Acta Scientific Applied Physics

Volume 3 Issue 5 May 2023

Review Article

Alteration of Electromagnetic Wavelengths by Reciprocation Between Moving Carriages

Oren Aharon*

CTO Duma Optronics, Israel

***Corresponding Author:** Oren Aharon, CTO Duma Optronics, Israel.

Received: March 08, 2023

Published: April 28, 2023

Abstract

This article discusses a device and a method for changing the wavelength of an electromagnetic or any other source with wavelength propagation characteristics.

A wavelength may be altered by reciprocating the original beam between two moving carriages. The device consists of two carriages that can move in either direction along a line and an electromagnetic beam reciprocating in between. A reflective element mounted on each carriage produces the reciprocation effect. The following discussion explores a method of changing the wavelength of a beam by reciprocation between reflective moving carriages. Each time the beam is reflected, its wavelength will change. The reflected beam will have a different wavelength each time it rebounds from a moving reflective surface. The amount of change for each reflection is according to what is commonly known as Doppler effect. Utilization of such a device or thought experiment could affect many aspects of modern physics in several areas such as:

- Continuous change in the wavelength of a laser or electromagnetic beam.
- Delivering energy from a remote source for propulsion purposes.
- Direct conversion of mechanical energy into light energy.

This article will explore the theory and applications of electromagnetic wavelength changes across a wide, almost infinite bandwidth. It also discusses actively increasing or decreasing the beams' energy by mechanical movement of reflective elements.

Keywords: Wavelengths; Carriages; Yielding

Theoretical description of the proposal

Imagine a simple arrangement of two carriages A and B departing from each other at a relative velocity of v. Carriage A is fitted with a collimated laser source aimed at carriage B which is fitted with a retro-reflector which reflects the beam back to carriage A. Carriage A is also fitted with a retro-reflector on top of the original laser source in such a way that the beam bounces back and forth between the two carriages. The light heads out to carriage B along what will be defined as x axis, which is also the relative movement direction between carriage A and B.

An observer in carriage B will perceive that light is coming from a moving source and so the frequency as observed by B will shift to red (assuming that the two carriages depart fromeach other) as compared to the original frequency fs.

Since according to relativity there is no absolute stationary reference, the incoming beam to carriage B will retain its red shifted wavelength when reflected back. Due to the relative movement between carriages the back reflected beam will shift farther to deeper red when it reaches its original source position again.

Due to the retro effect, the beam will bounce back and forth between the two departing carriages,causing the original sourceight wavelength to stretch by a given amount each time it bounces between the carriages. This behavior will last infinitely.

Various text books state that for v<< C where v is the relative speed between carriages, the wave elongation for each bounce is proportional to v /C. This relativistic redshift for a particle will then create a mechanism which will stretch the light wavelength to infinity when light bounces between two departing carriages., On the other hand, the wave length willshrink almost to zero when bouncing between two approaching carriages. An anomaly arises involving photon energy, E, proportional to its frequency, f, by

$$E = hf = \frac{hc}{\lambda} \quad \text{----(1)}$$

Where h is Planck's constant, $\lambda$is the wavelength and c is the speed of light. This is sometimes known as the Planck–Einstein equation.

Likewise, the momentum p of a photon is also proportional to its frequency and inverselyproportional to its wavelength:

$$p = \frac{E}{c} = \frac{hf}{c} = \frac{h}{\lambda}. \quad \text{---------(2)}$$

Einstein suggested that light is composed of particles (or could act as particles in some circumstances). Experimental measurements demonstrated that the energy of an individual ejected photon was proportional to the frequency, rather than the intensity, of the light. Applying this equation to the red or blue shift extremities in our imagined experiment can create very powerful photons on one hand (when λ is close to zero) or very weak when wavelength is stretched to very high values. Assuming that no photons are lost in the act of bouncing back and forth, we can see potential strong energy interaction between photons and carriage energy. Bouncing back andforth will change the wavelength according to Doppler effect each time the beam is reflected. Here Δλ is the amount of change in the wavelength of the incoming beam before it isreflected by the moving carriage. Λ is the incoming wave length before reflection. Since electromagnetic wavelength moves at the speed of light, multiple back and forth reflections will occur causing fast wavelength changes in a very short time. If the two carriages are departing from each other, the wavelength will increase and the opposite wavelength will decrease.

Moreover, if the carriages are approaching each other it is apparent that at collision (X=0) theenergy of the photon will increase to infinity. Since the beam is reflected its attenuation is given in percentages, i.e., regardless of the number of bounces there will always be some residual photons that potentially will end up with a wavelength very close to zero.

As shown by the formula, the photon's energy increases as wavelength shortens. Given enough energy to keep the carriages going, energy will be transferred from mechanical carriages to the reciprocating beam, decreasing the wavelength of residual light.

Description of possible configurations

The schematic drawing below illustrates a device and method of altering the wavelength of an electromagnetic beam over a large range. The wavelength alteration is performed over a wide range from awavelength of about zero to a wave length close to infinity. Performing the wavelength alteration requires the original electromagnetic beam to reciprocate between two moving reflective surfaces. The configuration discloses a wavelength changing device based on Doppler Effect applied to a beamreciprocating between two reflective surfaces.

Moreover the effect will increase or decrease the original beam energy according to the amount of changes in wavelength.

Figure 1 is a schematic representation of the proposed system. Carriage A has a laser source directed to carriage B, A and B are moving in relation to each other with a relative speed of 2v. A retro-reflector mounted on each carriage reflects back the incoming beam creating multiple reflections between the moving carriages. The laser beam will bounce back and forth multiple times, and its wavelength will change upon each reflection. The retro-reflector is a well-known optical device built as a corner of a cube where the three facets of the cornerare replaced by three perpendicular mirrors. The retro-reflector is used in this configuration as an example only, but any back reflecting device may be used to replace the retro-reflector. The original beam will reciprocate many times between the carriages until extinguished or until the distance between carriages willbe zero.

Figure 2 is a schematic representation of another configuration where the relative movement of thereflecting surfaces is achieved by counter rotation of the reflective surfaces.

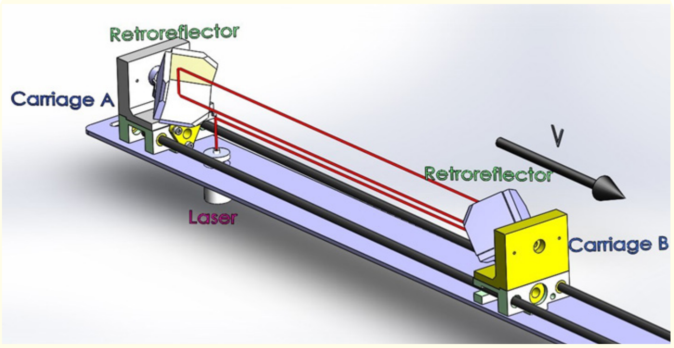

Figure 1: Proposed system configuration option 1.

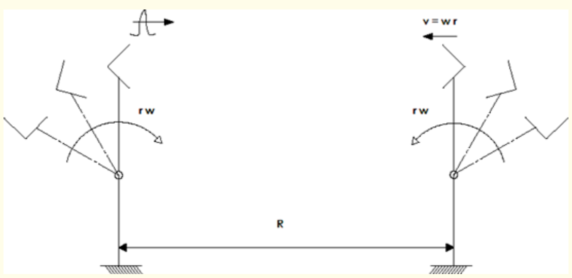

Figure 2: Proposed system configuration option 2.

Multiple reflective surfaces are mounted on rotating wheels with center points apart from each other. The rotating radius is identical for both wheels and creates a velocity of v on top of the rotating device. A pulsed beam is reciprocating between the two upper positions of the reflective surfaces respectively. The distance between the rotating carriages **r** is calculated in such a way that the traveling pulse of electromagnetic wave will be reflected by the next reflective surface after one or more full reciprocation. The relative speed of the reflective surfaces is V= WxR where W is the angular speed of the rotation and Ris the rotation radius of the reflective surfaces. This arrangement will decrease the wavelength of a beam ifthe reflective surfaces are rotating counter to each other, or increase the wavelength if they rotate away from each other. Another configuration with a rotating wheel of retro-reflectors is also feasible allowing a continuous beam to reciprocate and change its wavelength.

Challenges and Discussion

One of the challenges is that relatively high speeds between carriages A and B are required to achieve a noticeable effect. Preferably for a sustainable effect v/c should be larger than the absorbed light (not reflected light) when the beam is bounced back. However, the effect is viable, since residual light photons will be available to sustain the phenomenon. Reflectivity is relative to the bouncing beam power, and that will potentially create the residual effect.

The second major challenge will be to provide a retro-reflector element with very high reflectivity,preferably 100%. Current technology mirrors with reflectivity of 99.999% are available over a relatively large wavelength (700nm-900nm). Fiber optic technology relying on total internal reflection offers a reflectivity of 100%.

Commercial coatings offer a 99.9 percent reflectivity as a standard.

First we will analyze some basic energy aspects of frequency shifts occurring in the reciprocationprocess.

As previously demonstrated, the energy of an individual ejected photon is proportional tothe frequency, rather than the intensity,

$$E = hf = \frac{hc}{\lambda}$$

Assuming total reflection of retro reflectors, then for a given electromagnetic bouncing beam, thetotal number of photons will be constant during the reciprocating process. If that is the case, the energy of the beam increases or decreases as a function of the Doppler Effect according to the formula

$E = hf^1$ --------(3)

Where f^1 is the new frequency after one reflection.

The energy will increase if the carriages are approaching each other and will decrease if they aredeparting. The actual meaning is that the beam extracts energy due to the mechanical movement of the carriages when they are approaching each other, or delivers energy if they are departing.

An immediate application comes to mind:

Propulsion of a space shuttle from a remote location

In this case, we need two carriages where one propels the other. Propulsion is achieved by a high energy beam, reciprocating between a ground station and a high speed departing shuttle.

For this application a laser station could be activated from the moon. The laser will be directing itsenergy to a departing space shuttle equipped with a retro-reflector. Due to the lasers' frequency decaying process, (reciprocation will elongate the lasers' wavelength and thus reduce total beams energy) energy from the laser will be delivered to the space shuttle at a very high rate.

The obvious advantage of this arrangement is that the space shuttle does not need to carry fuel.

The same procedure could be used for slowing down incoming objects from space such as areturning shuttle.

An immediate second application will then be:

Stopping or slowing down a space shuttle or fast moving objects

In this case, a similar set-up as the previous arrangement will be used. Here, the space shuttlewill be approaching and the laser beam will be used for slowing down the shuttle.

As the distance between approaching elements is reduced, the back and forth turnaround time shortens and more and more energy per time unit is delivered from carriages to the laser beam.

As the distance is closer to zero, the beams energy tends to approachinfinity. This effect is caused by the fact that the photon wavelength is approaching zero.

Tuning laser wavelength by mechanical means

Likewise, the same approach could be used for tuning the laser wavelength to values which hadnot been achieved as yet, for example, very deep UV.

Experimental measurements demonstrated that the energy of an individual ejected photon was proportional to the frequency, rather than the intensity, of the light. Applying this equation to the red or blue shift extremities in our imagined experiment can create very powerful photons on one hand (when λ is close to zero) or very weak when the wavelength is stretched to very high values.

Condition for transferring mechanical energy to a reciprocating laser beam

In order to increase the beams' energy, the gain due to Doppler Effect should be larger or equalto the amount lost due to retro-reflection.

In a real world scenario, total reflections are almost impossible to achieve, state of the artreflections of 99.999% will imply that 0.001% of power is absorbed at each back reflection.

The following formula describes the energy gain after one reflection for approaching carriages.

$$\Delta E = hf^1 - hf \qquad \text{----------(4)}$$

Converting into fractional gain compared to input

$$\frac{\Delta E}{E} = \frac{h\left(f^1 - f\right)}{hf} = \frac{f^1}{f} - 1 \qquad \text{----------(5)}$$

Ratio f^1 to f is given by the following formula which is derived from the first reference

$$\frac{f^1}{f} = \frac{1 + \frac{v^2}{c^2}}{1 - \frac{v^2}{c^2}} \qquad \text{---------(6)}$$

Using simple mathematics we get:

$$\frac{\Delta E}{E} = \frac{2\frac{v^2}{c^2}}{1 - \frac{v^2}{c^2}} \qquad \text{-----------(7)}$$

In order to have energy gain for each bounce, the part absorbed by mirror ΔR is given by

$$2\frac{v^2}{c^2} = \Delta R \qquad \text{-----------(8)}$$

These elementary analyses of effects occurring when light is reflected from a moving mirror willenable calculation of minimum speed of carriage to yield a gain in beam's energy.

In the case of 99.999 % reflection ΔR=0.00001, minimum speed should be around 700 km per secondand for ΔR=0.001 the minimum speed will be 7000 km per second.

Contrary to the instinctive conclusions that those speeds are entirely theoretical, in reality there are many asteroids in space with similar speeds. Moreover further advances in total reflection phenomena may yield a solution with higher reflection mirrors where slower carriage speeds will suffice.

A very interesting phenomenon was calculated at the Technion University in Israel, Department of Physics,under the supervision of Professor Moti Segev*, yielding the following relation:

$$f^1 = f\,\frac{x_\circ}{x^1} \qquad \text{-----------(9)}$$

Where $x_\circ$ is the original distance between carriages and x^1 is the final distance. This result is independent of velocity and it will only depend on the ratio of initial distance of carriages and final distance. Assuming a reflection of 100% and final distance of 0 the total final energy tends to approach infinity [1].

Conclusions

In this paper we concentrate on two effects observed during reciprocating reflection from a uniformly moving mirror or retro elements. The first is that the total energy of an electromagnetic beam bouncing back and forth within a cavity with reflective moving elements at its ends, undergoes extreme energy alteration approaching infinity, on one hand, and zero on the other hand. The second is the change in the frequency of the reflected light with respect to the incident one over a very wide spectrum. In our approach we use the photon picture of light and investigatethe outcome of reciprocating movement. It turns out that if there is enough energy to sustain the speed of carriages in a collision track, one can compress an almost unlimited amount of energy into a massless photon with almost zero wavelength. Naturally, in order to do so the energy needed will approach infinity. It is safe to postulate that in the case of approaching carriages, theywill be brought to a halt at some point before collision, and the light energy will probably reverse the movement direction.

This article is a rudimentary introduction to light reciprocation between moving carriages, with many implications to modern physics and is presented only as a starting point for further possiblework.

Although the practicality of the proposed setup is low (it falls under the definition of thoughtexperiment), it is intended to direct our attention toward interesting outcomes such as:

- Direct conversion of mechanical energy to light energy (shortening or elongating thewavelength).
- Since reflection is given in percentage, no matter how many reciprocations we have therewill always be a residual light with high wavelength compression, yielding a massless photon with close to zero wavelength.

The Doppler Effect applied to a reciprocating electromagnetic beam reflected from a uniformly moving mirror or retro may lead to a big nothing on the one hand (a massless photon having almost zero wavelength) or to a big bang on the other hand, since it has acquired huge amountsof energy.

Bibliography

1. Aleksandar Gjurchinovski. Department of Physics, Faculty of Natural Sciences and Mathematics, Sts. Cyril and Methodius University P. O. Box 162, 1000 Skopje, Macedonia Technion University in Israel.