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ON THE DISTRIBUTION OF MINOR PLANET INCLINATIONS

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Abstract. The distribution of minor planet orbits with inclination to the ecliptic plane and with respect to the Jupiter orbit is studied. Position of the plane considered as the mean plane of the asteroid belt is determined.

Distribution of minor planets with inclination of their orbits to the ecliptic plane has been studied by many authors (see e.g. Chebotarev and Shor, 1978). In the present paper an attempt has been made to repeat some of the previously known results on the basis of essentialy greater statistics. The minor planet orbits are taken from the year-book for 1991 (Batrakov, 1990). It contains the osculating elements of 4265 numbered planets.

The characteristic features of the distribution of minor planets with respect to inclination to ecliptic plane are well known. It is characterized by the sharp increase of the number of minor planets as the inclination increases from 0° towards the greater values of inclination and then, having reached the maximum it decreases more or less smoothly. Only rather small number of planets is inclined to the ecliptic plane at more than 30°. It can be said that the minor planet orbits 'tend to avoid' both very large and very small inclinations.

Certainly this distribution is influenced by the observational selection which, in particular leads to the excess of the planets with small inclinations to ecliptic plane among the newly discovered minor planets (Kiang, 1966).

On the other hand, the use of ecliptic plane as the main reference plane for description of the asteroid belt is not entirely justified. It might be expected that some peculiarities of distributions, especially in the domain of small inclinations, manifest themselves more clearly when the Jupiter orbital plane is used as the reference plane instead of ecliptic one. This idea is suggested by the fact that Jupiter exerts the main perturbing action on the majority of minor planets.

Aiming at the verification of this assumption we transformed the ecliptic elements of minor planets into the elements referred to the Jupiter orbital plane. Then we marked the poles of minor planet orbits on Jovicentric celestial sphere of a unit radius and found rectangular coordinates of their projections on Jupiter orbital plane. Fig.1 shows a picture of projections of minor planet poles on the X,Y plane, which coincides with Jupiter orbital plane. The pole of Jupiter orbital plane is situated in the center of the picture. The poles of those minor planets whose inclination to the Jupiter orbital plane is less than 2° are to be found inside the circle.

Just a glance at the picture shows some interesting regularities. The pole of Jupiter orbital plane is located in the center of deserted area. This area is surrounded by the belt of

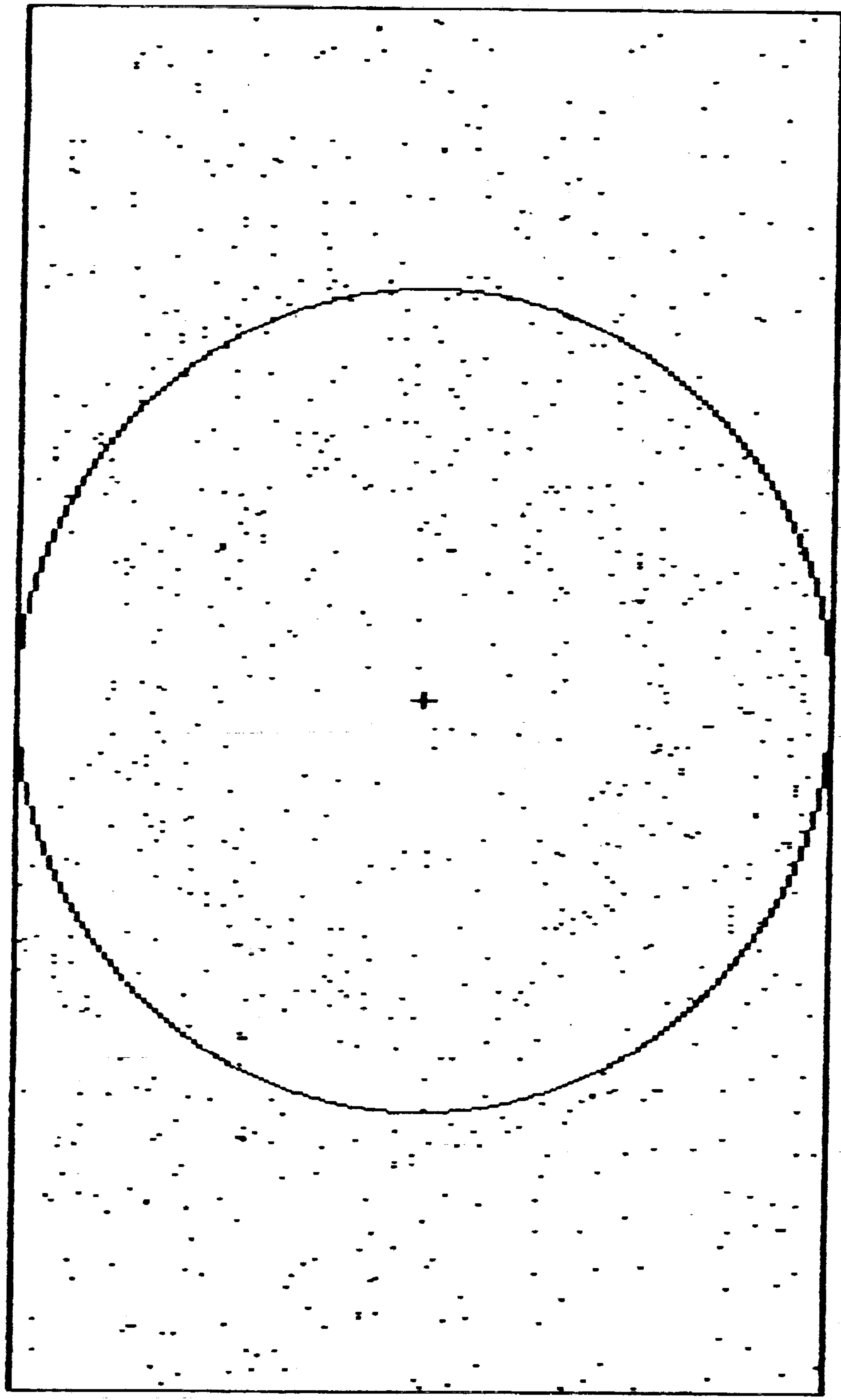

Fig.1. Positions of minor planet poles on Jupiter's orbit plane.
Circle radius is equal to 2° + - pole of Jupiter's plane

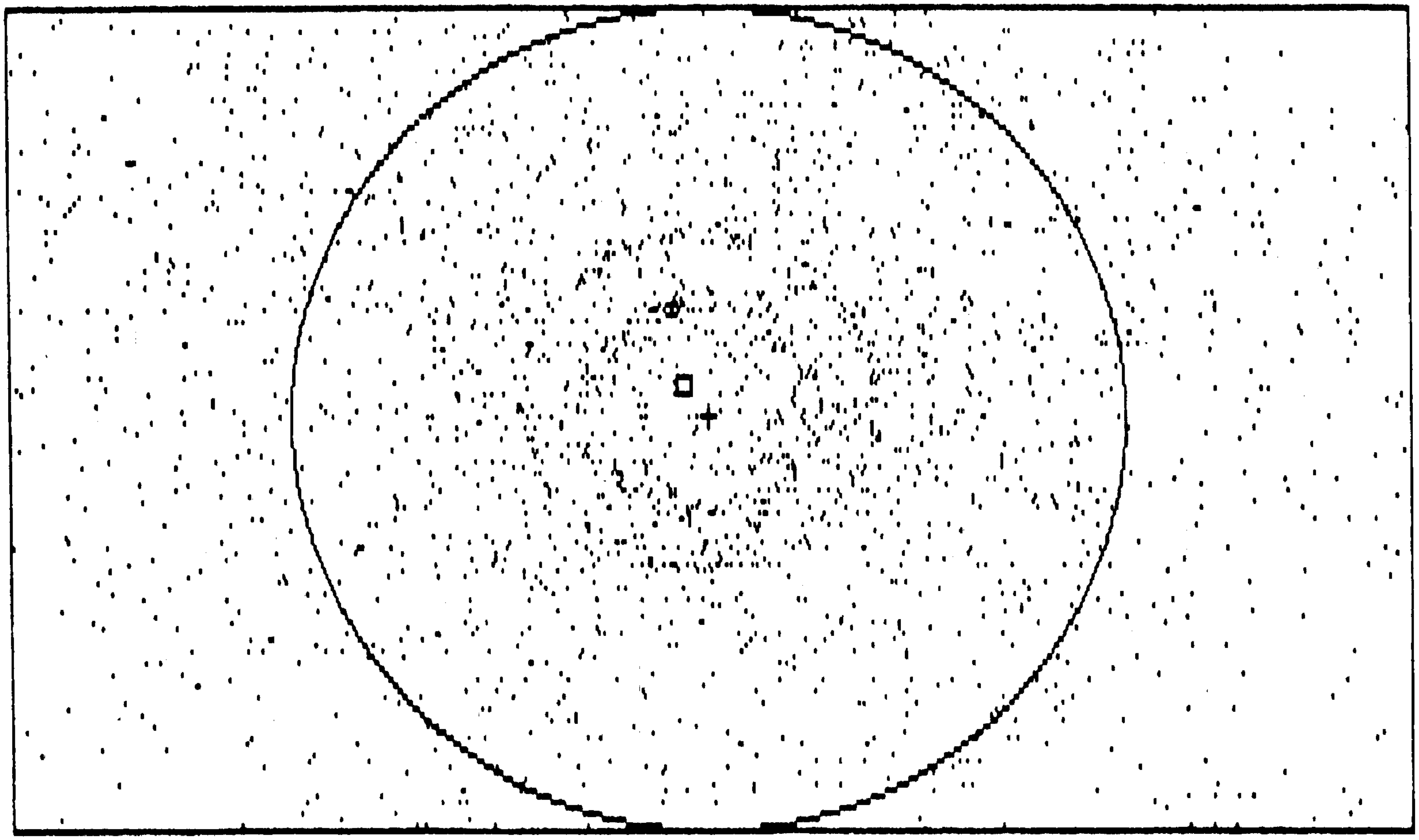

Fig.2. Positions of minor planet poles on Jupiter's orbit plane.

Circle radius is equal to 5°
+ - pole of Jupiter's plane
□ - pole of minor planets mean plane
∘ - pole of ecliptic

more densely distributed poles with the density decreasing rather steady outside the area. To characterize quantitatively these observations the distribution of the number of poles per an arbitrary unit area within the corresponding circular belt was considered. The distribution confirms that the rarefaction of the poles is observed within the region of very small inclinations. Density begins rapidly to increase within the range of 0.6° - 1.2° and reaches its climax in the 1.2° - 1.4° interval followed by its subsequent decrease. Undoubtedly, such a distribution is due to the perturbing action of Jupiter.

Of some interest is the answer to the question if the orbits of minor planets are arranged symmetrically with respect to Jupiter orbital plane. The answer to the question can be found through the determination of the center of gravity of the poles:

$$X = \frac{1}{n}\sum_{k=1}^{n} \sin\iota_k \cos(\Omega_k - 90^\circ), \qquad Y = \frac{1}{n}\sum_{k=1}^{n} \sin\iota_k \sin(\Omega_k - 90^\circ),$$

where ι is inclination of the orbit of minor planet to that of Jupiter and Ω is the longitude of node reckoned from some point of Jupiter orbit.

When making the necessary calculations, account must be taken of the effect of observational selection. The estimates fulfilled by us show that less than three percent of the last thousand of the numbered planets have the mean opposition magnitude less than or equal to 14.5. Hence we can assume that statistics of minor planets having the mean opposition magnitude not exceeding 14.5 is not distorted by observational selection. For 1193 planets with the mean opposition magnitude not exceeding 14.5 we found the coordinates of the center of gravity on the Jupiter orbital plane as follows: X = -0.0011 , Y = 0.0049 .

These coordinates can be considered as the coordinates of the pole of the asteroid belt mean plane. The inclination of this plane to the Jupiter orbit is equal to 0.29°. With respect to ecliptic it is inclined at 1.00° and its ecliptic longitude is equal to 96.4° (we note parenthetically that for 4265 planets the mean value of inclination to ecliptic is equal to 0.63°; in such a manner the observational selection distorts the position of the asteroid belt mean plane). Fig.2 shows pole of the asteroid belt mean plane (designated by small rectangle) against background of the poles of minor planets. The position of the pole of ecliptic is designated by small square. It is evident that the mean plane of the asteroid belt is essentially nearer to the Jupiter orbital plane than to the ecliptic one.

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