Contribution ID: **703** Type: **Oral**

QGP vortex rings as a new probe for jet-induced medium response and longitudinal dynamics

Tuesday, 5 September 2023 09:10 (20 minutes)

Hydrodynamics provides quantitative descriptions of various flow measurements in heavy-ion collisions, suggesting the strongly-coupled nature of the hot QCD matter. A ubiquitous phenomenon in fluid dynamics is the formation of vortex rings. In heavy-ion collisions, different conditions can give rise to toroidal vortex structure in the QGP medium, such as the medium's response to jet thermalization [1] and the early-stage longitudinal dynamics in asymmetric collisions [2]. Considering these scenarios, in this talk, we will present a systematic study of how Λ hyperon's polarization can probe these toroidal vortex structures in QGP. We define a "ring observable" in terms of the Λ production plane polarization [2]. It represents a measure of the effects caused by the vorticity induced in the ring formation. By conducting event-by-event analysis with the state-of-the-art (3+1)D theoretical framework [3, 4], we demonstrate that this ring observable is a highly sensitive probe for thermalizing energy-momentum currents deposited from high-energy jets and for the early-time longitudinal dynamics in asymmetric collision systems. An experimental indication of such "smoke rings" formed in the QGP would represent a significant advancement in studying the emergent phenomena of many-body QCD at multiple length scales.

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Category

Theory

Collaboration (if applicable)

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Session Classification: Chirality

Track Classification: Chirality