CHAPTER VI

SUMMARY AND CONCLUSIONS

The medium mass region provides a rich ground of testing the understanding of collective nuclear structure of doubly even nuclei. The collective nuclear structures of these nuclei have been analyzed, using empirical studies, phenomenological, geometrical, group theoretical models.

The values of asymmetry parameter (γ_0) of asymmetric rotor model are calculated using the experimental energies of $E2_2^+$ and $E2_1^+$ states for $50 \le Z \le 82$ and $82 \le N \le 126$ region. The whole calculated data is divided into four quadrants. The systematic dependence of γ_0 on N, N_B and NpNn has been carried out on *quadrant wise basis* to find out the role of valence nucleons and holes on nuclear structure. The role of Z=64 subshell effect for $N \le 90$ region is discussed. In quadrant-I and quadrant-II, the γ_0 decreases; from 30^0 in Q-I and from 22^0 in Q-II to 9^0- 10^0; with increasing N from 82 to 104 (i.e. the mid of N=82 to 126 neutron shell), signifying that the nuclear deformation (β) is increasing, while the energy ratio R_4 increases from 2 (for harmonic vibrators or SU(5) type nuclei) to 3.33 (for good rotors or SU(3) type nuclei). This indicates that in this region the nuclear structure depends much more on Z. Asymmetry parameter shows the shape phase transition at N=88-90 in Q-I. In Q-II and Q-III; γ_0 has a systematic dependence with N, but with different patterns. In quadrant-I, the γ_0 is having more correlated dependence on N, rather than on NpNn. Also in quadrant- I, the Z=64 sub-shell effect for $N \le 90$ nuclei affect the variation of γ_0 with N and NpNn product. The existence of X(5) symmetry in N=90 isotones established in recent works supports the formation of isotonic multiplets in this work. The calculated values of γ_0 are almost constant for N=90 isotones e.g. 13.8^0 for Nd, 13.24^0 for Sm and 13.86^0 for Gd; which supports the constant nuclear structure findings for N=90 isotones. The present work confirms the existence of isotonic multiplets in quadrant-I as reported earlier. In quadrant-III, the variation of γ_0 is different from quadrant I and II because the γ_0 increases sharply from 9^0 - 10^0 to 30^0 with increasing N from 104 to 126. This is signifying that the nuclear deformation (β) is decreasing and the nuclear structure changes from pure rotor SU(3) type to vibrational SU(5) or γ-unstable O(6) type. Further, the asymmetry parameter for different elements has smooth curve with NpNn with almost same slopes except for Hg isotopes.

The predictions of asymmetric rotor model for B(E2;4g→2g)/B(E2;2g→0g) ratio are compared with the experimental data. It is also noted that this B(E2) ratio is anomalously small in case of two non- magic nuclei i.e., $^{198}_{80}Hg_{118}$ and $^{144}_{60}Nd_{84}$ with only two vacancy of protons for Z =82 and two valence neutrons outside N=82, respectively. The data points for other nuclei are lying between SU(5) and SU(3) limits. The calculated B(E2) ratios of ARM are very close to the SU(3) limit of IBM indicating that it can explain the structure of only well deformed nuclei. Therefore the ARM is partially successful in explaining this branching ratio. The variation of experimental B(E2; 4g→2g)/ B(E2;2g→0g) branching ratio with N and Z is carried out for Nd–Hg nuclei. It is found that there is shape phase transition for N=88 and 90 isotones (Nd, Sm, Gd, Er) from an ideal spherical harmonic vibrator or SU(5) to an axially symmetric deformed rotor or SU(3). The present study supports the subshell closer effect around Z=64, for N≤ 90 and the constant nuclear structure of N=90 isotones.

The interacting Boson Model-1 is used to study the nuclear structure of ^{152}Sm (a best example of X(5) symmetry) and ^{154}Sm (a best example of SU(3) symmetry). The level structure of ^{152,154}Sm is well reproduced and is in agreement with the experiment. The B(E2) branching values and B(E2) branching ratios are calculated for inter-band and intra-band transitions for g-, β-, γ- and β_2- bands and the calculated results are in good agreement with experimental data. Present calculation supports that ^{152}Sm is as a best example of X(5) symmetry and ^{154}Sm is a SU(3) type in nature.