Study of evolution of energetically favored collectivity and hindered isomeric states in the $A \approx 90$ region

Thesis submitted in partial fulfillment
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in
PHYSICS

by

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Under the supervision of

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I would like to dedicate this thesis to my loving parents, my supportive husband and amazing friends, whose support and motivation kept me going through the tough times.

Certificate

It is certified that the work contained in the thesis titled ***"Study of evolution of energetically favored collectivity and hindered isomeric states in the $A \approx 90$ region"*** by ***Ms. Nidhi Goel***, Roll Number **18171505**, has been carried out under my supervision, and this work has not been submitted elsewhere for a degree.

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I, **Nidhi Goel**, certify that the work embodied in this thesis is my own bona-fide work and carried out by me under the supervision of **Dr. Somnath Nag** from January 2019 to December 2024 at the **Department of Physics**, Indian Institute of Technology (BHU), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers whenever and wherever their works have been cited in my work in this thesis. I further declare that I have not wilfully copied any others' work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

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—

Nidhi Goel

List of Acronyms

Acronym	Full form
ADC	Analog to Digital Converter
ACQ	Acquisition
BGO	Bismuth Germanate
CFD	Constant Fraction Discriminator
CNS	Cranked Nilsson Strutinsky
CU	Coincidence Unit
DCO	Directional Correlation
DDAQ	Digital Data Acquisition
FADC	Flash Analog to Digital Converter
FET	Field Effect Transistor
FIFO	Fast-In Fast-Out
FWHM	Full Width at Half Maximum
HPGe	High-Purity Germanium
INGA	Indian National Gamma Array
IPDCO	Integrated Polarization-Directional Correlation
LD	Liquid Drop
LDM	Liquid Drop Model
LSD	Lublin-Strasbourg Drop
LVDS	Low Voltage Differential Signalling
MARCOS	Multi Parameter Time-Stamp-Based Coincidence Search Program
PDCO	Polarization-Directional Correlation
PES	Potential Energy Surface
PT	Peak to Total
RLD	Rotating Liquid Drop
TFA	Timing Filtering Amplifier
TIFR	Tata Institute of Fundamental Research

List of Symbols

Symbols	Definition (unit)
A	Mass number
α	Signature quantum number
β	Axial deformation parameter
Δ	Pairing gap energy
Δ_{asym}	Polarization asymmetry parameter
ε_2	Quadrupole deformation parameter
e_i	Single-particle energy in MeV
E	Energy in proper units
$E2$	Electric quadrupole transition
γ	Triaxiality deformation parameter
$\hbar$	Reduced Plank constant (m^2kg/s)
$\mathscr{H}$	Hamiltonian
I	Total angular momentum of the nucleus
i_x	Aligned angular momentum in units of $\hbar$
j	Total angular momentum of nucleons; $j = l + s$
j_x	Projection of total angular momentum of on x axis
J	Moment of inertia of the system
J_{rig}	Rigid body moment of inertia
$J^{(1)}$	Kinematic moment of inertia of the system $(\hbar/MeV)$
$J^{(2)}$	Dynamic moment of inertia of the system $(\hbar^2/MeV)$
l	Orbital angular momentum
λ	Multipole mode
Λ	Projection of orbital quantum number along the symmetry axis
m/M	Mass
μ	Reduced mass
m_o	Rest mass of the electron
$M1$	Magnetic dipole transition

Symbols	Definition (unit)
N	Neutron number
N_q	Principal quantum number
ω	angular frequency
Ω	The projection of angular momentum along the symmetry axis
R	Radius in appropriate units
R_θ	Angular distribution ratio
s	Spin angular momentum
$\sum$	Projection of spin quantum number along the symmetry axis
θ	Angle
V	Potential in appropriate units
$Y_{20}(\theta,\phi)$	Spehrical polar harmonics
Z	Proton number

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