

# Atoms To Go

Version 7.0.0      October 19, 2012

## Introduction

Atoms To Go is a Periodic Table of the Elements.

# Atoms To Go

1.01																	4.00
H																	He
1																	2

6.94

9.01

Li

Be

3

4

22.99

24.31

Na

Mg

11

12

39.10

40.08

K

Ca

19

20

85.47

87.62

Rb

Sr

37

38

132.91

137.33

Cs

Ba

55

56

223.00

226.00

Fr

Ra

87

88

44.96

47.87

50.94

52.00

54.94

55.85

58.93

58.69

63.55

65.39

44.96

47.87

50.94

52.00

54.94

55.85

58.93

58.69

63.55

65.39

69.72

72.64

74.92

78.96

79.90

83.80

69.72

72.64

74.92

78.96

79.90

83.80

10.81

12.01

14.01

16.00

19.00

20.18

10.81

12.01

14.01

16.00

19.00

20.18

26.98

28.09

30.97

32.06

35.45

39.95

26.98

28.09

30.97

32.06

35.45

39.95

69.72

72.64

74.92

78.96

79.90

83.80

69.72

72.64

74.92

78.96

79.90

83.80

114.82

118.71

121.76

127.60

126.90

131.29

114.82

118.71

121.76

127.60

126.90

131.29

204.38

207.20

208.98

209.00

210.00

222.00

204.38

207.20

208.98

209.00

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222.00

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287.00

289.00

291.00

293.00

178.49

180.95

183.84

186.21

190.23

192.22

195.08

196.97

200.59

204.38

207.20

208.98

209.00

210.00

222.00

178.49

180.95

183.84

186.21

190.23

192.22

195.08

196.97

200.59

204.38

207.20

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293.00

138.91

140.12

140.91

144.24

145.00

150.36

151.96

157.25

158.93

162.50

164.93

167.26

168.93

173.04

174.97

138.91

140.12

140.91

144.24

145.00

150.36

151.96

157.25

158.93

162.50

164.93

167.26

168.93

173.04

174.97

227.00

232.04

231.04

238.03

237.00

244.00

243.00

247.00

247.00

251.00

254.00

257.00

258.00

255.00

256.00

227.00

232.04

231.04

238.03

237.00

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243.00

247.00

247.00

251.00

254.00

257.00

258.00

255.00

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When you first launch Atoms To Go, you see a normal presentation of the periodic table of the elements.

If you place the cursor over an element for a few seconds, you'll see the name of the element pop up. (This feature must be enabled in the preferences)

0	54.94	55.85	58
	Mn	Fe	
25		26	2
4	Manganese	7	10
43	Tc	44	4
36	186.20	190.20	19

Clicking on one of the elements brings up a window that contains detailed information about that element. You can copy many of the data values to the clipboard by clicking on the value with the mouse, you'll hear a short faint click sound when you click on a value you can copy. You can then paste the value into another application.

You can also open the text list of elements (from the File menu) to get an alphabetical list of elements. Double click on one to open the detailed view window for that element.

There are six different sets of detailed information you can display, selected from the tabs in the window. They are:

Lead

Main

Isotopes


Ions

Shells

Xray

Misc

Spectrum



Pb

207.2(1)


82

Group: 14

Period: 6

Block: p-block

Crystal Structure:



Cubic face centered

Density:

11.35 g/cc

Heat of Vaporization:

0.866 kJ/g

179.5 kJ/mol

Heat of Fusion:

0.023 kJ/g

4.77 kJ/mol

Specific Heat:

159 J/kg K

Thermal Conductivity

35.3 W/m/K

Linear Expansion Coefficient:

0.000029/ K

Melting Point:

327.5 °C

600.65 °K

621.5 °F

Boiling Point:

1740 °C

2013.15 °K

3164 °F

Atomic Radius:

1.75 Å

Covalent Radius:

1.47 Å

Susceptibility:

-23 microGauss

Resistivity:

208 nanoOhm meter

Electron Affinity:

0.364 eV

Electric Dipole Polariz:

6.8 10<sup>-24</sup> cc

Photoelectric Work:

4 eV

Pauling Electronegativity:

2.02

Oxidation State(s):

2 4

Ionization Potentials:

7.416 V

15.032 V

31.937 V

Superconductivity:

7.2 K

CAS Registry ID:

7439-92-1

Bulk Modulus

46 GPa

Poisson Ratio

0.44

Shear Modulus

5.6 GPa

Young's Modulus

16 GPa

All

**Isotopes View** - a list of all isotopes for this element, showing the atomic mass, decay mode, half life, and percent natural abundance. If there are too many isotopes to fit in the window, then you can scroll down the list.

Lead				
Main Isotopes Ions Shells Xray Misc Spectrum				
Parent	Daughter	Decay Mode	Half Life	Abundance
Pb194	Tl194	Electron Capture	12. m	
Pb195	Tl195	Electron Capture	15. m	
Pb196	Tl196	Electron Capture	37. m	
Pb197	Tl197	Electron Capture	8. m	
Pb198	Tl198	Electron Capture	2.4 h	
Pb199	Tl199	Electron Capture	1.5 h	
Pb200	Tl200	Electron Capture	21.5 h	
Pb201	Tl201	Electron Capture	9.33 h	
Pb202	Tl202	Electron Capture	52501.44 y	
Pb203	Tl203	Electron Capture	2.16 d	
Pb204	Pb204	Stable		1.48 %
Pb205	Tl205	Electron Capture	15.3 My	
Pb206	Pb206	Stable		23.6 %
Pb207	Pb207	Stable		22.6 %
Pb208	Pb208	Stable		52.3 %
Pb209	Bi209	Beta	3.253 h	
Pb210	Bi210	Beta	22.3 y	
Pb211	Bi211	Beta	36.1 m	
Pb212	Bi212	Beta	10.64 h	
Pb214	Bi214	Beta	26.8 m	

## Isotope Detail View

Clicking on an isotope will bring up the another window, with detailed information, such as the number of protons and neutrons, atomic mass, mass excess, binding energy, natural abundance, decay mode and half life, nuclear spin, magnetic moment, and alpha and beta radiation energies. (Not all information is available for all isotopes) In addition, possible parent nuclides are also listed, as well as the daughter product.

Lead - 209

Main Gammas Decay

82 Pb 209

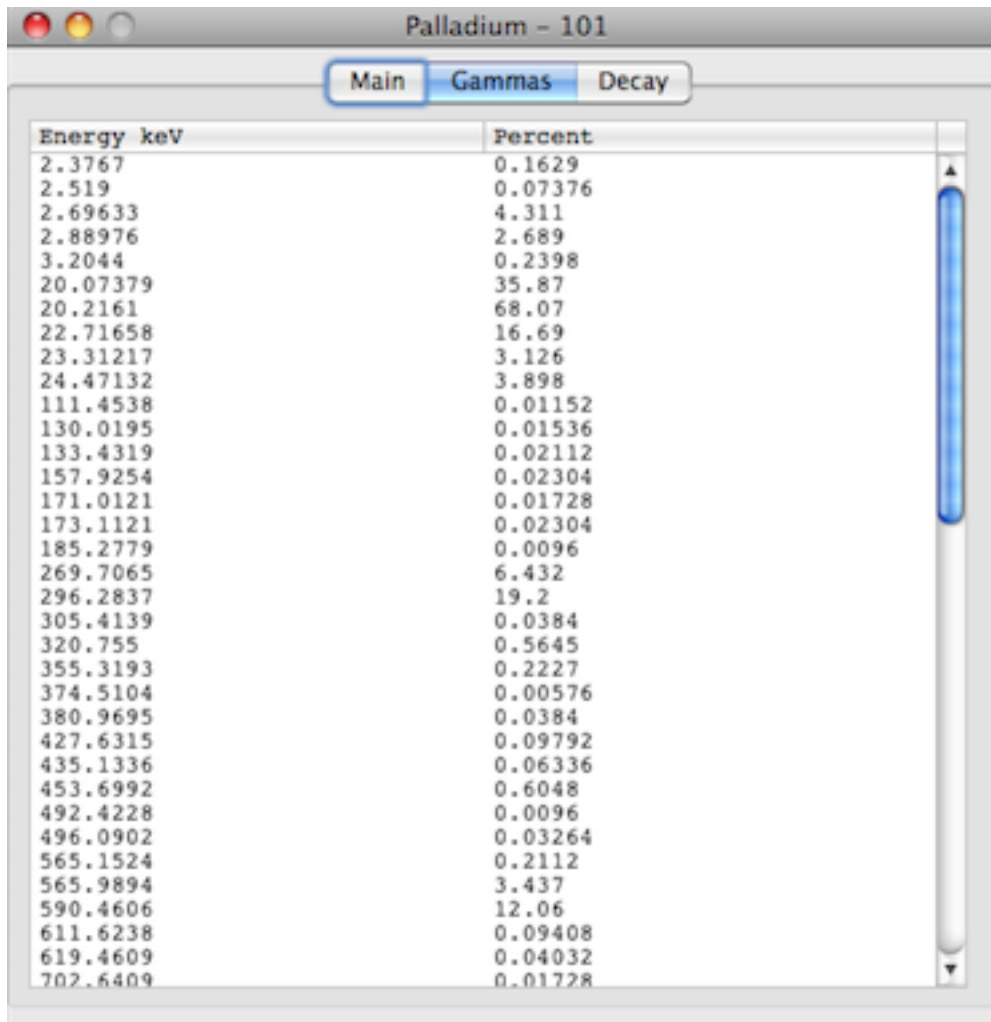
Number of Protons:	82
Number of Neutrons:	127
Atomic Mass:	208.9811 amu
Mass Excess:	-17.629 MeV
Binding Energy	1640.382 MeV
Q Value:	0.644 MeV
Decay Mode:	Beta
Half Life:	3.253 h
Nuclear Spin:	9/2+
Magnetic Moment:	-1.4735 nm
Electric Moment:	-0.27 barns
Alpha Radiation:	
Beta Radiation:	644.2 keV
EC Radiation:	
Natural Abundance:	Not naturally occurring
Daughter Product:	Bismuth-209
Possible Parents:	Thallium-209 Polonium-213

Production: Thermal neutron activation, Charged particle reaction

Decay Tree

## Gamma Rays

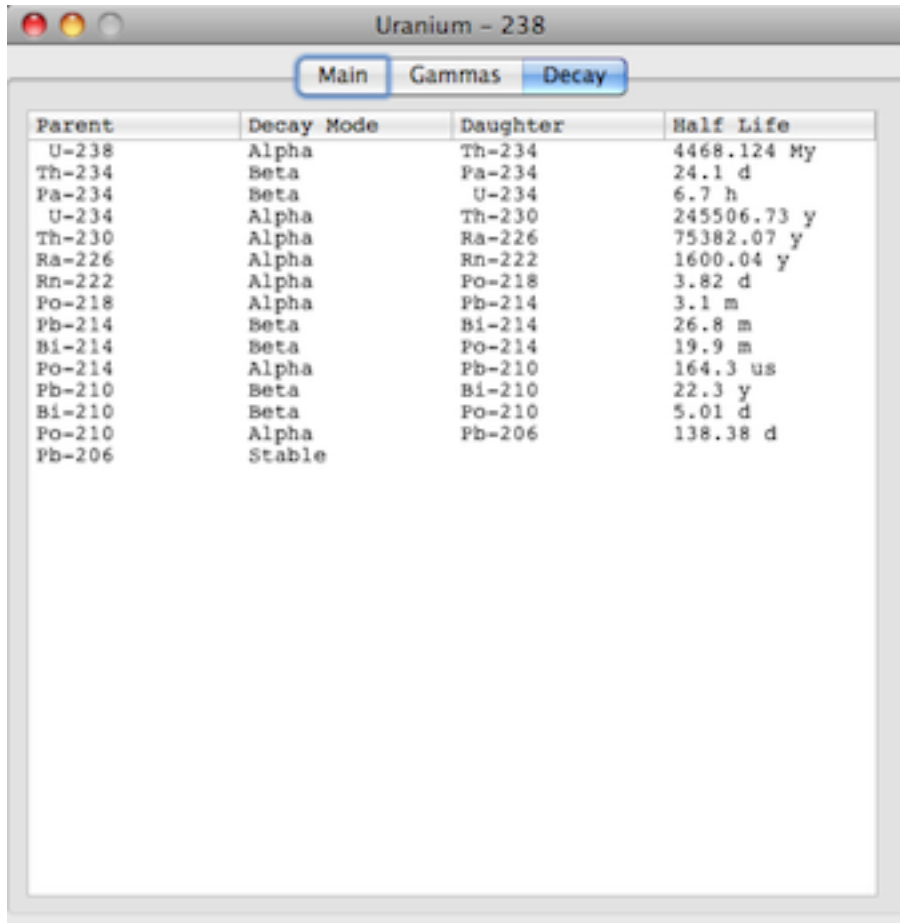
Clicking on the Gammas tab will bring up a window listing all of the gamma rays that occur in at least 0.1% of transitions.



Energy keV	Percent
2.3767	0.1629
2.519	0.07376
2.69633	4.311
2.88976	2.689
3.2044	0.2398
20.07379	35.87
20.2161	68.07
22.71658	16.69
23.31217	3.126
24.47132	3.898
111.4538	0.01152
130.0195	0.01536
133.4319	0.02112
157.9254	0.02304
171.0121	0.01728
173.1121	0.02304
185.2779	0.0096
269.7065	6.432
296.2837	19.2
305.4139	0.0384
320.755	0.5645
355.3193	0.2227
374.5104	0.00576
380.9695	0.0384
427.6315	0.09792
435.1336	0.06336
453.6992	0.6048
492.4228	0.0096
496.0902	0.03264
565.1524	0.2112
565.9894	3.437
590.4606	12.06
611.6238	0.09408
619.4609	0.04032
702.6409	0.01728

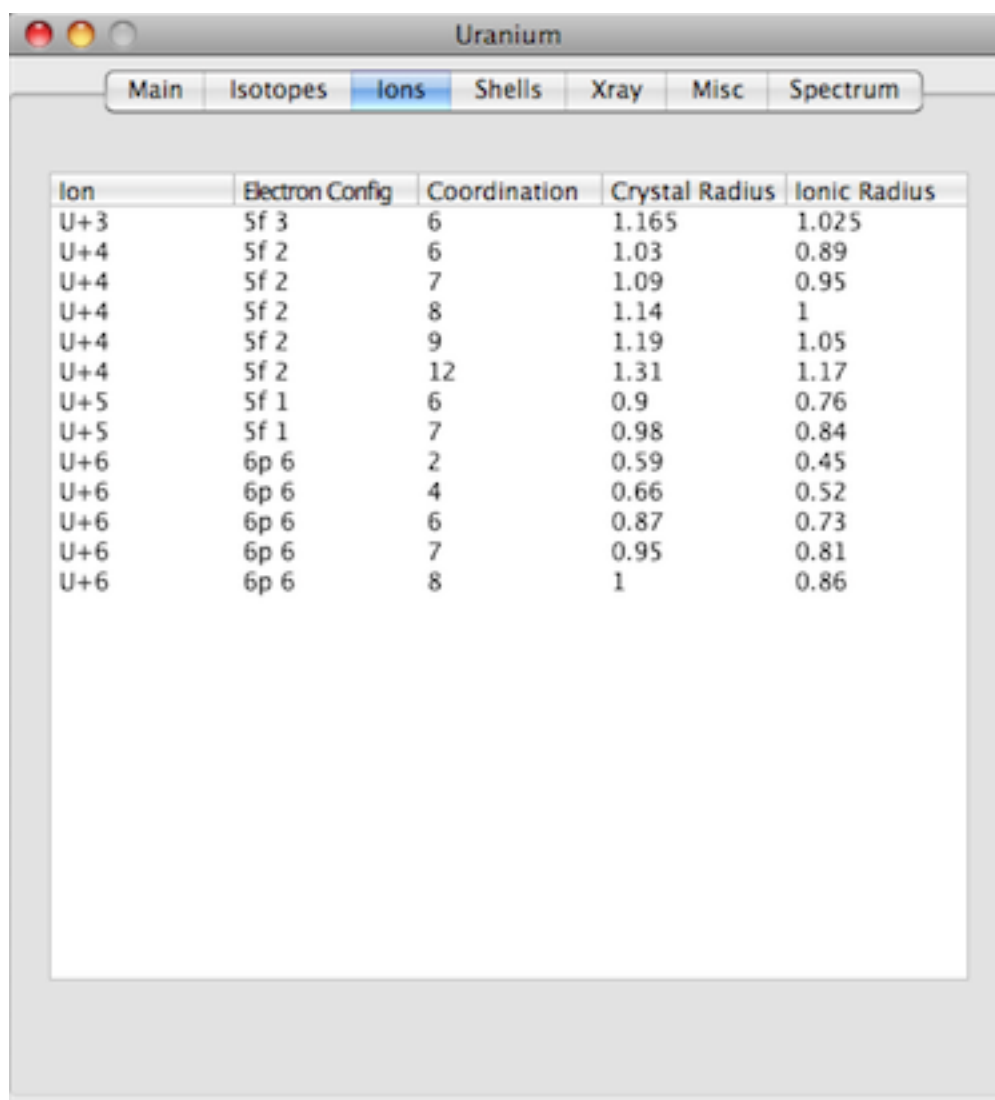
## Decay

Clicking on the Decay tab will display the path taken by the nuclide as it and daughter products decay, until they become stable. This view is of course only useful for radioactive nuclides.



Parent	Decay Mode	Daughter	Half Life
U-238	Alpha	Th-234	4468.124 My
Th-234	Beta	Pa-234	24.1 d
Pa-234	Beta	U-234	6.7 h
U-234	Alpha	Th-230	245506.73 y
Th-230	Alpha	Ra-226	75382.07 y
Ra-226	Alpha	Rn-222	1600.04 y
Rn-222	Alpha	Po-218	3.82 d
Po-218	Alpha	Pb-214	3.1 m
Pb-214	Beta	Bi-214	26.8 m
Bi-214	Beta	Po-214	19.9 m
Po-214	Alpha	Pb-210	164.3 us
Pb-210	Beta	Bi-210	22.3 y
Bi-210	Beta	Po-210	5.01 d
Po-210	Alpha	Pb-206	138.38 d
Pb-206	Stable		

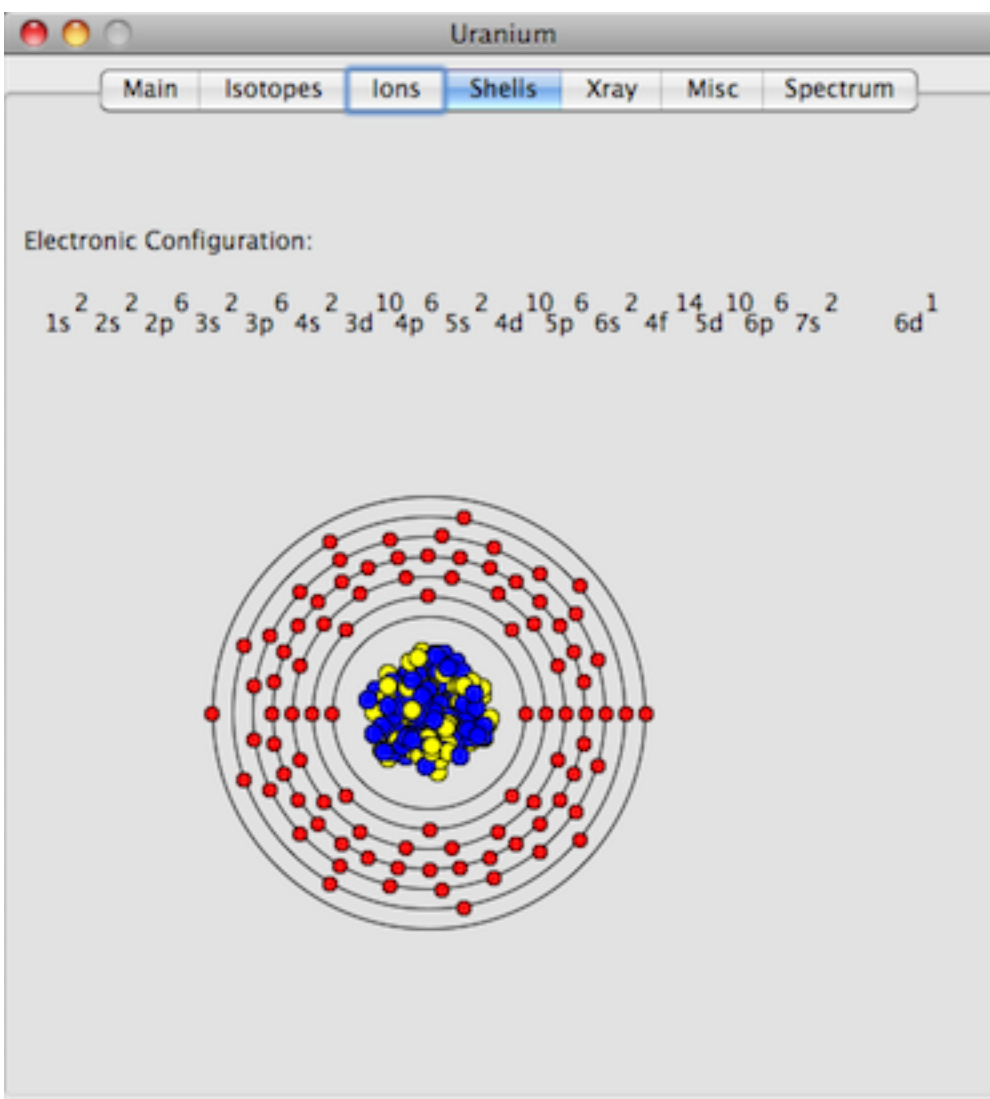
**Ions View** - a listing of the crystal and ionic radii for various ions and coordination numbers. Radii data are in Angstroms.



Ion	Electron Config	Coordination	Crystal Radius	Ionic Radius
U+3	5f 3	6	1.165	1.025
U+4	5f 2	6	1.03	0.89
U+4	5f 2	7	1.09	0.95
U+4	5f 2	8	1.14	1
U+4	5f 2	9	1.19	1.05
U+4	5f 2	12	1.31	1.17
U+5	5f 1	6	0.9	0.76
U+5	5f 1	7	0.98	0.84
U+6	6p 6	2	0.59	0.45
U+6	6p 6	4	0.66	0.52
U+6	6p 6	6	0.87	0.73
U+6	6p 6	7	0.95	0.81
U+6	6p 6	8	1	0.86



**Shells View** - a graphical display of the atom, showing the electron shells, along with the electronic configuration.



**X-Ray View** - A list of the K and L shell fluorescence energies, and K, L, M, and N shell binding energies. Clicking on the Photon Attenuation button will bring up a window showing the attenuation graph, while clicking on the Photon Attenuation Table button will bring up a tabular form of the same data. The information is based on the McMaster data. Clicking on the Photon Data button will bring up an interactive window, allow you to display the relevant data for any energy between 1 keV and 10 MeV.

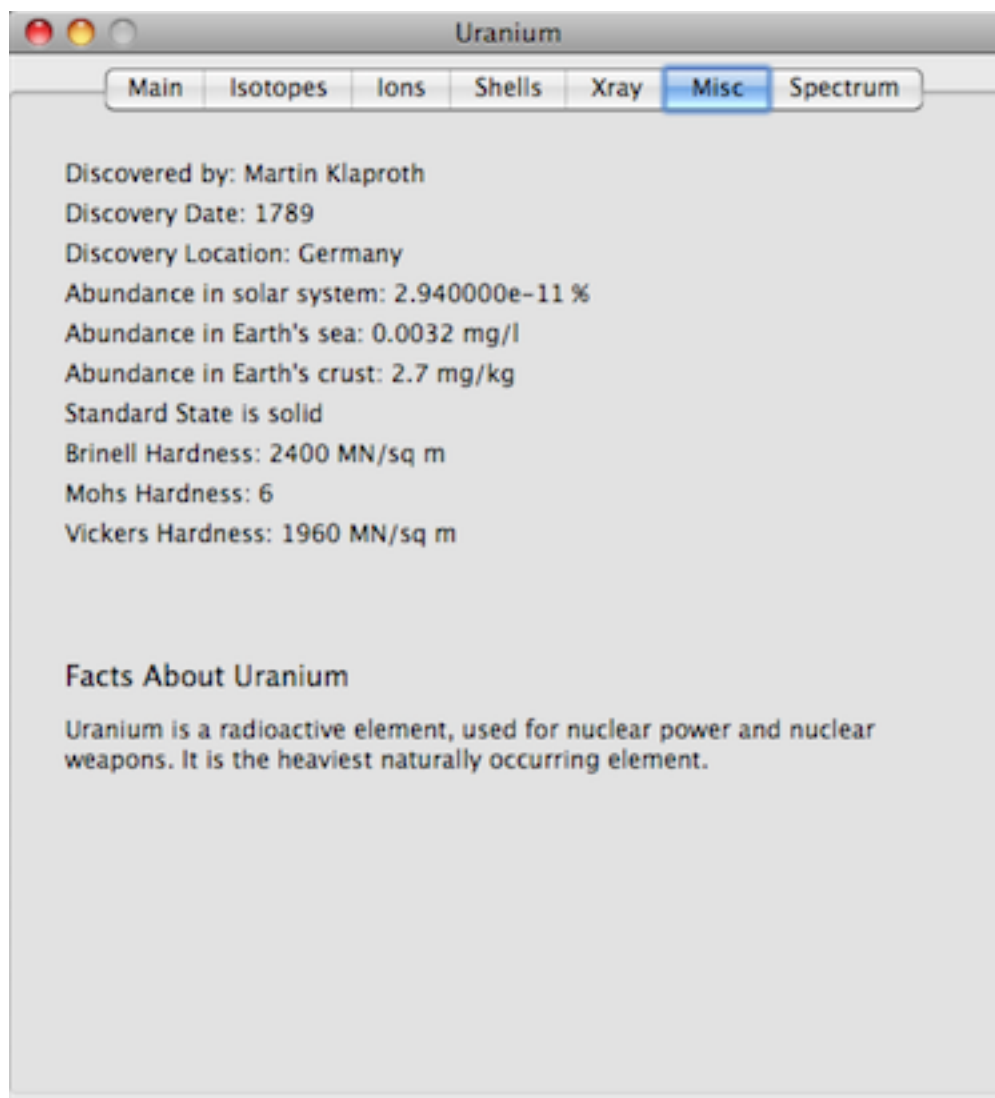
Fluorescence Emission Energies		
Ka1	98439 eV	0.1259503 Å
Ka2	94665 eV	0.1309716 Å
Kb1	111300 eV	0.1113964 Å
La1	13614.7 eV	0.9106645 Å
La2	13438.8 eV	0.9225842 Å
Lb1	17220 eV	0.7200014 Å
Lb2	16428.3 eV	0.7546991 Å
Lg1	20167.1 eV	0.6147847 Å
K Yield	0.972	
L1 Yield	0.467	
L2 Yield	0.489	
L3 Yield	0.187	

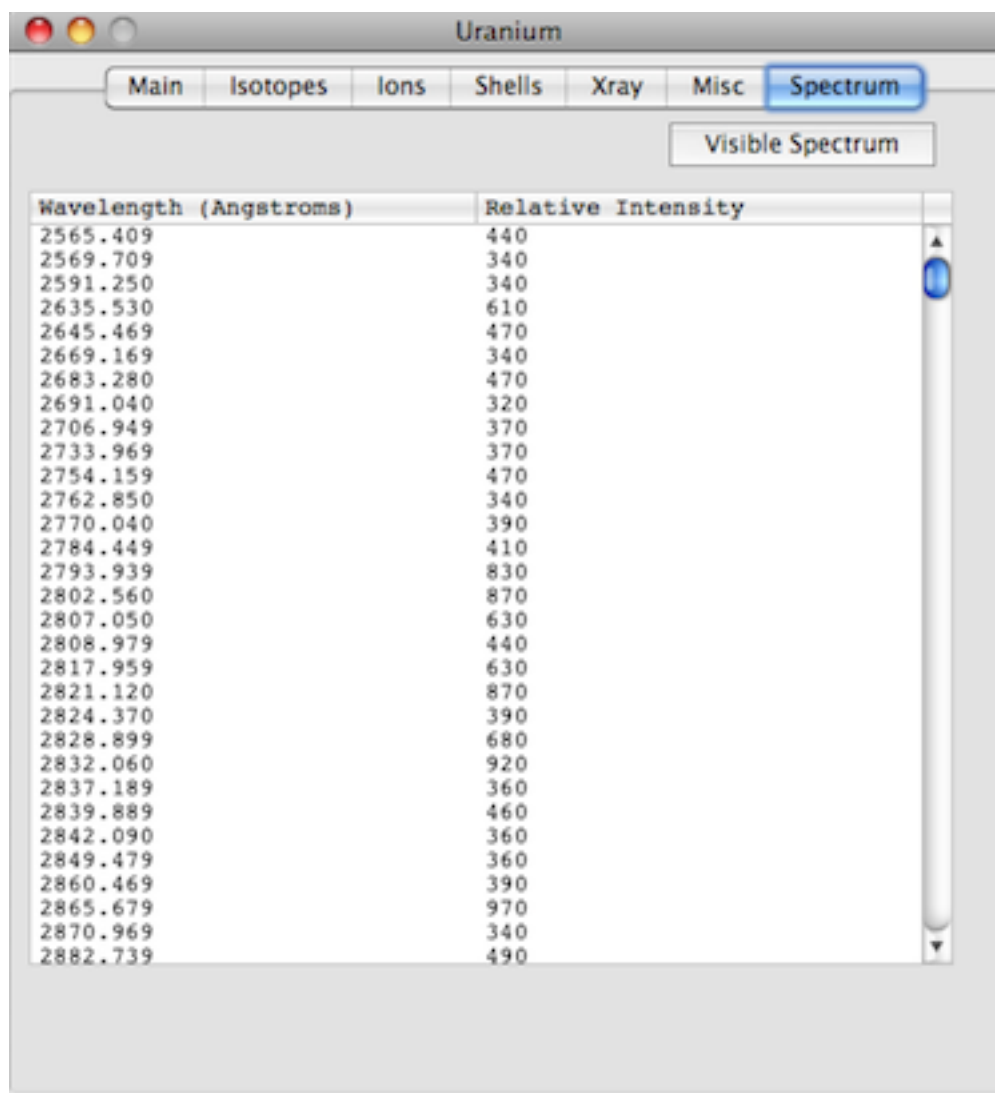
Binding Energies		
K	115603 eV	0.10725 Å
L1	21756 eV	0.5698853 Å
L2	20947 eV	0.591895 Å
L3	17167 eV	0.7222243 Å
M1	5549 eV	2.234353 Å
M2	5182 eV	2.392594 Å
M3	4303 eV	2.881344 Å
M4	3728 eV	3.325758 Å
M5	3552 eV	3.490547 Å
N1	1439 eV	8.616 Å
N2	1271 eV	9.754858 Å
N3	1043 eV	11.88727 Å

**Misc View** - General information showing the name of the discoverer of the element, and where and when it was discovered. Interesting bits of information are also displayed, including the Brinell, Mohs, and Vickers hardness, as well as the standard (room temperature) state of the element.

If you have any other interesting facts about an element, let us know, and we'll be glad to add them to a future version.



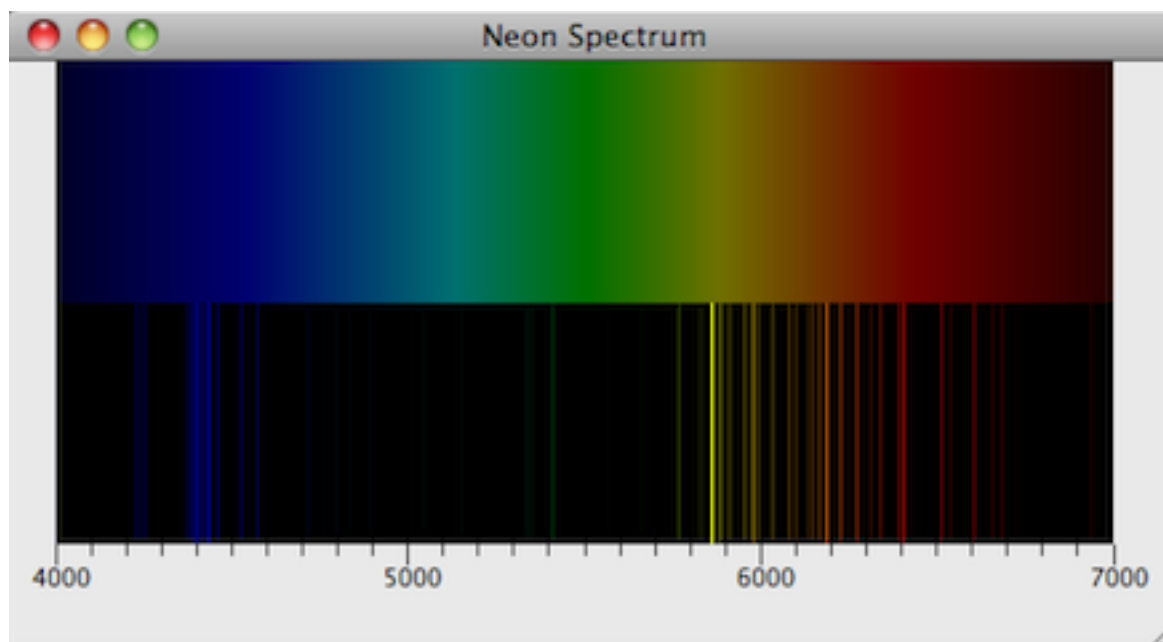
**Spectrum View** - A list of the wavelengths and relative intensities of the optical spectra of an element, including visible, UV, and IR.



Wavelength (Angstroms)	Relative Intensity
2565.409	440
2569.709	340
2591.250	340
2635.530	610
2645.469	470
2669.169	340
2683.280	470
2691.040	320
2706.949	370
2733.969	370
2754.159	470
2762.850	340
2770.040	390
2784.449	410
2793.939	830
2802.560	870
2807.050	630
2808.979	440
2817.959	630
2821.120	870
2824.370	390
2828.899	680
2832.060	920
2837.189	360
2839.889	460
2842.090	360
2849.479	360
2860.469	390
2865.679	970
2870.969	340
2882.739	490

## Visible Spectrum Display

Clicking on the Visible Spectrum button will bring up a window showing the visible line spectrum of the element, along with a complete (rainbow) spectrum for reference.



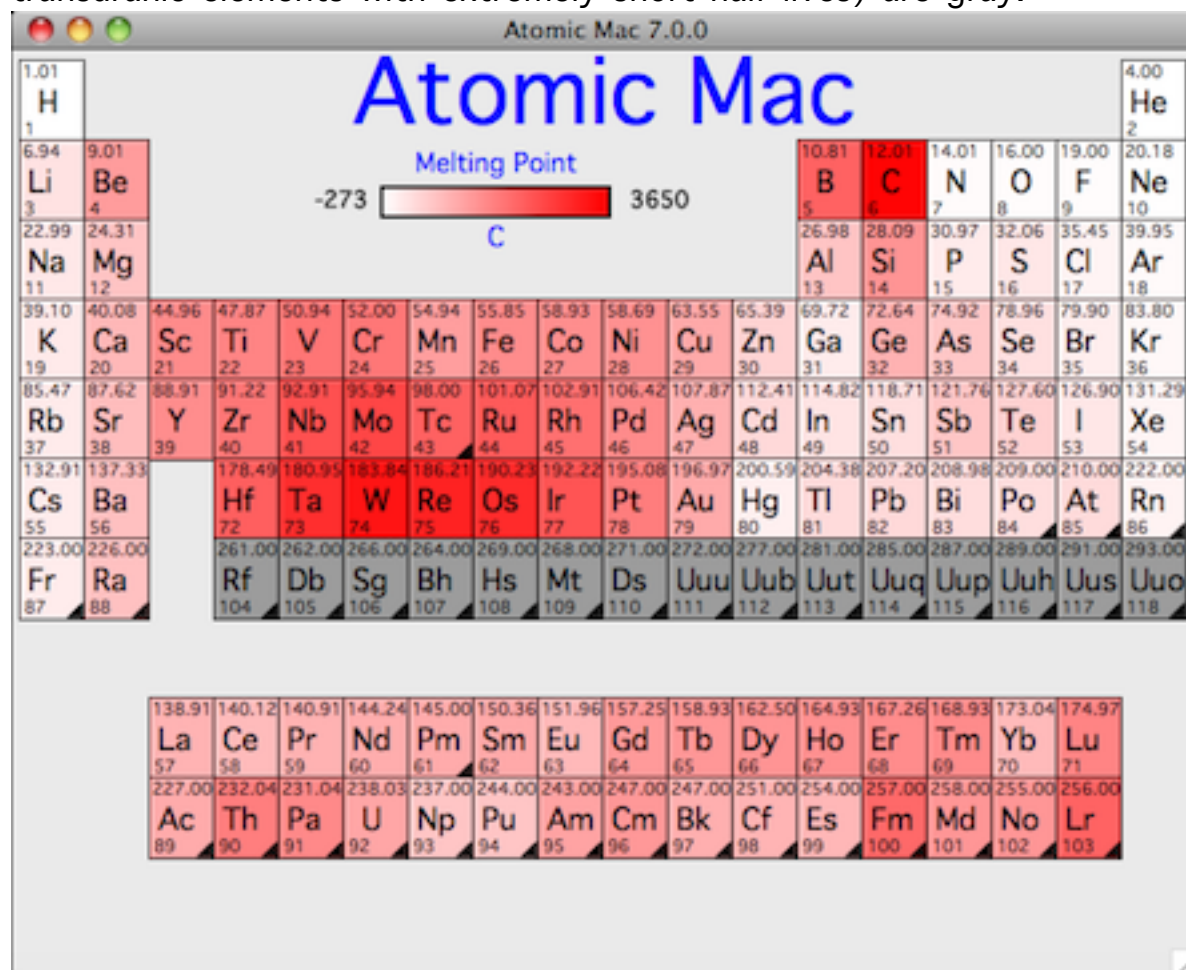
## Property View

You can also alter the periodic table display to shade each element, by several properties, which include:

- Density
- Heat of Vaporization
- Heat of Fusion
- Specific Heat
- Thermal Conductivity
- Linear Expansion Coefficient
- Melting Point
- Boiling Point
- Atomic Radius
- Covalent Radius
- Magnetic Susceptibility
- Electrical Resistivity
- Electron Affinity
- Electric Dipole Polarizability
- State (gas, liquid, solid)

Photoelectric Work Function  
 Electronegativity  
 Crystal Structure  
 Abundance in Crust  
 Abundance in Sea  
 Abundance in Atmosphere  
 Solar Abundance  
 Number of Isotopes  
 Number of Natural Isotopes  
 Number of Stable Isotopes  
 Atomic Mass  
 Superconducting Critical Temperature  
 First Ionization Potential  
 Second Ionization Potential  
 Third Ionization Potential

Below is a display with the view set to melting point. The elements with higher melting points are more red, those with lower melting points are more white. Elements for which there is no data (typically the man-made transuranic elements with extremely short half lives) are gray.



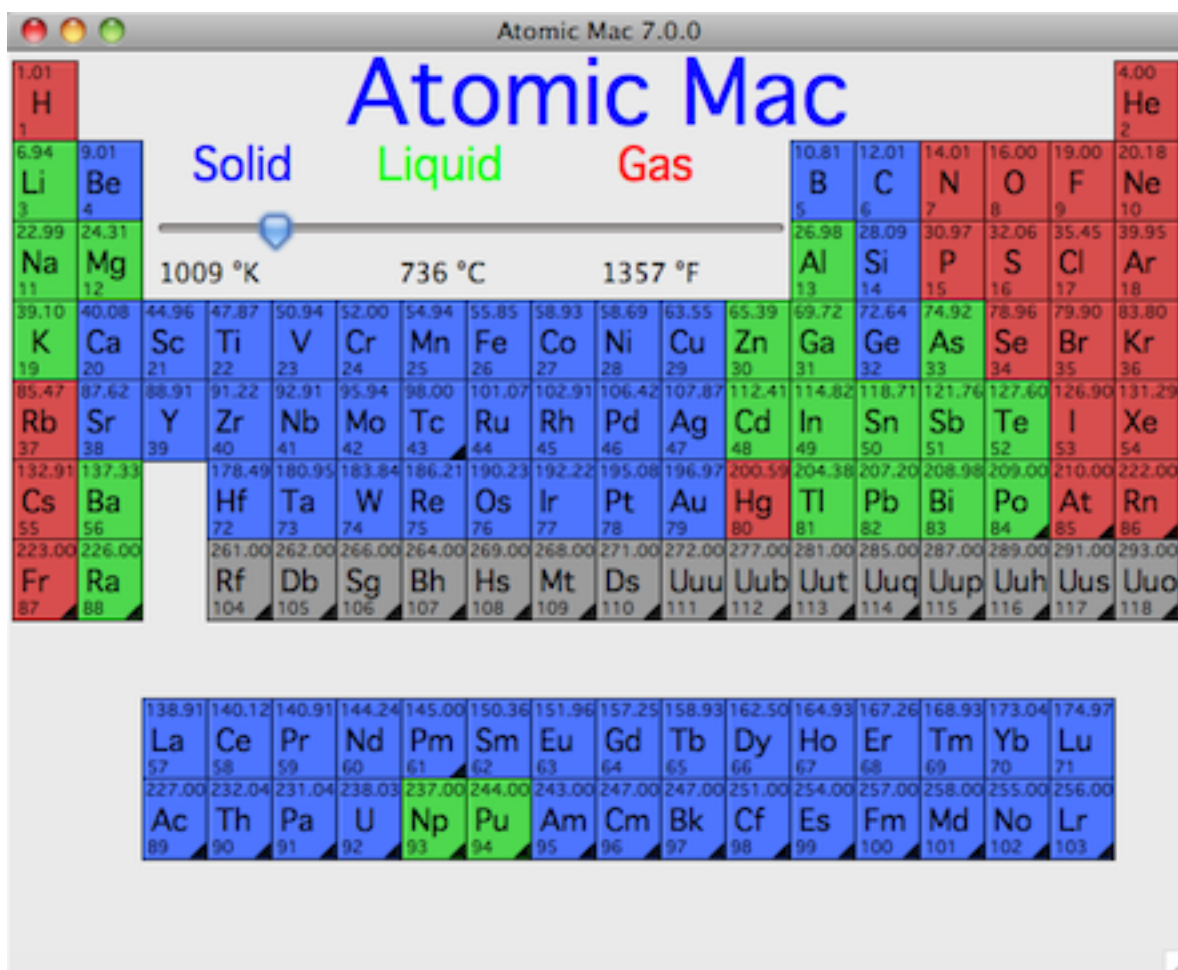
These properties are selected under the **View** menu. If you place the cursor over an element for a few seconds, you'll see the name of the element pop up, as well as the value for that view.

## Temperature State View

When viewing the state, you can change the temperature using the slider control. The selected temperature is displayed below, in degrees Kelvin, Centigrade, and Fahrenheit.

You can also use the + and - keys on the numeric keypad to increase and decrease the temperature by one degree. Holding down option will make the change 10 degrees, and holding down shift will make the change 100 degrees.

The following picture shows the state of each element at 1000 degrees Kelvin:



One of the views is the **Molecular Weight Calculator**. Selecting this will display a text entry box just above the periodic table. You can enter a



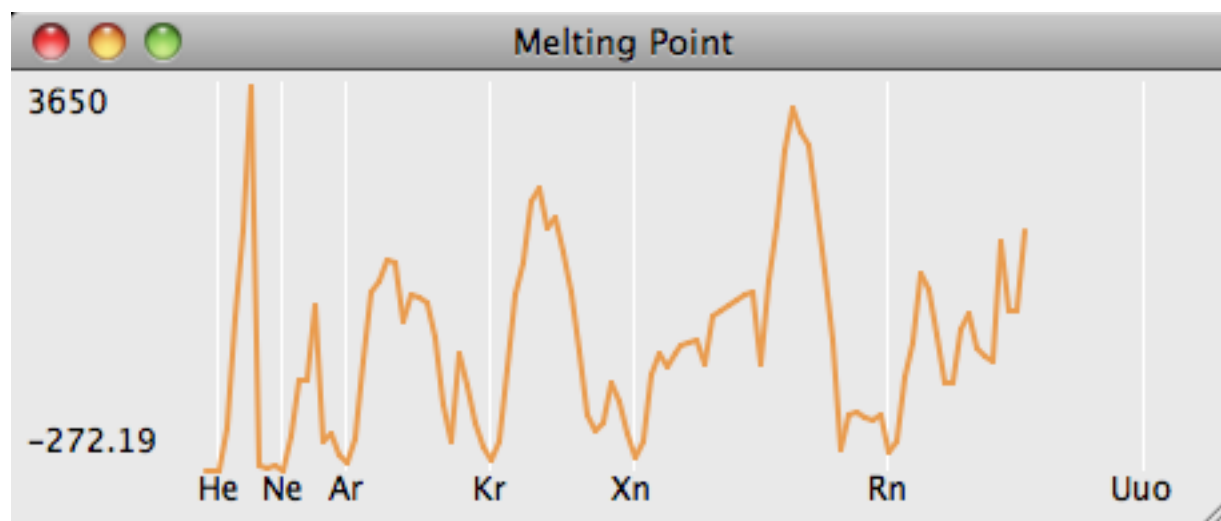
chemical formula into this box, and the molecular weight will be calculated for you. For example, entering H<sub>2</sub>O will compute the molecular weight of water. The text is case sensitive, so table salt must be entered as NaCl not NACL or nacl.

You can enter parenthesis in your formula, such as (H<sub>2</sub>O)<sub>2</sub>

You can also enter in a hydrated compound using the • symbol (option 8 on your keyboard). An example: CuSO<sub>4</sub>•5H<sub>2</sub>O

## Graphing Properties

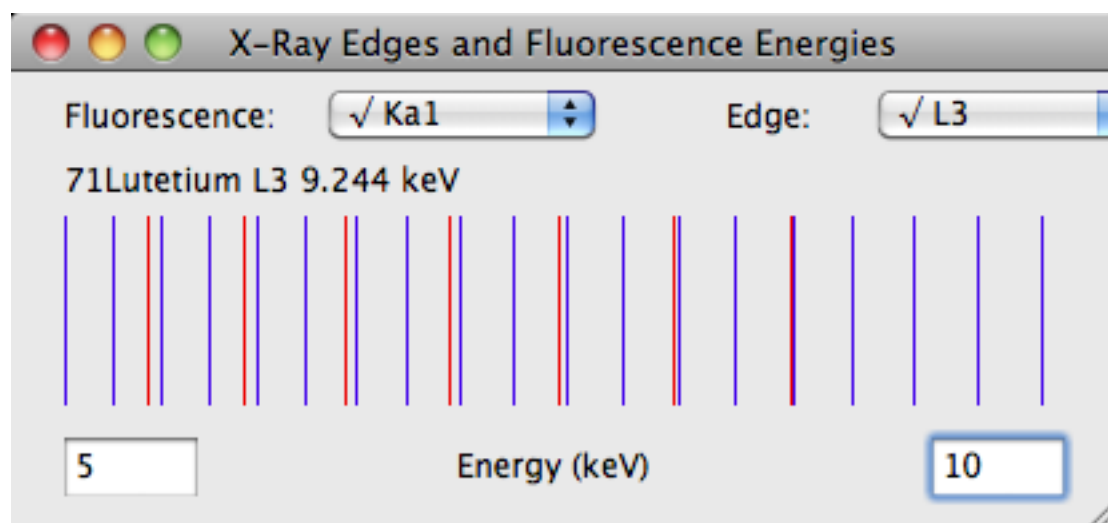
Under the **File** menu is an option to graph the current view. Selecting this opens a window which shows a plot of the selected property against atomic number. The following picture shows a plot of the covalent radius:



Values of adjacent elements with known values are connected with a line. If an element is surrounded by two other elements with unknown values, its value appears as an isolated dot.

## X-Ray Energies Graph Window

By selecting X-Ray Energies from the File menu, you can get a graph showing the various fluorescence and edge energies for the elements. The range of the horizontal (energy) axis can be changed, allowing you to zoom in on particular energy ranges. Positioning the cursor over a line shows the element, and the edge or fluorescence energy and type. Popup menus allow only specific transitions or edges to be displayed, removing unnecessary clutter.



## Table Of Nuclides

By selecting **Nuclides Table** from the File menu, you'll be presented with a large window showing all of the nuclides (isotopes) available. Clicking on one of them will bring up the window containing detailed information, such as nuclear spin, decay energies, etc. Here's a small portion of the table, the full table of course is huge, since Atoms To Go has information regarding about 1600 nuclides!

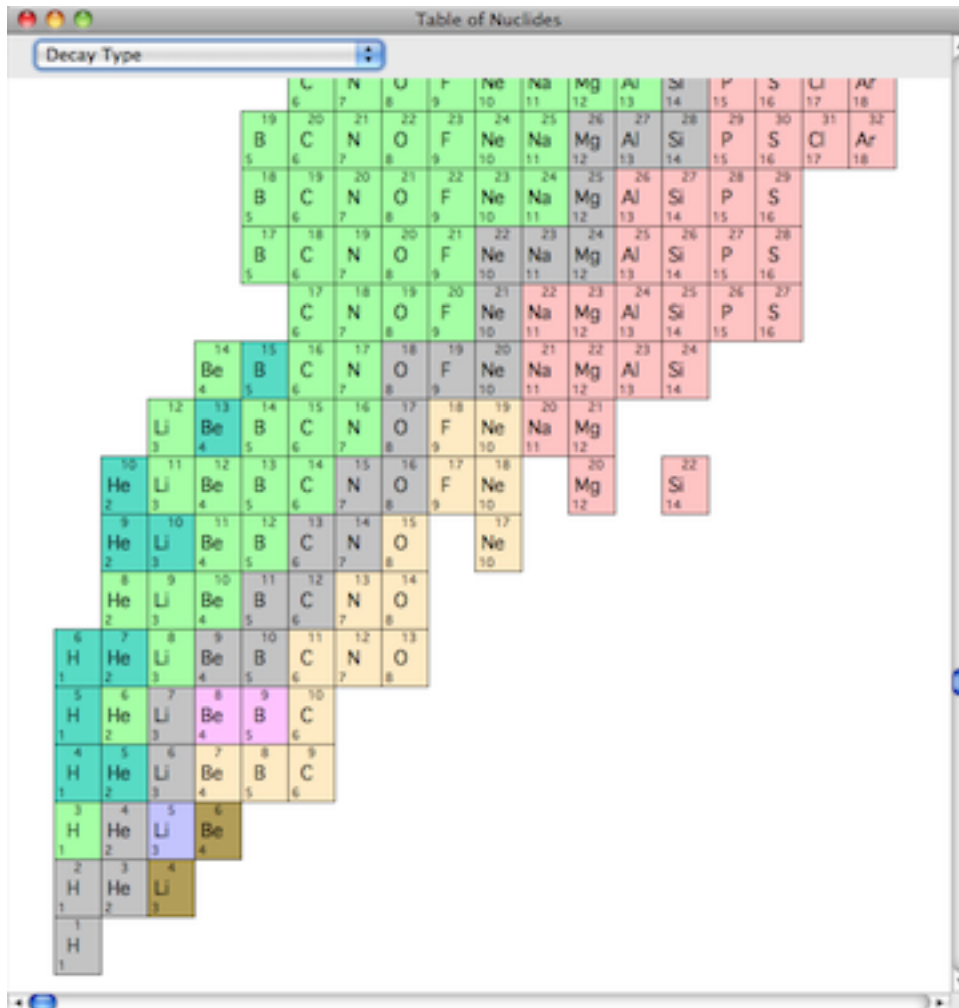
Color Code for Nuclides Table:

Stable	- Gray
Beta Decay	- Green
Alpha Decay	- Blue
Positron Decay	- Red
Electron Capture	- Orange
Double Alpha Decay	- Purple

Isometric	- Tan
Spontaneous Fission	- Yellow
Neutron Emission	- Aqua
Proton Emission	- Brown

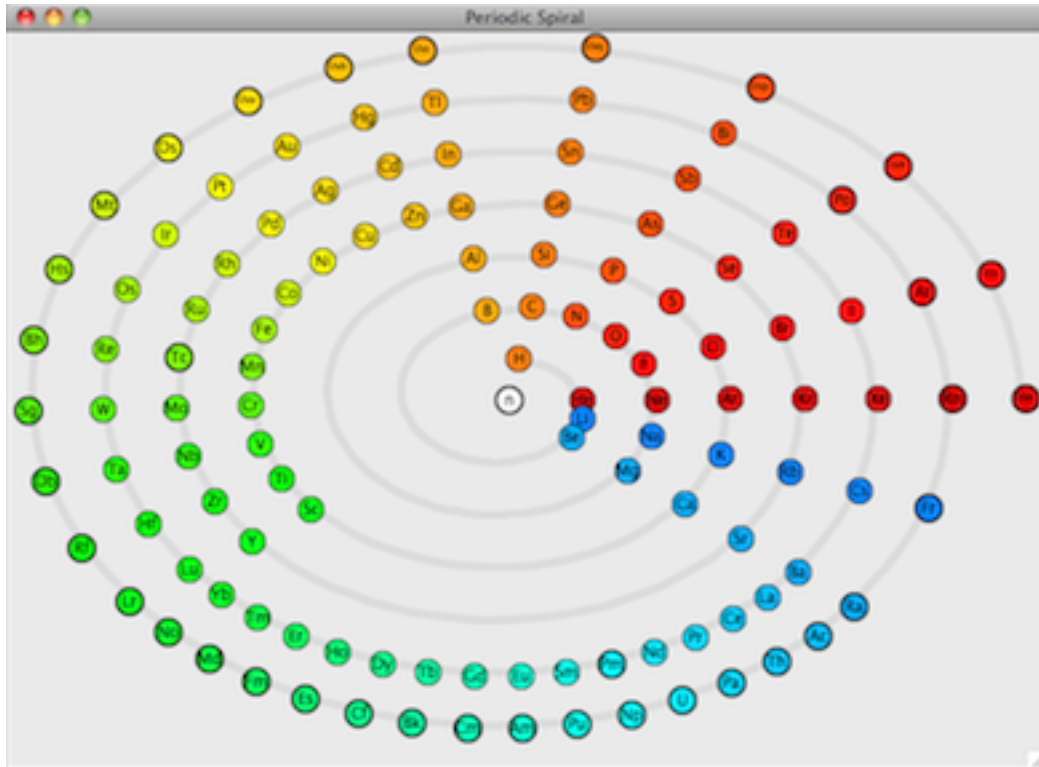
A popup menu in the upper left corner of the window allows you to change the display from decay mode to one of several other types of information:

Atomic Mass  
 Half Life  
 Binding Energy  
 Mass Excess  
 Q Value  
 Magnetic Moment  
 Electric Moment



## Periodic Spiral

By selecting **Periodic Spiral** from the **File** menu, you'll be presented with a large window showing an alternate presentation for the periodic table of elements.



In this presentation, the neutron is in the center, and the elements spiral outwards. Each radial line from the center is similar to a group or column in the standard table. One advantage over the traditional table is that there are no “edges” on each line or period, the elements continuously flow one after the other, much as they do in nature.

## Decay Tree Window

By clicking the **Decay Tree** button in an isotope window, you will display a window that shows the decay path until a stable nuclide is reached. This is only useful for radioactive nuclides, of course.

