Radiation Power Equilibrium as key to Nuclear Forces

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ABSTRACT: Assuming that the Hydrogen Proton is at rest, the force on the orbiting hydrogen electron is

$$m_{\mathrm{e}}\frac{v_{\mathrm{e}}^2}{r_{\mathrm{e}}} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{\mathrm{e}}^2}.$$

However, the accelerating electron radiates energy towards the proton, and would fall on the proton in a split second if that energy would not be returned by the proton to the electron. Thus, to prevent the annihilation of the Hydrogen Atom, the proton must be accelerating and orbiting the electron, the same as the sun orbits the earth. Then, the force on the proton is

$$M_{\mathrm{p}}\frac{V_{\mathrm{p}}^2}{\rho_{\mathrm{p}}} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{\rho_{\mathrm{e}}^2}.$$

The total ignorance of the proton's equation, renders baseless any Atomic analysis done since Bohr to these days. In particular, the Schrödinger equation does not compensate for the missing

electrodynamics here, because that equation too assumes that the proton is at rest.

We establish here, that the Proton's Motion is the key to Quantized Angular Momentum in the nucleus and in the Atom, to Nuclear Energy, to the Nuclear Forces, and to the Structure of the Nucleus, and the Atom.

In particular, we emphasize Nuclear Forces because the enigma of Nuclear Forces have never been resolved. To date there is no explanation why the closely packed positive protons that repulse each other at extreme forces inversely proportional to the squared distance, stay bonded together, and how the neutral neutrons bond them.

The claims that nuclear forces are the "leaking" of the strong forces between quarks that were never directly detected, are speculative if not hallucinated. And remind more of religious arguments, than Physics.

Here, perceiving the neutron as a mini-Hydrogen Atom, we establish the motion of the protons, and the radiation power equilibrium between nucleonic electrons and protons as the source of the Nuclear Forces.

The nuclear force is not a special force that defies electrical repulsion. It is the result of the motion of the Atomic protons, and the Neutronic protons in the nucleus. The moving protons stay packed together, bonded by the Neutronic electrons orbitals.

Using the Zinc Nucleus as an example, we compute (with Numbers, Not Lagrangians) Nuclear Forces, and Energies for the Zinc Nucleus.

Regarding Angular Momentum, the electron in the n^{th} Hydrogen orbit, has angular momentum $n\hbar$, and the Quantum of Angular Momentum for the Hydrogen Atom is $\hbar$.

This determines the n^{th} orbit radius, the speed of the Hydrogen electron in the n^{th} orbit, and the frequency of the electron motion in the n^{th} orbit.

For instance, the force on the n^{th} orbit Hydrogen electron is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_n^2} = m_e\frac{v_n^2}{r_n},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (m_e v_n r_n)^2 \frac{1}{m_e}\frac{1}{r_n},$$

And applying $m_e v_n r_n = n\dfrac{h}{2\pi}$,

$$r_n = n^2\frac{\varepsilon_0}{m_e e^2}\frac{h^2}{\pi}.$$

Thus, quantized angular momentum is essential to determining the radius, speed, and frequency in electron orbits:

[Born, p.113] expresses the false belief that $\hbar$ is the quantum of angular momentum for any atom:

> *"It seems now a natural suggestion, that we should regard the quantization condition for the angular momentum as an essential feature of the new mechanics. We therefore postulate that it is universally valid."*

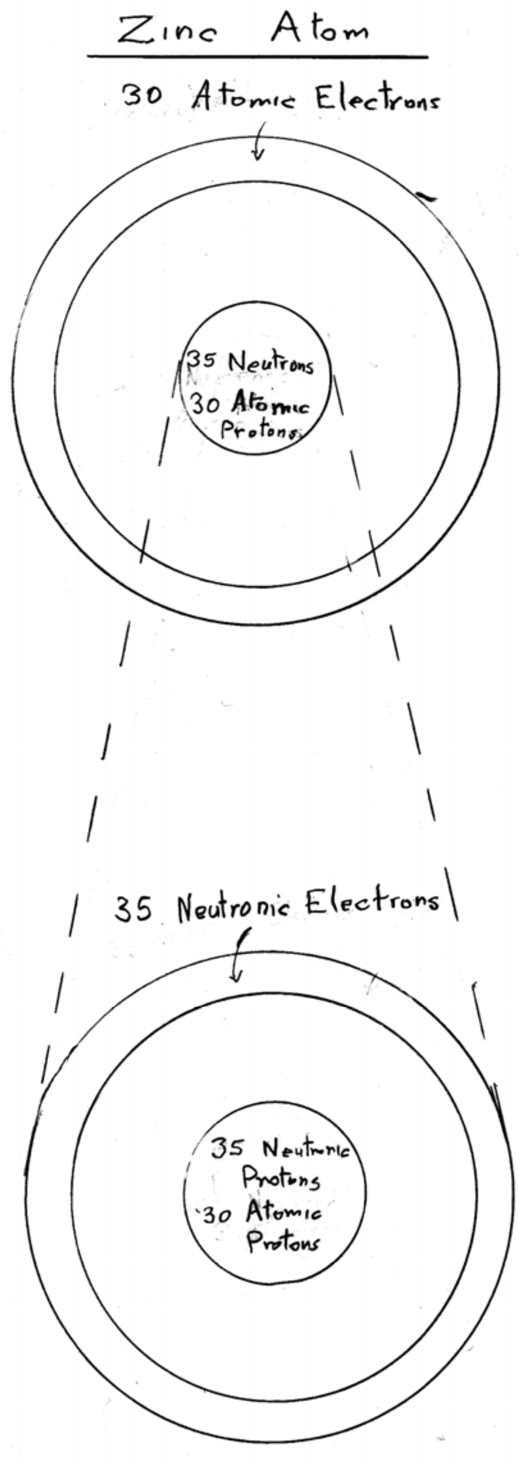
In fact, any Atom has its particular quantum of angular momentum for its proton orbits, and its particular quantum of Angular Momentum for its electron orbits, both different from $\hbar$.

Consequently, the radius, speed, and frequency obtained based on the assumption that the quantum of angular momentum is $\hbar$, are all wrong.

The existing theory requires the quantum of angular momentum in order to obtain the radius, speed and frequency. And to obtain that quantum of angular momentum we need to know the radius, and the speed.

We resolve this paradox by utilizing radiation equilibrium which is the reason for the quantized angular momentum.

As in [Dan5], we assume that the Neutron is a collapsed Hydrogen Atom. Consequently, in the Zinc nucleus the 35 neutrons add 35 protons to the 30 atomic protons, and 35 electrons that orbit those 65 protons, within the nucleus boundary. Clearly, the 60 protons are moving in their own orbits within the Nucleus.


Zinc Atom
30 Atomic Electrons
35 Neutrons
30 Atomic Protons
35 Neutronic Electrons
35 Neutronic Protons
30 Atomic Protons

The Zinc Nucleus has A=65 Nucleons: $Z = 30$ Protons, and $A - Z = 35$ Neutrons. We assume that each neutron is a mini-Hydrogen atom made of an electron and a proton.

The Nucleonic electrons orbitals bond the Protons, and the Neutronic Protons of the Nucleus.

The 30 Protons, the 35 Neutronic Protons and the 35 Nucleonic electrons constitute the Zinc Nucleus.

The 35 Nucleus electrons at orbit radius r_{Nuc}, encircle the 65 Protons that orbit the center at radius ρ_{p}.

We approximate the 35 Neutronic electrons by

a charge of 35e,

with mass $35m_{\text{e}}$

orbiting the center at radius r_{Nuc},

and speed $\beta_{\text{Nuc}}c$.

We approximate the 65 protons by

a charge of 65e,

with mass $65M_{\text{p}}$

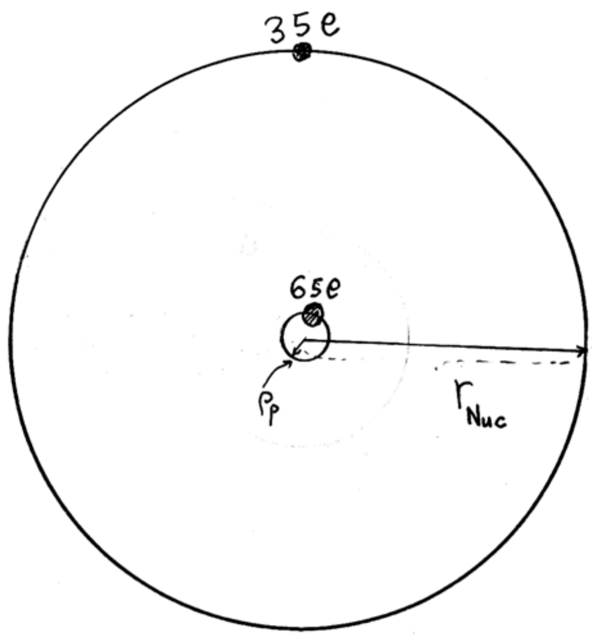
orbiting the center at radius ρ_{p},

and speed $\beta_{\text{p}}c$.

The nucleus is stable because the power radiated by the accelerating Neutronic electrons towards the Protons, equals the power radiated by the accelerating protons towards the Neutronic electrons

To derive the orbits speeds, radii, frequencies, angular momentums, and energies of the Neutronic electrons, and the protons in the nucleus, we apply Einstein's mass-energy equation, and our Radiation Power Equilibrium between the 35 Neutronic electrons, and the 65 protons.

ZINC-NUCLEUS RADIATION POWER EQUILIBRIUM



65 protons with mass $65M_{\text{p}}$, charge 65e, and radius ρ_{p}

30 electrons with mass $35m_{\text{e}}$, charge 35e and radius r_{Nuc}

Next, we assume that the Zinc Atom 30 spectral electrons interact only with the Zinc's 30 atomic protons, and those 30 protons orbits define the Zinc's nucleus boundary.

The 30 Atomic electrons orbitals orbit the 30 atomic protons, and bond the Zinc Atom.

Since the 30 Atomic electrons do not interact with the interior of the nucleus, the 30 Atomic protons appear located at the boundary of the nucleus, orbiting the center at radius r_{Nuc}.

We approximate the 30 atomic electrons by

a charge of 30e,

with mass $30m_{\text{e}}$

orbiting the center at radius r_{e},

and speed $\beta_{\text{e}}c$.

We approximate the 30 atomic protons by

a charge of 30e,

with mass $30M_{\text{p}}$

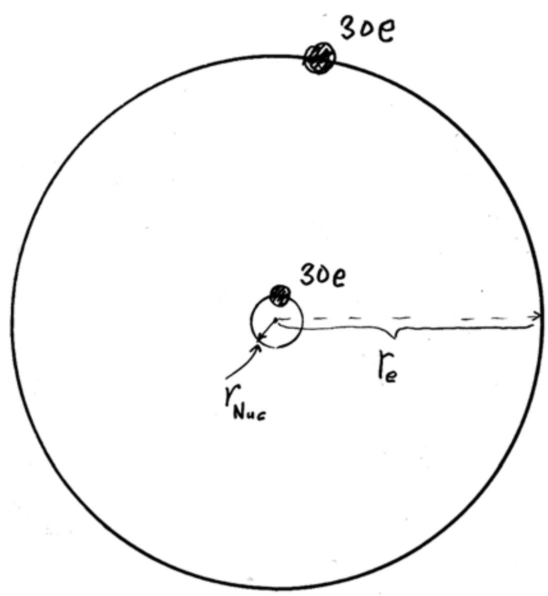
orbiting the center at radius r_{Nuc},

and speed $\beta_{\text{pNuc}}c$.

The Zinc atom is stable because the power radiated by the accelerating atomic electrons towards the Atomic Protons, equals the power radiated by the accelerating atomic protons towards the atomic electrons

To derive the orbits speeds, radii, frequencies, angular momentums, and energies of the 30 Atomic electrons, and the 30 Atomic protons in the nucleus, we apply our Radiation Power Equilibrium between the 30 Atomic electrons, and the 30 Atomic protons.

ZINC-ATOM RADIAION POWER EQUILIBRIUM



30 Atomic protons with mass $30M_p$**, and radius** r_{Nuc}

30 Atomic electrons with mass $30m_e$**, and radius** r_e

In conclusion, we obtain numerical values for orbit speeds, radii, frequencies, angular momentums, energies, and forces between electrons and protons, in the nucleus, and in the atom. We sum these up in the following Summary.

SUMMARY OF NUMERICAL RESULTS

Hydrogen Proton nth Orbit

$$\text{Radius}\quad \rho_{\mathrm{H},n} = n^2 r_{\mathrm{H}}\sqrt{\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}} \approx n^2(1.221173735)10^{-12}\ \mathrm{m}$$

$$\text{Speed}\ V_{\mathrm{H},n} = \frac{1}{n}\frac{c}{137}\left(\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}\right)^{\frac{1}{4}} \approx \frac{1}{n}334{,}528\ \mathrm{m/sec}$$

$$\text{Frequency}\ \frac{\Omega_{\mathrm{H},n}}{2\pi} = \frac{1}{n^3}\frac{\frac{c}{137}}{2\pi r_{\mathrm{H}}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx \frac{1}{n^3}4.311097293\times 10^{16}\,\text{cycles/sec}$$

$$\text{Angular Momentum}\ M_{\mathrm{p}}\rho_n^2\Omega_n = n\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}\hbar = n(6.546018057)\hbar$$

$$\text{Quantum of Angular Momentum}\ (6.546018057)\hbar$$

Neutron's Electron nth Orbit

$$\text{Radius}\ r_{\mathrm{ne},n} \sim n^2(9.398741807)10^{-14}\,\mathrm{m}$$

$$= n^2(1.776104665)10^{-3} r_{\mathrm{H}}$$

$$\text{Speed}\ v_{\mathrm{ne},n} \sim \frac{1}{n}51{,}558{,}134\ \mathrm{m/sec}$$

$$= \frac{1}{n}\frac{v_{\mathrm{H}}}{0.043132065}$$

$$\text{Frequency}\ \frac{\omega_{\mathrm{ne},n}}{2\pi} \sim 8.73067052\times 10^{19}\,\text{cycles/sec}$$

$$= \frac{1}{n^3} 1.305362686 \times 10^4 \frac{\omega_{\mathrm{H}}}{2\pi} \text{ cycles/sec}.$$

Angular Momentum $\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{ne},n}^2}} v_{\mathrm{ne},n} r_{\mathrm{ne},n} = n(0.043132065)\hbar$

Quantum of Angular Momentum $(0.043132065)\hbar$

Neutron's Proton n^th^ Orbit

Radius $\rho_{\mathrm{np},n} \sim n^2(2.209505336)10^{-15}$,

Speed $V_{\mathrm{np},n} \sim \frac{1}{n} 7,905,145 \text{ m/sec}$,

Frequency $\frac{\Omega_{\mathrm{np}}}{2\pi} \sim 5.69422884 \times 10^{20} \text{cycles/second}$.

Angular Momentum $\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np},n}^2}} (\beta_{\mathrm{np},n} c) \rho_{\mathrm{np},n} = n(0.277126027)\hbar$

Quantum of Angular Momentum $(0.277126027)\hbar$

The Zinc Nucleus

1) *is at Radiation Power Equilibrium* $\Leftrightarrow$

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}} r_{\mathrm{Nuc}}^2 \approx \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}} \rho_{\mathrm{p}}^2$$

2) $$\frac{1}{65}\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}\beta_{\mathrm{Nuc}}^2 r_{\mathrm{Nuc}} = \frac{e^2}{10^7} = \frac{1}{35}\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}\beta_{\mathrm{p}}^2\rho_{\mathrm{p}}$$

3) $$\frac{r_{\mathrm{Nuc}}}{35\beta_{\mathrm{Nuc}}^2} \approx \frac{\rho_{\mathrm{p}}}{65\beta_{\mathrm{p}}^2}$$

4) $$\frac{r_{\mathrm{Nuc}}}{\rho_{\mathrm{p}}} \sim \sqrt{\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}} \approx 42.5$$

5) $$\beta_{\mathrm{Nuc}}^2 \sim 42.5\frac{65}{35}\beta_{\mathrm{p}}^2$$

6) $$\frac{\Omega_{\mathrm{p}}}{\omega_{\mathrm{Nuc}}} \sim \sqrt{\frac{35}{65}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx 4.803464029$$

7) **Mass-Energy** $$\underbrace{M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}}}_{\Delta m} \approx \frac{1}{2}\frac{1}{10^7}65\frac{e^2}{\rho_{\mathrm{p}}}\left(1+\frac{\rho_{\mathrm{p}}}{r_{\mathrm{Nuc}}}\right)$$

Zinc Nucleus Proton n^th Orbit

Orbit Radius $$\rho_{\mathrm{p},n} \sim n^2(1.436178468)10^{-13}$$

Speed $$V_{\mathrm{p},n} \sim \frac{1}{n}5,801,257 \quad \mathrm{m/sec}$$

Frequency $$\frac{\Omega_{\mathrm{p},n}}{2\pi} = \frac{1}{n^3}6.42885789\times 10^{18}\,\mathrm{cycles/sec}$$

$$\text{Angular Momentum } \frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p},n}^2}} V_{\text{p},n}\rho_{\text{p},n} = n(13.21701291)\hbar$$

$$\text{Quantum of Angular Momentum } (13.21701291)\hbar$$

$$\text{Nucleus Radiation Equilibrium} \Leftrightarrow \text{Quantized Angular Momentum}$$

Zinc Nucleus Electron n^th Orbit

$$\text{Orbit Radius} \quad r_{\text{Nuc},n} \approx n^2 \frac{35}{65} \beta_{\text{Nuc},n}^2 \frac{\rho_{\text{p},n}}{\beta_{\text{p},n}^2} \sim n^2 (6.108688998)10^{-12}$$

$$\text{Speed} \quad v_{\text{Nuc},n} \sim \frac{1}{n} 51,560,184 \text{ m/sec}$$

$$\sim \text{Neutron Electron Speed}$$

$$\text{Frequency} \quad \frac{\omega_{\text{Nuc},n}}{2\pi} = \frac{1}{n^3} 1.343341943 \times 10^{18} \text{cycles/sec}$$

$$\text{Angular Momentum } \frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc},n}^2}} v_{\text{Nuc},n} r_{\text{Nuc},n} = n(2.761794253)\hbar$$

$$\text{Quantum of Angular Momentum } (2.761794253)\hbar$$

The Zinc Atom

1) *is at Radiation Power Equilibrium* $\Leftrightarrow$

$$\frac{30 m_{\text{e}}}{\sqrt{1-\beta_{\text{e}}^2}} r_{\text{e}}^2 \approx \frac{30 M_{\text{p}} + 35 M_{\text{n}}}{\sqrt{1-\beta_{\text{pNuc}}^2}} r_{\text{Nuc}}^2$$

2) $$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\beta_{\mathrm{e}}^2 r_{\mathrm{e}} = \frac{(30e)^2}{10^7} = \frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\beta_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}}$$

3) $$\frac{r_{\mathrm{e}}}{\beta_{\mathrm{e}}^2} \approx \frac{r_{\mathrm{Nuc}}}{\beta_{\mathrm{pNuc}}^2}$$

4) $$\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}} \approx \sqrt{\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} + \frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}} \approx 63$$

5) $$\beta_{\mathrm{e}}^2 \sim \frac{1}{\sqrt{63}}\frac{30}{65}\beta_{\mathrm{Nuc}}^2$$

6) $$\frac{\Omega_{\mathrm{pNuc}}}{\omega_{\mathrm{e}}} = \left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} + \frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx \sqrt{63} \approx 7.937253933$$

Zinc Atomic Electron nth Orbit

Orbit Radius $$r_{\mathrm{e},n} \sim n^2(3.903068097)10^{-10}\,\mathrm{m}$$

Speed $$v_{\mathrm{e},n} \sim \frac{1}{n}4,446,105 \ \mathrm{m/sec}$$

Frequency $$\frac{\omega_{\mathrm{e},n}}{2\pi} = \frac{1}{n^3}1.81298294 \times 10^{15}\,\mathrm{cycles/sec}$$

Angular Momentum $$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}v_{\mathrm{e},n}r_{\mathrm{e},n} = n(14.99154238)\hbar$$

$$\text{Quantum of Angular Momentum } (14.99154238)\hbar$$

Zinc Atomic Proton n[th] Orbit

$$\text{Orbit Radius} \quad r_{\text{Nuc},n} \sim n^2(6.108688998)10^{-12}$$

$$\text{Speed} \quad V_{\text{pNuc},n} \sim \frac{1}{n}556,225 \ \text{ m/sec}$$

$$\text{Frequency} \quad \frac{\Omega_{\text{pNuc},n}}{2\pi} \sim \frac{1}{n^3}(1.439010597)10^{16}\text{cycles/sec}$$

$$\text{Angular Momentum } \frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{pNuc},n}^2}} V_{\text{pNuc},n} r_{\text{Nuc},n} \approx n(53.89157159)\hbar$$

$$\text{Quantum of Angular Momentum } (53.89157159)\hbar$$

$$\text{Atomic Radiation Equilibrium} \Leftrightarrow \text{Quantized Angular Momentum}$$

Zinc Nucleus Zero Point Energy

$$-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\hbar\omega_{\text{Nuc}} \sim -268,285 \ \text{eV}$$

$$-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\text{Nuc}}} \sim -268,498 \ \text{eV}$$

$\sim$ *19,743×(Hydrogen's Zero Point Energy)*

The Zinc Nucleus Zero Point Energy Frequency

$$2\frac{268{,}498\ \text{eV}}{h} \sim 1.298451396 \times 10^{20}\,\text{cycles/sec}$$

$$(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi} \sim (1.297990381)10^{20}\ \ \text{cycles/sec}$$

Zinc Nucleus Nuclear Binding Energy

$$-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{p}}}\hbar\Omega_{\text{p}} = -11,415,889\ \text{eV}$$

$$-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\text{p}}} \sim -11,420,788\ \text{eV}$$

$\sim$ *42.5*$\times$*(Nucleus Zero Point Energy Binding)*

$\sim$ *19349*$\times$*(Hydrogen's Nuclear Energy Binding)*

Zinc Nucleus Nuclear Force

$\sim$ *1836*$\times$*(Zinc Nucleus Zero Point Energy Force)*

$\sim$ *7,287,084*$\times$*(Zinc Atomic Zero Point Energy Force)*

$\sim$ *694,938,230*$\times$*(Hydrogen's Nuclear Force)*

Zinc Atomic Nuclear Force

$\sim$ *3969*$\times$*(Zinc Atomic Zero Point Energy Force)*

Zinc Nuclear Binding Energy

$$\sim 19{,}688 \times (\text{Hydrogen Binding Energy})$$

$$\sim 108 \times (\text{The Zinc Atomic Binding Energy})$$

Force on a Zinc Nucleus Proton

$$\sim 2{,}142 \times (\text{Force on a Zinc Atomic Proton})$$

Force on a Zinc Nucleus Electron

$$\sim 8845 \times (\text{Force on a Zinc Atomic Electron})$$

Keywords: Subatomic, Photon, Neutron Radius, electron Radius, Composite Particles, Quark, electron, Proton, Proton Radius, Neutron, Graviton, Radiation Energy, Kinetic Energy, Gravitational Energy, Rotation Energy, Electric Energy, Orbital Magnetic Energy, Spin Magnetic Energy, Centripetal Force, Lorentz Force, Electric Charge, Mass-Energy, Wave-particle, Inertia Moments, Nuclear Structure, Nucleus Stability, Nuclear Force, Nuclear Bonding, Orbitals, Electromagnetic Spectrum, X Ray, Bohr Model, Hydrogen Atom, Radiation Equilibrium, Neutron Star,

Physics**A**stronomy**C**lassification**S**cheme**:** 14.20-c, 14.20.Dh, 14.60Cd, 14.60.Ef, 14.60.Fg, 14.60. 14.65.-q, 14.65.Bt, 14.70.Bh, 47.32.-y, 47.32.C, 03.75.-b, 03.75.Be, 61.05.J-, 61.05.fm,

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VI. SUMMARY OF NUMERICAL RESULTS

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Protons' Motion as key to Quantized Angular Momentum & Nuclear Forces

Assuming that the Hydrogen Proton is at rest, the force on the orbiting hydrogen electron is

$$m_{\mathrm{e}} \frac{v_{\mathrm{e}}^2}{r_{\mathrm{e}}} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{\mathrm{e}}^2}.$$

However, the accelerating electron radiates energy towards the proton, and would fall on the proton in a split second if that energy would not be returned by the proton to the electron. Thus, to prevent the annihilation of the Hydrogen Atom, the proton must be accelerating and orbiting the electron, the same as the sun orbits the earth. Then, the force on the proton is

$$M_{\mathrm{p}} \frac{V_{\mathrm{p}}^2}{\rho_{\mathrm{p}}} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{\rho_{\mathrm{e}}^2}.$$

The ignorance of this equation, renders baseless any analysis done since Bohr to these days. In particular, the Schrödinger equation does not compensate for the missing electrodynamics here, because that equation too assumes that the proton is at rest.

Only Proton's Motion ensures Radiation Power Equilibrium which is key to Quantized Angular Momentum in the nucleus and in the Atom, to Nuclear Energy, to the Nuclear Forces, and to the Structure of the Nucleus, and the Atom.

0.1 The Angular Momentum Quantum is $h/2\pi$ only for the Hydrogen Electron.

It can be shown that The electron in a Hydrogen orbit m, has angular momentum $m\hbar$, and that the Quantum of Angular Momentum for the Hydrogen Atom is $\hbar$.

This enables the determination of the orbit radius, the speed, and the frequency of the electron in the orbit:

For instance, the force on the n[th] orbit Hydrogen electron is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_n^2} = m_e\frac{v_n^2}{r_n},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (m_e v_n r_n)^2\frac{1}{m_e}\frac{1}{r_n},$$

And applying $m_e v_n r_n = n\dfrac{h}{2\pi}$,

$$r_n = n^2\frac{\varepsilon_0}{m_e e^2}\frac{h^2}{\pi}.$$

As shown in [Dan4], already the Hydrogen Proton in its orbits has a different Quantum of Angular Momentum.

[Born, p.113] expresses the false belief that $\hbar$ is the quantum of angular momentum for any atom:

> *"It seems now a natural suggestion, that we should regard the quantization condition for the angular momentum as an essential feature of the new mechanics.*
>
> *We therefore postulate that it is universally valid."*

In fact, any Atom has its own quantum of angular momentum for its proton orbits, and its own quantum of Angular Momentum for its electron orbits, which is different from $\hbar$.

For instance, $\hbar$ is NOT the Angular Momentum Quantum of a Zinc Electron.

The key to determining the Quantum of Angular Momentum is the Radiation Power Equilibrium mandated by the Proton's Motion:

0.2 Nuclear Motion, and Radiation Power Equilibrium as key to Quantized Angular Momentum

The Force on the Zinc electron is

$$\frac{m_e}{\sqrt{1-\beta_e^2}}\frac{v_e^2}{r_e} = \frac{1}{4\pi\varepsilon_0}\frac{30e^2}{r_e^2},$$

$$\frac{m_e}{\sqrt{1-\beta_e^2}}v_e^2 r_e = \frac{1}{4\pi\varepsilon_0}30e^2,$$

$$= \frac{c^2}{10^7} 30e^2.$$

Assuming $\sqrt{1-\beta_e^2} \approx 1$,

$$\frac{(m_e v_e r_e)^2}{m_e r_e} \approx \frac{c^2}{10^7} 30e^2.$$

Assuming that $m_e v_e r_e = k\hbar$,

$$\frac{(k\hbar)^2}{m_e r_e} \approx \frac{c^2}{10^7} 30e^2.$$

The orbit radius is

$$r_e \approx \frac{k^2}{30} \frac{10^7 \hbar^2}{m_e c^2 e^2}$$

$$= \frac{k^2}{30} 5.29177249 \times 10^{-11}$$

$$= k^2 \cdot 1.763924163 \times 10^{-12}$$

Radiation Power equilibrium mandated by the Nucleus motion enables us to obtain in 25.5,

$$r_e \sim 3.848474069 \times 10^{-10}\,\mathrm{m}$$

Therefore, we obtain

$$k = \sqrt{\frac{3.848474069 \times 10^{-10}\,\mathrm{m}}{1.763924163 \times 10^{-12}}},$$

$$= 14.77081054$$

Thus, the Zinc Quantum of Angular Momentum is

$$\sim (14.77081054)\hbar$$

0.3 Nuclear Orbital Motion as key to Nuclear Energy

The electron radiates its energy onto the proton and, if not compensated for that lost energy, would fall on the proton in a split second. To prevent the demise of Atom, the proton must radiate that energy back onto the electron.

This mandates the acceleration of the proton in an orbit so that power radiated in both directions will be in equilibrium.

In the Hydrogen Atom, radiation power equilibrium holds when the Inertia Moments of the electron and the proton are equal:

$$M_{\mathrm{p}}\rho_{\mathrm{p}}^2 = m_{\mathrm{e}}r_{\mathrm{e}}^2.$$

The proton orbit radius ρ_{p}, is smaller than the electron's r_{e}: in the Hydrogen Atom,

$$\frac{r_{\mathrm{e}}^2}{\rho_{\mathrm{p}}^2} = \frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} \approx 1836.$$

Thus, the Nuclear force, $\dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{\rho_{\mathrm{p}}^2}$

is 1836 times greater than

the Atomic force $\dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{r_{\mathrm{e}}^2}$.

And the Nuclear energy of the proton's ground orbit, $\dfrac{1}{4\pi\varepsilon_0}\dfrac{e^2}{\rho_{\mathrm{p}}}$

is $\sqrt{1836} \sim 42.5$ times greater than the Zero Point Energy of the electron's ground orbit, $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_e}$.

The protons' orbitals pack the nuclear energy that bonds the nucleus. Ignoring the protons' motion, eliminates 97.7% of the energy of the Hydrogen Atom. Consequently, any analysis that attempts to follow Bohr's method is not even wrong.

On the other hand, the Schrödinger equation is useless here, because it too assumes that the proton is at rest.

0.4 Radiation Power Equilibrium at the Zinc Nucleus

The Zinc Nucleus has A=65 Nucleons: $Z = 30$ Protons, and $A - Z = 35$ Neutrons. We assume that each neutron is a mini-Hydrogen atom made of an electron and a proton.

Consequently, the 35 Zinc neutrons add 35 protons to the 30 atomic protons, and 35 electrons that orbit those 65 protons, within the nucleus boundary. Clearly, the 65 protons are moving in their own orbits within the Nucleus.

The Nucleonic electrons at orbit radius r_{Nuc} encircle the 65 Protons that orbit the center at radius ρ_p. The electronic orbitals bond the Protons, and the Neutronic Protons of the Nucleus.

We approximate the 35 Neutronic electrons by

a charge of 35e,

with mass $35m_e$

orbiting the center at radius r_{Nuc},

and speed $\beta_{Nuc}c$.

We approximate the 65 protons by

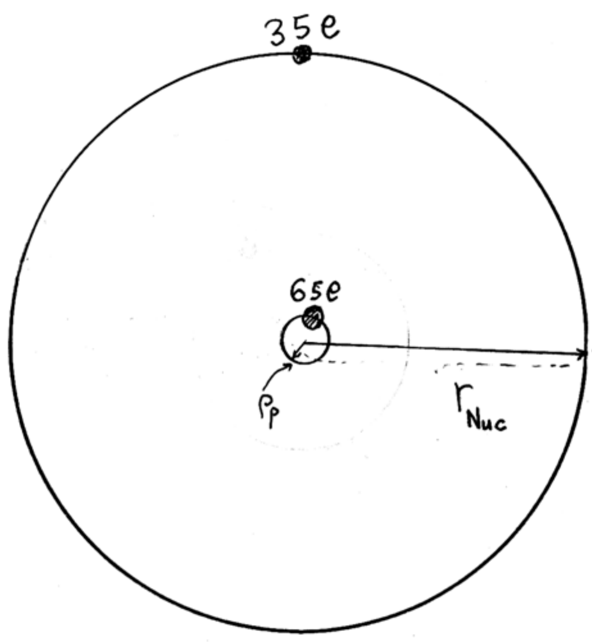
a charge of 65e,

with mass $65M_p$

orbiting the center at radius ρ_p,

and speed $\beta_p c$.

ZINC-NUCLEUS RADIATION POWER EQUILIBRIUM



65 protons with mass $65M_p$, charge 65e, and radius ρ_p

30 electrons with mass $35m_e$, charge 35e and radius r_{Nuc}

The nucleus is stable because the power radiated by the accelerating Neutronic electrons towards the Protons, equals the power radiated by the accelerating protons towards the Neutronic electrons.

To derive the orbits speeds, radii, frequencies, angular momentums, and energies of the Neutronic electrons, and the protons in the nucleus, we apply Einstein's mass-energy equation, and Radiation Power Equilibrium between the 35 Neutronic electrons, and the 65 protons.

The enigma of Nuclear Forces have never before been resolved. To date there is no explanation why the closely packed positive protons, that repulse each other at extreme forces inversely proportional to the squared distance, stay bonded together, and how the neutral neutrons bond them.

The claims that nuclear forces are the "leaking" of the strong forces between quarks that were never directly detected, are speculative if not hallucinated. And remind more of religious arguments, than physics.

Here, perceiving the neutron as a mini-Hydrogen Atom, we establish the motion of the protons, and the radiation power equilibrium between nucleonic electrons and protons as the source of the Nuclear Forces. We compute (with numbers, Not Lagrangians) Nuclear Forces, and Energies for the Zinc Nucleus.

0.5 Radiation Power Equilibrium at the Zinc Atom

Next, we assume that the Zinc Atom 30 spectral electrons interact only with the Zinc's 30 atomic protons, and those 30 protons orbits define the Zinc's nucleus boundary.

The 30 Atomic electrons orbit the 30 atomic Protons that orbit the center. The electrons' orbitals balance the 30 atomic protons, and bond the Zinc Atom

Since the 30 Atomic electrons do not interact with the interior of the nucleus, the 30 Atomic protons appear located at the boundary of the nucleus, orbiting the center at radius r_{Nuc}.

We approximate the 30 atomic electrons by

a charge of 30e,

with mass $30m_{\text{e}}$

orbiting the center at radius r_{e},

and speed $\beta_{\text{e}}c$.

We approximate the 30 atomic protons by

a charge of 30e,

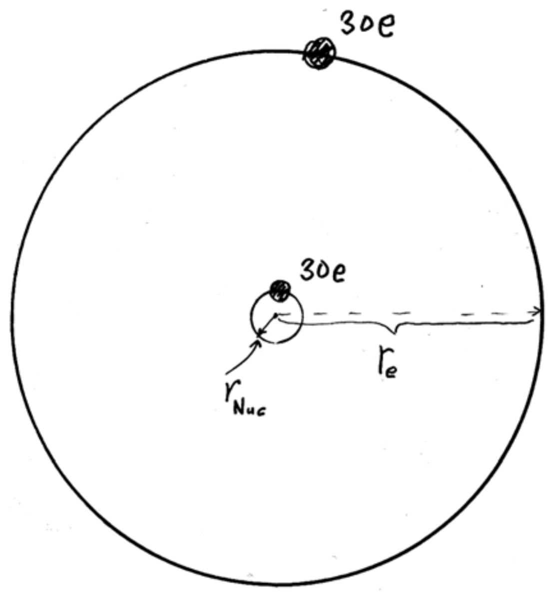
with mass $30M_{\text{p}}$

orbiting the center at radius r_{Nuc},

and speed $\beta_{\text{pNuc}}c$.

The Zinc atom is stable because the power radiated by the accelerating atomic electrons towards the Atomic Protons, equals the power radiated by the accelerating atomic protons towards the atomic electrons

ZINC-ATOM RADIAION POWER EQUILIBRIUM



30 Atomic protons with mass $30M_{\mathrm{p}}$, and radius r_{Nuc}

30 Atomic electrons with mass $30m_{\mathrm{e}}$, and radius r_{e}

To derive the orbits speeds, radii, frequencies, angular momentums, and energies of the 30 Atomic electrons, and the 30 Atomic protons in the nucleus, we apply our Radiation Power Equilibrium between the 30 Atomic electrons, and the 30 Atomic protons.

Our methods here apply to any other Atom.

****

Our computations are not too accurate. Most were done by a hand calculator, and sometimes we approximated the physical quantities.

For instance, we use for the speed of light

$$300,000,000 \text{ m/sec},$$

and for the Fine Structure Constant

1/137.

****

We account for relativistic speeds by using the relativistic mass

$$\frac{m}{\sqrt{1-\beta^2}}, \quad \text{where} \quad \beta = v \,/\, c.$$

I. HYDROGEN

1.

The Hydrogen Electron Quantum of Angular Momentum

1.1 The Hydrogen Electron 1st Orbit Angular Momentum

$$\boxed{mv_1r_1 = \hbar}$$

Proof: The Hydrogen electron 1st orbit Angular Momentum is

$$mv_1r_1 = \frac{m\omega_1^2 r_1^2}{\omega_1}$$

$$= \frac{1}{\omega_1} mv_1^2$$

From $m\frac{v_1^2}{r_1} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_1^2}$, we have

$$= \frac{1}{2\pi\nu_1}\left(\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_1}\right)$$

$$= \frac{1}{2\pi\nu_1}\left(-E_1\right).$$

Since $-E_1 = hR_{\text{ydberg}} = h\nu_1$,

$$= \frac{1}{2\pi\nu_1} h\nu_1 = \hbar . \square$$

It follows that

1.2 The Hydrogen Electron n^th orbit Angular Momentum

$$\boxed{mv_n r_n = n\hbar}$$

and that,

1.3 The Hydrogen Electron Angular Momentum Quantum is $\hbar$.

1.4 The Hydrogen Electron 1^st Orbit Radius, Speed, and Frequency

$$r_{\mathrm{H}} = \frac{\varepsilon_0}{m_e e^2} \frac{h^2}{\pi},$$

$$= 5.29177249 \times 10^{-11} \mathrm{m}$$

$$v_{\mathrm{H}} = \frac{e^2}{2\varepsilon_0 h} = \alpha c \approx \frac{c}{137},$$

$$= 2{,}189{,}781 \ \mathrm{m/sec}$$

$$\nu_{\mathrm{H}} = \frac{h}{4\pi^2 m_e r_{\mathrm{H}}^2}$$

$$= 6.58472424 \times 10^{15} \text{ cycles/sec}$$

Proof: The force on the Hydrogen 1st orbit electron is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{\mathrm{H}}^2} = m_e \frac{v_{\mathrm{H}}^2}{r_{\mathrm{H}}},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (m_e v_{\mathrm{H}} r_{\mathrm{H}})^2 \frac{1}{m_e}\frac{1}{r_{\mathrm{H}}},$$

Since $m_e v_{\mathrm{H}} r_{\mathrm{H}} = h / 2\pi$,

$$r_{\mathrm{H}} = \frac{\varepsilon_0}{m_e e^2}\frac{h^2}{\pi},$$

$$v_{\mathrm{H}} = \frac{h}{2\pi m_{\mathrm{e}} r_{\mathrm{H}}},$$

$$= \frac{h}{2\pi m_{\mathrm{e}} \frac{\varepsilon_0}{m_e e^2}\frac{h^2}{\pi}},$$

$$= \frac{e^2}{2\varepsilon_0 h} = \alpha c \approx \frac{c}{137}$$

$$= 2{,}189{,}781 \text{ m/sec}.$$

$$\frac{\omega_{\mathrm{H}}}{2\pi} = \frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}},$$

$$= \frac{\frac{h}{2\pi m_e r_{\rm H}}}{2\pi r_{\rm H}}$$

$$= \frac{h}{4\pi^2 m_e r_{\rm H}^2}$$

Substituting

$$\varepsilon_0 = 8.854187817 \times 10^{-12} \frac{\text{Coulomb}}{(\text{Volt})(\text{meter})},$$

$$h = 6.6260755 \times 10^{-34} \text{Joul},$$

$$m_{\rm e} = 9.1093897 \times 10^{-31} \text{Kg},$$

$$e = 1.60217733 \times 10^{-19},$$

we obtain

$$r_{\rm H} = 5.29177249 \times 10^{-11} \text{m},$$

$$\nu_{\rm H} = 6.58472424 \times 10^{15} \ \text{cycles/sec}.$$

1.5 The Hydrogen Electron n$^{\text{th}}$ Orbit Radius, Speed, and Frequency

$$r_n = n^2 r_{\rm H},$$

$$v_n = \frac{1}{n} v_{\rm H},$$

$$\frac{\omega_n}{2\pi} = \frac{1}{n^3} \frac{\omega_{\rm H}}{2\pi}.$$

Proof: The force on the electron in the n$^{\text{th}}$ Orbit in the Hydrogen Atom is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_n^2} = m_e \frac{v_n^2}{r_n},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (m_e v_n r_n)^2 \frac{1}{m_e}\frac{1}{r_n},$$

Since $m_e v_n r_n = n\dfrac{h}{2\pi}$,

$$r_n = n^2 \frac{\varepsilon_0}{m_e e^2}\frac{h^2}{\pi} = n^2 r_{\mathrm{H}}.$$

$$v_n = n\frac{h}{2\pi m_{\mathrm{e}} r_n},$$

$$= n\frac{h}{2\pi m_{\mathrm{e}} n^2 r_{\mathrm{H}}},$$

$$= \frac{1}{n}\frac{h}{2\pi m_{\mathrm{e}} r_{\mathrm{H}}},$$

$$= \frac{1}{n} v_{\mathrm{H}},$$

$$\frac{\omega_n}{2\pi} = \frac{v_n}{2\pi r_n},$$

$$= \frac{\frac{1}{n} v_{\mathrm{H}}}{2\pi n^2 r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}\frac{\omega_{\mathrm{H}}}{2\pi}.$$

2.

Hydrogen Radiation Equilibrium and Proton Quantized Angular Momentum

The Hydrogen Electron orbits at angular velocity ω_n along a circle of radius r_n a proton charge located a the center of the orbit.

The Hydrogen Proton orbits along a circle of radius ρ_n an electron charge located at the center of the orbit.

The electron orbits with angular momentums

$$m\omega_n r_n^2 = n\hbar,$$

determine the proton orbit with angular momentums

$$M\Omega_n \rho_n^2.$$

At equilibrium, the power radiated by the electron onto the proton equals the power radiated by the proton onto the electron.

In [Dan4] we showed that

- the hydrogen atom is electrodynamically stable if and only if the inertia moments of the electron and the proton are equal:

$$mr_n^2 = M\rho_n^2$$

- The Angular velocities of the proton, and the electron are related by

$$\frac{\Omega_n}{\omega_n} = \left(\frac{M}{m}\right)^{\frac{1}{4}} = \sqrt[4]{1836.152701} = 6.546018057$$

2.1 Hydrogen's Radiation Equilibrium is equivalent to the Proton's n^th Orbit Quantized Angular Momentum

$$\boxed{mr_n^2 = M\rho_n^2 \;\Leftrightarrow\; M\rho_n^2\Omega_n = n\hbar\left(\frac{M}{m}\right)^{\frac{1}{4}}}$$

Proof: $(\Rightarrow)$ The n^{th} orbit of the Proton has Angular Momentum

$$\underbrace{M\rho_n^2}_{mr_n^2}\Omega_n = \underbrace{mr_n^2\omega_n}_{n\hbar}\frac{\Omega_n}{\omega_n}$$

$$= n\hbar\left(\frac{M}{m}\right)^{\frac{1}{4}}.\square$$

$(\Leftarrow)$ The force on the Hydrogen proton in the n^{th} orbit is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{\rho_n^2} = M_p\frac{V_n^2}{\rho_n},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (MV_n\rho_n)^2\frac{1}{M}\frac{1}{\rho_n},$$

Since $(MV_n\rho_n)^2 = (M\Omega_n\rho_n^2)^2 = n^2\left(\frac{h}{2\pi}\right)^2\sqrt{\frac{M}{m}}$,

$$\rho_n = n^2 \frac{\varepsilon_0}{Me^2}\frac{h^2}{\pi}\sqrt{\frac{M}{m}},$$

$$= n^2 \frac{\varepsilon_0}{me^2}\frac{h^2}{\pi}\sqrt{\frac{m}{M}},$$

$$= n^2 r_{\mathrm{H}}\sqrt{\frac{m}{M}}$$

$$= r_n\sqrt{\frac{m}{M}}.$$

Squaring both sides, $mr_n^2 = M\rho_n^2 .\square$

2.2 The Hydrogen Proton n^th Orbit Angular Momentum

$$\boxed{M_{\mathrm{p}}\rho_n^2\Omega_n = n\hbar\left(\frac{M}{m}\right)^{\frac{1}{4}} = n(6.546018057)\hbar}$$

2.3 The Hydrogen Proton Quantum of Angular Momentum is the Angular Momentum of the 1^st Proton Orbit

$$\boxed{M\rho_1^2\Omega_1 = (6.546018057)\hbar}$$

3.

Hydrogen Proton nth Orbit Radius, Speed, and Frequency

3.1 Hydrogen Proton 1st Orbit Radius, Speed, & Frequency

$$\rho_{\mathrm{H}} = r_{\mathrm{H}}\sqrt{\frac{m}{M}},$$

$$V_{\mathrm{H}} = \frac{c}{137}\left(\frac{m}{M}\right)^{\frac{1}{4}},$$

$$\frac{\Omega_{\mathrm{H}}}{2\pi} = \frac{\omega_{\mathrm{H}}}{2\pi}\left(\frac{M}{m}\right)^{\frac{1}{4}}.$$

Proof: The force on the proton in the Hydrogen Atom 1st orbit is

$$\frac{1}{4\pi\varepsilon_0}\frac{e^2}{\rho_1^2} = M_p\frac{V_1^2}{\rho_1},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (MV_1\rho_1)^2\frac{1}{M}\frac{1}{\rho_1},$$

Since $(MV_1\rho_1)^2 = (M\Omega_1\rho_1^2)^2 = \left(\frac{h}{2\pi}\right)^2\sqrt{\frac{M}{m}}$,

$$\rho_1 = \frac{\varepsilon_0}{M_p e^2}\frac{h^2}{\pi}\sqrt{\frac{M}{m}},$$

$$= r_{\mathrm{H}}\sqrt{\frac{m}{M}}\,.$$

Since $MV_1\rho_1 = M\Omega_1\rho_1^2 = \frac{h}{2\pi}\left(\frac{M}{m}\right)^{\frac{1}{4}}$

$$V_1 = \frac{h}{2\pi}\left(\frac{M}{m}\right)^{\frac{1}{4}}\frac{1}{M\rho_1},$$

$$= \frac{h}{2\pi m\frac{M}{m}r_{\mathrm{H}}\sqrt{\frac{m}{M}}}\left(\frac{M}{m}\right)^{\frac{1}{4}},$$

$$= \frac{h}{2\pi m r_{\mathrm{H}}}\left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$= v_{\mathrm{H}}\left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$= \frac{c}{137}\left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$\frac{\Omega_1}{2\pi} = \frac{V_1}{2\pi\rho_1},$$

$$= \frac{v_{\mathrm{H}}\left(\frac{m}{M}\right)^{\frac{1}{4}}}{2\pi r_{\mathrm{H}}\sqrt{\frac{m}{M}}}$$

$$= \nu_{\mathrm{H}} \left(\frac{M}{m} \right)^{\frac{1}{4}},$$

where

$$r_{\mathrm{H}} = 5.29177249 \times 10^{-11} \mathrm{m},$$

$$\nu_{\mathrm{H}} = 6.58472424 \times 10^{15} \text{ cycles/sec}.$$

3.2 Hydrogen Proton n^th^-Orbit Radius, Speed, & Frequency

$$\rho_n = n^2 r_{\mathrm{H}} \sqrt{\frac{m}{M}},$$

$$V_n = \frac{1}{n} v_{\mathrm{H}} \left(\frac{m}{M} \right)^{\frac{1}{4}},$$

$$\frac{\Omega_n}{2\pi} = \frac{1}{n^3} \frac{\Omega_{\mathrm{H}}}{2\pi} \left(\frac{M}{m} \right)^{\frac{1}{4}}.$$

Proof: The force on the Hydrogen n^{th} orbit proton is

$$\frac{1}{4\pi\varepsilon_0} \frac{e^2}{\rho_n^2} = M \frac{V_n^2}{\rho_n},$$

$$\frac{e^2}{4\pi\varepsilon_0} = (M V_n \rho_n)^2 \frac{1}{M} \frac{1}{\rho_n},$$

Since $(M V_n \rho_n)^2 = (M \Omega_n \rho_n^2)^2 = n^2 \left(\frac{h}{2\pi} \right)^2 \sqrt{\frac{M}{m}}$,

$$\rho_n = n^2 \frac{\varepsilon_0}{Me^2} \frac{h^2}{\pi} \sqrt{\frac{M}{m}},$$

$$= n^2 \frac{\varepsilon_0}{me^2} \frac{h^2}{\pi} \sqrt{\frac{m}{M}},$$

$$= n^2 r_{\mathrm{H}} \sqrt{\frac{m}{M}}.$$

Since $MV_n\rho_n = M\Omega_n\rho_n^2 = n\frac{h}{2\pi}\left(\frac{M}{m}\right)^{\frac{1}{4}}$

$$V_n = n\frac{h}{2\pi}\left(\frac{M}{m}\right)^{\frac{1}{4}} \frac{1}{M\rho_n},$$

$$= n\frac{h}{2\pi m \frac{M}{m} n^2 r_{\mathrm{H}} \sqrt{\frac{m}{M}}}\left(\frac{M}{m}\right)^{\frac{1}{4}},$$

$$= \frac{1}{n}\frac{h}{2\pi m r_{\mathrm{H}}}\left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$= \frac{1}{n} v_{\mathrm{H}} \left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$= \frac{1}{n}\frac{c}{137}\left(\frac{m}{M}\right)^{\frac{1}{4}}$$

$$\frac{\Omega_n}{2\pi} = \frac{V_n}{2\pi\rho_n},$$

$$= \frac{\frac{1}{n} v_{\mathrm{H}} \left(\frac{m}{M} \right)^{\frac{1}{4}}}{2\pi n^2 r_{\mathrm{H}} \sqrt{\frac{m}{M}}}$$

$$= \frac{1}{n^3} \frac{\Omega_{\mathrm{H}}}{2\pi} \left(\frac{M}{m} \right)^{\frac{1}{4}}$$

II. NEUTRON

4.

The Neutron's Electron Quantum of Angular Momentum

In [Dan5], we established that the Neutron is a Collapsed-Hydrogen Atom composed of an electron and a proton:

The Neutron's Electron (to be denoted ne) has

$$\text{Orbit Radius } r_{\mathrm{ne}} \sim 9.398741807 \times 10^{-14}\,\mathrm{m},$$

$$\text{Speed } v_{\mathrm{ne}} \sim 51,558,134 \text{ m/sec},$$

$$\beta_{\mathrm{ne}} = 0.171860446$$

$$\text{Angular Velocity } \omega_{\mathrm{ne}} \sim 5.485642074 \times 10^{20} \text{ radians/sec},$$

$$\text{Frequency } \nu_{\mathrm{ne}} \sim 8.73067052 \times 10^{19}\,\text{cycles/second}.$$

The Nucleonic Electron Quantum of Angular Momentum is the Angular Momentum of the electron's 1^{st} orbit

4.1 Quantum of Neutron's Electron Angular Momentum

$$\frac{m_{\rm e}}{\sqrt{1-\beta_{\rm ne}^2}} v_{\rm ne} r_{\rm ne} = (0.043132065)\hbar$$

Proof:

$$\frac{1}{\sqrt{1-\beta_{\rm ne}^2}} = \frac{1}{\sqrt{1-(0.171860446)^2}}$$

$$= 1.015103413$$

$$\frac{m_{\rm e}}{\sqrt{1-\beta_{\rm ne}^2}} v_{\rm ne} r_{\rm ne} =$$

$$= \frac{(1.015103413)(9.1093897)10^{-31}(51,558,134)(9.398741807)10^{-14}}{(1.05457266)10^{-34}}\hbar$$

$$= (0.042490317)\hbar . \square$$

4.2 The Neutron's Electron 1st Orbit Radius, Speed, and Frequency

$$r_{\rm ne} \sim 9.398741807 \times 10^{-14}\,{\rm m}$$

$$= 1.776104665 \times 10^{-3} r_{\rm H}$$

$$v_{\rm ne} = \frac{c}{5.909092905} \quad {\rm m/sec}$$

$$= \frac{v_{\rm H}}{0.043132065}$$

$$\frac{\omega_{\rm ne}}{2\pi} = 1.305362686 \times 10^{4} \frac{\omega_{\rm H}}{2\pi}$$

Proof: The force on the Neutron's 1[st] orbit electron is

$$\frac{m_e}{\sqrt{1-\beta_{ne}^2}}\frac{v_{ne}^2}{r_{ne}} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r_{ne}^2},$$

$$\frac{e^2}{4\pi\varepsilon_0} = \left(\frac{m_e}{\sqrt{1-\beta_{ne}^2}}v_{ne}r_{ne}\right)^2 \frac{1}{\dfrac{m_e}{\sqrt{1-\beta_{ne}^2}}}\frac{1}{r_{ne}},$$

Since $\dfrac{m_e}{\sqrt{1-\beta_{ne}^2}}(\beta_{ne}c)r_{ne} = (0.043132065)\hbar$,

$$r_{ne} = (0.043132065)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_H}\sqrt{1-\beta_{ne}^2}, \quad (r_H = 5.29177249\times 10^{-11})$$

$$= (0.043132065)^2\left(\sqrt{1-(0.171860446)^2}\right)r_H$$

$$= 1.776104665\times 10^{-3} r_H.$$

$$v_{ne} = \frac{(0.043132065)\hbar}{\dfrac{m_e}{\sqrt{1-\beta_{ne}^2}}r_{ne}}$$

$$= \frac{(0.043132065)\hbar}{\dfrac{m_e}{\sqrt{1-\beta_{ne}^2}}(0.043132065)^2 r_H\sqrt{1-\beta_{ne}^2}}$$

$$= \frac{1}{0.043132065}\underbrace{\frac{\hbar}{m_e r_H}}_{v_H}$$

$$= \frac{1}{0.043132065} v_{\text{H}}$$

$$= \frac{1}{0.043132065} \frac{1}{137} c$$

$$= \frac{1}{5.909092905} c$$

$$\frac{\omega_{\text{ne}}}{2\pi} = \frac{v_{\text{ne}}}{2\pi r_{\text{ne}}}$$

$$= \frac{\frac{1}{0.043132065} v_{\text{H}}}{2\pi(1.776104665) \times 10^{-3} r_{\text{H}}}$$

$$= \frac{10^5}{(4.3132065)(1.776104665)} \frac{v_{\text{H}}}{2\pi r_{\text{H}}}$$

$$= 1.305362686 \times 10^4 \frac{\omega_{\text{H}}}{2\pi}$$

4.3 The Neutron's Electron nth Orbit Radius, Speed, and Frequency

$$r_{\text{ne},n} \sim n^2 (9.398741807) 10^{-14} \text{m}$$

$$= n^2 (1.776104665) 10^{-3} r_{\text{H}}$$

$$v_{\text{ne},n} = \frac{1}{n} \frac{c}{5.909092905} \quad \text{m/sec}$$

$$= \frac{1}{n} \frac{v_{\text{H}}}{0.043132065}$$

$$\frac{\omega_{\text{ne},n}}{2\pi} = \frac{1}{n^3} 1.305362686 \times 10^4 \frac{\omega_{\text{H}}}{2\pi} \text{ cycles/sec}.$$

Proof: The force on the Neutron's n$^{\text{th}}$ orbit electron is

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}} \frac{v_{\text{ne},n}^2}{r_{\text{ne},n}} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{r_{\text{ne},n}^2},$$

$$\frac{e^2}{4\pi\varepsilon_0} = \left(\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}} v_{\text{ne},n} r_{\text{ne},n} \right)^2 \frac{1}{\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}}} \frac{1}{r_{\text{ne},n}},$$

Since $\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}} (\beta_{\text{ne},n} c) r_{\text{ne},n} = n(0.043132065)\hbar$,

$$r_{\text{ne},n} = n^2 (0.043132065)^2 \underbrace{\frac{h^2}{\pi} \frac{\varepsilon_0}{m_e e^2}}_{r_{\text{H}}} \sqrt{1-\beta_{\text{ne},n}^2},$$

$$= n^2 (0.043132065)^2 \left(\sqrt{1-(0.171860446)^2} \right) r_{\text{H}}$$

$$= n^2 (1.776104665) 10^{-3} r_{\text{H}}.$$

$$v_{\text{ne},n} = \frac{n(0.043132065)\hbar}{\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}} n^2 r_{\text{ne},n}}$$

$$= \frac{1}{n} \frac{(0.043132065)\hbar}{\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne}}^2}} (0.043132065)^2 r_{\text{H}} \sqrt{1-\beta_{\text{ne}}^2}}$$

$$= \frac{1}{n}\frac{1}{0.043132065}\underbrace{\frac{\hbar}{m_{\mathrm{e}}r_{\mathrm{H}}}}_{v_{\mathrm{H}}}$$

$$= \frac{1}{n}\frac{1}{0.043132065}v_{\mathrm{H}}$$

$$= \frac{1}{n}\frac{1}{0.043132065}\frac{1}{137}c$$

$$= \frac{1}{n}\frac{1}{5.909092905}c$$

$$\frac{\omega_{\mathrm{ne}}}{2\pi} = \frac{v_{\mathrm{ne}}}{2\pi r_{\mathrm{ne}}}$$

$$= \frac{\frac{1}{n}\frac{1}{0.043132065}v_{\mathrm{H}}}{2\pi n^2(1.776104665)\times 10^{-3}r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}\frac{10^5}{(4.3132065)(1.776104665)}\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}1.305362686\times 10^4\nu_{\mathrm{H}}$$

5.

The Neutron's Proton Quantum of Angular Momentum

In [Dan5], we established that the Neutron is a Collapsed-Hydrogen Atom composed of an electron and a proton:

The Neutron's Proton (to be denoted np) has

$$\text{Orbit Radius } \rho_{\mathrm{np}} \sim 2.209505336 \times 10^{-15},$$

$$\text{Speed } V_{\mathrm{np}} \sim 7,905,145 \text{ m/sec},$$

$$\beta_{\mathrm{np}} = 0.02635048394$$

$$\text{Angular Velocity } \Omega_{\mathrm{np}} \sim 3.577789504 \times 10^{21} \text{ radians/sec},$$

$$\text{Frequency } \frac{\Omega_{\mathrm{np}}}{2\pi} \sim 5.69422884 \times 10^{20} \text{cycles/second}.$$

The Neutron's Electron n^{th} orbit has angular momentum

$$\frac{m_e}{\sqrt{1-\beta_{\mathrm{ne},n}^2}}\omega_{\mathrm{ne},n} r_{\mathrm{ne},n}^2.$$

The Neutron's Proton n^{th} orbit has angular momentum

$$\frac{M_p}{\sqrt{1-\beta_{\mathrm{np},n}^2}}\Omega_{\mathrm{np},n} \rho_{\mathrm{np},n}^2.$$

At equilibrium, the power radiated by the electron onto the proton equals the power radiated by the proton onto the electron.

Similarly to [Dan5], we obtain that

- the Neutron is electrodynamically stable if and only if the inertia moments of the n^th^ orbit electron and proton are equal:

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{ne},n}^2}} r_{\mathrm{ne},n}^2 = \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np},n}^2}} \rho_{\mathrm{np},n}^2$$

- The Angular velocities of the proton, and the electron are related by

$$\frac{\Omega_{\mathrm{np},n}}{\omega_{\mathrm{ne},n}} = \left(\frac{M}{m}\right)^{\frac{1}{4}} = \sqrt[4]{1836.152701} = 6.546018057$$

The Neutron's Proton Quantum of Angular Momentum is the Angular Momentum of its 1st orbit:

5.1 Quantum of Neutron's Proton Angular Momentum

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np}}^2}} (\beta_{\mathrm{np}} c) \rho_{\mathrm{np}} = (0.277126027)\hbar$$

6.

The Neutron's Proton n^th Orbit Radius, Speed, and Frequency

6.1 The Neutron's Proton 1^st Orbit Radius, Speed, and Frequency

$$\rho_{\mathrm{np}} = 4.181142667 \times 10^{-5} r_{\mathrm{H}}$$

$$\sim 2.212565574 \times 10^{-15} \ \mathrm{m}$$

$$V_{\mathrm{np}} = (3.608466555) v_{\mathrm{H}}$$

$$= 7{,}901{,}752 \quad \mathrm{m/sec}$$

$$\nu_{\mathrm{np}} = (86{,}303)\nu_{\mathrm{H}}$$

$$= (5.682814561)10^{20} \ \text{cycles/sec}$$

Proof: The force on the Neutron's 1^st orbit proton is

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np}}^2}} \frac{V_{\mathrm{np}}^2}{\rho_{\mathrm{np}}} = \frac{1}{4\pi\varepsilon_0} \frac{e^2}{\rho_{\mathrm{np}}^2},$$

$$\frac{e^2}{4\pi\varepsilon_0} = \left(\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np}}^2}} V_{\mathrm{np}} \rho_{\mathrm{np}} \right)^2 \frac{1}{\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np}}^2}}} \frac{1}{\rho_{\mathrm{np}}},$$

Since $\dfrac{M_{\rm p}}{\sqrt{1-\beta_{\rm np}^2}}(\beta_{\rm np}c)\rho_{\rm np} = (0.277126027)\hbar$,

$$\rho_{\rm np} = (0.277126027)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\rm H}} \sqrt{1-\beta_{\rm np}^2}\,\frac{m_{\rm e}}{M_{\rm p}},$$

$$= (0.277126027)^2 \left(\sqrt{1-(0.02635048394)^2}\right)\frac{1}{1836.152701} r_{\rm H}$$

$$= 4.181142667 \times 10^{-5} r_{\rm H}.$$

$$V_{\rm np} = \frac{(0.277126027)\hbar}{\dfrac{M_{\rm p}}{\sqrt{1-\beta_{\rm np}^2}}\rho_{\rm np}}$$

$$= \frac{(0.277126027)\hbar}{\dfrac{M_{\rm p}}{\sqrt{1-\beta_{\rm np}^2}}(0.277126027)^2 r_{\rm H}\sqrt{1-\beta_{\rm np}^2}\,\dfrac{m_{\rm e}}{M_{\rm p}}}$$

$$= \frac{1}{0.277126027}\underbrace{\frac{\hbar}{m_{\rm e} r_{\rm H}}}_{v_{\rm H}}$$

$$= (3.608466555) v_{\rm H}$$

$$= (3.608466555)\frac{1}{137}c$$

$$= 7,901,752 \text{ m/sec}$$

$$\frac{\Omega_{\text{np}}}{2\pi} = \frac{V_{\text{np}}}{2\pi\rho_{\text{np}}}$$

$$= \frac{(3.608466555)v_{\text{H}}}{2\pi(4.181142667)\times 10^{-5} r_{\text{H}}}$$

$$= 10^5 \frac{3.608466555}{4.181142667} \frac{v_{\text{H}}}{2\pi r_{\text{H}}}$$

$$= (86,303)\frac{\Omega_{\text{H}}}{2\pi}$$

$$= (86,303)(6.58472424)10^{15}$$

$$= (5.682814561)10^{20}$$

6.2 The Neutron's Proton n$^{\text{th}}$ Orbit Radius, Speed, and Frequency

$$\rho_{\text{np},n} \sim n^2(2.212565574)10^{-15}\,\text{m}$$

$$= n^2(4.181142667)10^{-5} r_{\text{H}}$$

$$V_{\text{np},n} = \frac{1}{n} 7,901,752 \quad \text{m/sec}$$

$$= \frac{1}{n}(3.608466555)v_{\text{H}}$$

$$\frac{\Omega_{\text{np},n}}{2\pi} = \frac{1}{n^3}(5.682814561)10^{20}\,\text{cycles/sec}$$

$$= \frac{1}{n^3}(86,303)\frac{\Omega_{\rm H}}{2\pi}.$$

Proof: The force on the Neutron's n[th] orbit proton is

$$\frac{M_{\rm p}}{\sqrt{1-\beta_{{\rm np},n}^2}}\frac{V_{{\rm np},n}^2}{\rho_{{\rm np},n}} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{\rho_{{\rm np},n}^2},$$

$$\frac{e^2}{4\pi\varepsilon_0} = \left(\frac{M_{\rm p}}{\sqrt{1-\beta_{{\rm np},n}^2}}V_{{\rm np},n}\rho_{{\rm np},n}\right)^2 \frac{1}{\frac{M_{\rm p}}{\sqrt{1-\beta_{{\rm np},n}^2}}}\frac{1}{r_{{\rm np},n}},$$

Since $\frac{M_{\rm p}}{\sqrt{1-\beta_{{\rm np},n}^2}}(\beta_{{\rm np},n}c)\rho_{{\rm np},n} = n(0.277126027)\hbar$,

$$\rho_{{\rm np},n} = n^2(0.277126027)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\rm H}}\sqrt{1-\beta_{{\rm np},n}^2}\frac{m_{\rm e}}{M_{\rm p}},$$

$$= n^2(0.277126027)^2\left(\sqrt{1-(0.02635048394)^2}\right)\frac{1}{1836.152701}r_{\rm H}$$

$$= n^2 4.181142667\times 10^{-5} r_{\rm H}.$$

$$V_{{\rm np},n} = \frac{n(0.277126027)\hbar}{\left(\frac{M_{\rm p}}{\sqrt{1-\beta_{{\rm np},n}^2}}\rho_{{\rm np},n}\right)}$$

$$= \frac{n(0.277126027)\hbar}{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{np}}^2}} n^2 (0.277126027)^2 r_{\mathrm{H}} \sqrt{1-\beta_{\mathrm{np}}^2}\, \frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}}$$

$$= \frac{1}{n} \frac{1}{0.277126027} \underbrace{\frac{\hbar}{m_{\mathrm{e}} r_{\mathrm{H}}}}_{v_{\mathrm{H}}}$$

$$= \frac{1}{n}(3.608466555) v_{\mathrm{H}}$$

$$= \frac{1}{n}(3.608466555)\frac{1}{137} c$$

$$= \frac{1}{n} 7,901,752 \text{ m/sec}$$

$$\frac{\Omega_{\mathrm{np},n}}{2\pi} = \frac{V_{\mathrm{np}}}{2\pi \rho_{\mathrm{np}}}$$

$$= \frac{\frac{1}{n}(3.608466555) v_{\mathrm{H}}}{2\pi n^2 (4.181142667) \times 10^{-5} r_{\mathrm{H}}}$$

$$= \frac{1}{n^3} 10^5 \frac{3.608466555}{4.181142667} \frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}(86,303) \frac{\omega_{\mathrm{H}}}{2\pi}$$

$$= \frac{1}{n^3}(86,303)(6.58472424) 10^{15}$$

$$= \frac{1}{n^3}(5.682814561) 10^{20}$$

III. ZINC NUCLEUS

7.

Nucleus Radiation Equilibrium

The Zinc Nucleus has A=65 Nucleons: $Z = 30$ Protons, and $A - Z = 35$ Neutrons. Each neutron is a mini-Hydrogen atom made of an electron and a proton.

The Nucleonic electrons orbitals bond the Protons, and the Neutronic Protons of the Nucleus.

The 30 Protons, the 35 Neutronic Protons and the 35 Nucleonic electrons constitute the Zinc Nucleus.

The Nucleus electrons at orbit radius r_{Nuc} encircle the 65 Protons that orbit the center at radius ρ_{p}.

We approximate the 35 Neutronic electrons by

a charge of 35e,

with mass $35m_{\text{e}}$

orbiting the center at radius r_{Nuc},

and speed $\beta_{\text{Nuc}}c$.

We approximate the 65 protons by

a charge of 65e,

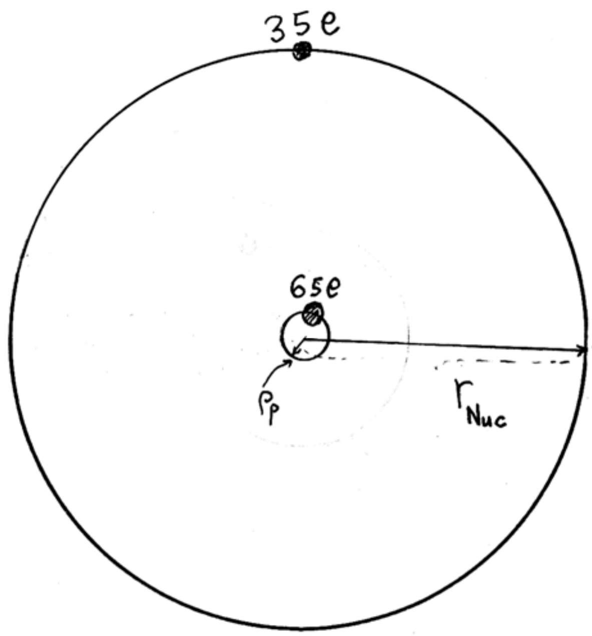
with mass $65M_{\mathrm{p}}$

orbiting the center at radius ρ_{p},

and speed $\beta_{\mathrm{p}}c$.

The nucleus is stable because the power radiated by the accelerating Neutronic electrons towards the Protons, equals the power radiated by the accelerating protons towards the Neutronic electrons

ZINC-NUCLEUS RADIATION POWER EQUILIBRIUM



65 protons with mass $65M_{\mathrm{p}}$, charge 65e, and radius ρ_{p}

30 electrons with mass $35m_{\mathrm{e}}$, charge 35e and radius r_{Nuc}

7.1 The Nucleus Electrons Acceleration

The electrons are attracted to the protons by the force

$$\frac{35m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}}a_{\text{Nuc}} \approx \frac{1}{4\pi\varepsilon_0}\frac{(65e)(35e)}{r_{\text{Nuc}}^2},$$

Thus, the electrons accelerate at

$$a_{\text{Nuc}} \approx \frac{\sqrt{1-\beta_{\text{Nuc}}^2}}{m_{\text{e}}}\frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\text{Nuc}}^2},$$

and radiate photons into the Protons fields.

7.2 The Nucleus Electrons Radiation Power

$$\boxed{\frac{(35e)^2}{6\pi\varepsilon_0 c^3}a_{\text{Nuc}}^2 \approx \frac{(35e)^2}{6\pi\varepsilon_0 c^3}\left(\frac{\sqrt{1-\beta_{\text{Nuc}}^2}}{m_{\text{e}}}\frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\text{Nuc}}^2}\right)^2}$$

7.3 The 65 Protons Acceleration

The 65 Protons of the Nucleus orbit with radius ρ_{p}, at speed β_{p}, the charge of the Nucleus Electron located at the center.

The Protons with mass $65M_{\text{p}}$, and charge $65e$ are attracted to the 35 Nucleus electron by the force

$$\frac{65M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}A_{\text{p}} \approx \frac{1}{4\pi\varepsilon_0}\frac{(65e)(35e)}{\rho_{\text{p}}^2}$$

Thus, the protons accelerate by

$$A_{\mathrm{p}} \approx \frac{\sqrt{1-\beta_{\mathrm{p}}^2}}{M_{\mathrm{p}}} \frac{1}{4\pi\varepsilon_0} \frac{35e^2}{\rho_{\mathrm{p}}^2},$$

and radiate photons into the Nucleonic electrons fields.

7.4 The 65 Protons Radiation Power

$$\boxed{\frac{(65e)^2}{6\pi\varepsilon_0 c^3} A_{\mathrm{p}}^2 \approx \frac{(65e)^2}{6\pi\varepsilon_0 c^3} \left(\frac{\sqrt{1-\beta_{\mathrm{p}}^2}}{M_{\mathrm{p}}} \frac{1}{4\pi\varepsilon_0} \frac{35e^2}{\rho_{\mathrm{p}}^2} \right)^2}$$

7.5 Nucleus radiation Equilibrium

At equilibrium, the Power radiated by the 35 Nucleus Electrons onto the 65 Protons, equals the Power radiated by the protons onto the Nucleus electrons.

$$\frac{(35e)^2}{6\pi\varepsilon_0 c^3} \left(\frac{\sqrt{1-\beta_{\text{Nuc-e}}^2}}{m_{\mathrm{e}}} \frac{1}{4\pi\varepsilon_0} \frac{65e^2}{r_{\text{Nuc-e}}^2} \right)^2 \approx \frac{(65e)^2}{6\pi\varepsilon_0 c^3} \left(\frac{\sqrt{1-\beta_{\mathrm{p}}^2}}{M_{\mathrm{p}}} \frac{1}{4\pi\varepsilon_0} \frac{35e^2}{\rho_{\mathrm{p}}^2} \right)^2$$

We use $\approx$ because we assume one orbit for the protons, and one orbit for the electrons, while there are 65 proton orbits, and 35 electron orbits.

This Electrodynamics equality leads to a surprisingly purely mechanical relation between the Relativistic Inertia Moments of the electron and the Nucleus:

7.6 The Zinc Nucleus' Inertia Moments Balance

The Zinc Nucleus is Electrodynamically stable if and only the Inertia Moments of its 1st orbit electron and 65 Protons are related by

$$\boxed{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}} r_{\mathrm{Nuc}}^2 \approx \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}} \rho_{\mathrm{p}}^2}$$

8.

$\frac{r_{\text{Nuc}}}{\rho_{\text{p}}}$

8.1 The Nucleus Force Balance

$$\boxed{\frac{1}{65}\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\beta_{\text{Nuc}}^2 r_{\text{Nuc}} = \frac{e^2}{10^7} = \frac{1}{35}\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\beta_{\text{p}}^2\rho_{\text{p}}}$$

Proof: The Force on the 1^{st} orbit nucleus electron is

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\frac{v_{\text{Nuc}}^2}{r_{\text{Nuc}}} = \frac{1}{4\pi\varepsilon_0}\frac{(65e)(e)}{r_{\text{Nuc}}^2}.$$

Dividing both sides by c^2,

$$\frac{1}{65}\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\beta_{\text{Nuc}}^2 r_{\text{Nuc}} = \frac{e^2}{4\pi\varepsilon_0 c^2},$$

$$= \frac{\mu_0}{4\pi}e^2,$$

$$= \frac{e^2}{10^7}.\square$$

The Force on the 1^{st} Orbit Proton is

$$\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\frac{V_{\text{p}}^2}{\rho_p} = \frac{1}{4\pi\varepsilon_0}\frac{(e)(35e)}{\rho_{\text{p}}^2}$$

Dividing both sides by c^2,

$$\frac{1}{35}\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\beta_{\text{p}}^2\rho_{\text{p}} = \frac{e^2}{4\pi\varepsilon_0 c^2},$$

$$= \frac{e^2}{10^7}.\square$$

Therefore,

$$\frac{1}{65}\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\beta_{\text{Nuc}}^2 r_{\text{Nuc}} = \frac{e^2}{10^7} = \frac{1}{35}\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\beta_{\text{p}}^2\rho_{\text{p}}.\square$$

8.2 $$\boxed{\frac{r_{\text{Nuc}}}{35\beta_{\text{Nuc}}^2} \approx \frac{\rho_{\text{p}}}{65\beta_{\text{p}}^2}}$$

Proof: Dividing the Nucleus Inertia Moments Balance 7.3,

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}} r_{\text{Nuc}}^2 \approx \frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\rho_{\text{p}}^2,$$

by the Nucleus Force balance 8.1,

$$\frac{35 m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\beta_{\text{Nuc-e}}^2 r_{\text{Nuc}} \approx \frac{65 M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}}\beta_{\text{p}}^2\rho_{\text{p}}.\square$$

8.3 $$\boxed{\frac{r_{\text{Nuc}}}{\rho_{\text{p}}} \sim \sqrt{\frac{M_{\text{p}}}{m_{\text{e}}}} \times 0.99 \approx 42.5}$$

Proof: By 2.4, $$\frac{m_{\rm e}}{\sqrt{1-\beta_{\rm Nuc}^2}}r_{\rm Nuc}^2 \approx \frac{M_{\rm p}}{\sqrt{1-\beta_{\rm p}^2}}\rho_{\rm p}^2,$$

$$\frac{r_{\rm Nuc}}{\rho_{\rm p}} \approx \sqrt{\frac{M_{\rm p}}{m_{\rm e}}}\sqrt[4]{\frac{1-\beta_{\rm Nuc}^2}{1-\beta_{\rm p}^2}}.$$

Even if $\beta_{\rm Nuc} = 0.5$, and $\beta_{\rm p} = 0.1$, then, $\sqrt[4]{\frac{1-\beta_{\rm Nuc}^2}{1-\beta_{\rm p}^2}} \approx 0.933 \sim 1.$

we'll use 0.99. Then,

$$\frac{r_{\rm Nuc}}{\rho_{\rm p}} \sim \sqrt{\frac{M_{\rm p}}{m_{\rm e}}}\times 0.99 = \sqrt{1836.152701}\times 0.99$$

$$\sim 42.5.\square$$

8.4 $$\boxed{\beta_{\rm Nuc}^2 \sim 42.5\frac{65}{35}\beta_{\rm p}^2}$$

8.5 $$\boxed{\frac{\Omega_{\rm p}}{\omega_{\rm Nuc}} = \sqrt{\frac{35}{65}}\left(\frac{M_{\rm p}}{m_{\rm e}}\right)^{\frac{1}{4}} = 4.803464029}$$

Proof: Divide the Force Balance,

$$\frac{35m_{\rm e}}{\sqrt{1-\beta_{\rm Nuc}^2}}\omega_{\rm Nuc}^2 r_{\rm Nuc}^3 = \frac{65M_{\rm p}}{\sqrt{1-\beta_{\rm p}^2}}\Omega_{\rm p}^2\rho_{\rm p}^3$$

by the Inertia Moments Equilibrium,

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}} r_{\mathrm{Nuc}}^2 \approx \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}} \rho_{\mathrm{p}}^2 .$$

Then,

$$35\omega_{\mathrm{Nuc}}^2 r_{\mathrm{Nuc}} = 65\Omega_{\mathrm{p}}^2 \rho_{\mathrm{p}}$$

$$\frac{\Omega_{\mathrm{p}}}{\omega_{\mathrm{Nuc}}} = \sqrt{\frac{35}{65}}\sqrt{\frac{r_{\mathrm{Nuc}}}{\rho_{\mathrm{p}}}}$$

$$= \sqrt{\frac{35}{65}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}$$

$$= (0.733799385)(6.546018057)$$

$$= 4.803464029 . \square$$

9.

The Neutronic Electron Energy

9.1 The Neutronic Electron's Electric Binding Energy in the 1st orbit

$$U_{\text{electric}} = -\frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\text{Nuc}}}$$

$$= -\frac{1}{10^7}c^2\frac{65e^2}{r_{\text{Nuc}}}$$

9.2 The Neutronic Electron's Magnetic Energy

$$U_{\text{magnetic}} = \tfrac{1}{4}\mu_0 r_{\text{Nuc}} e^2 \nu_{\text{Nuc}}^2$$

$$= \frac{1}{(4\pi)^2}\mu_0 v_{\text{Nuc}}^2 e^2 \frac{1}{r_{\text{Nuc}}}$$

Proof: The current due to the electron's charge e that turns ν_{Nuc} cycles/second is

$$I = e\nu_{\text{Nuc}}$$

The Magnetic Energy of this current is [Benson, p.486]

$$\tfrac{1}{2}LI^2.$$

By [Fischer, p.97]

$$L = \mu_0 \frac{\pi r_{\text{Nuc}}^2}{2\pi r_{\text{Nuc}}} = \tfrac{1}{2}\mu_0 r_{\text{Nuc}}.$$

Thus, the magnetic energy due to the electron's current is

$$\tfrac{1}{2}\tfrac{1}{2}\mu_0 r_{\mathrm{Nuc}}(e\nu_{\mathrm{Nuc}})^2 = \tfrac{1}{4}\mu_0 r_{\mathrm{Nuc}} e^2 \underbrace{\nu_{\mathrm{Nuc}}^2}_{\frac{1}{4\pi^2}\omega_{\mathrm{Nuc}}^2}$$

$$= \frac{1}{(4\pi)^2}\mu_0 v_{\mathrm{Nuc}}^2 e^2 \frac{1}{r_{\mathrm{Nuc}}}.$$

9.3 The Neutronic Electron's Magnetic Energy in its First Orbit is negligible compared to its Electric Energy

Proof:

$$\frac{U_{\mathrm{magnetic}}}{U_{\mathrm{electric}}} = \frac{\frac{1}{(4\pi)^2}\mu_0 v_{\mathrm{Nuc}}^2 e^2 \frac{1}{r_{\mathrm{Nuc}}}}{\frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\mathrm{Nuc}}}}$$

$$= \frac{1}{65}\frac{1}{4\pi}\frac{v_{\mathrm{Nuc}}^2}{c^2}$$

$$= \frac{1}{65}\frac{1}{4\pi}\beta_{\mathrm{Nuc}}^2$$

Even if $\beta_{\mathrm{Nuc}} = 0.5$,

$$= \frac{0.25}{65\cdot 4\pi} \approx 3\times 10^{-4}.\square$$

9.4 The Neutronic Electron Rotation Energy

$$\frac{1}{2}\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}}v_{\text{Nuc}}^2 = \frac{1}{2}\frac{c^2}{10^7}\frac{65e^2}{r_{\text{Nuc}}}$$

Proof: From the balance between the Centripetal and Electric forces on the electron in its Neutron orbit,

$$\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}}\frac{v_{\text{Nuc}}^2}{r_{\text{Nuc}}} = \frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\text{Nuc}}^2},$$

$$\frac{1}{2}\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}}v_{\text{Nuc}}^2 = \frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\text{Nuc}}}.$$

Substituting $\frac{1}{\varepsilon_0} = c^2\mu_0$, and $\mu_0 = \frac{4\pi}{10^7}$,

$$= \frac{1}{2}\frac{c^2}{10^7}\frac{65e^2}{r_{\text{Nuc}}}.\square$$

9.5 The Neutronic Electron Total Energy

$$U_{\text{electron}} \approx m_e c^2 + \frac{1}{2}\frac{1}{10^7}c^2\frac{65e^2}{r_{\text{Nuc}}}$$

Proof:

$$U_{\text{electron}} \approx m_e c^2 + \frac{1}{10^7}c^2\frac{65e^2}{r_{\text{Nuc}}} - \frac{1}{2}\frac{c^2}{10^7}\frac{65e^2}{r_{\text{Nuc}}}$$

$$= m_e c^2 + \frac{1}{2}\frac{1}{10^7}c^2\frac{65e^2}{r_{\text{Nuc}}}.\square$$

10.

The Protons' Energy

10.1 The Neutronic Proton Electric Binding Energy

$$U_{\text{electric}} = -\frac{1}{4\pi\varepsilon_0}\frac{35e^2}{\rho_{\text{p}}}$$

$$= -\frac{1}{10^7}c^2\frac{35e^2}{\rho_{\text{p}}}$$

10.2 The Neutronic Proton Magnetic Energy

$$U_{\text{magnetic}} = \tfrac{1}{4}\mu_0\rho_{6\text{p}}e^2\nu_{\text{p}}^2$$

$$= \frac{1}{(4\pi)^2}\mu_0 {V_{\text{p}}}^2 e^2\frac{1}{\rho_{\text{p}}}$$

Proof: The current due to the Neutronic Proton charge $-e$ that turns ν_{p} cycles/second is

$$I = -e\nu_{\text{p}}$$

The Magnetic Energy of this current is [Benson, p.486]

$$\tfrac{1}{2}LI^2.$$

By [Fischer, p.97]

$$L = \mu_0\frac{\pi{\rho_{\text{p}}}^2}{2\pi\rho_{\text{p}}} = \tfrac{1}{2}\mu_0\rho_{\text{p}}.$$

Thus, the magnetic energy due to the Nucleus current is

$$\tfrac{1}{2}\tfrac{1}{2}\mu_0\rho_{\mathrm{p}}(e\nu_{\mathrm{p}})^2 = \tfrac{1}{4}\mu_0\rho_{\mathrm{p}}e^2 \underbrace{\nu_{\mathrm{p}}^2}_{\frac{1}{4\pi^2}\Omega_{\mathrm{p}}^2}$$

$$= \frac{1}{(4\pi)^2}\mu_0 V_{\mathrm{p}}^2 e^2 \frac{1}{\rho_{\mathrm{p}}}.$$

10.3 The Neutronic Proton Magnetic Energy in its Orbit is negligible compared to its Electric Energy

Proof:

$$\frac{U_{\text{magnetic}}}{U_{\text{electric}}} = \frac{\frac{1}{(4\pi)^2}\mu_0 V_{\mathrm{p}}^2 e^2 \frac{1}{\rho_{\mathrm{p}}}}{\frac{1}{4\pi\varepsilon_0}\frac{35e^2}{\rho_{\mathrm{p}}}}$$

$$= \frac{1}{35}\frac{1}{4\pi}\frac{V_{\mathrm{p}}^2}{c^2}$$

$$= \frac{1}{35}\frac{1}{4\pi}\beta_{\mathrm{p}}{}^2$$

If $\beta_{\mathrm{p}} = 0.01$,

$$\approx \frac{0.01}{35\cdot 4\pi} \approx 2.3\times 10^{-5}.\square$$

10.4 The Neutronic Proton Rotation Energy

$$\frac{1}{2}\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}{}^{2}}}V_{\mathrm{p}}^{2} = \frac{1}{2}\frac{c^{2}}{10^{7}}\frac{35e^{2}}{\rho_{\mathrm{p}}}$$

Proof: From the balance between the Centripetal and Electric forces on the Neutronic Proton in its orbit,

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^{2}}}\frac{V_{\mathrm{p}}^{2}}{\rho_{\mathrm{p}}} = \frac{1}{4\pi\varepsilon_{0}}\frac{35e^{2}}{\rho_{\mathrm{p}}^{2}},$$

$$\frac{1}{2}\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^{2}}}v_{\mathrm{p}}^{2} = \frac{1}{2}\frac{1}{4\pi\varepsilon_{0}}\frac{35e^{2}}{\rho_{\mathrm{p}}}.$$

Substituting $\frac{1}{\varepsilon_{0}} = c^{2}\mu_{0}$, and $\mu_{0} = \frac{4\pi}{10^{7}}$,

$$= \frac{1}{2}\frac{c^{2}}{10^{7}}\frac{65e^{2}}{\rho_{\mathrm{p}}}.\square$$

10.5 The Neutronic Proton Total Energy

$$U_{\mathrm{Proton}} \approx M_{\mathrm{p}}c^{2} + \frac{1}{2}\frac{1}{10^{7}}c^{2}\frac{35e^{2}}{\rho_{\mathrm{p}}}$$

Proof:

$$U_{\mathrm{Proton}} \approx M_{\mathrm{p}}c^{2} + \frac{1}{10^{7}}c^{2}\frac{35e^{2}}{\rho_{\mathrm{p}}} - \frac{1}{2}\frac{c^{2}}{10^{7}}\frac{35e^{2}}{\rho_{\mathrm{p}}}$$

$$= M_{\mathrm{p}}c^{2} + \frac{1}{2}\frac{1}{10^{7}}c^{2}\frac{35e^{2}}{\rho_{\mathrm{p}}}.\square$$

11.

The Nucleus Mass-Energy

11.1 The Zinc Nucleus Mass-Energy Balance

$$\boxed{\underbrace{M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}}}_{\Delta m} \approx \frac{1}{2}\frac{1}{10^7}65\frac{e^2}{\rho_{\mathrm{p}}}\left(1 + \frac{\rho_{\mathrm{p}}}{r_{\mathrm{Nuc}}}\right)}$$

Proof:

$$30M_{\mathrm{p}}c^2 + 35M_{\mathrm{n}}c^2 = 65U_{\mathrm{Proton}} + 35U_{\mathrm{Neutronic\ electron}}$$

$$= 65M_{\mathrm{p}}c^2 + 65\frac{1}{2}\frac{1}{10^7}c^2\frac{35e^2}{\rho_{\mathrm{p}}} + 35m_{\mathrm{e}}c^2 + 35\frac{1}{2}\frac{1}{10^7}c^2\frac{65e^2}{r_{\mathrm{Nuc}}}.$$

Dividing by c^2,

$$35(M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}}) \approx \frac{1}{2}\frac{1}{10^7}35\cdot 65\frac{e^2}{\rho_{\mathrm{p}}}\left(1 + \frac{\rho_{\mathrm{p}}}{r_{\mathrm{Nuc}}}\right).\square$$

12.

The Protons' Orbit Radius

12.1 $$\boxed{\rho_{\text{p}} \approx 65 \cdot \frac{1}{2}\frac{1}{10^7}\frac{e^2}{\Delta m}\left(1+\frac{\rho_{\text{p}}}{r_{\text{Nuc}}}\right)}$$

12.2 $$\boxed{\rho_{\text{p}} \sim 1.436178468 \times 10^{-13}}$$

<u>*Proof*</u>: Substituting

$$e = -1.60217733 \times 10^{-19}\text{C},$$

$$M_{\text{N}} \approx 1.674\ 128\ 6 \times 10^{-27}\text{Kg},$$

$$M_{\text{p}} \approx 1.672\ 623\ 1 \times 10^{-27}\text{Kg},$$

$$m_{\text{e}} \approx 9.109\ 389\ 7 \times 10^{-31}\text{Kg},$$

$$\frac{1}{2}\frac{1}{10^7}\frac{e^2}{\Delta m} \approx \frac{1}{2}\frac{1}{10^7}\underbrace{\frac{(1.60217733)^2 \times 10^{-38}}{5.9456103 \times 10^{-31}}}_{0.431742422\ \times\ 10^{-7}}$$

$$= 2.15871211 \times 10^{-15}.$$

By 4.3, $\dfrac{\rho_{\text{p}}}{r_{\text{Nuc}}} \sim \dfrac{1}{42.5} \approx 0.0223529411$

$$\rho_{\text{p}} \approx 65 \times 2.15871211 \times 10^{-15}(1+0.0223529411)$$

$$= 1.436178468 \times 10^{-13}.\square$$

12.3 The Zinc Proton 1st Orbit Radius is

65×(Neutron Proton 1st Orbit Radius)

Proof: By [Dan5], the Proton Orbit Radius in the Neutron is

$$\rho_{\text{p in n}} = 2.209505336 \times 10^{-15}$$

$$\frac{\rho_{\text{p}}}{\rho_{\text{p in n}}} = \frac{1.436178468 \times 10^{-13}}{2.209505336 \times 10^{-15}}$$

$$= 64.9999999 \,.\square$$

By [Dan5, 8.3, or Dan4, p.21]

12.4 The Hydrogen Proton 1st Orbit Radius is

$$\rho_{\text{p in H}} = 1.221173735 \times 10^{-12}$$

12.5 The Hydrogen Proton 1st Orbit Radius is about

8.5×(The Zinc Proton 1st Orbit Radius)

Proof: $$\frac{\rho_{\text{p in H}}}{\rho_{\text{p}}} = \frac{1.221173735 \times 10^{-12}}{1.436178468 \times 10^{-13}}$$

$$\approx 8.502938613 \,.\square$$

13.

The Protons' Speed

13.1 $$\beta_p^4 + \left(35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\right)^2 \beta_p^2 - \left(35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\right)^2 \approx 0$$

Proof: From the Force Balance, 8.1,

$$\frac{M_p}{\sqrt{1-\beta_p{}^2}}\beta_p^2\rho_p = \frac{35e^2}{10^7}$$

$$\beta_p^2 \approx 35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\sqrt{1-\beta_p^2}$$

$$\beta_p^4 + \left(35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\right)^2 \beta_p^2 - \left(35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\right)^2 \approx 0.\square$$

Substituting

$$e = -1.60217733 \times 10^{-19}\text{C},$$

$$M_p \approx 1.672\ 623\ 1 \times 10^{-27}\text{Kg},$$

$$\rho_p \approx 1.436178468 \times 10^{-13}$$

$$35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p} \approx 35\frac{1}{10^7}\frac{(1.60217733)^2 \times 10^{-38}}{1.672\ 623\ 1 \times 10^{-27}}\frac{1}{1.436178468 \times 10^{-13}}$$

$$= 3.740095636 \times 10^{-4}.$$

$$\left(35\frac{1}{10^7}\frac{1}{M_p}\frac{e^2}{\rho_p}\right)^2 \approx 1.398831537\times 10^{-7}$$

13.2 $$\boxed{\beta_p^4 + 1.398831537\times 10^{-7}\beta_p^2 - 1.398831537\times 10^{-7} \approx 0}$$

Using MAPLE

```
> with(RootFinding):
> r0 := NextZero(x → x^2
        + 1.398831537·10^(-7) x
        − 1.398831537·10^(-7),
       0.0001);
                          r0 := 0.0003739396286
> sqrt(r0)
                               0.01933751868
```

13.3 $$\boxed{\beta_p^2 = 3.739396286\times 10^{-4}}$$

13.4 $$\boxed{\beta_p \approx 0.01933751868}$$

13.5 The Zinc Protons Speed

$$\boxed{V_{\text{p}} \sim 5{,}801{,}257 \ \ \text{m/sec}}.$$

Proof: $V_{\text{p}} = \beta_{\text{p}} c$

$$\approx 0.01933751868c$$

$$\approx 5{,}801{,}257 \ \text{m/sec}. \square$$

By [Dan5, 9.5],

13.6 The Neutron Proton Speed

$$V_{\text{p in N}} \sim 7{,}905{,}145 \ \text{m/sec}.$$

13.7 The Neutron Proton Speed is about 1.36×(The Zinc Protons Speed)

Proof: $$\frac{V_{\text{p-in-N}}}{V_{\text{p}}} \sim \frac{7{,}905{,}145}{5{,}801{,}257}$$

$$\approx 1.362660713. \square$$

By [Dan5, 9.6],

13.8 The Hydrogen Proton Speed

$$V_{\text{p in H}} \sim 330{,}420 \ \text{m/sec}$$

13.9 The Zinc Proton Speed is about 17.5 $\times$(Hydrogen Proton Speed)

Proof:
$$\frac{V_{\text{p}}}{V_{\text{p in H}}} \sim \frac{5,801,257}{330,420}$$
$$\approx 17.55722111. \square$$

14.

The 1st Orbit Proton Frequency

14.1 The 1st Orbit Proton Angular Velocity

$$\boxed{\Omega_{\mathrm{p}} = \frac{V_{\mathrm{p}}}{\rho_{\mathrm{p}}} = 4.039370544 \times 10^{19} \text{ radians/sec}}$$

Proof: $\Omega_{\mathrm{p}} = \frac{V_{\mathrm{p}}}{\rho_{\mathrm{p}}}$

$$\approx \frac{5{,}801{,}257 \text{ m/sec}}{1.436178468 \times 10^{-13}\text{m}}$$

$$= 4.039370544 \times 10^{19} \text{ radians/sec}.\square$$

14.2 The 1st Orbit Proton Frequency is

$$\boxed{\frac{\Omega_{\mathrm{p}}}{2\pi} = 6.42885789 \times 10^{18}\text{cycles/sec}}$$

Proof: $\frac{\Omega_{\mathrm{p}}}{2\pi} = \frac{4.039370544 \times 10^{19} \text{ radians/sec}}{2\pi}$

$$= 6.42885789 \times 10^{18}\text{cycles/sec}.\square$$

By [Dan5, 10.7],

14.3 The Neutron's Proton Frequency is

$$\frac{\Omega_{\text{p in n}}}{2\pi} = 5.69422884 \times 10^{20} \text{ cycles/sec}$$

14.4 The Neutron's Proton Frequency is 88×(the 1st Orbit Protons Frequency)

Proof:
$$\frac{\frac{\Omega_{\text{p in n}}}{2\pi}}{\frac{\Omega_{\text{p}}}{2\pi}} = \frac{5.69422884 \times 10^{20}}{6.42885789 \times 10^{18}}$$

$$\sim 88.57294632.\square$$

By [Dan5, 10.8]

14.5 The Hydrogen Proton Frequency is

$$\frac{\Omega_{\text{p in H}}}{2\pi} = 4.30634292 \times 10^{16} \text{ cycles/sec}$$

14.6 The 1st Orbit Proton Frequency is 149×(Hydrogen Proton's Frequency)

Proof:
$$\frac{\frac{\Omega_{\rm p}}{2\pi}}{\frac{\Omega_{\rm p\ in\ H}}{2\pi}} = \frac{6.42885789 \times 10^{18}}{4.30634292 \times 10^{16}}$$

$$\sim 149.2881082\,.\square$$

15.

The Nucleus Electron Speed from Radiation Equilibrium

15.1 $$\boxed{\beta_{\text{Nuc}}^2 \sim 42.5\beta_{\text{p}}^2 \frac{65}{35} \sim 0.02951452}$$

Proof: By 8.4, $\beta_{\text{Nuc}}^2 \sim 42.5\beta_{\text{p}}^2 \dfrac{65}{35}$

$$= 42.5 \cdot 3.739396286 \times 10^{-4} \frac{65}{35}$$

$$= 0.02951452 . \square$$

15.2 $$\boxed{\beta_{\text{Nuc}} \sim 0.171797906}$$

15.3 $$\boxed{v_{\text{Nuc}} \sim 51,539,372 \text{ m/sec}}$$

Proof: $v_{\text{Nuc}} \sim 0.171797906 \cdot 300,000,000 = 51,539,372 \text{ m / sec}$

Next, we solve the Force equation for β_{Nuc}^2, and obtain closer estimates to β_{Nuc}, and to v_{Nuc}.

16.

The Nucleus Electron Speed from the Force Equation

16.1 $$\boxed{\beta_{\text{Nuc}}^4 + \left(\frac{65}{42.5\rho_{\text{p}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \beta_{\text{Nuc}}^2 - \left(\frac{65}{42.5\rho_{\text{p}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \approx 0}$$

<u>*Proof*</u>: The Force on the Nucleus 1st orbit electron is

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}}\beta_{\text{Nuc}}^2 r_{\text{Nuc}} = 65\frac{e^2}{10^7},$$

$$\beta_{\text{Nuc}}^2 = \frac{65}{r_{\text{Nuc}} m_{\text{e}}}\frac{e^2}{10^7}\sqrt{1-\beta_{\text{Nuc}}^2},$$

Squaring both sides,

$$\beta_{\text{Nuc}}^4 + \left(\frac{65}{r_{\text{Nuc}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \beta_{\text{Nuc}}^2 - \left(\frac{65}{r_{\text{Nuc}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \approx 0$$

Since $r_{\text{Nuc}} \sim 42.5\rho_{\text{p}}$

$$\beta_{\text{Nuc}}^4 + \left(\frac{65}{42.5\rho_{\text{p}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \beta_{\text{Nuc}}^2 - \left(\frac{65}{42.5\rho_{\text{p}} m_{\text{e}}}\frac{e^2}{10^7}\right)^2 \approx 0.\square$$

$$\frac{65}{10^7}\frac{e^2}{(42.5\rho_{\text{p}})m_{\text{e}}} \sim \frac{65(1.60217733)^2\times 10^{-38}}{10^7(42.5)(1.436178\times 10^{-13})(9.109\ 389\ 7\times 10^{-31})}$$

$$= 3.0008759\times 10^{-2}.$$

$$\left(\frac{65}{10^7}\frac{e^2}{(42.5\rho_{\text{p}})m_{\text{e}}}\right)^2 \sim 9.005256346\times 10^{-4}.$$

$$\beta_{\text{Nuc}}^4 + (9.005256346\times 10^{-4})\beta_{\text{Nuc}}^2 - (9.005256346\times 10^{-4}) \approx 0.$$

16.2 $$\boxed{\beta_{\text{Nuc}}^4 + (9.005256346)10^{-4}\beta_{\text{Nuc}}^2 - (9.005256346)10^{-4} \approx 0}$$

Denoting $\beta_{\text{Nuc}}^2 \equiv x$, we seek the zeros of the polynomial

$$f(x) = x^2 + (9.005256346\times 10^{-4})x - (9.005256346\times 10^{-4})$$

between $x = 0$, and $x = 1$.

We used Maple Root-Finding Program.

Maple Input and Output follow:

```
> with(RootFinding):
> > r0 := NextZero(x → x^2
        + 9.005256346·10^-4 x
        − 9.005256346·10^-4, 0.01);
                    r0 := 0.02956187425
> sqrt(r0)
                    0.1719356689
```

16.3 $$\boxed{\beta_{\text{Nuc}}^2 \sim 0.02956187425}$$

Compare with 15.1 $\beta_{\text{Nuc}}^2 \sim 0.02951452$

16.4 $$\boxed{\beta_{\text{Nuc}} \sim 0.1719356689}$$

Compare with 15.2 $\beta_{\text{Nuc}} \sim 0.171797906$

16.5 The Nucleus Electrons Speed

$$\boxed{v_{\text{Nuc}} \sim 51,560,184 \text{ m/sec}}.$$

Compare with 15.3 $v_{\text{Nuc}} \sim 51,539,372$ m/sec

Proof: $\beta_{\text{Nuc}} c \sim 0.1719356689c$

$$\approx 51,560,184 \text{ m/sec}.\square$$

By [Dan5, 11.5],

16.6 The Neutron Electron Speed

$$v_e \sim 51,558,134 \text{ m/sec}.$$

16.7 Neutron Electron Speed $\sim$ (Nucleus Electrons Speed)

Proof: $$\frac{51,558,134}{51,560,184} \approx 1. \square$$

By [Dan5, 11.6],

16.8 The Hydrogen Electron Speed

$$v_{\mathrm{H}} \sim \underbrace{\alpha}_{\approx \frac{1}{137}} c = 2,189,781 \text{ m/sec}.$$

Thus,

16.9 Zinc Nucleus Electron Speed

$\sim$ 23.5 $\times$ (Hydrogen Electron Speed)

Proof: $$\frac{51,560,184}{2,189,781} \approx 23.5458176. \square$$

17.

Nucleus Electron 1st Orbit Radius

17.1 1st Orbit Radius of the Zinc Nucleus Electron

$$r_{\mathrm{Nuc}} \approx \frac{35}{65}\beta_{\mathrm{Nuc}}^2 \frac{\rho_{\mathrm{p}}}{\beta_{\mathrm{p}}^2} \sim 6.108688998 \times 10^{-12}$$

Proof: Substitute

$$\rho_{\mathrm{p}} \approx 1.436178468 \times 10^{-13},$$

$$\beta_{\mathrm{p}}^2 = 3.739396286 \times 10^{-4},$$

$$\beta_{\mathrm{Nuc}}^2 \sim 0.02953836208. \square$$

By [Dan5, 12.1],

17.2 Neutron Electron 1st Orbit Radius

$$R_{\mathrm{N}} \sim 9.398741807 \times 10^{-14}$$

17.3 Zinc Nucleus Electron 1st Orbit Radius

is $\sim 65\times$ (Neutron Electron Orbit Radius)

Proof: $$\frac{6.108688998 \times 10^{-12}}{9.398741807 \times 10^{-14}} = 64.99475274$$

By 2.3,

17.4 The Zinc Nucleus Electron Orbit Radius is

$\sim$42.5$\times$(The Zinc Proton Orbit Radius)

17.5 The Hydrogen Electron Orbit Radius

$$r_{\mathrm{H}} = 5.29277249 \times 10^{-11}\mathrm{m}.$$

17.6 The Hydrogen Electron Orbit Radius is about

8.7$\times$(Zinc Nucleus Electron Orbit Radius)

Proof: $$\frac{5.29277249 \times 10^{-11}}{6.108688998 \times 10^{-12}} = 8.664334511. \square$$

18.

1st Orbit Nucleus Electron Frequency

18.1 The 1st Orbit Zinc Nucleus Electron Angular Velocity

$$\boxed{\omega_{\text{Nuc}} = \frac{v_{\text{Nuc}}}{r_{\text{Nuc}}} = 8.440466361 \times 10^{18} \ \text{radians/sec}}$$

Proof: $\omega_{\text{Nuc}} = \dfrac{v_{\text{Nuc}}}{r_{\text{Nuc}}}$

$$\approx \frac{51{,}560{,}184 \ \text{m/sec}}{6.108688998 \times 10^{-12}\,\text{m}}$$

$$= 8.440466361 \times 10^{18} \ \text{radians/sec}\,.\square$$

18.2 The 1st Orbit Nucleus Electron Frequency

$$\boxed{\frac{\omega_{\text{Nuc}}}{2\pi} = 1.343341943 \times 10^{18}\,\text{cycles/sec}}$$

Proof: $\dfrac{\omega_{\text{Nuc}}}{2\pi} = \dfrac{8.440466361 \times 10^{18}}{2\pi}$

$$= 1.343341943 \times 10^{18}\,\text{cycles/sec}\,.\square$$

18.3 1st Orbit Neutron Electron Frequency is ~65× (1st Orbit Zinc Nucleus Electron Frequency)

Proof: $$\frac{\frac{\omega_{\text{e in n}}}{2\pi}}{\frac{\omega_{\text{Nuc}}}{2\pi}} = \frac{5.485642074 \times 10^{20}}{8.440466361 \times 10^{18}}$$

$$\sim 64.99216796 . \square$$

18.4 1st Orbit Hydrogen Electron Frequency

$$\frac{\omega_{\text{e in H}}}{2\pi} = 6.58472424 \times 10^{15}$$

Proof: $$\omega_{\text{e in H}} = \frac{v_{\text{e in H}}}{r_{\text{e in H}}} \approx \frac{2{,}189{,}781 \text{ m/sec}}{5.2977249 \times 10^{-11} \text{m}}$$

$$= 4.1334366 \times 10^{16} \text{ radians/sec}$$

$$\frac{\omega_{\text{e in H}}}{2\pi} = \frac{4.137304269 \times 10^{16} \text{ radians/sec}}{2\pi}$$

$$= 6.58472424 \times 10^{15} . \square$$

18.5 1st Orbit Zinc Nucleus Electron Frequency is ~204×(1st Orbit Hydrogen Electron Frequency)

Proof: $$\frac{\frac{\omega_{\text{Nuc}}}{2\pi}}{\frac{\omega_{\text{e in H}}}{2\pi}} = \frac{1.343341943 \times 10^{18}}{6.58472424 \times 10^{15}}$$

$$\sim 204.1997296. \square$$

19.

Nucleus Electron Quantum of Angular Momentum

We associated with the Zinc Nucleus Electron

$$\text{Orbit Radius } r_{\text{Nuc}} \sim 6.108688998 \times 10^{-12}\,\text{m},$$

$$\text{Speed } v_{\text{Nuc}} \sim 51,560,184 \text{ m/sec},$$

$$\beta_{\text{Nuc}} \sim 0.1719356689.$$

To obtain these, we averaged the 35 electrons orbits into one orbit.

Now, we will consider that one orbit as the 1st orbit of the electrons in the Nucleus, and construct on it the 2nd, 3rd, 4th,…,orbits.

The Zinc Nucleus Electron nth orbit has angular momentum

$$\frac{m_e}{\sqrt{1-\beta_{\text{Nuc},n}^2}}\,\omega_{\text{Nuc},n} r_{\text{Nuc},n}^2.$$

The Nucleus Electron Quantum of Angular Momentum is the Angular Momentum of its 1st orbit:

19.1 Zinc Nucleus Electron Quantum of Angular Momentum

$$\boxed{\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}} v_{\text{Nuc}} r_{\text{Nuc}} = (2.761794253)\hbar}$$

Proof:

$$\frac{1}{\sqrt{1-\beta_{\text{Nuc}}^2}} = \frac{1}{\sqrt{1-(0.1719356689)^2}}$$

$$\approx 1.015116939$$

$$\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}} v_{\text{Nuc}} r_{\text{Nuc}} =$$

$$= \frac{(1.015116939)(9.1093897)10^{-31}(51,560,184)(6.108688998)10^{-12}}{(1.05457266)10^{-34}}\hbar$$

$$= (2.761794253)\hbar . \square$$

19.2 Angular Momentum of the n^th orbit Nucleus electron

$$\boxed{\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc},n}^2}} v_{\text{Nuc},n} r_{\text{Nuc},n} = n(2.761794253)\hbar}$$

20.

The Nucleus Electron nth Orbit Radius, Speed, and Frequency

20.1 The Zinc Nucleus Electron 1st Orbit Radius, Speed, and Frequency

$$r_{\text{Nuc}} \sim 6.108688998 \times 10^{-12}\text{m}$$

$$= \frac{1}{65}(2.761794253)^2\sqrt{1-\beta_{\text{Nuc}}^2}\, r_{\text{H}}$$

$$= (0.110142785) r_{\text{H}}$$

$$v_{\text{Nuc}} \sim 51,560,184 \text{ m/sec}$$

$$= \frac{65}{2.761794253} v_{\text{H}}$$

$$= (23.53542445) v_{\text{H}}$$

$$\frac{\omega_{\text{Nuc}}}{2\pi} = 1.343341943 \times 10^{18}\text{cycles/sec}$$

$$= \frac{65^2}{(13.21701291)^3}\frac{1}{\sqrt{1-\beta_{\text{Nuc-e}}^2}}\frac{v_{\text{H}}}{2\pi r_{\text{H}}}$$

$$= (203.5958043)\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}.$$

Proof: The force on the Nucleus 1st orbit electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}\frac{v_{\mathrm{Nuc}}^2}{r_{\mathrm{Nuc}}} = \frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\mathrm{Nuc}}^2},$$

$$\frac{65e^2}{4\pi\varepsilon_0} = \left(\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}v_{\mathrm{Nuc}}r_{\mathrm{Nuc}}\right)^2 \frac{1}{\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}}\frac{1}{r_{\mathrm{Nuc}}},$$

Since $\dfrac{m_e}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}v_{\mathrm{Nuc}}r_{\mathrm{Nuc}} = (2.761794253)\hbar$,

$$r_{\mathrm{Nuc}} = \frac{1}{65}(2.761794253)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}}\sqrt{1-\beta_{\mathrm{Nuc}}^2},$$

$$= \frac{1}{65}(2.761794253)^2\sqrt{1-\beta_{\mathrm{Nuc}}^2}\,r_{\mathrm{H}}$$

$$= \frac{1}{65}\underbrace{(2.761794253)^2}_{7.627507496}\underbrace{\sqrt{1-(0.1719356689)^2}}_{0.985108179}\,r_{\mathrm{H}}$$

$$= (0.110142785)r_{\mathrm{H}}.$$

$$v_{\mathrm{Nuc}} = \frac{(2.761794253)\hbar}{\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}r_{\mathrm{Nuc}}}$$

$$= \frac{(2.761794253)\hbar}{\frac{m_e}{\sqrt{1-\beta_{\text{Nuc}}^2}}\left(\frac{1}{65}(2.761794253)^2\sqrt{1-\beta_{\text{Nuc}}^2}r_H\right)}$$

$$= \frac{65}{2.761794253}\underbrace{\frac{\hbar}{m_e r_H}}_{v_H}$$

$$= \frac{65}{2.761794253}v_H$$

$$= (23.53542445)v_H$$

$$\frac{\omega_{\text{Nuc}}}{2\pi} = \frac{v_{\text{Nuc}}}{2\pi r_{\text{Nuc}}}$$

$$= \frac{\frac{65}{2.761794253}v_H}{2\pi\left(\frac{1}{65}(2.761794253)^2\sqrt{1-\beta_{\text{Nuc}}^2}r_H\right)}$$

$$= \frac{65^2}{(2.761794253)^3}\frac{1}{\sqrt{1-\beta_{\text{Nuc}}^2}}\underbrace{\frac{v_H}{2\pi r_H}}_{\frac{\Omega_{\text{e in H}}}{2\pi}}$$

$$= (203.5958043)\frac{v_H}{2\pi r_H}$$

20.2 The Nucleus Electron nth Orbit Radius, Speed, and Frequency

$$r_{\mathrm{Nuc},n} = n^2 r_{\mathrm{Nuc}},$$

$$\sim n^2(6.108688998 \times 10^{-12})\mathrm{m}$$

$$v_{\mathrm{Nuc},n} = \frac{1}{n} v_{\mathrm{Nuc}},$$

$$\sim \frac{1}{n} 51,560,184 \ \mathrm{m/sec}$$

$$\frac{\omega_{\mathrm{Nuc},n}}{2\pi} = \frac{1}{n^3}\frac{\omega_{\mathrm{Nuc}}}{2\pi},$$

$$= \frac{1}{n^3}(1.343341943)10^{18}$$

Proof: The force on the Nucleus n^{th} orbit electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}}\frac{v_{\mathrm{Nuc},n}^2}{r_{\mathrm{Nuc},n}} = \frac{1}{4\pi\varepsilon_0}\frac{65e^2}{r_{\mathrm{Nuc},n}^2},$$

$$\frac{65e^2}{4\pi\varepsilon_0} = \left(\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} v_{\mathrm{Nuc},n} r_{\mathrm{Nuc},n}\right)^2 \frac{1}{\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}}}\frac{1}{r_{\mathrm{Nuc},n}},$$

Since $\dfrac{m_e}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} v_{\mathrm{Nuc},n} r_{\mathrm{Nuc},n} = n(2.761794253)\hbar$,

$$r_{\mathrm{Nuc},n} = \frac{1}{65} n^2 (2.761794253)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}} \sqrt{1-\beta_{\mathrm{Nuc},n}^2},$$

$$= \frac{1}{65} n^2 (2.761794253)^2 \sqrt{1-\beta_{\mathrm{Nuc},n}^2}\, r_{\mathrm{H}}$$

$$= n^2 \frac{1}{65} \underbrace{(2.761794253)^2}_{7.627507496} \underbrace{\sqrt{1-(0.1719356689)^2}}_{0.985108179} r_{\mathrm{H}}$$

$$= n^2 (0.110142785) r_{\mathrm{H}},$$

$$= n^2 r_{\mathrm{Nuc}}.$$

$$v_{\mathrm{Nuc},n} = \frac{n(2.761794253)\hbar}{\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} r_{\mathrm{Nuc},n}}$$

$$= \frac{n(2.761794253)\hbar}{\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} \left(\dfrac{n^2}{65} (2.761794253)^2 \sqrt{1-\beta_{\mathrm{Nuc},n}^2} r_{\mathrm{H}} \right)}$$

$$= \frac{1}{n} \frac{65}{2.761794253} \frac{\hbar}{\underbrace{m_{\mathrm{e}} r_{\mathrm{H}}}_{v_{\mathrm{H}}}}$$

$$= \frac{1}{n} \frac{65}{2.761794253} v_{\mathrm{H}}$$

$$= \frac{1}{n} (23.53542445) v_{\mathrm{H}}$$

$$= \frac{1}{n} v_{\mathrm{Nuc}}.$$

$$\frac{\omega_{\mathrm{Nuc},n}}{2\pi} = \frac{v_{\mathrm{Nuc},n}}{2\pi r_{\mathrm{Nuc},n}}$$

$$= \frac{\frac{1}{n}\frac{65}{2.761794253}v_{\mathrm{H}}}{2\pi\left(\frac{n^2}{65}(2.761794253)^2\sqrt{1-\beta_{\mathrm{Nuc}}^2}\,r_{\mathrm{H}}\right)}$$

$$= \frac{1}{n^3}\frac{65^2}{(2.761794253)^3}\frac{1}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}\underbrace{\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}}_{\frac{\Omega_{\mathrm{e\ in\ H}}}{2\pi}}$$

$$= \frac{1}{n^3}(203.5958043)\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}\frac{\omega_{\mathrm{Nuc},n}}{2\pi}$$

21.

The Nucleus Proton Quantum of Angular Momentum

We associated with the Zinc's Nucleus Proton

$$\text{Orbit Radius } \rho_{\mathrm{p}} \sim 1.436178468 \times 10^{-13},$$

$$\text{Speed } V_{\mathrm{p}} \sim 5,801,257 \quad \mathrm{m/sec},$$

$$\beta_{\mathrm{p}} \approx 0.01933751868.$$

To obtain these, we averaged the 65 protons orbits into one orbit.

Now, we will consider that one orbit as the 1st orbit of the protons in the Nucleus, and construct on it the 2nd, 3rd, 4th,…,orbits.

The Nucleus Electron n-th orbit has angular momentum

$$\frac{m_e}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}}\omega_{\mathrm{Nuc},n} r_{\mathrm{Nuc},n}^2.$$

The Nucleus Proton n-th orbit has angular momentum

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}}\Omega_{\mathrm{p},n}\rho_{\mathrm{p},n}^2.$$

The Zinc Nucleus Proton Quantum of Angular Momentum is the Angular Momentum of its 1st orbit:

21.2 Quantum of Zinc Nucleus Proton Angular Momentum

$$\boxed{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}} V_{\mathrm{p}} \rho_{\mathrm{p}} = (13.21701291)\hbar}$$

Proof:

$$\frac{1}{\sqrt{1-\beta_{\mathrm{p}}^2}} = \frac{1}{\sqrt{1-(0.01933751868)^2}}$$

$$\approx 1.000187022$$

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}} V_{\mathrm{p}} \rho_{\mathrm{p}} \frac{1}{\hbar}\hbar =$$

$$= \frac{(1.000187022)(1.6726231)10^{-27}(5,801,257)(1.436178468)10^{-13}}{(1.05457266)10^{-34}}\hbar$$

$$= (13.21701291)\hbar . \square$$

21.3 The Angular Momentum of the n$^{\text{th}}$ orbit proton

$$\boxed{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}} V_{\mathrm{p},n} \rho_{\mathrm{p},n} = n(13.21701291)\hbar}$$

22.

The Nucleus Proton nth Orbit Radius, Speed, and Frequency

22.1 The Zinc Nucleus Proton 1st Orbit Radius, Speed, and Frequency

$$\rho_{\text{p}} \sim 1.436178468 \times 10^{-13}\text{m}$$

$$= \frac{1}{35}(13.21701291)^2 \sqrt{1-\beta_{\text{p}}^2}\sqrt{\frac{m_{\text{e}}}{M_{\text{p}}}}(\rho_{\text{p in H}})$$

$$= (0.116456295)\rho_{\text{p in H}}$$

$$V_{\text{p}} \sim 5{,}801{,}257 \text{ m/sec}$$

$$= \frac{35}{13.21701291}\left(\frac{M_p}{m_e}\right)^{\frac{1}{4}} V_{\text{p in H}}$$

$$= (17.33452434) V_{\text{p in H}}$$

$$\frac{\Omega_{\text{p}}}{2\pi} = 6.42885789 \times 10^{18}\text{cycles/sec}$$

$$= \frac{35^2}{(13.21701291)^3}\left(\frac{M_p}{m_e}\right)^{\frac{3}{4}}\frac{1}{\sqrt{1-\beta_{\mathrm{p}}^2}}(\nu_{\mathrm{p\ in\ H}})$$

$$\approx (148.85)\nu_{\mathrm{p\ in\ H}}$$

Proof: The force on the Nucleus 1st orbit proton is

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}\frac{V_{\mathrm{p}}^2}{\rho_{\mathrm{p}}} = \frac{1}{4\pi\varepsilon_0}\frac{35e^2}{\rho_{\mathrm{p}}^2},$$

$$\frac{35e^2}{4\pi\varepsilon_0} = \left(\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}V_{\mathrm{p}}\rho_{\mathrm{p}}\right)^2 \frac{1}{\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}}\frac{1}{\rho_{\mathrm{p}}},$$

Since $\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}(\beta_{\mathrm{p}}c)\rho_{\mathrm{p}} = (13.21701291)\hbar,$

$$\rho_{\mathrm{p}} = \frac{1}{35}(13.21701291)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}}\sqrt{1-\beta_{\mathrm{p}}^2}\,\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}},$$

$$= \frac{1}{35}(13.21701291)^2 \underbrace{r_{\mathrm{H}}\sqrt{\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}}}_{\rho_{\mathrm{H}}}\sqrt{1-\beta_{\mathrm{p}}^2}\sqrt{\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}},$$

$$= \frac{1}{35}(13.21701291)^2\sqrt{1-\beta_{\mathrm{p}}^2}\sqrt{\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}}\rho_{\mathrm{H}}$$

$$= \frac{1}{35}\underbrace{(13.21701291)^2}_{174.6894303}\underbrace{\sqrt{1-(0.01933751868)^2}}_{0.999813012}\underbrace{\sqrt{\frac{1}{1836.152701}}}_{0.02333703}\rho_{\mathrm{H}}$$

$$= (0.116456295)\rho_{\mathrm{H}}.$$

$$V_{\mathrm{p}} = \frac{(13.21701291)\hbar}{\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}\rho_{\mathrm{p}}}$$

$$= \frac{(13.21701291)\hbar}{\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}\left(\dfrac{1}{35}(13.21701291)^2 r_{\mathrm{H}}\sqrt{1-\beta_{\mathrm{p}}^2}\,\dfrac{m_{\mathrm{e}}}{M_{\mathrm{p}}}\right)}$$

$$= \frac{35}{13.21701291}\underbrace{\frac{\hbar}{m_{\mathrm{e}} r_{\mathrm{H}}}}_{v_{\mathrm{H}}}$$

$$= \frac{35}{13.21701291}\underbrace{\left(\frac{M_p}{m_e}\right)^{\frac{1}{4}}}_{6.546018057}\underbrace{\left(\frac{m_e}{M_p}\right)^{\frac{1}{4}} v_{\mathrm{H}}}_{V_{\mathrm{H}}}$$

$$= (17.33452434)V_{\mathrm{H}}$$

$$\frac{V_{\mathrm{p}}}{2\pi\rho_{\mathrm{p}}} = \frac{\dfrac{35}{13.21701291}\left(\dfrac{M_p}{m_e}\right)^{\frac{1}{4}} V_{\mathrm{H}}}{2\pi\,\dfrac{1}{35}(13.21701291)^2\sqrt{1-\beta_{\mathrm{p}}^2}\sqrt{\dfrac{m_{\mathrm{e}}}{M_{\mathrm{p}}}}\rho_{\mathrm{H}}}$$

$$= \frac{35^2}{(13.21701291)^3}\left(\frac{M_p}{m_e}\right)^{\frac{3}{4}}\frac{1}{\sqrt{1-\beta_{\mathrm{p}}^2}}\underbrace{\frac{V_{\mathrm{H}}}{2\pi\rho_{\mathrm{H}}}}_{\frac{\Omega_{\mathrm{p\ in\ H}}}{2\pi}}$$

$$= (148.8500409)\frac{\Omega_{\text{p in H}}}{2\pi}$$

22.2 The Zinc Nucleus Proton n$^{\text{th}}$ Orbit Radius, Speed, and Frequency

$$\rho_{\text{p},n} = n^2\rho_{\text{p}},$$

$$\sim n^2(1.436178468\times 10^{-13})\text{m}$$

$$V_{\text{p},n} = \frac{1}{n}V_{\text{p}},$$

$$\sim \frac{1}{n}5,801,257 \quad \text{m/sec}$$

$$\frac{\Omega_{\text{p},n}}{2\pi} = \frac{1}{n^3}\frac{\Omega_{\text{p}}}{2\pi},$$

$$= \frac{1}{n^3}6.42885789\times 10^{18} \ \text{cycles/sec}$$

Proof: The force on the Nucleus n$^{\text{th}}$ orbit proton is

$$\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p},n}^2}}\frac{V_{\text{p},n}^2}{\rho_{\text{p},n}} = \frac{1}{4\pi\varepsilon_0}\frac{35e^2}{\rho_{\text{p},n}^2},$$

$$\frac{35e^2}{4\pi\varepsilon_0} = \left(\frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p},n}^2}}V_{\text{p},n}\rho_{\text{p},n}\right)^2\frac{1}{\dfrac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p},n}^2}}}\frac{1}{\rho_{\text{p},n}},$$

Since $\dfrac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p},n}^2}}V_{\text{p},n}\rho_{\text{p},n} = n(13.21701291)\hbar,$

$$\rho_{\mathrm{p},n} = n^2 \frac{1}{35}(13.21701291)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}} \sqrt{1-\beta_{\mathrm{p},n}^2}\,\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}.$$

$$= n^2 \rho_{\mathrm{p}}$$

Then,

$$V_{\mathrm{p},n} = \frac{n(13.21701291)\hbar}{\left(\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}}\rho_{\mathrm{p},n}\right)}$$

$$= \frac{n(13.21701291)\hbar}{\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}}\left(\dfrac{1}{35}n^2(13.21701291)^2 r_{\mathrm{H}}\sqrt{1-\beta_{\mathrm{p},n}^2}\,\dfrac{m_{\mathrm{e}}}{M_{\mathrm{p}}}\right)}$$

$$= \frac{1}{n}\frac{35}{(13.21701291)}\underbrace{\frac{\hbar}{m_{\mathrm{e}} r_{\mathrm{H}}}}_{v_{\mathrm{H}}}$$

$$= \frac{1}{n}\frac{35}{13.21701291}\underbrace{\left(\frac{M_p}{m_e}\right)^{\frac{1}{4}}}_{6.546018057}\underbrace{\left(\frac{m_e}{M_p}\right)^{\frac{1}{4}} v_{\mathrm{e\ in\ H}}}_{V_{\mathrm{p\ in\ H}}}$$

$$= \frac{1}{n}(17.33452434)V_{\mathrm{p\ in\ H}}$$

$$= \frac{1}{n}V_{\mathrm{p}}$$

That is,

the proton's n^th orbit speed is at most its 1^st orbit speed,

$$\beta_{\mathrm{p},n} \leq \beta_{\mathrm{p}},$$

$$\sqrt{1-\beta_{\mathrm{p},n}^2} \approx 1,$$

$$\rho_{\mathrm{p},n} \approx n^2 \frac{1}{35}(13.21701291)^2 r_{\mathrm{H}} \frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}$$

$$= n^2 \rho_{\mathrm{p}}$$

$$\frac{\Omega_{\mathrm{p},n}}{2\pi} = \frac{V_{\mathrm{p},n}}{2\pi\rho_{\mathrm{p},n}}$$

$$= \frac{\frac{1}{n}V_{\mathrm{p}}}{2\pi n^2 \rho_{\mathrm{p}}}$$

$$= \frac{1}{n^3}\frac{\Omega_{\mathrm{p}}}{2\pi}$$

23.

Nucleus Radiation Equilibrium is Equivalent to the Proton Quantized Angular Momentum

At equilibrium,

23.1

1) *the Nucleus is electrodynamically stable if and only if the inertia moments of the n^{th} orbit electron and the n^{th} orbit proton are equal:*

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} r_{\mathrm{Nuc},n}^2 = \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}} \rho_{\mathrm{p},n}^2$$

2) *The Angular velocities of the proton, and the electron are related by*

$$\frac{\Omega_{\mathrm{p},n}}{\omega_{\mathrm{Nuc},n}} = \sqrt{\frac{35}{65}} \left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} = 4.803464029$$

23.2 The n^{th} Orbit Radiation Equilibrium is equivalent to the n^{th} Orbit Quantized Angular Momentum

$$\boxed{\begin{aligned}&\frac{m_{\mathrm{e}} r_{\mathrm{Nuc},n}^2}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} = \frac{M_{\mathrm{p}} \rho_{\mathrm{p},n}^2}{\sqrt{1-\beta_{\mathrm{p},n}^2}} \\ &\Leftrightarrow \quad \frac{M_{\mathrm{p}} \rho_{\mathrm{p},n}^2 \Omega_{\mathrm{p},n}}{\sqrt{1-\beta_{\mathrm{p},n}^2}} = n(2.761794253)\hbar\sqrt{\frac{35}{65}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}}\end{aligned}}$$

__Proof__: The n[th] Orbit Radiation Equilibrium is

$$\frac{m_{\mathrm{e}} r_{\mathrm{Nuc},n}^2}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} = \frac{M_{\mathrm{p}} \rho_{\mathrm{p},n}^2}{\sqrt{1-\beta_{\mathrm{p},n}^2}}$$

$\Leftrightarrow$ the Proton's n^{th} orbit has Angular Momentum

$$\underbrace{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}} \rho_{\mathrm{p},n}^2}_{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} r_{\mathrm{Nuc},n}^2} \Omega_{\mathrm{p},n} = \underbrace{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}} r_{\mathrm{Nuc},n}^2 \omega_{\mathrm{Nuc},n}}_{n(2.761794253)\hbar} \underbrace{\frac{\Omega_{\mathrm{p},n}}{\omega_{\mathrm{Nuc},n}}}_{\sqrt{\frac{35}{65}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}}}$$

$$= n(2.761794253)\hbar\sqrt{\frac{35}{65}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}}. \square$$

IV. ZINC ATOM

24.

Zinc Atom Radiation Equilibrium

The Zinc Nucleus has A=65 Nucleons: $Z = 30$ Protons, and $A - Z = 35$ Neutrons.

The 30 Atomic electrons orbitals balance the 30 atomic protons, and bond the Zinc Atom

The 30 Atomic electrons orbit the 30 atomic Protons that orbit the center at radius r_e.

Since the 30 Atomic electrons do not interact with the interior of the nucleus, the 30 Atomic protons appear located at the boundary of the nucleus, orbiting the center at radius r_{Nuc}.

We approximate the 30 atomic electrons by

a charge of 30e,

with mass $30m_e$

orbiting the center at radius r_e,

and speed $\beta_e c$.

We approximate the 30 atomic protons by

a charge of 30e,

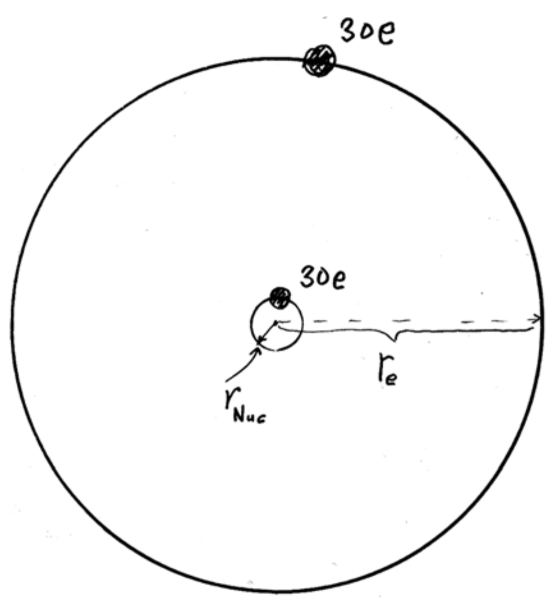
with mass $30M_{\text{p}}$

orbiting the center at radius r_{Nuc},

and speed $\beta_{\text{pNuc}}c$.

The Zinc atom is stable because the power radiated by the accelerating atomic electrons towards the Atomic Protons, equals the power radiated by the accelerating atomic protons towards the atomic electrons

ZINC-ATOM RADIAION POWER EQUILIBRIUM



30 Atomic protons with mass $30M_{\text{p}}$, and radius r_{Nuc}

30 Atomic electrons with mass $30m_{\text{e}}$, and radius r_{e}

24.1 The Atomic Electrons Acceleration

The Atomic electrons are attracted to the Atomic protons by the force

$$\frac{30m_e}{\sqrt{1-\beta_{\rm e}^2}}a_{\rm e} \approx \frac{1}{4\pi\varepsilon_0}\frac{(30e)(30e)}{r_{\rm e}^2},$$

Thus, the Atomic electrons accelerate at

$$a_{\rm e} \approx \frac{\sqrt{1-\beta_{\rm e}^2}}{30m_{\rm e}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\rm e}^2},$$

and radiate photons into the Atomic Protons fields.

24.2 The Atomic Electrons Radiation Power is

$$\boxed{\frac{(30e)^2}{6\pi\varepsilon_0 c^3}a_{\rm e}^2 \approx \frac{(30e)^2}{6\pi\varepsilon_0 c^3}\left(\frac{\sqrt{1-\beta_{\rm e}^2}}{30m_{\rm e}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\rm e}^2}\right)^2}$$

24.3 The Atomic Protons Acceleration

The Atomic protons orbit the charge of 30 Atomic Electrons, located at the center of a circle of Radius $r_{\rm Nuc}$, at speed $\beta_{\rm pNuc}$.

The Nucleus mass of $30M_{\rm p} + 35M_{\rm n}$, and charge $30e$ is attracted to the Atomic electrons by the force

$$\frac{30M_{\rm p} + 35M_{\rm n}}{\sqrt{1-\beta_{\rm pNuc}^2}}A_{\rm p\&n} \approx \frac{1}{4\pi\varepsilon_0}\frac{(30e)(30e)}{r_{\rm Nuc}^2},$$

The Nucleus accelerate towards the Atomic electrons at,

$$A_{\rm p\&n} \approx \frac{\sqrt{1-\beta_{\rm pNuc}^2}}{30M_{\rm p} + 35M_{\rm n}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\rm Nuc}^2},$$

and radiates photons into the Atomic electrons fields.

24.4 The Atomic Protons Radiation Power

$$\boxed{\frac{(30e)^2}{6\pi\varepsilon_0 c^3} A_{\text{p\&n}}^2 \approx \frac{(30e)^2}{6\pi\varepsilon_0 c^3}\left(\frac{\sqrt{1-\beta_{\text{pNuc}}^2}}{30M_{\text{p}}+35M_{\text{n}}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\text{Nuc}}^2}\right)^2}$$

24.5 Zinc Atom Radiation Equilibrium

At equilibrium, the Power radiated by the Atomic Electrons onto the Atomic Protons, equals the Power radiated by the Atomic Protons onto the Atomic electrons.

$$\frac{(30e)^2}{6\pi\varepsilon_0 c^3}\left(\frac{\sqrt{1-\beta_{\text{e}}^2}}{m_{\text{e}}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\text{e}}^2}\right)^2 \approx \frac{(30e)^2}{6\pi\varepsilon_0 c^3}\left(\frac{\sqrt{1-\beta_{\text{pNuc}}^2}}{30M_{\text{p}}+35M_{\text{n}}}\frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{\rho_{\text{Nuc}}^2}\right)^2$$

We use $\approx$ because we assume one orbit for the Atomic protons, and one orbit for the Atomic electrons, while there are 30 proton orbits, and 30 electron orbits.

This Electrodynamics equality leads to a surprisingly purely mechanical relation between the Relativistic Inertia Moments of the Atomic electrons and the Nucleons:

24.6 The Zinc Atom Inertia Moments Balance

The Zinc Atom is Electrodynamically stable if and only the Inertia

Moments of its 30 electrons and 65 Nucleons are related by

$$\boxed{\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}r_{\mathrm{e}}^2 \approx \frac{30M_{\mathrm{p}}+35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}r_{\mathrm{Nuc}}^2}$$

25.

$$\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}}$$

25.1 The Zinc Atom Force Balance

$$\boxed{\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\beta_{\mathrm{e}}^2 r_{\mathrm{e}} = \frac{(30e)^2}{10^7} = \frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\beta_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}}}$$

<u>*Proof*</u>: The Force on an Atomic electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\frac{v_{\mathrm{e}}^2}{r_{\mathrm{e}}} = \frac{1}{4\pi\varepsilon_0}\frac{30e^2}{r_{\mathrm{e}}^2}.$$

Dividing both sides by c^2,

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\frac{\beta_{\mathrm{e}}^2}{r_{\mathrm{e}}} = \frac{1}{4\pi\varepsilon_0 c^2}\frac{30e^2}{r_{\mathrm{e}}^2},$$

$$= \frac{\mu_0}{4\pi}\frac{30e^2}{r_{\mathrm{e}}^2},$$

$$= \frac{1}{10^7}\frac{30e^2}{r_{\mathrm{e}}^2},$$

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\beta_{\mathrm{e}}^2 r_{\mathrm{e}} = \frac{(30e)^2}{10^7}.$$

The Force on the Nucleons is

$$\frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\frac{V_{\mathrm{pNuc}}^2}{r_{\mathrm{Nuc}}} = \frac{1}{4\pi\varepsilon_0}\frac{(30e)^2}{r_{\mathrm{Nuc}}^2}$$

Dividing both sides by c^2,

$$\frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\frac{\beta_{\mathrm{pNuc}}^2}{r_{\mathrm{Nuc}}} = \frac{1}{4\pi\varepsilon_0 c^2}\frac{(30e)^2}{r_{\mathrm{Nuc}}^2},$$

$$= \frac{1}{10^7}\frac{(30e)^2}{r_{\mathrm{Nuc}}^2},$$

$$\frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\beta_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}} = \frac{(30e)^2}{10^7}.$$

Therefore,

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\beta_{\mathrm{e}}^2 r_{\mathrm{e}} = \frac{(30e)^2}{10^7} = \frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\beta_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}}.\square$$

25.2

$$\boxed{r_{\mathrm{e}} \approx \frac{r_{\mathrm{Nuc}}}{\beta_{\mathrm{pNuc}}^2}\beta_{\mathrm{e}}^2}$$

Proof: Divide the Nucleus Inertia Moments Balance 23.3,

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}r_{\mathrm{e}}^2 \approx \frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}r_{\mathrm{Nuc}}^2,$$

by the Force balance 24.1,

$$\frac{30m_{\text{e}}}{\sqrt{1-\beta_{\text{e}}^2}}\beta_{\text{e}}^2 r_{\text{e}} = \frac{30M_{\text{p}} + 35M_{\text{n}}}{\sqrt{1-\beta_{\text{pNuc}}^2}}\beta_{\text{pNuc}}^2 r_{\text{Nuc}}\,.\square$$

25.3
$$\boxed{\frac{r_{\text{e}}}{r_{\text{Nuc}}} \approx \sqrt{\frac{30M_{\text{p}} + 35M_{\text{n}}}{30m_{\text{e}}}}\sqrt[4]{\frac{1-\beta_{\text{e}}^2}{1-\beta_{\text{pNuc}}^2}}},$$

Proof: From the Inertia Moments Balance, 23.3,

$$\frac{30m_{\text{e}}}{\sqrt{1-\beta_{\text{e}}^2}}r_{\text{e}}^2 \approx \frac{30M_{\text{p}} + 35M_{\text{n}}}{\sqrt{1-\beta_{\text{pNuc}}^2}}r_{\text{Nuc}}^2,$$

$$\frac{r_{\text{e}}}{r_{\text{Nuc}}} \approx \sqrt{\frac{30M_{\text{p}} + 35M_{\text{n}}}{30m_{\text{e}}}}\sqrt[4]{\frac{1-\beta_{\text{e}}^2}{1-\beta_{\text{pNuc}}^2}}\,.\square$$

25.4
$$\frac{r_{\text{e}}}{r_{\text{Nuc}}} \approx \sqrt{\frac{M_{\text{p}}}{m_{\text{e}}} + \frac{7}{6}\frac{M_{\text{n}}}{m_{\text{e}}}}$$

$$\sim 63\,.$$

Proof: assuming electrons' speed, and Nucleus speed, much smaller than light speed,

$$\sqrt[4]{\frac{1-\beta_{\text{e}}^2}{1-\beta_{\text{pNuc}}^2}} \approx 1\,.$$

Therefore,

$$\frac{r_e}{r_{Nuc}} \approx \sqrt{\frac{M_p}{m_e} + \frac{7}{6}\frac{M_n}{m_e}}$$

$$= \sqrt{1836.152701 + \frac{7}{6}1838.683662}$$

$$= 63.09741389\,.\square$$

25.5 $$\boxed{r_e \sim 3.848474069 \times 10^{-10}\mathrm{m}}$$

Proof: $r_e \sim 63 r_{Nuc}$

$$\sim 63(6.108688998 \times 10^{-12}\mathrm{m})$$

$$= 3.848474069 \times 10^{-10}\mathrm{m}$$

25.6 $$\boxed{\frac{\Omega_{pNuc}}{\omega_e} = \left(\frac{M_p}{m_e} + \frac{7}{6}\frac{M_n}{m_e}\right)^{\frac{1}{4}} = 7.937253933}$$

Proof: Divide the Force Balance,

$$\frac{30m_e}{\sqrt{1-\beta_e^2}}\omega_e^2 r_e^3 = \frac{30M_p + 35M_n}{\sqrt{1-\beta_{pNuc}^2}}\Omega_{pNuc}^2 r_{Nuc}^3$$

by the Inertia Moments Equilibrium,

$$\frac{30m_e}{\sqrt{1-\beta_e^2}} r_e^2 \approx \frac{30M_p + 35M_n}{\sqrt{1-\beta_{pNuc}^2}} r_{Nuc}^2\,.$$

Then,

$$\omega_{\mathrm{e}}^2 r_{\mathrm{e}} = \Omega_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}}$$

$$\frac{\Omega_{\mathrm{pNuc}}}{\omega_{\mathrm{e}}} = \sqrt{\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}}}$$

$$= \left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} + \frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}} \right)^{\frac{1}{4}}$$

$$= 7.937253933 . \Box$$

26.

The Nucleus Speed

26.1 The Nucleus Speed

$$\boxed{\beta_{\text{pNuc}} \approx \sqrt{\frac{30}{65}} \frac{1}{\sqrt{\dfrac{M_{\text{p}}}{m_e} + \dfrac{35}{30}\dfrac{M_{\text{n}}}{m_{\text{e}}}}} \beta_{\text{Nuc}}}$$

<u>*Proof*</u>: Dividing the Atom Force Balance 24.1,

$$\frac{30M_{\text{p}} + 35M_{\text{n}}}{\sqrt{1-\beta_{\text{pNuc}}^2}} \beta_{\text{pNuc}}^2 r_{\text{Nuc}} = \frac{(30e)^2}{10^7},$$

by the Nucleus Force Balance, 8.1,

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}} \beta_{\text{Nuc}}^2 r_{\text{Nuc}} = \frac{65e^2}{10^7},$$

we have

$$\frac{1}{30^2} \frac{30M_{\text{p}} + 35M_{\text{n}}}{\sqrt{1-\beta_{\text{pNuc}}^2}} \beta_{\text{pNuc}}^2 r_{\text{Nuc}} = \frac{1}{65} \frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}} \beta_{\text{Nuc}}^2 r_{\text{Nuc}}$$

$$\beta_{\text{pNuc}}^2 = \frac{30}{65} \frac{1}{\dfrac{30M_{\text{p}} + 35M_{\text{n}}}{30m_{\text{e}}}} \sqrt{\frac{1-\beta_{\text{pNuc}}^2}{1-\beta_{\text{Nuc}}^2}} \beta_{\text{Nuc}}^2,$$

$$\beta_{\text{pNuc}} \approx \sqrt{\frac{30}{65}} \frac{1}{\sqrt{\dfrac{M_{\text{p}}}{m_e} + \dfrac{35}{30}\dfrac{M_{\text{n}}}{m_{\text{e}}}}} \sqrt[4]{\frac{1-\beta_{\text{pNuc}}^2}{1-\beta_{\text{Nuc}}^2}} \beta_{\text{Nuc}}$$

Since $\sqrt[4]{\frac{1-\beta_{\text{pNuc}}^2}{1-\beta_{\text{Nuc}}^2}} \approx 1$,

$$\beta_{\text{pNuc}} \approx \sqrt{\frac{30}{65}} \frac{1}{\sqrt{\frac{M_{\text{p}}}{m_e} + \frac{35}{30}\frac{M_{\text{n}}}{m_{\text{e}}}}} \beta_{\text{Nuc}} . \square$$

26.2 $$\boxed{\beta_{\text{pNuc}} = 0.001854083888}$$

Proof:
$$\beta_{\text{pNuc}} \approx \underbrace{\sqrt{\frac{30}{65}} \frac{1}{\sqrt{\frac{M_{\text{p}}}{m_e} + \frac{35}{30}\frac{M_{\text{n}}}{m_{\text{e}}}}}}_{0.01078359} \underbrace{\beta_{\text{Nuc}}}_{0.1719356689}$$

$$= 0.001854083888 . \square$$

26.3 $$\boxed{V_{\text{pNuc}} \sim 556,225 \text{ m/sec}}$$

Proof: $V_{\text{pNuc}} \sim 0.001854083888 \cdot 300,000,000$

$$= 556,225 \text{ m / sec}$$

27.

The Atomic Electrons Speed from Radiation Equilibrium

27.1

$$\beta_e^2 \sim \sqrt{\frac{M_p}{m_e} + \frac{7}{6}\frac{M_n}{m_e}}\beta_{pNuc}^2$$

$$\sim 63\beta_{pNuc}^2$$

Proof: $\beta_e^2 \approx \frac{r_e}{r_{Nuc}}\beta_{pNuc}^2$

$$\sim \sqrt{\frac{M_p}{m_e} + \frac{7}{6}\frac{M_n}{m_e}}\beta_{pNuc}^2$$

$$\sim 63\beta_{pNuc}^2 . \square$$

27.2

$$\boxed{\beta_e \sim \sqrt[4]{\frac{M_p}{m_e} + \frac{7}{6}\frac{M_n}{m_e}}\beta_{pNuc}}$$

27.3

$$\boxed{\beta_e \sim \sqrt{\frac{30}{65}}\frac{1}{\sqrt[4]{\frac{M_p}{m_e} + \frac{35}{30}\frac{M_n}{m_e}}}\beta_{Nuc}}$$

Proof: $\beta_{\mathrm{e}} \sim \sqrt{\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}}}\beta_{\mathrm{pNuc}}$

$$\approx \underbrace{\sqrt{\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}}}}_{\sqrt[4]{\frac{M_{\mathrm{p}}}{m_e}+\frac{35}{30}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}}} \sqrt{\frac{30}{65}} \frac{1}{\sqrt{\frac{M_{\mathrm{p}}}{m_e}+\frac{35}{30}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}}} \beta_{\mathrm{Nuc}}$$

$$\sim \sqrt{\frac{30}{65}} \frac{1}{\sqrt[4]{\frac{M_{\mathrm{p}}}{m_e}+\frac{35}{30}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}}} \beta_{\mathrm{Nuc}}.\square$$

27.4 $$\boxed{\beta_{\mathrm{e}} = 0.014716334}$$

Proof: $$\beta_{\mathrm{e}} \approx \underbrace{\sqrt{\frac{30}{65}}}_{.67936622} \underbrace{\frac{1}{\sqrt[4]{\frac{M_{\mathrm{p}}}{m_e}+\frac{35}{30}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}}}}_{\frac{1}{\sqrt{63}}} \underbrace{\beta_{\mathrm{Nuc}}}_{0.1719356689}$$

$$= 0.014716334.\square$$

27.5 $$\boxed{v_{\mathrm{e}} = 4,414,900}$$

Proof: $v_{\mathrm{e}} = 0.014716334 \cdot 300,000,000$

$$= 4,414,900 \text{ m/sec}.\square$$

28.

The Atomic Electron Speed from the Force Equation

28.1 $$\boxed{\beta_{\mathrm{e}}^4 + \left(\frac{30}{63 r_{\mathrm{Nuc}} m_{\mathrm{e}}} \frac{e^2}{10^7}\right)^2 \beta_{\mathrm{e}}^2 - \left(\frac{30}{63 r_{\mathrm{Nuc}} m_{\mathrm{e}}} \frac{e^2}{10^7}\right)^2 \approx 0}$$

<u>*Proof*</u>: The Force on the Atomic 1$^{\text{st}}$ orbit electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}} \beta_{\mathrm{e}}^2 r_{\mathrm{e}} = 30 \frac{e^2}{10^7},$$

$$\beta_{\mathrm{e}}^2 = \frac{30}{r_{\mathrm{e}} m_{\mathrm{e}}} \frac{e^2}{10^7} \sqrt{1-\beta_{\mathrm{e}}^2},$$

Squaring both sides,

$$\beta_{\mathrm{e}}^4 + \left(\frac{30}{r_{\mathrm{e}} m_{\mathrm{e}}} \frac{e^2}{10^7}\right)^2 \beta_{\mathrm{e}}^2 - \left(\frac{30}{r_{\mathrm{e}} m_{\mathrm{e}}} \frac{e^2}{10^7}\right)^2 \approx 0$$

where $r_{\mathrm{e}} \sim 3.848474069 \times 10^{-10}\,\mathrm{m}$.□

$$\frac{30}{10^7} \frac{e^2}{r_{\mathrm{e}} m_{\mathrm{e}}} \sim \frac{30(1.60217733)^2 10^{-38}}{10^7 (3.848474069) 10^{-10} (9.109\ 389\ 7) 10^{-31}}$$

$$= (2.196668758) 10^{-4}.$$

$$\left(\frac{30}{10^7}\frac{e^2}{r_e m_e}\right)^2 \sim 4.825353632 \times 10^{-8}.$$

$$\beta_e^4 + (4.825353632 \times 10^{-8})\beta_e^2 - (4.825353632 \times 10^{-8}) \approx 0.$$

28.2 $$\boxed{\beta_e^4 + (4.825353632)10^{-8}\beta_e^2 - (4.825353632)10^{-8} \approx 0}$$

Denoting $\beta_e^2 \equiv x$, we seek the zeros of the polynomial

$$f(x) = x^2 + (4.825353632 \times 10^{-8})x - (4.825353632 \times 10^{-8})$$

between $x = 0$, and $x = 1$.

We used Maple Root-Finding Program.

Maple Input and Output follow:

```
> with(RootFinding):
```

$> r0 := NextZero\big(x \to x^2 + 4.825353632 \cdot 10^{-8} x - 4.825353632 \cdot 10^{-8}, 0.0001\big);$

$$r0 := 0.0002196427503$$

$>$ sqrt$(r0)$

$$0.01482034920$$

28.3 $$\boxed{\beta_e^2 \sim 0.0002196427503}$$

28.4 $$\boxed{\beta_e \sim 0.01482034920}$$

Compare with **26.4** $\beta_e \sim 0.014716334$

28.5 The Atomic Electrons Speed

$$\boxed{v_e \sim 4,446,105 \text{ m/sec}}.$$

Compare with **26.5** $v_e = 4,414,900 \text{ m/sec}$

Proof: $v_e = \beta_e c$

$$\sim (0.01482034920)c$$

$$\approx 4,446,105 \text{ m/sec}. \square$$

By [Dan5, 11.6],

28.6 The Hydrogen Electron Speed

$$v_H \sim \underbrace{\alpha}_{\approx \frac{1}{137}} c = 2,189,781 \text{ m/sec}.$$

28.7 Zinc Atomic Electron Speed

$\sim$2×(Hydrogen Electron Speed)

Proof: $$\frac{4,446,105}{2,189,781} \approx 2.03038797. \square$$

29.

Atomic Electron 1st Orbit Radius

29.1 1st Orbit Radius of the Atomic Electron

$$\boxed{r_e \approx \frac{r_{Nuc}}{\beta_{pNuc}^2}\beta_e^2 \sim 3.903068097 \times 10^{-10}\,\mathrm{m}}$$

compare with 24.5, $r_e \sim 3.848474069 \times 10^{-10}\,\mathrm{m}$

Proof: Substitute

$$r_{Nuc} \approx 6.108688998 \times 10^{-12},$$

$$\beta_{pNuc}^2 \sim 3.437627064 \times 10^{-6},$$

$$\beta_e^2 \sim 0.0002196427503 . \square$$

By [Dan5, 12.1],

29.2 Neutron Electron 1st Orbit Radius

$$R_N \sim 9.398741807 \times 10^{-14}$$

29.3 Zinc Atomic Electron 1st Orbit Radius

is $\sim$4153$\times$ (Neutron Electron Orbit Radius)

Proof: $\dfrac{3.903068097 \times 10^{-10}}{9.398741807 \times 10^{-14}} = 4{,}152.755951$

29.2 The Hydrogen Electron Orbit Radius

$$r_{\mathrm{H}} = 5.29277249 \times 10^{-11}\mathrm{m}\,.$$

29.3 The Zinc Electron 1st Orbit Radius is about 7×(Hydrogen Electron Orbit Radius)

Proof: $$\frac{3.903068097 \times 10^{-10}}{5.29277249 \times 10^{-11}} = 7.367442007\,.\square$$

30.

1st Orbit Atomic Electron Frequency

30.1 The 1st Orbit Zinc Atomic Electron Angular Velocity

$$\boxed{\omega_{\text{e in Zinc}} = \omega_{\text{e}} = \frac{v_{\text{e}}}{r_{\text{e}}} = 1.139130779 \times 10^{16} \text{ radians/sec}}$$

Proof: $\omega_{\text{e}} = \dfrac{v_{\text{e}}}{r_{\text{e}}}$

$$\approx \frac{4,446,105 \text{ m/sec}}{3.903068097 \times 10^{-10}\text{m}}$$

$$= 1.139130779 \times 10^{16} \text{ radians/sec}.\square$$

30.2 The 1st Orbit Atomic Electron Frequency

$$\boxed{\frac{\omega_{\text{e}}}{2\pi} = 1.81298294 \times 10^{15} \text{cycles/sec}}$$

Proof: $\dfrac{\omega_{\text{e}}}{2\pi} = \dfrac{1.139130779 \times 10^{16}}{2\pi}$

$$= 1.81298294 \times 10^{15} \text{cycles/sec}.\square$$

30.3 1st Orbit Neutron Electron Frequency is ~30,258× (1st Orbit Zinc Atomic Electron Frequency)

Proof: $$\frac{\frac{\omega_{\text{e in n}}}{2\pi}}{\frac{\omega_{\text{e in Zinc}}}{2\pi}} = \frac{5.485642074 \times 10^{20}}{1.81298294 \times 10^{15}}$$

$$\sim 30{,}258\,.\square$$

30.4 1st Orbit Hydrogen Electron Frequency

$$\frac{\omega_{\text{e in H}}}{2\pi} = 6.58472424 \times 10^{15}$$

Proof: $$\omega_{\text{e in H}} = \frac{v_{\text{e in H}}}{r_{\text{e in H}}} \approx \frac{2{,}189{,}781 \text{ m/sec}}{5.2977249 \times 10^{-11}\text{m}}$$

$$= 4.1334366 \times 10^{16} \text{ radians/sec}$$

$$\frac{\omega_{\text{e in H}}}{2\pi} = \frac{4.137304269 \times 10^{16} \text{ radians/sec}}{2\pi}$$

$$= 6.58472424 \times 10^{15}.\square$$

30.5 1st Orbit Hydrogen Electron Frequency is ~3.6×(1st Orbit Zinc Atomic Electron Frequency)

Proof:
$$\frac{\frac{\omega_{\text{e in H}}}{2\pi}}{\frac{\omega_{\text{e in Zinc}}}{2\pi}} = \frac{6.58472424 \times 10^{15}}{1.81298294 \times 10^{15}}$$

$$\sim 3.631983564\,.\square$$

30.6 The 1st Orbit Atomic Proton Frequency

$$\boxed{\frac{\Omega_{\text{pNuc},n}}{2\pi} \sim \frac{1}{n^3}(1.439010597)10^{16}\,\text{cycles/sec}}$$

Proof:
$$\frac{\Omega_{\text{pNuc},n}}{2\pi} \sim \frac{1}{n^3}\sqrt{63}\,\frac{\omega_{\text{e}}}{2\pi}$$

$$\sim \frac{1}{n^3}\sqrt{63}(1.81298294)10^{15}\,\text{cycles/sec}$$

$$\approx \frac{1}{n^3}(1.439010597)10^{16}\,\text{cycles/sec}\,.\square$$

31.

Atomic Electron Quantum of Angular Momentum

We associated with the Zinc Atomic Electron

$$\text{Orbit Radius } r_{\text{e}} \sim 3.903068097 \times 10^{-10}\text{m},$$

$$\text{Speed } v_{\text{e}} \sim 4,446,105 \text{ m/sec},$$

$$\beta_{\text{e}} \sim 0.01482034920.$$

To obtain these, we averaged the 30 Atomic electrons orbits into one orbit.

Now, we will consider that one orbit as the 1st orbit of the electrons in the Nucleus, and construct on it the 2nd, 3rd, 4th,…,orbits.

The Zinc Atomic Electron nth orbit has Angular Momentum

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{e},n}^2}}\omega_{\text{e},n} r_{\text{e},n}^2,$$

$$\frac{\Omega_{\text{pNuc},n}}{\omega_{\text{e},n}} = \left(\frac{M_{\text{p}}}{m_{\text{e}}} + \frac{7}{6}\frac{M_{\text{n}}}{m_{\text{e}}}\right)^{\frac{1}{4}} = 7.937253933.$$

The Atomic Electron Quantum of Angular Momentum is the Angular Momentum of its 1st orbit:

31.1 Zinc Atomic Electron Quantum of Angular Momentum

$$\boxed{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}} v_{\mathrm{e}} r_{\mathrm{e}} = (14.99154238)\hbar}$$

Proof:

$$\frac{1}{\sqrt{1-\beta_{\mathrm{e}}^2}} = \frac{1}{\sqrt{1-(0.01482034920)^2}}$$

$$\approx 1.000109839$$

$$\frac{m_e}{\sqrt{1-\beta_{\mathrm{e}}^2}} v_{\mathrm{e}} r_{\mathrm{e}} =$$

$$= \frac{(1.000109839)(9.1093897)10^{-31}(4,446,105)(3.903068097)10^{-10}}{(1.05457266)10^{-34}}\hbar$$

$$= (14.99154238)\hbar . \square$$

31.2 Angular Momentum of the nth orbit Atomic Electron

$$\boxed{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}} v_{\mathrm{e},n} r_{\mathrm{e},n} = n(14.99154238)\hbar}$$

32.

The Atomic Electron nth Orbit Radius, Speed, and Frequency

32.1 The Zinc Atomic Electron 1st Orbit Radius, Speed, and Frequency

$$r_e \sim 3.903068097 \times 10^{-10}\,\text{m}$$

$$= \frac{1}{30}(14.99154238)^2\sqrt{1-\beta_e^2}\,r_H$$

$$= (7.490721986)r_H$$

$$v_e \sim 4,446,105 \text{ m/sec}$$

$$= \frac{30}{14.99154238}v_H$$

$$= (2.001128319)v_H$$

$$\frac{\omega_e}{2\pi} = 1.81298294 \times 10^{15}\,\text{cycles/sec}$$

$$= \frac{30^2}{(14.99154238)^3}\frac{1}{\sqrt{1-\beta_e^2}}\frac{v_H}{2\pi r_H}$$

$$= (0.267147589)\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}.$$

Proof: The force on the Nucleus 1st orbit electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\frac{v_{\mathrm{e}}^2}{r_{\mathrm{e}}} = \frac{1}{4\pi\varepsilon_0}\frac{30e^2}{r_{\mathrm{e}}^2},$$

$$\frac{30e^2}{4\pi\varepsilon_0} = \left(\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}v_{\mathrm{e}}r_{\mathrm{e}}\right)^2 \frac{1}{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}}\frac{1}{r_{\mathrm{e}}},$$

Since $\frac{m_e}{\sqrt{1-\beta_{\mathrm{e}}^2}}v_{\mathrm{e}}r_{\mathrm{e}} = (14.99154238)\hbar$,

$$r_{\mathrm{e}} = \frac{1}{30}(14.99154238)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}}\sqrt{1-\beta_{\mathrm{e}}^2},$$

$$= \frac{1}{30}(14.99154238)^2\sqrt{1-\beta_{\mathrm{e}}^2}\,r_{\mathrm{H}}$$

$$= \frac{1}{30}\underbrace{(14.99154238)^2}_{224.7463429}\underbrace{\sqrt{1-0.0002196427503}}_{0.999890172}\,r_{\mathrm{H}}$$

$$= (7.490721986)r_{\mathrm{H}}.$$

$$v_{\mathrm{e}} = \frac{(14.99154238)\hbar}{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}r_{\mathrm{e}}}$$

$$= \frac{(14.99154238)\hbar}{\frac{m_e}{\sqrt{1-\beta_e^2}}\left(\frac{1}{30}(14.99154238)^2\sqrt{1-\beta_e^2}\,r_H\right)}$$

$$= \frac{30}{14.99154238}\underbrace{\frac{\hbar}{m_e r_H}}_{v_H}$$

$$= \frac{30}{14.99154238}v_H$$

$$= (2.001128319)v_H$$

$$\frac{\omega_e}{2\pi} = \frac{v_e}{2\pi r_e}$$

$$= \frac{\frac{30}{14.99154238}v_H}{2\pi\left(\frac{1}{30}(14.99154238)^2\sqrt{1-\beta_e^2}\,r_H\right)}$$

$$= \frac{30^2}{(14.99154238)^3}\frac{1}{\sqrt{1-\beta_e^2}}\underbrace{\frac{v_H}{2\pi r_H}}_{\frac{\omega_{e\text{ in H}}}{2\pi}}$$

$$= (0.267147589)\frac{v_H}{2\pi r_H}$$

32.2 The Nucleus Electron nth Orbit Radius, Speed, and Frequency

$$r_{\mathrm{e},n} = n^2 r_{\mathrm{e}},$$

$$\sim n^2(3.903068097 \times 10^{-10})\mathrm{m}$$

$$v_{\mathrm{e},n} = \frac{1}{n} v_{\mathrm{e}},$$

$$\sim \frac{1}{n} 4,446,105 \ \mathrm{m/sec}$$

$$\frac{\omega_{\mathrm{e},n}}{2\pi} = \frac{1}{n^3}\frac{\omega_{\mathrm{e}}}{2\pi},$$

$$= \frac{1}{n^3}(1.81298294)10^{15}\mathrm{cycles/sec}$$

Proof: The force on the Nucleus n^th^ orbit electron is

$$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}\frac{v_{\mathrm{e},n}^2}{r_{\mathrm{e},n}} = \frac{1}{4\pi\varepsilon_0}\frac{30e^2}{r_{\mathrm{e},n}^2},$$

$$\frac{30e^2}{4\pi\varepsilon_0} = \left(\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}} v_{\mathrm{e},n} r_{\mathrm{e},n}\right)^2 \frac{1}{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}}\frac{1}{r_{\mathrm{e},n}},$$

Since $\frac{m_e}{\sqrt{1-\beta_{\mathrm{e},n}^2}} v_{\mathrm{e},n} r_{\mathrm{e},n} = n(14.99154238)\hbar$,

$$r_{\mathrm{e},n} = \frac{1}{30} n^2 (14.99154238)^2 \underbrace{\frac{h^2}{\pi}\frac{\varepsilon_0}{m_e e^2}}_{r_{\mathrm{H}}} \sqrt{1-\beta_{\mathrm{e},n}^2},$$

$$= \frac{1}{30} n^2 (14.99154238)^2 \sqrt{1-\beta_{\mathrm{e},n}^2}\, r_{\mathrm{H}}$$

$$= n^2 \frac{1}{30} \underbrace{(14.99154238)^2}_{224.7463429} \underbrace{\sqrt{1 - 0.0002196427503}}_{0.999890172} r_{\rm H}$$

$$= n^2 (7.490721986) r_{\rm H},$$

$$= n^2 r_{\rm e}.$$

$$v_{{\rm e},n} = \frac{n(14.99154238)\hbar}{\dfrac{m_{\rm e}}{\sqrt{1-\beta_{{\rm e},n}^2}} r_{{\rm e},n}}$$

$$= \frac{n(14.99154238)\hbar}{\dfrac{m_{\rm e}}{\sqrt{1-\beta_{{\rm e},n}^2}} \left(\dfrac{n^2}{30} (14.99154238)^2 \sqrt{1-\beta_{{\rm e},n}^2} r_{\rm H} \right)}$$

$$= \frac{1}{n} \frac{30}{14.99154238} \underbrace{\frac{\hbar}{m_{\rm e} r_{\rm H}}}_{v_{\rm H}}$$

$$= \frac{1}{n} \frac{30}{14.99154238} v_{\rm H}$$

$$= \frac{1}{n} (2.001128319) v_{\rm H}$$

$$= \frac{1}{n} v_{\rm e}.$$

$$\frac{\omega_{{\rm e},n}}{2\pi} = \frac{v_{{\rm e},n}}{2\pi r_{{\rm e},n}}$$

$$= \frac{\frac{1}{n}\frac{30}{14.99154238}v_{\mathrm{H}}}{2\pi\left(\frac{n^2}{30}(14.99154238)^2\sqrt{1-\beta_{\mathrm{e}}^2}r_{\mathrm{H}}\right)}$$

$$= \frac{1}{n^3}\frac{30^2}{(14.99154238)^3}\frac{1}{\sqrt{1-\beta_{\mathrm{e}}^2}}\underbrace{\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}}_{\frac{\omega_{\mathrm{e\ in\ H}}}{2\pi}}$$

$$= \frac{1}{n^3}(0.267147589)\frac{v_{\mathrm{H}}}{2\pi r_{\mathrm{H}}}$$

$$= \frac{1}{n^3}\frac{\omega_{\mathrm{e},n}}{2\pi}$$

33.

The Atomic Proton Quantum of Angular Momentum

We associated with the Zinc Atomic Proton

$$\text{Orbit Radius } r_{\text{Nuc}} \sim 6.108688998 \times 10^{-12}\text{m},$$

$$\beta_{\text{pNuc}} \sim 0.001854083888,$$

$$\text{Speed } V_{\text{pNuc}} = \beta_{\text{pNuc}} c \sim 556,225 \text{ m/sec}.$$

To obtain these, we averaged the 30 Atomic protons orbits into one orbit, at the boundary of the Nucleus.

The 30 atomic electrons react to the net charge of the 30 Atomic Protons as if the Atomic Protons where orbiting the nucleus at it boundary at radius r_{Nuc}.

We will consider that one orbit as the 1st orbit of the Atomic protons, and construct on it the 2nd, 3rd, 4th,…,orbits.

The Zinc Atomic Proton nth orbit has Angular Momentum

$$\frac{M_{\text{p}}}{\sqrt{1-\beta^2_{\text{pNuc},n}}} V_{\text{pNuc},n} r_{\text{Nuc},n}.$$

The Atomic Proton Quantum of Angular Momentum is the Angular Momentum of its 1st orbit:

33.1 Zinc Atomic Proton Quantum of Angular Momentum

$$\boxed{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}} V_{\mathrm{pNuc}} r_{\mathrm{Nuc}} \approx (53.89157159)\hbar}$$

<u>*Proof*</u>:

$$\frac{1}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}} = \frac{1}{\sqrt{1-(0.001854083888)^2}}$$

$$\approx 1.000001719$$

$$\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}} V_{\mathrm{pNuc}} r_{\mathrm{Nuc}} =$$

$$= \frac{(1.000001719)(1.6726231)10^{-27}(556,225)(6.108688998)10^{-12}}{(1.05457266)10^{-34}}\hbar$$

$$= (53.89157159)\hbar \,.\square$$

33.2 Angular Momentum of the n^th orbit Atomic Electron

$$\boxed{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}} V_{\mathrm{pNuc},n} r_{\mathrm{Nuc},n} \approx n(53.89157159)\hbar}$$

34.

Atomic Radiation Equilibrium is Equivalent to the Proton Quantized Angular Momentum

At equilibrium,

34.1

1) *the Nucleus is electrodynamically stable if and only if the inertia moments of the n^{th} orbit electron and the n^{th} orbit proton are equal:*

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}r_{\mathrm{e},n}^2 = \frac{30M_{\mathrm{p}}+35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}}r_{\mathrm{Nuc},n}^2$$

2) *The Angular velocities of the proton, and the electron are related by*

$$\frac{\Omega_{\mathrm{pNuc},n}}{\omega_{\mathrm{e},n}} = \left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}+\frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} = 7.937253933$$

34.2 The Atomic n^th^ Orbit Radiation Equilibrium is equivalent to the Proton's n^th^ Orbit Quantized Angular Momentum

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}r_{\mathrm{e},n}^2 = \frac{30M_{\mathrm{p}}+35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}}r_{\mathrm{Nuc},n}^2$$

$$\Leftrightarrow \quad \frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}}r_{\mathrm{Nuc},n}^2\Omega_{\mathrm{pNuc},n} = n(14.99154238)\hbar\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}+\frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}$$

Proof: The n^th^ Orbit Radiation Equilibrium is

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}r_{\mathrm{e},n}^2 = \frac{30M_{\mathrm{p}}+35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}}r_{\mathrm{Nuc},n}^2$$

$\Leftrightarrow$ the Proton's n^{th} orbit has Angular Momentum

$$\underbrace{\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{pNuc},n}^2}}r_{\mathrm{Nuc},n}^2}_{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}r_{\mathrm{e},n}^2}\Omega_{\mathrm{pNuc},n} = \underbrace{\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}r_{\mathrm{e},n}^2\omega_{\mathrm{e},n}}_{n(14.99154238)\hbar}\underbrace{\frac{\Omega_{\mathrm{pNuc},n}}{\omega_{\mathrm{e},n}}}_{\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}+\frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}}$$

$$= n(14.99154238)\hbar\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}+\frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}.\square$$

V. NUCLEAR FORCES

35.

Nucleus Zero Point Energy

The electrical binding energy will exist at temperature zero, where all thermal motions cease, and is called Zero Point Energy.

If the protons' motion is neglected, the Zero Point Energy is the electrons' total binding energy.

35.1

$$\boxed{\underbrace{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{(35e)(65e)}{r_{\text{Nuc}}}}_{-U_{\text{Electrons Binding}}} = \frac{1}{2}h\left((35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi}\right)}$$

<u>*Proof*</u>:

$$\frac{1}{2}\frac{1}{4\pi\varepsilon_0}\frac{(35e)(65e)}{r_{\text{Nuc}}} = \frac{1}{2}(35)(65)\underbrace{\frac{e^2}{4\pi\varepsilon_0 c\hbar}}_{\alpha}\underbrace{\frac{c}{\omega_{\text{Nuc}}r_{\text{Nuc}}}}_{1/\beta_{\text{Nuc}}}\hbar\omega_{\text{Nuc}}$$

$$= \frac{1}{2}h\left((35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi}\right).\square$$

35.2 ***The Nucleus electrons' orbit has photon's energy***

$$-\frac{1}{2}h\left((35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi}\right).$$

35.3 *The Nucleus Ground state Energy is Zero Point Energy*

$$\frac{1}{2}h\left((35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi}\right).$$

35.4 Nucleus Zero Point Energy

$$\boxed{-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\hbar\omega_{\text{Nuc}} \sim -268,285 \text{ eV}}$$

$$\boxed{-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\text{Nuc}}} \sim -268,498 \text{ eV}}$$

__*Proof*__: $\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\hbar\omega_{\text{Nuc}} =$

$$= \frac{1}{2}(35)(65)\frac{1/137}{(0.1719356689)}\left[(6.5821220)10^{-16}\text{eV}\right]8.440466361\times 10^{18}$$

$$= 268,285.5172 \text{ eV}$$

$$\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\text{Nuc}}} =$$

$$= \frac{1}{2}\frac{c^2}{10^7}(35)(65)\frac{(1.60217733)^2 10^{-38}}{(6.108688998)10^{-12}}\text{Joul}\frac{\text{eV}}{(1.60217733)10^{-19}\text{Joul}}$$

$$= 268,498.2722 \text{ eV}$$

35.5 The Zero Point Energy Frequency

$$\boxed{2\frac{268{,}498\text{ eV}}{h} \sim 1.298451396\times 10^{20}\,\text{cycles/second}}$$

$$\boxed{(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi} \sim (1.297990381)10^{20}\ \text{cycles/sec}}$$

Proof: $$2\frac{268{,}498\text{ eV}}{h} = 2\frac{268{,}498\text{ eV}}{4.1356692\times 10^{-15}\text{eV}}$$

$$\sim 1.298451396\times 10^{20}\,\text{cycles/second}$$

$$(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi} \sim (35)(65)\frac{1/137}{(0.171860446)}(1.343341943)10^{18}$$

$$\sim (1.297990381)10^{20}\ \text{cycles/sec}$$

35.6 Zinc Nucleus Zero Point Energy is ~35×(Neutron's Zero Point Energy)

Proof: $$\frac{268{,}498}{7{,}671} \sim 35.\square$$

35.7 Zinc Nucleus Zero Point Energy is ~19,743×(Hydrogen's Zero Point Energy)

Proof: $$\frac{268{,}498}{13.6} \sim 19{,}742.5.\square$$

36.

Nucleus Nuclear Energy Binding

Most of binding is due to the Nucleus orbiting protons, and the Protons' binding Energy is the actual Zero Point Energy.

36.1 Nucleus Nuclear Energy Binding

$$\boxed{\frac{1}{2}\frac{(35e)(65e)}{4\pi\varepsilon_0}\frac{1}{\rho_{\mathrm{p}}} = \frac{1}{2}\frac{c^2}{10^7}\frac{(35e)(65e)}{\rho_{\mathrm{p}}} = \frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\mathrm{p}}}\hbar\Omega_{\mathrm{p}}}$$

Proof:

$$\frac{1}{2}\frac{(35e)(65e)}{4\pi\varepsilon_0}\frac{1}{\rho_{\mathrm{p}}} = \frac{1}{2}(35)(65)\underbrace{\frac{e^2}{4\pi\varepsilon_0 c\hbar}}_{\alpha}\underbrace{\frac{c}{\Omega_{\mathrm{p}}\rho_{\mathrm{p}}}}_{1/\beta_{\mathrm{p}}}\hbar\Omega_{\mathrm{p}}$$

$$= \frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\mathrm{p}}}\hbar\Omega_{\mathrm{p}}.\square$$

36.2 Nucleus Nuclear Energy Binding is $\sim$42.5(Nucleus Zero Point Energy Binding)

Proof:

$$\frac{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\mathrm{p}}}}{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\mathrm{Nuc}}}} = \frac{r_{\mathrm{Nuc}}}{\rho_{\mathrm{p}}} \sim 42.5$$

36.3 Nucleus Nuclear Energy Binding is $\sim$0.977$\times$(Nucleus Total Energy Binding)

Proof: $\dfrac{1}{1+(1/42.5)} \sim 0.977\,.\square$

36.4

$$\boxed{-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{p}}}\hbar\Omega_{\text{p}} = -11,415,889 \text{ eV}}$$

$$\boxed{-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\text{p}}} \sim -11,420,788 \text{ eV}}$$

Proof: $\dfrac{1}{2}(35)(65)\dfrac{\alpha}{\beta_{\text{p}}}\hbar\Omega_{\text{p}} =$

$$= \frac{1}{2}(35)(65)\frac{1/137}{(0.01933751868)}\Big[(6.5821220)10^{-16}\text{eV}\Big](4.039370544)10^{19}$$

$$= 11,415,888.78 \text{ eV}$$

$$\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\text{p}}} \sim$$

$$\sim \frac{1}{2}\frac{c^2}{10^7}(35)(65)\frac{(1.60217733)^2 10^{-38}}{(1.436178468)10^{-13}}\text{Joul}\frac{\text{eV}}{(1.60217733)10^{-19}\text{Joul}}$$

$$= 11,420,788.42 \text{ eV}$$

36.5 Hydrogen's Nuclear Binding Energy

$$\boxed{\frac{1}{2}\frac{e^2}{4\pi\varepsilon_0}\frac{1}{\rho_{\mathrm{H}}} = \frac{1}{2}\hbar\left(\frac{\alpha}{\beta_{\mathrm{p\ in\ H}}}\Omega_{\mathrm{H}}\right) = \frac{1}{2}\hbar\left(\frac{\alpha c}{\rho_{\mathrm{H}}}\right)}$$

Proof:

$$\frac{1}{2}\frac{e^2}{4\pi\varepsilon_0}\frac{1}{\rho_{\mathrm{H}}} = \frac{1}{2}\underbrace{\frac{e^2}{4\pi\varepsilon_0 c\hbar}}_{\alpha}\underbrace{\frac{c}{\Omega_{\mathrm{H}}\rho_{\mathrm{H}}}}_{1/\beta_{\mathrm{p\ in\ H}}}\hbar\Omega_{\mathrm{H}} = \frac{1}{2}\hbar\left(\frac{\alpha}{\beta_{\mathrm{p\ in\ H}}}\Omega_{\mathrm{H}}\right).\square$$

$$= \frac{1}{2}\hbar\left(\frac{\alpha c}{\rho_{\mathrm{H}}}\right).\square$$

36.6

$$\boxed{\Omega_{\mathrm{H}} = \frac{v_{\mathrm{H}}}{r_H}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx (2.708286845)10^{17}\ \text{radians/sec}}$$

Proof:

$$\Omega_{\mathrm{H}} = \underbrace{\omega_{\mathrm{H}}}_{v_{\mathrm{H}}/r_{\mathrm{H}}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}$$

$$= \frac{\frac{1}{137}c}{(5.29277249)10^{-11}}(1836.152701)^{\frac{1}{4}}$$

$$= (2.708286845)10^{17}.\square$$

36.7

$$\boxed{-\frac{1}{2}\hbar\left(\frac{\alpha c}{\rho_{\mathrm{H}}}\right) = -590\ \text{eV}}$$

$$\boxed{-\frac{1}{8\pi\varepsilon_0}\frac{e^2}{\rho_{\text{H}}} \sim -590 \text{ eV}}$$

$$\frac{1}{2}\hbar\frac{\alpha c}{\rho_{\text{H}}} = \frac{1}{2}\Big[(6.5821220)10^{-16}\text{eV}\Big]\frac{\frac{1}{137}c}{(1.221173735)10^{-12}}$$

$$= 590.1455881 \text{ eV}.\square$$

$$\frac{1}{8\pi\varepsilon_0}\frac{e^2}{\rho_{\text{H}}} = \frac{1}{2}\frac{c^2}{10^7}\frac{(1.60217733)^2 10^{-38}}{(1.221173735)10^{-12}}\text{Joul}\frac{\text{eV}}{(1.60217733)10^{-19}\text{Joul}}$$

$$= 590.3990381 \text{ eV}.\square$$

36.8 Nucleus Nuclear Energy Binding is $\sim$19349$\times$(Hydrogen's Nuclear Energy Binding)

Proof: $\dfrac{11,415,889 \text{ eV}}{590 \text{ eV}} \sim 19,349.\square$

37.

Nuclear Force and Zero Point Energy Force

37.1 Zinc Nucleus Nuclear Force is

$\sim$1836$\times$(Zinc Nucleus Zero Point Energy Force)

<u>*Proof*</u>:
$$\frac{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\text{p}}^2}}{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\text{Nuc}}^2}} = \left(\frac{r_{\text{Nuc}}}{\rho_{\text{p}}}\right)^2 \sim \frac{M_{\text{p}}}{m_{\text{e}}} \approx 1836\,.\square$$

37.2 Zinc Atomic Nuclear Force is

$\sim$3969$\times$(Zinc Atomic Zero Point Energy Force)

<u>*Proof*</u>:
$$\frac{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(30)(30)\frac{e^2}{r_{\text{Nuc}}^2}}{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(30)(30)\frac{e^2}{r_{\text{e}}^2}} = \underbrace{\left(\frac{r_{\text{e}}}{r_{\text{Nuc}}}\right)^2}_{\sim(63)^2} \sim 3969\,.\square$$

37.3 Zinc Nucleus Nuclear Force is

$\sim$7,287,084$\times$(Zinc Atomic Zero Point Energy Force)

Proof: $$\frac{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_p^2}}{\frac{1}{2}\frac{1}{4\pi\varepsilon_0}(30)(30)\frac{e^2}{r_e^2}} = \frac{(35)(65)}{(30)(30)}\underbrace{\left(\frac{r_e}{r_{Nuc}}\right)^2}_{\sim(63)^2}\underbrace{\left(\frac{r_{Nuc}}{\rho_p}\right)^2}_{\sim 1836} \sim 7,287,084.\square$$

37.4 Zinc Nuclear Force

$\sim$694,938,230$\times$(Hydrogen's Nuclear Force)

Proof: $$\frac{\frac{1}{4\pi\varepsilon_0}\frac{(35e)(65e)}{\rho_p^2}}{\frac{1}{4\pi\varepsilon_0}\frac{e^2}{\rho_H^2}} = (35)(65)\left(\frac{\rho_H}{\rho_p}\right)^2.$$

By [Dan4, 4.4], $\rho_H \approx 1.221173735 \times 10^{-12}$

$$= (35)(65)\left(\frac{1.221173735 \times 10^{-12}}{2.209505336 \times 10^{-15}}\right)^2$$

$$\sim 694,938,230.\square$$

38.

Gamma Rays Origin is Neutron's Protons

Soft X Rays are photons at frequencies

$$10^{18}\text{cycles/sec}.$$

The Zinc Nucleus Electron Frequency

$$\frac{\omega_{\text{Nuc}}}{2\pi} = 1.343341943 \times 10^{18}\text{cycles/sec}$$

is in the range of soft X-rays.

And also the Zinc Nucleus Proton Frequency

$$\frac{\Omega_{\text{p}}}{2\pi} = 6.42885789 \times 10^{18}\text{cycles/sec}$$

is in the range of soft X-rays.

Hard X Rays start at

$$10^{19}\text{cycles/sec}$$

The Neutron's Electron Frequency

$$\frac{\omega_{\text{ne}}}{2\pi} = 8.73067052 \times 10^{19}\text{cycles/sec},$$

is in the range of Hard X Rays.

Gamma Rays start at

$$10^{20}\text{cycles/sec}$$

The Neutron's Proton Frequency

$$\frac{\Omega_{\text{np}}}{2\pi} \sim 5.69422884 \times 10^{20}\text{cycles/second},$$

is in the range of Gamma Rays.

Thus, the existence of Gamma rays Radiation proves that the Neutron is a condensed Hydrogen Atom, composed of an electron, and a proton.

That is,

38.1 ***a Neutron's Proton excited from its orbit into a higher orbit, returns to a lower Neutron's Orbit, and emits a Gamma Ray Photon***

39.

The Nuclear Binding Energy

39.1 The Zinc Nuclear Electric Binding Energy

$$\boxed{35(M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}})c^2 = 11.689515233 \text{ MeV}}$$

<u>*Proof*</u>:

From the Nucleus Mass-Energy Equation, 5.1, the source of the Electric Binding Energy

$$\frac{1}{2}\frac{1}{10^7}\frac{(65e)(35e)}{\rho_{\mathrm{p}}}c^2\left(1 + \frac{\rho_{\mathrm{p}}}{r_{\mathrm{Nuc}}}\right)$$

is the Nuclear Binding Energy

$$35(\underbrace{M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}}}_{\Delta m})c^2 = 35(5.9456103 \times 10^{-31})(3 \times 10^8)^2 \text{ Joul}$$

$$= 1.872867245 \times 10^{-12} \text{ Joul}$$

Since $\text{Joule} = \dfrac{10^{15}}{160{,}2177}\text{MeV}$,

$$= 11.89515233 \text{ MeV}. \square$$

39.2 The Hydrogen Atom Electric Binding Energy

$$\frac{1}{2}\frac{c^2}{10^7}\frac{e^2}{\rho_{\mathrm{p}}}\left(1 + \frac{\rho_{\mathrm{p}}}{R_{\mathrm{H}}}\right) = 604.1773234\text{eV}$$

Proof:

Substituting from [Dan4, p.21],

$$\frac{R_{\mathrm{H}}}{\rho_{\mathrm{p}}} = \frac{r}{\rho} = 42.8503524$$

$$\rho_{\mathrm{p}} = 1.221173735 \cdot 10^{-12}$$

$$\frac{1}{2}\frac{c^2}{10^7}\frac{e^2}{\rho_{\mathrm{p}}}\left(1+\frac{\rho_{\mathrm{p}}}{R_{\mathrm{H}}}\right) = \frac{1}{2}\frac{9\cdot 10^{16}}{10^7}\frac{(1.602177331)^2 10^{-38}}{1.221173735\cdot 10^{-12}}\underbrace{(1+\frac{1}{42.8503524})}_{1.02333703}$$

$$= 9.679990114 \times 10^{-17}\mathrm{J}$$

$$= 9.679990114 \times 10^{-17} \times (6.241507649)10^{18}\mathrm{eV}$$

$$= 604.1773234\mathrm{eV}\,.\square$$

39.3 The Zinc Nuclear (Electric) Binding Energy is $\sim$19,688$\times$(Hydrogen Electric Binding Energy)

Proof: $$\frac{11{,}895{,}152.33 \text{ eV}}{604.1773234 \text{ eV}} = 19{,}688.18072\,.\square$$

40.

The Atomic Binding Energy

40.1 The Zinc Atomic Electric Binding Energy

$$\frac{1}{2}\frac{1}{10^7}\frac{(30e)(30e)}{r_{\text{Nuc}}}c^2\left(1+\frac{r_{\text{Nuc}}}{r_{\text{e}}}\right)$$

Proof: The Zinc Atomic Binding Energy is the Electric energy that binds the 30 electrons to the 30 protons,

$$\frac{1}{2}\frac{1}{10^7}\frac{(30e)(30e)}{r_{\text{Nuc}}}c^2\left(1+\frac{r_{\text{Nuc}}}{r_{\text{e}}}\right).\square$$

40.2 The Zinc Nuclear Binding Energy is greater than $\sim$108 $\times$(The Zinc Atomic Binding Energy)

Proof: $$\frac{\frac{1}{2}\frac{1}{10^7}\frac{(65e)(35e)}{\rho_{\text{p}}}c^2\left(1+\frac{\rho_{\text{p}}}{r_{\text{Nuc}}}\right)}{\frac{1}{2}\frac{1}{10^7}\frac{(30e)(30e)}{r_{\text{Nuc}}}c^2\underbrace{\left(1+\frac{r_{\text{Nuc}}}{r_{\text{e}}}\right)}_{>1}} > \frac{(65)(35)}{(30)(30)}\underbrace{\frac{r_{\text{Nuc}}}{\rho_{\text{p}}}}_{42.85} = 108.3152778\,.\square$$

41.

Nuclear Forces versus Atomic Forces

The force between the Nucleus electrons and Protons is enormous compared to the force between the Atomic electrons and protons:

41.1 Force on a Zinc Nucleus Proton $\sim$ 2,142 $\times$ (Force on a Zinc Atomic Proton)

Proof: A Zinc Nucleus Proton is attracted to the 35 Neutronic Electrons by

$$\frac{1}{4\pi\varepsilon_0}\frac{(e)(35e)}{\rho_p^2}.$$

A Zinc Atomic Proton is attracted to the 30 Atomic Electrons by

$$\frac{1}{4\pi\varepsilon_0}\frac{(e)(30e)}{r_{\text{Nuc}}^2}.$$

$$\frac{\frac{1}{4\pi\varepsilon_0}\frac{(e)(35e)}{\rho_p^2}}{\frac{1}{4\pi\varepsilon_0}\frac{(e)(30e)}{r_{\text{Nuc}}^2}} = \frac{35}{30}\underbrace{\left(\frac{r_{\text{Nuc}}}{\rho_p}\right)^2}_{\sim 1836} \sim 2142.\square$$

41.2 Force on a Zinc Nucleus Electron is $\sim 8845\times$(Force on a Zinc Atomic Electron)

Proof: A Neutronic Electron is attracted to the 65 Protons by

$$\frac{1}{4\pi\varepsilon_0}\frac{(e)(65e)}{r_{\text{Nuc}}^2}.$$

An Atomic Electron is attracted to the 30 Atomic Protons by

$$\frac{1}{4\pi\varepsilon_0}\frac{(30e)(e)}{r_{\text{e}}^2}.$$

$$\frac{\frac{1}{4\pi\varepsilon_0}\frac{(65e)(e)}{r_{\text{Nuc}}^2}}{\frac{1}{4\pi\varepsilon_0}\frac{(30e)(e)}{r_{\text{e}}^2}} = \frac{65}{30}\underbrace{\left(\frac{r_{\text{e}}}{r_{\text{Nuc}}}\right)^2}_{\sim(63)^2} \sim 8600.\square$$

VI. SUMMARY OF NUMERICAL RESULTS

Hydrogen Proton nth Orbit

$$\text{Radius } \rho_{\mathrm{H},n} = n^2 r_{\mathrm{H}}\sqrt{\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}} \approx n^2(1.221173735)10^{-12} \text{ m}$$

$$\text{Speed } V_{\mathrm{H},n} = \frac{1}{n}\frac{c}{137}\left(\frac{m_{\mathrm{e}}}{M_{\mathrm{p}}}\right)^{\frac{1}{4}} \approx \frac{1}{n}334,528 \text{ m/sec}$$

$$\text{Frequency } \frac{\Omega_{\mathrm{H},n}}{2\pi} = \frac{1}{n^3}\frac{\frac{c}{137}}{2\pi r_{\mathrm{H}}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx \frac{1}{n^3}4.311097293\times 10^{16}\text{cycles/sec}$$

$$\text{Angular Momentum } M_{\mathrm{p}}\rho_n^2\Omega_n = n\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}}\hbar = n(6.546018057)\hbar$$

$$\text{Quantum of Angular Momentum } (6.546018057)\hbar$$

Neutron's Electron nth Orbit

$$\text{Radius } r_{\mathrm{ne},n} \sim n^2(9.398741807)10^{-14}\,\text{m}$$

$$= n^2(1.776104665)10^{-3} r_{\mathrm{H}}$$

$$\text{Speed } v_{\mathrm{ne},n} \sim \frac{1}{n}51,558,134 \text{ m/sec}$$

$$= \frac{1}{n}\frac{v_{\mathrm{H}}}{0.043132065}$$

$$\text{Frequency } \frac{\omega_{\text{ne},n}}{2\pi} \sim 8.73067052 \times 10^{19} \text{cycles/sec}$$

$$= \frac{1}{n^3} 1.305362686 \times 10^4 \frac{\omega_{\text{H}}}{2\pi} \text{ cycles/sec}.$$

$$\text{Angular Momentum } \frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{ne},n}^2}} v_{\text{ne},n} r_{\text{ne},n} = n(0.043132065)\hbar$$

$$\text{Quantum of Angular Momentum } (0.043132065)\hbar$$

Neutron's Proton n$^{\text{th}}$ Orbit

$$\text{Radius } \rho_{\text{np},n} \sim n^2(2.209505336)10^{-15},$$

$$\text{Speed } V_{\text{np},n} \sim \frac{1}{n} 7,905,145 \text{ m/sec},$$

$$\text{Frequency } \frac{\Omega_{\text{np}}}{2\pi} \sim 5.69422884 \times 10^{20} \text{cycles/second}.$$

$$\text{Angular Momentum } \frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{np},n}^2}} (\beta_{\text{np},n} c) \rho_{\text{np},n} = n(0.277126027)\hbar$$

$$\text{Quantum of Angular Momentum } (0.277126027)\hbar$$

The Zinc Nucleus

1) *is at Radiation Power Equilibrium* $\Leftrightarrow$

$$\frac{m_{\text{e}}}{\sqrt{1-\beta_{\text{Nuc}}^2}} r_{\text{Nuc}}^2 \approx \frac{M_{\text{p}}}{\sqrt{1-\beta_{\text{p}}^2}} \rho_{\text{p}}^2$$

2)
$$\frac{1}{65}\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc}}^2}}\beta_{\mathrm{Nuc}}^2 r_{\mathrm{Nuc}} = \frac{e^2}{10^7} = \frac{1}{35}\frac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p}}^2}}\beta_{\mathrm{p}}^2\rho_{\mathrm{p}}$$

3)
$$\frac{r_{\mathrm{Nuc}}}{35\beta_{\mathrm{Nuc}}^2} \approx \frac{\rho_{\mathrm{p}}}{65\beta_{\mathrm{p}}^2}$$

4)
$$\frac{r_{\mathrm{Nuc}}}{\rho_{\mathrm{p}}} \sim \sqrt{\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}} \approx 42.5$$

5)
$$\beta_{\mathrm{Nuc}}^2 \sim 42.5\frac{65}{35}\beta_{\mathrm{p}}^2$$

6)
$$\frac{\Omega_{\mathrm{p}}}{\omega_{\mathrm{Nuc}}} \sim \sqrt{\frac{35}{65}}\left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx 4.803464029$$

7) Mass-Energy
$$\underbrace{M_{\mathrm{n}} - M_{\mathrm{p}} - m_{\mathrm{e}}}_{\Delta m} \approx \frac{1}{2}\frac{1}{10^7}65\frac{e^2}{\rho_{\mathrm{p}}}\left(1+\frac{\rho_{\mathrm{p}}}{r_{\mathrm{Nuc}}}\right)$$

Zinc Nucleus Proton n^th^ Orbit

Orbit Radius $\rho_{\mathrm{p},n} \sim n^2(1.436178468)10^{-13}$

Speed $V_{\mathrm{p},n} \sim \frac{1}{n}5,801,257 \quad \mathrm{m/sec}$

Frequency $\frac{\Omega_{\mathrm{p},n}}{2\pi} = \frac{1}{n^3}6.42885789 \times 10^{18}\,\mathrm{cycles/sec}$

Angular Momentum $\dfrac{M_{\mathrm{p}}}{\sqrt{1-\beta_{\mathrm{p},n}^2}}V_{\mathrm{p},n}\rho_{\mathrm{p},n} = n(13.21701291)\hbar$

Quantum of Angular Momentum $(13.21701291)\hbar$

Nucleus Radiation Equilibrium $\Leftrightarrow$ Quantized Angular Momentum

Zinc Nucleus Electron n^th Orbit

Orbit Radius $r_{\mathrm{Nuc},n} \approx n^2 \dfrac{35}{65}\beta_{\mathrm{Nuc},n}^2 \dfrac{\rho_{\mathrm{p},n}}{\beta_{\mathrm{p},n}^2} \sim n^2(6.108688998)10^{-12}$

Speed $v_{\mathrm{Nuc},n} \sim \dfrac{1}{n}51,560,184 \text{ m/sec}$

$\sim$ Neutron Electron Speed

Frequency $\dfrac{\omega_{\mathrm{Nuc},n}}{2\pi} = \dfrac{1}{n^3}1.343341943\times 10^{18}\text{cycles/sec}$

Angular Momentum $\dfrac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{Nuc},n}^2}}v_{\mathrm{Nuc},n}r_{\mathrm{Nuc},n} = n(2.761794253)\hbar$

Quantum of Angular Momentum $(2.761794253)\hbar$

The Zinc Atom

1) *is at Radiation Power Equilibrium* $\Leftrightarrow$

$$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}r_{\mathrm{e}}^2 \approx \frac{30M_{\mathrm{p}}+35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}r_{\mathrm{Nuc}}^2$$

2) $$\frac{30m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e}}^2}}\beta_{\mathrm{e}}^2 r_{\mathrm{e}} = \frac{(30e)^2}{10^7} = \frac{30M_{\mathrm{p}} + 35M_{\mathrm{n}}}{\sqrt{1-\beta_{\mathrm{pNuc}}^2}}\beta_{\mathrm{pNuc}}^2 r_{\mathrm{Nuc}}$$

3) $$\frac{r_{\mathrm{e}}}{\beta_{\mathrm{e}}^2} \approx \frac{r_{\mathrm{Nuc}}}{\beta_{\mathrm{pNuc}}^2}$$

4) $$\frac{r_{\mathrm{e}}}{r_{\mathrm{Nuc}}} \approx \sqrt{\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} + \frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}} \approx 63$$

5) $$\beta_{\mathrm{e}}^2 \sim \frac{1}{\sqrt{63}}\frac{30}{65}\beta_{\mathrm{Nuc}}^2$$

6) $$\frac{\Omega_{\mathrm{pNuc}}}{\omega_{\mathrm{e}}} = \left(\frac{M_{\mathrm{p}}}{m_{\mathrm{e}}} + \frac{7}{6}\frac{M_{\mathrm{n}}}{m_{\mathrm{e}}}\right)^{\frac{1}{4}} \approx \sqrt{63} \approx 7.937253933$$

Zinc Atomic Electron n^th Orbit

Orbit Radius $$r_{\mathrm{e},n} \sim n^2(3.903068097)10^{-10}\,\mathrm{m}$$

Speed $$v_{\mathrm{e},n} \sim \frac{1}{n}4,446,105 \ \mathrm{m/sec}$$

Frequency $$\frac{\omega_{\mathrm{e},n}}{2\pi} = \frac{1}{n^3}1.81298294 \times 10^{15}\,\mathrm{cycles/sec}$$

Angular Momentum $$\frac{m_{\mathrm{e}}}{\sqrt{1-\beta_{\mathrm{e},n}^2}}v_{\mathrm{e},n}r_{\mathrm{e},n} = n(14.99154238)\hbar$$

Quantum of Angular Momentum $(14.99154238)\hbar$

Zinc Atomic Proton n$^{\text{th}}$ Orbit

Orbit Radius $r_{\text{Nuc},n} \sim n^2(6.108688998)10^{-12}$

Speed $V_{\text{pNuc},n} \sim \frac{1}{n}556,225 \ \text{m/sec}$

Frequency $\frac{\Omega_{\text{pNuc},n}}{2\pi} \sim \frac{1}{n^3}(1.439010597)10^{16}\text{cycles/sec}$

Angular Momentum $\frac{M_{\text{p}}}{\sqrt{1-\beta^2_{\text{pNuc},n}}}V_{\text{pNuc},n}r_{\text{Nuc},n} \approx n(53.89157159)\hbar$

Quantum of Angular Momentum $(53.89157159)\hbar$

Atomic Radiation Equilibrium $\Leftrightarrow$ Quantized Angular Momentum

Zinc Nucleus Zero Point Energy

$$-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\hbar\omega_{\text{Nuc}} \sim -268,285 \ \text{eV}$$

$$-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{r_{\text{Nuc}}} \sim -268,498 \ \text{eV}$$

$\sim$ *19,743*$\times$*(Hydrogen's Zero Point Energy)*

The Zinc Nucleus Zero Point Energy Frequency

$$2\frac{268{,}498\text{ eV}}{h} \sim 1.298451396\times 10^{20}\,\text{cycles/sec}$$

$$(35)(65)\frac{\alpha}{\beta_{\text{Nuc}}}\frac{\omega_{\text{Nuc}}}{2\pi} \sim (1.297990381)10^{20}\ \text{ cycles/sec}$$

Zinc Nucleus Nuclear Binding Energy

$$-\frac{1}{2}(35)(65)\frac{\alpha}{\beta_{\text{p}}}\hbar\Omega_{\text{p}} = -11,415,889\text{ eV}$$

$$-\frac{1}{8\pi\varepsilon_0}(35)(65)\frac{e^2}{\rho_{\text{p}}} \sim -11,420,788\text{ eV}$$

$\sim$ *42.5*$\times$*(Nucleus Zero Point Energy Binding)*

$\sim$ *19349*$\times$*(Hydrogen's Nuclear Energy Binding)*

Zinc Nucleus Nuclear Force

$\sim$ *1836*$\times$*(Zinc Nucleus Zero Point Energy Force)*

$\sim$ *7,287,084*$\times$*(Zinc Atomic Zero Point Energy Force)*

$\sim$ *694,938,230*$\times$*(Hydrogen's Nuclear Force)*

Zinc Atomic Nuclear Force

$\sim$ *3969*$\times$*(Zinc Atomic Zero Point Energy Force)*

Zinc Nuclear Binding Energy

$$\sim 19{,}688 \times (\textit{Hydrogen Binding Energy})$$

$$\sim 108 \times (\textit{The Zinc Atomic Binding Energy})$$

Force on a Zinc Nucleus Proton

$$\sim 2{,}142 \times (\textit{Force on a Zinc Atomic Proton})$$

Force on a Zinc Nucleus Electron

$$\sim 8845 \times (\textit{Force on a Zinc Atomic Electron})$$

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