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Revised Work on Absolute Position and Energy of a Particle and Its Anti-particle

Eyal Brodet[1]

[1] Jerusalem, Israel

Correspondence: Eyal Brodet, Jerusalem, Israel. E-mail: eyalbrodet@hotmail.com

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Abstract

The experimental indication that the universe expands may allow to use its expansion velocity to fix a unique and absolute reference frame in which an absolute position for a particle may be defined. The absolute position may include the particle's external information but also all its internal information. This was first discussed in [Brodet, 2017], [Brodet, 2018], [Brodet 2019] and is updated and developed further in this paper. The absolute position suggested here is built on the space-time structure of special relativity and the absolute reference frame fix. It includes the particle's mass and information related to the particle's charge and spin. Defining the particle's absolute position may subsequently allow to also define its absolute energy and momentum. Furthermore, we shall show that by adopting a deterministic approach to the decay time of a particle we may get novel absolute expressions for the particle's internal energy and for its mass, charge and magnetic moment. The absolute expressions we get for the energy, momentum, charge, mass and magnetic moment are all related to the running of the coupling constant and to the absolute reference fix. The absolute quantities discussed above are defined for a particle and for its anti-particle. In this context, the relationship between a particle and its anti-particle are discussed as well. Experimental ways to investigate the suggested additional information related to the fundamental quantities and to the relationship of a particle and its anti-particle are discussed.

Keywords: absolute, position, energy, particle, anti-particle

1. Introduction

In this paper we will discuss the concept of an absolute position for a particle and its anti-particle. The concept was first introduced in [Brodet 2017], [Brodet 2018], [Brodet 2019]. In this paper we will update and develop this concept further and will consider it as a parent quantity for all the particle's other quantities. It will be argued that the particle's absolute position summarizes all the external and internal information of the particle in a unique and absolute manner. The experimental indication that the universe expands may be used to fix an absolute reference frame which allows to define the absolute position of a particle in the universe. The absolute position is built on the space-time structure of special relativity but ads the absolute reference frame fix and also includes the particle's mass and information related to the particle's charge and spin. Defining the particle's absolute position may subsequently allow to also define its absolute energy and momentum. Furthermore, we shall show that by adopting a deterministic approach to the decay time of a particle we may get novel absolute expressions for the particle's internal energy and for its mass, charge and magnetic moment. The absolute expressions we get for the energy, momentum, charge, mass and magnetic moment are all related to the running of the coupling constant and to the absolute reference fix. The absolute quantities discussed above are defined for a particle and its anti-particle. In this context, the relationship between a particle and its anti-particle are discussed as well. Relative energy and momentum may be defined using relative velocity while keeping all the internal quantities in their absolute form as will be described in the text. Experimental ways to investigate the suggested additional information related to the fundamental quantities and to the relationship of a particle and its anti-particle are discussed.

The paper is divided into four sections. Section 2 describes the concept of an absolute position for a particle. This section describes how the absolute position is built and how it is related to the particle's absolute energy and momentum. Furthermore, it describes a novel expression for the particle's internal energy and also detailed expressions for mass, charge and magnetic moment. Section 3 describes the absolute position of a particle and its anti-particle. Moreover, it discusses the relationship between the quantities of a particle and its anti-particle.

Section 4 describes how it may be possible to experimentally test the suggestions made in sections 2 and 3.

2. The Particle's Absolute Position and Energy

2.1 Absolute Position

In previous works [Brodet 2017], [Brodet 2018], [Brodet 2019] we have introduced the possibility of an absolute reference frame that may be related to the universe expansion velocity $v_{\exp}$. Therefore, it was argued that we may define particle's i distance with respect to the above absolute frame in terms of its internal distance and external distance such:

$$D_{i(abs)}^2 = D_{i(\text{int})}^2 + D_{i(ext)}^2 \qquad \text{Equation 1}$$

Let us first consider the internal contribution $D_{i(\text{int})}$. As the general expression for distance is described using the formula $X = V \cdot t$, we may use the particle's i internal time and internal velocity, such:

$$D_{i(\text{int})} = c_{i(Tot)} \cdot t_{i(0)} \qquad \text{Equation 1a}$$

The particle's internal time may be its decay time for unstable particles or its internal time for stable particles as was discussed in the context of the hidden variable in time possibility that was first introduced in [Brodet 2010]. The value of $c_{i(Tot)}$ may be related to two known internal quantities namely charge and spin such:

$$(c_{i(Tot)} t_{i(0)})^2 = (c_i t_{i(0)})^2 + (v_i t_{i(0)})^2 \qquad \text{Equation 1b}$$

where c_i is related to the particle's charge and v_i to the particle's spin.

Based on special relativity 4-Vector in space structure, we may define particle's i absolute distance by:

$$(\gamma_{i(abs)} c_{i(Tot)} t_{i(0)})^2 = (c_{i(Tot)} t_{i(0)})^2 + (\gamma_{i(abs)} V_{abs} t_{i(0)})^2 \qquad \text{Equation 2}$$

where

$$\gamma_{i(abs)} = \frac{1}{\sqrt{1 - \frac{V_{abs}^2}{c_{i(Tot)}^2}}} \qquad \text{Equation 2a}$$

The distance in equation 2 is with respect to an absolute reference frame. If we define V_{abs} to be particle's i velocity with respect to the center of the universe, then the distance in equation 2 descries a particle's i absolute distance with respect to the center of the universe.

At this stage, in special relativity, equation 2 transforms into an energy-momentum equation by dividing all the terms by the time $t_{i(0)}^2$ and multiplying all the terms by $M_i^2 c_{i(Tot)}^2$ to give:

$$M_i^2 c_{i(Tot)}^2 (\gamma_{i(abs)} c_{i(Tot)})^2 = M_i^2 c_{i(Tot)}^2 (c_{i(Tot)})^2 + M_i^2 c_{i(Tot)}^2 (\gamma_{i(abs)} V_{abs})^2 \qquad \text{Equation 2b}$$

However, in this paper, we choose to recognize that the invariant quantity in equation 2 is $c_{i(Tot)} t_{i(0)}$ and not just $c_{i(Tot)}$. Accordingly, we choose to build the energy-momentum equation on $c_{i(Tot)} t_{i(0)}$ and not just $c_{i(Tot)}$.

We also recognize that according to electricity and magnetism the external velocity, V_{abs} of a charge particle is known to be associated with a magnetic field. Therefore, since the shape of the magnetic field and magnetic force is circular, it would mean that a moving charged particle defines external and therefore also internal angular momentum. Therefore, it is suggested that equation 2 may transform to an angular momentum equation such:

$$P_{i(abs)} = \frac{M_i}{t_{\min}}(\gamma_{i(abs)} c_{i(Tot)} t_{i(0)})^2 = \frac{M_i}{t_{\min}}(c_{i(Tot)} t_{i(0)})^2 + \frac{M_i}{t_{\min}}(\gamma_{i(abs)} V_{abs} t_{i(0)})^2 \quad \text{Equation 3}$$

where $P_{i(abs)}$ is defined as the particle's absolute position. This is where

M_i is the particle's mass and $t_{\min}$ is the minimum internal time defined in the particle's exponential distribution as will be explained in section 2.4.

The absolute position of a particle is given in the dimensions of angular momentum and it may reflect a point on the circumference of a circle centering the universe.

2.2 Absolute Energy and Momentum

One may identify the absolute energy, $E_{i(abs)}$, absolute momentum, $PP_{i(abs)}$, and absolute internal energy, $E_{i(\text{int})}$ in equation 3 such:

$$E_{i(abs)} \gamma_{i(abs)} t_{i(0)} = E_{i(\text{int})} t_{i(0)} + \gamma_{i(abs)} V_{abs} t_{i(0)} PP_{i(abs)} \quad \text{Equation 3a}$$

where

$$E_{i(abs)} = \gamma_{i(abs)} \frac{M_i}{t_{\min}} c_{i(Tot)}^2 t_{i(0)} \quad \text{Eqation 3b}$$

$$PP_{i(abs)} = \gamma_{i(abs)} \frac{M_i}{t_{\min}} V_{abs} t_{i(0)} \quad \text{Equation 3c}$$

$$E_{i(\text{int})} = \frac{M_i}{t_{\min}} c_{i(Tot)}^2 t_{i(0)} \quad \text{Equation 3d}$$

Which leads to the energy-momentum relationship of:

$$E_{i(abs)} = \frac{E_{i(\text{int})}}{\gamma_{i(abs)}} + V_{abs} PP_{i(abs)} \quad \text{Equation 4}$$

Which is consistent with special relativity energy momentum of:

$$E_{i(abs)}^2 = E_{i(\text{int})}^2 + c_{i(Tot)}^2 PP_{i(abs)}^2 \quad \text{Equation 4a}$$

The value of V_{abs} may be given by special relativity velocity law such:

$$V_{abs} = \frac{v_{\exp} + v_{prod}}{1 + \frac{v_{\exp} v_{prod}}{c_{i(Tot)}^2}}$$

Where

$v_{\exp}$ is the universe expansion velocity at the production position of the particle, v_{prod} is the velocity of the particle relative to its production position, $c_{i(Tot)}$ is the total internal velocity of the particle with a value around the speed of light c.

Relative energy and momentum may be defined using relative velocity while keeping $c_{i(Tot)}$ and M_i in their absolute form.

2.3 The Particle's Internal Energy, $E_{i(\text{int})}$

The possibility of a hidden variable in time was first introduced in [Brodet 2010]. The idea was that may be a hidden frequency, $f_{f(i)}$, within the particle that is related to its decay time or internal time for stable particles. Subsequently, $f_{f(i)}$ was also related to the particle's Briet-Wigner distribution (The expression here includes a normalization addition with respect to [Brodet 2016], [Brodet 2017]). Finally, if $f_{f(i)}$ indeed describes a hidden frequency within a particle then its period would naturally be $t_{i(0)}$. Therefore we may get three expressions for $f_{f(i)}$ such:

$$f_{f(i)} = f_i(A) e^{-\frac{t_{i(0)}}{\tau}} \qquad \text{Equation 5}$$

$$f_{f(i)} = f_i(A) \frac{E_{mean}^2 \Gamma^2}{k} \frac{k}{(E_{i(\text{int})}^2 - E_{mean}^2)^2 + E_{mean}^2 \Gamma^2} \qquad \text{Equation 5a}$$

$$f_{f(i)} = \frac{1}{t_{i(0)}} \qquad \text{Equation 5b}$$

where

K is given by:

$$k = \frac{2\sqrt{2} E_{mean} \Gamma \gamma}{\pi \sqrt{E_{mean}^2 + \gamma}} \qquad \text{with} \qquad \gamma = \sqrt{E_{mean}^2 (E_{mean}^2 + \Gamma^2)}$$

And the expression for $f_i(A)$ may be given by:

$$\frac{1}{t_{i(0)}} = f_i(A) e^{-\frac{t_{i(0)}}{\tau}}$$

$$f_i(A) = \frac{e^{\frac{t_{i(0)}}{\tau}}}{t_{i(0)}} \qquad \text{Equation 5c}$$

Using equation 5 and 5a we may get an expression for $E_{i(\text{int})}$ such:

$$f_i(A)e^{-\frac{t_{i(0)}}{\tau}} = f_i(A)\frac{E_{mean}^2\Gamma^2}{(E_{i(\text{int})}^2 - E_{mean}^2)^2 + E_{mean}^2\Gamma^2}$$

$$E_{i(\text{int})} = \sqrt{E_{mean}^2 \pm \sqrt{E_{mean}^2\Gamma^2 e^{\frac{t_{i(0)}}{\tau}} - E_{mean}^2\Gamma^2}} \qquad \text{Equation 6}$$

and using equation 3d we may get the expression for the particle's mass M_i such:

$$M_{i\pm} = \frac{t_{\min}\sqrt{E_{mean}^2 \pm \sqrt{E_{mean}^2\Gamma^2 e^{\frac{t_{i(0)}}{\tau}} - E_{mean}^2\Gamma^2}}}{t_{i(0)}c_{i(Tot)}^2} \qquad \text{Equation 6a}$$

2.4 The Value of $t_{\min}$

In order to define $t_{\min}$ let us first define $t_{\max}$. The value of $t_{\max}$ may be defined as the value of $t_{i(0)}$ when the value of the amplitude of the particles exponential distribution is 0.5% from its maximum value. After we have $t_{\max}$ we may evaluate $t_{\max}$ by dividing $t_{\max}$ by the elementary particle discreetness which defined in [Brodet 2013] to be 5.9×10^{16}, such:

$$t_{\min} = \frac{t_{\max}}{5.9\times10^{16}} \qquad \text{Equation 7}$$

2.5 The Particle's Decay Time

Special relativity describes the particle's decay time as measured in the lab in experiments such as LEP[Large Electron Positron] such:

$$t_{i(lab)} = \gamma_{i(sr)}t_{i(0)} \qquad \text{Equation 8}$$

where

$$\gamma_{i(sr)} = \frac{1}{\sqrt{1-\frac{V_{prod}^2}{c^2}}}$$

According to section 2.1 and 2.2, $\gamma_{i(abs)}$ should also include the effect of external velocity V_{prod} on the particle internal velocity $c_{i(Tot)}$ and also the effect of the expansion of the universe. Therefore, $t_{i(lab)}$ should change to:

$$t_{i(lab)\_(abs)} = \gamma_{i(abs)}t_{i(0)} \qquad \text{Equation 8a}$$

where

$$\gamma_{i(abs)} = \frac{1}{\sqrt{1 - \frac{V_{abs}^2}{c_{i(Tot)}^2}}}$$

2.6 The Value of $c_{i(Tot)}$

In section 2.1 we defined:

$$c_{i(Tot)}^2 = c_i^2 + v_i^2 \qquad \text{Equation 9}$$

Therefore, in order to get a more detailed expression for $c_{i(Tot)}$ we need to get expressions for c_i and v_i. let us first consider c_i. As discussed in section 2.1, c_i may be related to the particle's electric charge. Now, the units of an electric field in SI units is Volts per meter which is equivalent to Newton times length, which is equal to Joule. Therefore, the electric field has the units of energy. Now let us look at the expression for the Lorentz force given by:

$$F_{Lorentz} = qE + qVB \qquad \text{Equation 9a}$$

Where E is the electric field, B is the magnetic field and q is the electric charge.
If the electric field has the units of energy then we may identify the units of the charge q as 1/meter.
If we assume the electric charge is indeed related to c_i then we may define q_i as:

$$q_i = \frac{1}{c_i t_{i(0)}} \qquad \text{Equation 9b}$$

The question is now what may be the expression for c_i?. We can recall that in equation 6a we have got a relationship between $c_{i(Tot)}$ and $M_{i\pm}$. Another useful relationship in this context may be obtained from placing an electron in an equilibrium under the forces of gravity and electricity such:

$$q_{i-}E_{i-} = \frac{GM_{earth}M_{i-}}{r^2} \qquad \text{Equation 10}$$

where E_{i-} is the balancing electric field, q_{i-} is the electric charge, M_{i-} is the mass of the electron and r is the distance of the electron from the center of earth.
Using equation 9 for the electron's electric charge we get:

$$\frac{E_-}{c_i t_{i(0)}} = \frac{GM_{earth}M_{i-}}{r^2} \qquad \text{Equation 10a}$$

which gives:

$$c_i = \frac{E\_r^2}{GM_{earth}M_{i-}t_{i(0)}} \quad \text{Equation 10c}$$

Note that the expression for the gravitational force is non-relativistic. In the relativistic case the gravitational force expression would indeed change but so would the value of the balancing electric field. Therefore, the value of c_i wouldn't change by the relativistic change in the gravitational field. However c_i would indeed change by particle's i absolute velocity, V_{abs} as will be discussed later on in this section.

Before we continue let us first recall the suggested relationship between c_i and $c_{i(Tot)}$ may be given by equation 9:

$$c_{i(Tot)}^2 = c_i^2 + v_i^2$$

Therefore, we now need to find out the expression for v_i. In section 2.1 it was suggested that v_i may be related to the particle's spin. Subsequently, let us consider the Stern-Gerlich experiment[W. Gerlach and O. Stern, 1924] and try to evaluate v_i from it. In Stern-Gerlich experiment the particles are deflected a distance h_i as a result of a varying magnetic field along the h_i direction. Therefore, if we measure the time, t_{h_i} it gets the particle to travel from the point it passes the magnet until it gets deflected in the screen at point h_i, we may get its transverse velocity such: $V_{T_i} = \frac{h_i}{t_{h_i}}$. Therefore, in case of a non-relativistic electron, its transverse kinetic energy may be given by:

$$E_{i(kinetic)} = \frac{1}{2}M\_V_{T_i}^2 \quad \text{Equation 11}$$

Now, the electron's magnetic moment may be given by:

$$\mu_i = \frac{q_i}{2M_{i-}}L_i \quad \text{Equation 11a}$$

where L_i may be given by: $\frac{M_{i-}}{t_{\min}}v_i^2 t_{i(0)}^2$

which gives:

$$\mu_i = \frac{v_i^2 t_{i(0)}}{2t_{\min}c_i} \quad \text{Equation 11b}$$

Therefore, the energy that is given to the electron by the external magnetic field may be given by:

$$E_{i(magnetic)} = \mu_i B \quad \text{Equation 11c}$$

where B is the external magnetic field.

We may equate equation 11 and 11c for electrons and positrons such:

$$\frac{v_i^2 t_{i(0)}}{2t_{\min} c_i} B = \frac{1}{2} M_{i\pm} V_{T_i}^2 \quad \text{Equation 11d}$$

which gives:

$$v_i = \sqrt{\frac{t_{\min} c_i M_{i\pm} V_{T_i}^2}{B t_{i(0)}}}$$

Note that we assume here that $V_{T_{i\pm v_i}} = V_{T_i}$ while this may not be necessarily the case and may depend on the sign of the magnetic moment.

We may substitute for c_i from equation 10c to give:

$$v_i = \sqrt{\frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2}} \quad \text{Equation 11e}$$

Therefore, using equation 10d we get $c_{i(Tot)}^2$ such:

$$c_{i(Tot)}^2 = \frac{E_{i\pm}^2 r^4}{G^2 M_{earth}^2 M_{i\pm}^2 t_{i(0)}^2} + \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2} \quad \text{Equation 11f}$$

and using equation 6a we get:

$$M_{i\pm} = \frac{t_{\min} \sqrt{E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 e^{\frac{t_{i(0)}}{\tau}} - E_{mean}^2 \Gamma^2}}}{t_{i(0)} c_{i(Tot)}^2}$$

Therefore, substituting for $M_{i\pm}$:

$$c_{i(Tot)}^2 = \frac{E_{i\pm}^2 r^4 c_{i(Tot)}^4}{G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)})} + \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2} \quad \text{Equation 12}$$

$$\frac{E_{i\pm}^2 r^4 c_{i(Tot)}^4}{G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)})} - c_{i(Tot)}^2 + \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2} = 0 \quad \text{Equation 12a}$$

Let $x = c_{i(Tot)}^2$

$$\frac{E_{i\pm}^2 r^4 x^2}{G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)})} - x + \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2} = 0 \quad \text{Equation 12b}$$

which gives:

$$x_{1,2} = \frac{1 \pm \sqrt{1-4ac}}{2a}$$

$$x_{1,2} = \frac{(G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)}))(1 \pm \sqrt{1 - 4\frac{E_{i\pm}^2 r^4}{G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)})} \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2}})}{2E_{i\pm}^2 r^2} \quad \text{Equation 12c}$$

and

$$M_{i\pm} = \frac{t_{\min} \sqrt{E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 e^{\frac{t_{i(0)}}{\tau}} - E_{mean}^2 \Gamma^2}}}{t_{i(0)} x_{1,2}} \quad \text{Equation 12d}$$

We can see from equation 10d, 10h that $c_{i(Tot)}$ depends on $t_{i(0)}$. However, if c_i is indeed related to the electric charge it should also depend on the particle's velocity. We know this from the running of the coupling constant [Aitchison and A. Hey, 1982], [R.D. Field, 1989]. This dependence may be expressed in the value of the particle's width, Γ. We know that in the units $h = c = 1$ we get:

$$\tau\Gamma = 1$$

The effect of the running coupling may be included by replacing c by $c\Delta$ where

$$\Delta = \frac{c}{V_{abs}}$$

Therefore, if we keep the units $h = c = 1$ we get:

$$\tau\Gamma \frac{1}{V_{abs}^2} = 1$$

which gives:

$$c_{i(Tot)_{1,2}}^2 = \frac{(G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 \Delta^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)}))(1 \pm \sqrt{1 - 4\frac{E_{i\pm}^2 r^4}{G^2 M_{earth}^2 t_{\min}^2 (E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 \Delta^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)})} \frac{t_{\min} E_{i\pm} r^2 V_{T_i}^2}{G M_{earth} B t_{i(0)}^2}})}{2E_{i\pm}^2 r^2} \quad \text{Equation 12e}$$

and

$$M_{i\pm} = \frac{t_{\min} \sqrt{E_{mean}^2 \pm \sqrt{E_{mean}^2 \Gamma^2 \Delta^2 (e^{\frac{t_{i(0)}}{\tau}} - 1)}}}{t_{i(0)} x_{1,2}} \quad \text{Equation 12f}$$

Note that in equation 11, $c_{i(Tot)}^2$ and therefore also c_i^2 is equal for a particle and its anti-particle. This may not be necessarily the case and should be investigated experimentally by analyzing the distribution of a negatively charge particle and its corresponding positive charge distribution.

3. The Absolute Position, Energy, Momentum and Time of a Particle and Its Anti-particle

In section 2.1, equation 3 we have defined particle's i absolute position such:

$$P_{i(abs)} = \frac{M_i}{t_{\min}}(\gamma_{i(abs)}c_{i(Tot)}t_{i(0)})^2 = \frac{M_i}{t_{\min}}(c_{i(Tot)}t_{i(0)})^2 + \frac{M_i}{t_{\min}}(\gamma_{i(abs)}V_{abs}t_{i(0)})^2$$

Which could also be written such:

$$P_{i(abs)} = E_{i(\text{int})}t_{i(0)} + PP_{i(abs)}X_{i(0)} \qquad \text{Equation 13}$$

where

$E_{i(\text{int})}$ and $PP_{i(abs)}$ are defined in section 2.2 and

and

$$X_{i(0)} = \gamma_{i(abs)}V_{abs}t_{i(0)} \qquad \text{Equation 13a}$$

Therefore, the total derivative of $P_{i(abs)}$ is given by:

$$\Delta P_{i(abs)} = \frac{\partial P_{i(abs)}}{\partial E_{i(\text{int})}}\frac{\partial E_{i(\text{int})}}{\partial t_{i(0)}}\Delta t_{i(0)} + \frac{\partial P_{i(abs)}}{\partial PP_{i(abbs)}}\frac{\partial PP_{i(abs)}}{\partial X_{i(0)}}\Delta X_{i(0)} \qquad \text{Equation 13b}$$

where

$$\frac{\partial P_{i(abs)}}{\partial E_{i(\text{int})}} = t_{i(0)} \qquad \text{Equation 13c}$$

and from deriving equation 6 we get:

$$\frac{\partial E_{i(\text{int}+)}}{\partial t_{i(0)}} = \frac{E_{mean}^2\Gamma^2\frac{v_{\exp}^4}{V_{abs}^4}e^{\frac{t_{i(0)}}{\tau}}}{4\tau\sqrt{E_{mean}^2\Gamma^2\frac{v_{\exp n}^4}{V_{abs}^4}(e^{\frac{t_{i(0)}}{\tau}}-1)}\sqrt{E_{mean}^2+\sqrt{E_{mean}^2\Gamma^2\frac{v_{\exp n}^4}{V_{abs}^4}(e^{\frac{t_{i(0)}}{\tau}}-1)}}} \qquad \text{Equation 13d}$$

$$\frac{\partial E_{i(\text{int}-)}}{\partial t_{i(0)}} = \frac{E_{mean}^2\Gamma^2\frac{v_{\exp}^4}{V_{abs}^4}e^{\frac{t_{i(0)}}{\tau}}}{4\tau\sqrt{E_{mean}^2\Gamma^2\frac{v_{\exp n}^4}{V_{abs}^4}(e^{\frac{t_{i(0)}}{\tau}}-1)}\sqrt{E_{mean}^2-\sqrt{E_{mean}^2\Gamma^2\frac{v_{\exp n}^4}{V_{abs}^4}(e^{\frac{t_{i(0)}}{\tau}}-1)}}} \qquad \text{Equation 13e}$$

$$\frac{\partial P_{i(abs)}}{\partial PP_{i(abs)}} = X_{i(0)} \qquad \text{Equation 13f}$$

$$\frac{\partial PP_{i(abs)}}{\partial X_{i(0)}} = \frac{M_i}{t_{\min}} \qquad \text{Equation 13g}$$

Using the total derivative $\Delta P_{i(abs)}$ we may construct particle's i+ and its anti-particle i- absolute position such:

$$P_{i\pm(abs)} = P_{(mean)} \pm \Delta P_{i\pm(abs)} \qquad \text{Equation 14}$$

where

$$P_{(mean)} = E_{mean}t_{\min} + PP_{(mean)}X_{mean} \quad \text{Equation 14a}$$

where

$$E_{mran} = M_{mean}c^2_{i(Tot)\_(mean)} \quad \text{Equation 14b}$$

$$PP_{(mean)} = M_{mean}\gamma_{(abs)\_(mean)}V_{abs} \quad \text{Equation 14c}$$

$$X_{mean} = \gamma_{(abs)\_(mean)}V_{abs}t_{\min} \quad \text{Equation 14d}$$

$$\gamma_{(abs)\_(mean)} = \frac{1}{\sqrt{1-\frac{V^2_{(abs)}}{c^2_{(Tot)\_(mean)}}}} \quad \text{Equation 14e}$$

$$c^2_{i(Tot)\_(mean)_{1,2}} = \frac{(G^2M^2_{earth}t^2_{\min}(E^2_{mean} \pm \sqrt{E^2_{mean}\Gamma^2\Delta^2(e^{\frac{t_{\min}}{\tau}}-1)}))(1 \pm \sqrt{1-4\frac{E^2_{i\pm}r^4}{G^2M^2_{earth}t^2_{\min}(E^2_{mean} \pm \sqrt{E^2_{mean}\Gamma^2\Delta^2(e^{\frac{t_{\min}}{\tau}}-1)})}\frac{t_{\min}E_{i\pm}r^2V^2_{T_i}}{GM_{earth}Bt^2_{\min}}})}{2E^2_{i\pm}r^2}$$

Equation 14f

Similarly, we may construct particle/anti-particle i internal energy such:

$$E_{i(\text{int})} = E_{mean} \pm \Delta E_{i(\text{int})} \quad \text{Equation 15}$$

where

$$\Delta E_{i(\text{int}\pm)} = \frac{\partial E_{i(in\pm t)}}{\partial t_{i(0)}}\Delta t_{i(0\pm)} \quad \text{Equation 15a}$$

Equation 14a means that if we know $\Delta E_{i(\text{int}\pm)}, \frac{\partial E_{i(\text{int}\pm)}}{\partial t_{i(0)}}$ we may know $\Delta t_{i(0\pm)}$.

Therefore, since we may know $\Delta E_{i(\text{int}\pm)}$ from:

$$\Delta E_{i(\text{int}\pm)} = E_{i(\text{int}\pm)} - E_{mean}$$

and $\frac{\partial E_{i(\text{int}\pm)}}{\partial t_{i(0)}}$ from equation 12b,12c we may know $\Delta t_{i(0\pm)}$ for each $t_{i(0)}$

Therefore, for each particle and anti-particle i we may define:

$$t_{i\pm(true)} = t_{i(0)} \pm \Delta t_{i(0\pm)} \quad \text{Equation 15b}$$

where $t_{i\pm(true)}$ are the true internal times or measured decay times of particle/anti-particle i and

$$t_{i(0)} = \frac{t_{i-(true)}\,|\Delta t_{i(0-)}| + t_{i+(true)}\,|\Delta t_{i(0+)}|}{|\Delta t_{i(0-)}| + |\Delta t_{i(0+)}|} \quad \text{Equation 15c}$$

Therefore, substituting $t_{i\pm(true)}$ in equations 12e and 12f gives the true $c_{i\pm(true)}, M_{i\pm(true)}, \gamma_{i\pm(abs)\_(true)}$ and allows us to obtain the true absolute positions for particle and anti-particle i such:

$$P_{i-(abs)} = \frac{M_{i-(true)}}{t_{\min}} (\gamma_{i-(abs)\_(true)} c_{i-(true)} t_{i-(true)})^2 \quad \text{Equation 15d}$$

$$P_{i+(abs)} = \frac{M_{i+(true)}}{t_{\min}} (\gamma_{i+(abs)\_(true)} c_{i+(true)} t_{i+(true)})^2 \quad \text{Equation 15e}$$

4. Experimental Investigation

If indeed there is an additional information in the fundamental quantities of a particle, it should be expressed in their measurements. Therefore, we may suggest to test this in an experiment such as LEP[Large Electron Positron] or a LEP like experiment in which we may look at the process $e^+e^- \to f\vec{f}$ and measure the basic quantities of the outgoing fermions, mesons or hadrons produced. The suggested expressions for the particle's energy, momentum, charge and mass given in section 2, includes the particle's decay time or internal time. Therefore, we may measure the fermions, mesons or hadron's energy, momentum, charge and mass and search for a possible correlation with the particle's decay time. Furthermore, in order to test the particle/anti-particle relationship suggested in section 3, we may measure the correlation between $t_{i(0)}$ and $\Delta t_{i(0)}$ as defined by the fermion and anti-fermion in equations 15a and 15c. If the suggestion given in section 3 is correct there should be a correlation between $t_{i(0)}$ and $\Delta t_{i(0)}$. If it is not correct there shouldn't be a correlation.

5. Conclusions

The concept of an absolute position for a particle and its anti-particle was discussed. The concept was updated and developed further since its previous versions given in [Brodet 2017], [Brodet 2018], [Brodet 2019]. Subsequently novel expressions for energy, momentum, internal energy, mass, charge and magnetic moment were presented. Furthermore, the relationship between a particle and its anti-particle were discussed in the context of all the novel quantities that were developed in the text. Finally, possible experimental ways to test the suggestions presented in the paper were discussed.

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LEP, Large Electron Positron. Retrieved from https://home.cern/science/accelerators/large-electron-positron-collider