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SU(3)_f Constraints on Hypernuclear Energy Density Functionals

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Although not perfectly conserved, SU(3) group structures are useful guidelines for interactions of octet baryons by the exchange of scalar, pseudo-scalar, and vector nonet mesons by providing constraints on meson-baryon vertices in terms of a few fundamental SU(3) coupling constants - as incorporated in baryon interaction models. As discussed in [1,2], the SU(3) relations are especially useful for the derivation of a density functional theory for nucleons and hyperons, highly demanded for hypernuclear investigations over the full range of the nuclear mass table and for explorations of the still unsolved question on hyperons in neutrons stars. Various attempts have been made to extend energy density functionals, originally derived for nucleonic matter only, into the hypernuclear sector by adding hyperon interactions with empirically derived parameters. That approach, however, is hampered by the fact that data are only available for light S=-1 single-Λ hypernuclei. Since by construction the relevant SU(3) aspects are implicit to the nucleon sector, it is tempting to explore to what extent SU(3) relations can be used to extract from the nucleonic functionals the fundamental coupling constants g_D, g_F, and g_S as functionals of the density. If successful, the results provide a simple and transparent approach to investigate the meson-hyperon vertices of the mean–field producing condensed meson fields. As an example, the scheme is discussed for the covariant Giessen EDF derived from Dirac-Brueckner G-matrix interactions. In-medium meson-baryon vertices are extracted for scalar and vector mesons. Their density dependence is discussed and results for hypernuclear binding energies and spectral distributions for hyperon bound and continuum states are presented. Single-⊠ separation energies are compared to results obtained with EDF and mean-field approaches explicitly incorporating the SU(3) aspects. Implications for neutron star matter will be addressed.

[1] H. Lenske, M. Dhar, Th. Gaitanos, and Xu Cao, Prog.Part.Nucl.Phys. 98 (2018) 119-206.
[2] H. Lenske, M. Dhar, Lect.Notes.Phys. 948 (2018) 161-253.

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