Low-lying dipole response of the even-even $^{152\text{-}160}$Gd nuclei

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Abstract

Properties of the low-energy dipole states in $^{152\text{-}160}$Gd isotopes have been studied within rotational, translational and Galilean invariant Quasiparticle Random Phase approximation method [1]. Superiority of this free from the spurious solutions method are that, the restoration of broken symmetries and self consistent determination of the isoscalar and isovector effective forces coupling constants with the form of the mean-field make possible to treat the calculation more rigorously without any extra quadrupole interaction parameter. It has been shown that main part of spin-1 states, observed at energy 1.8÷4 MeV in $^{152\text{-}160}$Gd may be attributed to have M1 character and may be interpreted as main fragments of the scissors mode. The agreement between calculated mean excitation energies as well as summed B(M1) value of the scissors mode excitations and the available experimental data is quite good. As an example in the figure below, the results of calculations compared with the experimental data for the ^{158}Gd nucleus. The experimental data exceeds the calculation results for the summed B(M1) by a factor of 1.2 for M1 transitions. The reason for this discrepancy could be the negative parity K=1 dipole vibrations that are ignored in the experiment [2]. The calculated summed dipole width for K=1 states are about an order larger than K=0 ones below 4 MeV. Besides the experimental summed B(E1) value for ΔK=0 is systematically greater than theoretical one. A possible reason for this discrepancy could be that the experimental B(E1) value [2] was obtained adopting a negative parity to all observed ΔK=0 transitions.

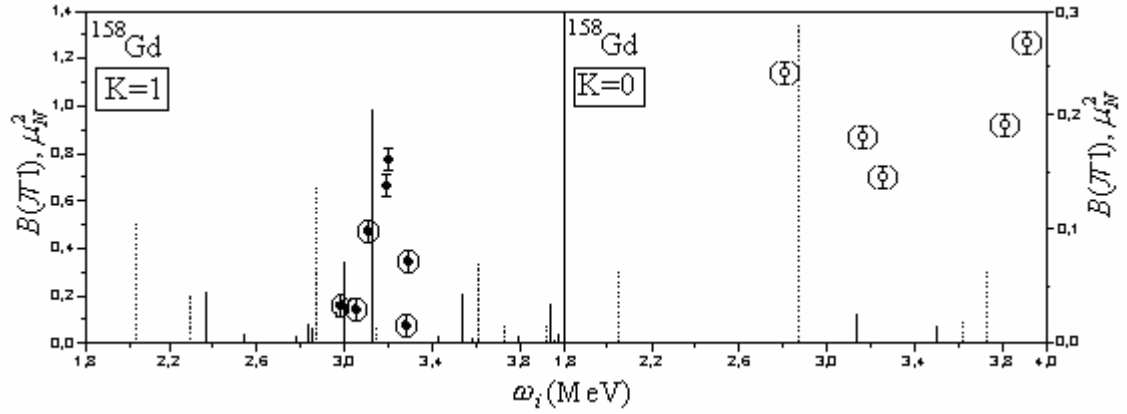

Figure. Comparison of the B(M1) and B(E1) values calculated for the ^{158}Gd nucleus in the rotational, translational and Galilean invariant QRPA with experimentally observed M1 and E1 dipole excitations. In the RPA results, M1 transitions are shown as a solid line and E1 transitions as a dashed line, respectively. Symbol ↧ denotes the experimental data for M1 excitations with ΔK=1 whereas ⊕ (⊛) denotes the experimental data for tentative K=1 (0) excitations with unknown parity assignment. As the parities are unknown for the most dipole excitations we give the dipole excitation strength B(π,1) in unit μ_N^2 and in according to the experiment we will exclude transitions with strength value of less than 0.01 μ_N^2 from the figure. π = E(M) for electric (magnetic) transitions.

Key Words: *Gd, scissors mode, spin, parity, electric and magnetic dipole transitions*

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