Triplet of Nuclear Scissors Modes

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Low energy $M1$ excitations are studied within the Time Dependent Hartree-Fock-Bogoliubov (TDHFB) approach [1]. The solution of TDHFB equations by the Wigner Function Moments method predicts three types of scissors modes. Together with the conventional scissors mode generated by the counter-rotation of protons against neutrons, two new modes arise due to spin degrees of freedom (“spin” scissors). Two states fall into the energy range of $2.7 < E < 3.7$ MeV, adopted for the scissors mode. Their mean excitation energies and summed excitation strengths are in rather good agreement with the experimental systematics obtained from nuclear resonance fluorescence (NRF) experiments on heavy deformed nuclei [2,3]. The lowest one generates a remarkable $M1$ strength below the conventional energy range [4]. The low lying group of 1^+ levels with the appropriate summarized M1 strength was observed by NRF experiments [5] only in ^{164}Dy. As a result the calculated summarized scissors strength $\sum B(M1) = 5.56\ \mu_N^2$ for ^{164}Dy in the energy range between 2 and 4 MeV is in the excellent agreement with NRF experimental results. The theoretical results and experimental data of Oslo group [6] are in very good overall agreement for all three Dy isotopes [7]. For all the rest rare earth nuclei the lowest nuclear scissors, found by calculations below 2.7 MeV, is the prediction. Thus, our calculations indicate that the $2 - 2.7$ MeV energy region, where the concentration of $M1$ strength associated with the “spin” scissors is expected, is still not fully investigated.

References

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