TRANSITION PROBABILITIES FROM THE 1305 keV 0^+ LEVEL IN ^{114}Cd

B. Fogelberg, A. Bäcklin* and J. McDonald**
The Swedish Research Councils' Laboratory, Studsvik, Nyköping, Sweden

It is well known that ^{114}Cd, normally characterized as a typical vibrational nucleus, exhibits 5 fairly closely spaced levels in the region where the 2-phonon triplet is expected. It is also well-known that the three lowest of these states, i.e. the 0^+ state at 1134 keV, the 2^+ state at 1210 keV and the 4^+ state at 1283 keV, have decay properties |1,2| in fair agreement with the vibrational model predictions. Although there have been many suggestions, the nature of the remaining two states, the 0^+ state at 1305 keV and the 2^+ state at 1363 keV, is not known. Of these the 1363 keV has been observed in Coulomb excitation |2|, while no information on the transition probabilities from the 1305 keV level has been reported.

The 1305 keV level is best studied in the (n,γ) reaction in which it has been observed to decay through E0 transitions to the ground state and the 1134 keV state and through E2 transitions to the 2^+ states at 558 and 1210 keV |3,4|. The ratio B(E2; 1305→1210)/B(E2; 1305→558) has the remarkably large value of $\sim 2.5 \cdot 10^4$, which together with the existence of the strong E0 competition suggests a half-life of the 1305 keV level in the region of nanoseconds.

The experiment was arranged at a beam of thermal neutrons from the R2 reactor at Studsvik. A plastic scintil-

*Institute of Physics, Uppsala University, Sweden
**AB Atomenergi, Studsvik, Nyköping, Sweden

lator and a 1" x 1" NaI detector were set up in a delayed coincidence experiment close to a $\sim$0.1 g/cm^2 target of natural Cd. The plastic detector was adjusted to accept all gamma radiation above $\sim$0.5 MeV and the NaI detector adjusted at the photopeak of the 651 keV transition. The observed time-spectrum contained a strong prompt peak (FWHM $\approx$ 1 ns) and a delayed component with a half-life of 5.5$\pm$0.3 ns. Several complementary experiments and considerations were made all indicating that this half-life must be ascribed to the 1305 keV level in ^{114}Cd.

Table 1 gives the values of B(E2) and ρ^2 calculated from the observed half-life of the 1305 keV level and the gamma-ray and conversion electron branching ratios of refs. |3,4|. The large B(E2) value of the 96 keV $0_3^+ \rightarrow 2_2^+$ transition indicates a strong collective component in the transition. On the other hand, the $0_3^+ \rightarrow 2_1^+$ transition is unusually slow, indicating that the 1134 and 1305 keV states mix very little. Also the E0 transitions are slow, their ρ^2-values being an order of magnitude smaller than normally observed in vibrational nuclei ($\rho^2 \approx 2.5 \cdot 10^{-2}$ for the 1134 keV $0^+ \rightarrow 0^+$ transition |3|).

It is not possible to draw definite conclusions about the nature of the 1305 keV level at this stage. One may however mention that the only calculation known to us that yields a very large value of B(E2; $0_3^+ \rightarrow 2_2^+$) as well as a very small value of B(E2; $0_3^+ \rightarrow 2_1^+$) is made by the Frankfurt group |5,6| assuming the 0_3^+ state to be essentially the head of a rotational band associated with a second minimum of large deformation in the nuclear potential (the large value of B(E2; $0_3^+ \rightarrow 2_2^+$) is then obtained from mixing between the 2_2^+ vibrational state and the 2_3^+ rotational state).

TABLE 1

Transition probabilities from the 1305 keV level in ^{114}Cd

Transition energy	Multipol.	I_γ %	I_e %	$(T_{1/2})_\gamma$ ns	$(T_{1/2})_e$ ns	B(E2) e^2b^2	Enhancement factor	ρ^2
1305	EO	0	10.5	-	52.4			$2.0 \cdot 10^{-3}$
747	E2	25	(0.05)	22		$1.10 \cdot 10^{-5}$	$\frac{1}{300}$	
171	EO	0	0.62	-	88.7			$6.8 \cdot 10^{-4}$
96	E2	23	40.7	24	13.5	0.290	88	

REFERENCES

|1| P.H. Stelson and F.K. McGowan, Phys. Rev. 121 (1961) 209;
F.K. McGowan, R.L. Robinson, P.H. Stelson and J.L.C. Ford, Jr., Nucl. Phys. 66 (1965) 97.

|2| W.T. Milner, F.K. McGowan, P.H. Stelson, R.L. Robinson and R.O. Sayer, Nucl. Phys. A129 (1969) 687.

|3| A. Bäcklin, N.E. Holmberg and G. Bäckström, Nucl. Phys. 80 (1966) 154.

|4| R.K. Smither, Nuclear Data A5 (1968) 30 (compiled by L.V. Groshev, G.A. Bartholomew et al.).

|5| G. Gneuss and W. Greiner, Nucl. Phys. A171 (1971) 449.

|6| L. v. Bernus, Diplomarbeit, Univ. of Frankfurt 1971.