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Study of the three-body dynamics at short range via femtoscopy by ALICE at the LHC

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Femtoscopy measurements in small systems like pp collisions have been demonstrated to be very sensitive to the effects of the final-state strong interaction. Such studies face now a new challenge with the extension for the first time to three-body systems. The study of three- and many-body dynamics has been a long-standing goal in nuclear physics, particularly for understanding the structure of light nuclei and describing neutron-rich and dense nuclear matter.

We present results obtained using high-multiplicity pp collisions at $\sqrt{s}$ = 13 TeV recorded by ALICE at the LHC. The first measurement of the genuine three-body effects obtained from p–p–p, p–p–Λ, p–p–K^+ and p–p–K^- correlation functions are obtained by utilising the formalism of the three-particle cumulants. Such measurements provide information on the genuine three-particle interaction and constitute important inputs for the calculation of the equation of state of neutron stars and the formation of kaonic nuclei.

We present as well a new experimental method to study three-body nuclear systems by utilizing correlations deuteron-hadron pairs. Measurements of the K^+–d and p–d correlations are compared with effective two-body calculations anchored to results from K^+–d and p–d scattering experiments. An excellent description of the measured K^+–d correlation is achieved, but the calculations fail to describe the p–d system. This discrepancy can only be resolved by performing a full three-body calculation, demonstrating that nucleons are the explicit degrees of freedom and opening the possibility of investigating the effect of genuine many-body nuclear interactions at the LHC in the future, including as well systems with strangeness and charm.

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