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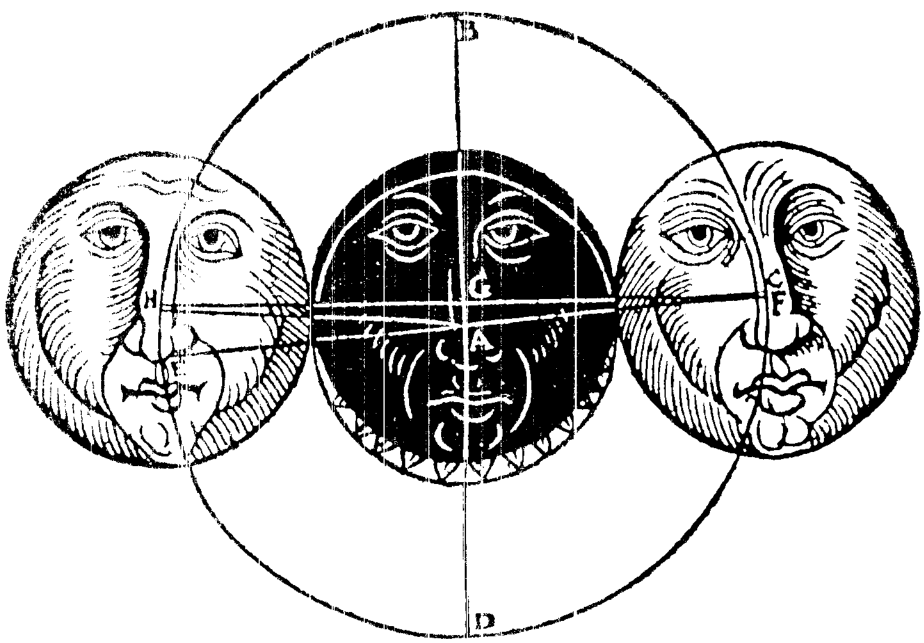
Fifty Year Canon of Lunar Eclipses: 1986–2035

Fred Espenak



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Fifty Year Canon of Lunar Eclipses: 1986–2035

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Office of Management
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Information Division

FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

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INTRODUCTION

Fifty Year Canon of Lunar Eclipses: 1986 - 2035 has been designed to compliment Fifty Year Canon of Solar Eclipses: 1986 - 2035 (NASA RP 1178 Revised). Like its companion volume, its primary goal is to provide a five decade reference of moderately detailed eclipse predictions and maps for use by the astronomical community. During the past century, Canon of Eclipses [Oppolzer, 1887] has served as an invaluable guide to both solar and lunar eclipses. However, with the advent of high speed electronic computers and modern ephemerides, eclipse predictions of far greater accuracy are possible today. Although such predictions are published annually in the Astronomical Almanac by the Nautical Almanac Office, this publication only becomes available three to six months before the beginning of each year. Canon of Lunar Eclipses: -2002 to +2526 [Meeus and Mucke, 1979] covers eclipses over an unprecedented 45 century interval. But due to the sheer number of eclipses covered in this work, the details for any one event must be rather brief. For instance, very little information is given concerning the visibility of an eclipse except for the geographic coordinates where the Moon appears at the zenith at greatest eclipse. While mathematical formulae are provided for calculating the Moon's altitude from any point on Earth, a map showing regions of visibility during each phase would convey a great deal of information at one glance.

Since Fifty Year Canon covers a much shorter time period, it's possible to include such maps in addition to diagrams showing the Moon's path through Earth's shadow. The graphical representation of this information provides the reader with an immediate appreciation of the geometry involved during each eclipse. Finally, data included with the figures and in the accompanying tables supplement the eclipse predictions.

Teachers, students, amateur astronomers and interested laymen should find this work useful as a general reference on eclipses during this century and the next. Lunar eclipses are one of the most dramatic and beautiful celestial phenomena visible to the naked eye. As such, they generate a great deal of interest among the general public and news media. Naturally, questions arise as to where a particular eclipse will be visible from, and when the next eclipse occurs. Unfortunately, there is very little information in print about the visibility of future eclipses and most references are obscure, not easily accessible and/or out of print. The eclipse path diagrams, world maps and detailed tables appearing in Fifty Year Canon should go far in addressing these issues.

ORGANIZATION OF THE CANON

Fifty Year Canon of Lunar Eclipses: 1986 - 2035 is composed of three major sections and two appendices. Section 1 is a catalog which lists the general characteristics of every lunar eclipse from 1901 through 2100. Section 2 graphically illustrates the path of the Moon through Earth's shadow and the global visibility of every lunar eclipse from 1901 through 2100. Finally, section 3 consists of detailed eclipse path figures and predicted contact times along with cylindrical projection maps (including political boundaries) of the global visibility for every lunar eclipse from 1986 through 2035.

Appendix A provides some general background on lunar eclipses and covers eclipse geometry, eclipse frequency and recurrence, enlargement of Earth's shadow, crater timings during eclipses, eclipse brightness estimation and time determination. Appendix B is a listing of a very simple Fortran program which can be used to predict the occurrence and general characteristics of lunar eclipses. It makes use of many approximations while maintaining a reasonable level of accuracy and reliability. The program is based primarily on algorithms devised by Meeus [1982] and the ample comments should make the program self-explanatory.

A detailed description of each section of Fifty Year Canon of Lunar Eclipses: 1986 - 2035 follows.

SECTION 1 - LUNAR ECLIPSE CATALOG: 1901 - 2100

Section 1 is a catalog which lists the general characteristics of every lunar eclipse during the two hundred year interval 1901 to 2100. During the first century, there are 230 eclipses of which 83 are penumbral, 66 are partial and 81 are total. The second century contains 230 eclipses of which 87 are penumbral, 58 are partial and 85 are total. In order to achieve a realistic frequency and type distribution of present eclipses, it's necessary to sample a period commensurate with the 18 year 11 day Saros cycle. The period from 1986 to 2003 contains 41 eclipses of which 15 (36.6%) are penumbral and 26 (63.4%) are umbral. Of these, 10 (24.4%) are partial and 16 (39.0%) are total. Since the Saros cycle is not static, these figures will change. For example, eclipses in Saros series 113 change from partial to penumbral in 2006.

The first two columns of the catalog list the Gregorian and Julian Dates of each eclipse. The Julian Date is the number of days elapsed since Greenwich Mean Noon on 1 January 4713 BC. Column 3 lists the value for delta T (seconds) used in the calculations. Delta T is the difference between Terrestrial Dynamical Time and Universal Time. For the period 1901 - 1985, the values for delta T are determined from observations. Beyond 1985, the values for delta T are extrapolated and are only approximate since fluctuations in the Earth's rotation rate are unpredictable (See: Appendix A - Time Determination). Column 4 characterizes the nature of the eclipse as follows:

T = Total Umbral Eclipse
P = Partial Umbral Eclipse
PN = Penumbral Eclipse
PNb = Beginning Penumbral Eclipse (first eclipse of Saros series)
PNe = Ending Penumbral Eclipse (last eclipse of Saros series)

The next column gives the Saros series to which the eclipse belongs. The Saros series numbers are consistent with those introduced by van den Bergh [1955]. Eclipses belonging to an even numbered Saros take place at the ascending node of the Moon's orbit (lunar ecliptic latitude decreases with each succeeding eclipse), while eclipses of an odd numbered Saros take place at the descending node (lunar ecliptic latitude increases with each succeeding eclipse). Column 6 lists the value GAMMA, which is defined as the minimum distance (equatorial Earth radii) of the Moon's center from the central axis of the shadow cone. This corresponds to the instant of middle or maximum eclipse. The sign of GAMMA indicates whether the Moon's center passes north (+) or south (-) of the shadow axis. Columns 7 and 8 give the penumbral and umbral magnitudes at the instant of middle eclipse. Eclipse magnitude is defined as the fraction of the Moon's diameter obscured by the penumbral or umbral shadow. For penumbral eclipses, the umbral magnitude is negative. For partial eclipses, the umbral magnitude is always greater than 0.00 and less than 1.00. For total eclipses, the umbral magnitude is greater than or equal to 1.00.

The Universal Time of middle eclipse (hours:minutes) is found in column 9. Middle eclipse is defined as the instant when the Moon passes closest to the axis of Earth's shadow. The semidurations (minutes) of the partial and total phases of each eclipse are listed in the next two columns. The semiduration of the partial phase is half of the time elapsed between the first and last external contacts of the Moon with Earth's umbral shadow. Similarly, the semiduration of the total phase is half of the time elapsed between the first and last internal contacts of the Moon with Earth's umbra. The start (U1) and end (U4) of the partial phase is calculated by subtracting or adding the partial semiduration to the instant of middle eclipse. Likewise, the start (U2) and end (U3) of the total phase is calculated by subtracting or adding the total semiduration to the instant of middle eclipse. Total eclipses have both partial and total phases while partial eclipses have partial phases only. Penumbral eclipses have neither partial nor total phases.

Columns 12 and 13 give the Moon's geocentric right ascension (hours) and declination (degrees) at middle eclipse, referred to the mean equinox of date. Finally, the last column lists the Greenwich Sidereal Time (hours) at 00:00 UT. The altitude and azimuth of the Moon during each phase of an eclipse depends on the time and the observer's geographic coordinates. Using the values tabulated in columns 12, 13 and 14, the Moon's altitude (a) and azimuth (A) may be calculated for any observer as follows:

$$h = 15\,(GST + UT - \alpha) - \lambda$$

$$a = \mathrm{ArcSin}\,[\mathrm{Sin}\,\delta\ \mathrm{Sin}\,\phi + \mathrm{Cos}\,\delta\ \mathrm{Cos}\,h\ \mathrm{Cos}\,\phi]$$

$$A = \mathrm{ArcTan}\,[-(\mathrm{Cos}\,\delta\ \mathrm{Sin}\,h)/(\mathrm{Sin}\,\delta\ \mathrm{Cos}\,\phi - \mathrm{Cos}\,\delta\ \mathrm{Cos}\,h\ \mathrm{Sin}\,\phi)]$$

where:	h	=	Hour Angle of the Moon
	a	=	Altitude
	A	=	Azimuth
	GST	=	Greenwich Sidereal Time at 00:00 UT

UT	=	Universal Time
α	=	Right Ascension of the Moon
δ	=	Declination of the Moon
λ	=	Longitude of Observer (West +, East -)
ϕ	=	Latitude of Observer (North +, South -)

These expressions do not include the effects of lunar parallax, atmospheric refraction or lunar orbital motion. At low altitudes, the errors may be on the order of 1°. Furthermore, the Moon's coordinates are strictly valid only at the time of middle eclipse. This may also lead to errors of about 1° for the beginning and end of the partial phase. With these caveats in mind, the expressions for altitude and azimuth are convenient and adequate for most planning purposes.

Finally, the geographic coordinates of the point where middle eclipse occurs in the zenith are:

$$\lambda = 15\ (GST + UT_m - \alpha)$$

$$\phi = \delta$$

where: UT_m = Universal Time at Middle Eclipse

SECTION 2 - ECLIPSE PATHS AND GLOBAL MAPS: 1901 - 2100

Diagrams of the Moon's path through Earth's shadow and maps of global visibility for every lunar eclipse are presented for the two hundred year period 1901 through 2100 (as tabulated in Section 1). The eclipse figures are plotted ten pair per page which typically covers four to five years. A typical pair are illustrated in Figure 2-1 for the total lunar eclipse of 17 August 1989.

Each diagram of the Moon's path through the shadow is plotted on the same scale with north at the top. The radius of the dark umbral shadow ranges from 0.64° to 0.78° and is surrounded by the lighter penumbral shadow with a radius of 1.17° to 1.31°. The axis of the shadow is marked by '+' and the cardinal points are plotted with respect to the axis. The ecliptic is represented by a dashed line which always passes through the shadow axis. The Moon's outline is plotted to scale at each of the umbral contacts as well as the external penumbral contacts and the instant of middle eclipse. Orbiting with an eastward motion, the Moon moves from right to left in each figure.

A heading at the top of every path diagram identifies the eclipse type (penumbral, partial or total), followed by the Gregorian date and the Universal Time of middle eclipse (hours:minutes) below the date. Directly beneath the eclipse type is the Saros series to which the eclipse belongs. In the lower left corner is the penumbral magnitude 'P' and in the lower right corner is the umbral magnitude 'U'.

To the right of each eclipse path diagram is an azimuthal equal-area or Lambert projection map of Earth, centered on the north pole. At any one instant, the Moon is always visible from one hemisphere of Earth. For each of the umbral contacts as well as the external penumbral contacts, the hemisphere facing the Moon is indicated as follows. For the external penumbral contacts, the hemispheres are plotted with a dotted line. For external umbral contacts (start and end of partial phase), a solid line delineates the appropriate hemispheres. Finally, for interior umbral contacts (start and end of total phase), a dark solid line marks the hemispheres.

The eclipse is not visible (Moon below the horizon) from the darkly shaded regions bordered by the external penumbral contact curves. All other regions of Earth will witness some phase of the eclipse. As seen from the north pole, Earth rotates in the counter-clockwise direction. If we fix our frame of reference with Earth, then the Moon and the hemisphere facing it rotate clockwise with time. Starting from any point in the shaded region and moving clockwise, the first hemispheric curve encountered would be for first external penumbral contact (P1). This would be followed by the hemispheres for first external umbral contact

(U1) and first internal umbral contact (U2). The final three hemispheric curves correspond to last internal umbral contact (U3), last external umbral contact (U4) and last external penumbral contact (P4).

The geographic point where the Moon appears in the zenith at middle eclipse is indicated with an '*'. It appears opposite the shaded or non-visibility zone and lies in a region bordered by the two external penumbral contact hemispheres. From this region, every phase of the eclipse is visible. For locations between this zone and the shaded zone, some phase of the eclipse is in progress at moonrise (clockwise from '*') or at moonset (counterclockwise from '*').

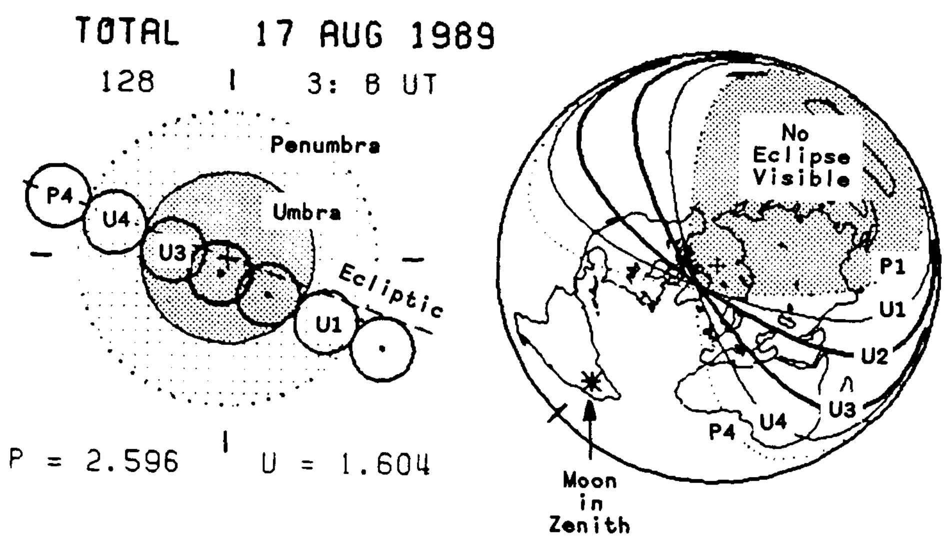

Figure 2-1

SECTION 3 - ECLIPSE PATHS AND WORLD MAPS: 1986 - 2035

Section 3 consists of a series of 114 path diagrams and visibility maps, one pair for every lunar eclipse during the fifty year interval 1986 to 2035. During this period, there are 42 penumbral eclipses and 72 umbral eclipses. The umbral eclipses consist of 28 partial and 44 total events.

Each lunar eclipse has two diagrams associated with it. The top figure shows the path of the Moon through Earth's penumbral and umbral shadows. Above and to the left of the path diagram is the time of middle eclipse (MID), followed by the penumbral (PMAG) and umbral (UMAG) magnitudes of the eclipse. The penumbral and umbral magnitudes are defined as the fraction of the Moon's diameter immersed in the penumbral and umbral shadows at middle eclipse. Below the eclipse magnitudes is the minimum distance (GAMMA) of the Moon's center from the shadow axis in units of Earth equarorial radii. To the upper right are the eclipse contact times (Universal Time or UT) which are defined as follows:

P1 = First external contact of the Moon with penumbra
(Penumbral eclipse begins)
U1 = First external contact of the Moon with umbra
(Partial eclipse begins)
U2 = First internal contact of the Moon with umbra
(Total eclipse begins)
U3 = Last internal contact of the Moon with umbra
(Total eclipse ends)
U4 = Last external contact of the Moon with umbra
(Partial eclipse ends)
P4 = Last external contact of the Moon with penumbra
(Penumbral eclipse ends)

In the lower left corner is the angle subtended between the Moon's center and the shadow axis at greatest eclipse (AXIS), and the angular radii of the penumbral (F1) and umbral (F2) shadows. The Moon's geocentric coordinates at maximum eclipse are given in the lower right corner. They consist of the right ascension (RA), declination (DEC), apparent semi-diameter (SD) and horizontal parallax (HP). Below, the Saros series of the eclipse is given, followed by a pair of numbers in parentheses. The first number identifies the sequence order of the eclipse in the series, while the second number is the total number of eclipses in the Saros series. The Julian Date (JD) at middle eclipse is given, followed by the extrapolated value of ΔT used in the calculations (ΔT is the difference between Terrestrial Dynamical Time and Universal Time).

The bottom map is a cylindrical equidistant projection of Earth which shows the regions of visibility for each stage of the eclipse. In particular, the moonrise/moonset terminator is plotted for each contact (i.e. - P1, U1, U2, U3, U4 and P4) and is labeled accordingly. The geographic position where the Moon is in the zenith at middle eclipse is indicated by an '*'. The region which is completely unshaded will observe the entire eclipse while the area shaded by solid diagonal lines will witness none of the event. The remaining shaded areas will experience moonrise or moonset while some phase of the eclipse is in progress. The shaded zones directly east of '*' will witness moonset before the eclipse ends while the shaded zones directly west of '*' will witness moonrise after the eclipse has begun.

ACCURACY OF THE EPHEMERIDES

The solar and lunar ephemerides used for these predictions are the same ones used in Fifty Year Canon of Solar Eclipses: 1986 - 2035. The solar ephemeris is based on the classic work of Newcomb [1895] and includes all planetary perturbation terms in longitude and latitude with arguments greater than 0.01 arc-seconds. The lunar ephemeris was developed primarily from the the work of Brown [1919] with modifications from Eckert, Jones and Clark [1954]. All solar perturbation terms in longitude and latitude with coefficients greater than 0.025 arc-seconds have been included. The cut-off for planetary perturbations is 0.025 and 0.01 in longitude and latitude respectively. Perturbations in lunar parallax include all terms with coefficients greater than 0.0010. Finally, all terms additive to the Moon's fundamental arguments with coefficients greater than 0.025 arc-seconds have been retained.

In order to determine the accuracy of these ephemerides, they have been compared against the Jet Propulsion Laboratory's Developmental Ephemeris 200 (or JPL DE-200) for 260 full moon dates over the interval 1980 through 2000. The mean differences and standard deviations of the solar and lunar ephemerides with the JPL DE-200 are as follows:

Comparison of Solar/Lunar Ephemerides with JPL DE-200

	RA Mean (sec)	RA S. Dev. (sec)	Dec Mean (arc-sec)	Dec S. Dev. (arc-sec)
Sun	+0.037	0.044	-0.029	0.172
Moon	–0.001	0.041	-0.006	0.399

The agreement between these ephemerides is quite good and actually exceeds the accuracy required for lunar eclipse predictions as follows. Due to the variable attenuation of the terrestrial atmosphere, the edge of Earth's shadow is rather poorly defined and limits the measurement of contact timings to a precision of about 0.1 minute. Since the Moon's mean angular velocity in right ascension with respect to the Sun (and Earth's shadow) is 0.0343 seconds per second, the combined uncertainties in right ascension can be transformed into an uncertainty of 1.1 seconds in contact times. However, this uncertainty is almost an order of magnitude smaller than the measurable precision of contact timings.

Positional shifts of the magnitude determined above are far too small to detect when plotted at the scale of the eclipse path figures presented in Sections 2 and 3. In fact, lunar occultation measurements including corrections for the lunar limb profile would be required to detect such small differences.

In the generation of eclipse predictions presented in the Fifty Year Canon of Lunar Eclipses, the author has applied a -0.6 arc-second correction to the Moon's ecliptic latitude. This takes into account the difference between the Moon's center of mass and center of figure. In accordance with the Astronomical Almanac, Earth's umbral and penumbral shadows have been increased by 2% to approximate the effects of an opaque layer in the middle atmosphere. Finally, a correction of -1.34 seconds has been applied to the lunar ephemeris to reconcile it with the FK4 equinox.

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FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

SECTION 1 - LUNAR ECLIPSE CATALOG: 1901 - 2100

CANON OF LUNAR ECLIPSES

DATE	JULIAN DATE	DELTA T	TYPE	SAROS	GAMMA	PENUMBRAL MAGNITUDE	UMBRAL MAGNITUDE	MIDDLE ECLIPSE (h:m)	PARTIAL S.DUR. (m)	TOTAL S.DUR. (m)	MOON RA	MOON DEC	GST (0 UT)
3 MAY 1901	2415508.27	-2.1	PN	110	-1.0102	1.0691	-0.0289	18:30.6	-	-	14.66	-16.52	14.73
27 OCT 1901	2415685.14	-1.0	P	115	0.9023	1.2088	0.2262	15:15.3	50.2	-	2.07	13.59	2.35
22 APR 1902	2415862.29	-0.2	T	120	-0.2681	2.4262	1.3373	18:52.6	112.8	42.7	13.96	-12.31	13.99
17 OCT 1902	2416039.75	0.4	T	125	0.2202	2.4766	1.4619	6: 3.3	106.6	44.9	1.41	9.13	1.65
12 APR 1903	2416216.51	1.0	P	130	0.4797	2.0135	0.9731	0:12.9	98.7	-	13.30	-7.73	13.27
6 OCT 1903	2416394.14	1.5	P	135	-0.5280	1.9392	0.8703	15:17.4	97.3	-	0.76	4.35	0.94
2 MAR 1904	2416541.63	1.9	PN	102	-1.4529	0.1998	-0.7853	3: 2.4	-	-	10.81	5.98	10.63
31 MAR 1904	2416571.02	2.0	PN	140	1.1666	0.7287	-0.2632	12:32.4	-	-	12.66	-2.99	12.56
24 SEP 1904	2416748.23	2.4	PN	145	-1.2838	0.5702	-0.5338	17:34.6	-	-	0.10	-0.62	0.21
19 FEB 1905	2416896.29	2.8	P	112	-0.7984	1.4060	0.4105	18:59.9	66.5	-	10.16	10.52	9.94
15 AUG 1905	2417072.65	3.5	P	117	0.8457	1.3515	0.2919	3:40.8	62.0	-	21.59	-13.54	21.53
9 FEB 1906	2417250.82	4.8	T	122	-0.1200	2.6762	1.6304	7:46.8	110.2	49.4	9.47	14.81	9.23
4 AUG 1906	2417427.04	5.4	T	127	0.0476	2.7868	1.7850	13: 0.0	109.9	51.1	20.91	-17.37	20.81
29 JAN 1907	2417605.07	6.0	P	132	0.6027	1.8199	0.7156	13:37.8	92.2	-	8.74	18.69	8.51
25 JUL 1907	2417781.68	6.6	P	137	-0.6925	1.5842	0.6207	4:22.3	78.9	-	20.23	-20.63	20.12
18 JAN 1908	2417959.06	7.3	PN	142	1.2939	0.5635	-0.5641	13:21.4	-	-	7.95	21.91	7.77
14 JUN 1908	2418107.09	7.8	PN	109	1.1056	0.8381	-0.1488	14: 6.4	-	-	17.51	-22.18	17.50
13 JUL 1908	2418136.40	7.9	PN	147	-1.4185	0.2542	-0.7135	21:33.7	-	-	19.52	-23.24	19.42
7 DEC 1908	2418283.41	8.5	PN	114	-1.0061	1.0599	-0.0049	21:54.9	-	-	4.96	21.72	5.08
4 JUN 1909	2418461.56	9.1	T	119	0.3757	2.2053	1.1628	1:28.6	105.6	30.7	16.76	-22.00	16.79
27 NOV 1909	2418637.87	9.7	T	124	-0.2714	2.3795	1.3712	8:54.4	103.7	41.0	4.17	20.79	4.38
24 MAY 1910	2418815.73	10.4	T	129	-0.3974	2.1889	1.1001	5:34.0	108.2	25.3	16.00	-20.95	16.06
17 NOV 1910	2418992.51	11.7	T	134	0.4088	2.1157	1.1306	0:20.6	97.0	25.8	3.42	19.12	3.68
13 MAY 1911	2419169.75	12.2	PN	139	-1.1413	0.8250	-0.2658	5:56.1	-	-	15.24	-19.08	15.33
6 NOV 1911	2419347.15	12.4	PN	144	1.1100	0.8408	-0.1676	15:36.4	-	-	2.68	16.80	2.98
1 APR 1912	2419494.43	13.0	P	111	0.9117	1.2138	0.1873	22:14.0	48.2	-	12.75	-3.90	12.66
26 SEP 1912	2419671.99	13.9	P	116	-0.9321	1.2036	0.1229	11:44.5	41.5	-	0.21	0.45	0.33
22 MAR 1913	2419849.00	14.7	T	121	0.1671	2.5590	1.5739	11:57.5	105.1	46.8	12.08	-0.36	11.96
15 SEP 1913	2420026.03	15.2	T	126	-0.2110	2.5383	1.4348	12:48.0	115.7	47.1	23.52	-3.32	23.59
12 MAR 1914	2420203.68	15.6	P	131	-0.5255	1.9013	0.9167	4:12.8	91.2	-	11.42	3.20	11.26
4 SEP 1914	2420380.08	15.7	P	136	0.5301	1.9386	0.8633	13:54.6	98.4	-	22.83	-6.95	22.86
31 JAN 1915	2420528.71	15.7	PN	103	1.5451	0.0710	-0.9938	4:57.4	-	-	8.88	19.05	8.62
1 MAR 1915	2420558.26	15.8	PN	141	-1.2573	0.5803	-0.4474	18:19.2	-	-	10.74	6.70	10.56
26 JUL 1915	2420705.02	16.0	PN	108	-1.3553	0.3798	-0.6069	12:24.3	-	-	20.34	-20.91	20.21
24 AUG 1915	2420734.39	16.3	PN	146	1.2436	0.6002	-0.4173	21:26.9	-	-	22.14	-10.18	22.14
20 JAN 1916	2420882.86	17.6	P	113	0.9146	1.2541	0.1371	8:39.3	44.4	-	8.09	21.17	7.89
15 JUL 1916	2421059.70	18.3	P	118	-0.5956	1.7600	0.8004	4:45.8	86.8	-	19.62	-22.19	19.51
8 JAN 1917	2421236.82	19.0	T	123	0.2415	2.4928	1.3686	7:44.4	114.1	44.2	7.27	22.52	7.15
4 JUL 1917	2421414.40	18.7	T	128	0.1419	2.6011	1.6242	21:38.7	106.9	48.5	18.89	-22.74	18.82
28 DEC 1917	2421590.91	18.4	T	133	-0.4485	2.0911	1.0103	9:46.2	101.6	7.3	6.44	22.89	6.42

CANON OF LUNAR ECLIPSES

DATE	JULIAN DATE	DELTA T	TYPE	SAROS	GAMMA	PENUMBRAL MAGNITUDE	UMBRAL MAGNITUDE	MIDDLE ECLIPSE (h:m)	PARTIAL S.DUR. (m)	TOTAL S.DUR. (m)	MOON RA	MOON DEC	GST (0 UT)
24 JUN 1918	2421768.94	18.9	P	138	0.9399	1.1628	0.1349	10:27.7	41.8	-	18.14	-22.54	18.12
17 DEC 1918	2421945.30	19.5	PN	143	-1.1036	0.8593	-0.1628	19: 5.6	-	-	5.64	22.26	5.71
15 MAY 1919	2422093.55	19.7	PN	110	-1.0820	0.9364	-0.1598	1:13.6	-	-	15.37	-19.53	15.45
7 NOV 1919	2422270.49	20.0	P	115	0.9247	1.1694	0.1835	23:44.1	45.5	-	2.79	17.13	3.07
3 MAY 1920	2422447.58	20.3	T	120	-0.3311	2.3078	1.2242	1:50.8	110.3	36.2	14.65	-15.84	14.71
27 OCT 1920	2422625.09	20.1	T	125	0.2502	2.4245	1.4040	14:11.2	106.1	43.0	2.10	13.05	2.38
22 APR 1921	2422801.82	20.6	T	130	0.4269	2.1070	1.0730	7:44.3	101.5	20.6	13.97	-11.65	13.99
16 OCT 1921	2422979.45	21.4	P	135	-0.4903	2.0116	0.9364	22:53.6	100.0	-	1.43	8.52	1.66
13 MAR 1922	2423126.98	21.8	PN	102	-1.4752	0.1572	-0.8245	11:28.4	-	-	11.49	1.69	11.35
11 APR 1922	2423156.36	21.8	PN	140	1.1229	0.8062	-0.1807	20:31.9	-	-	13.33	-7.17	13.28
6 OCT 1922	2423333.53	21.8	PN	145	-1.2350	0.6618	-0.4465	0:43.4	-	-	0.76	3.68	0.93
3 MAR 1923	2423481.65	21.9	P	112	-0.8175	1.3706	0.3758	3:31.8	64.1	-	10.85	6.45	10.66
26 AUG 1923	2423657.94	22.1	P	117	0.9133	1.2271	0.1684	10:39.4	47.6	-	22.26	-9.89	22.24
20 FEB 1924	2423836.17	22.4	T	122	-0.1338	2.6513	1.6046	16: 8.5	110.3	49.0	10.19	11.08	9.96
14 AUG 1924	2424012.35	22.5	T	127	0.1175	2.6578	1.6575	20:20.1	108.9	49.6	21.60	-14.16	21.53
8 FEB 1925	2424190.40	22.6	P	132	0.5921	1.8396	0.7349	21:41.9	93.3	-	9.48	15.46	9.23
4 AUG 1925	2424367.00	22.7	P	137	-0.6207	1.7159	0.7523	11:52.5	84.9	-	20.94	-17.95	20.84
28 JAN 1926	2424544.39	22.9	PN	142	1.2836	0.5816	-0.5444	21:20.0	-	-	8.72	19.36	8.49
25 JUN 1926	2424692.39	22.9	PN	109	1.1816	0.6997	-0.2894	21:24.7	-	-	18.26	-22.23	18.22
25 JUL 1926	2424721.71	22.9	PN	147	-1.3511	0.3791	-0.5911	4:59.8	-	-	20.26	-21.19	20.14
19 DEC 1926	2424868.76	22.9	PN	114	-1.0103	1.0511	-0.0117	6:19.7	-	-	5.76	22.45	5.81
15 JUN 1927	2425046.85	22.8	T	119	0.4544	2.0620	1.0173	8:24.3	101.9	9.9	17.51	-22.85	17.51
8 DEC 1927	2425223.23	22.7	T	124	-0.2797	2.3638	1.3561	17:34.7	103.3	40.3	4.96	22.40	5.10
3 JUN 1928	2425401.01	22.8	T	129	-0.3174	2.3354	1.2470	12: 9.5	112.0	38.1	16.74	-22.60	16.78
27 NOV 1928	2425577.88	22.9	T	134	0.3951	2.1419	1.1546	9: 1.3	97.6	27.9	4.19	21.51	4.40
23 MAY 1929	2425755.03	23.0	PN	139	-1.0650	0.9628	-0.1239	12:37.3	-	-	15.96	-21.47	16.04
16 NOV 1929	2425932.50	23.1	PN	144	1.0947	0.8713	-0.1420	0: 2.8	-	-	3.43	19.85	3.70
13 APR 1930	2426079.75	23.2	P	111	0.9547	1.1317	0.1115	5:58.5	37.4	-	13.42	-7.96	13.38
7 OCT 1930	2426257.30	23.3	P	116	-0.9813	1.1165	0.0298	19: 6.7	20.3	-	0.87	4.65	1.05
2 APR 1931	2426434.34	23.4	T	121	0.2044	2.4885	1.5078	20: 7.5	104.3	45.2	12.75	-4.61	12.68
26 SEP 1931	2426611.33	23.5	T	126	-0.2698	2.4320	1.3252	19:48.0	113.9	42.5	0.18	0.88	0.31
22 MAR 1932	2426789.02	23.6	P	131	-0.4957	1.9552	0.9722	12:32.2	93.1	-	12.09	-1.11	11.99
14 SEP 1932	2426965.38	23.5	P	136	0.4664	2.0555	0.9800	21: 0.5	102.4	-	23.48	-2.87	23.57
10 FEB 1933	2427114.05	23.5	PN	103	1.5599	0.0444	-1.0217	13:17.2	-	-	9.63	15.73	9.34
12 MAR 1933	2427143.61	23.5	PN	141	-1.2370	0.6177	-0.4102	2:32.6	-	-	11.41	2.48	11.29
5 AUG 1933	2427290.32	23.6	PN	108	-1.4215	0.2575	-0.7278	19:45.7	-	-	21.06	-18.27	20.93
4 SEP 1933	2427319.70	23.6	PN	146	1.1777	0.7207	-0.2960	4:51.9	-	-	22.81	-6.36	22.86
30 JAN 1934	2427468.20	23.7	P	113	0.9257	1.2338	0.1166	16:42.2	41.1	-	8.86	18.50	8.61
26 JUL 1934	2427645.01	23.7	P	118	-0.6680	1.6274	0.6673	12:15.2	80.9	-	20.36	-20.19	20.23
19 JAN 1935	2427822.16	23.6	T	123	0.2497	2.4768	1.3545	15:47.1	113.8	43.6	8.06	20.65	7.87

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16 JUL 1935	2427999.71	23.6	T	128	Ø.Ø672	2.7395	1.7599	4:59.7	1Ø7.9	5Ø.3	19.64	-21.46	19.54
8 JAN 1936	2428176.26	23.5	T	133	-Ø.4429	2.Ø998	1.Ø22Ø	18: 9.5	1Ø1.7	11.3	7.24	21.92	7.14
4 JUL 1936	2428354.23	23.6	P	138	Ø.8643	1.3Ø32	Ø.2719	17:25.Ø	58.7	-	18.9Ø	-22.Ø5	18.84
28 DEC 1936	242853Ø.66	23.6	PN	143	-1.Ø971	Ø.87Ø4	-Ø.1496	3:48.7	-	-	6.44	22.22	6.43
25 MAY 1937	2428678.83	23.7	PN	11Ø	-1.1582	Ø.7957	-Ø.2987	7:51.1	-	-	16.1Ø	-21.93	16.17
18 NOV 1937	2428855.85	23.9	P	115	Ø.9422	1.1389	Ø.1498	8:19.Ø	41.2	-	3.54	2Ø.11	3.8Ø
14 MAY 1938	2429Ø32.86	23.9	T	12Ø	-Ø.3994	2.18ØØ	1.1Ø14	8:43.6	1Ø7.Ø	25.2	15.36	-18.86	15.43
7 NOV 1938	242921Ø.44	23.9	T	125	Ø.2739	2.3839	1.3578	22:26.3	1Ø5.6	41.2	2.82	16.56	3.1Ø
3 MAY 1939	2429387.13	23.8	T	13Ø	Ø.3694	2.2Ø95	1.1817	15:11.3	1Ø4.Ø	31.7	14.66	-15.18	14.71
28 OCT 1939	2429564.78	23.9	P	135	-Ø.4581	2.Ø736	Ø.9923	6:36.3	1Ø2.1	-	2.12	12.42	2.38
23 MAR 194Ø	2429712.33	24.1	PN	1Ø2	-1.5Ø34	Ø.1Ø38	-Ø.8745	19:47.9	-	-	12.15	-2.67	12.Ø8
22 APR 194Ø	2429741.69	24.1	PN	14Ø	1.Ø742	Ø.8931	-Ø.Ø889	4:26.Ø	-	-	14.ØØ	-11.Ø8	14.Ø1
16 OCT 194Ø	2429918.83	24.7	PN	145	-1.1925	Ø.7419	-Ø.37Ø5	8: Ø.8	-	-	1.43	7.84	1.65
13 MAR 1941	243ØØ67.ØØ	25.Ø	P	112	-Ø.8437	1.3221	Ø.3281	11:55.4	6Ø.4	-	11.52	2.16	11.38
5 SEP 1941	243Ø243.24	25.Ø	P	117	Ø.9748	1.114Ø	Ø.Ø559	17:46.8	27.4	-	22.92	-5.9Ø	22.96
3 MAR 1942	243Ø421.52	25.1	T	122	-Ø.1546	2.6134	1.5661	Ø:21.5	11Ø.3	48.4	1Ø.88	7.ØØ	1Ø.68
26 AUG 1942	243Ø597.66	25.5	T	127	Ø.1817	2.5395	1.54Ø1	3:47.9	1Ø7.6	47.2	22.28	-1Ø.49	22.25
2Ø FEB 1943	243Ø775.73	25.8	P	132	Ø.5751	1.87Ø7	Ø.7662	5:37.9	95.Ø	-	1Ø.19	11.73	9.95
15 AUG 1943	243Ø952.31	26.Ø	P	137	-Ø.5534	1.8398	Ø.8755	19:28.3	89.7	-	21.64	-14.7Ø	21.56
9 FEB 1944	2431129.72	26.2	PN	142	1.2699	Ø.6Ø56	-Ø.518Ø	5:14.5	-	-	9.47	16.14	9.21
6 JUL 1944	2431277.69	26.3	PN	1Ø9	1.2598	Ø.5576	-Ø.4343	4:39.6	-	-	19.Ø1	-21.47	18.94
4 AUG 1944	24313Ø7.Ø2	26.3	PN	147	-1.2843	Ø.5Ø33	-Ø.47ØØ	12:26.4	-	-	2Ø.98	-18.48	2Ø.86
29 DEC 1944	2431454.12	26.3	PN	114	-1.Ø115	1.Ø477	-Ø.Ø127	14:49.1	-	-	6.57	22.25	6.53
25 JUN 1945	2431632.13	26.4	P	119	Ø.5371	1.9117	Ø.8643	15:13.9	96.8	-	18.27	-22.89	18.23
19 DEC 1945	24318Ø8.6Ø	26.9	T	124	-Ø.2845	2.3546	1.3479	2:2Ø.3	1Ø2.9	39.9	5.77	23.12	5.82
14 JUN 1946	2431986.28	27.2	T	129	-Ø.2324	2.4915	1.4Ø31	18:38.8	115.Ø	46.1	17.5Ø	-23.47	17.5Ø
8 DEC 1946	2432163.24	27.6	T	134	Ø.3864	2.1588	1.1695	17:48.Ø	97.9	29.1	4.98	23.1Ø	5.13
3 JUN 1947	243234Ø.3Ø	27.9	P	139	-Ø.985Ø	1.1Ø78	Ø.Ø248	19:15.2	18.5	-	16.71	-23.15	16.76
28 NOV 1947	2432517.86	28.1	PN	144	1.Ø838	Ø.8937	-Ø.1242	8:34.Ø	-	-	4.2Ø	22.22	4.43
23 APR 1948	2432665.Ø7	28.4	P	111	1.ØØ17	1.Ø425	Ø.Ø284	13:38.8	18.5	-	14.1Ø	-11.73	14.1Ø
18 OCT 1948	2432842.61	28.8	PN	116	-1.Ø246	1.Ø399	-Ø.Ø527	2:35.1	-	-	1.55	8.71	1.77
13 APR 1949	2433Ø19.67	29.Ø	T	121	Ø.2473	2.4Ø76	1.431Ø	4:1Ø.9	1Ø3.3	42.9	13.42	-8.69	13.4Ø
7 OCT 1949	2433196.62	29.2	T	126	-Ø.3219	2.338Ø	1.2281	2:56.4	111.8	36.8	Ø.84	5.Ø8	1.Ø3
2 APR 195Ø	2433374.36	29.3	T	131	-Ø.4599	2.Ø2ØØ	1.Ø385	2Ø:44.1	95.2	14.3	12.75	-5.37	12.71
26 SEP 195Ø	243355Ø.68	29.5	T	136	Ø.41Ø2	2.1588	1.Ø83Ø	4:16.6	1Ø5.3	22.7	Ø.14	1.33	Ø.29
21 FEB 1951	2433699.4Ø	29.7	PNe	1Ø3	1.58Ø6	Ø.ØØ69	-1.Ø6ØØ	21:29.2	-	-	1Ø.34	11.94	1Ø.Ø7
23 MAR 1951	2433728.94	29.8	PN	141	-1.21ØØ	Ø.6673	-Ø.36Ø8	1Ø:37.Ø	-	-	12.Ø8	-1.82	12.Ø1
17 AUG 1951	2433875.64	3Ø.1	PN	1Ø8	-1.4827	Ø.1449	-Ø.8395	3:14.2	-	-	21.76	-15.Ø7	21.65
15 SEP 1951	24339Ø5.Ø2	3Ø.1	PN	146	1.1188	Ø.8285	-Ø.1876	12:26.5	-	-	23.47	-2.27	23.58
11 FEB 1952	2434Ø53.53	3Ø.4	P	113	Ø.9415	1.2Ø46	Ø.Ø878	Ø:39.3	35.7	-	9.6Ø	15.2Ø	9.34

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5 AUG 1952	2434230.32	30.7	P	118	-0.7383	1.4991	0.5378	19:47.4	74.1	-	21.07	-17.53	20.95
29 JAN 1953	2434407.49	31.0	T	123	0.2606	2.4555	1.3358	23:47.3	113.3	42.7	8.82	18.02	8.59
26 JUL 1953	2434585.01	31.0	T	128	-0.0071	2.8515	1.8686	12:20.6	108.3	50.8	20.37	-19.45	20.26
19 JAN 1954	2434761.61	31.1	T	133	-0.4357	2.1111	1.0370	2:31.8	101.9	14.8	8.03	20.08	7.86
16 JUL 1954	2434939.51	31.3	P	138	0.7877	1.4456	0.4105	0:20.3	71.0	-	19.64	-20.77	19.55
8 JAN 1955	2435116.02	31.4	PN	143	-1.0908	0.8807	-0.1369	12:32.8	-	-	7.24	21.25	7.15
5 JUN 1955	2435264.10	31.6	PN	110	-1.2383	0.6480	-0.4450	14:22.9	-	-	16.85	-23.62	16.88
29 NOV 1955	2435441.21	31.5	P	115	0.9552	1.1167	0.1245	16:59.5	37.7	-	4.32	22.40	4.52
24 MAY 1956	2435618.15	31.7	P	120	-0.4725	2.0435	0.9698	15:31.3	102.7	-	16.09	-21.27	16.15
18 NOV 1956	2435795.78	31.9	T	125	0.2916	2.3542	1.3226	6:47.7	105.2	39.7	3.57	19.52	3.82
13 MAY 1957	2435972.44	32.1	T	130	0.3046	2.3253	1.3034	22:30.9	106.3	39.3	15.37	-18.20	15.43
7 NOV 1957	2436150.10	32.4	T	135	-0.4333	2.1221	1.0350	14:26.9	103.7	14.5	2.84	15.92	3.10
4 APR 1958	2436297.67	32.6	PNe	102	-1.5380	0.0385	-0.9363	3:59.7	-	-	12.82	-6.98	12.80
3 MAY 1958	2436327.01	32.6	P	140	1.0189	0.9924	0.0148	12:12.9	12.2	-	14.69	-14.60	14.73
27 OCT 1958	2436504.14	32.8	PN	145	-1.1572	0.8086	-0.3075	15:27.2	-	-	2.12	11.74	2.37
24 MAR 1959	2436652.34	33.0	P	112	-0.8757	1.2629	0.2699	20:11.4	55.3	-	12.19	-2.21	12.10
17 SEP 1959	2436828.54	33.1	PN	117	1.0296	1.0132	-0.0445	1: 3.0	-	-	23.58	-1.70	23.68
13 MAR 1960	2437006.85	33.3	T	122	-0.1798	2.5673	1.5197	8:27.8	110.2	47.4	11.55	2.70	11.40
5 SEP 1960	2437182.97	33.5	T	127	0.2421	2.4283	1.4295	11:21.2	105.9	43.8	22.94	-6.49	22.97
2 MAR 1961	2437361.06	33.9	P	132	0.5541	1.9089	0.8050	13:28.1	96.9	-	10.89	7.64	10.67
26 AUG 1961	2437537.63	34.1	P	137	-0.4895	1.9577	0.9920	3: 8.2	93.5	-	22.32	-11.02	22.28
19 FEB 1962	2437715.04	34.3	PN	142	1.2513	0.6382	-0.4824	13: 3.1	-	-	10.19	12.42	9.93
17 JUL 1962	2437863.00	34.5	PN	109	1.3371	0.4176	-0.5779	11:54.2	-	-	19.75	-19.92	19.66
15 AUG 1962	2437892.33	34.5	PN	147	-1.2212	0.6210	-0.3560	19:56.9	-	-	21.68	-15.22	21.58
9 JAN 1963	2438039.47	34.7	PN	114	-1.0128	1.0437	-0.0135	23:19.1	-	-	7.37	21.13	7.25
6 JUL 1963	2438217.42	35.1	P	119	0.6197	1.7617	0.7111	22: 2.4	90.4	-	19.02	-22.12	18.94
30 DEC 1963	2438393.96	35.4	T	124	-0.2890	2.3457	1.3404	11: 6.8	102.6	39.5	6.58	22.91	6.55
25 JUN 1964	2438571.55	35.6	T	129	-0.1461	2.6499	1.5612	1: 6.2	117.1	50.9	18.25	-23.53	18.21
19 DEC 1964	2438748.61	35.9	T	134	0.3801	2.1712	1.1805	2:37.3	98.2	30.0	5.80	23.80	5.85
14 JUN 1965	2438925.58	36.1	P	139	-0.9005	1.2610	0.1815	1:48.8	50.7	-	17.47	-24.06	17.48
8 DEC 1965	2439103.22	36.9	PN	144	1.0775	0.9074	-0.1147	17: 9.9	-	-	5.00	23.80	5.15
4 MAY 1966	2439250.38	37.3	PN	111	1.0554	0.9408	-0.0674	21:11.5	-	-	14.79	-15.07	14.82
29 OCT 1966	2439427.93	37.7	PN	116	-1.0600	0.9777	-0.1204	10:12.2	-	-	2.24	12.49	2.49
24 APR 1967	2439605.00	38.1	T	121	0.2973	2.3140	1.3413	12: 6.4	101.8	39.4	14.10	-12.45	14.12
18 OCT 1967	2439781.93	38.6	T	126	-0.3653	2.2599	1.1469	10:15.1	109.8	30.3	1.51	9.15	1.75
13 APR 1968	2439959.70	39.0	T	131	-0.4173	2.0974	1.1173	4:47.4	97.5	24.8	13.43	-9.44	13.43
6 OCT 1968	2440135.99	39.5	T	136	0.3605	2.2502	1.1740	11:41.9	107.4	31.9	0.80	5.54	1.01
2 APR 1969	2440314.27	39.9	PN	141	-1.1765	0.7288	-0.2994	18:32.4	-	-	12.75	-6.08	12.73
27 AUG 1969	2440460.95	40.1	PNe	108	-1.5406	0.0384	-0.9456	10:47.6	-	-	22.44	-11.43	22.37
25 SEP 1969	2440490.34	40.2	PN	146	1.0656	0.9260	-0.0899	20: 9.6	-	-	0.12	1.94	0.30

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21 FEB 1970	2440638.85	40.5	P	113	0.9620	1.1666	0.0508	8:30.0	27.2	-	10.31	11.43	10.06
17 AUG 1970	2440815.64	40.9	P	118	-0.8054	1.3769	0.4138	3:23.4	66.2	-	21.77	-14.33	21.67
10 FEB 1971	2440992.82	41.8	T	123	0.2741	2.4290	1.3127	7:44.6	112.8	41.5	9.56	14.75	9.32
6 AUG 1971	2441170.32	42.4	T	128	-0.0794	2.7208	1.7340	19:43.1	108.2	50.2	21.08	-16.79	20.98
30 JAN 1972	2441346.95	42.9	T	133	-0.4273	2.1244	1.0545	10:53.3	102.1	18.0	8.80	17.46	8.59
26 JUL 1972	2441524.80	43.1	P	138	0.7118	1.5872	0.5477	7:15.6	80.5	-	20.36	-18.77	20.27
18 JAN 1973	2441701.39	43.4	PN	143	-1.0846	0.8905	-0.1241	21:17.2	-	-	8.03	19.40	7.88
15 JUN 1973	2441849.37	43.9	PN	110	-1.3216	0.4948	-0.5972	20:49.9	-	-	17.61	-24.52	17.60
15 JUL 1973	2441878.99	44.0	PNb	148	1.5180	0.1302	-0.9538	11:38.5	-	-	19.62	-20.18	19.55
10 DEC 1973	2442026.57	44.4	P	115	0.9644	1.1011	0.1063	1:44.4	34.9	-	5.12	23.87	5.24
4 JUN 1974	2442203.43	44.9	P	120	-0.5487	1.9013	0.8321	22:16.0	97.3	-	16.84	-22.98	16.86
29 NOV 1974	2442381.13	45.4	T	125	0.3053	2.3314	1.2950	15:13.3	105.0	38.4	4.34	21.78	4.54
25 MAY 1975	2442557.74	45.9	T	130	0.2369	2.4468	1.4305	5:48.0	108.1	44.6	16.09	-20.61	16.15
18 NOV 1975	2442735.43	46.3	T	135	-0.4135	2.1611	1.0687	22:23.4	105.0	20.6	3.58	18.87	3.82
13 MAY 1976	2442912.33	46.8	P	140	0.9587	1.1007	0.1272	19:54.4	38.3	-	15.40	-17.60	15.45
6 NOV 1976	2443089.46	47.4	PN	145	-1.1277	0.8644	-0.2551	23: 1.2	-	-	2.83	15.24	3.09
4 APR 1977	2443237.68	47.8	P	112	-0.9148	1.1908	0.1985	4:18.3	47.9	-	12.86	-6.51	12.82
27 SEP 1977	2443413.85	48.3	PN	117	1.0767	0.9267	-0.1308	8:29.3	-	-	0.23	2.60	0.40
24 MAR 1978	2443592.18	48.8	T	122	-0.2140	2.5047	1.4570	16:22.4	109.7	45.8	12.22	-1.65	12.12
16 SEP 1978	2443768.30	49.3	T	127	0.2949	2.3315	1.3328	19: 4.1	104.1	39.8	23.60	-2.28	23.69
13 MAR 1979	2443946.38	49.8	P	132	0.5255	1.9609	0.8581	21: 8.0	99.3	-	11.56	3.36	11.39
6 SEP 1979	2444122.95	50.2	T	137	-0.4306	2.0667	1.0992	10:54.2	96.4	22.7	22.98	-7.00	23.00
1 MAR 1980	2444300.37	50.7	PN	142	1.2271	0.6806	-0.4363	20:45.2	-	-	10.88	8.34	10.65
27 JUL 1980	2444448.30	51.0	PN	109	1.4139	0.2787	-0.7208	19: 8.1	-	-	20.47	-17.67	20.37
26 AUG 1980	2444477.65	51.1	PN	147	-1.1609	0.7337	-0.2476	3:30.5	-	-	22.35	-11.51	22.30
20 JAN 1981	2444624.83	51.4	PN	114	-1.0142	1.0393	-0.0141	7:49.9	-	-	8.15	19.14	7.97
17 JUL 1981	2444802.70	51.8	P	119	0.7046	1.6078	0.5535	4:46.8	82.1	-	19.76	-20.56	19.66
9 JAN 1982	2444979.33	52.2	T	124	-0.2915	2.3400	1.3366	19:55.8	102.4	39.3	7.39	21.77	7.27
6 JUL 1982	2445156.81	52.6	T	129	-0.0579	2.8120	1.7226	7:30.9	118.3	53.4	19.01	-22.77	18.93
30 DEC 1982	2445333.98	53.0	T	134	0.3758	2.1795	1.1878	11:28.7	98.4	30.5	6.61	23.56	6.57
25 JUN 1983	2445510.85	53.4	P	139	-0.8153	1.4159	0.3394	8:22.3	67.8	-	18.23	-24.14	18.19
20 DEC 1983	2445688.58	53.8	PN	144	1.0747	0.9143	-0.1115	1:49.0	-	-	5.82	24.48	5.87
15 MAY 1984	2445835.70	54.0	PN	111	1.1130	0.8324	-0.1703	4:40.2	-	-	15.50	-17.87	15.54
13 JUN 1984	2445865.10	54.0	PNb	149	-1.5241	0.0900	-0.9363	14:25.7	-	-	17.46	-24.69	17.47
8 NOV 1984	2446013.25	54.3	PN	116	-1.0900	0.9253	-0.1781	17:55.2	-	-	2.96	15.85	3.21
4 MAY 1985	2446190.33	54.5	T	121	0.3519	2.2120	1.2428	19:56.4	99.9	34.3	14.80	-15.80	14.84
28 OCT 1985	2446367.24	54.8	T	126	-0.4022	2.1936	1.0780	17:42.3	107.9	22.5	2.21	12.95	2.47
24 APR 1986	2446545.03	55.1	T	131	-0.3683	2.1869	1.2079	12:42.6	99.8	32.3	14.11	-13.21	14.15
17 OCT 1986	2446721.30	55.3	T	136	0.3189	2.3266	1.2501	19:17.9	108.8	37.3	1.48	9.62	1.73
14 APR 1987	2446899.60	55.6	PN	141	-1.1365	0.8023	-0.2261	2:18.9	-	-	13.42	-10.15	13.45

CANON OF LUNAR ECLIPSES

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7 OCT 1987	2447075.67	55.9	PN	146	1.0190	1.0115	-0.0043	4: 1.5	-	-	0.79	6.15	1.02
3 MAR 1988	2447224.18	56.1	P	113	0.9885	1.1172	0.0030	16:12.7	4.4	-	11.00	7.35	10.78
27 AUG 1988	2447400.96	56.4	P	118	-0.8681	1.2630	0.2976	11: 4.5	57.1	-	22.44	-10.69	22.39
20 FEB 1989	2447578.15	56.7	T	123	0.2933	2.3917	1.2794	15:35.3	112.0	39.7	10.27	11.01	10.04
17 AUG 1989	2447755.63	57.0	T	128	-0.1489	2.5956	1.6042	3: 8.2	107.6	48.4	21.77	-13.59	21.70
9 FEB 1990	2447932.30	57.3	T	133	-0.4149	2.1447	1.0797	19:11.1	102.6	21.7	9.53	14.21	9.31
6 AUG 1990	2448110.09	57.6	P	138	0.6376	1.7256	0.6813	14:12.3	88.2	-	21.07	-16.11	20.99
30 JAN 1991	2448286.75	58.0	PN	143	-1.0754	0.9057	-0.1055	5:58.6	-	-	8.79	16.78	8.60
27 JUN 1991	2448434.64	58.3	PN	110	-1.4062	0.3391	-0.7521	3:14.7	-	-	18.38	-24.60	18.32
26 JUL 1991	2448464.26	58.3	PN	148	1.4372	0.2797	-0.8067	18: 7.8	-	-	20.34	-18.20	20.26
21 DEC 1991	2448611.94	58.6	P	115	0.9708	1.0905	0.0934	10:33.0	32.8	-	5.94	24.42	5.97
15 JUN 1992	2448788.71	59.0	P	120	-0.6287	1.7525	0.6874	4:57.0	90.4	-	17.59	-23.90	17.58
9 DEC 1992	2448966.49	59.4	T	125	0.3143	2.3173	1.2763	23:44.0	104.9	37.4	5.14	23.22	5.26
4 JUN 1993	2449143.04	59.7	T	130	0.1639	2.5782	1.5669	13: 0.4	109.4	48.4	16.84	-22.31	16.87
29 NOV 1993	2449320.77	60.1	T	135	-0.3995	2.1893	1.0920	6:26.0	105.9	23.8	4.35	21.12	4.54
25 MAY 1994	2449497.65	60.5	P	140	0.8934	1.2188	0.2489	3:30.4	52.9	-	16.12	-19.99	16.17
18 NOV 1994	2449674.78	60.8	PN	145	-1.1049	0.9077	-0.2148	6:43.9	-	-	3.57	18.20	3.81
15 APR 1995	2449823.01	61.1	P	112	-0.9593	1.1089	0.1172	12:18.1	37.2	-	13.53	-10.63	13.55
8 OCT 1995	2449999.17	61.5	PN	117	1.1179	0.8511	-0.2063	16: 4.1	-	-	0.89	6.88	1.12
4 APR 1996	2450177.51	61.9	T	122	-0.2533	2.4327	1.3848	0: 9.8	109.0	43.3	12.89	-5.95	12.84
27 SEP 1996	2450353.62	62.2	T	127	0.3426	2.2441	1.2452	2:54.3	102.1	35.1	0.26	2.03	0.41
24 MAR 1997	2450531.69	62.6	P	132	0.4899	2.0254	0.9240	4:39.4	102.0	-	12.23	-1.00	12.11
16 SEP 1997	2450708.28	63.0	T	137	-0.3768	2.1665	1.1968	18:46.6	98.7	31.2	23.64	-2.78	23.72
13 MAR 1998	2450885.68	63.4	PN	142	1.1965	0.7347	-0.3781	4:20.1	-	-	11.56	4.05	11.37
8 AUG 1998	2451033.60	63.7	PN	109	1.4876	0.1458	-0.8582	2:24.9	-	-	21.17	-14.80	21.09
6 SEP 1998	2451062.97	63.7	PN	147	-1.1058	0.8371	-0.1488	11:10.1	-	-	23.02	-7.49	23.02
31 JAN 1999	2451210.18	64.0	PN	114	-1.0191	1.0282	-0.0209	16:17.5	-	-	8.91	16.41	8.70
28 JUL 1999	2451387.98	64.4	P	119	0.7863	1.4600	0.4016	11:33.7	71.7	-	20.48	-18.30	20.38
21 JAN 2000	2451564.70	64.8	T	124	-0.2957	2.3312	1.3302	4:43.5	102.2	39.0	8.17	19.76	7.99
16 JUL 2000	2451742.08	65.2	T	129	0.0301	2.8636	1.7731	13:55.5	118.5	53.7	19.75	-21.22	19.65

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9 JAN 2001	2451919.35	65.6	T	134	0.3720	2.1867	1.1944	20:20.6	98.7	31.0	7.42	22.38	7.30
5 JUL 2001	2452096.12	66.0	P	139	-0.7288	1.5733	0.4995	14:55.3	80.1	-	18.99	-23.41	18.91
30 DEC 2001	2452273.94	66.3	PN	144	1.0732	0.9186	-0.1104	10:29.3	-	-	6.64	24.21	6.60
26 MAY 2002	2452421.00	66.7	PN	111	1.1759	0.7144	-0.2832	12: 3.4	-	-	16.23	-20.03	16.26
24 JUN 2002	2452450.39	66.7	PN	149	-1.4441	0.2347	-0.7872	21:27.1	-	-	18.22	-24.78	18.19
20 NOV 2002	2452598.57	67.0	PN	116	-1.1127	0.8862	-0.2219	1:46.5	-	-	3.71	18.65	3.93
16 MAY 2003	2452775.65	67.4	T	121	0.4123	2.0996	1.1335	3:40.1	97.4	26.3	15.51	-18.59	15.56
9 NOV 2003	2452952.56	67.8	T	126	-0.4320	2.1401	1.0221	1:18.5	106.1	11.8	2.93	16.33	3.19
4 MAY 2004	2453130.36	68.2	T	131	-0.3132	2.2877	1.3093	20:30.2	102.1	38.2	14.81	-16.54	14.87
28 OCT 2004	2453306.63	68.6	T	136	0.2847	2.3896	1.3129	3: 4.0	109.8	40.7	2.18	13.44	2.45
24 APR 2005	2453484.91	69.0	PN	141	-1.0886	0.8904	-0.1384	9:54.8	-	-	14.11	-13.91	14.17
17 OCT 2005	2453661.00	69.4	P	146	0.9797	1.0837	0.0678	12: 3.2	28.8	-	1.47	10.25	1.74
14 MAR 2006	2453809.49	69.7	PN	113	1.0210	1.0565	-0.0558	23:47.4	-	-	11.68	3.09	11.50
7 SEP 2006	2453986.29	70.1	P	118	-0.9261	1.1579	0.1897	18:51.2	46.2	-	23.11	-6.74	23.11
3 MAR 2007	2454163.47	70.5	T	123	0.3174	2.3452	1.2375	23:20.8	110.9	37.1	10.96	6.93	10.76
28 AUG 2007	2454340.94	70.9	T	128	-0.2145	2.4778	1.4815	10:37.2	106.5	45.4	22.45	-9.96	22.42
21 FEB 2008	2454517.64	71.3	T	133	-0.3993	2.1707	1.1110	3:25.9	103.1	25.4	10.25	10.47	10.03
16 AUG 2008	2454695.38	71.8	P	138	0.5648	1.8620	0.8124	21:10.0	94.5	-	21.76	-12.92	21.71
9 FEB 2009	2454872.11	72.2	PN	143	-1.0642	0.9244	-0.0830	14:38.1	-	-	9.53	13.53	9.32
7 JUL 2009	2455019.90	72.5	PN	110	-1.4915	0.1825	-0.9084	9:38.5	-	-	19.14	-23.86	19.03
6 AUG 2009	2455049.53	72.6	PN	148	1.3575	0.4276	-0.6617	0:39.0	-	-	21.05	-15.58	20.98
31 DEC 2009	2455197.31	72.9	P	115	0.9765	1.0808	0.0820	19:22.5	30.8	-	6.76	24.02	6.69
26 JUN 2010	2455373.99	73.3	P	120	-0.7090	1.6033	0.5420	11:38.3	81.9	-	18.35	-24.00	18.30
21 DEC 2010	2455551.85	73.7	T	125	0.3213	2.3064	1.2614	8:16.8	104.8	36.7	5.95	23.75	5.99
15 JUN 2011	2455728.34	74.1	T	130	0.0899	2.7117	1.7050	20:12.5	110.2	50.6	17.59	-23.23	17.58
10 DEC 2011	2455906.11	74.6	T	135	-0.3883	2.2120	1.1105	14:31.6	106.6	26.0	5.14	22.55	5.26
4 JUN 2012	2456082.96	75.0	P	140	0.8250	1.3429	0.3760	11: 3.1	63.8	-	16.86	-21.67	16.89
28 NOV 2012	2456260.11	75.4	PN	145	-1.0870	0.9417	-0.1831	14:32.8	-	-	4.33	20.46	4.53
25 APR 2013	2456408.34	75.8	P	112	-1.0121	1.0118	0.0205	20: 7.4	14.9	-	14.21	-14.43	14.27
25 MAY 2013	2456437.67	75.8	PNb	150	1.5352	0.0403	-0.9279	4: 9.9	-	-	16.15	-19.41	16.19
18 OCT 2013	2456584.49	76.2	PN	117	1.1507	0.7908	-0.2666	23:50.1	-	-	1.57	11.00	1.84
15 APR 2014	2456762.82	76.6	T	122	-0.3016	2.3440	1.2959	7:45.5	107.8	39.4	13.56	-10.05	13.56
8 OCT 2014	2456938.96	77.0	T	127	0.3825	2.1710	1.1717	10:54.4	100.2	29.9	0.92	6.31	1.13
4 APR 2015	2457117.00	77.5	T	132	0.4461	2.1052	1.0053	12: 0.1	104.9	4.3	12.89	-5.29	12.83
28 SEP 2015	2457293.62	77.9	T	137	-0.3297	2.2543	1.2820	2:47.0	100.4	36.4	0.29	1.53	0.44
23 MAR 2016	2457470.99	78.3	PN	142	1.1593	0.8008	-0.3075	11:47.0	-	-	12.22	-0.31	12.09
18 AUG 2016	2457618.91	78.7	PNe	109	1.5594	0.0166	-0.9925	9:42.4	-	-	21.85	-11.42	21.81
16 SEP 2016	2457648.29	78.7	PN	147	-1.0550	0.9329	-0.0580	18:54.2	-	-	23.67	-3.26	23.74
11 FEB 2017	2457795.53	79.1	PN	114	-1.0254	1.0141	-0.0302	0:43.7	-	-	9.64	13.05	9.42
7 AUG 2017	2457973.26	79.5	P	119	0.8668	1.3145	0.2515	18:20.3	58.1	-	21.18	-15.42	21.10

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31 JAN 2018	2458150.06	80.0	T	124	-0.3012	2.3196	1.3214	13:29.6	101.9	38.5	8.93	17.00	8.71
27 JUL 2018	2458327.35	80.4	T	129	0.1166	2.7056	1.6137	20:21.5	117.8	52.0	20.47	-18.97	20.36
21 JAN 2019	2458504.72	80.9	T	134	0.3686	2.1931	1.2005	5:12.1	98.9	31.5	8.21	20.34	8.02
16 JUL 2019	2458681.40	81.3	P	139	-0.6432	1.7293	0.6576	21:30.5	89.4	-	19.73	-21.88	19.63
10 JAN 2020	2458859.30	81.8	PN	144	1.0728	0.9208	-0.1109	19: 9.8	-	-	7.45	23.00	7.32
5 JUN 2020	2459006.31	82.1	PN	111	1.2405	0.5936	-0.3994	19:24.9	-	-	16.97	-21.45	16.98
5 JUL 2020	2459035.69	82.2	PN	149	-1.3640	0.3796	-0.6385	4:29.8	-	-	18.99	-24.05	18.91
30 NOV 2020	2459183.91	82.6	PN	116	-1.1309	0.8548	-0.2575	9:42.6	-	-	4.48	20.75	4.65
26 MAY 2021	2459360.97	83.0	T	121	0.4773	1.9790	1.0155	11:18.5	94.2	8.7	16.24	-20.74	16.28
19 NOV 2021	2459537.88	83.5	P	126	-0.4552	2.0984	0.9786	9: 2.7	104.6	-	3.67	19.15	3.91
16 MAY 2022	2459715.68	83.9	T	131	-0.2533	2.3973	1.4193	4:11.3	104.1	42.9	15.52	-19.33	15.59
8 NOV 2022	2459891.96	84.4	T	136	0.2571	2.4401	1.3635	10:58.9	110.4	42.9	2.90	16.85	3.17
5 MAY 2023	2460070.23	84.9	PN	141	-1.0351	0.9889	-0.0405	17:22.7	-	-	14.81	-17.24	14.89
28 OCT 2023	2460246.34	85.3	P	146	0.9473	1.1432	0.1273	20:13.8	39.3	-	2.16	14.08	2.46
25 MAR 2024	2460394.80	85.7	PN	113	1.0609	0.9821	-0.1278	7:12.6	-	-	12.34	-1.20	12.22
18 SEP 2024	2460571.61	86.2	P	118	-0.9792	1.0622	0.0908	2:44.0	32.2	-	23.77	-2.59	23.83
14 MAR 2025	2460748.79	86.6	T	123	0.3484	2.2858	1.1831	6:58.5	109.5	33.1	11.64	2.68	11.48
7 SEP 2025	2460926.26	87.1	T	128	-0.2751	2.3694	1.3676	18:11.5	105.1	41.5	23.11	-6.00	23.14
3 MAR 2026	2461102.98	87.6	T	133	-0.3765	2.2095	1.1557	11:33.4	104.0	29.6	10.94	6.40	10.75
28 AUG 2026	2461280.68	88.0	P	138	0.4965	1.9900	0.9347	4:12.6	99.5	-	22.44	-9.30	22.43
20 FEB 2027	2461457.47	88.5	PN	143	-1.0482	0.9515	-0.0516	23:12.6	-	-	10.24	9.79	10.04
18 JUL 2027	2461605.17	88.9	PNe	110	-1.5757	0.0279	-1.0629	16: 2.7	-	-	19.88	-22.34	19.75
17 AUG 2027	2461634.80	89.0	PN	148	1.2800	0.5713	-0.5211	7:13.4	-	-	21.73	-12.41	21.70
12 JAN 2028	2461782.68	89.4	P	115	0.9816	1.0722	0.0720	4:12.7	28.9	-	7.56	22.69	7.41
6 JUL 2028	2461959.26	89.9	P	120	-0.7902	1.4526	0.3945	18:19.4	71.3	-	19.11	-23.29	19.02
31 DEC 2028	2462137.20	90.3	T	125	0.3257	2.3001	1.2516	16:51.7	104.9	36.2	6.77	23.33	6.71
26 JUN 2029	2462313.64	90.8	T	130	0.0126	2.8515	1.8488	3:21.9	110.3	51.4	18.35	-23.34	18.30
20 DEC 2029	2462491.45	91.3	T	135	-0.3812	2.2268	1.1217	22:41.6	107.1	27.3	5.95	23.09	5.99
15 JUN 2030	2462668.27	91.8	P	140	0.7536	1.4725	0.5080	18:33.0	72.7	-	17.61	-22.56	17.61
9 DEC 2030	2462845.44	92.3	PN	145	-1.0733	0.9677	-0.1588	22:27.3	-	-	5.12	21.92	5.25
7 MAY 2031	2462993.66	92.7	PN	112	-1.0694	0.9067	-0.0847	3:50.5	-	-	14.92	-17.79	14.99
5 JUN 2031	2463022.99	92.8	PN	150	1.4734	0.1537	-0.8143	11:43.8	-	-	16.89	-21.05	16.91
30 OCT 2031	2463169.82	93.2	PN	117	1.1773	0.7420	-0.3152	7:45.1	-	-	2.27	14.83	2.56
25 APR 2032	2463348.14	93.7	T	122	-0.3556	2.2451	1.1966	15:13.3	106.1	33.2	14.24	-13.83	14.28
18 OCT 2032	2463524.29	94.2	T	127	0.4169	2.1082	1.1084	19: 2.1	98.4	24.1	1.60	10.42	1.85
14 APR 2033	2463702.30	94.7	T	132	0.3955	2.1971	1.0988	19:12.3	108.0	25.0	13.56	-9.39	13.55
8 OCT 2033	2463878.96	95.2	T	137	-0.2889	2.3305	1.3554	10:54.8	101.7	39.9	0.96	5.81	1.16
3 APR 2034	2464056.30	95.7	PN	142	1.1145	0.8805	-0.2231	19: 5.4	-	-	12.88	-4.59	12.81
28 SEP 2034	2464233.62	96.2	P	147	-1.0111	1.0160	0.0198	2:46.0	14.6	-	0.33	1.05	0.46
22 FEB 2035	2464380.88	96.6	PN	114	-1.0367	0.9908	-0.0482	9: 4.6	-	-	10.35	9.23	10.14

CANON OF LUNAR ECLIPSES

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19 AUG 2035	2464558.55	97.1	P	119	0.9432	1.1768	0.1089	1:10.6	38.9	-	21.86	-12.03	21.82
11 FEB 2036	2464735.43	97.7	T	124	-0.3108	2.3004	1.3053	22:11.5	101.5	37.7	9.67	13.62	9.44
7 AUG 2036	2464912.62	98.2	T	129	0.2003	2.5530	1.4593	2:50.9	116.2	48.1	21.18	-16.10	21.08
31 JAN 2037	2465090.08	98.7	T	134	0.3621	2.2050	1.2126	13:60.0	99.2	32.3	8.97	17.54	8.74
27 JUL 2037	2465266.67	99.2	P	139	-0.5583	1.8840	0.8141	4: 8.2	96.7	-	20.46	-19.64	20.35
21 JAN 2038	2465444.66	99.7	PN	144	1.0712	0.9249	-0.1090	3:48.2	-	-	8.24	20.93	8.04
17 JUN 2038	2465591.61	100.2	PN	111	1.3082	0.4674	-0.5216	2:43.4	-	-	17.72	-22.09	17.70
16 JUL 2038	2465620.98	100.3	PN	149	-1.2840	0.5249	-0.4901	11:34.3	-	-	19.74	-22.53	19.63
11 DEC 2038	2465769.24	100.7	PN	116	-1.1449	0.8308	-0.2849	17:43.3	-	-	5.27	22.02	5.37
6 JUN 2039	2465946.29	101.2	P	121	0.5460	1.8520	0.8906	18:52.8	90.2	-	16.99	-22.15	17.00
30 NOV 2039	2466123.21	101.8	P	126	-0.4721	2.0681	0.9470	16:54.7	103.5	-	4.45	21.28	4.63
26 MAY 2040	2466300.99	102.3	T	131	-0.1872	2.5188	1.5405	11:44.7	105.9	46.6	16.26	-21.46	16.31
18 NOV 2040	2466477.29	102.8	T	136	0.2362	2.4783	1.4021	19: 2.9	110.7	44.4	3.65	19.71	3.90
16 MAY 2041	2466655.53	103.4	P	141	-0.9748	1.1001	0.0696	0:41.3	30.0	-	15.53	-20.02	15.61
8 NOV 2041	2466831.69	103.9	P	146	0.9214	1.1907	0.1748	4:33.3	45.8	-	2.89	17.51	3.18
5 APR 2042	2466980.10	104.4	PN	113	1.1080	0.8943	-0.2130	14:28.4	-	-	13.01	-5.39	12.94
29 SEP 2042	2467156.95	104.9	P	118	-1.0262	0.9777	0.0027	10:44.0	3.5	-	0.43	1.64	0.56
28 OCT 2042	2467186.32	105.0	PNb	156	1.5567	0.0075	-0.9738	19:32.7	-	-	2.17	14.80	2.49
25 MAR 2043	2467334.11	105.5	T	123	0.3848	2.2163	1.1189	14:30.3	107.7	27.2	12.31	-1.62	12.20
19 SEP 2043	2467511.58	106.0	T	128	-0.3316	2.2686	1.2611	1:50.0	103.4	36.3	23.77	-1.86	23.86
13 MAR 2044	2467688.32	106.6	T	133	-0.3496	2.2557	1.2080	19:36.7	105.0	33.6	11.61	2.14	11.47
7 SEP 2044	2467865.97	107.1	T	138	0.4320	2.1114	1.0503	11:18.9	103.5	17.6	23.10	-5.37	23.15
3 MAR 2045	2468042.82	107.7	PN	143	-1.0276	0.9871	-0.0116	7:41.6	-	-	10.93	5.71	10.77
27 AUG 2045	2468220.08	108.2	PN	148	1.2064	0.7081	-0.3877	13:53.0	-	-	22.40	-8.81	22.41
22 JAN 2046	2468368.04	108.7	P	115	0.9884	1.0602	0.0591	13: 0.8	26.2	-	8.35	20.51	8.14
18 JUL 2046	2468544.55	109.3	P	120	-0.8689	1.3068	0.2515	1: 4.3	57.9	-	19.86	-21.79	19.73
12 JAN 2047	2468722.56	109.9	T	125	0.3315	2.2908	1.2394	1:24.4	104.9	35.5	7.57	21.99	7.43
7 JUL 2047	2468898.94	110.4	T	130	-0.0633	2.7566	1.7574	10:33.9	109.8	50.9	19.11	-22.62	19.02
1 JAN 2048	2469076.79	111.0	T	135	-0.3747	2.2401	1.1322	6:52.0	107.6	28.4	6.76	22.68	6.71
26 JUN 2048	2469253.59	111.6	P	140	0.6799	1.6069	0.6443	2: 0.6	80.1	-	18.37	-22.64	18.33
20 DEC 2048	2469430.77	112.2	PN	145	-1.0626	0.9878	-0.1396	6:25.9	-	-	5.92	22.48	5.97
17 MAY 2049	2469578.98	112.6	PN	112	-1.1337	0.7890	-0.2027	11:24.8	-	-	15.64	-20.60	15.71
15 JUN 2049	2469608.30	112.7	PN	150	1.4071	0.2755	-0.6930	19:12.3	-	-	17.64	-21.92	17.63
9 NOV 2049	2469755.16	113.2	PN	117	1.1963	0.7068	-0.3500	15:50.2	-	-	3.00	18.22	3.28
6 MAY 2050	2469933.44	113.8	T	122	-0.4180	2.1311	1.0820	22:30.1	103.5	22.2	14.94	-17.18	15.00
30 OCT 2050	2470109.64	114.4	T	127	0.4433	2.0600	1.0596	3:19.8	96.9	17.9	2.30	14.25	2.58
26 APR 2051	2470287.59	115.0	T	132	0.3373	2.3031	1.2065	2:14.5	110.9	35.2	14.24	-13.16	14.27
19 OCT 2051	2470464.30	115.6	T	137	-0.2543	2.3955	1.4174	19: 9.9	102.6	42.2	1.63	9.92	1.88
14 APR 2052	2470641.60	116.2	PN	142	1.0631	0.9724	-0.1263	2:16.1	-	-	13.55	-8.69	13.53
8 OCT 2052	2470818.95	116.8	P	147	-0.9729	1.0890	0.0872	10:44.0	32.2	-	0.99	5.31	1.19

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4 MAR 2Ø53	247Ø966.22	117.3	PN	114	-1.Ø53Ø	Ø.958Ø	-Ø.Ø753	17:2Ø.2	-	-	11.Ø3	5.Ø8	1Ø.86
29 AUG 2Ø53	2471143.84	117.9	PN	119	1.Ø163	1.Ø453	-Ø.Ø279	8: 3.8	-	-	22.53	-8.24	22.53
22 FEB 2Ø54	247132Ø.79	118.5	T	124	-Ø.3239	2.2747	1.283Ø	6:49.4	1ØØ.9	36.6	1Ø.38	9.77	1Ø.16
18 AUG 2Ø54	2471497.89	119.1	T	129	Ø.28Ø4	2.4Ø7Ø	1.3112	9:24.5	113.8	41.9	21.86	-12.71	21.8Ø
11 FEB 2Ø55	2471675.45	119.7	T	134	Ø.3529	2.2216	1.2298	22:44.3	99.7	33.4	9.71	14.14	9.47
7 AUG 2Ø55	2471851.95	12Ø.4	P	139	-Ø.4771	2.Ø323	Ø.9639	1Ø:51.3	1Ø2.2	-	21.17	-16.77	21.Ø6
1 FEB 2Ø56	247203Ø.Ø2	121.Ø	PN	144	1.Ø684	Ø.93Ø8	-Ø.1Ø47	12:24.Ø	-	-	9.ØØ	18.11	8.76
27 JUN 2Ø56	2472176.92	121.5	PN	111	1.3769	Ø.3396	-Ø.646Ø	1Ø: 1.1	-	-	18.48	-21.9Ø	18.42
26 JUL 2Ø56	24722Ø6.28	121.6	PN	149	-1.2Ø5Ø	Ø.6685	-Ø.3438	18:41.4	-	-	2Ø.47	-2Ø.29	2Ø.35
22 DEC 2Ø56	2472354.58	122.1	PN	116	-1.1559	Ø.8121	-Ø.3Ø65	1:46.8	-	-	6.Ø7	22.38	6.Ø9
17 JUN 2Ø57	2472531.6Ø	122.8	P	121	Ø.6166	1.7216	Ø.7616	2:24.3	85.2	-	17.75	-22.76	17.72
11 DEC 2Ø57	24727Ø8.54	123.4	P	126	-Ø.4852	2.Ø443	Ø.9226	Ø:51.5	1Ø2.5	-	5.24	22.58	5.35
6 JUN 2Ø58	2472886.3Ø	124.Ø	T	131	-Ø.1182	2.6458	1.6667	19:13.7	1Ø7.2	49.2	17.Ø1	-22.85	17.Ø3
3Ø NOV 2Ø58	2473Ø62.64	124.7	T	136	Ø.22Ø9	2.5Ø6Ø	1.43Ø6	3:14.1	11Ø.8	45.3	4.42	21.86	4.62
27 MAY 2Ø59	247324Ø.83	125.3	P	141	-Ø.9Ø99	1.2198	Ø.1879	7:53.4	49.1	-	16.26	-22.15	16.33
19 NOV 2Ø59	2473417.Ø4	126.Ø	P	146	Ø.9ØØ5	1.229Ø	Ø.2133	12:59.4	5Ø.2	-	3.64	2Ø.37	3.91
15 APR 2Ø6Ø	2473565.4Ø	126.5	PN	113	1.1621	Ø.7937	-Ø.311Ø	21:34.9	-	-	13.68	-9.35	13.65
9 OCT 2Ø6Ø	2473742.29	127.2	PN	118	-1.Ø67Ø	Ø.9Ø47	-Ø.Ø74Ø	18:51.4	-	-	1.Ø9	5.81	1.28
8 NOV 2Ø6Ø	2473771.67	127.3	PN	156	1.5333	Ø.Ø516	-Ø.9319	4: 2.1	-	-	2.9Ø	18.23	3.21
4 APR 2Ø61	2473919.41	127.8	T	123	Ø.4299	2.13Ø7	1.Ø389	21:51.9	1Ø5.2	15.7	12.97	-5.81	12.92
29 SEP 2Ø61	2474Ø96.9Ø	128.5	T	128	-Ø.38Ø9	2.1811	1.1677	9:36.Ø	1Ø1.6	3Ø.Ø	Ø.43	2.36	Ø.58
25 MAR 2Ø62	2474273.65	129.1	T	133	-Ø.3151	2.316Ø	1.2746	3:31.7	1Ø6.1	37.8	12.28	-2.16	12.19
18 SEP 2Ø62	2474451.27	129.8	T	138	Ø.3738	2.2214	1.1541	18:31.8	1Ø6.6	3Ø.2	23.75	-1.23	23.86
14 MAR 2Ø63	2474628.17	13Ø.5	P	143	-1.ØØ1Ø	1.Ø335	Ø.Ø395	16: 3.6	21.4	-	11.61	1.45	11.49
7 SEP 2Ø63	24748Ø5.36	131.2	PN	148	1.1377	Ø.8358	-Ø.2636	2Ø:38.9	-	-	23.Ø6	-4.9Ø	23.13
2 FEB 2Ø64	2474953.41	131.7	P	115	Ø.9967	1.Ø453	Ø.Ø437	21:46.7	22.5	-	9.11	17.6Ø	8.86
28 JUL 2Ø64	2475129.83	132.4	P	12Ø	-Ø.9471	1.1621	Ø.1Ø92	7:5Ø.6	38.6	-	2Ø.58	-19.58	2Ø.45
22 JAN 2Ø65	24753Ø7.92	133.1	T	125	Ø.3369	2.2821	1.2285	9:56.7	1Ø5.Ø	34.9	8.36	19.8Ø	8.15
17 JUL 2Ø65	2475484.24	133.8	T	13Ø	-Ø.14ØØ	2.6146	1.6181	17:46.4	1Ø8.6	49.Ø	19.85	-21.13	19.74
11 JAN 2Ø66	2475662.13	134.5	T	135	-Ø.3689	2.2518	1.142Ø	15: 2.5	1Ø8.Ø	29.4	7.56	21.36	7.43
7 JUL 2Ø66	2475838.9Ø	135.1	P	14Ø	Ø.6Ø57	1.7423	Ø.78Ø9	9:28.2	86.2	-	19.12	-21.91	19.Ø4
31 DEC 2Ø66	2476Ø16.1Ø	135.8	PN	145	-1.Ø541	1.ØØ33	-Ø.1241	14:27.8	-	-	6.73	22.1Ø	6.69
28 MAY 2Ø67	2476164.29	136.4	PN	112	-1.2Ø11	Ø.6656	-Ø.327Ø	18:53.8	-	-	16.38	-22.75	16.43
27 JUN 2Ø67	2476193.61	136.5	PN	15Ø	1.3396	Ø.3999	-Ø.5697	2:38.8	-	-	18.39	-21.97	18.35
21 NOV 2Ø67	247634Ø.5Ø	137.1	PN	117	1.21Ø6	Ø.68Ø4	-Ø.3758	Ø: 2.3	-	-	3.76	21.Ø2	4.Ø1
17 MAY 2Ø68	2476518.74	137.8	P	122	-Ø.485Ø	2.ØØ86	Ø.9586	5:39.9	1ØØ.Ø	-	15.65	-19.97	15.72
9 NOV 2Ø68	2476694.99	138.6	T	127	Ø.4644	2.Ø215	1.Ø2Ø7	11:44.6	95.6	1Ø.2	3.Ø2	17.62	3.3Ø
6 MAY 2Ø69	2476872.88	139.3	T	132	Ø.2719	2.4223	1.3273	9: 7.6	113.6	42.6	14.94	-16.51	14.99
3Ø OCT 2Ø69	2477Ø49.65	14Ø.Ø	T	137	-Ø.2263	2.4484	1.4673	3:32.7	1Ø3.3	43.8	2.33	13.72	2.6Ø
25 APR 2Ø7Ø	2477226.89	14Ø.7	PN	142	1.ØØ46	1.Ø773	-Ø.Ø165	9:19.Ø	-	-	14.23	-12.48	14.25

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19 OCT 2070	2477404.29	141.4	P	147	-0.9408	1.1508	0.1435	18:48.8	41.4	-	1.67	9.40	1.91
16 MAR 2071	2477551.56	142.0	PN	114	-1.0757	0.9134	-0.1140	1:28.8	-	-	11.71	0.76	11.58
9 SEP 2071	2477729.13	142.8	PN	119	1.0833	0.9252	-0.1535	15: 3.2	-	-	23.19	-4.16	23.25
4 MAR 2072	2477906.14	143.5	T	124	-0.3429	2.2380	1.2501	15:20.7	100.2	34.7	11.07	5.61	10.88
28 AUG 2072	2478083.17	144.2	T	129	0.3562	2.2692	1.1711	16: 3.2	110.6	32.6	22.53	-8.92	22.52
22 FEB 2073	2478260.81	145.0	T	134	0.3390	2.2466	1.2556	7:22.5	100.3	35.0	10.42	10.27	10.19
17 AUG 2073	2478437.24	145.7	T	139	-0.4000	2.1733	1.1058	17:40.2	106.2	25.5	21.85	-13.39	21.78
11 FEB 2074	2478615.37	146.5	PN	144	1.0613	0.9444	-0.0922	20:53.5	-	-	9.74	14.69	9.49
8 JUL 2074	2478762.22	147.1	PN	111	1.4456	0.2121	-0.7706	17:19.2	-	-	19.22	-20.91	19.14
7 AUG 2074	2478791.58	147.2	PN	149	-1.1294	0.8061	-0.2041	1:53.6	-	-	21.18	-17.41	21.07
2 JAN 2075	2478939.91	147.9	PN	116	-1.1642	0.7979	-0.3226	9:52.5	-	-	6.88	21.82	6.81
28 JUN 2075	2479116.91	148.6	P	121	0.6896	1.5873	0.6281	9:53.1	79.0	-	18.50	-22.54	18.44
22 DEC 2075	2479293.87	149.4	P	126	-0.4944	2.0275	0.9059	8:53.4	101.7	-	6.05	22.98	6.07
17 JUN 2076	2479471.61	150.2	T	131	-0.0453	2.7802	1.7999	2:37.3	108.1	50.6	17.77	-23.44	17.75
10 DEC 2076	2479647.98	151.0	T	136	0.2104	2.5245	1.4505	11:32.3	110.8	45.9	5.22	23.19	5.34
6 JUN 2077	2479826.12	151.7	P	141	-0.8389	1.3509	0.3172	14:57.3	63.0	-	17.02	-23.53	17.05
29 NOV 2077	2480002.40	152.5	P	146	0.8856	1.2559	0.2407	21:33.3	53.0	-	4.42	22.54	4.63
27 APR 2078	2480150.69	153.2	PN	113	1.2222	0.6822	-0.4198	4:33.2	-	-	14.36	-12.96	14.37
21 OCT 2078	2480327.63	154.0	PN	118	-1.1021	0.8422	-0.1404	3: 5.5	-	-	1.78	9.80	2.00
19 NOV 2078	2480357.03	154.1	PN	156	1.5148	0.0865	-0.8990	12:37.4	-	-	3.65	21.08	3.93
16 APR 2079	2480504.72	154.8	P	123	0.4798	2.0364	0.9502	5: 8.1	102.1	-	13.65	-9.79	13.64
10 OCT 2079	2480682.23	155.6	T	128	-0.4245	2.1042	1.0847	17:27.9	99.8	21.8	1.09	6.53	1.30
4 APR 2080	2480858.97	156.4	T	133	-0.2753	2.3858	1.3508	11:21.0	107.2	41.5	12.95	-6.38	12.91
29 SEP 2080	2481036.58	157.2	T	138	0.3205	2.3221	1.2487	1:50.0	109.1	37.3	0.41	2.98	0.58
25 MAR 2081	2481213.52	158.0	P	143	-0.9691	1.0898	0.1004	0:19.3	34.2	-	12.28	-2.86	12.21
18 SEP 2081	2481390.65	158.8	PN	148	1.0751	0.9526	-0.1505	3:32.7	-	-	23.72	-0.77	23.85
13 FEB 2082	2481538.77	159.5	P	115	1.0099	1.0212	0.0194	6:26.6	14.7	-	9.85	14.12	9.58
8 AUG 2082	2481715.12	160.3	PN	120	-1.0201	1.0273	-0.0238	14:44.0	-	-	21.29	-16.75	21.17
2 FEB 2083	2481893.27	161.2	T	125	0.3461	2.2661	1.2106	18:24.0	104.9	33.7	9.11	16.90	8.88
29 JUL 2083	2482069.55	162.0	T	130	-0.2140	2.4776	1.4835	1: 2.8	106.9	45.7	20.58	-18.92	20.46
22 JAN 2084	2482247.47	162.8	T	135	-0.3611	2.2667	1.1555	23:10.2	108.6	30.7	8.34	19.20	8.15
17 JUL 2084	2482424.21	163.7	P	140	0.5315	1.8783	0.9173	16:56.1	91.2	-	19.86	-20.40	19.76
10 JAN 2085	2482601.44	164.5	PN	145	-1.0456	1.0187	-0.1080	22:29.7	-	-	7.52	20.82	7.41
8 JUN 2085	2482749.60	165.2	PN	112	-1.2745	0.5318	-0.4623	2:14.8	-	-	17.13	-24.15	17.15
7 JUL 2085	2482778.92	165.4	PN	150	1.2697	0.5292	-0.4423	10: 1.9	-	-	19.14	-21.21	19.07
1 DEC 2085	2482925.85	166.1	PN	117	1.2188	0.6648	-0.3903	8:22.7	-	-	4.54	23.08	4.73
28 MAY 2086	2483104.03	167.0	P	122	-0.5583	1.8748	0.8235	12:41.0	95.2	-	16.39	-22.10	16.44
20 NOV 2086	2483280.35	167.8	P	127	0.4798	1.9935	0.9923	20:16.8	94.6	-	3.78	20.40	4.02
17 MAY 2087	2483458.16	168.7	T	132	0.2001	2.5533	1.4597	15:52.5	115.8	48.0	15.65	-19.30	15.71
10 NOV 2087	2483635.00	169.6	T	137	-0.2044	2.4901	1.5059	12: 2.7	103.8	44.9	3.06	17.07	3.33

CANON OF LUNAR ECLIPSES

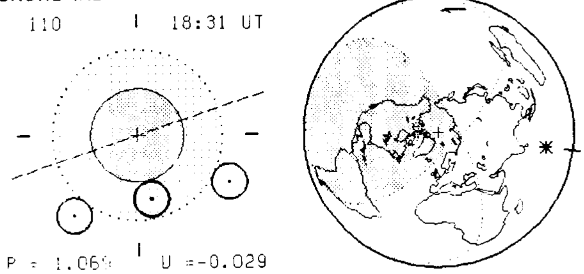
DATE	JULIAN DATE	DELTA T	TYPE	SAROS	GAMMA	PENUMBRAL MAGNITUDE	UMBRAL MAGNITUDE	MIDDLE ECLIPSE (h:m)	PARTIAL S.DUR. (m)	TOTAL S.DUR. (m)	MOON RA	MOON DEC	GST (Ø UT)
5 MAY 2Ø88	2483812.18	17Ø.5	P	142	Ø.939Ø	1.1952	Ø.1Ø62	16:13.9	39.Ø	-	14.92	-15.82	14.97
3Ø OCT 2Ø88	2483989.63	171.4	P	147	-Ø.9149	1.2ØØ9	Ø.1881	3: Ø.4	47.3	-	2.37	13.18	2.63
26 MAR 2Ø89	2484136.9Ø	172.1	PN	114	-1.1Ø37	Ø.8588	-Ø.1625	9:31.3	-	-	12.37	-3.6Ø	12.31
19 SEP 2Ø89	2484314.42	173.Ø	PN	119	1.1445	Ø.8157	-Ø.2688	22: 8.3	-	-	23.84	Ø.Ø9	23.97
15 MAR 2Ø9Ø	2484491.49	173.9	T	124	-Ø.3672	2.1914	1.2Ø73	23:45.6	99.2	32.Ø	11.74	1.28	11.61
8 SEP 2Ø9Ø	2484668.45	174.8	T	129	Ø.4255	2.1433	1.Ø427	22:49.5	1Ø7.Ø	16.5	23.18	-4.84	23.23
5 MAR 2Ø91	2484846.17	175.7	T	134	Ø.3216	2.2781	1.2882	15:55.4	1Ø1.1	36.9	11.11	6.Ø9	1Ø.91
29 AUG 2Ø91	2485Ø22.53	176.6	T	139	-Ø.3273	2.3Ø65	1.2396	Ø:35.4	1Ø9.2	36.8	22.52	-9.6Ø	22.5Ø
23 FEB 2Ø92	24852ØØ.72	177.6	PN	144	1.Ø512	Ø.9634	-Ø.Ø741	5:18.Ø	-	-	1Ø.45	1Ø.81	1Ø.21
19 JUL 2Ø92	2485347.53	178.3	PNe	111	1.513Ø	Ø.Ø874	-Ø.8931	Ø:39.Ø	-	-	19.95	-19.16	19.86
17 AUG 2Ø92	2485376.88	178.5	PN	149	-1.Ø571	Ø.9379	-Ø.Ø7Ø7	9:11.Ø	-	-	21.87	-14.Ø2	21.78
12 JAN 2Ø93	2485525.25	179.3	PN	116	-1.1732	Ø.7819	-Ø.3398	17:56.9	-	-	7.67	2Ø.36	7.53
8 JUL 2Ø93	24857Ø2.23	18Ø.2	P	121	Ø.7631	1.4525	Ø.4934	17:21.3	71.5	-	19.25	-21.52	19.16
1 JAN 2Ø94	2485879.21	181.2	P	126	-Ø.5Ø23	2.Ø125	Ø.8918	16:57.Ø	1Ø1.1	-	6.85	22.45	6.79
28 JUN 2Ø94	2486Ø56.92	182.1	T	131	Ø.Ø286	2.8118	1.8294	9:58.9	1Ø8.4	5Ø.8	18.53	-23.2Ø	18.47
21 DEC 2Ø94	2486233.33	183.1	T	136	Ø.2Ø17	2.5394	1.4674	19:53.4	11Ø.7	46.3	6.Ø3	23.62	6.Ø6
17 JUN 2Ø95	2486411.42	184.Ø	P	141	-Ø.7655	1.4868	Ø.45Ø7	21:57.1	73.9	-	17.78	-24.11	17.76
11 DEC 2Ø95	2486587.76	185.Ø	P	146	Ø.8744	1.276Ø	Ø.2617	6:11.9	55.Ø	-	5.22	23.87	5.35
7 MAY 2Ø96	2486735.98	185.8	PN	113	1.2896	Ø.5572	-Ø.5422	11:21.6	-	-	15.Ø6	-16.Ø9	15.Ø9
6 JUN 2Ø96	2486765.61	186.Ø	PNb	151	-1.5726	Ø.Ø3Ø4	-1.Ø54Ø	2:4Ø.5	-	-	17.ØØ	-24.14	17.Ø4
31 OCT 2Ø96	2486912.98	186.8	PN	118	-1.13Ø8	Ø.7917	-Ø.1948	11:27.3	-	-	2.48	13.46	2.72
29 NOV 2Ø96	2486942.39	187.Ø	PN	156	1.5Ø18	Ø.1111	-Ø.876Ø	21:19.2	-	-	4.44	23.23	4.65
26 APR 2Ø97	248709Ø.Ø1	187.8	P	123	Ø.5376	1.9274	Ø.847Ø	12:15.1	98.Ø	-	14.33	-13.42	14.35
21 OCT 2Ø97	2487267.56	188.8	T	128	-Ø.46Ø6	2.Ø4Ø9	1.Ø153	1:27.7	98.1	9.Ø	1.78	1Ø.52	2.Ø2
15 APR 2Ø98	2487444.29	189.8	T	133	-Ø.2273	2.47Ø7	1.442Ø	19: 1.6	1Ø8.3	44.9	13.62	-1Ø.37	13.63
1Ø OCT 2Ø98	2487621.89	19Ø.8	T	138	Ø.2751	2.4Ø87	1.329Ø	9:16.7	11Ø.9	41.8	1.Ø8	7.15	1.3Ø
5 APR 2Ø99	2487798.85	191.8	P	143	-Ø.93Ø6	1.1579	Ø.1733	8:27.7	44.6	-	12.95	-7.Ø8	12.93
29 SEP 2Ø99	2487975.94	192.8	PN	148	1.Ø177	1.Ø599	-Ø.Ø47Ø	1Ø:33.3	-	-	Ø.38	3.43	Ø.57
24 FEB 21ØØ	2488124.13	193.7	PN	115	1.Ø265	Ø.99Ø5	-Ø.Ø111	15: 1.9	-	-	1Ø.55	1Ø.2Ø	1Ø.31
19 AUG 21ØØ	24883ØØ.41	194.7	PN	12Ø	-1.Ø9Ø4	Ø.8975	-Ø.1521	21:41.7	-	-	21.98	-13.42	21.89

230 ECLIPSES 87 PENUMBRAL 58 PARTIAL 85 TOTAL 100.Ø YEARS

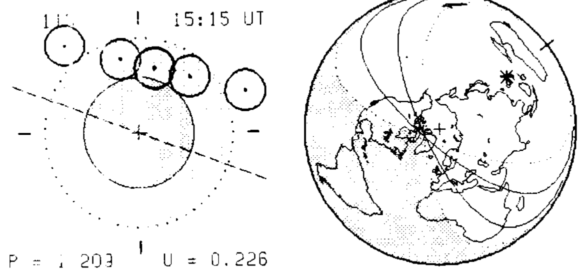
FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

SECTION 2 - ECLIPSE PATHS AND GLOBAL MAPS: 1901 - 2100

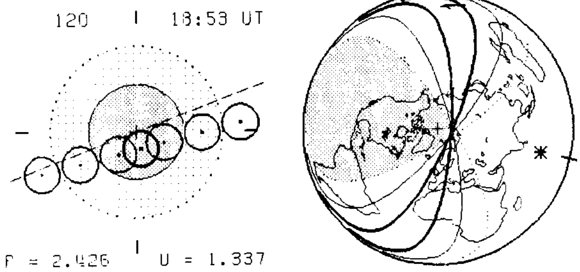
PENUMBRAL 3 MAY 1901



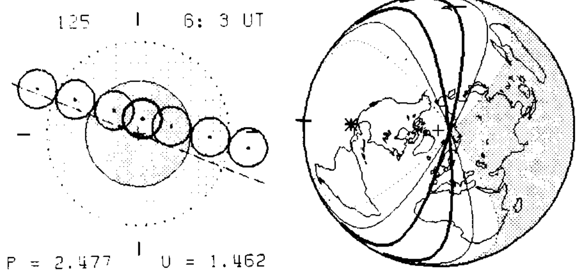
PARTIAL 27 OCT 1901



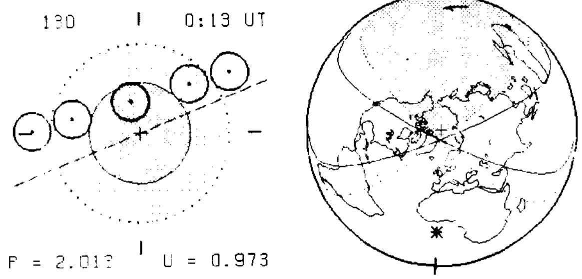
TOTAL 22 APR 1902



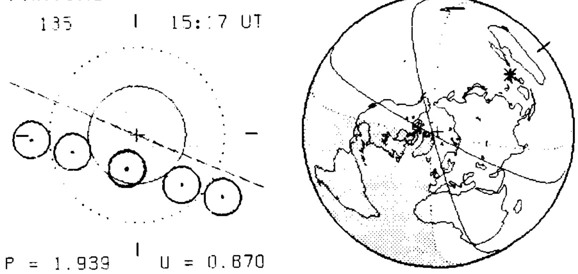
TOTAL 17 OCT 1902



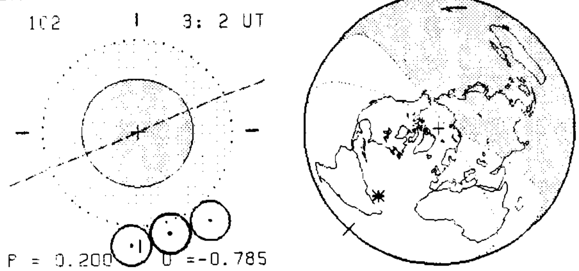
PARTIAL 12 APR 1903



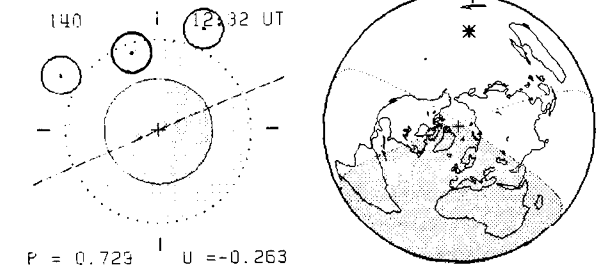
PARTIAL 6 OCT 1903



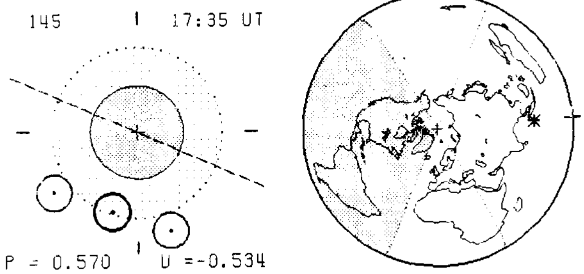
PENUMBRAL 2 MAR 1904



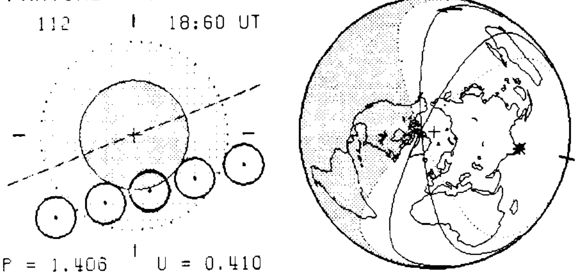
PENUMBRAL 31 MAR 1904



PENUMBRAL 24 SEP 1904



PARTIAL 19 FEB 1905

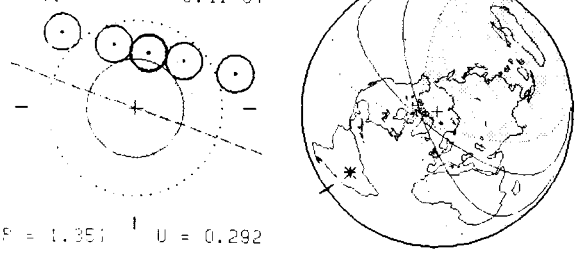


PRECEDING PAGE BLANK NOT FILMED

PAGE 32 INTENTIONALLY BLANK

PARTIAL 15 AUG 1905

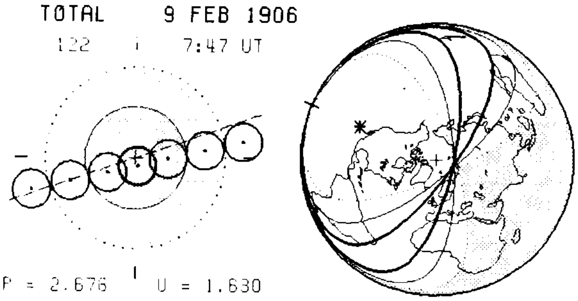
[illegible] 3:41 UT



P = 1.351 U = 0.292

TOTAL 9 FEB 1906

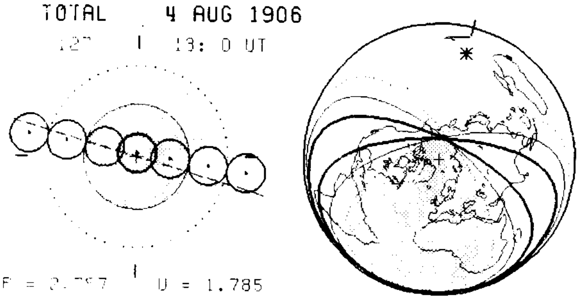
122 7:47 UT



P = 2.676 U = 1.630

TOTAL 4 AUG 1906

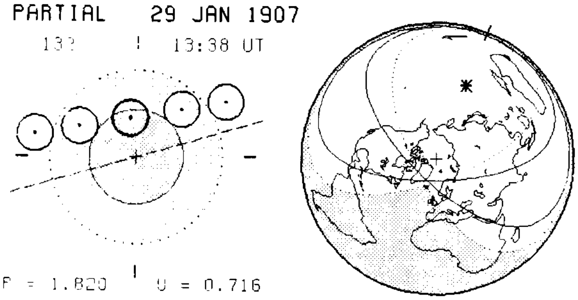
[illegible] 13: 0 UT



P = [illegible] U = 1.785

PARTIAL 29 JAN 1907

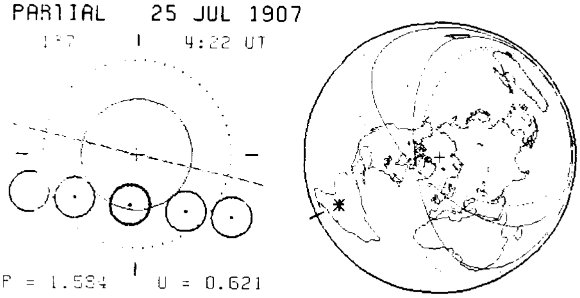
[illegible] 13:38 UT



P = 1.820 U = 0.716

PARTIAL 25 JUL 1907

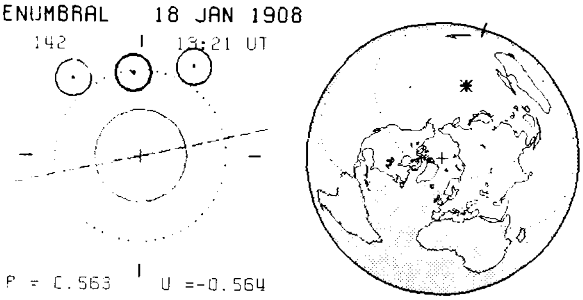
[illegible] 4:22 UT



P = 1.534 U = 0.621

PENUMBRAL 18 JAN 1908

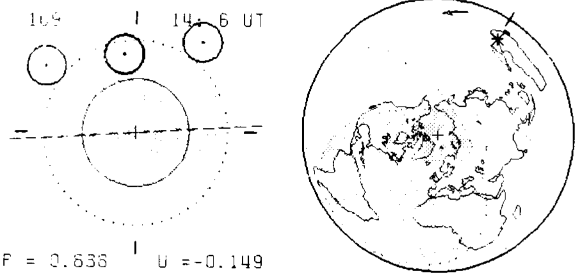
142 13:21 UT



P = 0.563 U =-0.564

PENUMBRAL 14 JUN 1908

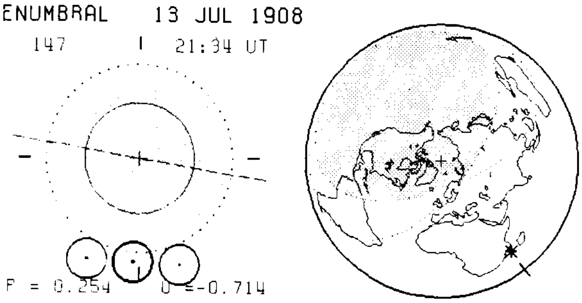
[illegible] 14: 6 UT



P = 0.636 U =-0.149

PENUMBRAL 13 JUL 1908

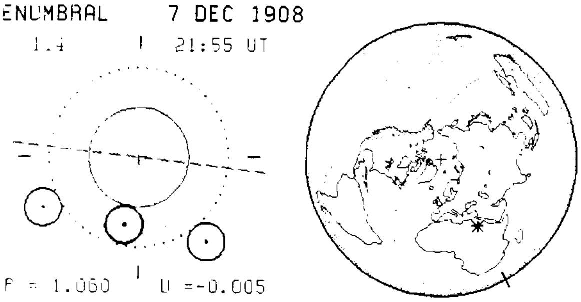
147 21:34 UT



P = 0.254 U =-0.714

PENUMBRAL 7 DEC 1908

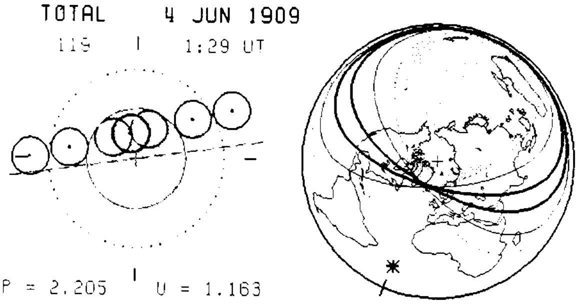
[illegible] 21:55 UT



P = 1.060 U =-0.005

TOTAL 4 JUN 1909

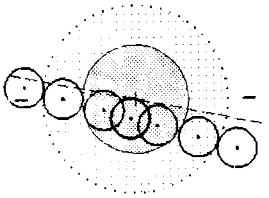
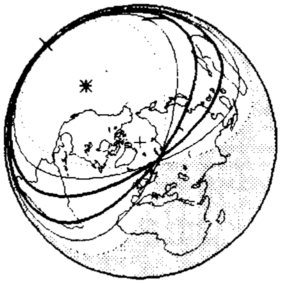
119 1:29 UT



P = 2.205 U = 1.163

TOTAL 27 NOV 1909

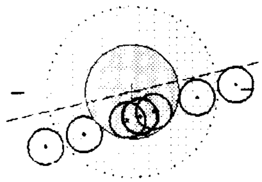
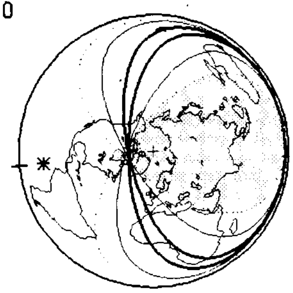
124 | 8:54 UT

P = 2.379 | U = 1.371

TOTAL 24 MAY 1910

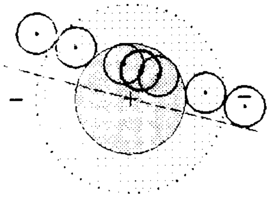
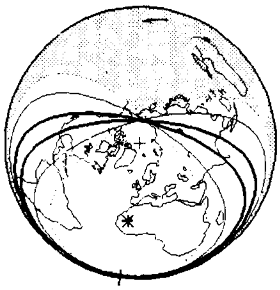
129 | 5:34 UT

P = 2.189 | U = 1.100

TOTAL 17 NOV 1910

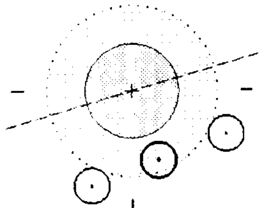
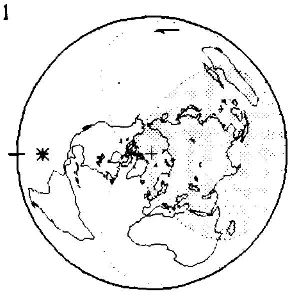
134 | 0:21 UT

P = 2.116 | U = 1.131

PENUMBRAL 13 MAY 1911

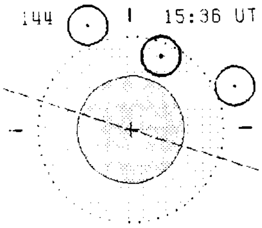
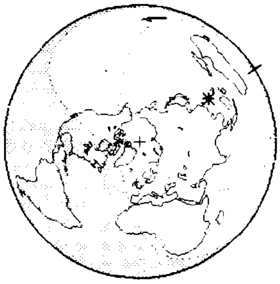
139 | 5:56 UT

P = 0.625 | U =-0.266

PENUMBRAL 6 NOV 1911

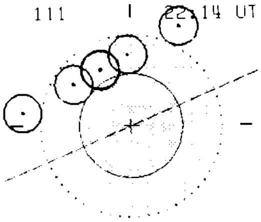
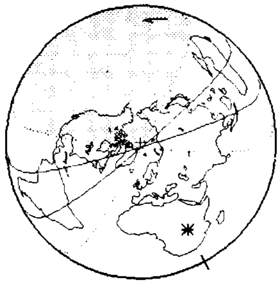
144 | 15:36 UT

P = 0.241 | U =-0.168

PARTIAL 1 APR 1912

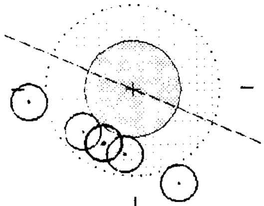
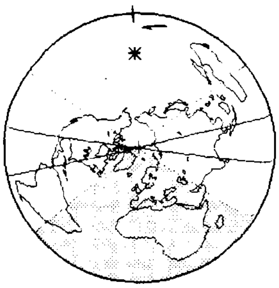
111 | 22:14 UT

P = 1.214 | U = 0.187

PARTIAL 26 SEP 1912

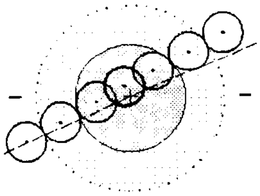
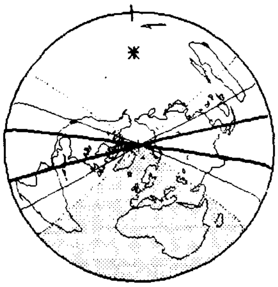
116 | 11:45 UT

P = 1.204 | U = 0.123

TOTAL 22 MAR 1913

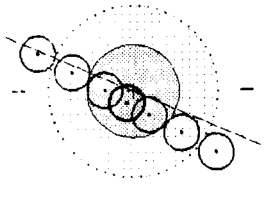
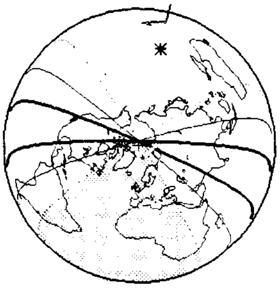
121 | 11:58 UT

P = 2.559 | U = 1.574

TOTAL 15 SEP 1913

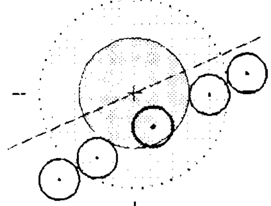
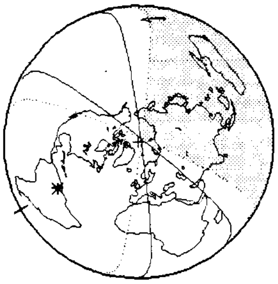
126 | 12:48 UT

P = 2.538 | U = 1.435

PARTIAL 12 MAR 1914

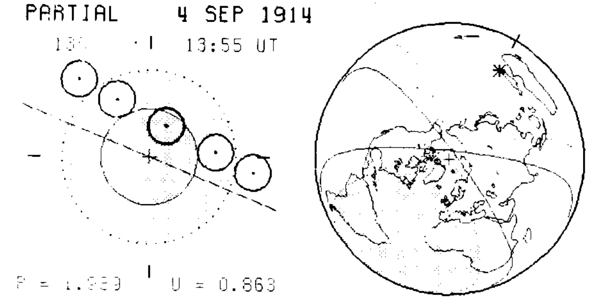
131 | 4:13 UT

P = 1.901 | U = 0.917

PARTIAL 4 SEP 1914

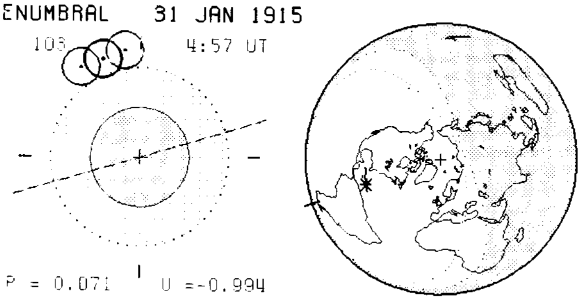
13[illegible] 13:55 UT



P = [illegible] U = 0.863

PENUMBRAL 31 JAN 1915

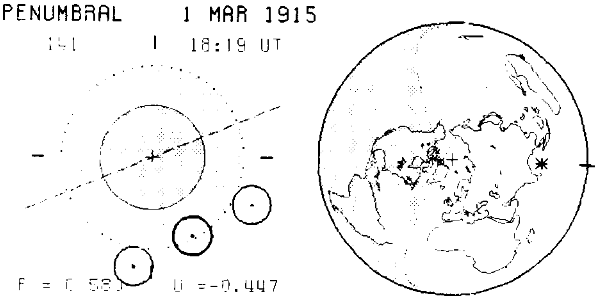
103 4:57 UT



P = 0.071 U =-0.994

PENUMBRAL 1 MAR 1915

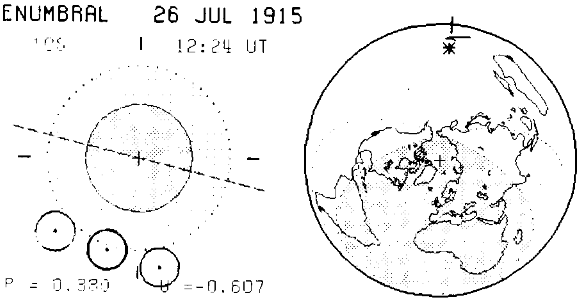
141 18:19 UT



P = 0.58[illegible] U =-0.447

PENUMBRAL 26 JUL 1915

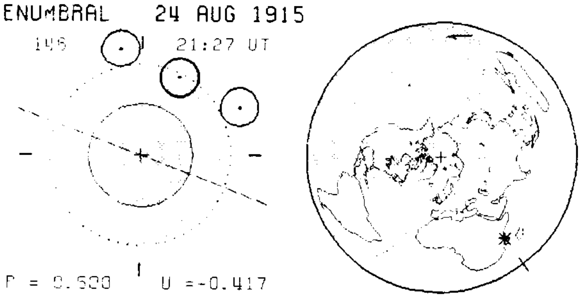
[illegible] 12:24 UT



P = 0.380 U =-0.607

PENUMBRAL 24 AUG 1915

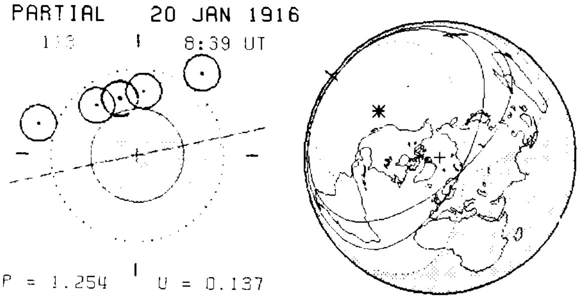
146 21:27 UT



P = 0.520 U =-0.417

PARTIAL 20 JAN 1916

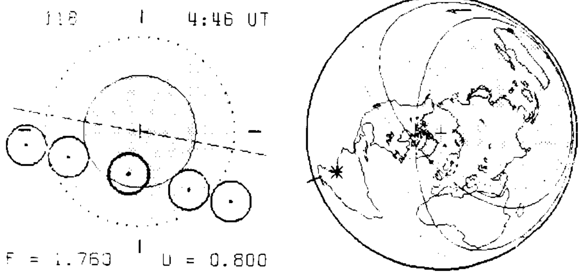
1[illegible] 8:39 UT



P = 1.254 U = 0.137

PARTIAL 15 JUL 1916

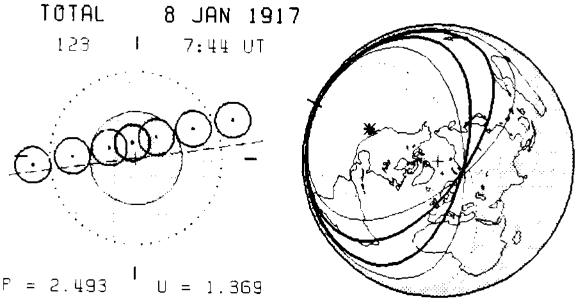
118 4:46 UT



P = 1.760 U = 0.800

TOTAL 8 JAN 1917

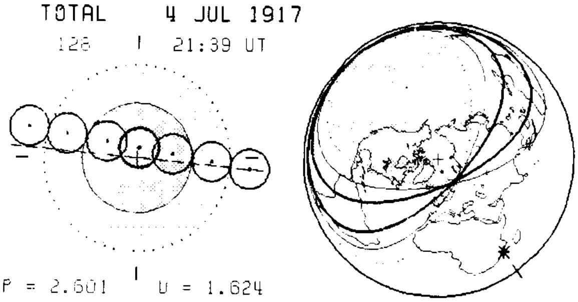
123 7:44 UT



P = 2.493 U = 1.369

TOTAL 4 JUL 1917

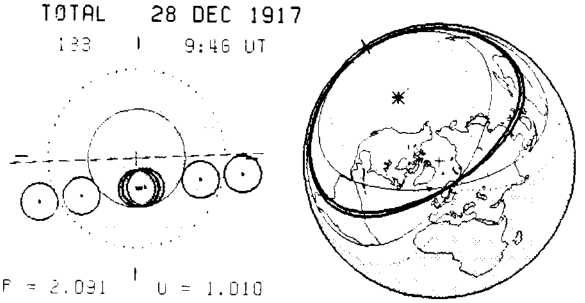
128 21:39 UT



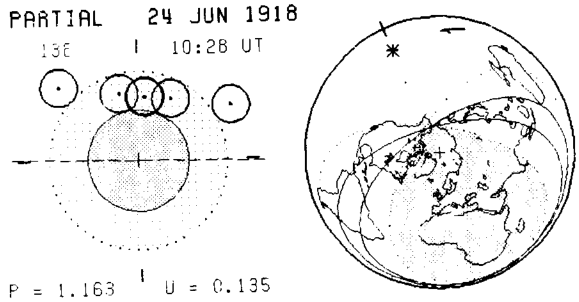
P = 2.601 U = 1.624

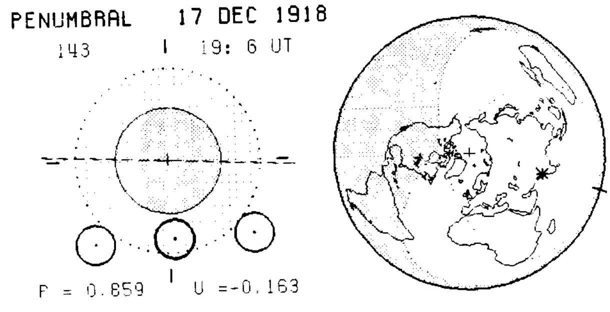
TOTAL 28 DEC 1917

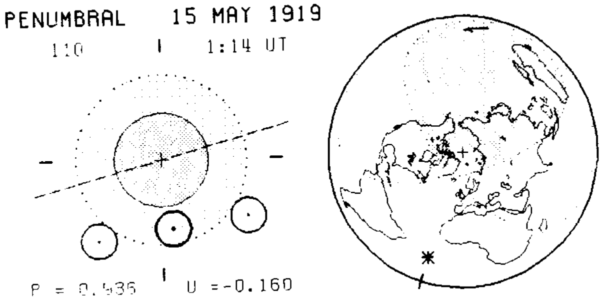
133 9:46 UT

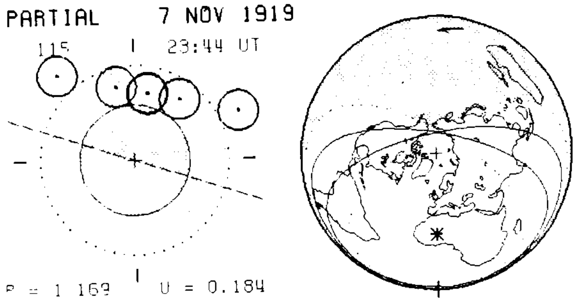


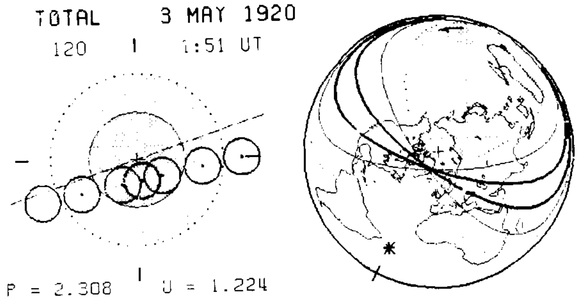
P = 2.091 U = 1.010

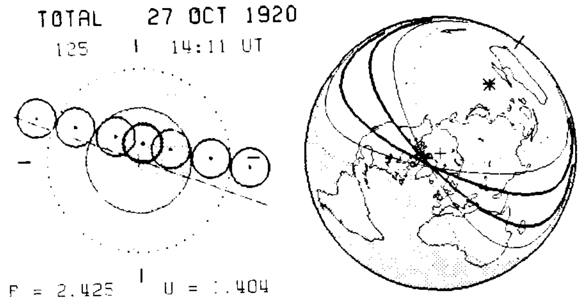

PARTIAL 24 JUN 1918
138 10:28 UT
P = 1.163 U = 0.135

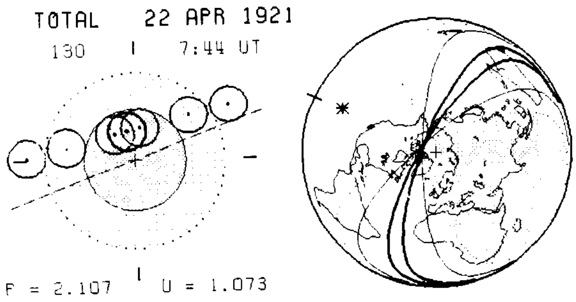

PENUMBRAL 17 DEC 1918
143 19: 6 UT
P = 0.859 U =-0.163

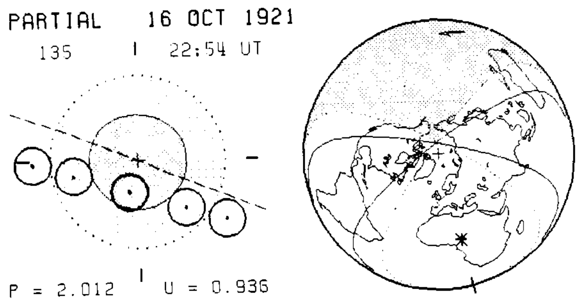

PENUMBRAL 15 MAY 1919
110 1:14 UT
U =-0.160

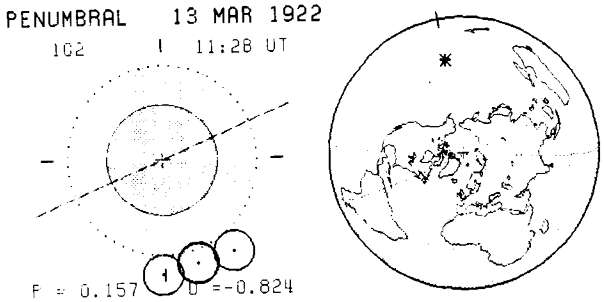

PARTIAL 7 NOV 1919
115 23:44 UT
P = 1.169 U = 0.184

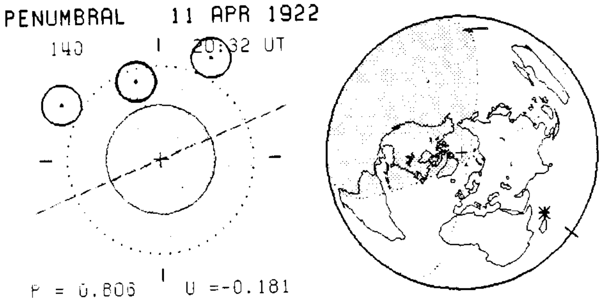

TOTAL 3 MAY 1920
120 1:51 UT
P = 2.308 U = 1.224

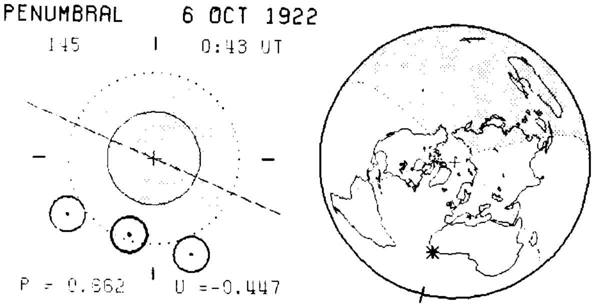

TOTAL 27 OCT 1920
125 14:11 UT
P = 2.425

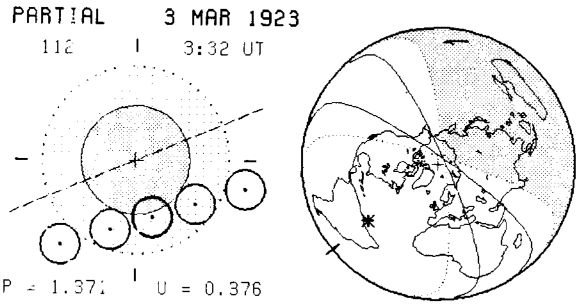

TOTAL 22 APR 1921
130 7:44 UT
P = 2.107 U = 1.073

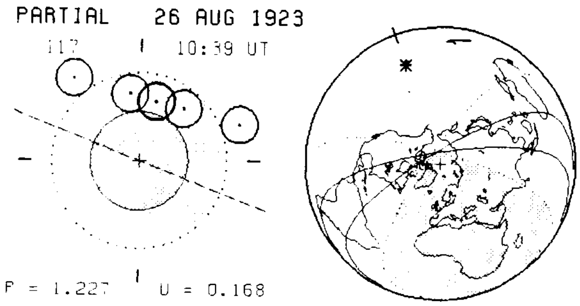

PARTIAL 16 OCT 1921
135 22:54 UT
P = 2.012 U = 0.936

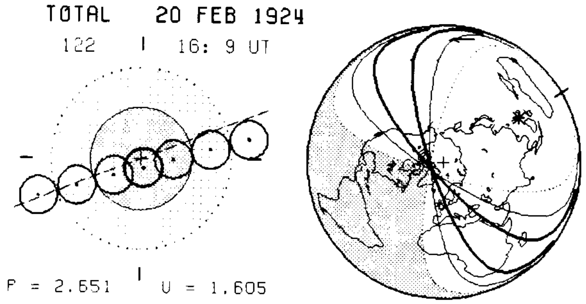

PENUMBRAL 13 MAR 1922
102 11:28 UT
P = 0.157 U =-0.824

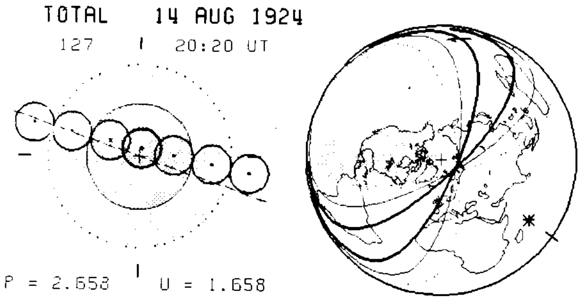

PENUMBRAL 11 APR 1922
140 20:32 UT
P = 0.806 U =-0.181

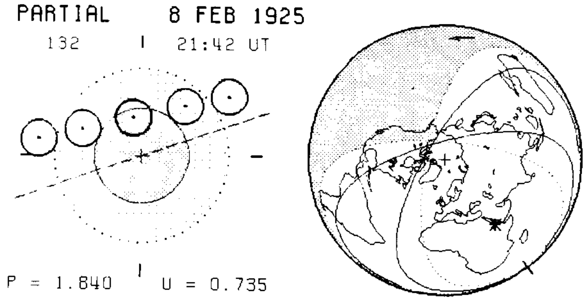

PENUMBRAL 6 OCT 1922
145 0:43 UT
P = 0.662 U =-0.447

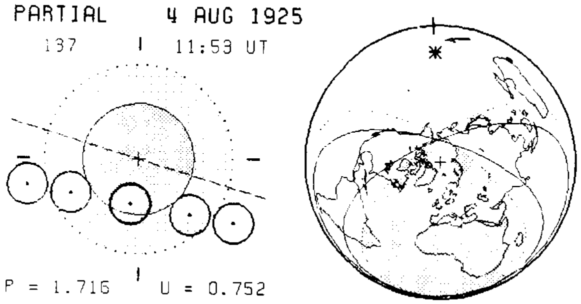

PARTIAL 3 MAR 1923
112 3:32 UT
P = 1.371 U = 0.376

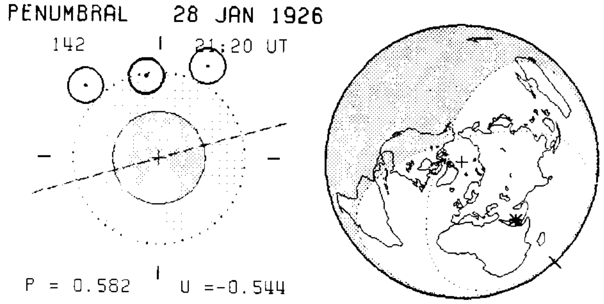

PARTIAL 26 AUG 1923
117 10:39 UT
P = 1.227 U = 0.168

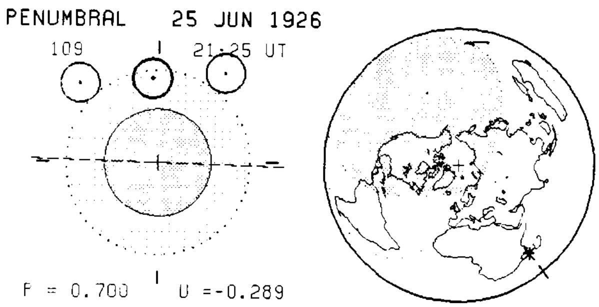

TOTAL 20 FEB 1924
122 16: 9 UT
P = 2.651 U = 1.605

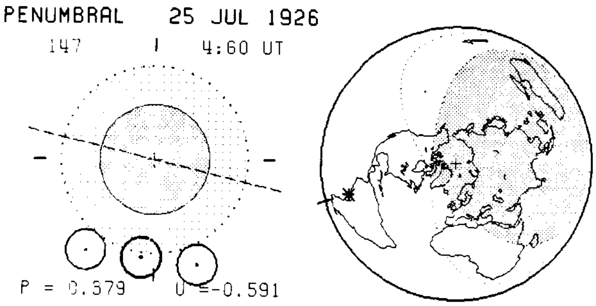

TOTAL 14 AUG 1924
127 20:20 UT
P = 2.658 U = 1.658


PARTIAL 8 FEB 1925
132 21:42 UT
P = 1.840 U = 0.735

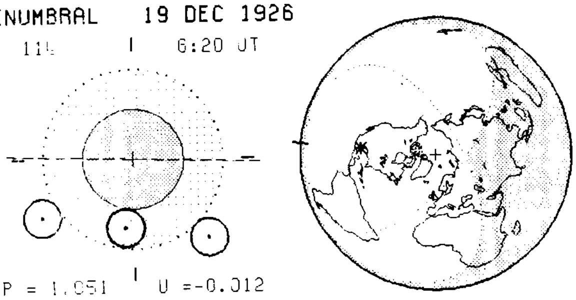

PARTIAL 4 AUG 1925
137 11:53 UT
P = 1.716 U = 0.752


PENUMBRAL 28 JAN 1926
142 21:20 UT
P = 0.582 U =-0.544


PENUMBRAL 25 JUN 1926
109 21:25 UT
P = 0.700 U =-0.289

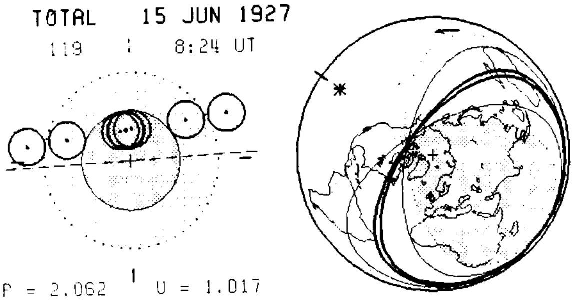

PENUMBRAL 25 JUL 1926
147 4:60 UT
P = 0.579 U =-0.591

PENUMBRAL 19 DEC 1926
114 | 6:20 UT



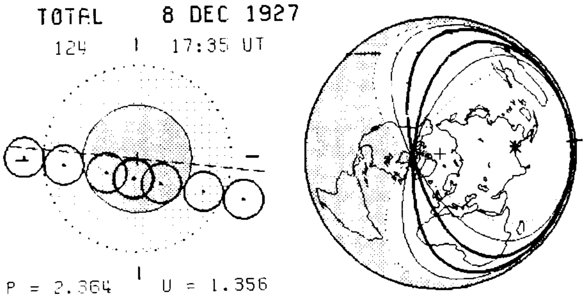
P = 1.051 | U =-0.012

TOTAL 15 JUN 1927
119 | 8:24 UT



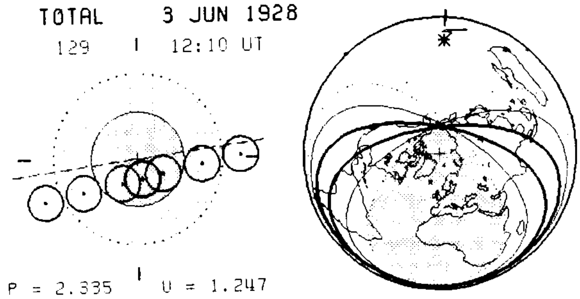
P = 2.062 | U = 1.017

TOTAL 8 DEC 1927
124 | 17:35 UT



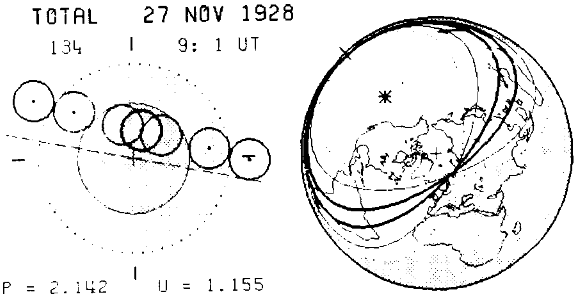
P = 2.364 | U = 1.356

TOTAL 3 JUN 1928
129 | 12:10 UT



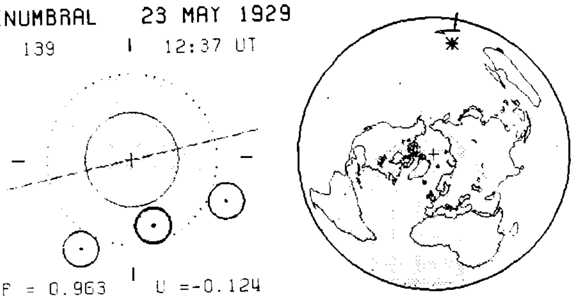
P = 2.335 | U = 1.247

TOTAL 27 NOV 1928
134 | 9: 1 UT



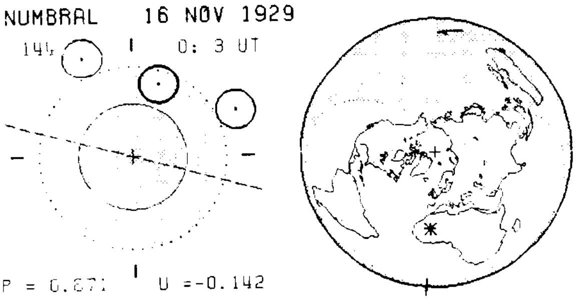
P = 2.142 | U = 1.155

PENUMBRAL 23 MAY 1929
139 | 12:37 UT



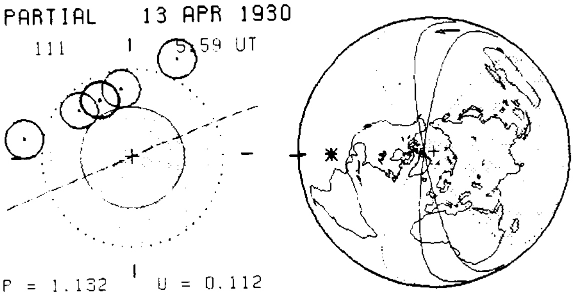
P = 0.963 | U =-0.124

PENUMBRAL 16 NOV 1929
144 | 0: 3 UT



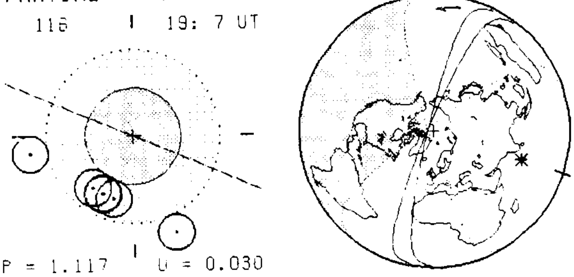
P = 0.871 | U =-0.142

PARTIAL 13 APR 1930
111 | 5:59 UT



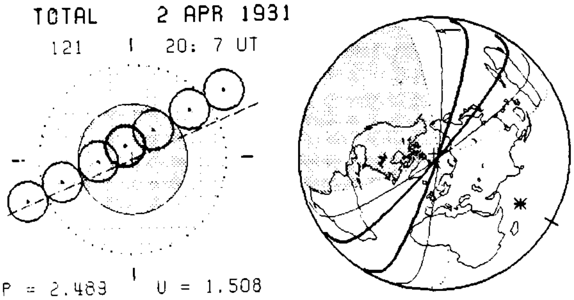
P = 1.132 | U = 0.112

PARTIAL 7 OCT 1930
116 | 19: 7 UT



P = 1.117 | U = 0.030

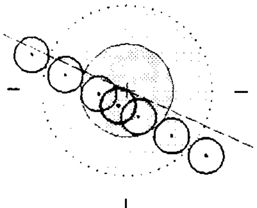
TOTAL 2 APR 1931
121 | 20: 7 UT

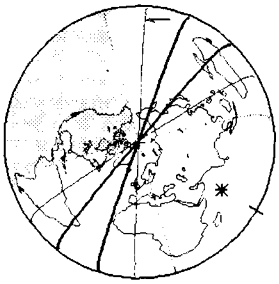


P = 2.483 | U = 1.508

TOTAL 26 SEP 1931

126 | 19:48 UT

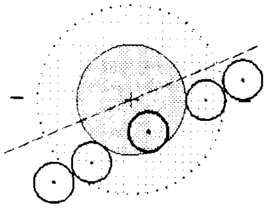


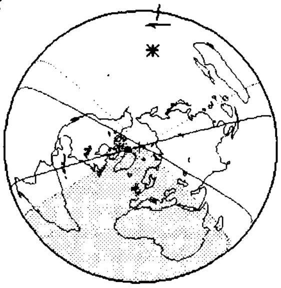


P = 2.432 | U = 1.325

PARTIAL 22 MAR 1932

131 | 12:32 UT

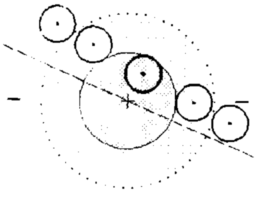


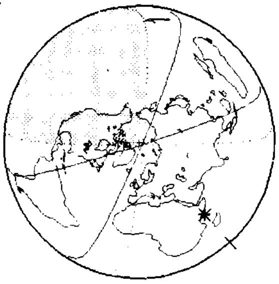


P = 1.955 | U = 0.972

PARTIAL 14 SEP 1932

136 | 21: 1 UT

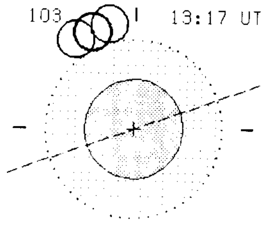


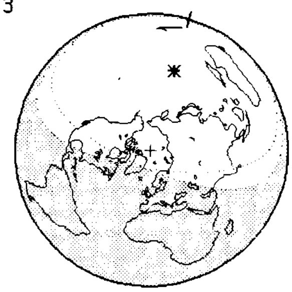


P = 2.059 | U = 0.980

PENUMBRAL 10 FEB 1933

103 | 13:17 UT

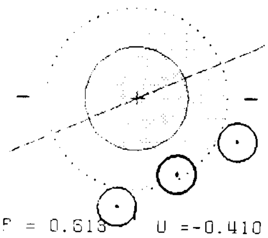


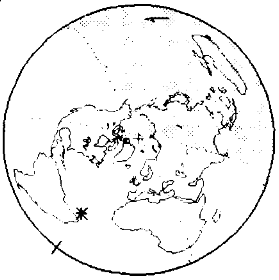


P = 0.044 | U =-1.022

PENUMBRAL 12 MAR 1933

141 | 2:33 UT

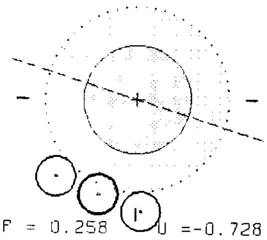


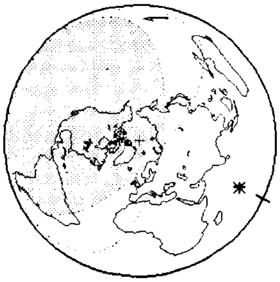


P = 0.613 | U =-0.410

PENUMBRAL 5 AUG 1933

108 | 19:46 UT

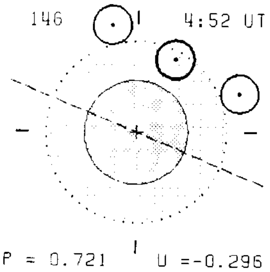


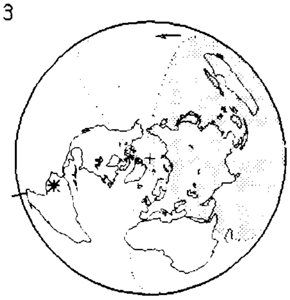


P = 0.258 | U =-0.728

PENUMBRAL 4 SEP 1933

146 | 4:52 UT

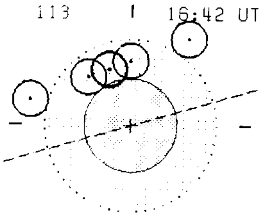


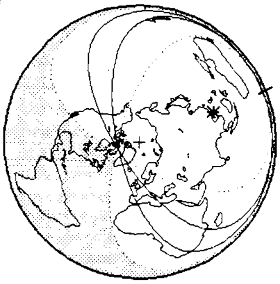


P = 0.721 | U =-0.296

PARTIAL 30 JAN 1934

113 | 16:42 UT

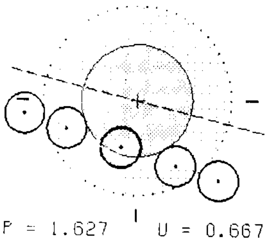


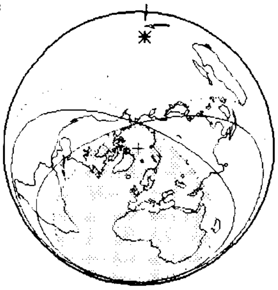


P = 1.234 | U = 0.117

PARTIAL 26 JUL 1934

118 | 12:15 UT

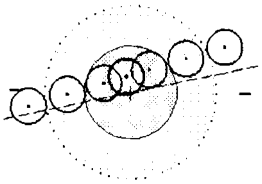


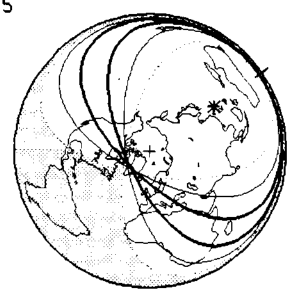


P = 1.627 | U = 0.667

TOTAL 19 JAN 1935

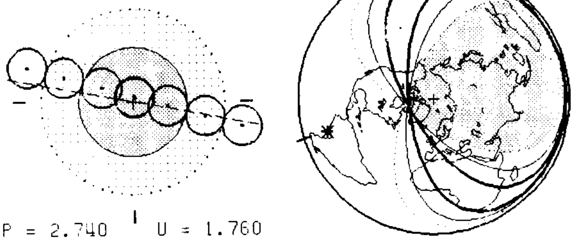
123 | 15:47 UT





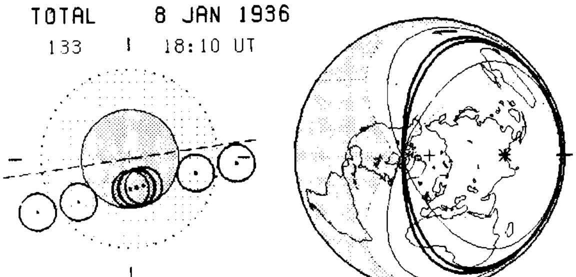
P = 2.477 | U = 1.354

TOTAL 16 JUL 1935
128 | 4:60 UT



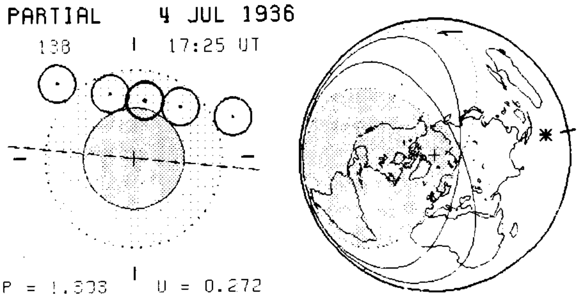
P = 2.740 | U = 1.760

TOTAL 8 JAN 1936
133 | 18:10 UT



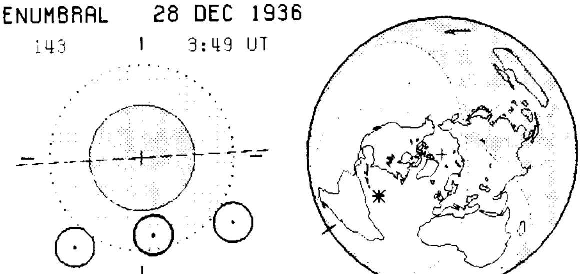
P = 2.100 | U = 1.022

PARTIAL 4 JUL 1936
138 | 17:25 UT



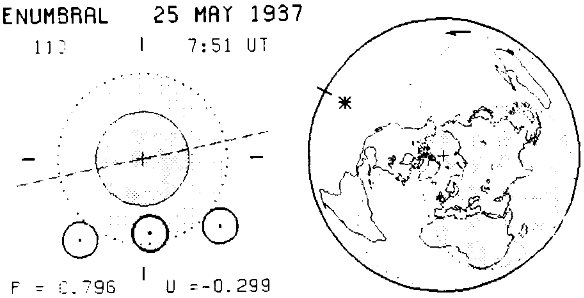
P = 1.533 | U = 0.272

PENUMBRAL 28 DEC 1936
143 | 3:49 UT



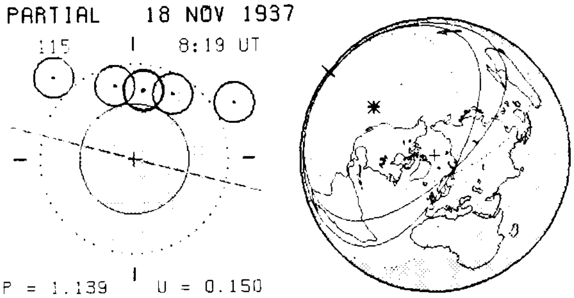
P = 0.870 | U =-0.150

PENUMBRAL 25 MAY 1937
110 | 7:51 UT



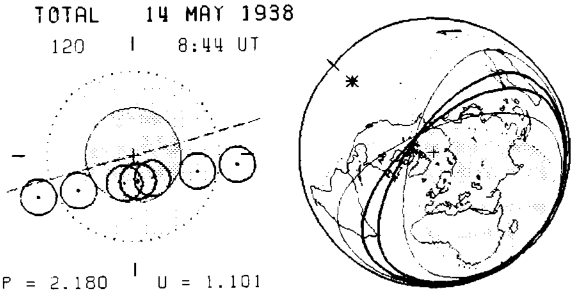
P = 0.796 | U =-0.299

PARTIAL 18 NOV 1937
115 | 8:19 UT



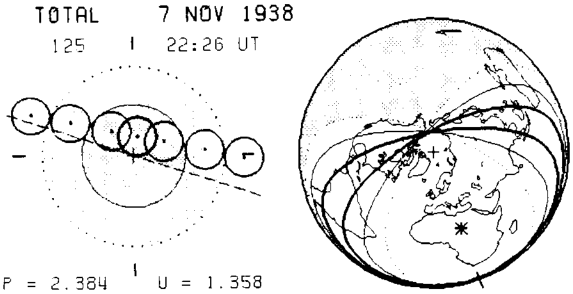
P = 1.139 | U = 0.150

TOTAL 14 MAY 1938
120 | 8:44 UT



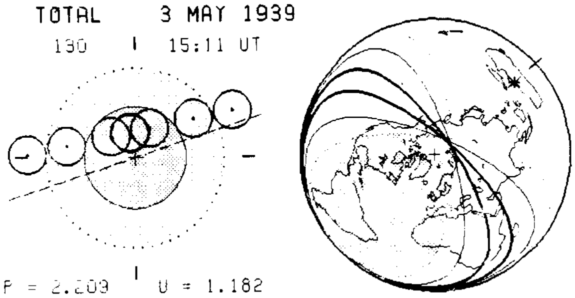
P = 2.180 | U = 1.101

TOTAL 7 NOV 1938
125 | 22:26 UT



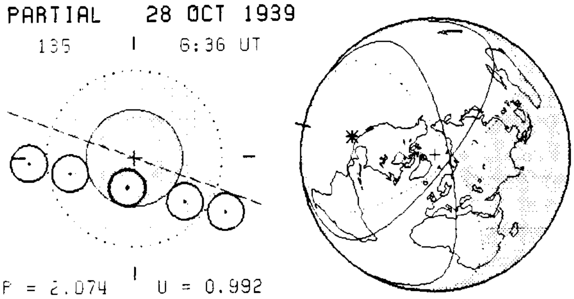
P = 2.384 | U = 1.358

TOTAL 3 MAY 1939
130 | 15:11 UT



P = 2.209 | U = 1.182

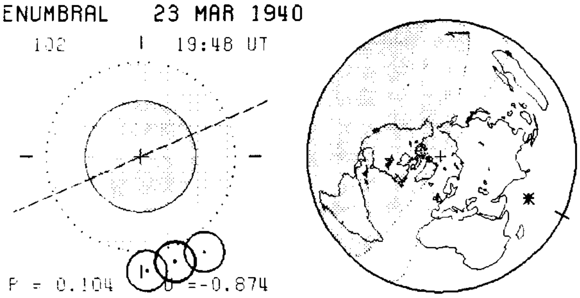
PARTIAL 28 OCT 1939
135 | 6:36 UT



P = 2.074 | U = 0.992

PENUMBRAL 23 MAR 1940

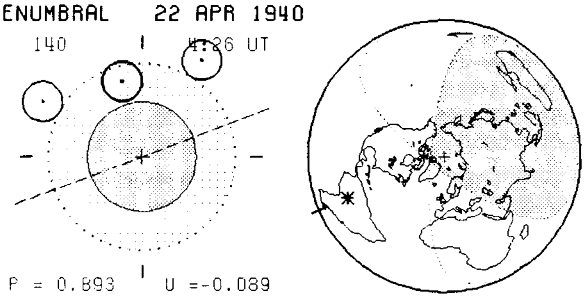
102 19:48 UT



P = 0.104 U =-0.874

PENUMBRAL 22 APR 1940

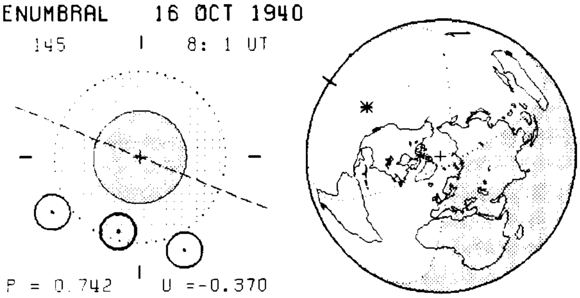
140 4:26 UT



P = 0.893 U =-0.089

PENUMBRAL 16 OCT 1940

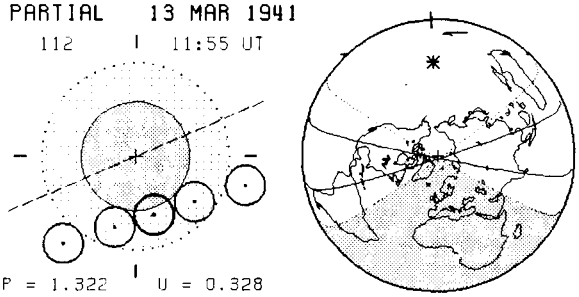
145 8: 1 UT



P = 0.742 U =-0.370

PARTIAL 13 MAR 1941

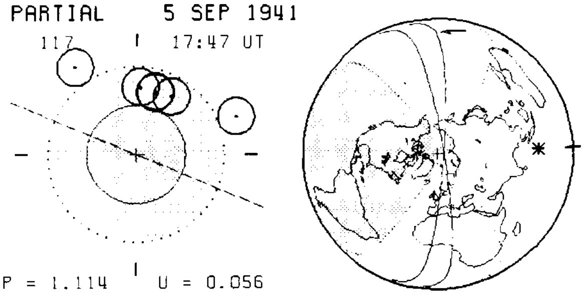
112 11:55 UT



P = 1.322 U = 0.328

PARTIAL 5 SEP 1941

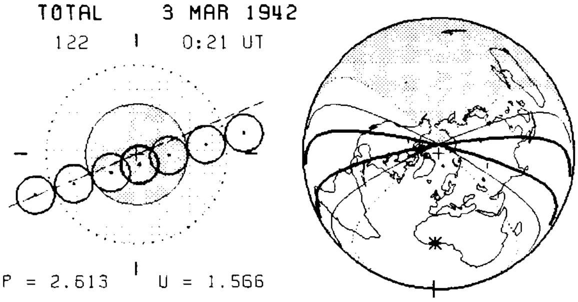
117 17:47 UT



P = 1.114 U = 0.056

TOTAL 3 MAR 1942

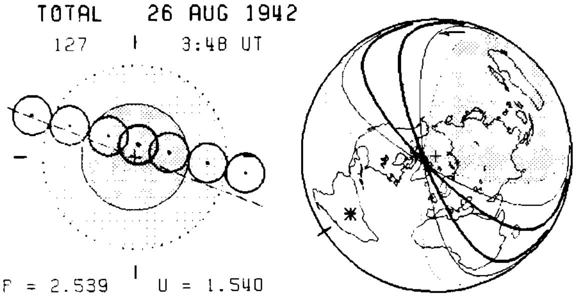
122 0:21 UT



P = 2.613 U = 1.566

TOTAL 26 AUG 1942

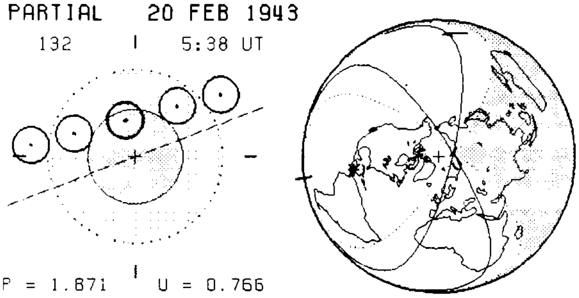
127 3:48 UT



P = 2.539 U = 1.540

PARTIAL 20 FEB 1943

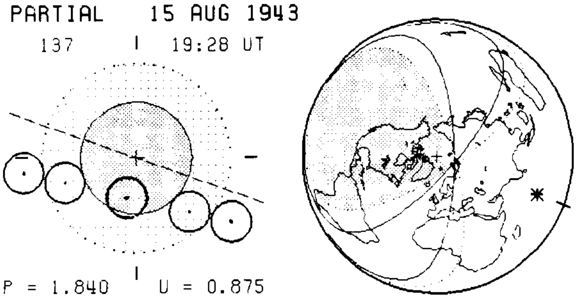
132 5:38 UT



P = 1.871 U = 0.766

PARTIAL 15 AUG 1943

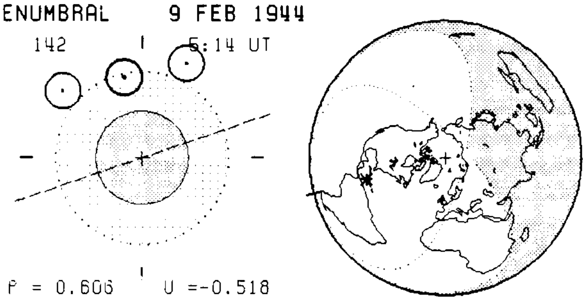
137 19:28 UT



P = 1.840 U = 0.875

PENUMBRAL 9 FEB 1944

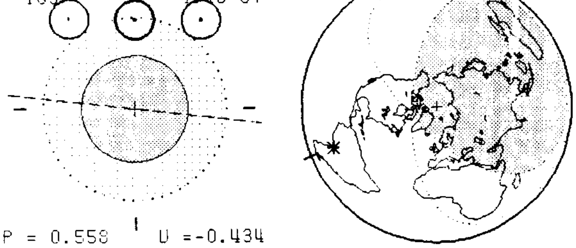
142 5:14 UT



P = 0.606 U =-0.518

PENUMBRAL 6 JUL 1944

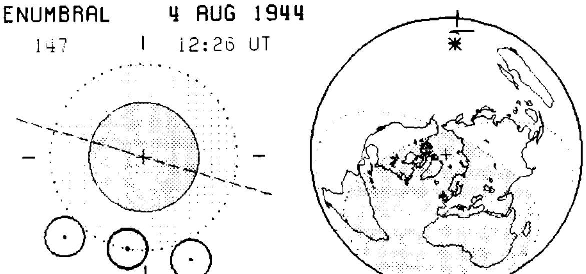
109 | 4:40 UT



P = 0.558 | U =-0.434

PENUMBRAL 4 AUG 1944

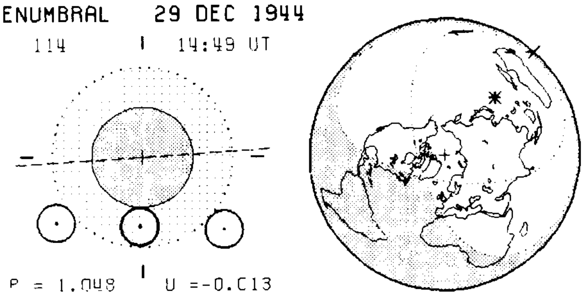
147 | 12:26 UT



P = 0.503 | U =-0.470

PENUMBRAL 29 DEC 1944

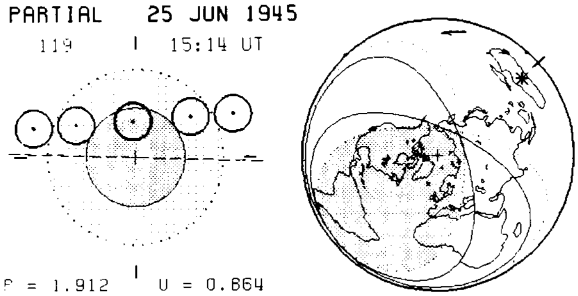
114 | 14:49 UT



P = 1.048 | U =-0.013

PARTIAL 25 JUN 1945

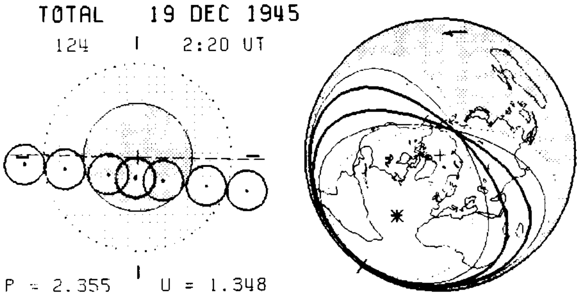
119 | 15:14 UT



P = 1.912 | U = 0.664

TOTAL 19 DEC 1945

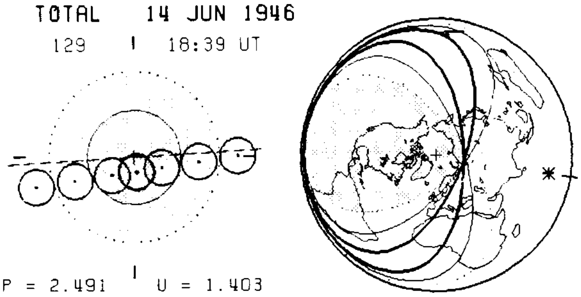
124 | 2:20 UT



P = 2.355 | U = 1.348

TOTAL 14 JUN 1946

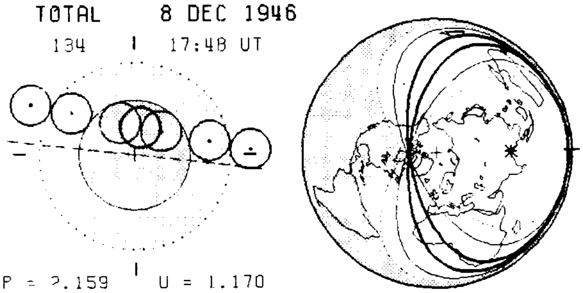
129 | 18:39 UT



P = 2.491 | U = 1.403

TOTAL 8 DEC 1946

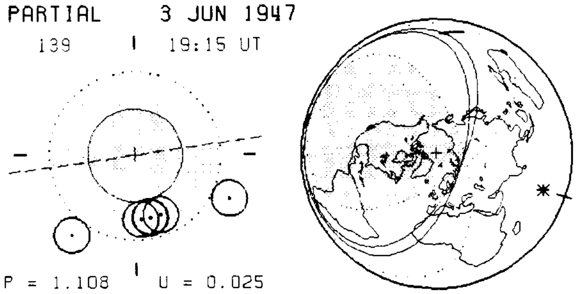
134 | 17:48 UT



P = 2.159 | U = 1.170

PARTIAL 3 JUN 1947

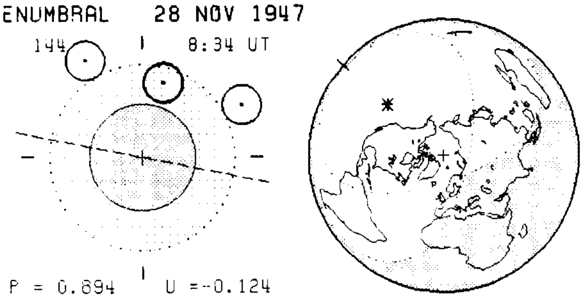
139 | 19:15 UT



P = 1.108 | U = 0.025

PENUMBRAL 28 NOV 1947

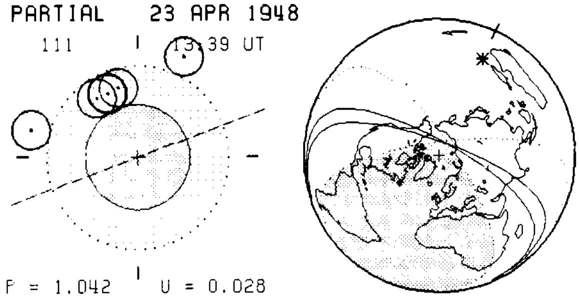
144 | 8:34 UT



P = 0.894 | U =-0.124

PARTIAL 23 APR 1948

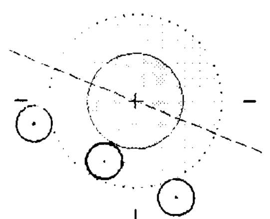
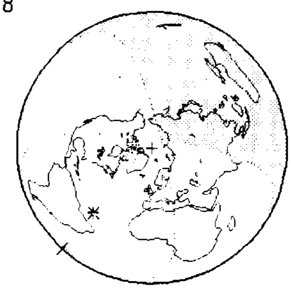
111 | 13:39 UT



P = 1.042 | U = 0.028

PENUMBRAL 18 OCT 1948

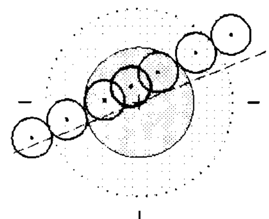
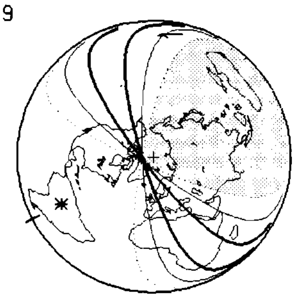
116 | 2:35 UT

P = 1.040 | U =-0.053

TOTAL 13 APR 1949

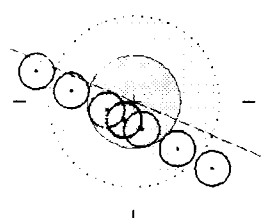
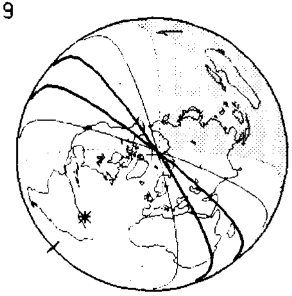
121 | 4:11 UT

P = 2.406 | U = 1.431

TOTAL 7 OCT 1949

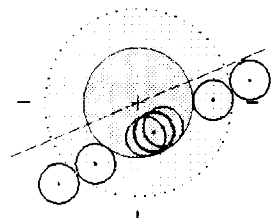
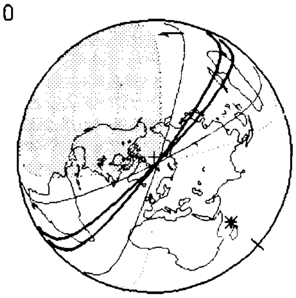
126 | 2:56 UT

P = 2.038 | U = 1.228

TOTAL 2 APR 1950

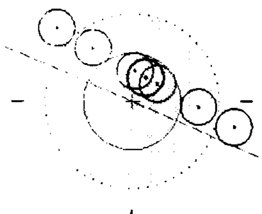
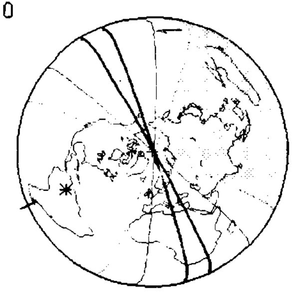
131 | 20:44 UT

P = 2.020 | U = 1.038

TOTAL 26 SEP 1950

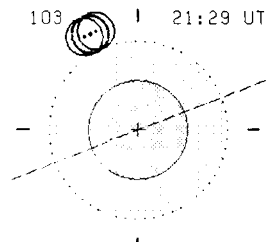
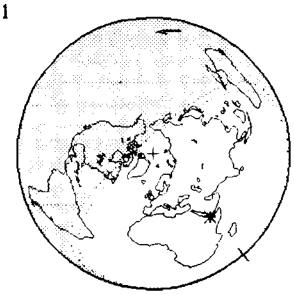
136 | 4:17 UT

P = 2.159 | U = 1.083

PENUMBRAL 21 FEB 1951

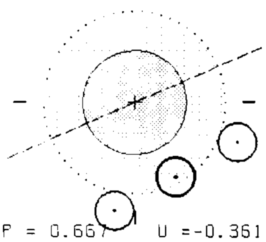
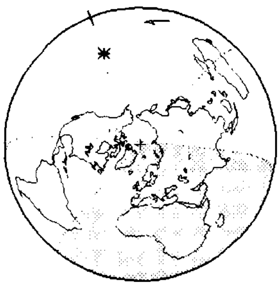
103 | 21:29 UT

P = 0.007 | U =-1.060

PENUMBRAL 23 MAR 1951

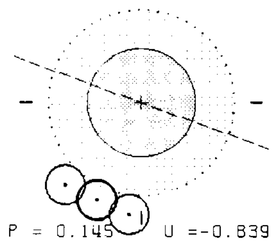
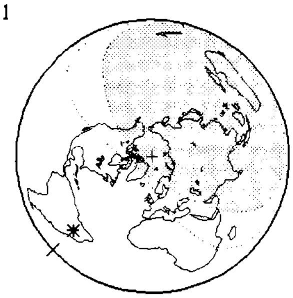
141 | 10:37 UT

P = 0.667 | U =-0.361

PENUMBRAL 17 AUG 1951

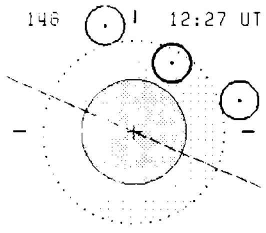
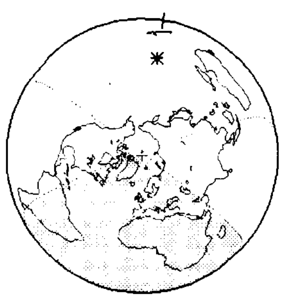
108 | 3:14 UT

P = 0.145 | U =-0.839

PENUMBRAL 15 SEP 1951

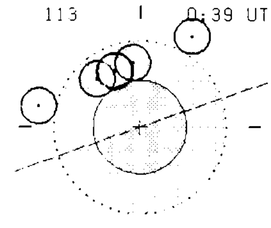
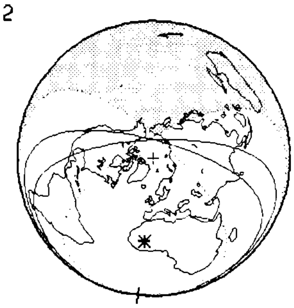
146 | 12:27 UT

P = 0.829 | U =-0.188

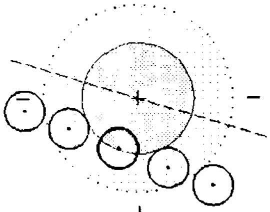
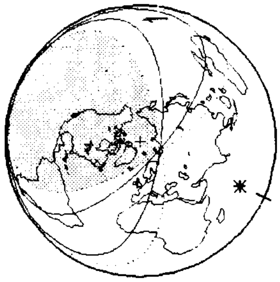
PARTIAL 11 FEB 1952

113 | 0:39 UT

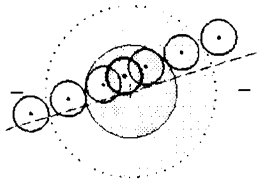
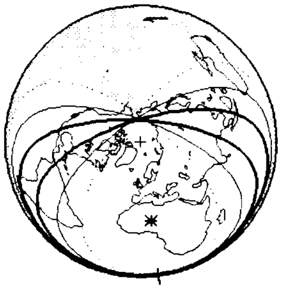
P = 1.205 | U = 0.088

PARTIAL 5 AUG 1952
118 I 19:47 UT

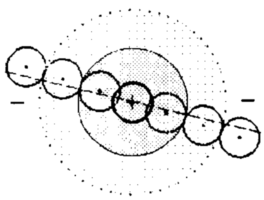
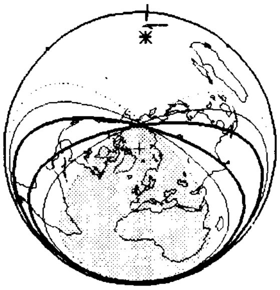
P = 1.409 I U = 0.538

TOTAL 29 JAN 1953
123 I 23:47 UT

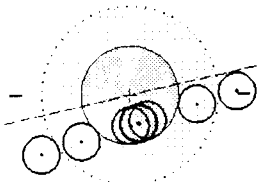
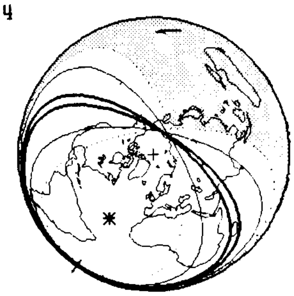
P = 2.455 I U = 1.336

TOTAL 26 JUL 1953
128 I 12:21 UT

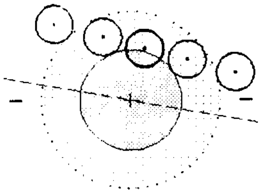
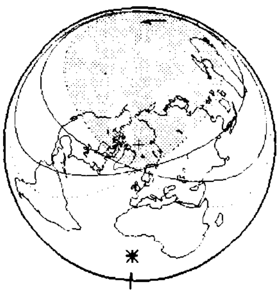
P = 2.852 I U = 1.869

TOTAL 19 JAN 1954
133 I 2:32 UT

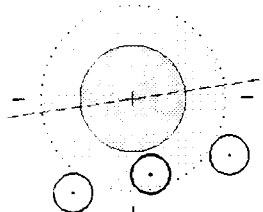
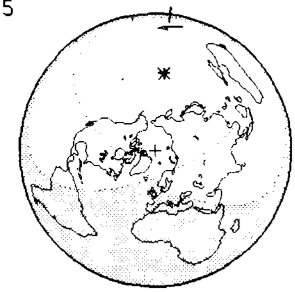
P = 2.111 I U = 1.037

PARTIAL 16 JUL 1954
138 I 0:20 UT

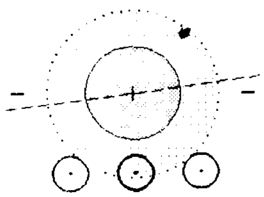
P = 1.446 I U = 0.410

PENUMBRAL 8 JAN 1955
143 I 12:33 UT

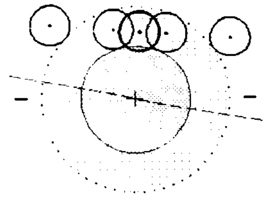
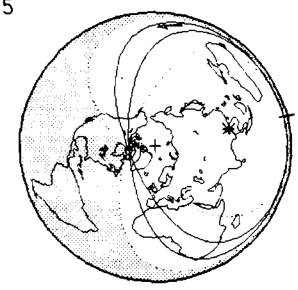
P = 0.881 I U =-0.137

PENUMBRAL 5 JUN 1955
110 I 14:23 UT



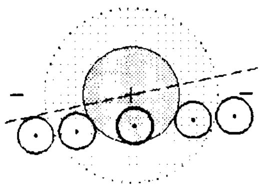

P = 0.648 I U =-0.445

PARTIAL 29 NOV 1955
115 I 16:59 UT

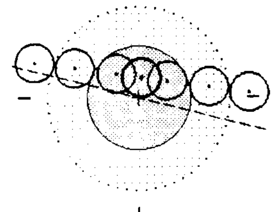
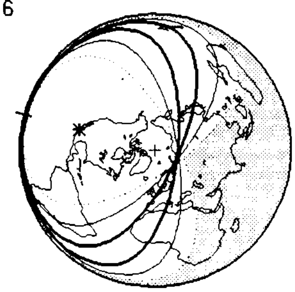
P = 1.117 I U = 0.125

PARTIAL 24 MAY 1956
120 I 15:31 UT




P = 2.043 I U = 0.970

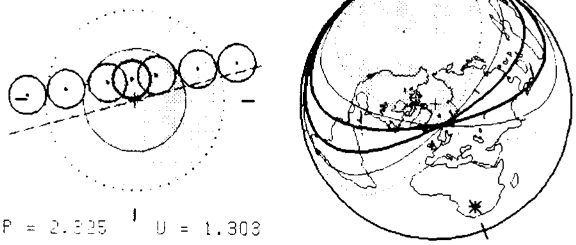
TOTAL 18 NOV 1956
125 I 6:48 UT

P = 2.354 I U = 1.323

TOTAL 13 MAY 1957

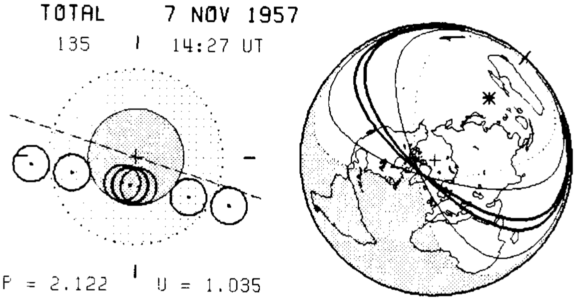
130 | 22:31 UT



P = 2.325 | U = 1.303

TOTAL 7 NOV 1957

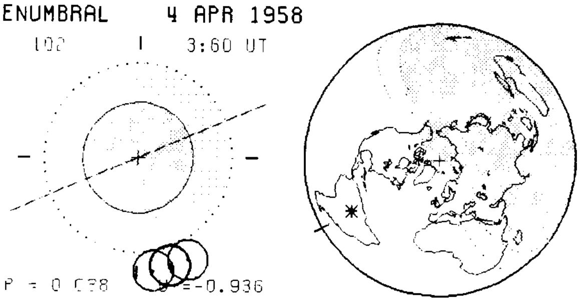
135 | 14:27 UT



P = 2.122 | U = 1.035

PENUMBRAL 4 APR 1958

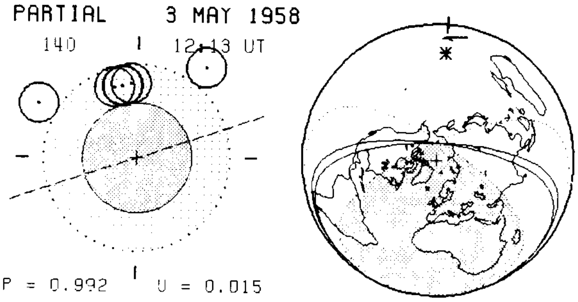
102 | 3:60 UT



P = 0.038 | U = -0.936

PARTIAL 3 MAY 1958

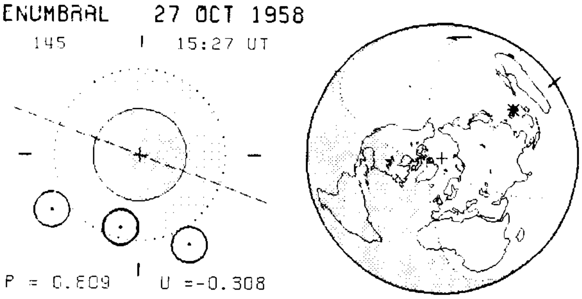
140 | 12:13 UT



P = 0.992 | U = 0.015

PENUMBRAL 27 OCT 1958

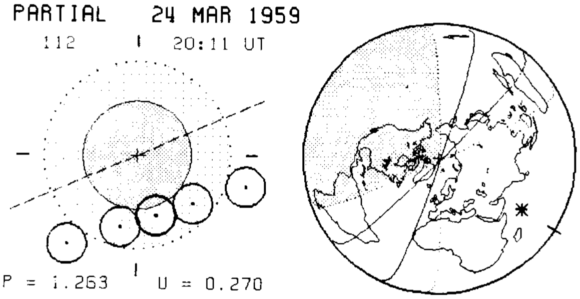
145 | 15:27 UT



P = 0.809 | U = -0.308

PARTIAL 24 MAR 1959

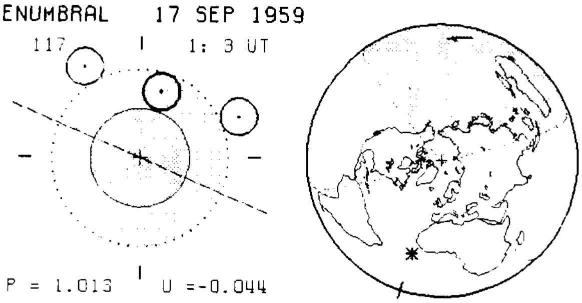
112 | 20:11 UT



P = 1.263 | U = 0.270

PENUMBRAL 17 SEP 1959

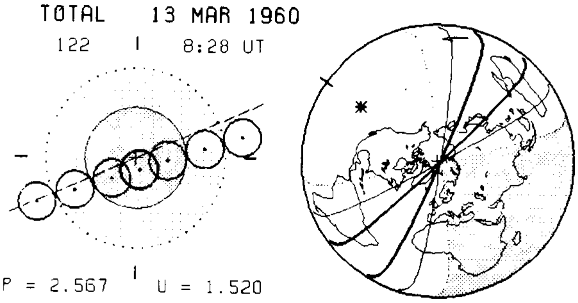
117 | 1: 3 UT



P = 1.013 | U = -0.044

TOTAL 13 MAR 1960

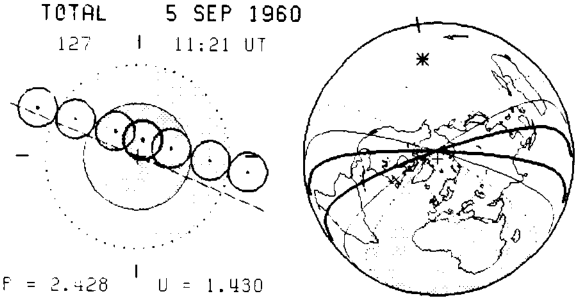
122 | 8:28 UT



P = 2.567 | U = 1.520

TOTAL 5 SEP 1960

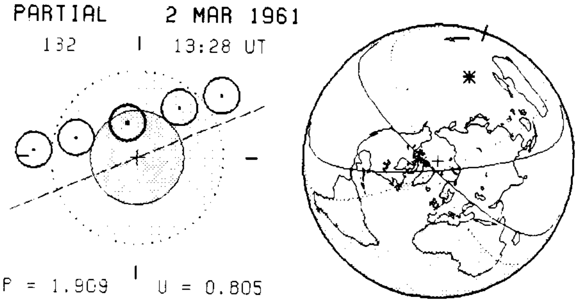
127 | 11:21 UT



P = 2.428 | U = 1.430

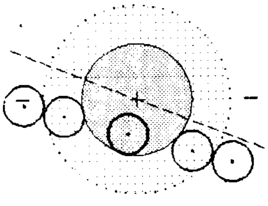
PARTIAL 2 MAR 1961

132 | 13:28 UT



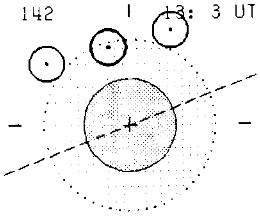
P = 1.909 | U = 0.805

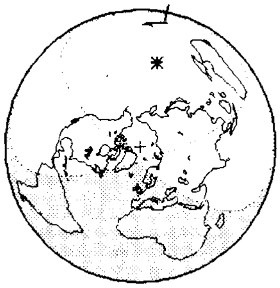
PARTIAL 26 AUG 1961
137 I 3: 8 UT



P = 1.958 I U = 0.992

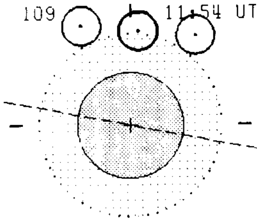
PENUMBRAL 19 FEB 1962
142 I 13: 3 UT

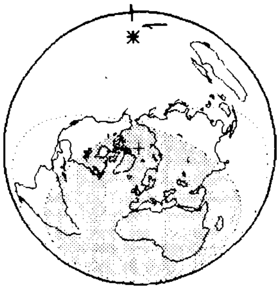




P = 0.638 I U =-0.482

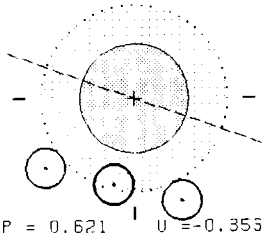
PENUMBRAL 17 JUL 1962
109 I 11:54 UT

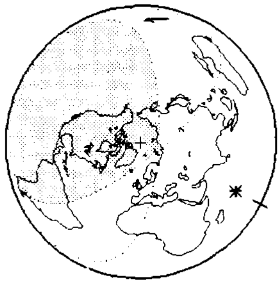




P = 0.418 I U =-0.578

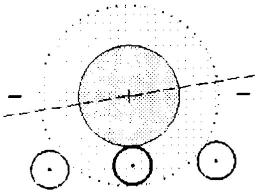
PENUMBRAL 15 AUG 1962
147 I 19:57 UT

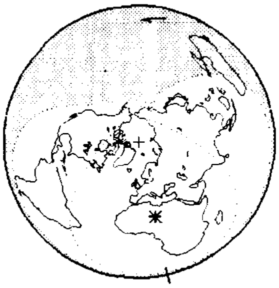




P = 0.621 I U =-0.355

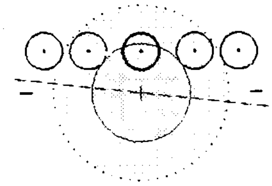
PENUMBRAL 9 JAN 1963
114 I 23:19 UT

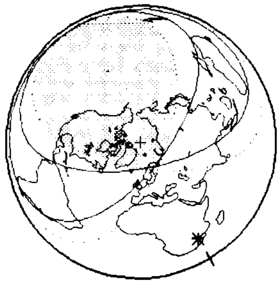




P = 1.044 I U =-0.014

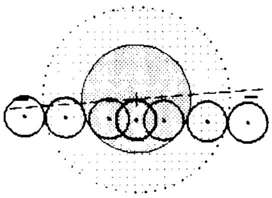
PARTIAL 6 JUL 1963
119 I 22: 2 UT

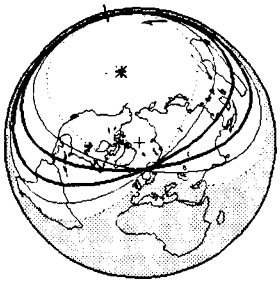




P = 1.762 I U = 0.711

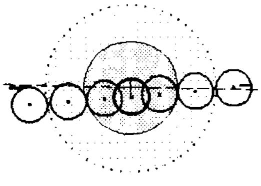
TOTAL 30 DEC 1963
124 I 11: 7 UT

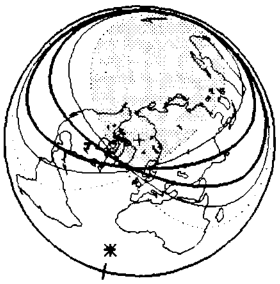




P = 2.346 I U = 1.340

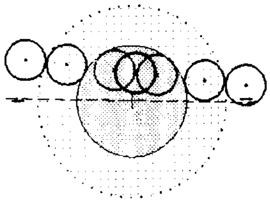
TOTAL 25 JUN 1964
129 I 1: 6 UT





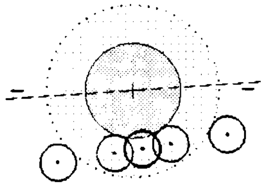
P = 2.650 I U = 1.561

TOTAL 19 DEC 1964
134 I 2:37 UT



P = 2.171 I U = 1.180

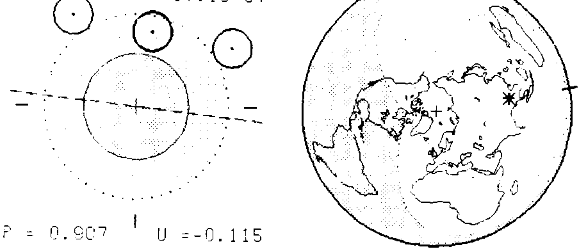
PARTIAL 14 JUN 1965
139 I 1:49 UT



P = 1.261 I U = 0.182

PENUMBRAL 8 DEC 1965

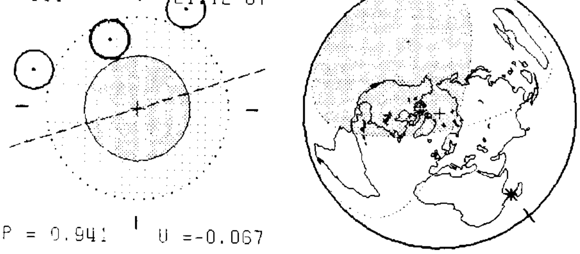
144 | 17:10 UT



P = 0.907 | U =-0.115

PENUMBRAL 4 MAY 1966

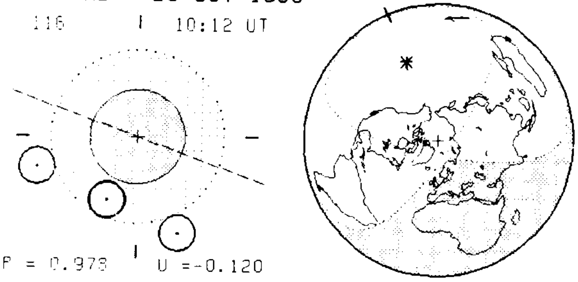
111 | 21:12 UT



P = 0.941 | U =-0.067

PENUMBRAL 29 OCT 1966

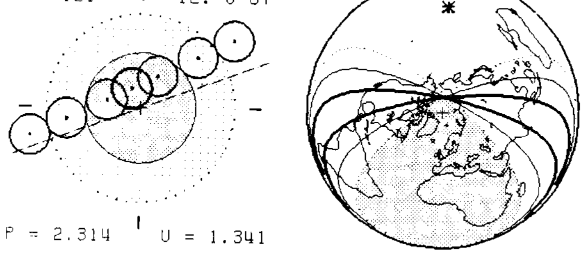
116 | 10:12 UT



P = 0.978 | U =-0.120

TOTAL 24 APR 1967

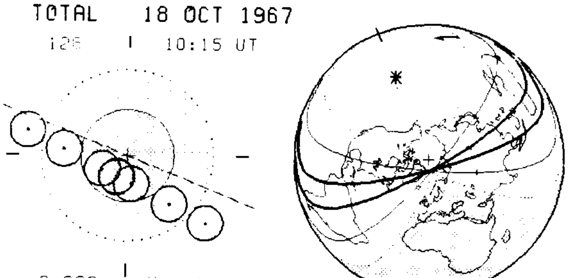
121 | 12: 6 UT



P = 2.314 | U = 1.341

TOTAL 18 OCT 1967

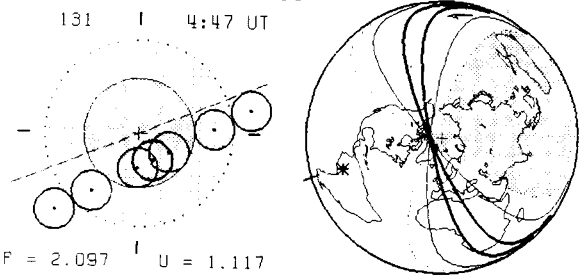
126 | 10:15 UT



P = 2.260 | U = 1.147

TOTAL 13 APR 1968

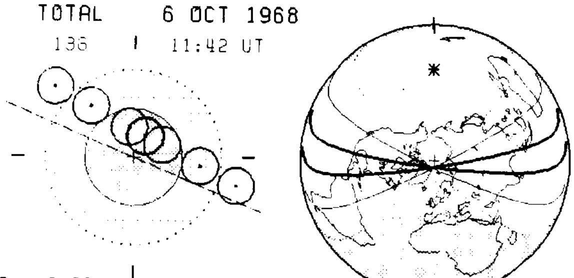
131 | 4:47 UT



P = 2.097 | U = 1.117

TOTAL 6 OCT 1968

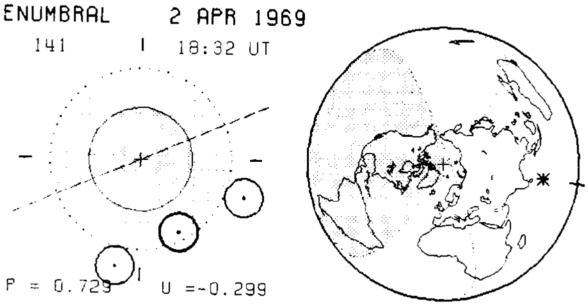
136 | 11:42 UT



P = 2.250 | U = 1.174

PENUMBRAL 2 APR 1969

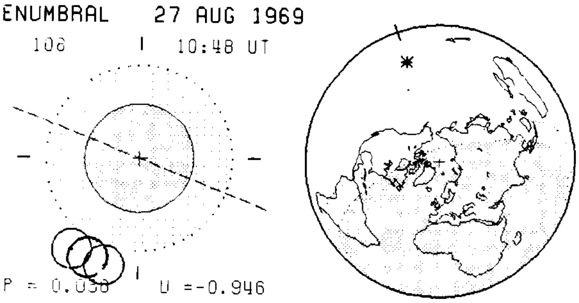
141 | 18:32 UT



P = 0.729 | U =-0.299

PENUMBRAL 27 AUG 1969

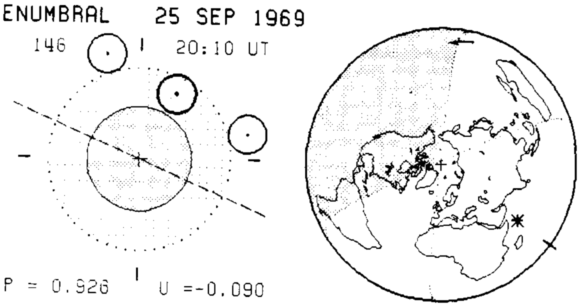
108 | 10:48 UT



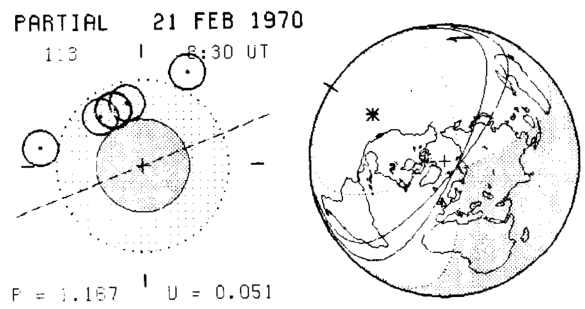
P = 0.058 | U =-0.946

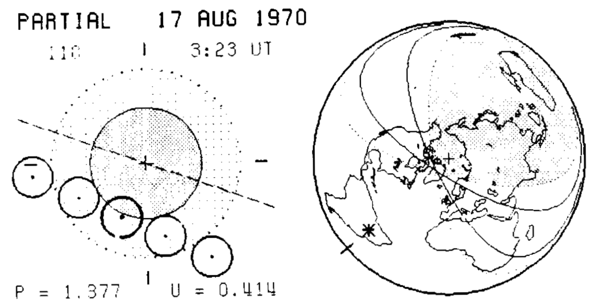
PENUMBRAL 25 SEP 1969

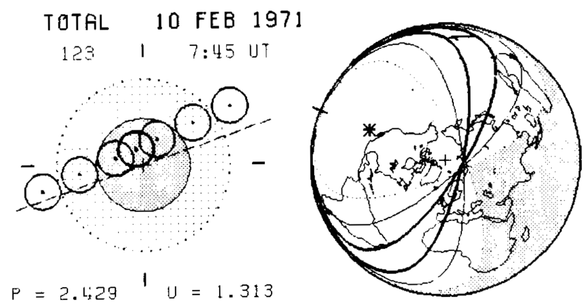
146 | 20:10 UT

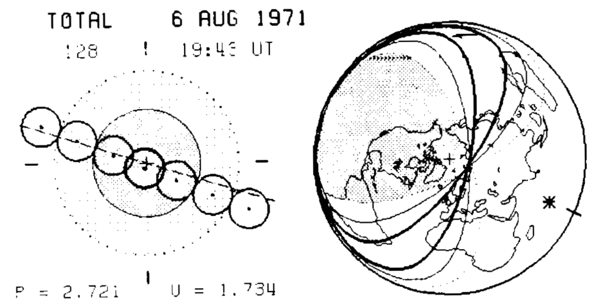


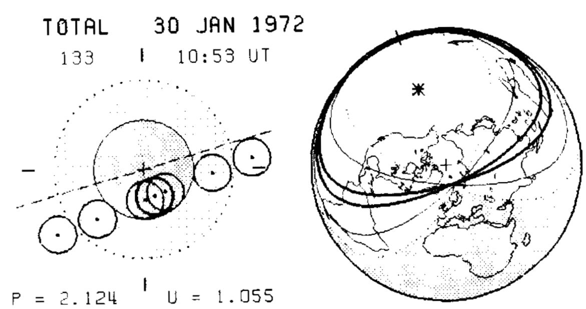
P = 0.926 | U =-0.090

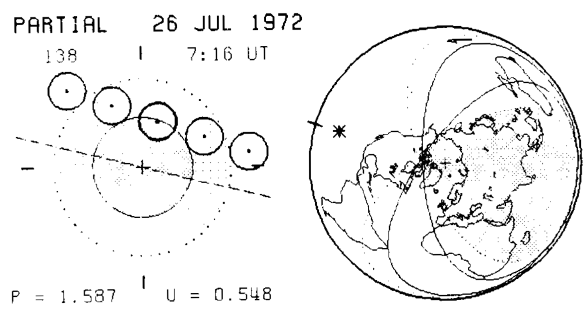

PARTIAL 21 FEB 1970
113 | 8:30 UT
P = 1.187 | U = 0.051

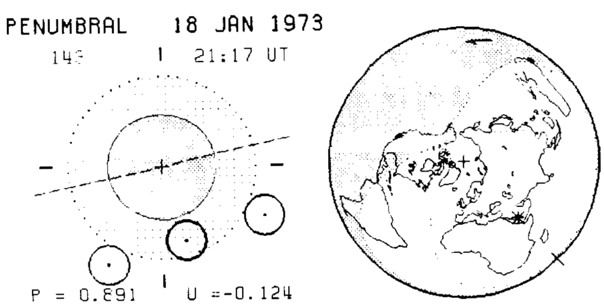

PARTIAL 17 AUG 1970
118 | 3:23 UT
P = 1.377 | U = 0.414

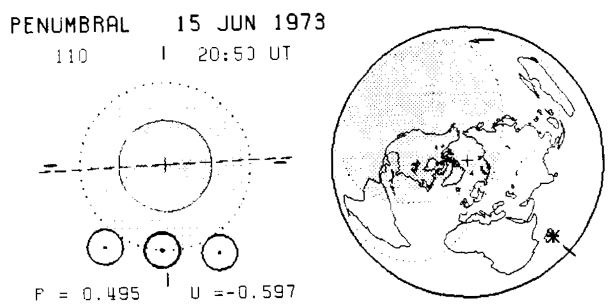

TOTAL 10 FEB 1971
123 | 7:45 UT
P = 2.429 | U = 1.313

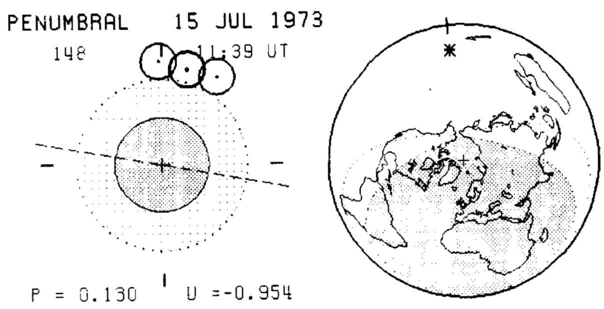

TOTAL 6 AUG 1971
128 | 19:43 UT
P = 2.721 | U = 1.734

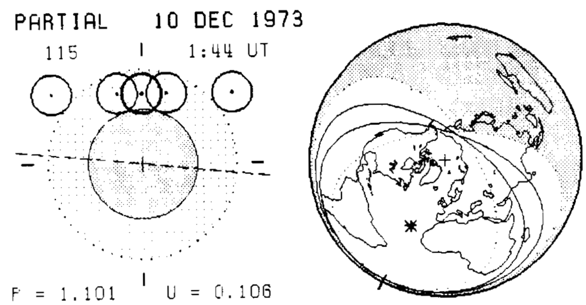

TOTAL 30 JAN 1972
133 | 10:53 UT
P = 2.124 | U = 1.055


PARTIAL 26 JUL 1972
138 | 7:16 UT
P = 1.587 | U = 0.548


PENUMBRAL 18 JAN 1973
143 | 21:17 UT
P = 0.891 | U =-0.124

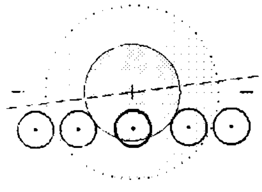

PENUMBRAL 15 JUN 1973
110 | 20:50 UT
P = 0.495 | U =-0.597

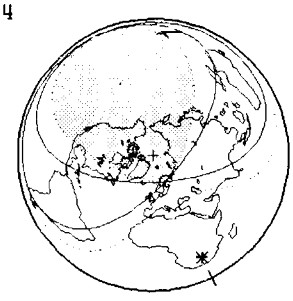

PENUMBRAL 15 JUL 1973
148 | 11:39 UT
P = 0.130 | U =-0.954


PARTIAL 10 DEC 1973
115 | 1:44 UT
P = 1.101 | U = 0.106

PARTIAL 4 JUN 1974

120 22:16 UT

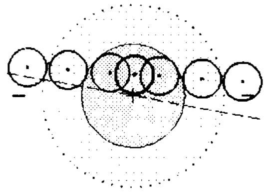


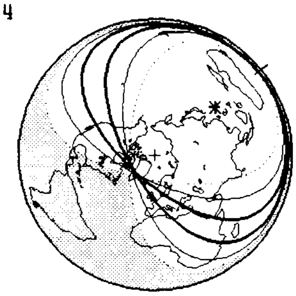


P = 1.901 U = 0.832

TOTAL 29 NOV 1974

125 15:13 UT

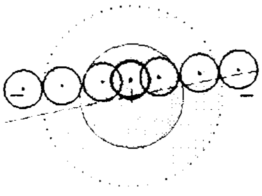


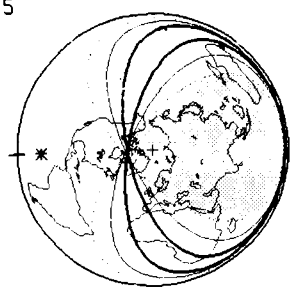


P = 2.331 U = 1.295

TOTAL 25 MAY 1975

130 5:48 UT

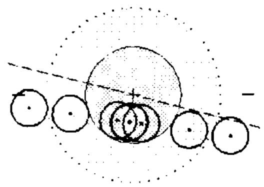


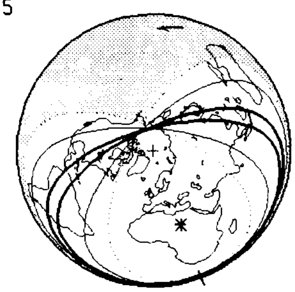


P = 2.447 U = 1.430

TOTAL 18 NOV 1975

135 22:23 UT

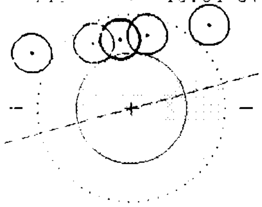


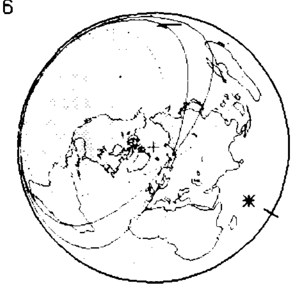


P = 2.161 U = 1.069

PARTIAL 13 MAY 1976

140 19:54 UT

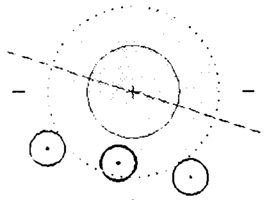


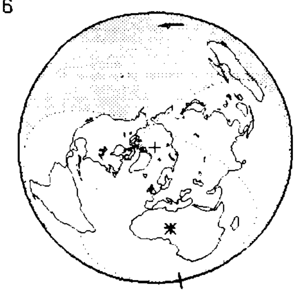


P = 1.101 U = 0.127

PENUMBRAL 6 NOV 1976

145 23: 1 UT

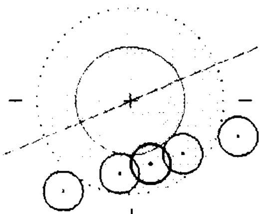


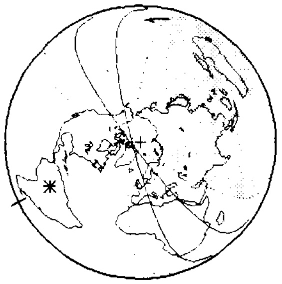


P = 0.864 U =-0.255

PARTIAL 4 APR 1977

112 4:18 UT

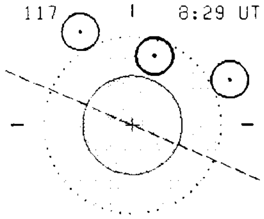




P = 1.191 U = 0.199

PENUMBRAL 27 SEP 1977

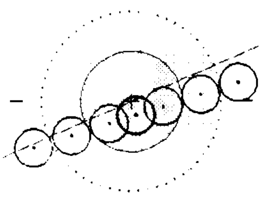
117 8:29 UT

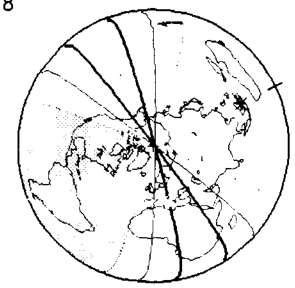


P = 0.927 U =-0.131

TOTAL 24 MAR 1978

122 16:22 UT

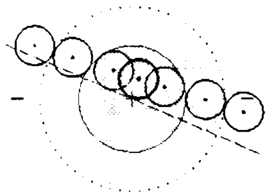


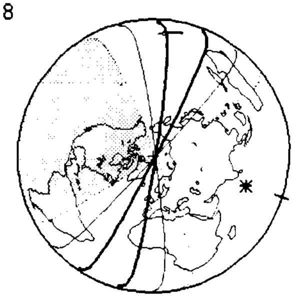


P = 2.505 U = 1.457

TOTAL 16 SEP 1978

127 19: 4 UT

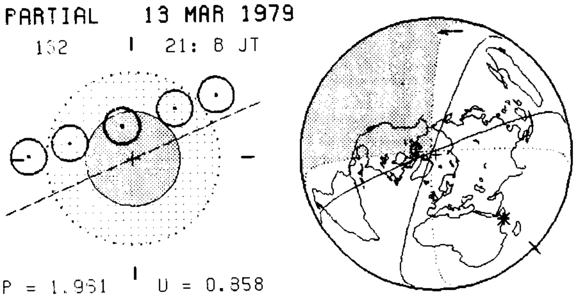




P = 2.332 U = 1.333

PARTIAL 13 MAR 1979

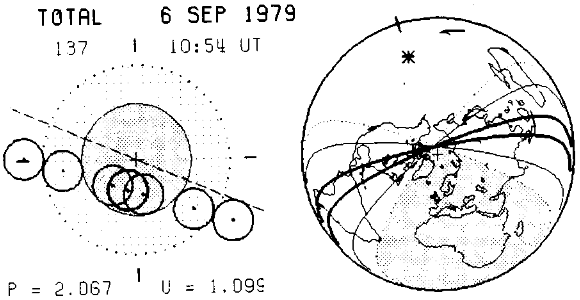
132 | 21: 8 UT



P = 1.961 | U = 0.858

TOTAL 6 SEP 1979

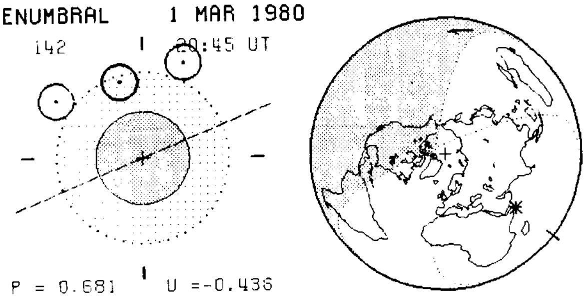
137 | 10:54 UT



P = 2.067 | U = 1.099

PENUMBRAL 1 MAR 1980

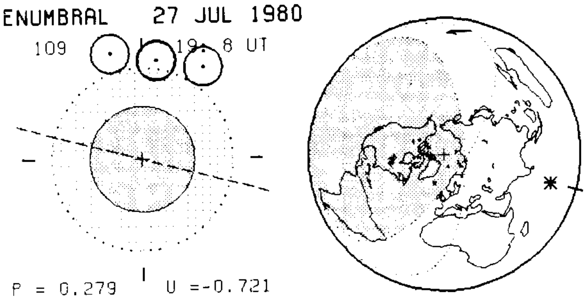
142 | 20:45 UT



P = 0.681 | U =-0.436

PENUMBRAL 27 JUL 1980

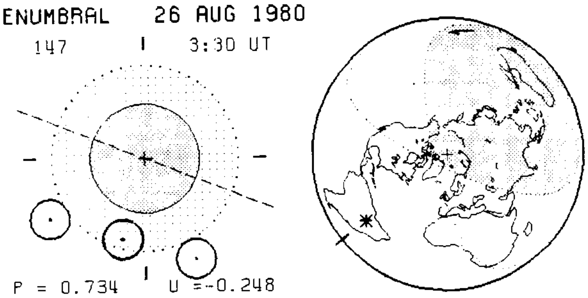
109 | 19: 8 UT



P = 0.279 | U =-0.721

PENUMBRAL 26 AUG 1980

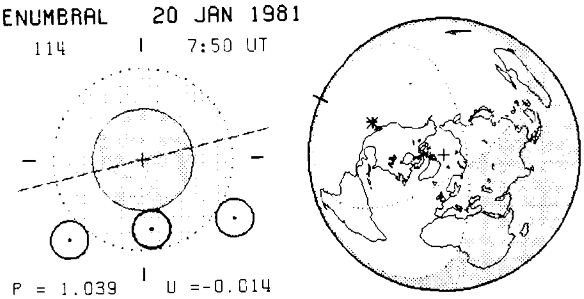
147 | 3:30 UT



P = 0.734 | U =-0.248

PENUMBRAL 20 JAN 1981

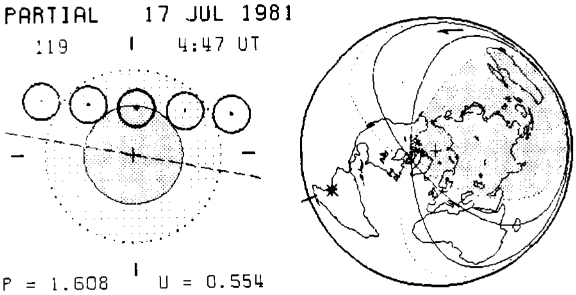
114 | 7:50 UT



P = 1.039 | U =-0.014

PARTIAL 17 JUL 1981

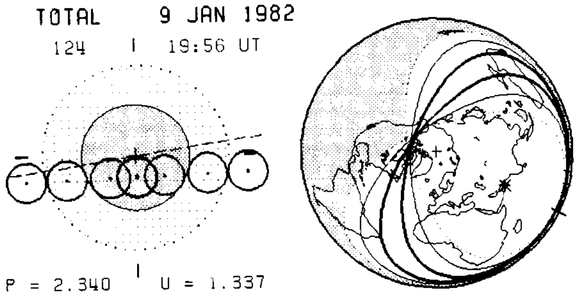
119 | 4:47 UT



P = 1.608 | U = 0.554

TOTAL 9 JAN 1982

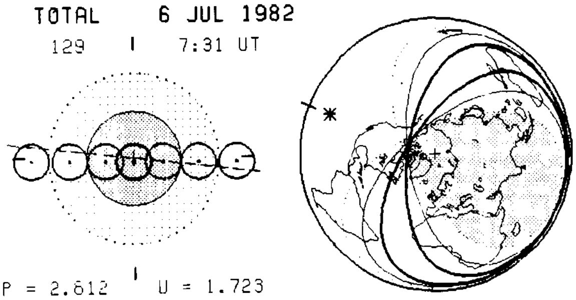
124 | 19:56 UT



P = 2.340 | U = 1.337

TOTAL 6 JUL 1982

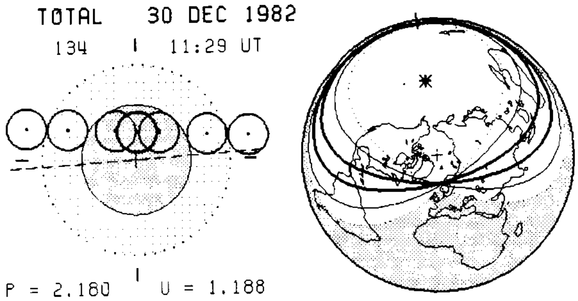
129 | 7:31 UT



P = 2.612 | U = 1.723

TOTAL 30 DEC 1982

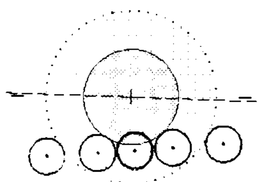
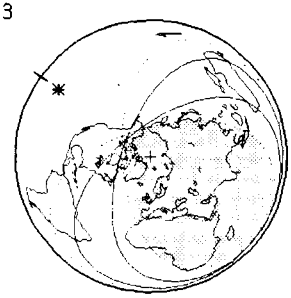
134 | 11:29 UT



P = 2.180 | U = 1.188

PARTIAL 25 JUN 1983

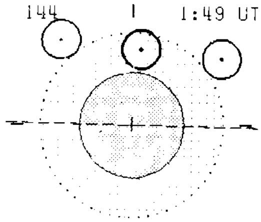
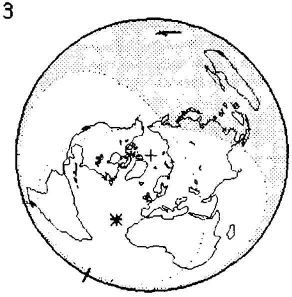
130 | 8:22 UT

P = 1.416 | U = 0.339

PENUMBRAL 20 DEC 1983

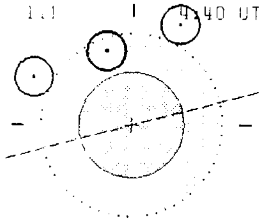
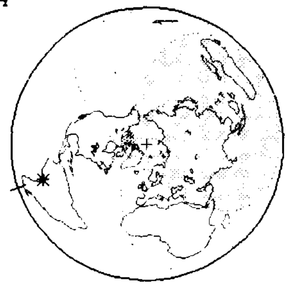
144 | 1:49 UT

P = 0.914 | U =-0.111

PENUMBRAL 15 MAY 1984

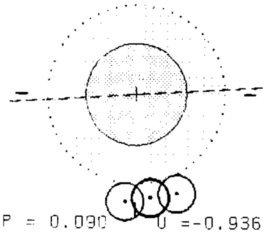
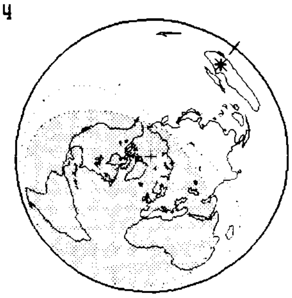
111 | 4:40 UT

P = 0.832 | U =-0.170

PENUMBRAL 13 JUN 1984

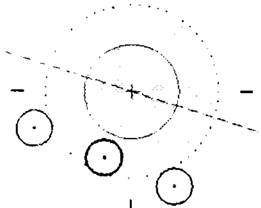
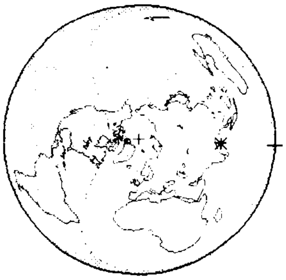
149 | 14:26 UT

P = 0.090 | U =-0.936

PENUMBRAL 8 NOV 1984

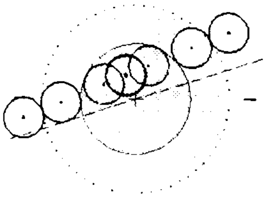
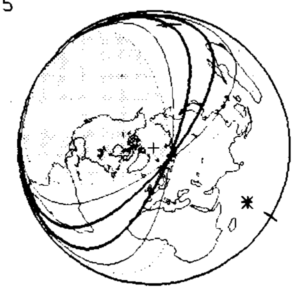
116 | 17:55 UT

P = 0.925 | U =-0.178

TOTAL 4 MAY 1985

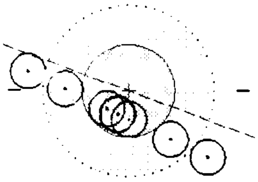
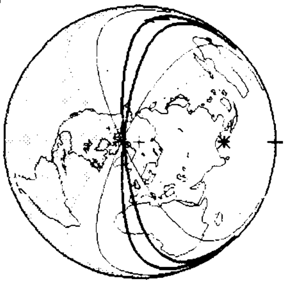
121 | 19:56 UT

P = 2.212 | U = 1.243

TOTAL 28 OCT 1985

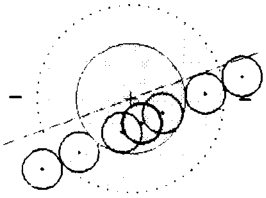
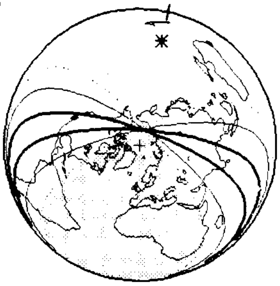
126 | 17:42 UT

P = 2.194 | U = 1.078

TOTAL 24 APR 1986

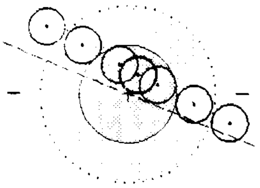
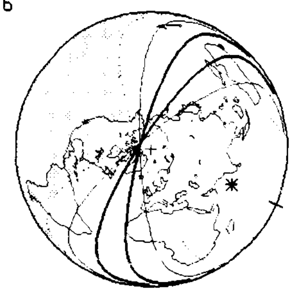
131 | 12:43 UT

P = 2.187 | U = 1.208

TOTAL 17 OCT 1986

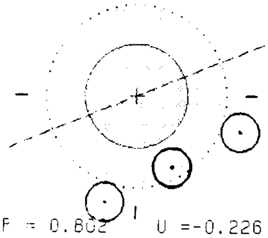
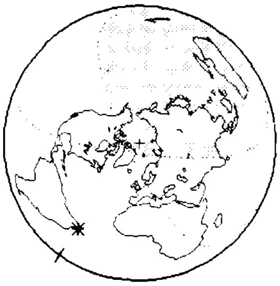
136 | 19:18 UT

P = 2.327 | U = 1.250

PENUMBRAL 14 APR 1987

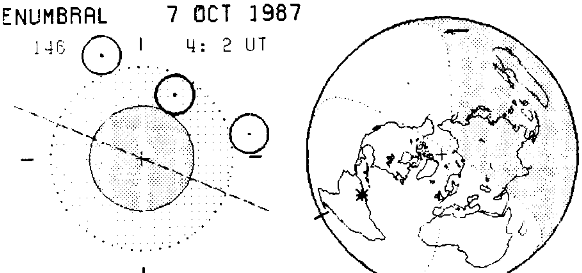
141 | 2:19 UT

P = 0.802 | U =-0.226

PENUMBRAL 7 OCT 1987

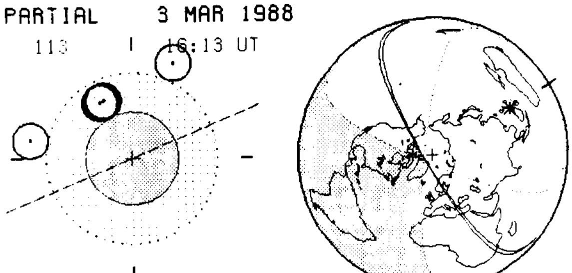
146 | 4: 2 UT



P = 1.011 | U =-0.004

PARTIAL 3 MAR 1988

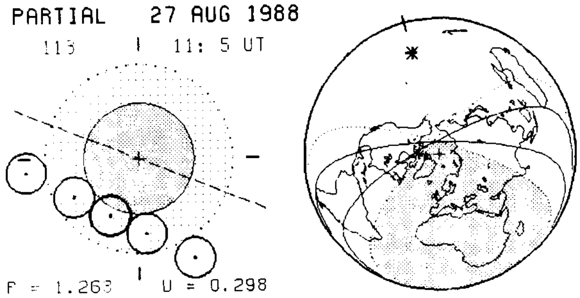
113 | 16:13 UT



P = 1.117 | U = 0.003

PARTIAL 27 AUG 1988

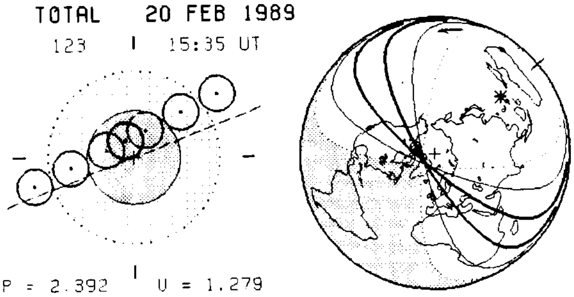
113 | 11: 5 UT



P = 1.263 | U = 0.298

TOTAL 20 FEB 1989

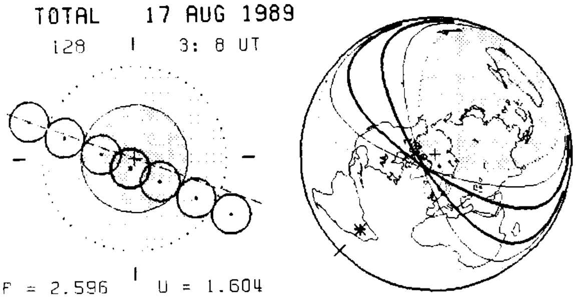
123 | 15:35 UT



P = 2.392 | U = 1.279

TOTAL 17 AUG 1989

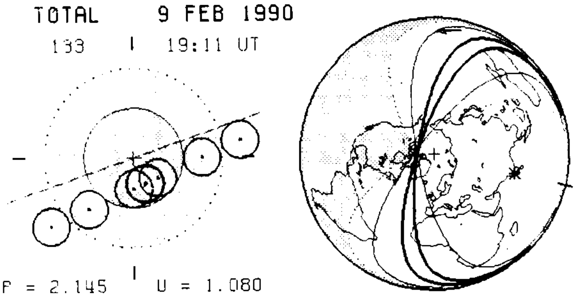
128 | 3: 8 UT



P = 2.596 | U = 1.604

TOTAL 9 FEB 1990

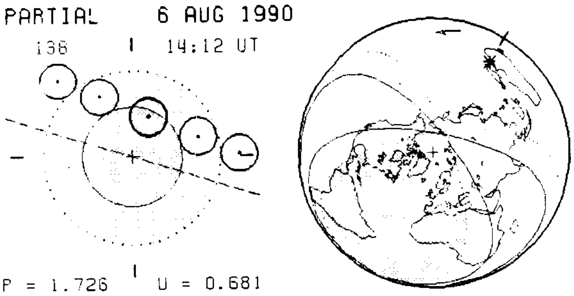
133 | 19:11 UT



P = 2.145 | U = 1.080

PARTIAL 6 AUG 1990

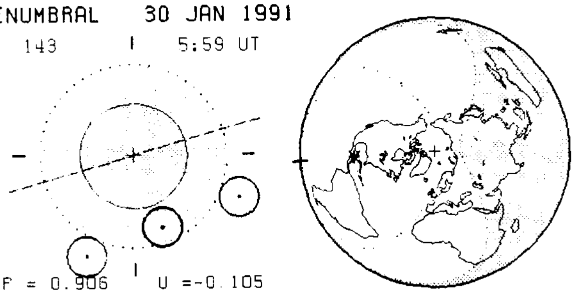
138 | 14:12 UT



P = 1.726 | U = 0.681

PENUMBRAL 30 JAN 1991

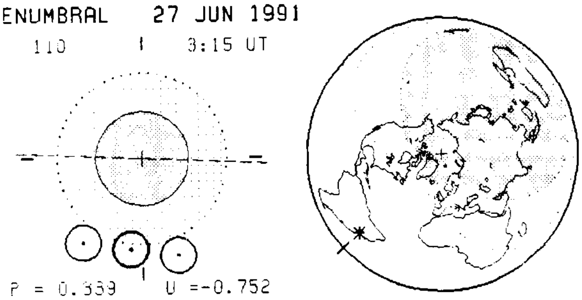
143 | 5:59 UT



P = 0.906 | U =-0.105

PENUMBRAL 27 JUN 1991

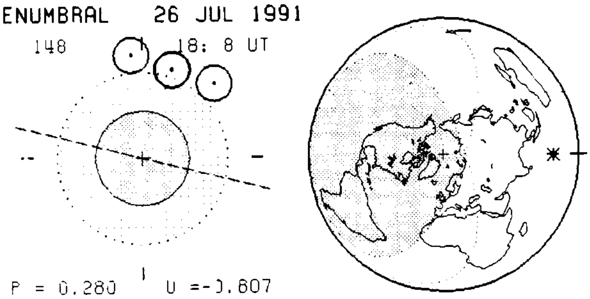
110 | 3:15 UT



P = 0.339 | U =-0.752

PENUMBRAL 26 JUL 1991

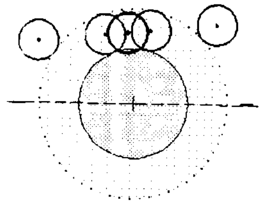
148 | 18: 8 UT

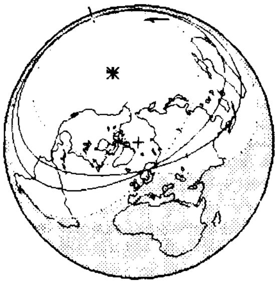


P = 0.280 | U =-0.607

PARTIAL 21 DEC 1991

115 | 10:33 UT

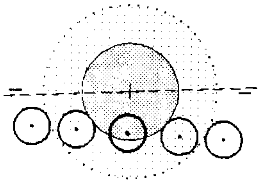


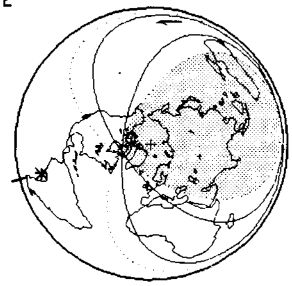


P = 1.090 | U = 0.093

PARTIAL 15 JUN 1992

120 | 4:57 UT

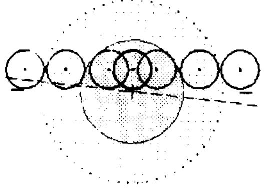


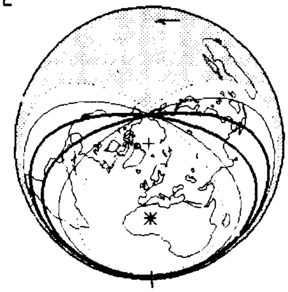


P = 1.752 | U = 0.687

TOTAL 9 DEC 1992

125 | 23:44 UT

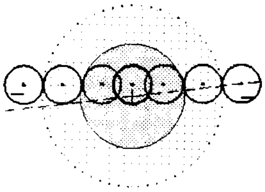


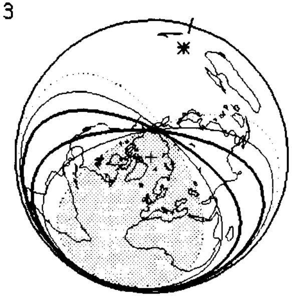


P = 2.317 | U = 1.276

TOTAL 4 JUN 1993

130 | 13: 0 UT

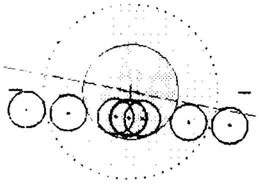


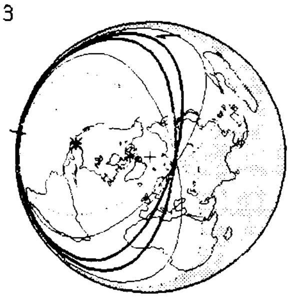


P = 2.578 | U = 1.567

TOTAL 29 NOV 1993

135 | 6:26 UT

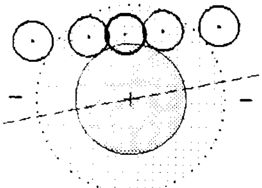


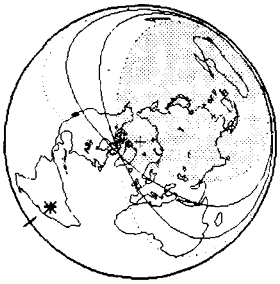


P = 2.189 | U = 1.092

PARTIAL 25 MAY 1994

140 | 3:30 UT

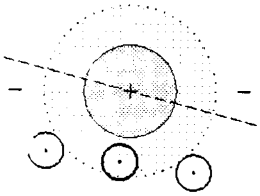


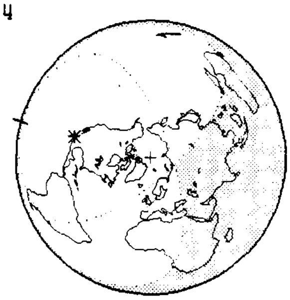


P = 1.219 | U = 0.249

PENUMBRAL 18 NOV 1994

145 | 6:44 UT

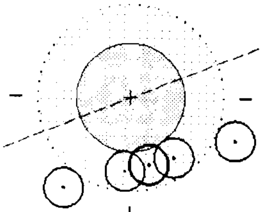


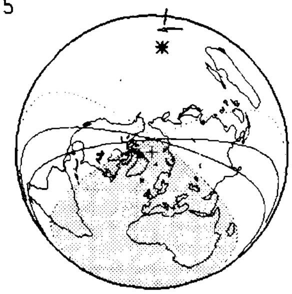


P = 0.908 | U =-0.215

PARTIAL 15 APR 1995

112 | 12:18 UT

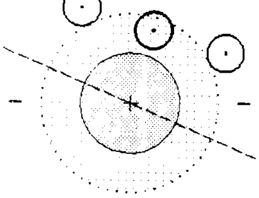


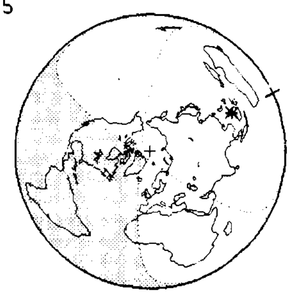


P = 1.109 | U = 0.117

PENUMBRAL 8 OCT 1995

117 | 16: 4 UT

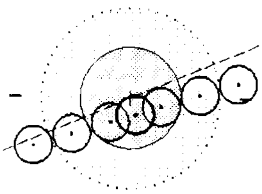


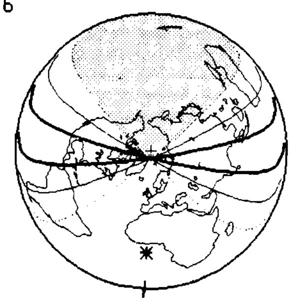


P = 0.851 | U =-0.206

TOTAL 4 APR 1996

122 | 0:10 UT

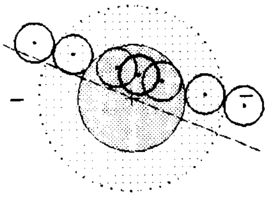
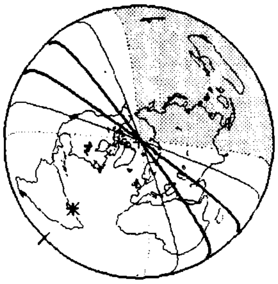




P = 2.433 | U = 1.385

TOTAL 27 SEP 1996

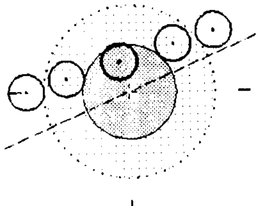
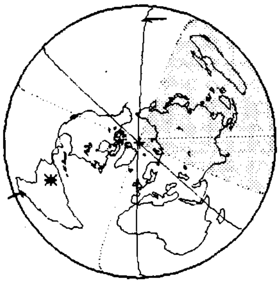
127 | 2:54 UT

P = 2.244 | U = 1.245

PARTIAL 24 MAR 1997

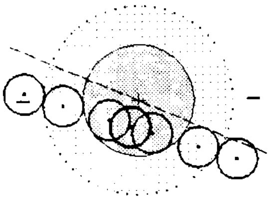
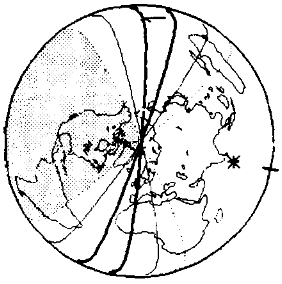
132 | 4:39 UT

P = 2.025 | U = 0.924

TOTAL 16 SEP 1997

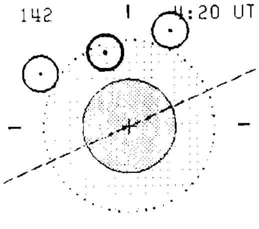
137 | 18:47 UT

P = 2.167 | U = 1.197

PENUMBRAL 13 MAR 1998

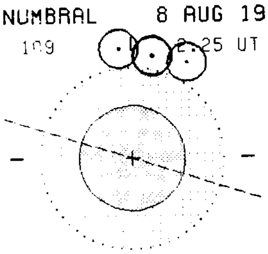
142 | 4:20 UT




P = 0.735 | U =-0.378

PENUMBRAL 8 AUG 1998

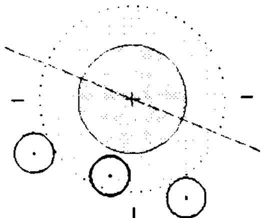
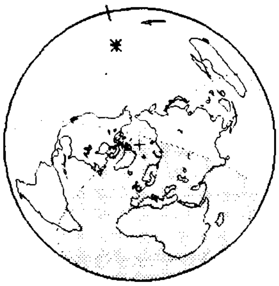
109 | 2:25 UT




P = 0.146 | U =-0.858

PENUMBRAL 6 SEP 1998

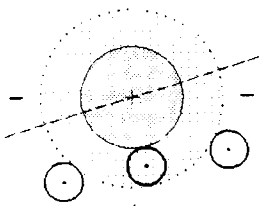
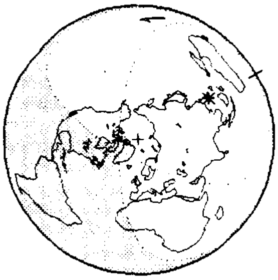
147 | 11:10 UT

P = 0.837 | U =-0.149

PENUMBRAL 31 JAN 1999

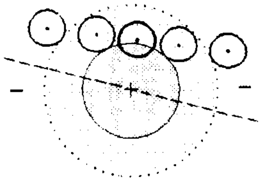
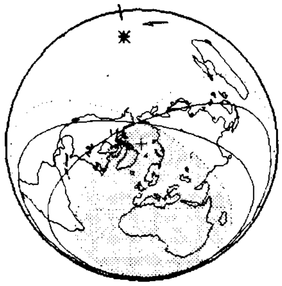
114 | 16:18 UT

P = 1.028 | U =-0.021

PARTIAL 28 JUL 1999

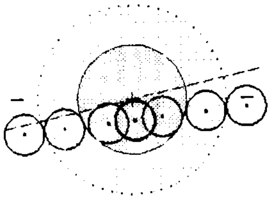
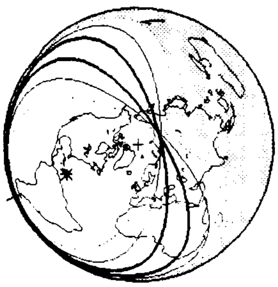
119 | 11:34 UT

P = 1.460 | U = 0.402

TOTAL 21 JAN 2000

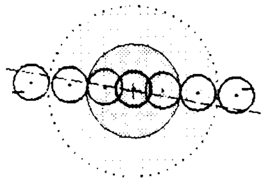
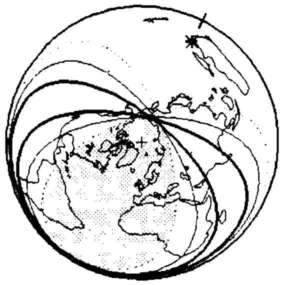
124 | 4:43 UT

P = 2.331 | U = 1.330

TOTAL 16 JUL 2000

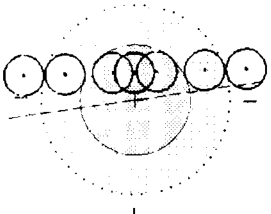
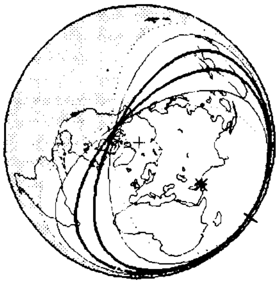
129 | 13:56 UT

P = 2.864 | U = 1.773

TOTAL 9 JAN 2001

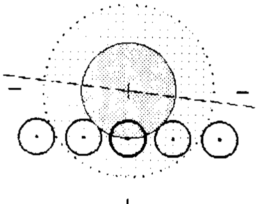
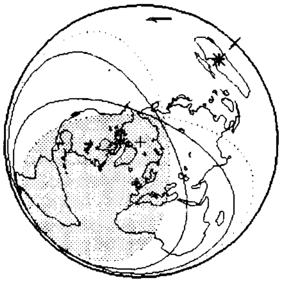
134 | 20:21 UT

P = 2.137 | U = 1.194

PARTIAL 5 JUL 2001

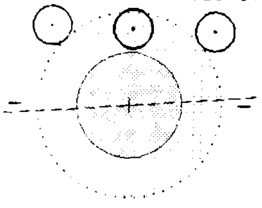
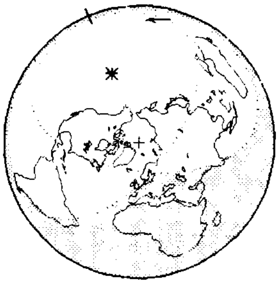
139 | 14:55 UT

P = 1.573 | U = 0.499

PENUMBRAL 30 DEC 2001

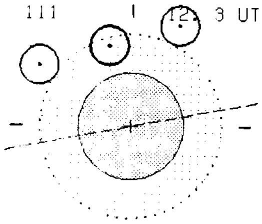
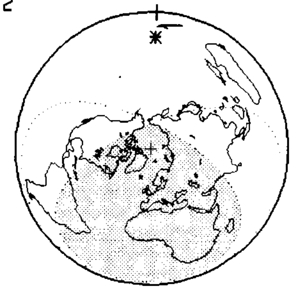
144 | 10:29 UT

P = 0.919 | U =-0.110

PENUMBRAL 26 MAY 2002

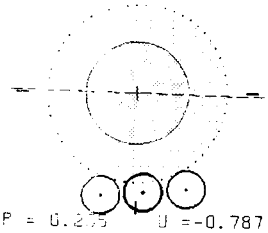
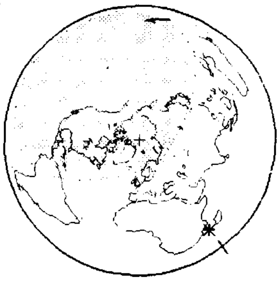
111 | 12: 3 UT

P = 0.714 | U =-0.283

PENUMBRAL 24 JUN 2002

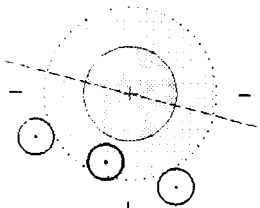
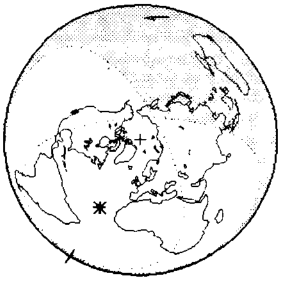
149 | 21:27 UT

P = 0.275 | U =-0.787

PENUMBRAL 20 NOV 2002

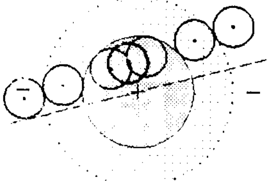
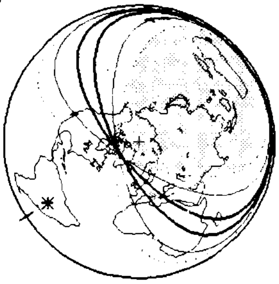
116 | 1:47 UT

P = 0.886 | U =-0.222

TOTAL 16 MAY 2003

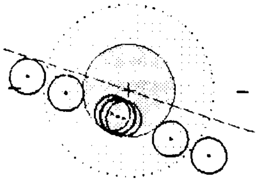
121 | 3:40 UT

P = 2.100 | U = 1.133

TOTAL 9 NOV 2003

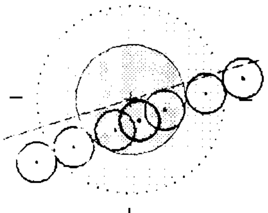
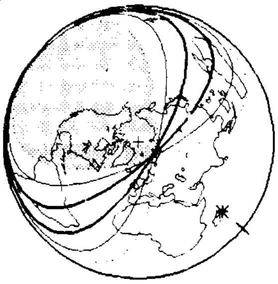
126 | 1:18 UT




P = 2.140 | U = 1.022

TOTAL 4 MAY 2004

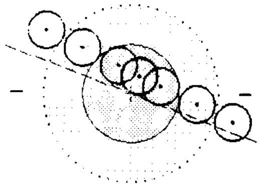
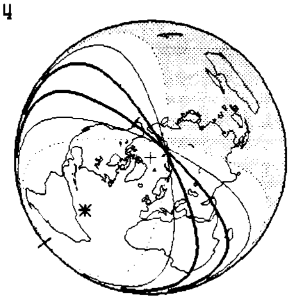
131 | 20:30 UT

P = 2.258 | U = 1.309

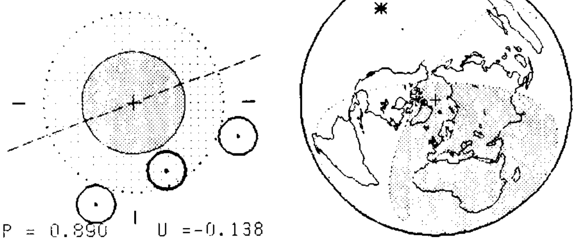
TOTAL 28 OCT 2004

136 | 3: 4 UT

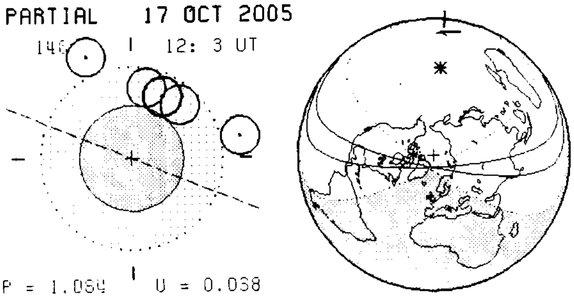
P = 2.590 | U = 1.313

PENUMBRAL 24 APR 2005
141 | 9:55 UT



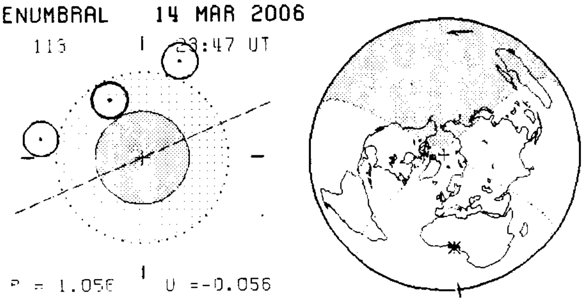
P = 0.890 U =-0.138

PARTIAL 17 OCT 2005
146 | 12: 3 UT



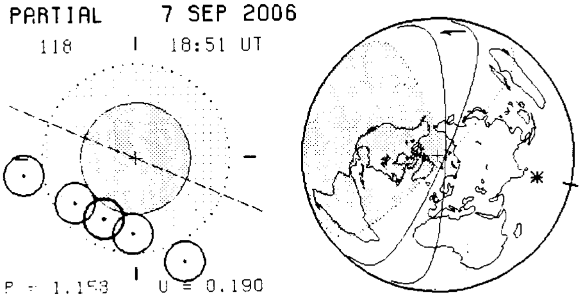
P = 1.064 U = 0.068

PENUMBRAL 14 MAR 2006
113 | 23:47 UT



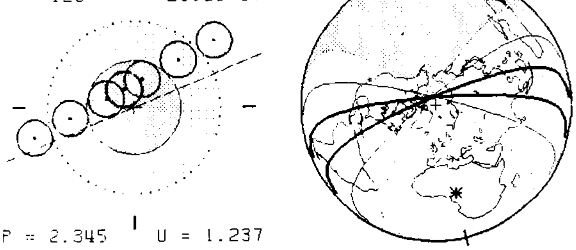
P = 1.056 U =-0.056

PARTIAL 7 SEP 2006
118 | 18:51 UT



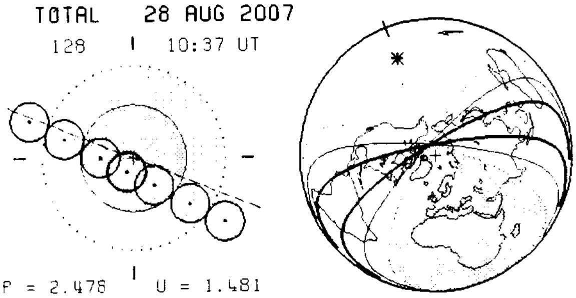
P = 1.158 U = 0.190

TOTAL 3 MAR 2007
123 | 23:21 UT



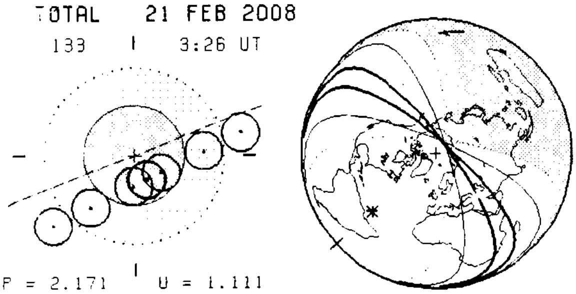
P = 2.345 U = 1.237

TOTAL 28 AUG 2007
128 | 10:37 UT



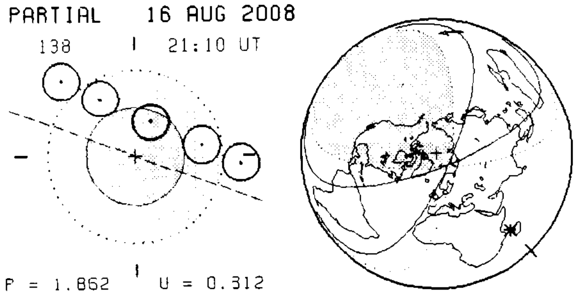
P = 2.478 U = 1.481

TOTAL 21 FEB 2008
133 | 3:26 UT



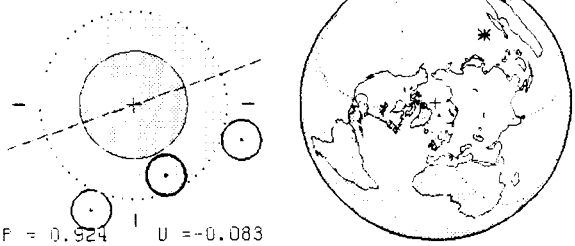
P = 2.171 U = 1.111

PARTIAL 16 AUG 2008
138 | 21:10 UT



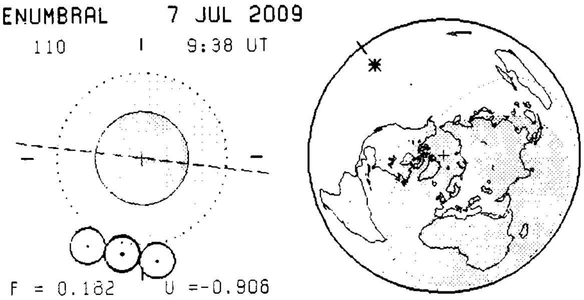
P = 1.862 U = 0.312

PENUMBRAL 9 FEB 2009
143 | 14:38 UT



P = 0.924 U =-0.083

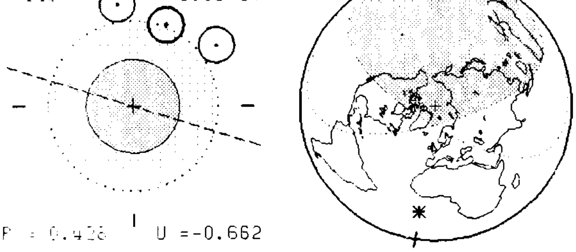
PENUMBRAL 7 JUL 2009
110 | 9:38 UT



P = 0.182 U =-0.906

PENUMBRAL 6 AUG 2009

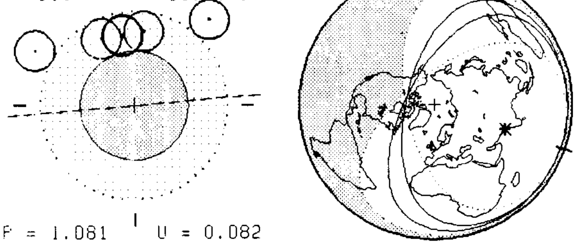
14. 0:39 UT



P = 0.426 U =-0.662

PARTIAL 31 DEC 2009

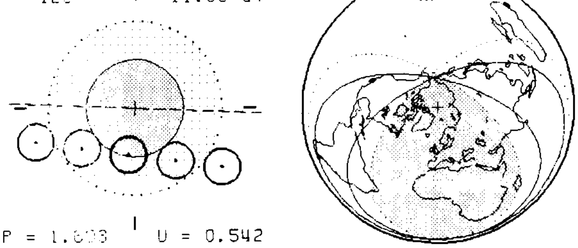
115 19:23 UT



P = 1.081 U = 0.082

PARTIAL 26 JUN 2010

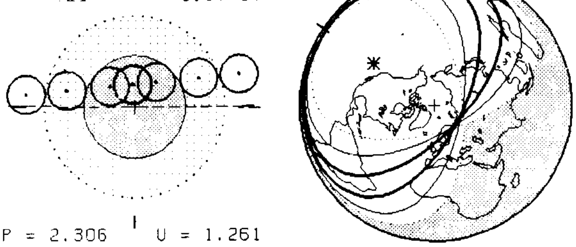
120 11:38 UT



P = 1.6[illegible]3 U = 0.542

TOTAL 21 DEC 2010

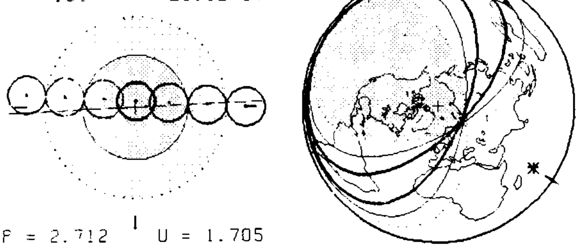
125 8:17 UT



P = 2.306 U = 1.261

TOTAL 15 JUN 2011

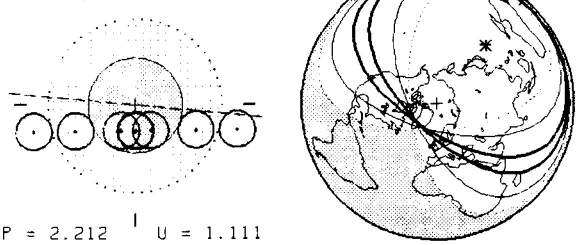
130 20:12 UT



P = 2.712 U = 1.705

TOTAL 10 DEC 2011

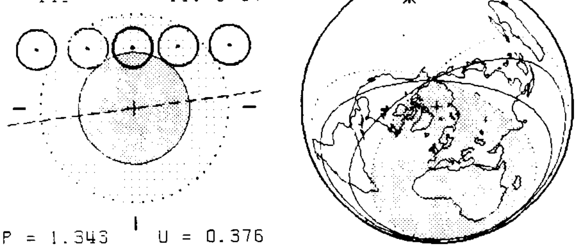
135 14:32 UT



P = 2.212 U = 1.111

PARTIAL 4 JUN 2012

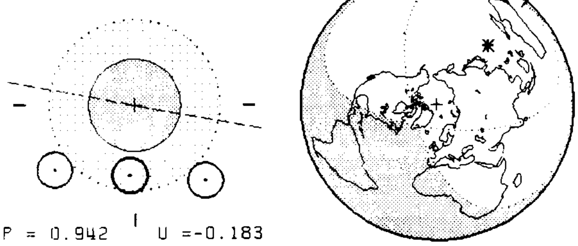
140 11: 3 UT



P = 1.343 U = 0.376

PENUMBRAL 28 NOV 2012

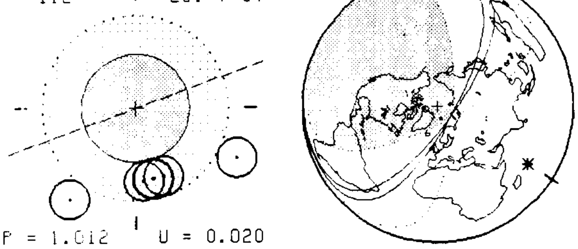
145 14:33 UT



P = 0.942 U =-0.183

PARTIAL 25 APR 2013

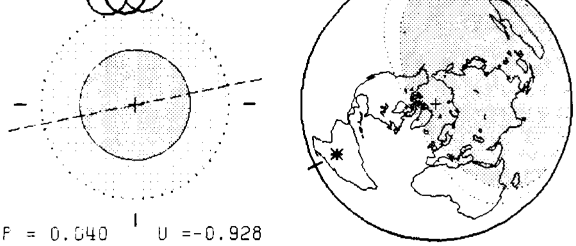
112 20: 7 UT



P = 1.012 U = 0.020

PENUMBRAL 25 MAY 2013

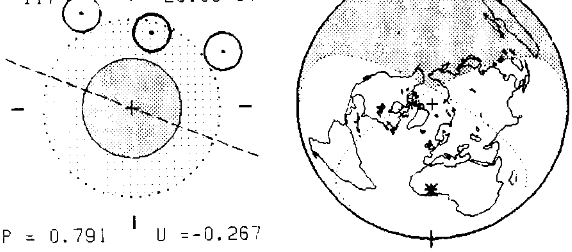
150 4:10 UT



P = 0.040 U =-0.928

PENUMBRAL 18 OCT 2013

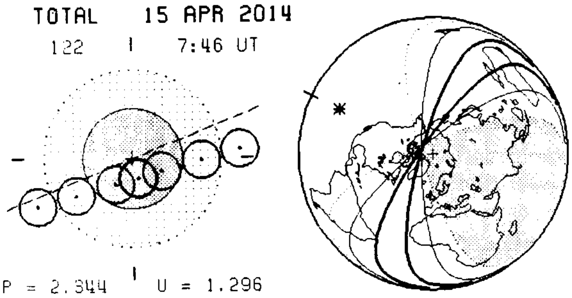
117 | 23:50 UT



P = 0.791 | U =-0.267

TOTAL 15 APR 2014

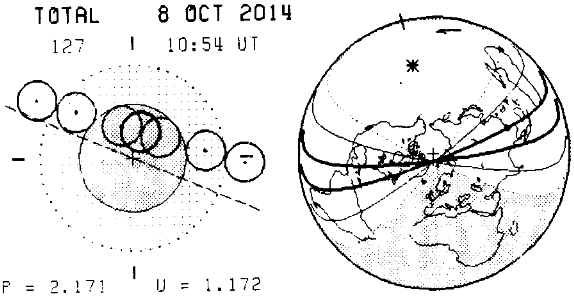
122 | 7:46 UT



P = 2.344 | U = 1.296

TOTAL 8 OCT 2014

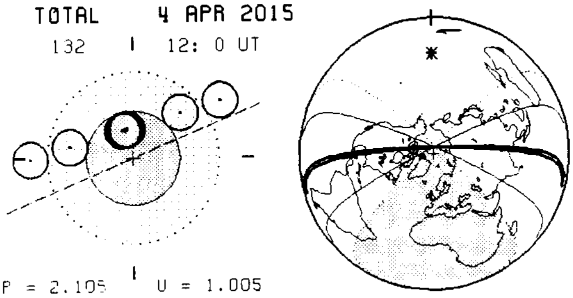
127 | 10:54 UT



P = 2.171 | U = 1.172

TOTAL 4 APR 2015

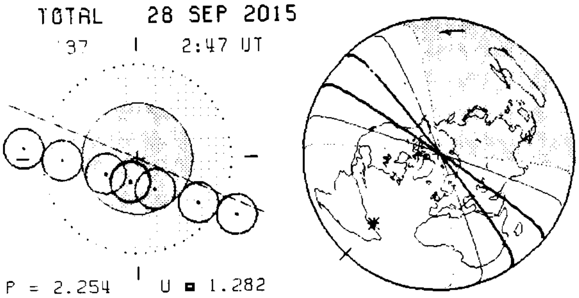
132 | 12: 0 UT



P = 2.105 | U = 1.005

TOTAL 28 SEP 2015

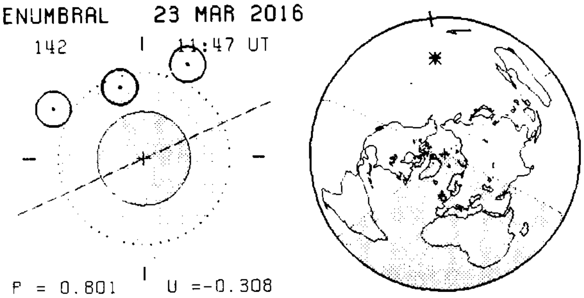
137 | 2:47 UT



P = 2.254 | U = 1.282

PENUMBRAL 23 MAR 2016

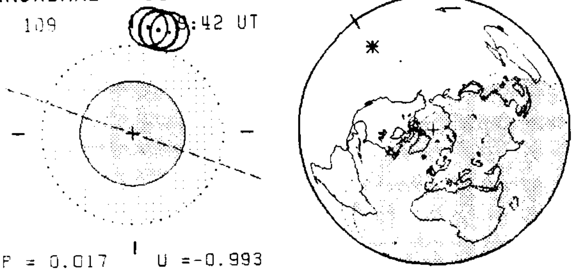
142 | 11:47 UT



P = 0.801 | U =-0.308

PENUMBRAL 18 AUG 2016

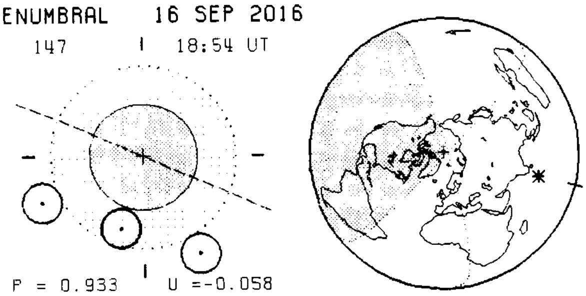
109 | [illegible]:42 UT



P = 0.017 | U =-0.993

PENUMBRAL 16 SEP 2016

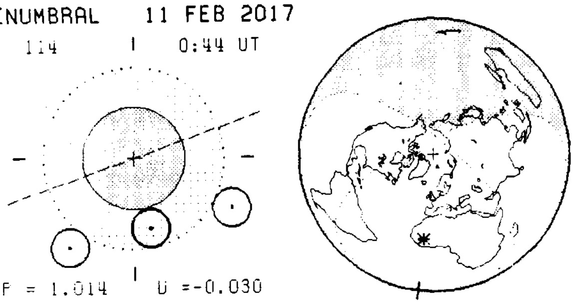
147 | 18:54 UT



P = 0.933 | U =-0.058

PENUMBRAL 11 FEB 2017

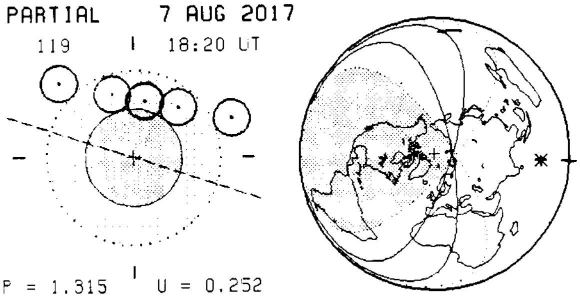
114 | 0:44 UT



P = 1.014 | U =-0.030

PARTIAL 7 AUG 2017

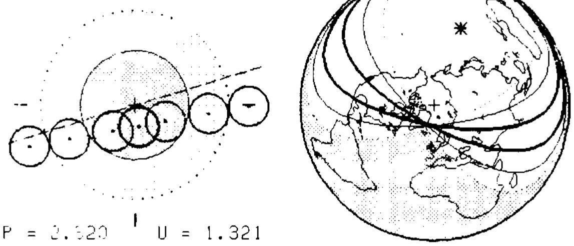
119 | 18:20 UT



P = 1.315 | U = 0.252

TOTAL 31 JAN 2018

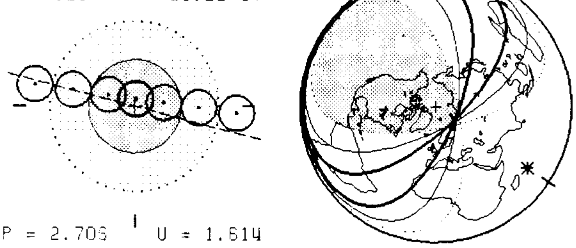
124 | 13:30 UT



P = 2.320 | U = 1.321

TOTAL 27 JUL 2018

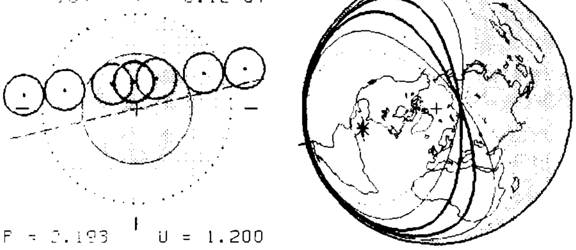
129 | 20:22 UT



P = 2.706 | U = 1.614

TOTAL 21 JAN 2019

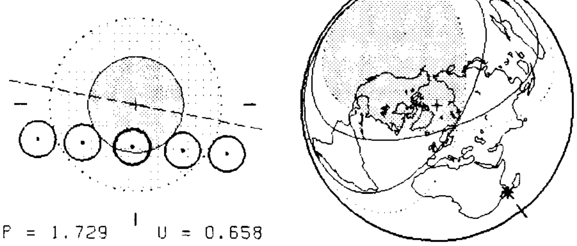
134 | 5:12 UT



P = 2.193 | U = 1.200

PARTIAL 16 JUL 2019

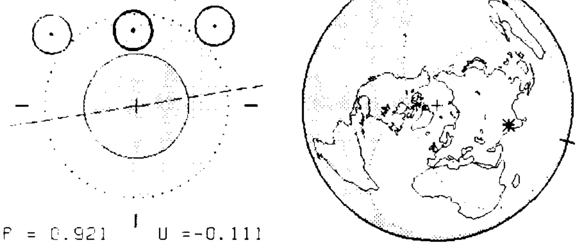
139 | 21:31 UT



P = 1.729 | U = 0.658

PENUMBRAL 10 JAN 2020

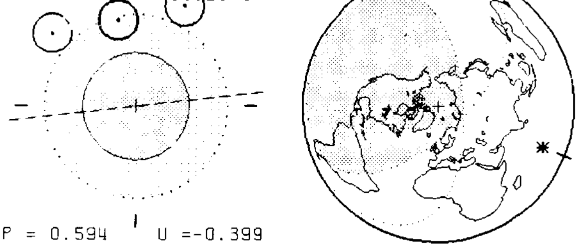
144 | 19:10 UT



P = 0.921 | U =-0.111

PENUMBRAL 5 JUN 2020

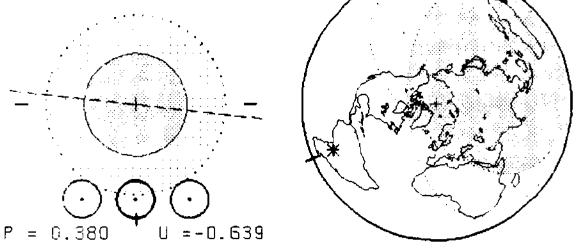
111 | 19:25 UT



P = 0.594 | U =-0.399

PENUMBRAL 5 JUL 2020

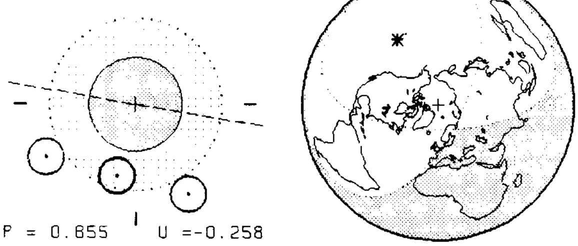
149 | 4:30 UT



P = 0.380 | U =-0.639

PENUMBRAL 30 NOV 2020

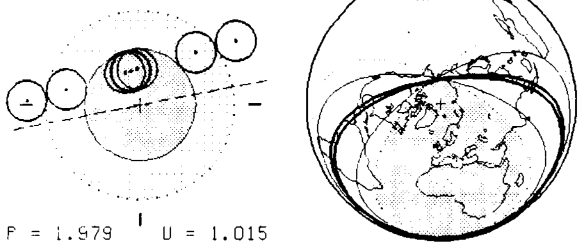
116 | 9:43 UT



P = 0.655 | U =-0.258

TOTAL 26 MAY 2021

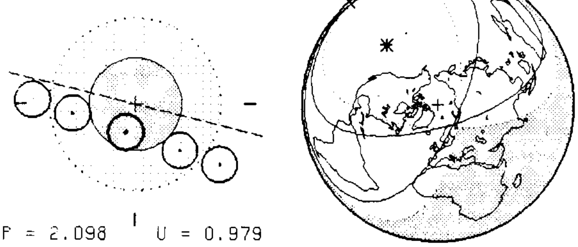
121 | 11:18 UT



P = 1.979 | U = 1.015

PARTIAL 19 NOV 2021

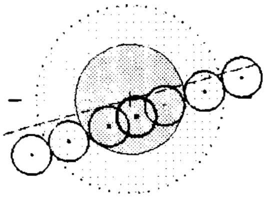
126 | 9: 3 UT

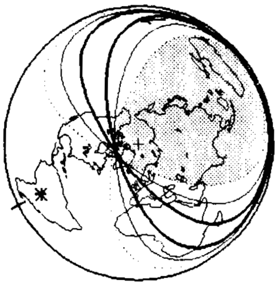


P = 2.098 | U = 0.979

TOTAL 16 MAY 2022

131 4:11 UT

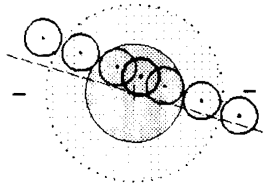


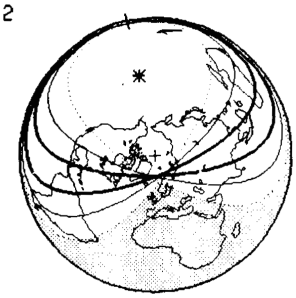


P = 2.397 U = 1.419

TOTAL 8 NOV 2022

136 10:59 UT

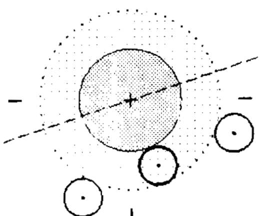


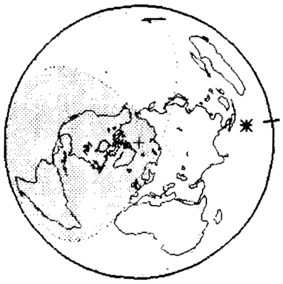


P = 2.440 U = 1.364

PENUMBRAL 5 MAY 2023

141 17:23 UT

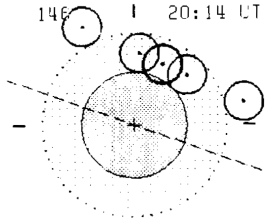


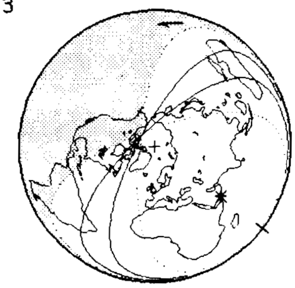


P = 0.999 U =-0.041

PARTIAL 28 OCT 2023

146 20:14 UT

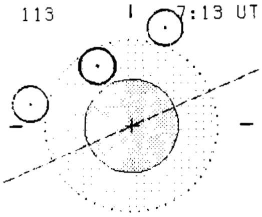


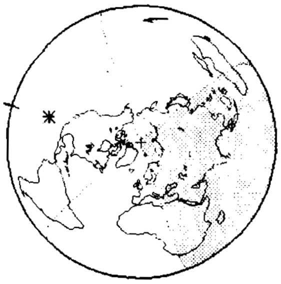


P = 1.143 U = 0.127

PENUMBRAL 25 MAR 2024

113 7:13 UT

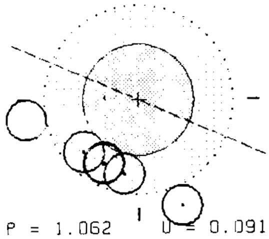


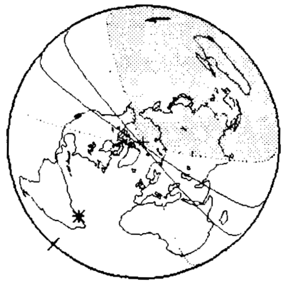


P = 0.982 U =-0.128

PARTIAL 18 SEP 2024

119 2:44 UT

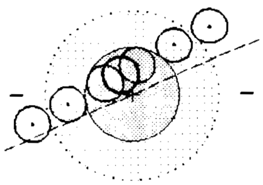


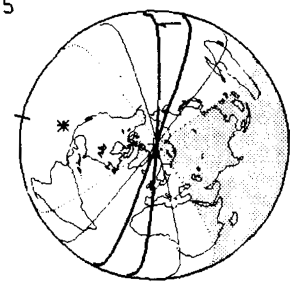


P = 1.062 U = 0.091

TOTAL 14 MAR 2025

123 6:58 UT

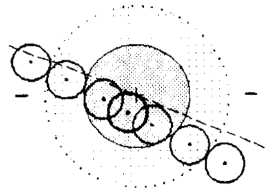


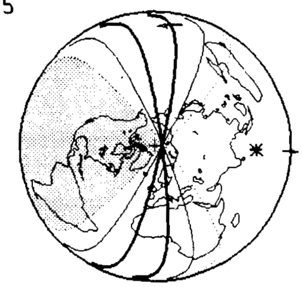


P = 2.286 U = 1.183

TOTAL 7 SEP 2025

128 18:11 UT

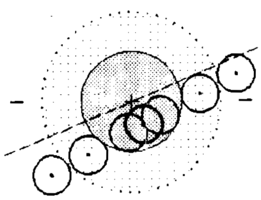


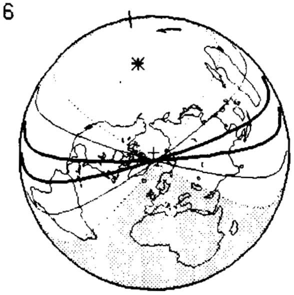


P = 2.369 U = 1.368

TOTAL 3 MAR 2026

133 11:33 UT

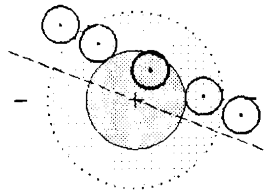


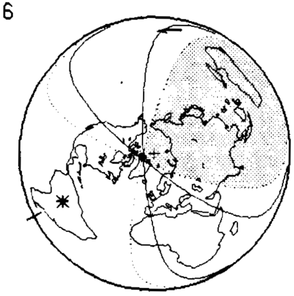


P = 2.210 U = 1.156

PARTIAL 28 AUG 2026

138 4:13 UT

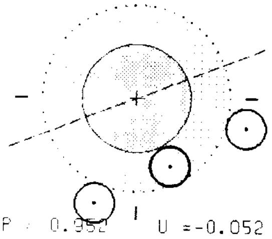




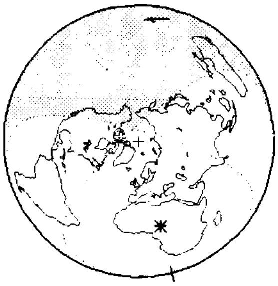
P = 1.990 U = 0.935

PENUMBRAL 20 FEB 2027

143 | 23:13 UT

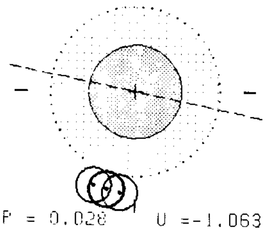


P = 0.952 | U = -0.052

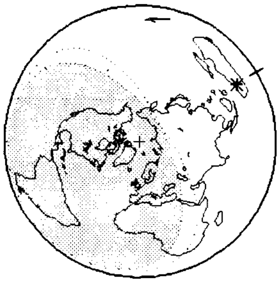


PENUMBRAL 18 JUL 2027

110 | 16: 3 UT

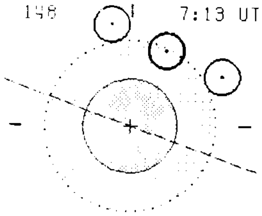


P = 0.028 | U = -1.063

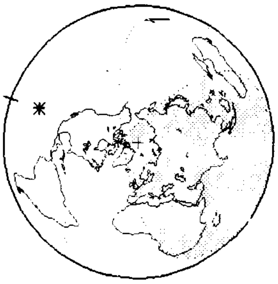


PENUMBRAL 17 AUG 2027

148 | 7:13 UT

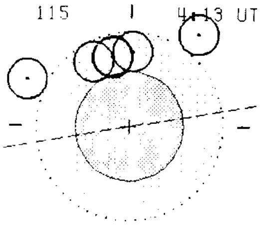


P = 0.571 | U = -0.521

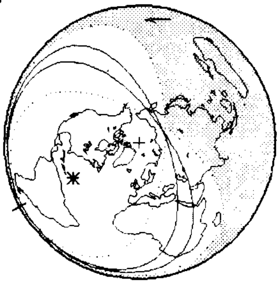


PARTIAL 12 JAN 2028

115 | 4:13 UT

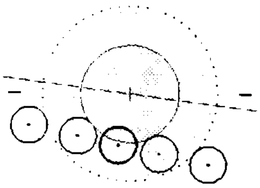


P = 1.072 | U = 0.072

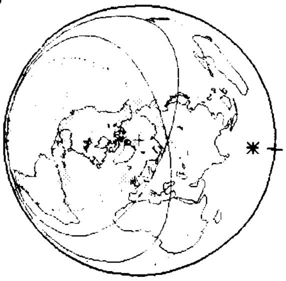


PARTIAL 6 JUL 2028

120 | 18:19 UT

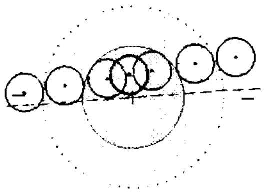


P = 1.453 | U = 0.394

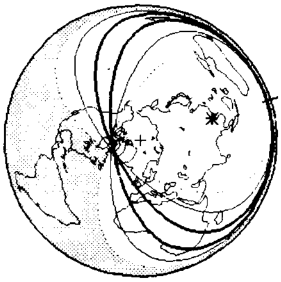


TOTAL 31 DEC 2028

125 | 16:52 UT

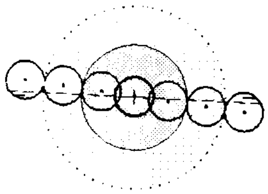


P = 2.300 | U = 1.252

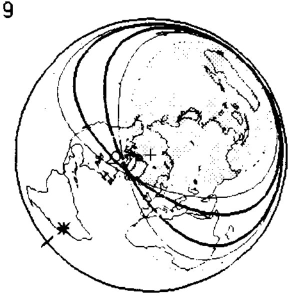


TOTAL 26 JUN 2029

130 | 3:22 UT

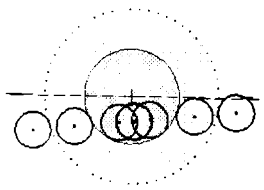


P = 2.852 | U = 1.849

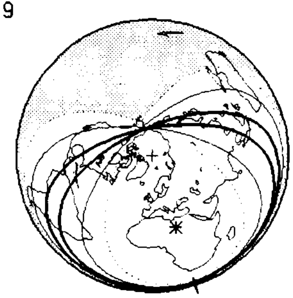


TOTAL 20 DEC 2029

135 | 22:42 UT

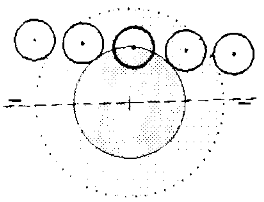


P = 2.227 | U = 1.122

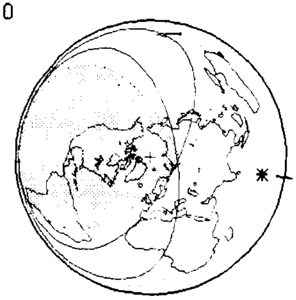


PARTIAL 15 JUN 2030

140 | 18:33 UT

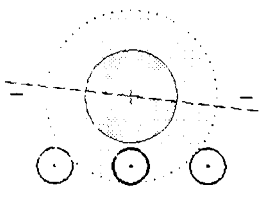


P = 1.472 | U = 0.508



PENUMBRAL 9 DEC 2030

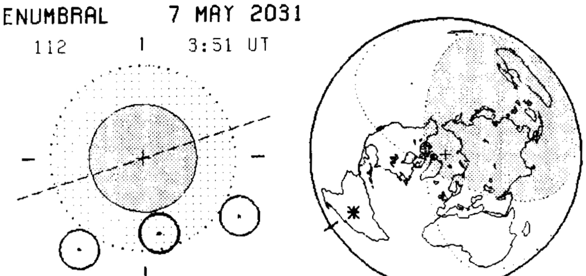
145 | 22:27 UT



P = 0.968 | U = -0.159

PENUMBRAL 7 MAY 2031

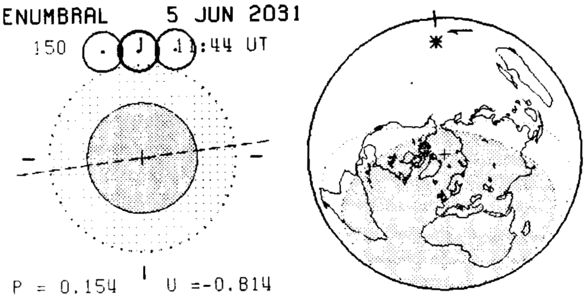
112 | 3:51 UT



P = 0.907 | U =-0.085

PENUMBRAL 5 JUN 2031

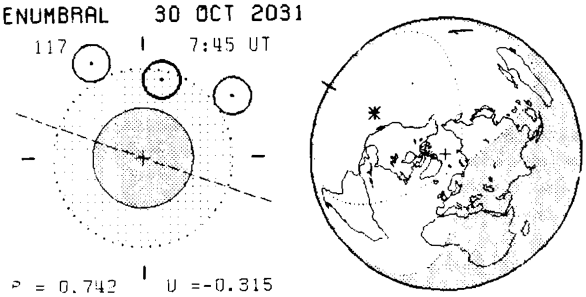
150 | 11:44 UT



P = 0.154 | U =-0.814

PENUMBRAL 30 OCT 2031

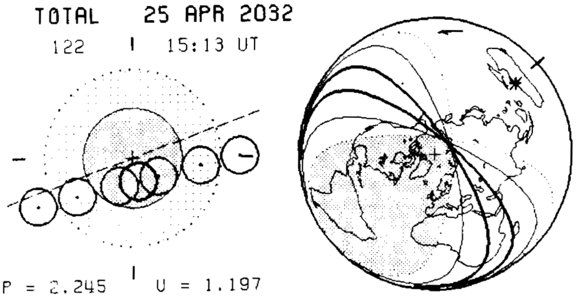
117 | 7:45 UT



P = 0.742 | U =-0.315

TOTAL 25 APR 2032

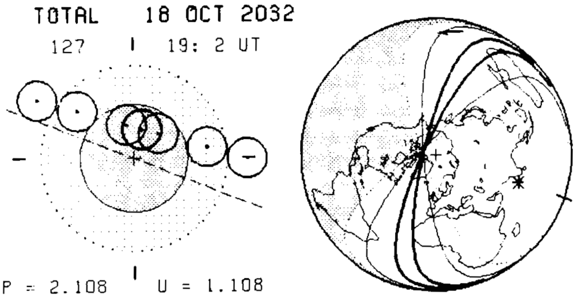
122 | 15:13 UT



P = 2.245 | U = 1.197

TOTAL 18 OCT 2032

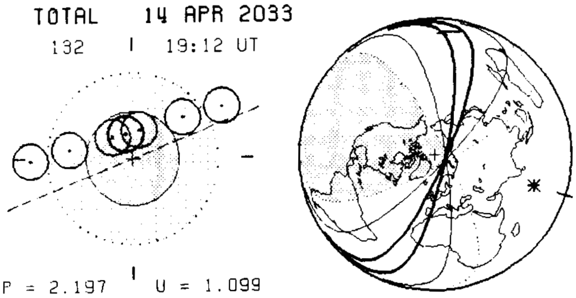
127 | 19: 2 UT



P = 2.108 | U = 1.108

TOTAL 14 APR 2033

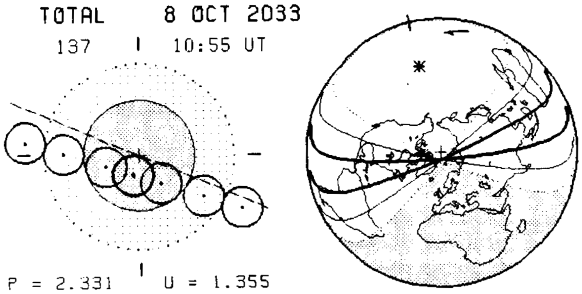
132 | 19:12 UT



P = 2.197 | U = 1.099

TOTAL 8 OCT 2033

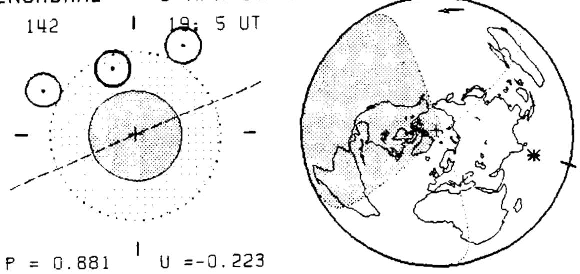
137 | 10:55 UT



P = 2.331 | U = 1.355

PENUMBRAL 3 APR 2034

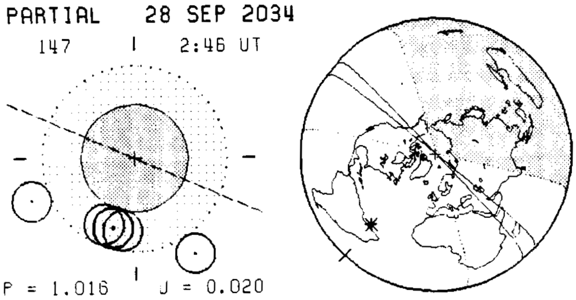
142 | 19: 5 UT



P = 0.881 | U =-0.223

PARTIAL 28 SEP 2034

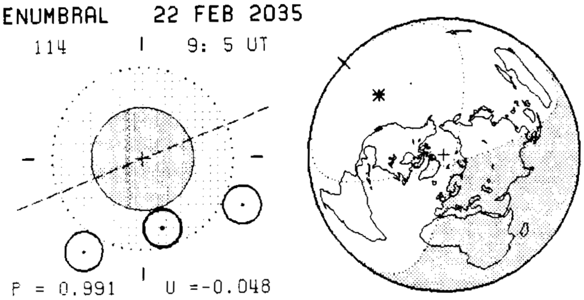
147 | 2:46 UT



P = 1.016 | U = 0.020

PENUMBRAL 22 FEB 2035

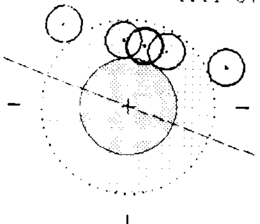
114 | 9: 5 UT



P = 0.991 | U =-0.048

PARTIAL 19 AUG 2035

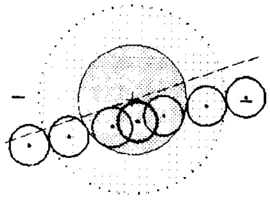
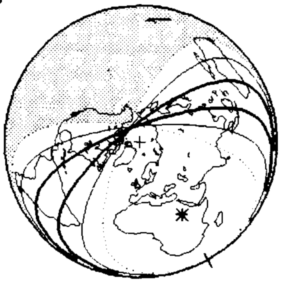
119 | 1:11 UT




P = 1.177 | U = 0.109

TOTAL 11 FEB 2036

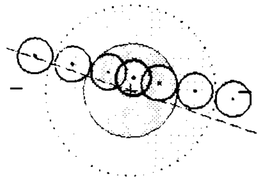
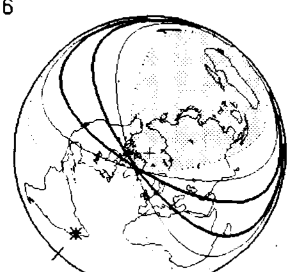
124 | 22:11 UT

P = 2.300 | U = 1.305

TOTAL 7 AUG 2036

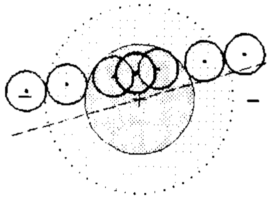
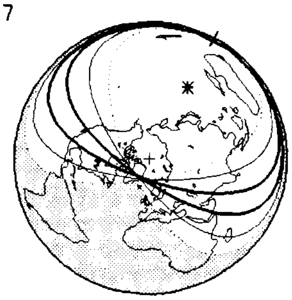
129 | 2:51 UT

P = 2.553 | U = 1.459

TOTAL 31 JAN 2037

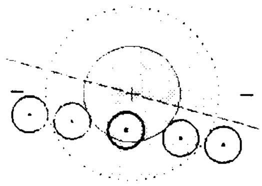
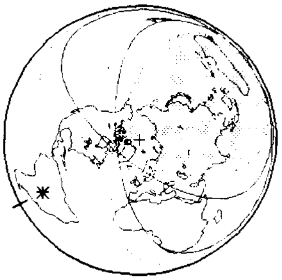
134 | 13:60 UT

P = 2.205 | U = 1.213

PARTIAL 27 JUL 2037

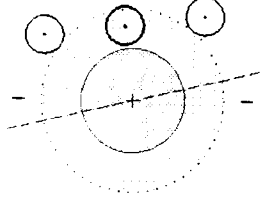
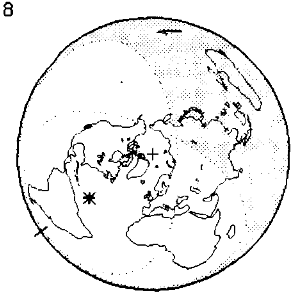
139 | 4: 8 UT

P = 1.884 | U = 0.814

PENUMBRAL 21 JAN 2038

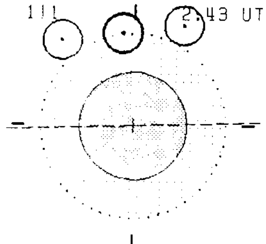
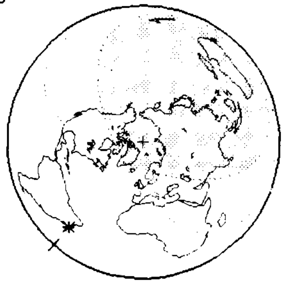
144 | 3:48 UT

P = 0.925 | U =-0.109

PENUMBRAL 17 JUN 2038

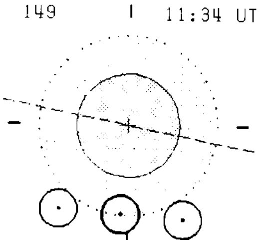
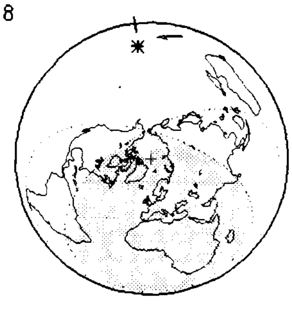
111 | 2:43 UT

P = 0.467 | U =-0.522

PENUMBRAL 16 JUL 2038

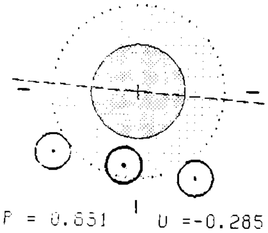
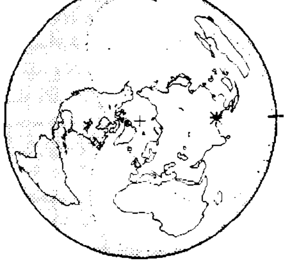
149 | 11:34 UT

P = 0.525 | U =-0.490

PENUMBRAL 11 DEC 2038

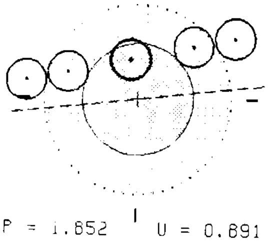
116 | 17:43 UT

P = 0.651 | U =-0.285

PARTIAL 6 JUN 2039

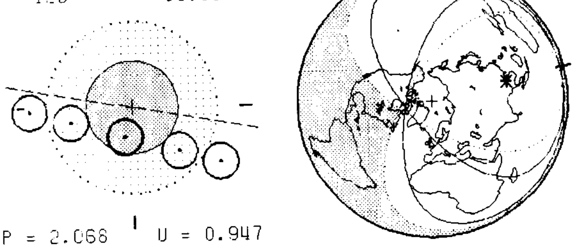
121 | 18:53 UT




P = 1.852 | U = 0.891

PARTIAL 30 NOV 2039

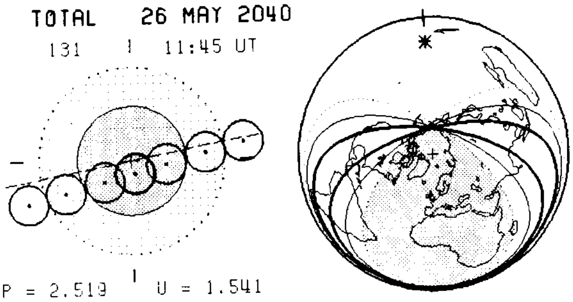
126 16:55 UT



P = 2.068 U = 0.947

TOTAL 26 MAY 2040

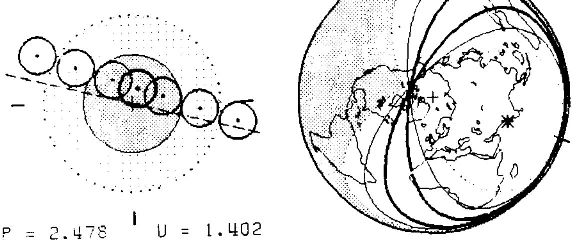
131 11:45 UT



P = 2.519 U = 1.541

TOTAL 18 NOV 2040

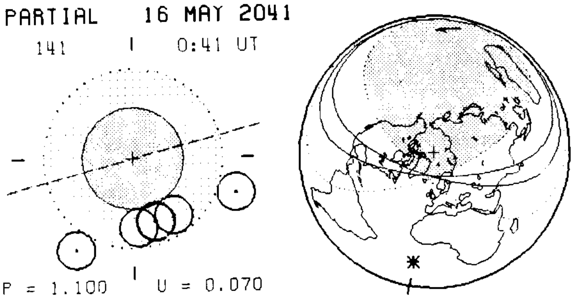
136 19: 3 UT



P = 2.478 U = 1.402

PARTIAL 16 MAY 2041

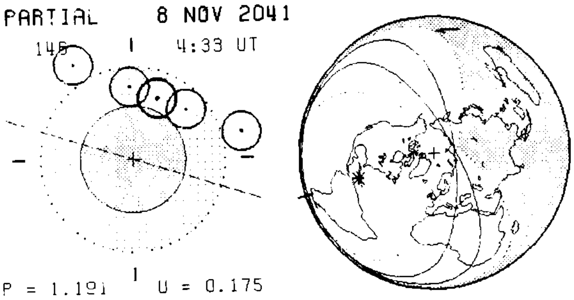
141 0:41 UT



P = 1.100 U = 0.070

PARTIAL 8 NOV 2041

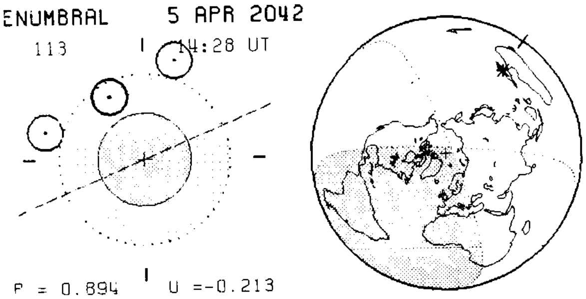
146 4:33 UT



P = 1.191 U = 0.175

PENUMBRAL 5 APR 2042

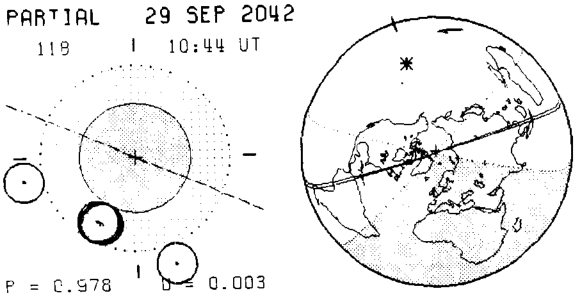
113 14:28 UT



P = 0.894 U =-0.213

PARTIAL 29 SEP 2042

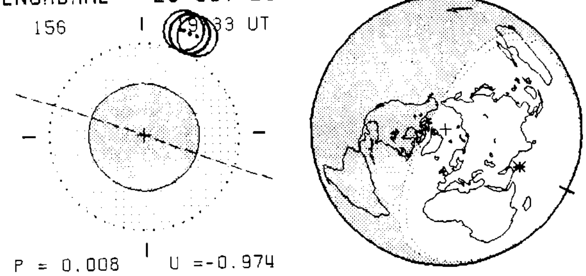
118 10:44 UT



P = 0.978 U = 0.003

PENUMBRAL 28 OCT 2042

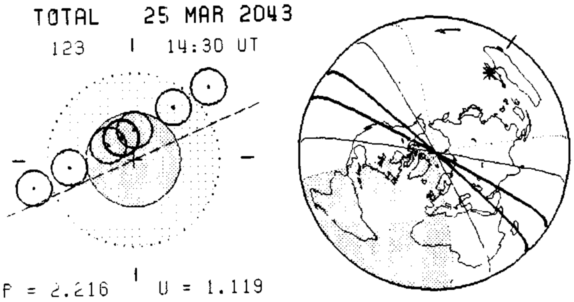
156 [illegible]:33 UT



P = 0.008 U =-0.974

TOTAL 25 MAR 2043

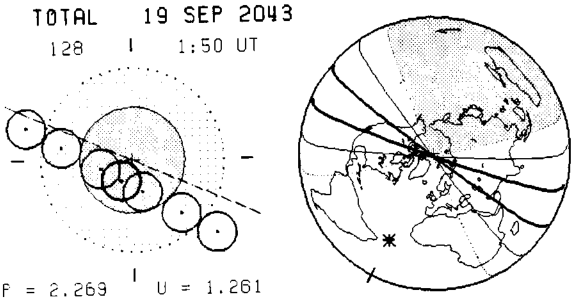
123 14:30 UT



P = 2.216 U = 1.119

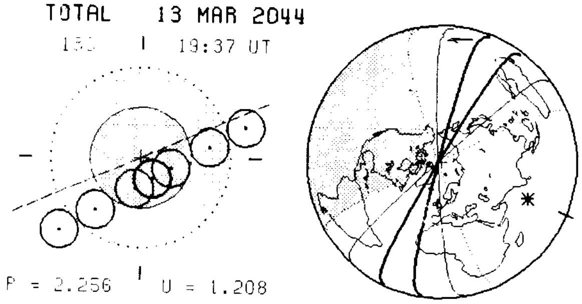
TOTAL 19 SEP 2043

128 1:50 UT



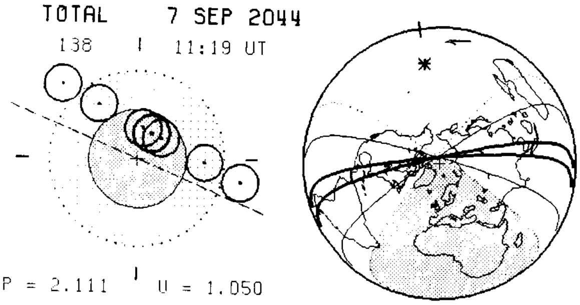
P = 2.269 U = 1.261

TOTAL 13 MAR 2044
133 | 19:37 UT



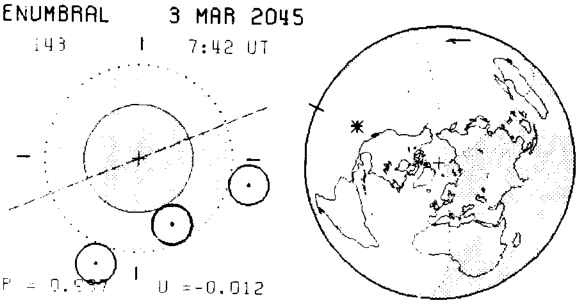
P = 2.256 | U = 1.208

TOTAL 7 SEP 2044
138 | 11:19 UT



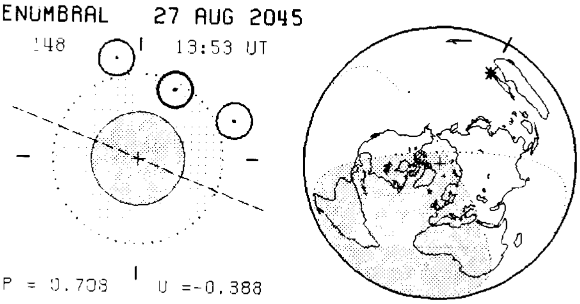
P = 2.111 | U = 1.050

PENUMBRAL 3 MAR 2045
143 | 7:42 UT



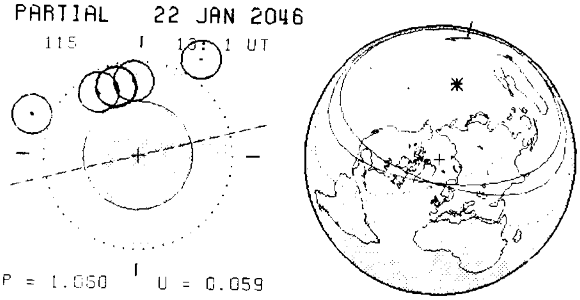
P = 0.9[illegible] | U =-0.012

PENUMBRAL 27 AUG 2045
148 | 13:53 UT



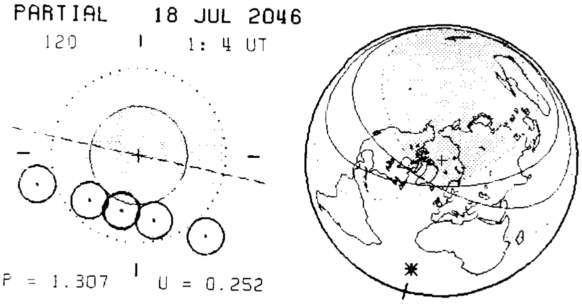
P = 0.708 | U =-0.388

PARTIAL 22 JAN 2046
115 | 13: 1 UT



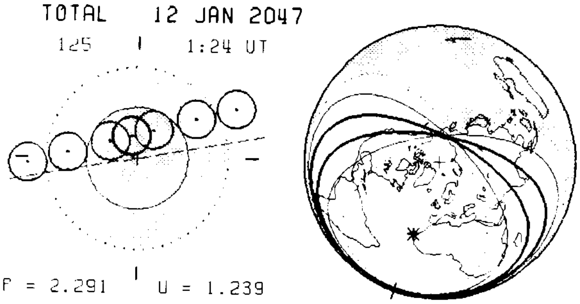
P = 1.050 | U = 0.059

PARTIAL 18 JUL 2046
120 | 1: 4 UT



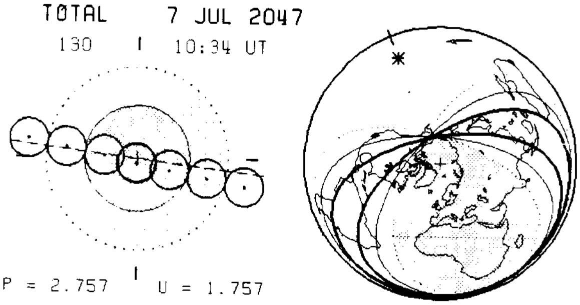
P = 1.307 | U = 0.252

TOTAL 12 JAN 2047
125 | 1:24 UT



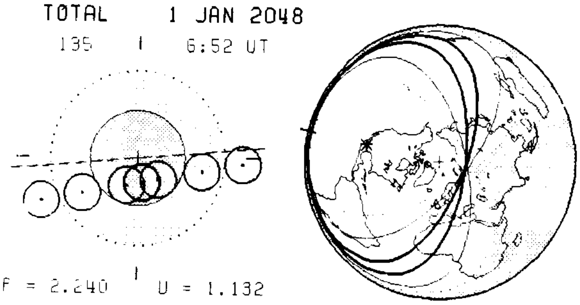
P = 2.291 | U = 1.239

TOTAL 7 JUL 2047
130 | 10:34 UT



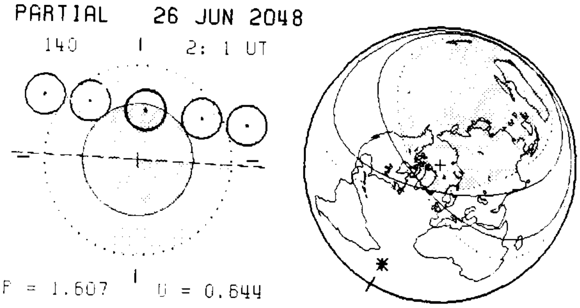
P = 2.757 | U = 1.757

TOTAL 1 JAN 2048
135 | 6:52 UT



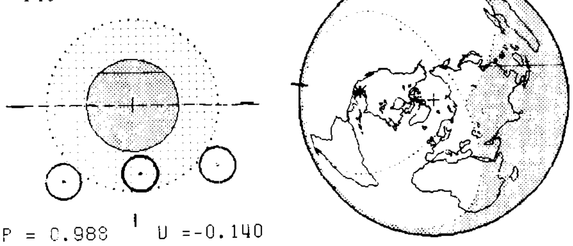
P = 2.240 | U = 1.132

PARTIAL 26 JUN 2048
140 | 2: 1 UT



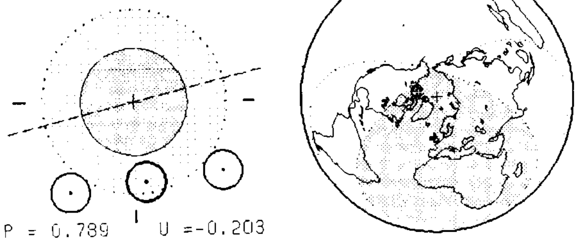
P = 1.607 | U = 0.644

PENUMBRAL 20 DEC 2048
145 I 6:26 UT



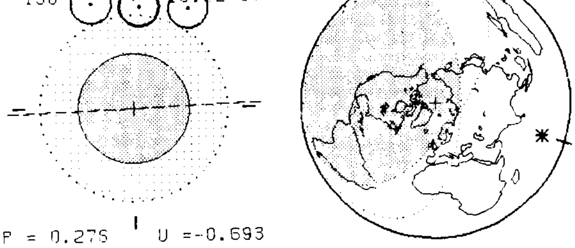
P = 0.988 I U =-0.140

PENUMBRAL 17 MAY 2049
112 I 11:25 UT



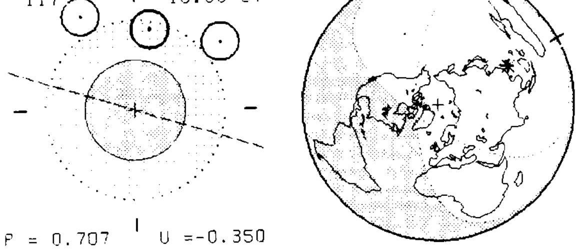
P = 0.789 I U =-0.203

PENUMBRAL 15 JUN 2049
150 I 19:12 UT



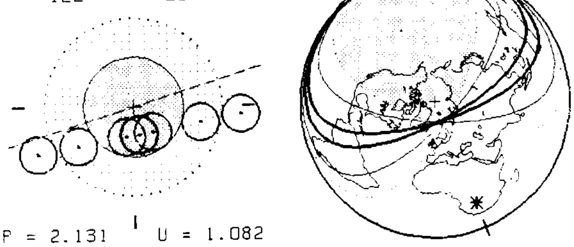
P = 0.279 I U =-0.693

PENUMBRAL 9 NOV 2049
117 I 15:50 UT



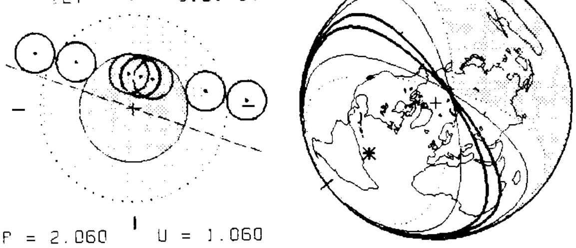
P = 0.707 I U =-0.350

TOTAL 6 MAY 2050
122 I 22:30 UT



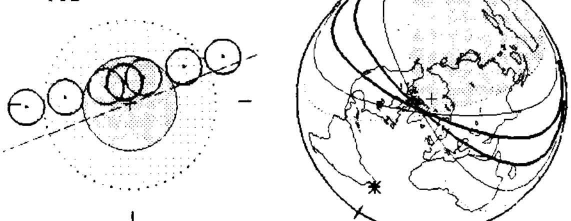
P = 2.131 I U = 1.082

TOTAL 30 OCT 2050
127 I 3:20 UT



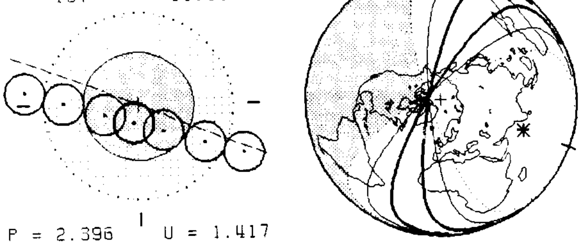
P = 2.060 I U = 1.060

TOTAL 26 APR 2051
132 I 2:15 UT



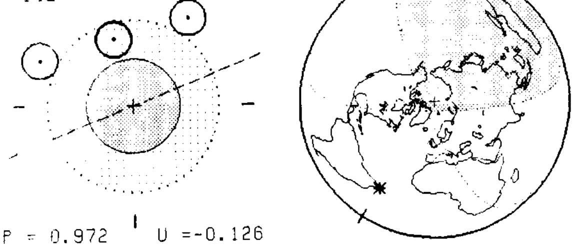
P = 2.303 I U = 1.207

TOTAL 19 OCT 2051
137 I 19:10 UT



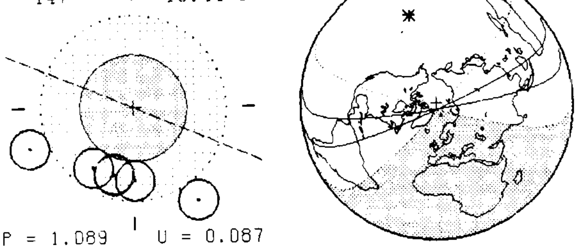
P = 2.396 I U = 1.417

PENUMBRAL 14 APR 2052
142 I 2:16 UT



P = 0.972 I U =-0.126

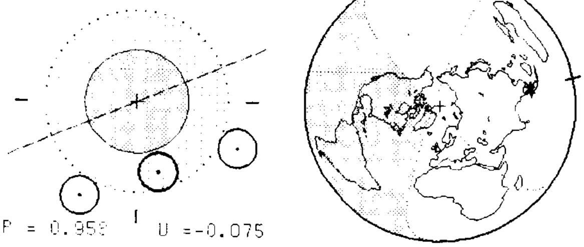
PARTIAL 8 OCT 2052
147 I 10:44 UT



P = 1.089 I U = 0.087

PENUMBRAL 4 MAR 2053

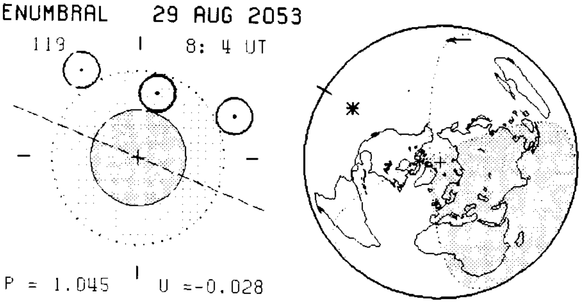
114 | 17:20 UT



P = 0.958 | U =-0.075

PENUMBRAL 29 AUG 2053

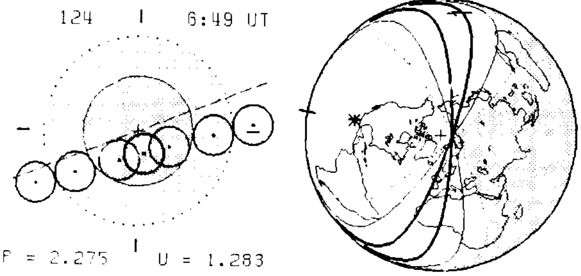
119 | 8: 4 UT



P = 1.045 | U =-0.028

TOTAL 22 FEB 2054

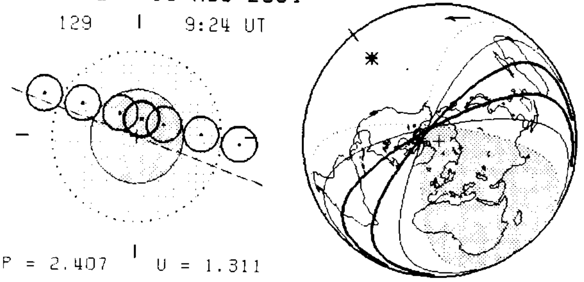
124 | 6:49 UT



P = 2.275 | U = 1.283

TOTAL 18 AUG 2054

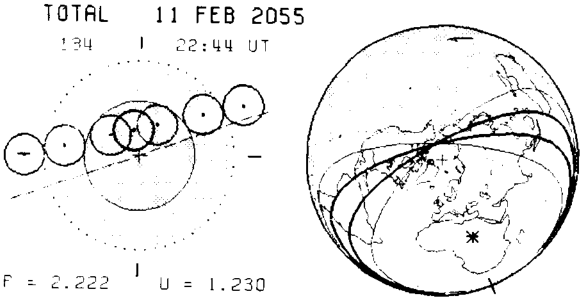
129 | 9:24 UT



P = 2.407 | U = 1.311

TOTAL 11 FEB 2055

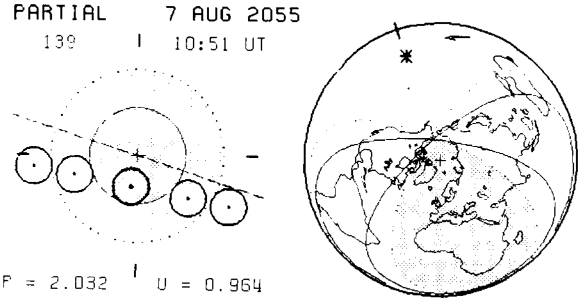
134 | 22:44 UT



P = 2.222 | U = 1.230

PARTIAL 7 AUG 2055

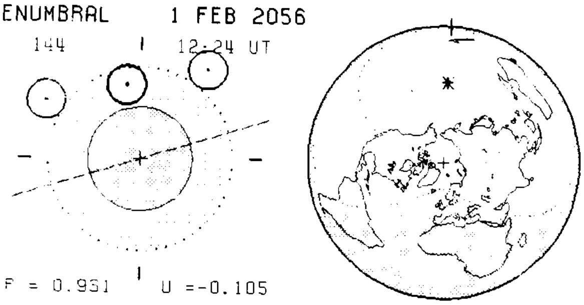
139 | 10:51 UT



P = 2.032 | U = 0.964

PENUMBRAL 1 FEB 2056

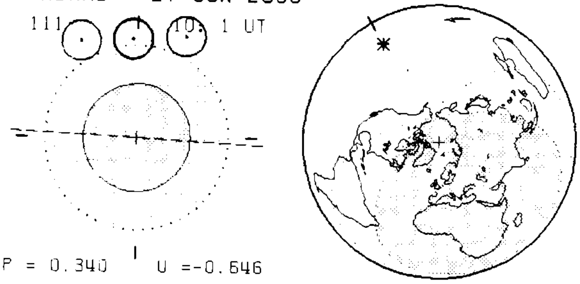
144 | 12:24 UT



P = 0.951 | U =-0.105

PENUMBRAL 27 JUN 2056

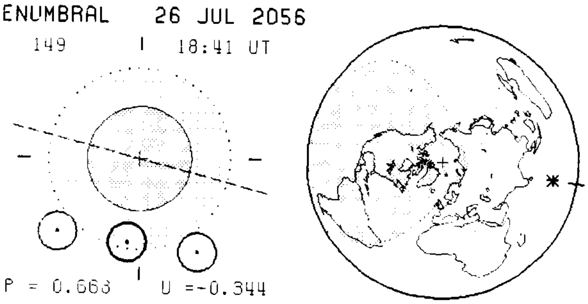
111 | 10: 1 UT



P = 0.340 | U =-0.646

PENUMBRAL 26 JUL 2056

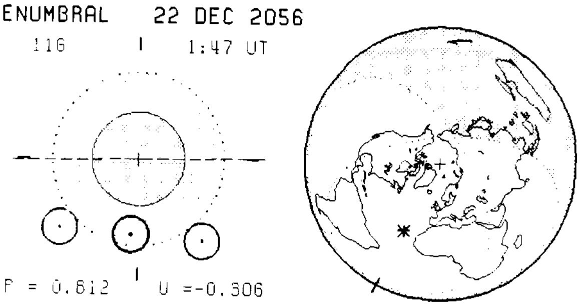
149 | 18:41 UT



P = 0.663 | U =-0.344

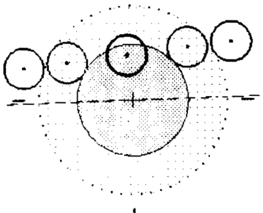
PENUMBRAL 22 DEC 2056

116 | 1:47 UT



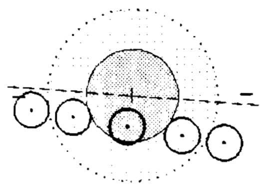
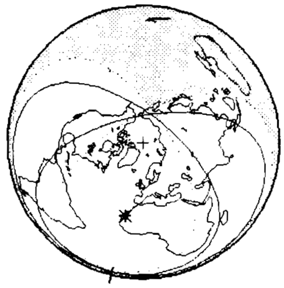
P = 0.612 | U =-0.306

PARTIAL 17 JUN 2057
121 | 2:24 UT



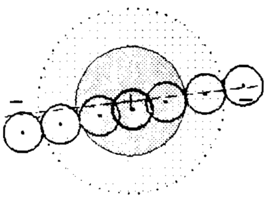
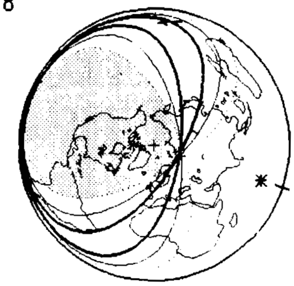

P = 1.722 | U = 0.762

PARTIAL 11 DEC 2057
126 | 0:52 UT

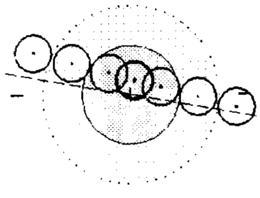
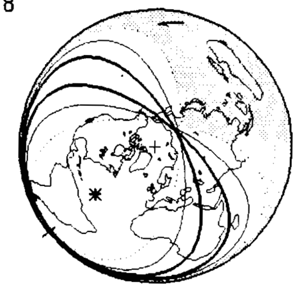
P = 2.044 | U = 0.923

TOTAL 6 JUN 2058
131 | 19:14 UT

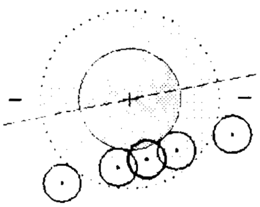
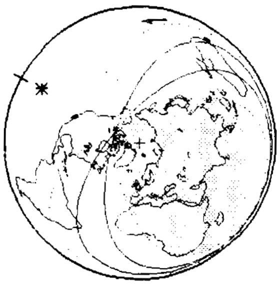
P = 2.646 | U = 1.667

TOTAL 30 NOV 2058
136 | 3:14 UT

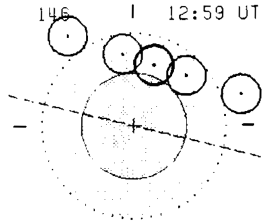
P = 2.506 | U = 1.431

PARTIAL 27 MAY 2059
141 | 7:53 UT

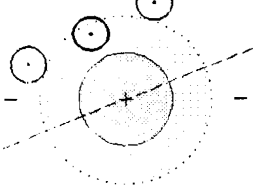
P = 1.220 | U = 0.188

PARTIAL 19 NOV 2059
146 | 12:59 UT



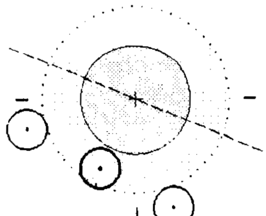

P = 1.229 | U = 0.213

PENUMBRAL 15 APR 2060
113 | 21:35 UT



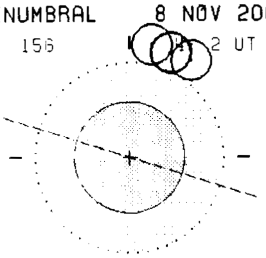
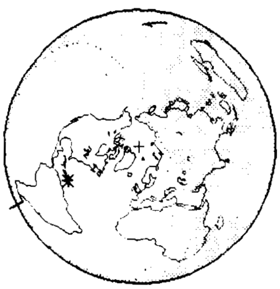

P = 0.794 | U =-0.311

PENUMBRAL 9 OCT 2060
118 | 18:51 UT



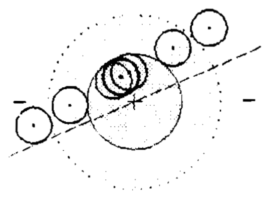
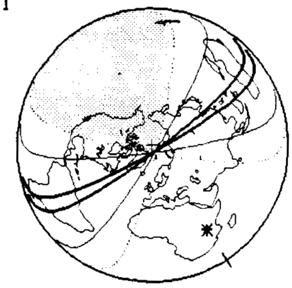

P = 0.905 | U =-0.074

PENUMBRAL 8 NOV 2060
156 | [illegible]2 UT

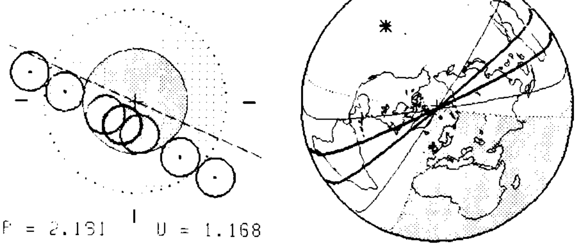
P = 0.052 | U =-0.932

TOTAL 4 APR 2061
123 | 21:52 UT

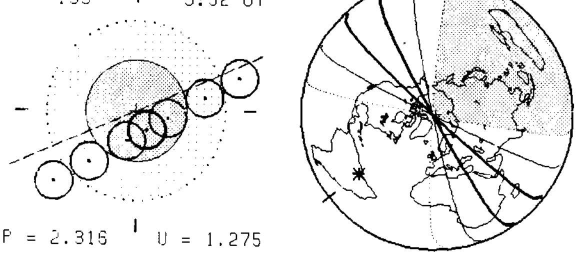
P = 2.131 | U = 1.039

TOTAL 29 SEP 2061
128 | 9:36 UT



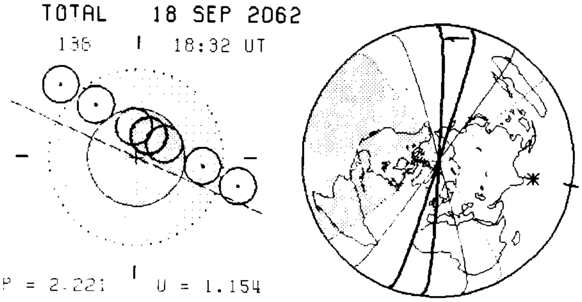
P = 2.131 | U = 1.168

TOTAL 25 MAR 2062
133 | 3:32 UT



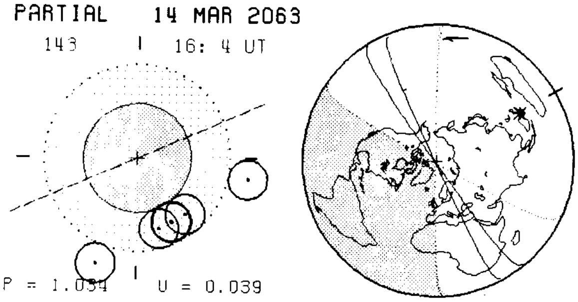
P = 2.316 | U = 1.275

TOTAL 18 SEP 2062
138 | 18:32 UT



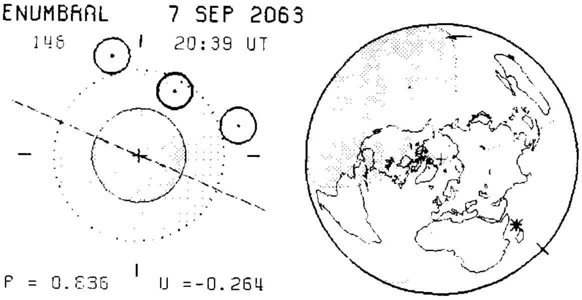
P = 2.221 | U = 1.154

PARTIAL 14 MAR 2063
143 | 16: 4 UT



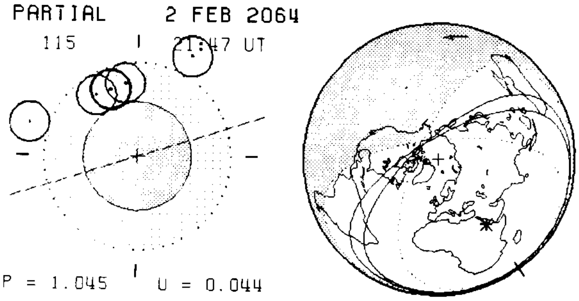
P = 1.034 | U = 0.039

PENUMBRAL 7 SEP 2063
148 | 20:39 UT



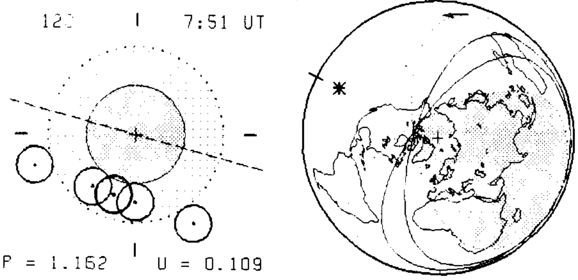
P = 0.836 | U =-0.264

PARTIAL 2 FEB 2064
115 | 21:47 UT



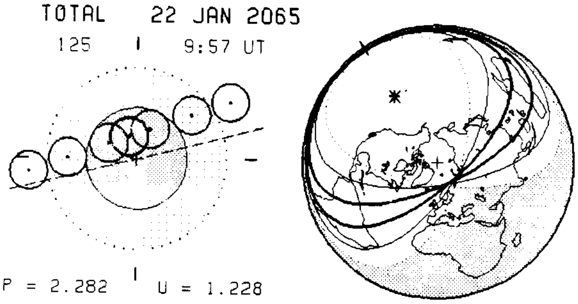
P = 1.045 | U = 0.044

PARTIAL 28 JUL 2064
120 | 7:51 UT



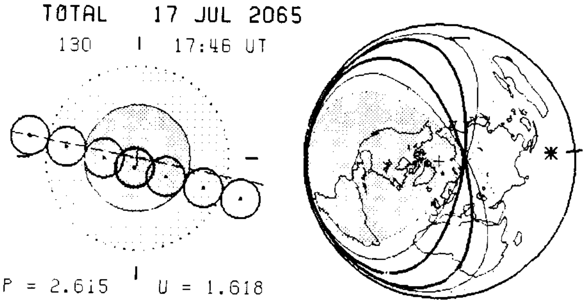
P = 1.162 | U = 0.109

TOTAL 22 JAN 2065
125 | 9:57 UT



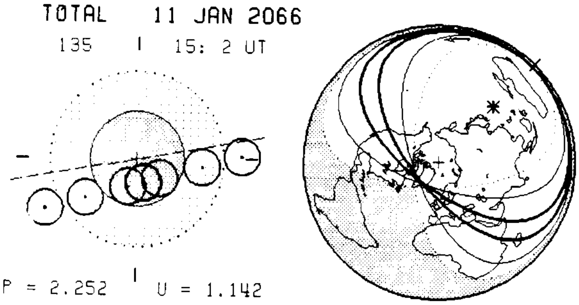
P = 2.282 | U = 1.228

TOTAL 17 JUL 2065
130 | 17:46 UT



P = 2.615 | U = 1.618

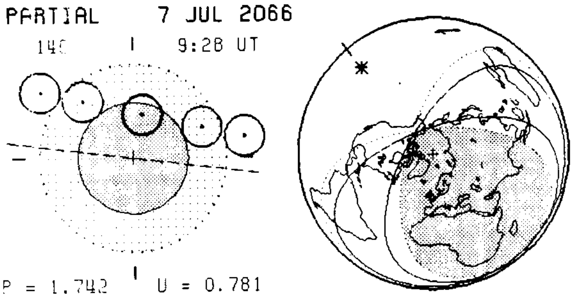
TOTAL 11 JAN 2066
135 | 15: 2 UT



P = 2.252 | U = 1.142

PARTIAL 7 JUL 2066

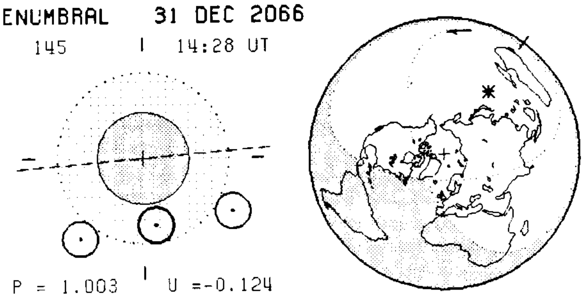
140 | 9:28 UT



P = 1.742 | U = 0.781

PENUMBRAL 31 DEC 2066

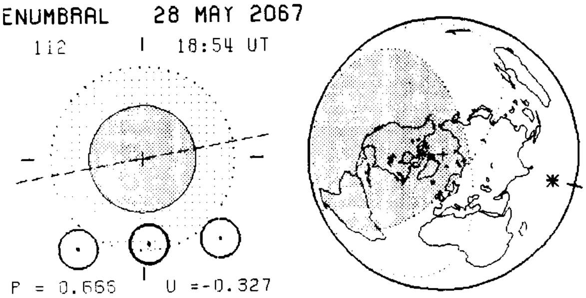
145 | 14:28 UT



P = 1.003 | U =-0.124

PENUMBRAL 28 MAY 2067

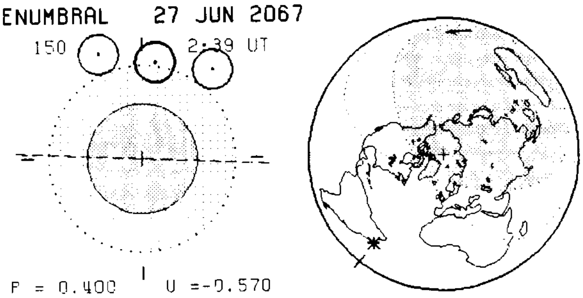
112 | 18:54 UT



P = 0.666 | U =-0.327

PENUMBRAL 27 JUN 2067

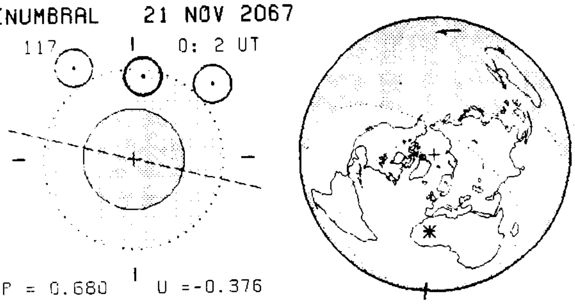
150 | 2:39 UT



P = 0.400 | U =-0.570

PENUMBRAL 21 NOV 2067

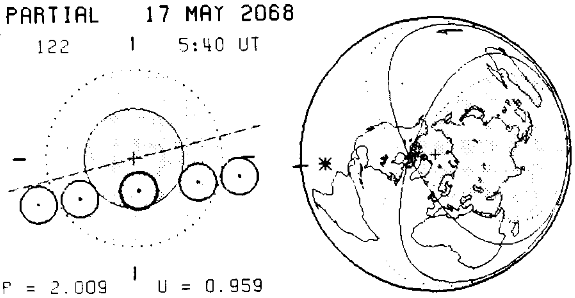
117 | 0: 2 UT



P = 0.680 | U =-0.376

PARTIAL 17 MAY 2068

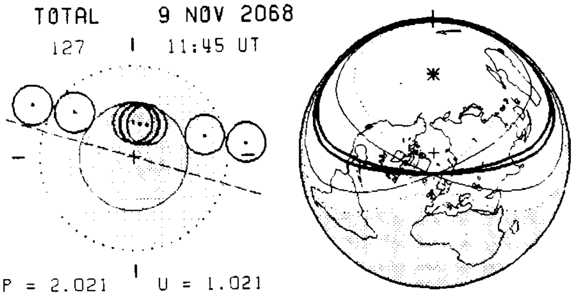
122 | 5:40 UT



P = 2.009 | U = 0.959

TOTAL 9 NOV 2068

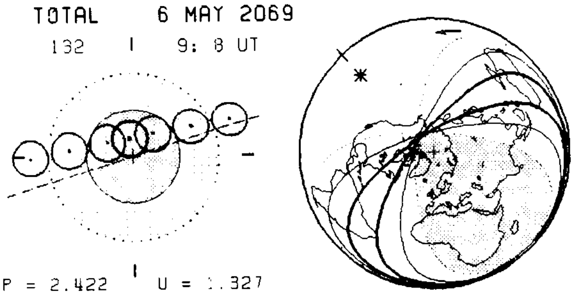
127 | 11:45 UT



P = 2.021 | U = 1.021

TOTAL 6 MAY 2069

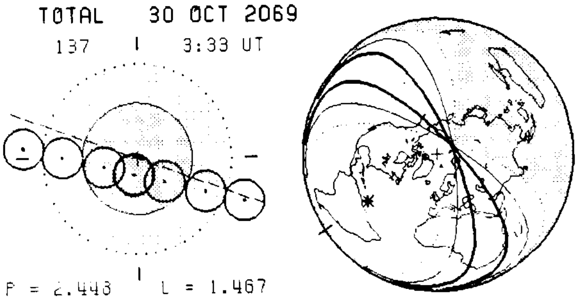
132 | 9: 8 UT



P = 2.422 | U = 1.327

TOTAL 30 OCT 2069

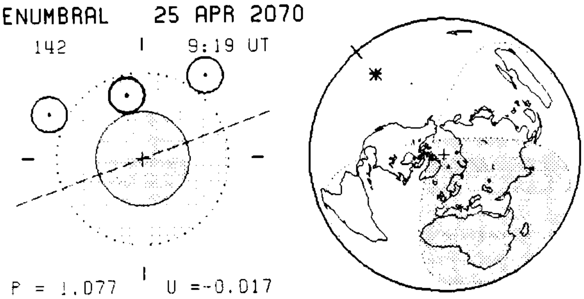
137 | 3:33 UT



P = 2.448 | U = 1.467

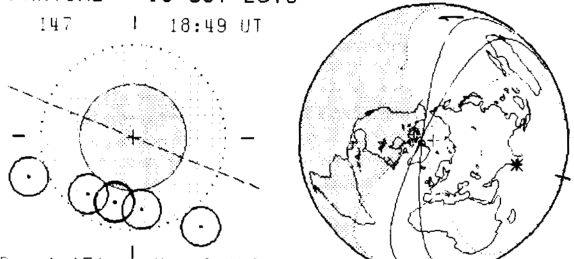
PENUMBRAL 25 APR 2070

142 | 9:19 UT



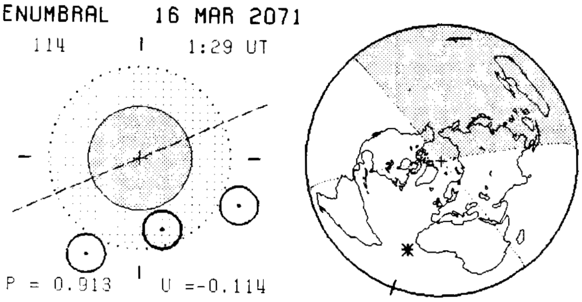
P = 1.077 | U =-0.017

PARTIAL 19 OCT 2070
147 18:49 UT



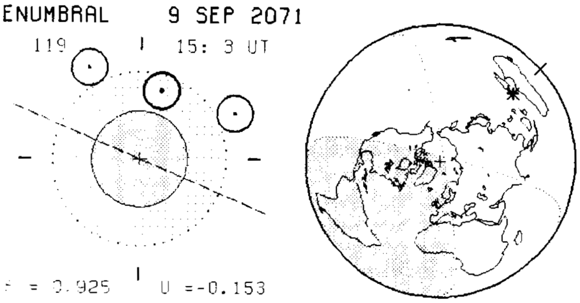
P = 1.151 U = 0.143

PENUMBRAL 16 MAR 2071
114 1:29 UT



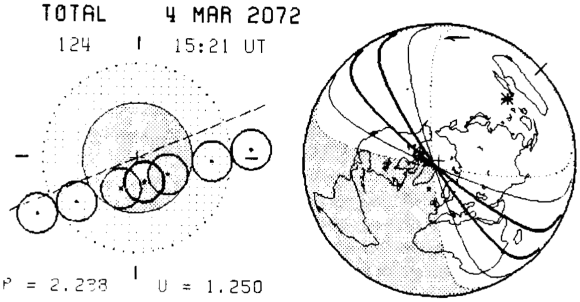
P = 0.913 U =-0.114

PENUMBRAL 9 SEP 2071
119 15: 3 UT



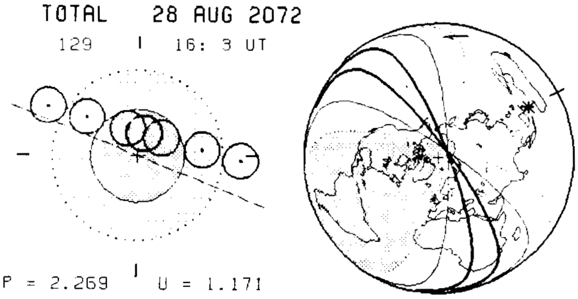
P = 0.925 U =-0.153

TOTAL 4 MAR 2072
124 15:21 UT



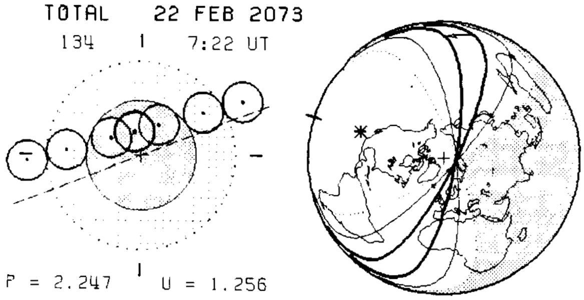
P = 2.238 U = 1.250

TOTAL 28 AUG 2072
129 16: 3 UT



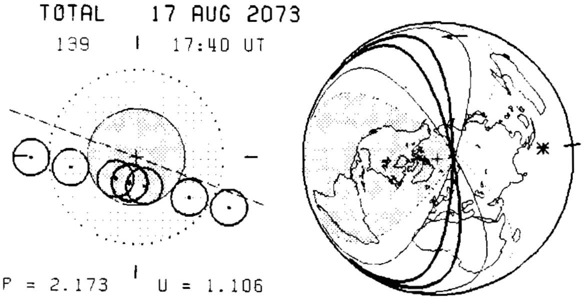
P = 2.269 U = 1.171

TOTAL 22 FEB 2073
134 7:22 UT



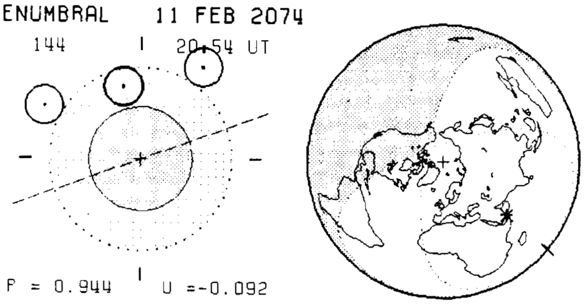
P = 2.247 U = 1.256

TOTAL 17 AUG 2073
139 17:40 UT



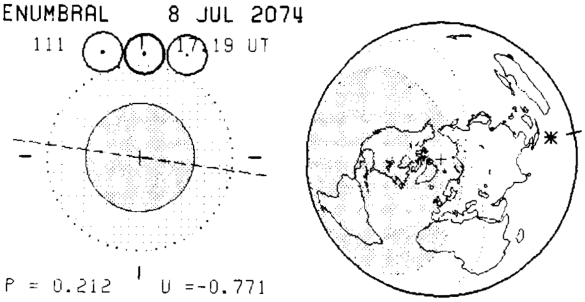
P = 2.173 U = 1.106

PENUMBRAL 11 FEB 2074
144 20:54 UT



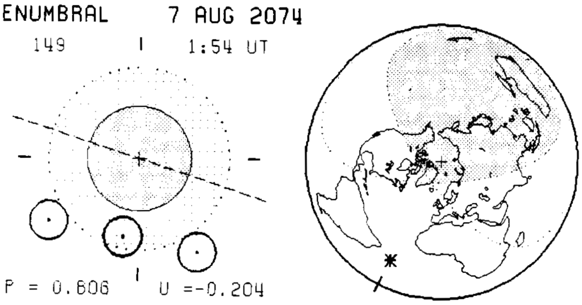
P = 0.944 U =-0.092

PENUMBRAL 8 JUL 2074
111 17:19 UT



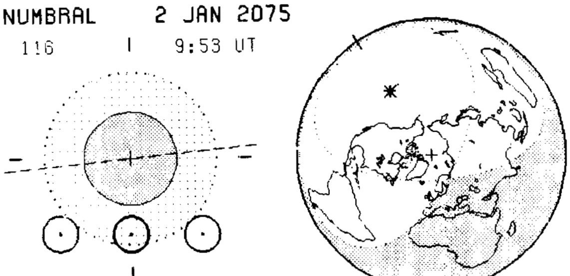
P = 0.212 U =-0.771

PENUMBRAL 7 AUG 2074
149 1:54 UT



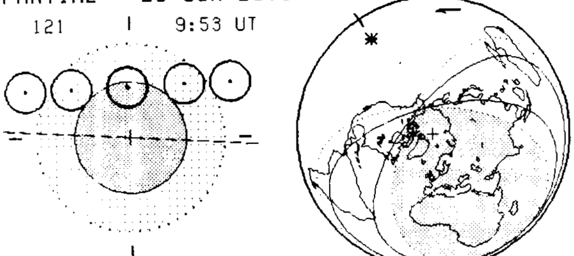
P = 0.606 U =-0.204

PENUMBRAL 2 JAN 2075
116 | 9:53 UT



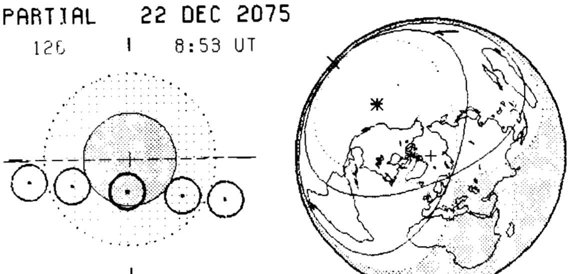
P = 0.798 | U =-0.323

PARTIAL 28 JUN 2075
121 | 9:53 UT



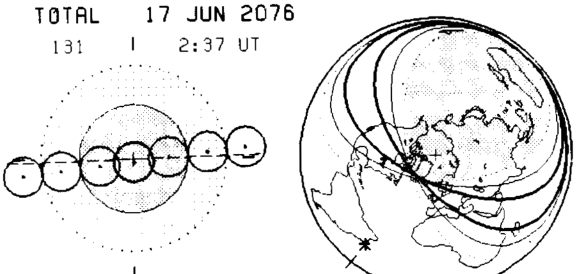
P = 1.587 | U = 0.628

PARTIAL 22 DEC 2075
126 | 8:53 UT



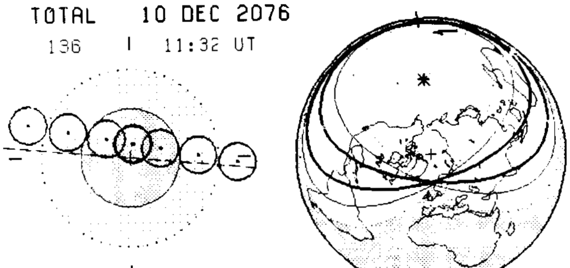
P = 2.027 | U = 0.906

TOTAL 17 JUN 2076
131 | 2:37 UT



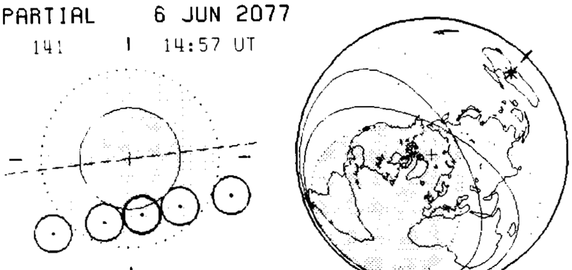
P = 2.780 | U = 1.800

TOTAL 10 DEC 2076
136 | 11:32 UT



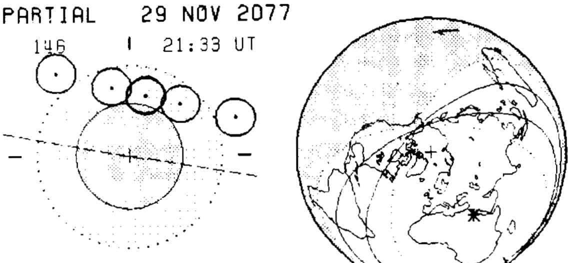
P = 2.524 | U = 1.450

PARTIAL 6 JUN 2077
141 | 14:57 UT



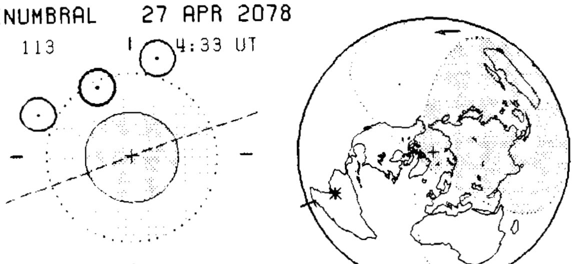
P = 1.351 | U = 0.317

PARTIAL 29 NOV 2077
146 | 21:33 UT



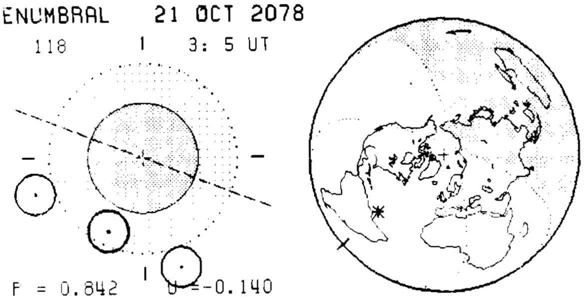
P = 1.256 | U = 0.241

PENUMBRAL 27 APR 2078
113 | 4:33 UT



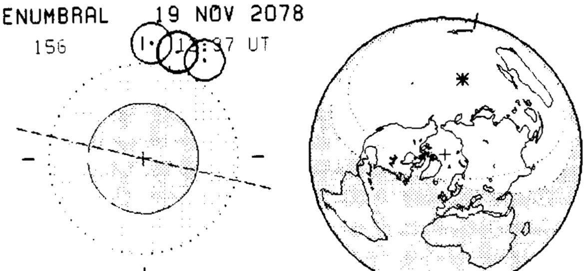
P = 0.682 | U =-0.420

PENUMBRAL 21 OCT 2078
118 | 3: 5 UT



P = 0.842 | U =-0.140

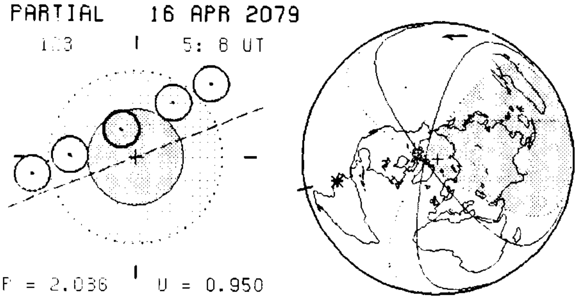
PENUMBRAL 19 NOV 2078
156 | 1[illegible]7 UT



P = 0.066 | U =-0.699

PARTIAL 16 APR 2079

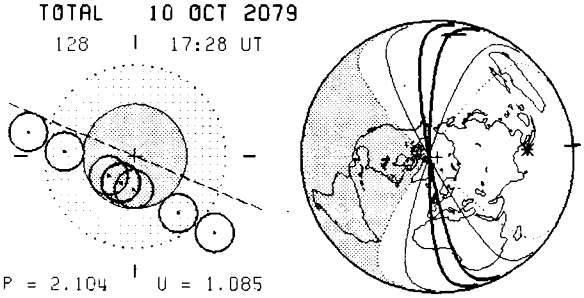
123 | 5: 8 UT



P = 2.036 | U = 0.950

TOTAL 10 OCT 2079

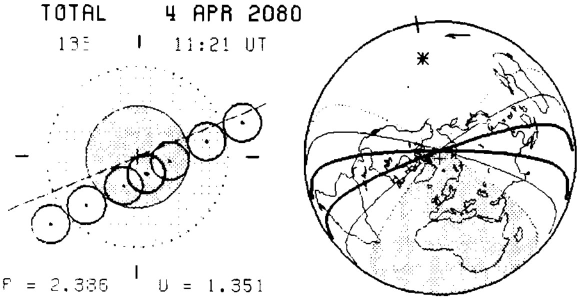
128 | 17:28 UT



P = 2.104 | U = 1.085

TOTAL 4 APR 2080

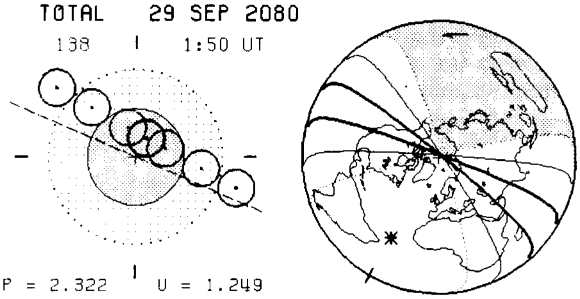
133 | 11:21 UT



P = 2.386 | U = 1.351

TOTAL 29 SEP 2080

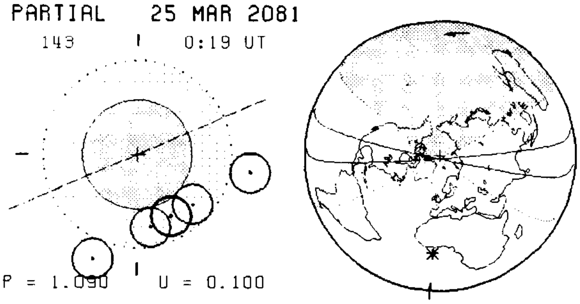
138 | 1:50 UT



P = 2.322 | U = 1.249

PARTIAL 25 MAR 2081

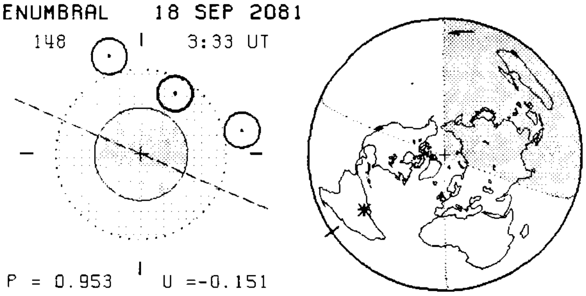
143 | 0:19 UT



P = 1.090 | U = 0.100

PENUMBRAL 18 SEP 2081

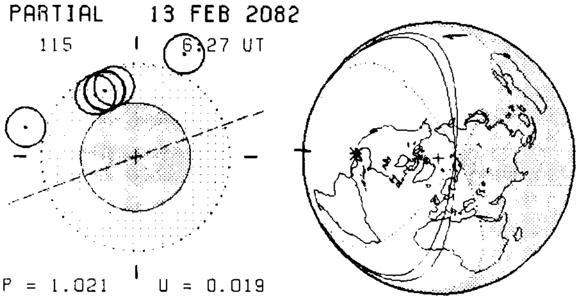
148 | 3:33 UT



P = 0.953 | U =-0.151

PARTIAL 13 FEB 2082

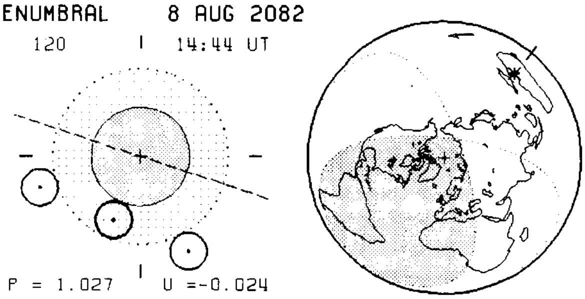
115 | 6:27 UT



P = 1.021 | U = 0.019

PENUMBRAL 8 AUG 2082

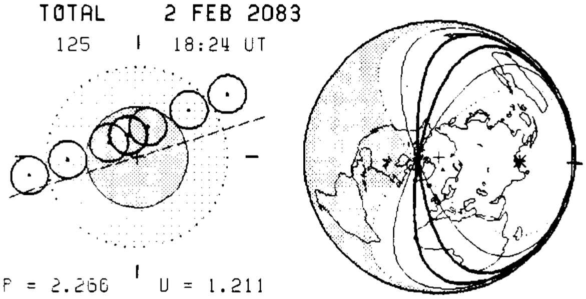
120 | 14:44 UT



P = 1.027 | U =-0.024

TOTAL 2 FEB 2083

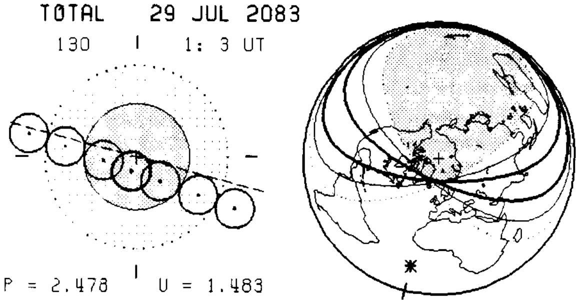
125 | 18:24 UT



P = 2.266 | U = 1.211

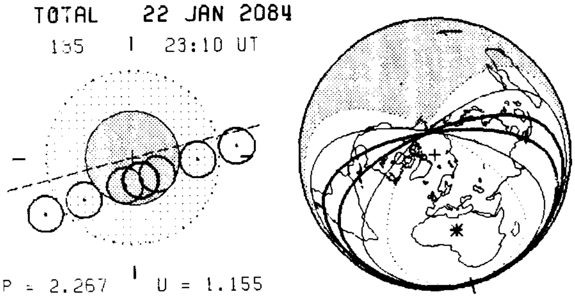
TOTAL 29 JUL 2083

130 | 1: 3 UT



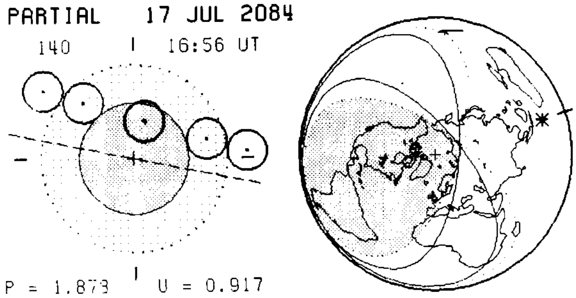
P = 2.478 | U = 1.483

TOTAL 22 JAN 2084
135 | 23:10 UT



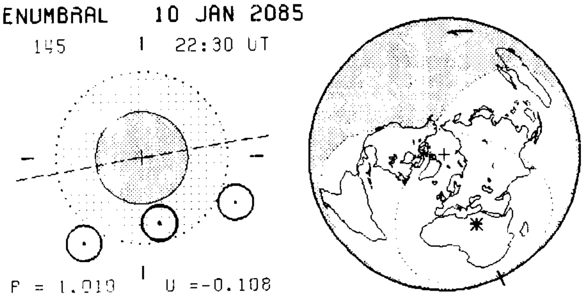
P = 2.267 | U = 1.155

PARTIAL 17 JUL 2084
140 | 16:56 UT



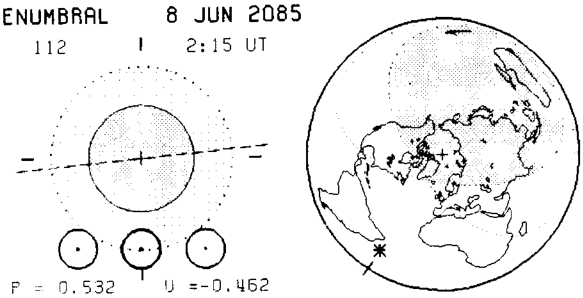
P = 1.873 | U = 0.917

PENUMBRAL 10 JAN 2085
145 | 22:30 UT



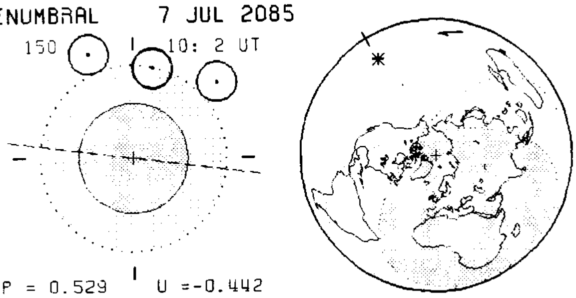
P = 1.010 | U =-0.108

PENUMBRAL 8 JUN 2085
112 | 2:15 UT



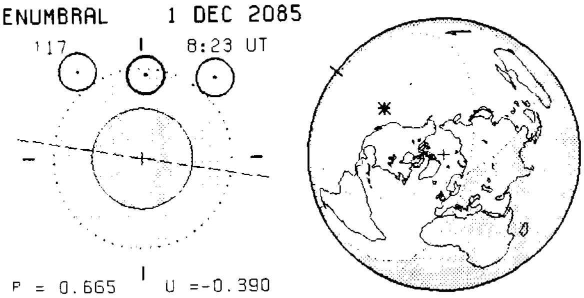
P = 0.532 | U =-0.462

PENUMBRAL 7 JUL 2085
150 | 10: 2 UT



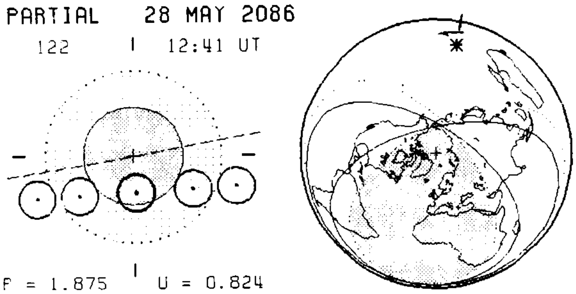
P = 0.529 | U =-0.442

PENUMBRAL 1 DEC 2085
117 | 8:23 UT



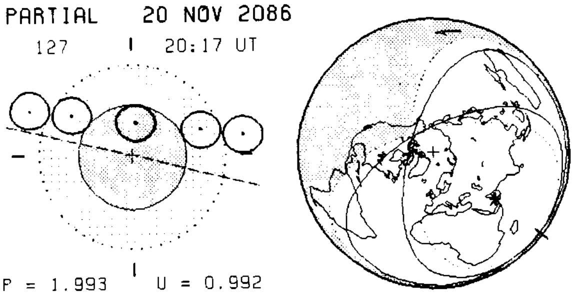
P = 0.665 | U =-0.390

PARTIAL 28 MAY 2086
122 | 12:41 UT



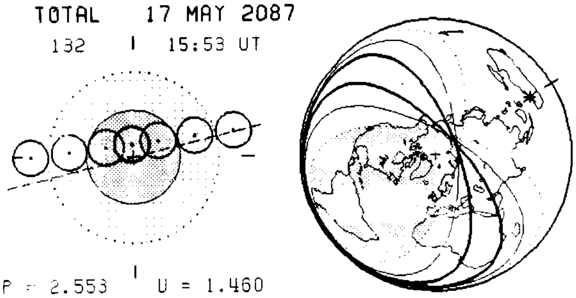
P = 1.875 | U = 0.824

PARTIAL 20 NOV 2086
127 | 20:17 UT



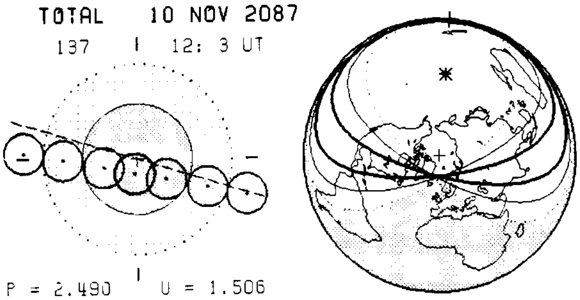
P = 1.993 | U = 0.992

TOTAL 17 MAY 2087
132 | 15:53 UT



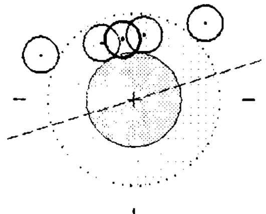
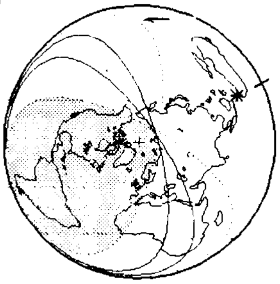
P = 2.553 | U = 1.460

TOTAL 10 NOV 2087
137 | 12: 3 UT



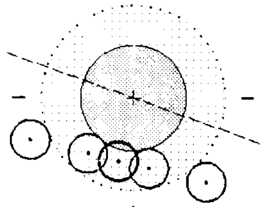
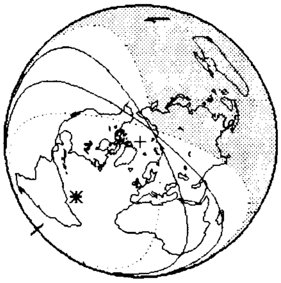
P = 2.490 | U = 1.506

PARTIAL 5 MAY 2088
142 | 16:14 UT

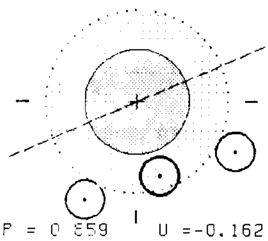
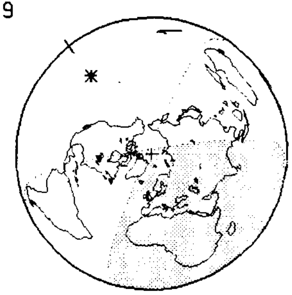
P = 1.195 | U = 0.106

PARTIAL 30 OCT 2088
147 | 3: 0 UT

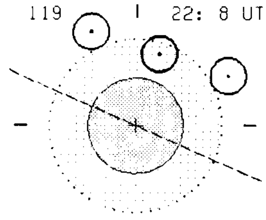
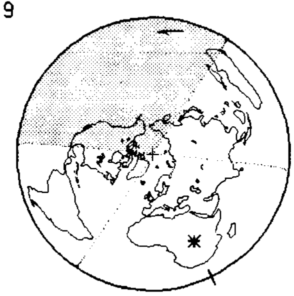
P = 1.201 | U = 0.188

PENUMBRAL 26 MAR 2089
114 | 9:31 UT

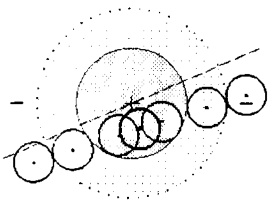
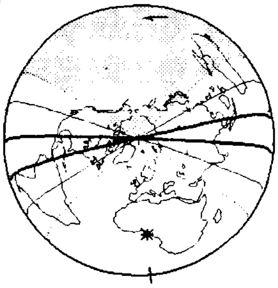
P = 0.859 | U =-0.162

PENUMBRAL 19 SEP 2089
119 | 22: 8 UT

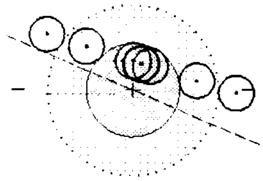
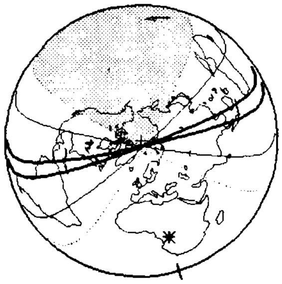
P = 0.816 | U =-0.269

TOTAL 15 MAR 2090
124 | 23:46 UT

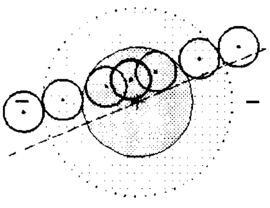
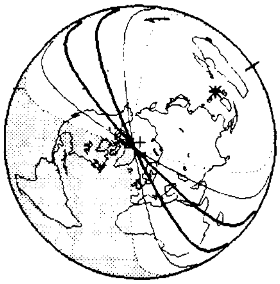
P = 2.191 | U = 1.207

TOTAL 8 SEP 2090
129 | 22:49 UT

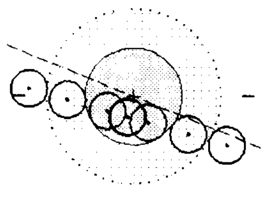
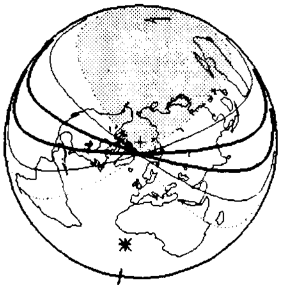
P = 2.143 | U = 1.043

TOTAL 5 MAR 2091
134 | 15:55 UT

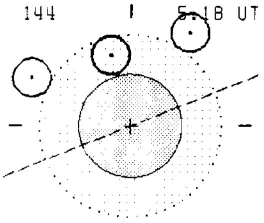
P = 2.278 | U = 1.288

TOTAL 29 AUG 2091
139 | 0:35 UT

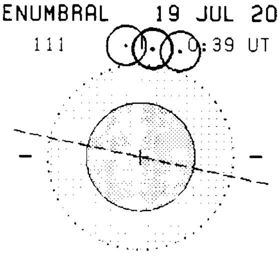
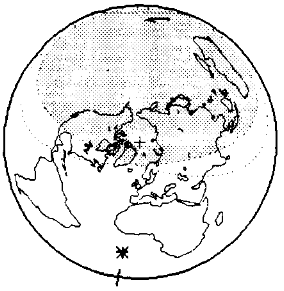
P = 2.306 | U = 1.240

PENUMBRAL 23 FEB 2092
144 | 5:18 UT




P = 0.963 | U =-0.074

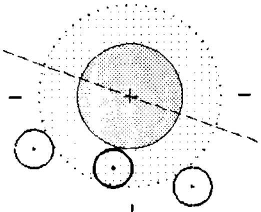
PENUMBRAL 19 JUL 2092
111 | 0:39 UT

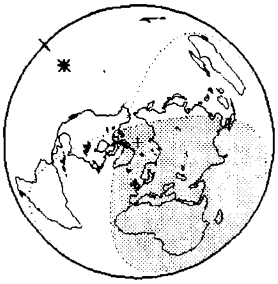



P = 0.087 | U =-0.893

PENUMBRAL 17 AUG 2092

149 9:11 UT

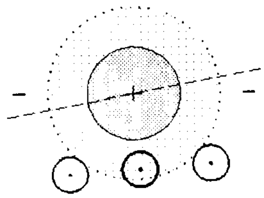


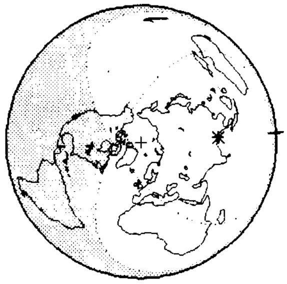


P = 0.938 U =-0.071

PENUMBRAL 12 JAN 2093

116 17:57 UT

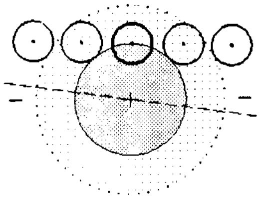


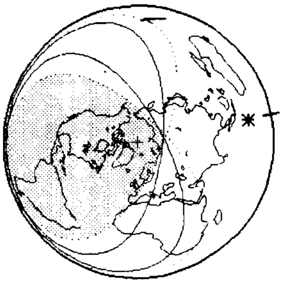


P = 0.782 U =-0.340

PARTIAL 8 JUL 2093

121 17:21 UT

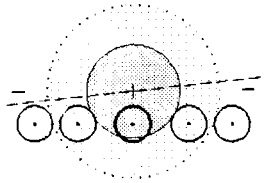


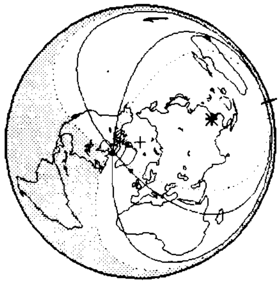


P = 1.452 U = 0.493

PARTIAL 1 JAN 2094

126 16:57 UT

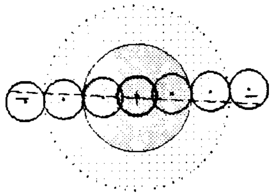


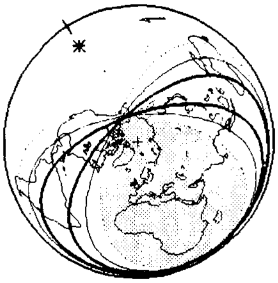


P = 2.012 U = 0.892

TOTAL 28 JUN 2094

131 9:59 UT

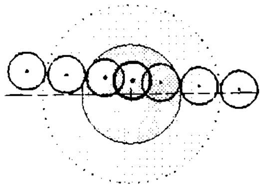


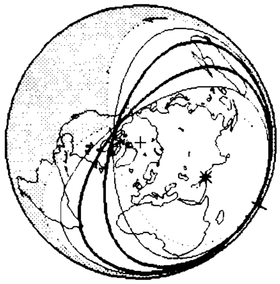


P = 2.812 U = 1.829

TOTAL 21 DEC 2094

136 19:53 UT

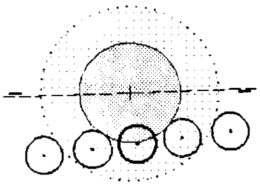


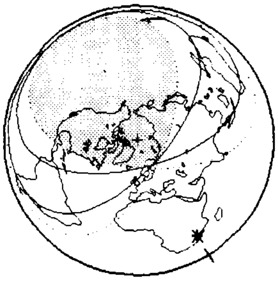


P = 2.539 U = 1.467

PARTIAL 17 JUN 2095

141 21:57 UT

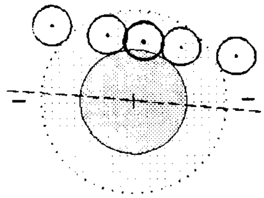


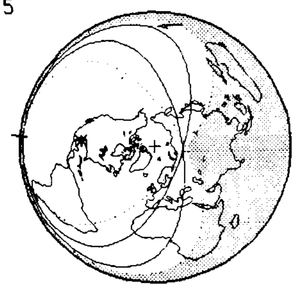


P = 1.487 U = 0.451

PARTIAL 11 DEC 2095

146 6:12 UT

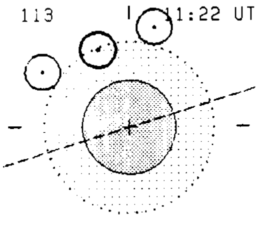


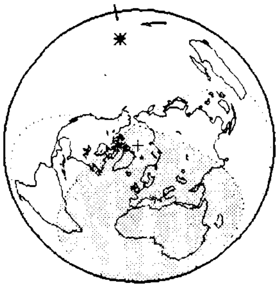


P = 1.276 U = 0.262

PENUMBRAL 7 MAY 2096

113 11:22 UT

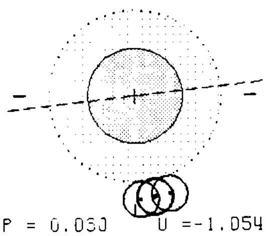


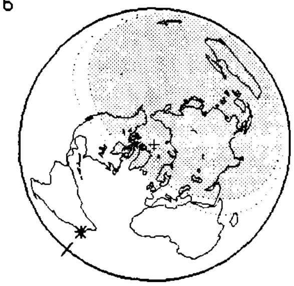


P = 0.557 U =-0.542

PENUMBRAL 6 JUN 2096

151 2:41 UT

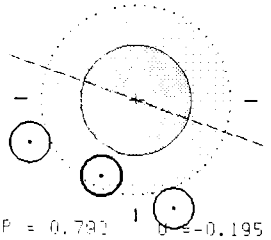


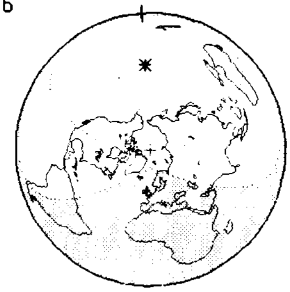


P = 0.030 U =-1.054

PENUMBRAL 31 OCT 2096

118 | 11:27 UT

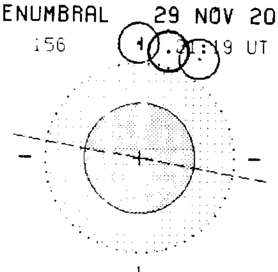


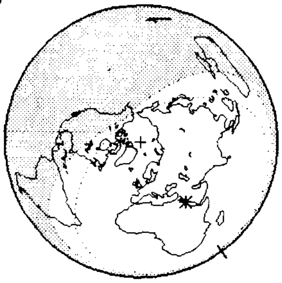


P = 0.791 | U =-0.195

PENUMBRAL 29 NOV 2096

156 | 21:19 UT

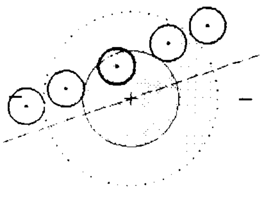


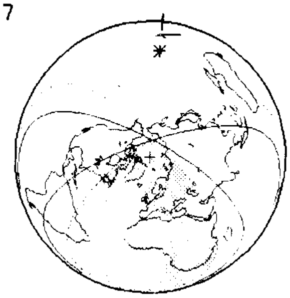


P = 0.111 | U =-0.876

PARTIAL 26 APR 2097

123 | 12:15 UT

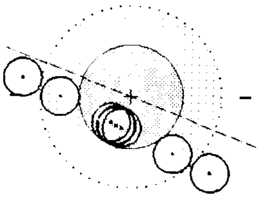


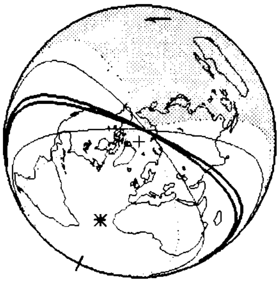


P = 1.927 | U = 0.847

TOTAL 21 OCT 2097

128 | 1:28 UT

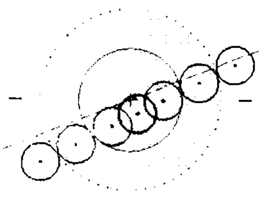


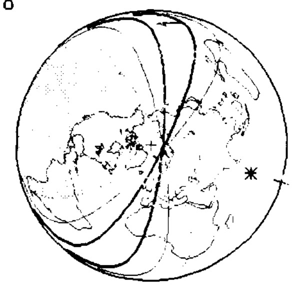


P = 2.041 | U = 1.015

TOTAL 15 APR 2098

133 | 19: 2 UT

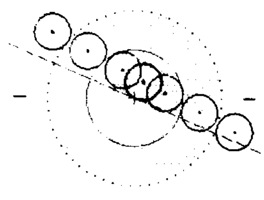


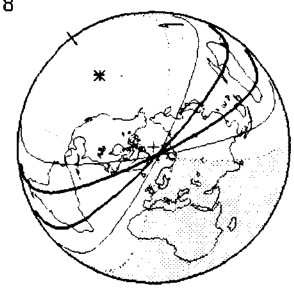


P = 2.471 | U = 1.442

TOTAL 10 OCT 2098

138 | 9:17 UT

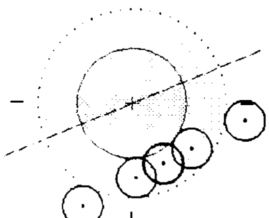


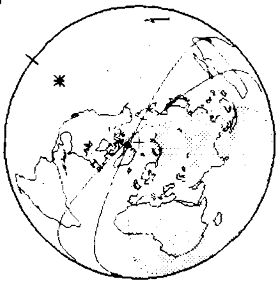


P = 2.409 | U = 1.329

PARTIAL 5 APR 2099

143 | 8:28 UT

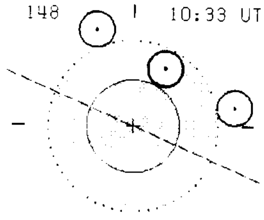


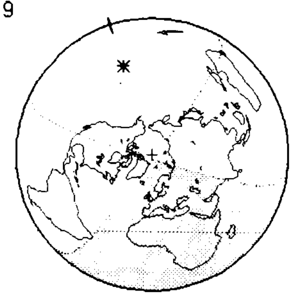


P = 1.158 | U = 0.173

PENUMBRAL 29 SEP 2099

148 | 10:33 UT

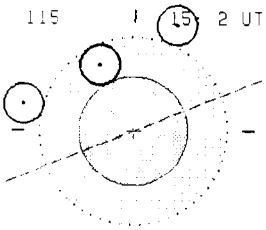


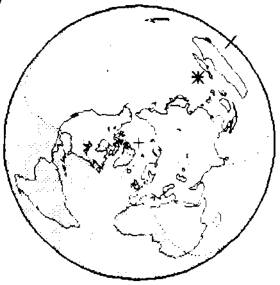


P = 1.060 | U =-0.047

PENUMBRAL 24 FEB 2100

115 | 15: 2 UT

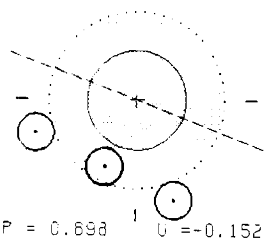


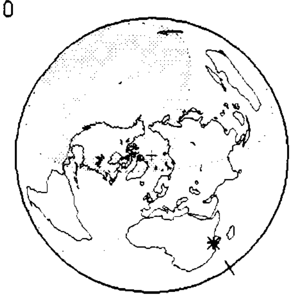


P = 0.990 | U =-0.011

PENUMBRAL 19 AUG 2100

120 | 21:42 UT





P = 0.898 | U =-0.152

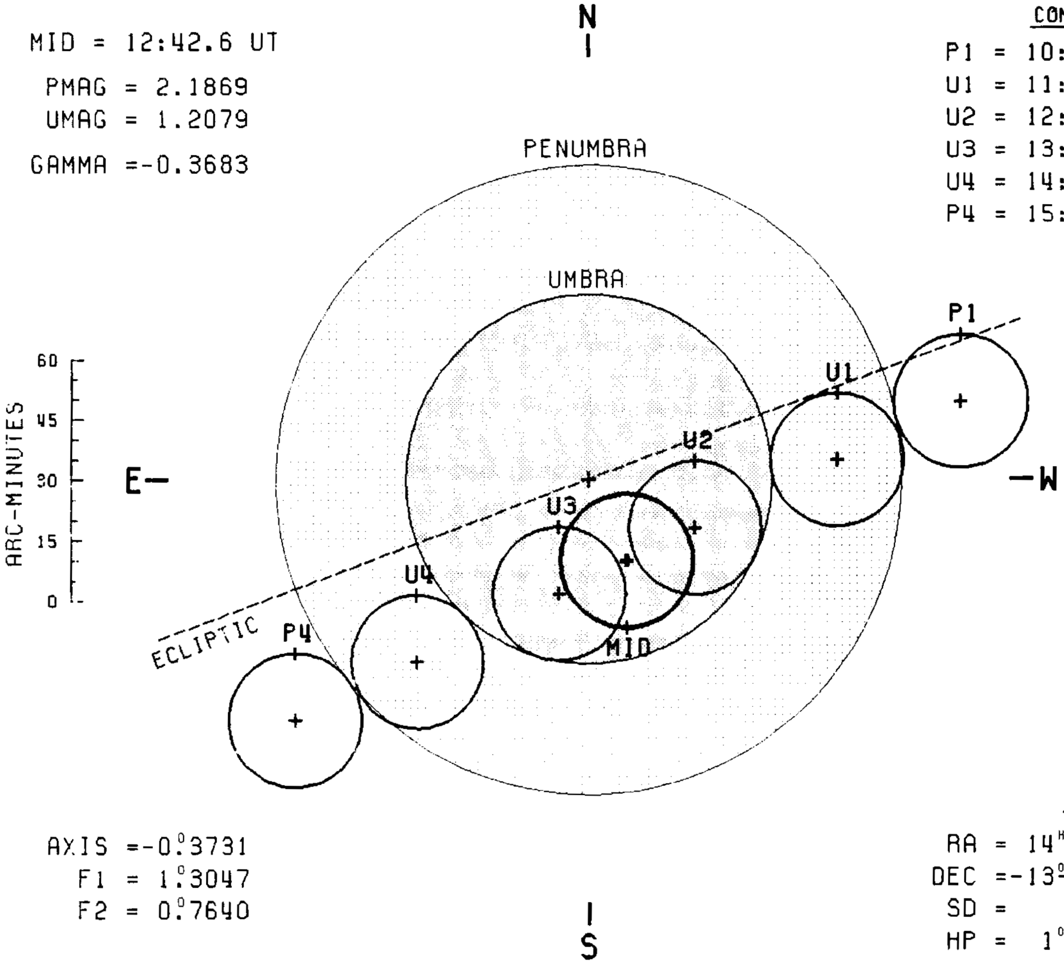
FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

SECTION 3 - ECLIPSE PATHS AND WORLD MAPS: 1986 - 2035

TOTAL LUNAR ECLIPSE - 24 APR 1986

MID = 12:42.6 UT
PMAG = 2.1869
UMAG = 1.2079
GAMMA =-0.3683

CONTACTS
P1 = 10: 4.6 UT
U1 = 11: 2.7 UT
U2 = 12:10.1 UT
U3 = 13:14.7 UT
U4 = 14:22.3 UT
P4 = 15:20.4 UT



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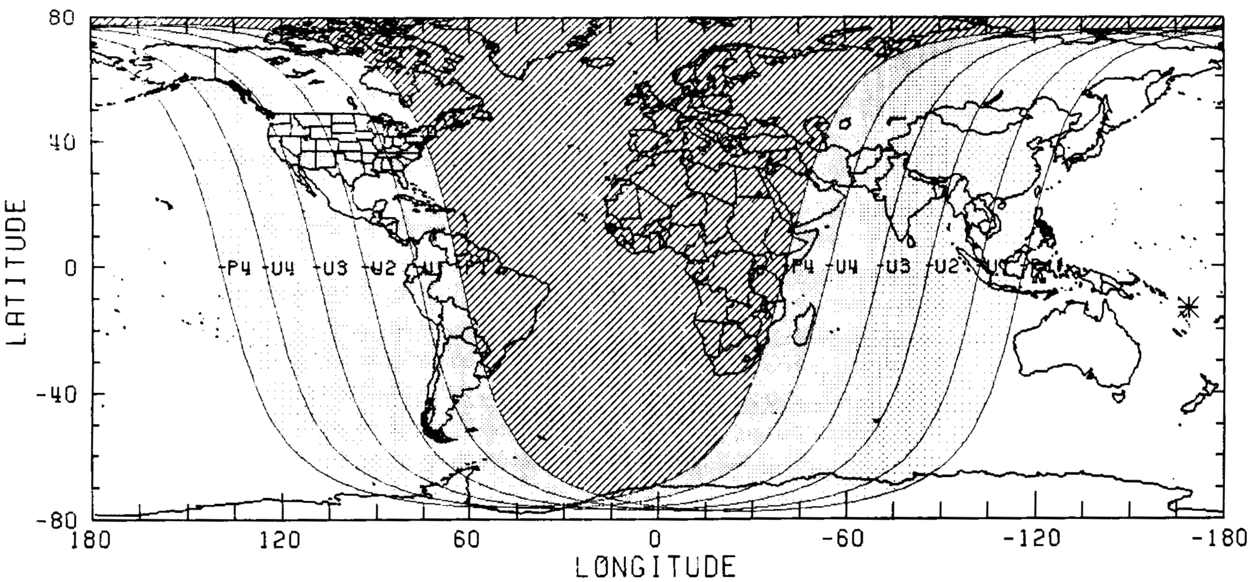
F1 = 1°3047
F2 = 0°7640

MOON
RA = 14ʰ 6ᵐ 30ˢ3
DEC =-13° 12' 19"0
SD = 16' 34"0
HP = 1° 0' 48"0

SAROS 131 (32/72) JD = 2446545.030 ΔT = 55.1 S



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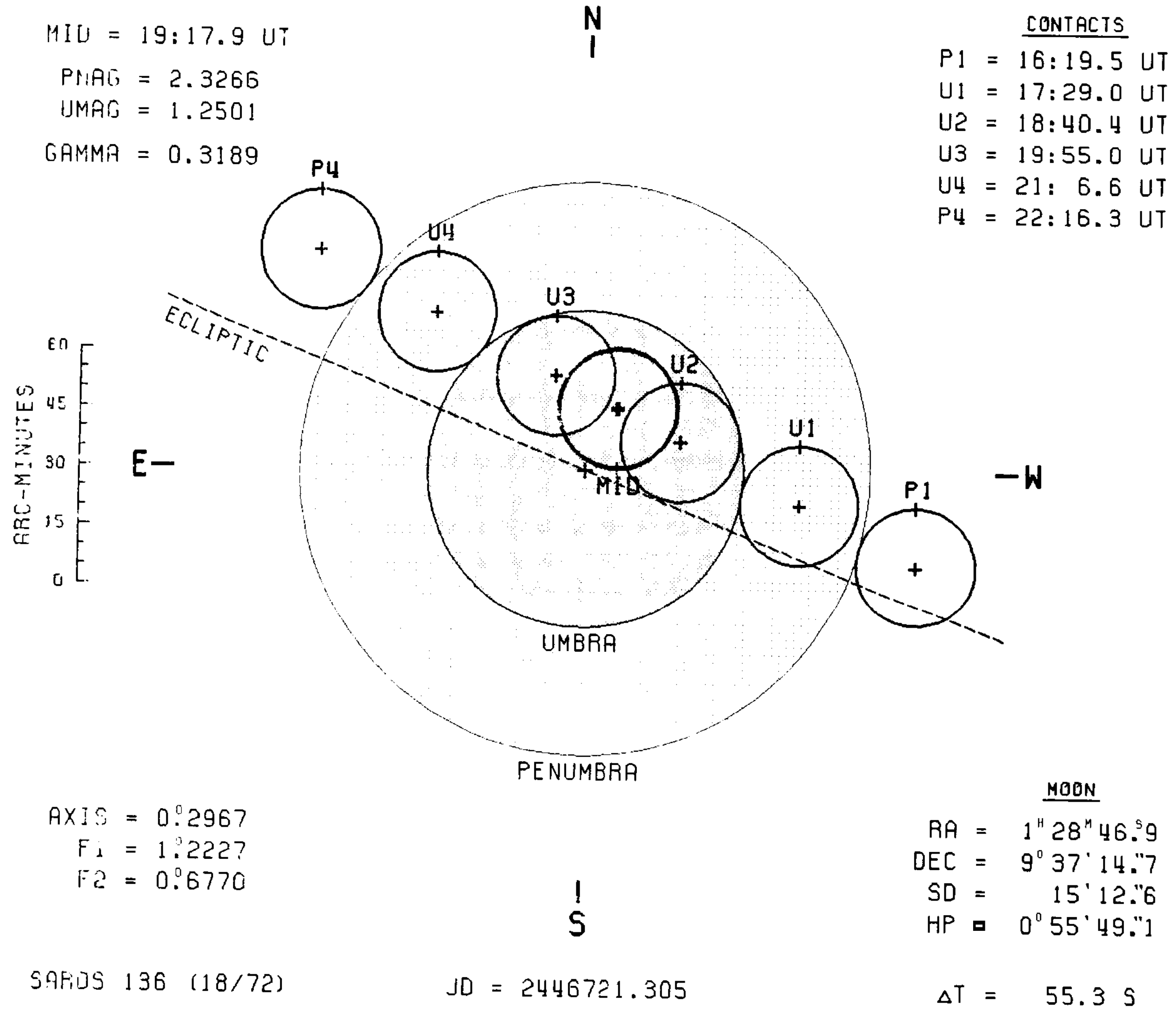
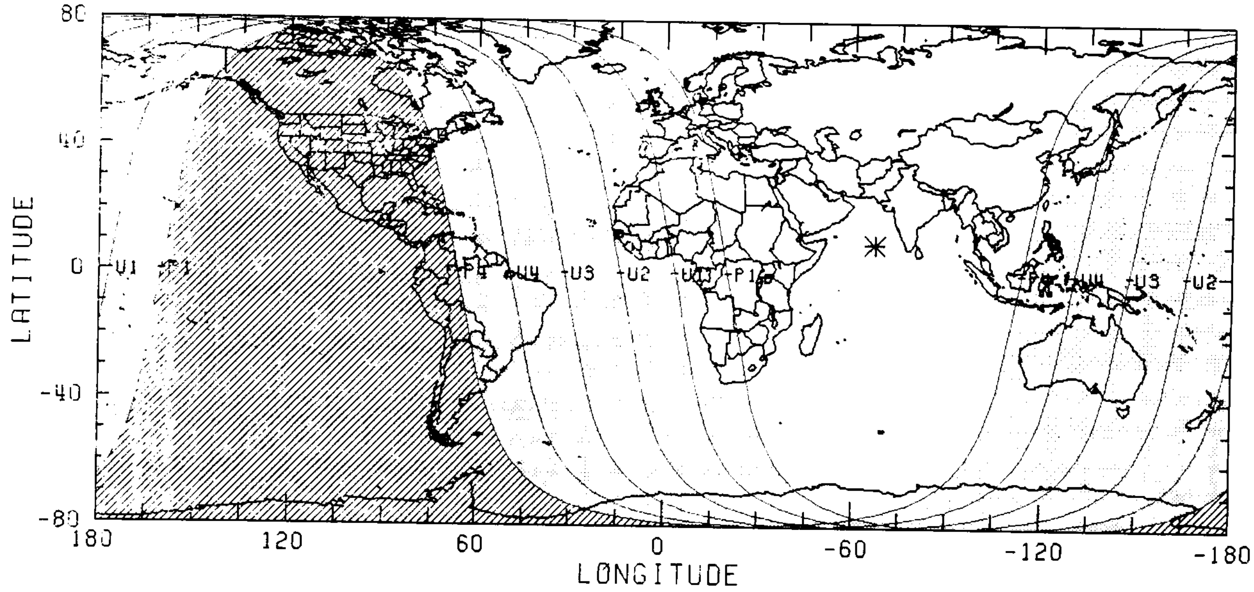
PAGE 80 INTENTIONALLY BLANK

TOTAL LUNAR ECLIPSE - 17 OCT 1986





PENUMBRAL LUNAR ECLIPSE - 14 APR 1987

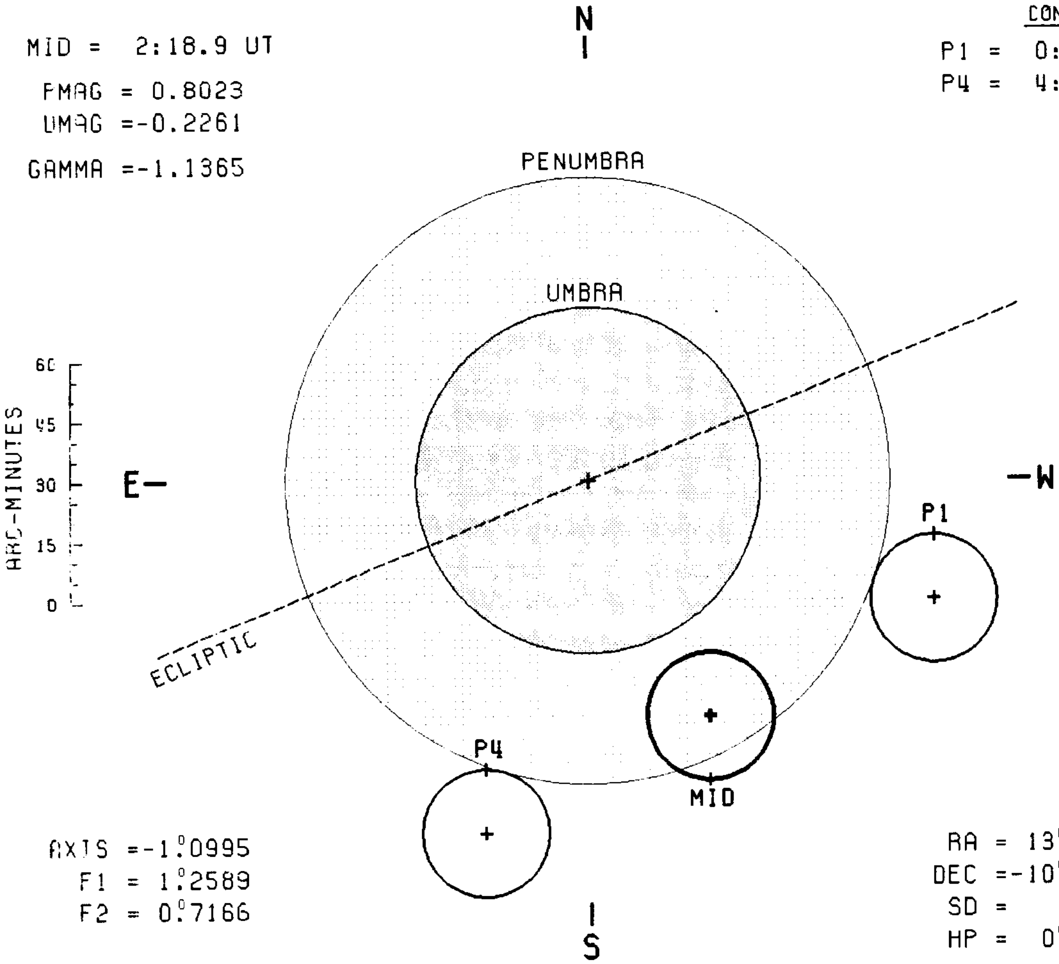
MID = 2:18.9 UT

PMAG = 0.8023
UMAG =-0.2261

GAMMA =-1.1365

CONTACTS

P1 = 0:19.4 UT
P4 = 4:18.0 UT

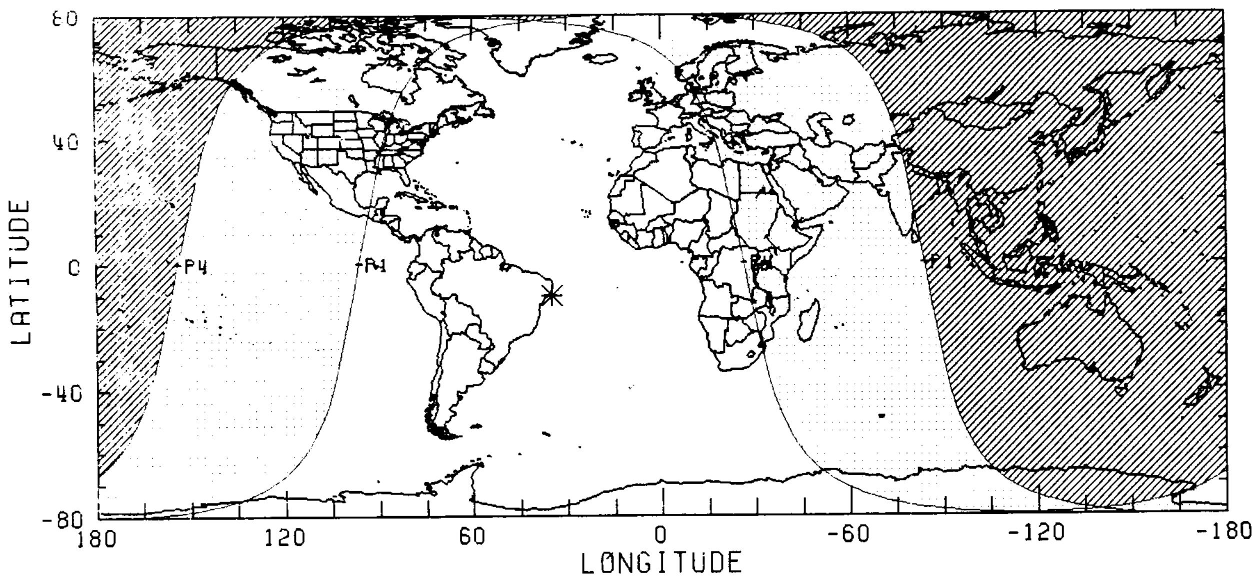


AXIS =-1.°0995
F1 = 1.°2589
F2 = 0.°7166

MOON

RA = $13^h 25^m 23.^s5$
DEC = $-10° -8' -55.''7$
SD = $15' 49.''1$
HP = $0° 58' 3.''3$

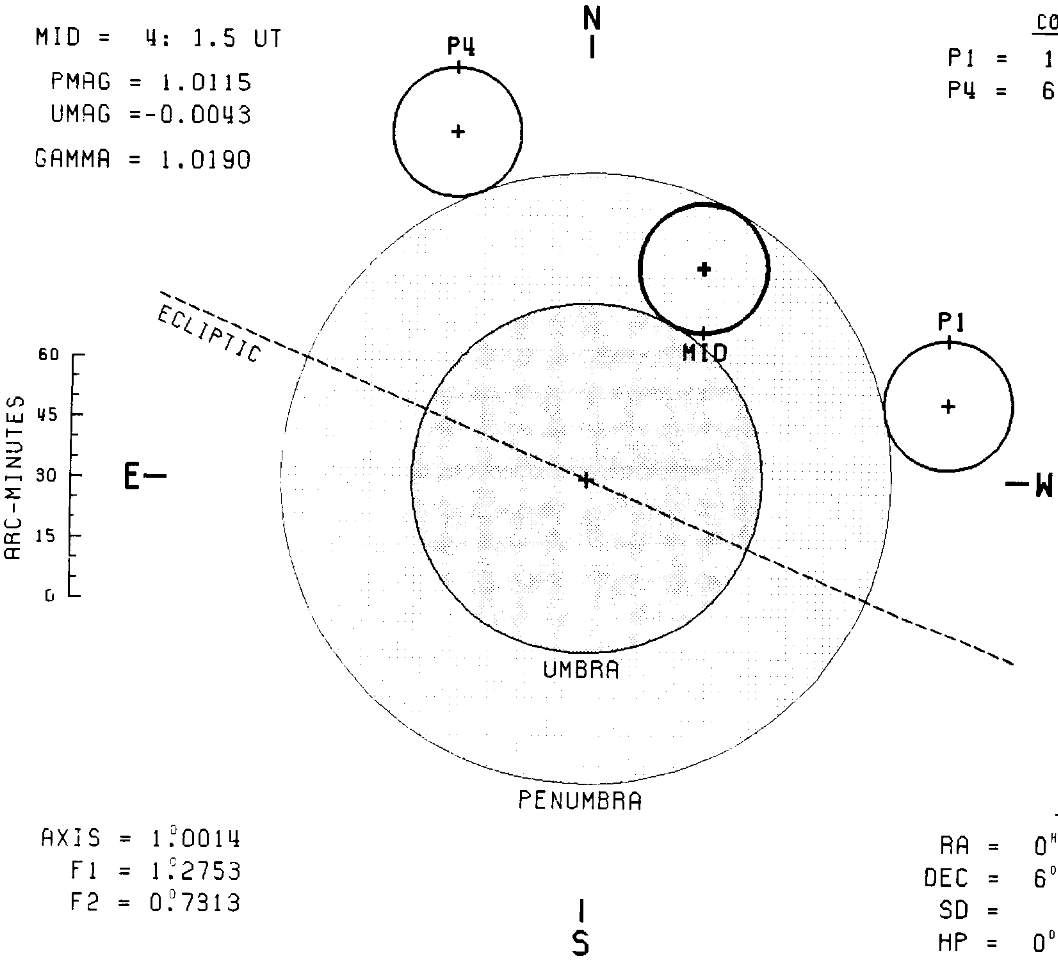
SAROS 141 (22/73)   JD = 2446899.597 ΔT = 55.6 S



PENUMBRAL LUNAR ECLIPSE - 7 OCT 1987

MID = 4: 1.5 UT
PMAG = 1.0115
UMAG =-0.0043
GAMMA = 1.0190

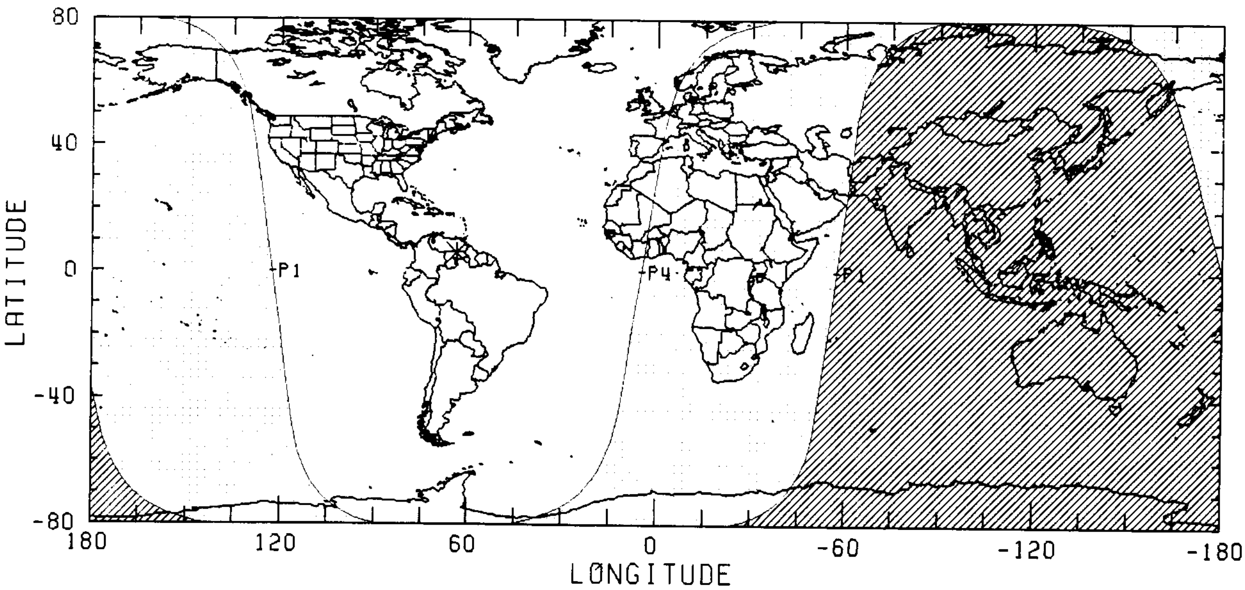
CONTACTS
P1 = 1:52.5 UT
P4 = 6:10.0 UT



AXIS = 1°.0014
F1 = 1°.2753
F2 = 0°.7313

MOON
RA = $0^h 47^m 14^s.3$
DEC = $6° \ 9' 13''.7$
SD = $16' \ 4''.1$
HP = $0° 58' 58''.1$

SAROS 146 (9/72)   JD = 2447075.668 ΔT = 55.9 S



PARTIAL LUNAR ECLIPSE - 3 MAR 1988

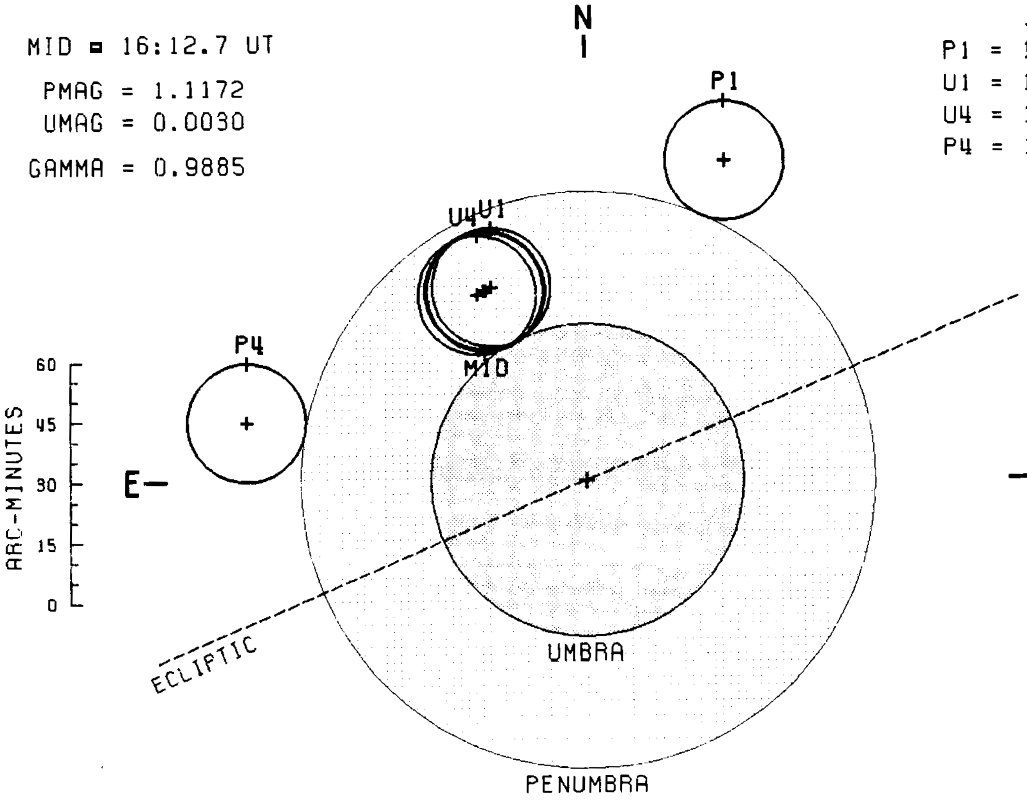
MID = 16:12.7 UT

PMAG = 1.1172
UMAG = 0.0030

GAMMA = 0.9885

CONTACTS

P1 = 13:43.8 UT
U1 = 16: 8.7 UT
U4 = 16:17.5 UT
P4 = 18:42.1 UT

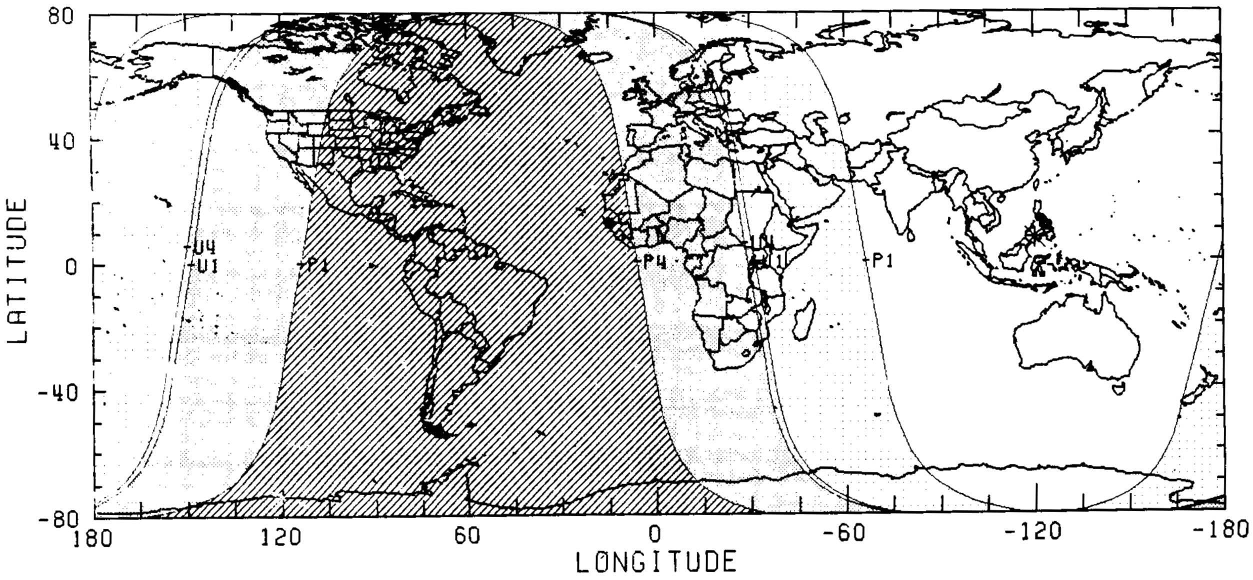


AXIS = 0.°8927
F1 = 1.°1965
F2 = 0.°6480

MOON

RA = 11ʰ 0ᵐ 10.ˢ3
DEC = 7° 20′ 53.″3
SD = 14′ 46.″0
HP = 0° 54′ 11.″5

SAROS 113 (62/71)   JD = 2447224.176   ΔT = 56.1 S



PARTIAL LUNAR ECLIPSE - 27 AUG 1988

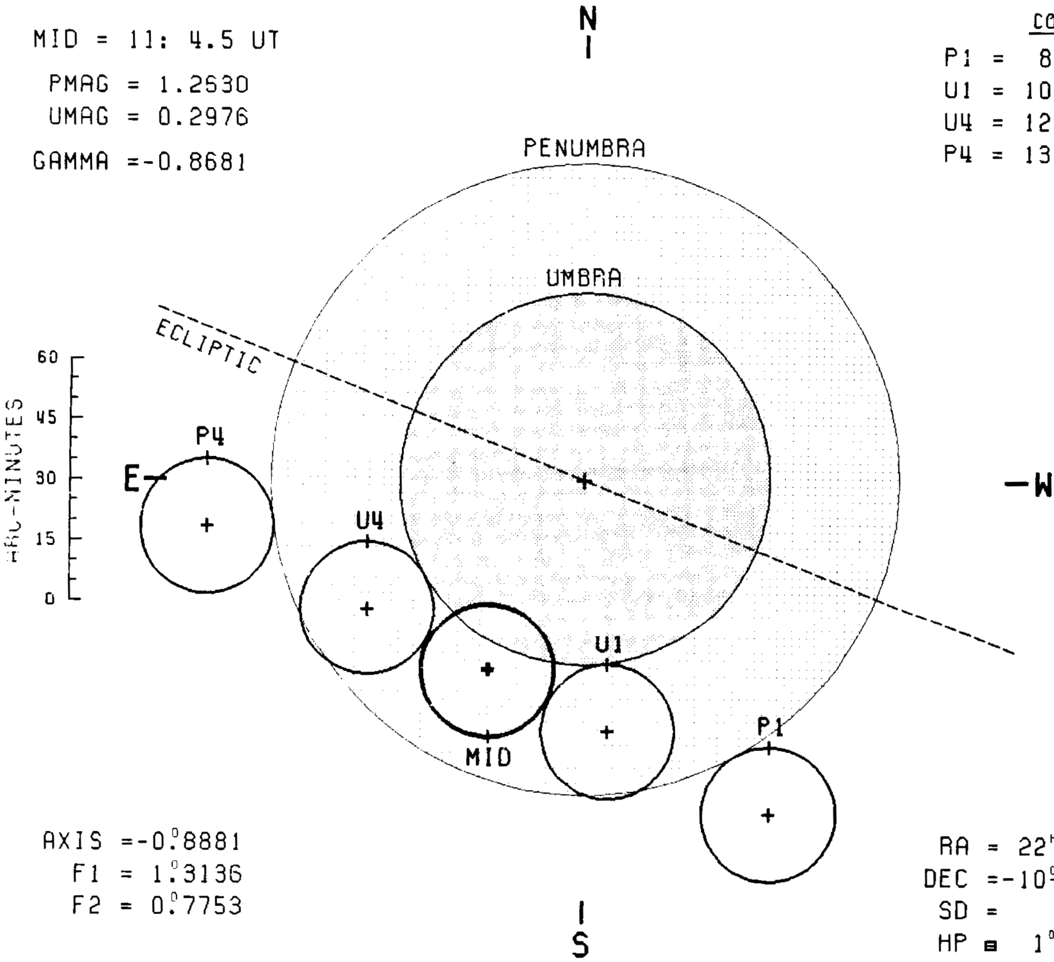
MID = 11: 4.5 UT

PMAG = 1.2630
UMAG = 0.2976

GAMMA =-0.8681

CONTACTS

P1 = 8:51.6 UT
U1 = 10: 7.7 UT
U4 = 12: 1.8 UT
P4 = 13:17.7 UT

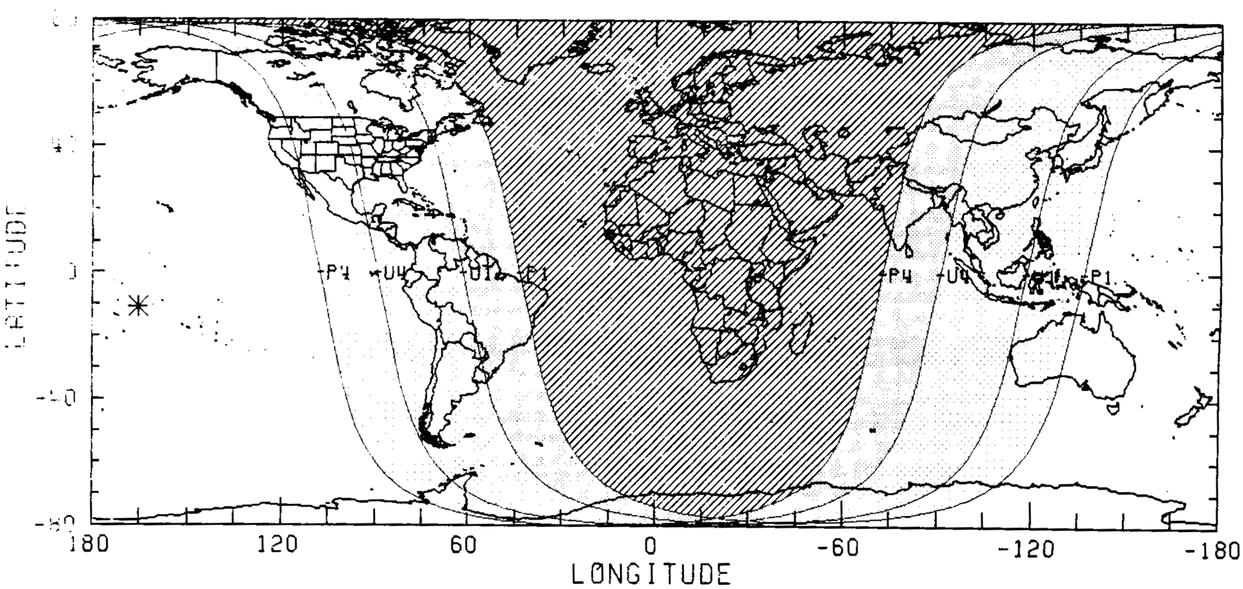


AXIS =-0°.8881
F1 = 1°.3136
F2 = 0°.7753

MOON

RA = 22ʰ26ᵐ40ˢ.3
DEC =-10°41'41".1
SD = 16'43".7
HP = 1° 1'23".6

SAROS 118 (51/75) JD = 2447400.962 ΔT = 56.4 S



TOTAL LUNAR ECLIPSE - 20 FEB 1989

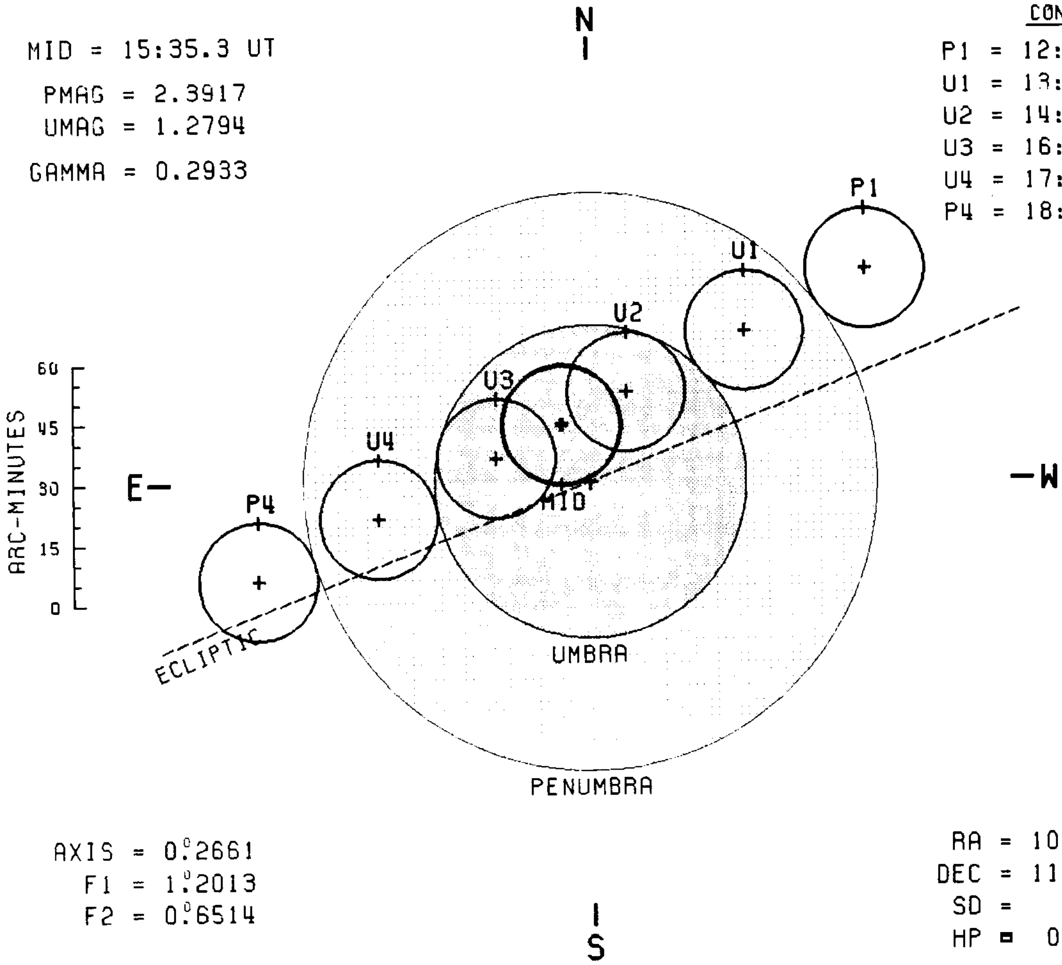
MID = 15:35.3 UT

PMAG = 2.3917
UMAG = 1.2794

GAMMA = 0.2933

CONTACTS

P1 = 12:29.7 UT
U1 = 13:43.4 UT
U2 = 14:55.8 UT
U3 = 16:15.2 UT
U4 = 17:27.4 UT
P4 = 18:41.1 UT

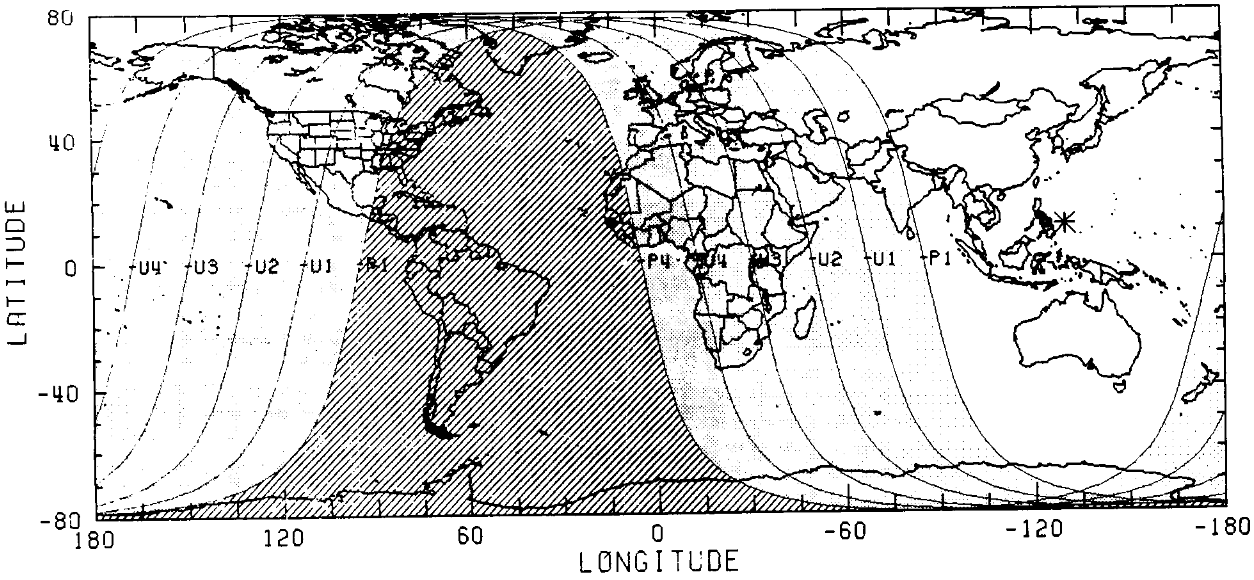


AXIS = 0.°2661
F1 = 1.°2013
F2 = 0.°6514

MOON

RA = 10ʰ 16ᵐ 24.ˢ5
DEC = 11° 0' 28."6
SD = 14' 49."9
HP = 0° 54' 25."9

SAROS 123 (51/73) JD = 2447578.150 ΔT = 56.7 S



TOTAL LUNAR ECLIPSE - 17 AUG 1989

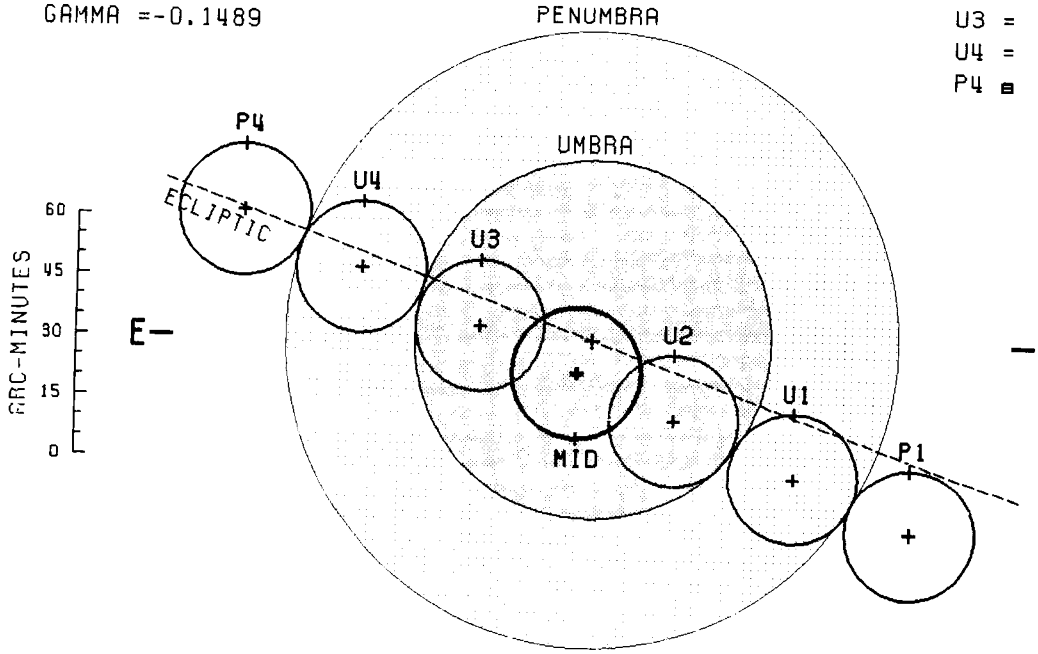
MID = 3: 8.2 UT

PMAG = 2.5956
UMAG = 1.6042

GAMMA =-0.1489

CONTACTS

P1 = 0:22.8 UT
U1 = 1:20.6 UT
U2 = 2:19.9 UT
U3 = 3:56.6 UT
U4 = 4:55.8 UT
P4 = 5:53.5 UT



AXIS =-0°.1481
F1 = 1°.2835
F2 = 0°.7463

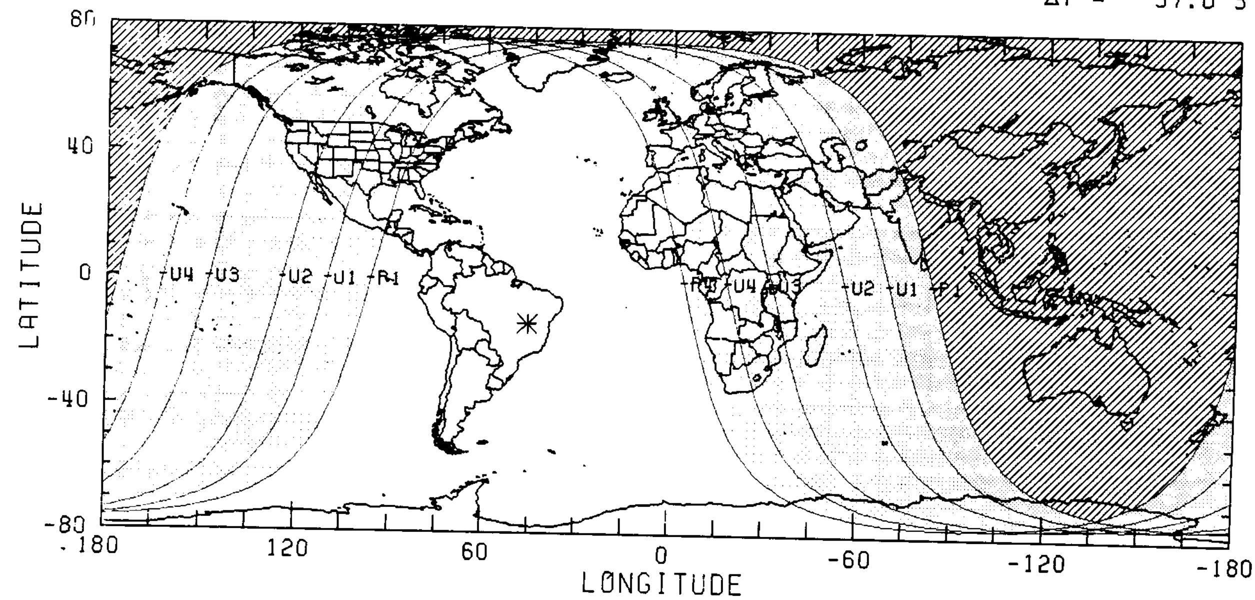
MOON

RA = 21ʰ46ᵐ17ˢ.4
DEC =-13°35'27".5
SD = 16'15".3
HP = 0°59'39".3

SAROS 128 (39/71)

JD = 2447755.631

ΔT = 57.0 S



TOTAL LUNAR ECLIPSE - 9 FEB 1990

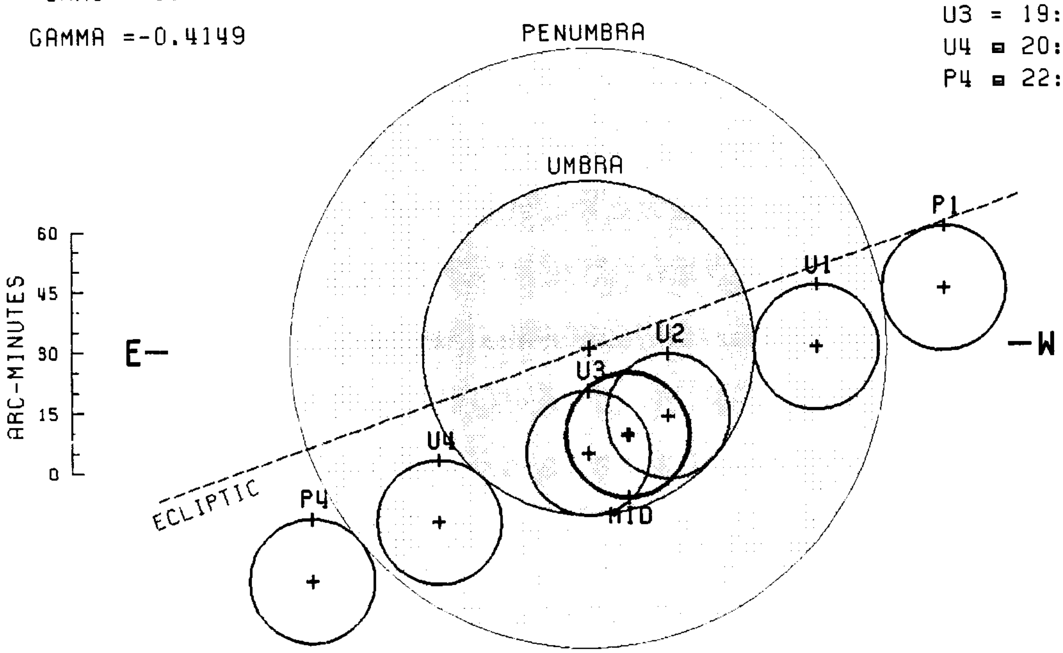
MID = 19:11.1 UT

PMAG = 2.1447
UMAG = 1.0797

GAMMA =-0.4149

CONTACTS

P1 = 16:19.4 UT
U1 = 17:28.3 UT
U2 = 18:49.1 UT
U3 = 19:32.5 UT
U4 = 20:53.5 UT
P4 = 22: 2.6 UT



AXIS =-0°.3940
F1 = 1°.2450
F2 = 0°.6939

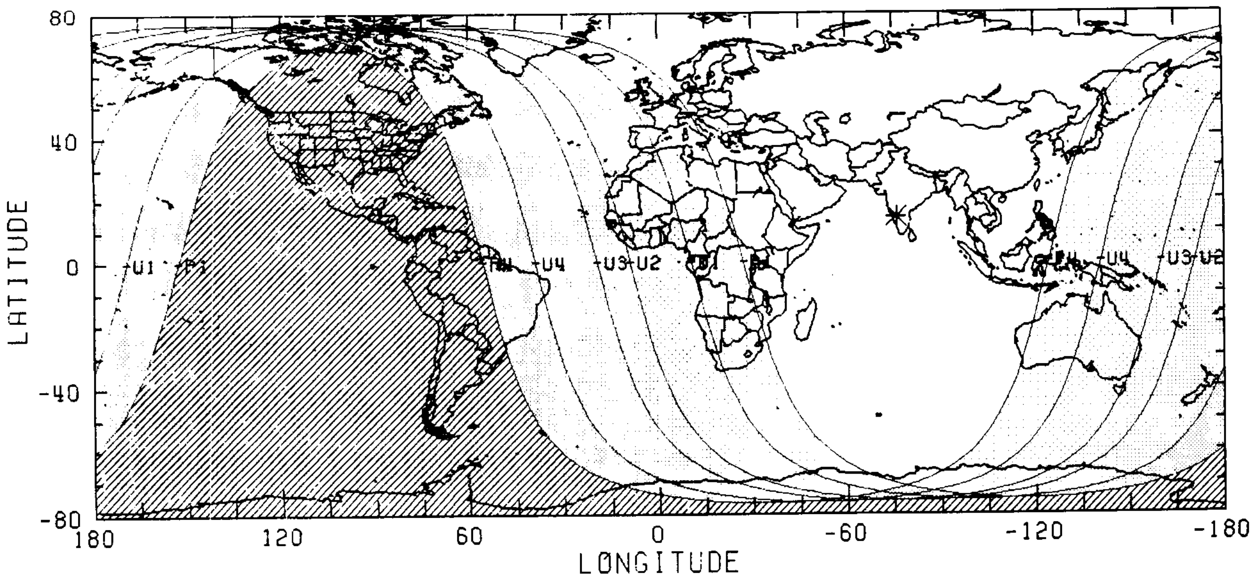
MOON

RA = 9ʰ 32ᵐ 1ˢ.7
DEC = 14° 12' 35".8
SD = 15' 31".5
HP = 0° 56' 58".5

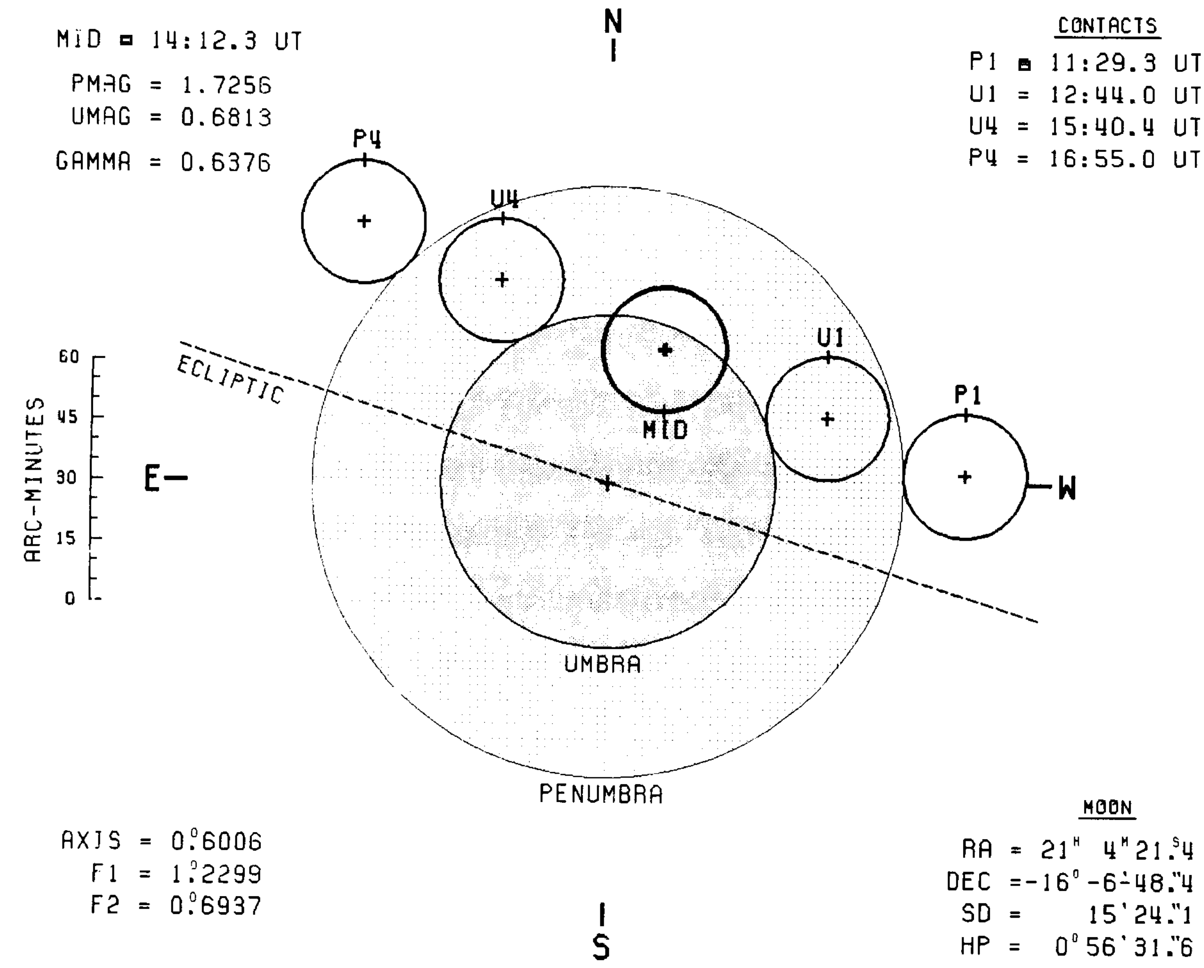
SAROS 133 (25/71)

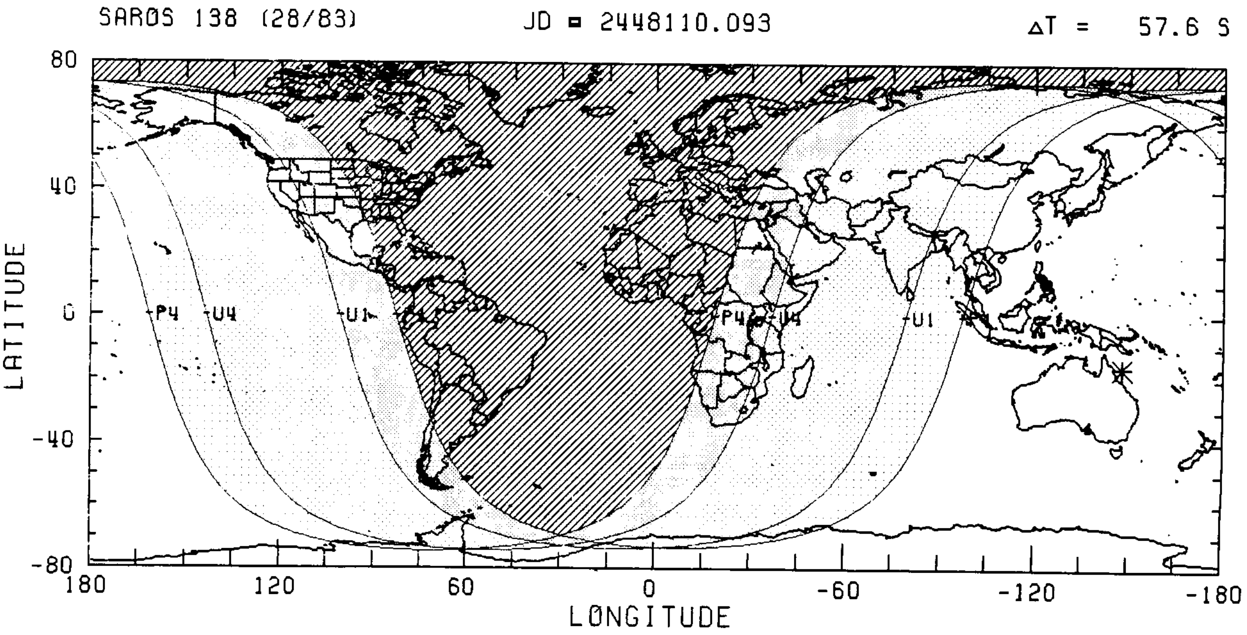
JD = 2447932.300

ΔT = 57.3 S



PARTIAL LUNAR ECLIPSE - 6 AUG 1990





PENUMBRAL LUNAR ECLIPSE - 30 JAN 1991

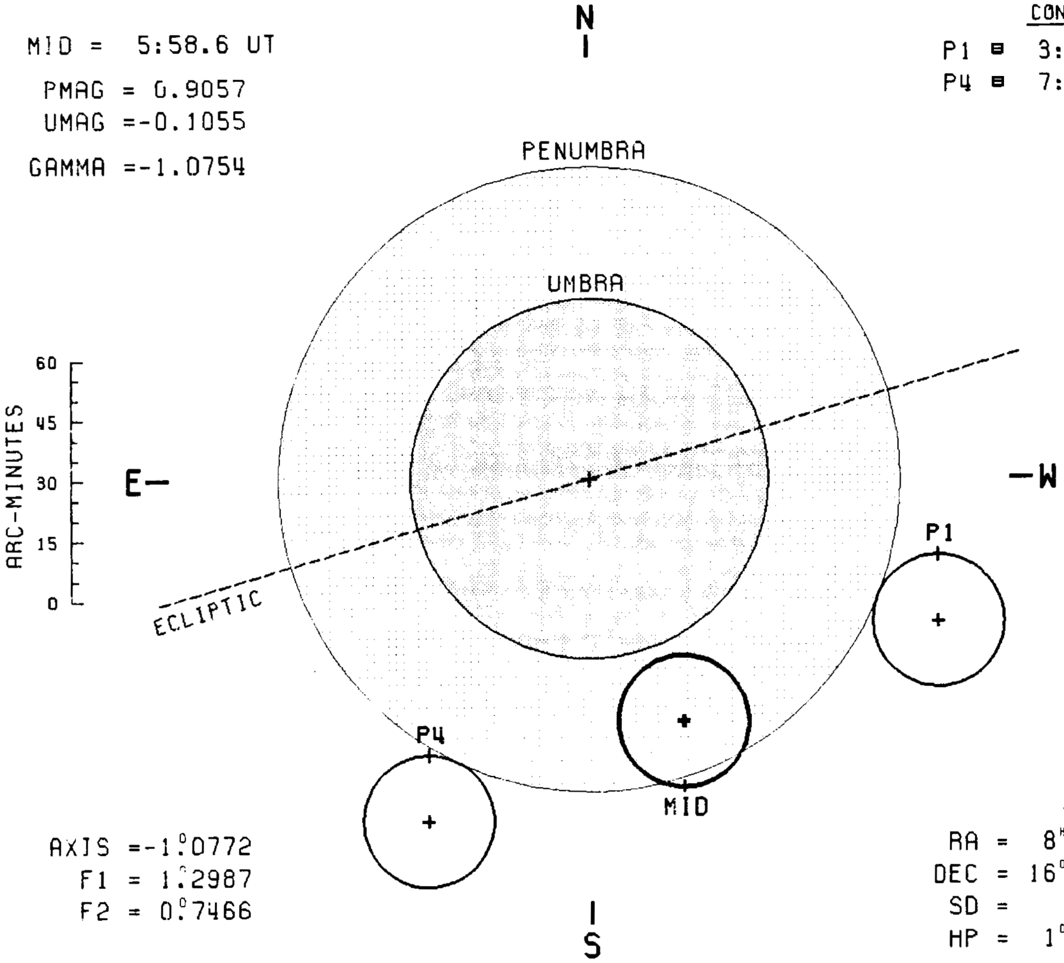
MID = 5:58.6 UT

PMAG = 0.9057
UMAG =-0.1055

GAMMA =-1.0754

CONTACTS

P1 = 3:57.6 UT
P4 = 7:59.2 UT

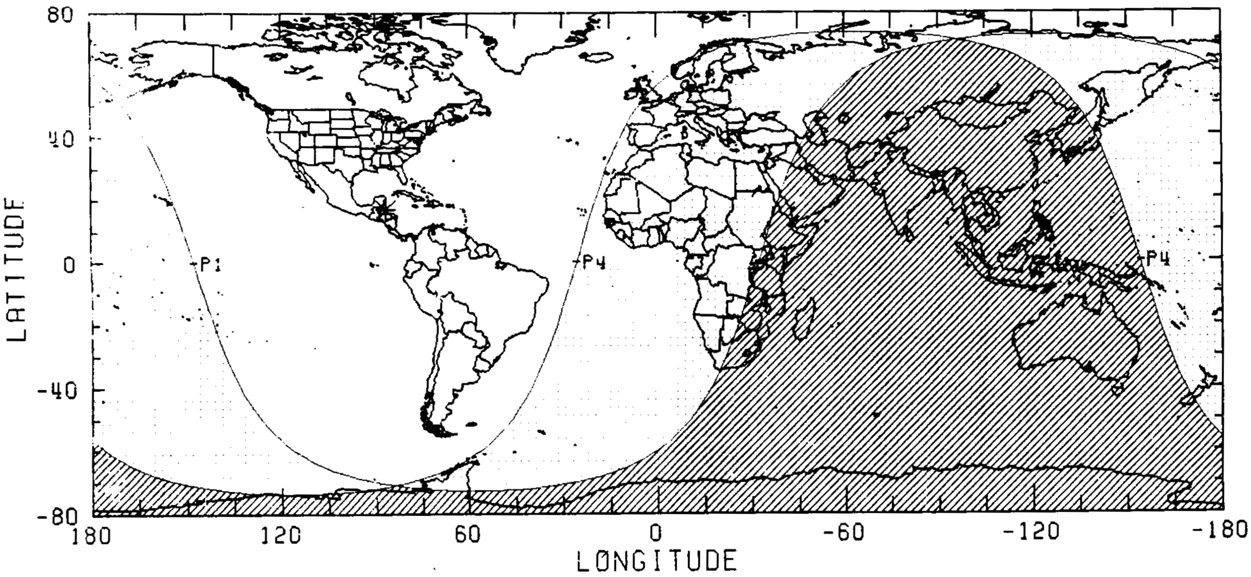


AXIS =-1°0772
F1 = 1°2987
F2 = 0°7466

MOON

RA = 8ʰ47ᵐ29ˢ9
DEC = 16°46'52"7
SD = 16'22"7
HP = 1° 0' 6"5

SAROS 143 (17/73) JD = 2448286.750 ΔT = 58.0 S



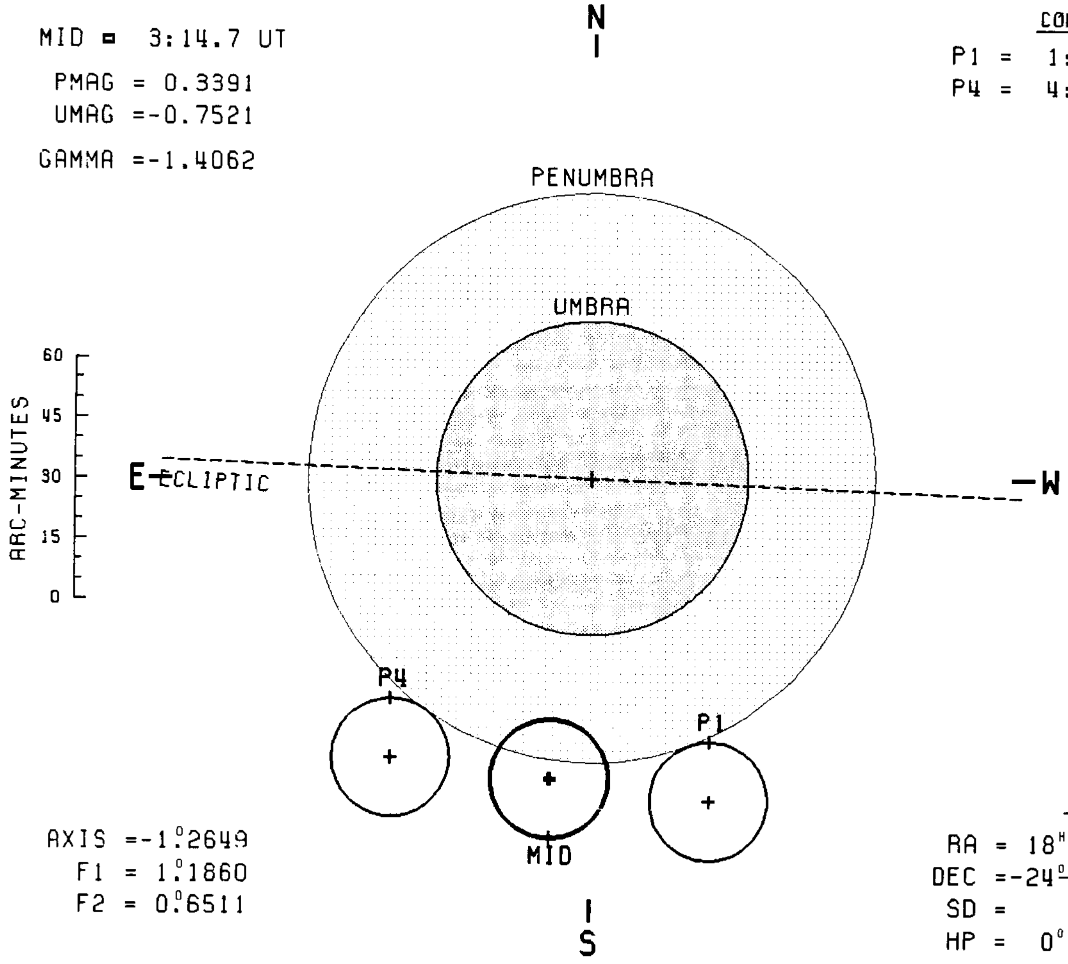
PENUMBRAL LUNAR ECLIPSE - 27 JUN 1991

MID = 3:14.7 UT

PMAG = 0.3391
UMAG =-0.7521

GAMMA =-1.4062

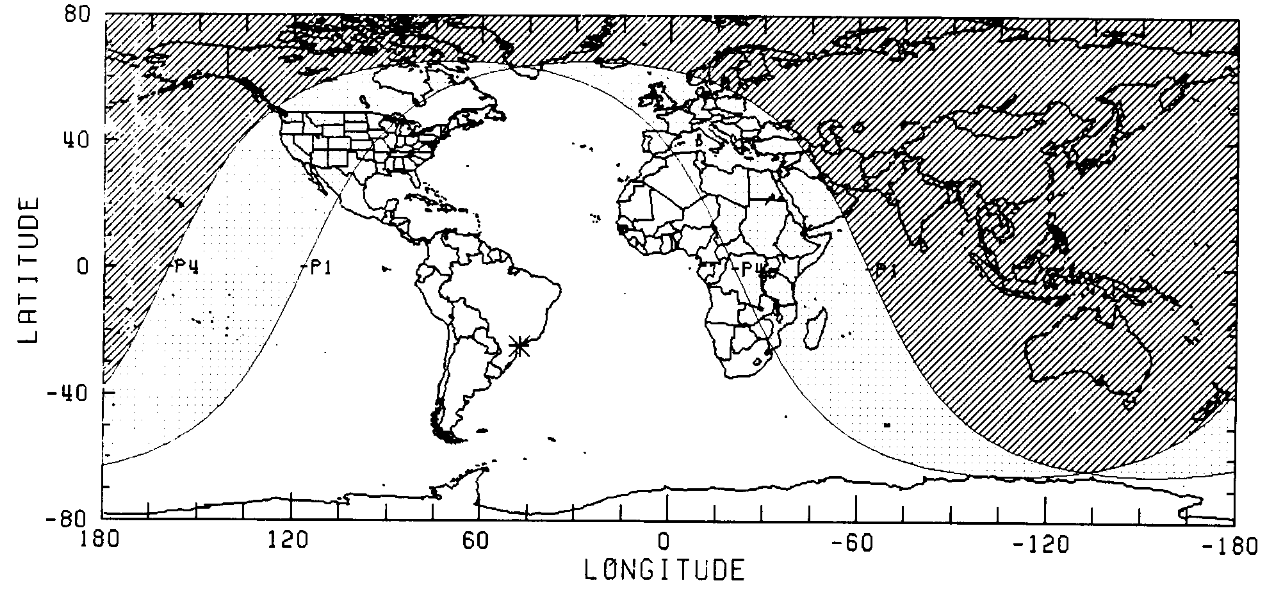
CONTACTS
P1 = 1:46.4 UT
P4 = 4:43.2 UT



AXIS =-1°.2649
F1 = 1°.1860
F2 = 0°.6511

MOON
RA = 18ʰ22ᵐ33ˢ.3
DEC =-24°35'59".7
SD = 14'42".4
HP = 0°53'58".6

SAROS 110 (70/72) JD = 2448434.636 ΔT = 58.3 S



PENUMBRAL LUNAR ECLIPSE - 26 JUL 1991

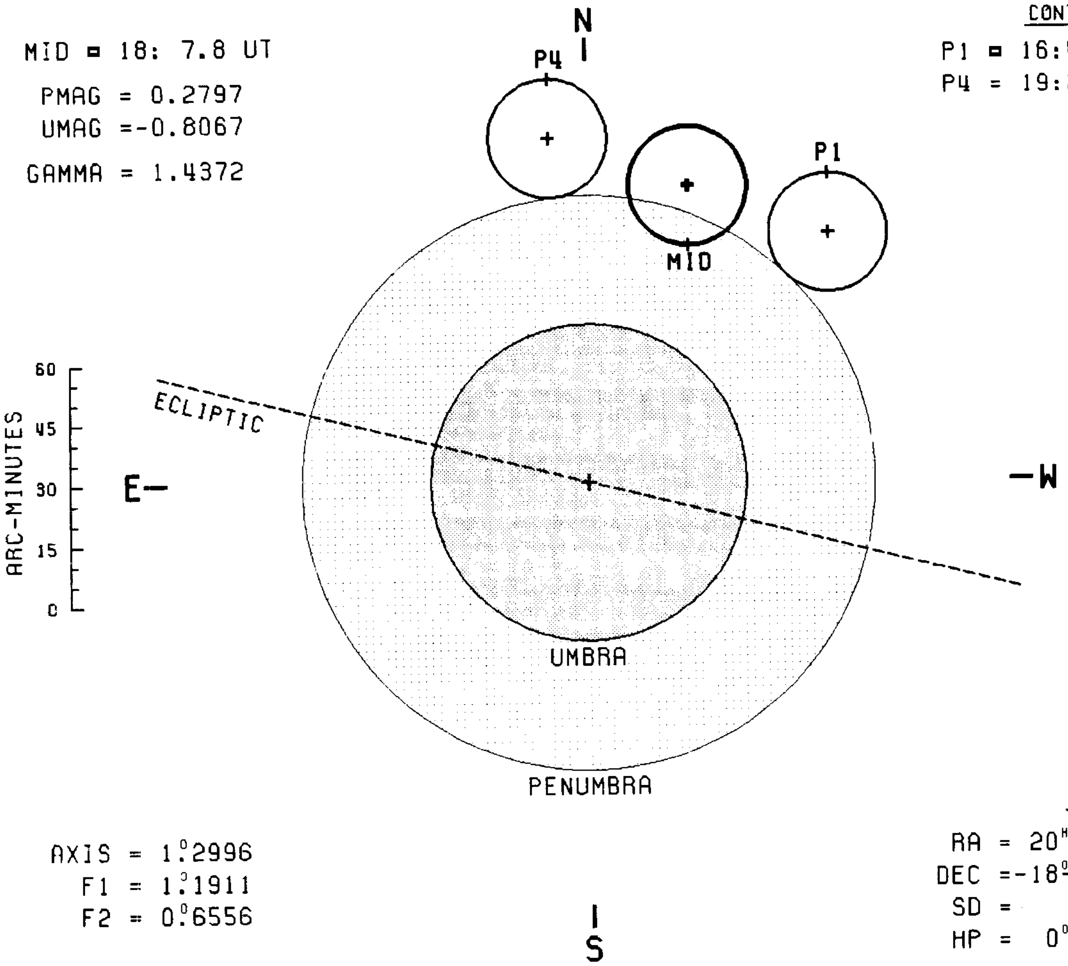
MID = 18: 7.8 UT

PMAG = 0.2797
UMAG =-0.8067

GAMMA = 1.4372

CONTACTS

P1 = 16:47.5 UT
P4 = 19:27.8 UT



AXIS = 1°2996
F1 = 1°1911
F2 = 0°6556

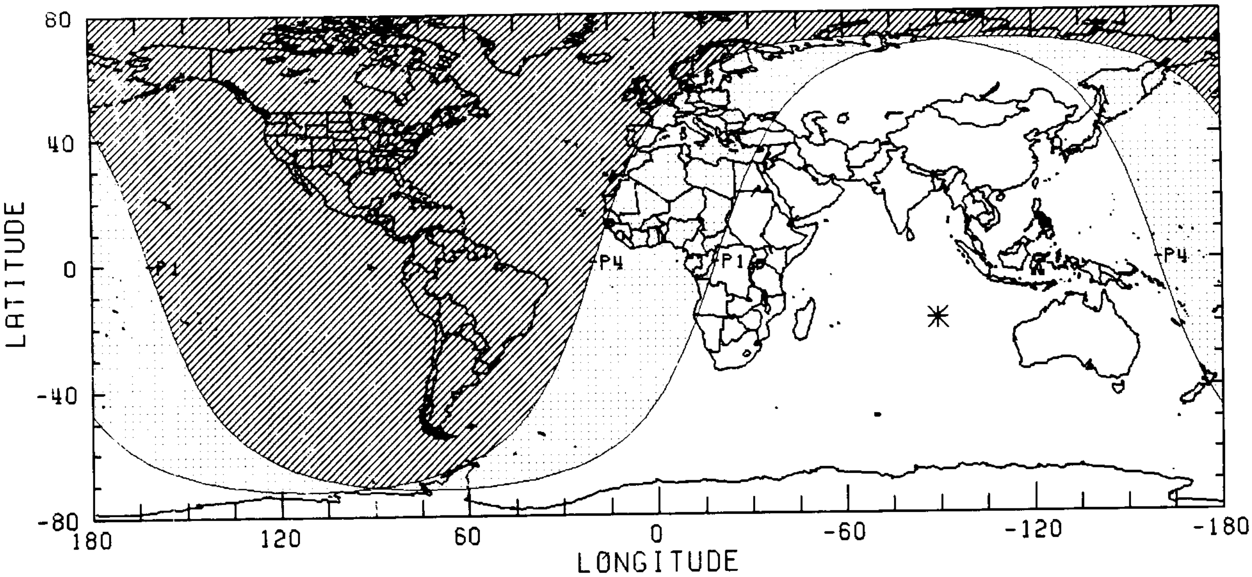
MOON

RA = 20ʰ20ᵐ27ˢ9
DEC =-18°-11'-57"7
SD = 14'47"1
HP = 0°54'15"6

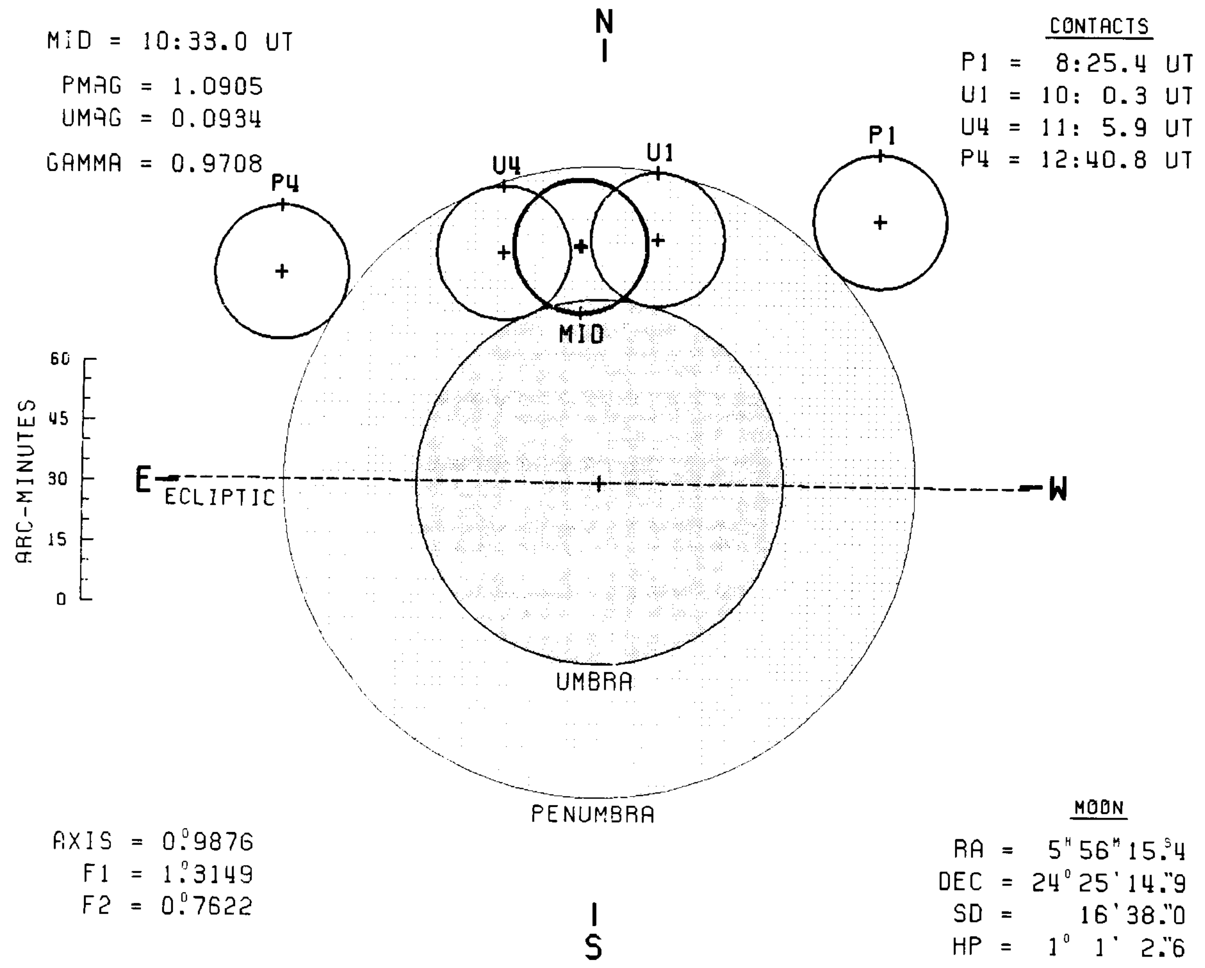
SAROS 148 (2/71)

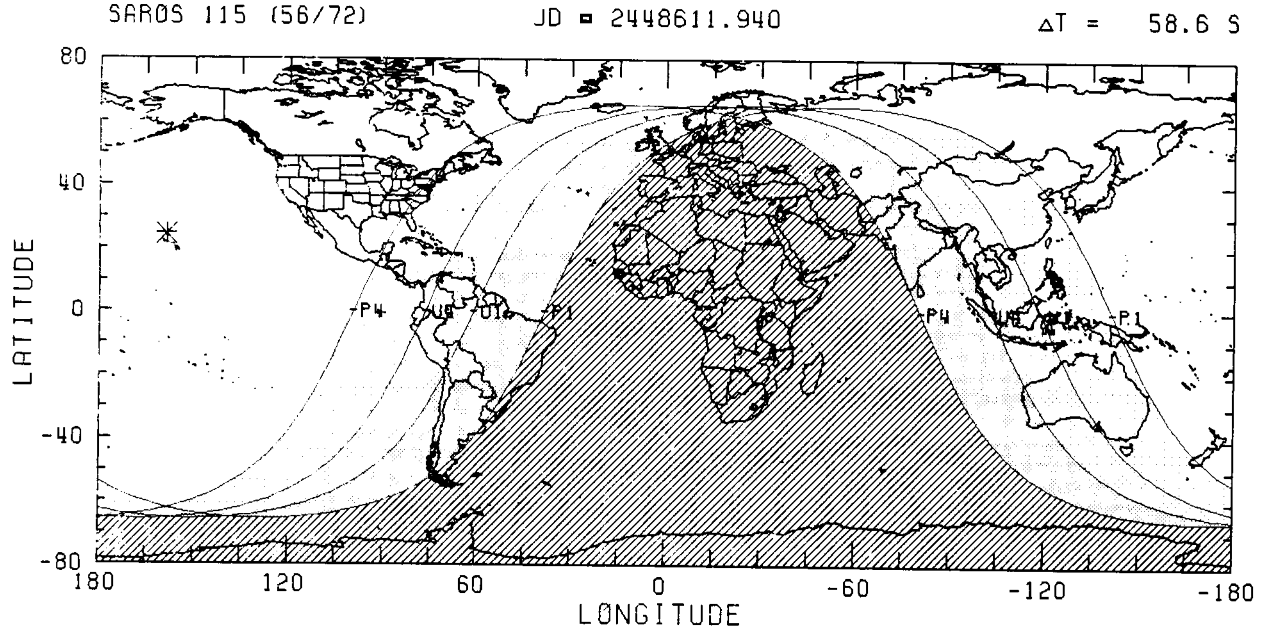
JD = 2448464.256

ΔT = 58.3 S



PARTIAL LUNAR ECLIPSE - 21 DEC 1991





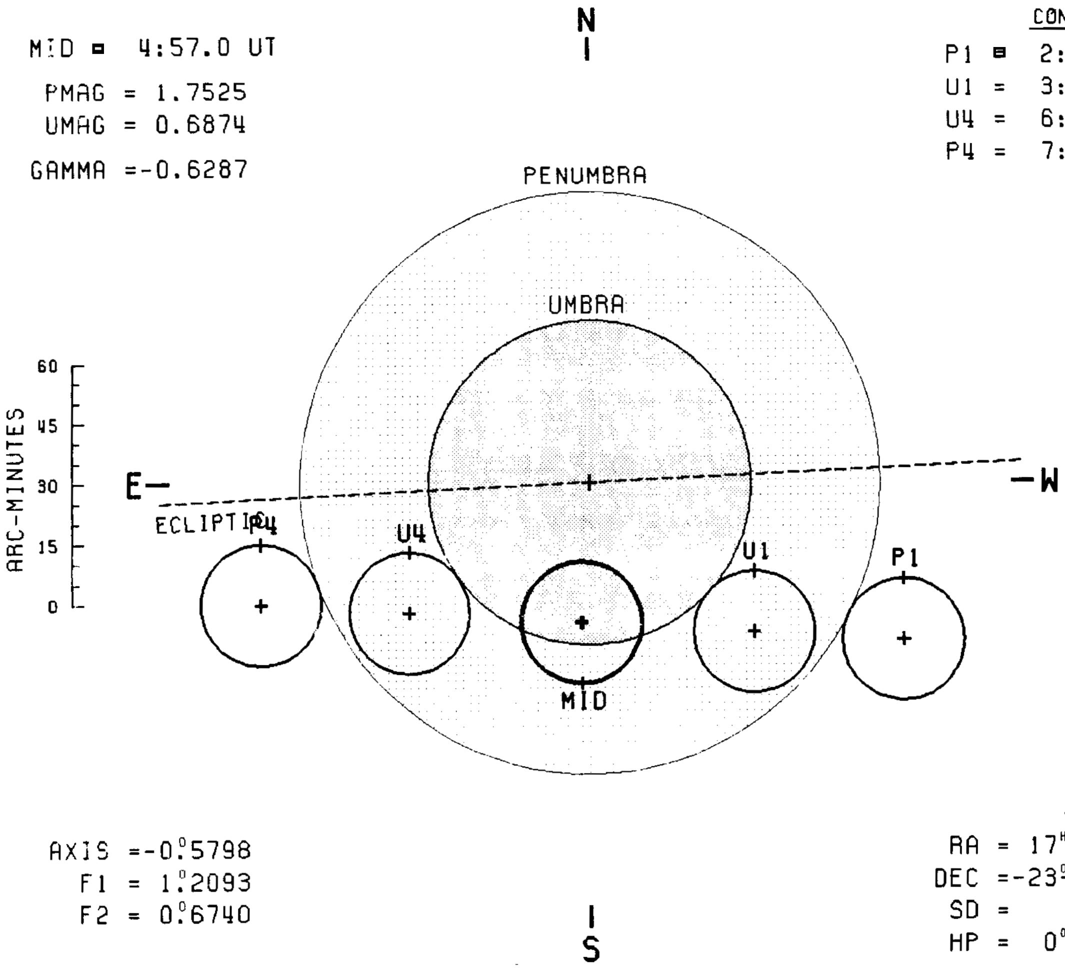
PARTIAL LUNAR ECLIPSE - 15 JUN 1992

MID = 4:57.0 UT

PMAG = 1.7525
UMAG = 0.6874

GAMMA =-0.6287

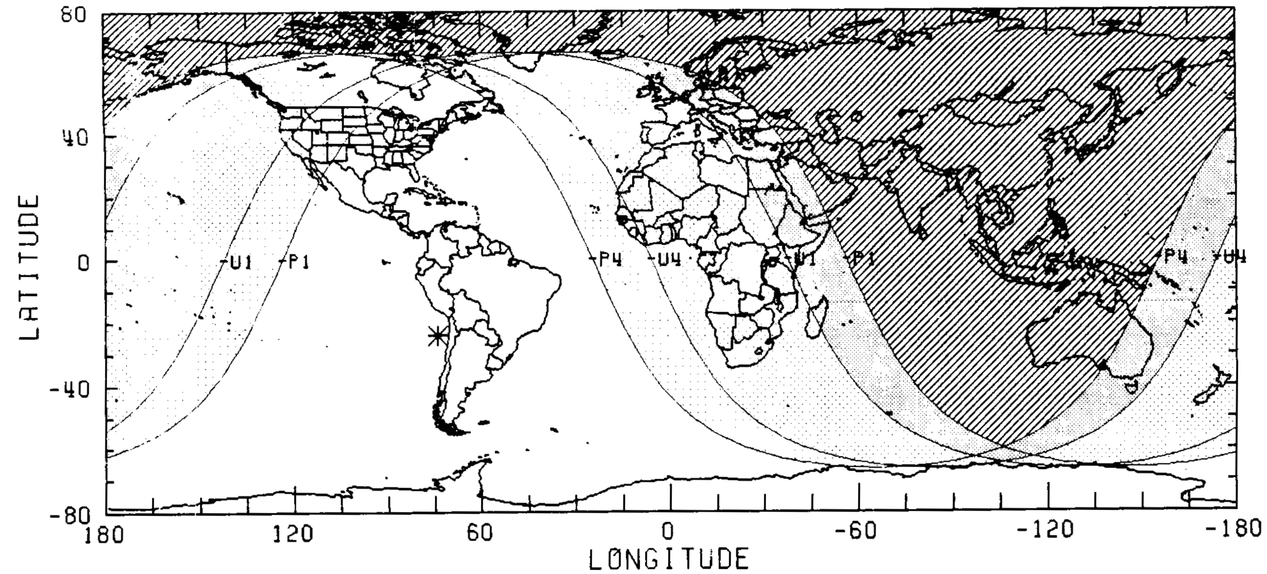
CONTACTS		
P1	=	2: 8.9 UT
U1	=	3:26.6 UT
U4	=	6:27.4 UT
P4	=	7:45.1 UT



AXIS =-0°.5798
F1 = 1°.2093
F2 = 0°.6740

MOON		
RA	=	17ʰ35ᵐ29ˢ.6
DEC	=	-23°53′53″.1
SD	=	15′ 4″.7
HP	=	0°55′20″.3

SAROS 120 (57/84) JD = 2448788.707 ΔT = 59.0 S



TOTAL LUNAR ECLIPSE - 9 DEC 1992

MID = 23:44.0 UT

PMAG = 2.3173

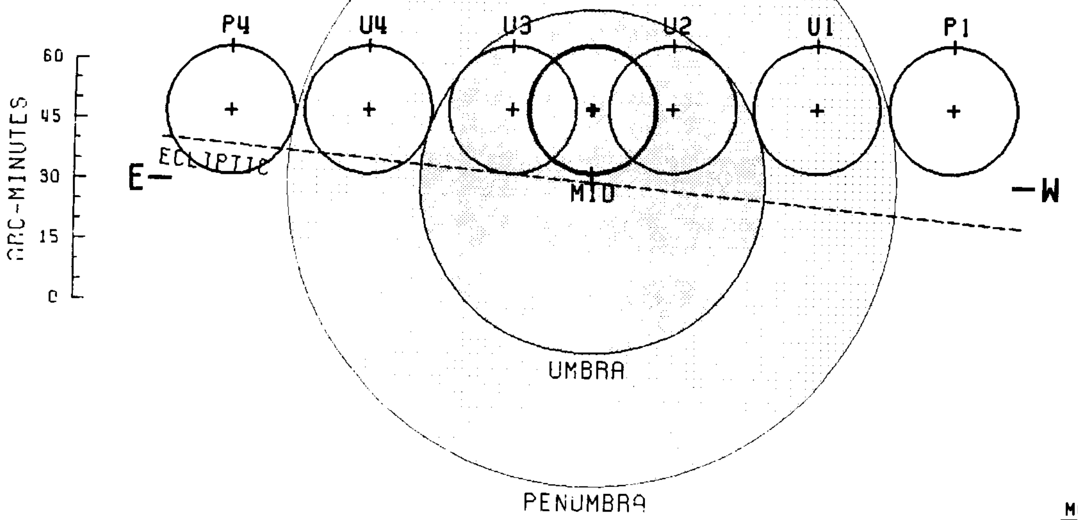
UMAG = 1.2763

GAMMA = 0.3143

N

CONTACTS

P1 = 20:55.2 UT
U1 = 21:59.2 UT
U2 = 23: 6.6 UT
U3 = 0:21.5 UT
U4 = 1:28.9 UT
P4 = 2:32.8 UT



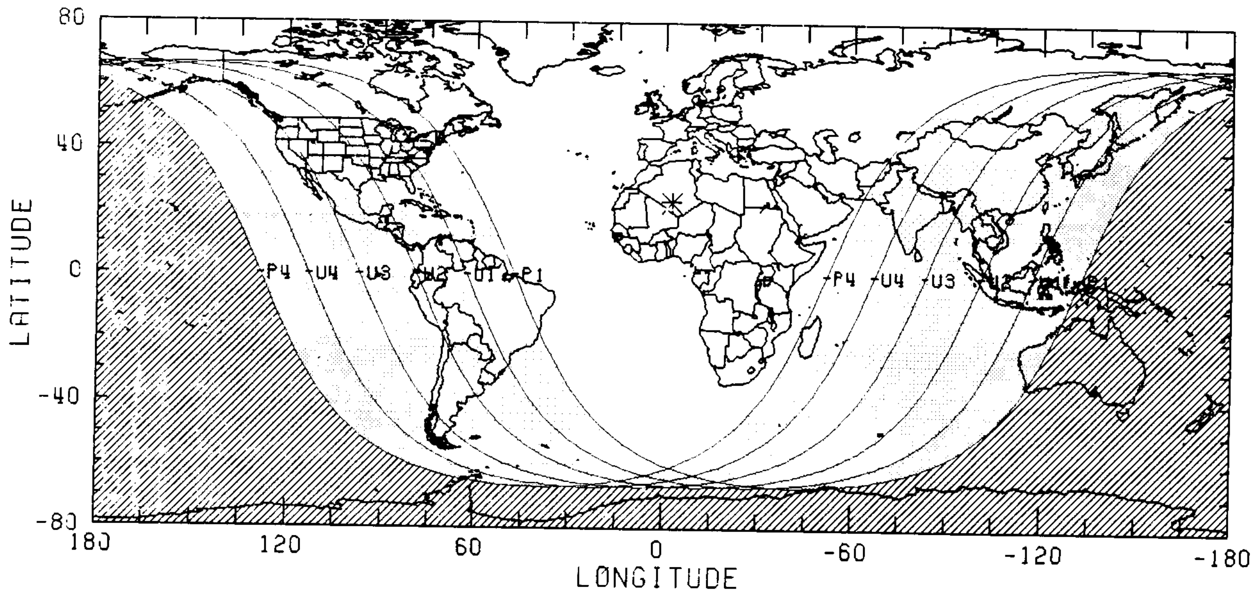
AXIS = 0°.3059
F1 = 1°.2699
F2 = 0°.7176

S

MOON

RA = 5h 8m 35.s3
DEC = 23° 13' 9."2
SD = 15' 54."8
HP = 0° 58' 24."2

SAROS 125 (47/72) JD = 2448966.490 ΔT = 59.4 S



TOTAL LUNAR ECLIPSE - 4 JUN 1993

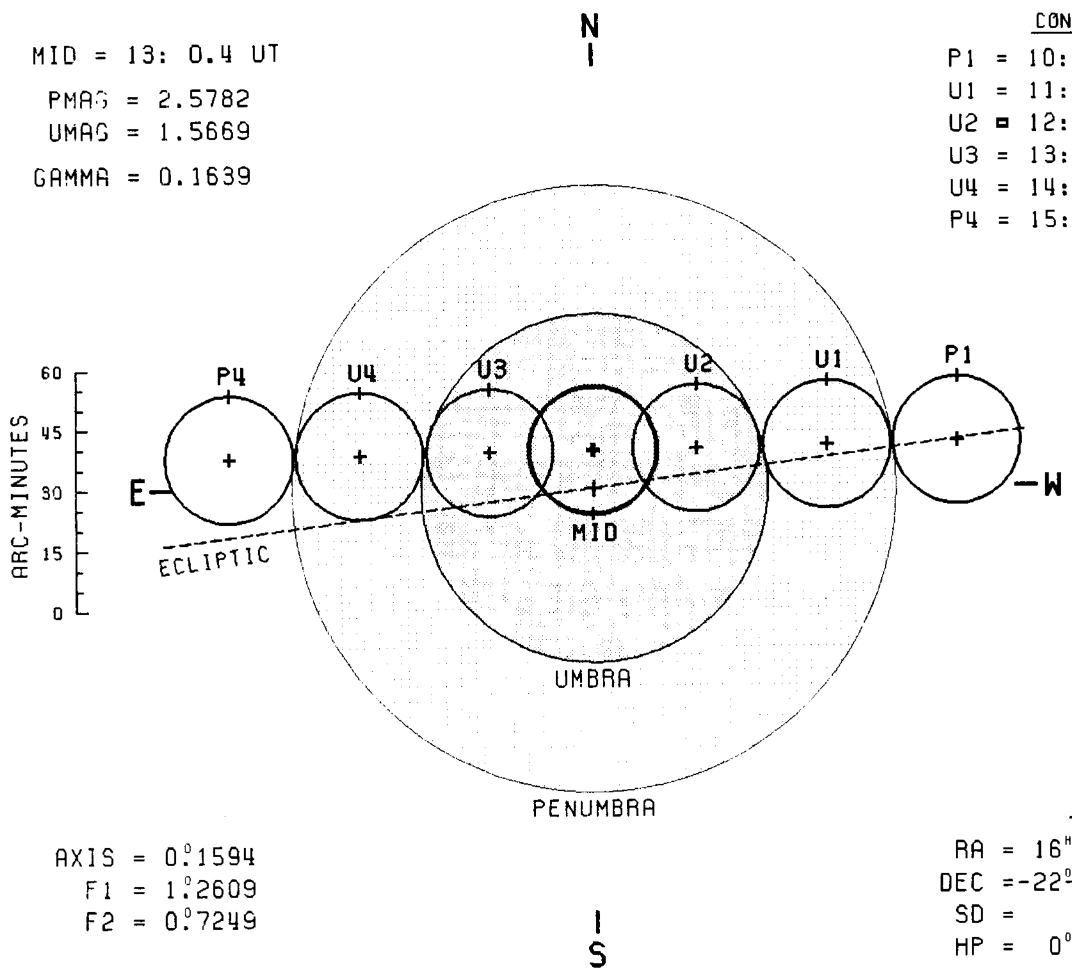
MID = 13: 0.4 UT

PMAG = 2.5782
UMAG = 1.5669

GAMMA = 0.1639

CONTACTS

P1 = 10:10.6 UT
U1 = 11:11.0 UT
U2 = 12:12.0 UT
U3 = 13:48.8 UT
U4 = 14:49.9 UT
P4 = 15:50.4 UT

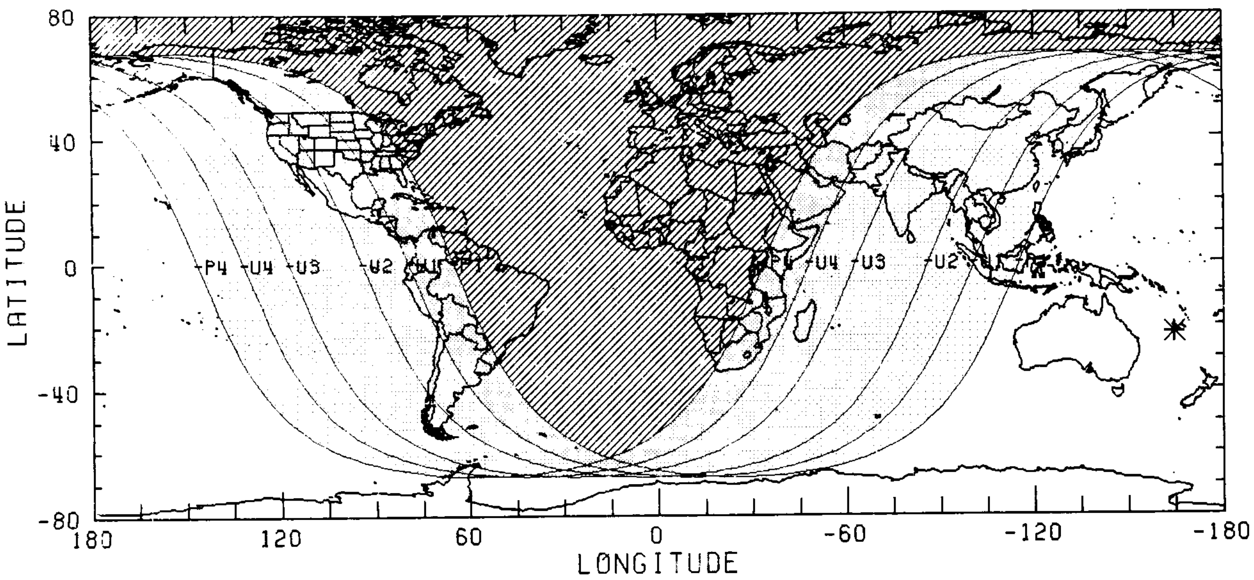


AXIS = 0°.1594
F1 = 1°.2609
F2 = 0°.7249

MOON

RA = 16ʰ50ᵐ13ˢ.2
DEC = -22°18'38".3
SD = 15'54".0
HP = 0°58'21".4

SAROS 130 (33/72) JD = 2449143.043 ΔT = 59.7 S



TOTAL LUNAR ECLIPSE - 29 NOV 1993

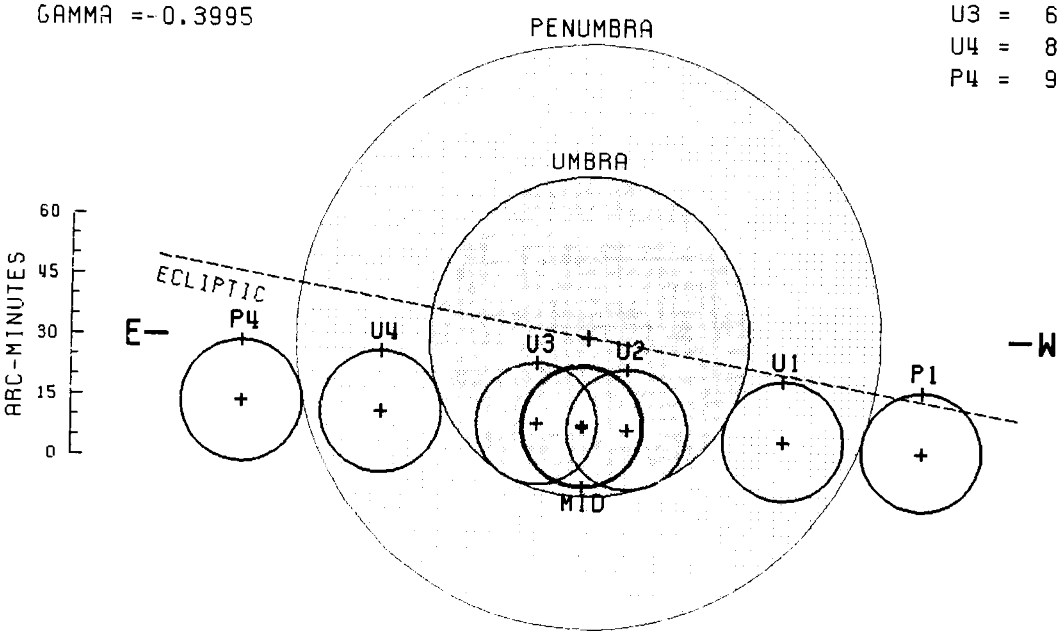
MID = 6:26.0 UT

PMAG = 2.1893
UMAG = 1.0920

GAMMA =-0.3995

N

CONTACTS		
P1	=	3:26.9 UT
U1	=	4:40.2 UT
U2	=	6: 2.3 UT
U3	=	6:49.9 UT
U4	=	8:12.0 UT
P4	=	9:25.1 UT

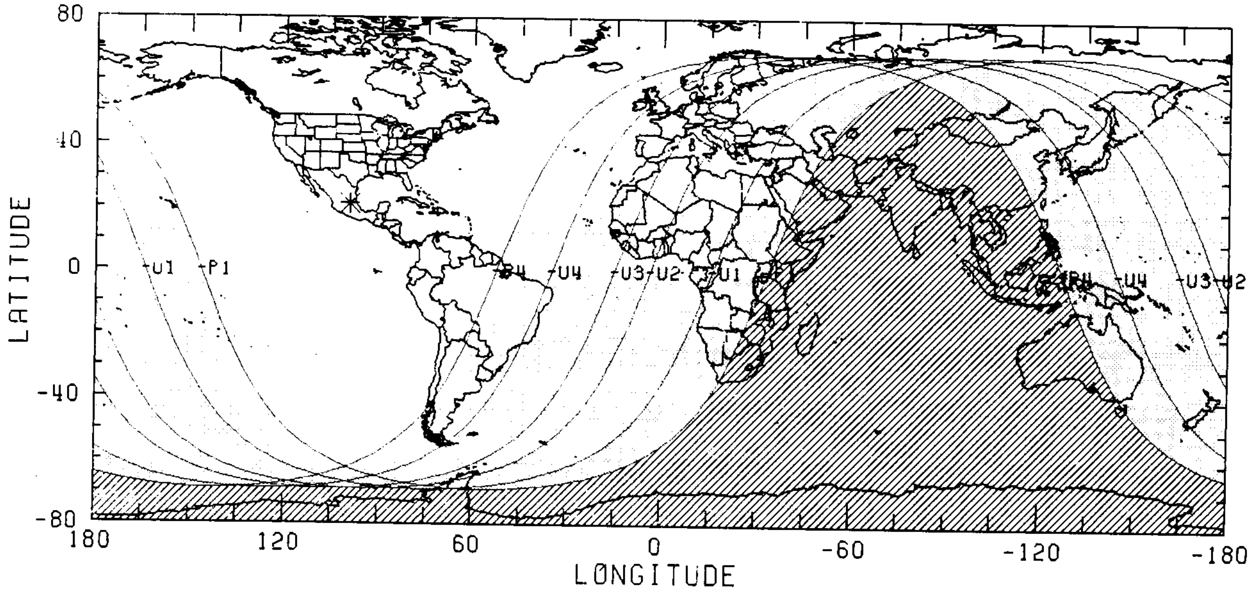


AXIS =-0°.3683
F1 = 1°.2171
F2 = 0°.6658

S

MOON		
RA	=	4ʰ21ᵐ 0ˢ.7
DEC	=	21° 7' 9".3
SD	=	15' 4".4
HP	=	0°55'19".3

SAROS 135 (22/71)   JD = 2449320.769   ΔT = 60.1 S



PARTIAL LUNAR ECLIPSE - 25 MAY 1994

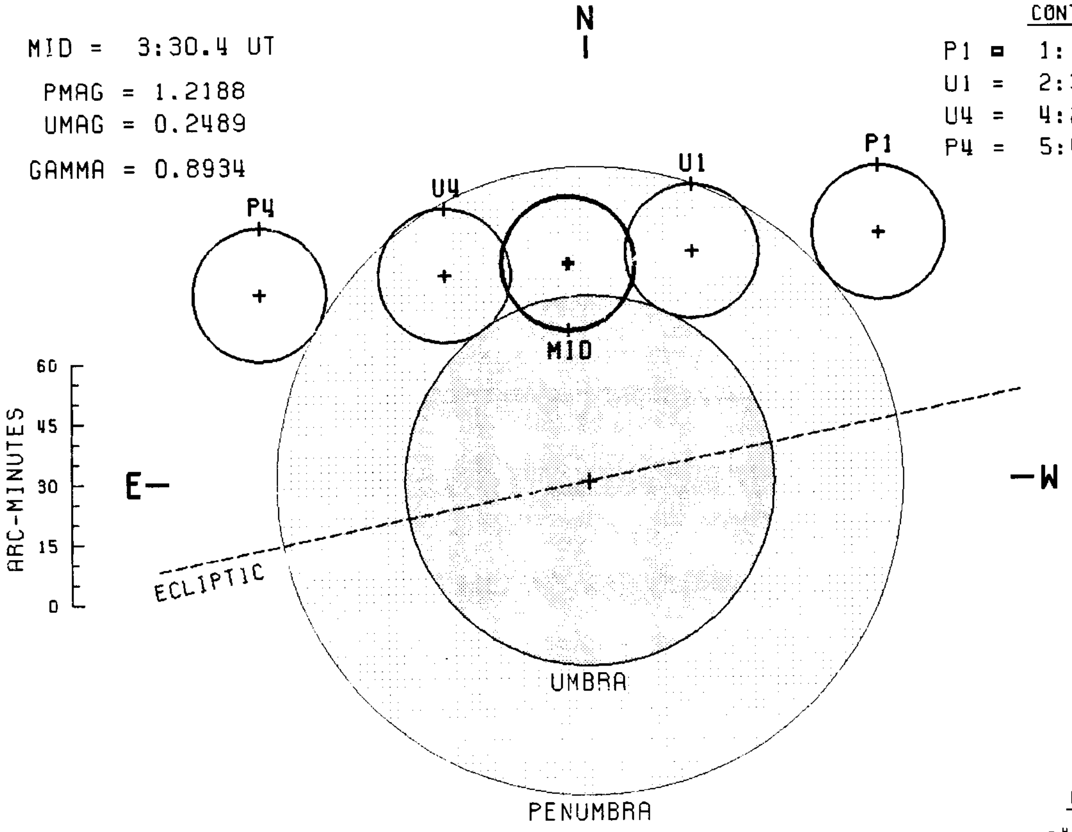
MID = 3:30.4 UT

PMAG = 1.2188
UMAG = 0.2489

GAMMA = 0.8934

CONTACTS

P1	=	1:17.9 UT
U1	=	2:37.5 UT
U4	=	4:23.2 UT
P4	=	5:42.8 UT

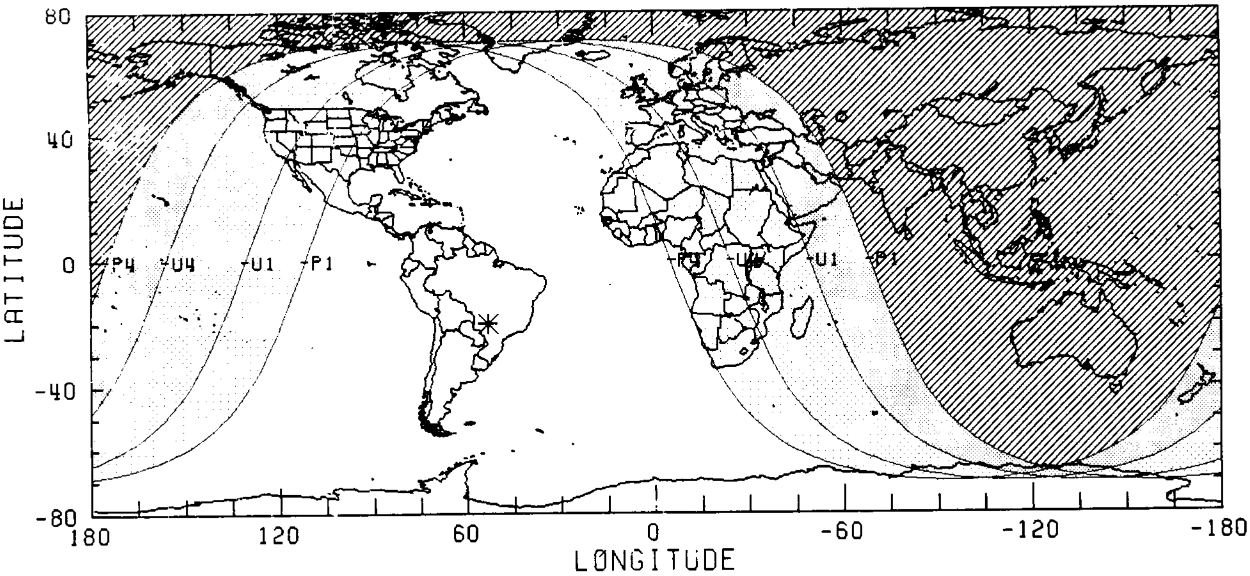


AXIS = $0.^\circ9074$
F1 = $1.^\circ3053$
F2 = $0.^\circ7684$

MOON

RA = $16^h\ 7^m\ 9.^s9$
DEC = $-19^\circ 59' 22.''0$
SD = $16' 36.''4$
HP = $1^\circ\ 0' 56.''9$

SAROS 140 (24/80) JD = 2449497.647 ΔT = 60.5 S



PENUMBRAL LUNAR ECLIPSE - 18 NOV 1994

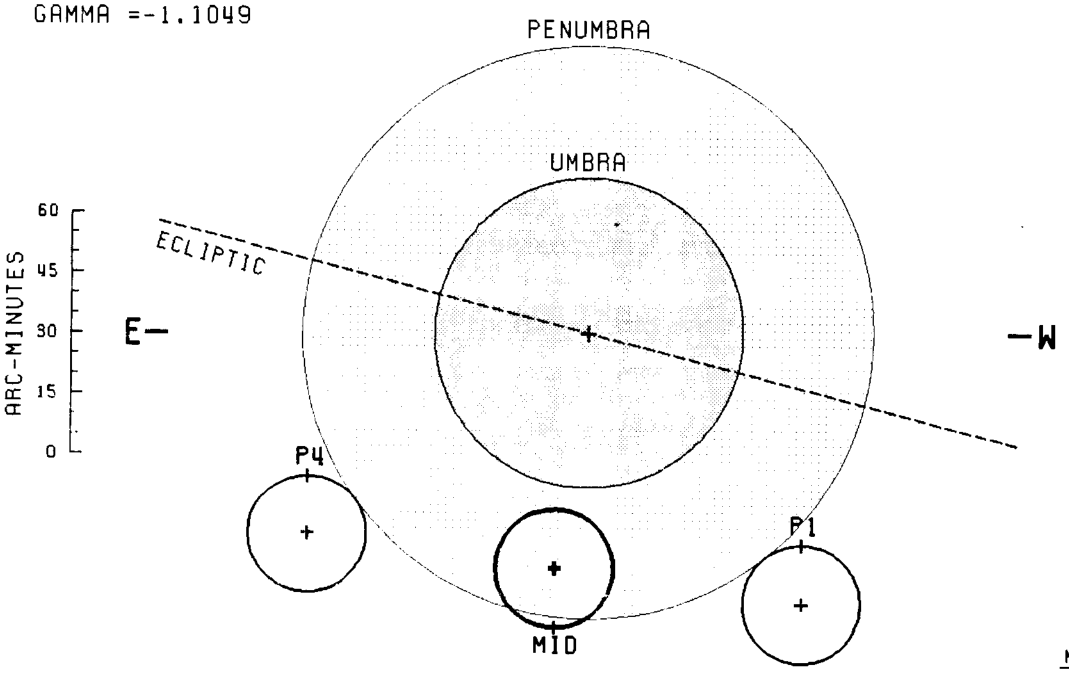
MID = 6:43.9 UT

PMAG = 0.9077
UMAG =-0.2148

GAMMA =-1.1049

N

CONTACTS
P1 = 4:25.7 UT
P4 = 9: 2.2 UT

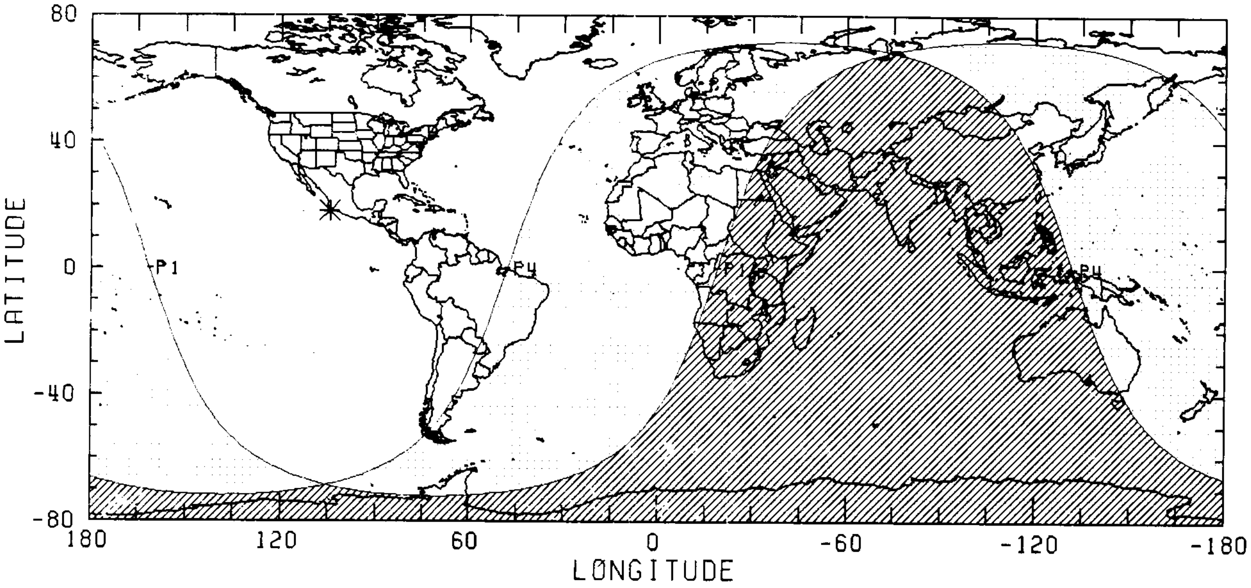


AXIS =-0.°9936
F1 = 1.°1934
F2 = 0.°6433

S

MOON
RA = 3ʰ 34ᵐ 2.ˢ6
DEC = 18° 11' 52."3
SD = 14' 42."2
HP = 0° 53' 57."7

SAROS 145 (10/71) JD = 2449674.781 ΔT = 60.8 S

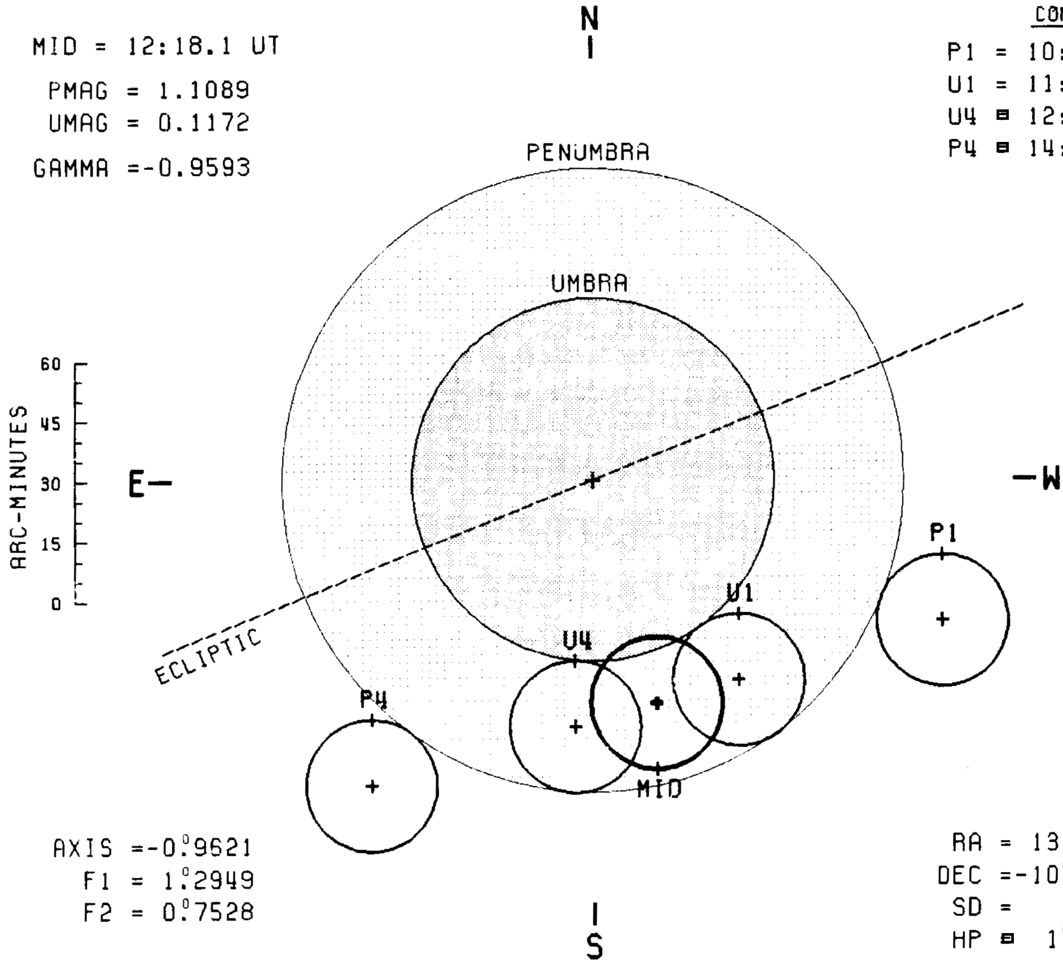


PARTIAL LUNAR ECLIPSE - 15 APR 1995

MID = 12:18.1 UT

PMAG = 1.1089
UMAG = 0.1172
GAMMA =-0.9593

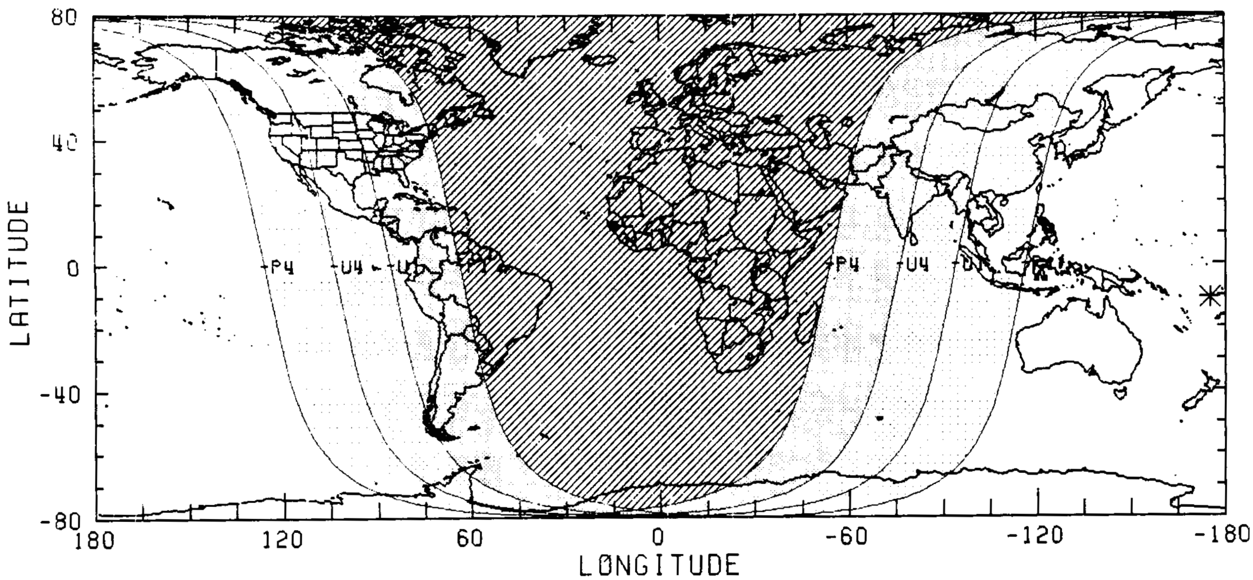
CONTACTS
P1 = 10: 7.9 UT
U1 = 11:40.8 UT
U4 = 12:55.1 UT
P4 = 14:28.0 UT



AXIS =-0°.9621
F1 = 1°.2949
F2 = 0°.7528

MOON
RA = 13ʰ31ᵐ50ˢ.7
DEC =-10°37'41".4
SD = 16'23".9
HP = 1° 0'10".9

SAROS 112 (64/72) JD = 2449823.013 ΔT = 61.1 S



C-2

PENUMBRAL LUNAR ECLIPSE - 8 OCT 1995

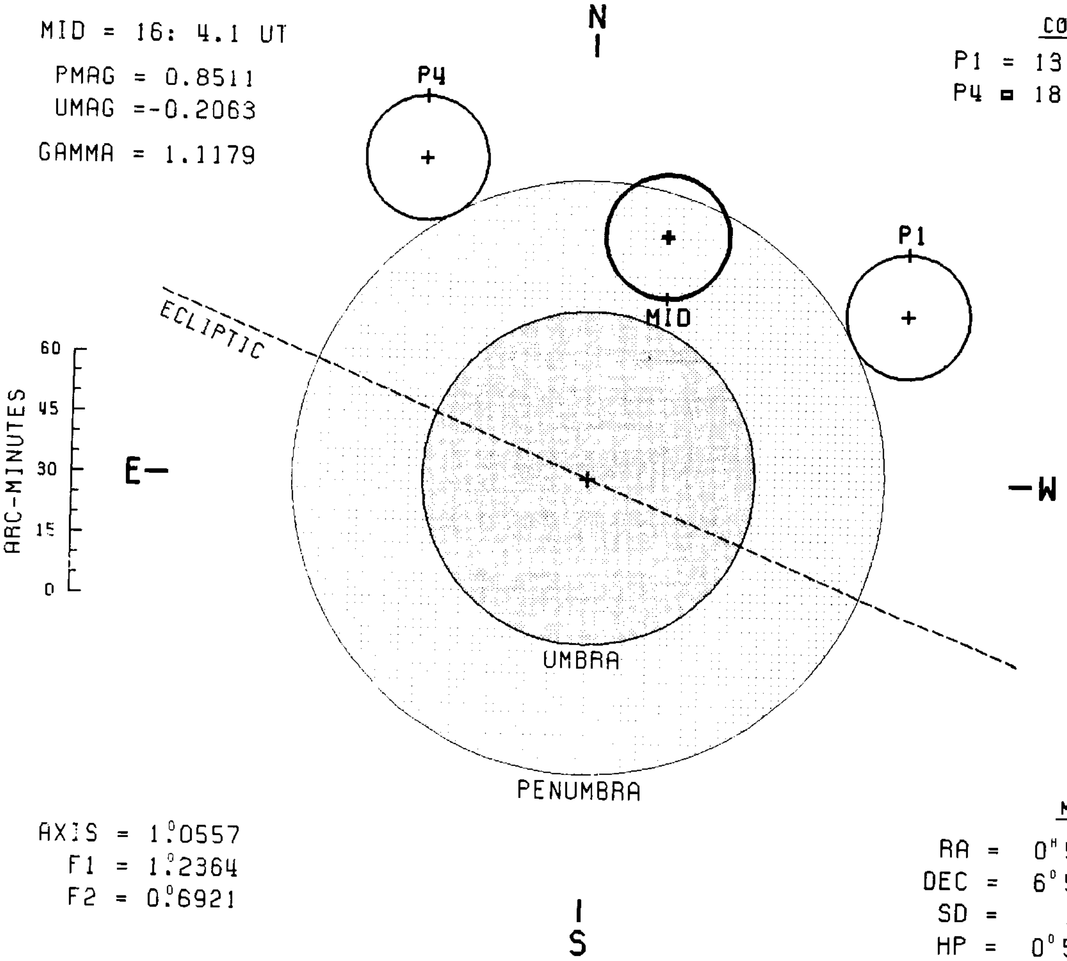
MID = 16: 4.1 UT

PMAG = 0.8511
UMAG =-0.2063

GAMMA = 1.1179

CONTACTS

P1 = 13:57.8 UT
P4 = 18:10.0 UT

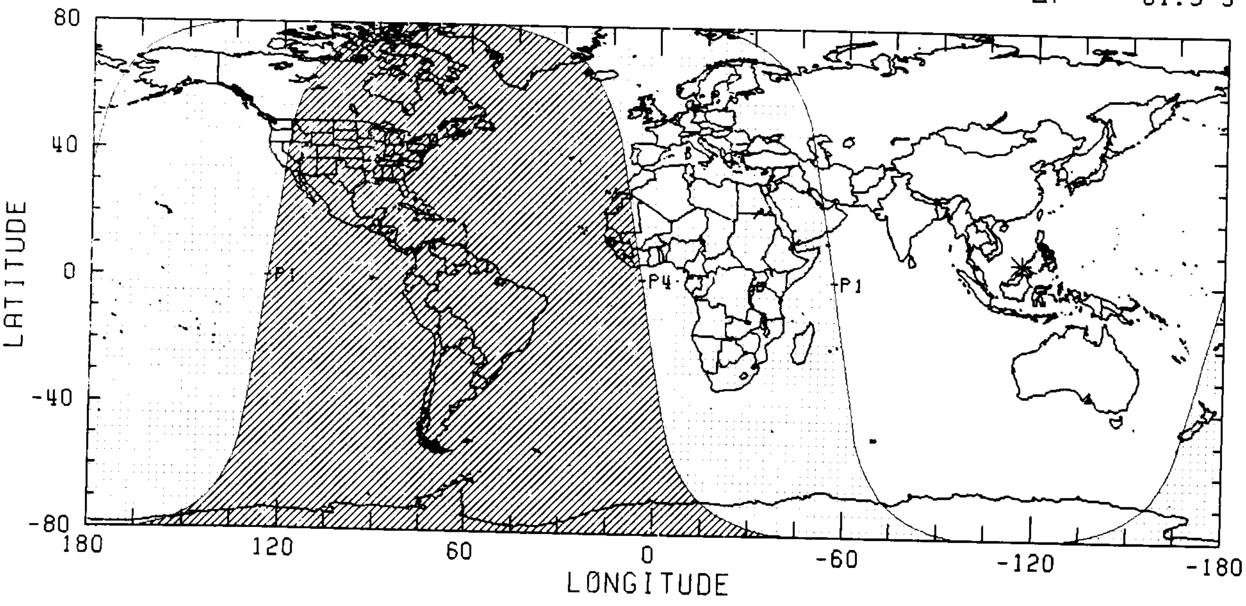


AXIS = 1.°0557
F1 = 1.°2364
F2 = 0.°6921

MOON

RA = 0ʰ53ᵐ37.ˢ7
DEC = 6°52'46."8
SD = 15'26."5
HP = 0°56'40."2

SAROS 117 (51/72) JD = 2449999.170 ΔT = 61.5 S



TOTAL LUNAR ECLIPSE - 4 APR 1996

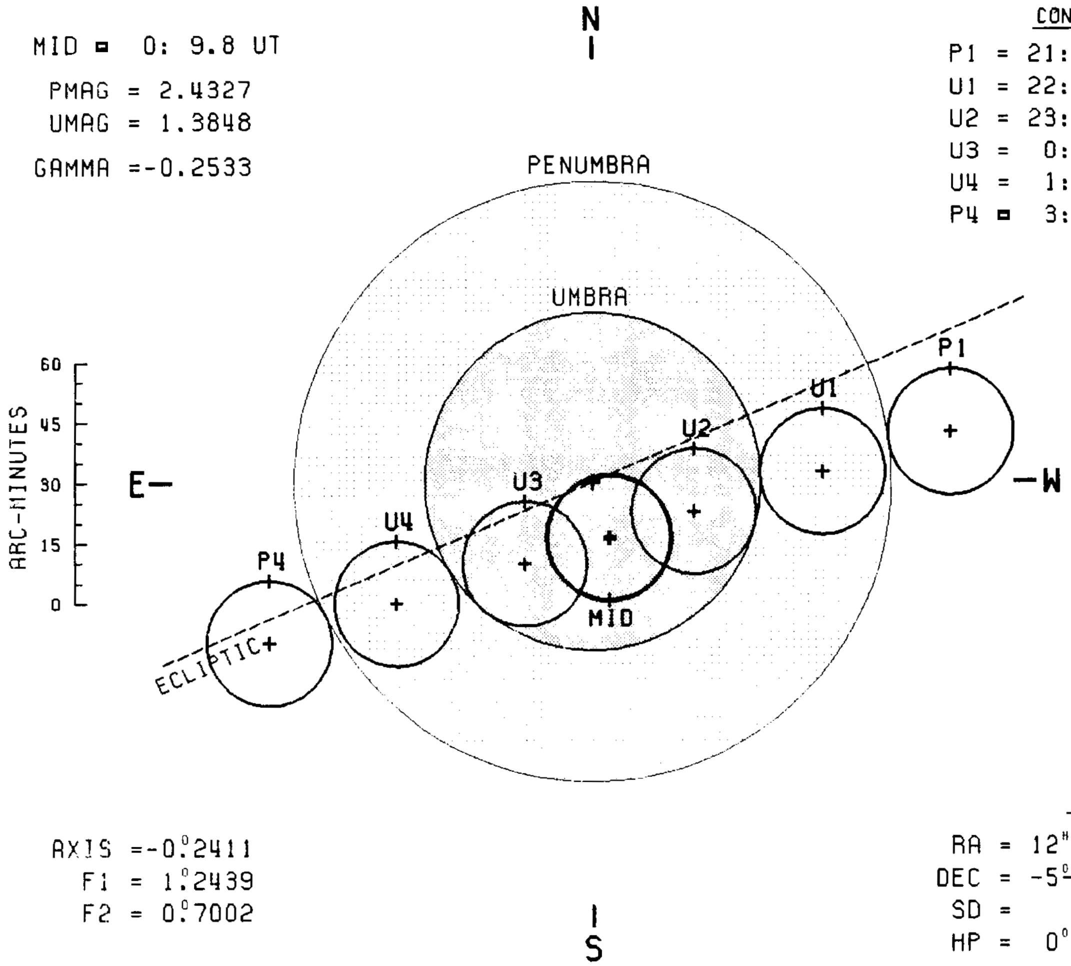
MID = 0: 9.8 UT

PMAG = 2.4327
UMAG = 1.3848

GAMMA =-0.2533

CONTACTS

P1 = 21:15.5 UT
U1 = 22:20.7 UT
U2 = 23:26.3 UT
U3 = 0:53.0 UT
U4 = 1:58.8 UT
P4 = 3: 3.8 UT

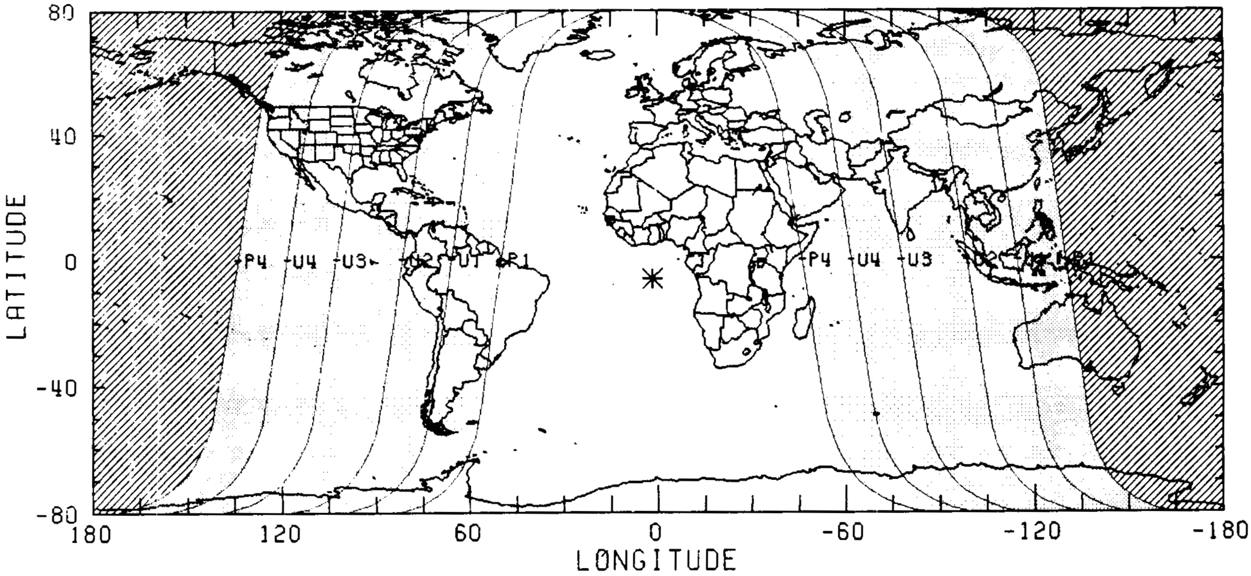


AXIS =-0°.2411
F1 = 1°.2439
F2 = 0°.7002

MOON

RA = 12ʰ53ᵐ 9ˢ.4
DEC = -5°57'-3".7
SD = 15'33".9
HP = 0°57' 7".5

SAROS 122 (55/75) JD = 2450177.507 ΔT = 61.9 S



TOTAL LUNAR ECLIPSE - 27 SEP 1996

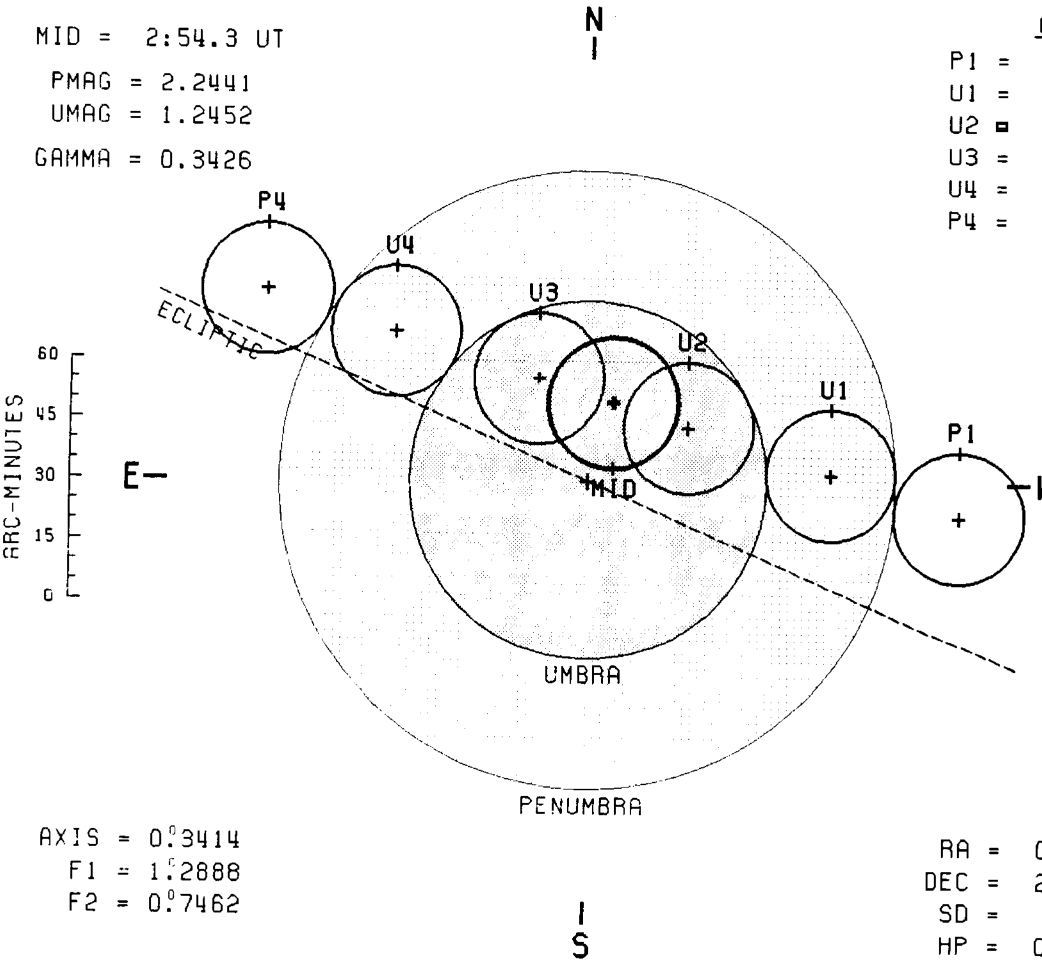
MID = 2:54.3 UT

PMAG = 2.2441
UMAG = 1.2452

GAMMA = 0.3426

CONTACTS

P1	=	0:12.2 UT
U1	=	1:12.1 UT
U2	=	2:19.1 UT
U3	=	3:29.2 UT
U4	=	4:36.4 UT
P4	=	5:36.4 UT

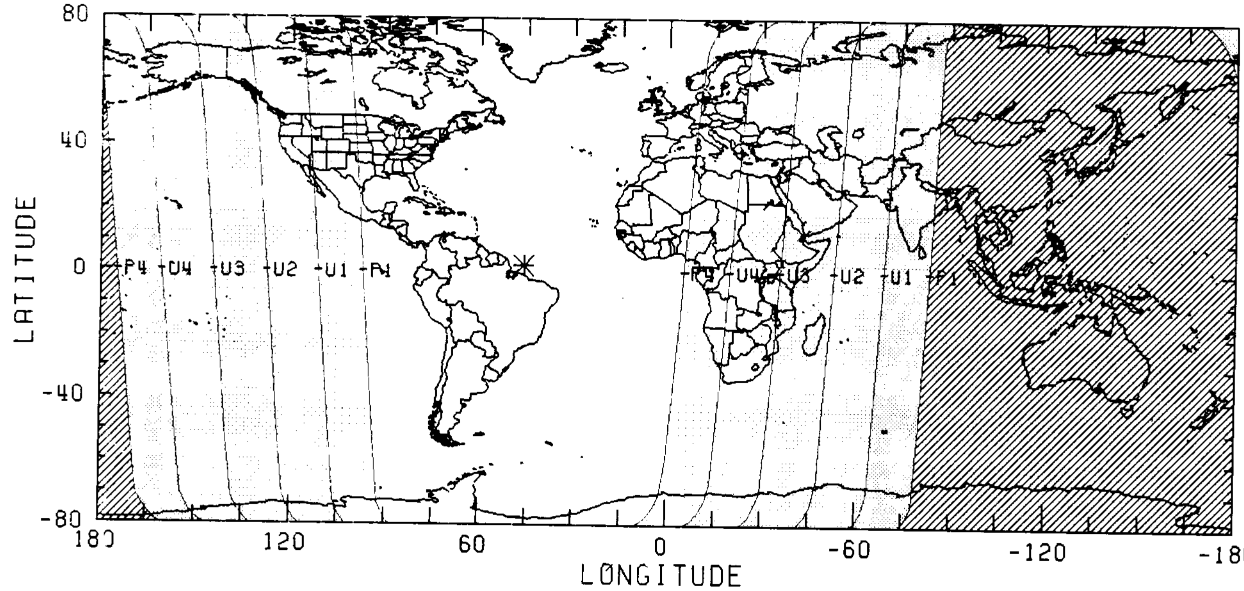


AXIS = 0.°3414
F1 = 1.°2888
F2 = 0.°7462

MOON

RA	=	$0^h 15^m 18.^s1$
DEC	=	$2^\circ 1' 36.''8$
SD	=	$16' 17.''8$
HP	=	$0^\circ 59' 48.''4$

SAROS 127 (41/72) JD = 2450353.622 ΔT = 62.2 S



PARTIAL LUNAR ECLIPSE - 24 MAR 1997

MID = 4:39.4 UT

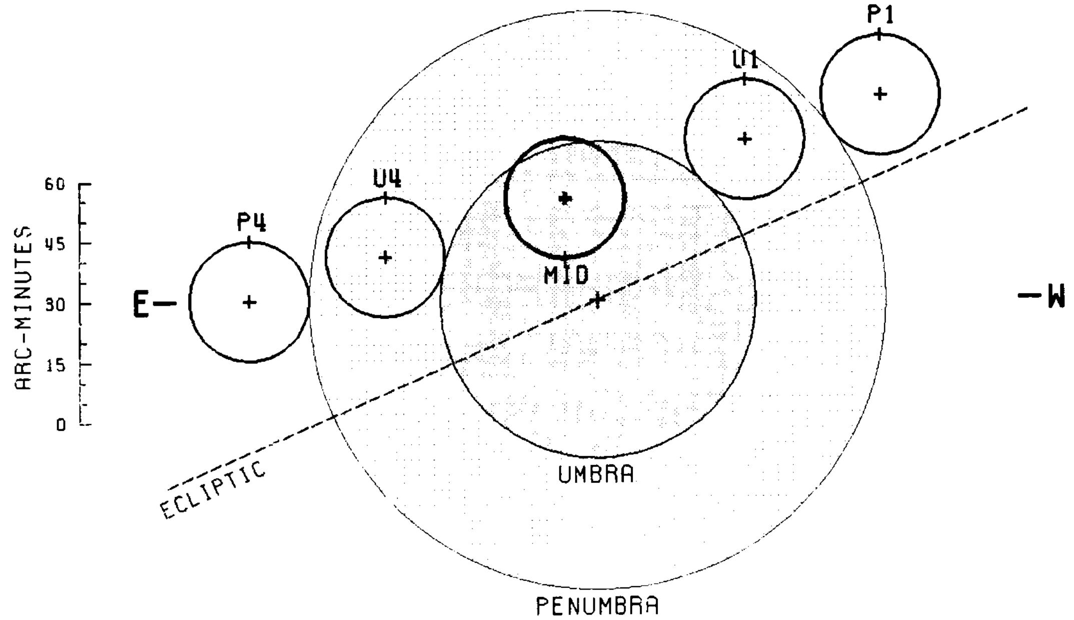
PMAG = 2.0254
UMAG = 0.9240

GAMMA = 0.4899

N

CONTACTS

P1 = 1:40.5 UT
U1 = 2:57.6 UT
U4 = 6:21.5 UT
P4 = 7:38.4 UT



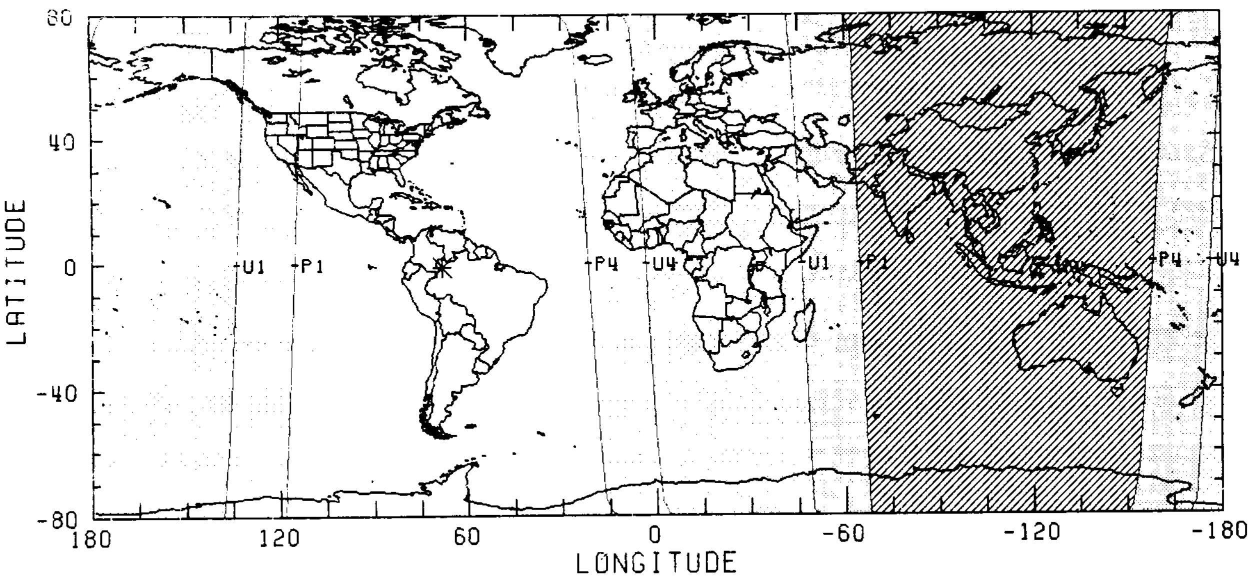
S

AXIS = 0°.4452
F1 = 1°.2005
F2 = 0°.6551

MOON

RA = $12^h 13^m 42^s.0$
DEC = -1° 0' -4".2
SD = 14' 51".3
HP = 0° 54' 31".3

SAROS 132 (29/71) JD = 2450531.695 ΔT = 62.6 S



TOTAL LUNAR ECLIPSE - 16 SEP 1997

MID = 18:46.6 UT

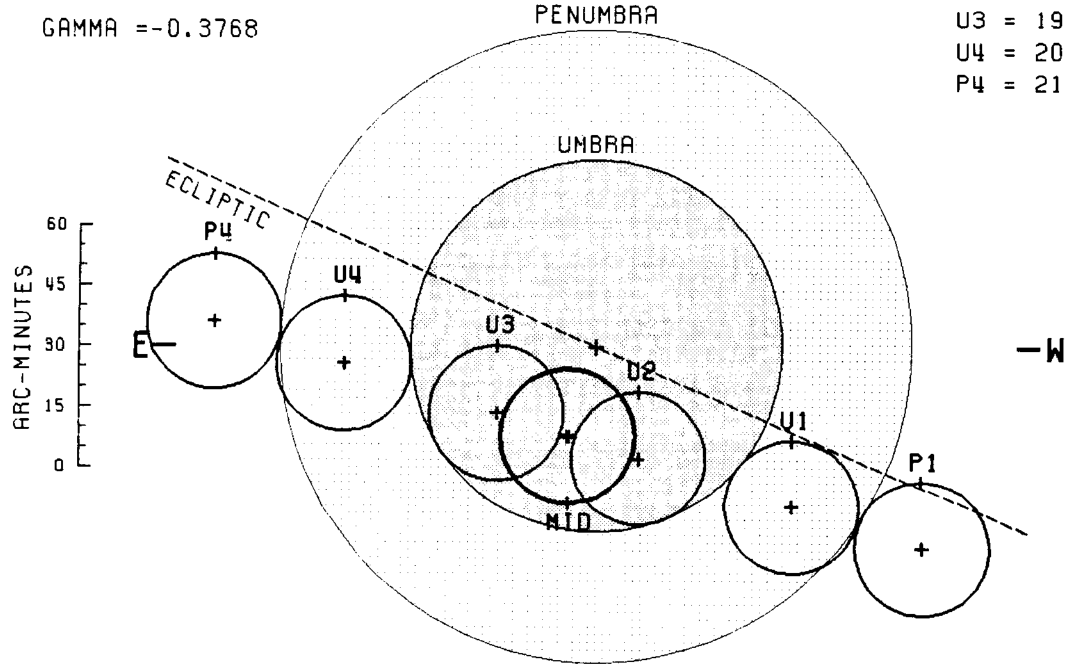
PMAG = 2.1665
UMAG = 1.1968

GAMMA =-0.3768

N

CONTACTS

P1 = 16:11.0 UT
U1 = 17: 8.0 UT
U2 = 18:15.6 UT
U3 = 19:18.0 UT
U4 = 20:25.4 UT
P4 = 21:22.4 UT



AXIS =-0°.3857
F1 = 1°.3155
F2 = 0°.7745

S

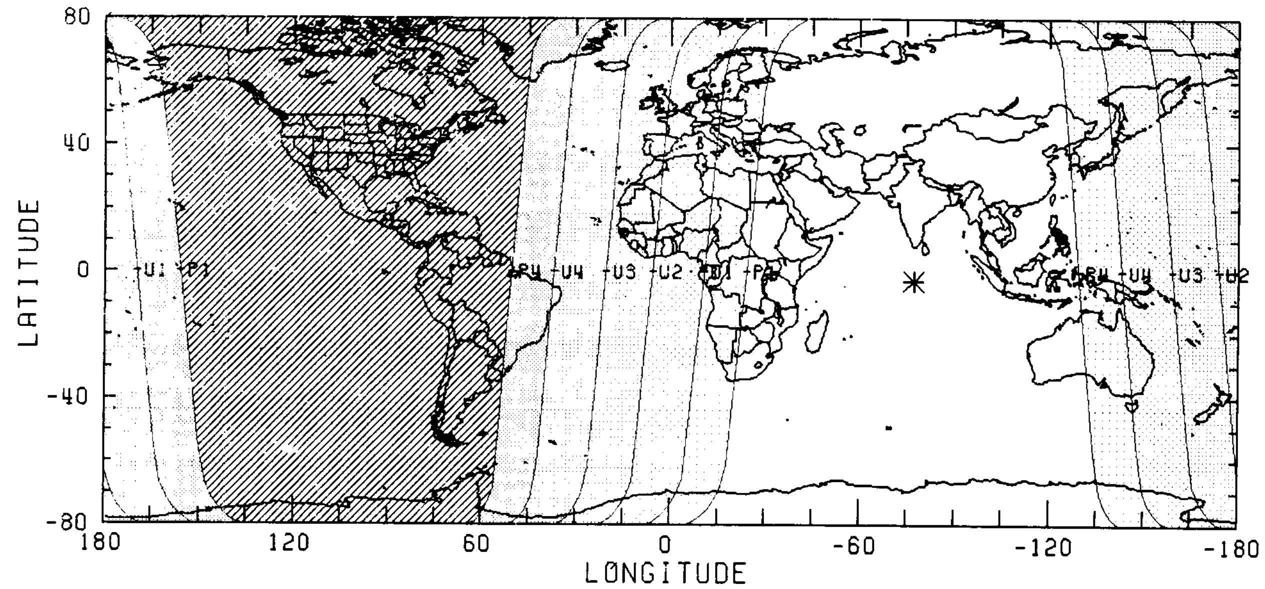
MOON

RA = 23h 38m 10.s6
DEC = -2° 46' 41."2
SD = 16' 44."2
HP = 1° 1' 25."4

SAROS 137 (27/81)

JD = 2450708.283

ΔT = 63.0 S



PENUMBRAL LUNAR ECLIPSE - 13 MAR 1998

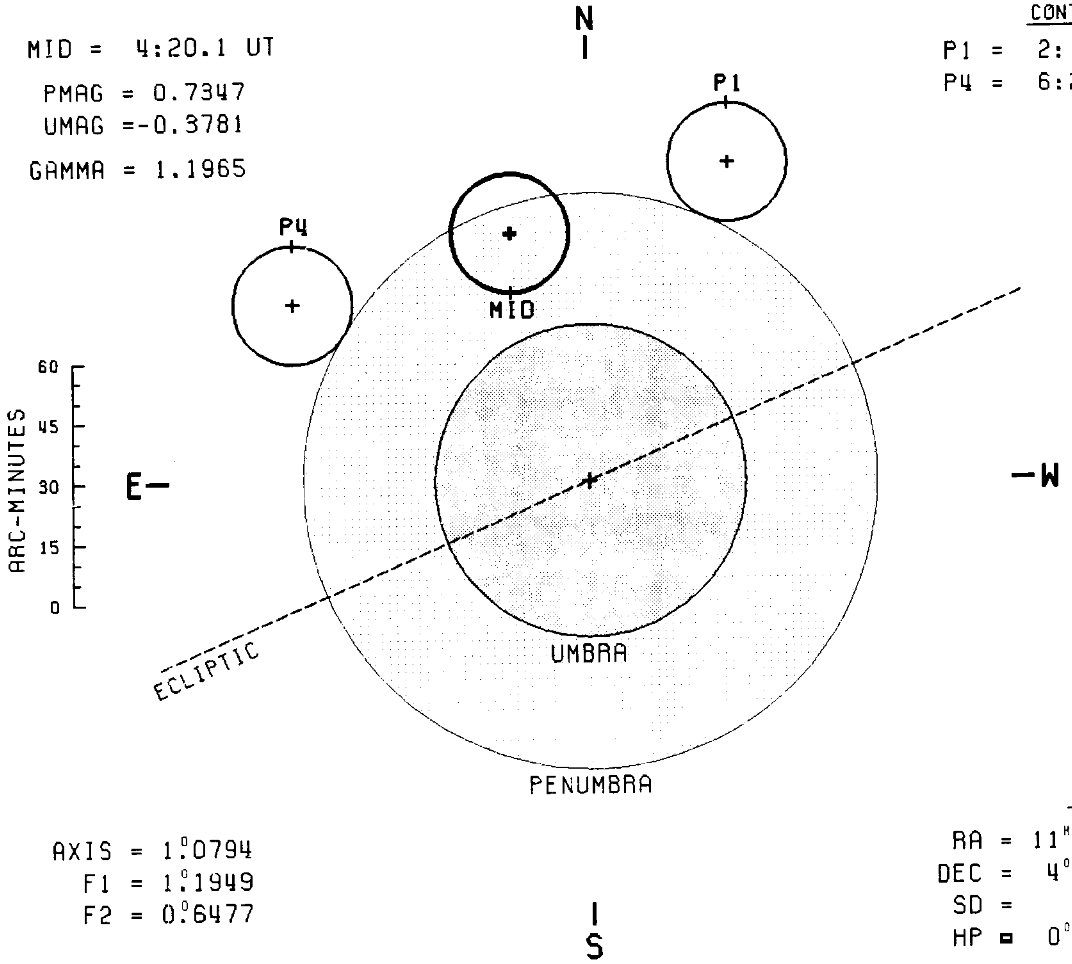
MID = 4:20.1 UT

PMAG = 0.7347
UMAG =-0.3781

GAMMA = 1.1965

CONTACTS

P1 = 2:14.4 UT
P4 = 6:26.0 UT

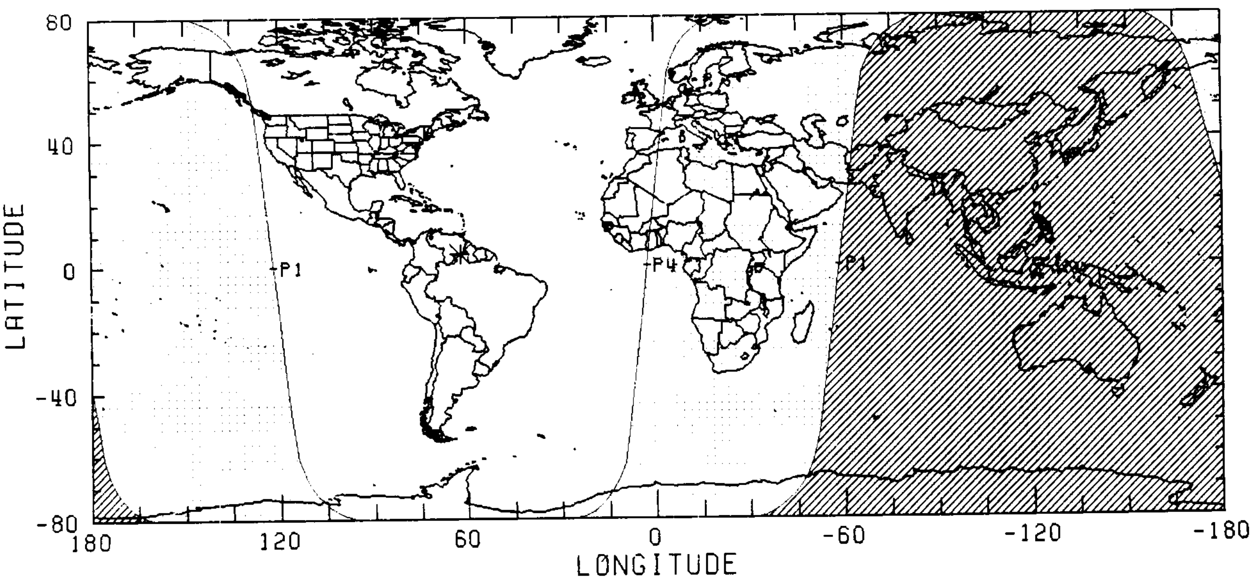


AXIS = 1°.0794
F1 = 1°.1949
F2 = 0°.6477

MOON

RA = $11^h 33^m 20^s.5$
DEC = 4° 2′58.″8
SD = 14′45.″0
HP = 0°54′ 8.″1

SAROS 142 (17/74) JD = 2450885.681 ΔT = 63.4 S



PENUMBRAL LUNAR ECLIPSE - 8 AUG 1998

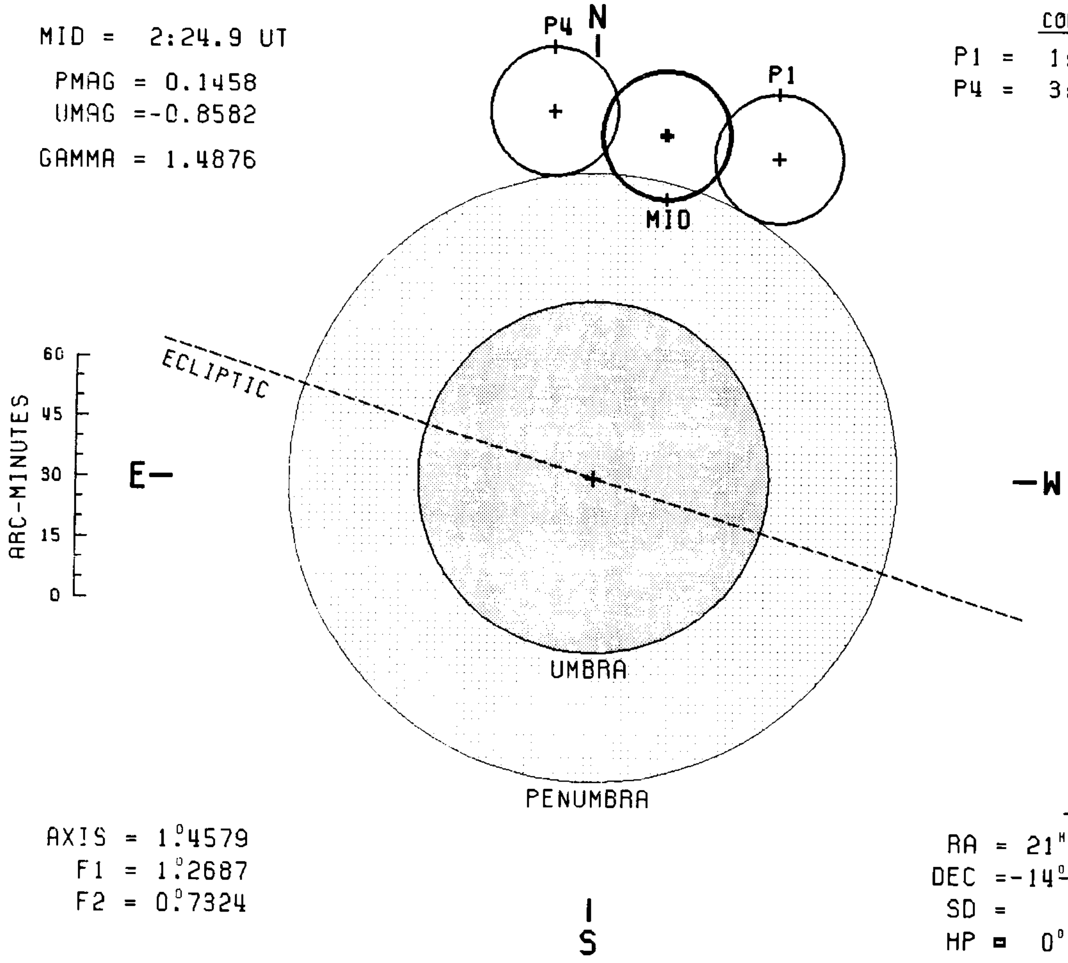
MID = 2:24.9 UT

PMAG = 0.1458
UMAG =-0.8582

GAMMA = 1.4876

CONTACTS

P1 = 1:32.1 UT
P4 = 3:17.7 UT

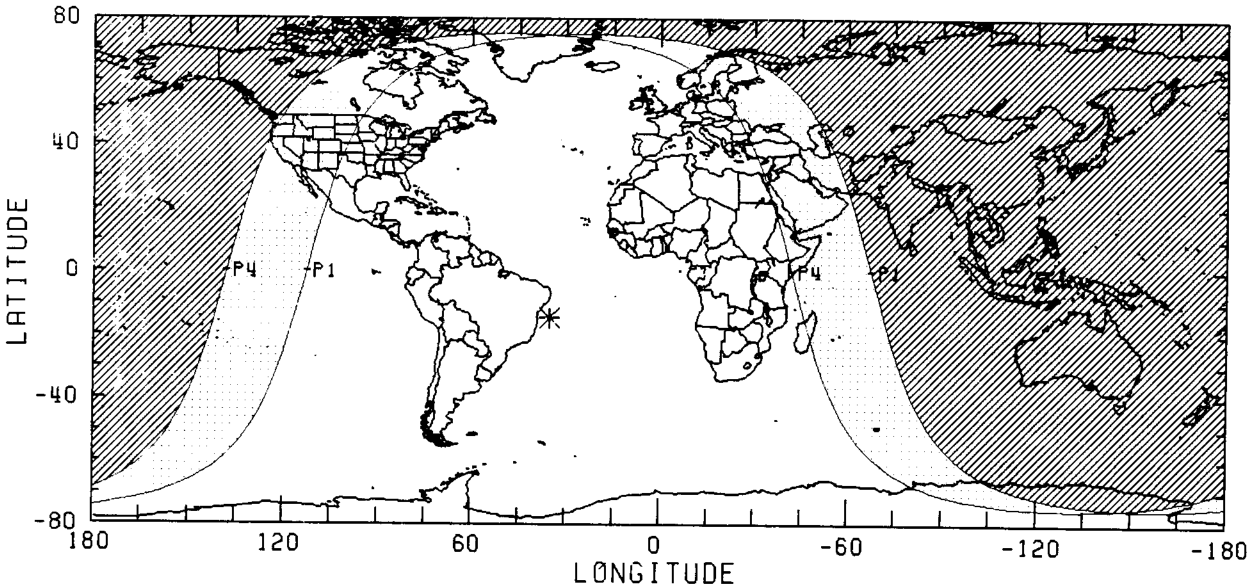


AXIS = 1.°4579
F1 = 1.°2687
F2 = 0.°7324

MOON

RA = 21ʰ 10ᵐ 4.ˢ4
DEC =-14°48'-1."3
SD = 16' 1."4
HP = 0°58'48."5

SAROS 109 (72/73) JD = 2451033.601 ΔT = 63.7 S



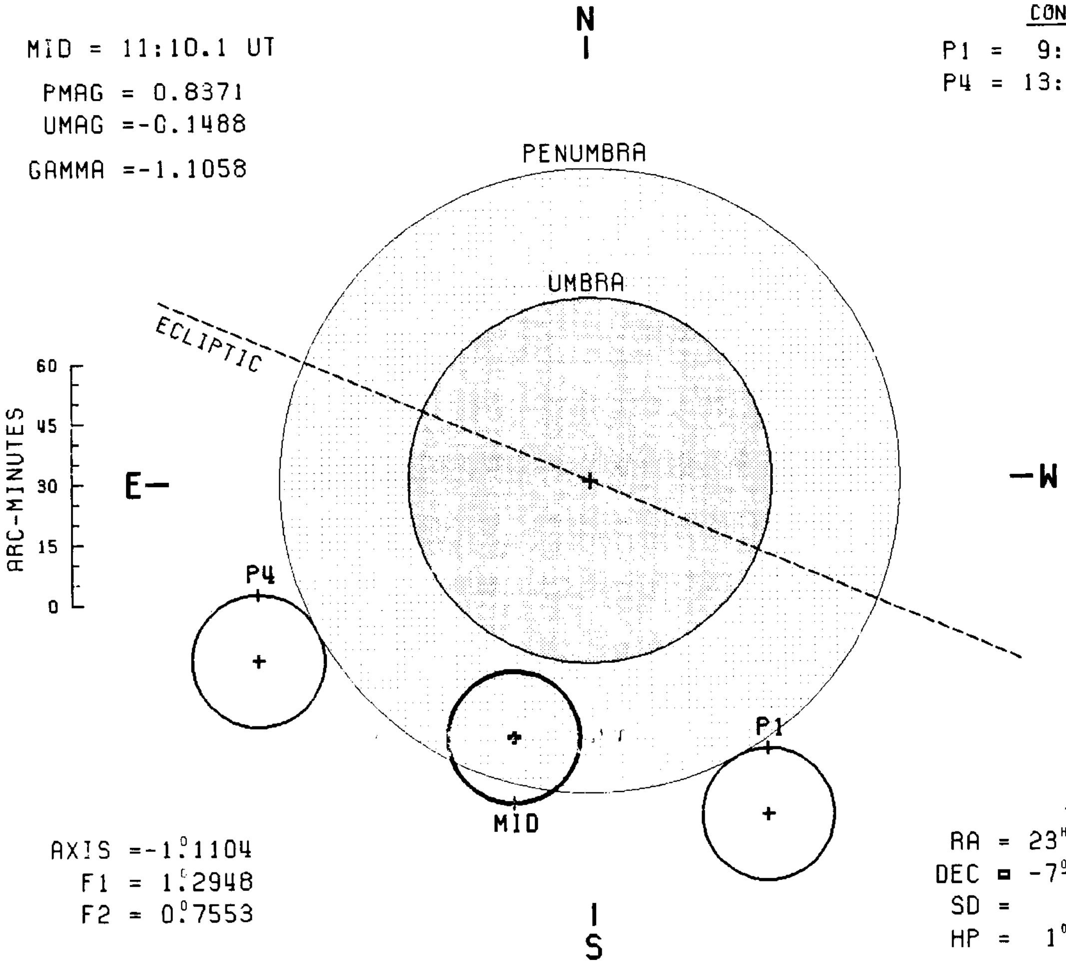
PENUMBRAL LUNAR ECLIPSE - 6 SEP 1998

MID = 11:10.1 UT

PMAG = 0.8371
UMAG =-0.1488

GAMMA =-1.1058

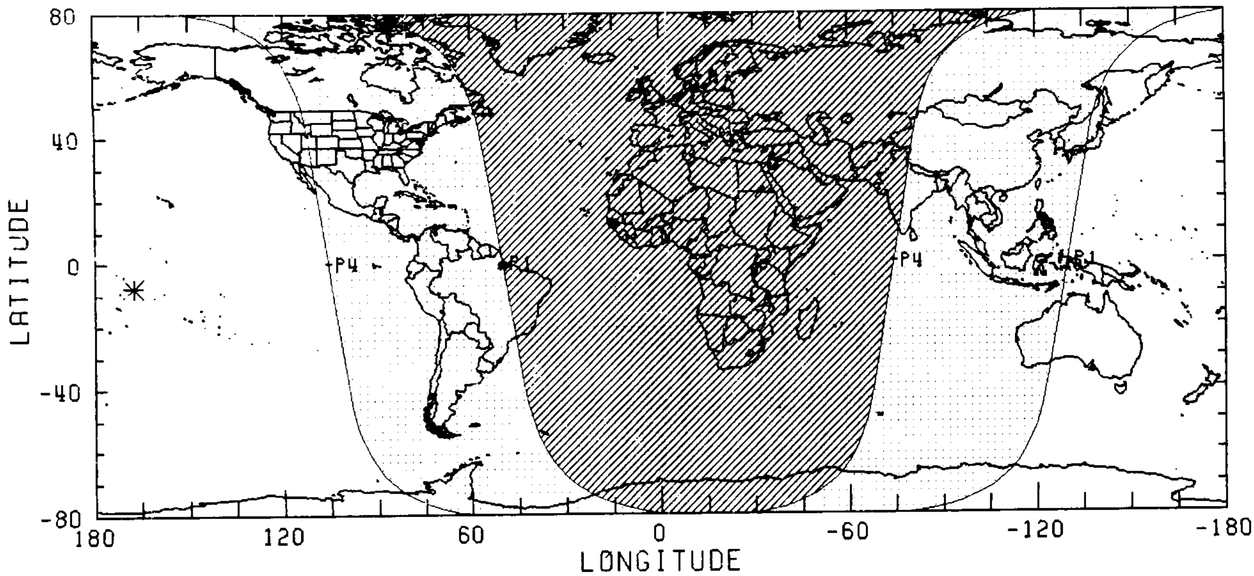
CONTACTS
P1 = 9:14.3 UT
P4 = 13: 6.2 UT



AXIS =-1°1104
F1 = 1°2948
F2 = 0°7553

MOON
RA = 23ʰ 1ᵐ 6ˢ0
DEC = -7°29'-7"7
SD = 16'25"0
HP = 1° 0'15"1

SAROS 147 (8/71) JD = 2451062.966 ΔT = 63.7 S



PENUMBRAL LUNAR ECLIPSE - 31 JAN 1999

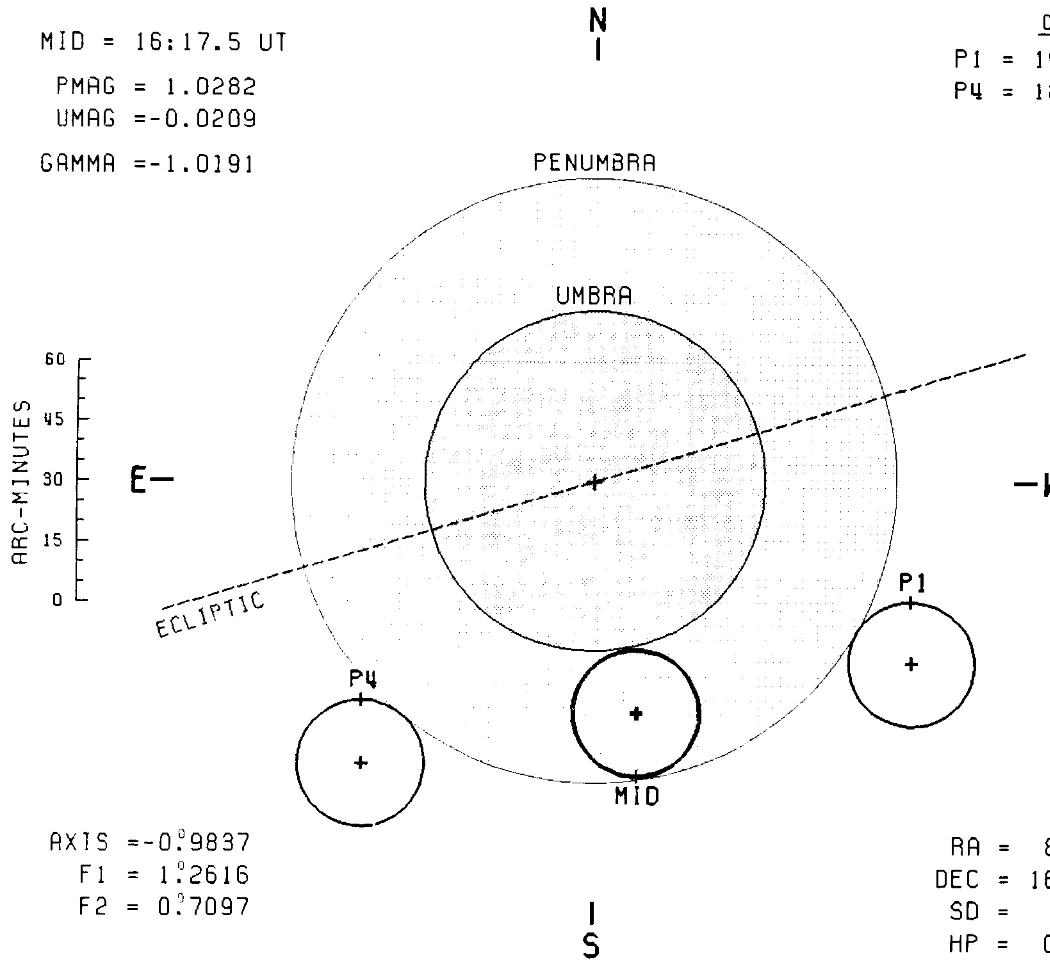
MID = 16:17.5 UT

PMAG = 1.0282
UMAG =-0.0209

GAMMA =-1.0191

CONTACTS

P1 = 14: 4.4 UT
P4 = 18:30.3 UT



AXIS =-0°.9837
F1 = 1°.2616
F2 = 0°.7097

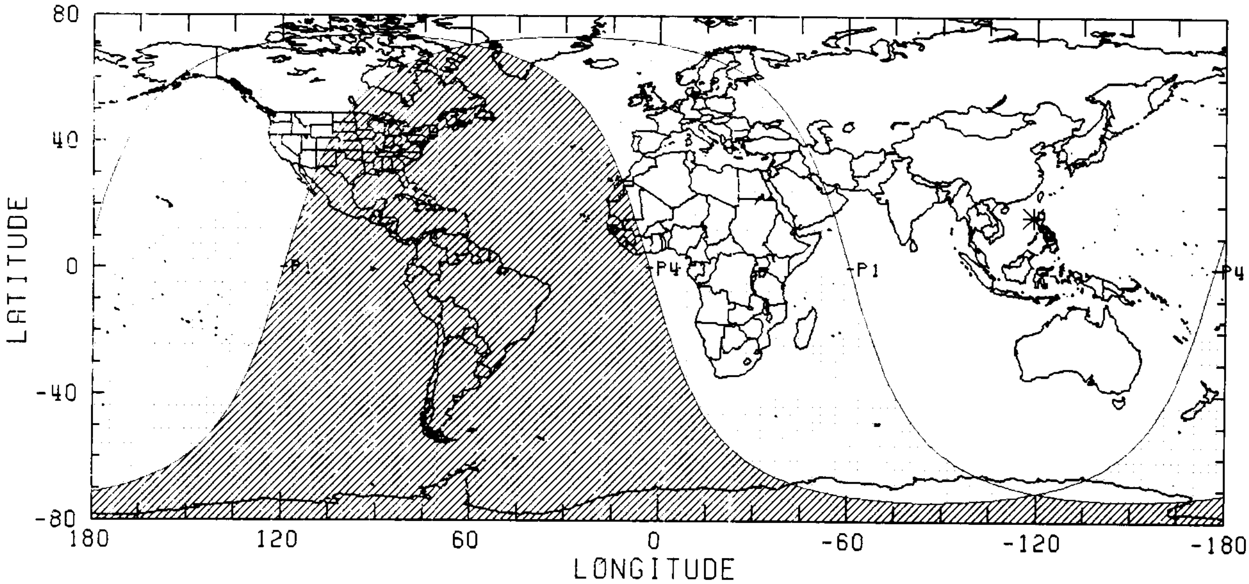
MOON

RA = 8ʰ54ᵐ26ˢ.3
DEC = 16°24'30".2
SD = 15'47".0
HP = 0°57'55".6

SAROS 114 (58/71)

JD = 2451210.180

ΔT = 64.0 S



PARTIAL LUNAR ECLIPSE - 28 JUL 1999

MID = 11:33.7 UT

PMAG = 1.4600

UMAG = 0.4016

GAMMA = 0.7863

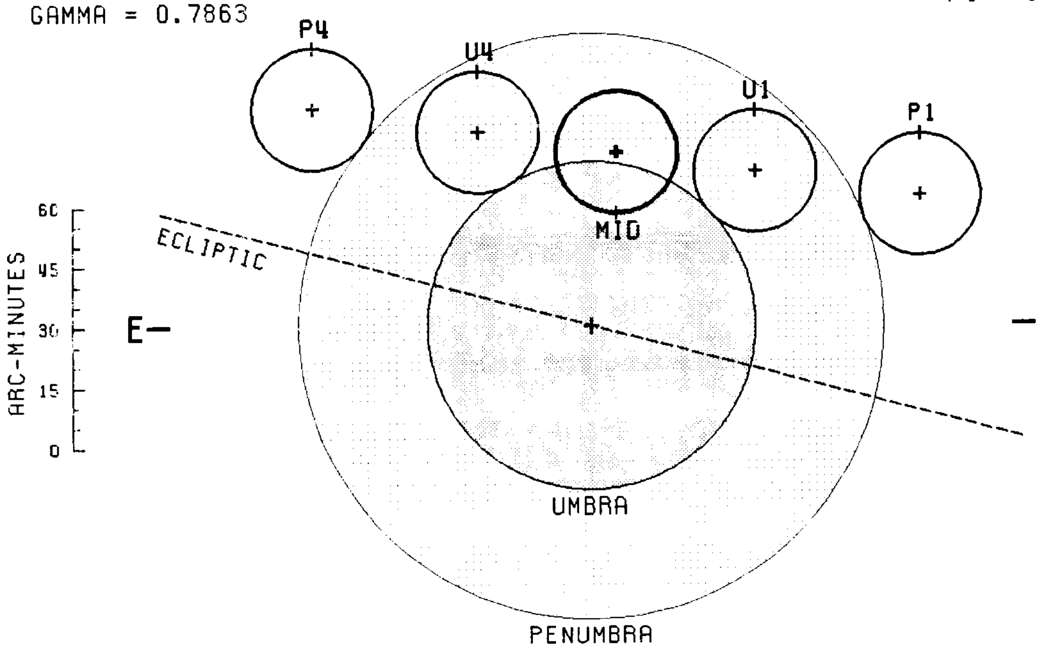
CONTACTS

P1 = 8:56.1 UT

U1 = 10:21.9 UT

U4 = 12:45.4 UT

P4 = 14:11.1 UT



AXIS = 0°7300

F1 = 1°2157

F2 = 0°6801

MOON

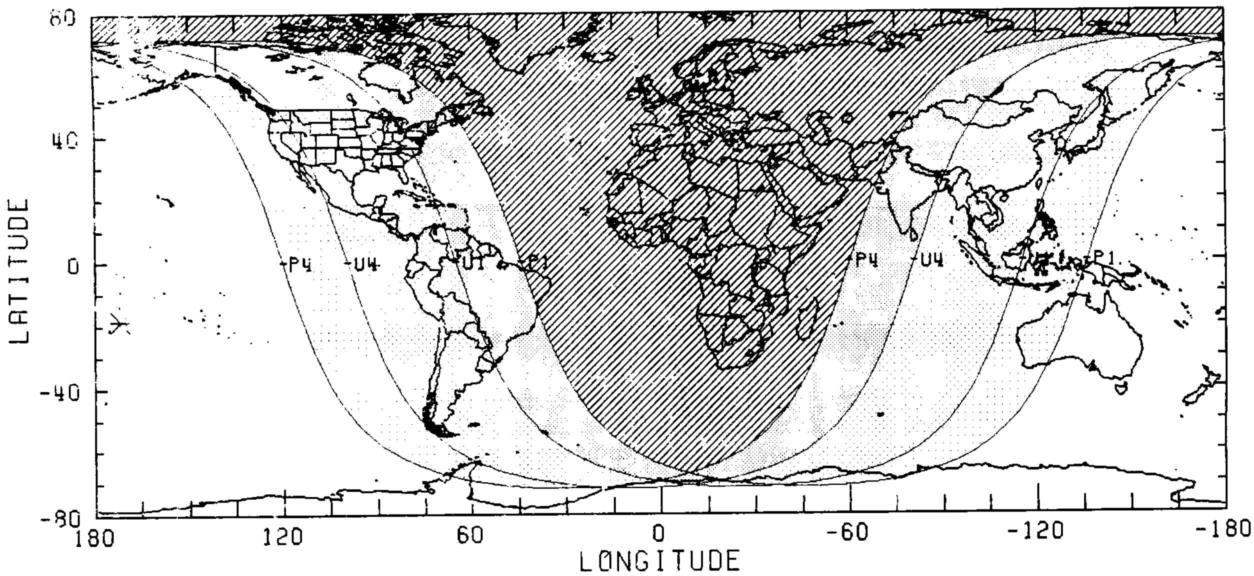
RA = $20^{H}28^{M}49^{S}.1$

DEC = -18°-18'-3."1

SD = 15'10."7

HP = 0°55'42."5

SAROS 119 (61/83) JD = 2451387.982 ΔT = 64.4 S



TOTAL LUNAR ECLIPSE - 21 JAN 2000

MID = 4:43.5 UT

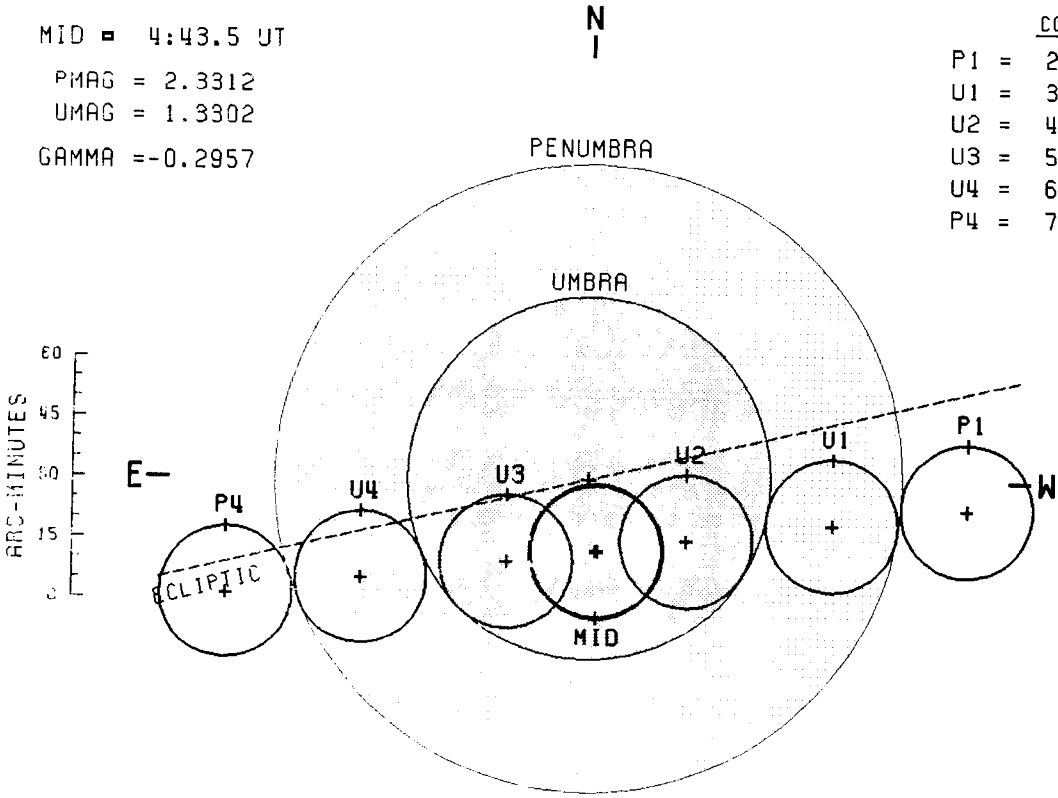
PMAG = 2.3312

UMAG = 1.3302

GAMMA =-0.2957

CONTACTS

P1 = 2: 2.7 UT
U1 = 3: 1.3 UT
U2 = 4: 4.4 UT
U3 = 5:22.4 UT
U4 = 6:25.6 UT
P4 = 7:24.3 UT



AXIS =-0.°2995
F1 = 1.°3104
F2 = 0.°7578

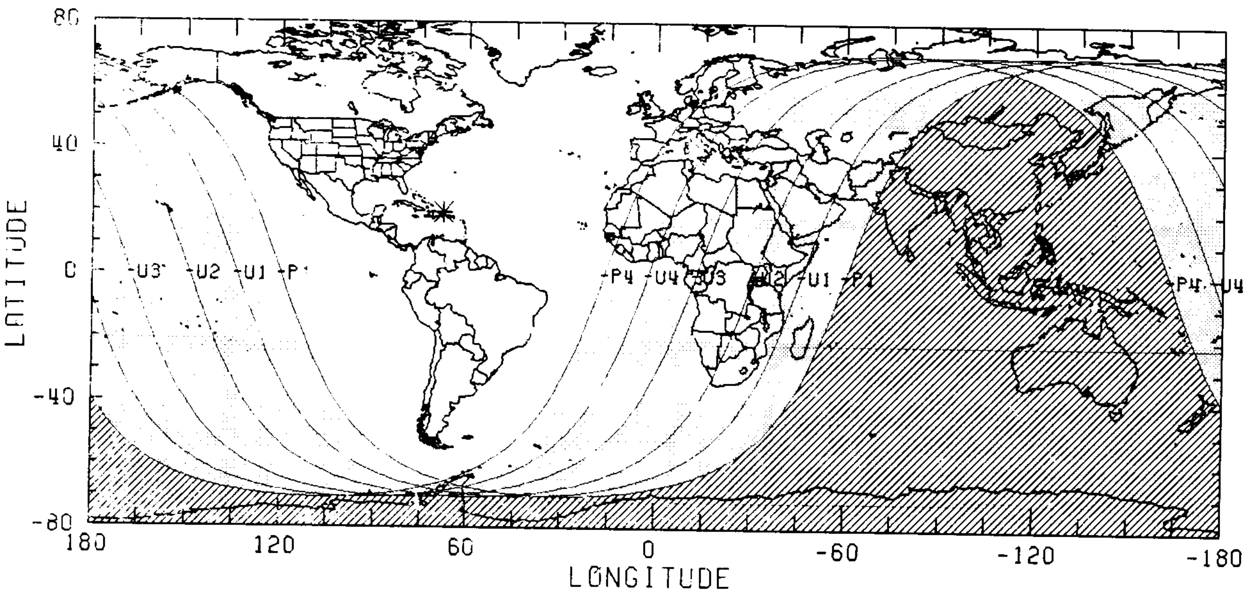
MOON

RA = 8ʰ 10ᵐ 23.ˢ9
DEC = 19° 45' 29."7
SD = 16' 33."7
HP = 1° 0' 46."8

SAROS 124 (48/74)

JD = 2451564.698

ΔT = 64.8 S



TOTAL LUNAR ECLIPSE - 16 JUL 2000

N

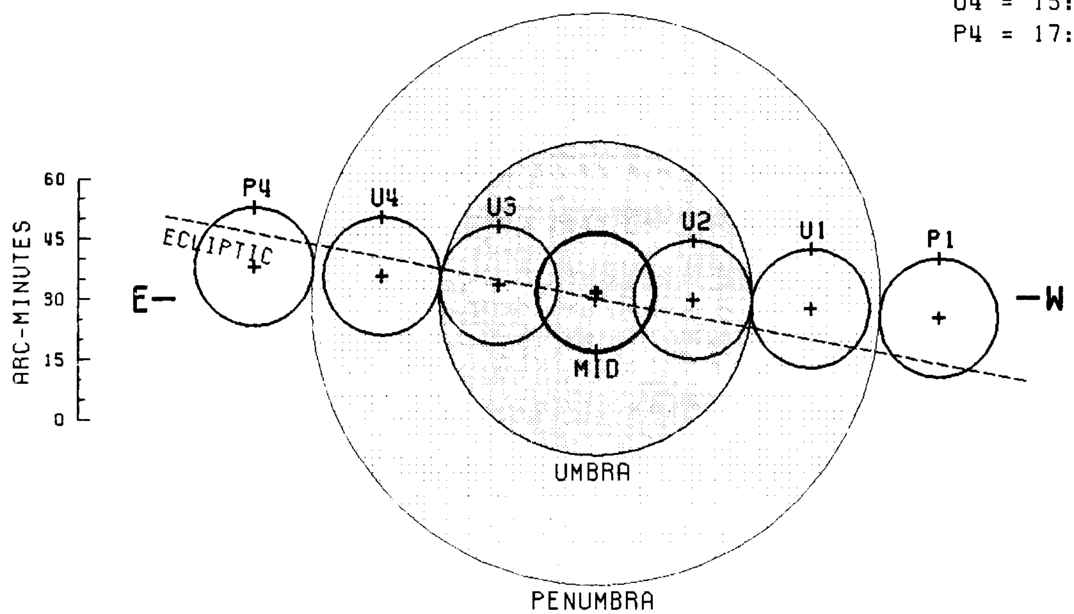
MID = 13:55.5 UT

PMAG = 2.8636
UMAG = 1.7731

GAMMA = 0.0301

CONTACTS

P1 = 10:46.4 UT
U1 = 11:57.0 UT
U2 = 13: 1.8 UT
U3 = 14:49.2 UT
U4 = 15:54.1 UT
P4 = 17: 4.7 UT



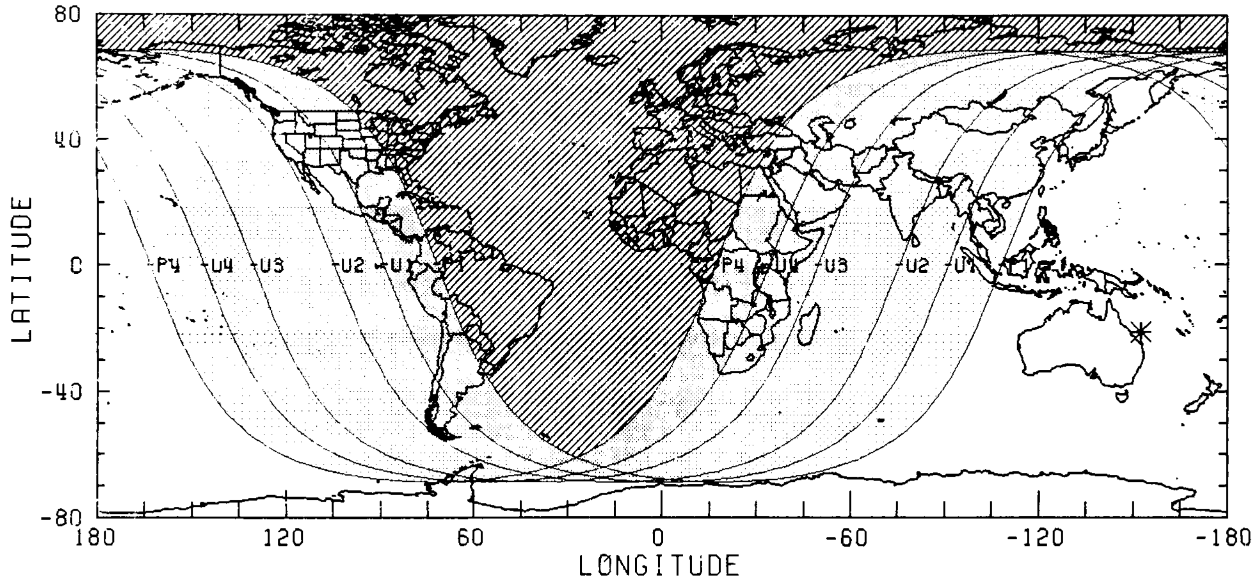
AXIS = 0°.0271
F1 = 1°.1868
F2 = 0°.6518

S

MOON

RA = 19ʰ44ᵐ54ˢ.1
DEC = -21°13'25".3
SD = 14'43".2
HP = 0°54' 1".2

SAROS 129 (37/71) JD = 2451742.081 ΔT = 65.2 S



TOTAL LUNAR ECLIPSE - 9 JAN 2001

N

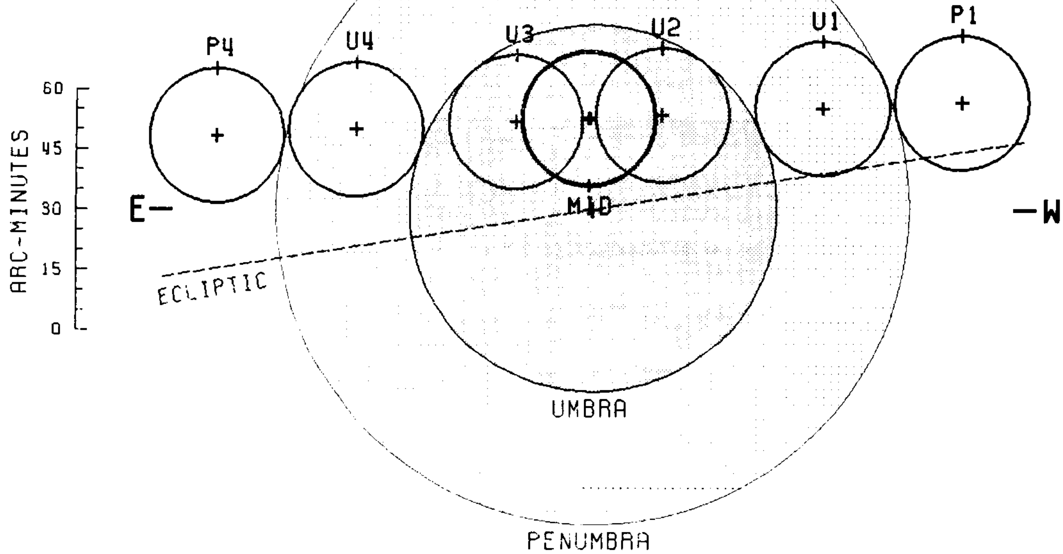
MID = 20:20.6 UT

PMAG = 2.1867
UMAG = 1.1944

GAMMA = 0.3720

CONTACTS

P1 = 17:43.4 UT
U1 = 18:41.9 UT
U2 = 19:49.6 UT
U3 = 20:51.6 UT
U4 = 21:59.2 UT
P4 = 22:57.7 UT



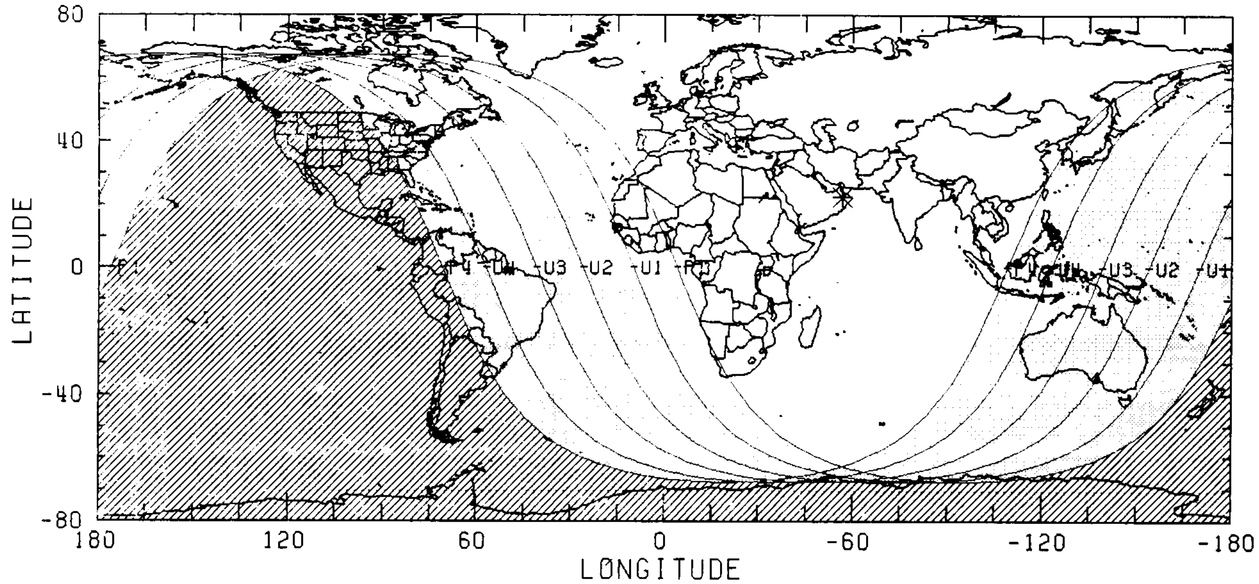
AXIS = 0.°3804
F1 = 1.°3203
F2 = 0.°7673

MOON

RA = 7ʰ 25ᵐ 7.ˢ9
DEC = 22° 22′ 46.″5
SD = 16′ 43.″0
HP = 1° 1′ 21.″1

S

SAROS 134 (26/73) JD = 2451919.348 ΔT = 65.6 S



PARTIAL LUNAR ECLIPSE - 5 JUL 2001

MID = 14:55.3 UT

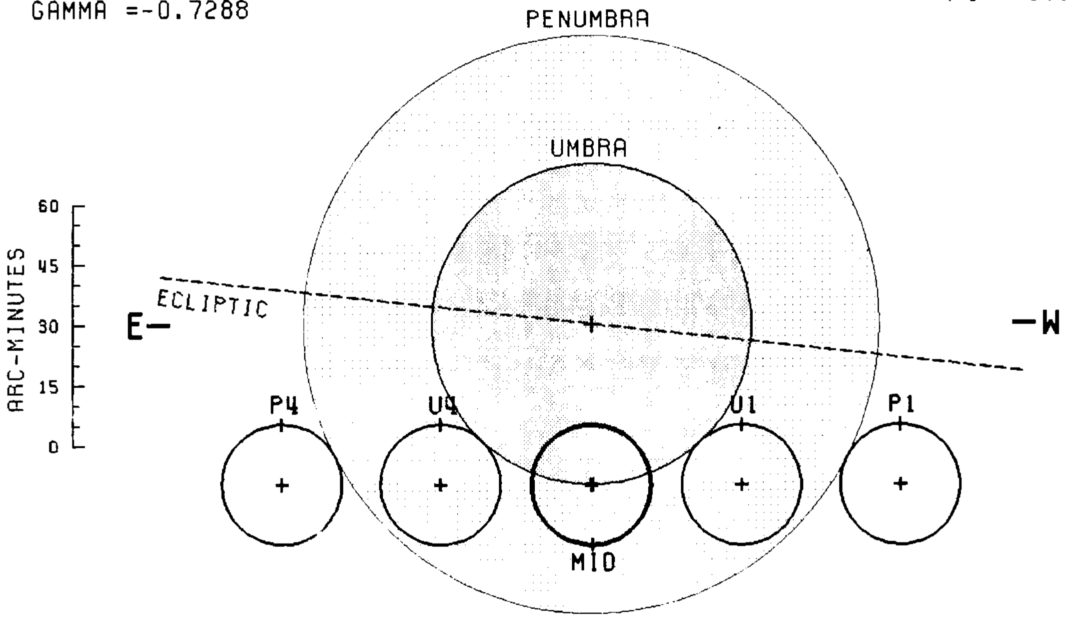
PMAG = 1.5733
UMAG = 0.4995

GAMMA =-0.7288

N

CONTACTS

P1 = 12:10.7 UT
U1 = 13:35.1 UT
U4 = 16:15.3 UT
P4 = 17:39.9 UT



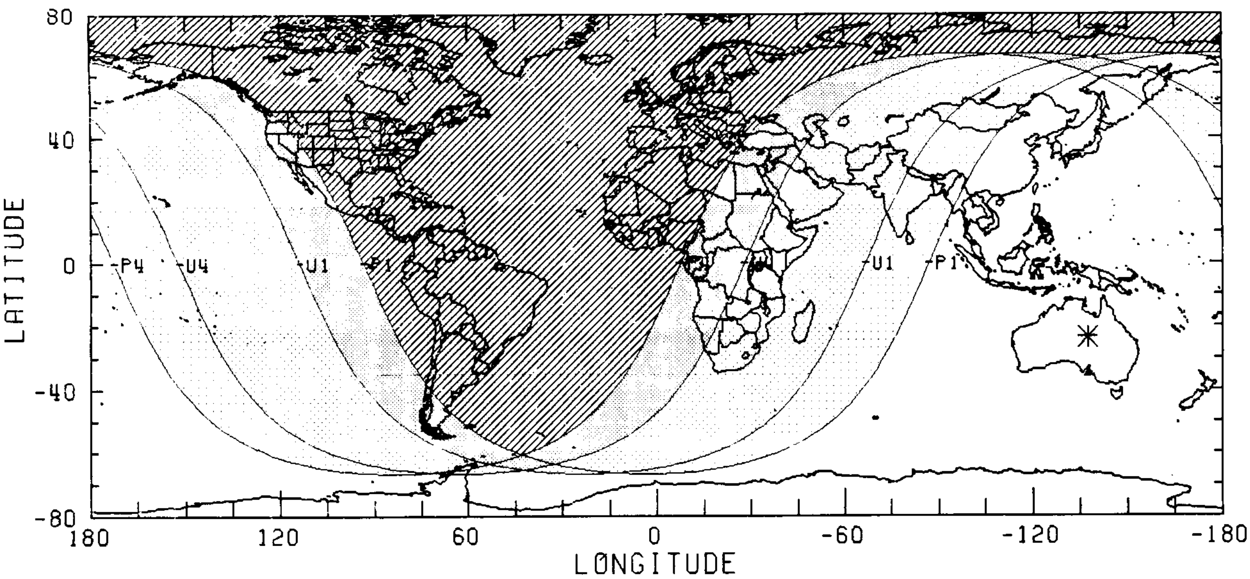
S

AXIS =-0°.6660
F1 = 1°.2006
F2 = 0°.6658

MOON

RA = 18ʰ 59ᵐ 16ˢ.6
DEC =-23° 24′ 20″.3
SD = 14′ 56″.6
HP = 0° 54′ 50″.4

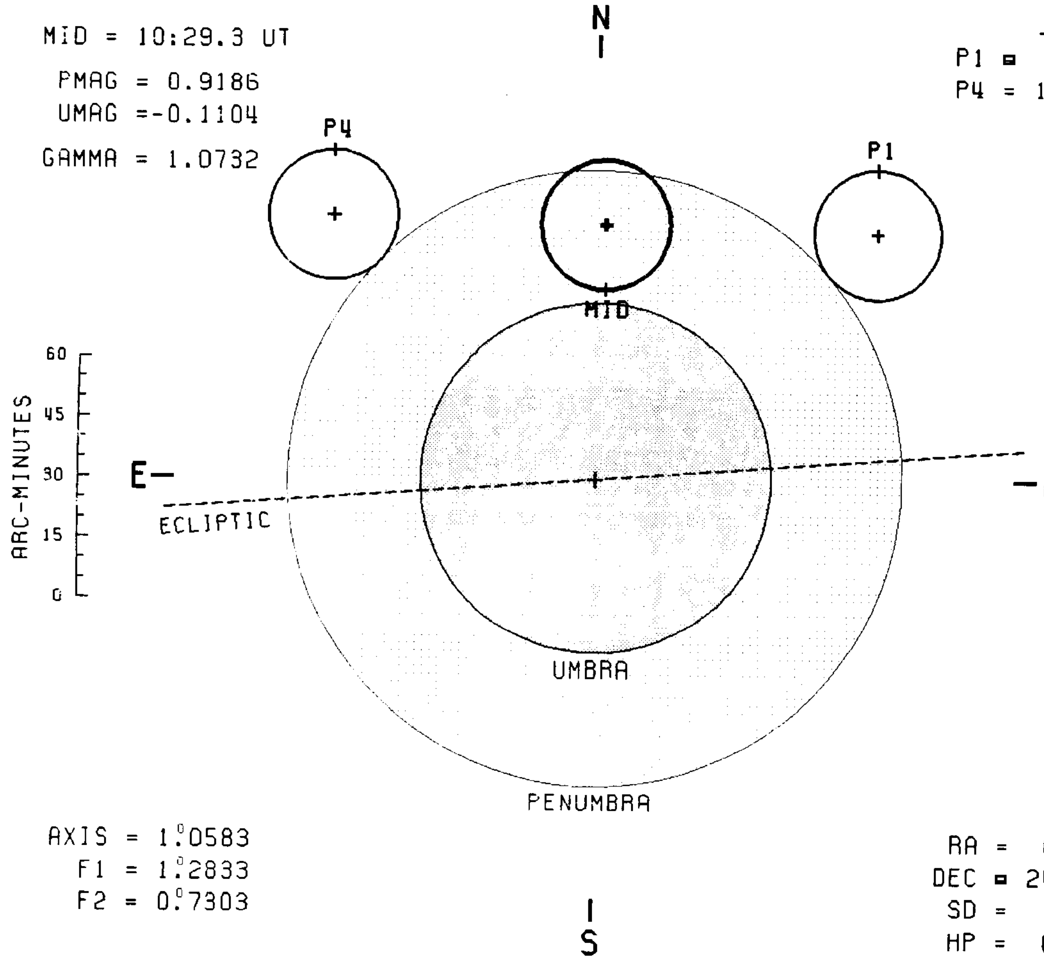
SAROS 139 (22/82) JD = 2452096.122 ΔT = 66.0 S



PENUMBRAL LUNAR ECLIPSE - 30 DEC 2001

MID = 10:29.3 UT
PMAG = 0.9186
UMAG =-0.1104
GAMMA = 1.0732

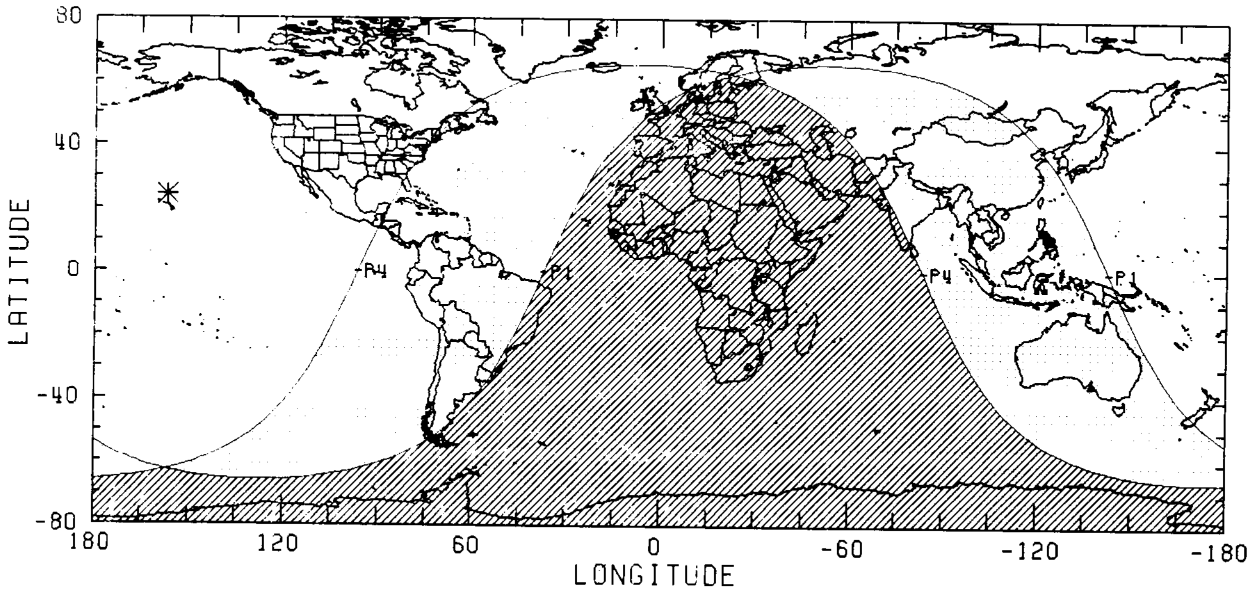
CONTACTS
P1 = 8:25.4 UT
P4 = 12:33.2 UT



AXIS = 1.°0583
F1 = 1.°2833
F2 = 0.°7303

MOON
RA = 6ʰ 38ᵐ 7.ˢ6
DEC = 24° 12' 19."1
SD = 16' 7."4
HP = 0° 59' 10."2

SAROS 144 (15/71)
JD = 2452273.938
ΔT = 66.3 S



PENUMBRAL LUNAR ECLIPSE - 26 MAY 2002

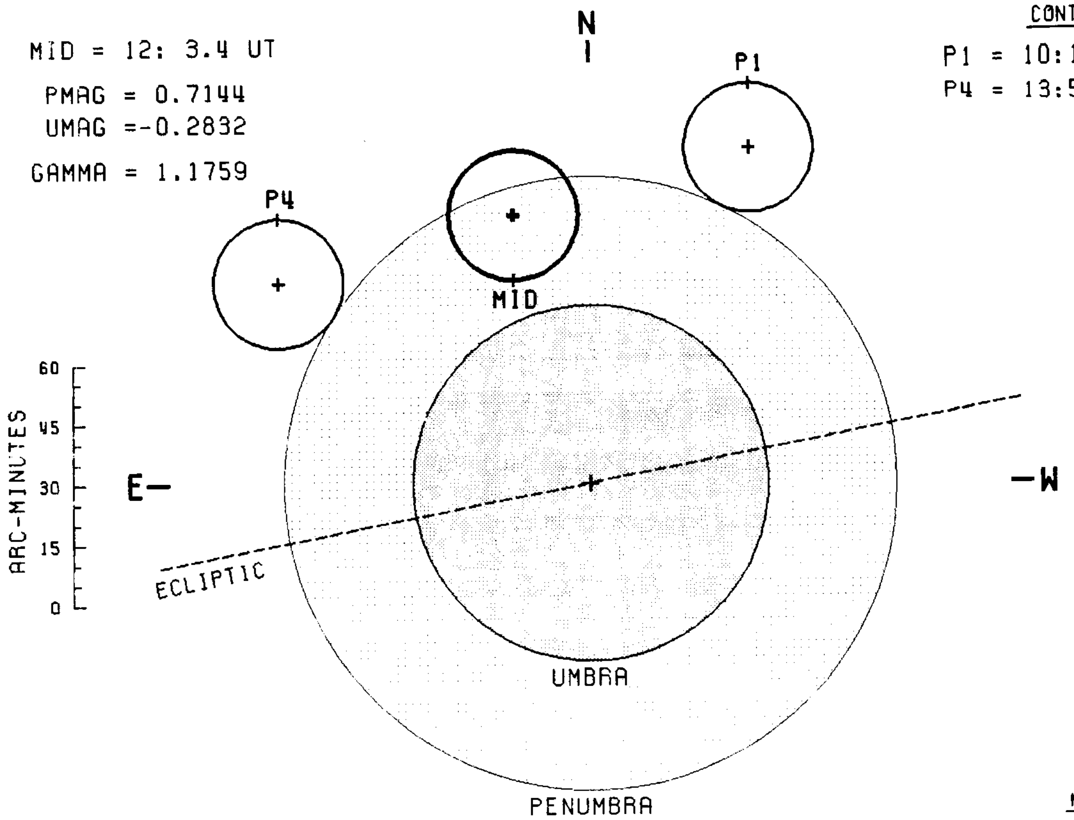
MID = 12: 3.4 UT

PMAG = 0.7144
UMAG =-0.2832

GAMMA = 1.1759

CONTACTS

P1 = 10:12.9 UT
P4 = 13:54.0 UT

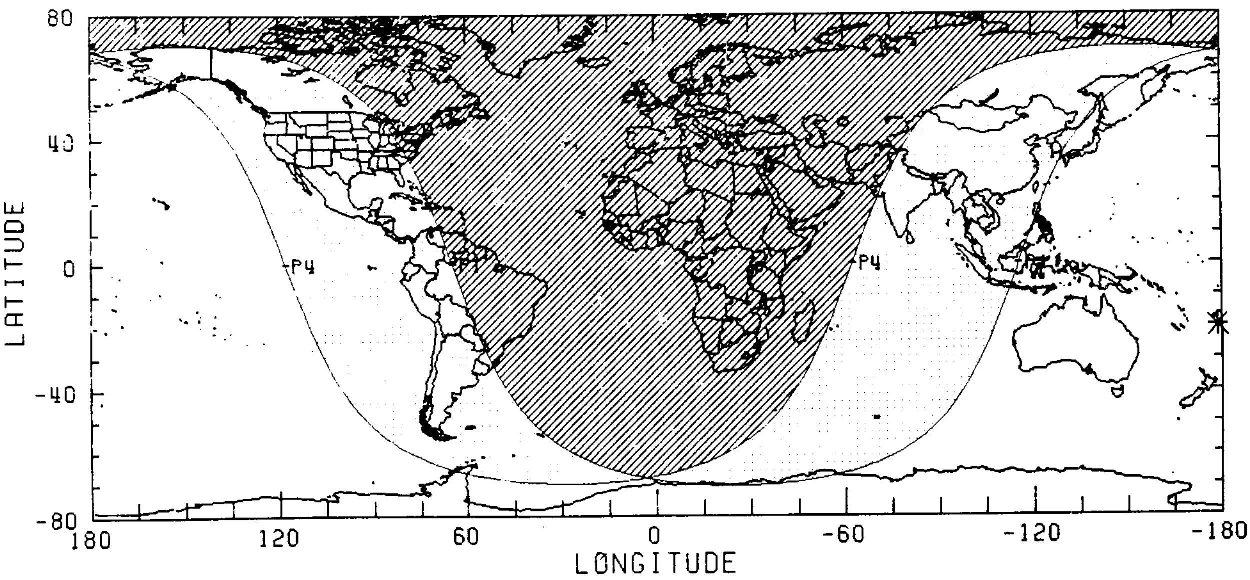


AXIS = 1°.1609
F1 = 1°.2763
F2 = 0°.7395

MOON

RA = 16ʰ13ᵐ52ˢ.1
DEC =-20°-1'-35".6
SD = 16' 8".5
HP = 0°59'14".5

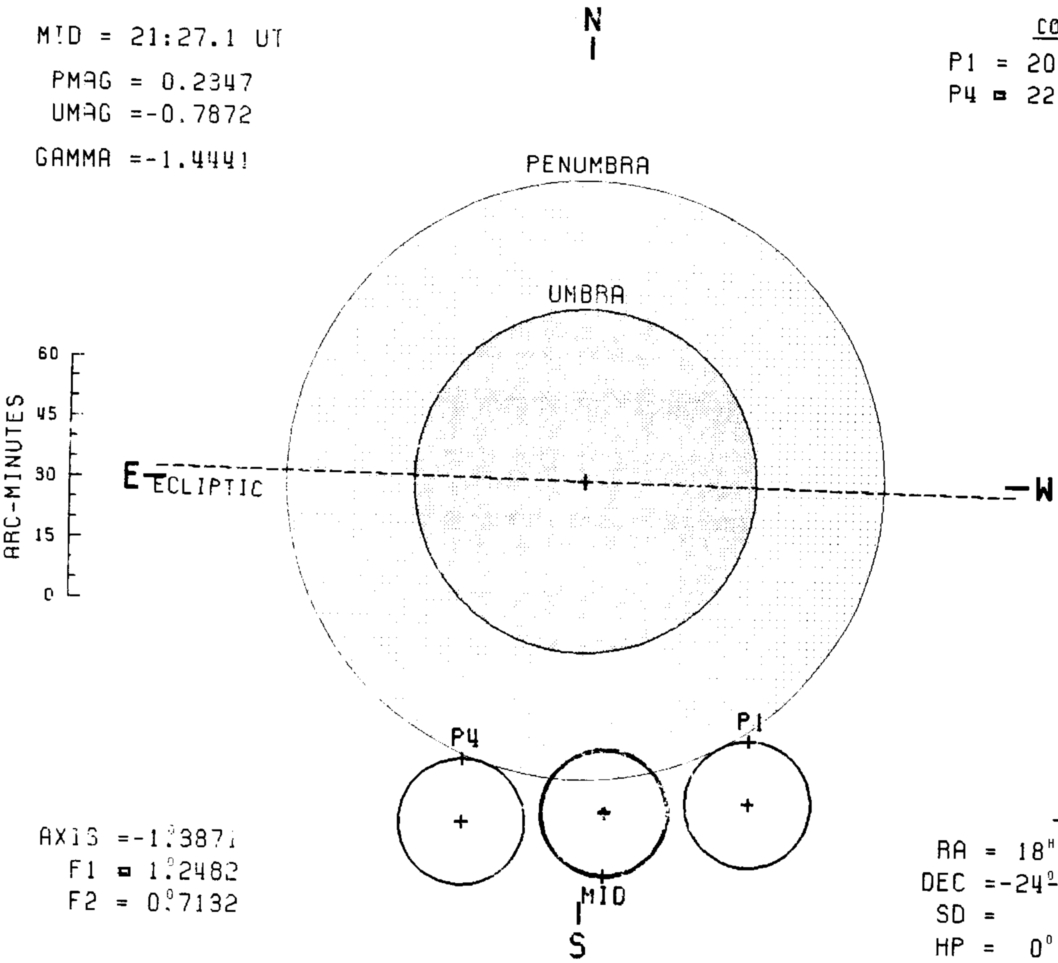
SAROS 111 (66/71) JD = 2452421.003 ΔT = 66.7 S



PENUMBRAL LUNAR ECLIPSE - 24 JUN 2002

MID = 21:27.1 UT
PMAG = 0.2347
UMAG =-0.7872
GAMMA =-1.4441

CONTACTS
P1 = 20:18.6 UT
P4 = 22:35.2 UT



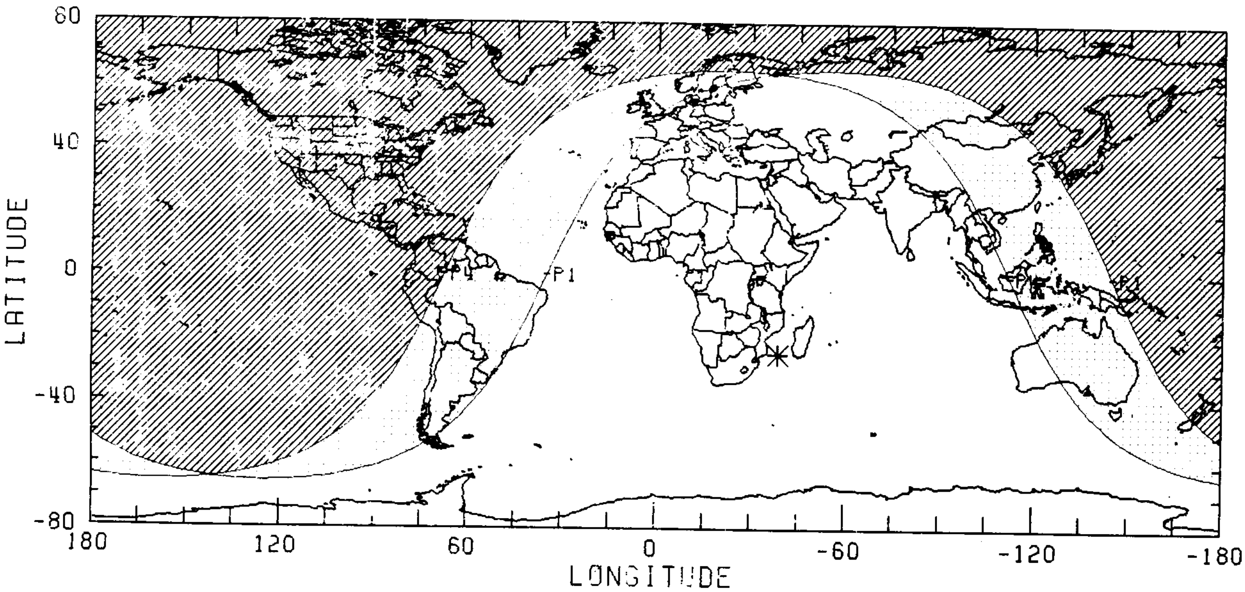
AXIS =-1.3871
F1 = 1.2482
F2 = 0.7132

MOON
RA = 18ʰ13ᵐ25.ˢ9
DEC =-24°47'-5."1
SD = 15'42."3
HP = 0°57'38."4

SAROS 149 (2/72)

JD = 2452450.395

ΔT = 66.7 S



PENUMBRAL LUNAR ECLIPSE - 20 NØV 2002

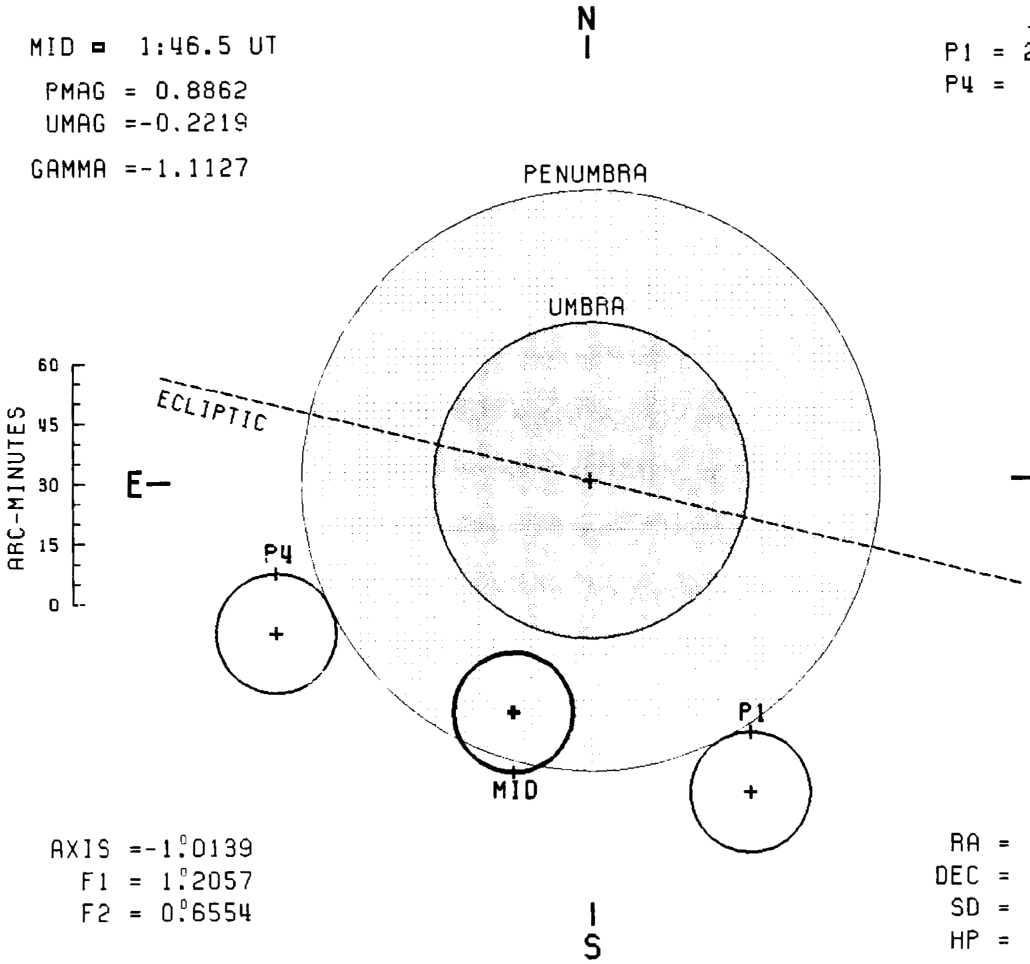
MID = 1:46.5 UT

PMAG = 0.8862
UMAG =-0.2219

GAMMA =-1.1127

CONTACTS

P1 = 23:32.1 UT
P4 = 4: 1.3 UT

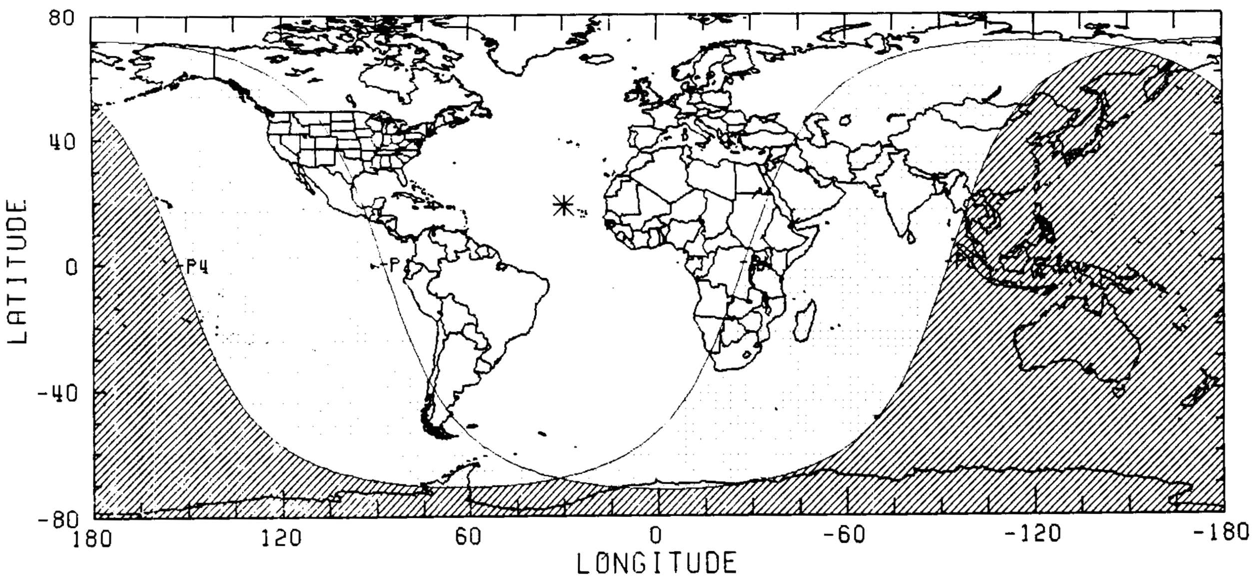


AXIS =-1°.0139
F1 = 1°.2057
F2 = 0°.6554

MOON

RA = 3ʰ42ᵐ30ˢ.2
DEC = 18°39'15".0
SD = 14'54".0
HP = 0°54'40".9

SARØS 116 (57/73) JD = 2452598.575 ΔT = 67.0 S



TOTAL LUNAR ECLIPSE - 16 MAY 2003

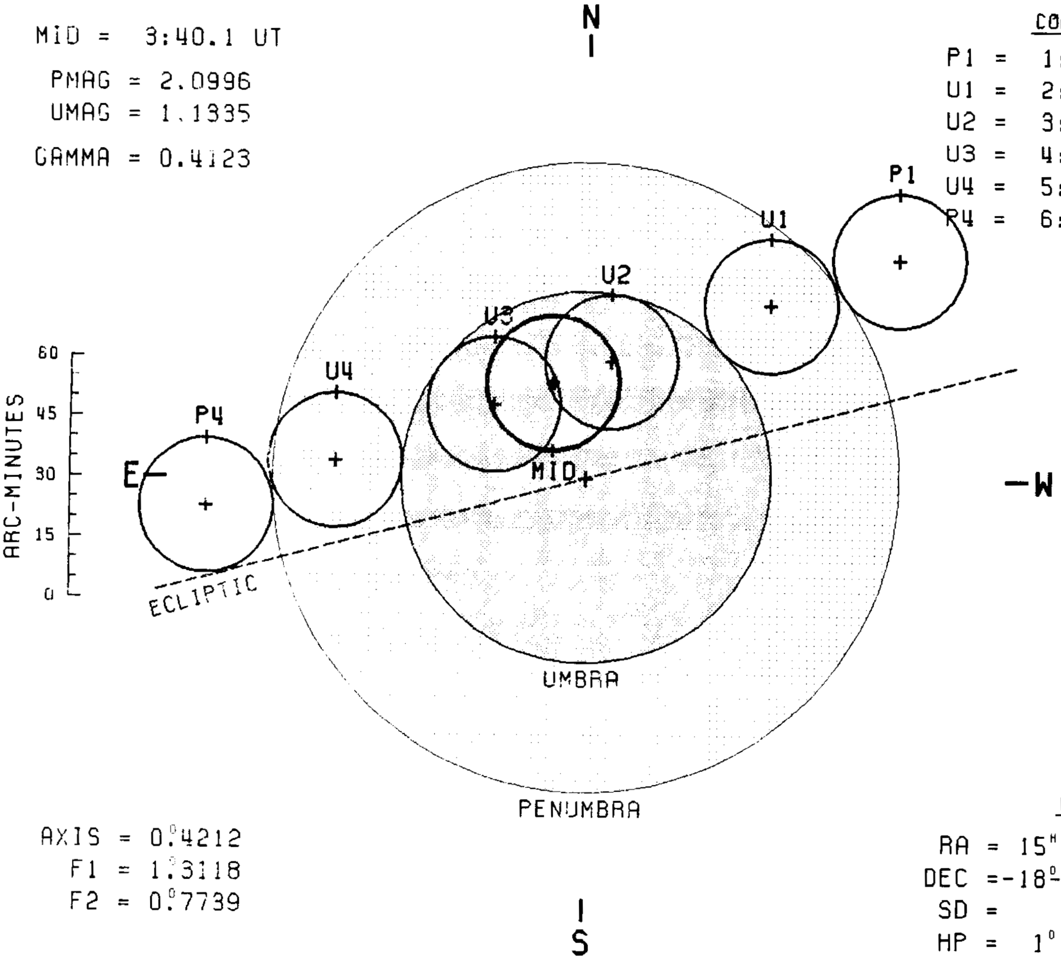
MID = 3:40.1 UT

PMAG = 2.0996
UMAG = 1.1335

GAMMA = 0.4123

CONTACTS

P1 = 1: 5.3 UT
U1 = 2: 2.7 UT
U2 = 3:14.0 UT
U3 = 4: 6.5 UT
U4 = 5:17.6 UT
P4 = 6:15.0 UT

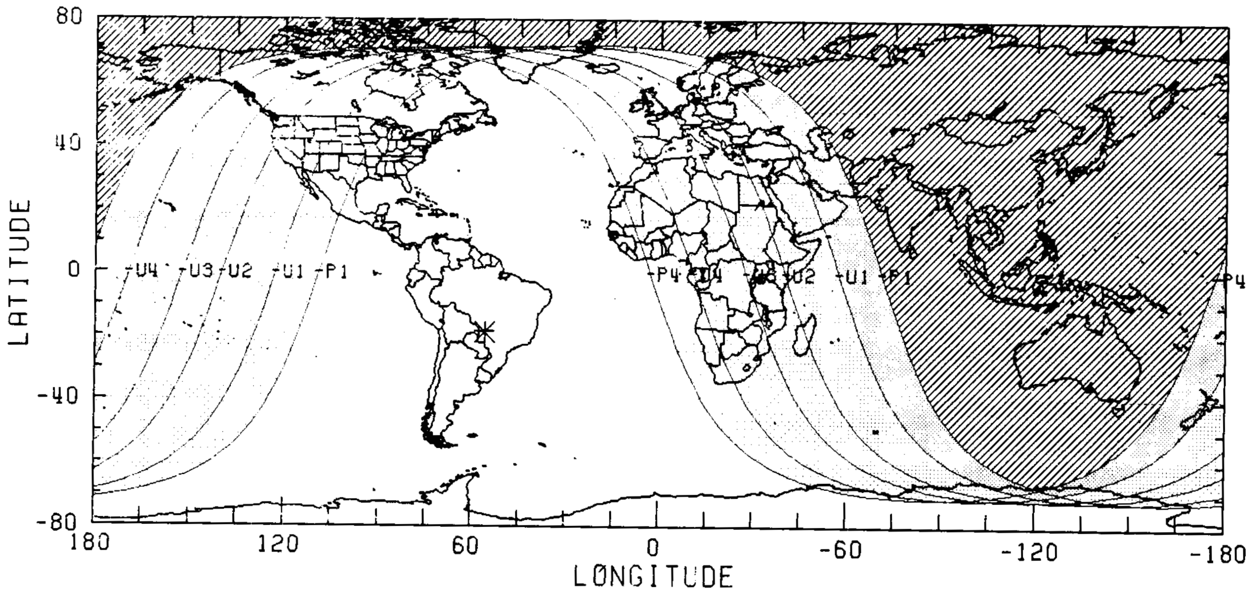


AXIS = 0°.4212
F1 = 1°.3118
F2 = 0°.7739

MOON

RA = 15h 30m 43.0s
DEC = -18° 35' 31.7"
SD = 16' 42.2"
HP = 1° 1' 18.1"

SAROS 121 (55/84)   JD = 2452775.654   ΔT = 67.4 S



TOTAL LUNAR ECLIPSE - 9 NOV 2003

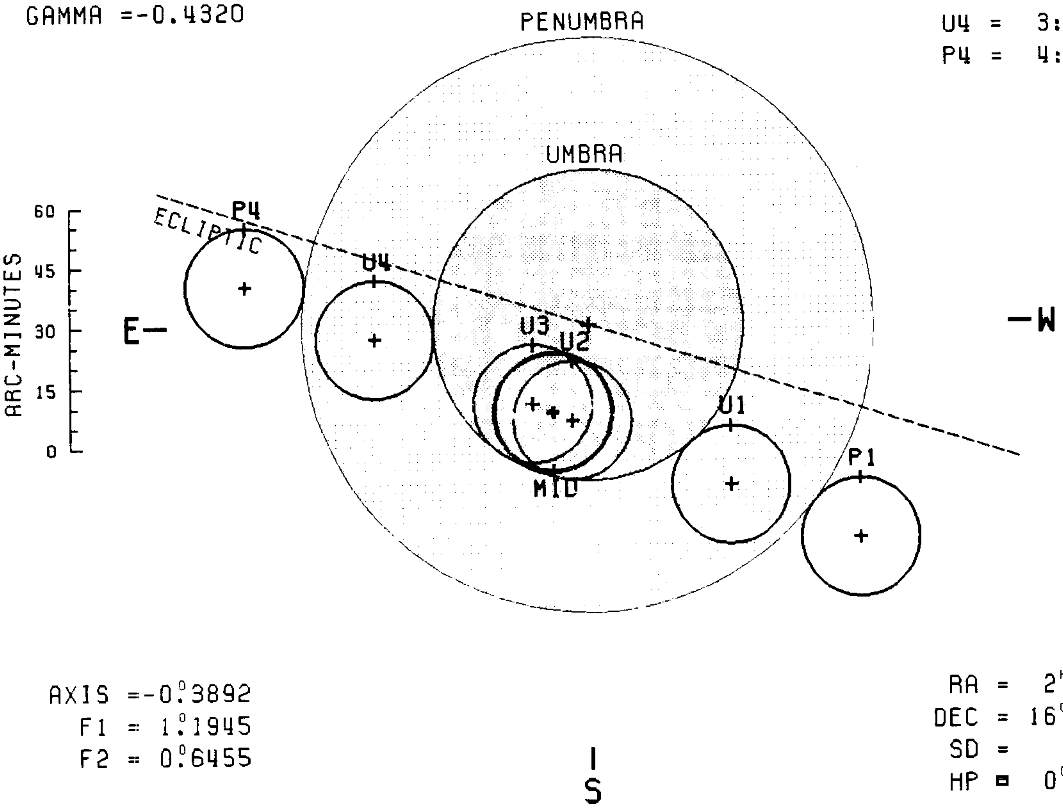
MID = 1:18.5 UT

PMAG = 2.1401
UMAG = 1.0221

GAMMA =-0.4320

CONTACTS

P1 = 22:15.0 UT
U1 = 23:32.4 UT
U2 = 1: 6.9 UT
U3 = 1:30.5 UT
U4 = 3: 4.7 UT
P4 = 4:22.1 UT

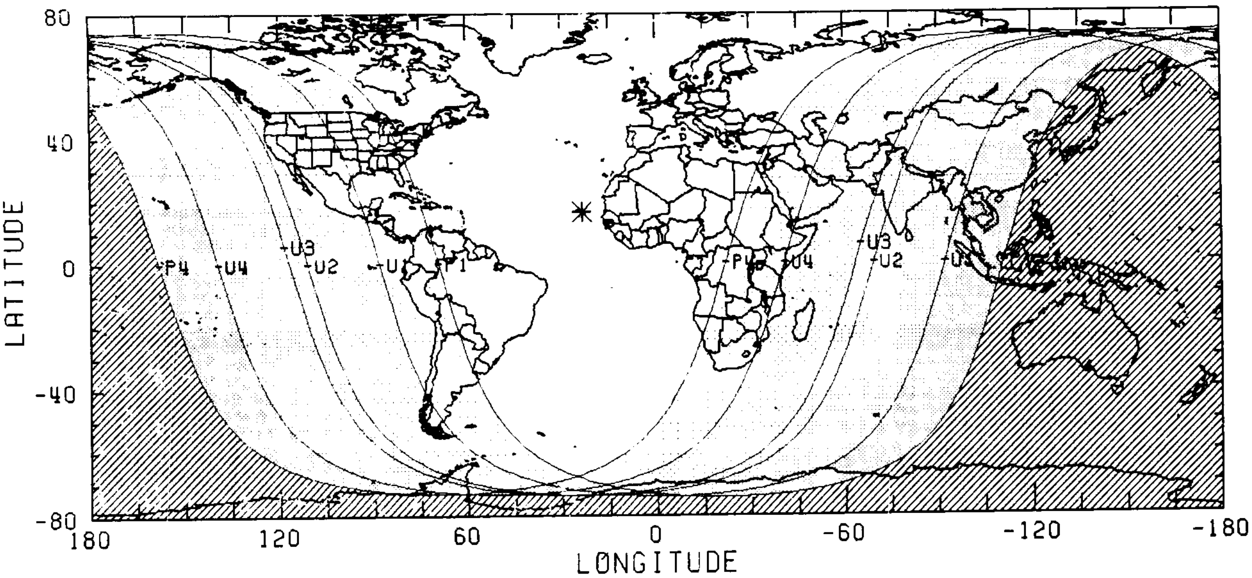


AXIS =-0°.3892
F1 = 1°.1945
F2 = 0°.6455

MOON

RA = 2ʰ 55ᵐ 37ˢ.0
DEC = 16° 19' 48".4
SD = 14' 43".8
HP = 0° 54' 3".6

SAROS 126 (45/72) JD = 2452952.555 ΔT = 67.8 S



TOTAL LUNAR ECLIPSE - 4 MAY 2004

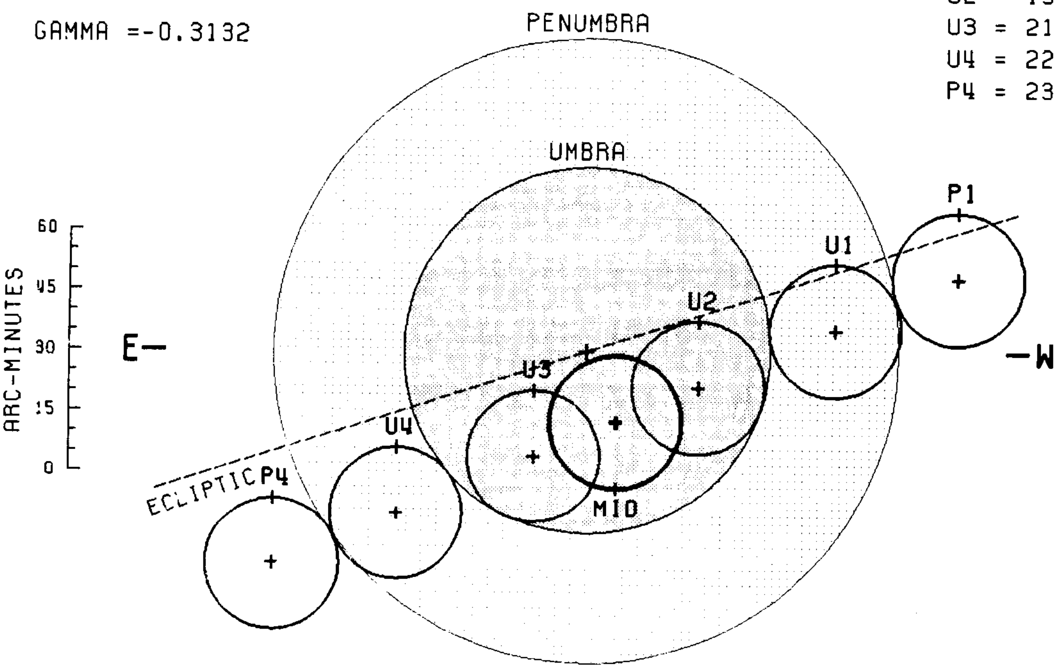
MID = 20:30.2 UT

PMAG = 2.2877
UMAG = 1.3093

GAMMA =-0.3132

CONTACTS

P1 = 17:50.6 UT
U1 = 18:48.1 UT
U2 = 19:51.8 UT
U3 = 21: 8.2 UT
U4 = 22:12.2 UT
P4 = 23: 9.6 UT



AXIS =-0.°3167
F1 = 1.°3019
F2 = 0.°7627

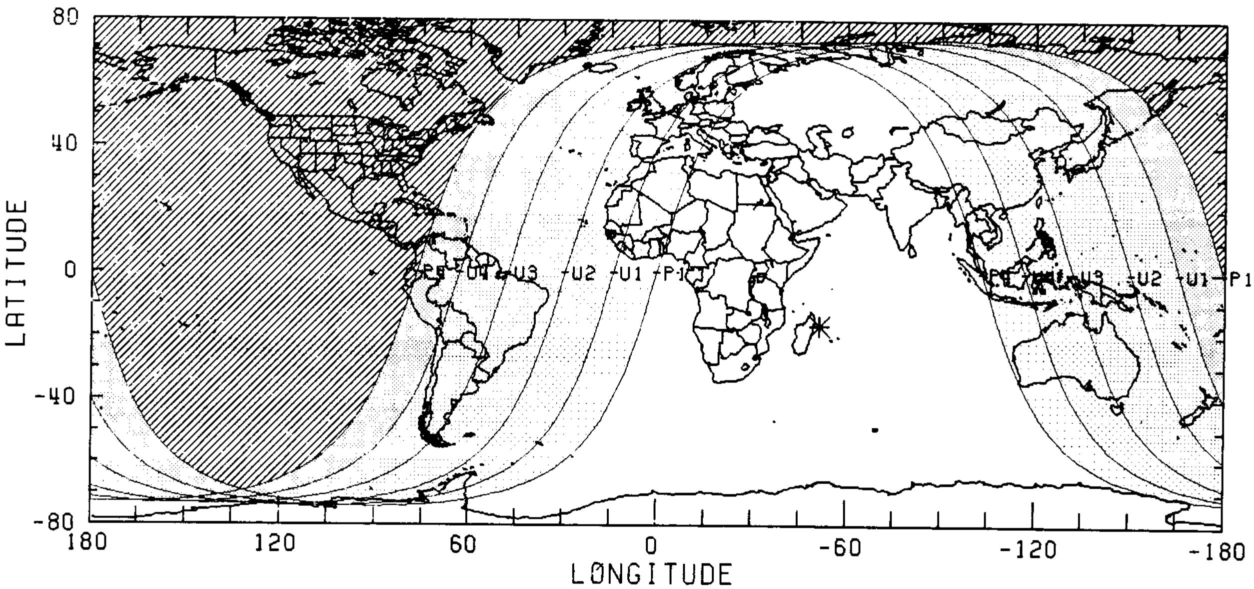
MOON

RA = 14h48m25.s1
DEC =-16°32'22."5
SD = 16'32."0
HP = 1° 0'40."8

SAROS 131 (33/72)

JD = 2453130.355

ΔT = 68.2 S



TOTAL LUNAR ECLIPSE - 28 OCT 2004

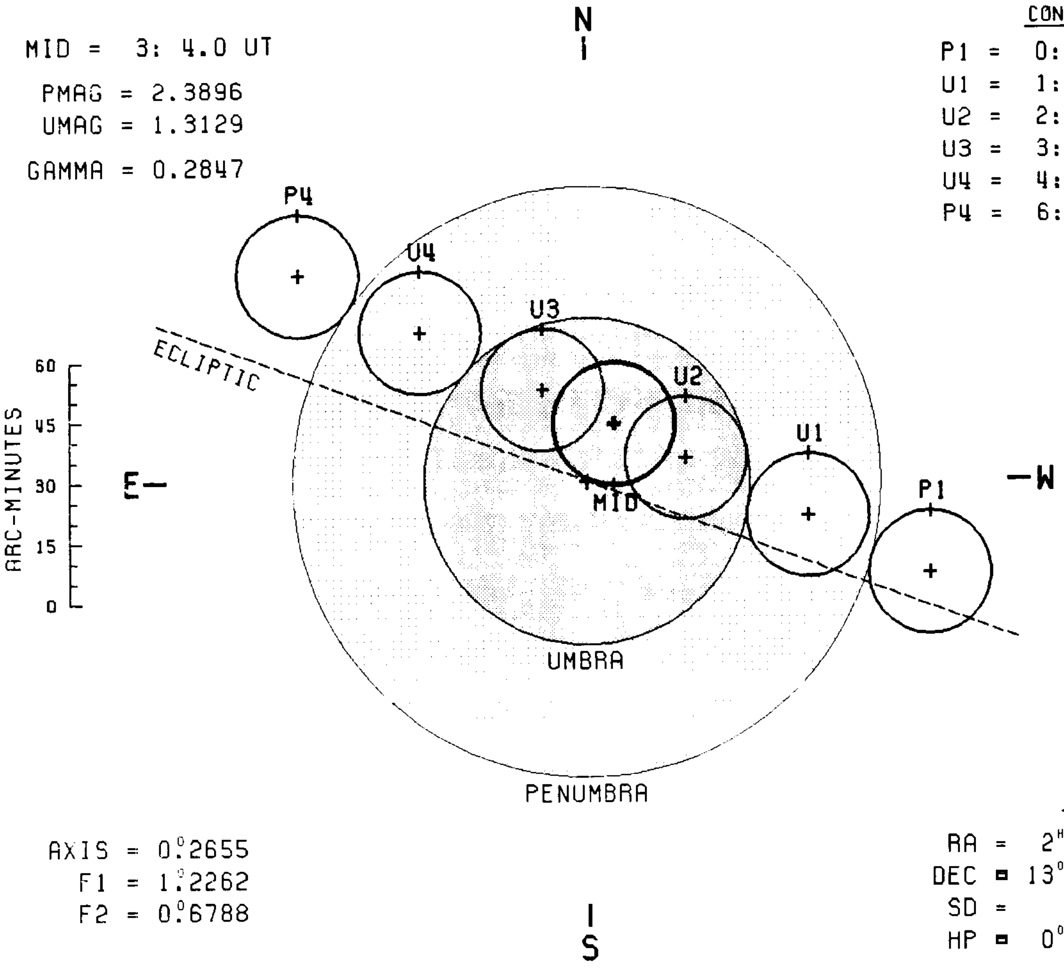
MID = 3: 4.0 UT

PMAG = 2.3896
UMAG = 1.3129

GAMMA = 0.2847

CONTACTS

P1 = 0: 5.3 UT
U1 = 1:14.1 UT
U2 = 2:23.2 UT
U3 = 3:44.5 UT
U4 = 4:53.7 UT
P4 = 6: 2.7 UT



AXIS = 0°.2655
F1 = 1°.2262
F2 = 0°.6788

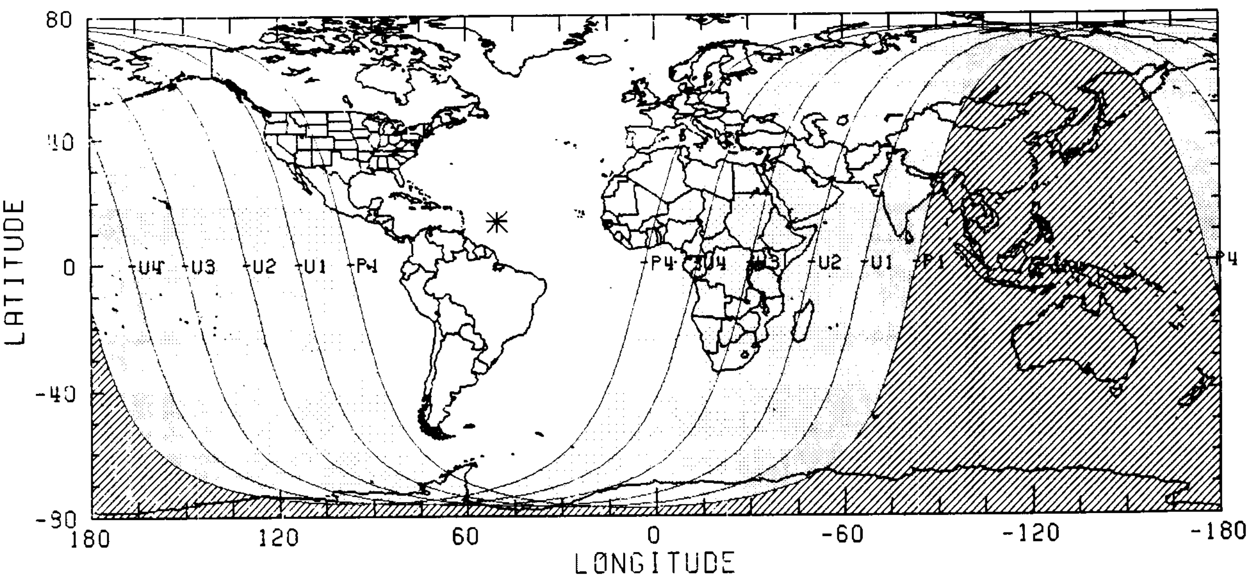
MOON

RA = 2ʰ 10ᵐ 32ˢ.6
DEC = 13° 26' 29".3
SD = 15' 15".1
HP = 0° 55' 58".4

SAROS 136 (19/72)

JD = 2453306.629

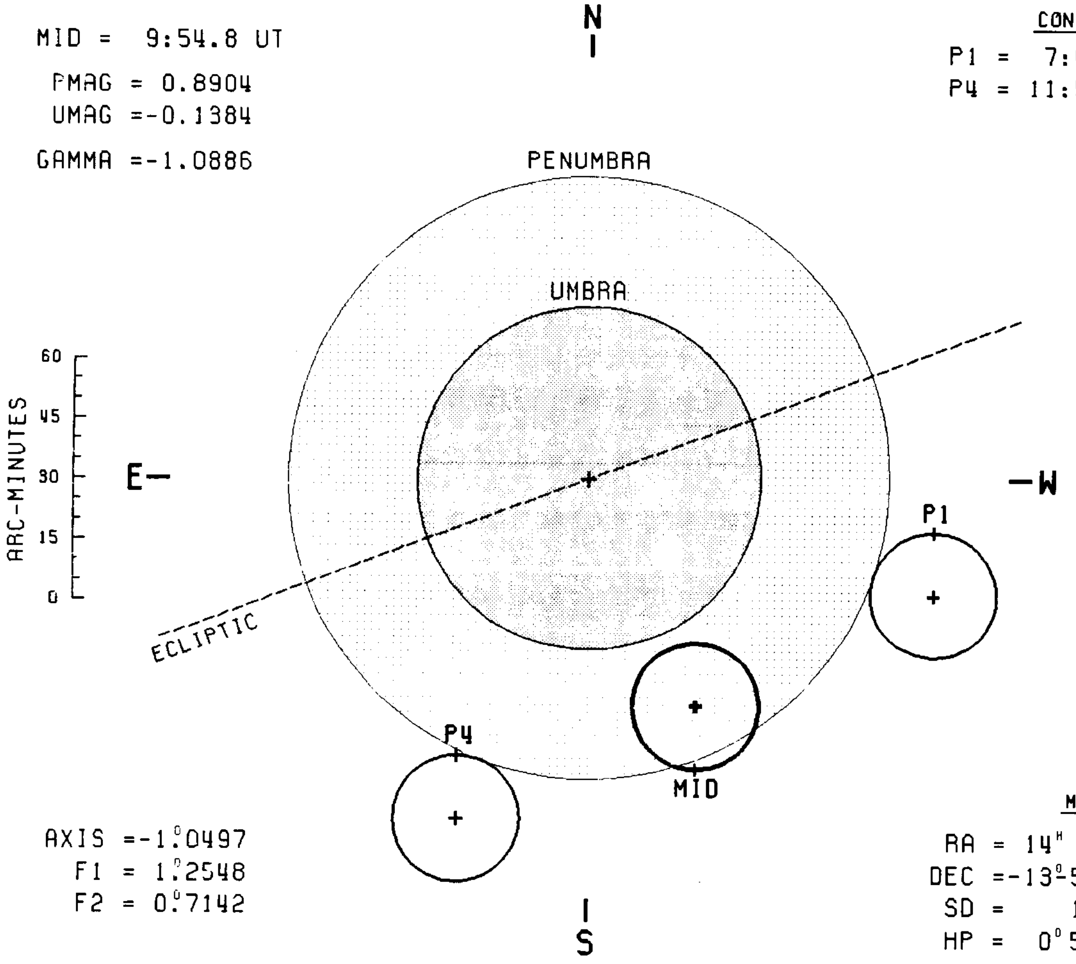
ΔT = 68.6 S



PENUMBRAL LUNAR ECLIPSE - 24 APR 2005

MID = 9:54.8 UT
PMAG = 0.8904
UMAG =-0.1384
GAMMA =-1.0886

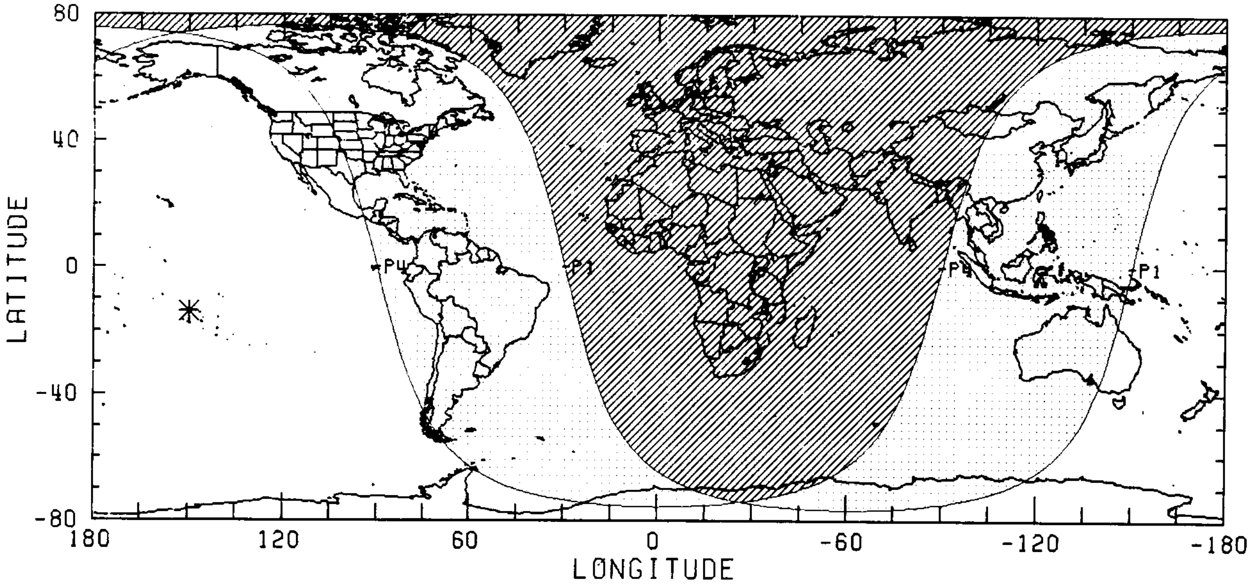
CONTACTS
P1 = 7:49.6 UT
P4 = 11:59.6 UT



AXIS =-1.°0497
F1 = 1.°2548
F2 = 0.°7142

MOON
RA = 14ʰ 6ᵐ 23.ˢ1
DEC =-13°54'32."9
SD = 15'46."0
HP = 0°57'51."8

SAROS 141 (23/73) JD = 2453484.914 ΔT = 69.0 S



PARTIAL LUNAR ECLIPSE - 17 OCT 2005

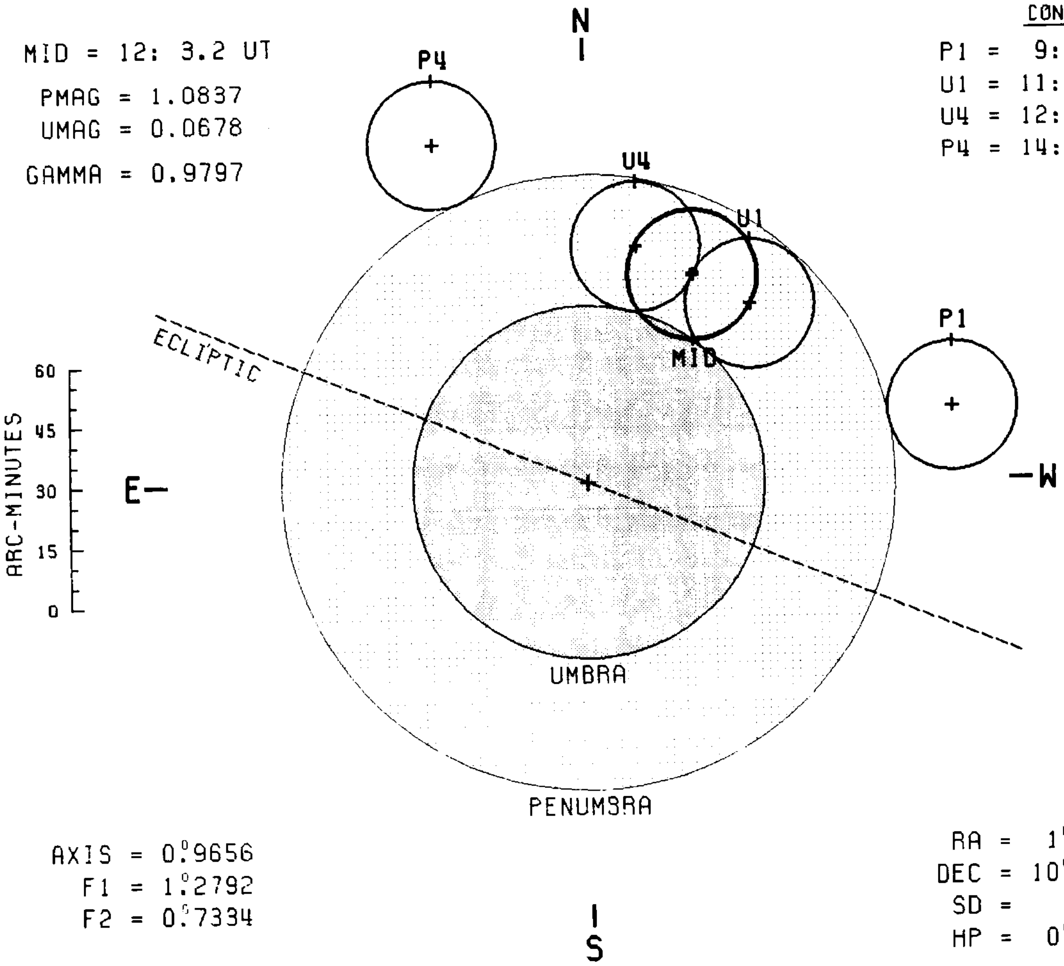
MID = 12: 3.2 UT

PMAG = 1.0837
UMAG = 0.0678

GAMMA = 0.9797

<u>CONTACTS</u>

P1 = 9:51.2 UT
U1 = 11:34.0 UT
U4 = 12:31.7 UT
P4 = 14:14.9 UT

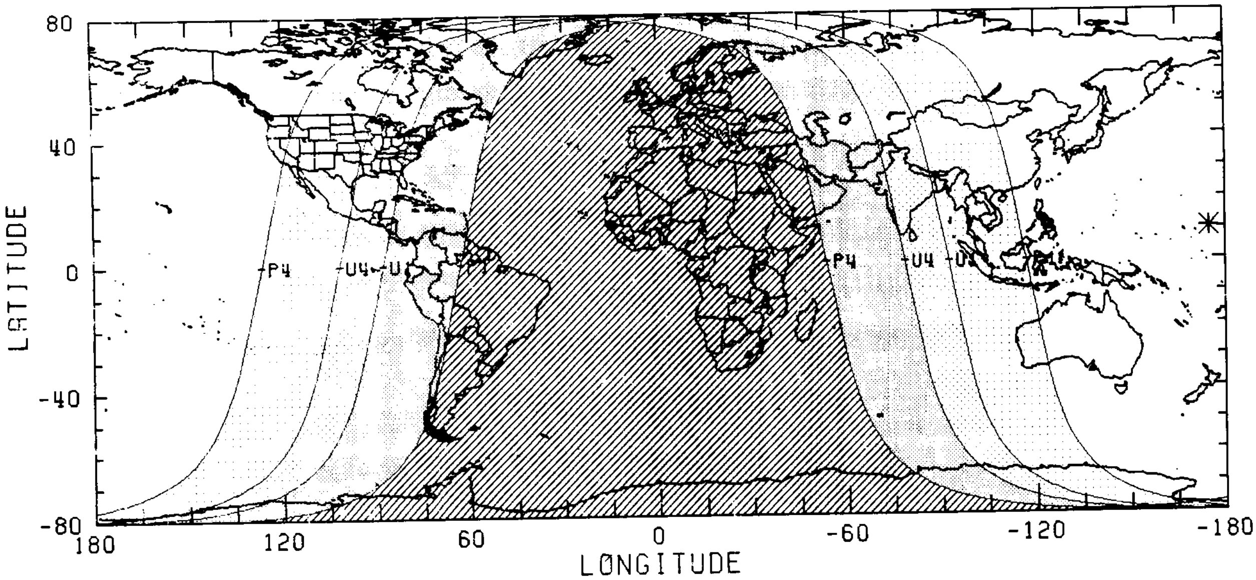


AXIS = 0°.9656
F1 = 1°.2792
F2 = 0°.7334

<u>MOON</u>

RA = 1h 27m 54s.1
DEC = 10° 15' 0".9
SD = 16' 6".9
HP = 0° 59' 8".7

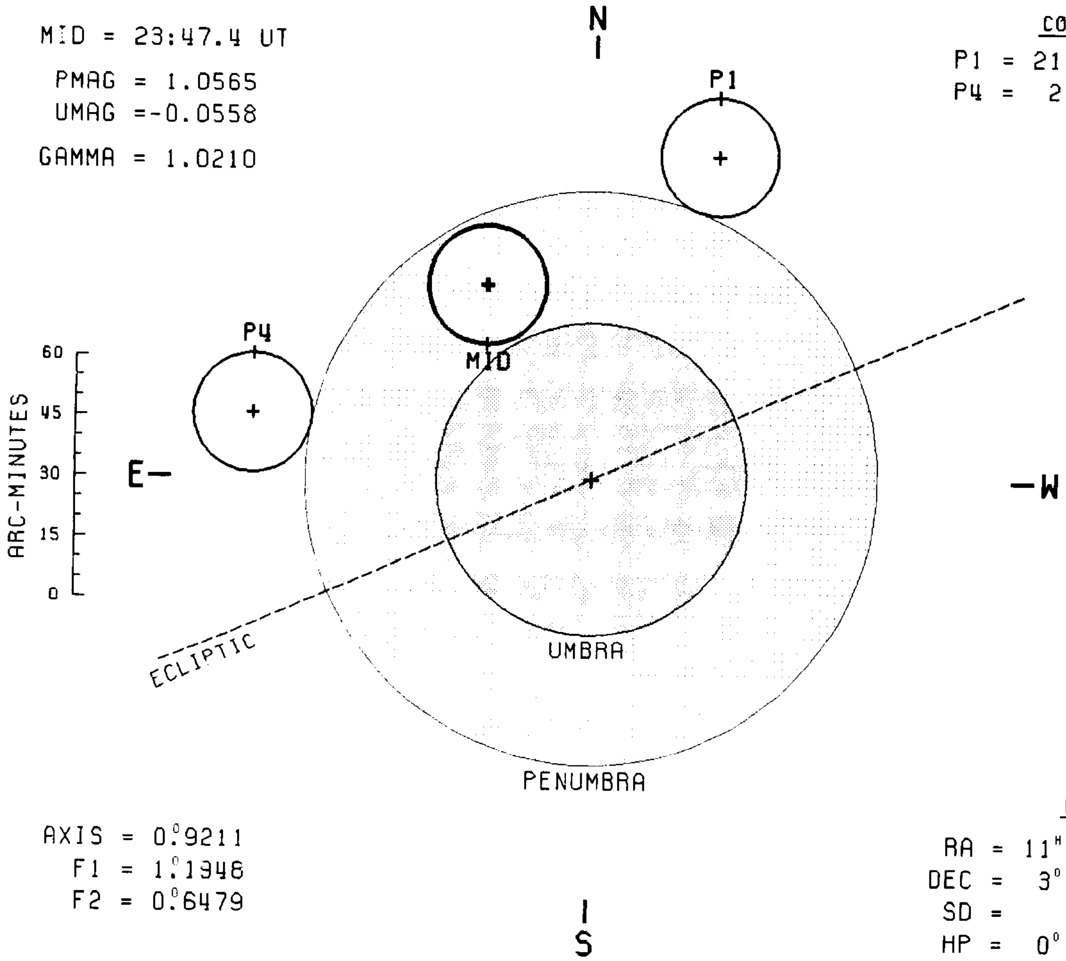
SAROS 146 (10/72) JD = 2453661.003 ΔT = 69.4 S



PENUMBRAL LUNAR ECLIPSE - 14 MAR 2006

MID = 23:47.4 UT
PMAG = 1.0565
UMAG =-0.0558
GAMMA = 1.0210

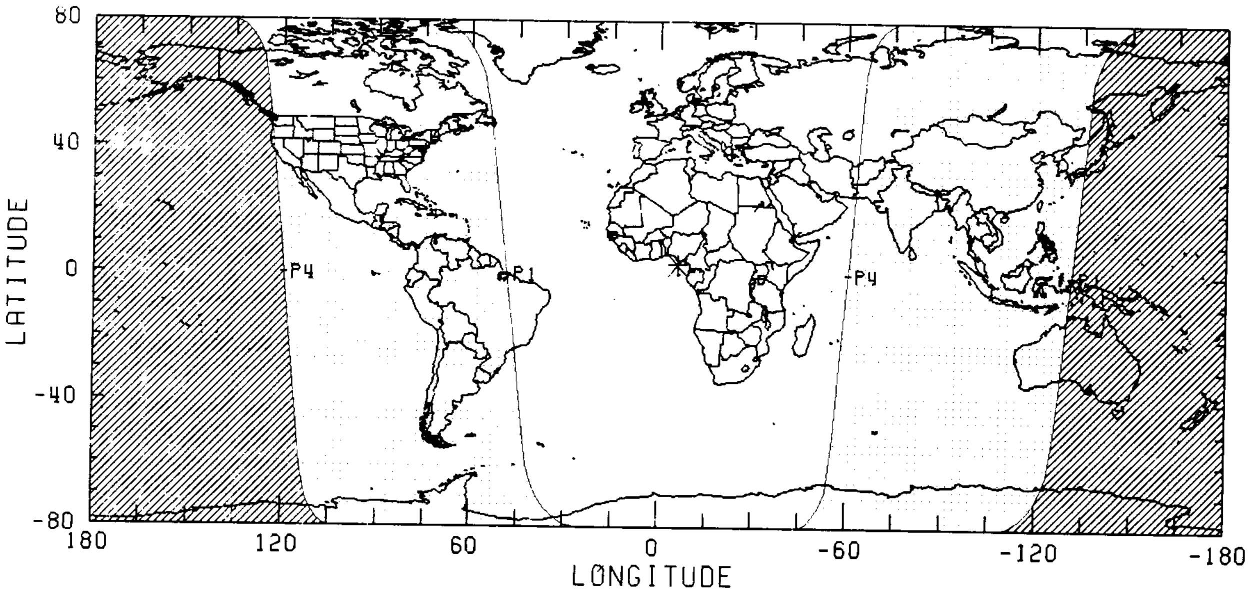
CONTACTS
P1 = 21:21.6 UT
P4 = 2:13.7 UT



AXIS = $0^{\circ}.9211$
F1 = $1^{\circ}.1346$
F2 = $0^{\circ}.6479$

MOON
RA = $11^{h}40^{m}41^{s}.3$
DEC = $3^{\circ}\ 5'\ 18''.0$
SD = $14'\ 45''.1$
HP = $0^{\circ}54'\ 8''.3$

SAROS 113 (63/71) JD = 2453809.492 ΔT = 69.7 S



PARTIAL LUNAR ECLIPSE - 7 SEP 2006

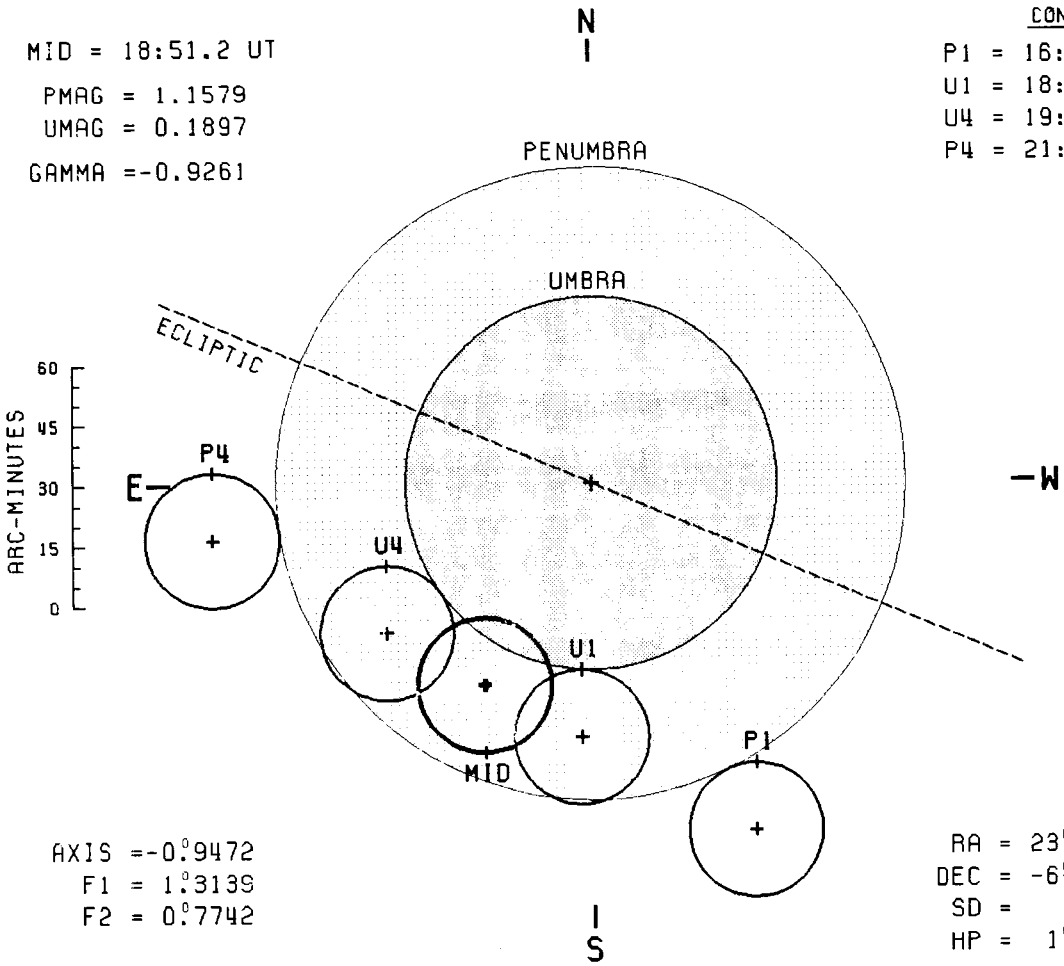
MID = 18:51.2 UT

PMAG = 1.1579
UMAG = 0.1897

GAMMA =-0.9261

CONTACTS

P1 = 16:42.4 UT
U1 = 18: 5.3 UT
U4 = 19:37.7 UT
P4 = 21: 0.4 UT



AXIS =-0°.9472
F1 = 1°.3139
F2 = 0°.7742

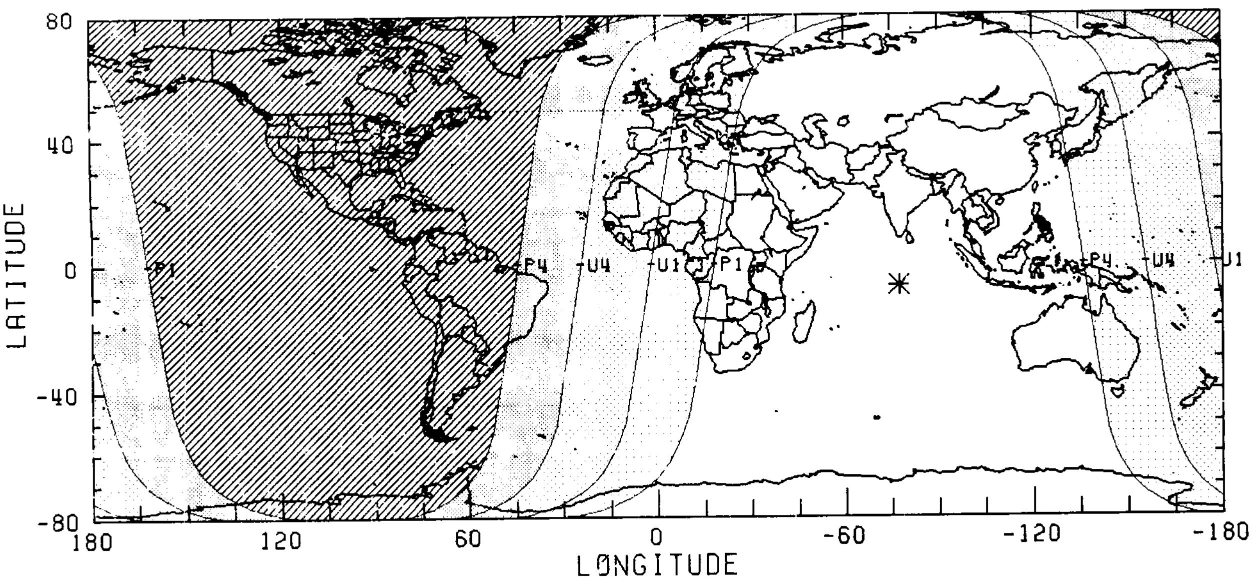
MOON

RA = 23ʰ 6ᵐ 35ˢ.5
DEC = -6° 44' 25".7
SD = 16' 43".3
HP = 1° 1' 22".3

SAROS 118 (52/75)

JD = 2453986.286

ΔT = 70.1 S



TOTAL LUNAR ECLIPSE - 3 MAR 2007

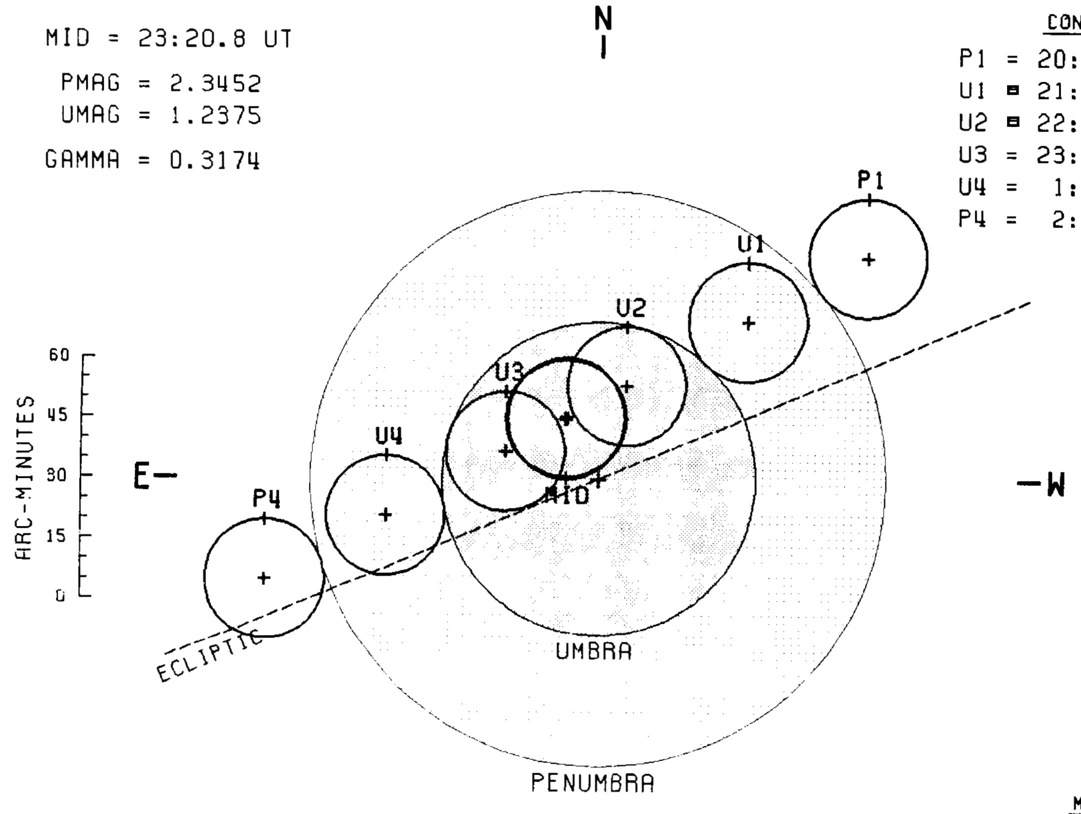
MID = 23:20.8 UT

PMAG = 2.3452
UMAG = 1.2375

GAMMA = 0.3174

CONTACTS

P1	=	20:16.3 UT
U1	=	21:29.9 UT
U2	=	22:43.9 UT
U3	=	23:58.1 UT
U4	=	1:11.8 UT
P4	=	2:25.5 UT

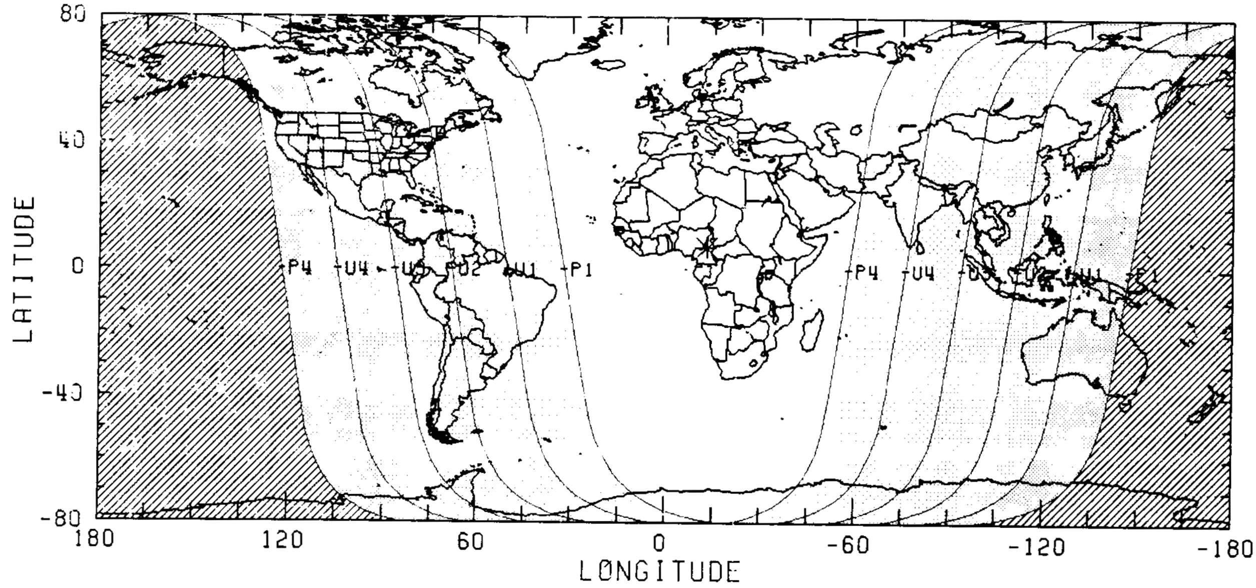


AXIS = 0°.2883
F1 = 1°.2020
F2 = 0°.6535

MOON

RA	=	10^{h}57^{m}52^{s}.2
DEC	=	6°56' 0".7
SD	=	14'51".3
HP	=	0°54'31".1

SAROS 123 (52/73) JD = 2454163.474 ΔT = 70.5 S



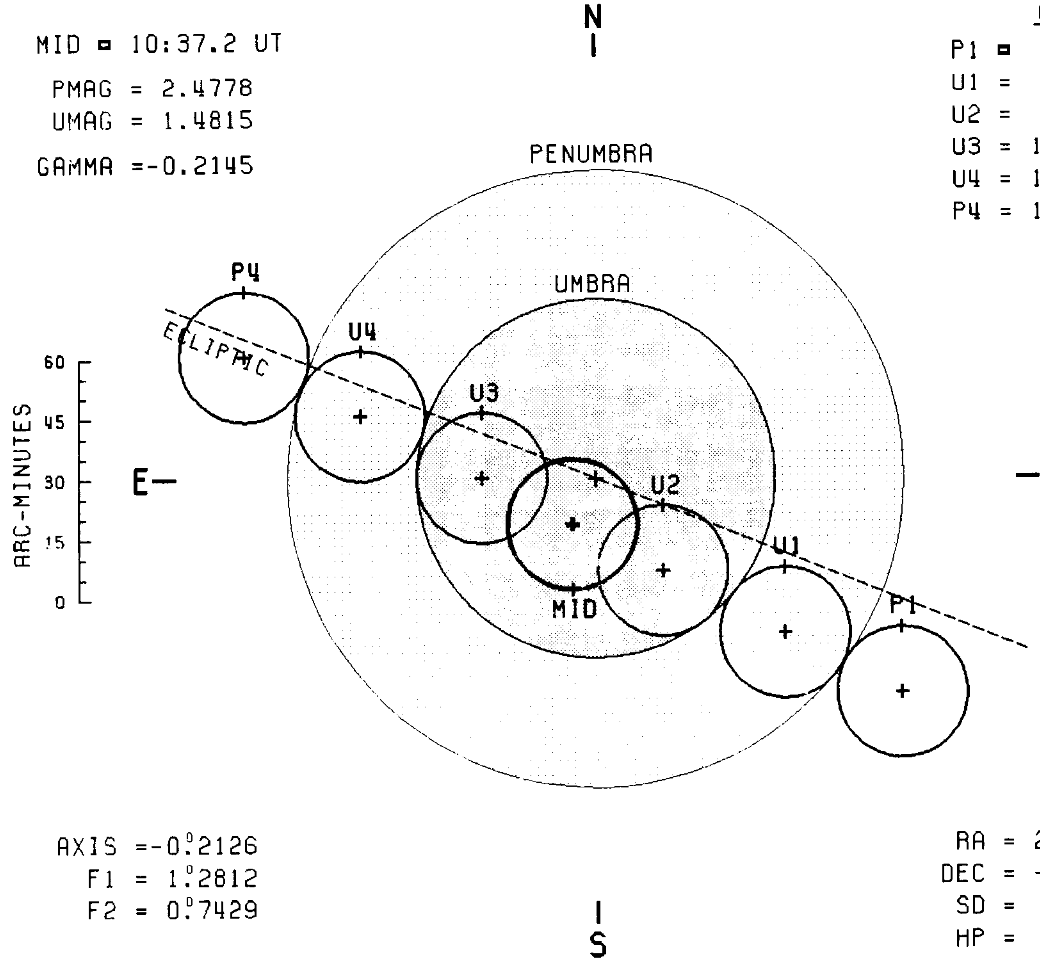
TOTAL LUNAR ECLIPSE - 28 AUG 2007

MID = 10:37.2 UT

PMAG = 2.4778
UMAG = 1.4815

GAMMA =-0.2145

CONTACTS		
P1	=	7:52.0 UT
U1	=	8:50.8 UT
U2	=	9:51.9 UT
U3	=	11:22.8 UT
U4	=	12:23.9 UT
P4	=	13:22.5 UT

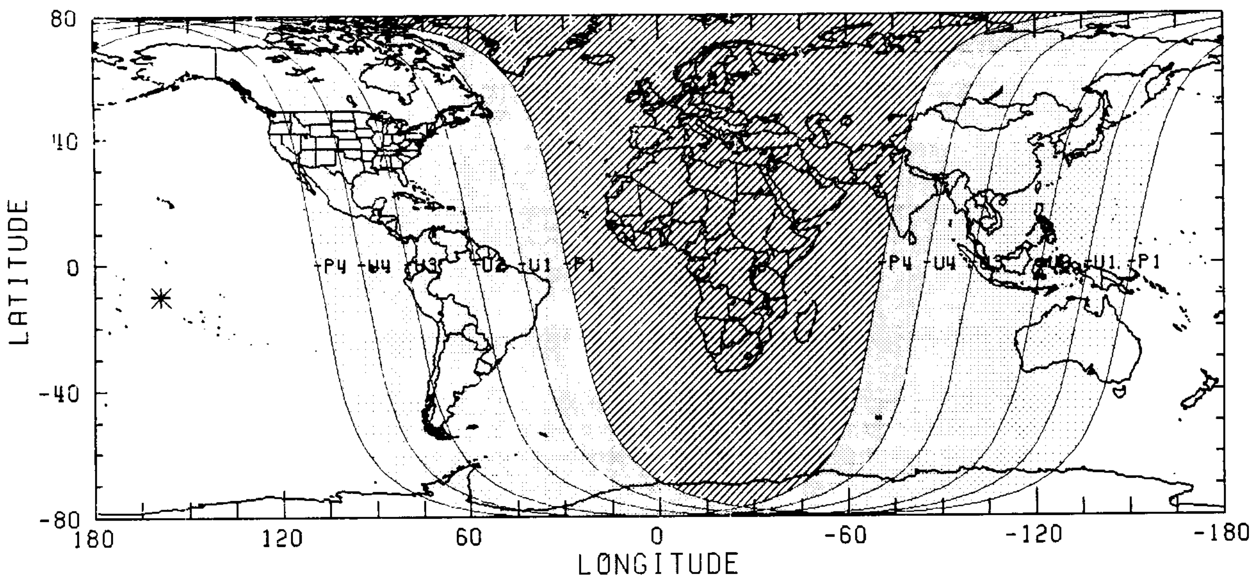


AXIS =-0°.2126
F1 = 1°.2812
F2 = 0°.7429

MOON

RA = 22ʰ 26ᵐ 50ˢ.4
DEC = -9° 57′ 18″.5
SD = 16′ 12″.5
HP = 0° 59′ 29″.2

SAROS 128 (40/71) JD = 2454340.943 ΔT = 70.9 S



TOTAL LUNAR ECLIPSE - 21 FEB 2008

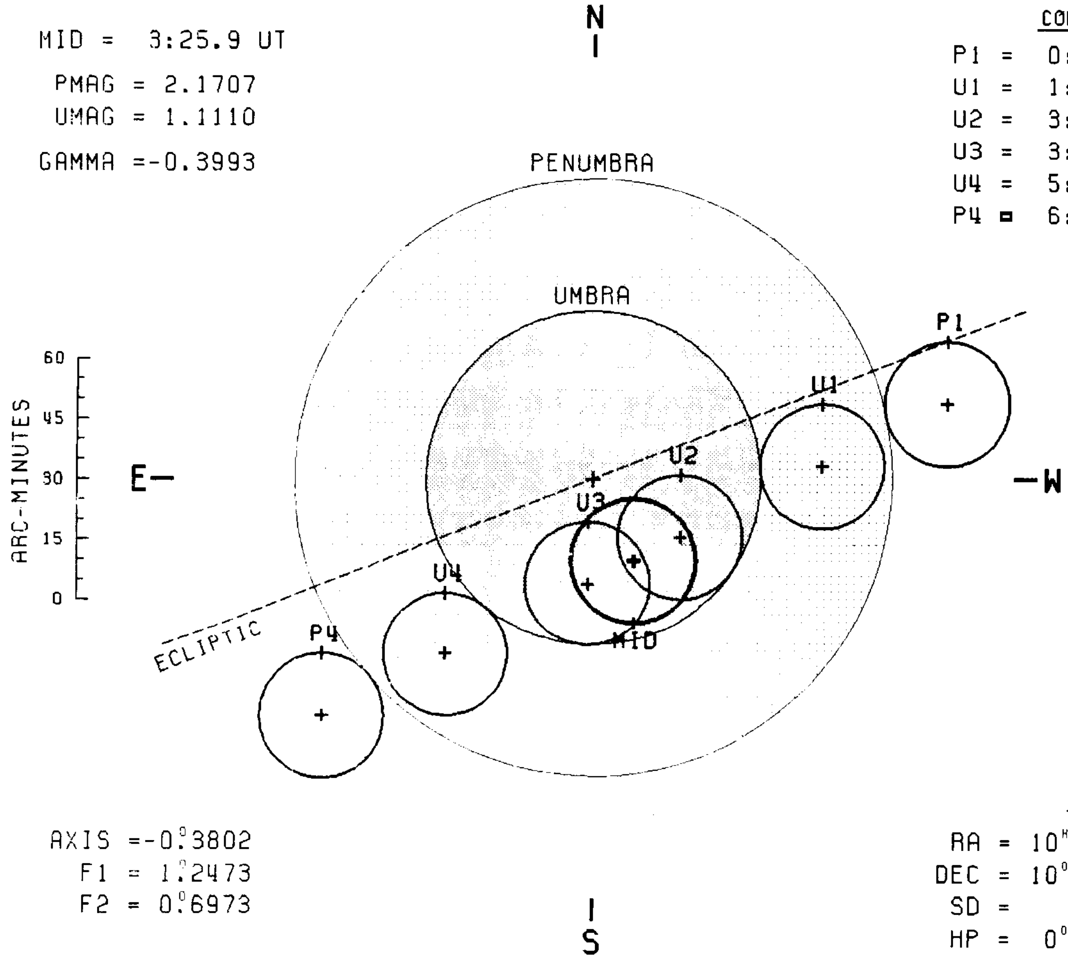
MID = 3:25.9 UT

PMAG = 2.1707
UMAG = 1.1110

GAMMA =-0.3993

CONTACTS

P1	=	0:34.7 UT
U1	=	1:42.6 UT
U2	=	3: 0.3 UT
U3	=	3:51.0 UT
U4	=	5: 8.9 UT
P4	=	6:17.2 UT

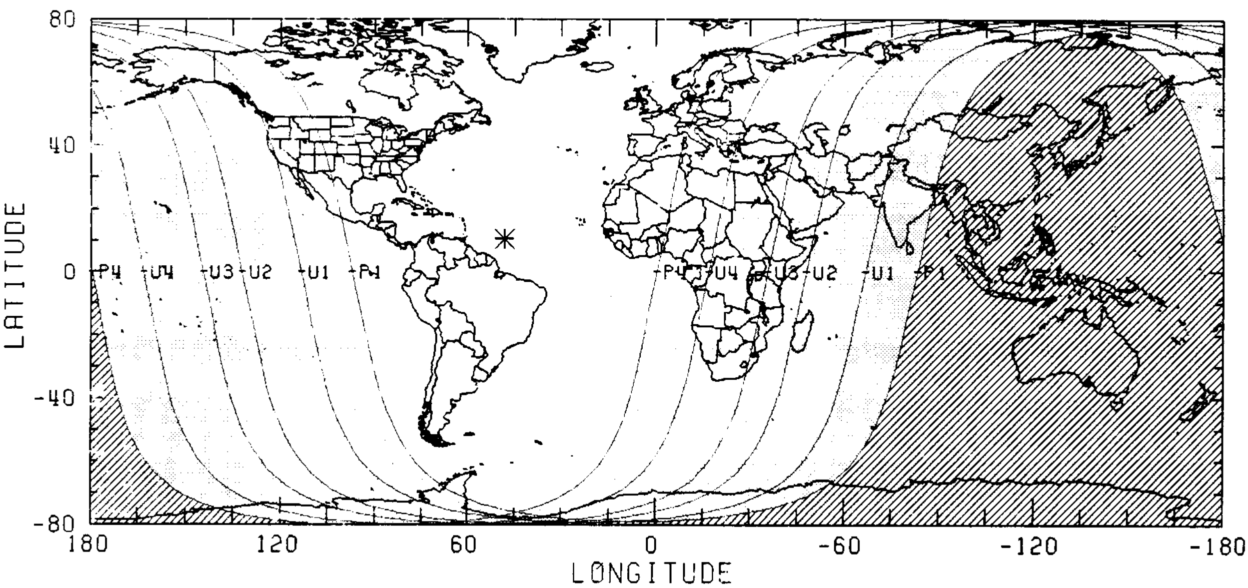


AXIS =-0°.3802
F1 = 1°.2473
F2 = 0°.6973

MOON

RA	=	10ʰ 14ᵐ 48ˢ.4
DEC	=	10° 28' 7".7
SD	=	15' 34".2
HP	=	0° 57' 8".5

SAROS 133 (26/71) JD = 2454517.644 ΔT = 71.3 S



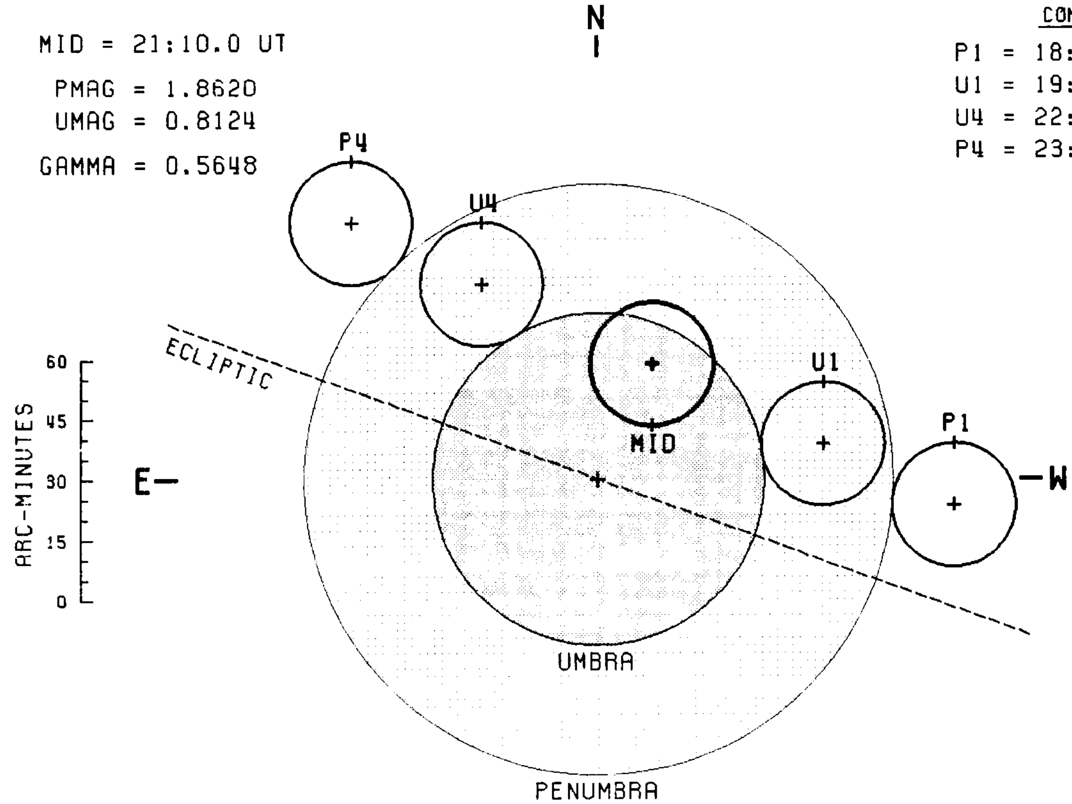
PARTIAL LUNAR ECLIPSE - 16 AUG 2008

MID = 21:10.0 UT

PMAG = 1.8620
UMAG = 0.8124
GAMMA = 0.5648

CONTACTS

P1 = 18:22.8 UT
U1 = 19:35.4 UT
U4 = 22:44.4 UT
P4 = 23:57.0 UT

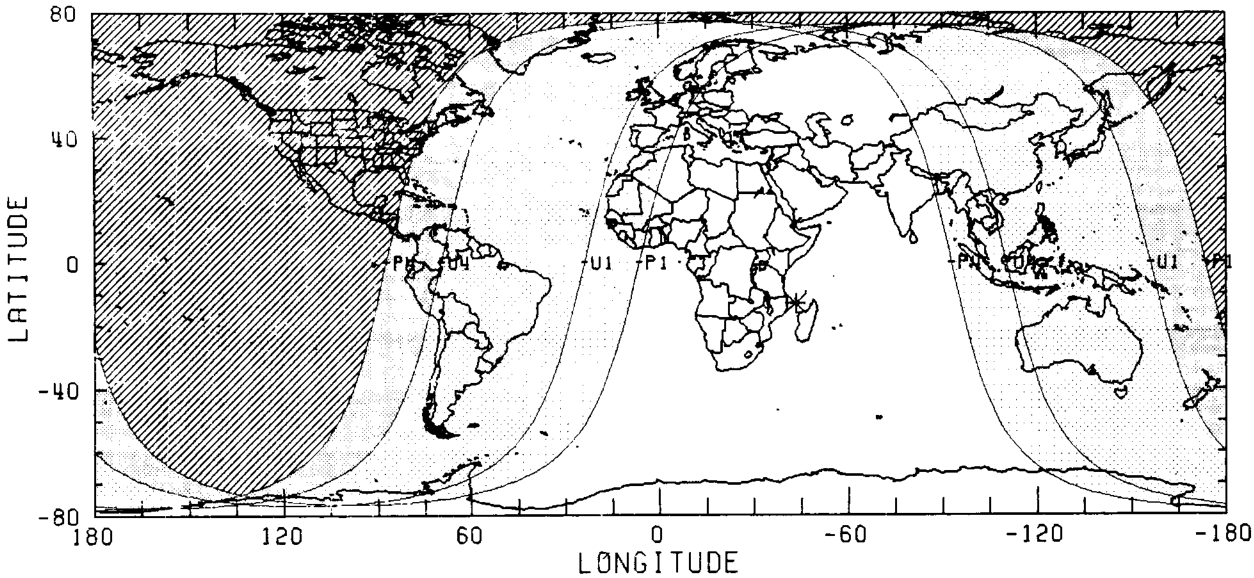


AXIS = 0.5303°
F1 = 1.2273°
F2 = 0.6901°

MOON

RA = 21h45m41.8s
DEC = −12°55'29.0"
SD = 15'21.1"
HP = 0°56'20.6"

SAROS 138 (29/83) JD = 2454695.383 ΔT = 71.8 S



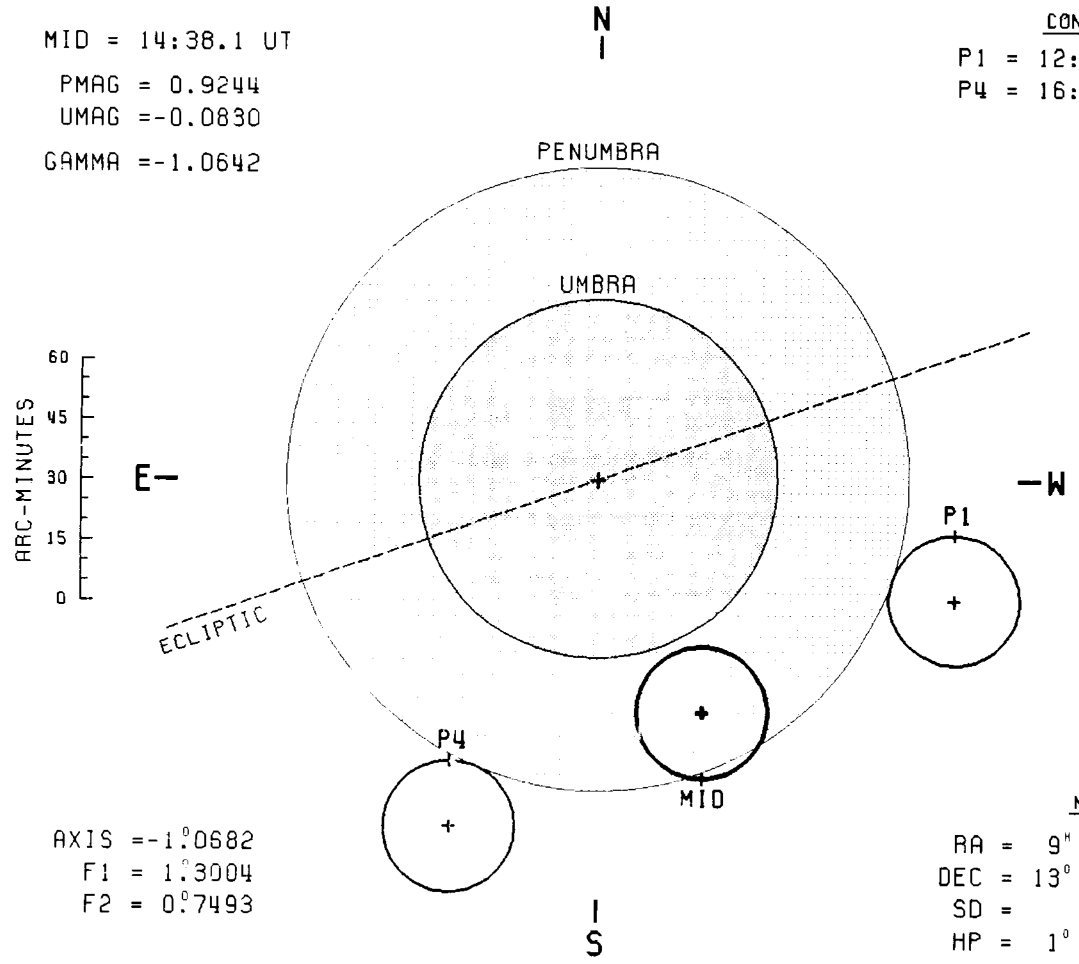
PENUMBRAL LUNAR ECLIPSE - 9 FEB 2009

MID = 14:38.1 UT

PMAG = 0.9244
UMAG =-0.0830

GAMMA =-1.0642

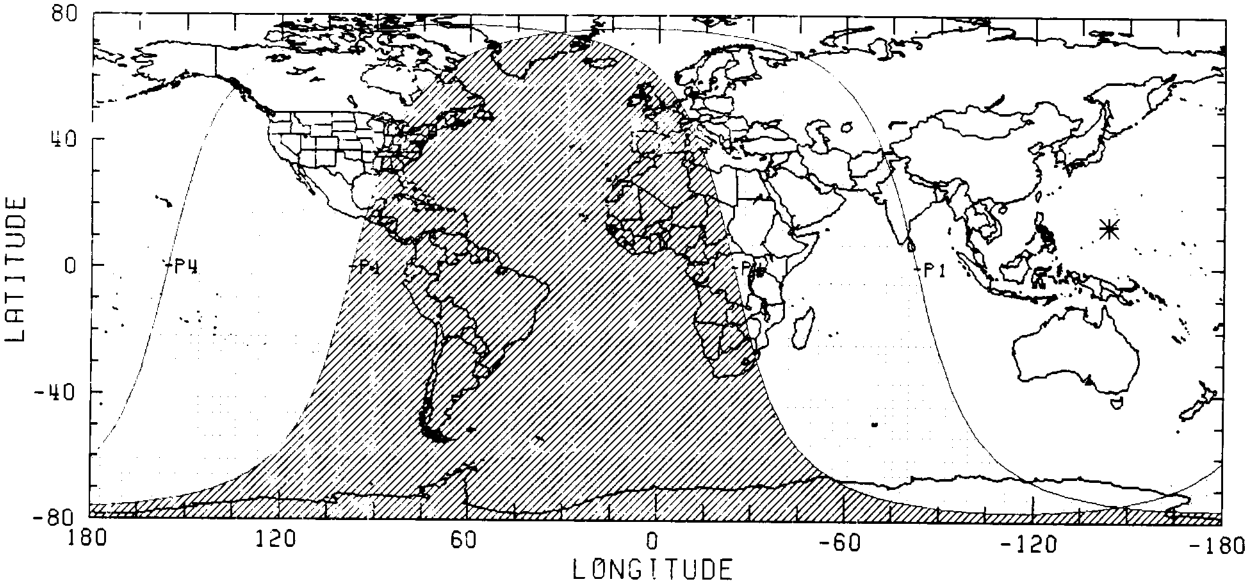
CONTACTS
P1 = 12:36.5 UT
P4 = 16:39.4 UT



AXIS =$-1.^\circ0682$
F1 = $1.^\circ3004$
F2 = $0.^\circ7493$

MOON
RA = $9^h 31^m 42.^s0$
DEC = $13^\circ 31' 37.''4$
SD = $16' 24.''8$
HP = $1^\circ 0' 14.''2$

SAROS 143 (18/73) JD = 2454872.111 ΔT = 72.2 S



PENUMBRAL LUNAR ECLIPSE - 7 JUL 2009

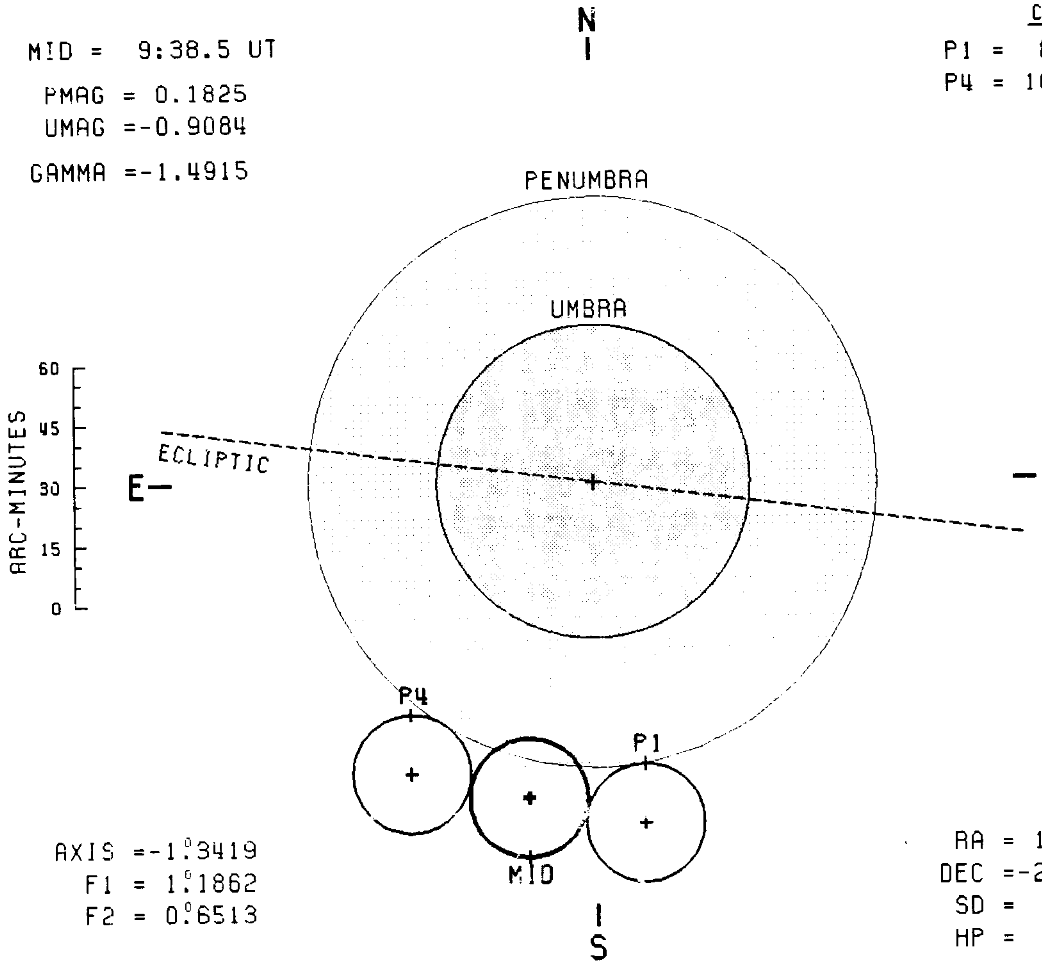
MID = 9:38.5 UT

PMAG = 0.1825
UMAG =-0.9084

GAMMA =-1.4915

CONTACTS

P1 = 8:33.1 UT
P4 = 10:44.2 UT



AXIS =-1°.3419
F1 = 1°.1862
F2 = 0°.6513

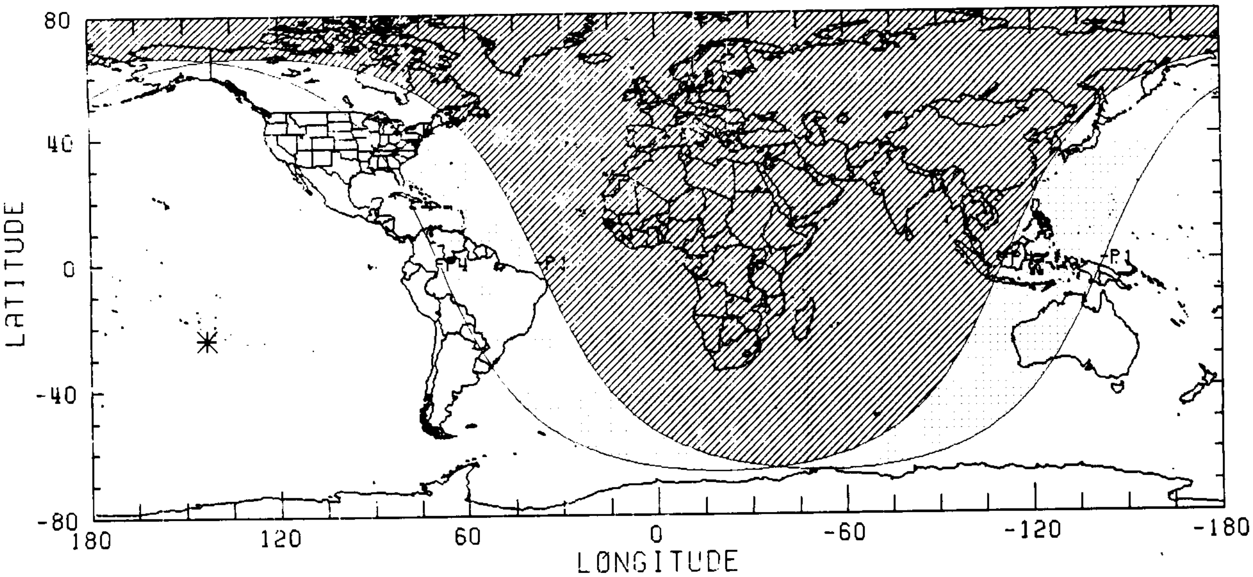
MOON

RA = 19h 8m 8s.0
DEC =-23°51'37".7
SD = 14'42".6
HP = 0°53'59".3

SAROS 110 (71/72)

JD = 2455019.903

ΔT = 72.5 S



PENUMBRAL LUNAR ECLIPSE - 6 AUG 2009

MID = 0:39.0 UT

PMAG = 0.4276

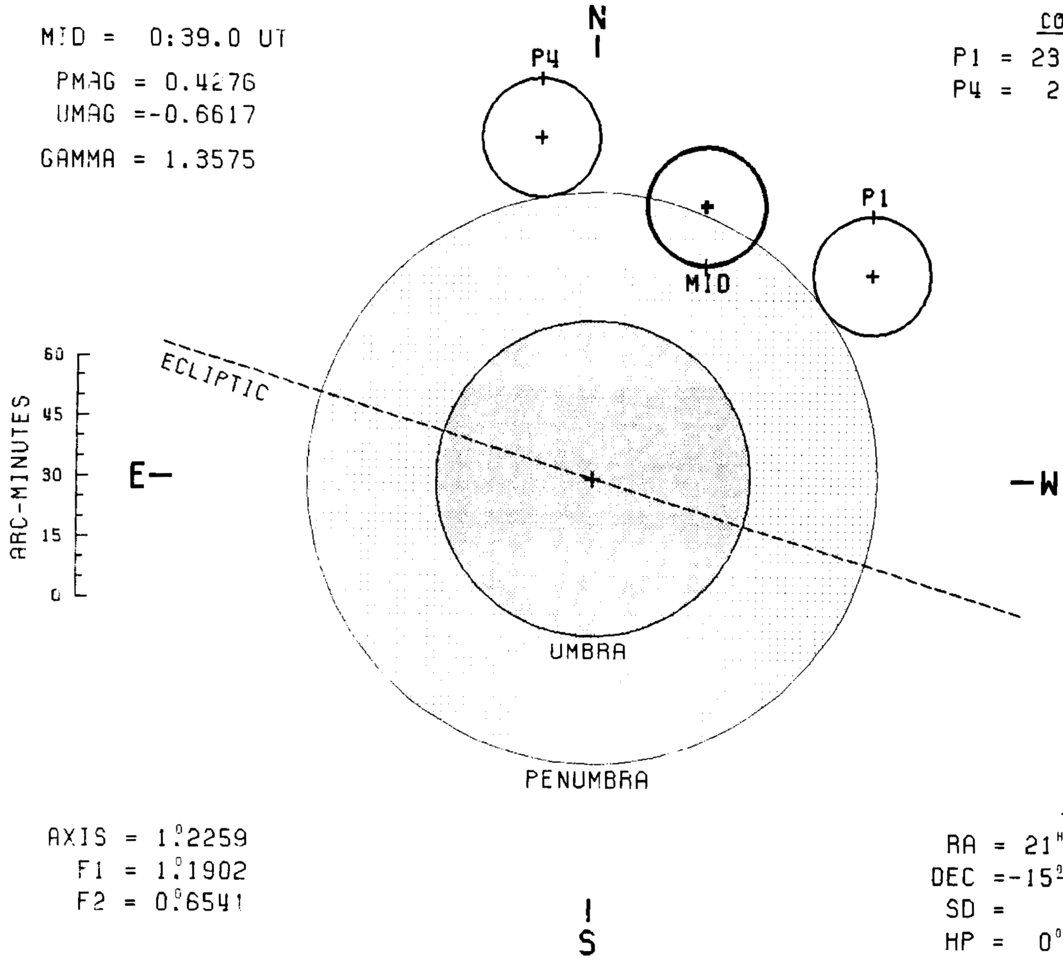
UMAG =-0.6617

GAMMA = 1.3575

CONTACTS

P1 = 23: 0.8 UT

P4 = 2:16.9 UT



AXIS = 1°.2259

F1 = 1°.1902

F2 = 0°.6541

MOON

RA = 21^h 2^{m}46.^{s}2

DEC =-15°34'32."4

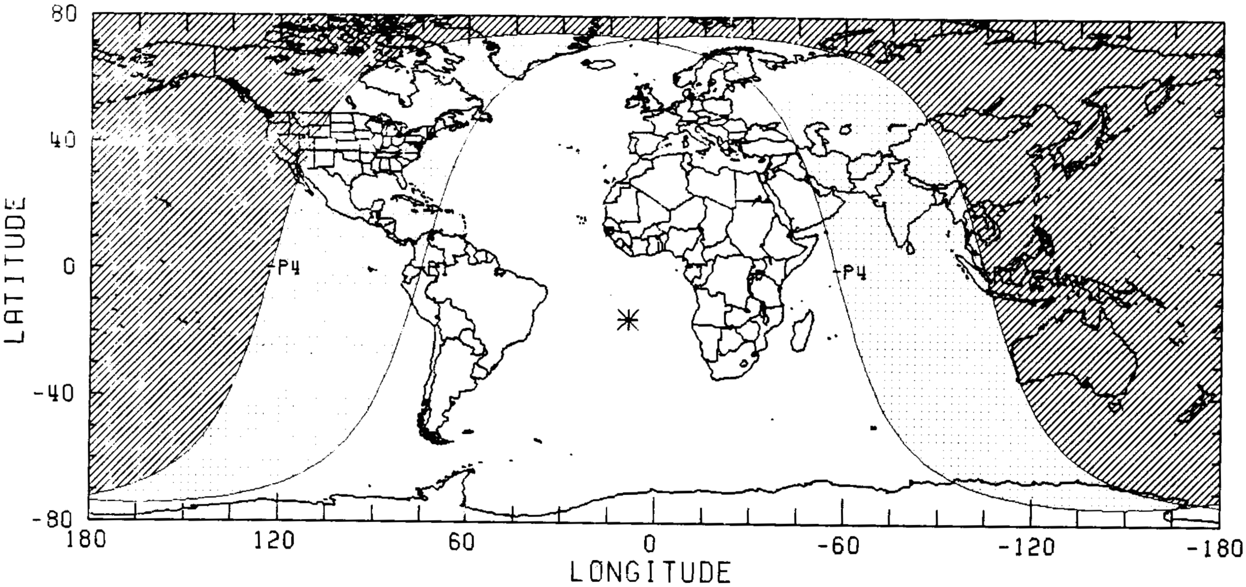
SD = 14'45."9

HP = 0°54'11."4

SAROS 148 (3/71)

JD = 2455049.528

ΔT = 72.6 S



PARTIAL LUNAR ECLIPSE - 31 DEC 2009

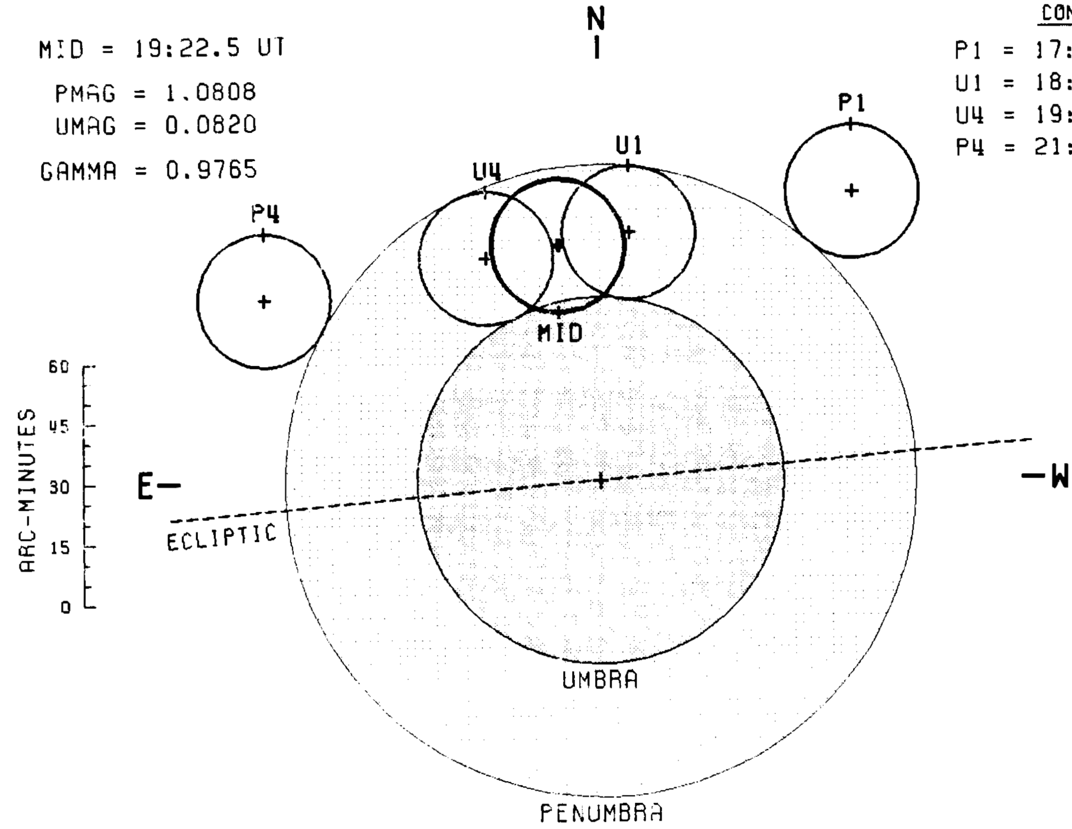
MID = 19:22.5 UT

PMAG = 1.0808
UMAG = 0.0820

GAMMA = 0.9765

CONTACTS

P1 = 17:15.1 UT
U1 = 18:51.9 UT
U4 = 19:53.5 UT
P4 = 21:30.1 UT

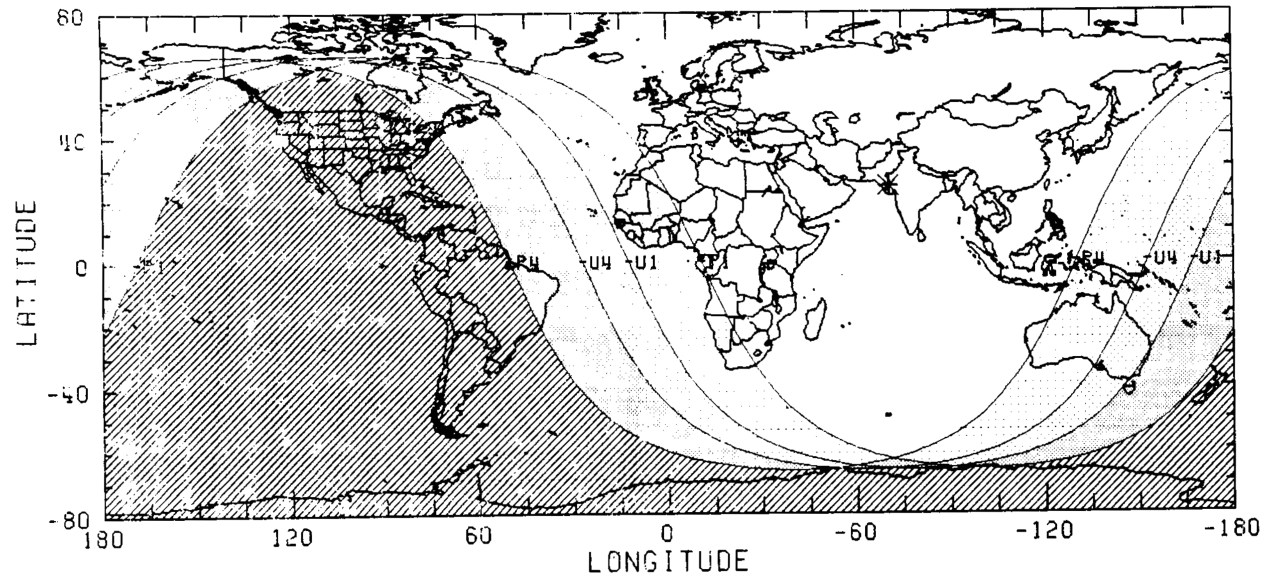


AXIS = 0.°9920
F1 = 1.°3136
F2 = 0.°7606

MOON

RA = 6ʰ45ᵐ22.ˢ3
DEC = 24° 1'10."2
SD = 16'36."6
HP = 1° 0'57."6

SAROS 115 (57/72) JD = 2455197.308 ΔT = 72.9 S



PARTIAL LUNAR ECLIPSE - 26 JUN 2010

MID = 11:38.3 UT

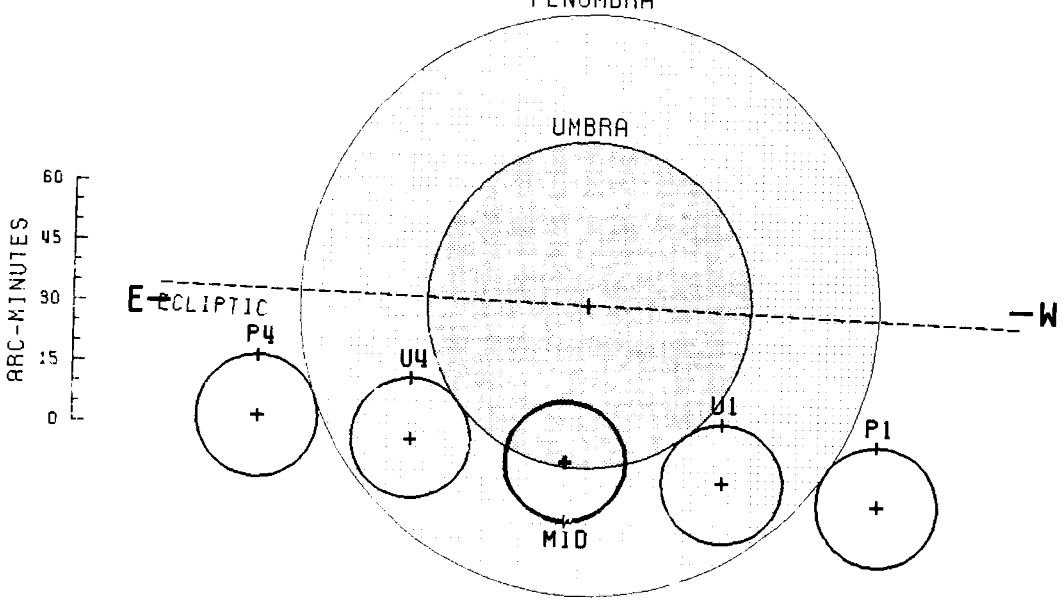
PMAG = 1.6033
UMAG = 0.5420

GAMMA =-0.7090

CONTACTS

P1 = 8:55.3 UT
U1 = 10:16.4 UT
U4 = 13: 0.3 UT
P4 = 14:21.5 UT

N



AXIS =-0.6557
F1 = 1.2118
F2 = 0.6768

S

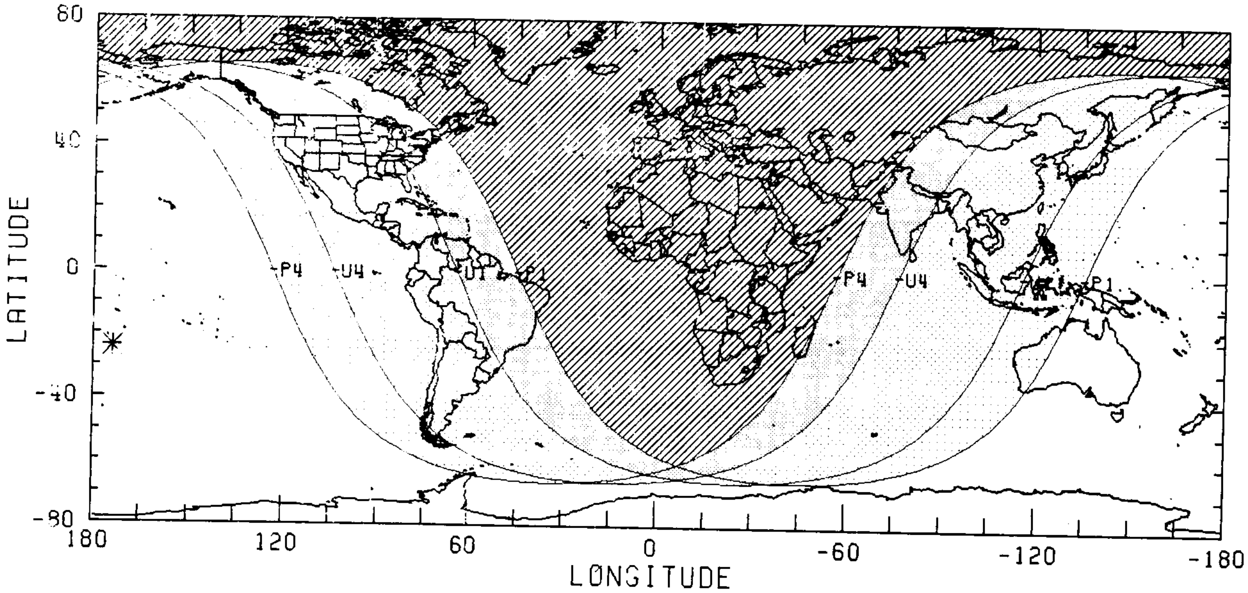
MOON

RA = 18ʰ21ᵐ11.ˢ7
DEC =-24° 0'-6."5
SD = 15' 7."3
HP = 0°55'29."7

SAROS 120 (58/84)

JD = 2455373.986

ΔT = 73.3 S



TOTAL LUNAR ECLIPSE - 21 DEC 2010

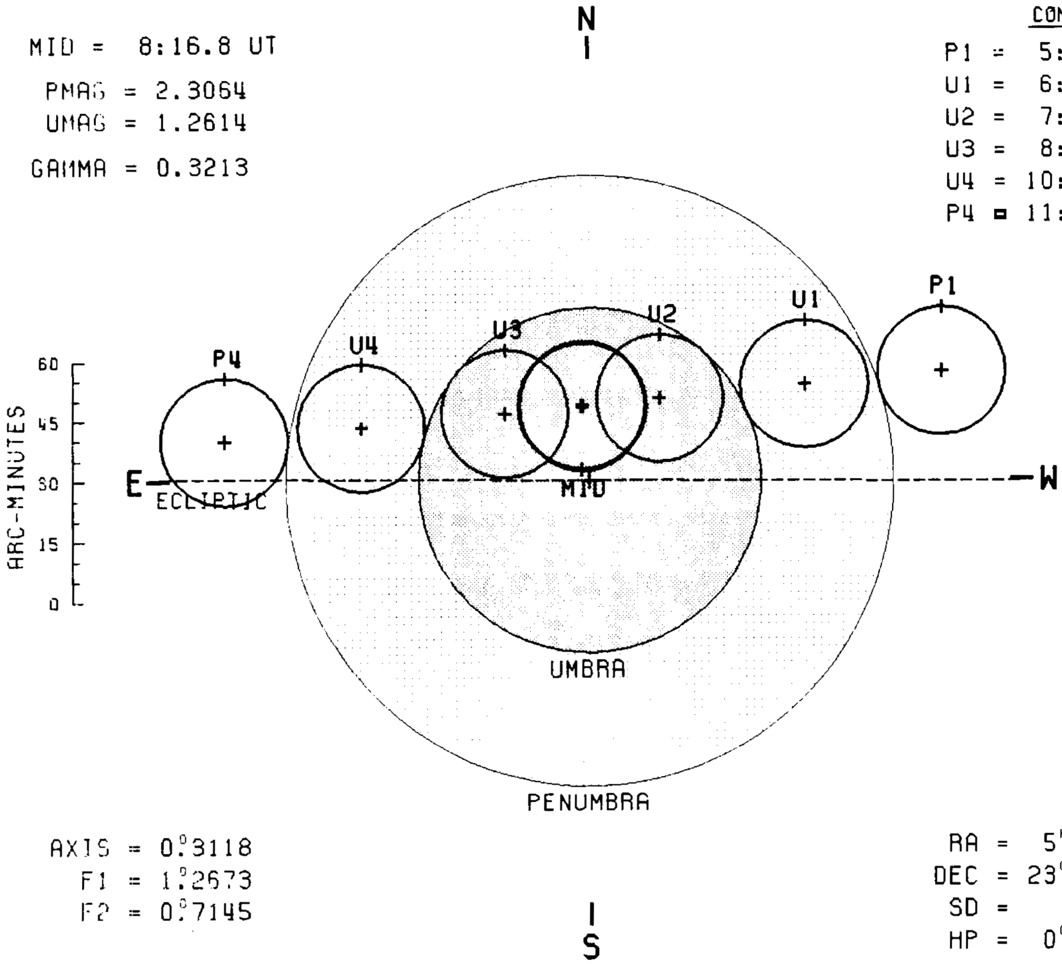
MID = 8:16.8 UT

PMAG = 2.3064
UMAG = 1.2614

GAMMA = 0.3213

CONTACTS

P1 = 5:27.4 UT
U1 = 6:32.0 UT
U2 = 7:40.2 UT
U3 = 8:53.5 UT
U4 = 10: 1.7 UT
P4 = 11: 6.1 UT

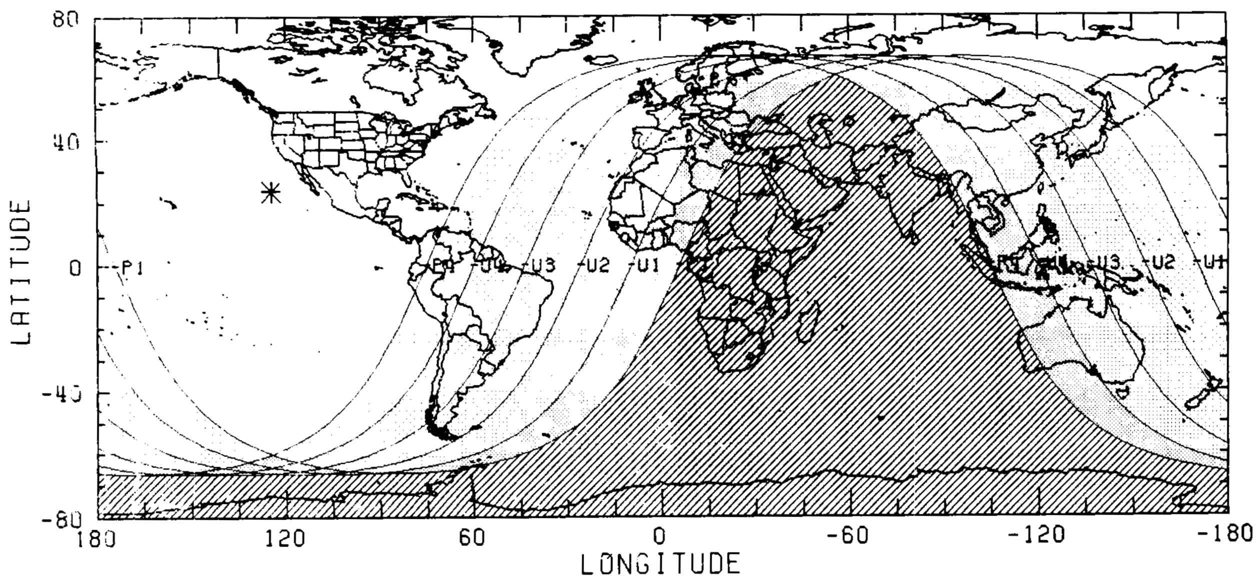


AXIS = 0°.3118
F1 = 1°.2673
F2 = 0°.7145

MOON

RA = 5h 57m 17s.2
DEC = 23° 44' 47".5
SD = 15' 52".1
HP = 0° 58' 14".3

SAROS 125 (48/72) JD = 2455551.846 ΔT = 73.7 S



TOTAL LUNAR ECLIPSE - 15 JUN 2011

N

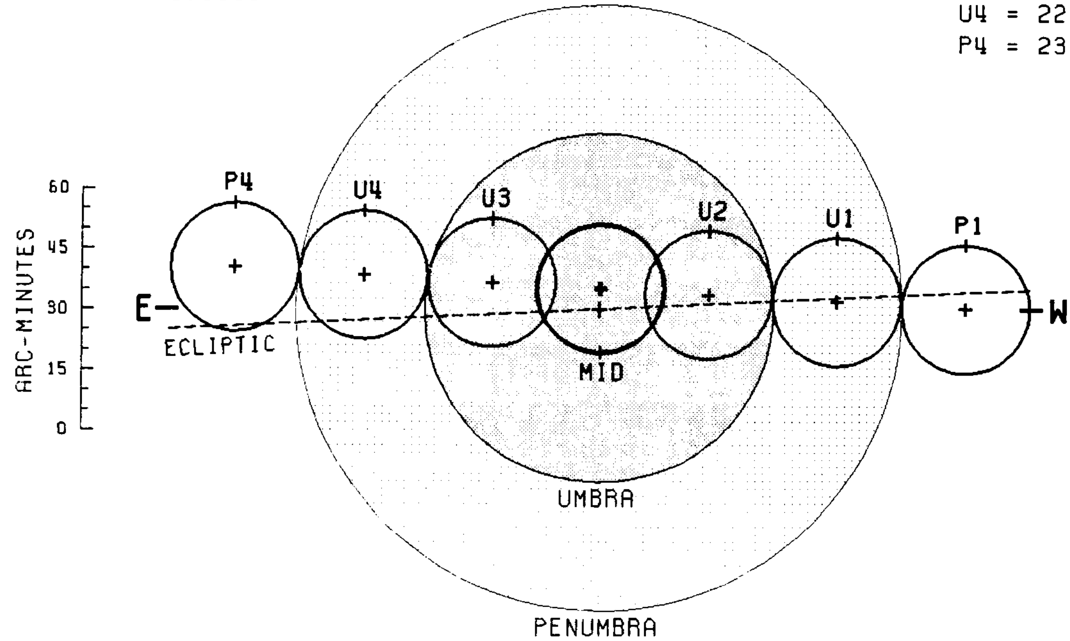
MID = 20:12.5 UT

PMAG = 2.7117
UMAG = 1.7050

GAMMA = 0.0899

CONTACTS

P1 = 17:22.8 UT
U1 = 18:22.3 UT
U2 = 19:21.9 UT
U3 = 21: 3.1 UT
U4 = 22: 2.6 UT
P4 = 23: 2.3 UT



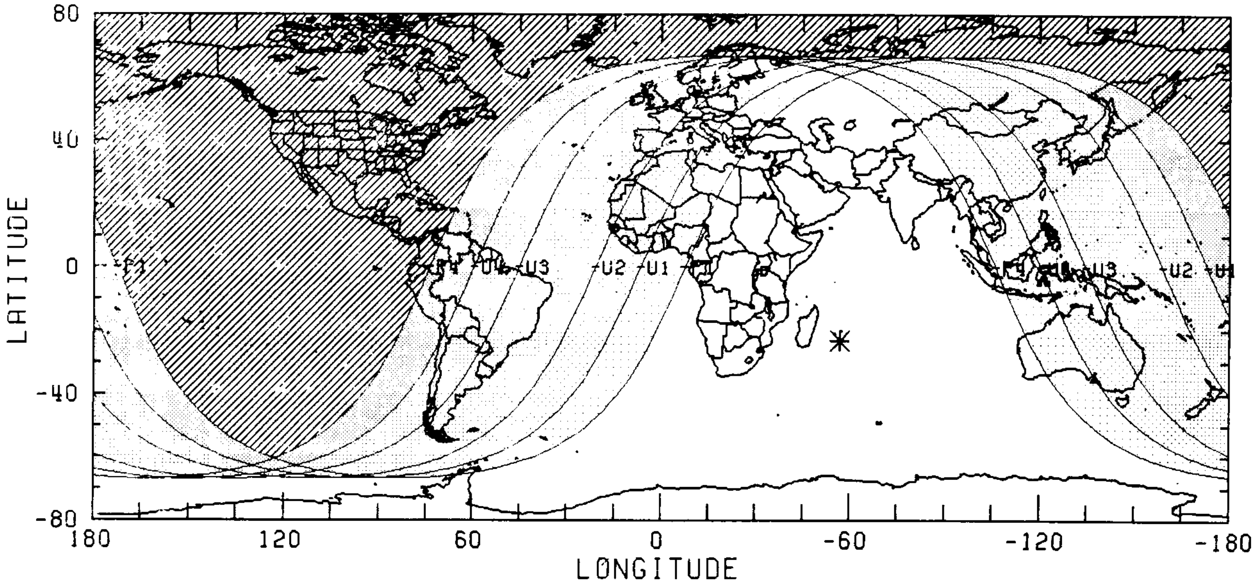
AXIS = 0°.0877
F1 = 1°.2638
F2 = 0°.7285

MOON

RA = 17h 35m 32s.2
DEC = -23° 13' 51".0
SD = 15' 57".2
HP = 0° 58' 33".0

S

SAROS 130 (34/72)   JD = 2455728.343   ΔT = 74.1 S



TOTAL LUNAR ECLIPSE - 10 DEC 2011

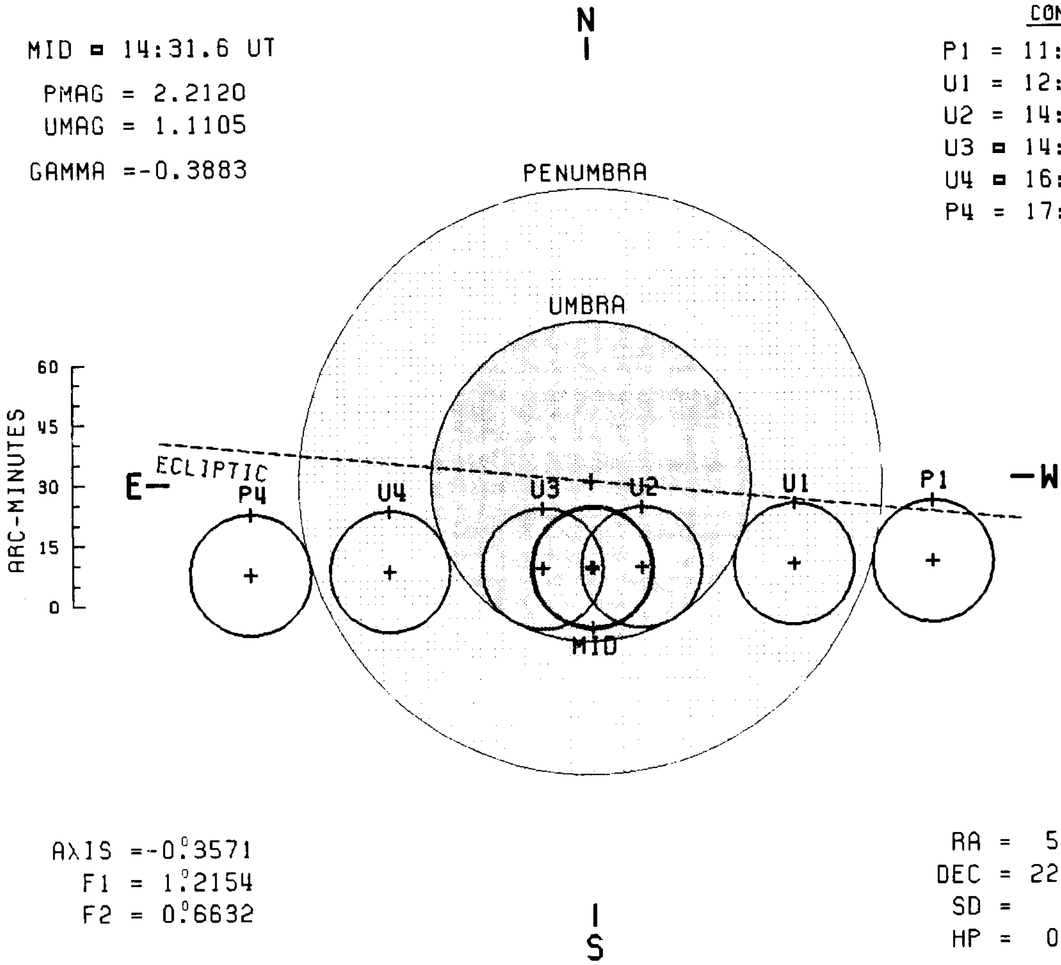
MID = 14:31.6 UT

PMAG = 2.2120
UMAG = 1.1105

GAMMA =-0.3883

CONTACTS

P1 = 11:31.5 UT
U1 = 12:45.1 UT
U2 = 14: 5.6 UT
U3 = 14:57.7 UT
U4 = 16:18.3 UT
P4 = 17:31.7 UT



AXIS =-0.°3571
F1 = 1.°2154
F2 = 0.°6632

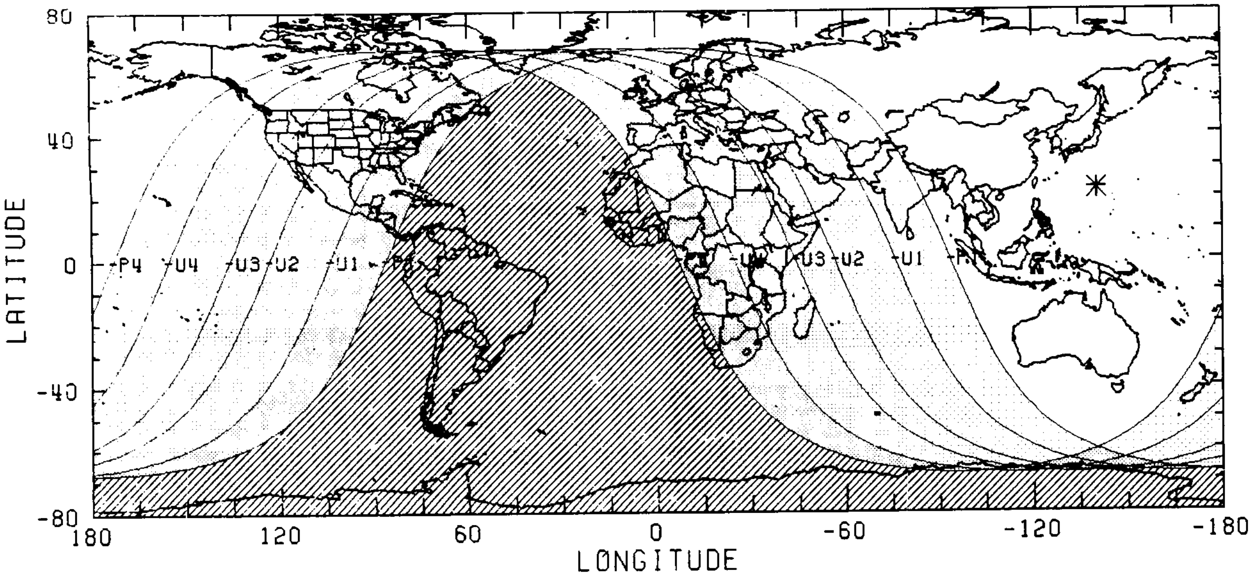
MOON

RA = 5ʰ 8ᵐ 33.ˢ8
DEC = 22° 33' 13.″0
SD = 15' 2.″4
HP = 0° 55' 11.″7

SAROS 135 (23/71)

JD = 2455906.106

ΔT = 74.6 S



PARTIAL LUNAR ECLIPSE - 4 JUN 2012

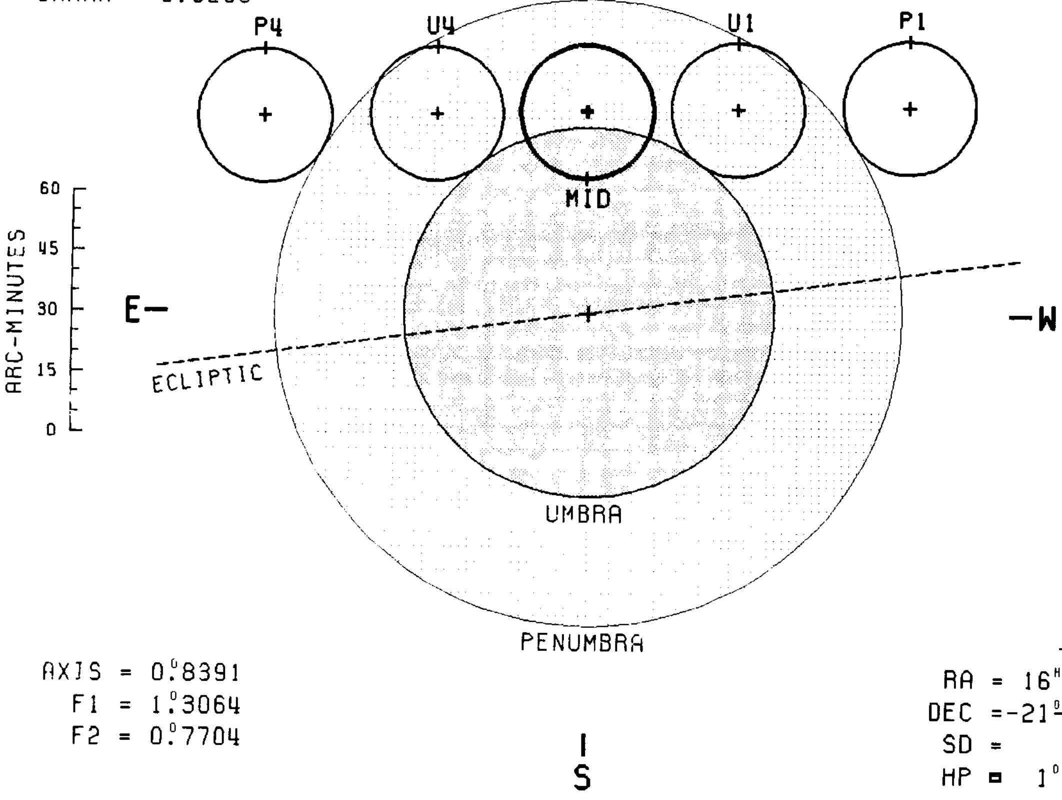
MID = 11: 3.1 UT

PMAG = 1.3429
UMAG = 0.3760

GAMMA = 0.8250

CONTACTS

P1 = 8:46.3 UT
U1 = 9:59.3 UT
U4 = 12: 6.9 UT
P4 = 13:19.9 UT

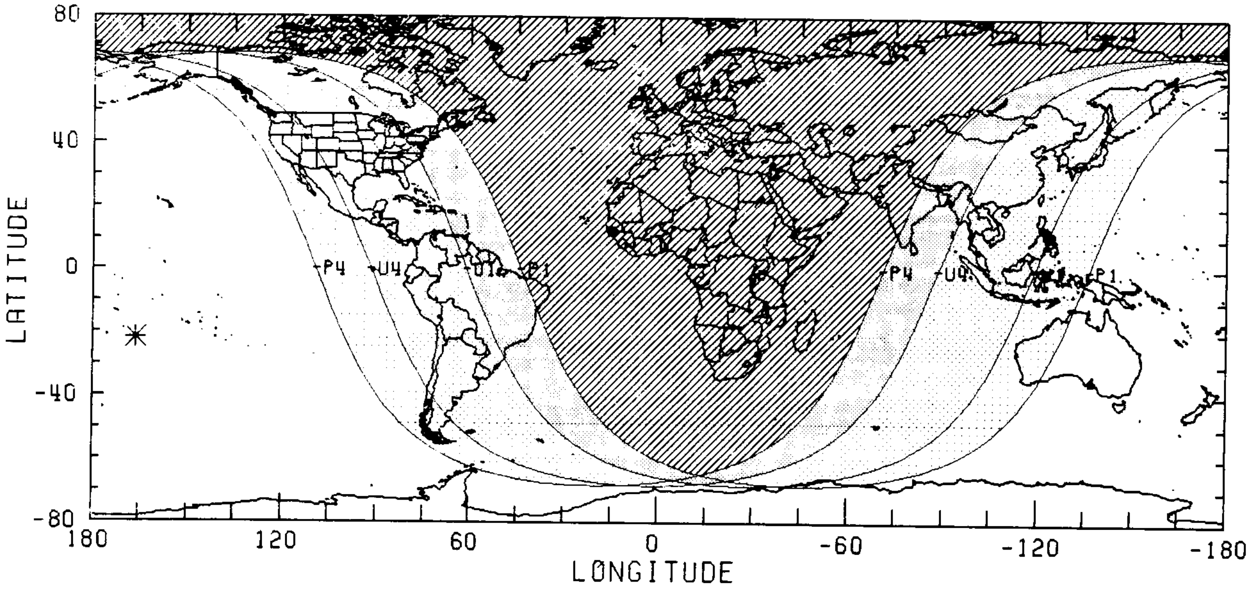


AXIS = 0°.8391
F1 = 1°.3064
F2 = 0°.7704

MOON

RA = 16h51m37s.6
DEC = -21°39'55".8
SD = 16'37".9
HP = 1° 1' 2".2

SAROS 140 (25/80) JD = 2456082.961 ΔT = 75.0 S



PENUMBRAL LUNAR ECLIPSE - 28 NOV 2012

N

MID = 14:32.8 UT

PMAG = 0.9417

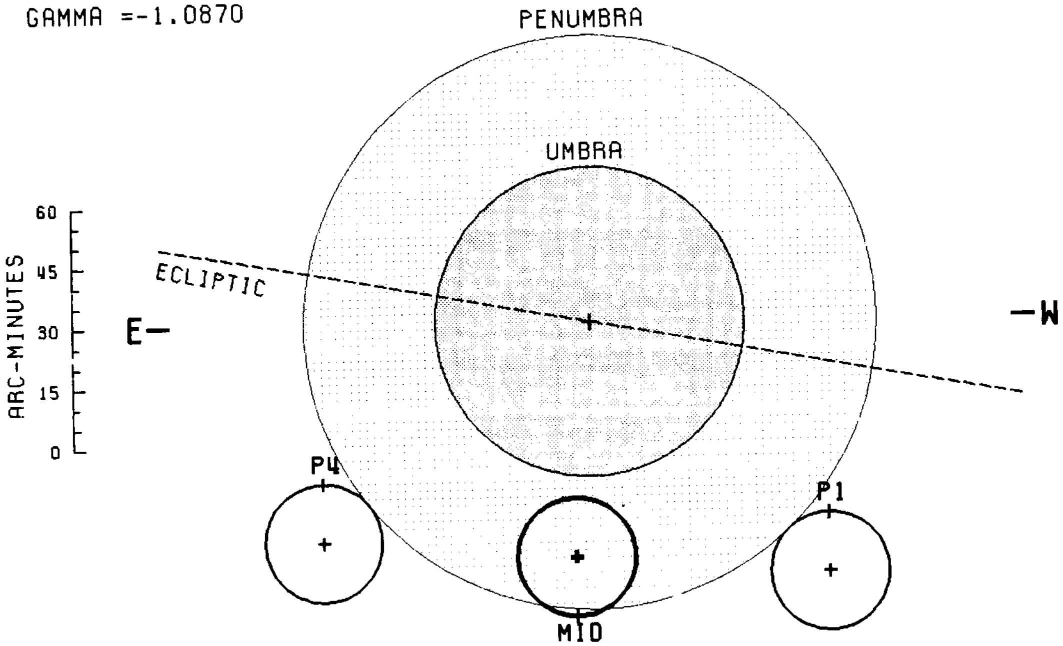
UMAG =-0.1831

GAMMA =-1.0870

CONTACTS

P1 = 12:12.4 UT

P4 = 16:53.3 UT



AXIS =-0°.9775

F1 = 1°.1940

F2 = 0°.6427

S

MOON

RA = 4h 20m 1s.0

DEC = 20° 27' 44".3

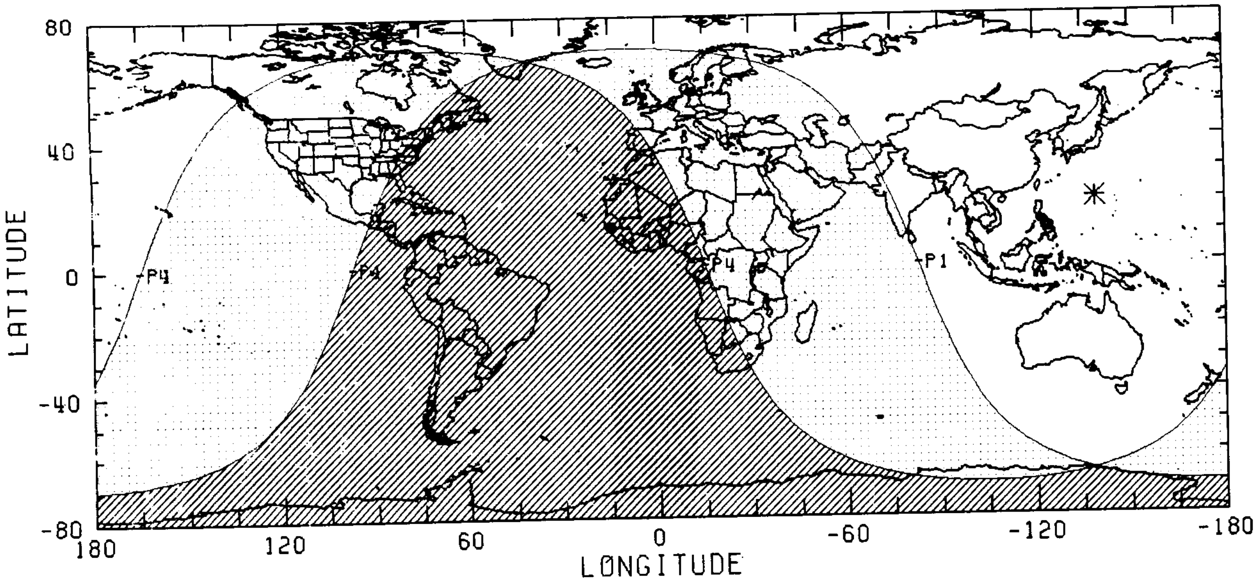
SD = 14' 42".2

HP = 0° 53' 57".7

SAROS 145 (11/71)

JD = 2456260.107

ΔT = 75.4 S



PARTIAL LUNAR ECLIPSE - 25 APR 2013

MID = 20: 7.4 UT

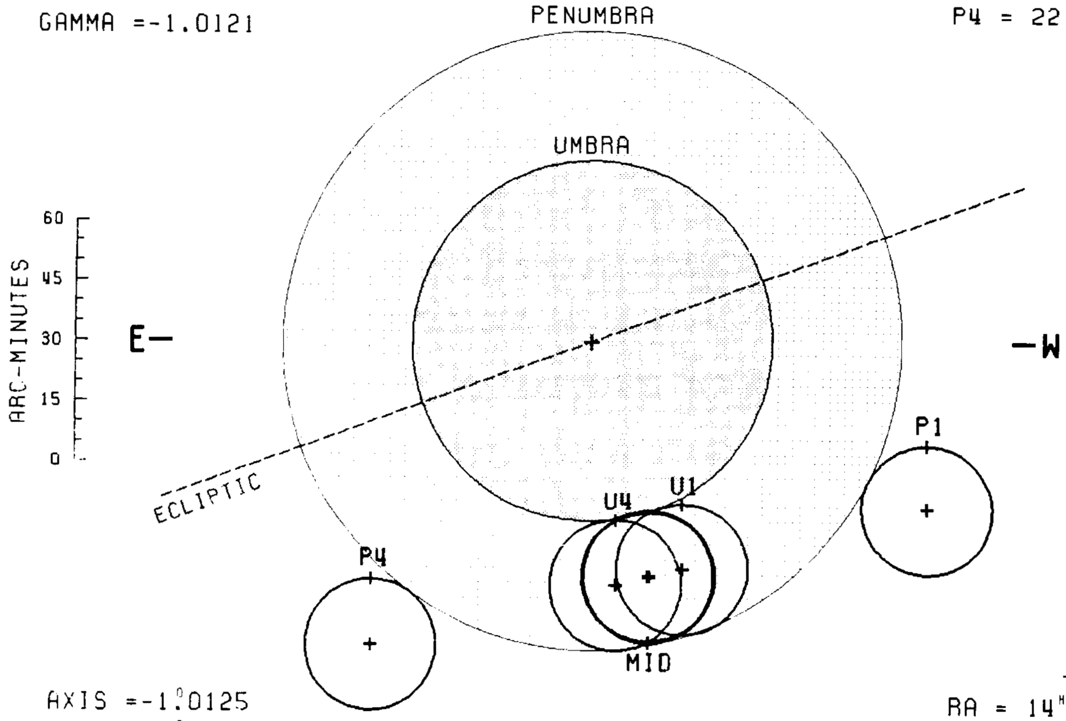
PMAG = 1.0118
UMAG = 0.0205

GAMMA =-1.0121

N

CONTACTS

P1 = 18: 1.5 UT
U1 = 19:52.4 UT
U4 = 20:22.3 UT
P4 = 22:13.2 UT



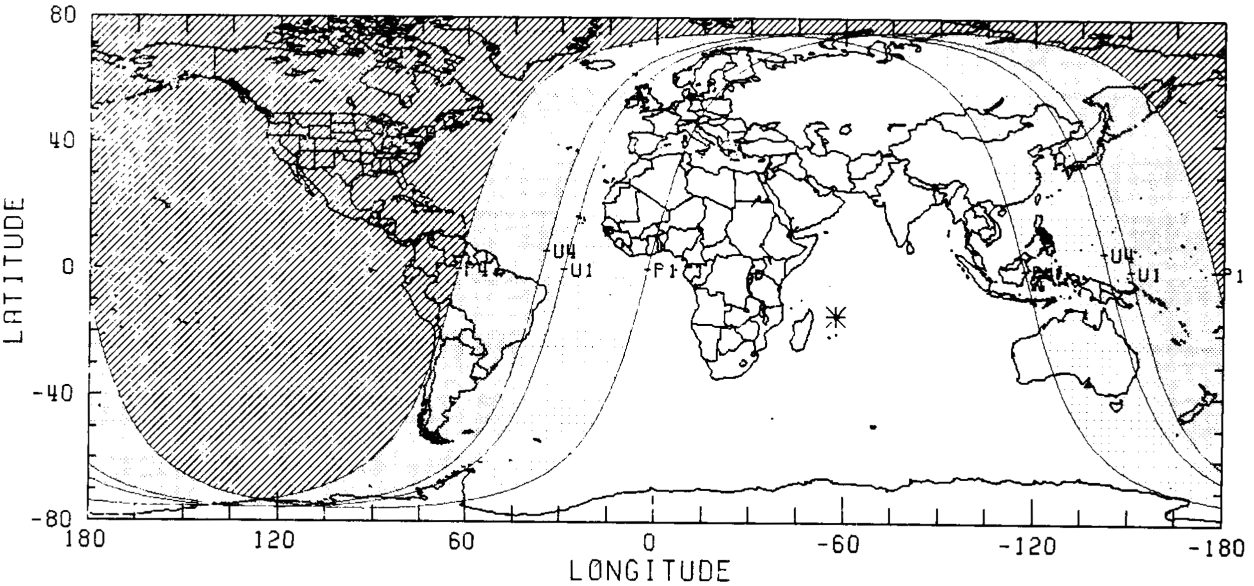
AXIS =-1°.0125
F1 = 1°.2915
F2 = 0°.7510

S

MOON

RA = 14ʰ 12ᵐ 51ˢ.4
DEC =-14° 25′ 34″.0
SD = 16′ 21″.4
HP = 1° 0′ 1″.7

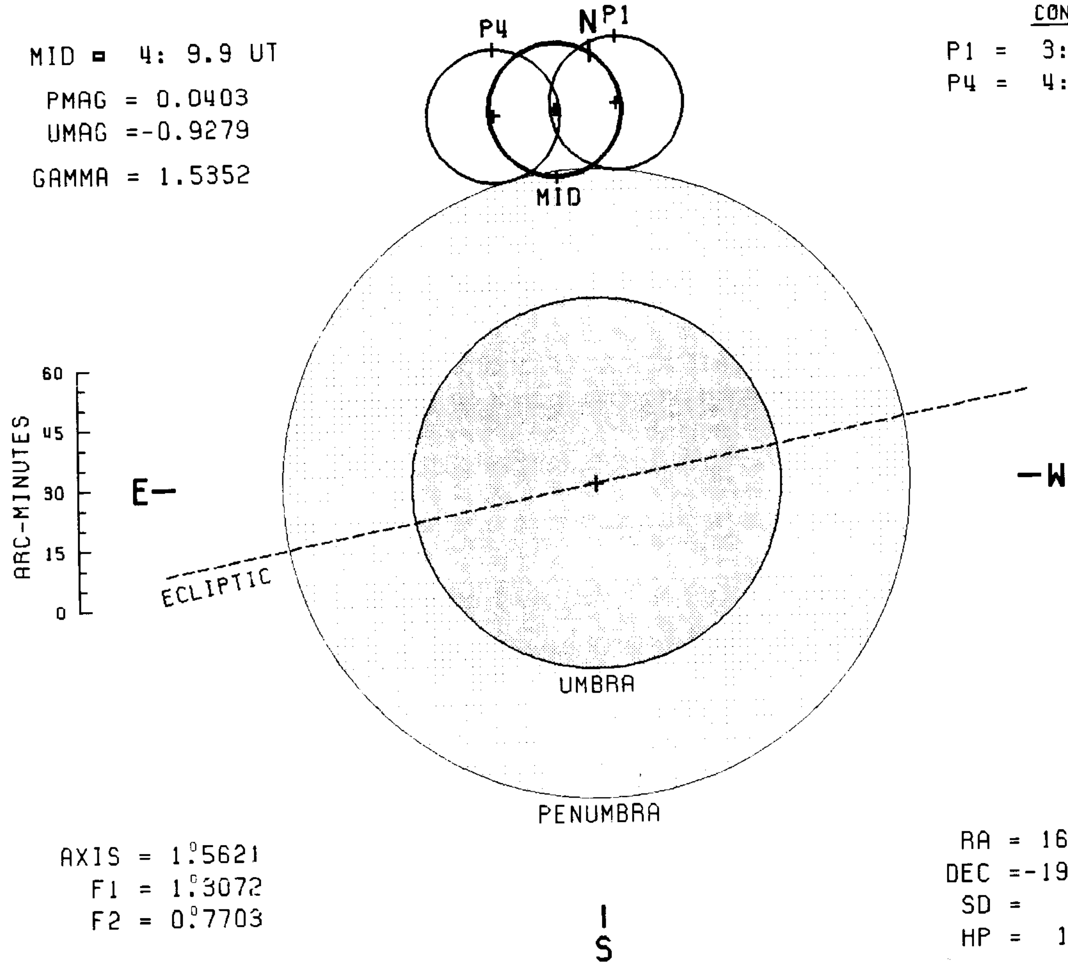
SAROS 112 (65/72) JD = 2456408.339 ΔT = 75.8 S



PENUMBRAL LUNAR ECLIPSE - 25 MAY 2013

MID = 4: 9.9 UT
PMAG = 0.0403
UMAG =-0.9279
GAMMA = 1.5352

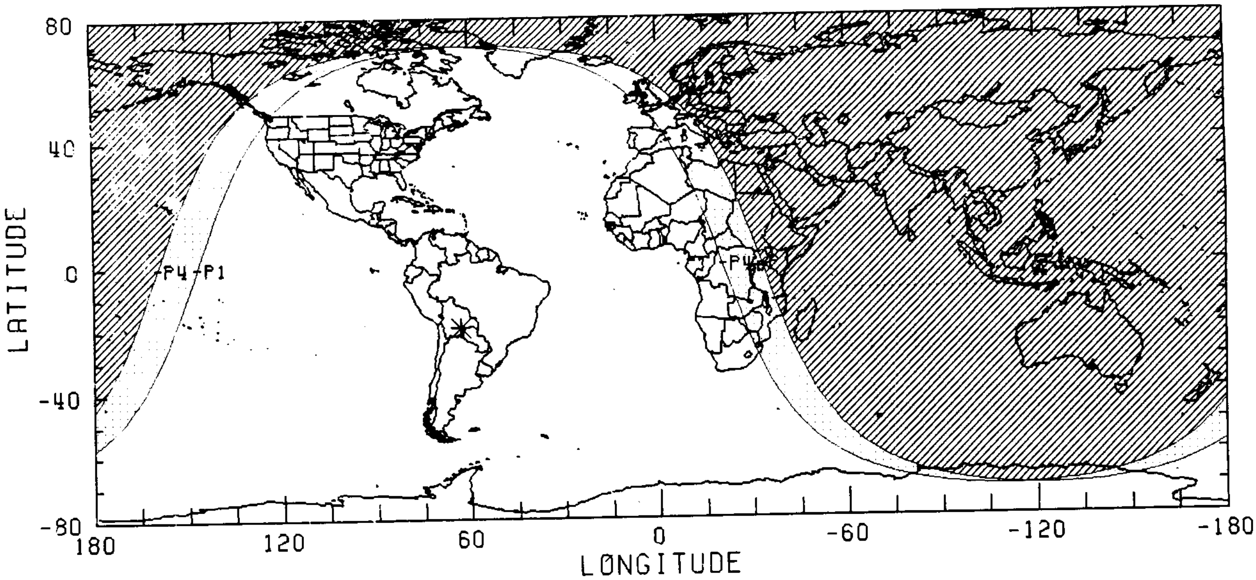
CONTACTS
P1 = 3:43.8 UT
P4 = 4:36.3 UT



AXIS = 1°.5621
F1 = 1°.3072
F2 = 0°.7703

MOON
RA = 16ʰ 9ᵐ 9ˢ.9
DEC =-19°24'45".0
SD = 16'38".2
HP = 1° 1' 3".5

SAROS 150 (1/71)   JD = 2456437.674   ΔT = 75.8 S



PENUMBRAL LUNAR ECLIPSE - 18 OCT 2013

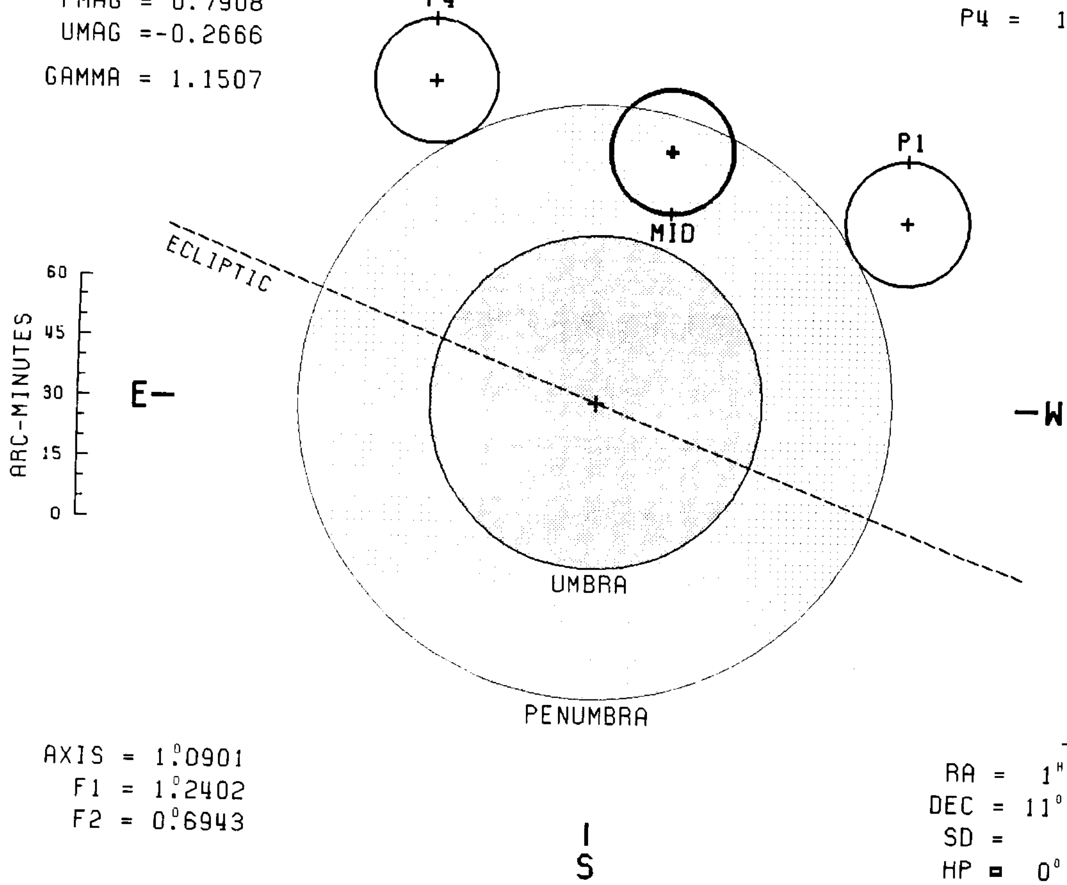
MID = 23:50.1 UT

PMAG = 0.7908
UMAG =-0.2666

GAMMA = 1.1507

CONTACTS

P1 = 21:48.0 UT
P4 = 1:51.8 UT



AXIS = 1.°0901
F1 = 1.°2402
F2 = 0.°6943

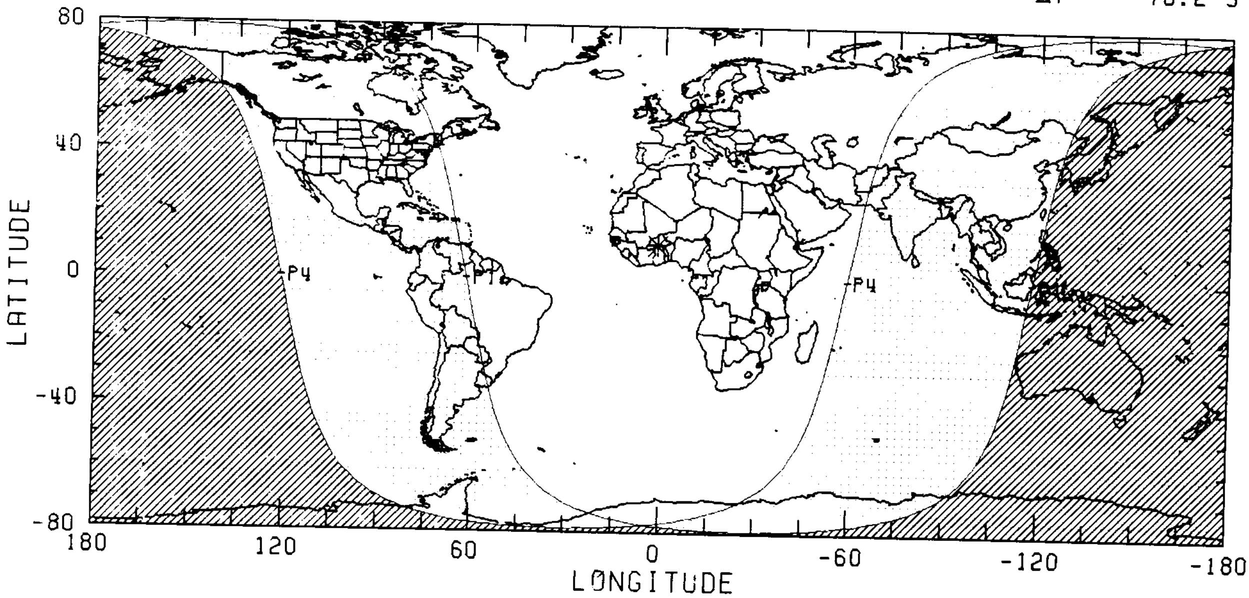
MOON

RA = 1ʰ34ᵐ19.ˢ5
DEC = 11° 0′11.″4
SD = 15′29.″3
HP = 0°56′50.″7

SAROS 117 (52/72)

JD = 2456584.494

ΔT = 76.2 S



TOTAL LUNAR ECLIPSE - 15 APR 2014

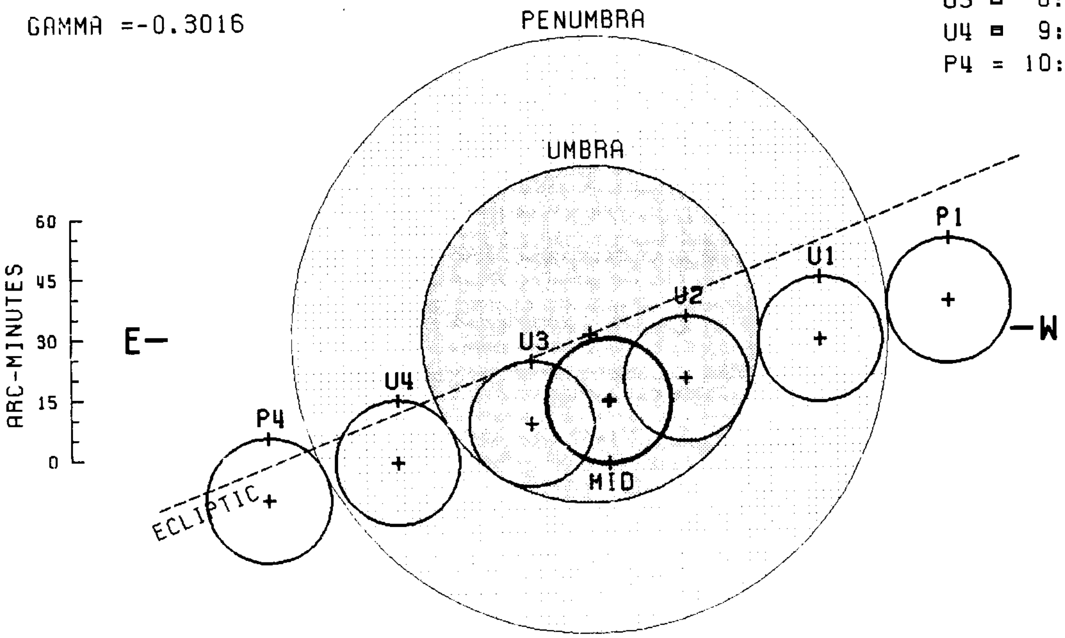
MID = 7:45.5 UT

PMAG = 2.3440
UMAG = 1.2959

GAMMA =-0.3016

N

CONTACTS		
P1	=	4:51.7 UT
U1	=	5:57.6 UT
U2	=	7: 6.0 UT
U3	=	8:24.8 UT
U4	=	9:33.3 UT
P4	=	10:39.2 UT



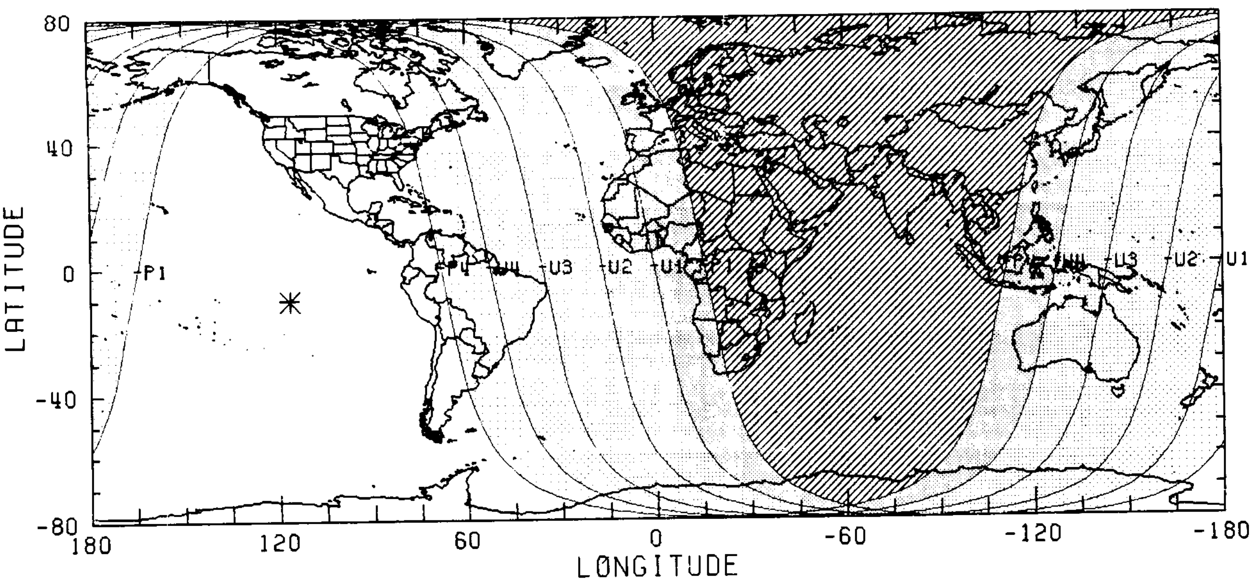
AXIS =-0°.2862
F1 = 1°.2399
F2 = 0°.6979

S

MOON

RA = 13ʰ 33ᵐ 21ˢ.1
DEC =-10° -2′-59″.4
SD = 15′ 30″.9
HP = 0° 56′ 56″.5

SAROS 122 (56/75) JD = 2456762.824 ΔT = 76.6 S



TOTAL LUNAR ECLIPSE - 8 OCT 2014

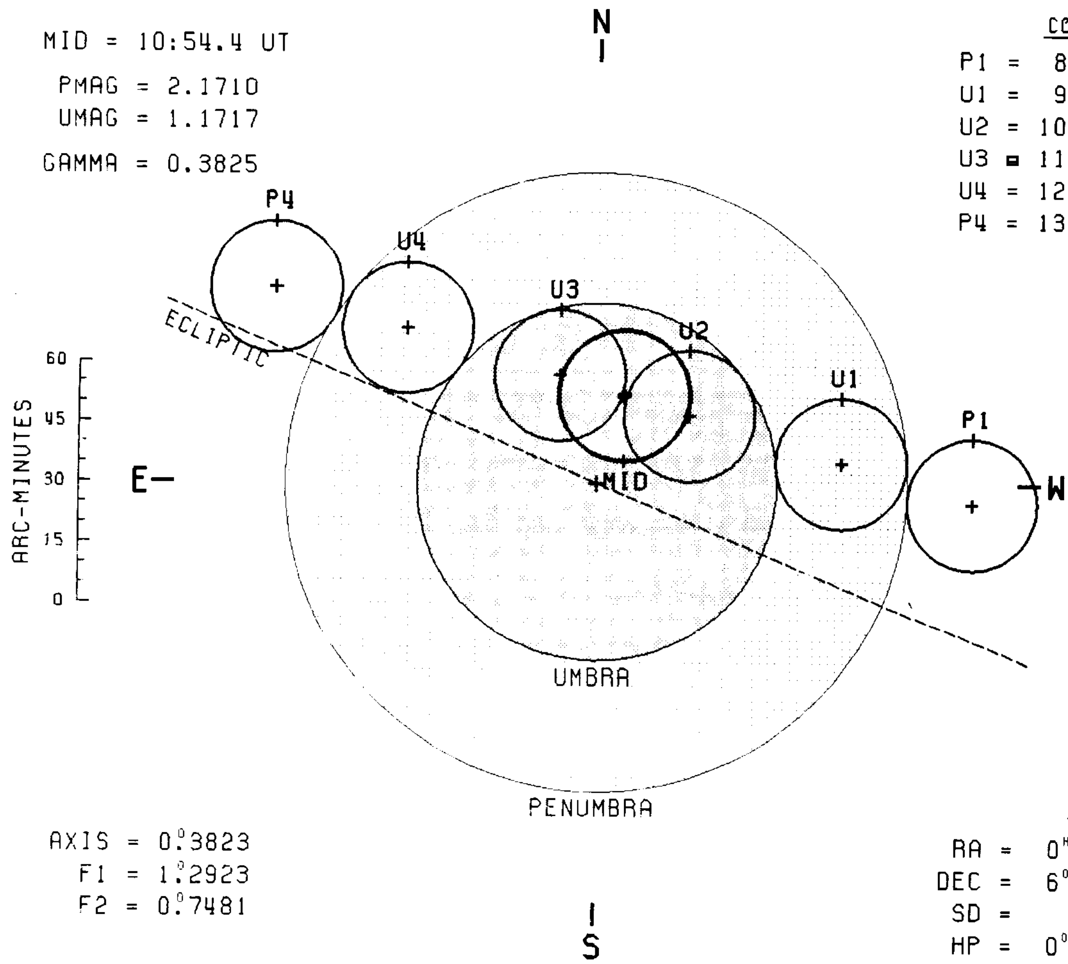
MID = 10:54.4 UT

PMAG = 2.1710
UMAG = 1.1717

GAMMA = 0.3825

CONTACTS

P1 = 8:13.7 UT
U1 = 9:14.1 UT
U2 = 10:24.3 UT
U3 = 11:24.1 UT
U4 = 12:34.6 UT
P4 = 13:35.1 UT

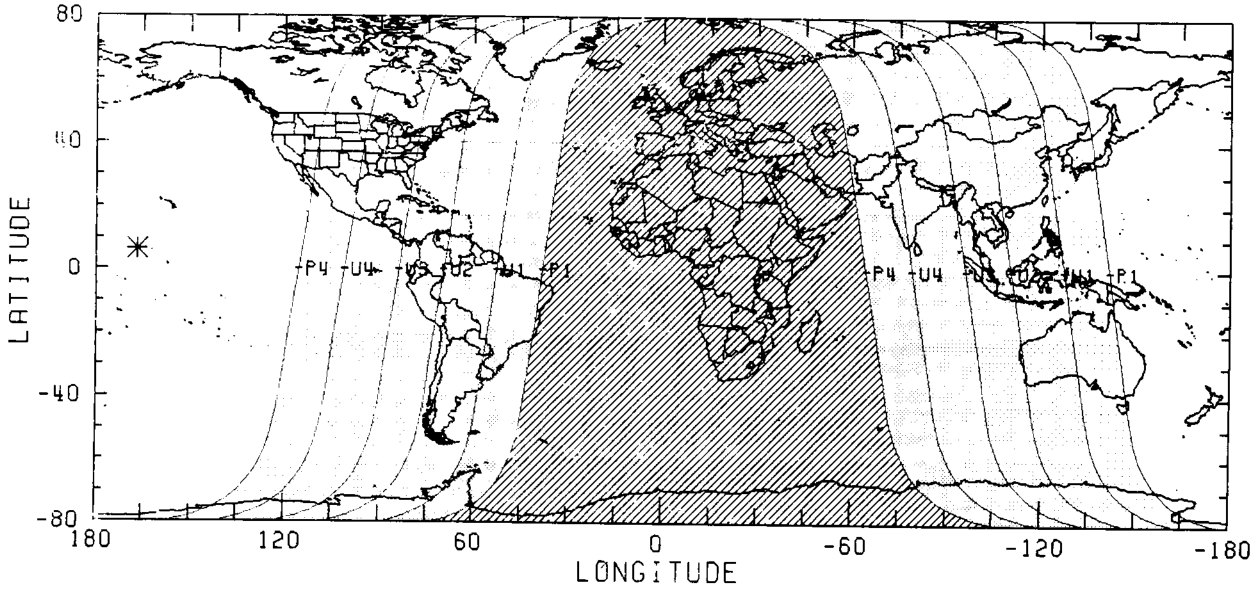


AXIS = 0.°3823
F1 = 1.°2923
F2 = 0.°7481

MOON

RA = 0ʰ 55ᵐ 7.ˢ1
DEC = 6° 18' 25."9
SD = 16' 20."3
HP = 0° 59' 57."9

SAROS 127 (42/72) JD = 2456938.955 ΔT = 77.0 S



TOTAL LUNAR ECLIPSE - 4 APR 2015

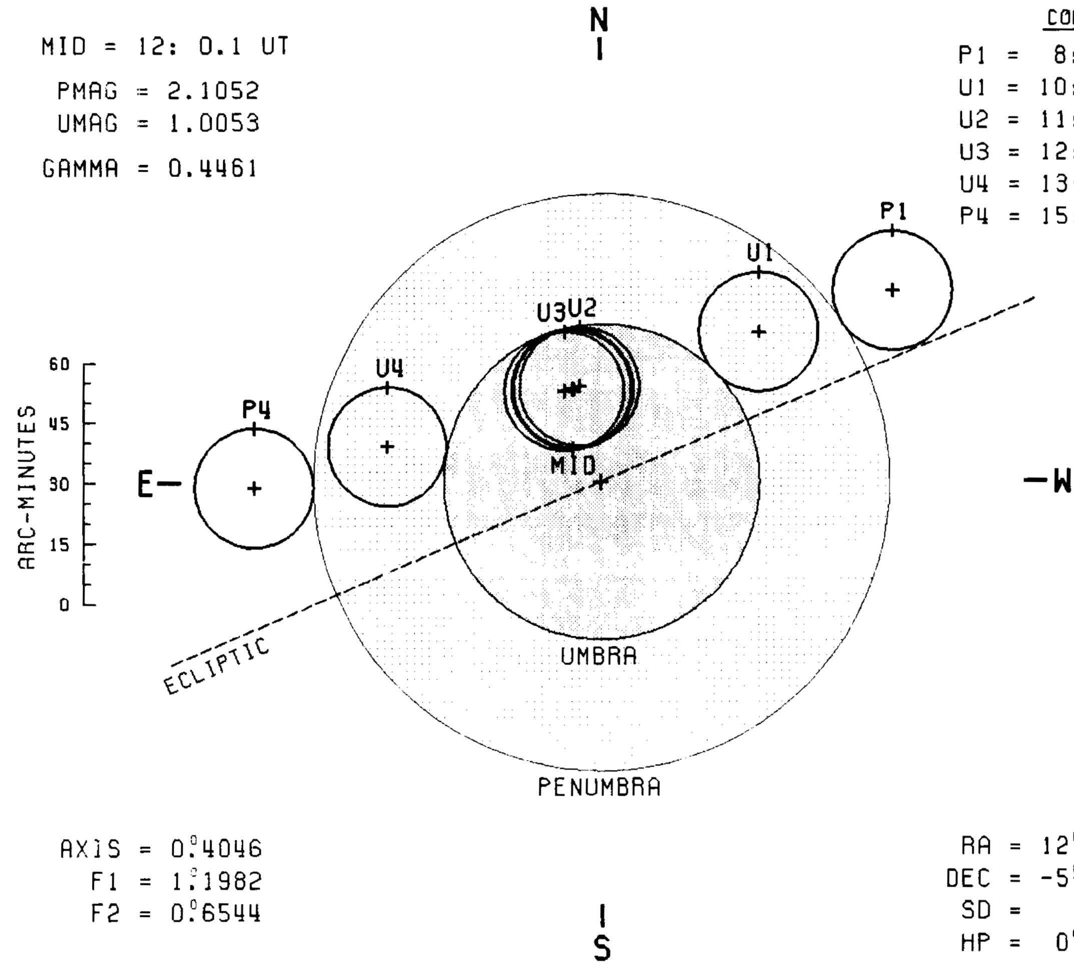
MID = 12: 0.1 UT

PMAG = 2.1052
UMAG = 1.0053

GAMMA = 0.4461

CONTACTS

P1 = 8:59.4 UT
U1 = 10:15.3 UT
U2 = 11:56.0 UT
U3 = 12: 4.6 UT
U4 = 13:45.2 UT
P4 = 15: 0.8 UT

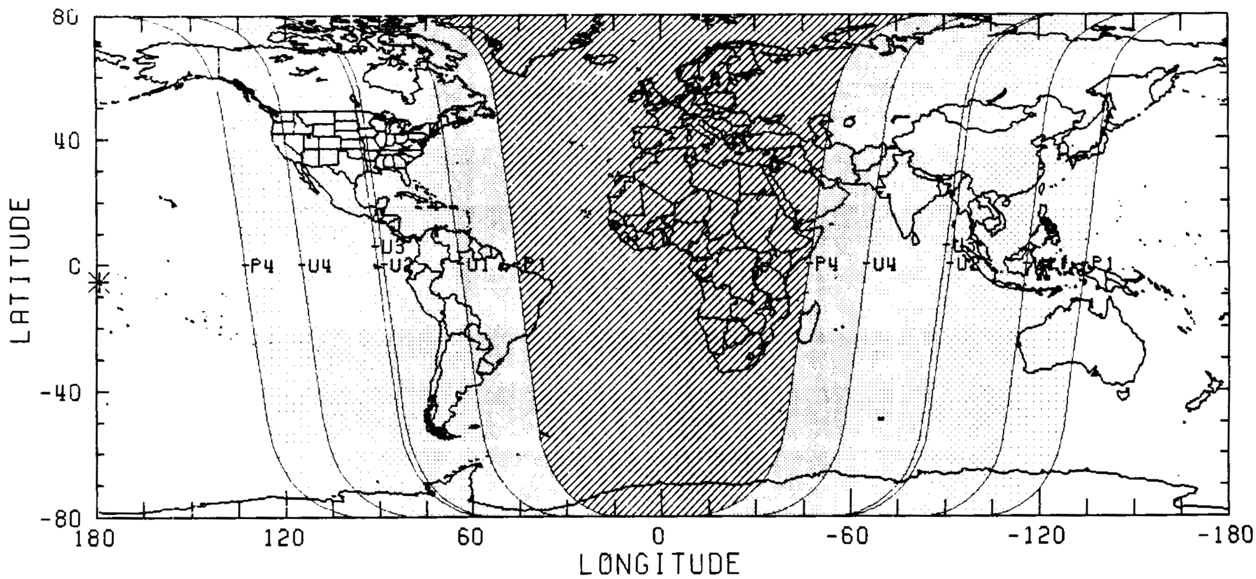


MOON

AXIS = 0°.4046
F1 = 1°.1982
F2 = 0°.6544

RA = 12h 53m 29s.7
DEC = -5° 17' 19".8
SD = 14' 49".9
HP = 0° 54' 25".9

SAROS 132 (30/71) JD = 2457117.001 ΔT = 77.5 S



TOTAL LUNAR ECLIPSE - 28 SEP 2015

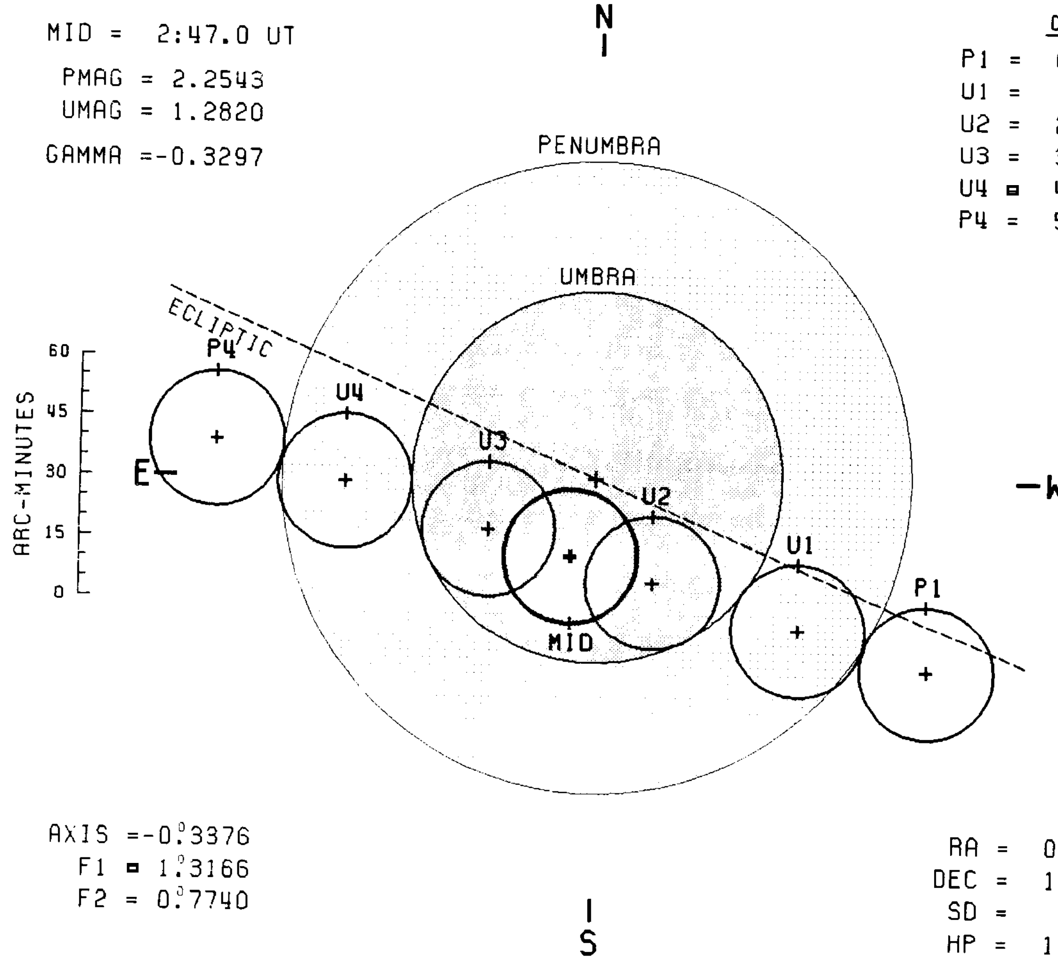
MID = 2:47.0 UT

PMAG = 2.2543
UMAG = 1.2820

GAMMA =-0.3297

CONTACTS

P1	=	0:10.1 UT
U1	=	1: 6.6 UT
U2	=	2:10.7 UT
U3	=	3:23.5 UT
U4	=	4:27.5 UT
P4	=	5:24.0 UT

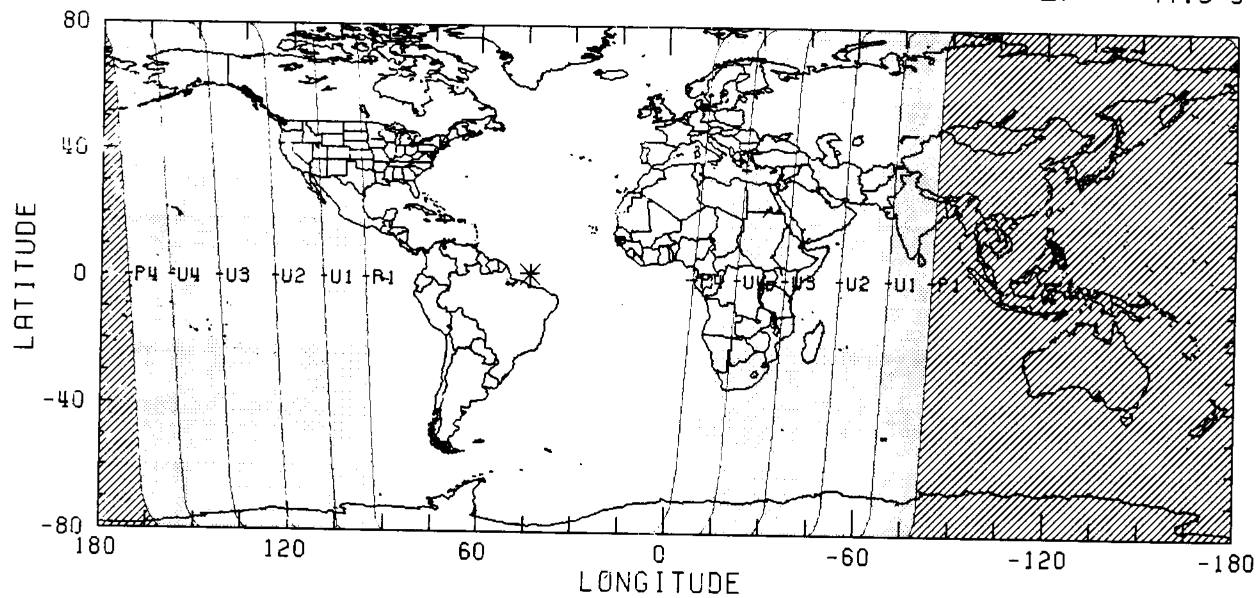


AXIS =-0.°3376
F1 = 1.°3166
F2 = 0.°7740

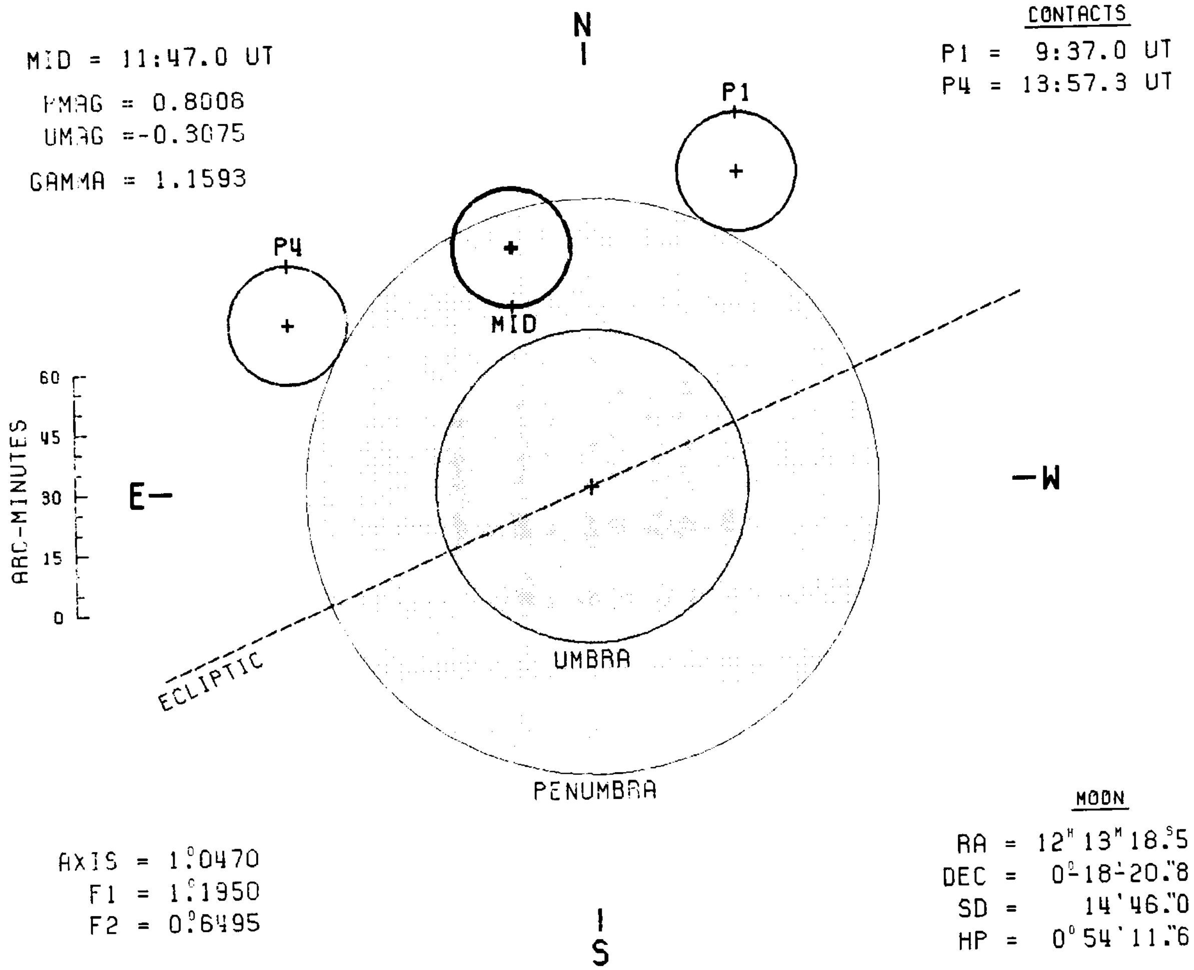
MOON

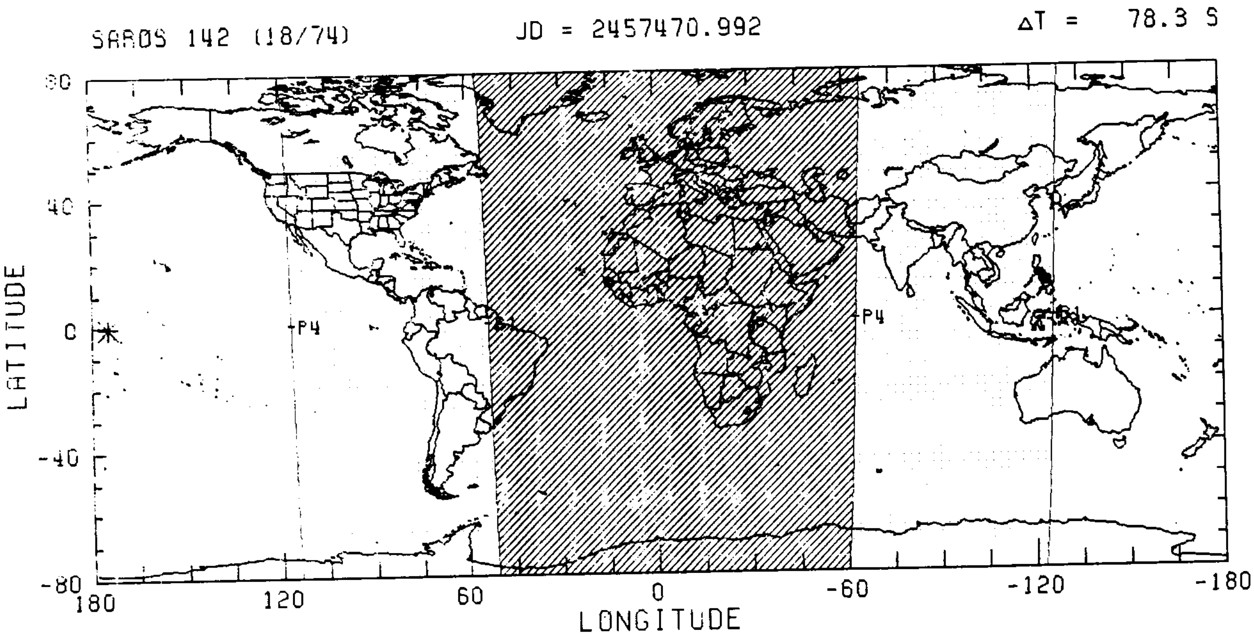
RA	=	0h 17m 33.s5
DEC	=	1° 32' 2."9
SD	=	16' 44."5
HP	=	1° 1' 26."5

SAROS 137 (28/81) JD = 2457293.617 ΔT = 77.9 S



PENUMBRAL LUNAR ECLIPSE - 23 MAR 2016





PENUMBRAL LUNAR ECLIPSE - 18 AUG 2016

MID = 9:42.4 UT

PMAG = 0.0166

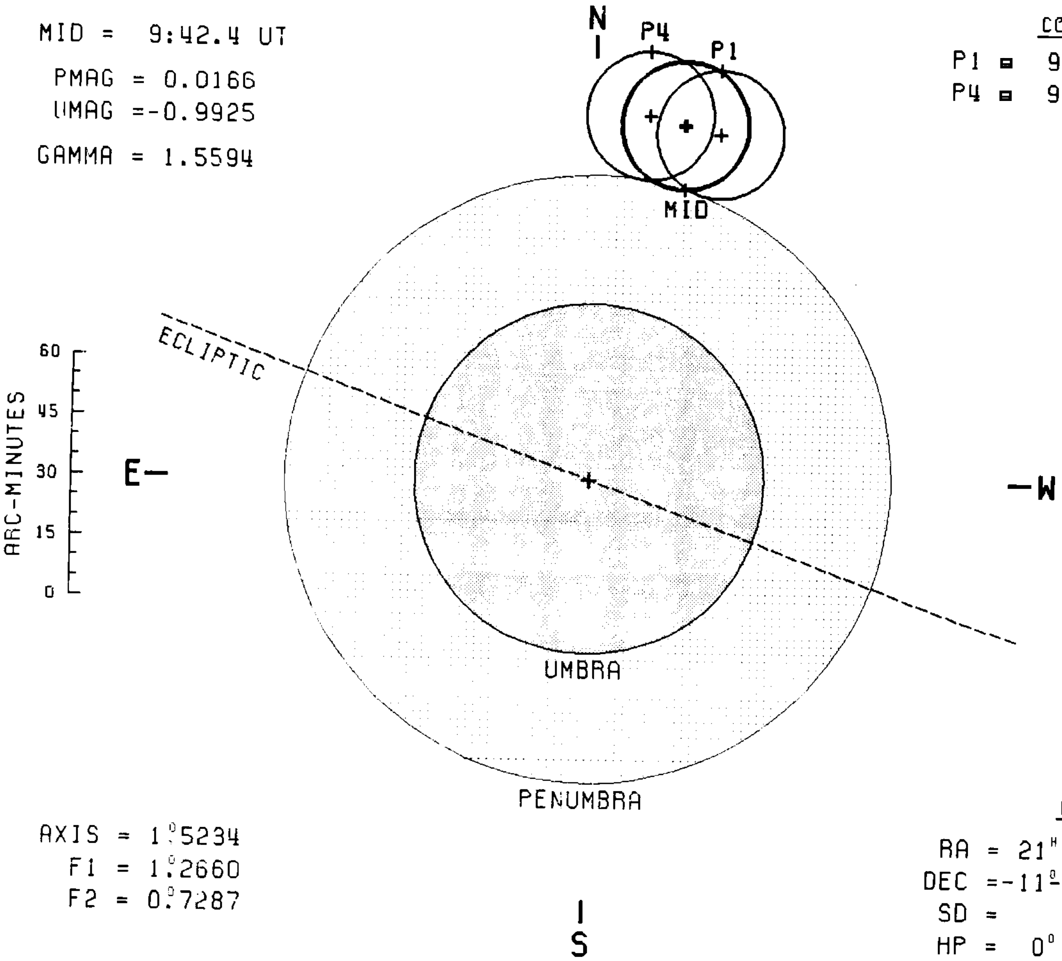
UMAG =-0.9925

GAMMA = 1.5594

CONTACTS

P1 = 9:25.6 UT

P4 = 9:59.2 UT



AXIS = 1°.5234

F1 = 1°.2660

F2 = 0°.7287

MOON

RA = 21^{h}50^{m}57^s.5

DEC =-11°24'59".8

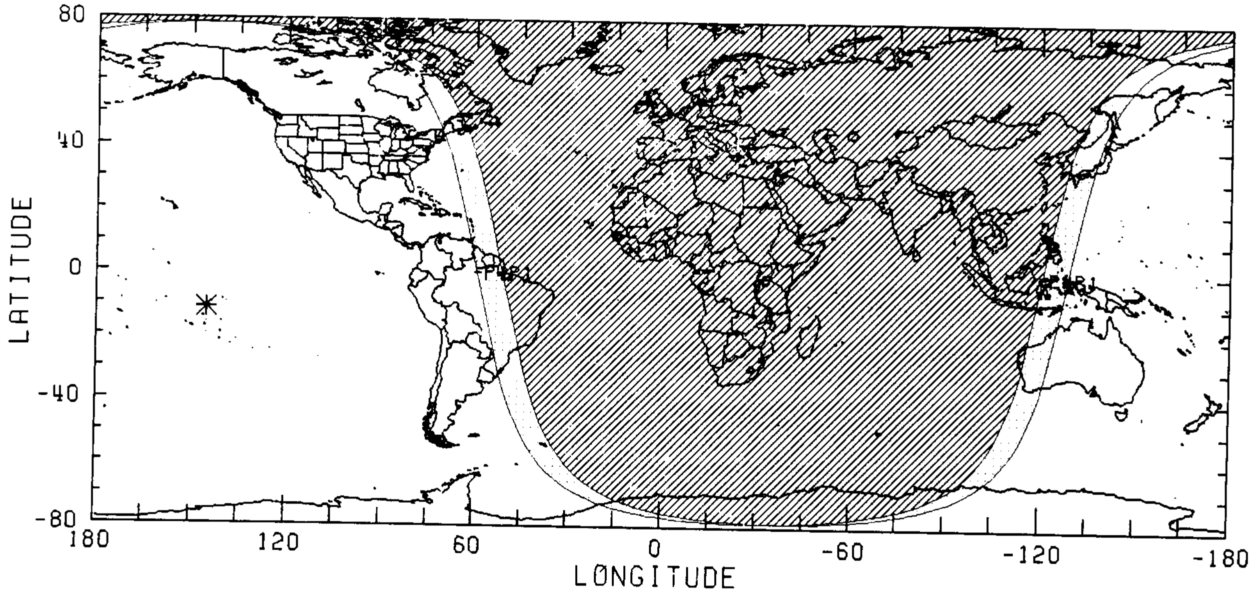
SD = 15'58".4

HP = 0°58'37".2

SAROS 109 (73/73)

JD = 2457618.905

ΔT = 78.7 S



PENUMBRAL LUNAR ECLIPSE - 16 SEP 2016

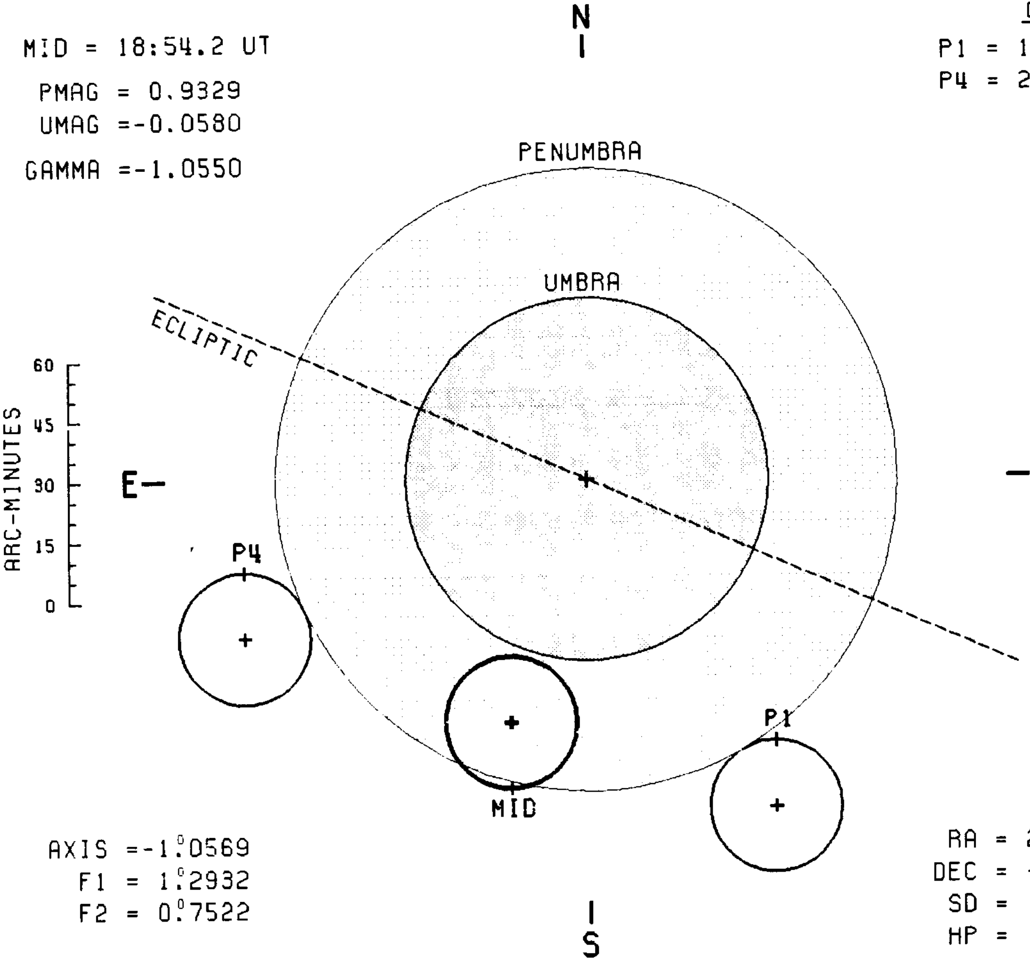
MID = 18:54.2 UT

PMAG = 0.9329
UMAG =-0.0580

GAMMA =-1.0550

CONTACTS

P1 = 16:52.7 UT
P4 = 20:56.0 UT



AXIS =-1°0569
F1 = 1°2932
F2 = 0°7522

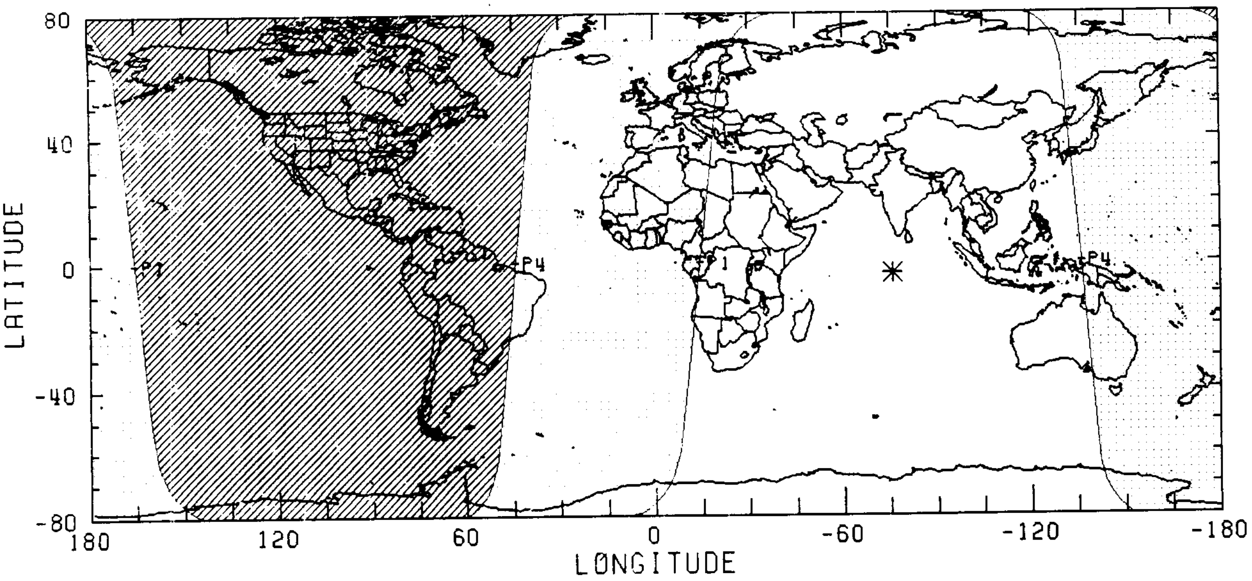
MOON

RA = 23ʰ40ᵐ27ˢ3
DEC = -3°15′37″2
SD = 16′22″8
HP = 1° 0′ 6″8

SAROS 147 (9/71)

JD = 2457648.289

ΔT = 78.7 S



PENUMBRAL LUNAR ECLIPSE - 11 FEB 2017

MID = 0:43.7 UT

PMAG = 1.0141

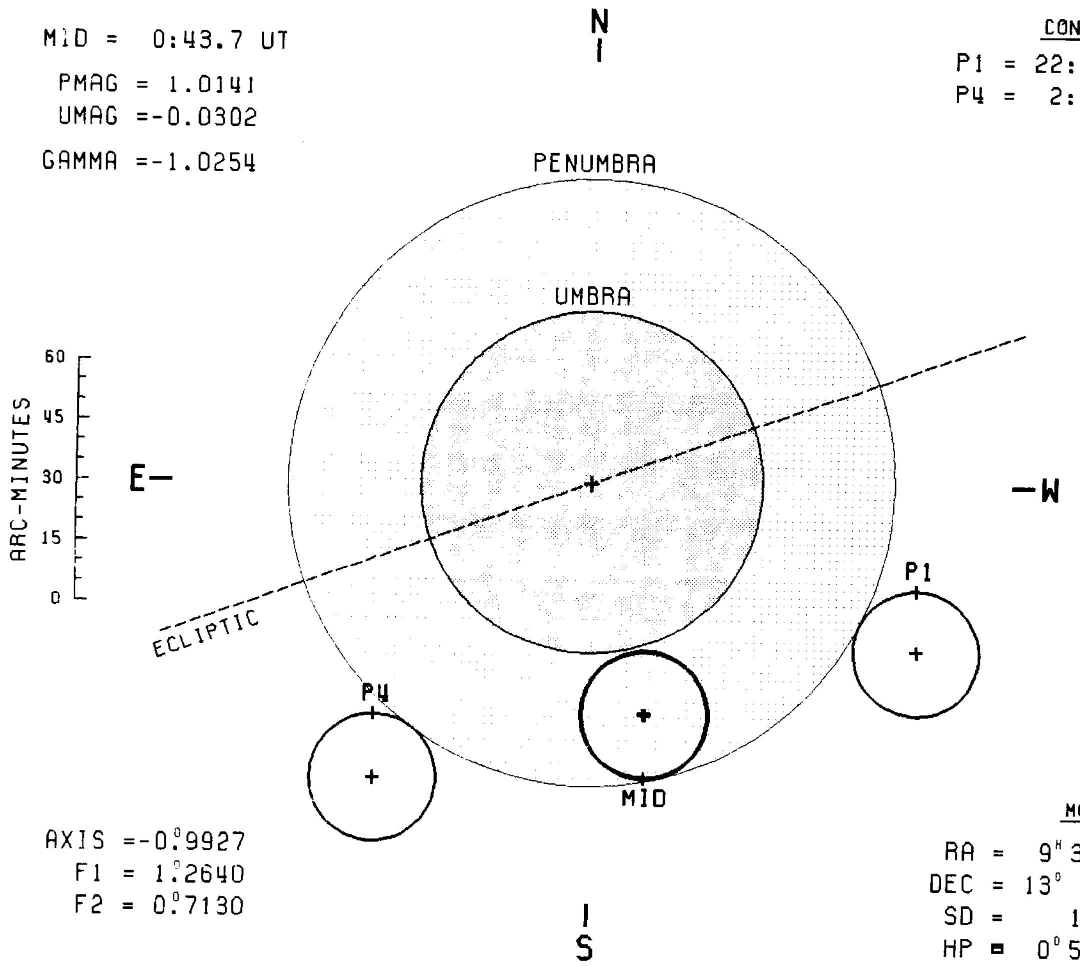
UMAG =-0.0302

GAMMA =-1.0254

CONTACTS

P1 = 22:31.9 UT

P4 = 2:55.3 UT



AXIS =-0°9927

F1 = 1°2640

F2 = 0°7130

MOON

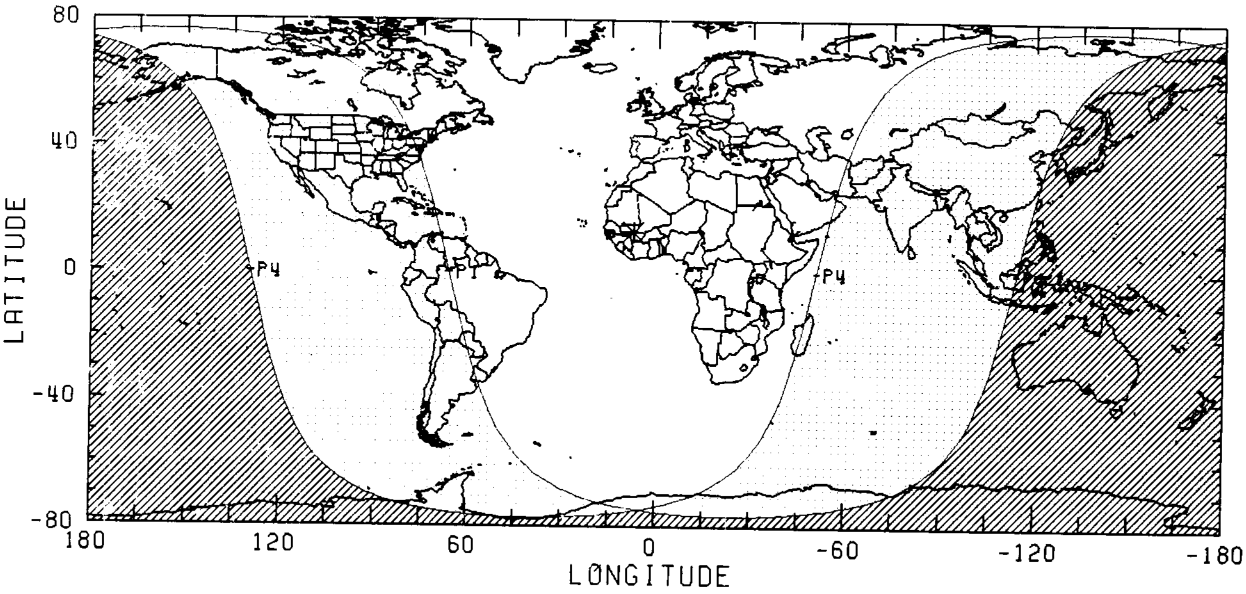
RA = 9ʰ 38ᵐ 22ˢ5

DEC = 13° 3' 10."8

SD = 15' 49."8

HP = 0° 58' 5."6

SAROS 114 (59/71) JD = 2457795.531 ΔT = 79.1 S



PARTIAL LUNAR ECLIPSE - 7 AUG 2017

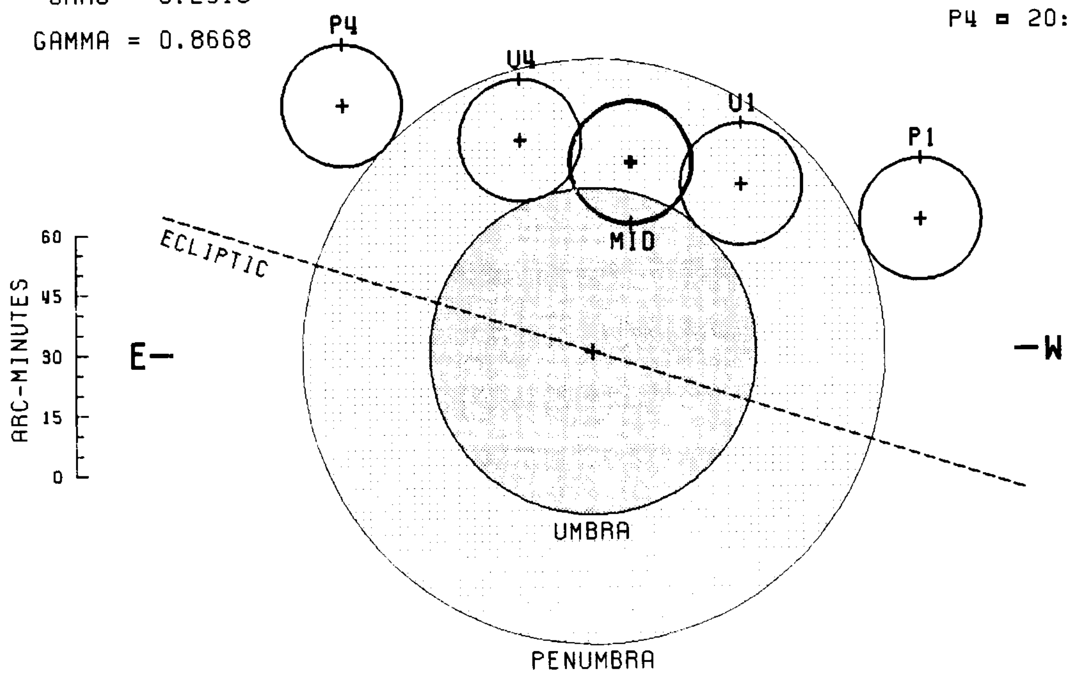
MID = 18:20.3 UT

PMAG = 1.3145
UMAG = 0.2515

GAMMA = 0.8668

CONTACTS

P1 = 15:47.7 UT
U1 = 17:22.1 UT
U4 = 19:18.4 UT
P4 = 20:52.7 UT

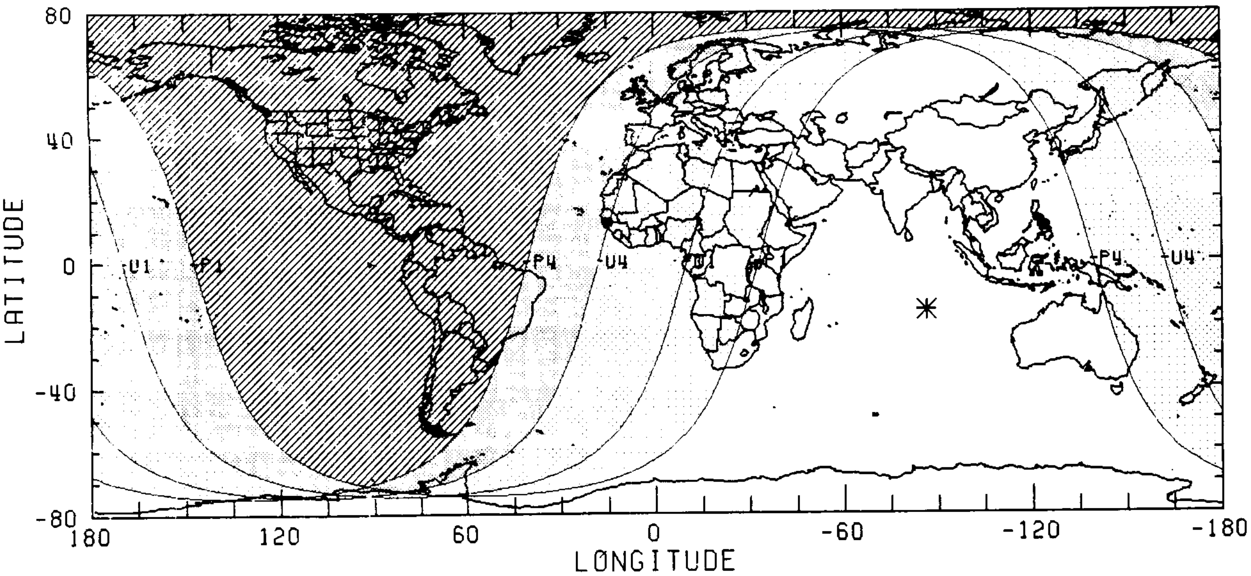


AXIS = 0°.8024
F1 = 1°.2133
F2 = 0°.6770

MOON

RA = $21^h 10^m 53^s.1$
DEC = $-15°25'17''.7$
SD = $15' 8''.1$
HP = $0°55'32''.7$

SAROS 119 (62/83) JD = 2457973.265 ΔT = 79.5 S



TOTAL LUNAR ECLIPSE - 31 JAN 2018

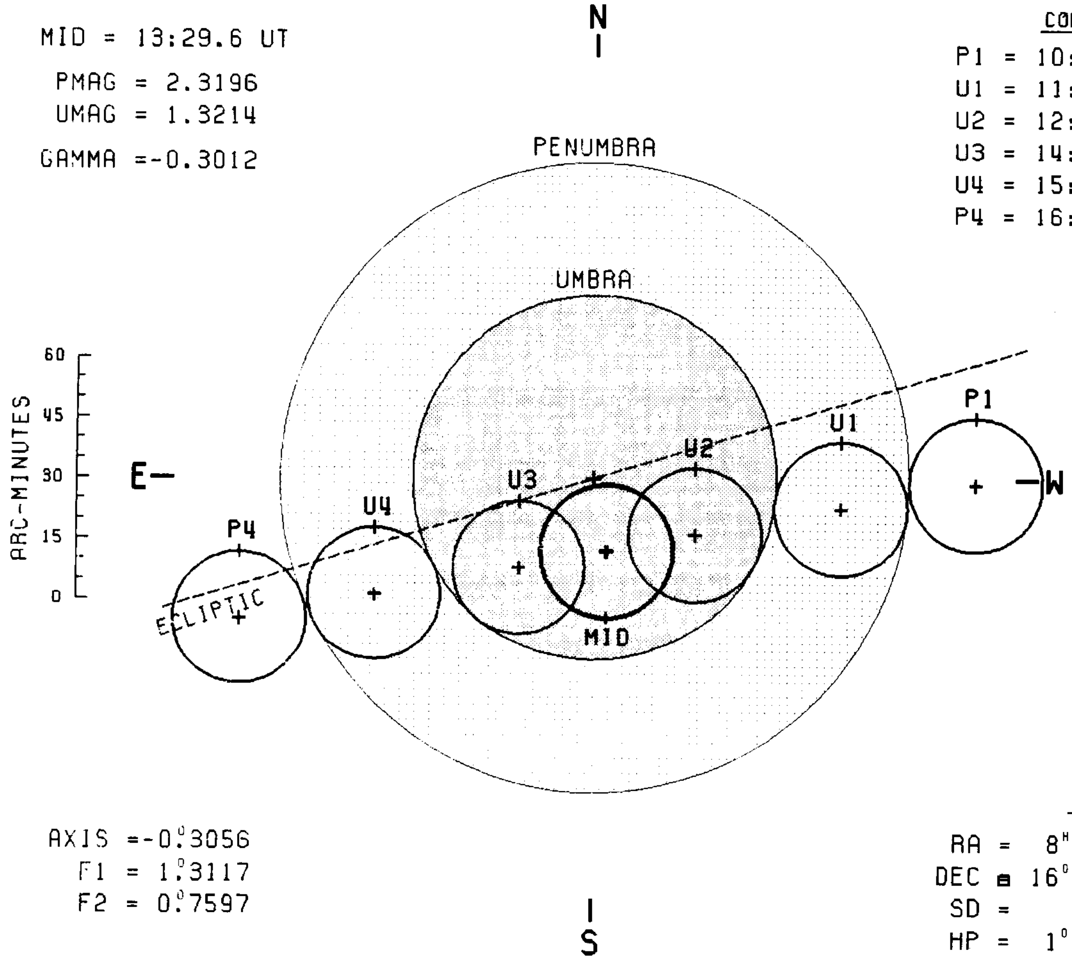
MID = 13:29.6 UT

PMAG = 2.3196
UMAG = 1.3214

GAMMA =-0.3012

CONTACTS

P1 = 10:49.4 UT
U1 = 11:47.7 UT
U2 = 12:51.0 UT
U3 = 14: 8.1 UT
U4 = 15:11.4 UT
P4 = 16: 9.9 UT

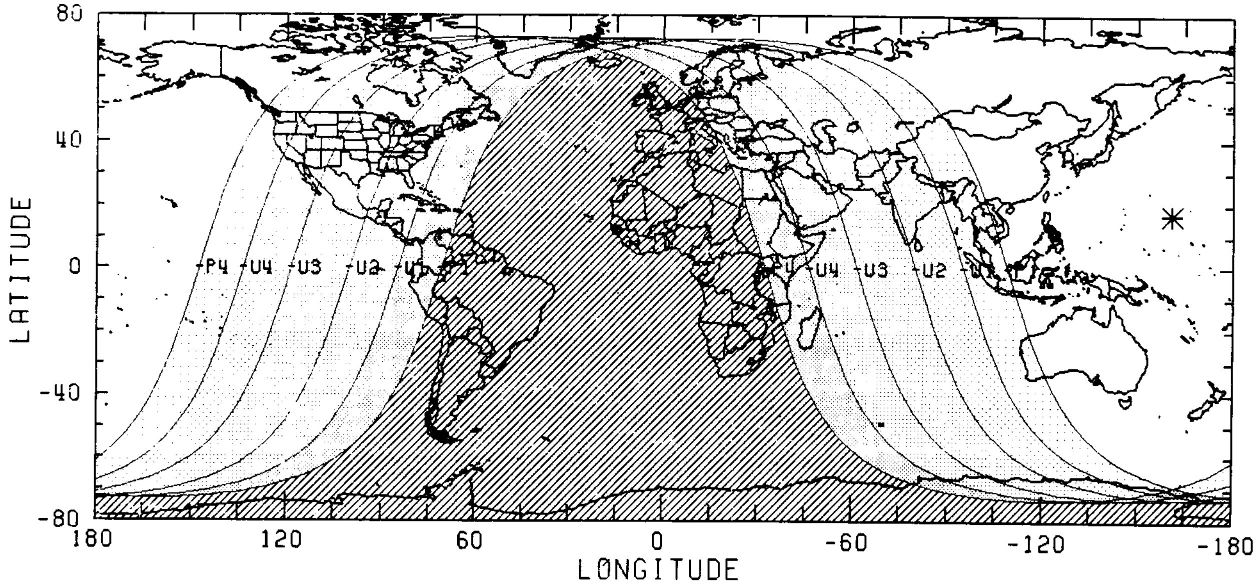


AXIS =-0.°3056
F1 = 1.°3117
F2 = 0.°7597

MOON

RA = 8ʰ 56ᵐ 4.ˢ9
DEC = 16° 59' 45."3
SD = 16' 35."2
HP = 1° 0' 52."5

SAROS 124 (49/74)   JD = 2458150.063   ΔT = 80.0 S



TOTAL LUNAR ECLIPSE - 27 JUL 2018

N

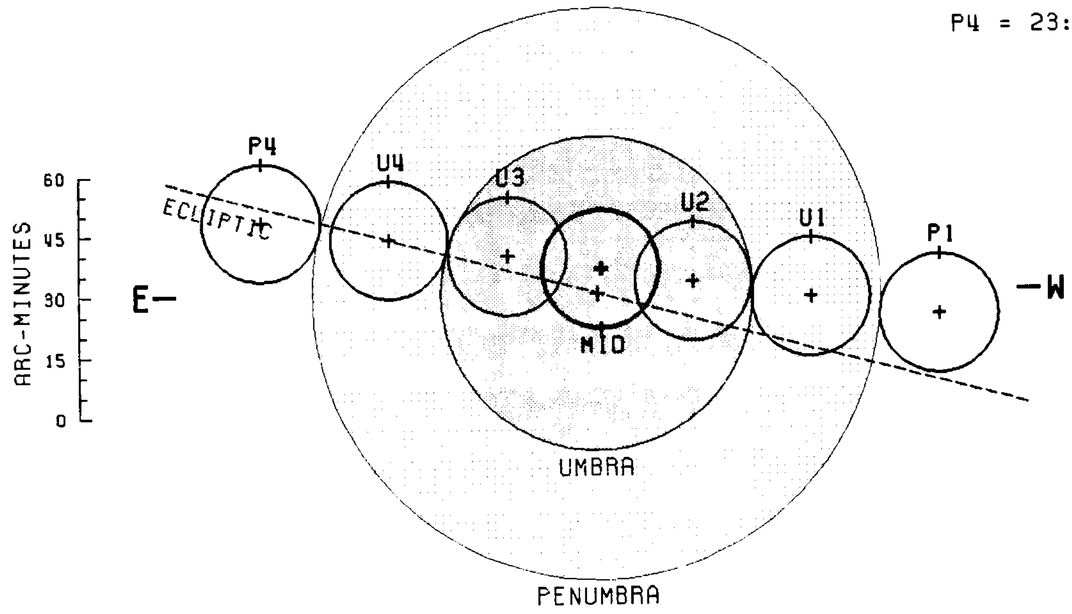
MID = 20:21.5 UT

PMAG = 2.7056
UMAG = 1.6137

GAMMA = 0.1166

CONTACTS

P1 = 17:12.7 UT
U1 = 18:23.8 UT
U2 = 19:29.6 UT
U3 = 21:13.5 UT
U4 = 22:19.3 UT
P4 = 23:30.4 UT



AXIS = 0°.1049
F1 = 1°.1866
F2 = 0°.6511

S

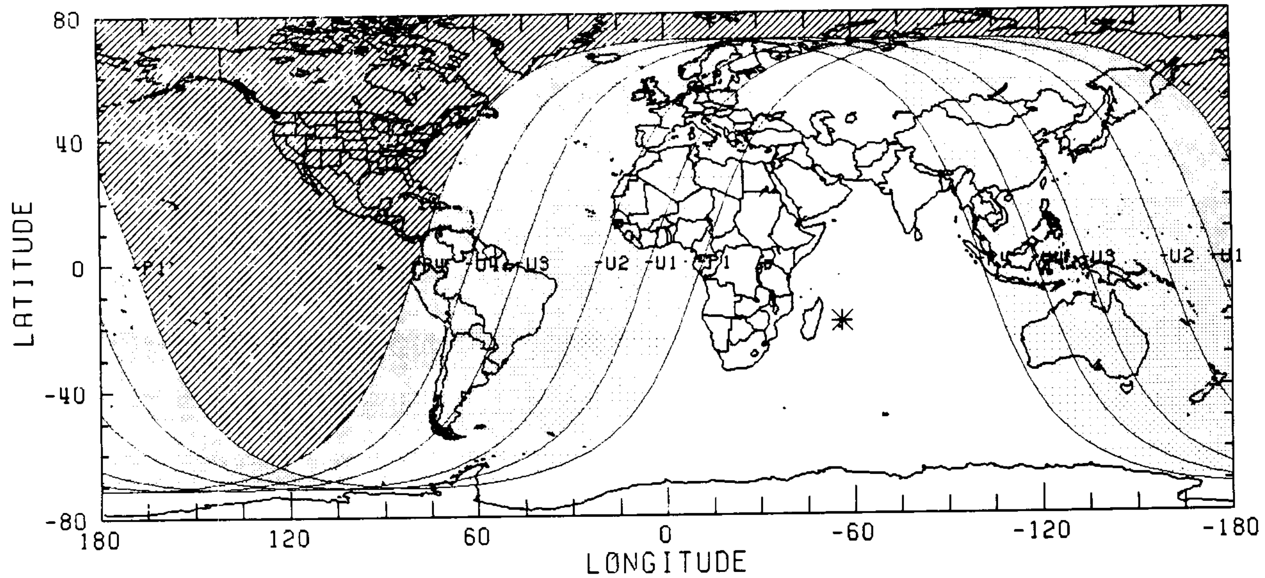
MOON

RA = 20ʰ28ᵐ18ˢ.2
DEC = −18°58′11″.5
SD = 14′42″.7
HP = 0°53′59″.7

SAROS 129 (38/71)

JD = 2458327.349

ΔT = 80.4 S



TOTAL LUNAR ECLIPSE - 21 JAN 2019

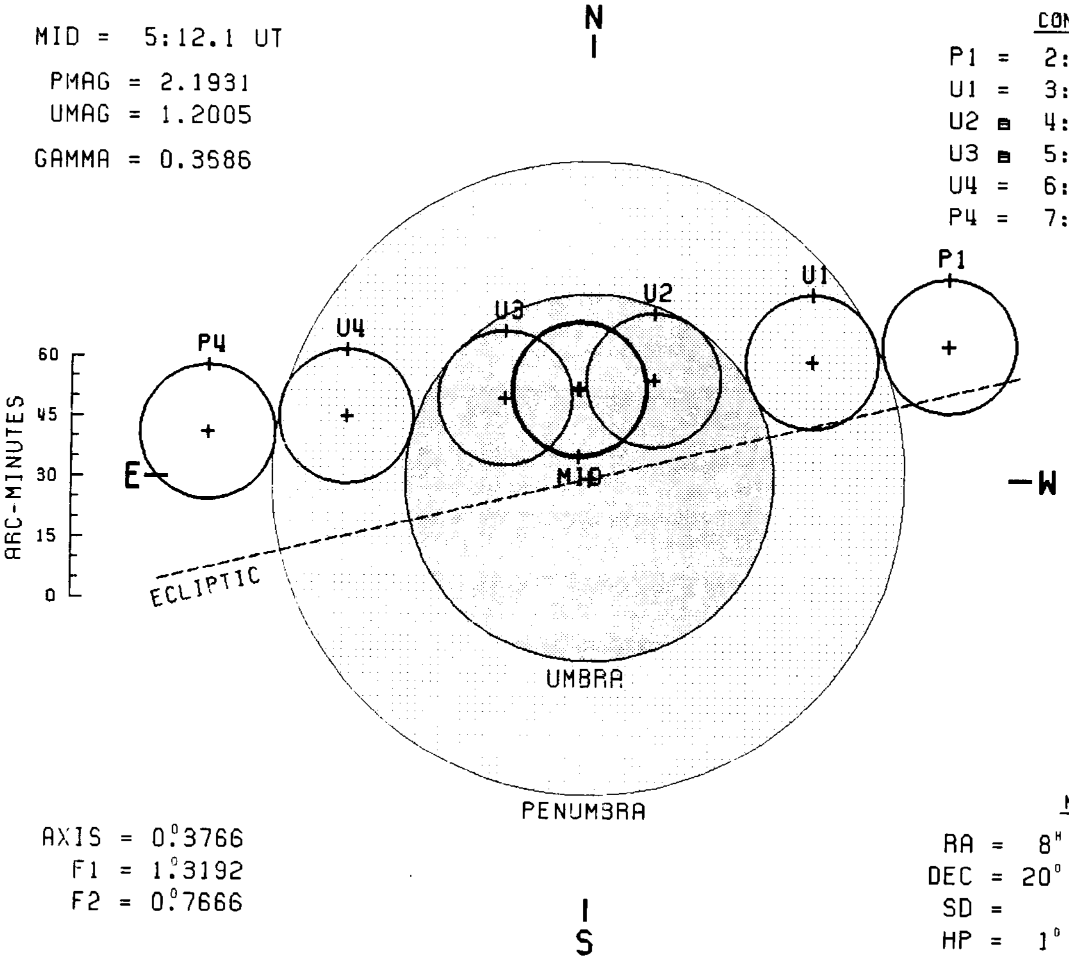
MID = 5:12.1 UT

PMAG = 2.1931
UMAG = 1.2005

GAMMA = 0.3686

CONTACTS

P1	=	2:34.7 UT
U1	=	3:33.2 UT
U2	=	4:40.7 UT
U3	=	5:43.6 UT
U4	=	6:51.0 UT
P4	=	7:49.5 UT

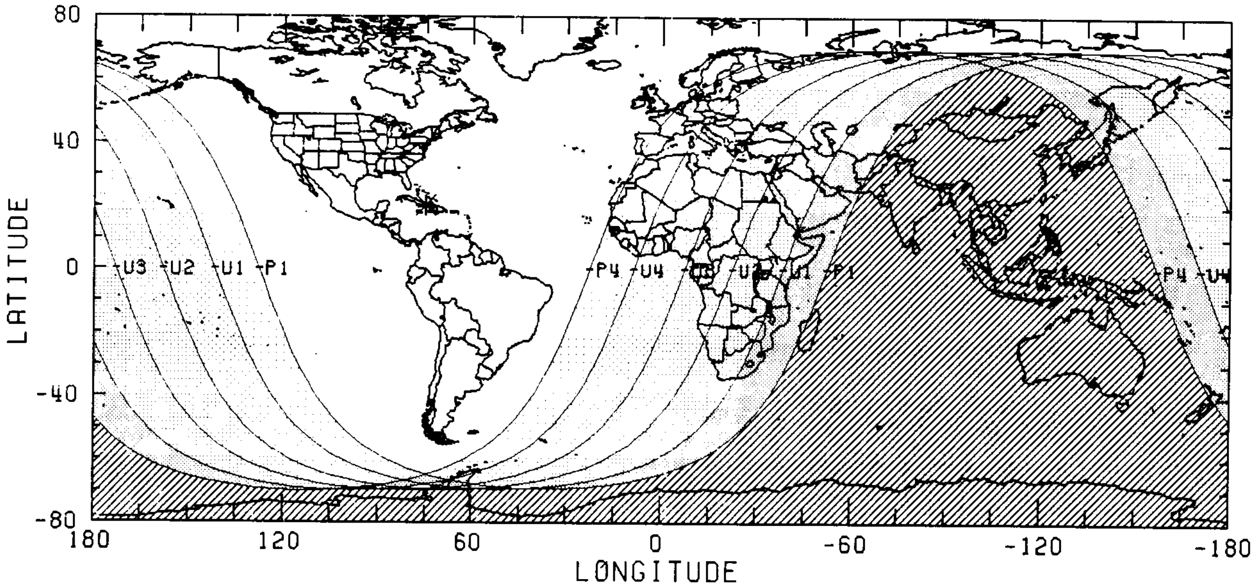


AXIS = 0°.3766
F1 = 1°.3192
F2 = 0°.7666

MOON

RA = 8ʰ 12ᵐ 28ˢ.6
DEC = 20° 20' 14".3
SD = 16' 42".1
HP = 1° 1' 17".9

SAROS 134 (27/73) JD = 2458504.718 ΔT = 80.9 S



PARTIAL LUNAR ECLIPSE - 16 JUL 2019

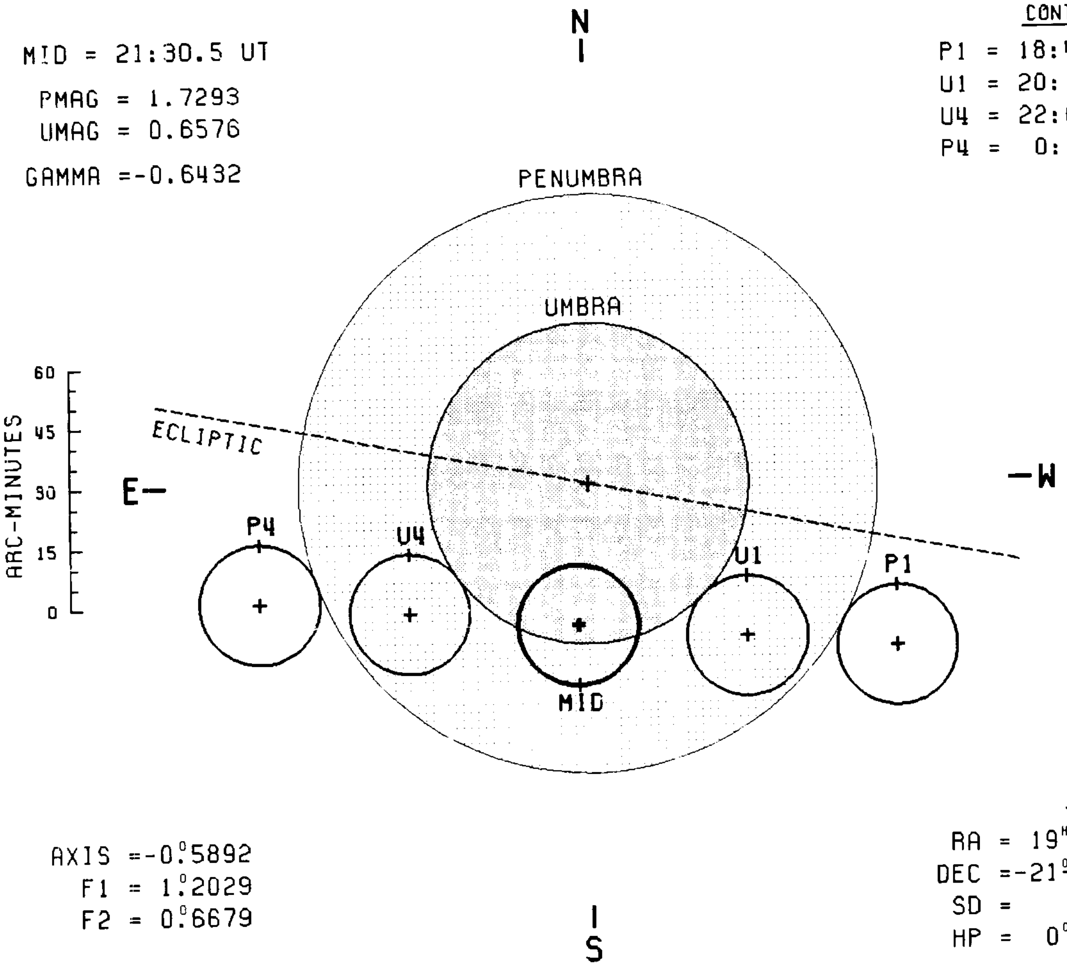
MID = 21:30.5 UT

PMAG = 1.7293
UMAG = 0.6576

GAMMA =-0.6432

CONTACTS

P1 = 18:41.7 UT
U1 = 20: 1.1 UT
U4 = 22:60.0 UT
P4 = 0:19.4 UT



AXIS =-0.°5892
F1 = 1.°2029
F2 = 0.°6679

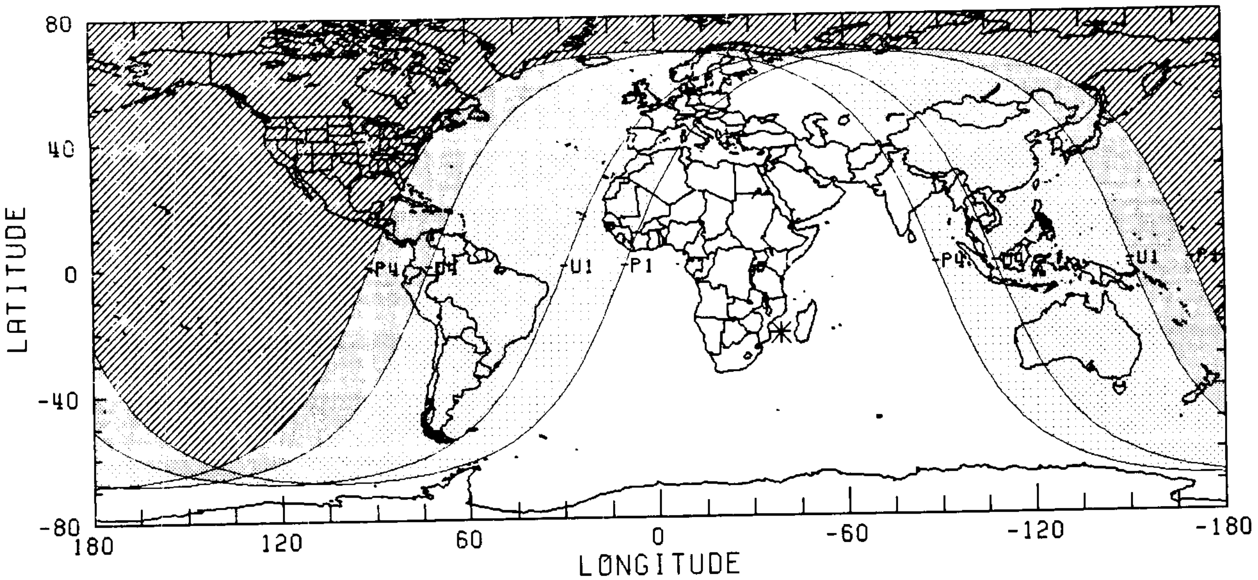
MOON

RA = 19ʰ44ᵐ 0.ˢ3
DEC =-21°52′53.″6
SD = 14′58.″7
HP = 0°54′58.″2

SAROS 139 (23/82)

JD = 2458681.397

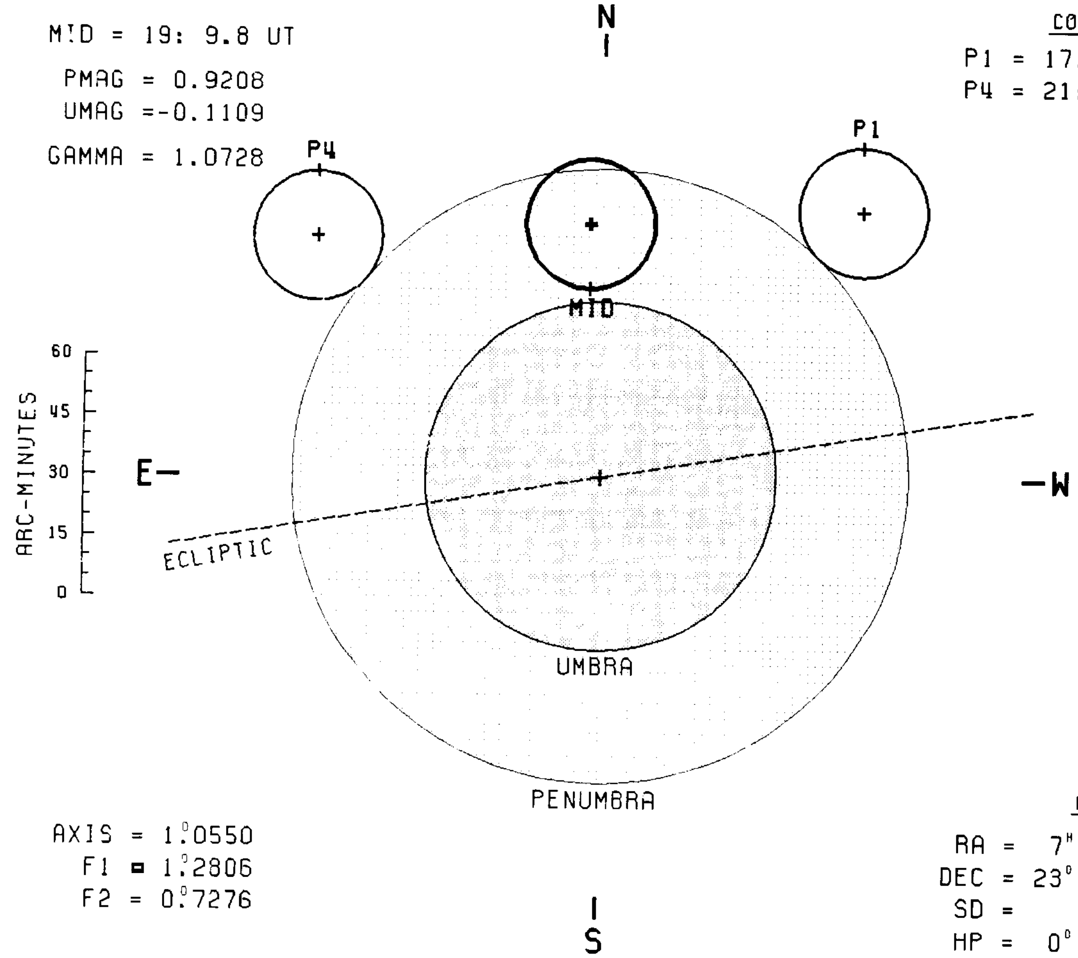
ΔT = 81.3 S



PENUMBRAL LUNAR ECLIPSE - 10 JAN 2020

MID = 19: 9.8 UT
PMAG = 0.9208
UMAG =-0.1109
GAMMA = 1.0728

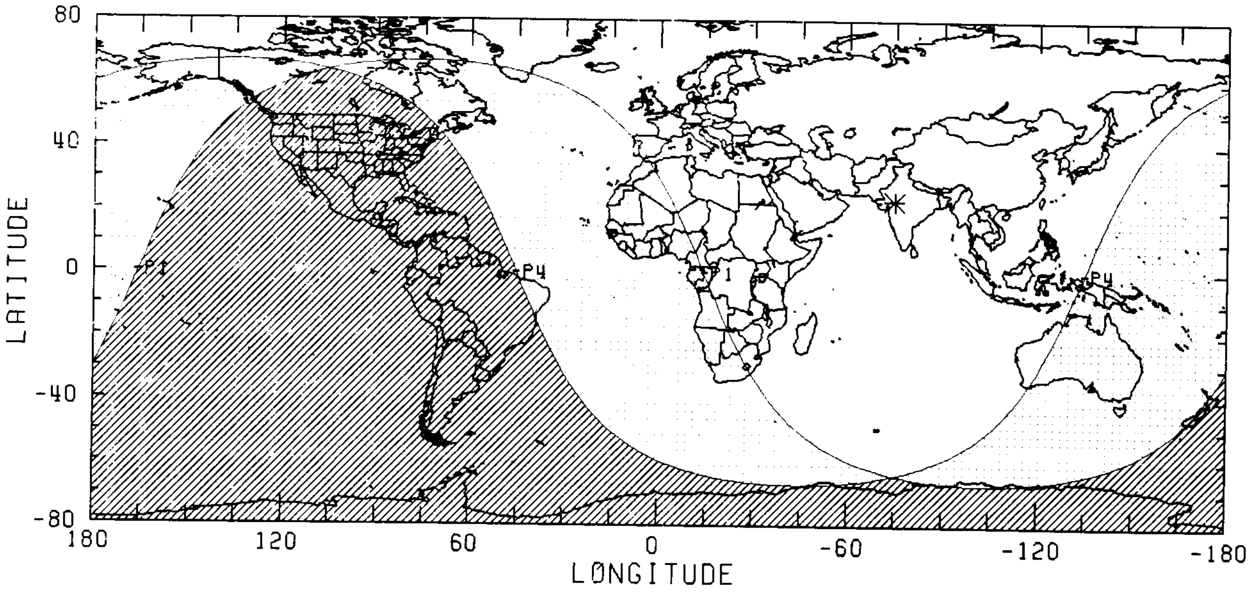
CONTACTS
P1 = 17: 5.4 UT
P4 = 21:14.3 UT



AXIS = 1°.0550
F1 = 1°.2806
F2 = 0°.7276

MOON
RA = 7ʰ26ᵐ45ˢ.7
DEC = 23° 0' 3".5
SD = 16' 4".8
HP = 0°59' 0".8

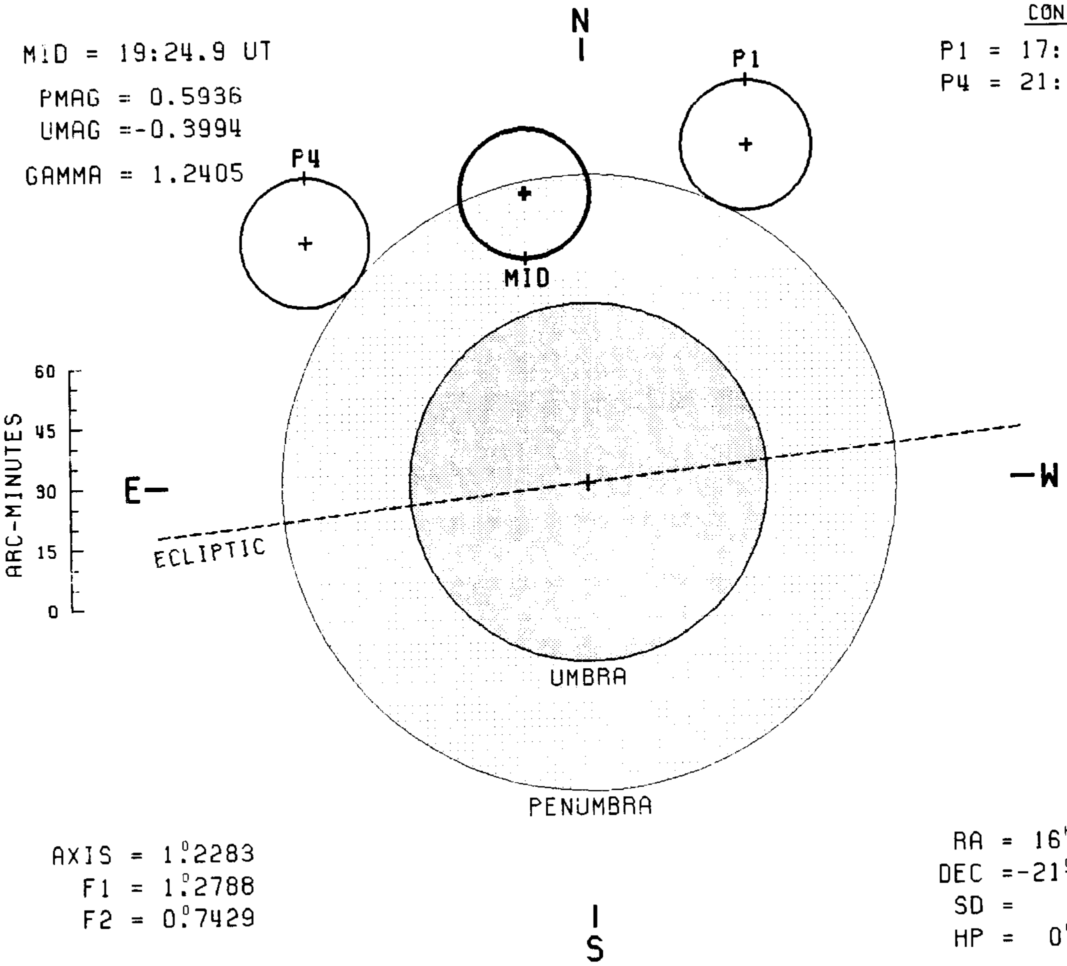
SAROS 144 (16/71) JD = 2458859.299 ΔT = 81.8 S



PENUMBRAL LUNAR ECLIPSE - 5 JUN 2020

MID = 19:24.9 UT
PMAG = 0.5936
UMAG =-0.3994
GAMMA = 1.2405

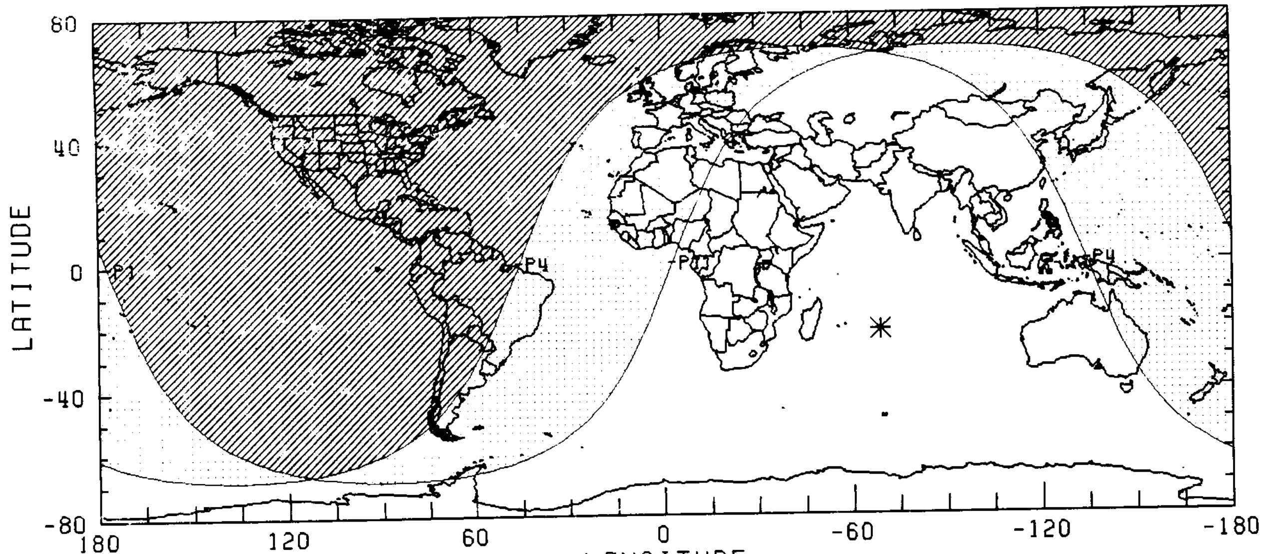
CONTACTS
P1 = 17:43.3 UT
P4 = 21: 6.4 UT



AXIS = 1°.2283
F1 = 1°.2788
F2 = 0°.7429

MOON
RA = 16ʰ58ᵐ25ˢ.5
DEC =-21°-27'-9".2
SD = 16'11".4
HP = 0°59'25".1

SAROS 111 (67/71)   JD = 2459006.310 ΔT = 82.1 S



PENUMBRAL LUNAR ECLIPSE - 5 JUL 2020

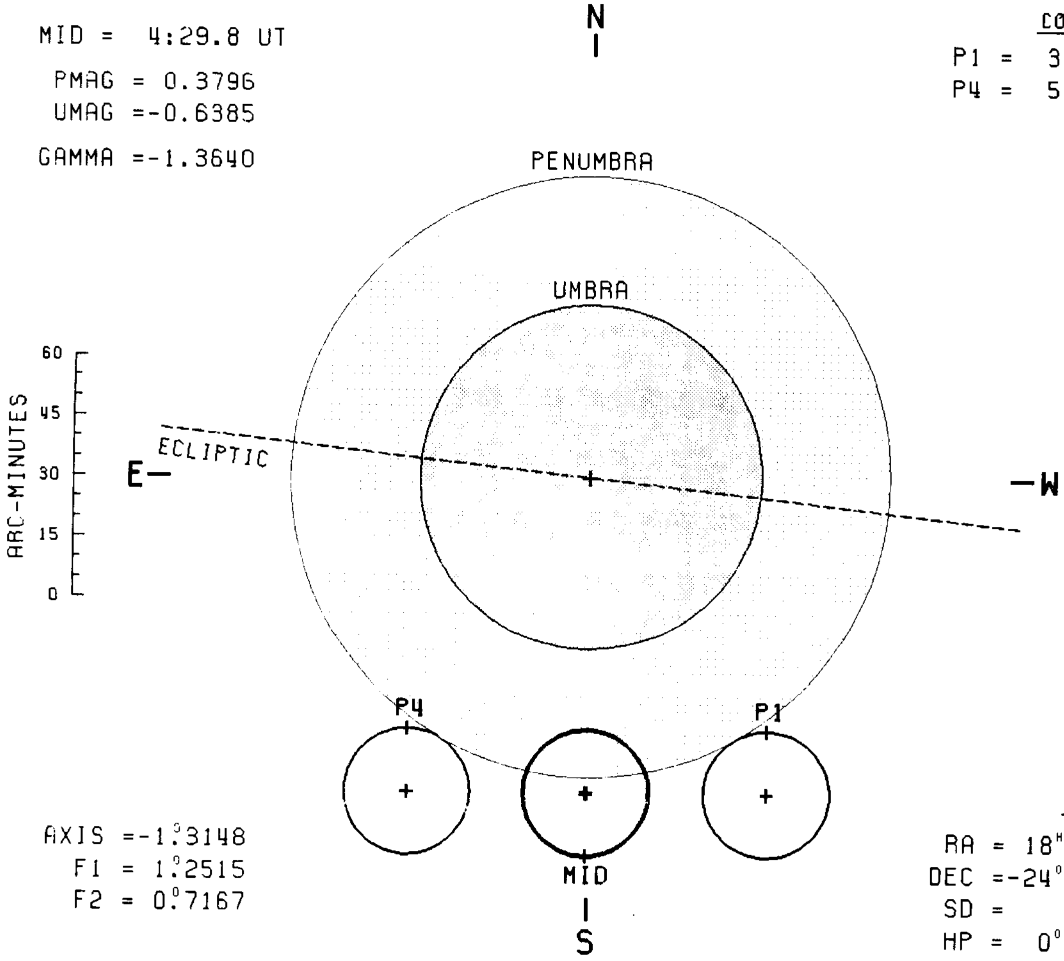
MID = 4:29.8 UT

PMAG = 0.3796
UMAG =-0.6385

GAMMA =-1.3640

CONTACTS

P1 = 3: 4.2 UT
P4 = 5:55.2 UT

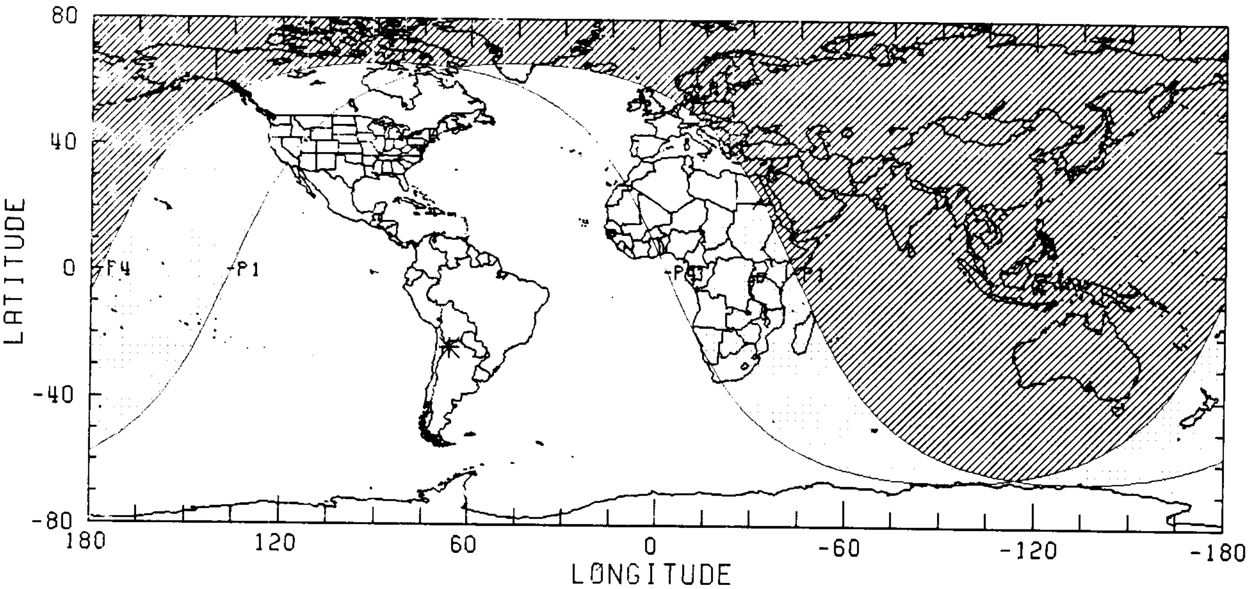


AXIS =-1°.3148
F1 = 1°.2515
F2 = 0°.7167

MOON

RA = 18h59m12.5s
DEC =-24°-3'-16."8
SD = 15'45."6
HP = 0°57'50."4

SAROS 149 (3/72)   JD = 2459035.688   ΔT = 82.2 S



PENUMBRAL LUNAR ECLIPSE - 30 NOV 2020

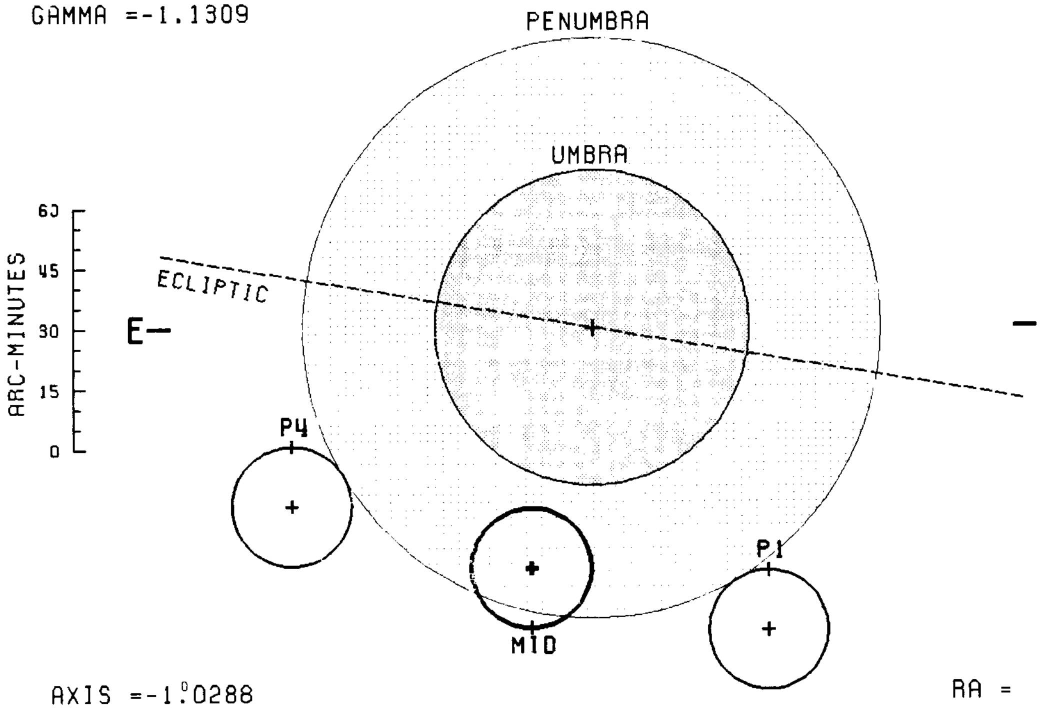
MID = 9:42.6 UT

PMAG = 0.8548
UMAG =-0.2575

GAMMA =-1.1309

CONTACTS

P1 = 7:29.8 UT
P4 = 11:55.7 UT

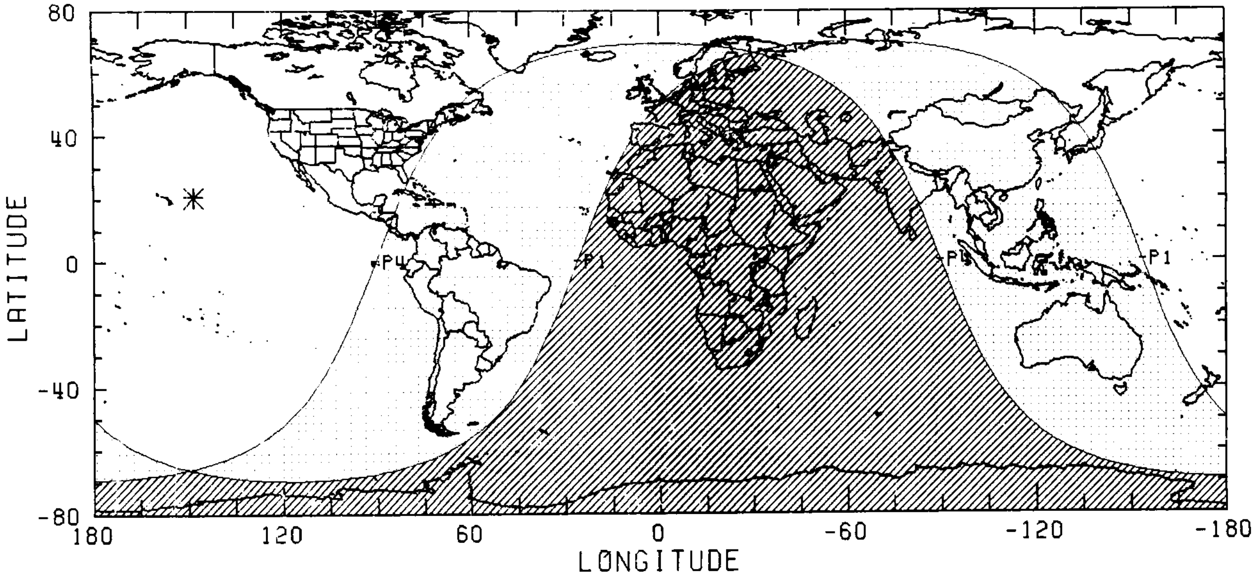


AXIS =-1.°0288
F1 = 1.°2047
F2 = 0.°6532

MOON

RA = 4ʰ28ᵐ46.ˢ5
DEC = 20°44'46."1
SD = 14'52."4
HP = 0°54'35."1

SAROS 116 (58/73) JD = 2459183.906 ΔT = 82.6 S



TOTAL LUNAR ECLIPSE - 26 MAY 2021

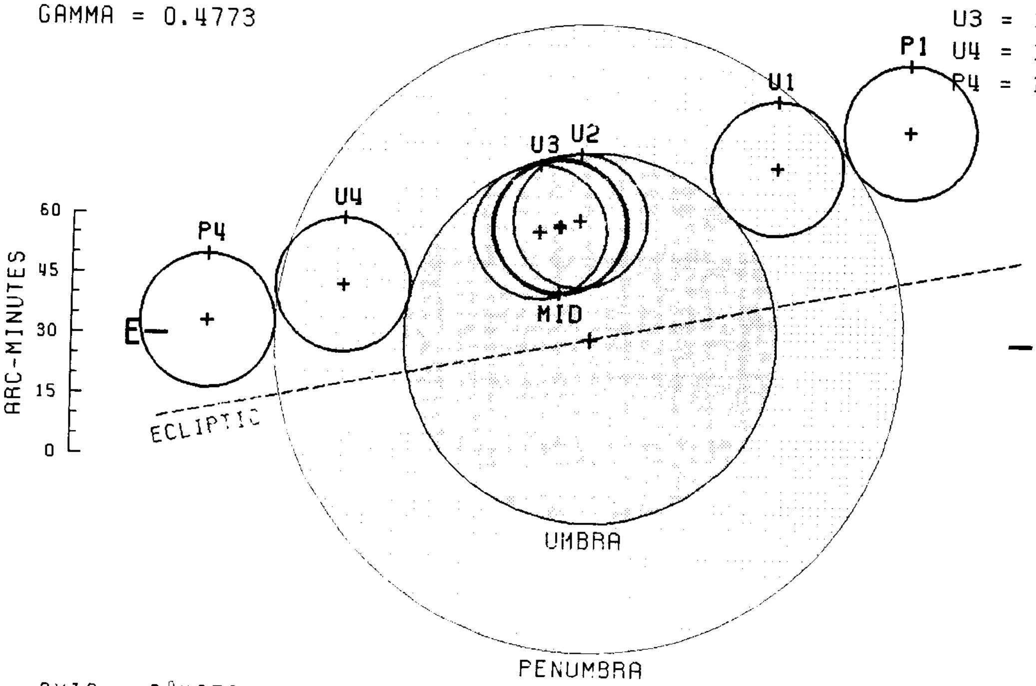
MID = 11:18.5 UT

PMAG = 1.9790
UMAG = 1.0155

GAMMA = 0.4773

CONTACTS

P1 = 8:45.9 UT
U1 = 9:44.4 UT
U2 = 11: 9.9 UT
U3 = 11:27.4 UT
U4 = 12:52.8 UT
P4 = 13:51.2 UT



AXIS = 0°.4879
F1 = 1°.3119
F2 = 0°.7751

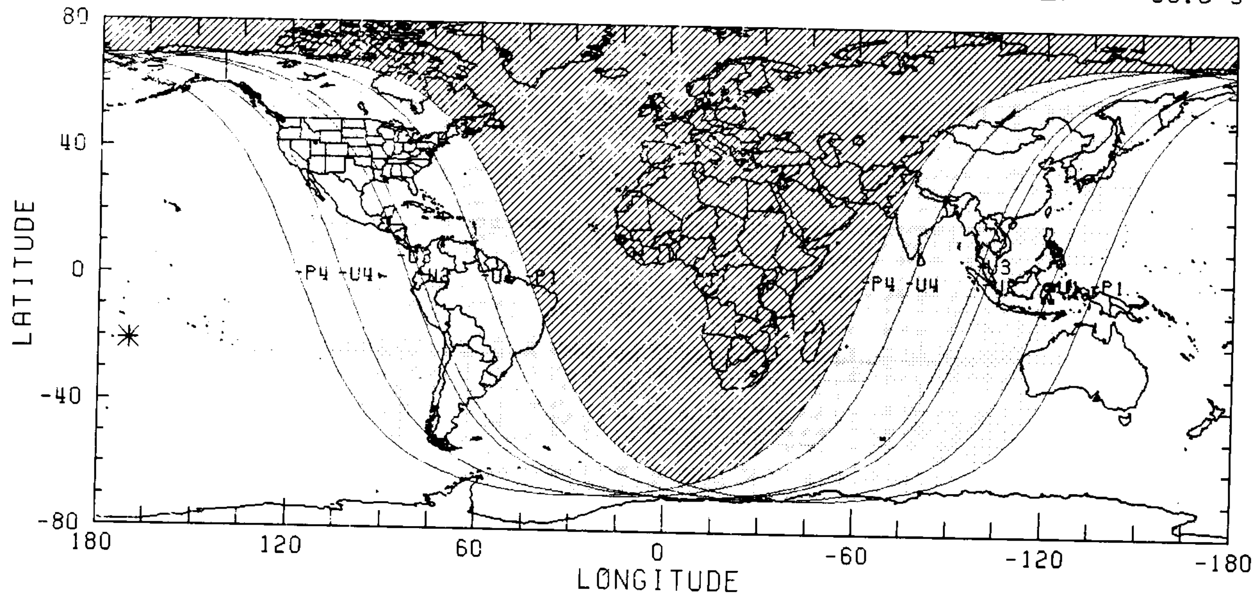
MOON

RA = 16ʰ 14ᵐ 37ˢ.7
DEC = -20° 44' 15".2
SD = 16' 42".8
HP = 1° 1' 20".5

SAROS 121 (56/84)

JD = 2459360.972

ΔT = 83.0 S



PARTIAL LUNAR ECLIPSE - 19 NOV 2021

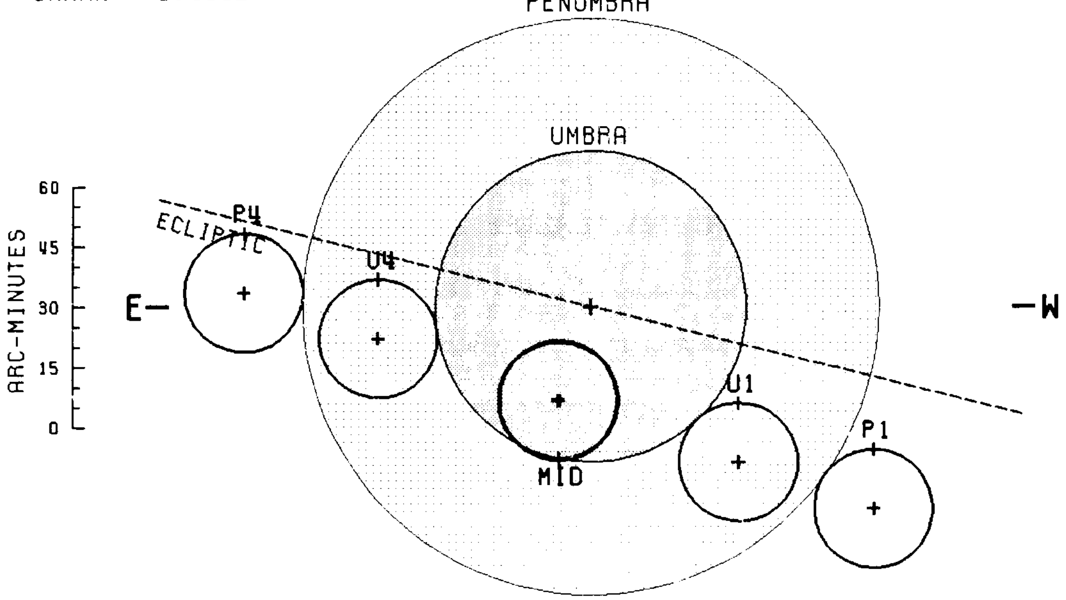
MID = 9: 2.7 UT

PMAG = 2.0984
UMAG = 0.9786

GAMMA =-0.4552

CONTACTS

P1 = 6: 0.0 UT
U1 = 7:18.1 UT
U4 = 10:47.4 UT
P4 = 12: 5.5 UT

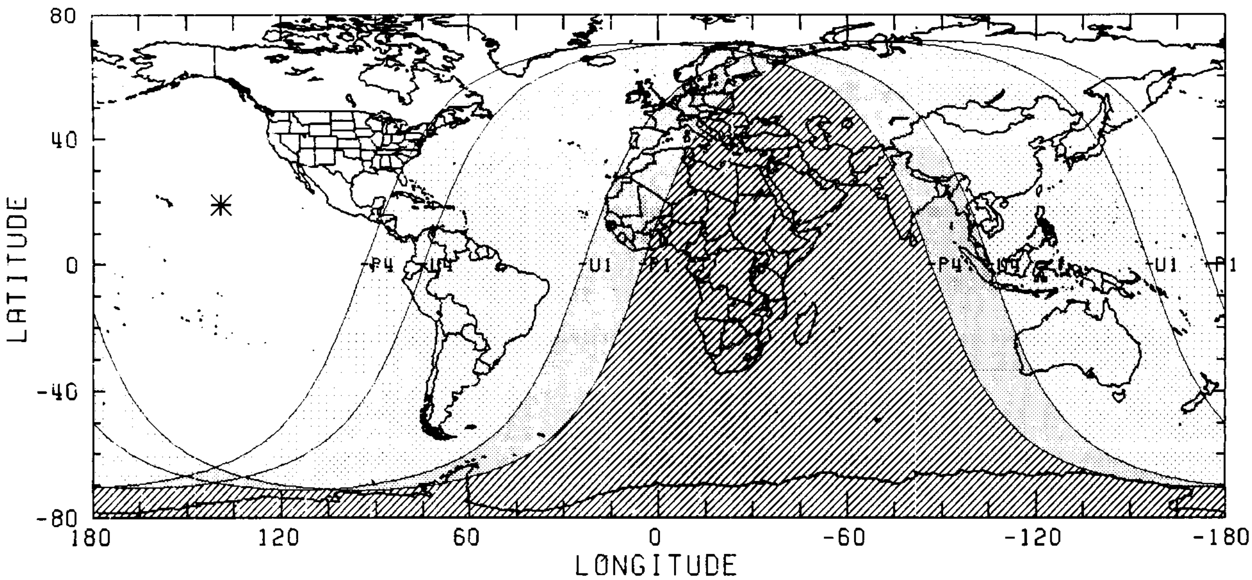


AXIS =-0.°4104
F1 = 1.°1958
F2 = 0.°6456

MOON

RA = 3ʰ40ᵐ24.ˢ7
DEC = 19° 9'15.''2
SD = 14'44.''5
HP = 0°54' 6.''0

SAROS 126 (46/72)   JD = 2459537.878   ΔT = 83.5 S



TOTAL LUNAR ECLIPSE - 16 MAY 2022

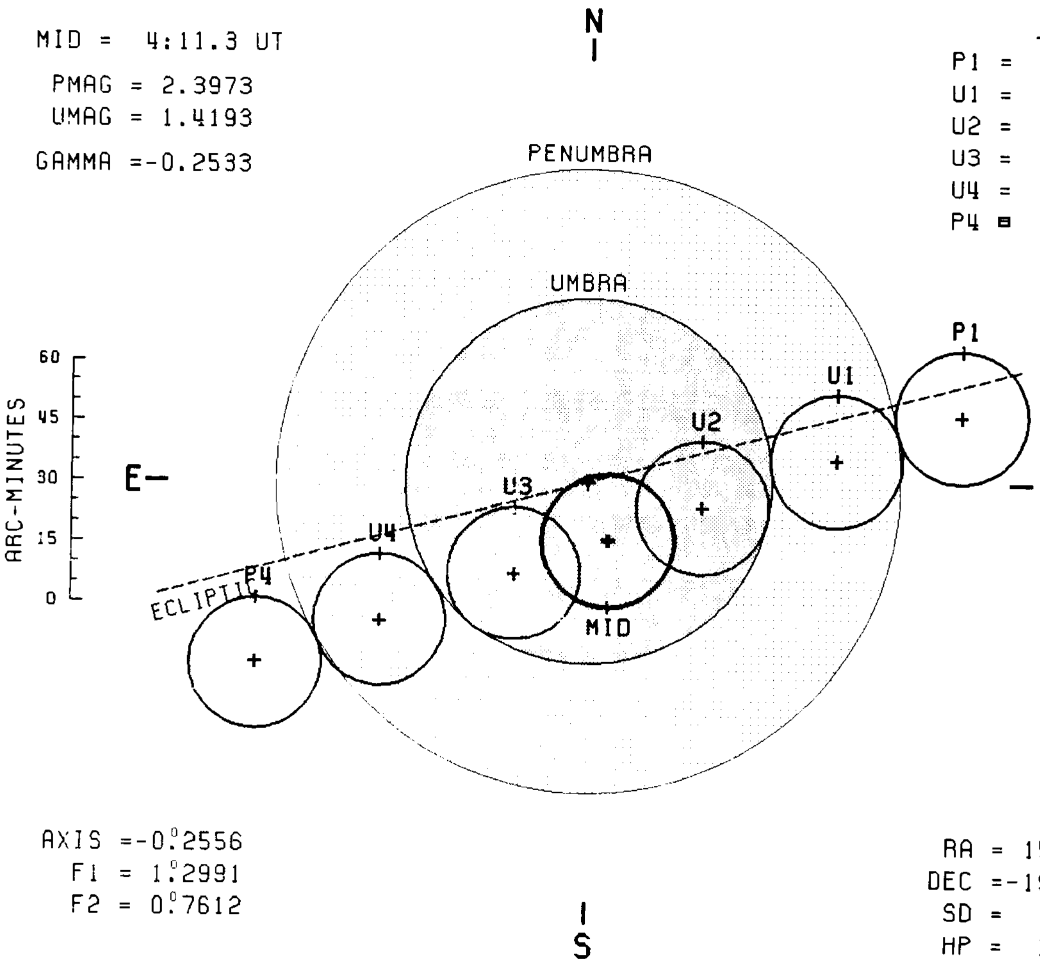
MID = 4:11.3 UT

PMAG = 2.3973
UMAG = 1.4193

GAMMA =-0.2533

CONTACTS

P1 = 1:30.3 UT
U1 = 2:27.1 UT
U2 = 3:28.3 UT
U3 = 4:54.1 UT
U4 = 5:55.3 UT
P4 = 6:52.2 UT

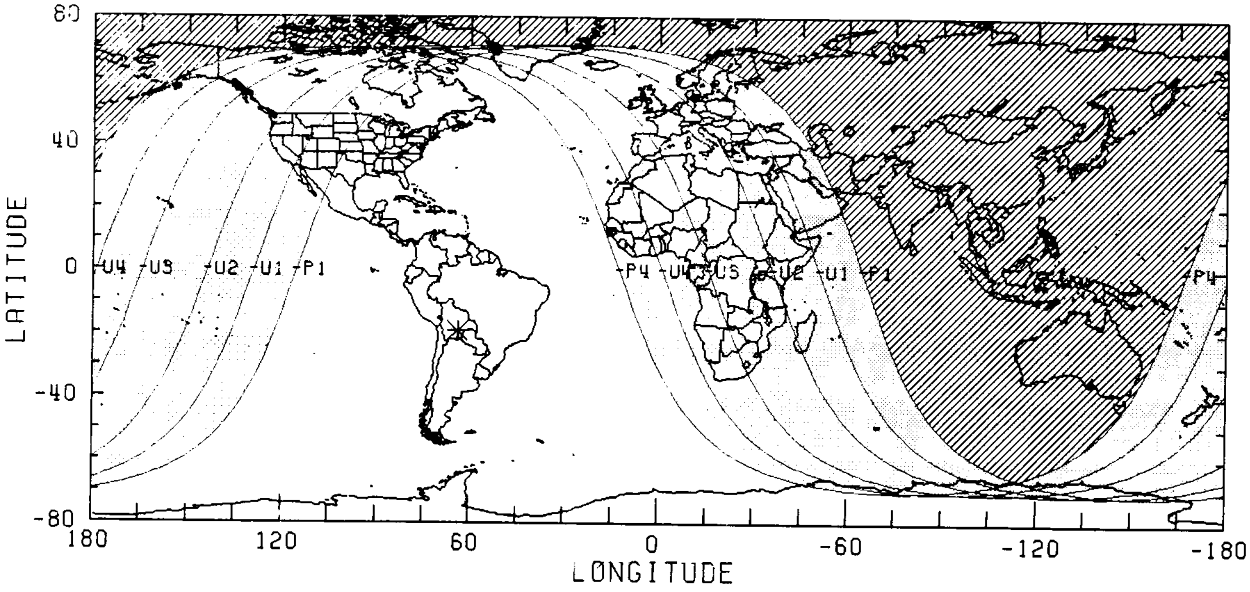


AXIS =-0°.2556
F1 = 1°.2991
F2 = 0°.7612

MOON

RA = 15ʰ 31ᵐ 27ˢ.7
DEC =-19° 19' 40".6
SD = 16' 29".9
HP = 1° 0' 33".1

SAROS 131 (34/72) JD = 2459715.675 ΔT = 83.9 S



TOTAL LUNAR ECLIPSE - 8 NOV 2022

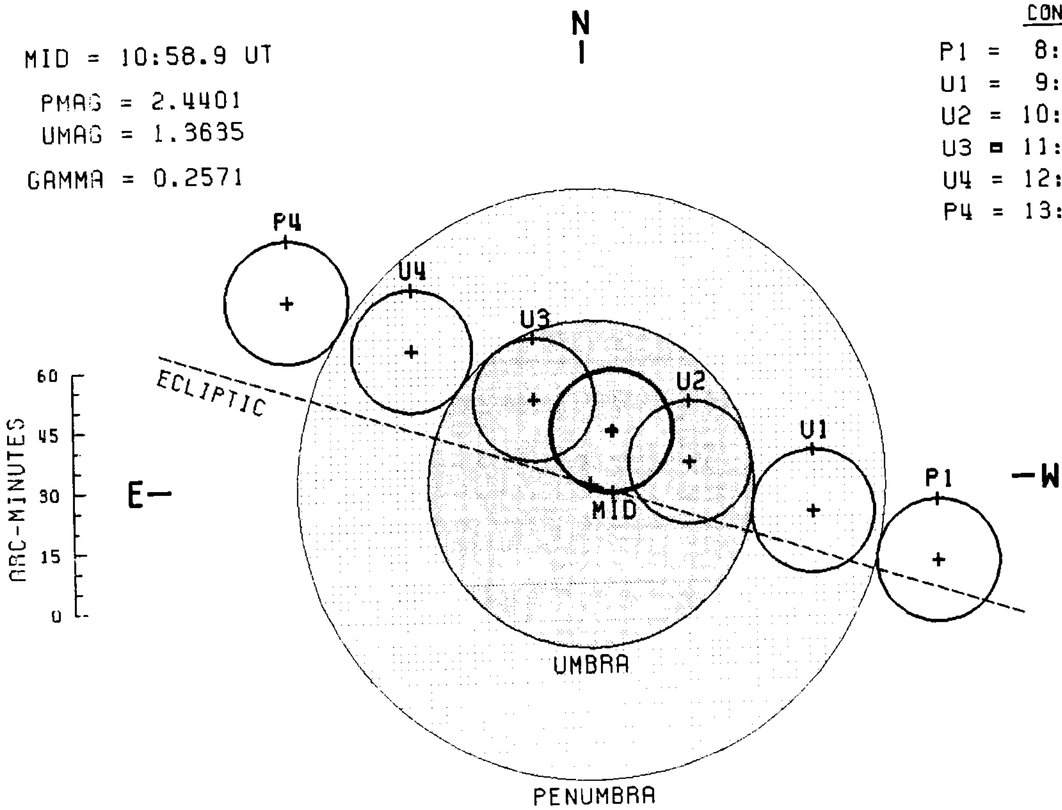
MID = 10:58.9 UT

PMAG = 2.4401
UMAG = 1.3635

GAMMA = 0.2571

CONTACTS

P1 = 8: 0.2 UT
U1 = 9: 8.4 UT
U2 = 10:15.8 UT
U3 = 11:41.7 UT
U4 = 12:49.2 UT
P4 = 13:57.7 UT



AXIS = 0.°2405
F1 = 1.°2296
F2 = 0.°6807

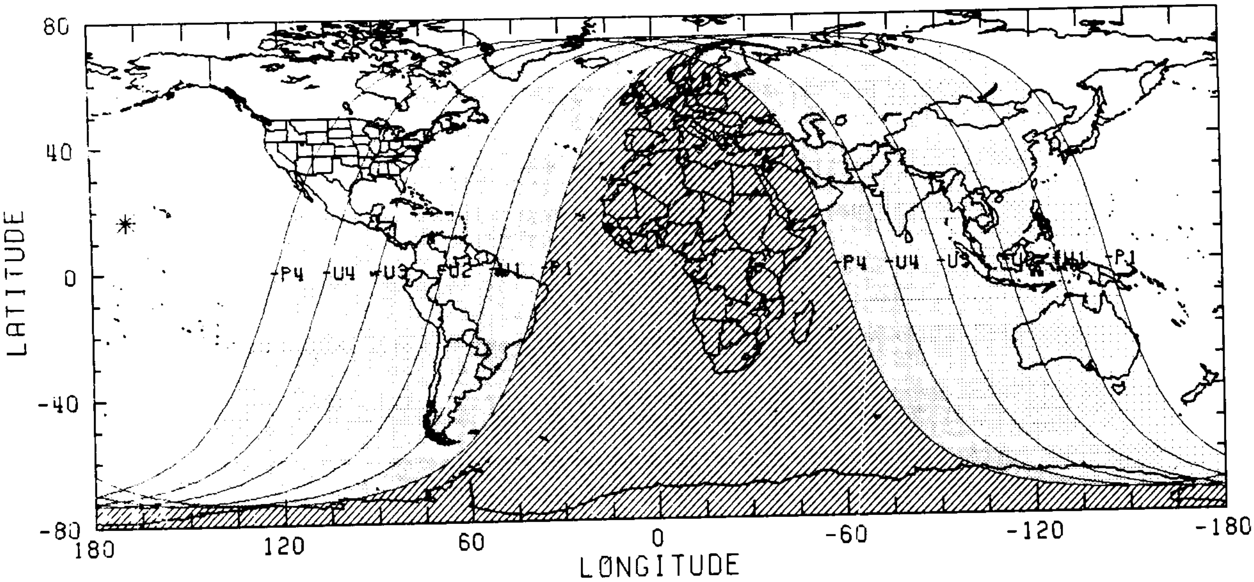
MOON

RA = 2ʰ53ᵐ48.ˢ0
DEC = 16°51' 6."4
SD = 15'17."7
HP = 0°56' 7."8

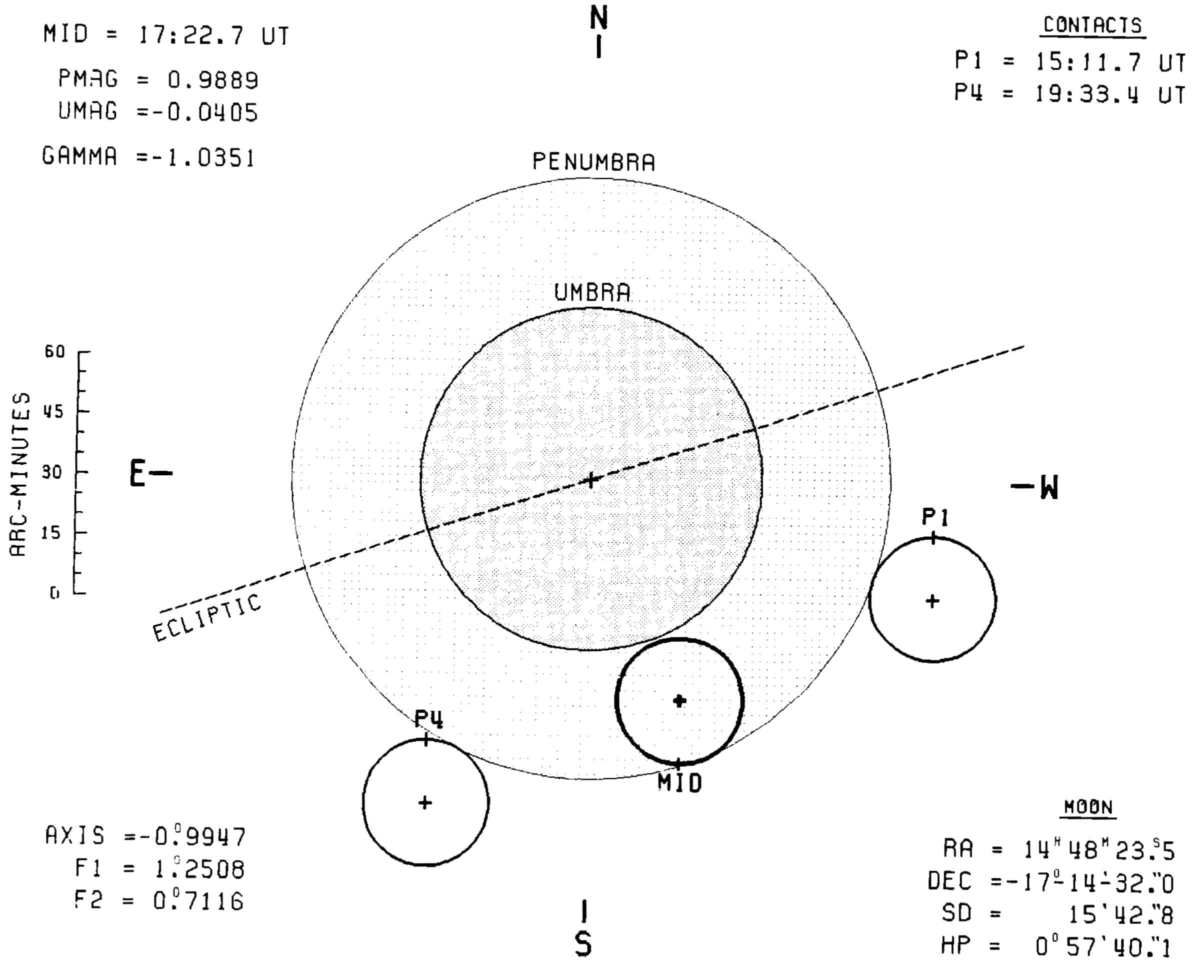
SAROS 136 (20/72)

JD = 2459891.959

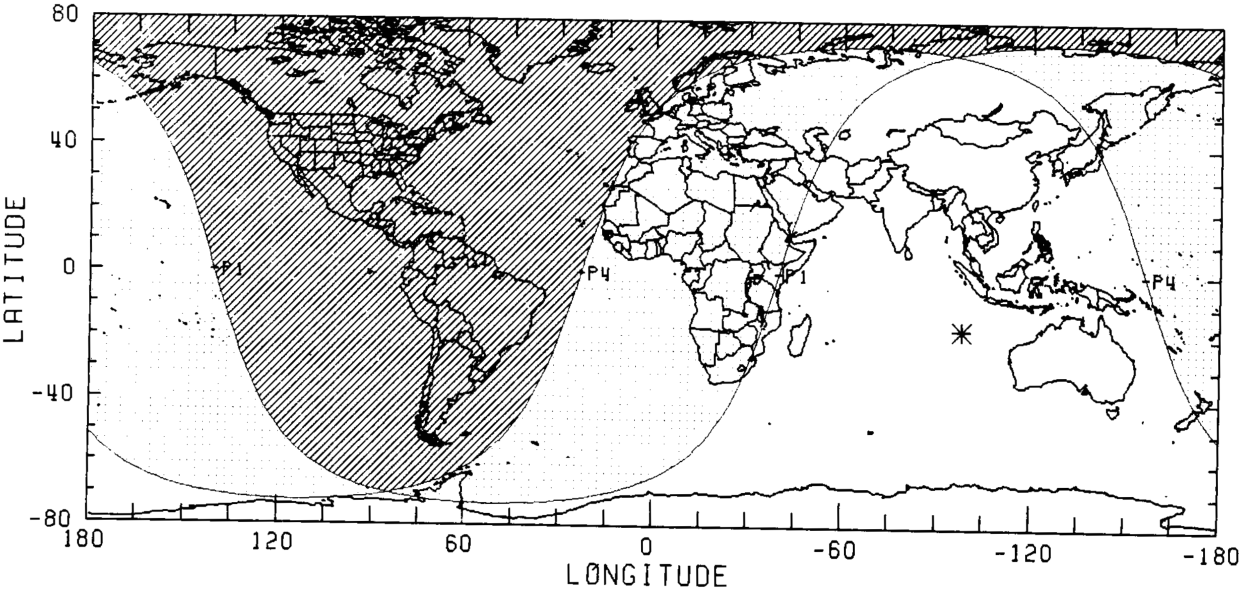
ΔT = 84.4 S



PENUMBRAL LUNAR ECLIPSE - 5 MAY 2023



SAROS 141 (24/73) JD = 2460070.225 ΔT = 84.9 S



PARTIAL LUNAR ECLIPSE - 28 OCT 2023

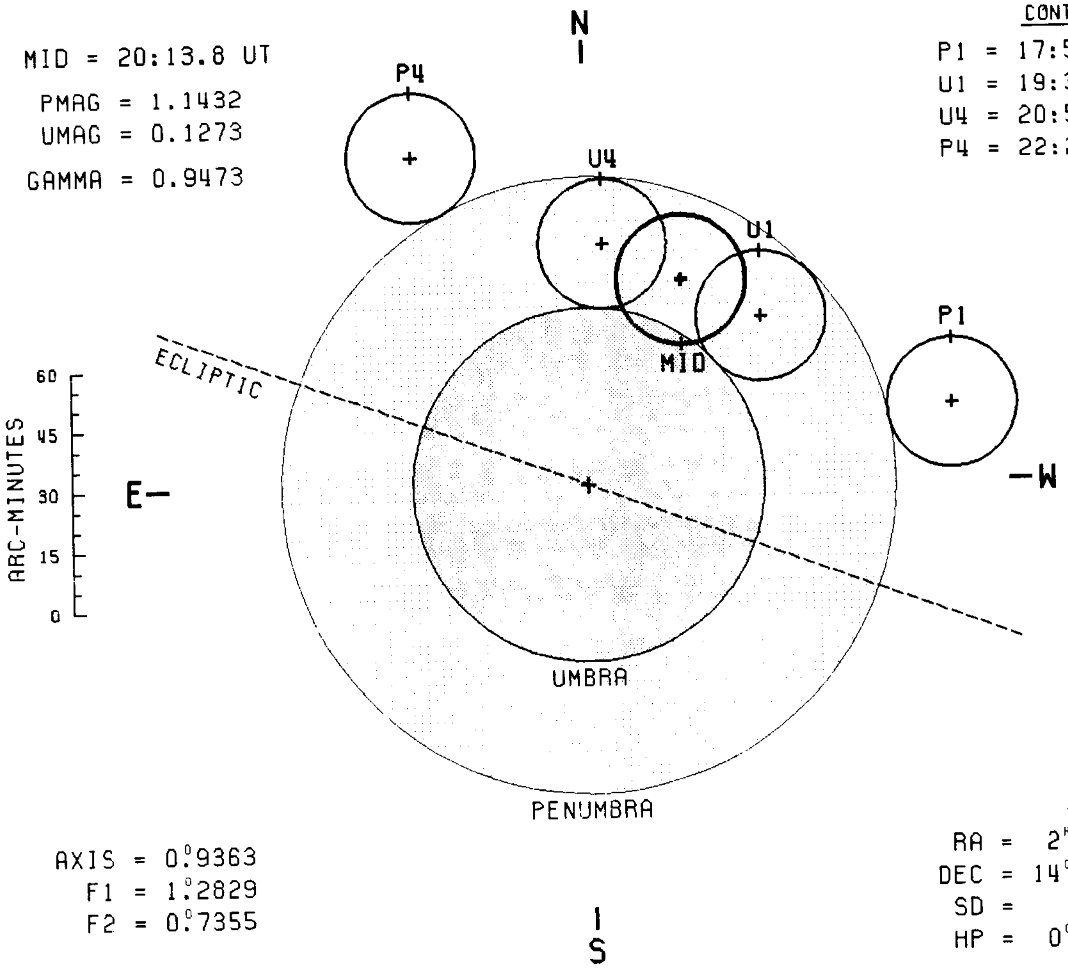
MID = 20:13.8 UT

PMAG = 1.1432
UMAG = 0.1273

GAMMA = 0.9473

CONTACTS

P1 = 17:59.4 UT
U1 = 19:34.1 UT
U4 = 20:52.8 UT
P4 = 22:27.8 UT

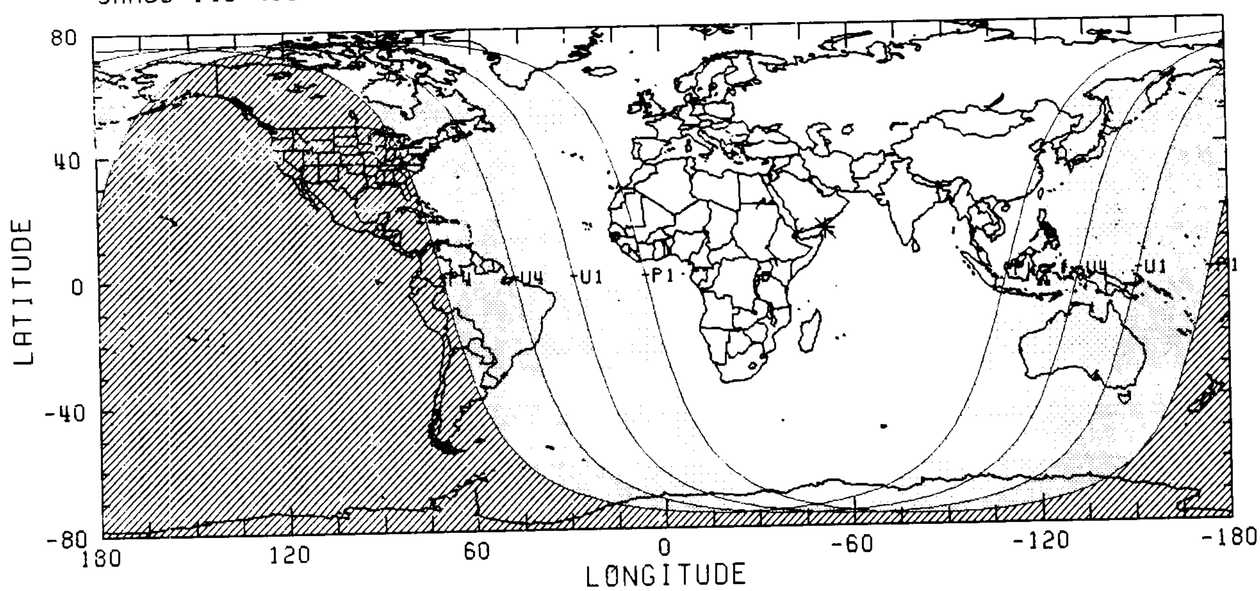


AXIS = 0°.9363
F1 = 1°.2829
F2 = 0°.7355

MOON

RA = $2^h\ 9^m 47.^s5$
DEC = $14°\ 5'\ 1.''5$
SD = $16'\ 9.''7$
HP = $0°59'18.''9$

SAROS 146 (11/72)   JD = 2460246.344 ΔT = 85.3 S



PENUMBRAL LUNAR ECLIPSE - 25 MAR 2024

MID = 7:12.6 UT

PMAG = 0.9821

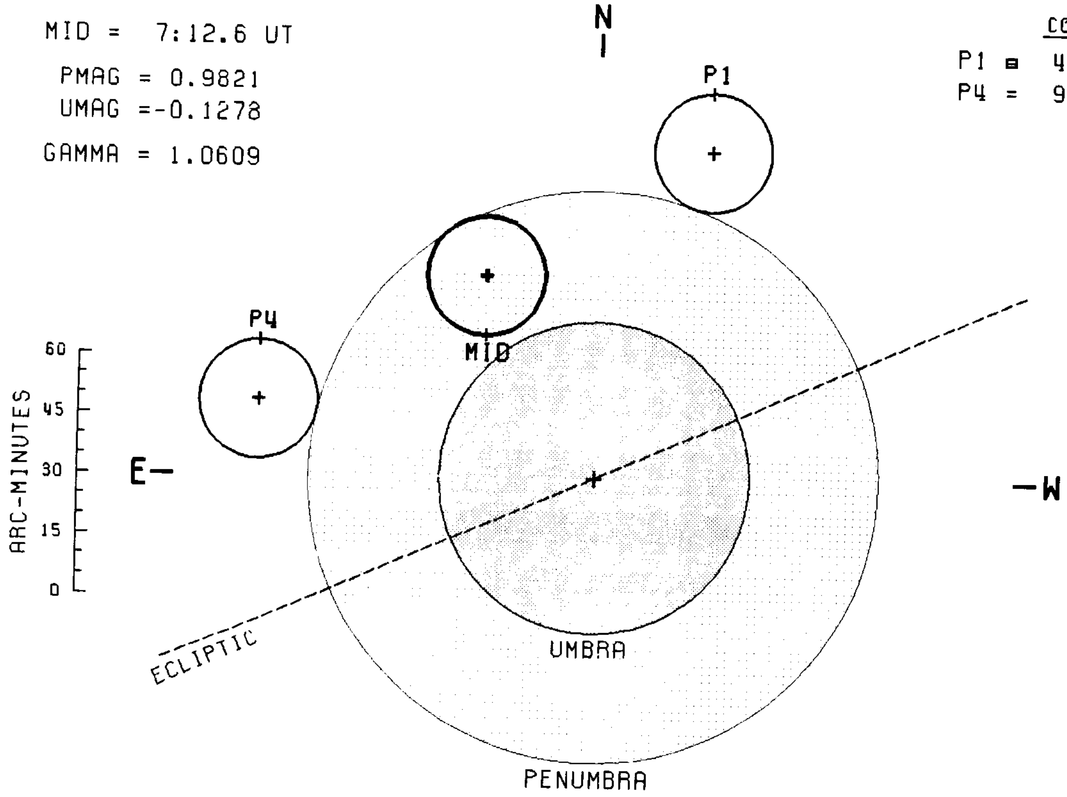
UMAG =-0.1278

GAMMA = 1.0609

CONTACTS

P1 = 4:50.9 UT

P4 = 9:34.7 UT



AXIS = 0.°9563

F1 = 1.°1931

F2 = 0.°6479

MOON

RA = $12^h 20^m 41.^s2$

DEC = $-1^\circ 12' -5.''6$

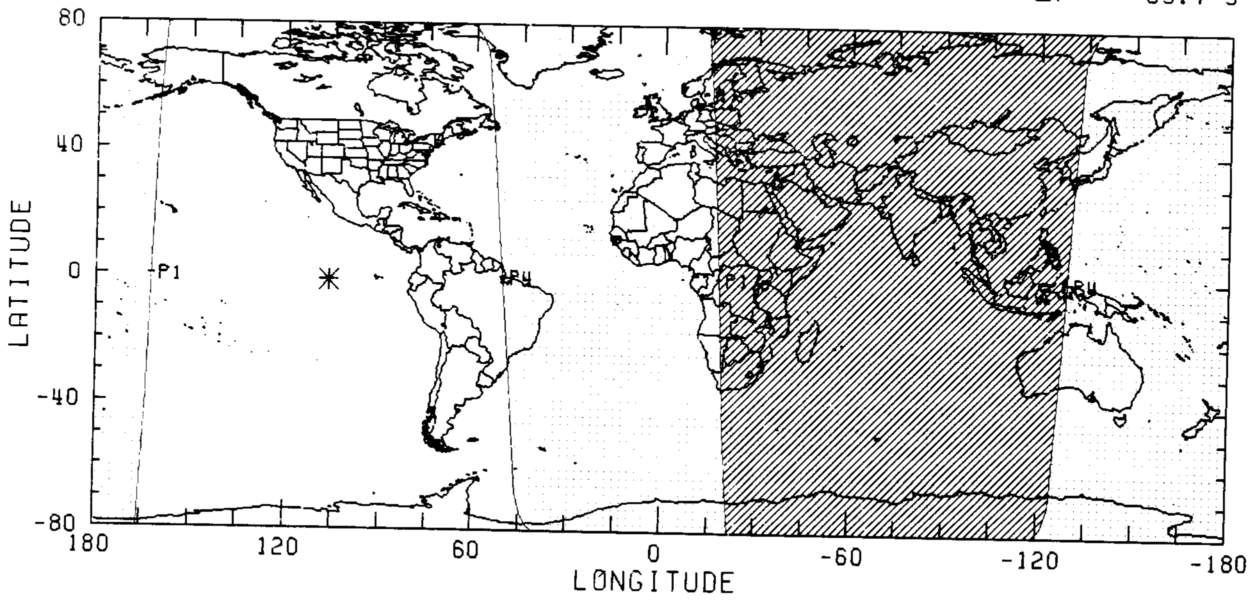
SD = $14' 44.''3$

HP = $0^\circ 54'\ 5.''4$

SAROS 113 (64/71)

JD = 2460394.801

ΔT = 85.7 S



PARTIAL LUNAR ECLIPSE - 18 SEP 2024

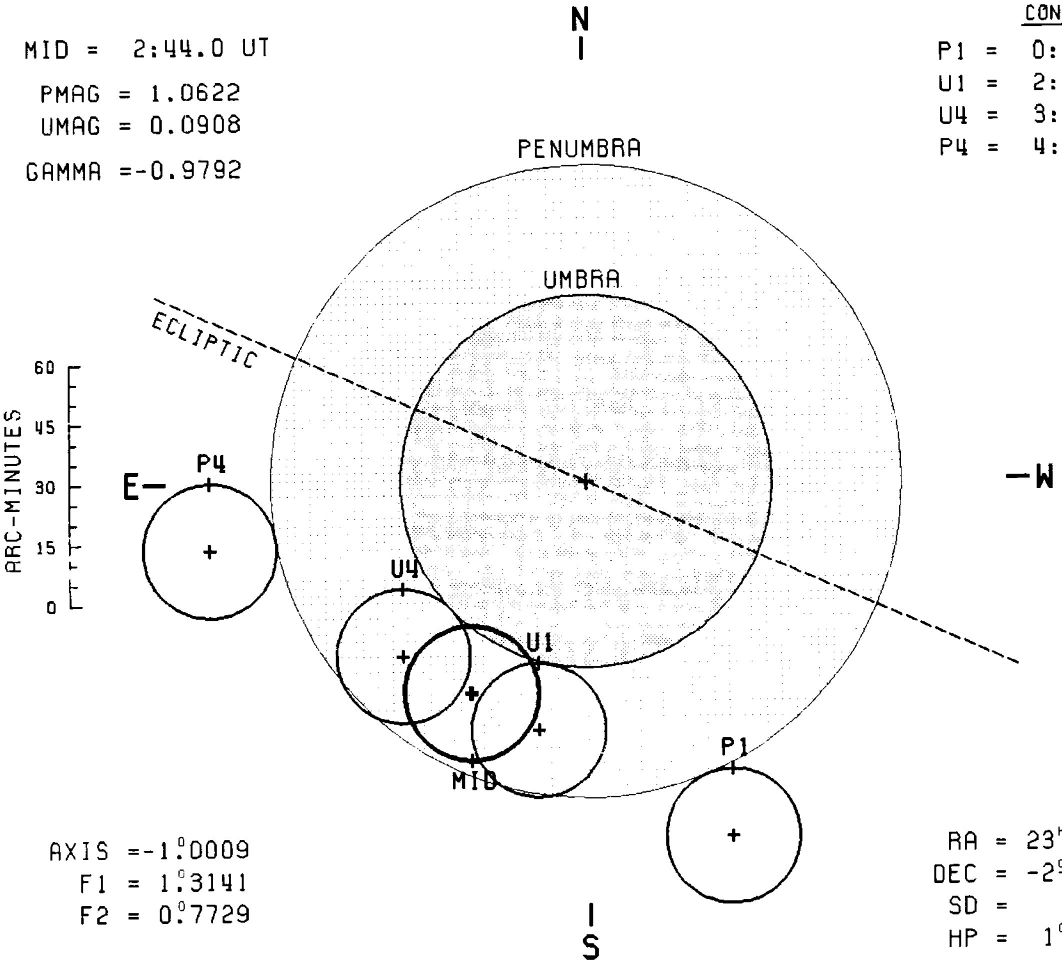
MID = 2:44.0 UT

PMAG = 1.0622
UMAG = 0.0908

GAMMA =-0.9792

CONTACTS

P1 = 0:39.2 UT
U1 = 2:12.0 UT
U4 = 3:16.5 UT
P4 = 4:49.2 UT

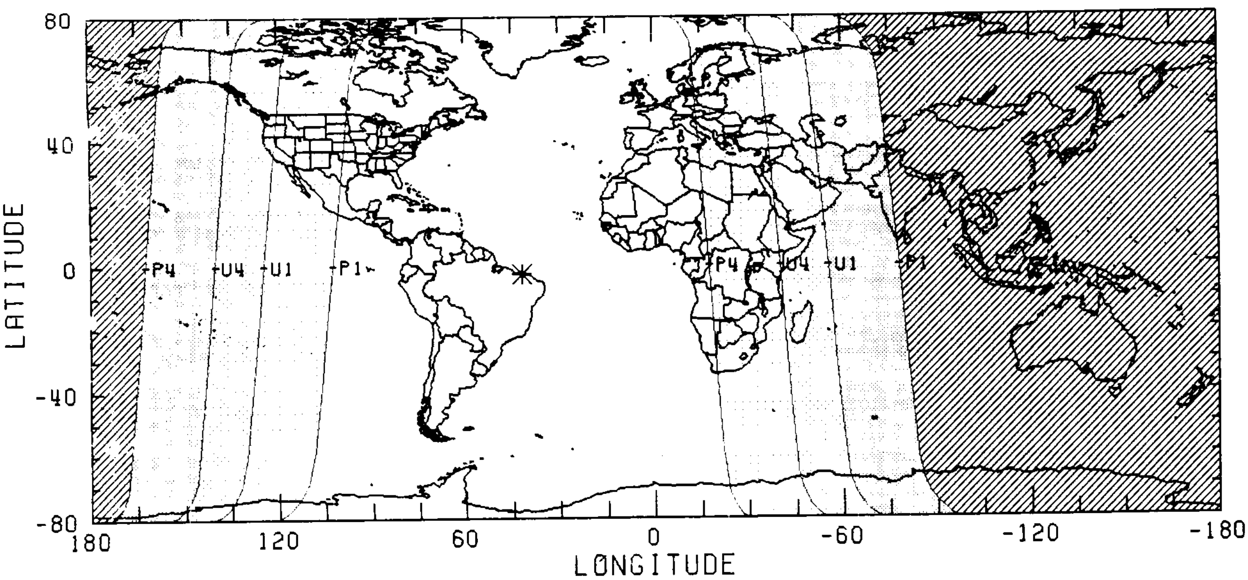


AXIS =-1°.0009
F1 = 1°.3141
F2 = 0°.7729

MOON

RA = 23ʰ46ᵐ 6ˢ.0
DEC = -2°35'26".9
SD = 16'42".8
HP = 1° 1'20".4

SAROS 118 (53/75) JD = 2460571.615 ΔT = 86.2 S



TOTAL LUNAR ECLIPSE - 14 MAR 2025

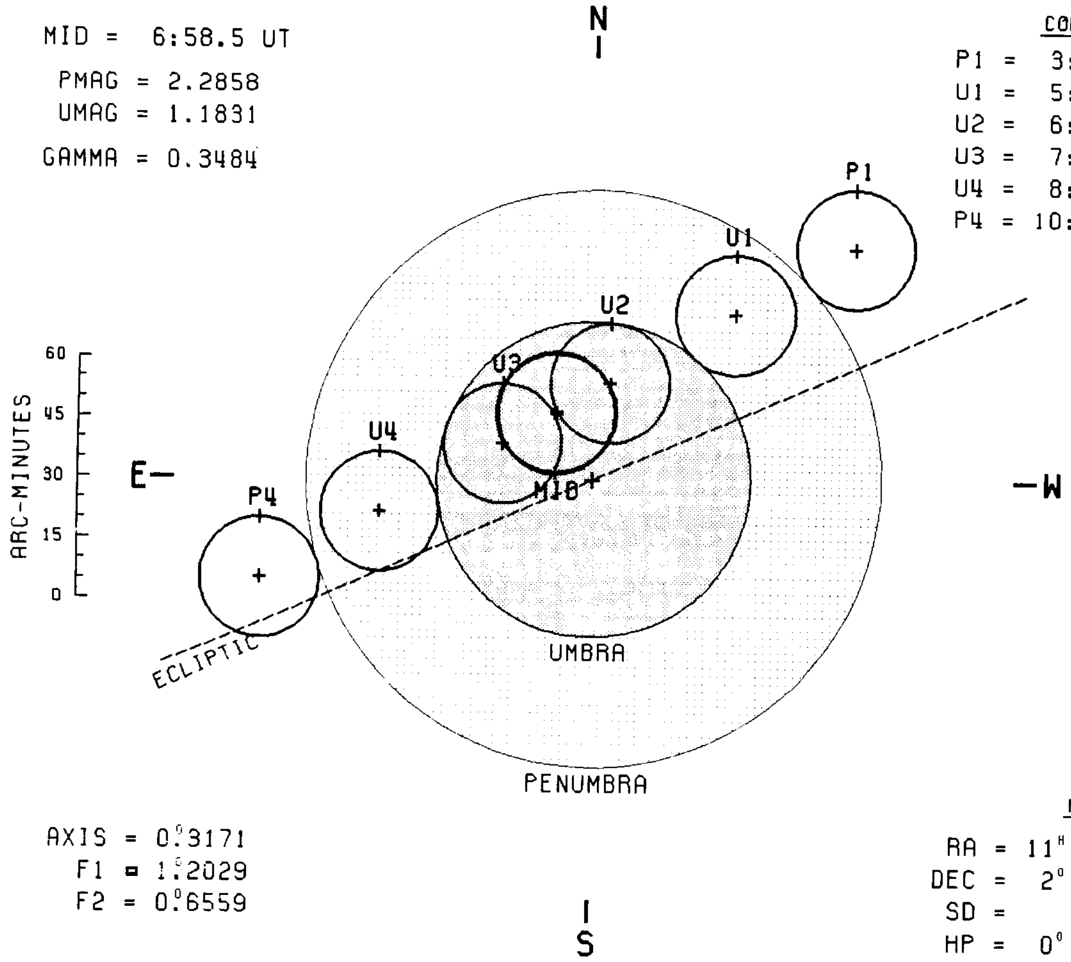
MID = 6:58.5 UT

PMAG = 2.2858
UMAG = 1.1831

GAMMA = 0.3484

CONTACTS

P1	=	3:55.4 UT
U1	=	5: 9.0 UT
U2	=	6:25.6 UT
U3	=	7:31.9 UT
U4	=	8:48.1 UT
P4	=	10: 1.8 UT

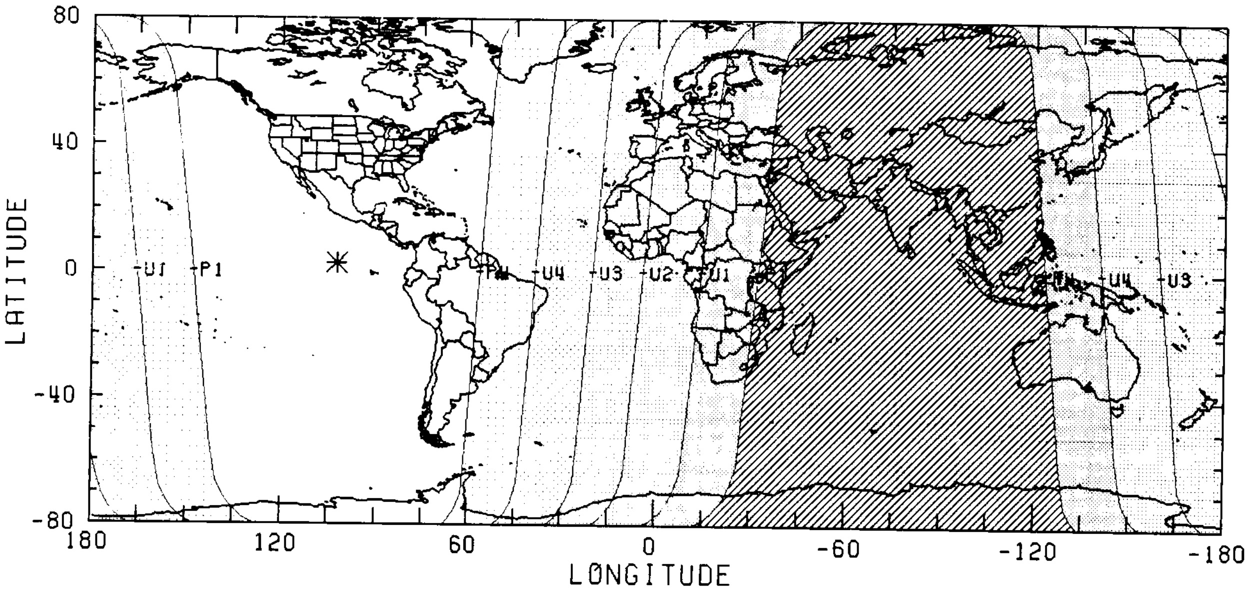


AXIS = 0°.3171
F1 = 1°.2029
F2 = 0°.6559

MOON

RA = 11ʰ38ᵐ22ˢ.9
DEC = 2°40'54".7
SD = 14'52".8
HP = 0°54'36".8

SAROS 123 (53/73) JD = 2460748.792 ΔT = 86.6 S



TOTAL LUNAR ECLIPSE - 7 SEP 2025

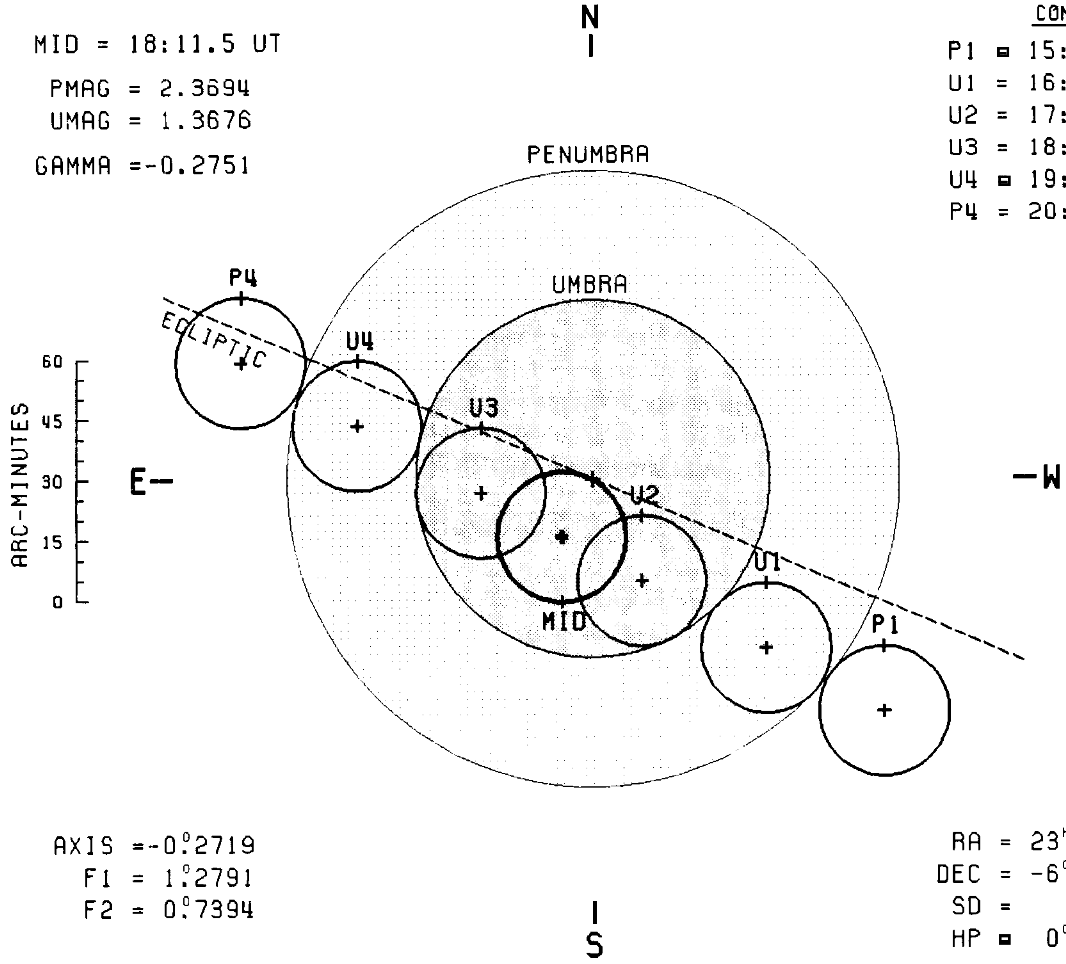
MID = 18:11.5 UT

PMAG = 2.3694
UMAG = 1.3676

GAMMA =-0.2751

CONTACTS

P1 = 15:26.5 UT
U1 = 16:26.4 UT
U2 = 17:30.2 UT
U3 = 18:53.2 UT
U4 = 19:56.7 UT
P4 = 20:56.5 UT

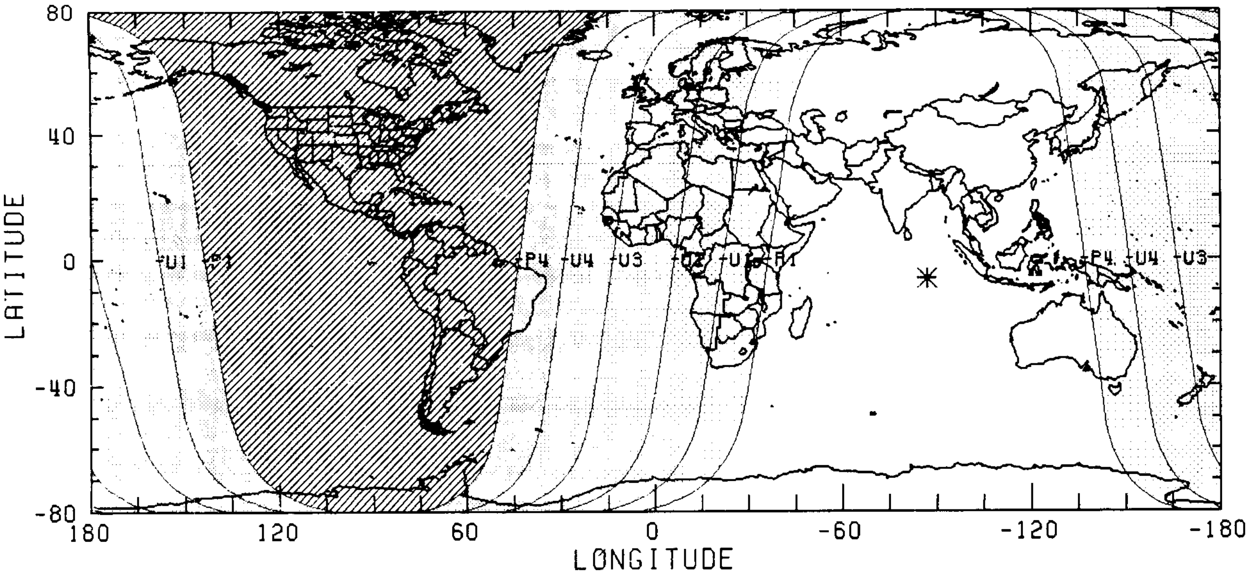


AXIS =-0°.2719
F1 = 1°.2791
F2 = 0°.7394

MOON

RA = 23ʰ 6ᵐ 40ˢ.3
DEC = -6° 0' -8".8
SD = 16' 9".8
HP = 0° 59' 19".1

SAROS 128 (41/71) JD = 2460926.259 ΔT = 87.1 S



TOTAL LUNAR ECLIPSE - 3 MAR 2026

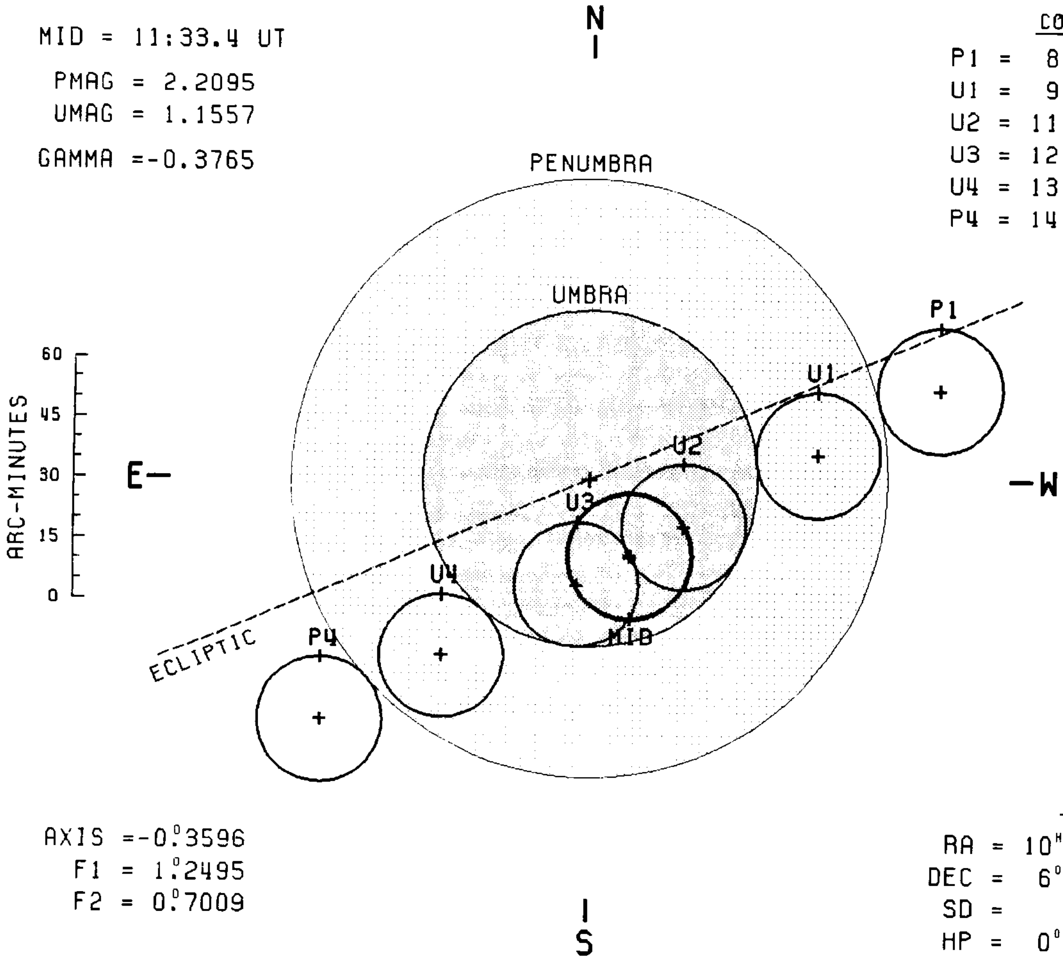
MID = 11:33.4 UT

PMAG = 2.2095
UMAG = 1.1557

GAMMA =-0.3765

CONTACTS

P1 = 8:42.3 UT
U1 = 9:49.3 UT
U2 = 11: 3.5 UT
U3 = 12: 2.8 UT
U4 = 13:17.3 UT
P4 = 14:24.4 UT

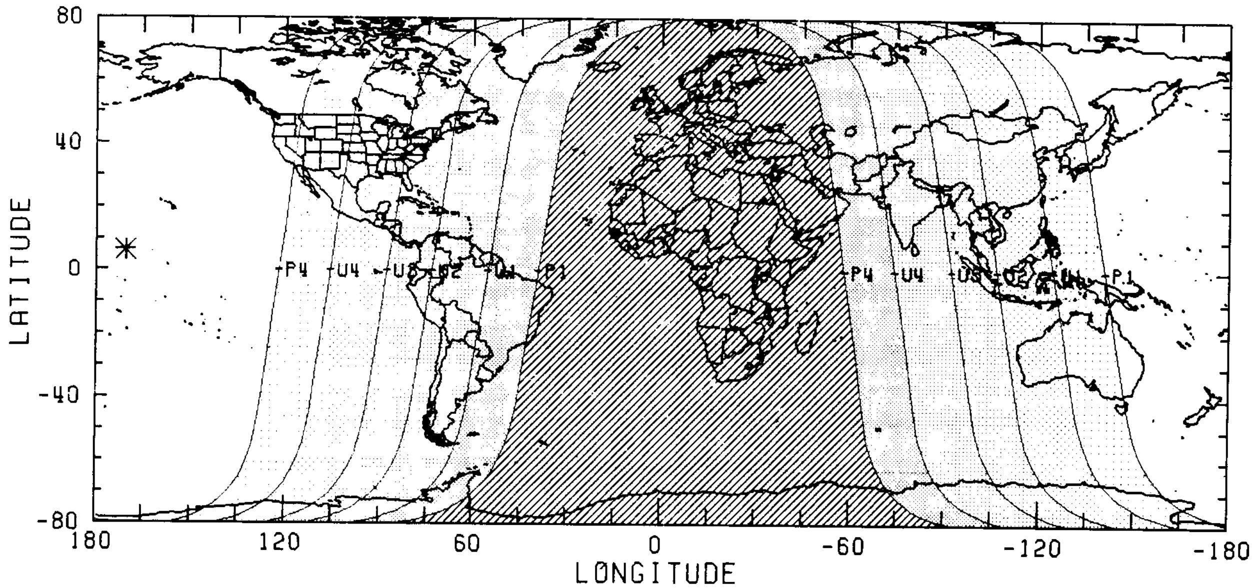


AXIS =-0°3596
F1 = 1°2495
F2 = 0°7009

MOON

RA = 10^{h}56^{m}14^{s}9
DEC = 6°24' 5."6
SD = 15'37."0
HP = 0°57'18."7

SAROS 133 (27/71) JD = 2461102.983 ΔT = 87.6 S



PARTIAL LUNAR ECLIPSE - 28 AUG 2026

MID = 4:12.6 UT

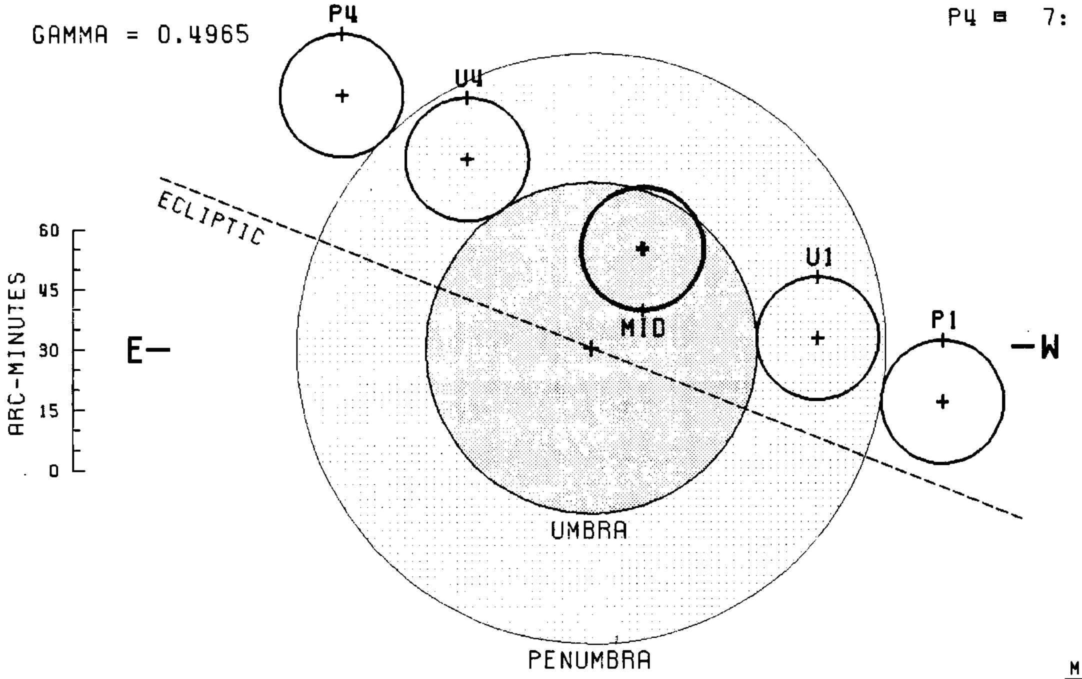
PMAG = 1.9900
UMAG = 0.9347

GAMMA = 0.4965

N

CONTACTS

P1 = 1:21.8 UT
U1 = 2:33.0 UT
U4 = 5:52.0 UT
P4 = 7: 3.2 UT



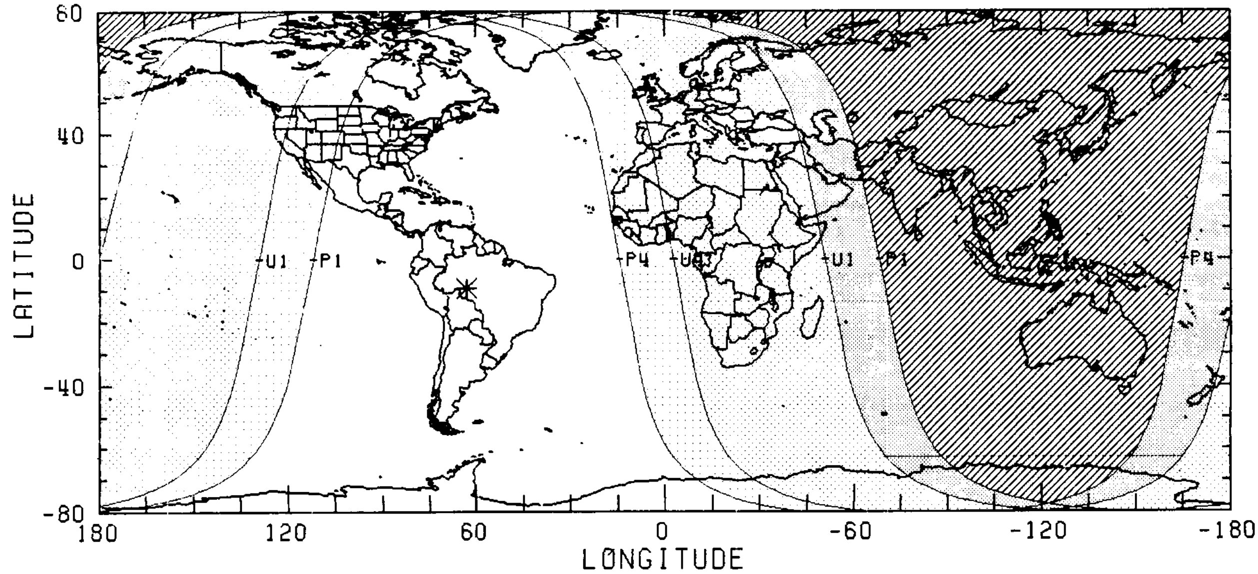
AXIS = 0°.4648
F1 = 1°.2248
F2 = 0°.6865

S

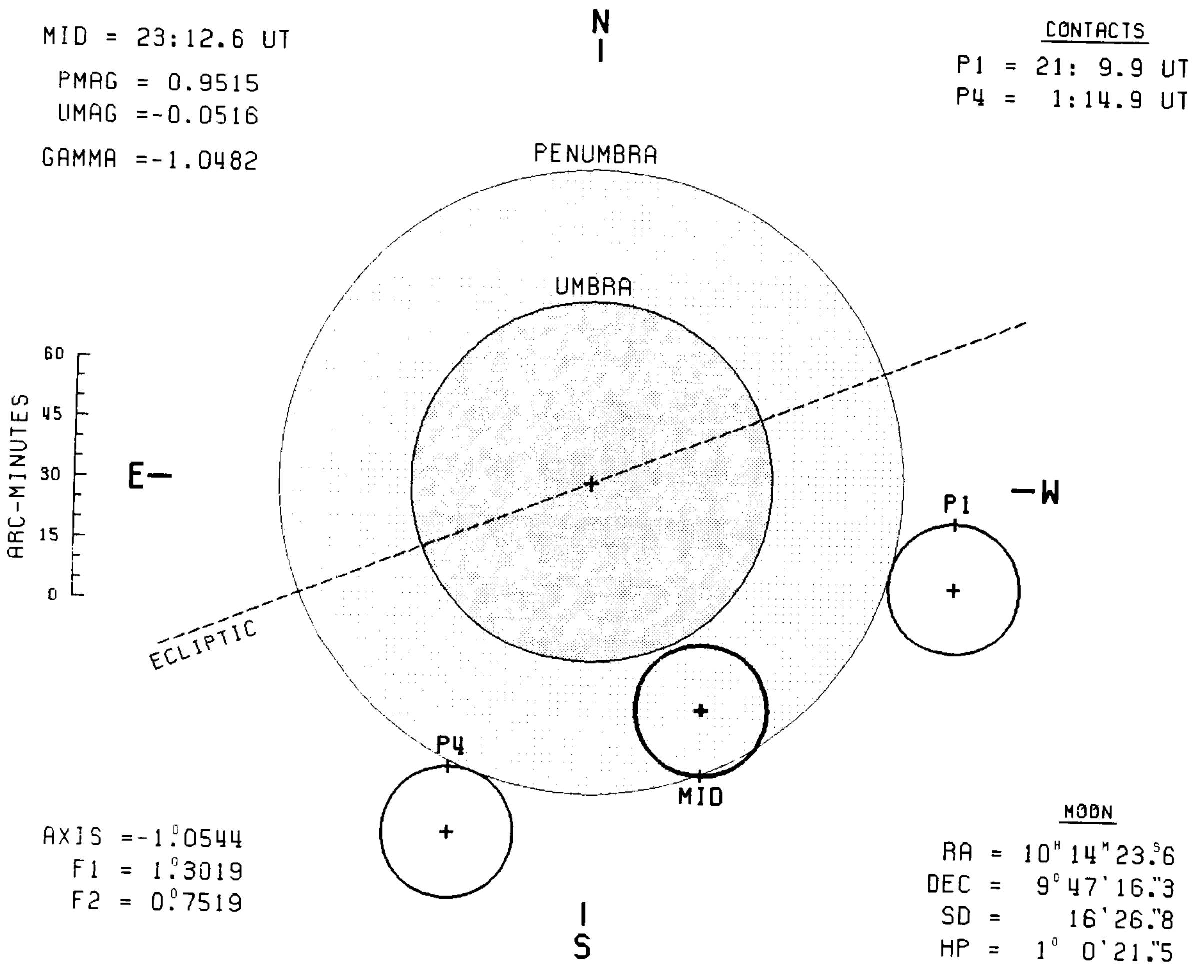
MOON

RA = 22h 26m 6s.3
DEC = -9° 18' -3".5
SD = 15' 18".2
HP = 0° 56' 9".9

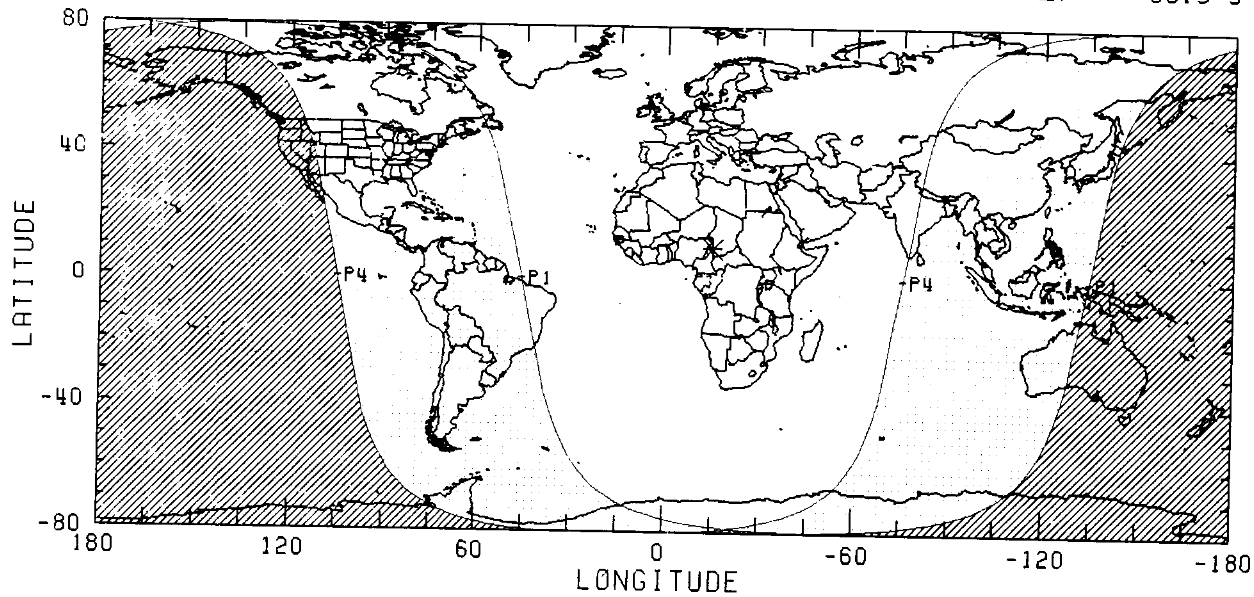
SAROS 138 (30/83) JD = 2461280.676 ΔT = 88.0 S



PENUMBRAL LUNAR ECLIPSE - 20 FEB 2027



SAROS 143 (19/73) JD = 2461457.468 ΔT = 88.5 S



PENUMBRAL LUNAR ECLIPSE - 18 JUL 2027

MID = 16: 2.7 UT

PMAG = 0.0279

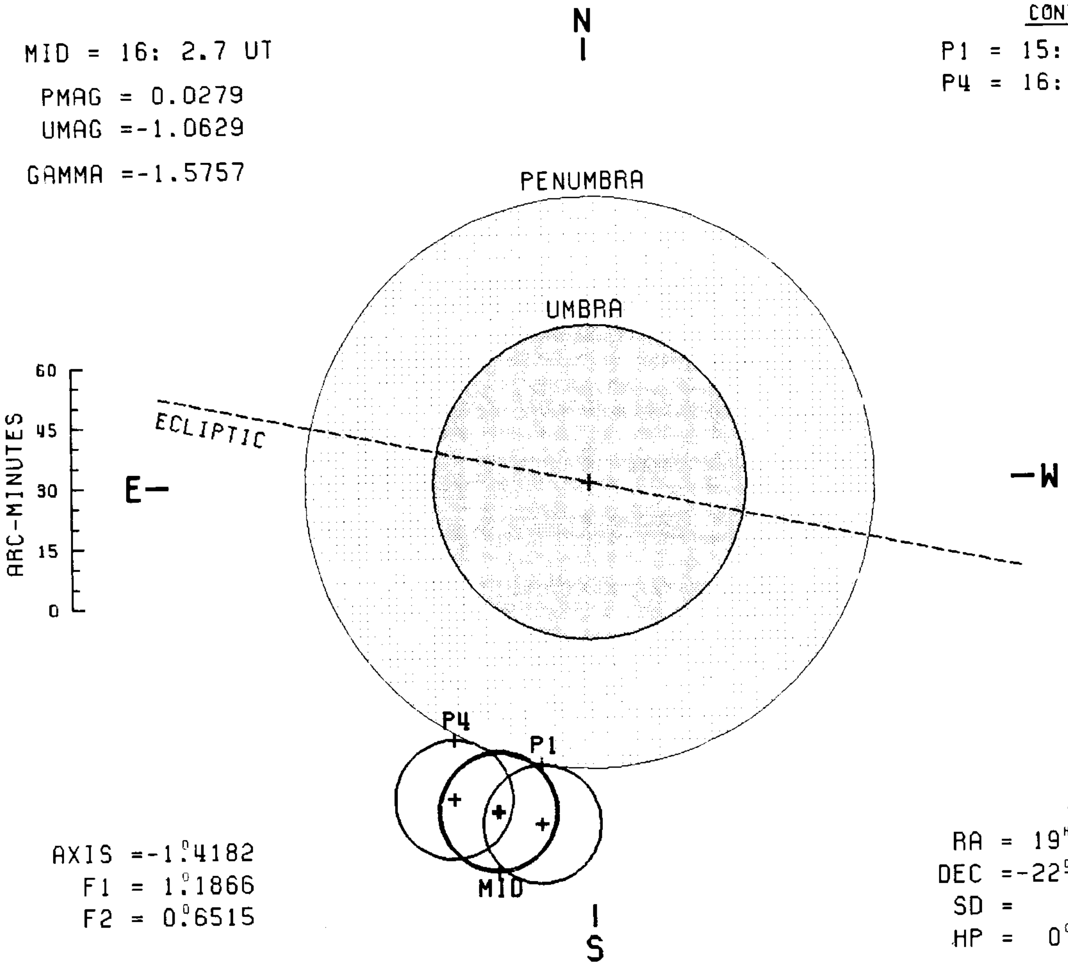
UMAG =-1.0629

GAMMA =-1.5757

CONTACTS

P1 = 15:37.6 UT

P4 = 16:28.0 UT



AXIS =-1.°4182

F1 = 1.°1866

F2 = 0.°6515

MOON

RA = 19h52m57.s2

DEC =-22°20'24.″8

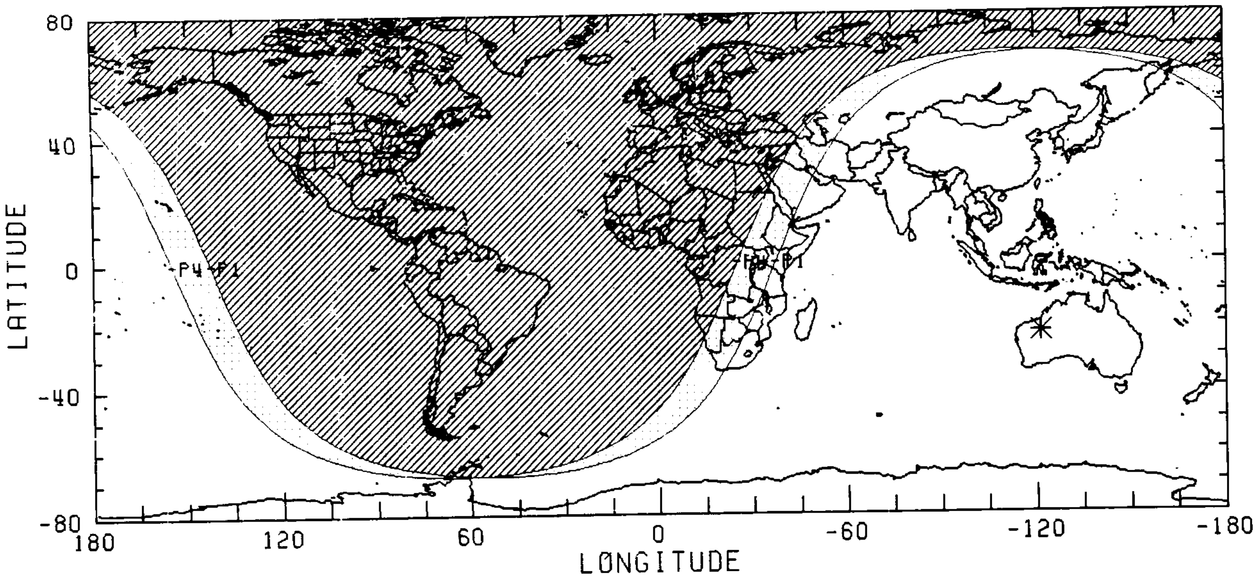
SD = 14'43.″0

HP = 0°54' 0.″6

SAROS 110 (72/72)

JD = 2461605.170

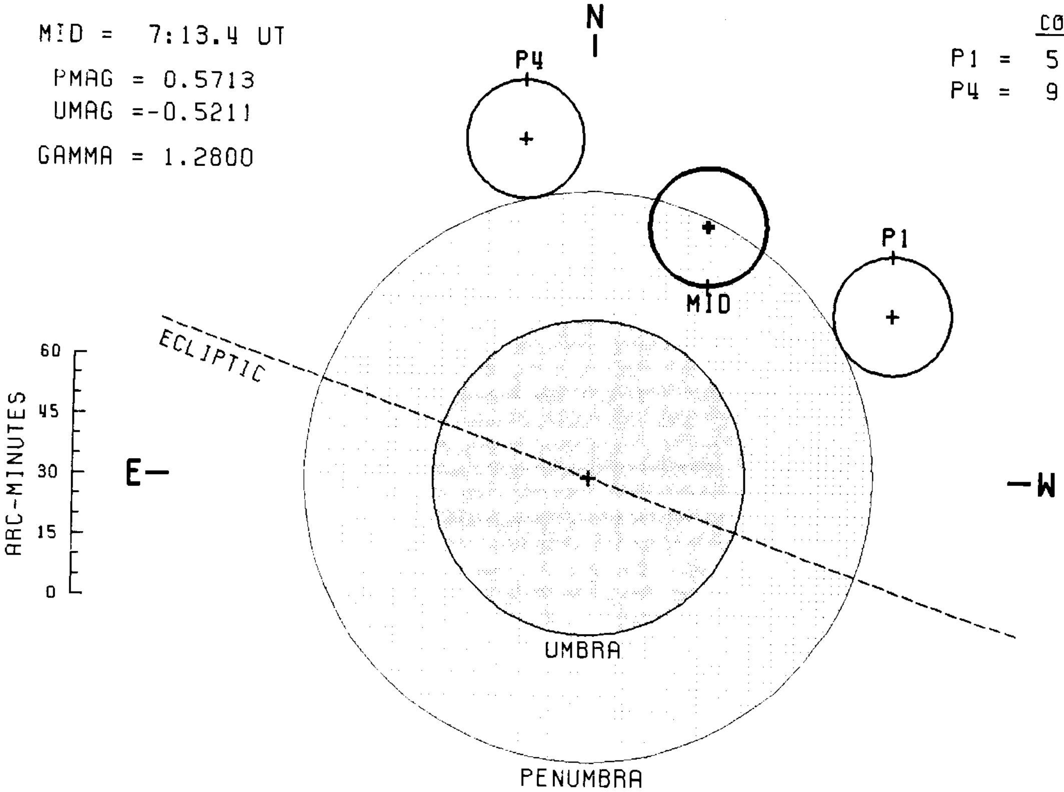
ΔT = 88.9 S



PENUMBRAL LUNAR ECLIPSE - 17 AUG 2027

MID = 7:13.4 UT
PMAG = 0.5713
UMAG =-0.5211
GAMMA = 1.2800

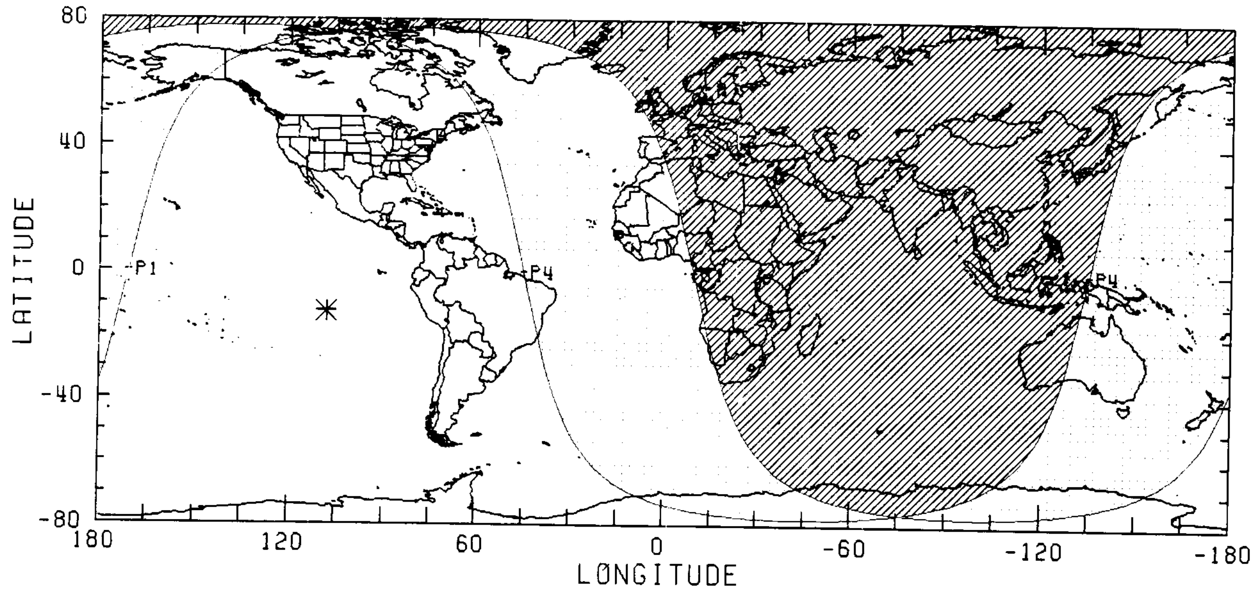
CONTACTS
P1 = 5:21.1 UT
P4 = 9: 5.3 UT



AXIS = 1°.1546
F1 = 1°.1897
F2 = 0°.6526

MOON
RA = 21ʰ43ᵐ58ˢ.7
DEC =-12°24'40".4
SD = 14'44".9
HP = 0°54' 7".7

SAROS 148 (4/71)   JD = 2461634.802   ΔT = 89.0 S



PARTIAL LUNAR ECLIPSE - 12 JAN 2028

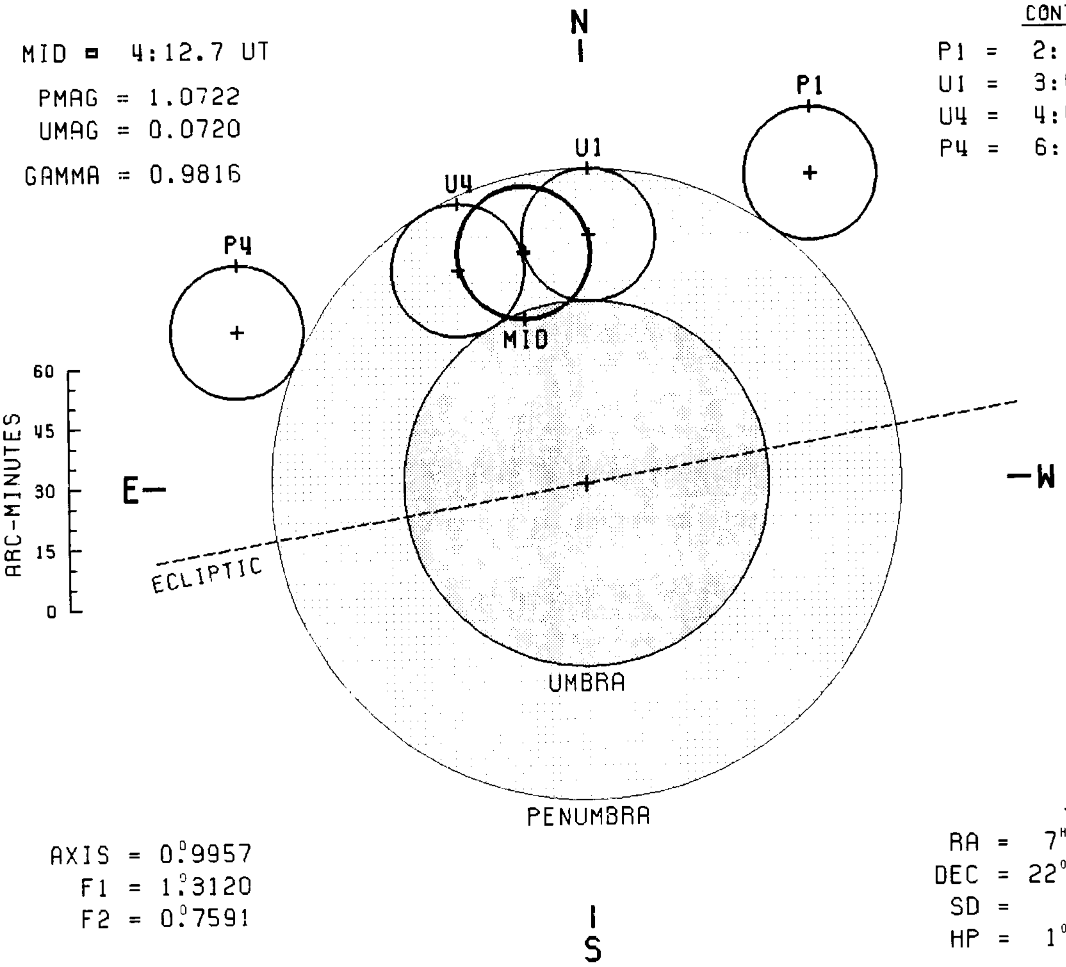
MID = 4:12.7 UT

PMAG = 1.0722
UMAG = 0.0720

GAMMA = 0.9816

CONTACTS

P1 = 2: 5.5 UT
U1 = 3:44.0 UT
U4 = 4:41.8 UT
P4 = 6:20.1 UT



AXIS = 0°.9957
F1 = 1°.3120
F2 = 0°.7591

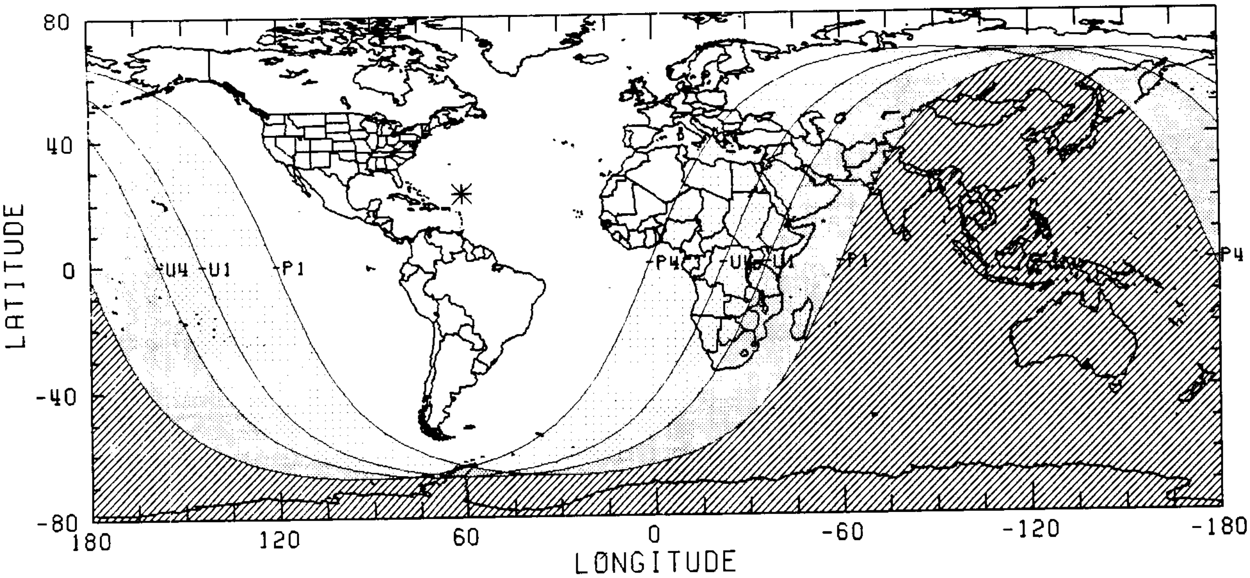
MOON

RA = 7ʰ 33ᵐ 52ˢ.9
DEC = 22° 41' 18".0
SD = 16' 35".1
HP = 1° 0' 52".0

SAROS 115 (58/72)

JD = 2461782.677

ΔT = 89.4 S



PARTIAL LUNAR ECLIPSE - 6 JUL 2028

MID = 18:19.4 UT

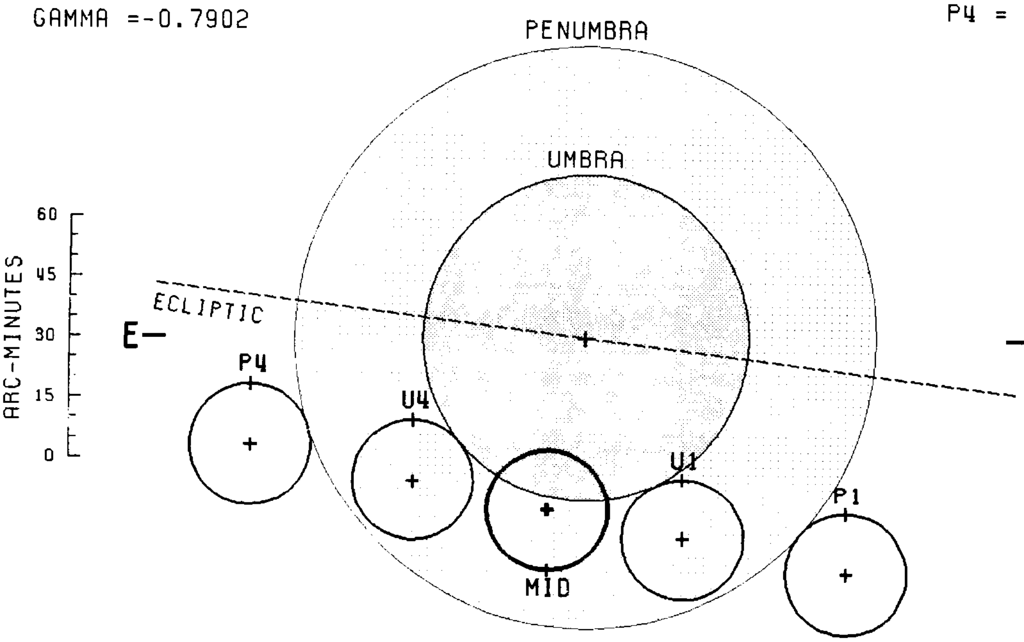
PMAG = 1.4526
UMAG = 0.3945

GAMMA =-0.7902

CONTACTS

P1 = 15:42.2 UT
U1 = 17: 8.2 UT
U4 = 19:30.8 UT
P4 = 20:56.9 UT

N



S

AXIS =-0°.7329
F1 = 1°.2145
F2 = 0°.6796

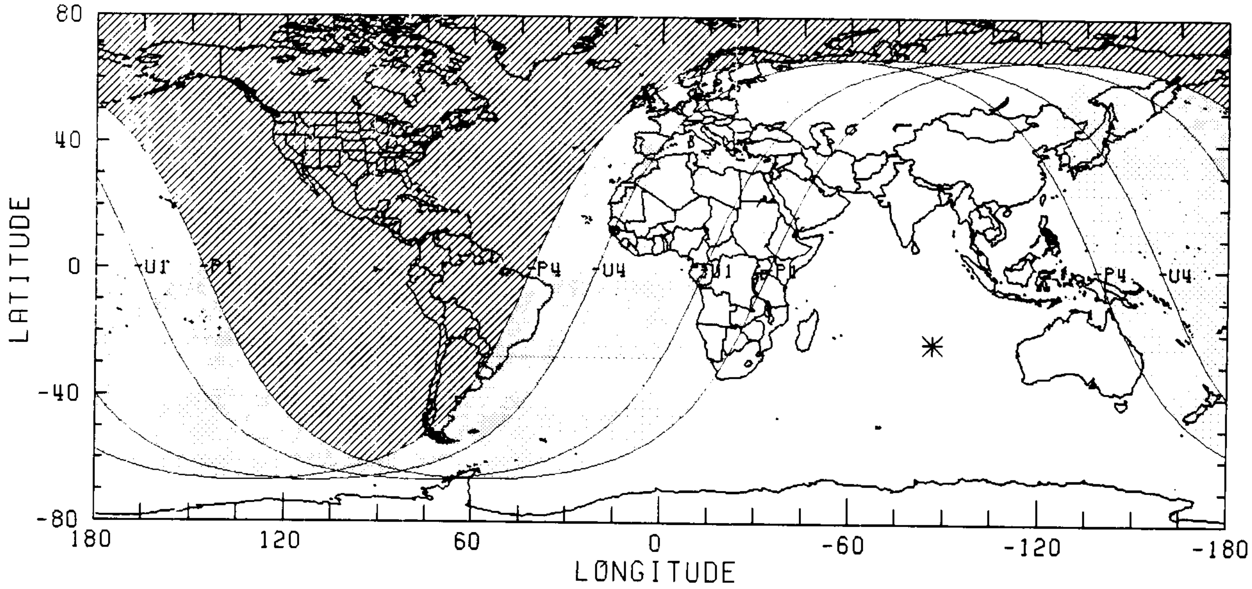
MOON

RA = $19^h\ 6^m\ 36^s.9$
DEC =$-23°17'15''.9$
SD = $15'\ 9''.9$
HP = $0°55'39''.4$

SAROS 120 (59/84)

JD = 2461959.265

ΔT = 89.9 S



TOTAL LUNAR ECLIPSE - 31 DEC 2028

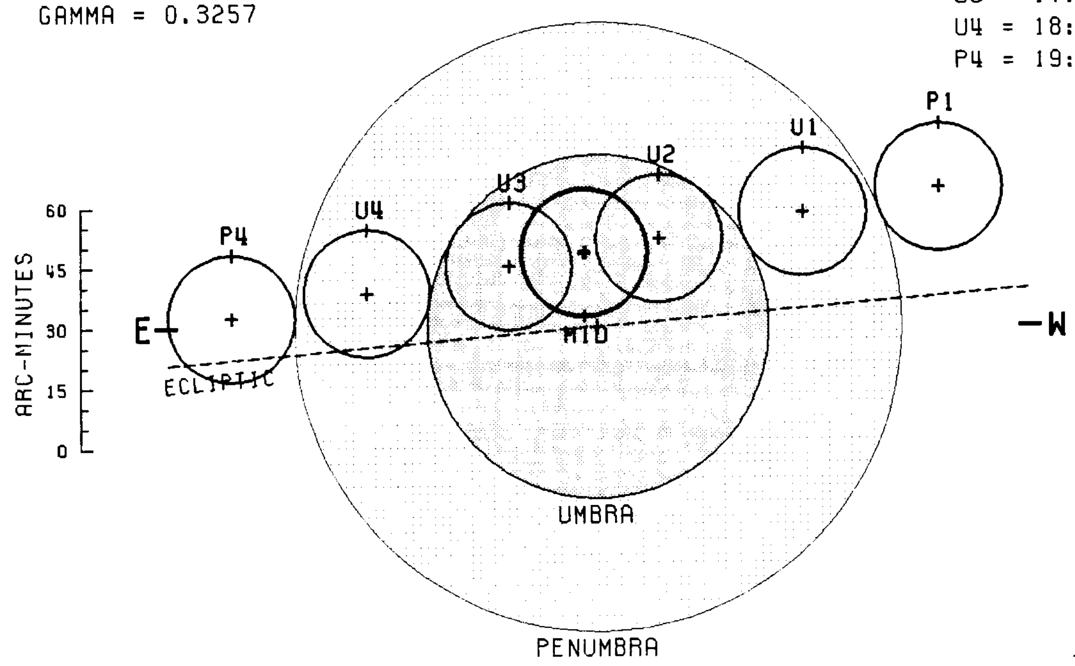
MID = 16:51.7 UT

PMAG = 2.3001
UMAG = 1.2516

GAMMA = 0.3257

CONTACTS

P1 = 14: 1.8 UT
U1 = 15: 6.9 UT
U2 = 16:15.7 UT
U3 = 17:28.0 UT
U4 = 18:36.7 UT
P4 = 19:41.6 UT

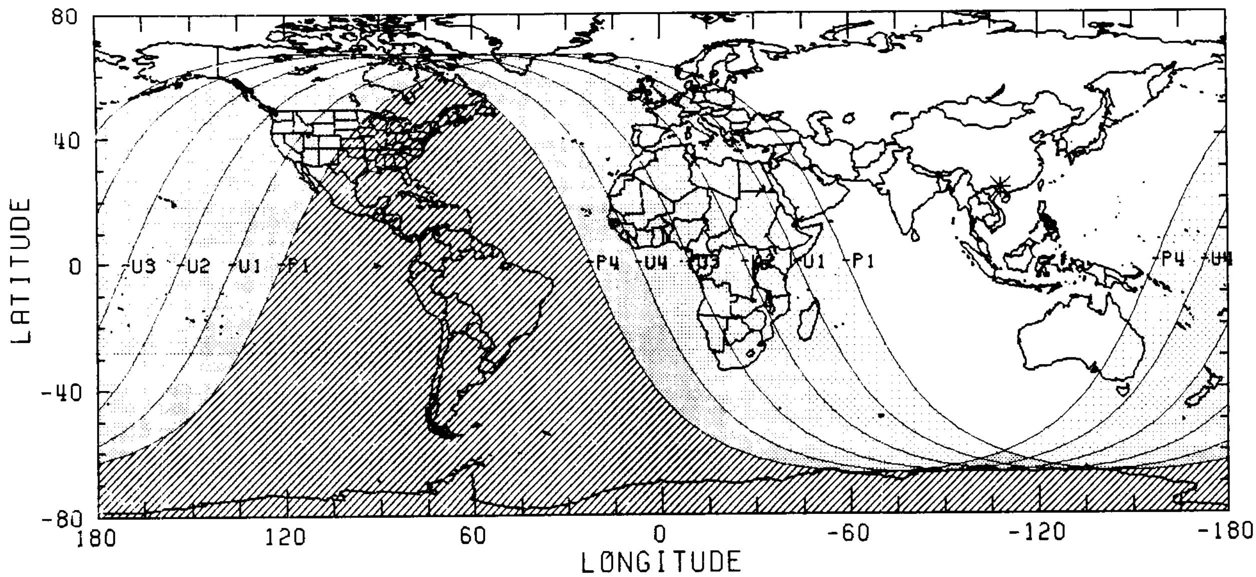


AXIS = 0°.3152
F1 = 1°.2646
F2 = 0°.7116

MOON

RA = 6ʰ46ᵐ 8ˢ.3
DEC = 23°19'37".1
SD = 15'49".4
HP = 0°58' 4".3

SAROS 125 (49/72) JD = 2462137.204 ΔT = 90.3 S



TOTAL LUNAR ECLIPSE - 26 JUN 2029

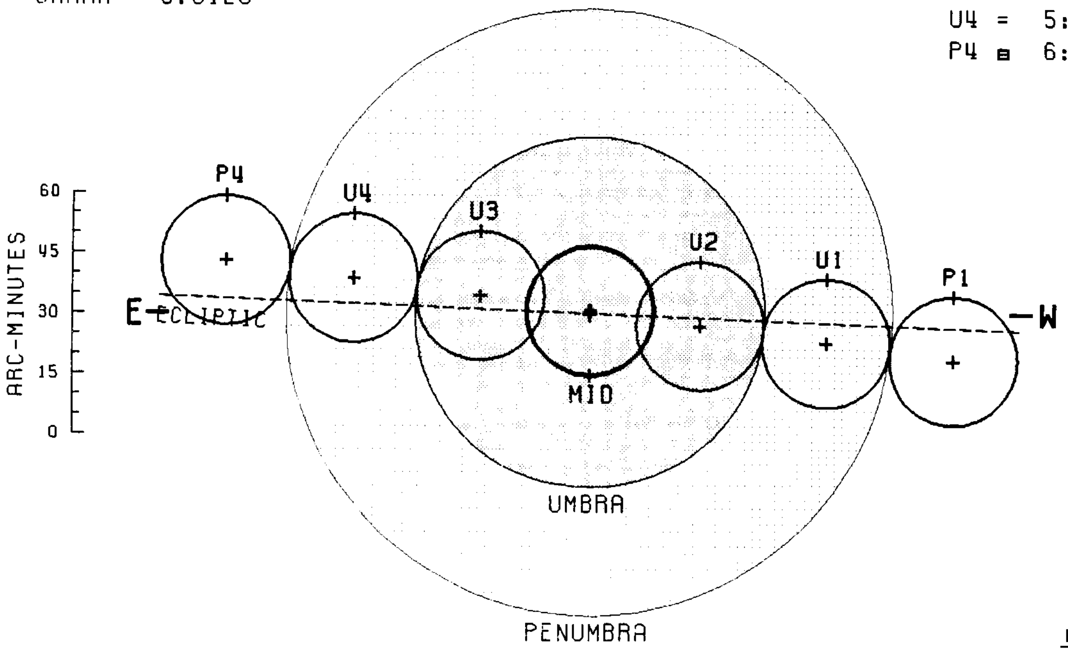
MID = 3:21.9 UT

PMAG = 2.8515
UMAG = 1.8488

GAMMA = 0.0126

N

CONTACTS		
P1	=	0:32.6 UT
U1	=	1:31.6 UT
U2	=	2:30.4 UT
U3	=	4:13.3 UT
U4	=	5:12.1 UT
P4	=	6:11.2 UT

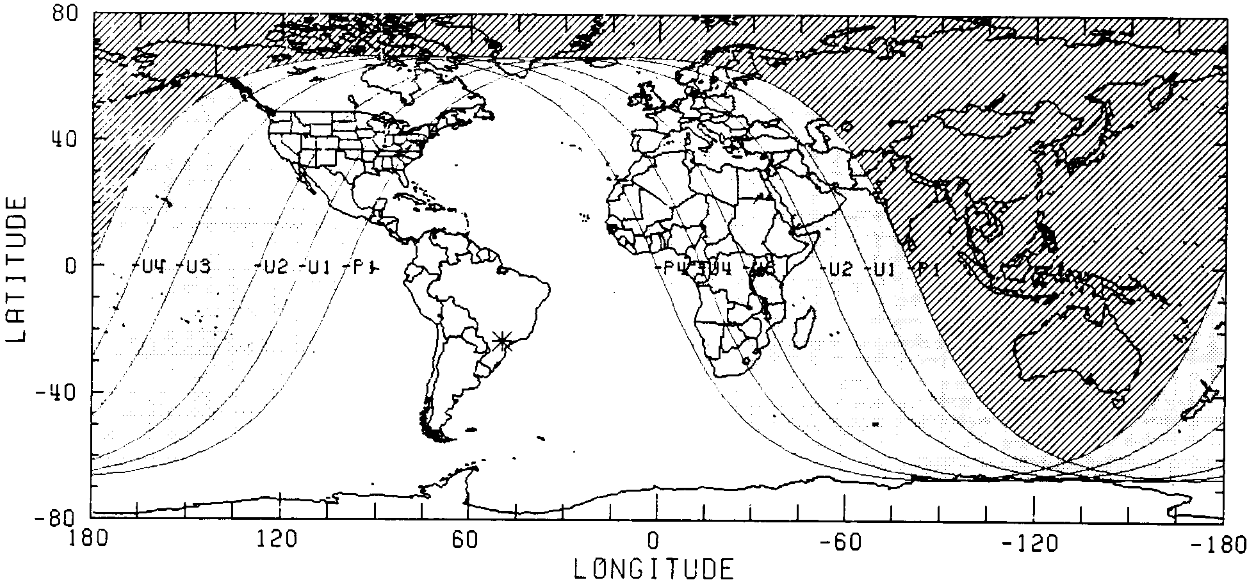


AXIS = 0°.0123
F1 = 1°.2669
F2 = 0°.7320

S

MOON		
RA	=	$18^h 21^m 2^s.6$
DEC	=	-23° 20' -6".4
SD	=	16' 0".4
HP	=	0° 58' 44".7

SAROS 130 (35/72) JD = 2462313.641 ΔT = 90.8 S



TOTAL LUNAR ECLIPSE - 20 DEC 2029

MID = 22:41.6 UT

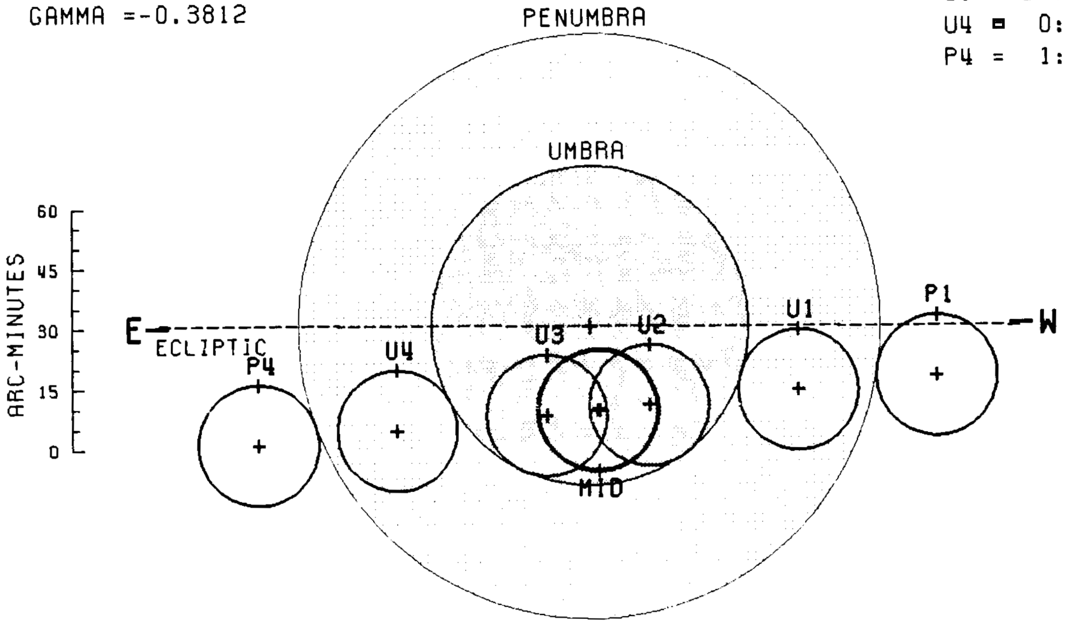
PMAG = 2.2268
UMAG = 1.1217

GAMMA =-0.3812

N

CONTACTS

P1 = 19:40.6 UT
U1 = 20:54.5 UT
U2 = 22:14.3 UT
U3 = 23: 8.8 UT
U4 = 0:28.7 UT
P4 = 1:42.5 UT



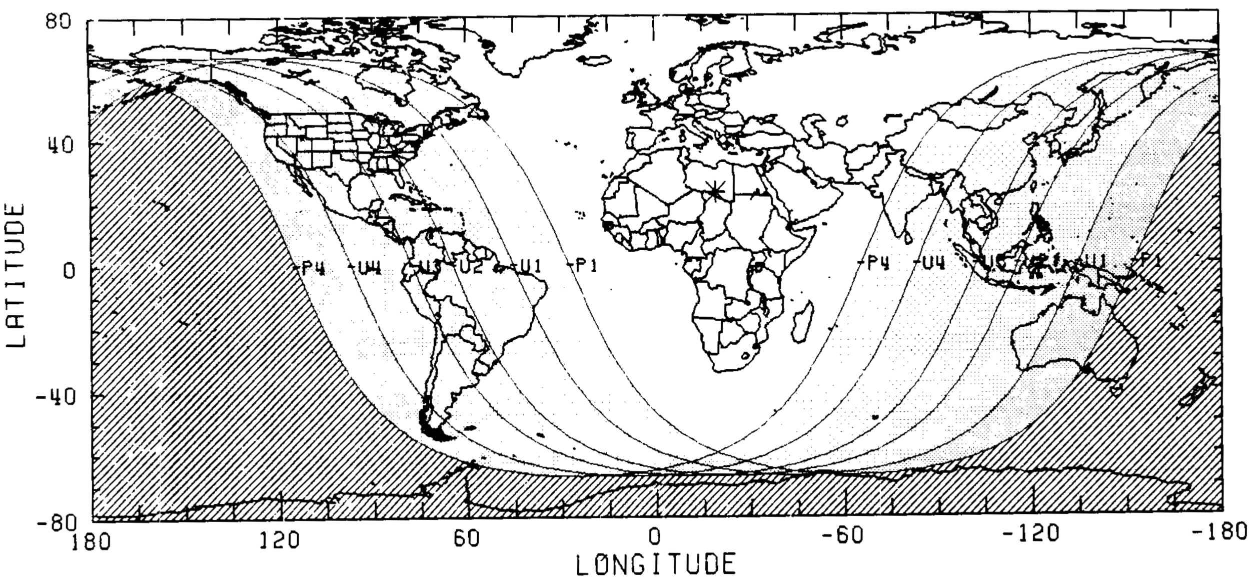
AXIS =-0°.3499
F1 = 1°.2137
F2 = 0°.6609

S

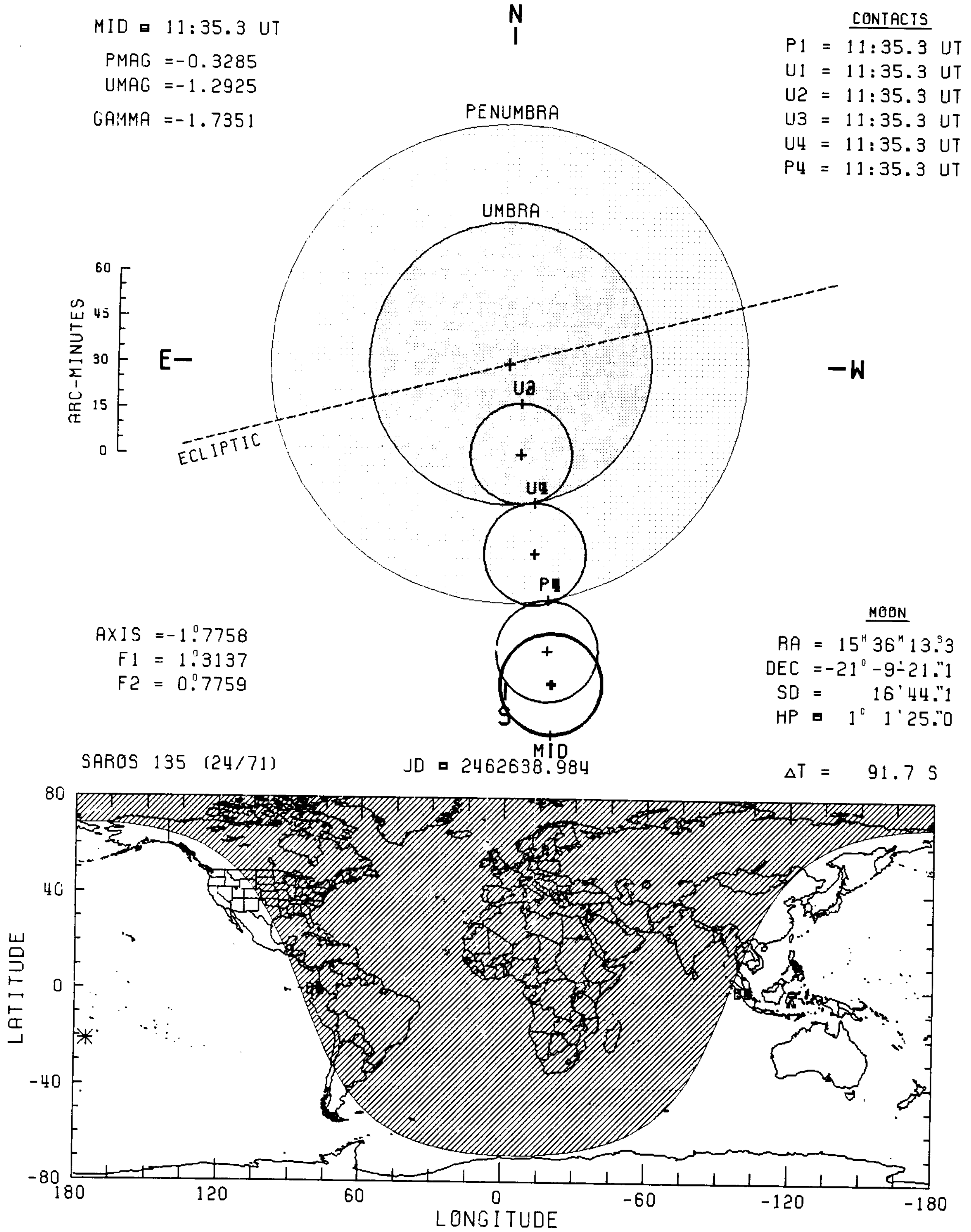
MOON

RA = 5ʰ56ᵐ58ˢ.8
DEC = 23° 5' 6".4
SD = 15' 0".4
HP = 0°55' 4".6

SAROS 135 (24/71) JD = 2462491.447 ΔT = 91.3 S



LUNAR ECLIPSE - 17 MAY 2030



PARTIAL LUNAR ECLIPSE - 15 JUN 2030

N

MID = 18:33.0 UT

PMAG = 1.4725

UMAG = 0.5080

GAMMA = 0.7536

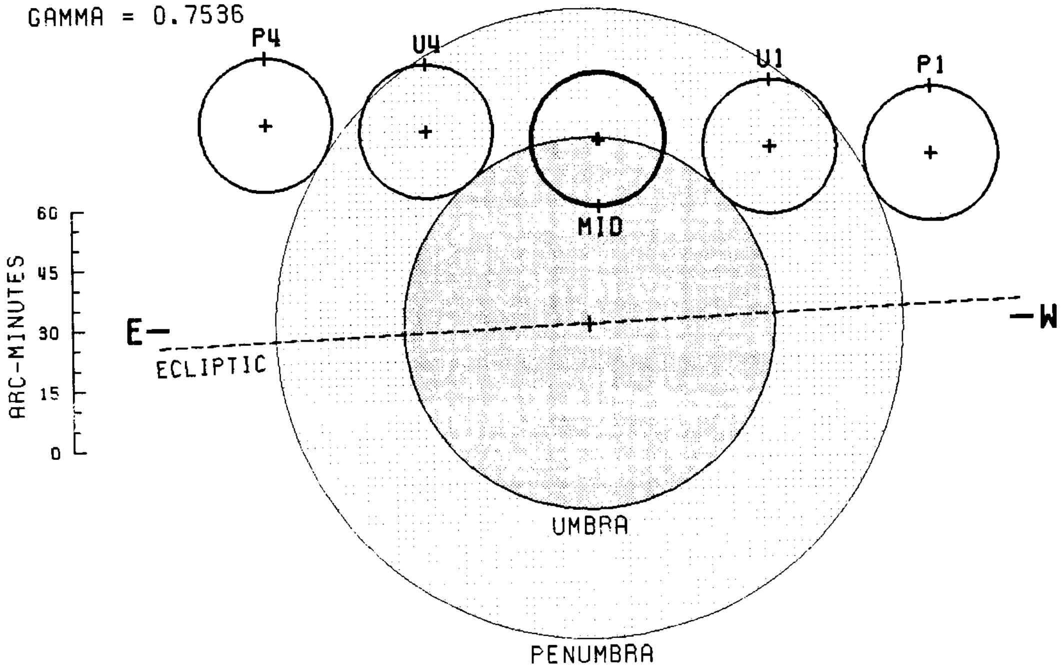
CONTACTS

P1 = 16:12.2 UT

U1 = 17:20.3 UT

U4 = 19:45.7 UT

P4 = 20:53.9 UT



MOON

RA = 17^{h} 36^{m} 46.^{s}1

DEC = -22° 33' 45."3

SD = 16' 39."2

HP = 1° 1' 7."1

AXIS = 0.°7676

F1 = 1.°3074

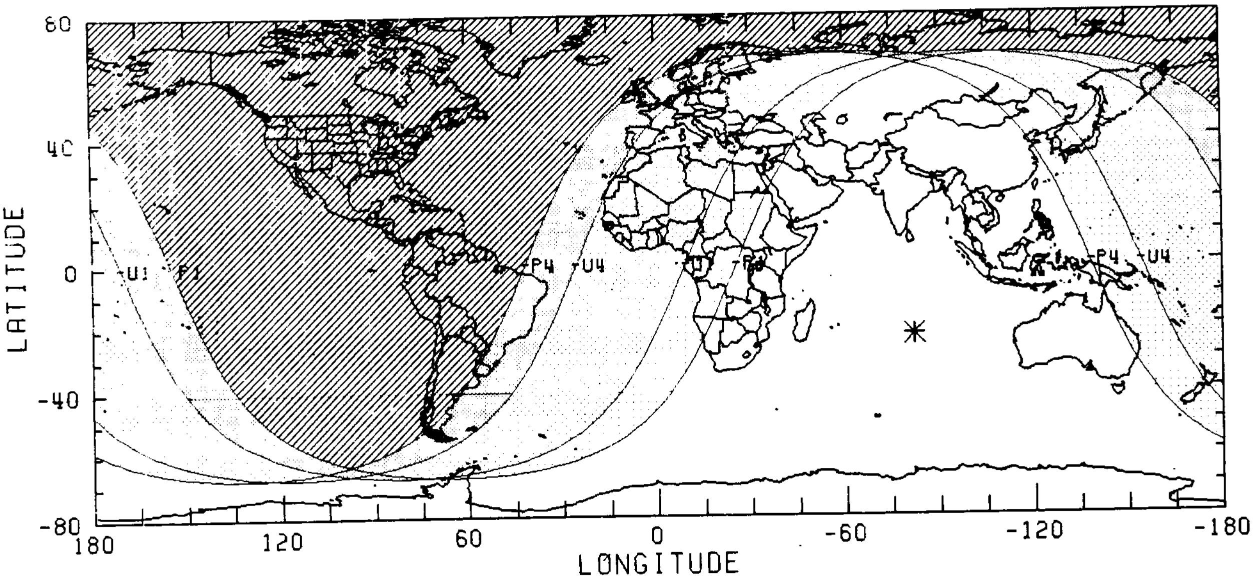
F2 = 0.°7721

S

SAROS 140 (26/80)

JD = 2462668.274

ΔT = 91.8 S



PENUMBRAL LUNAR ECLIPSE - 9 DEC 2030

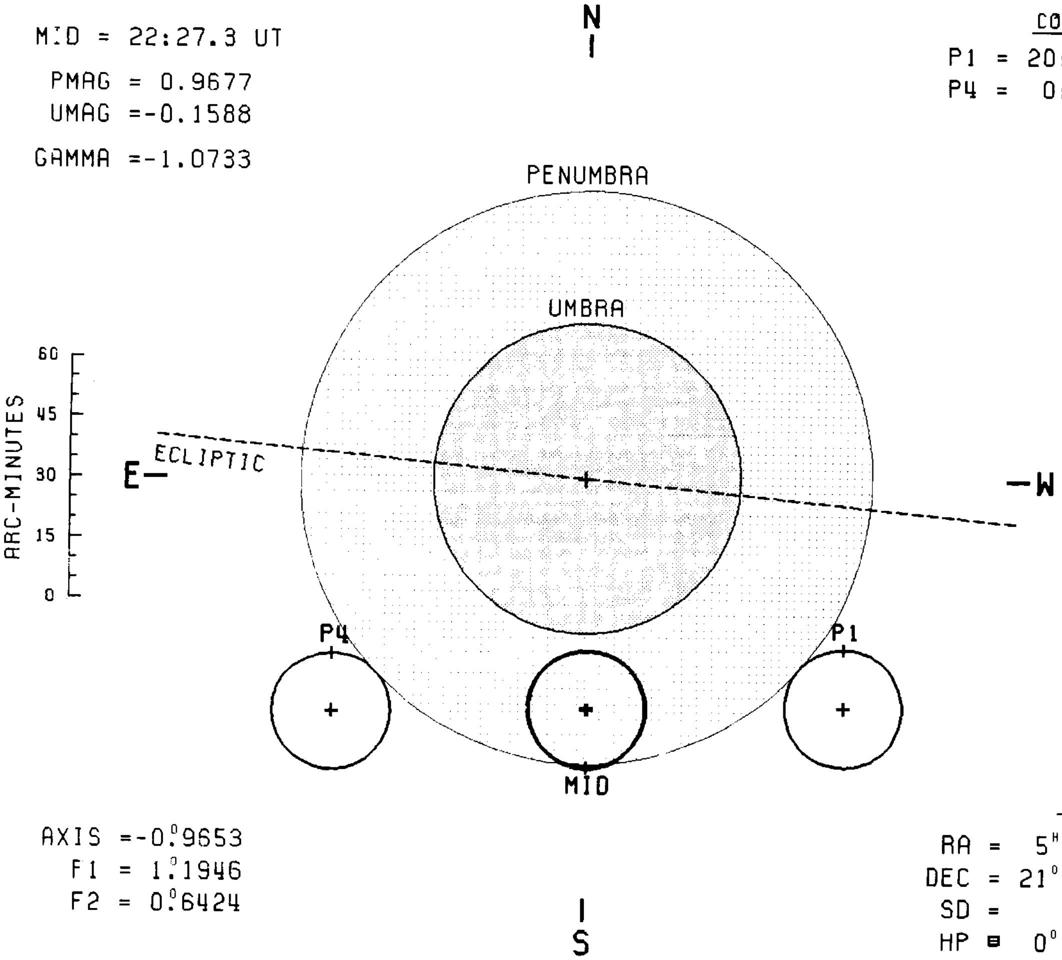
MID = 22:27.3 UT

PMAG = 0.9677
UMAG =-0.1588

GAMMA =-1.0733

CONTACTS

P1 = 20: 5.2 UT
P4 = 0:49.3 UT

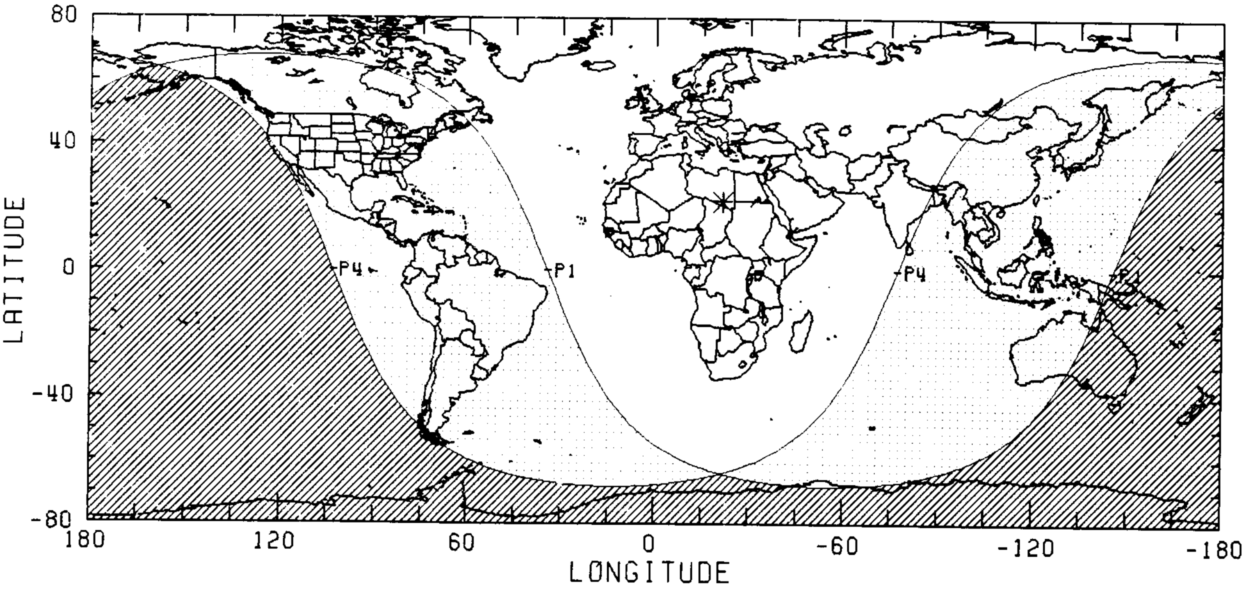


AXIS =-0.°9653
F1 = 1.°1946
F2 = 0.°6424

MOON

RA = 5ʰ 7ᵐ 19.ˢ0
DEC = 21° 55' 2."6
SD = 14' 42."3
HP = 0° 53' 58."1

SAROS 145 (12/71)   JD = 2462845.437   ΔT = 92.3 S



PENUMBRAL LUNAR ECLIPSE - 7 MAY 2031

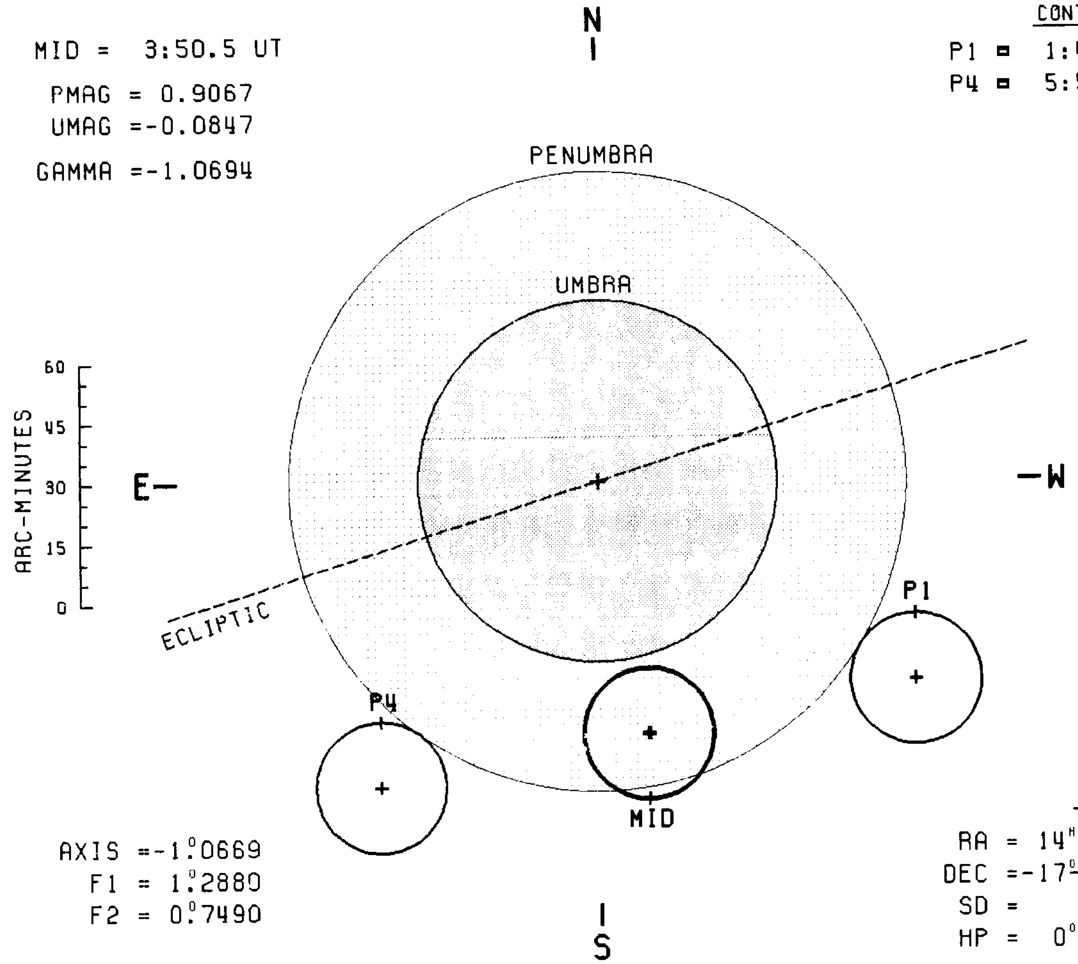
MID = 3:50.5 UT

PMAG = 0.9067
UMAG =-0.0847

GAMMA =-1.0694

CONTACTS

P1 = 1:49.7 UT
P4 = 5:51.2 UT

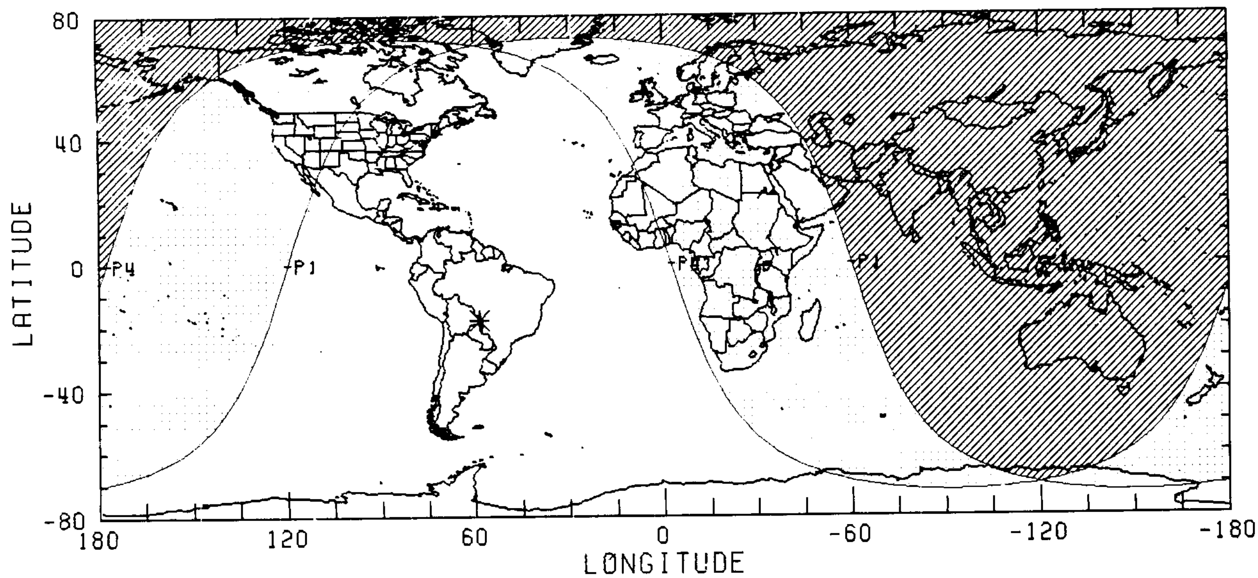


AXIS =-1°.0669
F1 = 1°.2880
F2 = 0°.7490

MOON

RA = 14ʰ 54ᵐ 58ˢ.0
DEC =-17° 47′ 29″.1
SD = 16′ 18″.7
HP = 0° 59′ 52″.0

SAROS 112 (66/72) JD = 2462993.661 ΔT = 92.7 S



PENUMBRAL LUNAR ECLIPSE - 30 OCT 2031

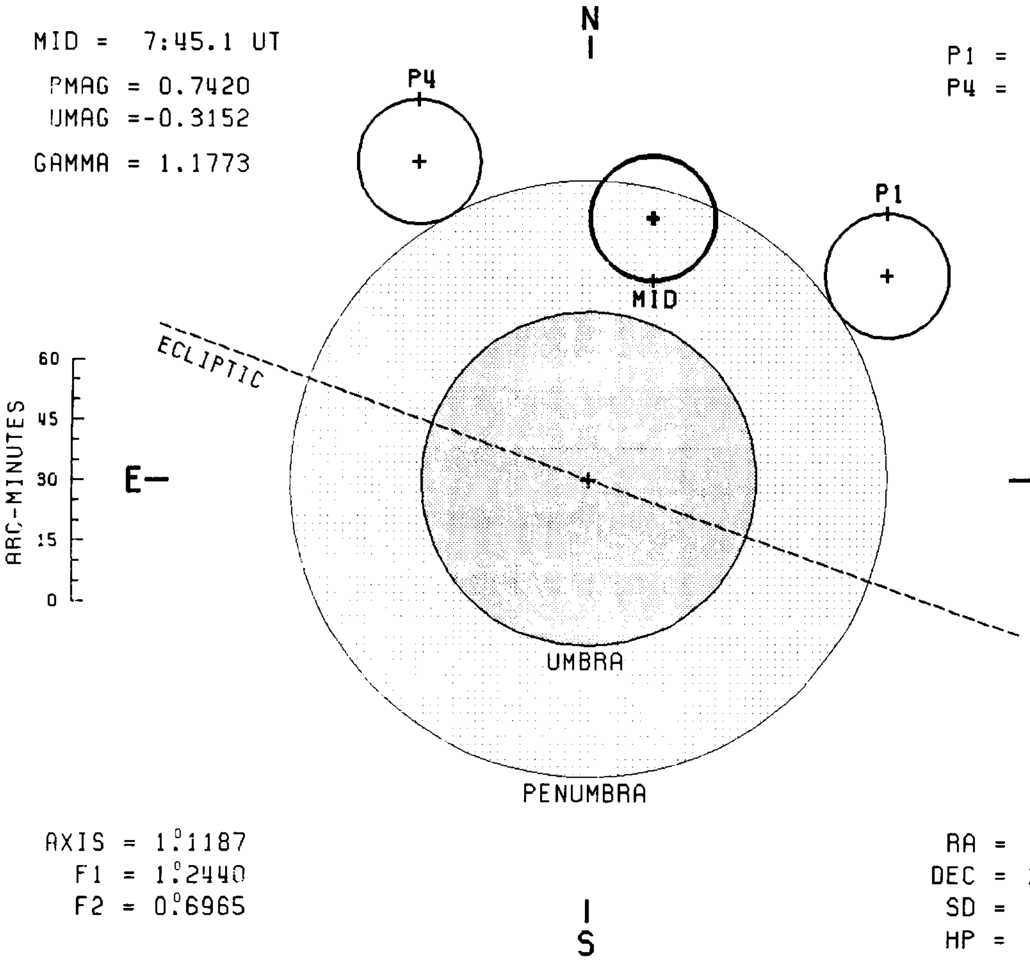
MID = 7:45.1 UT

PMAG = 0.7420
UMAG =-0.3152

GAMMA = 1.1773

CONTACTS

P1 = 5:46.7 UT
P4 = 9:43.2 UT



AXIS = 1°1187
F1 = 1°2440
F2 = 0°6965

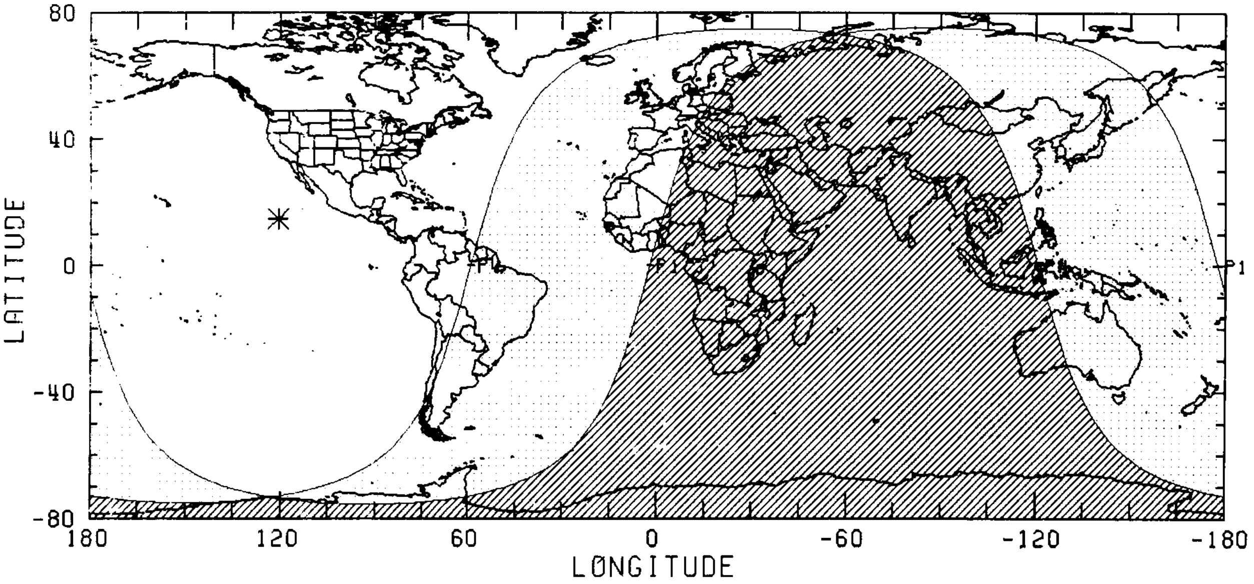
MOON

RA = 2ʰ 16ᵐ 19ˢ7
DEC = 14° 49' 52"5
SD = 15' 32"2
HP = 0° 57' 1"3

SAROS 117 (53/72)

JD = 2463169.824

ΔT = 93.2 S



TOTAL LUNAR ECLIPSE - 25 APR 2032

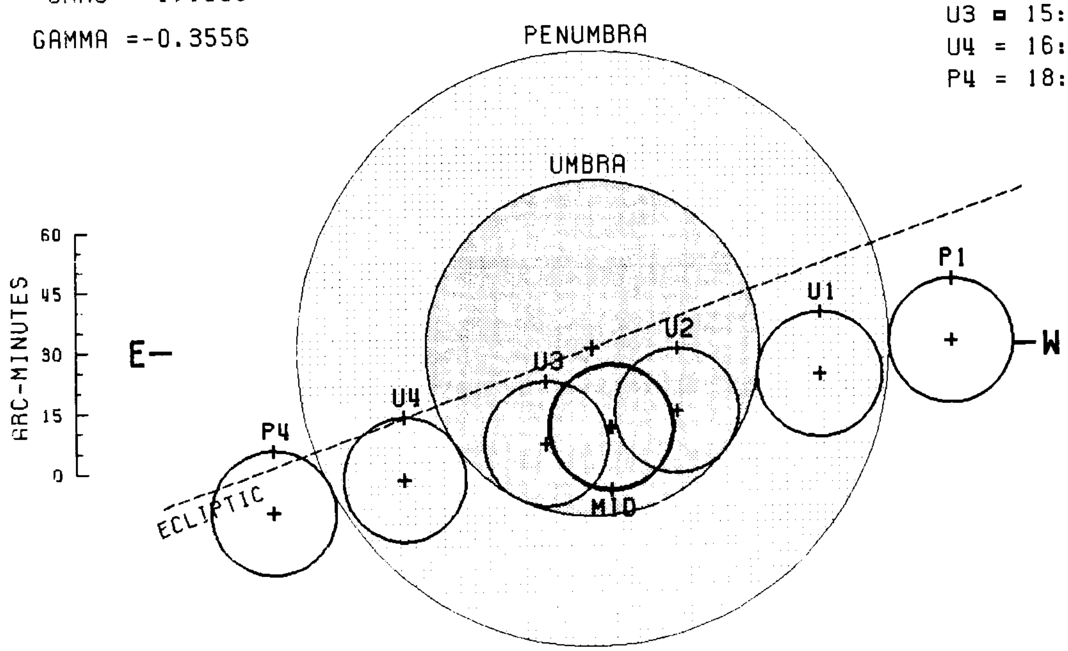
MID = 15:13.3 UT

PMAG = 2.2451
UMAG = 1.1966

GAMMA =-0.3556

CONTACTS

P1 = 12:20.1 UT
U1 = 13:27.2 UT
U2 = 14:39.9 UT
U3 = 15:46.4 UT
U4 = 16:59.3 UT
P4 = 18: 6.2 UT



AXIS =-0°.3364
F1 = 1°.2560
F2 = 0°.6955

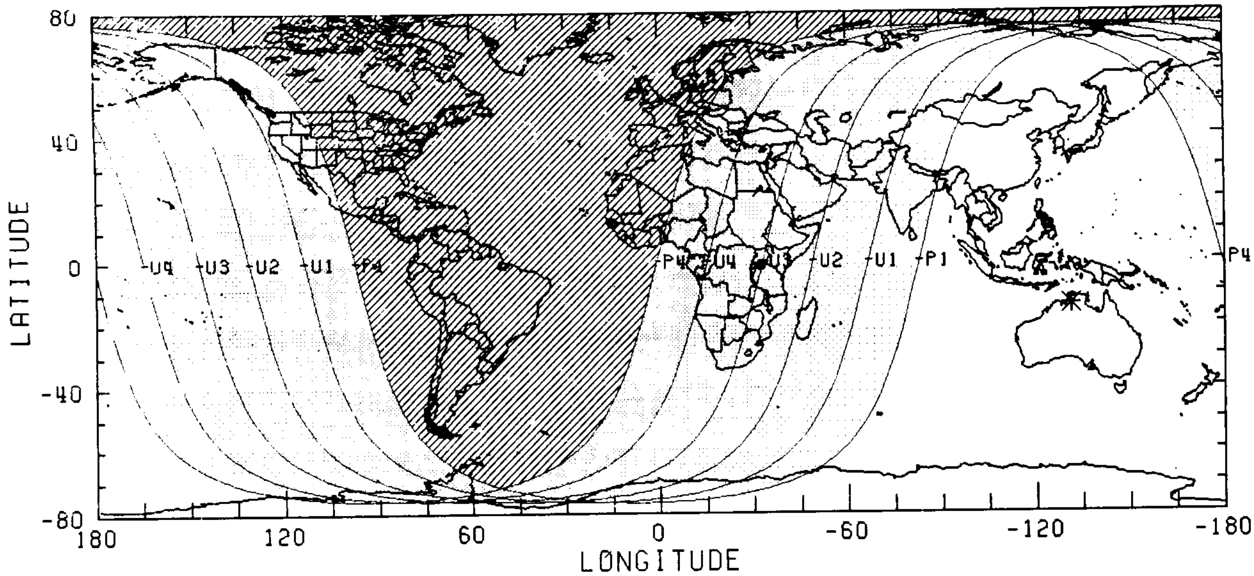
MOON

RA = 14h 14m 18s.5
DEC =-13°50'-5".5
SD = 15'27".9
HP = 0°56'45".4

SAROS 122 (57/75)

JD = 2463348.135

ΔT = 93.7 S

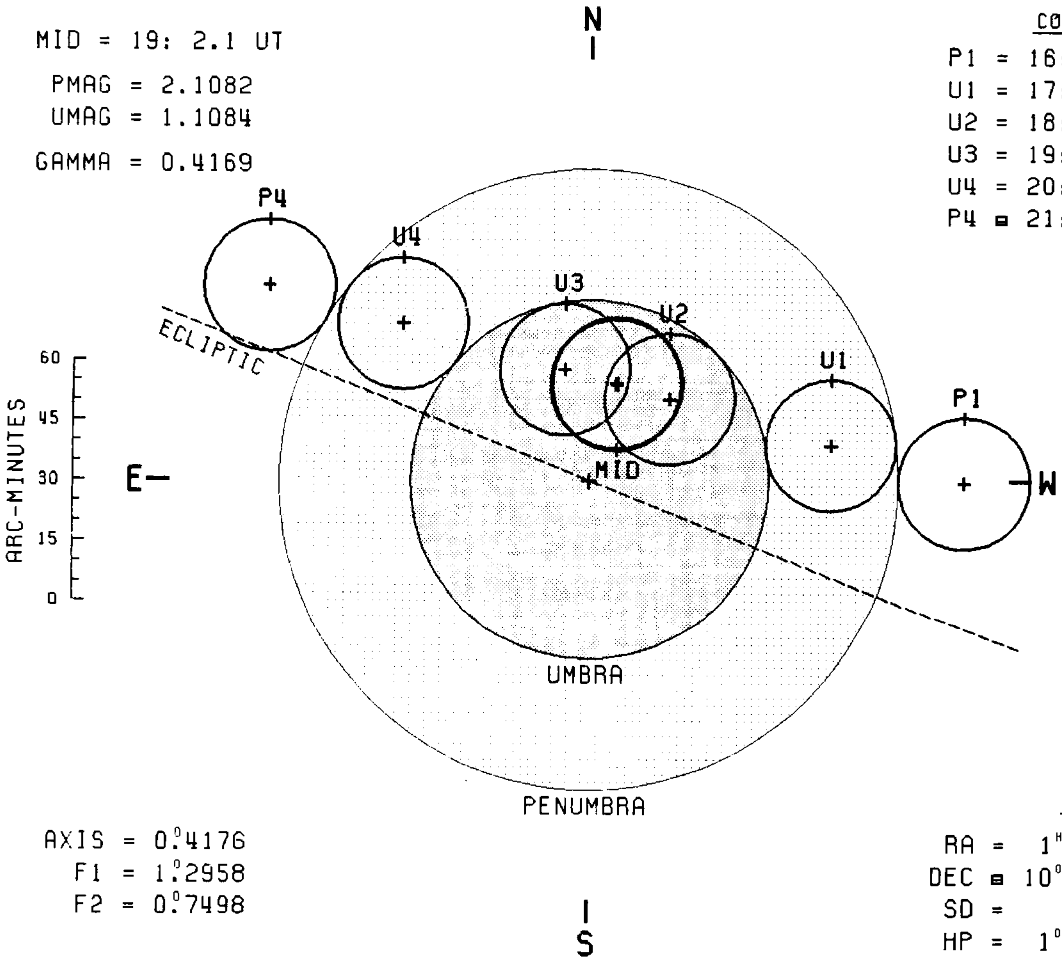


TOTAL LUNAR ECLIPSE - 18 OCT 2032

MID = 19: 2.1 UT
PMAG = 2.1082
UMAG = 1.1084
GAMMA = 0.4169

CONTACTS

P1	=	16:22.7 UT
U1	=	17:23.5 UT
U2	=	18:37.8 UT
U3	=	19:26.0 UT
U4	=	20:40.4 UT
P4	=	21:41.5 UT

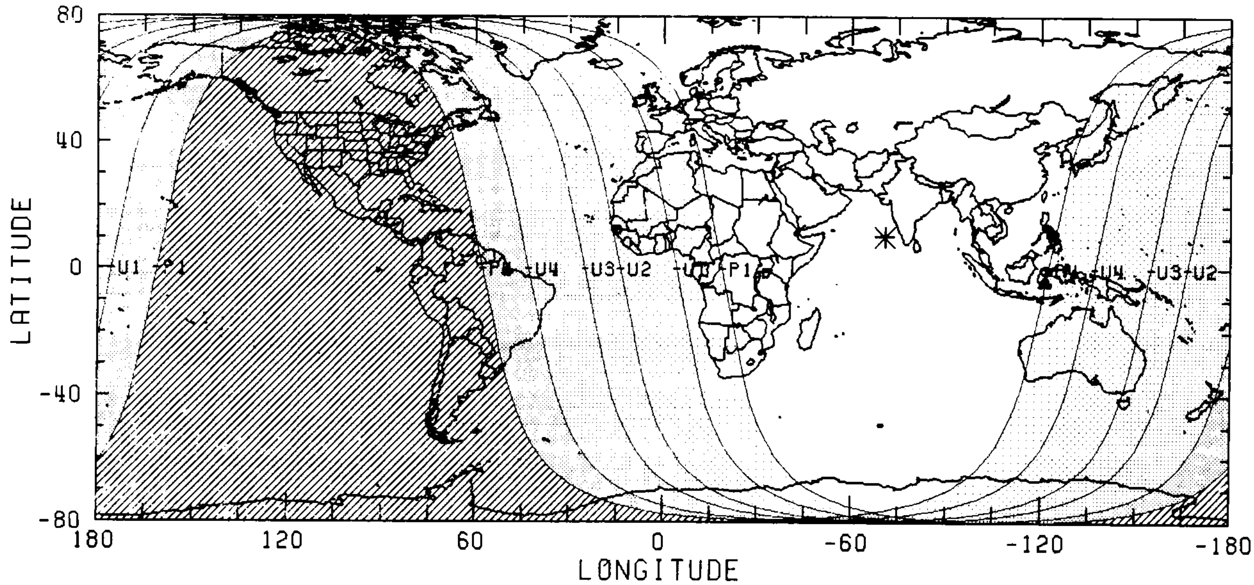


AXIS = 0°.4176
F1 = 1°.2958
F2 = 0°.7498

MOON

RA	=	$1^h 35^m 47^s.8$
DEC	=	10° 25' 28".1
SD	=	16' 22".8
HP	=	1° 0' 7".0

SAROS 127 (43/72) JD = 2463524.294 ΔT = 94.2 S



TOTAL LUNAR ECLIPSE - 14 APR 2033

N

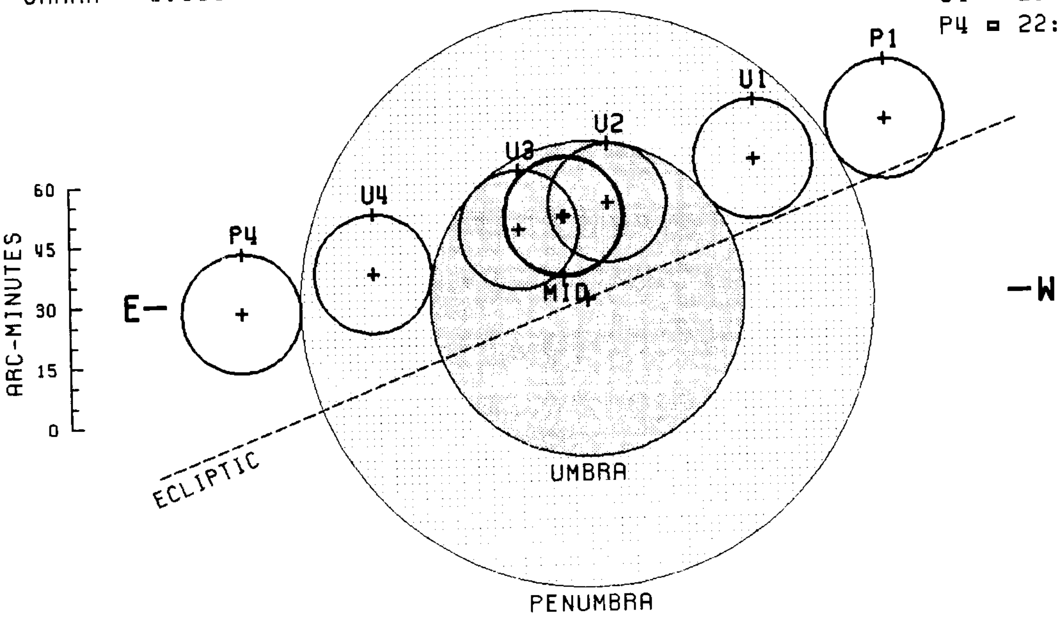
MID = 19:12.3 UT

PMAG = 2.1971
UMAG = 1.0988

GAMMA = 0.3955

CONTACTS

P1 = 16: 9.8 UT
U1 = 17:24.4 UT
U2 = 18:47.4 UT
U3 = 19:37.5 UT
U4 = 21: 0.3 UT
P4 = 22:14.8 UT



AXIS = 0°.3582
F1 = 1°.1959
F2 = 0°.6538

S

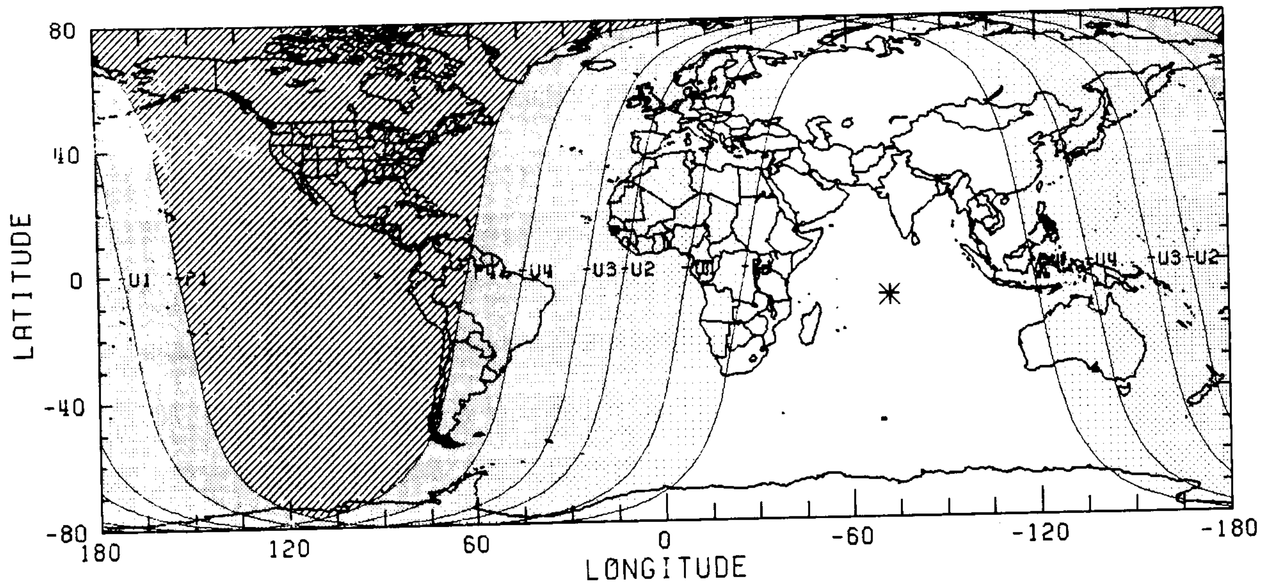
MOON

RA = $13^h 33^m 37^s.2$
DEC = $-9°23'-8''.2$
SD = $14'48''.5$
HP = $0°54'20''.9$

SAROS 132 (31/71)

JD = 2463702.301

ΔT = 94.7 S



TOTAL LUNAR ECLIPSE - 8 OCT 2033

MID = 10:54.8 UT

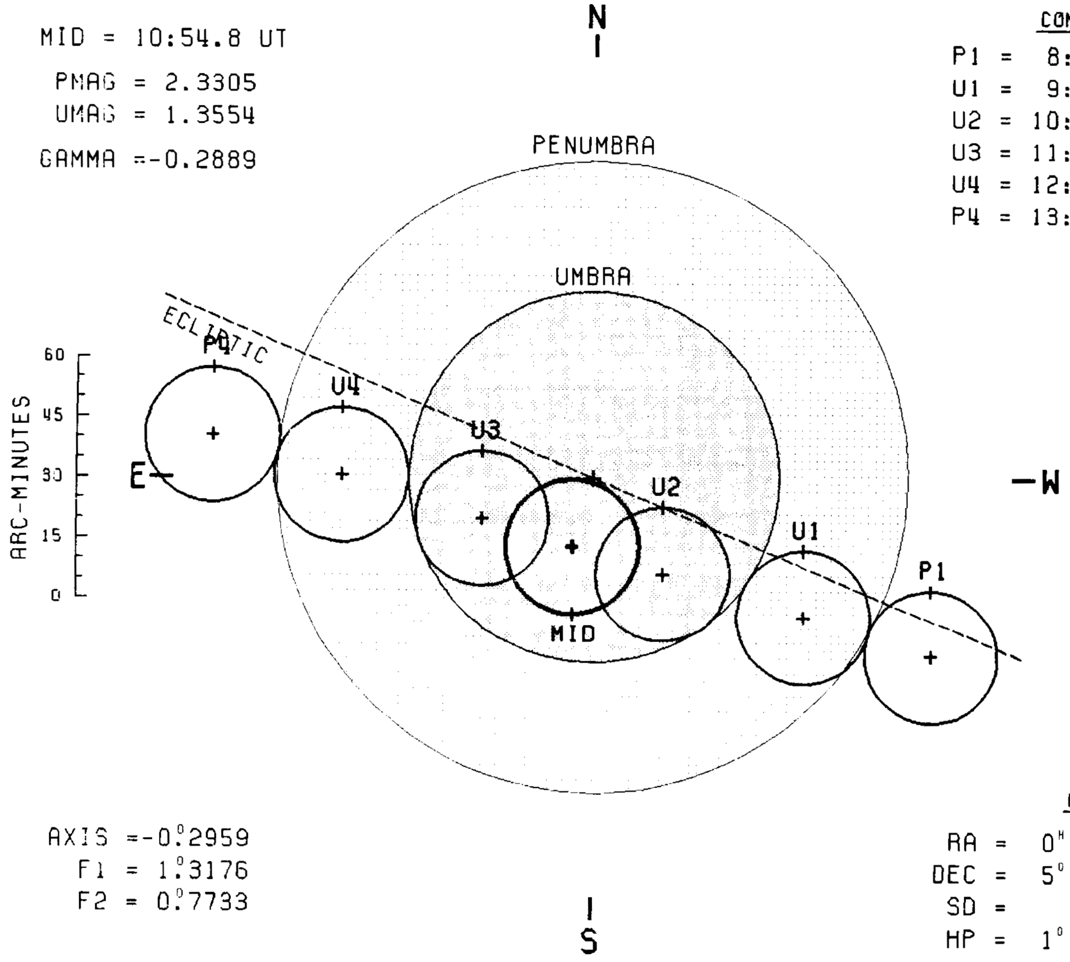
PMAG = 2.3305

UMAG = 1.3554

GAMMA =-0.2889

CONTACTS

P1 = 8:16.9 UT
U1 = 9:13.2 UT
U2 = 10:15.0 UT
U3 = 11:34.8 UT
U4 = 12:36.5 UT
P4 = 13:32.7 UT

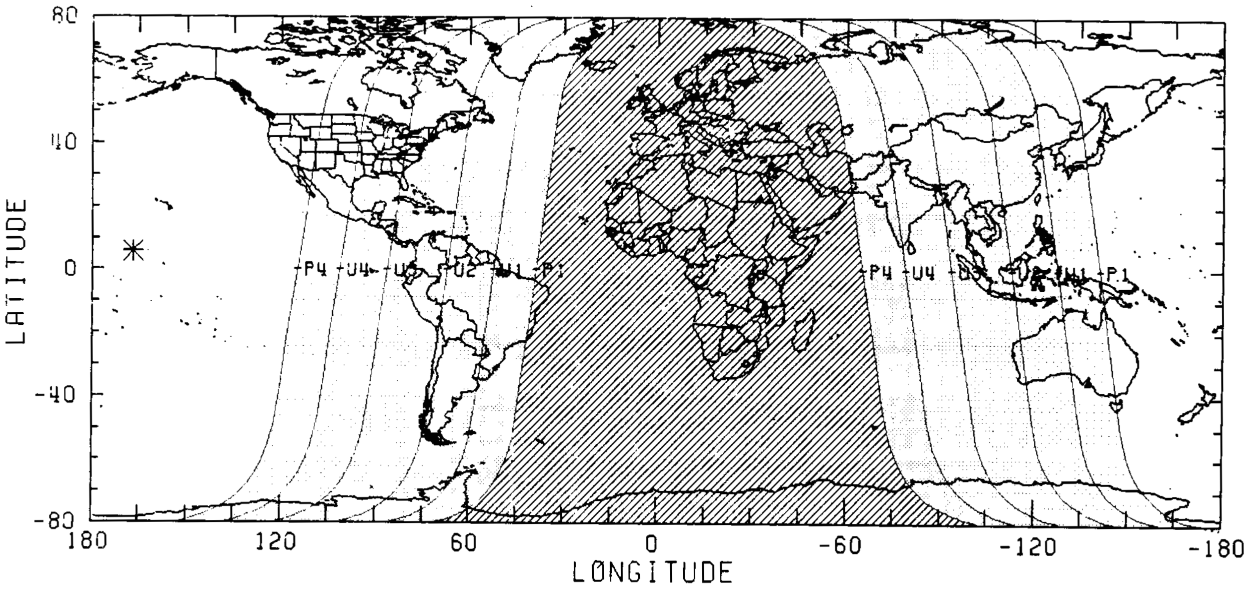


AXIS =-0°.2959
F1 = 1°.3176
F2 = 0°.7733

MOON

RA = 0ʰ57ᵐ22ˢ.7
DEC = 5°48'35".4
SD = 16'44".6
HP = 1° 1'27".1

SAROS 137 (29/81) JD = 2463878.956 ΔT = 95.2 S



PENUMBRAL LUNAR ECLIPSE - 3 APR 2034

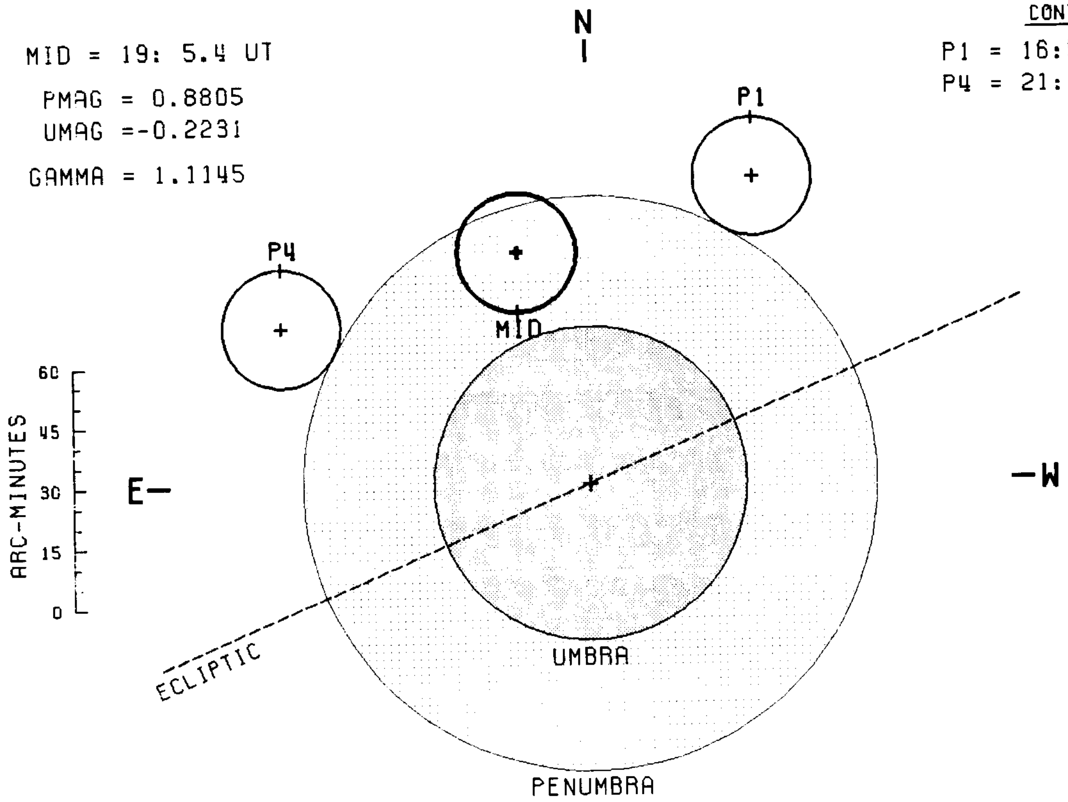
MID = 19: 5.4 UT

PMAG = 0.8805
UMAG =-0.2231

GAMMA = 1.1145

CONTACTS

P1 = 16:50.4 UT
P4 = 21:20.6 UT



AXIS = 1°.0078
F1 = 1°.1353
F2 = 0°.6514

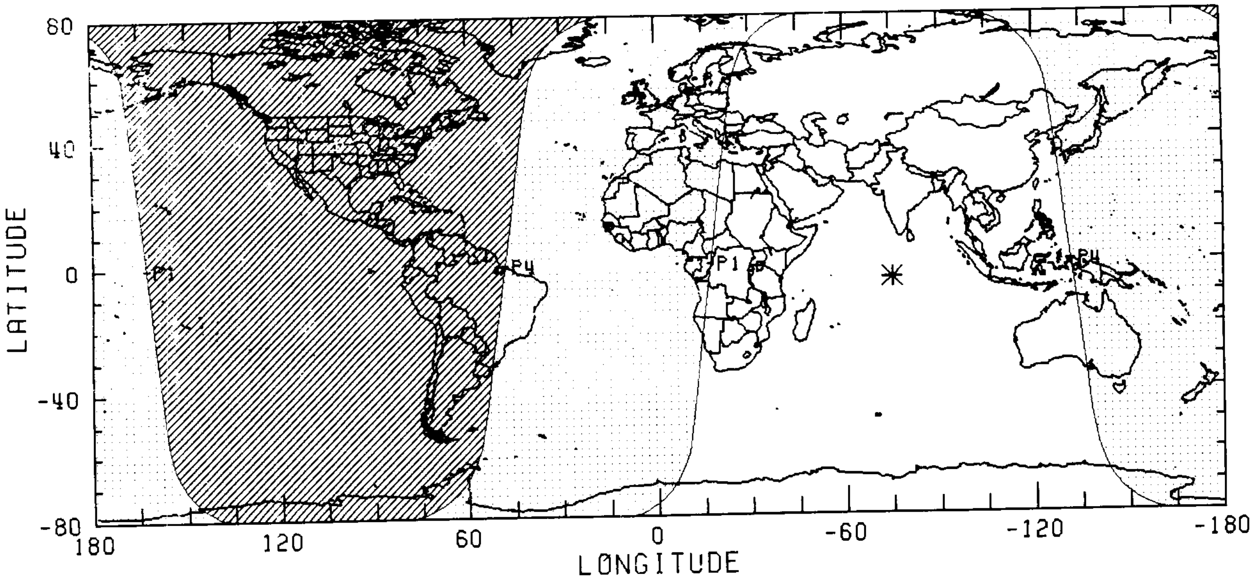
MOON

RA = 12ʰ53ᵐ 5ˢ.5
DEC = -4°35'41".6
SD = 14'47".1
HP = 0°54'15".6

SAROS 142 (19/74)

JD = 2464056.297

ΔT = 95.7 S



PARTIAL LUNAR ECLIPSE - 28 SEP 2034

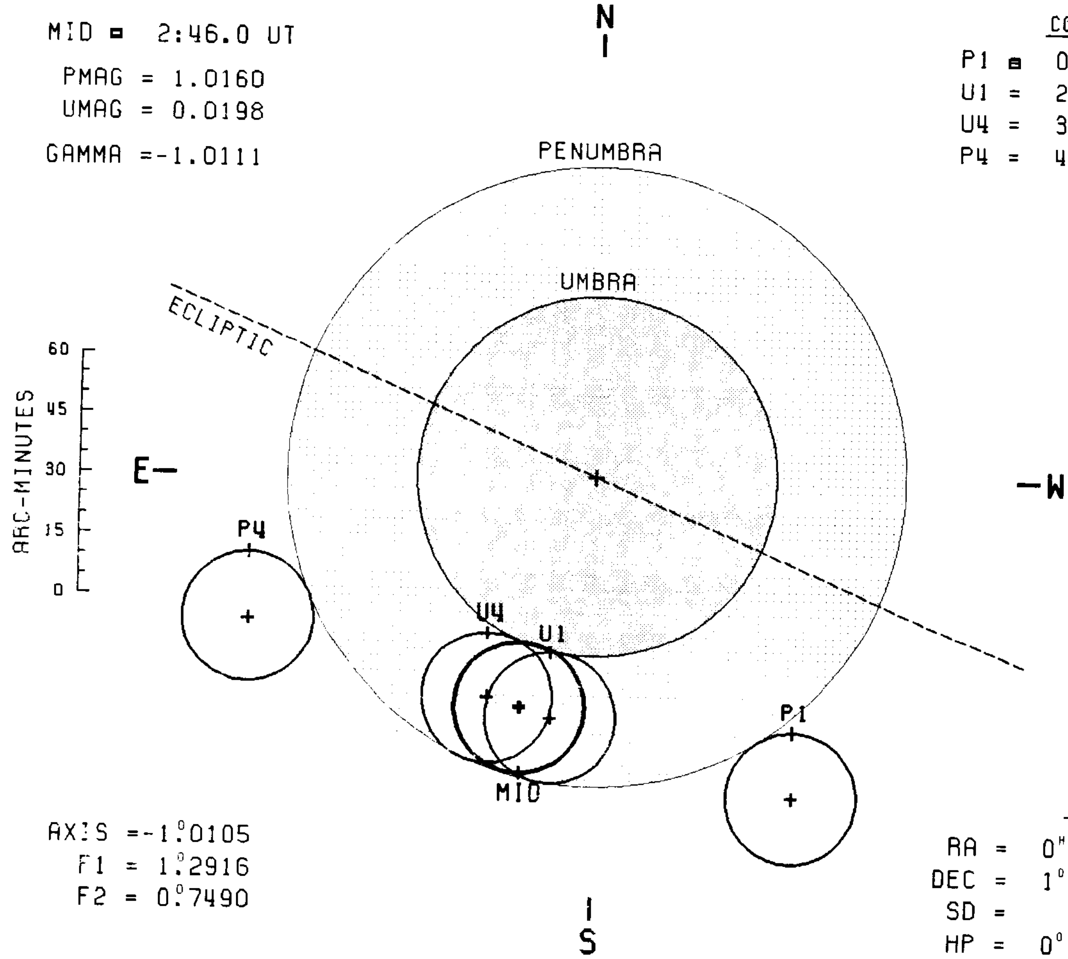
MID = 2:46.0 UT

PMAG = 1.0160
UMAG = 0.0198

GAMMA =-1.0111

CONTACTS

P1 = 0:39.9 UT
U1 = 2:31.6 UT
U4 = 3: 0.9 UT
P4 = 4:52.5 UT

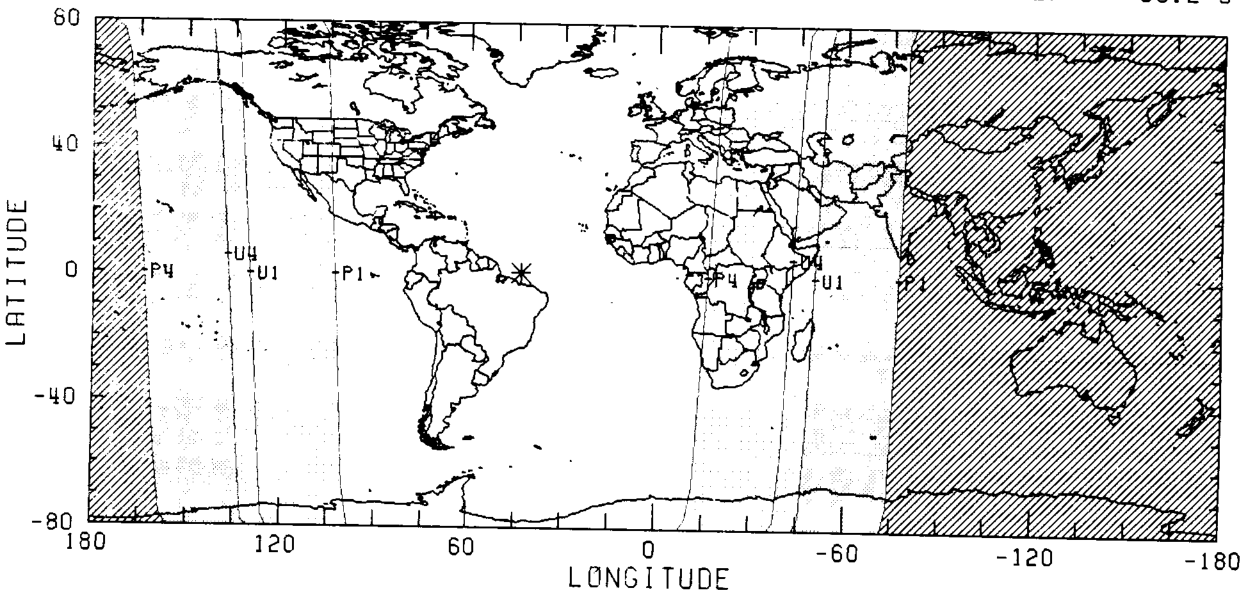


AXIS =-1.°0105
F1 = 1.°2916
F2 = 0.°7490

MOON

RA = 0ʰ 19ᵐ 49.ˢ9
DEC = 1° 2'58.″6
SD = 16'20.″4
HP = 0°59'58.″2

SAROS 147 (10/71) JD = 2464233.616 ΔT = 96.2 S



PENUMBRAL LUNAR ECLIPSE - 22 FEB 2035

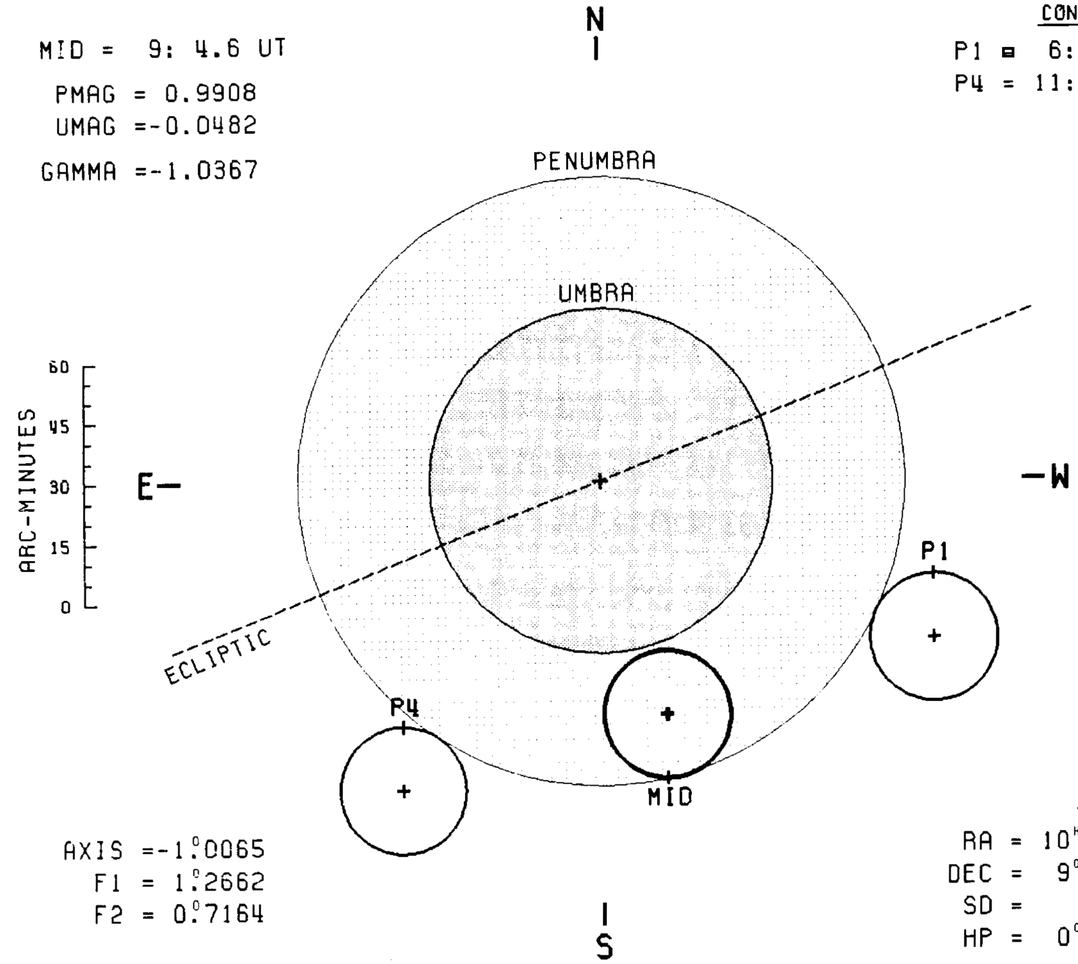
MID = 9: 4.6 UT

PMAG = 0.9908
UMAG =-0.0482

GAMMA =-1.0367

CONTACTS

P1 = 6:54.5 UT
P4 = 11:14.4 UT

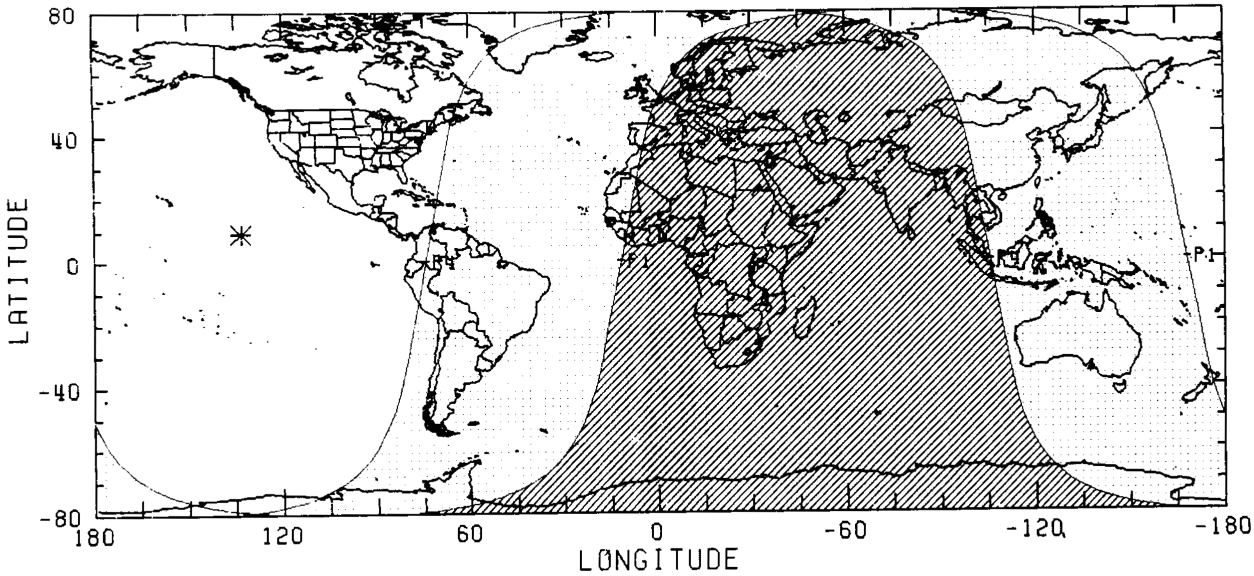


AXIS =-1°.0065
F1 = 1°.2662
F2 = 0°.7164

MOON

RA = $10^h 20^m 48.^s2$
DEC = $9° 13' 44.''0$
SD = $15' 52.''5$
HP = $0° 58' 15.''8$

SAROS 114 (60/71) JD = 2464380.879 ΔT = 96.6 S



PARTIAL LUNAR ECLIPSE - 19 AUG 2035

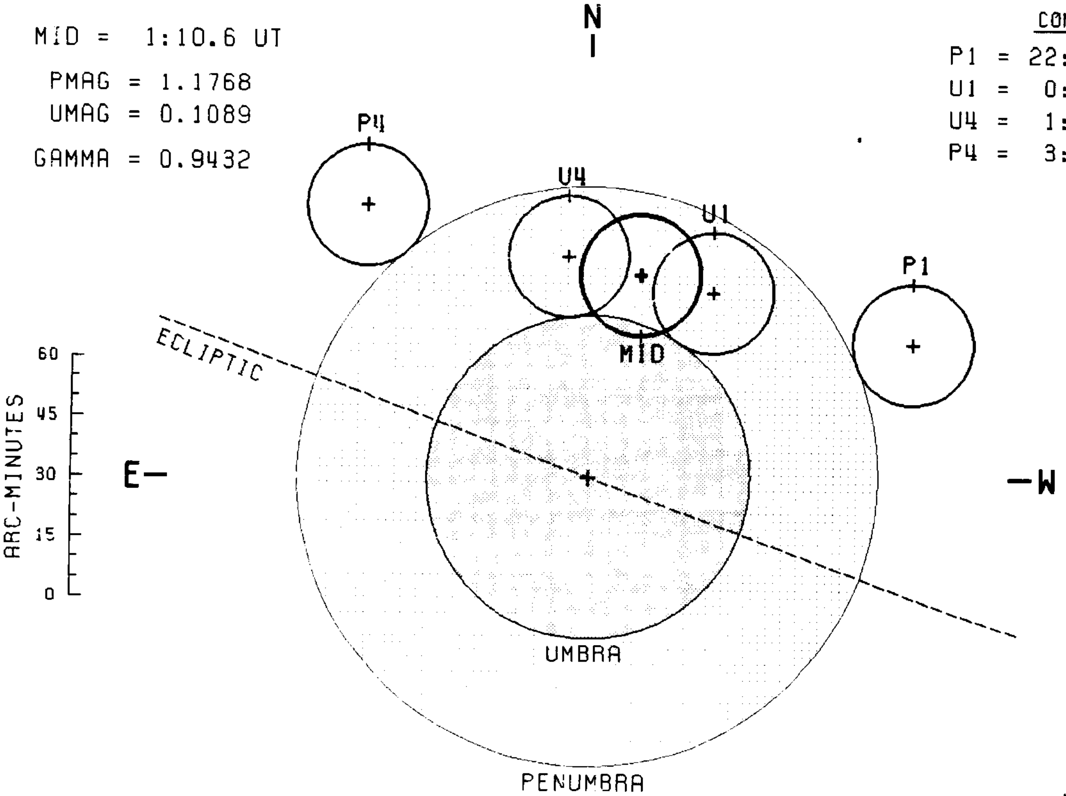
MID = 1:10.6 UT

PMAG = 1.1768
UMAG = 0.1089

GAMMA = 0.9432

CONTACTS

P1 = 22:43.4 UT
U1 = 0:31.7 UT
U4 = 1:49.4 UT
P4 = 3:37.6 UT

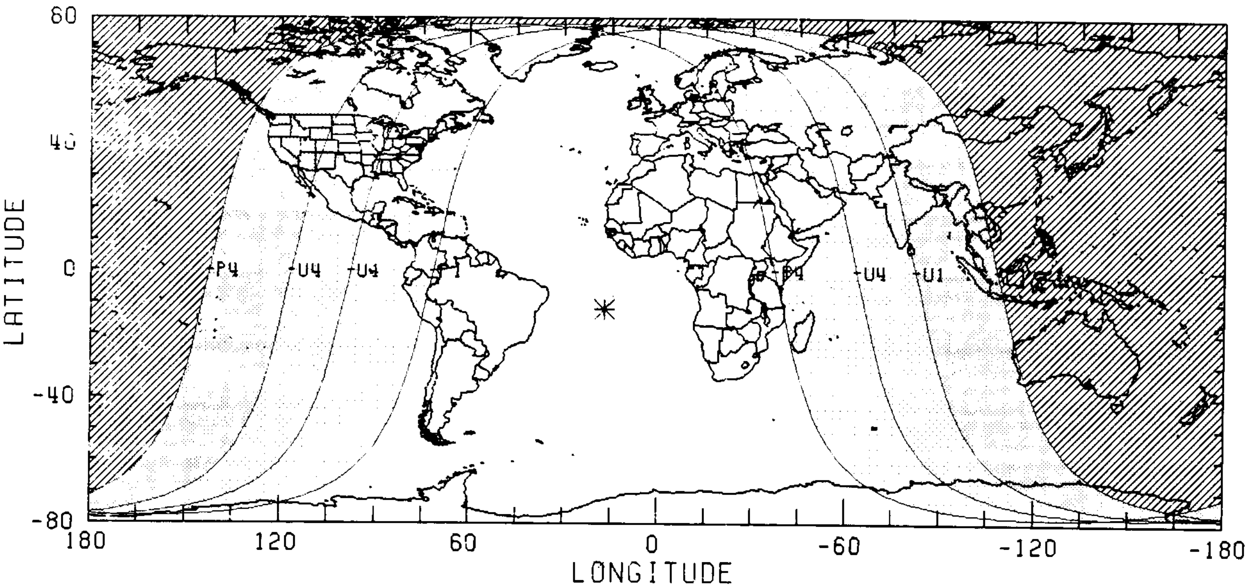


AXIS = 0°.8707
F1 = 1°.2111
F2 = 0°.6739

MOON

RA = 21ʰ51ᵐ50ˢ.6
DEC =-12°-1'-41".3
SD = 15' 5".5
HP = 0°55'23".4

SAROS 119 (63/83) JD = 2464558.550 ΔT = 97.1 S



FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

APPENDIX A - LUNAR ECLIPSES

GEOMETRY OF LUNAR ECLIPSES

The fundamental basis of the lunar eclipse is the alignment of the Sun, Earth and Moon such that some region of the Moon passes through Earth's shadow. This shadow is composed of two parts: the outer or penumbral shadow and the inner or umbral shadow. From within the penumbra, only part of the Sun is obscured by Earth. In contrast, the dark, central umbra is the shadow of complete or total eclipse. The Moon's path through Earth's shadow varies considerably from one eclipse to another with the specific geometry directly determining the nature of the eclipse. Lunar eclipses can be characterized as either penumbral or umbral. During a penumbral eclipse, the Moon passes through part of the penumbral shadow but misses the umbral shadow. Such events are relatively unimportant and, in fact, are rarely observable unless at least half of the Moon's diameter is immersed in the shadow. Nevertheless, penumbral eclipses have been included in Fifty Year Canon of Lunar Eclipses for completeness. However, the principle emphasis in this appendix will be on umbral eclipses which are readily observable, even with the unaided eye. They can be classified as either partial or total. If the Moon's path takes some part of it through the central axis of the shadow, then the eclipse is also known as a central eclipse. Since the radius of the umbral shadow always exceeds the Moon's apparent diameter, a central eclipse must also be a total eclipse.

As a consequence of its elliptical orbit around Earth, the Moon's distance and semi-diameter vary over the course of a month. From maximum apogee to minimum perigee, the Moon's distance from Earth's center ranges from 406,700 km to 356,400 km. This 12% range in distance corresponds to a variation in the Moon's apparent semi-diameter of 882 to 1006 arc-seconds.

Eclipse geometry is further complicated by the fact that Earth's orbit around the Sun is also elliptical. Thus, the Sun's apparent semi-diameter varies from 944 arc-seconds at aphelion to 976 arc-seconds at perihelion. This 3% range in apparent size is, of course, quite indistinguishable to the naked eye. However, it's a critical factor in determining the diameter of Earth's shadow at the point where it crosses the Moon's orbit. The umbra actually extends far beyond the Moon. Its length varies from 1,406,000 km at aphelion to 1,360,000 km at perihelion. The semi-diameter of the umbra at lunar perigee is 2772 (aphelion) to 2805 (perihelion) arc-seconds; at lunar apogee, the semi-diameter ranges from 2307 (aphelion) to 2340 (perihelion) arc-seconds.

ECLIPSE FREQUENCY. AND RECURRENCE

Having established the preliminary geometry for umbral lunar eclipses, a question immediately arises. Why doesn't a lunar eclipse occur at every Full Moon? Since the Moon cycles through its phases every 29 1/2 days or one synodic month, one would expect an eclipse to occur during each opposition with the Sun. If the Moon's orbit around Earth were in the same plane as Earth's around the Sun, this is precisely what would happen. However, the Moon's orbit is inclined to Earth's at a mean angle of 5°8'. Our planet's natural satellite passes through the ecliptic only twice a month at a pair of points called the nodes (Figure A-1). The rest of the time, the Moon is either above or below the plane of Earth's orbit (i.e. - the ecliptic). Since an eclipse can only occur when the Sun, Earth and Moon lie in the same plane, these conditions are met when Full Moon takes place at one of the nodes.

An examination of the geometry of the nodes yields further clues on the subject of eclipse recurrence. Since Earth's shadow and the Moon both subtend significant angles, neither one has to be exactly at the nodes in order to produce an eclipse. If Full Moon occurs while the shadow axis is within 10.9° of a node then an umbral eclipse is possible. However, a total eclipse can only occur if the shadow axis is within 5.2° of a node. The Sun (and Earth's shadow) travels along the ecliptic at about 1° per day and requires 22 days to cross the eclipse zone centered on each node. Full Moon occurs every 29 1/2 days, so it's quite possible that the Sun may pass through the eclipse zone before Full Moon occurs. Naturally, no umbral eclipse takes place under these circumstances.

The period during which the Sun is near a node is called an eclipse season and there are two eclipse seasons each year. If the line of nodes were fixed in space, then eclipse seasons would occur six months apart and at the same time each year. Actually, the line of nodes slowly drifts westward at the rate of 19° per year. As a result, eclipse seasons occur every 173.3 days. Two eclipse seasons constitute an eclipse year of 346.6 days. This is 18.6 days short of a lunar year and is equal to the time required by the Sun (and Earth's shadow) to cross the same node twice.

Although umbral lunar eclipses are not uncommon, they are actually somewhat rarer than solar eclipses. A detailed examination of eclipse geometry will substantiate this statement. An umbral eclipse is possible only when the Moon is within that section of its orbit inscribed by the exterior tangents of the Sun-Earth rays (Figure A-1). However, the sunward arc of the Moon's orbit is clearly longer than the anti-sunward arc which passes through the umbra. The number of solar and lunar eclipses that occur are proportional to the lengths of these two arcs which is almost 5 to 3. Thus, an average of about 5 out of every 8 eclipses are solar eclipses. This contradicts common experience which tells us that lunar eclipses are seen more frequently than solar eclipses. A selection effect is in operation here because a lunar eclipse can be seen from the entire nighttime hemisphere of Earth, while a solar eclipse is only visible from a small fraction of the daytime hemisphere.

In any one calendar year, there are at least two and as many as five solar eclipses. On the other hand, there can be no more than three umbral lunar eclipses per year and it's quite possible to have none at all. Combining both solar and lunar eclipses, it's possible for one calendar year to contain a maximum of seven eclipses. However, they can only occur in the combinations of five solar and two lunar or four solar and three lunar. In either case, the solar eclipses must all be partial. As a point of interest, 1982 happened to be one of the rare years containing seven eclipses. What made it even more remarkable was the fact that all three lunar eclipses were total. This will not happen again until the year 2485 AD.

In order to find a periodicity in the mechanics of lunar eclipses, we must search for a commensurability between the synodic month and the eclipse year. Fortunately, 19 eclipse years are almost exactly equal to 223 synodic months; they differ by only 11 hours. The coincidence is all the more remarkable when compared to a period known as the anomalistic month. This is the time required for the Moon to pass from perigee to perigee and is approximately 27 1/2 days. As unlikely as it may seem, 239 anomalistic months are also equal to 223 synodic months to within 6 hours.

This fortuitous commensurability results in the famous Saros cycle of 6585 1/3 days or 18 years, 11 days and 8 hours. Any two eclipses separated by one Saros cycle share very similar mechanical characteristics. They occur at nearly the same node with the Moon at the same distance from Earth and at nearly the same time of year. Because the Saros does not contain an integral number of days, its biggest drawback is that subsequent eclipses are visible from different parts of the globe. Although the 1/3 day displacement shifts the hemisphere facing the Moon 120° westward with each cycle, the series returns to approximately the same hemisphere every 3 Saroses or 56 years and 34 days. Note that because the Saros is slightly longer than 18 years, the eclipses in a series shift forward with respect to the seasons by about two months per century.

A Saros series doesn't last indefinitely because the various periods are not perfectly commensurate with one another. In particular, 19 eclipse years are 1/2 day longer than the Saros. As a result, the node shifts eastward by about 0.5° with each Saros cycle.

A typical Saros series begins when Full Moon occurs about 16.5° east of a node. If the Moon is near its descending node, the Saros number is odd [van den Berg, 1955] and the Moon is south of the ecliptic. Similarly, if the Moon is near its ascending node, the Saros number is even and the Moon is north of the ecliptic. With each succeeding eclipse in a series, the Moon shifts westward with respect to the node and northward (odd Saros) or southward (even Saros) in ecliptic latitude. The first seven to fifteen eclipses in a Saros series are penumbral events as each subsequent Full Moon occurs closer to the node. The penumbral eclipses are followed by ten to twenty partial umbral events of progressively increasing magnitude as the lunar path swings deeper into Earth's shadow. The change in magnitude between successive eclipses varies and is greatest when Earth is near aphelion (early July). Finally, the entire Moon passes through the umbra as we approach the middle of the Saros series. The next twelve to twenty-five eclipses are total, including three or four central eclipses midway through the sequence. The series now wanes as each eclipse retreats further west of the node. The total eclipses in the series are followed by another ten to twenty partial umbral eclipses of decreasing magnitude. Ultimately, the Saros series terminates about 16.5° west of the node after seven to fifteen penumbral eclipses. A typical series lasts thirteen to fourteen centuries and may be comprised of seventy to eighty eclipses of which some forty to fifty-five are umbral.

At any one time, there are a number of Saros series in progress. For instance, during the two hundred year period covered in Sections 1 and 2, there are 46 individual series in progress. A complete breakdown of these series including the dates of their first and last members, series duration and number of eclipses by type are included in Table A-1. As can be seen, the actual number of eclipses in each eclipse varies considerably. For comparison, a similar breakdown of all solar eclipse series in progress over the same period is presented in Table A-2. As old series terminate, new ones are always beginning and take their places. Although not as well known as the Saros, the Tritos, the Inex and Meton's Cycle are also useful relationships in eclipse recurrence (Table A-3).

Table A-1

SAROS SERIES SUMMARY FOR LUNAR ECLIPSES

SAROS SERIES	FIRST ECLIPSE	LAST ECLIPSE	SERIES DURATION (yrs)	NUMBER ECLIPSES	PENUMBRAL ECLIPSES	PARTIAL ECLIPSES	TOTAL ECLIPSES
102	5 OCT 461	4 APR 1958	1496.5	84	44	13	27
103	24 AUG 454	21 FEB 1951	1496.5	84	41	14	29
108	8 JUL 689	27 AUG 1969	1280.1	72	28	32	12
109	17 JUN 718	18 AUG 2016	1298.1	73	17	39	17
110	28 MAY 747	18 JUL 2027	1280.1	72	16	43	13
111	10 JUN 830	19 JUL 2092	1262.1	71	17	43	11
112	20 MAY 859	12 JUL 2139	1280.1	72	14	43	15
113	29 APR 888	10 JUN 2150	1262.1	71	16	41	14
114	13 MAY 971	22 JUN 2233	1262.1	71	27	31	13
115	21 APR 1000	13 JUN 2280	1280.1	72	18	28	26
116	11 MAR 993	14 MAY 2291	1298.1	73	29	17	27
117	3 APR 1094	26 MAY 2374	1280.1	72	32	15	25
118	2 MAR 1105	17 MAY 2421	1316.2	74	30	16	28
119	3 OCT 917	25 MAR 2396	1478.4	83	41	14	28
120	5 OCT 982	7 APR 2479	1496.5	84	45	14	25
121	25 SEP 1029	29 MAR 2526	1496.5	84	41	14	29
122	14 AUG 1022	8 NOV 2356	1334.2	75	32	15	28
123	16 AUG 1087	19 OCT 2385	1298.1	73	34	14	25
124	17 AUG 1152	31 OCT 2468	1316.2	74	30	16	28
125	17 JUL 1163	9 SEP 2443	1280.1	72	24	22	26
126	8 JUL 1210	30 AUG 2490	1280.1	72	31	27	14
127	9 JUL 1275	2 SEP 2555	1280.1	72	18	38	16
128	18 JUN 1304	2 AUG 2566	1262.1	71	14	42	15
129	10 JUN 1351	24 JUL 2613	1262.1	71	17	43	11
130	10 JUN 1416	5 AUG 2696	1280.1	72	16	42	14
131	10 MAY 1427	7 JUL 2707	1280.1	72	15	42	15
132	12 MAY 1492	26 JUN 2754	1262.1	71	26	33	12
133	13 MAY 1557	29 JUN 2819	1262.1	71	16	34	21
134	1 APR 1550	8 JUN 2848	1298.1	73	27	19	27
135	13 APR 1615	18 MAY 2877	1262.1	71	31	17	23
136	13 APR 1680	1 JUN 2960	1280.1	72	29	16	27
137	26 NOV 1528	1 MAY 2971	1442.4	81	38	15	28
138	5 OCT 1503	30 MAR 2982	1478.4	83	43	14	26
139	28 NOV 1640	24 APR 3083	1442.4	81	39	15	27
140	5 SEP 1579	29 JAN 3004	1424.3	80	36	16	28
141	25 AUG 1608	23 OCT 2906	1298.1	73	33	14	26
142	19 SEP 1709	27 NOV 3025	1316.2	74	32	15	27
143	7 AUG 1702	5 OCT 3000	1298.1	73	28	18	27
144	29 JUL 1749	4 SEP 3011	1262.1	71	30	20	21
145	11 AUG 1832	16 SEP 3094	1262.1	71	26	30	15
146	11 JUL 1843	29 AUG 3123	1280.1	72	16	39	17
147	21 JUN 1872	28 JUL 3134	1262.1	71	17	42	12
148	15 JUL 1973	20 AUG 3235	1262.1	71	16	43	12
149	13 JUN 1984	20 JUL 3246	1262.1	71	14	42	15
150	25 MAY 2013	30 JUN 3275	1262.1	71	20	39	12
151	6 JUN 2096	13 JUL 3358	1262.1	71	18	39	14
156	28 OCT 2042	5 APR 3503	1460.4	82	41	14	27

Table A-2

SAROS SERIES SUMMARY FOR SOLAR ECLIPSES

SAROS SERIES	FIRST ECLIPSE	LAST ECLIPSE	SERIES DURATION (yrs)	NUMBER ECLIPSES	PARTIAL ECLIPSES	ANNULAR ECLIPSES	ANN/TOT ECLIPSES	TOTAL ECLIPSES
108	3 JAN 550	8 APR 1902	1352.2	76	33	20	5	18
111	30 AUG 528	5 JAN 1935	1406.3	79	37	11	14	17
114	23 JUL 651	12 SEP 1931	1280.1	72	26	13	16	17
115	21 JUN 662	12 AUG 1942	1280.1	72	17	14	4	37
116	23 JUN 727	22 JUL 1971	1244.0	70	17	53	0	0
117	24 JUN 792	3 AUG 2054	1262.1	71	15	23	5	28
118	24 MAY 803	15 JUL 2083	1280.1	72	15	15	2	40
119	15 MAY 850	24 JUN 2112	1262.1	71	17	51	1	2
120	27 MAY 933	7 JUL 2195	1262.1	71	16	25	3	27
121	25 APR 944	7 JUN 2206	1262.1	71	16	11	2	42
122	17 APR 991	17 MAY 2235	1244.0	70	28	37	2	3
123	29 APR 1074	31 MAY 2318	1244.0	70	26	27	3	14
124	6 MAR 1049	11 MAY 2347	1298.1	73	29	0	1	43
125	4 FEB 1060	9 APR 2358	1298.1	73	33	34	2	4
126	10 MAR 1179	3 MAY 2459	1280.1	72	31	28	3	10
127	10 OCT 991	21 MAR 2452	1460.4	82	40	0	0	42
128	29 AUG 984	1 NOV 2282	1298.1	73	33	32	4	4
129	3 OCT 1103	21 FEB 2528	1424.3	80	39	29	3	9
130	20 AUG 1096	25 OCT 2394	1298.1	73	30	0	0	43
131	21 JUL 1107	2 SEP 2369	1262.1	71	30	30	5	6
132	13 AUG 1208	25 SEP 2470	1262.1	71	29	33	2	7
133	13 JUL 1219	5 SEP 2499	1280.1	72	19	6	1	46
134	22 JUN 1248	6 AUG 2510	1262.1	71	17	30	16	8
135	5 JUL 1331	17 AUG 2593	1262.1	71	18	45	2	6
136	14 JUN 1360	30 JUL 2622	1262.1	71	15	6	5	45
137	25 MAY 1389	28 JUN 2633	1244.0	70	15	36	9	10
138	6 JUN 1472	11 JUL 2716	1244.0	70	16	50	1	3
139	17 MAY 1501	3 JUL 2763	1262.1	71	16	0	12	43
140	16 APR 1512	1 JUN 2774	1262.1	71	24	32	4	11
141	19 MAY 1613	13 JUN 2857	1244.0	70	29	41	0	0
142	17 APR 1624	5 JUN 2904	1280.1	72	28	0	1	43
143	25 FEB 1599	23 APR 2897	1298.1	73	31	26	4	12
144	11 APR 1736	5 MAY 2980	1244.0	70	31	39	0	0
145	4 JAN 1639	17 APR 3009	1370.3	77	34	1	1	41
146	19 SEP 1541	29 DEC 2893	1352.2	76	35	24	3	14
147	12 OCT 1624	24 FEB 3049	1424.3	80	40	40	0	0
148	21 SEP 1653	12 DEC 2987	1334.2	75	32	2	1	40
149	21 AUG 1664	28 SEP 2926	1262.1	71	28	23	3	17
150	24 AUG 1729	29 SEP 2991	1262.1	71	31	40	0	0
151	14 AUG 1776	1 OCT 3056	1280.1	72	26	6	1	39
152	26 JUL 1805	20 AUG 3049	1244.0	70	15	22	3	30
153	28 JUL 1870	22 AUG 3114	1244.0	70	21	49	0	0
154	19 JUL 1917	25 AUG 3179	1262.1	71	15	17	2	37
155	17 JUN 1928	24 JUL 3190	1262.1	71	15	20	3	33
156	1 JUL 2011	14 JUL 3237	1226.0	69	17	52	0	0
157	21 JUN 2058	17 JUL 3302	1244.0	70	14	19	3	34
158	20 MAY 2069	16 JUN 3313	1244.0	70	17	16	2	35
164	24 OCT 2098	10 MAR 3523	1424.3	80	37	3	4	36

Table A-3

Saros Series Relationships

If an eclipse of Saros series 'X' is followed by another eclipse after a period of:		Then the second eclipse belongs to Saros series:	
1 Lunation	(~1 month)	X + 38	
5 Lunations	(~5 months)	X − 33	
6 Lunations	(~6 months)	X + 5	
135 Lunations	(~11 years − 1 month)	X + 1	(Tritos)
223 Lunations	(~18 years + 11 days)	X	(Saros)
235 Lunations	(~19 years)	X + 10	(Meton's Cycle)
358 Lunations	(~29 years − 20 days)	X + 1	(Inex)

(based on a table from Meeus and Mucke [1979])

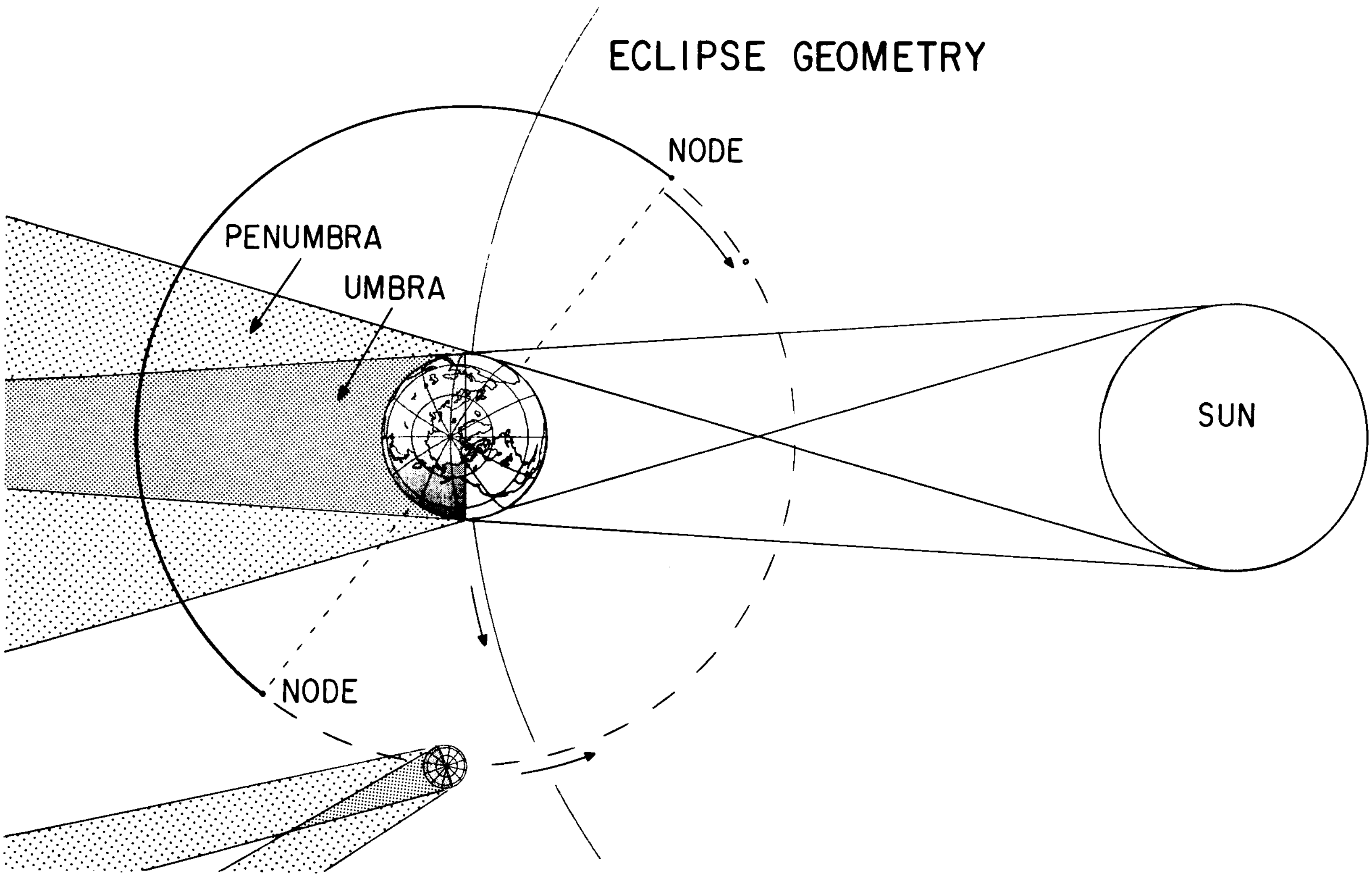


Figure A-1

ENLARGEMENT OF EARTH'S SHADOW

In 1707, Lahire made a curious observation about Earth's umbra. In order to accurately predict the duration of a lunar eclipse, he found it necessary to increase the radius of the shadow about 1/41 larger than warranted by geometric considerations. Although the effect is known to be related to layer of dust suspended in Earth's atmosphere, it is not completely understood since the shadow enlargement seems to vary from one eclipse to the next.

For many years, astronomers have accounted for this phenomenon in eclipse predictions by increasing the apparent radius of Earth's shadow by 1/50. Following this tradition, the Astronomical Almanac defines the geocentric angular radii of Earth's shadows at the distance of the Moon as:

$$\pi_1 = 0.99833\ \pi_m$$

penumbral radius: $f_1 = 1.02\ (\pi_1 + s_s + \pi_s)$

umbral radius: $f_2 = 1.02\ (\pi_1 - s_s + \pi_s)$

where: π_m = Equatorial horizontal parallax of the Moon
π_1 = Equatorial horizontal parallax of the Moon corrected for Earth's mean oblateness
s_s = Geocentric semi-diameter of the Sun
π_s = Equatorial horizontal parallax of the Sun

Danjon [1951] takes issue with this tradition and points out that the only reasonable way of taking into account the existence of a layer of opaque air surrounding Earth is to increase the planet's radius by the altitude of the layer. This can be accomplished by proportionally increasing the parallax of the Moon. Furthermore, Danjon argues that the radii of the umbral and penumbral shadows are subject to the same absolute correction and not the same relative correction employed in the traditional definition. Finally, he estimates the thickness of the occulting layer to be 75 km and this would result in an enlargement of Earth's radius and the Moon's parallax of about 1/85.

Since 1951, the French almanac Connaissance des Temps has adopted Danjon's definitions of the radii of Earth's shadows as:

penumbral radius: $f_1 = 1.01\ \pi_1 + s_s + \pi_s$

umbral radius: $f_2 = 1.01\ \pi_1 - s_s + \pi_s$

Danjon's geometric arguments are sound and his definitions have also been used by Meeus and Mucke [1979] in their ambitious work. Unfortunately, the C.d.T. value of 1/100 for the enlargement of Earth's radius (and the Moon's parallax) yields a mean umbral enlargement of 0.8% and this does not fit the observations nearly as well as the old 1/50 rule.

In an analysis of 57 eclipses covering a period of 150 years, Link [1969] finds a mean shadow enlargement of 2.3%. Furthermore, timings of crater entrances and exits through the umbra during four recent eclipses (Table A-4) closely support the traditional value of 2%. From a physical point of view, there is no abrupt boundary between the umbra and penumbra. The shadow density actually varies continuously as a function of radial distance from the central axis out to the extreme edge of the penumbra. However, the density variation is most rapid near the theoretical edge of the umbra. Kuhl's [1928] contrast theory demonstrates that the edge of the umbra is perceived at the point of inflexion in the shadow density. This point appears to be connected with a layer of meteoric dust in Earth's atmosphere at an altitude of about 120-150 km. This net enlargement of Earth's radius of 1.9% to 2.4% corresponds to an umbral shadow enlargement of 1.5% to 1.9%, in reasonably good agreement with the conventional value.

Table A-4

Umbral Shadow Enlargement From Craters Timings

Date of Eclipse	Crater Entrances % Enlargement	Crater Exits % Enlargement	Sky & Telescope Reference
30 Jan 1972	1.69 (420)	1.68 (295)	Oct 1972, p.264
24 May 1975	1.79 (332)	1.61 (232)	Oct 1975, p.219
5 Jul 1982	2.02 (538)	2.24 (159)	Dec 1982, p.618
30 Dec 1982	1.74 (298)	1.74 (90)	Apr 1983, p.387

Note: Figures in '()' are the number of observations included in each shadow enlargement measurement.

Ideally, the author would like to define the shadow radii using Danjon's geometry but substituting the 1.01 enlargement factor with a larger value closer to the traditional factor of 1.02. However, this would introduce a third pair of shadow definitions in the current literature which would prohibit comparisons with other eclipse predictions. Furthermore, the accuracy to which the umbral shadow's enlargement can be measured does not warrant the confusion that would be introduced by yet another set of definitions. Although the geometry of Danjon's definitions is correct and far more appealing, the author has chosen to use the traditional definitions of the Astronomical Almanac because they appear to yield more accurate predictions.

As a consequence of the different shadow radii definitions, comparisons between Fifty Year Canon of Lunar Eclipses and C.d.T or Canon of Lunar Eclipses: -2002 to +2526 will reveal that eclipse magnitudes in the latter two references are smaller by 0.005 for umbral eclipses and 0.026 for penumbral eclipses. Furthermore, it should be noted that in cases of very small penumbral magnitude, the European references will predict no eclipse at all. Whether an eclipse of this type occurs or not is basically of academic interest since such an event is wholely unobservable. Likewise, in cases where this work predicts a total or partial umbral eclipse of small magnitude, the previous references may predict either a partial or penumbral eclipse, respectively. Again the distinction is not critical since the umbra's edge is not sharp and the exact shadow enlargement is unknown. For example, this work predicts a partial eclipse on 3 March 1988 and a penumbral eclipse on 18 August 2016; in contrast, Canon of Lunar Eclipses: -2002 to +2526 predicts a penumbral eclipse on 3 March 1988 and no eclipse on 18 August 2016. Predictions in the Astronomical Almanac should be in close agreement with Fifty Year Canon of Lunar Eclipses. Any discrepencies between the two should reflect real differences in the solar and lunar ephemerides used.

Crater Timings During Lunar Eclipses

The enlargement of Earth's umbra can be measured through careful timings of lunar craters as they enter and exit the shadow. Such observations are best made using a low-power telescope and a clock or watch synchronized with radio time signals. Timings should be made to a precision of 0.1 minute. The basic idea is to record the instant when the most abrupt gradient at the umbra's edge crosses the apparent centre of the crater. In the case of large craters like Tycho and Copernicus, it is recommended that you record the times when the shadow touches the two opposite edges of the crater. The average of these times is equal to the instant of crater bisection. As a planning guide, Table A-5 lists twenty well-defined craters which are recommended for making umbral immersion and emersion timings during lunar eclipses.

It's important to be thoroughly familiar with these features before an eclipse in order to prevent confusion and misidentifications. The four umbral contacts with the Moon's limb can also be used in determining the shadow's enlargement. However, these events are less distinct and difficult to time accurately. Observers are encouraged to make crater timings and to send their results to Sky and Telescope for analysis.

Table A-5

Lunar Craters for Eclipse Timings

Crater	Latitude	Longitude
Aristarchus	23.7N	47.4W
Aristoteles	50.2N	17.4E
Billy	13.8S	50.1W
Campanus	28.0S	27.8W
Copernicus	9.7N	20.0W
Dionysius	2.8N	17.3E
Eudoxus	44.3N	16.3E
Goclenius	10.0S	45.0E
Grimaldi	5.2S	68.6W
Kepler	8.1N	38.0W
Langrenus	8.9S	60.9E
Manilius	14.5N	9.1E
Menelaus	16.3N	16.0E
Plato	51.6N	9.3W
Plinius	15.4N	23.7E
Proclus	16.1N	46.8E
Pytheas	20.5N	20.6W
Taruntius	5.6N	46.5E
Timocharis	26.7N	13.1W
Tycho	43.3S	11.2W

Danjon Scale of Lunar Eclipse Brightness

The Moon's appearance during a total lunar eclipse can vary enormously from one eclipse to the next. Obviously, the geometry of the Moon's path through the umbra plays an important role. Not as apparent is the effect that Earth's atmosphere has on total eclipses. Although the physical mass of Earth blocks off all direct sunlight from the umbra, the planet's atmosphere refracts some of the Sun's rays into the shadow. Earth's atmosphere contains varying amounts of water (clouds, mist, precipitation) and solid particles (meteoric dust, organic debris, volcanic ash). This material significantly filters and attenuates the sunlight before it's refracted into the umbra. For instance, large or frequent volcanic eruptions dumping huge quantities of ash into the atmosphere are often followed by very dark, red eclipses for several years. Extensive cloud cover along Earth's limb also tends to darken the eclipse by blocking sunlight. The French astronomer A. Danjon proposed a useful five point scale for evaluating the visual appearance and brightness of the Moon during total lunar eclipses. 'L' values for various luminosities are as follows:

L = 0	Very dark eclipse. Moon almost invisible, especially at mid-totality.
L = 1	Dark Eclipse, gray or brownish in coloration. Details distinguishable only with difficulty.
L = 2	Dark red or rust-colored eclipse. Very dark in central shadow, while outer edge of umbra is relatively bright.
L = 3	Brick-red eclipse. Umbral shadow often bordered with bright or yellow rim.
L = 4	Very bright orange or copper-red eclipse. Umbral shadow has a bluish, very bright rim.

The assignment of an 'L' value to lunar eclipses is best done with the naked eye, binoculars or a small telescope near the time of mid-totality. It's also useful to examine the Moon's appearance just after the beginning and before the end of totality. The Moon is then near the edge of the shadow and provides an opportunity to assign an 'L' value to the outer umbra. In making any evaluations, one should record both the instrumentation and the time. Also note any variations in color and brightness in different parts of the umbra, as well as the apparent sharpness of the shadow's edge. Pay attention to the visibility of lunar features within the umbra. Notes and sketches made during the eclipse are often invaluable in recalling important details, events and impressions. Meaningful Danjon brightness estimates are not possible during partial lunar eclipses.

TIME DETERMINATION

The measurement of time is of fundamental importance to all branches of science, but to none more so than astronomy. In fact, astronomy was born through man's first attempts to measure the passage of time by observing the motions of the Sun and the Moon. It should come as no surprise then, that time reckoning remains intricately entwined with astronomy even today. However, the Sun's apparent motion no longer plays the pivotal role as the ultimate temporal yardstick. It's been known for thousands of years that the length of the solar day is not constant but varies with an annual cycle. What was not known before Kepler's time was that Earth's elliptical orbit about the Sun, coupled with the inclination in the planet's axis were responsible for the periodic variations.

Mean Solar Time can be conceptualized as time kept by a fictitious or mean Sun which moves eastward along the celestial equator at the average rate of the true Sun. Greenwich Mean Time (GMT) or Universal Time (UT) is simply Mean Solar Time as measured from Greenwich, England and was used in navigation and surveying for hundreds of years. Unfortunately, this too has fallen by the wayside because Earth does not turn on its axis at a uniform and constant rate. As Earth spins, a tidal friction is imposed on it through the gravitational interaction with the Moon and, to a lesser extent, the Sun. This secular acceleration gradually transfers angular momentum from Earth to the Moon. As Earth loses energy and slows down, the Moon gains this energy and its distance from Earth increases. Although still in its infancy, the technique of lunar laser ranging has shown that the Moon's average distance from Earth is increasing by about four centimeters per year.

It should be pointed out that the secular acceleration of the Moon is very poorly known and may not be constant. Careful records for its derivation only go back as far as 100 years or so. Before then, spurious and often incomplete solar eclipse and lunar occultation observations from medieval and ancient manuscripts comprise the data base. In any case, the current value implies an increase in the length of the day by about 0.001 seconds per century. Such a trivially small amount may seem insignificant, but it has very measurable cumulative effects. In one century, Earth loses 45 seconds, while in one millennium, the planet is one and a quarter hours "behind schedule."

Earth's rotation on its axis is also subject to short term fluctuations for periods of up to several decades. It is believed that these fluctuations may be due to fluid motions in Earth's core which interact with and disturb the rotation of the mantle. However, climatological changes and variations in sea-level may also play a significant role since they should alter Earth's moment of inertia. Whatever the mechanism is, it is clear that its effects cannot be predicted with the current state of knowledge. A better standard than diurnal rotation for the absolute measurement of time is the use of solar system dynamics. The orbital motions of the planets and of the Moon are predictable to very high accuracy and are directly verifiable through observations. The resulting time is referred to as Ephemeris Time (ET).

In 1957, the International Astronomical Union adopted Ephemeris Time as the standard and defined the ephemeris second as 1/31,556,925.9747 of the tropical year 1900 at January 0 at 12 hours Universal Time. The difference between Ephemeris Time and Universal Time (=ΔT) is obtained through observations of the Moon. The Moon's position is predicted in terms of Ephemeris Time but it is observed with respect to Universal Time. Between 1900 and 1980, the slowing of Earth's rotation on its axis had caused Universal Time to lag 50.54 seconds (=ΔT) behind Ephemeris Time.

Ephemeris Time remained the basis of all time measurements until 1984. With the technological development of the atomic clock, a method of time measurement became available which has a permanence and stability unmatched by even celestial mechanics. The atomic or SI (for Systeme International) second is defined as 9,192,631,770 periods of the radiation corresponding to the transition between two hyperfine levels of the ground state of the Cesium 133 atom. The SI second was carefully chosen to agree as closely as possible to the ephemeris second. In 1984, the SI second was adopted as the newest time standard and Terrestrial Dynamical Time (TDT) replaced Ephemeris Time. For consistency, the time scale for Terrestrial Dynamical Time was chosen to agree with 1984 Ephemeris Time.

Eclipse predictions are now based on Terrestrial Dynamical Time but actual observations are made in Universal Time. Unfortunately, it's impossible to predict how ΔT (where: ΔT = TDT-UT) will vary in the future. At best, the current trends can be extrapolated but the resulting values of ΔT will inevitably diverge from actual observations. As such observations become available, corrections to the eclipse contact times can be calculated as follows:

$$\text{UT (corrected)} = \text{UT (predicted)} + (\Delta T1 - \Delta T2)$$

where: $\Delta T1$ = table value of ΔT (in seconds)
$\Delta T2$ = true or observed ΔT (in seconds)

During the period covered by Fifty Year Canon of Lunar Eclipses, corrections to the Moon's altitude and to the maps of eclipse visibility should be negligible.

FIFTY YEAR CANON OF LUNAR ECLIPSES: 1986 - 2035

APPENDIX B - Program MONECL

APPENDIX B : Program MONECL

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             1         2         3         4         5         6         7
    123456789012345678901234567890123456789012345678901234567890123456789012

    C****PROGRAM : MONECL
    C****PROGRAM MONECL SEARCHES FOR ALL LUNAR ECLIPSES
    C****OCCURRING WITHIN A GIVEN DATE INTERVAL.
    C****THE GENERAL CHARACTERISTICS AND TIMES FOR EACH ECLIPSE ARE
    C****THEN CALCULATED.
    C****THE PREDICTED ECLIPSE CHARACTERISTICS ARE STORED IN
    C****COMMON/ZERO/ WHERE :
    C****  MONTH,IDAY,IYEAR - CALENDAR DATE OF ECLIPSE.
    C****             ITYPE - TYPE OF ECLIPSE WHERE :
    C****                     =0  -  NO ECLIPSE OCCURS.
    C****                     =1  -  TOTAL LUNAR ECLIPSE.
    C****                     =2  -  PARTIAL LUNAR ECLIPSE.
    C****                     =3  -  PENUMBRAL LUNAR ECLIPSE.
    C****               FJD - JULIAN DATE OF INSTANT OF MIDDLE ECLIPSE.
    C****             FTIME - TIME (TDT) OF MIDDLE ECLIPSE.
    C****             GAMMA - DISTANCE OF MOON'S CENTER FROM AXIS OF
    C****                     EARTH'S SHADOW (UNITS OF EARTH RADII).
    C****              UMAG - UMBRAL MAGNITUDE OF ECLIPSE.
    C****                     (FRACTION OF MOON'S DIAMETER OBSCURED BY UMBRA
    C****              PMAG - PENUMBRAL MAGNITUDE OF ECLIPSE.
    C****                     (FRACTION OF MOON'S DIAMETER OBSCURED BY PENUM
    C****              NSAR - SAROS SERIES NUMBER.
    C****               IRP - RELATIVE POSITION FROM MIDDLE OF SAROS SERIES.
    C****                LN - LUNATION NUMBER (FROM 1/1/1900).
    C****          T1,T2,T3 - SEMI-DURATION OF TOTAL, PARTIAL AND
    C****                     PENUMBRAL PHASES (HOURS).
    C****                CT - CONTACT TIMES (TERRESTRIAL DYNAMICAL TIME).
    C****                     CT(1),CT(6) = BEGIN, END PENUMBRAL ECLIPSE.
    C****                     CT(2),CT(5) = BEGIN, END PARTIAL ECLIPSE.
    C****                     CT(3),CT(4) = BEGIN, END TOTAL ECLIPSE.
    C****WRITTEN BY F. ESPENAK - 26 MAY 1988.
    C****LAST MODIFIED - 18 JUL 1988.
          IMPLICIT REAL*8(A-H,O-Z)
          CHARACTER*4 MTH(12)
          CHARACTER*10 KIND(3)
          COMMON/ZERO/MONTH,IDAY,IYEAR,ITYPE,FJD,FTIME,DELTA,GAMMA,
         1            UMAG,PMAG,NSAR,IRP,LN,T1,T2,T3,CT(6)
          DATA SYNOD/29.530589D0/,K/0/
          DATA KIND/'  TOTAL  ',' PARTIAL ',' PENUMBRAL'/
          DATA MTH/' JAN',' FEB',' MAR',' APR',' MAY',' JUN',' JUL',

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     1        ' AUG',' SEP',' OCT',' NOV',' DEC'/
C****READ DATE INTERVALS OF ECLIPSE SEARCH.
C****    IM1,ID1,IY1 - MONTH, DAY AND YEAR OF START OF SEARCH INTERVAL.
C****    IM2,ID2,IY2 - MONTH, DAY AND YEAR OF END OF SEARCH INTERVAL.
      READ(20,100) IM1,ID1,IY1,IM2,ID2,IY2
  100 FORMAT(2I3,I5,2I3,I5)
      IF(IY1.EQ.0.OR.IY2.EQ.0) GO TO 99
C****CONVERT GREGORIAN (CALENDAR) DATES TO JULIAN DATES.
      CALL JULDAT(DJ1,IW1,ID1,IM1,IY1,0,0,0.0)
      CALL JULDAT(DJ2,IW2,ID2,IM2,IY2,0,0,0.0)
      IDAY=ID1
      MONTH=IM1
      IYEAR=IY1
      FJD=DJ1-SYNOD
      WRITE(6,200) IM1,ID1,IY1,IM2,ID2,IY2
  200 FORMAT(/1X,'***** LUNAR ECLIPSE SEARCH FROM ',
     1 I3,'/',I2,'/',I5,' TO ',I2,'/',I2,'/',I5/)
C****CALCULATE THE INSTANT OF FULL MOON SYZYGY AND DETERMINE WHETHER
C****AN ECLIPSE IS POSSIBLE.
    1 XJD=FJD+SYNOD
      IF(XJD.GT.DJ2) GO TO 99
      CALL PRELEC(XJD)
      IF(ITYPE.EQ.0.AND.DABS(GAMMA).GT.1.25) GO TO 1
C****PRINT HEADER FOR LUNAR ECLIPSE TABLE.
      K=K+1
      IF(MOD(K,50).EQ.1) WRITE(15,210)
  210 FORMAT(1H1/////55X,'TABLE OF LUNAR ECLIPSES'///
     1 70X,'PENUMBRAL',3X,'UMBRAL',5X,'MIDDLE',
     2 3X,'PARTIAL',2X,'TOTAL'/
     3 19X,'DATE',6X,'JULIAN DATE',5X,'TYPE',5X,'SAROS',
     4 3X,'GAMMA',3X,'MAGNITUDE',1X,'MAGNITUDE',3X,'ECLIPSE',
     5 4X,'S.DUR.',2X,'S.DUR.'/
     6 93X,'(h:m)',6X,'(m)',5X,'(m)')
      IF(MOD(K,10).EQ.1) WRITE(15,215)
  215 FORMAT(1X)
C****CONVERT TIMES TO OUTPUT FORMAT AND PRINT
C****MIDDLE ECLIPSE CIRCUMSTANCES.
      IHR=IDINT(FTIME+0.5/60.)
      MIN=IDINT(60*(FTIME+0.5/60.-IHR))
      ISDT=IDINT(60.0*T1+0.5)

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      ISDP=IDINT(60.0*T2+0.5)
      WRITE(15,220) IDAY,MTH(MONTH),IYEAR,FJD,KIND(ITYPE),NSAR,GAMMA,
     1              PMAG,UMAG,IHR,MIN,ISDP,ISDT
  220 FORMAT(16X,I2,A4,I5,2X,F11.2,2X,A10,I6,3(F9.3,1X),
     1 I7,':',I2,1X,2I8)
      GO TO 1
C****EXIT PROGRAM MONECL.
   99 WRITE(6,299) K
  299 FORMAT(/5X,'***** A TOTAL OF',I4,' ECLIPSES WERE PREDICTED FOR ',
     1 'THIS DATE INTERVAL.'/)
      STOP
      END

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      SUBROUTINE PRELEC(EJD)
C****SUBROUTINE PRELEC PREDICTS THE INSTANT OF FULL MOON SYZYGY
C****NEAREST TO THE INPUT JULIAN DATE 'EJD'.
C****SUBROUTINE PRELEC THEN DETERMINE WHETHER A LUNAR ECLIPSE
C****WILL OCCUR AND CALCULATES ITS CHARACTERISTICS.
C****BASED ON ALGORITHMS FROM
C****"ASTRONOMICAL FORMULAE FOR CALCULATORS", MEEUS, CH. 32,33.
C****THE PREDICTED ECLIPSE CHARACTERISTICS ARE STORED IN
C****COMMON/ZERO/ WHERE :
C****  MONTH,IDAY,IYEAR - CALENDAR DATE OF ECLIPSE.
C****             ITYPE - TYPE OF ECLIPSE WHERE :
C****                     =0  -  NO ECLIPSE OCCURS.
C****                     =1  -  TOTAL LUNAR ECLIPSE.
C****                     =2  -  PARTIAL LUNAR ECLIPSE.
C****                     =3  -  PENUMBRAL LUNAR ECLIPSE.
C****               FJD - JULIAN DATE OF INSTANT OF MIDDLE ECLIPSE.
C****             FTIME - TIME (TDT) OF MIDDLE ECLIPSE.
C****             GAMMA - DISTANCE OF MOON'S CENTER FROM AXIS OF
C****                     EARTH'S SHADOW (UNITS OF EARTH RADII).
C****              UMAG - UMBRAL MAGNITUDE OF ECLIPSE.
C****                     (FRACTION OF MOON'S DIAMETER OBSCURED BY UMBRA
C****              PMAG - PENUMBRAL MAGNITUDE OF ECLIPSE.
C****                     (FRACTION OF MOON'S DIAMETER OBSCURED BY PENUM
C****              NSAR - SAROS SERIES NUMBER.
C****               IRP - RELATIVE POSITION FROM MIDDLE OF SAROS SERIES.
C****                LN - LUNATION NUMBER (FROM 1/1/1900).
C****          T1,T2,T3 - SEMI-DURATION OF TOTAL, PARTIAL AND
C****                     PENUMBRAL PHASES (HOURS).
C****                CT - CONTACT TIMES (TERRESTRIAL DYNAMICAL TIME).
C****                     CT(1),CT(6) = BEGIN, END PENUMBRAL ECLIPSE.
C****                     CT(2),CT(5) = BEGIN, END PARTIAL ECLIPSE.
C****                     CT(3),CT(4) = BEGIN, END TOTAL ECLIPSE.
C****WRITTEN BY F. ESPENAK - 26 MAY 1988.
C****LAST MODIFIED - 18 JUL 1988.
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/ZERO/MONTH,IDAY,IYEAR,ITYPE,FJD,FTIME,DELTA,GAMMA,
     1            UMAG,PMAG,NSAR,IRP,LN,T1,T2,T3,CT(7)
      DATA SYNOD/29.53058868D0/,DJ0/2415021.065D0/
      DATA ZK/0.2725076/,F/0.5/
      DATA DTR,RTD/0.017453292519943D0,57.2957795131D0/

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          DATA KSAR,KLUN/129,1243/,KBRN/284/,INEX/358/
    C****CALCULATE TIME ELLAPSED IN LUNAR MONTHS SINCE FIRST NEW MOON
    C****OF 1900. (I.E. - 1/1/1900 13:34:05ET)
          DO 600 I=1,4
          S=+1.0
          IF(EJD.LT.DJO) S=-1.0
          Z=(DABS(EJD-DJO)-S*F*SYNOD)/SYNOD
          LN=IDINT(S*(Z+0.5))
          P=DFLOAT(LN)+F
          Q=SYNOD*P/36525.DO
    C****CALCULATE JULIAN DATE OF MEAN PHASE.
          PJD=2415020.75933DO+29.53058868DO*P+1.178D-04*Q*Q-1.55D-07*Q*Q*Q
         1    +3.3D-04*DSIN(DTR*(166.56+132.87*Q-9.173D-03*Q*Q))
    C****CALCULATE THE MEAN ANOMALIES OF THE SUN AND MOON.
          ZM=359.2242DO+29.10535608DO*P-3.33D-05*Q*Q-3.47D-06*Q*Q*Q
          XM=306.0253DO+385.81691806DO*P+1.07306D-02*Q*Q+1.236D-05*Q*Q*Q
          ZM=DMOD(ZM,360.DO)
          XM=DMOD(XM,360.DO)
    C****CALCULATE THE MOON'S ARGUEMENT OF LATITUDE.
          XF=21.2964DO+390.67050646*P-1.6528D-03*Q*Q-2.39D-06*Q*Q*Q
          XF=DMOD(XF,360.DO)
    C****CALCULATE DATE CORRECTION FOR ECLIPSE TEST.
          EPC=+(0.1734-3.93D-04*Q)*DSIN(DTR*ZM)+0.0021*DSIN(DTR*(ZM+ZM))
         1     -0.4068*DSIN(DTR*XM)+0.0161*DSIN(DTR*(XM+XM))
         2     -0.0051*DSIN(DTR*(ZM+XM))-0.0074*DSIN(DTR*(ZM-XM))
         3     -0.0104*DSIN(DTR*(XF+XF))
          IF(I.EQ.1) EPC=0.0
    C****CALCULATE INSTANT OF MAXIMUM ECLIPSE.
          EJD=PJD+EPC
      600 CONTINUE
    C****CALCULATE GREGORIAN DATE.
          FJD=EJD
          CALL CALDAT(FJD,IW,NDAY,IDAY,MONTH,IYEAR,
         1               IHR,MIN,ISEC,FTIME,FMIN,SEC)
    C****CALCULATE SHADOW AXIS DISTANCE OF MOON AT MAXIMUM ECLIPSE.
          S=+5.19595-0.0048*DCOS(DTR*ZM)+0.0020*DCOS(DTR*2.*ZM)
         1  -0.3283*DCOS(DTR*XM)-0.0060*DCOS(DTR*(ZM+XM))
         2  +0.0041*DCOS(DTR*(ZM-XM))
          C=+0.2070*DSIN(DTR*ZM)+0.0024*DSIN(DTR*2.*ZM)-0.0390*DSIN(DTR*XM)
         1  +0.0115*DSIN(DTR*2.*XM)-0.0073*DSIN(DTR*(ZM+XM))

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     2  -0.0067*DSIN(DTR*(ZM-XM))+0.0117*DSIN(DTR*2.*XF)
      GAMMA=S*DSIN(DTR*XF)+C*DCOS(DTR*XF)
C****CALCULATE THE RADII OF THE UMBRAL AND PENUMBRAL SHADOWS.
      U=+0.0059+0.0046*DCOS(DTR*ZM)-0.0182*DCOS(DTR*XM)
     1  +0.0004*DCOS(DTR*2.*XM)-0.0005*DCOS(DTR*(ZM+XM))
      SIG=0.7404-U
      RHO=1.2847+U
C****CALCULATE UMBRAL AND PENUMBRAL ECLIPSE MAGNITUDES.
      UMAG=0.5*(SIG+ZK-DABS(GAMMA))/ZK
      PMAG=0.5*(RHO+ZK-DABS(GAMMA))/ZK
C****DETERMINE TYPE OF LUNAR ECLIPSE.
C****     ITYPE=0  -  NO ECLIPSE OCCURS.
C****     ITYPE=1  -  TOTAL LUNAR ECLIPSE.
C****     ITYPE=2  -  PARTIAL LUNAR ECLIPSE.
C****     ITYPE=3  -  PENUMBRAL LUNAR ECLIPSE.
      ITYPE=0
      IF(PMAG.LE.0.0) GO TO 999
      IF(UMAG.GE.1.00) ITYPE=1
      IF(UMAG.GT.0.0.AND.UMAG.LT.1.0) ITYPE=2
      IF(UMAG.LT.0.0.AND.PMAG.GT.0.0) ITYPE=3
C****CALCULATE THE LUNAR ECLIPSE SEMIDURATIONS.
      S1=SIG-ZK
      S2=SIG+ZK
      S3=RHO+ZK
      ZN=0.5458+0.0400*DCOS(DTR*XM)
      T1=0.0D0
      T2=0.0D0
      T3=0.0D0
      IF(DABS(S1).GT.DABS(GAMMA)) T1=DSQRT(S1*S1-GAMMA*GAMMA)/ZN
      IF(DABS(S2).GT.DABS(GAMMA)) T2=DSQRT(S2*S2-GAMMA*GAMMA)/ZN
      IF(DABS(S3).GT.DABS(GAMMA)) T3=DSQRT(S3*S3-GAMMA*GAMMA)/ZN
C****CALCULATE ECLIPSE CONTACT TIMES (TDT).
      DO 610 I=1,6
      CT(I)=0.0
      IF(ITYPE.EQ.3.AND.I.GT.1.AND.I.LT.6) GO TO 610
      IF(ITYPE.EQ.2.AND.I.GT.2.AND.I.LT.5) GO TO 610
      DT=T3
      IF(I.GT.1.AND.I.LT.6) DT=T2
      IF(I.GT.2.AND.I.LT.5) DT=T1
      CTX=FTIME+24.0-DT

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      IF(I.GT.3) CTX=FTIME+24.0+DT
      CT(I)=DMOD(CTX,24.D0)
  610 CONTINUE
C****CALCULATE SAROS NUMBER (KEYED TO LUNAR ECLIPSE OF 16 JUL 2000).
      L=LN-KLUN
      I=JISIGN(1,L)
      IN=INT(FLOAT(61*L)/INEX+0.5*I-FLOAT(L)/(12*INEX*INEX))
      NSAR=KSAR+38*L-223*IN
C****CALCULATE RELATIVE POSITION IN SAROS SERIES.
      X=-61*L+INEX*IN
      IRP=INT(X-FLOAT(NSAR-KSAR)/12+0.5)
C****EXIT SUBROUTINE PRELEC.
  999 RETURN
      END

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      SUBROUTINE JULDAT(DJ,IW,ID,IM,IY,IHOUR,IMIN,SEC)
C****SUBROUTINE JULDAT COMPUTES THE JULIAN DECIMAL DATE (DJ) FROM
C****THE GREGORIAN (OR JULIAN) CALENDAR DATE.
C****THE GREGORIAN CALENDAR REFORM OCCURRED ON 1582 OCT 15.
C****THIS IS 1582 OCT 5 BY THE JULIAN CALENDAR.
C****INPUT :         ID,IM,IY - DAY,MONTH,YEAR.
C****            IHR,IMIN,SEC - HOUR,MINUTE,SECOND.
C****OUTPUT :               DJ - JULIAN DECIMAL DATE
C****                            (= 0 FOR B.C. 4713 JAN 1, 12 GMT).
C****                      IW - DAY OF WEEK (1=SUNDAY).
C****REFERENCE : "ASTRONOMICAL FORMULAE FOR CALCULATORS", MEEUS, P.23.
C****WRITTEN BY F. ESPENAK - APRIL 1982.
C****LAST MODIFIED - APRIL 1982.
      REAL*8 DJ,SEC,FRAC,GYR
C****CALCULATE DECIMAL DAY FRACTION.
      FRAC=DFLOAT(IHOUR)/24.+DFLOAT(IMIN)/1440.+SEC/86400.
C****CONVERT DATE TO FORMAT YYYY.MMDDdd
      GYR=DFLOAT(IY)+0.01*DFLOAT(IM)+0.0001*DFLOAT(ID)+0.0001*FRAC
     1   +1.0D-09
C****CALCULATE CONVERSION FACTORS.
      IY0=IY
      IM0=IM
      IF(IM.LE.2) IY0=IY-1
      IF(IM.LE.2) IM0=IM+12
      IA=IY0/100
      IB=2-IA+IA/4
C****CALCULATE JULIAN DATE.
      JD=IDINT(365.25D0*IY0)+IDINT(30.6001D0*(IM0+1))+ID+1720994
      IF(IY.LT.0) JD=IDINT(365.25D0*IY0-0.75)+IDINT(30.6001D0*(IM0+1))
     1               +ID+1720994
      IF(GYR.GE.1582.1015D0) JD=JD+IB
      DJ=DFLOAT(JD)+FRAC+0.5D0
C****CALCULATE DAY OF WEEK.
      JD=IDINT(DJ+0.5)
      IW=JMOD((JD+1),7)+1
      RETURN
      END

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      SUBROUTINE CALDAT(DJ,IW,ND,ID,IM,IY,IHR,IMIN,ISEC,AHR,AMIN,ASEC)
C****SUBROUTINE CALDAT CALCULATES THE DAY OF THE WEEK, THE DAY OF
C****THE YEAR, THE GREGORIAN (OR JULIAN) CALENDAR DATE AND
C****THE UNIVERSAL TIME FROM THE JULIAN DECIMAL DATE.
C****THE GREGORIAN CALENDAR REFORM OCCURRED ON 1582 OCT 15.
C****THIS IS 1582 OCT 5 BY THE JULIAN CALENDAR.
C****INPUT :               DJ - JULIAN DECIMAL DATE
C****                           (= 0 FOR B.C. 4713 JAN 1, 12 GMT).
C****OUTPUT :              IW - DAY OF THE WEEK (1=SUNDAY).
C****                      ND - DAY OF THE YEAR (1 JAN = 1).
C****                ID,IM,IY - CALENDAR DAY,MONTH,YEAR.
C****           IHR,IMIN,ISEC - INTEGER HOUR,MINUTE,SECOND.
C****           AHR,AMIN,ASEC - DECIMAL HOUR,MINUTE,SECOND.
C****REFERENCE : "ASTRONOMICAL FORMULAE FOR CALCULATORS", MEEUS, P.23.
C****WRITTEN BY F. ESPENAK - APRIL 1982.
C****LAST MODIFIED - 22 JULY 1986.
      REAL*8 DJ,FRAC,AHR,AMIN,ASEC
C****CALCULATE INTERGER JULIAN DATE.
      JD=IDINT(DJ+0.5)
C****CALCULATE DAY FRACTION.
      FRAC=DJ+0.5-DFLOAT(JD)+1.0D-10
C****CALCULATE CONVERSION FACTORS.
      KA=JD
      IF(JD.LT.2299161) GO TO 10
      IALP=IDINT((JD-1867216.25D0)/36524.25D0)
      KA=JD+1+IALP-IALP/4
   10 KB=KA+1524
      KC=IDINT((KB-122.1)/365.25D0)
      KD=IDINT(365.25D0*KC)
      KE=IDINT((KB-KD)/30.6001D0)
C****CALCULATE THE CALENDAR DAY, MONTH AND YEAR.
      ID=KB-KD-IDINT(30.6001D0*KE)
      IM=KE-1
      IF(KE.GT.13) IM=KE-13
      IF(IM.EQ.2.AND.ID.GT.28) ID=29
      IY=KC-4715
      IF(IM.GT.2) IY=KC-4716
      IF(IM.EQ.2.AND.ID.EQ.29.AND.KE.EQ.3) IY=KC-4716
C****CALCULATE THE UNIVERSAL TIME FROM THE FRACTIONAL DAY.
      AHR=FRAC*24.

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      IHR=AHR
      AMIN=(AHR-IHR)*60.
      IMIN=AMIN
      ASEC=(AMIN-IMIN)*60.
      ISEC=ASEC
C****CALCULATE THE DAY OF THE WEEK.
      IW=JMOD((JD+1),7)+1
C****CALCULATE THE DAY OF THE YEAR.
      LYR=4*(IY/4)
      ND=(275*IM)/9-2*((IM+9)/12)+ID-30
      IF(IY.EQ.LYR) ND=(275*IM)/9-((IM+9)/12)+ID-30
C      WRITE(6,200) IM,ID,IY,JD,IALP,KA,KB,KC,KD,KE
  200 FORMAT(I4,'/',I2,'/',I5,2X,I8,I4,
     1 2X,'KA-E =',5I8)
      RETURN
      END

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          1         2         3         4         5         6         7
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TABLE OF LUNAR ECLIPSES

DATE	JULIAN DATE	TYPE	SAROS	GAMMA	PENUMBRAL MAGNITUDE	UMBRAL MAGNITUDE	MIDDLE ECLIPSE (h:m)	PARTIAL S.DUR. (m)	TOTAL S.DUR. (m)
24 APR 1986	2446545.03	TOTAL	131	-0.372	2.155	1.196	12:42	99	31
17 OCT 1986	2446721.30	TOTAL	136	0.318	2.302	1.246	19:19	108	37
14 APR 1987	2446899.60	PENUMBRAL	141	-1.144	0.763	-0.245	2:21	0	0
7 OCT 1987	2447075.67	PENUMBRAL	146	1.019	0.986	-0.010	4: 0	0	0
3 MAR 1988	2447224.17	PENUMBRAL	113	0.992	1.085	-0.008	16:12	0	0
27 AUG 1988	2447400.96	PARTIAL	118	-0.872	1.230	0.284	11: 7	56	0
20 FEB 1989	2447578.15	TOTAL	123	0.295	2.363	1.271	15:38	111	39
17 AUG 1989	2447755.63	TOTAL	128	-0.150	2.568	1.596	3: 7	107	48
9 FEB 1990	2447932.30	TOTAL	133	-0.415	2.119	1.075	19:14	101	21
6 AUG 1990	2448110.09	PARTIAL	138	0.638	1.699	0.675	14:11	87	0
30 JAN 1991	2448286.75	PENUMBRAL	143	-1.077	0.876	-0.115	5:59	0	0
27 JUN 1991	2448434.63	PENUMBRAL	110	-1.412	0.302	-0.768	3:14	0	0
26 JUL 1991	2448464.26	PENUMBRAL	148	1.438	0.252	-0.814	18:10	0	0
21 DEC 1991	2448611.94	PARTIAL	115	0.977	1.054	0.078	10:35	30	0
15 JUN 1992	2448788.71	PARTIAL	120	-0.633	1.718	0.674	4:59	89	0
9 DEC 1992	2448966.49	TOTAL	125	0.317	2.286	1.266	23:44	103	36
4 JUN 1993	2449143.04	TOTAL	130	0.162	2.557	1.566	13: 3	108	48
29 NOV 1993	2449320.77	TOTAL	135	-0.398	2.166	1.089	6:24	105	23
25 MAY 1994	2449497.65	PARTIAL	140	0.895	1.191	0.240	3:31	52	0
18 NOV 1994	2449674.78	PENUMBRAL	145	-1.106	0.879	-0.222	6:47	0	0
15 APR 1995	2449823.01	PARTIAL	112	-0.961	1.081	0.109	12:21	36	0
8 OCT 1995	2449999.17	PENUMBRAL	117	1.124	0.814	-0.224	16: 4	0	0
4 APR 1996	2450177.51	TOTAL	122	-0.251	2.411	1.384	0:13	108	43
27 SEP 1996	2450353.62	TOTAL	127	0.346	2.213	1.234	2:56	101	34
24 MAR 1997	2450531.69	PARTIAL	132	0.493	1.995	0.913	4:40	101	0
16 SEP 1997	2450708.28	TOTAL	137	-0.379	2.138	1.188	18:47	98	30
13 MAR 1998	2450885.68	PENUMBRAL	142	1.201	0.699	-0.393	4:24	0	0
8 AUG 1998	2451033.60	PENUMBRAL	109	1.489	0.118	-0.866	2:26	0	0
6 SEP 1998	2451062.96	PENUMBRAL	147	-1.110	0.804	-0.163	11: 7	0	0
31 JAN 1999	2451210.18	PENUMBRAL	114	-1.019	1.002	-0.027	16:22	0	0
28 JUL 1999	2451387.98	PARTIAL	119	0.785	1.436	0.399	11:33	71	0

Sample output from program MONECL. Compare with predictions in Section 1.

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15. Supplementary Notes

16. Abstract

A complete catalog is presented, listing the general circumstances of every lunar eclipse from 1901 through 2100. To compliment this catalog, a set of figures illustrate the basic Moon-shadow geometry and global visibility for every lunar eclipse over the 200 year interval. Focusing in on the next fifty years, 114 detailed diagrams show the Moon's path through Earth's shadow during every eclipse, including contact times at each phase. The accompanying cylindrical projection maps of Earth show regions of hemispheric visibility for all phases.

The appendices discuss eclipse geometry, eclipse frequency and recurrence, enlargement of Earth's shadow, crater timings, eclipse brightness and time determination. Finally, a simple FORTRAN program is provided which can be used to predict the occurrence and general characteristics of lunar eclipses.

This work is a companion volume to NASA Reference Publication 1178: Fifty Year Canon of Solar Eclipses: 1986-2035.

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