Contribution ID: **19** Type: **Poster (In person)**

Shell model calculations of the electric dipole polarizability

Wednesday 29 November 2023 17:50 (1 minute)

The electric dipole (E1) polarizability has recently been used to explain the universality of elemental abundances [1]. Here, we present shell-model (SM) calculations of the E1 polarizability for the ground- and first-excited states of selected p- and sd-shell nuclei, substantially advancing previous knowledge. Our results for ground states [2] are slightly larger compared with the somewhat more scattered photo-absorption cross-section data, albeit agreeing with *ab initio* calculations at shell closures and presenting a smooth trend that follows the leptodermus approximation from the finite-range droplet model (FRDM). The total E1 strengths also show an increasing trend proportional to the mass number which follows from the classical oscillator strength (TRK) sum rule for the E1 operator. The enhancement of the energy-weighted sum over E1 excitations with respect to the TRK sum rule arises from the use of experimental single-particle energies and the residual particle-hole interaction. Furthermore, following the original work of Hausser, Barker and collaborators together with basic quantum mechanics, novel equations for the E1 polarizability of low-lying excited states in atomic nuclei are inferred in terms of electric dipole and quadrupole matrix elements [3]. These equations are valid for arbitrary angular momenta of the initial/ground and final/excited states. Consequently, new SM calculations of the E1 polarizability for excited states will be presented during the ISOLDE workshop, which are part of the effective quadrupole interaction and relevant to the analysis of Coulomb-excitation measurements in RIB facilities.

[1] José Nicolás Orce, Balaram Dey, Cebo Ngwetsheni, Srijit Bhattacharya, Deepak Pandit, Brenden Lesch, Andile Zulu, Enhanced symmetry energy may bear universality of r-process abundances, MNRAS 525(4) (2023) 6249 https://doi.org/10.1093/mnras/stad2539

[2] José Nicolás Orce, Cebo Ngwetsheni, and B. Alex Brown, Global trends of the electric dipole polarizability from shell-model calculations, to be published in PRC (2023).

[3] José Nicolás Orce, Electric dipole polarizability of low-lying excited states in atomic nuclei, submitted to PRC (2023).

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Session Classification: Poster Session