Study of the charge symmetry breaking effect in A=4 Λ-hypernuclei via gamma-ray spectroscopy

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The existence of a large charge symmetry breaking (CSB) effect in the A=4 hypernuclear systems ($^{4}_{\Lambda}$H and $^{4}_{\Lambda}$He) had been suspected since 1970s based on the data available at that time, but it eluded any quantitative explanations. Thus, high precision data obtained with independent techniques have long been awaited. In particular, the energy of $^{4}_{\Lambda}$He ($1^{+} \rightarrow 0^{+}$) **γ** transition measured by NaI counters is experimentally inconclusive due to lack of statistics. To end this deadlock, we carried out a precise measurement of the $^{4}_{\Lambda}$He($1^{+} \rightarrow 0^{+}$) **γ**-ray energy at the J-PARC K1.8 beam line (J-PARC E13) in 2015. The excited $^{4}_{\Lambda}$He(1^{+}) state was produced via the ^{4}He(K^{-},π^{-})$^{4}_{\Lambda}$He reaction with 1.5 GeV/c beam. **γ**-ray energy was measured using a high efficiency germanium detector array, Hyperball-J. The measured transition energy turned out to be 1.406 (4) MeV, drastically revising the previously reported value [PRL115(2015)222501)]. By combining the present result with other data, it is confirmed that CSB is not only ~~of~~ a large effect, but also ~~of~~ spin dependent. As a next step in studying the A=4 system for the CSB effects, re-measurement of the $^{4}_{\Lambda}$H($1^{+} \rightarrow 0^{+}$) gamma-ray energy with higher precision is planned via the ^{7}Li(K^{-},π^{-})$^{4}_{\Lambda}$H reaction with 0.9 GeV/c beam followed by a ^{3}He emission at the K1.1 beam line of J-PARC (J-PARC E63, stage-1 approval).
In this contribution, the results of E13 as well as an outline of E63 will be presented.