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Universe expansion and main spectral peak of CMB

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Abstract

The standard cosmological model states that the observed data confirms the Universe curvature absence, hence its total matter density ρ equals to the critical value $ρ_0$. In the paper I point out that the data can be satisfactory interpreted independently of a spatial metrics type, so an alternative cosmological model having another (e.g., spherical and closed) metrics type may be considered.

1. Introduction

As it is well known, the standard cosmological model (SCM) explains the CMBR temperature fluctuations power spectrum highest peak location at ℓ ≈ 200 (that corresponds to the angular size near 1°) using flat metrics type of the Universe geometry. The part of such fluctuations is shown in Fig. 1, the total spectrum is shown in Fig. 2.

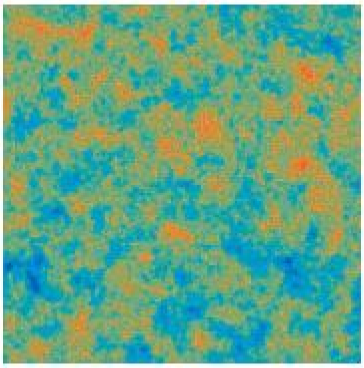

Figure 1(**[Wayne Hu, 2008]**)
The part of the temperature fluctuations map

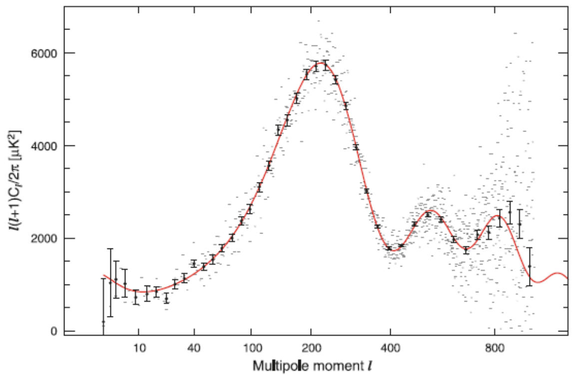

Figure 2 (**[Dunkley et al., 2008]**).
The power spectrum of the CMBR temperature fluctuations

Let us consider how SCM determines the needed values of the angle and multipole number ℓ (see, e.g., **[Bersanelli et al., 2002]**, **[Dunkley et al., 2008]**, **[Samtleben et al., 2008]**, **[Spergel et al., 2003]**, **[Wayne Hu, 2008]**):

- The angle's tangent is equal to the ratio where the numerator is the size of an object and the denominator is the photon travel distance from the object to the observer. If this ratio is small enough, then the angle is near to this ratio.
- The size s_r of the area is calculated using some complicate physical process model that extends from Big Bang at t=0 (z=∞) up to last scattering epoch t_r (z_r=1.1·10^3). As we talk about the *first* fluctuation harmonic, we can assume that s_r has simply the order of the Universe size in the last scattering epoch (at $t=t_r$).
- The photon travel distance cΔt is proportional to the time interval between t=0 (z=∞) and $t=t_r$ ($z=z_r$). We have neglect the interval preceding t_r, so we can set d_M=cΔt≈ct_0, where d_M is so-called metrical (coordinate) distance
- In fact, in this case one should use the angular diameter distance $d_A = d_M /(1+z)$, that takes into account the Universe expanding between photons emission and

registration time points. Because of that we have to multiply the angle by the factor (1+z):

$$\Theta = (s_r/\sqrt{3})/d_M = (1+z)\, ct_r / (\sqrt{3}c\Delta t) \approx$$
$$\approx (1.1\cdot 10^3\cdot 3.3\cdot 10^5) / (1.7\cdot 13.7\cdot 10^9) =$$
$$= (3.6/2.4)\cdot 10^{-2} = 1.5\cdot 10^{-2} \text{ radians} = 0.9°$$

(here the factor √3 is due to the relation between amplitudes of the gravitation potential fluctuation and temperature fluctuation). The corresponding multipole number is $\ell \approx 180°/0.9° = 200$.

One can use $c\Delta t$ as the metrical (coordinate) distance only in case of the flat[1] Universe. By-turn, in the SCM the flat metrics suggests that in the Einstein-Friedmann equations one has uses the matter density ρ equal to the so-called critical value ρ_0. And finally, as it is well known, in the SCM the relation between ρ and ρ_0 determines not only the *spatial* metrics type, but also the type of the Universe *time evolution*.

2. Alternative way to calculate the main CMBR spectral peak location

However, there exists another way to calculate the location of the CMBR temperature fluctuations power spectrum maximal peak that is not connected at all with the hypothesis of the flat Universe spatial metrics. This way is very simple, it consists in the follow: at the epoch of last scattering the sound horizon encircled completely an imaginary observer. After this epoch the basic wavelength ($\sim s_r$) remains constant while the Universe scale factor becomes larger with the factor (z+1). Hence, the multiplication factor for this harmonic of fluctuation for modern observer will be equal $(z_r+1)/\sqrt{3}$ (see the above remark). So, we get the angle value $\theta \approx 0.6°$ at z=1100 as it is exactly confirmed by the last observations data[2].

3. Alternative model of the Universe evolution

Since 1993 I develop an alternative cosmological model (see **[Shulman, 2007a]**). I called it the Spherical Expanding Universe Theory (SEUT). It considers our Universe as a black hole in some external super-Universe (such a possibility was discussed by the famous physicist J. Wheeler, see **[Smolin, 1994]**). If one neglects by the "quantum evaporation", then the matter and energy absorption by the black hole presents an *irreversible* process. Due to it the expansion of our Universe happens. If one supposes also that the Universe total electric charge and angular momentum are zero, then its increasing mass will be strongly proportional to its gravitational radius. Furthermore, this mass (from physical point of view) will be a single parameter "marking" the black hole states. It is a reason to introduce a "parametric" time that is (by definition) proportional to the mass and (as a consequence) to the size. For an "external" observer the parametric time will increment (just proportionally) *only when* the black hole mass will increase.

Let us write the standard Einstein-Friedmann's equations in such the Universe for an "internal" observer, where usual time is replaced by just such "parametric" time. Note, in this model we should not use the mass-energy conservation law, because the mass increases continuously (however, in the present epoch the relative error is not more than 10^{-10} per year). Instead of this boundary condition one should use another one: the postulated proportionality between the Universe size and age. In such the

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[1] In other cases, as it is well known, an additional factor appears that contains sin (closed geometry) or sinh (open geometry).

[2] In the last WMAP's report **[Komatsu et al., 2010]** the value θ=0.6° is pointed out.

solution any *expansion type* dependence on a *spatial metrics type* is eliminated in principle. As we could see, this does not lead to real contradiction with the observed data.

Is the parametric time a convenient mathematical abstraction only? Does there exist an objective base to percept this time by the different internal observers? I propose the following answer: the space and time extent are perceived by each quantum object because it has own “rod” and “clock”, i.e., the length and period of proper de Broglie wave. Thus, the universal and irreversible Time currency appears objectively for all observers as well as the estimates of temporal and spatial intervals.

4. Comparison between models

Let us consider three simplest model of the cosmological evolution that are present in the Fig. 3 as the cones. The top of each cone corresponds to the Big Bang, while the bottom base corresponds to the *current* spatial cross-section, i.e., to the simplified Universe picture at the present-day epoch. The time axis is directed in Fig. 3 downward along the *generatrix* of cone (meridian), while the parallels correspond to some spatial instantaneous states of the Universe.

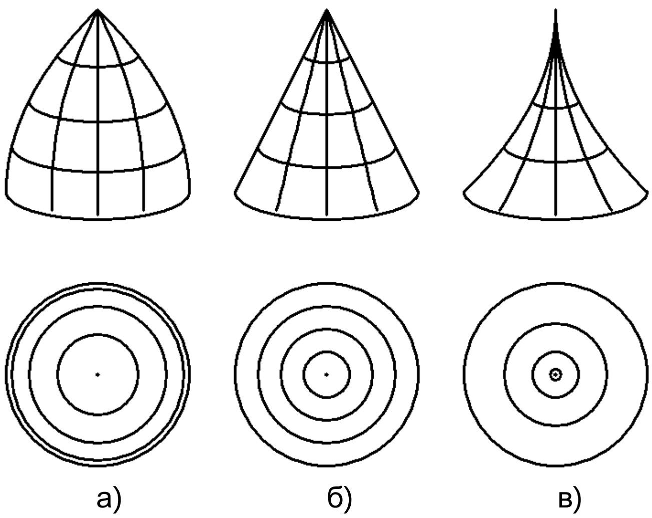

Figure 3.
The geometrical representation of the expanding Universe
(a) the decelerating expansion
(b) the uniform expansion
(c) the accelerating expansion

For all tree model in our Figure the Universe is depicted as simple *closed* circumference. In the SEUT this means that at each time point the expanding Universe (*independently* on a model or a *value* of ρ) is a volume closed on itself 3D, i.e., a finite 3D non-Euclidean hypersurface of the 4D-cone. When one considers a spatial-temporal cross-section of the cone including its generatrix, he may talk about different Universe evolution models that in the SCM *depend* on the relation between ρ и ρ_0 (see **[Palash, 1999]**). The corresponding non-uniformity of the Universe expansion is shown in three lower pictures of the Fig. 3.

Fig. 4 shows two laws of the Universe scale factor (a/a_0) evolution depending on the dimensionless age H_0t (where H_0 is the Hubble parameter in our epoch), see details in **[Shulman and Raffel, 2008]**. The red line corresponds to the exactly linear evolution law (SEUT), when the scale factor is exactly proportional to the Universe Age (linear generatrix of the evolution cone in Fig.3). The blue curve corresponds to the SCM approach, or ΛCDM-model (Ω_M = 0.25, Ω_L = 0.75, Ω_k = 0). In this case the cone generatrix grows with an *alternating acceleration sign* (not the case of Fig. 3).

Using a fitting of the "best" value of Ω_M, Ω_L, and Ω_k for such a law, SCM concludes that in our epoch the Universe expands with acceleration. However, the SEUT leads to another conclusion: the blue curve's parameters are selected to be having the same final point as the red line that provides the constant rate of the Universe expansion.

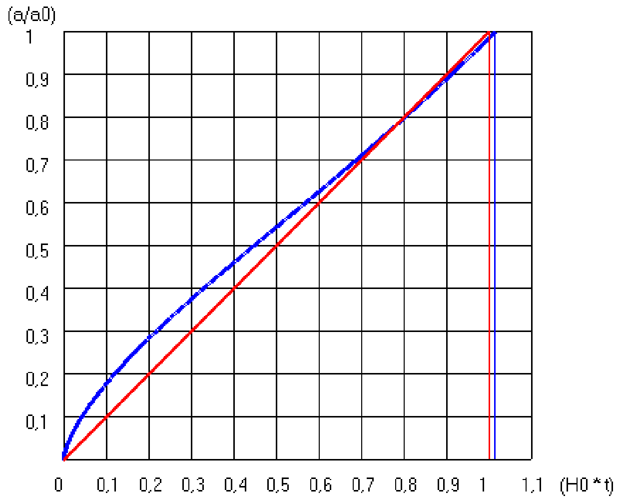

Рисунок 4

ΛCDM-модель (Ω_M = 0.25, Ω_L = 0.75, Ω_k = 0)
линейная модель (ТШРВ)

We should note the SCM cannot overcome several fundamental problems (particularly, Λ and vacuum energy problem), while these problems are effectively interpreted in the SEUT (see **[Shulman, 2007b]**) without any "fitting". Finally, SEUT explains the temperature spectral peak existing at ℓ = 4 – 5 (while SCM have not any explanations), and made also another new predictions (see **[Shulman and Raffel, 2008]**).

I have to add that there appear new publications on the linear connection between size and age of the Universe (see **[Kronov]**, **[Barak and Leibowitz, 2009]**, **[Benoit-Levy and Chardin, 2009]**, **[Farley, 2010]**).

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