A Density-Dependent Relativistic Hartree Approach for Hypernuclei

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Λ, Σ, and Ξ (multi–)hypernuclei are investigated within a density–dependent relativistic Hartree approach. To this end, the covariant field theory recently developed by Lenske and Fuchs is extended to hypernuclear systems, leading to rearrangement self–energies in the baryonic field equations. Self–consistent solutions, including ω–hyperon tensor couplings, are obtained in the Hartree limit with the σ– and ω–nucleon couplings adjusted to Dirac–Brueckner–Hartree–Fock results for infinite nuclear matter, utilizing a local density approximation. With the meson–nucleon couplings compatible with realistic nucleon-nucleon potentials, the description remains free of adjustable parameters on the nucleonic side, while meson–hyperon couplings are fixed by $SU(6)$ symmetry or fitted to available experimental data. In addition, results for Λ hypernuclei are presented within a purely phenomenological relativistic mean–field model including σ and ω self–interactions. Special attention is devoted to the impact of the ϱ–meson field in Σ and Ξ hypernuclei. Finally, the 'hyperon-halo' of multi-hypernuclei and the way it is affected by rearrangement effects is studied.

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Nuclear Structure Calculations in the Density-Dependent Relativistic Hartree Theory

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In this study we appraise the capability of the relativistic density–dependent Hartree theory to reproduce the properties of finite nuclei by using parametrizations of relativistic Brueckner–Hartree–Fock calculations for infinite nuclear matter, performed in the full Dirac space. We apply the density–dependent relativistic Hartree approach of Brockmann and Toki as well as its covariant extension including rearrangement contributions, recently developed by Lenske and Fuchs. Within this parameter–free theory the results for finite systems are satisfacory. We used the one–boson–exchange potentials A and B constructed by Brockmann and Machleidt.

There is a remarkable improvement of the results in all cases of density–dependent relativistic Hartree–approximations. By using the parametrizations of the relativistic Brueckner–Hartree–Fock calculations performed in the full Dirac space, both potentials give similiar results in contrast to the case where one performs the RBHF–calculations in the space of positive spinors only, where potential B underbinds the nuclei significantly.

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