

Transport of energetic particles and nonlinear medium response in high-energy collisions within nonadditive statistics

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One of the methods of characterizing the hot and dense quark-gluon plasma (QGP) medium created in high-energy collisions involves studying the energy loss of high-energy particles passing through the quark-gluon plasma. It has been observed that the stationary distributions of high-energy particles such as the heavy quarks may be describable by the quasi-exponential functions appearing in nonadditive statistics [1,2]. Also, energy density perturbations can originate due to high-energy particles depositing energy inside the QGP medium. The initial perturbations generated in QGP propagate through the medium showing nonlinear features and undergo modification due to medium effects. If the perturbation remains stable, it can lead to particle production. Experimental observations showing power-law behaviour [3,4] indicate that the QGP medium may experience fluctuations, long-range correlation, and memory effect and nonadditive statistics provides a framework to study medium response when energetic particles pass through it.

First, a nonadditive generalization of the Boltzmann transport equation [5] leading to such a stationary state will be reviewed. In the Landau kinetic approximation, it reduces to the Plastino-Plastino equation. With the help of this equation one may calculate the drag and diffusion coefficients of energetic particles such as the heavy quarks passing through the QGP. Further, methods to calculate various transport coefficients (e. g. the jet-quenching parameter that may lead to an estimate of the shear viscosity to entropy ratio) will be described [6]. These estimations help compute differential energy loss, and establish a connection between the transport coefficients and the experimental observables like the nuclear suppression factor that indicates existence of a medium.

Second, the evolution of the energy density perturbation inside the hot QGP will be discussed with the help of the Euler equation with the help of nonadditive MIT bag equation of state. The effect of non-additivity on the stability of waves in the presence of an external magnetic field, that may be produced in high-energy collisions, will be discussed. This framework can be used to estimate the drag coefficient due to medium response and can be combined with the kinetic theory approach mentioned in the previous paragraph to study experimental observables in high-energy collisions.

References:

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