**The symmetry energy density and isovector giant resonances energies in $^{208}$Pb**

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In this work [1], we have carried out fully self-consistent Hartree-Fock (HF)-based random phase approximation (RPA) calculations of the strength functions S(E) and centroid energies $E_{CEN}$ of isovector ($T = 1$) giant resonances of multipolarities $L = 0 - 3$ in $^{208}$Pb using a wide range of 34 commonly employed Skyrme type nucleon-nucleon effective interactions. We determined the sensitivities of $E_{CEN}$ to parameters of the symmetry energy density of nuclear matter (NM), associated with the Skyrme interactions.

The equation of state (EOS) of asymmetric NM, with proton density, $\rho_p$, and neutron density, $\rho_n$, can be approximated by

$$E[\rho_p, \rho_n] = E_0[\rho] + E_{sym}[\rho]\left(\frac{\rho_n - \rho_p}{\rho}\right)^2, \quad (1)$$

where $E_0[\rho]$ is the energy of symmetric NM at matter density, $\rho$, and $E_{sym}[\rho]$ is the symmetry energy, approximated as

$$E_{sym}[\rho] = J + \frac{1}{3} L\left(\frac{\rho - \rho_0}{\rho_0}\right) + \frac{1}{18} K_{sym}\left(\frac{\rho - \rho_0}{\rho_0}\right)^2, \quad (2)$$

where $J = E_{sym}[\rho_0]$ is the symmetry energy at saturation density, $\rho_0$, $L = 3\rho_0 \frac{\partial E_{sym}}{\partial \rho}\Big|_{\rho_0}$, and $K_{sym} = 9\rho_0 \frac{\partial^2 E_{sym}}{\partial \rho^2}\Big|_{\rho_0}$.

Figs. 1 and 2 show the comparison between the calculated and experimental results for the centroid energies with L and $K_{sym}$, respectively. It is clearly seen that, contrary to statements in the literature, a very weak correlation exist between the centroid energies of the isovector giant resonances and L or $K_{sym}$. Similar results were obtained for J.

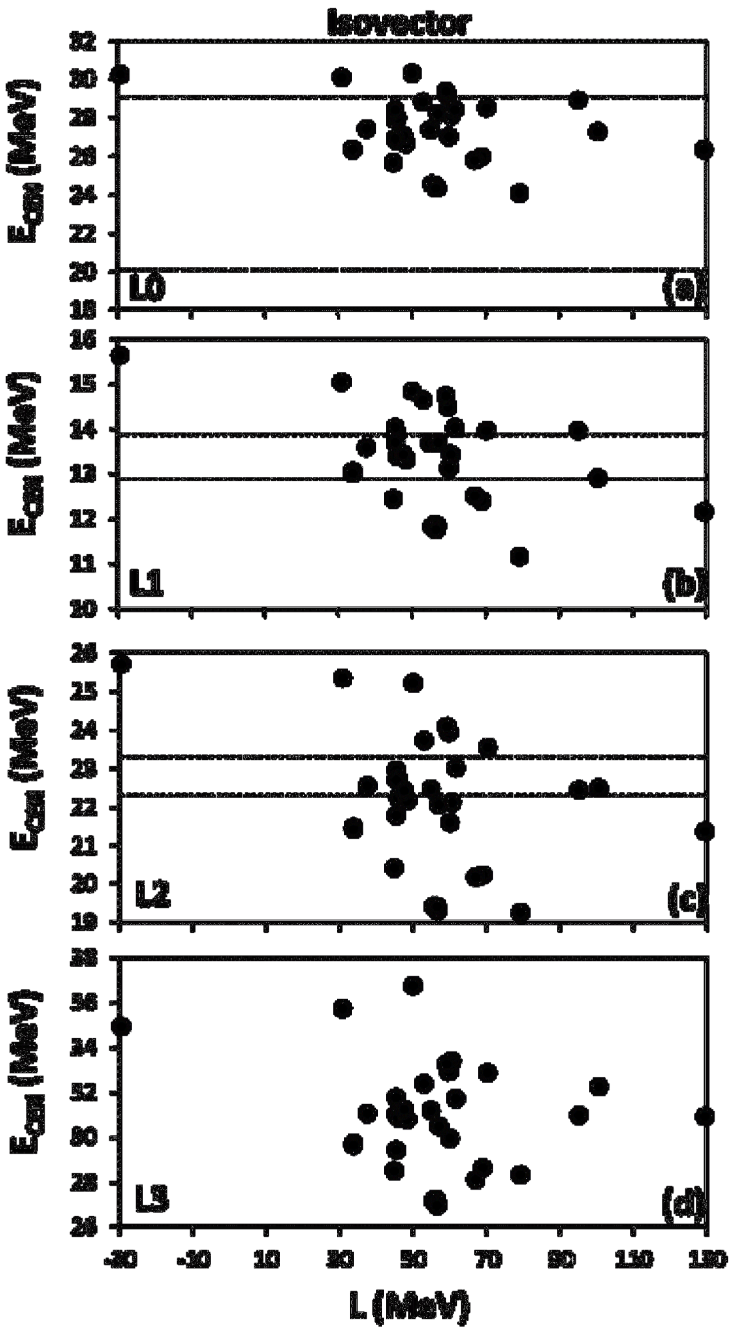


**FIG. 1.** Comparison of experimental data of the IVGMR (a), IVGDR (b), and IVGQR (c) centroid energies of $^{208}$Pb, shown as the regions between the dashed lines, with the results of fully self-consistent HF based RPA calculations (full circles) obtained using the Skyrme interactions, plotted vs. L. Calculated IVGOR (d) centroid energies are also shown.

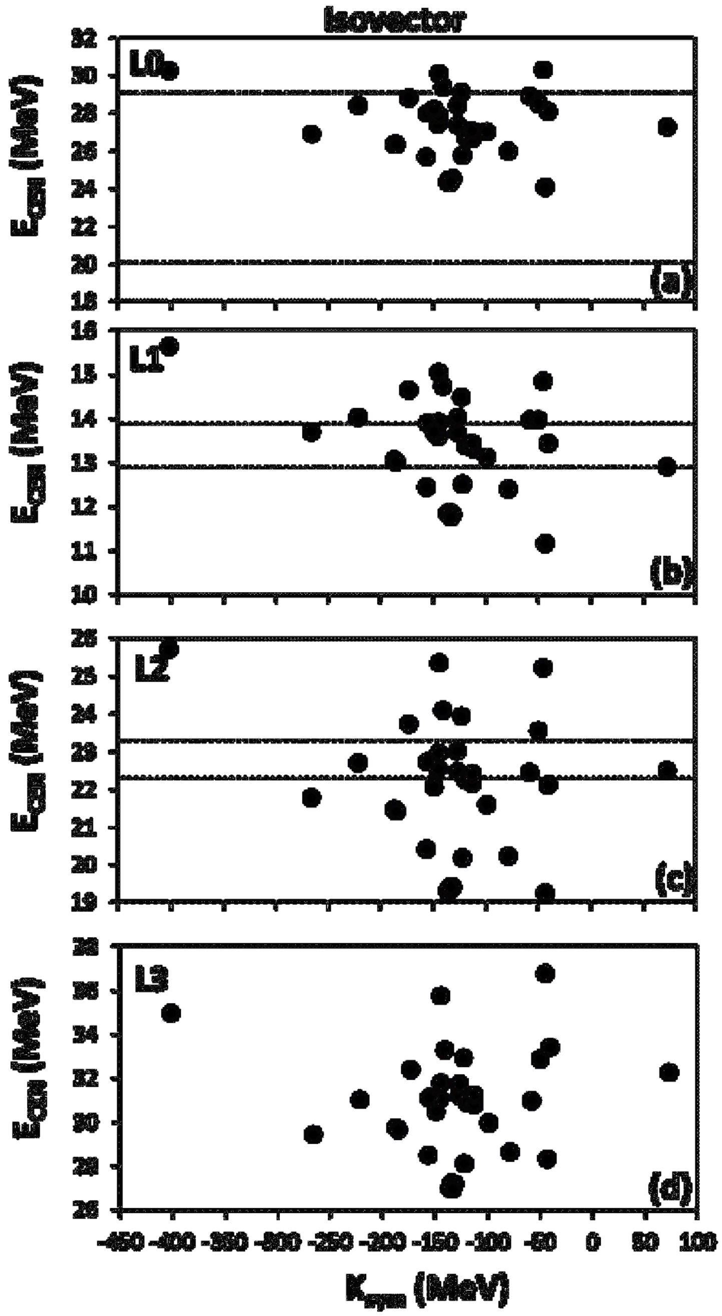


**FIG. 2.** Same as Fig. 1 for $K_{sym}$.

[1] M.R. Anders and S. Shlomo, (to be published).