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Recent experimental achievements and perspectives on strangeness nuclear physics

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Recent achievements and perspectives on strangeness nuclear physics are presented, based mainly on experimental highlights at J-PARC. Their connection to high-density matter in neutrons stars is also discussed.
A high-quality □-proton scattering experiment (J-PARC E40) successfully measured differential cross sections of □±p elastic and inelastic scattering [1,2]. They provide invaluable information to develop baryon-baryon interaction models, which are necessary to construct a realistic Equation of State for high-density matter in neutron stars. The phase-shift result of the □□p scattering helps us understand the origin of the repulsive core of nuclear force [2]. A high-quality □p scattering experiment is also planned at J-PARC.
Through recent data from heavy ion collisions, it is recognized that the lifetime and the binding energy of the lightest □ hypernuclei, hypertriton (3□H), should be measured reliably and precisely. Updated results have been reported from ALICE and STAR, and new measurements are on-going at J-PARC. In addition, the nn□ state, suggested to be bound in a GSI experiment, was searched for at JLab [3]. Those data will play essential roles to understand behavior of a □ hyperon in neutron stars.
Doubly strange hypernuclei were also studied at J-PARC (E07) with a hybrid emulsion technique. Among clearly-observed □ hypernuclear events [3,4], two of them have surprisingly large binding energies and naively interpreted as a state with a □ in the nuclear 0s orbit [5]. But this interpretation leads to extremely weak □N→□□□interaction inconsistent with theoretical predictions. A missing mass spectroscopy experiment of the (K□, K□) reaction for □ hypernuclei (E70), together with a □-atomic X-ray measurement (E96), will soon clarify the situation.
In the future, further investigation of the □NN three-body force is necessary to solve the "hyperon puzzle"in neutron stars, through high-resolution □ hypernuclear spectroscopy at JLab, and then at the extended Hadron Facility at J-PARC [6].

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Primary author: TAMURA, Hirokazu

Presenter: TAMURA, Hirokazu

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