g-Factor in High Spin States of ^{86}Zr

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The studies of mass-80 nuclei have shown many interesting features which include shape co-existence, structural softness, strong dependence on spin and particle numbers, magnetic rotation, quasi-particle alignment (QPA) in the $0g_{9/2}$ state [1] and important implications in rp-process [2]. Since last two decades, in this region Zr isotopes have been investigated at high spins with variety of theoretical and experimental techniques. The g-factors of the rotational states along the positive parity yrast band in ^{80,82,84}Zr were measured up to a spin J = 16$\hbar$ by a transient magnetic field-ion implanted perturbed angular distribution method and calculated by a cranking shell model [3]. Later on g-factor measurements of rotational states in ^{84,86}Zr has been reported by Zhu et al. [4] and structure of the transitional nucleus ^{85}Zr has been investigated through spectroscopy and lifetime measurements by Tandel et al. [5]. We have carried out study of g-factor for high spin states ^{86}Zr within the framework of cranked Hartree-Fock-Bogoliubov (CHFB) using the pairing + quadrupole + hexadecapole model interaction Hamiltonian [6–8].

We employ a quadrupole-plus-hexadecapole-plus-pairing model interaction hamiltonian,

$$H = H_0 - \frac{1}{2}\sum_{\lambda=2,4}\chi_\lambda \sum_\mu \hat{Q}_{\lambda\mu}(-1)^\mu \hat{Q}_{\lambda-\mu} - \frac{1}{4}\sum_{\tau=p,n} G_\tau \hat{P}^\dagger_\tau \hat{P}_\tau \ , \quad (1)$$

where, H_0 stands for the one-body spherical part, χ_λ term represents the quadrupole and hexadecapole parts with λ = 2, 4 and the G_τ term represents the proton and neutron monopole pairing interaction. Explicitly we have

$$\hat{Q}_{\lambda\mu} = (\frac{r^2}{b^2})Y_{\lambda\mu}(\theta,\phi)\,, \quad (2)$$

$$\hat{P}^\dagger_\tau = \sum_{\alpha_\tau,\bar{\alpha_\tau}} c^\dagger_{\alpha_\tau} c^\dagger_{\bar{\alpha_\tau}}\ . \quad (3)$$

In the above $c^\dagger$ are the creation operators with $\alpha \equiv (n_\alpha l_\alpha j_\alpha m_\alpha)$ as the spherical basis states quantum numbers with $\bar{\alpha}$ denoting the conjugate time-reversed orbital. The standard mean field CHFB equations are solved self-consistently for the quadrupole, hexadecapole and pairing gap parameters. The deformation parameters, and pairing gaps are defined in terms of the following expectation values:

$$D_{2\mu} = \chi_2 < \hat{Q}_{2\mu} >,\ D_{4\mu} = \chi_4 < \hat{Q}_{4\mu} > \quad (4)$$

$$\hbar\omega\beta\cos\gamma = D_{20}\ ,\hbar\omega\beta\sin\gamma = \sqrt{2}D_{22}\ ,\hbar\omega\beta_{40} = D_{40}\ ,$$

$$\Delta_\tau = \frac{1}{2}G_\tau < \hat{P}_\tau > \ . \quad (5)$$

The oscillator frequency $\hbar\omega = 41.0A^{-1/3}$ (MeV), and β, γ and β_{40} are the usual deformation parameters, while Δ_p and Δ_n are the pairing gap parameters for protons and neutrons, respectively.

The study of g-factor has been used in different mass region to examine structure of not only ground state but also excited states up to very high-spin. Importantly, variation of g-factors with spin can lead by neutron and/or proton alignments which is significant feature around A = 80 region. With this in view, we have shown comparison of calculated g-factor

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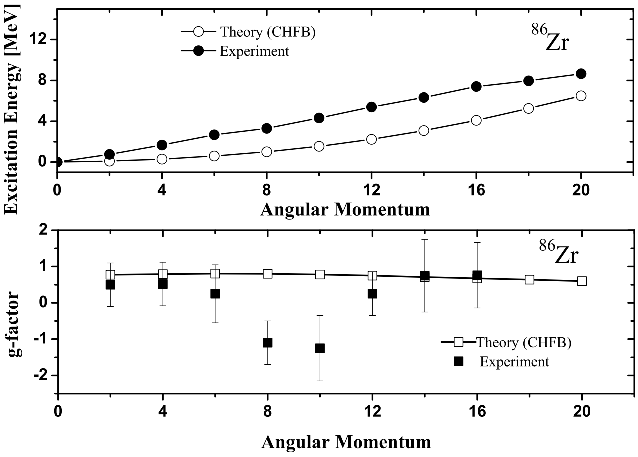

FIG. 1: Theoretical (g-factor) gyromagnetic factors in lower panel and Excitation Energy in upper panel are compared with experimental values for ^{86}Zr [4, 9].

and experimental g-factor values [4] as a function of spin in the lower panel of Fig. 1. It is important to note from the lower panel of Fig. 1 that calculated values of g-factor are in good agreement with experimental values of g-factor [4]. Specifically, at J = 2, 4, 14 and 16 the calculated values are rather in perfect match with experimental values. It is evident that the experimental values of calculated g-factor first decreases as spin increases from J = 2 to J = 10 suggesting that neutron alignment dominates over proton alignment at lower spins. For spin J$\geq$12 proton alignment starts to dominate leading to increment in the value of g-factor. However, from theoretical calculations this trend is not obtained as can be seen from lower panel of Fig. 1 but present g-factors strongly confirm the mixed configuration of proton and neutron alignments and support the predictions of proton and neutron interaction. Now, we check for the energies of the yrast levels as compared to the experimental values which are taken from ref. [9]. This is displayed in upper panel of Fig. 1. The parabolic shape is very well reproduced, but calculated values of energies are smaller as compared to the experimental values therefore one would expect larger theoretical values of the moments of inertia for ^{86}Zr.

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