ABOUT PRESSURE IN MODEL OF THE EXPANDING UNIVERSE

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Closed model of Universe on the earlier stage of its evolution is defined more precisely. It is considered here that after the Big Bang and De Sitter's (exponential) expanding phase in which the pressure is $p = -c^2\rho_c$ (see [1-3]) the post De Sitter's stage is beginning. State equation on this stage is written in the form $p(R) = -c^2\rho(R)A(R)$, where $A(R)$ is some pure geometrical factor. Here this equation is investigated and boundary conditions for it are formulated. Explicit expression for $A(R)$ in the class of almost periodical functions is found, that permits to integrate the conservation law. Outgoing from this we come to the following conclusion: at the post De-Sitter's stage the configuration space of Universe is the Bohr's compact. Manifold $\Re$ on which acceleration is positive $\ddot{R} > 0$ are found. Due to the vibrant character of depending $A(R)$ this manifold may advance far in future that is compatible with observed data.

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1. INTRODUCTION

As is known (see for example [4]), the main evolution equations in the Friedman's model of Universe are written in the form

$$\frac{\zeta}{R^2} + \left(\frac{\dot{R}}{cR}\right)^2 = \frac{8\pi G}{3c^2}\rho\,,\quad \ddot{R} = -\frac{4\pi G}{3c^2}(c^2\rho + 3p)R\,,$$

$$\frac{d}{dR}(c^2\rho R^3) = -3pR^2 \qquad (1)$$

(the third equation (conservation law) is a consequence of the first two ones), where ρ and p are mass (energy) density and pressure in Universe (always $\rho > 0$). If also to take into account so called cosmological constant λ (which for Einstein's ether is $\lambda > 0$), one needs to make the substitution in equations (1)

$$p \to p - \frac{\lambda c^2}{8\pi G},\quad \rho \to \rho + \frac{\lambda}{8\pi G}.$$

Formally (without clearing up of λ physical meaning) it may be considered two limiting cases: a) $\rho, p/c^2 >> \lambda/G$ (the Friedman's limit, herein $\ddot{R} < 0$, if $p > -c^2\rho/3$) and b) $\rho, p/c^2 << \lambda/G$ (the De Sitter's limit, herein $\ddot{R} > 0$). In the case b) the De Sitter's evolution equation is $\frac{\zeta}{R^2} + \left(\frac{\dot{R}}{cR}\right)^2 = \frac{\lambda}{3}$. In [5] it is supposed that the case b) is realized in the beginning of Universe evolution and is called there inflation (hereby λ is considered as a large magnitude which is connected with density energy of some hypothetic scalar field). After this (exponential) expansion the Friedman's stage is beginning. Nowadays there is just opposite tendency [6]: it is supposed that the case b) takes place in the end of Universe evolution (after finishing Friedman's expansion; hereby λ is considered as a very small magnitude connected with energy density of so called quintessence – some hypothetic media described by state equation $p = c^2\rho w$, where quantity $w < -1/3$; for Einstein's ether it is $w = -1$). Obviously both these hypothesis except each other.

2. LAGRANGIAN APPROACH

In contemporary cosmology one considers that from the dynamical point of view our Universe is always pure Lagrangian system (so that its main characteristic is some Lagrangian), and such a phenomenon as Big Bang took place namely in Lagrangian system (i.e. Big Bang is a Lagrangian explosion; as is known in such a system total energy is conserved, it is the famous E. Noether's theorem). After Big Bang, Universe evolution is described by the equations (1), from which it follows that for relativistic matter ($p = c^2\rho/3$), which after the explosion predominated over the non-relativistic one, and also for non-relativistic matter acceleration was negative: $\ddot{R} < 0$. However at space expansion (in the end of Friedman's evolution) density and pressure of matter decreases so much that the quintessence (or Einstein's ether) begins to play the decisive role (hereby it is considered that all time λ has a constant magnitude). Apparently the only consequent physical interpretation of cosmological constant λ is connected with mass m of quanta of metric field $g_{\mu\nu}$ (although notion of such a quanta is highly problematic, see [7]). In result the De-Sitter's (exponential) regime of expansion with positive acceleration $\ddot{R} > 0$ is coming. So according to this idea initial (Friedman's) phase of expansion with $\ddot{R} < 0$ is replaced by the phase with $\ddot{R} > 0$. The observations of radiation emitted some billions years back (red shift parameter $z \sim 10$) show [8]

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that at that time our Universe was *already* expanding with positive acceleration. However this result may be interpreted by another way: in that time (after the Big Bang and De Sitter's stage) our Universe was *still* expanding with positive acceleration. But nowadays it is expanding with negative acceleration. For such a statement there is a quite serious reason.

3. NON-LAGRANGIAN APPROACH. STATE EQUATION ON POST DE SITTER'S STAGE OF UNIVERSE EVOLUTION

According to the suggested in [1-3] model our Universe before the first Big Bang (in its zero cycle) has been an ensemble of the bi-Hamiltonian dynamical relativistic systems. In [1-3] such an ensemble is called ether (thus ether is the substance from which our Universe constituted before the first Big Bang). Mass of the ensemble (mass of Universe in zero cycle) equaled $M^{(0)} \sim 10^{45} g$, [1-3]. Ether is some kind of two level dynamical systems: its upper level f is characterized by positive energy and lower level $\dot{f}$ by negative one. The Big Bang is an irreversible total quantum transition $f \to \dot{f}$ taken place at the ether collapse (or at its condensation in result of which the state $\dot{f}$ arose). As a result of such a transition (confluence f with $\dot{f}$) the fundamental particles (Lagrangian matter) are arisen. Big Bang as a quantum jump is not described by any equation (jump is described by transition matrix element $\langle \dot{f}, f \rangle$, see [1-3]), but after explosion and forming usual particles (in the first cycle) dynamical (bi-Hamiltonian) type of Universe is changed: it becomes Lagrangian or Hamiltonian one. And only after this Universe is described by equations (1). In result of Big Bang (transition $f \to \dot{f}$, at which additional energy is secreted) mass of Universe becomes equaled $M^{(1)} \sim 10^{57} g$, [1-3] (hereby dimensionless parameter $M^{(1)} / M^{(0)} = \eta \sim 10^{12}$). Big Bang gives rise when ether density ρ is equaled (in result of collapse) to the critical maximally possible magnitude $\rho_c \sim 10^{30} g / cm^3$, [1-3]. At this time the radius of Universe (in zero cycle) was equaled $R^{(0)}_{\min} \sim 10^5 cm$ [1-3]. At constant density $\rho = \rho_c$ Universe expands to the size $R_s = \eta^{1/3} R^{(0)}_{\min} \sim 10^9 cm$ [1-3], that is determined from the formula $\rho_c R_s^3 = M^{(1)}$. At this stage pressure is constant $p = -c^2 \rho_c$ (it follows in particular from the third equation in (1)), and Universe expands according to the law $R(t) = R^{(0)}_{\min} e^{H_c t}$, where $H_c = \sqrt{\frac{8\pi G}{3} \rho_c} \sim 10^{11} s^{-1}$, that follows from the first equation in (1) (in which the member ς / R^2 may be omitted). Hereby mass of Universe changes according to the law $M(t) = M^{(0)} e^{3H_c t}$ (only it is compatible with 3-dimensionality of Universe space in zero cycle), where $0 < t < t_s = \ln\eta / 3H_c$. It is so called De Sitter's regime of expansion (in the end of it $\rho(R_s) = \rho_c$). Thus Universe expansion from the size $R^{(0)}_{\min}$ to the R_s is accomplished by indispensable energy pumping characterized by energy creation parameter $\rho_c H_c \sim 10^{40} g / cm^3 \cdot s$ (at this part of evolution the Universe is obviously non-Lagrangian system, see further). After finishing De Sitter's stage ($R = R_s$) a new, post De Sitter's stage is beginning (it may not be mixed with Friedman's one on which pressure $p \equiv 0$). On this stage (inertial expansion) energy is not pumped, mass of Universe $M^{(1)}$ [Note that only the smaller part of total mass (energy) of Universe $M^{(1)} = \eta M^{(0)}$ corresponds to the visible (charged) matter (for protons it is $\sqrt{\eta} M^{(0)} \sim 10^{51} g$, for electrons $\sim \eta^{1/4} M^{(0)} \sim 10^{48} g$, see [1-3]). The larger part of it ($\sim 10^{57} g$) spends on the expansion of space S^3 (it is *dark energy*)] does not change and connection between pressure and mass density (state equation) is another. Taking into account that on the previous stage this connection had the form $p = -c^2 \rho_c$, we consider that on the post De Sitter's stage (at $R > R_s$) state equation has the form

$$p(R) = -c^2 \rho(R) A(R). \quad (2)$$

Here p and ρ are physical characteristics of Universe and $A(R)$ is some pure geometrical factor satisfying the boundary conditions $A(R_s) = 1$, $\lim_{R \to \infty} A(R) = 0$. We show further that the last condition playing important role in Friedman's model is not obligatory: ratio $p / c^2 \rho$ may be small in another sense. Note, that the mean value of such function (in particular of $p / c^2 \rho$) upon almost its period has a small magnitude; in this sense the ratio $p / c^2 \rho$ is small only. Function $A(R)$ as a pure geometrical factor can not be connected with any property of matter. In fact after finishing the De Sitter's stage and stopping energy pumping (the number of transitions $f \to \dot{f}$ is finite, it is not bigger, than quantity of quanta f in zero cycle equaled 10^{75}, see [1-3]) space of Universe expands on inertia. Hereby matter particles continue to arise in every space point without any relative motions giving rise to pressure: at expansion (increasing of Universe radius R) particle coordinates on the sphere S^3 stay unchanged, particles are in rest. Therefore *pressure of matter* is zero $p = 0$ (that was taking into account in [1-3]). The formula (2) does not describe the matter pressure (apparently necessity in a new form of matter in connection with the equation (2) is not, in fact for matter ratio $p / c^2 \rho$ is always $1/3$

[9] meanwhile $A(R)$ in (2) may achieve the value -1, i.e. maximal rate of $p/c^2\rho$ is 1, see (11)), it describes joint reaction of space and matter on the Big Bang. Note if $A(R)=1$ at $R>R_s$, so the De Sitter's stage would be continue beyond the R_s (it follows from the conservation law at $p=-c^2\rho$), however it is impossible because energy pumping must stop (quantity of transitions $f\to\dot{f}$ is terminated). Emphasize that configuration space is not expanded at Lagrangian (or Hamiltonian) explosion of matter: in Lagrangian (Hamiltonian) system configuration space exists in already ready form. Writing the "conservation" law (third equation in (1)) in the form

$$d(\ln\rho R^3)=3A(R)\frac{dR}{R} \tag{3}$$

and integrating it we get

$$\rho(R)=\frac{M^{(1)}}{R^3}e^{3B(R)}, \tag{4}$$

where $M^{(1)}=\rho(R_s)R_s^3$, and

$$B(R)=\int_{R_s}^{R}A(R')\frac{dR'}{R'}. \tag{5}$$

It is comfortable to write the function $A(R)$ in the form $A=R\frac{dB}{dR}$ where $B(R)$ satisfies the boundary conditions $B(R_s)=0$ (that is obviously) and $B(\infty)=0$. In fact if $B(\infty)\neq 0$ so at $R\to\infty$ density ρ would be equaled $\rho=\widetilde{M}^{(1)}/R^3$, where $\widetilde{M}^{(1)}=M^{(1)}e^{3B(\infty)}\neq M^{(1)}$. However in Lagrangian system it is impossible: total energy (mass) of Universe must be conserved. Note on the post De Sitter's stage Universe is Lagrangian system: there is Lagrangian $L=T-U$, where $T=M^{(1)}\dot{R}^2/2$ and $U=-4\pi G M^{(1)^2}e^{3B(R)}/3R$ from which motion equation (second equation in (1)) and conserving Hamiltonian $H=T+U=-\zeta M^{(1)}c^2/2$ (first equation in (1)) follow. At $M^{(1)}(t)$ depending on time (on the De Sitter's stage), Universe is not Lagrangian. In connection with this we note that there is a "Lagrangian" $L/M^{(1)}(t)=\dot{R}^2/2+4\pi G\rho_c R^2/3$, concerning mass unite which describes the oscillator with image frequency iH_c. Automatically both conditions for $B(R)$ may be satisfied if we write $B(R)$ in the form of

$$B(R)=\frac{1}{R}\int_{R_s}^{R}C(R')dR', \tag{6}$$

where $C(R)$ is a summed function on interval $[R_s,R[$. Hereby all three functions A,B,C are connected by the relation (it is needed only to differentiate formula (6))

$$A+B=C \tag{7}$$

hereat C satisfies the boundary conditions $C(R_s)=1, C(\infty)=0$ (however the last condition is indeed not obligatory, see below Eq. (8)). It is essential to emphasize hereby that contribution in A (in pressure) from quite large class of singular and step functions $B(R)$ vanishes without living a trace because for such functions we have almost everywhere $\frac{dB}{dR}=0$, i.e. $A=0$, and therefore formula (4) is written in the form $\rho(R)=\frac{M^{(1)}}{R^3}$ (pressure $p=0$ and integral $\int\frac{dB}{dR}dR=0$). These functions are not restored on their derivatives, see [10]. Therefore further cosmological problem is considered solely in the class of *absolutely continuous* functions. Considering only continuous functions (without step functions) note that (7) is the well-known Lebesgue formula representing continuous function (C) as a sum of absolutely continuous (A) and singular (B) functions (continuous functions is called singular one if its derivative equals zero almost everywhere, see [10]; the well known example of such a function gives Cantor's staircase). If in (7) there is no absolutely continuous function ($A=0$), so $C=B$ and formula (6) leads to the integral equation for B

$$B(R)=\frac{1}{R}\int_{R_s}^{R}B(R')dR'. \tag{6.1}$$

It is the degenerate case of the homogeneous Volterra equation. Formula (6.1) may be considered as an integral characteristic of singular function; from it the differential characteristic $B'(R)=0$ follows (note that (6.1) does not take place for step functions). Actually consideration of cosmological problem based on singular functions (zero pressure) is given in [1-3]. We may indicate the suitable functions for the problem. Note first of all if the function C is given so the functions A,B are given too according to (6). To choose the suitable class of functions C the following circumstance helps us. Formula (6) determines function B as the mean value of $C(R)$ on the interval $[R_s,R[$ (so that $B(R)=\overline{C}(R)$). In expanding Universe the upper limit R in (6) depends on time t and grows with growing t. Hereby in open models ($\zeta=-1;0$; in these cases kinetic energy of expansion is always more than potential energy of gravitational interaction) R tends to ∞ at $t\to\infty$ (Universe behaves like a white hole). At the limit $R\to\infty$ integral $\lim_{R\to\infty}\frac{1}{R}\int_{R_s}^{R}C(R')dR'$ determines so called the Bohr's mean value of function C. Therefore it is natural to take $C(R)$ from the class of almost periodical functions on the ray $[R_s,\infty[$ which is denoted A_B. Strictly speaking [1-3] this class is factor-ring A'/A, where A' is ring of continuous functions on ray $[R_s,\infty[$ and A is maximal ideal in A' consisting of functions $C(R)$ obeying the condition $C(\infty)=0$. Note, the solution with dissipation belongs to A (hereby we have to consider not only this ray but all three dimensional space of Universe to be Bohr's compact, see [1-3]). Any such function is written in the form of generalized Fourier series [11] $C(R)=\sum_n c_n e^{ip_n \frac{R-R_s}{R_s}}$, where p_n is real and c_n is complex. Writing $c_n = a_n + ib_n$ we will have for real function satisfying the required boundary conditions (see above)

$$C(R)=\sum_n (a_n \cos p_n \frac{R-R_s}{R_s} - b_n \sin p_n \frac{R-R_s}{R_s}) \quad (8)$$

(in our case all $p_n \neq 0$, sum $\sum_n a_n = 1$ and b_n may be arbitrary. Note, mean value of such a function (in particular of $p/c^2\rho$) upon its almost period is a small magnitude. In this sense the ratio $p/c^2\rho$ is small only). However we are interested in another, closed model ($\zeta = 1$; note, only this value of ζ is compatible with conditions of Universe creation). Here R is restricted from above: $R \le R_g = 8\pi GM^{(1)}/3c^2$ (however R_g is indeed very large magnitude $R_g \sim 10^{29} cm$; Universe behaves like black hole, because its radius is always under the Schwarzschild's radius R_g). It is essential that in this model potential energy is more than kinetic one. Due to this not only Universe expansion is stopped but also momentum dissipation takes place in result of that the wave vectors are smearing (they become complex), i.e. $p_n = k_n + i\kappa_n$ (dimensionless k_n and κ_n we call universal wave vectors and decrement parameters). So in closed model real function C is written in the form ($\varphi_n = arctg \frac{b_n}{a_n}$, $C_n = \sqrt{a_n^2 + b_n^2}$)

$$C(R)=\sum_n C_n e^{-\kappa_n \frac{R-R_s}{R_s}} \cos(k_n \frac{R-R_s}{R_s} + \varphi_n) \quad (9)$$

with boundary condition $\sum_n c_n \cos\varphi_n = 1$ and $\pi/2 \le \varphi_n \le \pi/2$. At the obligatory condition $\kappa_n << k_n$ we have

$$B(R) \approx \frac{R_s}{R} \sum_n \frac{C_n}{k_n} [e^{-\kappa_n \frac{R-R_s}{R_s}} \sin(k_n \frac{R-R_s}{R_s} + \varphi_n) - \sin\varphi_n], \quad (10)$$

and also

$$A(R) = C(R) - B(R) \approx C(R) = \sum_n C_n e^{-\kappa_n \frac{R-R_s}{R_s}} \cos(k_n \frac{R-R_s}{R_s} + \varphi_n). \quad (11)$$

The solution (11) of the equation (2) we call the press (shock) wave in Universe. Further keeping only one item in sum (9) (under the simplifying condition $c=1, \varphi=0$), let us address to the inequality $1-3A<0$ (see the second equation in (1)), at fulfillment of which acceleration is positive $\ddot{R}>0$. At $R >> R_s$ this inequality is equivalent to the condition

$$\frac{1}{3} < e^{-\kappa \frac{R}{R_s}} \cos k \frac{R}{R_s}. \quad (12)$$

Inequality (12) has a solution in the form of non-connected manifold $\Re \subset \lfloor R_s, R_g \rfloor$. At $\kappa = 0$ (without dissipation) $\Re$ consists of segments $2\pi m - \arccos\frac{1}{3} < k\frac{R}{R_s} < 2\pi m + \arccos\frac{1}{3}$ where $m = 1,2...$ At $\kappa \neq 0$ numbers m are bounded from above because it must be at all $\frac{\kappa R}{R_s} < \ln 3$ (it follows from (12) at $k=0$). Hence $R < \frac{R_s}{\kappa}\ln 3$. Denoting $\frac{k}{\kappa} = M$ (it is quantity of connected components in $\Re$) we may approximately write $R < M\frac{R_s}{k}$. As k is small and M is large the length $M\frac{R_s}{k}$ may be very large. So components of $\Re$ on which acceleration $\ddot{R}>0$ may progress far in the future. A question about spectra of k and κ is arisen. We consider that the spectrum of k is connected with various phases (eras) in Universe evolution. At least there are a few different evidential phases distinguished by various value of Universe radius $R_n = R_s \eta^{n/3}$ [1-3]. So for hadron era $n=1$ (it begins at $n=0$ and finishes at $n=1$), for lepton one $n=2$, for atomic $n=3$, for galaxy $n=4$, for final era before stop of expansion $n=5$ (in our numeration the De Sitter's era begins at $n=-1$ and finishes at $n=0$). So interval from $R^{(0)}_{\min}$ to R_g we divide onto six eras (like octave consists of six big seconds: *as, b, c, d, e, fis*). Corresponding time of finishing of *n*-era may be calculated from the formula $t_n = H_n^{-1} = \sqrt{\frac{R_n}{R_g}}\frac{R_n}{c} = \tau\eta^{\frac{3n-5}{6}}$ where $\tau = R_s/c \sim 10^{-1}s$. Putting $R_n = R_s/k_n$ we will have $k_n = 1/\eta^{n/3}$. Let us consider when the *n*-era begins the preceding finishing (*n-1*)-era already decreased at least in e time. It means that $\kappa_{n-1}/k_n \sim 1$, i.e. $\kappa_n = 1/\eta^{\frac{n+1}{3}}$ and hence $M = \eta^{1/3} \sim 10^4$. Moreover considering *n*-era we may neglect all previous ones because they are described by fast oscillating (singular) items in (9) which do not give visible contribution in pressure at $R \sim R_s/k_n$. Further considering n-era we may put the contribution from the next (*n+1*)-era and following ones equaled $C_{n+1}\cos\varphi_{n+1}+...=0$ if $C_1\cos\varphi_1+...+C_n\cos\varphi_n=1$. So eras as if take part in relay race in which momentum from short wave lengths transfers onto long ones. The magnitude (frequency of pulsations) $\Omega_n = M/t_n = H_c/\eta^{\frac{3n-2}{6}}$ is important characteristic of *n*-era. As is known usually connection between k and κ is given by dispersion relations (cf. with [12]) however this approach is not utilized here. If to pay attention that the first four eras are very quick (they finish in $t_0 \sim 10^{-11}s$, $t_1 \sim 10^{-5}s$, $t_2 \sim 10s$, $t_3 \sim 10^7 s$; in these eras microstructure of Universe is formed) and only following era is long (it finished in $t_4 \sim 10^{13}s$) we may approximately unit all first four eras in one that will be characterized by $\varphi_3=0, C_3=1, k_3=1/\eta$. Then the next era is characterized by $\varphi_4=\mp\pi/2, C_4=1, k_4=1/\eta^{4/3}$. In this approximation neglecting dissipation we may use $C(R)=\cos(k_3R/R_s)\pm\sin(k_4R/R_s)$ (hereby we consider that sign plus corresponds to the closed model and minus – to open one). In our consideration the smallest value of k is $k_4 \sim 10^{-16}$. We consider that galaxy era (galaxy structure of Universe) is connected with k_4 i.e. $R_s\eta^{4/3} \sim 10^{25}cm$ is maximal size R_G of galaxy. As $R_s\eta^{4/3}=R_g\eta^{1/3}$ so we may conclude that our Universe consists of $\eta \sim 10^{12}$ galaxies. Conversely we may consider that galaxy structure of Universe testifies the Bohr's compact structure of configuration space of Universe. Now address to the first equation in (1). Not difficult to show that at $R-R_s << R_s$ dependence R on t is given by the formula $R(t)=R_s+\sqrt{\frac{8\pi GM^{(1)}}{3R_s}}t$ (where $\sqrt{\frac{8\pi GM^{(1)}}{3R_s}}=c\eta^{5/6} \sim 10^{20}cm/s$ is expanding velocity on this segment (emphasize it is analytical dependence on t). At $R_s << R << R_s/k$ we have another dependence $R(t)=R_s+(6\pi GM^{(1)})^{1/3}et^{2/3}$, and at $R_s/k << R << R_g$ (it is considered that $e^{3B(R)} \sim 1$) solution $R(t)=(6\pi GM^{(1)})^{1/3}t^{2/3}$ goes out on the Friedman's regime (acceleration is negative). At $\lambda << R << R_g$ we approximately have $t=\frac{\lambda^{3/2}}{c\sqrt{R_g}}\int_0^{R/\lambda}\sqrt{x}dx(1-\frac{3}{2}\frac{\sin x}{x})$ (here $\lambda=R_s/k$). Denoting $R_g/c=T$ we get from here

$$\frac{t}{T}=\frac{2}{3}\left(\frac{R}{R_g}\right)^{3/2}[1-\frac{9}{8}\sqrt{2\pi}\left(\frac{\lambda}{R}\right)^{3/2}+\frac{9}{4}\left(\frac{\lambda}{R}\right)^2\cos\frac{R}{\lambda}].$$

As is seen our expanding Universe pulsates (it as if breathes) but these pulsations of R in t are small. Practically R depends on t like in the Friedman's model: $R \sim t^{2/3}$. However pulsations of pressure is very important. Undoubtedly they together with gravity attractive affect played important role in forming of galaxy kernel and spacing between them. In order to consider a question about energy spectrum of $R(t)$ we have to apply the Fourier transform to the $R(t)$ (however we do not study this problem, note only the spectral density behaves like $\theta(\varepsilon)/\varepsilon^{5/3}$).

4. CONCLUSION

Here it is demonstrated how the recent cosmological observations [6, 8] might be coordinated with the relativistic bi-Hamiltonian dynamical system and Friedman's background of closed model of Universe (in (1) $\zeta=1$) without acceptance of supplementary hypothesis about quintessence (and *k*-essence) interpreted hereby quite freely. In fact, according to Aristoteles, quintessence and ether are synonyms, aren't they? Meaning of ether Aristoteles saw in its primogeniture: ether is the entity underlain our Worldbuilding. In connection with this we consider that in real cosmology it is quite enough only one hypothesis concerning Big Bang as an explosion taking place in the bi-Hamiltonian system (in ether): energy emitted in irreversible quantum transition originates in this system but not in Lagrangian one. In quantum Lagrangian system all processes are principally reversible (there is no time arrow) and go under the condition of strict fulfillment of conservation law of initial energy. On the contrary in bi-Hamiltonian system there exists time arrow: it is connected with non-unitary character of quantum theory of the system but here there is no energy conservation (hence such a system is an energy source) [1-3]. We also demonstrated here that in *R*-inhomogeneous Universe configuration space (Universe atlas on the post De Sitter's stage) is endowed by special topology in which it is so called Bohr's compact. Hereby micro-maps of this atlas where wave mechanics must be used are endowed by this topology too (one and the same boundary condition connected with the Bohr's compactification of configuration space, therefore pressure in cosmology and wave function in wave mechanics are almost periodical functions; from our point of view wave functions play the role of singular functions). A new kind of wave mechanics is connected with such a space structure, it is well adopted for description of special (living) form of matter [1-3].

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О ДАВЛЕНИИ В МОДЕЛИ РАСШИРЯЮЩЕЙСЯ ВСЕЛЕННОЙ

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Закрытая модель Вселенной на ранней стадии ее развития определена более точно. Считается, что после Большого Взрыва и де-ситтеровской (экспоненциально) расширяющейся стадии, на которой давление равно $p = -c^2\rho_c$ (см. [1-3]), начинается пост-де-ситтеровская стадия. Уравнение состояния на этой стадии написано в виде $p(R) = -c^2\rho(R)A(R)$, где $A(R)$ – некий чистый геометрический фактор. Исследовано это уравнение и сформулированы для него граничные условия. Найдено явное выражение для $A(R)$ в классе почти периодических функций, что позволяет проинтегрировать закон сохранения. Исходя из этого приходим к следующему выводу: на пост-де-ситтеровской стадии конфигурационное пространство Вселенной является боровски компактным. Найдено многообразие $\Re$, на котором ускорение является положительным, $\ddot{R} > 0$. Из-за вибрирующего характера зависимости $A(R)$ это многообразие может простираться дальше в будущее, что согласуется с наблюдаемыми данными.

ТИСК У МОДЕЛІ ВСЕСВІТУ, ЩО РОЗШИРЮЄТЬСЯ

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Закрита модель Всесвіту на ранній стадії її розвитку визначена більш точно. Вважається, що після Великого Вибуху й де-сітеровської стадії, що (експоненціально) розширюється і на якій тиск дорівнює $p = -c^2\rho_c$ (див. [1-3]), починається пост-де-сітеровська стадія. Рівняння стану на цій стадії написано у вигляді $p(R) = -c^2\rho(R)A(R)$, де $A(R)$ — якийсь чисто геометричний фактор. Досліджено це рівняння й сформульовані для нього граничні умови. Знайдено явний вираз для $A(R)$ в класі майже періодичних функцій, що дозволяє проінтегрувати закон збереження. Виходячи із цього, приходимо до наступного висновку: на пост-де-сітеровскої стадії конфігураційний простір Всесвіту є компактним за Бором. Знайдено різноманіття $\Re$, на якому прискорення є позитивним, $\ddot{R} > 0$. Через вібруючий характер залежності $A(R)$ це різноманіття може простиратися далі в майбутнє, що погоджується із даними спостереження.