Solution of Relativistic Hartree-Bogoliubov Equations in Configurational Representation: Spherical Neutron Halo Nuclei

P. Ring, G. A. Lalazissis, M. Stoitsov [a], and D. Vretenar [b]

[a] Institute for Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, Sofia–1784, Bulgaria
[b] Physics Department, Faculty of Science, University of Zagreb, Croatia

The scaled harmonic oscillator basis (SHO) is derived by a local scaling-point transformation of the spherical harmonic oscillator radial functions. The unitary scaling transformation produces a basis with improved asymptotic properties. The SHO basis is employed in the solution of the relativistic Hartree-Bogoliubov (RHB) equations in configurational space. The model is applied in the self-consistent mean-field approximation to the description of the neutron halo in Ne isotopes. It is shown that an expansion of nucleon spinors and mean-field potentials in the SHO basis reproduces the asymptotic properties of neutron densities calculated by finite element discretization in the coordinate space. In the RHB description of neutron skins and halos, SHO bases in two or three dimensions can be a useful alternative to technically complicated solutions on a mesh in coordinate space.

submitted to Phys. Rev. **C**

Thermal and Quantal Fluctuations for Fixed Particle Number in Finite Superfluid Systems

R. Rossignoli [a], N. Canosa [a], and P. Ring
[a] Departamento de Física, Universidad Nacional de La Plata, c.c. 67, 1900 La Plata, Argentina

We investigate fluctuations and even-odd effects in small superfluid systems at finite temperature by means of the static path approximation (SPA) plus RPA treatment, where exact number parity projection is introduced. The RPA correction to the SPA is evaluated exactly. Results are given first for a schematic 20-level pairing model, where an excellent agreement with the exact canonical results is obtained both for even and odd systems, and then for a heavy nucleus, where the smoothing of the BCS transition and the even-odd effects in the pairing energy and specific heat are examined.

published in Phys. Rev. Lett. **80** (1998) 1853

Compressed Nuclei in the Relativistic Thomas-Fermi Approximation

T. v. Chossy and W. Stocker

We obtain the structure of compressed nuclei by scaling ground state relativistic Thomas-Fermi (RTF) densities as well as by performing RTF calculations with a constraint as the equivalent of an external pressure. In a first approach we use the NL1 effective Lagrangian that has been proved to be realistic in RH calculations which themselves are well reproduced in RTF approximation. From the RTF nuclear energies calculated for a series of compression ratios q we extract the respective β-stability lines as well as the neutron and proton drip lines in the (N-Z)-plane. For scaling approaches it is found that – depending on the strength of the compression ratio – the β-stability line is bended to neutron richer nuclei. Thus nuclei – lying initially on the stability line in their ground states – first become β^+-unstable, and finally beyond a critical q-value proton-unstable. In other words, stable nuclei after compression decay under positron and eventually under proton emission. In addition we have a look on the dependence of the fission barriers on compression. The nuclear surface tension gets weaker through compression, and the Coulomb energy larger. Both these effects contribute to a lowering of the fission barrier after compression. Thus, e. g., for ^{238}U the fission barrier vanishes after compression of the nucleus corresponding to $q \approx 1.2$. Also the fissility parameter and the critical ratios $(Z^2/A)_{crit}$ were extracted. The latter vanishes for $q \approx 1.5$ such that no nucleus under such a compression remains fission stable.

We plan to extend our investigations by using the relativistic Hartree method in such a way that also changes of single-particle levels after compression can be studied.