Measurements of g Factors and Lifetimes of the first 2^+ States of $^{62-70}$Zn and their Shell Model Implication ◇

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The even-even Zn isotopes ^{62}Zn, ^{64}Zn, ^{66}Zn, ^{68}Zn and ^{70}Zn are characterized by 2 valence protons and 4 to 12 neutrons beyond doubly-magic ^{56}Ni which indicates collective behaviour increasing with the number of neutrons. For ^{62}Zn superdeformation was found only recently [1] supporting collectivity even for the lightest isotope. The proximity to the Ni isotopes for which shell model calculations in the full fp shell configuration space were extremely successful in describing the low level structure [2,3], suggests similarly good results for Zn. However, in this case, the influence of the $g_{9/2}$ intruder orbit plays a more important role which was emphasized in several earlier papers (see e.g. [4]). In addition, ^{56}Ni is not a good closed core: the excitation of $f_{7/2}$ nucleons is a crucial ingredient for the structure of fp shell nuclei.

The experimental situation with respect to g factors and $B(E2)$'s is rather sparse [5]. Therefore, both quantities were redetermined with higher precision under improved experimental conditions.

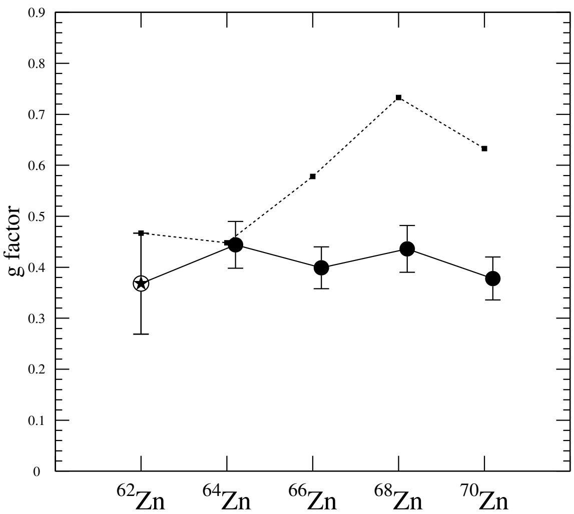

Fig. 1: Comparison of the experimental (large symbols) and theoretical (small symbols) g factors of the Zn isotopes. The lines are drawn to guide the eye.

We have remeasured the g factors of the first 2^+ states of all even Zn isotopes employing the technique of transient magnetic fields combined with Coulomb excitation in inverse kinematics. Isotopically pure Zn beams, provided by the Munich tandem accelerator with energies of 160 MeV, were excited by natural carbon of a single multilayered target. The latter consisted of thin layers of C-Gd-Ta-Cu. Deexcitation γ rays were measured with BaF_2 scintillators in coincidence with forward recoiling C ions which were detected in a 0° Si counter. More details of this technique are described in [6]. For the radioactive ^{62}Zn ($T_{1/2}$ = 9.2 h) the 2^+ state was efficiently populated in an α-transfer reaction bombarding the same target with a ^{58}Ni beam of 155 MeV. The g factors obtained are shown in Fig. 1.

In addition, the lifetimes of the 2^+ states were newly determined using the Doppler-Shift-Attenuation method. The deduced $B(E2)$ values in Weisskopf units are displayed in Fig. 2.

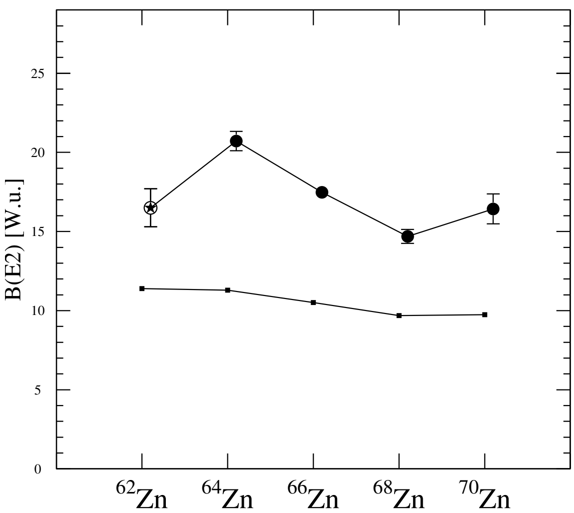

Fig. 2: Comparison of the experimental (large symbols) and theoretical (small symbols) $B(E2)$ values of the Zn isotopes. The lines are drawn to guide the eye.

The data are compared with results from large shell model calculations based on a closed ^{56}Ni core and excitations of valence nucleons in the fpg shell configuration space. As seen from the figures both the g factors and the $B(E2)$ values show distinct deviations which are attributed to the omission of core excitation. The surrender of the ^{56}Ni core was essential for the interpretation of the Ni data. At present it is rather difficult to include these additional degrees of freedom in the calculations due to computer limitations.

References

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