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Study of the Femtoscopic correlation at HADES (GSI)

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Hadron femtoscopy emerges as a potent tool in high-energy nuclear collision studies, providing a means to uncover intricate details of the particle-emitting source. This technique examines momentum space correlations between pairs of particles, offering insights into the spatial and temporal characteristics of the emission region. By analyzing interference patterns arising from quantum statistics and final-state interactions, hadron femtoscopy facilitates the extraction of information regarding the size, shape, and duration of the particle-emitting source.

In recent decades, there has been extensive interest in understanding the properties of dense matter, particularly in the context of hypernuclei and hyperons. The presence of these exotic particles inside neutron stars has been linked to the softening of the Equation of State (EoS), imposing a constraint on the maximum mass of neutron stars (known as the "hyperon puzzle") to be below two solar masses. However, the scarcity of experimental data at high baryon chemical potential poses significant challenges in constructing an accurate EoS. To investigate matter under conditions akin to neutron star cores, low-energy heavy-ion collisions are employed. The study of strong interactions involving hyperons and clusters, such as nucleon-hyperon (e.g., p–Λ) or nucleon-cluster (e.g., p − d, p − t, or p −3 He), remains a challenge due to incomplete understanding of their interactions. Exploring two-particle correlations involving clusters allows for the investigation of the ground state of 4Li or the excited state of 4He. The information carried by created hadrons and clusters, available post thermal freeze-out, makes them valuable for studying earlier collision stages. Particularly, the use of photons, with their relatively long mean free path and emission throughout the system's evolution, proves beneficial for examining earlier collision stages.

Femtoscopy, a method enabling the examination of the space-time characteristics of collision generated systems, operates within a time-span of 10−23 seconds and a spatial scale of femtometers (10−15 meters). Experimental measurements provide insights into two-body interactions, system geometry, and dynamics. This work utilizes the HADES detector at GSI/FAIR (Germany), employing various detectors, including electromagnetic calorimeters capable of detecting neutral particles. Through the application of specialized software, a dedicated framework, and reconstruction algorithms, the study aims to identify γ-particles, Λ-hyperons, and clusters. The correlation functions for p − Λ, p − d, p − t, p −3 He, and γ − γ will be presented.

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