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Kepler's Third Law in celestial mechanics, in electromagnetism and in cosmology. The Universe Formula.

Abstract. *From the coincidence of large numbers on a scale of 10^180, an unusual equation is obtained that combines the parameters of the Universe in the form of Kepler's Third Law. The equation combines 4 parameters of the universe: mass, radius, time and Newtonian constant of gravitation G. Instead of the parameters of the planet orbit, the equation includes the parameters of the universe in the form of Kepler ratio R^3/T^2. From the coincidence of large numbers on scales of 10^160, 10^120, 10^40, an equation is obtained that combines the parameters of the electron in the form of Kepler's Third Law. The equation unifies the 4 parameters of the electron: mass, classical radius, time, and electric charge. These equations show that the limits of applicability of Kepler's Third Law extend far beyond the mechanics of planets. The description of the mechanism of planetary motion is only a special case of the application of Kepler's law. Kepler's Third Law in the cosmological equation and Kepler's Third Law in the equation of electromagnetism reveal the universal character of this law. Kepler's Law applies not only to the planets, but also to the universe and even to the electron. Kepler's Third Law acquires the status of the most important law of physics and cosmology. Full disclosure of its role and place in electromagnetism and cosmology will provide answers to many unsolved problems of physics and cosmology. Kepler's Third Law is a major contender for a basic law for the new physics.*

Keywords: *large numbers, cosmological equations, Kepler's Third Law, electron, parameters of the observed Universe, Newtonian constant of gravitation G.*

1. Introduction

Kepler's Third Law in astronomy is given the role of an empirical relation for describing an idealized planetary orbit. It is believed that the boundary of applicability of Kepler's Third Law does not extend beyond the mechanics of solar system objects. Newton made a generalization of Kepler's Third Law. He introduced mass into Kepler's equation. But Newton's law of gravity leaves Kepler's law within the framework of celestial mechanics. Since then, for many centuries, Kepler's law has been considered to be the one that describes the idealized orbit of a planet.

From the coincidence of large numbers on a scale of 10^{180}, a cosmological equation is derived that unifies the parameters of the universe in the form of Kepler's Third Law. This is an unexpected result since the orbital motion of the planets and the expansion of the Universe are not comparable. The cosmological equation in the form of Kepler's Third Law shows the universality of Kepler's law. The universality of Kepler's law is that the Kepler ratio is true not only for the planets but also for the Universe as a whole. In addition, it is revealed that the Kepler ratio is included in the equation of electromagnetism, which combines 4 parameters of the electron: mass, classical radius, time, electric charge. Such an unexpected appearance of Kepler's law in the equation of the Universe and in the equation of electromagnetism makes us reconsider the limits of applicability of Kepler's Third Law.

2. The law of scaling of large numbers

The revealed regularities of the formation of large numbers, which follow from the relations of the dimensional parameters of the Universe, allowed us to derive the law of scaling of large numbers [1]. The law of scaling of large numbers has the form (Fig. 1):

$$D_i = (D_{20})^i = (\sqrt{\alpha D_0})^i$$
$$i = 0, \pm1, \pm2, \pm3, \pm4, \pm5, \pm6, \pm7, \pm8, \pm9$$

Fig. 1. The scaling law of large numbers. D_0 is a large Weyl number ($D_0 = 4.16561... \text{x } 10^{42}$), α - fine structure constant.

The scaling law provides a new method for calculating the values of large numbers. Its advantage is that large numbers are obtained from dimensionless constants. The scaling law generates large numbers up to scale 10^{180} with high accuracy. The large numbers obtained from the scaling law are close to the accuracy of the Newtonian constant of gravitation G. This makes it possible to obtain by mathematical method the parameters of the Universe with high accuracy close to the accuracy of the Newtonian constant of gravitation G. The values of the large numbers and the formulas for their calculation are given in Fig. 2.

$$(\sqrt{\alpha D_0})^0 = 1$$
$$D_{20} = (\sqrt{\alpha D_0})^1 = 1.74349... \bullet 10^{20}$$
$$D_{40} = (\sqrt{\alpha D_0})^2 = 3.03979... \bullet 10^{40}$$
$$D_{60} = (\sqrt{\alpha D_0})^3 = 5.29987... \bullet 10^{60}$$
$$D_{80} = (\sqrt{\alpha D_0})^4 = 9.24033... \bullet 10^{80}$$
$$D_{100} = (\sqrt{\alpha D_0})^5 = 16.1105... \bullet 10^{100}$$
$$D_{120} = (\sqrt{\alpha D_0})^6 = 28.088... \bullet 10^{120}$$
$$D_{140} = (\sqrt{\alpha D_0})^7 = 48.972... \bullet 10^{140}$$
$$D_{160} = (\sqrt{\alpha D_0})^8 = 85.383... \bullet 10^{160}$$
$$D_{180} = (\sqrt{\alpha D_0})^9 = 148.86... \bullet 10^{180}$$

FIG. 2. Large numbers and formulas for their calculation from the law of scaling large numbers.

The table in Fig. 3 summarizes the relations of dimensional quantities that lead to large numbers.Many coincidences of large numbers make it possible to derive new cosmological equations.

Ratios of dimensional constants	Scale
$\frac{Gm_e^2}{r_e\alpha^2\hbar H}=\frac{G\hbar}{r_e^3Hc^2}=\frac{Gm_e}{r_e^2\alpha Hc}=\frac{Gm_e^3c}{\alpha^3\hbar^2H}=\frac{c^2}{M_UR_UG\Lambda}=\frac{c^3}{M_UGH}=\frac{c^2R_U}{M_UG}=\frac{l_{Pl}^4}{\Lambda r_e^6}=$ $=\frac{c^3T_U}{M_UG}=\frac{\Lambda c^2}{H^2}=\frac{c^3T_U^3}{R_U^3}=\frac{H^2}{M_UR_UG\Lambda^2}=.\frac{cr_e^3A_0}{G\hbar}=\frac{c^4}{M_UR_UH^2G}=\frac{M_UR_UHA_0G}{c^5}=1$	10^0
$D_{20}=\frac{r_e}{l_{Pl}}=\frac{t_0}{t_{Pl}}=\frac{\alpha\, m_{Pl}}{m_e}=\frac{cl_{Pl}}{r_e^2H}=\frac{l_{Pl}R_U}{r_e^2}=\frac{c^2l_{Pl}}{r_e^2A_0}=\sqrt{\alpha D_0}$	10^{20}
$D_{40}=\frac{T_U}{t_0}=\frac{R_U}{r_e}=\frac{m_ec^2}{\alpha\hbar H}=\frac{1}{t_0H}=\frac{r_e^2}{l_{Pl}^2}=\frac{t_0^2}{t_{Pl}^2}=\frac{\alpha^2m_{Pl}^2}{m_e^2}=\frac{m_ec^3 4\pi\varepsilon_0}{He^2}=\frac{c^2}{r_eA_0}=(\sqrt{\alpha D_0})^2$	10^{40}
$D_{60}=\frac{T_U}{t_{Pl}}=\frac{R_U}{l_{Pl}}=\frac{M_U}{m_{Pl}}=\frac{c}{l_{Pl}H}=\frac{r_e^3}{l_{Pl}^3}=\frac{t_0^3}{t_{Pl}^3}=\frac{c^3}{Gm_{Pl}H}=\frac{c^2}{l_{Pl}A_0}=(\sqrt{\alpha D_0})^3$	10^{60}
$D_{80}=\frac{R_U^2}{r_e^2}=\frac{HM_U^2\alpha G}{c^3m_e}=\frac{c^2}{r_e^2H^2}=\frac{cr_e}{Hl_{Pl}^2}=\frac{1}{r_e^2\Lambda}=(\sqrt{\alpha D_0})^4$	10^{80}
$D_{100}=\frac{m_ec^3}{l_{Pl}\alpha\hbar H^2}=\frac{r_e\alpha M_U}{l_{Pl}m_e}=\frac{HM_U^2\alpha Gr_e}{c^3m_el_{Pl}}=\frac{R_U^2}{r_el_{Pl}}=\frac{1}{r_el_{Pl}\Lambda}=(\sqrt{\alpha D_0})^5$	10^{100}
$D_{120}=\frac{T_U^2}{t_{Pl}^2}=\frac{R_U^2}{l_{Pl}^2}=\frac{M_U^2}{m_{Pl}^2}=\frac{c^2}{l_{Pl}^2H^2}=\frac{R_U^3}{r_e^3}=\frac{M_Uc^2}{\hbar H}=\frac{GM_U^2}{\hbar c}=\frac{c^5}{G\hbar H^2}=\frac{c^3}{G\hbar\Lambda}=\frac{1}{l_{Pl}^2\Lambda}=(\sqrt{\alpha D_0})^6$	10^{120}
$D_{140}=\frac{r_e^2m_ec^3}{l_{Pl}^3\alpha\hbar H^2}=\frac{r_e^3\alpha M_U}{l_{Pl}^3m_e}=\frac{R_U^3}{l_{Pl}r_e^2}=\frac{1}{t_{Pl}t_0^2H^3}=\frac{c}{l_{Pl}r_e^2H\Lambda}=\frac{c^2}{l_{Pl}r_e^2A_0\Lambda}=(\sqrt{\alpha D_0})^7$	10^{140}
$D_{160}=\frac{M_UR_Uc^2\alpha^2}{Gm_e^2}=\frac{M_U^2R_UG\alpha}{c^2r_e^2m_e}=\frac{1}{r_e^4\Lambda^2}=(\sqrt{\alpha D_0})^8$	10^{160}
$D_{180}=\frac{r_e^4m_ec^3}{l_{Pl}^5\alpha\hbar H^2}=\frac{r_e^5\alpha M_U}{l_{Pl}^5m_e}=\frac{R_U^3}{l_{Pl}^3}=\frac{c^3}{l_{Pl}^3H^3}=\frac{c}{l_{Pl}^3H\Lambda}=\frac{c^2}{l_{Pl}^3A_0\Lambda}=\frac{GM_UT_U^2l_{Pl}}{\Lambda r_e^6}=(\sqrt{\alpha D_0})^9$	10^{180}

Fig. 3. Set of coincidences of large numbers. M_U is the mass of the observable Universe, α is the fine structure constant, ħ is Planck's constant, G is the Newtonian gravitational constant, Λ is the cosmological constant, R_U is the radius of the observable Universe, T_U is the time of the Universe, H is the Hubble constant, A_0 is the cosmological acceleration, r_e is the classical radius of the electron; c - speed of light in vacuum; $t_0 = r_e/c$, m_e - electron mass, D_0 - large Weyl number, t_{pl} - Planck time, l_{pl} - Planck length, m_{pl} - Planck mass.

3. The Universe Formula.

From the coincidence of large numbers on a scale of 10^{180} we obtained an equation linking 4 parameters of the Universe: mass, radius, time, Newtonian constant of gravitation G:

$$\mathbf{GM_UT_U^2 = R_U^3} \quad (1)$$

where: M_U is the mass of the observable Universe, G is the Newtonian gravitational constant, R_U is the radius of the observable Universe, T_U is the time of the Universe. From this equation follows the formula (Fig. 4) for the Newtonian constant of gravitation G:

$$G = \frac{R_U^3}{M_U T_U^2} \qquad (2)$$

Fig. 4. Formula of the Universe. M_U - mass of the observable Universe; R_U - radius of the observable Universe; T_U - time of Universe.

Formula (2) contains the parameters of the Universe and is close to the known equation, which follows from the combination of Kepler's Law and Newton's Law of Gravitation for the motion of planets in a circular orbit:

$$G = \frac{4\pi^2 R^3}{MT^2} \qquad (3)$$

The difference between equation (2) and equation (3) is that instead of frequency in radians per second, frequency in Hz is used. Other differences are that instead of the mass of the planet, the formula includes the mass of the Universe, and instead of the parameters of the orbit of the planet, the parameters of the Universe are used. The obtained formula (2) is Kepler's law as applied to the Universe. In this case. the formula (2) includes Kepler ratio R^3/T^2 is not the orbit parameters. but the Universe's own parameters. Contrary to the established opinion about the boundary of applicability of Kepler's law to the mechanics of planets, we see the applicability of the law to an object that has no orbital motion. This is not the only example of extending the applicability of Kepler's law.

Kepler's law is included in the formula Newtonian constant of gravitation G (Fig. 5), represented by means of electron constants [2]:

$$G = \frac{r_e^3}{t_0^2 m_e D_0} \qquad (4)$$

Fig. 5. Newtonian constant of gravitation G, represented by the electron constants and a large Weyl number. r_e - classical electron radius; $t_0 = r_e/c$; c - speed of light in vacuum; m_e - electron mass; D_0 is a large Weyl number ($D_0 = 4.16561... x\ 10^{42}$).

Formula (4) includes the Kepler ratio, represented as r_e^3/t_0^2. r_e^3/t_0^2 is the Kepler ratio for the electron. Planets and electrons are too different objects. But the Kepler ratio is valid for the intrinsic parameters of such different objects.

Kepler's law is used in [3] for gravitational interaction in atoms. The formula for the hydrogen atom also contains Kepler ratio [3]. These are not all examples demonstrating the universality of Kepler's law. Kepler's 3rd law found itself in the equation of electromagnetism.

4. Kepler's Third Law in the equation of electromagnetism

From the coincidence of large numbers on scales 10^{160}, 10^{120}, 10^{40} follows the equation relating the mass of the electron to the electric charge:

$$e^2 = m_e \bullet \frac{r_e^3}{t_0^2} \bullet 4\pi\varepsilon_0 \qquad (5)$$

where: e is the electric charge of the electron, m_e is the electron mass, r_e is the classical radius of the electron, $t_0 = r_e/c$, c is the speed of light in vacuum.

Formula (5) includes the Kepler ratio for the electron, represented as r_e^3/t_0^2. The electric charge and mass of the electron are related through the Kepler ratio. For planets, Kepler's law includes orbital parameters.For the Universe, Kepler's law includes the parameters of the Universe in the form of the $\mathbf{R_U^3/T_U^2}$ relation.For the electron, Kepler's law includes the parameters of the electron in the form of the ratio r_e^3/t_0^2.

5. Standard gravitational parameter of the Universe.

Formula (2) includes 4 basic parameters of the Universe $\mathbf{M_U, R_U, T_U, G}$. Other parameters of the Universe (Λ, A_0, H) are secondary parameters. They are calculated using the R_U and T_U parameters:

$$\mathbf{\Lambda T_U^2 = 1/c^2; \qquad A_0 T_U = c\ ; \qquad HR_U = c; \qquad \Lambda H^2 R_U^2 T_U^2 = 1} \qquad (6)$$

where: Λ is the cosmological constant, R_U is the radius of the observable Universe, T_U is the time of the Universe, H is the Hubble constant, A_0 is the cosmological acceleration, c is the speed of light in vacuum.

Equation (2) can be written in the form (Fig. 6):

$$\mu_U = GM_U = \frac{R_U^3}{T_U^2} = 7.69868...\text{x } 10^{42}\ m^3s^{-2} \qquad (7)$$

Fig. 6. Standard gravitational parameter of the Universe.

The product of GM_U is called the Standard gravitational parameter of the Universe. The Standard gravitational parameter of the Universe is equal to the Kepler relation for the universe. Here we use the concept of "*gravitational parameter of the Universe*", which was first introduced by Haug E. G. [4].

Coincidences of large numbers allow us to obtain equivalent formulas for the Standard gravitational parameter of the Universe. Fig. 7 shows 12 equivalent formulas.

$$\boldsymbol{\mu}_{\mathbf{U}} = \left\{ \begin{matrix} GM_U, & \dfrac{R_U^3}{T_U^2}, & \dfrac{A_0}{\Lambda}, & \dfrac{R_U^3 A_0^2}{c^2}, \\ c^2 R_U^3 \Lambda, & R_U^3 H^2, & \dfrac{R_U H^2}{\Lambda}, & c^2 R_U, \\ \dfrac{r_e^3 \alpha D_0}{t_0^2}, & c^3/H, & \dfrac{Hc}{\Lambda} & \dfrac{A_0 c^2}{H^2}. \end{matrix} \right\} = \mathbf{7.69868...x\ 10^{42}\ m^3 s^{-2}}$$

Fig. 7. Equivalent formulas for calculating the standard gravitational parameter of the Universe. M_U is the mass of the observable Universe, α is the fine structure constant, G is the Newtonian gravitational constant, Λ is the cosmological constant, R_U is the radius of the observable Universe, T_U is the time of the Universe, H is the Hubble constant, A_0 is the cosmological acceleration, r_e is the classical radius of the electron; c is the speed of light in vacuum; $t_0 = r_e/c$, D_0 is the large Weyl number.

All formulas give the same value of the Standard Gravitational Parameter of the Universe, equal to the Kepler relation for the Universe.

$$\boldsymbol{\mu}_{\mathbf{U}} = GM_U = \frac{R_U^3}{T_U^2} = \frac{A_0}{\Lambda} = \frac{R_U^3 A_0^2}{c^2} = c^2 R_U^3 \Lambda = R_U^3 H^2 = \frac{R_U H^2}{\Lambda} = c^2 R_U =$$
$$= \frac{r_e^3 \alpha D_0}{t_0^2} = c^3/H = \frac{Hc}{\Lambda} = \frac{A_0 c^2}{H^2} = 7{,}69868...\text{x}\ 10^{42}\ \text{m}^3\text{s}^{-2} \qquad (8)$$

The standard gravitational parameter of the Universe can be represented by means of the Kepler ratio for the electron and the large scale number 10^{40}

$$\mu_U = GM_U = \left(\frac{r_e^3}{t_0^2}\right) \bullet (\alpha D_0) = 7.69868... \bullet 10^{42} m^3 s^{-2} \qquad (9)$$

Formula (9) shows that the Kepler ratio for the Universe (R_U^3/T_U^2) is the scaled Kepler ratio for the electron (r_e^3/t_0^2). The scaling factor is the large number $D_{40} = 3.03979...$ x 10^{40} (Fig. 2).

6. Standard gravitational parameter of the electron.

The product Gm_e is called the Standard gravitational parameter of the electron.

$$\mu_e = Gm_e = \frac{r_e^3}{t_0^2 D_0} = 0.607987... \bullet 10^{-40} m^3 s^{-2} \qquad (10)$$

Fig. 8 shows 9 equivalent formulas for the Standard gravitational parameter of the electron.

$$\mu_e = \left\{ \begin{matrix} Gm_e, & \dfrac{r_e^3}{t_0^2 D_0}, & \dfrac{c^2 r}{D_0}, \\ \dfrac{m_e c^5 t_{Pl}^2}{\hbar}, & \dfrac{c^4 m_e}{F_0 D_0}, & \dfrac{\hbar c m_e}{m_{Pl}^2}, \\ \dfrac{\alpha\hbar c}{m_e D_0}, & \dfrac{c^3 r_e^2 m_e}{\alpha\hbar D_0}, & \dfrac{c^3 l_{Pl}^2 m_e}{\hbar}. \end{matrix} \right\} = \mathbf{0.607987\ldots x\ 10^{-40}\ m^3s^{-2}}$$

Fig. 8. Equivalent formulas for calculating the Standard gravitational parameter of the Universe. G is the Newtonian gravitational constant, F_0 is the force constant, α is the fine structure constant, ħ is Planck's constant, r_e is the classical radius of the electron; c is the speed of light in vacuum; $t_0 = r_e/c$, me is the electron mass, D_0 is the large Weyl number, t_{pl} is Planck time, l_{pl} is Planck length, m_{pl} is Planck mass.

7. Dimensionless Kepler ratios for the Universe and the electron

The obtained Kepler ratios for the universe R_U^3/T_U^2 and Kepler ratios for the electron r_e^3/t_0^2 set the range of possible Kepler ratios. The range occupies the region from elementary particles to the Universe. In between R_U^3/T_U^2 and r_e^3/t_0^2 is the Kepler ratio for elementary particles, atoms, planets, and galaxies.

Kepler ratio is conveniently represented by dimensionless quantities. In dimensionless units, the Kepler ratio for the Universe is equal to one:

$$\phi_U = \mathbf{GM_U/(R_U^3/T_U^2) = 1} \qquad (11)$$

In dimensionless units, the Kepler ratio for the electron is:

$$\phi_e = \mathbf{Gm_e/(r_e^3/t_0^2) = 2.4006}\ldots x\ 10^{-43} \qquad (12)$$

Between ϕ_U and ϕ_e are numbers for elementary particles, atoms, planets, galaxies. Within this range is the dimensionless Kepler ratio for our galaxy and for the planets of the solar system [5].

8. The main law of physics and cosmology.

Thus, Kepler's Third Law has many "professions". The Kepler ratio enters both the mechanic's equations and the equations of electromagnetism. This law describes the motion of the planets. It is an integral part of Newton's law of gravity. Kepler's Third Law is part of the cosmological equation of the universe. Kepler's Third Law relates the electric charge and mass of an electron. These are equations of different nature: the cosmological equation of the Universe, the electromagnetism equation for the electron, the law of motion of the planets, the equation for Newtonian constant of gravitation G. The universality of Kepler's law puts it in the rank of the main law of physics and cosmology. Such involvement of one physical law in phenomena of different nature requires deep study. No other physical law has such universality!

9. Conclusion

The limits of applicability of Kepler's Third Law go far beyond the mechanics of planets. The description of the mechanism of planetary motion is only a special case of the application of Kepler's Law. The potential of Kepler's Third Law has not been fully realized. Newton's generalization of

Kepler's law only partially revealed the potential of Kepler's Third Law. This law has a universal character. The application of Kepler's Third Law to electromagnetism and cosmology is next. In electromagnetism, the nature of electric charge is not revealed. Kepler ratio relates the electric charge and mass of an electron. In cosmology, Kepler's law can lead to the solution of the Hubble voltage problem and the problem of the cosmological constant.

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