Fundamentals Of Energy And Momentum At High Speed In Deep Space

21 December 2015

By
Jerry L Decker Ph.D.
Retired Professional Engineer

Abstract

Conventional equations of energy and momentum are rearranged to show how the components change during prolonged acceleration. Mass is shown to be a constant when light speed is constant, and a variable when light speed is variable.

Relations are developed among total energy, mass energy, and momentum energy, with conclusions that mass energy approaches zero at high speed, giving favorable predictions for Deep Space Transport .

Evaluation of Velocity in the Theory of Polarizable Vacuum

Force equations are used in the developing definitions of energy and momentum. Energy is the action of a force over a distance, or the potential to do the action.

1.1) $\quad dE = \mathbf{F} * d\mathbf{r}$

Momentum change over time is another way to describe the same force.

1.2) $\quad d\mathbf{p} / dt = \mathbf{F}$

Velocity can be defined by time and distance.

1.3) $\quad \mathbf{v} = d\mathbf{r} / dt$

Then energy is related to momentum by a velocity.

1.4) $d E = \mathbf{v} * d\mathbf{p}$

A system is chosen with v and p in the same direction.

1.5) $d E = v \; dp$

This is the first fundamental equation of energy and momentum. There are two other equations widely accepted from theories and experimental results.

1.6) $E^2 = (mc^2)^2 + (pc)^2$

1.7) $(pc) = E(v/c)$

The set of three equations are not complete, but are sufficient to predict modifications to familiar science at high speed. Notice that the energy balance of (1.6) is complicated when momentum is not zero.

1.8) $E < (mc^2) + (pc)$

This result (1.8) will be used later to suggest that (mc^2) is not constant when (pc) is changing.

Relativity allows (1.5) to be combined with (1.7).

1.9) $dE^2 = c^2 \, dp^2$

Energy is substituted using (1.6).

1.10) $d(mc^2)^2 + d(pc)^2 = c^2 \, dp^2$

1.11) $d(mc^2)^2 = - p^2 \, dc^2$

The result (1.11) adds useful conclusions without adding any unproven science. First if light speed is constant, mass is also constant. Second if light speed increases, mass decreases. It refutes a lot of published speculation about mass and light speed during acceleration.

Additional information can be obtained from the incomplete set of equations using (1.6) and (1.7).

1.12) $E^2 = (mc^2)^2 + E^2(v/c)^2$

1.13) $E^2 = (mc^2)^2 \; / \{1- (v/c)^2\}$

The result in (1.13) is that velocity can never exceed light speed in a physical system, no matter how much energy is applied. Momentum energy can be compared to mass energy by (1.7) and (1.13).

1.14) $(pc)^2 = (mc^2)^2 (v/c)^2 \; / \{1- (v/c)^2\}$

1.15) $p^2 = (mv)^2 / \{1- (v/c)^2\}$

This is the preferred representation of momentum (1.15) in a dynamic system where gravity is not strong enough to be considered. Notice from (1.14) that at high speed the momentum energy becomes greater than the mass energy. So far all of the results are conventional science of widely accepted physics. From (1.14) a simplification is made.

1.16) $(pc)^2 = (mc^2)^2 \; [v^2/ \{c^2- v^2\}]$

To make an energy balance from (1.6) and (1.8) it will be argued that mass energy decreases as momentum energy increases, also mass energy approaches zero near light speed. It requires a guess to be made for the missing fundamental equations to relate v and c. Arguments will be made that light speed must increase locally in a high energy region to make sense of the energy balances.

High Speed Effects On Physical Systems

A measure of speculation enters into the calculations, where a great many possibilities have been considered for the missing equations. A new equation for v and c is needed, but there is no such equation evident anywhere in science. Next best choice is to describe how an energy field interacts locally with the vacuum in hope of finding reasonable candidates for the missing equations. Heisenberg Uncertainty is the obvious starting place.

2.1) $\Delta E \, \Delta t \leq \hbar$

Planck law applies to each quantum interaction with the vacuum.

2.2) $E = h f$

It becomes necessary to express (2.1) in terms of frequency. A hint is taken from Niels Bohr [(1)] in a speech about Einstein and Heisenberg.

2.3) $\Delta t \sim 1/ \Delta f$

2.4) $\Delta E/\Delta f \leq \hbar$

A variable Planck's constant is implied from (2.2) and (2.3). A simplification is chosen for many quantum actions and a smallest possible change in Planck's constant.

2.5) $dE/df = \hbar$

This is rather far from being a new equation for v and c, but provides a path forward for developing the missing equation. Frequency must be related to light speed using any one of several metrics in General Relativity.

2.6) $c/c_o = f^2/f_o^2$

Integration of (2.5) using (2.6) give a relation of energy and light speed as previously shown in a modification of Polarizable vacuum theory.

2.7) $E^2/E_o^2 = (c^2/c_o^2)^{(1/4\pi)}$

Momentum is obtained from (1.9).

2.8) $p^2 = (1/(4\pi\text{-}1))(1 - (E^2/E_o^2)^{(1\text{-}4\pi)})(E_o^2/c_o^2)$

2.9) $(pc)^2 = (1/(4\pi\text{-}1))((E^2/E_o^2)^{(4\pi)}) - (E^2/E_o^2))\ E_o^2$

Velocity is related to light speed using (2.9) with (2.7) and (1.7).

2.10) $(c^2/c_o^2)^{(1/4\pi)}\ (v^2/c^2) = (1/(4\pi\text{-}1))((c^2/c_o^2) - (c^2/c_o^2)^{(1/4\pi)})$

2.11) $(v^2/c^2) = (1/(4\pi-1))((c^2/c_o^2)^{(1-1/4\pi)} - 1)$

2.12) $(c^2/c_o^2)^{(1-1/4\pi)} = 1+(4\pi-1) (v^2/c^2)$

This (2.11) is a proposal for the missing equation of v and c, derived from theoretical considerations and a hint from Niels Bohr.[(2)]

Now it is possible to predict mass energy at high speed using (1.13).

2.13) $(mc^2)^2/E^2 = 1- (1/(4\pi-1))((c^2/c_o^2)^{(1-1/4\pi)} - 1)$

The prediction is that mass energy approaches zero as v approaches c. All of the energy becomes momentum energy, in agreement with experiments that massless particles move at light speed.

Conclusions

In conclusion there is prediction for mass energy approaching zero at high speed, giving a favorable estimate of power required for Deep Space Transport. Implicit in this is a prediction that space energy reaches a maximum around a fast moving vehicle and cannot absorb more energy without opening a worm hole type structure.

There are other possible assumptions leading to other conclusions. In general many assumptions give results similar to this one. Many other assumptions give unsatisfactory results of energy and momentum reaching a maximum then decreasing to near zero as speed continues to increase.

Reference Notes

1) The reference to Niels Bohr is found in the 2010 Dover reprint ATOMIC PHYSICS AND HUMAN KNOWLEDGE, first published in 1961 by Science Editions in New York, shortly before Bohr died. The speech of 1949 was first published in 1949 in Contribution to ALBERT EINSTEIN: PHILOSOPHER SCIENTIST, Library of Living Philosophers, volume 7, starting on page 199. The quoted reference was to page 44 of the Dover edition for a relation of time interval to frequency interval.

2) Interpretation of the limit { $dE/df = \hbar$ } was not endorsed by Bohr, Einstein, Heisenberg, or Planck. It makes a reasonable extension of existing science, in a situation where a function something like this is needed to modify PV theory. It was used for the first time by this author in a companion article 9 November 2015.