EARTH–COMETS COLLISION PROBLEMS BY CONSIDERING SPHERE INFLUENCE OF EARTH

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YERİN TƏSİR SFERASININ NƏZƏRƏ ALINMASI İLƏ YER-KOMET TOQQUŞMA PROBLEMİ

XÜLASƏ

Yer planeti ilə toqquşma ehtimalı olan bütün qısa və uzunperiodlu kometlər araşdırılmışdır. Bütün komet qruplarının xarakteristikaları nəzərdən keçirilərək onların Yerlə dinamik əlaqələri tədqiq edilmişdir. 2009-cu ilədək aşkarlanmış bütün kometlərin orbit düyün məsafələri hesablanmışdır. Yer diskinin Günəş ətrafında fırlanma sahəsinin onun təsir sferası diskinin Günəş ətrafında fırlanarkən əmələ gətirdiyi zolağın səhəsinə nisbəti hesablanmışdır. Son 60 ildə aşkarlanaraq Yerin təsir sferası radiusunu kəsib keçən kometlərin Yerlə toqquşma periodunun müddəti 2633 il civarında olduğu hesablanmışdır.

Açar sözlər: Uzun peridolu və qısa periodlu kometlər, toqquşma, Yer

ПРОБЛЕМЫ СТОЛКОНОВЕНИЯ КОМЕТ С ЗЕМЛЕЙ ПУТЕМ РАССМОТРЕНИЯ СФЕРЫ ВЛИЯНИЯ ЗЕМЛИ

РЕЗЮМЕ

Все короткие и долгопериодные кометы, которые имеют возможность соприкосновения с Землей были исследованы. Обследовав характеристики всех групп комет были определены динамические связи с Землей. Измерены расстояния орбитальных узлов всех опознанных комет до 2009-го года. Было измерено соотношение площади вращения земного диска вокруг Солнца с площадью полосы, образованной в результате сферы влияния вращения диска вокруг солнца. В последние 60 лет было изучено, что время периода столконовения с Землей комет, пересекающих радиус сферы влияния Земли состовляет около 2633 года.

Ключевые слова: Долгопериодные и краткопериодные кометы, столконовение, Земля.

Introduction

When dealing with Earth safety, considering only asteroids and short–periodic comets is not adequate. During the last few years some authors discuss the possibility of long-periodical comet families of Earth and other planets like Mercury, Venus, and Mars.The long-periodical comet families are more unexpected and more dangerous. It is difficult to predict and count their orbit parameters because of parabolic and hyperbolic trajectories. We may any time meet so called an undesirable "guest". The Long-periodic comets encounter Earth with a velocity the up to 72 km/s which may cause a terrible global calamity. Up to now more than 230 blow craters have been

founded on the Earth surface. Probably, some great craters have formed as a result of the comets colliding with the Earth It is considered that our planet has passed through 5 giant processes of colliding with comets-asteroids periodically a 60-100 millions years. Cause of popular perishing of the dinosaurs is believed as the last of these giant collidings. One of the most important problems for astronomers is to investigate potential dangerous objects coming from sky and predict their orbital parameters in advance. Therefore, investigation programs of potential danger sources named as NEO (Near Earth Objects) are already accepted. Generally, conception of the NEO includes all asteroids, short-periodic and long-periodic comets which are near and crossing Earth's orbit - and traditionally they are divided into three groups as shown in Table 1.

Table1. Classification of NEO.

NEO	a(A.U)	q(A.U)	(%)
Amor	*a≥1,0*	*1,017<q<1,3*	32±1
Apollo	*a≥1,0*	*q<1,017*	62±1
Aten	*a<1,0*	*Q>0,983*	6±1

In addition to this classification there is an another asteroid group called IEA (Inner-Earth Asteroids) whose orbits are entirely inside of the Earth's orbits (Q < 0,983).The IEA group is not dangerous than other groups and constitute 2%- of total NEO population. In this paper investigation is focused on comets not the asteroids.

Statement of Problem

Totally 1188 comets discovered till 2009 year have been studied. Among these comets 227 of them are short-periodic and 961 are long-periodic. In the work distribution of orbit units of comets surrounding the Earth's orbit is investigated. Distance between Sun and any comet`s orbit unit is specified by the following formula:

$$R = \frac{q(1+e)}{1 \pm e \cdot \sqrt{1-\left(\frac{x}{1-y^2}\right)^2}} \qquad (1)$$

Where,

$x = \sin B \cos I' - \cos B \sin I' \sin(L - \Omega')$

$y = \cos i \cos I' + \sin i \sin I' \cos(\Omega - \Omega')$

In which,

q, e, i, Ω - comets orbits parameters;
L and B – according longitude and width perihelion of comets orbit,
I′ and Ω′ - plain parameters.

There are two root of expression introduced in formula (1) for R, or more correctly, two orbits points accordance to each roots, one of them is near knot, other is far knot. The second basic is our priority in the problem. It is known that, conception of planet's sphere of influence assumes very importance in investigating of the planets – comets dynamic relation. Consider problem of three bodies (the Sun, a planet and a comet) planet assume as the central body and the Sun as the perturbing body when computing perturbations. That means influence inside of such sphere planet greater than Sun. By Sky Mechanics areas we know formula to finding radius (ρ) of sphere of influence for planets:

$$\rho = r\sqrt[5]{(M_p / M_\circ)^2} \qquad (2)$$

Where, r and M_p – distance planets from the Sun and planets mass, M_o – the Sun's mass. According to expression (2) radius of the sphere of influence for the Earth is equal ρ = 0, 0062 a.u. We consider that we need to find comets orbits' units in expanded interval by addition radius of sphere of influence to value planets aphelion and perihelion distance. Then to apply this consideration for the Earth following mathematical expression:

$$a(1-e) - \rho < \delta < a(1+e) + \rho$$

if express this interval by numerical value,

$$0,9771 < \delta < 1,0229. \qquad (3)$$

Beforehand, while getting result we met some difficulties and inaccuracies. These are inevitable, because there is not exact solution of the problem. Some of them given below:

- After the comet enters to the sphere of influence its parameters probably is same with previous (before entering)
- Last 60 years has been fixed all of comets with $q \le 1+ \varepsilon (\delta)$ description.
- In spite of changing along of the Earth's orbit radius of influence sphere accepts constant.
- The number of passing comets from perihelion equal 1, which this comets orbit belong to interval sphere of influence rotating around the Sun.
- Orbit of the Earth was accepted as circle and etc.

Those and such conditions will less quite influences to our result. Consequently, to need separate number of comets, whose orbits belonging to (3) interval, from all comets catalogues. Total number of these comets are n = 5. That is organizing 0,6 %- of general comets number and Table 2 given their some basic orbital parameters. But, there is only 1 comets orbits units when overlooked radius of influence for the Earth in to interval $0,9833 < r < 1,0167$. It mustn't do confident for us, because of new comets discoveries frequency is increasing from year to year.

Table 2. Comets list, which orbits units within the interval $0,9761 < r < 1,0229$ a.u.

comets	Q	e	. ⚜	. ⚜	*i*	*r*
C/1969 T1	0,472638	0,99992	267,8339	101,6599	75,8178	0,982365
C/1991 X2	0,198771	1,000175	306,9902	288,7848	95,5664	0,998394
C/-146 P1	0,43	1	261	330	71	1,019482
C/1966 T1	0,419225	1,000391	79,784	75,7078	9,0798	1,019503
C/1763 S1	0,49818	1	88,571	359,747	72,497	1,021843

But let us to take more close distance to the Earth. Stripe forming by rotating boundaries interval of the Earth's influence circle $0,0062 < d < 0,0124$ a.u around the Sun was selected. We consider that which comet's intersections in this interval are much more dangerous. The number of the comet's intersection with orbit of the Earth's in this stripe equal $n_1 = 3$ and their parameters are indicated in the Table 3.

Table 3. Comets parameters within in interval $0,0062 < d < 0,0124$ a.u.

comets	Q	e	⚜⚜⚜⚜	⚜⚜⚜⚜	*i*	*r*
C/1963 R1	0,005065	0,999946	86,1601	7,9393	144,5821	0,010857
C/1887 B1	0,00483	1	83,513	4,585	144,383	0,01089
C/1880 C1	0,005494	1	86,2486	7,7774	144,6666	0,011757

Solution and Calculation

Compare plain area of the Earth's influence sphere- S_{ρ}, with its stripe rotating around the Sun- $S_{r.a}$ will clarify to the distribution of orbits intersection. That is to divide influence disks areas to the influence stripes areas which value given below:

$$K = \frac{S_{\rho}}{S_{r.a}} = 0,00155 \qquad (4)$$

To find comets intersection number in the interval of $0,0062 < d < 0,0124$ a.u. need multiplied (4) with comets number in this interval:

$$K_0 = K \cdot n_1 = 3 \cdot 0.00155 = 0,00465 \quad (5)$$

If we divided area stripe forming by the rotating of the Earth's disk around of the Sun - S_{Earth} , to the stripe area forming by rotating influence sphere around the Sun-

S_ϱ it will be important step to approach our result:

$$K_1 = \frac{S_{Earth}}{S_\rho} = 0{,}00689 \qquad (6)$$

The multiplication result K_2, quantities of K_0 and K_1 are indicated number of comets will be able to collide with the Earth:

$$K_2 = K_0 \cdot K_1 = 3{,}2 \cdot 10^{-5} \qquad (7)$$

It is known that comets are observed and noted their parameters since ancient times. Obviously, exactness of the parameters noted is absolutely straight proportionate with development of the technology. Therefore, it is quite difficult to say about more reliable result using modern comets catalogues including comets discovered past times with their "rough" parameters. For liquidating this misunderstanding we made decision to take into account comets are discovered since 1950 years separately. The numbers of the comets were discovered in last 60 years equal 712, that is organizes probably 60% of the general comets group. If multiply, this number with (7) we get the result impact frequency in 60 years:

$$K_3 = 712 \cdot K_2 = 712 \cdot 3{,}2 \cdot 10^{-5} = 0{,}028 \quad (8)$$

Calculating period for one completely comet impact with the Earth by known frequency number in (8):

$$\mathrm{T} = \frac{60}{0{,}028} = 2633 \text{ years}$$

Summary And Discussion

The problem of comet's hazard for Earth is highly urgent and widely talked over in astronomic literature. Earth-crossing comets number is quite a little than other members of Near–Earth Objects, but they are very important, because of their nucleus chemical content and unexpected trajectories and it encounters velocity by high orbital inclinations and eccentricities. In addition known as comets sources the Kuiper Belt Objects and the Oort clouds are not well investigated yet. Therefore, for safety of our planet from ice bodies we need to study them deeply by observing and theoretical.

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