JOURNAL OF THE PHYSICAL SOCIETY OF JAPAN VOL. 34, SUPPLEMENT, 1973
PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUCLEAR MOMENTS AND NUCLEAR STRUCTURE, 1972

V–15

Measurements of Quadrupole Deformation in ^{50,52,54}Cr

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As part of a continuing investigation into collective effects in the $N = 28$ semimagic and adjacent nuclei, we have measured quadrupole moments Q_{2^+} of the first excited states of ^{50,52,54}Cr, using the reorientation effect in Coulomb excitation. We have used the multiple particle-gamma coincidence technique to measure Q_{2^+} in ^{50}Cr; the method is described elsewhere.[1] A thin target of ^{50}Cr was Coulomb excited by a beam of 62 MeV ^{32}S ions and the inelastically scattered ^{32}S nuclei, as well as the recoiling ^{50}Cr nuclei were detected in coincidence with de-excitation gamma rays. Use of four particle detectors at forward angles allowed simultaneous observation of eight widely different *CM* angles. The experimental data were compared with de Boer-Winther Coulomb excitation calculations to derive values of $Q_{2^+} = -30.4 \pm 9.1$ $e$fm^2 and B(E2, $0^+ \rightarrow 2^+$) $= 910 \pm 50$ e^2fm^4. We have also performed an experiment to measure the relative moments of ^{50,52,54}Cr; the method is described elsewhere.[2] A thick target of natural chromium is Coulomb excited by carbon, oxygen, and sulfur beams of various energies below the Coulomb barrier, and the de-excitation gamma rays are observed in a Ge(Li) detector. The relative yields of the three gamma rays are calculated with the de Boer-Winther code and compared with experiment to determine the relative quadrupole moments. Using the values derived from this experiment and the previously measured Q_{2^+} for ^{50}Cr, we determine values of -9 ± 13 and -12 ± 10 $e$fm^2 for ^{52,54}Cr, respectively. Corresponding B(E2, $0^+ \rightarrow 2^+$) values are 595 ± 33 and 760 ± 19 e^2fm^4. Using the simplest shell model configuration for each of the three nuclei [$(f_{7/2})^{10}$ for ^{50}Cr, $(f_{7/2})^{12}$ for ^{52}Cr and $(f_{7/2}^{12}, p_{3/2}^2)$ for ^{54}Cr], Goode[3] has calculated $Q_{50} = -15$ $e$fm^2, $Q_{52} = Q_{54} = 0$ for $e_p = 1.5e$ and $e_n = e$. If one particle excitations are allowed into the upper fp shell, the moments for ^{52,54}Cr become -6.6 and -9.2 $e$fm^2. The one-particle-excited configuration is too large to calculate for ^{50}Cr, but results[1] from ^{48}Ti indicate that Q_{50} should become -30 $e$fm^2 in this configuration. These results are in excellent agreement with the experimental data.

* Supported by the National Science Foundation.

References

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