RECENT WORK AT UNISOR ON NEUTRON-DEFICIENT Au, Hg AND Tl NUCLEI IN THE MASS RANGE $184 \leq A \leq 197$

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The sudden and large change in the nuclear charge radius of ^{185}Hg as compared to that of ^{187}Hg, observed in optical pumping measurements has lead to considerable experimental and theoretical activity aimed at understanding the implied existence of large deformations near the Z = 82 closed shell. In-beam spectroscopy using heavy-ion reactions leading to ^{184,186,188}Hg has revealed that the yrast structure changes from that of a near-spherical band at low spins to a strongly deformed band at high spins, the change occurring at a decreasing value of spin with decreasing neutron number; however, in none of these nuclei does it imply a deformed ground state.

The aim of recent UNISOR experiments has been the thorough investigation of the single-particle and collective degrees of freedom for the region $184 \leq A \leq 197$, by studying the β^+-decays of neutron-deficient Pt, Au, Hg, Tl and Pb isotopes.

The UNISOR isotope separator[1]) is operated on-line to the Oak Ridge Isochronous Cyclotron (ORIC) and uses an in-beam target/ion source[2]) arrangement that collects and ionizes recoiling product nuclei following heavy-ion induced reactions on thin (metallic) targets. On-line extraction of Hg, Tl and Pb activities has been achieved following the bombardment of Ta, W and Re targets (including enriched ^{180}W and ^{182}W targets) with beams of ^{14}N and ^{16}O in the energy range 110 - 180 MeV. Some ion-source chemistry was performed by using different materials (tantalum metal and graphite felt) for catching the recoiling products, and by using the halogenating compound CCl_4. Standard techniques of γ-, e-, x-, β-, and α- spectrum-multiscaling and γ-γ-t, γ-x-t and γ-e-t, three-parameter coincidence spectroscopy using computer based analyzers[3]) were employed to study these activities.

Detailed studies of the excited states of even-mass $^{184-194}$Hg have been made following the decays of $^{184-194}$Tl. All of these Tl isotopes exhibit isomerism which results in the population of high- and low-spin ($0 \leq J \leq 8$) in the even-Hg nuclei. Heavy-ion reactions strongly favor the production of high-spin states, but it was possible in some cases to reach a low-spin state very effectively via the β^+-decay of a grandparent e.g. ^{192}Pb(0^+) → ^{192g}Tl(2^-) → ^{192}Hg. Some details of the decays of ^{186,188}Tl appear in an earlier communication[4]), the study of the decay of ^{190}Tl is completed[5]) and further details of the ^{184}Tl are given below. The systematics of the low-lying positive parity states in $^{184-190}$Hg, based on these studies, are given in Fig. 1. Our results reveal complete sets of excited states that form near-spherical ground-state bands and deformed bands built on excited 0^+ states.

The excited states of the odd-neutron nuclei $^{187-191}$Pt and $^{187-197}$Hg) where studied following the decays of $^{187-191}$Au, $^{187-197}$Tl; the odd-proton nuclei ^{185}Ir, $^{187-193}$Au, $^{191-197}$Tl were studied via the decays of ^{185}Pt, $^{187-193}$Hg and $^{191-197}$Pb. These nuclei lie in a region of transition between the spherical shell model and the Nilsson model and have been the center of considerable theoretical activity relating to intermediate coupling models, notably cluster-phonon coupling[6]), the triaxial rotor[7]) and the pseudo SU(3) coupling scheme[8]). Some of our results have already been reported[9]) in the light of these models.

Of particular note is the remarkable ability of the triaxial rotor model to give a simple unified description of collective modes of excitation built upon single-particle states with high-j. This has led us to propose the concept of <u>effective cores</u> for particle states and hole states in this region. In addition, we observe the $h_{9/2}$ and $i_{13/2}$ proton particle states to intrude across the Z = 82 closed shell to appear near the Fermi energy in the odd-mass Au and Tl nuclei. We believe this is due in part to the effect of residual quadrupole pairing. These ideas are outlined in more detail in contributions[10]) to this meeting and some of them are the subject of a forthcoming publication[11]). Quadrupole pairing has been argued[12]) to be important for explaining the occurrence of deformation in the neutron-deficient Hg nuclei.

Very recently the isotope ^{184}Tl was discovered at UNISOR and its decay to excited states in ^{184}Hg was studied in detail. The ^{184}Tl activity was produced in the reaction ^{180}W(^{14}N,10n), by bombardment of 93% enriched ^{180}W (natural abundance 0.135%) with 177 MeV $^{14}N^{5+}$ ions. Due to the high cost of the enriched target material, a special technique was developed whereby enriched $^{180}WO_3$ powder was sandwiched between graphite felt and reduced to a strongly bonded metallic layer on the graphite fibers using electron bombardment.

The isotope ^{184}Tl was observed as an 11 ± 1 sec activity decaying by both β^+- and α-branches and exhibiting evidence of a low-spin ground-state fed by isomeric decay. The half-life of the ground state is similar to that of the excited (high-spin) isomer. Very preliminary results of this experiment appear as a contribution[13]) to this meeting and we present here some important corrections.

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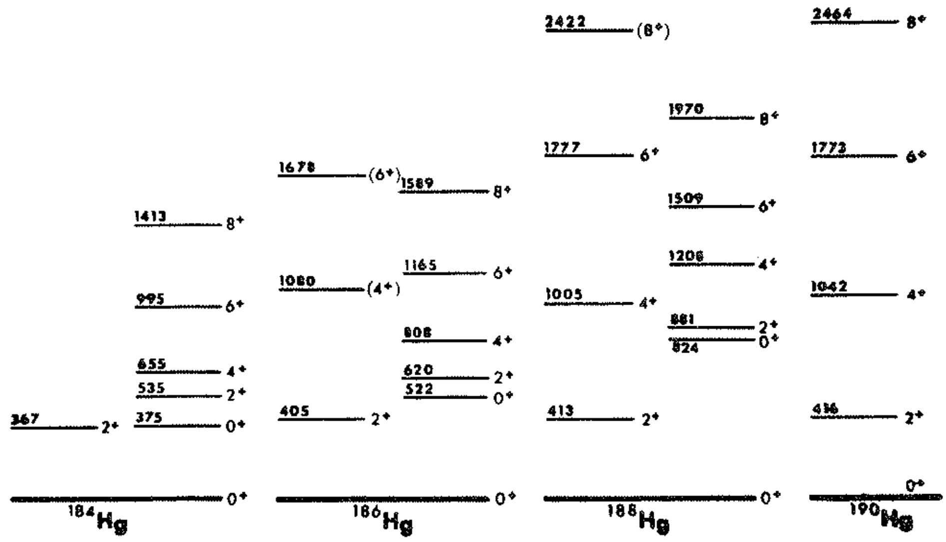

Fig. 1. Systematics of the light even-mass Hg isotopes showing the coexisting band structure.

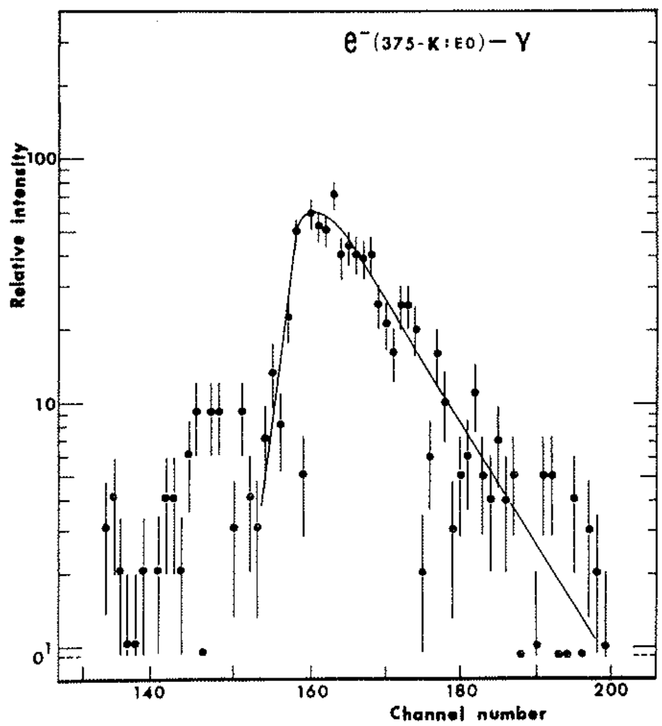

Fig. 2. Time spectrum showing the lifetime of the 375-keV, 0^+ level in ^{184}Hg.

The excited 0^+ state is established on the basis of a strong 375 keV, E0 transition. This 0^+ state is 8.5 keV above the 2^+ state at 366.7 keV. The second 2^+ state lies at 534.8 keV, and the second 4^+ state is placed at 1088.9 keV. Thus, two separate bands are established, closely analogous to the structures observed in $^{186,188}Hg$ (see Fig. 1), the deformed band showing a distorted rotational character, suggesting considerable band mixing. An e^--γ-delayed coincidence measurement shows the excited 0^+ state to have a half-life of 2.6 ± 0.7 ns (see Fig. 2). Dickmann and Dietrich[14]) predict this state to have a half-life of the order of 10 ns. Our results show that the deformed second minimum in $^{184,186,188}Hg$ is deep enough for the development of a rotational band.

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