Pulsars and Special Relativity

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***Abstract**: The mistaken belief held by countless mathematicians that light always arrives at c for all observers can be easily demonstrated to be totally false by observing pulsars at different times of the year. Where v is the speed of an observer on earth, light from pulsars will arrive at c+v when the earth is moving toward the pulsar and at c-v when the earth is moving away from the pulsar.*

Key words: Light; pulsar; second postulate; Einstein.

I. The Problem

In my paper about *Radar Guns and Einstein's Theories*[1] I tried to eliminate some of the confusion over Einstein's Second Postulate. Further research indicates that there are four groups of people with four different views regarding that postulate. The first group (to which I belong) sees the Second Postulate just as Einstein wrote it, which when translated into English says:

> light is always propagated in empty space with a definite velocity *c* which is independent of the state of motion of the emitting body[2]

In other words, regardless of how fast an **emitter** might be traveling, an emitter always emits light at speed *c*, never at *c+v* or *c-v*, where *v* is the speed of the emitter. That Second Postulate clearly says ***nothing*** about what an outside observer might observe.

The view held by the second group is that Einstein didn't ***mean*** what he wrote, since they believe it disagrees with Einstein's *First* Postulate. They claim with evangelistic certainty that Einstein ***meant*** to say what many textbooks now say:

> "The speed of light in a vacuum has the same value, c = 2.997 924 58 x 10^8 m/s, in all inertial reference frames, **regardless of the velocity of the observer or the velocity of the source emitting the light**."[3]

"Second Postulate: The speed of light is a constant and will be **the same for all observers** independent of their motion relative to the light source."[4]

"The unusual properties of the velocity of light are: **It is a constant for all observers, irrespective of how they are moving**. It is a universal speed limit, which no material object can exceed. It is independent of the velocity of its source and that of the observer**.**"[5]

"Light and all other forms of electromagnetic radiation are propagated in empty space with **a constant velocity c which is independent of the motion of the observer or the emitting body**."[6]

"Postulate 2: The speed of light in free space has **the same value for all observers, regardless of their state of motion**.[7]

The speed of light in vacuum has the same value, c = 3.00 x 10^8 m/s, in all inertial frames, **regardless of the velocity of the observer or the velocity of the source emitting the light.**[8]

The view held by the third group is that Einstein wrote what the textbooks say he wrote. Members of this group evidently never bother to compare what Einstein wrote to what the textbooks contain. They simply accepted what they were taught via their teachers and their textbooks. And they laugh at the very idea that all the textbooks could be wrong.

The view held by the fourth group is that Einstein was ***wrong*** when he claimed that the speed of light is a constant and will be the same for all observers independent of their motion relative to the light source. People in this group also never compared what Einstein wrote to what college textbooks claim he wrote. They just accepted that he wrote what the textbooks say he wrote, and they argue that it cannot be right because it doesn't agree with what they see happening in the world. Sometimes it is because they have their own theory and believe in the aether, sometimes it is because they cannot accept that an outside observer will see light arriving at *c* even if the observer is moving toward the source of the light at a high velocity. It disagrees with observations and experiments, so it must be wrong, and therefore Einstein was wrong.

In summary, the problem is that what many (or most) colleges teach about Einstein's Postulates and his Theory of Special Relativity is **wrong**. And **it can be easily proven to be wrong**.

II. Relative Motion

Central to the beliefs of the mathematicians who created the problem is their absurd belief that "all motion is relative." That belief declares that an emitter cannot measure speeds differently from an observer. If the emitter emits light toward an observer at *c*, the observer **must** see the light arrive at *c*, otherwise either the emitter or the observer becomes a "preferred" frame of reference. One observer becomes more "right" than the other. In the beliefs of mathematicians, there ***<u>can be no "preferred frame of reference."</u>*** They claim Einstein confirmed that by disproving the existence of an aether, which for centuries mathematicians and scientists had used as a "preferred frame of reference" from which all motion was measured.

In reality, what Einstein did was explain how the purely imaginary aether (whose existence no one had ever been able to confirm in spite of many attempts) was "superfluous," since **there is a maximum speed for light**, and that maximum speed can be used in place of the aether. All motion in the universe can be measured as being relative to the maximum speed of light, i.e., 299,792,458 meters per second at a point where a second has its maximum duration. And if you are not in a location where a second has its maximum duration, you can use the speed of light per local second, since the differences are very small. And, since nothing except electromagnetic energy, such as light, can travel at the speed of light, there can be no "relative motion." You cannot argue that you are moving at 0.0001% of the speed of light and light is moving at 0.0001% of your speed.

Mathematicians, it appears, cannot accept that, since they require all motion to be relative to some **physical** object. As they see it, if I am moving away from you, you are also moving away from me. The fact that I am sitting down and you are clearly walking has no relevance, since, as they see it in the greater scheme of things, even if I am sitting down, I might be moving faster than you if you are moving against the spin of the earth. I am moving at 750 mph as the earth spins on its axis, and you are moving at 747 mph, because you are walking at 3 mph toward the west, against the spin of the earth on its axis. The mathematicians argue that, with no "preferred frame of reference," no one can say that one speed is "preferred" over the other.

According to Einstein's theories, however, the speed of light is a "preferred frame of reference," and all speeds can be measured relative to the local speed of light. That means that light will always travel at local c away from the emitter, but observers who are not stationary relative to the emitter will see that light arriving at $c+v$ or $c-v$ where v is the speed of the observer toward or away from the emitter.

That means that every college textbook (or any other book or paper) which claims that Einstein's Second Postulate says anything like "The speed of light is a constant and will be the same for all observers independent of their motion relative to the light source" is not only absurdly wrong but can be demonstrated to be wrong by experiment.

III. Measuring the Speed of Light

Unfortunately, no one has yet devised a good way to measure the **one way** speed of light, so you cannot simply point a measuring device at some distant light source and measure the speed of the light coming from that source.

However, if the oncoming light involves **pulses** that were emitted at regular intervals, the duration of the intervals between pulses will change if the observer is moving toward or away from the source of the light. The pulses will arrive more frequently if the observer is moving toward the emitter and less frequently if the observer is moving away from the emitter. That doesn't provide the speed of the light, but it verifies that the observer is encountering the light photons at *c+v* or *c-v*, depending upon which direction the observer (*v*) is moving.

This was confirmed in 2010 by bouncing laser light pulses off of a mirror on the moon. When the spin of the earth was moving the observer toward the mirror on the moon, the intervals between pulses from the mirror were shorter than what was emitted toward the mirror. Unfortunately, the experimenter in that situation did not believe his own results,[9] so, no one else felt obligated to accept the experimental results, either.

However, Nature has provided the perfect demonstration of how electromagnetic energy pulses (such as light) change their duration depending upon the motion of the observer.

IV. Pulsars

"Pulsars are rapidly-rotating neutron stars; the collapsed cores of supergiant stars that have exploded as supernovae. They are exceedingly dense, weighing more than our Sun, but the size of a city. They are highly magnetised. As the star spins, radio waves emerge as a beam above the magnetic poles. Sometimes these beams will sweep across the Earth's position in space and we see regular pulses of energy, much like the flashes from a lighthouse."[10]

"The first pulsar was discovered in 1967 by Jocelyn Bell Burnell and Antony Hewis, and it surprised the scientific community by the regular radio emissions it transmitted. They detected a mysterious radio emission coming from a fixed point in the sky that peaked every 1.33 seconds. These emissions were so regular that some astronomers thought it might be evidence of communications from an intelligent civilization."[11]

Over 1,000 pulsars have been discovered so far, but the ones that are most useful for our purposes are the ones that rotate the fastest, and thus provide the shortest intervals between pulses. The fastest known pulsar rotates 642 times per second.[12]

The earth spins on its axis at the rate of 1,040 miles per hour when measured at the equator (about 750 mph when measured in the United States). In theory, that means that at around sunset, The Green Bank radio telescope in West Virginia can count the pulses from a pulsar while the telescope on the spinning earth is moving toward the pulsar at about 750 mph, and 12 hours later, at around sunrise, it can measure the pulses from that same pulsar as the telescope moves away from the pulsar at about 750 mph.

The earth also orbits the Sun once per year, traveling at about 67,000 miles per hour. That means that for purposes of this paper, as shown in Figure 1 below, at some point in the year, say in June, that same Green Bank radio telescope can measure the pulses from the same pulsar while the orbiting earth is moving toward the pulsar at 67,000 mph, and six months later, in December, it can measure the pulses from that same pulsar while the earth is moving away from the pulsar at 67,000 mph.

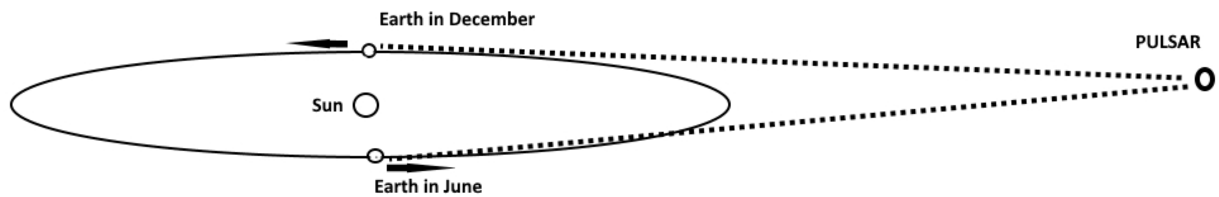

Figure 1

The pulses travel through space at the speed of light with the same amount of time between each pulse, but when they arrive at the radio telescope observatory, astronomers on earth can easily measure the *c+v* arrival rates and the *c-v* arrival rates.

Unfortunately, it is extremely difficult to find the differing arrival rates being reported by professional astronomers. The vast majority of papers in which astronomers measure pulses from pulsars, they measure the pulses being **emitted**, not received. They go through elaborate mathematical calculations to ignore the rotation of the earth's observatories around the sun, and they do their computations as if they were measuring the pulses from the center of the solar system's mass (i.e., its barycenter). They also seek out "binary pulsars," where a pulsar is orbiting another body. Thus they can compute the difference in pulse rates from **a moving emitter** and can demonstrate that a moving pulsar produces a Doppler Shift in frequencies just like a moving train. A train blows its horn at a constant frequency (and the vibrations travel at the speed of sound), but the sound vibrations are heard to be of a higher frequency if the train it moving toward the observer, and the vibrations are heard to be of a lower frequency if the train is moving away from the observer. Similarly, as is shown in Figure 2 below, the pulsar emits radio pulses at a constant rate (and at the speed of light), but the pulses will be measured to arrive at a higher frequency if the pulsar is moving toward the observer, and the pulses will be measured to arrive at a lower frequency if the pulsar is moving away from the observer.

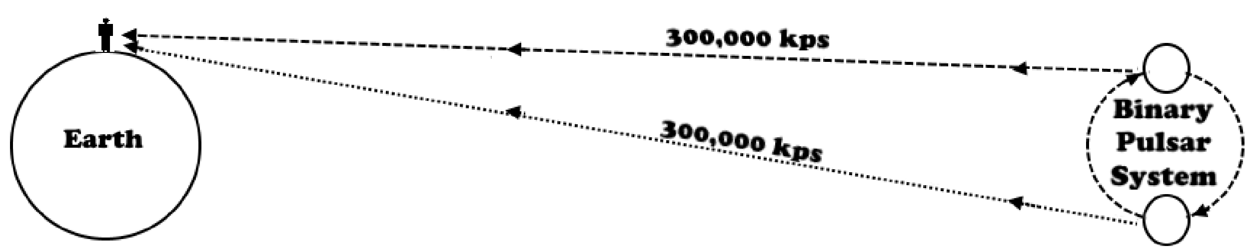

Figure 2

This practice of measuring pulsar pulse rates from the center of the solar system indirectly confirms that light arrives at *c+v* and *c-v* rates at earth observatories, since, if the speed of light was the same for all observers, thus making the pulsar pulse rate the same for all observers, there would be no need to convert everything to barycenter counts. You'd get the same rate regardless of where you were in earth's orbit around the sun.

After a great deal of searching, I found one relevant article written by professional astronomers working at the Nançay decimetric radio telescope (Le radiotélescope décimétrique de Nançay (NRT), which is part of the Nançay Radio Observatory, located in Nançay, two hours' drive south of Paris, France.[13] The article contains this graph:

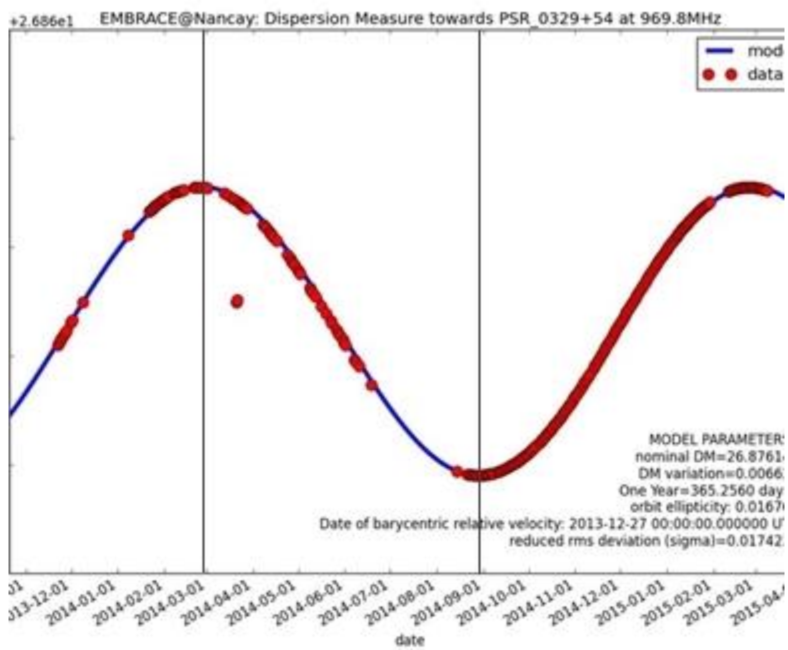

Figure 3

The caption for the graph says, "The Dispersion Measure [DM] towards Pulsar B0329+54 was measured each day since November 2013. The annual variation of DM is consistent with what is expected by the Doppler Effect due to the movement of the Earth in orbit around the Sun." (Note: "Dispersion Measure" is about the **emitted** frequency of the pulses, which, as stated above, can change if the pulsar is moving toward or away from the observer. The light travels at *c*, but the **pulses** will be closer together if they are emitted in the direction the pulsar is moving. The graph shows little movement by the pulsar.)

I added the two vertical lines to the graph make it more clear that the highest frequency of **received** pulses occurred around March 1, 2014 (repeating around March 1, 2015), and the lowest frequency of pulses occurred around September 1, 2014, a separation of six months.

The text accompanying the graph says,

> The movement of the Earth due to its orbit around the Sun introduces a Doppler Effect which modifies the signal frequency measured at the telescope compared to its value in the ISM [Inter-Stellar Medium]. The delay between reception of the high and low frequencies is also subject to the Doppler Effect due to the Earth's motion. The Earth is "catching up" or "moving away" from the signal, and so the time between reception of the high and low frequencies is reduced or delayed. The value of the Dispersion Measure varies throughout the year due to the Earth's orbit around the Sun as a function of the projected velocity onto the line of site to the pulsar.

Amateur astronomers, fortunately, do not seem to have any problem with measuring pulse arrival rates at different times of the year or day. It probably saves them the time and effort that would be required to make the barycentric and topocentric conversions. An amateur astronomer in Hawkesbury, NSW, Australia [14] even plotted the daily ("Diurnal") frequency changes of a pulsar that were caused by the earth spinning on its axis.

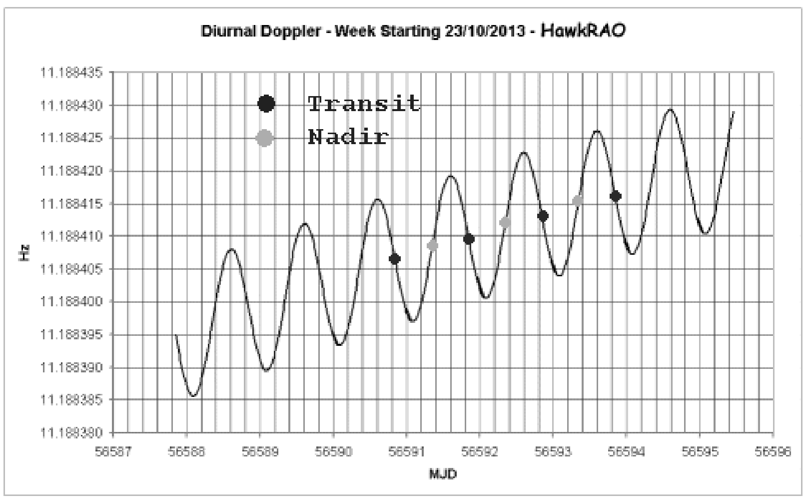

Figure 4

Figure 4 uses Modified Julian Dates (MJD) to identify the days, since some months are longer than others. 56588 converts to October 23, 2013.

Another amateur astronomer in Lucca, Italy, tracked Pulsar B0329+54 and provided a chart of daily readings (but no graph) for all of 2018 showing the highest frequency to have occurred on August 28 and the lowest on February 23, almost exactly 6 months apart.[15]

V. Conclusion

Experiments demonstrate that there can be no doubt that light is **emitted** at *c* regardless of the speed of the emitter, and there can also be no doubt that light arrives at a receiver at $c+v$ or $c-v$, where v is the speed of the receiver toward or away from the emitter. This confirms what Einstein wrote in his 1905 paper on Special Relativity, and it shows that all the textbooks which claim that Einstein actually meant something different are wrong. The evangelistic belief that all motion is relative, and therefore light must arrive at *c* for an observer if it was emitted at *c* by the emitter is undoubtedly the most absurd belief in all of physics. All motion in our universe is relative to the speed of light, just as Einstein theorized.

VI. References

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