Stony Brook University
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Abstract

Study of long-range azimuthal and longitudinal correlations in high energy nuclear collisions at the LHC using the ATLAS detector

By

Sooraj Radhakrishnan

Azimuthal correlations between particle pairs having large pseudo rapidity separation (commonly called 'ridge') have been observed in p+p and p+Pb collisions. Different interpretations towards its origin, including collective transverse expansion of produced partons and initial state correlations enhanced by gluon saturation have been proposed. We present a detailed measurement of the ridge and associated Fourier harmonics (v_n) in p+Pb collisions at 5.02 TeV at the LHC using the ATLAS detector. The ridge correlations are found to persist to high p_T (~10 GeV). Fourier harmonics up to order 5 are measured and found to be non-zero. The first order harmonic v_1 shows a p_T dependence characteristic of origin from collective expansion. Results are also compared to Pb+Pb collisions at similar multiplicity. The measured harmonics from the two systems are found to agree with expectations from a conformally invariant collective expansion model for the origin of these correlations. Multi-particle azimuthal correlations and cumulants are often used to study global correlations from collective expansion in nuclear collisions. We also investigate the limitations of this approach in studying collectivity in small systems.

Long range correlations had also been measured in nuclear collisions, between total multiplicity produced at different pseudorapidities. We present a new method to measure these 'longitudinal correlations', using two particle correlations in pseudorapidity. The performance of the method is studied using the Monte-Carlo models, HIJING and AMPT. Measurements of the longitudinal correlations in p+p, p+Pb and Pb+Pb collisions at the LHC using the ATLAS detector are presented. A data driven approach is used to separate the short-range correlations (SRC) arising during later stages of the system evolution and the long-range correlations (LRC) sensitive to the initial conditions. The SRC show a strong system size dependence, largest in small collision systems. The correlation functions are expanded in an orthonormal basis of Legendre polynomials to study different shape components. We find the LRC is dominated by a linear anticorrelation between the forward and backward rapidities, and that the magnitude of this anticorrelation is similar between the three systems. The implications of these measurements in constraining the initial conditions along the longitudinal direction are discussed.

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