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Isoscalar giant monopole strength in 58Ni, 90Zr, 120Sn and 208Pb

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Background: Inelastic α-particle scattering at energies of a few hundred MeV and very-forward scattering angles including 0° has been established as a tool for the study of the isoscalar giant monopole (IS0) strength distributions in nuclei. This compressional mode of nuclear excitation can be used to derive the incompressibility of nuclear matter.

Objective: An independent investigation of the IS0 strength in nuclei across a wide mass range was performed using the 0° facility at iThemba Laboratory for Accelerator Based Sciences (iThemba LABS), South Africa, to understand differences observed between IS0 strength distributions in previous experiments performed at the Texas A&M University (TAMU) Cyclotron Institute, USA and the Research Center for Nuclear Physics (RCNP), Japan.

Methods: The isoscalar giant monopole resonance (ISGMR) was excited in ^{58}Ni, ^{90}Zr, ^{120}Sn and ^{208}Pb using α-particle inelastic scattering with 196 MeV α beam and scattering angles $\theta_{\text{Lab}} = 0^\circ$ and 4°. The K600 magnetic spectrometer at iThemba LABS was used to detect and momentum analyze the inelastically scattered α particles. The IS0 strength distributions in the nuclei studied were deduced with the difference-of-spectra (DoS) technique including a correction factor for the 4° data based on the decomposition of $L > 0$ cross sections in previous experiments.

Results: IS0 strength distributions for ^{58}Ni, ^{90}Zr, ^{120}Sn and ^{208}Pb are extracted in the excitation-energy region $E_x = 9 - 25$ MeV. Using correction factors extracted from the RCNP experiments, there is a fair agreement with their published IS0 results. Good agreement for IS0 strength in ^{58}Ni is also obtained with correction factors deduced from the TAMU results, while marked differences are found for ^{90}Zr and ^{208}Pb.

Conclusions: Previous measurements show significant differences in the IS0 strength distributions of ^{90}Zr and ^{208}Pb. This work demonstrates clear structural differences in the energy region of the main resonance peaks with possible impact on the determination of the nuclear matter incompressibility presently based on the IS0 centroid energies of these two nuclei. The results also suggest that for an improved determination of the incompressibility, theoretical approaches should aim at a description of the full strength distributions rather than the centroid energy only.

Apply to be considered for a student ; award (Yes / No)?

No

Level for award;(Hons, MSc, PhD, N/A)?

N/A

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