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## Dipole polarizability effect on the quadrupole moment of the first 2+ state in $^{12}\text{C}$

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A high-statistics Coulomb-excitation study of  $^{12}\text{C}$  has been carried out using the  $^{208}\text{Pb}(^{12}\text{C}, ^{12}\text{C})^{208}\text{Pb}$  Coulomb-excitation reaction at 56 MeV using the Q3D spectrometer at the Maier-Leibnitz Laboratory (MLL) in Munich (Germany). Beam currents of approximately  $10^{11}$  pps allowed the determination of the spectroscopic quadrupole moment of the first 2+ state at 4.439 MeV with unprecedented accuracy.

Furthermore, the effect of the nuclear dipole polarizability on E2 collective properties was investigated using large-scale shell-model calculations. The dipole polarizability parameter  $k$  accounts for deviations of the hydrodynamic model prediction with respect to the actual effects from the Giant Dipole Resonance (GDR). Away from shell closures and light nuclei,  $k$  values for ground states are observed to follow a smooth trend consistent with  $k=1$ . However, for light nuclei, values of  $k>1$  are determined and recently, it has been shown that  $k$  values actually increase for excited states with respect to ground state values [1,2,3].

A no-core shell model (NCSM) calculation predicts  $\kappa(2+) = 2.1(2)$  and ground state  $\kappa(\text{g.s.}) = 1.5(2)$  in agreement with photo-absorption measurements  $\kappa(\text{g.s.}) = 1.6(2)$ . The phenomenological WBP shell model interaction predicts a smaller  $\kappa(2+) = 0.9$  and  $\kappa(\text{g.s.}) = 1.4$ . Assuming  $k(2+)\text{NCSM}=2.1(2)$  and  $k(2+)\text{WBP}=0.9$  yield  $Q_S(2+)=+0.12(3)$  eb and  $Q_S((2+)=+0.07(3)$  eb, respectively, confirming the oblate deformation for the 2+ state.

Such a discrepancy in  $k$  values is associated with the binding energy predictions by these models. The WBP interaction predicts a larger g.s. binding energy compared to experiment data hence the reduced  $\kappa$  value. Previous studies show highly bound nuclear systems e.g. magic nuclei present reduced  $\kappa$  values. This work proves sensitivity of polarizability to change in binding energies, a 5% decrease of binding energy results a significant change in polarizability. Therefore establishing the nuclear dipole polarizability as a probe for investigating long-range correlations of the nuclear force such as nuclear collectivity and shell effects.

[1] M. K. Raju, J.N.Orce, P.Navrátil, G.C.Ball, T.E.Drake et al., Phys. Lett. B. 777, 250 (2018).

[2] J. N. Orce, E. J. Martini, K. J. Abrahams, C. Ngwetsheni, et al., Phys. Rev. C 104, L061305 (2021).

[3] C. Mehl, J. N. Orce, C. Ngwetsheni et al., Under review for publication.

### Apply to be considered for a student ; award (Yes / No)?

Yes

### Level for award;(Hons, MSc, PhD, N/A)?

PhD

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