

The E2/M1 Multipole Mixing Ratios of the $2' + \rightarrow 2 +$ Transitions in ^{192}Pt and ^{194}Pt

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The multipole mixing of $2' + \rightarrow 2 +$ transitions in ^{192}Pt and ^{194}Pt has been determined by measuring the absolute K-internal conversion coefficients. The experiments are performed by means of an iron — free double focusing electron spectrometer and Ge(Li) detector. The measurements yield the following values of the E2 : M1 mixing ratio δ :

$$\begin{aligned}\delta(296) \text{ in } ^{192}\text{Pt} &= 6.0 \pm 0.5, \\ \delta(293) \text{ in } ^{194}\text{Pt} &= 6.24 \pm 0.55.\end{aligned}$$

The results are compared with angular correlation measurements.

1. Introduction

In recent years there has been considerable interest in the collective properties of spherical even nuclei. The nuclei of osmium and platinum form part of a transition region in which the shape of the nuclear surface turns from spherical to deformed. Nuclei in this region are therefore particularly suited for a critical test of nuclear models. From this point of view, platinum nuclei are very interesting isotopes¹. Though there appears to be a systematic trend of level energies, no simple trend is found in probabilities of the M1 transitions of $2' + \rightarrow 2 +$. Systematic searches for the E0 component in the $2' + \rightarrow 2 +$ transition and for the penetration or the dynamic effect in the M1 internal conversion would supply very crucial information^{2,3}. In order to evaluate such possibilities, an accurate knowledge is required of the E2 : M1 mixing ratio.

The decays of ^{192}Ir and ^{194}Ir have been extensively studied^{4,5}. However, more information about the $2' + \rightarrow 2 +$ transitions in ^{192}Pt and ^{194}Pt , are necessary.

The experiments described below were undertaken in order to furnish more data on transitions in such important nuclei. In the present work the absolute K-conversion coefficients of the 296 and 293 keV transitions in ^{192}Pt and ^{194}Pt respectively, see Fig. 1, were measured and the E2/M1 mixing ratios were determined.

2. Experimental Procedure

2.1. Source Preparation

For the radioactive sources, ^{194}Ir was prepared by thermal neutron irradiation of 98.7% pure ^{193}Ir in a flux of $\sim 10^{13}$ neutrons/cm² sec for about 6 hours. While ^{192}Ir was prepared by thermal neutron irradiation of metallic iridium for about 2 weeks. Two months after the irradiation, the irradiated iridium was chemically treated as follows: the metallic iridium was heated for one hour with a small amount of sodium chloride in the presence of chlorine gas. Iridium thus treated was dissolved in water, then converted into H₂SO₄ solution and fumed. Since the efficiency of electro-plating decreases with the presence of chlorine ions, the above fuming process was repeated. Finally, iridium was dissolved in an aqueous solution of H₂SO₄ and NH₄OH and then electroplated onto the cathode of 0.7 mg/cm² thick Ni foil.

As is well known, sources for conversion electron studies should be thin in order to avoid electron scattering in the sources. The plated sources were about 100 $\mu\text{g}/\text{cm}^2$ in thickness and 1.5 mm \times 15 mm in area. For quick measurements in case of ^{194}Ir sources, iridium was uniformly sputtered on aluminum foil of thickness $\sim 0.7 \text{ mg}/\text{cm}^2$. The sputtered material was distributed in a rectangular area (0.2 \times 2 cm²). The thickness of the material deposited was estimated to be $\sim 150 \mu\text{g}/\text{cm}^2$.

2.2. Conversion Electron Spectra

The internal conversion spectra were measured by means of a high resolution iron-free double focusing beta-ray spectrometer ($Q_0 = 50 \text{ cm}$). With this instrument relative momentum measurements could be made

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¹ H. IKEGAMI, K. SUGIYAMA, T. YAMAZAKI, and M. SAKAI, Nucl. Phys. **41**, 30 [1963].

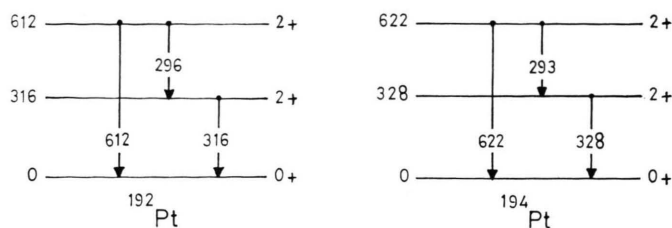
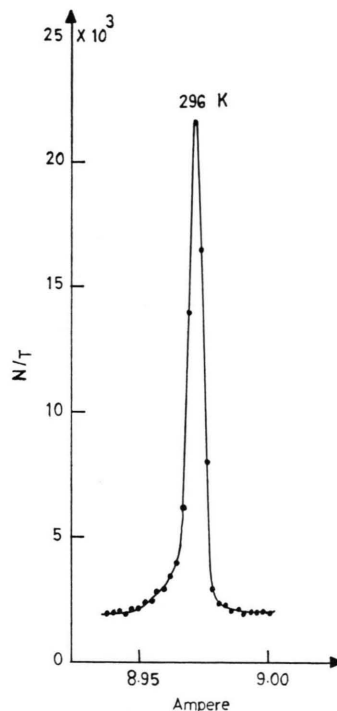
² M. SAKAI, M. NOZAWA, H. IKEGAMI, and T. YAMAZAKI, Nucl. Phys. **53**, 529 [1964].

³ T. HIROSE, S. MORINOBU, and H. IKEGAMI, Nucl. Phys. A **146**, 220 [1970].

⁴ P. G. E. REID, M. SCOTT, and N. J. STONE, Nucl. Phys. A **129**, 273 [1969].

⁵ G. D. BENSON, A. V. RAMAYYA, R. G. ALBRIDGE, and G. D. O'KELLY, Nucl. Phys. A **150**, 311 [1970].



Fig. 1. Low-lying levels in ^{192}Pt and ^{194}Pt .Fig. 2. The internal K-conversion line of the 296 keV transition in ^{192}Pt .

with an accuracy of a few parts in 10^5 . The spectrometer was set so as to get a resolution of about 0.15%. An example of a conversion line taken is shown in Fig. 2. The investigation of the $2' + \rightarrow 2 +$ transition requires measurements of the K-internal conversion electron intensity with respect to the intensity of the K-conversion line of pure E2 transition in the same isotope. In the present work the conversion intensities of 293 : 328 keV transitions in ^{194}Pt and of 296 : 316 keV transitions in ^{192}Pt were measured.

2.3. Gamma-ray Spectra

In order to obtain precise values of gamma-ray intensities, a Ge(Li) detector was employed whose intrinsic volume was approximately $0.7 \text{ cm} \times 3 \text{ cm}^2$. The resolution obtained was about 4 keV for the 510 keV annihilation gamma rays of ^{22}Na . The efficiency of the Ge(Li) detector was calibrated by using several standard sources. Gamma-ray spectra of the transitions in ^{192}Pt and ^{194}Pt are shown in Figs. 3 and 4.

3. Experimental Results and Discussion

The multiplicities of the 296 and 293 keV transitions in ^{192}Pt and ^{194}Pt respectively, were determined from the comparison of absolute K-conversion coefficients with the theoretical ones. The conversion coefficients were calculated from the photon intensities and conversion electron data. Normaliza-

tion between the two series of data is obtained by assuming that the 316 and 328 keV transitions are pure E2 transitions, in ^{192}Pt and ^{194}Pt respectively. For example;

$$\alpha^K(296) = \frac{e(296)}{e(316)} \times \frac{\gamma(316)}{\gamma(296)} \times \alpha^K(316).$$

The K-conversion coefficients of the 316 and 328 keV E2 pure transitions in ^{192}Pt and ^{194}Pt have been taken from the theoretical values calculated by SLIV and BAND⁶.

The relative gamma-ray intensities are found from our measurements as follows,

$$\gamma(293)/\gamma(328) = 0.185 \pm 0.010$$

and $\gamma(296)/\gamma(316) = 0.38 \pm 0.02$

which are compatible with previous results^{3, 5}.

The absolute K-conversion coefficients obtained are:

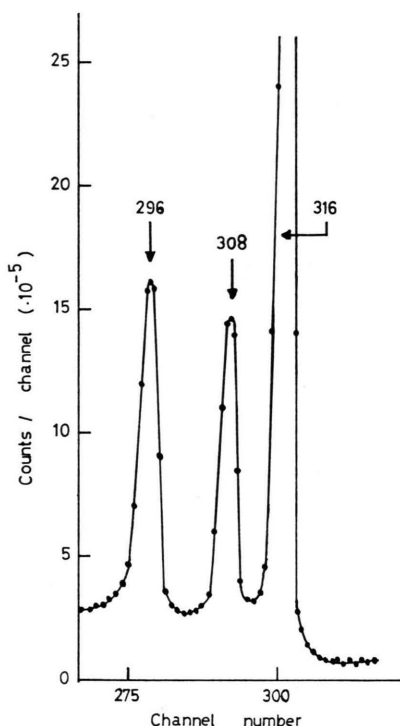
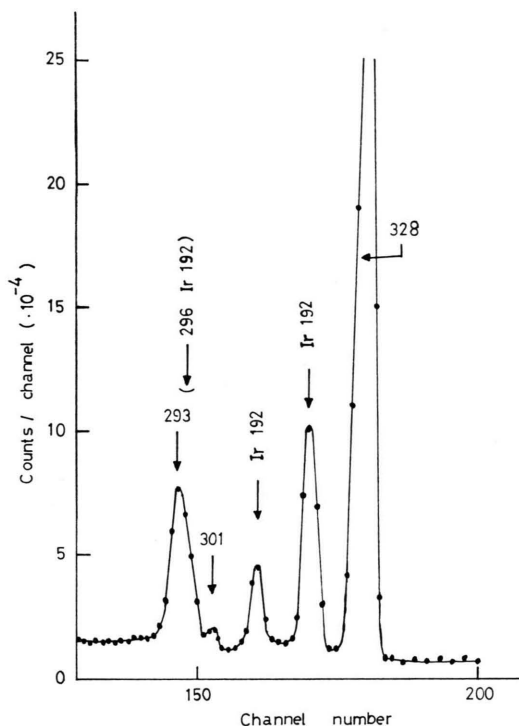
$$\alpha^K(293) = 0.0693 \pm 0.0055$$

and $\alpha^K(296) = 0.0688 \pm 0.0048$.

The mixing ratio $\delta = E2/M1$ has been calculated from the conversion coefficients data as,

$$\delta^2 = \frac{\alpha^K(M1) - \alpha^K(\text{exp})}{\alpha^K(\text{exp}) - \alpha^K(E2)}.$$

⁶ L. A. SLIV and I. M. BAND, Alpha-, beta-, gamma-ray spectroscopy, ed. K. SIEGBAHN, North-Holland, Amsterdam 1966.

Fig. 3. Part of gamma-ray spectrum from ^{192}Ir .Fig. 4. Part of gamma-ray spectrum from ^{194}Ir .

The mixing ratio δ for the $2' \rightarrow 2+$ (296 keV) transition was found to be 6.0 ± 0.5 .

Recently the E0 component was determined by MARINKOV et al.⁷ who measured the internal conversion ratio K/L_{111} for the 296 keV transition and the gamma-electron directional correlation for the 588–296 keV cascade. They concluded that the E0 component in the $2' \rightarrow 2+$ transition in ^{192}Pt is with certain probabilities equal to zero. Their⁷ results are almost consistent with HIROSE et al.³ results.

The present value for the mixing ratio of the 296 keV transition is in good agreement with values found by SIMONS et al.⁸, $|\delta| = 4.4$, by BUTT and DUTTA⁹ $|\delta| = 7.0$ and by HIROSE et al.³ $|\delta| = 5.5$.

However these values are much lower than the values obtained by REID et al.⁴, $|\delta| = 15$.

The value of δ (293 keV transition in ^{194}Pt) is (6.24 ± 0.55) . It is of the same magnitude as that of δ (296 keV transition in ^{192}Pt).

A definite conclusion was not possible since no angular correlation measurements were made on the $2' \rightarrow 2+$ transition in ^{194}Pt .

In order to obtain more detailed information about the low-lying collective states in platinum isotopes, it may be of value to measure by angular correlation technique the mixing ratio and the penetration effects in M1 transition of the 293 keV gamma-ray in ^{194}Pt .

⁷ L. MARINKOV, I. AMICIN, I. BIKIT, and R. STEPIC, Nucl. Phys. A 131, 601 [1969].

⁸ L. SIMONS, E. SPRING, and G. WENDT, Nucl. Phys. 31, 452 [1962].

⁹ D. K. BUTT and B. C. DUTTA, Nucl. Phys. 39, 517 [1962].