03 Forces of Interaction

Some well known “natural characteristics” include; Hawking temperature, Plank temperature, Schwarzschild radius, electric radius, binding energy, Plank length, Stefan-Boltzmann radiation, and Compton interaction.

All of these natural characteristics may be associated with some kind of “interaction”. An interaction is associated with a force. A force is represented as a vector. An interactive force includes scalar definitions for each component of the force vector. Each interactive force has a unique basis. An interactive force also includes one important vector restriction.

Eight forces of interaction will be considered, leading to definitions of various natural characteristics.

The Interactive Force Vector;

An interactive force \( (F_n) \) is; \[ F_n = F_{n1}e_{n1} + F_{n2}e_{n2} + F_{n3}e_{n3} \]

Where; \( n \) is an interaction identifier

\( e_{n1}, e_{n2}, e_{n3} \) are directional vectors in 3D (basis vectors) Each interaction has a unique basis.

\( F_{n1}, F_{n2}, F_{n3} \) are components of force (generally \( F_{nN} \))

The vector has a magnitude; \[ |F_n| = F_{n4} \]

The scalar components are related to magnitude; \[ F_{n1}^2 + F_{n2}^2 + F_{n3}^2 = F_{n4}^2 \]

Sub-components \( (F_{n5}, F_{n6}) \) are related as; \[ F_{n5}^2 = F_{n1}^2 + F_{n2}^2 = F_{n4}^2 - F_{n3}^2 \]
\[ F_{n6}^2 = F_{n2}^2 + F_{n3}^2 = F_{n4}^2 - F_{n1}^2 \]

Angular Geometry;

A 3D vector contains “component angles” \( (A_n, B_n) \);

\[ F_{n1} = F_{n5}\cos(\phi_n) \quad F_{n2} = F_{n5}\sin(\phi_n) \quad F_{n2} = F_{n5}\tan(\phi_n) \]
\[ F_{n5} = F_{n4}\cos(\theta_n) \quad F_{n3} = F_{n4}\sin(\theta_n) \quad F_{n3} = F_{n5}\tan(\theta_n) \]

Where; \( A_n = \phi_n \) and; \( B_n = \frac{\pi}{2} - \theta_n \)

An interaction includes one important restriction; \( A_n = B_n \)
Eight interactions \((I_n)\) will be represented, leading to definitions of natural characteristics;

- \(I_1\) gives Hawking temperature
- \(I_2\) gives Plank temperature
- \(I_3\) gives the Schwarzschild radius
- \(I_4\) gives the electric length scale
- \(I_5\) gives binding energy
- \(I_6\) gives Plank length
- \(I_7\) gives photo-electric radiation
- \(I_8\) gives Compton interaction

An interaction also includes scalar definitions for each component of force. The forces of interaction will be discussed as follows.

**Int. 1;**

Interaction 1 will give the definition of Hawking Temperature \((T_{H})\). The component forces are defined as;

\[
F_{11} = \frac{G m_0 m}{r^2} \\
F_{12} = \frac{mv}{\lambda} \\
F_{13} = \frac{4k_B T_H}{\lambda} \\
F_{14} = \frac{hc}{(\lambda_0 \lambda)} \\
F_{15} = \frac{hc}{\lambda_0^2}
\]

Where; \(k_B\) is the Boltzmann constant;

\(m_0, m\) are rest mass and dynamic mass

\(\lambda_0, \lambda\) wavelength associated with an object at rest, and dynamic wavelength

Quantization rule 1; \(\lambda_0 = n\lambda\) where; \(n\) is a quantum number (integer)

Quantization rule 2; \(n\lambda = 2\pi r\) (only an integer number of wavelengths may occupy a circumference)

The vector restriction is; \(A_1 = B_1\)

\[\tan(A_1) = \tan(B_1)\]

\[\frac{F_{12}}{F_{11}} = \frac{F_{13}}{F_{15}}\]
The reduced Plank constant ($\hbar$) is; $\hbar = h/2\pi$

Int.1 gives the definition of Hawking Temperature; $T_H = \hbar c^3/(8\pi G m_0^2)$

**Int.2;**

Interaction2 will lead to the definition of Plank Temperature ($T_P$). The forces of $I_2$ are defined as:

$$F_{21} = G m_0^2/r^2$$
$$F_{22} = m_0 v c/r$$
$$F_{23} = v(k_B T_P)^2/\hbar c^2$$
$$F_{24} = E_{24}^2/\hbar c = (k_B T_P)^2/\hbar c$$
$$F_{25} = m_0 c^2/r$$

The vector restriction is; $A_2 = B_2$

$$\cos(A_2) = \cos(B_2)$$
$$F_{21}/F_{25} = F_{25}/F_{24}$$
$$F_{21}F_{24} = F_{25}^2$$

$$G(k_B^2 T_P^2/\hbar c) = c^4$$

State 2 gives the definition of Plank Temperature; $T_P = (\hbar c^5/G k_B^2)^{1/3}$
Mass dilation may be represented as:
\[
\cos(A_2) = F_{21}/F_{25} = Gm_0/rc^2 = m_0/m
\]
\[
\sin(A_2) = F_{22}/F_{25} = v/c
\]
Where dynamic mass \(m\) is:
\[
m = rc^2/G
\]
Massive energy is:
\[
E_m = mc^2 = r(c^4/G) = rF_p \quad \text{(where; } F_p \text{ is Plank force)}
\]

**Int.3;**

Interaction 3 will lead to the definition of the Schwarzschild radius \((r_s)\). The forces of \(I_3\) are defined as;
\[
F_{31} = E_{31}^2/hc = (Gm^2/r_s)^2/hc = G^2m^4/(r_s^3hc)
\]
\[
F_{32} = \frac{1}{2}mvc/\lambda
\]
\[
F_{33} = hv/\lambda^2
\]
\[
F_{34} = hc/\lambda^2
\]
\[
F_{35} = \frac{1}{2}mc^2/\lambda
\]
The vector restriction is; \(A_3 = B_3\)
\[
\cos(A_3) = \cos(B_3)
\]
\[
F_{31}/F_{35} = F_{35}/F_{34}
\]
\[
F_{31}F_{34} = F_{35}^2
\]
\[
(G^2m^4/r_s^3hc)(hc/\lambda^2) = (\frac{1}{2}mc^2/\lambda)^2
\]
\[
G^2m^2/r_s^2 = \frac{1}{4}c^4
\]
\(I_3\) gives the definition of Schwarzschild radius \((r_s)\); \(r_s = 2Gm/c^2\)

**Int.4;**

Interaction 4 will lead to the definition of electric length scale. The forces of \(I_4\) are;
\[
F_{41} = Gm^2/r^2
\]
\[
F_{42} =mvc/r
\]
\[
F_{43} = v\kappa q_4 r^2/cr_Q^2
\]
\[
F_{44} = k_4 q^2/r_Q^2
\]
\[
F_{45} = mc^2/r
\]
Where; \( r \) is radial distance

\( r_Q \) is the electric length scale

\( m \) is mass

\( q \) is charge

The vector restriction is; \( A_4 = B_4 \)

\[
\begin{align*}
\cos(A_4) &= \cos(B_4) \\
F_{41}/F_{45} &= F_{45}/F_{44} \\
F_{41}F_{44} &= F_{45}^2 \\
(Gm^2/r^2)(k_eeq^2/r_Q^2) &= (mc^2/r)^3 \\
G(k_eeq^2/r_Q^2) &= c^4 \\
k_eeq^2 = (c^4/G)r_Q^2 &= Fpr_Q^2
\end{align*}
\]

I₄ gives the definition of electric length scale; \( r_Q = q(k_ee^\frac{1}{2}/F_p) = q(Gke^\frac{1}{2}/c^2) \)

Charge-energy equivalence is; \( E_q = r_QF_p = q(F_pke)^\frac{1}{2} \)

**Int.5;**

Interaction will lead to the definition of binding energy. The forces of I₅ are;

\[
\begin{align*}
F_{51} &= \frac{1}{2}Gm_e^2/r^2 \\
F_{52} &= \frac{1}{2}m_e^2c^2/r \\
F_{53} &= hv/\lambda^2 & \text{Reciprocal velocities are; } v_e + v = 0 \\
F_{54} &= (k_eeq_1q_2/r)^2/hc \\
F_{55} &= E_{55}/r & (E_{55} \text{ is binding energy})
\end{align*}
\]

Where; \( m_e \) is the rest mass of an electron

\( q_1 \) is the electric charge of an atomic nucleus; \( q_1 = Ze \)

\( q_2 \) is the electric charge of an electron; \( q_2 = -e \)

\( k_e \) is the electric constant; \( k_e = 1/4\pi\varepsilon_0 \)
The vector restriction is; \( A_5 = B_5 \)

\[
\sin(A_5) = \sin(B_5) \\
F_{52}/F_{55} = F_{53}/F_{54} \\
F_{52}F_{54} = F_{53}F_{55} \\
(-\frac{1}{2}m_e v c / r)(k_e q_1 q_2 / r)^2 / hc = (h \nu / \lambda^2)(E_{55}/r) \\
E_{55}/r = (\lambda^2 / h \nu)(-\frac{1}{2}m_e v c / r)(-k_e Z e^2 / r)^2 / hc \\
E_{55} = \lambda^2 (-\frac{1}{2}m_e)(-k_e Z e^2 / r)^2 / h^2 \\
E_{55} = -\frac{1}{2}m_e (k_e Z e^2 / r^2)(\lambda^2 / h^2) \\
E_{55} = -\frac{1}{2}m_e (Z e^2 / 16 \pi^2 \varepsilon_0^2 r^2)(\lambda^2 / h^2) \\
E_{55} = -\frac{1}{2}m_e (Z e^2 / 4 \pi^2 \varepsilon_0^2)(\lambda^2 / 4 \pi^2 r^2)(1 / h^2)
\]

The quantization rule is; \( n \lambda = 2 \pi r \) where; \( n \) is a quantum number (integer)

Quantization gives; \( E_{55} = -\frac{1}{2}m_e (Z^2 e^4 / 4 \pi^2 \varepsilon_0^2)(1 / n^2)(1 / h^2) \)

I_5 gives the definition of binding energy; \( E_{55} = -m_e Z^2 e^4 / 8 \pi^2 \varepsilon_0^2 n^2 h^2 \)

**Int. 6;**

Interaction 6 will lead to the definition of Plank length \( (r_p) \). The forces of \( I_6 \) are defined as;

\[
F_{61} = G m^2 / r_p^2 \\
F_{62} = m v c / \lambda \\
F_{63} = \hbar \nu / \lambda^2 \\
F_{64} = \hbar c / \lambda^2 \\
F_{65} = m c^2 / \lambda
\]

The vector restriction is; \( A_6 = B_6 \)

\[
\cos(A_6) = \cos(B_6) \\
F_{61}/F_{65} = F_{63}/F_{64} \\
F_{61}F_{64} = F_{65}^2 \\
(G m^2 / r_p^2)(\hbar c / \lambda^2) = (m c^2 / \lambda)^2
\]
 Forces of Interaction

\( r_P^2 = \hbar G/c^3 \)

Interaction 6 gives the definition of Plank length \( r_P \); \( r_P = (\hbar G/c^3)^{1/6} \)

\textit{Int.7;}

Interaction 7 will lead to the definition of the Stefan-Boltzmann constant \( (\sigma) \). This interaction represents photo-electric radiation. The forces of I 7 are defined as;

\[
F_{71} = (15)^{3/2} F_e \quad \text{(where; } F_e \text{ is emissive force)}
\]

\[
F_{72} = v(\pi k_B T)^2/hc^2
\]

\[
F_{73} = (15)^{3/2} \hbar v^2/\alpha \lambda^2
\]

\[
F_{74} = (15)^{3/2} \hbar v/\lambda^2
\]

\[
F_{75} = (\pi k_B T)^2/hc
\]

The vector restriction is;

\[
A_7 = B_7
\]

\[
\cos(A_7) = \cos(B_7)
\]

\[
F_{71}/F_{75} = F_{75}/F_{74}
\]

\[
F_{71}F_{74} = F_{75}^2
\]

\[
(15)^{3/2} F_e (15)^{3/2} \hbar v/\lambda^2 = (\pi k_B T)^4/\hbar^2 c^2
\]

Reduced Plank constant gives;

\[
15F_e h v/2\pi \lambda^2 = (\pi k_B T)^4/\hbar^2 c^2
\]

\[
15(F_e v)/\lambda^2 = 2\pi(\pi k_B T)^4/\hbar^2 c^2
\]

Emissive power \( (P_e) \) is;

\[
P_e = F_e v \quad \text{(power = force . velocity)}
\]

Emissive brightness \( (B_e) \) is;

\[
B_e = P_e/\lambda^2 \quad \text{(brightness = power/area)}
\]

Giving emissive brightness;

\[
B_e = 2\pi^5 k_B T^4/15\hbar^3 c^2 = \sigma T^4
\]

\textit{Int.8;}

Interaction 8 will lead to the definition of Compton interaction. The forces of I 8 are defined as;

\[
F_{81} = m_0 c^2/\lambda_3
\]

\[
F_{82} = (m_0 c^2)^2/hc
\]

\[
F_{83} = (mc)^2/hc
\]
F_{84} = \frac{hc}{\lambda_3^2}
F_{85} = \frac{mc^2}{\lambda_3}

Where;
- \( h \) is the Plank constant
- \( c \) is the light constant
- \( \lambda_3 \) is exchange wavelength
- \( m \) is dynamic mass of electron
- \( m_0 \) is rest mass of electron
- \( v \) is final velocity of electron

The vector condition is; \( A_8 = B_8 \)

Giving;
\[
\cos(A_8) = \cos(B_8)
\]
\[
\frac{F_{81}}{F_{85}} = \frac{F_{85}}{F_{84}}
\]
\[
F_{81}F_{84} = F_{85}^2
\]
\[
(m_0c^2/\lambda_3)(hc/\lambda_3^2) = (mc^2/\lambda_3)^2
\]

First result;
\[
(m_0c^2)(hc/\lambda_3) = (mc^2)^2
\]

Also;
\[
\sin(A_8) = \sin(B_8)
\]
\[
\frac{F_{82}}{F_{85}} = \frac{F_{83}}{F_{84}}
\]
\[
F_{82}F_{84} = F_{83}F_{85}
\]
\[
[(m_0c^2)^2/hc][hc/\lambda_3^2] = [(mvc)^2/hc][mc^2/\lambda_3]
\]

Second result;
\[
(m_0/m)(m_0c^2)[hc/\lambda_3] = (mvc)^2
\]

Mass dilation may be represented as;
\[
m_0/m = \left(1 - \frac{v^2}{c^2}\right)^{\frac{1}{2}}
\]

Where;
\[
m_0/m = \cos_B \quad \text{and} \quad v/c = \sin_B
\]

Dilation energies are;
\[
(m_0c^2)^2 + (mvc)^2 = (mc^2)^2
\]

Substituting first result gives;
\[
(m_0c^2)^2 + (mvc)^2 = (m_0c^2)(hc/\lambda_3)
\]

Substituting second result gives;
\[
(m_0c^2)^2 + (m_0/m)(m_0c^2)[hc/\lambda_3] = (m_0c^2)(hc/\lambda_3)
\]
\[
m_0c^2 + \cos_B[hc/\lambda_3] = (hc/\lambda_3)
\]
**Forces of Interaction**

\[
m_0c^2 = \frac{hc}{\lambda_3}(1 - \cos \beta) \\
\lambda_3 = \frac{h}{m_0c}(1 - \cos \beta)
\]

\(I_8\) gives the definition of Compton interaction; \(\lambda_2 - \lambda_1 = \frac{h}{m_0c}(1 - \cos \beta)\)

**Equivalent Energies;**

Energy equivalences for mass \((E_m)\) and charge \((E_q)\) may have a similar format;

\[
E_m = m(F_pG)^{1/2} = mc^2 \\
E_q = \pm q(F_pk_e)^{1/2} = \pm qv^2
\]

Where; \(m, q\) are matter forms (mass, charge)

\(G, k_e\) are field constants (gravitational field, electric field) and; \(4\pi\varepsilon_0k_e = 1\)

\(F_p\) is Plank force

\(c\) is the light constant; \(c = (F_pG)^{1/2}\)

\(v_e\) is a velocity dependent upon spatial medium \((\varepsilon_0)\); \(v_e = (F_pk_e)^{1/2}\)

A charged particle may have total energy \((E_T)\) as; \(E_T^2 = E_m(E_m \pm E_q)\)

This ensures that a charged particle must have mass.

**Conclusion;**

A vector of interactive force has one angular restriction. An interaction may be represented as a set of scalar definitions for each component of force. Interactions will lead to definitions of natural characteristics.