UDC 521.4 OSP

THE DISTRIBUTION OF PERIHELIA OF MINOR PLANETS

M. Kuzmanoski

Institute of Astronomy, Faculty of Sciences, Beograd

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Summary. One considers: the distribution of angles made by the projections of perihelical vectors on the mean plane with the intersection of that plane with the ecliptic, the distribution of inclinations of perihelical directions to the mean plane and the distribution of perihelical distances. The simultaneons consideration of these distributions gave the picture of the spatial distribution of perihelical points of asteroids. It is shown that perihelical points are distributed inside a belt and some of its characteristics are pointed our.

M. Kuzmanoski, RASPODELA PERIHELA MALIH PLANETA — Posmatrane su: raspodela uglova koje projekcije perihelskih vektora malih planeta na srednju ravan zaklapaju sa presečnom pravom srednje ravni i ravni ekliptike, raspodela nagiba perihelskih pravaca prema srednjoj ravni i raspodela perihelskih daljina. Objedinjavanjem ovih raspodela sagledan je prostorni raspored perihelskih tačaka malih planeta. Pokazalo se da su perihelske tačke raspoređene unutar jednog prstena i uočene su neke njegove karakteristike.

We have determined, by using numerated orbit elements of minor planets from „EMP for 1979" with the help of area vectors, the mean plane of asteroid orbits (Kuzmanoski, 1980). The position of this plane is determined, with respect to the ecliptic plane, by the node longitude $\Omega_s = 78.^{\circ}141$ and an inclination $i_s = 0.^{\circ}594$. Further investigations have been performed in a coordinate system attached to the mean plane, the x — axis representing its intersection with the ecliptic (determined by the angle Ω_s), the y — axis being orthogonal to it in the mean plane and z — axis orthogonal to both. In order to have a complete picture of the spatial distribution of perihelical points of asteroids we considered the distribution of angles between the x — axis and the projections of perihelical vectors $\mathbf{D}_i$, the distribution of their inclinations with respect to the mean plane and the distribution of perihelical distances.

We have obtained, by calculating the angles Ψ_i between the projections of perihelical vectors and the x — axis for every asteroid and grouping them in classes of10°, the distribution drawn in Table 1. and Fig. 1.

Table 1.

$\Psi(°)$	N	$\Psi(°)$	N	$\Psi(°)$	N
10	59	130	30	250	79
20	53	140	29	260	95
30	60	150	37	270	82
40	47	160	39	280	81
50	43	170	39	290	90
60	34	180	42	300	99
70	33	190	58	310	80
80	42	200	53	320	88
90	32	210	59	330	94
100	31	220	48	340	73
110	34	230	57	350	77
120	33	240	70	360	42

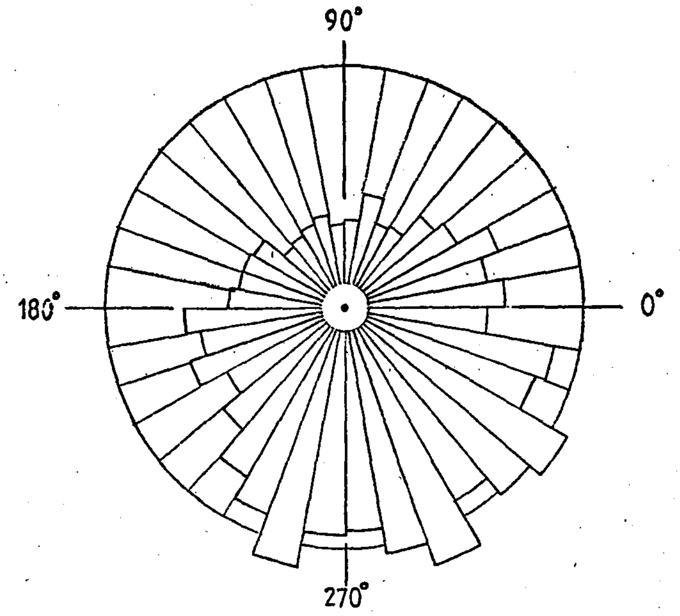

Figure 1

This distribution is analogous to that of perihelical longitudes and, due to the small inclination of the mean plane with respect to the ecliptic plane, it does not show any new essential characteristic different from these already obtained in earlier investigations that field (Kresak, 1967, Popović, 1973, Chebotarev, 1976). In our case, the angle Ψ_J for Jupiter is 295°. It is clear, from the histogram of Fig. 1, that the distribution of angles Ψ_i is in great part symmetric with respect to Ψ_J.

We can obtain a more complete picture of the distribution of perihelia of minor planets taking in account inclinations I_i of vectors $\mathbf{D}_i$ with respect to the mean plane. By grouping inclinations in classes of 1° we obtained a distribution (Table 2 and Fig. 2) which looks, at first sight, like the normal one, having its maximum about the mean plane. Mean while, investigations have shown that the hypothesis about the normal distribution could be discarded with a great probability. Among a total of 2042 asteroids, have perihelia under the mean plane and 1077 over it. If considering only inclinations between −4° and +4° one can remark the respective numbers are equal, 477 each. For the inclination of the perihelical direction of Jupiter one obtains the value $I_J = -0\overset{\circ}{.}787$, which is at the very minimum of the distribution.

Table 2.

$I^{(0)}$	N	$I^{(0)}$	N
—1	145	1	131
—2	134	2	140
—3	100	3	118
—4	98	4	88
—5	65	5	82
—6	54	6	78
—7	63	7	65
—8	45	8	67
—9	42	9	47
—10	32	10	38
—11	41	11	34
—12	29	12	36
—13	19	13	21
—14	12	14	24
—15	20	15	20
—16	10	16	21
—17	9	17	13
—18	5	18	13
—19	5	19	9
—20	5	20	4
—21	5	21	7
—22	4	22	5
—23	6	23	2
—24	6	24	3
—25	3	25	4
—25	8	25	7

Both above distributions are characterized by unhomogeneity with an accused concentration near the perihelical direction of Jupiter and an accused symmetry with respect to it. In order to unify the characteristics of previous two distuibutions and consider simultaneously the distributions of angles Ψ_i and inclinations I_i, we made a double distribution, grouping angles Ψ_i in classes of 20°, and inclinations I_i in classes of 2°. The frequences of this distribution are given in Table 3. One

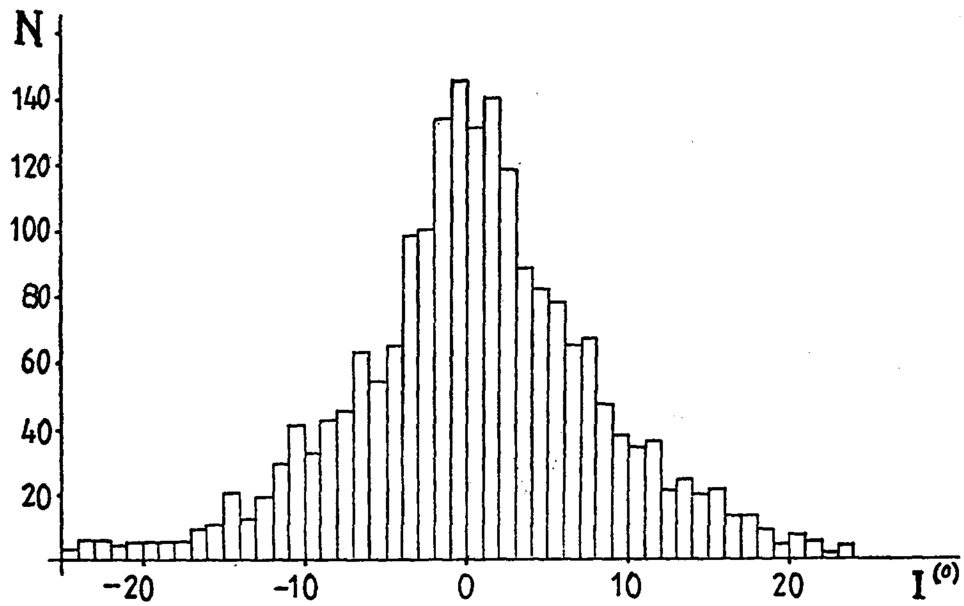

Figure 2

Table 3.

$\Psi^{(0)}$ \ $I^{(0)}$	<—12	—12	—10	—8	—6	—4	—2	2	4	6	8	10	12	>12
20	5	7	3	6	9	6	14	15	8	10	13	2	4	10
40	9	7	3	3	8	15	13	15	9	5	3	6	3	8
60	4	2	7	2	0	10	11	9	10	7	2	3	2	8
80	3	2	5	1	4	4	10	13	12	5	5	3	3	5
100	5	3	1	3	5	4	8	11	8	5	3	1	3	3
120	5	1	4	7	1	9	12	8	3	3	8	1	0	5
140	2	2	3	1	4	4	5	7	9	7	2	4	2	7
160	4	3	2	6	5	9	11	8	6	3	4	6	2	7
180	5	4	5	4	3	10	8	12	11	4	4	3	3	5
200	9	1	3	5	11	11	13	10	13	12	9	5	2	7
220	5	4	6	7	6	11	9	12	8	9	8	6	8	8
240	5	3	8	3	8	13	19	12	13	13	6	6	5	13
260	4	7	6	9	18	19	25	28	18	15	10	9	3	8
280	10	9	5	10	7	11	31	18	12	16	10	6	8	10
300	15	2	4	12	12	14	29	33	14	12	17	7	7	11
320	14	4	5	8	9	27	21	22	17	10	7	6	3	15
340	10	4	2	16	10	10	26	16	15	12	14	6	8	18
360	3	5	2	5	4	11	14	22	20	12	7	5	4	5

can remark an increased number of perihelia of asteroids about the perihelical direction of Jupiter not only near the mean plane (where it is most accused) but almost every angular distance from it.

Taking into consideration perihelical distances from previous distribution one can estimate the essential ordering of perihelical points of asteroids in space. By grouping perihelical distances in classes which differ by 0.05 AU we have obtained the distribution represented with the histogram on Fig. 3.

This distribution is irregular and characterized by two not very sharp maximums one of them in the neighbourhood of 2.0 AU, somewhat sharper, and another about 2.7 AU. At the left side the fall frequencies is abrupt and low frequencies apper about 1.7 AU, whereas at the right side that fall is somewhat slower, with small frequencies appearing after 3.05 AU.

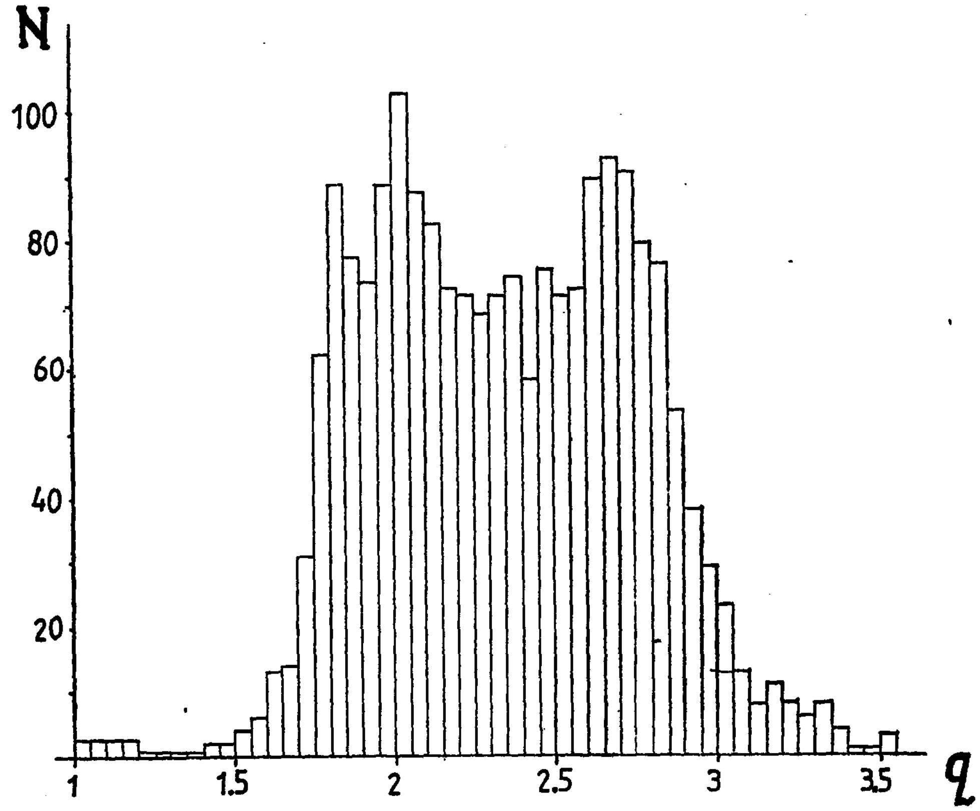

Figure 3

Thank the fact that the distribution of inclinations of perihelical directions shows their concentration about the mean plane we can represent the distribution of perihelical points in function of angles Ψ_i and their distances. Such a distribution of perihelia of asteroids whose directions form angles up to $\pm 4°$ with the mean plane are drawn on Fig. 4, whereas those which form angles up to $\pm 8°$ are drawn on Fig. 5. The first case includes almost a half of the asteroids, the seccnd one includes somewhat less than 3/4. True perihelical distances (not their projections on the mean plane) have been taken in both cases in order to make the picture of the essential distribution of perihelical points in space.

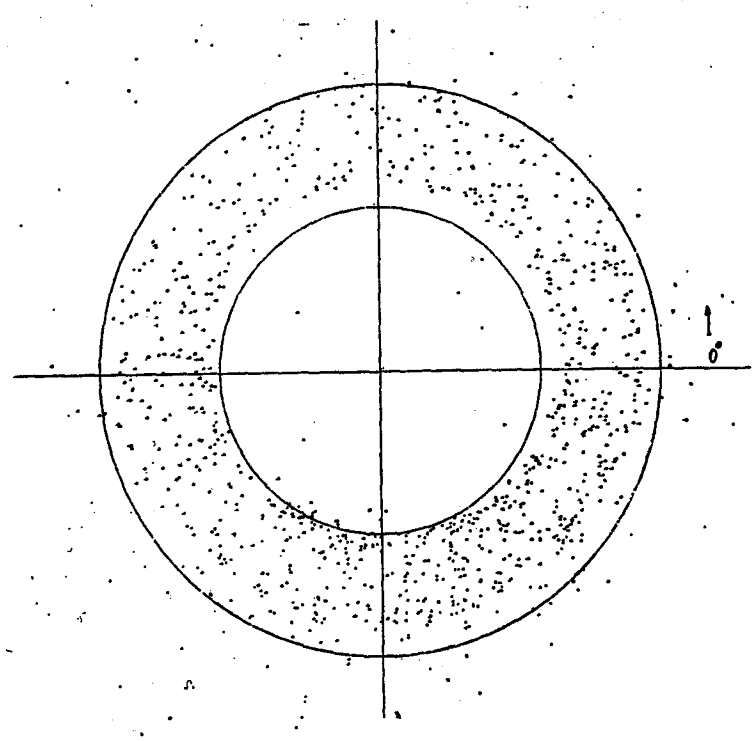

Figure 4

This picture of perihelical points shows that they are included in a ring having sharper limits at the inner side (nearer the Sun) than at the outer. One of the characteristics of that ring is its visible asymmetry. The limits of this ring at the outer side are equally distant from the Sun, whereas this is not the case for the inner side. In a larger angular interval about $\Psi = 250°$ the inner limit is at the distance of about 1.7 AU, whereas at the diametrally opposite side that limit is at about 2.0 AU.

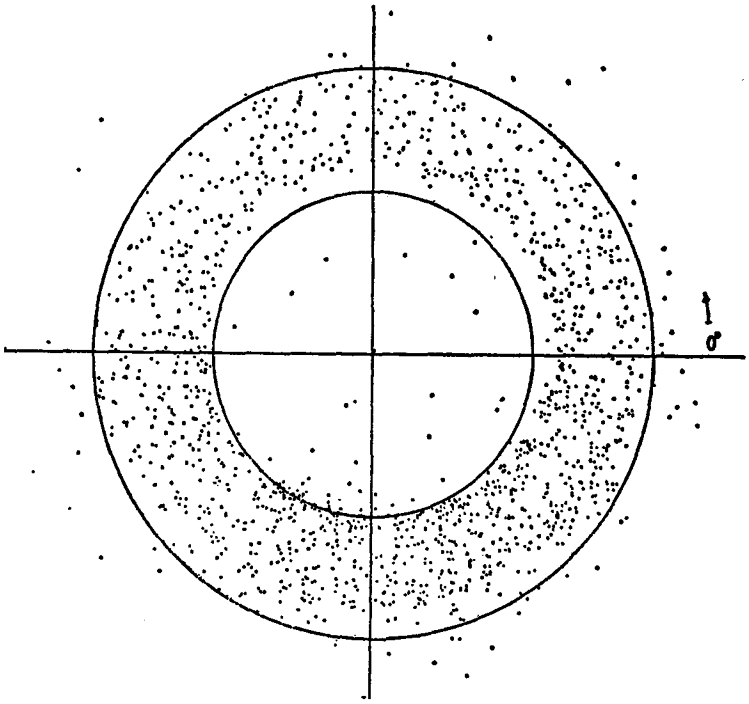

Figure 5

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