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On the problem of searching for the life belts in the double stars systems

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1. Introduction

There are known dozen factors determined possible origin and evolution of exoplanetary life. For the life of the Earth's type these factors are - the temperature of the star, semi major axes and eccentricity of the planetary orbit, period of planet's rotation, the angle between plane of equator and planetary orbit plane, water on the surface and the vapor in the atmosphere, vulcans, mass of the planet, satellite of the planet, the dependence "energy–mass–food–size of the animals" [1], [3]. Below we consider the quasiisothermal orbits of the habitable planet m_3 in the binary system consisted of two stars with mass m_1 and m_2 in the frame of the restricted planar circle 3 body problem.

2. Fundamental Equation

In accordance with the work [2] we have the vector differential equation (1) of the particle m_3 motion in the uniformly rotating system

$$d^2\boldsymbol{r_3}/dt^2+Gm_1(\boldsymbol{r}_3-\boldsymbol{r}_1)/(|\boldsymbol{r}_3-\boldsymbol{r}_1|)^3 +$$

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

Here, $\boldsymbol{r}_3$ is the radius-vector determined the position of the considered point m_3 in respect of the center mass of the system. $\boldsymbol{r}_1$ and $\boldsymbol{r}_2$ are radii – vectors in respect of the center mass of the system determined the positions of the star with mass m_1 and the star m_2 correspondingly. Ω is the angular velocity of uniformly rotation of the major bodies.

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

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

3. Examples

For the generating of the numerical experiments we put m_1/m_2 =50, m_3 is mass of a planet. In the process of the corresponding 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, where G is the gravitating constant. Moreover, we put for all considered cases the following *initial* conditions: $x_1\neq0$, $dx_1/dt=0$, $y_1=0$, $dy_1/dt=0$, $x_2\neq0$, $dx_2/dt=0$, $y_2=0$, $dy_2/dt=0$, $x_3\neq0$, $dx_3/dt=0$, $y_3=0$, $dy_3/dt\neq0$. The results of the numerical experiments in intervals of time t motion corresponded to hundreds and thousands revolutions of major bodies are presented in Fig.1 – 5.

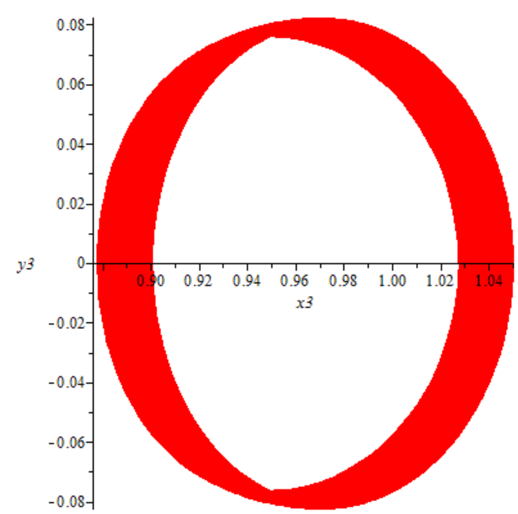

Figure 1: The habitable planet m_3 is moving near the star m_2. m_2/m_1 =1/50. x_{30}=1.05. $(dy_3/dt)_{t=0}$ = 0.5. t=1000. N=20000 (number of points).

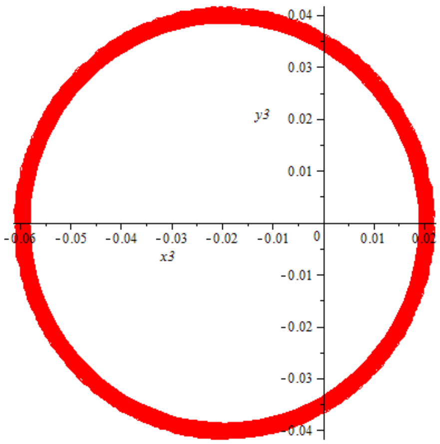

Figure 2: The habitable planet m_3 is moving near the star m_1. m_2/m_1 =1/50. x_{30}=0.02. $(dy_3/dt)_{t=0}$ = 5.05. t=200. N=2000 (number of points).

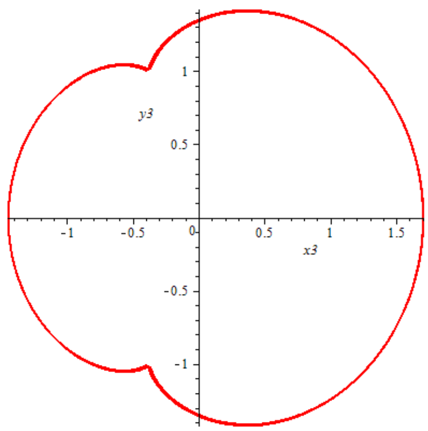

Figure 3: The habitable planet m_3 is moving near the stars m_1 and m_2. m_2/m_1 =1/50. x_{30}=-1.45. $(dy_3/dt)_{t=0}$ = 0.695. t=2000. N=20000 (number of points).

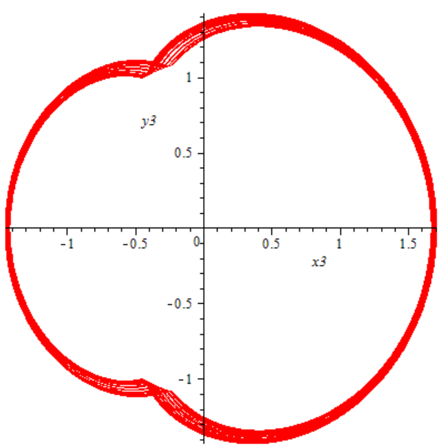

Figure 4: The habitable planet m_3 is moving near the stars $m_1$and m_2. m_2/m_1 =1/50. x_{30}=-1.45. $(dy_3/dt)_{t=0}$ = 0.69112. t=2000. N=20000 (number of points).

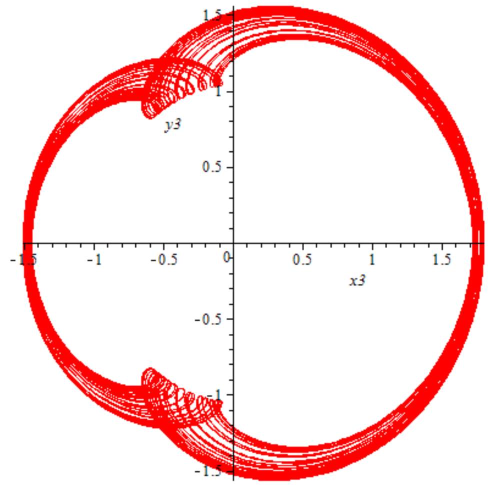

Figure 5: The habitable planet m_3 is moving near the stars m_1 and m_2. m_2/m_1 =1/50. x_{30}=-1.45. $(dy_3/dt)_{t=0}$ = 0.71. t=2000. N=20000 (number of points).

4. Conclusions

There are existed (theoretically) quasiisothermal trajectories (40°C<T<+40°C) for the habitable planets (in the binary systems of stars) in the form of the narrow rings – a) near the star – satellite; b) near the main star; c) near both stars (r_3>1). (Fig. 1. and Fig. 2.). Moreover, we found "strange" quasiisothermal trajectories of habitable planets (Fig. 3. – Fig. 5.). In the work [3] the life' belts are considered for two body problem like "a star and a planet".

References

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