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Extraction of the Giant Monopole Resonance strength distribution with Multipole Decomposition Analysis

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It has been established that inelastic alpha scattering at a few hundred MeV, particularly at very forward scattering angles including 0°, is effective for probing the Isoscalar Giant Monopole Resonance (ISGMR) strength distribution (E_0) in atomic nuclei. Two previous studies on the evolution of the ISGMR in the even-even ^{40,42,44,48}Ca isotopes were conducted at two different facilities: the Research Center for Nuclear Physics (RCNP) and the Texas A&M University Cyclotron Institute (TAMU). These studies produced conflicting results regarding the systematic trend of nuclear incompressibility across the calcium isotopic chain under investigation. In response, the iThemba LABS group conducted an independent study of the same isotopes to investigate the potential origins of these discrepancies. Measurements were carried out at 0° and 4° scattering angles, and an energy-dependent version of the difference-of-spectra (DoS) method was initially employed. While this method offers high energy resolution, it relies on the strength contributions of all $L \geq 0$ multipolarity components published in the literature, thereby compromising the independence of our results. To address this, Multipole Decomposition Analysis (MDA) was applied to extract the E_0 strength distributions. Although the limited angular range may reduce the precision for higher multipolarity strengths, it does allow for the accurate extraction of the E_0 component independently of other studies.

Two MDA methods were used in the analysis: the `emcee` Python code, which employs the sophisticated Markov Chain Monte Carlo (MCMC) sampling algorithm, and a second MDA method is based on the MINUIT algorithm, implemented within the ROOT data analysis framework. Selected results obtained using both methods will be presented at the conference.

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