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Spin Alignment of Vector Meson as a Probe of Anisotropy

The global spin alignment of ϕ meson has been observed by the STAR collaboration in Au+Au collisions at RHIC. However, the measured positive deviation from $1/3$ of the spin alignment is orders of magnitude larger than contributions of traditional mechanisms like vorticity or magnetic fields. We proposed that the anisotropy of local strong field fluctuation in meson's rest frame is a new mechanism that can incorporate the observed spin alignment. In heavy-ion collisions, such an anisotropy may arise from a faster longitudinal expansion of the QGP than transverse expansion, and from motion of the meson relative to the QGP. Our discussions are based on a relativistic spin kinetic theory derived from Kadanoff-Baym equations, with an effective quark-meson model for the strong interaction. The vector meson in our model is generated from quark-antiquark coalescence, where quark and antiquark are polarized by the local strong field. We calculated the spin alignment of the ϕ meson and showed its relation to the anisotropy of field fluctuations with respect to the spin quantization direction, while the strength of fluctuation can be extracted from experimental data as functions of collision energies. The transverse momentum dependence of ϕ meson's spin alignment is then calculated with our model, which agrees with the STAR's data. We further predicted azimuthal angle dependence and rapidity dependence that can be verified by future experiments.

Category

Theory

Collaboration (if applicable)

Author: SHENG, Xin-Li (INFN Firenze, Italy)

Co-authors: OLIVA, Lucia (Università di Catania, INFN Catania); Prof. WANG, Qun (University of Science and Technology of China); PU, Shi; Dr WANG, Xin-Nian (Lawrence Berkeley National Lab. (US)); LIANG, Zuo-tang (Shandong University)

Presenter: SHENG, Xin-Li (INFN Firenze, Italy)

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