RefracMirr, The CasiMirr Push

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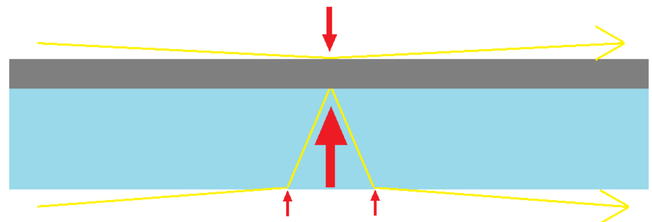
Fig. 1



NASA's Breakthrough Physics Propulsion Program final report raised the possibility of devising some sort of Light Diode to *interact* asymmetrically with the isotropic radiation pressure of the Quantum Vacuum to obtain energy for any purpose and to obtain impetus for propellant-less propulsion, according to Newton's First Law. This paper presents a similar approach that would also use the radiation pressure of the EM Quantum Vacuum. A thin, highly refractive coating covers the bottom side of an opaque, two-sided mirror. Equal and opposite EM Quantum Vacuum ***energy*** approaches both sides equally, from opposite directions. However, the *refracted* rays reflect from the bottom side of the mirror at steeper angles of attack than the non-refracted rays, on the top side. The base-assumptions are separately confirmed by peer-reviewed, published experiments. This is rigorously reconciled with the Conservation of Momentum, Laws of Motion and of Thermodynamics. Practical implementation may require little more than *modest* adaptations of *existing* Technology, equipment and expertise.

For over a hundred years, most aerospace research has proceeded on an incorrect assumption. It has assumed that rockets are the only way to boost a Space vehicle, up from the Earth's into Space. Rockets work using Newton's Third Law: "Every action has an equal and opposite reaction."

In contrast, the present proposal is based on Newton's First Law: "Every object in a state of uniform motion tends to remain in that state of motion *unless an external force is applied to it.* " So where can we find a useful *external* force to continuously accelerate a Space-craft? NASA's Breakthrough Physics Propulsion Program examined many proposals. Harnessing the isotropic Radiation-pressure of the EM Quantum Vacuum was among the ideas that were thought to be plausible. Specifically, the author of that section of the Report mentioned the possibility of creating a light diode that would allow the incoming radiation of the EM Quantum Vacuum to reflect from one side and to pass-through from the opposite side, thus producing asymmetric *responses* to the isotropic EM Field. This would result in a net force that originated from the energy of this isotropic field.

Similarly, this paper proposes using this same radiation pressure to propel a special two-sided mirror. (See Fig. 1.) One side is covered with a very-thin, highly-refractive material. Therefore, the refractive mirror causes the incoming photons to refract and so to impact the mirror at a steeper-angle than the equal and opposite photon-influx on the opposite side. This is expected to cause a net force that is acting toward the refractive mirror. It has been dubbed the Casimir ReFracMirr.

According to many Quantum Physicists, the EM Energy of the Quantum Vacuum fills the Universe. It is also called Zero-Point Energy, ZPE. It is thought to consist of subatomic particles, including photons, that continuously pop-into existence and promptly vanish. The vanishing particles are immediately replaced by the appearance of new particles in the same general distribution. This paper discusses the EM fluctuation part of the Quantum Vacuum. The EM Fluctuation is also called the EM Quantum Flux. It consists of individual photons, also called quanta, that pop into existence and out of existence. Its energy density is widely thought to exceed the atomic energy density that constitutes matter. Many serious researchers are presently pursuing various approaches to harness this energy.

Henrik Casimir seems to be the first person to propose using the Radiation Pressure of the EM Quantum Flux to move a physical object. He described the unavoidable, observable consequences that would *have* to occur if EM Zero-Point Energy really exists. In 19**, he proposed a thought experiment. He described two electrically uncharged, electrically-conducting, mutually-parallel plates. They would be separated from each other by a very small distance. He predicted that these plates would prevent the EM Quantum Flux from *forming* photons with wavelengths that were too long to fit between the plates.

The outward-directed Radiation Pressure Forces between the plates would be pushing the plates apart. The inward-directed Radiation Pressure, acting on the outside surfaces of the plate, would be pushing the plates together. The inward-directed Radiation Pressure, outside of the plates, consists of all-possible wavelengths. This is because all-possible wavelengths can form, *outside* the confines of the space between the Plates. The inward-directed Radiation Pressure, outside of the plates is stronger than the outward-directed Pressure that is between the plates. This is because the outward-directed Pressure excludes all photon wavelengths that do not fit between the plates. Therefore, the Inward-directed pressure, outside of the Plates, pushes the plates together because it is stronger than the Outward-directed pressure between the Plates.

In 19**, Steve Lamoreau, then at the University of Washington in Seattle, experimentally verified a version of this experiment. Many additional independent experiments have consistently verified this phenomenon within 96 % of the theoretical values, which is within the margins of error. The force that moves the "plates" together is *called* the Casimir Force. If Casimir's original idea is really correct, it should be called Casimir's EM Quantum-Flux Radiation Pressure Experiment.

The biggest problem with his experimental framework is this. As long as there are two "Plates" some scientists will always insist that the plates might somehow exert forces on each other. Indeed, it is often described as an *attractive* force that the two plates exert on each other. This is in diametric opposition to Casimir's original idea. Again, the original idea was that the plates were altering the wavelength demographics of the birth and death of the photons of the Quantum Flux that could arise between the Plates. Then the imbalance of EM Quantum Vacuum Radiation-pressure between the Cavity that is in-between the plate and the endless expanse, outside of the plates was what would push them together.

Casimir's wavelength exclusion model is based on well-understood, perfectly ordinary electrodynamics. The only really new thought here is this. Suppose the EM Quantum Flux really exists. Suppose it really pop in and out as described. Assume that ordinary electrodynamics is a correct description of EM behavior. Then the two plates would *have* to behave as described. There is *only* one way that other theories about the plates exerting attraction forces on each other *could* be true: The other theories could only be true if there is no EM Quantum-Flux-caused Radiation Pressure. This is because the Quantum Radiation Theory both predicts and requires all of the forces that have been experimentally measured. There is little or no force left over for the other theories to play a very large role in this phenomenon. (In other words, they would have to be hidden somewhere in the margin of error of four percent.

The alternative theories are held to be equal Guages with Casimir's theory. They are not! Suppose Casimir's Radiation Pressure Theory correctly models a real physical process. This means that the plates are not exerting any significant forces on each other. Instead, the plates are effortlessly altering the EM Quantum Vacuum Density by simply being there. This is as simple as the notion that electromagnetic photons cannot form inside of metals. It is simply part of the general nature of things that larger wavelengths of the EM Quantum Flux do not form inside of spaces that are smaller than those wavelengths, inside of cavities that are surrounded by conductors. In this sense, the Casimir Force Experiments are doing nothing that has not been continuously happening everywhere, since the formation of the first matter.

In other words, if Casimir's original Gedanken is the correct physically-accurate interpretation of the Casimir Force, the Plates would be moved by the EM energy of the Quantum Vacuum. No human is providing this energy. This is energy that was already present. This is energy that would have been there whether or not anyone chose to use it. Furthermore, this energy is left behind as heat, when the plates stop moving.

For example, Solar Energy is already-present. Solar *energy,* (the energy *itself,*) is Cost-Free Energy, (except where they tax it!) We only have to buy and maintain the *equipment,* not the energy source. Likewise, if the energy of the Radiation Pressure of the Quantum Vacuum already exists, then it also is Cost-Free energy. We would only have to buy and maintain the equipment. However, unlike cost-free energy sources such as the tides, wind and Sun, it is always available, everywhere in great abundance. This is why NASA's Breakthrough Physics Propulsion Program, BPPP, mentioned the EM Quantum Flux as a potential source of useful energy and momentum, an outside force for Propellantless Propulsion.

It would make Propellant-less Propulsion, (no reaction mass) possible. This is because the photon-collisions provide the “Outside Force” that is mentioned in Newton's First Law. This can move or levitate our vehicles and turn our generators.

The freely-moveable Plate is located directly between a high energy-density radiation-pressure region and a low-energy radiation-pressure region. If it did **not** move, *that* would violate the Zeroeth Law.

The First Law is not violated. This is because the energy that is entering as a high-energy flux of photons, is equal to the work and low-energy photon flux that is leaving system as heat .

The Second Law of Thermodynamics is not violated. This is because an already-existing high energy, low entropy photon flux is crossing the system boundary, performing work and shedding high-entropy heat which then exits across the System Boundary. Therefore Entropy is increasing in this process, just as it should.

The Third Law concerns the usual inability of energy to transfer in the absence of two differing *Thermal* Reservoirs. It is not the machine that is exceptional in this case. Rather, the Quantum Flux itself is *defined* as the energy that remains in otherwise empty space, *when all heat energy has been removed.* This is one reason why it is called Zero-Point Energy (ZPE.) Of course it is also still present at all non-zero temperatures.

ZPE literally has **no** *thermal* potential. However, its spectrum is nonetheless, highly energetic, especially at wavelengths below 50 nm. In other words, being at Zero-Temperature does not mean that its **energy** *potential* is Zero. Again, we are using the low-entropy, high-energy density Radiation Pressure of very-intense, very-small wavelengths to do work. That work is dissipated as low-energy, high-entropy wavelengths of infrared radiation. Basically the Third Law never comes into play since high and low frequencies always exist in the ZPE Spectrum at *all* temperatures, even at zero degrees.

The reason it has no thermal potential is quite simple. Its constituent photons do not persist long-enough to travel more than about half a wavelength before disappearing. As one generation of photons is vanishing, it is continuously being replaced by new photons that always appear in the same general distribution as the previous generations of photons.

This means that the energy in adjacent regions of space with differing energy-densities does not flow from high density region to the low density region. Thermodynamic energy would *have* to flow between two energy reservoirs if one had a higher potential and they were in contact with each other. For example, the open edges of Casimir's “Plates” form an abrupt boundary between the low density non-thermodynamic energy that exists between the Plates and the High energy-density that exists outside the Plates.

So how is the Plate pushed toward the low-energy region? It is pushed toward the low-energy region because the denser photon flux on its outside induces more momentum into the plate than the flux on the inside, between the “plates.” In other words, even though a photon vanishes soon after striking the plate, it first induces momentum in the plate. In other words the Plate stores some of the Kinetic Energy of *many* generations of ephemeral photons blinking in and out.

Many object that this would change the amount of energy in the Universe. We cannot say this with any certainty. It depends on where one draws the system-boundaries of the Universe. This is a mere semantic issue. *On the one hand,* if we define the Quantum Flux mechanism as part of the Universe then, perhaps, energy is not really being created and destroyed. Rather, it might be alternating between a hidden state and a manifest state. This is the essence of Paul Dirac's Theory of a vast Sea of Particles. *On the other hand,* if we posit that the Quantum Flux is not part of the Universe, then we are admitting that energy can enter and leave the Universe. Therefore, we would have no basis for assuming that matter and energy could not accumulate in one Universe while depleting another Universe. Really knowing whether each Universe would have to remain constant may actually be unknowable. Therefore, the overall balance of energy in a single Universe is unknowable and perhaps changeable.

At first glance, all of this appears moot. Seemingly, once the Plates come together, it will take at least as much energy to separate them again, as was generated as they came together in the first place. At first glance, two Plates do not seem to provide a basis for a practical device unless the Casimir Effect can be switched off and on. That thought forms the basis for some already-issued patents. In these patents, inventor Fabrizio Pinto proposes making a moving plate out of a semiconductor material that can be switched between a conducting and non-conducting state. Incredible forces exist when the plates have extremely small separations. Therefore, in principle, the energy that could be obtained, by switching the conductivity back and forth, could very well be much greater than the required bias-energy to switch to and from a conducting state. However, such machinery would have to be as small as the nano-scopic features on many "micro" processors.

This paper proposes a much simpler method of altering the radiation-pressure of the EM Quantum Flux. If successful, it will cause the EM Quantum Flux to push much harder on one side of a refractive mirror than on the non-refractive mirror on the opposite side. It would do this without needing a separate object to attract or repel it. Therefore, if successful, the reality of the EM Pressure of the Quantum Vacuum would be demonstrated to a high degree of certainty.

To gain an appreciation of what may be possible, this radiation-pressure will be derived and quantified. Boltzmann proved that isotropic radiation-pressure that is acting uniformly on a flat surface is equal to the energy-density above the surface, divided by three. This is easy to understand since the total energy of the EM Quantum Flux is isotropic. This means that it is normally equally-intense in all directions. Therefore, the total momentum of EMR, P_T, that is approaching the Surface, must be divided equally among the three Resultant momentum vectors, P_X, P_Y and P_Z.

Eq. 1 defines the momentum of a photon.

$P = E / c$ Eq. 1

Eq. 2 says that the total momentum of the photon is evenly distributed among the three momentum vectors.

$P_T / 3 = P_X = P_Y = P_Z$ Eq. 2

Horizontal vectors $+P_X$ and $-P_X$ as well as $+P_Y$ and $-P_Y$ cancel each other out and do not affect the top or bottom surfaces of a metal plate. $+P_Z$ acts only on the bottom surface and $-P_Z$ acts on the top surface of a flat object. (Important! The three vector momenta are being discussed, not the motions of the EM fields of a photon.)

The EM Quantum Vacuum Radiation Pressure is derived from energy values that have been experimentally detected. These values and their relationships are described by Planck's Black Body Radiation Spectrum Formula:

$\mathbf{u = h\,(n + 1/2);\ \{ n = 0, 1, 2, 3 \ldots n, n+1\}}$ **(Eq. 3)**

The existence of the Zero Point Energy Field is most clearly seen in the instance where n = 0; this leaves us with Eq. 2.

$\mathbf{u_{zpe} = \hbar\omega / 2}$ **(Eq. 4)**

Again, $\mathbf{u_{zpe}}$ is positively ***not*** a figment of our mathematics. Historically, Max Planck derived the formula that included this term before anyone had any thoughts about a Quantum Vacuum. It is an unavoidable mathematical consequence of physically-real experimental data. In other words, even if the theory of a Quantum Vacuum is wrong, *something* that is physically real is causing this term. The Zero-Point Energy interpretation came later. Saying that it is just a convenience to make our calculations work is like insisting that there is no unacknowledged-elephant in the room while we are engaged in the very act of holding our noses while cleaning up the mess he left on the floor. Maybe it is not an elephant but is a horse! Nonetheless, *something* that is physically-*real* is *forcing* us to use this term. When n = 0 something is still physically present.

Converting radians to frequency, **h** is Planck's Constant,

The constant h-bar, $\mathbf{\hbar = h / 2\pi}$ is used with $\boldsymbol{\omega}$ which is frequency in radians. $\boldsymbol{\omega = 2\pi f}$, **f** is frequency in Hertz.

(Eq. 2) = $[(h / 2\pi)\,(2\pi f) / 2] = \mathbf{u = h\,f /2}$ **(Eq. 5)**

(Eq. 4) gives us the total energy of quanta *of a single wavelength* that can fit into one cubic meter.

$\mathbf{u\,(\lambda) = h / 2\,\lambda^3}$ **(Eq. 6)**

$\mathbf{c = f\,\lambda}$ **(Eq. 7)**

$\mathbf{u\,(f) = h\,f^3 / c^3}$ **(Eq. 8)**

U (f) is the combined energies of all wavelength-sized photons that can occupy one cubic meter. In practice, longer wavelengths are negligible.

$\mathbf{U\,(f) = \int f^3 / c^3\,df = h\,f^4 / 8\,c^3}$ **(Eq. 9)**

Ludwig Boltzmann worked out that the pressure Pr, that is acting normal to a surface is equal to one third of its energy.

$\mathbf{Pr\,(f) = U_\varphi\,(f) / 3 = h\,f^4/ 24\,c^3}$ **(Eq. 10)**

$\mathbf{h\,c\,f^4 / 24\,c^4 = P_\varphi\,(\lambda) = h\,c / 24\,\lambda^4}$ **(Eq. 11)**

$\mathbf{P(\lambda) / = h\,c / [24\,(\lambda_1^4 - \lambda_2^4)\,A]}$ **(Eq. 12)**

In practice, we can justify not counting wavelengths that are larger than λ specified since we only need to specify wavelengths that significantly impact the material we have chosen. Having to subtract infinities from each other is not physically relevant since the energy density of progressively longer wavelengths quickly converges on zero. This is because every tenfold increase in wavelength is accompanied by a ten-thousand fold decrease in energy-density. This is due to the $\boldsymbol{\lambda^{-4}}$ term. For practical purposes, $\lambda = \infty$ can be any number that is one or more magnitudes of $\lambda_{specified}$ Likewise, consideration of ever-smaller wavelengths also converges rapidly on irrelevance for the present purposes. This is because matter rapidly becomes transparent as very small wavelengths are considered. In practice, integrating from $\lambda_{1\ \mathbf{specified}}$ to $\boldsymbol{\lambda_{2\ specified}}$ is physically valid, within any specified margin of error.

As Seen in the following chart, Radiation-pressure forces are quite dramatic in the first few nanometers. However, matter is very transparent to these wavelengths that are in and around the soft Xray spectrum, and smaller. Generally, these wavelengths can only be reflected at very shallow angles. Therefore, single-digit nanometer wavelengths are probably not a good part of the spectrum to utilize in the first proposed experiments.

So far, our metal plate is in static equilibrium. All forces acting on both sides are equal and opposite to other forces. Can we somehow redistribute some of these forces to cause the Quantum Flux to push harder on the bottom of the Plate than on the top? If we are dealing with **Newtonian** Momentum (P = ***m*** v) then the answer is a resounding NO! Or *is* it?

Suppose we have a wall that is made of doors. Two teams, one of cosmonauts and one of astronauts throw equal but opposite influxes of balls at the two sides of the walls. The wall is orbiting the Earth (or any planet of the reader's choosing!) One of the teams has rigged the wall with doors that swing open in only the same, one direction. The balls that are thrown at the one side bounce off of the doors and move the wall away from the incoming balls. However, the balls on the opposite side push the doors open and pass through the wall. They impart much less of their momentum than the balls that are coming from the opposite direction. In other words, equal and opposite influxes of balls are applying asymmetric forces to the wall, and it moves in one direction. So we must admit that, in principle, equal and opposite influxes of photons could be treated asymmetrically by opposite sides of an object. Indeed, as mentioned already, a ZPE Light Diode was mentioned as a possible approach to propellant-less propulsion by NASA's Breakthrough Physics Propulsion Program, final report.

Besides, we must admit that light *cannot* have *Newtonian* Momentum because it does not have mass. Its momentum is defined as P = E / c. Since we are already allowing momentum without mass, we should at least be open to the possibility of other irregularities. For example, the Minkowski-Abraham debate has been raging for many decades. *This author is not claiming to have the final word on this vast topic. His point is merely that it reveals a whole new World of photon-momentum weirdness and humbling-uncertainty.*

Minkowski argued that the momentum of light is greater inside a more-refractive medium than it was before the same light entered the more-refractive medium. Under some experimental circumstances, this can be verified.

$P_{Refracted} = n\ P_{Not\ Refracted}$ **Eq. 13**

Abraham argued that the momentum of light was smaller by a factor of 1/n after entering a more-refractive medium. Under other experimental circumstances, *this* can *also* be verified.

$P_{Refracted} = P\ /\ n_{Not\ Refracted}$ **Eq. 14**

In other words, not even the momentum of light is **conserved** *in the same manner* as Newtonian Momentum.

Instead of presuming that light even has momentum, **Eqs. 15 and 16** use directed-energy vectors, to track the changes in the direction of travel of the light-energy. **Eq. 14** is the distribution of these directed-energies before refraction. In other words **Eq. 15** is Boltzmann's equation, substituting directed-energy vectors in place of momentum vectors.

$\mathbf{E_T X / 3 + E_T Y / 3 + E_T Z / 3 = E_T}$ **Eq. 15**

It is interesting that the formulations of Minkowski *and* Abraham *both* appear in **Eq. 16**, below. This is the directed-energy vector distribution after the light is refracted.

$\mathbf{E_T X / (2n*3) + E_T Y / (2n*3) + n * E_T Z / 3 = E_T}$ **Eq. 16**

This equation says that the energy vectors exchanged *energy* as the photon was turning while it was being refracted. This happens whenever *any* object changes its direction of travel but is still being tracked in the original inertial frame of reference.

Eq. 15 equals **Eq. 16** since the total energy of the photon while it is inside the refractive medium is the same as the energy of the photon when it was outside of this medium. However now, more of the energy resides in the directed-energy vector **Z**. Less energy now resides in the other vectors.

Look at illustration 1. The non-refracted light is reflecting from the top of the mirror at a very shallow angle. Therefore, it is hitting the surface with less force than the light that is hitting the bottom of the mirror at a much steeper angle.

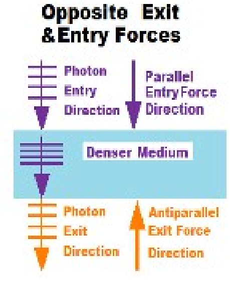
The point is this. Light that approached the refractive material at shallow angles is refracted so that it then reflects from the bottom of the mirror at a steeper angle than the non-refracted light that is reflecting from the top of the mirror. However, before entering the blue refractive material, the angle and intensity of this steeper-angle light on the bottom was equal and opposite to the angle and intensity of the light on top. *It looks like equal and opposite influxes of light could really exert a net force on the two-sided mirror.*

Can equal and opposite influxes of light really be made to exert asymmetric forces on the two-sided mirror? Before jumping to such an extraordinary conclusion, one should first examine other possible forces to see if they might counteract the asymmetric forces between the two sides of the system.

For example, what sort of forces are exerted on the refractive medium as the directed-energy of a photon is refracted? The normal forces are illustrated in Fig. 1.

Even if, *somehow,* there are parallel forces applied to the refractive material, they will counteract each other as different photons strike the surface from every direction.

Fig. 2



Light does not caused to change direction by the medium pushing sideways, *more* on one side of a photon than on the other side. The right side experiences the same forces as the left side *but at slightly different times.* The photon only turns because the one side remains in the faster medium a little longer than the other side as the photon is entering the medium.

The same thing happens in reverse, as the photon exits the second medium at an angle that is equal but opposite to the angle of entry. The opposite side of the photon then exits the slower medium sooner, so it is now traveling faster than the first side, which remains in the slower medium longer, this time. Therefore, if there are refraction forces, they would have *also* have to equal and opposite to the entry refractive forces. See Fig. 2.

Fig. 2 shows the normal forces that are exerted on the surface as a photon passes all of the way through a refractive medium. Although the length of the photon is shorter inside the medium, a train of photons will still pass through the medium at the same frequency, even though they are moving slower. This is possible because they are closer together. They are also wider.

The major point is this. The entry-force and the exit force are both exerted *toward the medium.* In this Fig. 2 these forces are equal and opposite. However, they are equal and opposite *in this instance* because the light is entering and exiting opposite sides of the medium. In contrast, because the mirror reflects the light, in Fig. 1, the light exits on the *same* side of the refractive medium as the side that it enters. *Both forces are still directed toward the material.* They are now equal and parallel instead of being equal and opposite. They are both directed upward in the same direction as the forces on the mirror.

As previously stated, the horizontal forces do not act on the mirror or on the refractive medium. Even if they did act on the mirror and the medium, they would cancel each other out, anyway. So we are left with **Eq. 17**. It calculates the *net* Pressure that pushes up on the bottom side of the mirror. The first term is the perpendicular vector from **Eq. 16** the second term is the perpendicular term from **Eq. 15**. Only the perpendicular terms are used since the horizontal terms are equal and opposite to each other.

$$(n * E_T Z /3) - E_T Z /3 = (n - 1) E_T Z /3 \qquad \textbf{Eq. 17.}$$

Combining **Eq. 16** with **Eq. 12** gives us **Eq. 17**.

$$P(\lambda, n) = (n - 1) * h c / [24 (\lambda_1^4 - \lambda_2^4) A] \qquad \textbf{Eq. 18}$$

In other words, the entry-refraction force and exit refraction-force are both directed toward the more refractive medium. Both of these statements have been experimentally verified. **

To all outward appearances this would seem to violate Conservation of Momentum. To the contrary, one can examine a circumstance where the same thing takes place with a physical object. A car drives onto a barge at a non-perpendicular angle to the sides of the barge. The left front wheel crosses the line, between the shore and the barge, sooner than the right front tire. Therefore left front wheel applies its brake just a little sooner than the right wheel. Since the left wheel enters the slow-speed zone sooner than the right front wheel. Therefore the angle of the car, relative to the line between the barge and the shore swings closer to a perpendicular reference line, since the right front wheel is in the high-speed zone a little longer than the left front wheel. In other words the path of the car is refracted. Regenerative brakes store the energy of car's deceleration as it enters the slower refractive, floating speed zone. Then the car coasts around a U-turn. As the car again crosses the line, it is re-accelerated by the same energy that is used to re-accelerate the car as it exits the refractive, floating slow-speed zone. The car imparted momentum to the barge once as it decelerated, twice as it went around the U-Turn and once when it accelerated as it left the barge. This is what the photon did as it passed into the refractive material, collided with the mirror and rebounded from the mirror, and once more as it accelerated upon leaving the refractive material.

Momentum is conserved because the light exits the material at an equal angle, in the opposite direction, as though it had merely reflected from a bare mirror.

The barge moved (a little bit) away from shore because of this impartation of momentum. So in the end, the car had a little less momentum than that with which it started. It is more difficult to imagine the details of how light seems to maintain the same energy level, the same frequency and wavelength, even after passing through a material where it loses energy due to dispersion forces. Nonetheless, the individual photons that make it through the material appear to have the same energy level as they had before entering the material.

As with everything else involving light, events must take place in whole-photon increments. Energy must be lost to any work that is performed with the RefracMirr as well as to dispersion losses. However, this can only occur because some photons entirely disappear as they impart kinetic energy to the system, or interact with dispersion forces. Other photons pass through the system unaltered. This author is not saying that these Quanta are absorbed by atoms in the sense that they help promote an electron from one level to a higher level. (That topic will require its own paper.) Rather, their energy imparts kinetic energy to the entire system. In other words, the photons that approach the mirror at a steeper angle each have a higher probability of imparting energy to the system than the photons that are striking at a shallower angle.