STUDY OF HIGH-SPIN STRUCTURES IN^{191}Au * **

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The high-spin states in ^{191}Au have been studied with two complementary experimental devices using the ^{186}W(^{11}B,6n) reaction. The γ-γ coincidences and angular distributions of the γ-rays have been established using the EUROGAM II array; the electron conversion coefficients were obtained in an additional e$^-$-γ experiment. The level scheme of ^{191}Au was extended up to 9.6 MeV excitation energy and spin of 75/2 $\hbar$. The shape coexistence of different structures in the ^{191}Au nucleus is discussed.

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1. Introduction

The gold isotopes lie in a region of coexistence of different nuclear shapes. The neutron deficient odd-mass isotopes (185≤A≤193) are transitional nuclei, lying in the region between spherical and prolate shaped nuclei. They exhibit a coexistence between prolate and oblate deformed states, which relative population depends on the nucleus mass [1–3]. It was shown that the axially-symmetric rotor+particle model could not reproduce all the properties of the low lying oblate deformed states and that it was necessary to introduce γ-deformation [4, 5]. Three superdeformed bands have been recently reported in ^{191}Au [6, 7].

In this work high-spin structures in ^{191}Au have been studied in order to investigate the evolution of the shape coexistence at higher spins.

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2. Experiments

In the first experiment, the high-spin states in ^{191}Au were populated in the ^{186}W(^{11}B, 6n)^{191}Au reaction at 84 and 86 MeV. The beam was provided by the Vivitron accelerator in Strasbourg. The γ-rays were detected by the EUROGAM II array, consisting of 30 Ge detectors and 24 clover detectors, arranged at 8 different angles. The target consisted of 2 stacked foils of 280 μg/cm^2 each made in G.S.I. $9{\cdot}10^8$ quadruple and higher fold events were recorded on tapes. Off-line analysis of several γ-γ matrices and a cube was performed. The angular distribution of the γ-lines was studied and the multipole order of most of the transitions were derived.

In order to firmly establish the multipolarity of the γ-transitions electron conversion coefficients had to be measured. This experiment was performed with the e$^-$-γ spectrometer in-beam with the Orsay tandem accelerator. The same above-mentioned reaction was used at a beam energy of 77 MeV. The 500 μg/cm^2 ^{186}W target was at 45° respective to the beam direction. The magnetic lens, set in the 90° configuration, guided the electrons emitted by the target to two Si(Li) detectors. An array of six BaF$_2$(2″×2″) was used as a reaction trigger [15]. Five large (80%) Compton-suppressed Ge detectors were located in the other half-sphere. Off-line analysis of the prompt electron and the corresponding γ spectra was made and the multipolarity of 32 transitions was deduced.

3. Results and discussion

From these analyses, the previously known level scheme of ^{191}Au [8, 9] could be extended up to an excitation energy of 9.6 MeV and a spin of 75/2 $\hbar$. A partial level scheme is presented in Fig. 1. The ground state of ^{191}Au presents an oblate deformation [8]. The low spin structures, built on the $\frac{11}{2}^-$, $\frac{21}{2}^+$, $\frac{27}{2}^+$ states are similar to those of ^{192}Hg (0^+, 5^-, 8^- respectively) and therefore they are interpreted as one proton-hole $\pi h^{-1}_{11/2}$ coupled to the corresponding oblate ^{192}Hg core [9]. The isomer $31/2^+$ has no analog level in ^{192}Hg. It can be explained as issued from the coupling of one proton to the 10^- isomer in ^{190}Pt [8] leading to the configuration $\pi h^{-1}_{11/2}\nu i_{13/2}h_{9/2}$. Assuming these configurations, one should note that the two neutrons $\nu i_{13/2}$ and $\nu h_{9/2}$ are not completely aligned in the $31/2^+$ isomer (such as in the 10^- states in ^{190,192}Pt and ^{190}Os [10–12]). At spin $43/2^+$ (~2.2 MeV above the $31/2^+$ isomer) a backbending is observed. It could be due to the breaking of a new pair of $\nu i_{13/2}$ neutrons, giving rise to a 5 quasi-particle band. At spin $53/2^+$ another structure becomes yrast. The spin of the band-head corresponds to the complete alignment of these 5 quasi-particles.

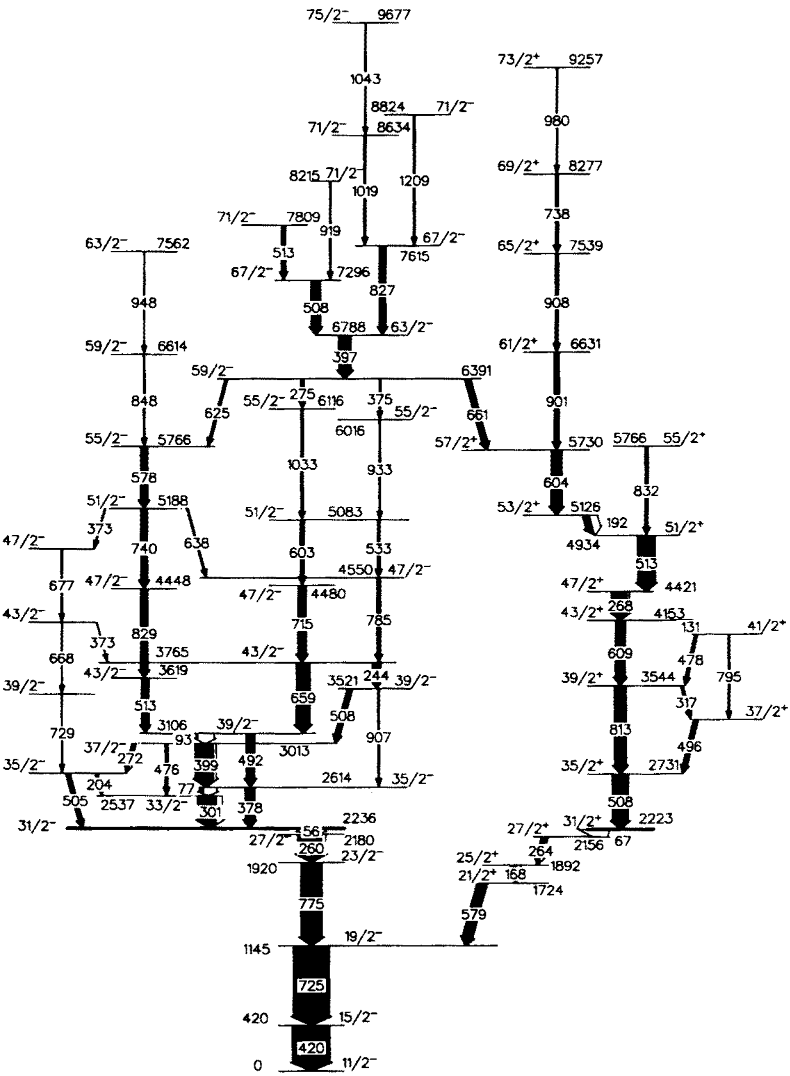

Fig. 1. Level scheme of ^{191}Au obtained in the present work

The $31/2^-$ isomer is a three quasi-particle state, $\pi h^{-1}_{11/2}\nu i^2_{13/2}$ [9]. The three quasi-particles are also not completely aligned in this case. On the top of the isomer, a strong structure consisting of M1 and E2 transitions has been observed. Similar (however longer) M1/E2 structures built on the top of the $\frac{31}{2}^-$ isomer have also been reported in ^{187,189}Au [1, 2, 13, 14]. Conversely, in ^{193}Au a rotational band is observed on the top of the $35/2^-$ isomer (corresponding to the complete alignment of the three quasi-particles) [8, 9]. Very weak bands built on the complete aligned $35/2^-$ state are also observed in ^{191}Au (similarly as in ^{187,189}Au [13, 14, 1]). This suggest that in these odd-mass Au isotopes a strong competition between structures built on completely aligned and incompletely aligned states exists and, depending on the nucleus mass, these structures are populated with different relative intensities. On the top of the M1/E2 structure three long E2 sequences have been observed in ^{191}Au which contains states of the same spin and parity. Therefore we propose that they might only differ in the degree of their γ-deformation.

It seems that above the state $\frac{59}{2}^-$ the collective structures terminate, giving rise to non-collective ones. The $59/2^-$ state at 6.391 MeV might be directly related to the 24^+ state at 6.4 MeV in ^{192}Hg and interpreted as the $\pi h_{11/2}^{-1} \nu i_{13/2}^{6}$ seven quasi-particles state with totally aligned angular momentum.

In summary a strong competition between structures built on totally aligned and incompletely aligned states, as well as coexistence between structures with different γ-deformation have been observed in ^{191}Au. In the same nucleus superdeformed states have also been found (not discussed in this work). So, at very high spins, the ^{191}Au nucleus still exhibit a variety of nuclear excitations.

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