

Light Has No Speed by David M. Fahrner

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Abstract: The concept of speed or velocity do not apply to light. Our primary and fundamental means of awareness (including all measurement) is mediated by light or electromagnetism, so any attempts to measure light speed is an invalid attempt to measure that on which measurement depends, a violation of the hierarchical relation between light and measurement.

It is clear from reading the history of physics that one of the fundamentals of physics is the nature and role of light in the development of physics. Starting with Newton, light was held to be infinite or at least irrelevant to the measurement of everyday objects and phenomenon. The physicists at the time believed that light was infinitely “fast” or was unmeasurable. With the work of Danish astronomer Roemer it was found that the speed of light could be inferred from the observations of the orbit of IO, a moon of Jupiter, as observed from Earth. Further developments continued with Faraday’s study of the induction of magnetism via moving electric charges culminating in Maxwell’s equations for electromagnetism which included light. One result of Maxwell’s equations was that the constancy of the speed of light c was derivable from measurements of the permittivity and permeability of free space. Einstein furthered this development by accepting the constancy of light speed in all reference frames as a postulate of his relativity theory and revise our concepts of space and time to be consistent with that postulate. [1]

In this essay I will make the conceptual argument [2] that the concept of velocity or speed cannot apply to light and that any attempts to measure it or assign a constant to it commits a form of circular reasoning. Our primary and fundamental means of awareness (including all measurement) is mediated by light or electromagnetism, so any attempts to measure light speed is an invalid attempt to measure that on which measurement depends, a violation of the hierarchical relation between light and measurement. My analysis will show that due to its special and fundamental role in all measurement, a proper and general theory of physics must hold that light is not metaphysically infinite but epistemologically infinite.

Before we look to the meaning of an advance concept such as velocity it is critical to consider the facts and observations that give rise to this concept. The facts being subsumed by the concept of velocity are related to the more general and omnipresent fact of motions in our field of awareness. As an observer we see many things in our field of view that are in motion relative to us. Moreover, at this level it is easy to see that the motion of the observer has similar effects in changing the position of objects relative to us.[3] This symmetry of motion is what is conceptualized by the principle of relativity of all motion. As an observer we see cars, birds, planes and other people in motion about us. These observations are the basic facts subsumed by the concepts of motion and ultimately velocity. From this analysis we can see that there are some essential elements to motion. The phenomenon always includes an observer and an entity (or entities) outside of and distinguishable from the observer. These observed entities have a position relative to the observer and motion is the observation that relative positions change over time. The concept of velocity builds on these observations but makes the relations formal and measureable through the introduction of a reference frame and a clock and the use of Newton’s calculus of change.

The concept of velocity is therefore dependent on an observer, a distinguishable entity being observed, their relative position and a change in that relative position. Note that all these dependencies are themselves dependent on our means of awareness which is mediated by light or electromagnetism. Without light there is nothing to observe, no entities to see and no relative positions or change in relative positions to measure. [4] Since all observations and measurement presuppose light as a means of measurement it is invalid to measure the means, i.e. that on which measurement depends. It is a form of circular reasoning to apply the concept of velocity to light. [5]

It is in this sense that I claim that light has no speed or velocity, or more correctly, the concepts do not apply. It is epistemologically invalid to apply measurement concepts such as velocity to that which makes measurement possible. How to deal with light in the equations of physics is an open question but I believe that ultimately light must be treated, not as metaphysically infinite, but as epistemologically infinite. The concept of infinity does not mean a large quantity or amount but in the sense of unspecified or unspecifiable quantity, i.e. indefinite.

Since the concept of velocity presupposes an entity to observe and measure, when we apply the concept of velocity to any phenomenon we imply a measurable entity that is moving relative to an observer. The predominant types of motion to which the concept of velocity can be applied are particle motion and wave motion. (Wave motion is the coordinated action of an ensemble of entities). By applying the concept of velocity to light we are implicitly assuming the presence of particles or waves. The math is agnostic regarding the valid or invalid application of a concept and will manifest one or the other depending on the circumstances of the measurement or experimental context. In other words, the misuse of the concept of velocity to conceptualize the properties of light results in the wave/particle duality of light in quantum mechanics. The math is just being consistent with the meaning of the concept and depending on the circumstance of the experiment or observation, we will “see” particles or waves.[6]

Another implication of the misuse of the concept of velocity is in our understanding of clocks and time.[7] Clocks measure time by the comparison of velocities to be measured against a known velocity that serves as a standard. Originally the speed of the earth around the sun was the universal standard but has since been superseded by more accurate standards of oscillating atoms in atomic clocks.[8] But the basic relation still holds, at root time is a comparison of velocities. In Einstein’s development of relativity he used the speed of light as his clock standard as expressed in the light clock. The ratio of v/c is a basic clock measurement and was used in his relativity theory to reconcile the constancy of the speed of light in all frames with the measurement of space and time. Relativity theory modifies Newton’s theory using Lorentz’s gamma factor. However, if the concept of velocity does not apply to light then it is invalid to use c as a clock standard. The quantities are incommensurate and is tantamount to trying to measure length in units of kilograms. This error is probably one of the major sources of paradoxes in modern physics.

This new conceptual approach explains some of the mysteries of modern physics such as the wave/particle duality of light and length contraction and time dilation in special relativity and warping of space-time in general relativity. This is not a repudiation of Einstein’s theories, no more than Einstein’s theories were a repudiation of Newton’s theories. It represents a different conceptual approach that may have wider application or generality. If one accepts that the concept of velocity applies to light then Einstein’s theories and all of modern physics follows from that assumption. The theory and the math are consistent (and useful) given the assumptions. However, with the existence of organizations such as FXQI or the Perimeter Institute it is clear that these theories have gone as far as they can go and physicists are looking for a new way forward. Today modern physicists press on with more advanced and complex math to try and reconcile quantum mechanics with general relativity with no end in sight. Einstein was moved by as subtle inconsistency between Maxwell’s equations and Newton’s equations to revise our concepts of space and time. He then found the math to express these new concepts. We should follow Einstein’s lead and look for ways to clarify and revise our basic concepts then use math to express them. Math in and of itself cannot fix conceptual errors as our concepts are more fundamental than the math.

Notes and References:

[1] In this essay I am questioning the validity of applying the concept of speed or velocity to light. To be consistent to the theme of the essay I should not be using the term “speed of light” or its variants. As a technical matter, I should use scare quotes when referring to the “speed” of light. However this usage would quickly become tiresome and awkward and detract from the ideas I am groping with and trying to express without the benefit of a fully developed theory. I hope the reader can forgive me for this transgression. In the appropriate context, I often think of “space-dependent time-lag” instead of “speed” as that formulation does not explicitly imply speed.

[2] In my view, the basic concepts and the meaning of these concepts are more fundamental than the math and need to be fully and consistently defined and applied before expression in mathematical form.

[3] To keep things simple, in developing these basic concepts I will ignore observer motion. Because of the symmetry of the relativity of velocity, once the basic concepts are defined the inclusion of observer motion is a later factor that can be added to the theory.

[4] In the primary sense, entity must mean “ponderable matter” to use Einstein’s term (cf. Sidelights on Relativity: Ether and the Theory of Relativity, an address delivered on May 5th, 1920 in the University of Leyden). However, we can infer the existence of non directly-observable entities such as atoms and molecules and include these in the concept of velocity, as long as our methods are able to distinguish their unity and existence apart from an observer. Einstein’s work on Brownian motion is one example of this method.

[5] If it is true that light is involved in all acts of observation and measurement then in principle its speed is unmeasurable. The fact that Maxwell’s equations result in a calculation for the speed of light c from other measurements implies that somewhere in the system of equations or in the measurements of the constants used in the equations it is assumed that a dt or dl due to light speed is small enough to ignore. If this assumption is removed and all terms or factors involving light are carried through the derivation and in measuring the constants then c should cancel out in the equations. Light is special in this regard. Since c does not cancel out in Maxwell’s equations (and by assumption cannot in Einstein’s equations) it implies the dropping of at least one term or factor involving c . Mathematically demonstrating this case would be clear evidence for my claims. Unfortunately, such a mathematical demonstration would have to be done by someone with far more patience and mathematical skills than I possess.

[6] I limit my discussion to the motions of particles or ensembles of particles in wave motion. However, as shown by Boltzman there is a third type of motion we perceive as the entropic perceptions of temperature and pressure. These are the random motion of atoms in a gas that have specific velocities but we can not directly perceive these properties, only the aggregate effects of innumerable particles in their maximum probability states, with the particles inferred.

[7] In its simplest form, time is the comparison or measurement of a unknown velocity to a clock with a standard velocity. (This is similar to the basic method of measuring length in comparing an unknown length to a standard unit of length). The results of time measurement can be carried through the equations as a duration, as is the common case. But time can also be expressed as a length such as the length of the orbit of the earth around the sun equal to one year if the earth/sun system is the standard clock.

[8] An important fact about time is that clocks used to measure time must be based on accelerated motion (as the standard velocity) and thus non-inertial. Typically time was measured using the orbit of the earth around the sun which is accelerated elliptical motion or the oscillation of atoms in an atomic clock. Clocks are inherently non-inertial because the clock must remain in the frame of the observer. An inertial or linear clock would be impractical because it would quickly leave the frame of the observer and could no longer serve its function as a local velocity standard. Because clocks are local to an observer the assumption is often made that the speed of light can be ignored in using the clock to measure other velocities and thus has implications for the issues raised in note [5].