The K-Conversion Coefficient of the 321 keV E1 transition in Hf$^{177}$

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With 3 Figures in the Text

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The K-conversion coefficient of the 321 keV E1 transition in Hf$^{177}$ has been measured by means of an iron free double focusing beta-ray spectrometer, using the internal-external conversion method. The result obtained for $\alpha_K(321)=0.162\pm0.016$ is in disagreement with the theoretical values for pure E1 transition ($\alpha_K=0.0154$) calculated by SLIV and BAND. The large anomaly observed in the K-conversion process of the inhibited E1 transition is compatible with a large M2 admixture or, more probable with the presence of penetration matrix elements.

1. Introduction

In a recent article$^1$, we have given experimental evidence for the existence of anomalous conversion process for some retarded E1 transitions in W$^{182}$. However, in another article$^2$, the results of the conversion process of the electric dipole transitions in Re$^{187}$ show good agreement with the theoretical values for pure E1 transitions. This phenomena could be understood on the basis of NILSSON and RASMUSSEN$^3$ theory. Since they pointed out that nuclear structure effects on internal conversion for hindered E1 transition may not occur below a certain "threshold" in the retardation factor.

An intrinsic excitation has been observed at 321 keV in Hf$^{177}$, see Fig. 1. It decays by E1 transitions to the members of the ground state rotational band, and the configuration is clearly identified$^4$ as (624, 9/2). The branching ratio for E1 transitions from the 321 keV level is dependent solely on geometrical factors$^5$, namely the Clebsh-Gordan coefficients. The theoretical branching ratio in order of increasing gamma ray energy is $1:250:4000$ while the experimental ratio is $2:220:3$ as found by

$^1$ BASHANDY, E., A. H. EL-FARRASH, and M. S. EL-NESt: Nuclear Phys. 52, 61 (1964).
$^2$ BASHANDY, E., M. G. MOUSA, and M. MIGAHEd: In course of publication in Physica.
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MARMIER and BOEHM\(^6\). CHASE and WILETS\(^7\) suggested that the large discrepancy arises because the E1 transitions are strongly forbidden according to the asymptotic quantum numbers. They have also calculated that the 321 keV transition is slower than the spherical independent particle model transition by a factor probably less than \(4 \times 10^{-3}\). No anomalous effects were observed in the conversion process of the retarded 208 keV transition, de-exciting the 321 keV level. The results of electron-gamma angular correlation\(^8\) as well as the conversion coefficient measurements show good agreement with the theory. The retardation factor for the 208 keV transition in Hf\(^{177}\) is of the order of \(10^4\) and has been experimentally determined by HAMILTON and SOOD\(^9\) to be \(8 \times 10^3\). Since the threshold of the hinderance factor is expected to lie somewhere between the values \(10^4\) and \(10^6\), it is likely that nuclear structure effects would not show up in the conversion process of the 208 keV transition.

The K-conversion coefficient of the 321 keV transition from \(9/2\), \(9/2 + (I, K \pi)\) to \(7/2, 7/2-\) was found to be twelve times higher than the theoretical value determined by extrapolation from SLIV and BAND’S\(^{10}\) table for E1 character. The partial mean-life of the 321 keV level for a ground state gamma transition is given by \(^9\),

\[
\tau_r(321 \text{ keV}) = 1.7 \times 10^{-8} \text{ sec},
\]

considering the intensity ratio\(^6\) 70:1 for the 208 keV to 321 keV gamma-decay modes. When the experimental transition probability is compared with the gamma ray transition probability in terms of the single particle model\(^11\), it was found that the 321 keV transition is retarded by factor \(2.6 \times 10^6\).

\(^8\) THUN, J. E., Z. GRABOWSKI, W. D. HAMILTON, and M. S. EL-NESSR: Nuclear Phys. 29, 13 (1962).