Correcting the Doppler Effect Formula

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Abstract

Christian Doppler, an Austrian physicist, described in 1842 the apparent change in frequency of a wave when motion of the source or the observer is involved. Named after him, this change in observational frequencies is known as the Doppler Effect. The formula for calculating the frequency change is taught in universities, textbooks, Youtube, and on the internet. Understanding the Doppler effect is used in applications such as radar and astronomy. Yet, the formula is wrong, yielding a different result when applying the same velocity, once to the source, then to the observer. This article will show the formula, the error, the correction to the formula, and how it disproves Einstein's theories of special and general relativity.

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1. Introduction

The Doppler Effect describes the change in observed frequency of waves due to the motions of the source, the observer, or both. Every type of wave travels at a constant velocity until conditions change. The velocity of sound changes with temperature and travels faster as the medium gets denser, going from about 340 meters/second in air to over 5,100 m/s through steel. "Water waves produced by a slow-moving tugboat have the same speed as those produced by a high-powered speedboat."[1] And light goes slower as the medium becomes denser, going from approximately 300,000 km/sec in a vacuum to about 200,000 km/sec through glass. The formula for the Doppler effect will be explained, examples given to show the error, the correction to the formula, and how applying the corrected formula to special relativity disproves the theory.

2. The Doppler Effect formula

$fd = fs\ (\frac{vw \pm vo}{vw \mp vs})$. The symbols are defined as follows: *fd* = frequency detected; *fs* = frequency of source; *vw* = velocity of waves; *vo* = velocity of observer; *vs* = velocity of source; ± = direction of motion: if *vo* is moving away from the source, then that velocity is subtracted from *vw*, and added to *vw* if the observer is approaching the source; if *vs* is moving away from the observer then that velocity is added to the *vw* and subtracted if the source is moving toward the observer. The formula to find the wavelength of one wave is: $\lambda = \frac{velocity\ of\ wave}{frequency}$ where λ equals the length of one wave.

3. Showing the error

Two examples will be given here: one with sound, and the other with the electromagnetic waves of radio. We will assume constant velocities of the waves used in these examples.

Example #1. Our source is a car horn; *fs* = 1,000 Hz; *vw* = 340 m/s; our observer is on a quiet electric bicycle and our car when moving travels at the same velocity; *vs* = 15 m/s; *vo* = 15 m/s. Part 1a of the example is with the observer stationary and the car approaching the observer; part 1b is with the car stationary and the observer riding toward the car.

Solving 1a: $fd = 1{,}000\ Hz\ \left(\frac{340\frac{m}{s} + 0\frac{m}{s}}{340\frac{m}{s} - 15\frac{m}{s}}\right)$; *fd* = 1,046.15 Hz.

Solving 1b: $fd = 1{,}000 Hz\ \left(\frac{340\frac{m}{s} + 15\frac{m}{s}}{340\frac{m}{s} - 0\frac{m}{s}}\right)$; *fd* = 1044.12 Hz.

Example #2: Our source is a radio transmitter broadcasting at 10 MHz; *vw* = 300,000,000 m/s; our source is on a fast spacecraft, while our observer is on another spacecraft; when each are moving their velocity is 0.8*c*, or 240,000,000 m/s. Part 2a of this example is with the observer stationary and the craft with the transmitter approaching the observer, and vice versa for part 2b. Parts 2c & 2d of the problem is where the observer and source are moving away from each other. When dealing with velocities such as with example #2, we can substitute *vw* = *c* instead of the approximate velocity of *c*, which is 300,000,000 m/s. Then, we would also represent the velocities of *vs* & *vo* as a fraction of *c*. Although not necessary since you would be dealing with smaller numbers, the condensing of the formula could also be done with the sound waves, such that *vs* & *vo* would be a fraction of the velocity of the sound wave.

Physics texts claim that the formula for calculating the Doppler effect is different for electromagnetic waves "due to the effect of relativity" and is expressed as: "$fd = fs\left(\frac{\sqrt{1-\frac{vrel}{c}}}{\sqrt{1+\frac{vrel}{c}}}\right)$"[2] and most do not distinguish the motion between the source and observer, substituting *vrel* for relative velocity. By replacing the light clock, which is the foundation of special relativity, with an example which uses radio transmitters, and receivers with counters which serve as the observer's clock, it will be shown that special and general relativity are false theories. That example will be provided in the conclusion of this paper. Thus, the relativistic form of the equation is incorrect. These formulas, however, will be illustrated in the solutions marked Parts E & F, while the standard equation will illustrated in Parts A - D .

Both, the longhand and the shorthand examples of the problem are illustrated for example parts A – D, and only the shorthand example for later examples.

Solving for part A - the source is approaching the stationary observer:
$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 0\frac{m}{s}}{300{,}000{,}000\frac{m}{s} - 240{,}000{,}000\frac{m}{s}}\right)$; or $fd = 10MHz\left(\frac{1c + 0c}{1c - 0.8c}\right)$; fd = *50MHz*.

Solving part B - the observer is approaching the stationary source:
$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 240{,}000{,}000\frac{m}{s}}{300{,}000{,}000\frac{m}{s} + 0\frac{m}{s}}\right)$; or $fd = 10MHz\left(\frac{1c+0.8c}{1c + 0c}\right)$; fd = *18Mhz*.

Solving part C - the source is moving away from the stationary observer:
$fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 0\frac{m}{s}}{300{,}000{,}000\frac{m}{s} + 240{,}000{,}000\frac{m}{s}}\right)$; or $fd = 10MHz(\frac{1\,c + 0c}{1\,c + 0.8\,c})$; fd = *5.555MHz*.

Solving part D - the observer moving away from the stationary source: $fd = 10MHz\left(\frac{300{,}000{,}000\,\frac{m}{s} - 240{,}000{,}000\,\frac{m}{s}}{300{,}000{,}000\,\frac{m}{s} + 0\,\frac{m}{s}}\right)$; or $fd = 10MHz(\frac{1c - 0.8c}{1c + 0c})$; fd = *2MHz.*

Solving part E using relativistic formula - the source and observer are approaching:

$$fd = 10\ MHz\left(\frac{\sqrt{1 - \frac{-0.8}{c}}}{\sqrt{1 + \frac{-0.8}{c}}}\right) = \ 30\ MHz$$

Solving part F using relativistic formula – the source and observer are moving apart:

$$fd = \ 10\ MHz\left(\frac{\sqrt{1 - \frac{0.8}{c}}}{\sqrt{1 + \frac{0.8}{c}}}\right) = 3.333\ MHz$$

Whether it was the source moving or the observer moving, the distance between the two was changing at the same rate, and therefore the waves should appear to be compressed when approaching, or expanded when moving apart, at the same rate. While the difference at lower velocities and frequencies, such as in example #1, is slight, and the answers given in some texts and online use the ≈ symbol for approximately, once we apply the formula to light speed equations as in example #2, the error in the Doppler equation becomes substantial.

As we look for the correct answer for example #2, we search for solutions. Our wavelength of *fs* is: $\lambda = \frac{vw}{fs} = \frac{300{,}000{,}000\ m/s}{10{,}000{,}000\ Hz}$; λ = 30 m. Our velocities of the observer and source closed the gap at 240,000,000 m/s when approaching each other. This meant that the electromagnetic waves had the appearance of moving at 540,000,000 m/s. When moving apart the waves appeared to have velocity of only 60,000,000 m/s. Approaching: $30m = \frac{540{,}000{,}000\ m/s}{fd}$; *fd = 18 Mhz*; receding: 30*m* $= \frac{60{,}000{,}000\frac{m}{s}}{fd}$; *fd* = 2 *MHz*. We should also realize that if we doubled our velocity of waves, the observed frequency would only be 20 *MHz*, and therefore parts a and c yielded an incorrect answer.

Relativity is wrong and there is no way to correct the errors in the relativistic versions of the Doppler effect formula. It was illustrated in parts E & F of the example only for the purpose of showing that it yielded an incorrect answer.

The instant implication of the error of the Doppler Effect formula being wrong is that every astronomer/ astrophysicist who has by means of redshift used the formula to calculate the velocity at which a star is moving away or a galaxy is expanding has reached an incorrect conclusion. Redshift is a measurement of the shift in the frequency detected of light from a star or galaxy based upon the assumption that the shift in frequency is caused by motion. It is an assumption because lower temperature, higher pressure, or a combination of the two can also cause a shift in the frequency of light.

4. Correcting the Doppler Effect Formula

Simply by moving the velocity of the source to the numerator and changing our ± use on the source such that as it approaches we add and as it recedes we subtract, we arrive at a correct solution: $fd = fs(\frac{vw \pm vs \pm vo}{vw})$. This can be reduced to $fd = fs\ (\ 1\ \pm vrel\ )$. Applying this to Example #2:

Part A: the source is approaching the stationary observer: $fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 240{,}000{,}000\frac{m}{s} + 0\frac{m}{s}}{300{,}000{,}000\frac{m}{s}}\right)$; $fd = 10MHz\left(\frac{1c + 0.8c + 0c}{1c}\right)$; *fd = 18 MHz*;

part B: the observer is approaching the stationary source: $fd = 10MHz\left(\frac{300{,}000{,}000\frac{m}{s} + 0\frac{m}{s} + 240{,}000{,}000\frac{m}{s}}{300{,}000{,}000\frac{m}{s}}\right)$; $fd = 10MHz\left(\frac{1c + 0c + 0.8c}{1c}\right)$; *fd = 18 MHz*;

part C: the source is moving away from the stationary observer: $fd = 10\ MHz(\frac{1c - 0.8c + 0c}{1c})$; *fd = 2 MHz*;

part D: the observer moving away from the stationary source: $fd = 10MHz(\frac{1c + 0c - 0.8c}{1c})$; *fd = 2 MHz.*

5. The Light Clock

The light clock is a thought experiment, fundamental to the teaching of special relativity which is comprised of two parallel, horizontal mirrors with a pulse of light bouncing between the mirrors. There are numerous errors made with the teaching of the light clock: 1. Representing light as not to act “independent of the state of motion of the emitting body”; 2. The observational delay when viewing the pulse of light; 3. The imaginative thought that you could see the individual pulse of light; 4. The angle of observation illustrated in college physics textbooks prohibits the moving observer from being in inertial motion with respect to the stationary observer; 5. The scale to which the illustration is drawn (light travels approximately 300,000 km/second, yet the observers are shown next to the clock as the pulse bounces between the mirrors); 6. A clock is merely an instrument attempting to measure time, just as a barometer is an instrument which attempts to measure atmospheric pressure: each instrument is subject to instrument error and neither time nor atmospheric pressure is determined by the instrument; and 7. The misunderstanding of what time is. Yes, an accurate clock can be used to calculate velocities such as race cars, and distances such as with timed radio signals. But time is a system of information exchange, how that God and men communicate events in relation to the rotation of Earth: how long it took God to create the Earth and the universe, how long Jesus was in the tomb, what you plan to do next month, and how fast something travels, including the velocity of light, all relate to the rotation of Earth. It is not the clock that determines the time, but the rotation of Earth.

While the light clock would cease to work once in motion, most people are apparently unaware of this fact. Calculations are made by the stationary observer, Bob, of the moving, Alice, observer's light clock using the Lorentz transformation equations, which are based upon Pythagorean's theorem. For a more detailed description of a few of these errors, look up and read my published paper, *It is Impossible to Teach Special Relativity Without Deceiving the Student.*[3]

6. Conclusion

Simply by replacing the light clock by each observer with two receivers which are equipped with pulse counters and a radio transmitter beside each observer, we have a thought experiment which is irrefutable in disproving special and general relativity. The transmitters emit a modulated pulse every second, similar to that of the U.S. Naval Observatory's WWV transmitter, which navigators monitor for their time signal. One of the receivers monitors the transmitter beside the observer and its counter represents the true time. The other receiver monitors the transmitted signal emitted from the other observer's transmitter. The receivers have autotune capability which is required because as Alice goes into motion, the Doppler effect will alter the observed frequency from the other observer's transmitter. All four counters/clocks are synchronized prior to Alice going into motion. Regardless of direction or velocity which Alice travels, the two receivers monitoring the other person's transmitted signal will stay in sync, but will not agree with the "true time" counters of the receivers monitoring the transmitter adjacent to it until Alice returns to her original starting point. Time dilation is impossible.

If you still think special relativity is true, work the math using the corrected Doppler equation until you see your error. Nothing false can be proven true by experiments or tests. Therefore, as special and general relativity are proven false, so also are all the claims made in support of these theories. Apply God's advice: "prove all things, hold fast that which is good", and you should have little difficulty in finding the errors of the claims or tests made in support of Einstein's theories of relativity. I addressed a few of the more popular deceptive claims in a recently published paper I had written.[4]

Acknowledgements

I thank God for giving me the understanding to see the error in this 180 year-old formula, and the solution to the formula.

References

[1] Physics, James Walker, ©2002, page 948

[2] College Physics, Nicholas Giordano, ©2010, page 785

[3] It is Impossible to Teach Special Relativity Without Deceiving the Student, Science and Philosophy Journal, Volume 10, Issue 2, ©2022, http://dx.doi.org/10.23756/sp.v10i2.1036

[4] Ibid.