Regional regularities for the even – even nuclei in intermediate mass region

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With the development of experimental techniques more and more nuclear data are accumulated and compiled for over five decades. The proton neutron interaction has been considered the key ingredient in the development of collectivity and ultimately the deformation in atomic nuclei. Phenomenologically, the correlation of the valence p-n interactions with onset of collectivity and deformation has been redefined in terms of the N_pN_n scheme [1]. The observables well known measure of collectivity are $R_{4/2}$ $(=E4_1^+/E2_1^+)$ and $E2_1^+$ in even – even nuclei which are directly obtained from experiment and thus, are model independent as far as the external parameters N_pN_n is concerned. It is the product of valence proton and neutron numbers counted to nearest closed shell clearly there is a general growth in $R_{4/2}$ from doubly magic nuclei towards midshell (largest N_pN_n values). However, a close look on the entries shows different phenomena. The $R_{4/2}$ values grow to saturation at different rates in different quadrants [2].

The purpose of the present study is to analyze the growth of $R_{4/2}$ in different mass regions. The rate of growth regions in regions having proton number Z = 38, 54, 60 and 76 with changing neutron number where the interaction between particle – particle, particle – hole and hole – hole. We will see whether the interaction grows faster when both protons and neutrons are in the first half of the shell i.e. proton – proton or hole – hole or both in the second half compared to one filling below and the above midshell i.e. particle – hole or hole – particle.

Table – I consist of observables, $E2_1^+$ $R_{4/2}$, a, β and external parameter N_pN_n. Following inferences from the table – I are made –

1. P – h is doubly strong than p – p configuration in Z = 32 in $R_{4/2}$ and $E2_1^+$ both.
2. P – p is stronger than p – h in $R_{4/2}$ and weaker than p – h in $E2_1^+$.
3. P – p is stronger lightly than P – h in Z = 54 in $R_{4/2}$ and $E2_1^+$ both.
4. P – p is faster in Z = 60 in $E2_1^+$ and $R_{4/2}$ both.

Table – I

The values of A, $R_{4/2}$, $E2_1^+$ a, β and external parameter N_pN_n in Xe nuclei (Z = 54).

A	N_pN_n	$E2_1^+$ (KeV)	$R_{4/2}$	a	β
116	48 (pp)	393	2.33	68.9	-
118	56(pp)	337	2.40	60.6	0.29
120	64(pp)	332	2.47	57.1	0.24
122	56(ph)	330	2.50	48.1	0.26
124	48(Ph)	354	2.48	60.4	0.30
126	40(Ph)	388	2.42	64.7	0.21
128	32(Ph)	442	2.33	71.8	0.21
130	24(Ph)	536	2.24	86.9	0.19
132	16(Ph)	667	2.15	-	0.17
134	08(Ph)	347	2.02	-	0.14
136	0(pp)	313	1.29	-	0.11
138	08(pp)	588	1.82	-	0.04
140	16(pp)	376	2.21	-	0.14

Nd nuclei (Z = 60)

A	N_pN_n	$E2_1^+$ (KeV)	$R_{4/2}$	a	β
136	60(ph)	374	2.61	65.4	0.167
138	40(ph)	521	2.40	86.6	0.139
144	20(ph)	696	1.89	112.8	0.114
148	60(pp)	302	2.51	60.2	0.169
150	80(pp)	130	2.93	28.3	0.253
152	100(pp)	72.5	3.16	15.8	0.334
154	120(pp)	70.8	3.23	15.4	0.333
156	140(pp)	66.9	-	14.5	0.337

Os nuclei (Z = 76)

A	N_pN_n	$E2_1^+$ (KeV)	$R_{4/2}$	γ	β
174	96(hp)	158	2.74	16.9	0.193
176	108(hp)	135	2.92	15.5	0.206
178	120(hp)	132	3.02	15.3	0.205
180	132(hp)	132	3.09	15.3	0.202
182	144(hp)	126	3.15	14.8	0.204
184	156(hp)	119	3.20	14.0	0.208
186	168(hp)	137	3.16	16.5	0.191
188	156(hh)	155	3.08	19.2	0.178
190	144(hh)	186	2.93	22.3	0.160
192	132(hh)	205	2.81	25.2	0.151
194	120(hh)	218	2.75	22.1	0.144

References:

1. R. F. Casten; Nucl. Phys A 443 (1985).
2. Yuvraj Singh et al; Physica Scripta (**Communicated**).