Conditional possibility of spacecraft propulsion at superluminal speeds

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Abstract: The concept at hand deals primarily with the application of the conditional replacement technique (CRT) (Pais, 1991) to Special Relativity Theory. It is observed that under certain physical conditions, the singularity expressed by the relativistic stretch factor 'gamma' as the spacecraft's speed (v) approaches the speed of light (c), is no longer present in the physical picture. This involves the instantaneous removal of energy-mass from the system (spacecraft) when the spacecraft's speed reaches $v = c/2$. Hence under such conditions, faster than light Spacecraft Propulsion, is feasible. The original concept at hand does not violate the Special Theory of Relativity, it rather builds on its foundations.

Keywords: faster than light travel; special relativity; spacecraft propulsion.

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1 Concept description

Using the Special Theory of Relativity (Born, 1962) we can express relativistic momentum (p) and relativistic total energy (E) as:

$$p = m_r\, v = \gamma m_0 v = m_0 v / (1 - v^2 / c^2)^{1/2} \tag{1}$$

$$E = m_r c^2 = \gamma m_0 c^2 = m_0 c^2 / (1 - v^2 / c^2)^{1/2}, \tag{2}$$

where γ ('gamma') is the relativistic stretch factor, m_r and m_0 are the relativistic mass and the rest mass respectively of spacecraft travelling at speed v.

Note that as ($v \to c$, $\gamma \to$ infinity), thus giving rise to a mathematical singularity at $v = c$.

The conditional replacement technique (CRT) is originally described in Pais (1991).

It involves the one to one assignment of algebraic terms to produce a given relationship, which can only be valid under set conditions, which depend on the physical validity of the original equations.

The CRT equations are:

$$z^2 / (a_1^{\,2} + b_1^{\,2}) = a^2 + b^2 \tag{3}$$

and

$$z = aa_1 + bb_1. \tag{4}$$

The combination of these two equations yields:

$$a_1 b = ab_1. \tag{5}$$

We can now apply the criteria of CRT to the relativistic total energy formulation. Using equations (1) and (2), we obtain:

$$E^2 = p^2c^2 + m_0^{\,2}E^2 / m_r^{\,2}. \tag{6}$$

Furthermore we can write the speed of light as the addition of the spacecraft's speed v and a velocity increment Δv:

$$c = v + \Delta v. \tag{7}$$

Now we assign the terms of equations (6) and (7) in a one to one correspondence with equations (3) and (4), resulting in:

$$z = c;\ z^2 / (a_1^{\,2} + b_1^{\,2}) = E^2;\ a = pc;\ b = m_0 E / m_r;\ a_1 = v / pc;\ b_1 = \Delta v m_r / m_0 E. \tag{8}$$

This one to one CRT term assignment yields an equation analogous to equation (5):

$$[E^2 = p^2c^2(m_r^2 / m_0^2)(\Delta v / v)]. \tag{9}$$

We can observe that the mathematical singularity of (as $v \to c$, $\gamma \to$ infinity) is removed from equation (9). Thus travel past the speed of light is permissible, but under what conditions?

The answer may be found in the conditions under which the CRT relationships given by equation (8), conform to the physically valid equations (6) and (7).

From $(a_1^{\,2} + b_1^{\,2}) = E^2$, we obtain:

$$[m_0^2 p^2 c^4]_{N1}(E^2) = [m_r^2 E^2 v^2]_{N2}(m_0^2 E^2 / m_r^2) + [E^2 \Delta v^{\,2} m_r^2]_{N3}(p^2c^2). \tag{10}$$

Therefore the conditions under which equation (9) is physically valid are the conditions for which equation (10) reduces to equation (6), namely:

If [$N3 = N2$] while [$N1 = N3$] Then

$$[E^2 = p^2c^2(m_r^{\,2} / m_0^{\,2})(\Delta v / v)]. \tag{11}$$

Relationship 11 may be re-written as:

If at [$v = c/2$; $m_r^2/m_0^2 = 4/3$; $E = 2pc$] we can have [$E = 3^{0.5}pc$], Then

$$[E^2 = p^2c^2(m_r^2 / m_0^2)(\Delta v / v)], \tag{12}$$

where $p = m_r v$ and $m_r^2/m_0^2 = c^2\Delta v/v^3$, as obtained in equation (15).

Thus if at $v = c/2$, the spacecraft's total energy can be reduced from ($2pc$) to ($3^{0.5}pc$) then the speed of light no longer presents a physical barrier to the spacecraft's velocity.

Furthermore, we can use a relativistic mass formulation to write:

$$m_r^2c^2 = m_0^2c^2 + m_r^2v^2 \text{ and } c = v + \Delta v. \tag{13}$$

By using the CRT one to one term assignment expressed by:

$$z = c;\ z^2 / (a_1^2 + b_1^2) = m_r^2c^2;\ a = m_0c;\ b = m_r v;\ a_1 = v / m_0c; b_1 = \Delta v / m_r v. \tag{14}$$

We come to the conclusion that:

If at [$v = c/2$; $m_r^2/m_0^2 = 4/3$] we can have [$m_r = m_0$], Then

$$[m_r^2 / m_0^2 = c^2\Delta v / v^3]. \tag{15}$$

Therefore we may infer that if at $v = c/2$, the spacecraft's relativistic mass can be reduced from [$(4/3)^{0.5}m_0$] to [m_0] then the speed of light no longer presents a physical barrier to the spacecraft's velocity.

Removal of energy-mass from the spacecraft instantaneously at $v = c/2$ results in possibility of Faster than Light travel, in other words spacecraft propulsion at superluminal speeds is a feasible concept under such conditions.

2 Conclusion

We have shown that if we can remove [$(2 – 3^{0.5})$ pc] worth of energy from the spacecraft of m_0 rest mass, instantaneously at $v = c/2$, than the spacecraft's motion is no longer hindered by the physical barrier presented by the speed of light.

Furthermore by applying the CRT criteria to the relativistic mass formulation we can deduce that removing [$((4/3)^{0.5} – 1)$ m_0] worth of mass from the spacecraft at $v = c/2$, will also result in the removal of the speed of light barrier.

The main question then becomes: How do we physically remove this relativistic energy-mass from our system exactly at $v = c/2$?

Exotic matter utilisation as propellant, as discussed in Alcubierre (1994), Kaku (2009) and Forward (1990), may present a solution to this query. Matter-Antimatter annihilation reactions would add energy to the system, thus proving ineffective insofar as providing a solution for our present query.

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