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A Realistic Coalescence Model for Deuteron Production

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Understanding the formation of (anti)nuclei in high-energy collisions has attracted large interest over the last few years. According to the coalescence model, nucleons form independently and then bind together after freeze-out if they are sufficiently close in phase-space. A recent advancement of the model is the Wigner function formalism, which allows the calculation of the coalescence probability based on the distance and relative momentum of the constituent nucleons, independently of the collision energy or system.

The interest in explaining nuclear formation processes extends beyond standard model physics, with implications for indirect Dark Matter searches. Understanding the production mechanism of antinuclei is crucial for correctly interpreting any future measurement of antinuclear flux in space, as it would allow for the differentiation of the background originating from collisions between high-energy Cosmic Rays and the stationary Interstellar Medium.

In this presentation, we provide a comprehensive overview of the state-of-the-art coalescence formalism, not only for deuterons but also for the more intricate case of A=3 nuclei. This represents a significant advancement, as previous efforts primarily focused on modeling the formation of simpler bounds states, e.g., deuterons. Furthermore, the model is tested for pp collision data and Heavy-Ion collisions measured at STAR. Our approach introduces a novel aspect by implementing this model into a purpose-built Monte Carlo generator called ToMCCA. This generator offers exceptional adaptability while maintaining superior performance compared to traditional general-purpose event generators.

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