

Title: Study of electric multipole transition probabilities & their importance in reaction dynamics

This highlight represents the outcome of one of the thesis works which addresses crucial aspects of nuclear collectivity on an absolute scale along the stable Sn isotopic chain within single experiments. The primary motivation has been to measure the ratio of neutron and proton transition matrix elements (M_n/M_p) of the dominant low-lying quadrupole (2_1^+) and octupole (3_1^-) excitations in the $^{112,116,118,120,122,124}\text{Sn}$ isotopes. Heavy-ion scattering offers a spectroscopic tool for the excitation of such collective states of nuclei. In this context, experiments were carried out at the BARC-TIFR Pelletron-LINAC Facility, Mumbai, with probes ^7Li and ^{12}C .

The deformation lengths and transition probabilities are extracted via extensive coupled-channels calculations employing the collective model approach. A prescription to remove the effects of finite projectile size is used to deduce the intrinsic mass deformation length for each isotope. The results indicate that neutron collectivity is the dominant contribution to the 2_1^+ and 3_1^- excited states in the Sn isotopes, as may be expected in proton-magic nuclei. The effect of size of the probe is the dominant factor that leads to discrepant transition rates; the effect of the nature of probe-target interaction is secondary.

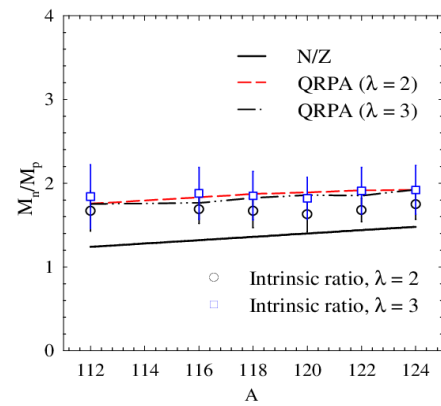


Figure: Intrinsic M_n/M_p for the low-lying excitations in the Sn isotopes.

In addition, an improved estimate of the mean lifetime of the 2_1^+ level in ^{120}Sn has been determined using the Doppler shift attenuation method implemented through updated methodologies. An enhancement in collectivity for the 2_1^+ state is confirmed, with the corresponding value of the proton transition matrix element, M_p , consistent with those obtained from the heavy-ion scattering measurements.

The coupling of the low-lying excitations of colliding nuclei to their relative motion has significant influence on cross sections of elastic scattering, complete fusion, as well as all intermediate peripheral channels. To this effect, a simultaneous description of elastic scattering, inelastic excitations and one-nucleon transfer channels has been attempted using the optical potential and structural deformation parameters determined in the previous chapters. New spectroscopic factors have been exclusively assigned for some states in residual nuclei populated by the nucleon-transfer reactions. A direct effect of inelastic couplings in calculating the fusion cross section through a multidimensional barrier is seen to be model dependent. Such a comparison between experimental and theoretical values of reaction observables can be useful as a test for nuclear reaction models.

References: (1) "Probing systematic model dependence of complete fusion for reactions with the weakly bound projectiles $^6,^7\text{Li}$ "- *Phys. Rev. C* **94**, 014603 (2016). (2) "Elastic, inelastic, and 1-nucleon transfer channels in the $^7\text{Li}+^{120}\text{Sn}$ system"- *Phys. Rev. C* **95**, 034615 (2017). (3) "Low-lying quadrupole and octupole collective excitations in the $^{112,116,118,120,122,124}\text{Sn}$ isotopes"- *Phys. Rev. C* **99**, 034609 (2019). (4) Reaffirmation of probe dependence of the mass deformation length for low-lying excitations in $^{112,116,118,120,122,124}\text{Sn}$ isotopes"- *Phys. Rev. C* **100**, 024614 (2019). (5) "Measurement of the 2_1^+ level lifetime in ^{120}Sn by the Doppler shift attenuation method: Evidence of enhanced collectivity"- *Phys. Rev. C* **100**, 034327 (2019).

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