Relativistic Hartree-Bogoliubov Theory in Coordinate Space: Finite Element Solution for a Nuclear System with Spherical Symmetry

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A C++ code for the solution of the Relativistic Hartree-Bogoliubov (RHB) equations in coordinate space is presented. This theory describes a nucleus as a relativistic system of baryons and mesons, where the nucleons move in self-consistent fields produced the mesons. In addition they feel a phenomenological pairing interaction, which causes a phase transition to a superfluid state. The RHB model is applied to the description of ground state properties of spherical nuclei. Finite range interactions are included to describe pairing correlations and the coupling to continuum states. The coupled system of Dirac-Hartree-Bogoliubov integro-differential equations for the nucleons and Klein-Gordon equations for the meson fields is treated by Finite Element Methods (FEM) in coordinate space. The bisection method is used for the solution of the resulting generalized algebraic eigenvalue problem and the systems of linear and nonlinear algebraic equations, respectively.

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Relativistic Hartree-Bogoliubov Theory with Finite Range Pairing Forces in Coordinate Space: Neutron Halo in Light Nuclei

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The Relativistic Hartree Bogoliubov (RHB) model is applied in the self-consistent mean-field approximation to the description of the neutron halo in the mass region above the s-d shell. Pairing correlations and the coupling to particle continuum states are described by finite range two-body forces. Finite element methods are used in the coordinate space discretization of the coupled system of Dirac-Hartree-Bogoliubov integro-differential eigenvalue equations, and Klein-Gordon equations for the meson fields. Calculations are performed for the isotopic chains of Ne and C nuclei. We find evidence for the occurrence of neutron halo in heavier Ne isotopes. The properties of the 1f-2p orbitals near the Fermi level and the neutron pairing interaction play a crucial role in the formation of the halo. Our calculations display no evidence for the neutron halo phenomenon in C isotopes.

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Relativistic Mean-Field Description of Light Λ Hypernuclei with Large Neutron Excess

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The Relativistic Hartree Bogoliubov model in coordinate space, with a finite range pairing interaction, is applied to the description of Λ-hypernuclei with a large neutron excess. The addition of the Λ hyperon to Ne isotopes with neutron halo can shift the neutron drip by stabilizing an otherwise unbound core nucleus. The additional binding of the halo neutrons to the core originates from the increase in magnitude of the spin-orbit term. Although the Λ produces only a fractional change in the central mean-field potential, through a purely relativistic effect it increases the spin-orbit term which binds the outermost neutrons.

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