Some parameters of 4D matter

Valery P. Skorobogatov

http://apeironics.ucoz.ru mailto://vps137.yandex.ru

Certain corrections to the parameters of 4D matter that was given earlier are obtained by other method. Also, a procedure for calculation of a planet’s distance from the sun is proposed, and it in several cases it corresponds well with observations.

The matter in the title refers to the hypothetical medium the Universe is supposed to consist of. Such matter is also presupposed not to fill all space. Therefore the Universe occupies only a limited region in space, the form of which is close to 4-sphere due to action of the force of (hyper-)surface tension. The boundary of the Universe that has three dimensions can be named as our visual World. It called visual because the light can penetrate only along the boundary hypersurface.

It is further supposed that in the Universe vortex-like structures can exist. The simplest of them can be assumed to be a so-called 4-whirl, for which the hypersurface has the form given by the function $x_4 = b^2/r$, where b is the parameter representing the size of whirl. It is shown in [1] that the hypersurface can be assigned additive properties when we take for granted that the shapes of whirl hypersurfaces can overlap each other in accordance with the rule like the superposition principle. It means that a group of 4-whirls $\sum \frac{b_i^2}{|r - r_i|}$ at rather large distance can replaced by one 4-whirl B^2/r , where $B^2 = \sum b_i^2$. Because the mass of a body is obeyed the same additivity principle and is equal to the sum of its constituents $\left(M = \sum m_i\right)$ one can accept the relation $m = k b^2$ as being justified with the constant k.

Here we will give the calculations of coefficient of hypersurface tension σ which value differs from presented earlier in [2] via comparison of perihelion shift of planets and coefficient k which binds together mass of particle and the size of 4-whirl associated with it. We apply the next expression for the force of attraction between two 4-whirls when one has much more size then another.

$$F = \frac{2\pi\sigma B^2 b^2}{r^2\sqrt{1+B^4/r^4}} \quad (2)$$

It has no singularity at $r \to 0$ as in the Newton law of gravitation but the juxtaposing with this law let us to establish the following identity between gravitational constant and our parameters

$$G = \frac{2\pi\sigma}{k^2} \quad (3)$$

To obtain the value of size of Sun 4-whirl B it is sufficient to equate the attraction force (2) applied to the Sun and the planet with the centrifugal force V^2/r that balanced planet on its orbit. Supposing the round orbit we have

$$\frac{GM}{r^2\sqrt{1+B^4/r^4}} = \frac{(2\pi)^2 r}{T^2} \quad (4)$$

where T is the period of planet revolution. From this equation we get

$$B = r\sqrt[4]{1-\left(\frac{GMT^2}{4\pi^2 r^3}\right)^2} \quad (5)$$

If the third Kepler's law (and therefore the Newton's law of gravitation) would be true, the ratio of cube of half big axis of orbit to its square of period of revolution a^3/T^2 will be equal to the constant value $GM/4\pi^2 = 7.495\cdot 10^{-6} a.e.^2/дн^3 = 3.36\cdot 10^{15} m^2/s^3$. Then to root in Eq.(5) will be equal to unit. However the substitution half axes and periods for the eight planet of Solar System shows that it is not so and the third Kepler's law not fulfills because in all cases half big axis a is greater then B.

Table *1*

Planet	a (ml n. km)	T (days)	B (mln km)
Mercury	57.9	0.24	20.04
Venus	108.2	0.62	45.48
Earth	149.6	1.0	21.89
Mars	227.9	1.88	48.95
Jupiter	778.6	11.86	203.1
Saturn	1433.5	29.46	584.3
Uranus	2876.7	84.01	1010.7

Neptune	4503.4	164.79	1409.7

It must be noted that only Venus which has the least eccentricity the radical expression is negative. The data in Table 1 shows that the spread of values is very big. However, it is obviously that the giant planets give the big value for B because of their big masses which occurs the significant distortions to the geometry of hypersurface from which Eq.(2) is obtained. Therefore we take the mean arithmetic value among th planet of Earth group for the beginning and calculate the values of parameters k and σ :

$$B = 34.1 \cdot 10^{6}\,км$$
$$k = 1.71 \cdot 10^{9}\,кг/м^{2}$$
$$\sigma = 3.1 \cdot 10^{7}\,кг/м\,c^{2}$$

To be confident that the value for parameter B is chosen properly let us consider to the expression determined the distance where the sign of mean curvature is changing under supposition of spherical Universe:

$$r_0 = \sqrt[7]{\frac{2}{3} b^6 R_0} \qquad (6)$$

Here R_0 is radius of Universe that is got to be equal to the Hubble distance $1.5 \cdot 10^{23}\,km$. For the size of Sun 4-whirl b=B Eq.(6) gives 5.5 bln km, the distance for the Kuiper belt where the Pluto is situated.

Table 2

Planet	b, thn km	r_0 , mln km	r_1 , mln km	r_a , mln km
Mercury	13.9	6.86	30.7	34.8
Venus	53.3	21.75	75.3	90.4
Earth	59.1	23.75	80.6	96.8
Mars	19.4	9.19	38.3	46.0
Jupiter	1053.5	280.5	550.1	660.6
Saturn	576.4	167.3	368.0	442.0
Uranus	225.2	74.8	196.7	366.2
Neptune	244.7	80.3	207.8	249.6

Because the orbit of Mercury is not so far from the size of Sun's whirl, one can suppose that this circumstance is the cause of spin-orbit resonance 3:2 that keeps the planet close to Sun. The most of satellites of giant planets are also captured by the gravitation of planet so that they are look on them only one side being in resonance 1:1. However, the Moon, Callisto, the satellite of Jupiter, and Titan, the satellite of Saturn, being on the far distances then their whirl sizes, are also captured. On the other hand, there are no satellites on too far distances. E.g. the most far satellite of Jupiter is on 30 mln km. It tells us that the region of capturing is not exceeded r_0 .

The Eq.(6) was obtained from the expression for mean curvature, cause by Sun's whirl with consideration of spherical form of Universe. Here it is

$$H=\left(\frac{3}{R_0}-2\frac{r^2}{R_0^3}+6\frac{b^4}{R_0 r^4}-6\frac{b^2}{R_0^2 r}-\frac{2b^6}{r^7}\right)/\sqrt{\left(1+\left(\frac{r}{R_0}-\frac{b^2}{r^2}\right)^2\right)^3} \quad (7)$$

At $R_0 \to \infty$, when the World is flat, H is negative everywhere. So the hypersurface is concave in every its point in the flat World. The most precise accounting shows that the change of sign occurs at even more distance the it was given above, at 6.9 bln km that are also in the region of Kuiper belt. Behind r_0 the action of gravitational force is not halted and the next peculiarity of function H(r) occurs when the second and third terms equated in Eq.(7). It gives

$$r_2=\sqrt[3]{\sqrt{3}\,b^2 R_0} \quad (8)$$

For b=B this formula yields $6.8\cdot 10^{12}\,km=45000\,AU$. It corresponds to the lower value of distance to the Oort cloud that is situated between 50 000 and 100 000 AU from Sun. The equality of third and fourth terms brings to a few less distance

$$r_1=\sqrt[3]{b^2 R_0} \quad (9)$$

that gives $5.7\cdot 10^{12}\,km$ for Sun's whirl. These two values show that coefficient k must be a little lower to correspond the size of Oort cloud. For example the value $k=10^9\,kg/m^2$ gives $r_1=44\,000\,AU$ and $r_2=53\,000\,AU$. Then the size of the Sun's whirl B obtains the most close meaning to the value for Venus pointed out in Table 1, $4.46\cdot 10^6\,km$.

The sizes of orbits of the planets

It turns out that the last value of k and appropriate values of sizes of 4-whirl of the planets fits for the rough estimation of the some semi-major axes a of the planet orbits. For this purpose it is suggested the simple expression that gives the mean distance form Sun to planet using calculated values of r_0 and the distance for the previous planet

$$a_{calc}^{i+1}=a_a^i+r_0^i+r_0^{i+1} \quad (10)$$

where upper index points on the sequence number of the planet. It gives rather good compliance for the planets of Earth group. The orbit of Mars is exception because of the influence of Jupiter. Zones of influence of Earth and Venus are overlapping. The giant planet, except Saturn, don't satisfy the rule (10), as it shown on the figure below. Such arrangement may tell us that Uranus and Neptune are situated in more spare state and depends from the gravitation of Sun but not from Jupiter and Saturn. As for Jupiter itself, its dropping out from the rule supports the known suggestion that between him and Mars should be planet Phaethon that disintegrated to the asteroid belt the three zones of which are shown by dotted lines on figure.

The "length of electron" and the density

Also one can give the rough value of density of matter in model suggested. For this purpose we consider the structure of 4-whirl for the least particle - electron. At the rather high "depth", at great distance from border hypersurface, it is the 4D cylinder with radius $b_e=\sqrt{m_e/k}=10^{-20}m$. We accept that the velocity of the walls of 4-whirl for electron reaches the most high value of light speed c. Form the Euler equation in the stationary regime for 4D matter it is follows that acceleration caused by the hypersurface pressure must be balanced by the centrifugal acceleration, i.e.

$$\partial_r\left(\frac{2\sigma}{\rho_4 r}\right)+\frac{c^2}{r}=0 \qquad (11)$$

From this we obtain

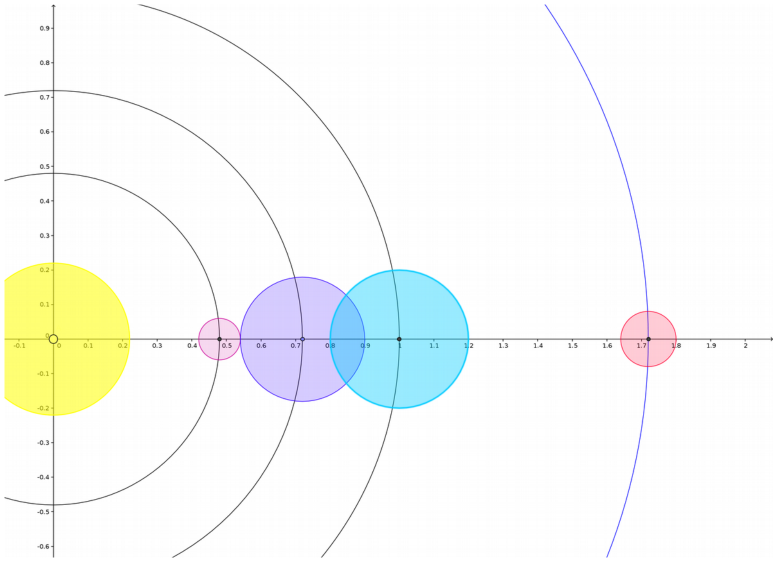
$$\rho_4=\frac{2\sigma}{b_e c^2}=7.8\cdot 10^9 kg/m^4 \qquad (12)$$

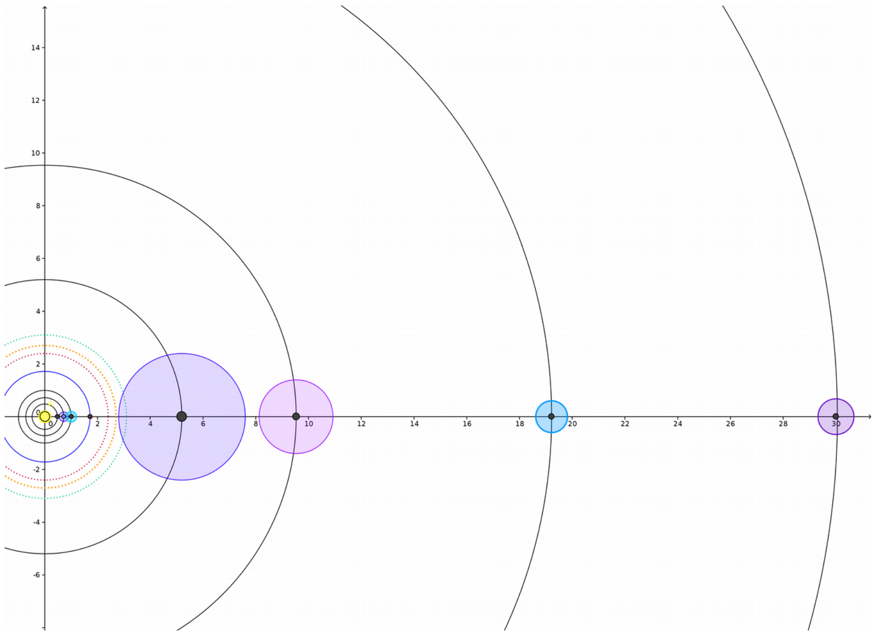
Then it is no hard to calculate the length of electron 4-whirl. For this purpose we divide the 4D volume of the hollow interior of electron whirl

$\Omega=\frac{m_e}{\rho_4}=1.2\cdot 10^{-40}m^4$ to the 3D volume of the cross section and get a enormous value $L_e=\frac{\Omega}{4\pi r_e^3/3}=1.0\cdot 10^{18}m$

The light would go this enormous distance for 107 years but it is infinitely small compared with the size of the Universe appreciated as 13.5 bln ly.

On the other hand, we can evaluate the 4D volume by the following. The coefficient σ can be presented in the units of energy as J/m^3 . The potential energy of vortex tube of radius b_e is equal to $U=2\sigma/b_e=6.7\cdot 10^{26}J/m^4$. Let us suppose that the virial theorem is valid for electron in the form presented above and its potential energy is composted the half of total energy of the electron at rest $E_e=0.511\,MeV=8.19\cdot 10^{-20}J$. So we can calculate the 4D volume that much less the we got above $\Omega=E_e/(2U)=6.1\cdot 10^{-47}m^4$ It gives us the much less value of the length of electron close to the mean lifetime of neutron $L_e=5.4\cdot 10^{11}m$ It needs only $t_e=L_e/c=1810\,s$ to pass for light.





The planets of Earth group are shown on upper picture. By yellow color it is shown the region of the Sun with radius B. Other colored circles are correspond to the regions of radius r_0 *around planets. On the low picture are the giant planets. The data from Table 3 is used.*

Therefore we ought to conclude that the last calculation is more reliable and the density of 4D matter is still to be reevaluate. In particular it is so because if we use obtained density to appreciate the mass of Universe, we get the value much bigger then values cited in literature [4], $10^{53}kg$:

$$M_0 = \frac{1}{2}\rho_4 \pi^2 R_0^4 = 1.8\cdot 10^{105} kg \qquad (13)$$

Conclusion

Thus the most agreeable values for characterize 4D matter ought to acknowledge the following ones

$$k = 10^9 kg/m^2$$
$$\sigma = 1.06\cdot 10^7 kg/m s^2$$
$$\rho_4 = 7.8\cdot 10^9 kg/m^4$$

Again it worth to note that the parameter for Sun's whirl gotten under given value of k is exactly correspond to the value of B in Table 1 given for Venus. It can tell us that her almost round orbit fits Eq.(4) in the best degree.

Accepting these values the parameters of the planets in Table 2 are changing to some degree and are presented in Table3. In the third column it is shown the ratio of size of the planet 4-whirls to the its radius. For Sun this ratio is equal to 64. It exceeds only for 3.3 times this factor for Jupiter. For all other planets it exceeds for approximately 5 times except Mercury and Mars for which it exceeds for 8 times. For Moon the ratio above mentioned is equal to 5.

Table 3

Planet	b, thn km	B/R	r_0 , mln km
Mercury	18.1	7.4	23.2
Venus	69.8	11.5	27.4
Earth	77.3	12.1	29.9
Mars	25.3	7.5	11.5
Jupiter	1377.9	19.2	253
Saturn	753.9	12.5	211
Uranus	294.6	11.5	94
Neptune	320.0	12.9	101

For neutron star [5] which has twice Sun mass and radius about 13 km the ratio is much greater, 4 800 000.

Electron has the ratio 230 of its whirl size b_e to the size of electron r_e measured by Demelt on the Penning trap, $10^{-22}m$ [6]. Thus one may say that the ratio b/r determine not only the class of celestial objects but the more wide class of objects of our World.

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