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Theoretical study of the ^{229m}Th isomer

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Abstract. Recent collective and microscopic models approaches in the study of the ^{229m}Th clock isomer will be reviewed. A basic consideration of these approaches is that being a member of the light actinive mass region the nucleus ^{229}Th exhibits pronounced reflection-asymmetric (octupole) shape properties which together with the underlying intrinsic structure determine the specific conditions for the isomer formation. It will be shown that the collective quadrupole-octupole core-plus-particle model approach explains the formation of the isomer as the result of a very fine interplay between collective axial quadrupole-octupole modes and single-particle motion which determines the energy and electromagnetic properties of the isomer [1,2,3]. Within a microscopic self-consistent Hartree-Fock plus BCS (HFBCS) approach with Skyrme effective interaction it will be shown that together with the pear-shape deformation the pairing interaction also plays a crucial role in the ^{229m}Th formation. It will be shown that by determining the pairing strength with respect to the moment of inertia characteristics of the nucleus one obtains the isomer energy in the range of few tens of keV [4]. Further decrease of the energy can be achieved through finer variation of the pairing constants. The latter brings the calculated ^{229m}Th energy into a sub keV range allowing for a consistent theoretical assessment of the isomer transition sensitivity to possible temporal variations of fundamental constants.

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