Dual Decay of the 50-Day In^{114} Isomer and Angular Momenta of the Excited States of Cd^{114}

ROLF M. STEFFEN
*Department of Physics, Purdue University, Lafayette, Indiana**
(Received May 11, 1951)

ACCORDING to recent measurements[1,2] the 72-sec ground state of In^{114} decays not only by β^- emission into Sn^{114} but also by K-capture and β^+ emission into an excited state of Cd^{114}, from which two successively emitted gamma-rays of 0.548- and 0.715-Mev energy lead to the ground state. A very weak gamma-ray of 1.26-Mev quantum energy has been interpreted as caused by a cross-over transition. Using the measured energy difference between the ground states of In^{114} and Cd^{114} of 2.07 ± 0.2 Mev,[3] the ft value of the K-decay from the In^{114} ground state into the 1.26-Mev level of Cd^{114} comes out to be $\sim$1200. This small value would indicate a superallowed transition, which seems to be improbable in this case. Thus, the question arises as to whether this K-decay originates from the 50-day isomeric state of In^{114}. Since this decay process would require an angular momentum of 4 or 5 for the 1.26-Mev level of Cd^{114}, whereas the K-capture from the In^{114} ground state is only compatible with $I=1$ or $I=2$, a determination of the angular momentum of this Cd level would give decisive information.

By measurement of the angular correlation of the two successively emitted gamma-rays the angular momenta of the two excited levels of Cd^{114} have been investigated.[4] The result of the correlation measurements, obtained with the previously described apparatus,[5] are shown in Fig. 1. The measured points follow, within experimental error, the angular correlation function $f(\theta)=1+0.125\cos^2\theta+0.042\cos^4\theta$, which is characteristic for two quadrupole transitions between states of angular momenta of 4, 2, and 0. The angular momentum 4 of the 1.26-Mev level supports strongly the assumption that this level is reached directly from the 50-day isomer. The ft value, 3×10^8 sec, of this K-decay suggests a first-forbidden transition.

The ft value, 3×10^4 sec, of the β^- decay gives evidence of an

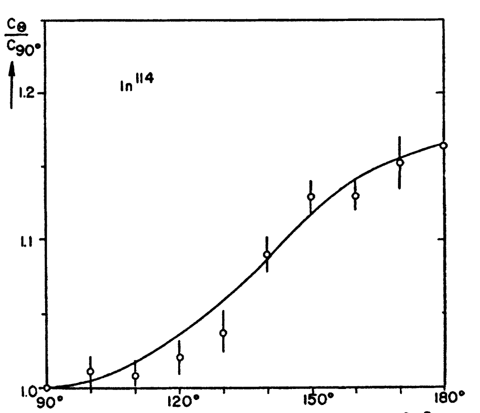

FIG. 1. Angular correlation of the gamma-rays emitted from the Cd^{114} nucleus. The points at $\theta=170°$ and $\theta=180°$ are corrected for the small number of positrons present in the In^{114} decay.

allowed transition to the ground state of the even-even nucleus Sn^{114} of zero angular momentum and presumably even parity. Hence, $I=1$ and even parity must be assigned to the ground state of In^{114}. The observed positrons must be due to the beta-transition from the ground state of In^{114} to the ground state of Cd^{114}. The ft value ($\sim10^6$ sec) suggests an allowed transition, indicating again even parity and $I=1$ for the In^{114} ground state. In order to determine the angular momentum and the parity of the 50-day isomeric state, the multipole character of the isomeric transition must be known. Since the previously measured conversion data are not conclusive, the conversion of the 0.192-Mev isomeric transition has been measured in two ways: (a) by comparison of the conversion lines and the β^--spectrum in a spectrometer and (b) by comparison of the absolute number of β-transitions determined in a calibrated spectrometer with the absolute intensity of the 0.192-Mev gamma-radiation using calibrated scintillation and GM-counters.[6] The result is shown in Table I. Besides the theo-

TABLE I. Conversion data and half-life of the isomeric transition in In^{114}.

	Experiment	Theory el. 2^4	Theory magn. 2^4	Theory el. 2^5
$\alpha_K=N_{eK}/N_\gamma$	(a) 2.4 ± 0.4 (b) 2.2 ± 0.2	2.5	11	57
α_K/α_L	1.10 ± 0.05	2.4	5.5	1.0
$T_{1/2}$gamma, sec	2.1×10^7	3.3×10^4	3.2×10^7	8.7×10^{10}

retical conversion data[7] the table also contains the half-life values of the isomeric state with respect to gamma-emission calculated from Weisskopf's formula.[8] Since the relativistic calculations for α_K are the most reliable, it is concluded that the isomeric transition is an electric 2^4-pole, indicating an angular momentum of 5 and even parity of the isomeric state. The Weisskopf theory gives about 1000 times too large a transition probability for the electric

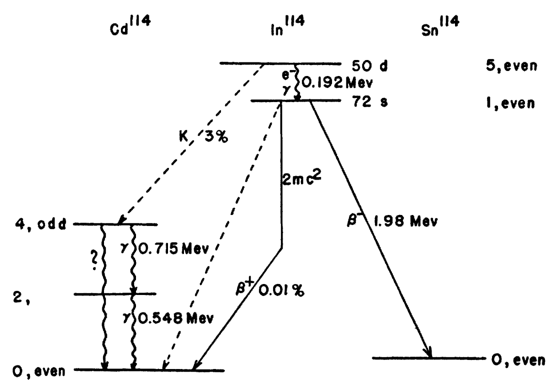

FIG. 2. Disintegration scheme of In^{114}.

2^4-pole. The presumably first-forbidden transition to the 1.26-Mev level of Cd^{114} makes it necessary to assign an odd parity to this level.

Our assignments (Fig. 2) would give for the cross-over transition to the ground state of Cd^{114} a relative intensity $<10^{-7}$, whereas a relative abundance of a few percent has been reported.[2] This makes the interpretation of the 1.26-Mev γ-ray as a cross-over transition doubtful. The final parity assignments to the Cd^{114} levels involved will be made by polarization-correlation experiments which are in progress at this laboratory.

* Supported in part by the AEC.
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