On the Cold Big Bang Cosmology and the Flatness Problem

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In my papers [3] and [4], I obtain a Cold Big Bang Cosmology, fitting the cosmological data, with an absolute zero primordial temperature, a natural cutoff for the cosmological data to a vanishingly small entropy at a singular microstate of a comoving domain of the cosmological fluid. Now, in this brief paper, we show the energy density of the t-sliced universe must actually be the critical one, following as consequence of the solution in [3] and [4]. It must be pointed out that the result obtained here in this paper on the flatness problem does not contradict the solution in [3], viz., does not contradict the open universe, with $k = -1$, obtained in [3], since the solution in [3] had negative pressure and negative total cosmological energy density, hence lesser that the critical positive density. The critical density we obtain here is due to the positive fluctuations I previously discussed regarding the Heisenberg mechanism in [4]. Hence, the energy density due to fluctuation turns out to be positive, the critical one, this being calculated in [4] from the fluctuations within the t-sliced spherical shell at its t-sliced hypersurface, being the total energy density that generates the fluctuations, actually, negative in [3] and [4], hence, again, lesser than the critical one and supporting $k = -1$. These results are complementary and support my previous results.

1 Explaining the observed critical energy density for the cosmological substratum

The proof is straightforward. Recalling the t-sliced spherical shell defined in [4], we proved its energy at the instant t of the cosmological time is given by:

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

being the Eq. (6) in [4] and the Eqs. (56) and (59) in [3]. From the Eq. (36) in [3], the Eq. (1) is simply rewritten:

$$E^+ = \frac{c^4 R}{2G}, \tag{2}$$

from which the energy density of the t-sliced spherical shell pertaining to its t-sliced hypersurface of simultaneity, being full of its t-simultaneous cosmological points of the substratum, turns out to be given by:

$$\rho_t = \frac{c^4 R}{2G}\frac{3}{4\pi R^3} = \frac{3c^4}{8\pi G}\frac{1}{R^2}. \tag{3}$$

Now, once defined the Hubble parameter for the spherical shell of the t-sliced hypersurface, centered at its comoving origin, namely H_t:

$$H_t = \frac{\dot{R}}{R}, \tag{4}$$

one obtains the energy density of the t-sliced spherical shell pertaining to its t-sliced hypersurface of simultaneity from the Eqs. (3) and (4):

$$\rho_t = \frac{3c^2 H_t^2}{8\pi G}\frac{c^2}{\dot{R}^2}. \tag{5}$$

Now, Eq. (35) in [3] shows $\dot{R}$ very rapidly reaches c. Hence, the energy density ρ_t of the t-sliced spherical shell pertaining to its t-sliced hypersurface of simultaneity actually is the very critical energy, viz.:

$$\rho_t \to \rho_{\text{crit}} = \frac{3c^2 H_t^2}{8\pi G}, \tag{6}$$

very rapidly, and it will continue being the critical energy density ρ_{crit} forever*. The time domain within which ρ_t deviates from the critical is $t \approx 0$, at which it reads:

$$\rho_0 = \frac{3c^7}{16\pi G^2 h} \approx 10^{111} J m^{-3}, \tag{7}$$

provided the energy density ρ_t of the t-sliced spherical shell being given by the Eq. (3) and with the $R_0 = \sqrt{2Gh/c^3}$ obtained in [3]. The Hubble parameter vanishes at $t = 0$ in our model†.

Universe is initially fine-tuned, naturally, due to its initially vanished entropy

Under the solution in [3], there is just an unique initial state for the cosmological substratum with its initial null entropy. As discussed in [3], Eq. (39), the temperature T of the cosmological substratum at each comoving domain vanishes at $t = 0$. Once permeated by radiation, the local entropy turns out to be proportional to T^3, with a local volume V of the t-sliced substratum proportional to $R_0^3 \neq 0$, with $R_0 = \sqrt{2Gh/c^3}$ as

*It will continue being given by the Eq. (6), but its value tends to vanish, as one easily infers from the Eq. (3). See [3] and [4].

†See [3] and [4].

discussed in [3]. Hence, the initial local entropy, at $t = 0$, at each comoving domain reads:

$$S\big|_{t=0} = \left.\frac{32\pi^5 k_B^4}{45h^3c^3} VT^3\right|_{t=0} = 0, \tag{8}$$

Hence, the solution in [3] naturally provides the required flatness, given by the Eq. (6) here, with an unique initial condition for the cosmological substratum, the minimal, initially vanished, entropy.

Conclusion

We conclude the cosmological model obtained in [3] and [4] provides the critical energy density for the t-sliced spherical shell pertaining to its t-sliced hypersurface of simultaneity of the cosmological substratum. One may explain the initial condition *ex post* in [3], since the vanished entropy explains the unicity for the solution in [3]. It is interesting the indeterminacy principle turns out to provide such an unicity for the solution.

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