COVARIANT DENSITY FUNCTIONAL THEORY FOR ISOSPIN PROPERTIES IN NUCLEI FAR FROM STABILITY*

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Relativistic Hartree-Bogoliubov (RHB) theory and relativistic quasi-particle random phase approximation (RQRPA) have been applied in an analysis of isospin properties of nuclei in the exotic region. The RQRPA is formulated in the canonical basis of the relativistic Hartree-Bogoliubov model. Both in the particle-hole and in the particle-particle channels, the same interactions are used in RHB calculations for the ground states and for the RQRPA calculations for the excited states. The RQRPA configuration space includes the Dirac sea of negative energy states. The RHB+RQRPA approach is tested in the example of multipole excitations of neutron rich oxygen isotopes. The RQRPA is applied in the analysis of the evolution of the low-lying isovector dipole strength in Sn isotopes and N=82 isotones [1].

The standard relativistic mean-field effective interactions based on non-linear meson exchange terms are extended to include density dependent meson-nucleon coupling constants [2]. Special care is taken for the density dependence in the isovector channel. This provides not only an improved description of the equation of state for neutron matter and asymmetric nuclear matter but also for isovector properties of finite nuclei far from stability such as the neutron skin thickness. The method is employed in a microscopic analysis of the nuclear matter compressibility and symmetry energy. The isoscalar monopole and the isovector dipole response of ^{208}Pb, as well as the differences between the neutron and proton radii are discussed for ^{208}Pb and several Sn isotopes [3]. The comparison of the calculated excitation energies with the experimental data on the giant monopole resonance in ^{208}Pb, restricts the nuclear matter compression modulus of structure models based on the relativistic mean-field approximation to $K_{\rm nm} \approx 250 - 270$ MeV.

The framework of proton-neutron quasiparticle random-phase-approximation is used investigate Gamow-Teller resonances (GTR) and isobaric analog states (IAS) for a sequence of even-even Sn nuclei. The calculations reproduce the experimental data on ground-state properties, as well as the excitation energies of the isovector excitations. It is shown that the isotopic dependence of the energy spacings between the GTR and IAS provides direct information on the evolution of neutron skin-thickness along the Sn isotopic chain. A new method is suggested for determining the difference between the radii of the neutron and proton density distributions along an isotopic chain, based on the measurement of the excitation energies of the GTR relative to the IAS [4].

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