Angular Correlation Study of Excited Levels in ^{193}Ir

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Abstract. In this work, the excited states in ^{193}Ir populated by the β^- decay of ^{193}Os were investigated via γ-γ angular correlation analysis, allowing for the confirmation of the spin assignments for the levels at 557 and 563 keV.

Keywords: ^{193}Ir, β-decay, angular correlation
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INTRODUCTION

The nucleus ^{193}Ir occupies an interesting place in the nuclide table; between the proate-deformed ^{192}Os nucleus and the oblate ^{194}Pt one; while the usual approach is to describe the ^{193}Ir nucleus as a triaxial rotor [1, 2, 3, 4], a recent study [5] has shown that it can be equally well described as a prolately-deformed.

Moreover, while the ^{193}Ir nucleus has been recently thorougly studied through many different reactions, the last full examination of the β^- decay from ^{193}Os was made in 1972 [6], using Ge(Li) detectors with much lower detection efficiency than the presently-available HPGe detectors.

EXPERIMENTAL PROCEDURE

The present experiment was performed using the planar multidetector array system assembled at the Laboratório do Acelerador Linear (LAL), in the Physics Institute of the São Paulo University [7]. For this experiment, four HPGe detectors, with volumes ranging from 50 to 120 cm^3, were used in coincidence mode. The detectors were placed around the sample forming the following angles (reduced to the second quadrant, for simplicity) 90^o (2 pairs), 120^o (2 pairs), 150^o (one pair) and 180^o (one pair).

The samples were produced by irradiating 5mg of 99% enriched ^{192}Os for 5 minutes in the IEA-R1 reactor, under a neutron flux of about $10^{12} cm^{-2} \cdot s^{-1}$. Two sources were produced every week, and this procedure was repeated for two months resulting in something around 1200h of counting.

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TABLE 1. Multipolarity assignment for γ-rays with uncertain assignment in [9].

E_γ (keV)	M ([9])	M (pres. work)	δ (pres. work)	χ^2
201.432	[M1,E2]	M1(+E2)	0.02 ± 0.04	1.72
234.529	(M1)	M1+E2	-0.41 ± 0.07	0.97

Data Analysis

In this work the γ-γ cascades were analysed independently in each of the two ways that each coincidence can be seen in our data (*i.e.*, $\gamma_1 \times \gamma_2$ and $\gamma_2 \times \gamma_1$); in each fit only the mixing ratio (δ) of one of the transitions was fitted, while the other was fixed to avoid the problems described in [8]. After using all N possible cascades to fit the multipole mixing ratio (δ) of a given transition, the weighted average was taken from the $2N$ resulting values for that mixing ratio and the χ^2 of this average was then calculated as a measure of the quality and consistency of that result.

For transitions between levels with well-defined spin that had no mixing ratio assigned to them in the last compilation [9], the procedure was simply to fit this transition's δ using all possible cascades. For the levels with unconclusive spin assignment, the aforementioned procedure was made using the suggested spin for that particular level and the resulting χ^2 was used as an indication of whether that assignment was consistent or not.

RESULTS AND DISCUSSION

Transitions with uncertain multipolarity

First, two γ-rays with uncertain multipolarity assignments were studied: the 201keV transition, which was studied using the coincidence with the transition with 218.9keV; and the 235keV transition which was analysed in coincidence with the transitions with 280, 321, 387 and 460keV. The results are shown in Table 1, where the multipolarity (M) deduced from this study is compared to the values suggested in [9].

Levels with unconclusive spin assignment

The levels at 516, 557, 563 and 806 keV have a spin assignment in the compilation [9], but that assignment is considered unconclusive so it would be interesting to analyse these levels in this work. For the levels at 516 and 806 keV there wasn't enough statistic to allow an angular correlation study, so they won't be analysed here.

The study of the level at 557keV was performed using the transitions with 484keV and 557keV, both with unknown mixing ratio and in coincidence with the γ-ray with 155keV that feeds the 557keV level; the results for these analyses are shown in Table 2,

TABLE 2. Angular correlation results for the γ-γ cascades that permit the analysis of the 577keV level, showing the average value for the mixing ratio (δ) of the shown transition, as well as the χ^2 of that average.

E_γ (keV)	δ	M	χ^2
484.379	0.28 ± 0.03	M1+E2	1.39
557.467	0.28 ± 0.03	M1+E2	2.04

TABLE 3. Angular correlation results for the γ-γ cascade that permits the analysis of the 563keV level, showing the average value for the mixing ratio (δ) of the 264keV transition, as well as the χ^2 of that average.

E_γ (keV)	δ	M	χ^2
263.997	-0.15 ± 0.20	M1(+E2)	2.29

and these results show that both cascades allowed consistent fits, indicating that the suggested value of $1/2$ for the spin of the 557keV level is consistent with our data.

For the study of the level at 563keV there is only one cascade with enough statistics to allow the fit of the angular correlation function, between the transition with 264keV and the transition with 219keV; the 219keV transition is a pure-E2 transition and the 264keV transition is supposed to be a pure M1, so the mixing ratio of this transition was fit assuming that the proposed $9/2$ spin for the 563keV level is correct; these results are shown in Table 3, and it can be seen that the 264keV transition is indeed compatible with a pure-M1, and the quality of the fit shows that the spin assignment for the 563keV level also seems to be correct.

CONCLUSIONS

In this work the γ-γ angular correlation analysis of the β^- decay from ^{193}Os to ^{193}Ir was performed; five transitions from this decay which had no compiled value for their multipole mixing ratio (δ) [9] were studied and had their multipolarities determined; this analysis also allowed the verification of the spin assignments for two levels at 557keV and 563keV, which were uncertain in the last compilation [9] ($1/2$ and $9/2$, respectively).

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