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Radiation in Nonequilibrium Relativistic Plasmas and Many-particle QED

With recent high-energy short pulse laser techniques, relativistic plasmas can be produced in laboratory experiments. Radiation transport is of fundamental interest in such laboratory plasmas as well as in astrophysical plasmas. Many-particle QED is applied to kinetic theory of radiative processes in many-component plasmas with relativistic electrons and nonrelativistic heavy particles. Within the framework of nonequilibrium Green's function technique, transport and mass-shell equations for fluctuations of the electromagnetic field are obtained. We show that the transverse field correlation functions can be decomposed into sharply peaked (non-Lorentzian) parts that describe resonant (propagating) photons and off-shell parts corresponding to virtual photons in plasmas. Analogous decompositions are found for the longitudinal field correlation functions and the correlation functions of relativistic electrons. As a novel result a kinetic equation for the resonant photons with a finite spectral width is derived. The influence of plasma effects and collisional broadening of the relativistic quasiparticle spectral function on radiative processes is discussed. The elaboration of nonequilibrium QED for correlated systems is a challenge for theory, being of relevance for new effects that are expected in plasmas at ultrahigh energy densities.