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UNREALISTIC OF THE LONG-PERIOD COMETS PERIHELION CONCENTRATION
IN THE AROUND OF ANY POINT IN THE CELESTIAL SPHERE

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The article studies the possibility of concentration of the perihelion positions of long-period comets around any point in the celestial sphere. As an object of analysis, we study the distribution of 1249 perihelion points in a neighborhood of two directions: the apex of the peculiar motion of the Sun and the point that is given by the Nathanson formulae. In the first case, the expected concentration does not have sufficient statistical reliability. In the second case, the concentration degree is high, but it can be associated with selection of the discovery of comets. It is concluded that the concentration of perihelion of the comets under consideration near the plane or great circle has no competition.

Keywords: long-period comets, perihelion, statistics, Planet X

Introduction

As shown in [1], the distribution of perihelion of long-period comets contains valuable information that can be used in theoretical searches of a massive unseen planet in the periphery of the solar system. Such a planet can create a certain belt of perihelion of comets along its orbit. This statement proceeds from the following considerations. It is known that the polar equation of the comet's orbit relative to the plane of motion of the planet can be represented as follows:

$$R = \frac{p}{1 + e \cos \omega'} \quad (1)$$

where ω' is the argument of perihelion in the new system, where the reference point is the ascending node of the planet relative to the ecliptic, p – parameter of orbit and e – eccentricity.

Let's say an almost parabolic comet interacts with a distant planet and begins a finite orbit from the planet distance. Then, in order for it to be visible, its parameter must be very limited. Then from the expression $\cos \omega' = 1 - p/R$ it becomes known that the parameter ω' should be either near 0° or 180° . For example, if you take $a = 340$ AU and $p = 5$ AU, then the value $\cos \omega'$ will be 0.985

or $= 9^\circ.8$. From the known expression: $\sin B' = \sin \omega' \sin i'$ it follows that the latitude of the perihelion of such a comet relative to the orbit of the planet should be no more than $9^\circ.8$. The above example shows that if an unknown planet injects a comet beam into the sphere of visibility, then their B' parameter values should concentrate near 0° . Therefore, one of the reasons for the perihelion belt of comets on the celestial sphere may be a planetary body. A prime example of this is Jupiter and its family of periodic comets.

Based on the above arguments, one of the authors hypothesized that there is a distant unknown massive planet. It is based on the fact that there is a concentration of perihelion of the LPCs in the vicinity of the plane:

$$\Omega = 273^\circ, i = 86^\circ \quad (2)$$

However, an alternative to the argument used in this hypothesis could be the fact that there is a concentration of perihelion of the orbits of the LPCs near any point in the celestial sphere. In particular there are evidences in the literature [2, 3, 4] that perihelia of LPCs might accumulate towards the solar apex, at ecliptic coordinates:

$$L_A = 270^\circ, B_A = 53.5^\circ \quad (3)$$

As for the distribution of the aphelion directions of the LPCs, also [5] and [6] have supported the hypothesis that LPCs aphelion directions are randomly distributed.

On asymmetry of longitudes distribution of LPCs perihelia relative to plane (2)

When analyzing the longitudes of perihelion (L') of 1249 a noticeable asymmetry (Table 1) in the intervals 0° - 180° and 180° - 360° (714 and 535 perihelia, respectively) draws attention. It is clear that they correspond to the northern and southern hemispheres of the celestial sphere, where comets are opened with different frequencies. Consequently, the extrema of the distribution $N(L')$ can also be associated with the real factor, which has come to be called the “selection effect” in cometary astronomy.

This feature shows that in fact the degree of real concentration of perihelion of long-period comets near the plane (2) is much higher than the observed one. This conclusion reinforces the hypothesis of an unknown massive planet under consideration.

Formulation of the problem and used data

In this paper, we will consider the question of the reality of the assumption of the concentration of cometary perihelion near point (3). A list of 1249 comets will be used as the database, which was used to construct the above hypothesis. Recall that these comets have perihelion and aphelion distances greater than 0.1 AU. and 30 AU, respectively.

Now suppose that we want to investigate the distribution of perihelia relative to a point having ecliptic coordinates L_0 and B_0 on the celestial sphere. Following [7] the angular distance A in this case can be defined by:

$$\cos A = \sin B \sin B_0 + \cos B \cos B_0 \cos(L - L_0) \quad (4)$$

where L and B are ecliptic coordinates of comet perihelion. In order to test this issue, we have computed the angular distance between all the 1249 comet perihelia and the solar apex using formula (4). Applying the results of this calculation to our basic comet list, we can quantify perihelia clustering in any surrounding of the solar apex. In [8] the point (L_0 ; B_0) was replaced by some other points on the celestial sphere for a comparative analysis of perihelion frequency, but no sign of dominance of solar apex clustering over the other chosen directions was found.

Results of calculations

In this work, we have revisited the topic of comet perihelia clustering on the grounds of improved data and the application of a more thorough analysis. In [8] the reference points were chosen randomly. In this work we will select them according to a clear system, in particular in the calculations, we set 12 values of the parameter L_0 (0° , 30° , ..., 330°) and 6 of B_0 (33.56° , 48.19° , 60° , 70.53° , 80.41° , 90°). Thus, we have identified 61 equidistant points on the northern celestial hemisphere for a comparative analysis of their surroundings. Then, we have determined the number of perihelia in the A-surrounding for each of them. The calculations have been carried out for cases where A is equal to 5° , 10° , 15° , ..., 45° . As for the analysis, the following values have been found: N —the number of perihelia in the A-surrounding of the solar apex, n —average number of perihelia corresponding to the A-surrounding of the 61 points on the celestial sphere, a —standard deviation, t —standard ratio, which, according to the one-sided Student's t -distribution should be greater than 1.67 at the significance level of 0.05 (see [9]).

Table 1

Comparative frequencies of perihelia relative to the solar apex and other directions

L' (deg)	0-30	30-60	60-90	90-120	120-150	150-180	180-210	210-240	240-270	270-300	300-330	330-360
N	157	119	82	106	134	116	124	63	61	63	108	116

Table 2

Comparative frequencies of perihelia relative to the solar apex and other directions

A(deg)	N	n	a	t	A(deg)	N	n	a	t
5	3	2.51	1.83	0.27	30	106	95.26	21.27	0.50
10	12	10.56	5.60	0.26	35	139	128.37	23.71	0.45
15	33	23.51	10.12	0.84	40	177	166	23.41	0.47
20	58	41.87	14.44	1.18	45	219	208.89	23.75	0.43
25	79	65.57	18.35	0.73					

Table 3

Comparative frequencies of perihelia relative to the point giving by Natanson's method and other directions

A(deg)	N	n	a	t	A(deg)	N	n	a	t
5	5	2.49	1.83	0.82	30	120	95.26	21.27	1.16
10	10	10.52	5.60	-0.09	35	139	128.37	23.71	0.45
15	30	23.51	10.12	0.6	40	241	166	23.41	3.2
20	51	41.87	14.44	0.63	45	278	208.89	23.75	2.91
25	82	65.57	18.35	0.9					

As shown in Table 2, the expected value of t is never achieved. In this context, extending the calculations to the southern celestial hemisphere is not necessary, since in this case the t -parameter will be even smaller. Thus, it may be concluded that the concentration of the LPCs perihelia in the area of solar apex is either non-existent or its statistical significance is too low (<1.67).

We performed similar calculations with respect to the point that the Natanson [10] approach provides. At 1249 points of the perihelion of long-period comets, such a point has coordinates $L_0 = 282^\circ.8$; $B_0 = 35^\circ.1$. The calculation results for this point are shown in Table 3. It can be seen that a positive result is obtained only by starting the value $A = 35^\circ$. Such a picture cannot be considered reliable, since starting from the value of A the external effect of the selection of comets is already affecting.

Conclusion

1. The working hypothesis about the concentration of perihelion of long-period comets near any point does not have the necessary confidence probability.

2. Concentrations of long-period perihelia near two planes of the celestial sphere re-

main the only reliable fact in the studied task. One of these two condensations of perihelion should be considered as an argument the hypothesis of a massive planet on the periphery of the Solar system.

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UZUNPERİODLU KOMETLƏRİN PERİHELLƏRİNİN SƏMANIN HANSISA BİR NÖQTƏSİ ƏTRAFINDA KONSENTRASİYASININ REAL OLMAMASI BARƏDƏ

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Məqalədə uzunperiodlu kometlərin perihellərinin səmanın hansisa bir nöqtəsi ətrafında konsentrasiyası ehtimalı öyrənilir. Tədqiqatın obyektı kimi 1249 komet gthbhelisinin iki səma nöqtəsinin həndəvərində paylanması öyrənilir: Günəşin pekulyar hərəkətinin apeksi və Natanson formullarının verdiyi nöqtə. Birinci halada ehtimal olunan konsentrasiya lazımi statistik etibarlılığı malik deyil. İkinci halada konsentrasiyanın dərəcəsi yüksəkdir, lakin onun kometlərin tapılmasındakı seleksiya ilə izahı mümkündür. Komet perihellərinin səmanın böyük dairəsinin ətrafında konsentrasiyası faktının konkurentliokdən kənarda olması nəticəsi vüqulanır.

Açar sözlər: uzunperiodlu kometlər, perihellər, statistika, Planet X

О НЕРЕАЛЬНОСТИ КОНЦЕНТРАЦИИ ПЕРИГЕЛИЕВ ДОЛГОПЕРИОДИЧЕСКИХ КОМЕТ В БЛИЗИ КАКОЙ-ЛИБО ТОЧКИ НЕБЕСНОЙ СФЕРЫ

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В статье изучается возможность концентрации точек перигелиев долгопериодических комет вблизи какой-либо точки небесной сферы. В качестве предмета анализа исследуется распределение 1249 точек перигелиев в окрестности двух направлений: апекс пекулярного движения Солнца и точка, которую дают формулы Натансона. В первом случае предполагаемая концентрация не имеет достаточной статистической надежности. Во втором случае степень концентрации высока, но она может быть связана с селекцией открытия комет. Сделан вывод о том, что концентрация перигелиев рассматриваемых комет вблизи плоскости или большого круга не имеет конкуренции.

Ключевые слова: долгопериодические кометы, перигелии, статистика, Планета X