Anomalous transport model study of chiral magnetic effects in heavy ion collisions

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Based on the anomalous transport model, which includes the propagation of massless partons according to the chiral kinetic equation [1-4] and allows the change of parton chiralities during their scattering, we have studied the elliptic flow difference between positively and negatively charged partons in non-central relativistic heavy ion collisions [5]. Using initial conditions from a blast wave model and assuming the presence of a strong and long-lived magnetic field, we have obtained an appreciable charge quadrupole moment in the transverse plane of the collision, which then leads to different elliptic flows for particles of positive and negative charges. The elliptic flow difference shows a linear dependence on the total charge asymmetry $A_{\pm}$ in the collision as show in Fig. 1, where $A_{\pm}= (N_{+}-N_{-})/(N_{+}+N_{-})$ with N_{+} and N_{-} being the total number of positively and negatively charged particles. These results are similar to those found from studies based on the anomalous hydrodynamics using similar initial conditions and assuming

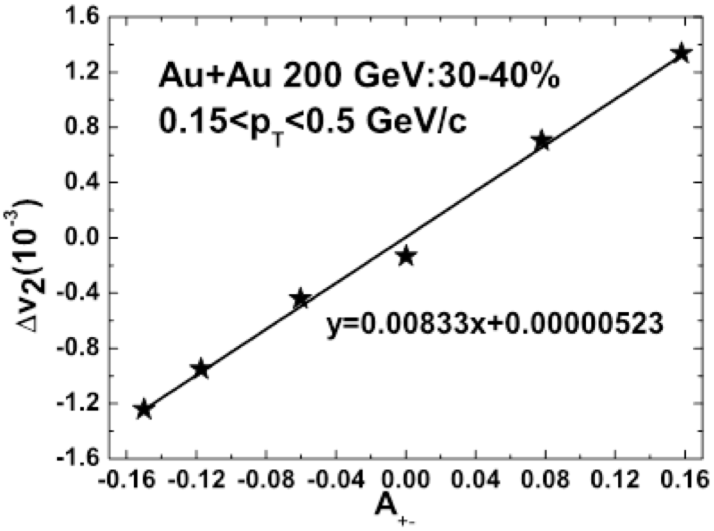

FIG. 1. Elliptic flow difference Δv_2 between negatively and positively charged particles as a function of charge asymmetry $A_{\pm}$.

similar strength and lifetime for the magnetic field [6]. Compared to the experimental data on the elliptic flow difference between positively and negatively charged particles, ours is, however, much smaller. A larger elliptic flow difference could be obtained if we allow the ratio of the charge chemical potential to the temperature in the initial blast wave to be larger in its center and smaller on its surface. Also, the different elliptic flows between charged particles could be partly due to the different mean-field potentials between particles and antiparticles in the partonic [7] and the hadronic [8] matter of finite baryon chemical potential [9]. Nonetheless, our study does indicate that the application of the anomalous transport model based on the chiral kinetic equation to heavy ion collisions can describe the effect of the chiral magnetic wave (CMW) on the elliptic flow of massless fermions of different charges in the

presence of a strong magnetic field. However, the justification for the existence of a long-lived magnetic field in relativistic heavy ion collisions remains missing, although its strength is known to be sufficiently strong. More work is needed to understand this very intriguing phenomenon that might be present in relativistic heavy ion collisions.

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