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Double-Λ and Ξ hypernuclei : Findings and Prospects

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Double-Lambda; and Xi; hypernuclei : Findings and Prospects

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Since the discovery of the doubly-strange hypernucleus in 1963, many efforts have been made but no new discoveries have been made. In the 1980s, we introduced the Emulsion-Counter “Hybrid-method” combining real-time detectors and nuclear emulsion, which led to the discovery of the charn and beauty particles, to our experiment to search for doubly-strange hypernucleus. As a result, we confirmed the existence of double-Lambda; hypernucleus, which decayed sequentially, at an absorption point of a Xi;⁻ particle in the KEK-E176 experiment. With developed hybrid method, the E373 (KEK) experiment succeeded in the unique identification of ⁶_{Lambda;Lambda;}He, where the interaction between Lambda; and Lambda; particles was understood to be weakly attractive. In the further improved E07 (J-PARC) experiment, we succeeded in detecting 33 cases of doubly-strange hypernuclei and the ground state of Xi; hypernuclei. From the 47 cases we have detected so far and one case in 1963, we found that the interaction between two Lambda; particles is a weak attraction and that the energy at which two Lambda; particles bind to a nucleus seems to depend linearly on the nuclear mass number. Additionally, the existence of the Xi; hypernucleus was confirmed, then the interaction between the Xi; and nucleon works attractively. Regarding the ¹⁵_{Xi;}C hypernuclei, the level stracture can be seen. We are currently developing an efficient detection method for the production and decay of doubly-strange hypernuclei by probing the entire volume of the emulsion and applying a machine learning model, without relying on information from real-time detectors. This development is expected to detect a large number of double-Lambda; hypernuclei emitted from the K⁻ reaction point as well as the Xi;⁻ absorption, which shall conduce to very important and more reliable information for understanding baryons in a unified manner under SU(3)_{f} symmetry.

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