Ground state Lifetime Correlation with $\frac{N_pN_n}{(N_pN_n)_{max}}$

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The importance of the N_pN_n parametrization was first demonstrated by Casten [1-3] in connection with the role of the proton-neutron interaction in the growth of deformation away from shell closures, and there have subsequently been many developments in this theme. The number of valence protons N_p and neutrons N_n (where nucleons are counted as holes beyond the middle of a major shell).

The observables which reflect collective structure such as $E(2^+)$, $R_{4/2} \equiv E(4^+)/E(2^+)$ and $B(E2: 2^+ \rightarrow 0^+)$ in case of deformed region for even-even nuclei [1-3] and enegy of excited states in odd-A [4, 5], are behaved smoothly with N_pN_n.

The smooth variation in observables increases interest to examine the comparison in the variation due to N_pN_n, for the isotopes chain of all elements. That intend to used a normalised form of N_pN_n. Therefore, the $\frac{N_pN_n}{(N_pN_n)_{max}}$ term has been utilised instead of N_pN_n. The comparison in the variation of all observables for the isotopes chain became easy by utilizing the modified term ($\frac{N_pN_n}{(N_pN_n)_{max}}$), because, the variations are observed at the values of $\frac{N_pN_n}{(N_pN_n)_{max}}$ between 0 and 1, for all isotopes of all elements.

An empirical parametrization based on $\frac{N_pN_n}{(N_pN_n)_{max}}$, among the transition probability (λ) of ground state of isotopes chain has been done as

$$\lambda_{N_pN_n} \equiv \lambda_0 + (p_f)A\left(\frac{N_pN_n}{(N_pN_n)_{max}}\right). \quad (1)$$

Where λ_0 is the transition probability at (N_pN_n=0). "p_f" is phase factor. "A" is model depends parameter and function of $\frac{N_pN_n}{(N_pN_n)_{max}}$. Note that the n-particle and n-hole states are not exactly equivalent. They have different total M values. For n-particles in a given j state occupying m states m_1, m_2...m_n, $M_p = {}^n\sum_{i=1} m_i$. For n-holes in the same orbit, one clearly must $M_h = -M_p$.

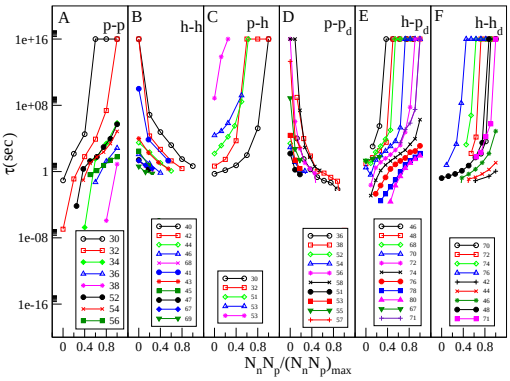

FIG. 1: The mean lifetimes of ground states for odd-A, even-even nuclei for different regions (p-p, h-h, p-h, p-p$_d$,h-p$_d$, h-h$_d$). The symbols "h" uses for holes, "p" for particles, "h$_d$" for holes from different shell and "p$_d$" for particles from different shell. The lifetime above (10^{16} sec) has been taken (10^{16} sec) to show the points in graphs. The mentioned values in legends box are proton numbers of nuclei in the chains of isotopes.

The phase factor has been assumed for holes (p_h =1) and for particles (p_p =-1). Whenever particles or holes are from different shells then (p_p^d =-1, p_h^d =-1). The phase factor p_f can written in form ($p_f = p_p \times p_h \times p_p^d \times p_h^d$). All the phase values and phase factor (p_f) for all regions have been shown in Table I.

The transition probability ($\lambda_{N_pN_n}$) varia-

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tion with $\frac{N_pN_n}{(N_pN_n)_{max}}$, depends on phase sign (p_f), if phase sign is positive then it means $\lambda_{N_pN_n}$ increases towards $\frac{N_pN_n}{(N_pN_n)_{max}}$. If it is negative sign then that means $\lambda_{N_pN_n}$ decreases with respect to $\frac{N_pN_n}{(N_pN_n)_{max}}$. The predicted pattern of lifetime with increasing $\frac{N_pN_n}{(N_pN_n)_{max}}$ for all regions from the empirical parametrization have been given in Table I. All experimental lifetime patterns are in agreement with the lifetime predicted from Eq. 1 and results shown in Table II.

regions	Phase Factors $p_p=-1$, $p_h=1$, $p_p^d=-1$, $p_h^d=-1$		p_f Sign	$\lambda_{N_pN_n}$	$\tau_{N_pN_n}$
p-p	p_p	-1	−	⇓	⇑
h-h	p_h	1	+	⇑	⇓
p-h	p_pp_h	(-1)×1	−	⇓	⇑
p-p_d	$p_pp_p^d$	(-1)×(-1)	+	⇑	⇓
p-h_d	$p_pp_h^d$	(-1)×(-1)	+	⇑	⇓
h-p_d	$p_hp_p^d$	1×(-1)	−	⇓	⇑
h-h_d	$p_hp_h^d$	1×(-1)	−	⇓	⇑

TABLE I: Table is given for lifetime ($\tau_{N_pN_n}$) with increasing $\frac{N_pN_n}{(N_pN_n)_{max}}$, predicted from the empirical parametrization. The sign "⇑" indicates enhance and "⇓" indicates reduction. p_f is phase sign for different regions.

Region	$\tau_{N_pN_n}$	$\tau_{expt.}$	Figures
p-p	⇓	⇑	Fig. 1 A
h-h	⇓	⇓	Fig. 1 B
p-h	⇑	⇑	Fig. 1 C
p-p_d	⇓	⇓	Fig. 1 D
h-p_d	⇑	⇑	Fig. 1 E
h-h_d	⇑	⇑	Fig. 1 F

TABLE II: Table is given for lifetime ($\tau_{N_pN_n}$) with increasing $\frac{N_pN_n}{(N_pN_n)_{max}}$, predicted from the empirical parametrization and experimental lifetime (τ_{expt}). The sign "⇑" indicates enhance and "⇓" indicates reduction.

References

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