Stony Brook University
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Abstract

Fast Parton Interactions with Hot Dense Nuclear Matter

via Two-Particle Correlations at PHENIX

By

Michael P. McCumber

Deconfinement of color charge in nuclear matter at high energy density is a topic of considerable theoretical interest and experimental effort. Predicted in QCD, a new phase of deconfined matter, the quark gluon plasma, is thought to describe a transitional period of the early universe following the Big Bang. The extremely high energy density medium created in relativistic collisions of large nuclei at RHIC afford an opportunity to study the properties of quark gluon plasma in a laboratory setting.

Fast partons (quarks and gluons) transiting the produced medium have been observed to experience a large energy loss. Correlations between pairs of final state particles at high transverse momenta ($p_T \gtrsim 4$ GeV/c) map the hadron jets resulting from these partons and show that partons crossing the medium are nearly fully quenched. The mechanism of energy loss on length scales comparable to the nucleus is not fully understood, so more differential measurements are needed to constrain theoretical models. Quenching as a function of the path length through the medium adds a new dimension of experimental discrimination of energy loss and initial state geometry.

The transiting partons deposit energy locally in the medium. The resulting medium excitations may lead to measurable signals related to the medium properties. Pair correlations at low p_T ($\lesssim 4$ GeV/c) can reflect the medium response. Comparison of correlations in heavy ion collisions with baseline measurements in proton-proton collisions show modifications to the correlation shape and yields. Two new structures are found, both extended in rapidity, one centered at small azimuthal opening angle $\Delta\phi$ (known as the "ridge") and the other occurring at $\Delta\phi = \pi \pm 1.1$ ("shoulder"). Comparisons between the two raise the possibility that both phenomena may result from the same mechanism.

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