9. ATOM'S SPECTROSCOPY   10th Edition

(Jack Kuykendall's English Translation and Rewrite using Symmetry Math and (Mrf) and $(M\vec{a}d)$ notations)

$$\left[\; M\vec{a}d\text{: mass}(kg)\text{ - }\overrightarrow{\text{acceleration}}\;(m/s^2)\text{ - distance }(d)\;\; \overset{m}{(kg)}\overset{a}{(m/s^2)}\overset{d}{(m)} \right]$$

$$\left[(M\vec{a}d) = MC^2 \quad \text{and} \quad (M\vec{a}d) = \vec{h}f \right]$$

$$\left[(M\vec{a}d) = MC^2 = (9.1093897 < 31kg)(8.987551 > 16\,m^2/s^2) = 8.18711 < 14(kg)\left(m/s^2\right)(m) \right]$$

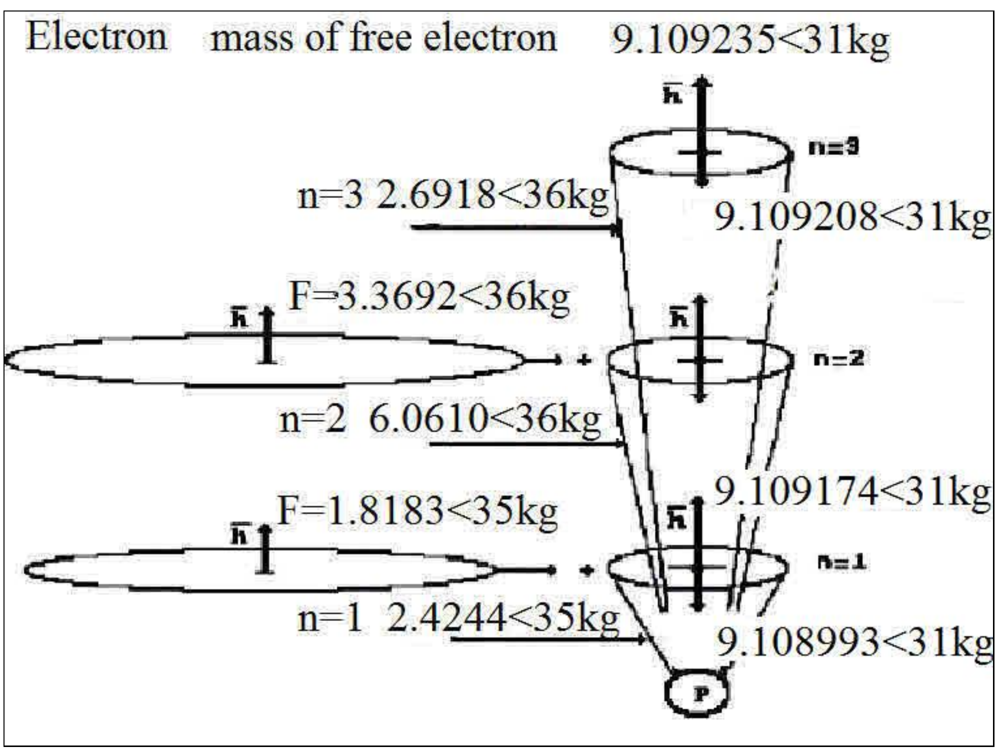
$$\left[(M\vec{a}d) = \vec{h}f = (6.6261 < 34(kg)\left(m/s^2\right)(m)(s))(1.235585 > 20\,rot/s) = 8.18711 < 14(kg)\left(m/s^2\right)(m) \right]$$

Mass: $$\left[M = \frac{(M\vec{a}d)}{C^2} = \frac{8.18711 < 14(kg)\left(m/s^2\right)(m)}{8.98755178 > 16\,m^2/s^2} = 9.109 < 31kg \right] \text{electron}$$

Frequency: $$\left[f = \frac{C}{r_{\exp}} = \frac{(M\vec{a}d)}{\vec{h}} = \frac{8.18711 < 14(kg)\left(m/s^2\right)(m)}{6.6261(kg)\left(m/s^2\right)(m)(s)} = 1.235585 > 20\,rot/s \right] \text{electron}$$

Radius: $$\left[r = \frac{C}{f} = \frac{2.99792458 > m/s}{1.235585 > 20\,rot/s} = 2.42631999 < 12m \right] \text{ electron}$$

$(Mr = \text{constant})$ $\left[Mr = (9.109 < 31kg)(2.42631999 < 12) = 2.21022 < 42kgm \right]$



9.2 Kanarev's theory of spectra

An electron in a free state has a mass of $(9.109235 < 31kg)$. When an electron bonds to a proton, it loses mass. The mass loss is in the form of an emitted photon.

The maximum mass loss is: $(2.424420 < 35kg)$.

The minimum electron mass in an atom will be:

$$\left[(9.109235 < 31kg) - (2.424420 < 35kg) = (9.108933 < 31kg)\right]$$

The bonding of an electron to a proton in a hydrogen atom on the 1st level (closest approach of an electron to a proton) is: $(M_1 = M_i = 2.424420 < 35kg)$.

When an electron on the 1st level absorbs a photon with a mass of $(1.81831 < 35kg)$ and jumps to the 2nd level, the bond with the proton decreases to:

$$\begin{bmatrix} \overbrace{(9.109235 < 31kg)}^{free\ electron\ mass} - \overbrace{(2.42442 < 35\text{kg})}^{1st\ level\ mass\ loss} + \overbrace{(1.81831 < 35kg)}^{absorbed\ photon\ mass} = \overbrace{9.109174 < 31\text{kg}}^{2nd\ level\ mass} \\ \text{M}_e \quad - \quad \text{M}_{1st} \quad + \quad \text{M}_{2nd} \quad = M_e - 6.06110 < 36\text{kg} \end{bmatrix} \quad (210)$$

The change in mass when an electron jumps from the 1st to the 3rd level is:

$$\begin{bmatrix} \overbrace{(9.109235 < 31kg)}^{free\ electron\ mass} - \overbrace{(2.42442 < 35\text{kg})}^{1st\ level\ mass\ loss} + \overbrace{(2.155238 < 35kg)}^{absorbed\ photon\ mass} = \overbrace{9.109208 < 31\text{kg}}^{3rd\ level\ mass} \\ \text{M}_e \quad - \quad \text{M}_{1st} \quad + \quad \text{M}_{3rd} \quad = M_e - 2.69182 < 36\text{kg} \end{bmatrix} \quad (211)$$

The change in mass when an electron jumps from the 1st to the 4th levels is:

$$\begin{bmatrix} \overbrace{(9.109235 < 31kg)}^{free\ electron\ mass} - \overbrace{(2.42442 < 35\text{kg})}^{1st\ level\ mass\ loss} + \overbrace{(2.155238 < 35kg)}^{absorbed\ photon\ mass} = \overbrace{9.109208 < 31\text{kg}}^{3rd\ level\ mass} \\ \text{M}_e \quad - \quad \text{M}_{1st} \quad + \quad \text{M}_{3rd} \quad = M_e - 2.69182 < 36\text{kg} \end{bmatrix} \quad (212)$$

Using equations (210, 211, 212), an equation that predicts the spectrum of the hydrogen atoms is:

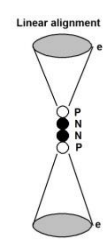
$$M_e - M_i + M_{ph} = M_e - \frac{M_1}{n^2} \Rightarrow M\vec{a}d_{ph} = M_i - \frac{M_1}{n^2} \quad (213)$$

where:

- $M\vec{a}d_{ph} = \vec{h}f_{ph}$ - $M\vec{a}d_{ph}$ of the absorbed or emitted photon;
- $M\vec{a}d_i = \vec{h}f_i$ - the ionization $M\vec{a}d_{ph}$
- M_1 - The binding mass of an electron with a proton on the 1st level.

Since $(M\vec{a}d_1 = M\vec{a}d_i = \vec{h}f_1 = \vec{h}f_i)$, equation (213) can be written using the frequency of the photons.

$$\vec{h}f_{ph} = \vec{h}f_i - \frac{\vec{h}f_1}{n^2} \Rightarrow f_{ph} = f_i - \frac{f_1}{n^2} \quad (214)$$



Equation (214) includes only the frequencies of the absorbed or emitted photon mass. This frequency is the rotation of mass around its axes. The equation makes NO predictions about an electron rotating around the proton (or nucleus; current quantum theory). Quantum and Chemistry theories of orbital motion of electrons around the nucleus should be abandoned.

An equation that accurately predicts the binding mass (M_b) of an electron to a proton is:

$$\left[M_b = \frac{M_i}{n^2} = \frac{M_1}{n^2} = \frac{(2.424420 < 35kg)}{n^2} \right] \tag{215}$$

where n =1,2,3...is the number of the mass levels of the electron in an atom.

Equation (215) accurately predicts the binding mass of electrons to protons in any atom.

- (M_1) is the binding mass on the 1st level.
- (M_i) is the ionization mass for any remaining electron of multi electron atoms.
- For hydrogen atom, (M_1) and (M_i) are the same value $(2.424420 < 35kg)$.

Since the spectral lines of absorption and emission are the same, the equations describe either process. When an electron is on the 1st level, it does not emit photons. This is its closest approach to a proton and the electron can only absorb photons and move to higher levels. An electron on the 2nd level $(M_e - 6.06110{<}36\text{kg})$ can emit a photon with a mass of $(M_{ph} = 1.818315 < 35\text{kg})$.

$$\left[(M_e - 6.061051 < 36\text{kg}) - 1.818315 < 35\text{kg} = M_e - 2.42442 < 35\text{kg} \right] \tag{216}$$

An electron on the 3rd level has a binding mass with the proton of: $(M_{b3} = 2.6918196 < 36\text{kg})$. An electron jumping from the 1st to the 3rd level emits a photon with a mass of:

$$\left[M_{ph3} = 2.155238 < 35\text{kg} \right].$$

$$\left[(M_e - 2.6918196 < 36\text{kg}) - 2.155238 < 35\text{kg} = M_e - 2.42442 < 35\text{kg} \right] \tag{217}$$

An electron is on the 4th level has a binding mass with the proton of: $(M_{b4} = 1.15263 < 36\text{kg})$. An electron jumping from the 1st to the 4th level emits a photon with a mass of:

$$\left[M_{ph4} = 2.272894 < 35\text{kg} \right].$$

$$\left[(M_e - 1.15263 < 36\text{kg}) - 2.272894 < 35\text{kg} = M_e - 2.42442 < 35\text{kg} \right] \tag{218}$$

In general: $$\left[\left(M_e - \frac{M_1}{n^2} \right) - M_{ph} = M_e - M_i \right] \text{ or } \left[M_e - M_{ph} = M_e + \frac{M_1}{n^2} - M_i \right] \tag{219}$$

Dividing by (M_e) and solving for (M_{ph}):

$$\left[M_{ph} = M_i - \frac{M_1}{n^2} \right] \tag{220}$$

Absorption equations (211), (212) and (213) are the same as the emission equations (216), (217) and (218).

Equation (221) accurately predicts the binding mass of electrons with protons.

$$M_b = \frac{M_1}{n^2} = \frac{\vec{h} f_1}{n^2} \tag{221}$$

In the hydrogen atom, the binding mass $(M_{b1} = M_1)$ of an electron with a proton corresponds to the 1st level with ionization mass (M_i).

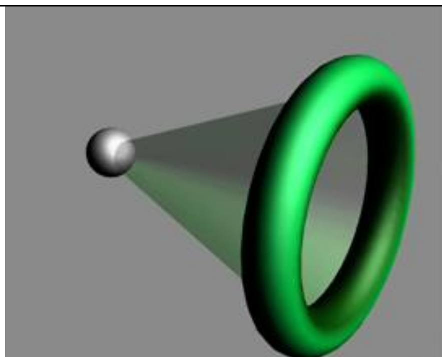
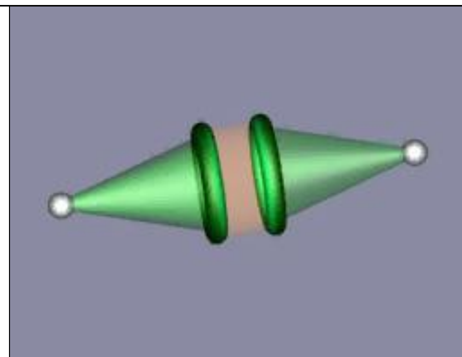
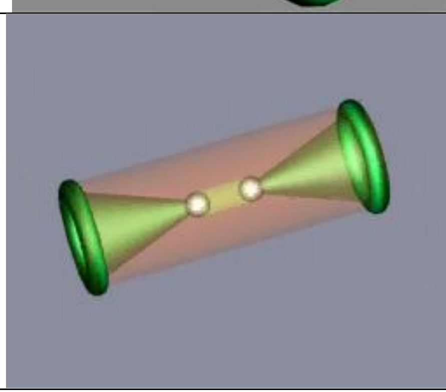
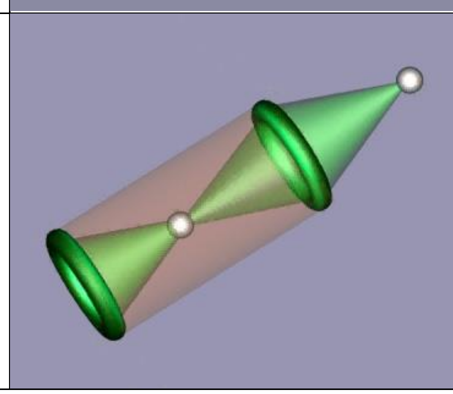
There is no spectral line for the 1st level. This is because an electron in a hydrogen atom bonds to the proton in gradual steps of emission of photons from the 108th level down to the 1st level. The electron does not emit a photon with a mass of $(2.424064 < 35\text{kg})$ when it first bonds to the proton.

The main source of atomic hydrogen $(1e1P)$ in space is from stars. The first contact of an electron with a proton begins on the 108th level $\left[2.078244<39\text{kg}\right]$. As atomic hydrogen is emitted from stars and the temperature decreases, the electron will emit photons in steps as it jumps to the1st levels. If the temperature gradient was zero, the electron could pass from the 108th to the 1st in one step and emit a photon with a mass of $(2.424064 < 35\text{kg})$ and a spectral line corresponding to this mass would appear. Since there is no spectral line at $(2.424064 < 35\text{kg})$, electrons approach protons in steps.

An electron bonding to a proton on the 108th level will emit a photon with a mass of: $(M_{108} = 2.078244 < 39\text{kg})$. The radius of the emitted photon will be:

$$r_{EXP} = \frac{2.21022 < 42kgm}{M_{108}} = \frac{2.21022 < 42kgm}{2.078244 < 39\text{kg}} = 0.001m$$

$(0.001m)$ is the largest radius of a photon. Larger radiuses (radio radius) are a combination of these photons.

	Hydrogen 1e1P		ortho Hydrogen PeeP 2e2P
	Ortho Hydrogen ePPe 2e2P		Para Hydrogen ePeP 2e2P

9.3 Spin of photons and electrons

The mass of a photon (M_{ph}) and (M_e) of a free electron is defined by identical equations:

$$(M\vec{a}d)_{photon} = \vec{h}f_{ph} \tag{222}$$

$$(M\vec{a}d)_{electron} = \vec{h}f_e = \vec{h}\frac{\vec{v}_{\phi e}}{2\pi} \tag{223}$$

Planck's constant $(\vec{h})$ is an Arrow.

$$(\vec{v}_{\phi e} = 2\pi f_e)$$

Angular frequency $(\vec{v}_{\phi e})$ and linear frequency (f frequency of one rotation) are both arrows that rotate in the same direction. (Fig-44).

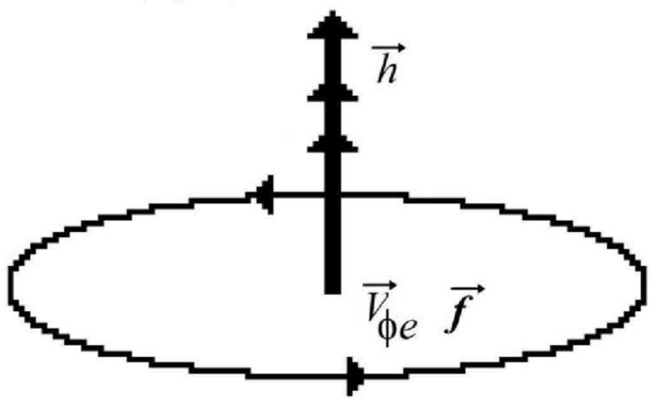
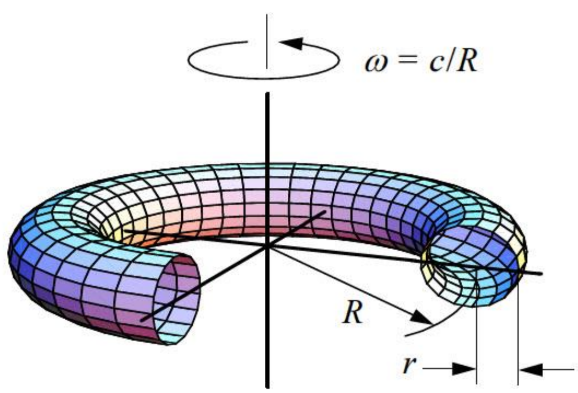


Fig-44: Direction of vectors $(\vec{h}, \vec{v}_{\phi e},$ and $f)$



The Spinning Ring Model of the Electron

9.4 Spectrum of the hydrogen atom

Using equations (220) and (221) with $(M_1 = M_i = 2.424064 < 35kg)$ and $n = 2, 3, 4, 5$.

(Equation 220)

$$\begin{bmatrix} M_{ph} = M_i - \dfrac{M_1}{n^2} \\ M_{ph} = 2.424064 < 35\text{kg} - \dfrac{2.424064 < 35\text{kg}}{2^2 = 4} = 2.424064 < 35\text{kg} - 6.061051 < 36\text{kg} = 1.818315 < 35\text{kg} \\ M_{ph} = 2.424064 < 35\text{kg} - \dfrac{2.424064 < 35\text{kg}}{3^2 = 9} = 2.424064 < 35\text{kg} - 2.6918196 < 36\text{kg} = 2.6918196 < 36\text{kg} \\ M_{ph} = 2.424064 < 35\text{kg} - \dfrac{2.424064 < 35\text{kg}}{4^2 = 16} = 2.424064 < 35\text{kg} - 1.51504 < 36\text{kg} = 2.272894 < 35\text{kg} \\ M_{ph} = 2.424064 < 35\text{kg} - \dfrac{2.424064 < 35\text{kg}}{5^2 = 25} = 2.424064 < 35\text{kg} - 9.697681 < 37\text{kg} = 2.327087 < 35\text{kg} \end{bmatrix}$$

(Equation 221)

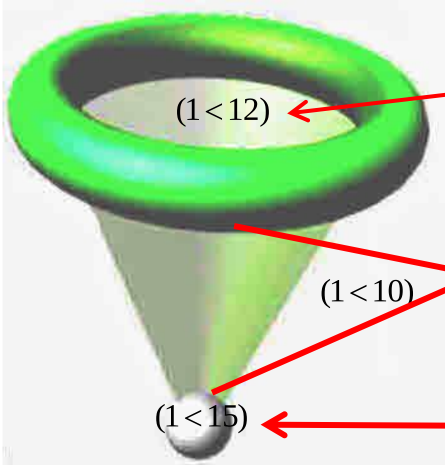
$$\begin{bmatrix} M_b = \dfrac{M_1}{n^2} = \dfrac{\vec{h}f_1}{n^2} = (2nd)\dfrac{2.424064 < 35kg}{2^2 = 4} = 6.061051 < 36kg \\ M_b = \dfrac{M_1}{n^2} = \dfrac{\vec{h}f_1}{n^2} = (3rd)\dfrac{2.424064 < 35kg}{3^2 = 9} = 2.6918196 < 36kg \\ M_b = \dfrac{M_1}{n^2} = \dfrac{\vec{h}f_1}{n^2} = (4th)\dfrac{2.424064 < 35kg}{4^2 = 16} = 1.15263 < 36kg \\ M_b = \dfrac{M_1}{n^2} = \dfrac{\vec{h}f_1}{n^2} = (5th)\dfrac{2.424064 < 35kg}{5^2 = 25} = 9.697681 < 37kg \end{bmatrix}$$

The distance between the electron and the proton can be calculated using Coulomb's equation:

$$\begin{bmatrix} d_{\text{distance108}} = \dfrac{e^2}{4\pi\varepsilon_o eV e_{108}} = \dfrac{(1.602 < 19coul)^2}{(4)(3.142)(8.854 < 12\dfrac{coul^2}{Nm^2})(0.001166eV)(1.602 < 19\dfrac{J(Nm)}{eV}} = 1.233633 < 6m \\ d_2 = \dfrac{e^2}{4\pi\varepsilon_o eV e_2} = \dfrac{(1.602 < 19coul)^2}{(4)(3.142)(8.854 < 12\dfrac{coul^2}{Nm^2})(3.4eV)(1.602 < 19\dfrac{J(Nm)}{eV})} = 4.23 < 10m \\ d_3 = \dfrac{e^2}{4\pi\varepsilon_o eV e_3} = \dfrac{(1.602 < 19coul)^2}{(4)(3.142)(8.854 < 12\dfrac{coul^2}{Nm^2})(1.51eV)(1.602 < 19\dfrac{J(Nm)}{eV})} = 9.54 < 10m \end{bmatrix}$$

Table-9: Experimental and theoretical spectrum of the hydrogen atom

Values	n	2	3	4	5
M_{ph} (exp)	*kg*	1.81831<35	2.15523<35	2.27289<35	2.32637<35
M_{ph} (theo)	*kg*	1.81795<35	2.15470<35	2.27253<35	2.32708<35
M_b (theo)	*kg*	6.061051<36	2.6918196<36	1.15263<36	9.62637<37
d_i (theo)	*meters*	4.23<10m	9.54<10m	16.94<10m	26.67<10m



If the radius of an electron was 1000 meters

The space between the electron and the proton would be 100,000 meters

And the proton would be 1 meter

$$\begin{bmatrix} \textit{electron radius} & r_e \approx 1 < 12m & \text{times} & 1 > 15 = 1,000m \\ \text{distance between } P_{to}e & R_{P_{to}e} \approx 1 < 10m & \text{times} & 1 > 15 = 100,000m \\ \text{Proton } \textit{radius} & r_P \approx 1 < 15m & \text{times} & 1 > 15 = 1m \end{bmatrix}$$

By scaling the size of the electron by $(1 > 15)$, it is easier to see how much space there is between the Proton and the electron.

From equation (220) $\left(M_{ph} = M_i - \frac{M_1}{n^2} \right)$, the photon mass absorbed and emitted during jumps between electron levels (n_1) and (n_2) will be:

$$\left(\Delta M_{ph} = M_{ph} = (M_1)\left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \right) \qquad (224)$$

$$\begin{bmatrix} \Delta M_{ph} = M_{ph} \\ = \quad (M_1) \quad \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \\ = 2.424064 < 35kg\left[\frac{1}{2^2} - \frac{1}{3^2} \right] = 2.424064 < 35kg(0.25 - 0.1111) \\ = 2.424064 < 35kg(0.1389) = 3.3367 < 36kg \\ = 2.424064 < 35kg\left[\frac{1}{3^2} - \frac{1}{4^2} \right] = 2.424064 < 35kg(0.1111 - .0625) \\ = 2.424064 < 35kg(0.0486) = 1.178 < 36kg \end{bmatrix}$$

For a hydrogen atom, the electron's mass (M_1) is equal to the mass of ionization $(M_1 = M_i)$.

Table-10: Photon mass emitted/absorbed between level jumps of electron in a hydrogen atom

Levels	$n_1..n_2$	2...3	3...4	4...5
M_{ph} (exp)	kg	3.369231<36	1.176556<36	5.347986<37
M_{ph} (theo)	kg	3.365665<36	1.178340<36	5.454946<37

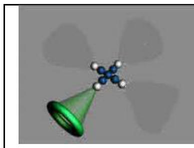
Equation (224) allows the calculation of the photon mass emitted/absorbed between any levels of the electrons. For example, a photon absorbed/emitted during a jump between the 3rd and 10th level will be:

3rd and 10th
$$\left[M_{ph} = 2.424064 < 35kg\left[\frac{1}{3^2} - \frac{1}{10^2} \right] = 2.451160 < 36kg \right] \qquad (225)$$

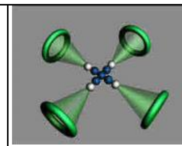
15th to the 5th
$$\left[M_{ph} = 2.424064 < 35kg\left[\frac{1}{5^2} - \frac{1}{15^2} \right] = 8.6102575 < 37kg \right] \qquad (226)$$

Equation (224) allows the calculation of photon mass absorbed/emitted between any two levels in a hydrogen atom.

9.5 Spectra of hydrogen-like-atoms (atoms with one electron remaining)



hydrogen like atom; one remaining electron



Beryllium with all 4 electrons in atom

Atoms having one remaining electron are named hydrogen-like-atoms. The bonding mass of the 1st (and only) electron in a hydrogen atom at the 1st level is equal to the ionization mass of the atom. A Similar mass level is observed in all hydrogen-like-atoms; an atom with one remaining electron.

The following convention has been accepted for the labeling of mass levels of the electrons.

- A helium atom has two electrons.
    - The ionization mass of $(4.383031<35\text{kg})$ has been labeled the 1st electron.
    - The ionization mass of $(9.700534<35\text{kg})$ has been labeled the 2nd electron.
- A lithium atom has three electrons.
    - The ionization mass of $(9.612114<36\text{kg})$ has been labeled the 1st electron.
    - The ionization mass of $(1.348370<34\text{kg})$ has been labeled the 2nd electron.
    - The ionization mass of $(2.182887<34kg)$ has been labeled the 3rd electron.

The binding mass when the last remaining electron is on the 1st level is proportional to the number of protons squared. The binding mass of the 1st (and only) electron to a proton to form a hydrogen atom on the 1st level is $(2.424064 < 35\text{kg})$. The binding mass (m_{P1}) of the last remaining electron of any other element on the 1st level will be:

$$M_{P1} = (2.424064 < 35\text{kg})(\#P)^2 \qquad (227)$$

Table-11 shows theoretical and experimental values for the binding mass for the last remaining electron on the 1st level for a few elements.

With an increase in the number of protons, the divergence between theoretical and experimental values increases. The reason will be explained during an analysis of the spectra of multi electron atoms. We will start this analysis when we analyze the spectra of all four electrons of the beryllium atom.

Table-11: Theoretical and experimental values of the binding mass of the last remaining electron when it is on the 1st level.

element	#P	Binding mass (M_b) kg	
		experiment	Theory $(2.424064 < 35\text{kg})(\#P)^2$
H	1	$(2.424064 < 35kg)$	-
He	2	9.700534<35 (2nd electron)	$(2^2 = 4) = 9.696255<35\text{kg}$
Li	3	2.182887<34 (3rd electron)	$(3^2 = 9) = 2.181657<34\text{kg}$
Be	4	3.881087<34 (4th electron)	$(4^2 = 16) = 3.878502<34\text{kg}$
B	5	6.064919<34 (5th electron)	$(5^2 = 25) = 6.060159<34\text{kg}$
C	6	8.734705<34 (6th electron)	$(6^2 = 36) = 8.726630<34\text{kg}$
N	7	1.189087<33 (7th electron)	$(7^2 = 49) = 1.187791<33\text{kg}$
O	8	-	$(8^2 = 64) = 1.551401<33\text{kg}$

$$\left[1\text{eV} = 1.782662 < 36\text{kg} \ = \ 11{,}604.505\text{T}_A\right] \left[\begin{array}{l} \dfrac{1.551401<33\text{kg}}{1.782662<36\text{kg}} \approx (870) \\ (870)(11604) \approx 10{,}000{,}000^o T_A \end{array}\right] \text{10 million degrees.}$$

After the 1st electron is emitted, we will label the binding mass of the remaining electrons as the "stationary mass level". Using equation (228), we can calculate the ionization levels

$$\left[M_{phn} = \vec{h}f_{phn} = \frac{M_1 P^2}{n^2}\right] \tag{228}$$

The symbol (f_{phn}) designates the frequency of the photon absorbed by an electron when its bond with the proton is broken and the electron leaves the atom as a free electron.
Using equation (228), the ionization mass of hydrogen-like-atoms is shown in Table-12.

Table-12: Binding mass of the last remaining electron with all the remaining protons.
Experimental (Exp) and Theoretical (The)

# P			Binding mass (M_b) *kg*			
			n=1	n=2	n=3	n=4
1	H	Exp The	2.42406<35	6.057486<36 6.059268<36	2.688254<36 2.693602<36	1.511697<36 1.513480<36
2	He	Exp The	9.70053<35	2.425490<35 2.425133<35	1.0777974<35 1.0777974<35	6.053920<36 6.062833<36
3	Li	Exp The	2.182887<34	5.456907<35 5.457263<35	2.424599<35 2.425668<35	1.363915<35 1.364271<35
4	Be	Exp The	3.881087<34	9.701781<35 9.702673<35	4.311012<35 4.312259<35	2.426738<35 2.425668<35
5	B	Exp The	6.064919<34	1.516101<34 1.516225<34	6.737928<35 6.738641<35	3.789405<35 3.790474<35
6	C	Exp The	8.734705<34	2.183066<34 2.183672<34	9.703208<35 9.705882<35	5.456907<35 5.459224<35
7	N	Exp The	1.189087<33	2.971501<34 2.972714<34	1.320756<34 1.321202<34	7.428174<35 7.431740<35

The following tables are calculations for helium when only one electron remains bonded to the protons (1e2p2N). A helium atom with one remaining electron (2nd electron) has a 1st level ionization binding energy of $(M_1 = M_i = 9.701 < 35kg)$. Table -13 is calculations using equations (220) $\left(M_{ph} = M_i - M_1/n^2\right)$ and (221) $\left(M_b = M_1/n^2 = \vec{h}f/n^2\right)$.

$$\left[\begin{array}{l} \left(M_{ph} = M_i - M_1/n^2\right) = \\ \text{(2nd) } (9.701 < 35kg) - \dfrac{9.701 < 35kg}{4} = 2.424 < 35kg \\ \text{(3rd) } (9.701 < 35kg) - \dfrac{9.701 < 35kg}{9} = 8.623 < 35kg \\ \text{(4th) } (9.701 < 35kg) - \dfrac{9.701 < 35kg}{16} = 9.095 < 35kg \\ \text{(5th) } (9.701 < 35kg) - \dfrac{9.701 < 35kg}{25} = 9.31 < 35kg \end{array}\right]$$

$$\left[\begin{array}{l} M_b = \frac{M_1}{n^2} \quad \text{(2nd)} \ \frac{9.701 < 35kg}{4} = 2.424 < 35\text{kg} \quad \text{(3rd)} \ \frac{9.701 < 35kg}{9} = 1.079 < 35\text{kg} \\ \text{(4th)} \ \frac{9.701 < 35kg}{16} = 6.061 < 36\text{kg} \quad \text{(5th)} \ \frac{9.701 < 35kg}{25} = 3.886 < 36\text{kg} \\ \text{(6th)} \ \frac{9.701 < 35kg}{36} = 2.692 < 36kg \end{array}\right]$$

Table-13: Spectrum of the 2nd **helium** electron and the binding (m_b) of the "stationary levels"

Values	n	2	3	4	5	6
$M_{ph-\exp}$	kg	7.293<35	8.623<35	9.095<35	9.31<35	9.430<35
$M_{ph-theor}$	kg	7.293<35	8.623<35	9.095<35	9.31<35	9.430<35
$m_{b-theor}$	kg	2.424<35	1.079<35	6.061<36	3.886<36	2.692<36

The last remaining electron of the lithium atom is the 3rd electron. The binding mass of the 3rd electron with all three protons is $(m_i = m_1 = 2.183 < 34\text{kg})$. Substituting $n = 2,3,4,...$ in equation (220) and (221), we obtain Table-14.

$$\left[\begin{array}{l} M_{ph} = M_i - \frac{M_1}{n^2} = \text{(2nd)} \ 2.183 < 34\text{kg} - \frac{2.183 < 34\text{kg}}{4} = 1.637 < 34\text{kg} \\ \text{(3rd)} \ 2.183 < 34\text{kg} - \frac{2.183 < 34\text{kg}}{9} = 1.940 < 34\text{kg} \\ \text{(4th)} \ 2.183 < 34\text{kg} - \frac{2.183 < 34\text{kg}}{16} = 2.046 < 34\text{kg} \\ \text{(5th)} \ 2.183 < 34\text{kg} - \frac{2.183 < 34\text{kg}}{25} = 2.096 < 34\text{kg} \end{array}\right]$$

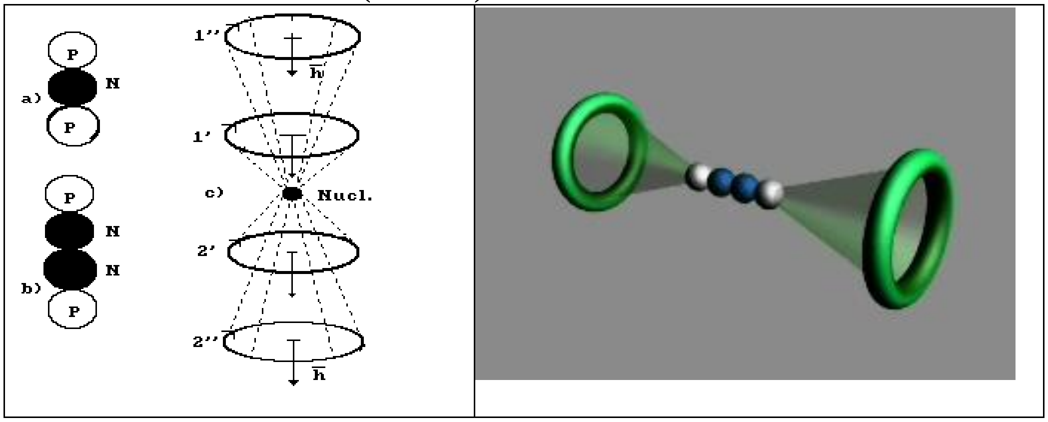
$$\boxed{\begin{array}{l} M_b = \frac{M_1}{n^2} \quad \text{(2nd)} \ \frac{2.183 < 34\text{kg}}{4} = 5.457 < 35\text{kg} \quad \text{(3rd)} \ \frac{2.183 < 34\text{kg}}{9} = 2.426 < 35\text{kg} \\ \text{(4th)} \ \frac{122.451}{16} = 1.364 < 35\text{kg} \quad \text{(5th)} \ \frac{2.183 < 34\text{kg}}{25} = 8.735 < 36\text{kg} \\ \text{(6th)} \ \frac{2.183 < 34\text{kg}}{36} = 6.061 < 36\text{kg} \end{array}}$$

Table-14: Spectrum of the 3rd electron of **lithium** when it is the only remaining electron. Bonded mass on the" stationary mass levels" of the 3rd electron with all three protons;

Values	n	2	3	4	5	6
$M_{ph-\exp}$	kg	1.637<34kg	1.940<34kg	2.046<34kg	2.096<34kg	2.122<34kg
$M_{ph-theor}$	kg	1.637<34kg	1.940<34kg	2.046<34kg	2.096<34kg	2.122<34kg
$m_{b-theor}$	kg	5.457<35kg	2.424<35kg	1.364<35kg	8.735<36kg	6.061<36kg

9.6 Spectrum of the helium atom

A helium atom has two electrons (2e2P2N).



The ionization mass of the 1st electron is $(M_{i1} = 4.383031<35\text{kg})$. The ionization mass of the 2nd electron is $(M_{i2} = 9.700534<35\text{kg})$. Excitation mass is the mass of the absorbed photons. The excitation mass is equal to the difference between the mass of ionization (M_i) and the binding mass level after the electrons absorb photons.

A helium atom with one remaining electron is in an ionized state of (1e2P2N). This state is labeled a helium ion.

For the 1st electron of the helium atom $(M_i = 4.383031<35\text{kg})$.

Table-15: Mass levels of the 1st electron of a **helium** atom

M_i-M_{ph}=M_b					
			Binding mass	Excitation mass	
Level	M_i	M_{ph}	M_b	M_{ph}	
1	4.383931<35	3.73646<35	0.000	3.73646<35	
2	4.383931<35	3.78281<35	0.000	3.78281<35	
3	4.383931<35	4.10191<35	0.000	4.10191<35	
4	4.383931<35	4.11617<35	0.000	4.11617<35	
5	4.383931<35	4.23204<35	0.000	4.23204<35	
6	4.383931<35	4.28552<35	9.75116<37	4.28552<35	
7	4.383931<35	4.31582<35	6.72064<37	4.31582<35	
8	4.383931<35	4.33365<35	4.93797<37	4.33365<35	
9	4.383931<35	4.34435<35	3.86838<37	4.34435<35	
10	4.383931<35	4.35326<35	2.97705<37	4.35326<35	
11	4.383931<35	4.35861<35	2.44225<37	4.35861<35	
12	4.383931<35	4.36217<35	2.08571<37	4.36217<35	
13	4.383931<35	4.36574<35	1.72918<37	4.36574<35	
14	4.383931<35	4.3693<35	1.37265<37	4.3693<35	
15	4.383931<35	4.37109<35	1.19438<37	4.37109<35	

Experimental accuracy of different authors and reference books are around $(\pm 3.565 < 38\text{kg})$. Calculations are accurate to only two decimal places.

The binding mass of the 1st electron on the 1st level is $(2.400889<35\text{kg})$. It is not equal to ionization mass of its electrons $(4.383031<35\text{kg})$. We shall provide and answer when we analyze the formation of the helium atom.

Table-16: Binding mass (M_b) of the 1st electron of the **helium** atom.

levels, n	Excitation mass M_{ph} kg	Binding mass kg	
		experiment	theory $M_b = M_1 / n^2$
1	4.382853<35	?	2.401246<35
2	3.782809<35	6.00757<36	6.007571<36
3	4.116167<35	2.67399<36	2.673993<36
4	4.232040<35	1.51526<36	1.515263<36
5	4.285519<35	9.80464<37	9.804641<37
6	4.315825<35	6.77412<37	6.774116<37
7	4.333651<35	4.99145<37	4.991454<37
8	4.344347<35	3.92186<37	3.921856<37
9	4.353261<35	3.03053<37	3.030525<37
10	4.358609<35	2.49573<37	2.495727<37
11	4.362174<35	1.78266<37	1.782662<37
12	4.365739<35	1.6044<37	1.604396<37
13	4.369305<35	1.42613<37	1.426130<37
14	4.371087<35	1.24786<37	1.247863<37

Using equation (220) and (221), we obtain Table-17. $(M_i = 4.383031<35\text{kg})$ and $(2.400889<35\text{kg})$

$$\left[M_{ph} = M_i - \frac{M_1}{n^2} = (M_i = 4.383031<35\text{kg}) - \frac{(2.400889<35\text{kg})}{4} = 3.782809<35\text{kg} \right]$$

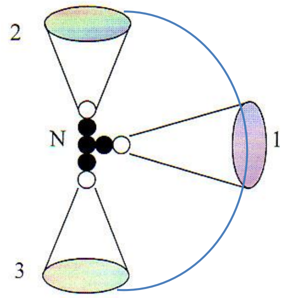
$$\left[M_b = \frac{M_1}{n^2} = \frac{(2.400889<35\text{kg})}{4} = 6.007571<36\text{kg} \right]$$

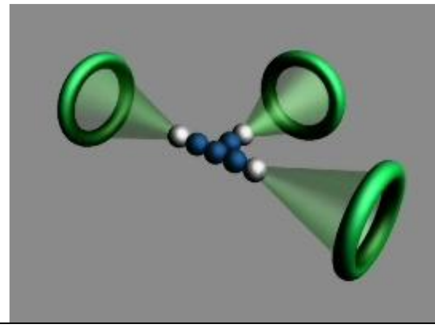
Table-17: Spectrum of the 1st electron of the helium atom.

Values	n	2	3	4	5	6
$M_{ph-\exp}$	kg	3.782809<35	4.116167<35	4.232040<35	24.04	24.21
$M_{ph-theory}$	kg	3.782809<35	4.116167<35	4.232040<35	24.05	24.21
$M_{b-theory}$	kg	6.007571<36	2.67<36	1.50<36	9.63<37	6.60<37

9.7 Spectrum of the **lithium** atom

The lithium atom has three electrons (3e3P4N).





The ionization mass of the 2nd electron of the lithium atom is $(M_i = 1.348 < 34\text{kg})$. We will calculate the binding mass of the 2nd electron at the 2nd level. From reference manuals, experimental excitation mass values for the 2nd electron on the 2nd level are:

$[1.113 < 34\text{kg}(2nd);\ 1.242 < 34\text{kg}(3rd);\ 1.288 < 34\text{kg}(4th);\ 1.310 < 34\text{kg}(5th)]$

[posted in Table-18 as $\left(M_{ph-\exp}\right)$].

The 2nd level of the 2nd electron is $(1.113 < 34\text{kg})$. The difference between the ionization mass $(M_i = 1.348 < 34\text{kg})$ and the excitation mass of the 2nd level $(M_{ph} = 1.113 < 34\text{kg})$.

$$\left[\Delta M = M_i - M_{ph} = 1.348 < 34\text{kg} - 1.113 < 34\text{kg} = 2.358 < 35kg\right] \quad (229)$$

The binding mass of the 2nd electron on the 2nd level $(n^2 = 2^2 = 4)$ is the binding mass of the 2nd electron on the 1st level $(M_1 = (2.358 < 35kg)(4) = 9.432 < 35\text{kg})$.

The ionization mass $(M_i = 1.348 < 34\text{kg})$ of the 2nd electron is not equal to the 1st level of $(M_1 = 9.432 < 35\text{kg})$.

Using these data in equation (220) $\left(M_{ph} = M_i - \frac{M_1}{n^2}\right)$ and (221) $\left(M_b = \frac{M_1}{n^2} = \frac{\vec{h}f_1}{n^2}\right)$ gives Table -18.

$$\left[\begin{array}{ll} M_{ph} = M_i - \frac{M_1}{n^2} = & \\ (2nd)\ 1.348 < 34\text{kg} - \frac{9.432 < 35\text{kg}}{4} = 1.113 < 34\text{kg} & (3rd)\ 1.348 < 34\text{kg} - \frac{9.432 < 35\text{kg}}{9} = 1.244 < 34kg \\ (4th)\ 1.348 < 34\text{kg} - \frac{9.432 < 35\text{kg}}{16} = 1.289 < 34\text{kg} & (5th)\ 75.638eV - \frac{52.912eV}{25} = 1.311 < 34\text{kg} \end{array}\right]$$

$$\left[\begin{array}{ll} M_b = \frac{M_1}{n^2} & \\ (2nd)\ \frac{9.432 < 35\text{kg}}{4} = 2.358 < 35\text{kg} & (3rd)\ \frac{9.432 < 35\text{kg}}{9} = 1.048 < 35\text{kg} \\ (4th)\ \frac{9.432 < 35\text{kg}}{16} = 5.901 < 36\text{kg} & (5th)\ \frac{9.432 < 35\text{kg}}{25} = 3.779 < 36\text{kg} \\ (6th)\ \frac{9.432 < 35\text{kg}}{36} = 2.621 < 36\text{kg} & \end{array}\right]$$

Table-18: Spectrum of the 2nd electron of the **lithium** atom

Values	n	2	3	4	5	6
$M_{ph-\exp}$	kg	1.113<34kg	1.242<34kg	1.288<34kg	1.310<34kg	-
$M_{ph-theory}$	kg	1.113<34kg	1.244<34kg	1.289<34kg	1.311<34kg	1.321<34kg
$M_{b-theory}$	kg	2.358<35kg	1.048<35kg	5.901<36kg	3.779<36kg	2.261<36kg

The ionization of the 1st electron on the 1st level is $(M_i = 9.612 < 36\text{kg})$. The excitation corresponding to the "stationary levels" are $[6.827595 < 36kg(3rd)]$;$[8.057632 < 36kg(4\text{th})]$; $[8.628084 < 36kg(5\text{th})]$; $[8.931137 < 36kg(6\text{th})]$; $[9.109 < 36\text{kg}(7th)]$; $[9.234 < 36\text{kg}(8th)]$; $[9.305 < 36\text{kg}(9th)]$; $[9.359 < 36\text{kg}(10th)]$; $[9.412 < 36\text{kg}(11th)]$; $[9.448 < 36\text{kg}(12th)]$; $[9.446 < 36\text{kg}(13th)]$.

The difference between the ionization mass of the 1st electron and the excitation of the 3rd "stationary level" is $(\Delta M = 9.609 < 36\text{kg} - 6.828 < 36\text{kg} = 2.781 < 36\text{kg})$. The binding mass of the 1st electron with the protons of the fictitious 1st level:

$$\left[M_1 = (\Delta M)(n^2) = (2.781 < 36\text{kg})(3^2) = 2.505 < 35\text{kg}\right] \quad (230)$$

The ionization mass of the 1st electron of lithium is $(M_i = 9.612 < 36\text{kg})$
The fictitious binding mass of the 1st level is $(M_1 = 2.505 < 35\text{kg})$
Using these data in equations (220) and (221), we obtain Table-19.

$$\left[\begin{array}{ll} M_{ph} = M_i - \dfrac{M_1}{n^2} = & \\ (2nd)\ 9.609 < 36\text{kg} - \dfrac{2.505 < 35\text{kg}}{4} = 5.954 < 36\text{kg} & (3\text{rd})\ 9.609 < 36\text{kg} - \dfrac{2.505 < 35\text{kg}}{9} = 1.214 < 35\text{kg} \\ (4\text{th})\ 9.609 < 36\text{kg} - \dfrac{2.505 < 35\text{kg}}{16} = 1.330 < 35\text{kg} & (5\text{th})\ 9.609 < 36\text{kg} - \dfrac{2.505 < 35\text{kg}}{25} = 1.546 < 35\text{kg} \\ (6\text{th})\ 9.609 < 36\text{kg} - \dfrac{2.505 < 35\text{kg}}{36} = 1.581 < 35\text{kg} & \end{array}\right]$$

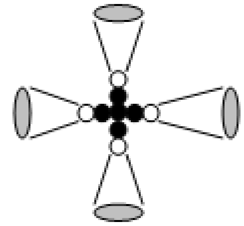
$$\left[\begin{array}{ll} M_b = \dfrac{M_1}{n^2} = (2nd)\dfrac{2.505 < 35\text{kg}}{4} = 6.257 < 36\text{kg} & (3\text{rd})\dfrac{2.505 < 35\text{kg}}{9} = 2.781 < 36\text{kg} \\ (4\text{th})\dfrac{2.505 < 35\text{kg}}{16} = 1.569 < 36\text{kg} & \end{array}\right]$$

Table-19: Spectrum of the 1st **lithium** electron

Values	n	2	3	4	5	6
$M_{ph-\exp}$	kg	-	6.828<36kg	8.058<36kg	8.628<36kg	8.931<36kg
$M_{ph-theory}$	kg	3.351<36kg	6.828<36kg	8.040<36kg	8.610<36kg	8.913<36kg
$M_{b-theory}$	kg	6.257<36kg	2.781<36kg	1.569<36kg	9.983<37kg	6.952<37kg

I am leaving the remainder of this article in the incorrect *eV* units. I would like for you to make the correction from *eV* to mass. This will allow for a better understanding that the only thing that exists is the interactions of mass in motion.

9.8 Spectrum of the Beryllium atom



Beryllium has four electrons (4e4P5N)(100% have **5N**). The ionization energy of the 3rd electron is equal to $(E_i = 153.893eV)$. The excitation energy of the 3rd electron is: 123.67(2nd); 140.39(3rd); 146.28(4th); 149.01(5th); 150.50(6th); 151.40(7th) eV. The difference between the ionization energy of the 3rd electron on energy level 1 and 2 is:

$$\Delta E = 153.893 - 123.67 = 30.223eV \qquad (231)$$

The binding energy of the 3rd electron corresponding to the 1st energy is:

$$E_1 = \Delta E \cdot n^2 = 30.223 \cdot 2^2 = 120.892eV \qquad (232)$$

Using $(E_i = 153.893eV)$ and $(E_1 = 120.892eV)$ in equations (220) and (221), gives Table-20.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 153.893 - \frac{120.892}{4} = 123.67eV \quad (3\text{rd})\ E_{ph} = 153.893 - \frac{120.892}{9} = 140.46eV$$
$$(4\text{th})\ 153.893 - \frac{120.892}{16} = 146.34eV \quad (5\text{th})\ 153.893 - \frac{120.892}{25} = 149.06eV$$
$$(6\text{th})\ 153.893 - \frac{120.892}{36} = 150.53eV$$

$$E_b = \frac{E_1}{n^2} \quad (2\text{nd})\ \frac{120.892}{4} = 30.22eV \quad (3\text{rd})\ \frac{120.892}{9} = 13.43eV \quad (4\text{th})\ \frac{120.892}{164} = 7.56eV$$
$$(5\text{th})\ \frac{120.892}{25} = 4.84eV \quad (6\text{th})\ \frac{120.892}{36} = 3.36eV$$

Table-20: Spectrum of the 3rd electron of the **<u>beryllium</u>** atom

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	123.7	140.4	146.3	149.0	150.5
E_{ph} (theor)	eV	123.7	140.5	146.3	149.0	150.5
E_b (theor)	eV	30.22	13.43	7.56	4.84	3.36

The ionization energy of the 2nd beryllium electron is $(E_i = 18.211eV)$. The excitation energies corresponding to the "stationary energy levels" are: 11.96(3rd); 14.70(4th); 15.99(5th); 16.67(6th); 17.08(7th) eV.

$$\Delta E = 18.21 - 11.96 = 6.25eV$$

The binding energy of the 2nd beryllium electron corresponding to the 1st fictitious energy level is $(E_1 = 6.25 \cdot 9 = 56.259eV)$. Substituting this size and energy of ionization $(E_i = 18.211eV)$ in formulas (220) and (221) gives Table-21.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 18.211 - \frac{56.259}{4} = 4.15eV \quad (3rd)\ E_{ph} = 18.211 - \frac{56.259}{9} = 11.96eV$$
$$(4th)\ 18.211 - \frac{56.259}{16} = 14.70eV \quad (5th)\ 18.211 - \frac{56.259}{25} = 15.96eV$$
$$(6th)\ 18.211 - \frac{56.259}{36} = 16.65eV$$

$$E_b = \frac{E_1}{n^2} \quad (2nd)\ \frac{56.259}{4} = 14.06eV \quad (3rd)\ \frac{56.259}{9} = 6.25eV \quad (4th)\ \frac{56.259}{16} = 3.52eV$$
$$(5th)\ \frac{56.259}{25} = 2.25eV \quad (6th)\ \frac{56.259}{36} = 1.56eV$$

Table-21: Spectrum of the 2nd beryllium electron

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	-	11.96	14.72	15.99	16.67
E_{ph} (theor)	eV	4.15	11.96	14.70	15.96	16.65
E_b (theor)	eV	~~14.81~~ 14.06	6.25	3.52	2.25	1.56

Theory predicts the existence of an excitation energy of $(4.15eV)$. Experiments do not show this line.

The ionization energy of the 1st beryllium electron is $(E_i = 9.322eV)$. The excitation energies are: 5.28(2nd); 7.46(3rd); 8.31(4th); 8.69(5th) eV. Energy difference is $\Delta E = 9.322 - 5.28 = 4.04eV$. The energy corresponding to the first fictitious energy level is $(E_1 = 4.04 \cdot 2^2 = 16.17eV)$.

Using $(E_i = 9.322eV)$ and $(E_1 = 16.17eV)$ in equation (220) and (221) gives Table-22.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 9.322 - \frac{16.17}{4} = 5.28eV \quad \text{(3rd)}\ E_{ph} = 9.322 - \frac{16.17}{9} = 7.53eV$$
$$\text{(4th)}\ 9.322 - \frac{16.17}{16} = 8.31eV \quad \text{(5th)}\ 9.322 - \frac{16.17}{25} = 8.67eV$$
$$\text{(6th)}\ 9.322 - \frac{16.17}{36} = 8.87eV$$

$$E_b = \frac{E_1}{n^2} \quad \text{(2nd)}\ \frac{16.17}{4} = 4.04eV \quad \text{(3rd)}\ \frac{16.17}{9} = 1.80eV \quad \text{(4th)}\ \frac{16.17}{16} = 1.01eV$$
$$\text{(5th)}\ \frac{16.17}{25} = 0.65eV \quad \text{(6th)}\ \frac{16.17}{36} = 0.45eV$$

Table-22: Spectrum of the 1st beryllium electron

Values	n	2	3	4	5	6	7	8
E_{ph} (exper)	eV	5.28	7.46	8.31	8.69	8.86	8.98	9.07
E_{ph} (theor)	eV	5.28	7.53	8.31	8.67	8.87	8.99	9.07
E_b (theor)	eV	4.04	1.80	1.01	0.65	0.45	0.33	0.25

Note: experimental excitation energy values corresponding to the 6th, 7th and 8th power levels are taken from directory [25].

Equations (220) and (221) do not take into account that electrons may wobble. Wobbling would change $(\vec{h})$ and be accompanied by absorption or emission of photons. This would extend spectral lines or form light strips observed in molecular spectra. Atoms with many electrons may require trigonometrical corrections.

When all the electrons are present in an atom, their energy of connection with protons are almost identical.

The electron with the lowest ionization energy is, again, named the 1st electron. We will also name it a valence electron. Every electron in an atom has the potential to be a valence electron. This actually makes the numbering of electrons conditional.

9.9 Spectrum of the 1st Boron electron

Boron has five electrons (5e5P5N). The 1st electron has the lowest ionization energy $(E_i = 8.298eV)$. Boron has the following excitation energies: 4.96(2nd); 5.93; 6.79; 6.82(3rd); 7.44; 7.46(4th); 7.75(5th); 7.88; 7.92(6th); 7.95; 8.02; 8.03(7th); 8.08; 8.09(8th); 8.13(9th); 8.16; 8.18; 8.20; 8.22; 8.23; 8.24; 8.25; 8.26; 8.27 eV. The underlined numbers are probably doublets and triplets. Calculation should give one of the underlined values or their average sizes. Energy difference is $(\Delta E = 8.298 - 4.96 = 3.34eV)$. The binding energy of the for the 1st fictitious energy level is $(E_1 = \Delta E \cdot 2^2 = 3.34 \cdot 4 = 13.35eV)$. Substituting $(E_i = 8.298eV)$ and $(E_1 = 13.35eV)$ in formulas (220) and (221) gives Table-23.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 8.298 - \frac{13.35}{4} = 4.96eV \quad (3rd)\ E_{ph} = 8.298 - \frac{13.35}{9} = 6.82eV$$

$$(4th)\ 8.298 - \frac{13.35}{16} = 7.46eV \quad (5th)\ 8.298 - \frac{13.35}{25} = 7.76eV \quad (6th)\ 8.298 - \frac{13.35}{36} = 7.93eV$$

$$(7th)\ 8.298 - \frac{13.35}{49} = 8.03eV \quad (8th)\ 8.298 - \frac{13.35}{64} = 8.09eV \quad (9th)\ 8.298 - \frac{13.35}{81} = 8.13eV$$

Table-23: Spectrum of the 1st Boron electron

Values	n	2	3	4	5	6	7
E_{ph} (exper)	eV	4.96	6.82	7.46	7.75	7.92	8.02
E_{ph} (theor)	eV	4.96	6.81	7.46	7.76	7.93	8.02
Values	n	8	9	10	11	12	13
E_{ph} (exper)	eV	8.09	8.13	8.16	8.18	8.20	8.22
E_{ph} (theor)	eV	8.09	8.13	8.16	8.18	8.20	8.22
Values	n	14	15	16	17	18	19
E_{ph} (exper)	eV	8.23	8.24	8.25	8.25	8.26	...
E_{ph} (theor)	eV	8.23	8.24	8.25	8.25	8.26	...

Theory and experiment is a very good match.

9.10 Valence electron spectra of selected atoms

Carbon has six electrons (6e6P6N). The valence (1st) [having the least ionization energy] is $(E_i = 11.256eV)$. The "stationary energy level" are: 7.48: 7.68; 7.95; 9.68; 9.71; 9.83; 10.38; 10.39; 10.40; 10.42; 10.43; 10.71; 10.72; 10.73; 10.88; 10.89; 10.98; 10.99; 13.12 eV. The first three underlined values are so close that they form a triplet. We will use an average value $(7.48+7.69+7.95)/3 = 7.70eV$. The energy differences will be $(\Delta E = 11.26 - 7.70 = 3.56eV)$. The fictitious binding energy of the 1st energy level will be $(E_1 = 3.56 \cdot 4 = 14.24eV)$. Substituting $(E_i = 11.256eV)$ and $(E_1 = 14.24eV)$ in equation (220) and (221) gives Table-24.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 11.256 - \frac{14.24}{4} = 7.70eV \quad (3rd)\ 11.256 - \frac{14.24}{9} = 9.67eV$$

$$(4th)\ 11.256 - \frac{14.24}{16} = 10.37eV \quad (5th)\ 11.256 - \frac{14.24}{25} = 10.69eV$$

$$(6th)\ 11.256 - \frac{14.24}{36} = 10.86eV$$

Table-24: Spectrum of 1st **carbon** electron

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	7.68	9.67	10.37	10.69	10.86
E_{ph} (theor)	eV	7.70	9.68	10.38	10.71	10.88
E_b (theor)	eV	3.58	1.58	0.89	0.57	0.39

The binding energy of all electrons to protons from a free electron condition is close to identical. This seems to contradict experiments as there are different binding energies to protons. The explanation is the conditions under which the binding energies are taken.

Spectral lines occur when an electron is emitted from an atom. Almost all of the electrons have and equal opportunity to be that electron. As soon as one electron is emitted from the atom, the protons increase their attractive action and the energy to remove the next electron is increased.

When there is only one electron remaining, the binding energy is proportionally to the square of number of protons.

All electrons have the same binding energy levels (E_b) as a hydrogen electron.

Oxygen has 8 electrons (8e8P8N). For oxygen electrons, the ionization energy of the 1st electron is $(E_i = 13.618eV)$. The binding energy of the 1st electron at the 1st energy level is $(E_1 = 13.752eV)$. Using equations (220) and (221) gives Table-25.

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 13.618 - \frac{13.752}{4} = 10.18eV \quad (3rd)\ 13.618 - \frac{13.752}{9} = 12.09eV$$

$$(4th)\ 13.618 - \frac{13.752}{16} = 12.76eV \quad (5th)\ 13.618 - \frac{13.752}{25} = 13.07eV$$

$$(6th)\ 13.618 - \frac{13.752}{36} = 13.24eV$$

$$E_b = \frac{E_1}{n^2} \quad (2nd)\ \frac{13.752}{4} = 3.43eV \quad (3rd)\ \frac{13.752}{9} = 1.53eV \quad (4th)\ \frac{13.752}{16} = 0.86eV$$

$$(5th)\ \frac{13.752}{25} = 0.55eV \quad (6th)\ \frac{13.752}{36} = 0.38eV$$

Table-25: Spectrum of the 1st **oxygen** electron

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	10.18	12.09	12.76	13.07	13.24
E_{ph} (theor)	eV	10.16	12.09	12.76	13.07	13.24
E_b (theor)	eV	3.44	1.53	0.86	0.55	0.38

For oxygen, the ionization energy of the 2nd electron is $(E_i = 35.116eV)$. The binding of the 2nd electron on the 1st energy level is $(E_1 = 83.98eV)$. Using equation (220) and (221) gives Table-26

$$E_{ph} = E_i - \frac{E_1}{n^2} = (2nd)\ 35.116 - \frac{83.98}{4} = 14.12eV \quad (3rd)\ 35.116 - \frac{83.98}{9} = 25.78eV$$

$$(4th)\ 35.116 - \frac{83.98}{16} = 29.87eV \quad (5th)\ 35.116 - \frac{83.98}{25} = 31.76eV$$

$$(6th)\ 35.116 - \frac{83.98}{36} = 32.78eV$$

$$E_b = \frac{E_1}{n^2} \quad (2nd)\ \frac{83.98}{4} = 21.00eV \quad (3rd)\ \frac{83.98}{9} = 9.33eV \quad (4th)\ \frac{83.98}{16} = 5.25eV$$

$$(5th)\ \frac{83.98}{25} = 3.36eV \quad (6th)\ \frac{83.98}{36} = 2.33eV$$

Table-26: Spectrum of the 2nd **oxygen** electron

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	14.12	25.83	29.81	31.73	32.88
E_{ph} (theor)	eV	14.12	25.79	29.87	31.76	32.78
E_b (theor)	eV	21.00	9.33	5.25	3.36	2.33

Chlorine has 17 electrons (17e17P18N). Ionization potential of the 1st electron is $(E_i = 12.967eV)$. The binding energy of the electron to the proton on the 1st energy level is $(E_1 = 15.548eV)$. Using equation (220) and (221) gives Table-27.

$$E_{ph} = E_i - \frac{E_1}{n^2} = \text{(2nd) } 12.967eV - \frac{15.548eV}{4} = 9.08eV \quad \text{(3rd) } 12.967eV - \frac{15.548eV}{9} = 11.24eV$$

$$\text{(4th) } 12.967eV - \frac{15.548eV}{16} = 11.99eV \quad \text{(5th) } 12.967eV - \frac{15.548eV}{25} = 12.34eV$$

$$E_b = \frac{E_1}{n^2} \quad \text{(2nd) } \frac{15.548}{4} = 3.89eV \quad \text{(3rd) } \frac{15.548}{9} = 1.72eV \quad \text{(4th) } \frac{15.548}{16} = 0.97eV$$

$$\text{(5th) } \frac{15.548}{25} = 0.62eV \quad \text{(6th) } \frac{15.548}{36} = 0.43eV$$

Table-27: Spectrum of 1-st electron of atom of chlorine

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	9.08	11.25	12.02	12.34	12.53
E_{ph} (theor)	eV	9.08	11.24	11.99	12.34	12.54
E_b (theor)	eV	3.89	1.72	0.97	0.62	0.43

Copper has 29 electrons (29e29P34N). The potential of ionization of its 1st electron is $(E_i = 7.724eV)$. The binding energy at the 1st fictitious energy level is $(E_1 = 98.85eV)$. Using equations (220) and (221) gives Table-28.

$$E_{ph} = E_i - \frac{E_1}{n^2} = \text{(5th) } 7.724eV - \frac{98.85eV}{25} = 3.77eV \quad \text{(6th) } 7.724eV - \frac{98.85eV}{36} = 4.98eV$$
$$\text{(7th) } 7.724eV - \frac{98.85eV}{49} = 5.71eV \quad \text{(8th) } 7.724eV - \frac{98.85eV}{64} = 6.18eV$$

$$E_b = \frac{E_1}{n^2} \quad \text{(5th) } \frac{98.85eV}{25} = 3.95eV \quad \text{(6th) } \frac{98.85eV}{36} = 2.75eV \quad \text{(7th) } \frac{98.85eV}{49} = 2.02eV$$
$$\text{(8th) } \frac{98.85eV}{64} = 1.54eV \quad \text{(9th) } \frac{98.85eV}{81} = 1.22eV$$

Table-28: Spectrum of 1st electron of the copper atom

Values	n	5	6	7	8	9
E_{ph} (exper)	eV	3.77	4.97	5.72	6.19	6.55
E_{ph} (theor)	eV	3.77	4.98	5.71	6.18	6.50
E_b (theor)	eV	3.96	2.75	2.02	1.54	1.22

Gallium has 31 electrons (31e31P38N). The ionization energy of the 1st electron is $(E_i = 6.00eV)$. The binding energy of the 1st electron on the 1st energy level is $(E_1 = 46.88eV)$. Using equations (220) and (221) gives Table-29.

$$E_{ph} = E_i - \frac{E_1}{n^2} = \text{ (5th) } 6.00eV - \frac{46.88eV}{25} = 4.12eV \text{ (6th) } 6.00eV - \frac{46.88eV}{36} = 4.70eV$$
$$\text{(7th) } 6.00eV - \frac{46.88eV}{49} = 5.04eV$$

$$E_b = \frac{E_1}{n^2} \text{ (5th) } \frac{46.88eV}{25} = 1.88eV \text{ (6th) } \frac{46.88eV}{36} = 1.30eV \text{ (7th) } \frac{46.88eV}{49} = 0.96eV$$
$$\text{(8th) } \frac{46.88eV}{64} = 0.73eV \text{ (9th) } \frac{46.88eV}{81} = 0.58eV$$

Table-29: Spectrum of 1st electron of the gallium atom

Values	n	5	6	7	8	9
E_{ph} (exper)	eV	4.11	4.71	5.06	5.23	5.40
E_{ph} (theor)	eV	4.12	4.70	5.04	5.27	5.42
E_b (theor)	eV	1.87	1.30	0.96	0.73	

Sodium has 11 electrons (11e11P12N)(100%). The 1st electron of the sodium atom has the least binding energy and is the main valence electron. The ionization energy of the 1st electron is $(E_i = 5.139eV)$. The binding energy of the 1st electron on the 1st energy level is $(E_{1`} = 13.086eV)$. Using equations (220) and (221) gives Table-30.

$$E_{ph} = E_i - \frac{E_1}{n^2} = \text{ (3rd) } 5.138eV - \frac{13.086eV}{9} = 3.68eV \text{ (4th) } 5.138eV - \frac{13.086eV}{16} = 4.32eV$$

$$\text{(5th) } 5.138eV - \frac{13.086eV}{25} = 4.61eV$$

$$E_b = \frac{E_1}{n^2} \text{ (2nd) } \frac{13.086eV}{4} = 3.27eV \text{ (3rd) } \frac{13.086eV}{9} = 1.45eV \text{ (4th) } \frac{13.086eV}{16} = 0.82eV$$

$$\text{(5th) } \frac{13.086eV}{25} = 0.52eV \text{ (6th) } \frac{13.086eV}{36} = 0.36eV$$

Table-30: Spectrum of 1st electron of the sodium atom

Values	n	2	3	4	5	6
E_{ph} (exper)	eV	-	3.68	4.31	4.62	4.78
E_{ph} (theor)	eV	-	3.68	4.32	4.62	4.77
E_b (theor)	eV	3.27	1.45	0.82	0.52	0.36

The 1st and 2nd energy levels are fictitious for sodium.