A new Cosmological model that including inflation, deceleration, acceleration and deceleration again

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Abstract

Since 1997[1,2], it is known that the universe is expanding with an acceleration. Many ideas have been employed to explain this phenomenon. Use of a variable cosmological parameter was proposed by Hemantha and de Silva (2003) & (2004)[3,4]. They wrote modified field equations in the form,

$$G^{\mu\nu} = \kappa T^{\mu\nu} + \Lambda g^{\mu\nu} \quad , \quad \text{where} \quad \kappa = -\frac{8\pi G}{c^2} \ .$$

Thus, the following equations were obtained.

$$\kappa p = \Lambda c^2 + \frac{kc^2}{R^2} + \frac{\dot{R}^2}{R^2} + \frac{2\ddot{R}}{R}$$

$$\kappa \rho = -\Lambda - \frac{3k}{R^2} - \frac{3\dot{R}^2}{R^2 c^2} \ ,$$

where $\cdot$ denotes differentiation with respect to cosmic time t.

The new solution $R = b\sqrt{(1-\cos^3 \omega t)}$ is obtained solving the above equations which results in inflation deceleration, acceleration and again deceleration, that describe the evolution of the universe. The two unknowns b and ω can be found under specified boundary conditions. In the literature it is found that the onset of acceleration took place at red shift 1.4 .We took this as our 1st boundary condition.

From $R = b\sqrt{(1-\cos^3 \omega t)}$ we found that $\frac{dR}{dt}$ at $t=0$ to be $\sqrt{\frac{3}{2}}\, b\omega$ .Assuming that at $t=0$ the universe began to expand with velocity of light we have $\sqrt{\frac{3}{2}}\, b\omega = c$ which was considered as our 2nd boundary condition.

We found values for two unknowns $b = 3.5\times10^{27}\,cm$ and $\omega = 6.8\times10^{-18}\,rad\,s^{-1}$ under specified boundary conditions. With these values, we obtained following results.

$$\rho = 6.26\times10^{-29}\,gcm^{-3}$$

$$\frac{d\rho}{dt} = 6.55\times10^{-45}\,gs^{-1} \text{ and}$$

$$\ddot{R} = -2.14\times10^{-7}\ cms^{-2}$$, at the present epoch which is $4.32\times10^{17}\,s$.

At present the density of the universe agrees with the value given above but the value of Λ is negative. In order to avoid a negative Λ we took $\frac{dR}{dt}$ at $t=0$ to be $\sqrt{\frac{3}{2}}\, b\omega$ and found the maximum value of $b = 2.5\times10^{27}\,cm$ that gives positive ρ and positive Λ .With these values of b, ω we found at $t=0$,

$$\rho = +\infty \quad , \quad \Lambda = +\infty$$

$$\frac{d\rho}{dt} = -\infty \ , \qquad \ddot{R} = 0$$

at $t = 10^{-35} s$,

$$\rho = 2.8 \times 10^{62}\, gcm^{-3}, \qquad \Lambda = 1.44 \times 10^{62}\, gcm^{-3}$$

$$\frac{d\rho}{dt} = -5.779 \times 10^{-62}\, gcm^{-3} s^{-1}, \quad \ddot{R} = 0$$

and

$$\rho = 1.8 \times 10^{-28}\, gcm^{-3} \ , \qquad \Lambda = 7.03 \times 10^{-30}\, gcm^{-3}$$

$$\frac{d\rho}{dt} = 6.42 \times 10^{-45}\, gcm^{-3} s^{-1} \ , \ \ddot{R} = -1.105 \times 10^{-7}\, cms^{-2}$$ at present epoch.

References:

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