Total Routhian Surface calculation for ^{127}I

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Introduction

The *Total Routhian Surface* (TRS) calculation is a very useful and well known way to understand the rotational motion of the atomic nuclei theoretically. The evolution of the deformations during the process of nuclear rotation can be studied theoretically under the framework of TRS. The quadrupole and triaxial deformation play crucial roles in the rotational properties of nuclei. The TRS formalism was developed mainly based on the macroscopic-microscopic model [1].

One of the most interesting structural features observed in transitional iodine isotopes in A$\sim$120 mass region is shape co-existence. In $^{119-125}$I, both oblate (high -K) and prolate (low-K) band based on $h_{11/2}$ and $d_{5/2}$ proton orbitals have been reported [2]. These observations were also supported by theoretical Particle Rotor Model (PRM) [3, 4] and Total Routhian Surface (TRS) [5] calculations.

The aim of the present work is to study the positive parity yrast rotational structure of ^{127}I in terms of deformation, under the framework of macroscopic-microscopic model.

Results and Discussion

The iodine isotopes are predicted to be γ-soft due to the interplay of the two opposite shape driving forces. The proton Fermi surface of these nuclei lie in the prolate-driving lower part of the $h_{11/2}$ sub-shell, whereas, the neutron Fermi surface lie in the oblate-driving upper part of the $h_{11/2}$ sub-shell. As a result, the triaxial parameter (γ) varies drastically with angular frequency.

The TRS calculation has been carried out for the positive parity states in ^{127}I with standard parameterization. At low frequency ($\hbar\omega$ = 150 keV), a broad minima has been found with $\beta_2 \sim 0.11$ and $\gamma \sim 40°$ as shown in figure 1.

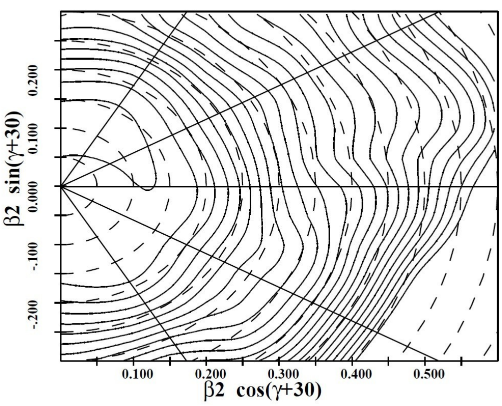

FIG. 1: TRS calculations for the positive parity states in ^{127}I at $\hbar\omega$=150 keV.

As rotational frequency increases to $\hbar\omega$ = 250 keV, the potential minima starts to take a shape near $\gamma \sim$ -38° (figure 2) with $\beta_2 \sim$ 0.09. It indicates a collective triaxial shape at that frequency (according to Lund convention [7]). Particle Rotor Model calculation also predicts such oblate deformed band structure in ^{127}I, based on $\pi d_{5/2}$ [402] $\frac{5}{2}$, $\pi g_{7/2}$ [404] $\frac{7}{2}$ configuration [4]. Similar oblate deformed band structure associated with $\pi d_{5/2}$ and $\pi g_{7/2}$ orbitals have also been predicted under the framework of PRM in $^{121-125}$I [3]. Such oblate band structures have also been

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observed experimentally in $^{121-127}$I [8–10].

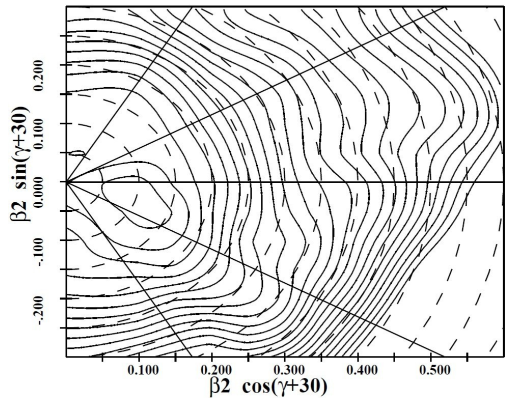

FIG. 2: TRS calculations for the positive parity states in ^{127}I at $\hbar\omega$=250 keV.

Interestingly, at high rotational frequency ($\hbar\omega$ = 550 keV) the TRS calculation indicates a second minimum at $\gamma \sim 11^\circ$ with $\beta_2 \sim 0.29$, along with the primary minimum at $\gamma \sim$ -36° and $\beta_2 \sim 0.095$. It indicates

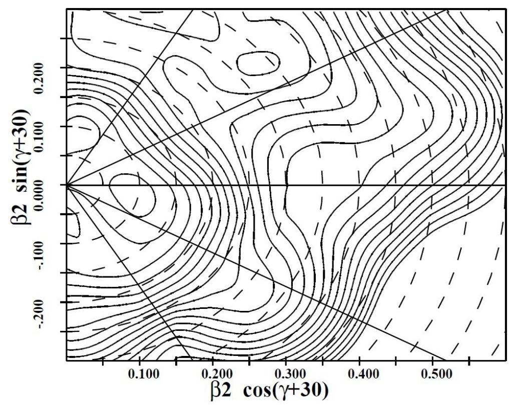

FIG. 3: TRS calculations for the positive parity states in ^{127}I at $\hbar\omega$=550 keV.

the possibility of co-existence of collective prolate and collective oblate shape at $\hbar\omega \sim 550$ keV. Experimentally, in ^{127}I, several multi-quasiparticle states have been reported [8], decaying to yrast ($\pi g_{7/2}/d_{5/2}$) band. In the previous studies on $^{123-127}$I [8–10], the authors reported two three-quasiparticle bands associated with $\pi g_{7/2}\otimes(\nu h_{11/2})^2$ configuration with different γ-deformation. Further, theoretical configuration-constrained TRS calculation is underway for deeper understanding on the structure of these bands.

Conclusion

The present study gives an overview on the variation of the quadrupole and triaxial deformation parameter (β_2 and γ) as a function of angular frequency under the framework of theoretical Total Routhian Surface (TRS) calculation in ^{127}I. This calculation also indicates a shape coexistence at higher frequency.

Acknowledgment

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