

Observation of high-spin rotational bands in ^{123}I

Purnima Singh^{1,*}, A. K. Singh¹, A. N. Wilson², J. Rogers², H. Hübel³, A. Bürger³, S. Chmel³, G. Sletten⁴, B. Herskind⁴, B. M. Nyakó⁵, J. Timár⁵, A. Korichi⁶, Hoa Ha⁶, P. Fallon⁷, A. Macchiavelli⁷, T. Lauritsen⁸, T. L. Khoo⁸, M. Carpenter⁸, F. Kondev⁸, S. Zhu⁸, K. Juhász⁹, and I. Ragnarsson⁹

¹Department of Physics & Meteorology,

Indian Institute of Technology Kharagpur, IN-721302, India

²R.S.P.S.E, A.N.U., Canberra, ACT 0200 Australia

³H.I.S.K.P, Universität Bonn, Nussallee 14-16, D-53115 Bonn, Germany

⁴Niels Bohr Institute, Blegdamsvej 17, DK-2100 Copenhagen, Denmark

⁵Institute of Nuclear Research of the Hungarian Academy of Sciences, H-4001 Debrecen, Hungary

⁶C.S.N.S.M Orsay, France

⁷Lawrence Berkeley National Laboratory, Berkely, California 94720, USA

⁸Argonne National Laboratory, Argonne, IL 60439, USA

⁹University of Debrecen, H-4000, Hungary and

⁹Dept. of Mathematical Physics, Lund Institute of Technology, S-221-Lund, Sweden

Introduction

In recent years several high-spin deformed rotational bands ($\varepsilon_2 \sim 0.35$) have been observed in the spectroscopic studies of mass $A \sim 125$ nuclei [1–4]. It was proposed that these bands involve one or two neutrons in $i_{13/2}$ intruder orbitals. In ^{125}I a well connected high-spin band extending upto $95/2\hbar$ has been reported [4]. This band was identified to be 'identical' to one of the bands in ^{126}Xe . CNS calculations for the two bands suggest that they involve both $\nu i_{13/2}$ as well as $\pi g_{9/2}$ orbitals [4]. These two orbitals are known to stabilize highly-deformed shapes in mass $A \approx 110$ as well as mass $A \approx 130$ region. A subsequent observation of high-spin states in other nuclei of this mass region can provide a complete description of the role of these deformation driving orbitals in stabilizing deformed nuclear shapes. In the present work, we document the results of an in-beam study of high-spin states in ^{123}I obtained with the Gammasphere spectrometer. New data have uncovered three high-spin rotational like sequences in ^{123}I . The behavior of these bands have been compared with the rotational bands

observed recently in the neighboring isotope ^{125}Xe [3] and ^{125}I [4].

Experimental Details

High-spin states in ^{123}I were populated using the reaction $^{80}\text{Se}(^{48}\text{Ca}, p4n)^{123}\text{I}$. The ^{48}Ca beam with an energy of 207 MeV and an intensity of 4 pnA was provided by the ATLAS accelerator at Argonne National Laboratory. The target consisted of a 0.6 mg/cm², ^{80}Se layer evaporated on a 0.3 mg/cm² Au backing. The γ -ray coincidence events were measured with the Gammasphere spectrometer array. In a beam time of 10 days, a total of 2.7×10^9 events, with a Ge detector coincidence fold of ≥ 4 were obtained. For the off-line analysis, the coincident events were sorted into γ^2 -matrices, γ^3 -cubes and γ^4 -hypercubes. The γ -ray spectroscopy software package RADWARE was used extensively for the data analysis.

Results and Discussion

Previous experimental work on ^{123}I has established both positive and negative parity bands upto a spin of $30\hbar$ [5]. A search for rotational bands with high moment-of-inertia values was undertaken and three such rotational-like sequences were observed in the present work for the first time. The maximum

*Electronic address: psingh@phy.iitkgp.ernet.in

intensities of these bands were estimated to be $\sim 1\%$ of the channel strength, this weakness precludes the firm establishment of linking transitions into the known ^{123}I levels.

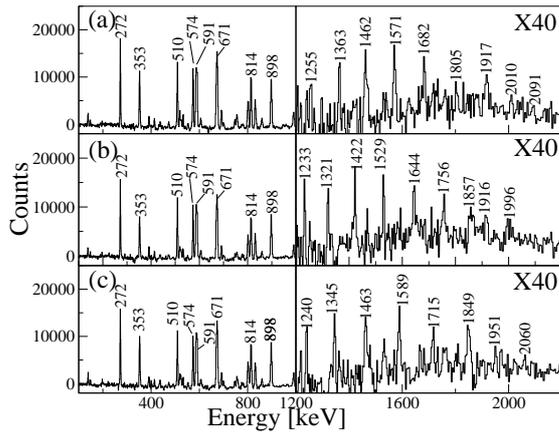


FIG. 1: Triple-gated, background-subtracted, γ -ray coincidence spectrum showing transitions of band a (upper panel), band b (middle panel), and band c (lower panel). The photopeaks labeled in (a), (b) and (c) correspond to the low-lying yrast states of ^{123}I . The spectrum has been magnified by a factor of 40 above 1200 keV to highlight the weak high-energy gammas.

A triple-gated γ -ray coincidence spectrum for the observed bands is presented in Fig 1. Although no linking transitions between the new bands and the normal-deformed, low-spin states could be established, yrast transitions of ^{123}I upto spin $30\hbar$ are visible which strongly support that these bands are associated with ^{123}I .

The dynamic moment of inertia $J^{(2)}$, of the bands has been calculated under the assumption that the in-band transitions are of stretched E2 character. These quantities are plotted as a function of rotational frequency $\hbar\omega$ in Fig. 2. For comparison the high-spin rotational bands L4 and L5 of ^{125}Xe [3] and band 6 of ^{125}I [4] are also plotted. In general, the $J^{(2)}$ values of bands in ^{123}I are comparable with those of its neighboring nuclei, suggesting a similar deformation. We note that the dynamic moment of inertia of all the bands in ^{123}I decreases with increasing frequency up

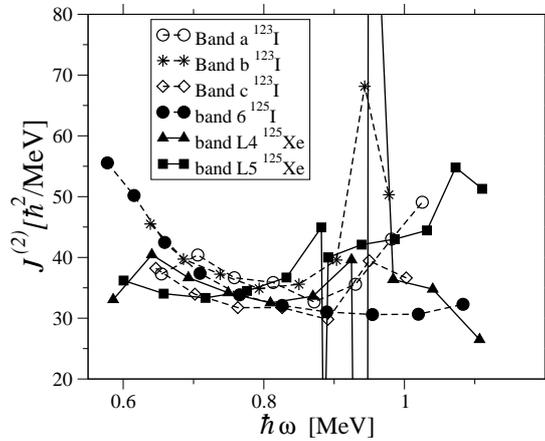


FIG. 2: Dynamic moments of inertia $J^{(2)}$ as a function of rotational frequency for newly observed band of ^{123}I , band L4 and L5 of ^{125}Xe [3] and band 6 of ^{125}I [4].

to $\hbar\omega \sim 0.9$ MeV. Band b shows a sudden jump at $\hbar\omega \sim 0.95$ MeV which might indicate a band crossing. Similar trend has been observed in bands L4 and L5 of ^{125}Xe .

Detailed theoretical calculations to assign possible configurations to these bands is in progress.

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