Exclusive Measurements of the Non-Mesonic Weak Decay of Hypernuclei: ${}^{5}_{\Lambda}$He and ${}^{12}_{\Lambda}$C

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Results will be presented on the recent measurements of the non-mesonic weak decay(NMWD) process of Λ hypernuclei, ${}^{5}_{\Lambda}$He and ${}^{12}_{\Lambda}$C. It is known that the dominant weak decay mode of Λ particle bound in nuclei is $\Lambda + N \to N + N$. This non-mesonic decay is the very unique strangeness-changing baryon-baryon weak interaction process, which can occur only in nuclei. Concerning the ratio of two non-mesonic decay modes, $\Gamma_n/\Gamma_p \equiv \Gamma(\Lambda + n \to n + n)/\Gamma(\Lambda + p \to n + p)$, recent experiments for $A = 5, 12$ suggests large Γ_n/Γ_p ratios [1,2]. However these reported results have large errors of 30−100% so the large Γ_n/Γ_p ratio is not yet established. So far, several theoretical calculations are carried out based on one-pion or one-boson exchange models or the the hybrid quark model, but none of them could simultaneously explain the NMWD rate and Γ_n/Γ_p ratio.

Up to now, most of the experiments concerning the Γ_n/Γ_p ratio of NMWD measured only protons from $\Lambda p \to np$ process and Γ_n was determined by the subtraction of all the other decay processes. Thus the obtained results must be much affected by the small change of the assumption on the rescattering process (final state interaction(FSI) effect) and by the possible existence of the two-nucleon induced NMWD process, $\Lambda NN \to NNN$. Recently, our group measured neutron energy spectrum from NMWD of ${}^{12}_{\Lambda}$C [3]; the spectrum shows no broad peak at around 70 MeV but has much low energy tail component. This seems to suggest the strong FSI effect and/or the considerable contribution from 2N-induced process, $\Lambda NN \to NNN$.

In order to measure the Γ_n/Γ_p ratio unambiguously, we choose light s-shell Λ hypernuclei, ${}^{5}_{\Lambda}$He, so as to minimize the FSI effect. In addition, we measured both of n+p- or n+n-pairs emitted from $\Lambda + p \to n + p$ or $\Lambda + n \to n + n$ NMWD process. When we select two-nucleon pairs which has back-to-back angular correlation and applied energy sum cut (Q-value for $\Lambda N \to NN$ decay process for ${}^{5}_{\Lambda}$He is about 152 MeV) for them, we can measure Γ_n/Γ_p ratio directly only from the n+p to n+n double coincidence pair numbers. The result of this measurement is free from the strength of FSI effect and also from the possible $\Lambda NN \to NNN$ contribution.

With superconducting kaon spectrometer(SKS) at KEK, we took (π^+,K^+) data during year 2000−2001 for ${}^{5}_{\Lambda}$He and we are taking data also for ${}^{12}_{\Lambda}$C in this year. In the preliminary analysis of ${}^{5}_{\Lambda}$He data (about 30% ot total), we established the way to identify back-to-back $n + p$- and $n + n$-pairs and obtained $\Gamma_n/\Gamma_p \sim 0.7 \pm 0.2$ (*very preliminary*), which is slightly smaller than one. We can achieve $\Delta(\Gamma_n/\Gamma_p) \sim 0.1$ error level for both of ${}^{5}_{\Lambda}$He and ${}^{12}_{\Lambda}$C. At the conference, we will discuss our updated results on Γ_n/Γ_p ratios for ${}^{5}_{\Lambda}$He and hopefully for ${}^{12}_{\Lambda}$C. We will discuss also for the asymmetry of proton emission from the NMWD of polarized hypernuclei.

References

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[3] H. Bhang *et al.*, Abstract in this conference (2002)