COUPLING GRAVITY, ELECTROMAGNETISM AND SPACE-TIME
FOR SPACE PROPULSION BREAKTHROUGHS

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SUMMARY:

Spaceflight would be revolutionized if it were possible to propel a spacecraft without rockets using the coupling between gravity, electromagnetism, and space-time (hence called "space coupling propulsion"). New theories and observations about the properties of space are emerging which offer new approaches to consider this breakthrough possibility. To guide the search, evaluation, and application of these emerging possibilities, a variety of hypothetical space coupling propulsion mechanisms are presented to highlight the issues that would have to be satisfied to enable such breakthroughs. A brief introduction of the emerging opportunities is also presented.

APPROACH:

Although studies have identified possible effects and theories related to the goal of space coupling propulsion [1-4], there is no problem definition against which to assess and augment this information. To correct this deficiency, a problem definition is derived from examining a variety of hypothetical propulsion mechanisms. These hypothetical mechanisms assume a priori that coupling propulsion is possible in order to illustrate the physics that would be required to make these mechanisms feasible. This is simply the first step of the Scientific Method: recognition and formulation of the problem.

HYPOTHETICAL PROPULSION MECHANISMS:

Fundamentally there are two different force producing mechanisms, collisions and interactions with fields. Analogies to these fundamental mechanisms are used to envision several different hypothetical propulsion mechanisms.

Propulsion using collisions: Conventional rocket propulsion is fundamentally based on the collisions between the propellant and the rocket. These collisions thrust the rocket in one direction and the propellant in the other. By definition, space coupling propulsion does not use propellant, so one must presuppose that space contains some form of reactive media. Assuming that there exists a media of momentum-carrying particles or waves throughout space, several propulsion mechanisms can be envisioned that induce propulsive forces using asymmetric collisions with these waves or particles, as depicted in figures 1 through 4.

Propulsion using fields: A second set of space coupling mechanisms is based on using fields. Electric fields accelerate charges and gravitational fields accelerate masses. For space coupling propulsion, one must presuppose that space contains properties from which fields can be
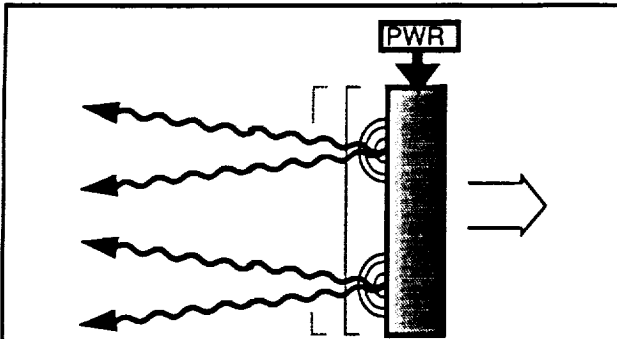
Figure 1: Radiation Emission Propulsion:
Analogous to the photon rocket, expulsion of momentum carrying waves creates propulsive forces.
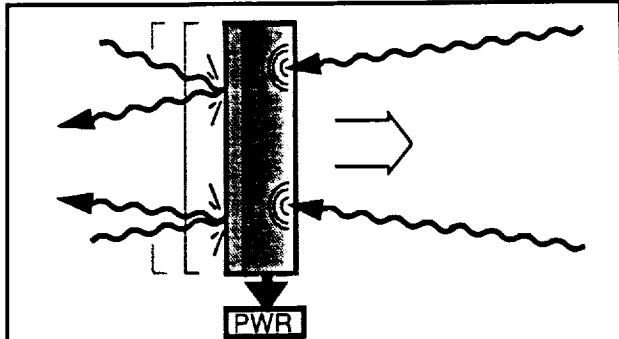
Fig. 2: Reflection/Absorption Propulsion:
Analogous to a radiometer vane, a net difference in radiation pressure exists across the reflecting and absorbing sides.
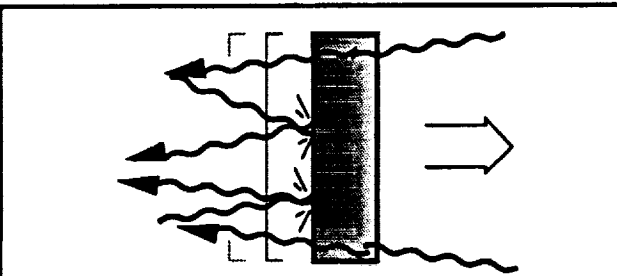
Fig. 3: Reflection/Transmission Propulsion:
Analogous to a diode, space radiation passes through one direction and reflects from the other, creating a net difference in radiation pressure.
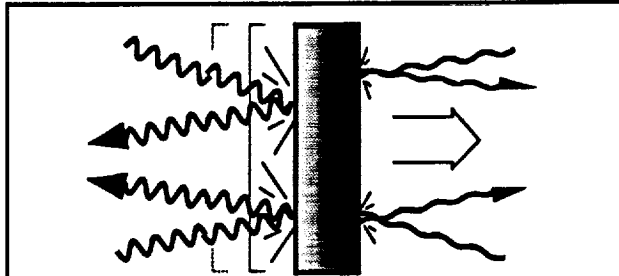
Figure 4: Differential Pressure Propulsion:
Analogous to creating a pressure gradient in a fluid, one side raises the media's intensity and the other lowers the intensity to create a net difference in radiation pressure.
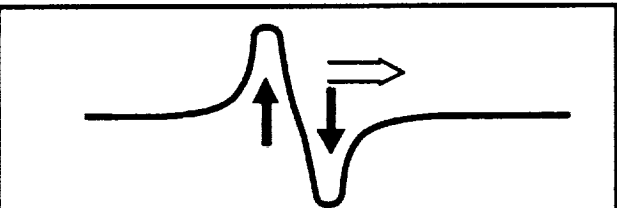
Figure 5: Differential Field Propulsion:
Analogous to a pressure gradient in a fluid, or to "negative mass propulsion" (ref. 17), a local field is induced in the otherwise flat scaler potential, resulting in gradient at the vehicle to produce thrust.

Fig. 6: Adjusted Field Source Propulsion:
Similar to differential field propulsion, this version assumes that a symmetric field is initially present and then adjusted asymmetrically to induce a gradient. This version evokes the need to describe fields as having an effective reaction mass.
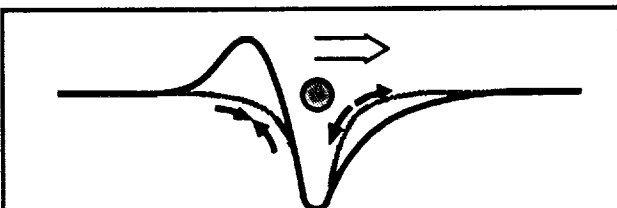
Figure 7: Asymmetric Tension Propulsion:
Almost identical to figure 6, this version assumes that the gradient is induced by altering the characteristics of space (Newton's constant G, or EM constants ε_0 or μ_0). This also evokes the issue of field reaction mass.
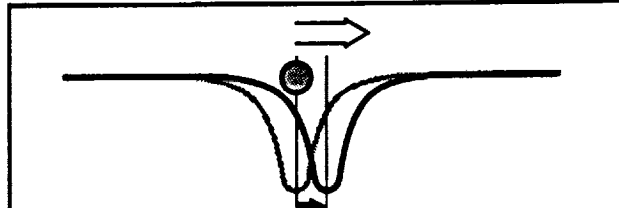
Figure 8: Source Displacement Propulsion:
This method assumes that a field's source is a separate entity from that which reacts to the field and that it has no inertia. By sustaining a displacement of the source from the reactant, the reactant accelerates.

induced, and in particular, that *controllable asymmetric fields* can be induced across the vehicle, and that these asymmetric fields can be *carried along with the vehicle* as the vehicle is propelled. Several examples are depicted in figures 5 through 8.

A critical and guiding issue with field propulsion is conservation of momentum. For field propulsion, the fields themselves must act as the reaction mass. This is difficult to conceptualize. To consider gravitationally flat space as a reaction mass, for example, a formalism of Mach's Principle or some other formalism which assigns an effective reaction mass to the scalar potential is required. Such formalisms do not yet exist.

PROBLEM STATEMENT:

From the hypothetical mechanisms, several common issues are revealed: (1) The space vacuum must contain something that can act as a reaction mass that satisfies these conditions; (a) must have an equivalent mass density sufficient to be used as a reaction mass, (b) must be available equally across all space and in all directions, and (c) must be tangible. (2) A coupling mechanism must exist with a property of space satisfying the above conditions and which satisfies these conditions; (a) must be able to induce asymmetric reaction forces, (b) must be controllable, (c) must be sustainable, (d) must be effective enough to propel the vehicle, and
(e) must satisfy conservation of energy and momentum.

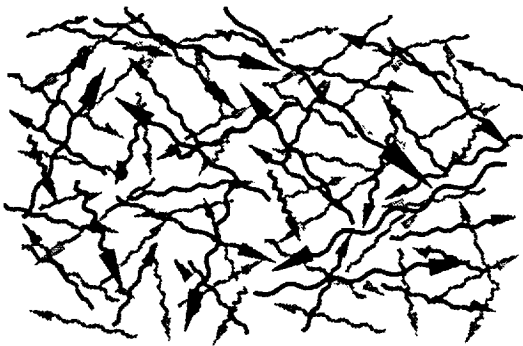The above is a checklist for evaluating or envisioning space coupling propulsion concepts.

EMERGING POSSIBILITIES:

Properties of space: Although the vacuum is generally thought to be empty, there are several known properties that are indicative of reactive media. These include the Cosmic Background Radiation[5] (figure 9), Zero Point Electromagnetic radiation[6] (figure 10), virtual pairs[7] (figure 11), dark matter[8] and the very-low-density intergalactic gas[9] (estimated to be only 10^{-28} g/cm^3). Based on the existence of gravitational and electromagnetic fields, it is reasonable to assume that space contains properties from which fields can be induced. It is also possible to consider the media in space as a property from which "pressure" fields can be induced.

Coupling mechanisms: Using the formalism of General Relativity, it has been confirmed that electromagnetism and gravity are coupled[9] (figure 12), but it is not yet known how to use these couplings for propulsion. It has been suggested that an intense magnetic field would induce accelerations[10], and it has been suggested that by warping the space-time metric, faster-than-light travel may be possible using a mechanism similar to that of figures 6 or 7[11].

Also, new theories are emerging that suggest alternative couplings between gravity and electrodynamics. These include theories that define inertia and gravity in terms of Zero Point Energy[12,13] and alternative derivations of Maxwell equations that include mass terms[1,14].

In addition to theories, there are some unusual experimental observations that also hint of unexplored couplings between mass and electromagnetics[15,16].
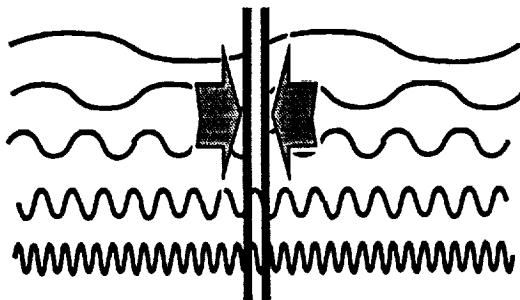
CBR Characteristics:

- Isotropic electromagnetic radiation
- Blackbody spectrum
- Velocity variant spectrum
- Peak frequency $\approx 2\times10^2$ GHz
- Mass energy density $\approx 10^{-34}$ $g/_{cm^3}$

Figure 9: Cosmic Background Radiation

Presumed to be the residual thermal energy of the Big Bang, a blackbody spectrum of microwaves exists throughout all space. Coincident with the mean rest frame of the universe, this media constitutes an absolute reference frame. Velocity can be measured relative to this frame by measuring Doppler shifts fore and aft.

ZPE Characteristics:

- Isotropic electromagnetic radiation
- Cubic frequency spectrum
- Lorentz invariant spectrum
- Cut-off frequency $\approx 10^{33}$ GHz
- Mass energy density $\approx 10^{54 \pm 38}$ $g/_{cm^3}$
- ZPE = $^{1}/_{2}\,h \times$ freq.
- Affects absolute zero, $T_{0Earth} = 4\times10^{-20}$ °K

$$F \propto {}^A/_{d^4}$$

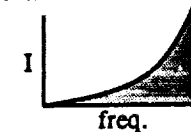$$F(A=1cm^2, d=0.5\mu m) = 0.2 \text{ mg}$$

Figure 10: Casimir Effect as Evidence of Zero Point Energy

Two parallel conducting plates will attract each other when closely spaced because more electromagnetic modes exist outside than are allowed between, resulting in a net radiation pressure forcing the plates together. The electromagnetic background that gives rise to this effect is Zero Point Energy (ZPE), a consequence on the non-zero energy of the lowest energy state of a harmonic oscillator, theoretically equal to the frequency times half Planck's constant. ZPE is also evidenced by the Lamb shift and deviations from classical heat of vaporizations for cryogens near absolute zero. (ZPE of solid H = 200 cal/mole, for solid He = 50 cal/mole)
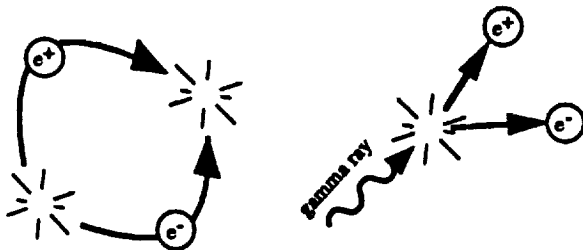
Figure 11: Virtual Pairs

Empty space is theorized to contain a sea of spontaneously created and annihilated electron-positron pairs. Gamma ray decay into pairs can be interpreted as corroborating physical evidence.
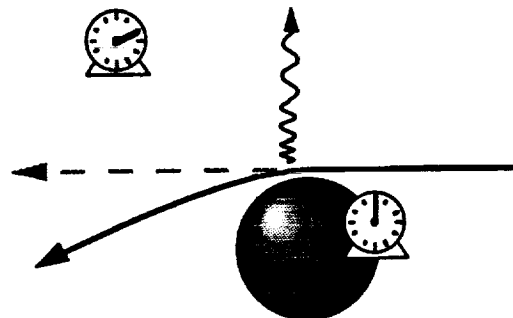
Figure 12: General Relativity

Gravity bends light, red-shifts light, and slows time.

CLOSING REMARKS:

Given the hypothetical examples, problem statement, and emerging evidence, a next step toward seeking this propulsion breakthrough is to compare the emerging physics with the problem statement and then to suggest areas warranting further investigation.

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