ization of the constant of the deformation potential $\Lambda \to \Lambda I_0(a)$. This seemingly small change leads to an interesting consequence. In fact, the sound absorption coefficient determined from the dispersion equation (6) has at sufficiently small damping the value

$$\alpha \equiv \frac{2}{s} Im\, \omega = \sqrt{\frac{\pi}{2}} \Lambda^2 I_0^2(a) \frac{m^{1/2} N q}{\rho s (kT)^{3/2}} \left(\frac{q^2}{q^2 + \kappa^2} \right)^2, \qquad (7)$$

where κ is the reciprocal of the screening radius and T the temperature of the crystal. Consequently, the electronic sound absorption coefficient oscillates at a function of the parameter a, vanishing at values of a corresponding to the zeroes of the Bessel function. The most interesting is the dependence of α on the frequency (or on the wave number) of the sound. Thus, when $q \gg \kappa$ and $\vec{q} \parallel \vec{E}_0$ we have

$$\alpha(q) \sim q I_0^2 \left(\frac{e E_0 q}{m \Omega^2} \right),$$

so that when $a \gg 1$ we have

$$\alpha(q) = \text{const} \cos^2 \left(\frac{e E_0 q}{m\Omega^2} - \frac{\pi}{4} \right),$$

i.e., the $\alpha(q)$ dependence has a purely oscillatory character.

The predicted effect can be interpreted physically as a geometrical resonance between the amplitude of the electric oscillations in the high-frequency field $eE_0/m\Omega^2$ and the given sound wave $2\pi/q$. This phenomenon is analogous to geometrical resonance in a magnetic field (see, e.g., [2]), but the role of the electron revolution in the Larmor orbit is played in this case by the electron oscillations in the high-frequency field.

Measurement of the period of the oscillations of the sound damping can be used to determine the effective mass of the electron, and measurement of the amplitude can be used to separate the lattice and electronic contributions to the sound absorption.

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"PHOTON STORMS" IN THE HOT UNIVERSE

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The serious difficulties of the fluctuation theory of galaxy formation in the Fridman cosmological model has made it necessary to return to a discussion of the old idea of the existence, even at a relatively early stage of the evolution of the Metagalaxy, of some pregalactic structure variations greatly exceeding in amplitude the statistical fluctuations of the density. The most widespread concept is that of the static structure - condensations of excess baryons against a homogeneous radiation background [1,2]. However, in a number of respects this hypothesis is not fully satisfactory. This pertains principally to the origin of the proper motions of the galaxies and particularly to their rotation. In [3] we formulated an alternative hypothesis of dynamic structure, according to which vortical motions of the photon gas and the plasma dragged by it ("photon storms") existed in the universe during the epoch when the radiation energy density ϵ_r exceeded the energy density of the matter ϵ_m. The notion of the presence of noticeable macroscopic motions in the pregalactic medium is arrived at from the picture of modern dynamic motions of galaxies [4,5].

The "photon storm" hypothesis leads inevitably to the existence of four phases of the pregalactic evolution of the dynamic structure in the Metagalaxy: (I) The pre-Fridman stage, during which the turbulent motions determined the metric properties of space-time. (II) The phase of large-scale isotropy and almost complete homogeneity of the density ($\delta\rho/\rho \ll 1$). (III) The passage of the velocity of the turbulent motions through the sound barrier, and the generation of potential motions and large density perturbations ($\delta\rho/\rho \sim 1$). (IV) The phase of dissipation of the macroscopic motions and of the formation of gravitationally coupled systems.

The absence of damping of the motions (due to viscosity in a two-component mixture of radiation and plasma) up to phase IV requires that the largest scale of the storms be sufficiently large. This requirement, however, is not very stringent, and according to numerical estimates [3] the mass contained in the smallest non-attenuating scale does not exceed, at any rate, the mass of the largest metagalactic formation - a galactic cluster.

Let us dwell in greater detail on two critical stages of the evolution of the dynamic structure.

The existence of storm motions is compatible with the Fridman metric (phase II) if the largest scale of the storms is small compared with the characteristic length ct (the latter is the distance to the horizon in the models with cosmological singularity). The mathematical aspect of this situation is close to the solution [6] of the linearized equations of the general theory of relativity for storm motions in an isotropic cosmological model.

The storm (s) motions generate, as a result of the hydrodynamic nonlinearity, potential (p) motions and corresponding density perturbations [7,8]:

$$\frac{v_p}{v_s} \sim \frac{v_s^2}{u^2}, \quad \frac{\delta\rho}{\rho} \sim \frac{v_p}{v_s}.$$

During phase II, when $\epsilon_r > \epsilon_m$, the speed of sound u is close to the speed of light, $u = c/\sqrt{3}$. For subsonic storms the quantities v_p/v_s and $\delta\rho/\rho$ remain quite small. However, during the course of the subsequent expansion recombination of the helium-hydrogen plasma sets in, starting with helium, and turns off in final analysis the interaction between the plasma and the radiation. The elasticity of the medium is greatly decreased thereby, and with it the speed of sound. If the speed of sound shortly before the recombination is

$$u \simeq (kT/m)^{1/2}(n_r/n_m)^{1/2},$$

then soon after recombination

$$u \simeq (kT/m)^{1/2}.$$

The ratio of the photon density n to the nucleon density n_m is a constant and rather large quantity, equal, according to modern data, to 10^9 - 10^{10}. During this relatively short time interval, when u experiences a strong jump, v_s remains practically unchanged. This results in scales in which $v_s > u$. In these scales, according to the presented formulas, rather large density perturbations can be generated. The efficiency of generation in a scale R depends on the ratio of the characteristic time $t_{sp} = R/v_s$ of the interaction of the (s) and (p) motions to the characteristic time of the cosmological expansion $t_{exp} = (d \ln \rho/dt)^{-1}$. In the region of scales where $v_s(R) > v_{exp}(R)$, where v_{exp} is the velocity of the regular expansion, the transition of the macroscopic motions into the supersonic mode, accompanied by shock-wave formation, gives rise to strong density disturbances. At a spectral turbulence index $n < 1$ ($v_s \sim R^n$) the conditions for the generation of the inhomogeneities are readily satisfied in small scales.

The fate of the density perturbations belonging to two scale regions, where $t_{sp} \lesseqgtr t_{exp}$, is appreciably different. In large scales, where

$$v_s(R) < v_{exp}(R),$$

the regular expansion is not fully suppressed. The resultant condensations continue to expand, albeit more slowly than the cosmological background. These large-scale condensations can be identified with galactic clusters. Within the framework of the present approach, the expansion of galactic clusters, which is evidenced by many astronomical data, can be naturally attributed to relict cosmological expansion.

At small scales, where $v_s(R) \geq v_{exp}(R)$, the cosmological expansion is fully suppressed. The corresponding condensations are subsequently transformed into galaxies, and the equality sign in the foregoing condition corresponds to the upper limit of the mass of the galaxy.

In order for a galaxy (gravitationally-coupled system) to be formed it is necessary that, besides the appearance of a density condensation with $\delta\rho/\rho \gtrsim 1$, also the total energy of the condensation be negative. The latter condition is not satisfied at the instant when the inhomogeneities are generated. The mechanism that ensures the transition of the condensation energy through zero is the dissipation of the kinetic energy followed by heat dissipation. The decrease of the kinetic energy continues until the condition for gravitational compression is satisfied for each individual condensation. Its compression automatically switches off the inelastic collisions at precisely that level of the total energy which is required for the formation of the coupled system. This transformation is the second qualitative jump (following the transition of the motions into the hypersonic mode) in the evolution of the metagalactic structure.

In conclusion we emphasize that the main role in the formation of the pregalactic conensations is poayed by hydrodynamic instability, whereas the role of the gravitational intability becomes appreciable only at a relatively later stage and evolves in the nonlinear egime.

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