New g Factor Measurement of the first 2^+ State of ^{54}Cr and its Shell Model Interpretation ◇

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Recent measurements of g factors and lifetimes of the first 2^+ states of ^{50}Cr and ^{52}Cr yielded results which were well explained by large scale shell model calculations based on a closed ^{40}Ca core and excitations of valence protons and neutrons to the fp shell orbits [1,2]. In particular, the newly measured g factor ratio of the 4^+ to the 2^+ state of ^{50}Cr is in excellent agreement with results of such calculations ending the longstanding puzzle arising from former data. With these new measurements the microscopic understanding of the nuclear structure has been well established.

In the systematics of the Cr nuclei a sufficiently precise g factor value of the first 2^+ state of ^{54}Cr was missing. The two known values [3] indeed agree within their individual errors yielding a mean value of $g = 0.55(8)$, however, tend to be smaller than predictions by shell model calculations [4,5]. A remeasurement with our technique was therefore justified.

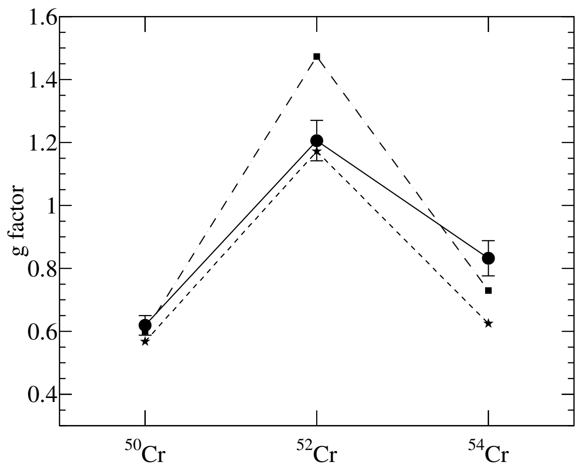

Fig. 1: Comparison of the experimental (large symbols) and theoretical (small symbols) g factors of the first 2^+ states of Cr isotopes. Squares refer to [4], stars to the present full calculations. The lines are drawn to guide the eye.

In the measurements a ^{54}Cr beam of 115 MeV, provided in its low natural isotopic abundance by the ion source of the Cologne tandem accelerator, was Coulomb excited by a thin carbon layer of the same composite target which had been also used for the other Cr isotopes. Again the powerful technique of inverse kinematics combined with the transient field of ferromagnetic gadolinium has been applied. In addition, the 2^+ state was also populated in an α-transfer reaction bombarding the same target with a ^{50}Ti beam of 110 MeV. In this case, the γ-angular correlation was less anisotropic following a g factor value of lower precision.

The g factor value obtained, $g = 0.835(55)$, was plotted together with the $g(2^+)$ values of the other two Cr isotopes. All results are then compared with several shell model calculations which mainly differ by the size of the fp shell model space (Fig. 1). As seen from the figure, the agreement between theory and experiment is rather striking. It is noted that the full calculation slightly underestimates the g value of ^{54}Cr whereas the same calculations give excellent agreement with the data of the lighter isotopes. Evidently, the dependence of the g factor on neutron number with its pronounced maximum for ^{52}Cr due to the N = 28 shell closure, is well explained.

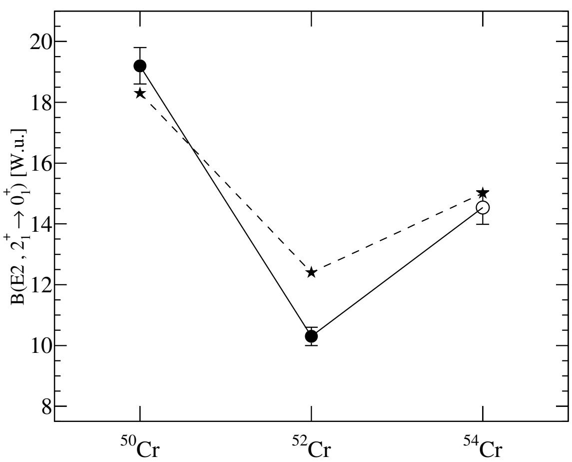

Fig. 2: Comparison of the experimental (large symbols) and theoretical (small symbols) $B(E2)$ values of the Cr isotopes. Stars refer to the full calculations. Closed circle points refer to [1,2], open circle to [6]. The line are drawn to guide the eye.

The same good agreement between experimental data and calculations is found for the $B(E2)$ values (Fig. 2 and [1,2]). In this case, a minimum in $B(E2)$ clearly signalizes shell closure at ^{52}Cr.

References

[1] R. Ernst *et al.*, Phys. Rev. Lett. **84** (2000) 416
[2] R. Ernst *et al.*, Phys. Rev. **C62** (2000) 024305
[3] P. Raghavan, At. Data Nucl. Data Tables **42** (1989) 189
[4] A. Pakou *et al.*, Phys. Rev. **C36** (1987) 2088
[5] H. Nakada *et al.*, Nucl. Phys. **A571** (1994) 467
[6] H. Junde *et al.*, Nucl. Data Sheets **68** (1993) 887

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