New Insights into Global Spin Alignment in Heavy-Ion Collisions: Measurements of ϕ, ω, ρ^0, and J/ψ at STAR

Dandan Shen, Zaining Wang, Gavin Wilks, Baoshan Xi (for the STAR collaboration)

Abstract

The global spin alignment of particles produced in heavy-ion collisions can reveal valuable information about the strong force field and the properties of the quark-gluon plasma. The STAR collaboration recently observed a large global spin alignment of ϕ-mesons in Au+Au collisions using the data from the first phase of the RHIC Beam Energy Scan program (BES-I) [1]. This cannot be explained by conventional mechanisms but may be attributable to the influence of vector meson force fields. In this contribution, we present new measurement of ρ^0 global spin alignment as a function of transverse momentum (p_T) and centrality for Au+Au, Ru+Ru, and Zr+Zr collisions at $\sqrt{s_{NN}} = 200$ GeV. We discuss the implications of our results for the search for the Chiral Magnetic Effect, as the global spin alignment of ρ^0 mesons can effectively influence the measurement of charge separation across the reaction plane. Additionally, we present new precision and differential measurements of ϕ-meson global spin alignment as a function of p_T, centrality, and rapidity (y) at $\sqrt{s_{NN}} = 7.7$, 14.6, and 19.6 GeV, using higher-statistics data from the BES-II program. Furthermore, we have conducted a comparative study of the global spin alignment of $\phi(s, \bar{s})$, $\omega(u, \bar{u}, d, \bar{d})$, and $J/\psi(c, \bar{c})$ through hadronic or leptonic decay modes in isobar collisions of Ru+Ru and Zr+Zr at $\sqrt{s_{NN}} = 200$ GeV. These studies with more differential measurements and with vector mesons of various quark contents aim to understand the role of the strong field in nuclear structure and the evolution of nuclear matter. The addition of new particle species and measurements through previously unexplored decay channels can help understand the intricate effects of in-medium and hadronization mechanisms on global spin alignment.

References

[1] STAR Collaboration. Nature **614**, 244248 (2023)