Accelerated time contraction of the universe

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A B S T R A C T

The metric expansion of space is the increase of the distance between two points in the universe with time. It is an intrinsic expansion of space itself changes. We propose this new model in which space is constant and time contracts.

Introduction

Today we know the observable universe in many senses, however still exist a great part of this we don't know. Today we think universe expands. We would like obtain a new model in which spatial part is constant while temporal part is varying, this model describe spatial and temporal relationships between actions occur in the universe.

First, I want to say in our universe model is static and time is contracting, the time contraction produce cosmological redshift[(1)] that we can observe in Hubble's law[(2)] . We define these conditions:

$$R = cte \tag{1}$$

$$dt \neq dt_0 \tag{2}$$

R is the radius of the visible universe, t and t_0 are different times.

Our metric assume space is homogeny and isotropy. It also assumes that the time component of the metric is time-dependent. One metric with these conditions in reduced-circumference polar coordinates has the form (3):

$$ds^2 = -c^2\alpha^2 {dt_0}^2 + \left[\left(dr/\sqrt{1-r^2/K^2}\right)^2 + (rd\theta)^2 + (r\sin\theta\, d\varphi)^2\right]$$

Where α is dimensionless function which indicate dt_0 contraction, r is the radial coordinate. K is the inverse of the curvature of the universe elevate squared, r is the distance between two points, P_1 and P_2, θ is the colatitude and φ is the azimuth.

We can change our temporal coordinate according to eq(3):

$$dt = \alpha dt_0 \tag{4}$$

Using this metric we create a new cosmological model. First we find the cosmological redshift.

To derive the redshift effect, eliminating $(rd\theta)^2 + (r\sin\theta\, d\varphi)^2$, we use the geodesic equation for a light wave, For an observer the wave at a position $r = 0$ and time $t = t_{now}$, was emitted at a time $t = t_{then}$ in the past and a distant position $r = R$. Integrating over the path we obtain:

$$c\int_{t_{then}}^{t_{now}} \alpha dt_0 = \int_R^0 dr/\sqrt{1 - r^2/K^2} \qquad (5)$$

Two positions and times considered changing due to properties of the metric. Next crest of light is emitted at the time $t_{then} + \lambda_{then}/c$ it had a wavelength λ_{then}, the observer sees wave with a wavelength λ_{now} to arrive at a time $t_{now} + \lambda_{now}/c$:

$$c\int_{t_{then}+\lambda_{then}/c}^{t_{now}+\lambda_{now}/c} \alpha dt_0 = \int_R^0 dr/\sqrt{1 - r^2/K^2} \qquad (6)$$

Using (5) and (6) we find:

$$\int_{t_{now}}^{t_{now}+\lambda_{now}/c} \alpha dt_0 = \int_{t_{then}}^{t_{then}+\lambda_{then}/c} \alpha dt_0 \qquad (7)$$

For very small variations in time the scale factor is essentially a constant ($\alpha = \alpha_{now}$ today and $\alpha = \alpha_{then}$ previously) therefore using redshift definition we find:

$$\frac{\alpha_{then}}{\alpha_{now}} = \frac{\lambda_{now}}{\lambda_{then}} = 1 + z \qquad (8)$$

Where z is the redshift. In a universe where time is contracting, the scale factor is decreasing as time passes, thus, z is positive and distant galaxies appear redshifted.

Suppose a galaxy is at distance D, v_r is "recession velocity" of the galaxy. If we use equation (8) we find (9):

$$v_r = cz = c\left(\frac{\alpha_{then}}{\alpha_{now}} - 1\right) \sim c(t_{then} - t_{now})\left(\frac{\dot{\alpha}_{then}}{\alpha_{then}}\right) \sim -D\left(\frac{\dot{\alpha}_{then}}{\alpha_{then}}\right)$$

Where $\dot{\alpha}_{then} < 0$ according to measurements, therefore due to α value is localized between zero and one, the time contraction is accelerating. If we compare this expression to Hubble law we find (10):

$$\frac{v_r}{D} = -\frac{\dot{\alpha}_{then}}{\alpha_{then}} = F(t_{then}) = H$$

We look for field equation of static universe of GTR[(3)], include cosmological constant **Λ**:

$$\mathbf{G} + \mathbf{\Lambda} = \mathbf{T} \qquad (11)$$

G is Einstein tensor

T is is energy − impulse tensor

$$R_{\mu\nu} - \frac{Rg_{\mu\nu}}{2} - \Lambda g_{\mu\nu} = \frac{8\pi G T_{\mu\nu}}{c^4} \qquad (12)$$

Use notation of point above a variable to denote derivate respect time, we can obtain partial derivatives of metric[(4)]:

First we need to calculate the Christoffel symbols of metric (3).

$$\Gamma^l_{ji} = \frac{1}{2} g^{lm}\left(- \frac{\partial g_{mi}}{\partial x^j} + \frac{\partial g_{mj}}{\partial x^i} + \frac{\partial g_{ij}}{\partial x^m}\right) \qquad (13)$$

Components which are different from zero are:

$$\Gamma^t_{tt} = \alpha^{-2}(\alpha\dot{\alpha}) = \alpha^{-1}\dot{\alpha} \qquad (14)$$

$$\Gamma^r_{rr} = \frac{r}{K^2(1 - r^2/K^2)} \qquad (15)$$

$$\Gamma^r_{\theta\theta} = -r(1 - r^2/K^2) \qquad (16)$$

$$\Gamma^r_{\varphi\varphi} = -r(\sin\theta)^2(1 - K^2 r^2) \qquad (17)$$

$$\Gamma^\theta_{\theta r} = \Gamma^\theta_{r\theta} = \Gamma^\varphi_{\varphi r} = \Gamma^\varphi_{r\varphi} = r^{-1} \qquad (18)$$

$$\Gamma^\theta_{\varphi\varphi} = - \sin\theta\cos\theta \qquad (19)$$

$$\Gamma^\varphi_{\varphi\theta} = \Gamma^\varphi_{\theta\varphi} = \cot\theta \qquad (20)$$

Once the Christoffel symbols have been calculated, we can calculate the Riemann tensor.

$$R^l_{kj,i} = \frac{\partial \Gamma^l_{kj}}{\partial x^i} - \frac{\partial \Gamma^l_{ki}}{\partial x^j} + \Gamma^m_{kj}\Gamma^l_{mi} - \Gamma^m_{ki}\Gamma^l_{mj} \qquad (21)$$

These components are enough to calculate the Ricci tensor ($R^l_{kj,i}$).

Temporal component of Ricci tensor ($k = j = t$):

$$R_{tt} = R^l_{tt,i} = \frac{\partial \Gamma^l_{tt}}{\partial x^i} - \frac{\partial \Gamma^l_{ti}}{\partial x^t} + \Gamma^m_{tt}\Gamma^l_{mi} - \Gamma^m_{ti}\Gamma^l_{mt} \qquad (22)$$

If we substituting Christoffel symbols in equation (22) we find:

$$R_{tt} = R^t_{tt,t} = \frac{\partial \Gamma^t_{tt}}{\partial x^t} - \frac{\partial \Gamma^t_{tt}}{\partial x^t} + \Gamma^t_{tt}\Gamma^t_{tt} - \Gamma^t_{tt}\Gamma^t_{tt} = 0 \qquad (23)$$

The only components of the Ricci tensor that are different from zero are:

Component r:

$$R_{rr} = R^m_{1m,1} = \frac{2}{K^2\left(1 - \frac{r^2}{K^2}\right)} \qquad (24)$$

Component θ:

$$R_{\theta\theta} = R^m_{\theta m,\theta} = \frac{2r^2}{K^2} \qquad (25)$$

Component φ:

$$R_{\varphi\varphi} = R^m_{\varphi m,\varphi} = \frac{2r^2}{K^2}(\sin\theta)^2 \qquad (26)$$

We can observe that the Ricci tensor is:

$$R = g^{ik}R_{ik} = g^{rr}R_{rr} + g^{\theta\theta}R_{\theta\theta} + g^{\theta\theta}R_{\varphi\varphi} \qquad (27)$$

$$R = g^{ik}R_{ik} = -\frac{6}{K^2} \qquad (28)$$

Now we use a postulate proposed by Weyl, average behavior of galaxies is a perfect fluid, we can take the energy-impulse tensor as:

$$T_{\mu\nu} = \begin{bmatrix} \rho & 0 & 0 & 0 \\ 0 & -P & 0 & 0 \\ 0 & 0 & -P & 0 \\ 0 & 0 & 0 & -P \end{bmatrix} \qquad (29)$$

.

Therefore we start with the temporal part:

$$-\frac{1}{2}Rg_{tt} - \Lambda g_{tt} = 8\pi G\rho g_{tt} \qquad (30)$$

In conclusion field equation is:

$$\frac{3}{K^2} - \Lambda = 8\pi G\rho \qquad (31)$$

Now we can study the spatial part. For each spatial component we reach the same equation(32):

$$-g_{ii}\frac{2}{K^2} - \frac{1}{2}Rg_{ii} - \Lambda g_{ii} = 8\pi G(-P)g_{ii}$$

Or

$$\frac{1}{K^2} - \Lambda = -8\pi GP$$

If we use (31) and (32) we find (33):

$$\Lambda = 4\pi G(\rho + 3P)$$

We can see, fields equations does not depend on α, because of α does not relate space dimension with time dimension.

We define curvature k :

$$k = \frac{1}{K^2} \qquad (34)$$

Another way, using considerations of dimensional consistency in equations equation (31), (33) and (34) we obtain:

$$kc^2 = \frac{8\pi G\rho}{3} + \frac{\Lambda c^2}{3} \qquad (35)$$

And

$$\Lambda c^2 = 4\pi G\left(\rho + \frac{3P}{c^2}\right) \qquad (36)$$

Conclusions

We can observe some conclusions. On the one hand, we have built a new universe model, in this universe model time change at every instant and this variation explains the cosmological redshift, on the other hand we have obtained equations to this model that represent a static universe.

References

(1)*Misner, Thorne and Wheeler (1973) and Weinberg (1971).*

(2)*Kutner, Marc, Cambridge University Press (2003).*

(3) *Robert M. Wald, General Relativity (1984).*

(4) *Joan A. Romeu, Derivation of Friedman equations (2014).*