

## The 170th HENPIC seminar by Prof. Qun Wang, and Dr. Xu Sun, a topical discussion on vector meson global spin alignment, August 4, 2022, Thursday, 10:30am (Beijing time)

Title: Spin alignments of vector mesons - new frontier of spin dynamics

Speaker: Prof. Qun Wang, USTC

Abstract: We present a relativistic spin Boltzmann equation (SBE) for spin dynamics of vector mesons based on Kadanoff-Baym equations. Using SBE and an effective quark-meson model, we calculate  $\rho_{00}$  (the 00-element of the spin density matrix) for  $\phi$  mesons in heavy-ion collisions formed by the coalescence of  $s$  and  $\bar{s}$  quarks which are assumed to be polarized by the vorticity and  $\phi$  fields. We show that the contributions to  $\rho_{00}$  from the vorticity and  $\phi$  fields all appear as local correlation between strong force fields of the same kinds and same components. This indicates that fluctuations of strong force fields play an important role in  $\rho_{00}$ , which can be formulated and extracted in relativistic quantum transport theory. Our results on the colliding energy, transverse momentum and centrality dependence of  $\rho_{00}$  are in good agreement with recent STAR data for  $\phi$  mesons.

Talk2:

Title: Observation of Global Spin Alignment at RHIC-STAR

Speaker: Xu Sun, UIC

Abstract: In non-central heavy-ion collisions (HIC), the large initial angular momentum can induce a non-vanishing polarization for hadrons with non-zero spin. The global spin alignment of vector mesons, quantified by the 00th element of spin density matrix element ( $\rho_{00}$ ), can offer information on the spin-orbital interactions of the QCD medium. Surprisingly large signal of vector meson  $\rho_{00}$  compared to hyperon spin polarization poses challenges to the conventional theoretical understanding of polarization in HIC.

In this talk, we will present the first observation of vector meson spin alignment signal from RHIC-STAR experiment. This observation from Beam Energy Scan (BES-I) include large deviations of  $\rho_{00}$  from 1/3 for  $\phi$  mesons, which can only be explained by introducing the vector meson strong force fields. We will also discuss the transverse momentum and collision centrality dependence of the global spin alignment signal at BES-I. In addition, we will briefly discuss the new measurement using recent high statistics Beam Energy Scan (BES-II) Au + Au collisions at 19.6 GeV, and isobar collisions (Zr+Zr and Ru+Ru) at 200 GeV. The BES-II data will provide unprecedented precision in  $\rho_{00}$  at these energies. Comparison of  $\rho_{00}$  in Au+Au and isobar species can provide information on the system size dependence of  $\rho_{00}$ . Moreover, since the magnetic moment of charged and neutral  $K^*$  differ by a factor of seven, the comparison of their  $\rho_{00}$  may serve as a new probe for the initial strong magnetic field in HIC.