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Hypernuclear Spectroscopy at Jefferson Lab[1]

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The central question of nuclear science is the structure of nuclear matter. For a complete understanding of the evolution of nuclear matter in the universe, detailed knowledge is necessary not only for stable nuclei, but also increasingly for unstable and exotic nuclear matter. Nuclear matter containing strangeness is thought to play an important role in stellar objects like neutron stars. The knowledge of the underlying interaction between strange baryons (hyperons) and nucleons (protons and neutrons) is incomplete. A complete theory of baryon-baryon interactions in the context of the underlying QCD degrees of freedom, quarks and gluons, will ultimately also have to describe interactions with and between strange baryons. In the laboratory, these can be best studied by implanting hyperons in ordinary nuclei, thus converting them to hypernuclei. The high quality electron beam at Jefferson Lab allowed for the first time to study hypernuclei by (e,e'K^+) reaction spectroscopy. Six experiments on a number of light to medium heavy targets were conducted. Currently, the hypernuclear spectroscopy system at Jefferson Lab is being upgraded to ensure compatibility with the higher beam energies after the 12 GeV upgrade. Four new experiments have already been approved. They will measure the hyperhydrogen nuclei ${}^{3}_{\Lambda}$H and ${}^{4}_{\Lambda}$H; comparison to ${}^{3}_{\Lambda}$He and ${}^{4}_{\Lambda}$He addresses charge symmetry breaking or isospin dependence. Spectroscopy of ${}^{40}_{\Lambda}$K and ${}^{48}_{\Lambda}$K will study the isospin dependence of the 3-body Λnn force. Finally, a study of the ^{208}Pb(e,e'K^+)${}^{208}_{\Lambda}$Tl reaction will provide data on an extended nucleus with large neutron excess; this is the closest approximation to neutron star matter than can be achieved in the laboratory. In this talk, I will first introduce the topic of hypernuclear physics and then review the results from the previous program. I will conclude with an outlook on the future experiments.

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