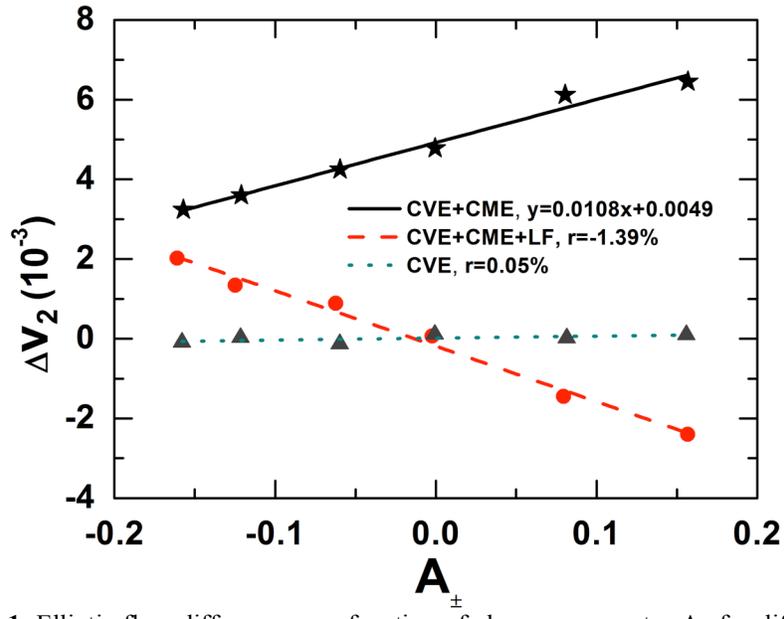
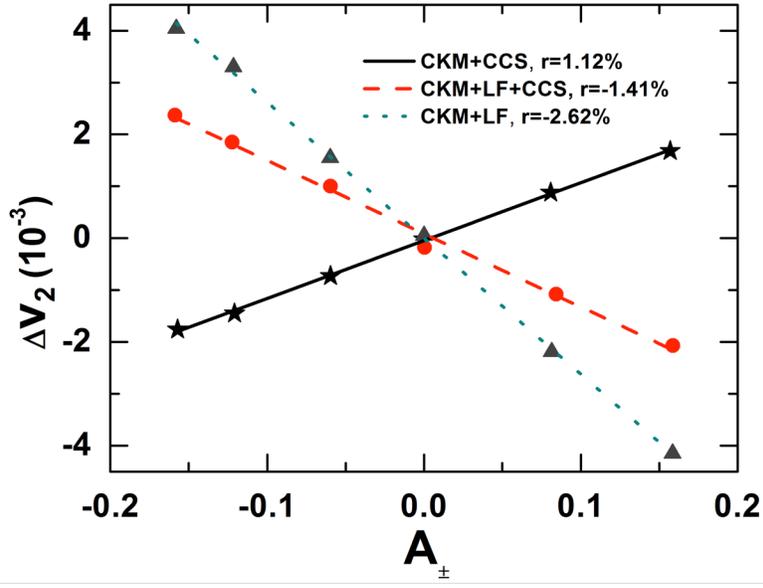


## Anomalous transport model study of chiral magnetic and vortical effects in heavy ion collisions

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Based on the anomalous transport model, which includes the propagation of massless quarks and antiquarks according to the chiral kinetic equation [1-3] and allows the change of chiralities during the scattering between positively and negatively charged partons, we have studied the elliptic flow of charged particles in non-central relativistic heavy ion collisions [4,5]. 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 negative and positive charges, shown in the upper window of Fig.1, as the system expands. The elliptic flow difference shows a linear dependence on the total charge asymmetry  $A_{\pm} = (N_{+} - N_{-}) / (N_{+} + N_{-})$  of the partonic matter, where  $N_{+}$  and  $N_{-}$  are the total number of positively and negatively charged particles, with a slope that is negative unless the Lorentz force is neglected. Compared to the experimental data, ours is, however, much smaller. Similar results are obtained if we also assume the presence of a vorticity field, which is modeled according to that from the AMPT model [6], except the appearance of a positive intercept at zero charge asymmetry, as shown in the lower panel of Fig.1, which is, however, larger than the experimental value [7]. With only the vorticity field, no elliptic flow splitting of negatively and positively charged particles is present when the charge asymmetry of the partonic matter is nonzero. As shown by dashed lines in Fig.1, the inclusion of the Lorentz force cancels the chiral effects due to the magnetic and vorticity fields and leads instead to a negative slope parameter in the charge symmetry dependence of the elliptic flow splitting of negatively and positively charged particles, contrary to that observed in experiments. Understanding this experimental result in terms of the chiral effects thus remains a challenge.

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**FIG. 1.** Elliptic flow difference as a function of charge asymmetry  $A_{\pm}$  for different scenarios of parton dynamics in their presence of only a magnetic field (left window) and both the magnetic and vorticity fields (right window).