Production of Neutron-Rich Lambda Hypernuclei at J-PARC

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We J-PARC E10 collaboration attempt to produce neutron-rich hypernuclei by using the secondary meson beams at the J-PARC 50 GeV Proton Synchrotron facility [1]. We also wish to study the details of the structure of the neutron-rich hypernuclei those are not studied well yet.

The neutron-rich hypernuclei have many interesting features. (a) Light neutron-rich hypernuclei have exotic structures due to the large neutron to proton ratios. The neutron-rich hypernuclei may be particle bound even at the very large neutron to proton ratios, say close to 4. (b) The ΛN-ΣN mixing in hypernuclei is expected to be stronger than the mixing between ΔN and NN in the ordinary nuclei due to the smaller mass difference. Further, possible large contributions of the ΛNN three-body interaction to the hypernuclear structures thorough the ΛN-ΣN mixing coherently summed up is predicted for neutron-rich hypernuclei. (c) The structures of the neutron-rich hypernuclei closely relate to the structure of the ordinary neutron-rich nuclei. We may see the higher lying states of the neutron-rich nuclei indirectly in the structure of the neutron-rich hypernuclei. (d) The ΛN interaction in the neutron-rich environment has links to the matter properties in the core of neutron stars.

The experimental studies require the copious production of the neutron-rich hypernuclei and the precise measurement of the hypernuclear structures. The requirements can be achieved at the same time by the spectroscopic studies with the double charge-exchange (DCX) reaction, the (π^-, K^+) reaction, by using a high-intensity pion beam line and a large acceptance magnetic spectrometer which have an excellent energy resolution [2]. As the first attempt of the studies on the neutron-rich hypernuclei, we are planning to produce the ${}^{6}_{\Lambda}\mathrm{H}$ and ${}^{9}_{\Lambda}\mathrm{He}$ hypernuclei by the ${}^{6}\mathrm{Li}(\pi^-, K^+){}^{6}_{\Lambda}\mathrm{H}$ and the ${}^{9}\mathrm{Be}(\pi^-, K^+){}^{9}_{\Lambda}\mathrm{He}$ reactions, respectively. Both neutron-rich hypernuclei are expected to have exotic structures. The core nuclei are ${}^{5}\mathrm{H}$, so called super-heavy hydrogen, and the typical halo-nuclei ${}^{8}\mathrm{He}$, respectively. The preparation of the experiment is in progress.

1. S. Ajimura, A. Sakaguchi, T. Kishimoto, *et al.*, J-PARC E10 collaboration, proposal P10 for J-PARC 50 GeV Proton Synchrotron *"Production of Neutron-Rich Λ Hypernuclei with the Double Charge-Exchange Reaction"*, 2006.
2. P.K. Saha, *et al.*, KEK-PS-E521 Collaboration, Phys. Rev. Lett. **94** (2005) 052502; P.K. Saha, T. Fukuda and H. Noumi, letters of Intent L09 for nuclear and particle physics experiments at the J-PARC *"Neutron-rich Λ hypernuclei by the double-charge exchange reaction"*, 2003-2004.