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E2-Transition Strengths in ^{46}Ca and ^{44}Ca

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Electric quadrupole moments in $(lf_{7/2})^{\pm 2}$ nuclei have recently been the object of a large experimental effort. In spite of that, the experimental information on ^{46}Ca is still scanty:[1] the only available values of quadrupole moments are based on old d,d' measurements, and come out very close to the corresponding ones in ^{42}Ca. On the other hand, ^{46}Ca could be expected to lie closer to the pure $(lf_{7/2})^{\pm 2}$ configuration, ^{48}Ca being a more stable core than ^{40}Ca.

We report here the results of a direct measurement of the ratio between the B(E2) values for the Coulomb excitation of the first 2^+ state in ^{46}Ca and ^{42}Ca. Measurements have been performed at the 5.5 MV Van de Graaff of Laboratori Nazionali di Legnaro, with an α-particle beam of energies $E_\alpha = 4.5$, 4.75 and 5.0 MeV. A 40 cm^3 Ge(Li) counter, placed at ~1 cm from the target and at 55° with respect to the beam direction, has been used to determine the γ-ray intensities.

Two series of measurements have been carried out: one with a target containing $(66.44 \pm 0.1)\%$ of ^{42}Ca and $(4.93 \pm 0.1)\%$ of ^{44}Ca to determine the ratio between the B(E2) values for ^{42}Ca and ^{44}Ca, the other with a target containing $(35.37 \pm 0.1)\%$ of ^{46}Ca and $(4.42 \pm 0.05)\%$ of ^{44}Ca to measure the same ratio for ^{46}Ca and ^{44}Ca.

The measured ratio between the B(E2) values for ^{44}Ca and ^{42}Ca is 1.30 ± 0.06. If one assumes for ^{42}Ca the value $B(E2\downarrow) = 75.3 \pm 6.2\ e^2\text{fm}^4$ corresponding to a weighted average of recent measurements,[2] the transition strength in ^{44}Ca comes out to be $98.0 \pm 9.2\ e^2\text{fm}^4$ instead of $68 \pm 12\ e^2\text{fm}^4$ as reported in the literature.[1] The corresponding ratio for ^{46}Ca and ^{42}Ca is 0.43 ± 0.03 and the resulting transition strength for ^{46}Ca is $B(E2\downarrow) = 32.5 \pm 3.4\ e^2\text{fm}^4$.

If a neutron effective charge is defined with respect to the pure $(lf_{7/2})^{\pm 2}$ configuration, one obtains $e_n = 1.13 \pm 0.06$ (for $\langle r^2 \rangle = 18.4\ \text{fm}^2$) in ^{46}Ca. This value is substantially smaller than the corresponding one, $e_n = 1.72 \pm 0.07$, for the $2^+ - 0^+$ transition in ^{42}Ca but slightly larger than the value[3] $e_n = 0.74$ obtained for the $6^+ - 4^+$ transition in the same nucleus. It compares also well with the value $e_p - 1 = 0.93 \pm 0.08$ for the corresponding $2^+ - 0^+$ proton transition[3] in the ^{54}Fe nucleus, whose level scheme shows stricking similarities to the one of ^{46}Ca.

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References

1) See, *e.g.*, R. A. Ricci and P. R. Maurenzig: Rivista del Nuovo Cimento **1** (1969) 291.
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3) S. Cochavi *et al.*: Phys. Rev. **C2** (1970) 2241; T. Nomura *et al.*: Phys. Rev. Letters **25** (1970) 1342.