ON THE METHOD OF SEARCHING FOR UNDISCOVERED HAZARDOUS COMETS AND METEOROIDS COLLIDING WITH TERRESTRIAL TYPE PLANETS. D. V. Kolesnikov[1] and N. I. Perov[2], [1]Astronomical Observatory. State Pedagogical University. Respublikanskaya, 108. Yaroslavl, 150000. Russia. E-mail: n.perov@yspu.yar.ru, [2]Astronomical Observatory. State Pedagogical University. Respublikanskaya, 108. Yaroslavl, 150000. Russia. E-mail: perov@yspu.yar.ru.

Introduction: It is assumed [1, 2] there are 10^{12}-10^{13} comets, moved along elliptical orbits, in the Oort's cloud. Stars and gigantic molecular clouds, passing by near the Sun, set some comets of Oort's cloud move into the internal part of the Solar system. It is considered up to day the discoveries of comets are random and unpredictable [3–4]. A model of forecasting appearances of undiscovered yet minor celestial bodies is presented below.

A Non-Traditional Model of Migration of Comets: Let us consider a model of interaction of a comet with a preliminary parabolic heliocentric orbit, and a planet of mass M_{pl}. The comet at the perihelion of the heliocentric orbit closes with the planet, which moves along circle orbit radius of which equals r_{pl} with velocity V_{pl}. An initial angle between the orbital planes of the comet and the planet is equal to i_0 . (Fig. 1). The process of interaction of the comet and the planet will be considered like momentary turn of velocity vector $\mathbf{V}_c$ of the comet, experienced the closest approach of the planet. (Fig.2).

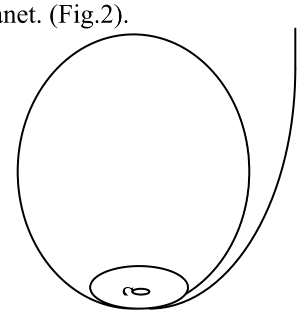

Fig.1. A parabolic comet and a terrestrial type planet.

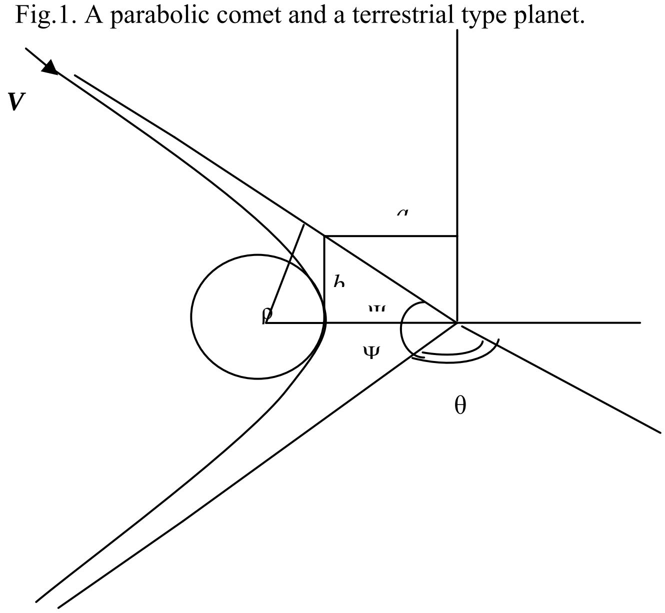

Fig. 2. Approaching the comet and the planet. V_∞ is the velocity of the comet at the boundary of the sphere of action of the planet. R_p is the radius of the planet. ρ is the impact parameter of the comet. a and b are real and imaginary semi major axes of the hyperbola. θ is the angle by which the velocity of the comet turns in the sphere of influence of the planet). 2Ψ is the angle between asymptotes of the hyperbola.

An angle of turn θ of the comet velocity vector (in the sphere of action of the planet) is maximum, if the comet approaches with the planet at the minimal distance without destroying. For this distance we take the radius of the planet R_p. (Roche limit is not taken into account). A target parameter of the comet is ρ should be in excess of ρ_{crit} (for the ρ_{crit} $r_{min}=R_{pl}$), otherwise the comet will collide with the planet and recover from further existence in the given model of motion. The comet with velocity of V enters into the sphere of influence of the Sun, whose mass is M_{Sun}. Setting for the heliocentric motion $r_{pl} \approx r$ (for the moment of time of "collision' of comet and planet) we determine by analytically tractable an angle of turn θ of a velocity vector of the comet in the sphere of influence of the planet, a semimajor axis a, an eccentricity e, true anomaly v of the comet for the new heliocentric orbit (after scattering the comet by gravitational field of the planet and egress of this object from the sphere of the planet influence) and an angle α between the heliocentric radius–vector of comet r and the vector of the heliocentric velocity V. The new perihelion distance of the comet denote by r_P. The parameters of the final orbit of the comet are concerned with some parameters of the original (parabolic in accordance with the model) orbit of the comet as well as the parameters of the planet by the following formulae (1-4), corrected with reference to [3]. Some results are presented in Tab.1.

$$\nu' = \frac{1}{\left[\frac{M_{Sun}}{M_{pl}} \cdot \frac{R_{pl}}{r_{pl}} (3 - 2\sqrt{2}\cos i_0) \;\; +1\right]^2} . \qquad (1)$$

$$a = \frac{r_{pl}}{4 \cdot \nu'(\sqrt{2}\cos i_0 - 1)}, \qquad (2)$$

$$e^2 = 1 - 8\nu'(\sqrt{2}\cos i_0 - 1)\{[1 - \sqrt{2}\nu'(\sqrt{2} - \cos i_0)]^2 + 2\nu'^2 \sin^2 i_0\}, \quad (3)$$

$$\tan i = \pm \frac{\sin i_0 (1 - 2\nu')}{\cos i_0 - \sqrt{2}\nu'(\sqrt{2}\cos i_0 - 1)}, \quad (4)$$

Table 1. Capture of comets by terrestrial type planets at the perihelia of the initial parabolic comets orbits with subsequent ejection.

Planet	ν'	a_f, AU	e_f	i_f, deg.
Mercury	$0{,}498\cdot10^{-3}$	468,822	0,999174	0
	$0{,}451\cdot10^{-6}$	- 88845,681	1,000004	180
Venus	0,041	10,654	0.933092	0
	$0{,}550\cdot10^{-4}$	- 1362,070	1,000530	180
Earth	0,0842	7,169	0,864789	0
	$0{,}141\cdot10^{-3}$	- 732,540	1,001363	180
Mars	0,0124	73,921	0,979476	0
	$0{,}135\cdot10^{-4}$	- 11638,875	1,000131	180

Hypothetical ephemerides of undiscovered hazardous comets: In Tab. 2 ephemerides of undiscovered periodical comets and radiants of unknown meteor's streams for the epochs of theirs collisions with the Earth are presented for the case i=0º.

Table 2. Ephemerides of undiscovered periodical comets and radiants of unknown meteor's streams for the epochs of theirs collisions with the Earth (after approaching the cometoids, migrated from the periphery of the Solar system, with major planets). γ is the angle at the Earth between directions: the Sun and the planet; χ – is the angle at the Earth between directions: the Sun and the comet (radiant of the meteor stream); λ and β are ecliptical coordinates (for the ecliptical circle orbits of the planet and ecliptical elliptical orbits of the comets (and the streams). The angles γ and χ are constant and they determine the epochs of searching for unknown comets and radiants of meteor streams. i=0º.

Epochs yyyy mm dd	Right ascension α h m	Declination δ ° '	Planet with which comet approaches	γ, ° '	χ, ° '
2010 02 08	18 47 23 49	-22 46 -01 22	Mercury	21 58	38 29
2010 02 10	17 31 01 11	-23 02 07 36	Venus	07 09	58 13
daily	$\lambda = \lambda_{Sun} + \chi$ β =0		Earth	-	80 16

Verifying the model at the first approximation: Distributions of the orbital elements of Jupiter's cometary family confirms, partially, the probability of existence of the considered model of comets migrating Fig.3 and [3].

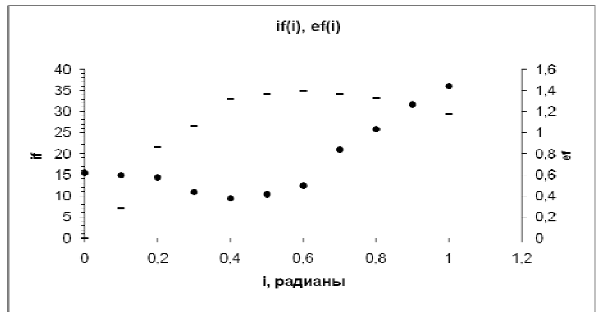

Fig. 3. Eccentricities - e_f (circles) and inclinations - i_f - degrees – (strokes) of the model orbits of the comets of Jupiter's family at the model pairwise two-body problem. i is an initial inclination (radians) of the plane of the parabolic orbit of the comet, at the plane of the circle orbit of the planet. Tisserand criterion equals $C=2\cdot2^{1/2}\cdot\cos i$.

Conclusion: The considered model of the transition of comets makes it possible to do the following: a) choose more definitely the initial conditions for the process of comet migration; b) dynamically explain the adopted classification of comets into planetary families; c) explain the deficit of observed comets with perihelion distance r_P<2.5 AU; d) interpret the formation of the association between a number of short-period comets on one hand and Jupiter ("six-year" comets), Saturn ("13-year" comets) on the other hand. Discrepancies are found to exist for the well-known families of Uranus ("33-year" comets) and Neptune ("75-yar" comets), because it follows from our study that comets with periods of 43 and 81 years must be assigned these families, whereas comets with period of 34 and 19 years must be assigned to the families of Venus and Earth, respectively; e) make out the searchfull ephemerides of undiscovered hazardous comets and radiants of unknown meteor streams and some meteoroids.

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