Does Light Travel with the Velocity of a Moving Source?

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Einstein resolves the issue of whether or not light travels with the velocity of a moving source by assuming time dilates (and length contracts) in a moving inertial reference frame. Based more on belief than empirical evidence, this resolution enables the theory of special relativity to claim validity, even though there are other explanations and interpretations that are simpler and more consistent with Occam's Razor. Some dissident physicists counter Einstein both by assuming the constant velocity of light is preserved, albeit without time dilation, as well as assuming light travels with the velocity of its source. While I am in the latter camp, I attempt to examine both sides of the argument from a non-relativistic perspective.

1. Introduction

Is the speed of light constant as proposed by Einstein in his Theory of Special Relativity? By manipulating time (dilation) and length (contraction), Einstein manages to render moot the question as to what effect motion of the light source has on light speed. Only the relative velocity between source and observer is relevant, and regardless of which is moving (undeterminable in his theory), the speed of light seen by the observer is always c. However, many dissident physicists, as well as myself (though not a physicist, but a nuclear engineer with a keen interest in physics), question relativity, and a key point of contention appears to be whether or not light travels with the velocity of its source, thereby enabling it to propagate faster or slower than c. While there appears to be general agreement that a moving observer will see light from a stationary source traveling faster or slower than c depending upon whether or not the observer approaches or recedes from the source, there clearly is not general agreement for the stationary observer and the moving source. Unlike Einstein, here I speak of moving against the vacuum medium of space, not relative speed between source and observer, although that is there regardless of which one moves.

2. Two Camps

Among the camp of dissidents favoring the position that light does not travel with its source velocity, a key point appears to be that Maxwell's equations define light speed as always c in a vacuum. Among these authors, I have come across the following: Richard Calkins, Justin Jacobs and Carel van der Togt. [1-3] They contend that to be immutable such that the light always emanates from its point of emission against the background of the vacuum medium and travels in spherical waves outward from this point at c (or in a straight line at c if emitted from, e.g., a laser) even if the source is moving. It is the point of emission that is critical.

Among the camp favoring the position that light does travel with its source velocity, the key is that, while light is emitted at c in the vacuum, it travels spherically outward at speeds ranging from c – v to c + v relative to a stationary observer, where v is the source velocity. Among these authors, I have come across the following: Stephen Bryant, Bernard Burchill and the late Paul Marmet. [4-6] What both camps agree upon is that, for a stationary source and moving observer (at v), the light speed seen by the observer will range from c – v to c + v. It should be apparent that, for the first camp (light not traveling with source velocity), there is an asymmetry in perceived light velocity depending upon whether it is the source or observer that is moving against the background of the vacuum medium. For the second camp, the two cases are symmetric.

3. Illustrative Examples

In this article, I examine three examples that show the (a)symmetry and then propose an experimental observation that, at least at some hopefully not too far future date, might solve the debate.

3.1 Moving vs. Stationary Spaceship

Figures 1-3 show a fairly simple example where a red spaceship flashes a light at time zero toward a green spaceship. In Figure 1, the red ship is stationary and the green ship approaches at 0.5c, starting from 450,000 km away at time 0. After 1 s, light has traveled 300,000 km and green ship 150,000 km closer, such that it sees the flash. In Figure 2, the green ship is now stationary, and the red ship approaches at 0.5c, having flashed its light at time 0 when 450,000 km away. If light travels with the velocity of a moving source, the flash from the red ship at time 0 reaches the green ship as before, at 1 s. This is symmetric with the first case where the observer, not the source, moves.

Figure 3 is analogous to Figure 2, but where we assume that light does not travel with the velocity of the source. In this case, the green ship does not see the light flash until 1.5 s have elapsed, 0.5 s longer than when it was moving toward the stationary source at 0.5c. This case is not symmetric with the first case where the observer, not the source, moves. Which is correct?

3.2 Two Moving/Stationary Spaceships and a Stationary/Moving Pulsar

Figures 4 and 5 add a pulsar to the two spaceships, now either both moving or stationary. In Figure 4, the two ships, one red and one green, each start at a distance d at time 0 on radially opposite sides of a pulsar with the same velocity, such that the red one approaches the pulsar at speed 0.5c while the green one recedes at 0.5c. The pulsar emits a light burst at time 0, known to travel spherically outward at c. At time 1 (t_1), the light burst reaches the red ship, which measures the effective light speed as the initial distance $d = 0.5ct_1 + ct_1$ divided by the time t_1, i.e., 1.5c. At time 2 (t_2), the light burst finally reaches the green ship, which measures the effective light speed as the same initial distance d divided by the time t_2, i.e., $1.5ct_1/t_2$. However, knowing that it traveled an additional $d = 0.5ct_2$ farther away from the pulsar, which was originally d ($= 1.5ct_1$) away, the green ship calculates the elapsed time as $t_2 = 3t_1$ (from $d = 1.5ct_1 = 0.5ct_2 \rightarrow t_2 = 3t_1$). Therefore, for the green ship, the effective light speed is 0.5c.

FIGURE 1. Stationary red spaceship with green spaceship approaching at 0.5c from 450,000 km away. After 1 sec, green spaceship sees the flash.

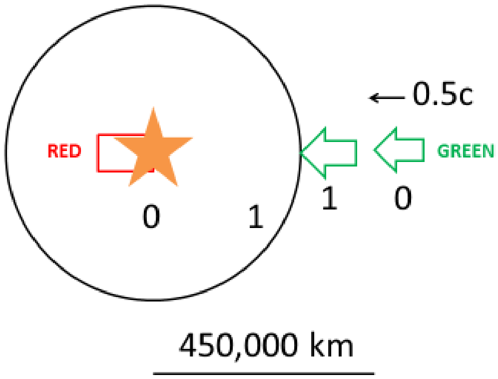
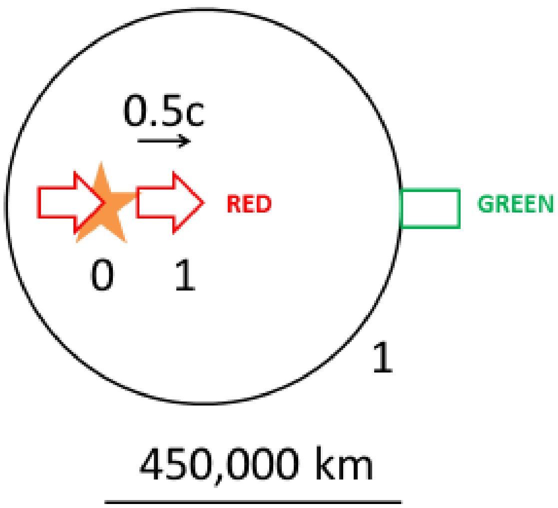


FIGURE 2. If light travels with the velocity of a moving source, the flash from the red spaceship reaches the green spaceship as before, at 1 sec.



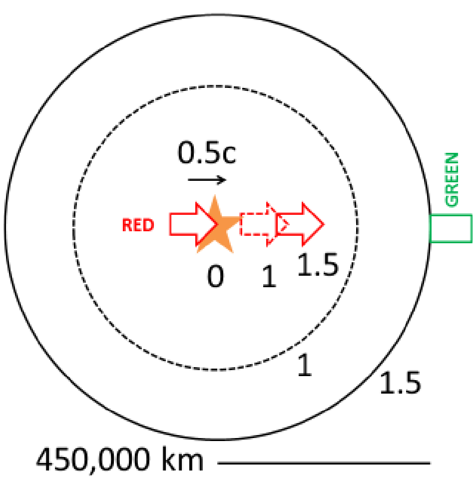


FIGURE 3. If light from moving source does NOT travel with the velocity of the source, green spaceship does not see light flash until 1.5 sec have elapsed.

3.3 Two Moving/Stationary Spaceships and a Stationary/Moving Pulsar

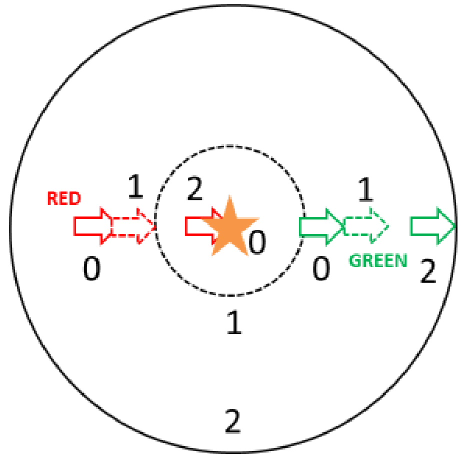
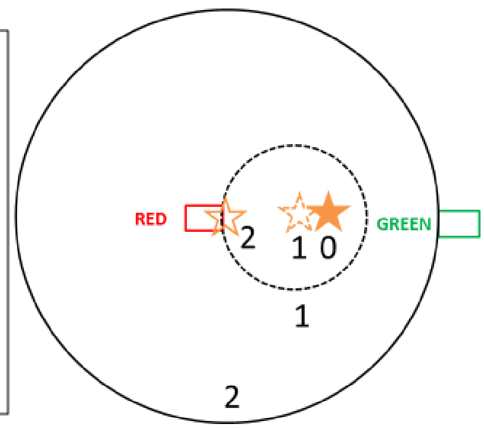


FIGURE 4. Two spaceships, one red and one green, equidistant from a pulsar traveling with the same velocity at 0.5c.

FIGURE 5. Now, the spaceships are stationary, but the pulsar approaches toward the red one and recedes from the green one along the same radial path at speed 0.5c.



Now, in Figure 5, the spaceships are stationary, but the pulsar approaches toward the red one and recedes from the green one along the same radial path at speed 0.5c, with both ships originally (time 0) equidistant (d) from the pulsar. A light burst emitted at time 0 reaches the red ship at time 1 after the pulsar has approached $0.5ct_1$ closer. It measures the effective light speed as the initial distance d, consisting of the pulsar's approach and the distance traveled by the light burst from time 0, i.e., $d = 0.5ct_1 + ct_1$, divided by the time t_1, i.e., 1.5c. As the pulsar continues to recede from the green ship, the initial light burst finally reaches it at time 2, at which the green ship measures the effective light speed as the same initial distance d divided by the time t_2, i.e., $1.5ct_1/t_2$. However, knowing that the pulsar moved an additional $d = 0.5ct_2$ farther away, the green ship calculates the elapsed time as $t_2 = 3t_1$ (from $d = 1.5ct_1 = 0.5ct_2 \rightarrow t_2 = 3t_1$). Therefore, for the green ship, the effective light speed is 0.5c.

It should be clear that assuming the light burst travels with the velocity of the moving source (Figure 5) yields symmetrically equivalent results with Figure 4, where the spaceships but not the pulsar are moving (parallel pair of different effective light speeds depending upon the <u>relative</u> movement between the ships and the pulsar, regardless of which is moving). If this symmetry is broken by assuming the light burst does NOT travel with the speed of the moving source, then Figure 5 (stationary ships, moving pulsar) will always yield effective light speeds of c for both ships, while the results from Figure 4 with the moving ships remain as before (different effective light speeds).

This asymmetry indicates that an observer (ship) could distinguish between a moving ship and a moving source based on the measured effective light speed (always c if the source is moving;

never c if the observer is moving [except for the unique case of perfectly circular motion]). If light always emanates from a source at c relative to the source (traveling with the source velocity if moving), we have symmetry. If light always emanates from the source at c regardless of whether the source is moving (i.e., dependent only upon the source's position at the time of emanation), we have asymmetry depending upon whether the observer is moving. Which is correct?

3.4 Stellar Aberration

Figures 6-8 examine the phenomenon of stellar aberration, comparing the classic case of moving Earth (observer) and stationary star with one where the star moves and the Earth is stationary. In Figure 6, light from a stationary star (dotted vector) and fixed, infinitely-distant background point A (dashed vector) emanates from the star's position at time zero and travels 10 light-years (L-y) at 300,000 km/s to position 1 (combined light shown as a black dot) at the front end of a 30^+-m long telescope moving with the Earth's velocity of 30 km/s to the left (30^+ indicates that the telescope is ever so slightly longer than 30 m because it is ever so slightly tilted off the perpendicular). After 0.05 µs, the combined light travels 15 m (300,000 km/s x 5E-8 s = 0.015 km) halfway down the telescope to position 2 (the telescope has moved 1.5 mm to the left [30 km/s x 5E-8 s]). After 0.1 µs, the combined light travels an additional 15 m (now a total of 30 m) to the end of telescope at position 3 where the observer's eye sees the star against background position A (the telescope has now moved an additional 1.5 mm, or a total of 3 mm, to the left).

Now, in Figure 7, assume the star is moving at 60 km/s to the right which, when compared to the Earth's 30 km/s velocity to the left, can be viewed as the star now moving 30 km/s (0.0001c) to the right relative to a stationary Earth. If light travels with the velocity of its source, then light emanated from the star at time 0 will travel $([10 \text{ L-y}]^2 + [10 \times 0.0001 \text{ L-y}]^2)^{1/2} = 10.00000005$ L-y diagonally (mixed vector) in 10 years to position 1 at the front end of the 30^+-m long telescope. However, now that the Earth is stationary, the light from background position A (dashed vector) that had reached the star at time 0 lags 0.001 L-y to the left (at position 1') when the star light reaches position 1. It is now light from background position B (dotted vector) which arrives with the star light at position 1 after 10 y, having reached the future position of the star (now its current position) 10 y ago. However, unlike the star light traveling along the diagonal, the ever so slight tilt of the telescope will prevent that dashed vector from traveling down the telescope to the observer's eye. Therefore, in this case (stationary Earth and moving star), the observer sees the star (black dot) against some sort of ever so slightly (possibly undetectable) muddled background, similar to, but not exactly, the same as in Figure 6.

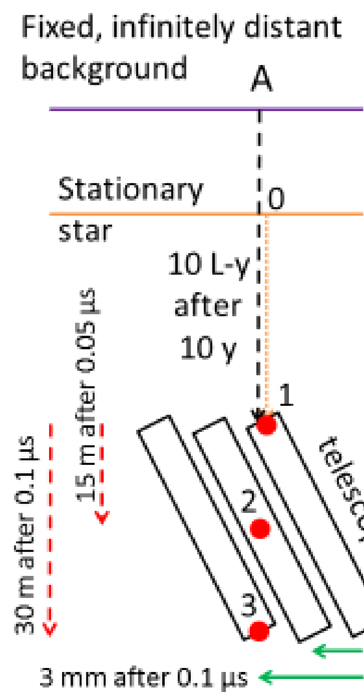


FIGURE 6. Stellar aberration for stationary star + moving earth at 30 km/s to left.

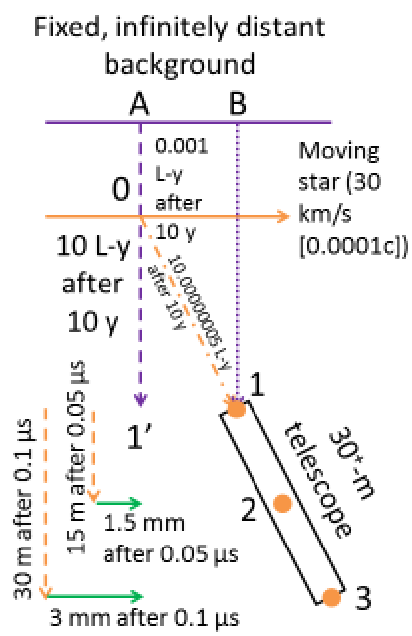


FIGURE 7. Stellar aberration for stationary earth + moving star at net speed of 30 km/s (0.0001c) to the right (light travels with source speed).

In Figure 8, again assume the star is moving at 60 km/s to the right which, when compared to the Earth's 30 km/s velocity to the left, can be viewed as the star now moving 30 km/s (0.0001c) to the right relative to a stationary Earth. However, if light does not travel with the velocity of its source, then light emanated from the star at time 0 will again travel in tandem with the light from background position A that had reached the star 10 y ago, reaching position 1 at the front end of the telescope after traveling 10 L-y in 10 y (black dot). However, now neither the light from the star nor that from background position A can travel down the ever so slightly tilted telescope to reach the observers eye. He will see neither. In this case, the telescope would have to be aligned perfectly with the perpendicular for the observer (dashed telescope) to see the star against background position A as in the first case.

Again, as in the previous two examples, we see symmetry when light is assumed to travel with the velocity of a moving source (except for some possible muddling of the background, which may be undetectable), but asymmetry when it is assumed not. Which is correct?

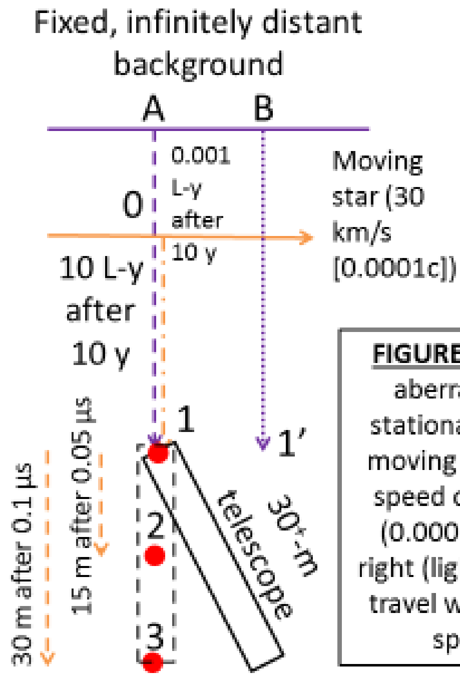


FIGURE 8. Stellar aberration for stationary earth + moving star at net speed of 30 km/s (0.0001c) to the right (light does not travel with source speed).

4. Observing a Pulsar

Having presented three examples illustrating the difference between observations when light travels with the velocity of its source vs. always traveling from the source at c (in a vacuum), namely symmetry vs. asymmetry between analogous situations where the observer moves but the source is stationary vs. moving source and stationary observer, the following is a potential experimental observation that could answer the question I posed after each – which is correct?

As shown in Figure 9, a millisecond pulsar is detected from Earth. Assume it has a typical pulsar radius of ~10 km (http://imagine.gsfc.nasa.gov/docs/science/know_l1/pulsars.html), such that its rotational speed is ~2π(10 km)(1000/sec) ≈ 60,000 km/sec, or 0.2c. If light velocity is independent of source motion, the pulse must be emitted at A and travel along the dashed vector at speed c to be detected. If light velocity travels with the velocity of the source, the pulse must be emitted earlier at B and travel along the vector sum of the solid (c) and dotted (0.2c) vectors, i.e., along the mixed vector at speed ~1.02c {≈ $\sqrt{c^2 + [0.2c]^2}$} which, though shown askew for clarity, is just the same vector as the dashed but with a higher speed.

If the exact distance between the pulsar and Earth were known (and the extremely rapid spin of the pulsar [0.2c] greatly exceeded any relative translational motion between the pulsar and Earth, such that they could be considered stationary relative to each other), the travel time from A (along the dashed vector) would be slightly longer than that from B (along the mixed vector), in the ratio of 1.02:1.00, or ~2%. While knowing the exact spin and radius of the pulsar, and its exact distance from Earth, is beyond present technology, at least theoretically a 2% time difference would be readily detectable even by today's technology and settle once and for all the question as to whether or not light travels with the velocity of its source.

5. Conclusion

I am unfortunately unable to make a conclusion regarding whether or not light travels with the velocity of its source. I believe it does, but philosophically there are convincing arguments for both pairs of views such as those that I have presented. However, until we can definitively travel at speeds that are not negligible fractions of the speed of light, or can precisely measure distances to pulsars along with their radii and rotational speeds (as required to carry out my proposed experimental observation), this debate will continue. The enormous speed of light compared to anything humans have ever experienced renders experimental observations from interstellar or intergalactic space speculative at best and completely dependent upon assumptions regarding virtually unmeasurable distances, speeds, sizes, etc. Given the negligible fractions of light speed usually involved, the precision needed to verify miniscule differences between phenomena renders experimental observations speculative, at best. Nonetheless, as food for thought, the problem remains most intriguing and likely will continue to occupy the human psyche until the necessary technological progress is achieved, well beyond our lifetimes and probably those of many future generations.

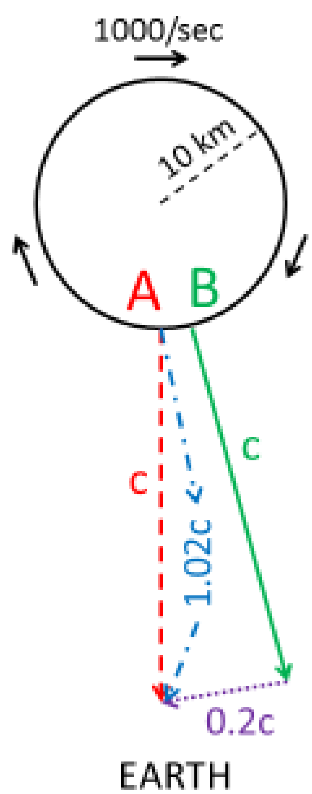


FIGURE 9. A millisecond pulsar is detected from Earth with a typical radius of ~10 km, such that its rotational speed is ~2π(10 km)(1000/sec) ≈ 60,000 km/sec, or 0.2c.

6. References

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2. J. Jacobs, *The Relativity of Light* (www.RelativityOfLight. com).
3. C. van der Togt, *Unbelievable; From Paradox to Paradigm* (www.paradox-paradigm.nl).
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5. B. Burchill, *Alternative Physics: Where Science Makes Sense* (http://alternativephysics.org/index.htm).
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Appendix

In his treatise *The Relativity of Light*, Jacobs examines the question "Does the transmission velocity of a light ray at velocity *c* relative to the medium of empty space vary depending upon the speed and direction of motion of the source body from which such light ray is emitted?" [2] For his answer, Jacobs

> "… defer[s] to Willem de Sitter's empirical binary star theory which asserts that the orbital velocity (v) of a light emitting binary star must not be added to (*c* + v) or subtracted from (*c* – v) the velocity *c* of the light which the star emits, because this would necessarily result in 'ghost star' images in a binary star system, which images have never been observed. Based on De Sitter's binary star observations and his resulting empirical theory, Einstein postulated 'that light is always propagated in empty space with a definite velocity *c* which is independent of the state of motion of the emitting body.'"

Jacobs concludes that

> "De Sitter's theory and the underlined part of Einstein's postulate are compatible with Maxwell's equations based on the wave theory of light, with the 1851 interference experiment of Fizeau …, with the null result of the Michelson [and] Morley experiment …, and with empirical measurements of the speed of sound waves. Measurements of the velocity of starlight received on Earth from stars with different relative speeds also appear to confirm these conclusions. Therefore, let us accept De Sitter's theory and the (underlined) second part of Einstein's above postulate as valid."

I was intrigued by this explanation for light not traveling with its source velocity and the claim that no ghost star images having ever been seen and measurements of light velocity from stars with different relative speeds have confirmed Jacobs' (and certainly others') conclusions. I performed the following illustrative calculation.

Assume a binary star system rotating counterclockwise of diameter 0.001π L-y rotates at 0.001π L-y/y. At t_0, both a green star (approaching Earth, from the left) and red star (receding from Earth, from the right) are 10 L-y from earth (with both stars aligned along an axis perpendicular to the line of sight from the Earth, i.e., a typical horizontal x axis). What would we observe over the next 12 months?

Assuming observations made at monthly intervals n/12 y (n = number of months since t_0), the vector component of each star's speed (in units of L-y/y) would be $v = {}^{\pm}0.001\pi \cos(2\pi[n/12]) = {}^{\pm}0.001\pi \cos(n\pi/6)$, with the $^{\pm}$ sign depending upon whether the star was approaching (+) or receding from (-) the Earth at month n. The corresponding light speed of each star (in L-y/y), if acquiring the velocity of the source, would just be $1 \pm v$. For each star, the time for the light to traverse the 10 L-y distance to Earth would be 10/v y, while the time at which the light reached the earth would be (n/12 + 10/v) y.

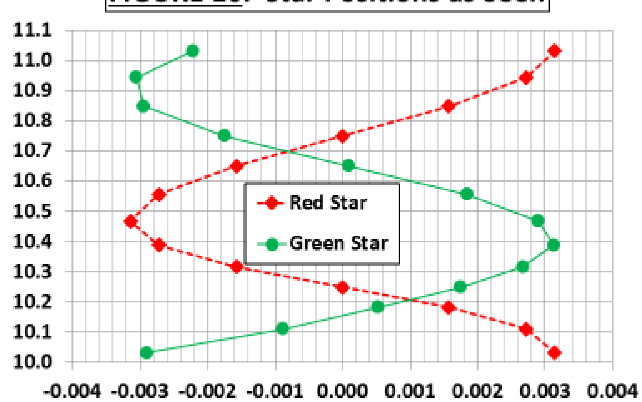
If we assume the red star's position (receding from the right) at t_0 to be 0 radian (and, thus, that of the green star approaching from the left to be π radians), the position of each star relative to its angular position when its light is seen on Earth would be nπ/6 radians for the red star and the following for the green star:

> At time t_n for n = 0, π x (1 + twice the difference between times when light from red and green stars reaches Earth);
>
> At time t_n for n > 0, position at time n = 0 + π x (twice the difference between time when light from red star reaches Earth at n and time when light from green star reached Earth at t_0).

Of interest are the horizontal (x-axis) displacements (in L-y) relative to each other that an Earth observer would see for each star at his monthly viewing. For the red star, that displacement would be 0.001π cos(nπ/6) occurring either slightly before or after the monthly time as measured by each star in its rotation, depending upon whether the red star is approaching or receding from Earth. For the green star, assuming the viewing took place when the light from each monthly interval from the red star reached Earth, this would be 0.001π cos(π x angular position calculated above).

Table 1 and Figure 10 show the positions for the 'dance' of the red (diamonds and dashed line) and green stars (circles and solid line) as seen from Earth when viewed at the time the light from the red star reached Earth based on the stars' monthly intervals of rotation. Month n = 0 corresponds to 10 y after time 0 when the stars 'began' their rotation cycle.

FIGURE 10. Star Positions as Seen



Binary star system of diameter 0.001π L-y rotates at 0.001π L-y/y. At time 0, both green star (approaching) and red star (receding) are 10 L-y from Earth.		Vector Component - Star Speed [L-y/y]		Vector Component - Light Speed [L-y/y]		Time for Light to Travel 10 ly to Earth (y)		Time When Light Reaches Earth (y)		Red Star Position "Seen" When Light Reaches Earth		Green Star Position "Seen" When Red Light Reaches Earth		Perceived Midpoint "Seen" When Red Light Reaches Earth
Month	Year	Green Star	Red Star	Green Star	Red Star	Green Star	Red Star	Green Star	Red Star	π rads	x disp (L-y)	π rads	x disp (L-y)	x disp (L-y)
0	0.000000	0.003142	-0.003142	1.003142	0.996858	9.968682	10.031515	9.968682	10.031515	0.000000	0.003142	1.125665	-0.002900	0.000121
1	0.083333	0.002721	-0.002721	1.002721	0.997279	9.972867	10.027281	10.056200	10.110615	0.166667	0.002721	1.409529	-0.000881	0.000920
2	0.166667	0.001571	-0.001571	1.001571	0.998429	9.984317	10.015733	10.150983	10.182399	0.333333	0.001571	1.553099	0.000522	0.001046
3	0.250000	0.000000	0.000000	1.000000	1.000000	10.000000	10.000000	10.250000	10.250000	0.500000	0.000000	1.688300	0.001752	0.000876
4	0.333333	-0.001571	0.001571	0.998429	1.001571	10.015733	9.984317	10.349066	10.317650	0.666667	-0.001571	1.823600	0.002671	0.000550
5	0.416667	-0.002721	0.002721	0.997279	1.002721	10.027281	9.972867	10.443948	10.389533	0.833333	-0.002721	1.967367	0.003125	0.000202
6	0.500000	-0.003142	0.003142	0.996858	1.003142	10.031515	9.968682	10.531515	10.468682	1.000000	-0.003142	2.125665	0.002900	-0.000121
7	0.583333	-0.002721	0.002721	0.997279	1.002721	10.027281	9.972867	10.610615	10.556200	1.166667	-0.002721	2.300700	0.001841	-0.000440
8	0.666667	-0.001571	0.001571	0.998429	1.001571	10.015733	9.984317	10.682399	10.650983	1.333333	-0.001571	2.490267	0.000096	-0.000737
9	0.750000	0.000000	0.000000	1.000000	1.000000	10.000000	10.000000	10.750000	10.750000	1.500000	0.000000	2.688300	-0.001752	-0.000876
10	0.833333	0.001571	-0.001571	1.001571	0.998429	9.984317	10.015733	10.817650	10.849066	1.666667	0.001571	2.886432	-0.002944	-0.000686
11	0.916667	0.002721	-0.002721	1.002721	0.997279	9.972867	10.027281	10.889533	10.943948	1.833333	0.002721	3.076196	-0.003052	-0.000166
12	1.000000	0.003142	-0.003142	1.003142	0.996858	9.968682	10.031515	10.968682	11.031515	2.000000	0.003142	3.251330	-0.002212	0.000465

<u>TABLE 1</u>. **Positions of Red and Green Stars as Seen from Earth when Viewed at the Time the Light from the Red Star Reached Earth Based on the Stars' Monthly Intervals of Rotation**

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Dr. Raymond HV Gallucci, PE

2nd Annual John Chappell Natural Philosophy Society Conference

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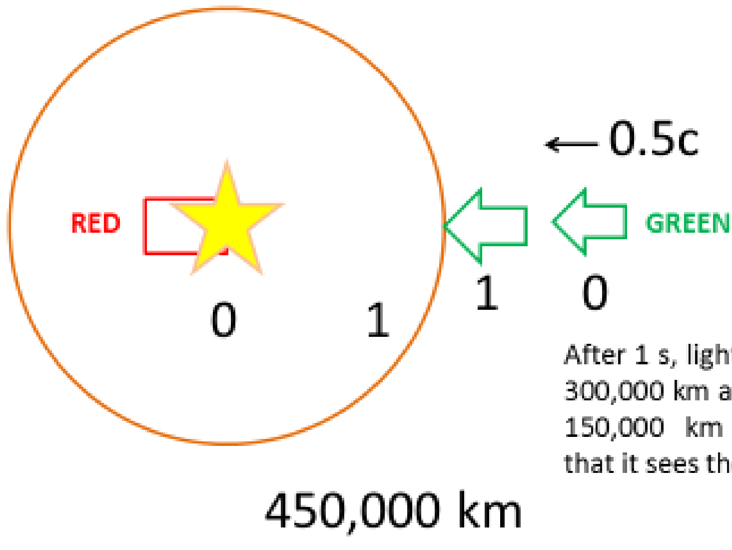
THE MATH WORKS – BUT IS IT TRUE?

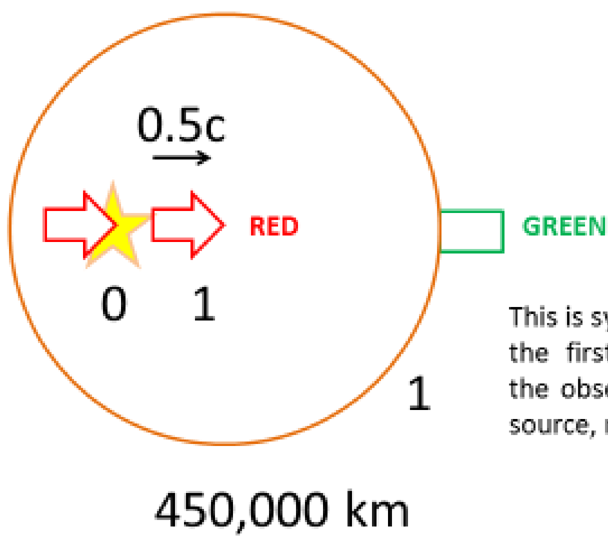
- By manipulating time (dilation) and length (contraction), Einstein manages to render moot the question as to what effect motion of the light source has on light speed.
- Among dissident physicists who do not adhere to a constant light speed,
  - They generally agree that a moving observer will see light from a stationary source traveling faster or slower than c depending upon whether or not the observer approaches or recedes from the source.
  - They disagree for the stationary observer and the moving source.

Stationary red spaceship with green spaceship approaching at 0.5c from 450,000 km away. After 1 sec, green spaceship sees the flash.



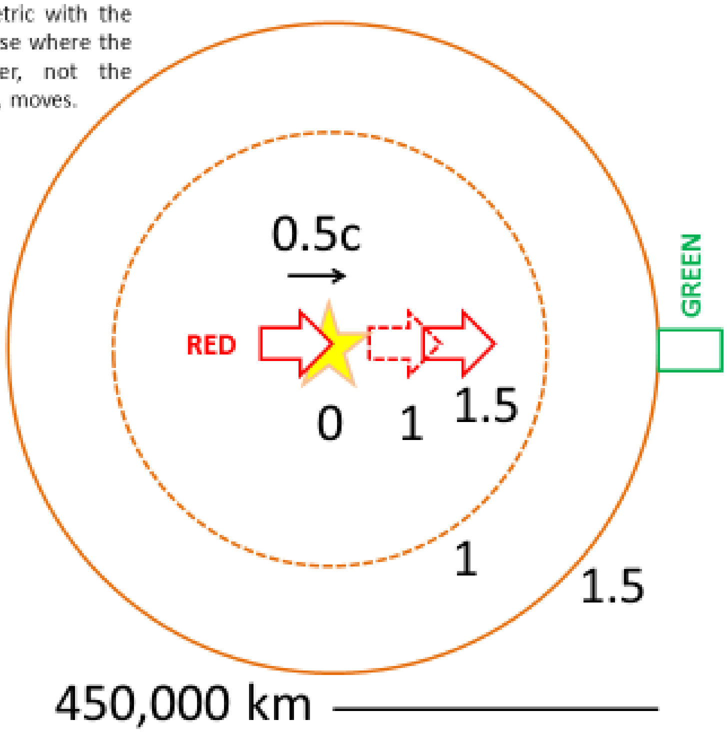
After 1 s, light has traveled 300,000 km and green ship 150,000 km closer, such that it sees the flash.

If light travels with the velocity of a moving source, the flash from the red spaceship reaches the green spaceship as before, at 1 sec.

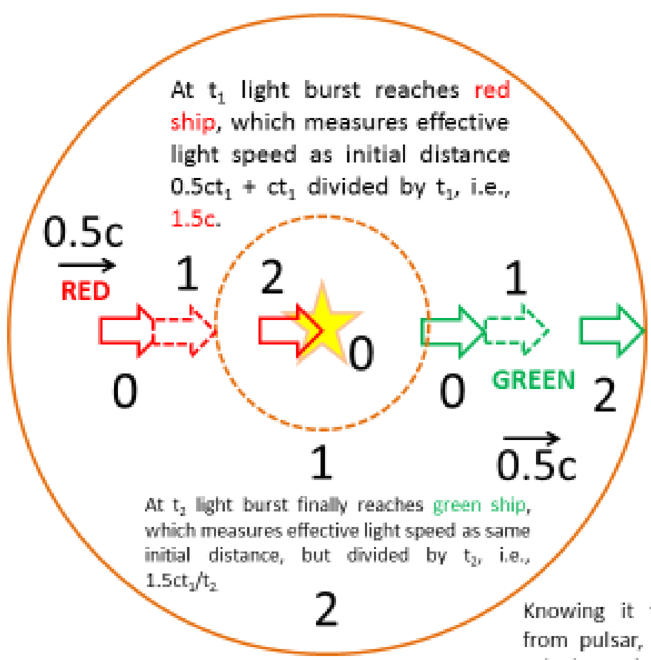


This is symmetric with the first case where the observer, not the source, moves.

This is not symmetric with the first case where the observer, not the source, moves.



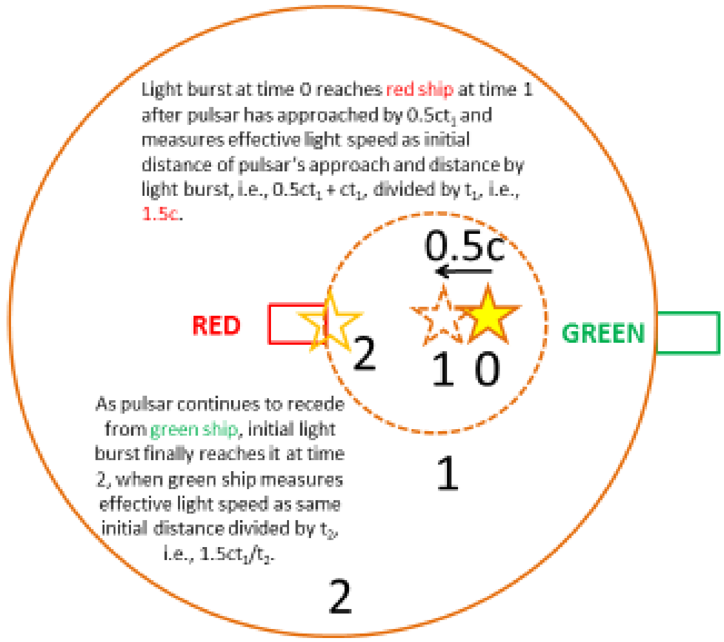
If light from moving source does NOT travel with the velocity of the source, green spaceship does not see light flash until 1.5 sec have elapsed.



Two spaceships, one red and one green, equidistant from a **PULSAR**, traveling with the same velocity at 0.5c.

Knowing it traveled additional $0.5ct_2$ farther from pulsar, originally $1.5ct_1$ away, green ship calculates elapsed time as $t_2 = 3t_1$ (from $1.5ct_1 = 0.5ct_2 \rightarrow t_2 = 3t_1$), with effective light speed 0.5c.

Now, the spaceships are stationary, but the **PULSAR** approaches toward the red one and recedes from the green one along the same radial path at speed 0.5c.



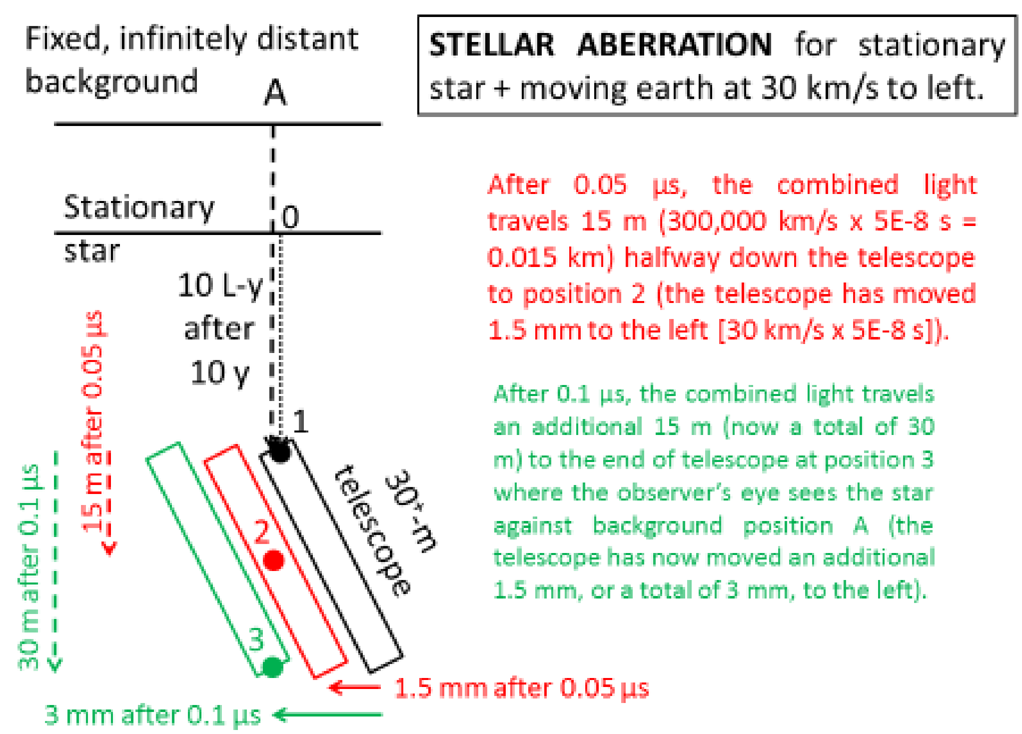
Knowing the pulsar moved an additional $0.5ct_2$ farther away, green ship calculates elapsed time as $t_2 = 3t_1$ (as before), with effective light speed = 0.5c.

TWO EXAMPLES

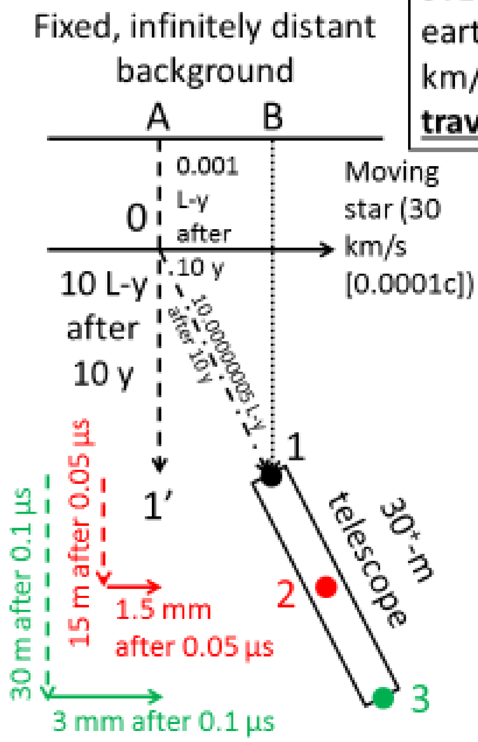
- Assuming the light burst travels with the velocity of the moving source yields symmetrically equivalent results with the case where the spaceships but not the pulsar are moving.
  - If this symmetry is broken by assuming the light burst does NOT travel with the speed of the moving source, then the case for stationary ships and a moving pulsar will always yield effective light speeds of c for both ships, while the results for the moving ships and stationary pulsar yield different effective light speeds.

TWO EXAMPLES

- This asymmetry indicates that an observer (ship) could distinguish between a moving ship and a moving source based on the measured effective light speed (always c if the source is moving; never c if the observer is moving [except for the unique case of perfectly circular motion]).
  - If light always emanates from a source at c relative to the source (traveling with the source velocity if moving), we have symmetry.
  - If light always emanates from the source at c regardless of whether the source is moving (i.e., dependent only upon the source's position at the time of emanation), we have asymmetry depending upon whether the observer is moving.
- Which is correct?

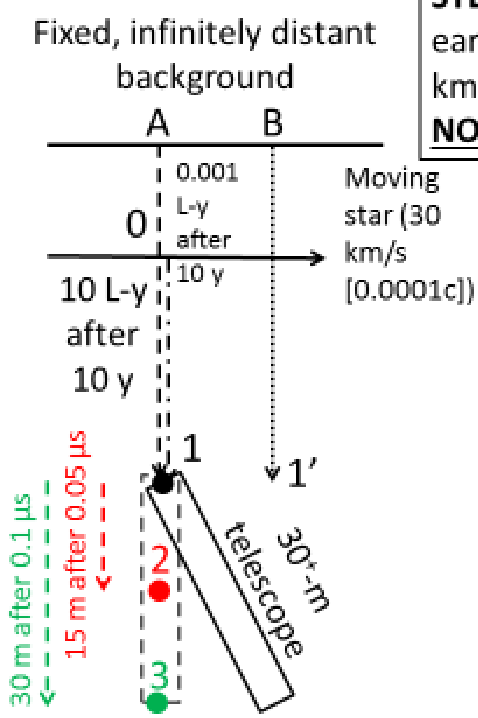


STELLAR ABERRATION for stationary earth + moving star at net speed of 30 km/s (0.0001c) to the right (**<u>light travels with source speed</u>**).



Now that the Earth is stationary, the light from background position A (dashed vector) that had reached the star at time 0 lags 0.001 L-y to the left (at position 1') when the star light reaches position 1. It is now light from background position B (dotted vector) which arrives with the star light at position 1 after 10 y, having reached the future position of the star (now its current position) 10 y ago. Unlike the star light traveling along the diagonal, the ever so slight tilt of the telescope will prevent that dashed vector from traveling down the telescope to the observer's eye. In this case (stationary Earth and moving star), the observer sees the star (dot) against some sort of ever so slightly (possibly undetectable) muddled background, similar to, but not exactly, the same as before.

STELLAR ABERRATION for stationary earth + moving star at net speed of 30 km/s (0.0001c) to the right (**<u>light does NOT travel with source speed</u>**).



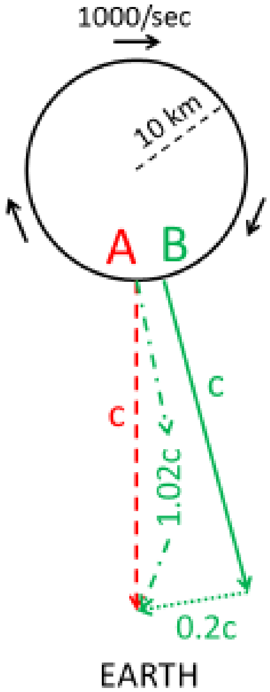
Now neither the light from the star nor that from background position A can travel down the ever so slightly tilted telescope to reach the observers eye. He will see neither. In this case, the telescope would have to be aligned perfectly with the perpendicular for the observer (dashed telescope) to see the star against background position A as in the first case.

STELLAR ABERRATION

- Again, as in the previous two examples, we see symmetry when light is assumed to travel with the velocity of a moving source (except for some possible muddling of the background, which may be undetectable), but asymmetry when it is assumed not.
- Which is correct?

OBSERVING A PULSAR

- The following is a potential experimental observation that could answer the question – which of the two different observations per experiment (symmetric vs. asymmetric) is correct?
  - If the exact distance between the pulsar and Earth were known (and the extremely rapid spin of the pulsar [0.2c] greatly exceeded any relative translational motion between the pulsar and Earth, such that they could be considered stationary relative to each other), the travel time from A (along the dashed vector) would be slightly longer than that from B (along the mixed vector), in the ratio of 1.02:1.00, or ~2%.



A **MILLISECOND PULSAR** is detected from Earth with a typical radius of ~10 km, such that its rotational speed is ~2π(10 km)(1000/sec) ≈ 60,000 km/sec, or 0.2c.

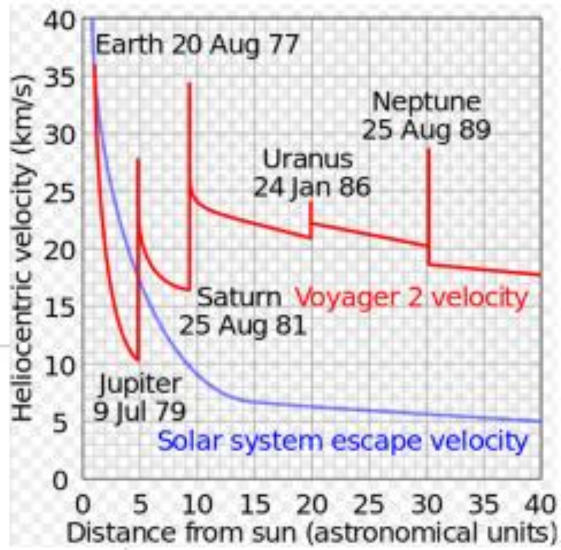
If light velocity is independent of source motion, pulse must be emitted at A and travel along dashed vector at speed c to be detected. If light travels with the velocity of the source, pulse must be emitted earlier at B and travel along the vector sum of the solid (c) and dotted (0.2c) vectors, i.e., along the mixed vector at speed ~1.02c which, though shown askew for clarity, is same vector as dashed but with a higher speed.

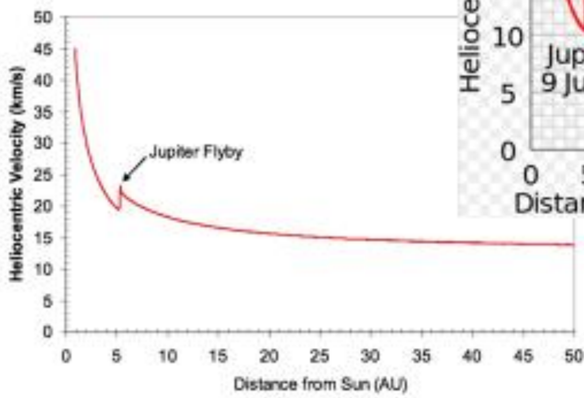
While knowing exact spin and radius of pulsar, and exact distance from Earth, is beyond present technology, at least theoretically a 2% time difference could be detected and settle the question as to whether or not light travels with the velocity of its source.

SUMMARY

- Unfortunately, I cannot prove my contention that light travels with the velocity of its source.
  - There are convincing arguments for both views.
  - The enormous speed of light compared to human experience renders experimental observations from inter-stellar/galactic space speculative, depending upon assumptions about unmeasurable distances, speeds, sizes, etc.
  - Given the negligible fractions of light speed usually involved, the precision needed to verify miniscule differences between phenomena renders experimental observations speculative, at best.

Even our fastest probes (*New Horizons*, below, and *Voyager 2*, right), only achieved ~$45/(3 \times 10^5) = 0.00015$, or 0.015% of light speed.





http://gizmodo.com/how-did-we-get-to-pluto-so-fast-1716533356

CONCLUSION

- As food for thought, the problem remains most intriguing and likely will continue to occupy the human psyche until the necessary technological progress is achieved, well beyond our lifetimes and probably those of many future generations.

De SITTER & EINSTEIN: NO 'GHOST IMAGES' = CONSTANT LIGHT SPEEED?

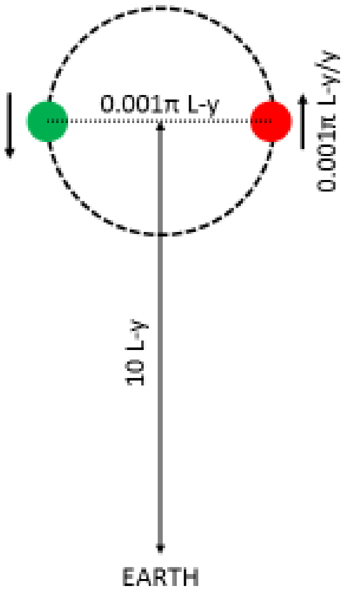
Dr. Raymond HV Gallucci, PE

2nd Annual John Chappell Natural Philosophy Society Conference

College Park, MD
July 20-23, 2016

CITING De SITTER

- In his treatise *The Relativity of Light*, Jacobs examines Willem de Sitter's empirical binary star theory
  - The orbital velocity (v) of a light emitting binary star must not be added to (c + v) or subtracted from (c – v) the velocity c of the light which the star emits, because this would necessarily result in 'ghost star' images in a binary star system, which images have never been observed.
    - Therefore, Einstein postulated 'that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body.'
  - Measurements of the velocity of starlight received on Earth from stars with different relative speeds also appear to confirm these conclusions.



Assuming observations made at monthly intervals n/12 y (n = number of months since t_0), the vector component of each star's speed (in units of L-y/y) would be v = ±0.001π cos(2π[n/12]) = ±0.001π cos(nπ/6), with the ± sign depending upon whether the star was approaching (+) or receding from (-) the Earth at month n. The corresponding light speed of each star (in L-y/y), if acquiring the velocity of the source, would just be 1 ± v. For each star, the time for the light to traverse the 10 L-y distance to Earth would be 10/v y, while the time at which the light reached the earth would be (n/12 + 10/v) y.

If we assume the red star's position (receding from the right) at t_0 to be 0 radian (and, thus, that of the green star approaching from the left to be π radians), the position of each star relative to its angular position when its light is seen on Earth would be nπ/6 radians for the red star and the following for the green star:

> At time t_n for n = 0, π x (1 + twice the difference between times when light from red and green stars reaches Earth);
>
> At time t_n for n > 0, position at time n = 0 + π x (twice the difference between time when light from red star reaches Earth at n and time when light from green star reached Earth at t_0).

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STAR 'DANCE'

- Of interest are the horizontal (x-axis) displacements (in L-y) relative to each other that an Earth observer would see for each star at his monthly viewing.
  - For the red star, that displacement would be 0.001π cos(nπ/6) occurring either slightly before or after the monthly time as measured by each star in its rotation, depending upon whether the red star is approaching or receding from Earth.
  - For the green star, assuming the viewing took place when the light from each monthly interval from the red star reached Earth, this would be 0.001π cos(π x angular position from previous slide).

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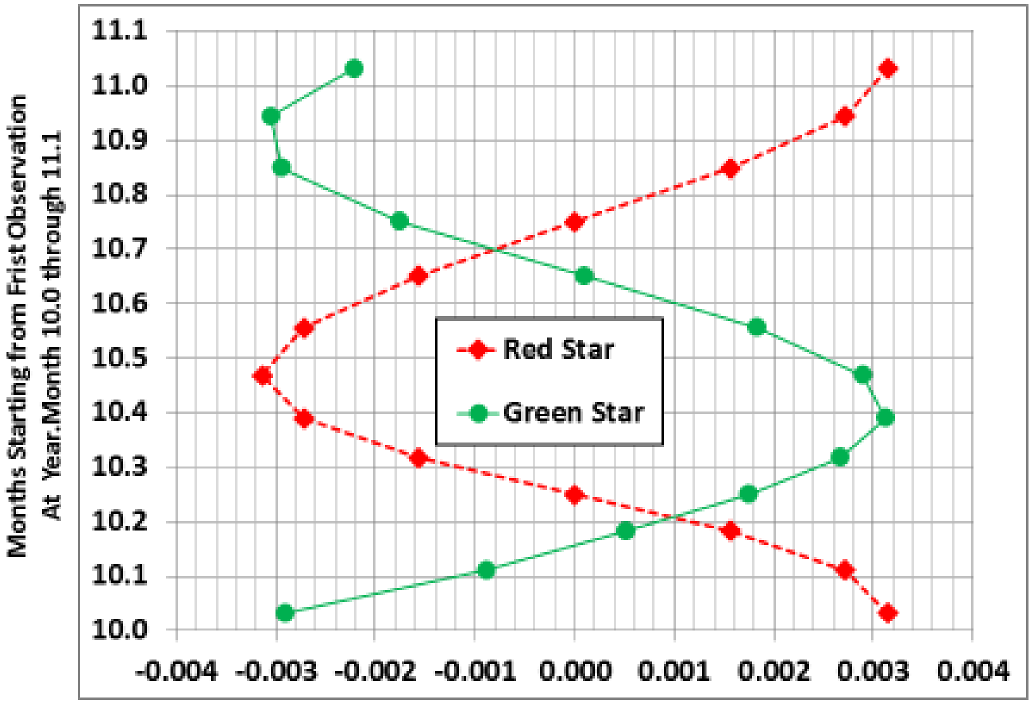
Star 'Dance:' Star Positions as Seen from Earth



NO 'GHOSTS'

- From this exercise, no ghost images would be expected.
  - The dance of the stars would be such that the slight asymmetry of the displacement of each about the supposed center would be difficult to measure.
    - Each star approaches and then recedes from the other in a fairly regular pattern, with the midpoint being perceived as shifting by no more ~0.002 L-y from right to left. This corresponds to a total angular displacement against a fixed background of arctan (0.002 L-y/10 L-y) = 0.0002, or 0.01°.
  - I remain skeptical whether such a miniscule displacement constitutes proof that light does not travel with the velocity of its source.