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Studying Λ interactions in nuclear matter with the 208Pb(e,e'K^+)208ΛTl reaction

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The recent observation of two-solar-mass neutron stars rules out most of the current models of hyperonic matter equation of state, which favour the appearance of hyperons in the neutron star interior but predict maximum masses (Mmax) incompatible with data. This issue, referred to as "hyperon puzzle", strongly suggests that the present understanding of nuclear interactions involving hyperons is far from complete. Owing to the severe difficulties involved in the extraction of the potential describing YN interactions from YN scattering data, the study of hypernuclear spectroscopy is the most effective approach to obtain new information, much needed to unravel the hyperon puzzle. For this reason the JLab hypernuclear collaboration has proposed to Jlab PAC a coherent series of studies of the $(e,e'K^+)$ reaction, to be performed using targets spanning a wide range of mass. The purpose of this analysis was investigation of the ΛN interactions in a variety of nuclear media. We submitted to the PAC a proposal on $^{40}_{\Lambda}$K and $^{48}_{\Lambda}$K targets, mainly focused on the isospin dependence of hyperon dynamics, which was approved. The hypernuclei $^{40}_{\Lambda}$K and $^{48}_{\Lambda}$K, show very different isospin asymmetry ($\delta = 0.05$ and 0.188, respectively) that allows us to extract isospin dependence of the 3-body ΛNN force. Note that in the non-strange sector the contribution of three-nucleon forces, which is known to be large and repulsive in nuclear matter at equilibrium density, is believed to be much smaller and attractive in ^{40}Ca. For this reason valuable additional information can be obtained by expanding the kaon electroproduction program to include a study of the $^{208}\mathrm{Pb}(e,e'K^+)^{208}_{\Lambda}\mathrm{Tl}$ reaction. Thanks to the extended region of constant density and the large neutron excess, ^{208}Pb provides the best available proxy of neutron star matter. Therefore, the use of a ^{208}Pb target will allow investigating hypernuclear dynamics in a new environment, in which three-body interactions are expected to play an important role. In addition, the availability of accurate $^{208}\mathrm{Pb}(e,e'p)^{207}\mathrm{Tl}$ data will allow extracting the Λ binding energies from the measured $(e,e'K^+)$ cross section using a largely model independent procedure. The results of this analysis will provide essential information, needed to constrain and improve the available models of YN and YNN potentials and confirm wether hyperonic three body forces could be the solution of the hyperon puzzle.

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