An Important Note on the Mechanism within the Cold Big Bang Cosmology

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In this paper, I discuss the postulate in [1], showing the result for the energy fluctuation follows from a discreteness hypothesis.

TO THE HEISENBERG INDETERMINACY RELATION

Recalling the eqn. (53) in [1]:

$$\delta E_\rho = \frac{E_0^+}{\sqrt{1-\dot{R}^2/c^2}}\frac{\dot{R}\,\delta\dot{R}}{c^2}, \tag{1}$$

δE_ρ, given by eqn. (1), seems to be exclusively valid when $\delta\dot{R}$ is infinitesimal, since this expression is a first order expansion term, where we do tacitly suppose the vanishing of high order terms. But its form will remain valid in a case of finite variation, as derived is this paper, under the same conditions presented in [1]. The eqn. (1), in terms of indeterminacy, says:

- There is an indeterminacy δE_ρ, at a given t, hence at a given $R(t)$ and $\dot{R}(t)$, related to a *small* inteterminacy $\delta\,\dot{R}(t)$.

A given spherical shell within a t-sliced hypersurface of simultaneity encloses an indeterminacy:

$$\sum_{l=1}^{k}\left(\delta E_\rho\right)_l = \left.\frac{E_0^+\dot{R}/c^2}{\sqrt{1-\dot{R}^2/c^2}}\right|_t \sum_{l=1}^{k}\left(\delta\dot{R}\right)_l. \tag{2}$$

The eqn. (2) is obtained from eqn. (1) by the summation over the simultaneous fluctuations within the spherical shell, where k denotes a partition, k fundamental fluctuating pieces of the simultaneous spacelike spherical shell within a t-sliced hypersurface. This sum gives the entire fluctuation within the shell. Since these pieces are within a hypersurface of simulteneity, they have got the same cosmological instant t. Hence, they have the same $R(t)$ and $\dot{R}(t)$, the reason why the summation index l does not take into account the common factor at the right-hand side of the eqn. (2). From eqn. (57) in [1], we rewrite the eqn. (2):

$$\sum_{l=1}^{k}\left(\delta E_\rho\right)_l = \left.\frac{E_0^+ R_0^2}{R^3\sqrt{1-\dot{R}^2/c^2}}\right|_t \sum_{l=1}^{k}\left(\delta R\right)_l. \tag{3}$$

Now, we have a sum of instantaneous fundamental fluctuations within the spherical shell, giving the total instantaneous fuctuation within this shell. Being the instantaneous spherical shell full of cosmological fluid at t, at each fundamental position with local indeterminacy R_0, within the shell, there is an instantaneous fundamental fluctuation δE_ρ. Hence, the total fluctuation is quantized:

$$N_t\delta E_\rho = N_t R_0 \left.\frac{E_0^+ R_0^2}{R^3\sqrt{1-\dot{R}^2/c^2}}\right|_t, \tag{4}$$

where N_t is the number of instantaneous fundamental domains, the number of fundamental fluctuations within the instantaneous spherical shell contained within a t-sliced hypersurface of simultaneity; R_0 is the same common fundamental quantum of local indeterminacy, the same $(\delta R)_l$ radial quantum fluctuation at a given point within the instantaneous spherical shell contained in a t-sliced surface of simultaneity $\forall\ l$. But $N(t)$ is given by:

$$N(t) = \frac{R^3}{R_0^3}. \tag{5}$$

Using the eqn. (5) in the eqn. (4), we obtain:

$$N_t\delta E_\rho = \frac{E_0^+}{\sqrt{1-\dot{R}^2/c^2}}. \tag{6}$$

The eqn. (6) gives the total positive fluctuation whitin the instantaneous spherical shell, the result used in my postulate in [1]. Furthermore, comparing the eqns. (1) and (6), we see the infinitesimal relation given by the eqn. (1) is valid in the finite fluctuation process given by the eqn. (6), provided $\dot{R}\delta\dot{R} \approx c^2$, the result used in the appendix of [1] to obtain the eqn. (56) in [1]. And the Heisenberg indeterminacy principle reads, for the entire fluctuation at a given t:

$$\left(N_t\delta E_\rho\right)\delta t = \frac{E_0^+\delta t}{\sqrt{1-\dot{R}^2/c^2}} \geq \frac{h}{4\pi}. \tag{7}$$

The increasing smearing out position indeterminacy related to the primordial indeterminacy in virtue of the Universe expansion postulated in [1]:

- The actual energy content of the universe is a consequence of the increasing indeterminacy of the primordial era. Any origin of a comoving reference frame within the cosmological substratum has an inherent indeterminacy. Hence, the indeterminacy of the energy content of the universe may create the impression that the universe has not enough energy, raising illusions as dark energy and dark matter speculations. In other words, since the original source of energy emerges as an indeterminacy, we postulate this indeterminacy continues being the energy content of the observational universe: $\delta E(t) = E^{+}(t) = E_0^{+}/\sqrt{1-\dot{R}^2/c^2}$,

follows from the increasing N_t, as one infers from the eqns. (5) and (7).

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[1] A. Assis, Progress in Physics **3-2011**, 58 (2011).