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Re-examining the premise of isobaric collisions and a novel method to measure the chiral magnetic effect

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Due to the topology of QCD vacuum, a strong magnetic field can lead to an electric current, or charge separation in heavy ion collisions, a phenomenon called chiral magnetic effect (CME). Finite azimuthal correlator ($\Delta\gamma$) signals have been measured in experiments, consistent with the CME, but contaminated by a major elliptic flow (v_2) induced background. The isobaric $^{96}_{44}$Ru+$^{96}_{44}$Ru and $^{96}_{40}$Zr+$^{96}_{40}$Zr collisions have been proposed and planned at RHIC in 2018 to search for the CME with their expected 15% signal difference and almost identical backgrounds. In this talk we will show, however, that these expectations may not hold as originally anticipated due to large uncertainties in the isobaric nuclear structures [1]. We demonstrate this using Woods-Saxon densities and the proton and neutron densities calculated by the density functional theory and the nuclear shell model. Furthermore, a novel method is proposed to gauge background and possible CME contributions in the same system, intrinsically better than the isobaric collisions of two different systems [2]. The new method is based on the opposite behaviors in the fluctuations of the magnetic field and v_2 in a single nucleus-nucleus collision, thus bears minimal theoretical and experimental uncertainties. We illustrate the method with Monte Carlo Glauber and AMPT (A Multi-Phase Transport) simulations.

References:
\[1]. Hao-jie Xu, Xiaobao Wang, Hanlin Li, Jie Zhao, B. Alex Brown, Zi-Wei Lin, Caiwan Shen, and Fuqiang Wang, Importance of isobar density distributions on the chiral magnetic effect search, arXiv:1710.03086.
\[2]. Hao-jie Xu, Jie Zhao, Xiaobao Wang, Hanlin Li, Zi-Wei Lin, Caiwan Shen, and Fuqiang Wang, Varying the chiral magnetic effect relative to flow in a single nucleus-nucleus collision, arXiv:1710.07265.

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