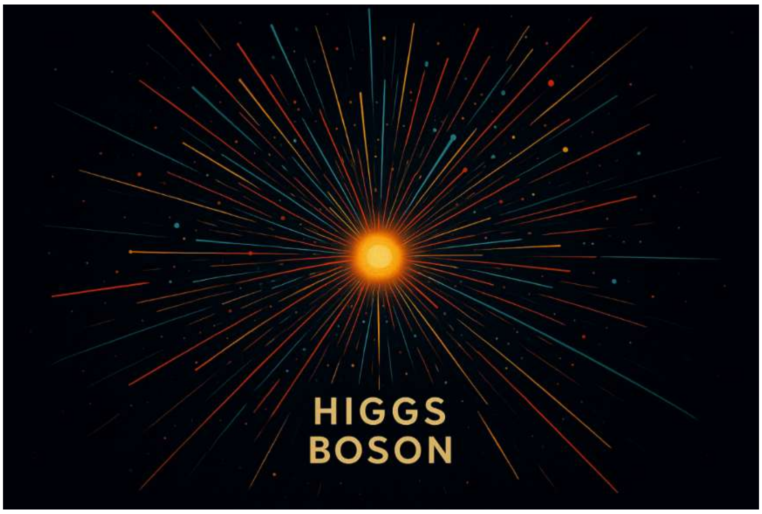
Part 3

Chapters 7 to 9

Philippe Hatt



CHAPTER 7

EVOLUTION OF THE A CORE STRUCTURE FROM ZINC TO RHODIUM.

Abstract

In the present chapter several atomic nuclei core structures are examined:

- Zn 30 and Ga 31, their core structure being similar to that of Ni 28 and Cu 29 (see chapter 6);
- Ge 32 and As 33, their core structure being very symmetrical: 16 α arranged with 4 structures of each 4 α, and 32 A bonds (16 NN + 16 NP);
- Zr 40 and Nb 41, their core structure being similar to that of Ge 32 and As 33, with a 4 x 4 α structure completed with an 1 x 4 α structure; this arrangement with 20 α is linked with 40 A bonds (= 20 NN + 20 NP); it is important to notice that this shape (equality of α number and (NN + NP) bonds number) occurs for the last time for stable nuclides;
- Mo 42 and Tc 43: the structure of 21 α and 42 A bonds is still existing. Nevertheless, there are difficulties establishing solidly that structure;
- Ru 44 and Rh 45: there is no longer an equality between α number and (NN + NP) bonds number. Instead, there are 22 α and 40 A bonds, this inducing a modification of the A bonds structure.

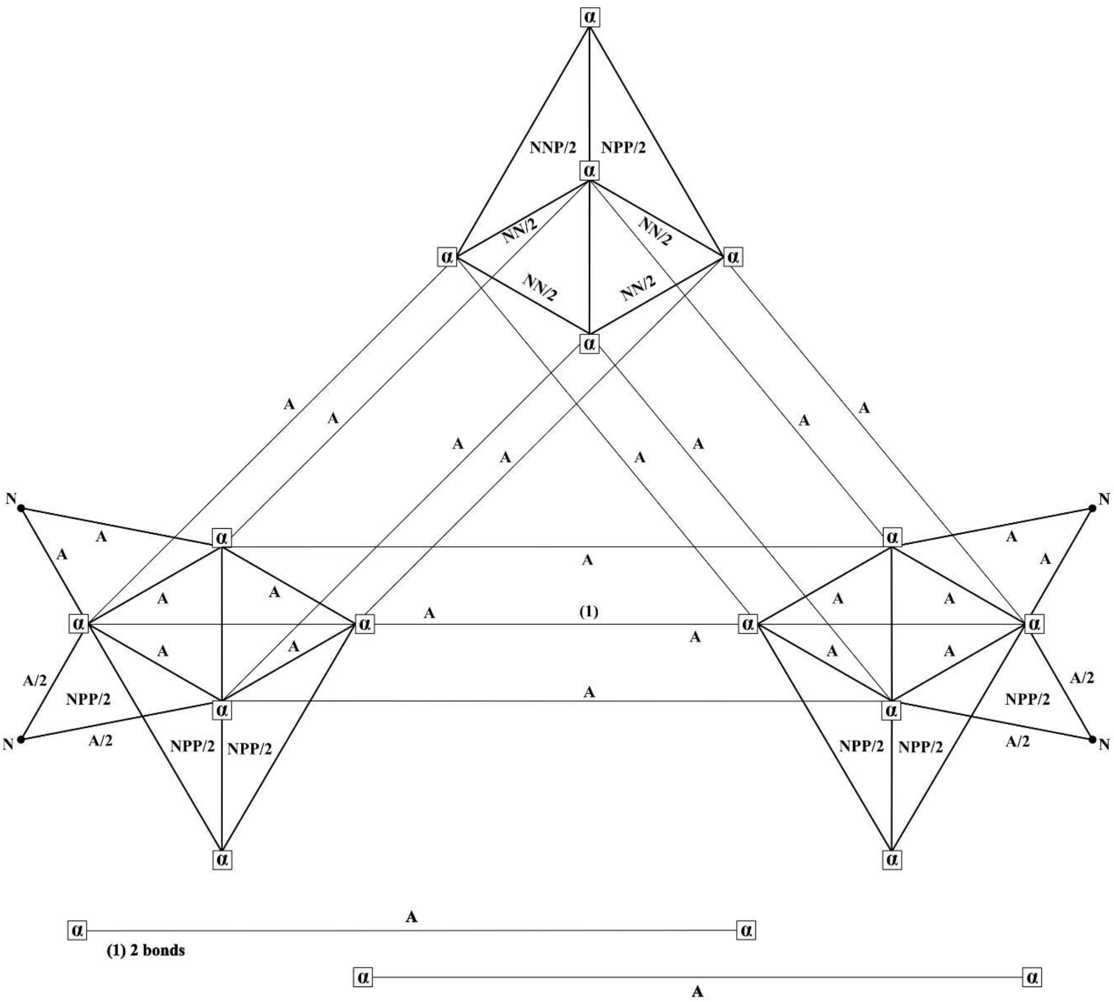
1. Zn and Ga stable nuclides

$^{64}_{30}$Zn

Structure: 15 α, 4 N, 0 P supplementary

Linear and cross bonds: 20 A, 2 NN, 0.5 NNP, 2.5 NPP

N supplementary bonds: 6 A, 1 NPP



$^{64}_{30}$Zn 15α, 4N, 0P supplementary EB in MeV = 559.0979

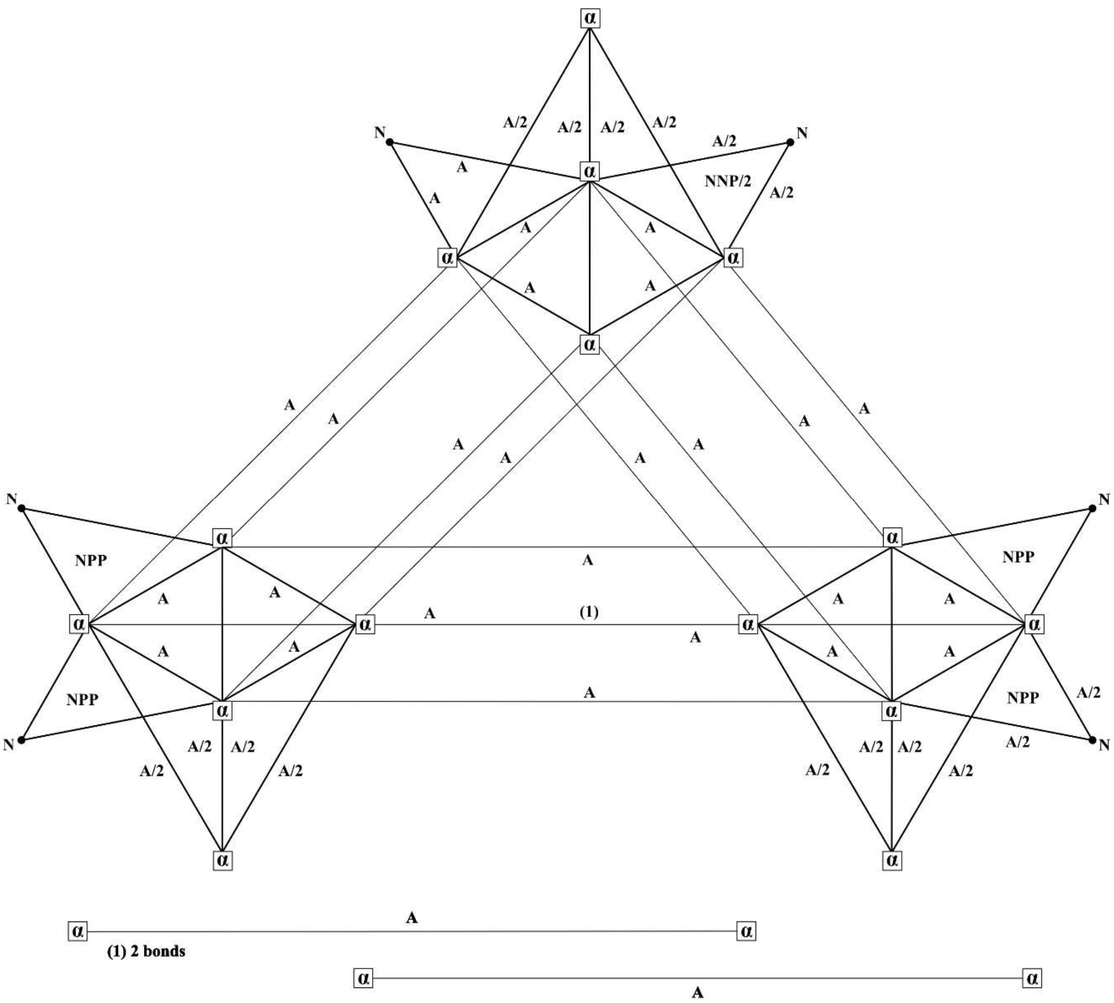
Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 48.6%	12	x	4.9365	59.2380	
	10	x	2.2246	22.2460	
	0.5	x	8.4818	4.2409	
	2.5	x	7.7180	19.2950	
	3	x	4.9365	14.8095	
	3	x	2.2246	6.6738	
	0	x	8.4818	0	
	1	x	7.7180	7.7180	
				559.0962	MeV
				- 0.002	

$^{66}_{30}$Zn

Structure: 15 α, 6 N, 0 P supplementary

Linear and cross bonds: 30 A

N supplementary bonds: 3 A, 0.5 NNP, 4 NPP



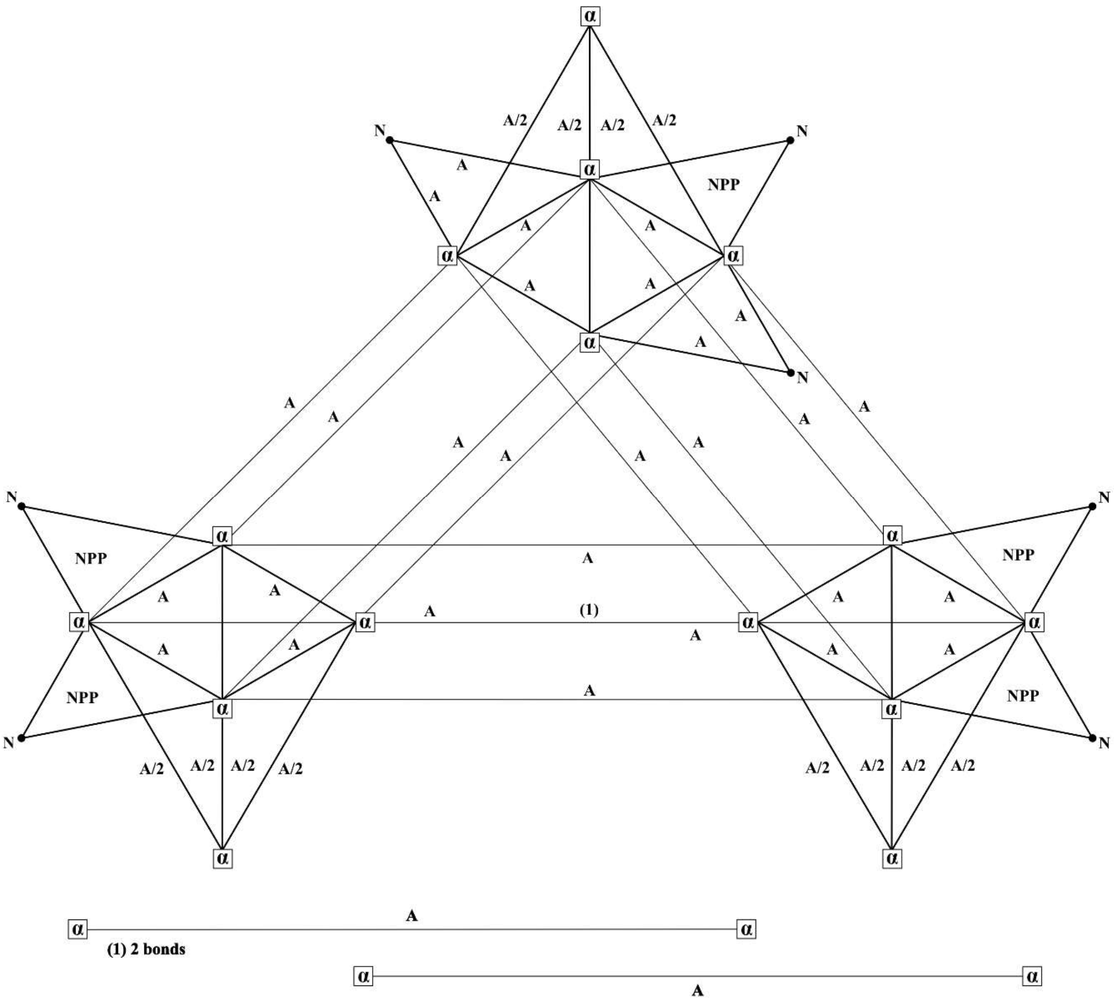
$^{66}_{30}$Zn	15α, 6N, 0P supplementary				EB in MeV = 578.1357
Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 27.9%	15	x	4.9365	74.0475	
	15	x	2.2246	33.3690	
	0	x	8.4818	0	
	0	x	7.7180	0	
	1.5	x	4.9365	7.4048	
	1.5	x	2.2246	3.3369	
	0.5	x	8.4818	4.2409	
	4	x	7.7180	30.8720	
				578.1461	MeV
				+ 0.011	

$^{67}_{30}$Zn

Structure: 15 α, 7 N, 0 P supplementary

Linear and cross bonds: 30 A

N supplementary bonds: 4 A, 5 NPP



$^{67}_{30}$Zn 15α, 7N, 0P supplementary EB in MeV = 585.1882

Stable

Nat. abundance: 4.1%

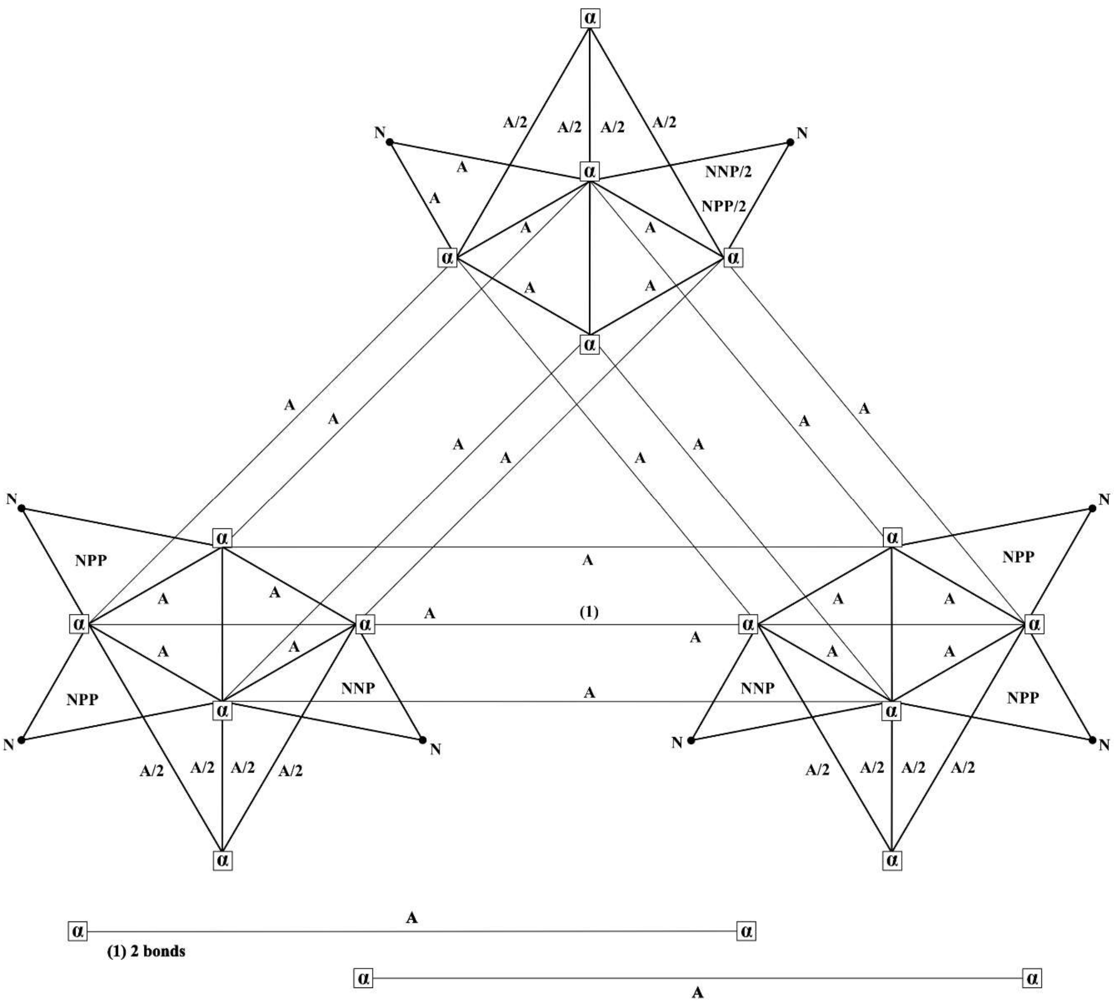
15	x	28.325	424.8750	MeV
15	x	4.9365	74.0475	
15	x	2.2246	33.3690	
0	x	8.4818	0	
0	x	7.7180	0	
2	x	4.9365	9.8730	
2	x	2.2246	4.4492	
0	x	8.4818	0	
5	x	7.7180	38.5900	
			585.2037	MeV
			+ 0.015	

$^{68}_{30}$**Zn**

Structure: 15 α, 8 N, 0 P supplementary

Linear and cross bonds: 30 A

N supplementary bonds: 2 A, 2.5 NNP, 4.5 NPP



$^{68}_{30}$**Zn**	15α, 8N, 0P supplementary	EB in MeV = 595.3862

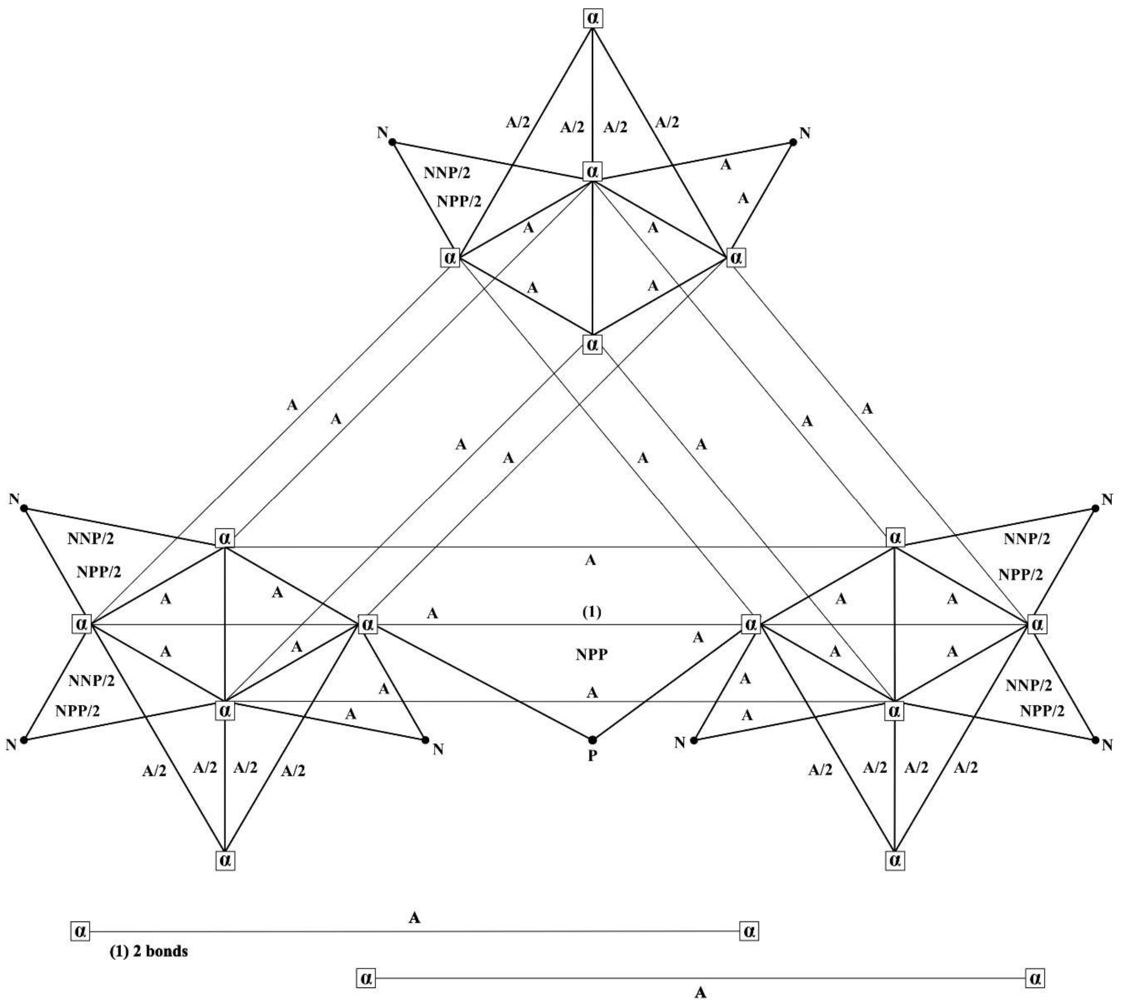
Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 18.8%	15	x	4.9365	74.0475	
	15	x	2.2246	33.3690	
	0	x	8.4818	0	
	0	x	7.7180	0	
	1	x	4.9365	4.9365	
	1	x	2.2246	2.2246	
	2.5	x	8.4818	21.2045	
	4.5	x	7.7180	34.7310	
				595.3881	MeV
				+ 0.002	

$^{69}_{31}$Ga

Structure: 15 α, 8 N, 1 P supplementary

Linear and cross bonds: 30 A

N, P supplementary bonds: 6 A, 2.5 NNP, 3.5 NPP



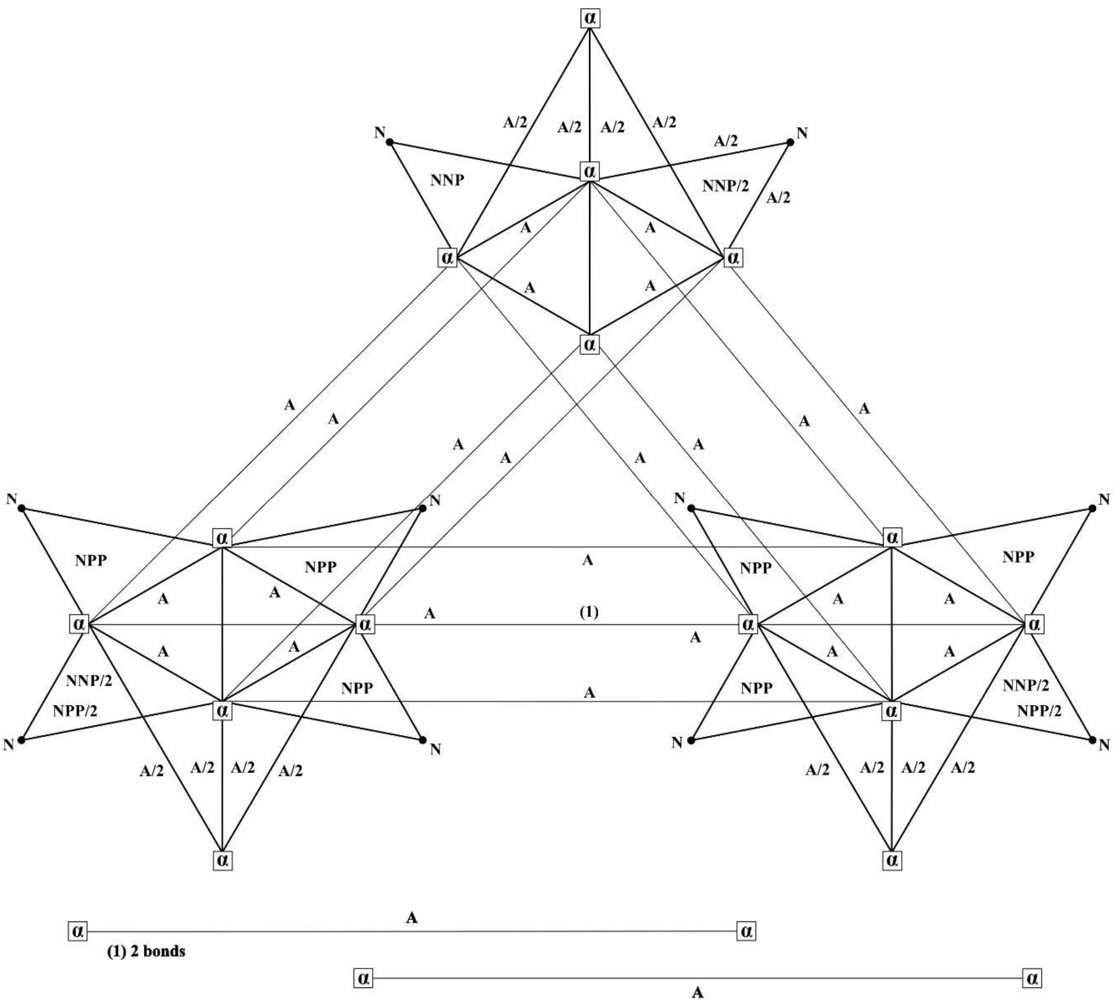
$^{69}_{31}$Ga	15α, 8N, 1P supplementary			EB in MeV = 601.9960	
Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 60%	15	x	4.9365	74.0475	
	15	x	2.2246	33.3690	
	0	x	8.4818	0	
	0	x	7.7180	0	
	3	x	4.9365	14.8095	
	3	x	2.2246	6.6738	
	2.5	x	8.4818	21.2045	
	3.5	x	7.7180	27.0130	
				601.9923	MeV
				- 0.004	

$^{70}_{30}$**Zn**

Structure: 15 α, 10 N, 0 P supplementary

Linear and cross bonds: 30 A

N supplementary bonds: 1 A, 2.5 NNP, 7 NPP



$^{70}_{30}$**Zn** 15α, 10N, 0P supplementary EB in MeV = 611.0866

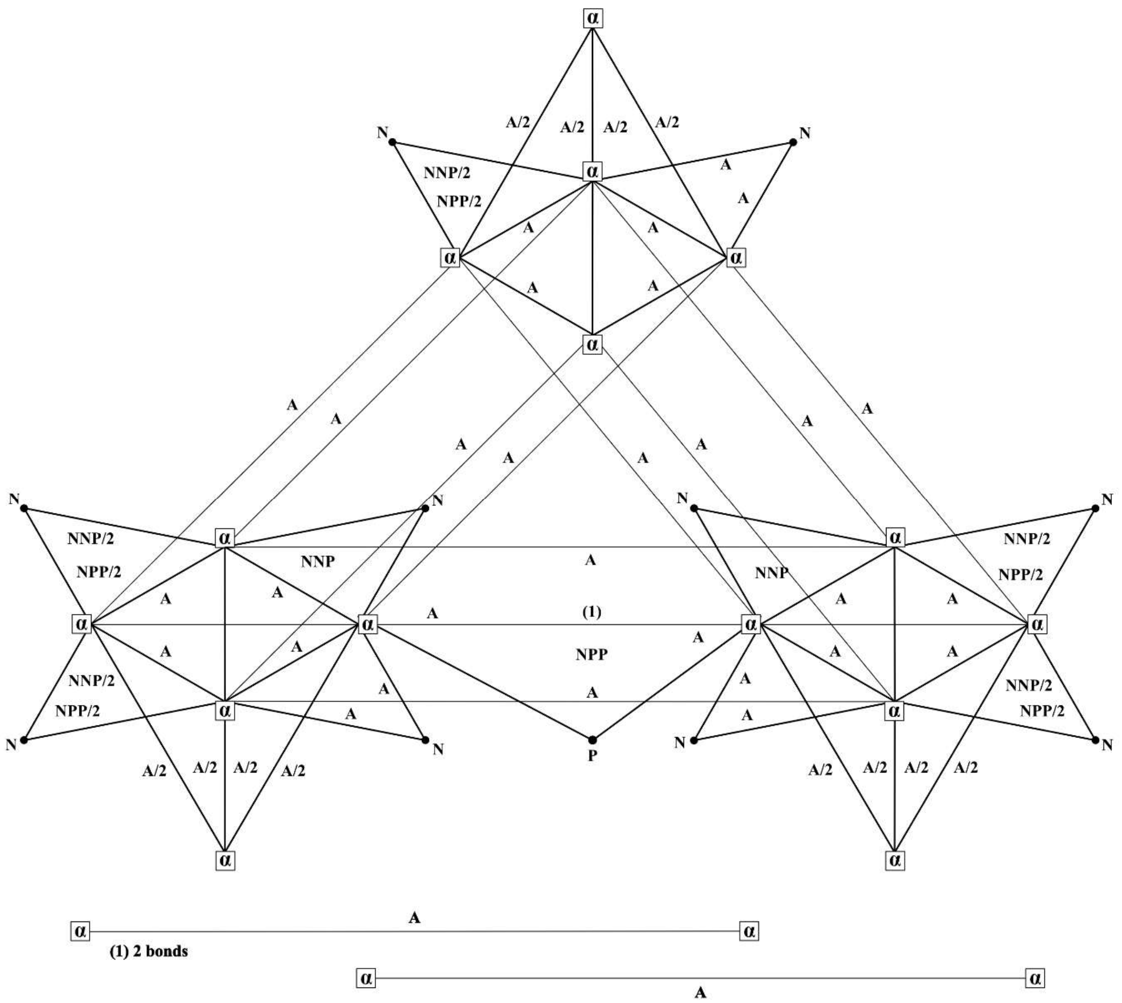
Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 0.6%	15	x	4.9365	74.0475	
	15	x	2.2246	33.3690	
	0	x	8.4818	0	
	0	x	7.7180	0	
	0.5	x	4.9365	2.4683	
	0.5	x	2.2246	1.1123	
	2.5	x	8.4818	21.2045	
	7	x	7.7180	54.0260	
				611.1026	MeV
				+ 0.016	

$^{71}_{31}$Ga

Structure: 15 α, 10 N, 1 P supplementary

Linear and cross bonds: 30 A

N, P supplementary bonds: 6 A, 4.5 NNP, 3.5 NPP



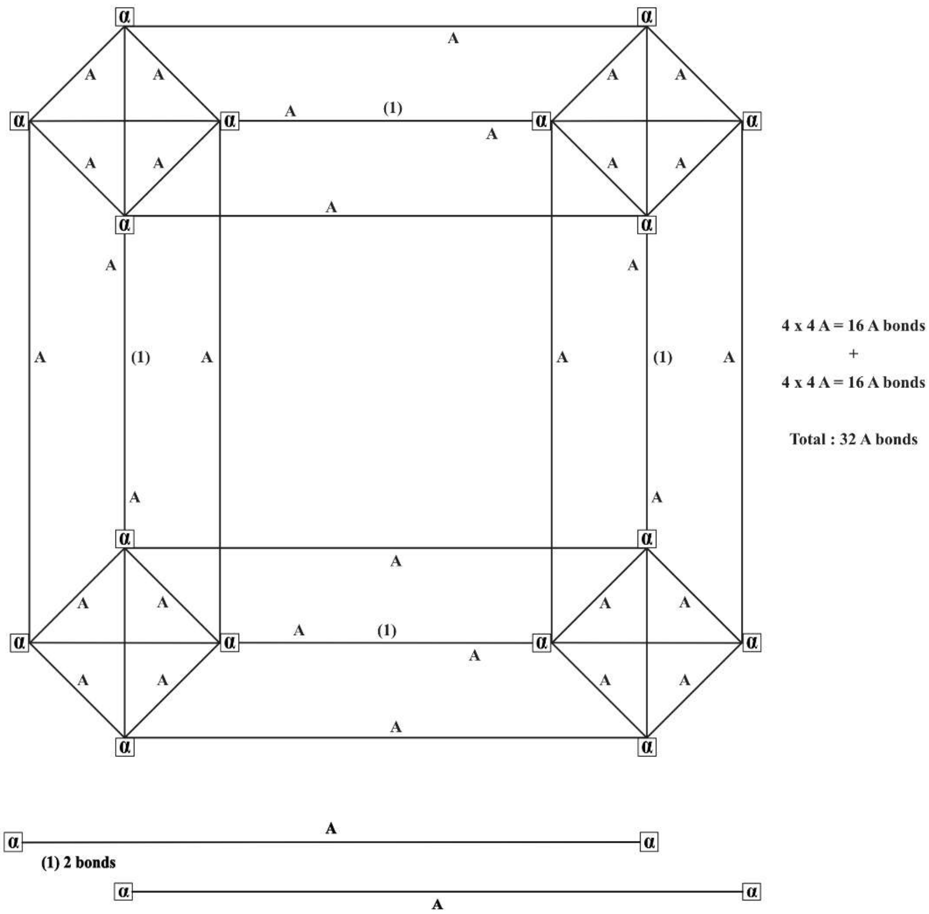
$^{71}_{31}$Ga 15α, 10N, 1P supplementary EB in MeV = 618.9499

Stable	15	x	28.325	424.8750	MeV
Nat. abundance: 40%	15	x	4.9365	74.0475	
	15	x	2.2246	33.3690	
	0	x	8.4818	0	
	0	x	7.7180	0	
	3	x	4.9365	14.8095	
	3	x	2.2246	6.6738	
	4.5	x	8.4818	38.1681	
	3.5	x	7.7180	27.0130	
				618.9559	MeV
				+ 0.006	

Compared to Ga 69, two N and two NNP bonds are added to that structure.

2. Ge and As stable nuclides

Core structures of Ge 32 and As 33: 16 α and 32 A bonds

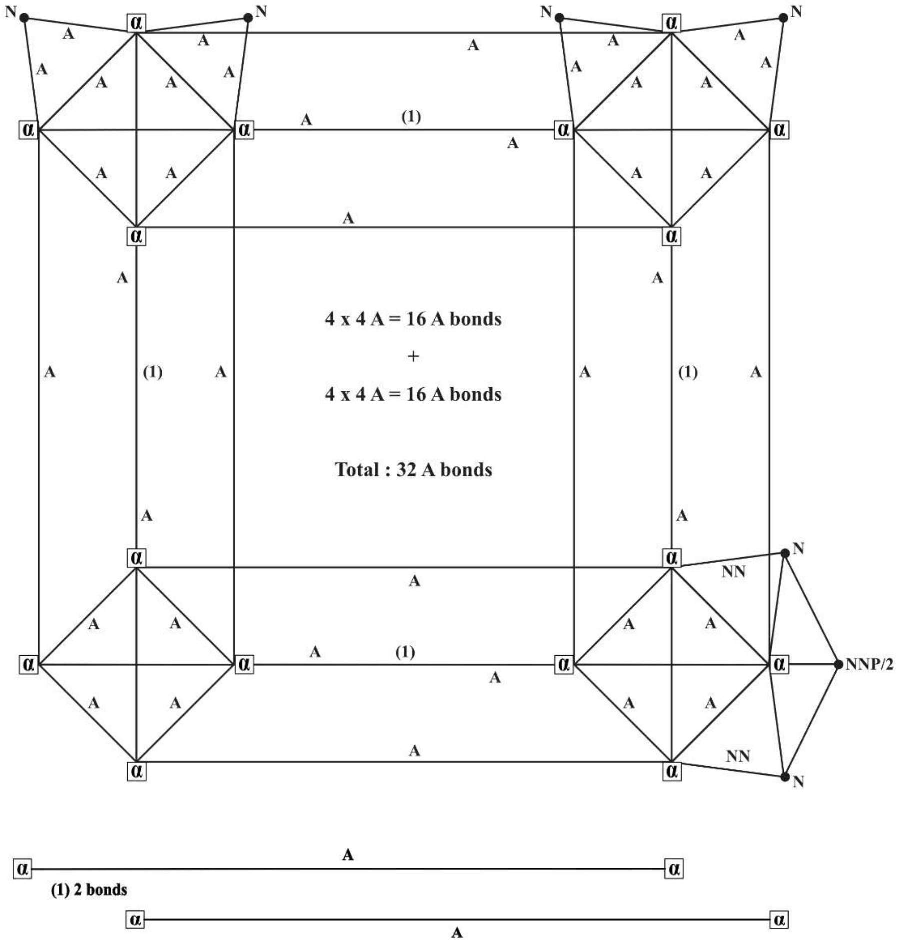


$^{70}_{32}$Ge

Structure: 16 α, 6 N, 0 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 8 A, 2 NN, 0.5 NNP, 0 NPP



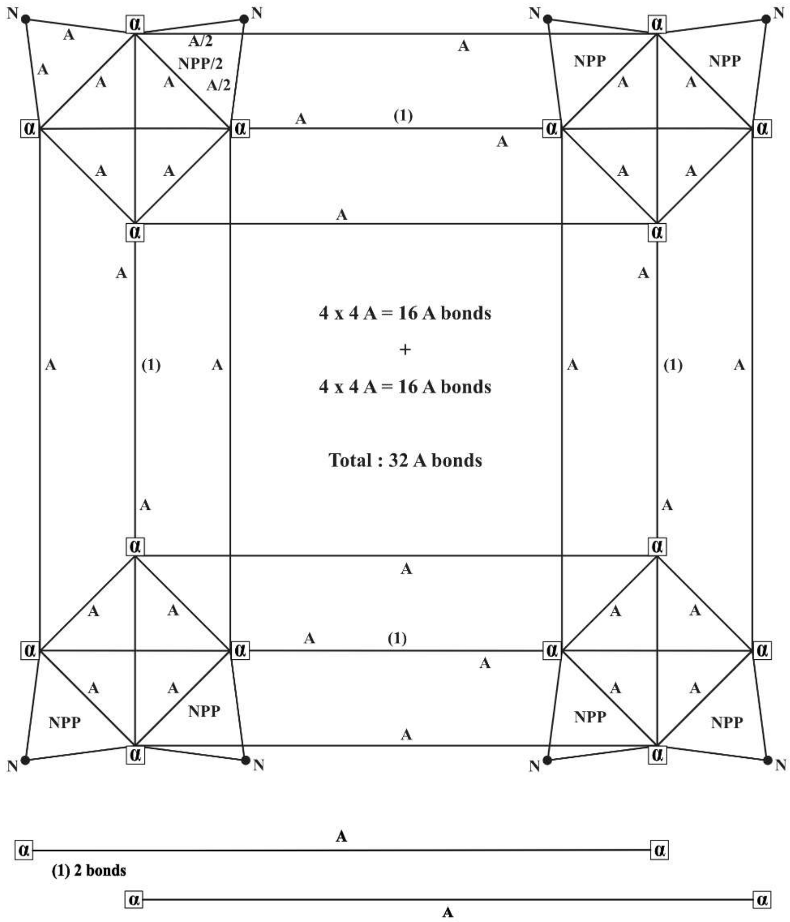
$^{70}_{32}$Ge	16 α, 6 N, 0 P supplementary			EB in MeV = 610.5190	
Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 20.5 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	6	x	4.9365	29.6190	
	4	x	2.2246	8.8984	
	0.5	x	8.4818	4.2409	
	0	x	7.7180	0	
				610.5359	MeV
				+ 0.017	

$^{72}_{32}$**Ge**

Structure: 16 α, 8 N, 0 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 3 A, 6.5 NPP



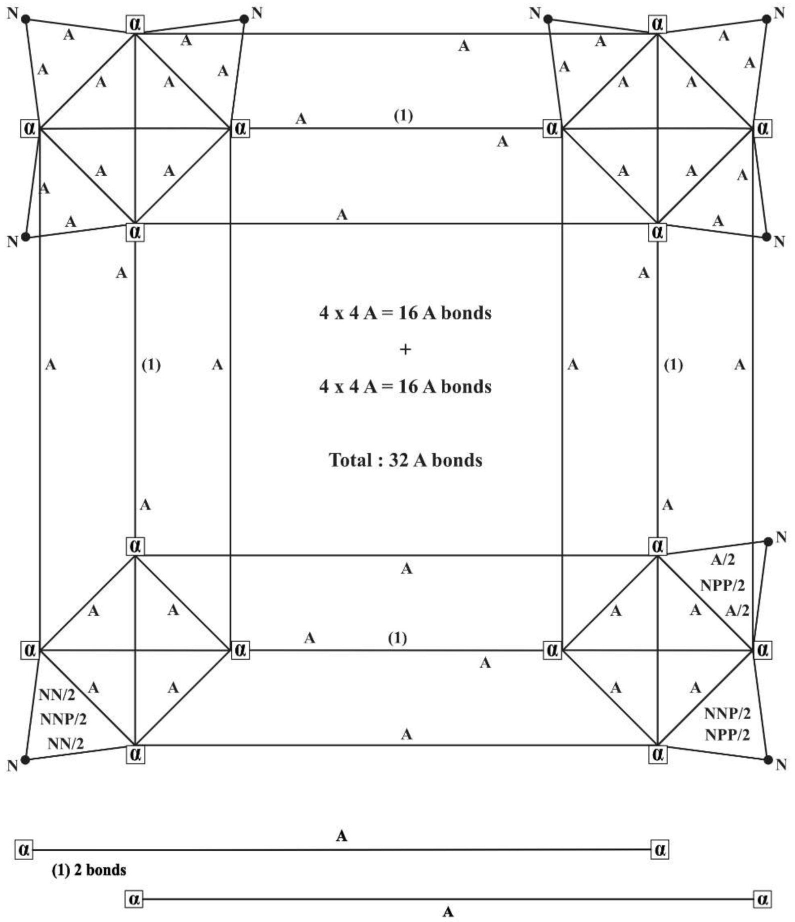
$^{72}_{32}$**Ge**	16 α, 8 N, 0 P supplementary			EB in MeV = 628.6856	
Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 27.4 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	1.5	x	4.9365	7.4048	
	1.5	x	2.2246	3.3369	
	0	x	8.4818	0	
	6.5	x	7.7180	50.1670	
				628.6863	MeV
				+ 0.001	

$^{73}_{32}$**Ge**

Structure: 16 α, 9 N, 0 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 13 A, 1 NN, 1 NNP, 1 NPP



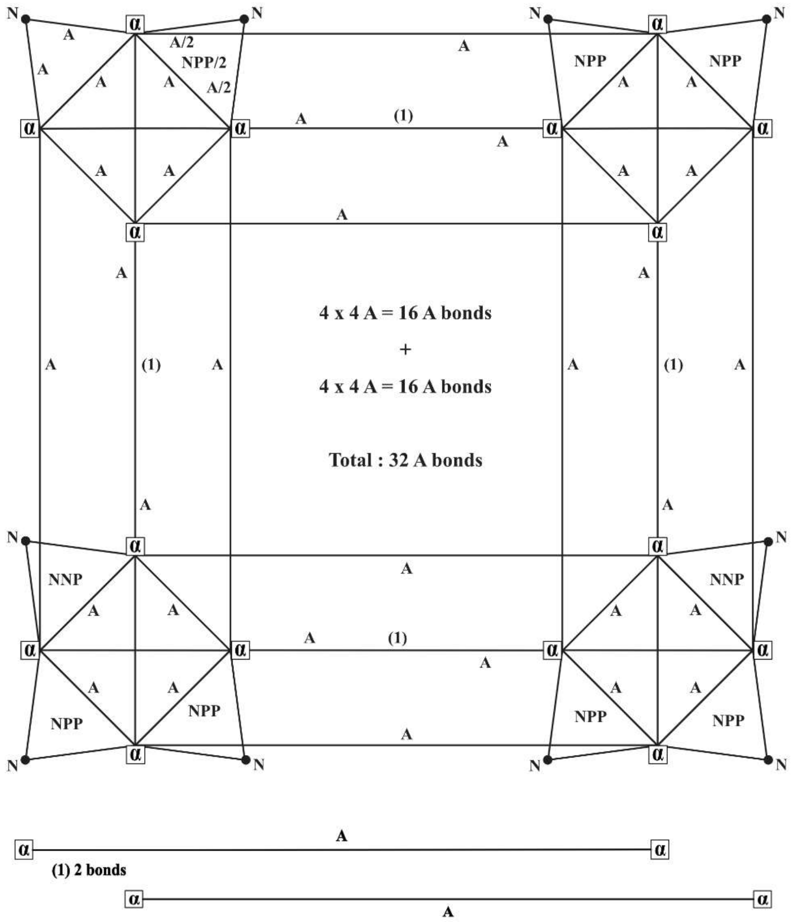
$^{73}_{32}$**Ge**	16 α, 9 N, 0 P supplementary			EB in MeV = 635.4686	
Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 7.8 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	7.5	x	4.9365	37.0238	
	6.5	x	2.2246	14.4599	
	1	x	8.4818	8.4818	
	1	x	7.7180	7.7180	
				635.4611	MeV
				- 0.007	

$^{74}_{32}$Ge

Structure: 16 α, 10 N, 0 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 3 A, 2 NNP, 6.5 NPP



$^{74}_{32}$Ge	16 α, 10 N, 0 P supplementary			EB in MeV = 645.6648	
Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 36.5 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	1.5	x	4.9365	7.4048	
	1.5	x	2.2246	3.3369	
	2	x	8.4818	16.9636	
	6.5	x	7.7180	50.1670	
				645.6499	MeV
				- 0.015	

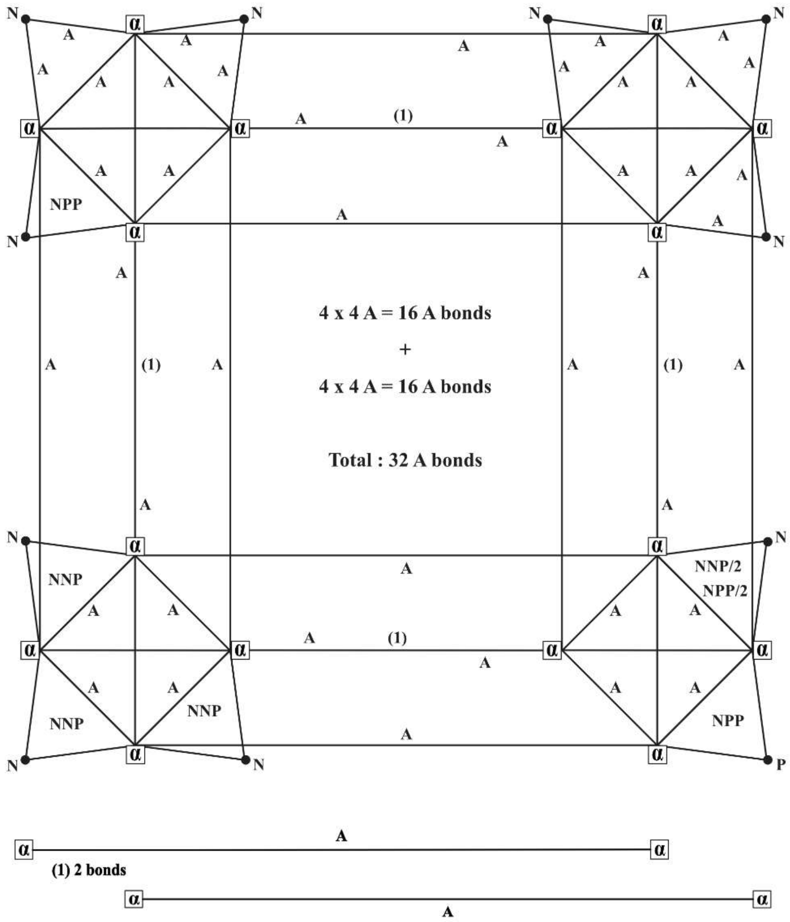
Compared to Ge 72, two N and two NNP bonds are added to that structure.

$^{75}_{33}$**As**

Structure: 16 α, 10 N, 1 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 10 A, 3.5 NNP, 2.5 NPP



$^{75}_{33}$**As** 16 α, 10 N, 1 P supplementary EB in MeV = 652.5656

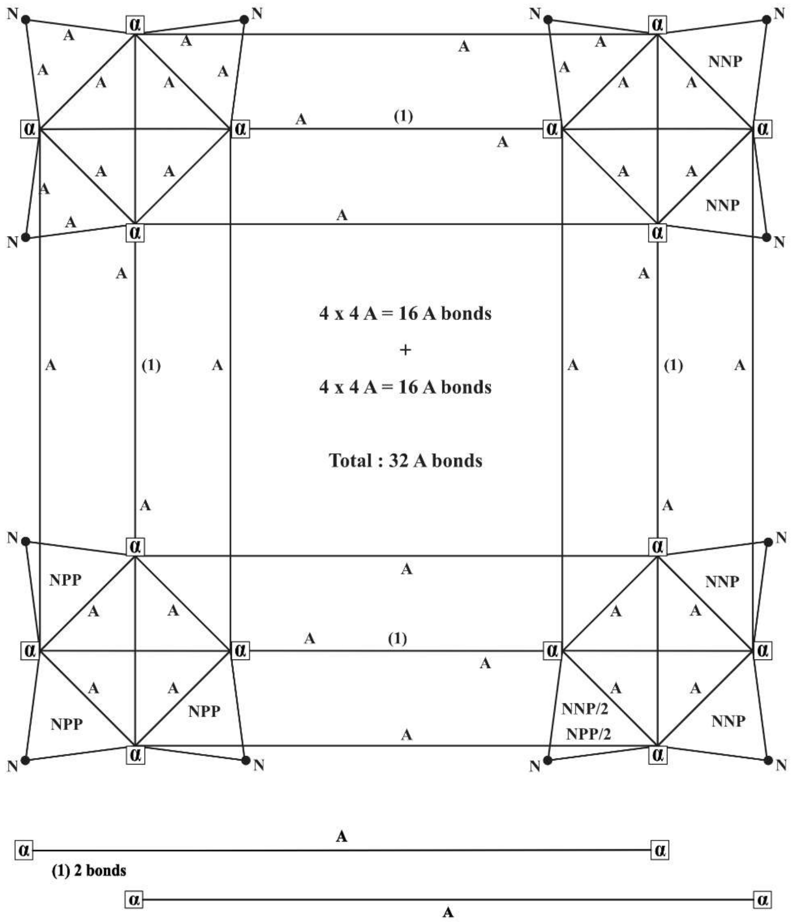
Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 100 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	5	x	4.9365	24.6825	
	5	x	2.2246	11.1230	
	3.5	x	8.4818	29.6863	
	2.5	x	7.7180	19.2950	
				652.5644	MeV
				- 0.001	

$^{76}_{32}$Ge

Structure: 16 α, 12 N, 0 P supplementary

Linear and cross bonds: 32 A

N supplementary bonds: 8 A, 4.5 NNP, 3.5 NPP

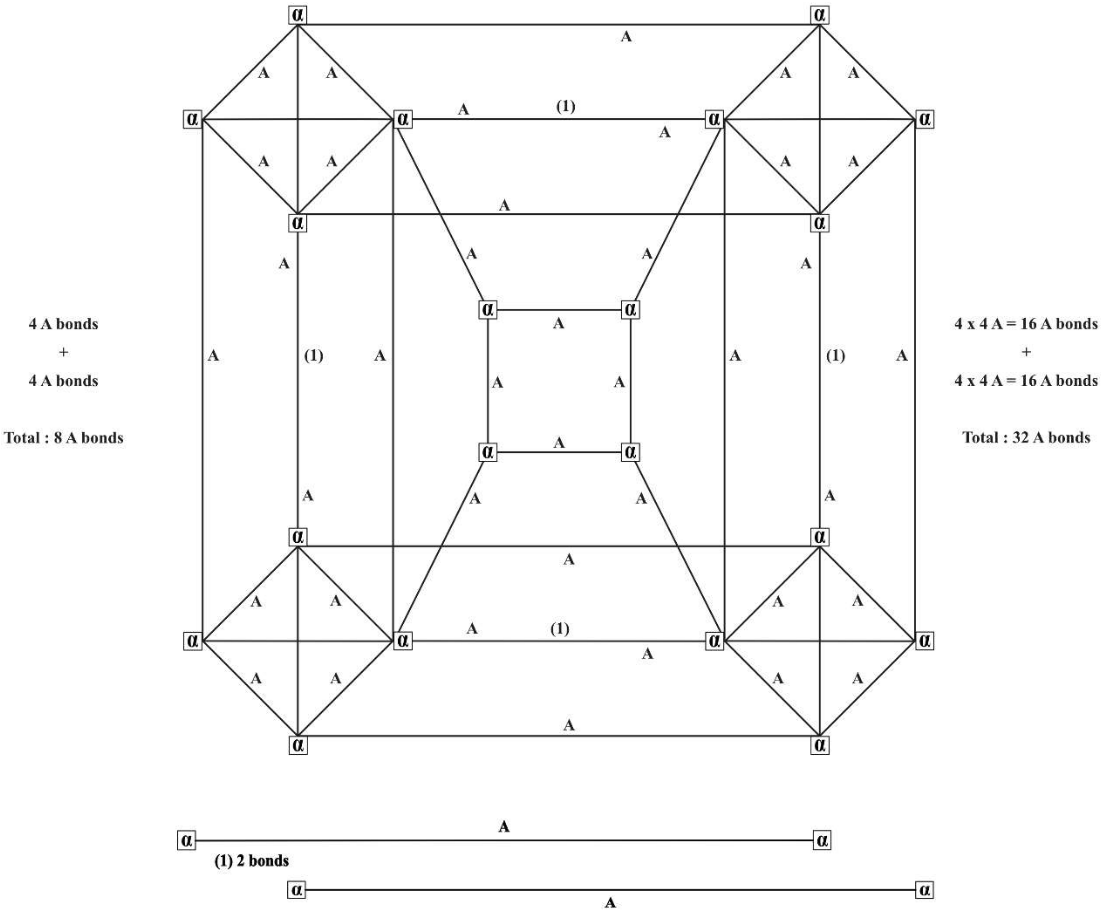


$^{76}_{32}$Ge 16 α, 12 N, 0 P supplementary E$_B$ in MeV = 661.5979

Stable	16	x	28.325	453.2000	MeV
Nat. abundance: 7.8 %	16	x	4.9365	78.9840	
	16	x	2.2246	35.5936	
	0	x	8.4818	0	
	0	x	7.7180	0	
	4	x	4.9365	19.7460	
	4	x	2.2246	8.8984	
	4.5	x	8.4818	38.1681	
	3.5	x	7.7180	27.0130	
				661.6031	MeV
				+ 0.005	

3. Zr 40 and Nb 41 stable nuclides

Core structure of Zr 40 and Nb 41: 20 α and 40 A bonds



$^{90}_{40}$**Zr** Nat. abund 51.4% 20α, 10 N suppl. EB in MeV = 783.8972

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
10 N suppl.	4.5	NN	22.2143	
	5.5	NP	12.2353	
	1.5	NNP	12.7227	
	3.5	NPP	27.0130	
			783.9073	MeV
			+ 0.010	

4 N → 4 x 2 A
1 N → 1 NNP
3 N → 3 NPP
1 N → (NNP/2 + NP)
1 N → (NPP/2 + A)

$^{91}_{40}$**Zr** Nat. abund 11.2% 20α, 11 N suppl. EB in MeV = 791.0916

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
11 N suppl.	7	NN	34.5555	
	7	NP	15.5722	
	0.5	NNP	4.2409	
	3.5	NPP	27.0130	
			791.1036	MeV
			+ 0.012	

7 N → 7 x 2 A
3 N → 3 NPP
1 N → (NNP/2 + NPP/2)

$^{92}_{40}$**Zr** Nat. abund 17.1% 20α, 12 N suppl. EB in MeV = 799.7264

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
12 N suppl.	4.5	NN	22.2143	
	5.5	NP	12.2353	
	2	NNP	16.9636	
	5	NPP	38.5900	
			799.7252	MeV
			- 0.001	

4 N → 4 x 2 A
1 N → 1 NNP
1 N → (NNP/2 + A)
1 N → (NNP/2 + NP)
5 N → 5 NPP

$^{93}_{41}$**Nb** Nat. abund 100% 20α, 12 N, 1 P suppl. EB in MeV = 805.7691

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
12 N, 1 P suppl.	7.5	NN	37.0238	
	8.5	NP	18.9091	
	2	NNP	16.9636	
	3	NPP	23.1540	
			805.7725	MeV
			+ 0.003	

7 N → 7 x 2 A
1 N → 1 NNP
1 N → (NNP/2 + A)
1 N → (NNP/2 + NP)
2 N → 2 NPP
1 P → 1 NPP

Compared with $^{92}_{40}$Zr, one P is added (bond = NPP) and 3 NPP of Zr 92 are transformed into 6 A bonds.

$^{94}_{40}$**Zr** Nat. abund 17.5% 20α, 14 N suppl. EB in MeV = 814.6793

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
14 N suppl.	9	NN	44.4285	
	9	NP	20.0214	
	2.5	NNP	21.2045	
	2.5	NPP	19.2950	
			814.6714	MeV
			- 0.008	

9 N → 9 x 2 A
5 N → 5 (NNP/2 + NPP/2)

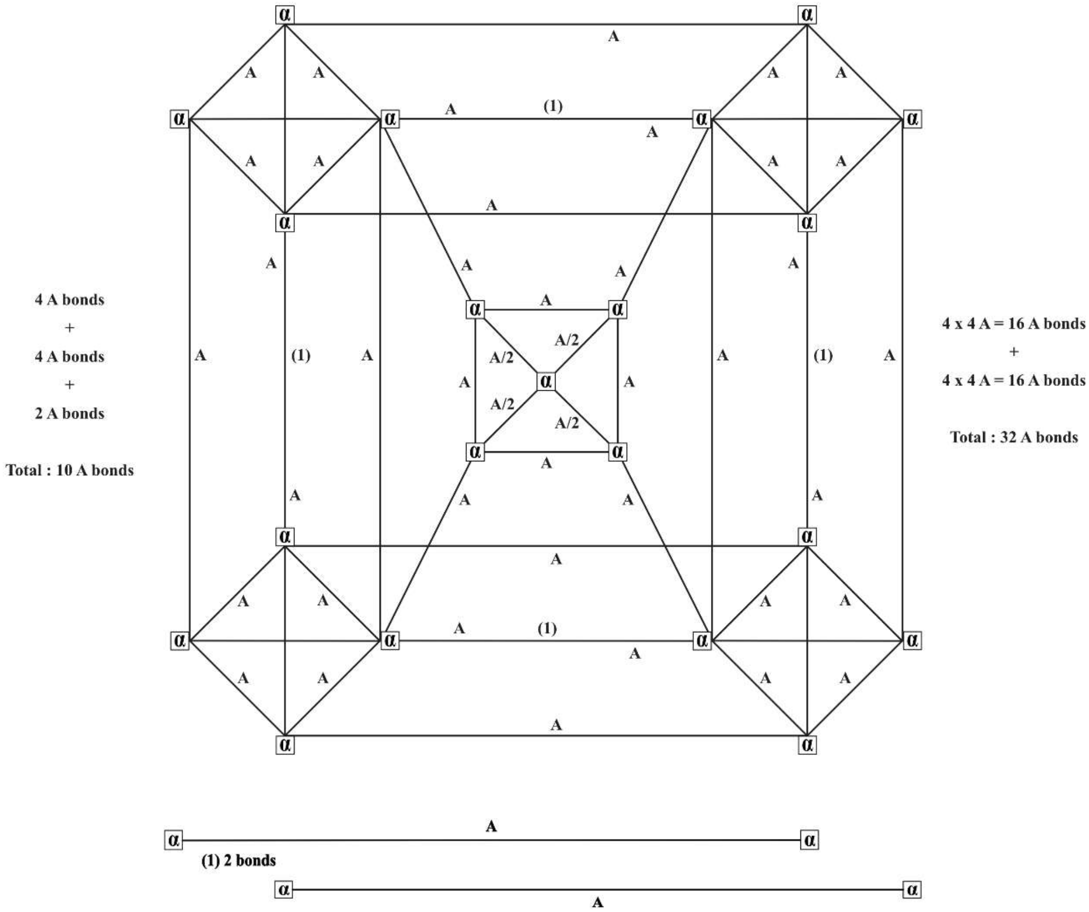
$^{96}_{40}$**Zr** Nat. abund 2.80% 20α, 16 N suppl. EB in MeV = 828.9914

Core	EB	20 α	566.5000	MeV
	20	NN	98.7300	
	20	NP	44.4920	
16 N suppl.	11	NN	54.3015	
	11	NP	24.4706	
	2.5	NNP	21.2045	
	2.5	NPP	19.2950	
			828.9936	MeV
			+ 0.002	

11 N → 11 x 2 A
5 N → 5 (NNP/2 + NPP/2)

4. Mo 42 and Tc 43 nuclides

4.1. Core structure of Mo42, Tc43: 21 α and 42 A bonds



$^{92}_{42}$**Mo** Nat. abund 14.8% 21α, 8 N suppl. EB in MeV = 796.5112

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
8 N suppl.	2.5	NN	12.3413	
	8.5	NP	18.9091	
	1	NNP	8.4818	
	1.5	NPP	11.5770	
			796.5173	MeV
			+ 0.006	

2 N → 2 x 2 A
1 N → A + NP
2 N → 2 (NNP/2 + NP)
3 N → 3 (NPP/2 + NP)

$^{94}_{42}$**Mo** Nat. abund 9.3% 21α, 10 N suppl. E_B in MeV = 814.2593

Core	E_B	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
10 N suppl.	6.5	NN	32.0873	
	9.5	NP	21.1337	
	0.5	NNP	4.2409	
	1.5	NPP	11.5770	
			814.2470	MeV
			- 0.012	

6 N → 6 x 2 A
1 N → NNP/2 + NP
2 N → 2 (NPP/2 + NP)
1 N → NPP/2 + A

$^{95}_{42}$**Mo** Nat. abund 15.9% 21α, 11 N suppl. E_B in MeV = 821.6284

Core	E_B	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
11 N suppl.	3.5	NN	17.2778	
	7.5	NP	16.6845	
	0	NNP	0	
	5.5	NPP	42.4490	
			821.6194	MeV
			- 0.009	

3 N → 3 x 2 A
1 N → NPP/2 + A
4 N → 4 (NPP/2 + NP)
3 N → 3 NPP

$^{96}_{42}$**Mo** Nat. abund 16.7% 21α, 12 N suppl. EB in MeV = 830.7828

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
12 N suppl.	4.5	NN	22.2143	
	7.5	NP	16.6845	
	0.5	NNP	4.2409	
	5.5	NPP	42.4490	
			830.7968	MeV
			+ 0.014	

4 N → 4 x 2 A
1 N → NNP/2 + A
3 N → 3 (NPP/2 + NP)
4 N → 4 NPP

$^{97}_{42}$**Mo** Nat. abund 9.6% 21α, 13 N suppl. EB in MeV = 837.6039

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
13 N suppl.	12	NN	59.2380	
	13	NP	28.9198	
	0.5	NNP	4.2409	
	0	NPP	0	
			837.6068	MeV
			+ 0.003	

12 N → 12 x 2 A
1 N → NNP/2 + NP

$^{97}_{43}$Tc Lifetime 2.6 x 10^6y, Ec decay 21α, 12N, 1P suppl. EB in MeV = 836.5013

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
12N, 1P suppl.	9.5	NN	46.8968	
	12.5	NP	27.8075	
	1.5	NNP	12.7227	
	0.5	NPP	3.8590	
			836.4941	MeV
			- 0.007	

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

$^{98}_{42}$Mo Nat. abund 24.1% 21α, 14 N suppl. EB in MeV = 846.2465

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
14 N suppl.	11	NN	54.3015	
	12	NP	26.6952	
	1	NNP	8.4818	
	1.5	NPP	11.5770	
			846.2636	MeV
			+ 0.017	

11 N → 11 x 2 A
1 N → NPP/2 + NP
1 N → NNP
1 N → NPP

$^{98}_{43}$**Tc** Lifetime 1.5 x 10^6y, β^- decay 21α, 13N, 1P suppl. EB in MeV = 843.7804

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
13N, 1P suppl.	8	NN	39.4920	
	12	NP	26.6952	
	2	NNP	16.9636	
	2	NPP	15.4360	
			843.7949	MeV
			+ 0.014	

8 N → 8 x 2 A
2 N → 2 (NNP/2 + NP)
1 N → NNP
2 N → 2 NPP
1 P → 2 NP

$^{99}_{42}$**Mo** Lifetime 66,69 hours, β^- decay 21α, 15N suppl. EB in MeV = 852.1719

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
15 N suppl.	12	NN	59.2380	
	14	NP	31.1444	
	1.5	NNP	12.7227	
	0.5	NPP	3.8590	
			852.1722	MeV
			/	

12 N → 12 x 2 A
2 N → 2 (NNP/2 + NP)
1 N → NNP/2 + NPP/2

$^{99}_{43}$**Tc** Lifetime 2.12 x 10^5y, 21α, 14N, 1P suppl. EB in MeV = 852.7474

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
14N, 1P suppl.	12.5	NN	61.7063	
	13.5	NP	30.0321	
	0.5	NNP	4.2409	
	1.5	NPP	11.5770	
			852.7644	MeV
			+ 0.017	

12 N → 12 x 2 A
1 N → NNP/2 + A
1 N → NPP
1 P → NPP/2 + NP

$^{100}_{42}$**Mo** Nat. abund 9.6% 21α, 16 N suppl. EB in MeV = 860.4662

Core	EB	21 α	594.8250	MeV
	21	NN	103.6665	
	21	NP	46.7166	
16 N suppl.	12.5	NN	61.7063	
	13.5	NP	30.0321	
	0.5	NNP	4.2409	
	2.5	NPP	19.2950	
			860.4824	MeV
			+ 0.016	

12 N → 12 x 2 A
1 N → NNP/2 + NP
1 N → NPP/2+ A
2 N → 2 NPP

4.2. "Liquid drop" arrangements

Hereunder the binding energy breakdown of the Mo 42 and Tc 43 nuclides. The structures of the core, on one side, and that of the N and P supplementary are partially inverted compared to the former presentation at point 4.1. The N supplementary are linked to the α's with 2 A bonds and the P supplementary with one NPP bond.

This occurs a "stress" among the core and a struggle between core and supplementary nucleons. There are not enough bond possibilities for both. The core area tends to organize itself with as many transversal A bonds as possible.

Summary of bonds values

	Direct bonds	Suppl. N and P bonds	Transversal bonds					Transversal bonds value
Mo 92	21A	16A	14A	0.5 NN	4 NP	1 NPP	/	124.4375
Mo 94	21A	20A	14A	/	3 NP	1.5 NPP	0.5 NNP	130.5625
Mo 95	21A	22A	17A	/	/	1 NPP	0.5 NNP	130.9375
Mo 96	21A	24A	15A	1 NN	/	1 NPP	1 NNP	134.5625
Mo 97	21A	26A	19A	/	1 NP	/	0.5 NNP	133.9375
Tc 97	21A	24A + NPP	17A	/	/	1 NPP	0.5 NNP	130.9375
Mo 98	21A	28A	16A	0.5 NN	/	1 NPP	1 NNP	136.5625
Tc 98	21A	26A + NPP	19A	1 NN	/	/	/	131.1875
Mo 99	21A	30A	19A	0.5 NN	/	/	0.5 NNP	134.3750
Tc 99	21A	28A + NPP	19A	0.5 NN	/	/	0.5 NNP	134.3750
Mo 100	21A	32A	20A	/	/	/	0.5 NNP	136.3750

The transversal bonds value should ideally be equal to 21A, as for the direct bonds value. It is slightly different.

Standard value: 21A = 135.1875 lines

1) Mo 98 and Mo 100 values are higher.

Mo 98	136.5625	+ 1.375 (NNP-NPP)
Mo 100	136.375	+ 1.1875 (NNP/2 - A)

In case of Mo 100, it is obvious that the replacement of NNP/2 by A leads to 21A.

In case of Mo 98, if the NNP bond were a NPP bond, the situation would be the same. Nevertheless, a supplementary transformation would be necessary to come to the result of 21A:

2 NPP = 4A + 0.5 NP
0.5 NN + 0.5 NP = A
So, 5A bonds would be created to be added to the 16A bonds.

2) Another interesting result is the relationship between Mo 97 and Tc 97, Mo 98 and Tc 98 and Mo 99 and Tc 99.

Mo 99 and Tc 99 have the same distribution of binding energy except that a supplementary P replaces a supplementary N, inducing a binding energy value of NP/4 more [NPP = NN + 1.25 NP]. This explains the rapid decay of Mo into Tc.

Concerning Mo 97 and Tc 97, the difference in E_B can be described as NP/2. The supplementary P and N bonds value differ with NP/4 (= 1 line = NPP - 2A) and the transversal bonds value with 0.75 NP (= 3 lines = 2A + NP - NPP). So, the total difference can be described as 2 lines or NP/2.

In case of Mo 98 and Tc 98 the difference can be described as

4.375 lines = [+ 1 line (NPP - 2A)
- 5.375 lines = - NP - NNP + NPP

3) Mo 92, Mo 94 and Mo 95 binding energy values are slightly inferior to the standard.

Mo 92	135.1875 - 124.4375 = 10.75
Mo 94	135.1875 - 130.5625 = 4.625
Mo 95	135.1875 - 130.9375 = 4.25

Nevertheless, these value differences are weak, between NP and (NP + NN).

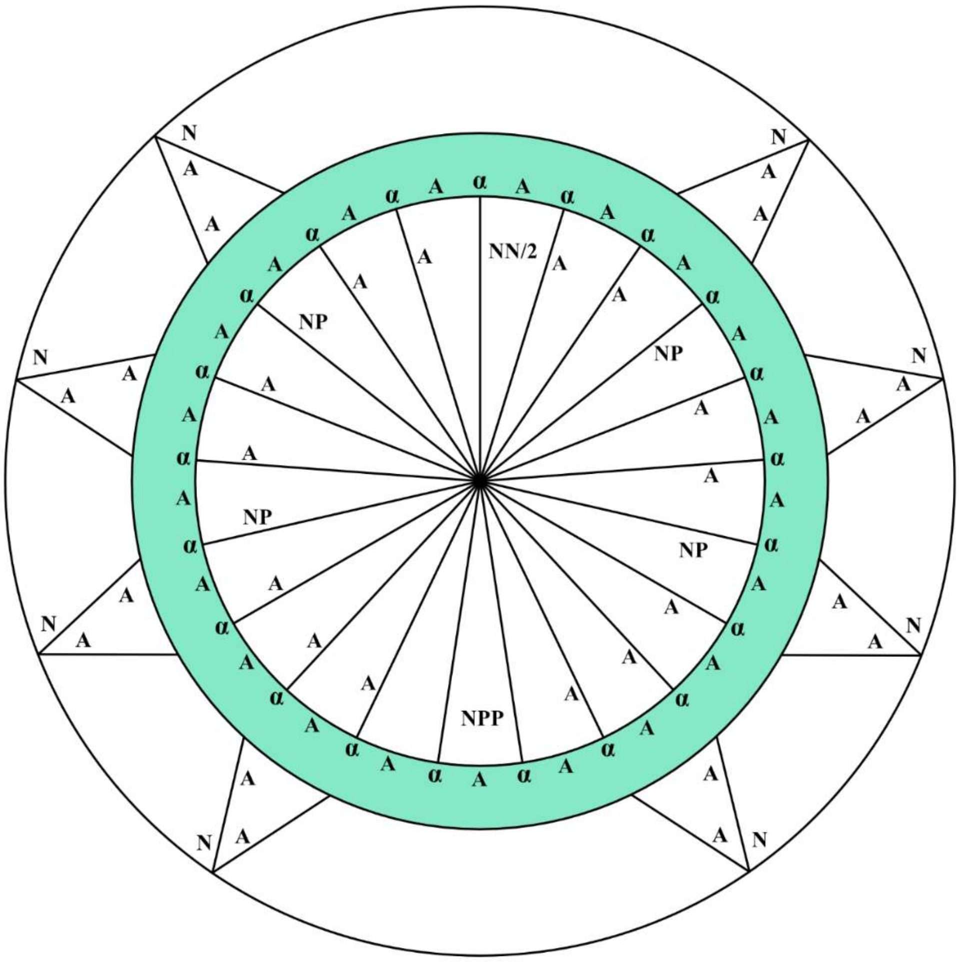
4) Tc 97, Tc 98 and Tc 99 are not stable:

- The bonds arrangement of Mo and Tc are very similar. Nevertheless, Mo contains 21 α and Tc 21 α and one proton more. This occurs a greater weakness of that element compared with Mo and Ru containing an even number of protons, hence only α particles and neutrons in their structure.
- Tc 97 decays into Mo 97, 2 NPP being transformed into 2 x 2 A occurring the creation of 1 NP bond.
- Tc 98 and Tc 99 become Ru 98 and Ru 99, the bonds arrangement of Ru being different: 22 α and 40 A bonds instead of 22 α and 44 A bonds (see point 5).

$^{92}_{42}$Mo 21α, 8N suppl. E_B exp. = 796.5112 MeV

21	E_B α	594.8250	MeV
26	NN	128.3490	
29.5	NP	65.6257	
1	NPP	7.7180	
		796.5177	MeV
		+ 0.006	

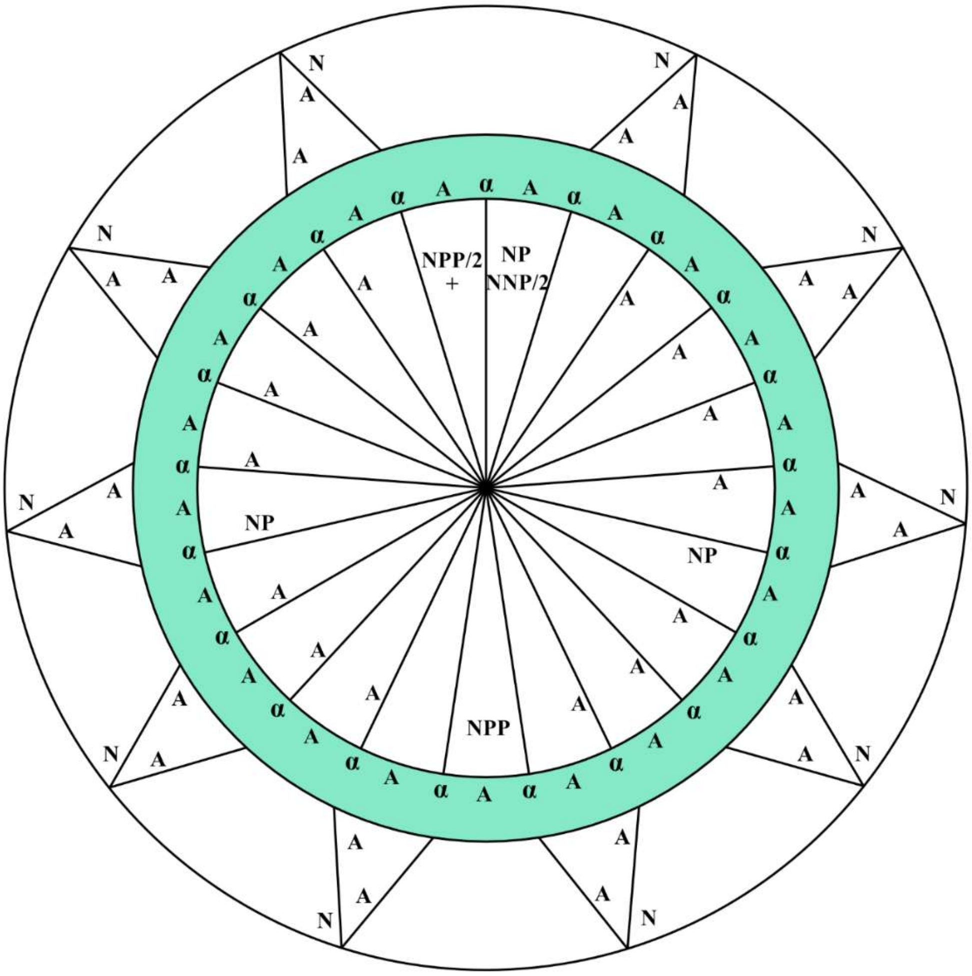
8 suppl. N linked each to 2 α by 8 x 2A bonds
21 α linked directly by 21A bonds and transversally by
14A, 0.5 NN, 4 NP, 1 NPP bonds



$^{94}_{42}$**Mo** 21α, 10N suppl. E_B exp. = 814.2593 MeV

21	E_B α	594.8250	MeV
27.5	NN	135.7538	
30.5	NP	67.8503	
1.5	NPP	11.5770	
0.5	NNP	4.2409	
		814.2470	MeV
		- 0.012	

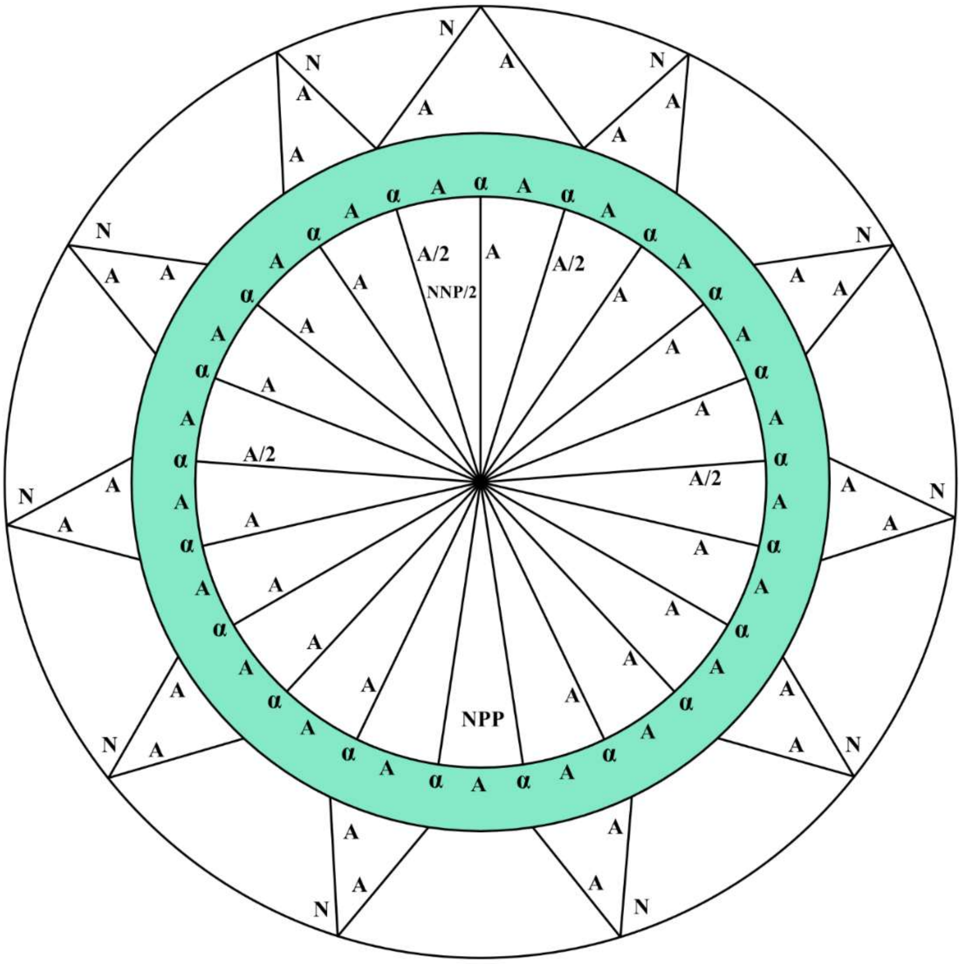
10 suppl. N linked each to 2 α by 10 x 2A bonds
21 α linked directly by 21A bonds and transversally by
14A, 3 NP, 1.5 NPP, 0.5 NNP bonds



$^{95}_{42}$**Mo** 21α, 11N suppl. E_B exp. = 821.6284 MeV

21	E_B α	594.8250	MeV
30	NN	148.0950	
30	NP	66.7380	
1	NPP	7.7180	
0.5	NNP	4.2409	
		821.6169	MeV
		- 0.012	

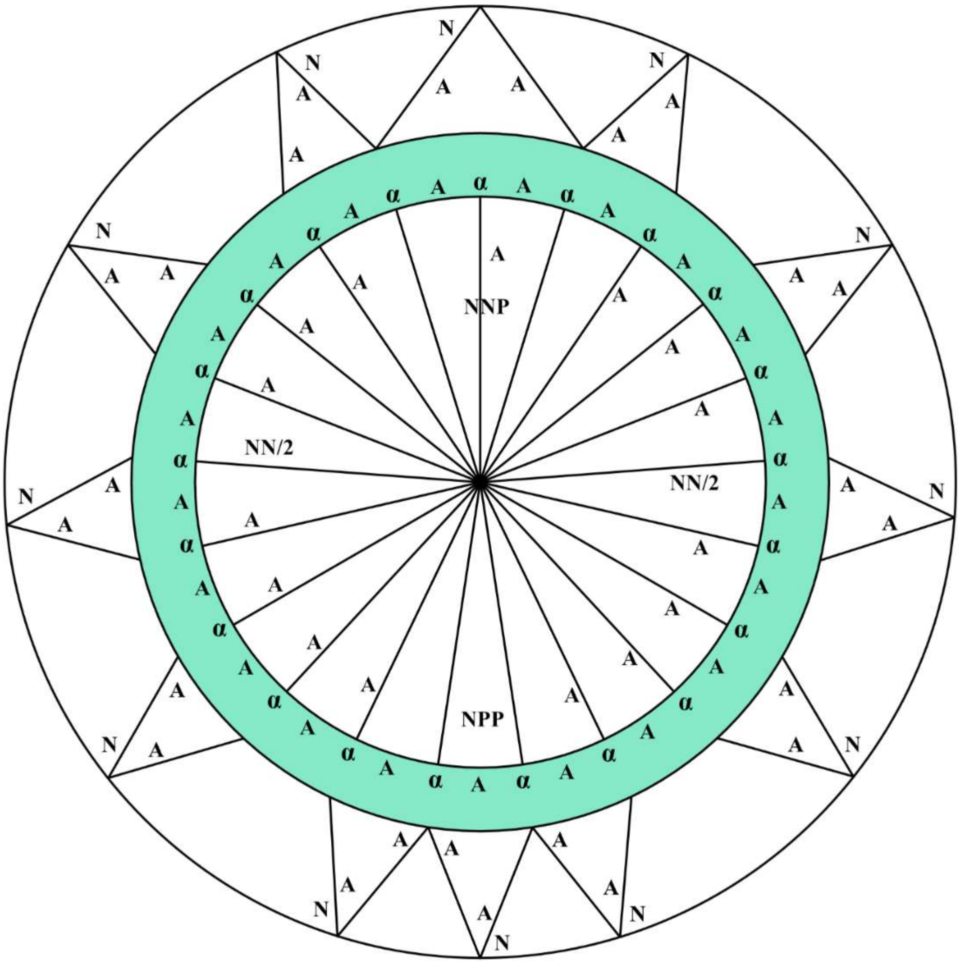
11 suppl. N linked each to 2 α by 11 x 2A bonds
21 α linked directly by 21A bonds and transversally by
17A, NPP, 0.5 NNP bonds



$^{96}_{42}$**Mo** 21α, 12N suppl. E_B exp. = 830.7828 MeV

21	E_B α	594.8250	MeV
31	NN	153.0315	
30	NP	66.7380	
1	NPP	7.7180	
1	NNP	8.4818	
		830.7943	MeV
		+ 0.012	

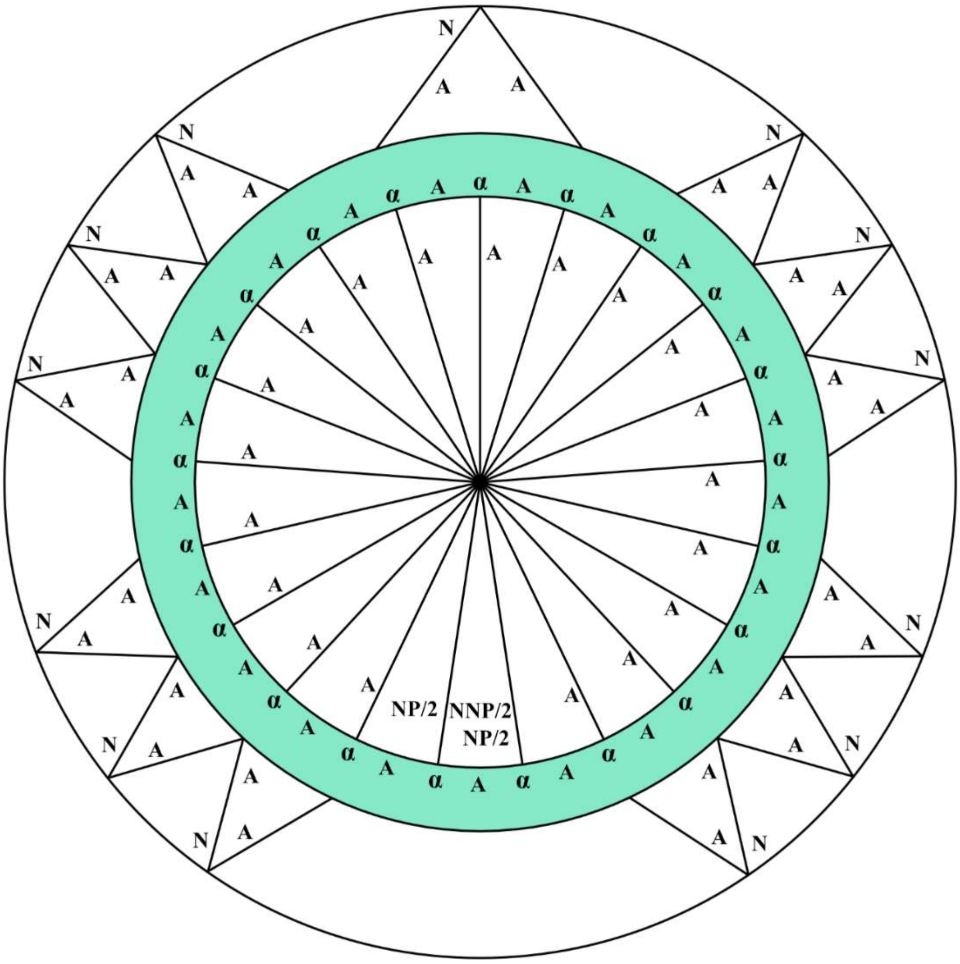
12 suppl. N linked each to 2 α by 12 x 2A bonds
21 α linked directly by 21A bonds and transversally by
15A, 1 NN, 1 NPP, 1 NNP bonds



$^{97}_{42}$**Mo** 21α, 13N suppl. E_B exp. = 837.6039 MeV

21	E_B α	594.8250	MeV
33	NN	162.9045	
34	NP	75.6364	
0.5	NNP	4.2409	
		837.6068	MeV
		+ 0.003	

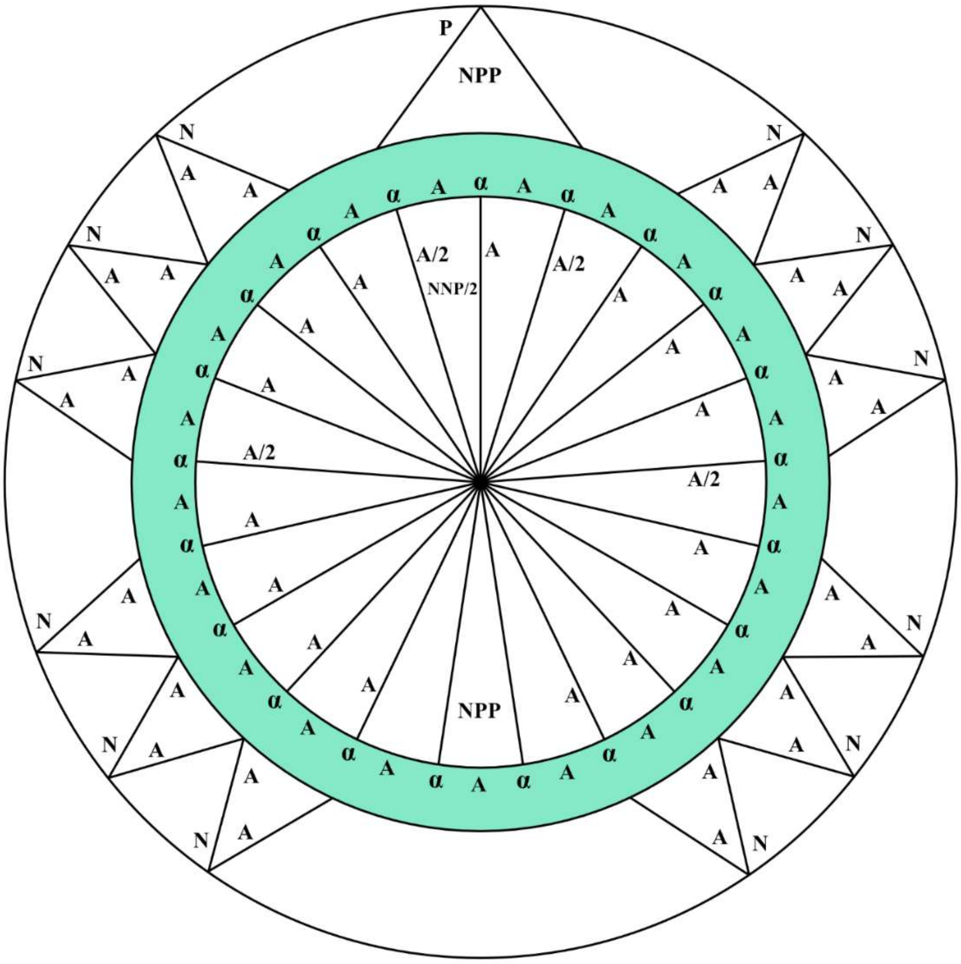
13 suppl. N linked each to 2 α by 13 x 2A bonds
21 α linked directly by 21A bonds and transversally by
19A, 1 NP, 0.5 NNP bonds



$^{97}_{43}$**Tc** 21α, 12N, 1P suppl. EB exp. = 836.5013 MeV

21	EB α	594.8250	MeV
31	NN	153.0315	
31	NP	68.9626	
2	NPP	15.4360	
0.5	NNP	4.2409	
		836.4960	MeV
		- 0.005	

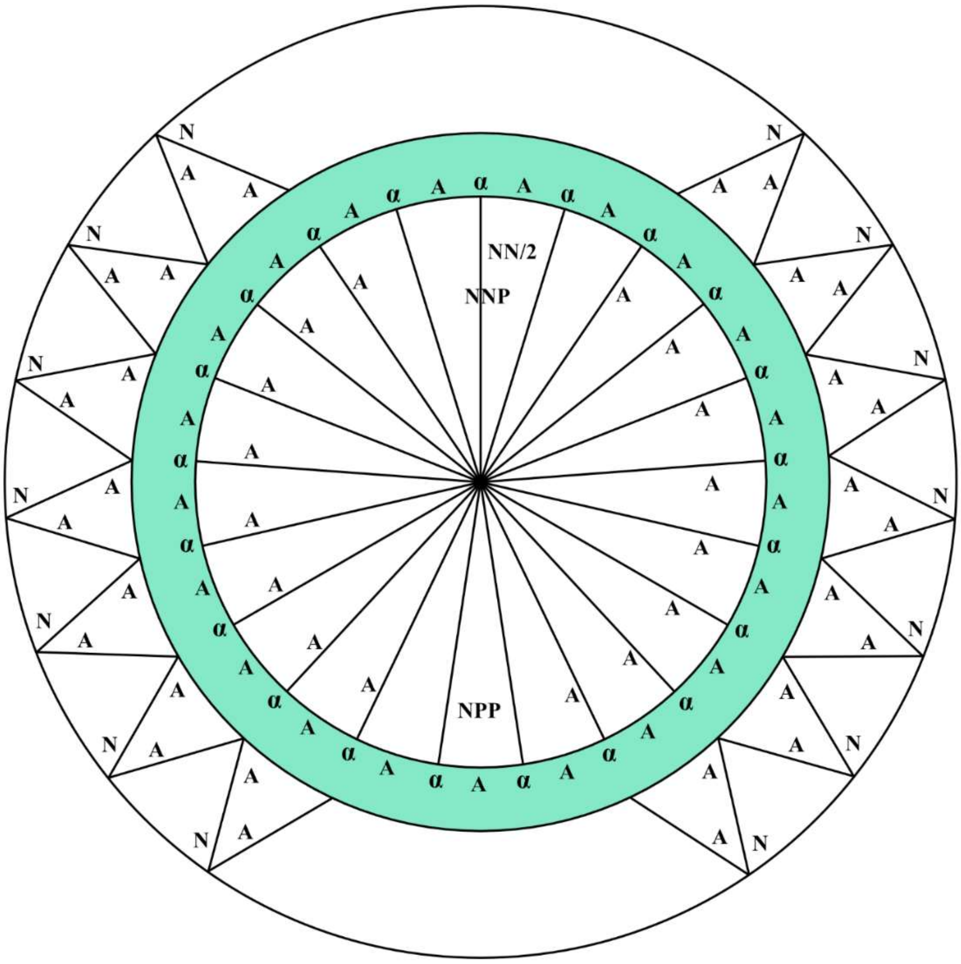
12 suppl. N linked each to 2 α by 12 x 2A bonds, 1 suppl. P linked to 2 α by 1 NPP bond.
21 α linked directly by 21A bonds and transversally by
17A, NPP, 0.5 NNP bonds



$^{98}_{42}$Mo 21α, 14N suppl. E_B exp. = 846.2465 MeV

21	E_B α	594.8250	MeV
33	NN	162.9045	
32.5	NP	72.2995	
1	NPP	7.7180	
1	NNP	8.4818	
		846.2288	MeV
		- 0.018	

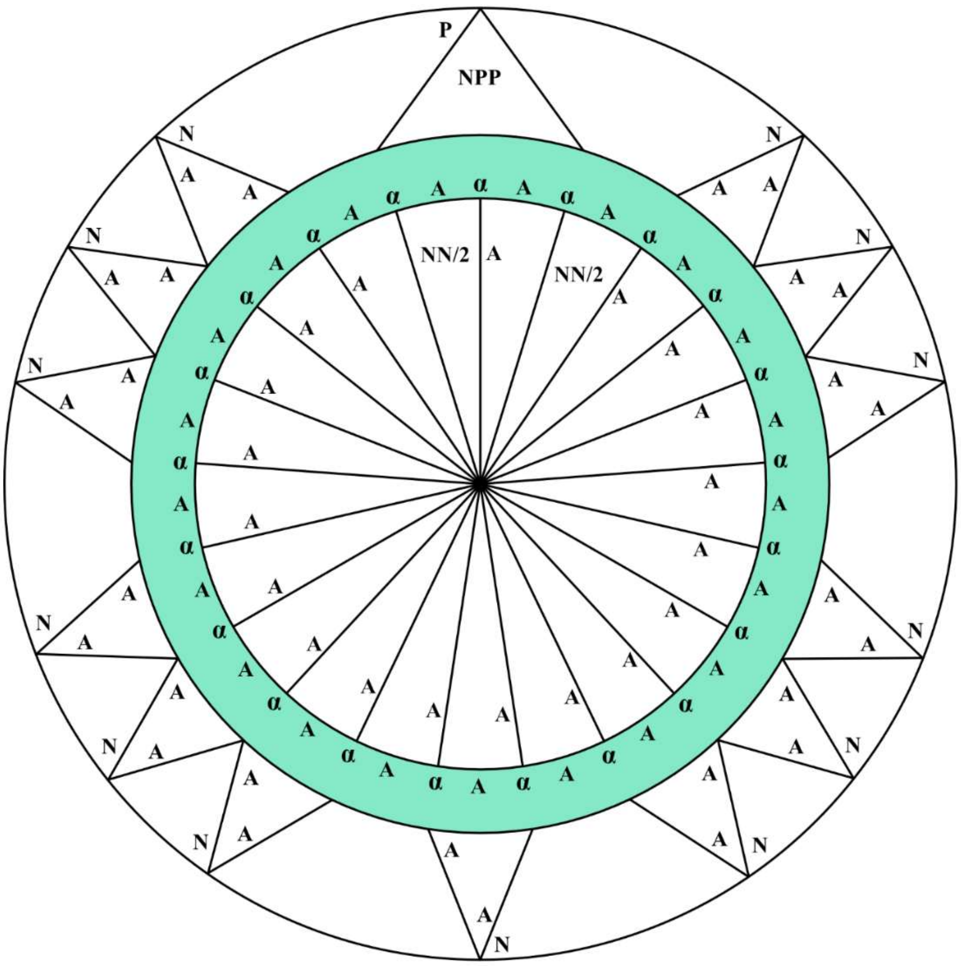
14 suppl. N linked each to 2 α by 14 x 2A bonds
21 α linked directly by 21A bonds and transversally by
16A, 0.5 NN, 1 NPP, 1 NNP bonds



$^{98}_{43}$**Tc** 21α, 13N, 1P suppl. E_B exp. = 843.7804 MeV

21	E_B α	594.8250	MeV
34	NN	167.8410	
33	NP	73.4118	
1	NPP	7.7180	
		843.7958	MeV
		+ 0.015	

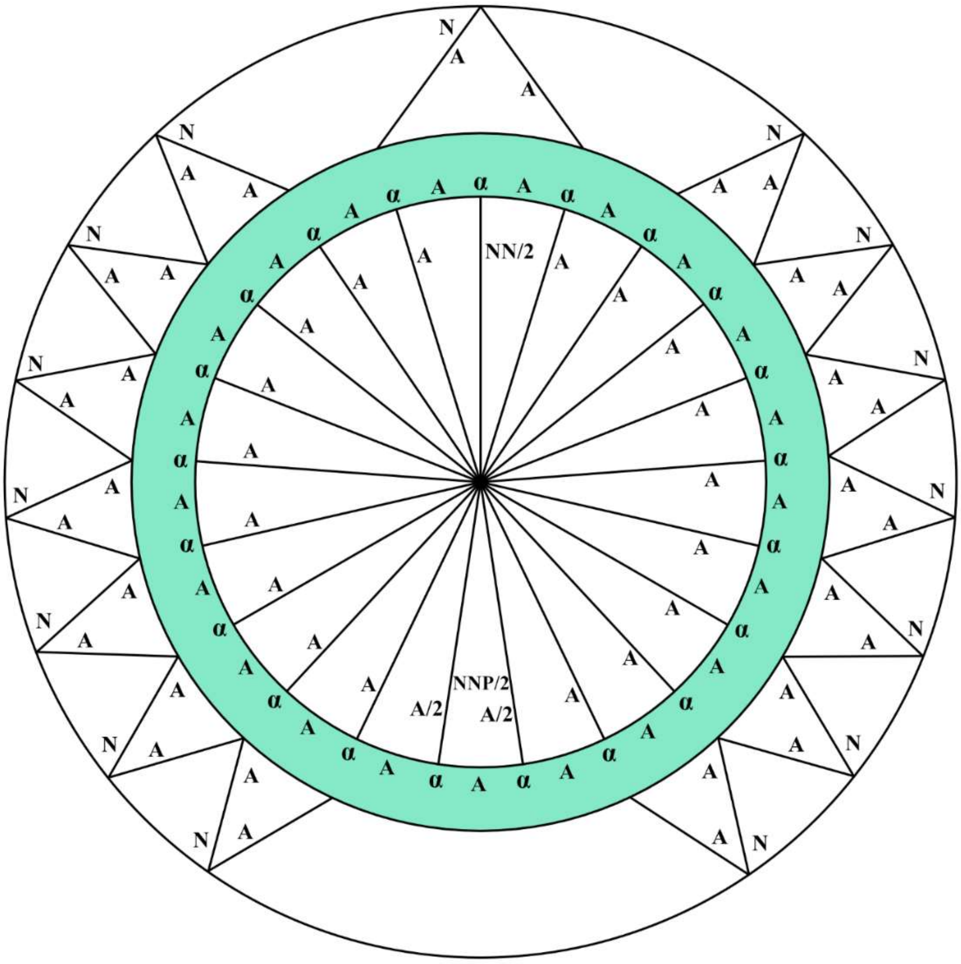
13 suppl. N linked each to 2 α by 13 x 2A bonds, 1 suppl. P linked to 2 α by 1 NPP bond.
21 α linked directly by 21A bonds and transversally by
19A, 1 NN bonds



$^{99}_{42}$Mo — 21α, 15N suppl. — E_B exp. = 852.1719 MeV

21	E_B α	594.8250	MeV
35.5	NN	175.2458	
35	NP	77.8610	
0.5	NNP	4.2409	
		852.1727	MeV
		+ 0.001	

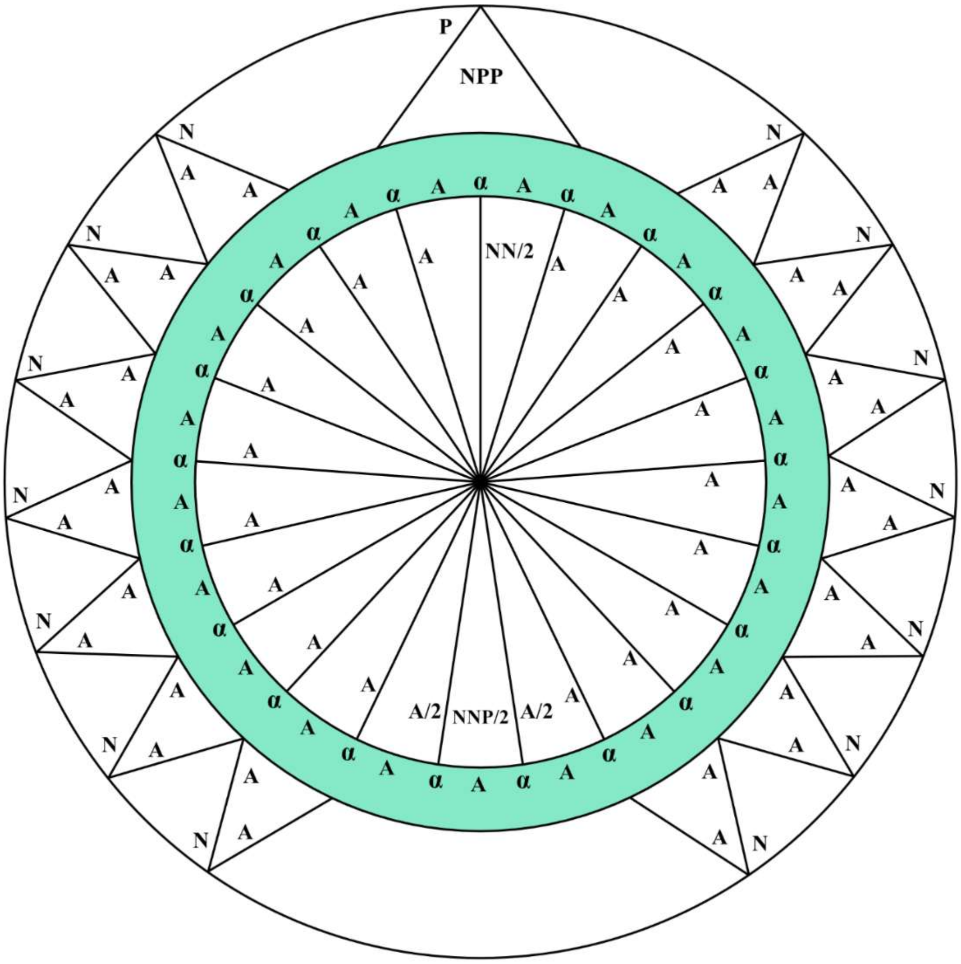
15 suppl. N linked each to 2 α by 15 x 2A bonds
21 α linked directly by 21A bonds and transversally by
19A, 0.5 NN, 0.5 NNP bonds



$^{99}_{43}$**Tc** 21α, 14N, 1P suppl. EB exp. = 852.7474 MeV

21	E_B α	594.8250	MeV
34.5	NN	170.3093	
34	NP	75.6364	
1	NPP	7.7180	
0.5	NNP	4.2409	
		852.7296	MeV
		- 0.018	

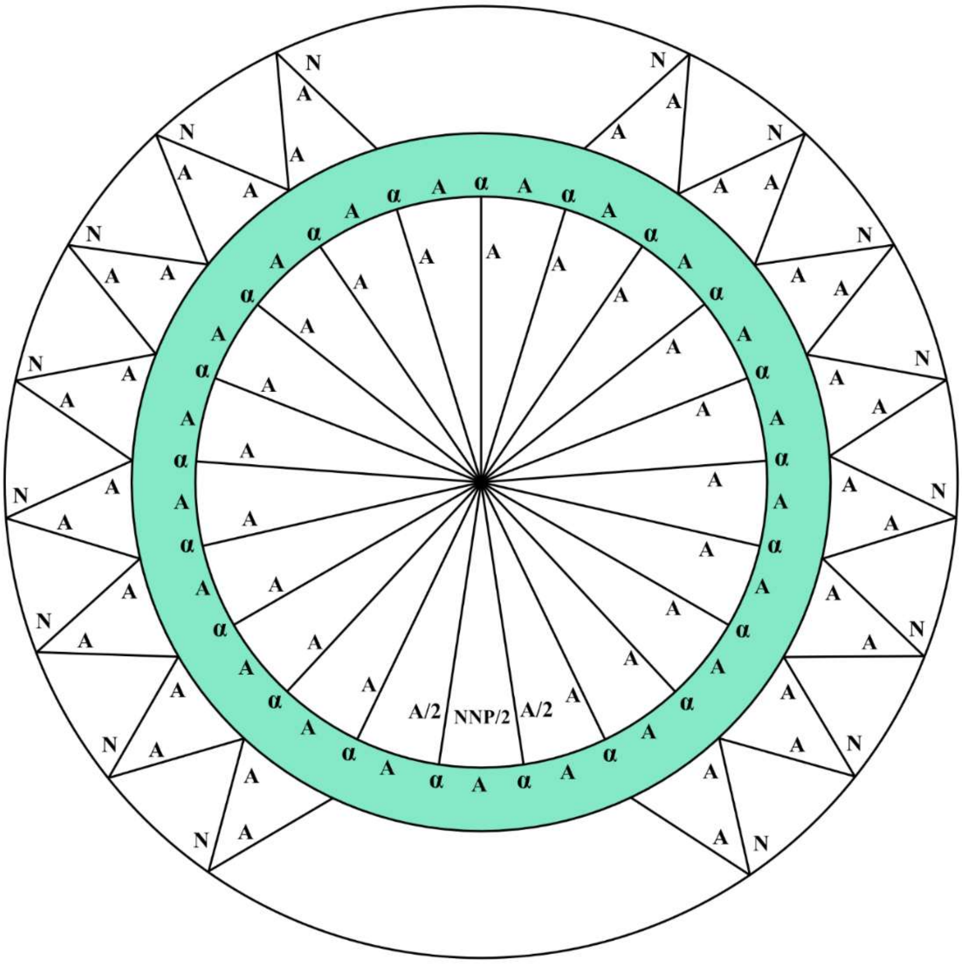
14 suppl. N linked each to 2 α by 14 x 2A bonds, 1 suppl. P linked to 2 α by 1 NPP bond.
21 α linked directly by 21A bonds and transversally by
19A, 0.5 NN, 0.5 NNP bonds



$^{100}_{42}$**Mo** 21α, 16N suppl. E_B exp. = 860.4662 MeV

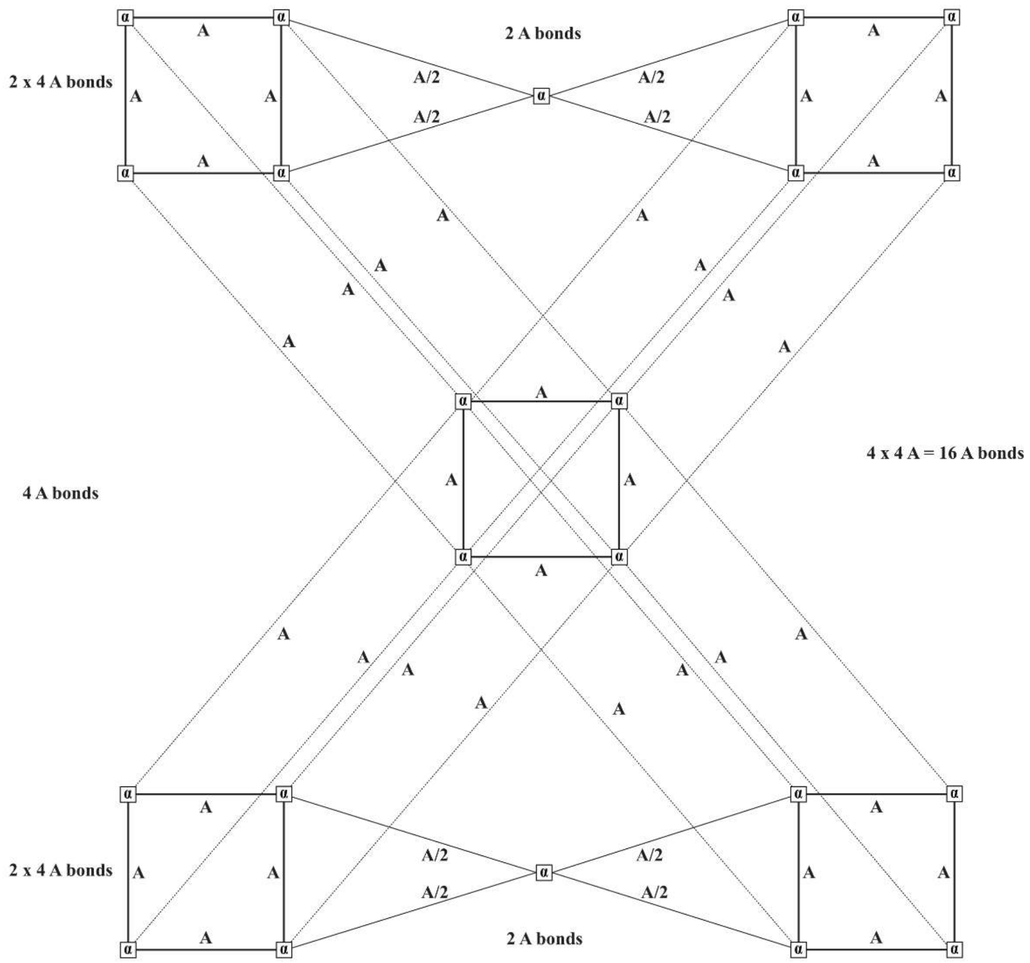
21	E_B α	594.8250	MeV
36.5	NN	180.1823	
36.5	NP	81.1979	
0.5	NNP	4.2409	
		860.4461	MeV
		- 0.020	

16 suppl. N linked each to 2 α by 16 x 2A bonds
21 α linked directly by 21A bonds and transversally by
20A, 0.5 NNP bonds



5. Ru 44 and Rh 45 stable nuclides

Core structure of Ru 44, Rh 45: 22 α and 40 A bonds



Core Structure	22 α 5 x 4 A = 20 A 2 x 4 A/2 = 4 A 4 x 4 A = 16 A	40 A = 20 NN + 20 NP

This core structure contains only 20 (NN + NP) instead of 22 (NN + NP), this inducing a modification of that structure.

$^{96}_{44}$**Ru** Nat. abund 5.5% 22α, 8 N suppl. EB in MeV = 826.5036

Core	EB	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
8 N suppl.	2	NN	9.8730	
	3	NP	6.6738	
	1.5	NNP	12.7227	
	4	NPP	30.8720	
			826.5135	MeV
			+ 0.010	

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

$^{98}_{44}$**Ru** Nat. abund 1.9% 22α, 10 N suppl. EB in MeV = 844.7907

Core	EB	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
10 N suppl.	0.5	NN	2.4683	
	0.5	NP	1.1123	
	2	NNP	16.9636	
	7.5	NPP	57.8850	
			844.8012	MeV
			+ 0.011	

1 N → (A + NPP/2)
2 N → 2 NNP
7 N → 7 NPP

$^{99}_{44}$**Ru** Nat. abund 12.7% 22α, 11 N suppl. EB in MeV = 852.2625

Core	EB	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
11 N suppl.	3	NN	14.8095	
	3	NP	6.6738	
	3.5	NNP	29.6863	
	4.5	NPP	34.7310	
			852.2726	MeV
			+ 0.010	

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

$^{100}_{44}$**Ru** Nat. abund 12.6% 22α, 12 N suppl. EB in MeV = 861.9359

Core	EB	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
12 N suppl.	4.5	NN	22.2143	
	3.5	NP	7.7861	
	5	NNP	42.4090	
	3	NPP	23.1540	
			861.9354	MeV
			/	

3 N → 3 x 2 A
4 N → 4 NNP
3 N → 3 NPP
1 N → (NNP/2 + NN)
1 N → (NNP/2 + A)

$^{101}_{44}$**Ru** Nat. abund 17.1% 22α, 13 N suppl. E_B in MeV = 868.7379

Core	E_B	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
13 N suppl.	2.5	NN	12.3413	
	2.5	NP	5.5615	
	4.5	NNP	38.1681	
	6	NPP	46.3080	
			868.7509	MeV
			+ 0.013	

2 N → 2 x 2 A
1 N → (NNP/2 + A)
4 N → 4 NNP
6 N → 6 NPP

$^{102}_{44}$**Ru** Nat. abund 31.6% 22α, 14 N suppl. E_B in MeV = 877.9576

Core	E_B	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
14 N suppl.	5.5	NN	27.1508	
	4.5	NP	10.0107	
	6.5	NNP	55.1317	
	2.5	NPP	19.2950	
			877.9602	MeV
			+ 0.003	

4 N → 4 x 2 A
6 N → 6 NNP
2 N → 2 NPP
1 N → (NPP/2 + NN)
1 N → (NNP/2 + A)

$^{103}_{45}$**Rh** Nat. abund 100% 22α, 14N, 1P suppl. E_B in MeV = 884.1718

Core	E_B	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
14N, 1P suppl.	2.5	NN	12.3413	
	2.5	NP	5.5615	
	4.5	NNP	38.1681	
	8	NPP	61.7440	
			884.1869	MeV
			+ 0.015	

2 N → 2 x 2 A
1 N → (NNP/2 + A)
4 N → 4 NNP
7 N → 7 NPP
1 P → NPP

$^{104}_{44}$**Ru** Nat. abund 18.6% 22α, 16 N suppl. E_B in MeV = 893.0895

Core	E_B	22 α	623.1500	MeV
	20	NN	98.7300	
	20	NP	44.4920	
16 N suppl.	4.5	NN	22.2143	
	4.5	NP	10.0107	
	7.5	NNP	63.6135	
	4	NPP	30.8720	
			893.0825	MeV
			- 0.007	

4 N → 4 x 2 A
1 N → (NNP/2 + A)
7 N → 7 NNP
4 N → 4 NPP

CHAPTER 8

PALLADIUM AND SILVER

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1. Recall of the basic rules for determining the nuclei binding energy.

- The calculation of binding energy of the stable isotopes of each light element satisfies the following rule:
  E_B n = x E_B α + x E_B (NN/2 + NP/2) + y E_B (NN + NP)
  (x = number of α particles, y = number of N and P supplementary within a given nucleus). This is the case of ^{16}O.

- The basic rule valid for the stable elements located at the center of the periodic table is:
  E_B n = x E_B α + (x + y) E_B (NN + NP)
  One should note that (NN + NP) bonds could be replaced by NNP or NPP bonds which have a higher energy value. This is the case of E_B ^{63}Cu.

- The rule for the heaviest nuclei is close to the first formulation, valid for the light element's isotopes.

For each intermediate-sized nucleus located near the center of the periodic table, each α particle is linked linearly to another α particle with one A bond. Also, each α particle is linked transversally to another α particle with one A bond. So, Fe binding energy has 13 A linear bonds and 13 A cross bonds because it contains 13 α particles. Nevertheless, A bonds could be replaced by NP, NN, NNP and NPP bonds.

The N supplementary are linked to two α particles by (NP + NN) bonds or by NNP or NPP bonds.

The P supplementary is linked by NP or NPP bonds, exceptionally by an NNP bond, to one or two α particles.

For nuclei heavier than Molybdenum and Technetium (see chapter 7) the number of cross or transversed bonds tends to diminish slowly.

This is the case of Palladium and Silver with 23α in their core and only 21 (NN + NP) bonds or 42 bonds instead of 46 bonds.

This is a consequence of the modification of the core structure of these elements (see figure 1).

There is a tendency to shrink the number of crossbonds. This has as consequence that the binding energy per nucleon is slightly reducing.

2. Core structure of Palladium and Silver

The core structure of these two nuclides is presented in figure 1. It is made out of 23 α particles, and 42 A (= NN/2 + NP/2) bonds.

These 42 A bonds are broken down in the following way:

- 20 A bonds linking 4 α particles, within five structures.
- 16 A bonds linking the five structures.
- 6 A bonds linking the three last α particles to the other α particles.

So, the core structure common to all stable Palladium and Silver nuclides is constituted with 23 α and 42 A (21 NN + 21 NP) bonds.

Consequently, the binding energy of each Pd and Ag nuclide differs only from the other nuclides as far as the N and P supplementary are concerned.

Summary table of the N and P supplementary binding energy of all stable Pd and Ag nuclides.

Nuclide	N suppl.	P suppl.	NN	NP	NNP	NPP	NPP P suppl.
Pd 102	10	0	4	5	0	5.5	0
Pd 104	12	0	5	5	1.5	5.5	0
Pd 105	13	0	7.5	7.5	2.5	3	0
Pd 106	14	0	3.5	3.5	2	8.5	0
Ag 107	14	1	7	7	2	5	1
Pd 108	16	0	5	5	3.5	7.5	0
Ag 109	16	1	6.5	6.5	3	6.5	1
Pd 110	18	0	10	10	6.5	1.5	0

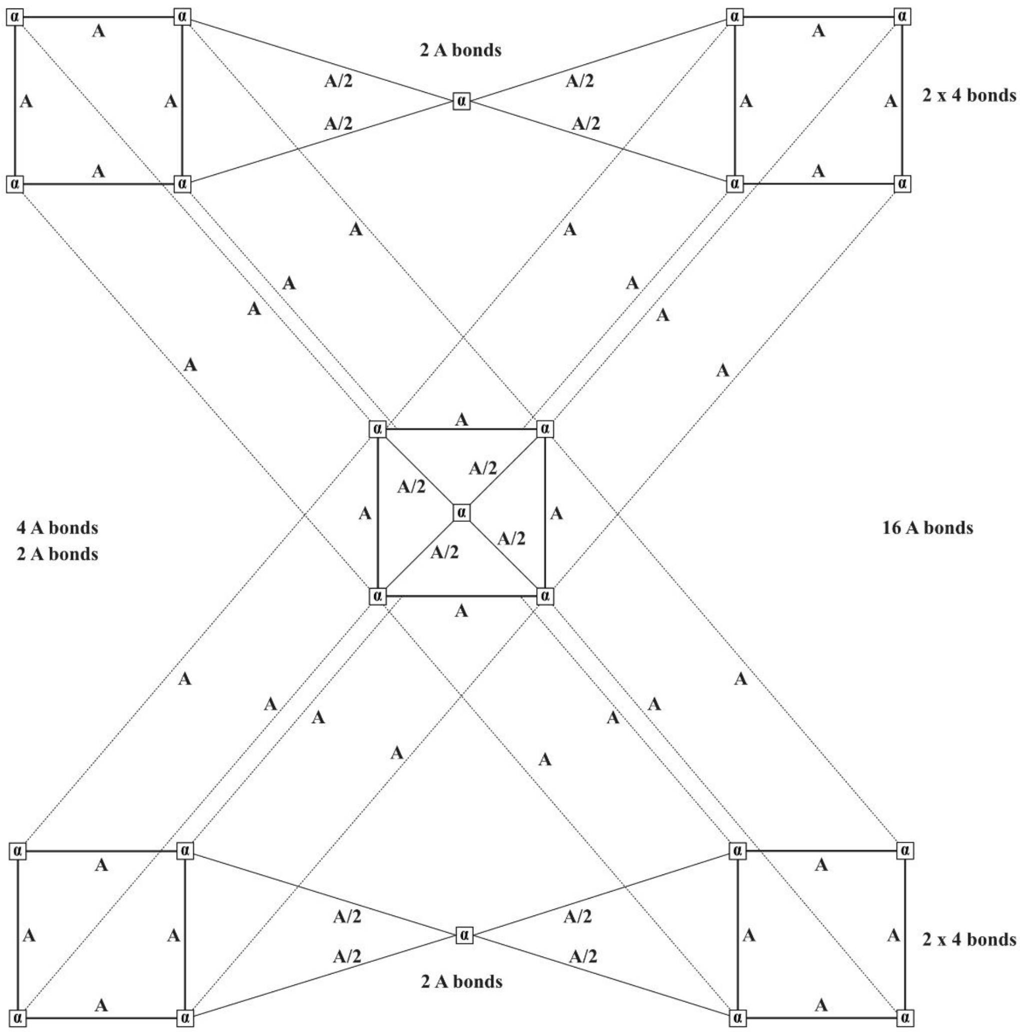
Comparison: modifications from nuclide to nuclide

Pd 104 and 105:	2.5 NPP	→ 2.5 (NN + NP),	1 NNP is added
Pd 105 and 106:	4 (NN + NP)	→ 4 NPP	
	0.5 NNP	→ 0.5 NPP,	1 NPP is added
Pd 105 and Ag 107:	0.5 (NN + NP)	→ 0.5 NPP	
	0.5 NNP	→ 0.5 NPP,	2 NPP are added
Pd 106 and Ag 107:	3.5 NPP	→ 3.5 (NN + NP),	1 NPP is added
Ag 107 and Pd 108:	2 (NN + NP)	→ 1.5 NNP + 0.5 NPP,	1 NPP is added
Pd 108 and Ag 109:	1.5 NPP	→ 1.5 (NN + NP)	
	0.5 NNP	→ 0.5 NPP,	1 NPP is added
Ag 109 and Pd 110:	6 NPP	→ 3.5 (NN + NP) + 2.5 NNP,	1 NNP is added

In figures 2 to 9 the binding energy structures are displayed.

Figure 1

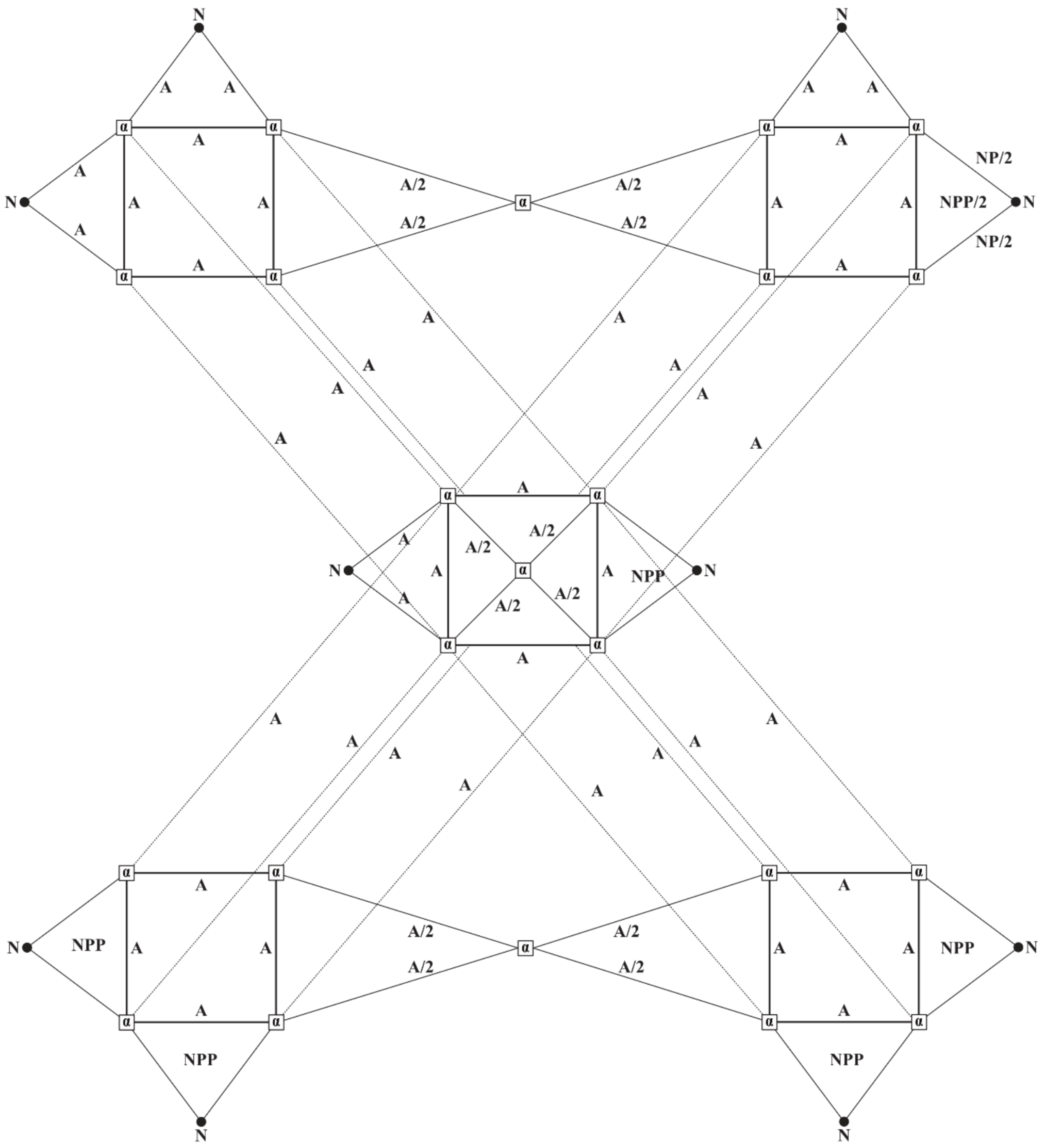
46 Pd 47 Ag
Core structure of Pd, Ag
23 α,   42 A bonds



Core Structure	23 α		
	5 x 4 A = 20 A		
	3 x 4 A/2 = 6 A	42 A = 21 NN + 21 NP	
	4 x 4 A = 16 A		

Figure 2

$^{102}_{46}$**Pd** Nat. abundance: 1 % 23α, 10 N suppl. EB in MeV = 875.1896 MeV

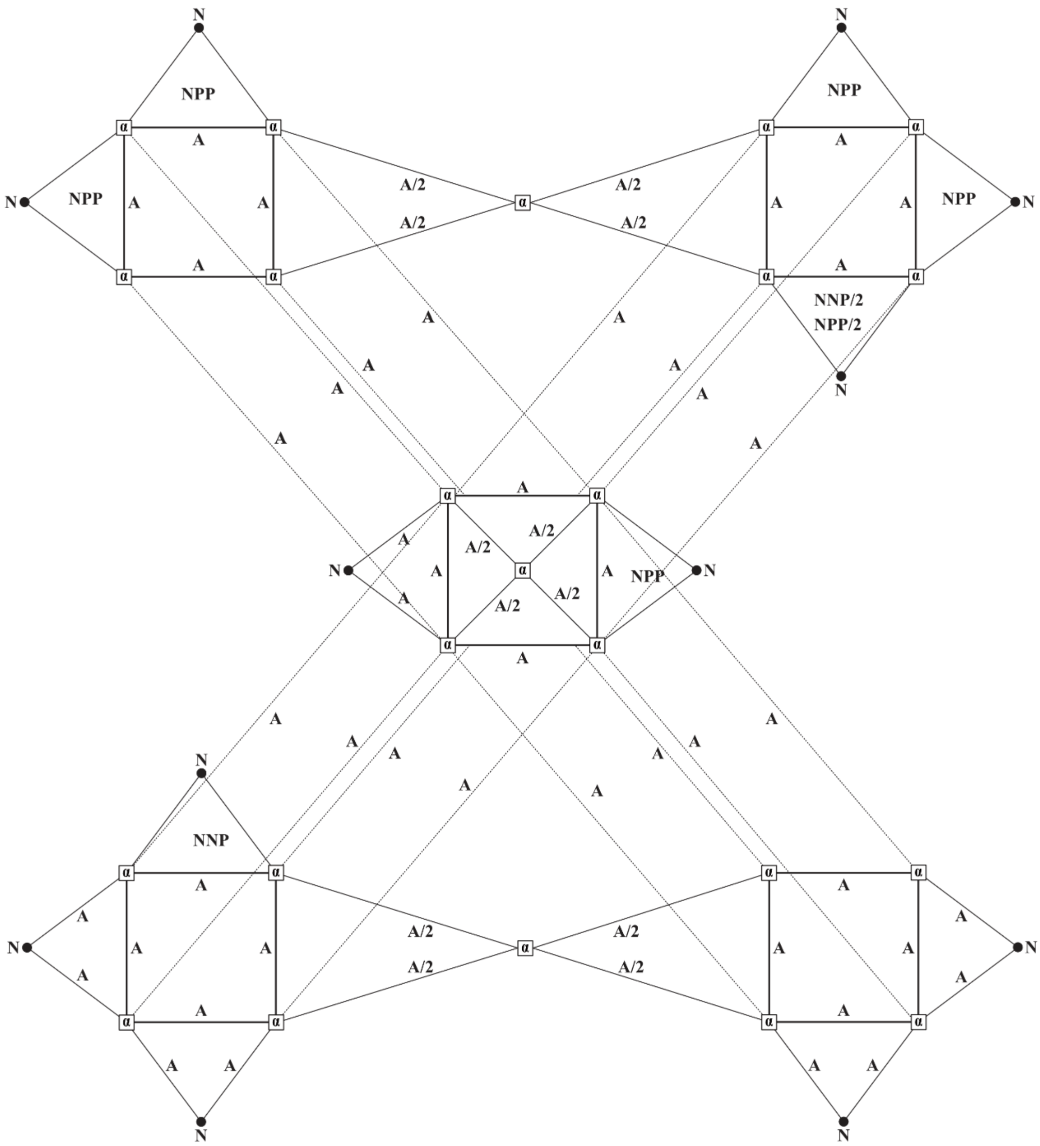


$^{102}_{46}$**Pd**

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
10 N suppl		4	x	4.9365	19.7460	
		5	x	2.2246	11.1230	
		0	x	8.4818	0	
		5.5	x	7.7180	42.4490	
					875.1761	MeV
					- 0.013	

Figure 3

$^{104}_{46}$**Pd** Nat. abundance: 11 % 23α, 12 N suppl. EB in MeV = 892.8242 MeV

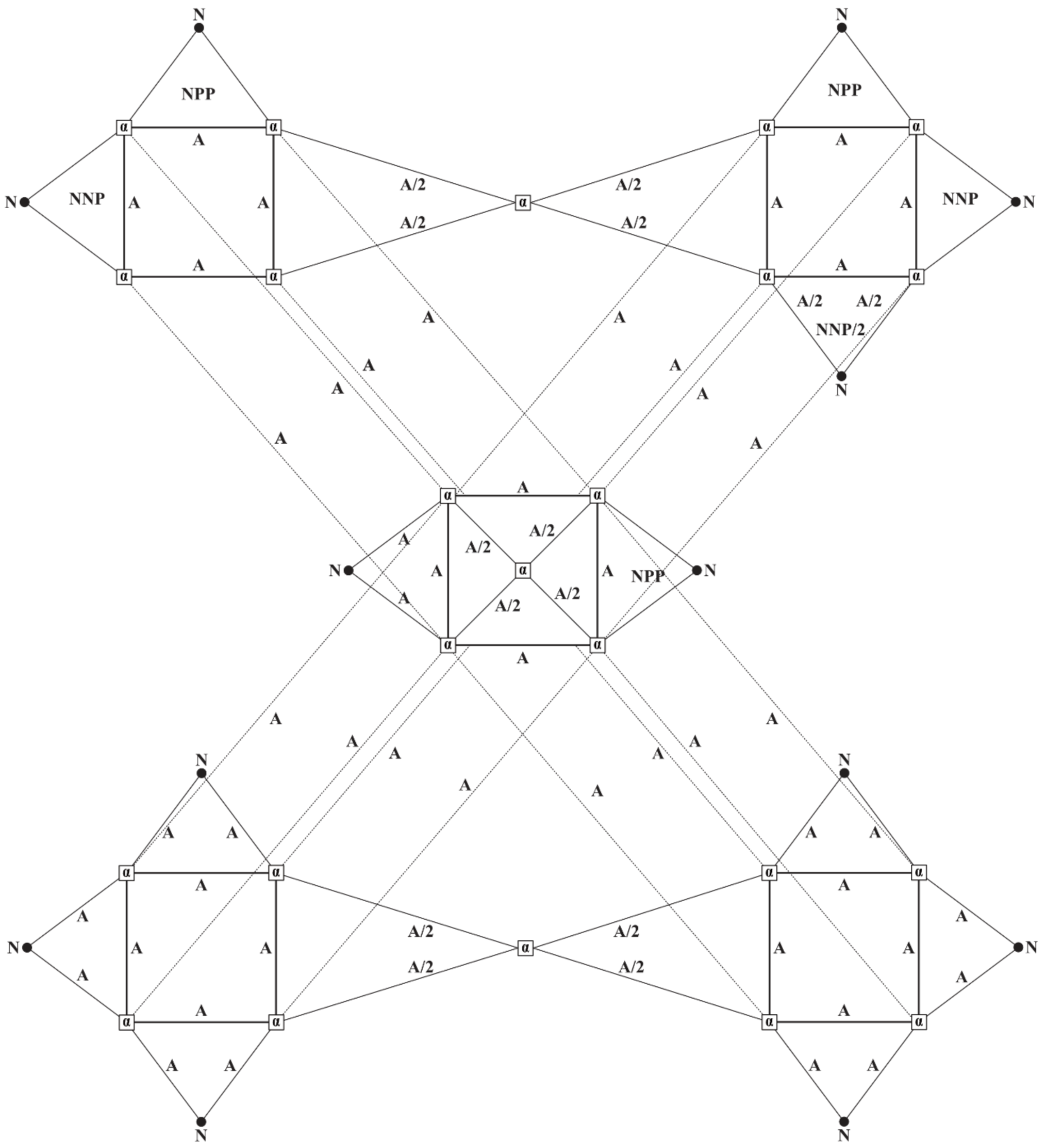


$^{104}_{46}$**Pd**

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
12 N suppl		5	x	4.9365	24.6825	
		5	x	2.2246	11.1230	
		1.5	x	8.4818	12.7227	
		5.5	x	7.7180	42.4490	
					892.8353	MeV
					+ 0.011	

Figure 4

$^{105}_{46}$**Pd** Nat. abundance: 22.2 % 23α, 13 N suppl. EB in MeV = 899.9183 MeV

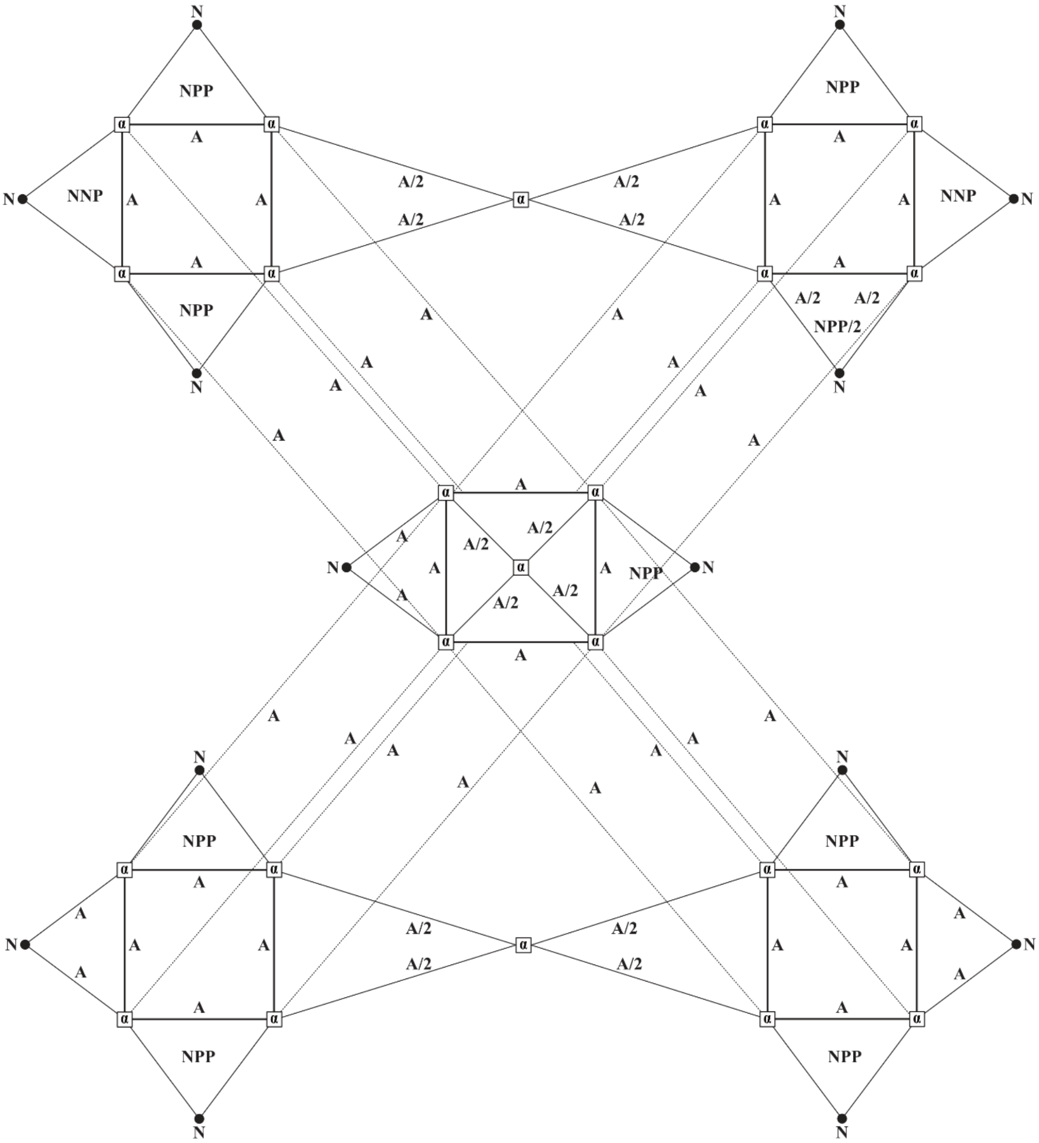


$^{105}_{46}$**Pd**

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
13 N suppl		7.5	x	4.9365	37.0238	
		7.5	x	2.2246	16.6845	
		2.5	x	8.4818	21.2045	
		3	x	7.7180	23.1540	
					899.9249	MeV
					+ 0.006	

Figure 5

$^{106}_{46}$**Pd** Nat. abundance: 27.3 % 23α, 14 N suppl. EB in MeV = 909.4792 MeV

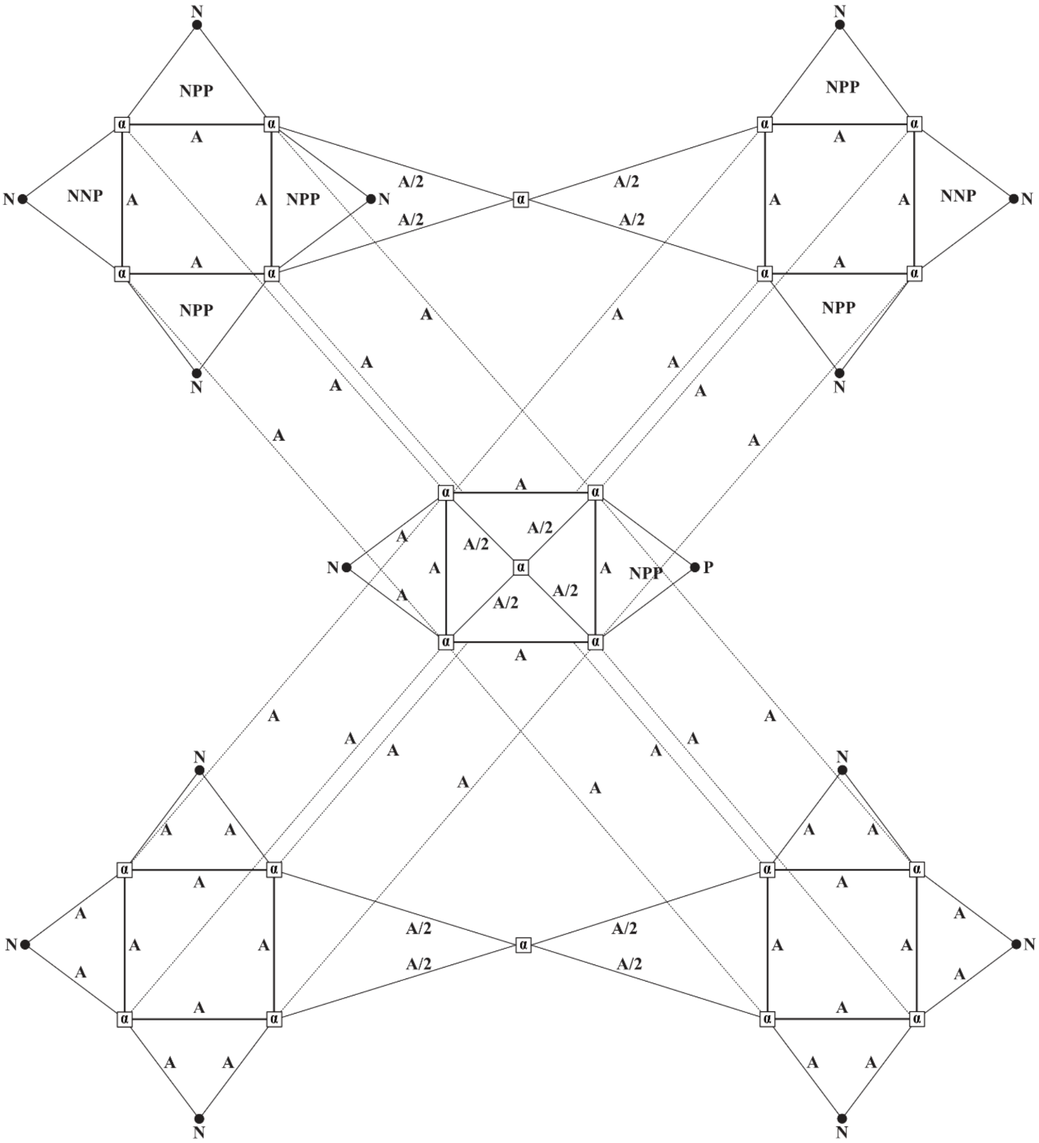


$^{106}_{46}$**Pd**

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
14 N suppl		3.5	x	4.9365	17.2778	
		3.5	x	2.2246	7.7861	
		2	x	8.4818	16.9636	
		8.5	x	7.7180	65.6030	
					909.4886	MeV
					+ 0.009	

Figure 6

$^{107}_{47}$**Ag** Nat. abundance: 51.83 % 23α, 14 N, 1 P suppl. EB in MeV = 915.2673 MeV

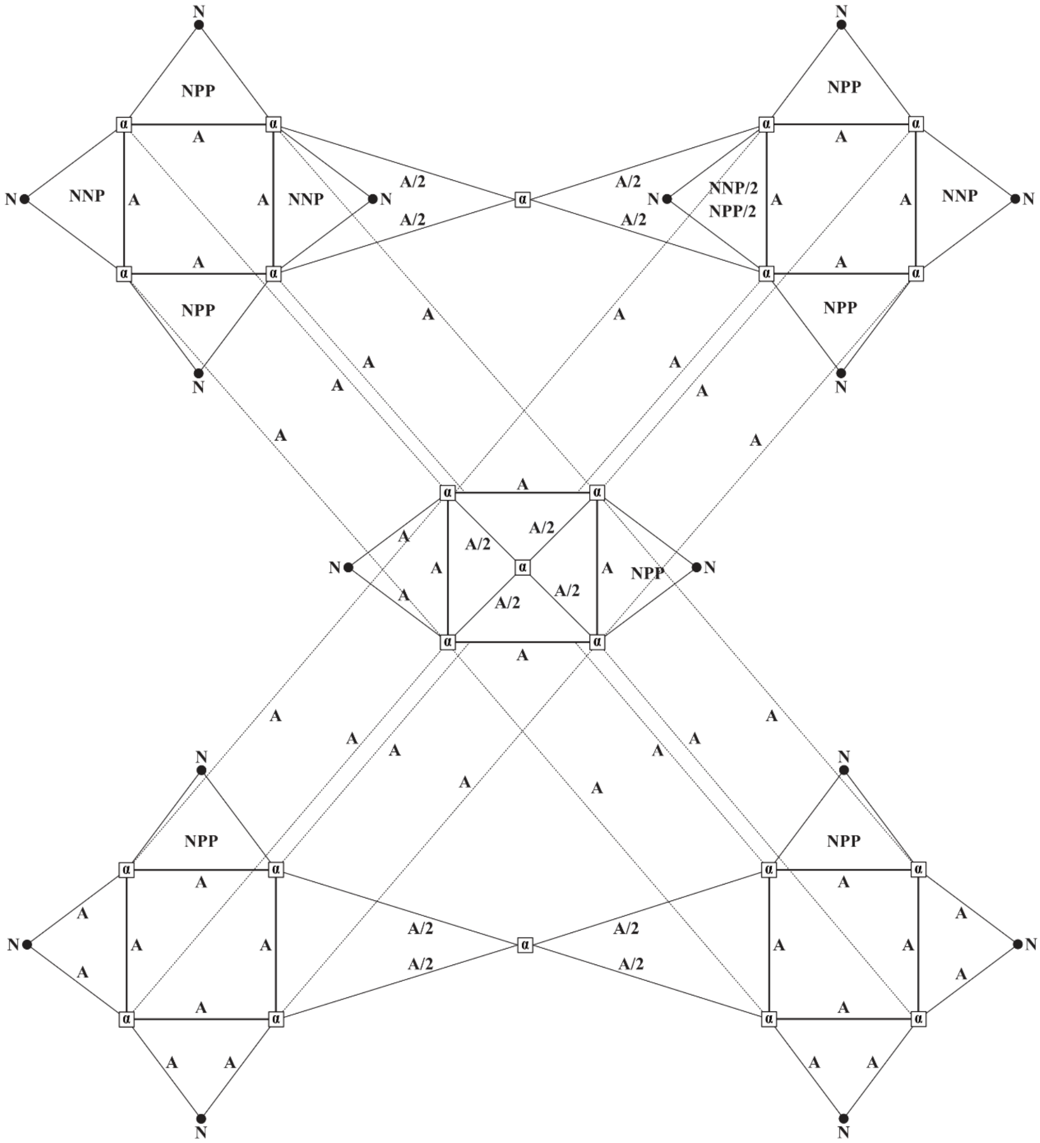


$^{107}_{47}$**Ag**

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
		7	x	4.9365	34.5555	
14 N, 1 P suppl		7	x	2.2246	15.5722	
		2	x	8.4818	16.9636	
		6	x	7.7180	46.3080	
					915.2574	MeV
					- 0.010	

Figure 7

$^{108}_{46}$Pd Nat. abundance: 26.7 % 23α, 16 N suppl. EB in MeV = 925.2385 MeV

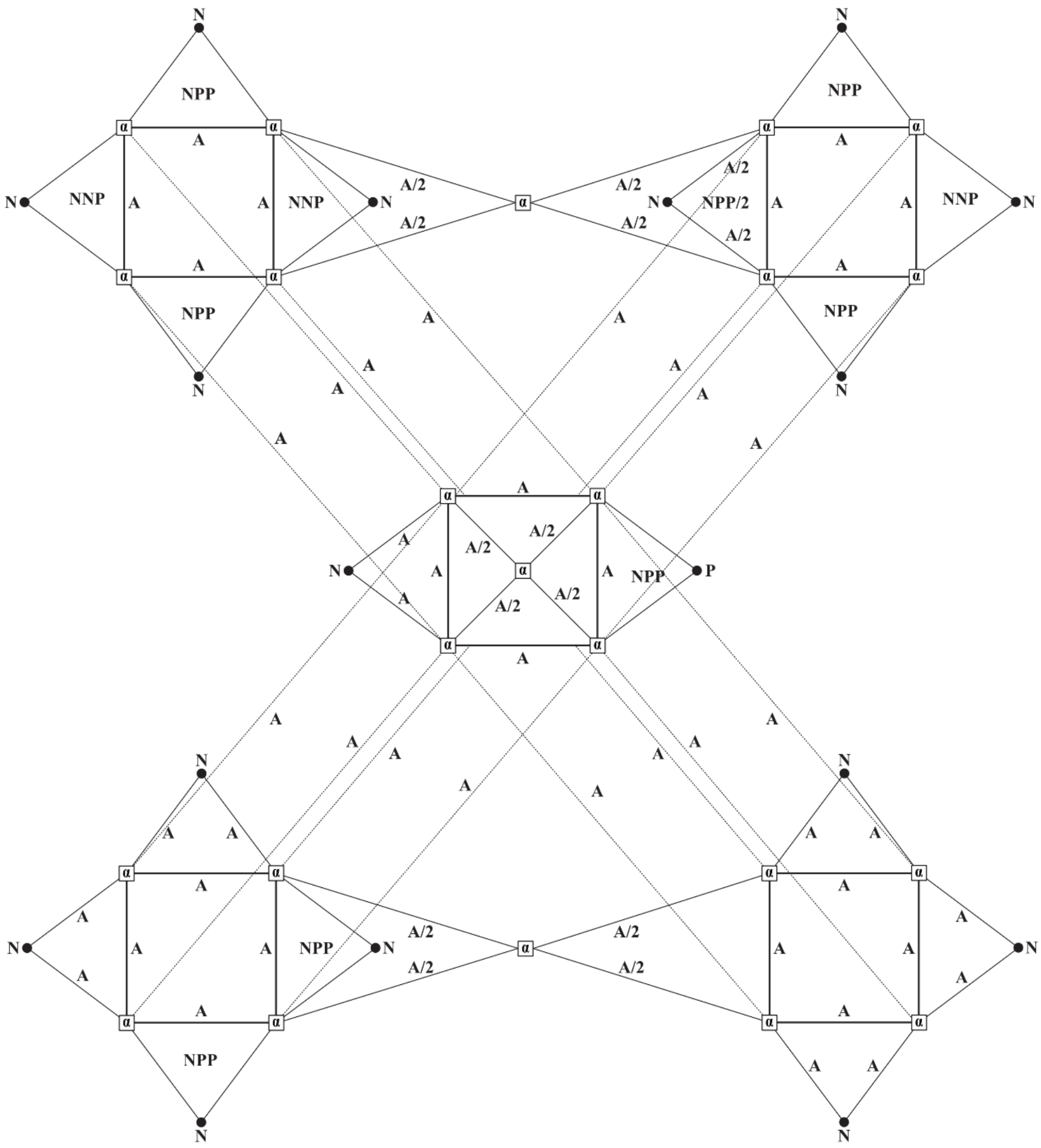


$^{108}_{46}$Pd

	EB	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
16 N suppl		5	x	4.9365	24.6825	
		5	x	2.2246	11.1230	
		3.5	x	8.4818	29.6863	
		7.5	x	7.7180	57.8850	
					925.2349	MeV
					- 0.004	

Figure 8

$^{109}_{47}$**Ag** Nat. abundance: 48.17 % 23α, 16 N, 1 P suppl. E_B in MeV = 931.7227 MeV

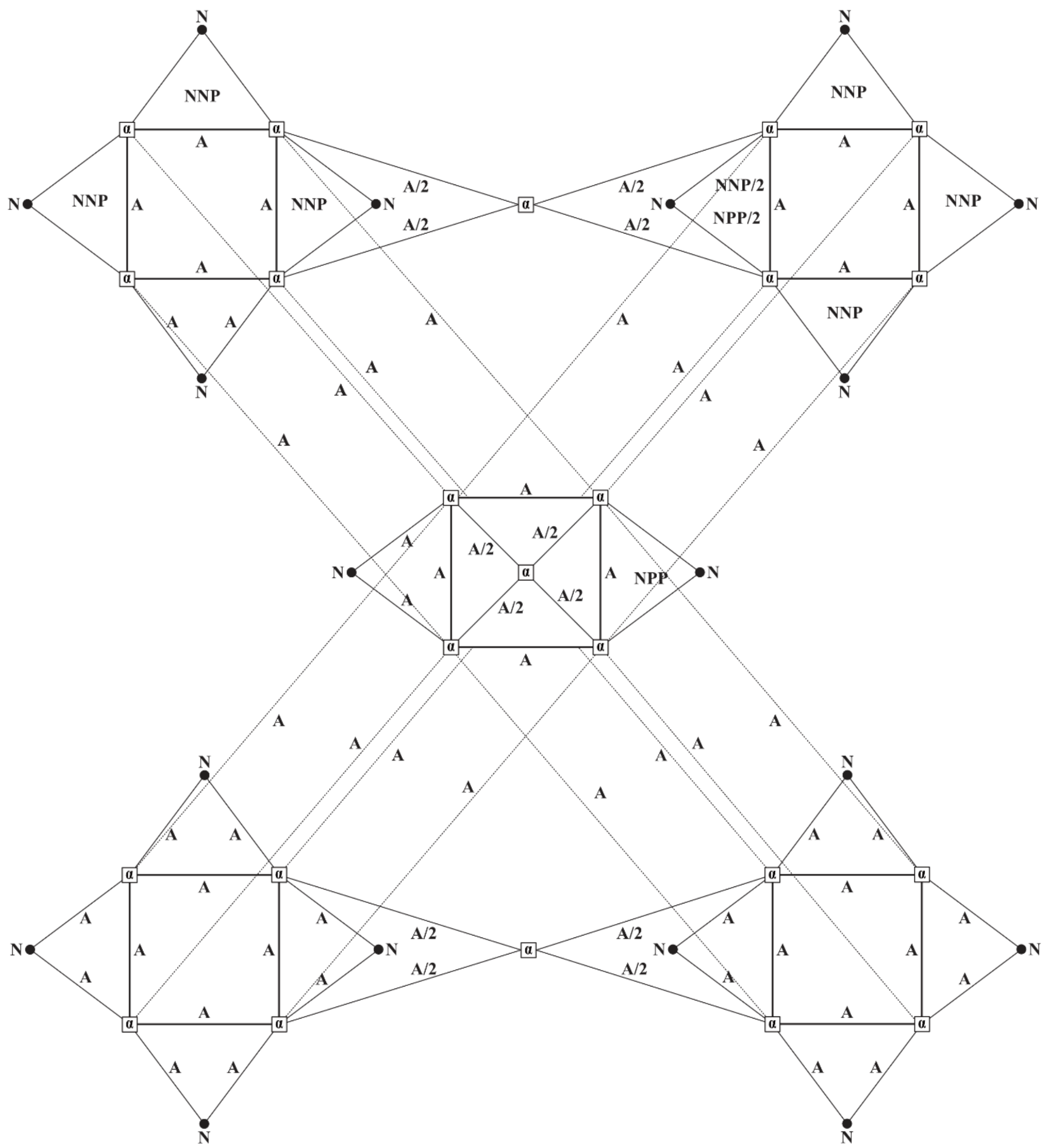


$^{109}_{47}$**Ag**

	E_B	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
16 N, 1 P suppl		6.5	x	4.9365	32.0873	
		6.5	x	2.2246	14.4599	
		3	x	8.4818	25.4454	
		7.5	x	7.7180	57.8850	
					931.7357	MeV
					+ 0.013	

Figure 9

$^{110}_{46}$**Pd** Nat. abundance: 11.8 % 23α, 18 N suppl. E_B in MeV = 940.1878 MeV



$^{110}_{46}$**Pd**

	E_B	23 α	x	28.325	651.4750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
18 N suppl		10	x	4.9365	49.3650	
		10	x	2.2246	22.2460	
		6.5	x	8.4818	55.1317	
		1.5	x	7.7180	11.5770	
					940.1778	MeV
					- 0.010	

CHAPTER 9

PLATINUM AND GOLD

1. Core structure of Platinum (Pt 78) and Gold (Au 79)

The core structure of these two nuclides is presented in figure 1 and 1 bis. It is made out of 39 α particles, and 42 A (=NN/2 + NP/2) bonds. This arrangement is presented in two parts: one upper structure and one lower structure.

These 42 bonds are broken down in the following way:

- 16 A bonds linking four structures of each 4 α particles to the "lower" structure made of 16 α particles (4 x 4) (see figures 1 and 1 bis).
- 16 A bonds linking the five structures of the upper structure.
- 3 x 2 A bonds linking the three last α particles to the other α particles.
- 4 A bonds linking the 4 α in the center.

The only differences between the core structure of Pd, Ag (see chapter 8) and Pt, Au are the following:

- The (4 x 4) A bonds binding the (4 x 4) α particles of Pd, Ag core structures are now linking the lower structure to the upper structure. The (5 x 4) α structures are now linked together with the 16 A bonds (see figure 1).
- The lower structure is made out of 16 α particles and 16 N supplementary. These 16 N supplementary are now binding together the 16 α particles four by four.

See also the comparison between Pt 190 and Pd 110 (point 2).

Summary table of the N and P supplementary binding energy of all stable Pt and Au nuclides.

Nuclide	N suppl.	P suppl.	NN	NP	NNP	NPP	NPP (P)
Pt 190	34	0	24	24	7.5	2.5	0
Pt 192	36	0	22.5	22.5	6	7.5	0
Pt 194	38	0	24	24	6	8	0
Pt 195	39	0	25.5	25.5	5	8.5	0
Pt 196	39 + 1	0	26.5	26.5	6	7.5	0
Au 197	39 + 1	1	30	30	6	4	1
Pt 198	39 + 3	0	29.5	29.5	5.5	7	0

Comparison:

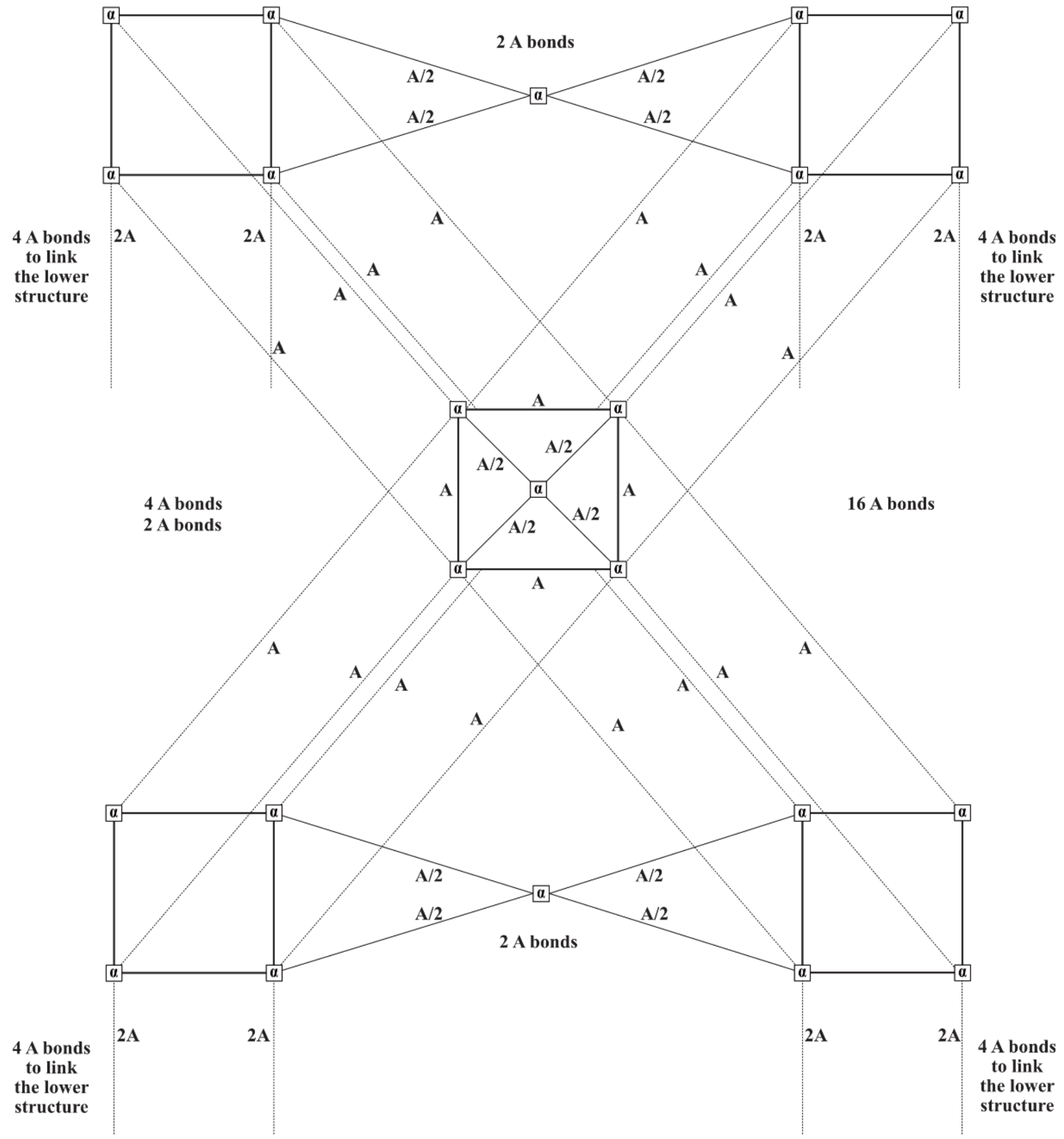
Pt 190 and 192:	1.5 (NN + NP) + 1.5 NNP	→ 3 NPP,	2 NPP are added
Pt 192 and 194:	1.5 NPP	→ 1.5 (NN + NP),	2 NPP are added
Pt 194 and 195:	1 NNP + 0.5 NPP	→ 1.5 (NN + NP),	1 NPP is added
Pt 195 and 196:	1 NPP	→ 1 (NN + NP),	1 NNP is added
Pt 196 and Au 197:	3.5 NPP	→ 3.5 (NN + NP),	1 NPP is added
Au 197 and Pt 198:	0.5 (NN + NP) + 0.5 NNP	→ 1 NPP,	1 NPP is added

The detailed structures are displayed in figures 2 to 8.

Figure 1

Core structure of Pt, Au
39 α, 42 A bonds

Upper structure



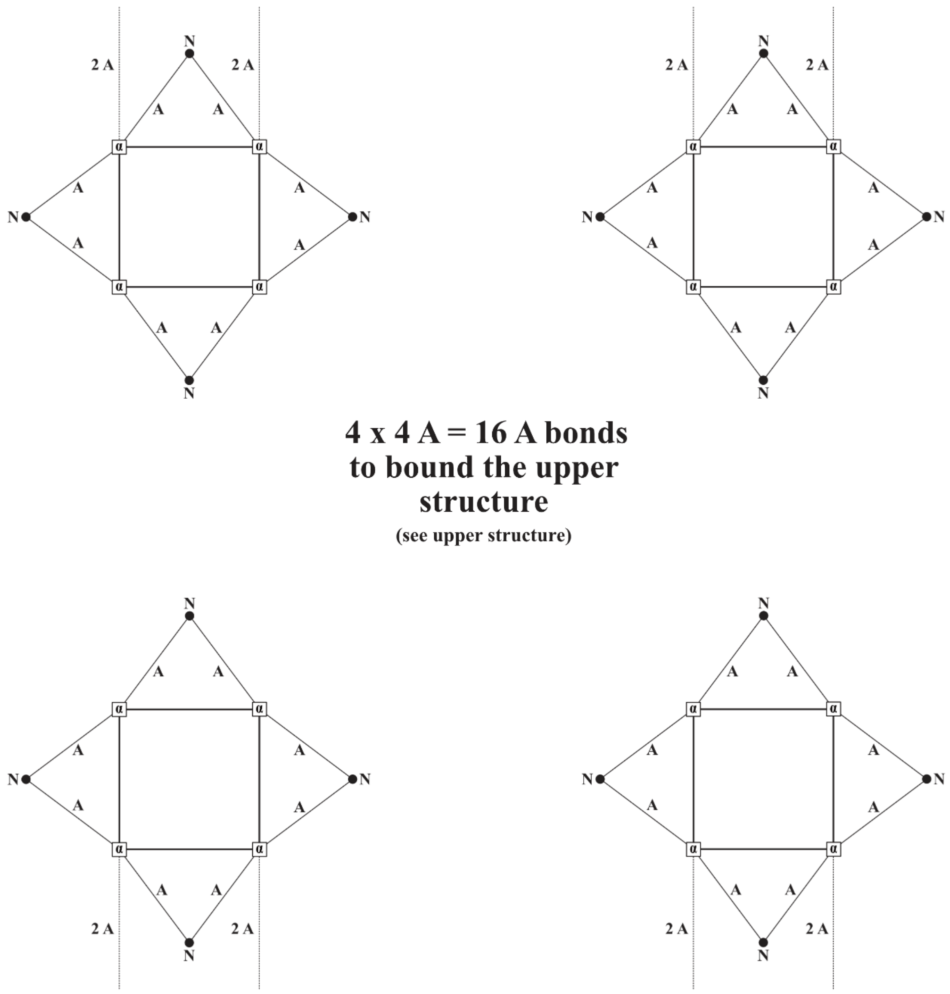
	23 α (1)	
Core	5 x 4 A = 20 A	
Structure	3 x 4 A/2 = 6 A	42 A = 21 NN + 21 NP
	4 x 4 A = 16 A	

(1) 4 A are bounding the four central α particles.
The 4 x 4 A of the peripheral α particles which were bonding 4 x 4 α particles of the Pd, Ag structure are now bounding the 4 x 4 α particles of the lower structure (see 2 x 2 A)

Figure 1 bis

Core structure of Pt, Au

Lower structure



The lower structure is constituted with 16 (4 x 4) α particles and 16 (4 x 4) N (neutrons) linked to the α particles with 2 A (NN + NP) bonds.

2. Comparison between Pt 190 and Pd 110

$^{190}_{78}$Pt = **$^{110}_{46}$Pd** + [16 α + 16 N] (= lower structure)

$^{110}_{46}$Pd	EB 23 α	**$^{190}_{78}$Pt**	EB 39 α (+ EB 16 α)
Core	21 NN	Core	21 NN
	21 NP		21 NP
	10 NN		24 NN (+ 16 NN - 2 NN)
	10 NP		24 NP (+ 16 NP - 2 NP)
	6.5 NNP		7.5 NNP (+ NNP)
	1.5 NPP		2.5 NPP (+ NPP)
	940.1778 Mev		1,509.8330 Mev
	- 0.010		/

16 α are added inducing an increase of binding energy of 16 EB α.
16 N (neutrons) are added inducing an increase of binding energy of (16 NN + 16 NP), or 32 A bonds.
Nevertheless, 4 A bonds (2 NN + 2 NP) are modified into 1 NNP + 1 NPP.

Considering these two nuclides, only 16 α and 16 neutrons are added to Pd 110 to create Pt 190. The binding energy is increased with 16 EB α and (14 NN + 14 NP) + NNP + NPP, these 16 bonds corresponding to the 16 neutrons.

This comparison is also possible in case of a core structure of

44 A (22 NN + 22 NP) instead of
42 A (21 NN + 21 NP)

$^{110}_{46}$Pd		EB 23 α	**$^{190}_{78}$Pt**		EB 39 α (+ EB 16 α)
	Core	22 NN		Core	22 NN
		22 NP			22 NP
		16 NN			30 NN (+ 16 NN - 2 NN)
18 N suppl.		16 NP	34 N suppl.		30 NP (+ 16 NP - 2 NP)
		1.5 NNP	(+ 16 N)		2.5 NNP (+ NNP)
		0.5 NPP			1.5 NPP (+ NPP)
		940.1785 Mev			1,509.8337 Mev
		- 0.009			/

Nevertheless, the Pd 110 N supplementary structure with 16 N supplementary minimum is only possible for Pd 108 (16 N supplementary) and for Ag 109 (16 N and 1 P supplementary) and not for all the others Pd and Ag stable nuclides.

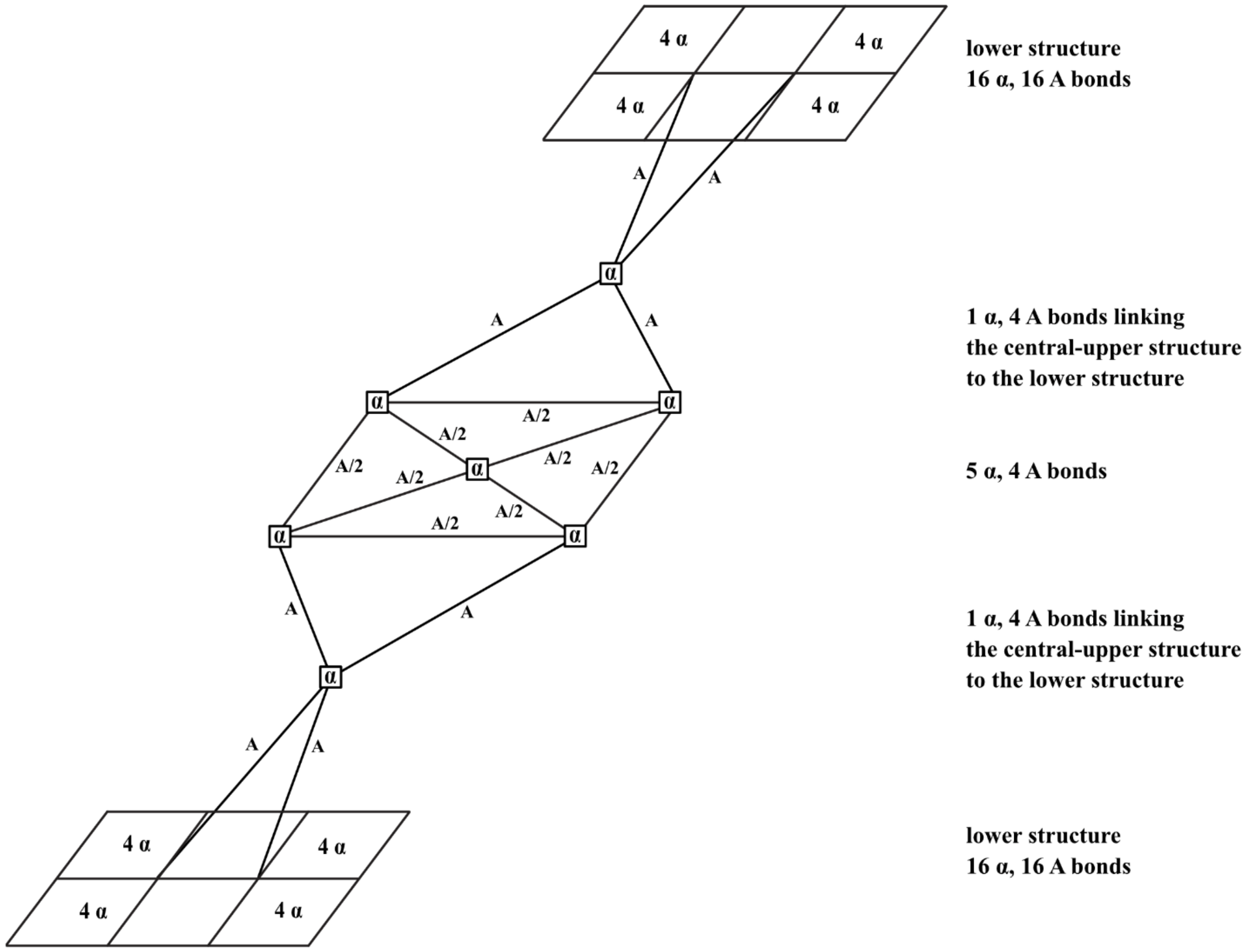
This example also shows why the binding energy per nucleon is slightly decreasing when the number of nucleons becomes bigger.

Remark: the interest of that chapter is to show the relationship between Pd and Ag elements, on one side, and Pt and Au elements, on the other side: their atomic number differs with 32. This number concerns the 16 α particles of the lower structure of Pt and Au.

So, the upper structures of the four elements are similar, nevertheless only with a core of 42 A. Both structures (42 A and 44 A) are studied in the following (see figures 2 to 8 and 9 to 15 bis).

At the end, it is the arrangement with 44 A for Pt and Au which has to be privileged as more stable.

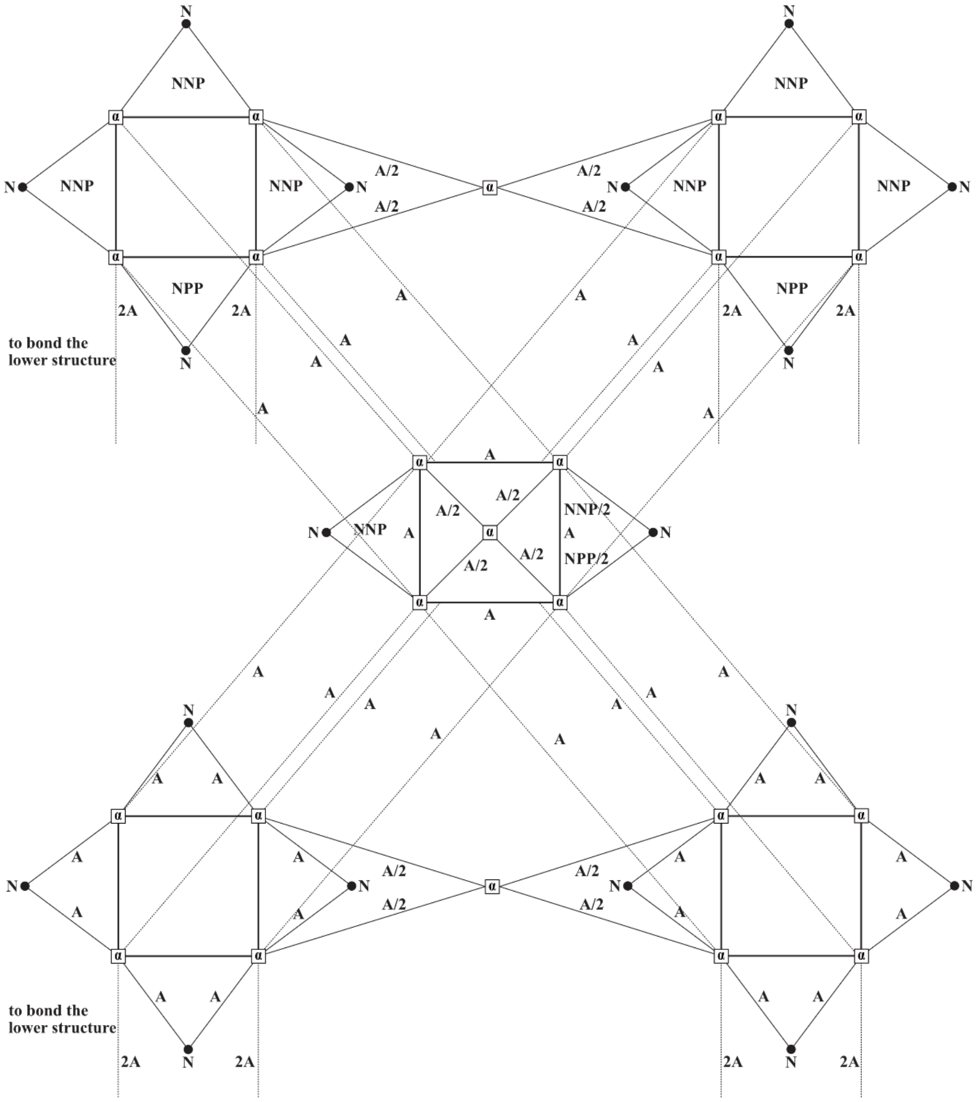
78 Pt, 79 Au Global structure



In total 44 A bonds, i.e. (22 NN + 22 NP) bonds.
So, the core structure is constituted with 39 α and 44 A bonds.

Figure 2

$^{190}_{78}$Pt Upper structure

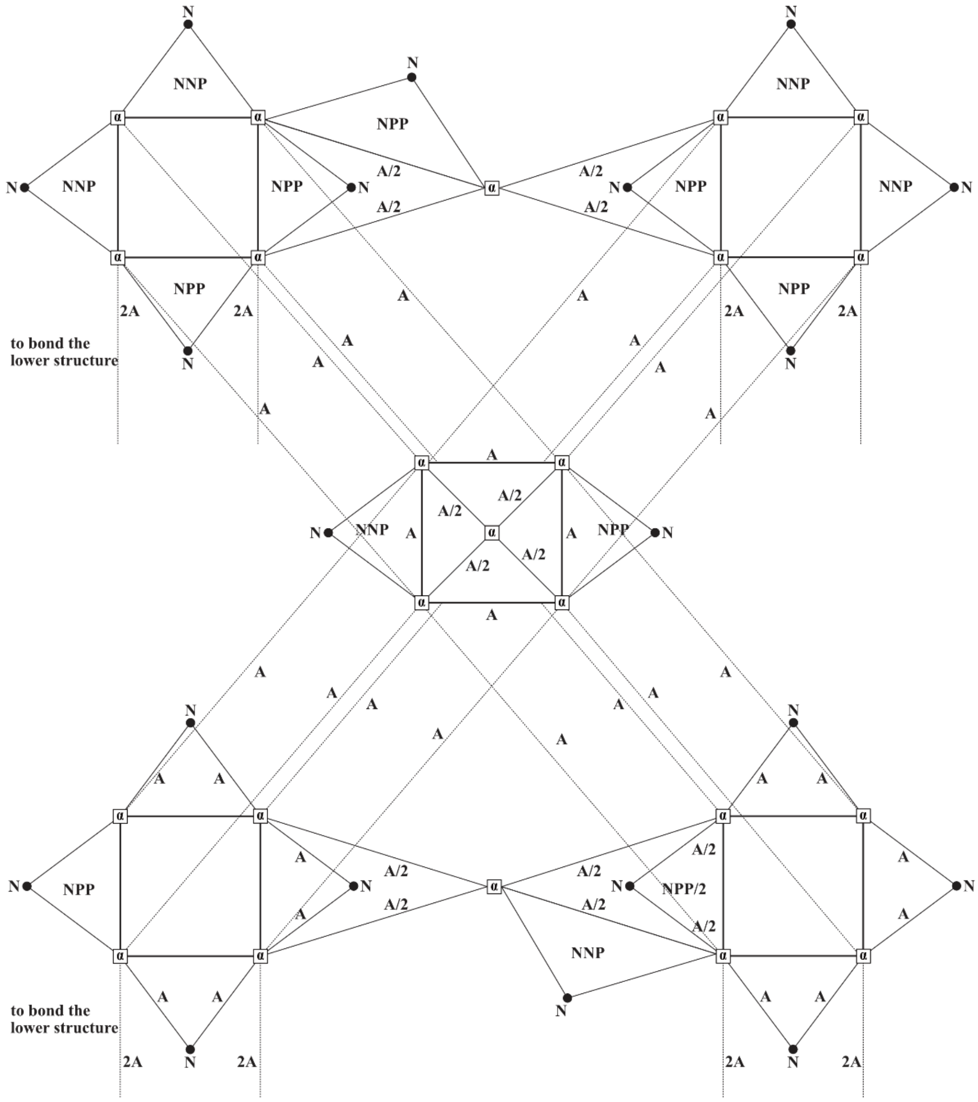


$^{190}_{78}$Pt Nat. abund.: 0.01% 39 α, 34 N suppl. E_B in MeV = 1,509.8337 MeV

	E_B	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
34 N suppl		24	x	4.9365	118.4760	
		24	x	2.2246	53.3904	
		7.5	x	8.4818	63.6135	
		2.5	x	7.7180	19.2950	
					1,509.8330	MeV
					/	

Figure 3

$^{192}_{78}$**Pt** Upper structure

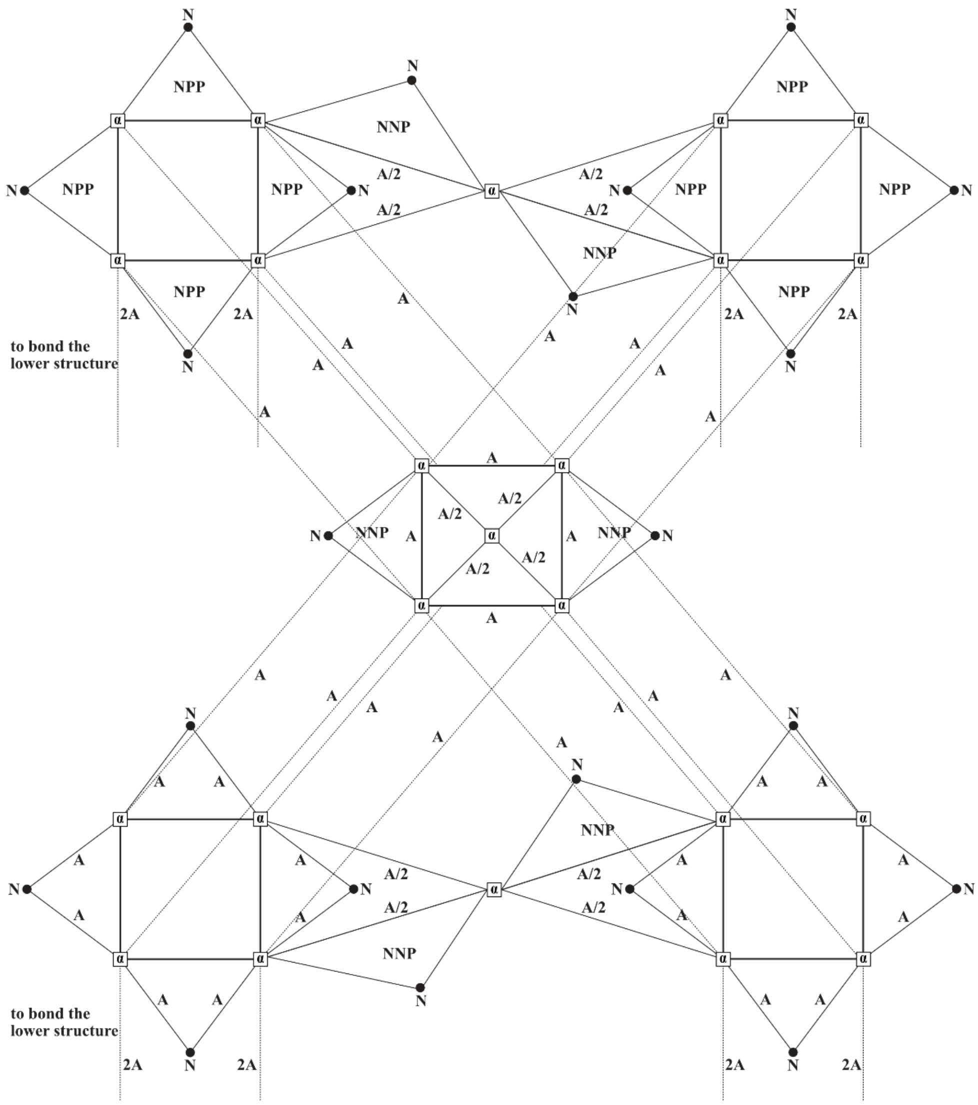


$^{192}_{78}$**Pt** Nat. abund.: 0.79% 39 α, 36 N suppl. E_B in MeV = 1,524.9583 MeV

	E_B	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
36 N suppl		22.5	x	4.9365	111.0713	
		22.5	x	2.2246	50.0535	
		6	x	8.4818	50.8908	
		7.5	x	7.7180	57.8850	
					1,524.9587	MeV
					/	

Figure 4

$^{194}_{78}$Pt Upper structure

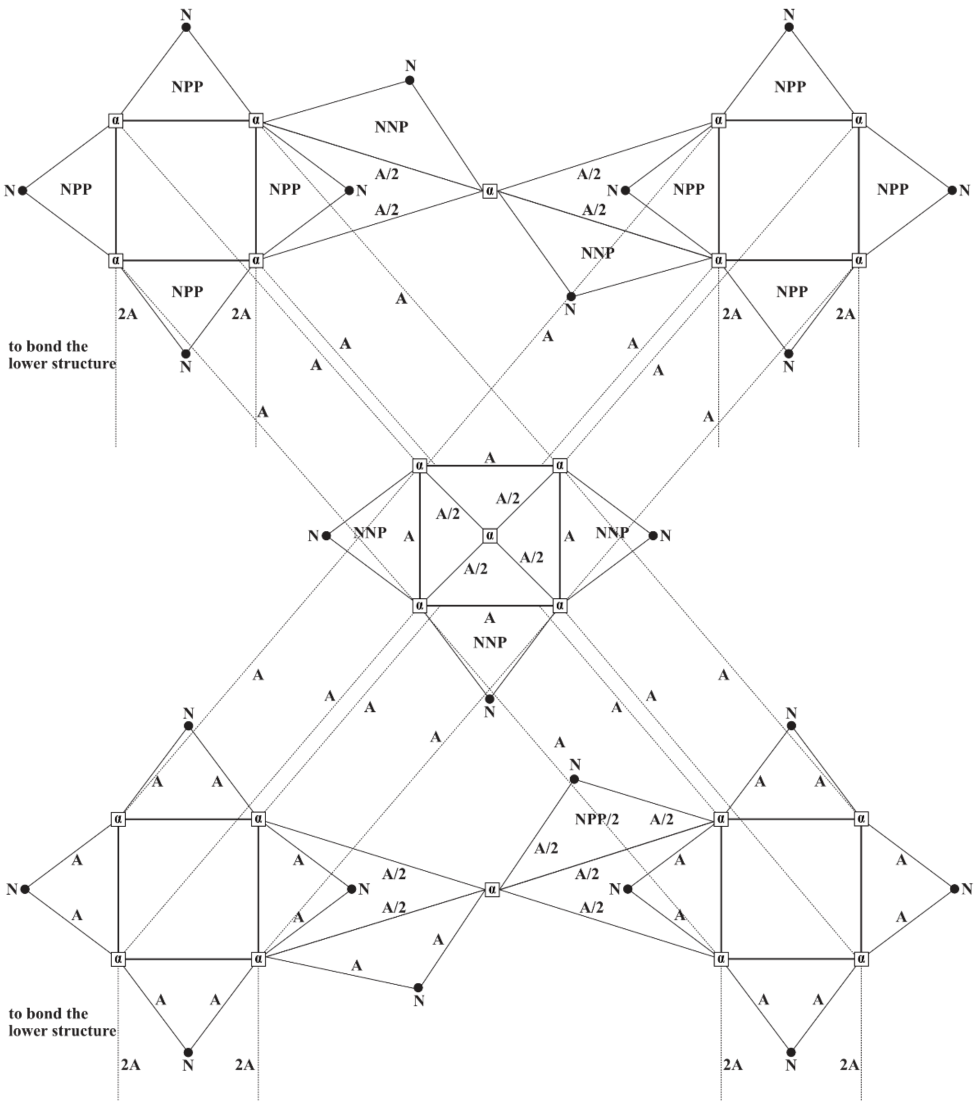


$^{194}_{78}$Pt Nat. abund.: 32.9% 39 α, 38 N suppl E_B in MeV = 1,539.5726 MeV

	E_B	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
38 N suppl		24	x	4.9365	118.4760	
		24	x	2.2246	53.3904	
		6	x	8.4818	50.8908	
		8	x	7.7180	61.7440	
					1,539.5593	MeV
					- 0.013	

Figure 5

$^{195}_{78}$**Pt** Upper structure

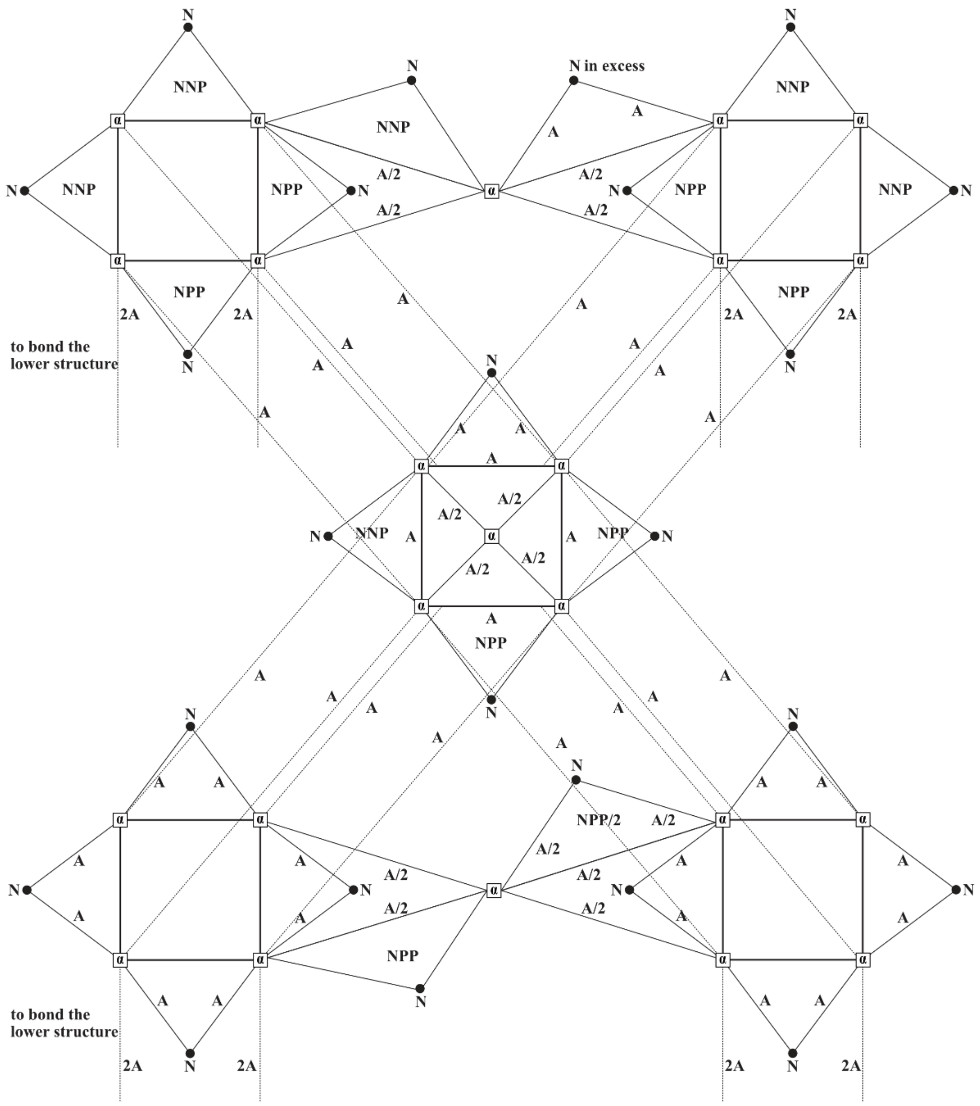


$^{195}_{78}$**Pt** Nat. abund.: 33.8% 39 α, 39 N suppl. EB in MeV = 1,545.6776 MeV

	EB	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
39 N suppl		25.5	x	4.9365	125.8808	
		25.5	x	2.2246	56.7273	
		5	x	8.4818	42.4090	
		8.5	x	7.7180	65.6030	
					1,545.6782	MeV
					+ 0.001	

Figure 6

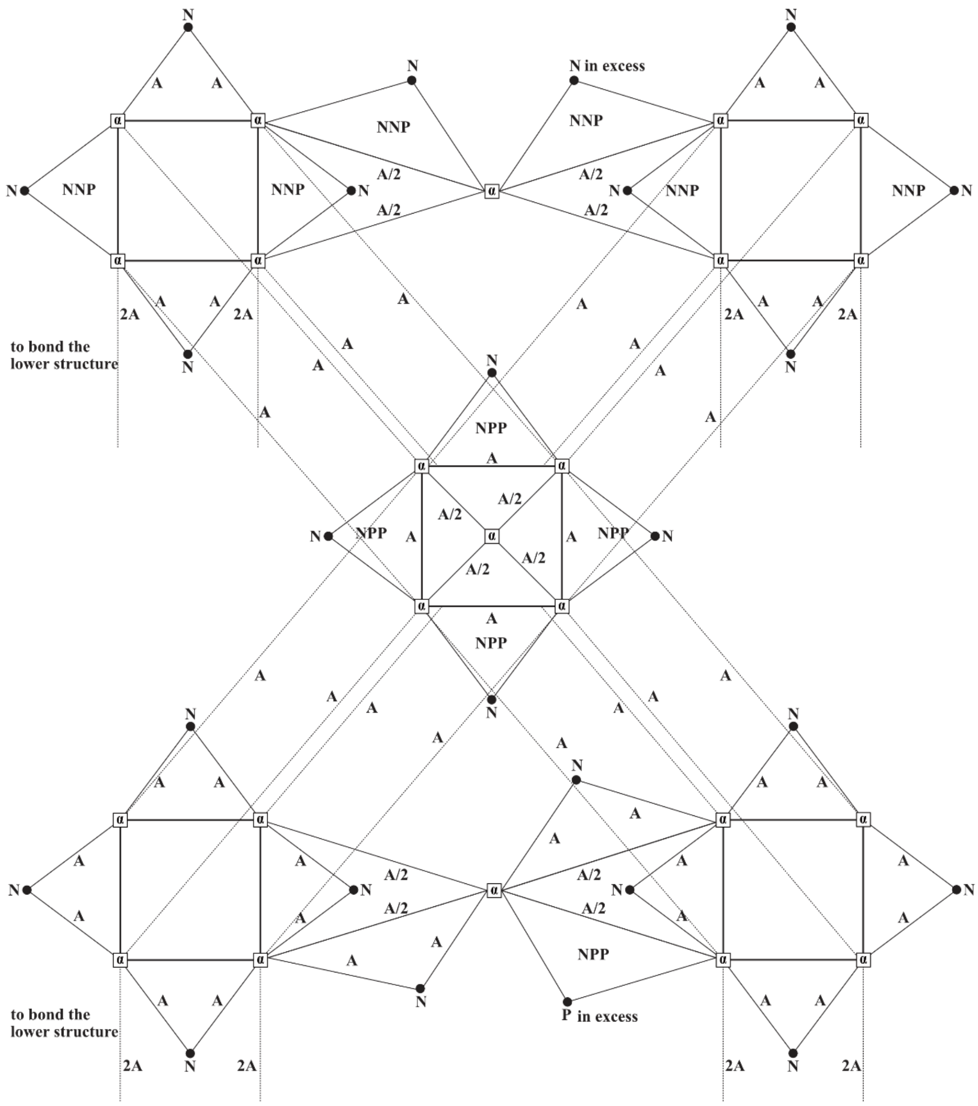
$^{196}_{78}$**Pt** Upper structure



$^{196}_{78}$**Pt**	Nat. abund.: 25.3%		39 α, 39 N suppl. 1 N in excess		E_B in MeV = 1,553.5997	MeV
	E_B	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
39 N suppl		25.5	x	4.9365	125.8808	
		25.5	x	2.2246	56.7273	
		6	x	8.4818	50.8908	
		7.5	x	7.7180	57.8850	
1 N in excess		1	x	4.9365	4.9365	
		1	x	2.2246	2.2246	
					1,553.6031	MeV
					+ 0.003	

Figure 7

$^{197}_{79}$**Au** Upper structure

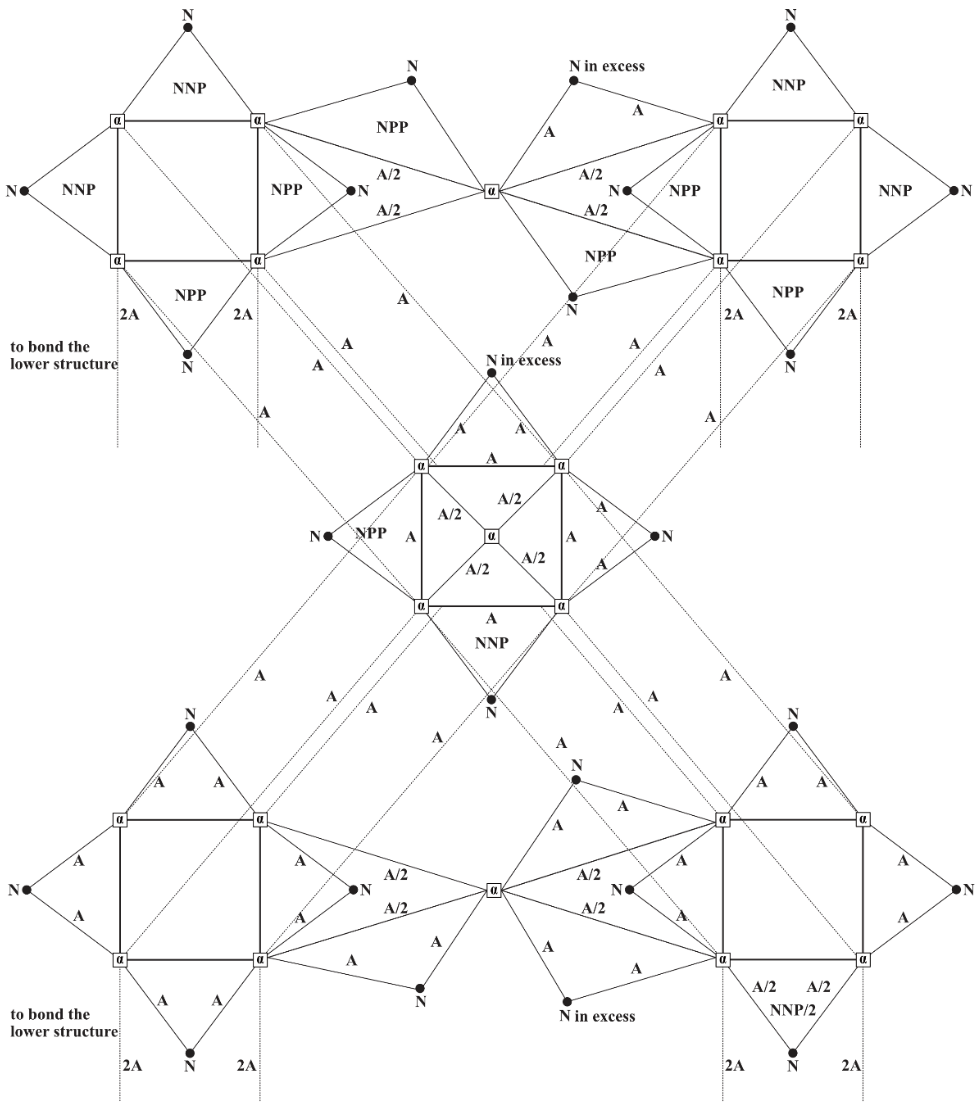


$^{197}_{79}$**Au** Nat. abund.: 100% 39 α, 39 N suppl. 1 N, 1 P in excess E_B in MeV = 1,559.3838 MeV

	E_B	39 α	x	28.325	1,104.6750	MeV
Core		21	x	4.9365	103.6665	
		21	x	2.2246	46.7166	
39 N suppl		30	x	4.9365	148.0950	
		30	x	2.2246	66.7380	
		5	x	8.4818	42.4090	
		4	x	7.7180	30.8720	
1 N in excess		1	x	8.4818	8.4818	
1 P in excess		1	x	7.7180	7.7180	
					1,559.3719	MeV
					- 0.012	

Figure 8

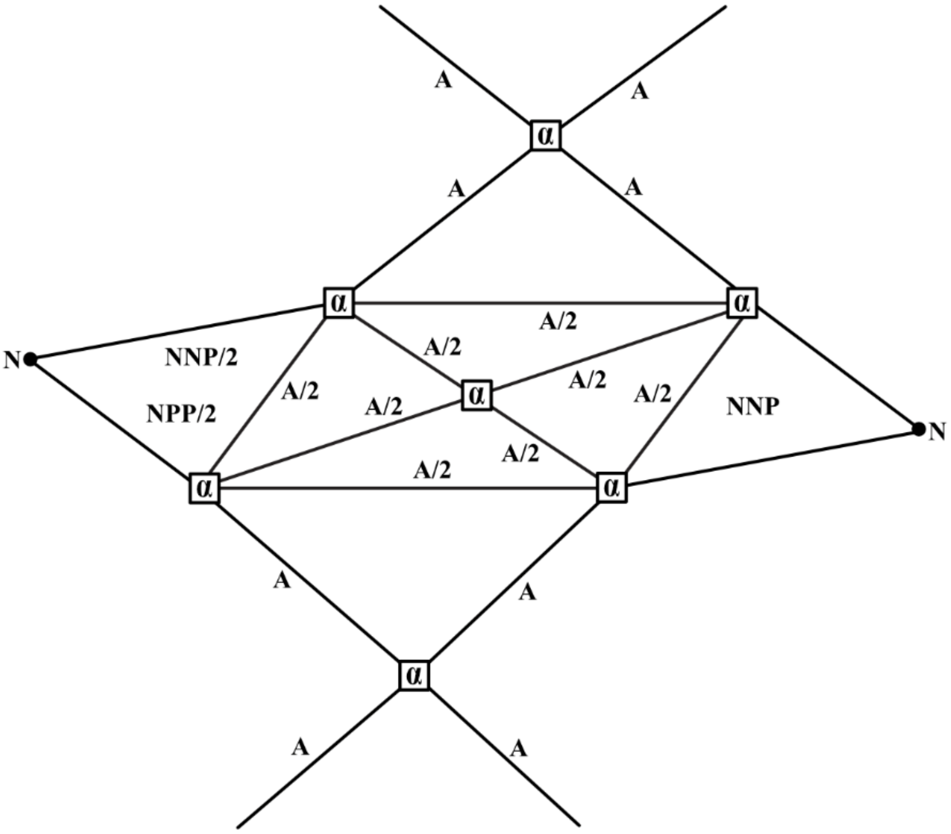
$^{198}_{78}$**Pt** Upper structure



$^{198}_{78}$**Pt**	Nat. abund.: 7.2%	39 α, 39 N suppl. 3 N in excess		E_B in MeV = 1,567.0017	MeV
	E_B	39 α	x	28.325	1,104.6750 MeV
Core		21	x	4.9365	103.6665
		21	x	2.2246	46.7166
39 N suppl		26.5	x	4.9365	130.8173
		26.5	x	2.2246	58.9519
		5.5	x	8.4818	46.6499
		7	x	7.7180	54.0260
3 N in excess		3	x	4.9365	14.8095
		3	x	2.2246	6.6738
					1,566.9865 MeV
					- 0.015

Figure 9

Pt 190 Central-upper structure



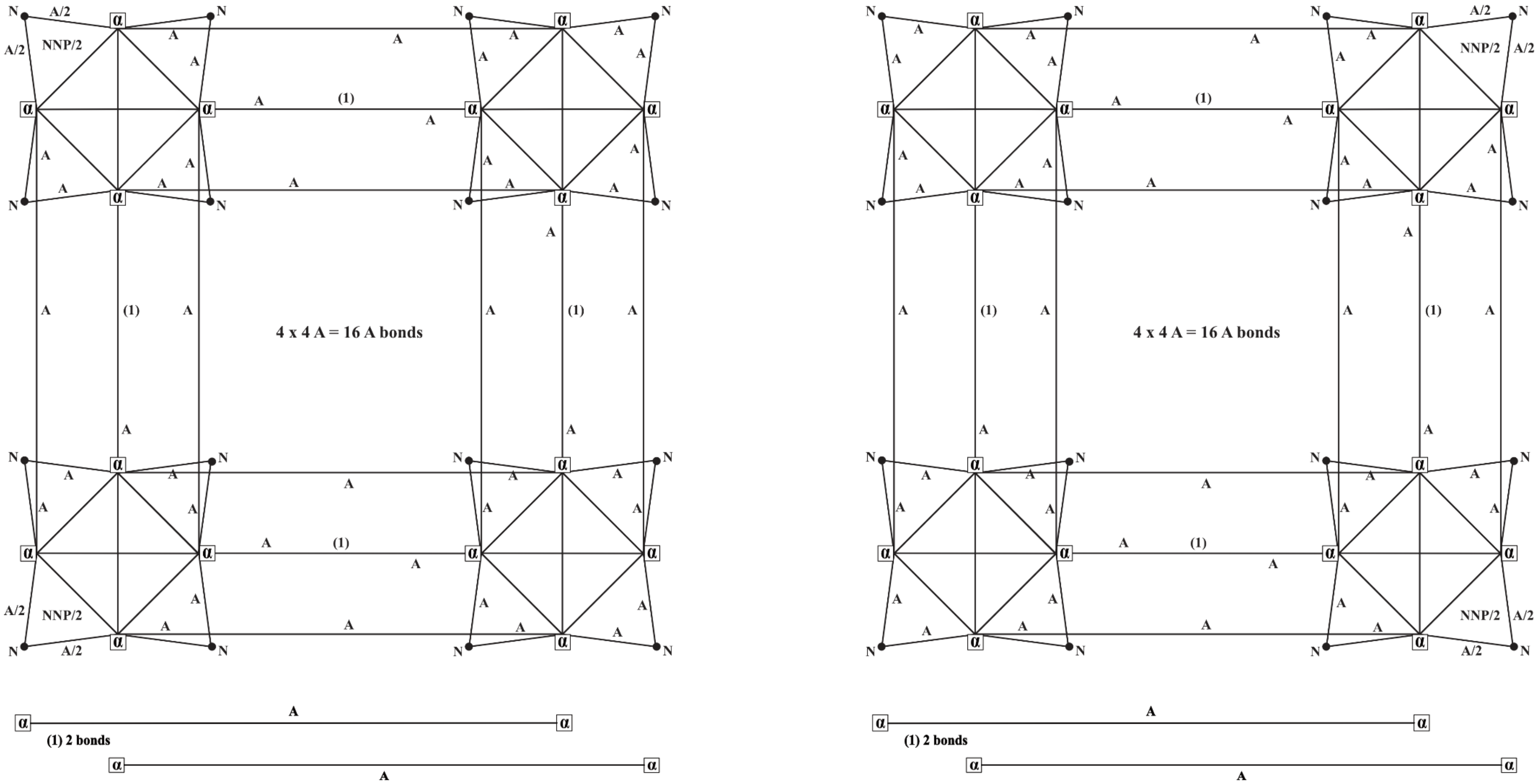
$^{190}_{78}$**Pt** Nat. abund.: 0.01% 39 α, 34 N suppl. E_B in MeV = 1,509.8337 MeV

E_B	39 α	x	28.325	1,104.6750	MeV
Core	22	x	4.9365	108.6030	
	22	x	2.2246	48.9412	
32 N suppl. of lower structure	30	x	4.9365	148.0950	
	30	x	2.2246	66.7380	
	2	x	8.4818	16.9636	
2 N suppl. of central-upper structure	0.5	x	8.4818	4.2409	
	1.5	x	7.7180	11.5770	
				1,509.8337	MeV

/

Figure 9 bis

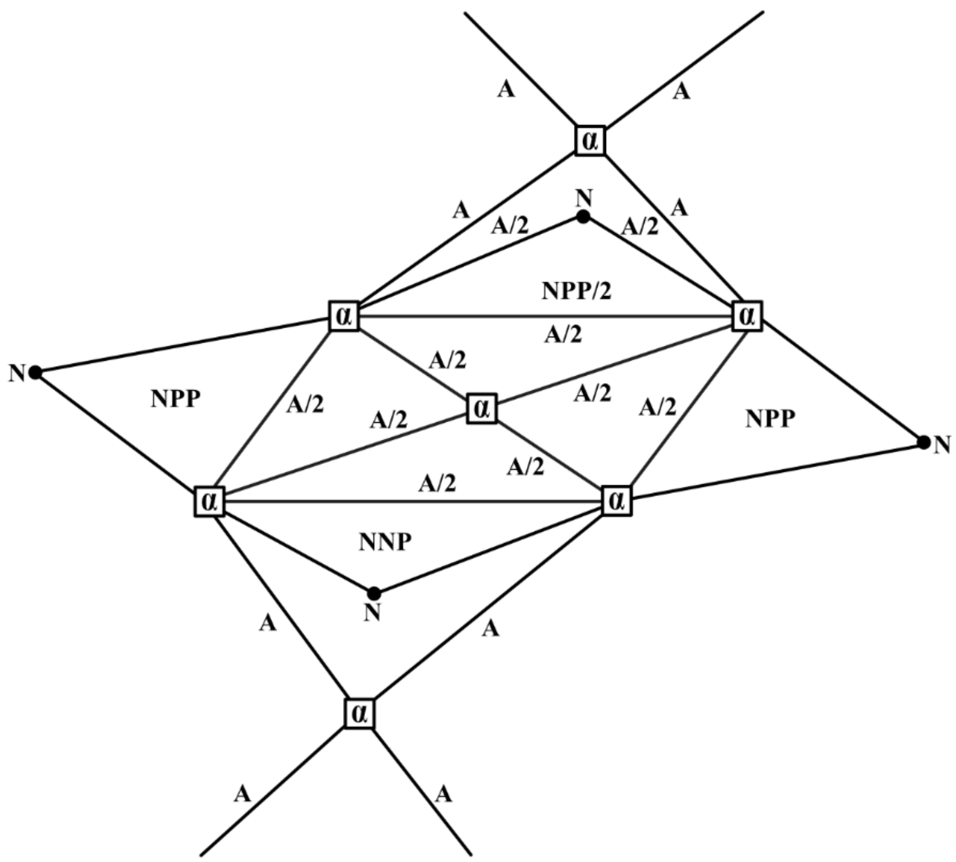
Pt 190 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds or (NNP/2 + A) bonds. They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 10

Pt 192 Central-upper structure

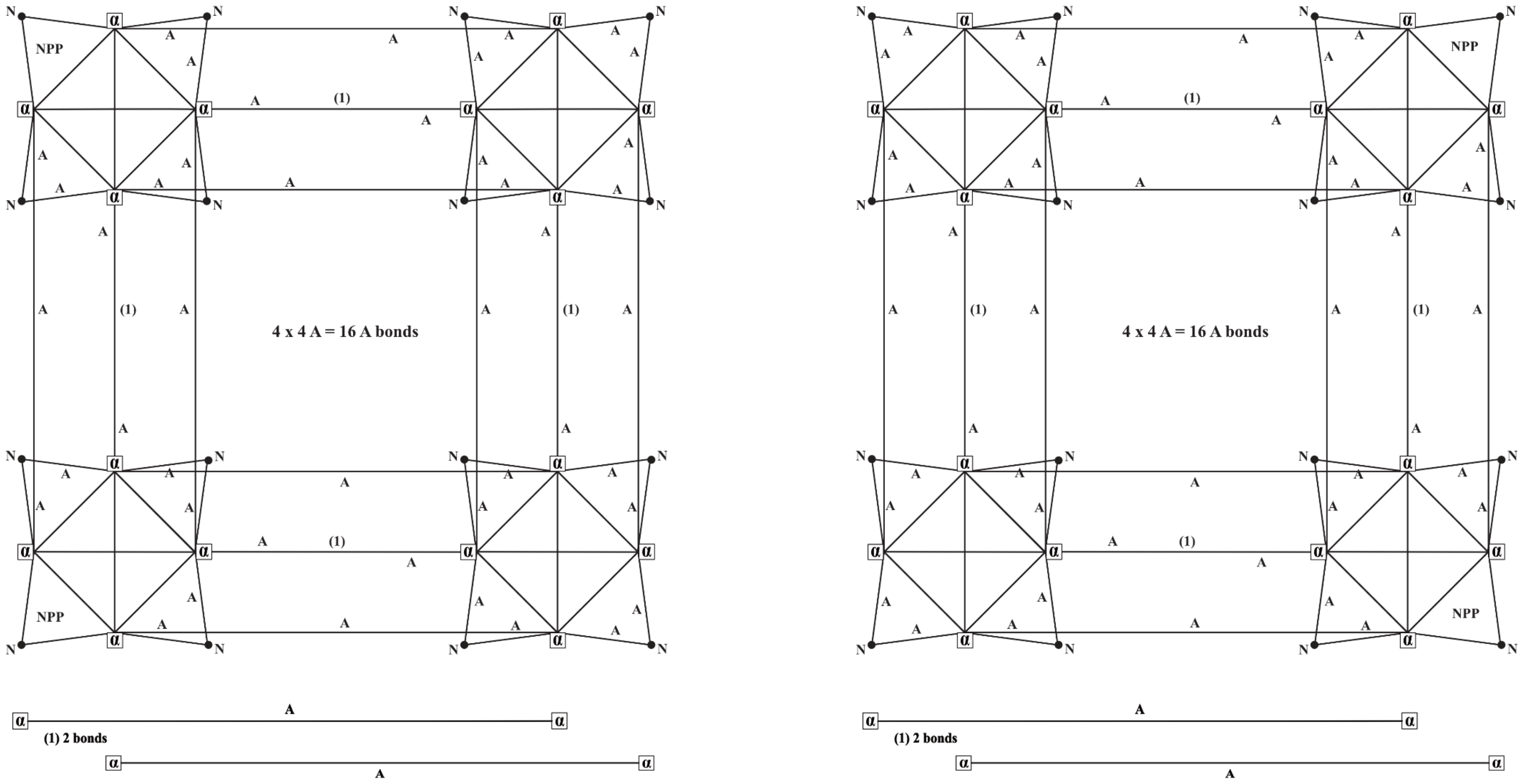


$^{192}_{78}$**Pt** Nat. abund.: 0.79% 39 α, 36 N suppl. EB in MeV = 1,524.9583 MeV

	EB	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
		28	x	4.9365	138.2220	
32 N suppl. of		28	x	2.2246	62.2888	
lower structure		4	x	7.7180	30.8720	
		0.5	x	4.9365	2.4683	
		0.5	x	2.2246	1.1123	
4 N suppl. of		1	x	8.4818	8.4818	
central-upper structure		2.5	x	7.7180	19.2950	
					1,524.9594	MeV
					+ 0.001	

Figure 10 bis

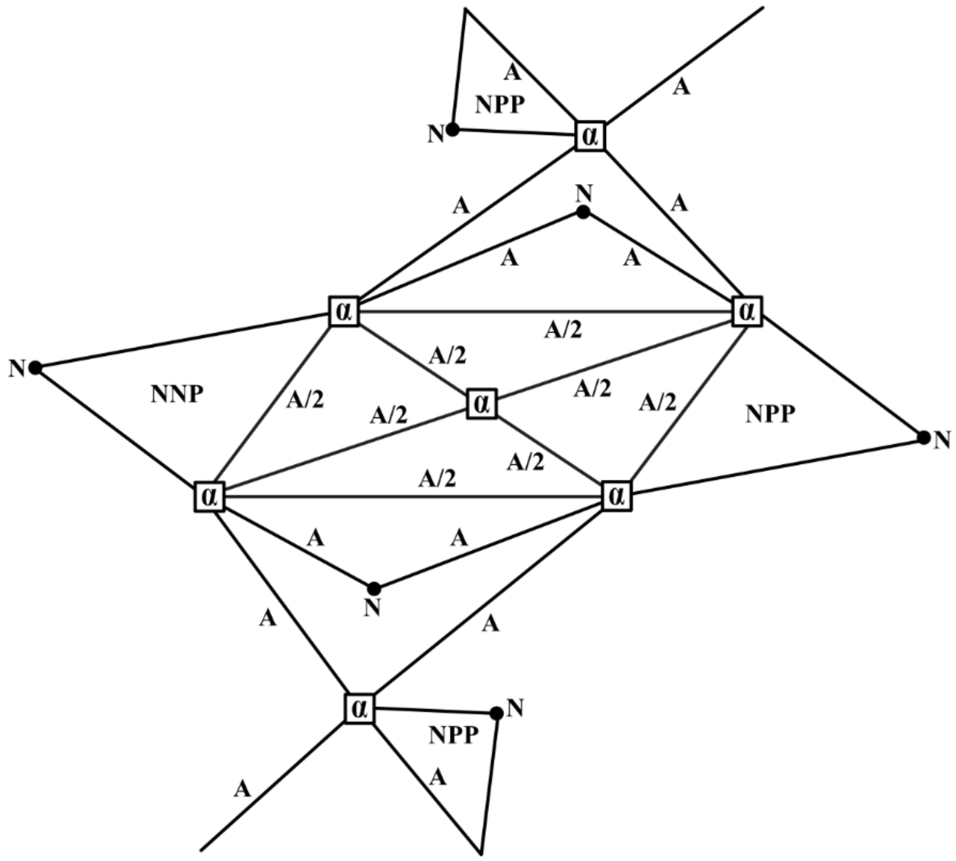
Pt 192 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds or NPP bonds. They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 11

Pt 194 Central-upper structure

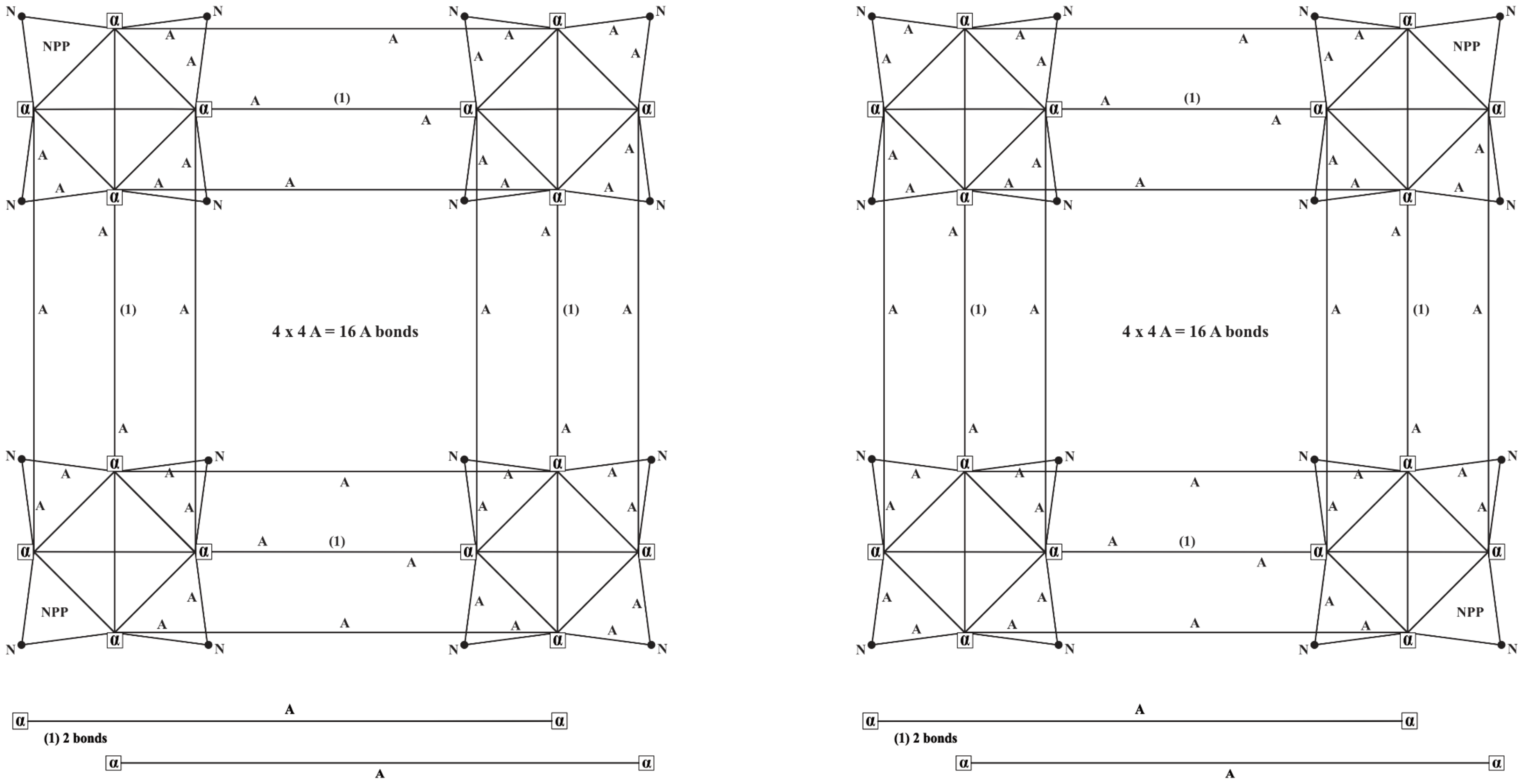


$^{194}_{78}$**Pt** Nat. abund.: 32.9% 39 α, 38 N suppl. EB in MeV = 1,539.5726 MeV

	EB	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
		28	x	4.9365	138.2220	
32 N suppl. of		28	x	2.2246	62.2888	
lower structure		4	x	7.7180	30.8720	
		2	x	4.9365	9.8730	
6 N suppl. of		2	x	2.2246	4.4492	
central-upper structure		1	x	8.4818	8.4818	
		3	x	7.7180	23.1540	
					1,539.5600	MeV
					- 0.012	

Figure 11 bis

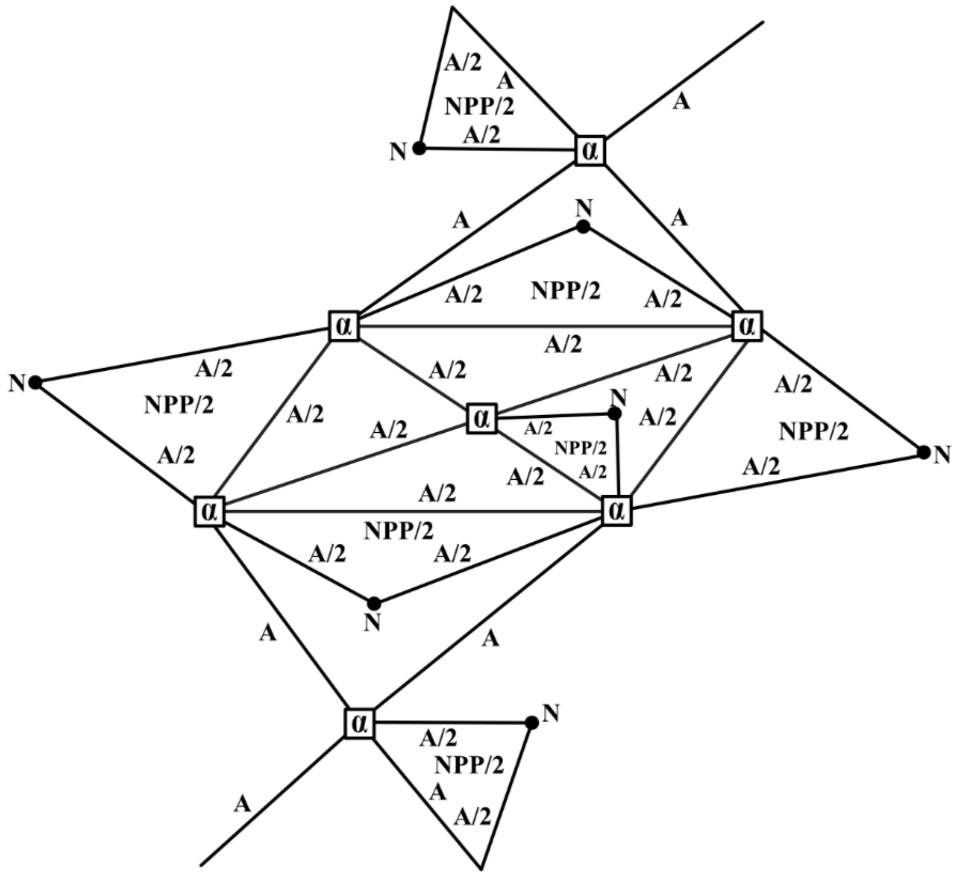
Pt 194 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds or NPP bonds. They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 12

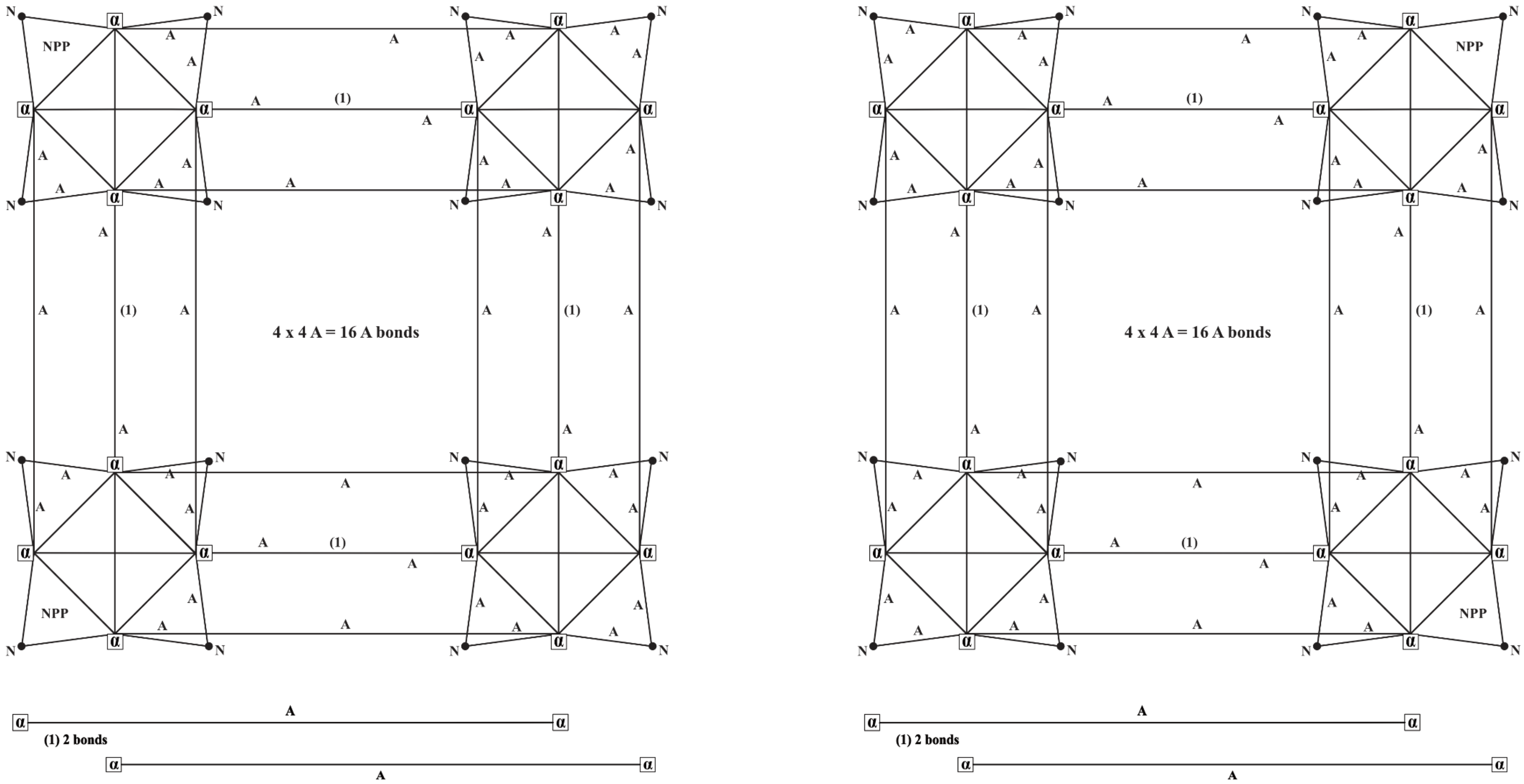
Pt 195 Central-upper structure



$^{195}_{78}$**Pt**	Nat. abund.: 35.8%		39 α, 39 N suppl.		E_B in MeV = 1,545.6776	MeV
	E_B	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
		28	x	4.9365	138.2220	
32 N suppl. of		28	x	2.2246	62.2888	
lower structure		4	x	7.7180	30.8720	
		3.5	x	4.9365	17.2778	
7 N suppl. of		3.5	x	2.2246	7.7861	
central-upper structure		3.5	x	7.7180	27.0130	
					1,545.6789	MeV
					+ 0.001	

Figure 12 bis

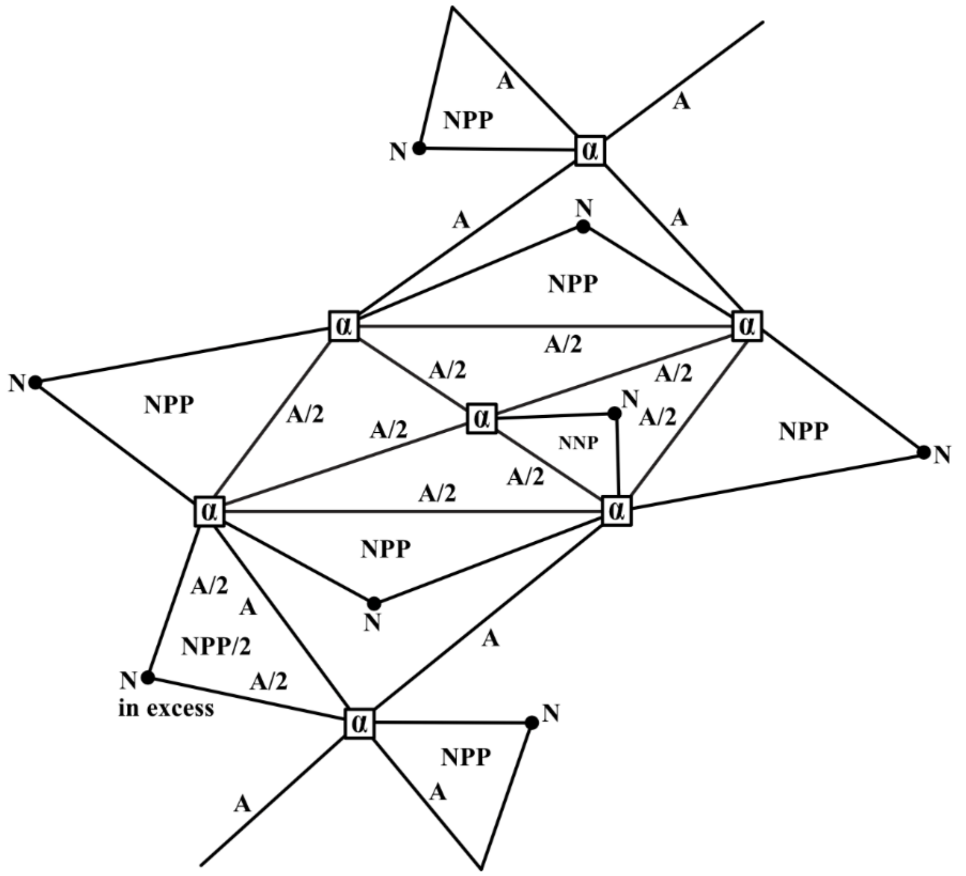
Pt 195 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds or NPP bonds. They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 13

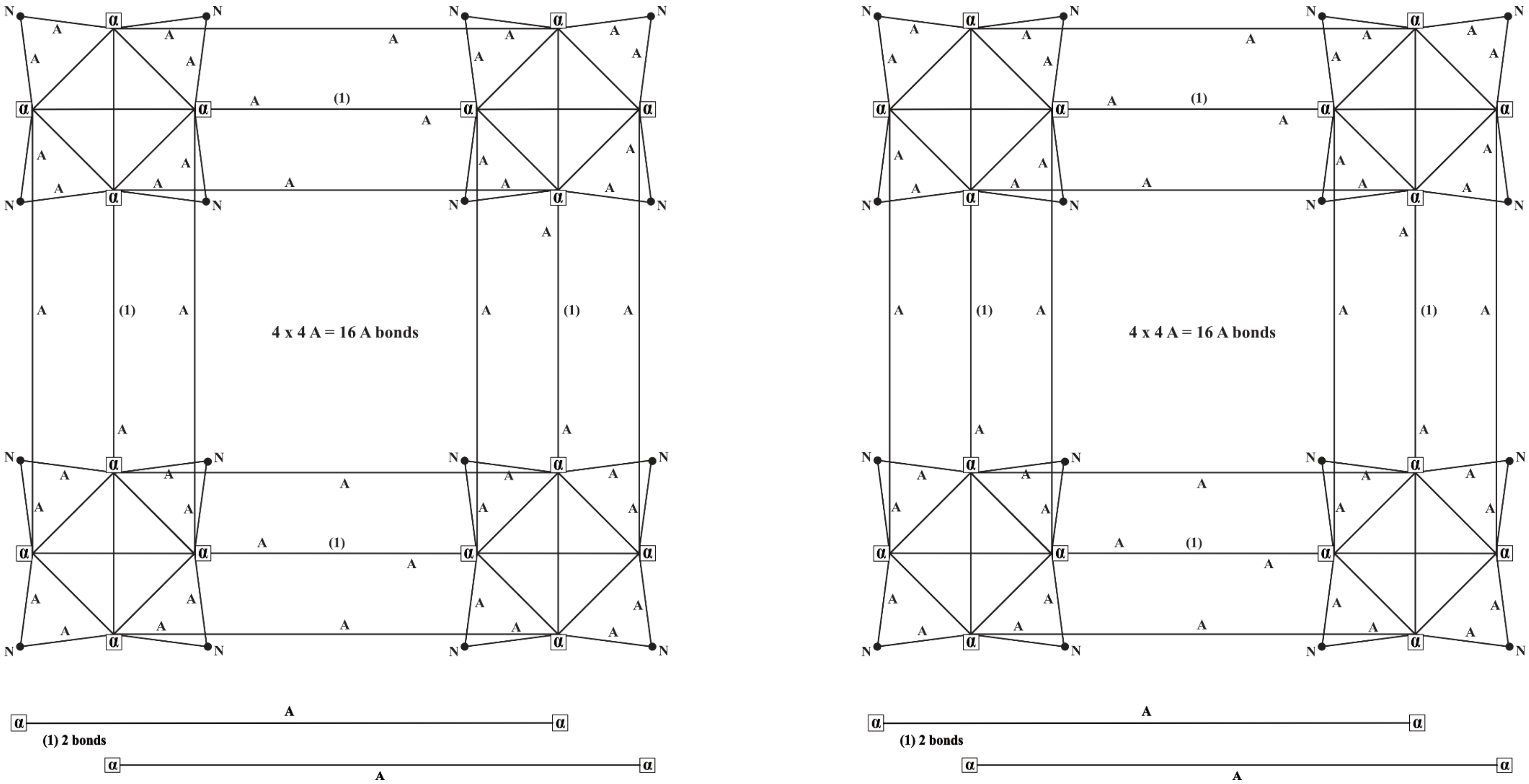
Pt 196 Central-upper structure



$^{196}_{78}$**Pt**	Nat. abund.: 25.3%	39 α, 39 N suppl., 1 N in excess			EB in MeV = 1,553.5997	MeV
	EB	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
32 N suppl. of lower structure		32	x	4.9365	157.9680	
		32	x	2.2246	71.1872	
7 N suppl. 1 N in excess of central-upper structure		0.5	x	4.9365	2.4683	
		0.5	x	2.2246	1.1123	
		1	x	8.4818	8.4818	
		6.5	x	7.7180	50.1670	
					1,553.6038	MeV
					+ 0.004	

Figure 13 bis

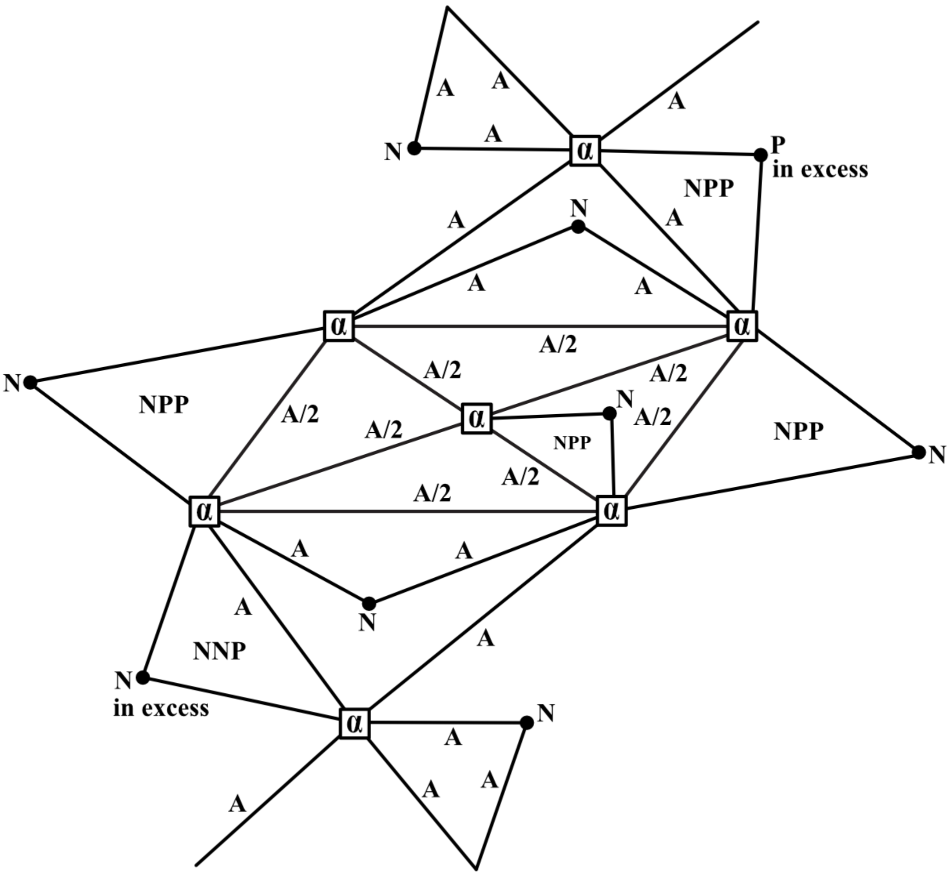
Pt 196 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds.
They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 14

Au 197 Central-upper structure

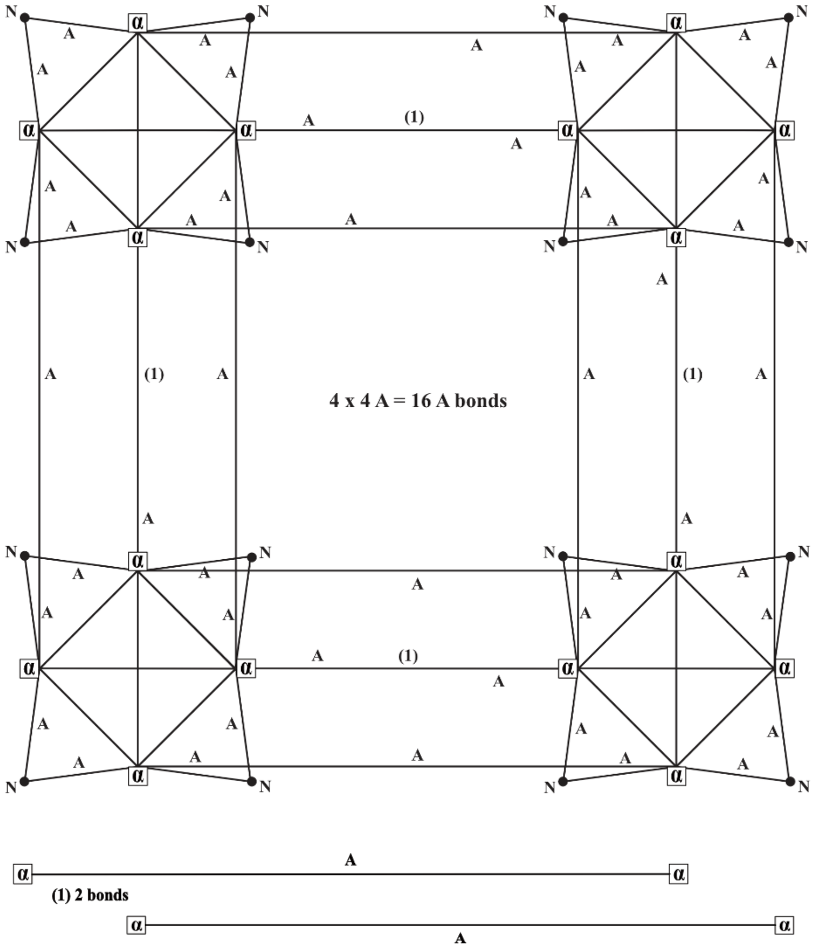


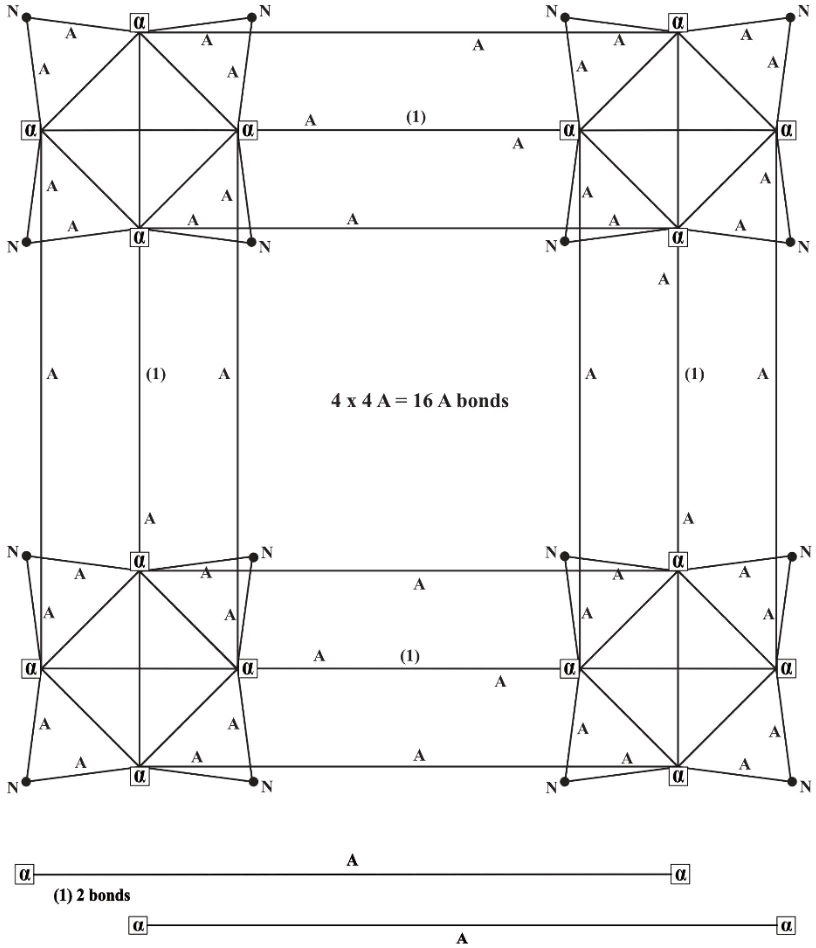
$^{197}_{79}$**Au** Nat. abund.: 100% 39 α, 39 N suppl., 1 N, 1 P in excess EB in MeV = 1,559.3838 MeV

	EB	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
32 N suppl. of lower structure		32	x	4.9365	157.9680	
		32	x	2.2246	71.1872	
7 N suppl. 1 N, 1 P in excess of central-upper structure		4	x	4.9365	19.7460	
		4	x	2.2246	8.8984	
		1	x	8.4818	8.4818	
		4	x	7.7180	30.8720	
					1,559.3726	MeV
					- 0.011	

Figure 14 bis

Au 197 - Lower structure

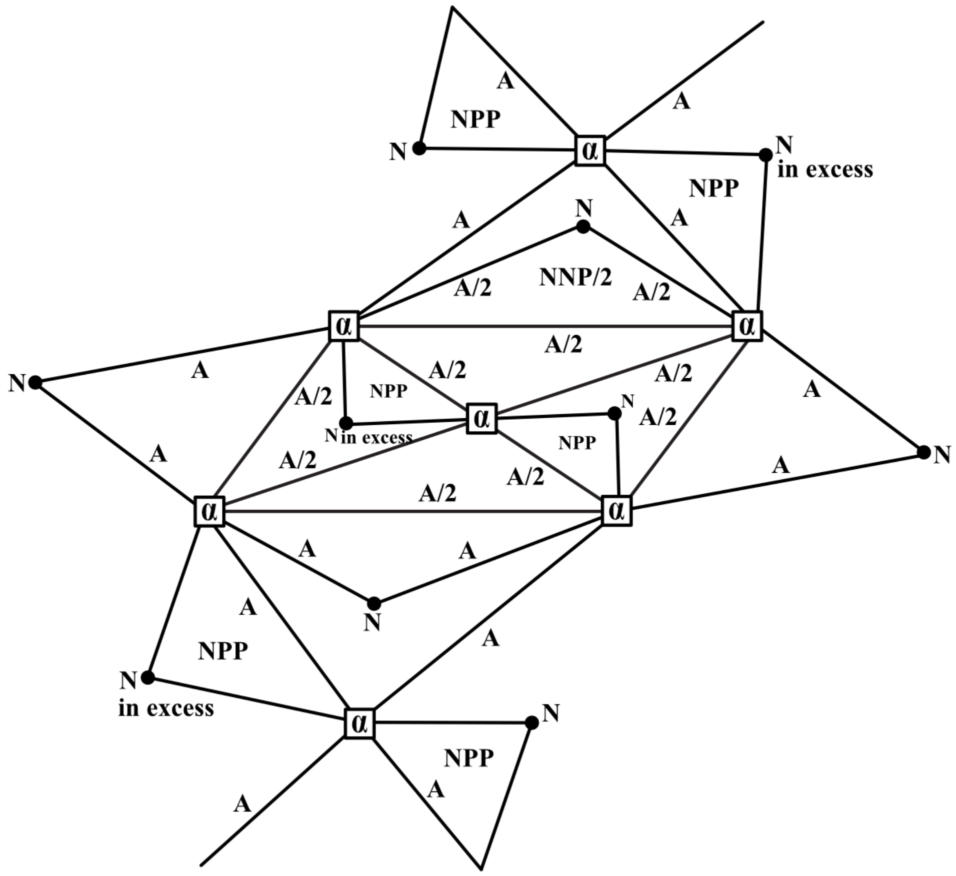




Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds.
They are also linked together with the 2 x 16A bonds of the lower structure.

Figure 15

Pt 198 Central-upper structure

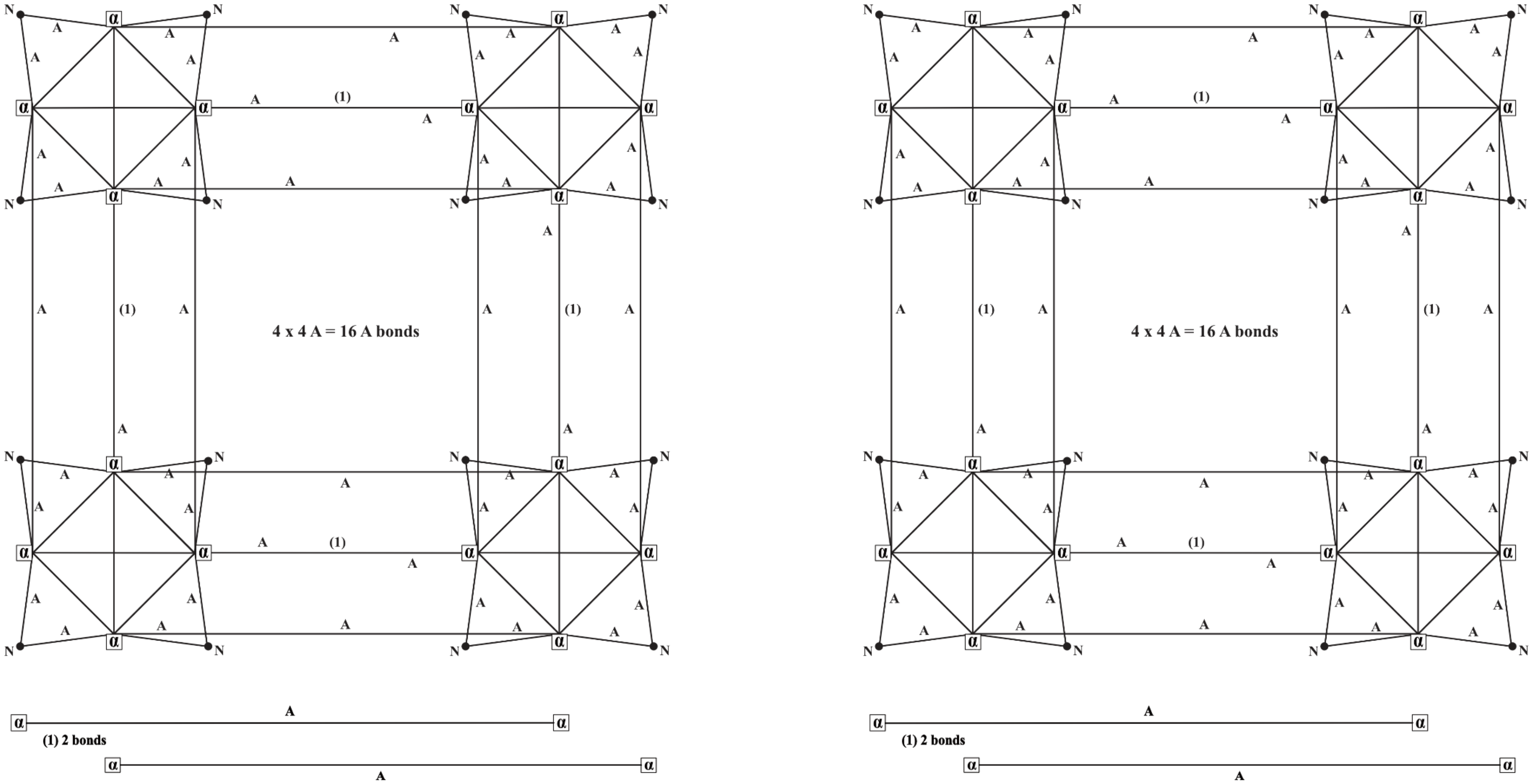


$^{198}_{78}$**Pt** Nat. abund.: 7.2% 39 α, 39 N suppl., 3 N, in excess E_B in MeV = 1,567.0017 MeV

	E_B	39 α	x	28.325	1,104.6750	MeV
Core		22	x	4.9365	108.6030	
		22	x	2.2246	48.9412	
32 N suppl. of		32	x	4.9365	157.9680	
lower structure		32	x	2.2246	71.1872	
7 N suppl.		3.5	x	4.9365	17.2778	
3 N in excess of		3.5	x	2.2246	7.7861	
central-upper structure		0.5	x	8.4818	4.2409	
		6	x	7.7180	46.3080	
					1,566.9872	MeV
					- 0.014	

Figure 15 bis

Pt 198 - Lower structure



Remark: the α particles are no longer linked together with direct A bonds but through the N (neutrons) supplementary to the α's with 2A bonds.
They are also linked together with the 2 x 16A bonds of the lower structure.