

## Microscopic band-mixing calculations in $^{154,156}\text{Gd}$

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**Abstract.** A many-body microscopic band-mixing formulation of variation after projection of angular momentum and conservation of nucleon number is used to study the yrast band and first excited  $K^\pi = 0^+$  band in the doubly even nuclei  $^{154,156}\text{Gd}$ . The computed energy spectra and the interband and intra-band B(E2) values are in good agreement with corresponding experimental data. Connection with the phenomenological model of Stephens and Simon is discussed, bringing out the role played by the  $i_{13/2}$  neutron pair in the microscopic formalism.

**Keywords.** Nuclear structure;  $^{154,156}\text{Gd}$ ; yrast band; first excited band; energy spectra; interband and intraband B(E2) values; band-mixing; angular momentum projection; conservation of nucleon number.

### 1. Introduction

The backbending phenomenon exhibited by many rare-earth nuclei has been a topic of interest for nuclear physicists in recent years. The phenomenological rotation alignment (RAL) model of Stephens and Simon (1972) explains the backbending in terms of band-crossing, where a band built on a decoupled  $o_{i_{13/2}}$  neutron pair crosses the ground band and backbending of the yrast band takes place. The anomalous backbending phenomenon is attributed by Mottelson and Valatin (1960) to the vanishing of the pairing correlations due to Coriolis force. There are theoretical approaches (Kumar 1972; Banerjee *et al* 1973; Nair and Ansari 1973; Krumlinde and Szymanski 1974) based essentially on the approximate angular momentum projection which qualitatively explain the phenomenon. The microscopic analysis of the processes responsible for backbending is of added importance because of the observations that not only the yrast band but also the yrare band in some nuclei exhibits backbending. The variational method with angular momentum projection has been successfully used to study the yrast states of a few rare-earth nuclei (Faessler *et al* 1974; Warke and Gunye 1975, 1976). In addition to angular momentum projection there is yet another complication due to number projection (Grummer *et al* 1975; Gunye and Warke 1979) from the pair-correlated state. It is found (Gunye and Warke 1979) that the number conservation in each angular momentum state is essential for a good agreement between theoretical and experimental results.

In this paper, we report the results of our study of  $^{154,156}\text{Gd}$  using the variation after projection (VAP) method. The nuclei are chosen with a view to understand the role played by  $i_{13/2}$  neutron-pair in the rare-earth region. We have, in addition, incorporated a band-mixing formulation to obtain the energy spectra of the two