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GAMMA SPECTROSCOPY OF EXCITED LEVELS IN ^{193}Ir

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ABSTRACT

The population and the mode of decay of the excited levels of ^{193}Ir have been investigated using a HPGe detector with high-energy-resolution and metallic samples of ^{193}Os. The energies of 74 gamma rays have been determined with a better overall precision than previously, 16 of them at the first time. In addition, a number of γ-transitions were confirmed.

Keywords: spectroscopy, Ir-193, beta decay

I. INTRODUCTION

The nuclear structures of double-even nuclei in the 190 mass region have been studied during the last years. In particular, the discussion involving the intrinsic equilibrium shape of these nuclei indicates changes from prolate (^{186,188}Os) to asymmetric (^{190,192}Os) and to oblate ($^{192\text{-}196}$Pt) which affect the character of the excited states, but experimental information about the odd-mass osmium isotopes (Z= 77) remained quite unexplored. As the nucleus ^{193}Os occupies a central position in the complex transitional region occurring between the deformed rare earth nuclei and the spherical nuclei near Lead, we decided to investigate the excited states of ^{193}Ir generated by the beta decay of ^{193}Os ($T_{1/2}$=30,5h) using a high resolution HPGe spectrometer with high statistics, in an attempt to better understand the trends in its nuclear structure.

II. EXPERIMENTAL PROCEDURE

The radioactive sources were obtained by the irradiation of 5mg of enriched osmium (99% ^{192}Os) for a period of 10 minutes in the IEA-R1 reactor at IPEN-São Paulo, with a thermal neutron flux of $5x10^{12}n.cm^{-2}.s^{-1}$. The direct gamma-ray spectrum from about 50keV to 1.3MeV was recorded over more than 800 hours of live counting. In order to positively identify the origin of the γ-rays, spectra were accumulated through two successive half-lives. The precise energy calibration of the γ-transitions spectra was taken with standard sources of ^{109}Cd, ^{133}Ba, ^{137}Cs and ^{152}Eu. The sources of ^{133}Ba and ^{152}Eu were also used for the relative efficiency calibration of the detector. Peak areas were evaluated by using the IDF computer code [1].

The single spectra were taking using a 160cm^3 HPGe detector (FWHM=1.89keV at 1.32MeV) and a ORTEC 671 amplifier in pile-up rejection mode. To determine the γ-ray energies with a precision similar to that of primary standards, we used the same procedure described by Medeiros et. al. [2].

III. RESULTS AND DISCUSSION

The measured energies are listed in Table 1, confronted with the data from previous results [3]. Sixteen γ transitions with energies 61.8, 71.5, 129.5, 153.9, 199.3, 297.3, 299.6, 343.6, 345.4, 395.1, 518.0, 615.9, 661.20, 698.5, 827.9 and 1044keV were observed for the first time. Besides, two gamma transitions at 154.7 and 668.4keV, observed only in present β-decay study, were also observed in ^{193}Ir(n,n'γ) [3] and Coulomb excitation [4] reactions experiments. Also, the photopeak at 619.2keV proposed in our spectroscopy experiment was reported in (n, n'γ) nuclear reaction[3].

From the analysis of the energy determinations, our data revealed no evidence for the doublet at 333.3keV and 337.7keV observed only by Price and Johns [5], as well as for the photopeaks at 378, 181, 219, 317, 378, 418, 556 and 560keV, deduced from γγ coincidence in this same study. The energy at 517keV, reported solely by Avida et. al. [6], was not observed in our study although the present experiment has achieved better observation limits. The photopeak at 154.74keV, previously reported as singlet [5], is here shown to be doublet at 153.95(7)keV and 155.057(69)keV. This fit can be observed in Fig. 1, along with the fits corresponding to some other doublets or triplets resolved in the present work.

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TABLE 1. Gamma Energies (E_γ), Compared To The Last Compilation By Firestone [3].

Energy (keV) Ref[3]	Energy (keV) Present Work
41.18(7) [a]	
	61.78(7)
	63.39(6) $K\alpha_2$
65.87(6)	65.05(6) $K\alpha_1$
	71.54(7)
73.039(12)	73.369(60) $K_{\beta1}+K_{\beta3}$
	75.97(6) $K_{\beta2}+K_{\beta4}$
80.22(2) [b]	
96.82(3)	97.05(6)
98.7(8)	99.11(7)
107.007(12)	107.21(6)
	129.53(6)
136 [a]	
138.92(3)	139.12(6)
142.13(8)	142.348(60)
153 [c]	
	153.95(7)
154.74(3)	155.057(69)
180.03(3)	180.257(70)
181 [a]	
181.81(3)	181.97(7)
197.4(2)	197.64(7)
	199.276(1)
201.5(3)	201.66(79)
218.8(2)	
219 [a]	
219.13(5)	219.318(71)
234.58(6)	234.784(71)
251.62(4)	251.81(7)
280.441(23)	280.61(8)
288.79(5)	288.937(8)
290 [c]	
	297.33(8)
298.83(5)	298.803(79)
	299.65(6)
317 [c]	
321.59(4)	321.736(78)
333.3(3) [d]	
337.7(5) [d]	
	343.55(9)
	345.43(9)
350.2(2)	350.95(8)
357,7	357.84(9)
361.81(5)	361.98(9)
377.31(7)	377.445(89)
378 [a]	
379.04(15)	379.27(91)
	386.486(88)
387.48(4)	387.685(92)
	395.06(11)
413.8(2)	413.82(88)
418 [a]	
418.35(8)	418.60(9)
420.3(5)	420.47(89)
440.95(5)	441.110(91)
460.49(3)	460.66(8)
484.25(5)	484.47(9)
486.11(15)	
512.3(3)	
514.95(1)	515.14(11)
516.3(4)	
517 [c]	
	518.00(9)
524.98(8)	525.336(11)
532.02(5)	532.261(13)
556 [a]	556.178(11)
557.36(8)	557.535(10)
559.26(8)	559.408(12)
560 [a]	
573.33(1)	573.36(14)
598.1(3)	598.334(16)
	615.936(22)
	617.065(16)
	619.242(12)
639.09(1)	639.273(13)
	646.20(12)
	661.19(18)
	665.13(17)
668.3	668.45(17)
695.12(1)	695.26(14)
	698.49(13)
	707.01(17)
709.93(15)	710.20(13)
712.1(1)	712.29(13)
735.3(3)	735.58(19)
775.9(3)	776.61(14)
778.48(15)	
784.2(2)	
800.9(3) [d]	
	827.91(15)
848.85(15)	846.84(14)
	849.27(16)
874.36(15)	874.38(13)
891.26(15)	892.20(14)
	1044.02(18)

a. Not directly observed: deduced from $\gamma\gamma$ measurements from Price and Johns[5].

b. This transition depopulates the isomer at 80.19keV [3].

c. Extracted from Avida et al [6]. According to authors no experimental uncertainty value was reported.

d. Observed only in γ spectroscopy measurements by Price and Johns [5].

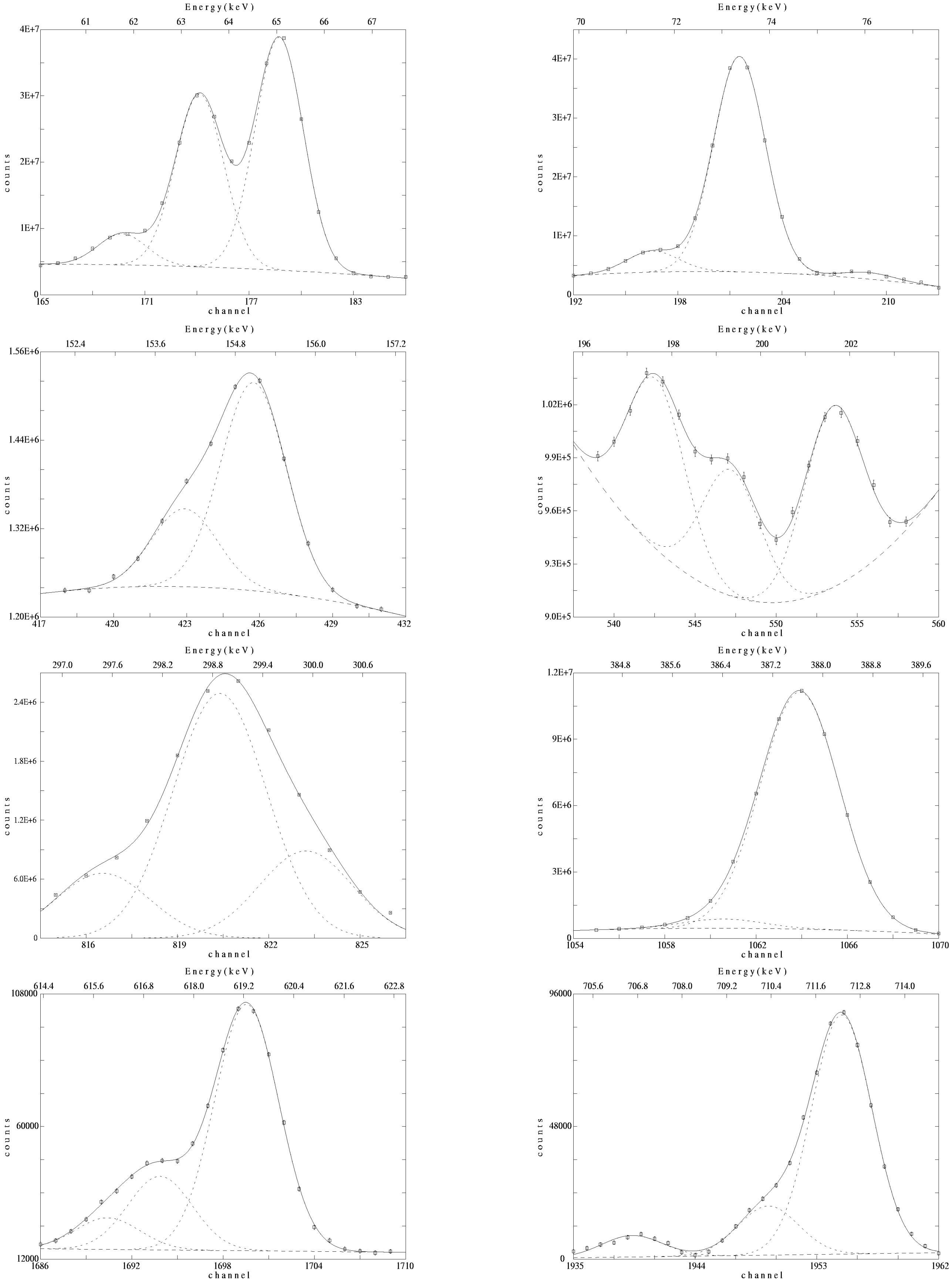

Figure 1. Fits for some of the newly-resolved doublets and triplets.

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III. CONCLUSIONS

From singles spectra analysis a number of new transitions are proposed and the results give the opportunity to study the extent to which susceptibility to deformation affects the low-lying states of this transitional nucleus, in an attempt to better understand the trends in its nuclear structure.

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