Photoabsorption studies

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Photoabsorption reactions, in which a nucleus responds to an external electric field, can tell us many interesting things about the behaviour of nuclei, including probing the symmetry energy - the cost of exchanging protons for neutrons in nuclear matter - and how likely neutron-capture reactions are to take place in nuclear reactors or stars. In recent years, there was an interesting result which found that photoabsorption reactions are modified by the shell structure of the nuclei of interest, notably that the dipole polarisability, a measure of nuclear diffuseness, showed structures at certain nuclear shell closures [1]. However, based on concerns expressed over the results of photoneutron reactions in recent IAEA reports and other papers [2], we decided to reinvestigate this effect to determine if it could be an experimental artefact rather than a physics effect. To this end, we have redetermined the dipole polarisabilities of a number of nuclei using updated experimental data or re-evaluations of past experimental results. Our preliminary finding is that we do not reproduce the magnitude of the previously observed drop in the dipole polarisability at the neutron shell closures but that there may still be some evidence for a shell structure effect but additional validation of the data must be carried out to ensure that the results are robust.

Fig. 1 shows the ratio of dipole polarisability parameter (the σ_{-2}) to a systematic trend σ_{-2} = 2.4 $A^{5/3}$ mb/MeV across a range of nuclei, and with various different sources for the photoabsorption strength. These results are still being finalised due to some inconsistencies in the description of the shapes of the isovector giant dipole response for some systems.

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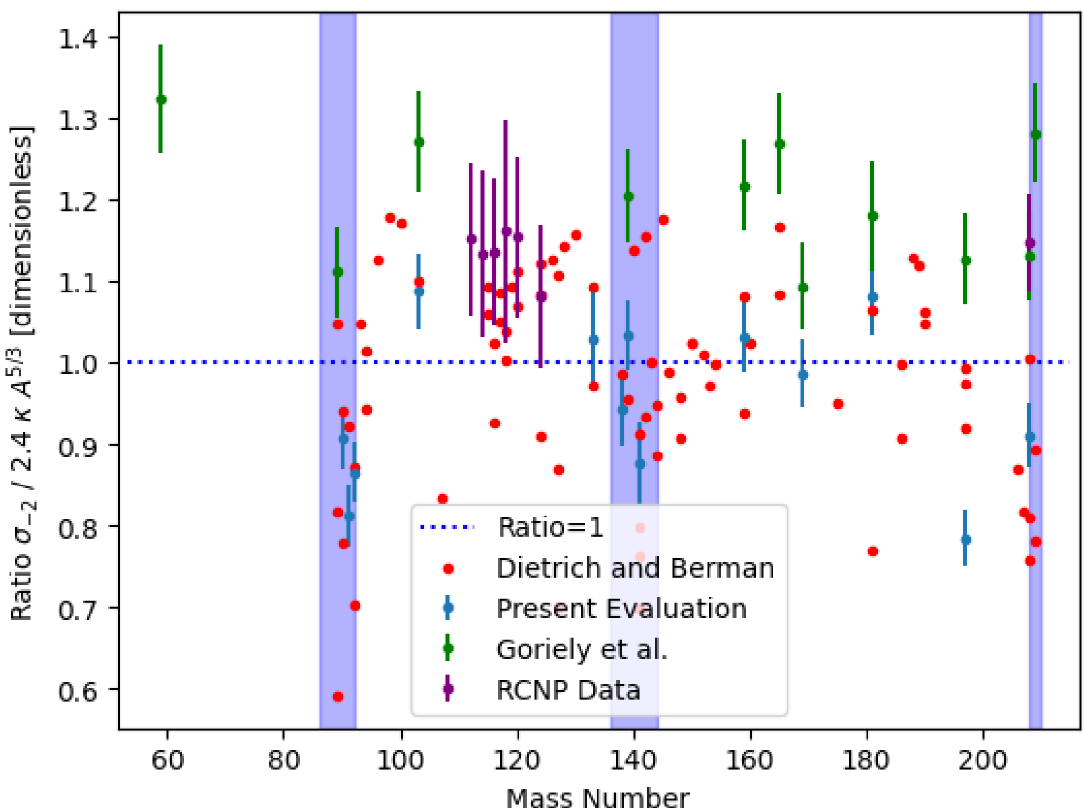

FIG. 1. Ratio of σ_{-2} from data vs systematic σ_{-2} = 2.4 (1) κ $A^{5/3}$ mb/MeV trend with data from various different sources.

[1] C. Ngwetsheni and J.N. Orce, Phys. Lett. B **792**, 335 (2019).

[2] T. Kawano *et al.*, Nuclear Data Sheets **163** 109 (2020); V.V. Varlamov *et al.*, Euro. Phys. J. A **54,** 74 (2018).