Astronomical Journal of Azerbaijan, 2023, Vol. 18, No. 2

)

ON THE ISSUE OF FAMILIES OF PERIODIC COMETS OF GIANT PLANETS (MOID - ANALYSIS)

A. S. Guliyev [a*], ***R. A. Guliyev*** [a], ***A. A. Gasimov*** [a]

[a] *N.Tusi Shamakhy Astrophysical Observatory of Azerbaijan National Academy of Sciences, Shamakhy, Azerbaijan*

MOID-values relative to 4 giant planets were calculated for 670 periodic comets with aphelion distances up to 30 astronomical units (a.u.). It is established that 379 comets have values that do not exceed the radii of the planets' spheres of influence. When categorized by families based on MOID-values, the number of comets associated with each giant planet is as follows: Jupiter (309), Saturn (69), Uranus (6), and Neptune (0). It is assumed that the influence of the selection effect on this distribution is very significant.

Key words: periodic comets – MOID-values – Giant planets

1. INTRODUCTION

The issue of the existence of families of periodic comets associated with giant planets has a long history. Opinions on this issue among specialists are divided. While most acknowledge only the existence of the Jupiter family of comets, the remainder are considered to be either periodic or "Halley-type" comets. In a recently published work [1], this issue was considered concerning non-periodic comets, considering MOID distances and convincing digital data were obtained in favor of a positive answer. It was found that the number of such comets is 1.4-1.7 times greater than the background values. Proponents of the existence of such families (Epik, Vsekhsvyatsky, Drobyshevsky, Konoplev, Guliyev, etc.) mainly base their arguments on the distribution of comets' aphelion distances and observed peaks at the average distances of the giant planets. This fact has also been utilized in theoretical searches for unknown trans-Neptunian planets. Even after

)AJAz:2023_2_5.pdf

* E-mail: quliyevayyub@gmail.com

http://doi.org/10.59849/2078-4163.2023.2.5

the discovery of new periodic comets, the concentration of aphelia in these regions remains significant. However, some of the new objects have aphelions in the intermediate Jupiter-Saturn, Saturn-Uranus, and Uranus-Neptune intervals. It should be noted that specialists who deny the existence of the families of Saturn, Uranus, and Neptune often proceed from the MOID distribution of comet distances. It should be noted that in work [1] MOID-values of distances of long-period comets relative to the orbits of giant planets were calculated and analyzed. In the present work, we decided to act in the same way concerning periodic comets.

USED DATA AND RESEARCH METHOD

In our study, the limiting distances for MOID value analysis for each planet, the values of the radius of the sphere of influence were used, determined by the formula [2]:

$$h = a\sqrt[5]{\left(\frac{m_{pl}}{M_S}\right)^2}$$

where, a – the semi-major axis of the planet's orbit, m_{pl} – its mass,M_S – Solar mass.

It should be noted that the values of the parameter h for Jupiter, Saturn, Uranus, and Neptune are 0.322, 0.364, 0.347a.u. and 0.58 a.u., respectively. Our study included 785 periodic comets with aphelion distances up to 30 a.u. Compiled List begins with Comet 2P (Encke's Comet) and ends with Comet P/2020 S5 (PANSTARRS). Their data is taken from a NASA source (ssd-jpl-nasa-gov). During the primary analysis of this list, it became apparent the presence of a certain number of separable cometary nuclei. For the purpose of this study, we used data from only one fragment (designated as A) from each such complex (a striking example is the comet D/1993 F2 - Shoemaker-Levy 9). Otherwise, in statistics, we can get false maxima. In addition, it was decided to exclude from the analysis all short-perihelion comets (of the SOHO class, etc.). However, there were no such comets in the compiled list. After this filtering, 670 comets remained for analysis.

2. RESULTS OF CALCULATIONS

For calculating MOID distances, we used a program compiled by Dunby [3]. MOID values relative to the 4 giant planets were calculated for all the comets on our list. The selection of comets for each planet for analysis was carried out based on h. The results of the calculations are given in Table 1.

Table 1. The number of comet families identified by MOID-values.

Planet	Jupiter	Saturn	Uranus	Neptune
h, a.u.	0.322	0.364	0.347	0.58
N	304	69	6	0

The table reveals that Jupiter has the most numerous cometary family, whereas Neptune has none. However, the obtained digital characteristics do not reflect the true picture. The selection effect must be taken into account, as it influences the discovery of new comets. It is clear that the greater the perihelion distance, the lower the chance of discovering a periodic comet. If the theoretical distribution for periodic comets were known, then some corrections could be made to the quantity of the obtained distribution of MOID distances. For example, according to estimates by M. Fouchard et al. [4], the true number of comets of the "family" of Saturn, we can consider the approximate dependence $q^{2.13}$. In this case, the N values in Table 1 may be much larger. The influence of the selection effect is also manifested in the distribution of the dates of discovery of the considered comets. For example, 59 out of 69 Saturn "family" comets were discovered after 2000. Approximately the same picture is found in the "family" of Uranus: 5 out of 6 selected comets were discovered after 1999. This means that the numerical contrast between the cometary families of the giant planets will decrease with time.

3. CONCLUSION

Based on the MOID - distances of periodic comets relative to the giant planets, it can be argued that the families in issue, the existence of which is not accepted by all experts, exist. At least this statement covers 379 of the 650 known comets. The selection influence significantly reduces the true number of these families. The "family" of Jupiter is affected least of all by this factor, and the group of Uranus most of all. The same reason can explain the fact of the absence of "Neptunian" comets. The existence of such groups is well explained by the generally accepted dynamic evolution of comets, the source of which is the Kuiper Belt [5]. In the future, there is a need to carry out such calculations as new periodic comets are discovered.

REFERENCES

1. Guliev A.S., Guliev R.A. On the existence of families of long-period comets of giant planets. Astronomy Letters, 2020, vol. 46, **10**, p. 747-749.

2. Abalakin, V.K., Aksenov, E.P., Grebennikov, E.A., and Ryabov, Yu.A., Spravochnoe rukovodstvo po nebesnoi mekhanike i astrodinamike (A Handbook on Celestial Mechanics and Astrodynamics), Moscow: Nauka, 1971.p.584 .

3. Danby, J. M. A. (2003). Fundamentals of celestial mechanics (2. ed., rev. and enlarged, 5. print. ed.). Richmond, Va., U.S.A.: Willmann-Bell. pp. 352–353.

4. M. Fouchard, H. Rickman , Ch. Froeschlé , and G. B. Valsecchi. Distribution of long-period comets: comparison between simulations and observations A&A **604**, A24 (2017) DOI: 10.1051/0004-6361/201630343.

5. Emel'Yanenko, V. V. Dynamical evolution of comets from high-eccentricity trans-Neptunian orbits to near-Earth space. Dynamics of Populations of Planetary Systems, Proceedings of IAU Colloquium 197, held 31 August - 4 Sepetember, 2004 in Belgrade, Serbia and Montenegro. Edited by Z. Knezevic and A. Milani. Cambridge: Cambridge University Press, p.323-328