SHELL STRUCTURE AND EVOLUTION OF COLLECTIVITY ON AND AWAY FROM THE STABILITY LINE

THESIS SUBMITTED FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY (SCIENCE) IN PHYSICS

BY

RITESH KSHETRI

UNIVERSITY OF CALCUTTA

KOLKATA

2008

Contents

Preface **1**

List of Publications **3**

Acknowledgements **9**

1 Introduction **13**

2 Characterisation of Compton suppressed Clover detector for high energy ($\leq$ 11 MeV) gamma-rays **16**

2.1 **Introduction** 16

2.1.1 Interaction of gamma-rays with matter 16

2.1.2 Gamma-ray spectrometer 20

2.1.3 Present study 27

2.2 **Experimental details** 29

2.3 **Results** 32

2.3.1 Comparison with previous study 35

2.3.2 Gain matching 36

2.3.3 Relative full energy peak efficiency 38

2.3.4 Addback factor 38

2.3.5 Hit pattern distribution 40

2.3.6 Energy resolution 43

2.3.7 Effects of pair production 44

2.4 **Discussion** 47

3 High spin structure of ^{35}Cl and the $sd - fp$ shell gap **48**

3.1 **Introduction** 48

3.2 **Experimental details** 51

3.3 **Experimental methods and data analysis** . . . 56
3.3.1 Calibration of detectors . . . 57
3.3.2 Placement of new transitions in the level scheme . . . 59
3.3.3 Spin and parity measurements . . . 59
3.3.4 Lifetime measurements . . . 66
3.4 **Experimental results** . . . 73
3.4.1 Level scheme . . . 73
3.4.2 Lifetime measurement . . . 83
3.5 **Theoretical interpretation using Shell Model** . . . 87
3.6 **Discussion** . . . 94

4 Study of neutron-rich nuclei in ^{132}Sn region **95**
4.1 **Introduction** . . . 95
4.2 **Experimental study using ^{252}Cf source** . . . 96
4.2.1 Experimental details . . . 97
4.2.2 Results . . . 97
4.3 **Theoretical study using the Particle Rotor Model** . . . 102
4.3.1 Motivations for study . . . 102
4.3.2 The model . . . 104
4.3.3 Results . . . 109
4.4 **Discussion** . . . 123

5 Summary and Conclusion **124**

A Typical electronics setup for a Clover array **127**

B Nuclear Shell Model - a short overview **131**

Bibliography **134**