New g Factor Measurement of the First 2_1^+ State of ^{44}Ca ◇

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An early measurement of the g factor of the first 2_1^+ state of ^{44}Ca employing the Tilted Foil method [1] yielded the value $g = -0.28(11)$ which was interpreted as a dominant $f_{7/2}$ neutron component in the wave function realizing that the effective Schmidt value is $g(\nu f_{7/2}) = -0.38$. In recent large-scale shell model calculations, including the full fp configuration space, we obtained $g = -0.40$ confirming the experimental result. In view of the precise $g(2_1^+)$ values for Ti and Cr isotopes [2] suggesting considerable excitations of protons and neutrons of the ^{40}Ca core to fp shell orbits a remeasurement of the g factor of the first 2_1^+ state of ^{44}Ca was performed to examine possible excitations by aiming at higher precision.

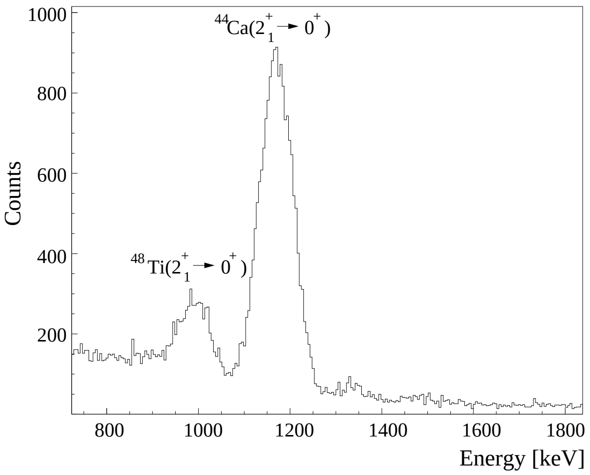

Fig. 1: NaI(Tl) coincidence spectrum of de-excitation γ-rays of the first 2_1^+ state of ^{44}Ca The other γ-peak refers to the first 2_1^+ state of ^{48}Ti obtained by an α-transfer reaction.

An isotopically pure ^{44}Ca beam was provided in its natural abundance ($\sim$ 2%) by the ion source of the Cologne tandem accelerator and accelerated to an energy of 95 MeV. Maximum beam intensities of $\simeq$2 nA on the target were achieved. For Coulomb excitation and precession a multilayer target was used consisting of C-Gd-Ta-Cu. De-excitation γ-rays were measured with 5“x5“NaI(Tl) scintillators in coincidence with the forward scattered and kinematically focused ^{12}C ions. As seen in Figs. 1 and 2 we also detected beside the ^{44}Ca γ-lines of the $(2_1^+ \to 0_1^+)$ and $(4_1^+ \to 2_1^+)$ transitions γ-lines from ^{48}Ti resulting from the α-transfer reaction $^{44}Ca(^{12}C, 2\alpha)^{48}Ti$. The γ-anisotropy and the precession have been measured for the $(2_1^+ \to 0_1^+)$ transition of ^{44}Ca in order to determine the logarithmic slope and the precession angle.

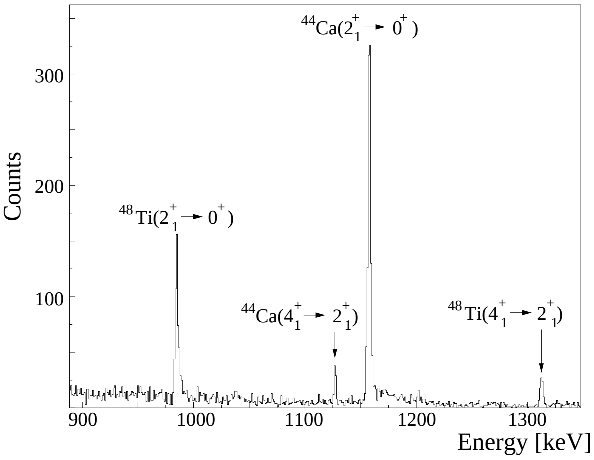

Fig. 2: Ge spectrum of coincident γ-rays from the α-transfer reaction and the Coulomb excitation of ^{44}Ca states.

The preliminary g-factor value deduced, $g = +0.15(6)$, is definitely positive and in contradiction to the old measurement as well as the fp shell model calculations. Our result can only be explained by assuming particle-hole excitations of the ^{40}Ca core. Calculations considering up to 4p-4h excitations from the $d_{3/2}$ or $s_{1/2}$ to $f_{7/2}$ or $p_{3/2}$ orbitals still predict a negative value, $g = -0.20$. Only with additional 6p-6h excitations one obtains a positive g factor, $g = +0.19$. This is indeed a surprising result. The experimental value will be improved in accuracy by additional measurements. Moreover, ^{42}Ca is another candidate to look for core excitations.

References

[1] Y. Niv *et al.*, Phys. Rev. Lett. **43** (1979) 326
[2] R. Ernst *et al.*, Phys. Rev. Lett. **84** (2000) 416

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