**Resonances in Pluto’s System.** N. I. Perov, State Autonomous Organization of Cultural and Education named after V.V. Tereshkova. Ul. Chaikovskogo, 3, Yaroslavl, 150000. Russian Federation. E-mail: perov@yarplaneta.ru.

**Introduction:** “New Horizons” obtained new data about the system of Pluto, which are allowed to forecast new phenomena in this group of the bodies and to construct in particularly new celestial mechanical theories for localization of undiscovered regions of gas and dust matter near Pluto. Taking into account the work [1] here the small body (dust matter) motion is considered in the frame of the restricted plane circle seven body problem (Pluto–Charon–Styx–Nyx–Kerber–Hydra–a particle). For motion of particles which are in resonance with Hydra are especially paid attention. The aim of this work is to state, using numerical simulations, the extended stable regions of particles motion near the Hydra’s resonances: 1:1; 1:2; 1:3; 1:4.

**The Basic Equation:** Let’s denote G is gravitational constant; m₀, mₐ, mₜ, mₙ, mₖ, mₜ are mass of Pluto, Charon, Styx, Kerber, and Hydra respectively; r, rₜ, rₐ, rₘ, rₖ are the Pluto’s centrically radii-vectors of the particle and Pluto’s satellites correspondingly; Pₜ, Pₐ, Pₘ, Pₖ are the periods of Pluto’s satellites motion along the circle orbits accordingly. The differential equation of the particle put in the form [2]

\[
d\mathbf{r}/dt = -Gmₜ\mathbf{r}/\left|\mathbf{r}\right|^3 - Gmₐ\left(rₜ-rₜ\right)/\left|\mathbf{r}-\mathbf{rₜ}\right|^3 - Gmₜ\left(rₜ-rₜ\right)/\left|\mathbf{r}-\mathbf{rₜ}\right|^3 - Gmₙ\left(rₜ-rₜ\right)/\left|\mathbf{r}-\mathbf{rₜ}\right|^3 - Gm₌\left(rₜ-rₜ\right)/\left|\mathbf{r}-\mathbf{rₜ}\right|^3  
\]

(1)

In the equation (1) instead of the Newtonian’s time t the angle φ of Charon uniformly rotating is used. The following units are used: m₀ is the units of mass, rₜ is the units of length and G=1.

**Examples:** Using the data from [3] it is possible to draw the figures (Fig.1 - Fig. 6), illustrated motion of the Hydra’s “resonance” particles in the Pluto’s system. Below P is a period, e₀ is an initial eccentricity, v₀ is a velocity of the particle in the initial moment of time (t₀=0).

**Fig.1.** Trajectory of the particle for k=Pₚ/Pₜ=1, e₀ = 0, x₀=-3.30271, y₀=0, vₓ₀=0, vᵧ₀=-0.519544, φ=1500 rad, N=200000 points.

**Fig.2.** Trajectory of the particle in the system of reference uniformly rotating with period of Pₚ for k=Pₚ/Pₜ=1, e₀ = 0, x₀=-3.30271, y₀=0, vₓ₀=0, vᵧ₀=-0.549544, φ=2460 rad, N=60000 points.

**Fig.3.** The stable trajectory of the particle in the system of reference uniformly rotating with period of Pₚ for k=Pₚ/Pₜ=1, e₀ = 0, x₀=-3.30271, y₀=0, vₓ₀=0, vᵧ₀=-0.549544, φ=10000 rad, N=400000 points.
Fig. 4. Trajectory of the particle for $k=P/P_H=1$, $e_0=0.05$, $x_0=-3.467850$, $y_0=0$, $v_{x0}=0$, $v_{y0}=-0.494185$, $\phi=2000$ rad, $N=40000$ points.

Fig. 5. Trajectory of the particle for $k=P/P_H=4$, $e_0=0.0$, $x_0=8.322320$, $y_0=0$, $v_{x0}=0$, $v_{y0}=0.327292$, $\phi=8000$ rad, $N=40000$ points.

Fig. 6. Trajectory of the particle for $k=P/P_H=4$, $e_0=0.6$, $x_0=13.315711$, $y_0=0$, $v_{x0}=0$, $v_{y0}=0.163646$, $\phi=8000$ rad, $N=40000$ points.

Fig. 7. Trajectory of the particle for $k=P/P_H=4$, $e_0=0.6$, $x_0=13.315711$, $y_0=0$, $v_{x0}=0$, $v_{y0}=0.163646$, $\phi=20000$ rad, $N=200000$ points.

**Conclusion:** 1. For $k=1$ and $e=0$ the region of the particles motion is greater than in the case $k=4$, $e=0$ (Fig. 1 and Fig. 5).

2. For $k=1$ the particles leave out the system at $e=0.05$ (Fig. 4), while for $k=4$ the particles leave out the system at $e=0.6$ (Fig. 6 and Fig. 7).

3. For the definite initial conditions $r_0$ and $v_0$ there are horseshoes trajectories (Fig. 2 and Fig. 3).

4. In the work [1] for the first time in the frame of the restricted circle three body problem ($m_1>m_2>m$) in the system of reference origin of which is placed in the center of mass it is shown: the stable horseshoes trajectories always exist if we have $m_1/m_2>700$, $x_0=x_2$, $y_0=0$, $v_{x0}=0$, $v_{y0}=0$. So, in the Pluto’s system the stable horseshoes trajectories must exist for the subsystems of “Pluto, a satellite of Pluto and a body with negligible mass” (Fig. 3), but there are no the such stable trajectories for the subsystem “Pluto–Charon–a particle”, because $m_0/m_{Ch}=8.2156 << 700$. (Mass $m_0$ of a satellite-i we determined using the formula $m_0=4/3\pi a b c \rho_{Ch}$, where $a$, $b$, $c$ are the semi axis of a satellite-i, $\rho_{Ch}$ is density of Charon [3]).

In the book [3] a partial case of the horseshoe trajectory for a satellite of Saturn is only considered.