Overview of collective dynamics with STAR at RHIC

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Abstract

High-energy heavy-ion collisions offer a unique opportunity to study the dynamics of nuclear matter. Analyzing flow harmonics such as directed, elliptic, and higher order flow harmonics (v_1, v_2, and v_n, $n > 2$) provides insights into the dynamics and properties of the Quark-Gluon Plasma (QGP). The v_1 slope (dv_1/dy) at mid-rapidity of net-baryons is expected to be sensitive to the first-order phase transition. The number of constituent quark (NCQ) scaling of v_2 is considered a signal of the formation of QGP. Triangular flow (v_3), typically arising from initial state fluctuations, is expected to provide constraints on the initial state geometry and fluctuations.

In this talk, we will discuss measurements based on various data sets collected by the STAR experiment at RHIC, focusing on collective flow at top RHIC energy ($\sqrt{s_{NN}}$ = 200 GeV), the Beam Energy Scan (BES) program ($\sqrt{s_{NN}}$ = 3.0 to 62.4 GeV), including the Fixed Target (FXT) program ($\sqrt{s_{NN}} < 4.5$ GeV). This includes results from the data collected with Au+Au collisions, smaller systems such as O+O and Cu+Cu, as well as deformed nuclei such as Isobars (Ru+Ru and Zr+Zr) and U+U collisions. We will discuss transverse momentum (p_T), rapidity (y), and centrality dependence, as well as beam energy dependence of flow harmonics. The experimental results will be compared with model calculations to improve our understanding of the underlying physics mechanisms in heavy-ion collisions.