Study of Nuclear Structure of Even Z Even N Nuclei in the Medium Mass Region of Nuclear Chart

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The present thesis is a theoretical study to understand the properties of nuclear structure of Even Z even N nuclei in medium mass region. The nuclear structure of the nuclei varies both sides of the closed shell with neutron number, atomic number, boson number, product NpNn, P-factor and energy ratio R_4[1]. Nuclear Structure is studied with various theoretical models and compare with experimental data.

In chapter I, the basics of nuclear structure physics including magic number, shell model (independent particle model, square well potential, harmonic oscillator and spin orbit interaction) and collective models are discussed. The Nilsson Model, Rigid Tri-axial Rotor model, BCS theory, DPPQ model and Interacting Boson Model are also briefly discussed.

In chapter II, The ground band is studied using power law with and without average parameters method. Gupta et al. (1995) [2] proposed an empirical relation and studied systematics of Power Law. Here this idea is extended and energy is calculated with both methods. The RMSD values of power law with average parameters method (PL1) are less than power law without average parameters method (PL2). In PL1 method, the RMSD values for most of the nuclei are lie below 100 KeV. The plot of energy ratio R_I of experimental, Bohr-Mottelson, Ejiri, Soft Rotor Formula and Power Law with R_4 is showing a correlation as observed by Mallmann (1959) [3]. The power law energy ratio curve is in good agreement up to R_4 =2.9. The systematics of scaling coefficient and power index is studied with neutron number, atomic number, product NpNn and P factor. The plot of scaling coefficient (a_{AV}) with asymmetric parameter (γ) and power index (b_{AV}) with quadrupole deformation parameter (β) versus neutron number N is studied and shows good agreement in quadrant wise plots as suggested by Gupta et al. (1990) [4] and slow change in power index with spin is studied in [5]. The moment of inertia from experimental rotor model, Soft Rotor Model and inverse of scaling coefficient shows same variation with neutron number N for medium mass nuclei.

In chapter III, The level energies of γ-band for the medium mass nuclei are studied. Recently, Bihari et al. (2008) [6] calculated negative moment of inertia using Soft Rotor formula of Gupta (1971) and Brentano et al. (2004) [7]. The negative moment of inertia does not give clear information about the nuclear structure of the nuclei. Here the level energies of γ-band are reproduced using Soft Rotor formula by subtracting band head difference ($E2\gamma$) with even spin input I=2, 4 and 6 and with odd spin I= 3, 5 and 7. Both the approaches reproduced nearly the same theoretical energies, moment of inertia and softness parameter. The moment of inertia and softness parameter reproduced positive using SRF with even and odd spin input separately with present method in Gupta et al. (2013) [8]. The level energies of γ-band is also calculated using even spin I=2, 4 and 6 in Power Law of Gupta et al (1995) [2] which are in good agreement with presently SRF theoretical reproduced level energies. The inverse of scaling coefficient of Power Law is comparable to the moment of inertia of SRF and rotor model. The RMSD of theoretically recalculated level energies in both methods are less in comparison to the calculation given in ref. [6], except N=88. The moment of inertia of γ-band is studied with moment of inertia of ground band. The γ-band of the some nuclei is more deformed than their ground band for a nuclei having moment of inertia of γ-band is more than the moment of inertia of ground band and supporting Marriscotti et al (1959) [9].

In chapter IV, the β-band is studied. In last fifteen years, it is a topic of great controversy that β-band head is not lie on ground band but lie on γ- band may be as γγ character by various workers. Here the β-band is studied and correlated with ground band. The level energies of β-band are calculated using Power law and SRF. The RMSD value from both methods is less than 100 keV. The separation ($E2_\beta$-$E0_\beta$) of β-band is comparable to the $E(2_g)$ of ground band. The energy ratio R_4 of β-band is studied with energy ratio R_4 of ground band. Most of nuclei lie on or near the diagonal [10]. The systematics of rotation vibration interaction coefficient, energy ratio R_4 of ground band and ratio of energy of β-band head to the energy of ground band $E(2_g)$ are studied [11]. The energy ratio R_I of experimental energies, Bohr- Mottelson [1], Ejiri, SRF [7] and Power Law[2] are studied with R_4 and shows similarity of ground band plot and with Mallmann (1959) [3]. The moment of inertia, softness parameter, energy ratios of both bands are in good correlation. The power index and scaling coefficient of β-band is studied with spin which is correlated with ground band.

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