Part 4

Chapter 10

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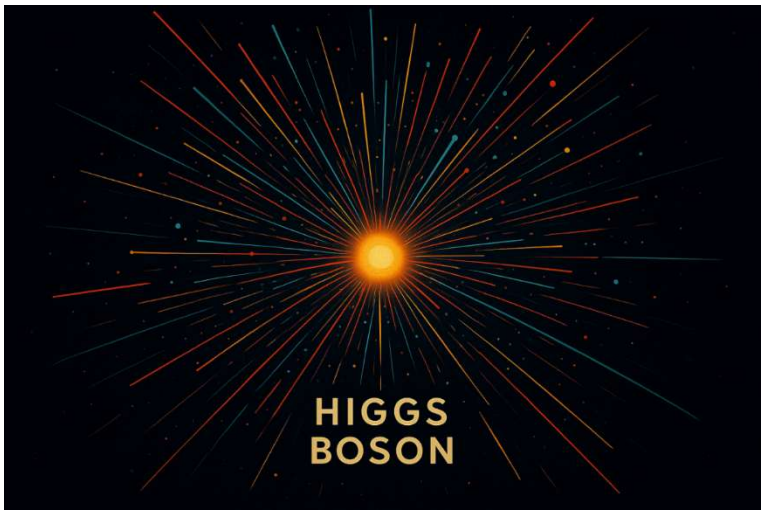
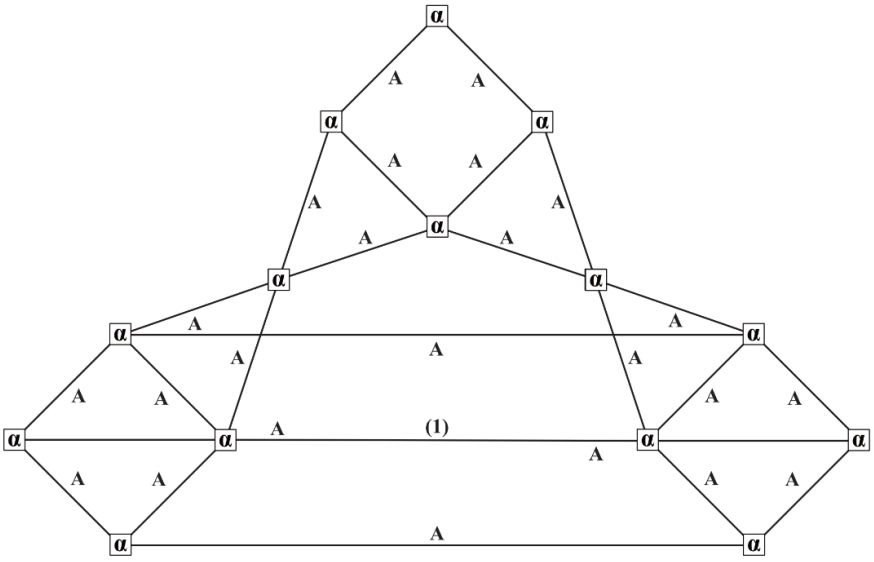


CHAPTER 10

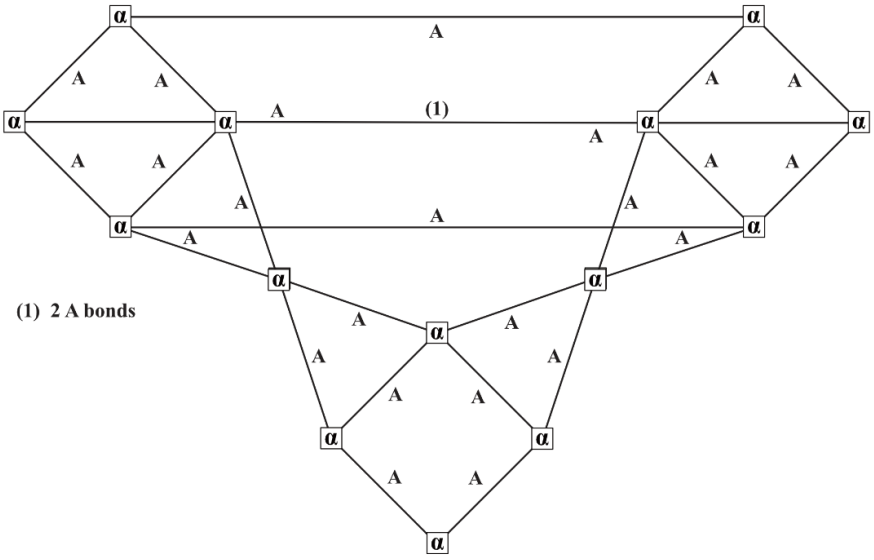
THE LANTHANIDES ALPHA ARRANGEMENTS

The Lanthanides alpha arrangements are resulting in the fusion of two symmetrical alpha arrangements schematized as follows (see figure 1).

Figure 1



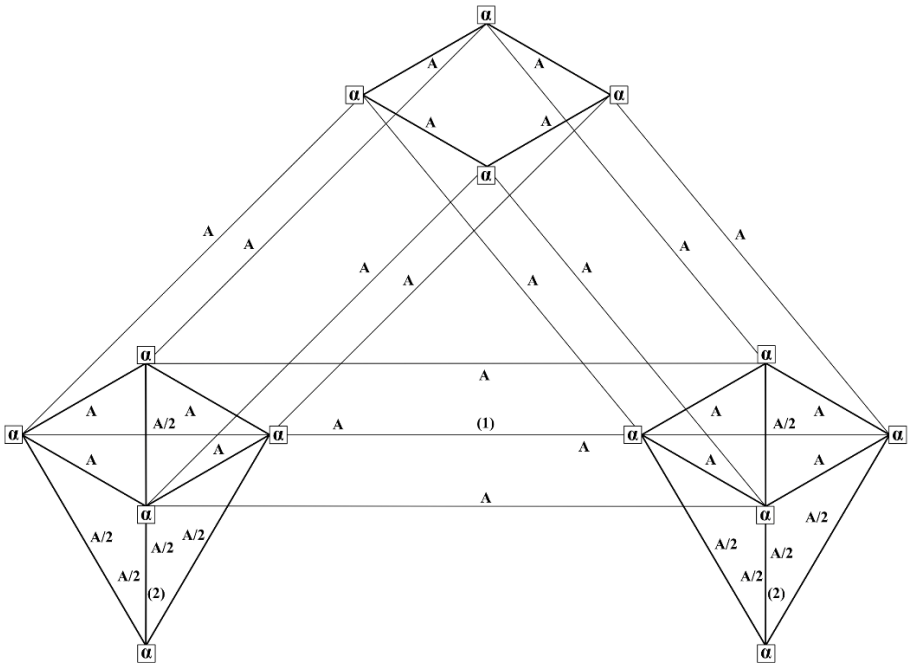
(1) 2 A bonds



(1) 2 A bonds

Each of these two alpha arrangements is an alternative solution of the following Ni and Cu typical arrangement (see figure 2).

Figure 2

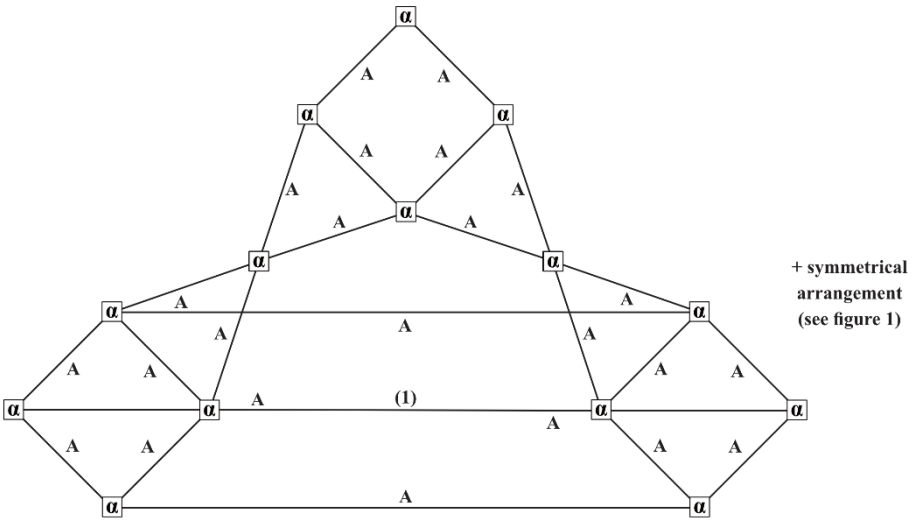


(1) 2 A bonds
(2) 2 A/2 bonds

Typical linear and cross bonds structure for Ni and Cu: 14α and 28 A bonds.

Compared with the Ni, Cu arrangement the linear bonds of the following arrangement are reduced to 12 A instead of 16 A and cross bonds are still limited to 12 A bonds. This is the consequence of a rearrangement of two α bonds located at the bottom. As a result, there are 4 A bonds less compared to the preceding Ni and Cu arrangement (see figure 3).

Figure 3

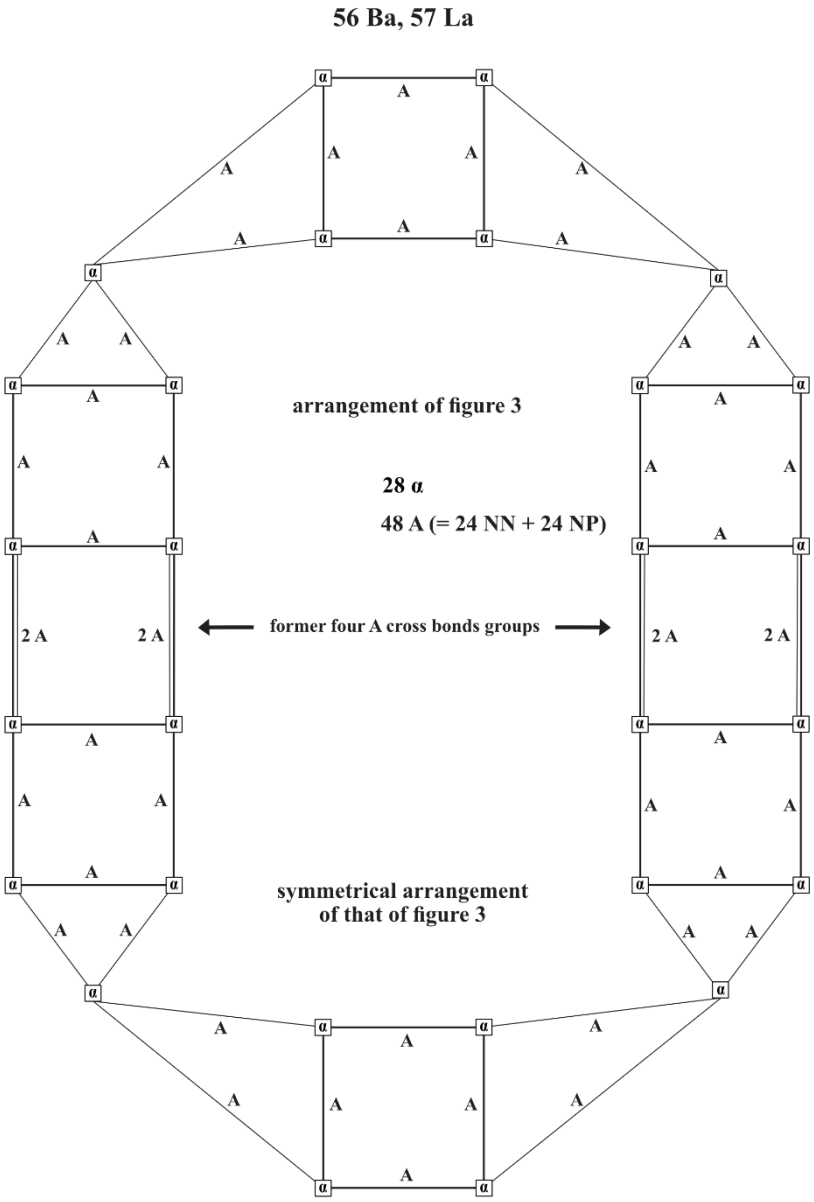


(1) 2 A bonds

The four A bonds group linking 2 x 4 alpha structures of this arrangement is now linked to 1 x 4 alpha structure of the following arrangement (see figure 4 the structure of 56 Ba and 57 La). The same occurs with the symmetrical arrangement.

Figure 4

Alpha structure of 56 Ba, 57 La



Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{130}_{56}$**Ba** Nat. abund 0.1% 28α, 18 N suppl. EB in MeV = 1,092.7214

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
18 N suppl.	16.5	NN	81.4523	
	17	NP	37.8182	
	1	NNP	8.4818	
			1,092.7187	MeV
			- 0.003	

Values of the 18 N suppl bonds: 16 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NN/2)
1 x (NNP/2 + NP)

$^{132}_{56}$**Ba** Nat. abund 0.1% 28α, 20 N suppl. EB in MeV = 1,110.0375

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
20 N suppl.	16.5	NN	81.4523	
	17.5	NP	38.9305	
	2	NNP	16.9636	
	1	NPP	7.7180	
			1,110.0308	MeV
			- 0.007	

Values of the 20 N suppl bonds: 16 x 2 A
1 x (NNP/2 + A)
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 NNP
1 NPP

$^{134}_{56}$**Ba** Nat. abund 2.4% 28α, 22 N suppl. EB in MeV = 1,126.6949

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
22 N suppl.	14.5	NN	71.5793	
	14.5	NP	32.2567	
	0	NNP	0	
	7.5	NPP	57.8850	
			1,126.6874	MeV
			- 0.007	

Values of the 22 N suppl bonds: 14 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
7 NPP

$^{135}_{56}$**Ba** Nat. abund 6.6% 28α, 23 N suppl. EB in MeV = 1,133.6670

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
23 N suppl.	16.5	NN	81.4523	
	16.5	NP	36.7059	
	0.5	NNP	4.2409	
	6	NPP	46.3080	
			1,133.6735	MeV
			+ 0.006	

Values of the 23 N suppl bonds: 16 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
6 NPP

$^{136}_{56}$**Ba** Nat. abund 7.9% 28α, 24 N suppl. EB in MeV = 1,142.7747

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	19.5	NN	96.2618	
	19.5	NP	43.3797	
	4.5	NNP	38.1681	
	0	NPP	0	
			1,142.7760	MeV
			+ 0.002	

Values of the 24 N suppl bonds: 19 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
4 NNP

$^{137}_{56}$**Ba** Nat. abund 11.2% 28α, 25 N suppl. EB in MeV = 1,149.6803

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
25 N suppl.	15.5	NN	76.5158	
	15.5	NP	34.4813	
	0.5	NNP	4.2409	
	9	NPP	69.4620	
			1,149.6664	MeV
			- 0.014	

Values of the 25 N suppl bonds: 15 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
9 NPP

$^{138}_{56}$**Ba** Nat. abund 71.7% 28α, 26 N suppl. EB in MeV = 1,158.2920

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	18	NN	88.8570	
	18	NP	40.0428	
	3.5	NNP	29.6863	
	4.5	NPP	34.7310	
			1,158.2835	MeV
			- 0.009	

Values of the 26 N suppl bonds:
A = NN/2 + NP/2

18 x 2 A
1 x (NNP/2 + NPP/2)
3 NNP
4 NPP

$^{138}_{57}$**La** Nat. abund 0.09% 28α, 25 N, 1 P suppl. EB in MeV = 1,155.7673

Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
25 N, 1P suppl.	15.5	NN	76.5158	
	16.5	NP	36.7059	
	0.5	NNP	4.2409	
	9.5	NPP	73.3210	
			1,155.7500	MeV
			- 0.017	

Values of the 25 N and 1 P suppl bonds:
A = NN/2 + NP/2

15 x 2 A
1 x (NNP/2 + A)
9 NPP
1 x (NPP/2 + NP) (P)

$^{139}_{57}$**La** Nat. abund 99.91% 28α, 26 N, 1 P suppl. EB in MeV = 1,164.5455

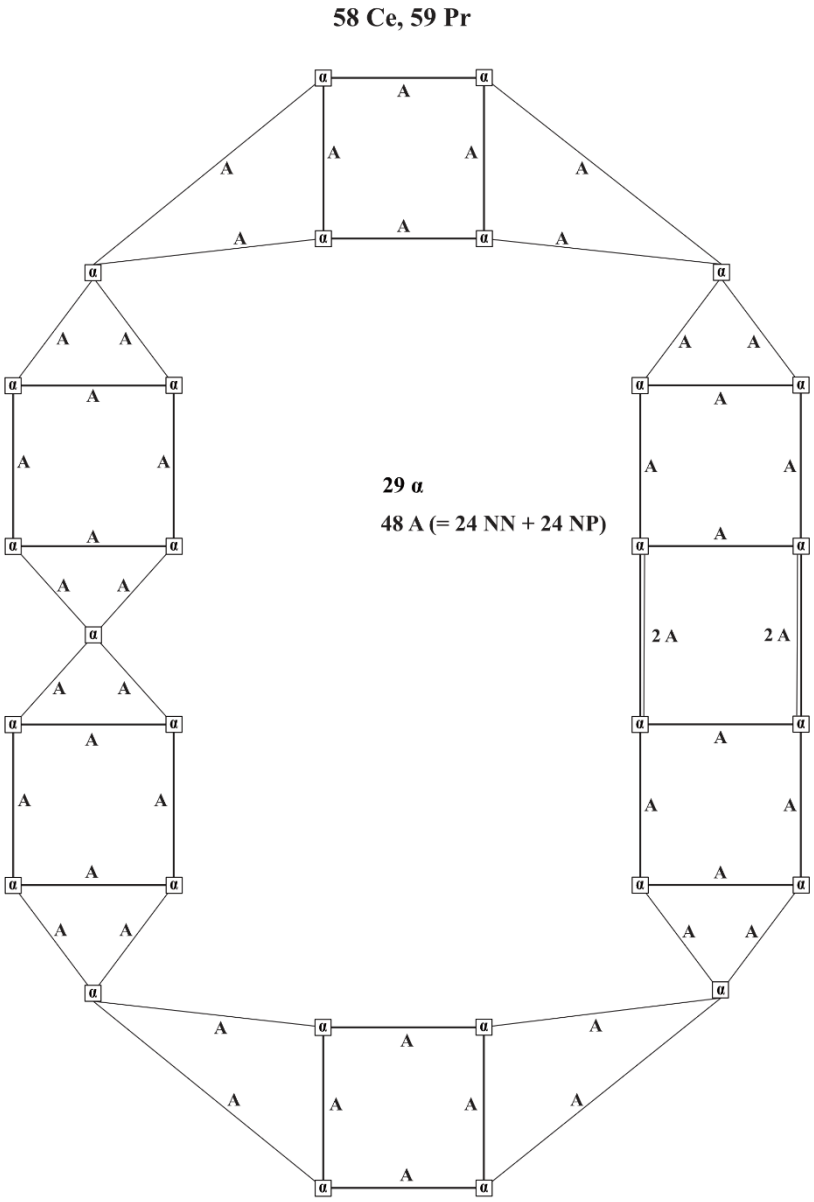
Core	EB	28 α	793.1000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N, 1 P suppl.	16.5	NN	81.4523	
	16.5	NP	36.7059	
	0.5	NNP	4.2409	
	10	NPP	77.1800	
			1,164.5455	MeV

/

Values of the 26 N and 1 P suppl bonds: 16 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
9 NPP
1 NPP (P)

Figure 5

Alpha structure of 58 Ce, 59 Pr



Compared with figure 4 (Alpha structure of 56 Ba, 57 La) one α particle is added. Nevertheless, the number of cross bonds is not increased: 4 A bonds are linking the new α particle to the structure as before.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{136}_{58}$**Ce** Nat. abund 0.2% 29α, 20 N suppl. EB in MeV = 1,138.8314

Core	EB	29 α	821.4250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
20 N suppl.	16.5	NN	81.4523	
	16.5	NP	36.7059	
	0.5	NNP	4.2409	
	3	NPP	23.1540	
			1,138.8445	MeV
			+ 0.013	

Values of the 20 N suppl bonds: 16 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
3 NPP

$^{138}_{58}$**Ce** Nat. abund 0.3% 29α, 22 N suppl. EB in MeV = 1,156.0366

Core	EB	29 α	821.4250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
22 N suppl.	17.5	NN	86.3888	
	17.5	NP	38.9305	
	3.5	NNP	29.6863	
	1	NPP	7.7180	
			1,156.0150	MeV
			- 0.021	

Values of the 22 N suppl bonds: 17 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
3 NNP
1 NPP

$^{140}_{58}$**Ce** Nat. abund 88.4% 29α, 24 N suppl. EB in MeV = 1,172.6844

Core	EB	29 α	821.4250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	16	NN	78.9840	
	16	NP	35.5936	
	4	NNP	33.9272	
	4	NPP	30.8720	
			1,172.6682	MeV
			- 0.016	

Values of the 24 N suppl bonds: 16 x 2 A
A = NN/2 + NP/2 4 NNP
4 NPP

$^{142}_{58}$**Ce** Nat. abund 11.1% 29α, 26 N suppl. EB in MeV = 1,185.2841

Core	EB	29 α	821.4250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	19	NN	93.7935	
	19	NP	42.2674	
	2.5	NNP	21.2045	
	4.5	NPP	34.7310	
			1,185.2878	MeV
			+ 0.003	

Values of the 26 N suppl bonds: 19 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NPP/2)
2 NNP
4 NPP

$^{141}_{59}$**Pr** Nat. abund 100% 29α, 24 N, 1 P suppl. EB in MeV = 1,177.9129

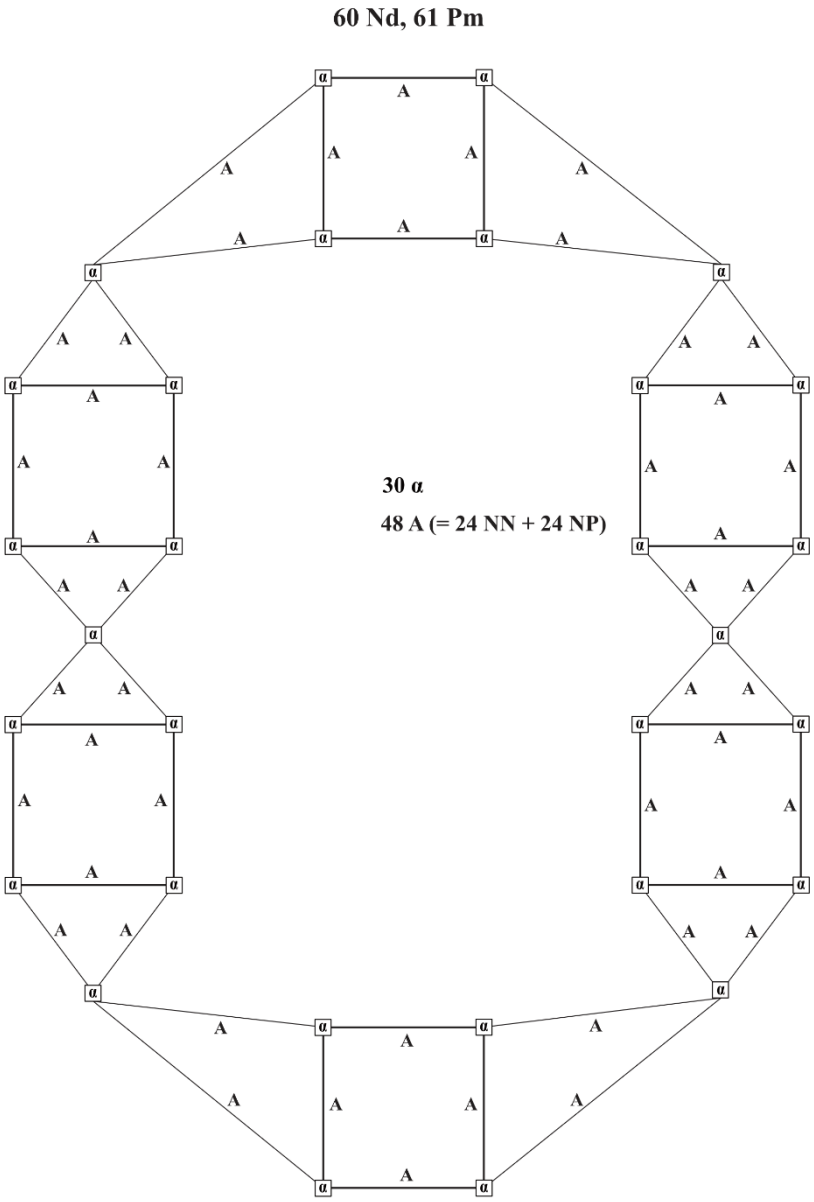
Core	EB	29 α	821.4250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N, 1 P suppl.	17.5	NN	86.3888	
	18.5	NP	41.1551	
	4	NNP	33.9272	
	3	NPP	23.1540	
			1,177.9165	MeV
			+ 0.004	

Values of the 24 N, 1 P suppl bonds:
A = NN/2 + NP/2

17 x 2 A
1 x (NPP/2 + A)
4 NNP
2 NPP
1 x (NPP/2 + NP) (P)

Figure 6

Alpha structure of 60 Nd, 61 Pm



Compared with figure 5, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{142}_{60}$**Nd** Nat. abund 27.2% 30α, 22 N suppl. EB in MeV = 1,185.1363

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
22 N suppl.	14	NN	69.1110	
	14	NP	31.1444	
	2	NNP	16.9636	
	6	NPP	46.3080	
			1,185.1434	MeV
			+ 0.007	

Values of the 22 N suppl bonds: 14 x 2 A
A = NN/2 + NP/2 2 NNP
6 NPP

$^{143}_{60}$**Nd** Nat. abund 12.2% 30α, 23 N suppl. EB in MeV = 1,191.2598

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
23 N suppl.	15.5	NN	76.5158	
	15.5	NP	34.4813	
	1	NNP	8.4818	
	6.5	NPP	50.1670	
			1,191.2623	MeV
			+ 0.003	

Values of the 23 N suppl bonds: 15 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
1 NNP
6 NPP

$^{144}_{60}$**Nd** Nat. abund 23.8% 30α, 24 N suppl. EB in MeV = 1,199.0768

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	16	NN	78.9840	
	16	NP	35.5936	
	1.5	NNP	12.7227	
	6.5	NPP	50.1670	
			1,199.0837	MeV
			+ 0.007	

Values of the 24 N suppl bonds:
A = NN/2 + NP/2

16 x 2 A
1 x (NNP/2 + NPP/2)
1 NNP
6 NPP

$^{145}_{60}$**Nd** Nat. abund 8.3% 30α, 25 N suppl. EB in MeV = 1,204.8321

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
25 N suppl.	17.5	NN	86.3888	
	17.5	NP	38.9305	
	0	NNP	0	
	7.5	NPP	57.8850	
			1,204.8207	MeV
			- 0.012	

Values of the 25 N suppl bonds:
A = NN/2 + NP/2

17 x 2 A
1 x (NPP/2 + A)
7 NPP

$^{146}_{60}$**Nd** Nat. abund 17.2% 30α, 26 N suppl. EB in MeV = 1,212.3974

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	20.5	NN	101.1983	
	20.5	NP	45.6043	
	2	NNP	16.9636	
	3.5	NPP	27.0130	
			1,212.3956	MeV
			- 0.002	

Values of the 26 N suppl bonds:
A = NN/2 + NP/2

20 x 2 A
1 x (NPP/2 + A)
2 NNP
3 NPP

$^{148}_{60}$**Nd** Nat. abund 5.7% 30α, 28 N suppl. EB in MeV = 1,225.0222

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	23.5	NN	116.0078	
	23.5	NP	52.2781	
	0.5	NNP	4.2409	
	4	NPP	30.8720	
			1,225.0152	MeV
			- 0.007	

Values of the 28 N suppl bonds:
A = NN/2 + NP/2

23 x 2 A
1 x (NNP/2 + A)
4 NPP

$^{150}_{60}$**Nd** Nat. abund 5.6% 30α, 30 N suppl. EB in MeV = 1,237.4366

Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	27	NN	133.2855	
	26	NP	57.8396	
	2	NNP	16.9636	
	1	NPP	7.7180	
			1,237.4231	MeV
			- 0.013	

Values of the 30 N suppl bonds:
A = NN/2 + NP/2

26 x 2 A
1 NNP
1 NPP
2 x (NNP/2 + NN/2)

$^{145}_{61}$**Pm** Lifetimme 17.7 years 30α, 24 N, 1 P suppl. EB in MeV = 1,203.8853

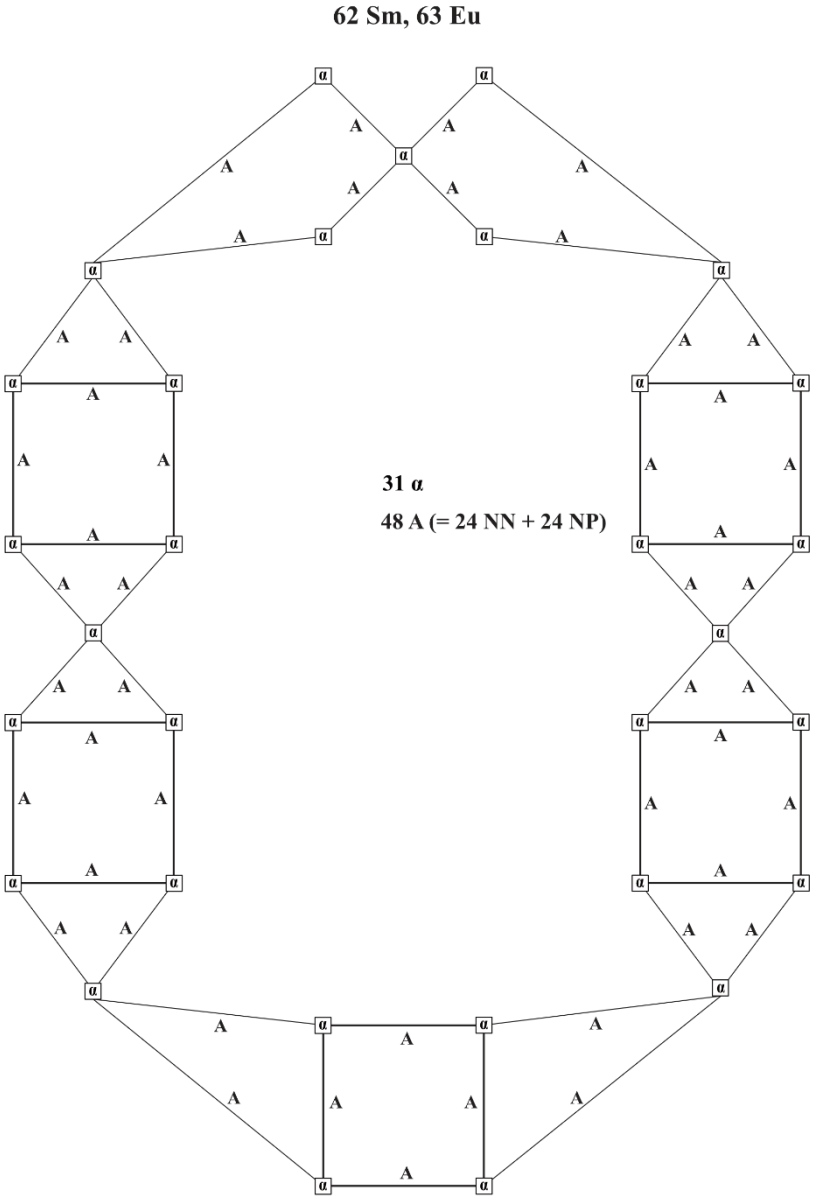
Core	EB	30 α	849.7500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N, 1 P suppl.	14	NN	69.1110	
	16	NP	35.5936	
	0.5	NNP	4.2409	
	9.5	NPP	73.3210	
			1,203.8829	MeV
			- 0.003	

Values of the 24 N, 1 P suppl bonds:
A = NN/2 + NP/2

14 x 2 A
1 x (NNP/2 + NPP/2)
9 NPP
2 NP (P)

Figure 7

Alpha structure of 62 Sm, 63 Eu



Compared with figure 6, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{144}_{62}$**Sm** Nat. abund 3.1% 31α, 20 N suppl. EB in MeV = 1,195.7298

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
20 N suppl.	19	NN	93.7935	
	18	NP	40.0428	
	0.5	NNP	4.2409	
	1	NPP	7.7180	
			1,195.7366	MeV
			+ 0.007	

Values of the 20 N suppl bonds: 18 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NN)
1 NPP

$^{147}_{62}$**Sm** Nat. abund 15.1% 31α, 23 N suppl. EB in MeV = 1,217.2445

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
23 N suppl.	19	NN	93.7935	
	19	NP	42.2674	
	0.5	NNP	4.2409	
	3.5	NPP	27.0130	
			1,217.2562	MeV
			+ 0.012	

Values of the 23 N suppl bonds: 19 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NPP/2)
3 NPP

$^{148}_{62}$**Sm** Nat. abund 11.3% 31α, 24 N suppl. EB in MeV = 1,225.3857

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	21	NN	103.6665	
	21	NP	46.7166	
	2.5	NNP	21.2045	
	0.5	NPP	3.8590	
			1,225.3880	MeV
			+ 0.003	

Values of the 24 N suppl bonds: 21 x 2 A
A = NN/2 + NP/2 2 NNP
1 x (NNP/2 + NPP/2)

$^{149}_{62}$**Sm** Nat. abund 13.9% 31α, 25 N suppl. EB in MeV = 1,231.2564

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
25 N suppl.	24.5	NN	120.9443	
	23.5	NP	52.2781	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,231.2637	MeV
			+ 0.007	

Values of the 25 N suppl bonds: 23 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
1 x (NPP/2 + NN)

$^{150}_{62}$**Sm** Nat. abund 7.4% 31α, 26 N suppl. EB in MeV = 1,239.2432

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	22.5	NN	111.0713	
	22.5	NP	50.0535	
	1.5	NNP	12.7227	
	2	NPP	15.4360	
			1,239.2249	MeV
			- 0.019	

Values of the 26 N suppl bonds: 22 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
1 NNP
2 NPP

$^{152}_{62}$**Sm** Nat. abund 26.6% 31α, 28 N suppl. EB in MeV = 1,253.0973

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	26	NN	128.3490	
	26	NP	57.8396	
	2	NNP	16.9636	
	0	NPP	0	
			1,253.0936	MeV
			- 0.004	

Values of the 28 N suppl bonds: 26 x 2 A
A = NN/2 + NP/2 2 NNP

$^{154}_{62}$**Sm** Nat. abund 22.6% 31α, 30 N suppl. EB in MeV = 1,266.9326

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	27.5	NN	135.7538	
	27.5	NP	61.1765	
	1	NNP	8.4818	
	1.5	NPP	11.5770	
			1,266.9305	MeV
			- 0.002	

Values of the 30 N suppl bonds: 27 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
1 NNP
1 NPP

$^{151}_{63}$**Eu** Nat. abund 47.8% 31α, 26 N, 1 P suppl. EB in MeV = 1,244.1338

Core	EB	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N, 1 P suppl.	25.5	NN	125.8808	
	25.5	NP	56.7273	
	0	NNP	0	
	1.5	NPP	11.5770	
			1,244.1265	MeV
			- 0.007	

Values of the 26 N, 1 P suppl bonds: 25 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
1 NPP (P)

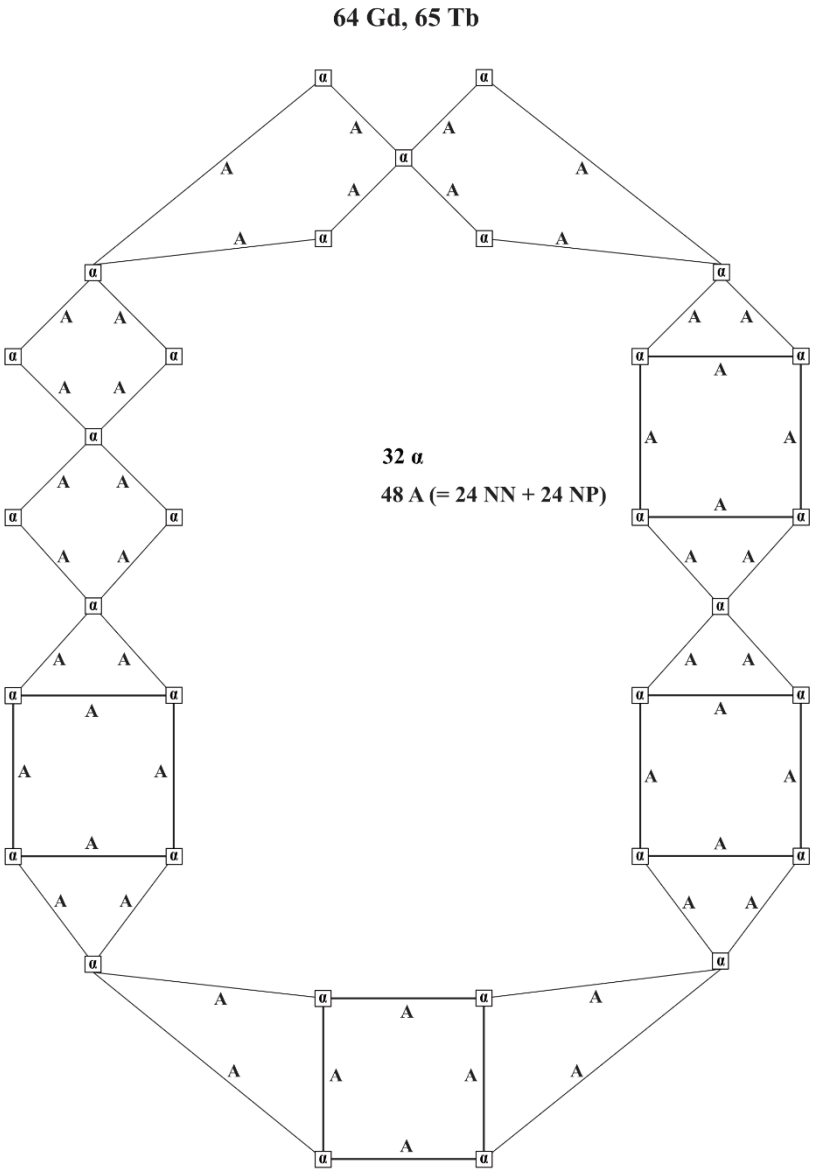
$^{153}_{63}$**Eu** Nat. abund 52.2% 31α, 28 N, 1 P suppl. E_B in MeV = 1,258.9909

Core	E_B	31 α	878.0750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N, 1 P suppl.	26.5	NN	130.8173	
	26.5	NP	58.9519	
	0	NNP	0	
	2.5	NPP	19.2950	
			1,259.0056	MeV
			+ 0.014	

Values of the 28 N, 1 P suppl bonds: 26 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
1 NPP
1 NPP (P)

Figure 8

Alpha structure of 64 Gd, 65 Tb



Compared with figure 7, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{152}_{64}$**Gd** Nat. abund 0.2% 32α, 24 N suppl. EB in MeV = 1,251.4770

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	24.5	NN	120.9443	
	23.5	NP	52.2781	
	0	NNP	0	
	0	NPP	0	
			1,251.4888	MeV
			+ 0.011	

Values of the 24 N suppl bonds: 23 x 2 A
A = NN/2 + NP/2 1 x (NN + A)

$^{154}_{64}$**Gd** Nat. abund 2.2% 32α, 26 N suppl. EB in MeV = 1,266.6186

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	23.5	NN	116.0078	
	23.5	NP	52.2781	
	1	NNP	8.4818	
	1.5	NPP	11.5770	
			1,266.6111	MeV
			- 0.007	

Values of the 26 N suppl bonds: 23 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + A)
1 NNP
1 NPP

$^{155}_{64}$**Gd** Nat. abund 14.8% 32α, 27 N suppl. EB in MeV = 1,273.0539

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
27 N suppl.	21.5	NN	106.1348	
	22.5	NP	50.0535	
	0	NNP	0	
	5	NPP	38.5900	
			1,273.0447	MeV
			- 0.009	

Values of the 27 N suppl bonds:
A = NN/2 + NP/2

21 x 2 A
1 x (NPP/2 + A)
1 x (NPP/2 + NP)
4 NPP

$^{156}_{64}$**Gd** Nat. abund 20.5% 32α, 28 N suppl. EB in MeV = 1,281.5902

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	25	NN	123.4125	
	25	NP	55.6150	
	1.5	NNP	12.7227	
	1.5	NPP	11.5770	
			1,281.5936	MeV
			+ 0.003	

Values of the 28 N suppl bonds:
A = NN/2 + NP/2

25 x 2 A
1 x (NNP/2 + NPP/2)
1 NNP
1 NPP

$^{157}_{64}$**Gd** Nat. abund 15.7% 32α, 29 N suppl. EB in MeV = 1,287.9501

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
29 N suppl.	29	NN	143.1585	
	28	NP	62.2888	
	0.5	NNP	4.2409	
	0	NPP	0	
			1,287.9546	MeV
			+ 0.004	

Values of the 29 N suppl bonds: 28 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NN)

$^{158}_{64}$**Gd** Nat. abund 24.8% 32α, 30 N suppl. EB in MeV = 1,295.8874

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	25	NN	123.4125	
	25	NP	55.6150	
	0	NNP	0	
	5	NPP	38.5900	
			1,295.8839	MeV
			- 0.004	

Values of the 30 N suppl bonds: 25 x 2 A
A = NN/2 + NP/2 5 NNP

$^{160}_{64}$Gd Nat. abund 21.8% 32α, 32 N suppl. EB in MeV = 1,309.2822

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N suppl.	30	NN	148.0950	
	30	NP	66.7380	
	1	NNP	8.4818	
	1	NPP	7.7180	
			1,309.2992	MeV
			+ 0.017	

Values of the 32 N suppl bonds: 30 x 2 A
A = NN/2 + NP/2 1 NNP
1 NPP

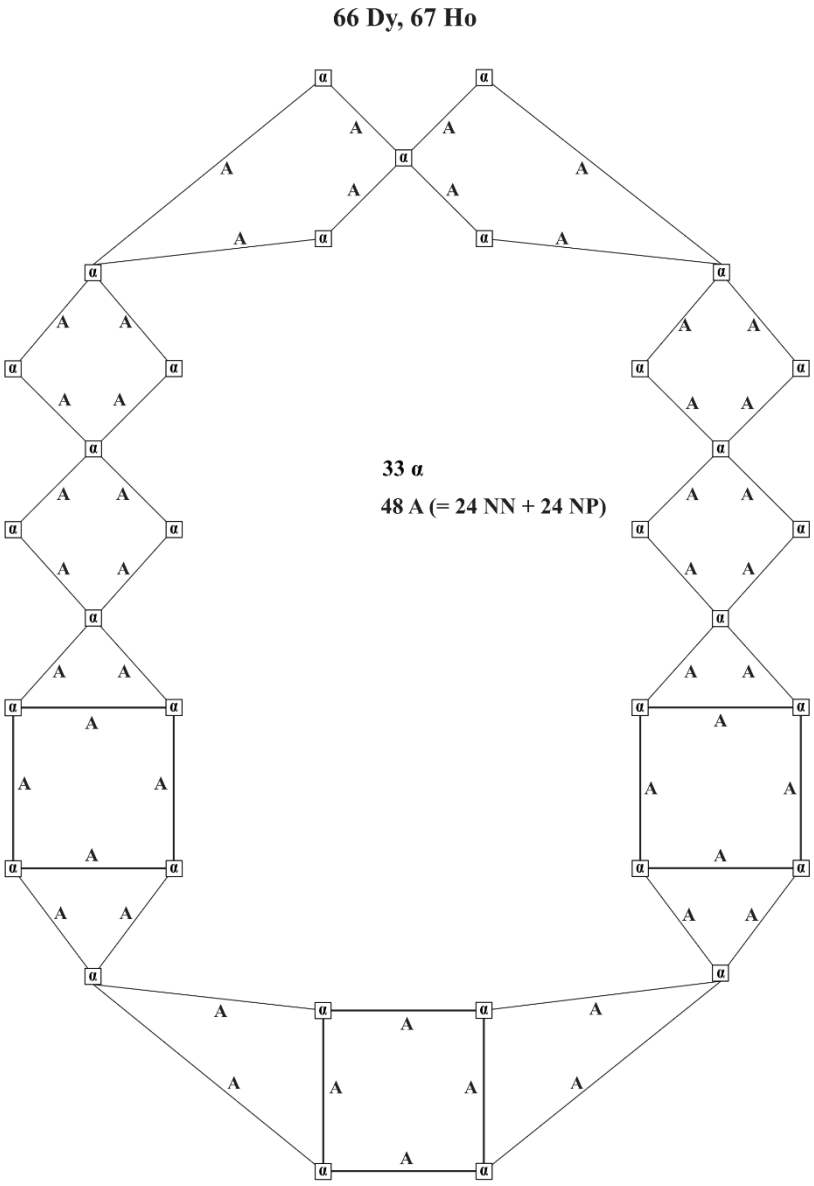
$^{159}_{65}$Tb Nat. abund 100% 32α, 30 N, 1 P suppl. EB in MeV = 1,302.0192

Core	EB	32 α	906.4000	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N, 1 P suppl.	22	NN	108.6030	
	24	NP	53.3904	
	0	NNP	0	
	8	NPP	61.7440	
			1,302.0038	MeV
			- 0.016	

Values of the 30 N, 1 P suppl bonds: 22 x 2 A
A = NN/2 + NP/2 8 NPP
2 NP (P)

Figure 9

Alpha structure of 66 Dy, 67 Ho



Compared with figure 8, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{156}_{66}$**Dy** Nat. abund 0.06% 33α, 24 N suppl. EB in MeV = 1,278.0195

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
24 N suppl.	22.5	NN	111.0713	
	23.5	NP	52.2781	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,278.0407	MeV
			+ 0.021	

Values of the 24 N suppl bonds: 22 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 x (NPP/2 + A)

$^{158}_{66}$**Dy** Nat. abund 0.1% 33α, 26 N suppl. EB in MeV = 1,294.0405

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	19.5	NN	96.2618	
	20	NP	44.4920	
	0.5	NNP	4.2409	
	5.5	NPP	42.4490	
			1,294.0351	MeV
			- 0.005	

Values of the 26 N suppl bonds: 19 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NN/2)
1 x (NPP/2 + NP)
5 NPP

$^{160}_{66}$**Dy** Nat. abund 2.34% 33α, 28 N suppl. EB in MeV = 1,309.4486

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	24.5	NN	120.9443	
	24.5	NP	54.5027	
	0.5	NNP	4.2409	
	3	NPP	23.1540	
			1,309.4333	MeV
			- 0.015	

Values of the 28 N suppl bonds: 24 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
3 NPP

$^{161}_{66}$**Dy** Nat. abund 18.9% 33α, 29 N suppl. EB in MeV = 1,315.9029

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
29 N suppl.	29	NN	143.1585	
	28	NP	62.2888	
	0	NNP	0	
	0.5	NPP	3.8590	
			1,315.8977	MeV
			- 0.005	

Values of the 29 N suppl bonds: 28 x 2 A
A = NN/2 + NP/2 1 x (NPP/2 + NN)

$^{162}_{66}$**Dy** Nat. abund 25.5% 33α, 30 N suppl. EB in MeV = 1,324.1000

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	25	NN	123.4125	
	26	NP	57.8396	
	2	NNP	16.9636	
	2.5	NPP	19.2950	
			1,324.1021	MeV
			+ 0.002	

Values of the 30 N suppl bonds:
A = NN/2 + NP/2

25 x 2 A
1 x (NPP/2 + NP)
2 NNP
2 NPP

$^{163}_{66}$**Dy** Nat. abund 24.9% 33α, 31 N suppl. EB in MeV = 1,330.3710

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
31 N suppl.	28.5	NN	140.6903	
	28.5	NP	63.4011	
	0.5	NNP	4.2409	
	2	NPP	15.4360	
			1,330.3597	MeV
			- 0.012	

Values of the 31 N suppl bonds:
A = NN/2 + NP/2

28 x 2 A
1 x (NNP/2 + A)
2 NPP

$^{164}_{66}$**Dy** Nat. abund 28.2% 33α, 32 N suppl. EB in MeV = 1,338.0291

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N suppl.	27	NN	133.2855	
	28	NP	62.2888	
	1.5	NNP	12.7227	
	3	NPP	23.1540	
			1,338.0424	MeV
			+ 0.013	

Values of the 32 N suppl bonds: 27 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 NNP
3 NPP

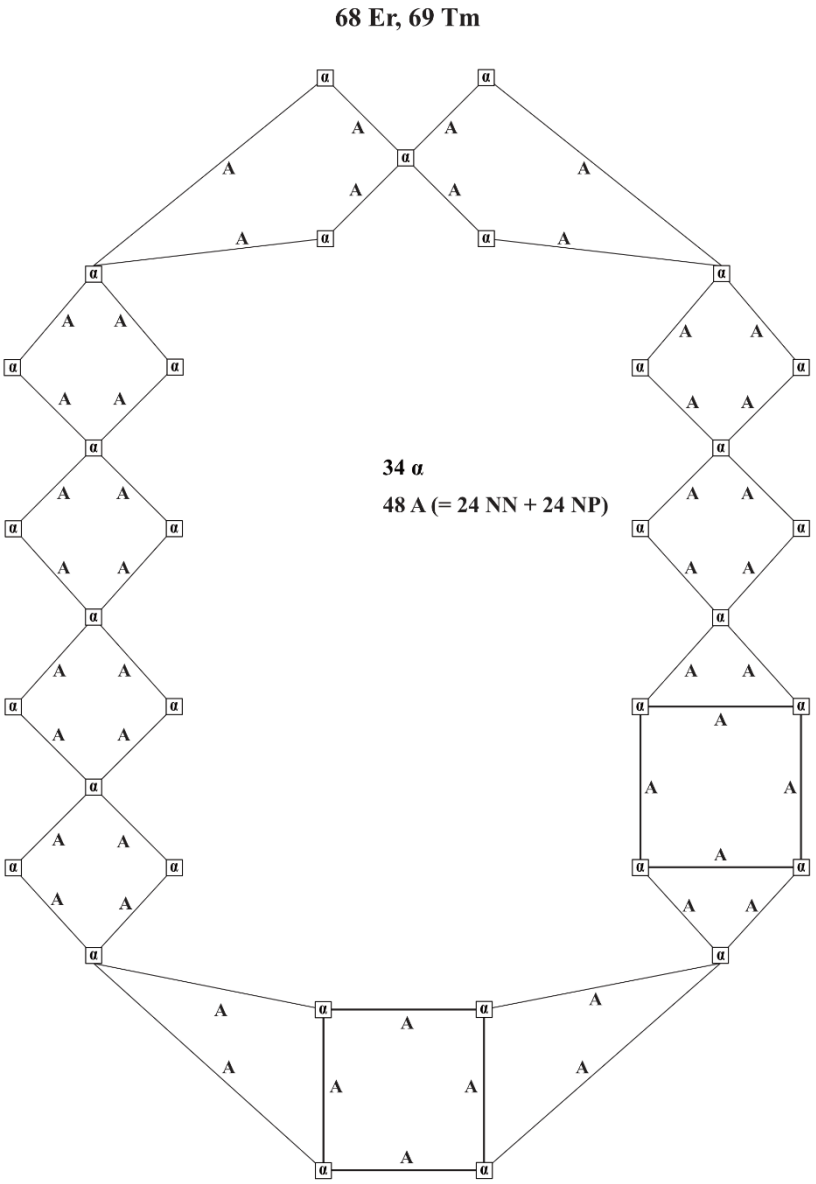
$^{165}_{67}$**Ho** Nat. abund 100% 33α, 32 N, 1 P suppl. EB in MeV = 1,344.2491

Core	EB	33 α	934.7250	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N, 1 P suppl.	29	NN	143.1585	
	30	NP	66.7380	
	1	NNP	8.4818	
	2.5	NPP	19.2950	
			1,344.2647	MeV
			+ 0.015	

Values of the 32 N, 1 P suppl bonds: 29 x 2 A
A = NN/2 + NP/2 1 NNP
2 NPP
1 x (NPP/2 + NP) (P)

Figure 10

Alpha structure of 68 Er, 69 Tm



Compared with figure 9, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{162}_{68}$**Er** Nat. abund 0.1% 34α, 26 N suppl. EB in MeV = 1,320.6883

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
26 N suppl.	24.5	NN	120.9443	
	25.5	NP	56.7273	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,320.6879	MeV
			/	

Values of the 26 N suppl bonds: 24 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
1 x (NPP/2 + NP)

$^{164}_{68}$**Er** Nat. abund 1.6% 34α, 28 N suppl. EB in MeV = 1,336.4393

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	21	NN	103.6665	
	23	NP	51.1658	
	0.5	NNP	4.2409	
	5.5	NPP	42.4490	
			1,336.4386	MeV
			- 0.001	

Values of the 28 N suppl bonds: 21 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 x (NPP/2 + NP)
5 NPP

$^{166}_{68}$**Er** Nat. abund 33.4% 34α, 30 N suppl. EB in MeV = 1,351.5652

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	24.5	NN	120.9443	
	25.5	NP	56.7273	
	0.5	NNP	4.2409	
	4.5	NPP	34.7310	
			1,351.5599	MeV
			- 0.006	

Values of the 30 N suppl bonds:
A = NN/2 + NP/2

24 x 2 A
1 x (NNP/2 + A)
1 x (NPP/2 + NP)
4 NPP

$^{167}_{68}$**Er** Nat. abund 22.9% 34α, 31 N suppl. EB in MeV = 1,358.0016

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
31 N suppl.	27.5	NN	135.7538	
	28.5	NP	63.4011	
	1	NNP	8.4818	
	2	NPP	15.4360	
			1,357.9891	MeV
			- 0.012	

Values of the 31 N suppl bonds:
A = NN/2 + NP/2

27 x 2 A
1 x (NNP/2 + A)
1 x (NNP/2 + NP)
2 NPP

$^{168}_{68}$**Er** Nat. abund 27.0% 34α, 32 N suppl. EB in MeV = 1,365.7730

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N suppl.	26	NN	128.3490	
	27	NP	60.0642	
	0	NNP	0	
	5.5	NPP	42.4490	
			1,365.7786	MeV
			+ 0.005	

Values of the 32 N suppl bonds:
A = NN/2 + NP/2

26 x 2 A
5 NPP
1 x (NPP/2 + NP)

$^{170}_{68}$**Er** Nat. abund 15.0% 34α, 34 N suppl. EB in MeV = 1,379.0330

Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
34 N suppl.	32	NN	157.9680	
	33	NP	73.4118	
	1.5	NNP	12.7227	
	0	NPP	0	
			1,379.0189	MeV
			- 0.014	

Values of the 34 N suppl bonds:
A = NN/2 + NP/2

32 x 2 A
1 x (NNP/2 + NP)
1 NNP

$^{169}_{69}$**Tm** Nat. abund 100% 34α, 32 N, 1 P suppl. EB in MeV = 1,371.3459

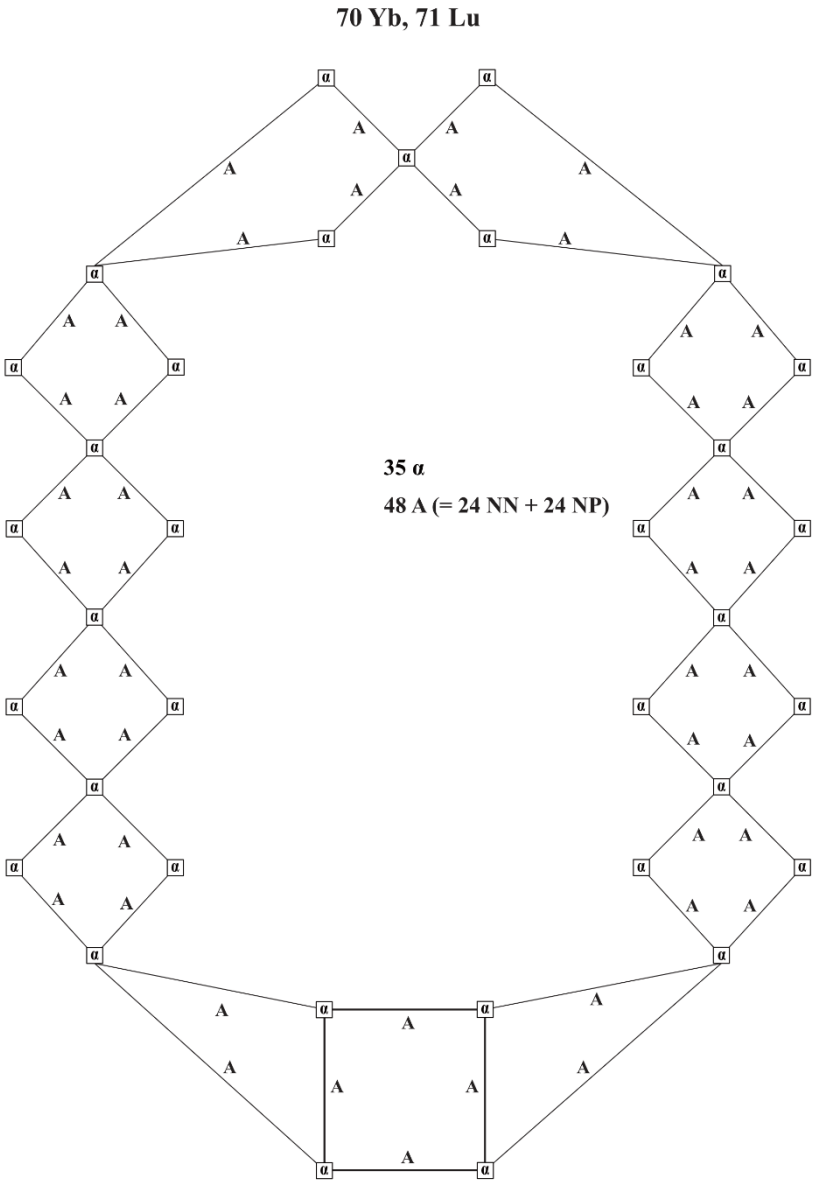
Core	EB	34 α	963.0500	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N, 1 P suppl.	29	NN	143.1585	
	31	NP	68.9626	
	1.5	NNP	12.7227	
	1.5	NPP	11.5770	
			1,371.3372	MeV
			- 0.008	

Values of the 32 N, 1 P suppl bonds:
A = NN/2 + NP/2

29 x 2 A
1 x (NNP/2 + NPP/2)
1 NNP
1 NPP
2 NP (P)

Figure 11

Alpha structure of 70 Yb, 71 Lu



Compared with figure 10, one α particle is added, the number of cross bonds being unchanged.

Some supplementary neutrons (N) and one supplementary proton (P) are bound to that structure with NN, NP bonds or NNP and NPP ones in the following way.

$^{168}_{70}$**Yb** Nat. abund 0.1% 35α, 28 N suppl. EB in MeV = 1,362.7989

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
28 N suppl.	24.5	NN	120.9443	
	26.5	NP	58.9519	
	0.5	NNP	4.2409	
	2	NPP	15.4360	
			1,362.8145	MeV
			+ 0.016	

Values of the 28 N suppl bonds:
A = NN/2 + NP/2

24 x 2 A
1 x (NNP/2 + A)
2 x (NPP/2 + NP)
1 NPP

$^{170}_{70}$**Yb** Nat. abund 3.1% 35α, 30 N suppl. EB in MeV = 1,378.1235

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
30 N suppl.	27	NN	133.2855	
	28	NP	62.2888	
	0	NNP	0	
	2.5	NPP	19.2950	
			1,378.1107	MeV
			- 0.013	

Values of the 30 N suppl bonds:
A = NN/2 + NP/2

27 x 2 A
1 x (NPP/2 + NP)
2 NPP

$^{171}_{70}$**Yb** Nat. abund 14.3% 35α, 31 N suppl. EB in MeV = 1,384.7378

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
31 N suppl.	26	NN	128.3490	
	28	NP	62.2888	
	0	NNP	0	
	4	NPP	30.8720	
			1,384.7512	MeV
			+ 0.014	

Values of the 31 N suppl bonds: 26 x 2 A
A = NN/2 + NP/2 2 x (NPP/2 + NP)
3 NPP

$^{172}_{70}$**Yb** Nat. abund 21.9% 35α, 32 N suppl. EB in MeV = 1,392.7578

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
32 N suppl.	25.5	NN	125.8808	
	27.5	NP	61.1765	
	0	NNP	0	
	5.5	NPP	42.4490	
			1,392.7477	MeV
			- 0.010	

Values of the 32 N suppl bonds: 25 x 2 A
A = NN/2 + NP/2 2 x (NPP/2 + NP)
1 x (NPP/2 + A)
4 NPP

$^{173}_{70}$**Yb** Nat. abund 16.2% 35α, 33 N suppl. EB in MeV = 1,399.1249

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
33 N suppl.	31.5	NN	155.4998	
	32.5	NP	72.2995	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,399.1406	MeV
			+ 0.016	

Values of the 33 N suppl bonds: 31 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + A)
1 x (NPP/2 + NP)

$^{174}_{70}$**Yb** Nat. abund 31.7% 35α, 34 N suppl. EB in MeV = 1,406.5894

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
34 N suppl.	32	NN	157.9680	
	33	NP	73.4118	
	0.5	NNP	4.2409	
	1	NPP	7.7180	
			1,406.5801	MeV
			- 0.009	

Values of the 34 N suppl bonds: 32 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 NPP

$^{176}_{70}$**Yb** Nat. abund 12.7% 35α, 36 N suppl. EB in MeV = 1,419.2790

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
36 N suppl.	34	NN	167.8410	
	36	NP	80.0856	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,419.2679	MeV
			- 0.012	

Values of the 36 N suppl bonds: 34 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NP)
1 x (NPP/2 + NP)

$^{175}_{71}$**Lu** Nat. abund 97.4% 35α, 34 N, 1 P suppl. EB in MeV = 1,412.0995

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
34 N, 1 P suppl.	33	NN	162.9045	
	35	NP	77.8610	
	0.5	NNP	4.2409	
	0.5	NPP	3.8590	
			1,412.1068	MeV
			+ 0.007	

Values of the 34 N, 1 P suppl bonds: 33 x 2 A
A = NN/2 + NP/2 1 x (NNP/2 + NPP/2)
2 NP (P)

$^{176}_{71}$**Lu** Nat. abund 2.6% 35α, 35 N, 1 P suppl. EB in MeV = 1,418.3875

Core	EB	35 α	991.3750	MeV
	24	NN	118.4760	
	24	NP	53.3904	
35 N, 1 P suppl.	29	NN	143.1585	
	33	NP	73.4118	
	0	NNP	0	
	5	NPP	38.5900	
			1,418.4017	MeV
			+ 0.014	

Values of the 35 N, 1 P suppl bonds: 29 x 2 A
A = NN/2 + NP/2 2 x (NPP/2 + NP)
4 NPP
2 NP (P)