtaining accurate ephemerides at future dates.

A method to improve the initial elements on the basis of observed or ephemeris positions without the extensive computation of perturbations was developed and tested. Theory and discussions are contained in Section 5. However, this method was found to be less important than originally anticipated because of the high speed of the numerical integration program, so its use is now planned for only those minor planets having low ephemeris accuracy as reflected in the Appendix A tabulation. For the other minor planets, the numerical integration program can be used economically to reduce the published elements from their epoch of osculation to the adopted standard date.

Section 7 contains recommendations with regard to work needed to establish and implement the new system on a permanent basis.

Section 2
HISTORICAL PROCEDURES

2.1 ASTRONOMICAL POSITION OBSERVATIONS OF MINOR PLANETS

Following the discovery of the first minor planet in 1801, an attempt was made by astronomers to secure as many accurate position observations as possible for every known minor planet. After 1845, new minor planets were discovered at an ever increasing pace and the number of known ones soon became so large that this practice could no longer be continued. In an attempt to provide some observational material for all known minor planets, the measurement and publication of approximate positions was eventually introduced. For much the same reason, many apparently accurate positions were published, although made with small telescopes equipped with inferior micrometers. As a result of these policies, it is often found that old position observations are good and that modern ones are excellent but that position observations made over the many intermediate years are only approximate and essentially useless.

With the exception of a few of the very brightest objects, all modern position observations of minor planets are made photographically. The first four minor planets and occasionally a few others are observed with meridian circles. During the last century and the first part of this one, most of the accurate position observations were made visually with the aid of filar micrometers attached to refracting telescopes of large apertures.

With the possible exception of the relatively few meridian circle observations, all position observations of minor planets are relative. This means that the position of the minor planet is compared, either on a photograph or visually at the telescope, with neighboring stars, called comparison stars, the positions of which are assumed to be known. The positions of these comparison stars are taken from one or more catalogs, which are based on meridian circle observations, either directly or indirectly. The relative positions of all stars change slowly with time because of the space motions

of the stars and the sun. These changes are called "proper motions." They vary enormously from star to star and must be determined by direct measurement. As a result, a catalog position may be accurate for some year (called the epoch of the catalog) but may be quite poor a few decades later (or earlier) unless the proper motion of the star is known. Good proper motions are known for most stars visible to the naked eye, for a considerable number of stars brighter than the 9th magnitude, and for a few fainter stars of special interest. The proper motions of faint stars that must necessarily be used as comparison stars on photographs made with large telescopes are totally unknown.

The older published positions of minor planets were based on comparison star positions taken from various catalogs. An intercomparison of these catalogs shows that each differs systematically from the others and that these differences depend on various factors, including the right ascension of the star, its declination, its brightness, and its color. Tables of these "systematic corrections" have been published for the important catalogs. An application of these systematic corrections and of proper motion reduces the position of a comparison star to a given adopted astronomical "system" and to the date of observation. This procedure is necessary in obtaining the most accurate results, but it involves a great deal of work so is often avoided.

Modern photographic positions of minor planets brighter than magnitude 12, say, are based on comparison star positions taken from special catalogs. The included stars are chosen to provide (1) a quite uniform distribution over the entire sky, (2) a spacing between stars suitable to secure an adequate number of comparison stars on photographs taken with telescopes of moderate apertures, and (3) magnitudes sufficiently large to eliminate some of the difficulties inherent in the use of comparison stars very much brighter than the minor planet. Positions obtained in this way can have a probable error of about 0.1 second of arc. For fainter minor planets and for larger telescopes, the same catalog positions of the comparison stars are often used; but the resulting positions for the minor planets are somewhat less accurate unless special procedures are used (such as a coarse objective grating, or field plates, or both). For the faintest minor planets and for the largest telescopes, comparison star positions must necessarily be taken from the Astrographic Catalog. About this catalog, suffice it to say that the epoch of the catalog is about 1900 and no proper motions are known

for comparison stars taken from it. As a result, minor planet positions based on this catalog are never known to better than 1.0 second of arc and can quite easily be in error by 4 seconds of arc.

Modern positions of minor planets are all referred to the standard mean equator and equinox of 1950.0. Somewhat earlier positions were often referred to the mean equator and equinox of the beginning of the year of observation (e.g., 1934.0). Still earlier positions, especially those from the last century, were referred either to a mean equinox or to a true equinox of date or they were apparent positions (true equinox and stellar aberration). Thus, for a particular position, reductions for precession, nutation, and stellar aberration may or may not be required. In the last century, the measurement of positions was practiced by most astronomers, all of whom were so familiar with the then current but changing practices that published positions often do not contain precise statements about the system to which they refer.

The ultimate accuracy inherent in a particular photograph or in a particular instrument was, and is, not always attempted. Often quality has been intentionally sacrificed for quantity. The purpose for which the observations were made governed this, and correctly so. The fact that such observations are now available for general use is an added feature. However, their correct usage depends on a knowledge of the intended usage, the standards attempted, the inherent advantages and defects of the instruments used, the actual accuracy attained, the systematic errors introduced, and on many other factors, sometimes including the habits of the observer!

2.2 DETERMINATION OF ORBITS OF MINOR PLANETS

Ceres was observed for several weeks following its discovery in 1801, after which it remained too close to the Sun to be observed for several months. For the first time there was need to provide a finding ephemeris for a star-like object on the basis of observations extending over only a small part of an elliptic orbit. The finding ephemeris needed to be good, since the only way to distinguish Ceres from the many stars of similar brightness nearby in the sky was to watch each star for several hours until one was found to be moving relative to its neighbors. The problem of furnishing a good finding ephemeris was that of determining a good orbit on the basis of observed

positions extending over only a short interval of time. The problem was solved by Gauss, who invented a complicated and ingenious method, the principles of which are still in use.

An elliptical orbit is defined by six constants, and as each observed position provides two independent measures (right ascension and declination) a total of three observations is necessary to find the orbit. A basic quantity in the orbit determination process depends on the geocentric distance of the minor planet, the radial velocity of the minor planet with respect to the Sun, and the energy of the orbit. In this basic quantity, the geocentric distance is multiplied by the square of the smallest time interval between any two of the three dates of observation, the radial velocity is multiplied by the cube of this interval, and the energy is multiplied by the fourth power of the interval. Thus, the geocentric distance is the easiest quantity to determine, whereas the energy is the most difficult to determine. The mean daily motion in the orbit depends solely upon the energy of the orbit, and so is much more difficult to determine than are the other elements. In the computation of an ephemeris, the mean daily motion is multiplied by the time, whereas none of the better determined elements is so multiplied. Thus, the accuracy of the ephemeris depends almost completely upon the accuracy of the mean daily motion, which is the most difficult element to determine. For best accuracy, the time interval between the first and last observations should be as long as possible, and the second observation should lie near the middle of this interval.

Geometrical considerations, as well as the above dynamical ones, affect the accuracy of an orbit determined from three observations. The determinant of the problem is very nearly the determinant of the 3 by 3 matrix formed by the direction cosines of the three observed positions. This determinant will be zero if the three observed positions lie along a great circle. A minor planet often moves many degrees across the sky in a path that approximates a great circle. Even if the motion does not lie on a great circle, nevertheless the three basic positions may, accidentally, lie on a great circle. If a minor planet should move in the ecliptic -- that is, if the inclination of its orbit should be zero -- it would permanently move in the great circle that is the ecliptic.

The determination of an orbit from observations extending over several weeks or months is essentially the problem of determining an orbit from three observations. The above dynamical and geometrical considerations still hold. The value of additional positions lies in the resulting opportunity to select three accurate ones at times that maximize the geometrical determinant or keep it as large as possible while keeping the time intervals as nearly equal as possible. If enough additional positions are available and distributed in a suitable manner, the three basic positions may be chosen as "normal positions," which are a general average of several nearby positions.

In principle, the determination of an orbit is the same as the solution of any set of transcendental equations. Methods peculiar to the problem at hand must first be used to find a good approximation for each constant needed to define the solution and to select the particular solution of interest if there is more than one solution.

When the constants that define the solution have been determined with sufficient accuracy, the problem can be "linearized"; that is, the problem of determining the constants themselves can be replaced by the problem of determining the corrections to an assumed set of constants. The equations that determine these corrections are linear, provided that the corrections are sufficiently small. If the corrections are not sufficiently small, the solution can be iterated through successive sets of linear equations, but the convergence of the process depends upon the accuracy of the initial set of constants and upon the degree of nonlinearity of the equations that define the original problem.

In the determination of the orbit of a minor planet, the direct solution based on three observations should ordinarily be employed throughout the discovery apparition and may continue to be used through the second or even a third apparition. For a numbered minor planet, an "apparition" covers the interval between successive conjunctions with the Sun. After two apparitions the problem must ordinarily be linearized — partly because the methods based on three observations become less satisfactory and partly because all or many of the accurate observations should be used through the application of least squares to the solution of the many linear equations, which number two for each observation.

In the last century, each new discovery was assigned a permanent number at its first apparition, even though only a few observations of questionable quality were obtained. In some cases the orbital elements determined from the observations of the first apparition were not accurate enough to provide a sufficiently good ephemeris for the next apparition; as a consequence, the minor planet was lost. The brighter minor planets so lost were rediscovered later, but 14 (mostly from this century) remain lost at this date. Over the years the requirements for assigning a permanent number have gradually been tightened, and as a result no additional numbered minor planets should be lost.

The enormous amount of research that was done on the orbits of the minor planets during the last century and early part of this century was collected, discussed, and condensed by Professor Leuschner in his Research Surveys, which was published in 1935⁵. This thick volume is the most authoritative reference on the orbital work done during the time interval it covers. No comparable publication exists for more recent work.

Section 3

SURVEY OF ACCURACY OF EXISTING MINOR PLANET EPHEMERIDES

3.1 OBJECTIVE OF THE SURVEY

The principal objective of the survey was to assess the ephemeris accuracy that has been achieved for each of the 1779 numbered minor planets. The data used to accomplish this have been taken from annual volumes of Ephemerides of Minor Planets and, to a much smaller degree, from other publications.

3.2 MINOR PLANET IDENTIFICATION

All of the lower-numbered minor planets have been assigned permanent names, but many of the higher numbered ones have not. By international agreement, the discoverer of a minor planet has the privilege of naming it when or after its permanent number has been assigned. Until the discoverer assigns a name, the temporary designation assigned at discovery continues to be used.

This temporary designation consists of the year of discovery followed by two letters, which may or may not be followed by an integer. The first of the two letters denotes the half-month of discovery. The second of the two letters is assigned in alphabetical order beginning with A and continuing through Z, after which A is again assigned, followed by the digit one, etc. Thus, a given numbered minor planet will often have two names associated with it: first, the temporary designation; later, the permanent name assigned by the discoverer. Sometimes the permanent name is not directly assigned, and the temporary designation continues to be used for many years.

3.3 LAST KNOWN OBSERVATION

The year of the last known observation for a numbered minor planet is a crude (but very effective) indicator of the gross accuracy of the orbital elements of that minor planet. If a minor planet has been observed in recent years, then its orbital elements

must at least be good enough to provide a satisfactory finding ephemeris. If, on the other hand, it has not been observed for many years, it is hopelessly lost and will probably be rediscovered only by accident. Several minor planets have not been observed since their discovery many, many years ago. Their orbital elements were not determined with suitable accuracy at that time, and they would not have been assigned permanent numbers under present rules. A few numbered minor planets that have not been observed recently, but which are deemed not to be hopelessly lost, are placed on a "critical list" to encourage observers to search for them.

The year of the last known observation for each minor planet is given in the annual volumes of Ephemerides of Minor Planets. Since this publication is the principal source (and almost the sole source) for much of the information about the orbits and ephemerides of the numbered minor planets, it seems desirable to digress with a discussion about some of its contents.

3.4 OPPOSITION VIEWING

The principal purpose of the annual volumes of Ephemerides of Minor Planets is to provide observers with "opposition ephemerides" for all numbered minor planets. A planet is said to be in opposition when its right ascension differs by 12 hours from that of the Sun. An object in opposition crosses the meridian of an observer at midnight, and so is observable all night, or nearly so. It is then closest to the Earth, and as a consequence is then at its brightest for the year. Each of these factors makes the neighborhood of opposition the most favorable location for observation of an ordinary minor planet.

The opposition ephemerides given in Ephemerides of Minor Planets are tabulated at an interval of ten days, and run for about one month before and one month after opposition. During that time the apparent motion of an ordinary minor planet is "retrograde"; that is, it moves westward relative to the stars with its right ascension decreasing. Just outside these opposition ephemerides (both before and after) the motion in right ascension halts, and the minor planet is said to pass through a "stationary" point, although its motion in declination does not necessarily vanish at the same time. Before the first stationary point, and after the second one, the apparent motion of an ordinary

minor planet is "direct"; that is, its motion relative to the stars is eastward and its right ascension increases. When the motion of an ordinary minor planet is direct, the planet is not close to the Earth and so is relatively faint; its position in the sky is also relatively unfavorable for observation. While the brightness and location in the sky are not unfavorable near the stationary points, the problem of identifying the minor planet there is acute. On a short photographic exposure, a minor planet and a star appear exactly alike. In order to easily distinguish a minor planet from a star, it is necessary on most photographs to continue the exposure until the motion of the minor planet relative to the stars produces a "trail" on the photographic plate. Thus the neighborhood of opposition is the only favorable location for observing the ordinary minor planets, and most minor planets are actually observed only in that neighborhood.

The needs of the professional minor planet observer are satisfactorily met by the opposition ephemerides. The needs of observers of things other than minor planets are not fully satisfied by the opposition ephemerides. For example, an observer may find a bright trail on a photograph he has taken for another purpose. He is curious to know whether this minor planet is new, or which one it is, if it is not new. If his photograph was taken in the opposition region, he can turn to the opposition ephemerides for a positive identification. If his photograph was not taken in the opposition region, his curiosity will probably never be satisfied. No ephemerides for most minor planets exist outside the opposition region. The identification of a minor planet without an ephemeris is a most time-consuming process, and may be entirely unsuccessful. Once or more each year some enthusiastic observer becomes convinced that his "bright trail" comes from a really new and unusual minor planet, or even from a comet (fuzzy appearance due to poor seeing and/or guiding), and announces his "discovery" by the usual astronomical telegraphic system. Then the professional must spend considerable time and effort to identify the minor planet and prove his identification.

The opposition ephemerides of minor planets are given with an accuracy of about one minute of arc. This accuracy is sufficient to properly point even large telescopes. The aim of the makers of the opposition ephemerides is to attain this accuracy, and their principal efforts are expended in this direction. The effort needed to maintain this accuracy for all of the numbered minor planets taxes to the limit the resources of those doing this work. In order to cover all of the numbered minor planets as well as possible,

approximations have often been found necessary, especially for the lower-numbered planets that are relatively bright and can be found quite far from their predicted positions. It should be noted that an observer searching for a stray minor planet need not look in all directions from the predicted position, but instead only along a narrow band through it. The constants that define this band are given with each opposition ephemeris and are computed on the basis that at any instant the orbit of the minor planet traces a line on the sky, and, of course, the minor planet itself must be somewhere on this line. For the higher-numbered minor planets that are relatively faint, efforts to obtain higher accuracy are often made to prevent their loss. The procedures that have been employed to provide the opposition ephemerides were adopted by necessity in view of the very small budgets available. The results have been adequate for the intended purpose. In fact, the results are somewhat remarkable when one realizes that some outstanding astronomers consider the minor planets to be the "vermin of the sky."

3.5 BASIS FOR ORBITAL ELEMENTS

Data about the orbital elements themselves – their observational basis, their likely accuracy, the perturbations that were included, etc. – are given in condensed form in the annual volumes of Ephemerides of Minor Planets for those planets for which new elements were computed since the previous volume was issued. Data were found in each of the annual volumes from 1948 through 1972. The data published vary slightly over the years, but usually consist of:

- a. The years of the first and last oppositions from which observed positions were used in the orbit computations
- b. The total number of oppositions that had usable observed positions
- c. The major planets included in the computation of the perturbations
- d. The largest residual in right ascension (see below)
- e. Reference to publication of the orbit work (Given only in recent years, and then for only a small number of the minor planets)

Item d. above needs some discussion. By "residual" is here meant the difference between an observed right ascension and the right ascension computed from the orbit elements and associated perturbations. This residual may be due to an incorrect observed position, to insufficient perturbations, to the employment of approximate

methods, or to other possible causes; nevertheless, when properly evaluated, it is a good measure of the accuracy of the orbit elements. It is given by the orbit computer solely for this purpose, and presumably the value he has quoted is based on his best judgment of the accuracy of his work. In any case, it is the only estimate of orbital accuracy that is consistently published for all of the numbered minor planets, and it must necessarily be used as a principal datum in the estimate of ephemeris accuracy.

New sets of elements for each numbered minor planet appeared at least twice in the annual volumes mentioned, and many minor planets had three or more sets of new elements in that time interval. Each set of new elements was keypunched into cards, and a computer program then selected the latest set for each numbered minor planet.

The orbital elements themselves were taken from the table of elements in the 1972 volume of Ephemerides of Minor Planets. For each minor planet, these are:

- Brightness (in astronomical magnitudes) of the minor planet itself
- Epoch and date of osculation (here identical, but not necessarily so, in general) to which the elements refer
- Mean anomaly at Epoch
- Argument of perihelion
- Longitude of the ascending node on the ecliptic of 1950.0
- Inclination to the ecliptic of 1950.0
- Eccentric angle (The eccentricity is the sine of this)
- Mean daily motion in seconds of arc
- Semi-major axis (Not used, since the value obtained from the mean daily motion is more accurate)

The date of osculation is the instant at which the elliptical orbit osculates -- not in the ordinary mathematical sense, but in an astronomical sense, which defines the osculating orbit to be the ellipse that represents the instantaneous orbit at the instant of osculation. Stated another way, the instant of osculation is the instant at which a numerical integration of the perturbed motion must be started with the stated elements. On the other hand, the epoch is the instant for which the position of the minor planet in the ellipse is stated. That the epoch and date of osculation are here identical is simply a matter of convenience -- a single date serves two purposes.

3.6 EPHEMERIS ACCURACY, A GENERAL DESCRIPTION

The principal part of the inaccuracy of an ephemeris computed from a given set of elements arises from the failure of those elements to fit exactly the actual positions of the minor planet at the times of observation. This may be due to errors in the observed positions themselves, to failure to fully compute the perturbations, to a distribution of observations that leads to a poorly conditioned determining matrix, or to other causes. Whatever the causes, the sizes of the residuals will usually be good indicators of the quality of the resulting orbital elements. A visual inspection of all the residuals is the best way to judge the quality of the elements, since it will reveal systematic trends that are often meaningful. A single number like the probable error (or mean error) of the mean daily motion lumps together the errors of observations, the blunders of computation, and the systematic trends, but usually provides a good and meaningful measure of the accuracy of the elements. In the present case, neither the residuals nor the probable errors are available for most of the minor planets. The only datum here available is the largest residual in right ascension, described earlier. This must necessarily be taken as the only available measure of the accuracy of the elements, or more particularly of the accuracy of the mean daily motion, since by far the largest part of the ephemeris error arises from this element, with the other elements playing only minor roles.

3.7 EMPIRICAL FORMULA DEVELOPMENT

In order to predict the ephemeris uncertainty, it was necessary to devise an empirical formula that utilized as well as possible the available data of somewhat doubtful quality. It is well known that the error in the mean daily motion is the most important source of error after a long time. During the computation of a predicted position, the mean daily motion is multiplied by the time interval since the epoch, while all the other elements are not so used. The problem of using the largest residual found during the orbit computations as a measure of the ephemeris accuracy is then the problem of converting this residual into an error in the mean daily motion. No rigorous theoretical basis exists for doing this. The method used was simply to assume that the error in the mean daily motion was equal to the quoted residual divided by the time interval covered by

the observations used in the orbit determination. In many cases, this will turn out to be a good assumption; in some cases it may be quite far from the truth. However, there is no apparent better way of proceeding.

A small error in the mean daily motion also arises from the limited precision with which the mean daily motion is quoted in Ephemerides of Minor Planets. This can give rise to an error as large as 0.0005 second of arc per day, which amounts to nearly 0.2 second of arc per year. After 20 years, which is often the interval since the epoch of the elements, this amounts to nearly four seconds of arc.

The epochs for current elements fall in the range of years from 1892 through 1969, with major clustering in 1951 (with 348 minor planets), 1957 (with 237 minor planets, and 1962 (with 395 minor planets).

Another small error arises from the limited precision with which the other elements are quoted in Ephemerides of Minor Planets. This error does not build up with the time.

Each of the above errors applies to the position as seen from the Sun. At opposition, the minor planet is one astronomical unit closer to the Earth than it is to the Sun; thus, the error computed from the empirical formula derived as outlined above must be multiplied by the factor $A/(A-1)$, where A is the semi-major axis of the elliptical orbit.

To compute the ephemeris uncertainty, the sum of the two errors in the mean daily motion was multiplied by the interval between the year of interest and the earlier of (1) the year of the epoch or (2) a year near the middle of the interval covered by the observations on which the orbit determination was based. To this was added the constant error of 1.8 seconds or arc. This sum was then multiplied by the factor $A/(A-1)$ to give the predicted ephemeris uncertainty in seconds of arc. The result was also reduced to kilometers in the orbit. Usually, 1 second of arc here corresponds to roughly 1000 kilometers; but the conversion factor depends, of course, upon the distance of the minor planet from the Earth.

This empirical formula, or procedure, has been used to estimate the ephemeris uncertainty for each of the numbered minor planets. A computer program provided a listing of the basic data, of the predicted uncertainties expressed in seconds of arc and in thousands of kilometers, and of brief remarks concerning a few special cases among the minor planets. The final computer listing of these results is shown in Appendix A. The computer program also writes all of this on a magnetic tape from which additional copies of the listing can be made directly.

The remark "LOST" appearing in Appendix A after 14 minor planets is self-explanatory.

The remark "ESTIMATED" appears after 46 minor planets. It indicates that for those minor planets the predicted uncertainty in seconds of arc was not computed from the empirical formula used for other minor planets. Instead, the uncertainty was estimated directly in seconds of arc, usually because the data needed by the empirical formula were either missing or inadequate. However, for the first four minor planets (Ceres, Pallas, Juno, and Vesta) it was estimated to be 1.0 second of arc because excellent orbit determinations and perturbations exist for these large and bright minor planets.

3.8 DISCUSSION OF SURVEY RESULTS

Results from the survey of published minor planet ephemeris data, primarily from Ephemerides of Minor Planets, can be summarized as follows:

- a. The details of how the orbit determination was computed are not often published.
- b. The only accuracy indicator provided by the published data is the maximum residual in right ascension.
- c. Using an empirical relationship to estimate current ephemeris accuracies resulted in a wide range of ephemeris uncertainties. An attempt to improve this empirical relationship, based on data from a few selected minor planets, showed no significant change.
- d. The survey showed that the published data provide ephemerides of acceptable accuracy for only a very few minor planets.

The distribution of the predicted uncertainties according to size, as taken directly from the computer listing of Appendix A, is shown in Table 3-1. It is hoped that the

accuracy of these estimated uncertainties is a little better than order-of-magnitude. At first sight, this may seem to be very low accuracy, but it should be noted that the estimated uncertainties range from 1 second of arc through 3000 seconds of arc. Thus, the presumed accuracy of the estimates is significant in that the numbered minor planets are separated into at least several groups between which the ephemeris uncertainties differ widely.

Table 3-1

DISTRIBUTION OF PREDICTED UNCERTAINTIES

Range (Seconds of Arc)	Number of Planets	Range (Seconds of Arc)	Number of Planets	Range (Seconds of Arc)	Number of Planets
0 - 10	49	0 - 100	1209	0 - 1000	1654
10 - 20	480	100 - 200	141	1000 - 2000	48
20 - 30	327	200 - 300	89	2000 - 3000	16
30 - 40	140	300 - 400	82	3000 - 4000	1
40 - 50	80	400 - 500	53		
50 - 60	49	500 - 600	26		
60 - 70	28	600 - 700	14	LOST	14
70 - 80	22	700 - 800	18		
80 - 90	21	800 - 900	13		
90 - 100	13	900 - 1000	9	ESTIMATED	46
	1209		1654		1779

Attempts were made to locate additional data in the literature with which to improve the accuracy of the predicted uncertainties. In the last century and during the early part of this one, all orbit determinations were published in considerable detail. This rarely happens now, presumably because of high cost and the desire to devote available space to other things. As a result, most orbit determinations for the numbered minor planets are not published outside of Ephemerides of Minor Planets, and a very condensed form is adopted for those that are published elsewhere. The additional data that were located in the literature added little that was new and helpful.

Accurate residuals with accurate perturbations included were computed for 21 numbered minor planets in an effort to calibrate or improve the empirical formula used. These residuals showed nothing unexpected and agreed with the estimated uncertainties within the (admittedly large) uncertainties of the uncertainties. No basis was found for attempting to make a significant improvement to the procedure adopted to estimate the ephemeris uncertainties or to the estimated uncertainties themselves. In a positive sense, the correctness of the early procedures was confirmed.

It is believed that the value of the results contained in the final listing would be lessened if any attempt were made to improve or change the predicted uncertainties for only a small portion of the planets. If this were done, the systematic and uniform basis for the results would be destroyed without any real gain. The final listing should remain as it now exists, and all effort in the future should be expended on an improved system for keeping track of the numbered minor planets.

Section 4

NEW SYSTEM FOR DETERMINING MINOR PLANET EPHEMERIDES

In the course of a survey of the accuracies with which the ephemerides of the numbered minor planets are currently known (the results of which are discussed in Section 3), it became increasingly apparent that not only were the uncertainties in most cases very large, but also that there exists at present no efficient method for using the available data. In this section a new system is described for determining the minor planet ephemerides. Numerical examples (based on the inadequate, low-quality orbit elements currently available) are included purely to illustrate the advantages of the new system. When fully implemented, this system will directly provide the information required by those involved with the ephemerides of the minor planets.

4.1 NEED FOR MORE DATA AND EPHEMERIDES

As a result of the perturbing influences of the major planets, the orbital elements and ephemerides of the minor planets are continually changing. Astronomers and mission analysts need a simple method for obtaining accurate data for specific dates. The astronomer may need data accurate for the date of his photograph or for an earlier date for which accurate position measurements have been made or published. The mission analyst may be planning a possible mission and thus requires the minor planet position several years in the future. The need for accurate orbit elements and positional coordinates of the minor planets at remote times is common to both the astronomer and the mission analyst.

The present system of publishing elements and opposition ephemerides of the numbered minor planets in the annual volumes of Ephemerides of Minor Planets provides the bare minimum of information needed by the astronomer, and almost none of the information needed by the mission analyst. For example, the opposition ephemeris gives an astronomer the means to point his photographic telescope at the minor planet, and auxiliary data given with the ephemeris permits him to identify the trail of the minor planet on his photograph with more or less certainty. No means whatever is provided for him

to compare an accurately measured position of the minor planet on his photograph with the position predicted by the published elements, and thus no monitoring of the accuracy of those elements is practicable. Similarly, the mission analyst wishes to find the position in space of the minor planet at some future date, with an accuracy of a very few thousands of kilometers. He cannot do this from the published orbital elements, because the perturbations since the epoch of those published elements may well amount to ten million kilometers or more.

The essential shortcoming of Ephemerides of Minor Planets is that the influences of the major planets are not available, and their computation is beyond the means of most astronomers and mission analysts. Thus, there is a need for a simple way to provide the perturbations in the osculating elements and in the rectangular coordinates relative to the published elements at the dates of osculation. These perturbations, added to the position derived through two-body formulae, will provide an accurate minor planet position. The astronomer will have a position as accurate as his measurement for comparison. The mission analyst will have a position for accurate planning of his mission.

A system developed to satisfy the needs of all those involved with the minor planets is described in the following paragraph.

4.2 THE NEW SYSTEM

The new system is characterized by the attempt to provide all of the data needed to satisfy the requirements of all users and to provide these data in a systematic and uniform manner for all of the numbered minor planets.

Elements of the new system are summarized as follows:

- a. Orbit elements for all numbered minor planets are defined at a single date.
- b. Orbit elements are advanced in 400-day intervals.
- c. Integration and processing is done in groups of 50 minor planets.
- d. The processing is highly efficient: 100 seconds of CDC6400 CPU time per 50 minor planets per 400 days at 4-day step intervals.

e. Perturbations in rectangular coordinates are computed only once for each minor planet in intervals of 4 days.

f. The new system provides:

- The osculating elements and their perturbations at intervals of 400 days over the years of interest, the angular elements being referred to mean ecliptic and equinox of 1950.0
- The rectangular coordinates and their perturbations at intervals of 4 days over the years of interest, referred to the mean equator and equinox of 1950.0

A standard date of 1972 October 10 was adopted. This corresponds to Julian Date 2441600.5 and is one of the standard 400-day dates recommended by the International Astronomical Union (i. e., the integral part is exactly divisible by 400). Nearby standard 400-day dates are given in Table 4-1. The data in the new system are then provided at the standard 400-day dates forward and backward from the adopted standard date.

A new observation is now never more than 200 days from a date of osculation, and the representation of the observation by means of the osculating two-body elements alone immediately gives an accuracy of a very few second of arc, since the perturbations over 200 days are very small. These perturbations are computed and tabulated between the 400-day dates at intervals of 4 days. When these perturbations in the rectangular coordinates are added to the rectangular coordinates computed from the osculating two-body elements, a perfect gravitational representation is achieved.

Perturbations in rectangular coordinates over an interval of 200 days are essentially independent of small errors in the osculating elements, and thus need to be computed only once. Since the dates of osculation of their orbit elements are all the same, perturbations for 50 minor planets are computed by numerical integration in a single computer run and output on tape for recovery as needed.

A significant benefit of the standardized nature of the new system lies in the efficiencies with which the data are computed for the approximately 1800 numbered minor planets. Thus, the data can be further and continually monitored and economically upgraded through the utilization of all past and current observations.

Table 4-1

STANDARD 400-DAY DATES

Julian Date	Calendar Date	Julian Date	Calendar Date
243,0000.5	1941 Jan 6.0	244,0000.5	1968 May 24.0
0400.5	1942 Feb 10.0	0400.5	1969 Jun 28.0
0800.5	1943 Mar 17.0	0800.5	1970 Aug 2.0
1200.5	1944 Apr 20.0	1200.5	1971 Sep 6.0
1600.5	1945 May 25.0	1600.5	1972 Oct 10.0
2000.5	1946 Jun 29.0	2000.5	1973 Nov 14.0
2400.5	1947 Aug 3.0	2400.5	1974 Dec 19.0
2800.5	1948 Sep 6.0	2800.5	1976 Jan 23.0
3200.5	1949 Oct 11.0	3200.5	1977 Feb 26.0
3600.5	1950 Nov 15.0	3600.5	1978 Apr 2.0
4000.5	1951 Dec 20.0	4000.5	1979 May 7.0
4400.5	1953 Jan 23.0	4400.5	1980 Jun 10.0
4800.5	1954 Feb 27.0	4800.5	1981 Jul 15.0
5200.5	1955 Apr 3.0	5200.5	1982 Aug 19.0
5600.5	1956 May 7.0	5600.5	1983 Sep 23.0
6000.5	1957 Jun 11.0	6000.5	1984 Oct 27.0
6400.5	1958 Jul 16.0	6400.5	1985 Dec 1.0
6800.5	1959 Aug 20.0	6800.5	1987 Jan 5.0
7200.5	1960 Sep 23.0	7200.5	1988 Feb 9.0
7600.5	1961 Oct 28.0	7600.5	1989 Mar 15.0
8000.5	1962 Dec 2.0	8000.5	1990 Apr 19.0
8400.5	1964 Jan 6.0	8400.5	1991 May 24.0
8800.5	1965 Feb 9.0	8800.5	1992 Jun 27.0
9200.5	1966 Mar 16.0	9200.5	1993 Aug 1.0
9600.5	1967 Apr 20.0	9600.5	1994 Sep 5.0
		245,0000.5	1995 Oct 10.0

4.3 DATA FURNISHED BY THE NEW SYSTEM

Data furnished by the new system are written on two series of tapes; complete listings are impracticable because of the large volume of material involved. In one series the osculating elements, perturbations in the elements, and some associated data for all of the 50 minor planets in a group are written onto tape at each 400-day date. The most important of these data are listed. Samples of these listings are shown in Appendixes B, D, and E. In the other series, the rectangular coordinates for all of the 50 minor planets in a group are written onto tape at each 4-day date, but are listed for only one of the minor planets in the group. Samples of this listing are given in Appendix C.

In the first series, a tape (or file) contains one record for each group of 50 minor planets (the last record may contain fewer minor planets, but is of the same size with unused words containing hash). Each record has 2804 words, consisting of an initial four words that describe the record and 56 words of data for each of the 50 minor planets contained therein. Contents of the initial descriptive four words are:

- 1 Total number of minor planets in this record. Integer.
- 2 Number of words (56) occupied by each planet. Integer.
- 3 Relative address (2749) of last minor planet. Integer.
- 4 Dimension (2804) assigned to the array that holds this record. Integer.

These first four words of each record define a fixed table, which may be operated upon by several useful subroutines.

The beginning of the array ELM of dimensions (56, 50) immediately follows the fourth word. The array holds the osculating elements and associated data for the 50 minor planets contained in the record.

The quantities shown in Table 4-2 are given for each minor planet at 400-day intervals. Quantities marked with an asterisk are listed in Appendixes B and D. The data given in these appendixes are for ten 400-day intervals, starting with the initial date of osculation at October 10, 1972. All quantities are generated in single-precision floating-point arithmetic unless otherwise specified. At a rate of 556 bytes per inch, each record occupies about 5 feet of tape, and a complete file occupies about 200 feet.

In the second series, a tape contains one file for each group of 50 minor planets (the last file may contain fewer minor planets, but has the same number of records). Since the step interval for the numerical integration is 4 days, there are 115 records in a file. These records correspond to seven steps before the initial date of osculation, the initial date of osculation, the 100 steps through the final date of osculation, and seven steps after the final data of osculation. The complete data in 4-day steps for a single minor planet are contained in Appendix C for ten 400-day intervals starting with the initial date of osculation at October 10, 1972. Appendix E contains the same data in 400-day steps for 50 minor planets.

Each record (including the last one, wherein unused words contain hash) has 401 words and contains the quantities shown in Table 4-3. Each word is generated in single-precision floating-point arithmetic unless otherwise specified. At 800 bpi, each record occupies about 6 inches of tape, and each file occupies about 60 feet of tape. Thus, one 2400-foot tape can accommodate about 2000 minor planets over one 400-day interval.

Table 4-2

CONTENTS OF ELM FOR ONE MINOR PLANET -- FIRST
SERIES OF DATA TAPES

<u>Word</u>	<u>Contents</u>
1*	Number of the minor planet. Integer.
2	Reserved for the future
3-6*	Name of the minor planet. 4A4 format.
7-8*	Source from which the elements were taken. A4, I4 format. At present this is always EMP and year, where EMP stands for <u>Ephemerides of Minor Planets</u> .
9-11*	Author of the elements. 3A4 format.
12-15*	Reference, if any, to a known publication of the elements where more complete details are given (such as the observations used, their residuals, etc.). 4A4 format.
16*	Absolute magnitude of the minor planet, which is defined as the astronomical magnitude the minor planet would have if it were placed one astronomical unit from both Earth and Sun. Here expressed as an integer with unit of 0.1 astronomical magnitudes.
17*	Quality of the elements. Indicates the stage of improvement of the elements for this planet. Integer. -1 denotes a "lost" minor planet. 0 refers only to the minor planet, number 864, which is identical with minor planet 1078. 1 denotes the initial adopted elements. 2 denotes that the initial adopted elements have been improved by the method of Section 5.2 applied to one or two positions taken from an opposition ephemeris. 3 denotes that elements of lower quality have been improved by the method of Section 5 applied to one or more accurate observed positions.

*Quantities listed in Appendixes B and D

Table 4-2 (Cont.)

<u>Word</u>	<u>Contents</u>
18*	Integral part of the present Julian Date of osculation. Date of osculation is this number +0.5.
19-24	Double-precision equatorial coordinates at date of osculation. Mean equator and equinox of 1950.0.
25-30	Double-precision equatorial velocities at date of osculation. Mean equator and equinox of 1950.0. Unit of time is the mean solar day.
31*	Argument of perihelion in degrees at the date of osculation. Equinox 1950.0.
32*	Longitude of ascending node on the ecliptic in degrees at the date of osculation. Equinox 1950.0.
33*	Inclination to the ecliptic in degrees at the date of osculation. Equinox 1950.0.
34-42	Equatorial PQR matrix. This matrix rotates from orbital coordinates to equatorial coordinates at the date of osculation. Equinox 1950.0.
43*	Mean anomaly in degrees at the date of osculation.
44*	Semimajor axis at the date of osculation.
45*	Eccentricity at the date of osculation.
46*	Mean daily motion in seconds of arc per mean solar day at the date of osculation.
47*	Semiminor axis at the date of osculation.
48*	Integral part of the initial Julian Date. This initial Julian Date is defined as Julian Ephemeris Date 2441600.5 = 1972 October 10.0 Ephemeris Time.
49*	Perturbation in the mean anomaly at the present Julian Date of osculation and since the initial Julian Date. Expressed in degrees. See par. 4.4, Example 6.
50*	Perturbation in the argument of perihelion at the present Julian Date of osculation and since the initial Julian Date. Expressed in degrees. Equinox 1950.0.
51*	Perturbation in the longitude of the ascending node at the present Julian Date of osculation and since the initial Julian Date. Expressed in degrees. Equinox 1950.0.
52*	Perturbation in the inclination at the present Julian Date of osculation and since the initial Julian Date. Expressed in degrees. Equinox 1950.0.

*Quantities listed in Appendixes B and D

Table 4-2 (Cont.)

<u>Word</u>	<u>Contents</u>
53*	Perturbation in the semimajor axis at the present Julian Date of osculation and since the initial Julian Date.
54*	Perturbation in the eccentricity at the present Julian Date of osculation and since the initial Julian Date.
55*	Perturbation in the mean daily motion at the present Julian Date of osculation and since the initial Julian Date. Expressed in seconds of arc per mean solar day.
56	Available for future use.

*Quantities listed in Appendix B and D

Table 4-3

CONTENTS OF SECOND SERIES OF DATA TAPES

<u>Word</u>	<u>Contents</u>
1	Integral part of current Julian Date. Integer.
2	Number of first minor planet in record. Integer.
3	Quality of elements for first minor planet. Integer.
4	Perturbed X-Coordinate
5	Perturbed Y-Coordinate
6	Perturbed Z-Coordinate
	} For first minor planet in record
7	Perturbation in X-Coordinate
8	Perturbation in Y-Coordinate
9	Perturbation in Z-Coordinate
	} For first minor planet
10	Number of second minor planet in record. Integer.
	Etc.

4.4 USE OF DATA FURNISHED BY THE NEW SYSTEM

The space ephemeris described in the previous section provides precisely the data required by the mission analyst. These same data are needed by the astronomer to

compute his opposition ephemeris or to represent his observed positions. He needs only to add the equatorial rectangular coordinates of the Sun to the perturbed equatorial rectangular coordinates taken from the space ephemeris. He obtains the equatorial rectangular coordinates of the minor planet referred to the observer as origin. From these, the astronomer easily computes the right ascension, declination, and other quantities in his opposition ephemeris, or the theoretical right ascension and declination at the date of his observation to compare with the observed right ascension and declination.

The data provided by the new system can be used in two basically different situations. In the first situation, the most accurate elements available to define the orbit of the minor planet are assumed to be those used to compute the data on the tapes and listings. In this case, all of the data are correct and may be used directly. In the second situation, it is assumed that a more accurate set of elements is available, differing only small amounts from the elements used to compute the taped and listed data. In this case, only the perturbations in the elements and in the rectangular coordinates should be used. Results will not be exactly correct, since the perturbations were computed about a different orbit, but they will be sufficiently accurate for most purposes.

Typical uses of the data on the tapes and in the listings include the following examples:

1. Obtain the perturbed equatorial rectangular space coordinates of a minor planet at a tabulated 4-day Julian Ephemeris Date. Assume the given orbital data.
2. Obtain the perturbations in the equatorial rectangular space coordinates of a minor planet at a tabulated Julian Ephemeris Date. Orbital data may be as given, or improved.
3. Same as example 1, except that coordinates are required at an untabulated Julian Ephemeris Date.
4. Same as example 2, except that perturbations are required at an untabulated Julian Ephemeris Date.
5. Determine the perturbed coordinates at a specified Julian Ephemeris Date from a set of improved elements.
6. Determine the mean anomaly at a specified Julian Ephemeris Date for a set of improved elements.

These uses of the data are best explained by specific numerical examples, which will also help to define the exact meaning of the various kinds of data provided.

Example 1: Rectangular Coordinates at a 4-Day Point. Suppose that the most accurate orbit available for the minor planet 1 Ceres is that used in computing the tabulated data, and that the perturbed equatorial rectangular space coordinates are wanted for Julian Ephemeris Date 2442164.5. This date is 164 days later than the immediately preceding 400-day date (Julian Ephemeris Date 24420000.5). Also, 164 is exactly divisible by 4, thus the required date is a tabulated 4-day point. Referring to the format description for the second series of tapes (par. 4.3) the required coordinates appear in words 4, 5, and 6 under Julian Ephemeris Date 2442164 and minor planet number 1. Line 42 of the listing in Appendix C contains these quantities, expressed in astronomical units. They are:

$$\begin{aligned} X &= 2.0544716593 \\ Y &= -1.7549533520 \\ Z &= -1.2457539671 \end{aligned}$$

Example 2: Perturbations at a 4-Day Point. Suppose that the perturbations in the equatorial rectangular space coordinates with respect to elements osculating at the immediately preceding 400-day date are wanted for the minor planet 1 Ceres at Julian Ephemeris Date 2442164.5. This example will provide the perturbations either in the given elements, or in improved elements when differences are small. Proceeding as in the previous example, the required perturbations appear on the second series of tapes in words 7, 8, and 9 under Julian Date 2442164 and minor planet number 1. Line 42 of the listing in Appendix C also contains these quantities, expressed in astronomical units. They are:

$$\begin{aligned} \text{del } X &= 0.0003656068 \\ \text{del } Y &= -0.0000453460 \\ \text{del } Z &= 0.0000252780 \end{aligned}$$

These perturbations for minor planet 1 Ceres correspond to about 55,000 kilometers in 164 days, or to about 30 seconds of arc as seen from the Earth at opposition. These amounts can be much larger or smaller for other minor planets.

Example 3: Interpolation for Rectangular Coordinates Between 4-Day Points. If the date in the first example were not a tabular date, then the coordinates would have to be interpolated from the given table. This can be done easily with the Zig-Zag interpolation formula, which is

$$X_n = X_0 + C_1 D_1 + C_2 D_2 + C_3 D_3 + C_4 D_4 + \dots$$

where

- X is the function being interpolated
 X_n is the required interpolated value
 X_0 is the preceding tabular value
 D_1 is the 1-st difference on the half-line below X_0
 D_2 is the 2-nd difference on the line through X_0
 D_3 is the 3-rd difference on the half-line below X_0
 D_4 is the 4-th difference on the line through X_0 ; etc.
n is the fractional way from the preceding tabular point to the following tabular point
- $C_1 = n$
 $C_2 = n(n-1)/2!$
 $C_3 = (n+1)n(n-1)/3!$
 $C_4 = (n+1)n(n-1)(n-2)/4!$
 $C_5 = (n+2)(n+1)n(n-1)(n-2)/5!$
etc.

As many differences as necessary to attain the required accuracy must first be computed from the tabular values for each of the coordinates. Then the corresponding number of C's must be computed.

Suppose that the perturbed equatorial rectangular space coordinates of the minor planet 1 Ceres are wanted for Julian Ephemeris Date 2442166.1, assuming the given orbit. For this date $n = 0.4$. Details of the interpolation are shown only for the X coordinate. The coordinate and differences to be used in the formula are underlined in the following table.

2442156.5	1.9987483181			
		+280436849		
60.5	2.0267920030		-3640286	
		+276796563		-46323
64.5	<u>2.0544716593</u>		<u>-3686609</u>	<u>+609</u>
		<u>+273109954</u>		<u>-45714</u>
68.5	2.0817826547		-3732323	+615
		+269377631		-45099
72.5	2.1087204178		-3777422	
		+265600209		
76.5	2.1352804387			

$$\begin{aligned}
 C_1 &= +.4 \\
 C_2 &= -.12 \\
 C_3 &= -.156 \\
 C_4 &= +.0224 \\
 X_n &= 2.0654405541
 \end{aligned}$$

Example 4: Interpolation for Perturbations Between 4-Day Points. If the date in the second example were not a tabular date, then the perturbations would have to be interpolated from the given table, just as were the coordinates in the previous example. Suppose the required date is the same; viz., 2442166.1. Then the values of the C's are the same, and the difference table is:

2442156.5	3262537			
		+193477		
60.5	3456014		+6577	
		+200054		+74
64.5	<u>3656068</u>		<u>+6651</u>	<u>+11</u>
		<u>+206705</u>		<u>+85</u>
68.5	3862773		+6736	+15
		+213441		+100
72.5	4076214		+6836	
		+220277		
76.5	4296491			

The interpolated value is $\text{del } X_n = .0003737947$

It is to be noted that the differences of the perturbations are appreciably smaller than those of the coordinates, and this fact makes the interpolations a little easier.

Example 5: Rectangular Coordinates for an Improved Orbit. Suppose that an improved set of orbit elements is available, osculating at the 400-day date preceding the date at which perturbed coordinates are wanted. The basic steps in the procedure for obtaining the required coordinates at a future date are as follows:

- Compute the unperturbed rectangular coordinates at the desired Julian Date from the improved set of osculating elements, using two-body formulae.
- Determine the perturbations at the desired future Julian Date, interpolating as in the previous example, if required.
- Add the perturbations to the unperturbed coordinates to obtain the perturbed rectangular coordinates at the desired Julian Date.

Purely as an illustration of the procedure, suppose that the improved osculating elements are in fact those used to compute the data and listings provided, and that the perturbed rectangular coordinates are wanted at Julian Ephemeris Date 2442164.5, as in the first example. The values obtained in the first example should result from the procedure and will serve as an informative check on the procedure computations, which were performed on an HP-45 calculator.

The orbital values required for this numerical example are contained on the appropriate tape in the first series. With the exception of the PQR matrix, the required values are listed in Appendix B. The first requirement, then, is to compute the PQR matrix (which rotates coordinates from the orbit plane to the equatorial system) according to the following formulae:

$$\begin{aligned}
 P_x &= +\cos \Omega \cos \omega - \sin \Omega \sin \omega \cos i \\
 P_y &= (+\sin \Omega \cos \omega + \cos \Omega \sin \omega \cos i) \cos \epsilon - \sin \omega \sin i \sin \epsilon \\
 P_z &= (+\sin \Omega \cos \omega + \cos \Omega \sin \omega \cos i) \sin \epsilon + \sin \omega \sin i \cos \epsilon \\
 Q_x &= -\cos \Omega \sin \omega - \sin \Omega \cos \omega \cos i \\
 Q_y &= (-\sin \Omega \sin \omega + \cos \Omega \cos \omega \cos i) \cos \epsilon - \cos \omega \sin i \sin \epsilon \\
 Q_z &= (-\sin \Omega \sin \omega + \cos \Omega \cos \omega \cos i) \sin \epsilon + \cos \omega \sin i \cos \epsilon \\
 R_x &= +\sin \Omega \sin i
 \end{aligned}$$

$$\begin{aligned} R_y &= -\cos \Omega \sin i \cos \epsilon - \cos i \sin \epsilon \\ R_z &= -\cos \Omega \sin i \sin \epsilon + \sin i \cos \epsilon \end{aligned}$$

where

- ω denotes the argument of perihelion
- Ω denotes the longitude of the ascending node
- i denotes the inclination
- ϵ denotes the obliquity of the ecliptic for 1950.0

From the listings of Appendix B, we have

$$\begin{aligned} \omega \quad (= \text{ARGPER}) &= 70^\circ.19002182 \\ \Omega \quad (= \text{NODE}) &= 80^\circ.41833167 \\ i \quad (= \text{INCLINATION}) &= 10^\circ.60075242 \end{aligned}$$

and for the equinox of 1950.0

$$\epsilon = 23^\circ.44578785$$

Substituting these values in the formulae, the components of the PQR matrix are

$$\begin{aligned} P_x &= -0.8554523125 \\ P_y &= 0.3789403134 \\ P_z &= 0.3529951552 \\ Q_x &= -0.4850733612 \\ Q_y &= -0.8250389098 \\ Q_z &= -0.2898527754 \\ R_x &= 0.1813978365 \\ R_y &= -0.4191837735 \\ R_z &= 0.8895952949 \end{aligned}$$

(Useful checks on the PQR components, which are direction cosines, are that the sum of the squares of any row (or column) of components should equal unity; and that the dot product of any two rows (or columns) should equal zero.)

We are now in a position to compute the required rectangular coordinates X, Y, Z:

(a) Compute

$$M = Mo + n (JD - JDo)$$

where

JDo denotes the Julian Date at osculation

JD denotes the Julian Date for which the coordinates are required

n denotes the mean daily motion

Mo denotes the mean anomaly at JDo

M denotes the mean anomaly at JD

From Appendix B

$$JDo (=IJDOSC + 0.5) = 2442000.5$$

$$n (=MEAN MOTION) = 770''.4945317$$

$$Mo (=MEAN ANOMALY) = 126^{\circ}.4530634$$

and

$$JD = 2442164.5$$

Therefore

$$M = 161^{\circ}.5533699 = 2.819638223 \text{ rads}$$

(b) Compute E from

$$E - e \sin E = M$$

where

E denotes the eccentric anomaly

e denotes the eccentricity

From Appendix B

$$e (=ECCENTRICITY) = 0.07829883826$$

Then E is obtained iteratively in the following manner:

- Assume first approximation $E_1 = M$ radians
- Compute $M_1 = E_1 - e \sin E_1$
- Compute $E_2 = E_1 + \frac{M - M_1}{1 - e \cos E_1}$

- Compute $M_2 = E_2 - e \sin E_2$
- Continue iterating until change in E is negligible

Thus

$$E = 2.842694665 \text{ rads} = 162^\circ .8744067$$

(c) Compute

$$\begin{aligned} \bar{X} &= a(\cos E - e) \\ \bar{Y} &= b \sin E \end{aligned}$$

where

$$b = a (1 - e^2)^{1/2}$$

and a denotes the semi-major axis.

From Appendix B

$$a \quad (= \text{SEMI-MAJOR AXIS}) = 2.767948524$$

therefore

$$\begin{aligned} \bar{X} &= -2.861949202 \\ \bar{Y} &= 0.812567832 \end{aligned}$$

(d) Compute the unperturbed coordinates.

$$\begin{pmatrix} X' \\ Y' \\ Z' \end{pmatrix} = \begin{pmatrix} P_x & Q_x & R_x \\ P_y & Q_y & R_y \\ P_z & Q_z & R_z \end{pmatrix} \begin{pmatrix} \bar{X} \\ \bar{Y} \\ 0 \end{pmatrix}$$

Thus

$$\begin{aligned} X' &= 2.054106054 \\ Y' &= -1.754908006 \\ Z' &= -1.245779244 \end{aligned}$$

(e) Compute the perturbed coordinates by addition of the perturbations obtained in the second example above.

Thus

$$\begin{aligned} X &= 2.054471661 \\ Y &= -1.754953352 \\ Z &= -1.245753966 \end{aligned}$$

Comparison with the values in the first example validates the computations.

Example 6: The Mean Anomaly for an Improved Orbit. Perturbations in the orbital elements contained in Appendix D are, except for the case of the mean anomaly, simply the differences between the elements contained in Appendix B at the corresponding date and at the initial date. The perturbation in the mean daily motion for 1 Ceres at 2443600.5, for example, is obtained as follows:

From Appendix B, the mean daily motion, n ,

$$\begin{aligned} \text{at JD } 2443600.5 &= 770.58375366239 \\ \text{at JD } 2441660.0 &= \underline{771.16700000000} \\ \text{Difference in } n &= -0.58324633761 \end{aligned}$$

This is precisely the value for the perturbation in n , DEL MDM, tabulated in Appendix D for JD 2443600.5.

The mean daily motion is constant in an unperturbed orbit. Any change in its value with time is due solely to the perturbations of the major planets. The same is true for any element.

The mean anomaly is not an element in the usual sense, since it changes linearly with time in an unperturbed orbit. It is therefore given by the formula

$$M = M_0 + n (JD - JD_0)$$

Thus the total perturbation in M consists of perturbations in the individual quantities M_0 and n . The quantity called DEL MO in Appendix D is the perturbation in M_0 only. To this must be added the effect of the perturbation in n , and this effect is in fact

an integral. For a tabular 400-day date this integral is the sum of all preceding values of DEL MDM multiplied by 400. M is expressed in degrees, while n is expressed in seconds of arc; thus in practice the sum of the tabular values is multiplied by 400/3600, or divided by 9.

The total perturbation of M could have been computed directly instead of that for M_0 , but this quantity would be tied to the initial standard date rather than to the preceding 400-day date. A considerable loss in flexibility would result.

As an illustration, find the value of M for 1 Ceres at 2443600.5 from the perturbations in Appendix D. Proceed as follows:

(a) From Appendix B, obtain the mean anomaly and mean daily motion for 1 Ceres at Julian Date $JD_0 = 2441600.5$

$$M_0 = 41^\circ .19588888888$$

$$n_0 = 771'' .16700000000$$

(b) Compute the unperturbed mean anomaly at $JD = 2443600.5$

$$JD - JD_0 = 2000.0$$

Thus

$$M = M_0 + 2000 \times \frac{771.16700000000}{3600}$$

$$= 469^\circ .62199999999$$

Subtracting 360° , the unperturbed mean anomaly at 2443600.5 is $109^\circ .62199999999$.

(c) Compute the perturbation in n . From Appendix D, obtain the values of DEL MDM preceding 2443600.5. These are

JD = 2442000.5	DEL MDM = - 0.67246831416
2442400.5	- 1.93973984903
2442800.5	- 0.15878519331
2443200.5	- 0.21417159313

The sum of the DEL MDM values is - 2.98516494963. Dividing by 9, the effect of the perturbation in n is

$$- 0.331684994403$$

(d) From Appendix D, obtain the perturbation in M_0 at JD 2443600.5. This is

$$\text{DEL } M_0 = -3.422076800154$$

(e) The total perturbation is then the sum of the values obtained in (c) and (d) above. This is

$$- 3.753761794557$$

(f) Obtain the perturbed mean anomaly by adding the total perturbation in (e) to the unperturbed value in (b)

$$M = 105.868238205442$$

This value compares closely with the perturbed mean anomaly at 2443600.5 tabulated in Appendix B for 1 Ceres, which is

$$M = 105.868238205548$$

The computations using the perturbations are thus confirmed.

Section 5 IMPROVED EPHEMERIS ACCURACY

It has been noted in the preceding sections that the elements initially adopted were obtained from published elements without the inclusion of perturbations over the often long intervals of time from the dates of osculation in the published elements to the initial 400-day date. The required numerical integration of these perturbations planet-by-planet was not practical within the contract period. In this section, provisional improvement of the initial elements is discussed and the theory of a method to do this for a minor planet orbit is developed.

The basic idea behind the theory depends on the known fact that by far the largest part of the error in the position of a minor planet usually lies in its mean anomaly. A change in the mean anomaly coupled with a small rotation of the orbit plane and no changes in the other elements can always be made to fit an observed or ephemeris position, and thus to produce better osculating elements at and near that date.

A suggested procedure to find suitable initial elements for all of the numbered minor planets is outlined in Figure 5-1. The reduction of published elements for all of the planets to the initial 400-day date with two-body formulas has been done. The basic program for numerical integration from the published epochs to the initial 400-day date is now available for use with those minor planets that possess good elements and thus deserve this relatively expensive treatment. For those minor planets that do not have good elements, the appropriate improvement method discussed below may be used.

5.1 IMPROVEMENT OF ELEMENTS FROM CURRENT OBSERVATIONS

The direct and efficient method developed in par. 5.3, of improving the accuracy of the minor planet elements at the adopted standard date (October 10, 1972), uses recent observations taken less than about 200 days from the standard date. During the time

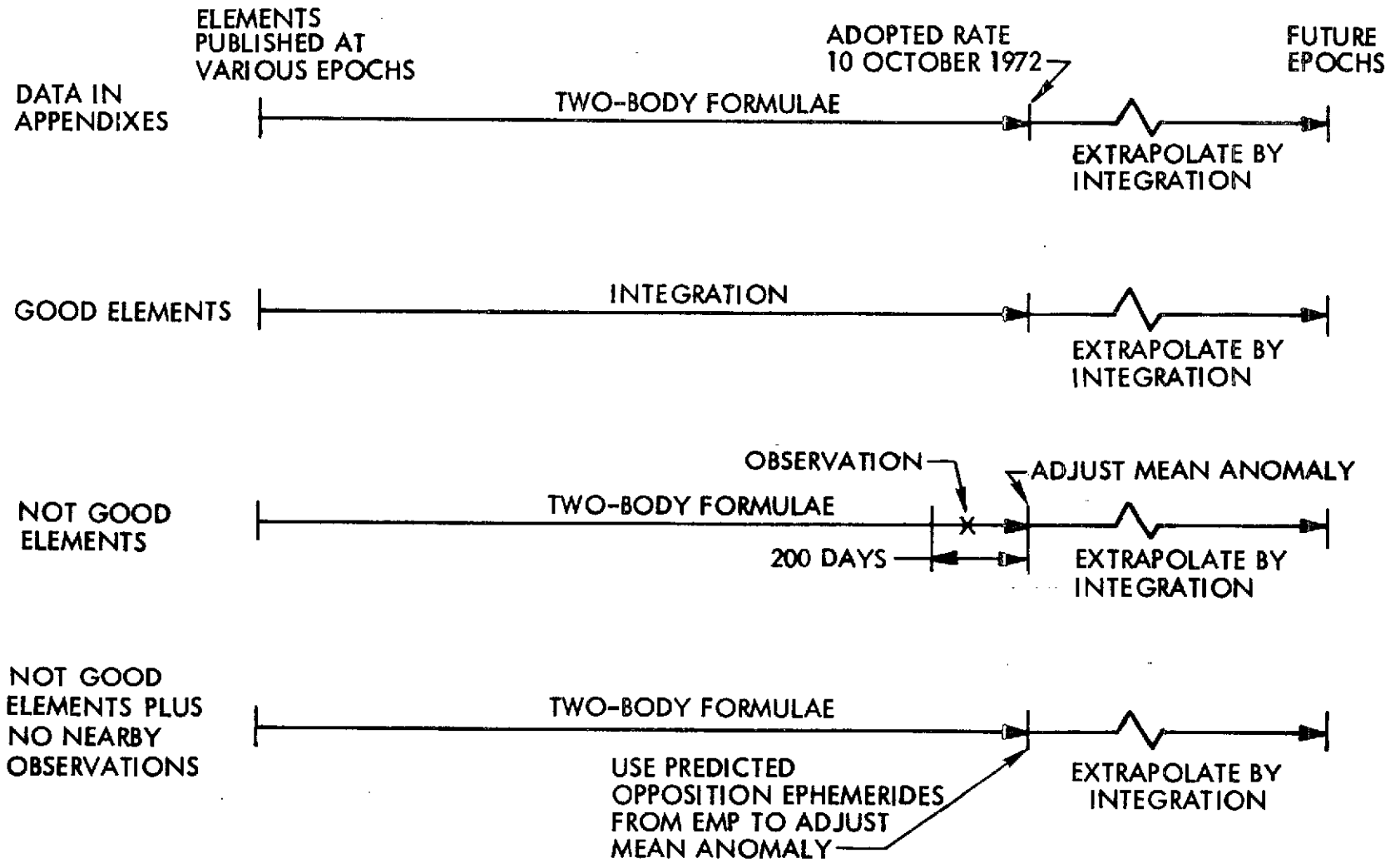


Figure 5-1 Minor Planet Accuracy Initial Improvement

within the 200-day interval, the effect of perturbations is negligible, and therefore orbit element improvements can be made using only two-body formulae. Unfortunately, only a few minor planets have available observations within 200 days from the adopted date.

An alternative is to make use of positions observed earlier. However, to attempt an improvement with observations several hundreds of days earlier than the standard date would increase the accuracy of the elements only if the perturbations are included. The means for improving orbital elements, using recent observations including effects of perturbations, is included in the new system. The theory is presented in par. 5.3.

5.2 IMPROVEMENT OF INITIAL ELEMENTS FROM PUBLISHED EPHEMERIDES

Instead of using current or recent observations to improve initial orbital elements, predicted opposition ephemerides from the published Ephemerides of Minor Planets can be used. These predicted positions are close (within 200 days) to the adopted date and therefore perturbation effects can be neglected. Furthermore, these predicted positions have been computed including perturbations from epoch to the date of tabulated ephemeris position. Therefore, the theory described in par. 5.3 can be applied directly to improving orbit elements at the adopted date.

5.3 THEORY OF ORBIT IMPROVEMENT METHOD

Suppose we have one perfect observation of a minor planet. How can we use this to improve the orbit of the minor planet?

An observation of a minor planet consists of two independent quantities; e.g., right ascension and declination. Thus, one observation imposes two conditions on the orbit; or, in other words, two orbital elements can be determined from one observation, provided the other four elements are otherwise known.

Here we propose to determine from the one observation the corresponding eccentric anomaly, E , and an angle θ , through which the assumed orbit plane must be rotated about a line in itself in order to obtain the actual orbit plane. The location in the orbit

plane of the axis of this rotation is arbitrary, but it should be nearly perpendicular to the radius vector in order to minimize the size of the rotation.

The assumed orbit plane is defined by a set of published or otherwise given angular elements ω^0 , Ω^0 , and i^0 . The small rotation θ will, in general, cause small changes in each of these angular elements. The value found for the eccentric anomaly determines the mean anomaly at Epoch, since both a and e are not changed. Thus, four of the six elements are here modified by the two conditions provided by a single observation; these are M_0 , ω , Ω , and i .

5.3.1 Rotation of Orbit Plane. Given a rectangular coordinate system $\bar{x}^0, \bar{y}^0, \bar{z}^0$ based on the assumed orbit plane as the $\bar{x}^0 \bar{y}^0$ -plane and let γ be the angle in this plane from the positive \bar{x}^0 -axis to the positive axis of rotation. Given also a rectangular coordinate system $\bar{x}, \bar{y}, \bar{z}$ based on the actual orbit plane as the $\bar{x} \bar{y}$ -plane, then the rotation matrix connecting the rectangular coordinate systems based on the assumed and actual orbit planes is obtained by three successive rotations; (1) about the \bar{z}^0 -axis through the angle γ , (2) about the resulting x-like axis through the angle θ , and (3) about the \bar{z} -axis through the angle $-\gamma$. Denote this rotation matrix by A , then

$$\begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} = A \begin{pmatrix} \bar{x}^0 \\ \bar{y}^0 \\ \bar{z}^0 \end{pmatrix}$$

$$A = \begin{pmatrix} \cos \gamma & -\sin \gamma & 0 \\ \sin \gamma & \cos \gamma & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos \theta & \sin \theta \\ 0 & -\sin \theta & \cos \theta \end{pmatrix} \begin{pmatrix} \cos \gamma & \sin \gamma & 0 \\ -\sin \gamma & \cos \gamma & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$A = \begin{pmatrix} 1 - \sin \gamma \sin \gamma (1 - \cos \theta) & \sin \gamma \cos \gamma (1 - \cos \theta) & -\sin \gamma \sin \theta \\ \cos \gamma \sin \gamma (1 - \cos \theta) & 1 - \cos \gamma \cos \gamma (1 - \cos \theta) & \cos \gamma \sin \theta \\ \sin \gamma \sin \theta & -\cos \gamma \sin \theta & \cos \theta \end{pmatrix}$$

Let $\gamma = f + 90^0$, where f is the true anomaly of the radius vector.

Then

$$\left. \begin{aligned} \sin \gamma &= \cos f \\ \cos \gamma &= -\sin f \end{aligned} \right\} \cdot \left. \begin{aligned} \sin \gamma \cos \gamma &= -\sin f \cos f \\ \sin \gamma \sin \gamma &= \cos f \cos f \\ \cos \gamma \cos \gamma &= \sin f \sin f \end{aligned} \right\}$$

$$A = \begin{pmatrix} 1 - \cos f \cos f (1 - \cos \theta) & -\cos f \sin f (1 - \cos \theta) & -\cos f \sin \theta \\ -\sin f \cos f (1 - \cos \theta) & 1 - \sin f \sin f (1 - \cos \theta) & -\sin f \sin \theta \\ \cos f \sin \theta & \sin f \sin \theta & \cos \theta \end{pmatrix}$$

The expected size of the angle θ is of the order of a few seconds of arc, or at most a few minutes of arc. Even for the extreme angle of one degree:

$$\sin \theta = .00175 \quad \cos \theta = .99985 \quad 1 - \cos \theta = .00015$$

Thus, to the accuracy needed in practice, the matrix A reduces to

$$A = \begin{pmatrix} 1 & 0 & -\cos f \sin \theta \\ 0 & 1 & -\sin f \sin \theta \\ \cos f \sin \theta & \sin f \sin \theta & 1 \end{pmatrix}$$

The complete matrix A may be written

$$A = I + B$$

where

$$B = \begin{pmatrix} -\cos f \cos f (1 - \cos \theta) & -\cos f \sin f (1 - \cos \theta) & -\cos f \sin \theta \\ -\sin f \cos f (1 - \cos \theta) & -\sin f \sin f (1 - \cos \theta) & -\sin f \sin \theta \\ \cos f \sin \theta & \sin f \cos \theta & -(1 - \cos \theta) \end{pmatrix}$$

Now

$$A^{-1} = I + \tilde{B}$$

thus

$$\begin{pmatrix} \bar{x}^0 \\ \bar{y}^0 \\ \bar{z}^0 \end{pmatrix} = A^{-1} \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} = \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} + \tilde{B} \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix}$$

Since

$$\begin{aligned} \bar{x} &= r \cos f \\ \bar{y} &= r \sin f \\ \bar{z} &= 0 \end{aligned}$$

$$\tilde{B} \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} = r \begin{pmatrix} -\cos f (1 - \cos \theta) \\ -\sin f (1 - \cos \theta) \\ -\sin \theta \end{pmatrix}$$

Hence

$$\begin{pmatrix} \bar{x}^0 \\ \bar{y}^0 \\ \bar{z}^0 \end{pmatrix} = \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} - r \begin{pmatrix} \cos f (1 - \cos \theta) \\ \sin f (1 - \cos \theta) \\ -\sin \theta \end{pmatrix}$$

5.3.2 Basic Equations in the Assumed Orbit Plane. The equations connecting the observer, the Sun, and the minor planet may be written

$$\begin{aligned} \rho \bar{\lambda}^0 &= \bar{x}^0 + \bar{X}^0 \\ \rho \bar{\mu}^0 &= \bar{y}^0 + \bar{Y}^0 \\ \rho \bar{\nu}^0 &= \bar{z}^0 + \bar{Z}^0 \end{aligned}$$

where $\bar{X}^0, \bar{Y}^0, \bar{Z}^0$ are the coordinates of the Sun with respect to the observer; $\bar{\lambda}^0, \bar{\mu}^0, \bar{\nu}^0$ are the direction cosines of the right ascension and declination measured by the observer; and ρ is the distance between the observer and the minor planet.

Substitute for the coordinates $(\bar{x}^0, \bar{y}^0, \bar{z}^0)$ relative to the assumed orbit plane the coordinates $(\bar{x}, \bar{y}, \bar{z})$ relative to the actual orbit plane. Then

$$\rho \begin{pmatrix} \bar{\lambda}^0 \\ \bar{\mu}^0 \\ \bar{\nu}^0 \end{pmatrix} = \begin{pmatrix} \bar{x} \\ \bar{y} \\ \bar{z} \end{pmatrix} + \begin{pmatrix} \bar{X}^0 \\ \bar{Y}^0 \\ \bar{Z}^0 \end{pmatrix} - r \begin{pmatrix} \cos f (1 - \cos \theta) \\ \sin f (1 - \cos \theta) \\ -\sin \theta \end{pmatrix}$$

Explicitly, the basic equations become:

$$\left. \begin{aligned} \rho \bar{\lambda}^0 &= a (\cos E - e) + \bar{X}^0 - r \cos f (1 - \cos \theta) \\ \rho \bar{\mu}^0 &= b \sin E + \bar{Y}^0 - r \sin f (1 - \cos \theta) \\ \rho \bar{\nu}^0 &= 0 + \bar{Z}^0 + r \sin \theta \end{aligned} \right\} (1)$$

5.3.3 Solution of Basic Equations. Since θ is so small, $(1 - \cos \theta)$ is negligible in the first approximation. To exploit this fact, let

$$\left. \begin{aligned} \bar{X}' &\equiv \bar{X}^0 - r \cos f (1 - \cos \theta) \\ \bar{Y}' &\equiv \bar{Y}^0 - r \sin f (1 - \cos \theta) \end{aligned} \right\} (2)$$

Thus, the basic equations (1) may be written:

$$\left. \begin{aligned} \rho \bar{\lambda}^0 &= a (\cos E - e) + \bar{X}' \\ \rho \bar{\mu}^0 &= b \sin E + \bar{Y}' \\ \rho \bar{\nu}^0 &= + \bar{Z}^0 + r \sin \theta \end{aligned} \right\} (3)$$

In the first approximation the terms in $(1 - \cos \theta)$ are set to zero, and in subsequent approximations they are computed from the previous approximation. In this way the first two of the above equations are used to determine ρ and E , while the last is used to determine $\sin \theta$.

To solve for ρ and E, write

$$\left. \begin{aligned} \cos E &= \left[\bar{\lambda}^0 \rho - (\bar{X}' - ae) \right] / a \\ \sin E &= \left[\bar{\mu}^0 \rho - \bar{Y}' \right] / b \end{aligned} \right\} \quad (4)$$

$$\therefore 1 = (\bar{\lambda}^0 \rho - \bar{X}' + ae)^2 / a^2 + (\bar{\mu}^0 \rho - \bar{Y}')^2 / b^2$$

or
$$b^2 (\bar{\lambda}^0 \rho - \bar{X}' + ae)^2 + a^2 (\bar{\mu}^0 \rho - \bar{Y}')^2 = a^2 b^2$$

$$\begin{aligned} \left[a^2 \bar{\mu}^0{}^2 + b^2 \bar{\lambda}^0{}^2 \right] \rho^2 - 2 \left[a^2 \bar{\mu}^0 \bar{Y}' + b^2 \bar{\lambda}^0 (\bar{X}' - ae) \right] \rho \\ + \left[a^2 \bar{Y}'^2 + b^2 (\bar{X}' - ae)^2 - a^2 b^2 \right] = 0 \end{aligned}$$

But

$$b^2 = a^2 (1 - e^2)$$

$$\therefore \left. \begin{aligned} \left[\bar{\mu}^0{}^2 + (1 - e^2) \bar{\lambda}^0{}^2 \right] \rho^2 - 2 \left[\bar{\mu}^0 \bar{Y}' + (1 - e^2) \bar{\lambda}^0 (\bar{X}' - ae) \right] \rho \\ + \left[\bar{Y}'^2 + (1 - e^2) (\bar{X}' - ae)^2 - b^2 \right] = 0 \end{aligned} \right\} \quad (5)$$

The solution (or solutions) to this quadratic is the required distance ρ . Then $\cos E$ and $\sin E$ follow from (4), $r = a (1 - e \cos E)$, θ is obtained from the third of (3), and a new iteration can be started with the computation of \bar{X}' and \bar{Y}' from equation (2).

When the iterations have converged, the mean anomaly (M_0) at Epoch is obtained from

$$M_0 = E - e \sin E + n(t - t_0)$$

Finally, the rotation matrix, A, is computed with θ and applied to the given PQR matrix to obtain the improved PQR matrix, from which the improved values of ω , Ω , and i may be computed by standard formula, if desired.

To examine the values of the roots of the quadratic (5), suppose $e = 0$ and $(1 - \cos \theta) = 0$. Then

$$(\bar{\lambda}^0{}^2 + \bar{\mu}^0{}^2)\rho^2 - 2(\bar{\lambda}^0\bar{X}^0 + \bar{\mu}^0\bar{Y}^0)\rho + (\bar{X}^0{}^2 + \bar{Y}^0{}^2 - a^2) = 0$$

Neglecting the small effect of all Z - terms, we have

$$\bar{\lambda}^0{}^2 + \bar{\mu}^0{}^2 = 1, \quad \bar{\lambda}^0\bar{X}^0 + \bar{\mu}^0\bar{Y}^0 = R \cos \psi, \quad \bar{X}^0{}^2 + \bar{Y}^0{}^2 = R^2$$

$$\rho^2 - 2\rho R \cos \psi + (R^2 - a^2) = 0$$

$$(\rho - R \cos \psi)^2 - (a^2 - R^2 \sin^2 \psi) = 0$$

$$\rho = R \cos \psi \pm \sqrt{a^2 - R^2 \sin^2 \psi}$$

In the neighborhood of opposition $\cos \psi = -1$, and there

$$(\rho + 1)^2 = a^2$$

$$\rho = a - 1 \quad \text{or} \quad -a - 1$$

Hence, only one positive root is possible there, and its value agrees with the value seen from the geometrical relations.

Roots of the general equation represent the distance from the observer to a point on the minor planet orbit in the direction observed. So long as the minor planet orbit lies outside that of the Earth, only one positive root is possible. If, however, the minor planet orbit penetrates that of the Earth, then a second positive root may be possible.

As soon as the distance ρ is obtained from the quadratic equation, $\sin E$, $\cos E$, $\sin f$, $\cos f$, r , etc., follow immediately. Then

$$r \sin \theta = \bar{v}^0 \rho - Z^0$$

and the solution is complete to the accuracy of the approximation.

The value for ρ obtained from the first approximation will probably always be sufficient. However, the solution of the basic equations can always be obtained to any desired accuracy in a practical case by easy iterations. In each iteration the values from the previous iteration are used to compute the terms neglected in the first approximation, and the iteration then proceeds exactly as in the first approximation.

Section 6

COMPUTER PROGRAM

Described in this section are the computer programs that were developed to provide the new system discussed in Section 4. A general overview of the program capabilities is given, and the numerical integration techniques employed are described. In addition, two data tapes, which were received to assist the contract work, are reviewed. The computer programs developed during the study are listed and briefly described in Appendix F.

Almost all programs were written in FORTRAN IV, and features peculiar to local installations were usually avoided. Advantage was taken of the 60-bit word length of the CDC6400, and conversion to a machine with a shorter word length would be difficult. Compilation and runs were done under a local version (CALIDOSCOPE) of the SCOPE operating system. Active programs and subroutines were maintained in a library kept in a permanent file on disk. The Berkeley machine has four tape drives, but no program requires more than two. Extended core storage was not directly used. The largest programs required about 70,000 (octal) words of central memory.

6.1 GENERAL PROGRAM LAYOUT

An overview of the computer programs is shown in Figure 6-1. The published minor planet elements at Epoch are reduced to the standard date with no perturbations and output on tape. Two subprograms are available for improving the taped elements at the standard date according to the data available. The taped elements are then input to a subprogram whose primary function is to integrate, forward or backward, the rectangular coordinates of 50 minor planets for one 400-day interval. Two series of tapes are produced (see par. 4.3). The first series is designated Tape B in Figure 6-1 (Tape A is an initial version to start the process) and contains the elements of the minor planets and associated data. The second series is designated Tape C and contains the rectangular coordinates and perturbations with respect to the preceding

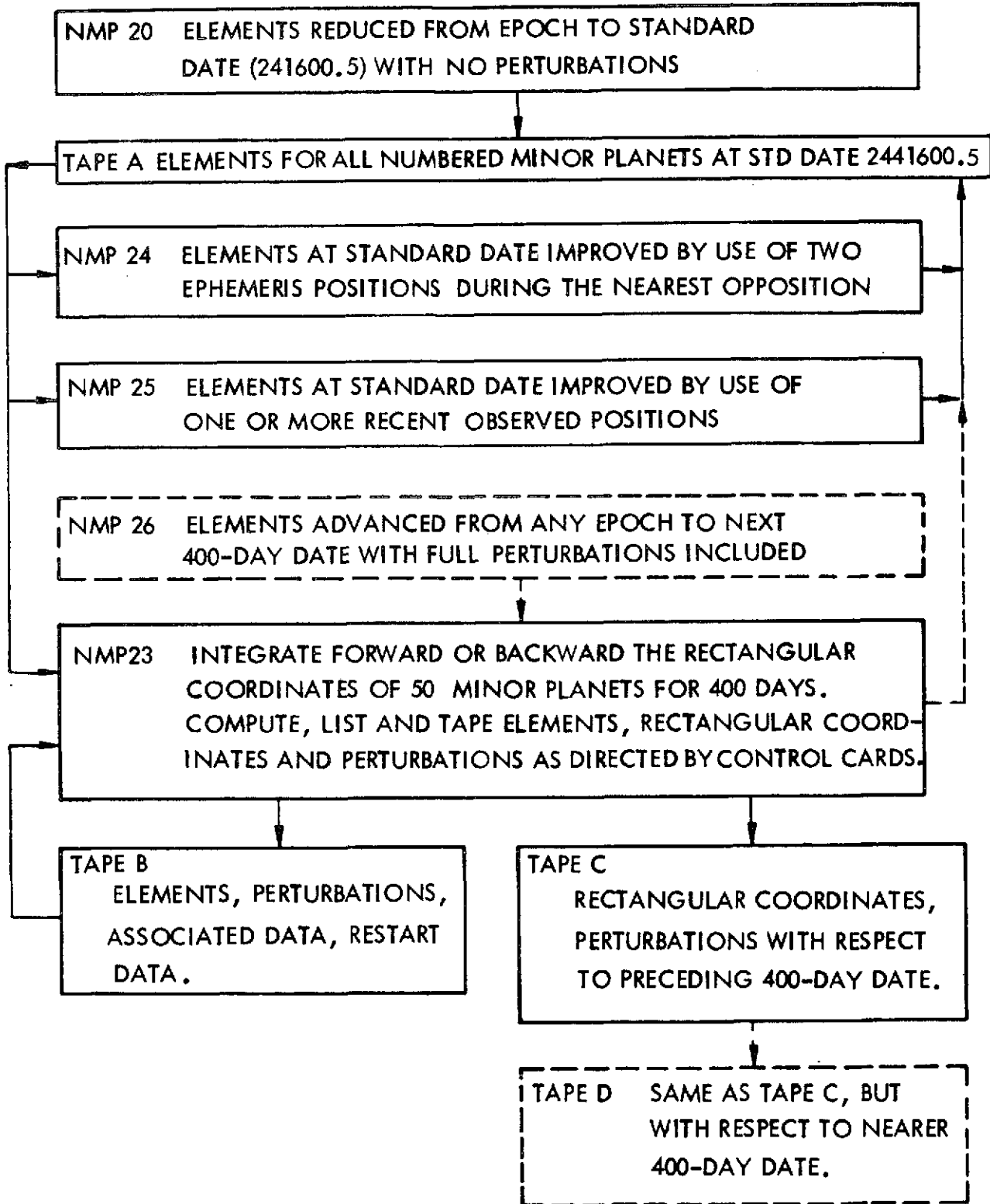


Figure 6-1 General Program Layout

400-day date. Existing capabilities are indicated by solid lines in Figure 6-1, future extensions are indicated by broken lines. A description of the program functions is given in the following paragraphs.

NMP 20. The taped elements described in par. 3.5 were reduced with Program NMP 20 to the standard data (Julian Ephemeris Date 244 1600.5 = 1972 October 10.0 Ephemeris Time) adopted in par. 4.2. The program uses two-body formulae; that is, all elements except the mean anomaly were adopted without change, while the mean anomaly at the standard date was computed from

$$M_{1600} = M_{\text{Epoch}} + n_{\text{Epoch}} (2441600.5 - JD_{\text{Epoch}})$$

This simple approximate method is intended only to provide a uniform set of elements for all of the numbered minor planets so that systematic methods and programs can be used henceforth. The adopted elements were output to magnetic tape, designated Tape A.

NMP 24. This program uses for each numbered minor planet two predicted positions taken from the opposition ephemeris nearest to the standard date, improves the initial adopted elements, and produces a new Tape A.

NMP 25. This program is similar to NMP 24 but uses a single observed position for each further improvement of the initial elements.

NMP 23. Tape A provides the initial input to NMP 23, which performs the prime function of integrating the rectangular coordinates of a set of up to 50 minor planets for an interval of 400 days either forward or backward. Two tapes are produced. Tape B contains the elements of the minor planets, the perturbations and associated data, and also restart data for a following 400 day interval. Tape C contains the rectangular coordinates and their perturbations with respect to the preceding 400-day date (see par. 4.3).

The methods employed in NMP 24 and NMP 25 are relatively inexpensive and satisfy an immediate need. However, they do not fully utilize the accuracy inherent in published elements that have been determined by the best methods from adequate data. For those minor planets that have excellent elements, perhaps osculating at a distant epoch, there is no alternative to reducing such elements from their epoch of osculation to the standard date 2441600.5 by means of accurate numerical integration. Since the epoch of osculation will usually not be a 400-day date, this reduction should be done in two steps:

- a. Use of NMP 26 to integrate one or more minor planets from a common osculating date to the following 400-day date
- b. Use of the principal program NMP 23 to reduce from that 400-day date to the standard date 2441600.5

Once initial elements at 2441600.5 have been obtained, the elements can be accurately extended to any earlier or later 400-day date by means of the principal program NMP 23.

NMP 26 is indicated on Figure 6-1 as a future extension of the new system that should be considered for implementation. An envisaged additional extension is Tape D. This tape is the same as Tape C except that the perturbations are with respect to the nearer (instead of preceding) 400-day date. This procedure will minimize the magnitude of the largest perturbation.

The principal Program NMP 23 will be discussed in more detail because of its importance in computing the data provided by the new system. A flow diagram of the program is shown in Figure 6-2.

NMP 23 has many options that may be exercised during test or production runs. They are specified by the numbers punched in two initial control cards. During production runs, they control the flow of the program from group to group of 50 minor planets or over successive 400-day intervals, as well as the type and quantity of listings to be produced.

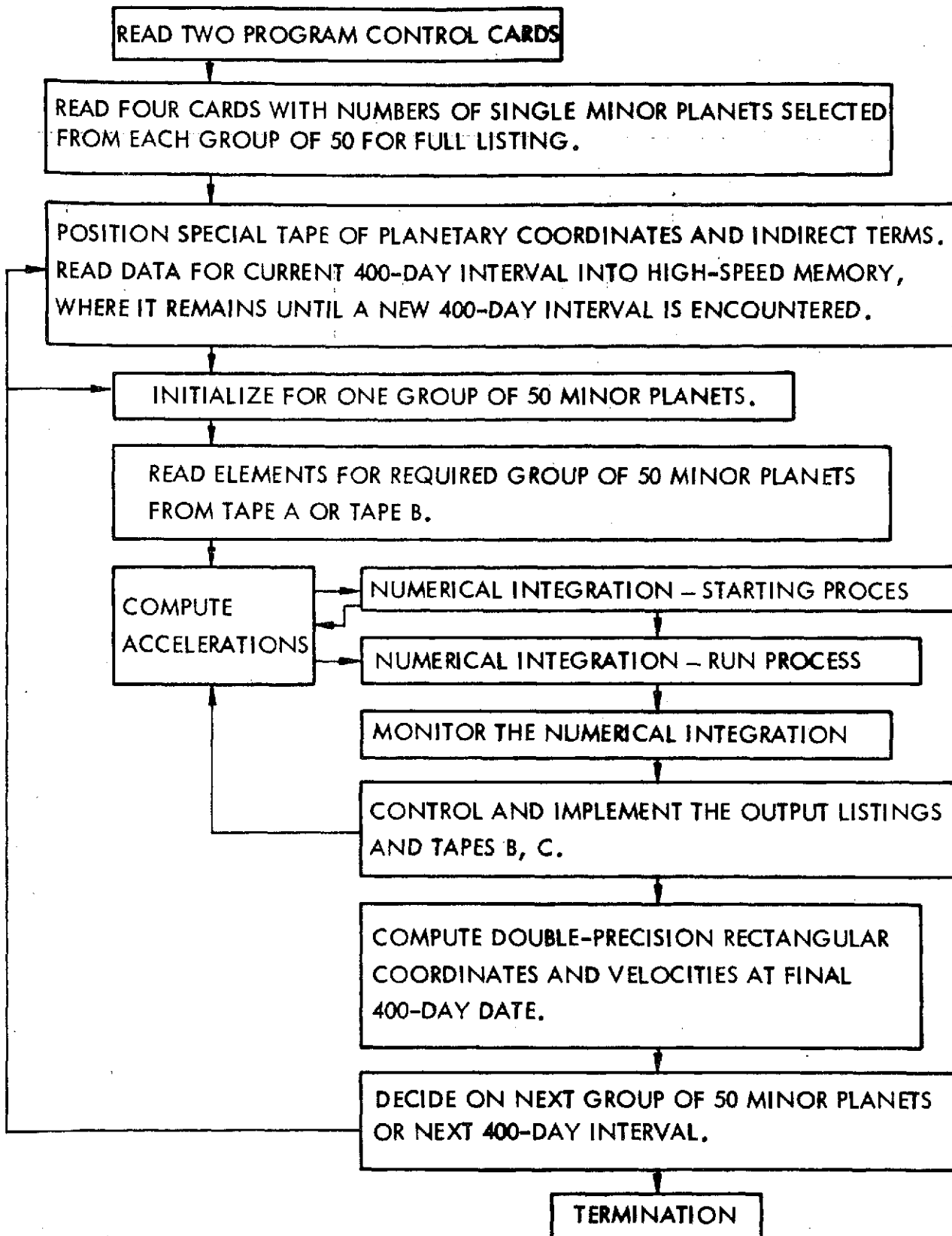


Figure 6-2 NMP 23 Flow Diagram

While the rectangular coordinates of each minor planet at each 4-day step are computed and output to Tape C, their complete listing would produce too much output for practical storage or use. Accordingly, a single minor planet among each group of 50 is chosen to receive such listings, and the extent of these is limited as specified in the initial control cards. The numbers of those planets selected in the groups of 50 are read from four further initial cards.

Options in the initial control cards specify the major planets that are to be included in the perturbations. In the current production runs, all major planets from Mercury through Pluto, both inclusive, have been used. These same options direct the prior preparation by Program JP18 of the special tape of planetary coordinates and indirect terms required by NMP 23. On this tape, each 400-day interval must be complete; that is, it must include data for dates before the starting osculating date and after the final one. Thus, each 400-day interval overlaps both the preceding and following ones. Indirect terms are those parts of the planetary accelerations that are due to the use of an origin at the center of the accelerated Sun.

The tapes (A and B) output by NMP 20, NMP 23, NMP 24, and NMP 25 all have the format required for input to NMP 23. The contents of these tapes are described in par. 4.3.

The numerical integration process and programs are described in par. 6.2.

Options contained in the initial control cards direct the program to start with a given group of 50 minor planets, to continue over one or more groups, and to end with a given minor planet. Or, a single group of 50 or fewer minor planets can be integrated over successive 400-day intervals, either forward or backward.

Numerous checks are provided in the program to ensure that a run is set up in a consistent and logical manner, and with the correct data. Failure of any check causes immediate termination with a diagnostic. Numbers that appear on the page and column headings are set by the program and are those actually used.

6.2 NUMERICAL INTEGRATION TECHNIQUES

The numerical integration is carried out with a predictor-corrector formula, and the process is started by an iterative method. The single and double sums are carried to double precision, but all other quantities are computed to single precision, which on the CDC 6400 amounts to about 14 significant places. The differential equations of motion in rectangular coordinates are integrated directly; that is, the so-called "Cowell method" is used. At the same time, the unperturbed coordinates are computed from the starting elements and are subtracted from the integrated ones to give the perturbations in the coordinates. This procedure is much to be preferred to the so-called "Encke method" when used on a modern electronic computer, since the sizes of the numbers are not as important as they were when the computations were done by hand. Each method, when properly done, will yield exactly the same accuracy - no more, no less.

To test the accuracy of the integration process and programs, integrations of several minor planets were made with only two-body accelerations. After 100 steps, it was found that the integrated coordinates agreed with the coordinates computed from two-body formulae within the accuracy of the latter (14 significant places). Of course, this agreement would not continue if the integrations were continued over a large number of steps.

The accelerations produced by all the major planets from Mercury through Pluto are included in production runs. The step interval of the integration is four days. This short interval is necessary because of the short period and high eccentricity of Mercury's orbit ($e = 0.206$). It should be remarked here that no other integration process (Encke method; integration of the elements; etc.) can use a step interval longer than can be used in the present process to attain the same accuracy. The limitation on the length of the step interval is inherent in all methods, so long as the attraction of Mercury is included. Even this short step interval may produce an appreciable error when the integrations are extended over a very large number of steps (1000's).

At each and every step of a numerical integration, a short test of the computer's central processor is made to prove that it is still functioning correctly. Any failure of

this test causes an immediate abort with listing of the central processor registers and storage areas. No error isolated from a general machine malfunction has been detected.

At each step of the integration the difference between the predicted and corrected values for each coordinate is monitored, as is the size of a specified difference of the accelerations at successive dates. These values are stored in memory for each of the 150 coordinates. Whenever a value larger than the stored one is encountered, the larger value replaces the one in storage. These monitor variables are not used to modify the step interval or to cause termination, since with the short step interval used here difficulties are not anticipated (except for the very few extraordinary minor planets moving in orbits of very high eccentricity, and these always require special treatment). The function of the monitor variables here is mainly to prove that nothing unexpected did actually happen, and they are ordinarily printed out at the end of each 400-day interval to give visual proof.

About 100 seconds of central processor time on the CDC 6400 are required to integrate 50 minor planets through one 400-day interval. Thus, the integration of the numbered minor planets would require about 1 hour of central processor time on this machine. This high speed demonstrates the economy of the mass production approach and makes practicable the integration of all of the numbered planets over long periods of time.

6.3 JPL PLANETARY POSITION DATA TAPE

The easy inclusion of the accelerations by all of the major planets was made possible through the generosity of Dr. J. H. Lieske, Jet Propulsion Laboratory, who kindly provided tapes containing the coordinates of the major planets at an interval of 4 days for the 19th and the 20th centuries. These tapes were translated to the system of the CDC 6400, and work tapes needed by the various programs can now easily be made.

6.4 MINOR PLANET OBSERVATION DATA TAPE

Dr. Paul Herget, Director, Minor Planet Center, Cincinnati Observatory, very kindly provided a tape containing all observations published since approximately 1940

for all of the numbered minor planets. An examination of the observations contained on this tape shows that for most minor planets the latest accurate observations lie several years prior to the adopted initial 400-day date of 1972 October 10. At the beginning of the work, only a very few more recent observations were available from other sources. For most minor planets, the perturbations from the adopted initial date backward to the latest accurate observations are large compared to the accuracy of the observations themselves. Thus perturbations must be included even in the first use of these observations, and the computation of the perturbations should be based on better initial elements than those furnished by the adopted initial ones derived solely from the two-body reduction from the published epoch to the adopted initial epoch. Accordingly, less use has actually been made of the observations on this tape than was originally anticipated.

Section 7

CONCLUSIONS AND RECOMMENDATIONS

Conclusions from the study are summarized as follows:

- a. The survey of the accuracy of minor planet ephemerides showed that the present system does not provide accurate ephemerides nor does it provide the means for comparing these data with current observations without prohibitive computation. The orbit elements for most numbered minor planets are not sufficiently good to provide the accuracy needed for mission planners, and are totally inadequate unless brought up to the date of the mission with the inclusion of perturbations by the major planets. The current system of providing approximate opposition ephemerides is barely sufficient for the simplest needs of astronomers and is not organized so as to provide extension to other research work.
- b. The new system is designed to satisfy the needs of mission analysts and astronomers alike. The best possible initial elements will be provided for all of the numbered minor planets, and perturbations relative to these elements will be computed over the time intervals of interest. Means will be provided to monitor the accuracy of the initial elements and to improve them, on the basis of recent observed positions, as the need arises. Results in formats easy to use will be made available to all who need them.
- c. Methods for quickly improving the accuracy of the initial approximate elements at the adopted standard date on the basis of published ephemerides or recent observations have been developed and tested. These are designed to give initial elements of a quality sufficient to provide good perturbations without extensive numerical integrations. They will serve to get the new system started in an economical and systematic manner.
- d. Computer programs to do the work required to set up the new system have been completed. Basic programs for the numerical integration of perturbations in groups of 50 minor planets have been designed, programmed, and tested. These programs possess the efficiencies of mass production, so that rather extensive numerical integrations are now practicable.

The following recommendations are suggested for continued development and use of the new system:

- a. Improve the accuracy of the osculating elements of all of the numbered minor planets at the standard date 1972 October 10, using techniques and computer programs now available. These programs are diagrammatically shown and described in par. 6.1.

- b. Continuously monitor the accuracy of the elements by representing all observed positions as soon after they are made as may be possible. Mass production methods will be used to do this economically.
- c. Plan how results that flow from the new system can best be distributed to all who need them. The needs of mission planners may be mostly satisfied by the listings and tapes described herein. But, for example, should not each mission that enters the belt of minor planets be examined for possible passes near some minor planet? Should astronomers be provided with improved opposition ephemerides? Etc., etc.
- d. Implement the plans derived from the above task to systematically distribute minor planet ephemeris data to all who need them in formats compatible with individual requirements.

Section 8

REFERENCES

1. Brooks, David R., and Hampshire, William F., II: "Multiple Asteroid Flyby Missions." 12th Colloquium of the International Astronomical Union, Tucson, Arizona, March 8-10, 1971.
2. Brooks, David R.; Drewry, Joseph W.; and Hampshire, William F., II: "Multiple Asteroid Flyby Opportunities in the 1970's and 1980's." AIAA Paper No. 72-52, AIAA 10th Aerospace Sciences Meeting, San Diego, Calif.; January 17-19, 1972.
3. Gehrels, T., ed.; Physical Studies of Minor Planets, NASA SP-267, 1972.
4. Herget, Paul, Minor Planet Circulars, Published by the Minor Planet Center, Cincinnati, Ohio.
5. Leuschner, A. O., Research Surveys of the Orbits and Perturbations of Minor Planets 1 to 1091 for 1801.0 to 1929.5, Lick Observatory Publications, XIX, 1935.

Appendix A
RESULTS FROM
ACCURACY SURVEY

Appendix A
RESULTS FROM ACCURACY SURVEY

The computer listing contained in Appendix A represents the final estimates of ephemeris accuracy for all of the 1779 numbered minor planets. An explanation of the headings on the computer listing table is given on page 37 of this listing (page A-38 of this Appendix). Comments on the method used to estimate the ephemeris uncertainties are given on page 38 of this listing (page A-39 of this Appendix).

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAQ	EPOCH		A	PLANETS			OPPOSITIONS		RESTIQUAL	LAST	ERROR SEC	ERROR KM3	
1	CERES		4.1	1968	MAY 24	2.7663							1969	1.0	1.3	ESTIMATED
2	PALLAS		5.2	1968	MAY 24	2.7687							1968	1.0	1.3	ESTIMATED
3	JUNO		6.4	1968	MAY 24	2.6680							1969	1.0	1.2	ESTIMATED
4	VESTA		4.3	1968	MAY 24	2.3619							1969	1.0	1.0	ESTIMATED
5	ASTRAEA		8.0	1956	NOV 23	2.5790	2	8	28	1918	1958	50.5	1969	101.1	115.7	
6	HEBE		6.7	1941	JAN 6	2.4259	2	8	0	-0	-0	1.6	1968	222.3	279.7	
7	IRYS		6.8	1935	AUG 20	2.3859	2	8	0	-0	-0	2.4	1969	340.8	342.3	
8	FLOPA		7.5	1951	DEC 20	2.2016	5	6	4	1954	1960	-180.0	1967	1000.3	871.7	
9	METIS		7.3	1957	JUN 11	2.3863	5	6	4	1955	1960	3.6	1967	22.9	23.0	
10	HYGIEA		6.6	1948	JUL 28	3.1508	5	6	10	1949	1962	-5.1	1969	26.7	41.6	
11	PARTHENOPE		7.8	1962	DEC 2	2.4525	5	6	7	1955	1964	-3.0	1969	13.5	14.2	
12	VICTORIA		8.8	1941	JAN 6	2.3332	2	8	0	-0	-0	9.3	1968	1100.4	1063.3	
13	EGEIA		8.0	1947	JAN 15	2.5763	5	6	7	1953	1961	-38.1	1969	215.2	245.8	
14	IRENE		7.4	1949	DEC 30	2.5878	2	9	18	1930	1957	21.6	1969	54.6	62.8	
15	EUNOMIA		6.3	1962	DEC 2	2.6424	2	8	18	1944	1968	3.6	1968	11.8	14.1	
16	PSYCHE		6.9	1951	DEC 20	2.9228	5	6	5	1950	1955	36.0	1969	210.7	292.9	
17	THETIS		8.7	1957	JUN 11	2.4692	5	6	4	1953	1957	-1.8	1969	17.1	18.2	
18	MELCOMENE		7.8	1962	DEC 2	2.2958	5	6	7	1955	1963	6.0	1967	22.2	20.8	
19	FORTUNA		8.4	1951	DEC 20	2.4418	5	6	6	1953	1961	90.0	1969	403.3	421.4	
20	MASSALIA		7.5	1956	NOV 23	2.4088	2	8	30	1916	1959	14.3	1968	34.0	34.7	
21	LUTETIA		8.7	1962	DEC 2	2.4349	5	6	10	1947	1965	-5.4	1969	16.4	17.0	
22	KALLIOPE		7.5	1947	JAN 15	2.9092	5	6	9	1951	1961	-6.3	1968	37.4	51.8	
23	THALIA		8.3	1956	NOV 23	2.6247	2	8	21	1920	1957	19.4	1967	44.9	52.8	
24	THEMIS		8.2	1957	JUN 11	3.1380	5	6	5	1954	1960	-2.4	1968	15.5	24.0	
25	PHOCAEA		9.1	1937	JAN 7	2.4007	2	8	0	-0	-0	3.4	1969	473.0	480.2	
26	PROSERPINA		8.6	1951	DEC 20	2.6556	5	6	5	1953	1958	-360.0	1969	2241.0	2689.7	
27	EUTERPE		8.6	1941	MAR 27	2.3472	2	8	0	-0	-0	2.1	1968	288.1	281.3	
28	BELLONA		8.2	1960	MAR 7	2.7761	2	8	39	1906	1953	10.4	1968	23.6	30.3	
29	AMPHITRITE		7.3	1951	DEC 20	2.5544	5	6	5	1953	1958	108.0	1969	678.9	764.8	
30	URANIA		8.8	1962	DEC 2	2.3652	5	6	10	1927	1966	10.5	1967	23.8	23.5	
31	EUPHROSINE		7.8	1962	DEC 2	3.1556	5	6	8	1949	1965	6.2	1969	17.3	27.1	
32	POMONA		8.7	1951	DEC 20	2.5876	5	6	5	1953	1958	-324.0	1968	2018.0	2322.1	
33	POLYHYMNIA		9.8	1956	NOV 23	2.8622	2	8	18	1921	1958	-73.9	1965	147.1	198.5	
34	CIRCE		9.6	1951	DEC 20	2.6868	5	6	4	1952	1958	-216.0	1969	1125.0	1375.4	
35	LEUKOTHEA		9.8	1962	DEC 2	2.9925	5	6	7	1948	1966	-4.5	1966	13.7	19.8	
36	ATALANTE		10.0	1956	NOV 23	2.7488	2	8	10	1928	1958	7.8	1969	22.8	28.8	
37	FIDES		8.5	1951	DEC 20	2.6428	5	6	5	1952	1958	-72.0	1967	381.1	453.7	
38	LEDA		9.7	1960	MAR 7	2.7398	2	8	20	1906	1963	8.1	1968	19.8	24.9	
39	LAETITIA		7.4	1962	DEC 2	2.7690	5	6	9	1953	1963	-1.5	1969	9.3	11.9	
40	HARMONIA		8.4	1962	DEC 2	2.2668	5	6	8	1955	1965	-3.0	1969	13.1	12.0	
41	DAPHNE		8.3	1951	DEC 20	2.7624	5	5	5	1948	1953	36.0	1968	203.2	259.6	
42	ISIS		8.8	1951	DEC 20	2.4410	5	6	6	1952	1959	90.0	1967	433.8	453.1	
43	ARIADNE		9.2	1956	NOV 23	2.2032	2	8	26	1917	1959	22.1	1969	48.6	42.4	
44	NYXA		8.0	1966	APR 25	2.4217	2	8	14	1943	1966	6.0	1968	15.6	16.1	
45	EUGENIA		8.5	1956	NOV 23	2.7214	2	8	23	1921	1959	11.9	1968	29.4	36.7	
46	HESTIA		9.3	1956	NOV 23	2.5245	2	8	29	1924	1958	-68.8	1969	139.3	154.0	
47	AGLAJA		9.2	1951	DEC 20	2.8773	5	5	6	1946	1953	72.0	1969	317.2	431.6	
48	DNRS		8.1	1968	MAY 24	3.1143							1968	300.0	459.7	ESTIMATED
49	PALES		8.7	1957	JUN 11	3.0989	5	6	5	1950	1960	-3.6	1966	16.4	25.0	
50	VIRGINIA		10.4	1956	NOV 23	2.6495	2	8	14	1924	1959	62.6	1969	125.6	150.2	

A-2

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ABMAG	EPCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KMS
51	VEGAUSA		9.7	1949 MAR 25	2.3657	2 8 8	1943 1954	.8	1969	12.9	12.8
52	FURROPA		7.6	1951 DEC 20	3.0956				1969	300.0	455.7 ESTIMATED
53	KALYPSO		9.8	1956 NOV 23	2.6164	2 8 23	1923 1958	35.3	1969	75.2	88.1
54	ALEXANDRA		8.8	1960 MAR 7	2.7085	2 8 20	1909 1951	17.2	1969	36.8	45.6
55	PANDORA		9.0	1951 DEC 20	2.7598	5 6 5	1954 1959	72.0	1968	469.6	599.0
56	MELETE		9.6	1951 DEC 20	2.5973	5 6 5	1952 1958	180.0	1965	939.2	1087.3
57	MNEMOSYNE		8.4	1938 APR 12	3.1578	2 8 0	-0 -0	2.4	1969	333.3	521.3
58	CONCORDIA		9.9	1951 DEC 20	2.6993	5 6 5	1953 1959	36.0	1967	200.9	247.5
59	ELPTS		8.7	1951 DEC 20	2.7141	5 6 5	1952 1961	90.0	1969	368.9	458.3
60	ECHO		10.0	1956 NOV 23	2.3933	2 8 23	1915 1959	73.8	1968	140.6	142.0
61	DANAE		8.8	1947 JAN 15	2.9891	5 6 7	1947 1962	-10.1	1968	41.9	60.4
62	ERATO		9.8	1947 JAN 15	3.1344	5 6 6	1952 1960	7.5	1968	48.7	75.4
63	EUSONYA		8.2	1956 NOV 23	2.3946	2 8 22	1924 1958	-43.0	1969	90.3	91.3
64	ANGELINA		8.8	1956 NOV 23	2.6818	2 8 26	1915 1957	129.2	1969	245.6	299.4
65	CYBELE		7.9	1962 DEC 2	3.4230	5 6 10	1947 1965	9.0	1968	22.1	38.8
66	MAJA		10.6	1951 DEC 20	2.6467	5 6 4	1952 1958	90.0	1968	474.1	565.8
67	ASTA		9.9	1951 DEC 20	2.4214	5 6 5	1952 1959	108.0	1967	518.7	534.4
68	LETO		8.3	1939 MAR 18	2.7839	5 6 10	1949 1962	21.6	1969	116.9	151.1
69	HESPERIA		8.3	1962 DEC 2	2.9791	5 6 11	1948 1962	4.2	1969	14.8	21.2
70	PANDORA		9.2	1956 NOV 23	2.6144	2 8 17	1920 1958	23.1	1968	50.8	59.4
71	NIOBE		8.5	1956 NOV 23	2.7559	2 8 17	1921 1957	84.6	1969	169.6	215.8
72	FERONIA		10.3	1964 JUL 4	2.2662	2 8 10	1946 1964	2.8	1968	11.3	10.4
73	KLYTIA		10.3	1951 DEC 20	2.6657	5 6 5	1953 1958	252.0	1968	1571.4	1807.2
74	GALATEA		10.1	1951 DEC 20	2.7786	5 6 4	1953 1957	144.0	1967	1052.8	1357.2
75	EURYDIKE		10.0	1951 DEC 20	2.6716	5 6 4	1952 1958	360.0	1967	1869.0	2264.4
76	FRIFIA		9.0	1957 JUN 11	3.3664	5 6 6	1950 1961	-45.0	1967	121.0	207.5
77	FRIGGA		9.6	1951 DEC 20	2.6694	5 6 4	1953 1957	108.0	1967	792.0	958.3
78	DIANA		9.1	1956 NOV 23	2.6186	2 8 16	1922 1957	-38.9	1967	83.2	97.6
79	EUPHYDOME		9.3	1957 JUN 11	2.4440	5 6 11	1945 1965	56.6	1969	177.5	185.8
80	SAPPHO		9.3	1957 JUN 11	2.7969	5 6 5	1953 1959	36.0	1969	200.7	269.6
81	TEPSTICHORE		9.7	1951 DEC 20	2.8535	5 6 5	1953 1959	36.0	1969	200.7	269.6
82	ALCMEDE		9.4	1962 DEC 2	2.7631	5 6 10	1953 1967	-7.0	1969	18.7	23.9
83	BEATRIX		9.8	1951 DEC 20	2.4309	5 6 5	1953 1958	72.0	1969	456.0	472.9
84	KLIO		10.3	1951 DEC 20	2.3625	5 6 5	1954 1959	180.0	1969	1161.8	1147.3
85	IO		8.9	1951 DEC 20	2.6544	5 6 6	1952 1959	108.0	1969	518.2	621.4
86	SEMELÉ		9.8	1957 JUN 11	3.1007	5 6 4	1953 1960	-9.0	1969	26.3	55.2
87	SYLVIA		8.3	1962 DEC 2	3.4812	5 6 10	1942 1964	5.0	1969	14.4	25.9
88	THISBE		8.2	1962 DEC 2	2.7680	5 6 10	1949 1964	3.8	1968	13.5	17.3
89	JULIA		8.2	1962 DEC 2	2.5530	5 6 10	1948 1964	-9.0	1968	24.0	27.0
90	ANTIOPE		9.3	1962 DEC 2	3.1377	5 6 7	1952 1965	4.1	1969	13.8	21.4
91	ARGINA		9.7	1951 DEC 20	2.5901	5 6 5	1953 1958	108.0	1969	678.8	782.3
92	UNDINA		8.0	1947 JAN 15	3.1999	5 6 9	1948 1952	-12.3	1968	50.5	80.6
93	MINERVA		8.8	1951 DEC 20	2.7541	5 6 4	1953 1958	108.0	1968	678.4	862.5
94	AUROPA		8.8	1947 JAN 15	3.1534	5 6 7	1951 1961	33.3	1967	155.8	243.2
95	APETHUSA		8.9	1948 JUL 28	3.0689	5 6 6	1952 1961	-24.6	1969	124.0	185.9
96	AFGLE		9.1	1947 JAN 15	3.0550	5 6 5	1953 1960	8.0	1966	57.5	85.6
97	KLOTHO		8.7	1951 DEC 20	2.6688	5 6 4	1953 1958	270.0	1966	1683.0	2035.7
98	IANTHE		10.4	1962 DEC 2	2.6919	5 6 10	1949 1967	-6.3	1967	17.0	20.8
99	DIKE		11.5	1962 DEC 2	2.6638	5 6 5	1938 1965	-8.4	1969	20.7	25.0
100	HEKATE		9.1	1951 DEC 20	3.0871	5 5 9	1942 1956	144.0	1967	388.9	588.3

A-3

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPHOC	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	EPHOC	SEC	ERROR	KM3
101	HELENA		9.3	1956 NOV 23	2.5830	2 8	17 1921 1958	-41.0	1967		85.3	97.8	
102	VIRIAM		10.4	1951 DEC 20	2.6591	5 6	5 1953 1959	-109.0	1969		595.0	703.5	
103	HEBE		8.6	1951 DEC 20	2.7017	5 6	5 1952 1957	72.0	1968		440.9	543.9	
104	KLYMENE		9.5	1948 JUL 28	3.1399	5 6	8 1949 1962	-4.8	1969		25.7	39.8	
105	ARTEMIS		9.8	1962 DEC 2	2.3736	5 6	9 1951 1966	-7.6	1967		21.0	20.9	
106	DIONE		8.8	1962 DEC 2	3.1619	5 6	10 1951 1968	-5.7	1969		15.4	24.1	
107	CAMILLA		8.2	1947 JAN 15	3.4895	5 6	6 1952 1962	-3.6	1965		25.1	45.3	
109	HECUBA		9.3	1962 DEC 2	3.2192	5 6	6 1949 1962	-3.0	1969		12.2	19.6	
109	FELICITAS		10.1	1951 DEC 20	2.6960	5 6	5 1953 1959	-252.0	1966		1352.0	1663.1	
110	LYDIA		8.6	1947 JAN 15	2.7325	5 6	9 1951 1962	21.8	1967		101.2	127.1	
111	ATE		9.1	1951 DEC 20	2.5931	5 6	4 1954 1958	36.0	1967		279.2	322.3	
112	TYTIGENIA		10.7	1962 DEC 2	2.4343	5 6	8 1953 1967	4.4	1969		14.3	14.9	
113	AMALTHEA		9.7	1964 NOV 1	2.3766	2 8	14 1938 1954	7.2	1968		18.6	18.6	
114	KASSANDRA		9.5	1956 NOV 23	2.6752	2 8	22 1919 1957	58.9	1967		119.1	144.7	
115	THYRA		9.1	1951 DEC 20	2.3793	5 6	5 1954 1959	103.0	1969		700.9	700.7	
116	SIPONA		8.8	1962 DEC 2	2.7671	5 6	7 1955 1964	6.6	1968		21.8	27.9	
117	LONTA		9.2	1962 DEC 2	2.9905	5 6	9 1948 1965	7.0	1968		19.0	27.5	
118	REYTHO		10.0	1957 JUN 11	2.4380	5 6	5 1953 1950	1.7	1969		13.3	13.8	
119	ALTHAEA		9.4	1951 DEC 20	2.5807	5 6	5 1952 1958	36.0	1969		195.2	223.6	
120	LACHESTS		8.9	1956 NOV 23	3.1209	5 7	19 1921 1958	-7.3	1968		20.8	31.9	
121	HEPMIONE		8.3	1948 JUL 28	3.4538	5 6	6 1951 1962	18.0	1969		80.7	143.5	
122	GERDA		9.1	1947 JAN 15	3.2119	5 6	7 1950 1960	9.9	1968		51.8	83.1	
123	SPUMHILD		10.1	1951 DEC 20	2.6936	2 8	10 1921 1955	28.9	1969		66.8	81.9	
124	ALKESTE		9.1	1951 DEC 20	2.6304	5 6	5 1952 1957	36.0	1969		225.1	266.0	
125	LIPERATRYX		9.6	1951 DEC 20	2.7429	5 5	60 1944 1953	108.0	1968		404.9	511.4	
126	VELLFOA		10.4	1962 DEC 2	2.4381	5 6	6 1948 1966	-10.8	1966		25.9	27.0	
127	JOHANNA		9.5	1957 JUN 11	2.7550	5 6	9 1950 1962	5.0	1968		18.8	23.9	
128	NEMESTS		8.8	1951 DEC 20	2.7515	5 6	5 1952 1957	72.0	1967		440.8	559.6	
129	ANTIGONE		7.8	1956 NOV 23	2.8741	2 8	23 1922 1957	-9.5	1968		25.7	34.9	
130	ELEKTRA		8.0	1957 JUN 11	3.1173	5 6	10 1947 1959	-5.1	1969		19.9	30.5	
131	VALA		11.0	1957 FEB 11	2.4309	5 6	4 1952 1957	21.6	1969		107.1	111.0	
132	ASTHRA		10.3	1925 JAN 10	2.6123	2 8	21 1873 1961	-6.5	1967		27.4	32.0	
133	CYRENE		9.0	1951 DEC 20	3.0616	5 6	5 1952 1958	180.0	1968		938.4	1402.1	
134	SOPHROSINE		9.7	1960 JAN 7	2.5642	5 6	5 1947 1953	28.8	1968		140.9	159.8	
135	HERTHA		9.2	1951 DEC 20	2.4281	5 6	5 1953 1958	72.0	1969		456.0	472.0	
136	AUSTRIA		10.9	1957 JUN 11	2.2872	5 6	5 1948 1964	3.2	1968		14.5	13.5	
137	MELTARDEA		9.0	1962 DEC 2	3.1248	5 6	9 1924 1968	-7.1	1969*		16.6	25.6	
138	TOLOSA		10.7	1951 DEC 20	2.4480	5 6	5 1954 1959	144.0	1966		931.1	977.2	
139	JUEWA		9.2	1951 DEC 20	2.7829	5 6	4 1952 1957	-144.0	1969		872.8	1127.9	
140	SIWA		9.5	1960 MAR 7	2.7324	2 8	23 1902 1960	7.1	1969		19.4	23.1	
141	LUMEN		9.6	1956 NOV 23	2.6653	2 8	20 1922 1956	-23.8	1968		54.5	65.7	
142	POLANA		11.4	1951 DEC 20	2.4187	5 6	5 1952 1959	180.0	1966		858.2	892.4	
143	ADRIA		10.6	1952 JUL 7	2.7599	2 8	10 1921 1954	6.6	1969		22.1	28.2	
144	VIRYLTA		9.0	1956 NOV 23	2.6544	2 8	18 1919 1958	-61.5	1966		122.7	147.1	
145	ADEONA		8.9	1957 JUN 11	2.6737	5 6	5 1953 1960	15.9	1967		59.5	72.2	
146	LUCINA		9.2	1960 MAR 7	2.7190	2 8	23 1910 1962	8.5	1968		20.7	25.8	
147	PROTYGENEIA		9.8	1957 JUN 11	3.1386	5 6	4 1952 1959	11.1	1968		44.7	69.3	
148	GALLIA		8.8	1956 NOV 23	2.7702	2 8	18 1918 1957	14.7	1967		35.3	45.3	
149	MEDUSA		12.2	1967 APR 20	2.1744	2 8	13 1936 1967	10.5	1968		22.6	19.3	
150	NUMA		9.2	1947 JAN 15	2.9825	5 6	6 1954 1961	16.2	1968		109.1	156.7	

A-4

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		A	PLANETS		OPPOSITIONS		RESIDUAL	LAST	ERROR	SEC	ERROR	KM3
151	ABUNDANTIA		10.4	1947	JAN	15	2.5922	5	6	5	1950	1957	13.5	1966	55.6	98.8
152	ATALA		9.7	1952	JAN	29	3.1331	5	6	6	1952	1962	-6.5	1969	30.8	47.5
153	ATLDA		8.8	1947	JAN	15	3.0754	5	6	6	1951	1961	13.1	1968	66.1	142.6
154	REPTHA		8.5	1957	JUN	11	3.1806	5	6	6	1947	1961	-8.7	1969	26.5	41.9
155	SCYLLA		12.0	1941	JAN	6	2.7596	2	9	6	1875	1950	-3.3	1950*	17.6	27.5
156	XANTHIPPE		9.6	1956	NOV	23	2.7284	2	8	22	1923	1959	-23.7	1969	51.6	64.6
157	DEJANIPA		12.4	1956	NOV	23	2.5778	2	8	7	1922	1958	-8.7	1968	24.1	27.6
158	KOPONIS		10.7	1947	JAN	15	2.8677	5	6	5	1949	1960	8.7	1969	44.6	60.3
159	ARMYLTA		9.4	1957	JUN	11	3.1092	5	6	5	1951	1965	8.1	1968	24.0	36.8
160	UNA		10.1	1956	NOV	23	2.7278	2	8	14	1921	1958	-8.5	1968	23.5	29.5
161	ATHOR		10.3	1942	AUG	29	2.3789	5	6	7	1947	1961	14.7	1968	71.4	71.3
162	LAURENTIA		10.1	1956	NOV	23	3.0261	2	8	14	1922	1956	-15.3	1968	37.2	54.6
163	EPIGONE		10.5	1957	JUN	11	2.3672	5	6	5	1952	1961	46.1	1968	135.9	134.7
164	EVA		9.8	1957	JUN	11	2.6321	5	6	6	1949	1967	-1.8	1966	11.5	13.6
165	LORELEY		8.8	1951	DEC	20	3.1282	2	8	16	1920	1956	28.1	1965	62.9	97.1
166	PHOENIX		10.8	1957	JUN	11	2.6858	5	6	6	1950	1964	-7.7	1964	23.7	29.0
167	URDA		10.7	1954	SEP	15	2.9523	2	8	10	1925	1956	18.0	1968	44.4	59.6
168	SIRYLLA		9.2	1948	JUL	28	3.3780	5	6	8	1951	1963	9.8	1969	45.5	78.5
169	ZELIA		10.6	1962	DEC	2	2.3576	5	6	9	1951	1963	2.6	1969	12.1	12.0
170	MARTA		10.7	1951	DEC	20	2.5539	5	6	5	1948	1956	396.0	1969	1494.3	1682.9
171	OPHELIA		9.8	1957	JUN	11	3.1336	5	6	9	1951	1962	-3.0	1969	14.0	21.7
172	PAUCIS		9.6	1946	JUN	29	2.3794	5	6	11	1947	1962	-7.2	1966	35.3	35.3
173	INDO		9.0	1957	MAR	23	2.7473	2	8	25	1930	1959	-5.0	1968	17.0	21.5
174	PHAEDRA		9.6	1951	DEC	20	2.8576	5	6	5	1953	1958	108.0	1969	678.3	913.2
175	ANDROMACHE		10.0	1947	JAN	15	3.2286	5	6	6	1947	1959	27.6	1969	108.1	174.6
176	IDUNA		9.5	1951	DEC	20	3.1681	5	5	6	1945	1954	10.8	1966	46.6	73.3
177	IRMA		10.6	1939	FEB	26	2.7722	2	8	4	1937	1951	-4.0	1969	27.1	34.8
178	RELISANA		10.7	1956	NOV	23	2.4597	2	8	12	1923	1957	18.6	1969	44.1	46.6
179	KLYTAEEMNESTRA		9.7	1951	DEC	20	2.9745	5	6	5	1952	1958	216.0	1969	1124.5	1609.3
180	SARDINA		11.5	1956	NOV	23	2.7237	2	8	11	1925	1959	-8.2	1966	22.9	28.6
181	EUCCHARIS		9.0	1947	JAN	15	3.1218	5	6	7	1952	1959	-10.2	1969	69.1	106.3
182	ELSA		10.0	1956	NOV	23	2.4163	2	8	14	1921	1958	28.2	1969	61.4	63.0
183	YSTRIA		11.0	1968	MAY	24	2.7908	2	8	8	1937	1968	-2.5	1968	8.1	10.5
184	DEJONEJA		9.5	1957	JUN	11	3.1753	5	6	8	1938	1963	-8.3	1969	22.2	35.0
185	EUMIKE		8.5	1941	JAN	6	2.7372	2	8	0	-0	-0	1.8	1966	247.6	311.7
186	CELUTA		10.4	1925	JAN	1	2.3620	5	6	7	1926	1955	450.0	1969	1445.6	1427.0
187	LAMPERTA		9.6	1969	FEB	14	2.7342	2	8	15	1941	1968	-5.9	1966	13.8	17.4
188	MENTOR		10.4	1951	DEC	20	2.7625	5	6	4	1952	1957	10.8	1966	73.6	94.1
189	PHYLIA		10.4	1951	DEC	20	2.4501	5	6	4	1954	1958	21.6	1969	171.5	180.3
190	ISMENE		8.6	1957	JUN	11	3.9526	5	6	8	1932	1959	-7.2	1969	20.5	43.8
191	KOLGA		10.0	1951	DEC	20	2.9036	2	8	26	1902	1961	14.3	1969	32.8	45.1
192	NAUSTKAA		8.4	1941	JAN	6	2.4025	2	6	7	1942	1955	79.3	1969	330.0	335.4
193	AMFOSIA		11.0	1956	NOV	23	2.5992	2	8	13	1916	1957	-91.8	1969	180.1	208.7
194	PROKNE		8.9	1962	DEC	2	2.6163	5	6	10	1952	1968	4.8	1969	14.3	16.7
195	EUPHYLETA		10.3	1941	JAN	6	2.8807	2	6	7	1940	1958	-4.3	1969	25.0	34.1
196	PHILOMELA		7.7	1962	DEC	2	3.1127	5	6	9	1953	1964	-5.9	1969	18.7	28.7
197	ARTE		10.9	1956	NOV	23	2.7386	2	8	15	1914	1957	-24.1	1968	52.3	65.9
198	AMPHELLA		9.7	1951	DEC	20	2.4594	5	6	5	1952	1957	21.6	1968	139.1	147.1
199	BYBLIS		10.0	1962	DEC	2	3.1716	5	6	5	1945	1958	-6.2	1967	21.5	33.9
200	DYNAMENE		9.4	1956	NOV	23	2.7375	2	8	21	1920	1959	-78.8	1969	152.0	192.6

A-5

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		A	PLANETS		OPPOSITIONS		RESIDUAL	LAST	ERROR SEC	ERROR KM3
201	PENELOPE		9.5	1951	DEC 20	2.6781	5	6	5	1952 1958	36.0	1966	195.0	237.2
202	OMPYSEIS		8.9	1957	JUN 11	3.0771	5	6	6	1957 1959	-2.4	1968	15.5	73.3
203	POMPEJA		10.2	1951	DEC 20	2.7382	5	6	4	1954 1958	36.0	1960	278.9	351.3
204	KALLISTO		10.3	1951	DEC 20	2.6711	5	6	5	1952 1958	144.0	1967	753.0	912.0
205	MARTHA		10.5	1955	NOV 23	2.7764	2	8	14	1925 1957	15.0	1967	36.9	47.5
206	HERSILIA		10.0	1951	DEC 20	2.7408	5	6	5	1952 1958	90.0	1968	473.9	597.9
207	MENDA		11.0	1957	JUN 11	2.2842	5	6	6	1948 1962	4.5	1969	18.0	16.8
208	LACRIMOSA		10.5	1947	JAN 15	2.8919	5	6	6	1950 1961	-30.3	1969	133.7	183.3
209	DIDO		9.1	1942	AUG 29	3.1567	5	6	6	1946 1961	21.2	1969	91.2	142.6
210	ISABELLA		10.6	1956	NOV 23	2.7222	2	8	9	1935 1959	-5.8	1969	19.3	24.1
211	ISOLDA		9.0	1957	JUN 11	3.0395	5	6	6	1952 1960	5.3	1969	22.7	33.5
212	MEDEA		9.5	1957	JUN 11	3.1202	5	6	5	1952 1961	60.2	1965	173.9	267.2
213	LILAFIA		10.0	1957	JUN 11	2.7522	5	6	5	1953 1958	-8.4	1969	44.1	56.0
214	ASCHERA		10.4	1962	DEC 2	2.6115	5	6	9	1948 1966	3.0	1966	11.4	13.3
215	GENONE		10.9	1964	SEP 2	2.7656	2	8	10	1942 1964	-4.0	1969	14.2	18.2
216	KLEOPATRA		8.1	1933	AUG 16	2.7929	2	8	0	-0 -0	2.7	1966	333.6	433.5
217	EUDORA		11.1	1957	JUN 11	2.8713	5	6	4	1948 1953	22.1	1968	126.3	171.3
218	BIANCA		9.9	1951	DEC 20	2.6655	5	6	5	1953 1958	-180.0	1967	1125.0	1358.1
219	THUSNELDA		10.4	1951	DEC 20	2.3541	5	6	4	1952 1959	360.0	1966	1706.9	1675.3
220	STEPHANIA		12.4	1962	DEC 2	2.3493	5	6	5	1932 1966	-6.0	1968	16.4	16.0
221	EOS		9.0	1947	JAN 15	3.0135	5	6	10	1947 1962	30.5	1964	107.1	156.3
222	LUCYA		10.4	1951	DEC 20	3.1469	2	8	22	1899 1961	178.2	1968	307.2	478.0
223	ROSA		11.1	1957	JUN 11	3.0931	5	6	4	1931 1953	-6.6	1966	22.3	33.8
224	JOSEFA		9.9	1951	DEC 20	2.6446	5	6	5	1953 1959	36.0	1969	201.1	239.7
225	HENRIETTA		9.6	1957	JUN 11	3.3475	5	6	5	1946 1955	1.2	1965	10.6	18.0
226	MERINGIA		11.1	1956	NOV 23	2.7153	2	8	10	1921 1957	4.7	1966	16.5	20.5
227	PHILOSOPHIA		10.2	1951	DEC 20	3.1349	5	5	6	1940 1953	144.0	1967	440.3	681.3
228	AGATHE		14.0	1957	JUN 11	2.2012	5	6	5	1944 1959	3.0	1967	15.5	13.5
229	ADELINDA		10.5	1962	DEC 2	3.3986	5	6	10	1930 1963	4.1	1968	12.5	21.7
230	ATHAMANTIS		8.6	1966	JUN 4	2.3825	2	8	14	1941 1966	7.0	1967	17.3	17.3
231	VINDOPONA		10.6	1962	DEC 2	2.0215	5	6	9	1942 1965	5.1	1966	14.9	20.6
232	RUSSIA		11.6	1951	DEC 20	2.5523	5	6	4	1953 1958	270.0	1966	1683.3	1893.8
233	ASTEROPE		9.6	1956	NOV 23	2.6603	2	8	21	1921 1958	18.6	1967	42.8	51.4
234	BARBARA		10.4	1960	JAN 7	2.3853	5	5	5	1948 1955	270.0	1968	1086.9	1091.3
235	CAROLINA		9.9	1957	JUN 11	2.8809	5	6	4	1954 1960	-10.7	1968	46.2	63.0
236	HONORIA		9.6	1957	JUN 11	2.7982	5	6	5	1953 1959	-11.6	1969	49.6	64.6
237	CELESTINA		10.8	1937	JAN 24	2.7627	5	6	7	1939 1961	-9.5	1968	51.1	65.3
238	HYPATIA		9.3	1957	JUN 11	2.9065	5	6	8	1951 1963	-4.5	1969	17.4	24.1
239	ARPASTEA		11.8	1957	JUN 11	2.9687	5	6	4	1949 1956	21.0	1966	87.8	125.3
240	VANADYS		9.8	1951	DEC 20	2.6658	5	6	5	1953 1958	72.0	1966	455.4	549.9
241	GERMANIA		8.8	1938	DEC 8	3.0481	2	8	59	1884 1964	10.7	1969	29.0	43.1
242	KRIEMHILD		10.6	1957	JUN 11	2.8651	5	6	5	1954 1961	-38.3	1966	132.8	179.5
243	IDA		11.2	1947	JAN 15	2.8608	5	6	5	1952 1957	-48.3	1966	376.9	508.3
244	SITA		13.4	1962	DEC 2	2.1748	5	6	4	1942 1953	4.5	1960	21.4	18.3
245	VERA		9.7	1957	JUN 11	3.1009	5	6	9	1951 1964	7.5	1969	73.4	75.7
246	ASPROPTNA		9.9	1951	DEC 20	2.6951	5	6	5	1952 1957	36.0	1966	225.0	276.4
247	EUKRATE		9.2	1947	JAN 15	2.7402	5	6	7	1950 1960	14.1	1969	70.6	89.1
248	LAMETA		11.5	1962	DEC 2	2.4717	5	6	6	1940 1963	-6.0	1967	17.6	18.7
249	ILSE		12.5	1962	DEC 2	2.3777	5	6	6	1950 1962	8.1	1960	25.2	25.1
250	BETTINA		8.8	1948	JUL 28	3.1403	5	6	7	1952 1962	14.6	1969	71.8	111.5

A-6

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KM2
251	SOPHIA		11.3	1962 DEC 2	3.0956	5 6 4	1949 1956	-1.5	1966		11.1		16.9
252	ELEMENTINA		10.6	1956 NOV 23	3.1544	2 8 15	1922 1958	40.3	1969		83.0		129.7
253	MATHILDE		11.5	1951 DEC 20	2.6474	5 6 4	1951 1957	144.0	1963		729.1		870.5
254	AUGUSTA		13.2	1957 JUN 11	2.1950	5 6 4	1951 1961	-5.7	1963		73.2		20.1
255	ZOPAVIA		11.5	1957 JUN 11	2.7462	5 6 4	1951 1956	-6.8	1969		39.8		50.3
256	WALPURGA		11.1	1965 JUN 29	2.9995	2 8 8	1935 1966	7.5	1966		17.4		25.3
257	SILFIA		10.2	1957 JUN 11	3.1217	5 6 9	1938 1942	4.5	1968		15.3		23.5
258	TYCHE		9.6	1951 DEC 20	2.6143	5 6 5	1953 1959	360.0	1969		1929.1		2257.1
259	ALETHEIA		9.7	1957 JUN 11	3.1357	5 6 8	1948 1959	5.4	1969		21.4		33.1
260	MURPERTA		10.4	1947 JAN 15	3.4499	5 6 6	1950 1958	26.6	1969		142.0		252.1
261	PHYMBO		10.6	1964 SEP 22	2.3309	2 8 13	1934 1964	5.6	1967		15.6		15.1
262	VALDA		12.8	1956 NOV 23	2.5553	2 8 6	1924 1957	6.3	1961*		20.2		22.7
263	DRESDA		11.7	1956 NOV 23	2.8884	2 8 13	1923 1958	6.3	1969		19.3		26.4
264	LIPUSCA		10.0	1962 DEC 2	2.7993	5 6 7	1947 1961	-7.7	1969		23.2		30.3
265	ANNA		12.8	1932 FEB 5	2.4204				1967		300.0		308.9 ESTIMATED
266	ELINE		9.6	1947 JAN 15	2.8024	5 6 6	1949 1962	-6.3	1967		32.7		42.7
267	TIRZA		12.1	1947 JAN 15	2.7742	5 6 5	1951 1961	1.8	1966		17.9		23.0
268	ADOLFA		9.6	1947 JAN 15	3.0950	5 6 8	1951 1953	22.7	1968		98.3		149.3
269	JUSTITIA		11.3	1951 DEC 20	2.6161	5 6 4	1949 1959	180.0	1967		621.1		727.5
270	ANAMITA		10.1	1957 JUN 11	2.1983	5 6 8	1952 1962	4.2	1968		19.2		16.7
271	PENTHESILEA		11.0	1962 DEC 2	3.0081	5 6 7	1941 1960	-1.5	1968		8.7		12.6
272	ANTONIA		11.8	1962 DEC 2	2.7779	5 6 9	1948 1964	7.4	1969		20.5		26.4
273	ATROPDS		11.6	1957 JUN 11	2.3949	5 6 4	1952 1950	20.1	1966		68.1		68.8
274	PHILAGORIA		11.3	1967 FEB 19	3.0486	2 8 12	1935 1967	7.2	1968		16.0		23.7
275	SAPIENTIA		10.0	1949 JAN 4	2.7739	5 6 5	1949 1960	-2.9	1969*		19.9		25.6
276	ADELHEID		9.4	1951 DEC 20	3.1192	5 5 5	1943 1951	216.0	1967		899.3		1381.3
277	ELVIRA		11.2	1951 DEC 20	2.9872	5 5 6	1947 1953	-180.0	1968		848.6		1160.8
278	PAULINA		10.7	1929 MAY 9	2.7546	2 8 7	1929 1957	-5.6	1969		32.1		40.9
279	THULE		9.8	1948 SEP 16	4.7829				1968		300.0		713.8 ESTIMATED
280	PHILTA		12.0	1969 AUG 12	2.9444	2 8 4	1948 1968	7.1	1968		15.9		22.4
281	LUCRETIA		12.9	1957 JUN 11	2.1876	5 6 5	1948 1962	8.7	1965		27.6		23.8
282	CLOPINDA		12.0	1968 MAR 25	2.3396	2 8 9	1950 1968	5.9	1968		14.6		14.2
283	EMMA		9.5	1947 JAN 15	3.0422	5 6 7	1950 1960	-19.2	1969		87.7		129.9
284	AMALTA		11.6	1966 OCT 22	2.3575	2 8 8	1940 1966	7.9	1969		18.7		18.4
285	PEGINA		11.9	1938 AUG 30	3.0838	2 8 4	1889 1954	-4.1	1968		19.2		28.9
286	ICLFA		10.4	1957 JUN 11	3.1914	5 6 6	1951 1958	-7.1	1969		32.0		50.8
287	NEPHTHYS		9.5	1941 JAN 6	2.3541	2 8 0	-0 -0	1.5	1967		209.5		205.6
288	GLAUKE		11.0	1956 NOV 23	2.7612	2 8 22	1916 1956	15.2	1968		36.3		46.3
289	NENETTA		10.8	1957 JUN 11	2.8724	5 6 4	1951 1960	-17.4	1968		57.2		77.7
290	APUNA		13.2	1963 MAR 12	2.3365	2 8 6	1915 1942	-7.2	1960*		25.0		24.2
291	ALICE		12.8	1957 JUN 11	2.2220	5 6 6	1949 1960	-4.1	1966		19.1		16.9
292	LUDOVICA		11.0	1959 FEB 1	2.5298	2 8 10	1918 1959	-7.7	1968		21.0		23.3
293	BRASILIA		11.0	1956 NOV 23	2.8616	2 8 8	1918 1958	5.8	1968		19.0		24.3
294	FELICIA		11.1	1940 AUG 1	3.1594				1968		300.0		469.5 ESTIMATED
295	THERESIA		11.6	1957 JUN 11	2.7970	5 6 4	1951 1959	6.9	1969		28.6		37.3
296	PHAETUSA		13.6	1957 JUN 11	2.2288	5 6 4	1932 1960	6.9	1967		21.5		19.2
297	CAECILIA		10.4	1962 DEC 2	3.1742	5 6 10	1948 1964	-3.5	1968		12.3		19.4
298	RAPTISTINA		12.5	1957 JUN 11	2.2638	5 6 5	1948 1961	-3.0	1968		15.3		14.0
299	THORA		13.1	1951 DEC 20	2.4337	5 6 5	1949 1958	180.0	1969		669.6		695.8
300	GERALDINA		10.6	1935 JUL 17	3.2096	2 8 25	1890 1964	-6.0	1968		22.1		35.3

A-7

LMSC-D420948

STATUS OF NUMERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		A	PLANETS	OPPOSITIONS		RESIDUAL	LAST	ERROR SEC	ERROR KM3
301	BAVARIA		11.4	1951	DEC 20	2.7248	2 9	9	1921 1955	14.8	1966	39.5	48.1
302	CLARISSA		12.3	1951	DEC 20	2.4060	5 6	5	1956 1961	180.0	1968	1233.6	1257.2
303	JOSEPHINA		10.0	1947	JAN 15	3.1248	5 6	5	1952 1960	4.4	1968	32.5	50.0
304	OLGA		11.0	1962	DEC 2	2.4030	5 6	6	1937 1963	-3.9	1963	13.4	13.6
305	GORDONIA		10.3	1947	JAN 15	3.0964	5 6	7	1948 1960	9.3	1968	43.5	66.1
306	UNITAS		10.2	1962	DEC 2	2.3581	5 6	12	1931 1956	180.0	1968	395.1	388.9
307	NIKE		11.0	1947	JAN 15	2.9136	5 6	6	1949 1956	-15.0	1968	91.1	126.4
308	POLYXO		9.1	1947	JAN 15	2.7491	5 6	7	1954 1961	-9.6	1965	69.0	87.4
309	FRATERMITAS		11.5	1962	DEC 2	2.6641	5 6	7	1930 1961	5.4	1966	15.9	19.2
310	MARGARITA		11.7	1955	NOV 23	2.7631	2 8	13	1913 1957	21.0	1968	46.1	58.9
311	CLAUDIA		11.2	1957	JUN 11	2.8980	5 6	4	1954 1959	6.2	1969	33.0	45.4
312	PIRETTA		10.3	1957	JUN 11	2.7809	5 6	8	1938 1960	3.9	1968	15.1	19.4
313	CHALDAEA		9.7	1957	JUN 11	2.3759	5 6	4	1950 1956	2.0	1970	16.2	16.1
314	ROSALIA		11.2	1962	DEC 2	3.1476	5 6	4	1941 1952	-7.9	1967	31.5	49.1
315	CONSTANTIA		13.9	1962	DEC 2	2.2411	5 6	5	1928 1955	-90.0	1968	199.9	179.8
316	SOPHIA		11.0	1957	JUN 11	3.1659	5 6	4	1948 1959	-15.0	1969	47.5	74.6
317	POXANE		11.2	1957	JUN 11	2.2866	5 6	6	1949 1963	1.1	1967	10.4	9.7
318	MAGDALENA		10.4	1947	JAN 15	3.2096	5 6	5	1948 1960	-3.9	1969	23.5	37.7
319	LEONA		11.4	1962	DEC 2	3.3768	5 6	6	1938 1960	6.9	1966	19.3	33.2
320	KATHARTIA		11.7	1957	JUN 11	3.0157	5 6	4	1949 1954	.3	1969	8.3	12.2
321	FLORENTINA		11.4	1951	DEC 20	2.8855	5 6	5	1950 1958	14.4	1969	66.2	90.5
322	PHAFI		10.4	1930	MAR 5	2.7799	5 6	7	1948 1959	-24.2	1969	184.2	237.6
323	RUPTA		11.4	1967	MAY 30	2.3820	2 8	11	1946 1967	6.3	1967	15.8	15.8
324	RAMBEGA		8.1	1951	DEC 20	2.6815	5 6	5	1953 1959	72.0	1969	393.0	478.9
325	HEIDELBERGA		10.1	1947	JAN 15	3.1897	5 6	60	1928 1955	8.2	1969	26.9	42.7
326	TAMARA		10.1	1957	JUN 11	2.3180	5 6	5	1950 1960	3.5	1967	17.4	16.7
327	COLUMBIA		11.4	1951	DEC 20	2.7761	5 5	6	1942 1953	-72.0	1968	244.4	314.7
328	SUDRUM		10.0	1947	JAN 15	3.1107	5 6	6	1953 1963	-2.3	1969	20.0	30.5
329	SVFA		10.7	1957	JUN 11	2.4755	5 6	4	1948 1956	1.1	1967	11.5	12.3
330	ADALBERTA	L	13.5	1892	MAR 21	2.0893					1892*	640000.0	505293.3 LOST
331	ETHEPIDGEA		10.4	1947	JAN 15	3.0251	5 6	7	1951 1961	8.9	1966	48.7	71.4
332	SIFY		10.8	1949	DEC 30	2.7718	2 8	15	1921 1957	-86.9	1968	175.9	225.9
333	BADENIA		10.5	1947	JAN 15	3.1284	5 6	7	1951 1961	-32.9	1969	154.1	237.7
334	CHICAGO		8.6	1947	JAN 15	3.8854	5 6	7	1950 1960	-4.7	1968	28.8	60.2
335	ROBERTA		10.0	1957	JUN 11	2.4729	5 6	4	1955 1961	4.2	1969	23.0	24.6
336	LACADIERA		11.0	1957	JUN 11	2.2518	5 6	5	1952 1963	2.0	1969	13.1	11.9
337	DEVOSA		10.0	1965	JUL 19	2.3834	2 8	15	1936 1965	6.0	1969	15.9	15.9
338	RINDOSA		9.8	1959	FEB 1	2.9116	5 7	19	1914 1959	-93.7	1969	175.0	242.5
339	DROTHEA		10.5	1947	JAN 15	3.0087	5 6	4	1948 1960	-6.6	1968	33.7	49.1
340	EDUARDA		11.1	1951	DEC 20	2.7488	5 6	6	1954 1960	270.0	1969	1493.9	1893.5
341	CALIFORNIA		12.6	1957	JUN 11	2.1993	5 6	5	1941 1960	3.5	1969	15.9	13.8
342	ENDYMION		11.2	1951	DEC 20	2.5675	5 6	5	1952 1958	144.0	1966	753.2	855.8
343	OSTARA		12.7	1951	DEC 20	2.4106	5 6	5	1951 1959	-684.0	1969	2831.1	2894.5
344	DESIDERATA		9.3	1962	DEC 2	2.5964	5 6	5	1930 1953	-6.0	1968	16.6	19.2
345	TERCIDINA		10.1	1957	JUN 11	2.3252	5 6	7	1949 1961	6.5	1969	23.7	22.7
346	HEPHEMERTIA		9.1	1962	DEC 2	2.7953	5 6	10	1947 1966	4.1	1967	13.2	17.2
347	PAPIANA		10.2	1962	DEC 2	2.6115	5 6	10	1947 1964	-7.4	1968	20.7	24.1
348	MAY		10.8	1947	JAN 15	2.9682	5 6	8	1950 1958	-4.4	1967	31.6	45.1
349	DEMBOWSKA		7.3	1947	JAN 15	2.9244	5 6	7	1955 1962	13.5	1969	94.5	131.8
350	ORNAMENTA		10.0	1947	JAN 15	3.1097	5 6	6	1950 1962	-13.1	1968	59.6	91.1

A-8

STATUS OF NUMBERED MINOR PLANET EPHIMERIDES

NUMBER	NAME	NOTE	ABMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM
351	YRSA		10.3	1940 MAY 11	2.7652	5 6 6	1949 1961	4.8	1965	35.6	45.5
352	GISELA		11.6	1951 DEC 20	2.1943	5 6 6	1952 1950	72.0	1969	349.8	302.9
353	RUPERTO-CAROLA		12.3	1930 JAN 24	2.7354	2 8 6	1920 1952	-8.3	1968	35.7	44.9
354	ELEONORA		7.6	1962 DEC 2	2.7954	5 6 9	1947 1965	3.0	1966	11.3	14.7
355	SABTELLA		11.6	1942 MAY 1	2.5396	2 8 17	1943 1960	-6.5	1966	23.5	26.4
356	LIGURIA		9.1	1951 DEC 20	2.7576	5 6 5	1953 1959	72.0	1969	392.8	500.4
357	NININA		9.5	1957 JUN 11	3.1440	5 6 7	1949 1962	3.6	1969	15.0	23.2
358	APOLLONIA		10.3	1956 NOV 23	2.8803	2 8 13	1922 1957	-11.4	1969	29.4	40.0
359	GEORGIA		10.5	1951 DEC 20	2.7300	5 6 5	1952 1961	90.0	1966	368.9	462.5
360	CARLOVA		9.6	1948 MAR 30	3.0004	5 6 10	1934 1961	6.3	1968	21.4	31.0
361	BONONIA		9.6	1957 JUN 11	3.9333	5 6 6	1932 1959	3.9	1968	13.9	29.5
362	HAVNIA		9.9	1951 DEC 20	2.5788	5 6 5	1952 1959	35.0	1969	178.9	204.7
363	PADUA		10.1	1962 DEC 2	2.7463	5 6 10	1932 1964	-6.5	1968	17.1	21.6
364	ISABA		11.1	1957 JUN 11	2.2204	5 6 6	1950 1963	-6.9	1967	23.6	20.9
365	COPDUBA		10.4	1951 DEC 20	2.8018	2 8 9	1921 1956	14.4	1968	37.1	48.5
366	VINCENTINA		9.8	1947 JAN 15	3.1422	5 6 6	1955 1962	12.7	1968	86.0	133.6
367	AMICITIA		12.1	1957 JUN 11	2.2196	5 6 5	1949 1959	-6.3	1966	25.9	22.9
368	HAIDEA		11.1	1956 NOV 23	3.0798	2 8 10	1921 1958	-18.2	1969	41.4	62.4
369	AERIA		9.6	1951 DEC 20	2.6484	5 6 5	1952 1958	180.0	1967	939.0	1121.9
370	MODESTIA		11.7	1957 JUN 11	2.3244	5 6 6	1939 1960	2.7	1967	13.6	13.1
371	BOHEMIA		10.0	1957 JUN 11	2.7272	5 6 5	1951 1951	12.3	1966	39.1	49.0
372	PALMA		8.5	1957 JUN 11	3.1603	5 6 4	1955 1960	8.4	1969	41.9	65.6
373	MELUSINA		10.3	1947 JAN 15	3.1252	5 6 4	1950 1969	11.3	1968	43.3	66.6
374	RUPGUNDIA		10.0	1951 DEC 20	2.7800	5 5 6	1944 1953	-36.0	1967	140.8	181.6
375	URSULA		8.4	1957 JUN 11	3.1363	5 6 10	1938 1963	3.5	1965	13.2	20.5
376	GEOMETRIA		10.6	1957 JUN 11	2.2882	5 6 6	1947 1962	-8.6	1966	27.0	25.2
377	CAMPANIA		9.9	1951 DEC 20	2.6901	5 5 6	1942 1953	-432.0	1968	1422.8	1742.9
378	HOLMIA		11.1	1957 JUN 11	2.7757	5 6 4	1951 1957	2.6	1966	17.5	22.5
379	HUENNA		10.1	1947 JAN 15	3.1454	5 6 6	1952 1959	2.7	1969	25.1	39.1
380	ETIUDIA		10.6	1951 DEC 20	2.6788	5 6 5	1952 1957	36.0	1967	225.0	273.8
381	MYPPHA		9.6	1951 DEC 20	3.2003	5 5 4	1948 1953	288.0	1969	1563.4	2493.3
382	DODONA		9.8	1951 DEC 20	3.1298	5 6 5	1956 1962	9.8	1969	65.4	101.0
383	JANTNA		10.8	1962 DEC 2	3.1260	5 6 10	1936 1961	2.1	1969	0.4	14.6
384	RUFDIGALA		10.7	1962 DEC 2	2.6516	5 6 10	1931 1965	6.0	1968	16.1	19.2
385	ILMATAP		8.9	1957 JUN 11	2.8451	5 6 8	1952 1962	-6.0	1967	22.6	30.2
386	STEGENA		9.4	1957 JUN 11	2.8955	5 6 5	1953 1959	2.4	1968	15.7	21.6
387	AQUITANIA		9.0	1951 DEC 20	2.7384	2 8 18	1924 1954	69.8	1968	155.5	195.9
388	CHARYDIS		9.4	1957 JUN 11	3.0081	5 6 8	1948 1964	-3.0	1969	12.8	18.6
389	INDUSTRIA		9.3	1951 DEC 20	2.6085	5 6 5	1953 1958	36.0	1968	232.3	270.9
390	ALMA		11.5	1951 DEC 20	2.6518	5 6 5	1951 1960	450.0	1960	1759.0	2106.0
391	INGERORG		12.3	1957 JUN 11	2.3197	5 6 5	1932 1964	8.4	1967	22.7	21.7
392	WILHELMINA		10.6	1925 JAN 10	2.8847	2 8 7	1933 1955	-8.8	1964	51.1	69.8
393	LAMPETIA		9.2	1942 JAN 1	2.7808	2 8 12	1921 1957	11.1	1968	32.6	42.1
394	ARDUINA		10.9	1949 OCT 27	2.7620				1969	300.0	383.1 ESTIMATED
395	DELIA		11.5	1956 NOV 23	2.7878	2 8 7	1926 1957	15.7	1968	38.8	50.2
396	AELIA		11.2	1956 NOV 23	2.7423	2 8 7	1925 1959	-6.3	1966	19.3	24.4
397	VIENNA		10.3	1962 AUG 24	2.6355	2 8 6	1936 1962	-6.8	1962	18.7	22.1
398	ADMETE		12.0	1951 DEC 20	2.7361	2 8 6	1930 1957	96.1	1969	208.2	262.0
399	PERSEPHONE		10.6	1951 DEC 20	3.0593	5 5 10	1938 1956	180.0	1968	438.4	654.3
400	DICROSA		11.4	1957 JUN 11	3.1299	5 6 7	1938 1963	7.5	1969	20.8	32.1

LMSC-D420943

A-9

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	APMAG	EPOCH		A	PLANETS		OPPOSITIONS		RESIDUAL	LAST	ERROR SEC	ERROR KM3		
401	OTTILIA		10.2	1962	DEC	2	3.3366	5	6	10	1932	1963	6.9	1969	17.6	29.9
402	CHLOE		10.0	1951	DEC	20	2.5554	5	6	4	1949	1958	108.0	1965	435.3	456.9
403	CYANE		10.3	1949	SEP	6	2.8095	5	5	4	1938	1953	72.0	1965	211.2	277.0
404	ARSTINOE		9.9	1951	DEC	20	2.6915	5	6	4	1950	1958	25.7	1966	110.0	126.9
405	THIA		9.7	1951	DEC	20	2.5831	5	6	4	1950	1959	90.0	1967	349.2	400.7
406	ERNA		11.4	1962	DEC	2	2.9192	5	6	10	1933	1965	3.6	1969	11.7	16.3
407	BRACHNE		10.3	1951	DEC	20	2.6239	5	6	4	1953	1958	7.2	1969	53.7	63.3
408	FAMA		10.8	1962	DEC	2	3.1650	5	6	10	1938	1965	-3.8	1969	12.1	19.9
409	ASPASIA		8.6	1936	APR	22	2.5749	2	8	0	-0	-0	1.0	1969	149.7	170.9
410	CHLOPIS		9.7	1959	FEB	1	2.7261	2	8	21	1919	1959	-16.8	1965	37.2	46.6
411	XANTHE		10.2	1962	DEC	2	2.9363	5	6	6	1923	1956	10.4	1969	26.3	36.9
412	ELISARETHA		10.3	1931	NOV	15	2.7618	5	6	7	1948	1962	-5.3	1968	44.5	56.8
413	EDBURGA		11.1	1962	DEC	2	2.5841	5	6	5	1929	1965	4.6	1969	13.7	15.7
414	LIRIOPE		10.7	1962	DEC	2	3.5072	5	6	6	1949	1960	-90.0	1966	242.3	440.4
415	PALATTA		10.4	1960	JAN	7	2.7869	5	5	6	1941	1951	144.0	1968	524.6	679.5
416	VATICANA		9.4	1960	JAN	7	2.7887	5	6	7	1948	1958	2.9	1967	14.6	19.0
417	SUEVIA		13.7	1947	JAN	15	2.7998	5	6	6	1952	1962	2.6	1968	21.6	28.2
418	ALEMANNIA		10.8	1951	DEC	20	2.5923	5	6	4	1954	1958	-36.0	1967	270.2	322.2
419	AURELIA		9.6	1951	DEC	20	2.5955	5	6	4	1954	1959	360.0	1967	2313.2	2675.0
420	BERTHOLDA		9.4	1962	DEC	2	3.4213	5	6	11	1948	1965	-6.3	1965	17.4	30.5
421	ZAMBINGIA		13.0	1956	NOV	23	2.5376	2	8	7	1904	1957	31.3	1969*	63.9	71.2
422	BEROLINA		12.1	1957	JUN	11	2.2278	5	6	7	1941	1962	9.0	1968	26.2	23.3
423	DIOTIMA		8.5	1947	JAN	15	3.0661	5	6	7	1954	1961	9.2	1966	66.0	98.8
424	GRATIA		10.8	1951	DEC	20	2.7743	5	5	6	1948	1954	-252.0	1969	1184.8	1523.7
425	CORNELIA		10.8	1947	JAN	15	2.8862	5	6	5	1953	1962	-21.8	1969	118.7	162.3
426	HIPPO		9.6	1962	DEC	2	2.8872	5	6	10	1949	1966	4.4	1969	13.8	18.9
427	GALENE		10.7	1957	JUN	11	2.9777	5	6	4	1951	1964	7.4	1969	23.3	33.5
428	MONACHIA		12.9	1962	DEC	2	2.3075	5	6	5	1932	1965	8.4	1969	20.9	19.8
429	LOTIS		10.9	1951	DEC	20	2.6074	5	6	4	1954	1958	216.0	1967	1629.1	1898.0
430	HYRRYS		11.8	1951	DEC	20	2.8434	5	6	6	1940	1957	90.0	1966	225.7	301.6
431	NEPHELE		10.1	1951	DEC	20	3.1312	5	5	6	1943	1954	72.0	1968	237.4	366.7
432	PYTHIA		10.0	1951	DEC	20	2.3713	5	6	5	1953	1961	180.0	1969	797.2	792.4
433	EPUS		12.4	1941	JAN	6	1.4581	2	8	15	1926	1965	-1.2	1968	26.0	8.6
434	HUNGARIA		12.1	1957	JUN	11	1.9443	5	6	6	1938	1963	8.3	1968	24.9	17.1
435	ELLA		11.3	1942	FEB	10	2.4490	2	8	28	1898	1966	6.9	1966	23.3	24.4
436	PATRICIA		11.1	1962	DEC	2	3.1951	5	6	5	1949	1960	4.7	1969	17.7	28.2
437	RHODIA		11.6	1962	DEC	2	2.3864	5	6	6	1950	1964	-2.3	1968	11.0	11.1
438	ZEUZO		10.6	1951	DEC	20	2.5543	5	6	4	1953	1958	108.0	1969	678.9	764.8
439	OHIO		10.7	1951	DEC	20	3.1304	5	5	6	1937	1952	-36.0	1964	111.5	172.1
440	THEODORA		12.9	1964	NOV	1	2.2109	2	8	5	1941	1965	9.9	1969	23.7	20.9
441	PATHILDE		9.8	1962	DEC	2	2.8050	5	6	10	1939	1966	-4.7	1968	13.8	18.1
442	EICHSELDIA		11.2	1951	DEC	20	2.3455	5	6	5	1953	1958	324.0	1969	2018.6	1968.6
443	PHOTOGRAPHICA		11.6	1966	AUG	23	2.2156	2	8	12	1942	1966	7.2	1966	17.9	15.8
444	GYOTIS		9.4	1957	JUN	11	2.7694	5	6	5	1953	1959	70.1	1969	264.1	338.7
445	EONA		10.2	1947	JAN	15	3.1786	5	6	8	1950	1961	-12.9	1969	62.1	98.0
446	AETERNITAS		10.0	1953	JAN	23	2.7869	2	8	23	1899	1963	9.2	1969	23.3	30.2
447	VALENTINE		13.4	1957	JUN	11	2.9854	5	6	5	1954	1960	6.3	1969	29.9	43.1
448	NATALIE		11.0	1945	DEC	11	3.1355	5	5	11	1927	1954	109.0	1969	245.9	380.6
449	HAMBURGA		10.7	1948	MAR	30	2.5541	5	6	6	1948	1960	2.6	1968	19.3	21.7
450	PRIGITTA		11.3	1962	DEC	2	3.0137	5	6	4	1951	1956	4.5	1969	27.0	39.4

A-10

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMA	EPHOC	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KMS
451	PATENTIA		8.3	1947 JAN 15	3.0606	5 6 9	1950 1962	7.5	1967		38.2		57.1
452	HAMILTONIA	E	13.4	1900 JAN 1	2.8652	0 0 2	1970 1940	144.0	1969*		498.1		673.4
453	TEA		12.0	1966 NOV 11	2.1827	2 8 12	1936 1966	38.0	1969		69.9		60.0
454	MATHEUS		10.1	1951 DEC 20	2.6272	5 6 4	1953 1960	450.0	1969		2194.8		2588.5
455	APUCHSALIA		10.0	1951 DEC 20	2.4589	5 6 4	1952 1957	360.0	1969		2169.0		2608.0
456	ARNORA		11.0	1951 DEC 20	2.7833	5 6 4	1952 1960	90.0	1966		391.3		505.8
457	ALLEGHENIA		13.0	1939 OCT 9	3.0897	2 8 3	1900 1940	7.4	1969*		28.9		43.7
458	HEPCYNTA		10.6	1947 JAN 15	2.9899	5 6 7	1951 1962	-18.2	1969		85.7		123.6
459	SIGNE		11.9	1947 DEC 1	2.6208	5 5 6	1947 1955	252.0	1969		1175.9		1381.3
460	SCANTA		12.0	1951 DEC 20	2.7186	5 6 5	1952 1958	72.0	1967		380.9		474.5
461	SASKIA		11.6	1951 DEC 20	3.1163	5 5 6	1935 1949	-144.0	1966		460.0		706.0
462	EPTOPHYLA		10.8	1962 DEC 2	2.8722	5 6 7	1929 1963	3.3	1967		11.4		15.4
463	LOLA		12.9	1962 DEC 2	2.3978	5 6 5	1926 1967	-3.8	1967		12.4		12.6
464	MECATRA		10.4	1947 JAN 15	2.8021	5 6 5	1950 1960	8.3	1969		45.6		59.5
465	ALEKTO		11.0	1962 DEC 2	3.0981	5 6 4	1950 1962	-2.4	1968		11.0		16.7
466	TISTPHONE		9.2	1957 JUN 11	3.3753	5 6 7	1951 1958	6.3	1965		28.9		49.8
467	LAIRA		12.1	1952 JUL 7	2.9458	2 8 4	1924 1952	22.2	1969		57.4		81.0
468	LINA		10.6	1957 JUN 11	3.1520	5 6 6	1949 1959	.9	1966		9.2		14.3
469	ARGENTINA		10.0	1957 JUN 11	3.1525	5 6 9	1942 1964	-9.9	1969		25.1		30.2
470	KILIA		11.5	1951 DEC 20	2.4046	5 6 5	1953 1958	36.0	1969		232.8		237.0
471	PAPAGENA		7.9	1951 DEC 20	2.8872	2 8 10	1938 1956	16.9	1965		49.0		67.0
472	ROMA		10.6	1951 DEC 20	2.5420	5 6 4	1954 1958	-72.0	1966		549.3		613.9
473	NOLLI	L	11.2	1901 FEB 14	2.9792				1901*	642000.0	918091.0	LOST	
474	PRUDENTIA		11.9	1962 DEC 2	2.4547	5 6 6	1933 1961	9.0	1969		23.2		24.4
475	COLLO		12.4	1968 OCT 11	2.5946	2 8 7	1930 1968	4.1	1968		10.7		12.4
476	HEDWIG		9.8	1962 DEC 2	2.6487	5 6 9	1952 1968	-2.7	1968		10.5		12.6
477	ITALIA		11.5	1957 JUN 11	2.4155	5 6 6	1950 1951	10.1	1968		33.5		34.3
478	TERGESTE		8.9	1957 JUN 11	3.0134	5 6 9	1948 1964	2.7	1969		12.2		17.8
479	CAPPERA		11.0	1951 DEC 20	2.7212	5 6 5	1954 1959	-108.0	1968		700.1		873.4
480	HANSA		10.0	1951 DEC 20	2.6448	5 6 5	1952 1957	270.0	1967		1629.1		1942.1
481	EMITA		9.8	1956 NOV 23	2.7431	2 8 18	1921 1958	12.4	1969		30.9		39.0
482	PETRINA		10.1	1962 DEC 2	2.9954	5 6 6	1938 1959	-8.3	1966		23.2		33.6
483	SEPPINA		9.7	1962 DEC 2	3.4288	5 6 7	1941 1962	2.2	1969		9.5		16.8
484	PITTSBURGHIA		11.5	1951 DEC 20	2.6702	5 6 4	1953 1956	360.0	1969		3360.0		4078.4
485	GENUA		9.7	1956 NOV 23	2.7483	2 8 22	1918 1958	42.7	1963		86.4		109.5
486	CREMONA		12.3	1967 MAY 30	2.3523	2 8 6	1952 1967	-2.1	1967		8.6		8.5
487	VENETIA		9.6	1951 DEC 20	2.8695	5 6 5	1953 1959	-36.0	1967		201.0		243.2
488	KREUSA		9.0	1957 JUN 11	3.1477	5 6 7	1950 1961	2.7	1969		13.5		21.1
489	COMACINA		9.8	1957 JUN 11	3.1500	5 6 8	1939 1958	9.0	1969		27.0		42.1
490	VERITAS		9.5	1962 DEC 2	3.1746	5 6 10	1939 1964	7.2	1968		18.5		29.2
491	CAPINA		10.0	1962 DEC 2	3.1953	5 6 7	1941 1963	-4.4	1968		13.7		21.8
492	GISMUNDA		11.0	1962 DEC 2	3.1077	5 6 10	1933 1966	6.0	1969		15.5		23.7
493	GRISFELDIS		11.8	1951 DEC 20	3.1134	5 6 4	1943 1960	180.0	1960*		421.2		645.2
494	VIFTUS		10.1	1957 JUN 11	2.9863	5 6 6	1951 1959	-9.0	1969		34.9		50.3
495	FULALTA		11.6	1957 JUN 11	2.4878	5 6 4	1953 1961	-3.8	1968		19.0		20.5
496	ROPYHIA		13.0	1969 APR 29	2.1993	2 8 11	1936 1969	3.8	1969		10.4		9.0
497	TVA		10.7	1960 JAN 7	2.8517	5 5 6	1938 1952	180.0	1969		533.3		715.7
498	TOKIO		10.0	1962 DEC 2	2.6499	5 6 10	1931 1966	6.3	1967		16.4		19.7
499	VENUSTIA		10.2	1948 SEP 6	3.9634	5 6 5	1949 1958	-3.2	1967		22.1		47.5
500	SELINUP		10.6	1951 DEC 20	2.6125	5 6 5	1952 1959	72.0	1969		348.6		407.4

LMSC-D420943

A-II

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	FORMER SEC	FORMER KM3	
501	JPHXTIDUR		10.2	1951 DEC 20	3.1518	5 5	6 1931 1951	-288.0	1968	742.7	1158.2	
502	SIGUNF		12.3	1941 JUL 25	2.2876				1962	300.0	300.8	ESTIMATED
503	EVELYN		10.3	1947 JAN 15	2.7230	5 6	7 1950 1960	-10.1	1969	53.5	66.8	
504	CORA		11.1	1960 JAN 7	2.7213	5 5	4 1951 1956	-7.7	1969	40.9	51.0	
505	CAVA		10.1	1955 NOV 23	2.6864	2 8	13 1916 1959	-89.8	1965	170.4	208.3	
506	MARION		0.8	1947 JAN 15	3.0449	5 6	7 1951 1962	-7.5	1969	40.8	60.5	
507	LANDICA		10.4	1962 DEC 2	3.1530	5 6	10 1938 1965	-3.0	1968	10.6	16.6	
508	PRINCETONIA		9.5	1947 JAN 15	3.1507	5 6	8 1948 1960	9.0	1968	42.3	66.2	
509	TOLANDA		9.8	1962 DEC 2	3.0619	5 6	7 1942 1964	5.7	1969	16.0	23.9	
510	MABELIA		11.0	1951 DEC 20	2.6088	5 6	5 1953 1958	360.0	1969	2741.1	2613.3	
511	DAVIDA		7.1	1957 JUN 11	3.1908	5 6	9 1950 1961	2.0	1969	11.7	18.6	
512	TAURIMENSTS		12.2	1962 DEC 2	2.1893	5 6	5 1932 1958	4.8	1968	16.5	14.2	
513	CENTESTIMA		10.6	1951 DEC 20	3.0131	5 5	6 1943 1953	61.2	1969	216.5	315.9	
514	ARIDA		10.3	1951 DEC 20	3.0508	5 5	6 1939 1952	-180.0	1967	562.2	835.7	
515	ATHALIA		11.9	1903 SEP 3	3.1239	2 8	8 1903 1964	3.7	1969	30.9	47.6	
516	AMPERSTIA		0.5	1941 JAN 6	2.6788	2 6	10 1937 1959	-32.6	1969	100.8	122.7	
517	EDITH		10.5	1962 DEC 2	3.1377	5 6	10 1931 1963	6.9	1969	17.6	27.3	
518	MALAME		12.3	1951 DEC 20	2.5375	5 6	4 1943 1959	360.0	1963	864.3	963.1	
519	SYLVANIA		10.3	1967 APR 20	2.7886	2 8	13 1956 1967	5.2	1968	14.6	19.0	
520	FRANZISKA		11.9	1962 DEC 2	3.0079	5 6	4 1942 1969	-9.0	1968	20.3	29.6	
521	PRIXIA		10.0	1951 DEC 20	2.7403	5 6	4 1952 1959	360.0	1966	1706.0	2151.9	
522	HELGA		10.0	1962 DEC 2	3.6283	5 6	9 1939 1963	-3.6	1968	11.8	22.4	
523	ADA		10.7	1957 JUN 11	2.9622	5 6	8 1949 1964	4.7	1969	16.6	23.6	
524	FIDELIO		10.9	1951 DEC 20	2.6361	5 6	5 1952 1958	72.0	1967	381.1	451.9	
525	ANELATDE		13.2	1957 JUN 11	2.2453	2 6	3 1908 1957	-3.6	1968	14.7	13.3	
526	JENA		10.9	1962 DEC 2	3.1246	5 6	7 1934 1963	-2.7	1968	10.3	15.8	
527	EUPYANTHE		11.4	1951 DEC 20	2.7236	5 6	5 1953 1961	90.0	1968	402.7	503.0	
528	PEZIA		9.9	1948 JUL 28	3.3943	5 6	8 1951 1962	11.3	1969	54.0	93.6	
529	PREZIOSA		11.1	1950 AUG 27	3.0194	5 6	5 1951 1961	-15.2	1967	66.5	97.3	
530	TUPANOOT		10.0	1949 SEP 1	3.2174	5 6	5 1950 1957	4.7	1968	32.2	51.8	
531	ZEPHYNA		12.3	1904 APR 30	2.7848	2 8	2 1904 1955	4.1	1955*	33.8	43.8	
532	HERCULINA		8.0	1935 DEC 24	2.7728	2 8	0 -0 -0	1.6	1968	232.6	298.8	
533	SARA		11.2	1957 JUN 11	2.9822	5 6	4 1948 1958	-2.6	1967	14.4	20.6	
534	NASSOVIA		11.0	1962 DEC 2	2.8843	5 6	10 1928 1968	-7.4	1969	17.4	23.7	
535	MONTAGUE		10.5	1951 DEC 20	2.5687	5 5	6 1943 1953	144.0	1966	498.8	567.2	
536	MERAPI		0.4	1947 JAN 15	3.5047	5 6	5 1951 1959	-5.6	1969	37.6	68.3	
537	PAULY		10.1	1951 DEC 20	3.0689	5 5	6 1946 1952	-108.0	1968	530.4	795.3	
538	FRIEDRIKE		10.6	1951 DEC 20	3.1645	5 5	6 1938 1953	-108.0	1968	310.6	487.3	
539	PAMINA		11.1	1951 DEC 20	2.7390	0 0	5 1941 1956	144.0	1968	383.3	483.1	
540	ROSAMUNDE		12.2	1957 JUN 11	2.2188	5 6	7 1948 1964	9.8	1967	27.9	24.6	
541	DEBORAH		11.3	1951 DEC 20	2.8152	5 6	5 1955 1961	360.0	1966	2048.7	2695.4	
542	SUSANNA		10.3	1962 DEC 2	2.9041	5 6	6 1942 1964	4.1	1967	13.2	18.2	
543	CHAPLOTTE		10.6	1966 APR 5	3.0591	2 8	16 1935 1966	-5.1	1966	13.0	19.4	
544	JETTA		11.3	1951 DEC 20	2.5913	5 6	5 1952 1957	7.2	1967	52.4	60.4	
545	MESSALINA		9.5	1957 JUN 11	3.1715	5 6	7 1950 1960	-3.6	1966	16.3	25.7	
546	HERODIAS		10.8	1951 DEC 20	2.5966	5 6	5 1953 1958	270.0	1967	1683.2	1947.8	
547	PRAXEDIS		10.9	1956 NOV 23	2.7766	2 8	12 1904 1957	-25.0	1968	52.2	67.2	
548	KRESSIDA		12.6	1928 OCT 1	2.2821	2 8	20 1904 1962	-24.8	1969	63.2	58.8	
549	JESSONDA		11.8	1962 DEC 2	2.6825	5 6	6 1936 1958	180.0	1969*	390.3	476.0	
550	SENTA		10.4	1951 DEC 20	2.5889	5 6	5 1952 1958	-72.0	1969	381.2	439.0	

A-12

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAQ	EPDOH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
551	ORTFUD		10.5	1957 JUN 11	2.9705	5 6 8	1931 1958	8.4	1969	24.0	34.2
552	SIGFLINDE		10.4	1951 DEC 20	3.1531	5 5 6	1939 1953	-144.0	1968	419.7	654.9
553	KUNDRY		13.5	1967 SEP 7	2.2309	2 8 6	1932 1967	-6.8	1967	16.2	14.4
554	PERAGA		9.5	1965 JUN 9	2.3751	2 8 14	1938 1965	3.9	1969	12.2	12.2
555	NOOMA		11.7	1968 MAY 4	3.1564	2 8 6	1931 1958	-6.8	1968	14.7	23.0
556	PHYLLIS		10.6	1951 DEC 20	2.4668	5 6 6	1952 1960	90.0	1969	392.0	416.7
557	VIOLETTA		13.1	1951 DEC 20	2.4414	5 6 4	1949 1955	252.0	1967	1185.5	1238.6
558	CARMEN		10.1	1957 JUN 11	2.9080	5 6 7	1951 1962	-3.2	1969	14.8	20.4
559	NANON		10.6	1951 DEC 20	2.7146	5 6 5	1954 1959	180.0	1969	1160.9	1442.7
560	DELTA		11.8	1957 JUN 11	2.7502	5 6 4	1947 1957	7.7	1969	30.2	38.3
561	INGWFLÖE		12.0	1951 DEC 20	3.1613	5 5 5	1927 1953	-684.0	1965*	1534.1	2403.1
562	SALME		10.9	1947 JAN 15	3.0185	5 6 4	1951 1959	-9.0	1969	55.6	81.4
563	SULEIKA		9.6	1951 DEC 20	2.7126	5 6 5	1954 1959	-72.0	1969	469.7	583.1
564	DUDU		11.8	1962 DEC 2	2.7469	5 6 6	1948 1965	3.6	1969	12.7	16.1
565	VAFBACHIA		12.1	1951 DEC 20	2.4413	5 6 4	1954 1959	36.0	1968	239.9	250.7
566	STEFROSKOPIA		9.2	1947 JAN 15	3.3855	5 6 8	1950 1962	3.0	1969	20.5	35.5
567	ELEUTHERIA		10.5	1951 DEC 20	3.1520	5 5 6	1944 1952	72.0	1968	296.2	462.1
568	CHEPOSKIA		10.4	1957 JUN 11	2.8846	5 6 4	1952 1962	-107.9	1969	287.5	392.7
569	MISA		10.9	1962 DEC 2	2.6570	5 6 9	1949 1962	8.8	1969	26.1	31.4
570	KYTHEOP		10.1	1962 DEC 2	3.4444	5 6 10	1931 1962	3.3	1969	11.2	19.8
571	DULCINEA		12.9	1951 DEC 20	2.4110	5 6 4	1950 1959	72.0	1970	291.6	288.0
572	PEREKKA		11.9	1951 DEC 20	2.4009	5 6 4	1949 1956	72.0	1963	312.2	323.1
573	PECHA		10.8	1951 DEC 20	3.0119	5 5 6	1939 1952	-144.0	1967	451.5	658.4
574	PEGNHILD		13.8	1962 DEC 2	2.2527	5 5 5	1947 1966	3.9	1966	13.7	12.4
575	RENATE		12.4	1951 DEC 20	2.5535	5 6 4	1953 1958	36.0	1966	232.5	261.7
576	EMANUELA		10.7	1947 JAN 15	2.9889	5 6 6	1951 1961	10.5	1967	55.8	80.4
577	RHEA		10.8	1934 DEC 29	3.1115	2 8 9	1905 1954	-43.9	1966	95.3	145.8
578	HAPPELIA		10.5	1967 MAR 11	2.7489	2 8 9	1941 1967	6.3	1969	14.9	18.9
579	SIDONIA		9.4	1947 JAN 15	3.0145	5 6 8	1950 1962	-3.2	1969	21.8	31.8
580	SELENE		11.0	1957 JUN 11	3.2234	5 6 5	1942 1961	-8.1	1965	23.6	39.1
581	TAUNTONIA		11.0	1951 DEC 20	3.2170	5 5 4	1941 1951	10.8	1961*	47.1	75.6
582	GLYMPIA		10.5	1957 JUN 11	2.6111	5 6 5	1940 1959	7.2	1966	24.6	28.7
583	KLOYILDE		10.4	1957 JUN 11	3.1883	5 6 4	1945 1955	2.1	1967	13.3	21.1
584	SEMTRAMIS		10.0	1957 JUN 11	2.3734	5 6 4	1954 1962	4.5	1969	21.3	21.2
585	ATLKIS		11.5	1951 DEC 20	2.4314	5 6 4	1952 1959	216.0	1968	1027.9	1066.4
586	THEKLA		10.4	1962 DEC 2	3.0415	5 6 10	1930 1966	-2.8	1969	10.1	14.9
587	HYPSTPYLE		13.6	1962 DEC 2	2.3346	5 6 5	1932 1957	90.0	1968*	214.2	207.7
588	ACHILLES		9.4	1948 AUG 7	5.2112	5 6 9	1906 1931	-4.7	1967	22.5	68.7
589	CRONIA		10.1	1962 DEC 2	3.1300	5 6 5	1951 1964	3.2	1968	12.2	16.9
590	TCMYRIS		11.2	1951 DEC 20	3.0003	5 5 6	1944 1954	144.0	1965	483.6	701.2
591	IRMGARD		11.9	1951 DEC 20	2.6784	5 6 5	1951 1959	180.0	1969	751.5	914.2
592	BATHSERA		10.6	1962 DEC 2	3.0240	5 6 4	1951 1965	7.1	1966	19.6	28.8
593	TITANIA		10.5	1951 DEC 20	2.6980	5 6 5	1952 1957	108.0	1966	656.9	808.5
594	MIPFILLE		13.8	1949 SEP 1	2.6307	2 8 3	1906 1936	-49.5	1965	143.3	169.4
595	POLYXENA		9.3	1957 JUN 11	3.2092	5 6 9	1942 1960	5.9	1969	19.4	31.0
596	SCHILLA		9.8	1947 JAN 15	2.9301	5 6 6	1951 1962	9.9	1968	51.1	71.4
597	RANDIUSTA		10.8	1947 JAN 15	2.6721	5 6 6	1951 1962	-6.6	1968	37.8	45.8
598	OCTAVIA		9.9	1951 DEC 20	2.7635	5 6 5	1951 1958	180.0	1967	831.7	1063.0
599	LUISA		10.1	1951 DEC 20	2.7750	5 6 4	1952 1958	108.0	1967	566.8	729.2
600	MUSA		11.4	1951 DEC 20	2.6586	5 6 5	1953 1959	72.0	1968	393.0	472.5

A-13

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ABMAG	EPOCH		A	PLANETS		OPPOSITIONS		RESIDUAL	LAST	ERPO2 SEC	ERPO2 KM3			
601	NERTHUS		10.4	1923	JUN	30	3.1345	5	5	10	1923	1955	649.0	1967	1980.0	3063.3	
602	MARIANNA		9.7	1947	JAN	15	3.0884	5	6	8	1951	1963	-3.0	1969	21.2	32.0	
603	TIMANDRA		13.6	1906	MAR	11	2.5519	2	8	2	1906	1951	-6.1	1951*	40.9	46.0	
604	TEKMESSA		10.3	1957	JUN	11	3.1667	5	6	7	1951	1960	2.1	1968	12.7	19.9	
605	JUVISIA		10.6	1962	DEC	2	2.9996	5	6	6	1939	1961	-8.6	1967	22.6	32.8	
606	BRANIGANE		11.6	1951	DEC	20	2.5862	5	6	4	1952	1956	-36.0	1958	261.2	300.3	
607	JENNY		10.9	1947	JAN	15	2.8515	5	6	5	1950	1962	-9.0	1969	44.3	59.4	
608	ADOLFINE		11.9	1942	JUL	20	3.0259							1969	300.0	440.5	ESTIMATED
609	FULVIA		11.3	1962	DEC	2	3.0873	5	6	5	1948	1965	2.7	1969	10.6	16.0	
610	VALFKA		13.3	1942	MAY	1	3.0797							1957*	300.0	452.2	ESTIMATED
611	VALFOYA		10.6	1957	JUN	11	2.9780							1967	300.0	430.1	ESTIMATED
612	VERONIKA	L	12.4	1906	OCT	17	3.1389	2	8	1	1906	1906	7.2	1912*	640070.0	992171.0	LOST
613	GINEVRA		11.0	1947	JAN	15	2.9199	5	6	8	1951	1960	12.5	1966	69.4	96.6	
614	PIA		12.1	1962	DEC	2	2.6927	5	6	4	1949	1957	1.4	1968	10.5	12.9	
615	ROSWITHA		11.3	1951	DEC	20	2.6313	5	6	5	1952	1957	144.0	1969	873.1	1032.3	
616	FLLY		11.7	1951	DEC	20	2.5519	5	6	5	1955	1961	450.0	1962	2559.3	2878.7	
617	PATROCCLUS		9.2	1948	AUG	7	5.2068							1965	300.0	914.7	ESTIMATED
618	FLFRIEDE		9.6	1957	JUN	11	3.1843	5	6	8	1951	1962	4.4	1969	17.4	27.6	
619	TRIBECCA		11.2	1962	DEC	2	2.5195	5	6	7	1946	1958	4.5	1969*	18.0	19.8	
620	DRAKONTA		12.5	1951	DEC	20	2.4352	5	6	5	1950	1959	72.0	1962	281.6	292.9	
621	HERDANDI		11.8	1962	DEC	2	3.1191	5	6	5	1959	1958	-4.2	1969	68.3	105.0	
622	ESTHER		11.8	1951	DEC	20	2.4143	0	0	6	1945	1955	-252.0	1969	816.0	836.5	
623	HEKMAERA		11.5	1951	DEC	20	2.4591	5	6	4	1954	1959	36.0	1966	239.9	253.7	
624	HEKTOP		8.7	1948	AUG	7	5.1211							1969	300.0	896.1	ESTIMATED
625	XENTIA		11.1	1951	DEC	20	2.6470	5	6	4	1951	1956	90.0	1969	531.1	633.9	
626	NOTBURGA		10.1	1962	DEC	2	2.5719	5	6	9	1953	1967	-9.0	1967	22.6	25.8	
627	CHARIS		11.1	1951	DEC	20	2.9003	5	5	6	1940	1949	-72.0	1969	304.6	419.5	
628	CHRISTINE		10.5	1951	DEC	20	2.5810	5	6	4	1953	1958	-72.0	1966	455.6	522.1	
629	BERNARDINA		10.9	1966	OCT	22	3.1200	2	8	5	1935	1956	-6.8	1969	15.9	24.4	
630	EUPHENTIA		12.5	1968	JUL	23	2.6245	2	8	6	1930	1968	-6.6	1968	14.7	17.3	
631	PHILIPPINA		10.2	1956	NOV	23	2.7913	5	5	6	1920	1930	72.0	1969	417.8	542.4	
632	PYRROHA		13.3	1951	DEC	20	2.6630	5	6	4	1951	1959	72.0	1969	306.0	368.9	
633	ZELINA		11.1	1962	DEC	2	3.0170	5	6	7	1949	1959	6.0	1969	22.2	32.5	
634	UTR		11.1	1962	DEC	2	3.0444	5	6	6	1932	1959	3.5	1967	12.4	18.4	
635	VUNDTYA		10.1	1962	DEC	2	3.1341	5	6	8	1939	1964	11.6	1967	26.7	41.2	
636	ERIKA		10.7	1951	DEC	20	2.9101	5	6	4	1953	1957	-36.0	1969	269.6	373.2	
637	CHRYSOTHEMIS		12.0	1957	JUN	11	3.1532							1969*	300.0	468.2	ESTIMATED
638	MOYRA		11.1	1956	NOV	23	2.7357	2	8	9	1925	1957	-4.1	1968	15.5	19.5	
639	LATONA		9.4	1962	DEC	2	3.0192	5	6	10	1941	1965	-7.1	1967	9.2	13.4	
640	BRAMPILLA		10.4	1962	DEC	2	3.1665	5	6	5	1950	1964	-8.6	1968	23.1	36.3	
641	AGNES		13.7	1962	DEC	2	2.2194	5	6	4	1932	1960	.8	1966	8.1	7.2	
642	CLARA		10.8	1962	DEC	2	3.1715	5	6	5	1930	1963	-6.6	1969	17.1	26.9	
643	SCHNEPEZADE		10.6	1962	DEC	2	3.3454	5	6	6	1930	1957	-4.5	1967	14.5	24.7	
644	COSIMA		11.8	1962	DEC	2	2.5993	5	6	7	1926	1965	-3.3	1969	11.5	13.3	
645	AGIPPINA		11.1	1962	DEC	2	3.1798	5	6	8	1930	1964	9.5	1968	21.8	34.4	
646	KASTALIA		14.3	1953	AUG	11	2.3251	2	8	4	1937	1964	-34.5	1964	71.9	69.0	
647	ADELGUNDE		12.7	1951	DEC	20	2.4444	5	6	4	1949	1962	270.0	1964	819.5	858.0	
648	PIDPA		10.8	1957	JUN	11	3.1718	5	6	7	1941	1963	-5.9	1969	17.9	28.2	
649	JOSEFA		14.2	1951	DEC	20	2.5505	5	6	2	1952	1956	9.6	1967	76.5	85.9	
650	AMALASUNTHA		13.6	1907	SEP	22	2.4577	2	6	7	1907	1953	51.5	1968	173.1	182.8	

A-14

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
651	ANTIKLEIA		11.2	1962 DEC 2	3.0744	5 6 8	1928 1964	-6.0	1964	15.7	23.1
652	JUPYLATRIX		12.4	1962 DEC 2	2.5554	5 6 7	1937 1955	3.0	1967	13.3	15.0
653	BERENTKE		10.6	1962 DEC 2	3.0121	5 6 9	1927 1968	2.4	1968	9.3	13.5
654	ZELINDA		9.9	1957 JUN 11	2.2969	5 6 8	1950 1964	8.1	1965	25.4	23.9
655	RTISEIS		10.6	1957 JUN 11	2.9867	5 6 7	1941 1964	8.3	1969	22.3	32.2
656	BEACLE		11.2	1947 JAN 15	3.1683	5 6 6	1950 1960	-4.4	1967	28.2	44.3
657	SINLOD		12.0	1957 JUN 11	2.6120	5 6 4	1951 1961	9.0	1968	30.8	35.9
658	ASTEPHA		11.7	1951 DEC 20	2.8548	5 6 6	1952 1959	36.0	1969	178.4	239.8
659	NESTOR		9.7	1963 DEC 17	5.2582	2 8 14	1931 1964	-6.0	1967	14.8	45.7
660	CROSCENTIA		10.0	1962 DEC 2	2.5367	5 6 10	1948 1966	-7.5	1966	19.7	22.0
661	CLOFLIA		10.7	1951 DEC 20	3.0179	5 6 5	1952 1960	180.0	1967	773.4	1128.4
662	NEWTONIA		11.9	1951 DEC 20	2.5531	5 6 4	1953 1957	-144.0	1969	1053.3	1185.6
663	CEPLINDA		10.6	1962 DEC 2	3.0700	5 6 6	1948 1966	-3.9	1969	12.5	18.8
664	JUDITH		11.4	1962 DEC 2	3.1694	5 6 5	1930 1964	7.8	1964	18.8	29.6
665	SARINE		9.8	1957 JUN 11	3.1517	5 6 5	1951 1957	3.9	1967	22.2	34.7
666	DESDEMONA		12.0	1957 JUN 11	2.5932	5 6 4	1950 1967	-58.1	1967	143.0	165.1
667	DEMYSE		10.6	1965 JUL 19	3.1908	2 8 6	1936 1965	6.2	1965	15.4	24.4
668	DORA		13.4	1964 MAY 25	2.7781	2 8 5	1936 1959	-2.6	1969	10.5	13.7
669	KYPRIA		11.4	1962 DEC 2	3.0102	5 6 6	1943 1966	7.5	1966	18.8	27.4
670	OTTECFRE		11.2	1962 DEC 2	2.8049	5 6 10	1927 1968	-3.0	1969	10.5	13.7
671	CARNEGIA		11.2	1951 DEC 20	3.0974	5 6 4	1952 1960	270.0	1970	1155.8	1757.1
672	ASTARTE		12.4	1951 DEC 20	2.5549	5 6 4	1948 1956	72.0	1969	279.3	314.7
673	EDDA		11.2	1947 JAN 15	2.8154	5 6 6	1950 1959	4.5	1969	30.9	40.6
674	PACHELF		8.5	1951 DEC 20	2.9207	5 6 4	1953 1957	25.2	1967	191.3	266.3
675	LUDMILLA		9.3	1951 DEC 20	2.7714	5 6 5	1952 1957	21.6	1968	138.4	177.7
676	MELITTA		10.6	1962 DEC 2	3.0635	5 6 7	1931 1965	-3.5	1968	11.4	17.0
677	AALIFE		11.0	1941 JUN 15	2.9557	2 8 14	1906 1961	-24.4	1968	53.0	75.1
678	FREDEGUNDIS		10.7	1962 DEC 2	2.5739	5 6 8	1934 1967	7.1	1969	17.8	20.3
679	PAX		9.2	1954 SEP 15	2.5869	0 0 6	1939 1953	720.0	1969	2065.4	2375.6
680	GENOVEVA		10.9	1962 DEC 2	3.1305	5 6 10	1933 1966	-7.5	1966	19.1	27.9
681	GREGO		12.0	1962 DEC 2	3.1120	5 6 5	1932 1966	1.0	1966	7.0	10.7
682	HAGAR		13.6	1909 JUN 23	2.6321	2 8 2	1909 1951	-11.8	1951*	56.8	67.2
683	LANZIA		9.6	1947 JAN 15	3.1168	5 6 7	1947 1963	-3.0	1968	18.6	28.5
684	HILDRUPG		12.2	1957 JUN 11	2.4326	5 6 4	1954 1962	35.7	1969	114.8	119.2
685	HEFMYA		13.0	1924 DEC 21	2.2357	2 8 10	1900 1959	-18.8	1966	59.7	53.5
686	GERSUIND		11.5	1938 JUL 1	2.5884	2 8 7	1922 1955	-3.2	1968	19.6	27.6
687	TINETTE		13.0	1957 JUN 11	2.7222	5 6 4	1951 1963	9.6	1969	29.6	36.9
688	MELANTE		11.7	1951 DEC 20	2.6987	5 6 5	1949 1956	540.0	1967	2323.2	2860.4
689	ZITA		13.4	1968 APR 14	2.3155	2 8 10	1934 1968	-48.0	1969	82.1	78.3
690	HRATISLAVIA		8.9	1951 DEC 20	3.1589	5 5 6	1946 1953	-36.0	1968	162.5	254.3
691	LFHIGH		10.5	1962 DEC 2	3.0142	5 6 10	1938 1966	6.8	1968	17.1	24.9
692	HIPPODAMIA		10.2	1961 JUL 20	3.3617	5 6 5	1949 1956	-21.6	1969	38.7	151.9
693	ZEPHINETTA		10.5	1951 DEC 20	2.9434	5 5 6	1944 1953	-108.0	1969	404.5	569.8
694	EKARO		10.2	1962 DEC 2	2.6700	5 6 8	1948 1965	-11.0	1969	27.1	32.9
695	PELLA		9.8	1951 DEC 20	2.5391	5 6 5	1953 1960	360.0	1969	1757.9	1961.0
696	LEONORA		10.3	1962 DEC 2	3.1885	5 6 8	1951 1965	6.2	1968	17.7	28.0
697	GALILEA		10.4	1947 JAN 15	2.8813	5 6 5	1951 1960	5.0	1966	33.6	45.9
698	EPNESTINA		11.9	1962 DEC 2	2.8681	5 6 7	1937 1966	90.0	1968	160.7	217.6
699	HFLA		13.2	1943 MAR 17	2.6134	2 8 9	1902 1957	5.7	1969	71.6	25.3
700	AURAVICTRIX		12.5	1957 JUN 11	2.2293	5 6 5	1938 1960	2.6	1967	13.5	12.1

A-15

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		Δ	PLANETS	OPPOSITIONS		RESIDUAL	LAST	ERROR SEC	ERROR KM/3				
701	OPTOLA		10.6	1951	DEC	20	3.0119	5	5	5	1948	1955	75.6	1969	321.6	469.0	
702	ALAUDA		8.7	1962	DEC	2	3.1935	5	6	7	1953	1961	-1.4	1967	9.3	14.8	
703	NOEMI		13.7	1962	DEC	2	2.1750	5	6	5	1934	1958	14.2	1966	36.3	30.0	
704	INTERAMNIA		7.6	1962	DEC	2	3.0569	5	6	10	1939	1966	-3.8	1970	12.0	17.9	
705	ERMINTA		9.8	1951	DEC	20	2.9228	5	6	4	1953	1958	-216.0	1969	1347.8	1878.3	
706	HIPUNDO		12.1	1962	DEC	2	2.7296	5	6	6	1930	1959	6.8	1968*	19.1	23.9	
707	STETNA		13.5	1962	DEC	2	2.1806	5	6	8	1932	1957	-1.5	1968*	9.9	8.5	
708	RAPHAELA		11.8	1957	JUN	11	2.6717	5	6	5	1952	1960	-3.8	1969	18.7	22.6	
709	FRINGILLA		9.9	1949	JUN	13	2.9139	5	6	7	1951	1963	3.0	1968	19.9	27.6	
710	GERTRUD		12.2	1962	DEC	2	3.1430	5	6	5	1938	1967	-8.0	1969	18.8	29.3	
711	MARMULLA		12.6	1962	DEC	2	2.2373	5	6	6	1942	1968	3.4	1969	12.2	10.0	
712	BOLIVIANA		9.6	1954	SEP	15	2.5764	0	0	6	1950	1957	360.0	1967	1345.5	1537.3	
713	LUSCINTA		10.0	1957	JUN	11	3.4096	5	6	8	1930	1962	8.0	1964	20.9	36.5	
714	ULULA		10.3	1962	DEC	2	2.5352	5	6	9	1949	1965	9.0	1969	23.4	26.1	
715	TRANSVAALIA		11.1	1957	JUN	11	2.7679	5	6	6	1951	1962	2.7	1968	13.7	17.6	
716	REPKELEY		11.9	1962	DEC	2	2.8101	5	6	5	1950	1963	4.4	1968	15.4	20.3	
717	WISTBADA		12.0	1957	JUN	11	3.1385	5	6	4	1950	1956	10.8	1967	51.7	80.1	
718	EPIDA		10.8	1957	JUN	11	3.0522	5	6	8	1941	1963	-5.4	1968	17.1	25.4	
719	ALBERT	L	16.9	1911	OCT	11	2.5839	2	8	1	1911	1911	-8.4	1911*	640000.0	734723.3	LDST
720	BOHLINIA		10.9	1951	DEC	20	2.8858	5	5	6	1946	1954	-72.0	1969	278.6	380.8	
721	TABORA		10.5	1962	DEC	2	3.5539	5	6	5	1931	1964	-11.4	1968	25.1	46.4	
722	FRIEDA		13.2	1962	DEC	2	2.1718	5	6	6	1952	1965	9.0	1968	25.4	21.6	
723	HAMMONTA		11.4	1962	DEC	2	2.9975	5	6	6	1934	1967	3.2	1967	10.8	15.6	
724	HAPAG	L	14.8	1911	OCT	31	2.4506	2	8	1	1911	1911	-4.6	1911*	640000.0	672889.5	LDST
725	AMANDA		12.4	1927	MAR	21	2.5712	2	8	11	1911	1960	-15.6	1964	49.2	56.0	
726	JOELLA		12.1	1926	MAY	5	2.5656	2	8	9	1927	1963	2.7	1964	24.3	27.6	
727	NIPPONIA		11.3	1962	DEC	2	2.5672	5	6	5	1951	1967	8.7	1967	21.7	24.7	
728	LEONTIS		13.9	1912	FEB	28	2.2556	2	8	1	1912	1912	4.4	1960*	295.7	269.1	
729	WATSONIA		11.0	1957	JUN	11	2.7585	5	5	6	1940	1953	-72.0	1969	223.1	284.4	
730	ATHANASIA		14.8	1912	MAY	18	2.2436	2	8	2	1912	1966	-11.7	1969*	53.6	48.3	
731	SCPGA		10.6	1947	JAN	15	2.9852	5	6	6	1950	1959	-7.5	1968	44.6	64.1	
732	TJILAKI		12.0	1932	AUG	21	2.4569	2	8	9	1912	1954	6.1	1967	27.4	28.9	
733	MOCTA		10.2	1957	JUN	11	3.3911	5	6	4	1949	1960	3.6	1969	15.9	27.6	
734	RENDA		11.0	1951	DEC	20	3.1533	5	5	6	1944	1953	216.0	1967	800.2	1249.0	
735	MARGHANNA		11.0	1957	JUN	11	2.7280	5	6	5	1951	1961	-2.2	1969	14.7	18.4	
736	HARVARD		12.2	1962	DEC	2	2.2024	5	6	5	1933	1964	9.0	1967	22.6	19.7	
737	AREQUIPA		9.8	1951	DEC	20	2.5908	5	6	5	1953	1961	90.0	1969	402.9	464.6	
738	ALAGASTA		11.1	1951	DEC	20	3.0334	5	5	5	1948	1956	43.2	1969	170.4	251.1	
739	MANDEVILLE		10.1	1960	JAN	7	2.7378	5	6	7	1941	1956	19.5	1965	57.0	71.8	
740	CANTARIA		10.4	1957	JUN	11	3.0487	5	6	7	1948	1963	4.7	1968	16.8	24.9	
741	POTOLPHIA		11.4	1951	DEC	20	2.7235	5	5	6	1941	1954	-36.0	1969	114.1	142.6	
742	EDISONA		10.5	1951	DEC	20	3.0129	5	5	6	1945	1953	-108.0	1968	426.9	622.9	
743	EUGENIUS		11.3	1947	JAN	15	2.7950	5	6	7	1951	1962	17.7	1969	83.9	109.2	
744	AGUNTINA		11.2	1951	DEC	20	3.1730	5	5	6	1941	1953	144.0	1967	452.2	712.2	
745	MAURITIA		11.1	1962	DEC	2	3.2595	5	6	6	1924	1957	3.4	1969*	11.9	19.5	
746	MAFLU		10.6	1947	JAN	15	3.1129	5	6	5	1951	1958	5.7	1968	41.9	64.2	
747	WINCHESTER		8.8	1947	JAN	15	2.9944	5	6	4	1952	1958	2.3	1968	24.5	35.4	
748	SIMEISA		9.8	1942	DEC	27	3.9511	2	8	19	1913	1962	16.4	1969	37.9	81.0	
749	MALZOVIA		13.0	1964	SEP	2	2.2430	2	8	8	1934	1964	-2.3	1964	9.9	9.0	
750	OSKAR		13.0	1962	DEC	2	2.4420	5	6	6	1932	1966	4.2	1968	13.2	13.8	

A-16

LMSC-D420943

NUMBER	NAME	NOTE	APMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	EPHED	KM3
751	FATMA		10.1	1951 DEC 20	2.5520	5 6 4	1953 1959	180.0	1967	969.3		1090.3	
752	SILAMITIS		11.5	1957 JUN 11	2.4633	5 6 5	1952 1960	-3.5	1968	19.1		19.2	
753	TIFLIS		11.9	1930 JAN 24	2.3295	2 8 5	1938 1956	-2.6	1967	27.7		26.7	
754	MALABAR		10.5	1947 JAN 15	2.9856	5 6 4	1953 1963	-8.3	1968	47.7		68.7	
755	QUINTILLA		10.7	1962 DEC 2	3.1618	5 6 10	1927 1967	10.5	1968	22.4		35.0	
756	LILLIANA		11.3	1908 APR 29	3.2288	2 8 4	1909 1950	6.3	1967*	38.6		62.3	
757	PORTLANDIA		11.5	1962 DEC 2	2.3729	5 6 10	1939 1966	-8.6	1969	21.2		21.1	
758	MANCUNIA		9.3	1962 DEC 2	3.2017	5 6 10	1939 1976	-2.4	1969	8.6		13.8	
759	VINTFIPA		12.1	1962 DEC 2	2.6192	5 6 5	1926 1968	-4.5	1968	13.0		15.3	
760	MASSINGA		9.6	1951 DEC 20	3.1461	5 5 5	1939 1953	-90.0	1969	327.3		507.2	
761	BRENDLIA		11.9	1957 JUN 11	2.8632	5 6 4	1951 1957	9.2	1962	43.8		59.1	
762	PULCOVA		9.3	1947 JAN 15	3.1505	5 6 5	1956 1962	4.4	1969	40.9		63.7	
763	CUPIDO		13.9	1963 JUN 20	2.2403	2 8 6	1940 1963	-75.0	1963	149.7		134.6	
764	GERANIA		10.7	1947 JAN 15	3.1810	5 6 5	1951 1957	-11.1	1966	70.6		125.9	
765	MATTIACA		14.1	1925 JAN 10	2.5488	2 8 3	1913 1939	3.9	1969*	28.2		31.6	
766	MDCUNIA		10.9	1962 DEC 2	3.0224	5 6 8	1947 1965	5.4	1968	15.3		22.4	
767	ROMDIA		11.2	1951 DEC 20	3.1157	5 5 6	1939 1951	-180.0	1968	593.3		909.8	
768	STOUVEANA		11.4	1957 JUN 11	3.1319	5 6 4	1951 1962	-9.3	1968	29.5		45.6	
769	TATJANA		10.2	1957 JUN 11	3.1959	5 6 5	1939 1957	12.0	1968	34.6		55.1	
770	PALT		12.2	1957 JUN 11	2.2208	5 6 6	1951 1964	-9.3	1969	29.0		25.7	
771	LIFERA		11.7	1951 DEC 20	2.6531	5 6 4	1951 1960	90.0	1969	359.0		430.2	
772	TANETE		9.8	1947 JAN 15	2.9997	5 6 5	1952 1958	8.9	1968	67.4		97.7	
773	IRMINTRAUD		10.6	1957 JUN 11	2.8568	5 6 7	1951 1960	-6.0	1965	24.3		32.7	
774	ARMOR		10.0	1957 JUN 11	3.0430	5 6 5	1952 1960	9.6	1968	35.6		52.7	
775	LUMFEE		11.4	1951 DEC 20	3.0119	5 5 5	1943 1951	108.0	1968	453.9		661.9	
776	BERBERICIA		8.9	1962 DEC 2	2.9327	5 6 10	1947 1966	-1.6	1969	8.4		11.8	
777	GUTEMPERGA		11.3	1957 JUN 11	3.2178	5 6 5	1950 1962	1.7	1969	10.6		17.0	
778	THEOBALDA		11.6	1957 JUN 11	3.1710	5 6 5	1934 1960	-10.5	1969*	27.2		42.8	
779	VINA		9.7	1957 JUN 11	2.6650	5 6 5	1953 1958	-3.3	1968	21.8		26.3	
780	ARMENTA		10.2	1962 DEC 2	3.1152	5 6 6	1943 1963	3.3	1969	11.8		18.1	
781	KARTVELIA		10.6	1962 DEC 2	3.2369	5 6 5	1950 1961	-5.1	1969	18.2		29.6	
782	MONTEFIORE		12.6	1948 FEB 19	2.1797	5 6 6	1951 1960	14.1	1966	75.7		64.7	
783	MIRA		12.2	1962 DEC 2	2.3418	5 6 6	1943 1965	-7.1	1967	19.2		18.7	
784	PICKERINGIA		10.4	1957 JUN 11	3.0999	5 6 6	1950 1959	7.7	1960	20.8		45.4	
785	ZWETANA		10.5	1957 JUN 11	2.5757	5 6 5	1952 1961	-8.6	1969	31.3		35.8	
786	BREDICHTNA		10.1	1962 DEC 2	3.1624	5 6 9	1933 1966	-9.4	1966	21.3		33.3	
787	MOSKVA		11.4	1951 DEC 20	2.5406	5 6 5	1950 1956	324.0	1968*	1575.3		1759.0	
788	HOHENSTEINA		9.6	1951 DEC 20	3.1229	5 5 6	1942 1953	36.0	1963	126.1		194.0	
789	LENA		12.4	1962 DEC 2	2.6861	5 6 7	1949 1962	-1.6	1968	9.5		11.6	
790	PRETORIA		9.1	1962 DEC 2	3.3973	5 6 9	1939 1966	7.7	1966	18.5		32.2	
791	ANI		10.7	1957 JUN 11	3.1361	5 6 4	1948 1953	1.5	1968	14.8		22.9	
792	METCALFIA		11.2	1962 DEC 2	2.6220	5 6 8	1947 1967	5.0	1968	14.6		17.2	
793	ARIZONA		11.0	1947 JAN 15	2.7969	5 6 5	1949 1959	-8.0	1969	43.5		56.6	
794	IPENAEAE		12.4	1957 JUN 11	3.1567	5 6 5	1936 1958	10.1	1969	29.2		46.1	
795	FINT		10.8	1925 JAN 10	2.7499	2 8 16	1914 1955	33.0	1969	95.2		120.7	
796	SAPITA		10.4	1951 DEC 20	2.6362	5 6 4	1951 1956	108.0	1969	635.5		753.6	
797	MONTANA		11.7	1951 DEC 20	2.5359	5 6 5	1952 1958	180.0	1965	939.3		1045.6	
798	PUTH		10.7	1962 DEC 2	3.0145	5 6 5	1945 1964	-1.2	1966	7.8		11.3	
799	GUDULA		11.5	1957 JUN 11	2.5414	5 6 4	1952 1961	-7.5	1969	28.3		31.6	
800	KRESSMANNIA		12.7	1968 OCT 11	2.1926	2 8 7	1951 1968	3.0	1968	9.9		8.6	

A-17

LMSG-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NGTF	APMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3		
801	HELWERTHA	12.5	1963	MAY 31	2.6060	2 8	7 1915 1957	18.8	1967	40.5	47.1		
802	EPYXA	13.6	1915	MAR 20	2.1963				1970	300.0	260.1	ESTIMATED	
803	PICKA	10.7	1957	JUN 11	3.2064	5 6	9 1930 1962	8.7	1968	22.4	35.8		
804	HISPANIA	9.2	1947	JAN 15	2.8390	5 6	6 1951 1960	6.8	1969	42.3	56.4		
805	HORMUTHIA	10.6	1951	DEC 20	3.2205	5 5	5 1938 1952	144.0	1969*	429.9	691.9		
806	GULDENIA	11.2	1951	DEC 20	3.1986	5 5	6 1938 1952	684.0	1969	2011.3	3205.1		
807	CERASKIA	11.9	1957	JUN 11	3.0187				1969	300.0	438.9	ESTIMATED	
808	MERXIA	11.0	1956	NOV 23	2.7459	2 8	13 1921 1958	-32.5	1969	68.9	87.2		
809	LUNDIA	13.2	1951	DEC 20	2.2836	5 6	4 1950 1960	144.0	1967	514.0	478.2		
810	ATOSSA	14.2	1915	SEP 20	2.1790	2 8	7 1915 1962	-5.1	1969	36.4	31.1		
811	NAUHEIMA	11.8	1962	DEC 2	2.8980	5 6	7 1934 1964	4.5	1969	13.5	18.6		
812	ADELFI	12.5	1951	DEC 20	2.6589				1969*	300.0	360.7	ESTIMATED	
813	RAIMEIA	13.2	1957	JUN 11	2.2230	5 6	8 1947 1960	90.0	1968*	229.8	203.7		
814	TAURIS	10.0	1957	JUN 11	3.1794				1965	300.0	473.9	ESTIMATED	
815	COPPELIA	12.0	1963	MAY 31	2.6580	2 8	8 1916 1957	-7.9	1966	20.4	24.5		
816	JULIANA	11.4	1957	JUN 11	3.0022	5 6	6 1950 1951	1.5	1965	10.6	15.4		
817	ANNKA	12.0	1951	DEC 20	2.5884	5 6	4 1951 1959	72.0	1968	306.2	352.5		
818	KAPTEYNIA	10.4	1951	DEC 20	3.1763	5 5	6 1946 1953	180.0	1964	770.6	1229.8		
819	BARNARDIANA	13.2	1962	NOV 12	2.1975	2 8	10 1916 1959	15.2	1969	34.2	29.7		
820	ADRIANA	11.2	1957	JUN 11	3.1278	5 6	6 1951 1962	10.8	1968	33.2	51.2		
821	FANNY	12.5	1951	DEC 20	2.7746	5 6	7 1930 1962	360.0	1968	661.3	850.6		
822	LABAGE	12.6	1962	DEC 22	2.2556	2 8	7 1936 1962	180.0	1967	345.7	314.6		
823	SISIGAMRIS	12.8	1967	SEP 7	2.2214	2 8	9 1937 1967	-6.2	1969	15.3	13.5		
824	ANASTASTA	11.5	1957	JUN 11	2.7924	5 6	5 1934 1959	-4.8	1969	16.9	21.9		
825	TANINA	13.1	1962	DEC 22	2.2258	2 8	20 1916 1963	13.7	1969	29.9	26.6		
826	HENRIKA	12.5	1951	DEC 20	2.7135	5 6	7 1934 1956	90.0	1966*	209.4	260.0		
827	MOLFIANA	13.9	1924	DEC 21	2.2743	2 8	7 1916 1961	0.8	1964	42.4	39.1		
828	LINDEMANNIA	11.2	1957	JUN 11	3.1860	5 6	6 1950 1961	3.3	1968	15.0	23.8		
829	ACADEMIA	12.0	1962	DEC 2	2.5792	5 6	9 1929 1966	7.5	1969	18.5	21.2		
830	PETROPOLITANA	10.6	1947	JAN 15	3.2004	5 6	6 1950 1960	2.4	1968	19.6	31.2		
831	STATEIRA	L	13.6	1916	OCT 24	2.2143	2 8	1 1916 1916	-5.5	1916*	640000.0	563277.0	LOST
832	KASTN	12.1	1952	JUL 7	2.8637	2 8	6 1916 1958	-39.6	1969	81.0	109.4		
833	MONTCA	12.3	1951	DEC 20	3.0091	5 6	4 1942 1953	180.0	1963*	597.5	870.1		
834	BURNHAMIA	10.5	1962	DEC 2	3.1519	5 6	7 1950 1961	-3.0	1966	12.9	20.2		
835	OLIVIA	12.0	1962	DEC 2	3.2023	5 6	5 1930 1951	-5.7	1969	19.7	31.4		
836	JOLE	14.4	1925	JAN 0	2.1902	5 5	5 1903 1955	-46.2	1968*	110.6	95.4		
837	SCHWAPZSCHILDA	13.0	1962	DEC 2	2.2980	5 6	5 1923 1967	-3.3	1967	11.7	11.0		
838	SERAPHINA	11.3	1957	JUN 11	2.8968	5 6	4 1940 1959	4.5	1965	16.9	23.2		
839	VALROPG	11.8	1957	JUN 11	2.6158	5 6	4 1953 1962	3.0	1966	15.7	18.4		
840	ZENOBIA	10.6	1951	DEC 20	3.1280	5 6	7 1927 1956	-90.0	1970*	194.5	300.0		
841	APABELLA	13.6	1962	DEC 2	2.2546	5 6	5 1933 1960	-7.8	1969*	21.8	19.8		
842	KEPSTIN	11.8	1969	OCT 11	3.2163	2 8	5 1939 1968	5.1	1968*	12.1	19.5		
843	NICOLATA	L	14.3	1916	OCT 4	2.2790	2 8	1 1916 1916	-4.3	1916*	640000.0	593289.4	LOST
844	LEONTINA	10.7	1957	JUN 11	3.1889	5 6	8 1950 1961	4.4	1967	17.8	28.3		
845	NAFMA	11.2	1957	JUN 11	2.9381	5 6	7 1939 1960	3.8	1966	14.8	20.8		
846	LYPPEPTA	11.5	1957	JUN 11	3.1430	5 6	4 1951 1954	-4.5	1966	41.2	63.9		
847	AGNIA	11.4	1962	DEC 2	2.7820	5 6	6 1939 1957	9.0	1967	26.7	34.4		
848	INNA	11.9	1951	DEC 20	3.1122	5 6	9 1934 1959	90.0	1968	191.9	293.8		
849	ARA	9.0	1962	DEC 2	3.1570	5 6	10 1926 1966	-8.0	1966	18.5	28.9		
850	ALTONA	10.7	1962	DEC 2	2.9990	5 6	4 1950 1964	-9.0	1964	24.1	34.9		

A-18

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ABMAG	EPHOC	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KMS
851	ZEPHYRA		13.0	1959 FEB	21	2.2281	2 8 8 1934 1959	5.6	1962		19.0		16.9
852	VLADILENA		11.4	1961 NOV	17	2.3631	2 8 9 1923 1960	-6.8	1967		19.1		18.9
853	NANSENIA		12.6	1966 AUG	23	2.3122	2 8 11 1938 1966	-180.0	1969	313.7		298.3	
854	FROSTIA		13.4	1961 DEC	27	2.3680	2 8 7 1942 1960	-24.0	1968		58.6		58.1
855	NEWCOMBIA		12.9	1967 APR	20	2.3619	2 8 5 1938 1967	1.3	1967		6.9		6.8
856	BACKLINDA		12.0	1957 JUN	11	2.4363	5 6 4 1950 1962	15.0	1966		42.7		44.4
857	GLASENAPPIA		12.8	1962 NOV	12	2.1908	2 8 14 1920 1962	-6.7	1968		12.3		15.8
858	EL DJEZAIR		11.5	1962 DEC	2	2.8081	5 6 5 1941 1964	3.8	1969		12.7		16.7
859	BOUTAZPEAH		11.0	1947 JAN	15	3.2056	5 6 7 1948 1961	2.6	1968		18.4		29.5
860	URSYNA		10.8	1957 JUN	11	2.7958	5 6 4 1956 1961	5.0	1965		29.1		37.8
861	AYDA		10.9	1957 JUN	11	3.1501	5 6 5 1951 1958	-3.0	1968		17.4		27.1
862	FRANZIA		11.3	1957 JUN	11	2.8026	5 6 5 1950 1960	26.7	1969		79.1		103.4
863	RENKOELA		10.3	1962 DEC	2	3.1951	5 6 6 1948 1960	10.4	1966		31.3		49.8
864	(=1078)		12.9	1951 DEC	20	2.2697	5 6 6 1950 1965	-180.0	1969	526.1		484.1	
865	ZURATDA		13.2	1962 DEC	2	2.4154	5 6 4 1934 1966	4.5	1968		12.8		14.1
866	FATME		10.4	1957 JUN	11	3.1236	5 6 4 1951 1958	-1.4	1969		11.7		18.0
867	KOVACIA		12.2	1962 DEC	2	3.0726	5 6 5 1928 1958	-90.0	1958*	182.4		274.0	
868	LOVA		11.2	1962 DEC	2	2.7022	5 6 10 1930 1963	7.4	1966		19.0		23.4
869	MELLENA		13.3	1964 NOV	1	2.6908	2 8 7 1917 1962	-10.7	1966		23.7		29.1
870	NANTO		13.0	1924 DEC	21	2.3217	2 8 8 1917 1960	-18.3	1964		63.7		61.0
871	AMNFRIS		13.8	1967 JUN	19	2.2223	2 8 6 1930 1967	-6.6	1967		15.8		14.0
872	HOLDA		11.2	1962 DEC	2	2.7300	5 6 7 1939 1962	-6.2	1968		17.9		22.4
873	WECHTHILD		12.4	1962 DEC	2	2.6270	5 6 9 1930 1965	6.0	1969		16.1		19.0
874	ROTPAUT		11.0	1962 DEC	2	3.1579	5 6 4 1933 1962	3.0	1969		10.9		17.0
875	NYMPHE		12.8	1949 DEC	30	2.5539	2 6 5 1917 1950	37.1	1966		90.8		102.3
876	SCOTT		12.0	1962 DEC	2	3.0134	5 6 4 1942 1965	.8	1965		6.9		10.0
877	WALKURE		11.8	1957 JUN	11	2.4858	5 6 4 1954 1958	6.9	1969		42.1		45.3
878	MILDRED		16.6	1916 OCT	4	2.3633	2 8 2 1916 1938	17.6	1938*	92.0		90.9	
879	PICARDA		12.8	1917 JUL	31	2.5298	2 8 3 1917 1949	-5.3	1949*	36.6		40.6	
880	HEPRA		13.1	1951 DEC	20	3.0093	5 6 5 1917 1943	90.0	1969*	243.8		355.1	
881	ATHENE		13.6	1936 NOV	8	2.6121	2 8 4 1917 1959	6.2	1964*	25.4		29.6	
882	SWEFLANA		11.6	1962 DEC	2	3.1329	5 6 7 1934 1967	90.0	1967	155.3		240.1	
883	MATTERANIA		13.7	1924 DEC	21	2.2384	2 8 9 1917 1961	5.8	1964		33.2		29.8
884	PRIANUS		9.9	1965 AUG	28	5.1855	2 8 13 1930 1965	3.0	1965		9.0		27.2
885	ULPIKE		11.8	1966 OCT	2	3.1009	2 8 10 1937 1966	90.0	1966	159.4		242.8	
886	WASHINGTONIA		10.3	1943 APR	26	3.1485	2 8 5 1928 1951	3.2	1969		18.2		28.3
887	ALINDA		16.3	1958 FEB	6	2.5158	2 8 8 1918 1957	4.4	1970*	15.6		17.1	
888	PARYSATIS		11.0	1962 DEC	2	2.7097	5 6 8 1927 1965	-8.6	1969		20.2		25.1
889	EPYNTA		12.3	1962 DEC	2	2.4460	5 6 4 1933 1965	2.7	1968		10.8		11.3
890	WALTRAUT		11.4	1967 JUL	29	3.2031	2 8 12 1934 1967	-90.0	1967	153.9		245.8	
891	GUNHILD		11.3	1956 NOV	23	2.8596	5 7 12 1918 1958	-7.4	1967		20.9		28.2
892	SEELIGERIA		10.7	1962 DEC	2	3.2365	5 6 5 1936 1961	1.8	1966		8.8		14.2
893	LEOPOLDINA		10.8	1947 JAN	15	3.0506	5 6 6 1949 1962	-6.2	1967		31.9		47.4
894	EPDA		11.0	1951 DEC	20	3.1169	5 5 6 1936 1952	-102.0	1969	305.3		468.4	
895	HELTO		9.8	1964 JUN	14	3.2033	2 8 9 1937 1964	3.4	1968		10.9		17.4
896	SPHINX		13.0	1959 FEB	1	2.2853	2 8 8 1918 1959	9.8	1967		25.3		23.6
897	LYSISTRATA		12.2	1962 DEC	2	2.5433	5 6 8 1950 1962	-90.0	1969	216.0		241.6	
898	WILDFGARD		13.5	1949 DEC	30	2.7314	2 8 6 1918 1951	-97.2	1967	218.6		274.3	
899	JOKASTE		11.5	1951 DEC	20	2.9095	5 6 4 1952 1957	45.0	1968		278.6		385.6
900	ROSALINDE		13.0	1962 DEC	2	2.4730	5 6 6 1937 1968	5.9	1969		15.8		16.9

LMSC-D420943

A-19

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPHOC	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KMS
901	REUNISTA		12.8	1963 JAN 31	2.2245	2 8	10 1905 1961	-10.2	1968		23.6		20.9
902	PROFITAS		13.6	1951 DEC 20	2.4468	5 6	5 1918 1958	180.0	1968		342.5		359.2
903	NEALLEY		10.8	1947 AUG 3	3.2445	2 8	4 1918 1947	5.7	1969*		22.8		37.0
904	POCKEFFELTA		11.4	1968 MAY 24	2.9009	2 8	6 1933 1968	-1.3	1969		5.9		9.5
905	UNIVERSITAS		12.3	1962 DEC 2	2.2163	5 6	4 1951 1959	.8	1967		9.1		8.0
906	REPSOLDA		10.7	1947 JAN 15	2.8945	5 6	3 1950 1962	-3.2	1969		22.0		30.2
907	PHODA		10.7	1944 MAY 30	2.9002				1968		300.0		391.4 ESTIMATED
908	BUDA		12.1	1962 DEC 2	2.4741	5 6	6 1931 1964	-6.2	1967		17.0		18.1
909	ULLA		9.6	1962 DEC 2	3.5513	5 6	9 1926 1963	4.6	1969		13.1		24.3
910	ANMELIESF		11.3	1951 DEC 20	2.9319	5 5	5 1939 1950	216.0	1966		774.4	1084.3	
911	AGAMEMNON		8.9	1963 DEC 17	5.1536	2 8	10 1935 1964	-4.6	1969		12.5		37.7
912	MASTITIMA		9.4	1957 JUN 11	3.1254	5 6	4 1950 1958	12.2	1969		46.3		71.4
913	OTILA		13.8	1919 MAY 22	2.1973	2 8	9 1909 1962	7.8	1968		39.2		34.0
914	PALISANA		10.5	1962 FEB 5	2.4545	2 8	16 1919 1962	0.2	1969		22.2		23.4
915	COSETTE		13.1	1962 DEC 2	2.2281	5 6	5 1951 1964	-5.3	1964		18.0		16.0
916	AMERICA		12.7	1962 DEC 2	2.3650	5 6	7 1951 1964	3.0	1969		12.7		12.6
917	LYKA		12.6	1963 APR 21	2.3812	2 8	17 1919 1963	12.0	1966		26.4		26.4
918	ITHA		12.1	1962 DEC 2	2.8635	5 6	8 1936 1963	180.0	1968		338.9		457.8
919	ILSEBILL		12.4	1951 DEC 20	2.7715	2 8	5 1918 1953	4.9	1969		18.9		24.3
920	ROBERTA		12.0	1969 JUN 8	2.6208	2 8	8 1940 1969	3.9	1969		10.1		11.9
921	JOVITA		11.2	1964 SEP 2	3.1789	2 8	6 1935 1964	6.9	1964		17.1		27.1
922	SCHLUTIA		13.1	1951 DEC 20	2.6879	5 6	5 1937 1963	90.0	1963*		175.1		214.2
923	HERLUGA		12.8	1949 JUN 13	2.6148	2 8	7 1919 1961	4.1	1969		16.9		19.8
924	TONT		10.5	1947 JAN 15	2.9355	5 6	6 1951 1961	14.1	1969		71.7		100.6
925	ALPHONSINA		8.7	1951 DEC 20	2.7001	5 5	9 1940 1954	180.0	1969		510.4		628.9
926	IMMILDE		11.7	1947 JAN 15	2.9789	5 6	5 1951 1962	29.6	1968		133.4		191.3
927	RATISBONA		10.2	1957 JUN 11	3.2176	5 6	8 1943 1964	8.7	1969		23.2		37.2
928	HILDRUN		10.8	1966 JUN 24	3.1424	2 8	9 1946 1966	-3.9	1966		11.3		17.5
929	ALGUNDE		13.7	1967 MAR 11	2.2388	2 8	7 1944 1967	4.5	1967		12.7		11.4
930	WESTPHALIA		12.6	1962 DEC 2	2.4301	5 6	7 1940 1962	90.0	1966		182.1		189.7
931	WHITTEMORA		10.5	1957 JUN 11	3.1607	5 6	6 1942 1962	3.0	1968		12.6		19.8
932	HOOVERIA		10.8	1941 JAN 6	2.4194	2 6	8 1942 1958	45.1	1967		170.6		175.5
933	SUSI		13.5	1950 APR 29	2.3699	2 8	6 1927 1956	-29.8	1967		71.7		71.2
934	THURINGIA		11.5	1957 JUN 11	2.7476	5 6	4 1952 1961	2.0	1969		12.7		16.1
935	CLIVIA		14.3	1920 OCT 23	2.2189	2 8	6 1920 1963	5.0	1963*		34.2		30.2
936	KUNIGUNDE		11.2	1951 DEC 20	3.1423	5 5	6 1946 1953	72.0	1968		316.8		492.0
937	BETHGEA		13.2	1950 APR 29	2.2314	2 8	8 1916 1953	-7.5	1969		25.7		23.0
938	CHLOSTINDE		12.4	1962 DEC 2	3.1742	5 6	4 1934 1965	4.8	1965		13.7		21.5
939	ISPERGA		13.4	1962 DEC 2	2.2474	5 6	9 1937 1957	90.0	1967		209.0		189.0
940	KOROLA		10.5	1957 JUN 11	3.3899	5 6	8 1949 1963	5.4	1969		18.0		31.2
941	MURRAY		12.1	1957 JUN 11	2.7798	5 6	3 1948 1957	-102.8	1966		338.3		436.4
942	ROMILDA		11.6	1962 DEC 2	3.1629	5 6	5 1931 1968	8.0	1968		18.3		28.6
943	PEGONIA		11.0	1951 DEC 20	3.1131	5 5	5 1949 1956	-126.0	1968		548.3		839.8
944	HIDALGO		12.0	1964 MAY 5	5.8201	2 8	11 1920 1964	-4.5	1964*		11.5		40.2
945	BARCELONA		11.4	1961 NOV 17	2.6396	2 8	12 1921 1962	-13.9	1968		30.5		36.3
946	POESIA		11.4	1957 JUN 11	3.1235	5 6	5 1947 1963	-4.8	1963*		16.6		25.5
947	MINTEROSA		11.0	1951 DEC 20	2.7511	5 6	5 1953 1959	90.0	1969		488.8		620.4
948	JUCUNDA		12.4	1962 DEC 2	3.0333	5 6	5 1932 1953	270.0	1966		661.1		974.3
949	HEL		11.0	1957 JUN 11	2.9927	5 6	7 1947 1963	7.5	1968		22.3		32.2
950	AHRFNSA		12.5	1924 FEB 4	2.3710	2 8	8 1921 1959	-3.3	1969		25.2		25.0

A-20

LMSC-D420943

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	SEPAR	SEC	APPROX	KM2
951	GASPARA		13.1	1962 DEC 22	2.2098	2 8	12 1976 1962	-5.6	1968		16.6		14.5
952	GATA		10.4	1951 DEC 20	2.9845	5 5	6 1941 1952	-252.0	1967		956.1		1231.4
953	PAINLEVA		11.6	1957 JUN 11	2.7893	5 6	4 1952 1959	-2.6	1969		16.0		20.7
954	LI		11.8	1957 JUN 11	3.1312	5 6	4 1949 1961	5.9	1969		20.9		32.3
955	ALSTEDF		12.7	1962 DEC 2	2.5941	5 6	9 1933 1967	180.0	1967*		302.4		349.4
956	FLISA		13.6	1925 JAN 10	2.2981	2 8	8 1921 1959	-51.0	1963*		157.6		143.6
957	CAMELIA		11.1	1962 DEC 2	2.9192	5 6	8 1926 1966	-3.9	1966		11.9		16.6
958	ASPLINDA		11.1	1957 JUN 11	3.9442				1961*		300.0		640.2
959	ARNE		11.9	1951 DEC 20	3.1917	5 6	4 1927 1957	-180.0	1969		368.2		584.9
960	BIRGIT		14.2	1921 OCT 19	2.2484	2 8	7 1921 1958	12.2	1968*		55.3		50.0
961	GUNNIE		12.5	1962 DEC 2	2.6932	5 6	4 1934 1956	2.7	1965		11.8		14.5
962	ESLIG		12.7	1921 NOV 7	2.9048	2 8	11 1916 1963	-7.5	1963		35.6		49.2
963	TOUBERGA		13.6	1921 OCT 19	2.2478	2 8	6 1921 1960	9.8	1968*		47.7		43.1
964	SURAYARA		12.0	1962 DEC 2	3.0477	5 6	4 1950 1963	90.0	1968		206.2		306.0
965	ANGELICA		11.8	1925 JAN 10	3.1676	2 8	7 1921 1938	74.3	1969		316.7		497.6
966	MUSCHT		11.2	1961 NOV 17	2.7177	2 8	16 1921 1960	-10.1	1969		24.4		30.4
967	HELTENAPE		13.3	1957 JUN 11	2.2255	5 6	4 1950 1954	3.2	1967		27.4		24.4
968	PETUNIA		11.4	1962 DEC 2	2.9663	5 6	4 1935 1957	2.7	1969		11.5		15.5
969	LECCADIA		13.4	1921 DEC 17	2.4622	2 8	6 1921 1963	-8.3	1966		41.2		43.7
970	PRIMILA		13.5	1962 DEC 2	2.5625	5 6	6 1929 1966	-180.0	1969		307.6		348.3
971	ALSATIA		11.3	1951 DEC 20	2.6411	5 6	5 1953 1959	450.0	1964		2409.1		2865.5
972	COHNTA		10.8	1951 DEC 20	3.0611	5 5	6 1942 1953	-108.0	1968		361.8		540.5
973	APALIA		11.0	1962 DEC 2	3.2275	5 6	9 1931 1968	-3.4	1969		10.8		17.4
974	LICRA		11.8	1951 DEC 20	2.5333	5 6	5 1952 1959	72.0	1968		348.7		387.6
975	PERSEVERANTIA		11.4	1949 DEC 30	2.8345	2 8	9 1922 1953	-33.8	1969		81.2		109.0
976	BENJAMINA		10.6	1962 DEC 2	3.1827	5 6	6 1950 1963	-4.5	1968		15.3		24.2
977	PHILIPPA		10.8	1947 JAN 15	3.1188	5 6	5 1951 1958	15.0	1967		95.1		146.0
978	ATOAMINA		10.8	1962 DEC 2	3.1953	5 6	5 1950 1958	5.1	1969		21.9		34.8
979	ILSEHA		11.0	1962 DEC 2	3.1444	5 6	4 1951 1960	-3.9	1968		16.6		25.8
980	ANACOSTIA		9.3	1962 DEC 2	2.7399	5 6	10 1938 1966	9.1	1966		19.6		24.7
981	MARTINA		12.2	1966 OCT 2	3.1026	2 8	8 1906 1966	-5.7	1969		13.4		20.4
982	FRANKLINA		11.4	1947 JAN 15	3.0692	5 6	5 1950 1960	-11.1	1966		57.2		85.7
983	GUNILA		10.8	1947 JAN 15	3.1688	5 6	5 1955 1961	-1.8	1968		21.9		34.4
984	GREYIA		10.8	1954 SEP 15	2.8042	2 8	12 1922 1955	-16.9	1969		42.2		55.2
985	ROSTINA		14.2	1963 JAN 31	2.3001	2 8	4 1922 1950	-10.6	1965		30.3		28.6
986	AMELIA		10.8	1951 DEC 20	3.1377	5 5	4 1942 1953	-10.8	1967		43.6		67.6
987	WALLTA		10.7	1947 JAN 15	3.1348	5 6	7 1950 1960	10.5	1966		54.5		84.3
988	ARPELLA		12.5	1962 DEC 2	3.1609				1966*		300.0		469.9
989	SCHWASSMANNIA		13.4	1941 JAN 6	2.6591	2 8	6 1922 1961	55.6	1965		113.2		136.1
990	YERKES		13.0	1962 DEC 2	2.6701	5 6	7 1933 1965	-4.5	1965		13.5		16.4
991	MCDONALDA		11.9	1951 DEC 20	3.1344	5 6	5 1922 1954	90.0	1966		193.9		300.0
992	SWASEY		12.2	1962 DEC 2	3.0227	5 6	8 1935 1967	-180.0	1969		303.5		445.0
993	MOULTONA		13.4	1951 DEC 20	2.9601	5 6	5 1923 1943	90.0	1969		274.2		369.6
994	CYTHILO		11.5	1962 DEC 2	2.5308	5 6	9 1943 1967	12.9	1969		28.0		31.1
995	STEFENBERGA		14.6	1951 DEC 20	2.6164	5 6	5 1949 1957	324.0	1969		1264.6		1481.6
996	HELAFITAS		11.7	1969 JUL 23	3.0949	2 8	8 1931 1968	4.0	1969		10.2		15.5
997	PRISKA		13.1	1962 DEC 2	2.6709	5 6	3 1923 1958	8.8	1968		22.6		27.4
998	RODEA		12.2	1951 DEC 20	3.1176	5 6	4 1923 1946	-90.0	1938*		247.0		379.1
999	ZACHIA		12.4	1962 DEC 2	2.6117	5 6	8 1940 1965	90.0	1969		167.9		196.1
1000	PIZZZIA		11.4	1962 DEC 2	3.2007	5 6	4 1944 1962	3.2	1969		11.8		18.9

ESTIMATED

ESTIMATED

A-21

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1001	GAUSSIA		10.6	1962 DEC 2	3.1843	5 6	10 1933 1965	-4.5	1969	13.0	20.6
1002	OLDFESTA		12.1	1956 NOV 23	2.7874	2 8	7 1923 1958	-5.1	1960	17.1	22.2
1003	LILDFEE		11.3	1962 DEC 2	3.1609	5 6	6 1946 1965	4.2	1968	13.3	20.8
1004	BELOPOLSKYA		10.8	1962 DEC 2	3.3993	5 6	9 1929 1967	-3.4	1968	10.7	18.5
1005	ARAGO		11.0	1962 DEC 2	3.1664	5 6	5 1923 1952	-3.0	1968	10.6	16.7
1006	LAGRANGEA		12.9	1956 MAY 7	3.1364	2 8	5 1923 1967	-2.4	1969	10.8	16.7
1007	PAWLOWIA		12.6	1951 DEC 20	2.7081	2 8	7 1923 1957	-6.6	1967	21.7	26.9
1009	LA PAZ		12.0	1951 DEC 20	3.0909	5 6	5 1950 1956	-90.0	1969	443.3	671.9
1009	STEFNE		15.9	1923 DEC 7	2.6277	2 8	1 1923 1923	-4.6	1967*	251.9	297.2
1010	MARLENE		11.8	1951 DEC 20	2.9316	5 5	6 1941 1953	72.0	1968	230.5	322.8
1011	LADONIA		13.7	1939 APR 7	2.3936	2 8	3 1974 1950	-9.2	1965	35.0	35.4
1012	SARFMA		13.2	1951 DEC 20	2.4830	5 6	4 1938 1954	180.0	1968	481.9	518.0
1013	TOMPECKA		10.7	1949 DEC 30	2.6831	2 8	6 1924 1957	-3.1	1965	15.7	19.1
1014	SEMPHYEA		13.0	1962 DEC 2	2.8050	5 6	4 1922 1957	1.1	1969	8.0	10.4
1015	CHRISTA		10.3	1962 DEC 2	3.2048	5 6	5 1930 1961	3.0	1966	10.9	17.4
1016	ANTYPA		13.3	1967 FEB 19	2.2196	2 8	6 1934 1967	3.4	1967	10.6	9.4
1017	JACQUELINE		12.3	1951 DEC 20	2.6085	5 6	5 1949 1959	648.0	1967	2212.3	2579.2
1018	ARNOLDA		11.7	1951 DEC 20	2.5358	5 6	9 1936 1962	-180.0	1969	348.5	388.0
1019	STRUCKEA		13.9	1962 DEC 2	1.9114	5 6	5 1932 1964	-4.2	1969	15.0	9.9
1020	ARCADIA	F	12.2	1924 APR 8	2.7963	0 0	4 1924 1948	72.0	1966*	268.5	347.6
1021	FLAMMARIO		10.0	1962 DEC 2	2.7375	5 6	10 1951 1967	-3.3	1969	11.7	14.7
1022	OLYMPIADA		11.3	1962 DEC 2	2.8090	5 6	5 1930 1966	.3	1967	6.1	8.0
1023	THOMANA		11.1	1967 MAR 11	3.1641	2 8	6 1933 1967	5.1	1969	12.4	19.4
1024	HALF		12.0	1945 MAR 6	2.8724	2 8	6 1924 1952	-13.9	1962*	41.1	55.8
1025	PIEMA		14.1	1962 DEC 2	1.9784	5 6	7 1936 1958	90.0	1967*	129.6	141.7
1026	INGRID	L	14.6	1923 AUG 29	2.2504	2 8	1 1923 1923	1.7	1923*	640000.0	580022.7 LOST
1027	AESCULAPIA		12.0	1957 JUN 11	3.1682				1968	300.0	471.5 ESTIMATED
1028	LYOTNA		10.4	1957 JUN 11	3.4092	5 6	7 1951 1960	-9.0	1967	32.4	56.6
1029	LA PLATA		12.0	1957 JUN 11	2.8892	5 6	7 1949 1960	-1.8	1969	11.7	16.0
1030	VITJA		11.6	1962 DEC 2	3.1204	5 6	8 1940 1964	-180.0	1968	335.3	515.4
1031	ARCTICA		10.8	1966 JUN 24	3.0472	2 8	5 1940 1966	-3.7	1966	10.7	15.9
1032	PAFUPI		11.0	1957 JUN 11	3.1374	5 6	4 1948 1958	-2.4	1965	13.6	21.1
1033	SIMONA		12.2	1924 FEB 5	3.0024	5 6	4 1924 1953	-45.0	1966*	158.6	230.2
1034	MOZARTIA		13.8	1924 OCT 2	2.2924	2 8	8 1924 1962	-5.6	1969*	34.2	32.0
1035	AMATA		11.8	1962 DEC 2	3.1371	5 6	4 1943 1961	-3.3	1969	12.3	19.0
1036	GANYMED		10.9	1950 JUN 28	2.6584	2 6	11 1927 1938	-6.5	1967	39.5	47.4
1037	DAVIDWETILLA	L	15.2	1924 NOV 11	2.1807				1924*	640000.0	547691.0 LOST
1038	TUCKIA		11.7	1924 DEC 21	3.9269	2 8	4 1924 1948	-4.1	1948*	28.5	60.5
1039	SOMMERBERGA		12.3	1962 DEC 2	2.6797	5 6	8 1924 1965	7.5	1965	18.4	22.4
1040	KLUMPKEA		11.6	1951 DEC 20	3.1222	5 6	5 1950 1958	180.0	1967	728.3	1120.2
1041	ASTA		11.0	1962 DEC 2	3.0740	5 6	5 1930 1965	450.0	1963	776.8	1167.7
1042	AMAZONE		11.0	1925 MAY 10	3.2079	2 8	8 1925 1961	-184.5	1967	532.7	852.5
1043	REATE		11.0	1962 DEC 2	3.0947	5 6	10 1943 1963	-180.0	1968	356.4	541.0
1044	TEJUTONTA		12.2	1951 DEC 20	2.5765	5 6	4 1950 1957	36.0	1966	168.6	192.7
1045	MICHELA		14.1	1951 DEC 20	2.3591	5 6	4 1924 1964	180.0	1964	315.8	311.1
1046	EDWIN		11.6	1967 JAN 30	2.9840	2 8	7 1934 1967	-5.7	1968	13.6	19.5
1047	GEISHA		13.5	1962 DEC 2	2.2415	5 6	7 1941 1961	90.0	1961	191.0	171.9
1048	FEDOSIA		10.7	1957 JUN 11	2.7289	5 6	9 1939 1963	-6.3	1968	19.0	23.8
1049	GOTHO		11.8	1962 DEC 2	3.0891	5 6	5 1937 1957	-180.0	1969	410.4	621.4
1050	META		13.9	1949 DEC 30	2.6239	2 8	5 1908 1948	360.1	1959*	765.9	901.5

A-22

NUMBER	NAME	NOTE	ABMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1051	MEPOPE		11.3	1962 DEC 2	3.2221	5 6 7	1942 1965	2.9	1965	107.6	17.0
1052	RELOICA		13.1	1969 JUL 23	2.7361	2 8 9	1973 1969	4.2	1968	11.6	10.4
1053	VIGOTIS		13.5	1929 SEP 26	2.6139	2 8 5	1925 1963	7.0	1969	35.6	41.6
1054	FORSYTHIA		11.7	1951 DEC 20	2.9215	5 5 6	1930 1950	72.0	1969	195.8	272.6
1055	TYNKA		12.7	1962 DEC 2	2.1989	5 6 11	1941 1967	130.0	1969	311.3	270.5
1056	AZALEA		12.9	1959 JAN 19	2.2302	2 8 8	1924 1959	-10.3	1965	30.0	26.7
1057	WANDA		12.0	1962 DEC 2	2.8953	5 6 6	1940 1964	-6.0	1969	16.5	22.7
1058	SPURRA		13.2	1962 DEC 2	2.1964	5 6 4	1945 1954	1.6	1967	12.3	10.7
1059	MUSSOROSKYIA		12.4	1941 FEB 26	2.6425				1967	330.0	357.1 ESTIMATED
1060	MAGNOLIA		14.4	1962 DEC 2	2.2373	5 6 6	1942 1965	90.0	1965	170.9	153.3
1061	PAERNTIA		12.1	1941 JAN 6	3.1261	2 8 3	1925 1953	6.0	1969	24.0	37.0
1062	LJURJA		11.3	1957 JUN 11	3.0075	5 6 6	1950 1960	-1.2	1969	10.0	14.6
1063	BOU'LEGIA		12.5	1966 MAY 15	2.3143	2 8 9	1941 1966	-6.7	1966	16.9	16.1
1064	AETHUSA		12.4	1962 DEC 2	2.5471	5 6 9	1934 1966	-14.1	1966	29.8	33.4
1065	AMUNOSENIA		13.9	1925 SEP 2	2.7606	2 8 6	1926 1961	17.0	1966	65.8	64.9
1066	L'PELYA		14.2	1951 DEC 20	2.4025	5 6 4	1930 1956	90.0	1967	200.0	203.3
1067	LUMARJA		12.2	1950 JUL 18	2.8735				1967	300.0	407.4 ESTIMATED
1068	NOFFETE		12.1	1957 JUN 11	2.9072	5 6 7	1931 1959	-8.1	1966	22.8	31.6
1069	PLANCKIA		10.8	1951 DEC 20	3.1271	5 5 6	1934 1952	-36.0	1969	102.3	157.7
1070	TUNICA		12.2	1962 DEC 2	3.2178	5 6 6	1934 1966	90.0	1966	157.1	252.6
1071	APITA		11.4	1955 OCT 20	2.8004	5 5 6	1941 1949	-18.0	1968	86.4	112.7
1072	MALVA		11.8	1962 DEC 2	3.1782	5 6 7	1926 1968	-3.4	1968*	10.7	16.9
1073	GELLYVAPA		12.6	1951 DEC 20	3.1733	5 5 6	1933 1951	-144.0	1968	322.2	617.8
1074	PELJAWSKYIA		11.4	1951 DEC 20	3.1535	5 5 6	1934 1953	792.0	1968	2009.1	3135.9
1075	HELINA		11.6	1947 JAN 15	3.0143	5 6 5	1951 1962	1.5	1967	15.8	23.1
1076	VIOLA		13.1	1962 DEC 2	2.4769	5 6 5	1951 1961	.5	1969	7.4	7.9
1077	CAMPANULA		14.0	1926 SEP 22	2.3923	2 8 4	1926 1948	10.7	1966*	54.1	54.6
1078	MENTHA		12.9	1951 DEC 20	2.2697	5 6 6	1950 1965	-180.0	1969	526.1	484.1
1079	MIMOSA		12.1	1962 DEC 2	2.8724	5 6 8	1932 1964	3.6	1969	11.9	16.1
1080	ORCHIS		13.6	1962 DEC 2	2.4203	5 6 4	1933 1951	3.3	1961*	15.0	15.4
1081	PESEDA		12.3	1962 DEC 2	3.0944	5 6 8	1927 1965	90.0	1965	156.9	238.2
1082	PIPOLA		11.7	1962 DEC 2	3.1352	5 6 6	1929 1965	-5.7	1969	15.0	23.2
1083	SALVIA		14.0	1950 JAN 19	2.3281	2 8 11	1910 1962	-7.7	1969	23.2	22.4
1084	TAMARJA		11.8	1951 DEC 20	2.6874	5 6 6	1953 1963	-180.0	1968	693.0	847.5
1085	AMAPYLLIS		10.8	1962 DEC 2	3.1751	5 6 7	1931 1964	7.2	1968	17.9	28.3
1086	VATA		10.7	1962 DEC 2	3.1638	5 6 7	1949 1960	-8.7	1969	28.2	44.3
1087	APARIS		11.0	1967 MAR 31	3.0120	2 8 10	1937 1967	-6.3	1969	14.6	21.2
1088	MITAKA		12.8	1962 NOV 12	2.2011	2 8 11	1932 1961	-5.2	1969	16.5	14.4
1089	TAMA		12.9	1962 DEC 22	2.2133	2 8 16	1919 1963	-9.1	1969	22.1	19.5
1090	SUMIDA		14.1	1963 APR 21	2.3612	2 8 2	1928 1957	-6.4	1964	19.0	18.7
1091	SPIPAFA		12.0	1928 APR 4	3.4235	2 8 2	1928 1932	3.5	1969*	57.6	101.2
1092	LIL'UM		11.8	1956 NOV 23	2.9009	2 8 7	1924 1956	-12.6	1965	32.4	44.6
1093	FREDA		10.0	1962 DEC 2	3.1460	5 6 6	1932 1959	7.7	1964	20.7	32.2
1094	SYBECTIA		13.0	1926 FEB 14	2.5482	2 8 9	1918 1959	9.6	1959*	40.2	45.1
1095	TULIPA		12.7	1942 JUN 10	3.0252	2 8 3	1926 1952	-8.0	1968	29.0	42.6
1096	REUNERTA		11.4	1944 APR 20	2.5004	2 8 8	1928 1957	-5.8	1966	23.0	26.7
1097	VICIA		13.2	1950 OCT 6	2.5385	2 8 5	1928 1954	-9.3	1967	29.8	35.3
1098	HAKONE		12.0	1951 DEC 20	2.6883	5 5 6	1936 1950	36.0	1968	110.5	146.3
1099	FIGNERIA		11.8	1968 DEC 30	3.1610	2 8 9	1928 1969	-3.8	1969	9.7	15.2
1100	ARNICA		12.4	1956 NOV 23	2.8976	2 8 11	1918 1958	25.8	1967	54.9	75.6

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KM3
1101	CLEMATIS		12.1	1928 OCT 1	3.2733	2 8	2 1928 1961	-4.1	1960*		25.8		42.6
1102	PERITA		11.0	1962 DEC 2	3.0704	5 6	5 1951 1965	3.0	1965		11.4		17.1
1103	SEQUOIA		13.6	1928 NOV 30	1.9738	2 8	8 1928 1965	-8.6	1965		43.6		29.5
1104	SYRINGA		13.6	1962 DEC 2	2.6310	5 6	9 1928 1966	-180.0	1968		304.3		359.7
1105	FRAGARIA		11.3	1962 DEC 2	3.0126	5 6	10 1930 1962	-90.0	1969		168.6		245.9
1106	CYDONIA		13.0	1951 DEC 20	2.5974	5 6	6 1929 1954	130.0	1969		412.4		477.4
1107	VICTORIA		10.3	1962 DEC 2	3.1877	5 6	8 1946 1965	-4.7	1966		14.2		22.5
1108	DEMETER		12.4	1951 DEC 20	2.4284	5 6	6 1929 1948	90.0	1967*		260.6		269.8
1109	TATA		11.0	1962 DEC 2	3.2019	5 6	10 1931 1964	-9.0	1966		19.3		30.9
1110	JAROSLAWA		13.4	1964 APR 15	2.2188	2 8	7 1934 1957	-3.8	1961		14.2		12.5
1111	REYNOLDIA		11.5	1962 DEC 2	2.9959	5 6	10 1932 1966	-10.0	1966		22.2		32.1
1112	POLONIA		11.0	1947 JAN 15	3.0188	5 6	4 1950 1959	13.8	1968		73.9		108.2
1113	KATJA		10.7	1957 JUN 11	3.1174	5 6	6 1950 1959	7.8	1967		30.1		46.2
1114	LORRAINE		10.8	1966 OCT 22	3.0922	2 8	7 1933 1966	-1.6	1966		7.0		10.6
1115	SAPAUDIA		10.6	1957 JUN 11	3.0994	5 6	7 1951 1960	-3.0	1966		15.4		23.4
1116	CATRIONA		10.9	1949 MAR 25	2.9215	2 8	9 1908 1956	-10.4	1969		28.2		39.3
1117	REGINITA		13.2	1962 DEC 2	2.2476	5 6	7 1948 1968	6.0	1968		16.7		15.1
1118	HANSKYA		11.1	1951 DEC 20	3.2014	5 5	6 1940 1953	288.0	1968		872.2		1391.6
1119	EURDIA		12.4	1965 OCT 7	2.6114	2 8	7 1930 1964	7.2	1969		17.5		20.4
1120	CANNONIA		13.4	1957 JUN 11	2.2159	5 6	4 1946 1953	-6	1968		10.8		9.6
1121	NATASCHA		12.6	1949 DEC 30	2.5468	2 8	6 1928 1956	-3.9	1967*		18.0		20.1
1122	NETTI		12.8	1928 SEP 11	2.6045	2 8	3 1924 1932	-2.4	1968		31.9		37.0
1123	SHAPLEYA		13.0	1962 DEC 2	2.2254	5 6	8 1940 1964	6.0	1964		17.6		15.6
1124	STROBANTIA		12.2	1961 MAR 2	2.9269	2 8	7 1931 1961	9.4	1961*		23.3		32.6
1125	CHINA	E	14.3	1958 JAN 0	3.1546				1967*		300.0		468.5 ESTIMATED
1126	OTERO		13.8	1962 DEC 2	2.2717	5 6	6 1929 1955	-6.6	1967		20.7		19.1
1127	MIMI		11.7	1951 DEC 20	2.5935	5 6	5 1946 1961	450.0	1965		1179.2		1361.9
1128	ASTRID		11.8	1957 JUN 11	2.7907	5 6	4 1950 1958	2.4	1967		14.9		19.3
1129	NEUJMINA		11.1	1962 DEC 2	3.0232	5 6	4 1940 1966	-4.5	1969		13.2		19.4
1130	SKULD		13.5	1962 DEC 2	2.2290	5 6	7 1939 1965	-13.6	1969		30.6		27.3
1131	ROFZIA		15.4	1929 OCT 16	2.2287	2 8	4 1929 1952	-6.9	1969		40.9		36.4
1132	HOLLANDIA		11.9	1959 FEB 1	2.6841	2 8	9 1929 1959	5.7	1969		17.7		21.6
1133	LUGDUNA		13.2	1962 DEC 2	2.1860	5 6	4 1939 1968	-2.6	1968*		11.0		9.4
1134	KEPIER		15.4	1969 OCT 6	2.6824	2 8	4 1929 1969	-2.5	1969*		7.7		9.4
1135	COLCHIS		11.8	1962 DEC 2	2.6659	5 6	6 1950 1963	2.9	1967		12.3		14.8
1136	MERCEDES		12.3	1962 DEC 2	2.5641	5 6	7 1933 1962	-90.0	1962*		173.5		196.7
1137	PAISSA		12.1	1962 DEC 2	2.4232	5 6	7 1939 1966	4.5	1969		14.0		14.4
1138	ATTICA		12.3	1951 DEC 20	3.1453	5 6	4 1929 1964	90.0	1964		165.1		256.7
1139	ATAMI		14.4	1941 JUL 5	1.9473	2 8	6 1929 1955	.3	1969		16.0		11.0
1140	CRIMEA		11.3	1965 AUG 28	2.7719	2 8	6 1935 1965	-1.8	1969		7.9		10.2
1141	BOHemia		14.6	1930 JAN 24	2.7707	2 6	3 1930 1956	-3.6	1961*		28.1		25.9
1142	ASTOLIA		11.6	1957 JUN 11	3.1711	5 6	7 1941 1960	6.0	1967		19.6		30.8
1143	ODYSSEUS		9.4	1965 JAN 20	5.2117	2 8	15 1930 1965	-5.2	1968		12.7		38.8
1144	ODA		11.0	1952 FEB 18	3.7525	2 8	9 1930 1952	5.7	1968*		21.2		42.2
1145	ROSELMONTE		12.3	1962 DEC 2	2.4244	5 6	6 1933 1956	-7.5	1967		22.8		23.5
1146	STAPYIA		11.0	1957 JUN 11	3.0489	5 6	6 1940 1961	-6.9	1967		20.9		31.0
1147	STAVROPOLIS		13.6	1962 DEC 2	2.2719	5 6	4 1950 1967	4.8	1967		15.2		14.0
1148	RAPAHU		11.3	1966 AUG 23	3.0152	2 8	7 1934 1966	4.0	1966		11.1		16.2
1149	VOLGA		11.5	1957 JUN 11	2.9009	5 6	8 1948 1963	11.1	1969		30.6		42.2
1150	ACHAIA		14.7	1962 DEC 2	2.0908	5 6	6 1929 1958	3.6	1968*		14.1		11.2

A-24

LMSC-D420943

NUMBER	NAME	NOTE	ARMAG	EPHCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1151	ITHAKA		14.9	1979 SEP 6	2.4063	2 8	2 1929 1966	5.4	1966*	31.0	31.6
1152	PAWONA		12.3	1962 DEC 2	2.4275	5 6	5 1939 1961	5.6	1969	17.4	18.0
1153	WALLENBERGIA		13.4	1962 DEC 2	2.1958	5 6	4 1950 1956	-1.5	1969	12.9	11.2
1154	ASTRONOMIA		11.4	1962 DEC 2	3.3981	5 6	9 1927 1966	-2.1	1968	8.6	15.0
1155	AEMMA		13.1	1962 DEC 2	2.4621	5 6	5 1948 1961	180.0	1968	435.3	461.3
1156	KTOP		14.0	1933 SEP 28	2.2603				1966	300.0	274.0 ESTIMATED
1157	APARIA		11.3	1951 DEC 20	3.2062	5 5	6 1930 1952	324.0	1969	788.7	1261.2
1158	LUDA		12.3	1951 DEC 20	2.5639	5 6	4 1952 1960	180.0	1969	774.2	877.6
1159	GRAMADA		13.0	1959 APR 27	2.3794	2 8	8 1929 1962	-7.4	1969	21.0	21.0
1160	ILLYRIA		12.0	1954 SEP 15	2.5602	5 6	7 1937 1953	-180.0	1968	492.1	556.5
1161	THESSALIA		12.8	1929 DEC 15	3.1645	2 8	4 1929 1938	-7.4	1968	61.0	95.7
1162	LAPISSA		10.3	1969 DEC 30	3.9429	2 8	9 1930 1969	7.6	1969	15.5	33.0
1163	SAGA		11.7	1957 JUN 11	3.2099	5 6	5 1931 1951	2.1	1966	11.9	19.1
1164	KOROLDA		14.1	1962 DEC 2	2.3059	5 6	5 1930 1965	90.0	1965	160.7	152.1
1165	IMPOINETTA		11.6	1962 DEC 2	3.1407	5 6	7 1935 1957	180.0	1968*	398.0	617.6
1166	SAKUNTALA		12.7	1956 NOV 23	2.5412	2 8	8 1930 1958	-9.1	1963	26.0	29.0
1167	DUBIAGO		11.0	1962 DEC 2	3.4215	5 6	7 1934 1966	7.5	1969	17.8	31.2
1168	BRANDIA		13.1	1950 JUN 8	2.5506	2 8	4 1930 1956	7.6	1967*	25.6	28.8
1169	ALWINE		14.4	1951 DEC 20	2.3185	5 6	6 1937 1962	180.0	1969	355.5	339.7
1170	SIVA		13.2	1942 FEB 10	2.3254	2 8	4 1930 1955	5.2	1969	24.4	23.5
1171	PUSTHAWELIA		10.8	1962 DEC 2	3.1485	5 6	6 1938 1964	-3.8	1969	12.2	19.0
1172	ANEA S		9.4	1966 OCT 22	5.1654	2 8	14 1934 1966	5.2	1966	12.4	37.3
1173	ANCHISES		10.1	1964 SEP 2	5.1663	2 8	11 1930 1964	-2.3	1964	8.0	24.3
1174	MARMARA		12.9	1962 DEC 2	3.0201	5 6	5 1930 1955	-3.2	1970*	12.5	18.2
1175	MARGO		11.7	1934 JUN 12	3.2201	2 8	11 1907 1964	-8.1	1968	26.5	42.6
1176	LUCIDOR		12.3	1945 MAR 6	2.6941	5 5	9 1927 1952	-180.0	1969	428.3	525.9
1177	GOMNESIA		10.5	1965 OCT 2	3.3531	2 8	15 1946 1966	2.8	1965	6.2	15.6
1178	IRMELA		13.0	1940 FEB 1	2.6792	2 8	4 1931 1953	-4.9	1962*	24.7	30.0
1179	MALLY		15.1	1931 APR 9	2.6166	2 8	2 1931 1936	1.1	1936*	25.8	30.2
1180	RITA		10.2	1962 DEC 2	3.9810	5 6	8 1931 1965	6.9	1966	16.6	35.9
1181	LILITH		12.7	1951 DEC 20	2.6644	5 6	7 1934 1954	-90.0	1969	225.0	271.4
1182	ILONA		12.7	1962 DEC 2	2.2596	5 6	5 1927 1962	7.0	1969	19.1	17.4
1183	JUTTA		13.1	1962 DEC 2	2.3833	5 6	7 1935 1964	90.0	1967	167.6	168.1
1184	GAFA		12.2	1962 DEC 2	2.6677	5 6	6 1931 1965	7.1	1968	17.9	21.6
1185	NIKKO		13.4	1962 DEC 22	2.2371	2 8	9 1927 1962	-29.2	1969	59.1	53.0
1186	TURNPEA		10.8	1957 JUN 11	3.0180	2 8	9 1929 1956	7.0	1966	21.6	31.5
1187	AFOE		12.9	1935 JUL 17	2.6395	2 8	7 1929 1963	5.0	1969	25.8	30.7
1188	GOTHLANDIA		13.1	1949 JUN 21	2.1910				1964	300.0	259.0 ESTIMATED
1189	TERENTIA		11.2	1962 DEC 2	2.9335	5 6	8 1950 1965	-3.0	1968	11.5	16.1
1190	PELAGIA		13.3	1930 OCT 31	2.4313	2 8	4 1909 1955	-7.4	1968	30.6	31.7
1191	ALFATERNA		11.7	1931 FEB 12	2.8939				1966	300.0	411.8 ESTIMATED
1192	PRISMA		13.7	1931 FEB 28	2.3649	2 8	4 1931 1953	6.3	1969*	37.3	36.9
1193	AFRICA		13.3	1931 JUN 8	2.6461	2 8	7 1931 1958	49.6	1969	165.6	197.5
1194	ALETTA		11.6	1931 JUN 8	2.9146	2 8	9 1931 1956	-10.4	1965	47.0	65.2
1195	ORANGIA		14.6	1931 JUL 18	2.2588	2 9	2 1931 1935	2.4	1935*	44.9	40.9
1196	SHERA		11.6	1931 JUN 8	2.6525	2 8	11 1931 1958	-34.9	1966	120.9	144.8
1197	RHODESIA		11.2	1957 JUN 11	2.8862	5 6	4 1948 1960	8.6	1965	28.4	38.9
1198	ATLANTIS		16.8	1931 OCT 6	2.2491	2 9	1 1931 1931	-1.3	1938*	72.6	65.7
1199	GELONIA		11.4	1962 DEC 2	3.0239	5 6	5 1951 1958	2.9	1967	15.8	23.1
1200	IMPERATRIX		11.8	1951 DEC 20	3.0590	5 5	5 1937 1953	-72.0	1969	201.9	301.3

STATUS OF NUMBERED MINOR PLANET EFFEMERIDES

25

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	EPROP	SEC	ERROR	KM3
1201	STPENSUA		12.7	1951 DEC 20	2.6992	5 5	4 1940 1949	36.0	1958*	156.9		193.3	
1202	MARTINA		11.4	1962 DEC 2	3.9504	5 6	4 1931 1954	2.4	1962	10.4		22.2	
1203	NANNA		13.2	1951 DEC 20	2.8837	5 6	6 1926 1952	180.0	1952*	417.1		569.4	
1204	RENZIA		13.6	1931 OCT 6	2.2628	2 8	5 1931 1955	5.0	1967	32.7		29.9	
1205	EBELLA		15.3	1931 SEP 16	2.5322	2 9	2 1931 1935	-3.9	1935*	61.2		67.9	
1206	NUMEROWIA	L	11.5	1931 OCT 29	2.8705	5 5	2 1931 1950	180.0	1932*	640070.0		867668.4	LOST
1207	OSTENTIA		12.3	1941 NOV 22	3.0186	2 8	3 1932 1938	-2.0	1968	25.5		37.3	
1208	TROTLUS		9.8	1965 OCT 7	5.1660	2 8	8 1931 1965	4.1	1965	10.8		32.6	
1209	PUMMA		11.6	1957 JUN 11	3.1818	5 6	4 1951 1961	-60.6	1969	164.2		259.6	
1210	MOPOSOVIA		11.4	1962 DEC 2	3.0107	5 6	5 1951 1968	-5.8	1968	15.7		22.8	
1211	BRESSOLE		12.2	1957 JUN 11	2.9275	5 6	7 1938 1965	-7.8	1965	20.8		29.0	
1212	FRANCETTE		10.9	1962 DEC 2	3.9544	5 6	7 1941 1965	6.9	1969	17.2		36.9	
1213	ALGERIA		12.2	1930 JAN 24	3.1379	5 6	5 1931 1956	5.7	1969	32.4		50.1	
1214	RICHILDE		12.1	1962 DEC 2	2.7094	5 6	9 1932 1966	-5.6	1966	15.1		18.8	
1215	1932 RA		11.9	1963 JUL 30	2.5786	2 8	14 1932 1963	-2.9	1969	10.9		12.4	
1216	ASKANIA		11.4	1966 JUN 24	2.2322	2 8	8 1932 1966	3.1	1969	10.4		9.3	
1217	MAXIMILIANA		14.6	1956 NOV 23	2.3525	2 8	8 1925 1957	5.6	1969	19.2		18.9	
1218	ASTEP		14.4	1931 DEC 5	2.2634	2 8	3 1932 1951	-3.1	1951*	28.2		25.8	
1219	BRITTA		13.3	1962 DEC 2	2.2125	5 6	6 1932 1965	7.6	1968	19.7		17.3	
1220	COCCUS		12.3	1956 NOV 23	3.0056				1966	300.0		436.1	ESTIMATED
1221	AMOR		19.2	1964 JUN 14	1.9206	2 9	5 1932 1964	4.0	1964	13.8		9.2	
1222	TINA		13.3	1962 DEC 2	2.7902	5 6	6 1932 1965	190.0	1965	316.6		410.7	
1223	NECKAR		11.7	1951 DEC 20	2.8687	5 5	6 1941 1954	-144.0	1969	429.6		581.8	
1224	FANTASTA		12.9	1962 DEC 2	2.3039	5 6	5 1939 1962	-4.2	1969	14.6		13.8	
1225	ARIANE		13.6	1968 SEP 21	2.2334	2 8	12 1930 1968	-107.0	1968	176.3		157.6	
1226	SOLTA		13.3	1969 SEP 16	2.5849	2 8	3 1930 1969	-4.9	1969*	11.6		13.3	
1227	GERANIUM		11.6	1962 DEC 2	3.2021	5 6	6 1931 1959	12.7	1969	30.2		48.2	
1228	SCARIOSA		12.8	1962 DEC 2	2.7677	5 6	5 1931 1962	-2.3	1962*	9.9		12.7	
1229	TYLIA		13.0	1951 DEC 20	3.1953	5 5	4 1931 1952	-144.0	1933*	364.8		590.4	
1230	PICETA		14.7	1962 DEC 2	2.5722	5 6	5 1931 1964	90.0	1964*	164.1		187.0	
1231	AURICULA		12.8	1931 OCT 26	2.6679	2 8	4 1931 1956	12.7	1966	55.0		66.5	
1232	CORTUSA		11.4	1954 NOV 4	3.1689				1969	300.0		471.6	ESTIMATED
1233	KORRESIA		12.4	1962 DEC 2	2.5543	5 6	5 1931 1963	-5.7	1967	16.1		18.1	
1234	ELYMA		12.1	1959 JAN 12	3.0107	2 8	6 1931 1959	-7.0	1963*	20.0		29.1	
1235	SCHORPTA		15.4	1931 SEP 16	1.9102	2 8	7 1931 1960	-4.7	1960*	33.3		21.9	
1236	THATS		12.9	1951 DEC 20	2.4305	5 6	5 1931 1957	90.0	1969	196.5		203.7	
1237	GENEVIEVE		12.1	1957 JUN 11	2.6117	5 6	4 1951 1960	6.3	1969	25.6		29.8	
1238	PEDAPPIA		13.1	1962 DEC 2	2.6672	5 5	5 1932 1952	30.2	1969	81.3		98.2	
1239	QUETLEFTA		13.6	1951 DEC 20	2.6618	5 6	4 1939 1958	90.0	1967	212.7		256.2	
1240	CENTENARIA		11.1	1964 NOV 1	2.8702	2 8	10 1932 1964	-3.9	1968	11.8		16.0	
1241	OYSONA		10.5	1951 DEC 20	3.1940	5 5	6 1939 1954	-432.0	1967	1189.0		1890.8	
1242	ZAMPESIA		11.3	1941 JUN 15	2.7378				1969	300.0		377.9	ESTIMATED
1243	PAMFLA		11.3	1957 JUN 11	3.0962	5 6	5 1947 1961	-1.5	1965	10.1		15.4	
1244	OFIDA		12.7	1947 AUG 3	2.3430	2 8	8 1921 1957	-12.7	1968	35.4		34.5	
1245	CALVINIA		11.0	1924 DEC 21	2.8942	2 8	20 1906 1963	-28.5	1968	74.1		101.8	
1246	CHAKA		12.8	1951 DEC 20	2.6212	5 6	7 1932 1954	90.0	1968	217.7		255.9	
1247	MEMORIA		11.7	1962 DEC 2	3.1378	5 6	4 1932 1965	-3.6	1966	11.5		17.9	
1248	JUGUPHA		11.0	1947 JAN 15	2.7219	5 6	6 1950 1961	9.5	1967	48.9		61.1	
1249	RUTHERFORDIA		13.0	1968 AUG 12	2.2245	2 8	10 1932 1968	5.6	1968	13.6		12.1	
1250	GALANTHUS		14.2	1951 DEC 20	2.5528	5 6	3 1933 1952	180.0	1970*	473.5		532.9	

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3	
1251	HEDEPA		11.9	1956 MAR 8	2.7205	2 8	7 1933 1956	2.4	1963*	12.8	15.9	
1252	CELESTIA		11.8	1962 DEC 2	2.6934	5 6	7 1933 1956	6.4	1965	20.0	24.5	
1253	FRISTIA		13.3	1957 JUN 11	3.1528				1933*	320000.0	499309.4	LOST
1254	FRIGIDIA		11.6	1962 DEC 2	3.1325	5 6	4 1933 1956	-12.0	1967*	31.0	49.4	
1255	SCHILOWA		11.7	1951 DEC 20	3.1541	5 5	4 1932 1940	324.0	1966	942.1	1470.9	
1256	NOTMANNIA		10.9	1966 JAN 15	3.9341	2 8	4 1932 1964	10.5	1967	22.3	47.3	
1257	MOPA		13.0	1962 DEC 2	2.4875	5 6	8 1932 1960	-90.0	1968	179.6	193.7	
1258	SICILIA		11.8	1969 JAN 19	3.1852	2 8	6 1932 1969	5.9	1969	17.8	20.3	
1259	ORYALLA		11.8	1951 DEC 20	3.1018	5 5	6 1930 1953	-360.0	1969	1036.0	1579.6	
1260	WALHALLA		13.0	1933 FEB 17	2.6144	2 6	6 1933 1956	4.4	1967	28.6	33.5	
1261	LEPTA		11.9	1962 DEC 2	3.1519	5 6	6 1938 1955	4.2	1969	15.9	24.9	
1262	SMIADECKIA		11.4	1951 DEC 20	3.0060	5 5	5 1940 1954	-180.0	1967	509.9	741.3	
1263	VARSAVIA		11.5	1962 DEC 2	2.6653	5 6	7 1946 1961	90.0	1961*	209.8	253.2	
1264	LETARA		10.9	1957 JUN 11	2.8640	5 6	4 1952 1957	5.1	1967	30.4	41.1	
1265	SCHWEIKARDA	E	11.1	1935 MAY 29	3.0144				1966*	300.0	438.0	ESTIMATED
1266	TONE		10.4	1951 AUG 22	3.3662	5 6	5 1952 1956	-6.3	1967	52.1	89.4	
1267	GEERTRUIDA		13.5	1951 DEC 20	2.4633	5 6	7 1938 1961	-180.0	1969	369.5	391.9	
1268	LITVA		10.0	1962 DEC 2	3.9309	5 6	10 1938 1958	-3.9	1969	11.2	23.9	
1269	ROLLANDIA		9.8	1957 JUN 11	3.9382	5 6	5 1950 1955	-5.0	1968	31.1	66.2	
1270	DATUQA		14.2	1930 MAR 5	2.2347	2 8	4 1930 1953	-5.1	1968	34.2	30.6	
1271	ISERGINA		11.8	1951 DEC 20	3.1357	5 5	9 1930 1953	360.0	1967	853.5	1321.2	
1272	GEFION		13.6	1962 DEC 2	2.7814	5 6	3 1931 1959	90.0	1954*	182.4	235.6	
1273	HELMA		14.1	1951 DEC 20	2.3929	5 6	5 1932 1958	180.0	1969*	376.6	380.2	
1274	DELPHOITIA		13.2	1932 OCT 20	2.2291	2 8	15 1918 1965	-6.4	1968	29.7	26.5	
1275	CIMBRIA		11.9	1932 OCT 20	2.6798	2 6	6 1932 1958	6.4	1965	34.0	41.4	
1276	UCOLIA		11.9	1951 DEC 20	3.1676	5 5	6 1933 1952	-720.0	1961	1865.1	2930.2	
1277	DOLORES		12.5	1943 OCT 31	2.6980				1968	300.0	369.2	ESTIMATED
1278	KENYA		12.5	1957 JUN 11	2.4037	5 6	5 1951 1959	12.3	1963	46.2	47.0	
1279	UGANDA		13.8	1933 MAY 8	2.3700	2 8	9 1933 1959	2.7	1966	26.5	26.3	
1280	PAILLAUDA		11.1	1962 DEC 2	3.4120	5 6	5 1939 1968	-4.4	1969	12.4	21.7	
1281	JEANNE		12.6	1962 DEC 2	2.5593	5 6	10 1933 1961	90.0	1969	176.3	199.3	
1282	UTOPIA		11.5	1962 DEC 2	3.1218	5 6	6 1933 1961	-9.6	1969	23.5	36.1	
1283	KOMSOMOLIA		12.0	1962 DEC 2	3.2155	5 6	6 1931 1966	-90.0	1966	157.0	252.1	
1284	LATVIA		11.5	1966 APR 5	2.6450	2 8	11 1933 1966	6.6	1966	15.9	18.9	
1285	JULIETTA		11.4	1962 DEC 2	2.9925	5 6	6 1936 1964	-7.8	1969	19.4	28.0	
1286	BANACHTWICZA		11.6	1951 DEC 20	3.0219	5 5	6 1938 1955	108.0	1968*	281.6	412.7	
1287	LORCIA		12.1	1930 JAN 24	3.0124	5 6	4 1937 1957	6.3	1967	39.1	57.0	
1288	SANTA		12.8	1962 DEC 2	2.8869	5 6	6 1933 1962	90.0	1967	173.1	236.8	
1289	KUTAISST		11.6	1951 DEC 20	2.8603	5 5	6 1941 1955	144.0	1967	399.5	538.7	
1290	ALPERTINE		13.8	1951 DEC 20	2.3665	5 6	7 1933 1955	-180.0	1966	418.8	414.8	
1291	PHRYNE		11.5	1957 JUN 11	3.0177	5 6	5 1949 1957	12.2	1969	48.0	70.1	
1292	LUCE		12.6	1962 DEC 2	2.5419	5 6	7 1948 1965	-3.0	1969	11.8	13.2	
1293	SOMJA		15.2	1962 DEC 2	2.2271	5 6	4 1933 1953	180.0	1953*	447.6	398.1	
1294	ANTWEPPIA		12.0	1957 JUN 11	2.6907	5 6	4 1952 1962	3.0	1968	15.0	18.4	
1295	DEFLOTTE		11.7	1962 DEC 2	3.3863	5 6	7 1935 1968	1.2	1969	7.1	12.3	
1296	ANDREE		12.7	1962 DEC 2	2.4191	5 6	8 1935 1959	-2.1	1963*	10.5	10.8	
1297	QUADEA		12.5	1934 FEB 12	3.0212	2 8	8 1927 1955	-6.1	1960	29.0	42.4	
1298	NOCTURNA		11.6	1957 JUN 11	3.1413	5 6	6 1934 1956	9.0	1966	26.7	41.4	
1299	MERTONA		13.0	1962 DEC 2	2.8037	5 6	10 1934 1958	90.0	1969*	193.1	252.5	
1300	MAPCELLE		12.4	1957 JUN 11	2.7822				1967	300.0	387.5	ESTIMATED

A-27

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	PERIQUAL	LAST	ERROR SEC	ERROR KM3
1301	YVONNE		11.9	1943 APR 6	2.7646	2 8	9 1934 1957	-6.5	1969	26.7	34.1
1302	WEPPIA		12.0	1966 APR 25	3.1262	2 8	6 1937 1963	-9.3	1966	21.4	33.0
1303	LUTHERA		10.5	1966 NOV 11	3.2046	2 8	9 1935 1964	5.8	1969	14.1	22.6
1304	AROSA		10.5	1952 SEP 5	3.1955	2 8	13 1928 1963	-18.2	1963	40.2	63.9
1305	PONGOLA		11.6	1962 DEC 2	3.0128	5 6	8 1935 1964	-4.1	1960	12.8	18.6
1306	SCYTHIA		10.9	1930 AUG 12	3.1446	5 5	7 1930 1956	-6.5	1968	34.1	53.0
1307	CIMMERIA		13.3	1930 OCT 11	2.2502	2 8	7 1933 1957	2.7	1967	26.1	23.7
1308	HALLETTA		12.0	1962 DEC 2	2.9109	5 6	6 1931 1963	2.6	1966	10.2	14.1
1309	HYPERBOREA		11.3	1951 DEC 20	3.2175	5 6	4 1931 1951	90.0	1968	237.7	382.0
1310	VILLYGEPA		12.8	1951 DEC 20	2.3924	5 6	5 1938 1960	190.0	1960*	377.9	351.3
1311	KNOPPIA		13.9	1962 DEC 2	2.4265	5 6	5 1929 1967	90.0	1967	153.0	158.2
1312	VASSAR		12.8	1962 DEC 2	3.0997	5 6	8 1933 1957	90.0	1968	196.6	299.2
1313	BERNA		13.0	1951 DEC 20	2.6563	5 6	5 1933 1957	180.0	1968*	391.5	470.0
1314	PAULA		14.2	1951 DEC 20	2.7951	5 6	4 1933 1959	90.0	1966*	190.0	178.3
1315	BONISLAWA		11.2	1951 DEC 20	3.2097	5 5	6 1939 1950	72.0	1967	213.9	342.6
1316	KASAM	L	14.9	1933 NOV 24	2.4107	2 8	1 1933 1933	-3.7	1933*	640010.0	654381.0 LOST
1317	SILVRETTA		9.8	1951 DEC 20	3.1675	5 5	6 1935 1954	396.0	1969	987.8	1551.8
1318	NERINA		13.2	1957 JUN 11	2.3076	5 6	4 1934 1955	190.0	1967*	428.0	405.6
1319	D'ISA		11.8	1941 OCT 13	2.9820	2 8	6 1908 1949	7.3	1965	26.4	37.9
1320	IMPALA		12.0	1962 DEC 2	2.9809	5 6	4 1934 1965	-3.4	1969	11.4	16.3
1321	MAJURA		11.2	1962 DEC 2	2.9417	5 6	6 1935 1960	5.3	1964	16.1	22.6
1322	COPPERNICUS		14.2	1934 JUN 17	2.4223	2 8	3 1934 1953	-9.5	1968*	48.4	49.9
1323	TUGELA		11.2	1951 DEC 20	3.1849	5 5	4 1948 1956	86.4	1968	332.2	526.1
1324	KNYSNA		13.7	1934 JUL 2	2.1847	2 8	2 1934 1937	-1.6	1969*	39.0	33.5
1325	INANDA		13.3	1962 DEC 2	2.5377	5 6	4 1934 1954	2.0	1954	10.8	12.0
1326	LOSACA		12.0	1962 DEC 2	2.6480	5 6	7 1934 1965	90.0	1969	162.6	196.5
1327	NAMAQUA		13.0	1962 DEC 2	2.7804	5 6	6 1934 1967	270.0	1967	455.7	588.0
1328	DEVOTA		11.4	1957 JUN 11	3.5058				1964	300.0	544.9 ESTIMATED
1329	ELTANE		11.5	1962 DEC 2	2.6175	5 6	4 1951 1968	5.0	1969	14.7	17.2
1330	SPIRIDONTA		11.6	1951 DEC 20	3.1851	5 6	4 1925 1950	-90.0	1970*	224.2	355.1
1331	SOLVEJG		11.6	1933 OCT 15	3.1047	2 8	8 1926 1960	2.9	1967	20.2	30.9
1332	MARCONIA		11.3	1962 DEC 2	3.0618	5 6	7 1939 1964	9.0	1969	21.9	32.8
1333	CFVENOLA		12.9	1951 DEC 20	2.6333	5 6	7 1934 1957	270.0	1968*	596.0	705.6
1334	LUNDMARKA		11.5	1948 MAY 9	2.9137				1969	300.0	416.1 ESTIMATED
1335	DEMOLINA		15.0	1962 DEC 2	2.2424	5 6	5 1934 1954	90.0	1954*	222.5	200.4
1336	ZEEI ANDIA		12.1	1957 JUN 11	2.8506	5 6	6 1951 1962	-1.5	1968	10.7	14.3
1337	GERAPDA		12.3	1962 DEC 2	2.9096	5 6	6 1934 1954	-90.0	1969	221.5	306.6
1338	DUPONTA		14.1	1934 DEC 29	2.2640	2 8	6 1935 1951	-5.0	1966	35.3	32.4
1339	DESAGNEFAUXA		11.6	1957 JUN 11	3.0234	5 6	6 1934 1962	-7.4	1969	20.5	30.1
1340	YVETTE		12.6	1962 DEC 2	3.1698	5 6	9 1935 1953	2.1	1968	10.7	16.8
1341	EDMEE		12.1	1962 DEC 2	2.7426	5 6	6 1949 1964	3.0	1969	11.9	15.0
1342	PARANTIA		13.4	1962 DEC 2	2.2888	5 6	6 1935 1964	90.0	1967	167.8	156.8
1343	NICOLE		12.6	1935 APR 28	2.5680	2 8	12 1935 1960	-7.1	1968	35.3	40.1
1344	GAUBETA		14.1	1935 APR 28	2.2481	2 8	6 1935 1962	9.0	1962*	41.4	37.5
1345	POTOMAC		10.8	1969 SEP 1	3.9827	2 8	6 1932 1964	-224.0	1968	395.4	854.7
1346	GOTHA		12.5	1947 MAY 15	2.6304	2 8	6 1929 1961	-3.4	1969	16.5	19.5
1347	PATRIA		12.2	1951 DEC 20	2.5743	5 5	4 1931 1951	-36.0	1966	101.0	115.3
1348	MICHEL		12.2	1951 DEC 20	2.7921	5 5	4 1933 1952	7.2	1966	27.3	35.5
1349	BECHUANA		11.7	1951 DEC 20	3.0185	5 5	6 1938 1950	-396.0	1969	1328.4	1943.5
1350	ROSSELIA		12.2	1962 DEC 2	2.8580	5 6	5 1934 1962	6.5	1968	17.6	23.8

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAC	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KMS
1351	UZBEKISTANIA		11.1	1951 DEC 20	3.1949	5 5	5 1935 1953	72.0	1966	192.2	305.8
1352	MAWEL		12.4	1962 DEC 2	2.7788	5 6	4 1935 1951	1.5	1968	9.9	12.7
1353	MAARTJE		11.2	1957 JUN 11	3.0128	5 6	8 1950 1964	3.0	1969	13.2	19.3
1354	ROTHA		12.2	1939 JAN 17	3.1278	2 8	6 1930 1952	-72.3	1968	128.8	306.6
1355	MAGGERA		13.9	1951 DEC 20	1.8531	5 6	6 1935 1955	180.0	1966	435.2	269.1
1356	NYANZA		11.4	1963 JUL 30	3.0813	2 8	7 1935 1963	4.2	1969	12.7	10.2
1357	KHAMA		10.7	1948 NOV 25	3.1072	2 8	3 1935 1947	-4.3	1968	24.4	38.9
1358	GAIKA		12.9	1962 DEC 2	2.4749	5 6	6 1951 1966	3.0	1966	11.9	12.7
1359	PRIESKA		11.0	1957 JUN 11	3.1166	5 6	6 1939 1963	-7.7	1969	21.1	32.4
1360	TAPKA		12.5	1951 DEC 20	2.4334	5 6	4 1935 1957	90.0	1969	205.4	243.2
1361	LEUSCHNEPIA		12.0	1935 SEP 15	3.0872	2 8	8 1935 1961	-6.4	1961*	31.4	47.4
1362	GRIQUA		11.5	1941 JAN 6	3.2807	2 8	6 1935 1956	2.7	1965	18.1	29.8
1363	HEBERTA		12.7	1951 DEC 20	2.9006	5 5	5 1935 1954	72.0	1968	186.7	257.2
1364	SAFARA		12.0	1962 DEC 2	3.0118	5 6	7 1937 1960	4.4	1966	14.4	21.0
1365	1928 PK		13.3	1928 SEP 11	2.2487	2 8	11 1928 1962	-3.9	1969	28.6	25.9
1366	PICCOLO		11.3	1962 DEC 2	2.8740	5 6	8 1939 1966	-3.2	1966	11.1	15.1
1367	1934 NA		14.3	1962 DEC 2	2.3443				1955*	320070.0	311790.0 LOST
1368	NUMIDIA		12.0	1951 DEC 20	2.5220	5 6	6 1948 1963	180.0	1968	501.3	553.0
1369	OSTANTINA		11.5	1962 DEC 2	3.1089	5 6	8 1939 1967	-90.0	1969	156.4	230.1
1370	HELLA	L	15.0	1935 SEP 15	2.2511	2 8	1 1935 1935	-4.0	1935*	640000.0	580347.4 LOST
1371	RESI		12.4	1962 DEC 2	3.2127	5 6	5 1933 1968	10.6	1968	72.5	36.1
1372	HAREMARI		12.8	1968 DEC 30	2.7674	2 8	8 1935 1969	6.0	1969	13.5	17.3
1373	CINCINNATI		14.3	1941 JAN 6	3.4111	2 8	10 1935 1949	-5.8	1949*	29.6	51.7
1374	ISOPA		14.8	1951 DEC 20	2.2506	5 6	4 1935 1955	00.0	1967*	221.6	200.9
1375	ALFREDA		12.9	1962 DEC 2	2.4476	5 6	7 1939 1968	5.0	1969	14.4	15.1
1376	MICHELLE		13.8	1962 DEC 2	2.2277	5 6	10 1935 1958	-90.0	1968*	198.3	176.5
1377	ROBERBRAUXA		14.3	1950 APR 29	2.2602	2 8	5 1936 1953	1.3	1967	13.9	12.7
1378	LEONCE		13.3	1962 DEC 2	2.3755	5 6	5 1940 1962	9.2	1969	24.2	24.2
1379	LOMENOSSOVA		12.2	1962 DEC 2	2.5267	5 6	6 1948 1965	-9.9	1968	25.2	27.9
1380	VOLODIA		13.2	1936 MAR 13	3.1454	2 8	2 1936 1938	6.5	1966*	139.0	216.2
1381	DANURTA		13.0	1951 DEC 20	2.4917	5 6	6 1934 1952	270.0	1969	714.4	772.4
1382	GEPTI		13.6	1962 DEC 2	2.2202	5 6	6 1936 1968	5.8	1969	16.0	14.2
1383	LIMPURGIA		12.9	1951 DEC 20	3.0756	5 6	5 1934 1962	-180.0	1962*	342.6	515.5
1384	KNIERTJE		12.9	1951 DEC 20	2.6768	5 6	5 1941 1963	-180.0	1969	369.0	448.4
1385	GELPIA		12.0	1951 DEC 20	2.7409	5 5	5 1941 1956	72.0	1966	196.1	247.4
1386	STOPERIA		14.8	1935 AUG 6	2.3642	2 8	1 1935 1935	-9.9	1949*	400.9	396.4
1387	KAMA		14.4	1935 AUG 26	2.2583	2 8	3 1935 1962	6.2	1969*	33.3	30.3
1388	APHOODITE		12.0	1951 DEC 20	3.0173	5 5	5 1943 1953	-108.0	1966	375.6	549.2
1389	ONNIE		12.6	1951 DEC 20	2.8659	5 6	6 1935 1952	90.0	1969*	252.2	341.0
1390	ABASTUMANI		10.1	1966 AUG 3	3.4345	2 8	9 1935 1966	2.8	1966	8.9	15.7
1391	CARLITA		13.0	1940 JAN 12	2.5490	2 8	4 1936 1957	8.0	1965	35.4	39.8
1392	PIERRE		13.0	1938 SEP 19	2.6085	2 8	5 1936 1959	4.0	1969*	24.6	28.7
1393	SOFALA		13.2	1951 DEC 20	2.4742	5 6	4 1936 1959	180.0	1967	385.2	400.4
1394	ALGOA		12.9	1951 DEC 20	2.4388	5 6	6 1948 1959	90.0	1966	295.9	308.6
1395	ARTREDA		12.8	1936 AUG 23	3.2007				1966	300.0	478.5 ESTIMATED
1396	OUTENTOUA		13.1	1962 DEC 2	2.2482	5 6	9 1936 1963	-90.0	1969	173.2	156.7
1397	UMTATA		12.8	1951 DEC 20	2.6829	5 6	8 1949 1962	90.0	1962*	279.0	340.3
1398	DOMNEPA		11.5	1962 DEC 2	3.1582	5 6	7 1936 1958	-4.1	1969	14.1	22.0
1399	TENERIFFA		15.3	1936 SEP 9	2.2160	2 8	2 1936 1956	-5.6	1969*	33.7	29.7
1400	TIRELA		13.0	1962 DEC 2	3.1141	5 6	2 1936 1968	3.3	1969*	10.7	16.4

A-29

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1401	LAVONNE		12.9	1962 DEC 2	2.2266	5 6	4 1935 1964	90.0	1965	168.0	149.3
1402	FRY		14.6	1936 AUG 20	2.6829	2 8	2 1936 1949	-3.4	1940*	28.0	34.1
1403	IDELSONIA		13.7	1936 SEP 9	2.7197	2 8	1 1936 1936	-2.9	1966	123.4	153.9
1404	AJAX		10.3	1964 JAN 6	5.2088	2 8	6 1936 1964	2.6	1964	8.7	26.5
1405	1936 BF		14.4	1936 OCT 19	2.2515	2 8	2 1936 1951	6.1	1968*	39.1	35.4
1406	KOMPPA		12.6	1942 JAN 1	2.6971	2 8	4 1936 1958	8.6	1969*	33.8	41.6
1407	LYNDLOF		12.4	1957 JUN 11	2.7653	5 6	4 1949 1954	-9.0	1969	53.9	69.0
1408	TRUSANDA		12.1	1962 DEC 2	3.1109	5 6	4 1936 1962	-1.6	1968	8.4	12.8
1409	ISKI		11.8	1966 NOV 11	2.6759	2 8	8 1937 1966	5.4	1969	13.9	16.9
1410	MARGRET		12.5	1962 DEC 2	3.0209	5 6	7 1937 1958	90.0	1969*	202.6	296.7
1411	ARJUNA		12.0	1962 DEC 2	3.0042	5 6	6 1937 1956	90.0	1966	218.6	317.5
1412	LASPILA		13.7	1937 JAN 27	2.2147	2 8	9 1937 1960	-5.8	1970*	32.6	28.7
1413	ROUCAPE		12.5	1953 FEB 12	3.0219	2 8	4 1937 1964	-3.5	1969	14.	20.8
1414	JEROME		13.8	1937 MAR 8	2.7844	2 8	2 1937 1951	2.0	1951*	20.8	26.9
1415	MALAUTRA		13.5	1962 DEC 2	2.2232	5 6	8 1938 1957	6.6	1967	21.9	19.4
1416	PENAUZA		11.8	1962 DEC 2	3.0189	5 6	9 1940 1961	-6.9	1969	19.5	28.6
1417	MALINSKIA		12.4	1962 DEC 2	2.9737	5 6	4 1937 1963	-4.4	1968	13.6	19.4
1418	FAYETA		13.1	1962 DEC 2	2.2418	5 6	6 1937 1967	9.8	1969	22.9	20.6
1419	DANZIG		12.9	1964 NOV 1	2.2932	2 8	6 1938 1964	-2.7	1964	10.7	10.0
1420	RADCLIFFE		12.9	1962 DEC 2	2.7484	5 6	8 1931 1967	190.0	1967	300.7	381.1
1421	ESPERANTO		11.5	1962 DEC 2	3.0906	5 6	4 1936 1955	4.5	1969	16.3	24.6
1422	STROMBENIA		13.8	1943 OCT 3	2.2472	2 8	4 1936 1963	6.0	1963	28.9	26.1
1423	JOSE		12.6	1951 DEC 20	2.8590	5 5	6 1939 1954	-180.0	1968	500.7	674.6
1424	SUNDMANIA		10.8	1957 JUN 11	3.1843	5 6	6 1937 1962	-2.9	1968	12.2	19.3
1425	TUDOLA		12.9	1937 MAY 27	2.6113	2 8	5 1937 1958	3.8	1968	25.4	29.7
1426	1937 GF		12.2	1937 APR 17	2.5808	2 8	14 1920 1959	-35.3	1967	83.1	95.7
1427	PIJVUMA		12.0	1942 NOV 17	2.7499	2 8	5 1937 1957	45.6	1969	136.8	173.5
1428	MOMPASA		11.6	1957 JUN 11	2.8092	5 6	4 1949 1956	11.6	1961	51.8	67.9
1429	POMPA		13.4	1962 DEC 2	2.5483	5 6	6 1937 1957	180.0	1966	411.0	461.2
1430	1937 NK		13.3	1951 DEC 20	2.5581	5 6	5 1937 1962	270.0	1966	527.6	595.9
1431	1937 OR		12.6	1962 DEC 2	2.6190	5 6	6 1937 1953	90.0	1967	247.7	290.7
1432	ETHIOPIA		13.4	1962 DEC 2	2.3809	5 6	4 1939 1959	2.0	1969	10.6	10.6
1433	GERAMTINA		12.9	1957 JUN 11	2.7871	5 6	4 1950 1955	47.6	1967*	245.1	317.4
1434	MARGOT		11.5	1962 DEC 2	3.0183	5 6	6 1951 1964	90.0	1969	199.3	291.5
1435	GAPLENA		14.8	1937 JAN 7	2.6471	2 8	2 1936 1933	-2.8	1938*	66.4	79.2
1436	1936 Y8		11.5	1951 DEC 20	3.1494	5 5	6 1940 1952	-108.0	1967	350.3	545.7
1437	OTOMEDES		9.2	1964 JAN 26	5.0826	2 8	9 1937 1963	2.4	1968	8.5	25.1
1438	WENDELIN		12.8	1951 DEC 20	3.1901	5 6	3 1931 1939	180.0	1939*	1020.7	1620.2
1439	VOGTIA		11.2	1962 DEC 2	3.9810	5 6	4 1937 1950	.5	1969*	6.5	13.9
1440	ROSTIA		12.9	1962 DEC 2	3.1527	5 6	2 1937 1954	45.0	1954*	121.8	190.0
1441	BOLYAI		14.2	1941 OCT 13	2.6320	2 8	4 1937 1954	-3.9	1954*	24.2	28.6
1442	COUVINA		12.6	1965 AUG 28	2.8745	2 8	9 1937 1966	-90.0	1968	159.9	217.2
1443	PIPPINA		12.4	1938 FEB 11	2.9395	2 8	7 1937 1956	29.2	1969	107.4	151.0
1444	1938 AF		12.2	1951 DEC 20	3.1638	5 6	3 1938 1950	90.0	1969	308.2	483.4
1445	KONKOLYA		12.0	1951 DEC 20	3.1143	5 6	6 1938 1964	90.0	1969	174.5	267.3
1446	1938 BA		14.0	1938 FEB 11	2.2460	2 8	3 1938 1958	2.3	1969*	21.8	19.7
1447	UTPA		12.9	1951 DEC 20	2.5348	5 6	6 1938 1959	90.0	1968*	202.2	224.9
1448	LINDRLADIA		14.4	1942 MAR 22	2.3722	2 8	3 1938 1949	-3.1	1966	24.7	24.6
1449	VIRTANEN		13.8	1938 MAR 23	2.2228	2 8	5 1938 1956	5.6	1969	33.5	29.7
1450	RAIMONDA		12.6	1962 DEC 2	2.6112	5 6	8 1934 1966	-9.6	1968	22.1	25.8

A-30

STATUS OF NUMBERED MINOR PLANET EPHIMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		A	PLANETS	OPPOSITIONS		RESIDUAL	LAST	ERROR SEC	ERROR KM3
1451	GRAND		13.9	1939	MAR 23	2.2034	2 8	3	1939 1962	-6.1	1964	32.4	28.3
1452	1938 D71		13.1	1949	MAR 25	3.1108	2 8	3	1938 1954	-9.7	1969*	34.3	52.5
1453	FENNIA		13.8	1965	OCT 7	1.8969	2 8	10	1938 1965	4.8	1965	15.0	0.8
1454	1936 DQ		14.3	1940	APR 21	2.3649	2 8	4	1936 1951	3.8	1965	76.2	25.9
1455	MITCHELLA		14.5	1962	DEC 2	2.2462	5 6	5	1937 1947	-90.0	1968	366.5	331.1
1456	1937 NG		11.9	1962	DEC 2	3.1940	5 6	6	1937 1960	-90.0	1966	189.2	300.9
1457	ANKARA		12.5	1951	DEC 20	2.6970	5 6	7	1947 1963	90.0	1959	239.6	294.7
1458	MINEURA		12.5	1951	DEC 20	2.6252	5 6	5	1950 1962	-180.0	1967	579.1	682.1
1459	MAGNYA		12.0	1962	DEC 2	3.1563	5 6	7	1937 1965	180.0	1968	320.3	500.6
1460	1937 WC		13.8	1941	OCT 13	2.5410	2 8	3	1937 1953	-3.7	1969*	24.1	26.9
1461	JEAN-JACQUES		10.8	1957	JUN 11	3.1242	5 6	8	1951 1963	-7.1	1968	23.2	35.8
1462	ZAMENHOF		12.2	1938	FEB 11	3.1450	2 8	2	1938 1961	-20.7	1969	73.8	114.8
1463	NORDBENMARKIA		12.1	1957	JUN 11	3.1354	5 6	7	1938 1958	8.9	1969	26.2	40.6
1464	ARMISTICIA		12.4	1939	DEC 3	3.0019					1968*	300.0	435.3 ESTIMATED
1465	AUTONOMA		12.2	1957	JUN 11	3.0229					1966	200.0	440.1 ESTIMATED
1466	MUNDLEPIA		14.1	1938	MAY 22	2.3774	2 8	4	1923 1953	-4.0	1967	22.5	22.4
1467	MASHONA		9.9	1957	JUN 11	3.3810	5 6	9	1948 1963	5.9	1968	19.0	32.8
1468	ZOMPA		14.6	1951	SEP 11	2.1956	2 8	2	1938 1951	-3.0	1951*	19.8	17.2
1469	LINZIA		11.0	1951	DEC 20	3.1249	5 5	4	1942 1953	180.0	1966	597.4	920.0
1470	CARLA		12.3	1962	DEC 2	3.1599	5 6	7	1938 1955	-180.0	1966	460.6	721.1
1471	1938 SL1		12.4	1939	OCT 29	2.7164	2 8	9	1931 1963	-7.4	1969	30.0	37.3
1472	1938 UO		14.0	1939	NOV 18	2.2339	2 8	5	1931 1954	-3.3	1968*	23.4	20.9
1473	1938 UT		13.6	1942	NOV 17	2.5742	2 8	3	1938 1954	2.5	1966	19.7	22.5
1474	PEIRA		13.0	1941	JAN 6	2.7329	2 8	4	1935 1950	45.5	1968*	157.4	197.6
1475	YALTA		14.2	1941	JAN 6	2.3495	2 8	3	1935 1953	-6.3	1966	31.2	30.5
1476	1936 RA		14.9	1962	DEC 2	2.2816	5 6	5	1936 1957	90.0	1967*	207.9	193.1
1477	ROMSDORFFIA		12.4	1942	OCT 8	3.1756	2 8	4	1938 1955	-4.1	1967*	23.2	36.5
1478	VITHURI		13.6	1938	FEB 11	2.4640	2 8	4	1938 1961	6.9	1969	34.2	36.3
1479	INKERT		12.5	1938	MAR 3	2.6754	2 8	9	1923 1960	-9.2	1969*	31.4	38.2
1480	AUNUS		14.4	1938	MAR 3	2.2023	2 6	4	1938 1951	-14.4	1969	74.5	64.9
1481	TURINGIA		11.9	1951	DEC 20	3.0183	5 6	5	1933 1959	180.0	1967	368.4	539.0
1482	SEPASTANA		12.2	1962	DEC 2	2.8728	5 6	7	1938 1964	-11.9	1969	27.1	36.7
1483	HAKDILA		12.7	1951	DEC 20	2.7178	5 6	5	1938 1956	90.0	1969	223.9	278.8
1484	POSTREMA		12.3	1968	DEC 10	2.7347	2 8	8	1938 1968	-2.6	1969	8.2	10.4
1485	ISA		12.6	1962	DEC 2	3.0288	5 6	4	1938 1954	-2.1	1965	10.9	16.1
1486	MARTILYN		14.6	1938	AUG 30	2.1988	2 8	9	1938 1964	4.7	1964	27.0	24.2
1487	RODA		11.8	1951	FEB 3	3.1360	2 8	5	1938 1951	7.2	1962	31.0	48.0
1488	1938 XF		12.1	1939	MAY 17	3.0389	2 8	6	1938 1955	-4.8	1969	28.0	41.4
1489	1939 GC		13.1	1939	MAY 17	3.1740	2 8	4	1935 1950	14.5	1967	77.3	121.8
1490	LIMPOPO		12.8	1962	DEC 2	2.3521	5 6	5	1937 1954	7.2	1969	24.9	24.4
1491	BALDWINUS		12.7	1962	DEC 2	3.1917	5 6	4	1950 1961	-13.8	1961*	40.4	64.2
1492	OPPOLZER		14.4	1941	FEB 15	2.1727	2 8	5	1938 1957	-5.6	1964	30.6	26.0
1493	STORIO		12.7	1962	DEC 2	2.4305	5 6	4	1949 1957	3.4	1968	17.6	18.3
1494	SAVO		14.0	1940	APR 21	2.1905	2 8	4	1938 1951	-28.2	1969	122.5	105.7
1495	1938 SW		13.5	1941	MAR 27	2.6394	2 8	6	1938 1963	-17.2	1968	57.4	68.2
1496	TURKU		13.9	1938	OCT 29	2.2055	2 8	8	1938 1957	-4.1	1967	28.2	24.7
1497	1938 SAI		13.0	1938	OCT 9	2.8941	2 8	6	1933 1962	5.5	1968	26.1	35.8
1498	1938 SKI		13.1	1938	OCT 9	3.0944	2 8	2	1938 1954	1.5	1954*	17.3	26.2
1499	1938 UF		12.7	1942	AUG 29	2.6706	2 8	5	1938 1955	-6.6	1967	31.8	38.5
1500	1938 UH		14.5	1943	MAR 17	2.2422	2 8	5	1938 1958	-3.9	1958*	23.3	21.0

A-31

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPHCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3	
1501	1938 UJ		13.7	1938 OCT 29	2.5471	2 8 4	1930 1950	-3.3	1950*	22.4	25.1	
1502	APENNA		12.8	1957 JUN 11	2.7321	5 6 6	1951 1960	-5.1	1960	21.9	27.5	
1503	1939 XD		11.9	1939 DEC 28	2.6263	2 8 10	1935 1961	-3.7	1967	22.9	27.0	
1504	1939 FM		13.0	1939 APR 7	2.3988	2 8 6	1939 1955	-6.0	1965	34.8	35.3	
1505	KORANNA		12.5	1939 MAY 17	2.6586	2 8 5	1939 1956	4.4	1967	27.8	33.4	
1506	XOSA		13.3	1962 DEC 2	2.5667	5 6 5	1939 1968	-4.4	1968*	13.2	15.0	
1507	1939 PD		14.7	1939 OCT 4	2.3315	2 8 2	1930 1957	-1.0	1964*	20.0	19.3	
1508	1938 UO		13.2	1962 DEC 2	2.7682	5 6 4	1935 1958	1.6	1967	9.1	11.6	
1509	ESCLANGOMA		14.1	1957 JUN 11	1.8664	5 6 5	1948 1957	-23.1	1965	84.2	52.9	
1510	1939 OC		12.6	1951 DEC 20	2.6695	5 6 4	1950 1954	180.0	1967	1179.0	1426.7	
1511	DALEPA		14.2	1950 MAR 20	2.3579	2 8 5	1928 1955	4.4	1968	19.5	19.2	
1512	QULU		10.5	1942 NOV 17	3.9332	2 8 9	1930 1965	4.3	1966	20.7	43.9	
1513	1940 EB		14.5	1940 MAY 31	2.1928	2 8 4	1940 1953	16.0	1963	78.0	67.5	
1514	PTICOUXA		13.6	1951 DEC 20	2.2405	0 0 4	1939 1953	-90.0	1966	267.3	240.3	
1515	1936 VG		14.0	1936 NOV 29	2.5659	2 8 1	1936 1936	-2.5	1950*	108.7	123.4	
1516	1938 PG		13.0	1953 OCT 30	2.6228				1966	300.0	352.9	ESTIMATED
1517	REORPAD		12.2	1951 DEC 20	2.7174	5 6 9	1934 1958	-180.0	1967	303.9	477.0	
1518	1938 UA		13.8	1938 OCT 29	2.2255	2 8 8	1928 1960	7.4	1960*	31.2	27.7	
1519	1938 UB		12.4	1960 OCT 13	3.1432	2 8 4	1938 1960	5.0	1966	16.1	25.0	
1520	1939 UY		11.7	1939 DEC 8	3.1072	2 9 7	1938 1960	30.1	1965	103.5	158.0	
1521	1938 UR1		13.3	1933 NOV 18	2.8503	2 8 3	1933 1959	2.9	1969	19.9	26.7	
1522	1938 WQ		13.7	1939 DEC 8	2.3679	2 8 4	1938 1956	-4.4	1967	29.8	29.5	
1523	1939 PC		13.4	1949 JAN 24	2.2422	2 8 6	1939 1957	13.8	1964	43.0	38.7	
1524	1930 SR		12.0	1962 DEC 2	3.1100	5 6 5	1931 1966	-6.9	1969	17.0	26.0	
1525	1939 SF		13.7	1939 DEC 3	2.6955	2 8 4	1930 1957	-3.4	1961*	20.6	25.3	
1526	1939 TF		14.8	1939 OCT 24	2.3152	2 8 2	1939 1953	3.3	1967*	26.5	25.3	
1527	KALMOUISTA		13.7	1962 DEC 2	2.2274	5 6 4	1932 1965	-8.1	1969	20.6	18.3	
1528	CONPADA		13.6	1962 DEC 2	2.4146	5 6 5	1929 1955	90.0	1967*	200.0	205.1	
1529	1938 RC		11.3	1939 FEB 11	3.9976	2 8 4	1938 1952	-3.9	1968*	26.0	56.5	
1530	1938 SG		14.6	1938 OCT 9	2.2487	2 8 3	1938 1965	3.9	1965	25.2	22.9	
1531	1938 SH		13.1	1957 JUN 11	2.6294	5 6 4	1951 1961	-13.4	1967	42.2	49.8	
1532	1938 SM		11.9	1951 DEC 20	3.0056	5 6 5	1936 1961	180.0	1969	361.2	525.1	
1533	1930 RD		11.9	1962 DEC 2	3.0191	5 6 5	1936 1960	90.0	1967	185.4	271.4	
1534	1939 RK		13.0	1957 JUN 11	2.7321	5 6 5	1933 1962	180.0	1967	342.3	429.8	
1535	1939 PL		12.9	1939 OCT 4	3.1519	2 8 3	1933 1956	-4.1	1966	22.5	35.1	
1536	1939 SE		14.6	1939 OCT 24	2.2044	2 8 6	1903 1957	-4.6	1967	22.5	19.6	
1537	1940 QA		13.2	1957 JUN 11	3.0458				1967	300.0	444.8	ESTIMATED
1538	1940 PF		15.6	1940 NOV 27	2.3610				1969*	300.0	295.9	ESTIMATED
1539	1940 UP		12.1	1957 JUN 11	3.1412	5 6 4	1951 1959	5.4	1966	23.5	36.5	
1540	1938 WK		11.9	1957 JUN 11	2.8513	5 6 4	1938 1960	6.9	1964	21.1	28.3	
1541	ESTONIA		12.6	1939 MAR 18	2.7691	2 8 8	1939 1960	102.8	1969	330.4	423.7	
1542	1941 QE		11.8	1962 DEC 2	3.0918	5 6 4	1951 1963	7.4	1968	22.0	33.4	
1543	1941 SJ		13.7	1941 SEP 3	2.6279	2 8 4	1911 1958	-11.7	1958*	33.2	39.2	
1544	VINTERHANSENIA		13.0	1941 NOV 2	2.3735	2 8 6	1919 1952	18.6	1968	52.3	52.1	
1545	1941 UW		12.9	1941 OCT 13	2.7718	2 8 3	1941 1952	-33.3	1955*	157.0	201.6	
1546	1941 SG1		11.8	1962 DEC 2	3.1674	5 6 6	1935 1952	180.0	1969	492.4	773.5	
1547	1929 CZ		12.8	1944 AUG 5	2.6455	5 5 6	1929 1953	-19.8	1968	56.5	67.4	
1548	PALOMAA		12.8	1935 JUL 17	2.7886	2 8 8	1935 1959	3.8	1968*	24.9	32.3	
1549	MIKKO		13.7	1937 MAR 28	2.2305	2 8 6	1937 1962	2.5	1965	22.1	19.7	
1550	TITO		13.6	1937 DEC 13	2.5483	2 8 8	1935 1959	10.9	1965	44.8	50.3	

A-32

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1551	ARGELANDER		13.7	1962 DEC 2	2.3940	5 6 7	1938 1968	-5.1	1968	14.6	14.7
1552	PESSFL		12.6	1939 MAR 23	3.0096	2 8 7	1933 1962	5.7	1969	26.3	38.4
1553	BAUERSEELDA		12.7	1968 OCT 31	2.9076	2 8 6	1940 1968	4.9	1968	11.9	16.5
1554	YUGOSLAVIA		12.7	1951 DEC 20	2.6206	5 6 5	1952 1961	90.0	1959	369.1	432.6
1555	DEJAN		12.5	1941 SEP 3	2.6906	2 8 7	1932 1962	-7.0	1967	27.4	33.6
1556	WINGOLFIA		11.3	1962 DEC 2	3.4149	5 6 7	1942 1958	5.6	1958*	18.4	32.3
1557	OEHLA		12.2	1957 JUN 11	3.0083	5 6 6	1930 1958	-90.0	1966	186.8	271.9
1558	1942 PD		11.5	1951 DEC 20	3.2197	5 6 6	1937 1960	90.0	1969	192.1	309.0
1559	1942 RF		13.1	1942 FEB 10	2.3904	2 8 8	1935 1961	33.9	1967	93.3	94.1
1560	STRATTONIA		12.8	1951 DEC 20	2.6834	5 6 4	1950 1959	180.0	1968	489.0	840.6
1561	1941 CG		12.0	1957 JUN 11	3.1742	5 6 4	1949 1958	26.6	1969	83.8	132.0
1562	1943 FF		13.4	1960 MAY 26	2.2266	2 8 7	1936 1960	-15.0	1961	37.2	33.1
1563	MOEL		13.8	1943 MAR 17	2.1913	5 5 4	1930 1953	-72.0	1969	182.1	157.2
1564	SRRITJA		12.1	1962 DEC 2	3.1447	5 6 6	1933 1953	-5.0	1969*	17.6	27.3
1565	1948 WA		13.7	1949 MAR 25	2.3936	2 8 4	1948 1955	6.7	1964	41.9	42.3
1566	TCAPUS		17.7	1949 JUN 23	1.0777				1968	10.0	.6 ESTIMATED
1567	1941 MN		10.9	1941 APR 16	3.2179	2 6 5	1941 1954	12.2	1968	58.7	94.3
1568	ATSLFEN		13.1	1947 JAN 15	2.3521	2 8 7	1946 1957	-4.3	1964	27.1	26.6
1569	EVITA		12.4	1957 JUN 11	3.1638	5 6 7	1948 1959	-7.8	1959*	27.9	43.8
1570	REUMONIA		12.5	1948 SEP 6	2.8432	2 8 6	1948 1958	-11.9	1969	55.9	74.7
1571	1950 FJ		13.1	1950 APR 29	3.1380	2 8 3	1950 1953	2.0	1967	26.5	41.1
1572	POSMANIA		11.3	1947 JAN 15	3.1075	5 6 7	1952 1960	5.7	1965	39.2	60.0
1573	VATSALA		13.9	1949 SEP 1	2.3703	2 8 4	1949 1956	-7.0	1967*	44.4	44.1
1574	MEYER		11.5	1947 JAN 15	3.5336	5 6 6	1950 1956	11.7	1966	81.0	148.8
1575	WINIFRED		13.9	1950 APR 29	2.3752	2 8 7	1939 1958	8.8	1956	30.0	29.9
1576	FARTOLA		11.8	1948 SEP 6	3.1366	2 8 9	1939 1959	7.1	1965	25.0	38.8
1577	1940 BA		15.2	1954 MAR 8	2.2312	2 8 5	1949 1956	-2.6	1968	18.6	16.6
1578	KIOKWOOD		11.7	1950 DEC 25	3.9584	2 8 5	1949 1957	3.6	1968	22.6	48.5
1579	1948 SP		11.0	1948 SEP 6	3.4317	2 8 7	1948 1957	4.5	1967	27.7	48.9
1580	BETULTA		15.6	1969 MAY 24	2.1956	2 8 7	1950 1963	12.4	1963	32.3	28.0
1581	ARANDERADA		11.3	1950 JUL 18	3.1695	2 8 4	1943 1955	3.3	1969	18.1	28.5
1582	MARTIR		13.1	1950 JUL 18	3.1706	2 8 5	1950 1956	-3.1	1967*	24.5	38.6
1583	ANTILOCHUS		9.8	1950 NOV 15	5.2765	2 8 7	1950 1955	-5.5	1969	40.2	124.5
1584	FUJI		12.4	1949 MAR 25	2.3755	2 8 8	1927 1962	6.4	1965	21.9	21.8
1585	UNION		11.8	1948 SEP 6	2.9294	2 8 7	1947 1957	9.5	1969	45.5	63.6
1586	1939 CJ		13.5	1943 MAR 17	2.4291	2 8 5	1939 1959	6.8	1964	30.8	31.9
1587	1933 FS1		12.9	1962 DEC 2	2.5452	5 6 7	1933 1959	5.0	1969*	16.0	17.9
1588	DESCAMISADA		12.2	1957 JUN 11	3.0295	5 6 4	1951 1958	-16.8	1968*	66.8	98.2
1589	FANATICA		13.3	1950 OCT 6	2.4177	2 8 8	1935 1958	28.8	1969	71.3	73.2
1590	TSIMLKOVSKAJA		13.1	1951 DEC 20	2.2295	5 6 7	1936 1956	90.0	1966	217.2	193.6
1591	RATZE		13.3	1951 JUL 13	2.3925	2 8 3	1951 1954	-4.8	1966	51.3	51.8
1592	1951 LA		13.0	1951 JUL 13	2.7697	2 8 3	1951 1957	-3.1	1965*	24.3	31.2
1593	1951 LR		14.6	1951 JUL 13	2.2248	2 8 5	1951 1961	5.1	1961	28.6	25.4
1594	DANJON		13.5	1952 SEP 25	2.2693	5 6 3	1940 1952	-2.6	1969	31.4	28.9
1595	1930 ME		12.6	1935 OCT 5	2.6420	5 5 4	1930 1950	-72.0	1968	237.0	282.0
1596	1951 EV		11.9	1951 DEC 20	2.8917	2 8 7	1934 1962	6.4	1965	20.5	28.1
1597	1949 FR		13.4	1951 DEC 20	2.8490	5 6 4	1949 1954	180.0	1954*	980.7	1314.3
1598	PALIQUE		14.4	1969 JUL 18	2.3318	2 8 9	1950 1969	-3.9	1969	10.7	10.3
1599	GYOMUS		12.3	1957 JUN 11	3.1379	5 6 5	1950 1955	-10.7	1955*	60.2	93.2
1600	1947 UC		14.3	1948 FEB 19	1.8491	2 8 5	1947 1961	-2.6	1969	21.6	13.3

A-38

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	APMAG	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1601	PATRY		13.7	1949 SEP 1	2.2342	2 8	6 1942 1956	-43.8	1969	129.7	116.1
1602	INDIANA		13.2	1967 MAY 10	2.2443	2 8	6 1950 1967	5.0	1968	14.0	12.6
1603	NEVA		12.1	1935 OCT 5	2.7552	2 8	11 1907 1962	31.5	1969	66.7	84.8
1604	1931 FH		11.8	1962 DEC 2	3.0262	5 6	8 1951 1964	2.7	1969	11.2	16.5
1605	1936 GA		11.4	1936 JUN 1	3.0145	5 5	4 1931 1952	396.0	1967	1200.5	1752.9
1606	1950 RH		12.8	1950 AUG 27	2.6889	5 5	5 1928 1954	180.0	1963	403.9	494.4
1607	1950 RA		12.9	1962 DEC 2	2.5456	5 6	5 1950 1966	-8.4	1966	21.7	24.3
1608	1951 PZ		13.7	1957 JUN 11	2.2140	5 6	3 1951 1961	9.5	1967	33.0	29.0
1609	1951 NL		12.0	1951 NOV 10	2.5849	2 8	6 1934 1957	-7.3	1969*	25.1	28.8
1610	MIGNAYA		14.8	1929 SEP 11	2.2024	5 5	2 1928 1954	6.4	1964	38.4	33.5
1611	PEYER		11.9	1950 FEB 28	3.2006	5 5	2 1950 1953	-5.4	1963	57.1	91.0
1612	HIPPOSE		13.2	1950 FEB 9	3.1023	2 8	8 1939 1961	7.9	1969	24.7	37.7
1613	1950 SO		13.0	1950 OCT 6	2.7377	2 8	6 1929 1959	-32.7	1970	72.4	91.2
1614	1952 HA		11.8	1952 APR 18	2.9960	2 8	9 1928 1957	-19.9	1969	48.7	70.4
1615	1950 RW		11.5	1949 DEC 30	3.1174	2 8	6 1926 1961	-5.5	1964	18.9	29.0
1616	1950 FA		12.4	1954 JAN 18	2.9116	5 6	3 1950 1954	-2.6	1962	23.3	32.3
1617	1952 FR		12.1	1954 SEP 15	3.1910	2 8	4 1952 1958	-23.4	1969	104.9	166.6
1618	1948 NF		12.7	1948 JUL 28	2.8692	2 8	5 1948 1958	2.4	1958*	19.8	25.5
1619	UETA		12.9	1953 OCT 30	2.2410	2 8	5 1926 1962	-29.4	1969	61.8	55.6
1620	GEOGRAPHOS		16.0	1969 MAY 24	1.2439	2 8	6 1951 1955	6.5	1969	25.9	4.6
1621	DRUZHBA		12.9	1926 OCT 12	2.2300	2 8	8 1926 1962	25.9	1969	90.4	80.6
1622	1952 FA		13.5	1952 APR 18	2.2344	2 8	7 1942 1960	-5.6	1969	22.0	19.7
1623	1948 PL		11.9	1948 SEP 6	3.1347	2 8	5 1948 1960	8.7	1968	39.5	61.2
1624	1931 TTI		11.9	1931 OCT 26	3.1742	2 8	4 1928 1954	-6.2	1968	31.9	50.3
1625	THE NORC		11.1	1953 SEP 20	3.1663	2 8	6 1929 1957	5.9	1969	19.7	30.9
1626	SADEYA		13.7	1927 JAN 20	2.3645	2 6	2 1927 1956	8.8	1964	44.4	43.9
1627	IVER		14.2	1957 JUL 1	1.9642	2 6	2 1929 1957	-1.3	1964	12.4	7.8
1628	1923 CG		11.7	1957 MAR 3	3.0143	2 6	2 1923 1957	-7.6	1968	13.8	20.1
1629	PECKER		14.1	1942 FEB 10	2.2380	2 6	4 1942 1953	-3.6	1967	28.5	25.6
1630	1952 DA		12.6	1952 MAR 9	3.0299	2 8	7 1924 1963	5.1	1968	17.0	25.1
1631	1926 TH		13.7	1936 NOV 8	2.2353	2 8	6 1926 1966	-7.0	1966	30.2	27.0
1632	1941 DF		12.7	1941 MAR 7	2.6551	2 6	3 1941 1956	7.2	1969	37.9	45.4
1633	1929 EC		11.6	1929 MAR 10	3.1686	2 6	5 1929 1957	21.6	1968	79.7	125.2
1634	1935 OP		14.6	1935 AUG 26	2.2456	2 6	4 1928 1955	-2.5	1969	22.0	19.9
1635	1924 QW		12.8	1924 APR 5	2.8536	2 6	5 1924 1955	5.0	1969	31.6	42.4
1636	1935 US		13.5	1950 FEB 8	2.2350	2 6	3 1950 1955	-4.7	1967	38.7	34.7
1637	1907 YT		11.4	1936 NOV 8	3.0679	2 8	7 1907 1962	6.4	1967	23.2	34.8
1638	1912 OX		12.9	1954 SEP 15	2.7482	2 6	4 1912 1954	19.2	1967	45.0	57.0
1639	1951 RR		12.3	1951 OCT 1	2.5753	2 6	4 1935 1959	-3.1	1969	15.5	17.7
1640	1951 QA		14.7	1951 SEP 11	2.2890	2 6	2 1951 1958	-4.9	1965	32.4	30.3
1641	1935 OJ		12.5	1957 JUN 11	3.0174	2 6	4 1930 1956	7.5	1969	22.7	33.1
1642	1951 QU		12.5	1951 OCT 21	2.7543	2 6	4 1940 1955	4.7	1967	21.4	27.2
1643	1951 PQ		13.8	1951 OCT 21	2.4899	2 6	3 1933 1955	4.8	1967	20.3	21.9
1644	RAFI TA		12.2	1935 DEC 24	2.5456	2 6	5 1935 1957	-28.4	1967	104.4	117.0
1645	1933 OJ		12.7	1933 SEP 5	3.0562	2 6	4 1933 1958	9.3	1966	41.9	62.4
1646	1939 PG		13.8	1939 JAN 17	2.3607	2 6	6 1937 1959	-11.6	1968*	47.3	46.7
1647	MENELAUS		11.5	1959 JUN 6	5.2224	2 6	3 1957 1959	6.2	1969	58.1	177.8
1648	SHAJNA		13.0	1952 NOV 4	2.2370	2 8	6 1934 1955	-95.8	1968	233.4	209.3
1649	1951 OF		12.7	1951 FEB 23	3.0205	2 8	4 1930 1956	-3.2	1967*	15.2	22.2
1650	1937 TG		12.3	1937 NOV 3	2.4358	2 8	3 1906 1955	4.2	1967	21.7	22.6

A-34

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAQ	EPOCH	A	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR SEC	ERROR KM3
1651	1936 HD		13.5	1936 MAY 12	2.1799	5 7	5 1936 1952	19.0	1959	90.1	77.0
1652	1933 HF1		14.3	1953 SEP 20	2.2510	2 8	3 1933 1956	7.2	1966	25.4	23.1
1653	YAKHONTOVA		12.8	1937 SEP 24	2.6111	2 8	4 1937 1962	6.3	1968	31.7	37.0
1654	ROJEVA		12.1	1957 OCT 29	3.0153	2 8	7 1931 1962	-23.4	1963	49.8	72.8
1655	1929 WC		12.9	1929 DEC 15	2.7819	2 8	3 1901 1954	4.8	1960	23.7	30.9
1656	1942 EC		14.2	1942 MAR 22	1.8775	2 8	3 1942 1955	-4.4	1958*	32.5	20.7
1657	CEMEROA		11.8	1961 MAR 2	2.3487	2 8	2 1961 1962	-10.5	1968	143.1	139.9
1658	1953 NA		12.4	1953 AUG 11	2.5599	2 8	3 1949 1957	3.9	1969	21.2	24.0
1659	1940 VL		11.3	1953 JUL 2	2.7847	2 8	6 1940 1953	-3.8	1967	19.6	25.4
1660	1953 GA		14.2	1953 JUN 12	2.3955	2 8	4 1931 1955	-18.4	1968	49.7	50.2
1661	1916 ZE		14.1	1915 APR 7	2.1838	2 8	4 1916 1961	5.6	1968	37.6	32.3
1662	HOFFMANN		13.1	1923 SEP 18	2.7424	7 8	5 1923 1955	7.4	1968	39.3	49.7
1663	1926 PE		14.9	1926 SEP 2	2.2400	2 8	5 1926 1963	-6.7	1960	36.0	33.2
1664	1929 CD		13.7	1929 JAN 29	2.3792	2 8	5 1929 1961	-3.2	1965	26.0	25.2
1665	SABY		12.4	1930 APR 14	2.4137	2 8	4 1930 1957	6.2	1957*	35.2	36.1
1666	VAN GENT		13.4	1930 AUG 12	2.1856	2 8	5 1930 1959	2.0	1969	23.4	20.1
1667	PELS		13.5	1929 SEP 21	2.1897	2 8	8 1930 1963	-3.6	1969	27.5	23.7
1668	HANNA		13.6	1933 JUL 27	2.8043	2 8	4 1933 1962	-3.6	1966	24.2	21.6
1669	DAGVAD		11.7	1934 AUG 31	3.1444	2 8	6 1934 1963	-5.8	1967	29.2	45.4
1670	1934 PZ		12.3	1934 OCT 10	2.9008	2 8	5 1934 1957	10.5	1969	46.7	64.3
1671	CHAIKA		12.9	1934 OCT 10	2.5871	2 8	4 1934 1963	-3.5	1962	24.1	27.8
1672	1935 AD		13.2	1935 MAR 19	3.1715	2 8	5 1929 1962	13.1	1962	44.6	70.3
1673	VAN HOUTEN		12.1	1950 FEB 9	3.1021	2 8	6 1937 1950	6.7	1966	22.6	34.4
1674	COENEVELD		11.9	1933 MAR 3	3.1756	2 8	3 1938 1955	-7.4	1969	37.8	59.6
1675	1938 FP		13.2	1953 NOV 19	2.2334	2 8	7 1931 1958	-4.5	1969*	18.7	16.7
1676	1939 LC		14.2	1939 MAY 17	2.2358	2 8	6 1939 1959	8.6	1969*	41.2	36.9
1677	1940 PQ		13.4	1940 SEP 8	2.5318	2 8	4 1916 1952	6.0	1968	25.0	27.7
1678	1940 YH		12.1	1941 JAN 6	3.1705	2 8	4 1919 1962	5.8	1967*	21.0	33.1
1679	1941 FO		11.6	1941 MAY 6	3.1179	2 8	5 1941 1963	-4.9	1964	25.2	38.7
1680	1942 CH		12.4	1942 MAR 22	2.7226	2 8	8 1902 1950	-8.7	1967	26.3	32.0
1681	1948 WF		11.9	1949 FEB 13	2.6974	2 8	6 1939 1957	3.9	1957*	18.6	22.9
1682	KARFL		14.5	1949 AUG 12	2.2390	2 8	5 1929 1950	3.9	1959	19.4	16.5
1683	1950 SL		12.9	1950 AUG 27	2.7344	2 8	5 1936 1959	3.5	1968*	16.5	20.7
1684	1951 QF		12.7	1951 AUG 22	3.0975	2 8	7 1922 1951	7.5	1968*	25.1	38.2
1685	TOPO		16.7	1968 MAY 24	1.3677	2 8	3 1948 1965	-6.4	1965	21.8	5.8
1686	DE SITTER		12.0	1935 OCT 5	3.1775	2 8	4 1935 1963	-4.5	1969*	25.2	39.7
1687	GLADINA		11.4	1965 SEP 17	3.1544	2 8	2 1954 1965	4.5	1968	14.3	22.4
1688	1951 EQ1		13.3	1951 APR 4	2.6194	2 8	3 1951 1964	1.5	1960	13.8	16.2
1689	1930 SO		11.6	1930 OCT 11	2.4493	2 8	4 1930 1951	-9.7	1968	50.2	52.7
1690	1948 VP		11.8	1956 APR 17	3.0380	2 8	2 1948 1956	-5.6	1969	26.6	39.3
1691	TOPT		11.8	1956 SEP 24	3.1644	2 8	3 1950 1956	-1.4	1964	12.7	20.0
1692	SURPOTINA		12.5	1936 AUG 20	2.7873	2 8	5 1936 1950	6.9	1969	41.1	53.3
1693	HEPTZSPRING		12.0	1935 JUN 7	2.8061	2 8	3 1935 1950	-3.6	1960	27.7	36.2
1694	KATSEF		13.8	1960 OCT 13	2.3958	2 8	2 1934 1960	-1.5	1969*	39.8	9.9
1695	1941 UO		13.0	1964 SEP 22	2.7843	2 8	2 1941 1964	3.0	1964*	10.7	13.8
1696	1939 FF		14.4	1939 MAR 18	2.2618	2 9	3 1930 1951	-1.1	1951*	44.2	40.4
1697	1940 PM		13.2	1940 SEP 28	2.3739	2 8	2 1940 1962	1.9	1969	18.8	15.7
1698	1934 CS		12.4	1934 FEB 12	3.1552	2 8	2 1934 1940	2.2	1968	30.0	46.0
1699	1941 OO		14.4	1941 OCT 13	2.2113	2 8	3 1931 1941	1.7	1964	12.4	18.8
1700	1940 QG		13.7	1940 SEP 8	2.3607	2 8	3 1929 1951	6.4	1969	29.3	28.9

A-35

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH	δ	PLANETS	OPPOSITIONS	RESIDUAL	LAST	ERROR	SEC	ERROR	KMS
1701	1953 MJ		11.5	1953 JUL 2	3.1772	2 8	2 1931 1953	2.8	1965*		14.3		22.6
1702	1924 SH		12.0	1948 JUL 28	2.8586	2 8	4 1924 1965	3.2	1967		14.9		20.1
1703	1930 FR		14.4	1930 SEP 21	2.2147	2 8	2 1930 1963	-2.4	1969		23.9		21.1
1704	1924 OT		13.9	1924 APR 5	2.2226	2 8	3 1924 1957	6.4	1964		38.2		33.9
1705	1941 SLI		14.2	1941 OCT 13	2.2994	2 8	3 1941 1955	2.4	1969*		22.1		20.8
1706	1931 TS		14.0	1962 OCT 3	2.1258	2 8	4 1931 1962	-4.6	1968		15.3		12.5
1707	1937 PL		13.6	1932 OCT 20	2.2192	2 8	4 1932 1965	-5.3	1967*		31.0		27.4
1708	1929 XA		12.9	1929 DEC 15	2.9128	2 8	2 1929 1934	10.3	1968*	119.8		166.0	
1709	UKRAINA		13.9	1925 SEP 7	2.3784	2 8	3 1925 1960	4.3	1969*		30.2		30.2
1710	1941 UF		14.6	1941 NOV 22	2.3227	2 8	3 1941 1962	6.2	1969		31.7		30.4
1711	1935 RR		12.1	1935 FEB 7	3.0123	2 8	5 1935 1959	-8.7	1969*		39.3		57.3
1712	1935 KC		11.0	1935 JUN 7	3.1647	2 8	4 1929 1965	-2.9	1968		19.4		30.4
1713	1951 SC		14.4	1951 OCT 1	2.2286	2 8	4 1931 1958	2.8	1968*		15.9		14.2
1714	1951 OA		12.8	1951 AUG 2	2.5644	2 8	3 1951 1963	-1.2	1966		13.1		14.0
1715	1938 GK		13.4	1953 JUN 12	2.3983	2 8	2 1938 1953	7.1	1969*		28.9		29.3
1716	1934 GF		13.0	1934 MAY 3	2.7335	2 8	3 1934 1957	-2.9	1968		23.0		28.9
1717	1954 AC		13.6	1954 JAN 18	2.1955	2 8	5 1941 1959	8.6	1967		28.4		24.7
1718	1942 RX		14.9	1953 OCT 30	2.3661	2 8	7 1942 1953	-2.3	1964*		16.7		16.5
1719	1950 OP		12.5	1950 MAR 20	2.6581	2 8	3 1950 1957	6.6	1965		40.4		48.6
1720	1935 CO		14.4	1935 FEB 27	2.1883	2 8	3 1927 1951	-4.4	1969*		27.7		23.8
1721	1953 TD3		11.9	1953 OCT 30	3.1442	2 8	4 1944 1958	4.0	1969*		17.7		27.5
1722	1938 EG		13.0	1938 MAR 3	2.5141	2 8	4 1938 1960	-6.9	1964		34.3		37.6
1723	1936 FX		11.5	1942 MAY 1	3.0139	2 8	6 1931 1965	-12.7	1968		37.0		54.1
1724	1932 DC		12.0	1932 MAR 14	2.7113	2 8	4 1932 1956	7.1	1969		36.9		45.8
1725	CRAD		12.3	1930 OCT 11	2.9028	2 8	3 1930 1950	3.3	1969		26.3		36.3
1726	1933 DE		13.0	1933 SEP 5	2.7876	2 8	4 1933 1962	-5.0	1962		28.2		36.6
1727	1965 RA		14.2	1965 JAN 20	1.8540	2 8	2 1965 1966	2.6	1968*		30.1		18.6
1728	GOETHE LINK		12.7	1964 NOV 1	2.5631	2 8	4 1943 1964	2.9	1964		10.9		12.3
1729	REPYL		13.6	1963 SEP 28	2.2304	2 8	5 1937 1963	5.0	1969		15.2		13.6
1730	1936 UF		12.8	1936 NOV 8	2.7843	2 8	5 1931 1959	-5.3	1968*		26.9		34.8
1731	1948 PH		11.0	1948 AUG 17	3.1778	2 8	5 1931 1960	8.7	1968		25.8		40.8
1732	1943 FY		12.0	1943 MAR 17	3.0087	2 8	5 1924 1966	3.2	1966		16.2		23.6
1733	1938 DLI		14.2	1938 MAR 3	2.1930	2 8	3 1938 1965	5.8	1969		30.8		26.7
1734	1928 TJ		12.6	1951 OCT 1	2.7768	2 8	4 1928 1965	-5.7	1969		18.5		23.8
1735	1948 RJI		10.8	1948 OCT 16	3.1428	2 8	5 1931 1959	-8.8	1968*		26.3		40.9
1736	FLOTPAC		13.3	1967 SEP 27	2.2288	2 8	6 1927 1967	7.7	1967		17.4		15.5
1737	SEVERNY		12.1	1966 OCT 22	3.0098	2 8	4 1950 1966	.7	1966		5.6		8.2
1738	1930 SP		13.7	1930 SEP 21	2.1834	2 8	4 1927 1952	2.5	1959*		25.2		21.6
1739	1939 PF		13.7	1939 AUG 25	2.2617	2 8	4 1936 1963	2.2	1969		19.8		18.1
1740	1939 UA		14.4	1939 OCT 24	2.4673	2 8	4 1930 1966	3.5	1966		22.7		24.2
1741	1960 RC		12.6	1960 FEB 16	2.8836	2 8	4 1951 1963	-3.9	1960		14.6		20.3
1742	1934 RC		12.3	1934 SEP 20	2.8888	2 8	5 1934 1964	5.0	1968		27.2		37.2
1743	SCHMIDT		13.1	1960 SEP 23	2.4685	2 8	5 1939 1960	3.4	1970		13.8		14.2
1744	HARRIET		14.5	1960 SEP 23	2.2289	2 8	4 1949 1960	2.3	1969		13.3		11.8
1745	1941 SYL		12.8	1960 SEP 23	2.8450	2 8	5 1941 1960	-2.5	1960*		11.5		15.4
1746	ROQUWER		10.9	1948 MAR 30	3.9731	2 8	4 1940 1963	3.2	1968		15.4		33.1
1747	1947 NH		14.5	1969 SEP 16	1.7091	2 8	4 1947 1968	-3.3	1969*		11.3		5.8
1748	MAUDERLI		11.7	1966 NOV 11	3.9191	2 8	3 1966 1969	2.7	1969*		13.8		29.2
1749	TELAMON		11.2	1949 OCT 11	5.2670	2 8	3 1941 1969	-1.5	1969*		10.5		32.3
1750	1950 NAI		14.7	1950 NOV 15	1.9265	2 8	3 1950 1969	2.0	1969*		17.5		11.7

A-36

LMSC-D420943

STATUS OF NUMBERED MINOR PLANET EPHEMERIDES

NUMBER	NAME	NOTE	ARMAG	EPOCH		A	PLANETS	OPPOSITIONS		RESIDUAL	LAST	ERROR	SEC	ERROR	KM3	
1751	1955 CC		13.5	1956	JAN	8	2.7899	2	8	3	1955	1969	-2.2	1969*	13.0	16.9
1752	1930 DK		14.6	1930	JAN	24	2.2393	2	0	4	1930	1967	7.5	1967	37.0	33.2
1753	1934 JM		12.2	1934	JUN	12	3.0156	2	9	4	1934	1967	-1.8	1967	17.9	26.1
1754	1935 FE		10.6	1934	JUN	12	3.0937	2	9	7	1935	1969	5.4	1969	25.0	56.3
1755	1936 VD		11.4	1936	AUG	20	3.0907	2	9	5	1936	1968	4.2	1968	23.4	35.5
1756	1937 YA		13.9	1961	OCT	28	2.5485	2	9	3	1937	1969	-3.4	1969*	11.7	13.1
1757	1939 FC		14.0	1969	MAY	24	2.3512	2	9	3	1939	1968	-7.6	1968*	17.0	16.6
1758	1942 DK		12.0	1968	MAY	24	3.0084	2	9	5	1942	1969	5.8	1969	13.7	19.3
1759	1942 RF		14.1	1943	MAR	17	2.6492	2	9	3	1942	1968	-4.3	1969*	22.5	26.9
1760	1950 GR		12.6	1968	MAY	24	3.1655	2	9	5	1935	1968	3.7	1968	9.8	15.3
1761	1952 FN		12.6	1951	DEC	20	3.1685	2	9	4	1950	1969	-3.2	1969	16.5	25.9
1762	1953 TZ		12.8	1954	FEB	27	2.8759	2	0	4	1947	1963	-2.5	1963	13.3	18.0
1763	1953 TN2		14.2	1954	FEB	27	2.1894	2	9	3	1953	1969	-4.0	1969*	19.6	16.9
1764	1953 VM1		12.5	1954	FEB	27	3.0973	2	9	10	1935	1969	-6.0	1969	17.0	25.0
1765	1957 XR		11.0	1957	JUN	11	3.1560	2	9	4	1945	1956	-4.6	1966	15.0	23.4
1766	1962 PF		13.5	1962	DEC	2	2.7491	2	0	3	1953	1969	-5.0	1969*	14.1	17.9
1767	1962 FJ		12.4	1962	DEC	2	3.0182	2	0	3	1941	1967	-2.7	1967*	10.0	14.6
1768	1965 SA		14.2	1966	MAR	16	2.4505	2	9	3	1965	1969	6.5	1969*	22.3	23.9
1769	1966 QP		14.0	1967	APR	20	2.1785	2	9	3	1937	1969	-4.6	1969*	12.3	10.5
1770	1967 JC		14.1	1969	MAY	24	2.4577	2	9	3	1943	1958	1.5	1968*	6.8	7.2
1771	1968 PD		11.2	1969	MAY	24	3.1334	2	9	5	1938	1968	6.8	1968	14.8	22.9
1772	1968 CR		13.2	1968	MAY	24	2.5302	2	0	4	1940	1969	6.0	1969	13.9	15.4
1773	1968 HF		13.3	1968	MAY	24	2.4350	2	9	9	1941	1969	4.8	1969	12.0	12.5
1774	1968 UC1		13.5	1968	MAY	24	2.8777	2	9	3	1931	1968	2.2	1968*	7.4	10.1
1775	1969 JA		13.3	1968	MAY	24	2.6058	2	9	3	1952	1969	1.5	1969*	6.7	7.8
1776	1930 ER		11.8	1960	SEP	23	3.1019	2	9	5	1930	1963	-3.1	1963	11.4	17.4
1777	1905 RN		12.6	1960	SEP	23	2.6255	2	0	6	1905	1964	-6.4	1964	17.0	20.0
1778	1936 HK		12.6	1960	SEP	23	3.1360	2	9	4	1952	1960	-0.7	1960	8.0	12.2
1779	1950 LZ		15.1	1960	SEP	23	2.1753	2	9	3	1950	1969	1.0	1969*	9.1	7.7

A-37

EXPLANATION OF HEADINGS IN ABOVE TABLE

NUMREP = PERMANENT NUMBER ASSIGNED TO THE MINOR PLANET.
NAME = PERMANENT NAME, IF ASSIGNED.
 OTHERWISE THE TEMPORARY DESIGNATION.
NOTE = L DENOTES THE MINOR PLANET IS LOST.
 F DENOTES NO PERTURBATIONS IN EPHEMERIS CALCULATIONS.
ABMAG = BRIGHTNESS OF THE MINOR PLANET AT ONE ASTRONOMICAL UNIT
 FROM SUN AND EARTH. IN ASTRONOMICAL MAGNITUDES.
EPOCH = YEAR, MONTH AND DAY OF THE EPOCH FOR THE ORBIT.
A = SEMI-MAJOR AXIS OF THE ORBIT IN ASTRONOMICAL UNITS.
PLANETS = NUMBERS OF INNERMOST AND OUTERMOST MAJOR PLANETS USED IN
 PERTURBATION CALCULATIONS OF THE ORBIT DETERMINATION.
 1 MERCURY 4 MARS 7 URANUS
 2 VENUS 5 JUPITER 8 NEPTUNE
 3 EARTH 6 SATURN 9 PLUTO
OPPOSITIONS = THE NUMBER OF OPPOSITIONS, THE YEAR OF THE FIRST
 OPPOSITION AND THE YEAR OF THE LAST OPPOSITION
 USED IN THE ORBIT DETERMINATION.
RESIDUAL = MAXIMUM RESIDUAL IN SECONDS OF ARC IN RIGHT ASCENSION
 FROM THE ORBIT DETERMINATION AS REPORTED IN
 EPHEMERIDES OF MINOR PLANETS.
LAST = YEAR OF LAST KNOWN OBSERVATION.
 AN ASTERISK INDICATES THE MINOR PLANET IS ON THE
 CRITICAL LIST OF THOSE NEEDING OBSERVATION.
ERROR SEC = ESTIMATED EPHEMERIS UNCERTAINTY IN SECONDS OF ARC AS
 SEEN FROM THE EARTH.
 METHOD OF ESTIMATION IS OUTLINED BELOW.
ERROR KM = ESTIMATED EPHEMERIS UNCERTAINTY IN SPACE.
 EXPRESSED IN THOUSANDS OF KILOMETERS.

A SHORT REMARK PERTAINING TO AN INDIVIDUAL MINOR PLANET MAY APPEAR TO THE RIGHT OF THE LAST HEADED COLUMN.

METHOD USED TO ESTIMATE THE EPHEMERIS UNCERTAINTY

THE PRINCIPAL PART OF THE EPHEMERIS UNCERTAINTY ARISES FROM THE UNCERTAINTY OF THE ORBIT DETERMINATION AS EVIDENCED BY THE MAXIMUM RESIDUAL IN RIGHT ASCENSION QUOTED IN *EPHEMERIDES OF MINOR PLANETS*. THE EFFECT OF THIS UNCERTAINTY BUILDS UP IN PROPORTION TO THE TIME AND INVERSELY AS THE TIME INTERVAL COVERED BY THE OBSERVATIONS ON WHICH THE ORBIT DETERMINATION WAS BASED. IT IS ASSUMED HERE THAT THE MAXIMUM RESIDUAL APPLIES TO THE LAST OPPOSITION AND THAT THE RESIDUAL AT THE FIRST OPPOSITION IS NEGLIGIBLE. LET

RESID DENOTE THE QUOTED MAXIMUM RESIDUAL.
 INTVOP DENOTE THE INTERVAL BETWEEN THE FIRST AND LAST OPPOSITIONS USED IN THE ORBIT DETERMINATION.
 INTVEP DENOTE THE INTERVAL BETWEEN THE EPOCH OF THE ORBIT ELEMENTS AND THE MEAN OF THE OPPOSITIONS USED.
 INTVMW DENOTE THE INTERVAL BETWEEN THE EPOCH OF THE ORBIT ELEMENTS AND THE CURRENT YEAR.

THEN THE UNCERTAINTY IN SECONDS OF ARC DUE TO THIS CAUSE IS

$$= \text{RESID} + \text{RESID} * (\text{INTVEP} + \text{INTVMW}) / \text{INTVOP}.$$

A LESSER PART OF THE EPHEMERIS UNCERTAINTY ARISES FROM THE POSSIBLE ROUNDING ERRORS IN THE ORBITAL ELEMENTS GIVEN IN *EPHEMERIDES OF MINOR PLANETS*. THE MEAN ANOMALY (M) AT EPOCH HAS A POSSIBLE ROUNDING ERROR OF 1.8 SECONDS OF ARC AND THE EFFECT OF THE ROUNDING ERROR IN THE MEAN DAILY MOTION (MU) CAN REACH 0.1825 SECONDS OF ARC PER YEAR.

THE ESTIMATED EPHEMERIS UNCERTAINTY IN SECONDS OF ARC AS SEEN FROM THE EARTH AND LISTED UNDER THE COLUMN HEADING *ERROR SEC* IS THE SUM OF THE PRINCIPAL AND LESSER PARTS ABOVE.

Appendix B
OSCULATING ELEMENTS AT
FUTURE DATES

Appendix B

OSCULATING ELEMENTS AT FUTURE DATES

Appendix B contains osculating elements for the first 50 minor planets at the initial standard date 1972 October 10 (244 1600.5) and at ten following 400-day dates through 1983 September 23 (244 5600.5). The elements osculating at 1972 October 10 are those that were obtained as described in par. 6.1, and do not contain the effects of perturbations from the individual published epochs of osculation to the standard date. Elements osculating at the other dates are accurately consistent with the elements osculating at the initial standard date 1972 October 10.

Page B-3 of this Appendix contains the names of the first 50 minor planets and some reference information.

SOURCE	shows that the elements were taken from the 1972 or 1973 volumes of <u>Ephemerides of Minor Planets</u>
REFERENCE	is to a more detailed publication, if any, of the orbital work
MAGABS	is the absolute brightness of the minor planet expressed in units of 0.1 astronomical magnitudes
QUAL	1 denotes the elements were obtained as stated above
IJDOSC	is the integral part of the Julian Date of osculation (here, the same as the initial standard date)
B	is the semi-minor axis of the orbit
IJDOO	is the integral part of the initial standard Julian Date

Page B-4 and succeeding pages of this Appendix contain the elements osculating at the dates stated in the page headings. These elements are:

ARGPER	Argument of perihelion in degrees Ecliptic and equinox of 1950.0
NODE	Longitude of ascending node in degrees Ecliptic and equinox of 1950.0

INCLINATION	Inclination in degrees Ecliptic and equinox of 1950.0
MEAN ANOMALY	in degrees at date of osculation
SEMI-MAJOR AXIS	in astronomical units at date of osculation
ECCENTRICITY	at date of osculation
MEAN MOTION	in seconds of arc per mean solar day at date of osculation

NUM	NAME	SOURCE	AUTHOR	REFERENCE	MAGARS	QUAL	JD0000	R	IJD00	
1	CERES	EMP	1972	HERGET	ASP 16,3	41	1	2441600	2.75777354002807	2441600
2	PALLAS	EMP	1972	HERGET	ASP 16,3	52	1	2441600	2.69007987325280	2441600
3	JUNO	EMP	1972	HERGET	ASP 16,3	64	1	2441600	2.57839550016058	2441600
4	VESTA	EMP	1972	HERGET	ASP 16,3	43	1	2441600	2.35267393781440	2441600
5	ASTROEA	EMP	1973	ITA		80	1	2441600	2.53244088189615	2441600
6	HEBE	EMP	1973	ITA		67	1	2441600	2.37545729955064	2441600
7	IRIS	EMP	1973	ITA		68	1	2441600	2.32198655545842	2441600
8	FLORA	EMP	1973	ITA		75	1	2441600	2.17479743797047	2441600
9	METIS	EMP	1973	ITA		73	1	2441600	2.36730310173369	2441600
10	HYGIEA	EMP	1972	ITA		66	1	2441600	2.13516019508198	2441600
11	PARTHENOPE	EMP	1972	ITA		78	1	2441600	2.43962530059167	2441600
12	VICTORIA	EMP	1973	ITA		89	1	2441600	2.27847999964013	2441600
13	EGERIA	EMP	1972	ITA		80	1	2441600	2.56693657739531	2441600
14	IRENE	EMP	1972	HERGET	MPC 2041	74	1	2441600	2.552577949285710	2441600
15	EUNOMIA	EMP	1972	ITA		63	1	2441600	2.59508879072925	2441600
16	PSYCHE	EMP	1972	SOCCHILINA		69	1	2441600	2.89594559506521	2441600
17	THETTIS	EMP	1972	ITA		87	1	2441600	2.44568248609573	2441600
18	MELPOMENE	EMP	1973	ITA		78	1	2441600	2.24072454691806	2441600
19	FORTUNA	EMP	1972	ITA		84	1	2441600	2.41131539770018	2441600
20	MASSALIA	EMP	1973	ITA		75	1	2441600	2.38286748557697	2441600
21	LUTETIA	EMP	1972	ITA		87	1	2441600	2.40268179708221	2441600
22	KALLIOPE	EMP	1972	ITA		75	1	2441600	2.89366789708145	2441600
23	THALIA	EMP	1972	HERGET	MPC 2081	83	1	2441600	2.55066260569133	2441600
24	THEMIS	EMP	1972	ITA		82	1	2441600	3.11501318477470	2441600
25	PHOENIX	EMP	1972	HERGET	MPC 2082	91	1	2441600	2.32110374553504	2441600
26	PROSERPINA	EMP	1972	ORLONSKAYA		86	1	2441600	2.64523683739209	2441600
27	EUTERPE	EMP	1972	HERGET	MPC 2082	86	1	2441600	2.31210868954633	2441600
28	BELLONA	EMP	1972	CINCINNATI	MPC 2427	82	1	2441600	2.74335928653456	2441600
29	AMPHITRITE	EMP	1972	MAKOVER		73	1	2441600	2.54746537586377	2441600
30	URANIA	EMP	1972	ITA		88	1	2441600	2.34596314196558	2441600
31	EUCHRYSYNE	EMP	1972	ITA		78	1	2441600	3.07636091746421	2441600
32	ROMONA	EMP	1977	ORLOSKAYA		87	1	2441600	2.57892415575797	2441600
33	POLYHIMNIA	EMP	1972	HERGET	MPC 2082	98	1	2441600	2.69162341437261	2441600
34	CIRCE	EMP	1972	ORLOSKAYA		96	1	2441600	2.67106254902779	2441600
35	LEUKOTHEA	EMP	1972	ITA		98	1	2441600	2.91583609794044	2441600
36	ATALANTE	EMP	1972	HERGET	MPC 2083	100	1	2441600	2.62168135817936	2441600
37	FIDES	EMP	1972	KHANINA		85	1	2441600	2.60183719726952	2441600
38	LEDA	EMP	1972	CINCINNATI	MPC 2428	97	1	2441600	2.70663924637055	2441600
39	LACTITIA	EMP	1972	ITA		74	1	2441600	2.75146511010045	2441600
40	HARMONIA	EMP	1972	ITA		84	1	2441600	2.26430307830856	2441600
41	DAPHNE	EMP	1972	IZVEKOV		83	1	2441600	2.65956619550621	2441600
42	ISIS	EMP	1973	ITA		88	1	2441600	2.37703358497392	2441600
43	ARJADNE	EMP	1972	HERGET	MPC 2083	92	1	2441600	2.17185674075536	2441600
44	NYSA	EMP	1972	DIRIKIS		80	1	2441600	2.39363734683127	2441600
45	EUGENIA	EMP	1972	HERGET	MPC 2084	85	1	2441600	2.71251195148999	2441600
46	HESTIA	EMP	1972	HERGET	MPC 2085	93	1	2441600	2.48762662914925	2441600
47	AGLAJA	EMP	1972	IZVEKOV		92	1	2441600	2.85098544171242	2441600
48	DOPTIS	EMP	1972	ZIELENBACH	AJ 74,4	81	1	2441600	3.10871612460124	2441600
49	PALES	EMP	1972	ITA		87	1	2441600	3.02010712414803	2441600
50	VIRGINIA	EMP	1972	HERGET	MPC 2085	104	1	2441600	2.53823044561685	2441600

GROUP OF MINOR PLANETS

OSCULATION IS JULIAN DATE 2441600.5

NUM	ORGPFF	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	69.762000000000	80.420000000000	10.604000000000	41.195398899988	2.76633916386105	.07963309943340	771.167000000000
2	310.109999999999	172.802000000000	34.849000000000	29.061555555554	2.76865174229971	.23661770246840	770.201000000000
3	247.095999999999	170.073000000000	13.000000000000	154.189333333332	2.66797253630162	.25696412479523	814.206000000000
4	149.937000000000	103.631000000000	7.137000000000	159.524777777777	2.36194427397895	.08351183900910	677.467000000000
5	356.151000000000	141.460000000000	5.330000000000	190.543999999998	2.57789190614648	.18695269309381	857.254000000000
6	239.114000000000	139.740000000000	14.770000000000	331.118999999997	2.42581805005707	.20270184127368	939.116000000000
7	144.013000000000	259.603999999999	5.502000000000	212.599199999995	2.38613887055499	.23032149102335	962.638000000000
8	284.492999999999	110.703000000000	5.887000000000	105.476999999999	2.20178496653779	.15508968724616	1086.036000000000
9	5.192000000000	68.764000000000	5.583000000000	53.708999999995	2.39552433547812	.12334168061387	963.010000000000
10	310.263999999999	285.374000000000	3.813000000000	15.1590888888886	3.15083225385771	.09961498429844	674.408000000000
11	193.566000000000	125.208000000000	4.629000000000	238.323999999997	2.45244532280394	.10211544029617	923.863000000000
12	68.603000000000	235.414000000000	8.372000000000	115.483000000000	2.33504494520296	.2197731541424	994.406000000000
13	77.407000000000	43.500000000000	16.530000000000	98.341333333330	2.57632536907330	.08529513595985	858.036000000000
14	95.659000000000	86.561000000000	9.129000000000	101.207133333330	2.58779265591171	.16442797180234	852.339000000000
15	96.787000000000	293.335999999999	11.734000000000	347.353999999999	2.64237773927113	.18834129714867	826.065000000000
16	225.364000000000	150.424000000000	3.098000000000	177.578999999998	2.92282710775284	.13530055705518	710.073000000000
17	136.817999999999	125.186000000000	5.593000000000	305.330111111107	2.46923547211901	.13779029068464	914.456000000000
18	227.009000000000	150.281999999999	10.142000000000	130.776999999995	2.29582327001356	.21776850018893	1019.997000000000
19	180.764000000000	211.955000000000	1.555000000000	126.894333333330	2.44183346933613	.15760656671193	929.892000000000
20	255.915000000000	206.277000000000	.699000000000	316.180999999997	2.40820082045349	.14466706256711	949.440000000000
21	248.342000000000	80.704000000000	3.076000000000	258.292999999998	2.43487163235196	.16206884794311	933.883000000000
22	353.862999999999	66.507000000000	13.724000000000	63.879399999990	2.90914610218744	.10301822504950	715.086000000000
23	58.291000000000	67.285000000000	10.165000000000	6.6051666666661	2.62466548292423	.23578669028676	834.441000000000
24	112.122000000000	36.259000000000	.769000000000	202.366222222217	3.13800462710465	.12082988487333	638.302000000000
25	89.497000000000	214.415000000000	21.571000000000	346.587244444439	2.40067510626754	.25532763626375	953.908000000000
26	193.012000000000	45.481000000000	3.562000000000	195.134555555553	2.65555726049658	.08807720983400	819.923000000000
27	355.165999999999	94.448000000000	1.587000000000	356.932599999986	2.34715912933017	.17216980276177	986.718000000000
28	340.755999999999	144.437000000000	9.407000000000	259.120722222222	2.77605274694041	.15302033186886	767.123000000000
29	62.680000000000	356.409000000000	6.095000000000	140.681777777776	2.55439399834728	.07360372704759	869.110000000000
30	85.863000000000	307.766000000000	2.099000000000	105.440999999999	2.36516031968374	.12715116723669	975.474000000000
31	64.250000000000	30.831000000000	26.291000000000	324.080999999998	3.15559222790246	.22268065686824	632.971000000000
32	335.576999999999	220.550000000000	5.449000000000	328.2821111111097	2.59763276651037	.08197329778781	852.418000000000
33	335.750000000000	8.667000000000	1.904000000000	134.614999999998	2.86717218506873	.340034837375969	732.762000000000
34	328.279999999999	184.146000000000	5.511000000000	285.029222222220	2.68681838864504	.10913816431348	805.655000000000
35	210.969999999999	354.359999999999	8.044000000000	224.315999999999	2.99252250732400	.22493404834384	685.410000000000
36	45.481000000000	358.798999999999	18.543000000000	222.026388888888	2.74877315626456	.30055598628679	778.571000000000
37	61.430000000000	7.534000000000	3.073000000000	41.077555555552	2.64275099209375	.17528081131441	825.890000000000
38	167.578000000000	296.057999999999	6.968000000000	274.284833333331	2.73981865940576	.15515869232091	782.391000000000
39	208.357000000000	157.134000000000	10.365000000000	265.143999999997	2.76899209411305	.11233611576153	770.059000000000
40	269.347000000000	93.989000000000	4.259000000000	240.353999999999	2.26679719217692	.04689724267182	1039.651000000000
41	43.915000000000	178.558000000000	15.873000000000	93.302333333333	2.76240501940586	.27031479767781	772.815000000000
42	235.916000000000	84.415000000000	8.532000000000	130.721999999994	2.44040775401956	.22641331344861	930.707000000000
43	15.179000000000	264.806999999999	3.467000000000	55.677777777775	2.20323233776013	.16816247865817	1084.966000000000
44	342.154999999999	131.275000000000	3.711000000000	321.932499999999	2.4216611348976	.15169211765858	941.535000000000
45	86.248000000000	147.853999999999	6.602000000000	266.349222222219	2.72136179064043	.08058165402095	790.364000000000
46	174.703000000000	181.016000000000	2.315000000000	217.612777777773	2.52454000803696	.17038148269576	884.572000000000
47	312.215999999999	3.551000000000	4.994000000000	228.941555555553	2.87732823678139	.13500657346062	726.980000000000
48	255.501999999999	183.786999999999	6.548000000000	253.728999999999	3.11432104634686	.0596841820938	645.597000000000
49	106.616000000000	288.079000000000	3.155000000000	33.009333333328	3.00891274892028	.22408366108899	650.418000000000
50	199.777999999999	173.650000000000	2.824000000000	236.961833333327	2.64951579298670	.28677536580444	822.729000000000

B-4

NUM	APPROX	NAME	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	70.190021817576	80.418331672823	10.600752416025	126.453063416526	2.76794852413730	.0782933825828	770.49453168584
2	310.075194988299	172.802220039130	34.847415670039	114.711013332899	2.76809717164545	.23641368597749	770.43246897992
3	247.007962463152	169.995335832838	12.997428538579	244.751277137742	2.66959517114864	.25636691327589	813.46309575840
4	150.038994524572	103.629876029544	7.135729818851	267.990262271491	2.36209502322939	.09330913732960	977.37963183920
5	356.143581086515	141.462196872938	5.338820949844	285.859427695744	2.57729908591777	.18742651931058	857.54979036237
6	238.176948840695	138.737712667357	14.779514095068	75.400476246433	2.42627103538834	.20283257583192	928.85301253297
7	143.985409322836	259.569503771172	5.496522460801	319.493052015345	2.38691608533403	.22930091938997	962.22797023224
8	284.421746580269	110.702902870388	5.887025554721	276.254419815658	2.20143158759608	.15624573673767	1086.29751004793
9	5.0586449493453	89.761374092095	5.683277459494	150.881676760297	2.39554402005074	.12339036959550	963.42210252423
10	309.828691632293	285.333527241521	3.807149744581	85.890664403926	3.15224169029479	.10151142855173	633.98256095589
11	193.37997585653	125.207091906345	4.627070771810	341.1110958554	2.45351522975515	.10246513290374	923.25876102839
12	68.679547524512	235.397492053710	8.371029049528	225.842634033339	2.33499356317967	.21444530743031	994.46431311608
13	78.010725867056	43.424351099731	16.519255740967	193.042794157063	2.57872783030766	.36452922348284	956.83720072837
14	95.474094214466	86.537270193139	9.127350440198	196.195312471761	2.58539130255330	.16937382059520	653.53172711403
15	96.819013917784	293.33489231302	11.733712757359	79.073407985563	2.64321106727087	.18963023629893	829.67437918865
16	225.259715217478	150.424747520067	3.083058330854	256.614758366822	2.92242096962757	.12545644167051	710.03333134598
17	136.775475751519	125.193850438939	5.593179227329	46.729091052473	2.47059092234176	.13838319549261	913.70912597063
18	276.978582829553	150.285363744379	10.142681160025	244.172679391065	2.29536327612770	.21403056132168	1020.30365518504
19	180.692200724635	211.953908160493	1.555175496321	230.325211168854	2.44150439141478	.15776936328877	930.08000943296
20	255.734299462269	206.262406123009	.697065838926	61.743981813511	2.40819017542258	.14472185422481	949.44629469381
21	248.127240826055	80.6295071466454	3.075111127486	2.216846269309	2.43600974733222	.16216570948520	933.23377662351
22	353.665026465644	66.496597291296	13.725021173589	143.560636791717	2.90782622575882	.10323053492014	715.53601574513
23	58.257545209781	67.282134329538	10.165242777475	99.393220729485	2.62394502415705	.27555697767592	834.78469332818
24	111.958409504173	36.259591245621	.747961507472	273.478399721347	3.13865077466578	.12096170206313	638.10490127070
25	82.511526635622	214.404497717502	21.573094403419	92.602546196414	2.40032534033153	.25507863630133	954.11650715922
26	193.123738929262	45.446221911097	3.561569652544	286.108774343598	2.65547965135264	.08785740090589	819.95894491132
27	355.073135179855	94.446898875046	1.593272346514	106.659364725594	2.34654733247976	.17216979912076	997.10328317052
28	340.627075311613	144.430638383948	9.405996049969	344.466805710970	2.77719369354869	.15313095473506	766.65445690769
29	62.410995961624	356.397515421204	6.034883661815	237.521365464814	2.55604342559114	.07297221425240	868.26887437233
30	85.779329444712	307.765015749968	2.099505310139	213.946556530892	2.36450565304640	.12739442766259	975.84200732035
31	64.207827800168	30.819195716391	26.263819543275	34.433029427379	3.15623538045291	.27285285942069	632.77964268169
32	335.748302867722	220.545595480818	5.449916564695	62.958256090189	2.58756198561726	.08184936832409	852.45297615918
33	335.778769085726	8.657857158021	1.904523791075	216.011288030963	2.86124520585003	.34045206453024	733.11812649542
34	328.184982682944	184.133027514233	5.511493936719	14.629334651691	2.68664735906908	.10796623236463	805.73193214300
35	210.948225392051	354.338255484528	8.043850037667	300.472072261429	2.99313203224396	.22459128348629	685.20064411401
36	45.421144026064	358.695645358133	18.542341582273	308.564819487332	2.750984402314985	.29954326998315	777.64094352592
37	61.315962815596	7.530828639966	3.079512470842	132.979507765224	2.64176402234807	.17539967234979	826.3509873230
38	167.498674785600	296.057325920432	6.967874058355	1.287145204554	2.7408618459235	.15542545808963	781.94436881666
39	208.185016174791	157.080246187447	10.3752731917539	350.821535977998	2.76824143614697	.11121480478817	770.37224405121
40	268.894544713369	93.979020305702	4.25784670959	356.247495939115	2.26685669658429	.04621742080421	1039.61006441015
41	43.875656120586	178.554892441254	15.872119440302	179.251921929053	2.76249167973619	.27007044592370	772.77863506987
42	235.975695649868	84.406197733236	8.531365211028	234.072449856472	2.43086339759252	.22665525537059	931.01949157472
43	15.249040186693	264.807813601174	3.466575578564	176.143834164150	2.20376831289595	.16792505455540	1084.57021468113
44	342.060430341177	131.274201752477	3.711238634787	66.630721543841	2.42130619662325	.15164144550543	941.74214060357
45	86.454428139433	147.956128735361	6.602699895000	353.982074452721	2.720280794050513	.08035988341132	750.83204764530
46	174.523240889738	180.990658402453	2.3144979830314	316.083615244528	2.52600887997375	.17344943796834	883.80474399924
47	312.279823792389	3.551538080699	4.994437978688	309.687326779139	2.87691324524924	.13525541830172	727.13730475566
48	255.851199952671	193.781069928959	6.549186130844	325.176623427344	3.11353898938775	.06029385377285	645.84025630661
49	106.582672321991	288.074848800970	3.154831443857	105.287202572354	3.09871246810836	.22434167169254	650.48105926316
50	198.647155694978	173.597734430909	2.824414965854	328.477925513427	2.65157709031257	.28644302648443	821.76982020023

B-5

LMSC-D420943

NUM	ARGPER	NJIDE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	71.572999074920	80.233297769380	10.587514579935	210.618190537669	2.77098774727591	.07725704363678	769.22726015197
2	310.049750424145	172.791891512534	34.852374487717	200.357442370711	2.764989627244227	.23554949505886	769.68197477912
3	246.845494700496	169.970063084911	13.005982296258	335.194155219160	2.67078309322251	.25543559542200	812.92156975317
4	150.162159373020	103.624353813608	7.136833985884	16.492591568964	2.36144458975343	.08809998196243	977.77726602097
5	356.078666588613	141.461109872977	5.338808180247	21.180536984616	2.57808530389842	.18763572081996	957.15754010771
6	238.215889086340	138.735306820231	14.769883818283	179.652196697306	2.42621799325575	.20302858126487	938.88380059797
7	144.065793361478	259.558774499244	5.496172381778	66.368891433361	2.38663772846327	.22923083753268	962.33619813736
8	284.226402335817	110.690423471647	5.885249847715	347.088274272206	2.20216703360022	.15593584356229	1085.75337798734
9	4.826924562234	68.741866267820	5.581840347805	268.156507017811	2.38628583558854	.12295638862749	962.54907188253
10	308.968160072782	285.205641620123	3.804814003175	157.406470991878	3.14565722346232	.10294130087496	635.97417363530
11	192.938845431888	125.198533636995	4.628567620240	84.167148451062	2.45236087968975	.10226448472607	923.91071802205
12	68.762443826786	235.389019884796	8.372326051292	336.32228498158	2.33430409112373	.21892551616676	994.87937581583
13	78.900781891254	43.334906115851	16.531853510853	287.438120695537	2.57633046116277	.08465841207485	858.03345615286
14	95.390285708152	86.535670016900	9.126888586754	291.145876914212	2.58564251099494	.16555767773456	853.40239177911
15	96.845334473279	293.322616088670	11.732404895674	170.779091438785	2.64291567630400	.18889849714711	825.81280787755
16	224.719676497789	150.416183873948	3.088746691720	335.961481494847	2.9266956577945	.13574365540149	708.67324615304
17	136.425511444404	125.174743827939	5.592765618407	148.863222761152	2.46867202945982	.13864879150320	914.76908710462
18	226.838250963116	150.282917444714	10.142366973588	357.628524872638	2.29620001470117	.21800467118571	1019.74597917049
19	180.465048437081	211.883619315825	1.556639079479	333.886981896492	2.44311488385540	.15759518356462	929.16050297213
20	255.614666710258	206.268087584169	.699297202327	167.383309019164	2.40753357315657	.14482129971506	949.83473291649
21	248.087616205977	80.686229938683	3.075051190453	106.013115756292	2.43514292665526	.16176643170006	933.72694134830
22	353.582405641042	66.495421925219	13.727036546676	223.185376148565	2.90716712275783	.10352637284212	715.81628891742
23	58.282334343176	67.258774233263	10.161146020779	192.148188134716	2.62545369559474	.23480364971976	834.06525488435
24	111.764296823471	36.259072455480	.767935581271	344.545990567569	3.14021019160249	.12119769166198	637.62963943362
25	89.574028203479	214.386979976282	21.567716794926	198.537957207853	2.40100301690033	.25479891074628	953.71259048143
26	193.207913078943	45.462761997822	3.561966814291	17.152549076925	2.65453683736230	.08753791922652	820.39582191714
27	354.991614541890	94.446535401763	1.586970995450	216.461269719519	2.34655561722498	.17212090808486	987.09805557740
28	340.535820708359	144.429132252410	9.406991182292	69.721897372008	2.77698801502528	.15325042421860	766.73549099244
29	62.581497255884	356.367017051272	6.087301707933	333.921847513824	2.55552503597248	.07170687141040	868.53308097728
30	85.466085135904	307.758660815653	2.097627152920	322.642599651568	2.36605454045626	.12731423523202	974.92104992463
31	64.139492481857	30.814292155784	26.294223756187	104.805575331328	3.15547702091915	.22302035090951	633.00753068243
32	336.903712862135	220.402358353732	5.453078773557	156.382399529654	2.59026831662054	.08210836077804	851.11735165996
33	335.844064946377	8.657015180111	1.904525899131	297.421891234897	2.86011497404317	.34065121774979	733.55272892909
34	328.022691603435	184.135960233439	5.512025510536	104.341704947507	2.68570748640848	.10780378053330	806.15492217549
35	210.925225153265	354.336417128299	8.044305263244	16.624186518510	2.99229343605172	.22431469937071	685.49870756106
36	45.484904128322	358.689002786936	18.554231047424	34.960596266309	2.749456942635715	.29913046561598	778.28058057596
37	61.249795748305	7.531358117990	3.078545442968	224.899883120495	2.64133482736013	.17560457206283	826.55429695723
38	167.420779652834	296.048800576318	6.967174558039	88.223709655758	2.74070118158497	.15557267831825	782.01312854825
39	208.290360396965	157.080870597338	10.376813614838	76.362722003105	2.76765432133885	.11087784299774	770.61739076151
40	269.161551090621	93.976416836621	4.257543190134	111.522440184505	2.26688398530781	.04603250244115	1039.59129224552
41	43.813949168250	178.545021202813	15.871191583934	265.181662005192	2.76351298103005	.25977393426645	772.35028522946
42	236.049843365432	84.399946703460	8.531956214740	337.478103045742	2.43931830378115	.22674219108967	931.33057923942
43	15.304088805259	264.792340999360	3.466036808479	296.584232807609	2.20376654445981	.16773910861014	1084.57152016154
44	341.966951623979	131.273576840901	3.711252582654	171.398455236548	2.42092611855557	.15159777859779	941.96392530323
45	86.935151637112	147.855908345250	6.602383707890	81.361488281770	2.72213093883073	.08060573249051	790.02904324535
46	174.398212723867	180.972006983614	2.316419969568	54.420383998282	2.52488221761112	.16993614771353	884.39217057181
47	312.039875320543	3.540271158496	4.994883242743	30.621189209950	2.88000009499883	.13625258119691	725.96857455671
48	255.921346955683	183.770773600528	6.549012840742	36.857120423182	3.11500891759334	.06075099438897	645.38316605558
49	106.608441161459	288.050249295971	3.154679902548	177.548413990948	3.09786566780546	.22474104289478	850.74779058280
50	198.673860776969	173.592418712201	2.825155859213	59.806300584896	2.65059739074930	.28607497183660	822.22546951455

NUM	ARGPER	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	72.906809833869	80.137235738551	10.598430985410	294.899929383964	2.76671895974808	.07759082796682	771.00821460e68
2	309.822673754234	172.785188467081	34.822589331405	285.929574744852	2.77376174154246	.22384821615958	768.07361109173
3	246.904474929481	159.969970702850	13.005682690221	65.502281430609	2.67030733521329	.25520881723655	813.13883192108
4	150.741945350248	103.576796507007	7.135360104987	124.522403216876	2.36327122227641	.03838387188215	976.67485445888
5	355.999409305063	141.453199559884	5.338387019034	116.502481143508	2.57747314930863	.18778563717569	857.46292311445
6	238.315393421569	138.723346391166	14.770266732467	283.893867128167	2.42543539071281	.20320195394378	939.33825433491
7	144.142524502648	259.537922709827	5.496608501680	173.197567058383	2.38695682204089	.22932823246022	962.14323379382
8	284.295855868761	110.683428074026	5.885007256377	107.698402381068	2.20203005663993	.15570413542891	1085.85468825900
9	4.779256782026	68.702634973756	5.583678410680	15.146863767670	2.38546832358344	.12216135709236	963.04391989312
10	308.799740390547	285.180466638132	3.806208405957	228.347645240541	3.14404355338291	.10356994235456	636.46385392262
11	192.936333519132	125.197971621992	4.628213694370	186.836894132230	2.45281610111259	.10195402685935	923.65352521621
12	68.738659595066	235.365787445745	8.376334907202	46.841275495099	2.33481674645510	.21937841774108	994.55172555011
13	79.058636235115	43.332726365227	16.5324582276512	22.646419176753	2.57648554989569	.08486403311453	857.95598473895
14	95.310385864944	86.527229283486	9.126319646516	26.019673455089	2.58636527059076	.16571598932738	853.04469146451
15	96.951803527260	293.205165544152	11.734646518582	262.454212323686	2.64197999059961	.18916714749167	826.25155246538
16	224.321655267854	150.404043778629	3.088492494758	55.106347180091	2.92353526700707	.13484914131820	709.81319592644
17	136.314902575036	125.174783878176	5.592357195096	250.625104939042	2.46918869842287	.13847928782458	914.43198385229
18	226.865823852476	150.281247376836	10.141739865752	110.944400464331	2.29597351460974	.21773394066478	1019.89688133838
19	180.458424164058	211.877054879890	1.557460910479	77.191929278054	2.44702095185813	.15710431165276	929.78059398258
20	255.441719144426	206.233378088372	.69966047312	273.124870481355	2.40665929852987	.14458910852689	949.16893008766
21	248.155404082741	80.678473222722	3.074734680149	204.66660532176	2.43598257050741	.16141922286454	933.24422196253
22	353.303835324097	66.482494688064	13.726721701843	303.021737141264	2.908624508631943	.10377027414998	715.27833080839
23	58.171734519142	67.157269878740	10.164619906964	284.867555054824	2.62879656773687	.23323177503614	832.47481975933
24	111.674248721601	36.271668902026	.767736443930	55.430942077828	3.14091798729709	.12146787655012	637.41411991559
25	89.581606780003	214.379115597093	21.569772452465	304.471541513352	2.40117025770729	.25454722932665	953.61295351145
26	193.571979432798	45.460668171672	3.561963472359	107.952015813332	2.65574692397317	.08735905594109	819.83516783376
27	354.76558462617	94.436647212491	1.586881185639	326.276085417181	2.34783652144714	.17154636296882	986.29037225565
28	340.419120912984	144.419659063050	9.407640775956	155.059480814879	2.77585817148946	.15352885104407	767.20365933673
29	62.609979794537	356.365519153094	6.087068261191	70.245165459975	2.55515128921535	.07147496214367	868.72365088244
30	85.432302442733	307.715382962508	2.097101070863	71.078259560530	2.36494373097045	.12678161837561	975.60800336539
31	64.095407026514	30.816356828817	26.296234866747	175.188471524675	3.15412691428267	.22351465598916	633.41424812941
32	337.575287835987	220.367514194686	5.462423312974	250.353610716390	2.58681406317672	.08343823770980	852.82270593727
33	335.854356755344	8.656435906038	1.904066768835	18.915034283565	2.86116952613672	.34099984901113	733.14721383716
34	327.920049550074	184.135304105898	5.512068645250	194.043279814761	2.68636607978300	.10740874227708	805.85848319470
35	210.886530112384	354.333662949473	8.044366806505	8.044366806505	2.99134438919241	.22404070868379	685.81495510276
36	45.551461053070	358.688750194642	18.552768467649	121.325711969176	2.75052318611262	.29922089988910	777.82806548558
37	60.984783977518	7.537895964271	3.077548797580	316.966052446754	2.64333112872754	.17566263753824	825.61812599625
38	167.359740629526	296.033428588307	6.968776833604	175.203463427682	2.73965359584027	.15595168998308	782.46170941020
39	208.490490897220	157.081014231186	10.375870723259	161.751040603773	2.76880973673421	.11069087981499	770.13507687035
40	269.463920964841	93.966755336326	4.257427582513	226.702089143889	2.26717231956133	.04594031124109	1039.39297896820
41	43.742115065314	178.542788274987	15.870983908354	351.036186044124	2.76440516730196	.26975298970295	771.97641200268
42	235.958130461352	84.367362381920	8.534058381477	81.015022144167	2.43945134129977	.22718867357540	931.25439394037
43	15.398255164017	264.780952137660	3.466252533234	57.031851715719	2.20375392029820	.16769486927574	1084.58083959528
44	341.729933285185	131.257840149447	3.709753793334	176.260085738695	2.42286926615161	.15093093735995	940.83096617779
45	88.074041193337	147.765050876800	6.5930786179698	167.843103630646	2.72312645900146	.08189187751794	789.59585479032
46	174.499788906785	180.965925262071	2.316509645512	152.578479534753	2.52566269801292	.16970778901389	883.98225988038
47	311.427006371114	3.523698912319	4.993084016719	111.954704665183	2.87619515223622	.13630713761443	727.40963079382
48	256.173464564870	183.767652011533	6.549220440665	108.273192754208	3.11610689953345	.06103148426467	645.04208823400
49	106.723407432864	288.023652906884	3.155836077737	249.766466076841	3.09655038184050	.22509067627776	651.16245054959
50	198.753815176320	173.588427968133	2.825329029830	151.047169430301	2.65161243597466	.28595700531429	821.75338912163

B-7

NUM	APCPEP	NOEP	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.083015339759	80.135013932030	10.594666685724	20.420122093370	2.76685146830293	.07776197433776	770.95222840687
2	309.930017801020	172.758014950743	34.811193821952	11.214896450728	2.77224120538153	.23341899956843	768.70561444611
3	246.987715587926	169.963086942034	13.002875915637	155.733353179192	2.67116693011030	.25513064566014	812.74635527732
4	151.054754159447	103.526593569010	7.1417093922294	232.783980359752	2.36132913582345	.08945524402208	977.94807750297
5	355.951153297063	141.450460736377	5.339856446028	211.863456385016	2.57659083401775	.18914807419619	857.90339884599
6	238.350534567892	138.709664286672	14.769701734262	28.240754947734	2.42614100728034	.20353608966365	938.92848975146
7	144.221726531534	250.535269675996	5.497847088467	280.020690194153	2.38632074574944	.22941997210979	962.52794985599
8	284.785232416609	110.672438591438	5.885137698671	228.233716567817	2.20232409779541	.15557728209425	1085.63723027312
9	4.912962842851	68.700466032723	5.583646249341	122.713204849427	2.38601621777343	.12211130748009	962.71222733465
10	308.660384901516	285.175677291889	3.805756919723	299.225361340887	3.14477296880628	.10375126150549	636.24242971176
11	192.868975679168	125.189054123178	4.627860737602	289.505988721051	2.45341251832740	.10167581358869	923.31673956926
12	68.590060023414	235.367499115132	8.377871756609	197.557483366973	2.33355965440346	.21979019519296	995.35548350972
13	79.168710579063	43.3314273932124	16.531868130042	117.827366768052	2.57706390901976	.08509978903312	857.66716000927
14	95.192520221777	86.527219108830	9.127351374119	120.929583625539	2.58551445790079	.16582613729043	852.46579196713
15	97.016083003077	293.202375367575	11.735650104768	354.227451407436	2.64190817345900	.18335444942918	826.28524371722
16	224.320721684655	150.401326834944	3.083496522538	134.010117214983	2.92354372076791	.13456130567981	709.91011716968
17	136.207933194851	125.166045479791	5.592024115035	352.316168310252	2.46972934902423	.13843772390467	914.18171577152
18	226.920791796362	150.270896138841	10.139879303256	224.183045501810	2.29650530506136	.21748212219169	1019.54264308200
19	180.563052866807	211.869934131701	1.557605333771	180.372558198772	2.44280038985297	.15687983028624	929.33994399871
20	255.263981269664	206.244263259496	.700604061230	18.689690672620	2.40827374602610	.14392356918768	949.39687496181
21	248.157115146411	80.675303667842	3.074837739184	313.331097763919	2.43604372166288	.16117529689263	933.20980191893
22	352.516630238473	66.463401670128	13.732453704854	23.134204499057	2.91002212398119	.10386341495126	714.76312422099
23	58.259471587039	67.146299840105	10.169488761436	17.310634143304	2.62685116758718	.23251082513076	833.39976544984
24	111.595768410425	36.253312221186	.767401317273	126.332294331917	3.14020353398335	.12176845885948	637.63166721501
25	89.622660438527	214.378943403621	21.569446397738	50.412388320699	2.40089092673623	.25441242352897	953.77938051026
26	194.831731366284	45.454049086915	3.557020530280	197.534194632703	2.65821210083719	.08702880083521	818.69498226704
27	354.823866040733	94.435215991451	1.586722723341	75.851495246342	2.34726413237665	.17123771409209	986.65116010007
28	340.382790596559	144.418226939720	9.409066661344	240.383619902016	2.77513511009919	.15387492776926	767.50352121103
29	62.874988291803	356.361570220923	6.085720261931	166.472486349416	2.55593949641907	.07139556809625	868.32183301005
30	85.558709409421	307.701168102454	2.096606731868	179.340832977397	2.36564598507854	.12656690681629	975.17361926747
31	64.156221430500	30.808485608405	26.295318548335	245.540792070045	3.15265022971036	.22402046944005	633.85933202707
32	337.615669673603	220.366029758084	5.462446159960	345.098619676583	2.58694887771490	.08371450252833	852.75604165044
33	335.747882200867	8.599374762818	1.903156956980	100.558103242286	2.85888576601965	.34112995807481	734.02587785296
34	327.481663957644	184.098227526770	5.506422670812	283.896875109684	2.68979742900400	.10600342912066	804.31693598633
35	210.896945208084	354.331412932253	8.041166223796	169.106426302834	2.99249840911838	.22341102150681	685.42171499158
36	45.612471071481	358.675386237707	18.547754602953	207.659844653886	2.75080139018712	.29915394900297	777.71006925377
37	60.846890952199	7.505067923369	3.075718110458	48.852207904590	2.64210656274435	.17510881391405	826.19217987336
38	167.379849166608	296.035630572447	6.970234628308	262.160346926757	2.73884614536679	.15632556732398	782.80775603406
39	208.572977260377	157.068394513816	10.374154402697	247.211889721301	2.7692630046993	.11042478133634	769.94599238322
40	269.829098218845	93.966387950780	4.257780926717	341.848444981319	2.26649270280278	.04585647673598	1039.86051312598
41	43.685417561843	178.535907119842	15.871607633016	76.889162578232	2.76337901203627	.26961323731570	772.40645138193
42	235.849998412292	84.365909624323	8.535121876643	184.659555695840	2.43865313731283	.22726175368106	931.71164949322
43	15.588518140769	264.728935535781	3.470636103461	177.286749096937	2.20365917994643	.16863268729719	1084.65078326597
44	341.760007408591	131.216898087232	3.709967433998	20.788280395864	2.42181135151576	.15019625648481	941.44750524237
45	88.553444258812	147.496515809674	6.594760695016	255.252301469549	2.71962651430682	.08319326957604	791.12056640024
46	174.524104622861	180.963144819610	2.316396444279	250.737550389432	2.52625642078094	.16938697083564	883.67064688362
47	311.291328337342	3.515203679027	4.993097433330	192.970391894996	2.87581091771995	.13527755536123	727.55542348630
48	256.409815721745	183.758758043682	6.548442122014	179.681128806236	3.11611483684418	.06119066162246	645.03962367645
49	106.841314273106	288.024022352267	3.156809389992	322.030111316289	3.09509482611894	.22513543037195	651.62184583853
50	198.790780227646	173.582487342824	2.824965716254	242.278721214752	2.65204596787645	.28568837369918	821.55189841173

NUM	APGPER	NOOE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.261270494812	80.134691373477	10.593394798934	105.868238205543	2.76773486221919	.07799585593883	770.58375366239
2	309.957689997592	172.751538784711	34.807205554803	96.556618047843	2.77289474560786	.23344111767120	768.43386750754
3	247.050152049698	167.942063234407	13.002095767724	245.958209166185	2.67137313113551	.25494865738276	812.65225429130
4	151.020575915706	103.525489079811	7.141222907201	341.485794182790	2.36152481103765	.08968861817947	977.72744362564
5	355.842052817736	141.442023163956	5.339803648965	307.312350260641	2.57749686047944	.18931289380057	857.45109090199
6	238.191409106988	139.689128791946	14.776312054109	132.764761754490	2.42491488951729	.20373050538289	939.64071063670
7	144.261346561940	259.535535877085	5.497635986529	26.937232269929	2.38674690005845	.22965306655787	962.27017192206
8	284.471193132125	110.672309435620	5.895563158806	348.787421055937	2.20180429262957	.15547819089609	1086.02170119144
9	5.019905004558	68.699307522983	5.583154169065	228.839920217623	2.38623813460116	.12201220181478	962.57793411337
10	308.553215417645	295.168593534912	3.805774366699	10.008345545867	3.14611700670176	.10409052526605	635.83476404090
11	192.830690080527	125.186023110261	4.628341653452	32.138267983450	2.45281246033989	.10141005603533	923.65558172104
12	68.536446774173	235.366878066536	8.377649854215	308.218572953325	2.33400013395688	.21981958807178	995.07372706537
13	79.272339104240	43.321065688031	16.530832856076	213.021294289904	2.57650115382178	.08537301890055	857.94319076136
14	95.117832235004	86.527128863730	9.127385450209	215.871538153526	2.58496068756109	.16605043597530	853.74006075303
15	96.838817022323	293.283812461521	11.741417340139	86.143554002570	2.64193850372537	.18993985110252	826.27101474506
16	224.316890205416	150.394017590972	3.088080239974	212.876305647173	2.92456182804570	.13416100620178	709.43949757378
17	136.096837514325	125.166183650945	5.592566122208	94.018750044340	2.46899572952255	.13830483420780	914.58919547935
18	226.961899275966	150.261092071185	10.140838914988	337.423640206605	2.29613875155678	.21728888587073	1019.78679111739
19	180.609210726397	211.863310853158	1.557452071747	283.560975579016	2.44288468857908	.15666218911010	929.29183954219
20	255.360380249938	206.242593515935	.700594310039	124.085486453508	2.40867246106227	.14381555804060	949.16114979596
21	248.193665594417	80.674763437887	3.074806332665	57.012127358719	2.43558629194210	.16095920062072	933.47199455744
22	352.168485716717	66.456027181445	13.731541570730	102.980813872794	2.90761325311040	.10335297804368	715.65154806533
23	59.333109269018	67.146831459057	10.167800490061	109.910779747109	2.62767987909722	.23259332408203	833.00554304455
24	111.621402866897	36.229807122808	.767437971599	197.183367292599	3.13888535839389	.12225214956391	638.03336971755
25	89.868736033202	214.304926927999	21.545836834920	156.068104412952	2.40226319385035	.25485263512781	952.96224243659
26	195.674833106094	45.402492137713	3.554809506701	287.769829755029	2.65493744041548	.08767960429033	820.21014484535
27	354.914354458440	94.43532316062	1.586898287956	185.351230715868	2.34778644334808	.17115033639914	986.32192866732
28	340.159156877975	144.396336320997	9.408784603305	325.885669351142	2.77710886768368	.15414379855111	766.68544199256
29	63.083607875801	356.344824383461	6.085834445060	262.736711042375	2.55574045526481	.07131892682019	868.42327238519
30	85.626204918857	307.690169252030	2.095878517648	287.607881942733	2.36565813744399	.12636940039698	975.16610508948
31	64.220171310868	30.803103781182	26.298421081055	315.945422831230	3.15208025913513	.22425582991446	634.03126491104
32	337.609355957295	220.362370619106	5.461828157504	79.824477981735	2.58751632751542	.08398871747857	852.47553923797
33	335.696300952328	8.586987782439	1.903428108767	182.239864238097	2.85807503603473	.34125204624791	734.33822391514
34	327.732340689801	184.036166569717	5.506295041077	13.100879333032	2.68731018776032	.10504194136879	805.43384821989
35	210.757478053287	354.259727969905	8.033646010705	245.424680690489	2.99629016198502	.22213737738459	684.11761371297
36	45.670290756800	358.654302560297	18.547630756385	294.012283223718	2.75041147713108	.29902093026227	777.87545362950
37	60.910656158578	7.502972709565	3.075221546392	140.594948143789	2.64260119888840	.17488666498416	825.96022353970
38	167.185983663979	296.022467721672	6.970936746596	349.310338933105	2.74086372664992	.15677286256446	781.94356444208
39	208.658194363085	157.057115340742	10.375581052506	332.677039035712	2.76860888916879	.11016591748571	770.21888207724
40	270.22152595004	93.964284517118	4.257780009276	96.929618483615	2.26768871536396	.04643863605507	1039.03796488903
41	43.625397544939	178.535693846385	15.872965760371	162.816173920266	2.76284203175440	.26957623000336	772.63164731163
42	235.784794345291	84.364302188664	8.535031815295	288.248080208503	2.43921469061088	.22717239749603	931.38992157961
43	15.608236620608	264.729745579911	3.470982956503	297.941820574640	2.20300382554166	.16908217799286	1085.13481569545
44	341.874205576421	131.210891104867	3.709931380011	125.270533650814	2.42241056369382	.15018125417558	941.09820942235
45	88.563853175134	147.693151780097	6.594798955020	343.167300094994	2.71988088848347	.08345173949375	791.0058583950
46	174.554631180982	180.952819854866	2.316450819438	348.892749469715	2.52577007003465	.16913685214693	883.92589254425
47	311.160669573355	3.514691003266	4.992259070157	273.940800724478	2.87663163446547	.13617304826137	727.24408313943
48	256.761712453850	183.741834064705	6.549118468340	251.005542350967	3.11516637473362	.06131700526767	645.33423500759
49	106.897343793017	288.015031254308	3.157160994269	34.352476480938	3.09790687128039	.22588170279816	650.73480779366
50	198.823475975814	173.569278477247	2.825013030996	333.527262364811	2.65156428492959	.28546135580585	821.77577315224

GROUP OF MINOR PLANETS

OSCULATION IS JULIAN DATE 2444000.5

NUM	ARGPEP	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.407359724401	80.126833676302	10.597212116421	191.322445124870	2.76759331929698	.07917464909565	770.64296932259
2	310.073790309463	172.735729614132	34.809111323024	181.839516398775	2.77354871749895	.23330135012112	768.16210131022
3	247.099564127085	169.934798788120	13.004204599582	336.206308301056	2.67066275002388	.25475240648734	812.97651717250
4	150.922206800188	103.523769409111	7.141005587448	90.194607203850	2.36161029132050	.09985029636696	977.67435972197
5	355.686855245207	141.430343371618	5.341511472877	42.707949158309	2.5770503026341	.18301029969678	857.67385888595
6	238.126897343415	138.687850654451	14.776284292597	237.259065552812	2.42510519537076	.20364481096587	939.53010725391
7	144.133350254281	259.512145500952	5.496587379632	134.011275483142	2.38568662418699	.22797418980071	962.91173891589
8	284.473334737833	110.669686245945	5.885137261884	109.389541383244	2.20225808135969	.15600638118987	1085.68604637565
9	5.154474618926	68.692013442193	5.593150444180	335.678058808709	2.39557499733411	.12191317472737	962.97938572794
10	308.521783491244	285.166793066428	3.805381734887	80.651913639821	3.14665069408959	.10437536418561	635.67300985962
11	192.997636862241	125.184772013917	4.623478101884	134.610190414196	2.45350195196363	.10110357665378	923.26625573646
12	68.488050450621	235.36029345548	8.377415151556	58.822332397461	2.33385239333830	.21977862325612	995.16821577529
13	79.432751210491	43.315699611738	16.532477536417	378.223803420375	2.57587868184383	.08555567592867	858.25919976201
14	94.983798227386	86.525971128387	9.124923193831	310.935597307026	2.58657016989516	.16598552691108	852.94333101450
15	96.688906750525	293.282483052273	11.741458289053	178.167406153845	2.64080208350344	.19309450382657	826.80442774178
16	224.208178277078	150.382959500930	3.088186339874	291.786276979614	2.92557063446608	.13387713507251	709.07258176004
17	136.051077138162	125.164679125294	5.592683707608	195.702202554801	2.46963476901787	.13789934737711	914.23423156892
18	227.069625254661	150.251403461260	10.142788051719	90.605764485243	2.29703321620346	.21753106399957	1019.19119170212
19	190.675141980476	211.855290158744	1.557592486009	26.779598954146	2.44231325907360	.15647647933176	929.61799907609
20	255.470685164391	206.216070320936	.700515220690	229.425399433703	2.40903606850358	.14365614644092	948.94626563524
21	248.620378858827	80.649498127848	3.072416415483	160.192463268436	2.43768607410855	.16093654621775	932.26613734615
22	352.153214666375	66.4583618446678	13.730271378345	192.521460664226	2.90925360683100	.10303078046840	715.41519750941
23	58.406377799326	67.135950992960	10.165904815275	202.263839213217	2.62795625803899	.23257261298266	832.87413724021
24	111.760902579890	36.226979621531	.767492234525	267.968546857546	3.13755939010890	.12261116821058	638.43787268550
25	90.040216400626	214.218083965856	21.551332026218	261.903020464377	2.40056450377230	.25564715978793	953.97392741963
26	195.745783314698	45.400262227123	3.554601811743	18.947008332842	2.65537782882893	.08793017844407	820.00610830662
27	354.996970648415	94.434022943210	1.596874847301	294.848137360650	2.34740419043575	.17108503101469	986.56285848646
28	339.909576364318	144.380498553135	9.413480217780	51.302963756024	2.7758423145532	.15372423669499	767.20943858318
29	63.300747919288	356.343645966506	6.086571556886	359.037988165286	2.55499457304599	.07117605012258	968.80357970022
30	85.709216950638	307.690033240744	2.096894919518	35.901813186325	2.36526862575886	.12623501685542	975.40699945397
31	64.711793943174	30.773842061412	26.294059682184	26.393188618708	3.15394341912548	.22475372493997	633.46952661197
32	337.570190895607	220.347700355469	5.462394420184	174.593015383488	2.58690450962762	.08429431988407	852.77798021635
33	335.657788821552	8.586425873085	1.903357881729	263.907918897159	2.85825433948580	.34137133712409	734.26912545652
34	327.903595236961	184.030254703713	5.505899972310	102.428869735828	2.68795293345008	.10501467807964	805.14497140638
35	210.627033626256	354.131123363293	8.033898587600	321.512532586125	2.99826872305532	.22082488095110	683.44055041090
36	45.710792443003	358.650713274570	18.549358557070	20.427742448634	2.74983267054625	.29890187458270	778.12106664327
37	60.947635892953	7.490676256429	3.074894766771	232.307052738512	2.64343314937450	.17451303964131	825.57033060410
38	166.923142514125	296.018652647492	6.971344798607	76.461411258178	2.73915301517029	.15643293920946	782.67621174263
39	208.723915211796	157.057386512184	10.375256551929	58.222571960687	2.76809098809160	.10993100157741	770.43505046617
40	269.840985880552	93.958464110651	4.257412787395	212.811094239602	2.26650580851165	.04699035016292	1039.85149389732
41	43.552340383088	178.523723456788	15.871706363692	248.774502849456	2.76362616306375	.26939578864029	772.30283926038
42	235.732538365769	84.361805693888	8.534569997413	31.767009303118	2.43927025040765	.22711414888911	931.35810005016
43	15.551794676589	264.726280299861	3.470733813768	58.445982191857	2.20322428876145	.16918325283069	1084.907194553485
44	341.964798910445	131.208058251617	3.710260993951	229.713990612127	2.42256576413000	.15011856955700	941.00777440788
45	88.559201218395	147.686817999999	6.595140907111	71.031528249615	2.72063690155312	.08375463803476	790.67989904518
46	174.692351440924	180.937730145921	2.316497823340	86.996742902726	2.52632466299509	.16905653158339	883.63484196403
47	311.029749437655	3.504848057574	4.991962797546	354.851868593742	2.87757288665580	.13625457868535	726.88729073128
48	257.162150730543	183.739995940635	6.550653425090	322.333211155163	3.11377383672334	.06121179049698	645.76719174984
49	106.602319307045	287.979517914702	3.155284576278	106.874354090694	3.09549253570363	.22709722228835	651.49626908795
50	198.916242170325	173.553254179902	2.825270826345	64.764764030847	2.65232732483452	.28552179169568	821.42117743469

B-10

IMSC-D420943

NUM	APCPER	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.664910413300	90.116972387940	10.599316647913	276.718422793067	2.76652786736275	.07937601633756	771.08809996424
2	310.128311478975	172.731653190965	34.813783374479	267.111022796720	2.77325746443264	.23319367187774	768.24156233822
3	247.198398440710	169.920330474079	13.005595614933	66.428739761459	2.67193391341719	.25501005921342	812.39642999608
4	150.782302328081	103.520095249915	7.141240368489	199.001059961700	2.361007701399871	.00003436299481	978.04867508617
5	355.745256665117	141.429999701707	5.341493159079	137.952239720175	2.57752221030502	.18779492364981	857.43844143344
6	238.055102649076	138.687094409564	14.775988674766	341.694015995521	2.425619449823238	.2035669681567	939.23133965403
7	144.076211063597	259.510216254726	5.4962559710691	241.085721737138	2.38586089339651	.221920777274771	962.81834716966
8	284.371728063084	110.663331491402	5.8847069559899	230.192106306370	2.201417288719418	.15631779665148	1086.16007423087
9	5.283304126372	68.66930634366	5.582275187035	92.923698944218	2.28669009331465	.12239815072195	962.32874377556
10	308.458385455715	285.149007874779	3.805158636972	151.352162239183	3.14574199527672	.10472634750035	635.94846650317
11	193.599868406642	125.173241382585	4.626996321108	236.459432630133	2.45406875571537	.10071022752959	922.94641049075
12	68.471195097851	235.353617943173	8.276903938835	169.447469973134	2.33395341126781	.21951425979029	995.10360732313
13	79.300315592311	43.280683240000	16.533630710265	43.681226664406	2.57719699092194	.08610949536769	857.60574472816
14	94.823635553644	86.501984215852	9.121100940675	45.789386373115	2.58561485751925	.16550980084207	853.41608223930
15	96.599674032519	293.285528296530	11.743499935534	250.127049935265	2.66449814301795	.18995965825040	826.48233645428
16	224.145579918492	150.382742487159	3.088471405942	101.173053935470	2.92511733158649	.13365190226844	709.23741468422
17	136.030619834034	125.156459553289	5.590797342853	297.193620270562	2.47060577638946	.13687136366535	913.69475579467
18	227.055349810361	150.251761735403	10.145466078712	203.856715227333	2.29568149755788	.21850046543200	1020.09148802697
19	181.012774526579	211.750323559706	1.558820884721	179.727495659902	2.44379317455996	.15702455748096	928.79649171075
20	255.587874147378	206.207044206230	.700816915262	334.766820769695	2.40831520570673	.14354130047363	946.37235895054
21	249.996325673426	80.589273612224	3.071855638568	263.476778693439	2.43561680937829	.16172408385769	933.45445049056
22	352.051199370771	66.451247487342	13.727409737648	262.091265099341	2.90931208041376	.10268143620823	715.07480666124
23	58.496708012597	67.121362859507	10.166614947477	294.723721849299	2.62722980595207	.23256251951302	833.21960667351
24	111.746948267172	36.230774364889	.767506729859	338.938035563504	3.13834627058534	.12298571976695	638.19777355561
25	90.060377694414	214.213340760554	21.552145619572	7.899997527633	2.40074600517033	.25585610219696	952.86574405267
26	195.782454006211	45.391265789997	3.554590329576	109.896426022579	2.65573950638469	.08817767664890	819.83860258562
27	355.069468990805	94.432555091985	1.586827744808	44.402261366978	2.34783372616046	.17129389795935	986.28898300754
28	339.935380885203	144.39070509327	9.413429298507	136.544103140372	2.77607357488925	.15345900793469	767.11436681636
29	63.729826398869	356.335743504947	6.0871629940998	95.079582706886	2.556805957693657	.07177119893315	867.88046971720
30	85.946331397898	307.651970194687	2.093694996306	143.961241093793	2.36607329408962	.12689258054763	974.90945902693
31	64.035497279230	30.745504057164	26.309354504879	97.006370667187	3.15155808429597	.22470387488047	634.18884234044
32	337.580857941255	220.347677286721	5.463181283638	269.370267697519	2.58637193343044	.08458472531602	853.04139513394
33	335.611954249485	8.585699525099	1.903300530493	345.523990333405	2.85927942218824	.34149728036483	733.47429567458
34	328.066543503604	184.019163879314	5.506508368331	191.698358398151	2.68550388761850	.10492127191969	804.89748696745
35	210.693086992355	354.1290363550012	8.040429075339	37.439279355330	2.99649170129196	.22032220489884	684.04859586554
36	45.783613970494	358.623706472537	18.561492727333	176.691409498741	2.75138665786987	.29985315700123	777.46193381139
37	60.966083255441	7.486625701527	3.075029605133	324.000201894487	2.64319443204624	.17427757562573	825.68217390489
38	166.924688174891	296.021076665003	6.970827269349	163.438150424159	2.73953072462730	.15614706884306	782.51435150861
39	209.420707489994	157.048359344588	10.378390993797	143.026630360489	2.77143296705763	.10974291769781	769.04190760571
40	269.525155520709	93.957185354299	4.257071357739	328.647016304614	2.26703591024426	.04698647502665	1039.48679200744
41	43.405100392300	178.496299198372	15.877052679516	334.670076045909	2.76525181000456	.26398133527222	771.62190278768
42	235.713197856669	84.359550370617	6.534293810253	135.307784536839	2.43905033232355	.22688851374641	931.48378095223
43	15.475502514091	264.721708183959	3.470963200506	179.114192234428	2.20282723219380	.16918376140222	1085.26530579640
44	342.079400345514	131.208095666516	3.710313439173	334.174814408949	2.42181404141199	.15006864919714	941.44593675154
45	88.468664494593	147.687129295176	6.5954223502004	158.768447149274	2.71994959769265	.08405507502338	790.97961324373
46	175.250311922253	180.850202317355	2.321637740233	184.670035646182	2.52737526641300	.16949070198985	883.08392260840
47	310.898493019979	3.503324819839	4.992366143238	75.746010320929	2.87677175969253	.13619012551577	727.19094857932
48	257.471707327093	183.736500773438	6.550889518956	33.504932010336	3.11432530527911	.06137255032359	645.59567569087
49	106.466002898826	287.924044377056	3.154580832238	179.947679620897	3.09223398374824	.22805645219006	652.52634651774
50	199.180703099587	173.483264099539	2.833960974389	155.603307082913	2.65323738981517	.28681344970362	820.99859036537

B-11

NUM	ARGPER	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.733095061363	80.110846476080	10.597946530470	2.347856970589	2.76714761943742	.07869673854034	770.82906606537
2	310.191865940242	172.731335667107	34.813906103467	352.426001724136	2.77247399751332	.23304033892401	758.60879936556
3	247.186445969173	169.920346473316	13.004479750876	156.605400178711	2.67061172081965	.25647233375405	812.99981943112
4	150.451394384147	103.497184512803	7.139266933670	307.973370480362	2.36222533962855	.08974058990790	977.29255163930
5	355.780179867730	141.429334135461	5.340938015632	233.154108014444	2.57810939467424	.18750184031534	857.14552575606
6	238.031235202653	133.684590493093	14.775912611676	86.102710249019	2.42511001578518	.20336719873184	939.52730598592
7	144.027419579852	259.500753555378	5.495709302633	348.098888125280	2.38627253490435	.22986333901497	962.55711952517
8	294.294841785102	110.660551085735	5.884442446058	350.925208179528	2.20194774948466	.15630372442243	1085.88598246912
9	5.102593749575	68.641677552362	5.584257986435	189.691293809400	2.38527177573167	.12298220231731	963.16295545635
10	308.518155353071	285.134251637297	3.806129623156	221.985630132700	3.14445191164052	.10515766082159	636.33997534506
11	193.884216203955	125.163669097449	4.626818277325	338.789499880355	2.45305172619625	.10089861221973	923.52044768432
12	68.510916948499	235.280752424259	8.379397721637	279.943552571609	2.33525055016629	.21859620974991	994.27461169240
13	78.877765671351	43.271335111285	16.539094778671	139.457491930429	2.57569390561306	.08612815417688	858.35155666654
14	94.920699771486	85.496694092535	9.122077245541	140.510838025235	2.58625434333977	.15536569316556	853.09957407260
15	96.536106267823	293.278862260322	11.738945003165	1.996744559538	2.64185751051836	.18992587143695	826.30901235773
16	224.064275987599	150.382650769051	3.084479374712	89.533161544148	2.92420616010232	.13340895667447	709.56993601511
17	136.175816359213	125.149747010994	5.590551728027	38.612430271862	2.46989902472299	.13668647936842	914.08751394181
18	227.036643566807	150.251081411742	10.145284744978	317.249095663950	2.29567103066043	.21874312927964	1020.09846461914
19	181.066448039064	211.729446849919	1.561391319211	232.937745815102	2.44185060236602	.15801044087041	929.88221325906
20	255.722410115329	206.163509527388	.701522004258	80.113721724453	2.409437050728303	.14400031663607	948.70938403060
21	249.006702590038	80.5846464123730	3.071861612429	7.190779449780	2.43581841558547	.16194634109491	933.33856357792
22	351.978905778911	66.440024135645	13.728051435630	341.594847845497	2.90937669457756	.10250014236313	715.00098688214
23	58.551874479737	67.116027535577	10.166976926199	27.267232402896	2.62758862735087	.23272363246390	833.04939674953
24	111.286822421705	36.38269828465	.766198624589	50.082194995336	3.14055090868641	.12395772023944	637.52587797972
25	90.016282554018	214.213030147894	21.555075920215	113.925957673649	2.40038015054793	.25596610182376	954.08382793942
26	195.784578656294	45.390336173404	3.554907285083	200.997642028759	2.65497607583923	.08851438322687	820.19224124525
27	354.924207594549	94.4248509498674	1.596861038529	154.131206778718	2.34690469294048	.17184054458498	986.87783414194
28	339.953669701707	144.342298372849	9.412380450953	221.731931081027	2.77696249010833	.15308272245562	766.74606238373
29	63.892936032730	359.324547306244	6.086131787036	191.728888084775	2.55491702162121	.07272101131294	868.84313722763
30	85.976816701153	307.620016001953	2.094453071943	252.355872261159	2.36486215966514	.12753231849539	975.65848634229
31	63.924133369835	30.747057029062	26.311957692256	167.640593419243	3.15062784159970	.22471621192492	634.46974144410
32	337.144219776136	220.315401337310	5.465063024162	4.546051651425	2.58786194312206	.08483065542011	852.30476949457
33	335.574168986877	8.582856144447	1.903199016725	67.109343982229	2.85960675714929	.34144211319110	734.13334527272
34	328.217627706777	184.019554100455	5.506996620901	280.969135753130	2.68794103716164	.10488880094828	805.15031652777
35	210.787669648214	354.131022557058	8.040008613113	113.324185349533	2.99754944758638	.22033430945952	683.66945133651
36	45.709069201230	358.6228800864396	18.561444157389	193.197945751649	2.74781802583597	.30158161848696	778.97697746838
37	61.017699688455	7.487285767976	3.074965124995	55.716582115386	2.64290583270393	.17411691451011	825.81742153715
38	166.892798215651	296.017983404361	6.968931620520	250.392410362364	2.7403747858480	.15579228309075	782.15284122046
39	210.118206363893	157.025129908920	10.373357241567	227.702203227410	2.76910768994286	.11072435221596	770.01078157185
40	269.279568138909	93.951554449717	4.257275827106	84.399881717949	2.26659423792162	.04687475514247	1039.79064099587
41	43.437709146773	178.497027257869	15.877804140462	60.410640252011	2.76452988313321	.26871004229778	771.92417350383
42	235.770532411090	84.299329802412	8.530875465200	238.724053062621	2.44109259803183	.22580752938524	930.31536528079
43	15.415040584290	264.667970132943	3.469995903816	299.745334149324	2.20375559245685	.16863928874390	1084.57222294642
44	342.097542019603	131.195722383305	3.709599236844	78.711577988805	2.42278632369337	.15060064083103	940.87927966310
45	88.482063159027	147.634589208322	6.595514359646	246.874505390337	2.71921283575992	.08437815770770	791.30110507419
46	175.415280051307	180.663703846790	2.323431702296	282.523183715100	2.52520701783881	.17024577015311	884.22154602140
47	310.765219191222	3.502301889856	4.992343473005	156.713244390343	2.87595162807425	.13624816996817	727.5022898818
48	258.554230780787	183.722511259527	6.554034301372	104.194840057525	3.11898950606530	.06257193676696	644.14806173279
49	106.444843162342	287.905494173947	3.155191152157	252.149889871475	3.09148257479241	.22850609828741	652.76426340129
50	199.305293153409	173.509665412756	2.837453861804	246.719295124517	2.64949183170596	.28849495850818	822.74016082991

B-12

NUM	ARGPER	NODE	INCLINATION	MEAN ANOMALY	SEMI-MAJOR AXIS	ECCENTRICITY	MEAN MOTION
1	73.379884734053	80.064389047814	10.604297242593	88.282273966320	2.76743683472938	.07949990258455	770.68734777921
2	310.248544220536	172.713618936006	34.801047332617	77.729636393635	2.77390361599981	.23347738797105	758.05621343417
3	247.224474090809	169.894516186316	13.003007579462	247.006160308739	2.66851723899235	.25743133870060	813.95717453511
4	150.506863392357	103.479702967581	7.140350932273	56.554137638089	2.35132042559976	.08927590225859	977.85438000832
5	355.820368425666	141.420717542534	5.340751478027	328.346302256496	2.57774494406895	.18729801983176	857.32731153421
6	238.160031011071	139.653739040151	14.767641342150	190.352309164185	2.42667564686690	.20266340947409	938.61921299990
7	144.014037962119	259.493493754658	5.496091882195	95.089248951102	2.38589868264758	.22969346840812	952.78741947736
8	284.260684745714	110.657767675788	5.864697341285	111.638612842193	2.20166210645814	.15614582238849	1036.12690790906
9	4.982786193577	68.639624243473	5.584221331751	296.833402093556	2.38574293795234	.12298843490117	962.87764584689
10	308.594351144376	285.134105480112	3.806707572507	292.647531777888	3.14387623716452	.10543511420829	636.51466342459
11	193.900271031069	125.1576E4309812	4.626535271197	81.362612608933	2.45359265054977	.10114336710649	923.21506253812
12	68.603939583379	235.275457797886	8.381648811307	30.369505554996	2.33453617082061	.21842287805480	974.73102585549
13	78.766371854060	43.270483406185	16.539056895232	234.941911504433	2.57630622942075	.08587462622253	858.04556167859
14	94.992046601826	86.484975609243	9.122389702988	235.202948880196	2.58665343689779	.16516033812542	852.90214518151
15	96.476566908140	293.275002512317	11.740302266549	93.894475655395	2.64112201488288	.18976873168619	826.65420029935
16	224.144688737119	150.378435413172	3.087866497117	168.303025885279	2.92570139750609	.13778410017029	709.02504472306
17	136.272296701378	125.143970972650	5.590169378082	140.055081901254	2.47039474869702	.13682017195892	913.81238846097
18	226.970834454515	150.246432605017	10.145086016199	70.629181592053	2.29557756804863	.21876006302168	1020.16076399768
19	181.019282591329	211.728013208213	1.5614583349719	336.316111874818	2.44223211692905	.15821293578472	929.65432871696
20	255.505049041193	206.200147941934	.702585037745	185.740340342505	2.40791768932361	.14467355096814	949.60746219041
21	248.952719319237	80.593352516992	3.072029944675	110.934896061058	2.43565133006187	.162099216795654	933.43460567258
22	351.878606361115	66.440757711538	13.7259238697206	61.155128155912	2.90834720973550	.10221765235132	715.38066016047
23	58.424677105409	67.099308541066	10.172425027445	119.919094323836	2.62668687580815	.23340384419731	833.47795684315
24	110.739873124577	36.275684924975	.765025630926	121.560906677122	3.13676922942130	.12402824165671	638.67912422785
25	89.976199232744	214.214125818983	21.555362229069	220.007602232221	2.39996051873806	.25615997550456	954.33401079908
26	195.802248462699	45.390683598366	3.554896462888	292.136704873434	2.65470562397418	.08875675121674	820.31758181273
27	354.844089345451	94.424191509922	1.586863859895	163.889207422279	2.34704993875539	.17186921263790	986.7862702153
28	339.941065155714	144.373425030256	9.411158255051	306.915733377307	2.77718473227615	.15283850760168	766.65402678958
29	63.356895038252	356.329529529681	6.085817935345	288.459229465043	2.55515735993880	.07285850621709	869.72055492170
30	85.888438899116	307.613935980607	2.094099351780	.839248912757	2.36543062672881	.12766706130479	975.30679791098
31	63.846040338749	30.747839153346	26.311914427625	238.245869959802	3.15132148812589	.22455483117799	634.26027050543
32	336.858515370621	220.317236164274	5.466565234487	99.579041313898	2.58643087184268	.08440885291314	853.01223722012
33	335.532161435527	8.576279324897	1.903272058443	148.767338096091	2.85787345412886	.34145998689510	734.41592079960
34	328.350372918025	184.019385254770	5.506994959556	10.325624618363	2.68751945881299	.10495265536302	805.33977408727
35	210.867017908376	354.127181799924	8.037907400249	189.169369606512	2.99877456027107	.22019343033592	683.43855456899
36	45.749611427162	358.609151324880	18.56000377406	279.793664698976	2.74683400621613	.30222750061234	779.48073411073
37	61.458670398452	7.458320695697	3.0658616185073	146.909425498129	2.64554863858143	.17428232901656	824.58028974001
38	166.871012137671	296.002523786849	6.968673858196	337.309391517771	2.74040478251293	.15558711349603	782.14000445785
39	210.345865327899	157.013419610978	10.373229044917	313.104867348708	2.76790282146639	.11110585982429	770.51361498047
40	269.316918343486	93.941687467876	4.257239155128	199.898671490976	2.26731640790621	.04645842623577	1039.29390014042
41	43.51016928167	178.495868367995	15.875721862963	146.070539115036	2.76542545259204	.26865335282536	771.54922808204
42	235.930624711720	84.254542044272	8.534899453810	341.951791399428	2.43990019804610	.22523970219555	930.99742814766
43	15.507966774427	264.655034751986	3.470664966110	60.208532087492	2.20339674493101	.16847672777311	1084.84456962423
44	341.913901610529	131.177595708117	3.709959048806	183.510345798030	2.42143995223117	.15100030295195	941.66411168969
45	88.1152506339513	147.672918404241	6.593594502529	335.148296340139	2.72088791707456	.08469580421051	790.57048530474
46	175.401462432732	180.863386923214	2.323420422865	20.777820322478	2.52578181115669	.17048329505927	893.91972914387
47	310.599493695127	3.506125652231	4.991350747219	237.723704676292	2.87696447105040	.13596766690142	727.11788427330
48	258.471634320907	183.696682700782	6.551544666016	175.925034321624	3.11425938737153	.06465302513831	645.61617328082
49	106.385649377044	287.902610829882	3.154774909874	324.746525961606	3.09243841723129	.22870480103035	652.46164222402
50	199.355725952466	173.510391986315	2.837454033685	338.130472602867	2.64902367825356	.28880665667234	822.95827080763

B-13

Appendix C
RECTANGULAR COORDINATES AND
PERTURBATIONS AT FUTURE DATES

Appendix C

RECTANGULAR COORDINATES AND PERTURBATIONS AT FUTURE DATES

Appendix C contains the perturbed equatorial rectangular coordinates and the perturbations in these rectangular coordinates for the minor planet 1 Ceres at each 4-day date from 1972 October 10 (244 1600.5) through 1983 September 23 (244 5600.5). The perturbations are always with respect to the elements osculating at the preceding 400-day date and contained in Appendix B.

Note that the perturbations are listed in terms of the 10th decimal of an astronomical unit.

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2441600.5	-2.447144476828598	-.905908695772876	.071311498992186	-0	-0	-0
2	1	2441604.5	-2.436077983692783	-.944279503833705	.051944598131843	252	133	-9
3	2	2441608.5	-2.424365123325614	-.981249774466468	.032063911181796	1029	530	-41
4	3	2441612.5	-2.4127010815723320	-1.013260385002222	.012174736203938	2362	1142	-100
5	4	2441616.5	-2.399020151476108	-1.054852354635436	-.007717656078118	4283	2085	-190
6	5	2441620.5	-2.385398387934245	-1.091166836724383	-.027608024153929	6822	3239	-312
7	6	2441624.5	-2.371150945337163	-1.127195120992575	-.047491157563151	10010	4641	-469
8	7	2441628.5	-2.356283402902463	-1.162928635640355	-.067361878699261	13876	6294	-661
9	8	2441632.5	-2.340801494859093	-1.198358949378964	-.087215044587720	18446	8198	-890
10	9	2441636.5	-2.324711106382239	-1.233477773393162	-.107045548645631	23747	10353	-1157
11	10	2441640.5	-2.308918269348537	-1.269276963200208	-.1268488322413482	29805	12755	-1467
12	11	2441644.5	-2.29072911825950	-1.302749520267016	-.146618337193281	36652	15395	-1826
13	12	2441648.5	-2.272850083393649	-1.336884593110504	-.166350605435444	44332	18265	-2244
14	13	2441652.5	-2.254397490828705	-1.370677477747563	-.186040181747431	52902	21365	-2726
15	14	2441656.5	-2.235347954766041	-1.404119618036084	-.205682163751168	62426	24710	-3270
16	15	2441660.5	-2.215738174998428	-1.437203606761230	-.225271693280544	72961	28336	-3864
17	16	2441664.5	-2.195564993293465	-1.469922187558900	-.2448039582082982	84549	32283	-4490
18	17	2441668.5	-2.174835319062439	-1.502268256647518	-.264274193541958	97217	36593	-5129
19	18	2441672.5	-2.153556245041386	-1.534234863785699	-.283677687989021	110985	41303	-5763
20	19	2441676.5	-2.131734932944738	-1.565815213367657	-.303099764097501	125863	46447	-6375
21	20	2441680.5	-2.109378650821463	-1.597002664684915	-.322265819865239	141860	52053	-6951
22	21	2441684.5	-2.086494909404044	-1.627790732222756	-.341441289518421	159984	58147	-7479
23	22	2441688.5	-2.063090957951167	-1.658173086261534	-.360531664635189	177239	64754	-7945
24	23	2441692.5	-2.039174380203221	-1.688143552714056	-.379532490959408	196627	71894	-8339
25	24	2441696.5	-2.014753040623461	-1.717696114331766	-.398439369278535	217151	79588	-8650
26	25	2441700.5	-1.989834590486559	-1.746824908838320	-.417247956281191	238810	87855	-8866
27	26	2441704.5	-1.964426964051461	-1.775524230928376	-.435953956335447	261602	96711	-8980
28	27	2441708.5	-1.938537774788941	-1.803788531220619	-.454553167238691	285522	106171	-8982
29	28	2441712.5	-1.912175311639828	-1.831612416348918	-.473041390931957	310565	116247	-8964
30	29	2441716.5	-1.885347535310842	-1.858990648798996	-.491414524181758	336723	126948	-8619
31	30	2441720.5	-1.858062574589120	-1.885918146707475	-.509668514240118	363986	138281	-8243
32	31	2441724.5	-1.830329672631491	-1.912389983631201	-.527799368491042	392344	150244	-7733
33	32	2441728.5	-1.802153933144741	-1.938401388254967	-.545803155075006	421790	162831	-7092
34	33	2441732.5	-1.773546816364501	-1.963947743900512	-.563676003426504	452321	176026	-6326
35	34	2441736.5	-1.744515634943127	-1.989024587562255	-.581414104567731	483952	189811	-5445
36	35	2441740.5	-1.715069800259502	-2.013627608341096	-.599013711033944	516710	204172	-4456
37	36	2441744.5	-1.685214769775655	-2.037752645924256	-.616471136662170	550634	219110	-3362
38	37	2441748.5	-1.654962045080545	-2.061395689264657	-.633782756735457	585758	234640	-2155
39	38	2441752.5	-1.624319169497674	-2.084552877645322	-.650945008643927	622104	250786	-822
40	39	2441756.5	-1.593294724598223	-2.107220499594661	-.667954392576220	659685	267566	647
41	40	2441760.5	-1.561897326786045	-2.129394992586910	-.684807471818083	698506	284998	2266
42	41	2441764.5	-1.530135623893010	-2.151072942337251	-.701500873151392	738570	303090	4041
43	42	2441768.5	-1.498018291533327	-2.172751091414075	-.718031286855691	779882	321848	5979
44	43	2441772.5	-1.465554030491099	-2.192926287957704	-.734395466657361	822449	341278	8086
45	44	2441776.5	-1.432751563636124	-2.213095584752566	-.750590229913236	866279	361390	10364
46	45	2441780.5	-1.399619633000782	-2.232756137795477	-.766612457504408	911382	382154	12818
47	46	2441784.5	-1.366166997173053	-2.251905255093590	-.782459093816630	957771	403602	15452
48	47	2441788.5	-1.332402428571712	-2.270540385443383	-.798127146719153	1005459	425724	18268
49	48	2441792.5	-1.298334710835839	-2.288659117132838	-.813613687486381	1054463	448519	21269
50	49	2441796.5	-1.263972636295925	-2.306259176654805	-.828915850712971	1104798	471988	24460
51	50	2441800.5	-1.229325003499326	-2.323338427414114	-.844030834215694	1156480	496132	27844

C-2

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN		10-TH DEC
1	51	2441804.5	-1.194470614794276	-2.339954868437355	-0.95895580925577	1209529	520948	31424
2	52	2441808.5	-1.159208273951073	-2.355925633100908	-0.873688368783849	1263958	546476	35204
3	53	2441812.5	-1.123756783773167	-2.371431987984748	-0.888225630642122	1319787	572591	39184
4	54	2441816.5	-1.099054743611482	-2.386409331121143	-0.9075665134172239	1377736	599403	43365
5	55	2441820.5	-1.052111546692288	-2.400857191596003	-0.916704391706421	1435732	626858	47740
6	56	2441824.5	-1.015935377354801	-2.414774226730700	-0.930640977858680	1495917	654941	52306
7	57	2441828.5	-0.979535208735966	-2.428159220716187	-0.944372528801757	1557645	683645	57058
8	58	2441832.5	-0.942919901503966	-2.441011079652910	-0.957996741434951	1620983	712991	62003
9	59	2441836.5	-0.906797903262502	-2.453328635046406	-0.971211372934526	1685983	742976	67155
10	60	2441840.5	-0.869078247529742	-2.465111638234404	-0.984314240844210	1752705	773667	72537
11	61	2441844.5	-0.831869551604367	-2.4763597622203859	-0.997203223212402	1821164	805088	78171
12	62	2441848.5	-0.794480514515516	-2.487069599746107	-1.009876258363612	1891389	837274	84081
13	63	2441852.5	-0.756919814963940	-2.497243662354890	-1.022331344793592	1963393	870255	90288
14	64	2441856.5	-0.719196109022427	-2.506880578380958	-1.0345666540685873	2037193	904056	96817
15	65	2441860.5	-0.681318070885920	-2.515980091351878	-1.046579963406373	2112799	938704	103673
16	66	2441864.5	-0.643294180947642	-2.524542058678776	-1.058369789250037	2190219	974221	110891
17	67	2441868.5	-0.605133144481467	-2.532566449903200	-1.069934252919595	2269460	1010630	118484
18	68	2441872.5	-0.566843470017591	-2.540053345216805	-1.081271647114413	2350525	1047953	126472
19	69	2441876.5	-0.528433678034482	-2.547002933997220	-1.092380322136407	2433415	1086209	134874
20	70	2441880.5	-0.489912257566125	-2.553415513304088	-1.103258685459068	2518129	1125418	143708
21	71	2441884.5	-0.451287664900925	-2.559291485420761	-1.113905201309336	2604659	1165596	152994
22	72	2441888.5	-0.412568322312961	-2.564631361421505	-1.124218390254302	2692996	1206758	162748
23	73	2441892.5	-0.373762616831279	-2.569435749771998	-1.134496828796695	2783129	1248914	172988
24	74	2441896.5	-0.334878899021694	-2.573705364976746	-1.144439148988774	2875036	1292070	183728
25	75	2441900.5	-0.295925481736445	-2.577441021279554	-1.154144038073056	2968700	1336226	194980
26	76	2441904.5	-0.256910639742625	-2.580643632382348	-1.163610238140109	3064102	1381372	206751
27	77	2441908.5	-0.217842603140942	-2.583314210740825	-1.172836545736999	3161227	1427489	219045
28	78	2441912.5	-0.178729565673653	-2.585453862259172	-1.181821811267753	3260370	1474553	231860
29	79	2441916.5	-0.139570673464111	-2.587063790960414	-1.190564938063773	3360645	1522544	245196
30	80	2441920.5	-0.100471029779121	-2.588145289689052	-1.199064881362091	3462971	1571451	259060
31	81	2441924.5	-0.061201694449945	-2.588699742192560	-1.207320647682160	3567061	1621278	273465
32	82	2441928.5	-0.021989683816960	-2.58878621947197	-1.215331294752993	3672914	1672032	288428
33	83	2441932.5	0.017227030437051	-2.588233491578848	-1.223095931494093	3780520	1723711	303966
34	84	2441936.5	0.056440522387243	-2.587216001641409	-1.230613717641305	3889860	1776310	320092
35	85	2441940.5	0.095642913001665	-2.585677889651322	-1.237883863509332	4000913	1829810	336815
36	86	2441944.5	0.134826371521109	-2.583620978384332	-1.244905629380327	4113660	1884188	354142
37	87	2441948.5	0.173983115842584	-2.581047174361899	-1.251678324887799	4228081	1939412	372075
38	88	2441952.5	0.213105413419113	-2.577958466724510	-1.258201308656638	4344160	1995444	390614
39	89	2441956.5	0.252185582010755	-2.574356925657938	-1.264473987684838	4461883	2052243	409758
40	90	2441960.5	0.291215990165377	-2.570244701104542	-1.270495816846029	4581239	2109760	429501
41	91	2441964.5	0.330189057847514	-2.565624021498408	-1.276266298416374	4702219	2167944	449838
42	92	2441968.5	0.369097256987356	-2.560497192471189	-1.281784981573871	4824819	2226739	470761
43	93	2441972.5	0.407933111983910	-2.554866595614541	-1.287051461919546	4949035	2286084	492259
44	94	2441976.5	0.446589200189910	-2.548734687277076	-1.292065381011980	5074867	2345914	514320
45	95	2441980.5	0.485358152375390	-2.542103997405064	-1.296826425919441	5202320	2406160	536931
46	96	2441984.5	0.523932653191363	-2.534977128439436	-1.301384328798966	5331398	2466748	560075
47	97	2441988.5	0.562405441682525	-2.527356754275303	-1.305588866510647	5462113	2527594	583731
48	98	2441992.5	0.600769311935888	-2.519245619248551	-1.309589860257226	5594482	2588609	607875
49	99	2441996.5	0.639017113954242	-2.510646537006622	-1.3133337175181580	5728533	2649695	632477
50	100	2442000.5	0.677141754652769	-2.501562388985278	-1.316830719762791	5864313	2710749	657505

C-3

LMSC-D420943

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN		10-TH DEC
1	0	2442000.5	.677141754652325	-2.501562388986116	-1.316830719783189	0	-0	-0
2	1	2442004.5	.715156198436099	-2.491946122371845	-1.320070444891172	1555	-125	92
3	2	2442008.5	.752993466749764	-2.481950748105135	-1.323056342854677	6334	-526	369
4	3	2442012.5	.790706637018882	-2.471429339822350	-1.325783446766630	14410	-1225	833
5	4	2442016.5	.828268842141771	-2.460435033630887	-1.328266830489483	25887	-2239	1494
6	5	2442020.5	.865673270839821	-2.448971027865340	-1.330491608635917	40849	-3583	2363
7	6	2442024.5	.902913168412454	-2.437040582395525	-1.332462936368273	59378	-5277	3450
8	7	2442028.5	.939981837134553	-2.424647017643693	-1.334181009022990	81553	-7343	4764
9	8	2442032.5	.976872637082099	-2.411793713543531	-1.335646061625134	107458	-9805	6312
10	9	2442036.5	1.013578985978995	-2.398484108260547	-1.336858368472036	137176	-12689	8102
11	10	2442040.5	1.050094359557107	-2.384721697458502	-1.337818242659523	170794	-16019	10142
12	11	2442044.5	1.086412291780825	-2.370510033107180	-1.338526035646083	208402	-19821	12440
13	12	2442048.5	1.122526374023941	-2.355852722582995	-1.338982136825926	250089	-24117	15003
14	13	2442052.5	1.158430259210341	-2.340753427800408	-1.339186973152870	295949	-28930	17842
15	14	2442056.5	1.194117053890565	-2.325215864319517	-1.339141008742608	346074	-34279	20966
16	15	2442060.5	1.229582326291393	-2.309243800517834	-1.338844744504065	400556	-40186	24386
17	16	2442064.5	1.264818102364487	-2.292841056801208	-1.338298717789399	459487	-46668	28114
18	17	2442068.5	1.299818866632897	-2.276011504863348	-1.337503502067506	522958	-53745	32160
19	18	2442072.5	1.334578562256922	-2.258759067005911	-1.336459706629711	591057	-61438	36536
20	19	2442076.5	1.369091191169566	-2.241087715524003	-1.335167976335498	663874	-69771	41251
21	20	2442080.5	1.403350814369333	-2.223001472120970	-1.333628991397975	741496	-78771	46312
22	21	2442084.5	1.437351552459361	-2.204504407207310	-1.331843467070577	824019	-88474	51721
23	22	2442088.5	1.471087586328991	-2.185600638804829	-1.329812153285005	911549	-98914	57481
24	23	2442092.5	1.504553157429378	-2.166294330938030	-1.327535833771108	1004207	-110121	63593
25	24	2442096.5	1.537742567059865	-2.146589692080312	-1.325015325252650	1102121	-122107	70070
26	25	2442100.5	1.570650175046922	-2.126490974494786	-1.322251476998268	1205410	-134872	76930
27	26	2442104.5	1.603270398953590	-2.106002474517368	-1.319245170939951	1314179	-148408	84198
28	27	2442108.5	1.635597714433992	-2.085128532718954	-1.315997321842914	1428520	-162709	91899
29	28	2442112.5	1.66762665536615	-2.063873533439661	-1.312508877132721	1548515	-177775	100055
30	29	2442116.5	1.699351815101373	-2.042241904581701	-1.308780816869294	1674239	-193614	108686
31	30	2442120.5	1.730767845412835	-2.020238116655264	-1.304814153346094	1805768	-210240	117807
32	31	2442124.5	1.761869457901639	-1.997866682041682	-1.300609930706962	1943176	-227671	127433
33	32	2442128.5	1.792651423410959	-1.975132154621811	-1.296169224815806	2086532	-245928	137575
34	33	2442132.5	1.823108572328842	-1.952039128963150	-1.291493142875339	2235910	-265041	148242
35	34	2442136.5	1.853235794496236	-1.928592239792316	-1.286582823175081	2391379	-285039	159441
36	35	2442140.5	1.883028039293286	-1.904796161483155	-1.281439434865455	2553010	-305960	171177
37	36	2442144.5	1.912480315676063	-1.880655607511848	-1.276064177708768	2720872	-327842	183451
38	37	2442148.5	1.941587692200649	-1.856175329963044	-1.270458281855873	2895034	-350732	196264
39	38	2442152.5	1.970345297058735	-1.831360119063760	-1.264623007638633	3075566	-374679	209611
40	39	2442156.5	1.998748318122686	-1.806214802753118	-1.258559645382476	3262537	-399739	223488
41	40	2442160.5	2.026792003020134	-1.780744246300735	-1.252269515247939	3456014	-425975	237882
42	41	2442164.5	2.054471659287444	-1.754953351977882	-1.245753967108584	3656068	-453460	252780
43	42	2442168.5	2.081782654689079	-1.728847058745053	-1.239014380454854	3862773	-482274	268159
44	43	2442172.5	2.108720417790323	-1.702430341809766	-1.232052164254647	4076214	-512509	283991
45	44	2442176.5	2.135280439676062	-1.675708211775621	-1.224868756610221	4296491	-542264	300243
46	45	2442180.5	2.161458269262980	-1.648685713268833	-1.217465624093855	4523723	-577632	316881
47	46	2442184.5	2.187249522624754	-1.621367923615992	-1.209844261009863	4758040	-612696	333876
48	47	2442188.5	2.212649871719847	-1.593759952411460	-1.202006189072065	4999574	-649527	351204
49	48	2442192.5	2.237655048660656	-1.565866942013812	-1.193952957634608	5248442	-688190	368844
50	49	2442196.5	2.262260845126505	-1.537694067902095	-1.185686143965455	5504760	-728757	386774
51	50	2442200.5	2.286463112715836	-1.509246538401001	-1.177207353175923	5768638	-771304	404967

C-4

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN	10-TH DEC	
1	51	2442204.5	2.310257763402831	-1.480529594656069	-1.168518218295020	6040189	-815917	423389
2	52	2442208.5	2.233640770238489	-1.451548509848500	-1.159620349962002	6319530	-852684	442005
3	53	2442212.5	2.356608167104284	-1.422308589632987	-1.150515586141324	6606784	-911699	460775
4	54	2442216.5	2.379156049039040	-1.392815166923278	-1.141205492083216	6902080	-963060	479654
5	55	2442220.5	2.401280572423033	-1.363073611233631	-1.1316918660032163	7205553	-1016863	498597
6	56	2442224.5	2.422977954945068	-1.333089318301617	-1.121976459064406	7517342	-1073209	517554
7	57	2442228.5	2.444244475748732	-1.302867114719198	-1.112061084949005	7837596	-1132197	536475
8	58	2442232.5	2.465076475529415	-1.272414256527249	-1.101947559984815	8166467	-1193925	555306
9	59	2442236.5	2.485470356621747	-1.241734428857157	-1.091637732862637	8504111	-1258494	573991
10	60	2442240.5	2.505422583100071	-1.210833745596929	-1.081133478542334	8850692	-1326000	592474
11	61	2442244.5	2.524929680890622	-1.179717749090074	-1.070436698149335	9206377	-1396542	610696
12	62	2442248.5	2.543988237915698	-1.148392009880894	-1.059549318901603	9571337	-1470217	628593
13	63	2442252.5	2.562594904319042	-1.116862126510249	-1.048473294068252	9945751	-1547123	646102
14	64	2442256.5	2.580746392860050	-1.085133725225058	-1.037210602959306	10329802	-1627361	663152
15	65	2442260.5	2.598439479563766	-1.053212460154114	-1.025763250866291	10723689	-1711032	679670
16	66	2442264.5	2.615671004517196	-1.021104011570735	-1.014133268798908	11127627	-1798236	695578
17	67	2442268.5	2.632437872256816	-.988814085632182	-1.002322712899726	11541852	-1889061	710802
18	68	2442272.5	2.648737051171949	-.956348412675553	-.990333663768633	11966614	-1983571	725273
19	69	2442276.5	2.664565572322815	-.923712747006423	-.978168226325632	12402161	-2081811	738933
20	70	2442280.5	2.679920528814677	-.890912867511418	-.965828529425947	12848729	-2183810	751727
21	71	2442284.5	2.694799076318930	-.857954578119553	-.953316723912142	13306550	-2289594	763602
22	72	2442288.5	2.709198433529764	-.824843707637704	-.940635002524562	13775850	-2399184	774505
23	73	2442292.5	2.723115887742576	-.791586109835031	-.927785555077751	14256854	-2512598	784379
24	74	2442296.5	2.736548770671419	-.758187662761067	-.914770615731058	14749791	-2629853	793165
25	75	2442300.5	2.749494508331097	-.724654268299457	-.901592438289384	15254889	-2750955	800807
26	76	2442304.5	2.761950571506830	-.690991852056740	-.888253301243843	15772381	-2875909	807245
27	77	2442308.5	2.773914501079801	-.657206362809177	-.874755507560913	16302500	-3004709	812421
28	78	2442312.5	2.785383903149821	-.623303772229473	-.861101384600833	16845482	-3137344	816277
29	79	2442316.5	2.796356449345183	-.589290074615782	-.847293284056633	17401562	-3273793	818754
30	80	2442320.5	2.806829877091232	-.555171286580752	-.833333581867734	17970975	-3414027	819797
31	81	2442324.5	2.816801989879693	-.520953446782062	-.819224678156345	18553957	-3558011	819348
32	82	2442328.5	2.826270657560698	-.486642615671492	-.804968997176438	19150743	-3705701	817352
33	83	2442332.5	2.835233816656540	-.452244875269578	-.790568987279315	19761565	-3857044	813753
34	84	2442336.5	2.843689470717933	-.417766328979301	-.776027120905070	20386655	-4011984	808495
35	85	2442340.5	2.851635690771914	-.383213101441829	-.761345894606634	21026245	-4170459	801521
36	86	2442344.5	2.859070615948852	-.348591338396410	-.746527829095204	21680566	-4332403	792773
37	87	2442348.5	2.865992454373981	-.313907206395296	-.731575469235899	22349858	-4497747	782188
38	88	2442352.5	2.872399484210959	-.279166892092512	-.716491383831645	23034372	-4666416	769704
39	89	2442356.5	2.878290054297878	-.244376600999296	-.701278165080520	23734376	-4838318	755261
40	90	2442360.5	2.883662583804949	-.209542556290784	-.685938427961155	24450142	-5013334	738812
41	91	2442364.5	2.888515561320816	-.174670998497082	-.670474810034268	25181938	-5191322	720316
42	92	2442368.5	2.892847544509593	-.139768186101200	-.654889971789618	25930017	-5372121	699741
43	93	2442372.5	2.896657160916902	-.104840395962372	-.639186597018622	26694620	-5555563	677060
44	94	2442376.5	2.899943108704562	-.069893923106444	-.623367392841878	27475481	-5741472	652243
45	95	2442380.5	2.902704157520517	-.034935080751088	-.607435089377534	28274327	-5929669	625263
46	96	2442384.5	2.904939149596132	.000029800453728	-.591392442014090	29089887	-6119966	596091
47	97	2442388.5	2.906646999913846	.034994372949165	-.575242226215412	29922888	-6312166	564703
48	98	2442392.5	2.907826696968101	.069952272480534	-.558987242554501	30773554	-6506064	531074
49	99	2442396.5	2.908477303371882	.104897118760598	-.542630313991552	31642114	-6701442	495185
50	100	2442400.5	2.908597956263520	.139822515863865	-.526174286277168	32528791	-6898075	457017

C-5

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN		10-TH DEC
1	0	2442400.5	2.908577956263293	.139822515864371	-.526174286276877	0	0	-0
2	1	2442404.5	2.908187867897027	.174722052623326	-.509622027869391	3618	-1553	431
3	2	2442408.5	2.907246326187149	.209589303137395	-.492976429320699	14423	-6228	1704
4	3	2442412.5	2.905772695248771	.244417827096588	-.476240405682480	32341	-14043	3785
5	4	2442416.5	2.903766415957875	.279201170302512	-.45941689.417550	57330	-25020	6638
6	5	2442420.5	2.901227006526227	.313932865021643	-.442508845324090	89227	-39176	10224
7	6	2442424.5	2.899154063114589	.348606430369818	-.425519247981155	128052	-56533	14503
8	7	2442428.5	2.894547260532576	.383215372654067	-.408451102222541	173706	-77111	19432
9	8	2442432.5	2.890406353112965	.417753185719668	-.391307433127709	226123	-100936	24962
10	9	2442436.5	2.885731175844981	.452213351451727	-.374091287958416	285249	-128035	31041
11	10	2442440.5	2.880521645650518	.486589340712291	-.356805735978501	351046	-158436	37613
12	11	2442444.5	2.874777762240129	.520874614816357	-.339453867343666	423492	-192154	44626
13	12	2442448.5	2.868499607982216	.555062626956971	-.322038793418944	502578	-229185	52033
14	13	2442452.5	2.861687347201283	.589146822749015	-.304563645511362	588290	-269504	59799
15	14	2442456.5	2.854341226048859	.623120634877413	-.287031575642835	680504	-313077	67892
16	15	2442460.5	2.846461573513253	.656977507936563	-.269445756739312	779487	-359865	76282
17	16	2442464.5	2.838048802341831	.690710848903180	-.251809382573388	884900	-409830	84939
18	17	2442468.5	2.829103410101553	.724314077382253	-.234125667844457	996803	-462932	93832
19	18	2442472.5	2.819625980447796	.757780601649202	-.216397847855745	1115159	-517129	102928
20	19	2442476.5	2.809617183463047	.791103824449763	-.198822934829756	1239930	-578376	112195
21	20	2442480.5	2.799077776588419	.824277143507725	-.180822934829756	1371081	-640629	121601
22	21	2442484.5	2.788008605387418	.857293952485247	-.162982413457603	1508579	-705831	131117
23	22	2442488.5	2.776410604110239	.890147641679157	-.145110929629381	1652389	-773325	140713
24	23	2442492.5	2.764284796436385	.922831598738828	-.127211818393997	1802479	-844847	150362
25	24	2442496.5	2.751632296165297	.955339209438371	-.109288434105620	1958814	-918530	160040
26	25	2442500.5	2.738454307900497	.987663858425545	-.091344150212439	2121359	-994899	169724
27	26	2442504.5	2.724752127746953	1.019798929968040	-.073382359049985	2290078	-1073875	179391
28	27	2442508.5	2.710527144020645	1.051737808690667	-.055406471642567	2464930	-1155377	189022
29	28	2442512.5	2.695780837991947	1.083473880289283	-.037419917522523	2645872	-1239318	198599
30	29	2442516.5	2.680514784712443	1.115000532218637	-.019426144573860	2832858	-1325611	208103
31	30	2442520.5	2.664730654013681	1.146311154392862	-.001428618888630	3025843	-1414171	217515
32	31	2442524.5	2.648430211762687	1.177399140049324	.016569175436100	3224784	-1504912	226814
33	32	2442528.5	2.631615321255268	1.208257887057435	.034563736723832	3429648	-1597747	235980
34	33	2442532.5	2.614287944180830	1.238860799772382	.052551546478601	3640416	-1692575	244996
35	34	2442536.5	2.596450140596076	1.269261290839651	.070529070218853	3857070	-1789277	253857
36	35	2442540.5	2.578104068333204	1.299392782124023	.088492757898746	4079583	-1887714	262567
37	36	2442544.5	2.559251982988513	1.329268704757773	.106439043796318	4307906	-1987738	271138
38	37	2442548.5	2.539896239046158	1.358882499400863	.124264346396876	4541979	-2089198	279586
39	38	2442552.5	2.520039290903711	1.388227617139350	.142265068626657	4781726	-2191945	287924
40	39	2442556.5	2.499683694044890	1.417297520169122	.160137597954779	5027062	-2295835	296167
41	40	2442560.5	2.478832106404909	1.446085683292246	.177978306909015	5277898	-2400723	304329
42	41	2442564.5	2.457487288807926	1.474585595170183	.195783553555227	5534135	-2506469	312424
43	42	2442568.5	2.435652105997974	1.502790759309256	.213549681770667	5795674	-2612930	320467
44	43	2442572.5	2.4133295274688486	1.530694695508480	.231273021782045	6062406	-2719969	328471
45	44	2442576.5	2.390522628210846	1.558290941056008	.248949890588166	6334218	-2827445	336451
46	45	2442580.5	2.367234589332725	1.585573051965639	.266576592384778	6610943	-2935224	344424
47	46	2442584.5	2.343468699014849	1.612534604281613	.284149419031102	6892605	-3043170	352404
48	47	2442588.5	2.319228353151360	1.639169195376844	.301664650512850	7178925	-3151151	360406
49	48	2442592.5	2.294517056112355	1.665470445265008	.319118555411107	7469814	-3259040	368447
50	49	2442596.5	2.269338421485585	1.691431997920041	.336507391373912	7765130	-3366712	376539
51	50	2442600.5	2.243696172838170	1.717047522589326	.353827405580985	8064725	-3474048	384695

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2442604.5	2.217594144546638	1.742310715097453	.371074835195197	8368443	-3530939	392925
2	52	2442608.5	2.191036282782704	1.767215299180201	.388245907812916	8576128	-3687284	401236
3	53	2442612.5	2.164026646738193	1.791755028000274	.405336841935942	8987628	-3792992	409628
4	54	2442616.5	2.1365679409966256	1.815923696125956	.422343847978487	9502799	-3897978	418100
5	55	2442620.5	2.108688861267788	1.839715092067384	.439263128868985	9621510	-4002155	426652
6	56	2442624.5	2.080329404562534	1.863123100772953	.456090881732797	9943632	-4105423	435291
7	57	2442628.5	2.051555558176830	1.886141605251758	.472823298420145	10269031	-4207673	444032
8	58	2442632.5	2.022351954695353	1.908764537342989	.489456365813207	10597551	-4308794	452892
9	59	2442636.5	1.992723341918783	1.930985868712263	.505986866094588	10929028	-4408632	461891
10	60	2442640.5	1.962674583686599	1.952799612493990	.522410377373731	11263285	-4507240	471042
11	61	2442644.5	1.932210660829170	1.974199824729929	.538723274190911	11600138	-4604384	480359
12	62	2442648.5	1.901336672270844	1.995180606633518	.554921728448033	11939426	-4700038	489849
13	63	2442652.5	1.8700578335180020	2.015736106605459	.571001910304378	12280900	-4794134	499519
14	64	2442656.5	1.838379485687284	2.035860521979652	.586959988880484	12624435	-4886609	509372
15	65	2442660.5	1.806707079382194	2.055548101353153	.602792133233670	12969822	-4977410	519410
16	66	2442664.5	1.773846191582329	2.074793146367284	.618494513224526	13316872	-5066487	529634
17	67	2442668.5	1.741002517737925	2.093590013935639	.634063300395063	13665396	-5153800	540041
18	68	2442672.5	1.707781873741453	2.111933118241353	.649494668894860	14015202	-5239313	550628
19	69	2442676.5	1.674190196186906	2.129816932949621	.664784796410796	14366098	-5322995	561389
20	70	2442680.5	1.640233542597642	2.147235992814657	.679929865109102	14717891	-5404823	572316
21	71	2442684.5	1.605918091618513	2.164184896793202	.694926062586081	15070385	-5484783	583401
22	72	2442688.5	1.571250143193737	2.180658309149962	.709769582817657	15423385	-5562866	594631
23	73	2442692.5	1.536236118778305	2.196650962050597	.724456627100803	15776693	-5639074	605988
24	74	2442696.5	1.500882561670508	2.212157657581130	.738983404998919	16130116	-5713421	617451
25	75	2442700.5	1.465196137548020	2.227173270045284	.753346135364122	16483465	-5785932	628994
26	76	2442704.5	1.429183635081863	2.241692748720283	.767541047599870	16836567	-5856637	640585
27	77	2442708.5	1.392851966054465	2.255711121160260	.781564383271174	17189265	-5925566	652194
28	78	2442712.5	1.356208164424608	2.269223496438187	.795412397793999	17541408	-5992736	663797
29	79	2442716.5	1.319259384778576	2.282225067503987	.809081361718473	17892841	-6058155	675378
30	80	2442720.5	1.282012901314857	2.294711112670242	.822567561494377	18243392	-6121831	686923
31	81	2442724.5	1.244476107892829	2.306676997329703	.835867300255536	18592884	-6183775	698417
32	82	2442728.5	1.206656517899368	2.318118176293993	.848976898960302	18941126	-6244009	709842
33	83	2442732.5	1.168561764217068	2.329030195914996	.861892697409903	19287928	-6302567	721174
34	84	2442736.5	1.130199599293903	2.339408697020090	.874611055697354	19633099	-6359490	732388
35	85	2442740.5	1.091577894229481	2.349249417566028	.887128355612415	19976447	-6414828	743453
36	86	2442744.5	1.052704638398154	2.358548195035283	.899441001859191	20317779	-6468638	754337
37	87	2442748.5	1.013587938807028	2.367300969271497	.911545423542229	20656905	-6520485	765003
38	88	2442752.5	.974236019197054	2.375503785041033	.923438075539103	20993633	-6571940	775411
39	89	2442756.5	.934657219242830	2.383152794620941	.935115439883571	21327773	-6621582	785519
40	90	2442760.5	.894859993622681	2.390244260429597	.946574027192142	21659133	-6669999	795280
41	91	2442764.5	.854852911003647	2.396774557626387	.957810378090119	21987521	-6717285	804646
42	92	2442768.5	.814644652960652	2.402740176699226	.968821064645436	22312745	-6763545	813561
43	93	2442772.5	.774244012825438	2.408137726030390	.979602691805859	22634613	-6808891	821969
44	94	2442776.5	.733659894486983	2.412963934425903	.990151898829712	22952933	-6853450	829804
45	95	2442780.5	.692901311191761	2.417215653603392	1.000465360702584	23267514	-6897359	836997
46	96	2442784.5	.651977384431518	2.420889860677661	1.010539789552283	23578168	-6940772	843470
47	97	2442788.5	.610897343000054	2.423983660796225	1.020371936135412	23884718	-6983859	849134
48	98	2442792.5	.569670522094288	2.426494290205810	1.029958591559385	24187003	-7026799	853896
49	99	2442796.5	.528306361873504	2.428419119835553	1.039296589345234	24484880	-7069777	857659
50	100	2442800.5	.486814404942892	2.429755658781247	1.048382807558689	24778220	-7112970	860328

C-7

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2442800.5	.486814404942633	2.429755658788068	1.048382807562369	0	0	0
2	1	2442804.5	.445204293179151	2.430501556852893	1.057214170521796	779	-515	-254
3	2	2442808.5	.403485765169014	2.430654606302483	1.065787650001276	3100	-2020	-1003
4	3	2442812.5	.361668654370149	2.430212743520302	1.074100266449925	6926	-4459	-2222
5	4	2442816.5	.317762887520329	2.429174051973773	1.082149090416642	12211	-7791	-3893
6	5	2442820.5	.277778482861342	2.427536763738265	1.089931244169954	18907	-11942	-5997
7	6	2442824.5	.235725548074596	2.425299261634734	1.097443903386640	26958	-16907	-8519
8	7	2442828.5	.193614278069125	2.422460085450496	1.104684298922400	36312	-22641	-11447
9	8	2442832.5	.151454952429141	2.419017929989806	1.111649718459267	46912	-29118	-14770
10	9	2442836.5	.109257933024947	2.414971650064899	1.118337508281996	59702	-36314	-19480
11	10	2442840.5	.067033661199500	2.410320262501187	1.124745074993868	71625	-44211	-22570
12	11	2442844.5	.024792655038958	2.405062948486687	1.130869887197306	85625	-52792	-27033
13	12	2442848.5	-.017454493516684	2.399199055962640	1.136709477215064	100643	-62046	-31867
14	13	2442852.5	-.059697121676067	2.392728101920724	1.142261442784456	116624	-71365	-37069
15	14	2442856.5	-.101924498893343	2.385649774634672	1.147523448740472	132507	-82546	-42639
16	15	2442860.5	-.144125830060484	2.377963935812133	1.152493228679383	151236	-93789	-48580
17	16	2442864.5	-.186790758773377	2.369670622651014	1.157168586592640	169752	-105704	-54996
18	17	2442868.5	-.229406870620132	2.360770049792336	1.161547398461458	188998	-118305	-61596
19	18	2442872.5	-.270464696402652	2.351262611207261	1.165627613823361	208923	-131616	-68694
20	19	2442876.5	-.312452715208021	2.341148882169435	1.169407257393206	229482	-145670	-76208
21	20	2442880.5	-.354359857459029	2.330429621591790	1.172884430831658	250650	-160503	-84162
22	21	2442884.5	-.396175008520602	2.319105774908833	1.176057314972576	272419	-176148	-92577
23	22	2442888.5	-.437987013405371	2.307178476182855	1.178924171989754	294788	-192624	-101468
24	23	2442892.5	-.479484682117389	2.294649050713602	1.181483346645138	317757	-209933	-110840
25	24	2442896.5	-.520956794482139	2.281519014667444	1.183733268437983	341315	-228076	-120699
26	25	2442900.5	-.562292103956427	2.267790076386348	1.185672451732891	365441	-247058	-131046
27	26	2442904.5	-.603479341671427	2.253464137486731	1.187299497697730	390113	-266895	-141990
28	27	2442908.5	-.644507220382778	2.238543293866869	1.188613095468341	415306	-287571	-153237
29	28	2442912.5	-.685364438373757	2.223029837311941	1.189612023799668	441003	-309137	-165101
30	29	2442916.5	-.726039684349018	2.206926256714709	1.190295152605202	467186	-331690	-177493
31	30	2442920.5	-.766521641801841	2.190235238927372	1.190661444263583	493843	-354986	-190429
32	31	2442924.5	-.806798993678903	2.172959669919152	1.190709955134224	520967	-379317	-203923
33	32	2442928.5	-.846960427299424	2.155102635528948	1.190439836897177	548552	-404617	-217992
34	33	2442932.5	-.886694639180231	2.136667427118649	1.189850337845300	576597	-430909	-232651
35	34	2442936.5	-.926290340005771	2.117657517135797	1.189340804156012	605105	-459219	-247918
36	35	2442940.5	-.965636259658162	2.098076609510514	1.187710691097087	634079	-485568	-263807
37	36	2442944.5	-1.004721152317920	2.077928589906165	1.186159514174179	663524	-515980	-280337
38	37	2442948.5	-1.043533901611815	2.057217550810066	1.184286950212559	693449	-546477	-297523
39	38	2442952.5	-1.082063025787605	2.035947786449654	1.182092738362080	723861	-578085	-315385
40	39	2442956.5	-1.120297682858073	2.014123792527187	1.179576731015651	754772	-610830	-333942
41	40	2442960.5	-1.158226675619744	1.991750265812215	1.176738884652266	786195	-644743	-353216
42	41	2442964.5	-1.195838956458402	1.968832103744710	1.173579260677144	818153	-679858	-373233
43	42	2442968.5	-1.233123532068449	1.945374404329819	1.170098026471812	850686	-716212	-394021
44	43	2442972.5	-1.270069468661987	1.921382466401944	1.166295456404789	883847	-753826	-415604
45	44	2442976.5	-1.306565898202027	1.896861789634613	1.162171933573035	917700	-792709	-437996
46	45	2442980.5	-1.342902025187804	1.871818073481755	1.157727950039195	952301	-832848	-461203
47	46	2442984.5	-1.378767132830177	1.845257215085181	1.152764107213592	987694	-874224	-485226
48	47	2442988.5	-1.414250588121604	1.820185307265966	1.147881115877816	1023911	-916881	-510062
49	48	2442992.5	-1.449341847054725	1.793608636942999	1.142479796512475	1060979	-960611	-535712
50	49	2442996.5	-1.484030459642725	1.766533683166394	1.136761079407641	1098919	-1005591	-562177
51	50	2443000.5	-1.518306074805921	1.738967115805359	1.130726005119179	1137755	-1051745	-589460

C-8

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2443004.5	-1.552158446140020	1.710915793750758	1.124375724754079	1177505	-1099063	-617564
2	52	2443008.5	-1.585577437045494	1.592386767272592	1.117711500048031	1218195	-1147534	-646493
3	53	2443012.5	-1.618553026052119	1.653387253358041	1.110734703460921	1259943	-1197150	-676252
4	54	2443016.5	-1.651075312276518	1.623924678816230	1.103446818257645	1302473	-1247900	-706846
5	55	2443020.5	-1.683134520676945	1.594006632316187	1.095849438355984	1346104	-1299778	-738279
6	56	2443024.5	-1.714721007316946	1.563640884514797	1.087944268178980	1390759	-1352773	-770558
7	57	2443028.5	-1.745825264589726	1.532835380716705	1.079733122397549	1436457	-1406679	-803697
8	58	2443032.5	-1.776437926372097	1.501598237920284	1.0712179255332554	1482218	-1462090	-837673
9	59	2443036.5	-1.806549773107989	1.469937741693492	1.062400711767026	1531059	-1518402	-872525
10	60	2443040.5	-1.836151736790896	1.437862342869451	1.053293623988518	1579398	-1575813	-908250
11	61	2443044.5	-1.865234905789990	1.405780654060501	1.043868913139200	1630053	-1634327	-944861
12	62	2443048.5	-1.893790529421430	1.372501446035329	1.034158938201955	1681245	-1693954	-982372
13	63	2443052.5	-1.921810022180935	1.339233644118928	1.024156164469318	1733603	-1754712	-1020804
14	64	2443056.5	-1.949294967765443	1.305586324900872	1.013863163403883	1787171	-1816617	-1060177
15	65	2443060.5	-1.976207123463659	1.271568713333131	1.003282612142478	1842010	-1879681	-1100513
16	66	2443064.5	-2.002568425446597	1.237190179589845	.992417293063522	1893190	-1943899	-1141821
17	67	2443068.5	-2.028360994476599	1.202460234887383	.981270092834311	1955776	-2009250	-1184105
18	68	2443072.5	-2.053577140875447	1.167388526312216	.969844000858838	2014819	-2075707	-1227363
19	69	2443076.5	-2.078209368262151	1.131984831785410	.958142107637194	2075365	-2143246	-1271593
20	70	2443080.5	-2.102250377323770	1.096259055492539	.946167603411347	2137452	-2211842	-1316793
21	71	2443084.5	-2.125493069250929	1.060221222978470	.933923776560306	2201116	-2281481	-1362965
22	72	2443088.5	-2.148530548931433	1.023881476952212	.921414012355076	2266399	-2352145	-1410110
23	73	2443092.5	-2.170756128807423	.997250072650010	.908641791544312	2333340	-2423821	-1458232
24	74	2443096.5	-2.192363332511093	.950337372878252	.895610688681124	2401985	-2496494	-1507333
25	75	2443100.5	-2.213345897238714	.913153843378996	.882324370622193	2472380	-2570151	-1557417
26	76	2443104.5	-2.233697777933287	.875710047825919	.868786594819632	2544575	-2644776	-1608486
27	77	2443108.5	-2.253413149813881	.838016642768086	.855001207541573	2618622	-2720352	-1660541
28	78	2443112.5	-2.272486411334725	.800094372535444	.840972142050607	2694575	-2796859	-1713584
29	79	2443116.5	-2.290712185914769	.761924064039430	.826703416697924	2772488	-2874278	-1767614
30	80	2443120.5	-2.309585329491340	.723546621497338	.812199122946294	2852417	-2952586	-1822631
31	81	2443124.5	-2.325800922908982	.684963021075703	.797463473318036	2934421	-3031759	-1878631
32	82	2443128.5	-2.342254284102310	.646184305445196	.782500699261131	3018556	-3111772	-1935614
33	83	2443132.5	-2.359040965035158	.607221578250158	.767315148928876	3104882	-3192601	-1993576
34	84	2443136.5	-2.373156754294286	.568085998540713	.751911234898826	3193461	-3274226	-2052520
35	85	2443140.5	-2.387597678258231	.528788775331734	.736293441839972	3284364	-3356627	-2112444
36	86	2443144.5	-2.401360001977466	.489341162577857	.720466324506503	3377678	-3439781	-2173353
37	87	2443148.5	-2.4144402730352156	.449754454642212	.704434505809612	3472503	-3523653	-2235241
38	88	2443152.5	-2.426835110138086	.410039981631305	.688202675035335	3571949	-3608187	-2298095
39	89	2443156.5	-2.438541632296321	.370209103796020	.671775585520013	3673117	-3693307	-2361891
40	90	2443160.5	-2.449557033531590	.330273205059333	.655158051766950	3777095	-3778927	-2426595
41	91	2443164.5	-2.459978706549887	.290243686806802	.638354966553971	3883958	-3864958	-2492173
42	92	2443168.5	-2.469504650303333	.250131962254315	.621371198330237	3993772	-3951307	-2558587
43	93	2443172.5	-2.478432569845282	.209949450602985	.604211788439592	4106598	-4037844	-2625601
44	94	2443176.5	-2.486660775905804	.169707572026814	.586881748742826	4222494	-4124597	-2693776
45	95	2443180.5	-2.494187735186017	.129417742326963	.569386159114959	4341516	-4211349	-2762473
46	96	2443184.5	-2.501012159846766	.089091367398527	.551730144740624	4463714	-4298044	-2831850
47	97	2443188.5	-2.507133007069939	.048739838135726	.533918873637313	4589136	-4384580	-2901864
48	98	2443192.5	-2.512549478605536	.008374525089948	.515957553995207	4717826	-4470851	-2972469
49	99	2443196.5	-2.517261019989661	-.031993226800116	.497851431577333	4849822	-4556750	-3043616
50	100	2443200.5	-2.521267319657468	-.072352103395404	.479605787033915	4985156	-4642167	-3115256

C-9

LMSC-D420943

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN	10-TH DEC
1	0	2443200.5	-2.521267319657454	-.072352103395441	-.479605787033892	-0	0
2	1	2443204.5	-2.524568307899145	-.112690826525050	.461225933265691	179	-235
3	2	2443208.5	-2.527164155647881	-.152998159109937	.442717212744026	726	-935
4	3	2443212.5	-2.529055273100255	-.193262910242541	.424384994825956	1652	-2090
5	4	2443216.5	-2.530242308150704	-.23347394023708	.405334673036132	2962	-3691
6	5	2443220.5	-2.530726144590290	-.273670165651723	.386471662339749	4658	-5730
7	6	2443224.5	-2.530507899982339	-.313690564193526	.367501396395072	6742	-8204
8	7	2443228.5	-2.529588923137567	-.353674179425582	.348429324882432	9220	-11111
9	8	2443232.5	-2.527970791332820	-.393560124897693	.329260911072602	12105	-14451
10	9	2443236.5	-2.525655307866188	-.43337587686177	.310001629735099	15426	-18222
11	10	2443240.5	-2.522644500478473	-.472995831956634	.290656965100483	19210	-22412
12	11	2443244.5	-2.518940620155348	-.517524203354268	.271232408379602	23477	-27003
13	12	2443248.5	-2.514546139152642	-.551912134155936	.251733454890239	28227	-31969
14	13	2443252.5	-2.509463747807416	-.591149148043812	.232165600956151	33449	-37286
15	14	2443256.5	-2.503696351401032	-.630224864214103	.212534341532105	39118	-42931
16	15	2443260.5	-2.497247066688701	-.669129001589358	.192945167432965	45203	-48885
17	16	2443264.5	-2.490119218241105	-.707851392105748	.173103563137811	51672	-55131
18	17	2443268.5	-2.482316335563468	-.746381934251751	.153315004502576	58489	-61651
19	18	2443272.5	-2.473842149492981	-.784710696694411	.133484956335108	65617	-68432
20	19	2443276.5	-2.464700589757637	-.822827821388931	.113618870247825	73015	-75463
21	20	2443280.5	-2.454895776605284	-.860723576855069	.093722182412291	80644	-82732
22	21	2443284.5	-2.444432027196143	-.898388351304114	.073800311354925	88461	-90229
23	22	2443288.5	-2.433313841987086	-.935812655611191	.053858655819062	96424	-97948
24	23	2443292.5	-2.421545906054508	-.972987126202444	.033902592652465	104487	-105981
25	24	2443296.5	-2.409133084361741	-1.009902527934775	.013937474731270	112607	-114025
26	25	2443300.5	-2.3968080417932879	-1.046549756276718	-.006011371083423	120735	-122377
27	26	2443304.5	-2.382393119985181	-1.082919840904935	-.025998645965368	128824	-130938
28	27	2443308.5	-2.368076571903373	-1.119003947218424	-.045959081124817	136827	-139712
29	28	2443312.5	-2.353136319011597	-1.154793379227307	-.0659074397772355	144701	-147708
30	29	2443316.5	-2.337578066054633	-1.190279581556247	-.085838519001354	152410	-157940
31	30	2443320.5	-2.321407672538641	-1.225454140978911	-.105747151316510	159935	-167426
32	31	2443324.5	-2.304631148528528	-1.260308787320135	-.125628205887743	167272	-177191
33	32	2443328.5	-2.287254651428967	-1.294835394370288	-.145476589645046	174428	-187216
34	33	2443332.5	-2.269784483249564	-1.329025981612752	-.165287248798604	181404	-197530
35	34	2443336.5	-2.250727087208574	-1.362872716694994	-.185055170829604	188199	-208123
36	35	2443340.5	-2.231589043229832	-1.396367917505678	-.204775386391905	194763	-218992
37	36	2443344.5	-2.211877063618473	-1.429504053583159	-.224442970945336	201104	-230138
38	37	2443348.5	-2.191597988504157	-1.462273747632445	-.244053045878646	207186	-241564
39	38	2443352.5	-2.170758781217842	-1.494669776111728	-.263600780648014	212987	-253276
40	39	2443356.5	-2.149366524546636	-1.526685070091908	-.283081392978076	218487	-265282
41	40	2443360.5	-2.127428416369114	-1.558312716202771	-.302490150679740	223670	-277590
42	41	2443364.5	-2.104951765561054	-1.589545957084283	-.321822372579904	228520	-290209
43	42	2443368.5	-2.081943989067451	-1.620378192024191	-.341073429640012	233027	-303149
44	43	2443372.5	-2.058412602837961	-1.650802577466924	-.360238746023674	237181	-316421
45	44	2443376.5	-2.034365227851026	-1.680814027398590	-.379313800092829	240975	-330034
46	45	2443380.5	-2.009809576173978	-1.710405213675308	-.398294125373656	244403	-343999
47	46	2443384.5	-1.984753452047443	-1.739570566278786	-.417175311483806	247461	-358327
48	47	2443388.5	-1.959204746996946	-1.768304273509692	-.435953005026199	250143	-373028
49	48	2443392.5	-1.933171435949589	-1.796600682135889	-.4546222910460174	252448	-388115
50	49	2443396.5	-1.906661573308234	-1.824454297500317	-.473180790957150	254371	-403601
51	50	2443400.5	-1.879683288890533	-1.851859783546907	-.491622469227327	255915	-419503

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2443404.5	-1.852244783659252	-1.878811562605660	-.509943828239763	257088	-763657	-435840
2	52	2443408.5	-1.824354325390075	-1.905305814654945	-.523140811669296	257916	-796309	-452635
3	53	2443412.5	-1.796020244874470	-1.931336476003445	-.546209423977750	258438	-830106	-469905
4	54	2443416.5	-1.767250933175120	-1.956899239042496	-.564148730424492	258701	-865066	-487659
5	55	2443420.5	-1.738054839425380	-1.981999546867545	-.581245857485874	258744	-901190	-505896
6	56	2443424.5	-1.709440468918040	-2.006603003691652	-.599605999760623	258593	-938473	-524612
7	57	2443428.5	-1.678416374749929	-2.030735364909972	-.617122390793728	258261	-976910	-543801
8	58	2443432.5	-1.647991163211650	-2.054382541558539	-.634491382549397	257753	-1016497	-563455
9	59	2443436.5	-1.617173480982366	-2.077540598934917	-.651709290988268	257071	-1057237	-583573
10	60	2443440.5	-1.585972015823558	-2.100205755342571	-.668772616173243	256216	-1099133	-604151
11	61	2443444.5	-1.554395492787584	-2.122374381176769	-.685677846461612	255184	-1142190	-625189
12	62	2443448.5	-1.522452670747349	-2.144042998142950	-.702421553824912	253972	-1186415	-646665
13	63	2443452.5	-1.490152339242925	-2.165208278039287	-.7192000374899920	252576	-1231816	-668639
14	64	2443456.5	-1.457503315525685	-2.185867041784491	-.735411011147395	250991	-1278402	-691052
15	65	2443460.5	-1.424514441501451	-2.206016258367384	-.7516502208975224	249207	-1326182	-713924
16	66	2443464.5	-1.391194580793176	-2.225653043179665	-.767714859815623	247215	-1375167	-737257
17	67	2443468.5	-1.357552615868698	-2.244774659645685	-.783601800175582	245003	-1425370	-761053
18	68	2443472.5	-1.323597445218994	-2.263378512583046	-.799308011687735	242556	-1476805	-785315
19	69	2443476.5	-1.289337980588755	-2.281462152554298	-.814930521132059	239858	-1529491	-810047
20	70	2443480.5	-1.254783144235368	-2.299023271975187	-.830166420460067	236890	-1583451	-835257
21	71	2443484.5	-1.219941866164937	-2.316059704533586	-.845312866821786	233630	-1638713	-860955
22	72	2443488.5	-1.184823081254258	-2.332569424025252	-.860267082582514	230061	-1695315	-887156
23	73	2443492.5	-1.149435726180712	-2.348550542995440	-.875026355251020	226170	-1753302	-913879
24	74	2443496.5	-1.1137088736309644	-2.364001310902751	-.889588037152055	221962	-1812724	-941149
25	75	2443500.5	-1.077891043137463	-2.378920111750987	-.903949544752464	217452	-1873624	-968985
26	76	2443504.5	-1.041751572801019	-2.393305461843084	-.918108357939190	212665	-1936030	-997405
27	77	2443508.5	-1.005379245134932	-2.407156008453541	-.932062019727649	207619	-1999961	-1026414
28	78	2443512.5	-.968782972118142	-2.420470529329819	-.945908136473115	202318	-2065429	-1056018
29	79	2443516.5	-.931971655292234	-2.433247931880260	-.959344378014130	196757	-2132454	-1086222
30	80	2443520.5	-.894954183436063	-2.445487251807307	-.972668477487776	190924	-2201058	-1117033
31	81	2443524.5	-.857739430044600	-2.457187651943769	-.985778231268405	184806	-2271273	-1148466
32	82	2443528.5	-.820336750825530	-2.4688348420254046	-.998671498452218	178391	-2343136	-1180533
33	83	2443532.5	-.782753482105720	-2.478968968232834	-1.011346200455606	171670	-2415687	-1213254
34	84	2443536.5	-.744999938666595	-2.489048829468075	-1.023800320755569	164633	-2491970	-1246646
35	85	2443540.5	-.707084411891778	-2.498587657815563	-1.036031904383222	157278	-2569033	-1280732
36	86	2443544.5	-.669015668128093	-2.507585225961774	-1.048039057546376	149602	-2647925	-1315535
37	87	2443548.5	-.630802446933903	-2.516041423346550	-1.059819847235752	141606	-2728696	-1351078
38	88	2443552.5	-.592453459451079	-2.523956255560122	-1.071372800799779	133292	-2811399	-1387387
39	89	2443556.5	-.553977386840476	-2.531329841776596	-1.082695905527430	124669	-2896088	-1424498
40	90	2443560.5	-.515382878761681	-2.538162413705933	-1.093787608230976	115740	-2982820	-1462411
41	91	2443564.5	-.476678551901168	-2.544454313975621	-1.104646314834540	106520	-3071654	-1501183
42	92	2443568.5	-.437872988521262	-2.550205994656054	-1.115270489978705	97020	-3162650	-1540838
43	93	2443572.5	-.398274734977365	-2.555418015833695	-1.125658656648675	87257	-3255875	-1581410
44	94	2443576.5	-.359992300111202	-2.560091044186890	-1.135809395811506	77253	-3351401	-1622937
45	95	2443580.5	-.320934153441469	-2.564225851402171	-1.145721345983411	67042	-3449305	-1665461
46	96	2443584.5	-.281808723303955	-2.567823312146913	-1.155393202559544	56675	-3549665	-1709030
47	97	2443588.5	-.242624395541472	-2.570884401547502	-1.1648823716817509	46223	-3652550	-1753683
48	98	2443592.5	-.203389513248675	-2.573410192832569	-1.174011694895682	35768	-3758010	-1799457
49	99	2443596.5	-.164112377044550	-2.575401855930295	-1.182955997223452	25384	-3866079	-1846375
50	100	2443600.5	-.124801244712538	-2.576860656923643	-1.191655538470769	15139	-3976785	-1894459

C-11

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN	10-TH DEC
1	0	2443600.5	-.124801244692320	-2.576860656934045	-1.191655528478422	-J	-0
2	1	2443604.5	-.085643229801276	-2.577787957185407	-1.200109287428063	163	-504
3	2	2443608.5	-.046109800514307	-2.5778185212168933	-1.208316266646877	663	-2012
4	3	2443612.5	-.006745778161766	-2.578053969964998	-1.216275552115903	1515	-4513
5	4	2443616.5	.032619663806655	-2.577395869677332	-1.223986272473709	2734	-8001
6	5	2443620.5	.071978500726142	-2.576212639970988	-1.231447608653554	4334	-12469
7	6	2443624.5	.111322757537574	-2.574506097047077	-1.238658793224403	6332	-17910
8	7	2443628.5	.150644509541286	-2.572278144190250	-1.245619109380636	8742	-24316
9	8	2443632.5	.189935883081238	-2.569530769290395	-1.252327892885425	11581	-31678
10	9	2443636.5	.229189056205474	-2.566266043985166	-1.258784526571823	14863	-39985
11	10	2443640.5	.268396259290757	-2.562486172170682	-1.264988444818322	18601	-49225
12	11	2443644.5	.307549775619474	-2.558193238673553	-1.270939130547838	22806	-59386
13	12	2443648.5	.346641941934410	-2.553389707961756	-1.276636115240599	27488	-70455
14	13	2443652.5	.385665148972750	-2.548077522904284	-1.282078978466572	32651	-82419
15	14	2443656.5	.424611842004934	-2.542260353593477	-1.287267347447568	38299	-95266
16	15	2443660.5	.463474521432987	-2.535939546231432	-1.292200896655402	44432	-109990
17	16	2443664.5	.502245743541078	-2.529118122034745	-1.296879347431314	51050	-123589
18	17	2443668.5	.540918121476537	-2.521798775991996	-1.301302467546058	58160	-139064
19	18	2443672.5	.579484326306620	-2.513984275188989	-1.305470070532294	65779	-155422
20	19	2443676.5	.617937087547908	-2.505677456653387	-1.309382014701612	73939	-172657
21	20	2443680.5	.656269192668244	-2.496881225381642	-1.313038202149876	82671	-190750
22	21	2443684.5	.694473486096321	-2.487598553332049	-1.316438578225913	92003	-209667
23	22	2443688.5	.732542868899223	-2.477832479277268	-1.319583131525533	101941	-229368
24	23	2443692.5	.770470299519289	-2.467586108359029	-1.322471893831569	112483	-249820
25	24	2443696.5	.808248794281560	-2.456862611137225	-1.325104939756237	123614	-270991
26	25	2443700.5	.845871428159281	-2.445665222865671	-1.327482386528189	135313	-292859
27	26	2443704.5	.883331335535981	-2.433997241957383	-1.329604393342386	147563	-315406
28	27	2443708.5	.920621710118589	-2.421862028898914	-1.331471160858577	160337	-338618
29	28	2443712.5	.957735805476137	-2.409263005324377	-1.333082920850622	173614	-362487
30	29	2443716.5	.994666935280360	-2.396203652744276	-1.33443985632258	187367	-387007
31	30	2443720.5	1.031408473410153	-2.382687511577927	-1.335542647632550	201573	-412175
32	31	2443724.5	1.067953854192659	-2.368718180165729	-1.336391278971064	216203	-437993
33	32	2443728.5	1.104296572570000	-2.354299313775797	-1.336986281018703	231232	-464464
34	33	2443732.5	1.140430184246327	-2.339434623665852	-1.337328093985711	246633	-491598
35	34	2443736.5	1.176348305830480	-2.324127876179219	-1.3374171965523873	262377	-519406
36	35	2443740.5	1.212044614974104	-2.308382891385927	-1.337254105350887	278437	-547905
37	36	2443744.5	1.247512850529532	-2.292203544781231	-1.336839374905338	294784	-577117
38	37	2443748.5	1.282746812781618	-2.275593761543192	-1.336173597039107	311391	-607073
39	38	2443752.5	1.317740363845203	-2.258557520802555	-1.335257400731294	328235	-637811
40	39	2443756.5	1.352487428305196	-2.241098852258105	-1.334091451742644	345305	-669378
41	40	2443760.5	1.386981993940957	-2.223221835352533	-1.332676452041326	362605	-701823
42	41	2443764.5	1.421218111928859	-2.204930597466496	-1.331013138914464	380155	-735190
43	42	2443768.5	1.455189996027449	-2.186229312286528	-1.3291022284072306	397986	-769510
44	43	2443772.5	1.488891521288288	-2.167122199165277	-1.326944693219112	416126	-804798
45	44	2443776.5	1.522317223452823	-2.147613523296371	-1.324541206148488	434590	-841066
46	45	2443780.5	1.555461299413693	-2.127707595605969	-1.321892696780488	453388	-878329
47	46	2443784.5	1.588318107448742	-2.107408772132871	-1.319000072905830	472523	-916606
48	47	2443788.5	1.620982067732239	-2.086721453631412	-1.315864276075814	492002	-955924
49	48	2443792.5	1.653147662837540	-2.065650084361607	-1.312486281054802	511835	-996311
50	49	2443796.5	1.685109437408144	-2.044199151334780	-1.308867095430223	532034	-1037797
51	50	2443800.5	1.716761998465152	-2.022373183714947	-1.305007759370213	552616	-1080413

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2443804.5	1.748100015417073	-2.000176751869631	-1.300909345141969	573602	-1124192	-486992
2	52	2443808.5	1.779118219947598	-1.977614466730998	-1.296572956902786	595018	-1169164	-506935
3	53	2443812.5	1.809811406045739	-1.954690979131939	-1.291399730191328	616892	-1215361	-527472
4	54	2443816.5	1.840174429969039	-1.931410979136949	-1.287190831206388	639256	-1262810	-548620
5	55	2443820.5	1.870202210195707	-1.907779195428039	-1.282147459424991	662145	-1311539	-570397
6	56	2443824.5	1.899889727379786	-1.883800394724226	-1.276370841328034	685596	-1361575	-592819
7	57	2443828.5	1.929237024311567	-1.859479381245961	-1.271362236169523	709648	-1412543	-615903
8	58	2443832.5	1.958724205903456	-1.834820996237013	-1.265622932748578	734341	-1465669	-639667
9	59	2443836.5	1.988361439263357	-1.809830117545168	-1.259654249837757	759720	-1519778	-664130
10	60	2443840.5	2.015138953940991	-1.784511659214701	-1.253457536002834	785833	-1575300	-689311
11	61	2443844.5	2.043052042428243	-1.758870570922980	-1.247034169439296	812736	-1632267	-715233
12	62	2443848.5	2.070596060751257	-1.732911836976271	-1.240385557481439	840505	-1690708	-741921
13	63	2443852.5	2.097766428545995	-1.706640474925612	-1.233513135875533	869230	-1750638	-769394
14	64	2443856.5	2.124558629127218	-1.680061533775984	-1.226418268022550	899007	-1812054	-797660
15	65	2443860.5	2.150968203102224	-1.653180094665792	-1.219102744697850	929927	-1874933	-826718
16	66	2443864.5	2.176990757690305	-1.626001270392635	-1.211567784295930	962067	-1939243	-856562
17	67	2443868.5	2.202621957113024	-1.598530206117769	-1.203915033013356	995493	-2004949	-887181
18	68	2443872.5	2.227857527761657	-1.570772078989506	-1.195846064744053	1030262	-2072018	-918568
19	69	2443876.5	2.252693257664561	-1.542737098052987	-1.187662481120611	1066427	-2140416	-950713
20	70	2443880.5	2.277124996944664	-1.514415503384228	-1.179265911117120	1104041	-2210113	-983608
21	71	2443884.5	2.301148657468474	-1.485827565658738	-1.170658010817171	1143154	-2281071	-1017244
22	72	2443888.5	2.324760213148352	-1.456973585873392	-1.161840463324161	1183813	-2353257	-1051612
23	73	2443892.5	2.347955699954468	-1.427858894718334	-1.152814978454906	1226064	-2426634	-1086703
24	74	2443896.5	2.370771215826225	-1.398488852254332	-1.143583292586229	1269951	-2501162	-1122504
25	75	2443900.5	2.393082920739772	-1.368868847558659	-1.134147168500412	1315514	-2576801	-1159005
26	76	2443904.5	2.415007036723608	-1.339004298360351	-1.124508395219387	1362790	-2653508	-1196194
27	77	2443908.5	2.436499847879702	-1.308900650723828	-1.114668787865391	1411813	-2731242	-1234057
28	78	2443912.5	2.457557700422740	-1.278563378758449	-1.1046330187537225	1462610	-2809959	-1272582
29	79	2443916.5	2.478177002738974	-1.247997984364602	-1.094394461208253	1515207	-2889618	-1311757
30	80	2443920.5	2.498354225488214	-1.217209997028228	-1.083963501654829	1569624	-2970191	-1351569
31	81	2443924.5	2.518085901803659	-1.186204573664090	-1.073339227421101	1625878	-3051611	-1392011
32	82	2443928.5	2.537368627681261	-1.154988498459041	-1.062523582803529	1683985	-3133880	-1433076
33	83	2443932.5	2.556199062633937	-1.123566182545523	-1.05151853772068	1743969	-3216965	-1474763
34	84	2443936.5	2.574573930446164	-1.091943663220050	-1.040326087658137	1805862	-3307846	-1517072
35	85	2443940.5	2.592490019416672	-1.060126602669349	-1.028946252527769	1869709	-3395494	-1560001
36	86	2443944.5	2.609944181604604	-1.028120686885600	-1.017387076553234	1935562	-3470863	-1603539
37	87	2443948.5	2.626933331637034	-.995931625540102	-1.005644627854522	2003460	-3556897	-1647669
38	88	2443952.5	2.643454446238408	-.963565152684382	-.993722998859455	2073427	-3643532	-1692367
39	89	2443956.5	2.659504564831167	-.931027027108609	-.981624306585161	2145477	-3730710	-1737613
40	90	2443960.5	2.675080789911689	-.898323032201077	-.969350692645115	2219613	-3818378	-1783386
41	91	2443964.5	2.690180287740091	-.865458976005694	-.956904323375429	2295834	-3906488	-1829670
42	92	2443968.5	2.704800289008574	-.832440690449282	-.944287389530292	2374141	-3995000	-1876451
43	93	2443972.5	2.718938088713259	-.799274031030933	-.931502106138115	2454532	-4083873	-1923715
44	94	2443976.5	2.732591046682685	-.765964876627386	-.918550712489782	2537003	-4173072	-1971452
45	95	2443980.5	2.745756587809723	-.732519128945792	-.905435471907889	2621555	-4262565	-2019652
46	96	2443984.5	2.758432202188957	-.698942712267552	-.892158671664653	2708185	-4352320	-2068306
47	97	2443988.5	2.770615445407643	-.665241573149597	-.878722622893228	2796892	-4442308	-2117405
48	98	2443992.5	2.782303938784381	-.631421680104911	-.865129660484058	2887677	-4532501	-2166943
49	99	2443996.5	2.793495369610682	-.597489023321074	-.851382143003747	2980538	-4622874	-2216914
50	100	2444000.5	2.804187491409536	-.563449614397353	-.837482452625849	3075476	-4713403	-2267311

C-13

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2444000.5	2.804187491409536	-.563449614397353	-.837482452625849	0	-0	-0
2	1	2444004.5	2.814378124210704	-.529309496107834	-.823432995079962	192	-267	-81
3	2	2444008.5	2.824065154867654	-.495074692206991	-.809236199627414	751	-1092	-331
4	3	2444012.5	2.833246537466479	-.460751307276039	-.794894519071555	1653	-2469	-760
5	4	2444016.5	2.841920793925639	-.426345426561797	-.780410429782204	2878	-4462	-1383
6	5	2444020.5	2.850084514853736	-.391863165637883	-.765786431654252	4419	-7097	-2219
7	6	2444024.5	2.857737360500949	-.357310659599710	-.751925047826996	6284	-10415	-3291
8	7	2444028.5	2.864877061190196	-.322694061767475	-.736128824087370	8499	-14448	-4617
9	8	2444032.5	2.871501916752294	-.288019542573956	-.721100328271607	11099	-19211	-6209
10	9	2444036.5	2.877610295519432	-.253293289411431	-.705942150137940	14114	-24703	-8069
11	10	2444040.5	2.883207634060330	-.218521507294140	-.690656901751758	17563	-30920	-10196
12	11	2444044.5	2.888271437970700	-.183710419164370	-.675247217791526	21456	-37857	-12588
13	12	2444048.5	2.892921282431015	-.148866265703771	-.659715755567088	25800	-45512	-15245
14	13	2444052.5	2.896848813095232	-.113995305334270	-.644065195174353	30599	-53888	-18167
15	14	2444056.5	2.900352746930409	-.079103813344807	-.628298239200948	35860	-62989	-21358
16	15	2444060.5	2.903331972278031	-.044198081727429	-.612417612603956	41592	-72818	-24819
17	16	2444064.5	2.905785049569459	-.009284418515063	-.596426062711277	47803	-83379	-28555
18	17	2444068.5	2.907711211738516	.025630852431252	-.580326359005490	54507	-94676	-32567
19	18	2444072.5	2.909109364545415	.060541391945671	-.564121293055170	61714	-106709	-36859
20	19	2444076.5	2.909978587053971	.095440845389791	-.547813678437272	69438	-119479	-41430
21	20	2444080.5	2.910318032055741	.130322845546977	-.531406350643547	77691	-132983	-46282
22	21	2444084.5	2.910126926501832	.165181007982275	-.514902167007804	86485	-147217	-51415
23	22	2444088.5	2.909404571952820	.200008936388660	-.498304006643596	95831	-162176	-56828
24	23	2444092.5	2.908150345049933	.234800220409570	-.481614770398936	105737	-177855	-62520
25	24	2444096.5	2.906363698031911	.269548436424662	-.464837380835409	116209	-194250	-68491
26	25	2444100.5	2.904044159352594	.304247147798966	-.447974782240799	127254	-211358	-74741
27	26	2444104.5	2.901191334493760	.338889905144931	-.431029940654764	138876	-229181	-81274
28	27	2444108.5	2.897804907043522	.373470246769312	-.414005843825009	151089	-247726	-88096
29	28	2444112.5	2.893884639872581	.407981699591531	-.396905500922259	163918	-266998	-95216
30	29	2444116.5	2.889430375789743	.442417780561046	-.379731941936125	177400	-286993	-102635
31	30	2444120.5	2.884442037204494	.476771997886910	-.362488217071347	191577	-307688	-110351
32	31	2444124.5	2.878919625372333	.511037851315251	-.345177396612957	206480	-329046	-118347
33	32	2444128.5	2.872863220383351	.545208831605159	-.327802571298950	222126	-351023	-126605
34	33	2444132.5	2.866272982215463	.579278420379808	-.310366852603138	238515	-373578	-135107
35	34	2444136.5	2.859149151553765	.613240090474758	-.292873372729508	255641	-396673	-143833
36	35	2444140.5	2.851492050946646	.647087306112862	-.275325284735855	273491	-420277	-152768
37	36	2444144.5	2.843302085914956	.680813523926240	-.257725762200721	292050	-444360	-161899
38	37	2444148.5	2.834579745287172	.714412193511766	-.240077999062450	311302	-468897	-171213
39	38	2444152.5	2.825325602196315	.747876757910706	-.222385209568833	331226	-493864	-180699
40	39	2444156.5	2.815540314769194	.781200654447304	-.204650628004568	351802	-519242	-190346
41	40	2444160.5	2.805224626733050	.814377315293903	-.1869377508558661	373008	-545011	-200146
42	41	2444164.5	2.794379368174290	.847400168102979	-.169069125173590	394821	-571154	-210089
43	42	2444168.5	2.783005456242208	.880262636676360	-.151228771370706	417214	-597658	-220170
44	43	2444172.5	2.771103895858673	.912958141617590	-.133359760087525	440161	-624512	-230380
45	44	2444176.5	2.758675780442545	.945480100987439	-.115465423516768	463631	-651707	-240717
46	45	2444180.5	2.745722292650626	.977821930953578	-.097549112952728	487595	-679239	-251176
47	46	2444184.5	2.732244705159133	1.009977046419991	-.079614198654462	512020	-707109	-261758
48	47	2444188.5	2.718244381540330	1.041938861638542	-.061664069731320	536874	-735324	-272464
49	48	2444192.5	2.703722777326760	1.073700790850481	-.043702134033647	562126	-763902	-283302
50	49	2444196.5	2.688681441334651	1.105256249131564	-.025731817963587	587755	-792864	-294284
51	50	2444200.5	2.673122017071464	1.136598653726338	-.007756566034777	613754	-822238	-305424

C-14

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2444204.5	2.657046243606345	1.167721425894108	.010220159895003	640133	-852043	-316736
2	52	2444208.5	2.640455955435257	1.198617992575007	.028194881395822	666908	-882285	-328223
3	53	2444212.5	2.623353091924122	1.229281787115909	.046164103774923	694083	-912955	-339884
4	54	2444216.5	2.605719647491134	1.259706249214886	.064124315889170	721667	-944042	-351711
5	55	2444220.5	2.587617772835159	1.289884325263725	.082071990061012	749633	-975536	-363699
6	56	2444224.5	2.5698989675909535	1.319810569192631	.100003582287264	777978	-1007436	-375843
7	57	2444228.5	2.549857673228459	1.349479143158322	.117915532327733	806668	-1039744	-388144
8	58	2444232.5	2.530224191097239	1.378879819091715	.135804264259948	835690	-1072466	-400601
9	59	2444236.5	2.510091716063840	1.408009479779693	.153666186862353	865029	-1105612	-413217
10	60	2444240.5	2.489462896018779	1.436860619893579	.171597693900154	894667	-1139193	-425996
11	61	2444244.5	2.468360440966585	1.465426747380512	.189295164637482	924594	-1173220	-438941
12	62	2444248.5	2.446727173705914	1.493701384590399	.207054964215820	954798	-1207707	-452057
13	63	2444252.5	2.424626020640261	1.521678069483684	.224773444398285	985269	-1242666	-465348
14	64	2444256.5	2.402040017531415	1.549350356874925	.242446942303054	1015999	-1278109	-478819
15	65	2444260.5	2.378972285225771	1.576711819677179	.260071784231235	1046991	-1314049	-492475
16	66	2444264.5	2.355426080392476	1.603756050147929	.277644282698747	1078207	-1350499	-506320
17	67	2444268.5	2.331404746255572	1.630476661137500	.2951160738566903	1109670	-1387472	-520360
18	68	2444272.5	2.306911738350920	1.656867287322918	.312617441122178	1141364	-1424992	-534600
19	69	2444276.5	2.281950620358359	1.682921586478002	.330010658475838	1173283	-1463047	-549049
20	70	2444280.5	2.256525065107425	1.708633240480744	.347336687989136	1205424	-1501688	-563718
21	71	2444284.5	2.230638855920771	1.733995957281451	.364591756725755	1237793	-1540934	-578621
22	72	2444288.5	2.204795887422930	1.7590034727367297	.381772122242829	1270411	-1580807	-593773
23	73	2444292.5	2.177500167287775	1.783649551490470	.398974023654068	1303313	-1621324	-609184
24	74	2444296.5	2.150255814962136	1.807927992913129	.415993692723428	1336539	-1662479	-624858
25	75	2444300.5	2.122567061456792	1.831832628763607	.432827354495858	1370123	-1704253	-640787
26	76	2444304.5	2.0944382429267128	1.855357325521966	.449671227439733	1404081	-1746618	-656958
27	77	2444308.5	2.065873833416404	1.878495985517283	.466421523704286	1438417	-1789548	-673358
28	78	2444312.5	2.036878382220280	1.901242547472122	.483074449671905	1473129	-1833018	-689975
29	79	2444316.5	2.007456578376093	1.923590588599180	.499626206397785	1508207	-1877008	-706798
30	80	2444320.5	1.977613219943208	1.945535326810301	.516072990522954	1543640	-1921499	-723818
31	81	2444324.5	1.947353220536769	1.967069622051980	.532410995015039	1579413	-1966472	-741023
32	82	2444328.5	1.916681610151997	1.988187978252490	.548636409824013	1615509	-2011913	-758407
33	83	2444332.5	1.885603535635376	2.008884545328641	.564745422767686	1651909	-2057803	-775960
34	84	2444336.5	1.854124261049748	2.029153520981879	.580734220289393	1688508	-2104129	-793673
35	85	2444340.5	1.822249168154364	2.048989152578556	.596598988249674	1725520	-2150874	-811539
36	86	2444344.5	1.799983756794598	2.068385739076220	.612335912753095	1762573	-2198026	-829550
37	87	2444348.5	1.757333645262563	2.087337632944752	.627941180976876	1800012	-2245572	-847698
38	88	2444352.5	1.724304570636590	2.105839242103286	.643410982010870	1837497	-2293502	-865977
39	89	2444356.5	1.690902389099286	2.123885031860297	.658741507703425	1875082	-2341812	-884382
40	90	2444360.5	1.657193076258553	2.141469526845611	.673928953504070	1912718	-2390500	-902911
41	91	2444364.5	1.62309227524707	2.158587312933761	.688969519297615	1950352	-2439572	-921565
42	92	2444368.5	1.588517558635616	2.175233039210511	.703859410247979	1987930	-2489043	-940349
43	93	2444372.5	1.553683906399257	2.191401420157078	.718594837738259	2025403	-2539393	-959275
44	94	2444376.5	1.518502229471507	2.207087238337593	.733172020578809	2062735	-2589286	-978356
45	95	2444380.5	1.482997108541639	2.222785347601215	.747587186554291	2099900	-2640107	-997607
46	96	2444384.5	1.447157245465939	2.236990676095900	.761836573980769	2136878	-2691413	-1017031
47	97	2444388.5	1.410995461945461	2.251198228341948	.775916432808923	2173639	-2743203	-1036630
48	98	2444392.5	1.374518698909760	2.264903086542787	.789323025249465	2210135	-2795477	-1056401
49	99	2444396.5	1.337734016881335	2.278100412319219	.803552626527217	2246310	-2848241	-1076344
50	100	2444400.5	1.300648596021382	2.290785448932596	.817101525933492	2282099	-2901508	-1096461

C-15

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2444400.5	1.300648595995760	2.290785448916836	.817101525927693	0	0	0
2	1	2444404.5	1.263269736493790	2.302953523355924	.830466027767588	287	-123	-47
3	2	2444408.5	1.225604858539171	2.314600049280358	.843642452413587	1119	-485	-185
4	3	2444412.5	1.187661502043149	2.325720529393919	.856627139482089	2450	-1081	-410
5	4	2444416.5	1.149447326333352	2.336310558066497	.869416445151273	4235	-1910	-719
6	5	2444420.5	1.110970109733081	2.346365823901806	.882006747471337	6428	-2973	-1113
7	6	2444424.5	1.072237749062445	2.355882112338875	.894394445650327	8985	-4278	-1591
8	7	2444428.5	1.033253259062578	2.364855308223710	.906575961993428	11863	-5834	-2159
9	8	2444432.5	.994033771750352	2.373281398411933	.918547742885384	15016	-7654	-2821
10	9	2444436.5	.954590535693193	2.381156474371650	.930306260518503	18403	-9757	-3583
11	10	2444440.5	.914918915212212	2.389476734778877	.941848014128979	21981	-12162	-4455
12	11	2444444.5	.875033389518752	2.395238488100730	.953169531404917	25707	-14895	-5446
13	12	2444448.5	.834942551306897	2.401438155150302	.964267369880375	29541	-17987	-6571
14	13	2444452.5	.794655108355659	2.407072271611611	.975138118314337	33443	-21476	-7846
15	14	2444456.5	.754175877732298	2.412137490584342	.985778398077201	37380	-25407	-9293
16	15	2444460.5	.713525790165203	2.416630585322508	.996184854631182	41329	-29833	-10939
17	16	2444464.5	.672701886901187	2.420548452450760	1.006354209275855	45284	-34811	-12813
18	17	2444468.5	.631717318918401	2.423888115663686	1.016283161226696	49258	-40389	-14942
19	18	2444472.5	.590591344542386	2.426646729197785	1.025968489693149	53270	-46596	-17345
20	19	2444476.5	.549303326569664	2.428821580324879	1.035497005492324	57335	-53454	-20033
21	20	2444480.5	.507892730057339	2.430410091051328	1.044595562178174	61460	-60977	-23014
22	21	2444484.5	.466359121042538	2.431409820210717	1.053531057295316	65641	-69180	-26296
23	22	2444488.5	.424712164891988	2.431818465997409	1.062210433916611	69872	-78085	-29889
24	23	2444492.5	.382961624913467	2.431633868320276	1.070630682067666	74146	-87718	-33805
25	24	2444496.5	.341117360749172	2.430854011974120	1.078788840621883	78461	-98107	-38059
26	25	2444500.5	.299189325924948	2.429477029266991	1.086681999001947	82814	-109280	-42664
27	26	2444504.5	.257137565947850	2.427501202579606	1.094307298799613	87207	-121268	-47637
28	27	2444508.5	.215122215960296	2.424924967216455	1.101661935608774	91645	-134101	-52994
29	28	2444512.5	.173003498220033	2.421746913935024	1.108743160716180	96134	-147808	-58750
30	29	2444516.5	.130841719611577	2.417965791499384	1.115548282813954	100682	-162415	-64920
31	30	2444520.5	.089647268991103	2.413580509207208	1.122074669727980	105298	-177950	-71519
32	31	2444524.5	.046430614425250	2.408590139339452	1.128319750128014	109993	-194437	-78563
33	32	2444528.5	.004202300334246	2.402993919546475	1.134281015228268	114777	-211899	-86064
34	33	2444532.5	-.038027055460712	2.396791255155279	1.139956020467132	119661	-230361	-94037
35	34	2444536.5	-.080246764759345	2.389981721382156	1.145342387158529	124653	-249847	-102497
36	35	2444540.5	-.122446072017589	2.382565065447167	1.150437804105160	129763	-270383	-111461
37	36	2444544.5	-.164614157304378	2.374541208639982	1.155240029191859	135005	-291999	-120947
38	37	2444548.5	-.206740139103655	2.365910248511796	1.159746891044918	140400	-314732	-130979
39	38	2444552.5	-.249813077157941	2.356572461476009	1.163956290928503	145983	-338613	-141579
40	39	2444556.5	-.290821975971239	2.346828305819187	1.167866204943330	151803	-363665	-152768
41	40	2444560.5	-.332755789419990	2.336378424407144	1.171474686190535	157913	-389893	-164555
42	41	2444564.5	-.374603425853035	2.325323646338120	1.174779866436872	164359	-417285	-176943
43	42	2444568.5	-.416353725819539	2.313664987733191	1.177779957264185	171170	-445824	-189928
44	43	2444572.5	-.457995599074129	2.301403652853637	1.180473251314467	178362	-475495	-203510
45	44	2444576.5	-.499517761455975	2.288541035576529	1.182858123780463	185946	-506285	-217684
46	45	2444580.5	-.540909005490420	2.275078720620641	1.184933033749509	193924	-538188	-232454
47	46	2444584.5	-.582158070716186	2.261018485514327	1.186696525983237	202300	-571198	-247822
48	47	2444588.5	-.623253675032714	2.246362301935974	1.188147232461141	211075	-605312	-263790
49	48	2444592.5	-.664184518784108	2.231112336920461	1.189283873810140	220246	-640532	-280366
50	49	2444596.5	-.704939289275710	2.215270954277102	1.190105260907202	229811	-676857	-297555
51	50	2444600.5	-.745506665437222	2.198840715610871	1.190610296300257	239765	-714291	-315364

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2444604.5	-.745876322434023	2.191824381294916	1.190797975613037	250104	-752837	-333800
2	52	2444598.5	-.826033936417751	2.154224911342401	1.190667389255547	250818	-792500	-352374
3	53	2444612.5	-.965971189353321	2.146045466127518	1.190217722095618	271898	-833289	-372594
4	54	2444616.5	-.905675773908555	2.127289406971457	1.189448258036528	283333	-875212	-392971
5	55	2444620.5	-.945136398402713	2.107960296577318	1.188358177916508	295108	-919282	-414017
6	56	2444624.5	-.984341791784257	2.088061899299589	1.186947562310920	307209	-962517	-435749
7	57	2444628.5	-1.023280708578127	2.067598181244321	1.185215392256708	319618	-1007938	-458193
8	58	2444632.5	-1.061941933705455	2.046573310250821	1.1831615550251320	332324	-1054577	-481343
9	59	2444636.5	-1.100314287103380	2.024991655930350	1.180785821273720	345323	-1102471	-505256
10	60	2444640.5	-1.138386628331581	2.002857790045027	1.178088093999382	358626	-1151658	-529951
11	61	2444644.5	-1.176147861794078	1.980176487224490	1.175068362274345	372259	-1202171	-555456
12	62	2444648.5	-1.213586943010355	1.956952725302962	1.171726726500019	386258	-1254024	-581791
13	63	2444652.5	-1.250692885306847	1.933191684535309	1.168063394482324	400647	-1307221	-608968
14	64	2444656.5	-1.287454765762206	1.908898745892458	1.164078681716020	415441	-1361760	-636996
15	65	2444660.5	-1.323841730166591	1.884079489628327	1.159773011727786	430646	-1417643	-665985
16	66	2444664.5	-1.359902998284456	1.858739694133021	1.1551469166815024	446253	-1474875	-695647
17	67	2444668.5	-1.395567868785919	1.832885334482256	1.150201037395632	462292	-1533470	-725297
18	68	2444672.5	-1.430845724265097	1.806522581669263	1.144936124750309	478736	-1593442	-757852
19	69	2444676.5	-1.465726037085794	1.779657301144950	1.139353039478870	495600	-1654809	-790332
20	70	2444680.5	-1.500198374502162	1.752297551182615	1.133452752805191	512891	-1717591	-823756
21	71	2444684.5	-1.534232404158615	1.724448581396750	1.127236346805262	530618	-1781905	-858145
22	72	2444688.5	-1.567977899631895	1.696117830816942	1.120705014635021	548796	-1847473	-893520
23	73	2444692.5	-1.601054745827358	1.667312425881441	1.113850060641294	567440	-1914613	-929904
24	74	2444696.5	-1.633892944414420	1.638039678258579	1.106702900487562	586566	-1983244	-967318
25	75	2444700.5	-1.666082619234942	1.608307082519275	1.099235061121938	606195	-2053383	-1005784
26	76	2444704.5	-1.697894021668610	1.578122313610962	1.091458180680078	626346	-2125049	-1045323
27	77	2444708.5	-1.729227535947238	1.547493224162530	1.083374008286768	647042	-2198258	-1085958
28	78	2444712.5	-1.760073684386242	1.516427841595643	1.074984403750555	668305	-2273028	-1127712
29	79	2444716.5	-1.790423132465435	1.484934365045440	1.066291337144783	690161	-2349378	-1170509
30	80	2444720.5	-1.820256693687444	1.453021162145895	1.057296898293493	712638	-2427332	-1214676
31	81	2444724.5	-1.849595334055330	1.420696765860832	1.048003246250886	735776	-2506915	-1259944
32	82	2444728.5	-1.8784600176496783	1.387969871647648	1.039412708945566	759631	-2588150	-1306441
33	83	2444732.5	-1.906672505724124	1.354849334950408	1.028527683058641	784273	-2671045	-1354193
34	84	2444736.5	-1.934403774041066	1.321344168304478	1.018350683773484	809779	-2755591	-1403216
35	85	2444740.5	-1.961585607430692	1.287463537321678	1.007884333974481	836217	-2841757	-1453513
36	86	2444744.5	-1.988209810760509	1.253216755771412	.997131362854347	863643	-2929505	-1505084
37	87	2444748.5	-2.014268371876824	1.218613280957399	.986094604569352	892100	-3018797	-1557927
38	88	2444752.5	-2.039753465880267	1.183662709390326	.974776997057302	921524	-3109599	-1612037
39	89	2444756.5	-2.064657458898552	1.148374772185363	.963181580712725	952245	-3201846	-1667411
40	90	2444760.5	-2.0898972911904321	1.112759331169691	.951311497292480	983994	-3295524	-1724048
41	91	2444764.5	-2.112692585117372	1.076826374322820	.939169988718739	1016896	-3390580	-1781940
42	92	2444768.5	-2.135809441625099	1.040586011093083	.926760395579443	1050975	-3486971	-1841083
43	93	2444772.5	-2.158316651227167	1.004048467907523	.914096155803715	1086249	-3584647	-1901468
44	94	2444776.5	-2.180207594189142	.967224083291807	.901150803131266	1122737	-3683558	-1963087
45	95	2444780.5	-2.201475864721573	.930123302955636	.887957965451761	1160448	-3783649	-2025928
46	96	2444784.5	-2.222115274367994	.892756674798651	.874511363182748	1199388	-3884864	-2089978
47	97	2444788.5	-2.242119855234918	.855134843794776	.860814807480747	1239556	-3987144	-2155221
48	98	2444792.5	-2.261483863051708	.817268546780923	.846872198402469	1280945	-4090428	-2221642
49	99	2444796.5	-2.280201780052920	.779168607142498	.832687522975224	1323541	-4194655	-2289223
50	100	2444800.5	-2.298268317655157	.740845929389341	.818264853174771	1367320	-4299766	-2357946

C-17

LMSC-D420943

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2444900.5	-2.298268317655157	.740845929389341	.818264853174771	-0	0	0
2	1	2444904.5	-2.315678418867620	.702311493628862	.803508343807309	-487	-625	-456
3	2	2444908.5	-2.332427260340850	.663576349996966	.788722230317738	-1984	-2514	-1834
4	3	2444912.5	-2.343510253984401	.624551613234119	.773610826616949	-4542	-5685	-4154
5	4	2444916.5	-2.363923048346905	.585548457697929	.758278523103545	-8199	-10160	-7435
6	5	2444920.5	-2.378661530397139	.546278112817788	.742729784948004	-12983	-15951	-11694
7	6	2444924.5	-2.392721828146136	.506851858238026	.726969150290537	-19918	-23057	-16939
8	7	2444928.5	-2.406100313405602	.467281017999200	.711001227861587	-26041	-31460	-23171
9	8	2444932.5	-2.419793603642612	.427576953896484	.694930694201588	-34406	-41141	-30396
10	9	2444936.5	-2.430798562597388	.387751059292929	.678442290780278	-44079	-52086	-38582
11	10	2444940.5	-2.442112301034583	.347814753338836	.661900321478575	-55135	-64285	-47756
12	11	2444944.5	-2.452732176909933	.307779475052843	.645151149857643	-67656	-77736	-57913
13	12	2444948.5	-2.462655795532143	.267656678241735	.628218196867643	-81724	-92443	-69055
14	13	2444952.5	-2.471881010243052	.227457825876630	.611106738298953	-97426	-108411	-81188
15	14	2444956.5	-2.480405922264993	.187194384489612	.593822402139100	-114849	-125651	-94320
16	15	2444960.5	-2.489228880737040	.146877818890763	.576369666100884	-134082	-144179	-109459
17	16	2444964.5	-2.495348482619093	.106519586632309	.558753854930989	-155214	-164011	-123614
18	17	2444968.5	-2.501763572294834	.066131132574092	.540980138021570	-178338	-185167	-139794
19	18	2444972.5	-2.507473241064346	.025723893504221	.523053726269413	-203546	-207671	-157011
20	19	2444976.5	-2.512476826463754	-.014690757226091	.504979869903909	-230934	-231547	-175276
21	20	2444980.5	-2.516773911409487	-.055101415028705	.486763855547171	-260597	-256826	-194600
22	21	2444984.5	-2.520344323164742	-.095496749372832	.468411003551768	-292635	-283541	-214999
23	22	2444988.5	-2.523248132106517	-.135865459055373	.449926665259854	-327145	-311729	-236687
24	23	2444992.5	-2.525425650238091	-.176196287441125	.431316220231164	-364230	-341436	-259082
25	24	2444996.5	-2.526497429356069	-.216478027613444	.412595073462450	-403984	-372715	-282805
26	25	2444900.5	-2.527654258809523	-.256699527249021	.393738652691768	-446495	-405624	-307683
27	26	2444904.5	-2.527727163054209	-.296849692927506	.374782405963410	-491837	-440227	-333742
28	27	2444908.5	-2.527087399645367	-.336917493887084	.355721799513727	-540068	-476576	-361006
29	28	2444912.5	-2.525746458093565	-.376891965951875	.336562315632930	-591239	-514708	-389489
30	29	2444916.5	-2.523708658942395	-.416762216352902	.317309450050757	-645409	-554649	-419137
31	30	2444920.5	-2.520968151913280	-.456517429208766	.297969706853062	-702653	-596417	-450137
32	31	2444924.5	-2.517534912930486	-.496146870460684	.278545605555879	-753051	-640037	-482294
33	32	2444928.5	-2.513409741324326	-.535679892295247	.259045658452520	-826692	-685536	-515685
34	33	2444932.5	-2.508592256509402	-.574985937597070	.239474387871259	-893665	-732946	-550309
35	34	2444936.5	-2.503098294742682	-.614174543465101	.219837313923454	-964059	-782302	-586170
36	35	2444940.5	-2.496899906459163	-.653195345186099	.200139954047396	-1037962	-833642	-623271
37	36	2444944.5	-2.490030352853395	-.692038080085304	.180387820521832	-1115461	-887004	-661616
38	37	2444948.5	-2.482483102734335	-.730692590978169	.160586418203612	-1196641	-942427	-701210
39	38	2444952.5	-2.474261829328043	-.769148829791259	.140741242151734	-1281588	-999949	-742054
40	39	2444956.5	-2.455370406867549	-.807396861002925	.120857775309044	-1370386	-1059609	-784149
41	40	2444960.5	-2.455812907163505	-.845426864957112	.100941486233585	-1463119	-1121443	-827496
42	41	2444964.5	-2.445593596094170	-.883229141093210	.080997826850211	-1559871	-1185491	-872095
43	42	2444968.5	-2.434716930015071	-.920794111073594	.061032230233484	-1660729	-1251790	-917943
44	43	2444972.5	-2.423187552088422	-.958112321819151	.041050108416279	-1765777	-1320380	-965039
45	44	2444976.5	-2.411010286511306	-.995174448466187	.021056850215622	-1875105	-1391300	-1013382
46	45	2444980.5	-2.398190144589577	-1.031971297242599	.001057819071839	-1988798	-1464597	-1062970
47	46	2444984.5	-2.384732300566895	-1.068493808207648	-.018941649077938	-2106942	-1540321	-1113806
48	47	2444988.5	-2.370642107148853	-1.104733057672384	-.038936247799588	-2229613	-1618527	-1165894
49	48	2444992.5	-2.355925080928827	-1.140680260015785	-.058920701860775	-2356872	-1699271	-1219241
50	49	2444996.5	-2.340586900361657	-1.176326768916404	-.078889768572527	-2488769	-1782598	-1273846
51	50	2445000.5	-2.324633402703483	-1.211664078733904	-.098838239123285	-2625346	-1868539	-1329701

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	51	2445004.5	-2.3080703541268453	-1.246683826761711	-.118750940357357	-2766655	-1957107	-1365789
2	52	2445008.5	-2.290904581848110	-1.281377796112551	-.138652736991427	-2912765	-2048315	-1445099
3	53	2445012.5	-2.273141699121208	-1.315737918033520	-.158508533631307	-3063751	-2142179	-1504579
4	54	2445016.5	-2.254788367351756	-1.349756273705140	-.178323276501840	-3219699	-2238716	-1565238
5	55	2445020.5	-2.235851165651709	-1.383425096054580	-.198091955229605	-3380696	-2337958	-1627050
6	56	2445024.5	-2.216336803456329	-1.416736770627729	-.217809604112430	-3546829	-2439936	-1690000
7	57	2445028.5	-2.196252121648200	-1.449683836923676	-.237471303574956	-3718187	-2544689	-1754074
8	58	2445032.5	-2.176604087044988	-1.482258989593880	-.257072181626169	-3894855	-2652255	-1819250
9	59	2445036.5	-2.154399789258758	-1.514455079251597	-.276607415075874	-4076920	-2762684	-1895549
10	60	2445040.5	-2.132546431595454	-1.546265113454353	-.296072230845101	-4264466	-2876026	-1952932
11	61	2445044.5	-2.110351335865151	-1.577682257511640	-.315461907205352	-4457578	-2992338	-2021404
12	62	2445048.5	-2.087521933210525	-1.608659835177511	-.334771774941434	-4656338	-3111680	-2090961
13	63	2445052.5	-2.064165755030388	-1.639311329270264	-.353997218495325	-4860827	-3234119	-2161601
14	64	2445056.5	-2.040290437856683	-1.669510382205047	-.373133677054570	-5071125	-3359727	-2233326
15	65	2445060.5	-2.015903714268120	-1.699290796451642	-.392176645608589	-5287310	-3489584	-2305141
16	66	2445064.5	-1.991013409789048	-1.728646534933802	-.411121675978459	-5509458	-3620779	-2383054
17	67	2445068.5	-1.965627439723288	-1.757571721371065	-.429964377824371	-5737641	-3756410	-2455079
18	68	2445072.5	-1.939753799831230	-1.786060640509476	-.448700419614422	-5971923	-3895586	-2531238
19	69	2445076.5	-1.913400571785673	-1.814107738059960	-.467325529459847	-6212354	-4038429	-2608557
20	70	2445080.5	-1.886575908643935	-1.841707620062088	-.485835495645595	-6458966	-4185066	-2687069
21	71	2445084.5	-1.859288035898551	-1.868855051700031	-.504226166803136	-6711768	-4335619	-2766805
22	72	2445088.5	-1.831545247659093	-1.895544956311170	-.522493452079718	-6970760	-4490199	-2847793
23	73	2445092.5	-1.803355904162231	-1.921772415306037	-.540633321756221	-7235940	-4648908	-2933052
24	74	2445096.5	-1.774728428541550	-1.947532668753823	-.558641808300443	-7507318	-4811850	-3013604
25	75	2445100.5	-1.745671302667503	-1.972821115430364	-.576515007227503	-7784900	-4979133	-3098472
26	76	2445104.5	-1.716193063353563	-1.997633312402847	-.594749077674029	-8068695	-5150875	-3184685
27	77	2445108.5	-1.686302298199256	-2.021964974667952	-.611840243037843	-8358705	-5327206	-3272278
28	78	2445112.5	-1.656007641705117	-2.045811973898083	-.629284791110049	-8654921	-5508260	-3361289
29	79	2445116.5	-1.625317772142537	-2.069170337708755	-.646579074410432	-8957329	-5694176	-3451761
30	80	2445120.5	-1.594241407772060	-2.092036248830041	-.663719510530193	-9265902	-5885100	-3543741
31	81	2445124.5	-1.562787303586099	-2.114408043947810	-.680702582250184	-9580603	-6081181	-3637278
32	82	2445128.5	-1.530964248086867	-2.136276212772188	-.697524837768608	-9901386	-6282569	-3732426
33	83	2445132.5	-1.499781060031057	-2.157643396985421	-.714182890867406	-10228196	-6489420	-3829241
34	84	2445136.5	-1.468246585300269	-2.178504389134787	-.730673421032524	-10560966	-6701889	-3927780
35	85	2445140.5	-1.433369693835672	-2.198856131511917	-.746993173557094	-10899619	-6920134	-4028104
36	86	2445144.5	-1.400159275632586	-2.218695715006035	-.763138959620701	-11244072	-7144314	-4130277
37	87	2445148.5	-1.366624242792639	-2.238020377944210	-.779107656351865	-11594228	-7374590	-4234364
38	88	2445152.5	-1.332773516606352	-2.256827504934591	-.794896206884989	-11949784	-7611126	-4340433
39	89	2445156.5	-1.298616034609218	-2.275114625713684	-.810501620417831	-12311225	-7854088	-4449559
40	90	2445160.5	-1.264160742515763	-2.292879413942714	-.825920972249850	-12677821	-8103648	-4558817
41	91	2445164.5	-1.229416591968793	-2.310119685770474	-.841151403709954	-13049625	-8359982	-4671290
42	92	2445168.5	-1.194392537313156	-2.326833397880634	-.856190121800800	-13426464	-8623260	-4786052
43	93	2445172.5	-1.159097533039727	-2.343018645054642	-.871034398510151	-13808141	-8893642	-4903215
44	94	2445176.5	-1.123540532300865	-2.358673657995155	-.885681570146733	-14194445	-9171267	-5022820
45	95	2445180.5	-1.087730485826953	-2.373796802123323	-.900129037151473	-14585154	-9456256	-5144943
46	96	2445184.5	-1.051676340085884	-2.388386577095375	-.914374264366398	-14980089	-9748720	-5269642
47	97	2445188.5	-1.015397034538193	-2.402441615833240	-.928414781130758	-15379015	-10049768	-5396977
48	98	2445192.5	-.978871499274472	-2.415960683160748	-.942248181121137	-15781734	-10356508	-5527010
49	99	2445196.5	-.942138652287806	-2.428942674546221	-.955872122280201	-16188033	-10672046	-5659802
50	100	2445200.5	-.905197397049630	-2.441386614013993	-.969284326263640	-16597692	-10995487	-5795415

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN 10-TH DEC		
1	0	2445200.5	-.705197397050667	-2.441386613999754	-.969284326255913	-0	-0	-0
2	1	2445204.5	-.869056620808176	-2.453291652647195	-.982482578123445	-1543	-235	-103
3	2	2445208.5	-.830725192255244	-2.464657067021548	-.995464726013427	-6159	-928	-400
4	3	2445212.5	-.793211959772638	-2.475482257409558	-1.009228680705692	-13783	-2059	-874
5	4	2445216.5	-.755525749575433	-2.485766746230794	-1.0207772415245718	-24368	-3610	-1507
6	5	2445220.5	-.717675363948484	-2.495510176437762	-1.033093964555412	-37864	-5560	-2282
7	6	2445224.5	-.679669579542491	-2.504712309909024	-1.045191425023631	-54222	-7889	-3180
8	7	2445228.5	-.641517145777857	-2.513373025973975	-1.057062954113661	-73392	-10575	-4185
9	8	2445232.5	-.603226783001595	-2.521492319354564	-1.068706769956485	-95329	-13598	-5279
10	9	2445236.5	-.564807181435981	-2.529070299643195	-1.080121150958576	-119989	-16938	-6445
11	10	2445240.5	-.526266999140972	-2.536107189926875	-1.091304435426025	-147329	-20578	-7669
12	11	2445244.5	-.487614860681395	-2.542603320357387	-1.102255021211981	-177309	-24505	-8938
13	12	2445248.5	-.448859355352356	-2.548559137610255	-1.112971365366711	-209888	-28712	-10241
14	13	2445252.5	-.410709035249447	-2.553975192246796	-1.123451993667429	-245017	-33196	-11575
15	14	2445256.5	-.371072413345534	-2.558852142795176	-1.133695450064067	-282634	-37955	-12936
16	15	2445260.5	-.332057962221281	-2.563190748585072	-1.143700395363254	-322665	-42978	-14315
17	16	2445264.5	-.292974113843545	-2.566791874482781	-1.153465506559940	-365031	-48235	-15699
18	17	2445268.5	-.253829259713360	-2.570256482632956	-1.162989526214858	-409667	-53686	-17063
19	18	2445272.5	-.214631750225912	-2.572985635441711	-1.172271252494514	-456520	-59284	-18380
20	19	2445276.5	-.175389893109186	-2.575180493892233	-1.181305538960129	-505550	-64986	-19624
21	20	2445280.5	-.136111952226938	-2.576842316200313	-1.190103294271253	-556726	-70756	-20771
22	21	2445284.5	-.096806145982415	-2.577972456593045	-1.198651481790890	-610021	-76561	-21799
23	22	2445288.5	-.057480646020090	-2.578572363281268	-1.206953118873656	-665405	-82374	-22690
24	23	2445292.5	-.018143576603914	-2.578643577048326	-1.215007276349226	-722856	-88169	-23427
25	24	2445296.5	.021196986604605	-2.578187729798557	-1.222813078051090	-782346	-93926	-23992
26	25	2445300.5	.060533017338182	-2.577206542860679	-1.230369700165788	-843852	-99624	-24372
27	26	2445304.5	.099956539456142	-2.575701825589562	-1.237676370730348	-907349	-105244	-24553
28	27	2445308.5	.139159627752136	-2.573675473910697	-1.244732369103104	-972813	-110773	-24523
29	28	2445312.5	.178434408661540	-2.571129468876990	-1.251537025426110	-1040220	-116194	-24270
30	29	2445316.5	.217673060932982	-2.568065875273987	-1.258089720105602	-1109547	-121476	-23783
31	30	2445320.5	.256867816272175	-2.564486840257530	-1.264389883302755	-1180773	-126670	-23053
32	31	2445324.5	.296010959961533	-2.560394592036701	-1.270436994441951	-1253878	-131707	-22073
33	32	2445328.5	.335094831485073	-2.555791438614790	-1.276230581746432	-1328839	-136606	-20836
34	33	2445332.5	.374111825218042	-2.550679766587663	-1.281770221907271	-1405639	-141368	-19340
35	34	2445336.5	.413054391277711	-2.545062039941627	-1.287055539164356	-1484249	-146002	-17587
36	35	2445340.5	.451915036597496	-2.538940798664072	-1.292086205806150	-1564639	-150524	-15582
37	36	2445344.5	.490696326009119	-2.532318656983334	-1.296961940414104	-1646756	-154948	-13331
38	37	2445348.5	.529360882683243	-2.525198300576818	-1.301382507306180	-1730578	-159276	-10839
39	38	2445352.5	.567931387540167	-2.517582495597927	-1.305647715441644	-1815912	-163503	-8101
40	39	2445356.5	.606390578315740	-2.509474036723176	-1.309657417933124	-1902817	-167595	-5102
41	40	2445360.5	.644731249439253	-2.500875847444405	-1.313411512037682	-1991202	-171524	-1925
42	41	2445364.5	.682946252841543	-2.491790879295948	-1.316909938990818	-2081026	-175258	1746
43	42	2445368.5	.721728498413261	-2.482222160839555	-1.320152683617899	-2172255	-178770	5630
44	43	2445372.5	.758970954894433	-2.472172786775047	-1.323139774052855	-2264955	-182036	9840
45	44	2445376.5	.796765650411957	-2.461645916255918	-1.325971280997873	-2358791	-185034	14390
46	45	2445380.5	.834408672517399	-2.450644771836764	-1.328347317251570	-2454030	-187741	19294
47	46	2445384.5	.871890168644669	-2.439172638378395	-1.330568037274752	-2550535	-190134	24565
48	47	2445388.5	.909204346294529	-2.427232861722572	-1.332533636587144	-2648270	-192189	30217
49	48	2445392.5	.946344473132527	-2.414828847670947	-1.334244351320116	-2747199	-193879	36266
50	49	2445396.5	.983303877180504	-2.401964060914437	-1.335700457749503	-2847285	-195178	42725
51	50	2445400.5	1.020075946931442	-2.388642023983437	-1.336902271828357	-2948493	-196054	49613

C-20

LMSC-D420943

L	STEP	JULIAN DATE	X	Y	Z	PERTURBATIONS IN		10-TH DEC
1	51	2445404.5	1.056654131444844	-2.374866316254810	-1.3278502148740491	-3050799	-196477	56946
2	52	2445409.5	1.093031940432923	-2.369640572999003	-1.338544482501653	-3154142	-196412	64743
3	53	2445412.5	1.129702944340570	-2.345948486480181	-1.338755705510929	-3258520	-195824	73023
4	54	2445416.5	1.165160774448367	-2.330953735120973	-1.339174289036272	-3363338	-194679	81805
5	55	2445420.5	1.200979123058310	-2.315700302770762	-1.339110738859057	-3470243	-192944	91108
6	56	2445424.5	1.236411743863215	-2.299211857737870	-1.338795603002566	-3577543	-190590	100946
7	57	2445429.5	1.271692452548763	-2.282892362236993	-1.338229463289018	-3685758	-187538	111334
8	58	2445432.5	1.306735127431295	-2.266045768569043	-1.337412938765610	-3794941	-183910	122285
9	59	2445436.5	1.341533700459203	-2.248776077475195	-1.336346683946246	-3904738	-179513	133920
10	60	2445440.5	1.376082201207552	-2.231087336580856	-1.335031387959567	-4015394	-174334	145966
11	61	2445444.5	1.410274665559275	-2.212983639704706	-1.333467774205232	-4126765	-168224	158764
12	62	2445448.5	1.444405225220898	-2.194469129108096	-1.331955660049958	-4238527	-161310	172257
13	63	2445452.5	1.478163063187773	-2.175547988272612	-1.329598659010699	-4351567	-153298	186491
14	64	2445456.5	1.511657422871373	-2.156224453345061	-1.327294776110328	-4464989	-144175	201510
15	65	2445460.5	1.544867608680413	-2.136502801700800	-1.324745812158554	-4579100	-133865	217358
16	66	2445464.5	1.577792986315394	-2.116387355914156	-1.321952660963724	-4693914	-122291	234077
17	67	2445468.5	1.610427982448527	-2.095882482166232	-1.319316249466348	-4809451	-109380	251712
18	68	2445472.5	1.642767085040099	-2.074992589597201	-1.315637537465612	-4925739	-95058	270303
19	69	2445476.5	1.674904843255899	-2.053722129431478	-1.312117517181690	-5042903	-79254	289823
20	70	2445480.5	1.706555867374626	-2.032075594400709	-1.308357212975039	-5160684	-61897	310524
21	71	2445484.5	1.737954828806224	-2.010057518111187	-1.304357681045886	-5279423	-42919	332240
22	72	2445488.5	1.769756460049399	-1.987672474425914	-1.300120009134091	-5399068	-22253	355091
23	73	2445492.5	1.799835554652091	-1.964925076896840	-1.295645316244986	-5519675	165	379089
24	74	2445496.5	1.830286967181017	-1.941819978228672	-1.290934752392005	-5641304	24398	404305
25	75	2445500.5	1.860405613203739	-1.918361869787283	-1.285989498363556	-5764025	50501	430767
26	76	2445504.5	1.890186469311189	-1.894555481163181	-1.280810765522673	-5887910	78525	458514
27	77	2445508.5	1.919624573240625	-1.870405579787700	-1.275399795644439	-6013039	108513	487577
28	78	2445512.5	1.948715024194804	-1.845916970541118	-1.269757860768635	-6139491	140499	517987
29	79	2445516.5	1.977452983417386	-1.821094495162527	-1.263886262972015	-6267344	174507	549768
30	80	2445520.5	2.005833674802290	-1.795943031177750	-1.257786333885520	-6396661	210558	582941
31	81	2445524.5	2.033852384882763	-1.770467490393749	-1.251459433915336	-6527498	248680	617530
32	82	2445528.5	2.061504461823944	-1.744672817717706	-1.244906951535356	-6659907	288911	653568
33	83	2445532.5	2.088785314118283	-1.718563990992003	-1.238130303092959	-6793954	331303	691093
34	84	2445536.5	2.115690410137304	-1.692146021551423	-1.231130933089545	-6929720	375905	730145
35	85	2445540.5	2.142215278626850	-1.665423954289089	-1.223910314294749	-7067303	422758	770763
36	86	2445544.5	2.168355508872381	-1.638402867387832	-1.216469947647674	-7206795	471898	812993
37	87	2445548.5	2.194106751328675	-1.611087872152183	-1.208811362259809	-7348314	523349	856837
38	88	2445552.5	2.219464717953642	-1.583484112040473	-1.200976114959148	-7491962	577130	902353
39	89	2445556.5	2.244429181944024	-1.555596762331739	-1.192845790113033	-7637850	632251	949557
40	90	2445560.5	2.268983978108911	-1.527431029717462	-1.184541999476117	-7786086	691718	998473
41	91	2445564.5	2.293137002835362	-1.498992151664133	-1.176026381874230	-7936780	752531	1049120
42	92	2445568.5	2.316990214068249	-1.470285396063105	-1.167300603041852	-8090041	815687	1101520
43	93	2445572.5	2.340709631372403	-1.441316060815659	-1.158366355435923	-8245978	881175	1155687
44	94	2445576.5	2.3637213357960457	-1.412089473425148	-1.149225358042239	-8404700	948982	1211638
45	95	2445580.5	2.385611470710785	-1.382610990631321	-1.139879356234978	-8566318	1019090	1269386
46	96	2445584.5	2.407676240199848	-1.352885998069034	-1.130330121575305	-8730940	1091476	1329942
47	97	2445588.5	2.429311910748539	-1.322913909964699	-1.120579451731984	-8898677	1166111	1390315
48	98	2445592.5	2.450514810510754	-1.292718168882011	-1.110629170358060	-9069639	1242961	1453510
49	99	2445596.5	2.471281329664720	-1.262286245514758	-1.100481127033689	-9243937	1321982	1518530
50	100	2445600.5	2.491607920803077	-1.231629638465513	-1.090137197217494	-9421674	1403125	1585372

C-21

Appendix D
PERTURBATIONS IN OSCULATING ELEMENTS
AT FUTURE DATES

Appendix D

PERTURBATIONS IN OSCULATING ELEMENTS AT FUTURE DATES

Appendix D contains the perturbations in the orbital elements for the first 50 minor planets at successive 400-day dates from 1973 November 14 (244 2000.5) through 1983 September 23 (244 5600.5). The dates of osculation are contained in the page headings. All of the perturbations are with respect to elements osculating at the initial standard date 1972 October 10 (244 1600.5). However, to find the mean anomaly at an osculating date see par. 4.4, Example 6.

NUM	Number of the minor planet
DEL ARGPER	Perturbation in degrees of the argument of perihelion
DEL NODE	Perturbation in degrees of the longitude of the ascending node
DEL INCL	Perturbation in degrees of the inclination
DEL MO	Perturbation in degrees of the mean anomaly at the initial standard date 244 1600.5 (Also see par. 4.4, Example 6.)
DEL A	Perturbation in astronomical units of the semi-major axis
DEL E	Perturbation in the eccentricity
DEL MDM	Perturbation in the mean daily motion, which is expressed in seconds of arc per mean solar day

NUM	DFL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MOM
1	.428021917534	-.001660327179	-.003247583975	-.428047694587	.00160936027625	-.00333425117211	-.67246831416
2	-.034905011710	.000939039138	-.001415670039	.071573889446	-.00055457095426	-.00020401647091	.23146897992
3	-.078037536849	-.027664167163	-.0007571461421	.104510471080	.00162215484683	-.00059721451934	-.74200424160
4	.106994524569	-.001323070457	-.0007270181149	-.141259950728	.00014075435044	-.00020270067949	-.09736816080
5	-.007418913497	.002196872938	.000820980944	.064783250902	-.00059292032871	.00047382521678	.29579036237
6	.062948840685	-.002287332645	.000514095068	-.064745975786	.00045298533126	.00013073555824	-.26298746701
7	-.027599677167	-.034490228827	-.005477539199	-.065725762426	.00067781476903	-.00102058063338	-.41002976776
8	-.071253419730	-.000007179613	.000025554721	.106753149993	-.00035337894171	.00015554378651	.26151004793
9	-.133350506549	-.004671907907	.000277459494	.171565649191	-.00068031841738	.00004868898163	.41210252423
10	-.435308367061	-.042472758480	-.005850255419	.232797737262	.001409436643707	.00189644425329	-.42543904411
11	-.185062414348	-.000909093655	.000070721810	.179708514119	.00106990695122	.00034969250755	-.60423897161
12	.076547284517	-.016507946789	-.000991950472	-.090751462211	-.00009128202329	.00007189221607	.05831311609
13	.603725847055	-.075648909271	-.011744759033	-.635872509600	.00240246123435	-.00076597247601	-1.19879927163
14	-.184905785536	-.023720806861	-.001749559802	.283845804697	-.00241135325841	.00094594879286	1.19272711403
15	.032018919781	-.001110769699	-.000287246241	-.065592413430	.00093332799974	.00028893715015	-.39062081135
16	-.104284782523	.000087520064	.000055330554	.138998366827	.00010886187474	.00015588461533	-.03966865402
17	-.042574248482	-.002149561064	.000178227329	-.008252280837	.00134540022275	.00059290480797	-.74687402937
18	-.030417170449	.003363744378	.000681150025	.062679391071	-.00046003388586	.00026206113276	.30865518604
19	-.071799275367	-.001091839596	.000175496321	.109544502193	-.00032907792135	.00016279657684	.18800943296
20	-.080710537732	-.014593876003	.000065838826	.069648480181	-.00001064403091	.00005475175769	.00629469391
21	-.214759173945	-.009922533547	-.000888870514	.159108491534	.00112911498026	.00009686154209	-.64922337648
22	-.197973534356	-.010402718704	.001021173999	.226636751726	-.00121987692862	.00020230837064	.45001574513
23	-.033454790220	-.002965670365	.000242777475	.072387396359	-.00072745876718	-.00022071261084	.54369332818
24	-.163590495828	.000591245618	-.000038492528	.190233054687	.00064614756113	.00013181718980	-.19709872930
25	.014526635619	-.010512282501	-.000905966581	.025523974196	-.00034976593611	-.00024894996842	.208500715922
26	.111739927259	-.014778098906	-.000430347456	-.128336767510	-.00007760914394	-.00022480892711	.03594491132
27	-.092864820144	-.001111124955	-.000027613386	.101431392264	-.00061079685041	-.000000006464101	.38528317052
28	-.128924688396	-.006311616053	-.000003950031	.110194599758	.00113094660928	.00016062286620	-.46854309231
29	-.269004038379	-.021484578796	-.000116338185	.272409909263	.00164942724386	-.00063151278518	-.84112562767
30	-.083670055290	-.000994750033	.000050310139	.119556530892	-.00059466663734	.00023326042590	.36800732035
31	-.042177199932	-.011804093621	-.002180456725	.021918316270	.00063615255046	.00016420255245	-.19135731831
32	.171302867722	-.004404519183	-.000083435305	-.136966142018	-.00007078089311	-.00012343146371	.03497615919
33	.028769085726	-.009142841980	.0007523791075	-.021711969035	-.00092697920870	.00041717077054	.35612649542
34	-.095017317057	-.021297748577	.000493936719	.082890217247	-.00017102957595	-.00017193154885	.076923214301
35	-.021774607951	-.021744515470	-.0001449962333	-.000594405235	.00060952491997	-.00034276485755	-.20935588599
36	-.059855973937	-.103354641866	.006341582273	.030541709559	.00219124688529	-.00101271630362	-.93005647408
37	-.114037184405	-.003171360437	.000512440842	.1363966554118	-.00098297064568	.00011885103538	.46099873230
38	-.089325214401	-.000674079569	-.000125941645	.069978537899	-.00104318758659	.00026676576873	-.44663118334
39	-.171983825210	-.053753812554	.010231837539	.115474866889	-.00075065795603	-.00112131147336	.31324405121
40	-.452455286631	-.009979694300	-.001215329141	.376708160340	.00005950440736	-.00067982186761	-.04093558985
41	-.039343879416	-.003107558747	-.000980559698	.081255262387	.00008666033033	-.00024435175411	-.03636493013
42	.059695649867	-.008807266765	-.0007634788972	-.061439032412	-.00054435647664	.00024194192197	.31149157472
43	.070040186692	.000813601175	-.000424421436	-.085721391402	.00053597512583	-.00023744410277	-.39578531987
44	-.094569685822	-.000798247525	.000238634787	.083221543842	-.00035511685652	-.00005066915316	.20714060357
45	.208428139431	.002128735359	.000699895000	-.185369991719	-.00107385013530	-.00022177060963	.46804764531
46	-.179759110262	-.025341597549	-.000070169686	.185059689973	.00146087193679	.00006795527258	-.76725600076
47	.063823792389	.000538080698	.000437979688	-.029784332968	-.00041499153215	.00024834484110	.15730475566
48	.349199952670	-.005930071042	.001186130844	-.285376572654	-.00078205695911	.00032543556347	.24325630661
49	-.033327678011	-.004151199031	-.000168556143	.009202572361	-.00020028081192	.00025801060354	.06305926316
50	-.130844305022	-.052265569091	.000414965854	.101758846769	.00206129732587	-.00033233932001	-.95917979977

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MDM
1	1.810999074914	-.186702230621	-.016485420065	-1.873424094087	.00464358341486	-.00137604579362	-1.93973984803
2	-.060249575854	-.010108487470	.004374487718	.114390261835	.00124453014256	-.00106820740954	-.51902522098
3	-.240505294505	-.052936915090	.005982296258	.152600134899	.00280955692070	-.00152852937322	-1.28443024683
4	.230154373015	-.006646186393	-.000166014116	-.237367524274	-.00049968422552	-.00041185604667	.31026602097
5	-.072333411390	.001109872974	.000908180247	.102782499911	.00019339775194	.00068302772616	-.39645989229
6	.101889086338	-.004693179773	-.000116181717	-.130026917464	.00039994319867	.00032673999119	-.23219940203
7	.052793361476	-.045225500755	-.005827618222	-.104105259103	.00049885789828	-.00109065349067	-.30180186264
8	-.266597664184	-.012576528356	-.001750152285	.240884266885	.00038206706243	-.00015384368387	-.28262201266
9	-.365075437770	-.024133732182	-.001159652195	.399495626236	.00076149711042	-.00038529198638	-.46092811747
10	-1.295839927217	-.170358379877	-.003185996825	1.316097552339	-.00517502989540	.000332631657652	1.56617363530
11	-.627154568116	-.009466363008	-.000432379760	.607397225693	-.00008444311419	.00014904442989	.04771802205
12	.159443826786	-.024960115206	.000326051292	-.147361848067	-.00074075407923	.00005210075252	.47337561583
13	1.493781891251	-.165093884152	.001853510853	-1.444679385389	.00000509208947	-.00063678388401	-.00254384714
14	-.268714291851	-.025329983102	-.002111413246	.397551679325	-.00215014571677	.00112980593222	1.06339177911
15	.058334473273	-.013383911333	-.001595104326	-.1013806248840	.00053793703287	.00055719999844	-.25219212245
16	-.644323502213	-.007816126057	.000746691720	.592899123080	.00394745802661	.00044309834631	-1.39975384696
17	-.392488555597	-.011256172063	-.000234381593	.403653208861	-.00056344265919	.00095850081856	.31308710462
18	-.170749036886	.000917444711	.000366973588	.151452074198	.00037674458761	-.00023617099678	-.25102082951
19	-.298951562923	-.071280684178	.000639079479	.329091959506	.00128141451927	-.00001138314731	-.73149702787
20	-.200333289744	-.008912415844	.000297202327	.214942942079	-.00066724729692	.00015423714795	.39473291649
21	-.254383794025	-.017770061320	-.000948809547	.262696131460	.00027129430330	-.00030241624305	-.15605865170
22	-.280594358959	-.011578074784	.003036546676	.347374399120	-.00197897942961	.00050614779262	.73028891742
23	-.008665656827	-.026225766742	-.003853979271	.073499987146	.00078821267051	-.00098304056700	-.37574511565
24	-.357703176531	.000072455474	-.000064418729	.356779315276	.00220556449784	.00036780678865	-.67236056638
25	.077028203475	-.028020023721	-.003283205074	-.052010254276	.00032791063269	-.00052872552347	-.19540951857
26	.195913078940	-.018233002183	-.000033185709	-.191111468772	-.00102042313428	-.00053929060748	.47282191714
27	-.174385458111	-.001464598241	-.000029004550	.215193811699	-.00060251210519	-.00004889467691	.38005557740
28	-.220179291642	-.007867747594	-.000009817708	.181457715596	.00093526808487	.00023009234974	-.38750900756
29	-.298502744121	-.041982948729	.002301707933	.197972583570	.00113103762520	-.00189685563719	-.57691902272
30	-.396914864101	-.007339184351	-.001372847080	.388709949308	.00089422077252	.00016306799533	-.55295007537
31	-.110507518144	-.016707844221	.003223756187	.085615033364	-.00012140698331	.00033169404127	.03653068244
32	1.326712862134	-.147641646268	.004078773557	-1.329820043575	.00263555011017	.00013506299023	-1.30064834003
33	.094064946377	-.009984819892	.000525899131	-.068678375705	-.00205721102556	.00061632399009	.79072892909
34	-.257308396565	-.010039766563	.001025510536	.269490264953	-.00111090223656	-.00033438378018	.49992217549
35	-.044774846738	-.023582871701	.000305263244	.018114950290	-.00022907127227	-.00061934897313	.07870756106
36	.003904128320	-.109997213065	.011231047424	-.021764207880	.00068377002959	-.00142552067080	-.29041942404
37	-.180204251697	-.002641882016	.000545442968	.239994372467	-.00141616563363	.00032376074842	.66429695723
38	-.157220347170	-.009199423683	-.000825441961	.123835342798	.00088252217921	.00041398599734	-.37787145175
39	-.066139603037	-.053129402666	.010813614838	.059694886309	-.0013377277419	-.00145827275379	.55839078152
40	-.185448909378	-.012583163381	-.001456809866	.139433027824	.00008679313089	-.00086474023067	-.05970775448
41	-.101050831756	-.012978797189	-.001808416066	.146702552986	.00110796162419	-.00054086341136	-.46471477054
42	.133843365431	-.015053296545	-.000043785260	-.102284907000	-.00108945023841	.00032887764106	.62357923943
43	.125088805256	-.014659000641	-.000946391521	-.153123499178	.00053420669968	-.00042339004804	-.39447983846
44	-.188048376021	-.001423159101	.000252582654	.212939613932	-.00073519493419	-.00009433906080	.42892530323
45	.687151637107	.001908345246	.000383707890	-.676185678814	.00076914819030	.00002407846956	-.33495675464
46	-.304787271136	-.043993016388	.001419969568	.321301331707	.00034220957416	-.00044533498222	-.17982942819
47	-.176124679459	-.010728841506	.000883242743	.111044237103	.00267185821744	.00124600773629	-1.01142544329
48	.419346955681	-.016226399475	.001012840742	-.364938055326	.00068787124648	.00078257617959	-.21383394442
49	-.007558838544	-.028750704030	-.000320097452	-.005259260510	-.00104708111482	.00065738180579	.32979058280
50	-.104139223033	-.057581287801	.001155859213	.122376118215	.00108159776259	-.00070039396784	-.50353048545

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MOM
1	3.144809833862	-.282764261454	-.005569014590	-3.061380820232	.00037979588703	-.00104226146358	-.15378519331
2	-.287326240767	-.015311532925	-.025410668595	.166303216076	.00510999924275	-.00276943630882	-2.12738890827
3	-.181525070522	-.053029297153	.005682690221	.136107484883	.00233379891148	-.00175530755668	-1.06716807892
4	.809945350244	-.054203492997	-.001639895013	-.849414323136	.00127695229746	-.00012796612695	-.79214554112
5	-.151590694943	-.006890440122	.000887019034	.184994980167	-.00041875713785	.00083294408189	.20892311445
6	.201393421565	-.016653608840	.000266732467	-.208778775268	-.00038265934427	.00050011267009	.22225633491
7	.129524502645	-.0066077290172	-.005393498320	-.201673871565	.00081795147590	-.00099325856313	-.49476620617
8	-.197144131242	-.019171925978	-.001992743623	.211748154932	.00024509010214	-.00038555181725	-.18131174010
9	-.412743217981	-.063365026246	.000678410680	.439955502260	-.00095601489468	-.00118032352151	.03391989313
10	-1.464259609453	-.195533361868	-.006791594043	1.593474730416	-.00678869937480	.00395495805612	2.05585392262
11	-.629666480872	-.010028378012	-.000786305630	.620396459970	.00037077830865	-.00016141343683	-.20947478379
12	.135659595064	-.048212554258	.004334907202	-.170467721549	-.00022809874785	.00060500232683	.14572555011
13	1.651636235110	-.167273634779	.002458276512	-1.573431587875	.00016018082239	-.00043116284433	-.08001526105
14	-.348114135060	-.033770716516	-.002680433484	.448860244745	-.00142738521495	.00128811752505	.70569146451
15	.164803527252	-.030834455851	.000646518582	-.183364016997	-.00039774867152	.00082585034299	.18655248538
16	-1.042344732148	-.019956221378	.000492494758	.996283013541	.00071315925423	-.00045141573698	-.25980407356
17	-.503097424968	-.011216121820	-.000642804904	.524525708461	-.00006477369614	.00068899713994	.02598385229
18	-.143176147529	-.000752623168	-.000260134248	.162218869173	.00015024459618	-.00003455952415	-.10011866162
19	-.305575835948	-.077945120112	.001460910479	.393983455273	.00019504924890	-.00050225505917	-.11140601741
20	-.373280855576	-.043521911635	.000660477312	.419311857997	.00045847807638	-.00007795404023	-.27106991234
21	-.186595917261	-.025526777285	-.001261319811	.168747799755	.00111093831545	-.00064962507857	-.63877803747
22	-.559164675906	-.024015331939	.0002721071843	.648592178772	-.00052151586800	.00075204910048	.19233080839
23	-.119265480862	-.127730123266	-.000380093036	.118950497883	.00413108481264	-.00255491525062	-1.96618024067
24	-.447751278403	.012668902018	-.000263556070	.393993110691	.00291336019244	.00063799167679	-.83788008441
25	.084606779998	-.035884402911	-.001227547534	-.086491557824	.00049515143965	-.00078040694310	-.29504648855
26	.559979432794	-.020331828335	-.000036527641	-.546736056494	.00018966347659	-.00071815389291	-.08783216624
27	-.400415537384	-.011352778515	-.000118814361	.352447778539	.00067839211697	-.00062343989295	-.42762774435
28	-.336879087019	-.017340936956	.000640775956	.326208825976	-.00019457545095	.00050851917521	.08065933673
29	-.070020205469	-.043480846907	.002068261191	.017614865577	.00075729086807	-.00212876490392	-.38634911756
30	-.430697557273	-.050617037497	-.001898929137	.499808755532	-.00021658871329	-.00036954886108	.13400836539
31	-.154592973489	-.014643171191	.005234866747	.134341150886	-.001472131361979	.00082599912092	.44324812941
32	1.998287835984	-.182485805315	.013423312974	-1.927203485724	-.00081870333365	.00146493992199	.40470593728
33	.104356755342	-.010564093966	.000066768835	-.081394096935	-.00100265893201	.00096475525143	.38521383716
34	-.359950449929	-.010695894103	.001068645250	.398296001596	-.00045230886204	-.00072942203640	.20348319470
35	-.083469887621	-.026337050527	.000366806505	.099785301136	-.00117811813159	-.00089333966005	.40495510276
36	.070461053067	-.110249805359	.009768467649	-.088735153247	.00175002984805	-.00133508639768	-.74293451442
37	-.445216022486	.003895964262	-.000451202420	.466797370147	.00058013573378	.00038182622382	-.27187400375
38	-.218259370478	-.024571411694	.000776833604	.213241498252	-.00016506356549	.00079299766217	.07070941020
39	.133490897217	-.052985768820	.009870723259	-.176141044300	-.00018235737883	-.00164523594654	.07607687035
40	.116920964840	-.022244663676	-.001572417487	-.191061595626	.00037512738440	-.00095693143072	-.25802103180
41	-.172884934695	-.015231725018	-.002016091646	.184528233091	.00200014789610	-.00056180797436	-.83858799732
42	.042130461348	-.047637618089	.002058381477	-.046541279622	-.00095641271979	.00077536012679	.54739394037
43	.219255164011	-.026047862342	-.000747466766	-.213452155684	.00052158253807	-.00046762938243	-.38516040472
44	-.425066714815	-.017159850555	-.001246206666	.411911749052	.00120795266184	-.00076118028864	-.70403382221
45	1.826041193330	-.088949123205	-.008921380302	-1.975573134980	.00176466836103	-.00131022349699	-.76814520968
46	-.203211093220	-.050074737934	.001509645512	.213600137977	.00112268997596	-.00067369368186	-.58974011962
47	-.788993628088	-.027301087684	-.000915983281	.781384741589	-.00113308454517	.00130056415381	.42963579382
48	.671464564868	-.019347988473	.001220440665	-.658076397143	.00178585318659	.00106306605529	-.55491176600
49	.107407432861	-.055347093119	.000836077737	-.092517239373	-.00236236707978	.00100701518877	.74445054960
50	-.024184823684	-.061572031871	.001329029830	.004859462002	.00209664298795	-.00081836049015	-.97561087837

NUM	DEL ARGOP2	DEL NODE	DEL INCL	DEL MO	DEL A	DEL F	DEL MO
1	3.321015339749	-.284986067978	-.005333314276	-3.208767533790	.00051230444188	-.00087111509264	-.21417159313
2	-.179982198981	-.043935749964	-.036806178048	.110112578426	.00358946308182	-.00319870289997	-1.49538555388
3	-.098284417079	-.050913057969	.002875915637	.018420130124	.00319339320949	-.00183347813509	-1.45964472268
4	1.122754159442	-.104416430997	.0040993727294	-1.107325454468	-.00061513815550	.00094344601298	.38197750297
5	-.199846702946	-.009539263629	.001856446028	.272317077846	-.00130107212873	.00119538110238	.64939884600
6	.236534567898	-.030335713334	-.001298265738	-.232808104025	.00032295722325	.00083424838997	-.18751024854
7	.208726531531	-.068731324005	-.004152911533	-.283354490661	.00018187518445	-.00090151891356	-.11005014401
8	-.107767583395	-.030561309569	-.001862301329	.095841423914	.00053913125763	-.00051240515190	-.39876972688
9	-.279037157157	-.065533767281	.001646249341	.301416593891	.00049187930131	-.00123037313378	-.29777266535
10	-1.603615998483	-.200322708111	-.007243090277	1.752784839261	-.00605928505144	.00413627720705	1.83442971176
11	-.697024320838	-.019945876829	-.001139267398	.661221580325	.00096719552346	-.00043962670750	-.54626041074
12	-.003939976588	-.046510884873	.005871756609	.039993468981	-.00148519079950	.00101677977371	.94948350972
13	1.761710579056	-.168576067885	.001868130042	-1.720926745330	.00073953994645	-.00019540692573	-.36881999073
14	-.466479778228	-.033783891172	-.001648625881	.575026989140	-.00277819791093	.00139826548809	1.12679196713
15	.229093003087	-.033624632430	.001650104768	-.215152937177	-.000469969581212	.00101315228051	-.22024371722
16	-1.043278315348	-.022673165044	.000496522538	1.031920167716	.00072161301507	-.00073925137537	-.26288283032
17	-.610066805155	-.019954520216	-.002975884965	.606479762751	.00049387590522	.00064743322003	-.27428422948
18	-.088208203644	-.011103861165	-.002120696744	.078988272389	.00068203504780	-.00028637799724	-.45435651800
19	-.200947133198	-.085065868305	.001605333771	.265657479038	.00096691951684	-.00072673642569	-.55205600129
20	-.551018273040	-.032736740512	.001604061230	.520917595077	.00007292557261	-.00074349337943	-.04312503819
21	-.184884853592	-.028696336165	-.001162260816	.139437771220	.00117208931093	-.00089355105047	-.67391808107
22	-1.346369761530	-.043598329878	.008453704854	1.285689436743	.00087602179376	.000284518990176	-.32287577901
23	-.031528412968	-.138700159903	-.003488761436	.064926590882	.00218568455295	-.00327586515600	-1.04123455016
24	-.526231589582	-.005687778823	-.000598682727	.471554263047	.00219890687870	.00093857398616	-.67033278499
25	.125660438520	-.036056596386	-.001553602262	-.102139585084	.00021581976858	-.00091521274078	-.12861948974
26	1.819731366279	-.026950913092	-.004979469720	-2.057353663095	.00265484034061	-.00104840899879	-1.22801773296
27	-.342133959268	-.012784008555	-.000077276659	.340238468185	.00010600304648	-.00093208866968	-.06683989993
28	-.373209403446	-.019773060288	.002066661344	.405496875701	-.00091763684122	.00085459590040	.38052121103
29	.194988291794	-.047429779079	.000720261931	-.279914293027	.00154549807179	-.00220815895133	-.78816698995
30	-.304790590586	-.064831897551	-.002393269132	.361492354023	.00048566539490	-.00058426042040	-.30038073253
31	-.093778569506	-.022514391603	.005318548335	.107300742991	-.00294899819210	.00133181257182	.88933202707
32	2.038669673599	-.183970241920	.013446159960	-1.940272963006	-.00068388879546	.00174120474052	.33804165044
33	-.002117799137	-.067625237189	-.0018433043020	.100873324325	-.00328541904908	.00109506431511	1.26387785296
34	-.798336042360	-.047772473234	-.004577329188	.712759830443	.00297904035897	-.00213473519283	-1.33806401367
35	-.083054791921	-.028587167748	-.002833776204	.133281105300	-.00003409820562	-.00152302683703	.01171499158
36	.131471071476	-.123613712294	.004754602953	-.179943078045	.00202823392256	-.00140203728381	-.86093074623
37	-.583109047806	-.028932076642	-.002281899542	.617605495067	-.00064443024941	-.00017199740037	.30217987336
38	-.198150833399	-.022369427556	.002234628302	-.229935062864	-.00097251403386	.00116687500307	.41675603406
39	.215927260371	-.065605486190	.008154402697	-.285856023474	.00027093635688	-.00191133442519	-.11300761678
40	.482098218843	-.022612049223	-.001219173283	-.532314532438	-.00030448937414	-.00104083593584	.20951312598
41	-.229582438165	-.022097880163	-.001392366984	.262347878011	.000973997263041	-.00070155036211	-.40854861807
42	-.066001587715	-.049090375687	.073121876643	.125281834233	-.00175461670673	.00084844923245	1.0064649322
43	.409518140761	-.078064464222	.003636103461	-.467536951717	.0004284218630	.00047018963901	-.31521673403
44	-.394992591409	-.058101912771	-.001032566002	.403332386468	.00015003802599	-.00149586117378	-.08749475763
45	2.305444258804	-.157484190331	-.007239304984	-2.299248053556	-.00173527633360	.00261161455509	.75656640024
46	-.178895377147	-.052855180398	.001396446279	.152419894835	.00171641274397	-.00099451186912	-.90135311638
47	-.924671662662	-.035796329077	-.000902566670	.973779105425	-.00151731906145	.00127098190061	.57542348630
48	.907815721741	-.028241956326	.000442122014	-.921483482227	.00179379049732	.0012224341308	-.55737632354
49	.225314273102	-.054977647738	.001809389992	-.180255394323	-.00381792280135	.00105176928296	1.20384583854
50	.012780227640	-.067512657180	.000965716254	-.069520878169	.00253017488974	-.00108699210525	-1.17710158827

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MOM
1	3.499270494802	-.285309626531	-.005605201066	-3.422076900154	.00139569835814	-.00063723349157	-.58324633761
2	-.112310002409	-.050461215298	-.040794445197	.043099237085	.00424300330815	-.00317658459720	-1.76713249246
3	-.035847950308	-.080939765598	.002095767724	-.061374468254	.00339959493370	-.00201546741247	-1.55374570900
4	1.088575915699	-.105510920199	.004222907201	-1.055398019446	-.00041946294130	.00117678017037	.26044362564
5	-.308947182271	-.017979836051	.001803648965	.399111101699	-.00039504566703	.00136020070677	.19709090199
6	.077409106983	-.050971208063	.006312054109	-.034189047430	-.00090316153978	.00102866410921	.52471063670
7	.248346561937	-.068464122916	-.004364013471	-.314162398884	.00060802949346	-.00066842446548	-.36792807794
8	-.021806867881	-.030690564388	-.001436841194	.023886992800	.00001932609179	-.00061149635007	-.01429980856
9	-.172094995454	-.066699477022	.000154169065	.160106702679	.000071379612304	-.00132947879909	-.43206588662
10	-1.710784582356	-.207406469190	-.007225633301	1.842365743036	-.00471524715596	.00447554096761	1.42676604080
11	-.735309919481	-.021971889746	-.000659346548	.702951994475	.00036713753595	-.00070538426086	-.20741827895
12	-.066553225832	-.047111933471	.005649854215	1.06028732029	-.00104471124608	.00104617265753	.66772706537
13	1.865339104232	-.178934311978	.003832856076	-1.823352557811	.00017578474848	.00007782294170	-.08780923864
14	-.541167765001	-.033871136275	-.001614549791	.688449006335	-.00283196825062	.00162255417296	1.40106075303
15	.051817022311	-.052187538484	.007417340139	-.109121916179	-.00043923554576	.00159855395385	.20601474506
16	-1.047109794588	-.029982409036	-.00080239974	1.030317803277	.00173972029286	-.00113955085340	-.63350242622
17	-.721162485683	-.01976349064	-.000433877792	.733315300004	-.00023974259646	.00051454352316	.13319547805
18	-.047100724041	-.020907928822	-.001161085012	.037067009187	.00031548154323	-.00047961431820	-.21020888261
19	-.154799273609	-.091689146848	.001452071747	.194081091646	.00105121924295	-.000394437760183	-.60016045781
20	-.454619750068	-.034406484072	.001594310039	.428171713542	.00047164060878	-.00085150452651	-.27885020414
21	-.148334405589	-.029235562121	-.001193667335	.130569375029	.00071465959014	-.00110964732239	-.41100544255
22	-1.694514283288	-.050972818561	.007541570730	1.714173907036	-.00153284907704	.00033475299418	.56554806533
23	.042109269009	-.138169541951	.002800490061	-.035001744185	.00301439617299	-.00319336620473	-1.43545695545
24	-.500597133112	-.029192977201	-.000562028401	.474664199839	.00088073128924	.00142276469058	-.26863028245
25	.371736033194	-.110073072010	-.0025163165080	-.422410216190	-.00158808758270	-.00047500114193	-.94575756341
26	2.662833106099	-.078507862298	-.007190493299	-2.787827681550	-.00061982008110	-.00039760554367	.28714484535
27	-.251645541561	-.012677683946	-.000101712044	.211867259928	.00062831401792	-.00101941636363	-.29607133268
28	-.596843122032	-.040663679014	.001784603305	.629377301379	.00105612074327	.00112346668225	-.43755800744
29	.403607875789	-.064175616542	.007934445060	-.495893317853	.00134645691753	-.00228480922739	-.68672761381
30	-.236795081153	-.075830747977	-.002121482352	.275916956307	.00049781776025	-.00078176683971	-.30789491052
31	-.029828689138	-.027896218828	.007421081055	.083116984503	-.00351896876732	.00156717304622	1.06026491104
32	2.032355957290	-.187629380900	.012828157504	-1.965085952346	-.00011643999495	.00201541969076	.05753923797
33	-.053699047676	-.080012217568	-.000571891233	.224203447586	-.00409714903400	.00121715248921	1.57622391514
34	-.547659110203	-.109833430288	-.004704958923	.547515610866	.00049179911528	-.00309622294470	-.22115178010
35	-.212521946720	-.100272130097	-.010353989295	.293567160559	.00376765466102	-.00279667095925	-1.29238628703
36	.189290756793	-.144697439704	.004630756385	-.239734425297	.00163832086652	-.00153505602450	-.69554637050
37	-.519343841428	-.031027290450	-.002778453608	.561214637226	-.00014979410535	-.00039414633026	.07022353970
38	-.392016336031	-.035532278333	.002936746596	.401287509874	.00104506724416	.00161417024355	-.44743555792
39	.301194336077	-.076884659265	.009581052506	-.370261418309	-.00038320494426	-.00217019827583	.15988207724
40	.874592595002	-.024715482887	-.001219990724	-.991698044141	.00089152318704	-.00045860661674	-.61303511097
41	-.289602455072	-.022306153620	-.000034239629	.366420177612	-.00043701234854	-.00073856767446	-.18335268837
42	-.131205654718	-.050697911348	.003031815295	.190289736540	-.00119306340868	.00075908404742	.68292157961
43	.429736620599	-.077254420092	.003982856503	-.429219170233	-.00022851221847	.00091969933469	.16881569645
44	-.280794423579	-.064108895138	-.001068619989	.280307281155	.00074925020405	-.00151086348300	-.43679057765
45	2.315853175125	-.160848219908	-.007201044980	-2.286534580693	-.00148090215696	.00287008547280	.64558583950
46	-.148368819027	-.063181145142	.001450819438	.121991543605	.00123006199769	-.00124463054883	-.64610745575
47	-1.055335042649	-.036308996740	-.001740929843	1.104696436432	-.00069660231593	.00116647480075	.26408313943
48	1.259712453844	-.045165935306	.001118468340	-1.268139234879	.00084532838676	.00134858705829	-.26276499241
49	.281343793013	-.063968745697	.002160994269	-.260317545064	-.00100587763990	.00179804170916	.31680779366
50	.045475975807	-.080721522758	.001013030996	-.104523996080	.00204849194289	-.00131400999359	-.95322684776

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MOM
1	3.645359724389	-.293165323707	-.006787883579	-3.588286954429	.00125415543593	-.00045844033475	-.52413067740
2	-.036209690537	-.066271385876	-.033889676976	-.059543246152	.00429697519924	-.0031635234729	-2.03892868978
3	.013564127075	-.088201211885	.004204599582	-.108470254607	.00268921372206	-.00221171830789	-1.22948282749
4	.990206800179	-.107231590900	.004005587448	-.932967623659	-.0003398265845	.00133845835787	.20735972197
5	-.464144754802	-.029656628391	.003511472877	.521866565810	-.00084137588307	.00105706660298	.41985888595
6	.012897343408	-.052149345560	.006284292597	.055591346816	-.00071285458631	.00094296969219	.41410725391
7	.120350254278	-.071854499049	-.005412670368	-.159227177010	-.00045224637800	-.00034730122264	.27373891599
8	-.019665262174	-.033313754066	-.001862738116	-.043070591051	.00047311482190	-.00008330605629	-.34995326235
9	-.037525381089	-.073986557814	.000150444180	.045141503397	.0000505885599	-.00142850588650	-.03061427206
10	-1.742216508759	-.209206933574	-.007618265113	1.837626721343	-.00418156976813	.00476037988717	1.26500985902
11	-.568363137769	-.023277986090	-.000521898116	.546376461213	.00105662915969	-.00101186364241	-.59674426354
12	-.114949549385	-.053700654462	.005415151556	.146040724459	-.00119245186465	.00100520784187	.76221577529
13	2.025751210480	-.184307038272	.002477536417	-1.948420178604	-.00044668722947	.000726047996982	-.22319976201
14	-.775201172620	-.035029871618	-.004176806169	.892601409498	-.00122248691655	.00155765510875	.60433101450
15	-.098093249489	-.053515947733	.007458289053	.106739707866	-.00157565575758	.00175320667829	.73942774178
16	-1.155821722929	-.041040499080	.000186339874	1.113678254187	.00274852671325	-.00142342198267	-1.00041823996
17	-.766922861847	-.021320874715	-.000316292392	.795746090690	.00039529689886	.00010905669247	-.22176843109
18	.059625254653	-.030596538749	.000788051719	-.090452169665	.00120994618990	-.00023743618936	-.80580829788
19	-.088858019531	-.099709841263	.001592486009	.158055528755	.00047978973747	-.00113008738017	-.27400092391
20	-.344314835616	-.060929679075	.001515220690	.305734716421	.00083524815020	-.00101091612620	-.49373436476
21	.278378858820	-.054501872160	-.003583584517	-.408205221436	.00281444375659	-.00113230172336	-1.61686265385
22	-1.709785335632	-.048638155331	.006271378345	1.737782024544	-.00089249535644	.00001255541890	.32919750941
23	.115377799313	-.149049007050	.000904815276	-.138113127473	.00329077511476	-.00321407730411	-1.56686275979
24	-.361097420127	-.032020378480	-.007507765475	.367247129503	-.00044523699574	.00178128333725	.13587268550
25	.543216400616	-.196916034154	-.019667973782	-.472187768832	-.00011060549534	.00031952351818	.06592741963
26	2.733783314692	-.080737772889	-.007398188257	-2.845109642109	-.00017943166765	-.00014703138993	.08310830662
27	-.169029351586	-.013977056798	-.000125152699	.117448497229	.00024606110559	-.00109477174708	-.15514151354
28	-.846423635689	-.056501446878	.006480217780	.859400373753	-.00020851548508	.00070390482613	.08643858318
29	.620747919274	-.065354033497	.001571556886	-.586090904517	.00060057469871	-.00242767692500	-.30642029978
30	-.153783049373	-.075966759265	-.002115080482	.218058745511	.00010830707512	-.00091615038127	-.06700054603
31	-.038206056834	-.057157938598	.003059682184	.082964348530	-.00165580877697	.00206506807173	.49852661198
32	1.993190895602	-.202299644538	.013394420184	-1.916052910368	-.00072925688275	.00232102209627	.35998021635
33	-.092211178453	-.080574126725	-.009642118271	.299122116077	-.00391784558293	.00133644336440	1.50712545652
34	-.376404763043	-.115745296294	-.005100027690	.382956211450	.00113454480504	-.00312348623384	-.51002859362
35	-.342966373752	-.229976636709	-.005101412400	.368350965865	.00574621573132	-.00410916739274	-1.96944958910
36	.229792442995	-.148286725431	.006358557070	-.254881159213	.00105951428169	-.00165411170408	-.44993335673
37	-.482364107054	-.043323743586	-.003105233229	.499961060872	.00068215638075	-.00076777167310	-.31966993950
38	-.654857485886	-.039347352515	.003344798607	.669741563608	-.00066564428546	.00127424688855	.28521174263
39	.366915211787	-.076613487825	.010256551929	-.404504279698	-.00090110602144	-.00240511418412	.37605046618
40	.493985880548	-.030535989357	-.001293636308	-.558385053601	-.00029138366527	.00009310749111	.20049389732
41	-.362659616923	-.034275543218	-.001293636308	.476788294400	.00122114365789	-.00091900903752	-.51216073962
42	-.183461634242	-.053194306125	.002569997413	.221449766752	-.00113750361191	.000700F3544050	.65110005016
43	.372794676579	-.080719700141	.003733813768	-.395592630401	-.00000804999868	.00102075417252	.00594534885
44	-.190201089557	-.066941748388	-.000739706049	.157296528872	.00000845064023	-.00157354810158	-.52722559212
45	2.311201218385	-.167182000098	-.006859092889	-2.312260408239	-.00072488908731	.00317298401381	.315899C4518
46	-.010648559088	-.078269854090	.001497823340	.011996916144	.00178465495813	-.00132495111237	-.93715803597
47	-1.186250562350	-.046151942432	-.002037202454	1.210366179095	.00024464987440	.00124800522473	-.09270926872
48	1.660150730535	-.047004059375	.002653425090	-1.644274320413	-.00054720952352	.00124337228761	-.17019174985
49	-.013680692962	-.091482085303	.000284576278	-.042307467938	-.00342021321666	.00301356119936	1.07826908796
50	.138242170317	-.096745820105	.001270826345	-.175441569183	.00281153184781	-.00125357410876	-1.30782256531

D-7

LMSC-D420943

NUM	DEL ARCPPE	DEL MDDF	DEL INCL	DEL MO	DEL A	DEL E	DEL MDM
1	3.902910413384	-.303020612071	-.005683352187	-3.819294766519	.00018870350171	-.00025707309284	-.078900003576
2	.018311478772	-.070346609045	-.034216625561	-.138381438232	.00470572213293	-.00343403059066	-1.95943766178
3	.112398440699	-.092669525930	.005595614933	-.216762924483	.000396037711536	-.00195406558181	-1.80957000392
4	.850302328072	-.110944751199	.004240368499	-.906799279361	-.00093657259024	.00152252478572	.58167508617
5	-.405743334393	-.030014298303	.003483159079	.469060695905	-.00036969584146	.00084223055600	.18144143845
6	-.058897351933	-.052905590448	.005988674766	.098307650202	-.00019860122470	.00085485554199	.11533965403
7	.063211063597	-.093783745277	-.005744029309	-.074974085883	-.00029797716849	-.000740071127564	.18034716967
8	-.121271936925	-.039668518610	-.002094444101	.117712002448	-.00016767938361	.00022810940532	.12407423097
9	.091304126356	-.100624565643	-.000724812965	-.106927986420	.00112571483653	-.00094352999192	-.68125622443
10	-1.805614544290	-.226982125223	-.007841363128	1.907540890847	-.00509025858099	.00511136320191	1.54046650317
11	.033868406630	-.034758617545	-.007043678892	-.190520799119	.00162343391143	-.00139621266659	-.91658950925
12	-.131804906156	-.060382006839	.004803938835	.198931103679	-.00109143393514	.00074084437604	.69760732313
13	1.893315582300	-.219316760013	.003035706265	-1.842430441458	.00086161184863	.00091420940384	-.43025527184
14	-.835364446364	-.059015784154	-.005854059374	-.973807751754	-.00021779829346	.00108192903973	1.07708223930
15	-.187325967498	-.050471703478	.006499835534	.194255351311	-.00088959525327	.00161836110173	.41733645428
16	-1.218420081605	-.041257512854	.007471405942	1.158864205328	.00229522383366	-.00164865478674	-.83558531578
17	-.787390165977	-.029540446722	-.002202657147	.695592521006	.00137130427045	-.00091892701828	-.76124420533
18	.046349810353	-.030238264608	.003466078712	-.082767172255	-.00014177235568	.00073196524307	.09448802687
19	.248774526572	-.204676440302	.002820884721	-.184936454723	.00191970522383	-.00058200923097	-1.09550828925
20	-.227125852631	-.069955793781	.001816915263	.208682092943	.00011438525324	-.00112576209348	-.06764104946
21	.644325673416	-.114726387787	-.004144361432	-.709016168425	.00074517702633	-.00034476408542	-.42854950944
22	-1.811800629235	-.055752512668	.003409737648	1.817208957615	.00016597822632	-.00033678984127	-.06119333876
23	.205708012574	-.163637140504	.001614947477	-.219801896856	.00256432292784	-.00322417177374	-1.22139332649
24	-.375051732841	-.028225635124	-.003493270141	.399194425961	.00034164348070	.00215583489362	-.10422644439
25	.563377694401	-.201659239458	-.019254380428	-.472313752201	.00007089890269	.00052846592721	-.04225594733
26	2.770454006704	-.089734210116	-.007409670424	-2.907481764218	.00018224588811	.00010046681490	-.08439741438
27	-.096531009196	-.015444908026	-.0009172255192	.053477116173	.00068056683029	-.00087590480242	-.42901699246
28	-.820619114806	-.056294912687	.006429298507	.855046582190	.00002082794884	.00043867606583	-.00863318364
29	1.049826398852	-.073256495056	.002169940998	-1.178227440720	.00241197858929	-.00183252811444	-1.22953028290
30	.083331397987	-.104029805323	-.004305003694	-.101068842407	.000912974403588	-.00025858668906	-.56454097307
31	-.214502720781	-.085495942847	.018354504879	.310643440123	-.00404114360659	.00201521801223	1.21784834045
32	2.003852941249	-.202322713289	.014181283638	-1.891909509264	-.00126093307993	.00261142752821	.62339513395
33	-.138045750522	-.081300414913	-.000699469517	.331625168266	-.00289276288049	.00146238660513	1.11229567459
34	-.213456496400	-.126836120195	-.004491631669	.191792485286	.00168549897346	-.00321689239379	-.75751303255
35	-.276913007652	-.230936449992	-.003570924661	.357258700526	.00396919396796	-.00461184344500	-1.36140413446
36	.302613970485	-.169793527464	.019482727333	-.449110407802	.00261350160531	-.00070282928555	-1.10906618861
37	-.463916744568	-.047374298490	-.002970394867	.4530734483061	.00044343905249	-.00100323569868	-.20782609511
38	-.653311825121	-.036923335003	.002827268349	.682457202631	-.00028793477846	.00098937652215	.12335150861
39	1.063702489984	-.085640655473	.012390993797	-1.204440376136	.00244087294459	-.00259319808072	-1.01709239429
40	.178155520705	-.031814645710	-.001928642261	-.262017866065	.00023871806734	.00008923235483	-.16420799256
41	-.59899607714	-.051700801634	.004052679516	.560934907364	.00284679059870	-.0013346240559	-1.19309721232
42	-.202802143343	-.055449629395	.002293810233	.277991661565	-.00135692169601	.00047520029779	.77678095223
43	.296902514080	-.085291816045	.003963230506	-.279820980591	-.00040510556633	.00102126274405	.29930579640
44	-.075599654490	-.066904333489	-.003686560827	.061700947041	.00015272792223	-.00162346846145	-.08906324846
45	2.220664494580	-.166870704934	-.006576497996	-2.228663624712	-.00141219294778	.00347342100244	.61561324374
46	.497311922241	-.165797182657	.006637740233	-.596359447511	.00283525837604	-.00089078070591	-1.48807739160
47	-1.317506980027	-.047675180169	-.001653856762	1.339753390584	-.00055647708886	.00118355205515	.21094857932
48	1.969707327084	-.050499226574	.002889518956	-1.924463659667	.00000425893225	.00140413211421	-.00132430913
49	-.149997111181	-.154955622951	-.000419167762	.242543719160	-.00667876517204	.00397279110107	2.10834651775
50	.402703099579	-.166735900468	.009960974389	-.605918232082	.00372159682847	.00003808389919	-1.73040963463

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MOM
1	3.971095061348	-.309153523933	-.006053469530	-3.866316140578	.000080445557638	.00006364910994	-.33793393463
2	.081865990240	-.070464332907	-.034093896533	-.183576103947	.00392225521361	-.00357736364440	-1.59220063444
3	.100445769161	-.102653526694	.004479750876	-.306372506795	-.00263919451783	-.00049179104118	-1.20619156888
4	.519394384137	-.133915487214	.002266933670	-.505763770270	.00028106565000	.00122875189881	-.17444836070
5	-.370820132281	-.030665864550	.002938015632	.393992052568	.00021749852777	.00054914722153	-.10847424394
6	-.092747737357	-.055419506920	.005912611676	.147964164364	-.00070803427190	.00066535745815	.41130598582
7	.014419573845	-.103246444625	-.006290697367	-.041624099933	.00013366433936	-.00045815207837	-.08088047483
8	-.198158214509	-.042448914279	-.002557553942	.176360583289	.00020278294687	.00021403717628	-.15001753088
9	-.089409250442	-.124327347647	.001257986435	.135251004100	-.00025256274645	-.00035947829656	.15295545635
10	-1.745844646935	-.241748362707	-.006870376844	1.880068062870	-.00639034221720	.0055267652315	1.93187534506
11	.318216203941	-.044330902561	-.002181722675	-.409054764536	.00060640339231	-.00121682807646	-.34255231568
12	-.092083051120	-.133237575756	.007397721638	.125947221004	.00020570496334	-.00017720666434	-.13138830760
13	1.470765671336	-.228654888728	.009094778671	-1.366192167454	-.00063146346024	.00083295821802	.31555666654
14	-.738300228524	-.064315907475	-.006922754358	.872251766174	-.00153831247194	.00093782136323	.76057027260
15	-.250893732195	-.057137739688	.004945003165	.237548758440	-.00052022875276	.00159457428826	.26401235773
16	-1.299724012009	-.041349230964	.000479374712	1.270563253798	.00138405234948	-.00189160038070	-.50406598489
17	-.642183530900	-.036252589019	-.002448271973	.602752989565	.00066355260398	-.00110381131622	-.36849605819
18	.027643566798	-.030918588269	.003284744978	-.034085405288	-.00015223935313	.00097462909071	.10146461914
19	.302448039056	-.225593150089	.005391319211	-.174296486606	.00001713302989	.00040387415848	-.00978674093
20	-.092589983679	-.113491472624	.002522004258	.069765386532	.00123623682954	-.00066674593104	-.73061596940
21	.664702590027	-.117595876281	-.004138387571	-.712176577701	.00094678323352	-.00012250684819	-.54443642208
22	-1.984094221095	-.066975854367	.004051435630	1.873390964635	.00023059239012	-.00051808268637	-.08501311786
23	.260874479722	-.168972464435	.001976926199	-.256247639314	.00292314442665	-.00306305782286	-1.39206325047
24	-.835177578309	.049269828451	-.001901375411	.632490129396	.00254628158176	.00312783536611	-.77612202028
25	.519282554003	-.201869852118	-.015924079785	-.431436278704	-.00023495571971	.00063846555401	.17582793942
26	2.772578656284	-.090663826613	-.007092714917	-2.904443822903	-.000581184665735	.00043717339287	.26924126525
27	-.241792405453	-.023149101336	-.000138961471	.194757749297	-.00025343638968	-.00032925817679	.15993414194
28	-.802330230302	-.054701627167	.005380450953	.807944876586	.00090974316792	.00006239078676	-.37693761627
29	.849836032681	-.080452693761	.001131787036	-.960085364743	.00052302327393	-.000388271573464	-.26686277237
30	.113816701141	-.145483998060	-.004546628057	-.029710899755	-.00029816001860	.00038115125870	.18448634229
31	-.325906630179	-.083942970952	.020957692256	.479438598795	-.00497138630276	.00202755505668	1.49874144410
32	1.567239976128	-.234598662701	.016063024162	-1.498502792463	.00022917661170	.00285735763230	-.11323050543
33	-.175831013130	-.084143855565	-.00800983275	.373500408805	-.00356542791944	.00140721943140	1.37134527272
34	-.062372293229	-.126045839557	-.004003379099	.029515742772	.00112264851660	-.00324936336520	-.50468347223
35	-.182330351796	-.228977442948	-.003991386887	.236765154114	.00507694026238	-.00459973888432	-1.74054866349
36	.227069201268	-.176119915606	.018444157389	-.327233462271	-.00095513042859	.00102563220018	.40597746838
37	-.412300311556	-.046714232045	-.003034875005	.436989936748	.00015483971018	-.00116389680430	-.07257845285
38	-.695201784363	-.040016595645	.000931620520	.690678084324	.00055613917904	.00063359076984	-.23815877954
39	1.761206363881	-.108870091091	.007357241567	-1.977968354295	.00011559582981	-.00141176354557	-.04921842815
40	-.067431861095	-.037445550293	-.001724172894	-.007684897999	-.00020295425530	-.00002248752935	.13964099587
41	-.477290853243	-.060972742140	.004804140462	.565732136056	.00212486372735	-.00160475538003	-.89082649617
42	-.145467508934	-.115670157603	-.001124534800	.196062303767	.00068484401227	-.00060578406337	-.39153471921
43	.237040584278	-.139029867063	.002995903816	-.233713043071	.00053325469672	.00047679008572	-.39377705358
44	-.057457380402	-.079277616700	-.001400763156	-.006639556606	.00112501020361	-.00109147682756	-.65572033690
45	2.234063159012	-.169410791688	-.006485640354	-2.209229077394	-.00214895488051	.00379650368675	.93710507419
46	.712280051295	-.152296153225	.008431702296	-.763647223968	.00066700980184	-.00013571254264	-.35045397860
47	-1.450780408784	-.048698110153	-.001656526995	1.507993163410	-.00137660870715	.00124159650755	.52202898818
48	3.152230780775	-.064488740485	.006034301372	-3.267408467022	.00466845971845	.00260351855758	-1.44893826721
49	-.171156837667	-.173505926060	.000191152157	.341826578879	-.00743017412788	.00442243719842	2.34626340129
50	.527293153398	-.140334587253	.013453861804	-.711995786631	-.00002396128075	.00171959270375	.01116082991

D-9

LMSC-D420943

NUM	DEL ARGPER	DEL NODE	DEL INCL	DEL MO	DEL A	DEL E	DEL MDM
1	3.617884739037	-.355010952200	.000297242593	-3.579573152110	.00114767086833	.00086681325415	-.47965222079
2	.138544220532	-.083381754007	-.046952667383	-.720919141733	.00515187370910	-.00314031249735	-2.14478156583
3	.138474090796	-.128483813696	.003007579462	-.238925535778	.00054370259053	.000051721390537	-.24852546489
4	.574863392347	-.151257032437	.003350432273	-.510057905798	-.00062334837919	.00078406424950	.38738800832
5	-.330631574347	-.039282457477	.072751478027	.353794543946	-.00014696207752	.00034532673795	.07331153421
6	.0466031011061	-.086260959863	-.002358657850	.005440192216	.00035759681183	-.00003843179959	-.49778700010
7	.001037962109	-.105506245345	-.005908117805	-.002054332464	-.00025018791742	-.000063802261523	.15141949736
8	-.232315254299	-.045232324228	-.002302658715	.235767193830	-.00012294007964	.00005613514233	.09070790806
9	-.209213806043	-.126375756539	-.091221331751	.259253126038	.00021859947422	-.00035324571270	-.13235415311
10	-1.669649315612	-.241894515892	-.006292427493	1.937539114164	-.00695601669320	.00582012990985	2.10666342459
11	.334271031954	-.050315690198	-.002464726803	-.449325111993	.00114732774583	-.00097207318969	-.64793746188
12	.000939583369	-.138532202131	.009649811307	.076943351680	-.00050867438235	-.00035053735944	.32502585549
13	1.3593719354043	-.229516593830	.005056895232	-1.254367778620	-.00001713652255	.00057943026368	.00956167859
14	-.666953398188	-.075024304770	-.006611297012	.775521057516	-.00113921891192	.00073246632309	.56314518151
15	-.310433091880	-.060997486693	.006302266549	.323168370105	-.00125572438824	.00142743453751	.58920029935
16	-1.219311262892	-.045364586844	-.000133502883	1.199434926584	.00297928975325	-.00251645688489	-1.04795527694
17	-.545703298638	-.045029127366	-.002830621918	.480125192091	.00115927657801	-.00097011882571	-.64361153902
18	-.018165545494	-.035567394996	.003086016199	.001726676244	-.00024570195493	.000099156283275	.15376399768
19	.255282591319	-.225886791797	.005453349719	-.116176344563	.00039854759292	.00060636907279	-.22767128304
20	-.309950918818	-.076952059079	.003585037745	.284230223409	-.00028313062988	.00000648840102	.16746219041
21	.610719339224	-.120047483022	-.003970055325	-.672344809416	.0007796770992	.00003036901344	-.44839432742
22	-1.984393638893	-.056242298474	.005328697206	1.989317177035	-.00079889245194	-.00080057269818	-.15376399768
23	.133677105390	-.185691458948	.007425027445	-.165378690544	.00202137288392	-.00239284608945	-.96304315685
24	-1.382126675436	.016684924958	-.002974369074	1.274993146766	-.00123539768335	.00319835678338	.37712422785
25	.479199232726	-.200874181031	-.015637770931	-.359105935622	-.00071448752958	.00083233923481	.42601079908
26	2.790249462687	-.090316401653	-.007103537112	-2.892852230121	-.00085153652240	.00067954138274	.35458181273
27	-.321910605486	-.023808490088	-.000136130105	.299665710423	-.00010819057478	-.00030059012387	.06822702153
28	-.814934844297	-.063574969761	.004158255051	.797740241342	.00113198533575	-.00018182426718	-.46897321042
29	.676895038232	-.079471470326	.000817935346	-.767870343097	.00076336159152	-.00074522083049	-.38944507830
30	.025438899102	-.152064019407	-.004900648220	.047167269367	.00027030704507	.00051589406810	-.16720209902
31	-.403959561267	-.083150846669	.020914427625	.578077201120	-.00427773077657	.00186617430975	1.28927050544
32	1.281515370611	-.232763835738	.017565234487	-1.166043073834	-.00120189466769	.00243555512533	.59423722012
33	-.217938564480	-.090720675118	-.000727931557	.461122825698	-.00429873093987	.00142509313540	1.65392079960
34	.070372918017	-.126614735243	-.004005040444	-.075141672856	.00070107016795	-.00328550895046	-.31522591273
35	-.102982191535	-.232818200082	-.006090599751	.118677040369	.00575205294707	-.00474061795792	-1.97144543101
36	.268611427149	-.190849673123	.017000877406	-.284512011429	-.00213915004844	.00167151432556	.90973411073
37	.028670388438	-.075679304326	-.008383814927	-.127657562414	.00279764558768	-.00099848229785	-1.30971125999
38	-.706987952344	-.055476213158	.000673858196	.701787993014	.00058612310717	.00042842117512	-.25099554214
39	1.988965327387	-.120580389033	.007229044917	-2.132057240979	-.00108927264665	-.00123025593724	.45461498047
40	-.030081656518	-.047312532137	-.001760844872	-.041188568957	.00051921572928	-.00043881643605	-.35709985958
41	-.404830718333	-.061131632014	.002721862963	.456278387544	.00302043319618	-.00166144485245	-1.26577191796
42	.014624711705	-.160457955746	.002899453810	.055426720486	-.00050755597346	-.00117361125306	.29042814766
43	.328968774411	-.151565248020	.003664966110	-.278539876726	.00016440717089	.00031422911494	-.12143037577
44	-.241098389477	-.097404291890	-.001040951194	.249986067833	-.00022136152860	-.00069181480663	.12911168969
45	1.867250639898	-.181081595769	-.008405497471	-1.857783135831	-.00047387356587	.00411415018956	.20648530474
46	.698462432720	-.152613076800	.008420422865	-.755849063411	.00124180311973	.00010181236351	-.65227085613
47	-1.616506304879	-.044874347779	-.002649252781	1.684894672893	-.00036376573100	.00096109334080	.13788427330
48	2.969634320896	-.090317299233	.003544666016	-3.109221062121	-.00006165897533	.00468460692894	.01917328082
49	-.230350622965	-.176389170127	-.000225090126	.409100068864	-.00647433168899	.00462113994135	2.04364222402
50	.577725952455	-.139608013695	.013454033685	-.716391733826	-.00049211473315	.00203129086790	.22927080763

D-10

NUM	DEL A600P	DEL NODE	DEL INCL	DEL MQ	DEL A	DEL E	DEL MOM
1	3.154898907831	-.353350168785	.002255222376	-3.050871156520	-.00052242132947	.00112927160382	.21850335880
2	.054750620737	-.133121591003	-.047400133812	-.117091941651	.00363759782425	-.00271424921007	-1.51540590516
3	.119111722688	-.130362799746	.002507429440	-.20298904311	.0010272325419	.00275649147083	-.46954902751
4	.764061275189	-.157870154384	.003345116858	-.723430140811	.00000744929504	.00072149811704	-.00462419987
5	-.235081410046	-.046607473552	.002632534829	.283350976562	.00013179394618	.00033229448203	-.06573607735
6	.324717885847	-.187310653904	.007963566379	-.261507172603	.00034357065112	-.00059947560022	-.19945314843
7	.131660764131	-.129721409572	-.003969349579	-.192335993421	.00170536506249	-.00157253653977	-1.03106980947
8	-.072112811638	-.080149802427	-.007964098989	.022253486080	.00109145732727	-.00086753557347	-.80704307829
9	-.304989821117	-.127590145199	.001237437442	.337239673393	.00008785944030	-.00042823593484	-.05319939881
10	-1.986499101179	-.279291595149	-.005624361240	2.046431694798	-.00376397830653	.00665930310811	1.14031149049
11	.282738022281	-.054484194785	-.001777579868	-.388957155424	.00049694407913	-.00067654601845	-.28073528071
12	.079032995935	-.140333108348	.003686156251	.017714914618	-.00027587318694	-.00016739568720	.17625173565
13	1.237069985018	-.230367290334	.007913854482	-1.164463777444	.0003426498170	.00040074862348	-.16696156643
14	-.584091652614	-.077273989881	-.005805793140	.694137312039	-.00187093050076	.00056336878492	.92517616908
15	-.304631708292	-.077752269535	.005809032247	.347593453254	-.00044543608760	.00096215551631	.20892359951
16	-1.141741753261	-.168084820696	-.001984026410	1.061536945072	.00726231800056	-.00448522392259	-2.63827515526
17	-.45432843851	-.051827713469	-.001915765177	.392357130332	.00058405393964	-.00074389985014	-.31324787397
18	-.060391369389	-.038348120088	.002925567148	.077801369360	-.00033597266381	.00065926660294	.22394176627
19	.177437078869	-.228979233230	.005528406131	-.052974839247	.00021019941795	.00066190161702	-.12005633908
20	-.411085119187	-.079770165812	.003599066680	.397880535136	.00014463899198	.00004750228542	-.08553007759
21	.553277285861	-.119390479435	-.003926332132	-.583686813894	.00016456207929	.00028262397108	-.09466746252
22	-1.955196684470	-.066213987195	.005380586030	1.986245308522	-.00043027448169	-.00112719425612	.15867550555
23	.039097588658	-.184189661759	.007882232266	-.007703954452	.00111258006821	-.00204302757902	-.53029086231
24	-1.529500643694	.014865506750	-.003008196119	1.467722125486	-.00138191398958	.00311505928300	.42187522636
25	.369535161993	-.200914364610	-.019516860103	-.280183368937	.00030011783484	.00075064323567	-.17884973632
26	2.330653938036	-.095157208938	-.009955522219	-2.519523487776	.00054332824406	.00105217006772	-.25157059727
27	-.393954867246	-.023853087982	-.000110409066	.343829834550	.00014675152829	-.000334827766867	-.09253172379
28	-.801568563092	-.048827167550	.005176133433	.807109790036	.00014971194004	-.00048691676146	-.06205198968
29	.495586535904	-.087398095700	-.000117383054	-.611770649368	.00120939881425	-.00066030160414	-.61686580983
30	-.095432827324	-.159622909854	-.004537460799	.173078138312	-.00030251051224	.00050527205516	.18717870008
31	-.517416039274	-.079081252665	.018585650538	.669035356914	-.0028591167311	.00180953253799	.87232231710
32	1.358704670933	-.232381928232	.017343779411	-1.258554534710	-.00038716191830	.00210299568777	.19134410755
33	-.262216494473	-.090230832313	-.007923694011	.543135276537	-.00417926570152	.00141658320547	1.60787296535
34	.327124345564	-.173166542088	-.007397281643	-.401337714167	.00260145890682	-.00239851318169	-1.16867479613
35	-.027861684674	-.252233582240	-.007414640531	.031359711859	.00555824910585	-.00487868664708	-1.90517545612
36	.246569042036	-.192167048950	.015519658408	-.270100655696	-.00133044726817	.00189656398603	.56560217723
37	.533721579959	-.237187621624	-.012603555696	-.501422168858	-.00027953269094	.00032004638705	.13105308596
38	-.719937045178	-.056738481984	.001439448123	.744016633609	-.00023894154286	.00015551106028	.10236047575
39	1.971702506675	-.125978095308	.005966272599	-2.134484591206	-.00011560460985	-.00090862066406	.04822712377
40	.656329716698	-.060373736662	-.000458598375	-.749756688507	-.00013258111007	-.000082917430258	.09121779545
41	-.344996551405	-.075275496449	-.000296410924	.371962903886	.000318642472428	-.00177613487357	-1.33523376217
42	.056254857060	-.162724076992	.003028949089	-.003544192859	.00008010968180	-.00100564774699	-.03438530659
43	.388393216246	-.157868108101	.004104976823	-.362945776749	.00027916960650	.00044441170513	-.20617995635
44	-.345977739016	-.101057702104	-.001289915389	.355412336350	.00038303782385	-.00076580480476	-.22334185889
45	1.383553263324	-.235291225749	-.007406006509	-1.351732317376	-.00186795047057	.00374989258928	.81446091556
46	.634682786007	-.158772267947	.003480354554	-.695381755109	.00083386280119	.00026747870369	-.43808412028
47	-1.985636280795	-.112822699597	-.000132294843	1.9889801257081	.00020372192215	.00023473354147	-.75872407126
48	3.015089299934	-.109813881747	.003712529856	-3.060958314702	-.00210052249766	.00546792246005	.65370679993
49	-.269590706324	-.187593304418	-.000075429313	.426773564392	-.00578039790948	.00480730170269	1.82408819579
50	.553326942321	-.145642209896	.013438294409	-.712372302667	-.00028712079784	.00218500491859	.13375346359

D-11

LMSC-D420943

Appendix E

**PERTURBATIONS IN RECTANGULAR
COORDINATES AT FUTURE DATES**

Appendix E

PERTURBATIONS IN RECTANGULAR COORDINATES AT FUTURE DATES

Appendix E contains the perturbed equatorial rectangular coordinates and the perturbations in these rectangular coordinates for the first 50 minor planets at successive 400-day dates from 1973 November 14 (244 2000.5) through 1983 September 23 (244 5600.6). The date of the perturbations themselves is contained in the column heading, while the date of osculation is contained in the page heading. Orbital elements at the date of osculation are contained in Appendix B.

Note that the perturbations are listed in terms of the 10th decimal of an astronomical unit.

These pages illustrate the variations between individual minor planets of the perturbations over 400-day intervals.

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2442000.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	.677141754652769	-2.501562388985278	-1.316830719762791	5864213	2710749	657505
2	2	1	-.531191337821960	-3.038286057101516	-.639986250252360	2910246	4145432	-257018
3	3	1	.494824143179542	-2.935335754911318	-.580401376154327	7690620	3217127	-1086924
4	4	1	-2.087629941389813	.955868540748167	.654853515286124	-2967531	5494293	2536205
5	5	1	1.878629697259321	1.637763755935255	.456857539493655	-9129773	-4831310	-1491160
6	6	1	-1.0603722512122874	2.058981623389599	.631573367273628	-3822658	-2782980	209345
7	7	1	1.928770394690922	-.659959163208654	-.075189626574640	19058146	-17520208	-7315098
8	8	1	-.832039433878026	-2.187101167915344	-.769160126392091	2919719	3922511	1239191
9	9	1	-1.381572622407269	-2.109590086624593	-.865691834640376	1994125	3449335	1235487
10	10	1	2.803872455631478	-1.394340073287424	-.436439104051740	22975828	-28279515	-12694285
11	11	1	.953878580798285	-1.849701755673841	-.769062295458134	4584535	3541574	994359
12	12	1	-2.457074768784679	1.201890542106359	.093049668593948	-2544727	5214551	2138183
13	13	1	1.806886243736656	-1.495997207739109	-1.513918800684138	11223098	-6991066	-805774
14	14	1	2.877504144057937	.839680124384795	-.131234780724714	-5129639	-12559341	-3062340
15	15	1	-1.714980366425785	1.902548970372408	.648263761149053	-2485754	3040253	1023779
16	16	1	-.638818698289025	-2.806697136068091	-1.045721175273080	4054215	4288091	1541091
17	17	1	1.780781614003792	-1.259256472138730	-.615367443866894	5436207	-223345	-651673
18	18	1	-1.206193781824169	-2.241165580674476	-.475149573390149	2517404	3974431	1134642
19	19	1	-.898325262324483	-2.371849720603578	-.978268726427682	3175420	3958857	1726961
20	20	1	-2.286083324229736	.022957954048754	-.003730237577375	-3749278	4601766	1970219
21	21	1	1.798655373271636	-.839358832381436	-.477045777464109	6876051	-3107194	-1510233
22	22	1	-2.684736581721850	-1.648965313314399	-.230042511726405	154437	3738468	1142464
23	23	1	-.998215810442822	-2.445553767990647	-1.082504370325530	2619768	3599740	1086589
24	24	1	2.120816601176344	2.147538177422675	.940655278085309	-6937042	-700732	-307163
25	25	1	1.171870405941291	2.246327249079130	.461549580399549	-2294245	-3374656	-2143350
26	26	1	-2.357947017357089	.956700889028145	.581715657502357	-2798828	5534932	2471131
27	27	1	-2.096104214567021	-1.307862669949763	-.500819953499509	-1344140	2754269	1209143
28	28	1	-.577486857520086	2.199646784891002	.678536474064533	-3204799	1521370	1087168
29	29	1	.895462193025885	-2.197477745214011	-1.231683529931146	6282621	1633716	1510000
30	30	1	-1.298645663529570	-2.055696455685322	-.988307864408785	2265837	3532245	1682809
31	31	1	-2.112206154126497	.684780816311068	1.433793600532254	-2555152	4204071	2317827
32	32	1	-.098423797389954	-2.360778496781464	-.833179619853123	3506478	4021077	1741100
33	33	1	-3.720714158304560	-.221688158331210	-.084332899221282	-790621	4346772	1876820
34	34	1	-2.375372902201661	.39255758520466	.106636391026420	-3296358	5210309	2147686
35	35	1	-1.425102161986395	2.049047616839374	1.230190613025674	-2442485	5922955	2486407
36	36	1	1.958619846595843	-1.175311158081058	-1.039798810516800	15538781	-12604436	1112567
37	37	1	-2.467538232018754	-1.525435750706478	-.741074232683141	266947	3247921	1392698
38	38	1	-.614838508231397	2.026239171091262	.935741846272791	-3494458	862533	-44918
39	39	1	2.446123442914867	-.206003723632959	-2.28047136762442	19611104	-22401972	-12371505
40	40	1	2.155894756869429	.020069556142127	-.165556683577983	15056234	-14781937	-7066115
41	41	1	2.605673771657649	2.331284708750431	.292037168861471	-6565776	-1014990	-96790
42	42	1	-2.795731957269529	-.020952159976772	.448450655527296	-1807695	4275849	1848647
43	43	1	-.324597285472267	2.355067059932580	.984767192538843	-3503270	354940	-9907
44	44	1	-2.221970719840201	-.674303503221353	-.142866052517713	-3437691	3754891	1724329
45	45	1	-1.691307743950404	-1.785462971561266	-.466001664962839	615985	3314279	1323097
46	46	1	.983601709804162	-1.896462666191503	-.732234474881626	5573017	2572943	790237
47	47	1	-.811529741634817	-2.233282157278936	-1.204100304397414	2984256	4063560	1974844
48	48	1	2.250536470129916	1.839564233805334	.576971383976410	-8820998	-3856948	-1922185
49	49	1	-3.248897339336764	1.005939259648407	.269912134750703	-2144810	4731427	2027979
50	50	1	1.529114684792852	-1.334225235898352	-.511516199665994	9644663	-3353046	-2028346

E-2

LMSC-D420943

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2442400.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	2.903597956263520	.139822515863865	-.526174286277168	32528791	-6898075	457017
2	2	1	2.483013620969089	-2.299752003593596	.273137716083808	3802395	7191011	-3650161
3	3	1	2.020535274139604	.559813705108414	.024447776075376	25671005	-2895914	-4520409
4	4	1	.134202376933309	-1.999550194515585	-.815574378689877	-1927246	2128303	842621
5	5	1	-2.0977777923003406	.356065105626680	.253491057859291	-3623373	40398	270408
6	6	1	-2.741530882469533	-.964846289400533	.269245010506040	-5005782	2175975	1234936
7	7	1	-1.640605443202553	1.521979364898463	.440819678170145	-1651819	-8910227	-3968652
8	8	1	1.779039042141323	.577483023577837	.041761781738561	10948944	-555802	-754836
9	9	1	2.047819605938244	-1.090795527707130	-.726178331212257	3749702	4378130	2204617
10	10	1	2.796531025649315	1.750049575274695	.955359181495004	5961936	-21211741	-12633660
11	11	1	1.434190675597151	1.891573770386238	-.616188259154757	20183455	-5534396	-3205186
12	12	1	-.100483225761824	-1.785678401952573	-.616084460261018	-2514979	1742961	880351
13	13	1	1.928318178383208	1.515685291473147	-.613901198516192	20281853	-14217924	-1515942
14	14	1	-.182996605254767	2.263449952006781	1.034969091334143	-5118065	-6467738	-1882832
15	15	1	-2.811552711757088	-.881930524766663	-1.077678641176810	-4645507	2223793	1026964
16	16	1	2.469967238484188	-.653781262530831	-.318105927353258	10439535	3402112	717374
17	17	1	1.475723885890403	2.240328967498669	.699363880065082	6794903	-9811846	-3819463
18	18	1	1.738369308971976	.450824696373139	-.039868023893786	6458909	1389644	-255153
19	19	1	2.108281336334130	-.126290337261212	-.018684227108309	8725901	-1481958	224184
20	20	1	.112323356657888	-2.532670418931545	-1.064951118014392	-1069483	3293639	1475011
21	21	1	-.063998300444118	2.372499018300871	1.057235579012563	-1365866	-7740338	-3131699
22	22	1	.280594619435426	-2.703878227409263	-1.570940217984507	-895030	4305251	1824981
23	23	1	2.174414953222552	-1.934705435248752	-1.407150205984451	4854259	5261288	3158830
24	24	1	-1.719102067076108	1.986155092945694	.901920164360760	-4459401	319075	167328
25	25	1	-2.014468339563265	2.201681800246817	-.222110911494297	-4240775	1078004	1107402
26	26	1	-.461242065859460	-2.158358541028178	-1.027432709572636	-2551207	2043175	931126
27	27	1	1.177974511056782	-2.209249898130665	-.987924713753358	395252	4842679	2071575
28	28	1	-2.261112166831253	-1.447072838340425	-.184278204108986	-5219478	1783970	1067083
29	29	1	2.098270768600756	.995470239867625	.579093656621131	33293959	-9472676	-3605075
30	30	1	2.076891124983959	-.502230429005259	-.165128389704261	5050997	-3075239	1291857
31	31	1	-2.603180252630565	-1.961037849191570	-1.181999333466990	-3747673	2273546	773268
32	32	1	2.778551542177425	-.194219075997362	-.113696276468528	20562174	-1972469	-2978864
33	33	1	-1.262180972863781	-2.183407350264957	-1.026441605647314	-3050139	2725102	1297101
34	34	1	-.097923897247277	-2.648005470411334	-.858447550475297	-1554990	2925778	1191119
35	35	1	-1.460619263142611	-1.578214695275101	-.988935859951699	-5025552	1585558	635559
36	36	1	-.612695245000780	1.569328035664356	1.406794073584301	3949800	-6290967	-3547138
37	37	1	.597596350004540	-2.632570754172534	-1.317127017114615	-415648	4466896	2209731
38	38	1	-2.416461050268452	-1.112635780138632	-.851233847839932	-5063193	1957268	771514
39	39	1	-.224493703775067	2.636074060034758	.667274013413060	-4185523	-8764767	-2141075
40	40	1	-1.132988066457109	1.815447119146839	.867736996494713	-3347613	-7650193	-2960971
41	41	1	-.464919986423910	2.948591351384309	-.395606961566298	-5126765	-1670131	552864
42	42	1	.486458055048928	-1.694376194180983	-.844161925946544	-1210848	3305884	1283225
43	43	1	-1.986548225976186	-.549256058925355	-.364923938534822	-6058677	2483684	1001408
44	44	1	.807868206831238	-2.473751515699291	-.991517249856191	-247647	4298186	1646283
45	45	1	2.227984303307352	-1.415375957042983	-.599204136189620	2975843	4859312	1353679
46	46	1	.889941757381216	2.009139661080383	.777113449285622	18334157	-3260401	-1973384
47	47	1	2.550909587187519	-.171829305456062	-.108624553286735	11671291	509946	665985
48	48	1	-1.527072097806659	2.438318489021142	.729349145555055	-4380640	-837587	85135
49	49	1	-3.173968796035680	-1.817136524893272	-1.007859423705469	-4179132	2523578	1267431
50	50	1	-.623871737736657	2.228709269376267	.843082376415854	2248741	-5802619	-2473111

L	NUM	QUAL	X,Y,Z COORDINATES AT JULIAN DATE 2442800.5		PERTURBATIONS IN 10-TH DEC			
1	1	1	.486814404942892	2.429755658781247	1.048382807558689	24778220	-7112970	860328
2	2	1	2.522980851048445	1.010785882701107	-.384353965554576	18450847	17244313	859424
3	3	1	-2.246779153994022	1.163801613985477	.308228142487469	3304605	-8669558	-1707750
4	4	1	2.209688558034770	1.142608544044933	.166748371230958	4546931	5688929	2983020
5	5	1	.062015166475851	-2.695238312010503	-.945855861407111	-4637507	-1059673	-301582
6	6	1	.350105447966197	-2.312900958930356	-.562795695202080	-4498149	-377094	-186940
7	7	1	-2.260289816987012	-1.632778750510496	-.905859358409227	-6302338	-973176	-355506
8	8	1	-2.179060802489460	.721586700743355	.507696687119541	2989821	-7567013	-3145353
9	9	1	-.103136471763355	1.895840908385537	.913833815482192	24346951	11644549	4825317
10	10	1	-.248235792135260	3.072964782461582	1.379290227936941	662281	+10957532	-5825840
11	11	1	-2.175906973625160	1.439842575242871	.699986364714007	-923509	-5339107	-1995225
12	12	1	1.364190209653714	1.831301459637082	.742253702423895	7616472	4558890	984656
13	13	1	-1.977180255156867	.795486603091295	1.054466976958359	1100760	-7019315	-5085582
14	14	1	-1.726856262330443	-1.359646692353685	-.302347682187751	-5819696	-1069418	-18322
15	15	1	.131762709314170	-2.473755522547634	-1.294882698122834	-4743797	-222026	271912
16	16	1	.297984009961615	2.547818506400475	.957288434460771	26141695	3464156	820763
17	17	1	-1.949012136448786	1.585019798089405	.749688580925525	-1335683	-5510995	-1962315
18	18	1	-2.189757083243435	1.216964613722524	.515643684218176	2403756	-7321016	-1983338
19	19	1	-1.473070473577614	-1.782336411717253	-.701743614373566	6138126	-4246514	-1995597
20	20	1	2.438693302244687	-0.71036607749335	-.015606555905782	-1918965	6102910	2462175
21	21	1	-2.750087246429601	.351789404767837	.315710053860494	-4440143	-936882	-334356
22	22	1	2.672264962508578	-.067570504558501	-.718665022279129	-2394446	5481170	4272307
23	23	1	2.373159170721181	1.085810830329656	-.122778153325290	15832332	11712527	8597867
24	24	1	-2.399613990981678	-1.588778561569505	-.688669448704565	-6517623	-821140	-215533
25	25	1	-1.673154978157257	-1.318361861984890	-.480703480438367	-6903075	-1007532	-357523
26	26	1	2.735773822983134	-.114691855339071	-.190664293726377	-2105264	5479269	2816359
27	27	1	1.506932668403586	1.277933976115328	.505647974496039	10731330	7205363	2876427
28	28	1	.900275904762687	-2.902368984519413	-.909092866800115	-4199342	922212	206559
29	29	1	-1.837154843180208	1.488362957456573	.828593389190328	1914794	-8535006	-4954225
30	30	1	-1.101478574326833	1.850745649316003	.817265314169035	10024042	1025940	62474
31	31	1	-.059104256836283	-2.667818579244681	-2.785542894576807	-5144388	264665	699180
32	32	1	.486419220882491	2.472481939743702	.896648962570126	24860198	-3258796	-3716196
33	33	1	1.830103245724601	.734604490240379	.337562592006602	-4133924	4455468	2092424
34	34	1	2.844676355988497	-.810835328592230	-.241929950101412	-2734275	5988277	1895981
35	35	1	2.518416662350091	-1.657010680852295	-.972690012293285	-3484523	3226616	2108595
36	36	1	-3.274122114581544	-.389313344663300	-.382542380564404	-5377425	-553284	-400694
37	37	1	2.318760513162985	.349285161982896	-.155874928267141	-260167	6585997	3109954
38	38	1	.547244133508691	-2.816396671863728	-1.338148325493052	-4403809	391121	490468
39	39	1	-3.018959315755481	.405722279190996	.318850063048830	-4760173	-946189	-26450
40	40	1	-1.608201072828400	-1.607297362227676	-.557362177838844	-6745413	-1277478	-255213
41	41	1	-1.825764800106441	-.893976457963412	-.106149523057738	-6062368	-626235	120224
42	42	1	.947429197646148	2.141356526871874	.811183783323294	-12455620	5035555	2153571
43	43	1	2.040990474164985	-.209949385985725	.044191239309878	-3382558	3323459	1273987
44	44	1	2.381770907605429	.515614639784069	.073663742092674	2232387	7257965	3037939
45	45	1	2.052643688227604	2.040864809890238	.525359701727020	39613496	11752864	4941450
46	46	1	-2.656946255555283	1.127330912380458	.433729304108120	-2349305	-3011429	-1065301
47	47	1	.511944344052910	2.658860664412600	1.436294931905351	20205794	-4146455	-3234918
48	48	1	-3.082059786340452	-.764801080702419	-.256662726298378	-6162218	-497883	26345
49	49	1	-.420876037864780	-3.116176614224941	-1.439308983027743	-5445960	-78716	206016
50	50	1	-3.340457781190779	.246242185139172	.112391508213501	-5178489	-643954	-85846

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2443200.5		PERTURBATIONS IN 10-TH DEC			
1	1	1	-2.521267319657468	-.072352103395404	.479605787033915	4695156	-4642167	-3115256
2	2	1	-1.694060621352535	1.378018593148795	-.133094553056318	8317982	7163413	5506676
3	3	1	-2.453367077879885	-2.205271036567510	-.316149576974301	-3439296	-3318553	-1223898
4	4	1	-1.235060976518355	1.958174650618275	-.943841013155275	17558446	13618649	6730739
5	5	1	2.821540091951718	-.919625921489654	-.495054610913035	-4815059	46210	7339
6	6	1	.987674902702844	1.751252840545526	.207471790947261	-5782599	1284719	1728092
7	7	1	1.10850239224256	-2.021733850277528	-.721623853518651	-3404801	-3605633	-1396450
8	8	1	-.767426206664705	-2.198574627035029	-.780501612998105	-3973738	-3911551	-1499831
9	9	1	-2.285957970947550	-1.120088829127890	-.303261206249761	1762904	-2880755	-1639139
10	10	1	-2.861227337358184	.919703760537729	.716288059170259	1928258	-4860321	-1954927
11	11	1	-1.326672792322984	-1.892165985590196	-.624055419599987	-3643253	-3353739	-1290613
12	12	1	-1.694996706699351	1.955421952332299	.409511842628374	9264641	-4211333	-1001989
13	13	1	-1.018897580306479	-2.137759525634237	-1.287557821904931	-3741253	-3564145	-1687666
14	14	1	2.065100268997410	-1.636163991658718	-1.091093950275030	-3029114	-2138555	-861671
15	15	1	1.952236573772019	.538073547286608	.708830990247225	-5986283	1598233	4659
16	16	1	-2.998535844986819	1.068363230410107	.490339922295151	3511924	-5073256	-1935558
17	17	1	-.692618679135246	-1.913430008122874	-.645554001372216	-3601160	-3608590	-1328454
18	18	1	-1.818885107932658	-1.950658982331985	-.346632130468509	-3547784	-3272918	-1212032
19	19	1	-2.377924009397375	-1.401614887440644	-.606551959831677	-2151990	-2917162	-1115084
20	20	1	-1.242221597199986	1.547624852363015	.643827594272921	11593481	23901229	9747816
21	21	1	-.124259081447089	-2.015722056569814	-.887910665784631	-4293136	-4546160	-1845566
22	22	1	.143790278211707	2.318515505847614	1.249537670006518	15190976	22357544	11973248
23	23	1	-1.816574239486613	.686360077921304	.693699748571781	10092099	14970985	7531773
24	24	1	.845884932591428	-2.998334767083932	-1.346337488025426	-3865505	-3534156	-1402227
25	25	1	1.961616450896152	.669704241492958	.481140149706528	-3792555	692122	-794588
26	26	1	.742621879100376	2.516814521168627	1.187861288912949	18124259	28633766	11870414
27	27	1	-2.307692545172131	-.272915727420002	-.018073165228377	7484783	-2454700	-1265268
28	28	1	2.984848890036346	-.343905049104682	-.393502673150976	-5571605	792535	305494
29	29	1	-1.847386784380504	-1.747645414443973	-1.003932035285612	-3073031	-3069925	-1330917
30	30	1	-2.240132655475250	-1.282850984757431	-.662232982508311	-1350554	-2829966	-1117184
31	31	1	2.547607552276453	-1.231290342962801	-2.156266840752119	-4743152	-2023919	463416
32	32	1	-2.374486303270217	.040205753114331	-.141325375765910	5428137	-5384694	-1486997
33	33	1	-1.583319600239122	2.628444881302983	1.252706255181749	12899477	6564447	2074947
34	34	1	1.188091769197165	2.251626209254056	.738136682157009	4881975	17513504	7184162
35	35	1	3.470508491985029	.946739236924227	.635198143230827	-5339236	5314257	2398370
36	36	1	-1.749796807163669	-2.258929304869952	-2.050470092090237	-4325600	-3850539	-1552758
37	37	1	-1.678163463200050	1.520381104347621	.771016626900906	10955747	17922600	7671556
38	38	1	2.787905112456954	-.637450348422593	.023704314691750	-5300361	469480	142460
39	39	1	-1.356615887329305	-2.525409950180020	-.525551534064203	-4243124	-3861909	-1435518
40	40	1	2.077716212499880	-.491390000465774	-.377936640210747	-3036761	-1035867	-338452
41	41	1	2.422773516970352	-1.376316096964224	-.200207906597160	-2733948	-1547835	-852704
42	42	1	-2.368204861121285	1.499214924434670	1.060098434053195	5741555	-5130346	-2827910
43	43	1	-.373229210412600	2.351791529593541	.9799037611152332	15956009	20159217	7655463
44	44	1	-1.627163670096509	1.194453636436535	.543425409637091	10102457	20921160	8538271
45	45	1	-1.507887356321646	2.208815450218992	.809341819026258	17961368	-1219258	1738234
46	46	1	-1.776100955333987	-1.928655931269518	-.746649570942918	-3934180	-3456579	-1343801
47	47	1	-2.662541680876885	1.647350231340639	.907974076290678	4553359	-5559389	-345026
48	48	1	-.582072379361318	-3.113122959431848	-.951058854612100	-4253644	-4054826	-1575142
49	49	1	2.412352593755265	-.985562817295957	-.308625241578863	-4504990	-810531	-264398
50	50	1	-1.996577891578518	-2.273362678138412	-.844491486141322	-4323928	-3777174	-1482002

E-5

LMSC-D420943

L	NUM	QUAL	X,Y,Z COORDINATES AT JULIAN DATE 2443600.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	-0.124801244712538	-2.576860656923643	-1.191655538470769	15139	-3976785	-1894459
2	2	1	-1.234599842295339	-2.648487287910484	.612696170656232	2466546	-1903350	-1194072
3	3	1	.544236851461967	-2.965948098267248	-.578813078071761	-663456	-5421107	-2274092
4	4	1	-1.307421313681019	-1.652320282369928	-.488376011755975	7129329	-74753	-960116
5	5	1	.987700804374256	2.032589141438677	.649634176250039	-6217137	-996605	136774
6	6	1	-2.671023169292098	.61038851431821	.599242274229049	4054272	9341979	5162977
7	7	1	.120002029450637	1.779959754745207	.747543859790706	-5094418	-2025986	-1340240
8	8	1	1.750402453552290	.649916934671388	.073040893064688	-41541	-3041100	-1334895
9	9	1	1.097854023266809	-2.118369336764758	-1.111098407556398	-384104	-5293574	-2351422
10	10	1	-1.140443814717834	-2.321521417375024	-1.135606071756235	1046910	-3253508	-1212872
11	11	1	2.242661999979657	-.052141292183791	-.179310523372467	472190	-4073184	-1780355
12	12	1	-1.377033470438591	-1.442040379760016	-.662530774585658	4817673	-1641368	106647
13	13	1	2.337932437065547	-.869151174535816	-1.195479891401824	-323596	-4525593	-2032158
14	14	1	2.574983607109630	1.433475818895936	.186307691582734	-4337327	-2366516	-304755
15	15	1	-1.981019633137159	1.764420074644477	.516318958425359	-281514	19157988	7013118
16	16	1	-2.489815353129728	-2.000807182172291	-.687556695357493	1750015	-3115419	-1386671
17	17	1	2.485441149082320	.516777328544340	-.021361373696505	-881774	-2824839	-1196338
18	18	1	1.764393477143422	-.503405716020129	-.291161262562806	1014776	-5580722	-2181741
19	19	1	1.133625764698166	-1.978429934298232	-.786720337684340	-369484	-5672712	-2375865
20	20	1	-1.395707762563795	-2.055008827134145	-.872767319311469	4531867	-1066460	-415997
21	21	1	1.660384672971752	1.451309978066483	.549184431845194	-2758445	-1941297	-683777
22	22	1	-2.903882038353342	.045278610024226	.765517755363092	10302712	4153551	-1162279
23	23	1	-.642599820711574	-2.597414114107735	-1.228743951575780	1269282	-2594740	-1455454
24	24	1	3.326072460848593	-1.000970493863659	-.479830619575912	-1545590	-4185376	-1754117
25	25	1	-.874969949867786	2.848122084015330	.082390048840313	-1273181	18448706	9894474
26	26	1	-2.426872891188211	.794133051376743	.505622497077190	11462577	14806515	4967553
27	27	1	.153188486456932	-2.518158085830763	-1.090298302025197	-176029	-4323265	-1873396
28	28	1	.459928289898304	2.325492117263380	.611151909991616	-6330039	887319	1651760
29	29	1	1.806407549482458	-1.622769429354889	-.904810991515369	-108006	-5368148	-2396417
30	30	1	1.377483121700045	-1.702020336189825	-.739926896326473	-135740	-5680920	-2444248
31	31	1	2.389347381278270	1.246865745360914	.503642555084941	-4470438	-2923966	93734
32	32	1	.760843968280642	-2.329383501001345	-.764989326444432	-79324	-4524290	-1793669
33	33	1	-3.709994690544406	.862561504831046	.428600999115540	7534542	-1823769	-1105692
34	34	1	-2.361140706457263	.493393021263577	.139862726584492	3936230	17692926	8311476
35	35	1	1.145324859555345	2.703034203027428	1.671275233678010	-11555373	7299952	933757
36	36	1	1.474484800999377	-1.644042008804121	-1.464892888864810	-490948	-5410673	-2413463
37	37	1	-2.324820213998251	-1.741485995803579	-.849875749291542	3931842	-1873308	-863976
38	38	1	.057470960703947	2.073937395273518	1.041812387534108	-5642685	2312720	-34235
39	39	1	2.210114217838736	-1.099290919969235	-.431762195808071	926	-5001443	-2090059
40	40	1	-.642088894731081	1.997274216669865	.905871683037731	-3431528	5352667	2632158
41	41	1	2.959869993087707	1.829731202611164	.222545018287325	-5109860	-1678123	-674498
42	42	1	-1.750867444195606	-1.568578940397259	-.421056402441561	3562589	-1755283	-1485593
43	43	1	-1.960587741555685	-.593491129341110	-.382231681685560	10847081	-108605	533053
44	44	1	-.866985190815363	-2.366877907006767	-.863283418078844	2547371	-1751939	-917143
45	45	1	-2.008819328032288	-1.456513663839750	-.339661255875047	6538867	-1215670	-733171
46	46	1	1.979128303766004	-.683111028096455	-.262570820892193	680640	-5347086	-2211758
47	47	1	-2.433295113644931	-1.398229130317645	-.742163840046537	3176572	-2480637	-1146404
48	48	1	2.611485656335006	-1.754145417371355	-.512984410998229	-706362	-4854541	-2114386
49	49	1	.093659570197360	2.352769156657644	1.073801634076375	-5440605	1817153	340989
50	50	1	1.674468570271145	-1.087280453083572	-.419393612497220	297789	-5962575	-2456791

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2443600.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	2.804187491409536	-.533449614397353	-.837482452625849	3075476	-4713403	-2267311
2	2	1	1.970137185418039	-2.767262053805666	.399963634538084	2538709	-3982135	-2157631
3	3	1	1.994779937108781	.6227331217617286	-.036979018655512	3547212	-4080073	-1804681
4	4	1	2.354760690077640	-.087192290249865	-.343542891706525	3764387	-4380095	-2180568
5	5	1	-2.166209985787305	-.679698327490083	-.104149776453560	-13876047	12742836	6159584
6	6	1	-1.436431992608689	-2.333735731812368	-.255184452470276	5807072	1841451	-652906
7	7	1	-2.7319222910354192	-.476417502903379	-.484674053895061	-4680489	10641612	4911953
8	8	1	-2.211254450813101	.664208091136718	.488633129766352	-6384604	5828778	2874253
9	9	1	1.555432738996572	1.355295743856198	.493908949877074	1982593	-3002665	-1356432
10	10	1	2.597680632945381	-1.6466924169955206	-.565405827295642	7980506	-4900261	-2118254
11	11	1	-.476857213470748	2.415582461473932	.950093165325296	-4188256	-3394476	-974567
12	12	1	1.919484650377967	.847550141545995	.530850285428809	4594478	-3654676	-1029662
13	13	1	1.145722890916318	1.895149749701370	1.070683949946599	-1428061	-3754665	-1274571
14	14	1	-1.015489681898245	1.867111518568116	1.009635563960103	-6123956	-1697738	-181493
15	15	1	-2.696380311846241	-1.107554598053774	-1.174280105046158	7410437	3683816	3559925
16	16	1	1.031762150740839	-2.452696519870400	-.959142414846376	2632301	-3969493	-1788810
17	17	1	-.164767027435145	2.618666918763657	.978447026799891	-4668907	-3526378	-868503
18	18	1	-1.618275576519258	1.683414841212240	.585726048933328	-3710649	-1722405	327921
19	19	1	.757551331337698	1.826486971733530	.754735276909039	146863	-2750524	-1218981
20	20	1	2.036572735861191	-1.580133333942278	-.652855715764918	2903201	-4868627	-2133528
21	21	1	-1.975367829737625	1.734958703940276	.907146546807560	-10718089	8867163	3946537
22	22	1	-1.562614137224770	-2.599587242616835	-1.043758806121062	4851309	295539	-795290
23	23	1	2.409632443469860	-1.664479346360146	-1.311418530294240	2870463	-4934292	-2300819
24	24	1	2.371533391321648	1.965953620627040	.857408395812971	-497620	-4220373	-1854009
25	25	1	-2.568422987924620	.164657630207629	-.529184012215616	1380196	9609855	12043877
26	26	1	-.272790731117775	-2.182756008483253	-1.048522310808231	5620901	2249786	827222
27	27	1	2.231015854471664	.207664484950162	.022428975066309	3631933	-4374765	-1985233
28	28	1	-2.493404573133105	-.550128989071250	.092567584404176	-12291243	15566243	8034602
29	29	1	1.238088288893792	1.757647279214076	1.0048624972629414	-360408	-3187417	-1466495
30	30	1	.408261897608401	1.971793248689202	.888879601736981	-1026322	-3018315	-1422400
31	31	1	-1.726179894991417	.934391239512696	1.618465206546290	-5641766	1520197	-1622790
32	32	1	2.724797957493365	.549138316851927	.370305616421465	2446465	-3843196	-1696789
33	33	1	-2.723135823520906	-1.616756084408998	-.750258133375603	6494158	865417	381689
34	34	1	-.208210437684357	-2.632830563707032	-.854568726945146	4454392	784333	128457
35	35	1	-2.134571290953474	1.212257666706620	.705436940199029	-21342362	22093407	6097403
36	36	1	.256160084133073	1.494292340148341	1.347593230709116	-451717	-2723693	-1580839
37	37	1	.863515453909223	-2.539084518321985	-1.272383336732098	2612947	-3809957	-1670431
38	38	1	-2.563713340889449	-.603519256528518	-.615492646186013	-7369732	13457145	5559557
39	39	1	.644357018771423	2.490049267188624	.568335279316610	-2095540	-3853674	-1120622
40	40	1	-1.952622016148979	-1.264145068446673	-.382832302444742	477129	8400101	3313775
41	41	1	.218898660871917	3.145099078718573	.416921379740055	-5655494	-4560530	56669
42	42	1	1.966467183769765	.423837640928987	-.130679496365170	4590890	-4304844	-2493146
43	43	1	2.053310665098039	-.149114121296458	.071155942396466	3507606	-3581194	-1399792
44	44	1	2.353147004297668	-1.161699032283725	-.568775358976570	3165553	-4990983	-2224430
45	45	1	1.938609143994912	-1.679209214662403	-.672967141635478	2688521	-4083157	-1807118
46	46	1	-.527685402291180	2.351551756944033	.908410097037603	-3582185	-3473480	-1311730
47	47	1	1.520844472445972	-1.727309758541615	-.944261754491837	2595705	-3857415	-1745305
48	48	1	2.317420660230340	1.768453945796892	.555624234243847	232373	-3843392	-1735608
49	49	1	-3.290289652052650	.936435179905256	.235762410170365	-10374396	2744412	12328328
50	50	1	-.872965712938758	2.223313565592719	.842550246995653	-3224249	-3312616	-1170538

E-7

LMSC-D420943

L	NUM	QUAL	X,Y,Z COORDINATES AT JULIAN DATE 244400.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	1.300648596021382	2.2907854489327596	.817101525933492	2282099	-2901508	-1096461
2	2	1	2.926012776214561	.252399820624085	-.265731611935491	4719253	-2769565	-1502441
3	3	1	-2.285031151789800	1.122253350185632	.302265844084458	-2065439	-4842337	-574507
4	4	1	-.016505378234429	2.380180212340227	.952629897318487	278960	-3912398	-1406798
5	5	1	.887891587729847	-2.658205262168795	-.987777507900900	3115505	2614457	697995
6	6	1	1.911812398757035	-.271299733473763	-.393003550158367	3949690	-1850753	-1098293
7	7	1	-.247397243354806	-2.505731988701029	-1.060267590708008	3887776	3819506	2054966
8	8	1	-.705317445972831	-2.208264489168073	-.790759667447848	1895778	7155031	2299080
9	9	1	-2.341408500303686	.2563143746633244	.362910250251055	-4774833	-1795616	-1016938
10	10	1	2.970264841163939	1.494569844056993	.888702016482004	3848985	-2732978	-1314597
11	11	1	-2.584831367031086	-.330693687594604	.057229568963981	-24629909	8848142	4667429
12	12	1	-1.262745620380749	2.454938984346640	.669139623726149	-1581470	-5269731	-1942534
13	13	1	-2.359403620834030	-.013865440029726	.567544170571729	-7066605	7296	-1465715
14	14	1	-1.054106351356715	-1.9511111391124462	-.688483559928439	-14478074	3763225	2342008
15	15	1	.478005284522614	-2.418015473775142	-1.201055946479597	3682239	1591714	1447790
16	16	1	2.233025191669356	1.157572596683487	.375191659953927	4996493	-2237244	-1108283
17	17	1	-2.344058689513147	-.201330053198297	.125449721133895	-20906062	5613099	3227906
18	18	1	-2.299841281103312	-1.528689706793500	-.190081390777793	-13616504	10877599	5251061
19	19	1	-2.707699994797301	.248171036330917	.059029395644552	-12105626	2425495	1585122
20	20	1	.781253622757099	1.801749828149127	.762593519144065	2982437	-1788100	-848082
21	21	1	-2.069900530651395	-1.387041405524343	-.496152948673606	-17007929	13533690	5698710
22	22	1	1.814546609571089	-1.840059904312312	-1.483291491927012	3834802	-1418350	-685073
23	23	1	2.060520144271862	1.382081585261105	.334797077142296	4248104	-2387438	-1149283
24	24	1	-1.435340737206438	2.175094959849673	.983814270756667	-1540789	-5616516	-2489675
25	25	1	1.267043643601890	-1.265392116809551	.149989758459767	2219293	7389365	1472063
26	26	1	2.750138774836175	.058939132562712	-.106447979722450	4714607	-2435944	-1202251
27	27	1	-1.816797045195592	.948161236688656	.463440585854823	-549842	-5434748	-2332918
28	28	1	.096175754961415	-2.990534931467323	-.854120096312258	3540350	3849760	723667
29	29	1	-2.476389370810510	.656171089891362	.352268410225864	-7264005	-1080653	-1021360
30	30	1	-2.608570675598031	-.191954690117683	-.166876179638121	-15166867	4846923	2400214
31	31	1	-2.761091057767835	-1.738615075717092	-.897503204514980	-4935316	10640581	672135
32	32	1	-.341226631557706	2.446700138433471	.833387729198723	-47111	-4610463	-1936044
33	33	1	1.34561183792507	-1.275438120690559	-.611035003990594	2942489	1405692	672084
34	34	1	2.814202209235745	-.896082903282263	-.270441176225669	4510258	-2619185	-1225926
35	35	1	-.374713544959059	-2.143056500931920	-1.315702207073547	-878051	7289741	3640105
36	36	1	-3.180613848668926	.029272568868564	-.006234940016679	-15874794	7240892	1092592
37	37	1	2.187652106955424	.656802791733238	.310307971350207	5383964	-2537057	-1199328
38	38	1	.046009676662410	-2.824142922128516	-1.403417634607628	3695636	2651327	1748583
39	39	1	-2.770048444024283	1.118094732492096	.477083042446264	-12022286	-1385842	1400297
40	40	1	1.865113068896669	-.970959792822903	-.565911632984538	2631514	442614	70511
41	41	1	-2.146965436231071	.066284096786626	.024362601102549	-12988336	176397	2938664
42	42	1	-.991222512592724	2.401685056387990	1.246322871599347	-1069756	-4942425	-1955267
43	43	1	-.426467165505688	2.345817272390937	.973931606582969	-397592	-4229942	-1992422
44	44	1	.417467041365701	1.935758513152244	.721253460448072	1988419	-2290435	-1000045
45	45	1	2.294970153065775	1.790381938205231	.425518847122031	3762107	-2292851	-1119484
46	46	1	-2.954551309722845	.032215427607834	.010542785307828	-25930639	9864600	5674458
47	47	1	1.977277069157232	1.788456622273586	.956222632141472	3696543	-2051846	-933089
48	48	1	-1.442101427107751	2.475670073929621	.741370448851423	-1509109	-5694133	-1765308
49	49	1	-3.139310672587570	-1.871693286649432	-1.030493398798257	2730237	12102555	6853185
50	50	1	-3.371302911219345	.079176357675179	.050021910586219	-29819981	14695421	8344906

E-8

LMSC-D420943

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2444400.5			PERTURBATIONS IN		10-TH DEC
1	1	1	-2.298268317655157	.740845929389341	.818264453174771	1367330	-4290766	-2357946
2	2	1	-.738713174503926	1.957727024547040	-.327707067058130	2942404	-783873	-71926
3	3	1	-2.423433273841463	-2.239854147900331	-.323220319592547	-28892325	3370702	2068664
4	4	1	-2.167944723111789	-.579256720469107	.052850249692288	-4409460	-3777621	-1763654
5	5	1	2.903411627159755	-.156341478364682	-.233439369107431	4425448	324582	-21437
6	6	1	-1.470535155091660	1.855990474430832	.668353130591769	1995166	-1805526	-433191
7	7	1	1.698119176093416	.639823913003364	.437015740957634	3540556	766926	339208
8	8	1	1.714138691330149	.724174065490477	.105878273834842	2264247	1415168	484668
9	9	1	-.403714572924244	-2.402900444479101	-1.104663153140322	-9516631	4466684	1692815
10	10	1	.097746548789458	3.055195784006179	1.413613856863423	3610804	-1526744	-868990
11	11	1	.874827430373369	-1.852601414462604	-.779910244521300	-3103866	8017143	2934564
12	12	1	-2.221536264054242	-.618987910461222	-.491783271343937	-13294367	-5103838	-368832
13	13	1	-.173270330615312	-2.251513083221582	-1.572261664746073	-7036820	5331896	1849573
14	14	1	2.568336270196355	-1.084543721100566	-.933636231124964	1864986	2645337	1208177
15	15	1	1.759688613046345	.876980753278172	.848490375475375	4598744	341136	416636
16	16	1	-1.447224683182256	2.413940616139328	.956276935261421	2312432	-2649652	-1070225
17	17	1	1.444281427009958	-1.530592787976417	-.688459875696150	-2667422	7391367	2689866
18	18	1	1.332187168538039	-1.351828318438621	-.477828002368087	-453263	8329251	2153009
19	19	1	-.795139349319779	-2.393840311972909	-.985198516072479	-12134351	6192609	3411582
20	20	1	-2.274972229124424	-.658441361090229	-.307153673826562	-3118628	-3196479	-1165777
21	21	1	1.915619119541041	-.608438510568014	-.381209325117235	-1196535	6684387	3024879
22	22	1	2.097978895517808	1.551982628088055	.326359849991881	5207282	293986	-107724
23	23	1	-2.057667272499145	.210776582228389	.491536103026988	2097210	-3715148	-2250878
24	24	1	-2.539242681338038	-1.329476234334251	-.571659675409080	-20717117	-4253996	-1229399
25	25	1	.499304806139483	2.690677728262472	.358113131035569	3173740	273743	-183061
26	26	1	.557148582528299	2.548535225341482	1.212541247783683	3762720	-453394	-280852
27	27	1	-.900711248007429	-2.366961907600583	-.993425699376242	-15060281	276260	478033
28	28	1	2.842090157260657	-1.133621096267710	-.602717131280475	3699229	1084995	202739
29	29	1	-.933825208168365	-2.235974113339807	-1.273345092350809	-16970938	2971437	1979895
30	30	1	.121693008754488	-2.259588804853578	-1.036592600020128	-4518567	7093256	3790624
31	31	1	-.395119516060701	-2.701872792417177	-2.710752519458197	917660	6462420	4721650
32	32	1	-2.130878124856179	-.819957060765926	-.429351193392598	-7794205	-3878448	-827543
33	33	1	-.045269810433920	2.531675190752239	1.198462780018808	3002424	270411	63893
34	34	1	1.284089694242958	2.217190180099934	.727448021925920	4753669	204052	-80683
35	35	1	3.136288680676628	-1.063359180384282	-.597623353840238	3162166	1265460	721967
36	36	1	-2.201292352708592	-2.071161905358181	-1.887691429638892	-16813964	11811039	9478273
37	37	1	1.944986448209391	1.322105817206818	.674212750611119	1899115	-3018526	-1529163
38	38	1	-2.705225641656185	-1.122277334434180	-.228299510881257	3644483	1019429	390254
39	39	1	-2.045539498999567	-2.146229322930338	-.391573029568385	-35904991	2949529	1593559
40	40	1	-.118432184592187	2.072735987423065	.895889398440008	3418322	511250	120953
41	41	1	1.754007047567178	-1.868517780229432	-.261120614844097	-2509444	6039164	1128028
42	42	1	-2.772255922268798	-.161113005954587	.381215317481487	-8608399	-5678434	-3456187
43	43	1	-1.925745203442162	-.650284226568591	-.404097863822248	-7358453	-3623330	-1113731
44	44	1	-2.094162109186954	-1.138010948911287	-.327519120175321	-6030634	-2660571	-945804
45	45	1	-1.178463066397988	2.420306976104854	.856263342936458	2549095	-2752358	-950876
46	46	1	-.468098735927228	-2.254815982891365	-.886843477919381	-10280478	7808868	3782072
47	47	1	-1.436488026603463	2.553106637057610	1.390805512444402	2420621	-2919794	-1619055
48	48	1	-3.092054418147427	-.655520092818175	-.235336760280997	-17890213	-7419576	-1176260
49	49	1	-.347775872761774	-3.105848674169764	-1.430000556426876	929778	7931806	4108711
50	50	1	-1.831806942275179	-2.349711163760560	-.873486193968127	-19915749	13789533	6694007

E-9

EMSC-D420948

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2445200.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	-0.705197397049630	-2.441386614013993	-0.969284326263640	-16597692	-10995487	-5795415
2	2	1	-1.8293064665807292	-2.032344707617156	.535353880492131	-3013746	-5299887	-1879207
3	3	1	.579853083890921	-2.951898384811003	-.577759298380119	-9900752	8688430	157639
4	4	1	1.710507243049562	-1.279597987736871	-.735395291617987	-6795162	-.955553	-514902
5	5	1	-.059535001809260	2.073354899798887	.728985395827699	4642088	3358110	1156921
6	6	1	-2.606873537469824	-1.287772439189908	.176063292268799	-956568	-6199106	-3395916
7	7	1	-2.432734304737357	.764544776944948	.056685406424241	2721246	-985068	-292358
8	8	1	-2.243995243175220	.603910263845243	.468455909106638	2636443	-584905	-333158
9	9	1	2.271758391804738	-.019817167947201	-.238457533346921	-1489575	4189838	2190651
10	10	1	-2.750715276699225	1.256890708349211	.377196762766892	4241450	-2003837	-872842
11	11	1	1.496059440246938	1.836368274466865	.591005913549349	3151696	2395275	873655
12	12	1	1.891415516773279	-.384001214892017	.111301777945743	-6223923	1631236	370418
13	13	1	2.605808356923224	-.148669416979967	-.744921131615961	-250309	3490665	2657844
14	14	1	2.078172869739788	1.920122681409886	.490683180959534	4794379	2501186	900831
15	15	1	-2.225006951933742	1.599676758895733	.375494611818693	2944384	-186222	-230914
16	16	1	-3.29142094053154	-.328225284811811	-.030672437160633	2480616	-5475833	-2254711
17	17	1	1.742626614334377	2.035120322326449	.601234709018769	4030255	2467077	869284
18	18	1	-.834567504048512	1.965079037020061	.592649360355214	3208169	3789647	1009795
19	19	1	2.100615215048975	-.004054058376021	.030848521356216	-3040023	5195122	2064005
20	20	1	.751194668901865	-2.442135433593137	-1.022879953963262	-11669730	-1155713	-49908
21	21	1	-.293659035879848	2.379791685881813	1.074018646286405	3809762	2884795	1148772
22	22	1	-1.740389418528913	1.688101976032307	1.380250098800190	3313128	682195	144770
23	23	1	-2.252582054306190	-2.691478914557109	-1.348722425196708	-15878882	-7525084	-3670047
24	24	1	.568343257332621	-3.033180666933831	-1.359345916058103	-13596395	3803299	2366813
25	25	1	-2.405003474831616	1.617189706318939	-.358416304684530	3767607	-2044933	382444
26	26	1	-2.475743744907717	.612605873531688	.419696230814331	3956858	-2075958	-1204113
27	27	1	2.212796265771402	-.951637480091865	-.476856798105779	-2522323	5741123	2545741
28	28	1	1.430823760212441	2.087010456173502	.447229069280482	5076214	2777254	866470
29	29	1	2.358045237791174	-.753151660125635	-.408054194025889	-2488104	5316610	2985084
30	30	1	1.697517450272592	1.044162337546624	.534913475996927	289907	2625213	1082607
31	31	1	2.332712332804633	-1.475486711074176	-2.341275465315931	565698	4058526	4045451
32	32	1	1.547361813018718	-2.048912345255104	-.615178914912757	-7815123	1652215	793033
33	33	1	-3.167360091755796	1.813120930416815	.875490479671644	3985739	-2060184	-1081611
34	34	1	-2.330775401800992	.592904039766207	.175618856757975	3647085	-1730249	-511712
35	35	1	3.123597626950182	1.5E4776731671404	1.021420082257031	4867233	2443865	955523
36	36	1	.972927233068514	-1.9E8302416747663	-1.789200582414644	-5659509	6070295	7448077
37	37	1	-2.157715000950283	-1.937471956649517	-.948784461501273	-10706691	-11121818	-4253886
38	38	1	.724161791091845	1.972718853313410	1.072903367899535	5025311	2956489	1384926
39	39	1	1.673343336344395	-1.872325973586463	-.584176250383749	-6084672	7876969	1486347
40	40	1	-2.196700920363390	-.959999321344127	-.190315540957447	2854369	-3492949	-1839057
41	41	1	3.190395180356910	1.244987889213476	.142474140297759	3810687	2407651	757070
42	42	1	.694300526164405	-1.600129949592770	-.836449467025460	-17588687	-15342879	-6949472
43	43	1	2.067515319755326	-.090931484202446	.096922703212531	-5574296	3463600	1353935
44	44	1	1.210078012501221	-2.321572188006328	-.954427277096214	-8124328	3172648	1102606
45	45	1	-2.245101000357266	-1.114552735422365	-.214167833487330	1493423	-4850455	-2097144
46	46	1	1.924893874686120	.861471764125440	.334065846063341	-1904587	3537579	1362623
47	47	1	-3.119792364948552	.000288708216581	.019032572645400	3364363	-4547735	-2315912
48	48	1	-.657721874566274	-3.107393764502802	-.949615093321054	-33450575	-7609691	-3560085
49	49	1	2.424557936866876	-.866850714845835	-.253887593556511	-697242	4927734	2083018
50	50	1	1.770451368360256	-.842207015381884	-.327593416215365	-5908327	8615212	3290624

L	NUM	QUAL	X, Y, Z COORDINATES AT JULIAN DATE 2445600.5			PERTURBATIONS IN 10-TH DEC		
1	1	1	2.491607920807077	-1.231629638465513	-1.090137197217494	-9421674	1403125	1585372
2	2	1	1.347098646165918	-3.033173546153304	.506477362424938	-7626740	-1053131	-9979276
3	3	1	1.957479458368215	.679200246636292	.048872164477855	-5595839	3844775	862600
4	4	1	1.209699071896836	2.152373392955923	.701127588680283	1431065	3170395	1362692
5	5	1	-1.814614228278350	-1.576588481577133	-.439299372569564	5242751	-698168	-569535
6	6	1	.798538366295411	-2.175952424245785	-.590781147460337	-10224097	-21178972	-11503008
7	7	1	-1.543948110060498	-2.217644032033988	-1.073842474862943	1922594	-8718284	-2602726
8	8	1	-.637461969397830	-2.216835877414198	-.801258659569040	-552735	-8711846	-4321902
9	9	1	-1.352439551837016	1.502718387591543	.852628105672927	1931358	5022593	2230707
10	10	1	-1.489389125537080	-2.131672698277171	-1.073908963573462	3953392	-5891149	-1760577
11	11	1	-2.134745314103981	1.491862485318947	.715969435041975	2280031	2730659	1132502
12	12	1	-.353019430206755	2.612182251570051	.836572592523083	2400288	4256615	1627053
13	13	1	.174345560539830	1.956961110627311	1.360734833438549	3065729	4429864	2104952
14	14	1	-1.692568232227444	1.295494474438545	.833955140355737	2121886	3741057	1625775
15	15	1	-2.551776858707854	-1.327107822482162	-1.260355795244293	5126560	-3314148	32823
16	16	1	-1.137429606916129	-2.726426210392489	-1.001303927945905	-800801	-19715275	-9070043
17	17	1	-1.723507156123368	1.853690953243387	.829619630656250	2501916	3413626	1413442
18	18	1	-2.61367772396883	-.934280027120496	-.022248746748979	5125354	-948937	-609573
19	19	1	-1.580928136668923	1.722354427864403	.675532158970015	1739401	4527576	1836785
20	20	1	2.230420208127185	.610579345338380	.269955634956167	-4117787	3347343	1369433
21	21	1	-2.763375475643571	.154649185234605	.228775574971157	4201102	396372	-42676
22	22	1	-2.783130729427906	-1.4688760695528772	-.105498937765527	5239846	-1013326	-1873375
23	23	1	2.604671085593509	-1.356411258782326	-1.193433866375358	-7779855	3331459	2921406
24	24	1	3.234904195487843	-1.251453146147398	-.586806181907786	-4907230	4568434	2110327
25	25	1	-.752942890633318	-1.776420885495448	-.327547889068024	3518531	-3822109	-376512
26	26	1	-.047433063669591	-2.197428214473206	-1.066714509590255	-1884337	-10402544	-4465999
27	27	1	-.624550008268112	1.699366239671889	.751472431916937	2448514	4881976	2033984
28	28	1	-2.372967500193569	.434734793267697	.356876290067458	2469953	1788706	788240
29	29	1	.061551890511859	2.078501440597705	1.177313682578635	2723083	4247362	1962899
30	30	1	-2.275211240496574	.959642221416146	.369324707847639	1804231	2520454	1019050
31	31	1	2.633035093917676	1.014213932076061	.178031613526820	456757	3243751	2283185
32	32	1	2.43783739416178	1.240808097649520	.593340671562295	-565312	3188092	1074450
33	33	1	-3.551769186179087	-.656305160411172	-.291159537484214	5978984	-1517465	-732779
34	34	1	-.305283721985607	-2.613224696179032	-.848968719920578	-2631642	-11832186	-5139267
35	35	1	.206218742800720	2.715577899106705	1.663698705071056	3384495	4460701	1854613
36	36	1	1.051523505905713	1.174727051937617	1.086656166335352	-2991511	2035806	1331800
37	37	1	1.113354208910323	-2.430343715208579	-1.219453567185120	-21089964	-21058279	-6720675
38	38	1	-2.589774673641969	-.057396677185964	-.346159173491541	3610605	404334	250471
39	39	1	1.444124421639920	2.054653916050341	.402916876722395	457768	2971768	1174316
40	40	1	1.540292239529954	-1.330066120732833	-.718894672977669	-6310460	-17686925	-7715980
41	41	1	.903099917290887	3.169494301175050	.415085098995162	3356632	4420242	1714148
42	42	1	.811793401576850	2.219522014017869	.869479176517718	-862536	1991819	1126137
43	43	1	-.476558547600526	2.338418112579888	.967173063885109	2540103	4447298	1839061
44	44	1	2.152065258549968	.937277813611050	.247416379236509	-2458806	3061398	1377990
45	45	1	1.616596615322976	-1.945779554327643	-.731995051768877	-9107536	-16840382	-7507843
46	46	1	-1.809944304081174	1.973655179610930	.761286605073085	2065258	3628941	1462331
47	47	1	-.414399900540012	-2.269927988597569	-1.226002257546320	-2540063	-16171632	-6125097
48	48	1	2.561489537809280	-1.841179318441071	-.540057591001620	-10174081	4240730	337512
49	49	1	-.072076134058882	2.376048218461918	1.076467676945076	2664883	4329417	1843936
50	50	1	-1.132777124440523	2.184935603906965	.829196629229717	1872665	4437095	1742783

E-11

LMSC-D420948

Appendix F
LIST OF COMPUTER PROGRAMS

Appendix F
LIST OF COMPUTER PROGRAMS

The following list of 119 computer programs developed for this study is divided into two categories: main programs and subroutines. All but three of the 32 main programs are new developments. Fifty-five of the 87 subroutines are new developments; the remaining 32 are modified subroutines taken from previously existing computer programs. A few subroutines have both single and double precision versions, and sometimes both are used. Any skipped numbers appearing in the sequence of computer programs is simply the result of omitting programs when they become obsolete in the development cycle.

MAIN PROGRAMS

CIN1	List Observations on Cincinnati Tape
CIN3	Reduce Observations on Cards and Cincinnati Tape
CIN4	Copy Cincinnati Observation Tape (Needed because of the frequent parity errors that occurred during the reading of the original tape.)
CIN5	Last Accurate Observation Each Minor Planet
CIN6	Copy Cincinnati Tape with Long Blocks
CIN7	Cincinnati Observation Tape to Binary Form
JPL1	Translate JPL Ephemeris Tape (Translates the JPL tape written with a UNIVAC to the CDC 6400 form.)
JPL2	Prepare Working Tape from JPL Ephemeris Tape (Prepares from the translated JPL ephemeris tape a working tape containing only the necessary data and covering only the specified interval of time.)
JPL8	Prepare Tape of Planetary Coordinates for 400-Day Integrations
LECPY	List, Punch or Tape BCD Cards

- NMP1 Status of Numbered Minor Planet Ephemerides
(The program computes the estimated ephemeris uncertainties for all of the numbered minor planets, and provides the listings of the results. It uses data from tapes prepared by other main programs of the NMP series.)
- NMP3 Prepare Tape of Data from Opposition Ephemerides
- NMP4 Prepare Tape of Numbered Minor Planet Names and Synonyms
- NMP6 Consolidate Numbered Minor Planet Tapes
- NMP7 Prepare Multi-Record Tape of Orbit Data
(Data selected by groups of 200 minor planets; costly large storage is avoided in this way.)
- NMP8 Prepare Tape of Orbit Information
- NMP9 Distribution of Ephemeris Uncertainties
(Computes and lists several statistics relating to the orbital elements and the ephemeris uncertainties.)
- NMP12 Integrate Coordinates of One Minor Planet
(Numerical integration of the rectangular coordinates with perturbations by specified major planets included. Any number of minor planets can be integrated in succession.)
- NMP13 Integrate Elliptic Motion
(The same as NMP12, but without perturbations by the major planets. Used in the development of NMP12, and to study the maximum size of step interval.)
- NMP15 Residuals for Minor Planets
(Computes the residuals of observed right ascensions and declinations. Rectangular coordinates of the minor planets are taken from a tape prepared during a numerical integration. Reduced observed positions are taken from another tape.)
- NMP16 Prepare Tape of Numbered Minor Planet Elements
(Consolidates elements and other data from earlier tapes.)
- NMP17 Consolidate Numbered Minor Planet Basic Data
(Forms the basic tape for initializing the new system.)
- NMP18 Prepare Tape of Ephemeris Positions Near Standard Date

- NMP20 Prepare Elements Tape for Integrations
- NMP22 Integrate Elliptic Motion for Group of Minor Planets
 (Used to prove the accuracy of the procedures and processes of NMP23. Elliptic motion permits essentially exact checks.)
- NMP23 Integrate Perturbed Motion for Group of Minor Planets
 (This is NMP22 with perturbed accelerations.)
- NMP24 Improve Elements from Nearby Ephemeris Positions
 (Provides provisional improvement of initial elements during initialization of new system. Intended for use only when more accurate and expensive procedures are not justified.)
- NMP25 Improve Elements from Recent Observed Positions
 (Provides provisional improvement of initial elements during initialization of the new system. Intended for use when expensive numerical integrations are not justified.)
- NMP26 Integrate Perturbed Motion of Group from any Epoch
 (The Epoch must be the same for all members of the group, but it need not be a 400-day date.)
- SUN01 Check and Tape Solar Coordinates
 (Basic program to provide solar coordinates in coded form.)
- SUN21 Solar Coordinates to Blocked Tape
 (Basic program to provide solar coordinates in binary form and ready to be interpolated for the date of an observation.)
- SUN30 List Solar Coordinates from Tape in SUN01 Form

SUBROUTINES

- PRNTA General Page Handling Routine
 (This subroutine is used in all main programs. It is machine dependent, and may be installation dependent. It prints page headings, column headings, page numbers; dates each page; prints elapsed times on each page; limits the number of lines on each page; provides vertical spacing where needed. Several entries provide for various other features, including automatic input of the headings and control parameters.)
- SUB09 Solve Kepler's Equation
- SUB42 Calendar Date to Julian Date

SUB43 Observatory Topocentric Constants

SUB46 Matrix for Rotating About N Axes

SUB86 Mean Obliquity of the Ecliptic

SUB100 Check Arithmetic Unit
 (Used at each step of the numerical integration to ensure the
 continued accuracy of the arithmetic unit.)

SB217 Julian Date to 3Q

SB138 Space Coordinates in Elliptic Orbit

SB155 4-Point Lagrange Interpolation of Q Quantities
 (Required in the interpolation of the solar coordinates.)

SB191 Space Coordinates and Velocities in Elliptic Orbit

SB236 Apply Constant Term of Stellar Aberration

SB245 Extended Gregorian Calendar Date to Julian Date

SB253 Ecliptic Angles to Equatorial PQR Matrix

SB282 Perturbed Two-Body Space Accelerations for One Point
 (The principal subroutine for the computation of the accelerations
 in the rectangular coordinates as required in the numerical inte-
 grations.)

SB332 Convert Alphanumeric Array to Floating Point Number
 (Provides for the printing of input data in its original form
 and for its conversion to binary numbers.)

SB339 Logical Sum of N Words

SB380 Mean Obliquity from Julian Date

SB381 Greenwich Mean Sidereal Time from Julian Date

SB384 Precession Matrix from Reference Equinox to Julian Date

SB385 Besselian Year to Julian Date

SB386 General Precession Matrix

SB396 Rotate Array with Direct or Transposed Matrix

SB400 Initialize Fixed Table

SB403 Place One Item at End of Fixed Table

SB405 Search of General Table with Argument in N Integer Cells

SB406 M Alphanumerical Characters to N Collating Integers

SB407 Place One Item in Sequential Table with Integer Arguments

SB408 Redimension Fixed Table

SB409 Convert Integer Representation to Decimal Fraction for Printing

SB410 Sort with M-Word Argument and N-Word Function

SB411 N Collating Integers to M Alphanumerical Characters

SB412 Rotate String of Words

SB413 Search Table with Sequential Integer Arguments in N Cells

SB416 Collect N Words for L Lines

SB424 Orbit Coordinates to Equatorial Coordinates

SB425 Julian Date to Precessed Space Coordinates in Ellipse

SB426 Reduce Least Squares Matrix

SB427 Solve Least Squares Equations

SB428 N-Point Lagrange Interpolation of M Functions

SB429 Topocentric Coordinates of Date from Sidereal Time

SB430 Topocentric Coordinates of Date from UT Julian Date

SB431 Topocentric Coordinates to Mean Equinox from Julian Date

SB432 Lagrange Interpolation Coefficients

SB434 Set Integer in Heading

SB435 Angle to Sexagesimal

SB436 Roots of Real Quadratic

SB437 Difference of Two Nearby Angles

SB438 Equatorial PQR Matrix to Ecliptic Angles

SB439 Julian Date to Besselian Year

SB440 Angle to Sexagesimal for Printing

SB441 Residuals from Perturbed Elliptic Orbit

SB442 Coordinates and Velocities to Elliptic Elements

SB447 I8 Integer to 2A4 Format

BFILL
BMOVE Bit Manipulation Package

CIN2 Table of Observatory Numbers – Cincinnati to LEC
(Converts the observatory numbers on the Cincinnati tape to those adopted in comet work.)

CMT6 Reduce One Observation with Solar Coordinates on Disk
(This is the principal subroutine for reducing observed positions. It does much of the actual computing and controls the subroutines that do the remainder.)

CONV1 Convert UNIVAC Fielddata to CDC Display Code

CONV2 Convert UNIVAC Integer to CDC Integer

CONV3 Convert UNIVAC Single-Precision Floating-Point Numbers to CDC

CONV4 Convert UNIVAC Double-Precision Floating-Point Numbers to CDC

CONV5 Logical Checksum of N UNIVAC Cells

DMPBC Dump Blank Common

EFT3 Set Table of Reductions to Ephemeris Time

EFT4 Look Up Reduction to Ephemeris Time

INTG2 Integration Setup
(Reads the controls and options that govern the numerical integration programs. Sets default values and initializes other parameters.)

INTG3 Integration, Initial Start
(Controls and carries out the repetitive processes that start the numerical integration from the coordinates and velocities at the date of osculation.)

- INTG4 Integration, Run
(Controls and carries out the full numerical integration processes at each step of the integration.)
- INTG5 Monitor Differences During Numerical Integration
- INTG6 Coordinates and Velocities for Restart
- INTG7 Setup for Coordinate Integration
- INTG8 Start Coordinate Integration
- INTG9 Coordinate Integration - Run
- JPL3 Planetary Coordinates in Numerical Integration
(Positions the tape containing the coordinates of the major planets and loads the coordinates required during the starting process of the numerical integration and then the coordinates required at each step of the integration that follows.)
- JPL4 Indirect Terms in Numerical Integration
(Computes and stores the indirect terms needed during the starting process and later at each step of the integration. These terms do not depend upon the coordinates being integrated, and so do not need recomputation during the predictor-corrector processes.)
- JPL5 Planetary Accelerations in Numerical Integration
(Computes and recomputes as needed all of the accelerations by the specified major planets at each step of the starting and running processes.)
- JPL6 Indirect Terms for One Date
- JPL7 Planetary Masses and Gravitation Factors
- NMP14 Interpolate Minor Planet Coordinates
(Positions the tape written by the numerical integration program and reads two adjacent records of 50 points each. The coordinates for the given Julian Date are interpolated with a Lagrange formula of specified order.)
- NMP19 Improve Orbit from One Observed Position
(Uses an observed or ephemeris position to improve the given orbit in the neighborhood of the date of the position. Adjusts the mean anomaly, and then rotates the orbit plane slightly to give exact fit.)

- NMP21 Perturbed Accelerations in 400-Day Block
(Computes the complete perturbed accelerations during one step of the numerical integration of a group of minor planets.)
- NTG10 Monitor Differences and Integration Convergence
(Monitors the accuracy and convergence during the numerical integration of a group of minor planets.)
- OBSY3 Set Table of Observatory Constants
(Reads punch-cards containing the latitude, longitude, and height of each observatory. For each observatory, it computes and sets in the table three constants needed to compute the topocentric coordinates.)
- OBSY4 Set Earth Constants
(Reads a punch-card with the constants that define the size and shape of the Earth and the units used. Required by OBSY3.)
- SET50 Input Elliptic Elements in Various Forms
(Needed to input the elements that define the initial osculating orbit.)
- SUN22 Interpolate Solar Coordinates from Tape
- TAN2 Arctangent with Range 0 to 360 Degrees