Using Elastic-Inelastic ZPE Collisions With Matter To Harness The Electromechanical Flux of the Quantum-Vacuum

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The NASA Breakthrough Physics Propulsion Program correctly concluded that the virtual-photons of the Quantum-Vacuum exert real radiation pressure on matter; but they then issued a negative final analysis, saying that a "Quantum Sail" cannot possibly experience a *net* force. (Really, they are discussing a Quantum (Nichols) *Radiometer* not a "Sail.") Unfortunately, for many in the Advanced Propulsion Community, that has become the "final word" for what potentially is a quickly-implementable technology. First, it incorrectly argued that absorbed-energy and reflected energy would impart equal and opposite forces to a "Sail" even though that "Sail" had a reflective surface on one side and an absorptive surface on the opposite side. Second, it was argued, without justification, that the Quantum Sail "**had** to" alter the local vacuum to *somehow* generate an equal and opposite force to prevent violations of energy conservation, when the Quantum Flux continually depletes and renews itself all the time, already.

Besides, wouldn't such a conservation mechanism also keep small particles from being kicked around by virtual photons? That also happens all of the time. An isolated particle that is accelerated by the action of an incident virtual photon will indeed, eventually, be decelerated by other virtual photons; nonetheless, even though the *particle* ends up with no net energy gain, each of those virtual photons are leaving energy behind and gaining entropy every time they accelerate that particle in *any* direction. *No engine consumes (destroys) energy; actually, engines convert low entropy to high entropy.* Clearly, virtual photons do net work in each collision, and that energy now possesses increased entropy as these photons are either reflected or are absorbed-then-re-emitted; then these now-higher-entropy virtual photons are removed by the vacuum. We *know* this because the Vacuum emits and removes virtual photons of all wavelengths, all of the time. The Quantum Flux, functionally speaking, behaves as a High Energy Reservoir, introducing low entropy energy, and a second aspect *behaves as* a Low Energy Reservoir when it removes the same amount of energy, that sometimes then has a higher entropy if it has interacted with matter.

Mechanically harnessing the totally-random, omnidirectional, radiation-pressure of the electromagnetic flux of the Quantum-Vacuum seems as ludicrous as setting up a windmill to harness the thermal motions of air molecules; nonetheless, if there are significant asymmetries in how well some materials absorb and re-emit virtual-photons and how well other materials reflect them, then we should be able to build a (Nichols) Quantum Radiometer and obtain a macroscopic, mechanical net-force.

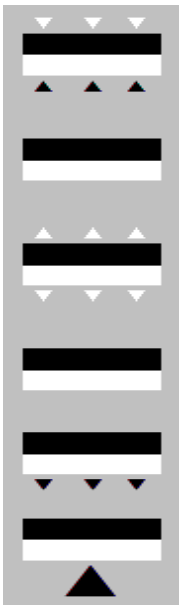
It is well-known that a Reflector will experience twice as much recoil from its elastic collision with visible light as an Absorber experiences from its in-elastic collision with an identical light source; it might work exactly the same way with the radiation pressure of the Quantum Vacuum--but how does it really work?

1. A (Nichols) Radiometer works because of the asymmetric manner in which the materials-themselves, re-radiate previously absorbed-energy back into space from both sides equally while reflecting from only one side.
2. Incident light imparts no net momentum; both reflected light and absorbed light, impart equal and opposite impact forces to the reflector and the absorber.
3. Previously-Absorbed Then Re-Emitted light imparts no net forces and no net momentum, because it is:
    - Re-emitted with (nearly) equal intensity from both sides as Black Body Radiation.
    - Re-radiated in proportion to the temperatures of the surfaces from which it is radiating.
    - A good conductor of heat, so all sides passively maintain nearly the same temperature.
4. Rebounding Light causes the only recoil that is not counteracted by any of the other other forces; it is what causes the net force that acts toward the reflector.

It appears that a very small part of the virtual spectrum may provide useful low-entropy energy for all of our engines. The very-real radiation pressures of so-called Virtual Photons are measured in k-Pa in the highest frequencies of the VUV, and measured in M-Pa and G-Pa in the Soft X-ray part of the Virtual Spectrum, even when we are summing very narrow bandwidths.

Such an experiment appears very feasible: Advanced VUV and X-ray Optics Technology. Mirrors that are 60 percent effective in reflecting VUV and X-rays are commercially available. These mirrors are made of meta-materials that consist of layers that have thicknesses that are smaller than the wavelengths they are guiding; therefore, there is a good prospect of manipulating virtual-photons to absorb or reflect in the ways we have been describing, within the limits of their brief lifetimes.

This may only work a non-ionizing medium, so as to not suppress the formation of virtual-photons in these ranges.



The Omnidirectional, Incident Radiation acts equally, in opposite directions on each side.

Incident radiation imparts no net force.

All absorbed energy re-emits from both sides equally, and in opposite directions.

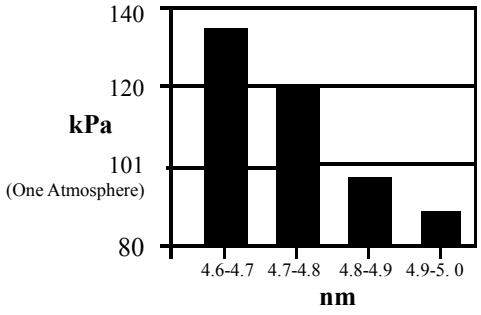
Re-emitting previously-absorbed energy exerts no net force.

Only rebound forces remain as each photon completes its reflection.

A net force from an omnidirectional conventional light source.

Quantum Vacuum Radiation Pressure

$1.30 \times 10^{(-27)} * (\lambda_1^{-4} - \lambda_2^{-4})$



Very high radiation-pressures are present, even when just counting the wavelengths that are included in very narrow bandwidths, that are only 46 pico-meters wide, between 4.70000 to 4.746 nm.