VELOCITIES OF INTERSTELLAR METEORS NEAR THE EARTH'S ORBIT. N. I. Perov[1,2] and V. E. Pakhomycheva[2], [1]Cultural and Educational Center named after V.V. Tereshkova. Ul. Chaikovskogo, 3, Yaroslavl-150000, Russian Federation. E-mail: perov@yarplaneta.ru. [2]State Pedagogical University named after K.D. Ushinskii. Ul. Respublikanskaya, 108, Yaroslavl-150000, Russian Federation. E-mail: pahomycheva.vika@mail.ru.

Introduction: Particles arrived in the Solar System from interstellar medium are found but their nature is not cleared [1, 2]. Discovering of such particle fluxes and working out the criteria of galactic meteors identification is a problem of the modern astronomy [2]. It is usually supposed that interstellar meteoroids' particles velocities near the Earth's orbit may vary from dozens to hundreds kilometers per second [1, 2]. Below it is stated the heliocentric velocities of meteoric particles near the orbit of the Earth may be equal almost zero if light pressure and effect of Pointing-Robertson as well as gravitational force acting on the particle from the Sun are taken into account.

The based equations: The model equation of particle motion we put in the form (1) [3]

$$d^2\mathbf{r}/dt^2=-GM'\mathbf{r}/r^3-2b'v\cos(u)\mathbf{e}_r/r^2-b'v\sin(u)\mathbf{e}_t/r^2 \quad (1)$$

Here, v is velocity of the considered particle, u is an angle between the vector of the velocity **v** and the heliocentric radius-vector **r** of the particle, $\mathbf{e}_r$ and $\mathbf{e}_t$ are units' orts of radial and tangent directions of the particle vector acceleration,

$b'=\pi R^2 q r_{SE}^2/(Mc^2)$,

$M'=M_S - \pi R^2 q r_{SE}^2/(GMc)$,

G is the gravitational constant, c is the velocity of light, R is a radius of the particle, q is the solar constant, M' is reduced mass of the Sun, M_S is the mass of the Sun, M is mass of the particle, r_{SE} is the averaged distance between the Earth and the Sun.

Using the density ρ of the spherical black particle we have

$$M=\frac{4}{3}\pi R^3\rho,$$

$b'=(3/4)q r_{SE}^2/(\rho R c^2)$,

$M'=M_S-(3/4)q r_{SE}^2/(\rho R G c)$.

If the particle moves along the straight line in the gravitational field of the Sun (light pressure and effect of Pointing-Robertson are also taken into account), then equation (1) is simplified (u=π) and we have v=v(r)

$$\frac{dv}{dr}v=-\frac{GM'}{r^2}+\frac{2b'v}{r^2}. \quad (2)$$

After integrating the differential equation (2) v(r) may be found from the expression

$$\frac{v-v_0}{2b'}+\frac{GM'}{(2b')^2}\cdot\ln\left(\frac{2b'v-GM'}{2b'v_0-GM'}\right)=\frac{1}{r_0}-\frac{1}{r}. \quad (3)$$

Where v_0 is the initial velocity of the particle, r_0 is the initial positions of the particle, the final distance of the particle from the Sun is equal to $r=r_{SE}$. It should be noted v(r) is expressed in evidence form with help of Lambert function. (See the expressions after Fig. 5.).

Examples: Graphs of v (v_0, ρ·R) functions, presented in figures (Fig.1-Fig.5), are plotted for values: q=1360 Wt. /m^2, $r_{SE}=1.49597\cdot10^{11}$ m, $M_S=2\cdot10^{30}$kg, r_0=100000 AU, $G=6.672\cdot10^{-11}$ m^3/ (kg·s^2), $c=3\cdot10^8$m/s; $0<v_0<100000$m/s, 0<ρ·R<1000 kg/m^2.

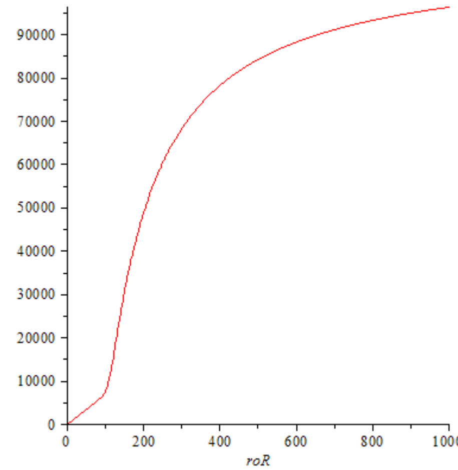

Fig.1. Dependence of v near the Earth's orbit on ρ·R for v_0=100000 m/s

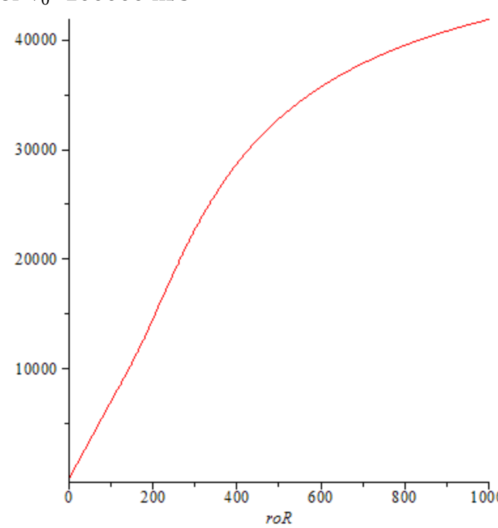

Fig.2. Dependence of v near the Earth's orbit on ρ·R for v_0=30000 m/s.

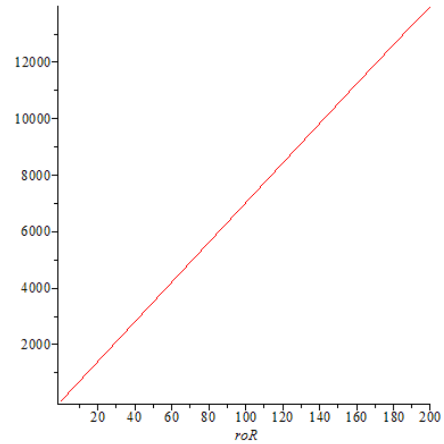

Fig.3. Dependence of v near the Earth's orbit on ρ·R for v_0=1 m/s.

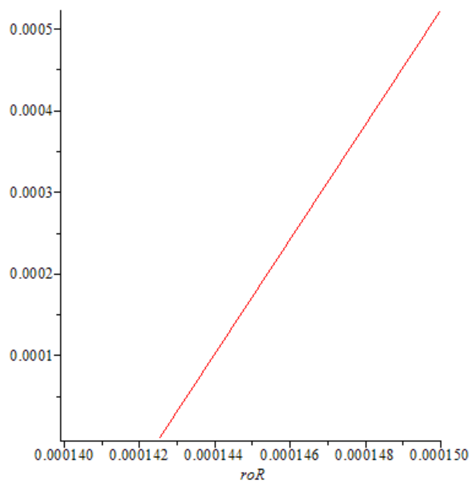

Fig.4. Dependence of v near the Earth's orbit on ρ·R for v_0=1 m/s.

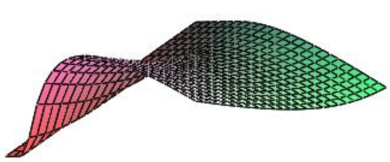

Fig.5. The graph of the function of v=v (v_0, ρ·R) near the Earth's orbit. 10000<v_0<100000 m/s, 0.000143< ρ·R< 1000 kg/m^2. 0<v<100000 m/s.

In Fig.5. v is the function of the variables of R and ρ·R and it is plotted in 3D, with using the formula

$$v=\frac{1}{2}\cdot\frac{GM'}{b'}\cdot\Bigg(\mathrm{LambertW}\Bigg(-(-2b'v_0+GM')/GM'\cdot \exp\left(-\frac{2b'rr_0v_0+GM'rr_0-4b'^2r_0+4b'^2r}{GM'rr_0}\right)\Bigg)+1\Bigg). \quad (4)$$

In Fig. (1-5) for the case of equality of the light wave length λ and the radius R of the particle effects of diffraction are not taken into account [3].

It should be noted [2] the middle mass of the detected interstellar particles is equal to $8\cdot10^{-16}$kg and the corresponding flux equals $1.5\cdot10^{-4}m^{-2}c^{-1}$ in accordance with the data of "Galileo" probe.

Conclusion: The small values of the radii R and the low density ρ of the particles make the velocities of interstellar meteoroids near the Earth's orbit tend to zero even for the large initial velocities of these meteoroids (Fig.1., Fig.2.).

The large values of the radii R and the great density ρ of the particles make the velocities of interstellar meteoroids tend to parabolic (hyperbolic) ones near the Earth's orbit even for the small initial velocities of these meteoroids (Fig.3).

For the small values of product of ρ·R and the small values of the initial meteoroids velocity v_0 the final velocity of the meteoroid (near the orbit of the Earth) tends to zero (Fig.4).

So, the interstellar meteoroids in some cases have almost zero velocities near the Earth's orbit and majority of them may be lost for their searching in accordance with the method [4], using only the criterion of high velocities of interstellar meteoroids.

References: [1] Hajdukov'a M., Paulech Jr. and Paulech T. (2007) *Contrib. Astron. Obs. Skalnat'e Pleso.*V. 37. P. 18-30. (http://www.ta3.sk/caosp/Eedition/FullTexts/vol37no1/pp18-30.pdf). [2] Kramer E.N. and Smirnov V.A. (1999) *Solar System Research*. V. 33. P.77. [3] Radzievskii V.V. (2003) *Photogravitational Celestial Mechanics.* Nijnii Novgorod: Editor Chief Yu. A. Nikolayev. 196 pp. (In Russian). [4] Slivinskii A.P., Bushuev F.I., Kalyujnyi N.A. and Shulga A.V. (2013). *NTR*. V. 92. N 2. P. 28-34.