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Unveiling Critical Behavior in Rapidity Scans Using Cross-Cumulants for intermediate energy collision

Recent heavy-ion collision experiments at intermediate energies are intensively focused on probing the QCD phase diagram to reveal critical behavior associated with the possible critical point. In these collisions, the produced fireball exhibits significant inhomogeneity along the rapidity direction, covering a broad region of the QCD phase diagram. This spatial variation offers a unique opportunity to study critical phenomena in greater detail. **To capitalize on this opportunity, we focus on studying higher-order cumulants of conserved charges beyond mid-rapidity region—the rapidity scan method that complements the traditional beam energy scan approach.**

However, to accurately identify critical signals, it is essential to establish a complete baseline that accounts for non-critical background effects. **In this talk, we present our work on establishing such a baseline for rapidity scans.** Our studies reveal that conservation effects of baryon number can cause cumulant measurements to mimic critical behavior, potentially leading to false positives [1]. To overcome this challenge, **we introduce a novel observable—the cross-cumulant—for rapidity scans, designed to be sensitive to critical fluctuations while being less affected by conservation effects.** Using hydrodynamic simulations, we demonstrate how cross-cumulants can effectively distinguish genuine critical signals from background effects. Our results indicate that cross-cumulants provide a powerful tool for future experiments aiming to explore the QCD critical point through rapidity scans. We discuss the implications of our findings for ongoing and upcoming heavy-ion collision programs, and outline how this method can enhance the search for critical phenomena in the QCD phase diagram.

[1] J. Li, L. Du, and S. Shi, Rapidity scan approach for net-baryon cumulants with a statistical thermal model, *Phys. Rev. C* **109**, 034906 (2024).

Category

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Author: LI, Jianing

Co-authors: DU, Lipei (McGill University); Dr SHI, Shuzhe (Tsinghua University)

Presenter: LI, Jianing

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