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

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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 N_tN_p/N_d^2 and $N_{^3He}N_p/N_d^2$ 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 (N_tN_p/N_d^2) is observed in the most central Au+Au collisions at $\sqrt{s_{NN}}$ = 19.6 and 27 GeV with a combined significance of 4.1σ. 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, $\bar{p}$, d, $\bar{d}$, and ^3He in Au+Au collisions at BES-II energies of $\sqrt{s_{NN}}$ = 7.7 – 27 GeV. We will also report the centrality and energy dependence of integrated particle yields (dN/dy) and mean p_T ($\langle p_T\rangle$) of light nuclei. We will discuss the centrality and p_T dependence of the coalescence parameters ($B_2(d)$ and $B_3(^3He)$). The physics implications of these results will be discussed.