The Discovery of the Hydrogen Spectrum

by James Carter

In 1996, I found a list of the first few photons in the Lyman, Balmer and Paschen series of Hydrogen's spectrum. After a few false starts, I was able to put together a simple mathematical system that could calculate the wavelength of each photon in the Hydrogen spectrum.

The thermal radiation of Hydrogen's spectra exists in many different series of precise photon wavelengths. The first 16 photons of the first nine series are illustrated in the chart *Hydrogen's First 144 Photons*. The first of these groups is the Lyman series with photons in the ultraviolet part of the spectrum. The next group is the Balmer series with most of its photons in the visible portion of the spectrum. These groups of photons from Hydrogen and the other elements allows spectra of distant stars to be analyzed in order to determine their chemical composition. One example of this is that Helium was actually identified as an unknown element on the sun before it was discovered here on Earth.

Each group is an endless series of photons with smaller and smaller wavelengths beginning at λ_1 and culminating at $\lambda\infty$. The most energetic photon possible for the Lyman series is the *intrinsic photon* ${}_{Ly}\lambda\infty$ of Hydrogen. The energy of the intrinsic photon represents the total ionization energy between a proton and an electron. The formula invented to calculate Hydrogen's intrinsic wavelength is ${}_{Ly}\lambda\infty = 4\pi a_o/\alpha = 9.1176 \times 10^{-8}$ m. (Wavelength is equal to 4 pi times the Bohr radius divided by the fine structure constant). The rest of Hydrogen's other series of thermal photons form endless groups of photons with longer and longer wavelengths that can all be calculated with variations on this formula.

The Hydrogen atom feeds on angular momentum. When an electron couples to a proton the pair shares the angular momentum contained in their relative velocity before they unite. The centripetal force between the electron and proton pulls the atom down toward the Bohr radius a_o. The ionization energy generated by this force is released in a series of photons that each removes a unit of angular momentum $I\omega = M_E a_o \alpha C$ from the atom. The atom reaches a ground state at the Bohr radius when it no longer has a unit of angular momentum $I\omega = m\lambda C/2\pi$ to produce a photon when the tertiary coils of the proton and electron reach their equilibrium ratio of $1/\sqrt{\alpha}$. A ground-state atom remains dormant and cannot produce more photons until it can acquire more energy and units of angular momentum from contact with other atoms or the absorption of a photon.

Hydrogen's First 144 Photons

The first four values at the top of this chart are in the octal system of counting. The octal system has far more beautiful equations than the decimal system when it comes to calculating the circlon model photons of the hydrogen atom. As this chart is carried farther out in octal, the values and equations become more and more symmetrical and repetitive.

Hydrogen's First 144 Photon Fractions with Base Eight Numbers

Octal Numbers

Lyman 1 $(1+1)^2$ 4	Balmer 2 $(2+2)^2$ 20	Paschen 3 3^3 33	Brackett 4 $(4+4)^2$ 100	Pfund 5 $(5+5)^2$ 144	#6 Orbit 6 $(6+6)^2$ 214	#7 Orbit 7 $(7+7)^2$ 304	#10 Orbit 10 $(10+10)^2$ 400	#11 Orbit 11 $(11+11)^2$ 504
$_1\lambda_\infty = \frac{4\pi a_o}{\alpha}$	$_2\lambda_\infty = \frac{16\pi a_o}{\alpha}$	$_3\lambda_\infty = \frac{27\pi a_o}{\alpha}$	$_4\lambda_\infty = \frac{64\pi a_o}{\alpha}$	$_5\lambda_\infty = \frac{100\pi a_o}{\alpha}$	$_6\lambda_\infty = \frac{144\pi a_o}{\alpha}$	$_7\lambda_\infty = \frac{196\pi a_o}{\alpha}$	$_8\lambda_\infty = \frac{256\pi a_o}{\alpha}$	$_9\lambda_\infty = \frac{324\pi a_o}{\alpha}$
911.267052Å	3,645.06821Å	8,201.40347Å	14,580.2728Å	22,781.6763Å	32,805.6139Å	44,652.0856Å	58,321.0914Å	73,812.6312Å
$_{Ly}\lambda_\infty = {}_1\lambda_\infty\left(\frac{Me}{Mp}+1\right)$	$_{Ba}\lambda_\infty = {}_2\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{Pa}\lambda_\infty = {}_3\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{Br}\lambda_\infty = {}_4\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{Pf}\lambda_\infty = {}_5\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{\#6}\lambda_\infty = {}_6\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{\#7}\lambda_\infty = {}_7\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{\#8}\lambda_\infty = {}_8\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$	$_{\#9}\lambda_\infty = {}_9\lambda_\infty\left(\frac{Me}{2Mp}+1\right)$
$_{Ly}\lambda_\infty$= 911.76334Å obs (911.75348Å) 1.0000108143	$_{Ba}\lambda_\infty$= 3,646.061Å obs (3,645.982Å) 1.0000216677	$_{Pa}\lambda_\infty$= 8,203.637Å obs (8,203.569Å) 1.0000082891	$_{Br}\lambda_\infty$=14,584.243Å obs (14,584.173Å) 1.0000047997	$_{Pf}\lambda_\infty$=22,787.880Å obs (22,787.803Å) 1.000003379	$_{\#6}\lambda_\infty$= 32,814.547Å obs (32,814.463Å) 1.00000255985	$_{\#7}\lambda_\infty$= 44,664.245Å obs (44,664.153Å) 1.0000020598	$_{\#8}\lambda_\infty$= 58,336.972Å obs (58,336.874Å) 1.0000016799	$_{\#9}\lambda_\infty$= 73,832.731Å obs (73,832.627Å) 1.0000014086
1/1=13.5983175 eV	1/4=3.3995794 eV	1/9=1.5109242 eV	1/16=.84989484 eV	1/25=.5439327 eV	1/36=.37773141 eV	1/49=.277516683 eV	1/64=.212473711 eV	1/81=.16788046 eV
$_{Ly}\lambda_1 = \frac{2^2}{2^2-1} = \frac{4}{3}$	$_{Ba}\lambda_1 = \frac{3^2}{3^2-4} = \frac{9}{5}$	$_{Pa}\lambda_1 = \frac{4^2}{4^2-9} = \frac{16}{7}$	$_{Br}\lambda_1 = \frac{5^2}{5^2-16} = \frac{25}{9}$	$_{Pf}\lambda_1 = \frac{6^2}{6^2-25} = \frac{36}{11}$	$_{\#6}\lambda_1 = \frac{7^2}{7^2-36} = \frac{49}{13}$	$_{\#7}\lambda_1 = \frac{8^2}{8^2-49} = \frac{64}{15}$	$_{\#8}\lambda_1 = \frac{9^2}{9^2-64} = \frac{81}{17}$	$_{\#9}\lambda_1 = \frac{10^2}{10^2-81} = \frac{100}{19}$
$_{Ly}\lambda_2 = \frac{3^2}{3^2-1} = \frac{9}{8}$	$_{Ba}\lambda_2 = \frac{4^2}{4^2-4} = \frac{4}{3}$	$_{Pa}\lambda_2 = \frac{5^2}{5^2-9} = \frac{25}{16}$	$_{Br}\lambda_2 = \frac{6^2}{6^2-16} = \frac{9}{5}$	$_{Pf}\lambda_2 = \frac{7^2}{7^2-25} = \frac{49}{24}$	$_{\#6}\lambda_2 = \frac{8^2}{8^2-36} = \frac{16}{7}$	$_{\#7}\lambda_2 = \frac{9^2}{9^2-49} = \frac{81}{32}$	$_{\#8}\lambda_2 = \frac{10^2}{10^2-64} = \frac{25}{9}$	$_{\#9}\lambda_2 = \frac{11^2}{11^2-81} = \frac{121}{40}$
$_{Ly}\lambda_3 = \frac{4^2}{4^2-1} = \frac{16}{15}$	$_{Ba}\lambda_3 = \frac{5^2}{5^2-4} = \frac{25}{21}$	$_{Pa}\lambda_3 = \frac{6^2}{6^2-9} = \frac{4}{3}$	$_{Br}\lambda_3 = \frac{7^2}{7^2-16} = \frac{49}{33}$	$_{Pf}\lambda_3 = \frac{8^2}{8^2-25} = \frac{64}{39}$	$_{\#6}\lambda_3 = \frac{9^2}{9^2-36} = \frac{9}{5}$	$_{\#7}\lambda_3 = \frac{10^2}{10^2-49} = \frac{100}{51}$	$_{\#8}\lambda_3 = \frac{11^2}{11^2-64} = \frac{121}{57}$	$_{\#9}\lambda_3 = \frac{12^2}{12^2-81} = \frac{16}{7}$
$_{Ly}\lambda_4 = \frac{5^2}{5^2-1} = \frac{25}{24}$	$_{Ba}\lambda_4 = \frac{6^2}{6^2-4} = \frac{9}{8}$	$_{Pa}\lambda_4 = \frac{7^2}{7^2-9} = \frac{49}{40}$	$_{Br}\lambda_4 = \frac{8^2}{8^2-16} = \frac{4}{3}$	$_{Pf}\lambda_4 = \frac{9^2}{9^2-25} = \frac{81}{56}$	$_{\#6}\lambda_4 = \frac{10^2}{10^2-36} = \frac{25}{16}$	$_{\#7}\lambda_4 = \frac{11^2}{11^2-49} = \frac{121}{72}$	$_{\#8}\lambda_4 = \frac{12^2}{12^2-64} = \frac{9}{5}$	$_{\#9}\lambda_4 = \frac{13^2}{13^2-81} = \frac{169}{88}$
$_{Ly}\lambda_5 = \frac{6^2}{6^2-1} = \frac{36}{35}$	$_{Ba}\lambda_5 = \frac{7^2}{7^2-4} = \frac{49}{45}$	$_{Pa}\lambda_5 = \frac{8^2}{8^2-9} = \frac{64}{55}$	$_{Br}\lambda_5 = \frac{9^2}{9^2-16} = \frac{81}{65}$	$_{Pf}\lambda_5 = \frac{10^2}{10^2-25} = \frac{4}{3}$	$_{\#6}\lambda_5 = \frac{11^2}{11^2-36} = \frac{121}{85}$	$_{\#7}\lambda_5 = \frac{12^2}{12^2-49} = \frac{144}{95}$	$_{\#8}\lambda_5 = \frac{13^2}{13^2-64} = \frac{169}{105}$	$_{\#9}\lambda_5 = \frac{14^2}{14^2-81} = \frac{96}{115}$
$_{Ly}\lambda_6 = \frac{7^2}{7^2-1} = \frac{49}{48}$	$_{Ba}\lambda_6 = \frac{8^2}{8^2-4} = \frac{16}{15}$	$_{Pa}\lambda_6 = \frac{9^2}{9^2-9} = \frac{9}{8}$	$_{Br}\lambda_6 = \frac{10^2}{10^2-16} = \frac{25}{21}$	$_{Pf}\lambda_6 = \frac{11^2}{11^2-25} = \frac{121}{96}$	$_{\#6}\lambda_6 = \frac{12^2}{12^2-36} = \frac{4}{3}$	$_{\#7}\lambda_6 = \frac{13^2}{13^2-49} = \frac{169}{120}$	$_{\#8}\lambda_6 = \frac{14^2}{14^2-64} = \frac{49}{33}$	$_{\#9}\lambda_6 = \frac{15^2}{15^2-81} = \frac{25}{16}$
$_{Ly}\lambda_7 = \frac{8^2}{8^2-1} = \frac{64}{63}$	$_{Ba}\lambda_7 = \frac{9^2}{9^2-4} = \frac{81}{77}$	$_{Pa}\lambda_7 = \frac{10^2}{10^2-9} = \frac{100}{91}$	$_{Br}\lambda_7 = \frac{11^2}{11^2-16} = \frac{121}{105}$	$_{Pf}\lambda_7 = \frac{12^2}{12^2-25} = \frac{144}{119}$	$_{\#6}\lambda_7 = \frac{13^2}{13^2-36} = \frac{169}{133}$	$_{\#7}\lambda_7 = \frac{14^2}{14^2-49} = \frac{4}{3}$	$_{\#8}\lambda_7 = \frac{15^2}{15^2-64} = \frac{225}{161}$	$_{\#9}\lambda_7 = \frac{16^2}{16^2-81} = \frac{256}{175}$
$_{Ly}\lambda_8 = \frac{9^2}{9^2-1} = \frac{81}{80}$	$_{Ba}\lambda_8 = \frac{10^2}{10^2-4} = \frac{25}{24}$	$_{Pa}\lambda_8 = \frac{11^2}{11^2-9} = \frac{121}{112}$	$_{Br}\lambda_8 = \frac{12^2}{12^2-16} = \frac{9}{8}$	$_{Pf}\lambda_8 = \frac{13^2}{13^2-25} = \frac{169}{144}$	$_{\#6}\lambda_8 = \frac{14^2}{14^2-36} = \frac{49}{40}$	$_{\#7}\lambda_8 = \frac{15^2}{15^2-49} = \frac{225}{176}$	$_{\#8}\lambda_8 = \frac{16^2}{16^2-64} = \frac{4}{3}$	$_{\#9}\lambda_8 = \frac{17^2}{17^2-81} = \frac{289}{208}$
$_{Ly}\lambda_9 = \frac{10^2}{10^2-1} = \frac{100}{99}$	$_{Ba}\lambda_9 = \frac{11^2}{11^2-4} = \frac{121}{117}$	$_{Pa}\lambda_9 = \frac{12^2}{12^2-9} = \frac{16}{15}$	$_{Br}\lambda_9 = \frac{13^2}{13^2-16} = \frac{169}{153}$	$_{Pf}\lambda_9 = \frac{14^2}{14^2-25} = \frac{196}{171}$	$_{\#6}\lambda_9 = \frac{15^2}{15^2-36} = \frac{25}{21}$	$_{\#7}\lambda_9 = \frac{16^2}{16^2-49} = \frac{256}{207}$	$_{\#8}\lambda_9 = \frac{17^2}{17^2-64} = \frac{289}{225}$	$_{\#9}\lambda_9 = \frac{18^2}{18^2-81} = \frac{4}{3}$
$_{Ly}\lambda_{10} = \frac{11^2}{11^2-1} = \frac{121}{120}$	$_{Ba}\lambda_{10} = \frac{12^2}{12^2-4} = \frac{36}{35}$	$_{Pa}\lambda_{10} = \frac{13^2}{13^2-9} = \frac{169}{160}$	$_{Br}\lambda_{10} = \frac{14^2}{14^2-16} = \frac{49}{45}$	$_{Pf}\lambda_{10} = \frac{15^2}{15^2-25} = \frac{9}{8}$	$_{\#6}\lambda_{10} = \frac{16^2}{16^2-36} = \frac{64}{55}$	$_{\#7}\lambda_{10} = \frac{17^2}{17^2-49} = \frac{289}{240}$	$_{\#8}\lambda_{10} = \frac{18^2}{18^2-64} = \frac{81}{65}$	$_{\#9}\lambda_{10} = \frac{19^2}{19^2-81} = \frac{361}{280}$
$_{Ly}\lambda_{11} = \frac{12^2}{12^2-1} = \frac{144}{143}$	$_{Ba}\lambda_{11} = \frac{13^2}{13^2-4} = \frac{169}{165}$	$_{Pa}\lambda_{11} = \frac{14^2}{14^2-9} = \frac{196}{187}$	$_{Br}\lambda_{11} = \frac{15^2}{15^2-16} = \frac{225}{209}$	$_{Pf}\lambda_{11} = \frac{16^2}{16^2-25} = \frac{256}{231}$	$_{\#6}\lambda_{11} = \frac{17^2}{17^2-36} = \frac{289}{253}$	$_{\#7}\lambda_{11} = \frac{18^2}{18^2-49} = \frac{324}{275}$	$_{\#8}\lambda_{11} = \frac{19^2}{19^2-64} = \frac{361}{297}$	$_{\#9}\lambda_{11} = \frac{20^2}{20^2-81} = \frac{400}{319}$
$_{Ly}\lambda_{12} = \frac{13^2}{13^2-1} = \frac{169}{168}$	$_{Ba}\lambda_{12} = \frac{14^2}{14^2-4} = \frac{49}{48}$	$_{Pa}\lambda_{12} = \frac{15^2}{15^2-9} = \frac{25}{24}$	$_{Br}\lambda_{12} = \frac{16^2}{16^2-16} = \frac{16}{15}$	$_{Pf}\lambda_{12} = \frac{17^2}{17^2-25} = \frac{289}{264}$	$_{\#6}\lambda_{12} = \frac{18^2}{18^2-36} = \frac{9}{8}$	$_{\#7}\lambda_{12} = \frac{19^2}{19^2-49} = \frac{361}{312}$	$_{\#8}\lambda_{12} = \frac{20^2}{20^2-64} = \frac{25}{21}$	$_{\#9}\lambda_{12} = \frac{21^2}{21^2-81} = \frac{49}{40}$
$_{Ly}\lambda_{13} = \frac{14^2}{14^2-1} = \frac{196}{195}$	$_{Ba}\lambda_{13} = \frac{15^2}{15^2-4} = \frac{225}{221}$	$_{Pa}\lambda_{13} = \frac{16^2}{16^2-9} = \frac{256}{247}$	$_{Br}\lambda_{13} = \frac{17^2}{17^2-16} = \frac{289}{273}$	$_{Pf}\lambda_{13} = \frac{18^2}{18^2-25} = \frac{324}{299}$	$_{\#6}\lambda_{13} = \frac{19^2}{19^2-36} = \frac{361}{325}$	$_{\#7}\lambda_{13} = \frac{20^2}{20^2-49} = \frac{400}{351}$	$_{\#8}\lambda_{13} = \frac{21^2}{21^2-64} = \frac{441}{377}$	$_{\#9}\lambda_{13} = \frac{22^2}{22^2-81} = \frac{484}{403}$
$_{Ly}\lambda_{14} = \frac{15^2}{15^2-1} = \frac{225}{224}$	$_{Ba}\lambda_{14} = \frac{16^2}{16^2-4} = \frac{64}{63}$	$_{Pa}\lambda_{14} = \frac{17^2}{17^2-9} = \frac{289}{280}$	$_{Br}\lambda_{14} = \frac{18^2}{18^2-16} = \frac{81}{77}$	$_{Pf}\lambda_{14} = \frac{19^2}{19^2-25} = \frac{361}{336}$	$_{\#6}\lambda_{14} = \frac{20^2}{20^2-36} = \frac{100}{91}$	$_{\#7}\lambda_{14} = \frac{21^2}{21^2-49} = \frac{9}{8}$	$_{\#8}\lambda_{14} = \frac{22^2}{22^2-64} = \frac{121}{105}$	$_{\#9}\lambda_{14} = \frac{23^2}{23^2-81} = \frac{529}{448}$
$_{Ly}\lambda_{15} = \frac{16^2}{16^2-1} = \frac{256}{255}$	$_{Ba}\lambda_{15} = \frac{17^2}{17^2-4} = \frac{289}{285}$	$_{Pa}\lambda_{15} = \frac{18^2}{18^2-9} = \frac{36}{35}$	$_{Br}\lambda_{15} = \frac{19^2}{19^2-16} = \frac{361}{345}$	$_{Pf}\lambda_{15} = \frac{20^2}{20^2-25} = \frac{16}{15}$	$_{\#6}\lambda_{15} = \frac{21^2}{21^2-36} = \frac{49}{45}$	$_{\#7}\lambda_{15} = \frac{22^2}{22^2-49} = \frac{484}{435}$	$_{\#8}\lambda_{15} = \frac{23^2}{23^2-64} = \frac{529}{465}$	$_{\#9}\lambda_{15} = \frac{24^2}{24^2-81} = \frac{64}{55}$
$_{Ly}\lambda_{16} = \frac{17^2}{17^2-1} = \frac{289}{288}$	$_{Ba}\lambda_{16} = \frac{18^2}{18^2-4} = \frac{81}{80}$	$_{Pa}\lambda_{16} = \frac{19^2}{19^2-9} = \frac{361}{352}$	$_{Br}\lambda_{16} = \frac{20^2}{20^2-16} = \frac{25}{24}$	$_{Pf}\lambda_{16} = \frac{21^2}{21^2-25} = \frac{441}{416}$	$_{\#6}\lambda_{16} = \frac{22^2}{22^2-36} = \frac{121}{112}$	$_{\#7}\lambda_{16} = \frac{23^2}{23^2-49} = \frac{529}{480}$	$_{\#8}\lambda_{16} = \frac{24^2}{24^2-64} = \frac{9}{8}$	$_{\#9}\lambda_{16} = \frac{25^2}{25^2-81} = \frac{625}{544}$

$\lambda_\infty = \frac{4\pi a_o}{\alpha}$ = 9.11267052 x10^{-8}m $\frac{Me}{Mp}$ = .000544617 $\left(\frac{Me}{2Mp}+1\right)$ =1.0002723085 $\frac{\lambda_{Ce}}{Me}$ = .00002661124 $\frac{\lambda_{Ce}}{Mp}$ = .000000014492933

λ_∞ = photon mass = 13.5983175 eV
Me = electron mass = 510,999.06 eV
Mp = proton mass = 938,272,310 eV

The radiation of the circlon model atom is represented in these 144 circlon model equations. The energy, momentum and wavelength values of each of these equations are very close approximations to the measured spectral photon emissions of the Hydrogen atom. This spectrum begins with hydrogen's intrinsic photon $\lambda\infty = 4\pi a_o/\alpha = 9.11\text{x}10^{-8}$ m *and extends to infinity with photon equations of increasingly longer wavelengths.*

This chart shows the individual wavelength of each of the photons that makes up a blackbody distribution curve. It is basically this same group of photons that made up the 2.7°K CBR except that the CBR contains some spectra from the other elements.

This list of photons is a discovery and not a theory. The photons are measurements and the equations are theories for their values.

