ASI-TR-88-340
WO-87-322

AFAL-TR-88-037

FINAL TECHNICAL REPORT

COMPRESSIBLE FLUID DYNAMICS STUDY

AF Contract No. F04611-87-C-0046

Submitted to

AFFTC (AFSC)
Directorate of Contracting/PKRA
Edwards AFB, CA 93523-5000

Prepared by

Aerospace Systems, Inc. (ASI)
121 Middlesex Turnpike
Burlington, MA 01803

May 1988

ASI-TR-88-340
WO-87-322

AFAL-TR-88-037

FINAL TECHNICAL REPORT

COMPRESSIBLE FLUID DYNAMICS STUDY

AF Contract No. F04611-87-C-0046

Submitted to

AFFTC (AFSC)
Directorate of Contracting/PKRA
Edwards AFB, CA 93523-5000

Prepared by

Aerospace Systems, Inc. (ASI)
121 Middlesex Turnpike
Burlington, MA 01803

May 1988

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ASI TR-88-323	5. MONITORING ORGANIZATION REPORT NUMBER(S) AFAL-TR-88-037
6a. NAME OF PERFORMING ORGANIZATION Aerospace Systems, Inc. 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Air Force Astronautics Laboratory
6c. ADDRESS (City, State and ZIP Code) 121 Middlesex Turnpike Burlington, MA 01803	7b. ADDRESS (City, State and ZIP Code) AFAL/USAF Edwards AFB, CA 93523-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F04611-87-C-0046
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.

11. TITLE (Include Security Classification)
Compressible Fluid Dynamics Study

12. PERSONAL AUTHOR(S)
Roos, Jan; Whitney, Cynthia Kolb; Foss, Peter; and Zvara, John

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
Final	FROM 87/6 TO 88/1	88/5/15	36

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	Compressible Fluid Dynamics, Energy Density, Space Energy Conversion, Field Gradient Force Vectors

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The report includes the results of an investigation to identify promising dynamic field-matter interactions with the scalar velocity potential of vacuum space by using the theory of compressible fluid dynamics. A two-dimensional fluid dynamic field-field interaction matrix of flow singularities was developed. Early in the study the analysis was shifted from the fluid dynamic non-linear description towards the relativistic non-linear description. Both descriptions were developed in parallel for the qualitative and quantitative determination of non-zero surface integrals. The investigation showed that a non-zero surface integral is to be found in the radiation reaction of a two-body system such as the hydrogen atom. Uncovering an error in the derivation of the Lienard-Wiechert potentials provides the theoretical basis for a mechanism to couple radiation energy from space into matter through rotational torque moments arising from

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☒ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION Unclassified	
22a. NAME OF RESPONSIBLE INDIVIDUAL Franklin B. Mead, Jr.	22b. TELEPHONE NUMBER (Include Area Code) (805) 275-5540	22c. OFFICE SYMBOL USAF

DD FORM 1473, 83 APR EDITION OF 1 JAN 73 IS OBSOLETE.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

non-linear retardation of the position of the radiation source. This principle will be applied in the construction of proof-of-principle experiments, proposed to be carried out in Phase II.

The zero point quantum energy fluctuations that appear to explain the energy exchange are still considered by the investigators as a tentative solution for a process that can be better described by a theory with a new first principle n-dimensional fundamental framework of mathematical physics in which the presence of energy with a finite signal propagation speed is the first and only condition to develop the theory of relativity and quantum mechanics (see R. E. Var; "On a New Mathematical Framework for Fundamental Theoretical Physics", Foundations of Physics, Vol. 5, No. 3., September 1975).

Physicists have always believed that classical field-matter energy exchange is strictly one-way, fields receiving energy and matter losing it, via radiation. That belief is consistent with the accepted formulation for potentials created by relativistically moving sources. But that formulation has recently been shown to embed an error. Correction of the error allows reverse energy transfer, from fields to matter. Though previously unexpected, this mechanism becomes credible by offering a candidate explanation for certain otherwise mysterious natural phenomena.

The mechanism behind the reverse energy transfer is relativistic torquing within any interacting multi-body system. The existence of relativistic torquing invites human intervention, to induce controlled energy transfer that can be tapped for human purposes such as propulsion. The design of an engineering system to demonstrate such a function on a laboratory scale is here discussed.

In summary, the theoretical study of this Phase I effort positively identified one principle for energy extraction from the vacuum space energy density as that of relativistic torquing due to non-linear effects, brought about by retardation of time and position in the language of relativity, with nature's example of the hydrogen atom. Based on this principle two field-matter geometries are identified as promising candidates for Phase II proof-of-principle experimental testing. The expected result of this principle is non-rotational energy if the non-linear torquing energy can be made to exceed dissipative energy effects of the experiment itself.

TABLE OF CONTENTS

INTRODUCTION

This Technical Report gives on account of the technical objectives that were accomplished during the course of this Phase I contract. Early in the study the analysis was shifted from the fluid dynamic non-linear description towards the relativistic non-linear description. Both descriptions were developed in parallel for the qualitative and quantitative determination of non-zero surface integrals. In the technical paper prepared under this study and presented in the Appendix, it is shown that a non-zero surface integral is to be found in the radiation reaction of a two-body system such as the hydrogen atom. Uncovering an error in the derivation of the Lienard-Wiechert potentials, the paper provides the theoretical basis for a mechanism to couple radiation energy from space into matter through rotational torque moments arising from non-linear retardation of the position of the radiation source. This principle will be applied in the construction of proof-of-principle experiments, proposed to be carried out in Phase II, and is the one principle positively identified in Phase I for energy extraction from the vacuum space energy density and for the derivation of force vectors.

The zero point quantum energy fluctuations that appear to explain the energy exchange are still considered by the investigators as a tentative solution for a process that can be better described by a theory with a new first principle n-dimensional fundamental framework of mathematical physics in which the presence of energy with a finite signal propagation speed is the first and only condition to develop the theory of relativity and quantum mechanics (see R. E. Var, "On a New Mathematical Framework for Fundamental Theoretical Physics", Foundations of Physics, Vol. 5, No. 3, September 1975).

The report follows the format of the six steps of the Phase I technical objectives, given again below. The technical paper suitable for publication in a technical journal that resulted from the Phase I effort is presented in the Appendix. Two fold-out drawings presenting the fluid dynamic field-field interaction matrix of flow singularities developed in the study are included at the end of this report.

ANALYSIS STEPS AND RESULTS

This section presents a summary of the six steps followed in the Phase I study along with technical data generated under each step. The six steps consisted of the following:

1. Write a complete matrix table of dynamic field-matter geometries.

2. Enter equations for forces and moments for field-field and field-scalar potential derivative interactions.

3. Determine geometric matter boundary conditions required to obtain non-zero closed surface integrals of the forces of interaction at the material surfaces of the field-matter geometries.

4. Enter vector force resultants in the table, expressed in independent parameters including the vacuum space energy density.

5. Determine the most probable value of the energy density for the zero point quantum dynamic energy of vacuum space.

6. Select the most promising of the optimized field-matter geometric models using simple criteria of efficiency, economy, and force vector magnitude or based on system trade-off criteria.

TECHNICAL OBJECTIVES ACCOMPLISHED

Step 1: Write a Complete Matrix Table of Dynamic Field-Matter Geometries.

1A. During a part of the study of fluid dynamic field-field interaction matrix of flow singularities, a two dimensional matrix was completed (see Drawing No. E-WO87-322-01, Sheets 1 and 2, Compressible Fluid Dynamics Interaction Matrix Field-Field of Fluid Flow Singularities presented as fold-outs at the end of this report). Inclusion of alternating flow features expanded the matrix size beyond what was originally anticipated. The expanded 12 row by 12 column basic matrix in addition has 4 columns of multibody interactions, resulting in a total of 134 field-field interactions.

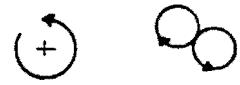
The above number of possible interactions made it impossible to map all the matter geometries to complete the third dimension of the matrix within the timeframe of Phase I. Instead, only the cases that promise the non-linear torque interaction have been selected for further immediate analysis.

1B. Promising Field-Field Interactions

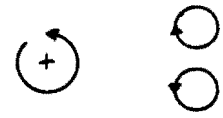
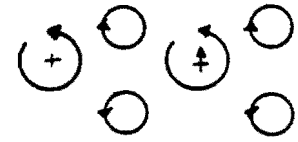
The field theoretical analysis of multiple bodies that are in rotation with respect to each other and attract or repel each other, shows they are most promising for extraction of energy out of the vacuum. A resultant torquing can be demonstrated from the retardation of time and position, and it becomes more pronounced the closer the system operates to the signal propagation speed (speed of light or sonic speed).

The fluid dynamic matrix gives the following set of flow candidates:

A. Vortex Flow

- Vortex/Vortex 
- Vortex/Linear Dipole 

Multibody

- Vortex/Dual Linear Dipole Opp Pair 
- Vortex/Dual Linear Dipole Opp Vortex 
- Vortex/Dual Linear Dipole Opp Vortex Pair

B. Dipole Flow

• Dipole + Dipole	Add: Rotation
• Dipole - Dipole	Add: Rotation
• Dipole + Dip-Dip	Add: Rotation
• Dual(+)Dipole/$_{\text{Attr.}}$Dual(-)Dipole	Add: Rotation

C. Gyration Stabilized Vortex

• Gystto + Gystto	Add: Rotation
• Gystto - Gystto	Add: Rotation
• GST + GST - GST	Add: Rotation

The above simple cases selected from the two dimensional matrix are the preliminary candidates for incorporation into the three dimensional matrix, where the geometric boundary conditions are added. Rotation of the systems is one or the other form: Vortex rotation with ωr = constant (fluid vortex) and plain body rotation with ω = constant.

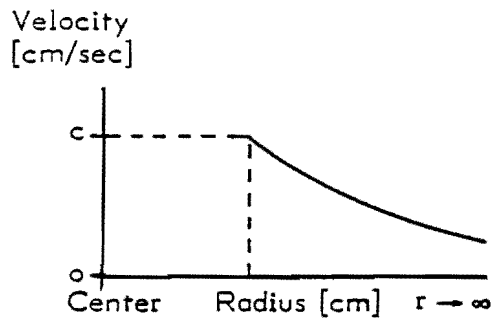
Step 2: Enter Equations of Forces and Moments for Field-Field and Field-Scalar Potential Derivative Interactions.

2A. Vortex in Sonic Limit Flow

For both rotations the tangential velocity is here limited to the sonic velocity c. For a vortex or circulation strength Γ therefore a minimum vortex radius R exists:

$$R = \Gamma / 2\pi c$$

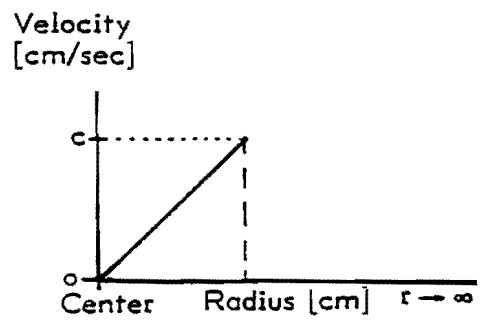
For $r > R$: Velocity $v = \Gamma / 2\pi r$



This is Anton Betz' velocity field surrounding the vortex singularity.

For $r < R$: $v = \frac{r}{Rc}$

$$= r \frac{2\pi c}{\Gamma} c = 2\pi r c^2/\Gamma$$



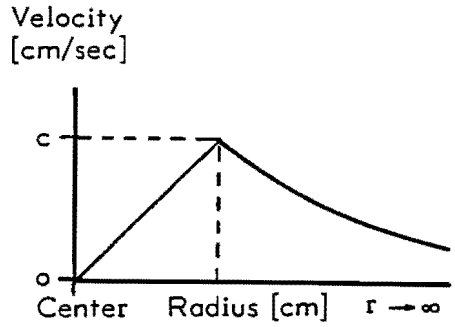
This defines the singularity as a vortex body with a finite diameter rotating at the limiting signal propagation speed.

For the plain matter geometric rotation, $v = \omega\, 2\pi R$, limiting v to the sonic velocity c therefore gives a maximum geometric cylinder radius of

$$R = \frac{c}{2\pi\omega} \quad .$$

Each of the above rotating systems thus has a tangential velocity, that is defined for a range of r.

For $r = 0$ to $r = \infty$.



By superposition of the two ranges the entire region from $r = 0$ to $r = \infty$ can thus define the vortex singularity with matter boundary conditions. It represents a rotating cylinder with a sonic surface velocity at the center of a fluid vortex with circulation: $\Gamma = 2\pi R c$.

2B. Vortex in Compressible Flow

Here we allow supersonic velocities as $M = \infty$. The streamlines external to the vortex singularities are circles. The circulation inside each circle is $\Gamma = 2\pi r \cdot v$.

$$r = \frac{\Gamma}{2\pi v} = \frac{\Gamma}{2\pi Mc} = \frac{\Gamma}{2\pi Mc_o}\,\frac{c_o}{c} = \frac{\Gamma}{2\pi c_o}\left(\frac{c_o^2}{M^2 c^2}\right)^{1/2}$$

Where:

c_o = Speed of sound at the stagnation temperature

$$r = \frac{\Gamma}{2\pi c_o} \left(\frac{1 + \frac{1}{2}(\gamma - 1) M^2}{M^2} \right)^{1/2}$$

$$r = \frac{\Gamma}{2\pi c_o} \left[\frac{1}{M^2} + \frac{1}{2}(\gamma - 1) \right]^{1/2}$$

Examination of this expression for r reveals that r has a minimum value r_{min} when $M = \infty$:

$$r_{min} = \frac{\Gamma}{2\pi c_o} \left[\frac{\gamma - 1}{2} \right]^{1/2}$$

Here r_{min} is shown to be very dependent on the magnitude of the thermodynamic property $\gamma = c_p/c_v$, the ratio of the fluid properties of specific heat at respectively constant pressure and at constant volume. For $c_p = c_v$, $\gamma = 1$ and $r_{min} = o$. For $c_p \neq c_v$:

$$\frac{r}{r_{min}} = \left[1 + \frac{2}{(\gamma - 1) M^2} \right]^{1/2}$$

As r increases, M must steadily decrease. M becomes one for:

$$r = R = r_{min} \left[\frac{\gamma + 1}{\gamma - 1} \right]^{1/2}$$

The largest r_{min} is obtained for large γ for mono atomic gases such as helium, $\gamma = 5/3$ and:

$$r_{min} = R/2 = (r_{min})_{max} \text{ for } \gamma = 5/3$$

2C. The following are papers pertinent to field-field and field-scalar interactions and matter boundary conditions. They uncover errors in the Lienard-Wiechert potentials for energy transfer in the electromagnetic domain. They positively identify one principle for energy extraction from the vacuum space energy density as that of relativistic torquing.

- C. K. Whitney, "Distinct Questions in Relativity Theory", Physics Essays, Vol. 1, April 1988.

- C. K. Whitney, "Manifest Covariance in Relativistic Potential Theory", Physics Essays, Vol. I, April 1988.

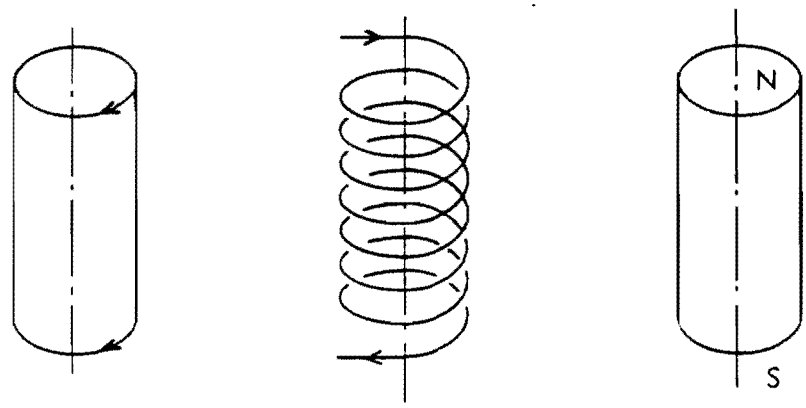
- C. K. Whitney, "Field Lines in Classical Theory", The Hadronic Journal 10, pp. 91-93, 1987.

Step 3: Determine Geometric Matter Boundary Conditions Required to Obtain Non-Zero Closed Surface Integrals.

3A. A. Betz shows in his paper, "The Use of Fluid Flow Singularities for the Derivation of Forces and Moments of Bodies in Potential Flow", that the forces resulting from the velocity disturbances of the singularities vanish at a large distance and that the only forces that remain are those arising from the products with the far field flow velocities. Only in the case where two-dimensional velocity moments are present can the quadratic terms for pressure and momentum be considered. Both are multiplied by area and moment arm, both increase as r, and their products as r^2, and the product of the flow velocities reduce as $1/r^2$. Large values of r will thus still give finite values for the moments. For 3-dimensional flow the contributions of the quadratic terms disappear also for the moments. Moments can thus still be found at relatively large distances from 2-dimensional singularities.

3B. From the above we may immediately conclude that large separations of singularities characterized by 2-dimensional flow will give quantitatively the larger effects and must be pursued to maximize the optimization. Linear vortices, line sources or line sinks and line dipoles are thus the preferred singularities and are candidates for analysis as dual and multibody combinations. The 3-dimensional singularities such as the dipole and the gyration stabilized toroid or vortex appear less attractive for optimization of the forces and moments since non-zero surface integrals cannot be shown to persist at increased distances from these singularities. If close spacing can induce collimated flow however non-zero integrals may still be possible.

3C. The 2-dimensional cylindrical vortex can be simulated in electromagnetic experiments by a current carrying solenoid coil or a cylindrical bar magnet.



Vortex Solenoid Magnet

3D. Placement in multiples on rotating tables with axis parallel will satisfy the requirements of this geometric analysis and identifies the most promising field-matter geometry obtained from the fluid dynamic selection procedure.

3E. Step 3 is represented by three papers on the hydrogen atom, showing that the two bodies, proton and electron, achieve a steady state because radiation OUT is balanced by torquing energy IN via a NON-ZERO line integral around a particle path. The equivalent surface integral is similar to that which must be taken to properly handle the radiation reaction.

- C. K. Whitney, "A New Perspective on the Hydrogen Atom", Physics Essays, Vol. 1, June 1988.
- C. K. Whitney, "Harmonics in the Hydrogen Atom", Physics Essays, Vol. 1, June 1988.
- C. K. Whitney, "Multiple States in the Hydrogen Atom", Physics Essays, Vol. 1, June 1988.

3F. The relationship between the field theoretic non-zero line integral and the fluid dynamic non-zero surface integral requires further study beyond the scope of the Phase I effort. Additional research on radiative reaction in classical electrodynamics and in multi-body systems is proposed as part of the Phase II effort.

1. The idea of a global Hamiltonian, including both particles and fields, provides a basis for the possibility of energy flow out of the vacuum of space and into physical systems. Preliminary studies show that such a Hamiltonian concept leads to the correct dipole formula for radiation reaction on a single accelerating charge.

2. Related studies show how the same concept applied to a two-body system correctly gives radiation reaction for the two bodies. The result is double the sum of dipoles for attracting opposite charges, and reduces to quadrupole for attracting similar masses. This extension to two bodies is important because two bodies interacting provide the minimal system to extract energy from the vacuum.

3. Part of the radiation reaction on charge e1 is the result of the field cross-product E1xB2, E1 being caused by e1 and B2 by e2. Under the proposed Phase II contract the other possible cross-product, E2xB1, will be developed to yield the non-zero torquing energy-gain rate in the form of a surface integral, rather than the equivalent line integral found in the present contract.

3G. The following observations apply to an experimental concept and identify the most promising field-matter geometry obtained from the relativistic exploratory analysis.

1. The minimal system for drawing energy from the vacuum of space is two attracting bodies interacting. For an engineering demonstration using electromagnetic interactions, it is convenient to replace the two orbiting bodies with two coaxial current loops interacting. The two loops should have opposing current flow, and so would repel each other. To minimize losses due to mechanical strains, it is desirable to replace the two loops with two interleaving coils. To minimize resistive losses, it is desirable to make the coils superconducting.

2. The use of coils makes the proposed system somewhat reminiscent of a Newman motor. But the use of two coils rather than one should enable the device to run without distinct pulses, thus removing the candidate explanation that such a device works by explosive cleaning of battery electrodes. The two interleaving coils may be somewhat reminiscent of a Smith-Killick tensor coil, although the documentation we have on that is insufficient to be sure. But the output of interest will be measurable energy into a motor, capacitor or other dump, rather than any kind of propagating beam.

3. Moving charge average velocity β and density ρ are important design parameters in such a system. The longitudinal force F on an electron will be proportional to a function of ρ and β:

$$F \propto \rho\beta\,[1/(1-\beta) + 1/(1+\beta)] \propto I/(1-\beta^2) \quad [N]$$

The energy gain rate or power P into the system will then be proportional to a stronger function:

$$P \propto \rho\beta\, F \propto I^2/(1-\beta^2) \qquad [N\ m/sec]$$

Clearly large ρ and β are desirable for the I^2 factor. In addition, if β approaching 1 can be achieved, the $(1 - \beta^2)$ denominator becomes important. This factor is essentially energy squared, and for very high voltage scales as voltage squared, or current squared, making P altogether scale as I^4, a highly desirable regime to be in.

4. Nonlinearity is a significant design factor in such a system. Consider the following analogy: the harmonics in the hydrogen atom are like a bleed mechanism working on what the system would have been with perfectly circular orbits. The first reference in 3E (Ref. 20 in the Appendix) shows that system would have had its equilibrium orbit at a radius 30.9 times smaller. The energy throughput dipole radiation is proportional to the square of acceleration a and Coulombic radiation is proportional to the inverse square of radius r. Thus radiation scales as $1/r^4$. It then follows that at the smaller radius the hydrogen radiation, and hence energy throughput, would have been larger by a factor of $(30.9)^4 = 10^6$. So if the

bleed mechanism had not been so strong a factor (29.9), its absolute magnitude would have been larger.

Clearly, there is an optimum fraction x at which to bleed a system. In the hydrogen example, the optimum x is such that the product of the bleed fraction x, times energy throughput of the bled system, $(1 + x)^{-4}$, is maximized. That is:

$$x/(1 + x)^4 = \text{maximum, from which } x = 1/3.$$

Step 4: Enter Vector Force Resultants in the Table, Expressed in Independent Parameters Including the Vacuum Space Energy Density.

4A. The rate of energy flow through the hydrogen atom is calculated as follows:

1. The rate at which the hydrogen atom pumps energy through its ground state is at least the classical radiation rate, given for example in J. D. Jackson, Classical Electrodynamics, 2nd Edition, Equation 14.31, (John Wiley, New York, 1975).

In the present notation:

$$P = 2\, q^2\, r_1^2\, \omega_1^4/(4\pi\epsilon_0)\, 3\, c^3$$

Where q is the source charge in Coulomb, r_1 and ω_1 are the ground state radius and frequency, ϵ_0 is the permittivity of free space and c is the speed of light.

$$P = \frac{2\,(1.6 \times 10^{-19})^2\ (0.5 \times 10^{-10})^2\ (4 \times 10^{16})^4}{(4\pi\ 8.85 \times 10^{-12})\ 3\,(3 \times 10^8)^3}$$

$$= 3.6 \times 10^{-8}\ \text{J/sec}$$

Harmonics are to be superposed on the baseline circular motion from Step 3E; as a result P is scaled up by a factor of 30.9 (see Ref. 20 in the Appendix) yielding:

$$1.2 \times 10^{-7}\ \text{J/sec}$$

2. For comparison, the kinetic energy of the electron in motion around the nucleus is only:

$$q^2/2\,(4\pi\,\epsilon_0)\, r_1 = \frac{(1.6 \times 10^{-19})^2}{2\,(4\pi\, 8.85 \times 10^{-12})\,(0.53 \times 10^{-10})}$$

$$= 2.2 \times 10^{-18}\ \text{J}$$

3. Even the mc^2 energy is only:

$$(1.67 \times 10^{-27})(3 \times 10^8)^2 = 1.5 \times 10^{-10} \text{ J}$$

4. This means that the energy throughput of the hydrogen atom is enormous. In one second, about a thousand times the mc^2 energy passes through. Tapping into such a system at any macroscopic fraction would be much more efficient than nuclear or other previously known power source.

4B. The modern mathematical physics of compressible fluid dynamics provides a consistent and efficient language for describing fundamental physical phenomena. Starting from an energy continuum one can by application of first principles quickly obtain all the exact interrelated field equations to describe observed field phenomena. This problem if approached by a relativity theorist, would require him to follow a more arduous path with many appropriate assumptions to be made. However, this is not necessary with the approach described by Robert E. Var in: "On a New Mathematical Framework for Fundamental Theoretical Physics", Foundations of Physics, Volume 5, No. 3, September 1975. Robert E. Var's n-dimensional ENERGY CONTINUUM hypothesis explains all of relativity in energy terms. It also shows how the nonlinearity of compressible fluid dynamics admits particle solutions (soliton solutions), de Broglie waves and general quantum features of particle physics by virtue of a common Mach 1 structure parameter. Furthermore, Var's paper shows the derivation of natural and artificial gravity from the n-dimensional energy continuum and first principles.

The above powerful applied mathematical approach is a beginning and an illustration of the direct and systematic method suggested for Phase II to obtain the desired answers of understanding the energy/propulsion conversion possibilities of the n-dimensional energy continuum (hyper energy), which brings into view a hyper energy field, previously unknown, to be the object of a systematic evaluation during Phase II. In comparison, Phase I analyses were limited to the three ordinary spatial dimensions and time.

Step 5: Determine the Most Probable Value of the Energy Density for the Zero Point Quantum Dynamic Energy of Vacuum Space.

5A. Introduction

The known properties of vacuum space are:

c = speed of light

ϵ_0 = dielectric permittivity of vacuum

μ_0 = magnetic susceptibility of vacuum

Their relationship is given by the Maxwellian result:

$$c^2 = 1/\epsilon_0\mu_0$$

If the energy density of vacuum space is written as its fundamental meaning, Energy/Unit Volume (E/V), we can write:

$$c^2 = f[E/V]$$

The following equation can now be written with a dimensionless parameter C, by dimensionally balancing the equation with a density term, ρ:

$$c^2 = C \cdot E/V\rho$$

For further simplification we may write:

$$V\rho = m$$

where m = unidentified parameter with dimensionality of mass.

It is also dimensionally correct to write:

$$E/V = p$$

where p = hydrostatic pressure.

C can be shown to be γ (Ref. 26 of Appendix), the ratio of specific heats. Thus:

$$c^2 = \gamma E/m \text{ or } E = \frac{mc^2}{\gamma}$$

and

$$c^2 = \gamma \frac{E}{m} = \gamma \frac{pV}{\rho V}$$

or $$c^2 = \gamma\, p/\rho \qquad \text{Eq (3)}$$

Equation (3) is found in text books on compressible fluid dynamics and follows from the application of the momentum and continuity equations to the propagation of a pressure pulse. Instead of hydrostatic pressure of a fluid, p has here taken on the identity of the energy density of space while ρ instead of being the fluid density appears to assign to space a mass density parameter.

The theory of relativity is nonlinear by the term:

$$(1 - v^2/c^2)^{-1/2}$$

A similar term appears in compressible fluid dynamics. Pressure differences in compressible flow are:

$$(1 - kM^2)^{-1/2} \qquad k = \frac{C_p}{C_v}$$

times as great as in incompressible flow. Here M is the Mach number: M = v/c, where c = the speed of sound in the fluid medium. In relativity c is the speed of light, C_p = SPECIFIC HEAT AT CONSTANT PRESSURE OF GAS, C_v = SP. HEAT AT CONSTANT VOLUME. k IS HERE THE DIMENSIONALESS THERMODYNAMIC CONSTANT FOR A GAS.

In "Alternate Propulsion Energy Sources", by R. L. Forward (AFRPL.TR-83-030) a technical assessment of 26 out of 62 propulsion energy concepts was made. The remaining 36 concepts "were not felt to show sufficient promise...not because they violate conservation laws, but because of the lack of hard evidence to base any assessment on. (Indeed, the real breakthrough in propulsion will come when we can find a way around the momentum conservation laws, just as the last breakthrough came when Einstein and Fermi found a way around the law of conservation of mass by demonstrating how to convert mass into energy.)"

The presence of zero point quantum dynamic energy in vacuum space is in principle sufficient to remove the stigma of 'being in violation of existing conservation laws' for several of the remaining concepts. It may prove possible to tap the energy of vacuum space with less expenditure of energy than is obtained by a present concept, in the same way that a heat pump can pump more heat from a lower temperature to a higher temperature by expenditure of rotational energy with a smaller heat equivalent than the heat flux transferred in the process. It may prove to be simpler yet to tap an existing field with a natural gradient such as the gravitational field.

5B. Energy Density of Space

One of the most extensive books on the vacuum properties of space is "Physics Unified", by Harold Aspden, PhD, Trinity College, Cambridge, England (Sabberton Publications, P.O. Box 35, Southampton, England). On page 48 he writes: "The doctrines of relativity have been exercised to suppress those who have advocated belief in the aether medium, with the result that interest in experiments of the kind now performed by NASA in the United States has been slow to develop. The renewed interest in the aether medium which should now follow these recent developments could herald other discoveries which may have great practical consequences. It is timely, therefore, to examine this mysterious vacuum through which we move at phenomenal speed and speculate a little on its properties in the light of modern experimental evidence. We have, it would seem, arrived at the crossroads in science of which we were alerted by Dingle in his famous book attacking relativity."

It has been shown* that the fluid dynamic model of the energy of vacuum space has the interesting result that all field energy densities are hydrostatic pressures with a negative sign, to be subtracted from the ambient rest pressure or

*Roos, Jan, "The Pressure of Magnetic Fields and the Minimum Energy Density of the Space-Time Continuum", British-American Scientific Research Association 10 (6), June 1985.

Roos, Jan, "The Energy Density of Space-Time", British-American Scientific Research Association 11 (7), September 1987.

energy density to obtain the actual "static" pressure that is experienced by the observer inside the field. For example: the higher the intake air velocity is in the venturi throat of the carburetor of an automobile, the higher the suction pressure is to draw gasoline into the carburetor throat. The same holds true for a magnetic field: the higher the field strength between the pole surfaces, the higher the ambient scalar potential energy density difference with the remaining pressure in the gap becomes. Adding $-B^2/2\mu_0$ (note the minus sign) to the field energy density or pressure (energy density has the same dimensionality as pressure) in the magnetic pole gap explains the attraction between the north and south magnetic poles as compression forces by the ambient acting on the pole surfaces to close the pole gap. The pressure differential exists across the pole surface because in the ferromagnetic material μ is much larger than μ_0 and thus $B^2/2\mu$, in the ferromagnetic material is very small compared with $B^2/2\mu_0$ in vacuum or in air. Without the negative sign, attraction cannot be explained in the fluid dynamic model, which documents the negative sign in the law of Bernouilli, which, when expanded to include electromagnetic and gravitational fields, becomes:

$$P_{surroundings} = P_{static} + \frac{\rho V^2}{2} + \frac{B^2}{2\mu_0} + \frac{\epsilon_0 E^2}{2} + \frac{g^2}{8\pi k} = \text{constant},$$

so that for singularly acting fields, the pressure P_{static}, the actual pressure that is experienced in the field, is expressed as follows:

$$P_{static} = P_{surroundings} - \left[\frac{\rho V^2}{2} + \frac{B^2}{2\mu_0} + \frac{\epsilon_0 E^2}{2} + \frac{g^2}{8\pi k}\right]$$

where $P_{surroundings}$ is the energy density or hydrostatic pressure of the zero point quantum dynamic energy of vacuum space. Negative pressure was described in an article by J. Gribbin* as a very strange phenomenon, unlike anything in our everyday experience. However, from the point of view of fluid dynamics, the negative pressure in the above article must be taken as a negative pressure <u>differential</u> with respect to the maximum <u>stagnation</u> pressure of the energy continuum. The negative pressure itself then becomes the <u>static</u> pressure of the energy continuum, which is the observable pressure in the presence of non-scalar vectorial energy of any field energy density after its subtraction from the continuum energy density/pressure. Now, negative pressure has become a very real concept in the realm of the energy continuum of space, and all the deductions in Gribbin's article become at once realistically plausible.

*Gribbin, J., "Cosmologists Move Beyond the Big Bang", <u>New Scientist,</u> June 5, 1986.

5C. Literature Survey

A literature survey of publications in support of the concept of accessible energy density in space was conducted in the following three categories: text books, published papers, and papers without peer review.

A. Text Books

- Maxwell, James Clerk, A Treatise on Electricity and Magnetism, Volume 1 and 2, 1891 Unabridged 3rd Edition, Dover Publications, Inc., p. 493, 1954.
- Burn, Max, Atomic Physics, Sixth Edition, Hafner Publishing Company, New York, NY, p. 445, 1957.
- Jackson, John D., Classical Electrodynamics, John Wiley & Sons, New York, NY, p. 641, 1962.
- Melcher, James R., Continuum Electromechanics, MIT Press, p. 574, 1981.
- Beckmann, Peter, Einstein Plus Two, The Golem Press, p. 212, 1987.
- Landau, L. D. and Lifshitz, W. M., The Classical Theory of Fields, Course of Theoretical Physics, Volume 2, Fourth Revised English Edition, Pergamon, p. 398, 1975.
- Milne-Thomson, L. M., Theoretical Hydrodynamics, Fifth Edition, The MacMillan Company, New York, NY, p. 743, 1968.
- Janossy, L., Theory of Relativity Based On Physical Reality, Akademiai Kiado, Budapest, p. 317, 1971.

B. Published Papers

- Var, R. E., "On a Mathematical Framework for Fundamental Theoretical Physics", Foundations of Physics, Vol. 5, No. 3, pp. 407-431, September 1975.
- Ashurst, W. T. and Meiron, D. I., "Numerical Study of Vortex Reconnection", Physical Review Letters, 58(16), pp. 1632-1635, April 1987.
- Calkin, M. G. and Kiang, D., "Proper Treatment of the Delta Function Potential in the One-Dimensional Dirac Equation", American Journal of Physics, 55(8), pp. 737-739, August 1987.
- Clayton, N. and Grimer, F. J., "A General Approach to Strength of Materials", Science and Technology, 1(1), pp. 5-13, January 1978.

- Dewitt, B. S., "Quantum Gravity", Scientific American, pp. 112-129.

- Driver, H. S. T., "Angular Momentum in Static Electric and Magnetic Fields: A Simple Case", American Journal of Physics, 55(8), pp. 755-759, August 1987.

- Edwards, W. F., Kenyon, C. S., and Lemon, D. K., "Continuing Investigation Into Possible Electric Fields Arising From Steady Conduction Currents", Physical Review Digest, 14(4), pp. 922-938, August 1976.

- Ellingson, J. G., "The Deflection of Light by the Sun Due to Three-Space Curvature", American Journal of Physics, 55(8), pp. 759-760, August 1987.

- Goldin, G. A., Menikoff, R., and Sharp, D. H., "Diffeomorphism Groups and Quantized Vortex Filaments", Physical Review Letters, 58(21), pp. 2162-2164, May 1987.

- Graneau, P., and Graneau, P. N., "The Electromagnetic Impulse Pendulum and Momentum Conservation", Il Nuovo Cimento, 7(1), Gennaio, pp. 31-44, 1986.

- Grischkowsky, D., Dulling III, I. N., Chen, J. C. and Chi, C. C., "Electromagnetic Shock Waves from Transmission Lines", Physical Review Letters, 59(15), pp. 1663-1666, October 12, 1987.

- Hicks, W. M., "Research in Vortex Motion", Part I, Philosophic Transactions, 1884; Part II, Philosophic Transactions, 1885; and Part III, "On Spiral or Gyro Static Vortex Aggregates", Philosophic Transactions, pp. 33-99, 1898.

- Hill, M. J. M., "On a Spherical Vortex", Philosophic Transactions, pp. 213-245, 1894.

- Iizuka, S., and Tanaca, H., "Nonlinear Evaluation of Double Layers and Electron Vortices in an Unstable Plasma Diode", Journal Plasma Physics, 33 (Part 1), pp. 29-41, 1985.

- Ivory, D. F., Gobie, W. A., Beckwith, J. B., Hergenrother, R., and Malec, M., "Electromagnetic Stabilization of Weakly Conducting Fluids", Science, Volume 238, pp. 58-61.

- Lanczos, C., "The Dynamics of a Particle in General Relativity", Physical Review, Volume 59, pp. 813-819, May 15, 1941.

- Lanczos, C., "Matter Waves and Electricity", Physical Review, pp. 715-720, 1942.

- Lanczos, C., "Lagrangian Multiplier and Riemannian Spaces", Reviews of Modern Physics, 21(3), p. 497, July 1942.

- Lanczos, C., "Electricity and General Relativity", Reviews of Modern Physics, 29(3), pp. 337-350, July 1957.

- Lanczos, C., "The Splitting of the Riemannian Tensor", Reviews of Modern Physics, 34(3), pp. 379-389, July 1962.
- Lanczos, C., "Undulatory Riemannian Spaces", Journal of Mathematical Physics, 4(7), pp. 951-959, July 1963.
- Lanczos, C., "Signal Propagation in a Positive Definite Riemannian Space", Physical Review, 134(2B), pp. B476-B480, April 27, 1964.
- Lanczos, C., "Metrical Lattice and the Problem of Electricity", Journal of Mathematical Physics, 7(3), pp. 316-324, February 1966.
- Lugt, H. J., "Vortices and Vorticity in Fluid Dynamics", American Scientist, Volume 73, pp. 162-167, March-April 1985.
- Martin, T. J., "A 24,000 RPM Alternator for Aircraft", Electrical Engineering, Volume 68, p. 243, March 1949.
- Pumir, A., and Kerr, R. M., "Numerical Simulation of Interacting Vortex Tubes", Physical Review Letters, 58(16), pp. 1636-1639, April 1987.
- Puthoff, H. E., "Ground State of Hydrogen as a Zero-Point-Fluctuation-Determined State", Physical Review Digest, 35(10), pp. 3266-3269, May 15, 1987.
- Ranch, S. E., "Design Principles of Flux-Switch Alternators", AIEE, pp. 1261-1268, December 1955.
- Ranch, S. E., "High-Frequency Alternators", Electrical Engineering, Volume 73, pp. 735-737, August 1954.
- Saunders, R. M., "Design of Permanent Magnet Alternators", Electrical Engineering, Volume 70, p. 991, November 1951.
- Shapere, A., and Wilczek, F., "Self-Propulsion at Low Reynolds Number", Physical Review Letters, 58(20), pp. 2051-2054, May 1987.
- Stehle, P., "The Momentum of a Transverse Wave", American Journal of Physics, 55(7), pp. 613-615, July 1987.
- Taub, A. H., "Relativistic Fluid Mechanics", American Review Fluid Mechanics, 10, pp. 301-332, 1978.
- Thomson, D. E., "Kaluza-Klein: The Koenigsberg Connection", Science News, Volume 26, pp. 12-14, July 7, 1984.
- Weiner, J. H., "Enthropic versus Kinetic Viewpoints in Rubber Elasticity", American Journal of Physics, 55(8), pp. 746-749, August 1987.
- Witten, E., "Search for a Realistic Kaluza-Klein Theory", Nuclear Physics B, 186(3), pp. 412-428, August 1981.

C. Papers without Peer Review

- Mallove, E. F., "Forward Motion", Air & Space, pp. 98-101, June/July 1987.
- Mitsopoulos, Theodore D., "Unification of the Potentials and of the Four Fundamental Forces", The Toth-Maatian Review, 4(3), pp. 2091-2103, October 1985.
- Newman, J. W., "History of the Continuous Change in Beliefs of the Scientific Community as to How and Why the Universe is Motivated".
- Reed, D., "Towards a New Electromagnetic Reality".
- Smith, W. B., "The New Science".
- Thomsen, D. E., "The Fifth Force: Pulling Both Ways".

Step 6: Select the Most Promising of the Optimized Field-Matter Geometric Models.

Steps 3D and 3G identify the most promising field-matter geometries as rotating magnets and two interleaving coils or Moebius Strip following, respectively, a fluid dynamic selection procedure and relativistic exploratory analysis. The relativistic analysis was presented as a final report paper, entitled "Field-To-Matter Energy Transfer", by the principal consultant on this study, Dr. Cynthia K. Whitney, and is included in a condensed print format in the Appendix.

CONCLUSION

The theoretical study of this Phase I effort positively identified one principle for energy extraction from the vacuum space energy density as that of relativistic torquing due to non-linear effects, brought about by retardation of time and position in the language of relativity, with nature's example of the hydrogen atom. Based on this principle two field-matter geometries are identified as promising candidates for Phase II proof-of-principle experimental testing. The expected result of this principle is non-rotational energy if the non-linear torquing energy can be made to exceed dissipative energy effects of the experiment itself.

LIST OF SYMBOLS

Φ	scaler potential
$\underline{A}$	vector potential
$\underline{x}$, t; $\underline{x}'$, t'	observer and source spatial and temporal coordinates
q	source charge
U	$4 \pi \epsilon_0$ factor for MKS units
π	3.14159
ϵ_0	permittivity of free space
MKS	meters-kilograms-seconds
$\underline{\beta}$	normalized source velocity $\underline{v}/c$
$\underline{v}$	source velocity
c	speed of light
k	$1-n \cdot \underline{\beta}$ factor in Lienard-Wiechert potentials
$\underline{n}$	unit vector along $\underline{x}-\underline{x}'$
R	magnitude of vector $\underline{x}-\underline{x}'$
γ	relativistic stretch factor $[1 - \beta^2]^{-1/2}$
R'	same as R, but measured in source coordinate frame
$\underline{E}$	electric field
r_1	first Bohr orbit radius in hydrogen atom
ω_1	first Bohr orbit frequency in hydrogen atom
P_r	radiative energy loss rate
P_t	torque-induced energy gain rate
J, J/sec	Joules, Joules per second

LIST OF SYMBOLS (CONCLUDED)

m	mass of hydrogen atom
x	bleed fraction, system design parameter
$\underline{\beta}'$, $\underline{\beta}''$	normalized speeds related to $\underline{\beta}$
z, z'	charge-to-charge separation, retarded separation
$\underline{E}'$, $\underline{E}'_+$, $\underline{E}'_-$, $\underline{E}'_{+-}$	residual electric fields caused by retarded separation
$\underline{F}\ d\underline{s}$	dot product of force and distance

APPENDIX

FIELD-TO-MATTER ENERGY TRANSFER

APPENDIX

FIELD-TO-MATTER ENERGY TRANSFER

Dr. Cynthia Kolb Whitney

Consultant, Aerospace Systems, Inc.
Burlington, MA 01803,U.S.A.

Visiting Industry Professor,
Tufts University Electro-Optics Technology Center,
Medford, MA 02155, U.S.A.

ABSTRACT

Physicists have always believed that classical field-matter energy exchange is strictly one-way, fields receiving energy and matter losing it, via radiation. That belief is consistent with the accepted formulation for potentials created by relativistically moving sources. But that formulation has recently been shown to embed an error. Correction of the error allows reverse energy transfer, from fields to matter. Though previously unexpected, this mechanism becomes credible by offering a candidate explanation for certain otherwise mysterious natural phenomena.

The mechanism behind the reverse energy transfer is relativistic torquing within any interacting multi-body system. The existence of relativistic torquing invites human intervention, to induce controlled energy transfer that can be tapped for human purposes such as propulsion. The design of an engineering system to demonstrate such a function on a laboratory scale is here discussed.

PACS number 89.30.+f (Energy Resources).

+This research was sponsored by the United States Air Force under contract F04611-87-C-0046, awarded to Aerospace Systems, Inc. of Burlington, MA by the Air Force Astronautics Laboratory, Edwards Air Force Base, CA.

I. INTRODUCTION

Radiation by accelerating sources is known to occur in any theory involving finite signal propagation speed. The commonly known examples are electromagnetic dipole radiation [1] and gravitational quadrupole radiation [2]. Radiation always produces a reaction on the radiating source [3], [4], which robs it of kinetic energy. For this reason, systems of interacting sources are assumed to "run down" in any classical theory. This assumption was compared to the reality of the hydrogen atom early in the present century, and thereby created one of the motivations for the quantum hypothesis and development of quantum mechanics [5], [6].

Radiation has always been assumed the only significant energy transfer mechanism introduced by finite signal propagation speed. Relativistic field theory as understood today is otherwise surprisingly close to Newtonian. Most significantly, in a two-body system the low-order relativistic forces conform to the familiar Newtonian central field pattern. This is the inevitable consequence of the believed form for relativistic potentials, which was derived for the electrodynamic case by Lienard [7] and Wiechert [8] at the turn of the present century.

It is noteworthy that the Lienard-Wiechert derivations for relativistic point-source potentials were done before the full development of special relativity theory [9], and before the development of the modern mathematical methods of generalized function theory [10]. Geometry was the only tool available to Lienard and Wiechert. English-language presentations of the original geometric argument are available, for example, in [11] and [12]. That original derivation method has recently been shown faulty; it fails to conserve total charge [13]. This by itself doesn't mean the results are wrong, but it raises suspicion.

Modern derivation methods have been retrofitted to the Lienard-Wiechert results in most present-day texts. The fact that questions have now started to surface concerning the Lienard-Wiechert potentials prompts a review of these modern rederivations. Such review produces results that make it look as if the modern retrofits have all been done in a spirit of reconfirmation, rather than re-examination.

Some modern rederivations involve a confusion between Lorentz transformation and relativistic length contraction [14]. Some obscure a lack of covariance with an overly abbreviated notation [15]. Some apply generalized functions without the Jacobian needed to accommodate a variable change between function argument and integration variable [16]. This leads to a situation in which mathematical operators do not commute: the differentiations required to extract fields do not commute with the integrations and limits involved in forming the potentials [17].

Fixing any or all of the difficulties noted above produces an altered formulation for the potentials, and, correspondingly, an altered formulation for the resulting fields. What is significant is the directionality of the longitudinal $\underline{E}$ field. According to Lienard-Wiechert, this field aligns to the projected present position of the source. According to the new formulation, the longitudinal $\underline{E}$ field aligns to the retarded position of the source [18]. The

retarded source position is causally connected: it is where the source was when it emitted a signal later being detected field observation point. The projection involved in the Lienard-Wiechert formulation is away from this causally connected point, at constant velocity, for the time required for signal propagation.

The field directionality becomes significant in any multi-body system. The simplest case is the two-body system. The Lienard-Wiechert field direction is central, but the corrected field direction is non-central. The system as a whole then has a torque on it, which produces an energy transfer that works in opposition to radiation, moving energy from fields and to particle orbits [19].

In Newtonian physics, such orbit increase would be seen as non-conservation of energy. But in relativistic physics, it is nothing of the sort. The concept of conservation applies only to a closed system, and in relativistic physics, a system cannot be closed without including the fields that surround it. If the material system could be closed, then the fields separately would also form a closed system, whose energy could increase via radiation.

One example of a two-body system subject to relativistic torque is the hydrogen atom. The torque in that case is exceedingly significant; it causes an energy gain rate that is 30.9 times larger than the loss rate due to radiation [20]. This fact completely turns around the situation that was believed to require the twentieth-century quantum hypothesis. The question is not why the hydrogen atom doesn't decay; rather it is why the hydrogen atom doesn't twist apart.

This altered question seems easily resolved without a quantum hypothesis. Instead, one can recognize that the hydrogen atom is a nonlinear system by virtue of its inverse square law attraction. Any nonlinear system tends to create harmonics; i.e., multiples of some baseline frequency, in the case of the hydrogen atom the baseline frequency is the circular orbit frequency. An inquiry into the spectrum of harmonics that the nonlinearity will create leads to a classical model that predicts a numerical value for Planck's constant [21]. In general form, this model leads to all the excited states of the hydrogen atom also, thus providing a covering theory for the quantum theory of atoms [22].

Another such two-body system has been proposed as a candidate factor in establishing barred spiral galaxy structure. A pair of major masses, such as black holes, orbiting at the center of a galaxy would have a steady state based on balance between quadrupole gravitational radiation and relativistic torquing [23]. A steady-state two-body system creates a background gravitational field with barred spiral structure to it [24]. The other much smaller stars would move as test particles in this background, and develop a disc shape galaxy with radial profiles of star density, tangential speed, age, etc., quite similar to those actually seen [25].

Naturally, systems at the atomic scale or the galactic scale are not directly accessible to human intervention. But some analog at an intermediate, laboratory scale, based on electromagnetic interactions, would be so. The author and her colleagues at ASI have sought to design a system in which current elements would interact in a manner analogous to the bodies in a two-body system. The process could then be tapped, to effect an energy transfer from distributed fields to some storage device.

It should be clear that such an engineering system definitely is not the kind of phantom popularly known as a "perpetual motion machine". It is not drawing energy out of nothing;

it is drawing energy out of fields, in a manner demonstrated in nature by the hydrogen atom and by the galaxy. It is taking advantage of a vision in which the so-called "vacuum" of space is actually a real and significant participant in any physical system [26]. This view is gaining currency everywhere; vacuum fluctuations are thought to underlie the creation of everything from individual particles to the entire universe [27], [28]. But where vacuum fluctuations would be a random process, the mechanisms envisioned in [26] and in the present work are completely deterministic in spirit.

It needs to be made clear too that the prevailing view of relativistic field theory as finished business, and electromagnetic applications as mature technology, is definitely not held by all. There are known theoretical inconsistencies between gravitational and electromagnetic theories [29]. Alternative formulations are widely considered [30] - [34]. Experiments reveal more troubling inconsistencies [35] - [39]. Unusual devices have been proposed before [40]. The main novel feature of the present work is the marriage between theoretical resolution and technological proposal.

II. ANALYSIS

The accepted Lienard-Wiechert formulae for the potentials of a relativistically moving point charge q are

$$\Phi, \underline{A}(\underline{x}, t) = \frac{q\,(1, \underline{\beta})}{U\,k\,R}\Bigg|_{\substack{\text{evaluated} \\ \text{at } \underline{x}', t' \\ \text{retarded}}} \tag{A-1a}$$

where

$$U = 4\pi\varepsilon_\theta \tag{A-1b}$$

is for MKS units only, and

$$\begin{aligned} \underline{\beta} &= \underline{v}/c \\ k &= 1 - \underline{n}\cdot\underline{\beta} \\ \underline{n} &= \text{unit}\,(\underline{x} - \underline{x}') \\ R &= \text{magnitude}\,(\underline{x} - \underline{x}') \end{aligned} \tag{A-1c}$$

and the specification "retarded" means that source position $\underline{x}'$ is to be evaluated at time $t' = t - R/c$.

The explicit specification "retarded" on (A-1a) conveys not only the fact that propagation delay has been considered, but also the impression that it has indeed been considered fully and correctly. But from [13] - [17], one sees that this impression is quite false. There is a time-shift error in the accepted formulae. Such an error is seductively subtle, so much so that it has evaded notice for nearly ninety years.

The time shift results in a curious behavior noted in [29]: To compute potentials or fields, it is not generally sufficient to consider only the total values of charge and current density; instead, it is necessary to consider every charge-velocity combination separately. For example, suppose two charges, plus and minus, are colliding at retarded time. Then the source charge density is zero, but the potential is

$$\Phi = \frac{q}{U R} \left[\frac{1}{1 - \underline{n} \cdot \underline{\beta}} - \frac{1}{1 + \underline{n} \cdot \underline{\beta}} \right]_{\text{ret.}} \tag{A-2a}$$

which is generally not zero. Similarly, if the charges are of the same sign, then the current density is zero, but the vector potential is

$$\underline{A} = \frac{q\,\underline{\beta}}{U R} \left[\frac{1}{1 - \underline{n} \cdot \underline{\beta}} + \frac{1}{1 + \underline{n} \cdot \underline{\beta}} \right]_{\text{ret.}} \tag{A-2b}$$

again generally not zero.

The above curious behavior is, however, not truly a necessary feature of electromagnetic theory. The alternative believed by the present author is the time-shift-corrected formulae

$$\Phi, \underline{A}(\underline{x}, t) = \frac{q\,\gamma\,(1, \underline{\beta})}{U R'} \Bigg|_{\substack{\text{evaluated} \\ \text{at } \underline{x}', t' \\ \text{retarded}}} \tag{A-3a}$$

where

$$\begin{aligned} \gamma &= [1 - \beta^2]^{-1/2} \\ R' &= \left| \underline{x} - \underline{x}' \right| \text{ measured in source coordinate frame} \end{aligned} \tag{A-3b}$$

These altered potentials do not exhibit the curious behaviour at all. The altered potentials lead to altered fields, most significantly so in the case of longitudinal electric field. Instead of the Lienard-Wiechert

$$\underline{E} = \frac{q\,(\underline{n} - \underline{\beta})}{U\,\gamma^2\,k^3\,R^2} \tag{A-4a}$$

which aligns with the projected present position of the source, we have

$$\underline{E} = \frac{q\,\gamma\,\underline{n}}{U\,R'^2} \tag{A-4b}$$

which aligns with the causally connected source position from which the signal creating the field propagated.

In a two-body system, the altered field directionality produces a tangential force, which in turn leads to energy transfer in opposition to radiation. When the two competing effects exactly balance, there is a system steady state. An example is the hydrogen atom in its ground state. The classical dipole radiation rate [1] evaluated for circular motion in the ground state radius r_1 and orbit frequency ω_1 [5], [6] is

$$P_r = 2\,q^2\,r_1^{\,2}\,\omega_1^{\,4}/(4\,\pi\,\epsilon_0)\,3\,c^3 =$$

$$\frac{2\,(1.6 \times 10^{-19})^2\,(0.5 \times 10^{-10})^2\,(4 \times 10^{16})^4}{(4\,\pi\;8.8 \times 10^{-12})\,3\,(3 \times 10^8)^3} = 3.8 \times 10^{-8}\ \text{J/sec} \tag{A-5a}$$

With harmonics superposed on the baseline circular motion [21], this energy flow rate is scaled up by a factor of 30.9, yielding total power throughput

$$P_t = 1.2 \times 10^{-7}\ \text{J/sec} \tag{A-5b}$$

For comparison, the kinetic energy of the electron is only

$$K.E. = q^2/2\,(4\,\pi\,\epsilon_0)\,r_1 = \tag{A-6a}$$

$$\frac{(1.6 \times 10^{-19})^2}{2\,(4\,\pi\,8.8 \times 10^{-12})\,(0.5 \times 10^{-10})} = 2.4 \times 10^{-18}\ J$$

Even the mass energy is only

$$m\,c^2 = 1{,}840 \times (9 \times 10^{-31})\,(3 \times 10^8)^2 = 1.5 \times 10^{-10}\ J \tag{A-6b}$$

This means that the energy throughput of the hydrogen atom is <u>enormous.</u> In one second, about a <u>thousand times</u> the mass energy passes through the system. Tapping into such a system at <u>any</u> macroscopic fraction would be <u>much</u> more efficient than nuclear or other previously known power source.

We have, therefore, speculated at length about how to design an engineering system analogous to the hydrogen atom, in order to tap into it. A system of macroscopic, laboratory size would most conveniently use electromagnetic fields, rather than say gravitational ones. The minimal system for drawing energy from the vacuum of space is two interacting bodies like those in the hydrogen atom, but for an engineering demonstration it would be convenient to replace the two orbiting bodies with two current loops. To minimize resistive losses, it is desirable to make these loops superconducting.

Nonlinearity can be shown to be a significant design factor in the design of such a system by consideration of an analogy. The harmonics in the hydrogen atom are like a bleed mechanism working on the system as it would have been with perfectly circular orbits. That system would have had its equilibrium orbit at a radius 30.9 times

smaller, where the energy throughput would have been larger by a factor of $(30.9)^4 = 10^6$. So if the bleed mechanism had not been so strong a factor (29.9), its absolute magnitude would have been larger. So, clearly there is an optimum fraction x at which to bleed a system. In the hydrogen example, the optimum x is such that $x / (1 + x)^4$ is maximum, from which $x = 1/3$.

Also important in the design is geometric configuration. The two loops should have opposing current flow, and so would repel each other. To minimize losses due to mechanical strains, it is desirable to replace the two loops with two interleaving coils. Better yet, the coils can be integrated in a single Moebius strip configuration. Opposing current flows are not predicted by standard theory, but have indeed been observed in such geometries.

Important physical parameters in the design are moving charge density p and average normalized velocity β. These affect the longitudinal force F on an electron as follows. Consider one of the electrons in one of the two opposing currents. In a coordinate frame instantaneously at rest with respect to that electron, the positive charges that balance the two currents are moving by at $-\beta$, and, by relativistic velocity addition, the electrons of the other current are moving by at

$$\beta' = 2\beta/(1 + \beta^2) \qquad \text{(A-7a)}$$

These speeds determine the retardation with which charges at a given longitudinal distance z are seen. For z increasing or decreasing, β'' equal β or β', the retarded separation is

$$z' = z/(1 \pm \beta) \qquad \text{(A-7b)}$$

These retarded positions determine incremental modifications to inverse square E fields from the charges. Fields from equal charges at $\pm z$ do not exactly cancel, but instead leave a residue

$$E' \approx (-2E)\, 2\beta''/(1 - \beta''^2) \qquad \text{(A-7c)}$$

From (A-7c), the field from the positive charges (two at +z, two at -z) sum to

$$E'_+ \approx -8 E_+ \beta/(1 - \beta^2) \qquad \text{(A-8a)}$$

while those from the counter-travelling electrons at $\pm z$ sum to

$$E'_- \approx -4 E_- \beta'/(1 - \beta'^2) \qquad \text{(A-8b)}$$

and with $E_- = -E_+$ and (A-7a),

$$E'_- = -E'_+ (1 + \beta^2)/(1 - \beta^2) \qquad \text{(A-8c)}$$

From (A-8c), the E'_- is slightly larger in magnitude than the E'_+, and works in opposition to it, providing a net $\bar{E}$ along $+\underline{\beta}$ of magnitude

$$E'_{+-} \approx \left|E'_+\right| [(1 + \beta^2)/(1 - \beta^2) - 1] \qquad \text{(A-9a)}$$

Simplifying

$$E'_{+-} \approx \left|E'_+\right| 2 \beta^2/(1 - \beta^2) \qquad \text{(A-9b)}$$

and using (A-8a)

$$E'_{+-} \approx 16 E_+ \beta^3/(1 - \beta^2)^2 \qquad \text{(A-9c)}$$

Because it lies along $\underline{\beta}$, the field (A-9c) appears as $E_{+-} = E'_{+-}$ unaltered in the laboratory coordinate frame, where it produces a force $\bar{F}_{+-} = q\bar{E}_{+-}$. Because the electron is moving at speed in the laboratory frame, the force produces energy increase at rate

$$P_t = \gamma^2 c \beta F_{+-} \qquad \text{(A-10a)}$$

and from (A-9c),

$$P = 16 c q E_+ \beta^4/(1 - \beta^2)^3 \qquad \text{(A-10b)}$$

This power is replicated for every pair of positive charges creating an E_+, and for every electron in both current loops. Clearly the resulting P_t to the system as a whole involves

$$\frac{32\ c\ \beta^4}{U\ (1 - \beta^2)^3} \iint \frac{p\ (z_1)\ p\ (z_2)}{(z_1 - z_2)^2}\ dz_1\ dz_2 \qquad \text{(A-10c)}$$

and scales with the square of moving charge density, p^2. In addition, if β approaching 1 can be achieved, the $(1 - \beta^2)^3$ denominator becomes important. This denominator essentially implies a factor of energy to the sixth power, and for very high voltage this factor scales as voltage to the sixth power. This is a hugely desirable regime in which to harvest the optimal fraction of the energy loss that necessarily compensates P_t.

III. DISCUSSION

The present research gives the basic principles required to design a device to accomplish field-to-matter energy transfer. The principles derive from a correct understanding of relativistic field theory. The device exploits electromagnetic fields between counter-travelling currents in interleaving coils or Moebius strip configuration.

These features make the device physically similar to certain devices previously proposed by others. For example, the use of coils is somewhat reminiscent of the as-yet unpatented Newman motor. But the use of two coils or a Moebius strip, rather than one simple coil, enables the device to run without distinct pulses, thus removing the skeptic's explanation that such a device works only be explosive cleaning of battery electrodes. With two interleaving coils, the device is reminiscent of a Smith -Killick tensor coil, although the output of interest will be energy into a motor, capacitor, or other dump, rather than any kind of propagating beam. With a Moebius strip configuration, the device is like that studied by Seike, although our explanation has nothing to do with tachyions.

The most significant feature of the present research lies in its generation of the device concept from the theory, rather than the reverse. The recently discovered relativistic torquing mechanism cited in the references is the basis for the design developed here. Such torquing apparently leads to energy transfer from fields to matter in natural systems from atomic to galactic scale, and so can be made to do the same in an engineering system of laboratory scale.

The phenomenology going on can be characterized in a variety of intuitively appealing ways. The energy gain due to the relativistic torque can clearly be characterized in terms of a line integral (the usual $\underline{F}.d\underline{s}$). It can also be characterized in terms of a <u>surface</u> integral, analogous to the type of surface integral needed to characterize radiative reaction. The surface-integral concept leads to a detailed picture in which the energy inflow is strongest in the orbit plane, varying down to zero on the poles, more or less the complement of a dipole radiation pattern.

With both the radiative and the torquing mechanisms active, one can imagine energy flowing continuously through the system. That is, one can imagine the static physical existence of the system to be supported by dynamic energy flow. If the radiation is dipole, then the total flow forms a double toroid pattern. Depending on whether the radiation or the torquing dominates, the double toroid has a positive or negative dipole pattern superposed on it. The strengths of the two patterns depend on various powers of source velocity and acceleration.

The features noted above make the problem of characterizing the energy flow similar to a problem in non-linear fluid dynamics. Viewed in these terms, the energy flow appears to be like inviscid and infinitely compressible fluid flow. The fluid dynamic vision of the energy flow makes available an analysis approach, that is different from but entirely complementary to the field-theoretic approach vision of the relativistic torquing and resultant field-to-matter energy transfer.

At this point, much work remains to be done, both in detailing and building the device envisioned, and in fully developing all the alternative theoretical approaches to its description and explanation.

ACKNOWLEDGMENT

The author is grateful to Dr. Franklin B. Mead, Jr. of the Astronautical Laboratory, Edwards Air Force Base, for encouraging this research, and to her colleague Robert Var for drawing her into it. The many technical discussions involving Jan Roos and Peter Foss of ASI are gratefully acknowledged.

REFERENCES

1. Jackson, J. D., Classical Electrodynamics (Second Edition, Chapter 9), John Wiley and Sons, New York, 1975.

2. Einstein, A., Sitzker. Preuss. Akad. Wiss., p. 688, 1916; p. 154, 1918.

3. Abraham, M., Electromagnetishe Theorie der Strahlung, B. G. Teubner, Berlin, 1908.

4. Lorentz, H. A., The Theory of Electrons, Dover, NY, 1952.

5. Born, M., Atomic Physics, Blackie and Son, Ltd., Glasgow, 1960.

6. Dicke, R. H. and Wittke, J. P., Introduction to Quantum Mechanics, Addison-Wesley Publishing Company, Reading, MA, 1960.

7. Lienard, A., Eclairage Electrique, 16, pp. 5-14, 53-59 and 106-112, 1898.

8. Wiechert, E., Archives Neerlandes, 5, pp. 549-573, 1900.

9. Einstein, A., Annalen der Physik, 17, p. 891, 1905.

10. Schwartz, L., Theorie des Distributions, Hermann, Paris, 1966.

11. Heitler, W., The Quantum Theory of Radiation, Oxford University Press, 1936.

12. Feynman, R. P.; Leighton, R. B.; and Sands, M., The Feynman Lectures on Physics, Addison-Wesley Publishing Company, Reading, MA, 1964.

13. Whitney, C. K., "On the Lienard-Wiechert Potentials", The Hadronic Journal, 11.

14. Whitney, C. K., "Distinct Questions in Relativity Theory", Physics Essays, 1, April 1988.

15. Whitney, C. K., "Manifest Covariance in Relativistic Potential Theory", Physics Essays, 1, April 1988.

16. Whitney, C. K., "Generalized Functions in Relativistic Potential Theory", The Hadronic Journal, 10, pp. 289-290, 1987.

17. Whitney, C. K., "Operator Non-Commutation in Classical Field Theory", The Hadronic Journal, 10.

18. Whitney, C. K., "Field Lines in Classical Theory", The Hadronic Journal, 10.

19. Whitney, C. K., "Equations of Motion for the Gravitational Two-Body Problem", The Hadronic Journal, 11.

20. Whitney, C. K., "A New Perspective on the Hydrogen Atom", Physics Essays, 1, June 1988.

21. Whitney, C. K., "Harmonics in the Hydrogen Atom", Physics Essays, 1, June 1988.

22. Whitney, C. K., "Multiple States in the Hydrogen Atom", Physics Essays, 1, June 1988.

23. Whitney, C. K., "Steady State in the Relativistic Two-Body Problem", The Hadronic Journal, 11.

24. Whitney, C. K., "Barred Spiral Field Pattern Around a Relativistic Two-Body System", The Hadronic Journal, 11.

25. Whitney, C. K., "Distribution of Stars as Test Particles in a Relativistic Two-Body Field", The Hadronic Journal, 11.

26. Var, R. E., Foundations of Physics, 5, pp. 407-431, 1975.

27. Putoff, H., Physics Review Digest, 35, pp. 3266-3269, 1987.

28. Guth, A. H. and Steinhardt, P. J., Scientific American, 250, pp. 116-128, 1984.

29. Santilli, R. M., "Patrons and Gravitation: Some Puzzling Questions", Annals of Physics, 83, pp. 108-157, 1974.

30. Mirchandaney, A. S.; Spencer, D. E.; Uma, S. Y.; and Mann, P. J., "The Theory of Retarded Potentials", The Hadronic Journal, 11.

31. Phipps, T. E., Heretical Verities: Mathematical Themes in Physical Description, Classic Non-Fiction Library, Urbana, IL, 1986.

32. Beckmann, P., Einstein Plus Two, Golem Press, Boulder, CO, 1987.

33. Yilmaz, H., "New Theory of Gravitation", presented at Fourth Marcel Grossman Meeting, Rome, 1985.

34. Graneau, P., Ampere-Neumann Electrodynamics of Metals, Hadronic Press, Inc., Nonantum, MA, 1985.

35. Graneau, P. and Graneau, P. N., Il Nuovo Cimento 7D, pp. 31-45, 1986.

36. Pappas, P. T., Il Nuovo Cimento, B, 76, pp. 189-196, 1983.

37. Sansbury, R., Review of Scientific Instruments, 56, pp. 415-417, 1985.

38. Edwards, W. F.; Kenyon, C. S.; and Lemon, D. K., Physics Review Digest, 14, pp. 922-938, 1976.

39. Cure, J., presentation on Milikan oil drop experiment in a magnetic field, Electromagnetics Symposium, Northeastern University, 7 Nov. 1987.

40. Reed, D., "Towards a New Electromagnetic Reality", written for International Symposium on Non-Conventional Energy Technology, 1981.

Appendix A
Solicitation No. 87.1
Proposal Cover Sheet

DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

Topic Number: 192 ☐ Army ☐ Navy ☒ Air Force ☐ DARPA ☐ DNA ☐ SDIO

Proposal Title: Application of Compressible Fluid Dynamics to Field-Matter Interactions with the Vacuum Space Scalar Velocity Potential to Generate Force Vectors.

Submitted By:
Firm: Aerospace Systems, Inc. (ASI)
Address: 121 Middlesex Turnpike
City: Burlington State: MA Zip Code: 01803

Submitted To:
(Activity identified with the topic) Air Force Rocket Propulsion Lab/TSTR
Address: Building 8252, Room 12
City: Edwards Air Force Base State: CA Zip Code: 93523-5000

Small Business Certification:

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C 631 and in the Definition Section of the Program Solicitation.

"The above firm certifies that it qualifies as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement." Yes ____ No X

The above firm certifies that it qualifies as a woman-owned small business firm: Yes ____ No X

This proposal has been submitted to other US Government agency/agencies:

Yes ____ ; Name(s) ____
No X

Disclosure permission statement as follows:
All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

"Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? Yes X No ____

Number of employees including all affiliates (average for preceding 12 months): 15

Proposed Cost (Phase I): $50,000 Proposed Duration: 6 months (not to exceed six months).

Project Manager/Principal Investigator		Corporate Official (Business)	
Name	Jan P. Roos	Name	John Zvara
Title	Principal Investigator	Title	Program Manager
Signature		Signature	
Date	January 7, 1987	Date	January 7, 1987
Telephone	(617) 272-7517	Telephone	(617) 272-7517

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) 3 thru 9 of this proposal. Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

Nothing on this page is classified or proprietary information/data

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH PROGRAM
PHASE 1 – FY 1987
PROJECT SUMMARY

Topic No. 192 Military Department/Agency AF87

Name and Address of Proposing Small Business Firm

Aerospace Systems, Inc. (ASI)
121 Middlesex Turnpike
Burlington, MA 01803
Telephone: (617) 272-7517

Name and Title of Principal Investigator

Jan P. Roos, P.E., Principal Investigator

Proposal Title

Application of Compressible Fluid Dynamics to Field-Matter Interactions with the Vacuum Space Scalar Velocity Potential to Generate Force Vectors

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

The project objective is to identify promising dynamic field-matter interactions with the scalar velocity potential of vacuum space by using the theory of compressible fluid dynamics and to select the geometry with the optimum coefficient of performance for experimental verification. The zero point quantum dynamic energy singularities of vacuum space will be treated in statistical mechanics fashion to obtain transport properties and allow treatment as a compressible fluid medium. Special emphasis is placed on the determination of the physical value of the energy density of vacuum space, because it defines the magnitude of vector forces that can be generated. It is intended to model the fields of gravitation, electromagnetism and strong and weak interaction in terms of the fluid dynamic space-time derivatives of the vacuum space energy scalar velocity potential. Forces and moments of interaction between colinear flow, cylindrical vortex flow, toroidal flow, spherically symetric sink and source flow and periodic flow will be identified and quantized, subject to imposed field-matter boundary conditions. Only by coupling a conventional field to a matter geometry will a theoretically demonstrated interaction of the conventional field with vacuum space be able to manifest itself by measurable effects on the matter geometry.

Anticipated Benefits/Potential Commercial Applications of the Research or Development

The anticipated benefit of using fluid dynamic models is easy and complete coverage of all possible combinations of field-matter geometries for force vector generation and the ability to select the best performers. If it can be experimentally shown that a field-matter model uncovered by this study requires less consumable lift-off load, has a higher conversion efficiency and/or is more economical to produce than state of the art approaches, additional benefits will accrue to the entire field of transportation.

List a maximum of 8 Key Words that describe the Project.

Space energy conversion, field gradient force vectors.

Appendix A
Solicitation No. 87.1
Proposal Cover Sheet

DEFENSE SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

Topic Number: 192 ☐ Army ☐ Navy ☒ Air Force ☐ DARPA ☐ DNA ☐ SDIO

Proposal Title: Application of Compressible Fluid Dynamics to Field-Matter Interactions with the Vacuum Space Scalar Velocity Potential to Generate Force Vectors.

Submitted By:
Firm: Aerospace Systems, Inc. (ASI)
Address: 121 Middlesex Turnpike
City: Burlington State: MA Zip Code: 01803

Submitted To:
(Activity identified with the topic) Air Force Rocket Propulsion Lab/TSTR
Address: Building 8252, Room 12
City: Edwards Air Force Base State: CA Zip Code: 93523-5000

Small Business Certification:

The above firm certifies it is a small business firm and meets the definition stated in the Small Business Act 15 U.S.C. 631 and in the Definition Section of the Program Solicitation.

"The above firm certifies that it qualifies as a minority or disadvantaged small business as defined in the Definition Section of the Program Announcement." Yes ____ No X.

The above firm certifies that it qualifies as a woman-owned small business firm: Yes ____ No X.

This proposal has been submitted to other US Government agency/agencies:

Yes ____ ; Name(s) ____
No X

Disclosure permission statement as follows:
All data on Appendix A is releasable information. All data on Appendix B, for an awarded contract, is also releasable.

"Will you permit the Government to disclose the information on Appendix B, if your proposal does not result in an award, to any party that may be interested in contacting you for further information or possible investment? Yes X No ____."

Number of employees including all affiliates (average for preceding 12 months): 15

Proposed Cost (Phase I): $50,000 Proposed Duration: 6 months (not to exceed six months).

Project Manager/Principal Investigator		Corporate Official (Business)	
Name	Jan P. Roos	Name	John Zvara
Title	Principal Investigator	Title	Program Manager
Signature		Signature	
Date	January 7, 1987	Date	January 7, 1987
Telephone	(617) 272-7517	Telephone	(617) 272-7517

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use, or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s) 3 thru 9 of this proposal. Failure to fill in all appropriate spaces may cause your proposal to be disqualified.

Nothing on this page is classified or proprietary information/data

IDENTIFICATION OF THE OPPORTUNITY

This proposal addresses category (4) of AF87-192: Esoteric concepts; theoretical developments of zero point quantum dynamic energy of vacuum space. The description of this topic in the program solicitation shows that the NEW physics, that transcends the Einsteinian physics by including the space energy scalar potential, is now coming of age. The inclusion in the SBIR program brings the new physics outside the realm of purely theoretical physics and provides the opportunity to all branches of science to bring manpower to bear on solving the practical ramifications of the theory. Its importance lies in its promise to obtain new energy conversion methods for obtaining propulsion force vectors that are very efficient and economical and may reduce consumable fuel loads for launching or maneuvering and increase payload, or may be simpler and less of a radiation hazard than nuclear propulsion.

PHASE I TECHNICAL OBJECTIVES

1. Write a complete matrix table of dynamic field-matter geometries.

2. Enter equations for forces and moments for field-field and field-scalar potential derivative interactions.

3. Determine geometric matter boundary conditions required to obtain non-zero closed surface integrals of the forces of interaction at the material surfaces of the field-matter geometries.

4. Enter vector force resultants in the table, expressed in independent parameters including the vacuum space energy density.

5. Determine the most probable value of the energy density for the zero point quantum dynamic energy of vacuum space.

6. Select the most promising of the optimized field-matter geometric models using simple criteria of efficiency, economy, and force vector magnitude or based on system trade-off criteria.

RELATED WORK

The known properties of vacuum space are:

c = speed of light

ϵ_0 = dielectric permittivity of vacuum

μ_0 = magnetic susceptibility of vacuum

Their relationship is given by the Maxwellian result:

$$c^2 = 1/\epsilon_0\mu_0 \tag{1}$$

If the energy density of vacuum space is written as Energy/Unit Volume E/V we can write:

$$c^2 = f[E/V]$$

If we ascribe a mass density ρ to vacuum space we may write:

$$c^2 = C \cdot E/V\rho$$

where C is dimensionless. For further simplification we may write:

$$V\rho = m$$

where m = total mass, or:

$$E/V = p$$

where p = hydrostatic pressure. C can be shown to be unity. Thus:

$$c^2 = E/m \quad \text{or} \quad E = mc^2 \tag{2}$$

and

$$c^2 = p/\rho \tag{3}$$

Equation (3) is found in text books on compressible fluid dynamics and follows from the application of the momentum and continuity equations to the propagation of a pressure pulse.

The theory of relativity is nonlinear by the term:

$$(1 - v^2/c^2)^{-\frac{1}{2}}$$

A similar term appears in compressible fluid dynamics. Pressure differences in compressible flow are:

$$(1 - M^2)^{-\frac{1}{2}}$$

times as great as in incompressible flow. Here M is the Mach number: $M = v/c$, where c = the speed of sound in the fluid medium. In relativity c is the speed of light.

In light of the above we conclude that compressible fluid dynamics is as powerful an analytical tool as any to deal with the aspects of the space-time continuum. In fact, because of experimental confirmation of the planar extention of a shock wave, perpendicular to the direction of propagation, we may make a case for relativistic transformation of the Cartesian coordinates, that differs from the Einsteinian

transformations, and that will allow expansion of y and z. Rather than advocating mass increase as the speed of light is approached, we can then assign the mass-energy increase to the energy required to form the bow wave, or shock wave when the speed of light is reached and transcended.

In "Alternate Propulsion Energy Sources", by R. L. Forward (AFRPL.TR-83-030) a technical assessment of 26 out of 62 propulsion energy concepts was made. The remaining 36 concepts "were not felt to show sufficient promise...not because they violate conservation laws, but because of the lack of hard evidence to base any assessment on. (Indeed, the real breakthrough in propulsion will come when we can find a way around the momentum conservation laws, just as the last breakthrough came when Einstein and Fermi found a way around the law of conservation of mass by demonstrating how to convert mass into energy.)"

The presence of zero point quantum dynamic energy in vacuum space is in principle sufficient to remove the stigma of 'being in violation of existing conservation laws' for several of the remaining concepts. It may prove possible to tap the energy of vacuum space with less expenditure of energy than is obtained by a present concept, in the same way that a heat pump can pump more heat from a lower temperature to a higher temperature by expenditure of rotational energy with a smaller heat equivalent than the heat flux transferred in the process. It may prove to be simpler yet to tap an existing field with a natural gradient such as the gravitational field.

One of the most extensive books on the vacuum properties of space is "Physics Unified", by Harold Aspden, PhD, Trinity College, Cambridge, England (Sabberton Publications, P.O. Box 35, Southampton, England). On page 48 he writes: "The doctrines of relativity have been exercised to suppress those who have advocated belief in the aether medium, with the result that interest in experiments of the kind now performed by NASA in the United States has been slow to develop. The renewed interest in the aether medium which should now follow these recent developments could herald other discoveries which may have great practical consequences. It is timely, therefore, to examine this mysterious vacuum through which we move at phenomenal speed and speculate a little on its properties in the light of modern experimental evidence. We have, it would seem, arrived at the crossroads in science of which we were alerted by Dingle in his famous book attacking relativity."

Many researchers have projected the mass density or the energy density of vacuum space or "aether". Values of calculated energy density range from 0.9 J/M^3 ("Decisive Experiments in Moderne Physics", Marco Todeschini) to 4.14×10^{30} J/M^3 ("On a New Mathematical Framework for Fundamental Theoretical Physics", R. E. Var, Foundations of Physics, Vol. 5, No. 3, Sept. 1975). Recent calculations give, based on earth geophysical constants, 3.3×10^{20} J/M^3 ("The Energy Density of the Space-Time Continuum", J. P. Roos, to be published in BASRA, Jan. - Feb. 1987).

In support of higher values of the energy density of vacuum space than the 2.7°K black body radiation of interstellar space are:

1. The high estimated value of the energy density of BALL lightning; 2 to 5×10^9 J/M^3 (M. D. Altschuler, et al, Nature, 228, 545, 1970).

2. The energy density of the gravitational field at the earth's surface:

$$g^2/8\pi k = 57 \times 10^9 \text{ J/M}^3$$

where

g = gravitational acceleration

k = gravitational constant

3. The energy density of a 3 million gauss magnetic B-field:

$$B^2/2\mu_0 = 35 \times 10^9 \text{ J/M}^3$$

The Principal Investigator of this proposal shows in his two papers on the subject matter that the fluid dynamic model of the energy of vacuum space has the interesting result that all field energy densities are hydrostatic pressures with a negative sign, to be subtracted from the ambient rest pressure or energy density to obtain the actual "static" pressure, that is experienced by the observer inside the field. For example: the higher the intake air velocity is in the venturi throat of a car carburetor, the higher the suction pressure is to draw gasoline into the carburetor throat. The same holds true for a magnetic field: the higher the field strength between the pole surfaces, the higher the ambient scalar potential energy density difference with the remaining pressure in the gap becomes. Adding $-B^2/2\mu_0$ to the field energy density or pressure (energy density has the same dimensionality as pressure) in the magnetic pole gap explains the attraction between the north and south magnetic poles as compression forces by the ambient acting on the pole surfaces to close the pole gap. The pressure differential exists across the pole surface because in the ferromagnetic material μ is much larger than μ_0 and thus $B^2/2\mu$ in the ferromagnetic material is very small compared with $B^2/2\mu_0$ in vacuum or in air. Without the negative sign, attraction cannot be explained in the fluid dynamic model, which documents the negative sign in the law of Bernouilli, which, when expanded to include electromagnetic and gravitational fields, becomes:

$$P_{surroundings} = P_{static} + \frac{\rho V^2}{2} + \frac{B^2}{2\mu} + \frac{\epsilon E^2}{2} + \frac{g^2}{8\pi k} = \text{constant},$$

so that for singularly acting fields, the pressure P_{static}, the actual pressure that is experienced in the field, is expressed as follows:

$$P_{static} = P_{surroundings} - \frac{\rho V^2}{2} \qquad \text{fluid dynamics}$$

$$P_{static} = P_{surroundings} - \frac{B^2}{2\mu} \qquad \text{magnetic fields}$$

$$P_{static} = P_{surroundings} - \frac{\epsilon E^2}{2} \qquad \text{electric fields}$$

$$P_{static} = P_{surroundings} - \frac{g^2}{8\pi k} \qquad \text{gravitational fields}$$

where $P_{surroundings}$ is the energy density or hydrostatic pressure of the zero point quantum dynamic energy of vacuum space.

PHASE I - WORK PLAN

All Phase I work is theoretical and will be carried out in the offices of Aerospace Systems, Inc. at 121 Middlesex Turnpike, Burlington, Massachusetts. The university libraries of MIT and Harvard are nearby, as well as the DTIC library branch at Hanscom Air Force Base. Consultation with experts in the field will be sought if required to further the goal of this work.

The Phase I work plan is organized in six steps towards achieving the final goal, which is the identification of the most promising of the fluid dynamic models. Fluid dynamic theory will be the main theoretical vehicle to accomplish the analysis proposed in this work. The previous section "Related Work" shows justification for this choice. It is the opinion of the Principal Investigator that the fluid dynamic model has a better visual and more realistic grasp of the problems at hand than the 10-dimensional string theory. It is fortunate that the mathematical existence of singularities in the spacetime fabric to explain the cosmology of the universe has been shown by D. T. Lee, the field theorist. They also appear in Feynman graphs when the complex plane blows up and infinities occur. A renormalization technique exists to shrink these singularities so that in a macro sense they can still be dealt with mathematically.

1. The first step in the Phase I work plan is the construction of a three dimensional matrix of possible concepts to represent:

   a. operating conventional fields

   b. matter geometries

   c. fluid dynamic models of the zero point quantum dynamic singularities of space

2. The second step will identify the equations that apply to field-field and field-scalar interactions, with emphasis on force vector parameter descriptions, before imposing matter boundary conditions.

3. The third step will consider the matter boundary conditions for each of the matrix concepts of Step 1. This is the most crucial part of the analysis and requires a creative look at possible boundary conditions in order to identify those cases where the closed surface integrals do give nonzero answers, indicating that propulsive force vector resultants are likely to occur.

4. This step combines Step (2) and (3) in the matrix table for the purpose of expressing any force vectors that are found in terms of known physical parameters and the energy density of vacuum space.

5. This step requires a thorough literature search to categorize the many values of published properties of the "aether" of space and will be completed with an assessment of the statistical probability range of values in which the energy density is most likely to fall. In the extraordinary case that experimental verification of the energy density of space is found reported, the effort of this step will concentrate on determining the authenticity and validity of the report.

6. The final step of the work plan combines Step (4) and (5) and adds cost estimation and conversion efficiency analysis to find the most promising concepts in terms of efficiency and economy, the ability to scale or based on system savings when compared with state-of-the-art concepts.

RELATIONSHIP WITH FUTURE RESEARCH

1. The project will be partially successful if nonzero closed surface integrals, described in technical objective (3), can be found.

2. The project will be fully successful if it can be in addition convincingly shown that the energy density of the vacuum space is high enough that propulsion force vectors can be generated in a way that is superior to presently favored concepts, without requiring the very high temperatures or pressures of fusion research.

3. The theoretical results of a broad search during Phase I, if successful, should make it possible to select a winning concept for development under Phase II to verify the theory. This could include a determination of the energy density of vacuum space, the degree of coupling that can be obtained between the winning field-matter geometry and the vacuum space scalar potential, and an assessment of how scaling will affect the performance parameters.

POTENTIAL POST APPLICATIONS

1. If Phase I and II are successful commercial applications will exist in the areas of transportation and energy conversion.

2. If Phase I is successful, redirection of goals could lead to savings by the federal government. If Phase II is also successful, additional potential use is expected in space launching and maneuvering, weapons delivery or novel defense systems.