Absolutes and Confusion or Absolute Confusion

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If absolutes are defined as quantities that remain constant independent of the dynamics due to the laws of nature then space and time may not be absolutes. The laws of nature, such as the thermodynamic laws, are differential equations that relate changes in space with changes in other variables. However, these laws require a limiting velocity that is independent of the force and prevents any force from accelerating something to velocities greater than this limiting velocity. This means that the natural laws require an absolute velocity and space and time are to be defined within this requirement. The special theory of relativity used arguments of synchronicity and light speed to specify how one must transform quantities from one coordinate system to another and uses these transforms to modify the laws to fit the transformations between inertial coordinate systems. The thermodynamic laws require that everyone see the same laws and the same absolute velocity thereby specifying the transformations between all coordinate systems regardless of any motion between the coordinate systems. The decades of writings and discussions concerning whether or not space or time are absolute and whether Einstein's constancy of light should hold, plus discussion of transformations have so confused the study of physics as to put the whole into a state of absolute confusion. This article hopes to present a way out of the confusion.

1. Introduction

Newton's equations of motion and his words entered into the discussion of the philosophy of space and time and whether either space or time might be absolute. Einstein introduced his special theory of relativity and argued that the constancy of the speed of light meant that in order to find the dynamics caused by some force that one needed to examine transformations to modify the Newtonian force laws to adhere to the constancy postulate.

On the other hand the laws of classical thermodynamics have been shown [1] to require an absolute velocity for pure mechanical systems just as it requires an absolute temperature for pure thermodynamic systems. This requires that everyone, even those moving with a variable velocity with respect to each other, see the same absolute velocity. This requirement determines a transformation between different observers.

The First Law of thermodynamics has been shown to be a generalization of Newtonian mechanics [1]. The First law is a differential equation in which time is not explicitly included. Time has been introduced into the differential equation in order to obtain Newton's equations of motion. It is important to notice how time is introduced with relation to the absolute velocity. This is because the laws require the absolute velocity so time and space must adapt to this requirement. Further, the requirement of an absolute velocity prevents the laws from requiring either time or space to be absolute.

The transformations introduced with the special theory of relativity initiated considerable discussion, and confusion, concerning inertial coordinate systems and whether one should use Einstein's transformations or the Lorentz transformations.

2. Derivation of Equations of Motion

There are numerous books and texts which develop the relativistic equations of motion so there is no need to develop them here. Details of the development of the equations of motion, mechanical entropy and the absolute velocity may be found in [1]. However, major aspects and the results are needed here so they will be briefly presented.

The First Law is the statement of conservation of energy as

$$đQ = dU - F_i dx^i \text{ where } i = 1.2.3...n \tag{1}$$

where Q represents any energy exchanged between the system and its surroundings, U represents the energy of the system, and the forces F_i must be functions of both position and the velocity.

Next we note that the mechanical entropy is given by

$$dS \geq \frac{đQ}{\phi(\overline{v})} = \frac{dU}{\phi(\overline{v})} - f_i(\overline{x})dx^i . \tag{2}$$

It should be noted that the requirement that the mechanical entropy to be a state function requires the form in Eq. (2) and that the function of velocity be

$$\phi(\overline{v}) = \sqrt{1-\beta_a^2} \text{ with } \beta_a^2 = \frac{\overline{v}\bullet\overline{v}}{{c_a}^2} . \tag{3}$$

where c_a is the absolute velocity to distinguish it from light speed.

An isolated system is one for which no energy is exchanged between the system and its surroundings so that

$$dS \geq 0 = \frac{dU}{\phi(\overline{v})} - f_i(\overline{x})dx^i . \tag{4}$$

For reversible processes the equality sign holds and there is no change in the mechanical entropy. For dS to be a total derivative the system energy U must be only a function of velocity. Then Eq. (4) requires that

$$\frac{dU}{dt} = \phi(\overline{v}) f_i(\overline{x}) \frac{dx^i}{dt} = \overline{F}\bullet\overline{v} . \tag{5}$$

It should be noted that the differential of the local time has been introduced in the denominator on both sides of the equation.

Since the system energy is only a function of velocity it has been shown that

$$U = \frac{m_o c_a^{\ 2}}{\phi(\bar{v})}. \tag{6}$$

Then Eq. (4) may be written as

$$\frac{m_o v_i a^i}{\phi^2(\bar{v})} = f_i(\bar{x}) v^i \tag{7}$$

Eq. (7) reduces to the three Newtonian equations of motion for velocities that are low with respect to the absolute velocity.

It is important to note that the speed of light has not yet entered into the development of the equations of motion from the first law. However, the absolute velocity plays a role similar to the role played by the speed of light in special relativity and this could be the source of much confusion. Also, potentially adding some confusion is the fact that herein there is no limitation on the velocity in the β_a factor. It may be variable; indeed it must vary if there is a force at work.

3. Moving Coordinate Systems

Moving coordinate systems is another place for potential confusion. In Einstein's relativistic theories transformations between moving coordinate systems have become the overriding consideration when approaching a new application. In the preceding section the velocity dependent force displays many aspects of Einstein's theory without involving any transformation. If the laws are to be the same for all coordinate systems then they should have the same form for all coordinate systems. This requirement means that all coordinate systems see the same absolute velocity.

Then consider a moving coordinate system such that

$$\begin{aligned} w_x &= \frac{dx'}{dt'} = \frac{A_1^1 v_x + A_4^1}{A_1^4 v_x + A_4^4} = v_x - W \\ w_y &= v_y \\ w_z &= v_z \end{aligned} \tag{8}$$

where in Eq. (8) the velocity is not required to be constant. This would be the case if one observer is stationary with respect to an event wherein a force is acting on an object using the laws of Section 2 above while a second observer is passing by while riding on by on a stage coach with horses that cannot maintain a constant velocity. Both observers are watching the same event and, given that the moving observer is collecting data instantaneously, only the velocity W will cause a difference in the equations of motion for the moving observer.

The requirement that both observers see the same limiting velocity requires that the transformation of Eqs. (8) be such that both observers see the force vanish at c_a. Then considering that

$$\bar{w}\bullet\bar{w} = (v_x - W)^2 + \frac{\bar{v}\bullet\bar{v} - (v_x)^2}{\left(A_1^4 v_x + A_4^4\right)^2}. \tag{9}$$

The laws require

$$c_a^{\ 2} = (v_x - W)^2 + \frac{c_a^{\ 2} - v_x^{\ 2}}{\left(A_1^4 v_x + A_4^4\right)^2} \Rightarrow \left(A_1^4 v_x + A_4^4\right) = \pm\sqrt{\frac{1 - \dfrac{v_x^{\ 2}}{c_a^{\ 2}}}{1 - \dfrac{w_x^{\ 2}}{c_a^{\ 2}}}}. \tag{10}$$

By using Eqs. (8), (9), and (10) it may be seen that the velocity transformation must be

$$\left.\begin{aligned} dx' &= \eta dx - W\eta dt \\ dy' &= dy \\ dz' &= dz \\ dt' &= \eta dt \end{aligned}\right\} \text{ with } \eta = \sqrt{\frac{1 - \dfrac{v_x^{\ 2}}{c_a^{\ 2}}}{1 - \dfrac{w_x^{\ 2}}{c_a^{\ 2}}}} \tag{11}$$

In Eqs. (11) the velocity of the event appears in the numerator while the velocity of the moving coordinate system appears in the denominator. It is, perhaps, easy now to see how confusion might arise because in relativistic theories only one velocity appears in the transformations.

4. Application (Sagnac Effect)

The Sagnac effect has been analyzed for decades with the result that for the stationary frame the time difference between the counter rotating light beams is given by

$$(\Delta t)_s = \frac{4\pi R^2 \omega}{c^2 - (\omega R)^2} \tag{12}$$

where R is the radius of the circular loop, ω is the angular rate of rotation and c is the speed of light [2]. There seems to be a considerable amount of disagreement with regards to any time dilation due to relativistic theory where the special theory of relativity is valid only in inertial frames of reference.

However, the transformation determined above that goes from the stationary coordinate system to the moving coordinate system has no restriction such as a constant velocity. Then considering the transformations given by Eqs. (11) may be generalized to

$$\left.\begin{aligned} dx' &= \eta\left(dx - W_x dt\right) \\ dy' &= \eta\left(dy - W_y dt\right) \\ dz' &= \eta\left(dz - W_z dt\right) \\ dt' &= \eta dt \end{aligned}\right\} \text{ with } \eta = \sqrt{\frac{1 - \dfrac{\bar{v}\bullet\bar{v}}{c_a^{\ 2}}}{1 - \dfrac{\bar{w}\bullet\bar{w}}{c_a^{\ 2}}}} \tag{13}$$

the time difference of Eq. (12) transforms to the time difference

$$(\Delta t)_m = \frac{4\pi R^2 \omega}{\left[c^2 - (\omega R)^2\right]\sqrt{\dfrac{1 - \dfrac{\bar{v}\bullet\bar{v}}{c_a^{\ 2}}}{1 - \dfrac{\bar{w}\bullet\bar{w}}{c_a^{\ 2}}}}}. \tag{14}$$

However, for this application $\bar{v}\bullet\bar{v} = 0$ and $\bar{w}\bullet\bar{w} = \omega^2 R^2$ so that the time difference in the moving coordinate system would be given by

$$(\Delta t)_m = \frac{4\pi R^2 \omega \sqrt{1 - \dfrac{(\omega R)^2}{c_a^{\ 2}}}}{c^2\left[1 - \dfrac{(\omega R)^2}{c^2}\right]}. \tag{15}$$

If the speed of light is shown to be identical to the absolute velocity then the time difference of Eq. (15) becomes the one argued for even given the inertial frame violation in special relativity. A review of the Sagnac effect in 1967 concluded that the experiments available then were not sufficiently accurate to be able to discern the difference between the various suggested time differences for the moving frame [2].

There is no intention herein to discuss various interpretations of the constancy of the speed of light. It is only noted that if the speed of light were to be considered equal to the absolute velocity and that both coordinate systems have physics requiring them to agree on the absolute velocity, then Eq. (15) reduces to the currently used expression.

5. Moving Coordinate Systems (delayed data collection)

Stellar aberration is a phenomenon that depends upon the transverse velocity of the observer to the direction of the observed object. Stellar aberration does not depend upon either the distance to the observed object or the object's velocity, but is a situation where the event is observed by light traveling from the event to the moving observation point with a finite velocity.

For stellar aberration the angle of the aberration depends upon the speed of light near the moving observation point. Let this speed be denoted as c. Then, in the moving coordinate system where the light from the distant star is collected, the aberration angle is found to be

$$\cot\alpha' = \eta\left(\cot\alpha - \frac{w_y}{c}\csc\alpha\right). \tag{16}$$

The star is considered to be standing still so $\bar{v}\bullet\bar{v} = 0$ while $\bar{w}\bullet\bar{w} = w_y^2$ so that Eq. (16) becomes

$$\cot\alpha' = \frac{\cot\alpha - \frac{w_y}{c}\csc\alpha}{\sqrt{1 - w_y^2 / c_a^2}} \tag{17}$$

Here too, if the speed of light is identical to the absolute velocity the prediction of Eq. (17) is a generalization of the prediction of the special theory of relativity. When w_y is a constant then the prediction becomes the same as the prediction of the special theory of relativity.

Another type of delayed data collection system is one that sends a light beam from the point of data collection to the event and then the observation is taken from the reflected light coming back from the event. In this case there is a delay in both directions. This is the type of data collection that is used in the Michelson-Morley experiment. When the η of Eq. (13) is used with $\bar{v} = 0$ a null result is obtained.

6. Comparing Theories

Einstein's special theory of relativity and the classical laws of thermodynamics both predict a deviation from Newtonian dynamics when the velocities approach the speed of light. They differ in how they predict this deviation. Special relativity uses arguments based upon the constancy of the speed of light in inertial coordinate systems. Thermodynamic laws require an absolute velocity for all coordinate systems and produce a more general result in that its equations of motion applies to all observers regardless of the velocity or acceleration between the coordinate systems.

An experimental way of distinguishing between Einstein's special theory of relativity and the thermodynamic laws would be to find an event with non-zero velocity that may be observed from a moving coordinate system so that the velocity factor, η, in Eq. (13) has a non-zero velocity in both the numerator and the denominator. The relativity velocity factor has no velocity in the numerator and, therefore, such an experiment should see a difference in the velocity factors of the two approaches.

One such possible experiment might be the binary stars. At least observing binary stars should provide a velocity for the numerator due to the velocity of the stars about each other while the motion of the Earth would provide a velocity for the denominator. The problem may be that either or both of these velocities are too small for the data to show a difference.

7. Conclusion

This article is intended to point out that if an absolute is defined as something that is constant and the same for every observer as required by the fundamental laws then the only absolute that is required by the classical laws of thermodynamics is absolute velocity. Space and time may be seen to be different by different observers who are moving with respect to each other, yet all must see the same absolute velocity.

Other conclusions that may be reached from the above include:

1. The absolute velocity required of the First and Second laws establish an absolute, or limiting, velocity for all forces.
2. The limiting velocity causes a time dependent force that appears to be the modified Newtonian forces that Einstein used in his special theory of relativity.
3. However, these velocity dependent forces do not come from any consideration of relative motion and, therefore, should not be considered as relativistic forces.
4. There is no mass increase as velocity increases.
5. There is no time dilation due to the limiting velocity.
6. The inclusion of the velocity limiting factor, $\sqrt{1-\beta_a{}^2}$, is strictly the factor that determines the velocity dependence of the force as required by the Second law and has no relativistic origin though its similarity to the relativistic factor may be confusing.
7. If all observers are to have the same physical laws they must see the same absolute velocity.
8. The velocity transformations of Eqs. (11) or (13) are the transformations to use when there is a velocity difference, constant or variable, between observers.
9. The fact that both observers must see the same limiting velocity requires that their time differentials be related by the ratio of their velocity limiting factors, or η. However, this does not cause a contraction of space.
10. The ratio of limiting velocity factors adds another point of potential confusion as the form of this ratio may be confused with relativistic functions.
11. None of these limiting velocity factors depend upon the speed of light in any way. They all depend upon the absolute velocity.

References

[1] P. E. Williams, "Mechanical Entropy and Its Implications", *Entropy* **3**: 76-115 (2001), http://www.mdpi.org/entropy/list01.htm#new.

[2] E. J. Post, "Sagnac Effect", *Reviews of Modern Physics* **39** (2): 479-493 (1967).