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TEMPERATURE FLUCTUATION AND EXPECTED LIMIT OF HUBBLE PARAMETER IN THE SELF-CONSISTENT MODEL

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ABSTRACT

A relation between temperature and time has been constructed in the self-consistent model (SCM). This relation is used to calculate the a CMBR temperature. This temperature has been found to be 2.9K. The temperature gradient of microwave background radiation (CMBR) is calculated in the Self Consistent Model. Two relations between Hubble parameter and time derivative of the temperature, have been presented in two different cases. In the first case the temperature is treated as a function of time only, while in the other one,it is assumed to be a function in time and solid angle, beside the assumption that the universe expands adiabatically.

Key Words : CMBR — temperature gradient — Hubble parameter — self consistent model

I. INTRODUCTION

The cosmic microwave background radiation (CMBR) temperature is one of the important parameters of any cosmological model. The three characteristics of this radiation are its spectrum, spatial anisotropy and polarization. The COBE Far-Infrared Absolute Spectrophotometer (FIRAS) has determined the black body temperature of (CMBR) to be 2.728 ± 0.004K (Keating et al. 1998), this value is in agreement with El Naschie (2002; 2003) estimated value. The COBE Differential Microwave Radiometer (DMR) experiment has detected spatial anisotropy of the (CMBR) on 10° scales of $\frac{\Delta T}{T} \simeq 1.1 \times 10^{-5}$ K. Ground and balloon-based experiments have detected anisotropy at smaller scales (Douglas, Silk & White, 1995). Many authors attributed these anisotropies to simple linear or non-linear processing in the primordial fluctuations (Hu et al. 1997; Challinor ; Lasenby 1999; Melek 2002).

Recently Wilkinson Microwave Anisotropy Probe (WMAP) satellite, which is designed for precision measurement of the CMBR anisotropy on the angular scales ranging from the full sky down to several arc minutes. This ongoing mission has already provided a clear record of the conditions in the universe from the epoch of last scattering to the present. WMAP results were used to test cosmological theories of the accelerating Universe to seek clues to the nature of the dark energy. Despite the absence of a direct dark-energy interaction with our baryonic world, the CMBR photons provide a probe of the presence of the dark energy, complementary to the type 1a supernovae (Rebort Caldwell and Michael Doran 2003). Joshue et al. (2003) showed that the Planck CMBR mission can be significant. In general the observational limit of the temperature fluctuations $\frac{\Delta T}{T}$ becomes lower and lower and it has reached almost 10^{-6} (Keating et al. 1998).

In the next two sections a brief review of the self-consistent model (SCM) and its validity will be given. In §4, time-temperature relation in the SCM is calculated. In §5, the theoretical technique for calculating the gradient of any scalar cosmic field is described. In §6, a relation between CMBR gradient and Hubble parameter is detected in the self-consistent model. In §7, discussion and concluding remarks are given.

II. THE SELF-CONSISTENT MODEL (SCM)

Wanas(1989) has constructed the SCM, a cosmological model in the frame work of Generalized Field Theory (GFT) (Mikhail & Wanas 1977). This theory was constructed in a 4-dimensional Absolute Parallelism (AP)-Geometry. In 1986 Wanas suggested a set of conditions to be satisfied by any geometric structure in AP-Geometry to be suitable for cosmological applications. This set of conditions, if satisfied, would guarantee that a geometric structure would represent, a homogeneous, isotropic, electrically neutral and non-empty universe. Wanas (1989) has used one of the AP-structures, constructed by Robertson (1932), satisfying the conditions mentioned above, to construct SCM. The geometric structure used in that model is given in the spherical polar coordinates by,

$$\underset{i}{\lambda}^{\mu} = \begin{pmatrix} \sqrt{-1} & 0 & 0 & 0 \\ 0 & \frac{L^+S_{14}}{4R} & \frac{(L^-S_{24}-KrS_3)}{4rR} & \frac{-(L^-S_3+KrS_{24})}{4rRS_1} \\ 0 & \frac{L^+S_{13}}{4R} & \frac{(L^-S_{23}-KrS_4)}{4rR} & \frac{(L^-S_4-KrS_{23})}{4rRS_1} \\ 0 & \frac{L^+S_2}{4R} & \frac{-L^-S_1}{4rR} & \frac{K}{16R} \end{pmatrix}, \quad (1)$$

where $S_1 = \sin\theta$, $S_2 = \cos\theta$, $S_3 = \sin\phi$, $S_4 = \cos\phi$, $S_{14} = S_1\ S_4$, $S_{24} = S_2\ S_4$, $S_{23} = S_2\ S_3$, $S_{13} = S_1\ S_3$, and $K = 4k^{\frac{1}{2}}$. Also $L^{\pm} = 4 \pm kr^2$, where k is the curvature of the space and $R(t)$ is an unknown function of t only. It is to be considered that the Riemannian space, associated with (1), is given by

$$dS^2 = \hat{g}_{\mu\nu}\, dx^\mu\, dx^\nu, \tag{2}$$

with the metric tensor given by,

$$\hat{g}_{\mu\nu} = \sum_i e_i \underset{i}{\lambda}_\mu\ \underset{i}{\lambda}_\nu,$$

$$\hat{g}^{\mu\nu} \stackrel{def.}{=} \sum_i e_i \underset{i}{\lambda}^\mu\ \underset{i}{\lambda}^\nu, \tag{3}$$

where $e_i(= 1, -1, -1, -1)$ is Levi-Civita's indicator. The metric tensor corresponding to the tetrad (1) is given by

$$\hat{g}^{\mu\nu} = \left[1\ ,\ \left(\frac{L^+}{4R}\right)^2\ ,\ \frac{-g^{11}}{r^2}\ ,\ \frac{-g^{11}}{r^2 \sin\Phi}\right], \tag{4}$$

$$\hat{g}_{\mu\nu} = \left[1,\ \left(\frac{4R}{L^+}\right)^2\ ,\ -g_{11}r^2\ ,\ -g_{11}r^2 \sin\Phi\right] \tag{5}$$

where $\mu\ ,\ \nu(= 0, 1, 2, 3)$.

According to the GFT (Mikhail & Wanas 1977), the field equations are given by

$$E^\mu{}_\nu = 0, \tag{6}$$

where $E^\mu{}_\nu$ is a second order tensor, non-symmetric tensor defined in AP-space. Wanas (1989) has used (6) and tetrad (1) to find the following set of differential equations:

$$\frac{\dot{R}^2}{R^2} + \frac{4k}{R^2} = 0, \tag{7}$$

$$\frac{2\ddot{R}}{R} + \frac{\dot{R}^2}{R^2} + \frac{4k}{R^2} = 0, \tag{8}$$

where the dots represents differentiation with respect to time t. Integration of (7), gives immediately

$$R = \tilde{R} \pm\ 2(-k)^{\frac{1}{2}}\ t, \tag{9}$$

where $\tilde{R}$ is a constant of integration, giving the value of the scale factor at $t = 0$. If k takes the value zero, the SCM will be a static empty model, and when $k = +1$ it will give an imaginary scale factor. So we must take $k = -1$ for non-static, non-empty model, and the solution (9) will take the form,

$$R = \tilde{R} + 2t, \tag{10}$$

with $k = -1$.

The geometric energy momentum tensor $S_\mu{}^\nu$ in the SCM, according to GFT is defined as

$$S_{\mu\nu} \stackrel{\text{def}}{=} \varpi_{\mu\nu} - \sigma_{\mu\nu} + g_{\mu\nu}\Lambda, \tag{11}$$

$$\Lambda \stackrel{\text{def}}{=} \frac{1}{2}(\sigma - \varpi), \tag{12}$$

where

$$\varpi_{\mu\nu} \stackrel{\text{def}}{=} \gamma^\alpha_{.\mu\epsilon}\gamma^\epsilon_{.\alpha\nu} + \gamma^\alpha_{.\nu\epsilon}\gamma^\epsilon_{.\alpha\mu},$$

$$\sigma_{\mu\nu} \stackrel{\text{def}}{=} \gamma^\epsilon_{.\alpha\mu}\gamma^\alpha_{.\epsilon\nu}\ ,$$

$$\gamma^\alpha_{.\mu\nu} \stackrel{\text{def}}{=} \underset{i}{\lambda}^\alpha\ \underset{i}{\lambda}_{\mu;\nu},$$

and the semi-colon (;) denotes covariant differentiation. Wanas (1989) has got the non-vanishing values of $S_{\mu\nu}$ by evaluating (11) and (12) using the tetrad (1) as:

$$S_0{}^0 = \frac{9k}{R^2}\ ,\ S_1{}^1 = S_2{}^2 = S_3{}^3 = \frac{3k}{R^2}, \tag{13}$$

III. VALIDITY OF THE SELF-CONSISTENT MODEL (SCM)

To facilitate comparison of SCM with the results of the relativistic cosmology, and those of observations, Wanas (1989) has defined the used quantities in relativistic cosmology as follows:

$H \stackrel{\text{def}}{=} \frac{\dot{R}}{R}$ *the Hubble parameter,*

$\tau \stackrel{\text{def}}{=} H^{-1}$ *the age parameter,*

$h \stackrel{\text{def}}{=} \frac{\ddot{R}}{R}$ *the acceleration parameter,*

$q \stackrel{\text{def}}{=} \frac{h}{R}$ *the deceleration parameter.*

the material energy tensor of the GFT is a purely geometrical object. Therefore to get an idea about the material contents of this model, Wanas (1989) has used the quantity

$$\Omega \stackrel{\text{def}}{=} -\frac{S^0_{\ 0}}{3H^2}, \tag{14}$$

where $S^0_{\ 0}$ is a component of the mixed form of the tensor (11). The value of this quantity at the present epoch (Ω_o) is called matter parameter. Evaluating the previous quantities for SCM, he got

$$H = \frac{2}{\tilde{R} + 2t},$$

$$\tau = \frac{1}{2}\tilde{R} + 2t\ ,$$

$$h = 0,$$

$$q = 0,$$

$$\Omega = \frac{3}{4}.$$

Wanas (1989) has used The value of the Hubble parameter ($\simeq 50$ km s^{-1} Mpc^{-1}) required by time -scale agreements with FRW-models for $q_0 = 0$. He got the age of the universe $t_0 = 2 \times 10^{10}$ years. The previous result are in consistent with observed values except for Ω_0 which is greater than the observed upper limit (for more details see Wanas 1989). This means that the SCM is a cosmological model fixing the curvature constant to be -1. It also satisfies the weak and strong energy conditions, and it is free of particle horizon (for more details about the model and its relation with Friedman-Robertson-Walker cosmological model, see Wanas [1989], [2003]). The model is not contradict with recent supernovae observations (Riess et al. 2004). The negative curvature, uniquely fixed by the model, is among recently discussed reasons of the WMAP low multi-pole anomaly (Gurzadyan et al. 2003; Ichikawa et al. 2006). So, this model deserves further examination. It is worth mentioning that the energy momentum tensor in this model is not a phenomenological object but it is a geometrical one.

IV. THE TIME-TEMPERATURE RELATION IN SCM

In the following we are going to find the relation between time and temperature in SCM. We accept a hot Big Bang thermal history (Narlikar 1983, Weinberg 1972) to find the time and temperature relation in SCM. We are going to assume that, in the early stages of the universe, the radiation was that of a black body with temperature T given by Narlikar (1983)

$$B_0{}^0 = a\, T^4, \tag{15}$$

where $B_\mu{}^\nu$ is the phenomenological energy-momentum tensor, and a is the radiation constant.

If we assume that the geometric energy momentum tensor is related to the phenomenological one via the relation,

$$S_\mu{}^\nu = \mathcal{H} B_\mu{}^\nu, \tag{16}$$

where $\mathcal{H}$ is a conversion constant equal to $\frac{8\Pi G}{c^2}$, G is the gravitational constant and c is the speed of light. If we use (10), (13), (15) and (16), we have

$$T = \left(\frac{9}{4a\mathcal{H}}\right)^{1/4} \left(\frac{2}{\tilde{R}+2t}\right)^{1/2}. \tag{17}$$

As it is well known that the relation between temperature and time depends on the type of particles filling the model and the kind of interaction between them at a certain temperature range. Thus, it is more convenient to rewrite the relation (17) in the form,

$$T = \left(\frac{9}{a\mathcal{H}\ \gamma^4\ (\tilde{R}+2t)^2}\right)^{1/4}, \tag{18}$$

where γ is a parameter depending on types of particles and their interactions. Since we accept the same temperature history of hot Big Bang, we accept also the type of particles and its interactions for each temperature range. Then γ takes the values (Narlikar 1983): $\gamma = \frac{9}{2}$ in temperature range ($10^{12} - 10^9$ K) and $\gamma = 1.45$, when temperature less than 10^9K.

The relation (18) may be used to determine the parameter $\tilde{R}$, if all other constants are known. If it is assumed that at time $t = 0$, the temperature of the universe was 10^{12} K as it is usually used in the literature (Narlikar 1983), the value of the parameter $\tilde{R}$ is obtained to be 3.7×10^{-4} sec. The relation (18) takes the form

$$T = \left(\frac{9}{a\mathcal{H}\ \gamma^4\ (3.7\times 10^{-4}+2t)^2}\right)^{1/4}. \tag{19}$$

If we detect that at the temperature $\simeq$ 4000K nuclei and electrons recombine, so that the matter becomes effectively transparent to the background radiation (McCrea 1983). This recombination temperature is constant for any cosmological model, since it depends only on the thermal history of the universe, to be transparent to the background radiation. If we use the equation (19) to find the ratio between the temperatures at the time of recombination and now, we have

$$\left(\frac{T_r}{T_{0\ SCM}}\right) = \left(\frac{t_r}{t_{0\ SCM}}\right)^{1/2}. \tag{20}$$

where the subscripts r and 0 mean at recombination and now. As it is well known that in the standard model (SM), which was constructed in the frame work of the General Theory of Relativity (GTR), the time-temperature relation is given by Narlikar (1983), as

$$T_{SM}\ \alpha\ t_{SM}^{1/2}. \tag{21}$$

So we can write a relation similar to (20) for the SM, as

$$\left(\frac{T_r}{T_{0SM}}\right) = \left(\frac{t_r}{t_{0\ SM}}\right)^{1/2}. \tag{22}$$

From (20) and (22), taking into our consideration that the recombination temperature and the age of the universe are the same in both of the two models i.e

$$T_{r\ SCM} = T_{r\ SM} \quad , \quad t_{0\ SCM} = t_{0\ SM},$$

we have

$$\left(\frac{T_{0\ SCM}}{T_{0\ SM}}\right) = \left(\frac{t_{r\ SCM}}{t_{r\ SM}}\right)^{1/2}, \tag{23}$$

The time of recombination in the SCM, is determined by using (18). It takes the value ($t_{r\ SCM} = 2.1 \times 10^{13}$sec), while the corresponding time in the SM was given by Weinberg (1972, page 540) as ($t_{r\ SM} = 1.92 \times 10^{13}$ sec). If we use these two values in equation (23), we find

$$\left(\frac{T_{0\ SCM}}{T_{0\ SM}}\right) = 1.09, \tag{24}$$

As it is well known that the accepted value for CMBR temperature in SM is 2.7K. So the CMBR temperature in SCM takes the value 2.95K. This is somewhat higher than the most recent temperature determined by FIRAS instrument on COBE to be 2.725 ± 0.001K (Michael 2002).

V. THE GRADIENT OF ANY COSMIC SCALAR FIELD

A procedure, used in meteorology, to study the temperature gradient in the Earth's atmosphere has been generalized by Melek (1992). The generalized technique has been used to study the matter density and temperature gradients in the universe. He defined the function F_g, for any cosmic measurable scalar field S, in a curved space-time with metric $g_{\mu\nu}$, as:

$$F_g \stackrel{def.}{=} \frac{dG}{d\tau}, \tag{25}$$

$$where \quad G \stackrel{def.}{=} (g^{\mu\nu} S_\mu S_\nu)^{1/2}, \tag{26}$$

$$and \quad S_\mu = \frac{\partial S}{\partial x^\mu}, \tag{27}$$

where S_μ is a time-like covariant vector, $\mu = 0, 1, 2, 3$ and τ is the cosmic time. Melek has shown that the function F_g has the form:

$$F_g = \frac{1}{G}\, g^{\mu\nu}\, S_{\mu;\sigma}\, S_\nu\, u^\sigma, \tag{28}$$

where $S_{\mu;\sigma}$ is the usual covariant derivative with respect to x^σ and $u^\sigma \stackrel{def.}{=} \frac{dx^\sigma}{d\tau}$. The second derivative of the absolute value of the gradient of any cosmic scalar field S, with respect to the cosmic time τ, is given by:

$$\frac{d^2G}{d\tau^2} = \frac{1}{G}\, \{ g^{\mu\nu} u^\sigma u^\alpha [\, S_{\mu;\sigma\alpha}\, S_\nu + S_{\mu;\sigma} S_{\nu;\alpha}] - F_g^2 \}. \tag{29}$$

Melek (1995) has applied this procedure to a spatially perturbed Friedman-Robertson-Walker cosmological model, to put a lower limit for the Hubble parameter. Melek (2000), also has used the same technique for FRW to study limits on cosmic time scale variations of gravitational and cosmological constants. The same procedure has been used by Melek (2002), to find the primordial angular gradients in the temperature of the microwave background radiation and the density functions in the same cosmological model.

In what follows we are going to use the same technique to find the gradient of microwave back ground radiation's temperature in SCM. Also, we will find a relation between this gradient and the Hubble parameter.

VI. CMBR TEMPERATURE GRADIENT IN THE SCM AND AN EXPECTED LIMIT OF HUBBLE PARAMETER

The metric of the Riemannian space, associated with the AP-space (1), can be written using, equations (2), (4) and (5), as

$$dS^2 = dt^2 - \frac{16\, R^2}{L^{+2}} \left[dr^2 + r^2\, d\theta^2 + r^2\, \sin\theta\, d\phi \right], \tag{30}$$

where $L^+ = 4 + r^2 k$.

Now if we follow the coordinate transformation,

$$dt = R(t) d\tau, \tag{31}$$

in the metric (24), we can write

$$dS^2 = R^2(t) \left\{ d\tau^2 - \frac{16}{L^{+2}} \left[dr^2 + r^2\, d\theta^2 + r^2\, \sin\theta\, d\phi \right] \right\}, \tag{32}$$

where $R(t)$ is the scale factor and τ is the cosmic time. If we assume that the microwave background radiation temperature $T(t)$ is our scalar field, and this field varies with time only. If we use (27), then we can write

$$T_\mu \stackrel{def.}{=} \frac{d\,T}{d\,x^\mu}, \tag{33}$$

$$T_0 = \frac{d\,T}{d\,t}\,\frac{d\,t}{d\,\tau} = R\,\dot{T}, \tag{34}$$

where $\dot{T} = \frac{d\,T}{d\,t}$. Since the covariant differentiation is defined as,

$$T_{\mu\,;\,\nu} = T_{\mu\,,\,\nu} - \left\{ {\rho \atop \mu\nu} \right\} T_\rho, \tag{35}$$

Now if we use (35) by taking $\mu = \nu = 0$ and considering that the temperature is a function of time only (i.e $T_1 = T_2 = T_3 = 0$ and $\left\{ {0 \atop 00} \right\} = 0$), we have

$$\begin{aligned} T_{0\,;\,0} &= T_{0\,,\,0} \\ T_{0\,;\,0} &= R(R\,\ddot{T} - \dot{R}\,\dot{T}), \end{aligned} \tag{36}$$

If we assume that the CMBR is independent of the radial coordinate at any fixed cosmic time and the motion in the universe is only due to its expansion. We use (25), (26), (27), (28), (29) and (36), to have

$$F = \left(\ddot{T} - \frac{\dot{R}}{R}\,\dot{T} \right). \tag{37}$$

Since the SCM has been assumed to be homogenous and isotropic then $F = 0$ i.e,

$$\ddot{T} - \frac{\dot{R}}{R}\,\dot{T} = 0. \tag{38}$$

Equation (37) leads directly to the following result,

$$\frac{\ddot{T}}{\dot{T}} = \frac{\dot{R}}{R} . \tag{39}$$

Noting that $\frac{\dot{R}}{R} = H$, as usually done, then we get

$$\frac{\ddot{T}}{\dot{T}} = H . \tag{40}$$

It is clear from the last equation that all the quantities on its left hand side are unmeasurable quantities until now. If these quantities are measured by COBE, WMAP or any other satellite, the Hubble parameter is determined. If we assume that the microwave background radiation temperature T, our scalar field, varies with time and solid angle instead of time only. Then cosmological perturbation theories are useful in such case. Many authors handled the problem of cosmological perturbation in detail. Kodama & Sasaki (1984) reviewed and reformulated the linear cosmological perturbation theory of spatially homogeneous and isotropic universe. They imposed three types of perturbation on the metric and the phenomenological energy momentum tensor, for n-dimensional space. Many other authors follow the same or similar formulations (Tomita 2005; Hwang & Noh 2005; Bozza & Veneziano 2005). Since the energy momentum tensor in the SCM is not a phenomenological object but is a geometrical one. Therefore any perturbation theory using phenomenological energy tensor must be reformed to suit the used model. This point will be considered in a future work. So for simplicity we will use the spatially perturbed form of the metric, in the spherical polar coordinates, to write the metric (32) (Melek [2002], [2000], [1995]; Linder [1997], Wright et al. [1994]; Suto, Gouda & Sugiyama [1990], Peebles & Yu [1970] and references therein) as:

$$\begin{aligned} dS^2 &= R^2(t)\{d\tau^2 - \frac{16(1+h_1)^2}{L^+} dr^2 - h_2 r dr d\Omega \\ &\quad -r^2\,(1+h_3)\,d\Omega^2\}, \end{aligned} \tag{41}$$

where Ω is the solid angle defined in terms of θ and ϕ as $d\Omega^2 = d\theta^2 + \sin^2\theta\, d\phi^2$ and h_1, h_2 and h_3 are small spatial perturbations. If we use the metric (41) taking into our consideration that the homogeneity is valid (i.e $\frac{\partial T}{\partial r} = 0$, and $\frac{\partial^2 T}{\partial t\, \partial r} = 0$), and we assume that the expansion is the only motion in the universe, and this expansion affects on the temperature. If we consider the temperature of the CMBR as a function of the cosmic time and direction i.e $T(t, \Omega)$ and we follow the same procedure as before, then equation (28) takes the form

$$F = \left(\frac{\dot{T}}{G\,R(t)}\right)\left(\ddot{T} - \frac{\dot{R}}{R}\,\dot{T}\right) - \left(\frac{1-h_2}{r^2}\right)\left(\frac{\partial T'}{\partial\, t} - \frac{\dot{R}}{R}\,T'\right) \tag{42}$$

where $T' \overset{def.}{=} \frac{\partial\, T}{\partial\, \Omega}$. If we write now the metric of the SCM as

$$dS^2 = R^2(t)\left\{d\tau^2 - \frac{16}{L^{+2}} dr^2 - r^2\, d\Omega^2\right\}, \tag{43}$$

then, after some straight forward calculations, the temporal variation of the magnitude of the gradient of T is given by:

$$F_{SCM} = \left(\frac{\dot{T}}{G\,R(t)}\right)\left(\ddot{T} - \frac{\dot{R}}{R}\,\dot{T}\right) - \left(\frac{T'}{r^2}\right)\left(\frac{\partial T'}{\partial\, t} - \frac{\dot{R}}{R}\,T'\right). \tag{44}$$

Using (44), we can write (42) in the the following form

$$F = F_{SCM} + \left(\frac{h_2}{r^2}\right)(T')\left(\frac{\partial T'}{\partial\, t} - \frac{\dot{R}}{R}\,T'\right). \tag{45}$$

Since SCM is an isotropic and homogenous model and our calculations are performed in spatial co-moving coordinates (i.e $\frac{dr}{d\tau} = \frac{d\Omega}{d\tau} = 0$), assuming that the universe expands adiabatically, then the gradient (44) vanishes. In another wording the primordial born differences in temperature of CMBR at different places in the universe will remain constant during this adiabatic expansion. Then the temporal variation G with respect to proper time should vanish and as a direct consequence of that, we have

$$\left(\frac{h_2}{r^2}\right)(T')\left(\frac{\partial T'}{\partial\, t} - \frac{\dot{R}}{R}\,T'\right) = 0. \tag{46}$$

Since $T' \neq 0$, then

$$\left(\frac{\partial T'}{\partial\, t} - \frac{\dot{R}}{R}\,T'\right) = 0. \tag{47}$$

Since $H = \frac{\dot{R}}{R}$, then the Hubble parameter can be written as

$$H = \left(\frac{\partial T'}{\partial\, t}\right) / T'. \tag{48}$$

Since COBE, WMAP and other space and ground based measurements have detected and confirmed anisotropy in the temperature of the CMBR, this means that the denominator of the right hand side of the equation (46), can be measured easily. But the numerator can be specified after a period of time, fixing the value of the Hubble parameter.

VII. DISCUSSION AND CONCLUDING REMARKS

Wanas (1989) has used the AP-structure (1) to find a unique pure geometric world model. This model is nonempty and has no particle horizons. This model fixes a value for $k(= -1)$ i.e. it has no flatness problem. It has no singularity at t=0, as it is clear from equation (10). A further advantage of using pure geometric theories is that one did not need to impose any condition from outside the geometry used (e.g. equation of state) in order to solve the field equations (Wanas 1986; 1989)).

The relation between time and temperature in SCM is given by (18). This relation has been used to find the(CMBR) temperature to be 2.95K. This is, some what, higher than the most recent temperature.

The generalized procedure for studying gradients, which has been used by Melek (1992), is used to find the temperature gradient in the SCM. When we assumed that the CMBR temperature is a function of time only, the Hubble parameter (H) is given by (34). But all the quantities on the right hand side of this relation are nonmeasurable. So this relation can not determine the numerical value of H, without knowing the gradient of temperature and its rate of change with respect to time observationally.

When it is assumed that the temperature is a function in time and solid angle and that the universe expands adiabatically, the Hubble parameter is given by the relation (46). The quantity in the denominator of the right hand side of (46) may be determined by observation, while the quantity in the numerator cannot be determined at time being. Since the explanation of the small-amplitude of the observed CMBR temperature fluctuation in the anisotropic universe, definitely need fine tuning, but it can be calculated after the accumulation of further data, and then the Hubble parameter can be determined.

It is clear also from the relation (45), that the value of the Hubble parameter decreases as the temperature gradient decreases. This result is in agreement with Bellini (2001) results.

It is worth mentioning that the gradient relation may give the same form for many of cosmological models but each result depends essentially on the scale factor which is fixed by the model under consideration, i.e this procedure is model dependent.

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