Contribution ID: **73** Type: **not specified**

Anomalous chiral phenomena in isobaric collisions

Due to the similar backgrounds but different magnetic fields, isobaric collisions are believed to be more effective to measure the anomalous chiral effects. The isobaric program at the Relativistic Heavy Ion Collider (RHIC) has been going on by colliding $^{96}_{44}$Ru $+^{96}_{44}$ Ru and $^{96}_{40}$Zr $+^{96}_{40}$ Zr elements [1]. Here we focus on the properties of electromagnetic fields in the two isobaric collisions by using a multiphase transport (AMPT) model.

Firstly, we focus on the correlations between magnetic field direction $\Psi_{\rm B}$ and participant plane angle Ψ_2 [or spectator plane angle $\Psi_2^{\rm SP}$] , i.e. $\langle\cos 2(\Psi_{\rm B}-\Psi_2)\rangle$ [or $\langle\cos 2(\Psi_{\rm B}-\Psi_2^{\rm SP})\rangle$]. We confirm that the magnetic fields of $^{96}_{44}$Ru $+$ $^{96}_{44}$Ru collisions are stronger than those of $^{96}_{40}$Zr $+$ $^{96}_{40}$Zr collisions due to their larger proton fraction. We find that the deformation of nuclei has a non-negligible effect on $\langle\cos 2(\Psi_{\rm B}-\Psi_2)\rangle$ especially in peripheral events. Because the magnetic-field direction is more strongly correlated with $\Psi_2^{\rm SP}$ than with Ψ_2, the relative difference of the chiral magnetic effect observable with respect to $\Psi_2^{\rm SP}$ is expected to be able to reflect much cleaner information about the chiral magnetic effect with less influences of deformation [2].

Then the induced effects of the electromagnetic fields are dicussed. We present the spatial distributions of electromagnetic fields ($\mathbf{E}$ and $\mathbf{B}$) and electromagnetic anomaly $\mathbf{E}\cdot\mathbf{B}$ in the two isobaric collisions. A dipolar distribution of $\mathbf{E}\cdot\mathbf{B}$ is observed in non-central collisions. We find that the coupling of the $\mathbf{E}\cdot\mathbf{B}$ dipole and magnetic field $\mathbf{B}$ can induce an electric quadrupole moment which can further lead to the difference in elliptic flows between positively charged particles and negatively charged particles through final interactions [3]. The centrality dependences of the density of $\mathbf{E}\cdot\mathbf{B}$ for the two isobaric collisions are similar to the trend of the slope parameter r measured from the difference in elliptic flows between positive pions and negative pions for Au+Au collisions by the STAR collaboration. We also predict a relative difference of the slope parameter between the two isobaric collisions. The novel mechanism offers a new tool to study anomalous chiral phenomena in isobaric collision.

[1] J. Adam et al. [STAR], Nucl. Sci. Tech. 32, no.5, 48 (2021) [arXiv:1911.00596 [nucl-ex]].

[2] X. L. Zhao, G. L. Ma and Y. G. Ma, Phys. Rev. C 99, no.3, 034903 (2019) [arXiv:1901.04151 [hep-ph]].

[3] X. L. Zhao, G. L. Ma and Y. G. Ma, Phys. Lett. B 792, 413 (2019) [arXiv:1901.04156 [hep-ph]].

Primary author: Dr ZHAO, Xinli (Fudan University)

Co-author: Prof. MA, Guoliang (Fudan University)

Presenter: Dr ZHAO, Xinli (Fudan University)