The Angular Momenta of the Excited States of Pt^{196}†

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THE angular correlation of the Pt^{196} gamma-rays has been measured before[1] and was interpreted as characteristic for two quadrupole transitions between levels of angular momenta I of 2, 2, and 0. Internal conversion data[2] indicate electric quadrupole radiation for both transitions.

Recently, a number of parity unfavored gamma-transitions were found to be a mixture of magnetic dipole and electric quadrupole radiation.[3-5] A similar mixed transition may be expected for the first gamma-ray of the Pt^{196} cascade, being due to a parity unfavored transition between states of the same angular momentum ($I=2$). The accuracy of the former Pt^{196} angular correlation measurements was not sufficient to allow a determination of the dipole admixture intensity; the Pt^{196} gamma-gamma correlation was therefore remeasured using much improved experimental techniques and evaluation methods.[6]

To avoid the detection of scattered radiation two techniques were employed which yielded the same angular correlation (within 1.5 percent): (1) the two NaI(Tl) crystals which were used to detect the Pt^{196} gamma-rays of 0.330 Mev and 0.358 Mev were covered with 0.2-cm lead on the front and 1.5-cm lead on the side, or (2) pulse-height discrimination was employed making the use of any lead absorber unnecessary. The discriminator bias was set at the lower edge of the 0.330-Mev photopeak. The data for the Pt^{196} gamma-gamma angular correlation are shown in Fig. 1.

The Au^{196} sources used were in the form of dilute solutions of $AuCl_3$ in order to obtain the maximum angular correlation;[7,8] however, sources of dry $AuCl_3$ and Au^{196} imbedded in gold (Au^{196} produced by the $Au^{197}(n, 2n)Au^{196}$ reaction) showed the same angular correlation as above (within 3 percent).

The data, fitted by least squares to an angular correlation function $W(\theta)=1+a_2\cos^2\theta$, $+a_4\cos^4\theta$, taking the finite angular resolution of the apparatus into account,[9] give for the correlation coefficients: $a_2=-1.02\pm0.05$ and $a_4=+1.32\pm0.05$. The maximum anisotropy, calculated from the coincidence rate at $\theta=90°$, $\theta=270°$, and $\theta=180°$ after correction for the angular resolution was determined as $(a_2+a_4)=+0.28\pm0.03$. This correlation function is consistent with the assignment 2, 2, 0 for the angular momenta of the excited states and the ground state of Pt^{196}, the first transition being a mixture of 95 percent quadrupole and 5 percent dipole radiation and the two components being out of phase (in Lloyd's[10] notation; same sign of the reduced electric and magnetic matrix elements in the notation of Biedenharn and Rose[11]). The data on internal conversion are consistent with both transitions being mainly electric quadrupole (+5 percent magnetic dipole in the first transition), indicating the same parity for all three levels involved (Fig. 2).

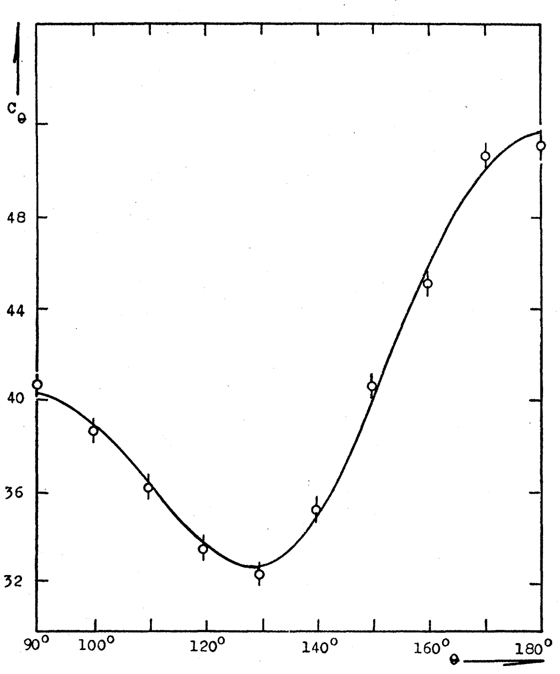

FIG. 1. Gamma-gamma angular correlation of the Pt^{196} gamma-rays. The solid curve represents the correlation function $W(\theta)=1-1.02\cos^2\theta+1.32\cos^4\theta$, corrected for the finite angular resolution.

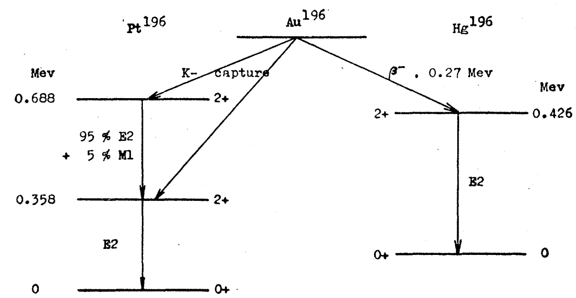

FIG. 2. Decay of Au^{196} and the angular momenta of the excited states of Pt^{196}.

These assignments would suggest a strong cross-over transition of 0.688-Mev energy to the ground state of Pt^{196}. The search for such a gamma-radiation with a scintillation spectrometer resulted in an upper limit for the intensity of the cross-over transition of less than 1 percent.

It is interesting to note that, in the very similar case of the Cd^{114} gamma-rays,[4,5] the magnetic dipole (96 percent) and electric quadupole (4 percent) components are in phase, whereas the case of Pt^{196} there is a phase difference of π.

Recently, an angular correlation of the Pt^{196} gamma-rays in agreement with these measurements has been observed by the Zurich group.[12]

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States of S^{33} and Si^{29} from (d, p) Stripping

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WE have used a proportional counter telescope to examine the angular distributions within the range 0° to 90° of several groups of protons from the reactions $S^{32}(d, p)S^{33}$ and $Si^{28}(d, p)Si^{29}$ with 8-Mev deuterons. By comparing these distributions with the theories of the stripping process,[1,2] the appropriate value of the orbital angular momentum l of the captured neutron has been determined in each case. These values are given in Tables I and II, together with the excitation energies of the final states. The spins of these states have one of the values $l\pm\frac{1}{2}$. Some of the