Preface

The nucleus of an atom has been discovered in 1911 by Ernest Rutherford. Its very existence has provided a clue to the unravelling of the structure of atoms, a development that was rapidly leading to the establishment of quantal mechanics, but the internal structure of the nucleus remained unexplored. However, the variety of radiations emitting from the radioactive substances had given the first indication of the richness of the nuclear phenomena. The distinction between the α-, β- and γ-rays established by early pioneers was gradually to be recognised as a manifestation of the hierarchy of the strong, weak and electromagnetic interactions. The complete understanding of the nuclear structure has been part of the broad development of quantal concepts appropriate to the description of systems with many degrees of freedom.

When the nuclei absorb excitation energy and angular momentum, they become excited and some changes in their intrinsic structure can occur. An excited nuclear state has particular properties (such as energy, angular momentum etc.), which can be experimentally measured and thus it becomes possible to deduce the changes in the nuclear structure. The excited states usually live for a short time (typically in the pico second (ps) range) and decay most often by emitting γ-rays. These γ-rays carry information about the nuclear transition from the initial to the final level only, such as what amount of energy, angular momentum, parity etc. is taken away. Thus in order to deduce the absolute values of the excitation energy, angular momentum etc. of the initial level, we need to know the absolute values for these quantities for the final levels. In studying excited states of nuclei, the primary observables are the excitation energy, spin, and parity of the states.

Due to the unprecedented advancement of experimental techniques and facilities, it is now possible to create nuclei under extreme conditions of iso-spin and angular momentum. These new experimental information have opened up not only the opportunity to test the applicability of various models for nuclei under extreme conditions but have also become very useful for applications in astrophysics scenario. Nuclei close to the shell closures, with a few valence particles are always interesting, for they furnish data useful in constructing empirical shell model Hamiltonian consisting of single-particle energies (SPEs) of the valance orbitals and the residual nucleon-nucleon interaction matrix elements. Also the investigation on the high-spin structure of nuclei in and around proton shell closures has a great impact on testing and improving the quantitative shell model description. The observed level structure allows extracting important input parameters for shell model calculations. In this context, nuclei at shell closures and the ones near to the proton shell closures are most appropriate for such attempts. In view of this, the present work was motivated to investigate the level structure of nuclei in the vicinity of proton shell closures. In particular we have chosen to investigate the high-spin states of difficult to access odd-odd nuclei around the Z ~ 20, 28 proton shell closures and expected triaxial nuclear deformation for low-spin states in the vicinity of Z ~ 82 proton shell closure.

The present thesis aims to study the nuclear structure of some nuclei in the vicinity of proton shell closures. Multi-clover arrays such as INGA (Indian National Gamma Array) at VECC (Variable Energy Cyclotron Centre, Kolkata, India) and AFRODITE (AFRican Omnipurpose Detector for Innovative Experiments) at iThemba LABS, (Cape Town, South Africa) were used in the present work. The high spin states in the nuclei such as odd-odd ^{36}Cl, ^{54}Mn and odd-even nuclei ^{195}Tl have been studied extensively. Many new levels have been found in these nuclei. Their multipolarity has been determined through DCO, IPDCO calculations, and also relative intensities have been calculated. The experimental results were interpreted with the help of shell model for both ^{36}Cl, and ^{54}Mn.

This thesis is divided into seven chapters; chapter 1 provides a brief overview of the basic nuclear properties, various types of nuclear reaction mechanism and motivation behind the work. Chapter 2 describes the nuclear structural properties and theoretical models associated with the work presented in the thesis. Chapter 3 describes the present Compton suppressed multi-Clover arrays like INGA (Indian National Gamma Array) & AFRODITE (AFRican Omnipurpose Detector for Innovative Techniques and Experiments), used in modern γ-ray spectroscopic measurements. The electronics and data acquisition systems are also outlined in this chapter. Chapter 4 brings in the procedures adopted for the analysis of the coincidence data sets. This chapter also introduces the use of Clover detectors as a Compton polarimeter. Chapter 5 describes the experimental results on the level structures of odd-odd around the Z ~ 20, 28 proton shell closures. Emphasising on the level structures of ^{36}Cl and ^{54}Mn produced in the reactions ^{20}Ne+^{27}Al and ^{20}Ne + ^{51}V. Chapter 6 discusses the structure of ^{195}Tl nuclei which falls around the Z ~ 82 proton shell closure. Its high spin states apart from the known superdeformed bands will be discussed in detail. Chapter 7, we present the summary and conclusions of the thesis work done.