Probing electromagnetic field with charge dependence of directed flow in STAR experiment at RHIC

Ashik Ikbal Sheikh (for the STAR Collaboration)

Department of Physics, Kent State University, Kent, OH 44242, USA

Email: asheikh2@kent.edu

Strong electromagnetic fields produced in the early stages of heavy-ion collisions can lead to splitting of the rapidity-odd directed flow (v_1) of positive and negative hadrons. However, the interpretation of such measurements with light hadrons is complicated by the low magnitude of directed flow at mid-rapidity or higher beam energy, as well as by ambiguities arising from transported quarks (u, d). In order to avoid such complications, we focus on the particle species where all constituent quarks are produced ($\bar{u}$, $\bar{d}$, s, $\bar{s}$), as opposed to possibly transported, and demonstrate using a novel analysis method that the coalescence sum rule holds for hadrons with identical quark content. We examine the coalescence sum rule as a function of rapidity for non-identical quark content having the same/similar mass at constituent level but different electric charge (Δq) and strangeness (ΔS). The difference in the directed flow of different quark and anti-quark combinations, e.g., $v_1(\Omega^-(sss)) - v_1(\bar{\Omega}^+(\bar{s}\bar{s}\bar{s}))$, is a measure of coalescence sum rule violation, and we call it directed flow splitting (Δv_1) between quarks and anti-quarks. First we measure v_1 as a function of rapidity; and then we estimate Δq and ΔS dependence of the Δv_1-slope ($d\Delta v_1/dy$) between produced quarks and anti-quarks in Au+Au collisions at $\sqrt{s_{NN}} =$ 27 GeV and 200 GeV. The $d\Delta v_1/dy$ increases when Δq and ΔS increase. This $d\Delta v_1/dy$ signal becomes stronger going from collision energy $\sqrt{s_{NN}} =$ 200 GeV to 27 GeV. We compare our measurements with the Parton-Hadron String Dynamics (PHSD) model calculations including electromagnetic field.