Rare-Earth Nuclei: Radii, Isotope-Shifts and Deformation Properties in Relativistic Mean Field Theory

G. A. Lalazissis, P. Ring, and M. M. Sharma [a,b]
[a] Physics Department, Kuwait University, Kuwait 13060
[b] Max Planck Institut für Astrophysik, D-85740 Garching, Germany

A systematic study of the ground-state properties of even-even rare earth nuclei has been performed in the framework of Relativistic Mean-Field (RMF) theory using the parameter set NL-SH. Nuclear radii, isotope shifts and deformation properties of the heavier rare-earth nuclei have been obtained, which encompass atomic numbers ranging from Z=60 to Z=70 and include a large range of isospin. It is shown that RMF theory is able to provide a good and comprehensive description of the empirical binding energies of the isotopic chains. At the same time the quadrupole deformations β_2 obtained in the RMF theory are found to be in good agreement with the available empirical values. The theory predicts a shape transition from prolate to oblate for nuclei at neutron number N=78 in all the chains. A further addition of neutrons up to the magic number 82 brings about the spherical shape. For nuclei above N=82, the RMF theory predicts the well-known onset of prolate deformation at about N=88, which saturates at about N=102. The deformation properties display an identical behavior for all the nuclear chains. A good description of the above deformation transitions in the RMF theory in all the isotopic chains leads to a successful reproduction of the anomalous behavior of the empirical isotopic shifts of the rare-earth nuclei. Thus, the RMF theory exhibits a remarkable success in providing a unified and microscopic description of various empirical data.

Relativistic Hartree-Bogoliubov Calculations with Finite Range Pairing Forces

T. Gonzalez-Llarena [a], J. L. Egido [a], G. A. Lalazissis, and P. Ring
[a] Departamento de Física Teórica C-XI, Universidad Autónoma de Madrid, E-28049, Spain

We propose a relativistic extension of Hartree-Bogoliubov theory on the basis of relativistic mean field theory. Pairing correlations are taken into account by an effective interaction of finite range adjusted by Gogny and his group. This allows a fully self-consistent description of pairing correlations over the entire periodic table. The method is applied for the investigation of several isotope chains of spherical Pb, Sn, and Zr nuclei with magic proton configurations.

Representation of Three-Dimensional Rotations in Oscillator Basis Sets

R. G. Nazmitdinov [a], J. L. Egido [b], L. M. Robledo [b], and P. Ring

[a] Joint Institute for Nuclear Research, Bogoliubov Lab. of Theoretical Physics, 141980 Dubna, Russia
[b] Departamento de Física Teórica C-XI., Universidad Autónoma de Madrid, E-28049 Madrid, Spain

Using the generating function technique we calculate matrix elements of the rotation operator between harmonic oscillator wave functions of different oscillator lengths. Closed analytical expressions for the matrix elements for harmonic oscillator wave functions in Cartesian and cylindrical coordinates are provided. They are given in terms of finite sums and are adequate for computer programs.