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Correction of the Cooper-Frye prescription

We consider a single-particle spectrum of secondary hadrons created in relativistic nucleus-nucleus collisions. The particles are radiated from the system (fireball) which exhibits a sharp kinetic freeze-out: space-like and time-like hypersurfaces separate the exited (interacting) system of particles from its noninteracting stage of the evolution process. The standard and widely used method to get the spectra is the so-called Cooper-Frye prescription (CFp), that treat the system at the decay stage of evolution as a locally equilibrated ideal gas at a space-like hypersurface. Meanwhile, this prescription presents some serious problems, because, usually, the freeze-out hypersurface contains nonspace-like sectors. We propose a certain correction of the CFp which allows to drop out the problem. We prove that the corrected prescription is valid for both pieces of the freeze-out hypersurface, for the space-like and for the time-like as well. It is important to note, that the problem of negative contribution to the spectra, caused by integration over a time-like piece of the hypersurface, emerges for a "model" distribution function (MDF), for instance when one takes a distribution function defined for local thermodynamic equilibrium. Meanwhile, there is no such a problem for a "true" distribution function, which can be obtained, for instance, from the transport Boltzmann equation. We show also, that even for MDF the corrected CFp gives a right result. Indeed, in this case the integration over the time-like piece of the hypersurface gives negative contribution which is compensated by the positive contribution obtained as a result of integration over a proper piece of the space-like hypersurface.

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