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Research Article

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Derivation of Some Physical Characteristics of the Big Bang Theory

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Abstract We propose a simple empirical formula for Big Bang theory, which allows us to obtain sensible physical characteristics of this model.

Keywords Physical Characteristics, Big Bang Theory

1. Derivation of an Empirical Formula

The Big Bang was a gigantic massive heat explosion that started the universe 13.7 billion years. However, it is practically impossible to obtain physical characteristics of this model, like very high-density, high-temperature, value of a force and time interval during which this enormous explosion is taken place and so on. In this short notice, we porpose an empirical formula

$$F_{PN} = \frac{G\hbar}{c}\frac{M_U}{r^3}. \tag{1}$$

We call it a Planck-Newtonian force. Here G, $\hbar$ and c are the Newtonian, Planckian and light velocity constants,

$$M_U \sim 1.5 \times 10^{53}\text{kg}, \tag{2}$$

is approximately total mass of our visible Universe.

2. Physical Characteristics of the Big Bang

For this model, it is naturally to assume in formula (1):

$$r = L_{Pl} \tag{3}$$

where

$$L_{Pl} = \sqrt{\frac{G\hbar}{c^3}} \tag{4}$$

is the Planck length. To obtain a force for creation of the Universe we put the Planck length into the Planck-Newtonian force formula (1) and get

$$F_{BB} = \frac{G\hbar}{c}\frac{M_U}{L_{Pl}^3} = \frac{M_U}{L_{Pl}}c^2 = 5.241 \times 10^{105}\,\text{H(Newton)}. \tag{5}$$

This value of the force is sufficient to create our universe from a point like region due to quantum fluctuations. Time interval during which this force acts is given by

$$t_{BB} = \frac{c \cdot M_U}{F_{BB}} = 8.58 \times 10^{-45}\,\text{sec}. \tag{6}$$

Initial values of an acceleration and velocity of the universe take the forms:

$$a_{BB}^0 = \frac{c}{t_{BB}} = 3.5 \times 10^{52}\,\frac{\text{m}}{\text{sec}^2}, \tag{7}$$

$$v_{BB}^0 = a_{BB}^0 \cdot t_{BB} = c. \tag{8}$$

The last case means that at the present time $t_p = 13.7$ billion years, our Universe occupies the spherical domain with radius

$$R_p = ct_p = 1.295 \times 10^{26}\text{m}. \tag{9}$$

Moreover, density and pressure of the universe at Big Bang are given by

$$\rho_{BB}^{0} = \frac{M_U}{V_{Pl}} = \frac{1.5\times 10^{53}\,\text{kg}}{\left(\frac{4}{3}\right)\pi r_{Pl}^{3}} = 8.48\times 10^{156}\,\frac{\text{kg}}{m^3}, \quad (10)$$

$$P_{BB}^{0} = \frac{F_{BB}}{S_{Pl}} = \frac{5.2406\times 10^{105}\,\text{H}}{4\pi r_{Pl}^{2}} = 1.6\times 10^{174}\,\frac{\text{H}}{\text{m}^2}. \quad (11)$$

We know that roughly $N = 10^{86}$ elementary particles of matter that exist in the visible universe. Therefore, if we use the problematic assumption that the universe grows, cools and starts from the ideal gas condition until approximately 100 sec. after Big Bang, then its equation holds:

$$P_{BB}^{100}\cdot V_{BB}^{100} = nRT_{BB}^{100}. \quad (12)$$

Here $nR = Nk_B$, $V_{BB}^{100} = 10^6\cdot V_{BB}^{0}$, $P_{BB}^{100} = 10^{-4}P_{BB}^{0}$, $k_B = 1.381\times 10^{-23}\text{JK}^{-1}$ is the Boltzman constant. From equation (12) we have temperature for early universe:

$$T_{BB}^{100} = \frac{P_{BB}^{100}\cdot V_{BB}^{100}}{Nk_B} = 2\times 10^{9}\text{K}. \quad (13)$$

We think that quantities (5), (6), (7), (8), (10), (11) and (13) are sensible numbers for the Big Bang theory.
For ten (the string theory) and eleven (M theory) dimensions instead of the formula (1) we have

$$F_{st} = \frac{G^5\hbar^2}{c^{10}}\frac{M^4}{r^8}, \quad (14)$$

and

$$F_{Mt} = \frac{G^6\hbar^2}{c^{12}}\frac{M^5}{r^9} \quad (15)$$

respectively. We assume that process of the universe creation does not depend on numbers of spacetime dimensions and therefore

$$F_{st} = F_{Mt} \quad (16)$$

from which one gets remarkable relation:

$$M = \frac{rc^2}{G}. \quad (17)$$

Last formula (17) gives unexpected results:

- If $r = R_p = 1.295\times 10^{26}$m then total mass of the universe is calculated :

$$M = M_U = 1.7438\times 10^{53}\text{kg}, \quad (18)$$

coinciding with an empirical quantity (2).

- If $r = L_{Pl} = 1.616255\times 10^{-35}$m, then Planck mass is given by

$$M = M_{Pl} = \frac{L_{Pl}\cdot c^2}{G} = \frac{\hbar}{L_{Pl}\cdot c} = 2.1764\times 10^{-8}\text{kg}. \quad (19)$$

Finally, notice that relation (17) arises also from other (5, 6, 7, 8, 9) space time dimensions, as it should be.
According to Einstein's general theory of gravitation the formula (17) may be understood as half value of the gravitational radius of a body with mass M. For example, for Sun and Earth we have

$$r_{\odot} = 1.4771\times 10^{3}\text{m},$$
$$r_{\oplus} = 4.4361\times 10^{-3}\text{m},$$

respectively.

3. Dark or Ghost Force

We assume that side by side with the real matter creation force (1) for the universe there exists a dark or ghost force:

$$F_{DG} = \frac{G\hbar^2}{c^2}\frac{1}{r^4} = 1.21\times 10^{44}\text{H} \quad (20)$$

where $r = L_{Pl}$.

This force is responsible at the beginning for inflation and later on accelerating expansion of the universe. Let us calculate, at present time acceleration rate of this mechanism:

$$F_{DG} = M_U\cdot a_{expan}, \quad (21)$$

where

$$a_{expan} = 7\times 10^{-10}\,\frac{\text{m}}{\text{sec}^2}. \quad (22)$$

This quantity gives rise accelerating expansion of our universe at large scale. For example for one and one million years we have expansion rates:

$$R_1 = R_p + \frac{a_{expan} \cdot t^2}{2} = 3.48 \times 10^2 \text{km} + R_p \quad (23)$$

$$R_2 = R_p + S_2 = 3.48 \times 10^{14} \text{km} + R_p \quad (24)$$

respectively.

References

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