Experimental g Factors and B($E2$) Values of Excited States in ^{64,68}Zn Compared to Shell Model Predictions

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In view of previous experimental results for g factors and B($E2$) values in ^{64}Zn and ^{68}Zn isotopes [1,2] and their predictions by large-scale shell model calculations the insufficient accuracy of some of the data was motivation for a series of new measurements. In these experiments the 4_1^+ states were of particular interest since theory predicts for the B($E2$) strikingly different values in case of ^{68}Zn depending on the model space. In fact, with a ^{56}Ni core (closed $f_{7/2}$ subshell) and the inclusion of $g_{9/2}$ neutrons in the fp shell model space, the B($E2$; $4_1^+ \rightarrow 2_1^+$) is significantly larger than the corresponding value based on a ^{40}Ca core but with the exclusion of the $g_{9/2}$ orbital (see also [2]). This feature, however, is less pronounced for ^{64}Zn where the two calculations yield practically the same values. On the other hand, a measurement of the 4_1^+ g factor in ^{68}Zn was not succesful in former experiments. A bigger effort was therefore made in the present experiments. As in previous measurements Coulomb excitation was applied in inverse kinematics to 180 MeV ^{64}Zn and ^{68}Zn projectiles using carbon of a multilayered target for nuclear excitation and Gd as ferromagnetic host for the spin precession in the transient field, altogether under very similar conditions as in the earlier experiments [2]. Sufficiently intense ion beams were provided by the Munich tandem accelerator. In addition to NaI(Tl) scintillators two Ge detectors of 40% relative efficiency were used for γ detection.

An additional Ge detector, placed at 0° relative to the beam direction, was used to determine the nuclear lifetimes of several states by analyzing the Doppler-broadened lineshapes. The superior energy resolution of the Ge detectors was crucial for the g factor measurement of the 4_1^+ state in ^{68}Zn but not so for ^{64}Zn. In case of ^{68}Zn, a ($2_3^+ \rightarrow 2_1^+$) γ transition of 1261 keV was lying very close to the ($4_1^+ \rightarrow 2_1^+$) γ line due to the large Dopplershift in the forward hemissphere. Hence, at forward angles the scintillators were replaced by Ge detectors whereas for the backward angles the resolution of the scintillators was sufficient to separate the two interfering γ lines.

Beside the spin precessions in the transient field and lifetime determinations detailed γ-angular correlations have been measured to determine the slopes relevant to the precession angles. For the g factor analysis the effective transient field was determined on the basis of the empirical linear parametrization including an attenuation factor due to demagnetization effects of the Gd layer by the Zn beams (see [2] and refs. therein).

B($E2$)'s were deduced from the lifetimes for transitions in both ^{64}Zn and ^{68}Zn. Results of g factors and B($E2$)'s for the 4_1^+ states are shown in Figs. 1 and 2 and are compared with shell model predictions. Evidently, for ^{68}Zn the ^{56}Ni core calculations with the explicit inclusion of the $g_{9/2}$ orbital agree very well with the experimental B($E2$) value whereas for ^{64}Zn both calculations are in fair agreement with the experimental data. A surprising result was obtained for the g factor of ^{68}Zn(4_1^+) which heavily contradicts with present calculations. The negative sign clearly favours a dominant $g_{9/2}$ neutron component in the nuclear wave function. That neutron excitations should play an important role in ^{68}Zn was already emphasized in the early work by Bruandet et al. [3].

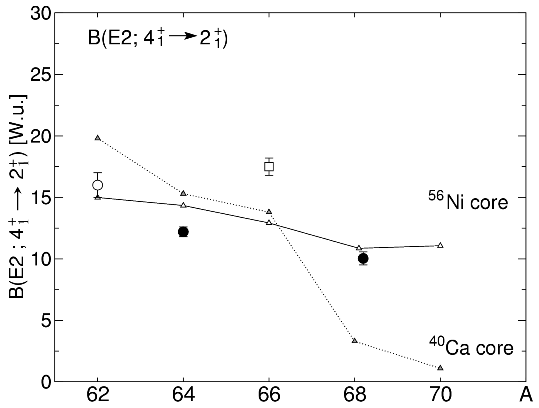

Fig. 1: Experimental B($E2$) values of $4_1^+ \rightarrow 2_1^+$ transitions in Weisskopf units are compared with results from shell model calculations. Closed circles refer to present open symbols to previous measurements. [1,4](see text)

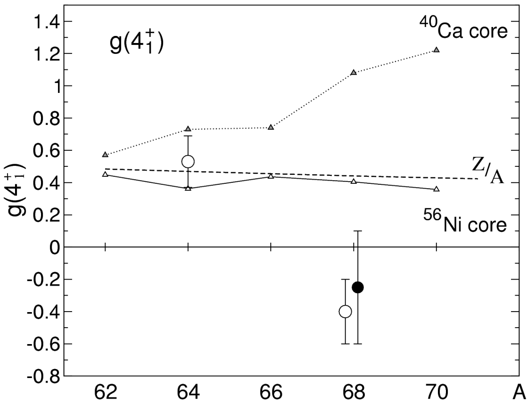

Fig. 2: Experimental g factors of 4_1^+ states are compared with results from shell model calculations. Closed circles refer to present open symbols to previous measurements. [2](see text)

References

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