GRAVITY FIELD IN EXTERNAL PARTS OF THE SOLAR SYSTEM

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ABSTRACT. Taking into account the gravitational perturbations from the center of the galaxy and using the catalogue closest to the Sun, stars modeled surfaces of equal gravitational potential energy fields in the outskirts of the solar system. Constructed three-dimensional model of equipotential surfaces in the vicinity of the solar system. It is shown that for certain values a constant of the energy the Sun is within the common equipotential surface Toliman, Sirius and Procyon.

Key words: nearest stars; attraction; potential energy; galactic center

The solar system is a combination of many celestial bodies, held by gravity. About 99.8% of the mass falls on the Sun. Therefore, almost all of the Sun determines the motions of the solar system. Move around the Sun eight major planets with satellites, dwarf planets, asteroids, comets, Kuiper belt objects, meteoroid and gas-dust complexes. With the sun's surface continuously flows expire plasma – the solar wind. With increasing distance from the Sun, its density and velocity continuously decrease. At some distance the solar wind mixes with the interstellar medium. This boundary is called the heliopause. At present, it is assumed that it is at a distance of 119 AU from the Sun (NASA, 2012).

With increasing distance from the center of the solar system, the attraction of the sun diminishes. To describe the boundaries of the space within which, it is advisable to take the main attraction of the sun, apply the concept of the incidence (Chebotarev, 1965; Balk, 1965). When moving inside the sphere, acceleration, directed towards the Sun is considered the main, all other speed - disturbing. The radius of incidence of the sun relative to the galactic center is estimated at 60 000 AU (Chebotarev, 1965). The area of the circumsolar space that lies beyond this distance is called the outskirts of the solar system. In this region the gravitational acceleration toward the Sun is comparable to the gravitational acceleration to other celestial bodies surrounding the solar system.

Thus, part of the Kuiper belt objects and comets move in the interstellar medium, but remain deep within the incidence of the Sun. According to (Oort, 1950) exist cloud around the Sun of comet nuclei, called the Oort cloud. This cloud is not available observations. But if it exists, the comet nucleus moving near the outskirts of the solar system.

At the outskirts of the solar system must take into account the attraction of the nearest stars, and the additive effect of our Galaxy.

It is known that our galaxy is a collection of hundreds of billions of stars, gas-dust matter and other objects a length several thousand parsecs. The masses in the galaxy are concentrated toward the center. The Sun is located about 8000 pc from the galactic center (Binney & Merrifield, 1998). The size of the solar space is much smaller than the size of the galaxy. For this reason, gravitational perturbations from the Galaxy in the first approximation can be regarded as a perturbation a centre of the galaxy. Its diameter is small compared with the diameter of the galaxy, and the distance to the Sun. This allows approximately replaced an attraction of the central part of the Galaxy by the attraction of a point mass $1.3 \cdot 10^{11} M_\odot$ (Chebotarev, 1965).

Because the diameters of stars are negligible compared to interstellar distances, then the abstraction of "material point" is fully applicable for the description of gravitational fields close to the outskirts of the solar system of stars. To examine the behavior of particles in the interstellar distances is necessary to consider the influence of nearby stars. For this purpose, we used the Zakhozhaj Catalogue of Nearest Stars until $10pc$ (Zakhozhaj, 1996). This is one of the few catalogues that contain estimates of the masses of nearby stars that are within 10 pc from the Sun.

To describe the gravitational field, we use the concept of potential energy. Relative to an arbitrary material point of the potential energy is given by:

$$U_i = -G\frac{m_i}{r_i} \tag{1}$$

were G – the gravitational constant;

m_i – mass of the material point;

r_i – the distance from the material point.

If a material point is isolated, then the surfaces of equal potential energy presented a set of concentric spheres. In the case of set of N material points, the potential energy with respect to each of them, summed up:

$$U = -G \sum_{i=1}^{N} \frac{m_i}{r_i} \qquad (2)$$

View surfaces of equal potential energy depends on the relative positions and masses of all the N material points. Thus, taking into account the gravity 355 nearby stars and the central part of the Galaxy, we have constructed a set of surfaces of equal potential energy. Figure 1 shows the equipotential surfaces surrounding the nearest star, the distance to which does not exceed 3.5 ps. Red dwarfs are not shown. The value a constant of the energy is sufficiently small, therefore a surface deviates from spherical shape. The radius of the equipotential surface that surrounds the sun, close to the radius of the sphere of the sun relative to the center of the galaxy.
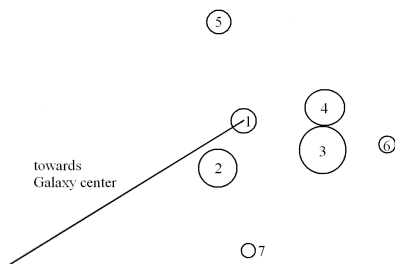

Figure 1: Equipotential surfaces for small values of potential energy, separately covering the Sun and the nearest massive star 1 – The Sun, 2 – Toliman (α Centauri), 3 – Sirius (α Canis Major), 4 – Procyon (α Canis Minor), 5 – 61 Cygni, 6 – ε Eridani, 7 – ε Indi.

Modelling of the gravitational field in the vicinity of the solar system shows that among the nearest neighbors of the Sun released some of the most massive stars or star systems. First of all, this is the closest star system – α Centauri. Its total mass, taking into account the mass of Proxima Centauri is more than twice the mass of the Sun. In a set of equipotential surfaces exist such that the system includes the Sun and α Centauri. For the same value the constant of the energy surface of a covering Sirius and Procyon neighbors (Fig. 2).

For larger value the constant of the energy surface exist, covering all four relatively massive stars (the
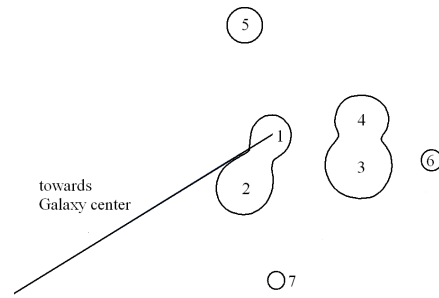

Figure 2: Equipotential surfaces for a larger value of the potential energy, covering a group of stars.
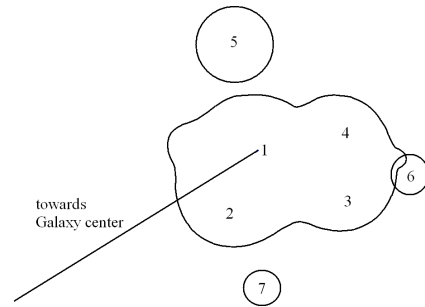

Figure 3: Equipotential surfaces for the maximum value of potential energy, covering a group of stars.

system) – Sun, α Centauri, Sirius and Procyon. Inside of the equipotential surface are also much smaller red dwarfs – Leyte (near Procyon) and Barnard's Star. Since the stars have proper motions, their position in space is continuously changing. Therefore, the outskirts of the solar system gravitational field strength is anisotropic, the anisotropy is variable. Equipotential surfaces deform and move. The interstellar medium and the celestial bodies, is not associated with stars, moving in a variable gravitational field with small gradient.

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