Two and Three-Body Exchange Currents in the Nonmesic Decay of Λ-Hypernuclei

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The lifetime and decay modes of Λ - hypernuclei, particularly the nonmesic decay channels, still pose a longstanding puzzle: inspite of significant recent experimental ([1]) and theoretical ([2],[3],[4])progress a detailed and quantitative understanding, such as of the Γ_n/Γ_p ratio or of the basic decay mechanisms, is still missing. In particular, it is still unclear if the data can be described within the conventional effective mesonic and baryonic degrees of freedom or if the inclusion of geniune quark effects is required.
Focussing on meson-exchange models we investigate the nonmesic decay of Λ hypernuclei in a one and two pion-exchange model; the exchange of heavy mesons - which turns out be important, is, however, due to its short ranged nature presently fairly uncontrolled - is simulated by phenomenological soft form factors and short range correlations. We focus particularly on two aspects:

- the uncorrelated and correlated 2π exchange box diagram, simulating the effective scalar S=T=0 σ exchange in close analogy to the modeling of the medium range attraction in the NN system;
- the NN induced nonmesic Λ decay via genuine resonance dominated ΛNN 3-body forces, again mediated by two-pion exchange. As the leading resonances we include the $\Delta(1232)$ isobar and the $\Sigma(1193)$ hyperon.

For the practical evaluation we suppress weak nonlocalities of the various diagrams (for static intermediate baryon resonances); the nuclear structure is included in the shell model framework for light nuclei towards local density approximations for very heavy nuclei. Final state interactions, which enter in a rather uniform way with increasing nuclei [5], are estimated from optimal momentum sharing in the WKB limit.

Though final conclusions still have to await a further detailed testing of our model, particuarly on recent BNL and KEK data, present results already suggest a very strong influence of effective 3-body ΛNN foces on the nonmesic decay channels.

References

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