Computer Program for the Relativistic Mean Field Description of the Ground State Properties of Even-Even Axially Deformed Nuclei

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We present a Fortran program for the calculation of the ground state properties of axially deformed even-even nuclei in the framework of Relativistic Mean Field Theory (RMF). In this approach a set of coupled partial differential equations has to be solved self-consistently: the Dirac equation for the nucleons and the Klein-Gordon equations for the mesons and the electromagnetic field. Self-consistency is achieved by the fact that the nucleons move in average fields, which are determined by the mesons. On the other side the scalar and the vector densities of the nucleons form the sources of the Klein-Gordon equations for the meson fields. For the solutions of this coupled set of equations the Dirac spinors as well as the meson fields are expanded in terms of anisotropic oscillator wave functions in cylindrical coordinates. This requires a matrix diagonalization for the solution of the Dirac equations and the inversion of symmetric matrices for the solution of the Klein-Gordon equations. The Greens function method is used for the determination of the meson fields.

Monopole Giant Resonances and Nuclear Compressibility in Relativistic Mean Field Theory

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Isoscalar and isovector monopole oscillations that correspond to giant resonances in spherical nuclei are described in the framework of time-dependent relativistic mean-field (RMF) theory. Excitation energies and the structure of eigenmodes are determined from a Fourier analysis of dynamical monopole moments and densities. The generator coordinate method, with generating functions that are solutions of constrained RMF calculations, is also used to calculate excitation energies and transition densities of giant monopole states. Calculations are performed with effective interactions which differ in their prediction of the nuclear matter compression modulus $K_{\rm nm}$. Both time-dependent and constrained RMF results indicate that empirical GMR energies are best reproduced by an effective force with $K_{\rm nm} \approx 270$ MeV.

A Giant Halo at the Neutron Drip Line

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Relativistic Hartree-Bogoliubov (RHB) theory in coordinate space is used to describe the chain of even-even Zirconium isotopes reaching from ^{116}Zr to the drip line nucleus ^{140}Zr. Pairing correlations are taken into account by a density dependent force of zero range. For neutron numbers larger than the magic number $N = 82$ a giant neutron halo outside the core of ^{122}Zr is observed. It is formed by up to six neutrons.