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Transverse Momentum Spectra of Hadrons in the Blast-Wave Model with Local Equilibrium and Tsallis Statistics with Global Equilibrium

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In this study, we calculate the transverse momentum distributions of hadrons using two frameworks: the finite-volume blast-wave model under local equilibrium and the Tsallis-3 statistics model under global equilibrium. To implement the local equilibrium model, we analyzed the relativistic Planck and Ott transformations for thermodynamic quantities. The Planck transformations are derived from the conjugate fundamental thermodynamic potential, specifically the negative Lagrangian, with velocity as an independent state variable. In contrast, the Ott transformations, derived from the total relativistic energy as a function of velocity, face a theoretical limitation, as this energy does not qualify as a true thermodynamic potential. We developed consistent Boltzmann-Gibbs and Tsallis blast-wave models for finite-volume freeze-out firecylinders in heavy-ion collisions, incorporating Planck and Ott transformations to determine temperature and chemical potential in the laboratory reference frame K. Comparative analysis of local and global equilibrium models shows that Planck transformations yield consistent transverse momentum distributions, whereas Ott transformations exhibit significant discrepancies. Applying the Boltzmann-Gibbs blast-wave model with Planck transformations, we successfully described the experimental transverse momentum spectra of charged pions produced in heavy-ion collisions at high energies.

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