The splitting of directed flow for identified light hadrons (π, K, and p) and strange baryons (Ξ and Ω) in Au+Au and isobar collisions at STAR

In relativistic heavy-ion collisions, the directed flow (v_1) of hadrons can provide insights into the ultra-strong electromagnetic (EM) field [1, 2], the constituent quark content of hadrons [3], and the role of transported quarks [4]. Here, the first measurement is reported for rapidity-odd directed flow of Ξ and Ω in Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6, 27, and 200 GeV, as well as v_1 for identified charged hadrons with unprecedented precision in Au+Au and isobar collisions at $\sqrt{s_{NN}} = 200$ GeV. The coalescence sum rule is examined with various combinations of hadrons where all constituent quarks are produced. For such combinations a systematic violation of the sum rule is observed with increasing difference in the electric charge and the strangeness content of the associated constituent quarks. By comparing with the Parton-Hadron-String Dynamics model that includes an EM field, the results suggest that the constituent quark sum rule could be violated in the presence of a strong EM field that drives the v_1 of produced quarks and anti-quarks to opposite directions. The splitting of v_1 slope with rapidity ($\Delta(dv_1/dy)$) between positively and negatively charged hadrons (π, K, p) is also studied with large statistics. A clear transition of $\Delta(dv_1/dy)$ from positive in central collisions to negative in peripheral collisions is observed for protons and kaons. With the effects of both transported quarks and the EM field considered, it is found that the significant negative values in peripheral events can only be explained by the presence of an EM field with the Faraday or Coulomb effect being dominant.

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[1] U. Gursoy, D. Kharzeev, E. Marcus, K. Rajagopal and C. Shen, Phy. Rev. C **98**, 055201 (2018).
[2] U. Gursoy, D. Kharzeev and K. Rajagopal, Phy. Rev. C **89**, 054905 (2014).
[3] A. I. Sheikh, D. Keane and P. Tribedy, Phy. Rev. C **105**, 014912 (2022).
[4] Y. Guo, F. Liu and A. Tang, Phys. Rev. C **86**, 044901 (2012).