

The Existence and Interaction Equations

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[Working Document](#)

[The Relativistic Unit Circle](#)

$$(ct) > 0, (vt') > 0$$

It is important to emphasize that the following analysis takes place as “scalars” in “one dimension”; that is vectors are irrelevant; any interaction between dimensions is modeled as “imaginary” (see below). That is, “periodic” functions (“waves”) are characterized by vectors in more than one dimension, where vector interactions are “imaginary”

The first order existence equation is $\# := (ct') = (ct) + (vt')$ where

$$\frac{\#}{\#} := \frac{(ct')}{(ct')} = \left(\frac{1}{\gamma} \right) + (\beta), \gamma := \frac{t'}{t}, \beta = \frac{v}{c}$$

The second order interaction equation is:

$$\#^2 := (ct')^2 = [(ct) + (vt')]^2 = [(ct)^2 + (vt')^2] + [2(ct)(vt')] \text{ where}$$

$[(ct)^2 + (vt')^2]$ represents the existence (addition) of the interacting elements, and $[2(ct)(vt')]$ represents their interaction (multiplication, entanglement, entropy).

Note that the matrix expression of the interaction equation:

$$\#^2 := (ct')^2 = Tr \begin{vmatrix} (ct)^2 & 0 \\ 0 & (vt')^2 \end{vmatrix} + Det \begin{vmatrix} (ct) & (ct) \\ -(vt') & (vt') \end{vmatrix} = [(ct)^2 + (vt')^2] + [2(ct)(vt')] \text{ is not equivalent}$$

to the four- dimensional case where

$$Tr \begin{vmatrix} (ct) & 0 & 0 & 0 \\ 0 & (vt') & 0 & 0 \\ 0 & 0 & (ct) & 0 \\ 0 & 0 & 0 & (vt') \end{vmatrix}^2 = Tr \begin{vmatrix} (ct)^2 & 0 & 0 & 0 \\ 0 & (vt')^2 & 0 & 0 \\ 0 & 0 & (ct)^2 & 0 \\ 0 & 0 & 0 & (vt')^2 \end{vmatrix} = 2(ct)^2 + 2(vt')^2$$

(Compare this with the [Electromagnetic Tensor](#) – Wikipedia, noting that it results from the vector formulation via Relativity and Maxwell’s Equation)

For $(ct) > 0$ There are three (real) possibilities to consider:

1. "Trigonometric" regime $0 \leq (vt') \leq (ct)$, $(ct) \leq \# \leq 2(ct)$
2. $(vt') = (ct)$, $\# = (ct) + (ct) = 2(ct)$
3. "Hyperbolic" regime $(ct) \leq \#$

"Trigonometric" Regime

Transition from $\# = 1$ to $\# = 2$, $(ct) > 0$, $0 \leq (vt') \leq (ct)$

(Note that the analysis also applies to the transition $\# = n$ to $\# = n + 1$)

For $(vt') \leq (ct)$, the equation can be represented by

$$(ct') = (ct) \cos(\theta) + (vt') \sin(\theta), \quad 0 \leq \sin(-\theta) \leq 1, \quad -\sin(\theta) = i^2 \sin(\theta), \quad i := \sqrt{-1}$$

Initial State (No second element)

$$\theta = 0 \leftrightarrow \# = (ct') = (ct), \quad (vt') \sin \theta = 0$$

$$\#^2 = (ct)^2 = (ct')^2$$

Final State (Transition from one to two elements)

The first order interaction equation is given by:

$$(ct') = (ct) + (vt')$$

$$1_{ct'} = \frac{(ct')}{(ct)} = \frac{t}{t'} + \frac{v}{c} = \frac{1}{\gamma} + \beta, \quad \gamma := \frac{t'}{t}, \quad \beta := \frac{v}{c}$$

The second order interaction equation is given by:

$$1_{(ct')^2} = \left(\frac{ct'}{ct} \right)^2 = \left(1_{(ct')} \right)^2 = \left[\left(\frac{1}{\gamma} \right)^2 + \beta^2 \right] + \left[2 \left(\frac{\beta}{\gamma} \right) \right], \quad \gamma := \frac{t'}{t}, \quad \beta := \frac{v}{c}, \text{ where}$$

$\#^2 = \#^2 \left(\frac{\#^2}{\#^2} \right) = (ct')^2 = (ct')^2 \frac{(ct')^2}{(ct')^2}$ is an invariant (prime) number representing the final state during

the transition.

Note that in the expression $(ct')^2 = [(ct) \pm (vt')]^2 = [(ct)^2 + (vt')^2] \pm [2(ct)(vt')]$ the value of the result of the interaction is always positive $[(ct)^2 + (vt')^2] \geq [2(ct)(vt')]$

At the end of the transition, $t' = t$, $v = c$ so that

$2\left(1_{(ct')^2}\right) = \left[(1_t)^2 + (1_c)^2\right] + \left[2(1_t)(1_c)\right] = \left[(1_t) + (1_c)\right]^2$ where $1_t = 1_c$ is understood to represent the individual bases of each term $\frac{t'}{t'}$, $\frac{c}{c}$ so that both terms are invariant (prime).

$$t' = \frac{t'}{t'} = t'(1_t), c = c\left(\frac{c}{c}\right) = c(1_c)$$

Note that the relation $\left(1_{(ct')}\right)^2 = \left[\left(\frac{1}{\gamma}\right)^2 + \beta^2\right]$ suggests the identification $\left(\frac{1}{\gamma}\right)^2 = \cos^2 \theta$, $\beta^2 = \sin^2 \theta$:

So that $\left(1_{(ct')}\right)^2 = \left[\cos^2 \theta + \sin^2 \theta\right]$ but the trigonometric identity

$$\left(1_{(ct')}\right)^2 = \left[\cos^2 \theta + \sin^2 \theta\right] \text{ cannot be derived from } \left(1_{(ct')}\right) = \left[\cos \theta + \sin \theta\right].$$

Complex numbers must be introduced, where:

$$\psi = 1 = \cos \theta + i \sin \theta$$

$$\psi^* = 1^* = \cos \theta + i \sin \theta$$

$$\psi\psi^* = (1)(1^*) = \cos^2 \theta + \sin^2 \theta$$

$$1^2 = \cos^2 \theta + \sin^2 \theta$$

, and the interaction terms $\pm(\cos \theta)(i \sin \theta)$ have been eliminated by conjugation. However, in the context of the full interaction equation the terms have been restored, so that the equations are equivalent:

$$\left(1_{(ct')}\right)^2 = \left[\cos^2 \theta + \sin^2 \theta\right] + \left[2 \sin \theta \cos \theta\right] = \left[\psi\psi^*\right] + \left[2 \cos \theta \sin \theta\right]$$

Note: complex numbers (vectors) are the foundation of Electromagnetism, Special Relativity (existence without interaction) and relativistic Quantum Field Theory (interaction without existence).

“Radial” Interpretation (“Waves”)

Multiplying (interacting) by π yields:

$$\pi\left(1_{(ct')^2}\right) = \left[\pi\left(\frac{1}{\gamma}\right)^2 + \pi\beta^2\right] + \left[\frac{1}{\gamma}(2\pi\beta)\right]$$

Note that the existence term represents the areas of two circles, while the interaction term represents the surface area of a cylinder with length $\frac{1}{\gamma}$ and radius β (circumference of $(2\pi\beta)$). For electromagnetism, the areas then represent the flux through each of the areas at the end of a virtual wire cylinder for $\frac{1}{\gamma} = \beta = r$.

Spin

If the interaction is defined so that $h^2 := \left[2 \left(\frac{\beta}{\gamma} \right) \right] = 2S^2$, $S = \frac{\beta}{\gamma}$, then the Spin is characterized by the relation $S = \frac{h}{\sqrt{2}}$. Note that this is different from the conventional definition of spin, since π is lacking

in the first order expression, and thus π^2 in the second order term. (π is only defined in the second order radial expression.) One can include it by the relation:

$$h^2 := \left[\frac{1}{\gamma} (2\pi\beta) \right] = \pi \left(2 \frac{\beta}{\gamma} \right) \leftrightarrow h := (\sqrt{\pi}) \left(\sqrt{\left(2 \frac{\beta}{\gamma} \right)} \right) = (\sqrt{\pi})(\sqrt{2})\sqrt{S^2}$$

$$S = \frac{h}{\sqrt{2\pi}}$$

$$, \text{ so that } \frac{h}{\sqrt{2\pi}} = S \neq \hbar := \frac{h}{2\pi}$$

Quarks

For the two particle interaction case, the terms can be differentiated by color, so that:

$$h^2 := \left[2 \left(\frac{\beta}{\gamma} \right) \right] = 2S^2, S = \frac{\beta}{\gamma}$$

$$\left(1_{(ct')^2} \right) = \left[\left(\frac{1}{\gamma} \right)^2 + \beta^2 \right] + \left[2 \frac{\beta}{\gamma} \right], \text{ where } \left[2 \frac{\beta}{\gamma} \right] > \beta^2 \text{ so that if the difference } \left[2 \frac{\beta}{\gamma} \right] - \beta^2 = \delta \text{ is added}$$

to the equation, the sum will be three particles $\phi^2 = \left[\left(\frac{1}{\gamma} \right)^2 \right] + 2 \left[2 \frac{\beta}{\gamma} \right]$. If the parameters are now

increased so that $t' = t$, $v = c$ the result becomes $\#^2 = [1^2] + 2(1^2) = 3(1^2)$. This suggests that quarks

are particles in the transition from $\cos^2(\theta) + \sin^2 \theta \rightarrow 3 \cos^2(\theta)$ as an intermediate state in the transition from two to four particles $4(1^2) = (1+1)^2 = [1^2 + 1^2] + 2(1^2)$

Quark Transition

Consider the expression $\zeta^2 = \beta^2 + i(h^2) := \beta^2 + i(h^2) = \beta^2 + h^2$ However, if both of these terms exist, they must result from the sum $\# = \beta + h$ so that $\#^2 = [\beta^2 + h^2] + [2\beta h]$ where the term $[2\beta h]$ is a quark interaction term in the transition from two to four particles.

Sub Families (standing on the backs of turtles.. ☺)

This can then be extended by considering the term $\#_{\beta h} := h + \sqrt{2\beta h}$ so that in second order

$(\#_{\beta h})^2 = (h + \sqrt{2\beta h})^2 = [h^2 + 2\beta h] + 2[h(\sqrt{2(\beta)})]$ but for the “radial” term one must multiply by the $\sqrt{\pi}$: $(\sqrt{\pi})(\#_{\beta h})^2 = (\sqrt{\pi})(h + \sqrt{2\beta h})^2 = (\sqrt{\pi})[h^2 + 2\beta h] + 2[h(\sqrt{2\pi(\beta)})]$, but $\sqrt{2\pi(\beta)}$ now represents the square root of a circumference.

Note that the process can again be extended by considering

$(\#_{(\sqrt{2\beta h})(\sqrt{h})})^2 = \{(\sqrt{h} + \sqrt[4]{2\beta h})\}^2 = [h + \sqrt{2\beta h}] + 2[(\sqrt{h})(\sqrt[4]{2\beta h})]$ and so forth, each time yielding a new family of particles within the transition from two to four particles.

Transition for $(vt') \geq (ct)$

Beginning again with the first order transition equation

$(ct') = (ct) + (vt')$, the second order transition equation

$\#^2 := (ct')^2 = [(ct) + (vt')]^2 = [(ct)^2 + (vt')^2] + [2(ct)(vt')]$ is now divided by $(ct)^2$ so that

$$\left(\frac{ct'}{ct}\right)^2 = \left[\left(\frac{ct}{ct}\right)^2 + \left(\frac{vt'}{ct}\right)^2\right] + \left[2\frac{(ct)(vt')}{(ct)^2}\right] \text{ and } \gamma^2 = \left[(1_{ct})^2 + (\beta\gamma)^2\right] + [2\beta\gamma], \gamma := \frac{t'}{t}, \beta := \frac{v}{c}$$

Note that the hyperbolic identity $\cosh^2 \theta = 1^2 + \sinh^2 \theta$ is suggested by the identifications

$\gamma^2 = \cosh^2 \theta$ and $(\beta\gamma)^2 = \sinh^2 \theta$ but cannot be derived from the relation $\# = \cosh \theta = 1 + \sinh \theta$ in first order. However, as in the trigonometric case, one can use complex variables so that

$$\psi := [1 + i \sinh \theta]$$

$$\psi^* := [1 - i \sinh \theta]$$

$$\gamma^2 := \cosh^2 \theta := \psi\psi^* := [1 + i \sinh \theta][1 - i \sinh \theta] = [1^2 + \sinh^2 \theta]$$

So that the expression becomes $\psi\psi^* = \cosh^2 \theta = [1^2 + \sinh^2 \theta]$ where the interaction terms $\pm(1)\sinh \theta$ have been eliminated in the conjugation.

However, if the terms are inserted back into the equation

$$\#^2 = \cosh^2 \theta = (1 + \sinh \theta)^2 = [1^2 + \sinh^2 \theta] + [2 \sinh \theta \cosh \theta] \text{ so that}$$

$$\#^2 = \cosh^2 \theta = \psi\psi^* = (1 + \sinh \theta)^2 = [1^2 + \sinh^2 \theta] + [2 \sinh \theta \cosh \theta] \text{ then the count } \# \text{ is preserved.}$$

Note that $\cosh \theta := \frac{e^\theta + e^{-\theta}}{2}$, $\sinh \theta := \frac{e^\theta - e^{-\theta}}{2}$ so that at the limit $\theta \rightarrow \infty$ $\cosh \theta \rightarrow \sinh \theta$ so that

$$\lim_{\theta \rightarrow \infty} (\cosh \theta + \sinh \theta) = \lim_{\theta \rightarrow \infty} \left(\frac{e^\theta + e^{-\theta}}{2} + \frac{e^\theta - e^{-\theta}}{2} \right) = 2e^\theta \text{ so the difference between } \cosh \theta \text{ and } \sinh \theta$$

disappears and one is left only with the existence (addition) term $2e^\theta = [e^\theta + e^\theta]$.

Multiplying by π yields $\pi(\#^2) = \pi(\cosh^2 \theta) = \pi[1^2 + \sinh^2 \theta] + [(\cosh \theta)(2\pi \sinh \theta)]$ where again, $(\cosh \theta)$ can be imagined as a "radius" and $(2\pi \sinh \theta)$ as a circumference.

This result suggests the [Gamma Function](#) $\Gamma(n+1) = n\Gamma(n)$ as the interpolation between first order steps.

Finally, for $\# = 1 + n$, where $\#^2 = (1+n)^2 = [1^2 + n^2] + [2(1)(n)]$, the relation $(1+n)^2 = [1^2 + n^2]$ can only be defined via complex conjugation by eliminating the "interaction" product $\pm(1)(n)$.

Quarks can be introduced in a similar way as for $vt' < ct$, as can subsets of elements.

Physical Interpretation

Note that if the final state $(1_{(ct')})^2$ (“trigonometric” realm) can become the initial state $(1_{(ct)})^2$ (“hyperbolic” realm) of a subsequent interaction, and vice versa)

Final State $(vt') < (ct)$

Note that if $\left(\frac{1}{\gamma}\right)$ represents the force due to mass and β represents the force due to charge, then

$\left(\frac{\beta}{\gamma}\right)$ represents the charge to mass force ratio during the transition from pure mass (e.g. proton in a hydrogen atom) (no electron) to the final state of equal mass and charge where the mass of the electron is equal to that of the proton. The sign of the transition depends on the direction of rotation in the RUC (Positive if CCW in quadrants I and III, CW in II and 4, Negative if vice versa). The area of the triangle in each quadrant (generated by multiplication) represents the energy of a change in entropy (entanglement, etc.) Experimentally, the change is fixed for a given nucleus and electron with invariant values and is very small.

The first order “quark” change represents the radiation of an ionized hydrogen atom in which

$\left[(1_{(ct')})^2 + \beta^2\right]$ represents the ionized atom (where β characterizes an electron), and $\left[2\frac{\beta}{\gamma}\right]$ represents

the bound electron at the moment of ionization where the electron no longer interacts with the atom, so a positive “hole” (electron site) is created around the proton nucleus and the negative electron is ejected (keeping in mind that in the context of the total equation, the value of the electron is less than the atom, and so remains positive for $(1_{(ct')})^2 = \left[(ct)^2 + (vt')^2\right] + 2(ct)(vt')$, $(vt') \ll (ct)$).

The second change (quark transition from one particle to two particles) is called “second quantization”, and is responsible for the fine structure of hydrogen), with photon “charge” again determined by the second “angle” of rotation within the context of the first.

In a radio/radar antenna the change in second quantization represents a “signal” transmitted by the photon, and its value is the “charge to mass” ratio of a photon to an electron within the context of the hydrogen atom. In an antenna, consisting of a metal in which electrons are assumed to be on the surface, but independent of the lattice structure of the antenna (i.e., they are in the “Fermi” level of the metal, and both the metal and the motion of the electrons are independent of that of the photons, then the photons are the “moving” elements on the surface which are radiated into the atmosphere by ignoring any change to the antenna or the electrons (since the signal is powered by an external source of electric (photon) field at each end of the antenna).

Note that adding both changes the value of $\left(1_{(ct')}\right)^2$ in the second order interaction equation; the recalculation of this value at each stage is called “renormalization”; in the above example, the only change is in the “signal”.

The process of adding interactions in this way can be continued for even finer experimental energy levels.

The analysis can then be extended to more complex atomic structures via the multinomial expansion and the introduction of approximations such as screening of energy levels, etc., which is beyond the scope of this document.

Initial State

$(vt') > (ct)$ “Hyperbolic Realm”

In this realm, particle count is increment at each step of

$$(ct') = (ct) + (vt')$$

$$\gamma = \left(\frac{t'}{t}\right) = 1_{(ct)} + \beta$$

$$n\gamma = n\left(1_{(ct)} + \beta\right)$$

in first order so that $n\left(\frac{t'}{t}\right) = n\left(1_{(ct)}\right) + \left(\frac{ct'}{ct}\right) = (n+1)\left(1_{(ct')}\right)$ at each integer step.

However,

$$\left(n(1_{t'})\right)^2 = \left(n(1_{t'})\right)^2 = (n)^2 \left(1_{(ct)} + 1_{(ct')}\right)^2 = n^2 \left(1_{(ct)} + 1_{(ct')}\right)^2 = n^2 \left\{ \left[\left(1_{(ct)}\right)^2 + \left(1_{(ct')}\right)^2 \right] + \left[2\left(1_{(ct)}\right)\left(1_{(ct')}\right) \right] \right\}$$

In second order.

Voltage, Current, and Resistance

In the macro world, this relation is represented by

$$\# = I + R$$

$$\#^2 = (I + R)^2 = \left[I^2 + R^2 \right] + \left[2(I)(R) \right]$$

Where I represent current, R represents resistance and $V = IR$ represents voltage. (Note that if only the vector “right hand” rule (vector cross product) is represented, then $V = I \otimes R$ but that I and R no longer exist separately, since

$$\begin{vmatrix} I & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & 0 \end{vmatrix} = \begin{vmatrix} I \\ 0 \\ 0 \end{vmatrix} + \begin{vmatrix} 0 \\ R \\ 0 \end{vmatrix} + \begin{vmatrix} 0 \\ 0 \\ 0 \end{vmatrix} \text{ where } \left(\begin{vmatrix} I \\ 0 \\ 0 \end{vmatrix} \otimes \begin{vmatrix} 0 \\ R \\ 0 \end{vmatrix} \right) + \begin{vmatrix} 0 \\ 0 \\ 0 \end{vmatrix} \rightarrow \begin{vmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & IR \end{vmatrix} \text{ so that } V = IR \text{ but } [I^2 + R^2]$$

(existence) is ignored, and $V = IR$ is a model of change only in first order.

Thermal Voltage

The thermal voltage for change in voltage in a semiconductor is given by the first order expression

$$V_T := \left(\frac{n_e}{n_e + n_h} \right) \left[\exp \left(\frac{\kappa}{q} T \right) \right], \text{ where:}$$

1. $\# = n_e + n_h$ is the total number of electrons knocked from lattice sites (“holes”) and $n_e = \# - n_h$ by perturbing (from outside) photo-electrons.
2. $\frac{\kappa}{q}$ is Boltzmann’s constant per unit charge and T is the temperature.
3. κ models $\# = \kappa$ non-interacting particles (affine “vectors”; an “electron gas”) interacting with pressure on the area of an box with unit sides (or surface of an imaginary sphere with unit radius)

Then $V_T := \left(\frac{n_e}{n_e + n_h} \right) \left[\exp \left(\frac{\kappa}{q} T \right) \right]$ is analogous to $V = IR$ where the existence of the lattice structure of the semiconductor and the photo-electrons are ignored, and only the change is characterized.