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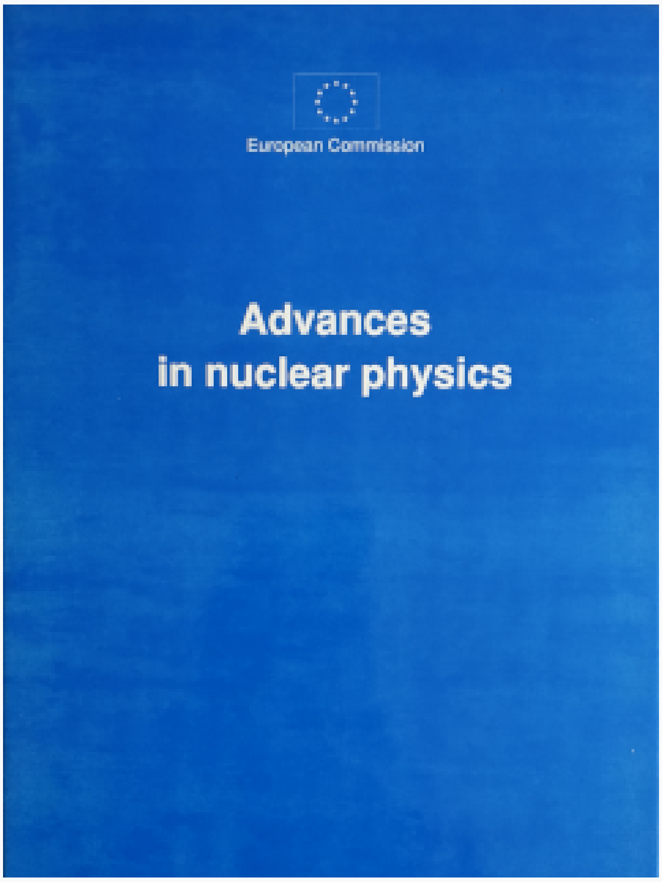

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High-spin phenomena in ^{194}Hg †

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Abstract

High-spin states in the isotope ^{194}Hg were populated using the ^{150}Nd (^{48}Ca,4n) reaction at a beam energy of 213 MeV. The analysis of γ-γ coincidences, which were detected using the EUROGAM detector array, has revealed two new structures at excitation energies above 6 MeV and at moderate spin. The first one could be interpreted as a manifestation of a band termination phenomenon while the second one is associated with a single-particle decay mode.

I. Introduction

The mercury isotopes have been proved an excellent testing ground for comparison between cranked shell model (CSM) calculations and experimental results in oblate rotating systems [1]. The deformation of these isotopes is generally small and oblate near their respective ground states ($\epsilon_2 \sim 0.15$, $\gamma = -60°$). A theoretical study suggests that these nuclei are rather 'γ - soft', i.e. alignment of high-j quasiparticles can lead to departures from axial symmetry [2]. The first experimental observation of such a softness to γ-deformation was the shape change from oblate collective $\gamma = -60°$ to prolate non-collective $\gamma = -120°$ in ^{191}Hg [3].

We present here two new structures in ^{194}Hg. The first one could be related to a band termination phenomenon while the second involves single-particle angular momentum generation phenomena.

† Presented by N. Fotiades

II. Experimental Procedure

The reaction ^{150}Nd (^{48}Ca,4n) ^{194}Hg was used to populate high spin states of ^{194}Hg at beam energy E(^{48}Ca) = 213 MeV at the Nuclear Structure Facility at Daresbury, U.K.. The ^{150}Nd target was 2 mg/cm^2 thick isotopically enriched. The target was evaporated on a 7 mg/cm^2 thick gold foil in order to stop the recoiling nuclei. The EUROGAM detector array which, in our measurement, consisted of 35 hyperpure Compton-suppressed Ge detectors [4], was used to detect the γ-rays. Approximately 4 $\times$ 10^9 coincident events, of unsuppressed fold five or higher, were collected.

For the analysis of the data two 4096$\times$4096 channel matrices were produced. The first matrix was used to establish the coincidence relationships of the γ-rays while the second one was especially built to investigate the directional correlations of the γ-rays $I(90°, 158°)/I(158°, 90°)$ (DCO-ratios). From the analysis of the former matrix the level scheme, reported previously by Hübel et al. [1], has been justified and enriched with two new structures.

III. Experimental Results

The two structures are shown in Fig. 1. Structure "1" is the continuation of the known band T [1]. The spins in this band, which were uncertain in the previous work, have been established in our experiment but the parity remains uncertain. As in the case of ref. [1], the standard Cranking Shell Model notation will be used throughout this communication to classify the previously known bands of this isotope.

Structure "1" exhibits a rather unusual level pattern. A common level at 6816 keV is fed by two branches (739.8, 1006.0 keV and 772.6, 973.6 keV transitions) which deexcite one single level at an excitation energy of 8562 keV. This level is fed by two decay paths (1003.2, 317.0 keV and 1029.7, 290.4 keV) which join up to a single level at an excitation energy of 9882 keV. The directional correlations of the 343.6 and 377.9 keV transitions indicate that they are of dipole nature.

The level pattern of structure "2" is quite complicated. The head of structure "2" is a level at 6033 keV excitation energy. The decay out of the 6033 keV level is fragmented into a large number of branches. All these branches end up in bands AB, ABCD and ABCE. There is also a minor branch (335.3, 441.5, 763.6, 804.8 and 1027.6 keV transitions) feeding the bandhead of band ABCD without going through the 6033 keV level. The relative placement of 763.6 and 804.8 keV transitions in Fig. 1 is still uncertain due to their almost equal intensity. The main path of deexcitation above the 6033 keV level consists of the 757.8, 791.5, 359.8 and 345.4 keV transitions.

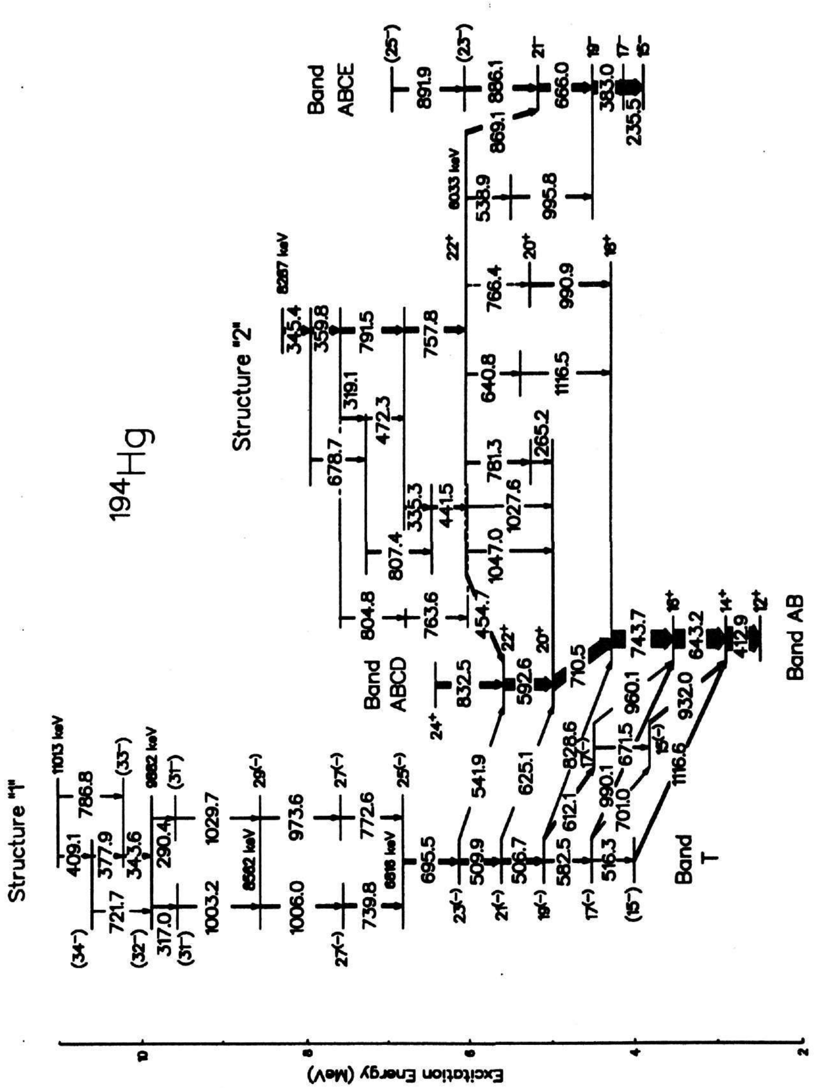

FIG. 1 : *Partial level scheme showing the two new structures and the previously known bands [1] towards which these structures deexcite. The transitions are labeled by their energy in units of keV. The width of the arrows represent the intensity of the transitions relative to the 412.9 keV transition which is the strongest among them. The uncertainty on the γ-ray energies varies from 0.2 keV for the strong transitions to 0.8 keV for the weakest ones.*

IV. Discussion

The excitation energy for the levels of band T and structure "1" (up to 9882 keV level) relative to a rigid rotor reference ($E_{rr} = 0.009I(I+1)$) is plotted as a function of spin in Fig. 2. The down-sloping behaviour of the curve indicates an energetically cheap acquirement of spin which could be attributed in a terminating band phenomenon. The slope changes significantly at spin $27^{(-)}$ and (31^-) indicating that the alignment of the nucleons of the configuration responsible for these levels takes place at spin $27^{(-)}$ and adds 4 units of angular momentum in the spin of the nucleus. The two $27^{(-)}$ and the two (31^-) levels are very close in energy (ΔE = 33 and 27 keV respectively) implying that they have very little interaction while the interaction vanishes at the $29^{(-)}$ level. Similar structures in the A = 120, 160 regions have been related to shape changes from prolate collective towards oblate non-collective [5,6]. Based on the similarity we suggest an analogous shape transition from oblate collective $\gamma = -60°$ towards prolate non-collective $\gamma = -120°$ for structure "1".

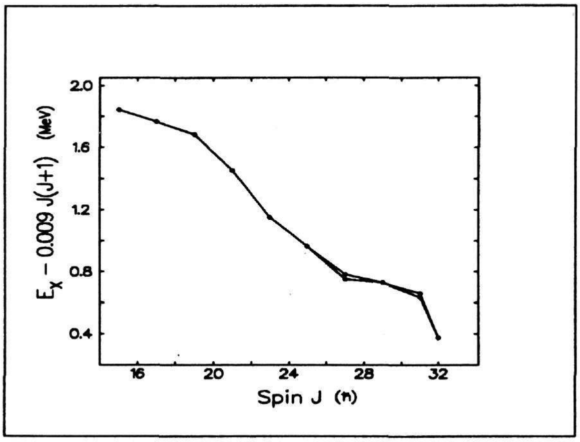

FIG. 2 : *Excitation energy E_x for the levels of band T and structure "1" (up to 9882 keV level) relative to a rigid rotor reference as a function of spin.*

The level pattern of structure "1" above the 9882 keV level is reminiscent of the $\Delta I = 1$ bands recently observed in the neighbouring Hg and Pb nuclei [7-16]. Such bands consist of dipole transitions competing favorably with quadrupole ones. The results in ^{194}Hg are not yet enough to justify such an interpretation but if this is valid then ^{194}Hg would be one of the scarce cases where the decay out of such a $\Delta I = 1$ band has been observed.

Above the 6033 keV level the structure "2" exhibits an irregular pattern while below it the decay proceeds towards several bands indicating that this structure differs in character from the lower rotational yrast levels. This picture is reminiscent of a deexcitation of single-particle character already observed in nuclei of the A = 150 region [17,18] and recently in the neighbouring ^{191}Hg isotope [3]. The spin of the 6033 keV level can easily be reproduced if one couples a pair of fully aligned $h_{11/2}$ protons to a pair of fully alligned $i_{13/2}$ neutrons.

V. Conclusion

Two new structures have been observed in ^{194}Hg which become yrast at moderate spins. The first one could be interpreted as a band termination phenomenon while a single-particle nature is proposed for the second one. This interpretation needs to be tested further with experiments in this and the neighbouring nuclei.

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