The Velocity of Light

The apparent distance travelled and time taken by light from its source to an observer differ according to whether we look at it from the point of view of the source or that of the observer.

Basis For The Velocity of Light

The velocity of light in free space is usually represented by the letter **c**. It is understood to be an invariant quantity. In other words it is a natural constant, which is built into the fundamental fabric of the universe. Why should the velocity of light have this fixed finite value? Why shouldn't the velocity of light be infinite? It is because light is an electromagnetic disturbance, and space has a natural *reluctance* to being electromagnetically disturbed.

Consequently, when an electric field is applied at a particular place, the immediate space around it takes time to polarize. It has a kind of electrical inertia that impedes the electric field's effort to polarize it. The surrounding space lags more and more behind in adopting a polarized state the further it is from the place where the electric field is applied. The adoption of this polarized state therefore "travels" outwards spherically from the place where the electric field is applied. Due to the natural quantitative value of space's reluctance to polarize, the velocity of this "travel" (or propagation) is **c**, the velocity of light.

Suppose the applied electric field starts off with zero strength. In other words, it doesn't exist yet. Then it starts to grow. It grows slowly at first. Then its *rate of growth* gradually increases to a maximum. Its *rate of growth* then reduces, becoming zero again as the strength of the field reaches its maximum. Then the field starts to decay (reduce). Its *rate of decay* is slow at first, speeds up and then decays back to zero as the strength of the electric field reaches zero again. This process forms an electric field pulse.

A complementary property of space is that the *rate of change* of an electric field becomes manifested as the strength of what is generally known as a magnetic field. Space does not polarize magnetically. It doesn't have "ends" or *poles*. Rather, it adopts something that is perhaps better conceptualized as a kind of fundamental *rotational* inertia. This results in a situation where, as the electric field is growing or collapsing, the associated magnetic field is at its strongest. Conversely, as the magnetic field is changing (growing or collapsing), the electric field is at its strongest.

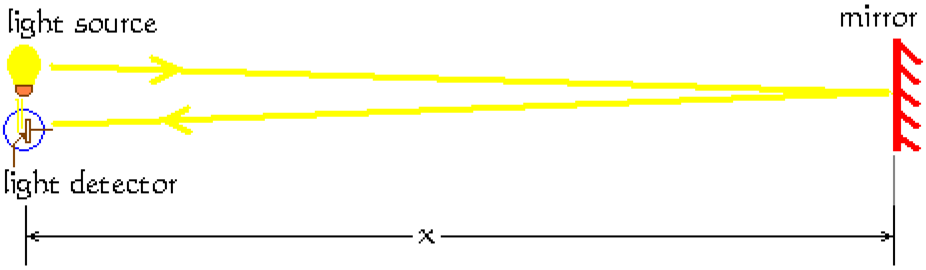
The result is that the electric and magnetic fields exchange energy repeatedly rather like the bob of a pendulum continually exchanges its potential energy (due to its height) with its kinetic energy (due to its speed). The result is that these two types of "force fields" fall away from their source as an ever-expanding sphere, playing a game of "throw and catch" with their energy. This energy becomes evermore thinly spread over the area of an ever-expanding spherical surface. The frequency with which the electric and magnetic fields exchange energy is the frequency of the electromagnetic disturbance.

The important thing to note from this rather over-simplistic description of electromagnetic propagation in free space is that the effective electromagnetic wave propagates spherically at this fundamental velocity **c** away from ***its source***.

Notwithstanding, an observer has no way of sensing the *approach* of a light-pulse. He has no way of sensing *when* it left its source. He has no way of sensing *how far* it has travelled. He has no way of sensing how much time it took to reach him. He therefore has no way of sensing *how fast* it is travelling towards him. He can only sense it when it eventually "hits" him. Even then, he has no way to sense its *velocity of impact*.

A Two-Way Trip is Necessary

To acquire some idea of how "fast" light travels, he must use the principle of radar. He must set up a source of light that he can control. He must have a stop-clock to measure time. He must have a distant object (ideally a mirror) that can reflect the light emitted by his source. He must have a means of detecting the light reflected from the distant object. He can use his eyes, of course. However, an electronic detector will help him to make a more accurate measurement. He must know accurately the distance **x** that the distant object is from him. His light-source must be wired so that it automatically starts his clock when it emits a pulse of light. His light-detector must be wired so that it stops the clock immediately it detects the arrival of the light-pulse reflected from the distant object.



The observer triggers his light-source to emit a short pulse of light. At the same time, the light-source starts the clock. The light-pulse travels to the distant object (mirror). The mirror then reflects the light pulse back towards the observer. The observer's light detector detects the arrival of the returning light-pulse and immediately stops the clock. The clock reveals the amount of time **t** the light-pulse took to travel the distance **2x** to the distant object and back again. The velocity of light is thus revealed as **c = 2x/t**.

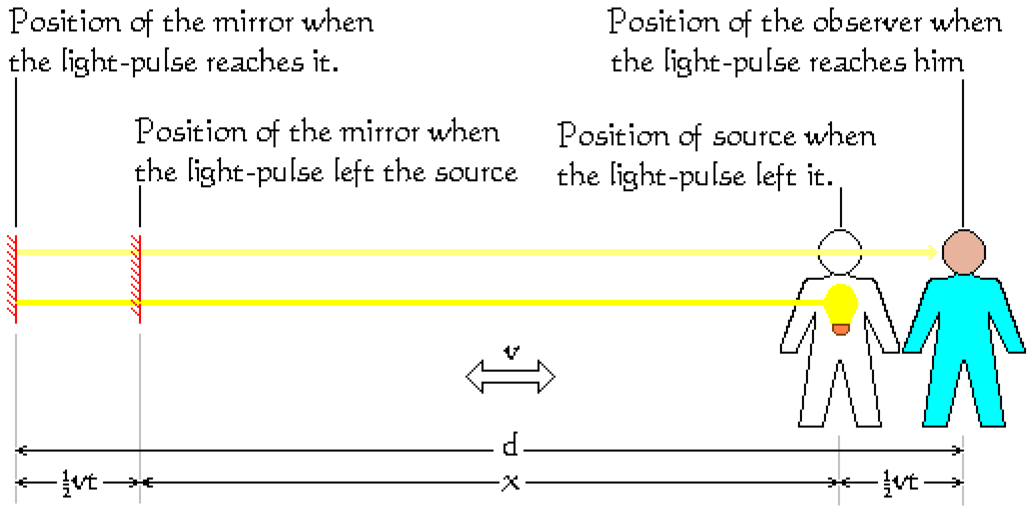
This is simply an illustrative experiment. Nowadays, much more refined techniques and apparatus are used to provide more accurate measurements of the velocity of light.

Frames of Reference

I proposed in my previous article that the frame of reference relative to which light travels at its universal velocity **c** be exclusively that of its source. So what happens in this case when light is reflected back to the original source? In whose frame of reference is the light travelling at the universal velocity **c**? Isn't it that of the observer who was the original source? What would be the case if the distant object (the mirror) were moving away from the source/observer at a velocity **v** that was a significant fraction of the velocity of light?

Let me suggest the following. When light is reflected from an object such as a mirror, the process is not the same as that of a ball bouncing off a wall. The original light is not reflected back. Instead, the original light is absorbed by the atoms of the material of which the mirror is made. These atoms then use that energy to generate new light. In other words, a mirror is itself a separate light-source that is "powered" by the energy from the incident light. This is consistent with the observation that an object rarely reflects the same colour of light that it receives. It radiates a colour that is charactistic of the material of which it is made.

If this be the case, then the outbound light pulse is travelling at velocity **c** with respect to the source/observer frame of reference and the return light-pulse is travelling at velocity **c** with respect to the distant object's (the mirror's) frame of reference. This situation is illustrated below.



When the light-pulse is emitted by the source, the mirror is at a distance **x**. The light-pulse travels towards the mirror. It travels at velocity **c** relative to the frame of reference of the source. By the time the light-pulse reaches the mirror, the mirror has travelled a further distance **½vt** away from the source. The total distance travelled by the light on the outbound journey is therefore **x + ½vt**. The mirror absorbs the energy of the light-pulse. It uses this energy to generate another light-pulse. This new light-pulse travels in the direction of the observer. It does so at velocity **c** relative to the frame of reference of the mirror. By the time the new light-pulse reaches the observer, the observer has travelled yet a further distance of **½vt** away from the mirror. The returning light-pulse therefore travels a distance **x + vt**. The total distance travelled by the outbound and return light-pulses is therefore **2x + 1·5vt**. The distance **x** is therefore given by **x = ½(c - 1·5v)t**.

When the returning light-pulse reaches the observer, it will appear to him to have originated from where the mirror is at that instant. The mirror will appear to be at a distance **d** given by the formula

d = x + vt = ½(c - 1·5v)t + vt = (½c + ¼v)t.

where **t** is the amount of time that has elapsed since the observer's light-source emitted the original outbound light-pulse and **v** is the relative velocity at which the observer and the mirror are receding from each other. This reasoning requires that the "velocity" with which wave-crests approach the receding observer is necessarily **c - v**, and for an approaching observer, **c + v**. However, this does not mean that anything is materially travelling faster than light. Nor does it mean that information is travelling faster than light.

Again, although this double source-centred view appears to work, it is not - as mentioned in the previous essay - consistent with any view of gravitational phenomena. Notwithstanding, if the observer-centred Ætherial View is applied to the above thought experiment, the mathematical reasoning is essentially the same. And it is consistent with a means of explaining gravity.
