ID de Contribution: **64** Type: **Non spécifié**

Accessing the strong interaction in three-hadron systems via proton-deuteron femtoscopy

mercredi 6 novembre 2024 14:10 (25 minutes)

Understanding the structure of light nuclei and the interactions among their constituents has been a long-standing goal in nuclear physics. Nuclear systems composed of three hadrons, such as unbound ensembles formed by a deuteron and a third nucleon, serve as fundamental references in nuclear physics for constraining nuclear interactions and understanding the properties of nuclei.

In this talk, I will present hadron-deuteron femtoscopic correlations measured by the ALICE Collaboration in proton-proton (pp) collisions at $\sqrt{s} = 13$ TeV at the Large Hadron Collider (LHC). These momentum-space correlations between deuterons and kaons or protons provide insights into three-hadron systems at distances comparable to the proton radius. The K^+–d correlation analysis shows that the relative distances at which deuterons and protons/kaons are produced are around 2 fm. The analysis of the p–d correlation demonstrates that only a full three-body calculation that accounts for the internal structure of the deuteron can explain the data. Specifically, the sensitivity of the observable to the short-range part of the interaction is emphasized. Additionally, the measured p–d correlation function is sensitive to the inclusion of higher-order partial waves. This study opens an avenue for strong interaction studies in three-body systems, including Λ/Σ–d or Λ_c–d, to investigate three-baryon systems in the strange and charm sectors, which are otherwise inaccessible.

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