An Investigation into Three Relativistic Fringe Subjects.

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Abstract

Within the Relativistic Space-Time Domain D_0, this paper investigates three "fringe" subjects that are not currently realisable. They are, (i) time travel, (ii) the conversion of matter into useable energy, and (iii) spatial travel at the velocity of light, (or more correctly, the terminal velocity of D_0).

1 Introduction.

The three subjects of this paper have, over the last hundred years or so, largely been the prerogative of science fiction writers. Latterly however, they have begun to command the attention of serious scientific investigation, albeit on the fringes of mainstream relativity research. Accordingly, it is of some interest to determine whether the activities contained in these subjects are theoretically realisable within the Relativistic Space-Time Domain, D_0, (Pseudo-Euclidean Space-Time), as defined in this series of papers.
These three subjects, time travel, matter to energy conversion and travel at the terminal velocity of D_0, ($\sim$ the velocity of light), are all very closely related and governed by the application of artificial temporal forces.

It is important to note that the applicable analyses here are based upon the definition of time as detailed in [2], and this definition should be thoroughly understood prior to reading this paper.

In the interests of brevity, unless necessary for complete clarity, a parameter will only be defined in this paper if it has not previously been so in either [1] or [2] with which familiarity is assumed.

2 The Application of Artificial Temporal Forces in D_0.

2.1 Time Travel.

To induce the motion of a mass within the spatial dimensions of D_0 it is necessary to apply a spatial force in the desired direction of travel. The relativistics of the motion so incurred were investigated in detail in [1]. It is consequently not unreasonable to suppose that to effect motion of a mass in the temporal direction, it is necessary to apply an accelerating force in that direction. To investigate this consider the Existence Momentum of an energy mass m in D_0, i.e. from [1], Eq.(3.1)

$$\mathbf{M} = m\mathbf{V} = m\left\{v_r\boldsymbol{r} + \boldsymbol{j}\,c\left(1-\frac{v_r^2}{c^2}\right)^{1/2}\right\} \tag{2.1}$$

where

v_r is the spatial velocity.

$\boldsymbol{r}$ is a unit vector in the direction of spatial motion

Expressing the temporal component of (2.1) as

$$v_t = c\left(1-\frac{v_r^2}{c^2}\right)^{1/2} \tag{2.2}$$

then v_r can clearly be expressed as

$$v_r = c\left(1 - \frac{v_t^2}{c^2}\right)^{1/2} \tag{2.3}$$

which then allows (2.1) to be restated as

$$\mathbf{M} = m\left\{c\left(1 - \frac{v_t^2}{c^2}\right)^{1/2} \boldsymbol{r} + \boldsymbol{j}\, v_t\right\} \tag{2.4}$$

Differentiating (2.4) with respect to time gives the rate of change of momentum thus

$$\mathbf{F} = \frac{d\mathbf{M}}{dt} = \left\{c\frac{dm}{dt}\left(1 - \frac{v_t^2}{c^2}\right)^{1/2} - \frac{mv_t}{c\left(1 - \frac{v_t^2}{c^2}\right)^{1/2}}\frac{dv_t}{dt}\right\}\boldsymbol{r} + \boldsymbol{j}\left(\frac{dm}{dt}v_t + m\frac{dv_t}{dt}\right) \tag{2.5}$$

If now $\mathbf{F}$ is specified as

$$\mathbf{F} = 0\boldsymbol{r} + \boldsymbol{j}\, F_t \tag{2.6}$$

then a temporal force is being applied to m in such a direction as to encourage motion into the past, i.e. in the same direction as the natural temporal flow. This can be simply illustrated in the following figure where nomenclature is identical to that in [2], Fig.2.3

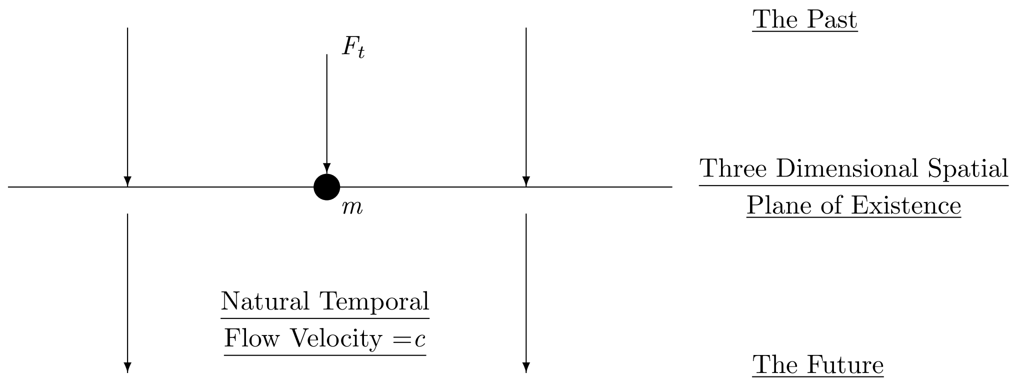

Fig.2.1 The Application of a Positive Temporal Force.

Combining (2.5) and (2.6) gives

Spatial

$$c\frac{dm}{dt}\left(1-\frac{v_t^2}{c^2}\right)^{1/2} - \frac{m}{c\left(1-\frac{v_t^2}{c^2}\right)^{1/2}}\frac{dv_t}{dt} = 0$$

(2.7)

Temporal

$$\frac{dm}{dt}v_t + m\frac{dv_t}{dt} = F_t$$

First consider the spatial part of (2.7). This can be integrated immediately to give

$$mc\left(1-\frac{v_t^2}{c^2}\right)^{1/2} = k \tag{2.8}$$

In (2.8) the constant of integration, k , is given by initial conditions which are, when $t = 0$, $v_t = c$ and the mass $m = m_0$. This simply means that the mass m was spatially stationary at $t = 0$. These conditions give $k = 0$ so (2.8) becomes

$$mc\left(1-\frac{v_t^2}{c^2}\right)^{1/2} = 0 \tag{2.9}$$

Now because m cannot be zero, (2.9) infers that

$$v_t = c \tag{2.10}$$

This therefore shows that the temporal velocity of the mass m has not been changed by the application of the temporal force, i.e. there is no increased velocity along the temporal axis. From (2.3) this also shows that v_r is also zero, i.e. there is no spatial motion. Consequently, in accordance with the law of conservation of energy, the applied force has been absorbed in some other way. To determine this the temporal part of (2.7) is integrated with respect to the time to give

$$mv_t = F_t t + k \tag{2.11}$$

Applying the above initial conditions yields

$$k = m_0 c \tag{2.12}$$

so that

$$mv_t = m_0 c + F_t t \tag{2.13}$$

and therefore from (2.10)

$$m = m_0 + \frac{F_t t}{c} \tag{2.14}$$

Eq.(2.14) shows that the applied temporal force is absorbed as an increase in mass. This result is therefore identical in part to the application of a spatial force as analysed in depth in [1]. The only difference here is the absence of an accompanying spatial acceleration. Also it can be easily shown that if the above analysis were carried out using (2.1) instead of (2.4), the result would be the same.

Thus it is clear that with time defined as in this series of papers, travel through time is not theoretically possible.

Albeit this is so, a small modification of the above analysis could lead to a potentially more useful result. This is the subject of the next Section.

2.2 Matter to Energy Conversion.

In (2.6) above, if the applied temporal force is in the opposite temporal direction, i.e. if

$$\mathrm{F} = 0\boldsymbol{r} - \boldsymbol{j}\, F_t \tag{2.15}$$

so as to encourage temporal motion into the future, then via an identical analysis to that above, (2.14) becomes

$$m = m_0 - \frac{F_t t}{c} \tag{2.16}$$

This result infers that energy is being extracted from the mass by the applied temporal force. Converting (2.16) to energy gives

$$E = m_0 c^2 - F_t tc \tag{2.17}$$

and the rate of extraction is then

$$P = \frac{dE}{dt} = -F_t c \tag{2.18}$$

Consequently it would appear that the power available from such a conversion could, from the application of a very small force, be substantial. For instance, with F_t =*1gm*, in (2.18)

$$P = 300,000 Kgm.m/\sec = 2.94 MW \tag{2.19}$$

Also in (2.17) when $E = 0$

$$t = \frac{m_0 c}{F_t} \tag{2.20}$$

and therefore a *1gm.sec*^{2}*/m* mass of matter, subjected to the *1gm* temporal force would last for

$$t = 9.51\, years \tag{2.21}$$

delivering the above power. This is sufficient to provide all the power requirements of about 1,960 typically British homes for nearly 10 years, assuming losses are small by comparison.

Such a source of power, if it could be harnessed, would be virtually limitless and extremely inexpensive. The main problem to be solved however, which is obviously a formidable one, is the development of a means of generating and applying a temporal force.

2.3 Spatial Travel at the Terminal Velocity of D_0, ($\sim$ the Velocity of Light).

It is well known that Einstein's Special Theory of Relativity shows that it is not possible to accelerate a mass to the velocity of light. To do so would require an infinite amount of energy, and take an infinite amount of time. However, this result assumes that the applied force is all purely spatial.

To investigate the effect of a combined spatial/temporal force, consider the time differential of (2.1), i.e.

$$\mathbf{F} = \frac{d\mathbf{M}}{dt} = \left(m\frac{dv}{dt} + v\frac{dm}{dt} \right) \boldsymbol{r} + \boldsymbol{j} \left\{ c\frac{dm}{dt}\left(1 - \frac{v^2}{c^2}\right)^{1/2} - \frac{vm}{c\left(1 - \frac{v^2}{c^2}\right)^{1/2}} \frac{dv}{dt} \right\} \tag{2.22}$$

where the subscript r has been dropped from the spatial velocity as no longer necessary.
If the applied force is a spatial/temporal one such that

$$\mathbf{F} = F_0 \left(1 - \frac{v^2}{c^2}\right)^{1/2} \boldsymbol{r} - \boldsymbol{j}\, F_0 \frac{v}{c} \tag{2.23}$$

where F_0 is a constant, then substitution of (2.23) into (2.22) gives

Spatial

$$m\frac{dv}{dt} + v\frac{dm}{dt} = F_0\left(1 - \frac{v^2}{c^2}\right)^{1/2} \tag{2.24}$$

Temporal

$$c\frac{dm}{dt}\left(1 - \frac{v^2}{c^2}\right)^{1/2} - \frac{vm}{c\left(1 - \frac{v^2}{c^2}\right)^{1/2}}\frac{dv}{dt} = -F_0\frac{v}{c} \tag{2.25}$$

and as will be shown below, (2.24) and (2.25) represent the "zero mass rate" equations of motion of the mass m. In this case the spatial-temporal Force/Velocity diagram is as shown in Fig.2.2 below.

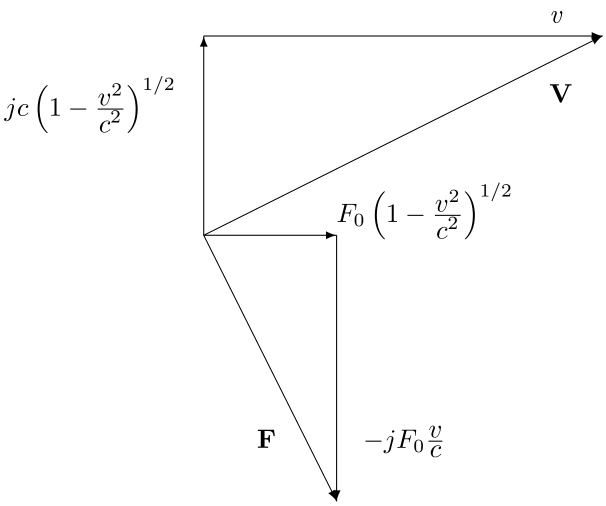

Fig. 2.2 - Zero Mass Rate Force/Velocity Diagram

and the force/reaction diagram as in Fig. 2.3 below

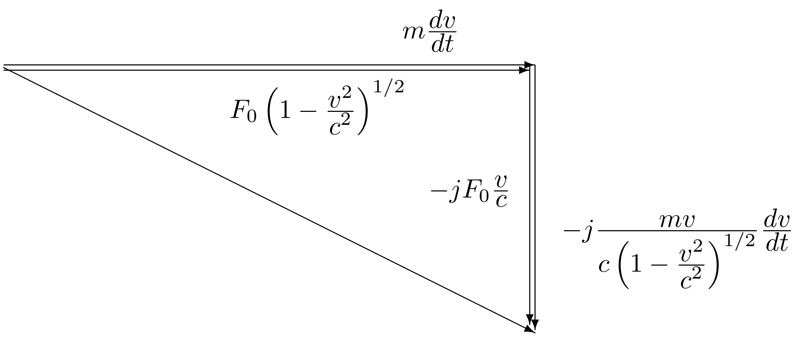

Fig. 2.3 - Zero Mass Rate Force/Reaction Diagram.

These diagrams can be compared with [1], Figs. 3.1 and 3.2 to show the difference to the application of a purely spatial force.

It is clear from (2.23) that the spatial/temporal force vector F is applied precisely at right angles to the Existence Velocity vector and then continuously adjusted to remain so. It is this

feature of the applied force vector that ensures that the mass rate remains non-existent. Hence the absence of the mass rate terms in the diagrams. The ensuing analysis will confirm this and derive the other characteristics of the motion.
With F_0 being constant, (2.25) can be integrated by inspection to give

$$mc\left(1-\frac{v^2}{c^2}\right)^{1/2}=-F_0\frac{r}{c}+k \tag{2.26}$$

where although this has been derived from a temporal equation, r is the spatial distance moved in the direction of travel. Invoking the initial conditions viz. $v=0$, $r=0$, and $m=m_0$ when $t=0$ gives

$$k=m_0c \tag{2.27}$$

and substitution of this into (2.26) then gives

$$m=\frac{m_0c^2-F_0r}{c^2\left(1-\frac{v^2}{c^2}\right)^{1/2}} \tag{2.28}$$

Clearly the application of the negative temporal component of the applied force is extracting energy from the mass. This energy could then be used to supply the spatial part of the impressed force. The mass is thereby acting as "matter fuel" to maintain its own drive. Also it would appear from (2.28) that $m=0$ when

$$r=\frac{m_0c^2}{F_0} \tag{2.29}$$

and, it will shown later that this result still represents an anomaly, even though at this point $v=c$ so that in fact (2.28) then becomes indeterminate,.
Now differentiating (2.28) with respect to the time gives the time rate of change of mass thus

$$\frac{dm}{dt}=\frac{\left(m_0c^2-F_0r\right)\frac{v}{c^2}\frac{dv}{dt}-F_0v\left(1-\frac{v^2}{c^2}\right)}{c^2\left(1-\frac{v^2}{c^2}\right)^{3/2}} \tag{2.30}$$

Eqs (2.28) and (2.30) may now be substituted into (2.24) to give

$$\frac{m_0c-F_0r}{c^2\left(1-\frac{v^2}{c^2}\right)^{1/2}}\frac{dv}{dt}+\frac{\left(m_0c^2-F_0r\right)\frac{v^2}{c^2}\frac{dv}{dt}-F_0v^2\left(1-\frac{v^2}{c^2}\right)}{c^2\left(1-\frac{v^2}{c^2}\right)^{3/2}}=F_0\left(1-\frac{v^2}{c^2}\right)^{1/2} \tag{2.31}$$

which reduces to

$$\frac{m_0c^2-F_0r}{c^2\left(1-\frac{v^2}{c^2}\right)^{1/2}}\frac{dv}{dt}=F_0\left(1-\frac{v^2}{c^2}\right)^{1/2} \tag{2.32}$$

and comparison of (2.32) with (2.24) and (2.28) clearly shows that

$$\frac{dm}{dt}=0 \tag{2.33}$$

i.e. the mass rate is non-existent.

The interpretation of this is that the relativistic increase in mass due to the application of the spatial part of the impressed force, is exactly offset by the reduction in mass due to the extraction of energy by the temporal part of the impressed force. Consequently not only are there no inertial effects, but effectively there is no increase in mass due to the storage of kinetic energy, i.e. energy

mass is maintained at the level of rest mass during the whole period that the impressed force obeys (2.23).
Accordingly (2.30) can be equated to zero to yield after minor reduction

$$\frac{dv}{dt} = a_0 \frac{1 - \frac{v^2}{c^2}}{1 - a_0 \frac{r}{c^2}} \tag{2.34}$$

where

$$a_0 = \frac{F_0}{m_0} \tag{2.35}$$

and is the spatial acceleration at $t = 0$.
Also, in (2.28) this means that the mass m must be constant at the value of rest mass , thus

$$m_0 = \frac{m_0 c^2 - F_0 r}{c^2 \left(1 - \frac{v^2}{c^2}\right)^{1/2}} \tag{2.36}$$

This permits the spatial velocity v to be expressed as a function of the spatial distance travelled thus

$$v = c \left\{1 - \left(1 - \frac{a_0 r}{c^2}\right)^2\right\}^{1/2} \tag{2.37}$$

and it can easily be shown that the time differential of (2.37) equates to (2.34). Converting (2.37) to a simple differential equation in r gives

$$cdt = \frac{dr}{\left\{1 - \left(1 - \frac{a_0 r}{c^2}\right)^2\right\}^{1/2}} \tag{2.38}$$

This is a standard integral easily solved by putting

$$1 - \frac{a_0 r}{c^2} = \cos\phi \quad sothat \quad dr = \frac{c^2}{a_0} \sin\phi d\phi \tag{2.39}$$

The result is

$$r = \frac{c^2}{a_0}\left(1 - \cos\frac{a_0 t}{c}\right) \tag{2.40}$$

Consequently

$$v = \frac{dr}{dt} = c \sin\frac{a_0 t}{c} \tag{2.41}$$

and therefore finally

$$a = \frac{dv}{dt} = a_0 \cos\frac{a_0 t}{c} \tag{2.42}$$

From (2.41) $v = c$ when

$$\sin\frac{a_0 t}{c} = 1 \tag{2.43}$$

i.e. when

$$t = \frac{\pi c}{2a_0} \tag{2.44}$$

and clearly this time may be made as small as required by making a_0 as large as necessary. Also insertion of (2.40) and (2.41) into (2.28) confirms that the mass remains constant at m_0.

Thus it would appear that "light" velocity has been achieved in a finite time whilst maintaining the mass constant at m_0, the rest mass. However, unfortunately, all is not as simple as it seems, as was indicated by (2.29). The problem is revealed by determining the energy levels involved.

From [1], Eq.(3.19) the kinetic energy associated with spatial motion at relativistic velocities is

$$E_k = mc^2 - m_0c^2 \tag{2.45}$$

expanding this to

$$E_k = mc^2 \left\{ 1 - \left(1 - \frac{v^2}{c^2} \right)^{1/2} \right\} \tag{2.46}$$

enables it to be sensibly applied to the current process. Inserting (2.41) for v and m_0 for m gives

$$E_k = m_0c^2 \left(1 - \cos\frac{a_0t}{c} \right) \tag{2.47}$$

so that the matter energy is then

$$E_m = m_0c^2 \cos\frac{a_0t}{c} \tag{2.48}$$

and therefore when t reaches the value in (2.44)

$$E_k = m_0c^2$$

$$\tag{2.49}$$

and

$$E_m = 0$$

What appears to have happened is that the matter energy of the rest mass has all been converted to kinetic energy. The precise manner in which this kinetic energy exists in D_0 is unclear, but may be addressed in a future paper.

Accordingly, if the above process were proposed for the drive of a futuristic interstellar vehicle, it would be necessary to apply the temporal force in (2.23) only to that part of the vehicle mass identified as "matter fuel". This would mean that the final velocity attained would be less that that of light and therefore to maximise this velocity and thereby minimise the relativistic mass increase of the non- matter fuel component of the vehicle, its infra-structure would have to be as small and as light as possible compared to the mass of the "matter fuel".

Also in this application, the ratio of the spatial and temporal components of the impressed force, from (2.23) shows that while the spatial part of (2.23) was larger than the temporal part, the energy extracted from the matter fuel would be insufficient to supply all of the spatial drive. Consequently some form of additional power would be needed during this period. However, once the ratio had reversed and more energy was being extracted than was needed to supply the spatial drive, the subsidiary fuel could thereby be replenished.

3 Concluding Remarks.

3.1 Time Travel

The fact that time travel in the Relativistic Domain D_0 has been found to be impossible is a direct consequence of the criterion of existence in that Domain. The spatial plane of existence may therefore be considered as the only temporal location on which all physical events, past present and future can take place. Temporal separation of these events is then effected by the temporal movement of the spatial plane on the temporal axis. This will be so irrespective of the presence of a gravitational source or not. It is also a direct result of the manner in which time has been defined in this series of papers.

The inability to travel back in time is perhaps a good thing in view of the possible philosophical implications.

3.2 Matter to Energy Conversion.

Sustainable energy supplies will soon become a major issue in the maintenance of our technological society. As reserves of fossil based fuels become more and more depleted, the necessity to find a permanent replacement will eventually overtake all other pressing needs. The energy contained within matter itself is clearly vast as exemplified by Einstein's classic matter/energy relationship. To be able to harness it and convert it into a useable form would solve this problem long into the future. Moreso even than the ability to generate controlled nuclear fusion.

Such energy is clearly, from the analysis presented here, inextricably associated with the temporal dimension, and the application of a suitable artificial temporal force the key to its release. The solution to such a formidable problem as generating artificial temporal forces will surely not be found in the macro fields of the gravitational or cosmological sciences, but most probably in those of the quantum mechanics of particle physics.

3.3 Travel at Light Velocity.

This is the second subject within which the application of an artificial temporal force could be put, eventually, to good use. The energy extracted from a source of matter fuel could be converted into a form useable as a propulsion drive as discussed in Section 2.3. However, because of the manner in which the matter fuel is used, all converted to kinetic energy, this application would have to be tempered in such a way that light velocity would not be achieved. However, as a source of propulsive power for a future interstellar vehicle drive, it would still provide a much superior solution than the application of simple spatial forces.

3.4 Summary.

All of the subjects investigated here, would, justifiably, be classified as on the fringe of mainstream relativity research. Short term practical applications are most improbable if not non-existent. However, there is some small measure of potential in both knowledge and application in the far distant future, provided the necessary research can be funded and performed. In particular the conversion of matter to energy would be the most beneficial to society.

REFERENCES.

[1] P.G.Bass, *The Special Theory of Relativity - A Classical Approach.* Apeiron (4) Vol.10 October 2003.

[2] P.G.Bass, *Generation of the Gravitational Acceleration Potential and the Time Dilatation Effect.* Apeiron (1) Vol.11. January 2004.

Note: Both of the above references also appear on the authors website :-

www.relativitydomains.com