Production Spectra of Λ Hypernuclei from a Lithium-6 Target

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Content

Understanding the structure and reaction dynamics of hypernuclei is essential to exploring the behavior of hyperons in nuclear matter and in constraining baryon–baryon interactions in the strangeness sector. In particular, the study of Λ production spectra via (K^-, π^-) and (π^+, K^+) reactions on light nuclear targets such as ^{6}Li offers a unique opportunity to probe cluster dynamics and continuum states in Λ hypernuclear systems [1].

In this talk, we theoretically investigate the production spectra of Λ hypernuclei via the (K^-, π^-) and (π^+, K^+) reactions on a ^{6}Li target using the distorted-wave impulse approximation (DWIA) with Fermi-averaged elementary amplitudes [2,3]. The Λ production spectra are calculated with the Green's function method for a ^{5}Li core + Λ system, employing a folding-model Λ-nucleus potential. The folding potential is constructed from α–p and ^{3}He-d cluster densities, based on OCM wave functions.

The results show that the calculated spectra, including Λ-bound, resonant, and continuum states of $^6_\Lambda$Li, agree well with the experimental data [4] for the ^{6}Li(K^-, π^-) reaction at $p_{K^-} = 790$ MeV/c, where substitutional $(0p_\Lambda, 0p_n^{-1})$ and $(0s_\Lambda, 0s_n^{-1})$ configurations dominate under near-recoilless kinematics [2]. A narrow peak corresponds to a high-lying excited state with spin-parity $J^P = 1^+$ at $E_\Lambda = 13.8$ MeV near the $^3\mathrm{He} + d + \Lambda$ threshold.

For the ^{6}Li(π^+, K^+) reaction, the calculated spectrum is in good agreement with the experimental data [5] at $p_{\pi^+} = 1.05$ GeV/c, suggesting that cluster-like configurations such as $^4_\Lambda$He-d play an important role in describing the Λ continuum states of $^6_\Lambda$Li near and above the threshold, due to the large momentum transfer ($q \approx$ 360-400 MeV/c) characteristic of the (π^+, K^+) reaction. The production mechanism of a $^4_\Lambda$He hyperfragment is also discussed.

In conclusion, this study offers a valuable theoretical framework for extracting essential information on the structure and production mechanisms of hypernuclear states from experimental data. These findings provide useful insights for future experiments at J-PARC or J-Lab.

Reference

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