${}^{5}_{\Lambda}$He, ${}^{4}_{\Lambda}$H(e), and ${}^{3}_{\Lambda}$H Measurements from the Beam-Energy Scan-II Program

Chenlu Hu, Yuanjing Ji, Yulou Lan, Xiujun Li, Yue Hang Leung, Fengyi Zhao, Yingjie Zhou

November 8, 2024

Despite extensive measurements on the production yields of light nuclei in heavy-ion collisions, a consensus on their formation mechanism remains elusive. While coalescence models can describe $A < 4$ nuclei yields with remarkable accuracy over a wide range of collision energies, recent results at the LHC indicate that the yields of ^{4}He is underestimated by such models. In contrast to normal nuclei, hypernuclei carry strangeness and offer an additional dimension for such studies. In particular, the ${}^{5}_{\Lambda}$He and the $A = 4$ mirror hypernuclei (${}^{4}_{\Lambda}$H(0^{+}), ${}^{4}_{\Lambda}$He(0^{+})) are all substantially tighter bound compared to the hypertriton (${}^{3}_{\Lambda}$H). The existence of excited states (${}^{4}_{\Lambda}$H($^{*}1^{+}$), ${}^{4}_{\Lambda}$He($^{*}1^{+}$)) may also enhance the measured yields through feed-down. As such, studying the $A = 3 - 5$ hypernuclei yields allow us to extract information on the effects of hypernuclear binding, spin, and isospin content on hypernuclei production in heavy-ion collisions.

In this talk, we will present the first measurements of ${}^{5}_{\Lambda}$He production in heavy-ion collisions utilizing the fixed-target dataset at $\sqrt{s_{NN}} = 3$ GeV from the STAR beam energy scan II program. We will also present the yields of ${}^{4}_{\Lambda}$He, ${}^{4}_{\Lambda}$H, and ${}^{3}_{\Lambda}$H from $\sqrt{s_{NN}} = 3 - 27$ GeV. The transverse momentum spectra and rapidity distributions will be shown. Their mean transverse momenta will be presented as a function of energy, and compared to a blast-wave expectation using the freeze-out parameters from light hadrons. Calculations from the thermal model and coalescence model will be compared to these results, and the physics implications will be discussed.