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Two-particle femtoscopy at the HADES experiment

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Over the past decades, the properties of dense matter have been widely concerned in connection with hypernuclei and hyperons. Their existence inside neutron stars softens the Equation of State (EoS), consequently limiting their masses to be lower than two solar masses (known as the "hyperon puzzle"). The limited number of experimental references in the region of high baryon chemical potential poses significant challenges for constructing an EoS. The matter under conditions similar to neutron star cores can be obtained with low-energy heavy-ion collisions. The strong interactions for hyperons and clusters can be studied with two-body systems, for example, nucleon-hyperon (e.g., $p-\Lambda$) or nucleon-cluster (e.g., $p-d$, $p-t$, or $p-{}^3He$) as their interaction is not fully understood. Studies of two-particle correlations with clusters enable one to search for ground state of ${}^4Li$, or the excited state of ${}^4He$. Created hadrons and clusters carry information available after thermal freeze-out. Therefore, photons with a relatively long mean free path and being emitted through the whole system's evolution are considered for studying earlier collision stages.

Femtoscopy is a technique of measuring two-particle correlations in momentum space, proven to be a powerful tool for determining parameters of interactions and lifetimes in heavy-ion physics. It allows for the investigation of collision-generated system's spacetime features, having a lifespan of 10^{-23} seconds and a lifetime of femtometers (10^{-15} m). One can study the two-body interactions, geometry, and dynamics by conducting such measurements experimentally.

The analysis uses the HADES detector at GSI/FAIR (Germany). Using detectors included in the spectrometer (among others, electromagnetic calorimeters, capable of detecting neutral particles) combined with specially created software, a dedicated framework, and reconstruction algorithm, one can identify γ particles, Λ hyperons, and clusters. The $p-\Lambda$, $p-d$, $p-t$, $p-{}^3He$, and $\gamma-\gamma$ correlation functions will be presented for the first time.

Category

Experiment

Collaboration (if applicable)

HADES experiment

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