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The isoscalar giant monopole resonance in the Ca isotope chain

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Interest in the evolution of the isoscalar giant monopole resonance (ISGMR) within the calcium isotope chain follows from a 2017 study which suggests that the monopole resonance energy, and thus the incompressibility of the nucleus KA, increase with mass. In 2020 a different group reported a weak decreasing trend of the energy moments, resulting in a generally accepted negative value for Kτ, which is the asymmetry term in the nuclear incompressibility.

We provide an independent measurement of the ISGMR in the Ca isotope chain to gain a better understanding of the origin of the different systematic trends. Inelastic scattering of 196 MeV α particles from a range of calcium targets 40,42,44,48Ca, observed at small scattering angles, including 0°, were momentum analyzed in the K600 magnetic spectrometer at iThemba LABS, South Africa. Monopole strengths spanning an excitation-energy range 9.5 - 25.5 MeV were obtained using the difference-of-spectra (DoS) technique, adjusted to correct for the variation of the angular shape of the sum of the L>0 multipoles as a function of excitation energy, and compared with previous results that employed multipole-decomposition analysis (MDA) techniques.

It was found that the structure of the E0 strength distributions of 40,42,44Ca agrees well with the results from the previous measurement that supports a weak decreasing trend of the energy moments, while no two datasets agree in the case of 48Ca. Despite the variation in the structural character of the E0 strength distribution from the different studies we find, within the excitation-energy range that covers the resonance peak, fair agreement between moment ratios of specific isotopes from different studies. And while it is difficult to identify from the moment ratio calculation in this excitation energy range a clear systematic trend as a function of mass, it appears as if different mass trends previously observed for the nuclear incompressibility are caused by contributions to the measured strength distribution outside of the region defined by the peak of the resonance, and in particular for high excitation energies. While procedures exist to identify and subtract instrumental background, more work is required to characterize and subtract continuum background contributions at high excitation energies, to ensure that the measured strength distributions from this work as well as earlier studies only represent ISGMR.

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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