Compressional Properties of Nuclei in Relativistic Mean-Field Approximation

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In this investigation we studied nuclear compressional properties in the relativistic mean-field approach. The incompressiblity K_A of finite nuclei that follows empirically from isoscalar monopole giant resoncances is analyzed theoretically on the basis of a scaling model by decomposing it in a leptodermous expansion into volume, surface and Coulomb parts. First, the properties of compressed asymmetric infinite nuclear matter is discussed in the relativistic Hartree approximation of the $\sigma\omega\rho$ model. For compressed symmetric semi-infinite nuclear matter we present a nonrelativistic pocket model based on the density functional theory. Results on the pressure dependent surface tension are obtained. This pocket model serves as a starting point for the generalization of the relativistic Thomas-Fermi approximation to the compression case. In general, compression in the scaling model requires a constraint in the energy expression in order to simulate the external pressure. The vanishing of the total local pressure then is the condition to be fulfilled in the static case. We study constraints in the non-relativistic pocket model as well as in the RTF approximation. The constraint may be a function of baryon as well as meson densities. In particular we were able to give a proof for the $\dot{\sigma} = 0$ theorem [1] in the RTF case for a class of compression modes. We evaluate the finite nucleus incompressiblity K_A in the RTF approach for three parameterizations, NL1, NL-SH and PW42, of the $\sigma\omega\rho$ model. The comparison with empirical K_A values favours the NL1 set where $K_\infty = 211$ MeV.

References

[1] W. D. Myers and W. J. Swiatecki, Ann. Phys. (N. Y.) **55** (1969) 395

Relativistic Mean-Field Description of Collective Motion in Nuclei: The Pion Field

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The influence of the pion field on isovector dipole and spin-dipole collective oscillations is investigated in a time-dependent model based on relativistic mean field theory. We find that the inclusion of the long range pion-nucleon interaction provides an additional strong damping mechanism for the isovector dipole vibrations. The inclusion of the pion field has also a strong effect on the dynamics of spin-dipole vibrations, and in particular on the splitting of excitation energies of the J^π $(0^-,1^-,2^-)$ components of the isovector spin-dipole resonance.

Double Giant Resonances in Time Dependent Relativistic Mean Field Theory

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Collective vibrations in spherical nuclei are described in the framework of time-dependent relativistic mean field theory (RMFT). Isoscalar quadrupole and isovector dipole oscillations that correspond to giant resonances are studied, and possible excitations of higher modes are investigated. We find evidence for modes which can be interpreted as double resonances. In a quantized RMFT they correspond to two-phonon states.