Probing Electromagnetic-field Effects and Coalescence Dynamics using Directed and Elliptic Flow of Identified Particles at STAR

(Dated: November 15, 2024)

Investigating the presence of an electromagnetic (EM) field in the quark-gluon plasma (QGP) has gained significant interest in heavy-ion collision studies. The EM field is a prerequisite for observing the chiral magnetic effect (CME) and could offer insight into the conductivity of QGP. Affecting positively and negatively charged quarks differently, the fleeting EM field contributes to the splitting between their directed flows (v_1) and eventually between particles and anti-particles. Features of initial baryon configuration may also impact the v_1 splitting between baryons and anti-baryons. In this talk, we present measurements of $v_1(y)$ and $\Delta(dv_1/dy)$ for $\pi^{\pm}$, $K^{\pm}$, and $p(\bar{p})$ in Au+Au collisions at $\sqrt{s_{NN}}$ =7.7-19.6 GeV and in U+U collisions at $\sqrt{s_{NN}}$ =193 GeV, as well as of $\Lambda^0(\bar{\Lambda}^0)$ and $\Xi^-(\bar{\Xi}^+)$ in Au+Au collisions at $\sqrt{s_{NN}}$ =7.7-27 GeV.

With the exception of $\pi^{\pm}$ at top RHIC energies, negative values of $\pi^{\pm}$, $K^{\pm}$ and $p(\bar{p})$ $\Delta(dv_1/dy)$ are observed in peripheral collisions in both Au+Au and U+U collisions. Clear system-size dependence can be observed for $p(\bar{p})$ $\Delta(dv_1/dy)$ with an ordering of U+U > Au+Au > isobar but not for $\pi^{\pm}$ and $K^{\pm}$. The measured $\Lambda^0(\bar{\Lambda}^0)$ $\Delta\,(dv_1/dy)$ is compared with $p(\bar{p})$ $\Delta\,(dv_1/dy)$ and the difference between $p(\bar{p})$ $\Delta\,(dv_1/dy)$ and $K^{\pm}$ $\Delta\,(dv_1/dy)$, motivated by the coalescence picture. These measurements are discussed with the expectation of EM-field effects dominated by Faraday induction and the Coulomb effect.

At lower RHIC energies, quarks transported to mid-rapidity become crucial in anisotropic flow measurements . In this talk, we also present measurements of the elliptic flow (v_2) of $\pi^{\pm}$ and $\bar{p}$ in Au+Au collisions at $\sqrt{s_{NN}}$ =7.7-27 GeV. The ratio $(v_2^{\pi^-} - \frac{2}{3}v_2^{\bar{p}})/(v_2^{\pi^+} - \frac{2}{3}v_2^{\bar{p}})$ is compared to the d/u ratio of the colliding nuclei, in view of a generalized coalescence sum rule that accounts for the difference between transported and pair-produced quarks.