Study of Charge Symmetry Breaking in A = 4 hypernuclei in $\sqrt{s_{NN}} = 3$ GeV Au+Au collisions at RHIC

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(Dated: March 1, 2022)

The Λ binding energy difference, which is called the charge symmetry breaking in the ground states of a pair of A = 4 hypernuclei, ${}^4_\Lambda$H and ${}^4_\Lambda$He, was measured to be $\Delta B^4_\Lambda(0^+_{g.s.}) \approx 350$ keV in nuclear emulsion experiments in 1970s. In the 2015 experiment from J-PARC, the binding energy difference in excited states $\Delta B^4_\Lambda(1^+_{exc}) \approx 30$ keV was found to be much smaller than the ground states. In 2016, the A1 collaboration updated the values to $\Delta B^4_\Lambda(0^+_{g.s.}) \approx 233$ keV and $\Delta B^4_\Lambda(1^+_{exc}) \approx -83$ keV. These values are difficult to be reproduced in existing theoretical models. The full understanding of the charge symmetry breaking in A = 4 hypernuclei still remains an open question.

As a part of the STAR fixed target program, the STAR detector took the data in Au+Au collisions at $\sqrt{s_{NN}} = 3$ GeV in 2018. The high production yield of hypernuclei provides an opportunity to measure the binding energies of both A = 4 hypernuclei in ground states in the same experiment to address this charge symmetry breaking puzzle. In this talk, we will present the measurement of the charge symmetry breaking in A = 4 hypernuclei in Au+Au collisions at $\sqrt{s_{NN}} = 3$ GeV. The signal reconstruction and binding energy measurement of ${}^4_\Lambda$H and ${}^4_\Lambda$He, including corrections and systematic uncertainty evaluation, will be discussed. Combined with the energy levels of excited states, our preliminary result for the Λ binding energy difference in excited states shows a negative value and its magnitude is comparable to the value of ground states. These results will be compared to previous measurements and theoretical models. Future study with a factor of 7 more events from STAR taken in 2021 will also be discussed.

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