New Fundamental Light Particle and Breakdown of Stefan-Boltzmann’s Law

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Recently, we predicted the existence of fundamental particles in Nature, neutral Light Particles with spin 1 and rest mass \( m = 1.8 \times 10^{-26} m_c \), in addition to electrons, neutrons and protons. We call these particles Light Bosons because they create electromagnetic field which represents Planck’s gas of massless photons together with a gas of Light Particles in the condensate. Such reasoning leads to a breakdown of Stefan–Boltzmann’s law at low temperature. On the other hand, the existence of new fundamental neutral Light Particles leads to correction of such physical concepts as Bose-Einstein condensation of photons, polaritons and exciton polaritons.

1 Introduction

First, the quantization scheme for the local electromagnetic field in vacuum was presented by Planck in his black body radiation studies [1]. In this context, the classical Maxwell equations lead to appearance of the so-called ultraviolet catastrophe; to remove this problem, Planck proposed the model of the electromagnetic field as an ideal Bose gas of massless photons with spin one. However, Dirac [2] showed the Planck equations lead to appearance of the so-called ultraviolet catastrophe. First, the quantization scheme for the local electromagnetic field in vacuum was presented by Planck in his black body law at low temperature. On the other hand, the existence of new fundamental neutral Light Particles breaks Stefan-Boltzmann’s law for black body radiation at low temperature.

2 Breakdown of Stefan-Boltzmann’s law

Now, we consider the results of letter [3], where the average energy density of black radiation \( \frac{U}{V} \) is represented as:

\[
\frac{U}{V} = \frac{mc^2 N_{LT}}{V} + \frac{2}{V} \sum_{0 \leq k < k_0} \hbar c k T \frac{k}{k^2} \frac{1}{e^{\frac{k}{k} T} - 1},
\]

where \( \frac{mc^2 N_{LT}}{V} \) is a new term, in regard to Planck’s formula (1), which determines the energy density of Light Particles in the condensate; \( \frac{2}{V} \sum_{0 \leq k < k_0} \hbar c k T \frac{k}{k^2} \frac{1}{e^{\frac{k}{k} T} - 1} \) is the average energy density vanishes in Eq.(1), i.e. \( \frac{U}{V} = 0 \), which follows from Stefan-Boltzmann’s law.

However, as we show, the existence of the predicted Light Particles breaks Stefan-Boltzmann’s law for black body radiation at low temperature.
\[ L_k^2 = \frac{\hbar^2 k^2}{2m} + \frac{m^2 c^2}{2} - \hbar k c. \]  

(5)

Our calculation shows that at absolute zero the value of \( \overline{L_k^2} \overline{i_k} = 0 \), and therefore the average energy density of black radiation \( \frac{U}{V} \) reduces to

\[ \frac{U}{V} = \frac{mc^2 N_{0,T=0}}{V} = \frac{mc^2 N}{V} - \frac{m^4 c^5 B(2, 3)}{4\pi^2 \hbar^3} \approx \frac{mc^2 N}{V}, \]

(6)

where \( B(2, 3) = \int_0^1 x(1-x)^2 dx = 0.1 \) is the beta function.

Thus, the average energy density of black radiation \( \frac{U}{V} \) is a constant at absolute zero. In fact, there is a breakdown of Stefan-Boltzmann’s law for thermal radiation.

In conclusion, it should be also noted that Light Bosons in vacuum create photons, while Light Bosons in a homogeneous medium generate the so-called polaritons. This fact implies that photons and polaritons are quasiparticles, therefore, Bose-Einstein condensation of photons [7], polaritons [8] and exciton polaritons [9] has no physical sense.

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