Electron Orbital Filling Order and Magic Numbers and the Double Tetrahedron Sphere Packing Nucleus Model.

Jeff Driscoll 7/17/2016

This presentation attempts to lay out a an atomic nucleus model to explain the order that electrons fill orbit states in an atom where the orbitals are filled in the well known order:

1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s

This presentation also provides a partial explanation for the "magic numbers" of protons and neutrons seen in isotopes of certain atoms that have exceptional stability to radioactive decay.

Order of Filling of Electron States

As the periodic table of the elements is built up by adding the necessary electrons to match the atomic number, the electrons will take the lowest energy consistent with the Pauli exclusion principle. The maximum population of each shell is determined by the quantum numbers and the diagram at left is one way to illustrate the order of filling of the electron energy states.

For a single electron, the energy is determined by the principal quantum **n** number and that quantum number is used to indicate the "shell" in which the electrons reside. For a given shell in multi-electron atoms, those electrons with lower orbital quantum number *l* will be lower in energy because of greater penetration of the shielding cloud of electrons in inner shells. These energy levels are specified by the principal and orbital quantum numbers using the spectroscopic notation. When you reach the 4s level, the dependence upon orbital quantum number is so large that the 4s is lower than the 3d. Although there are minor exceptions, the level crossing follows the scheme indicated in the diagram, with the arrows indicating the points at which one moves to the next shell rather than proceeding to higher orbital quantum number in the same shell.

The electron configuration for any element may be found by clicking on that element in the periodic table. The first exception to the above scheme that is encountered is chromium, where the fifth 3d electron state is occupied instead of the second 4s state.

See another approach to the order of filling

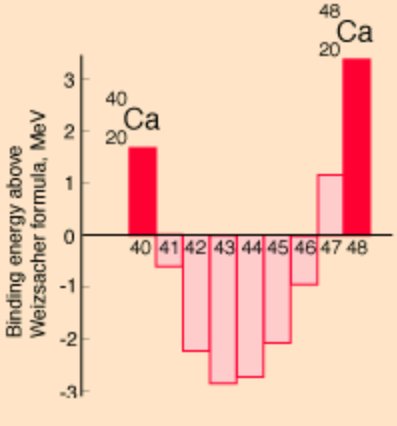
"Magic Numbers" in Nuclear Structure

It is found that nuclei with even numbers of protons and neutrons are more stable than those with odd numbers. In particular, there are "magic numbers" of neutrons and protons which seem to be particularly favored in terms of nuclear stability:

2,8,20,28,50,82,126

Magic Numbers

Nuclei which have both neutron number and proton number equal to one of the magic numbers can be called "doubly magic", and are found to be particularly stable.



$^{4}_{2}He$ $^{16}_{8}O$ $^{40}_{20}Ca$ $^{48}_{20}Ca$ $^{208}_{82}Pb$

Calcium provides a good example of the exceptional stability of "doubly magic" nuclei since it has two of them. The existence of several stable isotopes of calcium may have to to with the fact that Z=20, a magic number. The two highlighted isotopes have neutron numbers 20 and 28, also magic numbers. Compared to the binding energy calculated from the Weizsaecker formula, they both have more than the expected binding energy.

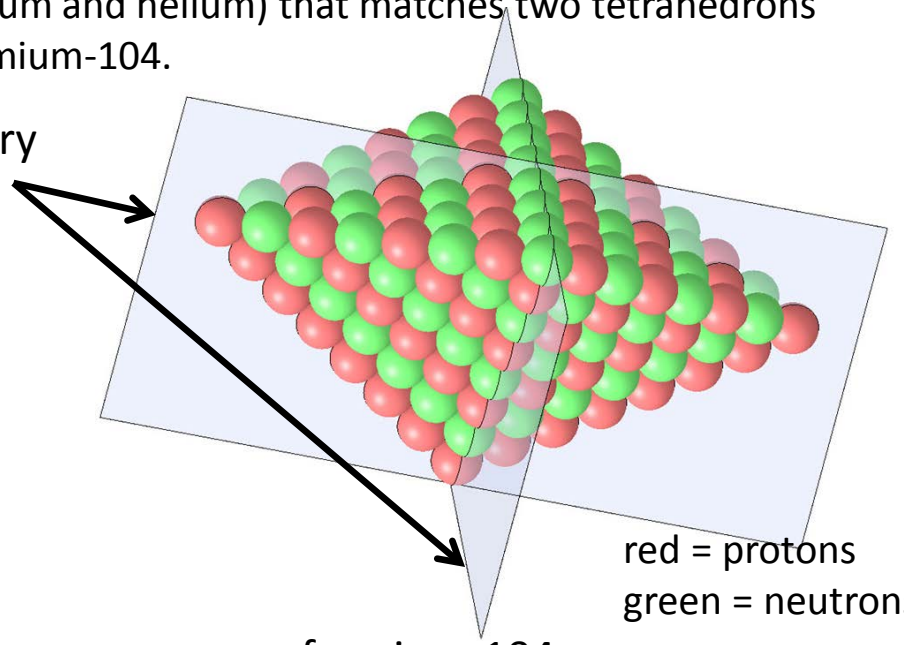
The existence of these magic numbers suggests closed shell configurations, like the shells in atomic structure. They represent one line of reasoning which led to the development of a shell model of the nucleus. Other forms of evidence suggesting shell structure include the following.

1. Enhanced abundance of those elements for which Z or N is a magic number.
2. The stable elements at the end of the naturally occuring radioactive series all have a "magic number" of neutrons or protons.
3. The neutron absorption cross-sections for isotopes where N = magic number are much lower than surrounding isotopes.
4. The binding energy for the last neutron is a maximum for a magic neutron number and drops sharply for the next neutron added.
5. Electric quadrupole moments are near zero for magic number nuclei.
6. The excitation energy from the ground nuclear state to the first excited state is greater for closed shells.

From hyperphysics:
http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/shell.html#c2

The atoms shown in this presentation (except helium) do not have protons or neutrons that perfectly match the commonly known **nuclei magic numbers** of: 2,8,20,28,50,82,126.
This presentation hypothesizes that the double tetrahedron model shown can be used to partially explain the commonly known magic number series listed above. Any differences could due to extra or missing neutrons/protons in some areas of the nucleus model such as in the middle of a planar face or at the extreme tips of the tetrahedron nucleon model.

This presentation focuses on the following 5 atoms with a proton/neutron arrangement that have exactly 2 planes of symmetry and an outer shape (except for lithium and helium) that matches two tetrahedrons joined on one face as shown in the figure below for fermium-104.



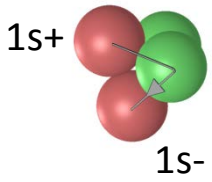
fermium-104

This presentation focuses on:
1. **fermium** (104 protons, 100 neutrons)
2. **silver** (47 protons, 44 neutrons)
3. **sulphur** (16 protons, 14 neutrons)
4. **lithium** (3 protons, 2 neutrons)
5. **helium** (2 protons, 2 neutrons)

The isotopes listed above for fermium, silver, sulphur and lithium are not the most abundant or the ones having the most stability since the isotopes that have the most abundance and stability have more neutrons.

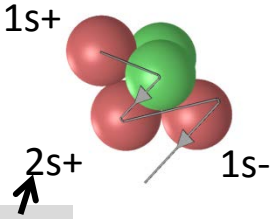
Fermium (along with silver, sulphur, lithium and helium) has perfect symmetry about the two planes shown above based on the model presented. In the image above, protons are red spheres and neutrons are green spheres.

(symmetry planes not shown)



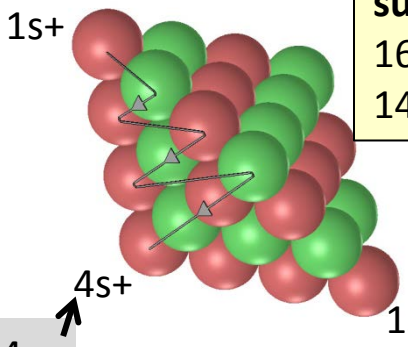
helium:
2 protons,
2 neutrons

(symmetry planes not shown)

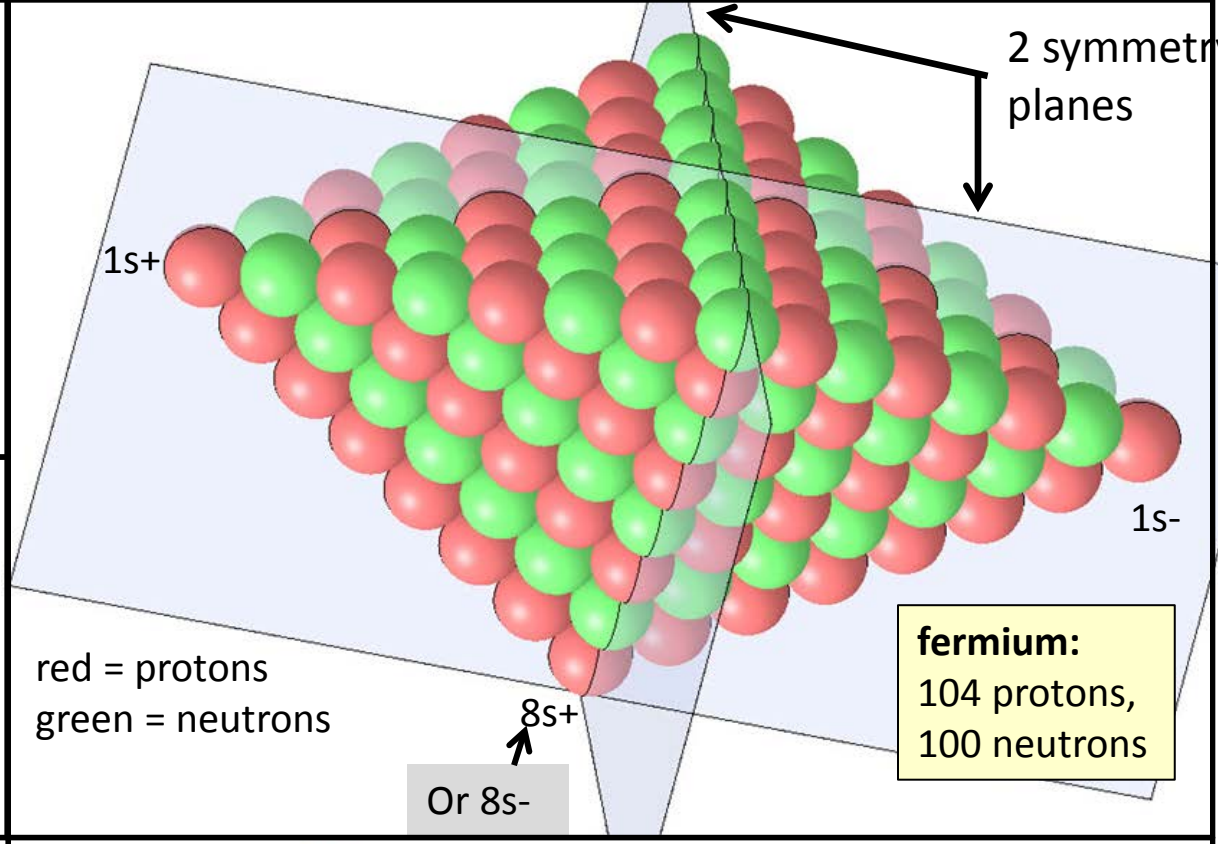


lithium:
3 protons,
2 neutrons

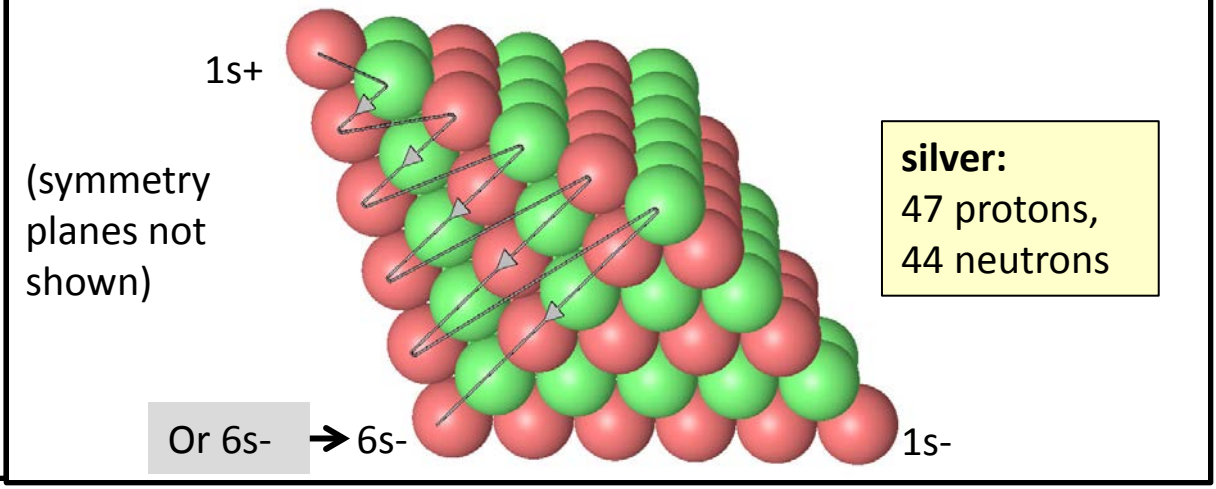
(symmetry planes not shown)



sulphur:
16 protons,
14 neutrons



fermium:
104 protons,
100 neutrons

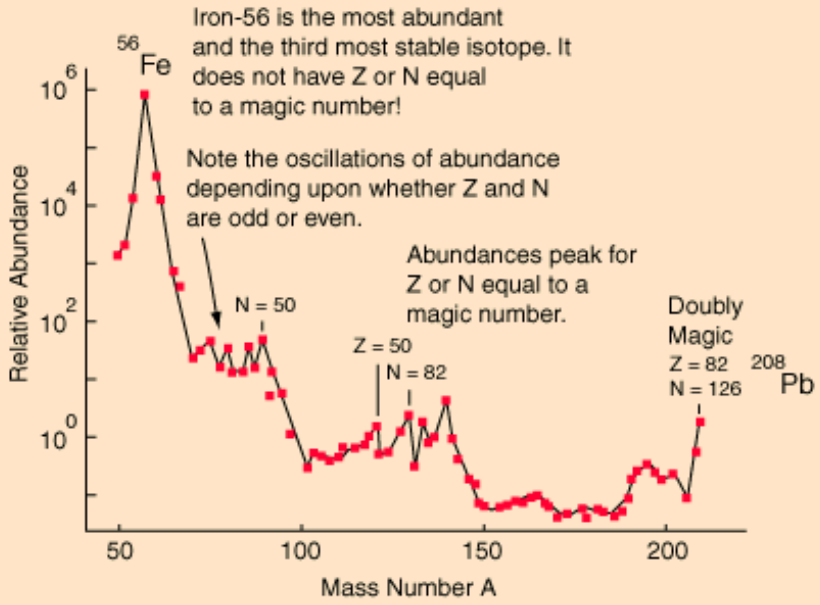


silver:
47 protons,
44 neutrons

The atoms on this page have symmetry about the two planes depicted for fermium in the upper right corner (only the symmetry planes for fermium are shown).

Enhanced Abundance of Magic Number Nuclei

Part of the motivation for the shell model of nuclear structure is the existance of "magic numbers" of neutrons and protons at which the nuclei have exceptional stability, implying some kind of "closed shell". One indication of this stability is the enhanced abundance of isotopes which have a magic number of neutrons or protons.



After Booth & Combley

The illustration examines the abundance of elements around iron and above. Our model of heavy element formation involves extraordinary processes in supernovae. Since these nuclei are born in the maelstrom of neutrons and neutrinos in the violent outer reaches of the supernovae, one would expect a statistical advantage for those isotopes which are most stable and therefore have the smallest cross-section for the kind of scattering which would disrupt them.

From hyperphysics:
http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/shell2.html

Nuclei having the number of protons or neutrons equal to one of the **magic numbers**: 2,8,20,28,50,82,126 are the most stable to decay and show up as peaks in a graph of relative abundance versus nuclei mass (shown at left). Nuclei having a number of protons and neutrons equal to any one of the magic numbers are even more stable and are termed **"doubly magic"**. Examples of doubly magic nuclei are:

Helium-4 (made of 2 protons, 2 neutrons)
Oxygen-16 (made of 8 protons, 8 neutrons)
Calcium-40 (made of 20 protons, 20 neutrons)
Calcium-48 (made of 20 protons, 28 neutrons)
Nickel-48 (made of 28 protons, 20 neutrons)
Nickel-78 (made of 28 protons, 50 neutrons)
Lead-208 (made of 82 protons, 126 neutrons)

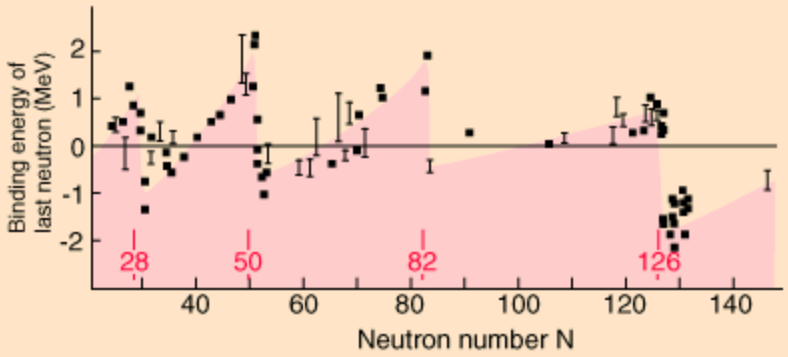
While the peaks in abundance for the magic number isotopes do not appear to be particularly prominent, keep in mind that the vertical scale is logaritmic.

The iron-56 is a particularly unique case, as shown by its extraordinary abundance. Iron-56 is an even-even nucleus and therefore expected to be particularly stable because of the Pauli contribution in the liquid drop model, but does not have magic numbers of either N or Z. It is exceeded in binding energy only by nickel-62 (the most stable nuclide) and iron-58. It is near the peak of the binding energy curve, and therefore can be considered to be one of the end points of both nuclear fusion and fission sequences, so perhaps that is the explanation for its extraordinary abundance.

From hyperphysics:
http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/shell2.html

Binding Energy for the Last Neutron as Evidence of Shell Structure

Part of the motivation for the shell model of nuclear structure is the existance of "magic numbers" of neutrons and protons at which the nuclei have exceptional stability, implying some kind of "closed shell". Part of this evidence comes from measuring the energy required to remove a neutron from the nucleus.



After Booth & Combley

This dependence of the energy to remove the last neutron is strong evidence for a kind of shell structure. At the magic numbers, the shell is "closed" and it is hard to remove a neutron. Just above the closed shell, the added neutrons are less tightly bound, reminiscent of the alkali metals in the chemical shell structure. The zero in energy above is the expected binding energy from the Weizsaeker formula.

Evidence for nuclear shell structure | "Magic numbers" of nucleons

Binding energy nuclei having a neutron number equal to a magic number of 28, 50, 82, 126 or slightly higher have higher binding energies as seen in graph at left.

From Wikipedia:
https://en.wikipedia.org/wiki/Magic_number_(physics)

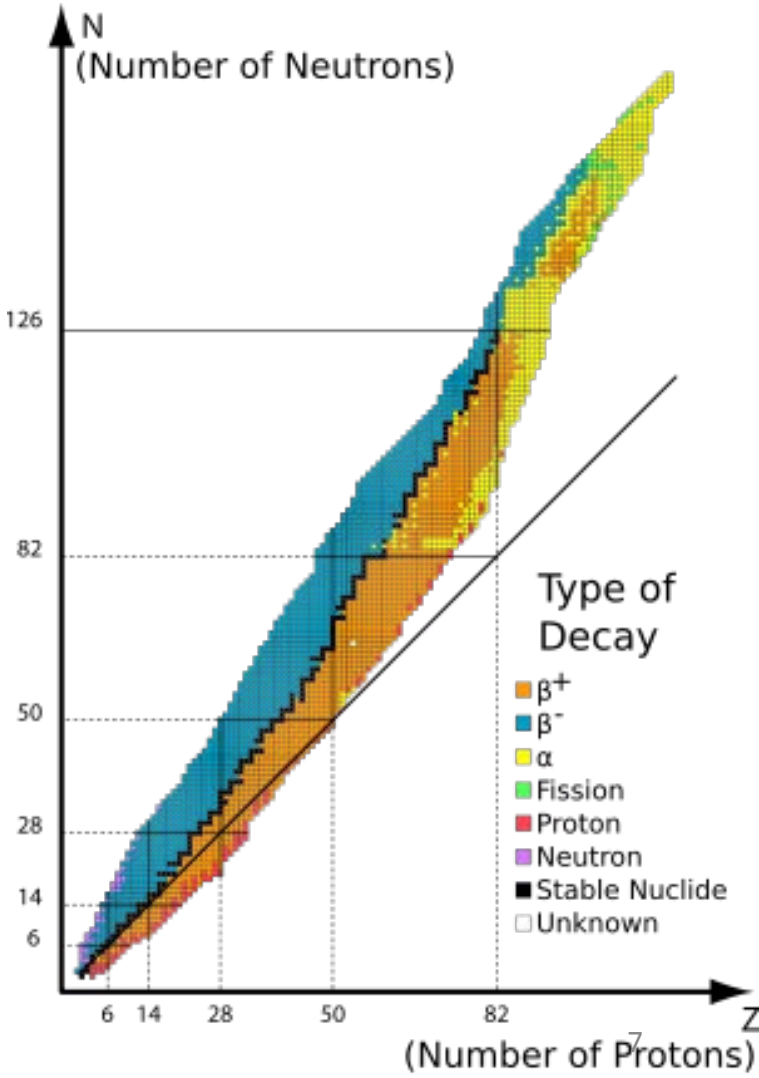
In nuclear physics, a magic number is a number of nucleons (either protons or neutrons) such that they are arranged into complete shells within the atomic nucleus. The seven most widely recognized magic numbers as of 2007 are 2, 8, 20, 28, 50, 82, and 126 (sequence A018226 in OEIS). Atomic nuclei consisting of such a magic number of nucleons have a higher average binding energy per nucleon than one would expect based upon predictions such as the semi-empirical mass formula and are hence more stable against nuclear decay

[…]Nuclei which have neutron number and proton (atomic) numbers each equal to one of the magic numbers are called "double magic", and are especially stable against decay. Examples of double magic isotopes include helium-4, oxygen-16, calcium-40, calcium-48,nickel-48, nickel-78, and lead-208.

Double-magic effects may allow existence of stable isotopes which otherwise would not have been expected. An example is calcium-40, with 20 neutrons and 20 protons, which is the heaviest stable isotope made of the same number of protons and neutrons. Bothcalcium-48 and nickel-48 are double magic because calcium-48 has 20 protons and 28 neutrons while nickel-48 has 28 protons and 20 neutrons. Calcium-48 is very neutron-rich for such a light element, but like calcium-40, it is made stable by being double magic. Nickel-48, discovered in 1999, is the most proton-rich isotope known beyond helium-3.[5] At the other extreme, nickel-78 is also doubly magical, with 28 protons and 50 neutrons, a ratio observed only in much heavier elements apart from tritium with one proton and two neutrons (Ni-78: 28/50 = 0.56; U-238: 92/146 = 0.63).[6]

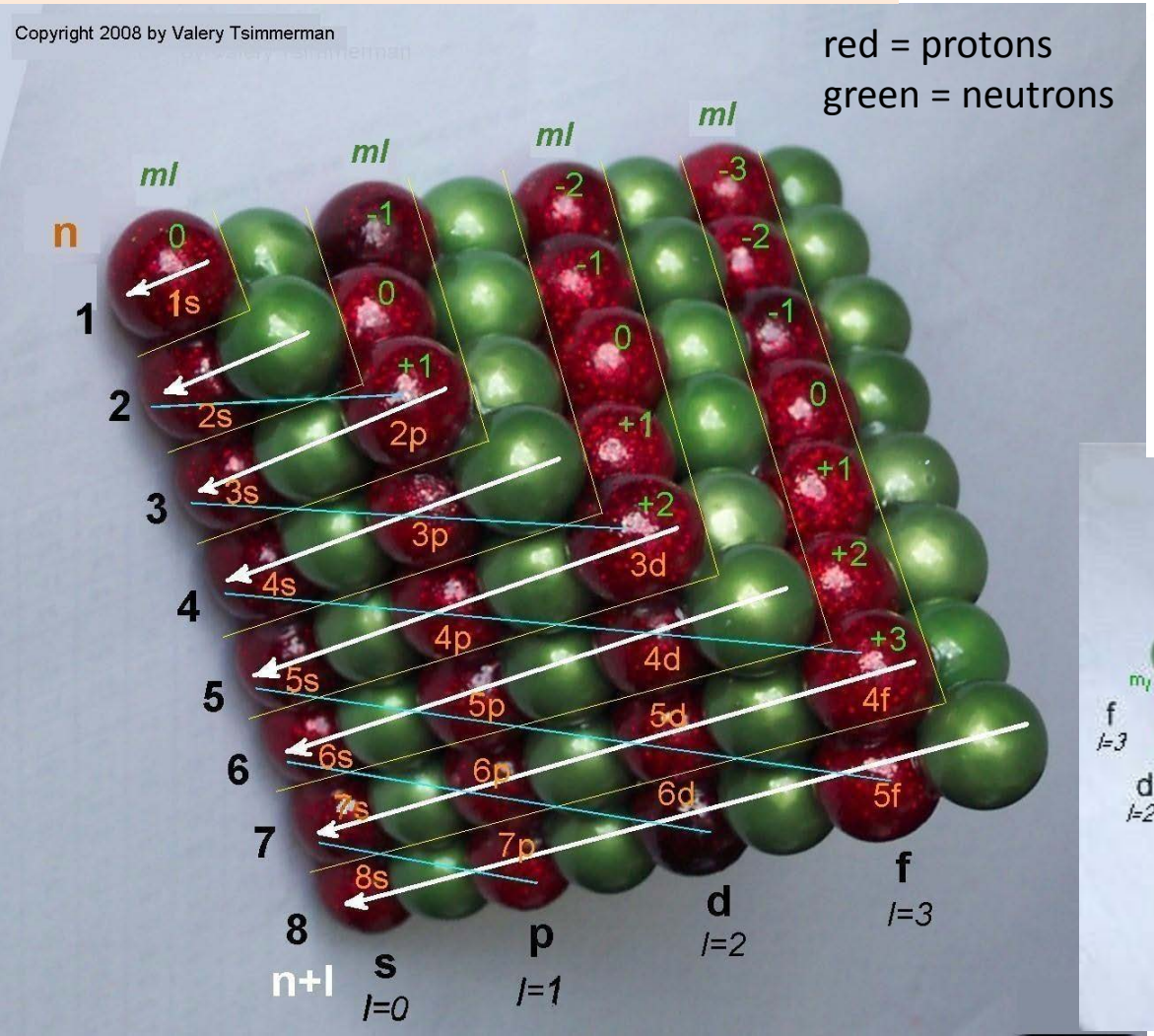
Magic number shell effects are seen in ordinary abundances of elements: helium-4 is among the most abundant (and stable) nuclei in the universe[7] and lead-208 is the heaviest stable nuclide.

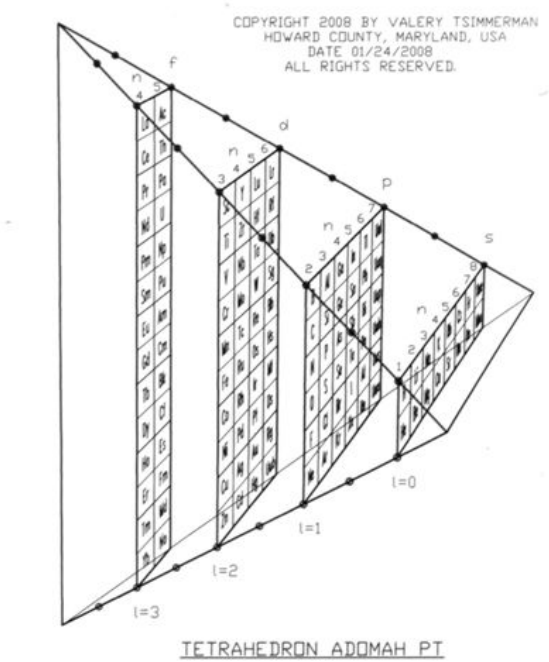
Magic effects can keep unstable nuclides from decaying as rapidly as would otherwise be expected. For example, the nuclides tin-100 and tin-132 are examples of doubly magic isotopes of tin that are unstable, and represent endpoints beyond which stability drops off rapidly.

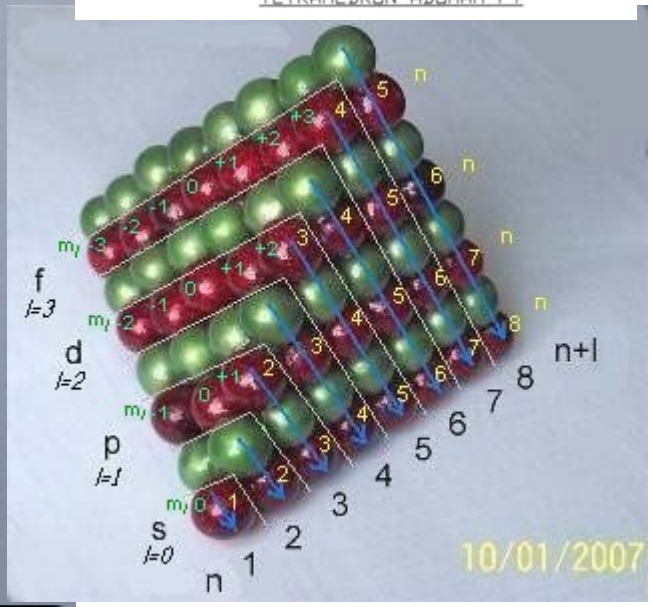


Is there a geometric shape that the protons and neutrons arrange themselves such that the magic numbers are seen in the nuclei stability data and the filling order of electron orbitals is explained? This presentation describes a proton/neutron arrangement structure according to what I found on the following website created by ***Valery Tsimmerman***:
http://perfectperiodictable.com/default.html

Valery Tsimmerman named his periodic table the **Tetrahedron ADOMAH Periodic Table**



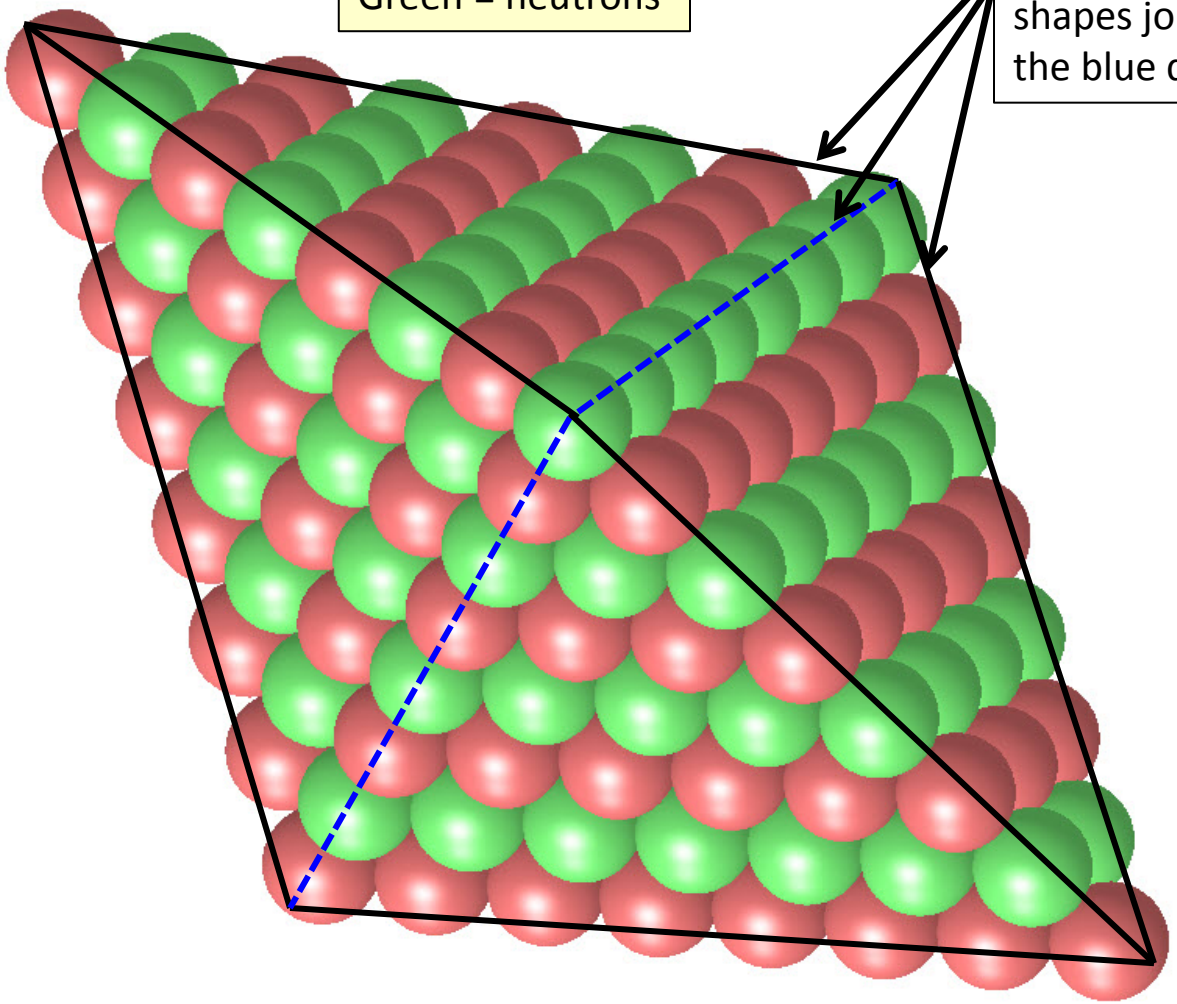


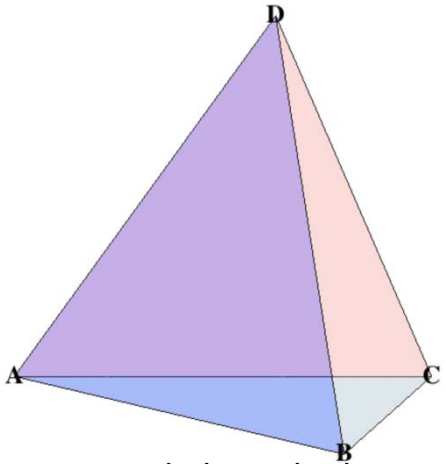


If 104 protons and 100 neutrons are stacked together in the nucleus such that the outer shape is two tetrahedrons joined on one face then the nucleus would look like the following:

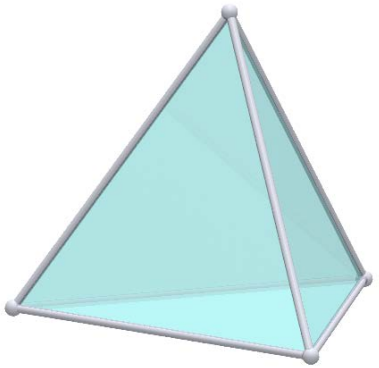
Red = protons
Green = neutrons

The black lines are two tetrahedron shapes joined on one face indicated by the blue dashed line.



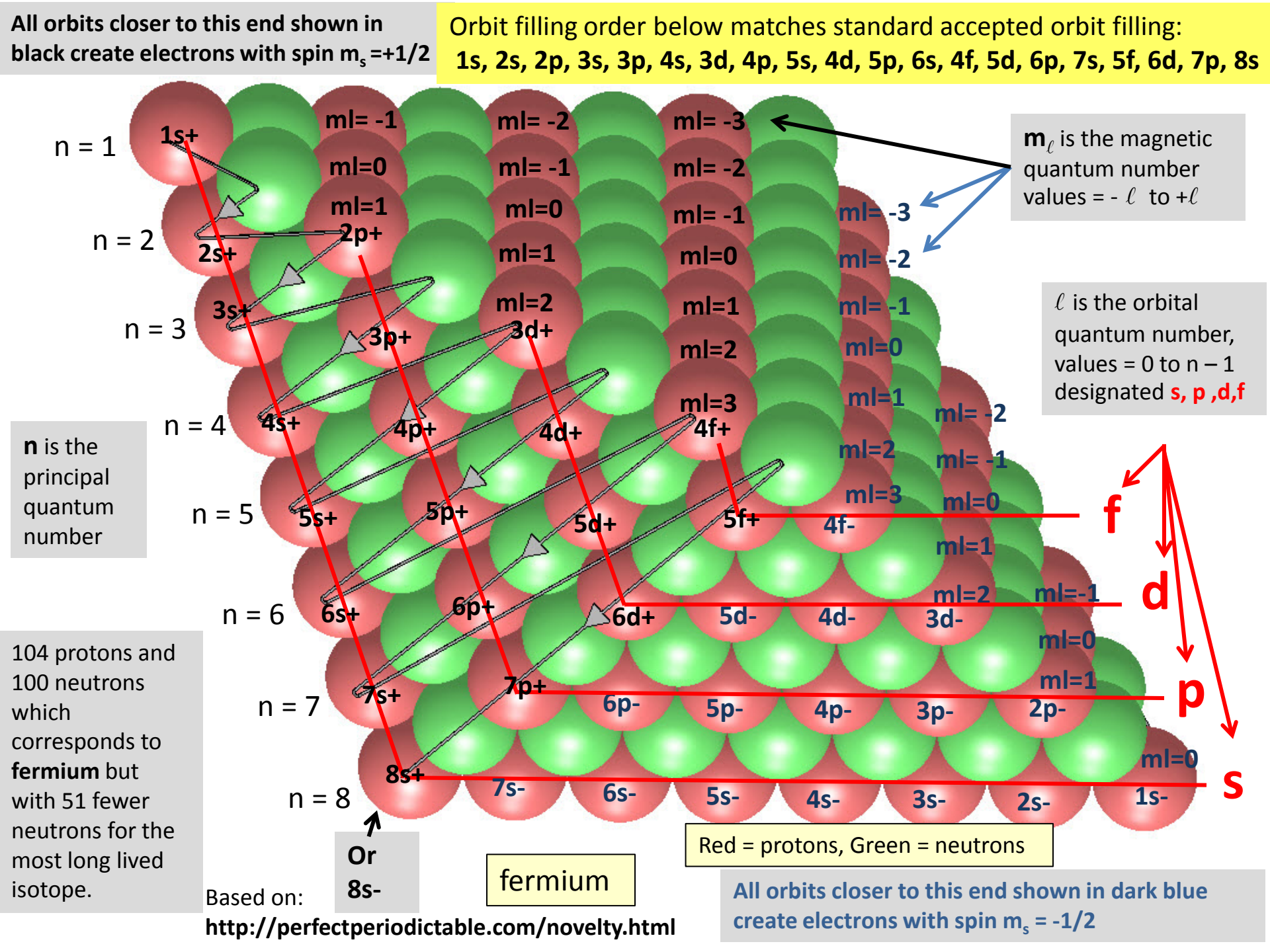


4 sided tetrahedron

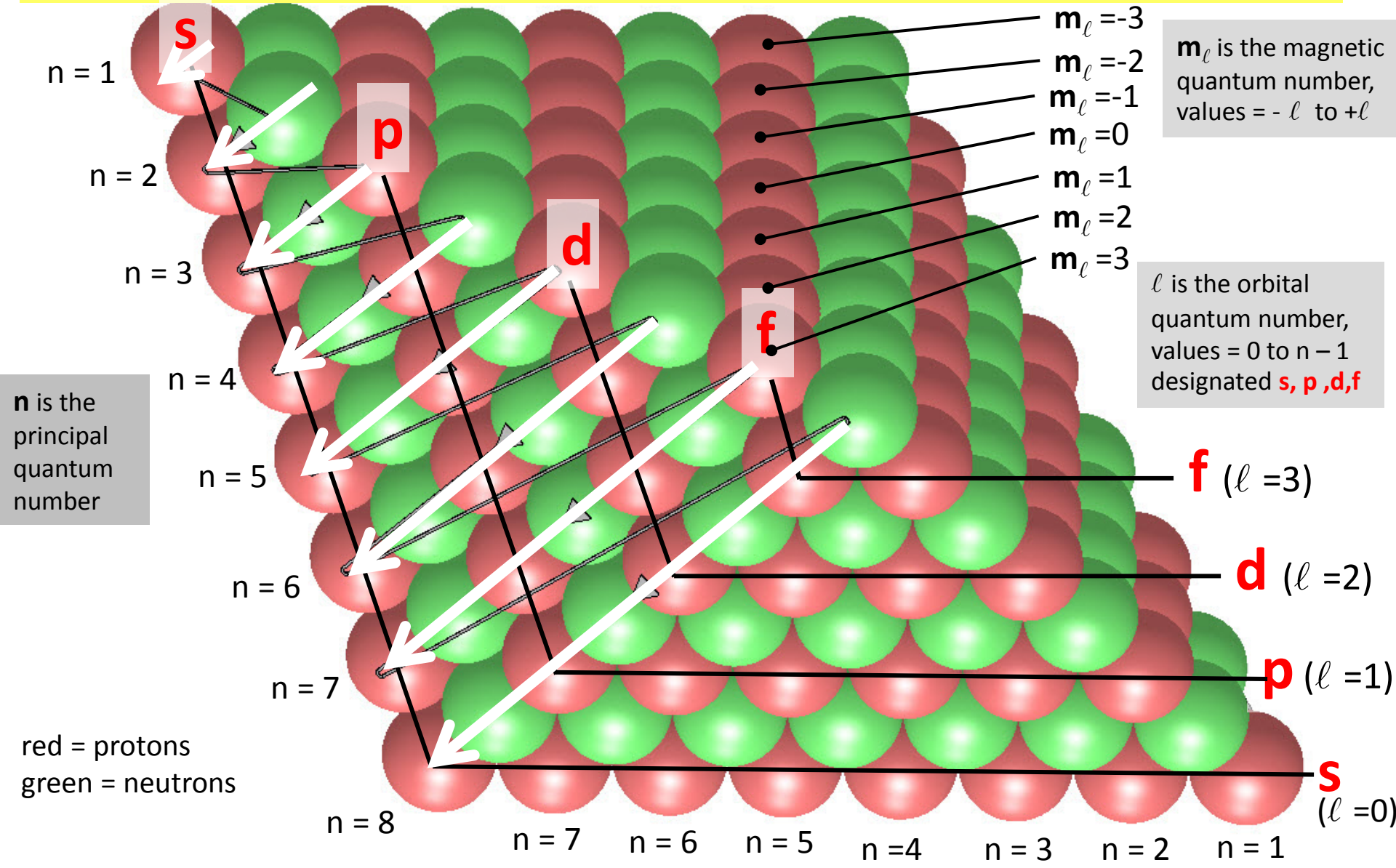


4 sided tetrahedron

The resulting electron orbit filling order could then be inserted directly onto the model above as shown on the next page.


All orbits closer to this end shown in black create electrons with spin m_s =+1/2
Orbit filling order below matches standard accepted orbit filling:
1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s
m_ℓ is the magnetic quantum number values = - ℓ to +ℓ
ℓ is the orbital quantum number, values = 0 to n – 1 designated s, p ,d,f
n is the principal quantum number
n = 1
n = 2
n = 3
n = 4
n = 5
n = 6
n = 7
n = 8
1s+
2s+
2p+
3s+
3p+
3d+
4s+
4p+
4d+
4f+
5s+
5p+
5d+
5f+
6s+
6p+
6d+
7s+
7p+
8s+
ml= -3
ml= -2
ml= -1
ml=0
ml=1
ml=2
ml=3
4f-
5d-
4d-
3d-
6p-
5p-
4p-
3p-
2p-
7s-
6s-
5s-
4s-
3s-
2s-
1s-
f
d
p
s
Or
8s-
104 protons and 100 neutrons which corresponds to fermium but with 51 fewer neutrons for the most long lived isotope.
Based on:
http://perfectperiodictable.com/novelty.html
fermium
Red = protons, Green = neutrons
All orbits closer to this end shown in dark blue create electrons with spin m_s = -1/2

Orbit filling order indicated by white arrows matches standard accepted orbit filling:
1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s



n is the principal quantum number

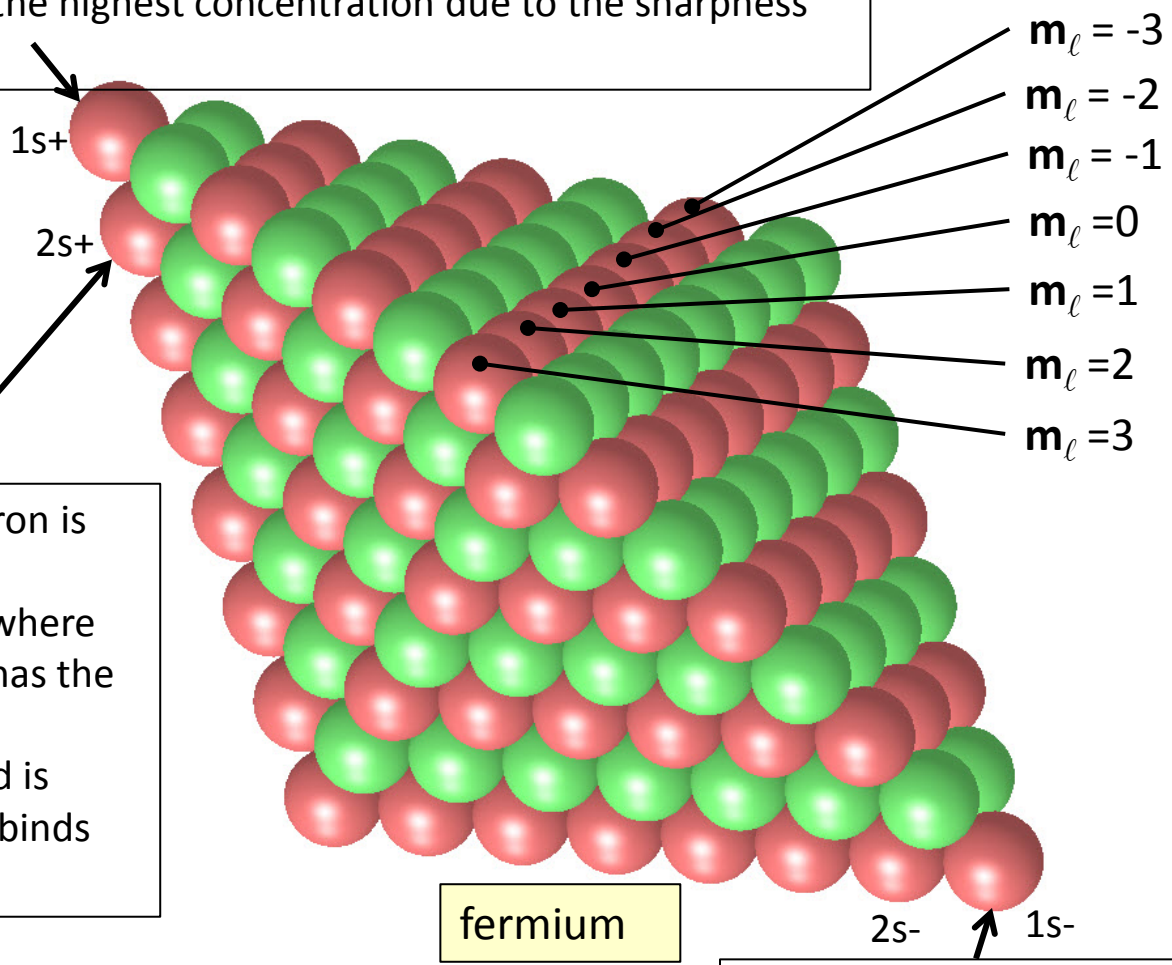
m_ℓ is the magnetic quantum number, values = - ℓ to +ℓ

ℓ is the orbital quantum number, values = 0 to n – 1 designated **s, p ,d,f**

red = protons
green = neutrons

Fermium = 104 protons and 100 neutrons (extra neutrons give added lifetime stability)

1. The first electron is captured by either of the two protons labeled 1s+ ($\mathbf{m_s}$ = +1/2) and 1s- ($\mathbf{m_s}$ = -1/2) at the tips where the electric field has the highest concentration due to the sharpness of the tip.



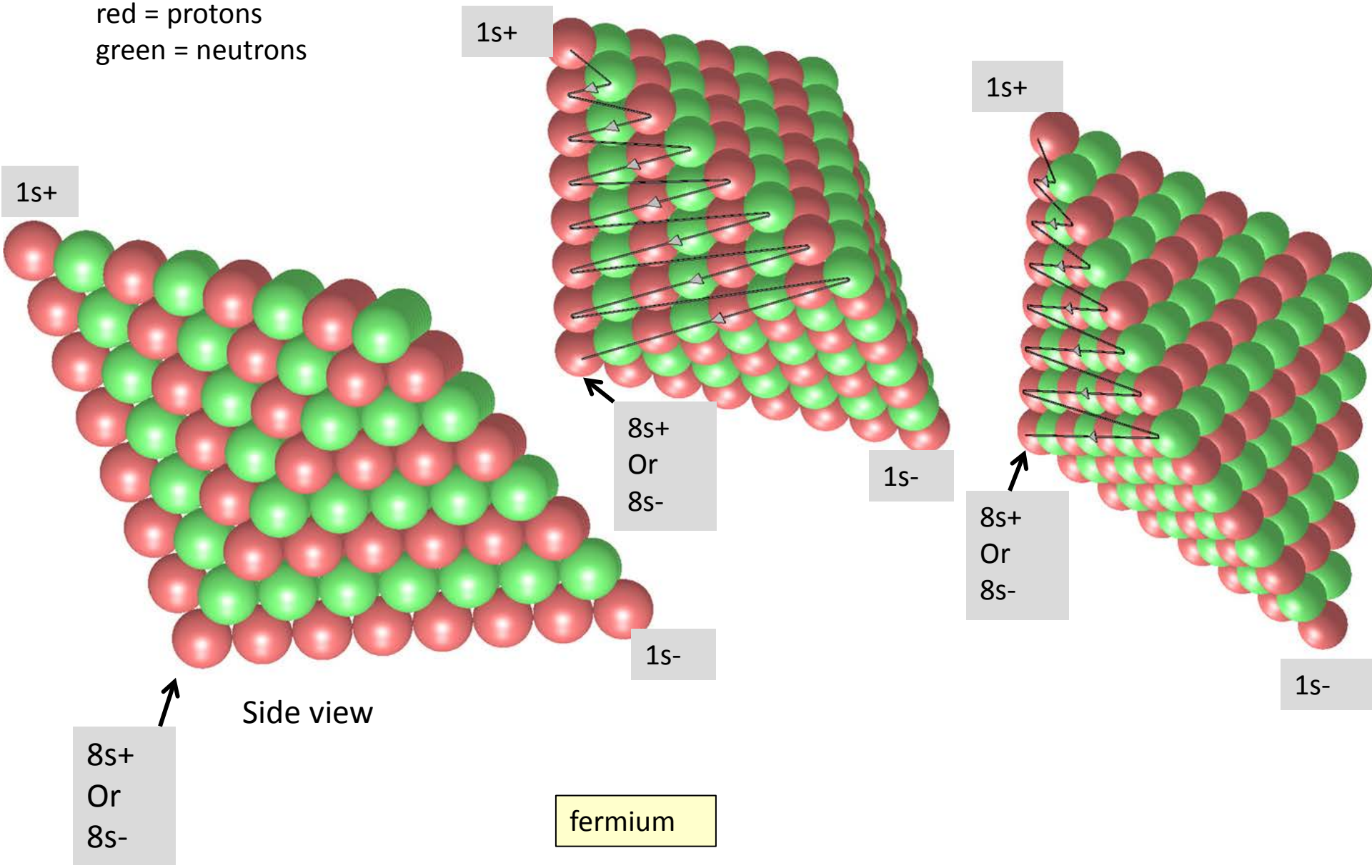
3. The third electron is captured by next available proton where the electric field has the third highest concentration and is labeled 2s+ (or it binds with 2s-)

fermium

2. The second electron is captured by the proton at the opposite tip, labeled 1s- ($\mathbf{m_s}$ = -1/2) , where the electric field is the most concentrated <u>and</u> due to the fact that the electron is repelled by the first electron on the opposite end.

4. Electrons fill the rest of the orbits according to decreasing electrostatic voltage potential. The electron can gain or lose energy by lattice phonons, photons, molecular vibrations and/or molecular spinning and "jump" to (or bond with) a new proton as long as energy is conserved in the jump.

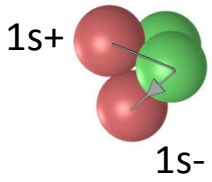
red = protons
green = neutrons



fermium

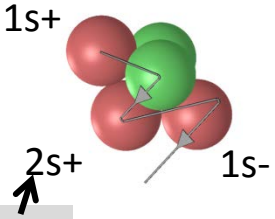
Fermium shown in different orientations.

(symmetry planes not shown)



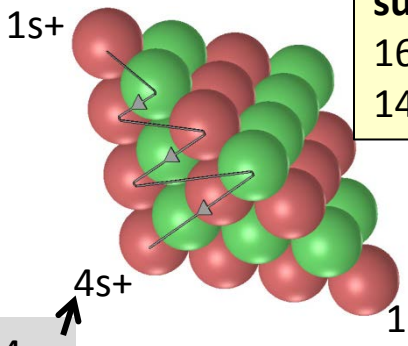
helium:
2 protons,
2 neutrons

(symmetry planes not shown)

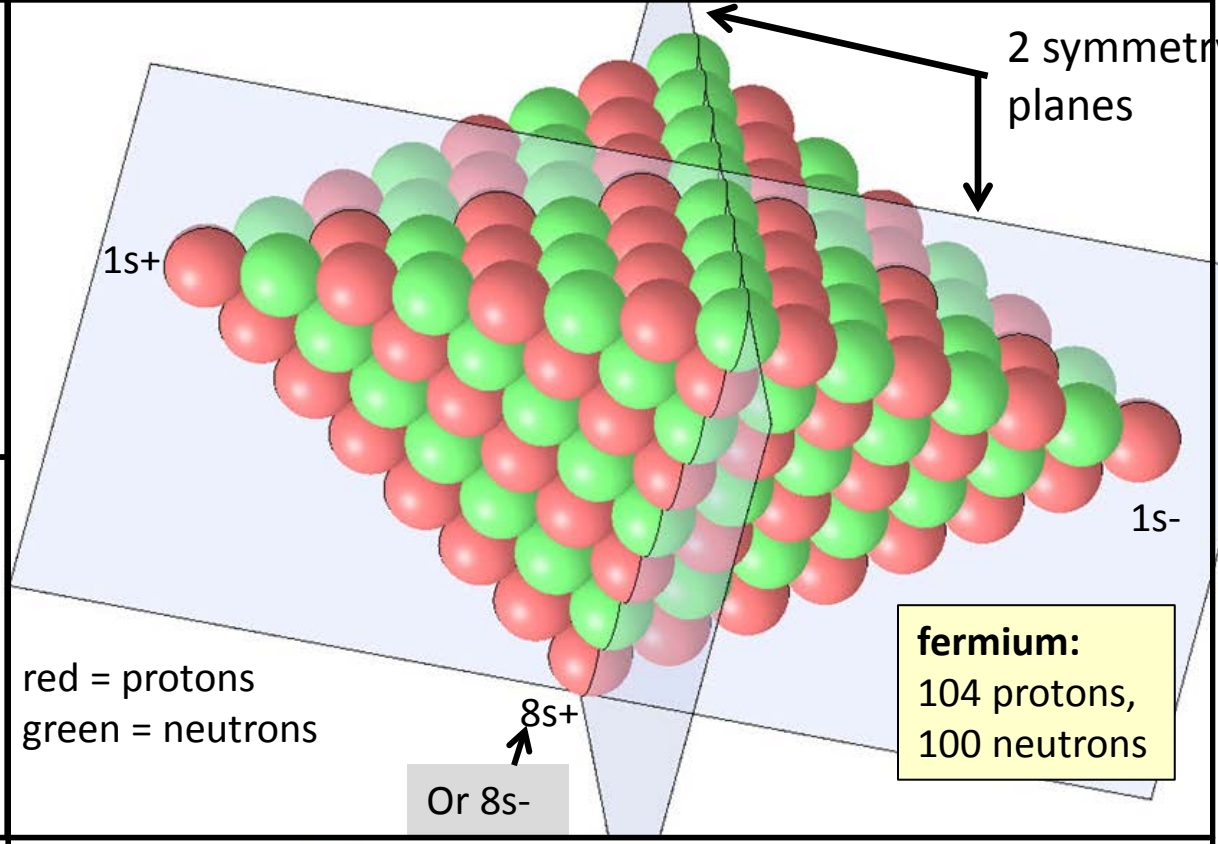


lithium:
3 protons,
2 neutrons

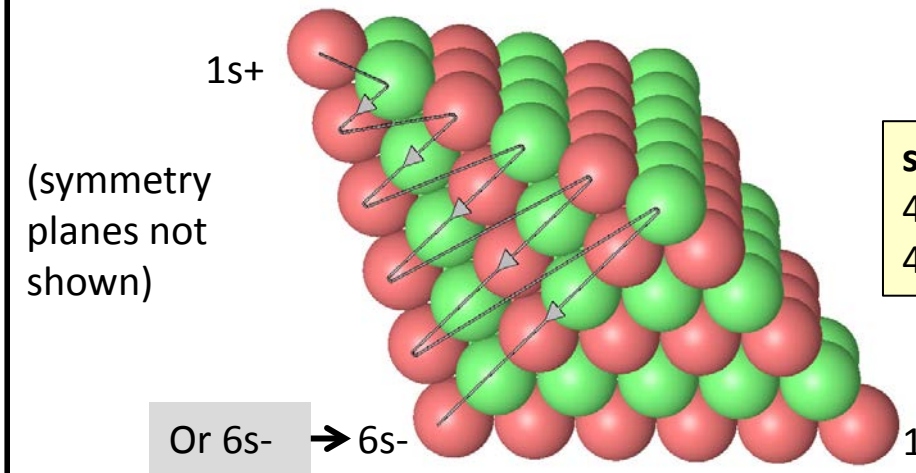
(symmetry planes not shown)



sulphur:
16 protons,
14 neutrons



fermium:
104 protons,
100 neutrons

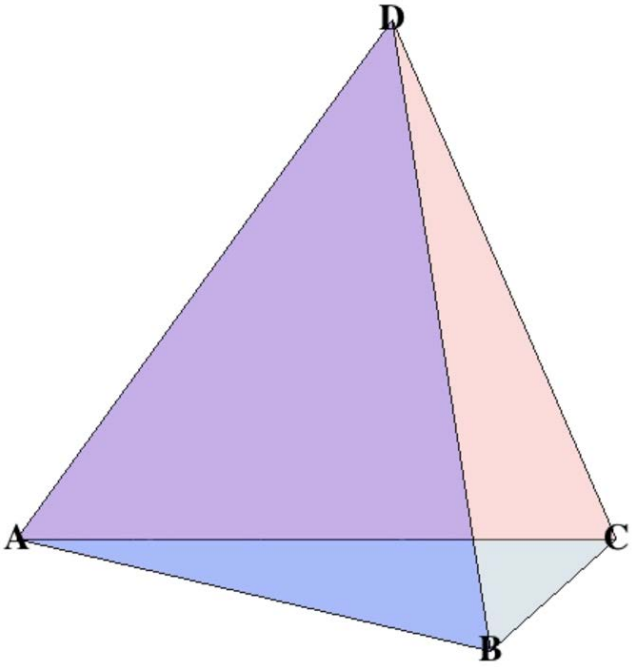


silver:
47 protons,
44 neutrons

The atoms on this page have symmetry about the two planes depicted for fermium in the upper right corner (only the symmetry planes for fermium are shown).

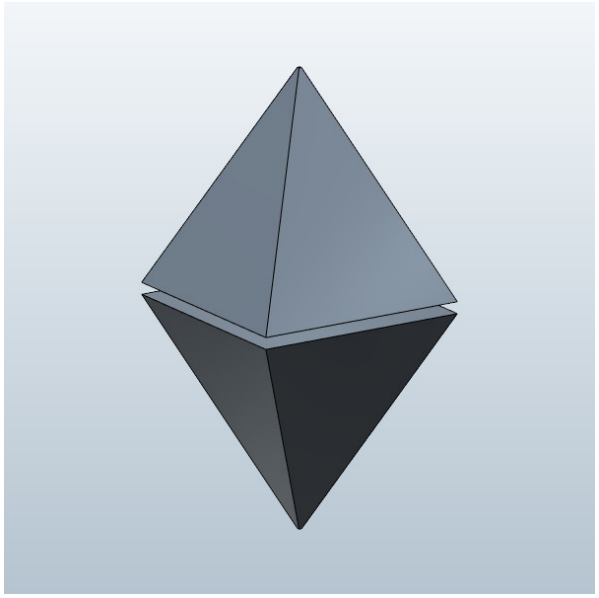
Fermium on previous pages was created by joining two groups of protons and neutrons that have an outer tetrahedron shape.

A tetrahedron is a triangle faced shape with 4 sides. Below are tetrahedron images taken off the internet. Fermium, silver and sulphur shown in this presentation are similar to each other since they can be formed by two groups of protons and neutrons having an outer tetrahedron shape joined together on one face similar to Figure (b) below which shows a mirror image of a tetrahedron.



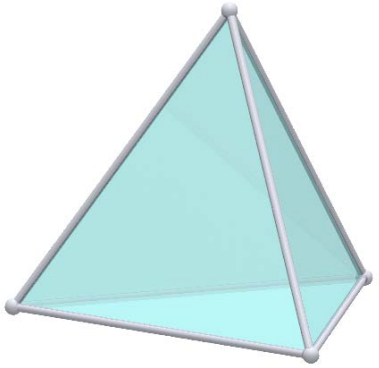
4 sided tetrahedron

Figure (a)



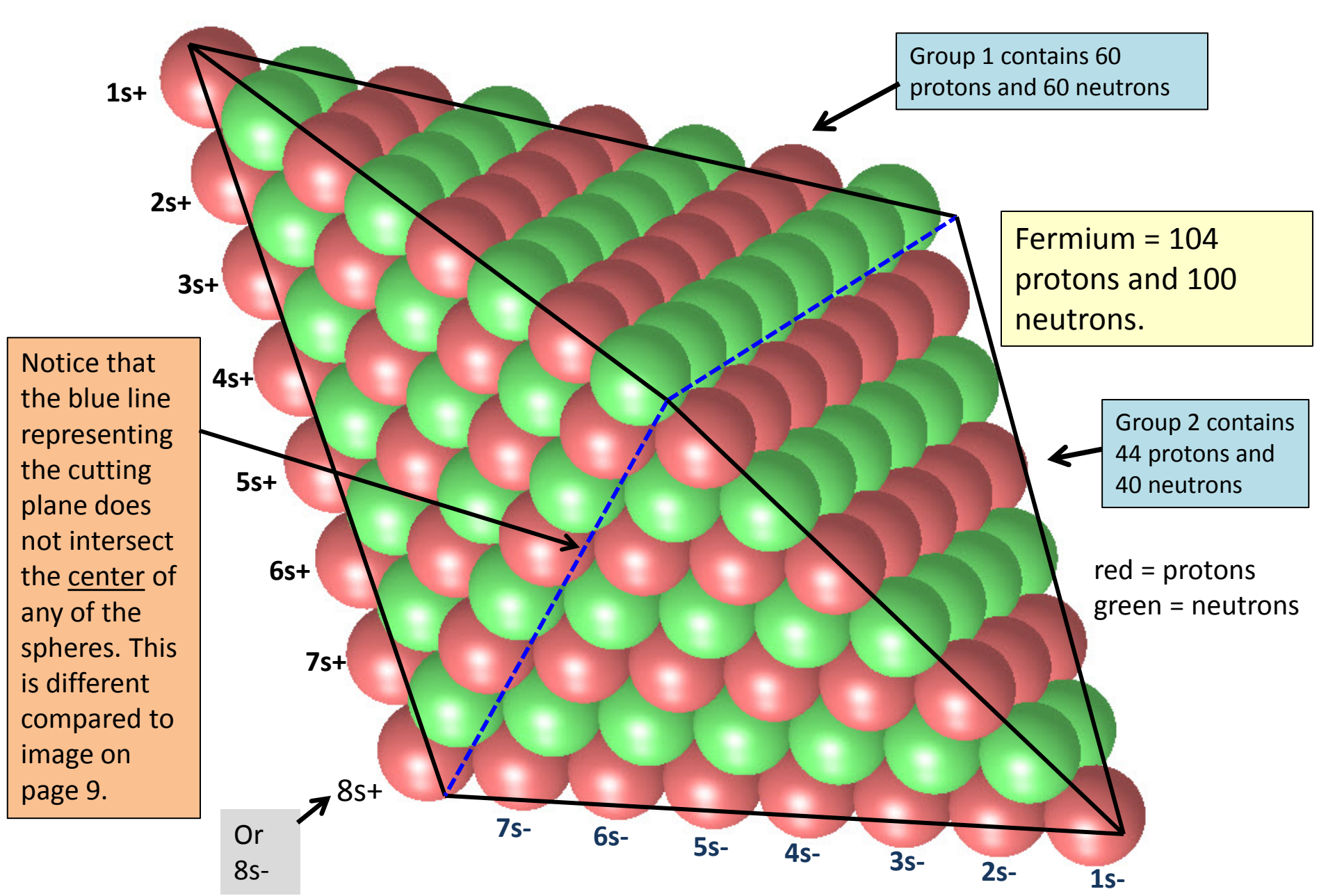
4 sided tetrahedron with mirror image.

Figure (b)

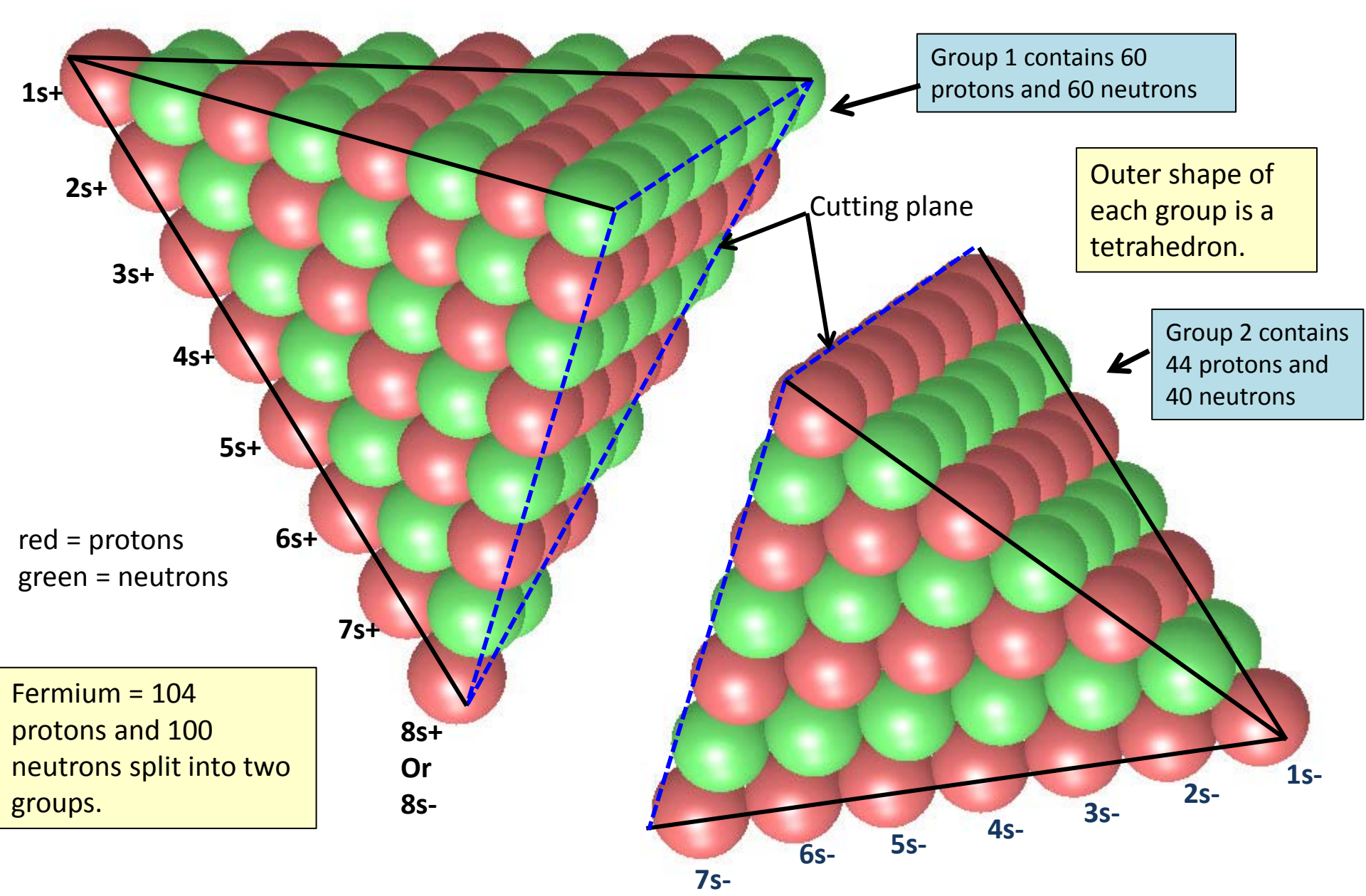


4 sided tetrahedron

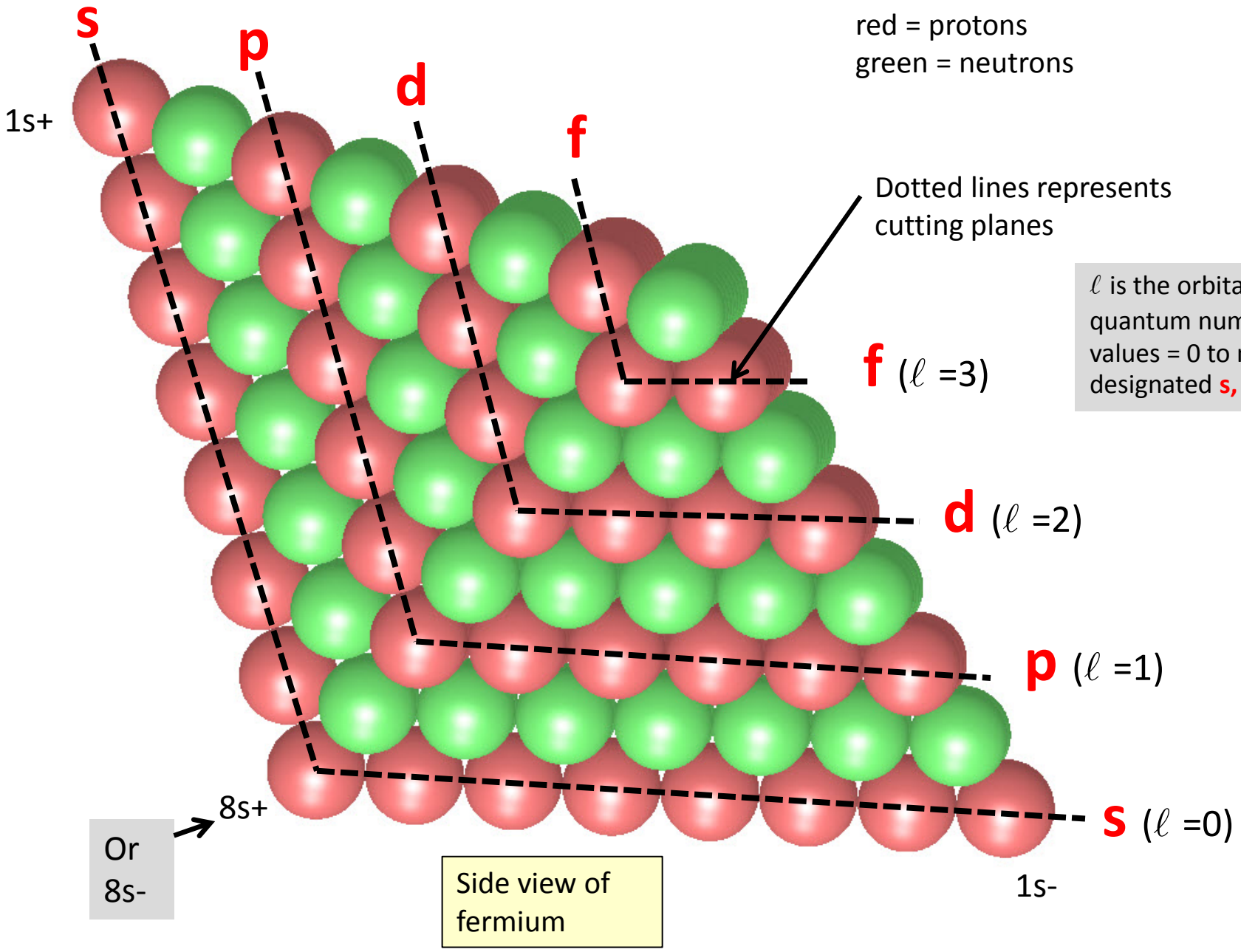
Figure (c)



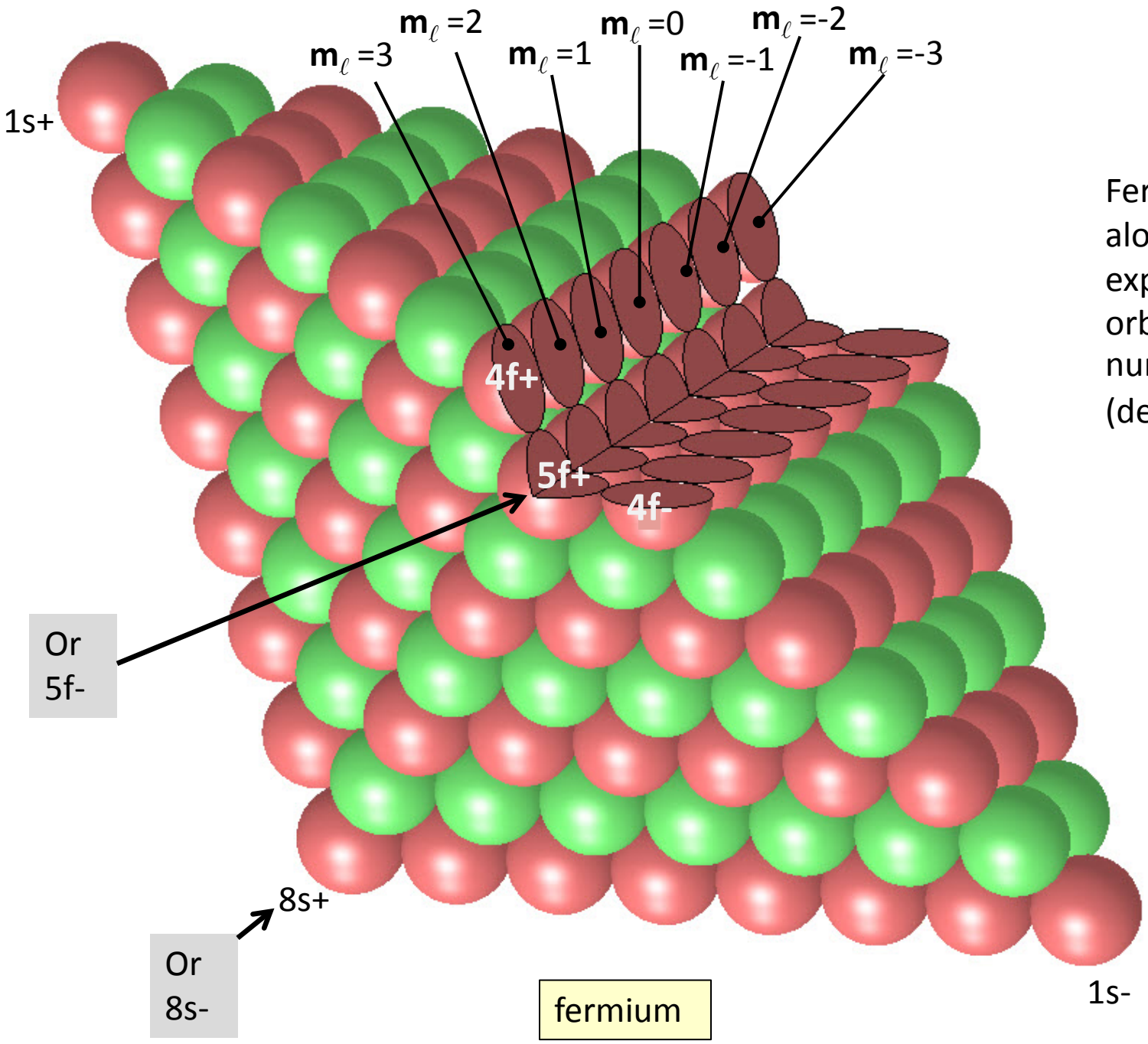
The image on the next page of two tetrahedrons is created if fermium (above) is split along the plane outlined with blue dashed lines which creates two groups of protons and neutrons.



Fermium, 104 protons and 100 neutrons, split into two groups. Each group has a tetrahedron outer shape. The individual neutrons and protons are shown with a spherical shape for simplicity. An exploded view of the image above is shown on page 24.



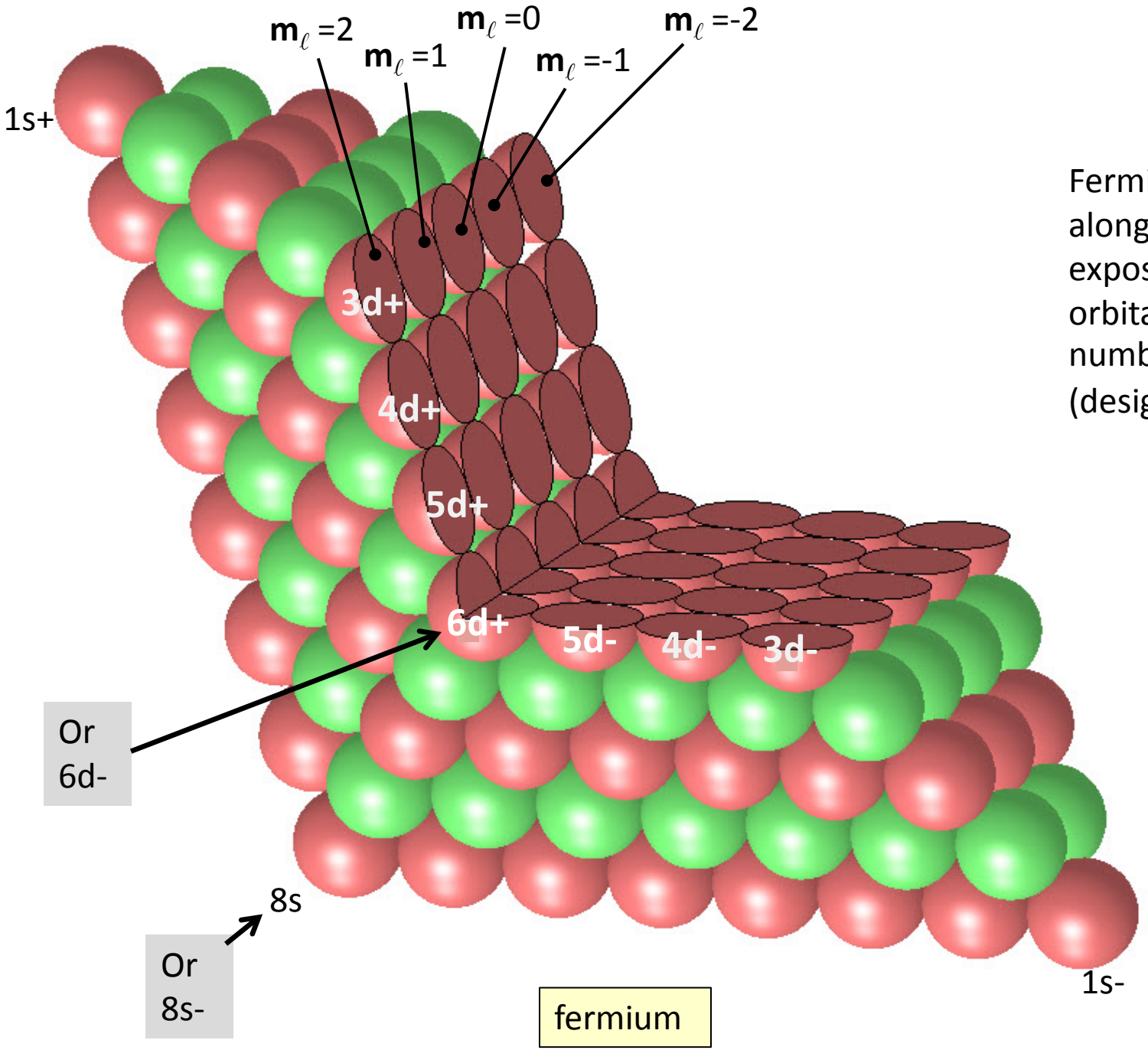
Fermium can be sectioned along the dotted lines above to expose protons with the same orbital quantum number ℓ with the results on the following pages.



fermium

Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =3 (designated **f** orbital).

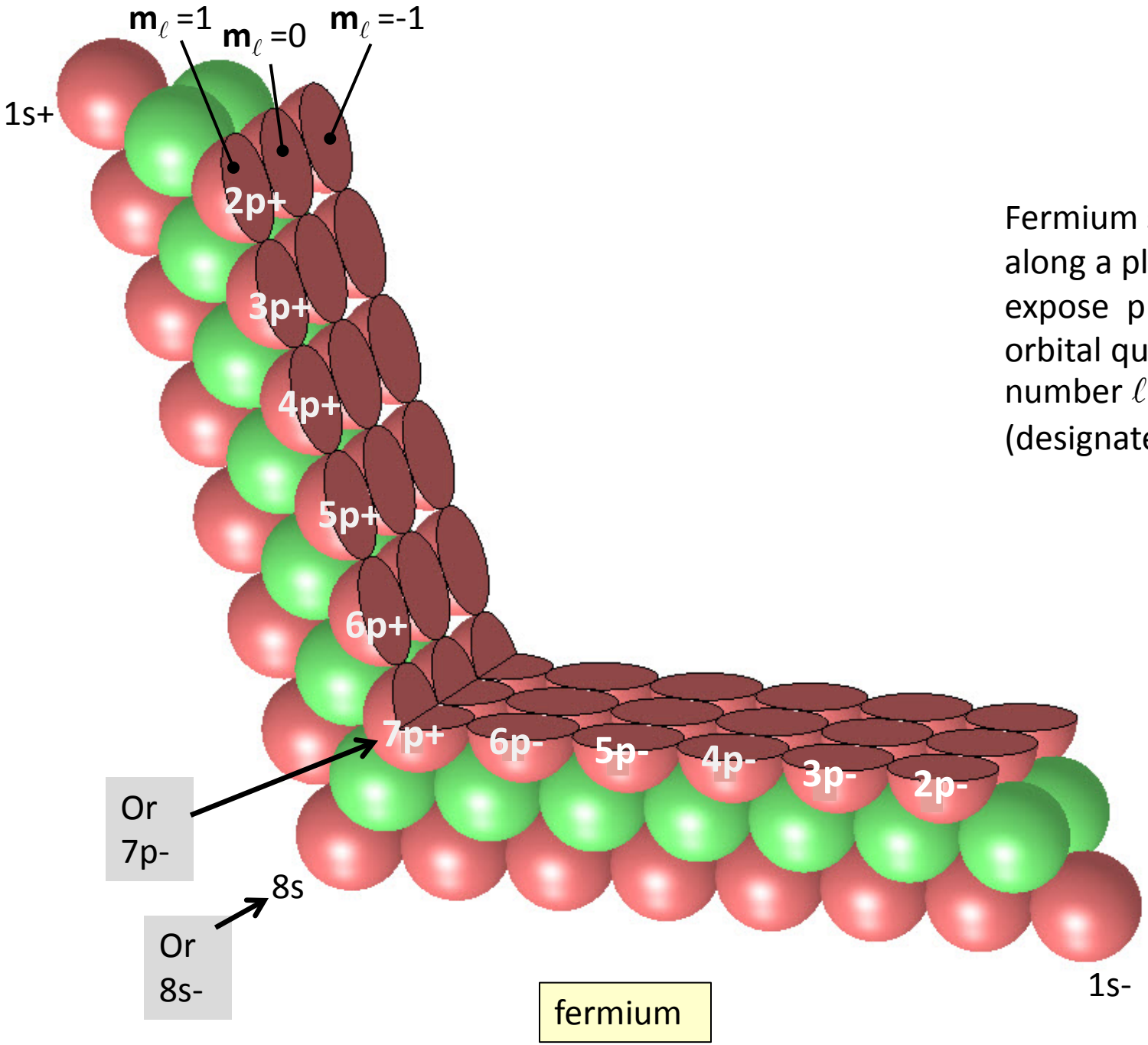
red = protons
green = neutrons



Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =2 (designated **d** orbital).

red = protons
green = neutrons

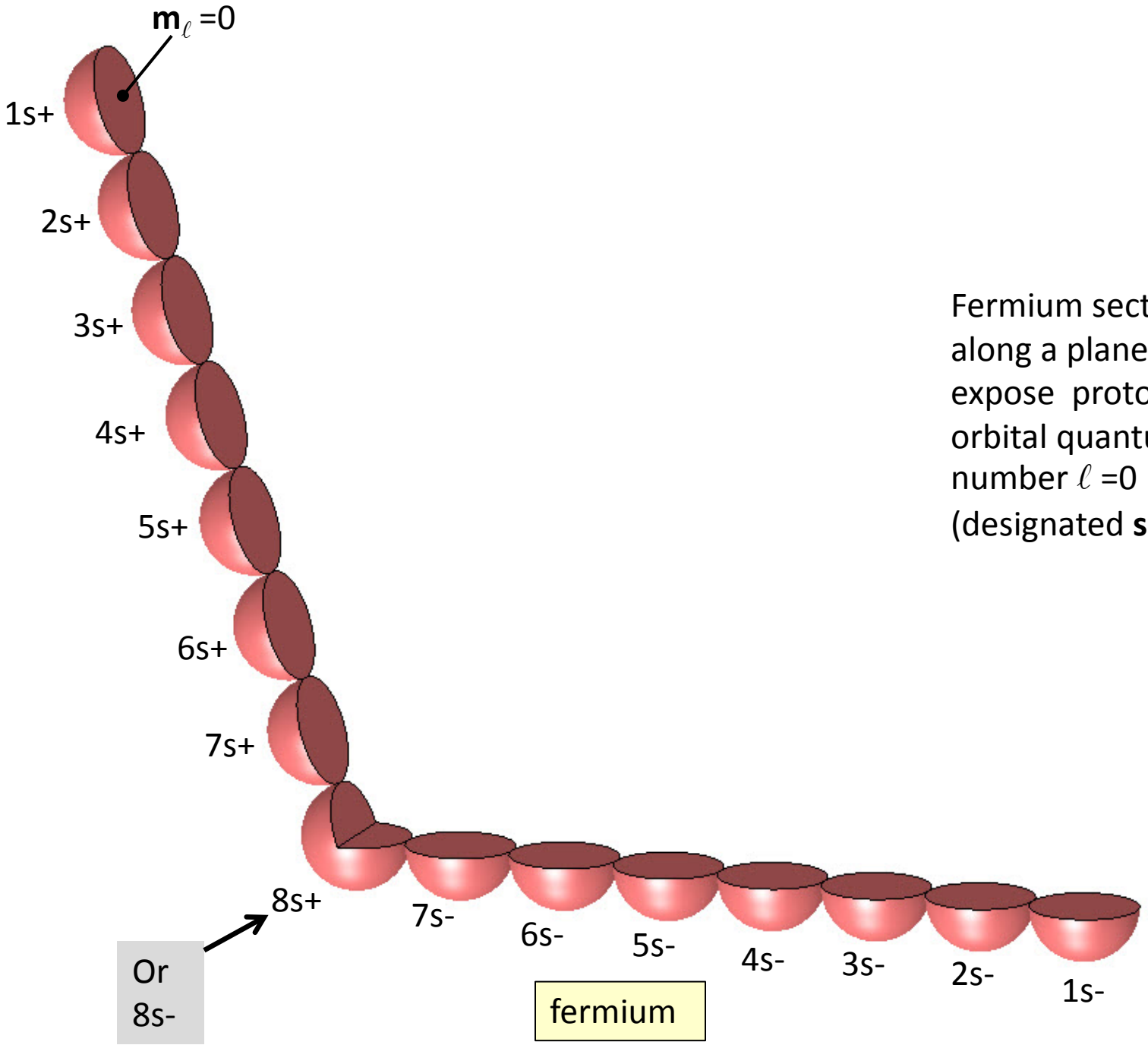
fermium



Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =1 (designated **p** orbital).

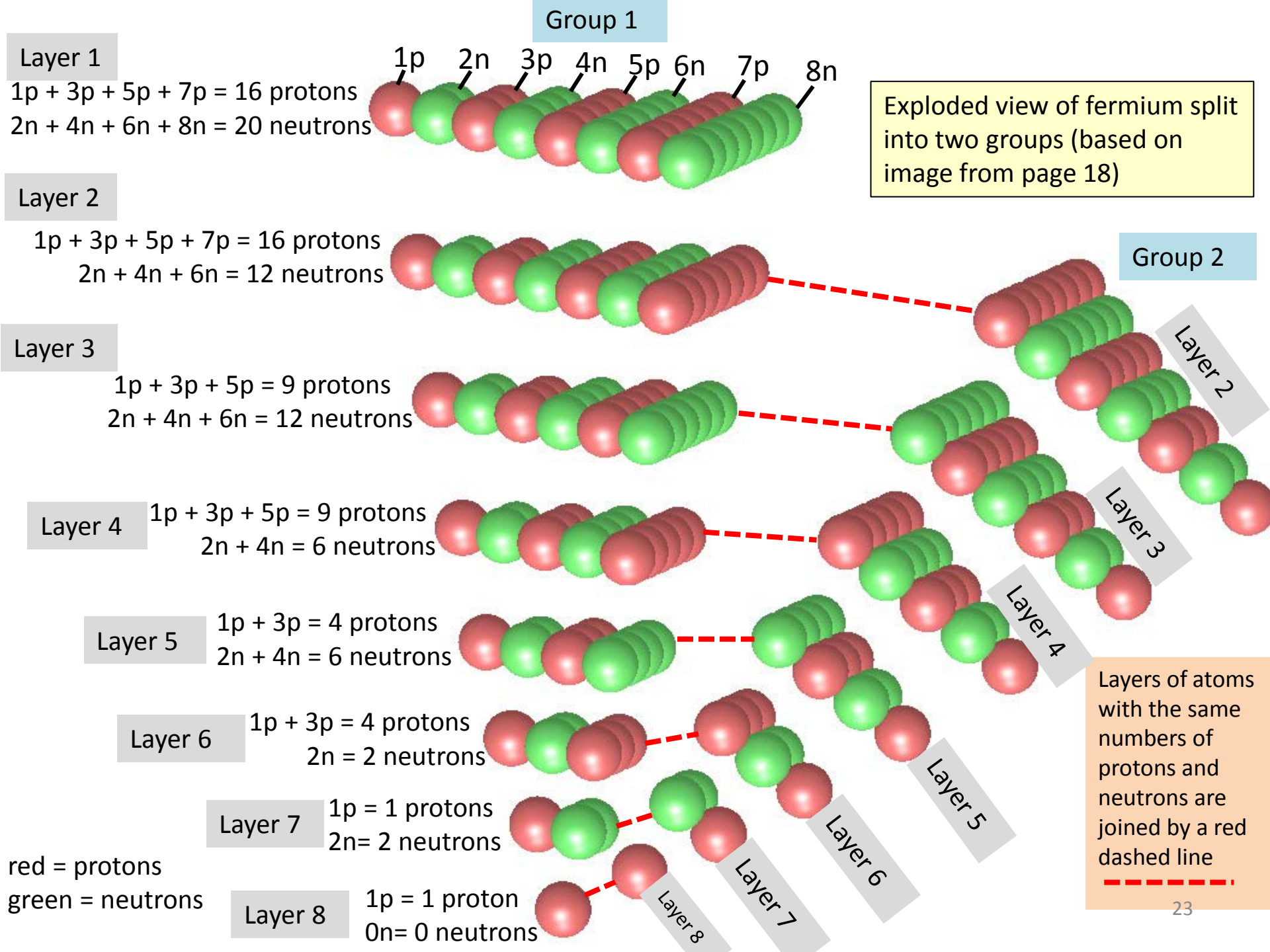
red = protons
green = neutrons

fermium



Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =0 (designated **s** orbital).

red = protons
green = neutrons


Group 1
Layer 1
1p + 3p + 5p + 7p = 16 protons
2n + 4n + 6n + 8n = 20 neutrons
1p
2n
3p
4n
5p
6n
7p
8n
Exploded view of fermium split into two groups (based on image from page 18)
Layer 2
1p + 3p + 5p + 7p = 16 protons
2n + 4n + 6n = 12 neutrons
Group 2
Layer 3
1p + 3p + 5p = 9 protons
2n + 4n + 6n = 12 neutrons
Layer 4
1p + 3p + 5p = 9 protons
2n + 4n = 6 neutrons
Layer 5
1p + 3p = 4 protons
2n + 4n = 6 neutrons
Layer 6
1p + 3p = 4 protons
2n = 2 neutrons
Layer 7
1p = 1 protons
2n= 2 neutrons
Layer 8
1p = 1 proton
0n= 0 neutrons
red = protons
green = neutrons
Layer 2
Layer 3
Layer 4
Layer 5
Layer 6
Layer 7
Layer 8
Layers of atoms with the same numbers of protons and neutrons are joined by a red dashed line

Group 1, fermium		Group 2, fermium	
Layer 1		Layer 1 not included in Group 2	
1p + 3p + 5p + 7p	= 16 protons		
2n + 4n + 6n + 8n	= 20 neutrons		
Layer 2:		Layer 2:	
1p + 3p + 5p + 7p	= 16 protons	1p + 3p + 5p + 7p	= 16 protons
2n + 4n + 6n	= 12 neutrons	2n + 4n + 6n	= 12 neutrons
Layer 3:		Layer 3:	
1p + 3p + 5p	= 9 protons	1p + 3p + 5p	= 9 protons
2n + 4n + 6n	= 12 neutrons	2n + 4n + 6n	= 12 neutrons
Layer 4:		Layer 4:	
1p + 3p + 5p	= 9 protons	1p + 3p + 5p	= 9 protons
2n + 4n	= 6 neutrons	2n + 4n	= 6 neutrons
Layer 5:		Layer 5:	
1p + 3p	= 4 protons	1p + 3p	= 4 protons
2n + 4n	= 6 neutrons	2n + 4n	= 6 neutrons
Layer 6:		Layer 6:	
1p + 3p	= 4 protons	1p + 3p	= 4 protons
2n	= 2 neutrons	2n	= 2 neutrons
Layer 7:		Layer 7:	
1p	= 1 protons	1p	= 1 protons
2n	= 2 neutrons	2n	= 2 neutrons
Layer 8:		Layer 8:	
1p	= 1 proton	1p	= 1 proton
0n	= 0 neutrons	0n	= 0 neutrons
Total: 60 protons and 60 neutrons		Total: 44 protons and 40 neutrons	

+

=

fermium:
104 protons
and
100 neutrons

Fermium is made from Group 1 + Group 2

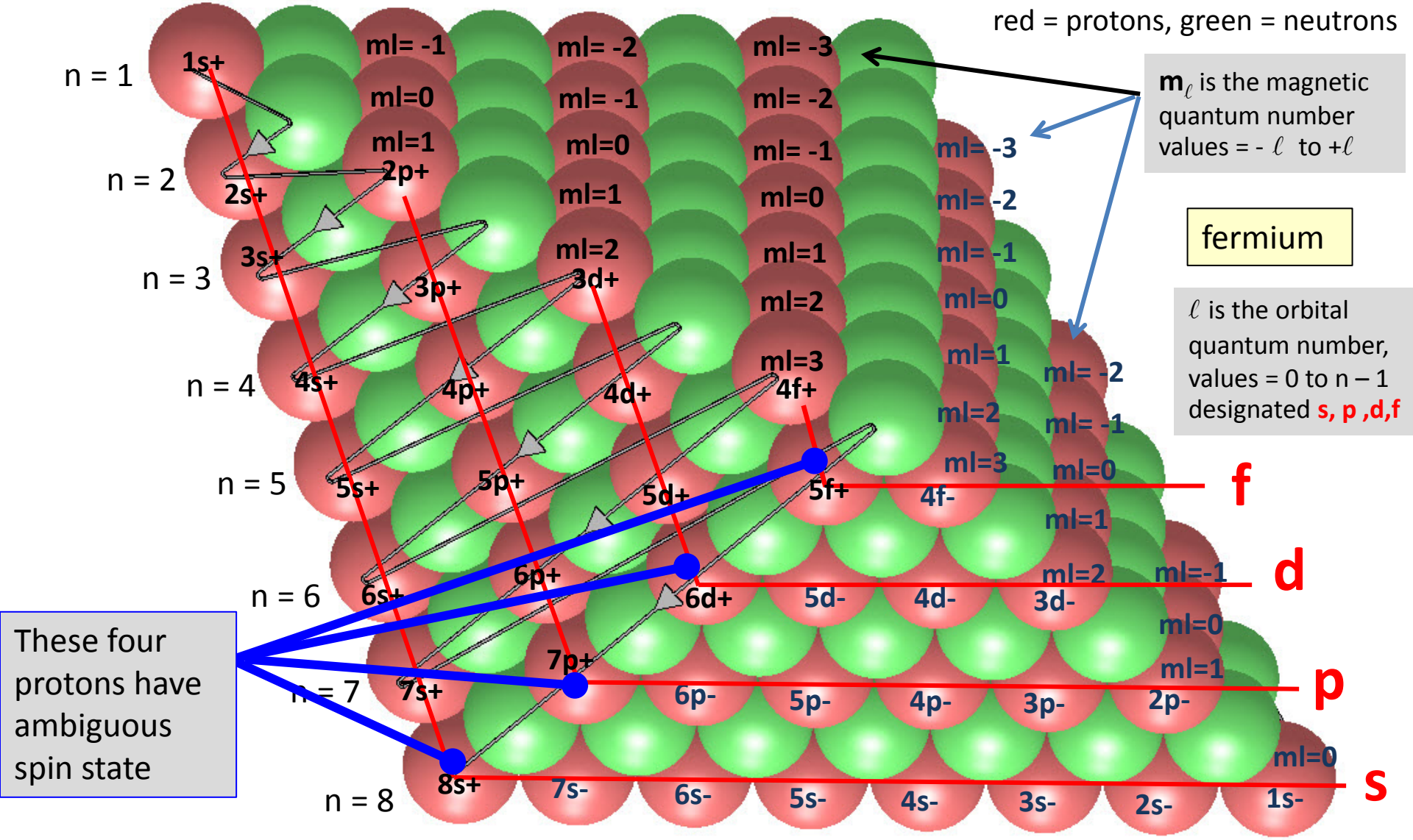
Fermium: 104 protons, 100 neutrons, is made from 2 groups:
Group 1 is made from:
Layer 1 + Layer 2 + Layer 3 + Layer 4 + Layer 5 + Layer 6 + Layer 7 + Layer 8
Group 2 is made from:
Layer 2 + Layer 3 + Layer 4 + Layer 5 + Layer 6 + Layer 7 + Layer 8

Silver: 47 protons, 44 neutrons, is made from 2 groups:
Group 1 is made from:
Layer 3 + Layer 4 + Layer 5 + Layer 6 + Layer 7 + Layer 8
Group 2 is made from:
Layer 4 + Layer 5 + Layer 6 + Layer 7 + Layer 8

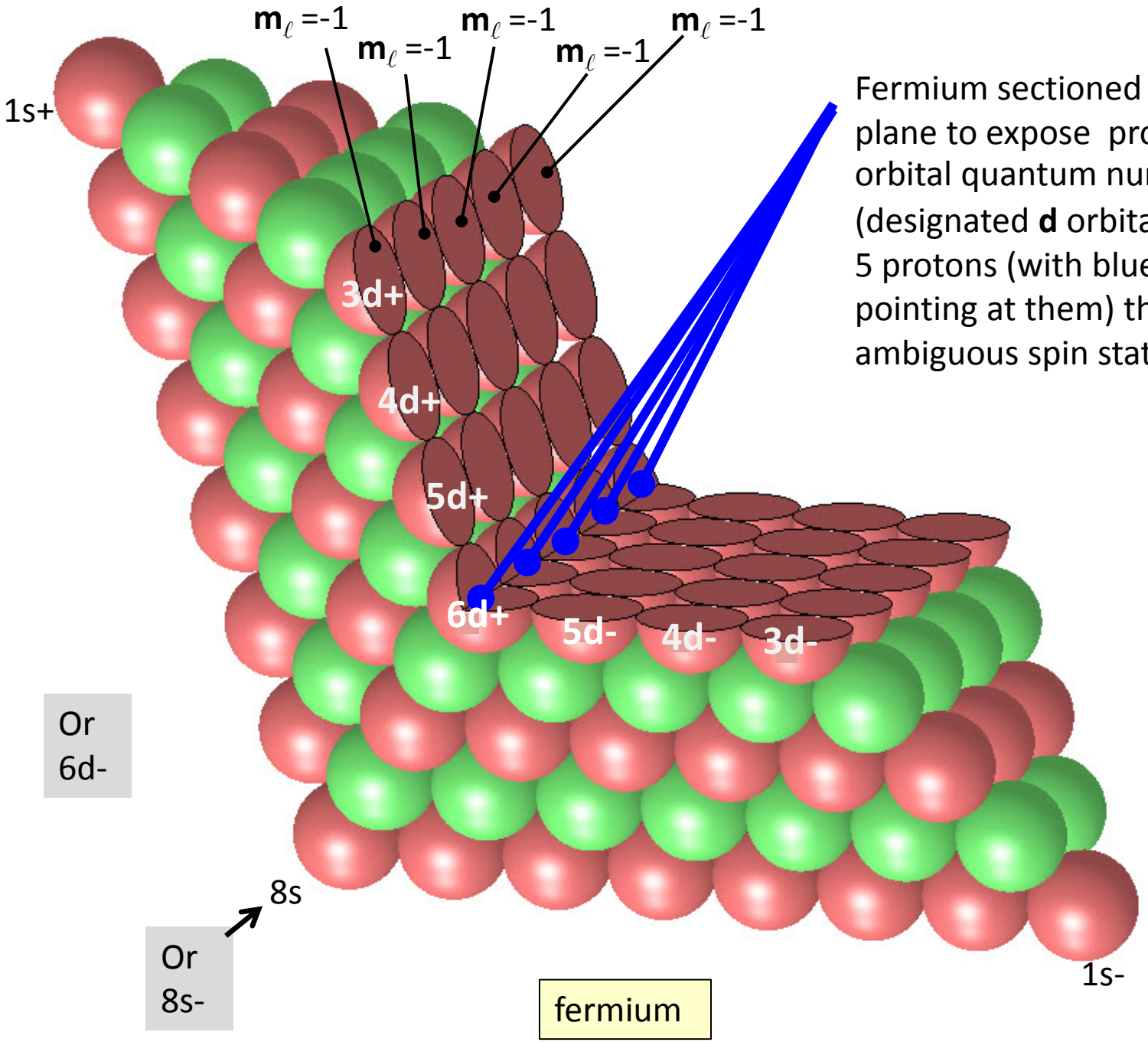
Sulphur: 16 protons, 14 neutrons, is made from 2 groups:
Group 1 is made from:
Layer 5 + Layer 6 + Layer 7 + Layer 8
Group 2 is made from:
Layer 6 + Layer 7 + Layer 8

Lithium : 3 protons, 2 neutrons, is made from 2 groups:
Group 1 is made from:
Layer 7 + Layer 8
Group 2 is made from:
Layer 8

Helium : 2 protons, 2 neutrons, is made from 2 groups:
Group 1 is made from:
Layer 7
Group 2 is made from:
Layer 8

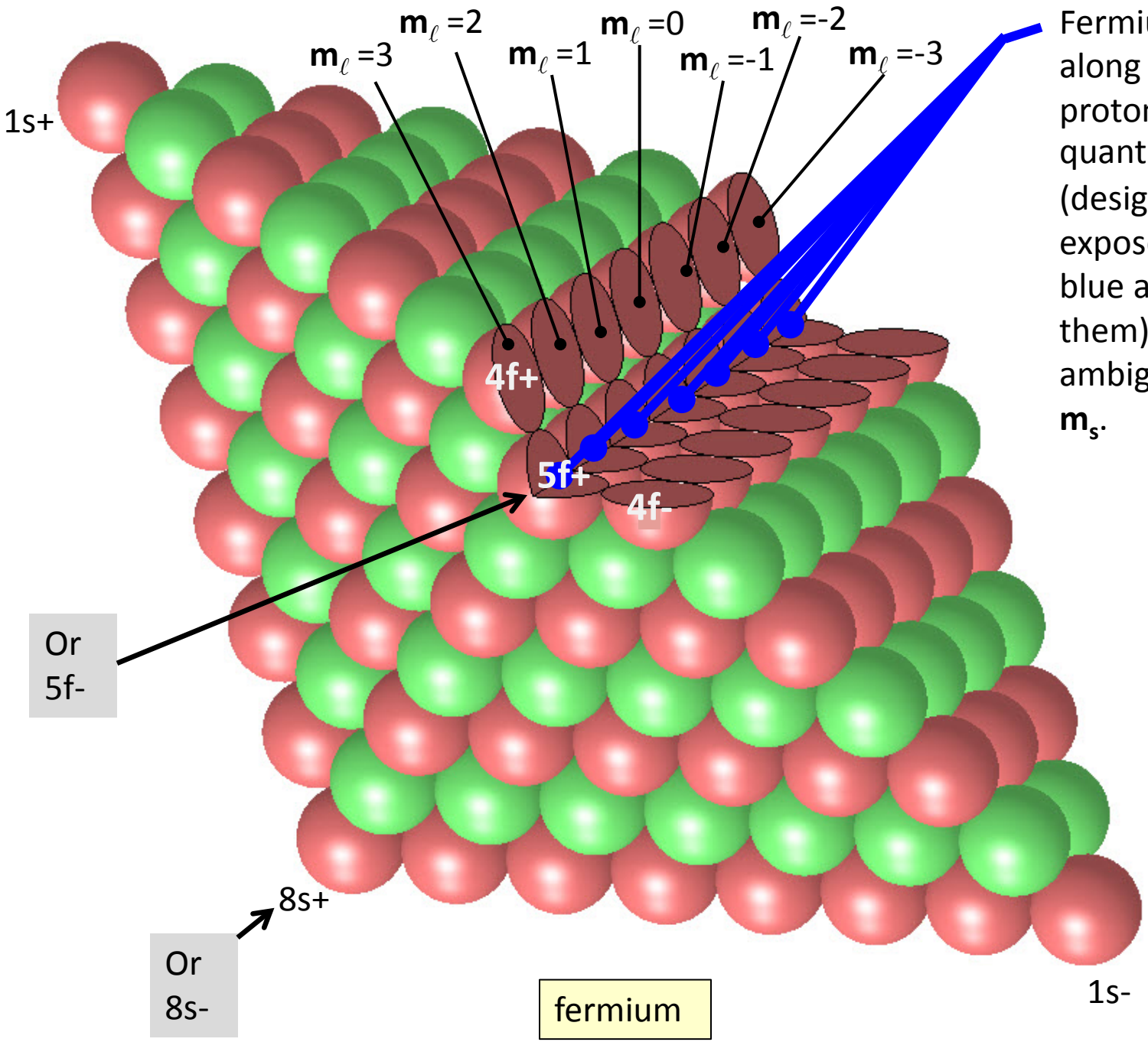


The four protons indicated above by blue arrows and the protons hidden behind them with the same principle quantum number **n** but different magnetic quantum number $\mathbf{m}_\ell$ have a spin state $\mathbf{m}_s$ that is ambiguous since there is nothing that sets the spin state $\mathbf{m}_s$ one way or the other. They can be either spin $\mathbf{m}_s$ =+1/2 or $\mathbf{m}_s$ =-1/2. Could this be the angular momentum issue that results in the **Stern Gerlach experiment** where silver atoms are split into two beams, one having +1/2 spin and the other -1/2 spin?



Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =2 (designated **d** orbital) exposes 5 protons (with blue arrows pointing at them) that have ambiguous spin states $\mathbf{m_s}$.

red = protons
green = neutrons

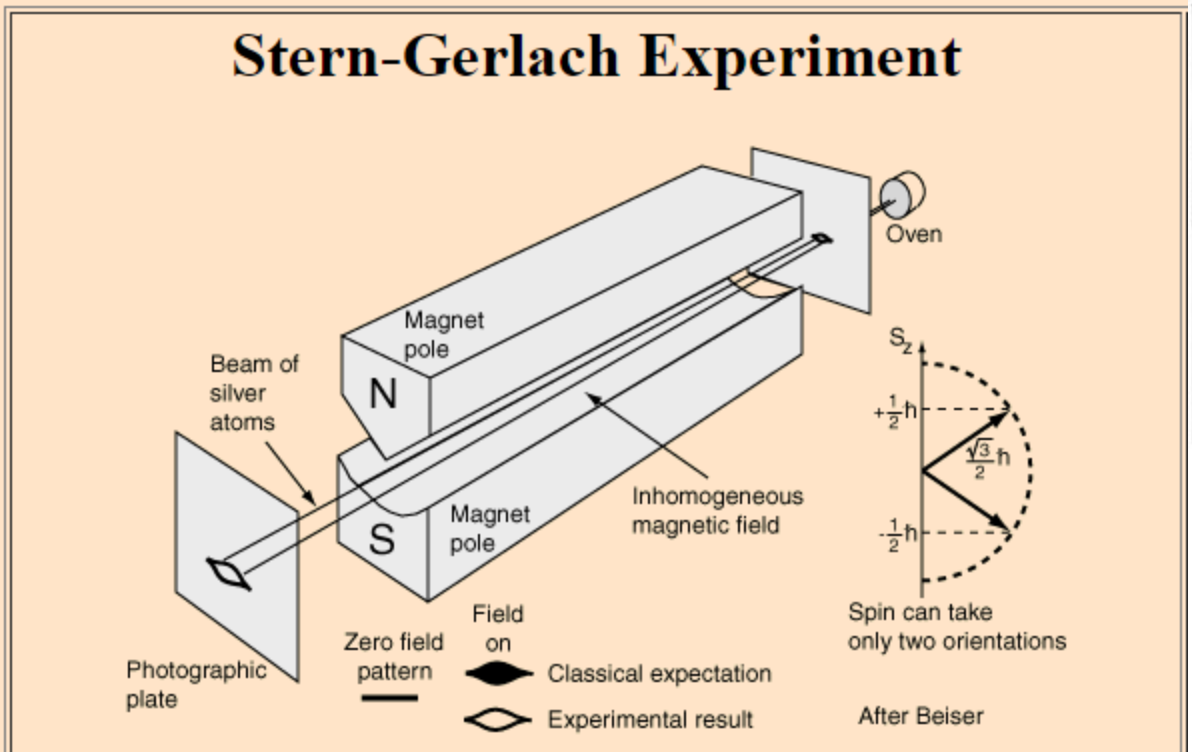


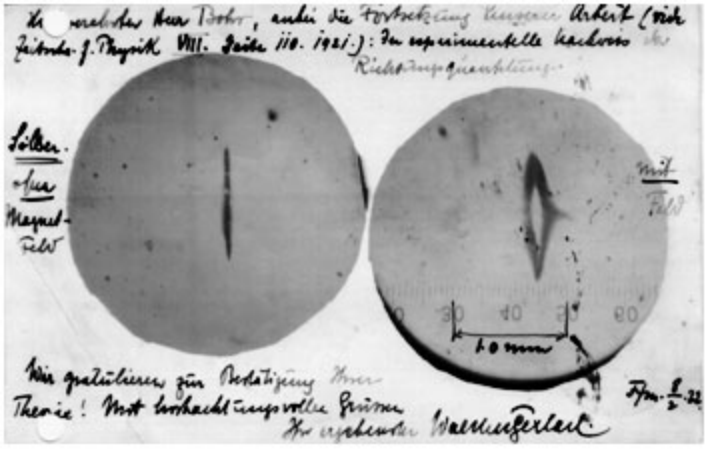
Fermium sectioned along a plane to expose protons with orbital quantum number ℓ =3 (designated **f** orbital) exposes 7 protons (with blue arrows pointing at them) that have ambiguous spin states m_s.

red = protons
green = neutrons

The protons with ambiguous spin states could have some pattern of spin states or possibly they are random (although the magnetic quantum number $\mathbf{m}_\ell$ for the associated protons in that "row" would not be random.

I don't have the knowledge to fully explain the pattern seen on the photographic plate in the Stern Gerlach experiment but it has something to with the fact that the extra electron in the silver atom precesses (as explained in Randell Mills' GUTCP) which puts a downward or upward force on the silver atom causing it to deflect in the up or down direction relative to the external magnetic field.

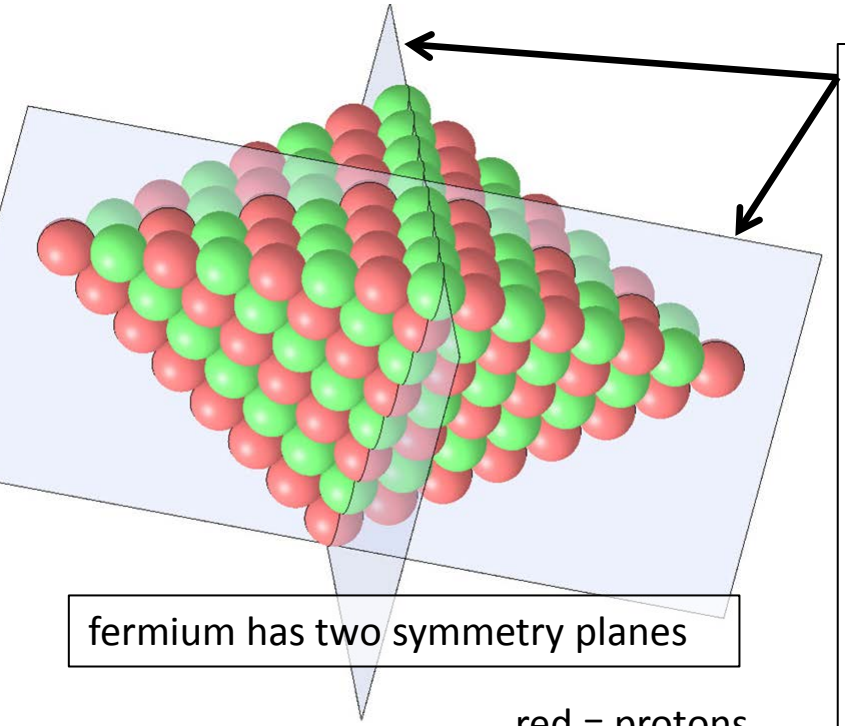




Postcard sent from Gerlach to Niels Bohr.

Summary of electron filling order.

Each proton in a multi-proton nucleus has a charge of +e and the voltage (i.e. the electrostatic potential) measured at any specific location of a bare nucleus (i.e. no electrons bound to it) is a function of the distance from infinity to that location and is affected by the protons surrounding it. This voltage could be calculated using finite element software. Electrons fill orbits according to the electrostatic voltage potential and the highest electrostatic potential is at the tip or closest to the two tips (the 1s- and 1s+ positions). The protons at the tips have opposite spin and the electrons that bond with them have opposite spins relative to each other and thus the magnetic fields of the 2 electrons cancel each other out. The electrons repel each other which causes an alternating filling of orbits, i.e. **1s+, 1s-, 2s+, 2s-, 2p+, 2p-, 3s+, 3s-, 3p+, 3p-** etc. The magnetic number $\mathbf{m}_\ell$ (i.e. $\mathbf{m}_\ell$ = 3 or 2 or 1 or 0 or -1 or -2 or -3) is due to the spin direction of the specific proton that the electron bonds with and the electrostatic potential relative to infinity which is a function of the distance to the other protons in the nucleus. Writing the orbital filling pattern while ignoring the +/- spin states gives the well known electron filling order **1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s** as can be seen in any chemistry book. An electron can gain or lose energy by lattice phonons, photons, molecular vibrations and/or molecular spinning and "jump" to (i.e. bond with) a new proton as long as energy is conserved in the jump. Jumping to a new proton with a higher electrostatic potential requires a specific amount of energy input that could be calculated using some method. When the electron jumps to a new orbit, the new "center" point for the orbiting electron is precisely on the new proton. This precise orbiting position is hypothesized to be the same thing as magnetic flux pinning in superconductivity. An electron "pins" its magnetic flux precisely on one proton only and no other electron can pin its flux on the same proton *at the same* time based on the data that led to the Pauli exclusion principle.



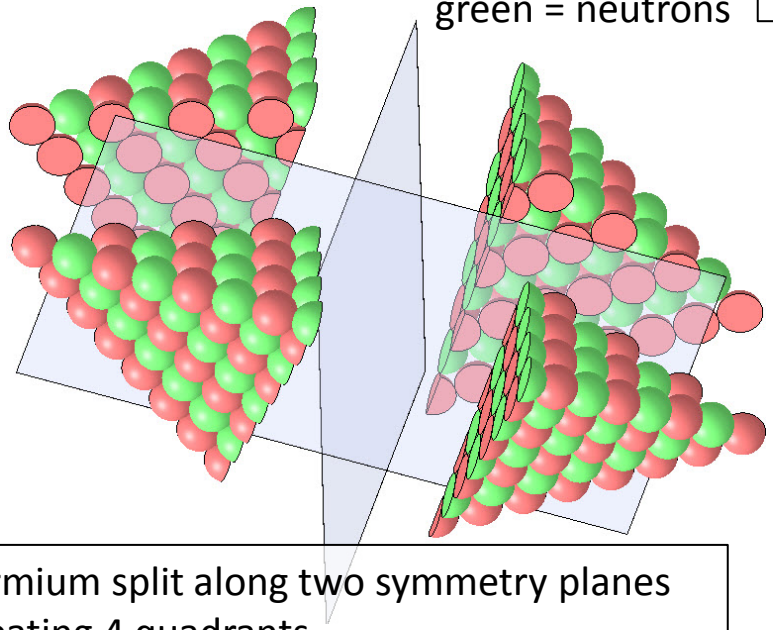
fermium has two symmetry planes

Fermium (along with silver, sulphur, lithium and helium) has perfect symmetry about these two planes which creates **four symmetric quadrants** as shown below and to the left. This symmetry could be used to rearrange the orbit filling order shown on page 10 due to electrons repelling each other. The labels for the orbit would be rearranged but the filling order would still be:

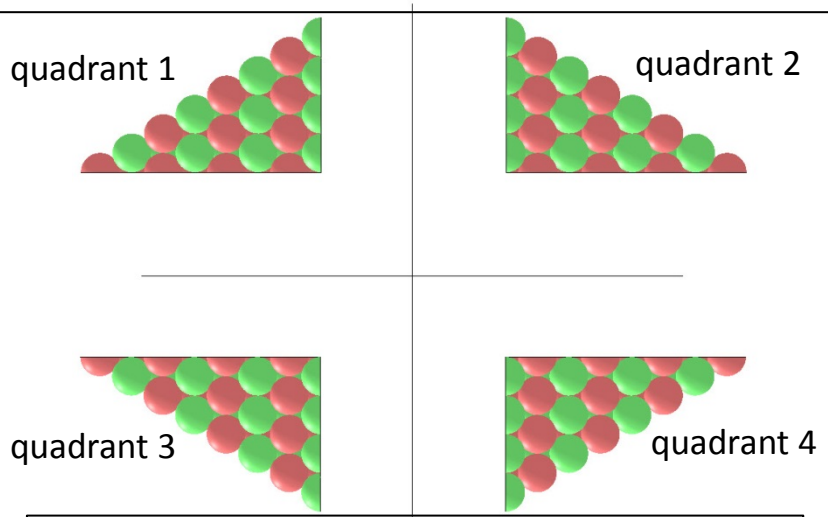
1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, 7p, 8s

For example, on page 10, the 2p+ and the 3d+ are shown in the same quadrant. The 3d+ could be in a different quadrant which would allow the electrons to be <u>further</u> spaced apart during filling due to electrostatic repelling of similar charges.

red = protons
green = neutrons



fermium split along two symmetry planes creating 4 quadrants



fermium, top view, showing 4 quadrants after splitting along symmetry planes.

Fermium Facts

https://en.wikipedia.org/wiki/Fermium

Fermium is a synthetic element with symbol Fm and atomic number 100. It is a member of the actinide series. **It is the heaviest element that can be formed by neutron bombardment of lighter elements**, and hence the last element that can be prepared in macroscopic quantities, although pure fermium metal has not yet been prepared.[1] A total of 19 isotopes are known, with 257Fm being the longest-lived with a half-life of 100.5 days.

http://www.rsc.org/chemistryworld/podcast/Interactive_Periodic_Table_Transcripts/Fermium.asp

Fermium is an actinide, part of the floating bar of elements that is squeezed out from between actinium and lawrencium. **Perhaps its greatest claim to fame on the periodic table is that it defines the start of the most obscure of the artificial elements** - those above 100 are referred to as the transfermium elements. It is certainly the highest numbered element that has had a practical use identified.

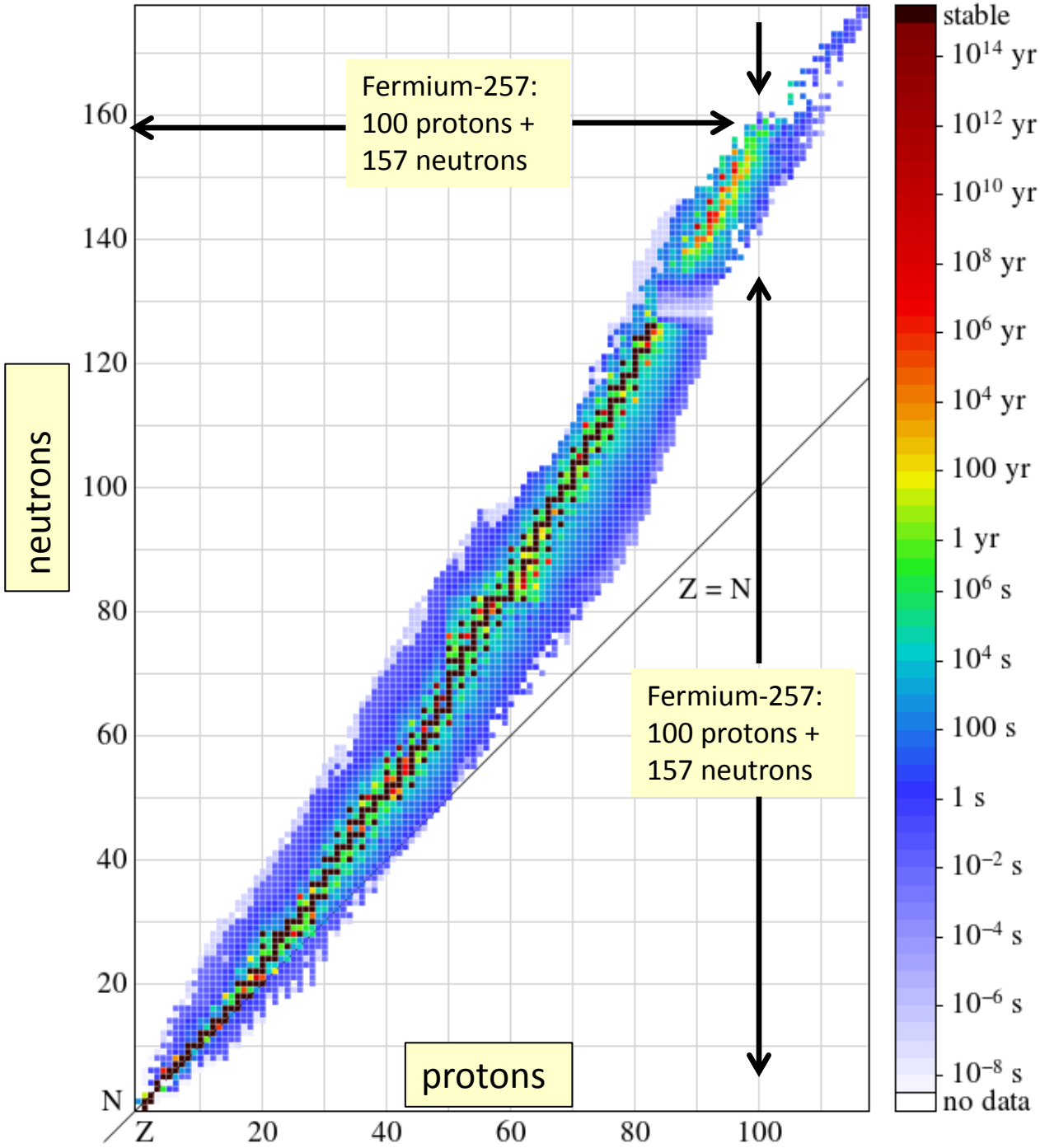
proton number →

Increasing proton number ↓

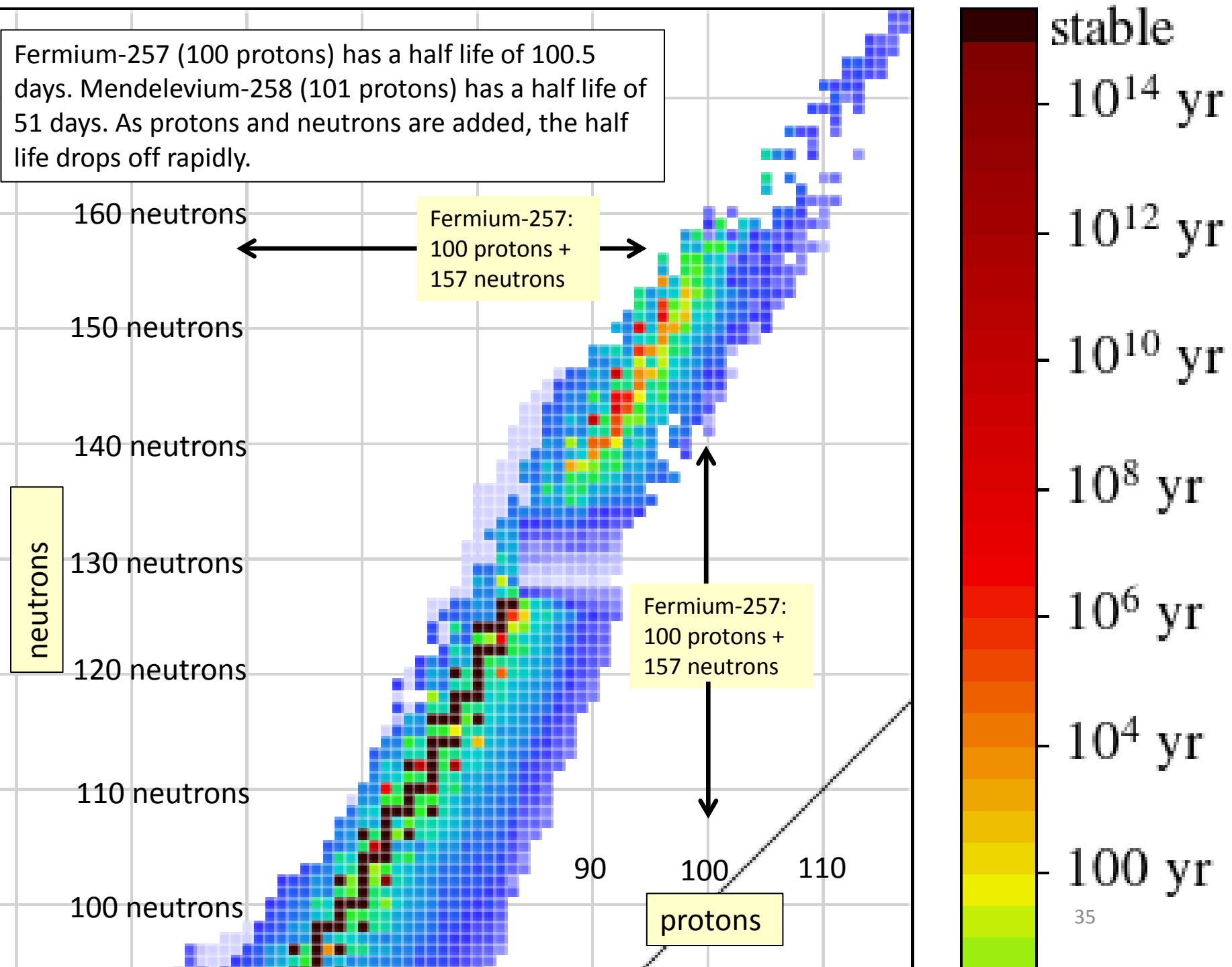
Known isotopes of elements 83 through 118[9][10][11]

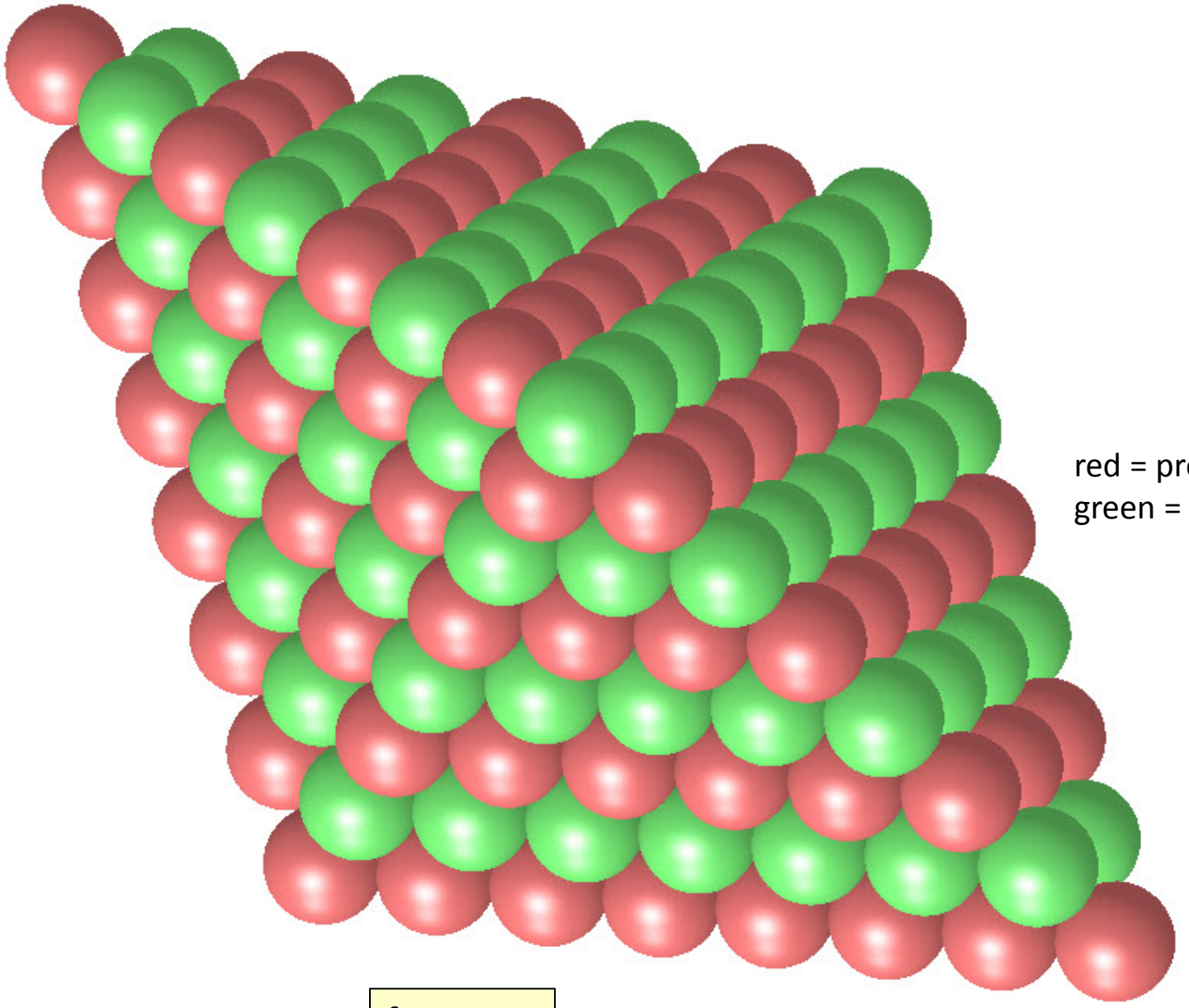
Number	Name	Longest-lived isotope	Half-life	Article
83	Bismuth	^{209}Bi	2 × 10^{19} years	Isotopes of bismuth
84	Polonium	^{209}Po	130 years	Isotopes of polonium
85	Astatine	^{210}At	8 hours	Isotopes of astatine
86	Radon	^{222}Rn	3.824 days	Isotopes of radon
87	Francium	^{223}Fr	22.0 min	Isotopes of francium
88	Radium	^{226}Ra	1600 years	Isotopes of radium
89	Actinium	^{227}Ac	21.77 years	Isotopes of actinium
90	Thorium	^{232}Th	1.41 × 10^{10} years	Isotopes of thorium
91	Protactinium	^{231}Pa	32800 years	Isotopes of protactinium
92	Uranium	^{238}U	4.47 × 10^{9} years	Isotopes of uranium
93	Neptunium	^{237}Np	2.14 × 10^{6} years	Isotopes of neptunium
94	Plutonium	^{244}Pu	8.0 × 10^{7} years	Isotopes of plutonium
95	Americium	^{243}Am	7400 years	Isotopes of americium
96	Curium	^{247}Cm	1.6 × 10^{7} years	Isotopes of curium
97	Berkelium	^{247}Bk	1000 years	Isotopes of berkelium
98	Californium	^{251}Cf	900 years	Isotopes of californium
99	Einsteinium	^{252}Es	470 days	Isotopes of einsteinium
100	Fermium	^{257}Fm	100.5 days	Isotopes of fermium
101	Mendelevium	^{258}Md	51.5 days	Isotopes of mendelevium
102	Nobelium	^{259}No	58 minutes	Isotopes of nobelium
103	Lawrencium	^{266}Lr	~11 hours	Isotopes of lawrencium
104	Rutherfordium	^{267}Rf	~1.3 hours	Isotopes of rutherfordium
105	Dubnium	^{268}Db	1.3 days	Isotopes of dubnium
106	Seaborgium	^{269}Sg	~3.1 minutes	Isotopes of seaborgium
107	Bohrium	^{270}Bh	3.8 minutes	Isotopes of bohrium
108	Hassium	^{277m}Hs	~130 seconds	Isotopes of hassium
109	Meitnerium	^{278}Mt	7.6 seconds	Isotopes of meitnerium
110	Darmstadtium	^{281m}Ds	~3.7 minutes	Isotopes of darmstadtium
111	Roentgenium	^{282}Rg	2.1 minutes	Isotopes of roentgenium
112	Copernicium	^{285m}Cn	~8.9 minutes	Isotopes of copernicium
113	Ununtrium	^{286}Uut	19.6 seconds	Isotopes of ununtrium
114	Flerovium	^{289m}Fl	~1.1 minutes	Isotopes of flerovium
115	Ununpentium	^{289}Uup	220 milliseconds	Isotopes of ununpentium
116	Livermorium	^{293}Lv	61 milliseconds	Isotopes of livermorium
117	Ununseptium	^{294}Uus	78 milliseconds	Isotopes of ununseptium
118	Ununoctium	^{294}Uuo	890 microseconds	Isotopes of ununoctium

Fermium-257 (100 protons) has a half life of 100.5 days. Mendelevium-258 (101 protons) has a half life of 51 days. As protons and neutrons are added, the half life drops off rapidly.



Fermium-257 (100 protons) has a half life of 100.5 days. Mendelevium-258 (101 protons) has a half life of 51 days. As protons and neutrons are added, the half life drops off rapidly.


Fermium-257 (100 protons) has a half life of 100.5 days. Mendelevium-258 (101 protons) has a half life of 51 days. As protons and neutrons are added, the half life drops off rapidly.
160 neutrons
150 neutrons
140 neutrons
130 neutrons
120 neutrons
110 neutrons
100 neutrons
neutrons
Fermium-257: 100 protons + 157 neutrons
Fermium-257: 100 protons + 157 neutrons
90
100
110
protons
stable
10^{14} yr
10^{12} yr
10^{10} yr
10^{8} yr
10^{6} yr
10^{4} yr
100 yr



red = protons
green = neutrons

fermium

Appendix

Warning: wild speculation below

Does the electron have an elliptical shape (as in Sommerfield model) with a specific proton in the nucleus at one of the foci?

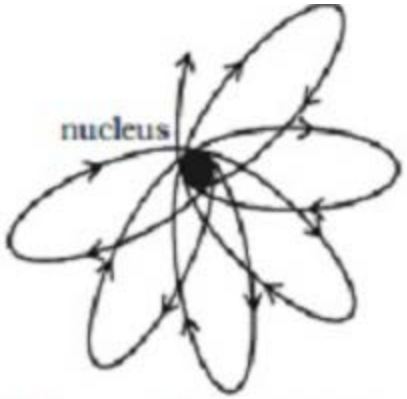


Fig Rosette path of an electron

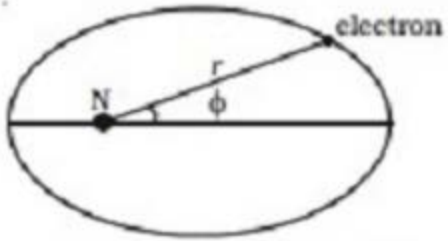
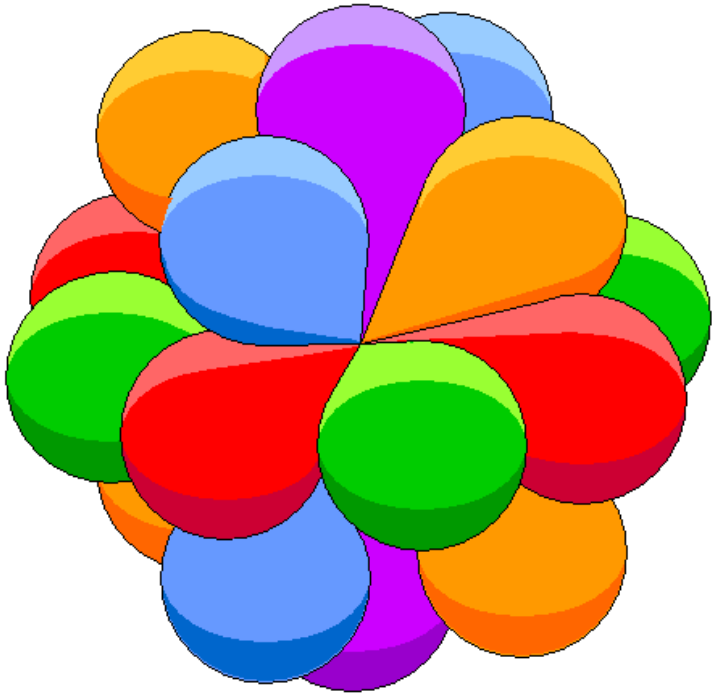


Fig Sommerfeld atom model

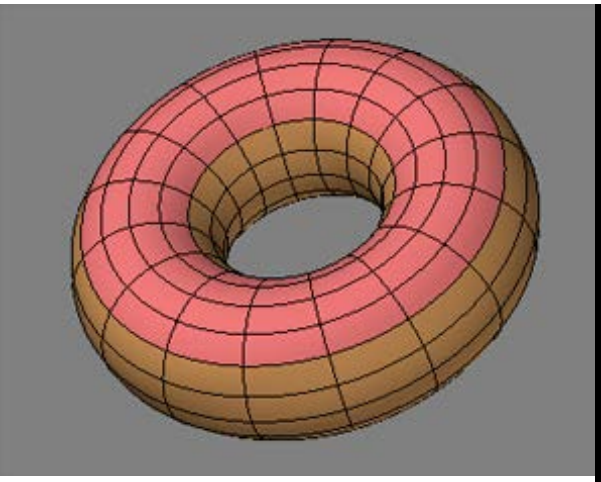


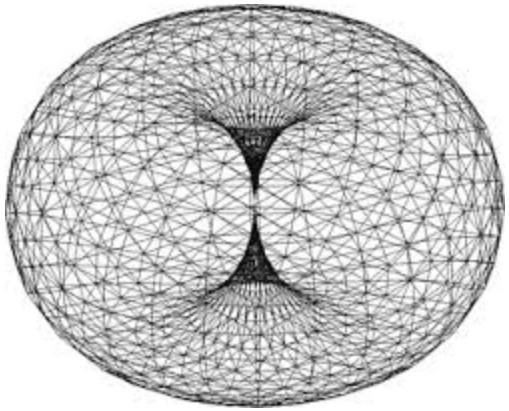
Each electron in the multi-proton atom has a balloon shape with a specific proton at the foci of its elliptical-ish orbit.

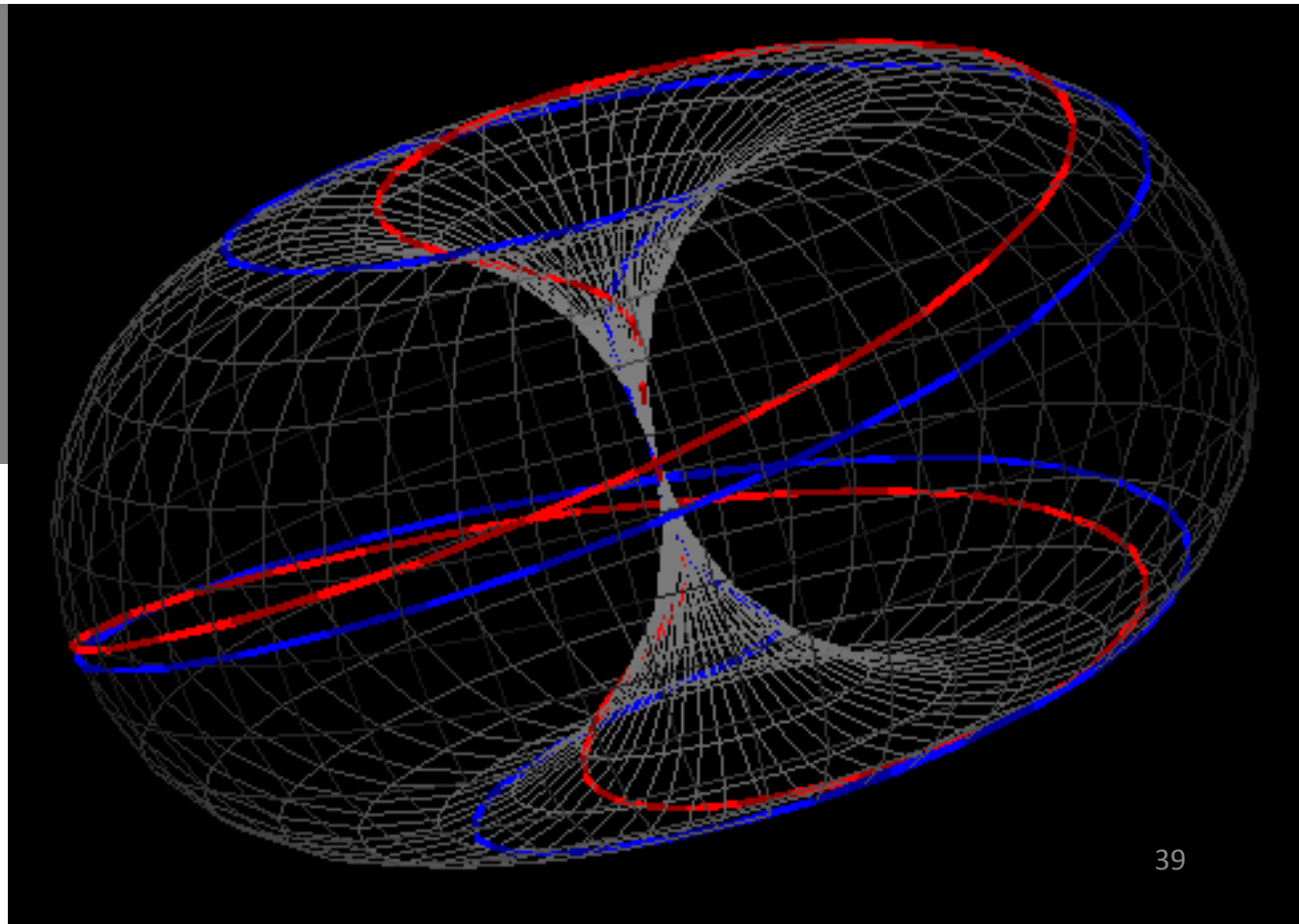
Warning: wild speculation below

It is hypothesized that the electron centers itself *precisely* on one of the protons and bonds with that proton. Another possible configuration that would allow electrons to bond with a one proton in a multi-proton nucleus is an electron that has a toroidal shape with the infinitesimals masses and charges orbiting such that they create a toroid shape. The shape would be similar to a toroidal shaped transformer used in everyday electronics:

Is the electron shaped like a toroid?





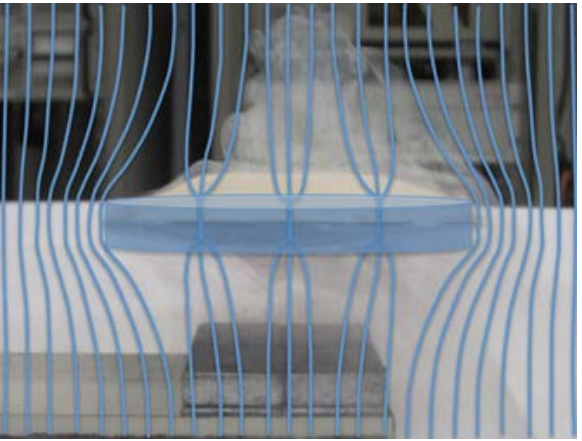


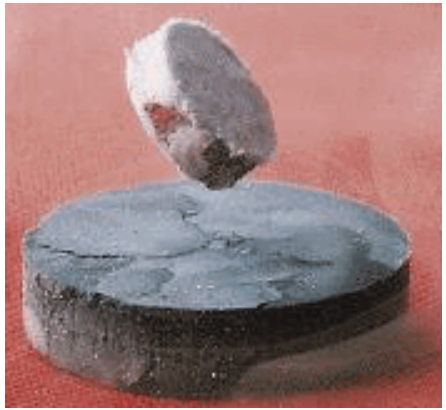
Warning: wild speculation below

If the middle part of the toroid creates a funnel shape of electric and/or magnetic field, like a tornado, down to a specific proton then that electron could be "pinned" to a proton the same way superconductors of type-II get pinned to impurities inside the superconductor. This could explain the Pauli exclusion principle:

From Wikipedia: **Pauli exclusion principle**
https://en.wikipedia.org/wiki/Pauli_exclusion_principle
The Pauli exclusion principle is the quantum mechanical principle that states that two identical fermions (particles with half-integer spin) cannot occupy the same quantum state simultaneously. In the case of electrons, it can be stated as follows: it is impossible for two electrons of a poly-electron atom to have the same values of the four quantum numbers: n, the principal quantum number, ℓ , the angular momentum quantum number, mℓ, the magnetic quantum number, and ms, the spin quantum number. For two electrons residing in the same orbital, n, ℓ, and mℓ are the same, so ms, the spin, must be different, and thus the electrons have opposite half-integer spins, 1/2 and -1/2. This principle was formulated by Austrian physicist Wolfgang Pauli in 1925.

From Wikipedia: **Flux Pinning**
https://en.wikipedia.org/wiki/Flux_pinning
Flux pinning is the phenomenon where a superconductor is pinned in space above a magnet. The superconductor must be a type-II superconductor because type-I superconductors cannot be penetrated by magnetic fields.[1]The act of magnetic penetration is what makes flux pinning possible.



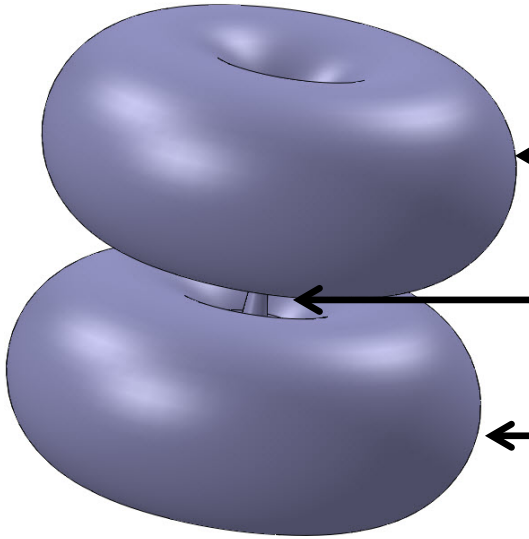


Magnetic field lines penetrate a Type II superconductor in a process called flux pinning.

Warning: wild speculation below

If the electron is a toroid with magnetic and/or electric field lines that extend down to the proton in a funnel shape then two electrons in the helium atom could look like the following with the two protons and two neutrons at the tip of the two electron funnels. The electrons would be a thin shell of orbiting infinitesimal masses and charges similar to Randell Mills' GUTCP model of the electron (except that Mills' model is spherical shells, not toroids).

Two electrons with opposite spin (magnetic fields cancel) with 2 protons and 2 neutrons at center.

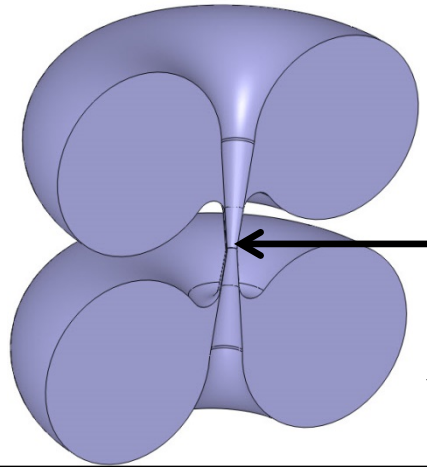


electron #1, spin +1/2

nucleus, 2 protons + 2 neutrons (helium) at center

electron #2, spin -1/2

Section view



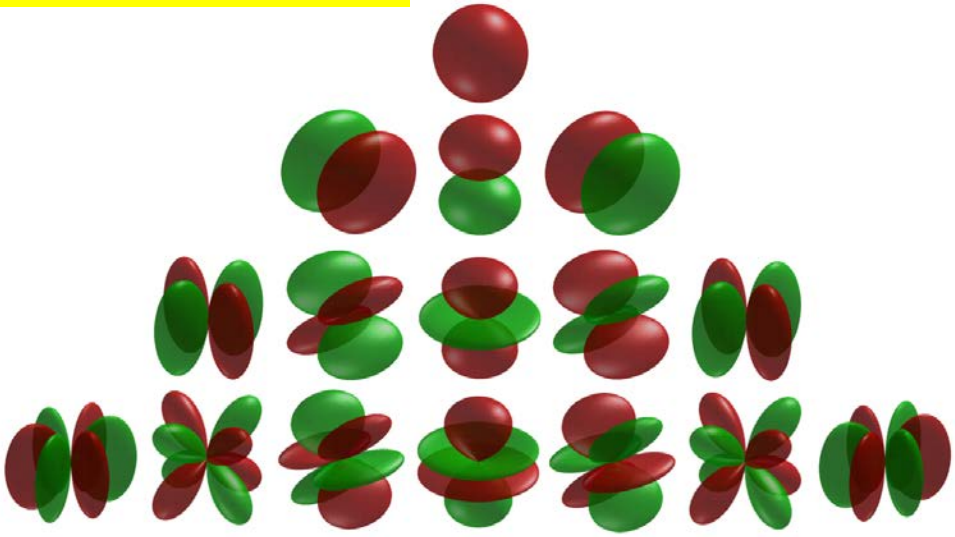
electron #1, spin +1/2

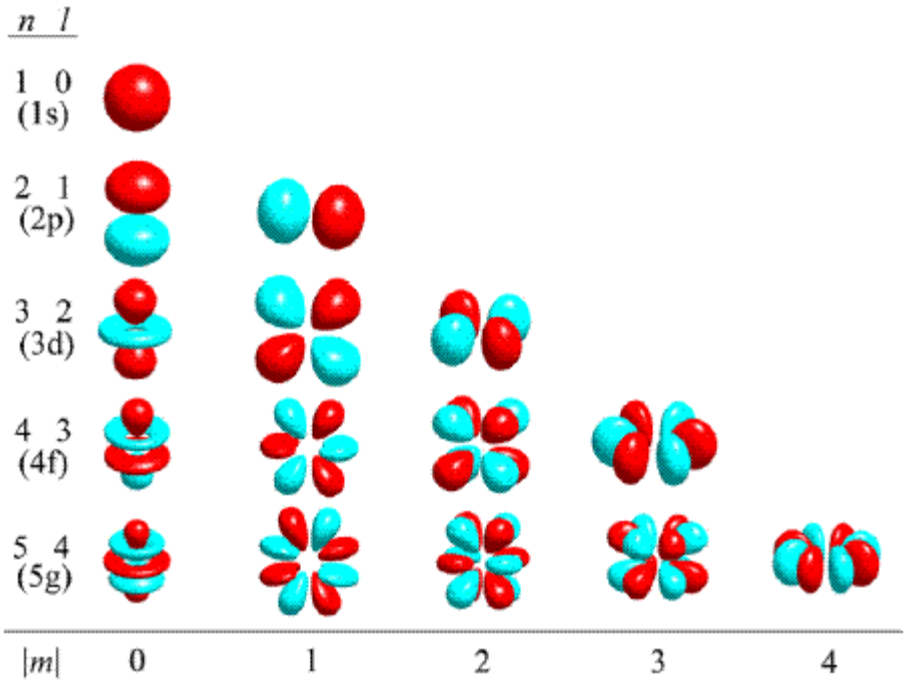
nucleus, 2 protons + 2 neutrons (helium) at center (not shown)

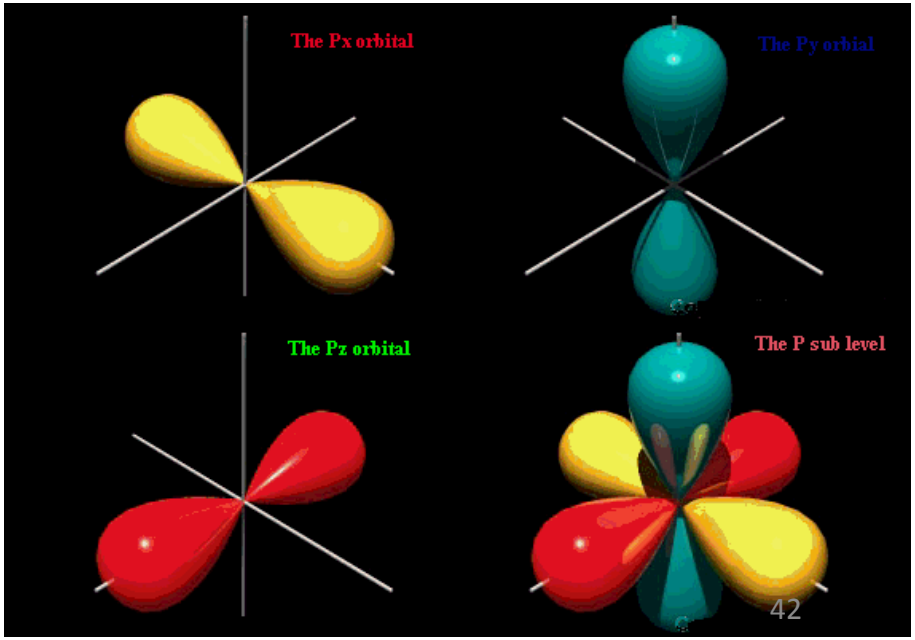
electron #2, spin -1/2

Warning: wild speculation below

The electron toroid orbitals could look similar to the standard quantum mechanics picture of orbitals, with each electron pinned (via flux pinning) on one of the protons as described in this presentation.

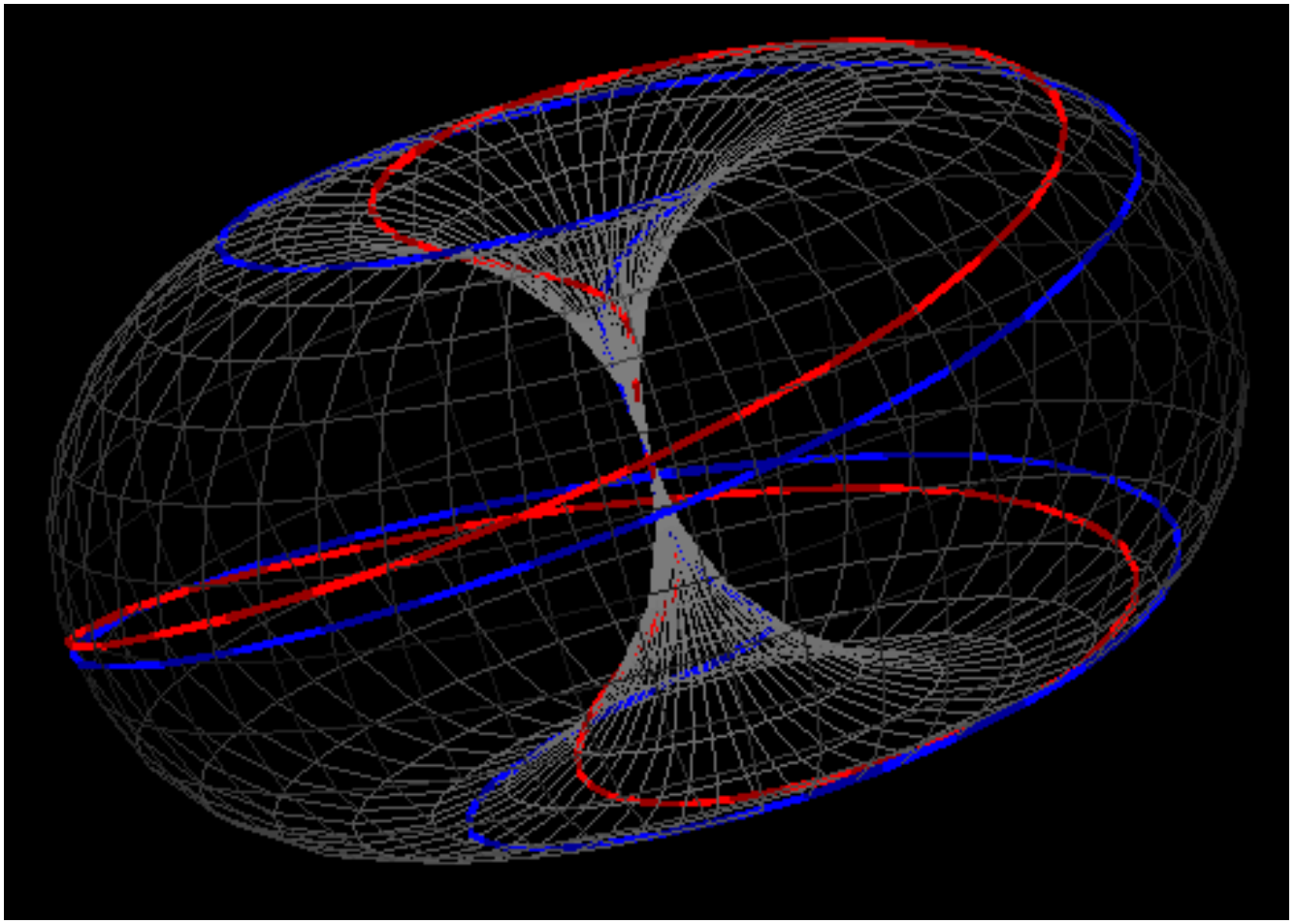






Warning: wild speculation below

One way for an electron to create a toroid shape as it orbits a proton is if each infinitesimal charge and mass orbits along some path that looks like the red or blue line in the picture below. The surface created by all of the infinitesimal charges and masses creates an object that looks like a toroid with the proton at the geometric center point.

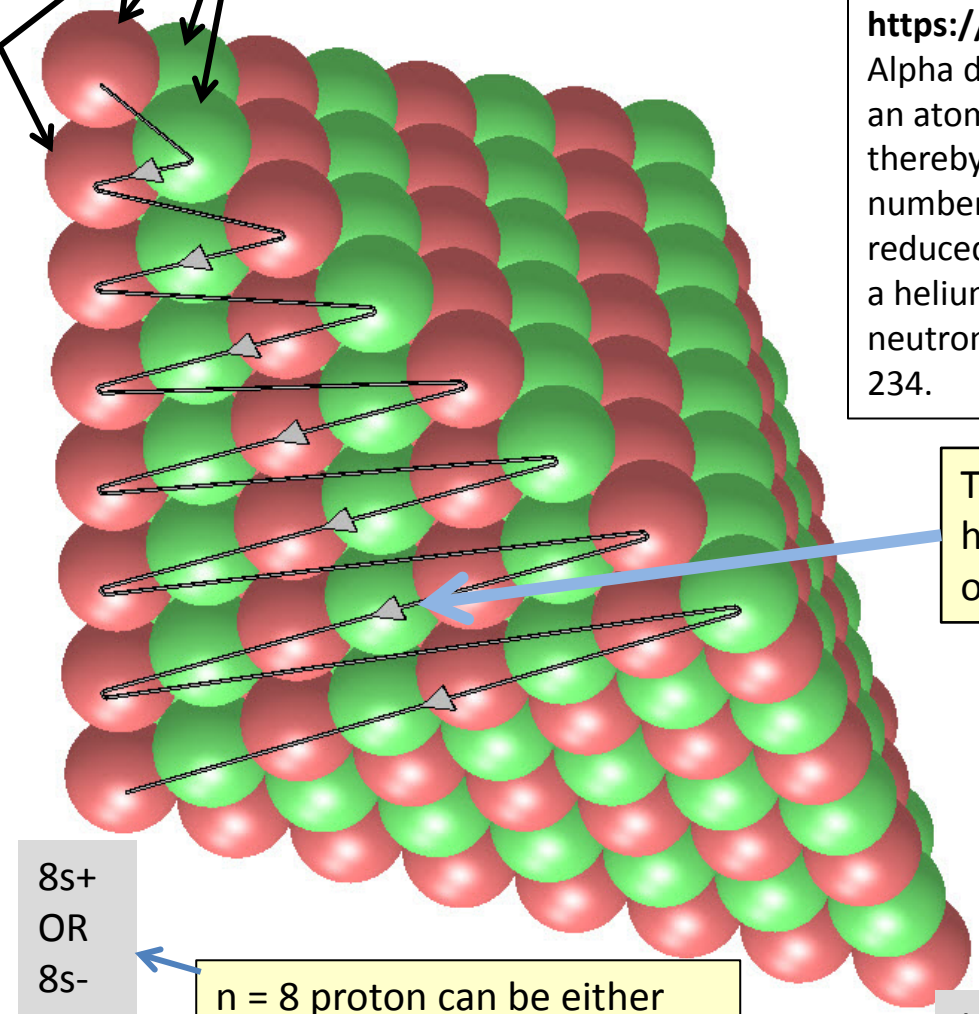


Plus sign “+” represents
m_s = +1/2 spin

Helium would be just these 2 protons and 2 neutrons if they were to split off. Alpha emission is the emitting of a helium atom.

1s+

From Wikipedia:
https://en.wikipedia.org/wiki/Alpha_decay
Alpha decay or α-decay is a type of radioactive decay in which an atomic nucleus emits an alpha particle (helium nucleus) and thereby transforms or 'decays' into an atom with a mass number that is reduced by four and an atomic number that is reduced by two. An alpha particle is identical to the nucleus of a helium-4 atom, which consists of two protons and two neutrons. For example, uranium-238 decays to form thorium-234.



These thin direction arrows having a gray color indicate orbit filling order.

red = protons
green = neutrons

fermium

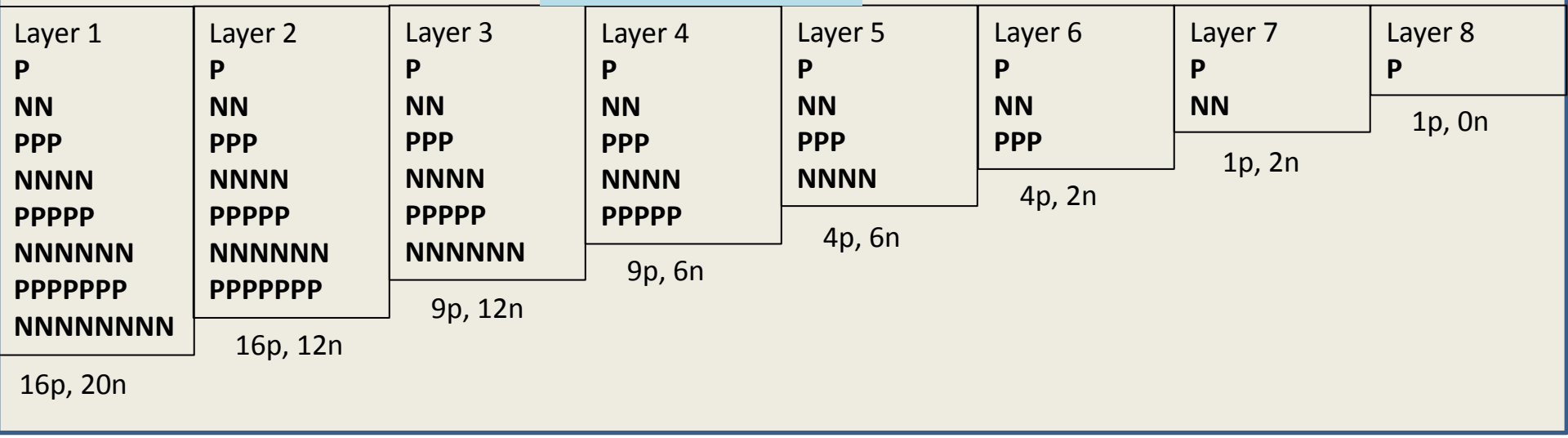
8s+
OR
8s-

n = 8 proton can be either +1/2 or -1/2 spin

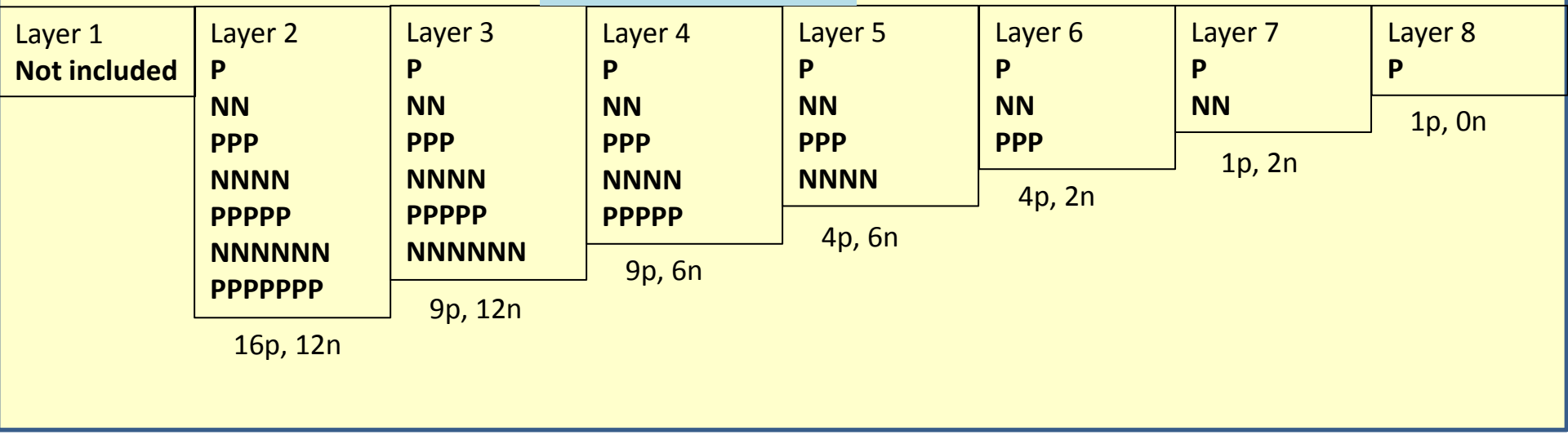
1s-

Minus sign “-” represents
m_s = -1/2 spin

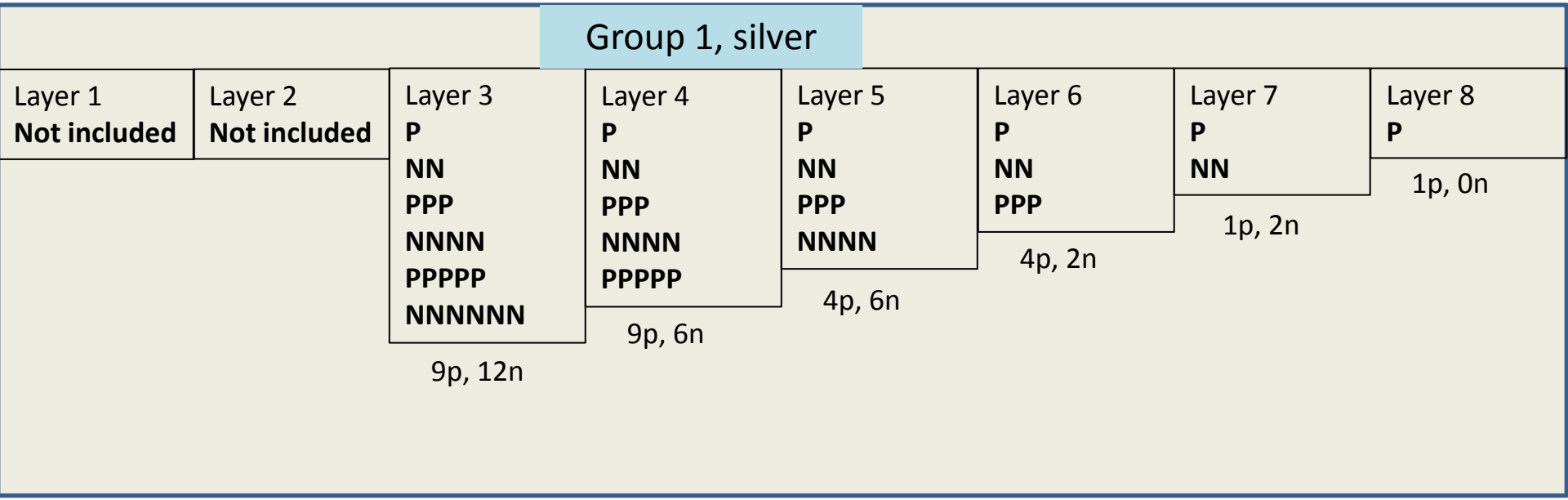
Group 1, fermium

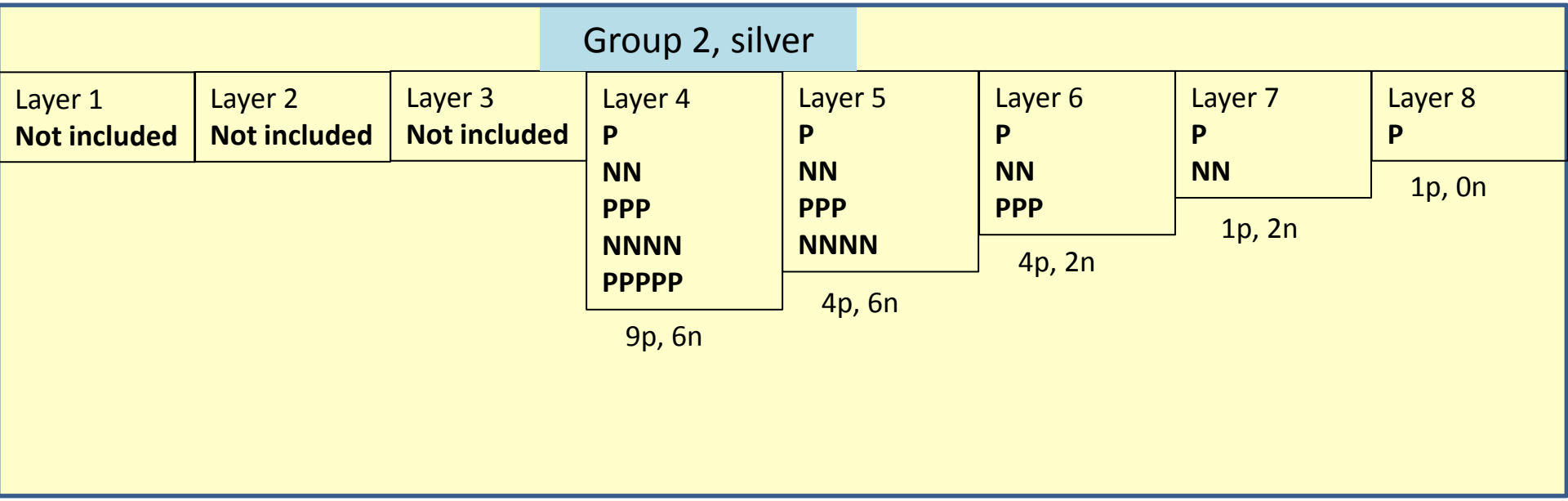


Group 2, fermium



Fermium is equal to Group 1 + Group 2 = 104 protons and 100 neutrons





Silver is equal to Group 1 + Group 2 = 47 protons and 44 neutrons

Group 1, sulphur

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**P** **NN** **PPP** **NNNN**	**P** **NN** **PPP**	**P** **NN**	**P**
				4p, 6n	4p, 2n	1p, 2n	1p, 0n

Group 2, sulphur

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**Not included**	**P** **NN** **PPP**	**P** **NN**	**P**
					4p, 2n	1p, 2n	1p, 0n

Sulphur is equal to Group 1 + Group 2 = 16 protons and 14 neutrons

Group 1, lithium

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**P** **NN**	**P**
						1p, 2n	1p, 0n

Group 2, lithium

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**P**
							1p, 0n

Lithium is equal to Group 1 + Group 2 = 3 protons and 2 neutrons

Group 1, helium

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**P** **NN**	**Not included**

1p, 2n

Group 2, helium

Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7	Layer 8
Not included	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**Not included**	**P**

1p, 0n

helium is equal to Group 1 + Group 2 = 2 protons and 2 neutrons