Excitation of 2-particle 2-hole Λ-hypernuclear states at high momentum transfers

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Conceptionally there are two different ways to form hypernuclei (for the sake of a convenient notation we furtheron focus on Λ - hypernuclei): the recoilles production in (K, π) processes in flight[1] and quasi-free production of Λ states in (λ, K^+) reactions with photon, pion or proton beams ([2],[3],[4]). While the former process dominantly populates 1p1h states (in closed shell nucllei) with low total spin, the latter reactions favour due to the large momentum transfer the population of Λ states with high spin.
So far the investigation of hypernuclei was focussing on states bound on the level of strong interactions. At increasing high momentum transfers a class of hypernuclear states, such as 2p1h or 2p2h states, might be expected. The origin of such excitations is evident: while the population of ,say, Λ s-states are produced in a direct single particle substitution process with a cross section of typically

$$\frac{d\sigma}{d\Omega} \sim \; ((aQ)^2)^{l_n} \, exp(-(aQ)^2/2)$$

(with l_n being the angular momentum of the neutron-hole state), 2p2h states with the Λ particle dominantly involve in addition the particle-hole transition density, yielding in an oscillator basis with equal width parameters for the Λ and the conventional nucleon state, in zero range approximation for the exchange current

$$\frac{d\sigma}{d\Omega} \sim \; ((aQ)^2)^{(l_n+l_p+l_h)} \, exp(-(aQ)^2/4)$$

Clearly, 2p2h states allow from their structure a more appropriate momentum sharing on the hypernucleus resulting in large excitation strenghts, as well known from other elastic or inelastic processes at momentum transfers $\Delta q >> k_{Fermi}$ in nuclei.
Quantitatively, the signature of highly excited states in the continuum depends crucially on the production mechanism: we investigate different szenarios from meson-exchange models, including two and three-body correlations. Beyond that, possibly the selective excitation strengths together with details of the partial decay fractions might provide new insight into basic questions of nonmesic decay mechanisms, such as the role of multibaryon forces, new quenching effects at large momenta or the violation of the $I = 1/2$ rule.

References

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