

Isovector giant resonances in ^{208}Pb and the symmetry energy

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It is well-known that accurate knowledge of the dependence of the symmetry energy, $E_{\text{sym}}(\rho)$, on the matter density ρ , commonly parameterized in terms of the quantities J , L and K_{sym} , is needed for better description of nuclei away from the valley of stability and for the EOS of asymmetric nuclear matter (NM), the needed ingredient in the study of astrophysical phenomena. There have been many attempts to determine $E_{\text{sym}}(\rho)$ by considering physical quantities sensitive to $E_{\text{sym}}(\rho)$, such as the energy of the isovector giant dipole resonance (IVGDR), since the restoring force for the IVGDR oscillation is due to the n-p interaction.

To study the sensitivity of the isovector giant resonances to the symmetry energy density we carried out fully self-consistent HF-based RPA calculations of the strength functions and centroid energies of the isovector giant monopole resonance (IVGMR), IVGDR, first overtone of the IVGDR (IVGDR2), isovector giant quadrupole resonance (IVGQR) and the isovector giant octupole resonance (IVGOR) in ^{208}Pb , using 34 commonly employed Skyrme type effective nucleon-nucleon interactions. Fig. 1 shows the results [1] of HF-based RPA calculations (full circles), for the centroid energies E_{CEN} of the IVGMR, IVGDR, IVGDR2, IVGQR and IVGOR in ^{208}Pb as functions of the symmetry energy coefficient J , in the range of $J = 26.80 - 36.7$ MeV. The dashed lines show the regions of the experimental data. An agreement with experimental data is obtained for several interactions. However, a very weak correlation is obtained between the centroid energies and J . Similar results were also obtained when using instead of J , the quantities L and K_{sym} [1]. These results, which contradict statements in the literature, can be understood by noting that the strength distributions of giant resonances also depend on other nuclear matter (NM) quantities, such as K and m^*/m , which have different values for different interactions used in the calculations.

[1] M.R. Anders and S. Shlomo, in preparation.

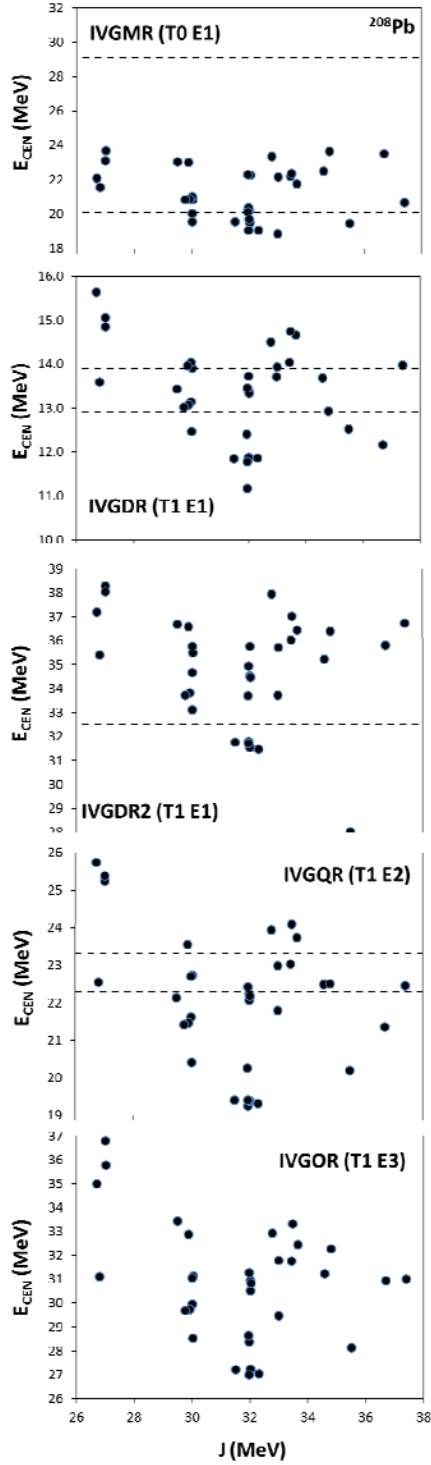


FIG. 1. The centroid energies, E_{CEN} , of the IVGMR, IVGDR, IVGDR2, IVGQR and IVGOR in ^{208}Pb , as functions of the symmetry energy coefficient J . The experimental data are shown as the region between the dashed lines. The results of fully self-consistent HF-based RPA calculation using 34 commonly employed Skyrme interactions [1] are shown as solid points