Reducing approximate cosmological equations to exact equations

Abstract: At different times, famous scientists have proposed equations that demonstrate the relationship between cosmological parameters and fundamental physical constants. Some equations are approximate and the coincidences in them are estimated only by order of magnitude. The new large numbers on scales $10^{140}$, $10^{160}$, and $10^{180}$ derived from the scaling law allow us to bring the approximate cosmological equations to exact equations. The approximate Dirac, Teller, Eddington-Weinberg, and Rice equations are reduced to exact equations. The exact equations are obtained from the coincidence of large numbers on the scale $10^{60}$ and on the previously unknown scales $10^{140}$, $10^{160}$ and $10^{180}$.

Keywords: large numbers, Dirac equation, Teller equation, Eddington-Weinberg equation, Rice equation, cosmological parameters, parameters of the observable Universe.

1. Introduction

At different times, equations have been proposed by renowned scientists to show the relationship between cosmological parameters and fundamental physical constants. Cosmological equations have been derived from coincidences of large numbers of order $10^{40}$.

The cosmological equations linking the Hubble parameter $H$ to the Newtonian constant of gravitation $G$ are the Dirac equation [1, 2], the Stewart equation [3, 4], the Eddington-Weinberg equation [5], the Teller equation [6, 7], and the Valev equation [8, 9].

The equation relating the radius of the universe to the Newtonian constant of gravitation $G$ is the Rice equation [10].

The equation relating the cosmological constant $\Lambda$ to the Newtonian constant of gravitation $G$ is the Nottale equation [11, 12].

The equations linking the three parameters of the Universe: radius, mass, and Newtonian constant of gravitation $G$ are the equations of Milne [13, 14] and E.A. Bleksley [15].

The equations linking the three parameters of the Universe: mass, Hubble parameter and Newtonian constant of gravitation $G$ are the equations of Hoyle [16] and Carvalho [22].

Some equations are approximate and coincidences in them are estimated only by order of magnitude. For a long time it was thought that several orders of magnitude would not matter much in expressions of scale $10^{40}$ and larger.

As a result, both exact equations and approximate cosmological equations are now known. Efforts have been made to reduce the approximate equations to exact equations [17, 18, 19, 20].

The large numbers obtained from the law of scaling [21] make it possible to bring the approximate cosmological equations to exact equations.
2. The law of scaling of large numbers

The regularities of the origin 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 [21].

The law of scaling of large numbers has the form (Fig. 1):

\[
D_i = (D_{20})^i = (\sqrt{\alpha D_0})^i
\]

\[i = 0, \pm 1, \pm 2, \pm 3, \pm 4, \pm 5, \pm 6, \pm 7, \pm 8, \pm 9\]

Fig. 1. The scaling law of large numbers. \(D_0\) is a large Weyl number \((D_0 = 4.16561... \times 10^{42})\), \(\alpha\) is the 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. The values of the large numbers and the formulas for their calculation are given in Fig. 2.

![Large numbers and formulas for their calculation from the law of scaling large numbers.](image)

The table in Fig. 3 summarizes the relations of dimensional quantities that lead to large numbers. The many coincidences of large numbers make it possible to derive the cosmological equations, which include cosmological parameters and fundamental physical constants.
Fig. 3. Set of coincidences of large numbers. MU is the mass of the observable Universe, α is the fine structure constant, h 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. Exact cosmological equations.

Among the known cosmological equations, the exact equations are the Stewart equation [3, 4], the Nottale equation [11, 12], the E. A. Milne equation [13], the A. A. Milne equation. E.H. Bleksley [15], the equation of J. C. Carvalho [22].
The **GH**-equation of Stewart [3, 4] establishes the relationship between the two parameters of the universe G and H. The formula is of the form

\[
Gm_e^2 / r_e = \alpha^2 \hbar H
\]  

(1)

**GA**-equation of Nottale [11, 12] establishes the relationship between the two parameters of the universe G, Λ. The formula is of the form:

\[
c^3 / G\hbar\Lambda
\]

(2)

**GMT**-equation Milne [13] establishes the relationship between the three parameters of the universe G, M_U, T_U. The formula is of the form:

\[
M_U = c^3 T_U / G
\]

(3)

**GMR**-equation Bleksley [15] establishes the relationship between the three parameters of the Universe G, M_U, R_U. The formula is of the form:

\[
M_U = c^2 R_U / G
\]

(4)

The **GMH**-equation of Carvalho [22] establishes the relation between the three parameters of the Universe G, M_U, H. The formula is of the form:

\[
M_U = c^3 / G H
\]

(5)

4. Approximate cosmological equations that combine fundamental physical constants and parameters of the Universe.

The approximate equations are the Dirac equation [1, 2], the Eddington-Weinberg equation [5], the Teller equation [6, 7], and the James Rice equation [10].

The **GH**-Dirac equation [1, 2] is of the form:

\[
m_e c^3 / (He^2) \approx e^2 / (Gm_e^2)
\]

(6)

The **GH**-equation of Eddington-Weinberg [5] has the form:

\[
\hbar^2 H \approx Gc m_p^3
\]

(7)

The **GH**-Teller equation [6, 7] has the form:

\[
2 \frac{G\hbar H}{c^4 l_{pl}} = 2 t_{pl} H = 2 \frac{Gm_{pl} H}{c^3} \approx \exp(-1/\alpha)
\]

(8)

The **GR**-equation of James Rice [10] has the form:

\[
\frac{4\pi}{\alpha} \approx \frac{r_e c^2}{6 R_U Gm_e}
\]

(9)

5. Reducing approximate cosmological equations to exact equations

The law of scaling of large numbers allows us to reduce the approximate cosmological equations of Dirac, Eddington-Weinberg, Teller, and Rice to exact equations.
The Dirac $GH$-equation [1, 2] is an approximate equation. Earlier attempts were made to bring the Dirac equation to exact equality of the left and right parts [17, 18]. The large numbers obtained from the scaling law (Fig. 1) allow us to obtain the exact equation (Fig. 4).

<table>
<thead>
<tr>
<th>Approximate Dirac equation</th>
<th>Exact equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m_e c^3/(H e^2) \approx e^2/(G m_e^2)$</td>
<td>$m_e c^3/(H e^2) = \alpha e^2/(G m_e^2)$</td>
</tr>
</tbody>
</table>

Fig. 4. Dirac's equation reduced to exact equality.

It should be borne in mind that Dirac proposed his equation before the SI system was introduced. Therefore, when using a charge value of $1.602\ldots \times 10^{-19}$ C in the formula, $(k = c^2 10^{-7})$ must be considered.

The $GH$-equation of Eddington-Weinberg [5] does not take into account the electron mass and the fine structure constant alpha. An exact equation is obtained on a scale of $10^{40}$ (Fig. 5). The same exact equation was obtained in [19, 20].

<table>
<thead>
<tr>
<th>Approximate Eddington-Weinberg equation</th>
<th>Exact equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hbar^2 H \approx G c m_p^3$</td>
<td>$\hbar^2 \alpha^3 = G c m_e^3$</td>
</tr>
</tbody>
</table>

Fig. 5. Eddington-Weinberg equation reduced to exact equality.

The $GH$-equation of Teller [6] is an approximate equation. From the coincidence of large numbers on scales $10^{60}$, $10^{120}$ and $10^{180}$, the exact equation is obtained (Fig. 6).

<table>
<thead>
<tr>
<th>Approximate Teller's equation</th>
<th>Exact equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2 \frac{\hbar H}{c^4 l_p} = 2 t_p H = 2 \frac{G m_p H}{c^3} \approx \exp(-1/\alpha)$</td>
<td>$\frac{\hbar H}{c^4 l_p} = t_p H = \frac{G m_p H}{c^3} = (\sqrt{\alpha D_c})^{-3}$</td>
</tr>
</tbody>
</table>

Fig. 6. E. Teller equation reduced to exact equality.

The GR-equation of Rice [10] is an approximate equation. At a scale of $10^{60}$, the exact equation is obtained (Fig. 7).

<table>
<thead>
<tr>
<th>Approximate equation Rice</th>
<th>Exact equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$2 \pi \frac{r_e^2 c^2}{\alpha} = \frac{r_e^2 c^2}{6 R_c 2 G m_e}$</td>
<td>$R_c G m_e \frac{r_e^2 c^2}{\alpha} = \alpha$</td>
</tr>
</tbody>
</table>

Fig. 7. James Rice equation reduced to exact equality.

References


12. Laurent Nottale. Solution to the cosmological constant problem from dark energy of the quark vacuum. 2019. (hal-02133255).


21. Mykola Kosinov. THE LAW OF SCALING FOR LARGE NUMBERS: origin of large numbers from the primary large number D20 = 1.74349...x 10^20. January 2024. DOI: 10.13140/RG.2.2.33664.20480