γ - TRANSITION RATES IN TRANSITIONAL ODD GOLD NUCLEI

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Abstract

The results of two half-life measurements of excited states in $^{185}\text{Au}$ are presented. One supports the proposed interpretation of the ground state configuration, the other one calls attention to the $h\ 9/2$ to $h\ 11/2$ M1 transitions in odd mass gold nuclei, which, in spite of considerable deformation changes of the $h\ 9/2$ state, all show the same retardation.

A. Introduction

The impressive number of experimental data on odd Au nuclei has focused attention on these nuclei as an attractive field for test and development of old and new nuclear models. The sequence and spacings of the excited states of these nuclei are now rather well reproduced theoretically; to go further it is important to make comparisons with experimentally determined absolute $\gamma$-transition probabilities. To produce such data, half-life measurements of excited levels in the $\beta$ decay of 60 s $^{185}\text{Hg}$ and 30 s $^{185}\text{Hg}$ have been made at the ISOCLE separator, using an on-line Gerholm-Lindskog $\beta$ -spectrometer. As examples two results are presented.

B. Experiments and results

1. The ground state of $^{185}\text{Au}$

In $^{185}\text{Au}$ the ground state with spin 5/2$^+$ has been suggested to be, as in $^{185}\text{Ir}$, the anti-aligned 5/2$^-$ member of a decoupled $h\ 9/2$ band. The ample information on the structure of this band$^{2, 3}$ has invited to several theoretical studies$^1, 2$ and, in order to obtain a low lying 5/2$^-$ state, all of them have predicted a pronounced prolate deformation ($\beta \approx 0.25$). The 9/2$^+$ band head was proposed$^3$ at 8.9 keV on account of the systematic trend of the 9/2$^+$ level in odd mass Au nuclei (see Fig. ) and of $\gamma$ - $\gamma$ coincidence relations. It seemed important to verify the existence of the 8.9 keV ground state transition and if possible get an estimate of the nuclear deformation.

Thanks to the application of an electron accelerating potential in front of the magnetic lens spectrometer it is possible to detect very low energy electrons. In the spectrum of $^{185}\text{Au}$ an electron line corresponding in energy to 8.9 M was observed.
Delayed electron-electron coincidences between this line and the K electrons of the h 11/2 to h 9/2 transition gave the half-life of the 8.9 keV level equal to (4.8 ± 0.4) ns. The result corresponds to a B(E2) = 1.2 e²b² = 185 B(E2)s.p. compatible with an intraband E2 transition. Assuming a K = 1/2, 9/2" to 5/2" transition the collective model relations:

\[ B(E2, I_f \rightarrow I_g) = \frac{5}{16n} Q_0 < I_f I_g > \]

\[ Q_0 = 0.8 Z R^2 \delta (1 + 0.5 \delta) \]

give the deformation \( \delta = 0.20 \).

Consequently the result strongly supports the interpretation of the ground state as the 5/2 member of the h 9/2 band. It also agrees with the prediction of a well developed prolate shape.

In 185_{15}^4, where the 9/2" level lies at 5.8 keV the corresponding results are: B(E2) = 1.4 e²b² = 200 B(E2)s.p. and \( \delta = 0.21 \).

2. The h 9/2 to h 11/2 M1 transition in 185_{15}^4 Au and in odd-mass gold nuclei.

The measurement of the half-life, \((26 ± 2)\) ns, of the 11/2" state in 185_{15}^4 Au has permitted the calculation of the M1 transition probability between the heads of the h 11/2 and the h 9/2 systems of states. As seen in the figure these two decoupled systems develop in very different ways in the odd mass Au nuclei. The 11/2" system stays nearly unchanged from 195_{18}^{95} Au to 185_{15}^4 Au with the bandhead at about 250 keV and is well described in all nuclei using the deformation parameters \( \beta = 0.15, \gamma = 35° \).

The 9/2" family on the contrary lowers rapidly in energy with decreasing massnumber (bandhead at 1064 keV in 195_{18}^{95} Au, at 8.9 keV in 185_{15}^4 Au). The deformation changes drastically from \( \beta = 0.15, \gamma = 33° \) in 195_{18}^{95} Au to \( \beta = 0.25, \gamma = 0° \).

Taking into account these observations one could expect notable variations in the transition probabilities of the 9/2" to 11/2" transitions connecting the two systems. Our experiments have shown the contrary; in spite of the change of the 9/2" system, the transition rates stay constant as witnessed by very high but stable hindrance factor \( F_W \sim 17000 \) (see Fig. 1). The E2 parts of the transitions are retarded by a factor \( \sim 10 \).

One would conclude that the hindrance of the 9/2" to 11/2" transitions only weakly depends on the changes of shape and deformation but very strongly on the level configurations. According to the simple rotation aligned model, the 9/2" and the 11/2" states are represented as respectively an h 9/2 particle coupled to a Pt core and an h 11/2 hole coupled to a Hg core. Could this difference in structure explain the important hindrance of the interband transitions? Evidently not completely. In order to reproduce the 9/2" band structure in 185_{15} Au ref. 1 and 3 are led to admit admixture of other states, for instance f 7/2 and p 3/2. Theorical values of the 9/2" to 11/2" transition rates have never been calculated even for the nuclei where the two systems have the same shape (A \( \gg \) 191).

References


