ГРАВИТАЦИЯ И КОСМОЛОГИЯ

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THE THEORETICAL FORMULAE FOR CALCULATION OF THE GRAVITATIONAL CONSTANT AND PLANCK UNITS

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The theoretical formulae for calculation of gravitational constant *G* and Planck mass, length and time are obtained. From formula it follows, that the Planck mass is only invariant mass (or rest mass) of the Planck elementary particle. The energy of this particle increases with velocity according to special relativity. Planck length and time change with velocity too.

Key words: gravitational constant, Planck mass, Planck length, Planck time, mass of electron, special relativity.

The value of the gravitational constant *G* is known to be determined with low accuracy, that is in striking contrast with other constants. It is due to the significant difficulties in experimental determination of this value. According to CODATA [1], the most exact experimental value makes:

$$G_{exp} = (6.673 \pm 0.010) \cdot 10^{-11} \mathrm{m^3 \cdot s^{-2} \cdot kg^{-1}}. \quad (1)$$

The theoretical formula, allowing the value *G* calculation with higher accuracy, until now was not known. We offer such formula.

Let us consider the correlation

$$m_{pl} = \text{б}^{-12} \cdot \frac{m_e^2}{m_p} = \text{б}^{-12} \cdot m_x, \quad (2)$$

where $\text{б} = e^2 / \hbar c$, m_{pl} is Planck mass, m_e is mass of electron, m_p is mass of proton, $m_x = m_e^2 / m_p = 278.3 \mathrm{eV}$.

Proceeding from the CODATA data [1], $\text{б} = 7.297352533(27) \cdot 10^{-3}$, $c = 299\,792\,458 \mathrm{\,m \cdot s^{-1}}$, $\hbar = 1.054571596(82) \cdot 10^{-34} \mathrm{\,J \cdot s}$, $m_p / m_e = 1836.1526675(39) \mathrm{\,kg}$, $m_e = 9.10938188(72) \cdot 10^{-31} \mathrm{\,kg}$ we obtain

$$m_{pl} = 2.1756858 \cdot 10^{-8} \mathrm{\,kg}.$$

According to CODATA, $m_{pl\,(CODATA)} = 2.1767(16) \cdot 10^{-8}$. The value, obtained by formula (2), is in a good agreement with CODATA.

From formula $m_{pl} = \sqrt{\hbar c / G}$ and correlation (2) we obtain a formula

$$G = \frac{\hbar c}{m_{pl}^2} = \hbar c \cdot \text{б}^{24} \cdot \frac{m_p^2}{m_e^4} \quad (3)$$

and a value

$$G = 6.6788915(22) \cdot 10^{-11} \mathrm{\,m^3 \cdot s^{-2} \cdot kg^{-1}}. \quad (4)$$

From formula (2) it follows such values of the Planck units:

$$m_{pl} = 2.1756858(5) \cdot 10^{-8} \mathrm{\,kg},$$
$$l_{pl} = 1.6168107(3) \cdot 10^{-35} \mathrm{\,m}, \quad (5)$$
$$t_{pl} = 5.3930999(1) \cdot 10^{-44} \mathrm{\,s}.$$

CODATA gives such values:

$$l_{pl\,(CODATA)} = 1.6160(12) \cdot 10^{-35} \mathrm{\,m},$$
$$t_{pl\,(CODATA)} = 5.3906(40) \cdot 10^{-44} \mathrm{\,s}.$$

From formula (2) it follows, that the Planck mass is only invariant mass (or rest mass) m_0 of the Planck elementary particle, $m_{pl} = m_0$, $E_{pl} = m_{pl} \cdot c^2 = m_0 \cdot c^2$, if velocity of the Planck particle is $v = 0$. Then

$$б^{-12} \cdot \frac{m_e^2}{m_p} \cdot \frac{1}{\sqrt{1-в^2}} = \frac{m_{pl}}{\sqrt{1-в^2}} = \frac{E_{pl}}{c^2 \cdot \sqrt{1-в^2}} = \sqrt{\frac{\hbar c}{G(1-в^2)}}, \quad (6)$$

$в = v/c$.

From $m_e^2 c^4 = e_e^2 - p_e^2 c^2$ it follows

$$m_{pl}^2 c^4 = \tilde{e}_{pl}^2 - \tilde{p}_{pl}^2 c^2 \quad (7)$$

$$G_e = G_N (1-в^2),$$

$$G_e \sim 1/e_e^2,\ G_p \sim 1/p_e^2. \quad (8)$$

Then

$$G_N^{-1} = G_e^{-1} - G_p^{-1}, \text{ where } G_p = G_e \cdot \frac{c^2}{v^2}, \quad (9)$$

$$\text{or } G_N = G_t - G_x, \text{ where } G_t = \frac{G_N}{1-в^2},\quad G_x = \frac{в^2 G_N}{1-в^2}. \quad (10)$$

Then

$$G_e \cdot G_t = G_p \cdot G_x = G_N^2. \quad (11)$$

for $\hbar = const$, $c = const$.

$$l'_{pl} = \sqrt{\frac{G'\hbar}{c^3}} = \sqrt{\frac{G(1-в^2)\hbar}{c^3}} = l_{pl}\sqrt{1-в^2}; \quad (12)$$

$$t'_{pl} = \frac{l'_{pl}}{c} = t_{pl}\sqrt{1-в^2} \quad (13)$$

The change of the values G_e, G_p, l'_{pl} and t'_{pl} with velocity entails the certain changes in theories, which are based on the gravitational constant and Plank values as well as on the theory of gravity, quantum cosmology and the theory of superstrings.

References:

1. *CODATA.* http://www.codata.org .

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Теоретические формулы для вычисления гравитационной постоянной и планковских массы, длины и времени

Получены теоретические формулы для определения гравитационной постоянной *G*, планковских массы, длины и времени. Из формул следует, что известная планковская масса является только массой покоя планковской элементарной частицы. Но энергия такой частицы зависит от скорости согласно специальной теории относительности. Соответственно зависят от скорости планковские длина и время.

Ключевые слова: гравитационная постоянная, планковская масса, планковская длина, планковское время, масса электрона, специальная теория относительности.