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Curved Crystal Study of De-excitation Gamma Rays in ^{184}W Following Neutron Capture

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Earlier studies of the ^{184}W level scheme from radioactive decay of the two ^{184}Re isomers (McMillan et al. 1974) and from the $^{183}W(n,\gamma)$ reaction (Greenwood and Reich 1974) have provided a rather detailed picture of the rotational-band structure of this nucleus in the region below ∿2 MeV. The analysis of these data permitted a number of conclusions to be drawn regarding the nature and the strength of the coupling among the different bands of both collective and two-quasiparticle character. One of the interesting features to emerge from these studies was the observation of low-energy γ rays which could be assigned as transitions between excited positive-parity collective bands. To provide more definite information on these possible low-energy γ rays and hence to address the question of the existence of non-zero E2 matrix elements between the collective positive-parity bands in ^{184}W, we have remeasured the secondary γ-ray spectrum emitted following thermal-neutron capture in ^{183}W.

The capture γ-ray spectrum was studied using the curved-crystal γ-ray spectrometers installed at the High Flux Reactor of the ILL in Grenoble. Approximately 150 γ-ray transitions, from ∿85 keV to 2.33 MeV, were assigned to ^{184}W. A partial level scheme of ^{184}W, showing the first four excited positive-parity bands and their de-exciting γ-ray transitions as observed in this study, is shown in Fig. 1. Especially noteworthy is the observation of a number of transitions connecting the various excited bands. Of the nine such γ rays shown in Fig. 1, only three (those from the 1386-keV state to 2^+_γ and 3^+_γ and the one from 1322 keV to 2^+_γ) were previously reported and one (from 1431 keV to 3^+_γ) was only tentatively placed in the earlier (n,γ) study (Greenwood and Reich 1974). Three new transitions to the ground-state band are also observed. The placement of two of these (from 1523 keV to 4^+_g and 1322 keV to 2^+_g) is considered

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definite, while that of one of them (from the tentative 4^+ level at 1359 keV to 4^+_g) is considered as uncertain.

The transitions connecting the different excited bands are intrinsically rather strong. For those involving excited 0^+ states, where E2 multipolarities can be assigned with confidence, the B(E2) values, relative to those of transitions to the ground-state band, are quite large. From the 1322-keV, $0^{+\prime}$ state, for example, we calculate $B(E2; 1322 \rightarrow 1121)/B(E2; 1322 \rightarrow 2^+_g) \sim 960$, and $B(E2; 1322 \rightarrow 903)/B(E2; 1322 \rightarrow 2^+_g) \sim 230$. For the 1386-keV, $2^{+\prime}$ state, we find $B(E2; 1386 \rightarrow 1002)/B(E2; 1386 \rightarrow 0^+_g) = 5.2$. From the measured B(E2) value of the 1386-keV, ground-state transition, we calculate $B(E2; 1386 \rightarrow 1002) = 0.022 e^2 \cdot b^2$, a relatively large value.

These E2-transition-rate data are presently being analyzed, using both a phenomenological five-band mixing approach and the results of IBA-model calculations, to see if non-zero values for the E2 matrix elements between the excited bands are required to explain these interband B(E2) values.

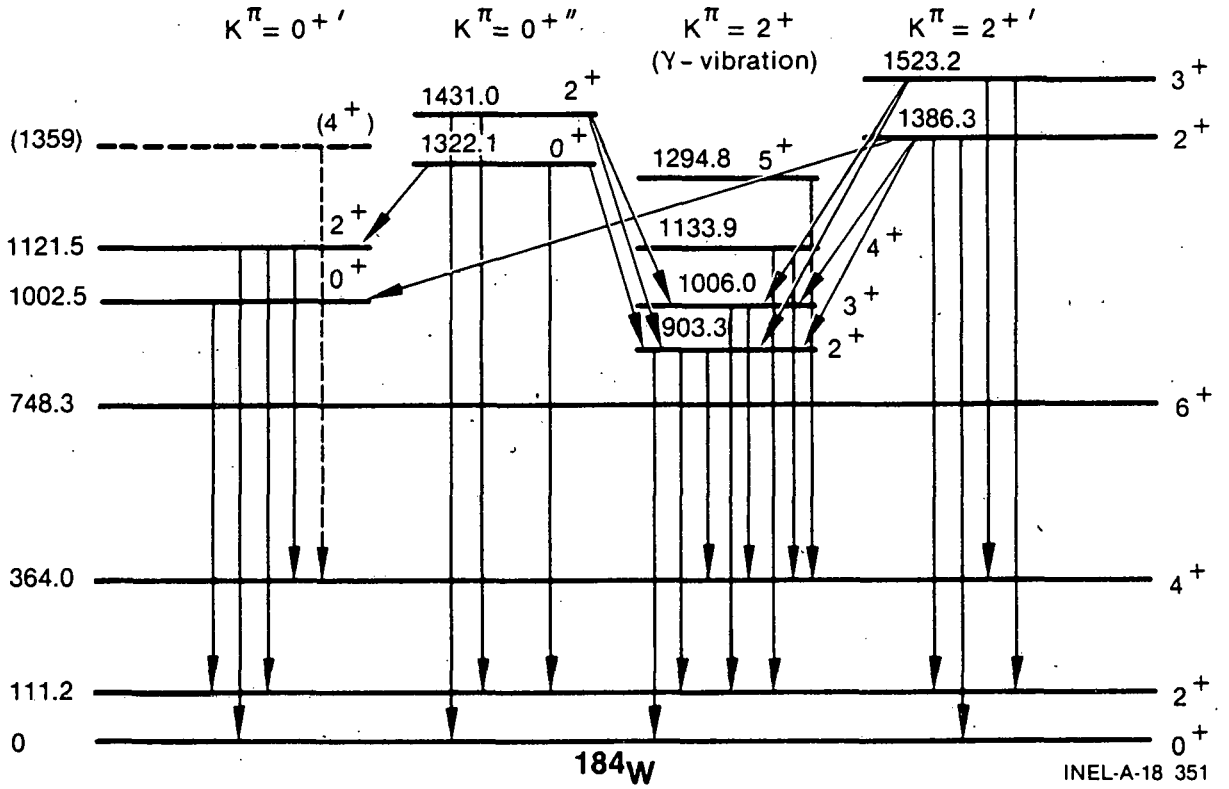

Fig. 1 $K^\pi = 0^+$ and 2^+ bands below ∿1.5 MeV in ^{184}W.

McMillan D J, Greenwood R C, Reich C W and Helmer R G 1974 Nucl. Phys. A223 29.
Greenwood R C and Reich C W 1974 Nucl. Phys. A223 66.