g Factor and Lifetime Measurements of Coulomb Excited $2_1^+, 4_1^+$ and 3_1^- States in ^{64}Zn ◇

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g factors and lifetimes of the first 2^+ states of all stable even-even Zn isotopes and radioactive ^{62}Zn from recent systematic measurements, were well reproduced by large-scale shell model calculations in the fp and fpg model spaces for valence protons and neutrons and ^{40}Ca, ^{56}Ni and ^{48}Ca inert cores with the effective NN interaction KB3G [1]. Since the calculated g factors of the first 4^+ states exhibit larger variations than those of the 2^+ states, due to the influence of the $g_{9/2}$ intruder orbit, new measurements on ^{64}Zn were performed under improved experimental conditions to further test the model predictions.

Isotopically pure ^{64}Zn beams of 175 MeV, provided by the Munich tandem accelerator, were Coulomb excited in a carbon layer of a multilayered target consisting of 0.4 mg/cm^2 carbon, followed by 4.4 mg/cm^2 gadolinium evaporated on a 1.1 mg/cm^2 thick tantalum layer which was backed by 3.4 mg/cm^2 copper. In the polarized gadolinium layer the large transient magnetic fields cause precessions of the excited states before the nuclei are stopped in the Cu backing of the target.

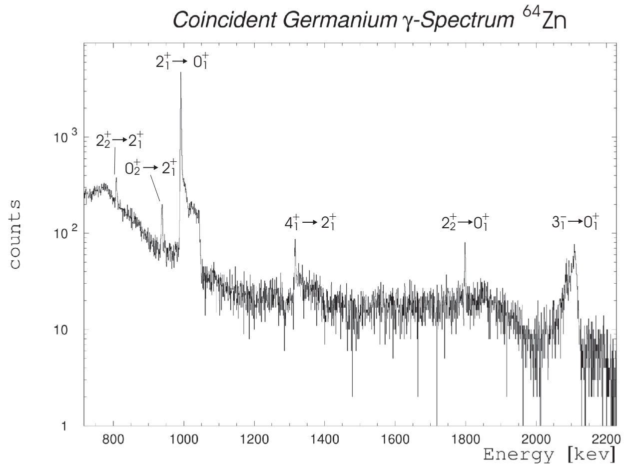

Fig. 1: *Coincident Ge γ spectrum of ^{64}Zn*

De-excitation γ-rays were detected in four large volume BaF_2 scintillators in coincidence with forward scattered carbon ions. Lifetimes were measured simultaneously with the nuclear spin precessions using the Doppler-Shift-Attenuation-Method with a Ge detector of 23% relative efficiency placed at 0° to the beam axis. The higher beam energy compared to previous experiments enabled the population of several states in ^{64}Zn up to the first 3^- at 2998 keV (Fig.1). The newly determined g factors and B(E2)'s (summarized in Table 1) are compared with earlier data and results from shell model calculations. In addition, this study was supplemented by lifetime measurements of the 2_1^+ and 4_1^+ states in the radioactive ^{68}Ge ($T_{1/2} = 270d$) formed in an α-transfer reaction.

Table 1: Present results compared with previous measurements and shell model calculations

^{64}Zn

	Experiment	[1,2]	Theory $^{40}Ca-Core$	Theory $^{56}Ni-Core$
$g(2_1^+)$	+0.430(44)	+0.445(46)	+0.48	+0.448
$g(4_1^+)$	+0.3(5)	-	+0.73	+0.362
$\tau(4_1^+)$	1.02(8)ps	0.48(10)ps		
B(E2)	13(1)W.u.	28(6)W.u.	15.3 W.u.	14.3 W.u.
$g(3_1^-)$	+0.95(66)	-		
$\tau(3_1^-)$	0.228(15)ps	0.127(22)ps		
B(E3)	70(40)W.u. $^{a)}$			
B(E3)	70(4)W.u. $^{b)}$			

^{68}Ge

		[3]
$\tau(2_1^+)$	3.27(30)ps	2.6(3)ps
B(E2)	14(1)W.u.	18(2)W.u.
$\tau(4_1^+)$	0.98(20)ps	1.15(14)ps
B(E2)	16(3)W.u.	14(2)W.u.

$^{a)}$ with and $^{b)}$ without error of branching ratio

The accurate $B(E2)$ of the $4_1^+ \to 2_1^+$ transition in ^{64}Zn differs significantly from previous data [1,2] but is in excellent agreement with the calculated values. The g factors of the 4_1^+ and 3_1^- states in ^{64}Zn have been measured for the first time. The B(E3,$3_1^- \to 0_1^+$) and $g(3_1^-)$ factor agree within their large errors with the expectation for collective octupole vibrations. Since the accuracy of the $g(4_1^+)$ value of ^{64}Zn is not sufficient to make a clear decision between the two different cores used in the calculations new experiments are in progress.

References

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