To the form of equilibrium radiation in plasma model of early Universe and in a dense low-temperature plasma

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The equilibrium distribution of electromagnetic radiation (Planck radiation or the black body radiation) is generalized for the system containing an extremely dense fully ionized plasma (S.A. Trigger, Phys. Lett. A 370 (5), p. 365, 2007).

The spectral distribution of the emitted in vacuum radiation is the Planck distribution with high accuracy. At the same time there exists a medium, plasma, in which the electromagnetic radiation can exist without damping or with a weak damping, and it possesses the dispersion $\omega = \sqrt{c^2k^2 + \Omega_p^2}$, different than that in vacuum, where $\omega = ck$. Therefore, the gap in the spectrum of radiation distribution for $\omega < \Omega_p$ and the deviation from the Planck distribution are exist. Consideration of the adiabatic character of radiation expansion in early Universe leads to the conclusion that equilibrium distribution of the primordial radiation in the presence of charged particles could be different from the Planck distribution in some regions of the spectrum. The conditions of the adiabatic expansion of radiation for the model of the early Universe are found. The thermodynamic functions of such radiation are the functions of the dimensionless parameter $\hbar\Omega_p/T$. When $\hbar\Omega_p/T \ll 1$, the thermodynamic functions for radiation closely coincide with the ones obtained with the Planck distribution. However, in the case when $a \equiv \hbar\Omega_p/T \geq 1$ the situation dramatically changes. Realization of this latter condition in the early Universe seems possible, because a(t) monotonically decreases in time for the model of primordial plasma with a fixed composition. In this case our understanding of the history of the Universe is modified. Possible applications to the dense plasma-like systems in the Earth conditions (e.g., to liquid metals) are discussed.