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学位論文名	Polarization and Weak Decay of $^{11}_{\Lambda}$B and $^{12}_{\Lambda}$C by means of (π^+, K^+) Reactions ((π^+, K^+) 反応で生成された $^{11}_{\Lambda}$B と $^{12}_{\Lambda}$C の偏極と弱崩壊)
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論文内容の要旨

The present paper reports on the first observation of the asymmetry of weak decay from Λ hypernuclei produced by the (π^+, K^+) reaction on ^{12}C. It gives thus the first experimental evidence of the spin polarization of Λ hypernuclei by the (π^+, K^+) reaction, as predicted by Ejiri *et al.*, and Bandō *et al.*

The Λ hypernuclei decay mostly by the nonmesonic decay process, which is unique of hypernuclei. Mechanism of the nonmesonic decay has not been studied well. So far, only limited observations on branching ratios have been done experimentally and no detailed calculations have been carried out theoretically. The decay is caused by the weak interaction with a strangeness change $\Delta S = -1$. This means that one can expect asymmetric angular distribution of decay particles with respect to the polarization. Therefore it is very important for the understanding of the weak decay mechanism to produce polarized hypernuclei and to measure asymmetry of the weak decay particles.

We carried out the first experiment to excite polarized hypernuclei and to observe the asymmetry. We employed the (π^+, K^+) reaction to produce Λ hypernuclei. The PIK spectrometer at the K2 beam line of KEK 12 GeV PS was used to measure the (π^+, K^+) reaction.

A decay counter system for the asymmetry measurement was constructed to measure

the charged particles decaying from the polarized hypernuclei. The counter system is rotated around the beam axis to measure the up-down asymmetry with respect to the reaction plane.

Bound and unbound states of ${}^{12}_{\Lambda}C$, for which appreciable amount of polarization was expected, were excited by the ${}^{12}C(\pi^+, K^+)$ reaction. The asymmetry of protons from the nonmesonic weak decay of the ground state of ${}^{12}_{\Lambda}C(1^-)$ was measured to be $-2 \pm 7 \pm 1\%$, where errors are statistical and systematical, respectively. The asymmetry for the ${}^{11}_{\Lambda}B\ (5/2^+)$ populated through the ${}^{12}C\ (\pi^+, K^+ p_\gamma)$ reaction exciting the 2^+ excited states in ${}^{12}_{\Lambda}C$ was obtained to be $-16 \pm 7^{+2}_{-3}\%$.

Polarization of the Λ in the hypernuclei and that of the hypernuclei itself were evaluated from the observed asymmetries by using the angular momentum algebra in various kinds of models. Polarization of ${}^{11}_{\Lambda}B\ (5/2^+)$, which is derived by use of the asymmetry parameter (A_1) evaluated by the meson exchange process including up to heavy mesons is $-0.79 \pm 0.34^{+0.10}_{-0.16}$ The polarization is in accord with the calculation. The sign of A_1 reflects the interference term of the isospin 1 and 0 amplitudes of the nonmesonic decay. It is very interesting to compare the sign with proper theoretical evaluatiors. Recantly detaild theoretical calculation was carried out which was triggered by the present work. The calculation reproduces the sign and magnitude of the observed asymmetry. The absolute value of the polarization for ${}^{12}_{\Lambda}C\ (1^-)$ is considerably smaller than the theoretical estimate, while that for ${}^{11}_{\Lambda}B\ (5/2^+)$ is consistent with the estimate. We showed that r decay explains the polarization.

In the present work we observe asymmetries of nonmesonic weak-decay protons from polarized hypernuclei successfully. This is the new step for experiments of the spectroscopic study with angular distributions of weak and electromagnetic decays.

論文審査の結果の要旨

本論文は、ハイパー核の偏極生成と弱崩壊の研究で，次の点で重要な成果を挙げた。

1. (π^+, K^+)反応による偏極Aハイパー核生成と弱崩壊の実験には，高性能のスペクトロメーター崩壊粒子測定装置，(π^+, K^+)反応と崩壊粒子の同時計測を必要とする。これまで，この種の実験はきわめて困難であったが，それを成功させ，精度よい同時計測実験を可能にした。
2. 偏極ハイパー核からの崩壊粒子の非対称性測定を可能にした。
3. ${}^{12}_{\Lambda}C$と${}^{11}_{\Lambda}B$の基底状態を${}^{12}C$の(π^+, K^+)反応で励起し，非中間子崩壊の非対称性を${}^{12}_{\Lambda}C$と${}^{11}_{\Lambda}B$に対して，それぞれ，$A = -2 \pm 7 \pm 1\%$，$A = -16 \pm 7^{+2}_{-3}\%$を得た。

4. ${}^{11}_{\Lambda}\mathrm{B}$について有限な偏極を実験的に証明した。

5. ${}^{11}_{\Lambda}\mathrm{B}$の非中間子弱崩壊角分布（$1 + P_{\Lambda} A_1 P_1 (\cos\theta)$）の非対照係数$A_1 = -0.79 \pm 0.34^{+0.10}_{-0.16}$を求めることに成功し，弱崩壊機構の解明に重要な情報を与えた。

6. これらの実験は，Ejiri et al. やBando et al. の理論を実証するもので，将来への偏極ハイパー核分光研究への新しい道を開くものである。

以上の点はいずれも世界で最初の実験であり，ハイパー核研究への重要な進歩をもたらした。よって本論文は理学博士論文として十分価値があるものと認める。