Bull. Astr. Soc. India (1993) **21**, 409-412

The origin of dark matter and its estimate in the metagalaxy

D. N. Srivastava
Electronics Systems Division, Bhabha Atomic Research Centre, Bombay 400 085

Abstract. On dark matter, whereas current researches are in the field of weakly interacting particles, this work puts forward a different line of approach. It interprets dark matter as a transformation of matter by a generalised non-Euclidean time metric. This brings a concept of time horizon at which speeds of physical processes become infinite giving rise to big bang. Beyond the time horizon, the physical properties of systems become imaginary. It explains the discrepancies in the masses of distant galaxies determined from the dynamics of their satellites and luminosity; and shows that dark matter is nothing but ordinary matter which has gone beyond time horizon.

Key words : dark matter—non-Euclidean time—time horizon

1. The general time metric

For two epochs E_1 and E_2, having time coordinates t_1 and t_2 in a given frame of reference, the Euclidean time interval t_{12} is given by $t_{12} = t_1 - t_2$. Now we generalise it to

$$t_{12} = f\,(t_1,\ t_2).$$

To deduce the function f, we postulate the time to be homogeneous. Introducing this extended concept of time in the strong cosmological principle, we state a new 'symmetric cosmological principle' as : "For any observer, the universe, apart from local differences, presents the same view from any place, in any direction, at any time, and on any time axis."

The one dimensional general non-Euclidean time can be conceived of as curved time in two Euclidean dimensions. Thus the course of advancement of time can be represented by an arc in an Euclidean plane. The homogeneity of time implies the constancy of the radius of curvature (P) of the time arc (figure 1).

For a given frame of reference of colocal observers, $E_1E_2E_3$ is the course of advancement of time with a constant radius of curvature P. E_1A_1, E_2A_2, E_3A_3 are the instantaneous time axes. The contemporary (con-) observer determines the time interval between E_1 and E_2 by starting his clock at E_1 and stopping it at E_2. Thus the con-interval, or the invariant interval (t_{12}), is the arc E_1E_2 of time. The archaeological (arch-) observer comes on the scene at E_3

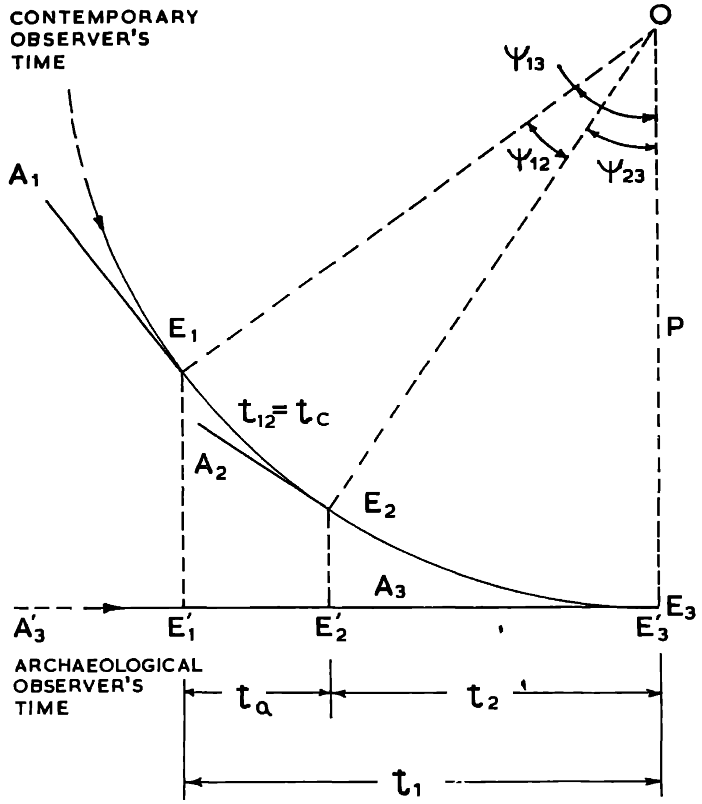

Figure 1. Representatin of the one dimensional non-Euclidean time in two Euclidean dimensions.

and for him the epochs are their projections on his time axis $E_3'A_3'$. The arch-time interval t_a is $t_1 - t_2$. The general time metric is given by

$$t_{12} = P\Psi_{12} = P(\Psi_{13} - \Psi_{23}) = P\left[\sin^{-1}\left(\frac{t_1}{P}\right) - \sin^{-1}\left(\frac{t_2}{P}\right)\right]. \qquad \ldots (1)$$

2. The time horizon

To correlate physical quantities measured by colocal con- and arch-observers (suffix c and a) of different eras, we put $t = t_2 = t_1 - t_a$, where $t_a \ll t_1 < P$, in equation (1). This gives chrono-transformation laws which in respect of time interval (t), velocity (V), temperature (T), and rate of reaction (R) are :

$$t_a = t_c/\alpha,\ V_a = V_c\alpha,\ T_a = T_c\alpha^2,\ R_a = R_c\alpha, \qquad \ldots (2)$$

where $\alpha = \left(1 - \frac{t^2}{P^2}\right)^{-1/2}$.

These show that, for the arch-observer, the speeds of physical processes were higher in the past. The critical point of time, $t = P$, at which the speeds of physical processes become infinite, is 'big bang'. Thus for an arch-observer, the past time $t = P$ becomes the moment of creation of the universe, and P is its age.

The relation between physical quantities measured by con-stationary observer (suffix c) and arch-moving observer (primed symbol with suffix a) are obtained by replacing the relative velocity term v of two frames of reference in special relativity (Einstein 1905) by their arch-relative velocity v_a. This replacement gives chrono-Lorentz transformation laws which in respect of length (L), mass (M) and time interval (t) are :

$$L'_a = L_c/\beta_a, M'_a = M_c\beta_a, t'_a = (t_c/\alpha)\beta_a, \quad \ldots (3)$$

where $\beta_a = \left(1 - \frac{v_c^2\alpha^2}{c^2}\right)^{-1/2}$.

The relativistic limit to velocity ($v < c$) for all observers implies that in the (t/P), (v_c/c) diagram, any point representing the con-velocity v_c of a system and its past time of observation t, must be within a circle $(t/P)^2 + (v_c/c)^2 = 1$ (figure 2), for the system to be real for the arch-observer. This circle represents time horizon, within which any system has real physical properties; and beyond which, imaginary.

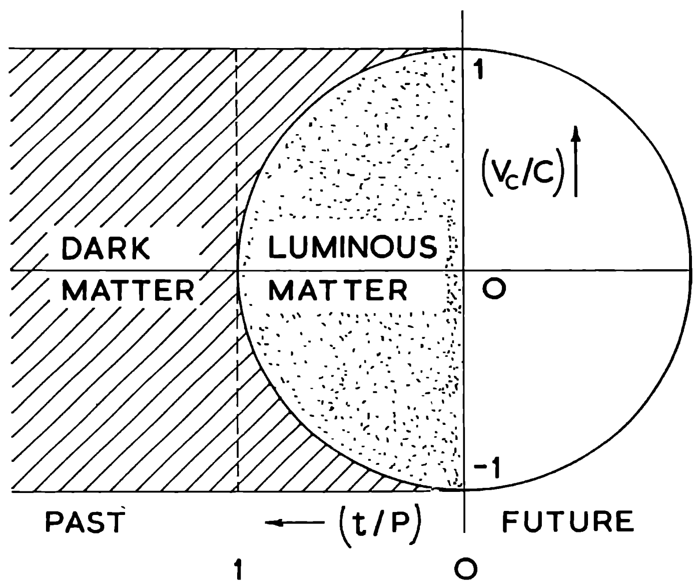

Figure 2. The time horizon circle separating luminous and dark matter.

3. Dark matter

Beyond the time horizon circle, there is a velocity-time zone defined by $(c/\alpha) < v_c < c$, in which physical properties of the system are real for the con-observer, but imaginary for the arch-observer. This implies that the system is observable by the con-observer but not by the arch-observer. This is the basic feature of the dark matter. The dark matter is unobservable by the earth observer but it determines the dynamics of nearby matter. Hence it is inferred that dark matter is only ordinary matter which has gone beyond time horizon.

At the limit $t = P$, even the matter at rest becomes dark matter. Thus P is the absolute horizon and that defines the boundary of the metagalaxy, the observable part of the universe. Assuming the metagalaxy to be Euclidean, its total matter content becomes $(4/3)\ \pi c^3P^3N_0$, where N_0 is the average matter density in the universe.

The quantity of dark matter in any galaxy is the number of particles which have gone beyond time horizon. A cold galaxy for which thermal velocities of particles are very small compared to recession velocity, transforms abruptly into dark matter when its recession velocity-distance crosses time horizon, called thermal horizon $[t_0 = (H_c^2 + P^{-2})^{-1/2}]$ in this case. For hot galaxies the transformation is gradual but has central symmetry with respect to the point $(t_0/P,\ 1/2)$ (figure 3). Thus for cold as well as hot galaxies, the total quantity

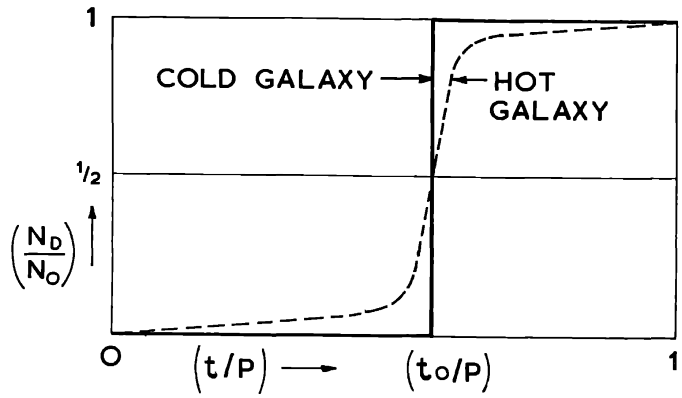

Figure 3. The general shape of the distribution of dark matter in receding galaxies.

of dark matter in the metagalaxy is approximately the matter coming between distances (expressed in time units) t_0 and P; and that is $(4/3)\ \pi c^3\ (P^3 - t_0^3)N_0$. Hence the average dark matter density (N_D) to the total matter density (N_0) in the metagalaxy is given by

$$\left(\frac{N_D}{N_0}\right)_{\text{average}} = 1 - [1 + (H_c P)^2]^{-3/2} = 0.45 \text{ to } 0.88 \qquad \ldots (4)$$

for Hubble constant (H_c) value 40 to 100 km s^{-1} Mpc^{-1}; and the age of the universe (P), 1.7×10^{10} years.

Reference

Einstein A., 1905, Ann. Phys.,17, 891, English translation: A. I. Miller, Albert Einstein's Special Theory of Relativity, Addison-Wesley, Massachusetts, 1981.