

# The Chemical Table: An Open Dialog between Visualization and Design

---

Francis T. Marchese  
Department of Computer Science  
Pace University  
New York, NY 10038

<http://csis.pace.edu/~marchese>  
[fmarchese@pace.edu](mailto:fmarchese@pace.edu)

# Chemical Table

---

- ❑ Created over 300 years ago
- ❑ Tool to organize and visualize chemical reactivity
- ❑ Evolved into periodic charts and tables
- ❑ During the past 150 years over 700 visualizations of chemical periodicity have appeared

# Chemical Tables and Charts

---

- Organizing constructs for basic components of chemical knowledge
- Search for complete, coherent, systematic representation of chemical information organization
- two-dimensional periodic table remains *de facto* representation

# Chemical Tables and Charts

---

- Contents: chemical information
  - e.g. atomic weights, ionization potentials, oxidation states, reaction rates, melting points, crystal structures
- Physically measurable quantities
  - But have neither intrinsic nor causal geometric correlations
- Must be considered a visualization of abstract data organized on a conceptual substrate such as a  $xy$  grid.

# Chemical Tables and Charts

---

- designed artifacts
- built to organize chemical knowledge
- Used as tools for reasoning
- dynamic as well
- form is *plastic*

# Purpose of Talk

---

- Review the chemical table from an historical perspective as a designed tool for information visualization
- Argue why the 2D Periodic Table is the *de facto* representation of chemical information

# Representations

---

- Tables
- Charts
- Physical Models

TABLE DES DIFFERENTS RAPPORTS  
observés entre différentes substances.

Mém. de l'Acad. 1718. Pl. 8. pag. 212.

↶	⊖	⊙	⊕	▽	⊖	⊕ <sup>^</sup>	SM	△ <sub>♀</sub>	♀	♁	♀	☾	♂	♁	▽
⊖	♃	♂	△ <sub>♀</sub>	⊕	⊕	⊕	⊖	⊖	○	☾	♀	♁	♁	♂	▽ <sup>s</sup>
⊕ <sup>^</sup>	♁	♀	⊖	⊙	⊙	⊙	⊕	♂	☾	♀	PC	♀	♁ <sup>♀</sup>	♁ <sup>♀</sup>	⊖
▽	♀	♁	⊕ <sup>^</sup>	⊖	⊖	⊖	⊖	♀	♁						
SM	☾	♀	▽		⊕		⊕	♁	♀						
	♀	☾	♂		△ <sub>♀</sub>			☾	♃						
			♀					♁	♁						
			☾					♀							
	○							○							

- |                       |                           |                        |                                       |
|-----------------------|---------------------------|------------------------|---------------------------------------|
| ↶ Esprits acides      | ▽ Terre absorbante.       | ♀ Cuivre.              | △ Soufre mineral.                     |
| ⊖ Acide du sel marin. | SM Substances metalliques | ♂ Fer.                 | △ Principe huileux ou Soufre Principe |
| ⊙ Acide nitreux       | ♀ Mercure                 | ♁ Plomb.               | ⊕ Esprit de vinaigre.                 |
| ⊕ Acide vitriolique.  | ♁ Regule d'Antimoine.     | ♃ Etain.               | ▽ Eau.                                |
| ⊕ Sel alcali fixe     | ○ Or.                     | ♃ Zine.                | ⊖ Sel.                                |
| ⊕ Sel alcali volatil  | ☾ Argent                  | PC Pierre Calaminaire. | ▽ Esprit de vin et Esprits ardents.   |

Étienne-François Geoffroy's "Table des différents rapports, 1718



			Ti = 50	Zr = 90	? = 180.
			V = 51	Nb = 94	Ta = 182.
			Cr = 52	Mo = 96	W = 186.
			Mn = 55	Rh = 104,4	Pt = 197,1.
			Fe = 56	Rn = 104,4	Ir = 198.
			Ni = Co = 59	Pt = 106,8	Os = 199.
H = 1			Cu = 63,4	Ag = 108	Hg = 200.
	Be = 9,1	Mg = 24	Zn = 65,2	Cd = 112	
	B = 11	Al = 27,1	? = 68	Ur = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79,4	Te = 128?	
	F = 19	Cl = 35,5	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85,4	Cs = 133	Tl = 204.
		Ca = 40	Sr = 87,6	Ba = 137	Pb = 207.
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75,6	Th = 118?		

Dimitri Mendeleev's periodic table of 1869

<i>f</i> -Block														<i>d</i> -Block										<i>p</i> -Block						<i>s</i> -Block	
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	B	C	N	O	F	Ne	H	He
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	Al	Si	P	S	Cl	Ar	Li	Be
														Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Ga	Ge	As	Se	Br	Kr	Na	Mg
														Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	In	Sn	Sb	Te	I	Xe	K	Ca
																								Tl	Pb	Bi	Po	At	Rn	Rb	Sr
																								Uut	Uuq	Uup	Uuh	Cs	Ba		
																								Fr	Ra						

Charles Janet's periodic table of 1927

# PERIODIC TABLE

## Atomic Properties of the Elements

**NIST**

National Institute of Standards and Technology  
Technology Administration, U.S. Department of Commerce

**Frequently used fundamental physical constants**

For the most accurate values of these and other constants, visit [physics.nist.gov/constants](http://physics.nist.gov/constants)

1 second = 9 192 631 770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of  $^{133}\text{Cs}$

speed of light in vacuum	$c$	299 792 458 m s <sup>-1</sup>	(exact)
Planck constant	$h$	$6.6261 \times 10^{-34}$ J s	( $h = h/2\pi$ )
elementary charge	$e$	$1.6022 \times 10^{-19}$ C	
electron mass	$m_e$	$9.1094 \times 10^{-31}$ kg	
	$m_e c^2$	0.511 MeV	
proton mass	$m_p$	$1.6726 \times 10^{-27}$ kg	
fine-structure constant	$\alpha$	1/137.036	
Rydberg constant	$R_\infty$	$10 973 732$ m <sup>-1</sup>	
	$R_\infty c$	$3.289 842 \times 10^{15}$ Hz	
	$R_\infty hc$	$13.6057$ eV	
Boltzmann constant	$k$	$1.3807 \times 10^{-23}$ J K <sup>-1</sup>	

- Solids
- Liquids
- Gases
- Artificially Prepared

Group	PERIODIC TABLE																18		
	1											8	18						
IA											IIIA	IVA	VA	VIA	VIIA	VIIIA			
1	<b>1</b> <b>H</b> Hydrogen 1.00794 1s 13.5984											<b>13</b> <b>B</b> Boron 10.811 1s <sup>2</sup> 2s <sup>2</sup> 2p 8.2980	<b>14</b> <b>C</b> Carbon 12.0107 1s <sup>2</sup> 2s <sup>2</sup> 2p 11.2603	<b>15</b> <b>N</b> Nitrogen 14.0067 1s <sup>2</sup> 2s <sup>2</sup> 2p 14.5341	<b>16</b> <b>O</b> Oxygen 15.9994 1s <sup>2</sup> 2s <sup>2</sup> 2p 13.6181	<b>17</b> <b>F</b> Fluorine 18.9984032 1s <sup>2</sup> 2s <sup>2</sup> 2p 17.4228	<b>18</b> <b>Ne</b> Neon 20.1797 1s <sup>2</sup> 2s <sup>2</sup> 2p 21.5645		
2	<b>2</b> <b>He</b> Helium 4.002602 1s <sup>2</sup> 24.5874	<b>3</b> <b>Li</b> Lithium 6.941 1s <sup>2</sup> 2s 5.3917	<b>4</b> <b>Be</b> Beryllium 9.012182 1s <sup>2</sup> 2s 9.3227											<b>5</b> <b>Al</b> Aluminum 26.981538 [Ne]3s <sup>2</sup> 3p 9.9858	<b>6</b> <b>Si</b> Silicon 28.0855 8.1517	<b>7</b> <b>P</b> Phosphorus 30.973761 10.4867	<b>8</b> <b>S</b> Sulfur 32.065 10.3600	<b>9</b> <b>Cl</b> Chlorine 35.453 12.9670	<b>10</b> <b>Ar</b> Argon 39.948 15.7596
3	<b>11</b> <b>Na</b> Sodium 22.989770 [Ne]3s 5.1391	<b>12</b> <b>Mg</b> Magnesium 24.3050 7.6462											<b>11</b> <b>IB</b>	<b>12</b> <b>IIB</b>					
4	<b>19</b> <b>K</b> Potassium 39.0983 [Ar]4s 4.3407	<b>20</b> <b>Ca</b> Calcium 40.078 [Ar]4s 6.1132	<b>21</b> <b>Sc</b> Scandium 44.955910 [Ar]3d <sup>1</sup> 4s <sup>2</sup> 6.5615	<b>22</b> <b>Ti</b> Titanium 47.867 [Ar]3d <sup>2</sup> 4s <sup>2</sup> 6.8281	<b>23</b> <b>V</b> Vanadium 50.9415 [Ar]3d <sup>3</sup> 4s <sup>2</sup> 6.7462	<b>24</b> <b>Cr</b> Chromium 51.9961 [Ar]3d <sup>5</sup> 4s 6.7665	<b>25</b> <b>Mn</b> Manganese 54.938049 [Ar]3d <sup>5</sup> 4s <sup>2</sup> 7.4340	<b>26</b> <b>Fe</b> Iron 55.845 [Ar]3d <sup>6</sup> 4s <sup>2</sup> 7.9024	<b>27</b> <b>Co</b> Cobalt 58.933200 [Ar]3d <sup>7</sup> 4s <sup>2</sup> 7.8810	<b>28</b> <b>Ni</b> Nickel 58.6934 [Ar]3d <sup>8</sup> 4s <sup>2</sup> 7.6398	<b>29</b> <b>Cu</b> Copper 63.546 [Ar]3d <sup>10</sup> 4s 7.7264	<b>30</b> <b>Zn</b> Zinc 65.409 [Ar]3d <sup>10</sup> 4s 9.3942	<b>31</b> <b>Ga</b> Gallium 69.723 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p 5.9993	<b>32</b> <b>Ge</b> Germanium 72.64 [Ar]3d <sup>10</sup> 4s <sup>2</sup> 4p 7.8994	<b>33</b> <b>As</b> Arsenic 74.92160 9.7886	<b>34</b> <b>Se</b> Selenium 78.96 9.7524	<b>35</b> <b>Br</b> Bromine 79.904 11.8138	<b>36</b> <b>Kr</b> Krypton 83.798 13.9999	
5	<b>37</b> <b>Rb</b> Rubidium 85.4678 [Kr]5s 4.1771	<b>38</b> <b>Sr</b> Strontium 87.62 [Kr]5s 5.6949	<b>39</b> <b>Y</b> Yttrium 88.90585 6.2173	<b>40</b> <b>Zr</b> Zirconium 91.224 [Kr]4d <sup>5</sup> 5s 6.6330	<b>41</b> <b>Nb</b> Niobium 92.90638 [Kr]4d <sup>5</sup> 5s 6.7589	<b>42</b> <b>Mo</b> Molybdenum 95.94 7.0924	<b>43</b> <b>Tc</b> Technetium (98) [Kr]4d <sup>5</sup> 5s <sup>2</sup> 7.28	<b>44</b> <b>Ru</b> Ruthenium 101.07 [Kr]4d <sup>7</sup> 5s 7.3605	<b>45</b> <b>Rh</b> Rhodium 102.90550 7.4589	<b>46</b> <b>Pd</b> Palladium 106.42 [Kr]4d <sup>10</sup> 7.5762	<b>47</b> <b>Ag</b> Silver 107.8682 7.5762	<b>48</b> <b>Cd</b> Cadmium 112.411 8.9938	<b>49</b> <b>In</b> Indium 114.818 5.7864	<b>50</b> <b>Sn</b> Tin 118.710 7.3439	<b>51</b> <b>Sb</b> Antimony 121.760 8.6084	<b>52</b> <b>Te</b> Tellurium 127.60 9.0096	<b>53</b> <b>I</b> Iodine 126.90447 10.4513	<b>54</b> <b>Xe</b> Xenon 131.293 12.1298	
6	<b>55</b> <b>Cs</b> Cesium 132.90545 [Xe]6s 3.8939	<b>56</b> <b>Ba</b> Barium 137.327 [Xe]6s 5.2117	Lanthanides Actinides										<b>81</b> <b>Tl</b> Thallium 204.3833 6.1082	<b>82</b> <b>Pb</b> Lead 207.2 7.4167	<b>83</b> <b>Bi</b> Bismuth 208.98038 7.2855	<b>84</b> <b>Po</b> Polonium (209) [Po]6p 8.414	<b>85</b> <b>At</b> Astatine (210) [Po]6p 8.414	<b>86</b> <b>Rn</b> Radon (222) [Po]6p 10.7485	
7	<b>87</b> <b>Fr</b> Francium (223) [Rn]7s 4.0727	<b>88</b> <b>Ra</b> Radium (226) [Rn]7s 5.2784											<b>57</b> <b>La</b> Lanthanum 138.9055 [Xe]5d <sup>1</sup> 6s 5.5769	<b>58</b> <b>Ce</b> Cerium 140.116 [Xe]4f <sup>1</sup> 5d <sup>1</sup> 6s 5.5387	<b>59</b> <b>Pr</b> Praseodymium 140.90765 5.473	<b>60</b> <b>Nd</b> Neodymium 144.24 5.5250	<b>61</b> <b>Pm</b> Promethium (145) [Xe]4f <sup>6</sup> 6s 5.582	<b>62</b> <b>Sm</b> Samarium 150.36 5.6437	<b>63</b> <b>Eu</b> Europium 151.964 5.6704
			<b>89</b> <b>Ac</b> Actinium 227.0381 [Rn]5f <sup>7</sup> 7s 5.17	<b>90</b> <b>Th</b> Thorium 232.0381 6.3067	<b>91</b> <b>Pa</b> Protactinium 231.03588 [Rn]5f <sup>2</sup> 7s 5.89	<b>92</b> <b>U</b> Uranium 238.02891 6.1941	<b>93</b> <b>Np</b> Neptunium (237) [Rn]5f <sup>7</sup> 7s 6.2657	<b>94</b> <b>Pu</b> Plutonium (244) [Rn]5f <sup>7</sup> 7s 6.0200	<b>95</b> <b>Am</b> Americium (243) [Rn]5f <sup>7</sup> 7s 5.9738	<b>96</b> <b>Cm</b> Curium (247) [Rn]5f <sup>7</sup> 7s 5.9914	<b>97</b> <b>Bk</b> Berkelium (247) [Rn]5f <sup>7</sup> 7s 6.1979	<b>98</b> <b>Cf</b> Californium (251) [Rn]5f <sup>7</sup> 7s 6.2817	<b>99</b> <b>Es</b> Einsteinium (252) [Rn]5f <sup>7</sup> 7s 6.42	<b>100</b> <b>Fm</b> Fermium (257) [Rn]5f <sup>7</sup> 7s 6.50	<b>101</b> <b>Md</b> Mendelevium (258) [Rn]5f <sup>7</sup> 7s 6.58	<b>102</b> <b>No</b> Nobelium (259) [Rn]5f <sup>7</sup> 7s 6.65	<b>103</b> <b>Lr</b> Lawrencium (262) [Rn]5f <sup>7</sup> 7s 4.9 ?		

<sup>1</sup>Based upon <sup>12</sup>C. ( ) indicates the mass number of the most stable isotope.

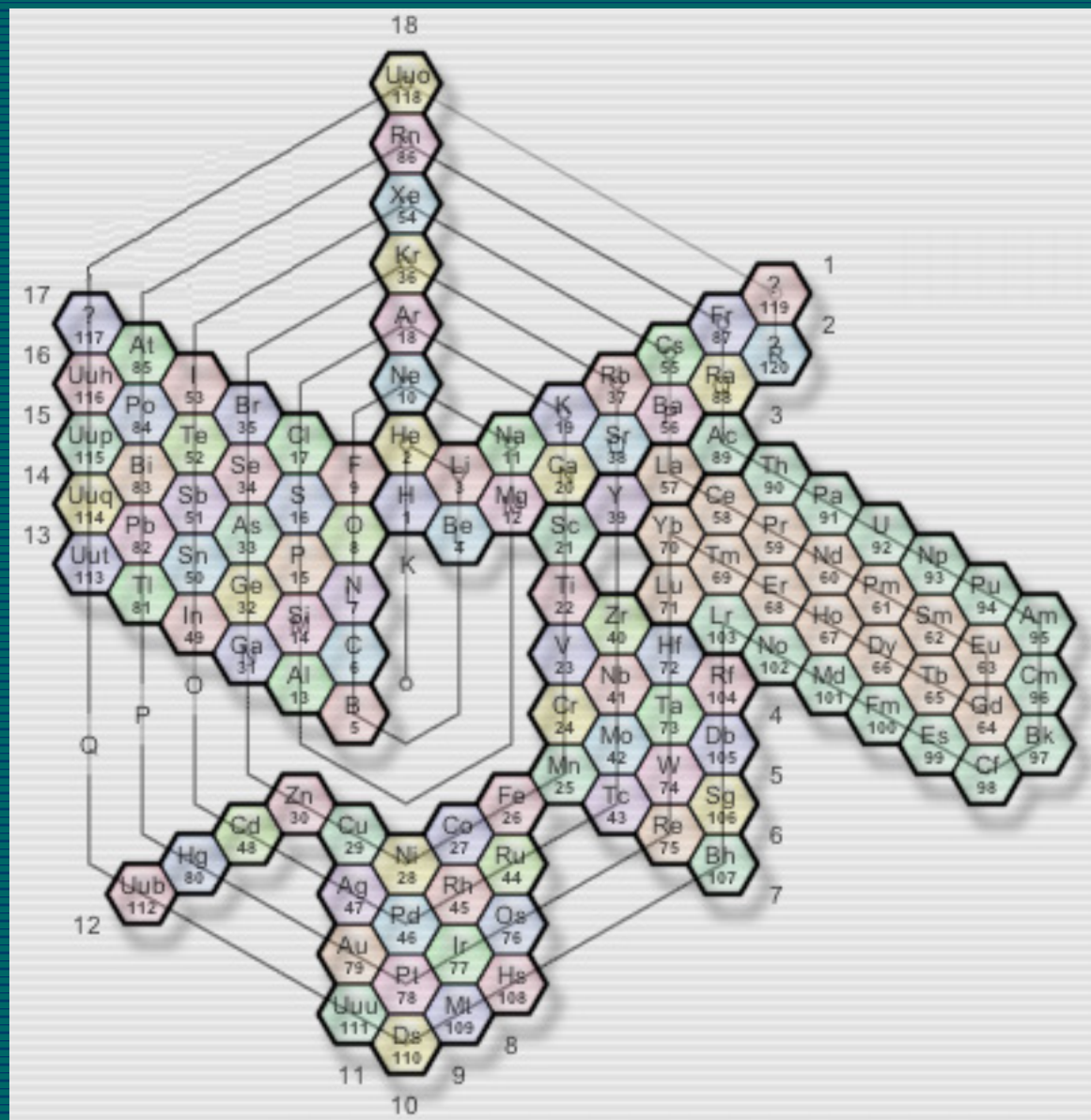
For a description of the data, visit [physics.nist.gov/data](http://physics.nist.gov/data)

NIST SP 966 (September 2003)

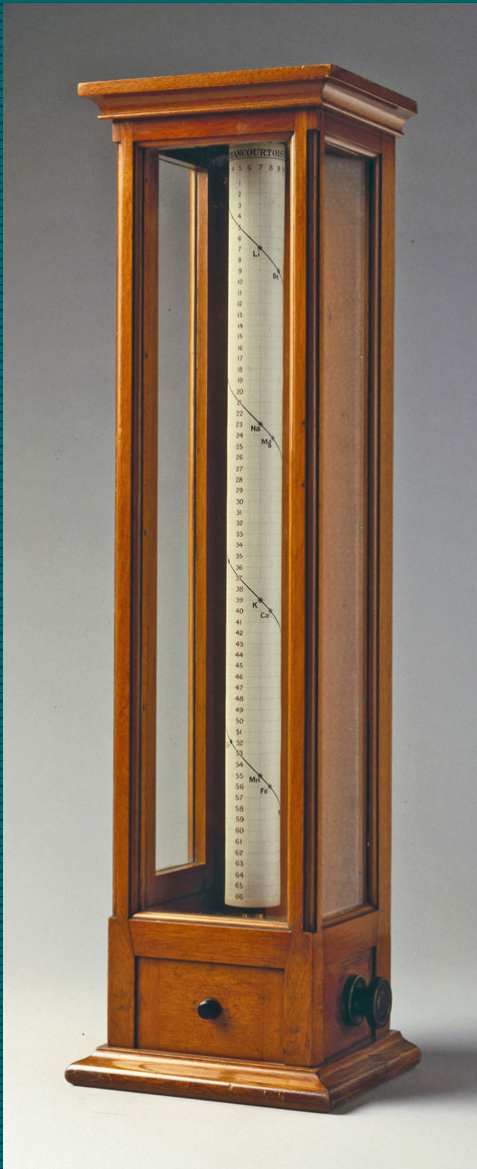
Contemporary Periodic Table by U.S. NIST

	ns																																	
1	H	He																																
	np																																	
2	Li	Be	B	C	N	O	F	Ne																										
3	Na	Mg	Al	Si	P	S	Cl	Ar																										
	(n-1)d																																	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																
	(n-2)f																																	
6	Cs	Ba	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
7	Fr	Ra	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr	Rf	Db	Sg	Bh	Hs	Mt	110	111	112	113	114	115	116	117	118		
	ns	(n-2)f														(n-1)d						np												

Bayley-Thomsen-Bohr Periodic Table of 1882, 1895, 1922, & 1989



Periodic Spiral by Electric Prism, Inc.



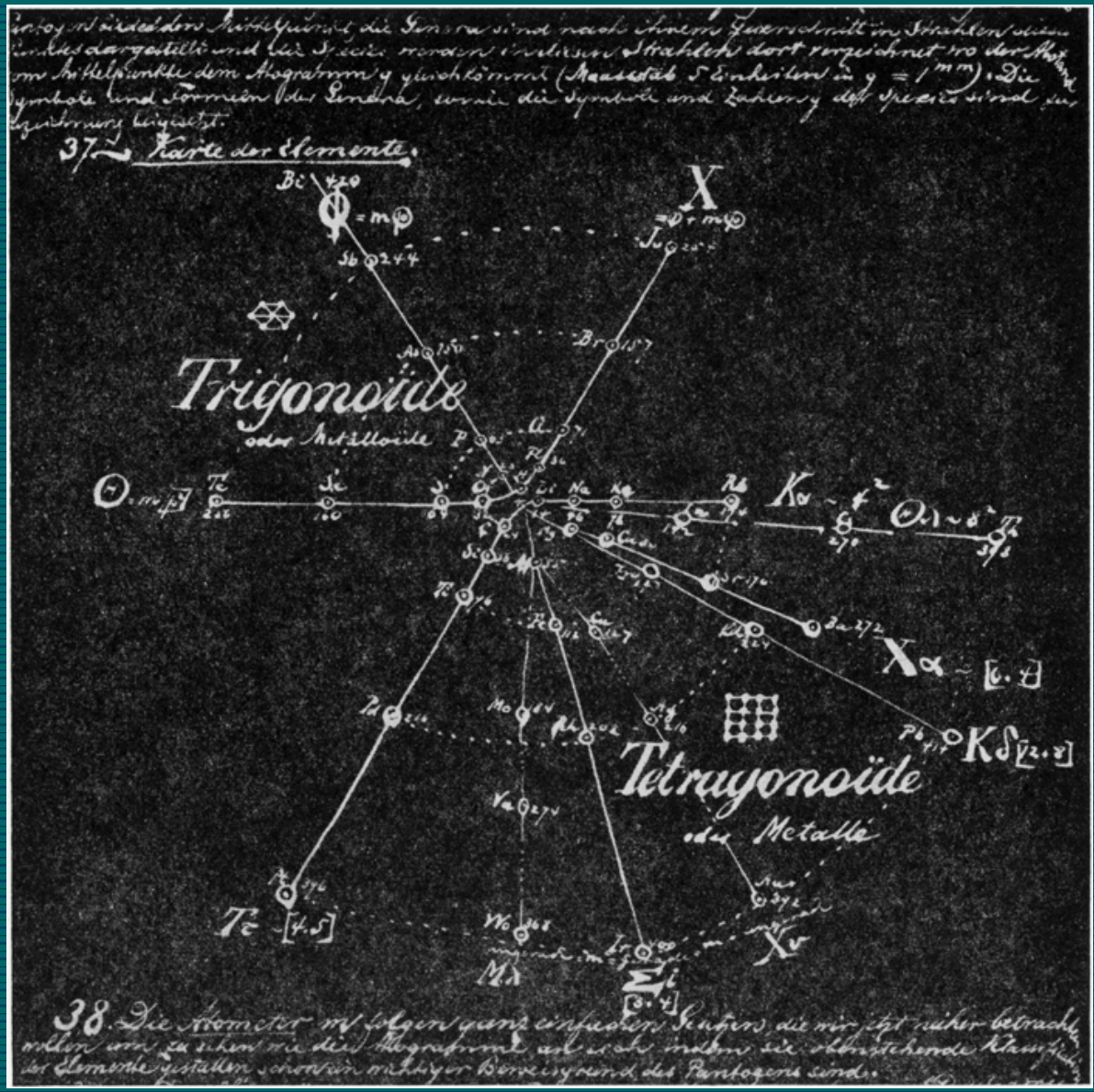
PREMIERE EDITION 7 Avril 1862.

### VIS TELLURIQUE

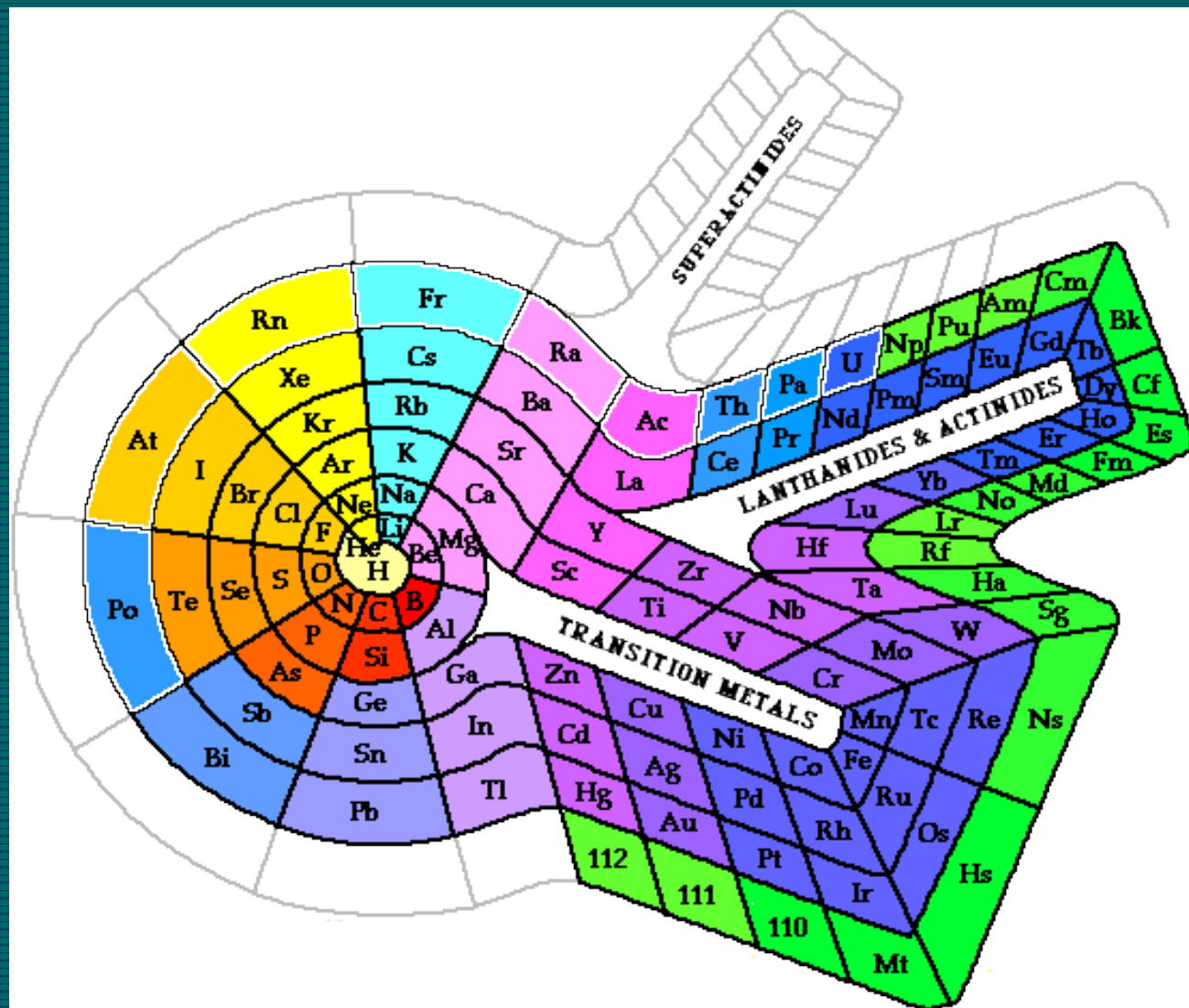
CLASSEMENT NATUREL DES CORPS SIMPLES OU RADICAUX  
obtenus au moyen d'un  
SYSTEME DE CLASSIFICATION HELICOIDE ET NUMERIQUE  
par  
A. E. BEGUYER DE CHANCOURTOIS  
de la Promotion de 1836 à l'Ecole Polytechnique  
Inspecteur en Chef et Professeur-Adjoint de Géologie à l'Ecole Impériale des Mines.

Symbole	N°	Nom	Période des années	Tableau des Cassioires Géométriques		N° de
				développement d'un cylindre de 0°20' de diamètre		
H	1	Hydrogène	1800	1	0	
Li	2	Lithium	1817	2	1	
B	3	Bore	1808	3	2	
Be	4	Beryllium	1828	4	3	
C	5	Carbone	1789	5	4	
N	6	Azote	1774	6	5	
O	7	Oxygène	1774	7	6	
F	8	Fluore	1810	8	7	
Na	9	Sodium	1807	9	8	
Mg	10	Magnésium	1808	10	9	
Al	11	Aluminium	1825	11	10	
Si	12	Silicium	1823	12	11	
P	13	Phosphore	1669	13	12	
S	14	Soufre	1771	14	13	
Cl	15	Chlore	1774	15	14	
K	16	Potassium	1807	16	15	
Ca	17	Calcium	1808	17	16	
Sc	18	Scandium	1829	18	17	
Ti	19	Titanium	1791	19	18	
V	20	Vanadium	1801	20	19	
Cr	21	Chrome	1797	21	20	
Mn	22	Manganèse	1774	22	21	
Fe	23	Fer	1774	23	22	
Ni	24	Nickel	1751	24	23	
Cu	25	Cuivre	1751	25	24	
Zn	26	Zinc	1751	26	25	
As	27	Arsenic	1749	27	26	
Se	28	Sélénium	1817	28	27	
Br	29	Brome	1826	29	28	
I	30	Iode	1811	30	29	
Ba	31	Baryum	1808	31	30	
La	32	Lanthane	1839	32	31	
Ce	33	Cerium	1803	33	32	
Pr	34	Praseodyme	1840	34	33	
Nd	35	Néodyme	1841	35	34	
Sm	36	Samarium	1879	36	35	
Eu	37	Europium	1888	37	36	
Gd	38	Gadolinium	1880	38	37	
Tb	39	Terbium	1828	39	38	
Dy	40	Dysprosium	1845	40	39	
Ho	41	Holmium	1878	41	40	
Er	42	Erbium	1843	42	41	
Y	43	Yttrium	1828	43	42	
Zr	44	Zirconium	1789	44	43	
Nb	45	Niobium	1801	45	44	
Mo	46	Molibdène	1781	46	45	
Sn	47	Stannum	1781	47	46	
Pb	48	Plomb	1781	48	47	
Bi	49	Bismuth	1783	49	48	
Po	50	Polonium	1881	50	49	
At	51	Astatoine	1868	51	50	
Rn	52	Radiation	1896	52	51	
Ac	53	Actinium	1898	53	52	
Th	54	Thorium	1828	54	53	
Pa	55	Protactinium	1902	55	54	
U	56	Uranium	1789	56	55	
Np	57	Neptunium	1940	57	56	
Pu	58	Plutonium	1941	58	57	

Alexandre-Émile Béguyer de Chancourtois's Telluric Screw, 1862. ©Science Museum, London. Used with permission.

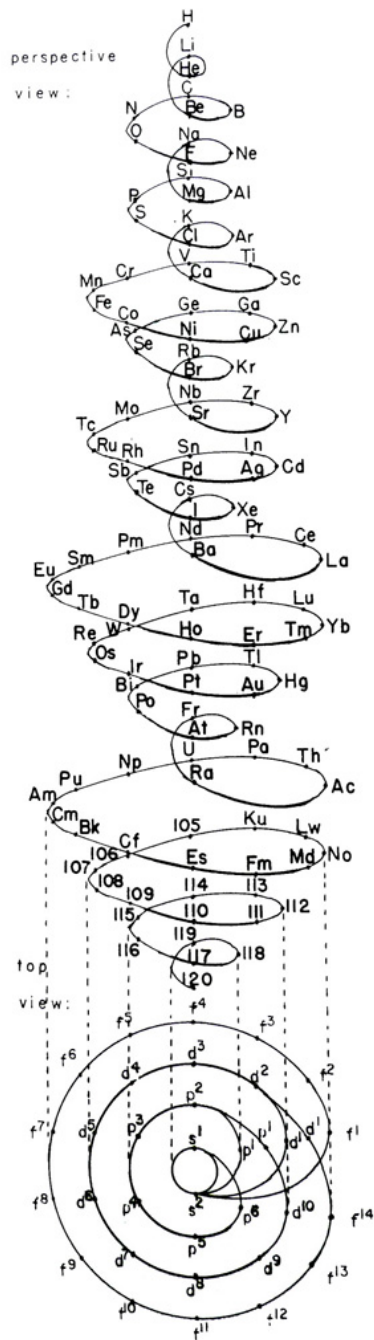


Gustavus Detlef Hinrichs's spiral/radial alignment, 1867

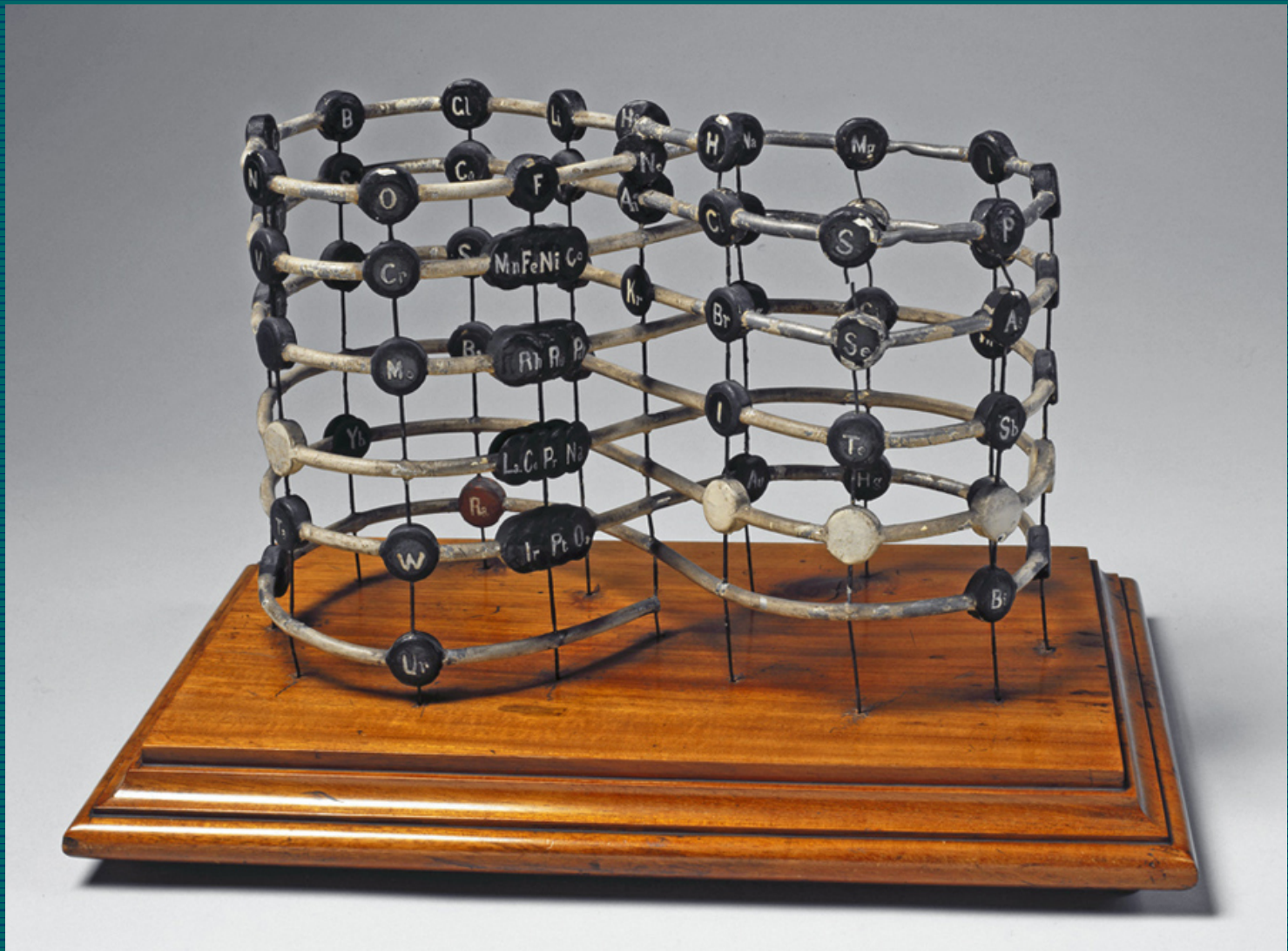


Theodor Benfey's spiral table of 1960.

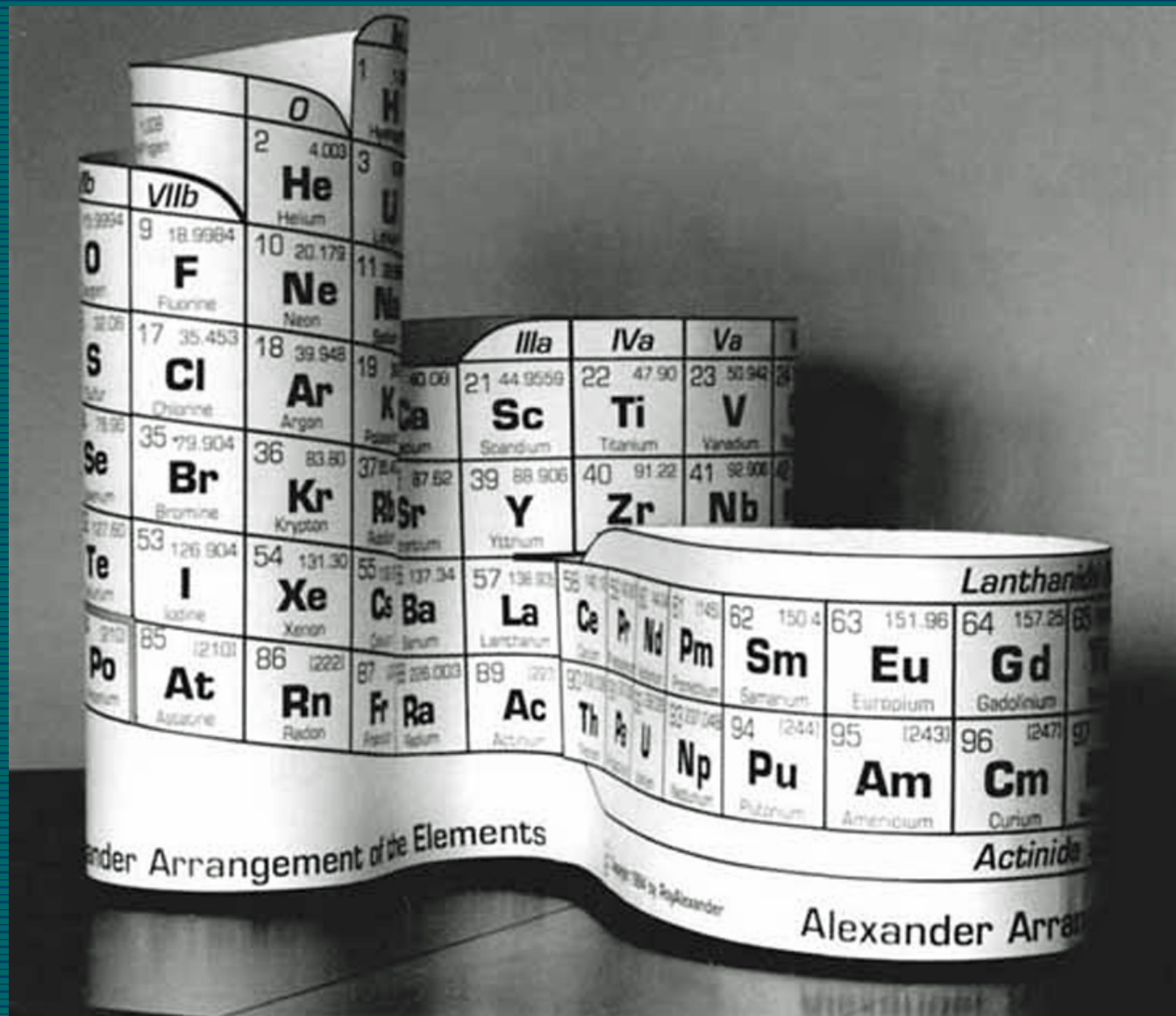




Georg Schaltenbrand's helices of 1920



William Crooke's *pretzel* model of 1888.  
©Science Museum, London. Used with permission.

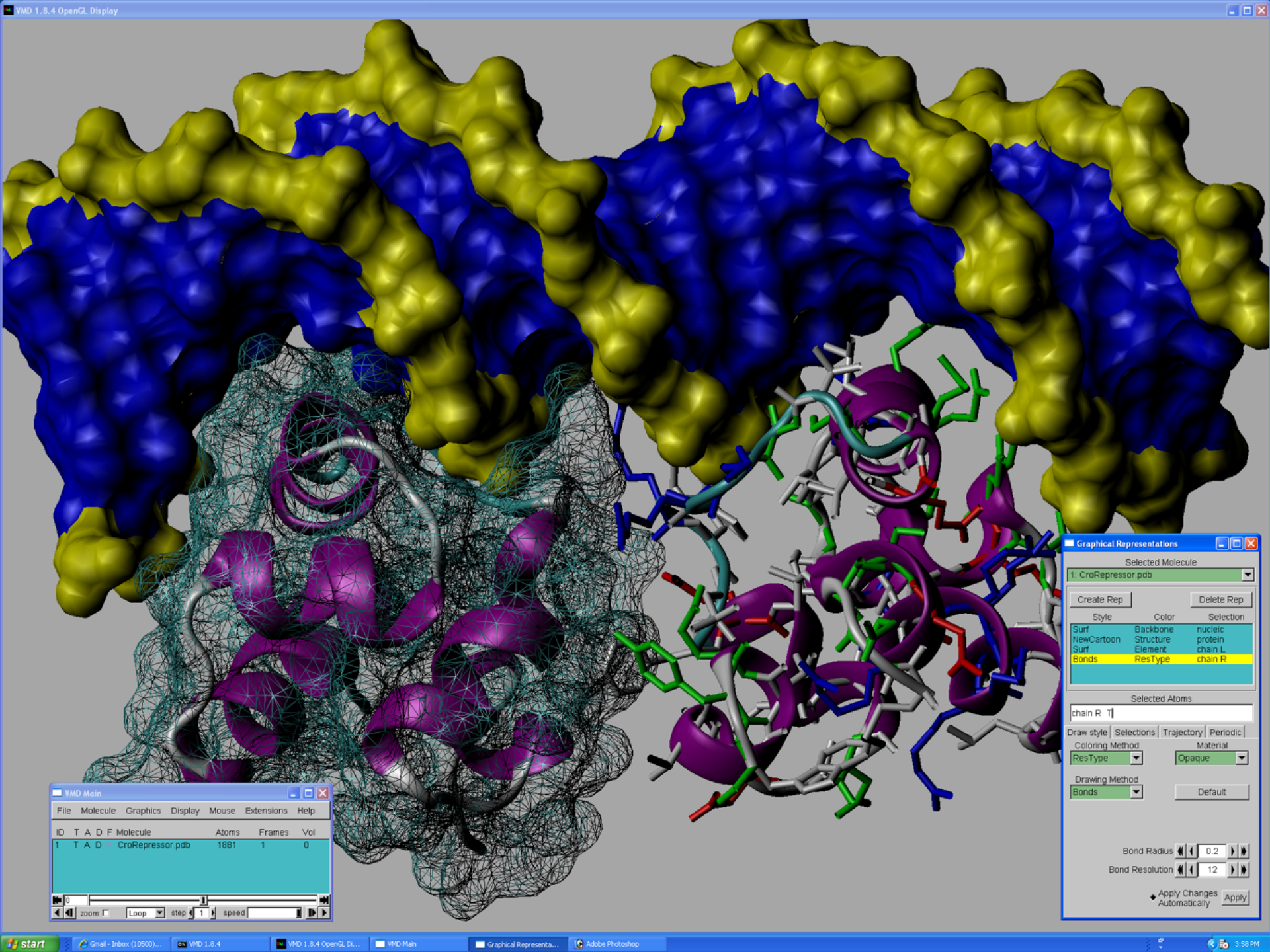


Roy Alexander's contemporary periodic model based on Courtines and Clark's model of 1925

# Analysis

---

- Complex three dimensional charts and physical models are:
  - difficult to construct
  - even more difficult to interpret without machine intervention
- Advances in CG and HCI *not* used to build systems that display these complex relationships



VMD Main

File Molecule Graphics Display Mouse Extensions Help

ID	T	A	D	F	Molecule	Atoms	Frames	Vol
1	T	A	D		CroRepressor.pdb	1881	1	0

0

zoom Loop step speed

Graphical Representations

Selected Molecule

1: CroRepressor.pdb

Create Rep Delete Rep

Style	Color	Selection
Surf	Backbone	nucleic
NewCartoon	Structure	protein
Surf	Element	chain L
Bonds	ResType	chain R

Selected Atoms

chain R T1

Draw style Selections Trajectory Periodic

Coloring Method Material

ResType Opaque

Drawing Method

Bonds Default

Bond Radius 0.2

Bond Resolution 12

Apply Changes Automatically Apply



What do you want find about the chemical elements?

- The essentials
- History
- Contents
- Uses
- Geology
- Biology
- Compounds
- Electronegativity
- Bond enthalpies
- Lattice energies
- Physics
- Pictures
- Allotropes
- Chemistry
- Crystal structures
- Thermochemistry
- Atoms
- Atom and ion sizes
- Isotopes
- NMR
- Orbital properties

Explore the **electronegativity** of the chemical elements through this periodic table

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	* 71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	** 103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Uub	113 Uut	114 Uuq	115 Uup	116 Uuh	117 Uus	118 Uuo
*Lanthanoids	* 57 La 58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Yb																	
**Actinoids	** 89 Ac 90 Th 91 Pa 92 U 93 Np 94 Pu 95 Am 96 Cm 97 Bk 98 Cf 99 Es 100 Fm 101 Md 102 No																	

# Tables

---

- important data visualization tool
- first stage in information visualization pipeline
- compactly organized structure
- facilitates understanding of relationships among different data

# Four Rationales for *Table Usage*

---

- Exploration
- Communication
- Storage
- Illustration

H. Wainer, *Educational Researcher*, 21(1) 1992, pp. 12-23.

H. Wainer, *Journal of Educational and Behavioral Statistics*, Spring 1997, 22 (1) pp. 1-30.



# Analysis of Geoffroy's *Table Usage*

---

- Table *explored*
  - Used to find best reaction to solve laboratory separation problems
- *Communication* medium
  - translated chemical narrative of reaction selection into understandable graphic form
- Open-ended *storage* medium
  - contained a history of chemical practice that could be appended to over time
- an *illustration* serving the greater narrative of chemical synthesis
  - acted as a focal point for analysis and discourse

# Requirements for Table Design

---

- Must reflect kinds of questions asked of the data it contains.
- Three levels of inquiry:
  1. Elementary questions about data:
    - single category data inspection or extraction
  2. Intermediate questions about data:
    - comparisons, trends, and relationships among data entries
  3. General questions about data:
    - require understanding of the underlying data structure and the ability to build a level of abstraction for the entire data set

# Analysis of Modern *Table Design*

---

- Single category data inspection :
  - each location is a box, a container that displays atomic data.
- Comparisons and relationships :
  - Designed to organize chemical information so that relationships among chemical properties may be exposed
- Understanding of the data structure :
  - chemical table continued design and redesign



# Further requirements for Hypermedia Tables

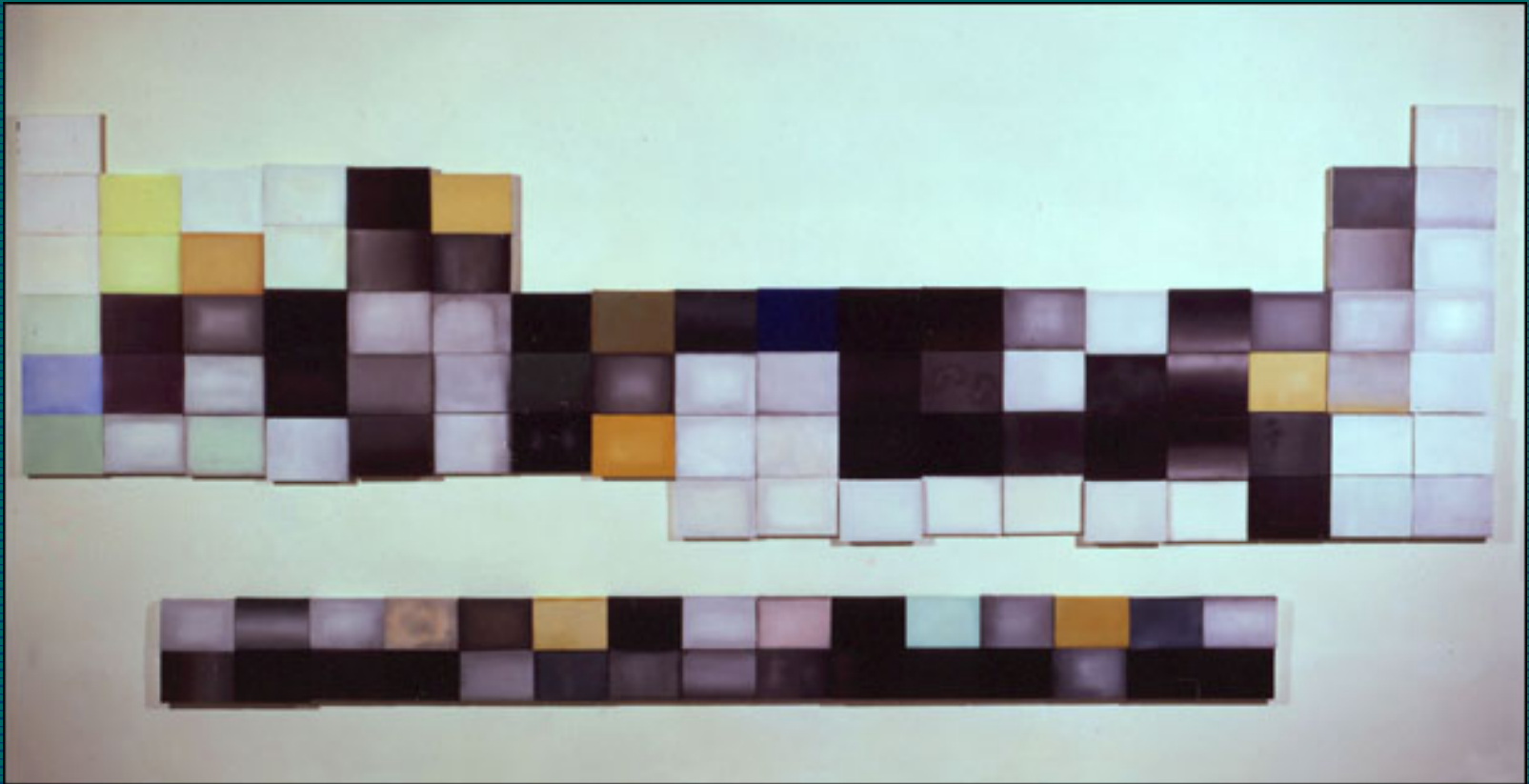
---

- Ability to display meaningful patterns trends, and exceptions
- Use of visualization best practices
- Dynamic linking of table contents to supporting chemical documentation and narrative

# Summary & Conclusions

---

- Explored the historical development of the chemical table as a tool designed for chemical information visualization
- Shown why the design of the two-dimensional periodic table remains the *de facto* standard for chemical information display
- Periodic Table is dynamic and continues to evolve



Suzanne Caporael, *Periodic Table of the Elements*, 1995.  
112 books, oil on linen, muslin, 78" x 192"

**Thank you !**