Deformation, Rotation-alignment and Band Structure of ^{197}Hg

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Introduction

^{198}Hg, ^{197}Hg and nearby isotopes are oblate deformed nuclei and show rotation-alignment because of the proximity of the $m = 1/2^+$ of $i_{13/2}$ neutron orbit to the neutron Fermi surface [1, 2]. In this contribution we have made theoretical study of the band structure of ^{197}Hg using deformed Hartree-Fock and angular momentum projection methods [3, 4].

Method

The model space consists of $2s_{1/2}$, $1d_{3/2}$, $1d_{5/2}$, $0g_{7/2}$, $1h_{11/2}$ and $1h_{9/2}$ orbits for protons and $p_{1/2}$, $p_{3/2}$,$f_{5/2}$,$f_{7/2}$, $h_{9/2}$ and $i_{13/2}$ orbits for neutrons with reasonable single-particle energies for this mass region and surface delta residual interaction. Both prolate and oblate solutions were obtained for ^{198}Hg and ^{197}Hg, the oblate shapes being lower in energy by about 5 MeV. In Fig. 1 we have sketched schematically the ordering of Hartree-Fock orbits neat the proton and neutron Fermi surfaces. Thus the lowest bands belong to the oblate shape. Among the bands of low energy are $K = 1/2^-$ (ground band), $K = 1/2^+$ excited band, $K = 1/2^+$ rotation-alignment band and $K = 9/2^+$ 3-quasiparticle band. The last named $K = 9/2^+$ band has the intrinsic configuration $(\nu 1/2^+ \pi(9/2^- - 1/2^- 4^+))$.

Results

These bands, obtained by angular momentum projection of the intrinsic states, are plotted in the Figure and compared with the experimentally known low-lying bands. The experimentally known bands are fairly well reproduced in our calculation. Also plotted in the figure is an excited $K = 1/2^-$ band. Some comments are in order about the $K = 1/2^+$ neutron rotation-aligned band. It shows prominent signature effect, the $J = 3/2^+, 7/2^+, 11/2^+, ...$ branch being systematically higher in energy. Among the $J = 1/2^+, 5/2^+, 9/2^+, ...$ branch the lowest state is $J = 13/2^+$. Experimentally $J = 13/2^+$ and higher J states are known and our calculation fairly well reproduces those (combining the spectra of the $K = 1/2^+$ and $K = 9/2^+$ bands).

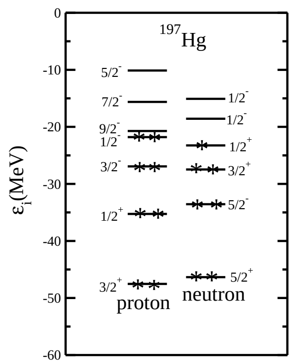

FIG. 1: Schematic diagram of orbits near proton and neutron Fermi surfaces of ^{197}Hg.

Electromagnetic transition matrix elements $(E2, M1)$ are evaluated in our calculation. These and the missing branches of the $K = 1/2^+$ band provide valuable clues for the future study of band structure of this nucleus. One expects a slow down of $E2(M1)$ transitions in the region of crossing of the $K = 1/2^+$ and $K = 9/2^+$ bands.

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TABLE I: Bands and Configuration of ^{197}Hg.

Band K^π	Quasi Particle	Configuration
$1/2^+$	1QP	$\nu 1/2^+$
$1/2^-$	1QP	$\nu 1/2^-$
$1/2^-$	1QP	$\nu 1/2^-$ (excited)
$9/2^+$	3QP	$\pi(9/2^- {-} 1/2^-)\nu 1/2^+$

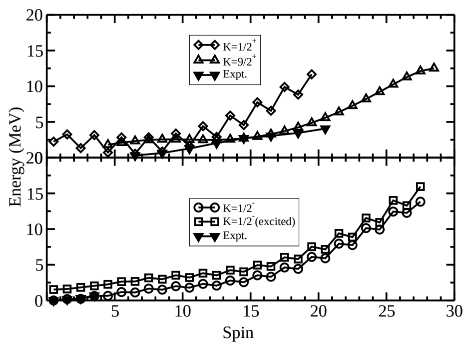

FIG. 2: The theoretical bands of ^{197}Hg are compared with the experimental [5] bands.

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