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Production of light nuclei in Au+Au collisions with the STAR BES-II program

The production mechanism of light (anti-)nuclei in heavy-ion collisions can be either by the thermal model or the coalescence model. By studying the yields and ratios of light (anti-)nuclei, we can gain insight into their production mechanism and physical properties of the expanding system at freeze-out. Furthermore, the enhancement in the light nuclei compound ratios such as $\mathrm{N_t} \times \mathrm{N_p}/\mathrm{N_d^2}$ and $\mathrm{N_{^3He}} \times \mathrm{N_p}/\mathrm{N_d^2}$ from the coalescence baseline, has been suggested as a potential probe to search for the critical phenomena in the QCD phase diagram. This enhancement might be a consequence of the enhanced baryon density fluctuations when the system is in vicinity of the critical point or the first-order phase transition. In the first phase of the Beam Energy Scan (BES-I) program at RHIC, an enhancement relative to the coalescence baseline of the light nuclei yield ratio ($\mathrm{N_t} \times \mathrm{N_p}/\mathrm{N_d^2}$) is observed in the most central Au+Au collisions at $\sqrt{s_{\mathrm{NN}}}$ = 19.6 and 27 GeV with a combined significance of 4.1 σ. The large datasets ($\sim$ 10$\times$BES-I) taken by the STAR BES-II with enhanced detector capabilities will greatly improve the precision of the new measurements.
In this talk, we will present the centrality and energy dependence of transverse momentum (p_{T}) spectra of p, p, d, d, and ^{3}He in Au+Au collisions at BES-II energies of $\sqrt{s_{\mathrm{NN}}}$ = 7.7 –27 GeV. We will also report the centrality and energy dependence of integrated particle yields ($\mathrm{dN/dy}$) and mean p_{T} ($\langle p_{\mathrm{T}} \rangle$) of light nuclei. We will discuss the centrality and pT dependence of the coalescence parameters ($B_2(\mathrm{d})$ and $B_3(^3\mathrm{He})$). The physics implications of these results will be discussed.

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