Quantum Vacuum Engineering for Power and Propulsion from the Energetics of Space

H. David Froning*

PO Box1211, CA, 90262, USA
Phone: 310-459-5291; Emailfroning@infomagic.net

Abstract. This talk describes challenges and possibilities for exploiting the stupendous energetics that may be contained within the zero-point ground state of seemingly "empty" space for meeting Earths future power and propulsion needs. In particular, it's suggested that intense vacuum energetics, in addition to those that reside within the vacuum's more well known electromagnetic modes, and research on specially conditioned electromagnetic radiation to interact with these energetic modes is described. And, in addition to its energy, it is shown that quantum vacuum negative pressure could conceivably enable less labored vehicle motion in it.

INTRODUCTION

The most bizarre possibility for meeting Earth's power and propulsion needs may be the harvesting the stupendous energetics that possibly exist within the quantum mechanical ground states of the vacuum of "empty" space. These energetics are symbolized in Figure 1 as electromagnetic pulsations that - like lightening flashes – forever appear and disappear throughout the entire cosmos in countless times and places. The more simple interpretations of quantum theory predict that quantum fluctuations in the vacuum state of space give rise to energy fluctuations whose average expectation values could be 40-100 orders of magnitude greater than all of the energy contained in cosmic matter. Wheeler, 1968 speculates that the enormous vigor and vitality within the submicroscopic intensity of individual vacuum energy fluctuations is diminished by some sort of wave interference-like effect that almost totally diminishes their intensity over the much larger scales of time and distance that unaided senses can perceive. So, space is inert and empty to ordinary observation. But Figure 1 shows that zero-point energy densities of 1.0 J/cm^3 to 10,000 J/cm^3 would be revealed to hypothetical probes that could sense and resolve physical activity occurring over 10^{-6} cm 10^{-7} cm scales of distance. And at 10^{-7} cm scales, much more violent 10^3 J/ cm^3 activity would be perceived.

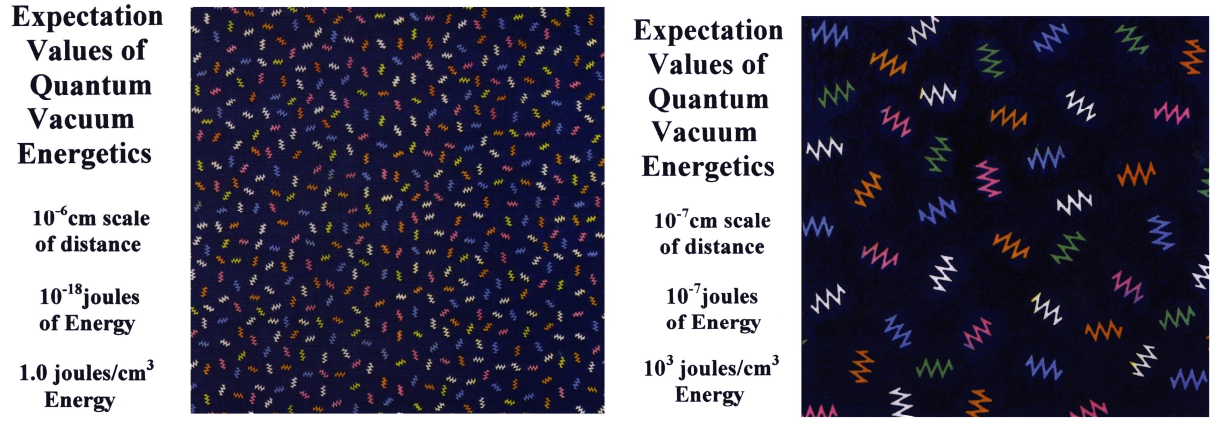

Figure 1 Expectation Values of Zero-Point Energy in $10^{-6}$and 10^{-7}cm. Regions within the Quantum Vacuum of Space

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In his book "The Lightness of Being" Frank Wilczek defines the quantum vacuum as 'the grid', with its various constituents being: (1) quantum fields associated with radiation, matter and gravitation; (2) virtual particle pairs and weak superconducting condensates; and (3) dark energy. Unfortunately, many quantum vacuum unknowns remain, with no scientific consensus as to its essence and extreme doubt over possibility of exploiting its energetics for power or propulsion. Typical questions: Is the quantum vacuum an enormous sea of stupendous zero-point energy, or does it have a much more meager energy allocation? Is the quantum vacuum the supreme source from where matter gets all its energy; or does it only exchange energy with matter? And, of course, the critical engineering and science issue: Can more zero-point energy be extracted from quantum vacuum than the required input of energy into vacuum for its extraction? These questions will be touched on more from the standpoint of engineering than science.

QUANTUM VACUUM ENGINEERING TO DEFINE ENERGY EXTRACTION NEEDS

Froning, 1980 is the first known peer-reviewed article to suggest the possibility and problems of extracting zero-point energy from the quantum vacuum for power and propulsion. Figure 2, from this article, indicates spaceflight as the chosen application. Zero-point energy expectation values given in Wheeler, 1968 were used, and processes that could: (a) materialize electrons and positrons out of the vacuum for mutual annihilation; and (b) gather the resulting photons into a thrusting beam of light were assumed. The investigation identified the scales of time and distance that zero-point energy must be interacted with and extracted from the quantum vacuum, to swiftly accelerate starships to almost light-speed. It was found that interaction with and extraction of zero-point energy from the vacuum must occur over 10^{-6} to 10^{-7}cm scales of distance – distance 4 to 5 orders of magnitude larger than the diameters of atoms.

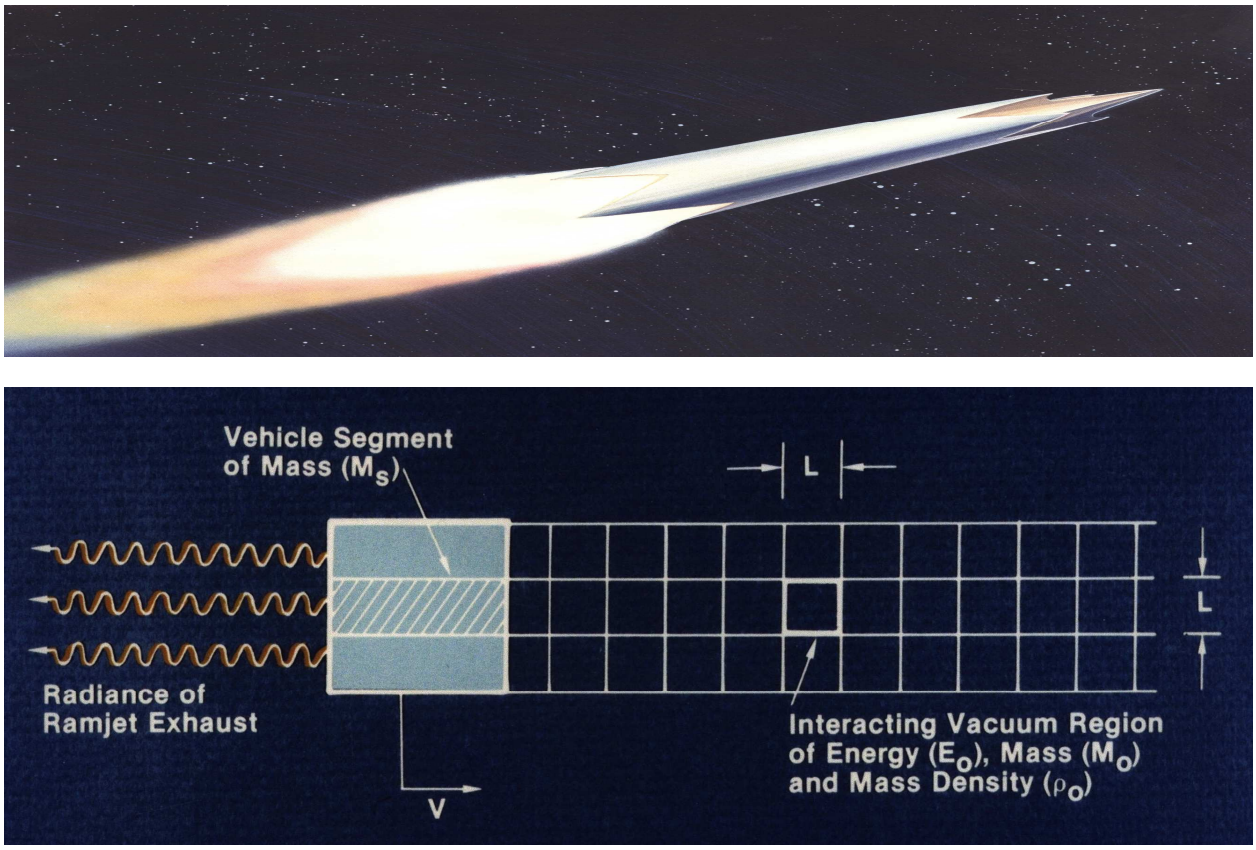


Figure 2. Schematic Representations of a "Quantum Interstellar Ramjet" Extracting Zero-Point Energy from Space

Energy extraction within 10^{-6} cm of distance requires times as short as 10^{-16} s. At the time of this investigation, the shortest achievable times were electrical switching times of about 10^{-11}s. But, femtosecond lasers operating in the extreme ultraviolet now have beam widths of the order of 10^{-6} cm and pulse widths of the order of 10^{-16} s. Thus, electromagnetic devices now operate at times and distances that may be of interest for zero-point energy interaction.

INTERACTING WITH THE QUANTUM VACUUM BY SPECIAL EM RADIATION

It's generally agreed that quantum vacuum fields are associated with the matter fields that comprise weak and strong force interactions in nuclei and with the radiation fields that are associated with electromagnetism and gravitation. In this respect, zero-point energy modes associated with the quantum fields associated with electro-magnetism have been fairly extensively studied the most and have revealed extremely interesting quantum field phenomenon such as the Casmir Effect. But more robust zero-point energy modes may be associated with some of the other quantum vacuum fields. One example is the intense zero-point vacuum field associated with the strong force that guides and controls quark motions within protons. As shown in Figure 3, This intense vacuum field action is manifested in the mass-less, ever-changing gluon fields that materialize-dematerialize-rematerialize in proton-occupied space in less than a trillionth of a trillionth of a trillionth of a second, and which comprise about 97 % of a proton's total energy.

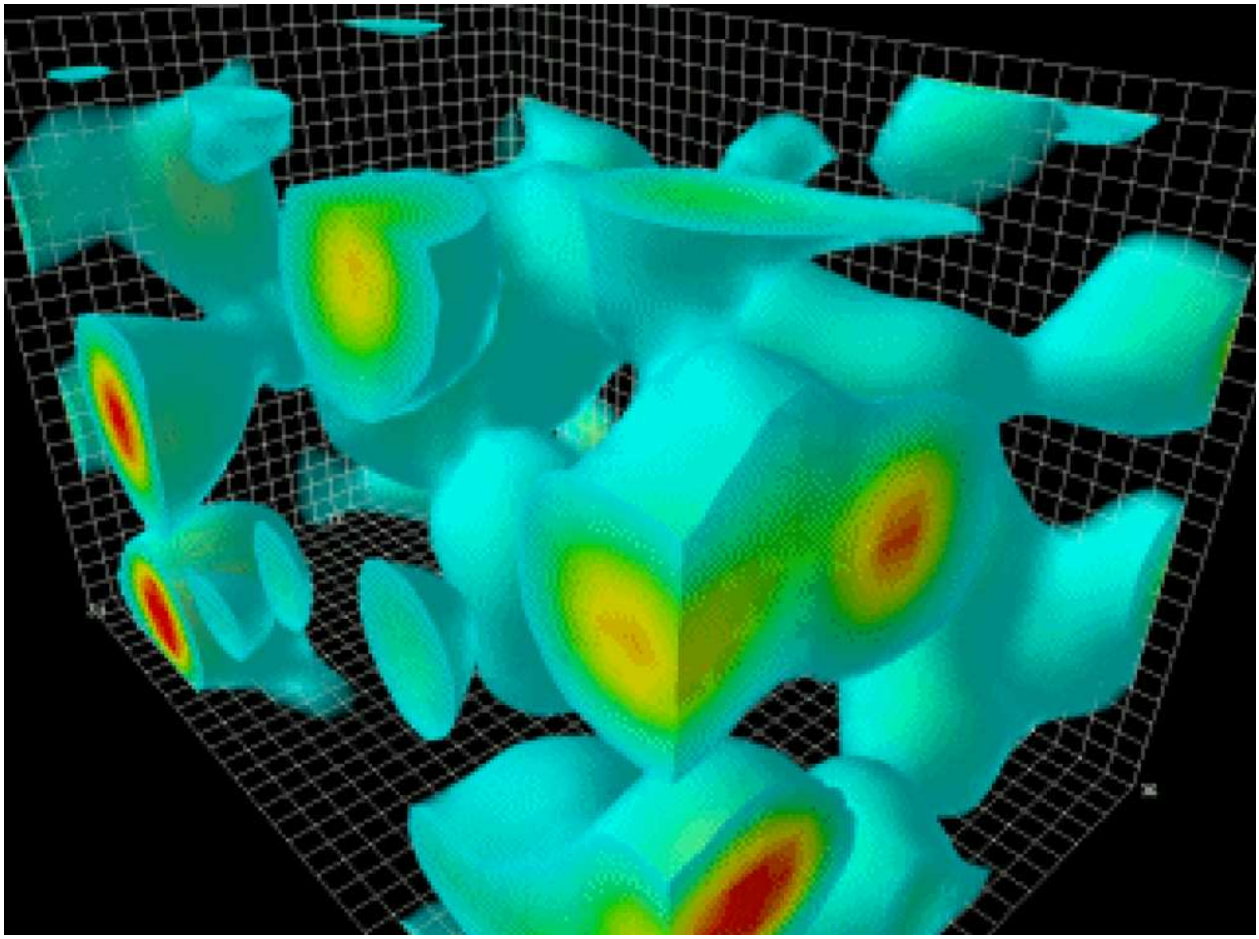


Figure 3. Manifestation of the Quantum Vacuum as Gluon Field Activity in Hadron-Occupied Space – Image Computed by Dr. Derek Leinweber , University of Adelaide, ARC Special Research Center for the Subatomic Structure of Matter

Robust quantum vacuum field activity may also be associated with the weak-interactions that change neutrons into protons by mutating quarks into different quarks within hadrons. Here, it is generally believed that a Higgs vacuum field is associated with the "Higgs Boson" that gives rise to the Z and W bosons that mediate such weak interactions.

The matter fields associated with weak and strong interactions in nuclei possess a high SU(2) and SU(3) symmetry. Similarly their associated zero-point quantum vacuum fields are of SU(2) and SU(3) form. In this respect, classical electromagnetic radiation possesses a lower U(1) field symmetry; and, presumably, a U(1) vacuum field as well. But Barrett, 2007 has used group and gauge theory and topolological analysis to show the possibility of conditioning ordinary U(1) electromagnetic radiation to SU(2) or even higher field symmetry form.. Such electromagnetic (EM)

radiation fields are considered classical. But they have (in addition to electric and magnetic field content) A-vector fields whose mathematical structure closely resembles that of the quantum vacuum fields associated with the strong and weak force. Figure 4 shows expanded Maxwell Equations that describe actions of specially conditioned SU(2) EM fields in accordance with Gauss's and Ampere's and Faraday's Laws. It is seen that Maxwell Equations for specially conditioned SU(2) EM fields contain electric and magnetic field terms - as ordinary U(1) EM fields do – plus added terms that involve coupling of electric and magnetic fields with A-vector and A-scalar potential fields. Like quantum fields, A-field terms involve non-abelian algebra (wherein vector and dot products such as (A E - E A) and (A x E – E x A) are not zero. This quantum mechanical similarity of classical SU(2) and SU(3) EM fields and SU(2) and SU(3) quantum vacuum fields is encouraging our investigation of the possibility of the A-vector field energetics in SU(2) or SU(3) EM beams coupling with the zero-point energetics in SU(2) or SU(3) quantum fields.

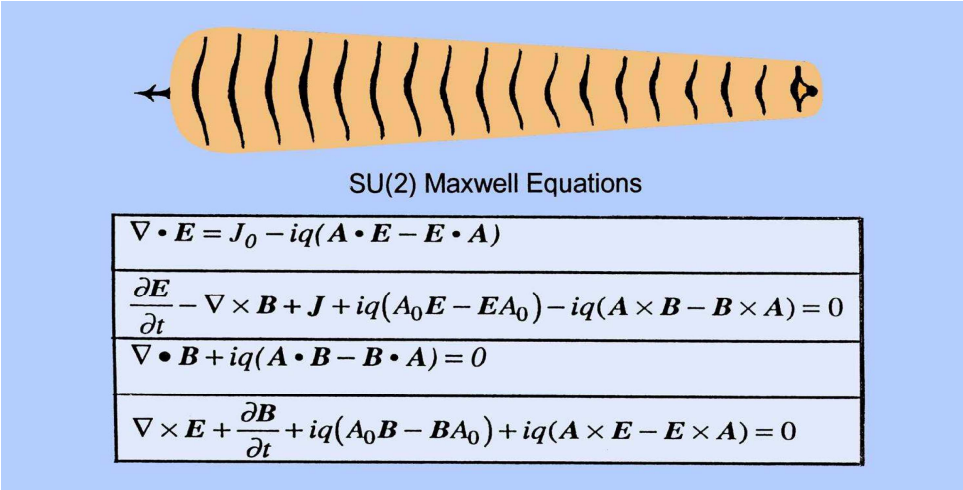


Figure 4. Expanded Maxwell Equations for Specially Conditioned SU(2) Electromagnetic Radiation

Up to now, two ways of generating specially conditioned EM fields have been developed. One generates SU(2) and possibly SU(3) fields by polarization modulation of radio-frequency or microwave or laser beams by the orthogonal polarization and phase modulation of input waveforms. The other generates SU(2) fields by toroids with appropriate geometry and coil winding; and resonant frequency – whereby mainly A-vector field energy is emitted. Figure 5 shows several of the successfully tested toroid transmitters. The tests are described in Froning and Hathaway, 2002.

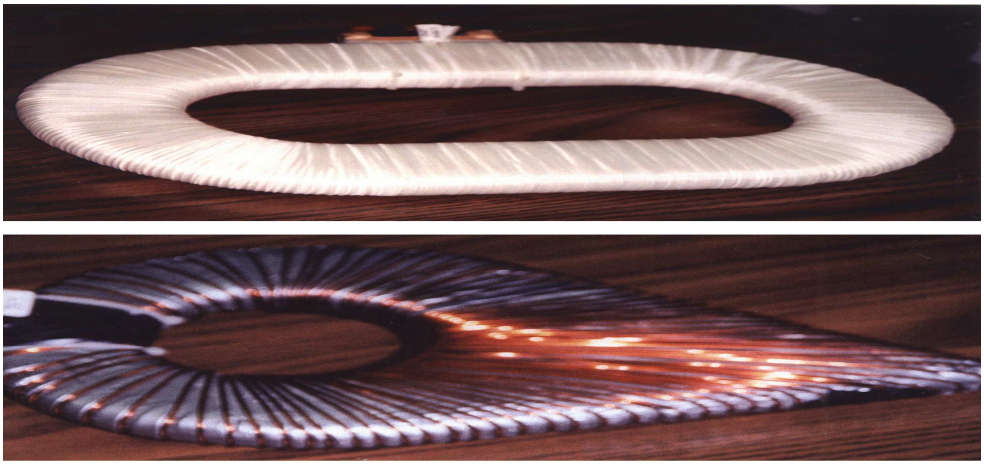


Figure 5. Asymmetric, Caduceus-Wound, Toroidal RF Field Generators of SU(2) EM Radiation

Although not designed for or tested for zero-point energy interaction, both ordinary and symmetrical SU(2) toroid transmitters were swept through radio frequencies between 0,4 and 110 MHz and enormous increase in transmitted signal occurred when transmitting toroids operated at their different resonant frequencies within this frequency band.

PRELIMINARY SIMULATIONS OF FLIGHT THROUGH ZERO-POINT VACUUM

Haisch etal.1994 has proposed that the electromagnetic quantum vacuum interacts with the electromagnetic structure of accelerating bodies to cause or, at least, contribute to their inertia, and Puthoff, 2002 proposes that space-warping fields emitted by a body for propulsion can be viewed as perturbing the electrical permittivity (ε) and magnetic permeability (μ) of the vacuum. In this respect, Froning and Roach, 1999, 2002, 2007 have developed fluid dynamic methodologies to make very preliminary simulations of accelerated vehicle flight through the quantum vacuum. The accuracy of such fluid dynamic approximations, of course, depends upon degrees of similarity between air flight in planetary atmospheres and space flight in the vacuum of space. In this respect, Figure 6 from Froning and Roach shows some similarity in densities associated with thermal radiation pressures from air molecule interactions in the atmosphere and zero-point radiation pressures from virtual particle pair creation and annihilation in the vacuum of space. As shown in the lower picture, this allows similarity in the aerodynamic and radiation pressure gradients that form over an accelerating vehicle at 99 percent of speed-of-sound in air and 99 percent of speed-of-light in space.

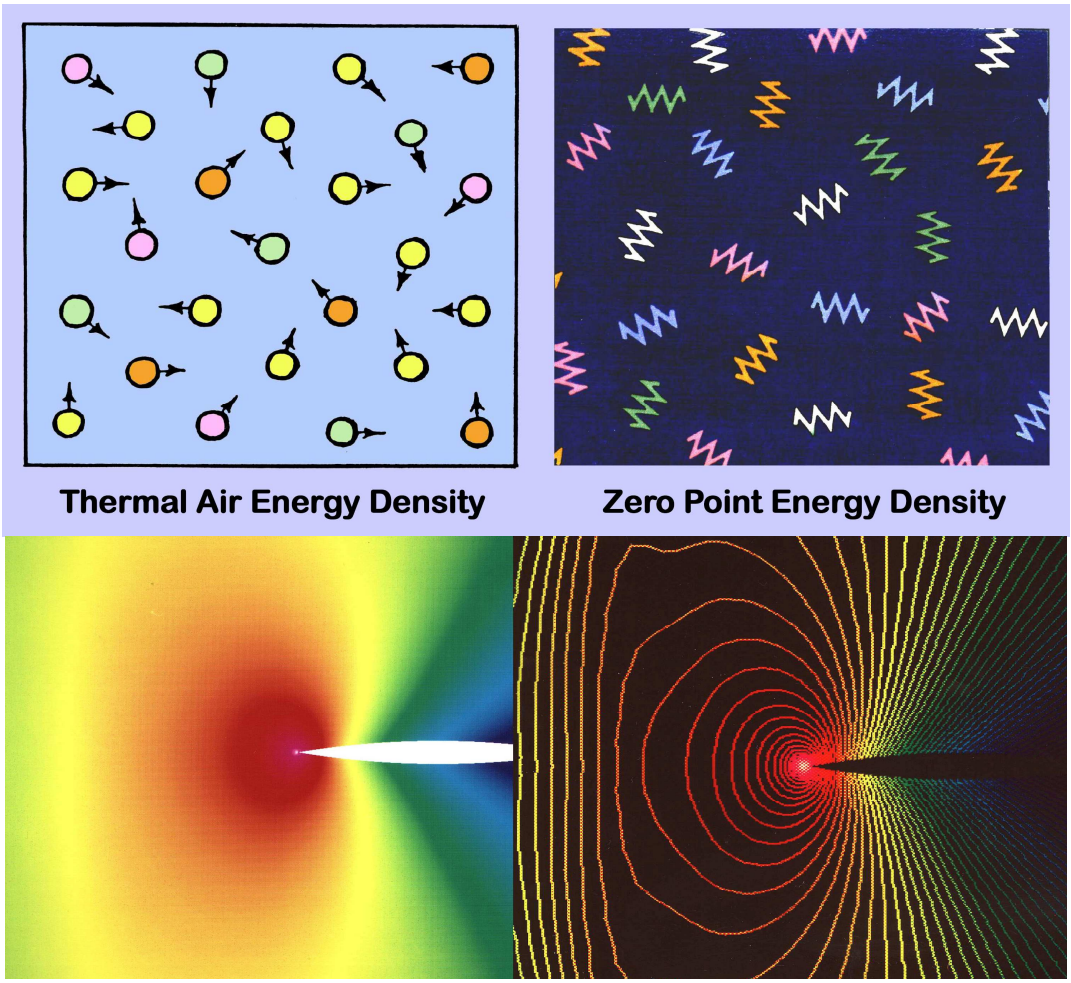


Figure 6. Similarity in Pressures and Gradients at 0.99 Sound Speed in Air and 0.99 Light Speed in Vacuum of Space

Froning and Roach 1999, 2002 showed similarity in acoustic disturbance propagation in air and electro-magnetic disturbance propagation in space. This enabled modeling of space-warping by perturbing vacuum ε and μ in a space vehicle's vicinity by appropriate perturbation of gas constant (R) and air specific heat ratio ratio (γ) in the vicinity of an appropriately scaled air vehicle. They also showed: (a) similarity in flight resistance increase as accelerating air and space vehicles approach sound speed in air and light-speed in space; and (b) similarity in the variation of air and space vehicle flight resistance as they reach and exceed sound and light speed during there acceleration through air and space. This enabled space-warping actions by accelerating space vehicles at a given flight to light-speed ratio to be modeled by airflow distorting actions of appropriately scaled air vehicles at a similar flight to sound-speed ratio.

ACCELERATED FLIGHT THROUGH ZERO-POINT QUANTUM VACUUM

The thermal radiation pressures of air are "positive" exerting "inward-pushing" pressures over the entire surface of any accelerating vehicle – such as the upper vehicle shown in Figure 7. Airflow is both compressed and expanded as the speed of sound is approached, reached, and exceeded and an adverse pressure gradiemt forms about the vehicle. Here, higher than ambient pressures acting upon the front of the vehicle cause a resisting "push" and lower than ambient pressures acting on the rear of the vehicle cause a resisting "pull". And it may be noted that air pressures are resisted by a very thin repulsive field region that is caused by electrical repulsion between electrons of the outer-most atoms of the vehicle's skin and the most nearby electrons of the atoms of passing air. In air-less vacuum, such a thin repulsive field vanishes, and Haisch, 1994 shows that an electromagnetic interaction between the accelerating vehicle and its quantum vacuum medium causes an inward-pushing electromagnetic radiation pressure gradient that is somewhat similar to an aerodynamic pressure gradient. And this flight resistance can be viewed as vehicle inertia.

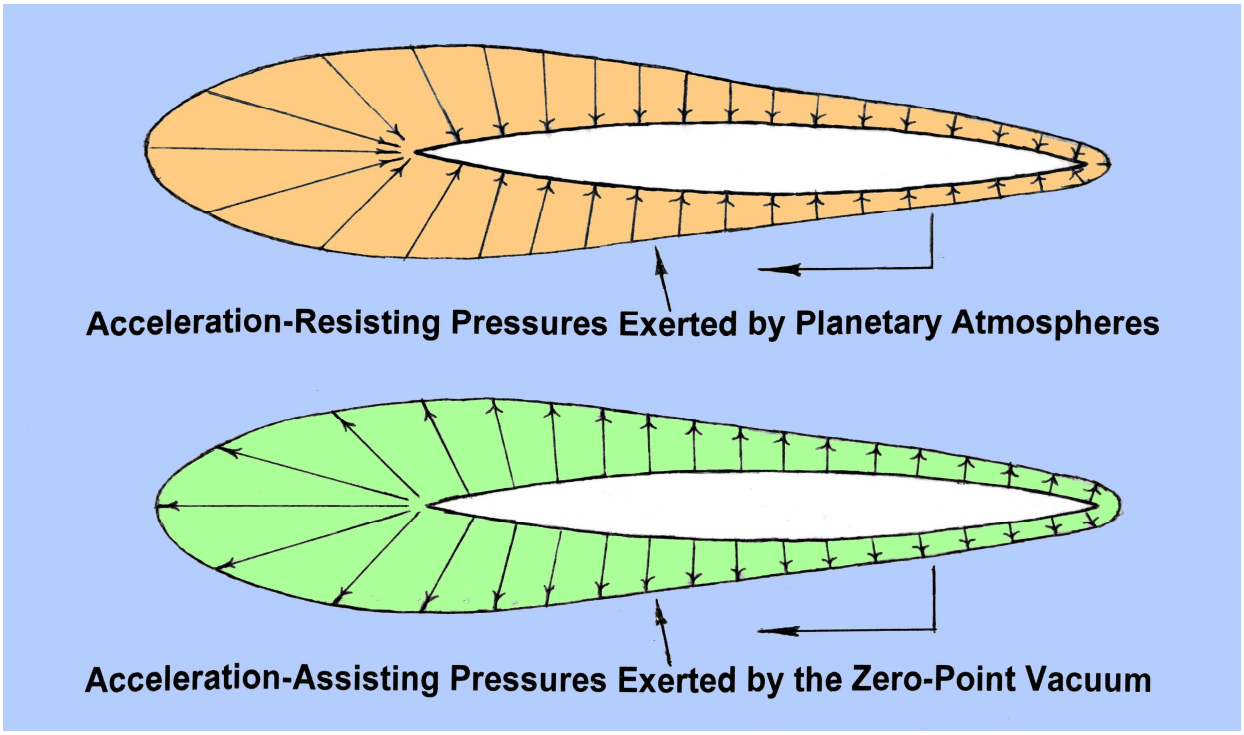


Figure 7. "Resisting" and "Assisting" Vehicle Pressures Exerted by Planetary Atmospheres and the Quantum Vacuum

A repulsive field similar to that generated by electronic interaction between air vehicle skin and passing air can be provided the lower vehicle of Figure 7 – which is accelerating with respect to the quantum vacuum - by embodying space-warping, particle-repelling field generators in its outer skin. But the quantum vacuum has a "negative" pressure which can be viewed as acting in the opposite direction that inward-pushing positive pressure fields act. So, with repulsive field pressures already acting "outward" from the vehicle skin, there is nothing to prevent "outward-pulling" (rather than inward-pushing) pressures to act over the entire ship. And this would cause higher-than-ambient, outward-pulling, acceleration-assisting force to act upon the front of the vehicle; and lower-than-ambient, outward pulling pressures to act upon its rear – that also results in a acceleration-assisting force. Such acceleration-assisting force would maximize in the transluminal speed range where pressure gradients become the most intense. Such force would be diminished by entropy-increasing energy dissipation in shock waves – such as emitted Cherenkov radiation. However, a negative pressure vacuum should still assist repulsive field propulsion systems.

It must be admitted that fluid dynamic analogues of vehicle flight through warp-able space and perturb-able vacuum by simulations using Computational Fluid Dynamics (CFD) are only first-order approximations inadequate for any kind of precise computation for actual vehicle or propulsion system design. But it is believed that they are useful in introducing persons such as engineers to features and problems of field-propelled flight by visualization rather than the complex tensor mathematics of General Relativity. Figure 8 and Figure 9 show samples of such visualizations.

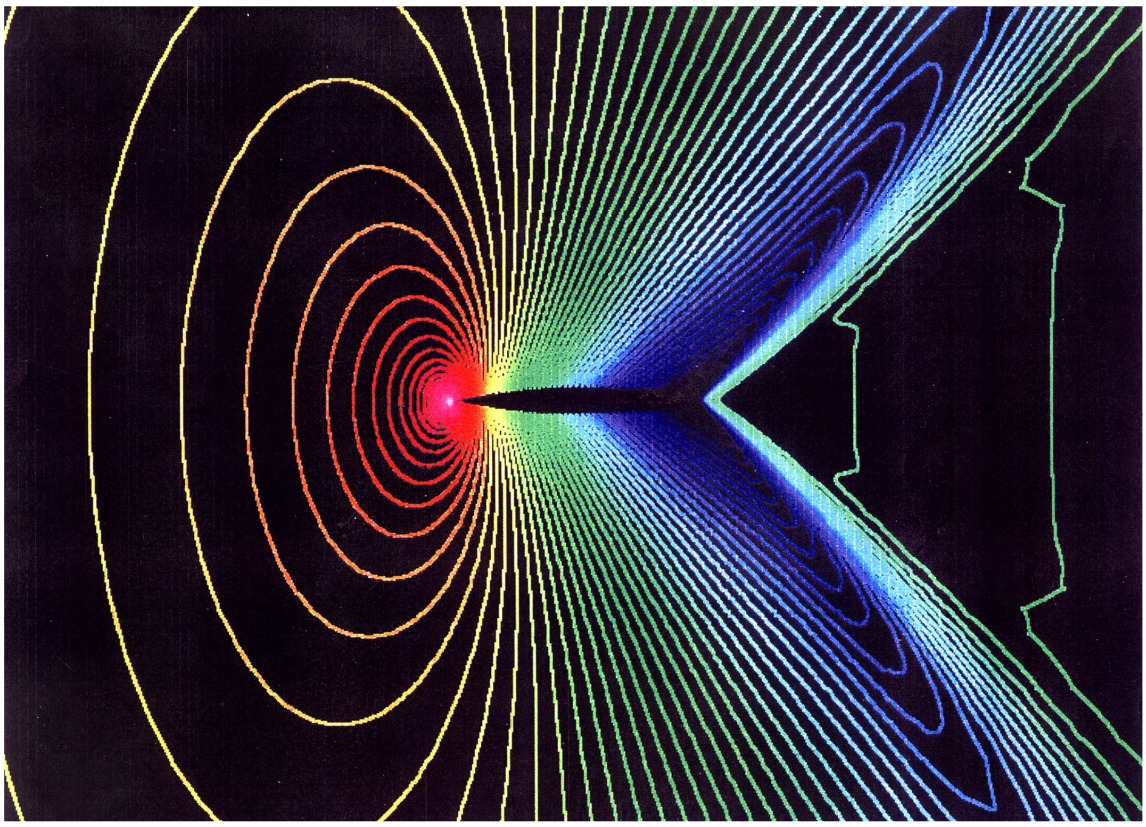


Figure 8. Zero-Point Radiation Pressure Gradient Caused by Accelerating Ship at 99 percent of the Speed-of-Light

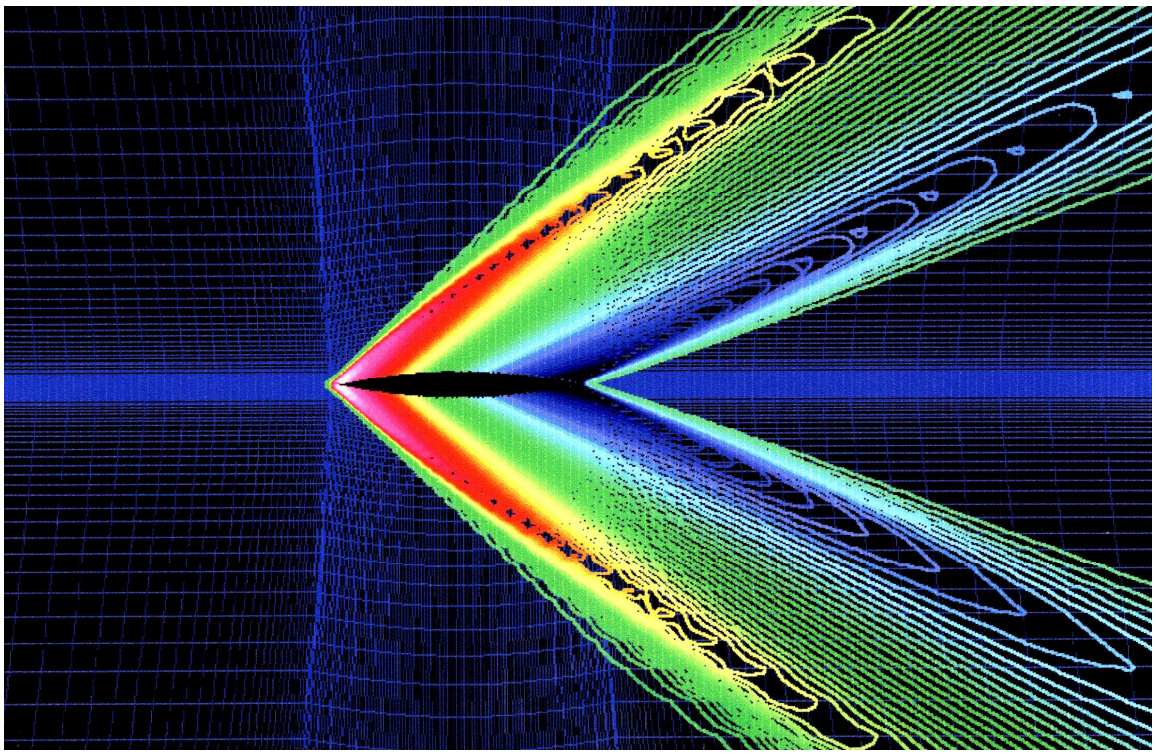
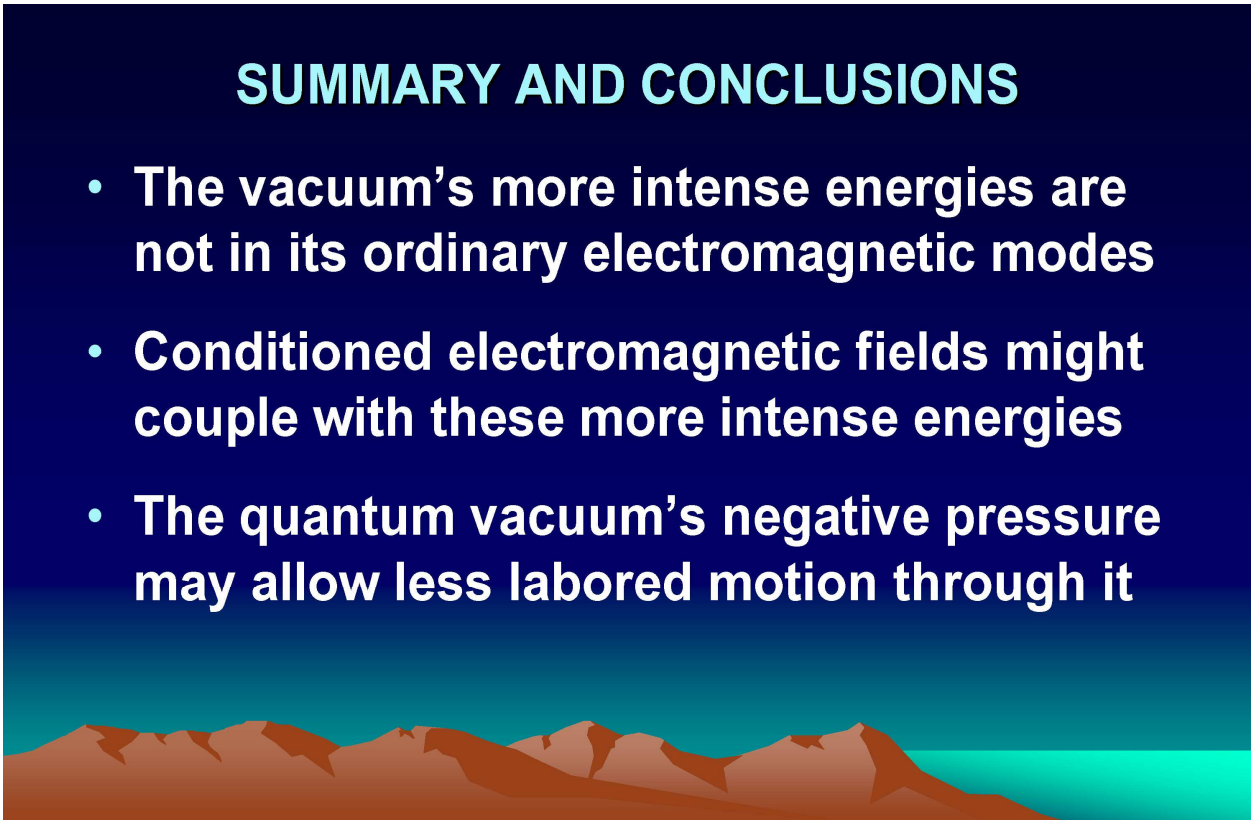


Figure 9. Zero-Point Radiation Pressure Gradient Caused by Accelerating Ship at Twice the Speed-of-Light



REFERENCES

Barrett, T.W., "Topological Foundations of Electromagnetism", *World Scientific,* 2008

Froning, H.D., "Propulsion Requirements for a Quantum Interstellar Ramjet", *Journal of the British Interplanetary Society*, Vol 33, No 7 (1980)

Froning, H.D., Roach, R.L., "Fast Space Travel by Vacuun Zero-Point Field Perturbations", Proceedings of *Space Technologies and Applications Forum (STAIF1999*, Edited by M.S. EL Genk, American Institute of Physics, Melville, New York, 1999

Froning, H.D., Roach, R.L., "Preliminary Simulations of Vehicle Interactions with Zero-Point Vacuum by Fluid Dynamic Approximations", AIAA 2000-3478, 36th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Huntsville Alabama (2000)

Froning, H.D., Roach, R.L., "Fluid Dynamic Simulations of Warp Drive Flight through Negative Pressure Zero-Point Vacuum", Proceedings of *Space Technologies and Applications Forum (STAIF2007)*, Edited by M.S. EL Genk, American Institute of Physics,Melville,New York, 2007

Haisch, B., Rueda, A.,Puthoff, H., "Inertia as a zero-point field Lorenz Force", *Phys. Rev. A,* Vol 49, p678

Puthoff, H.E., Little, S.R., Ibsen, M., "Engineering the Zero-Point Field and Polarizable Vacuum for Interstellar Flight", *Journal of the British Interplanetary Society*, Vol 55, p137 (1980)

Wheeler, J.A., "Superspace and the Nature of Quantum Geometrodynamics", Topics in Non Linear Physics, p615-644. Proceedings of the Physics Section, International School of Non Linear Mathematics and Physics, Springer-Verlag (1968)