Abstract

In this work we explore various effects involved in the computation of the cross sections for electroproduction of hypernuclei. The model calculations are performed in the Impulse Approximation (IA) further assumed in the Optimal Factorization Approach (OFA) where the elementary amplitude is evaluated for an effective proton momentum. Our analysis introduces a general two-component form of the elementary amplitude facilitating inclusion of arbitrary effective momentum, thus accounting for Fermi motion effects. At this point, our calculations develop previous calculations performed with the zero value of the proton momentum, i.e., in the so called frozen-proton approximation. Distortion of the final-state kaon wave function is addressed via the eikonal approximation, employing an optical potential for the kaon re-scattering on the nucleus, which can be adjusted using diverse forms of nuclear density.

Furthermore, our formalism for the calculations in Distorted Wave Impulse Approximation (DWIA) accommodates a sufficiently large model space of single-particle states, which is crucial for electroproduction of the medium- and heavy-mass hypernuclei. The single-particle transition densities, represented by the One-Body Density Matrix Elements (OBDME), are obtained from various many-body calculations utilizing different forms of the effective hyperon-nucleon (YN) interactions.

This developed advanced formalism enables a comprehensive examination of predicted cross sections for the electroproduction reaction across a wide range of hypernuclei. In particular, we investigate the impact of the Fermi motion, various kinematical assumptions, the kaon distortion, as well as various many-body approaches and forms of the effective YN interactions. In our analysis we explore effects in the angular and energy dependent cross sections for various hypernuclear states, including the p-shell hypernuclei ${}^{12}_{\Lambda}$B and ${}^{16}_{\Lambda}$N, and the sd-shell hypernuclei ${}^{40}_{\Lambda}$K and ${}^{48}_{\Lambda}$K. Comparisons with experimental data for ${}^{12}_{\Lambda}$B and ${}^{16}_{\Lambda}$N highlight sensitivity of the cross sections to different computational schemes, emphasizing importance of selecting the optimum proton momentum.

Moreover, the analysis reveals systematic variations in the Fermi motion effects among groups of the hypernuclear states with a specific spin and parity, allowing to formulate a "dynamical selection rule". It was also shown that the kaon distortion significantly suppresses the cross sections, particularly for deeply Λ bound states. These effects are more pronounced in heavier hypernuclei. The predicted spectra for medium-mass hypernuclei, ${}^{48}_{\Lambda}$K and ${}^{40}_{\Lambda}$K, show a potential of the Tamm-Dancoff approach and provide insights into preparation and data analysis of the experiments planned at the Jefferson Laboratory (JLab).

In conclusion, our comprehensive theoretical framework offers valuable insights into the complex dynamics of hypernuclear electroproduction, facilitating deeper understanding of it. It can be also utilized in preparing future experiments in hypernuclear physics.