EVOLUTION OF ODD A TRANSITIONAL IRIDIUM NUCLEI AT THE STRONG DEFORMATION LIMIT : LEVELS OF ^{185}Ir

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ABSTRACT

A level scheme is proposed for neutron deficient ^{185}Ir obtained by the decay of ^{185}Pt produced with the ISOLDE on-line separator (CERN). This level scheme is compared to those of heavier mass iridium nuclei where the negative parity levels had been interpreted in the asymmetric-rotor-plus-particule model. In ^{185}Ir similar systems of levels appear with a stronger prolate deformation of the nucleus. They seem correctly described by coupling an odd-particle (or a hole) to a symmetric rotor.

1 - INTRODUCTION

Systematic studies have recently been focused on the transitional odd-A iridium nuclei region through complementary on-line radioactivity and in-beam experiments [1-4]. Different kinds of nuclear shape coexistence have been considered : coexistence of spherical and deformed states[1] and recently triaxial shape [5] was proposed in ^{187}Ir and ^{189}Ir for two families of negative parity states belonging to h9/2 and h11/2 orbitals.

The study of ^{185}Ir levels excited by the decay of ^{185}Pt isomers (33.0 ± 0.8 min and 70.9 ± 2.4 min) [6] had been initiated with the former ISOLDE 1 isotopic separator on-line with the 600 MeV synchrocyclotron of CERN and was worked out with the ISOLDE 2 facilities on-line with the reconstructed synchrocyclotron.

In the meanwhile, in-beam experiments were made in the Grenoble variable energy cyclotron [7]. The coupled band built on the 11/2- state belonging h11/2 orbital was observed and the decoupled band built on the h9/2 spherical state was excited up to spin 37/2-, but the position of the 9/2- band-head was not determined.

2 - EXPERIMENTAL PROCEDURES

A complete set of spectroscopic on-line and off-line measurements has been performed, including e^--γ multipolemeter measurements, γ-γ and e^--γ coincidences with various Ge(Li) and Si(Li) detectors. In order to separate the transitions decaying from the two ^{185}Pt isomers (33.0 min and 70.9 min) we made for each experiment at least two distinct measurements with different sets of values for collecting, waiting and counting times.

A double lens Gerholm type spectrometer [8] has been used for e^--e^- coincidences and lifetime measurements. Low energy conversion electrons (0-150 keV) have been measured with a magnetic semi-circular spectrograph. The photographic plates were analyzed with the digital Optronics microdensitometer of E.S.O. laboratory, Geneva, written as biparametrical spectra on magnetic tapes and handled in Orsay with the ARIEL computing facilities.

3 - EXPERIMENTAL RESULTS

A level scheme is built up to 1.6 MeV. Due to the existence of two isomers in ^{185}Pt, an important range of spins is observed ; the low spin levels are fed by the 33 min ^{185}Pt ground state while the high spin levels are fed by the 71 min high spin ^{185}Pt isomer.

Similarly to heavier odd-A iridium isotopes, we observe the strongly mixed positive parity bands built on 3/2+|402| and 1/2+|400|, but the 3/2+ 3/2|402| level is no longer the ground state and is located at 229.6 keV. Simultaneously, the negative parity levels become much more numerous and more strongly fed.

The ground state spin has recently been measured as 5/2- by Rubinsztein and al [10] by ABMR method. It was expected that for deformations higher than $\beta = 0.22$, the 1/2-|541| state from h9/2 orbital would appear lower than 3/2+|402|. As was already observed in ^{187}Ir [2] and in odd-A rhenium nuclei [11], the strong mixing with other states from h9/2 (mainly 3/2-|532|) and from f7/2 (1/2-|530|), strongly perturbs the band energies, and the 5/2- levels appear at lower energy than the intrinsic 1/2- state (see fig. 1).

As noticed in section 1, the decay of the decoupled band built on 9/2- level had not been observed [7] and therefore its energy had to be less than 70 keV.

In the low energy spectrum obtained with the β spectrograph with 15 kV preacceleration, we observed, between M and L Auger spectra, two lines of 2.7 and 3.2 keV which we interpret as the M_{II} and M_{III} lines of an E2 transition of 5.8 keV. The N lines are visible but mixed with L Auger. Using a 6 kV preacceleration, the 3 keV line appeared clearly between both Auger groups in a spectrum obtained with the Gerholm spectrometer. We searched for coincidences between this line and the K line of the 152.8 keV E2 transition (see fig.1) which had been established by in-beam experiments [7] as the first member of the decoupled band. We effectively observed coincidences and we measured for the 5.8 keV transition a 5 ± 1 nsec half-life, leading to $B(E2) = 200\ B_{sp}(E2)$, which is consistent with an intraband E2 transition.

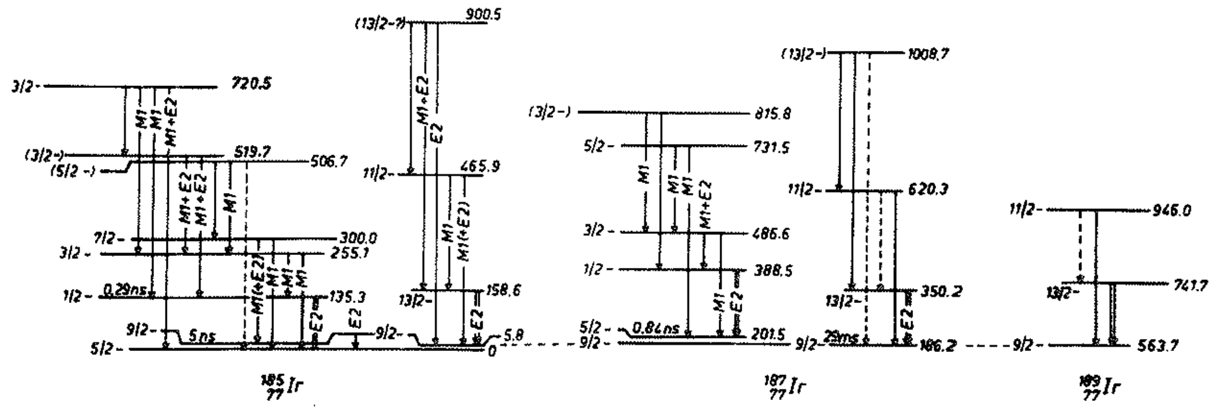

Figure 1 - Low spin levels related to the h9/2 system

These measurements locate the 9/2- band-head of the decoupled band belonging to h9/2 system at 5.8 keV. In the strong coupling limit, the most important component would correspond to 9/2- 1/2|541| level. The measured B(E2) gives definitive support to 5/2- 1/2|541| assignment for the ground state level.

4 - DISCUSSION

4.1 - Levels related to the h9/2 orbital

We present in fig.1 the main experimental levels obtained for ^{185}Ir from radioactivity measurements and belonging to h9/2 orbital, compared to similar levels in ^{187}Ir and ^{189}Ir. Transitions with double arrow are the first members of decoupled bands. These partial schemes are drawn relative to 9/2- levels.

In ^{187}Ir and ^{189}Ir, this system was correctly described by the coupling of an h9/2 proton to the corresponding prolate asymmetric Osmium core [5]. The deformation parameters were $\beta = 0.23$ and $\gamma = 16°$ for ^{187}Ir.

In ^{185}Ir, the comparison of experimental values to similar calculations with the rotor-plus-particle model obtained by coupling a h9/2 proton to a ^{184}Os core gives a good agreement when assuming a symmetric prolate shape ($\beta = 0.25$, $\gamma = 0°$).

The 3/2- 720.5 keV level is not predicted in the theoretical h9/2 system. It probably corresponds to a mainly 3/2 - 1/2|530| component from f7/2 orbital strongly coupled with the lower states from the h9/2 orbital.

4.2 - Levels related to the h11/2 orbital

In fig.2, similar systematics is presented for the low spin levels related to h11/2 system relative to the energy of the 11/2- isomeric level which is the band-head of the coupled band. Transitions with double arrow represent first member of coupled bands. We can remark that we do not observe the 7/2- level. Its energy is expected [5] to increase rapidly with decreasing asymmetry.

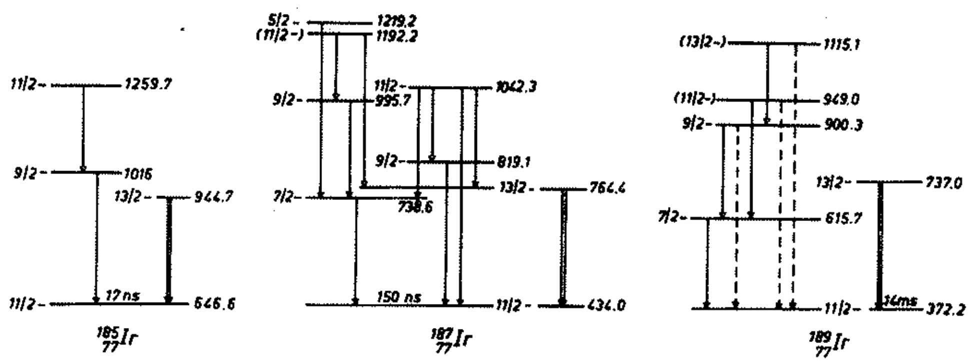

Figure 2 - Low spin levels related to the h11/2 system

^{187}Ir and ^{189}Ir were correctly described by coupling a h11/2 hole state to the corresponding prolate asymmetric platinum core [5].

In comparing the experimental levels in ^{185}Ir to predictions of the rotor-plus-particle model by coupling a h11/2 hole state to a ^{186}Pt core, we obtain good agreement for an axial symmetric prolate core, but it should be noticed that the theoretical values corresponding to observed levels are not very sensitive to small γ variations.

We considered in ^{187}Ir and ^{185}Ir the strongly hindered M1 interband transitions connecting the h11/2- isomeric level from h11/2 system to the 9/2- band-head of the decoupled h9/2 band (247.6 keV from 434.0 keV 11/2- level to 186.2 keV 9/2- level in ^{187}Ir and 640.8 keV from 646.6 keV 11/2- level to 5.8 keV 9/2- level in ^{185}Ir). The hindrance factors appear to be practically the same for both nuclei ($F_W = 1.3\ 10^5$ in ^{187}Ir and $F_W = 1.9.10^5$ in ^{185}Ir) which is an order of magnitude more than the corresponding M1 transition in ^{189}Au [12,13]. As it happens in odd-A ^{189}Au to ^{193}Au nuclei, the hindrance factor for this M_1 11/2- → 9/2- transition remains constant when transforming from prolate to oblate shape. In the more deformed ^{187}Ir and ^{185}Ir, the hindrance factor is an order of magnitude stronger and remains constant when changing from triaxial to stable prolate shape.

5 - CONCLUSIONS

Similar negative parity systems are observed in odd Ir nuclei from A = 189 to A = 185. The strong coupling limit seems to be reached for ^{185}Ir and both systems can be described correctly in terms of a h9/2 (or h11/2) particle (hole) coupled to a symmetric rotor. This fact, connected with the continuous evolution of both systems in three isotopes leads to think that the asymmetry observed in heavier iridium is rather a soft fluctuating asymmetry than a stable triaxial shape.

It is to be noticed than in terms of rotor plus-particle model, the h9/2 system in ^{187}Ir is described by coupling a h9/2 proton to a ^{186}Os core and the h11/2 system by coupling of h11/2 hole to a ^{188}Pt core. ^{186}Os appearing as prolate [15] and ^{188}Pt as oblate [16 17], this could suggest a shape coexistence or a certain fluctuating shape for ^{187}Ir. In ^{185}Ir, the corresponding cores are ^{184}Os and ^{186}Pt which both appear as prolate ; this is consistent with the more rigid shape observed for ^{185}Ir.

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