THE CLOSED TRAJECTORIES OF UNDISCOVERED SMALL BODIES IN THE SOLAR SYSTEM. N. I. Perov, Cultural and Educational Centre named after Valentina Tereshkova, ul. Chaikovskogo, 3, Yaroslavl, 150000, Russian Federation. E-mail: perov@yarplaneta.ru.

Introduction: There are known 700000 celestial bodies and almost all of them have been discovered with using optical observations [1]. Existence only several bodies or group of the bodies has been predicted by theoretical way (Neptune, Trojans). Below, we consider the region of motion of a particle with negligible small mass m_3 in the frame of the planar circular restricted three body problem [2], [3]. Let us, m_1 and m_2 are mass of main bodies, r_{12} is a distance between these bodies, *and G* is the gravitational constant. We find the region of the point motion, – distance r_3, ($\mathbf{r}_3=\mathbf{r}_3(x_3,y_3)$) *in* respect of the system center mass, – and numerically investigate the region of the particle stability motion, using method of Runge-Kutta integrating, where N is the numbers of points in the figures. The regions of the particles stable motion, in the given model, will be considered as the regions of concentration of undiscovered bodies in these systems.

Fundamental Equation: In accordance with works [2], [3] and [4] we have the vector differential equation (1) of the particle m_3 motion in the uniformly rotating system

$$d^2\mathbf{r}_3/dt^2+Gm_1(\mathbf{r}_3-\mathbf{r}_1)/(|\mathbf{r}_3-\mathbf{r}_1|)^3 + Gm_2(\mathbf{r}_3-\mathbf{r}_2)/(|\mathbf{r}_3-\mathbf{r}_2|)^3)-2[d\mathbf{r}_3/dt, \boldsymbol{\Omega}]-\Omega^2\mathbf{r}_3 = 0. \qquad (1)$$

Here, $\mathbf{r}_3$ is the radius-vector determined the position of considered point in respect of the center mass of the system. $\mathbf{r}_1$ and $\mathbf{r}_2$ are radii – vectors in respect of the center mass of the system determined the positions of major bodies with mass m_1 and m_2 correspondingly. Ω is the angular velocity of uniformly rotation of the major bodies.

$$\mathbf{r}_1=-(m_2/(m_1+m_2))\mathbf{r}_{12},\ \mathbf{r}_2=(m_1/(m_1+m_2))\mathbf{r}_{12}, \qquad (2)$$

$$\Omega=\sqrt{\frac{G(m_1+m_2)}{r_{12}^3}}\ .$$

Examples: For the numerical experiments we put $G=6.672\cdot10^{-11}$ m^3/ (sec$^2\cdot$kg), $m_1=2\cdot10^{30}$kg (mass of the Sun), m_2 is mass of a planet. In the process of the equation (1) solving we use the following units: m_1 is the unit of mass, r_{12} is the unit of length, the unit of time t is corresponded for the case G=1. Moreover, we put for all considered cases the following *initial* conditions: $x_1\neq0$, $dx_1/dt=0$, $y_1=0$, $dy_1/dt=0$, $x_2\neq0$, $dx_2/dt=0$, $y_2=0$, $dy_2/dt=0$, $x_3\neq0$, $dx_3/dt=0$, $y_3=0$, $dy_3/dt=0$. The results of the numerical experiments in intervals of time motion corresponded hundreds and thousands revolutions of major bodies are presented in Fig. 1 – 5.

Conclusions: a) For the curves (Fig.1. – Fig.5.) the velocity of m_3 equals zero only in initial moment of time but in the work [2] the corresponding curves are plotted, mainly, only for V≡0. b) Asteroid 2010 SO16 moves along the trajectory like presented in Fig. 1. (Fig. 4.) and it approaches the Earth [5], so, it may be supposed – there are undiscovered small bodies in the systems “the Sun and a major planet” moving along the curves presented in Fig. 1. and Fig.4. c) In Fig. 2. illustrated “strange” closed trajectories of small bodies in the system “the Sun and a major planet” , the regions for for casting of undiscovered small bodies, moved in main belt of asteroids, Kuiper belt and in the systems “the Sun and Saturn” and “the Sun and Uranus” are pointed out. d) Fig. 3 and Fig. 5. are not contradicted with the celestial mechanical model of some main belt asteroids, some Kuiper belt objects and some short periodical comets origin (transfers from planet centrically to heliocentrically orbits and vise – verse).

References: [1] http://www.minorplanetcenter. net/ iau/lists /ArchiveStatistics.html. [2] Szebehely V. (1967) *Theory of Orbits. The Restricted Problem of Three Bodies.* Yale University. New Haven Connecticut. Academic Press New York and London. [3] Perov N. I. et. al. (2011) *Theoretical Methods of Localization in the Space–Time of Unknown Celestial Bodies*, Yaroslavl, YSPU, 208 pp. [4] Perov N. I. (2014) *LPS XLV*, Abstract #1798. [5] http://archive.org/pdf1104.0036v.

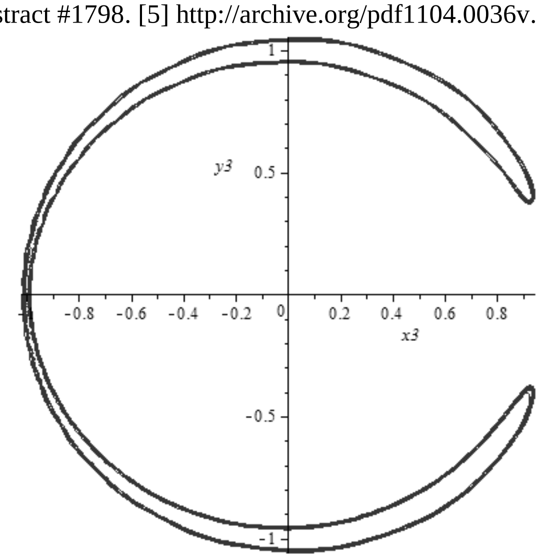

Fig.1. The closed trajectory of the small body m_3 in the system “The Sun (m_1=1) and Jupiter ($m_2=m_1/1048$)”, in respect of the center mass of the system (m_1 and m_2). $x_1=-1/1049$, $x_2=1048/1049$. $x_{30}=-x_2-\varepsilon$. $\varepsilon=1\cdot10^{-11}$. Unit of length equals r_{12}. Time of m_3 motion τ=3000 units of time. $\Omega=274838^{1/2}/524$. ($\Omega\approx1$).

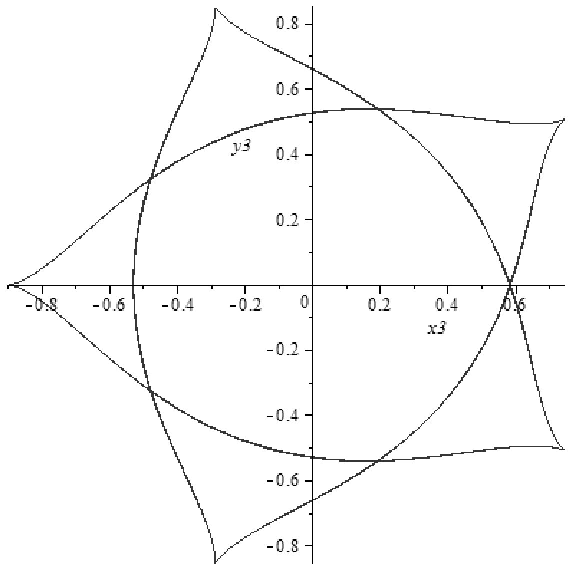

Fig.2. The closed trajectory of the small body m_3 in the system "The Sun (m_1=1) and **Jupiter** (m_2=m_1/1048)", in respect of the center mass of the system (m_1 and m_2). x_1=-1/1049, x_2=1048/1049. x_{30}=-x_2+ε. ε=0.0983. Unit of length equals r_{12}. Time of m_3 motion equals τ=2000 units of time. Ω=274838$^{1/2}$/524. (Ω≈1).

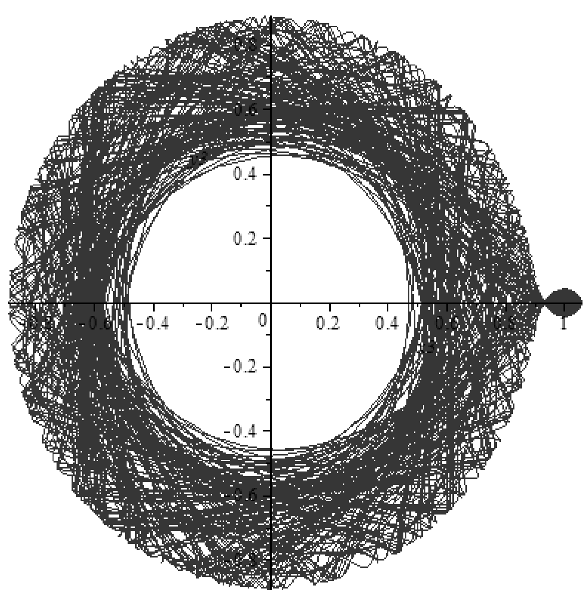

Fig.3. The "closed" trajectory of the small body m_3 in the system "The Sun (m_1=1) and **Jupiter** (m_2=m_1/1048)", in respect of the center mass of the system (m_1 and m_2). x_1=-1/1049, x_2=1048/1049. x_{30}=ε. ε=1.0576. Unit of length equals r_{12}. Time of m_3 motion equals τ=2800 units of time. Ω=274838$^{1/2}$/524. (Ω≈1).

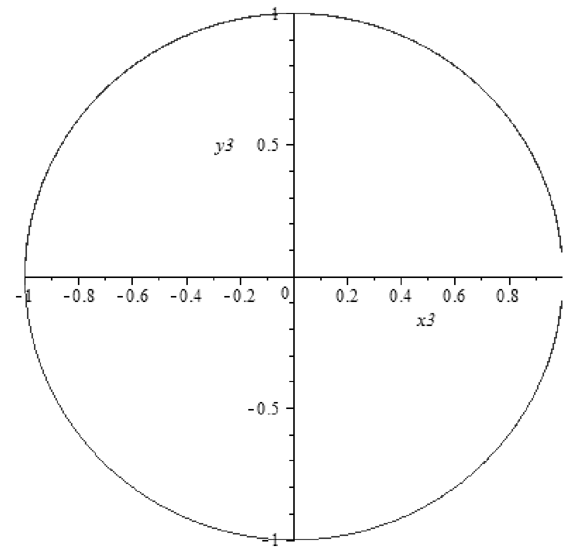

Fig.4. The closed trajectory of the small body m_3 in the system "The Sun (m_1=1) and **Pluto** (m_2=m_1/ (1.35·10^8))", in respect of the center mass of the system (m_1 and m_2). x_1=-7.40740740·10^{-9}, x_2=0.99999999259259. x_{30}=-x_2-ε. ε=1·10^{-4}. Unit of length equals r_{12}. Time of m_3 motion τ=16000 units of time. Ω=1.0000000037037037. (Ω≈1). Number of points is equal to 160000.

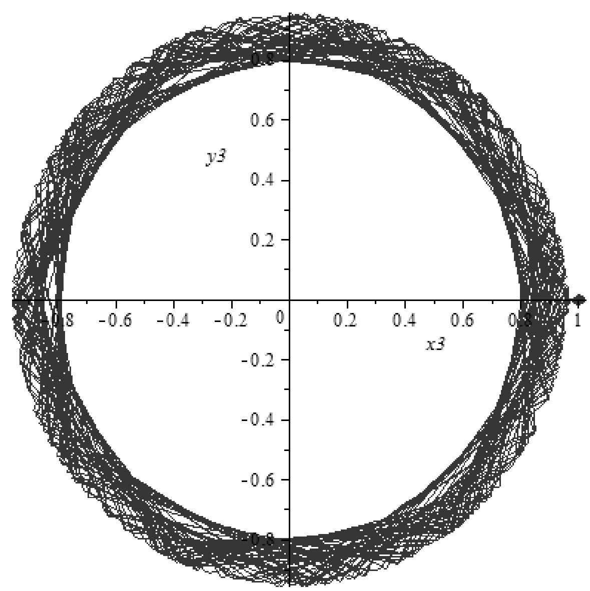

Fig.5. The "closed" trajectory of the small body m_3 in the system "The Sun (m_1=1) and **Neptune** (m_2=m_1/19412)", in respect of the center mass of the system (m_1 and m_2). x_1=-1/19412, x_2=19412/19413, x_{30}=ε. ε=1.024. Unit of length equals r_{12}. Ω= (3/9706) ·10467921$^{1/2}$. (Ω≈1).