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Lambda polarization in heavy ion collisions: from RHIC BES to LHC energies

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In hydrodynamic picture of heavy ion collisions, local thermal vorticity of the QGP fluid leads to polarization of nonzero spin hadrons produced out of it [1]. The nonzero polarization of Λ hyperons has been recently discovered by STAR in non-central Au-Au collisions in RHIC Beam Energy Scan program [2].

We further study the predictions of the hydrodynamic model for different components of the Λ polarization in the framework of 3-dimensional viscous hydrodynamic model with UrQMD initial state, and demonstrate that:

1. at RHIC Beam Energy Scan energies, the global polarization P of produced Lambda is directed along the total angular momentum of the fireball (perpendicular to reaction plane). P decreases with collision energy from 1.7 to 0.2% [3], in agreement with STAR results [2]. The global Λ polarization further decreases towards LHC energies,
2. at full RHIC and LHC energies, the dominant component of polarization is the one in the beam direction. This component has a quadrupole structure in transverse momentum plane. Its amplitude f_2 shows a mild decrease with collision energy, and it is thus detectable at LHC energies.

We show that different components of polarization are driven by different properties of the hydrodynamic expansion: whereas the global polarization P is a result of initial shear flow in the reaction plane, f_2 is driven by anisotropy of the transverse expansion (which is also responsible for elliptic flow v_2). Polarization component in the beam direction is a generic effect present even in a simple 2-dimensional hydrodynamic calculation with longitudinal boost invariance [4].

[1] F. Becattini, V. Chandra, L. Del Zanna, E. Grossi, Ann. Phys. 338 (2013) 32.

[2] STAR collaboration, Nature 548 (2017), 62–65

[3] I. Karpenko, F. Becattini, Eur. Phys. J. C (2017) 77: 213.

[4] F. Becattini, Iu. Karpenko, arXiv:1707.07984, accepted to Phys.Rev.Lett.

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