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# Revealing Proton Spin Polarization via Hypertriton Production in Nuclear Collisions

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Ultra-relativistic nuclear collisions create the quark–gluon plasma (QGP) known as the hottest, least viscous, and most vortical fluid ever produced in terrestrial laboratories. Its vortical structure has been uncovered through the spin polarization of Lambda (Λ) hyperons, attributed to the spin–orbit coupling that transfers the system’s orbital angular momentum to the quark spin, which is then inherited by hadrons via quark recombination or coalescence. However, Λ polarization reflects primarily the strange-quark component, leaving the spin dynamics of the up and down quarks largely unexplored. Although the proton is an ideal probe, its stability makes direct measurements experimentally challenging.

Here, we propose to unravel proton spin polarization via hypertriton measurements, exploiting the fact that spin information is preserved when polarized nucleons and Λ coalesce to form hypertriton. We show that, over a broad range of collision energies, the polarizations of proton, Λ, and hypertriton are related by a simple linear scaling law. Since both Λ and hypertriton polarizations can be measured via their self-analyzing weak decays, this linear relation provides a practical experimental avenue for accessing spin polarizations of protons and neutrons–the dominant baryonic degrees of freedom in nuclear collisions.

**Primary authors:** LIU, Daineng (Fudan University); SUN, KaiJia (Institute of Modern Physics, Fudan University); Prof. 马, 余刚 (Fudan University)

**Presenter:** LIU, Daineng (Fudan University)

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