Radar Guns and Einstein's Theories

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Abstract*: Basic radar guns provide an excellent means of explaining and demonstrating some of Einstein's theories in a very simple and undeniable way. Specifically, basic radar guns demonstrate how the speed of the emitter cannot add to the speed of the light being emitted, but the speed of light can be combined with the speed of the receiver. In practice, this appears to conflict with a basic tenet of mathematicians who believe that motion is relative, and the speed of light will be the same for the emitter as for the receiver. A step by step analysis of how basic radar guns work shatters that tenet.*

Key words: Radar; Relativity; motion; light; particle; wave.

I. Different Types of Radar Guns.

Contrary to what was unintentionally implied in the first version of this paper, all radar guns do not work the same way and produce the same results. They can, however, be organized into two categories: **basic** radar guns and **complex** radar guns.

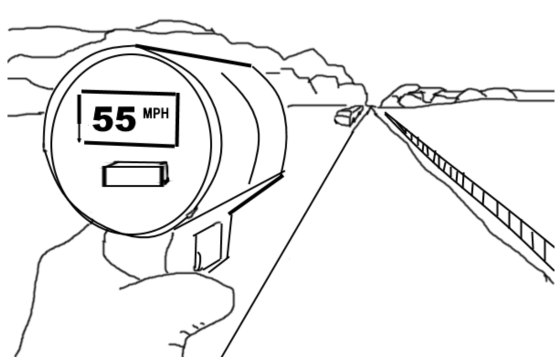

Figure 1

Most people are generally familiar with how a radar gun works. Figure 1 above shows a radar gun being pointed at an oncoming car that is traveling toward the gun at 55 miles per hour. There is no way to tell, however, if the gun in Figure 1 is a "basic" gun or a "complex" gun.

With both types of guns that look like the one in Figure 1 the operator turns on the gun by pressing the button on the back beneath the display screen. He then simply points the gun at a target and squeezes the trigger, which causes radio wavelength photons to be emitted toward the oncoming car. Some of the photons get reflected off the car and return back to the gun with a different oscillating wavelength. The gun then compares the different wavelengths, computes the difference in velocity the different oscillating wavelengths represent, and the operator reads the mileage calculation on the small display screen on the back of the gun.

The differences between the two types of guns is what **else** might happen inside the gun between the pressing of the trigger and the creation of the 55 mph reading on the display screen. A basic radar gun essentially just compares the different photon oscillating frequencies, i.e., the oscillating frequency of the photons the gun emitted and the oscillating frequency of the photons that return to the gun from the target. It converts the Hertz difference to miles per hour and displays that number **for the fastest moving object** it detected. If there are 10 cars in range of the gun, it displays the speed of the fastest car, regardless of which direction the car is moving.

A "complex" radar gun, such as the Bushnell Speedster 101911, first "filters" the signal, then it is "digitized in an Analog to Digital Converter (ADC), and passed onto the Digital Signal Processing (DSP) chip. Using complex algorithms, the DSP chip filters out false and low level return signals, to identify and display the speed of the desired target." The DSP chip software also filters "out bad information, providing valid accurate information."[1]

Exactly what it considers to be "bad information" isn't made clear by material supplied for the Bushnell gun, but, since it is designed for use in sports, it does **not** show the tip of a golf club as moving faster than the golf ball the club hit, while a basic radar gun will show **only** the fastest speed measured, which is most likely the tip of the golf club. The Bushnell software also prevents measuring the speed of an arrow shot toward the gun, probably because the point of the arrow returns too few photons to be considered "good information." Evidently, the Bushnell also measures any movement of the radar gun itself which might affect a reading. That means that "if you would like to know the speed of the vehicle you are in, point the Speedster at a stationary object, such as the ground."[2]

Other "complex" radar guns give readings for multiple targets, and/or give readings for the vehicle carrying the gun **and** the speed of a target. Some have multiple emitters and receivers. Such radar guns are used by the police when they are in a moving patrol car.

Basic radar guns are used by the police only when sitting in a patrol car that is parked at the side of the road or when the officer is standing next to the parked car while holding the gun. Such basic radar guns best demonstrate Einstein's theories.

II. Basic Radar Gun Physics.

The first question addressed in this paper is: What speed does the **basic** radar gun display if, *contrary to its intended use*, the gun is operated from a vehicle moving at 60 mph and the gun is pointed at a stationary object such as the ground, a highway sign, a tree or parked car at the side of the road? The answer is the basic gun will show no reading, which means the speed it measures is less than 10 mph. That is very different from the 60 mph reading that a **complex** radar gun will display. So, why do the radar displays differ, and which is “correct”?

The reading produced by a complex radar gun (60 mph) is “wrong” because it is in disagreement with fundamental physics. It disagrees with what Dutch physicist Willem de Sitter observed in 1913[3] and wrote about in 1916 in “*Einstein's Theory of Gravitation, and its Astronomical Consequences*.”[4] And it also disagrees with Albert Einstein who used de Sitter’s observations in his book “*Relativity: The Special and General Theory*.”[5]

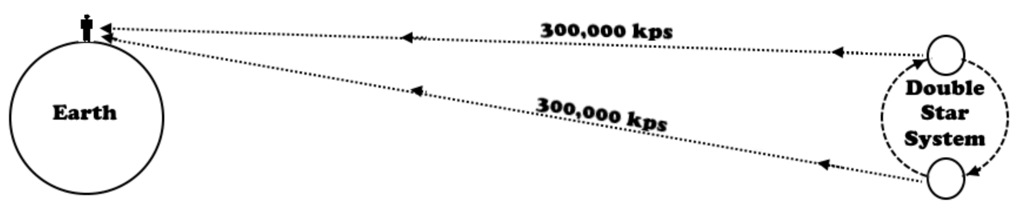

Figure 2

Figure 2 illustrates de Sitter’s observation. The two stars in the double star system orbit each other, which means that when one star is moving toward the earth, the other is moving away from the earth. According to Isaac Newton and Swiss theoretical physicist Walther Ritz, the light from the star moving toward the earth should travel at $c+v$, where v is the speed of the star toward earth, and the light from the star moving away from the earth should travel at $c-v$. That has become known as “Emission Theory.” De Sitter’s observations showed that “Emission Theory” was <u>*not true*</u>. The light arrives at 300,000 kilometers per second (kps) from *both* stars. If “Emission Theory” were true, that would mean that, while the light from the receding star is traveling to the earth, the faster moving light from the oncoming star would pass by the slower moving light, and an observer on earth would see the same star in different locations. That doesn’t happen.

Einstein agreed. He decided there must be a *maximum speed limit* in our universe that prevents light from traveling faster than 300,000 kps. And all light *must* be emitted at 300,000 kps *in all directions*. The binary star moving away from the earth still emitted light that traveled at 300,000 kps even though $c-v$ would not be in conflict with the maximum speed. That means that, no matter how fast the emitter is traveling, *or in what direction*, the light that a source emits will travel at 300,000 kps.

And that means that a radar gun will always send out photons at 300,000 kps regardless of how fast the gun is moving.

So, if a police car is parked at the side of the road and the officer points his basic radar gun at a highway sign 20 feet way, the gun will give “no reading,” which is equivalent to a speed reading of zero. The photons of light going from the gun to the sign traveled at the same speed and with the same oscillation wavelength as the light returning from the highway sign to the gun.

The target was moving at 0 mph and the radar gun could compute no difference in oscillation wavelengths.

If the officer gets into his patrol car and starts it moving while keeping his radar gun pointed at signs alongside the road (or at the ground ahead) he will still get no readings. The gun emits photons at the same speed as when parked and the signs and highway are still stationary, so the gun shows no reading (i.e., a speed of zero).

If the officer points his basic radar gun at a car coming toward him at 55 mph, the light photons from the gun will travel at *c* to the target, the target car will encounter the photons as arriving at *c+v*, giving the photons more energy than they actually possess. The new photons sent back from the target will again travel at *c*, but the oscillation wavelength of the returned light photons will be shorter, representing greater energy. The radar gun will compute the difference in oscillation wavelengths and show 55 mph, just as seen in Figure 1 when the gun was stationary. If the police car starts moving and travels toward the oncoming car at 60 mph as the officer takes another reading, the radar gun will *still* show the speed of the oncoming car as 55 mph. The speed of the patrol car will not alter the speed of the light photons traveling to the oncoming car. The light photons still travel at *c* to the oncoming car, ***and*** the patrol car's speed has no effect on the oscillation wavelengths of the photons the radar gun emits. Only the speed of the target affects the oscillation wavelengths.

Those basic radar readings are all in full accord with de Sitter and Einstein.

III. Photons and Wavelengths

A photon and its oscillating electromagnetic fields are described in my paper *Photons and Polarization.*[6] The problem when using photons in an illustration for a paper like this one is that photons are fluctuating particles that are constantly changing shape **in two different directions**. Plus, there are typically billions of them moving and oscillating at the same time. That is difficult to depict on a two dimensional drawing. Scientific articles, therefore, typically depict photons as tiny waves[7] as shown on the left in Figure 4 below.

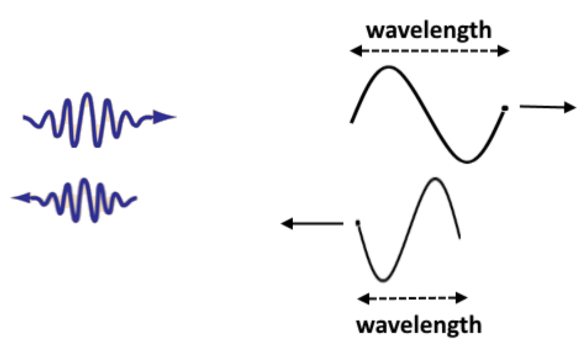

Figure 4

In this paper I will use the less common version on the right. It represents a photon starting at the point where one of its electromagnetic fields is halfway extended, then the field fully extends (the "crest") and fully contracts (the "trough") before returning to the midway point once again. The photon itself moves in a straight line.

So, what happens when the operator pulls the trigger on a basic radar gun?

First, the radar gun's transmitter sends out a burst of billions of individual photons like shotgun pellets from a shotgun, as shown in Figure 5 below.

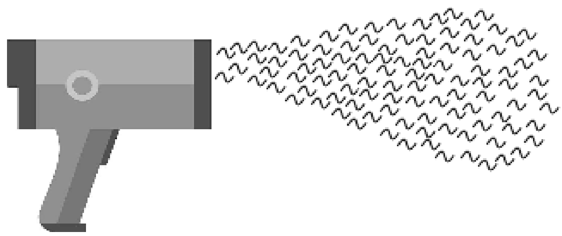

Figure 5

The billions of photons travel at the speed of light *c* in the direction of the target – but spreading out in a cone pattern (as shown above) along the way. 800 feet from the gun the photons will cover a target area around 30 feet in diameter. As a result of the spreading, only a small fraction of the photons actually hit the target. And because the target is coming toward the emitter radar gun, the photons hit atoms in the target at the speed of light plus the speed of the target or $c+v$. When a photon hits an electron within an atom, the electron gains energy and jumps to a higher energy level. That creates an unstable atom, so the electron immediately drops back down to its normal level and a *new* photon is released in a random direction. Because the incoming photon was received at $c+v$, the new photon has a shorter oscillating wavelength and higher energy than the original. (The kinetic energy of the photon moving toward the atom added to the energy of the new photon.)

Since the atoms in the target car send the new photons off in all directions, only a tiny fraction of the photons emitted by the car actually make it back to the radar gun. Meanwhile, the radar gun's transmitter has switched to receiver mode and receives back those photons. The receiving equipment within the gun ignores the countless photons of different frequencies that also arrive, such as those emitted by radios, light bulbs, the sun, and virtually every object, and only accepts those photons oscillating close to the frequency of the original photons (i.e., only the returning photons). Comparisons of oscillation frequencies are made, and a computer chip within the gun then compares the wavelength of the original photons it sent out to wavelength of the returned photons. The original photons were sent at *c* and with their original wavelength. The returned photons were also emitted at *c* but with the shorter, higher energy ($c+v$) wavelength. The computer chip within the gun essentially subtracts the *c* wavelength from $c+v$ wavelength and gets *v*, which is the speed of the oncoming car.

IV. A Proposed Experiment

The above examination of the workings of radar guns suggests an interesting experiment. So far, as far as I have been able to determine, the experiment described below is only a "gedanken" or "thought experiment," but it should be very easy and inexpensive to verify or disprove by real experiments using a **basic** radar gun.

Einstein's First Postulate to this Special Theory of Relativity states as follows:

> The same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good.**[8]**

That postulate has generally been interpreted to mean that a person within one frame of reference will get the same results to an experiment as a person in another frame of reference performing an identical experiment, even if one frame of reference is stationary and the other is moving at a high inertial speed. It is only when the details of the two experiments are compared that it will be discovered that **the length of a second** is longer in the frame of reference that was moving. Therefore, even though both frames measured the speed of light to be 300,000 kilometers *per second*, the length of a second was different, which means the measured speed of light was also different.

The physics of basic radar guns seem to show another way that test results within a stationary frame are actually different from test results in a moving frame, even though the same laws of electrodynamics and optics are used, and even though the same equations of mechanics are used.

In the book Albert Einstein wrote with Leopold Infeld**[9]**, Einstein and Infeld describe what happens when a light bulb is turned on in the center of a moving laboratory.

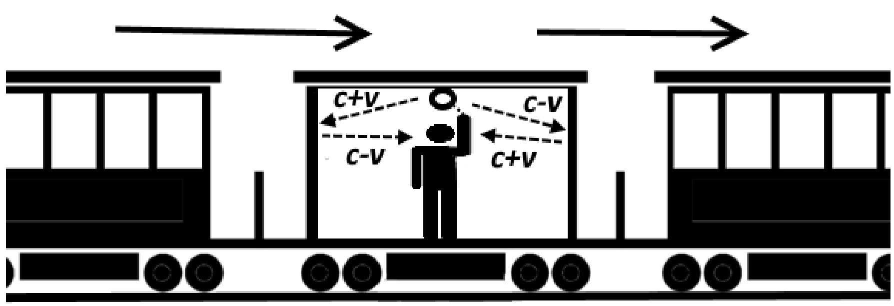

Figure 5

In Figure 5, the moving laboratory is on a train that is traveling at high speed (*v*) from left to right. When the light above the observer is turned on, it emits photons. The rear wall of the laboratory is moving toward the oncoming photons at *v*, so that wall encounters the photons at *c*+*v* and that wall is illuminated first. However, the newly created photons emitted at *c* from the illuminated rear wall have to catch up with the observer as he moves away (at velocity *v*) from the point in space where those new photons were created. Meanwhile, the opposite happens with the front wall. Light photons take longer to reach that wall because it is moving away from the oncoming photons (*c-v*), but the new photons that are created by the front wall's atoms take less time to reach the observer who observes those photons as arriving at *c+v*. The result is that the observer sees both walls illuminated at the same time.

But, what would happen in that same moving laboratory if a *basic radar gun* was pointed at the rear and front walls?

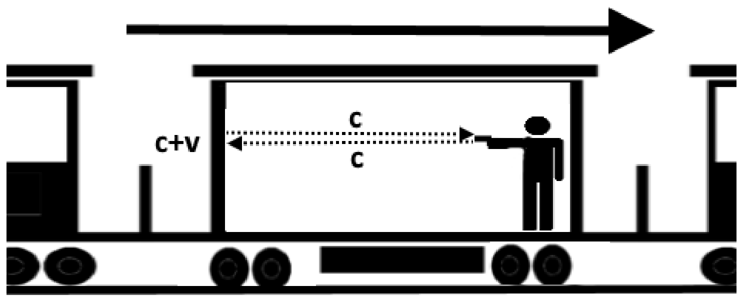

Figure 6

Figure 6 shows an observer with a basic radar gun firing the gun at the rear wall on a train that is moving from left to right at velocity *v*, which we can assume to be 60 mph. Since the movement of the emitter does not add to the speed of the photons emitted, the photons travel to the wall at *c*. However, the rear wall is moving toward the oncoming photons at velocity *v* (i.e., 60 mph), thus the photons hit the atoms in the rear wall at *c+v*. New photons with higher energy and a shorter oscillating wavelength are then emitted by atoms in the wall back to the radar gun at velocity *c*. The radar gun compares the oscillating wavelength of the photons it emitted to the wavelength of the returned photons and calculates the speed of the rear wall (and the laboratory) to be 60 mph.

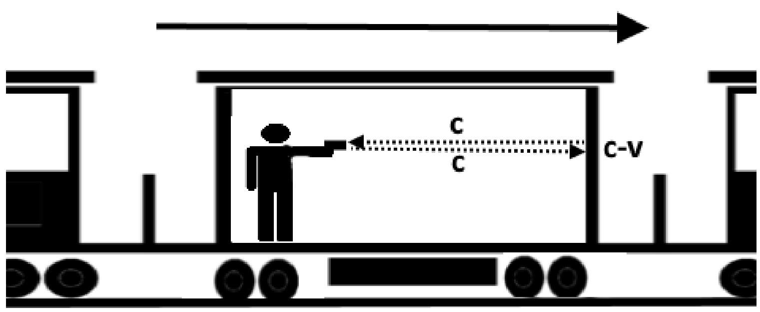

Figure 7

When the observer moves to the opposite end of the laboratory on the train as shown in Figure 7, and when he fires the basic radar gun at the front wall, the front wall encounters the photons traveling at *c-v*, and the atoms return photons with less energy and a longer wavelength. The radar gun compares the wavelength of the photons it emitted to the wavelength of the photons it received back and calculates the speed of the train to be *negative* 60 mph. (The gun cannot normally show negative numbers, so it displays 60 mph regardless of whether the number is positive or negative. If the gun *could* show negative numbers, it could also tell the direction the laboratory is moving.)

This experiment says that an observer within an inertial frame of reference *can* determine if he is moving or not relative to the ground outside by using a basic radar gun, and he or she can (in theory) even tell in which *direction* the reference frame is moving. This is *not* movement relative to any imaginary ether (or aether), it is movement **relative to the speed of light.** Photons are **emitted** at 300,000 kps, regardless of any movement by the emitter.

Special Relativity says that the length of a second will be longer for a moving object than for a stationary object. And the faster an object moves, the longer a second will be for that object. However, in this situation the emitter and the railroad car are moving at the same speeds so velocity time dilation does not apply. (And General Relativity time dilation does not apply, since the emitter and observer are at the same altitude and experience the same pull of gravity.) The only difference in this situation is that the emitter will emit photons which travel at c, but the photons can hit moving objects at $c+v$ or $c-v$, where v is the speed of the object.

While such movement by the receiving object is relative to the speed of light, it is definitely *not reciprocal*. The moving railroad car and the emitter are stationary relative to one another. The radar gun emits photons at c regardless of any motion by the emitter or receiver. The receiving object, however, receives the photons at $c+/-v$ depending upon the whether the receiver's movement is toward or away from the emitter.

Since a **basic** radar gun always emits photons at c, it cannot tell if it is moving or not. However, a **complex** radar gun, like the Bushnell Speedster 101911, can measure its own speed and direction of movement the same way the speed of the railroad car was determined in the above discussion. The gun just needs to emit and receive back a photon that hits some obstacle **inside the gun**. That gives it the gun's speed of 60 mph. The gun can then subtract the gun's speed from the speed of zero that it receives back from the ground. Zero minus 60 mph is -60 mph. The gun does not distinguish between negative and positive results, so it displays 60 mph.

V. Conclusion

The explanations above clearly conflict with what is written in most college physics textbooks. Such textbooks typically describe light as waves, and they describe the Doppler effect as working the same way whether the emitter is moving toward an observer or the observer is moving toward the emitter.[10] Very few (if any) textbooks contain anything like this quote from Richard Feynman's book "*QED*":

> "I want to emphasize that light comes in this form — particles. It is very important to know that light behaves like particles, especially for those of you who have gone to school, where you were probably told something about light behaving like waves. I'm telling you the way it does behave — like particles.[11]

Einstein said somewhat the same thing, but it was in his typical, much more convoluted and less easily decipherable way:

> Indeed, it seems to me that the observations of "blackbody radiation," photoluminescence, production of cathode rays by ultraviolet light, and other related phenomena associated with the emission or transformation of light appear more readily understood if one assumes that the energy of light is discontinuously distributed in space. According to the assumption considered here, in the propagation of a light ray emitted from a point source, the energy is not distributed continuously over ever-increasing volumes of space, but consists of a finite number of energy quanta localized at points of space that move without dividing, and can be absorbed or generated only as complete units.[12]

There can be no doubt that light consists of photons, not waves, and when radar gun photons are emitted toward a target or are returned from a target they are actually a scattering of oscillating particles that are totally unlike a wave.

Furthermore, a moving light source emits photons at the same speed (the local speed of light) whether the photons are emitted behind the moving source, ahead of the moving source, or at right angles to the direction the source is moving. The only difference is that, because the emitter is moving, the photons emitted behind the emitter will be more widely scattered than the photons emitted in the direction the emitter is moving, as illustrated in Figure 8 below.

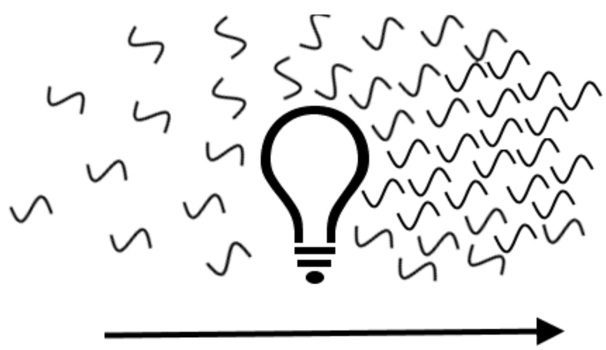

Figure 8

Many college text books incorrectly proclaim that the speed of light is the same for the emitter as for the observer, meaning that the observer (or target) never encounters light arriving at $c+v$ or $c-v$.[13, 14] That is not only disproved by basic radar guns, it is a demonstrably *incorrect* interpretation of Einstein's Second Postulate, a subject which I wrote about in another paper.[15]

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