Radar Guns vs Wave Theory

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***Abstract**: Radar guns seem to be a simple way to illustrate some of the biggest misunderstandings in science. Radar guns clearly demonstrate that light (and all electromagnetic energy) travels in the form of photons, not as waves. Radar guns also show that Wave Theory is both misleading and totally wrong.*

Key words: Light; wave theory; photon; radar; relativity.

For some unclear reason, police radar guns are nearly always depicted and described as emitting <u>waves</u> of energy which the guns supposedly utilize along with the Doppler Effect to measure the velocity of a target.

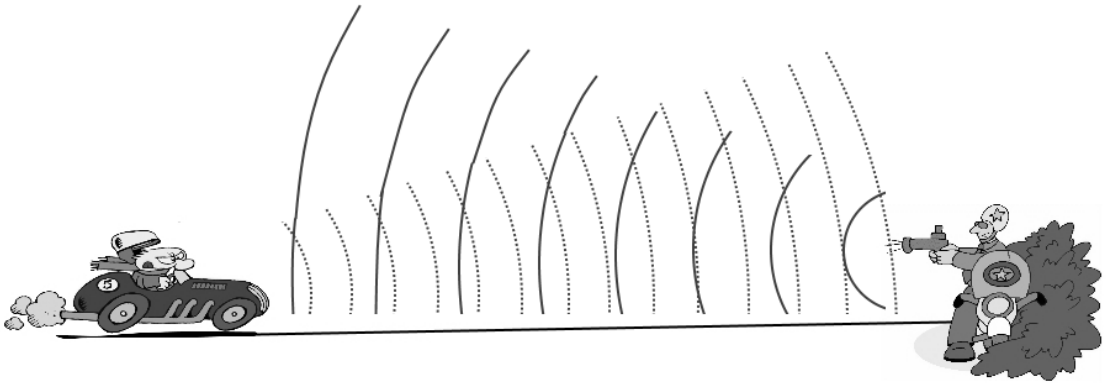

Figure 1

In Figure 1 above, the radar gun is imagined as emitting energy waves at a given frequency. The waves reflect off of the front of the oncoming target vehicle and return at a higher frequency because as each wave hits, the target has moved a bit closer to the gun. It is

explained that the difference in the frequency of the waves emitted by the gun and the frequency of the returning waves allows the gun to compute the speed of the target. This method of explaining the wave theory of light is then compared to sound waves and how the whistle of an oncoming train sounds high-pitched as it comes toward you and then lower-pitched as it moves away from you.

The comparison of imaginary light waves to actual sound waves is misleading in many ways. The train whistle is emitting the sound waves, the waves are not being emitted by anything held by the listener standing on the embankment somewhere ahead of the train. So, the listener is hearing the sound directly, not a reflection of sound. When the engineer on the train pulls a cord that turns on the whistle, he hears the sound of the whistle as perfectly normal. The listener up ahead hears high pitched waves as the train approaches, then lower pitched waves after the train has passed and moves away. That has virtually nothing to do with how the radar gun in Figure 1 works.

Using actual numbers,[1] the radar gun in Figure 1 supposedly emits waves at 24.125 Gigahertz (GHz) or 24125000000 Hertz (Hz), which is 24,125,000,000 waves per second. (24.125 GHz was chosen as the gun's emission frequency because it is not a frequency commonly emitted by anything else.) If the target is traveling at 60 miles per hour (mph) in the situation illustrated in Figure 1 above, the gun gets back 24,125,004,308.035713 waves per second. The gun then subtracts one wave frequency from the other and determines a difference of 4,308.035713 Hz, which equals 26.785714285714285 meters per second or 60 mph.

In my paper on *Radar Guns and Einstein's Theories*,[2] I used Figure 2 below to illustrate how NASA explained on their web site[3] that a single photon emitted by a radar gun can actually measure the speed of a target.

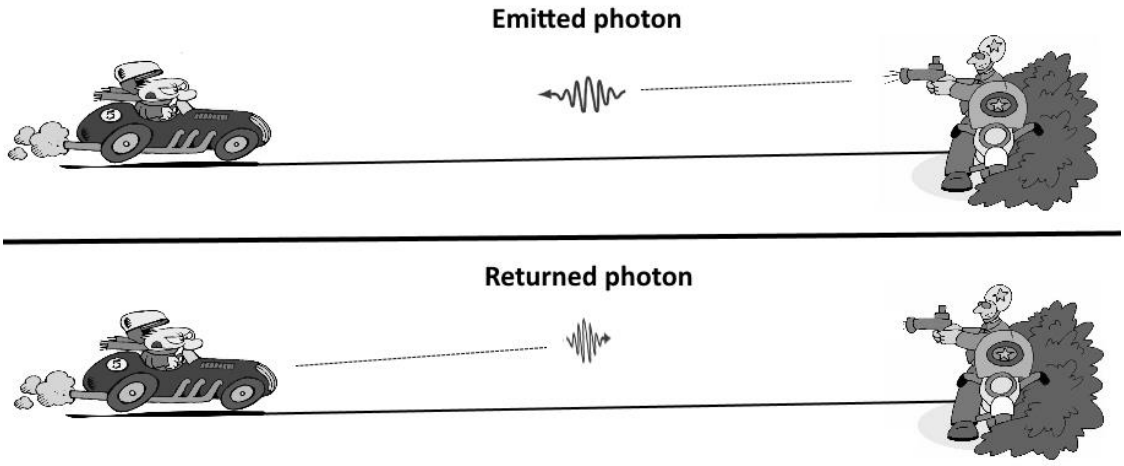

Figure 2

The emitted photon travels at the speed of light *c*, but it hits the target vehicle at *c+v*, where *v* is the speed of the target. The photon is absorbed by an electron within an atom within

some part of the target, say its front bumper. The atom becomes unstable because the electron is unable to hold the extra energy of the photon. To get rid of the excess energy, the atom emits a **new** photon back toward the radar gun. Because the photon hit the target at *c+v*, combining the photon's original energy with the kinetic energy of the moving target, the new photon which is emitted back toward the radar gun contains that extra kinetic energy in the form of a higher oscillation frequency than that of the original photon.

The radar gun receives the new photon and compares its oscillation frequency to the oscillation frequency of the photon it originally emitted and determines a "beat frequency," which is the difference in oscillation frequencies. That "beat frequency" is directly convertible into a measurement of the speed of the target vehicle.

Again using actual numbers, the radar gun emits photons that oscillate at 24.125 Gigahertz (GHz) or 24,125,000,000 times per second. In the situation illustrated in Figure 2 above, it gets back a photon that oscillates 24,125,004,308.035713 times per second. The gun then subtracts one oscillation frequency from the other and determines a "beat frequency" of 4,308.035713 Hz, which equals 26.785714285714285 meters per second or 60 mph.

I. Which is correct?

Do radar guns emit waves or photons?

Physicist Richard Feynman once said and wrote, "We know that light is made of particles because we can take a very sensitive instrument that makes clicks when light shines on it, and if the light gets dimmer, the clicks remain just as loud—there are just fewer of them. Thus light is something like raindrops—each little lump of light is called a photon—and if the light is all one color, all the 'raindrops' are the same size."[4] Professor Feynman then added:

> "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.
>
> "You might say that it's just the photomultiplier that detects light as particles, but no, every instrument that has been designed to be sensitive enough to detect weak light has always ended up discovering the same thing: light is made of particles."[5]

A radar gun could not work if it emitted waves as shown in Figure 1. Wave theory inexplicably assumes that the *only* way waves can get back to the radar gun is if they bounce off of the **front** of the oncoming car. In reality, of course, waves would also bounce off the chrome around the windshield, off of stones on the ground, off of trees, parked cars, highway signs, etc. And, in Wave Theory, **other waves** such as light waves from the sun are also bouncing off of everything in sight. How do you determine the speed of the target if you emit waves at a specific

frequency and get back a massive jumble of waves with no way to distinguish one wave from another in order to determine frequency? You can't.

With photons, however, it is all very simple.

The radar gun emits photons that oscillate at 24125000000 Hz. If the target is traveling at 60 mph, the photons that return from the target will oscillate at 24125004308.035713 Hz. Since it is unlikely that any target will travel over 200 mph, and since there is no need to measure targets traveling less than 10 mph, the radar gun is built to ignore all returning photons that oscillate faster than 24125014360.11905 Hz (the 200 mph rate) and slower than 24125000718.00595 Hz (the 10 mph rate). That eliminates all photons from the sun's reflected light and from radio stations, and all photons bouncing off of stationary objects such at the ground, rocks, trees and highway signs. Only targets traveling between 10 and 200 mph will get their speed measured.

II. A simple experiment.

In order to perform some radar gun experiments, I purchased a used TS-3 police radar gun via EBay. The TS-3 is manufactured by Municipal Electronics, Inc., in Decatur, Illinois, with a list price of $500.[6] The gun uses a power cord to get electricity via the cigarette lighter socket in a car, so I also had to buy an adaptor to do in-door experiments. Total cost: less than $100.

The experiment I'll describe here is extremely simple: Standing to one side of an ordinary floor fan running at high speed, I merely pointed the gun at the moving blades. When I pointed the gun at the tips of the spinning blades at the top of their arc, the gun displayed their speed to be 43 mph. When I pointed the gun at the center of the blades, the gun displayed 32 mph. When pointed at the base of the blades, the speed was measured to be about 20 mph.

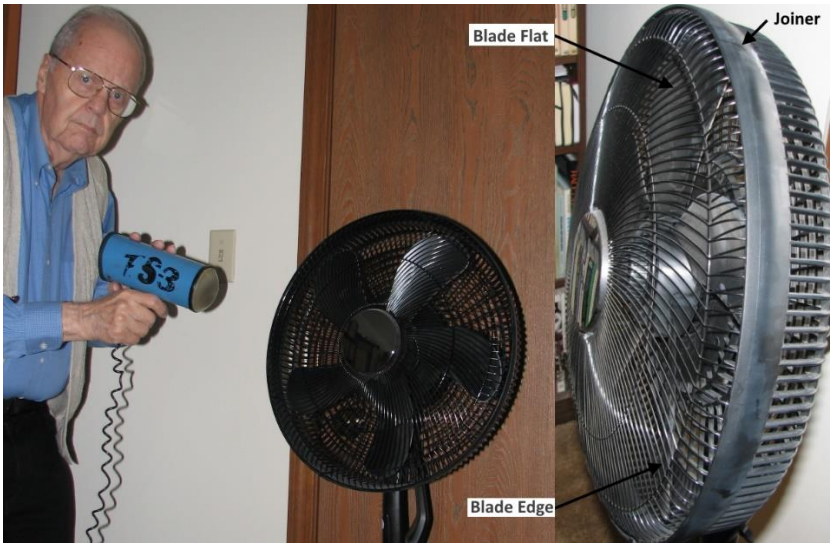

Figure 3

What did the experiment demonstrate? It demonstrated that the gun could routinely measure the speeds of the spinning blades **through the wire mesh that surrounds the blades**. Figure 3 above shows front and side views of the fan I used. It is a simple matter for individual photons to pass through the mesh. The photons that hit the stationary mesh are either deflected or measure a speed of zero. The same with the photons that pass through the mesh on both sides, missing the blades, and hitting the stationary wall beyond. Only the photons that actually hit the blades measure a speed.

Another interesting fact I learned what that a better and steadier reading is obtained if the angle allows the photons to hit the flat parts of the blades instead of only the thin edges of the blades. In Figure 3, the flat-side view is at the top and the edge view is at the bottom. From the opposite side of the fan, the flat-side view is at the bottom, the edge view at the top. I tried that angle, too, and the results agreed.

How is this explained with waves? When I asked some mathematicians via the Internet, most refused to answer. One simply declared that radar guns emit "standing waves," which makes no sense at all, and, of course, he wouldn't explain further.

III. Why is Wave Theory used?

Since experiments clearly show that light definitely consists of photons, why would colleges and universities teach students about "light behaving like waves"? Dr. Thomas Gold of Cornell University seems to have provided an answer to that question in a 1989 paper when he wrote that there is a "herd instinct" in science, and

> "It presumably dates back to tribal society. I am sure it has great value in sociological behavior in one way or another, but I think on the whole the "herd instinct" has been a disaster in science."
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> and
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> "It is not just the herd instinct in the individuals that you have to worry about, but you have to worry about how it is augmented by the way in which science is handled. If support from peers, if moral and financial consequences are at stake, then on the whole staying with the herd is the successful policy for the individual who is depending on these, but it is not the successful policy for the pursuit of science."
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> and
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> "Staying with the herd to many people also has an advantage that they would not run the risk of exposing their ignorance. If one departs from the herd, then one will be asked, one will be charged to explain why one has departed from the herd. One has to be able to offer the detailed justifications, and one's understanding of the subject will be criticized.

If one stays with the herd, then mostly there is no such charge. 'Yes, I believe that because doesn't everybody else believe that?' That is enough justification."[7]

For the past 100 years and more, colleges, universities and mathematician-physicists of all kinds seem content with the "particle-wave duality of light." When light appears to act like waves, as is the case with radar guns, they have a mathematical model they can use to adequately explain the properties of light using wave theory. When light acts like particles, as it does with the photo-electric effect when light photons hit a metal surface and individual electrons are ejected, they have a different mathematical model for that.

As long as they have a mathematical model that works, it seems mathematicians do not care about reality. That is a very serious problem if you are a scientist who wants to understand how something **actually** works.

This means that Thomas Young's famous Double Slit Experiment,[8] which is holy gospel for believers in Wave Theory, is also totally wrong. The Double Slit experiment also works the same way when photons are sent through the slits one a time to hit a photomultiplier. You still get dark lines and bright lines, only it can be positively stated that the dark lines are areas where no photons hit, instead of being areas where waves magically negate one another while violating the fundamental law of physics that says energy cannot be destroyed.

IV. The Physics "House of Cards"

Another apparent reason why wave theory is generally used to describe how radar guns work is because it avoids the question not asked in Figure 2: How can a single photon traveling at the speed of light *c* hit an oncoming vehicle at *c+v*, where *v* is the speed of the vehicle, if virtually every college text book says that is impossible because it conflicts with Einstein's Second Postulate? Nearly every college textbook has its own version of Einstein's Second Postulate:

"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."[9]

"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."[10]

"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**."[11]

"The constancy of the speed of light: The speed of light in a vacuum has the same value, c = 2.997 924 58 x 108 m/s, in all inertial reference frames, **regardless of the velocity of the observer or the velocity of the source emitting the light**."[12]

In reality, Einstein's Second Postulate says absolutely **nothing** about what an observer will observe when encountering light from an emitter. Einstein's Second Postulate merely 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**."[13]

How can so many textbooks get this simple statement so wrong? They get it wrong because Einstein's version conflicts with a fundamental belief held by countless mathematicians that, without any "stationary ether" to use as a "preferred frame of reference" from which all speeds are measured, **all motion *must* be relative**. I.e., if the emitter is moving at 50 mph relative to the observer, then the observer must also be moving at 50 mph relative to the emitter.

Such a belief makes absolutely no sense, but mathematicians will argue that logic and "common sense" have no meaning in physics. If the math works, then it is correct.

Einstein stated that measuring object speeds relative to the speed of light made the imaginary ether "superfluous."[14] But measuring speeds relative to anything other than a solid object appears to be a concept that most mathematicians simply cannot accept. It is not what they were taught in school, and "Too many people think that what they learned in college or in the few years thereafter is all that there is to be learned in the subject, and after that they are practitioners not having to learn anymore."[15]

If you believe that light consists of waves, you do not have to address any problem where light hits a vehicle at *c+v*, where *v* is the speed of the vehicle. Addressing such a problem would bring your whole system of beliefs crashing down like a house of cards.

V. Conclusion

"Wave-Particle Duality" is a Quantum Mechanics concept. In science it can be called "dedicated ignorance," which means a person does not know if light consists of waves or particles, and that person **does not care**. Einstein and Leopold Infeld wrote about this problem and saw there was only one solution:

> Science forces us to create new ideas, new theories. Their aim is to break down the wall of contradictions which frequently blocks the way of scientific progress. All the essential ideas in science were born in a dramatic conflict between reality and our attempts at understanding. Here again is a problem for the solution of which new principles are needed.[16]

New principles are needed to clarify how light works, but some old principles also need to be re-emphasized, particularly one clearly stated by Richard Feynman:

> **If it disagrees with experiment it is wrong. In that simple statement is the key to science.** It does not make any difference how beautiful your guess is. It does not make any

difference how smart you are, who made the guess, or what his name is - **if it disagrees with experiment it is wrong.**[17]

Radar guns routinely demonstrate that electromagnetic energy consists of photons, not waves. Double Slit Experiments using photomultipliers also routinely confirm this. If this disagrees with some mathematical model, then the model needs to be revised. If it disagrees with some mathematical principle, then that "principle" is **wrong**. Mathematics is not science, a mathematical model is merely a "tool," like a telescope, microscope, photomultiplier, etc. Science uses tools when tools are needed, and when a tool fails to work properly it is fixed or replaced. After all, for a thousand years the "herd" believed that the Earth was at the center of the universe, and they had a mathematical model to confirm it. Yet it was totally wrong.

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