Scaling-Model Analysis of Nuclear Breathing Modes in View of a Realistic Relativistic Mean-Field Parametrization

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We calculate breathing-mode energies in the scaling model for several parameter sets that are under discussion in nuclear relativisitc mean-field theory. The relativistic Hartree approximation is used together with a schematic approach for the surface incompressibility. Empirical data can only be reproduced reasonably with parameter sets that lead to a nuclear matter compressibility modulus not higher than 230 MeV.

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A Phenomenological Neutron-Proton Interaction in the Lead Region ◇

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With just one proton and one neutron beyond the strongly doubly closed shell nucleus ^{208}Pb, ^{210}Bi is an ideal nucleus for testing the shell model calculations on odd-odd spherical nuclei. The model we use in calculating the levels in ^{210}Bi is the generalized intermediate coupling model (GICM) [1]. In the GICM, odd-odd nuclei are assumed to consist of an interacting vibrating even-even core and two outer nucleons (odd proton and odd neutron). The neutron-proton interaction consists of the central part, non-central tensor part and spin-orbit part. In [1] 34 experimental levels of ^{210}Bi were fitted with the GICM involving the neutron-proton interaction with a Gaussian radial dependence with and without an interaction between octupole core vibrations and odd nucleons. χ^2 values were somewhat lower with the interaction between octupole core vibrations and odd nucleons taken into account. The obtained interaction parameters were then used to calculate other ^{210}Bi levels.

In [2] the well known experimental levels of ^{208}Bi were calculated with the parameters from ^{210}Bi [1]. Energies of 36 experimentally assigned states in ^{208}Bi were quite remarkably reproduced in spite of the fact that the neutron-proton interaction parameters had been transferred from fitting in ^{210}Bi, a neutron shell away.

In ref. [3] an effective pairing interaction between valence neutrons and/or between valence protons was introduced. The neutron-proton interaction parameters were taken over from ^{210}Bi [1]. In ^{210}Bi the $\pi 0h_{9/2} \otimes \nu 1g_{9/2}$ configuration and other low lying configurations all have the inverted parabola shape in a plot of spin versus energy. When additional pairs of protons and/or neutrons are added, leading to heavier odd-odd nuclei, the inverted parabola becomes more compressed. Using the GICM, it was possible to reproduce the level structures of ^{212}Bi, and ^{212}At reasonably well, and partially also ^{216}At, ^{216}Fr.

References

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