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The observation of a strong E0 component in the $2_2^+ \rightarrow 2_1^+$ transition in ^{184}Hg from the β-decay of laser-ionized thallium isotopes: a strong signature for shape coexistence.

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The mass region of neutron-deficient mercury and lead isotopes near the midshell (N=104) is well known for the phenomenon of shape coexistence. In neutron-deficient even-even $^{180-188}$Hg isotopes, an oblate (β_2~ -0.15) ground state band is found to coexist with an excited prolate (β_2~0.25) band at low spin and low-excitation energies. This band is built on top of a deformed excited 0^+ state, which is interpreted as resulting from proton excitations across the Z=82 closed shell. Such *intruder* states have been found to be a widely occurring structural feature of nuclei at and near closed shell.
The low-lying coexisting states in ^{180,182,184}Hg have been studied at ISOLDE, CERN through the β^+/EC decay of ^{180,182,184}Tl as part of a systematic α, β, and β-delayed fission study of neutron-deficient thallium isotopes [1]. The β^+/EC decay is a very simple but still powerful tool which allows to effectively populate low-lying not-yrast states in the daughter nucleus, normally not easily accessible with other techniques, thus providing complementary information to the ones from in-beam γ-spectroscopy studies [2] and from α-decay studies from the Pb parent nuclei [3].

Mass-separated Tl beams, produced at ISOLDE, CERN, in the bombardment of ^{238}U by 1.4 GeV protons and selectively laser ionized, were implanted on a carbon foil mounted on a rotating wheel. The implantation foil was surrounded by two Si detectors for α, β and electron detection while γ rays were detected with two high-resolution single-crystal Ge detectors.
By means of unambiguously Si-γ and γγ coincidences, a detailed level scheme of the coexisting states in Hg has been built-up as well as a detailed description of their decay properties (γ intensities, E0 component of $2^+ \rightarrow 2^+$ transitions). The newly observed or better energy-determined 0_2^+, 2_2^+, 2_3^+ states in ^{180,182}Hg follow well the general trend of the prolate band. They confirm that the minimum of the parabolic behavior in excitation energy of the prolate band occurs in ^{182}Hg, as expected. The exceptionally large E0 component observed in the $2_2^+ \rightarrow 2_1^+$ transition in ^{184}Hg (23±5) confirm that the two states are strongly mixed and they have different deformation.

Isomerism is well-known in the heavier thallium isotopes and the population of low-spin states as well as high-spin states (up to 8^+ in ^{182,184}Hg) in the β-decay points to similar features in the lighter thallium isotopes.
Thanks to the laser selective ionization, the decay properties of the three isomeric states (2^-, 7^+, and 10^-) in ^{184}Tl have been singled out.

The knowledge on the decay properties of these nuclei has been largely improved by this study. The information gathered can be combined with the ones obtained with different techniques, such as in-beam γ and conversion-electron spectroscopy, Coulomb excitation on post-accelerated radioactive ions (recently performed at ISOLDE), lifetime measurements and laser spectroscopic studies to get a deeper knowledge of the shape-coexistence phenomenon.

[1] J. Elseviers et al., Phys. Rev. C 84, 034307 (2011)
[2] T. Grahn et al., Phys. Rev. C 80, 014324 (2009)
[3] J. Wauters et al., Phys. Rev. C50, 2768 (1994)