

"Pairs and Squares" Periodic Table

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Abstract

I present a new "Pairs and Squares" rendering of the Periodic Table. It takes advantage of the number of orbitals at each atomic energy level being a whole square. This makes the table very regular and intuitive in contrast with its currently used presentations.

In a century and a half since [1], a huge number of forms of the Periodic Table have been designed (see, e.g., [2, 3, 4]). However, they all share a problem: Their irregularity overwhelms their periodicity. This is especially bothersome at one's early exposures to this icon of science.

Yet, there is one numeric pattern none of these renditions of the table seem to exploit for a full effect. The number of orbitals in each electron shell is a whole square. And so is their number at each Madelung energy level (roughly the sum of the first two quantum numbers). And those squares are each the sum of the first several odd integers, representing the numbers of orbitals on the respective subshells.

This pattern allows a completely regular rendering of the table with a very intuitive look. Each period fills a square, with each cell of the square holding a pair of consecutive elements. Nested subsquares, sharing the lower-left corners, group the color-coded blocks: in each period each subsquare adds one more block in a **┐**-shaped stripe. And if squares are not on one page but stapled together instead, similar elements fall at the same place in the respective layers.

I also give two variations of the layout that avoid paring two elements per cell, doubling instead square periods into $n \times 2n$ rectangles (vertical or horizontal).

Of course, one may question the need to add another form of the Periodic Table to the huge number of those already designed. But I think one look at this Table (see the next page, in color) may convince that the extra comfort given by its perfect¹ regularity comes as some justification.

References

- [1] D. I. Mendeleev. 1871. The natural system of elements and its application to the indication of the properties of undiscovered elements. *J. Russian Chemical Soc.* **3**:25–56. (in Russian.)
- [2] E. Mazurs. *The Graphic Representation of the Periodic System During 100 Years*. 1974. U. Alabama Press.
- [3] Mark R. Leach. 1999-. *The Internet Database of Periodic Tables*.
https://www.meta-synthesis.com/webbook/35_pt/pt_database.php
- [4] Eric Scerri. *The Periodic Table, Its Story and Its Significance*. 2020. OUP, New York. Chapter 13.

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¹Admittedly, a really perfect pattern would start with two pink 1-cell periods.

However the H/He period is special, suggesting a yellow color.

So, the small imperfection of merging the two into one 2-cell yellow/pink period seems more revealing.

This "Pairs and Squares" colored rendering of the Periodic Table seems most intuitive in view of quadratic number of orbitals at each atomic energy level.

3 Li 6.94 Lithium	1 H 1.008 Hydrogen
4 Be 9.012 Beryllium	2 He 4.003 Helium
1. staple here	

5 B 10.81 Boron	7 N 14.007 Nitrogen
6 C 12.011 Carbon	8 O 15.999 Oxygen
11 Na 22.990 Sodium	9 F 18.998 Fluorine
12 Mg 24.31 Magnesium	10 Ne 20.180 Neon
2. staple here	

13 Al 26.982 Aluminium	15 P 30.974 Phosphorus
14 Si 28.085 Silicon	16 S 32.06 Sulfur
19 K 39.098 Potassium	17 Cl 35.45 Chlorine
20 Ca 40.078 Calcium	18 Ar 39.948 Argon
3. staple here	

21 Sc 44.956 Scandium	23 V 50.942 Vanadium	25 Mn 54.94 Manganese
22 Ti 47.867 Titanium	24 Cr 51.996 Chromium	26 Fe 55.845 Iron
31 Ga 69.723 Gallium	33 As 74.922 Arsenic	27 Co 58.933 Cobalt
32 Ge 72.630 Germanium	34 Se 78.971 Selenium	28 Ni 58.693 Nickel
37 Rb 85.468 Rubidium	35 Br 79.904 Bromine	29 Cu 63.546 Copper
38 Sr 87.62 Strontium	36 Kr 83.798 Krypton	30 Zn 65.38 Zinc
4. staple here		

57 La 138.91 Lanthanum	59 Pr 140.91 Praseodymium	61 Pm 144.9 Promethium	63 Eu 151.96 Europium
58 Ce 140.12 Cerium	60 Nd 144.24 Neodymium	62 Sm 150.4 Samarium	64 Gd 157.2 Gadolinium
71 Lu 174.97 Lutetium	73 Ta 180.95 Tantalum	75 Re 186.21 Rhenium	65 Tb 158.93 Terbium
72 Hf 178.49 Hafnium	74 W 183.84 Tungsten	76 Os 190.23 Osmium	66 Dy 162.50 Dysprosium
81 Tl 204.38 Thallium	83 Bi 208.98 Bismuth	77 Ir 192.22 Iridium	67 Ho 164.9 Holmium
82 Pb 207.2 Lead	84 Po 208.98 Polonium	78 Pt 195.08 Platinum	68 Er 167.26 Erbium
87 Fr 223.02 Francium	85 At 209.99 Astatine	79 Au 196.97 Gold	69 Tm 168.9 Thulium
88 Ra 226.03 Radium	86 Rn 222.02 Radon	80 Hg 200.59 Mercury	70 Yb 173.05 Ytterbium
6. staple here			

39 Y 88.906 Yttrium	41 Nb 92.906 Niobium	43 Tc 96.91 Technetium
40 Zr 91.224 Zirconium	42 Mo 95.95 Molybdenum	44 Ru 101.07 Ruthenium
49 In 114.82 Indium	51 Sb 121.76 Antimony	45 Rh 102.91 Rhodium
50 Sn 118.71 Tin	52 Te 127.60 Tellurium	46 Pd 106.42 Palladium
55 Cs 132.91 Caesium	53 I 126.90 Iodine	47 Ag 107.87 Silver
56 Ba 137.33 Barium	54 Xe 131.29 Xenon	48 Cd 112.41 Cadmium
5. staple here		

89 Ac 227 Actinium	91 Pa 231 Protactinium	93 Np 237 Neptunium	95 Am 243 Americium
90 Th 232 Thorium	92 U 238 Uranium	94 Pu 244 Plutonium	96 Cm 247 Curium
103 Lr 262 Lawrencium	105 Db 270 Dubnium	107 Bh 270 Bohrium	97 Bk 247 Berkelium
104 Rf 267 Rutherfordium	106 Sg 269 Seaborgium	108 Hs 269 Hassium	98 Cf 251 Californium
113 Nh 286 Nihonium	115 Mc 289 Moscovium	109 Mt 278 Meitnerium	99 Es 252 Einsteinium
114 Fl 289 Flerovium	116 Lv 293 Livermorium	110 Ds 281 Darmstadtium	100 Fm 257 Fermium
119 Uue ? Ununennium	117 Ts 293 Tennessine	111 Rg 281 Roentgenium	101 Md 258 Mendelevium
120 Ubn ? Unbinilium	118 Og 294 Oganesson	112 Cn 285 Copernicium	102 No 259 Nobelium
7. staple here			

"Pairs and Squares" Periodic Table.

Merged H/He, Li/Be periods:

H/He period is yellow, thus its placement is slightly odd.	3 Li 6.94 Lithium	1.
	4 Be 9.012 Beryllium	S t a p l e
1 H 1.008 Hydrogen	2 He 4.003 Helium	

6 C 12.011 Carbon	5 B 10.81 Boron
7 N 14.007 Nitrogen	11 Na 22.990 Sodium
8 O 15.999 Oxygen	12 Mg 24.31 Magnesium
9 F 18.998 Fluorine	10 Ne 20.180 Neon

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15 P 30.974 Phosphorus	19 K 39.098 Potassium
16 S 32.06 Sulfur	20 Ca 40.078 Calcium
17 Cl 35.45 Chlorine	18 Ar 39.948 Argon

23 V 50.942 Vanadium	22 Ti 47.867 Titanium	21 Sc 44.956 Scandium
24 Cr 51.996 Chromium	32 Ge 72.630 Germanium	31 Ga 69.723 Gallium
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26 Fe 55.845 Iron	34 Se 78.971 Selenium	38 Sr 87.62 Strontium
27 Co 58.933 Cobalt	35 Br 79.904 Bromine	36 Kr 83.798 Krypton
28 Ni 58.693 Nickel	29 Cu 63.546 Copper	30 Zn 65.38 Zinc

This "Pairs of Squares" colored rendering of the Periodic Table seems most intuitive in view of quadratic number of orbitals at each atomic energy level. (Stripes are C-shaped.)

41 Nb 92.906 Niobium	40 Zr 91.224 Zirconium	39 Y 88.906 Yttrium
42 Mo 95.95 Molybdenum	50 Sn 118.71 Tin	49 In 114.82 Indium
43 Tc 96.91 Technetium	51 Sb 121.76 Antimony	55 Cs 132.91 Caesium
44 Ru 101.07 Ruthenium	52 Te 127.60 Tellurium	56 Ba 137.33 Barium
45 Rh 102.91 Rhodium	53 I 126.90 Iodine	54 Xe 131.29 Xenon
46 Pd 106.42 Palladium	47 Ag 107.87 Silver	48 Cd 112.41 Cadmium

60 Nd 144.24 Neodymium	59 Pr 140.91 Praseodymium	58 Ce 140.12 Cerium	57 La 138.91 Lanthanum
61 Pm 144.9 Promethium	73 Ta 180.95 Tantalum	72 Hf 178.49 Hafnium	71 Lu 174.97 Lutetium
62 Sm 150.4 Samarium	74 W 183.84 Tungsten	82 Pb 207.2 Lead	81 Tl 204.38 Thallium
63 Eu 151.96 Europium	75 Re 186.21 Rhenium	83 Bi 208.98 Bismuth	87 Fr 223.02 Francium
64 Gd 157.2 Gadolinium	76 Os 190.23 Osmium	84 Po 208.98 Polonium	88 Ra 226.03 Radium
65 Tb 158.93 Terbium	77 Ir 192.22 Iridium	85 At 209.99 Astatine	86 Rn 222.02 Radon
66 Dy 162.50 Dysprosium	78 Pt 195.08 Platinum	79 Au 196.97 Gold	80 Hg 200.59 Mercury
67 Ho 164.9 Holmium	68 Er 167.26 Erbium	69 Tm 168.9 Thulium	70 Yb 173.05 Ytterbium

92 U 238 Uranium	91 Pa 231 Protactinium	90 Th 232 Thorium	89 Ac 227 Actinium
93 Np 237 Neptunium	105 Db 270 Dubnium	104 Rf 267 Rutherfordium	103 Lr 262 Lawrencium
94 Pu 244 Plutonium	106 Sg 269 Seaborgium	114 Fl 289 Flerovium	113 Nh 286 Nihonium
95 Am 243 Americium	107 Bh 270 Bohrium	115 Mc 289 Moscovium	119 Uue ? Ununennium
96 Cm 247 Curium	108 Hs 269 Hassium	116 Lv 293 Livermorium	120 Ubn ? Unbinilium
97 Bk 247 Berkelium	109 Mt 278 Meitnerium	117 Ts 293 Tennessine	118 Og 294 Oganesson
98 Cf 251 Californium	110 Ds 281 Darmstadtium	111 Rg 281 Roentgenium	112 Cn 285 Copernicium
99 Es 252 Einsteinium	100 Fm 257 Fermium	101 Md 258 Mendelevium	102 No 259 Nobelium

"Pairs of Squares" Periodic Table (C-shaped Stripes).

This "Pairs of Squares" colored rendering of the Periodic Table seems most intuitive in view of quadratic number of orbitals at each atomic energy level. (Stripes are II-shaped.)

H/He period is yellow, thus its placement is slightly odd.		1 H 1.008 Hydrogen
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1. staple here

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5 B 10.81 Boron	11 Na 22.990 Sodium	12 Mg 24.31 Magnesium	10 Ne 20.180 Neon

2. staple here

14 Si 28.085 Silicon	15 P 30.974 Phosphorus	16 S 32.06 Sulfur	17 Cl 35.45 Chlorine
13 Al 26.982 Aluminium	19 K 39.098 Potassium	20 Ca 40.078 Calcium	18 Ar 39.948 Argon

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"Pairs of Squares" Periodic Table (II-shaped Stripes).