Investigating the dependence of the value of the isovector giant octupole resonance in select spherical nuclei on the symmetry energy and on the energy weighted sum rule enhancement coefficient for the IVGDR

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We have performed fully self-consistent Hartree-Fock (HF)-based random phase approximation (RPA) calculations of the centroid energies for the isovector resonances up to L=3 multi-polarity for several ^{40,48}Ca, ^{68}Ni, ^{90}Zr, ^{116}Sn, ^{144}Sm and ^{208}Pb. The calculations were done using 33 different Skyrme-type effective nucleon-nucleon interaction commonly adopted in the literature.

The Pearson linear correlation coefficient (C) is calculated for every nuclear matter (NM) property in an effort to make constraints on NM property when the correlation is high. In Fig. 1 we study the centroid energy of the isovector giant octupole resonance (IVGOR), calculated within the HF-RPA framework with the 33 Skyrme interactions, as a function of the symmetry energy *J*. Each nucleus has its own panel. We don't have any available experimental data for the IVGOR. We do not find any correlation between the calculated E_{CEN} and *J* (C ~ -0.32) for all nuclei considered. Similar results were found for the first derivative of the symmetry energy, *L* (C ~ 0.19) and for the second derivitative of *J*, K_{Sym} (C ~ 0.02). On the other hand, we find a strong correlation between the E_{CEN} of the IVGOR and the energy weighted sum rule enhancement coefficient κ for the isovector giant dipole resonance (Pearson linear correlation coefficient C ~ 0.81), as can be seen in Fig. 2. Similar calculations were carried out for both the isoscalar and the isovector resonances of multipolarity L = 1, 2 and 3. Analysis was also performed for all the resonances of these nuclei [1] and other nuclear matter quantities. These results will be used to determine the next generation nuclear energy density functional with improved predictive power for properties of nuclei and nuclear matter.

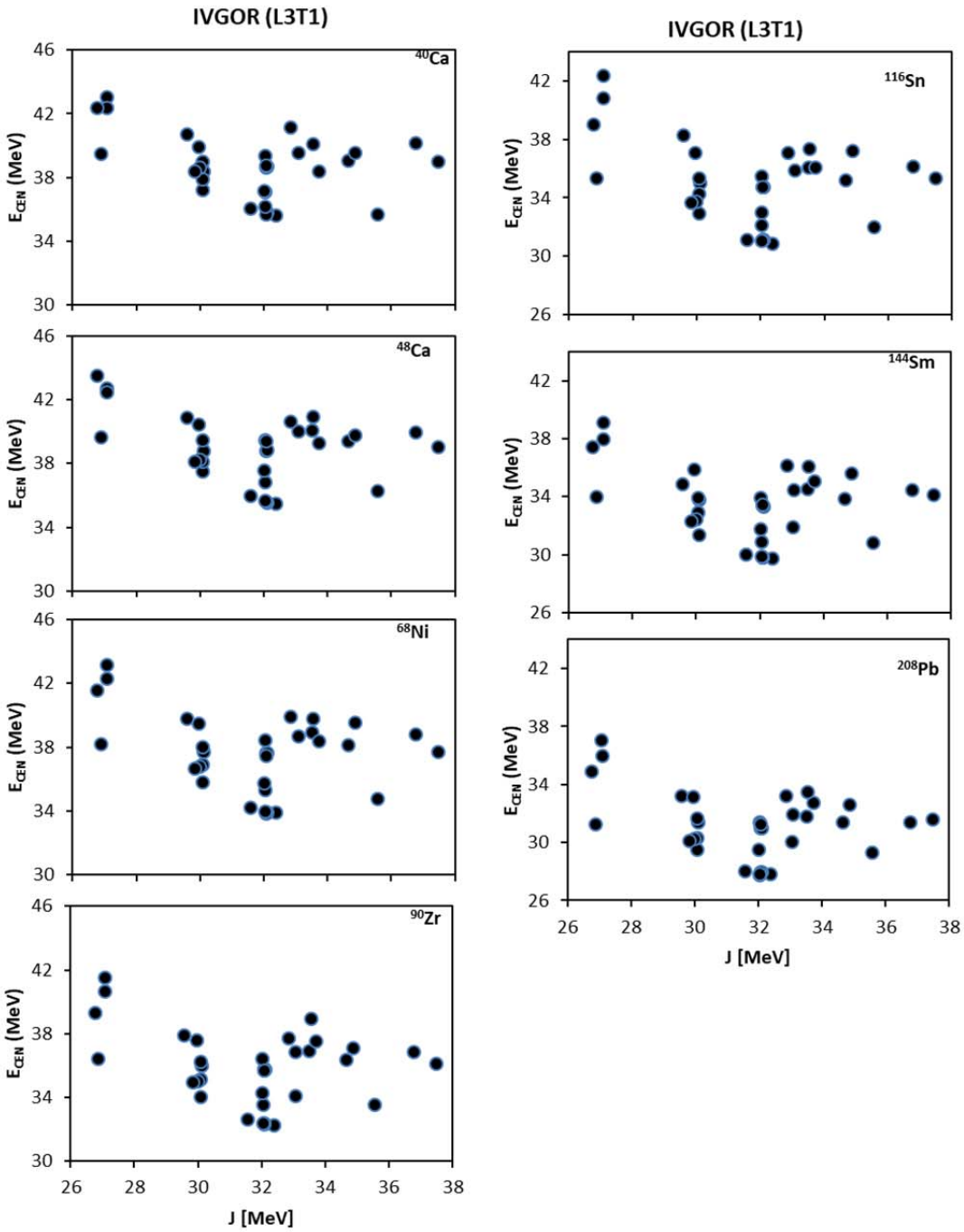

FIG. 1. Calculated centroid energies, E_{CEN}, in MeV (full circle) of the isovector giant octupole resonance (IVGOR), for different interactions, as a function of the symmetry energy coefficient *J*. We don't find any correlation between this isovector property and the value of the E_{CEN} with a Pearson linear correlation coefficient of C ~ -0.32.

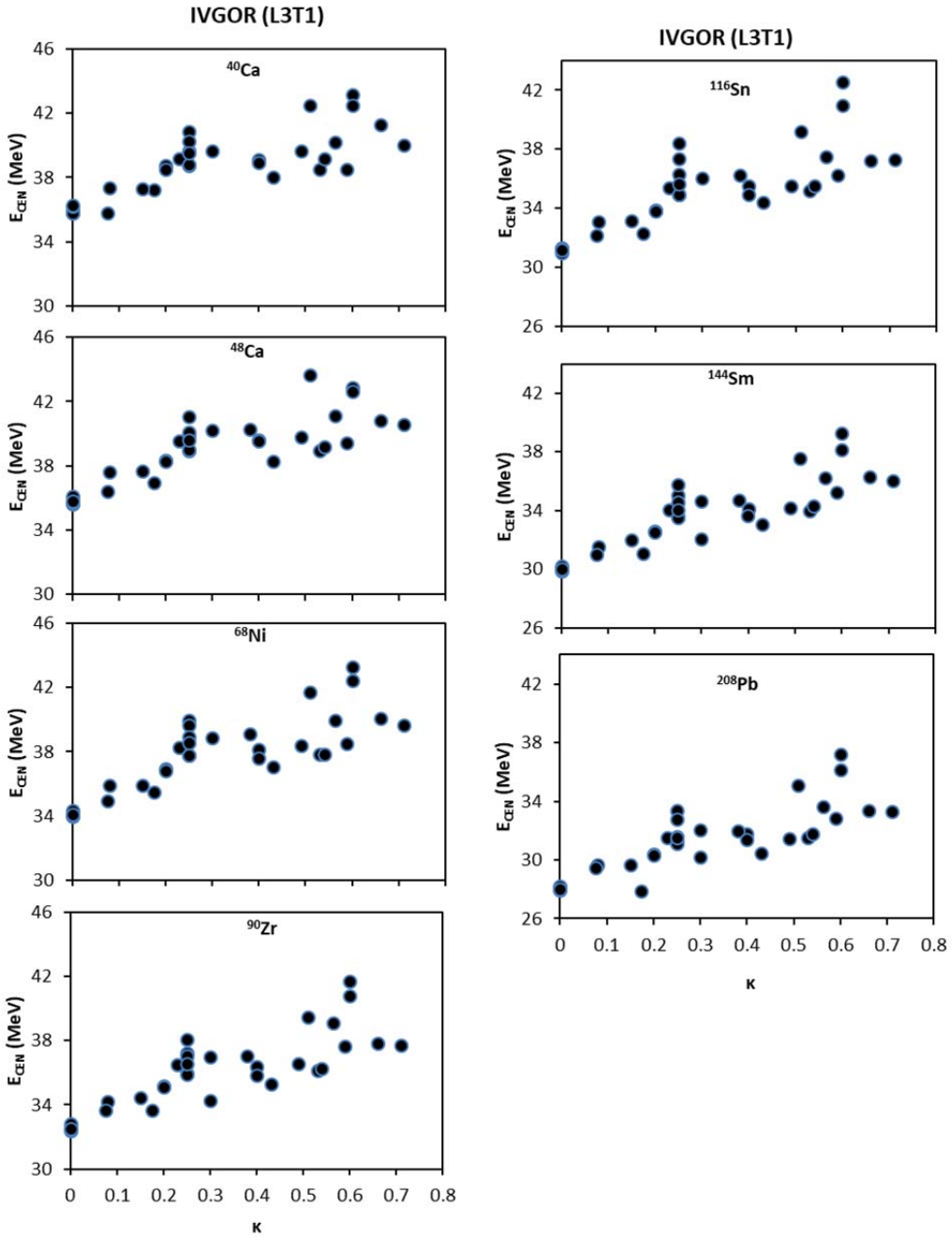

FIG. 2. Calculated centroid energies, $E_{CEN,}$ in MeV (full circle) of the isovector giant octupole resonance (IVOGR), for the different interactions, plotted against the energy weighted sum rule enhancement coefficient for the isovector giant dipole resonance. We find a strong correlation between this NM property and the calculated E_{CEN} with a Pearson linear correlation coefficient close to C = 0.81 for all isotopes considered.

[1] G. Bonasera *et al*., in preparation for publication.