Study of charge symmetry breaking in ΛN interaction via the gamma-ray spectroscopy of ${}^{4}_{\Lambda}$He

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A gamma-ray spectroscopy study of ${}^{4}_{\Lambda}$He was performed at the J-PARC K1.8 beam line as the first phase of the J-PARC E13 experiment [1]. By measuring the ${}^{4}_{\Lambda}$He$(1^+ \to 0^+)$ gamma transition, we can examine the existence of charge symmetry breaking(CSB) in ΛN interaction by comparing with the mirror hypernucleus, ${}^{4}_{\Lambda}$H [2,3,4]. The old experiments suggested large differences in the excitation energies $(E(1^+) - E(0^+))$ as well as the g.s. Λ-binding energies $(B_\Lambda(0^+))$ between the mirror hypernuclei, leading to unexpectedly large CSB in ΛN interaction. However, statistical quality for the ${}^{4}_{\Lambda}$He $(1^+ \to 0^+)$ gamma-ray data in the past experiment [2] is insufficient to confirm the existence of a large CSB, and thus more precise measurement of the energy spacing was long awaited. In order to break through this situation, we performed a gamma-ray spectroscopy experiment of ${}^{4}_{\Lambda}$He to measure the transition energy of the Λ-spin doublet states $(1^+, 0^+)$ using germanium(Ge) detectors with an energy resolution of 3 keV.

${}^{4}_{\Lambda}$He hypernuclei were produced by the (K^-, π^-) reaction with a 1.5 GeV/c kaon beam and a liquid ^{4}He target. K^- beams and scattered π^- mesons were particle-identified and momentum-analyzed by the beam line spectrometer and the modified SKS spectrometer (SksMinus), respectively. On the other hand, gamma rays were detected by a newly developed Ge detector array, Hyperball-J, placed around the target. Through coincidence measurement between these spectrometer systems and Hyperball-J, gamma rays from ${}^{4}_{\Lambda}$He hypernuclei were measured.

The whole detector system was installed and tested with beam in 2013, and it was confirmed to have sufficient performance. Data taking for the ${}^{4}_{\Lambda}$He gamma-ray measurement was performed in April, 2015 after the operation of the J-PARC Hadron Experimental Facility was resumed. We irradiated a 3 g/cm^2 liquid ^{4}He target with 2.3×10^{10} kaons. The data is being analyzed and a precise value of the transition energy will be determined soon. In this talk, a new experimental result will be presented and physics discussion based on the new data will be made.

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