

Field Propulsion Systems for Space Travel

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Conventional Propulsion System

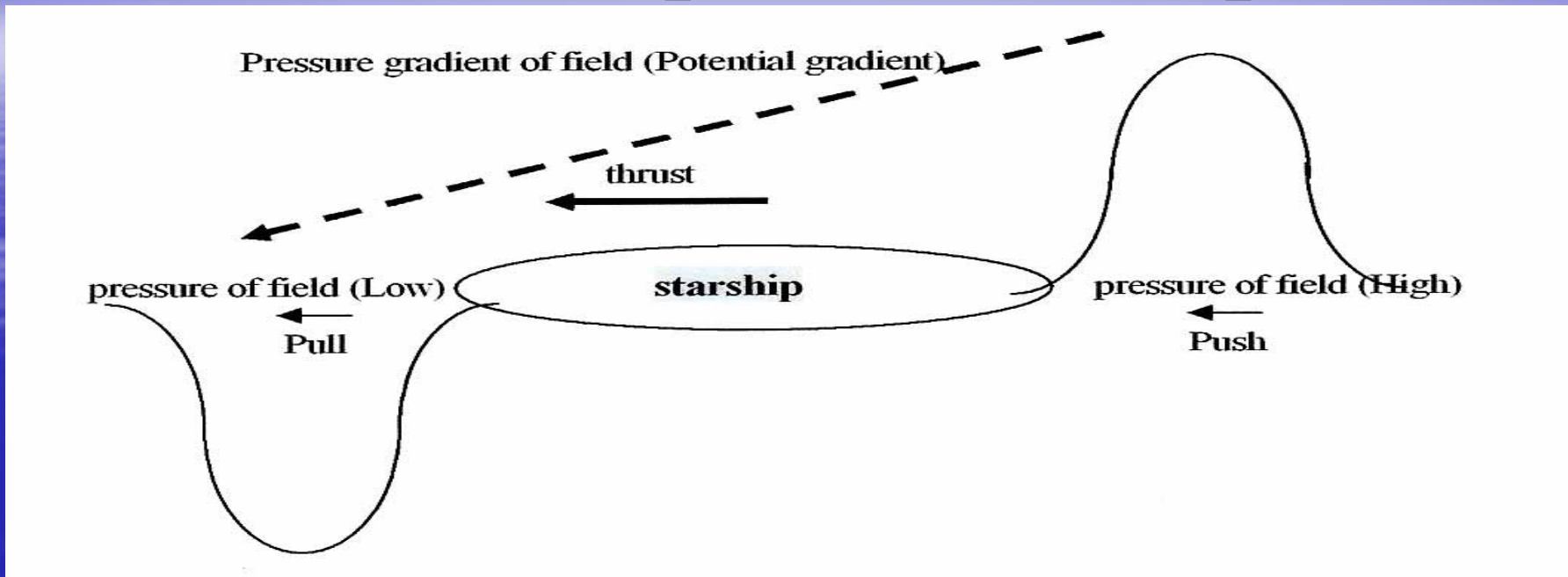


1. All existing propulsion systems (chemical, electric, laser, nuclear) are based on expulsion of mass to induce a reaction thrust.
2. Maximum speed is limited in momentum thrust; hence, the speed of rocket is too slow for interplanetary or interstellar travel.
Breakthrough in propulsion.

Introduction of Field Propulsion

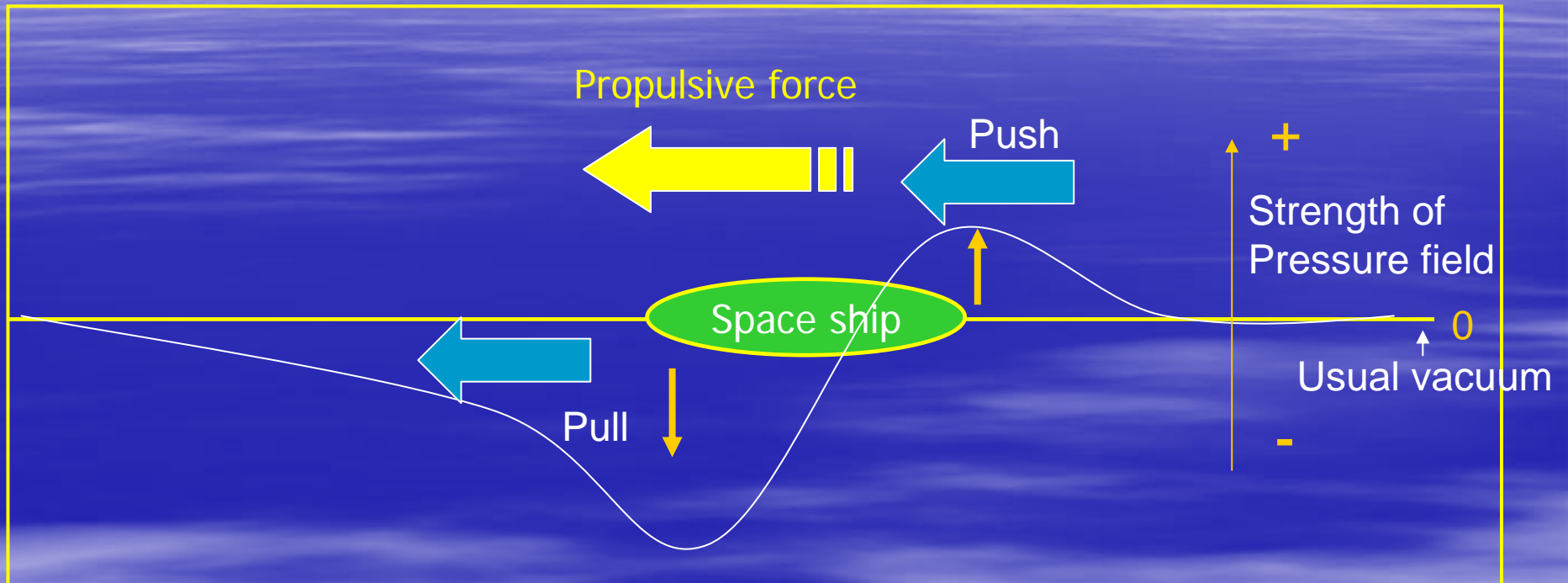
1. A possible breakthrough could rely on the notion of Field Propulsion.
2. Field propulsion would employ a physical means to asymmetrically interact with the space vacuum.
3. Field propulsion must satisfy the following criteria:
Conservation of momentum and Conservation of energy.
4. The most promising interpretation is to consider that space itself as vacuum is a kind of reaction mass.
5. Candidate of Field Propulsion: Space Drive Propulsion (**Minami**); ZPF Propulsion (**Froning**), Warp Drive Propulsion (**Alcubierre**); Space Coupling Propulsion (**Millis**) and so on.

Field Propulsion Principle



As is shown in these figures, the propulsion principle of field propulsion is not momentum thrust but pressure thrust induced by a potential gradient arising from space or vacuum field between the bow and the stern of starship. The propulsive force as a pressure thrust arises from the interaction of space around the starship. Starship is propelled against the space-time structure. The pressure gradient of the vacuum field (potential gradient) is formed over the entire range of the starship, so that the starship is propelled by pushing from the pressure gradient of the vacuum field.

Field Propulsion Principle

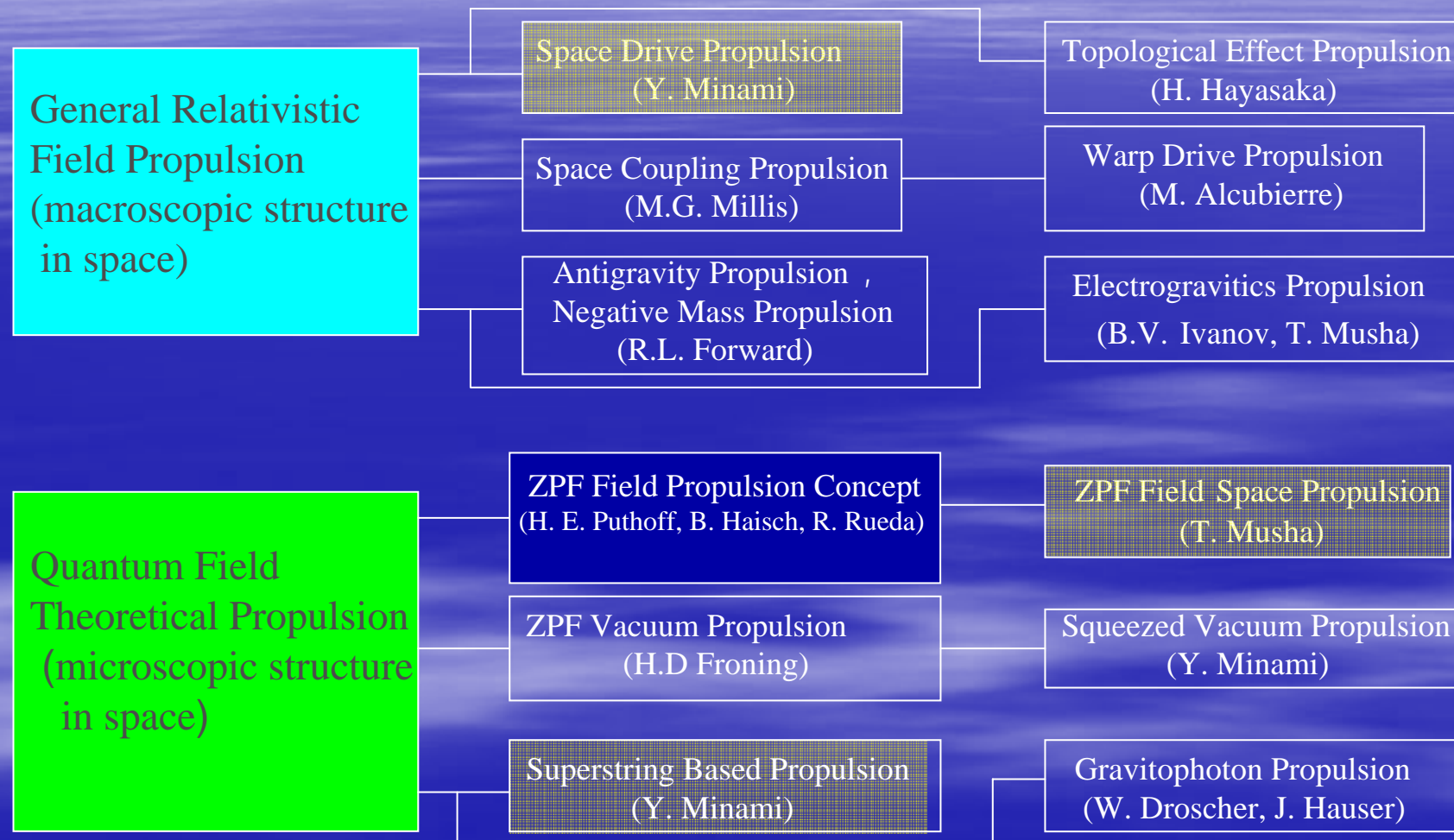


Asymmetrically interaction with the pressure of field creates propulsive force for the space ship.

The strength of pressure field ahead of the spaceship is diminished and its behind increased, this would result in favorable pressure gradients.

Field Propulsion Classified Map

(representative example)



Field Propulsion Classified Map

Basic Concept for Space-Time

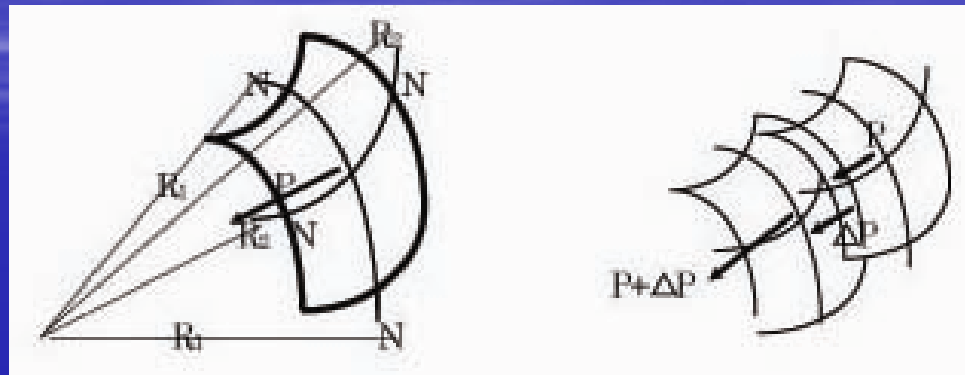
- Space as a vacuum possesses a substantial physical structure
 1. Macroscopic structure based on continuum mechanics: Curvature, Strain → **General Relativity**
 2. Microscopic structure based on statistical mechanics: Zero-point fluctuation, Entropy → **Quantum Field Theory**
- Several kinds of field propulsion system can be proposed by making choice of above-stated physical concept.
- Propulsion principle is identical in regard to utilize the substantial physical structure of space, that is, **Spaceship is propelled against space physical structure**, even if whether the constituents of physical structure are curvature, zero-point fluctuation, or statistical entropy.

Basic Principle of Space Drive

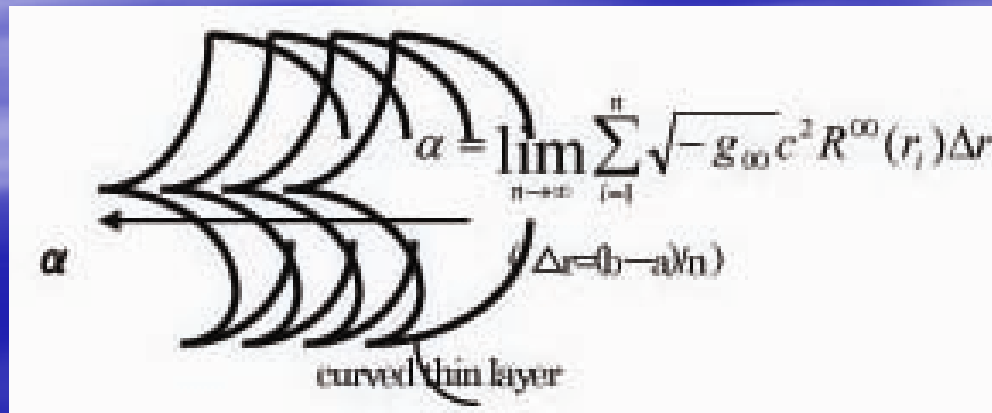
- Space is an infinite continuum **Elastic Field.**
- Space can be deformed such as expansion, contraction, torsion.
- Propulsion principle is based on the pressure thrust not momentum thrust (reaction thrust)
Action of the Medium of Strained or Deformed field of space.
- A certain structural deformation is described by strain tensor e_{ij} (g'_{ij}, g_{ij} are metric tensor).

$$e_{ij} = 1/2 \cdot (g'_{ij} - g_{ij})$$

- Curvature of Space plays a significant role for propulsion theory.
- If space curves, then inward normal stress (surface force) “P” is generated A SORT OF PRESSURE FIELD.



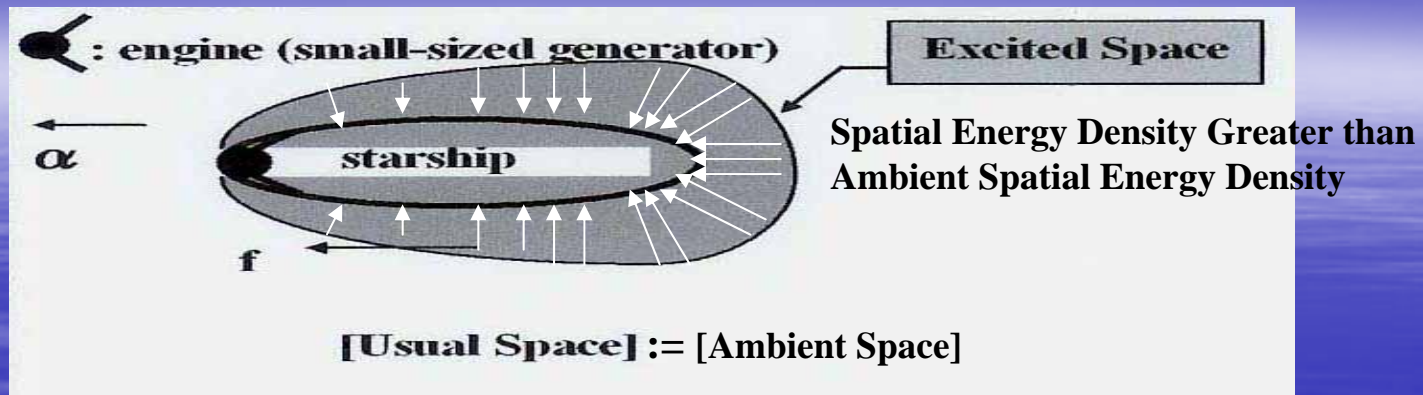
A large number of curved thin layers form the unidirectional surface force, i.e., *Acceleration Field* .



Acceleration is proportional to the integral of curvature tensor

$$\alpha = \sqrt{-g_{00}} c^2 \int_a^b R^{00}(r) dr$$

SPACE DRIVE PROPULSION SYSTEM



- Curvature of SPACE (R^{00}) plays a significant role for propulsion theory (Y.Minami:1988).

$$F^i = m\sqrt{-g_{00}}c^2\Gamma_{00}^i = m\alpha^i = m\sqrt{-g_{00}}c^2\int_a^b R^{00}(x^i)dx^i$$

$$R^{00} = \frac{4\pi G}{\mu_0 c^4} \cdot B^2$$

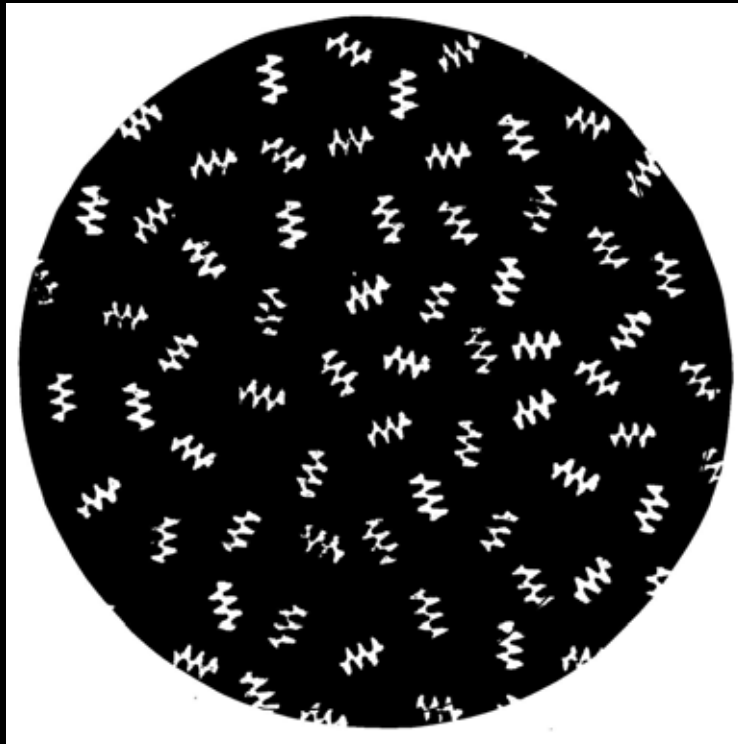
Both strength of curvature and its extent (volume) are important.

- Acceleration induced by de Sitter solution is found in 1996 by Minami : constant acceleration (i.e. no tidal force inside of the starship).

$$\alpha = \frac{2\pi G\lambda}{3c^2} \phi_0^4 = 1.6 \times 10^{-27} \lambda \phi_0^4$$

ϕ_0 : non-zero vacuum expectation value of field

Electrogravitic Propulsion by ZPF field



Manipulation of ZPF field by applying electromagnetic field
For generating thrust

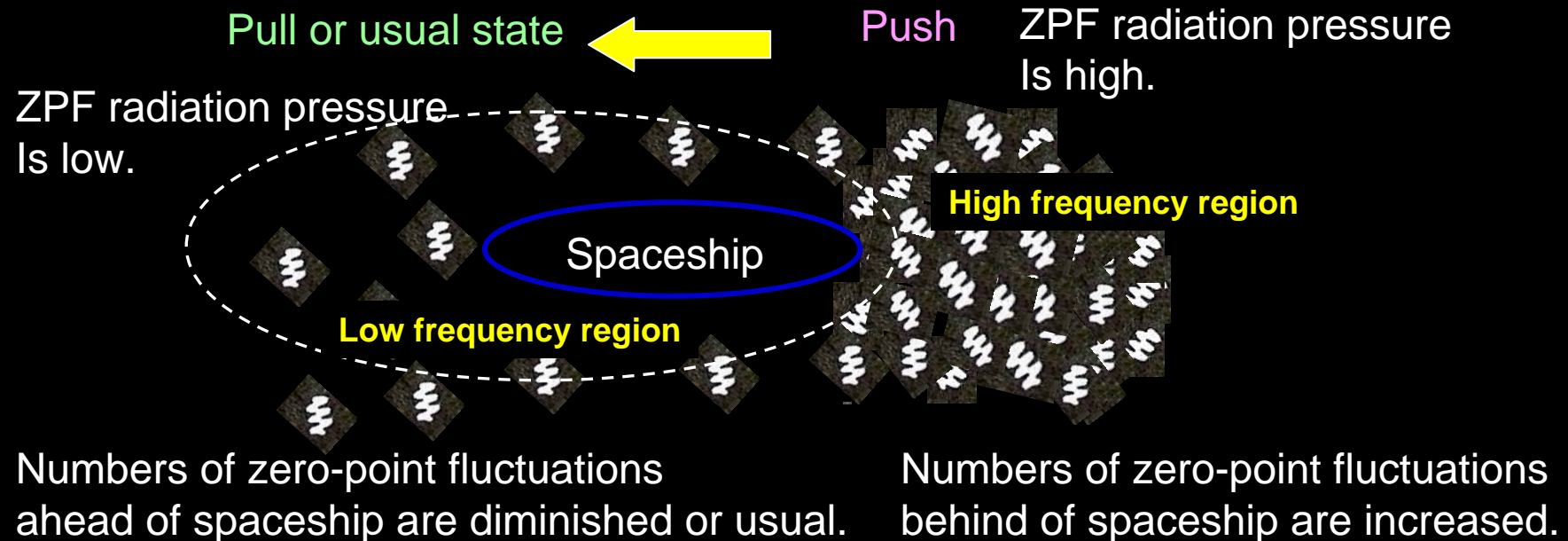
(A) Electrodynamic Hamiltonian by P.Milonni

$$H_A = \frac{e^2}{2m_0c^2} \langle A^2 \rangle$$

(B) Electromagnetic Hamiltonian corresponding
Zero-point fields
(B.Haisch, A.Rueda, H.E.Puthoff)

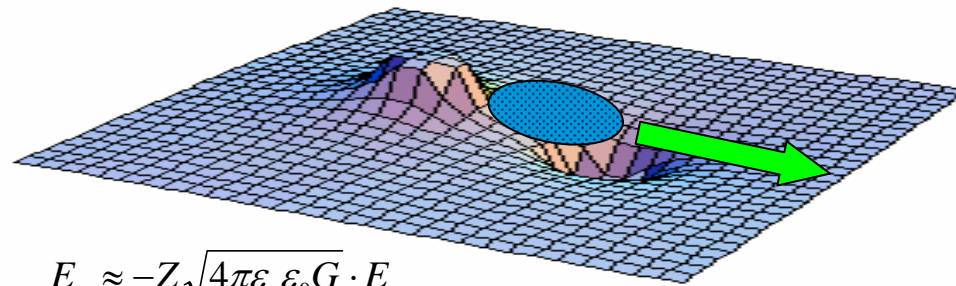
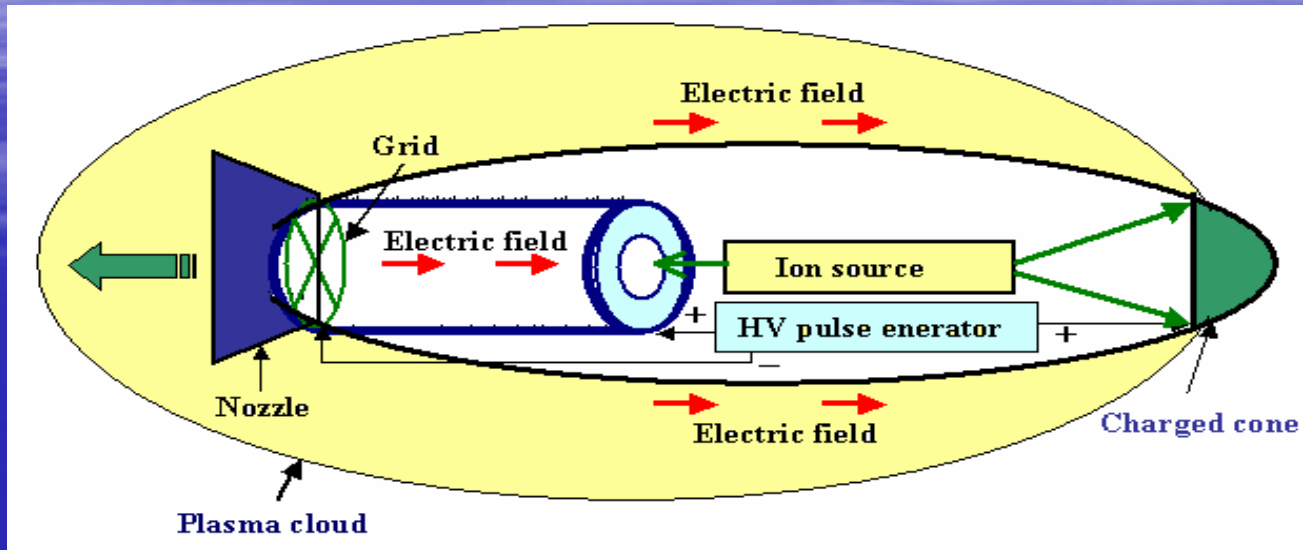
$$H'_A = \frac{e^2\hbar}{2\pi m_0c^3} \omega_c^2$$

Interacting with Radiation Pressure of Zero-Point Energy for Propulsion



Radiation pressure gradient (i.e. pressure gradient) is generated. Asymmetrically interaction with the pressure of field creates propulsive force for the spaceship.

Spacecraft by Electro-gravitic Propulsion System

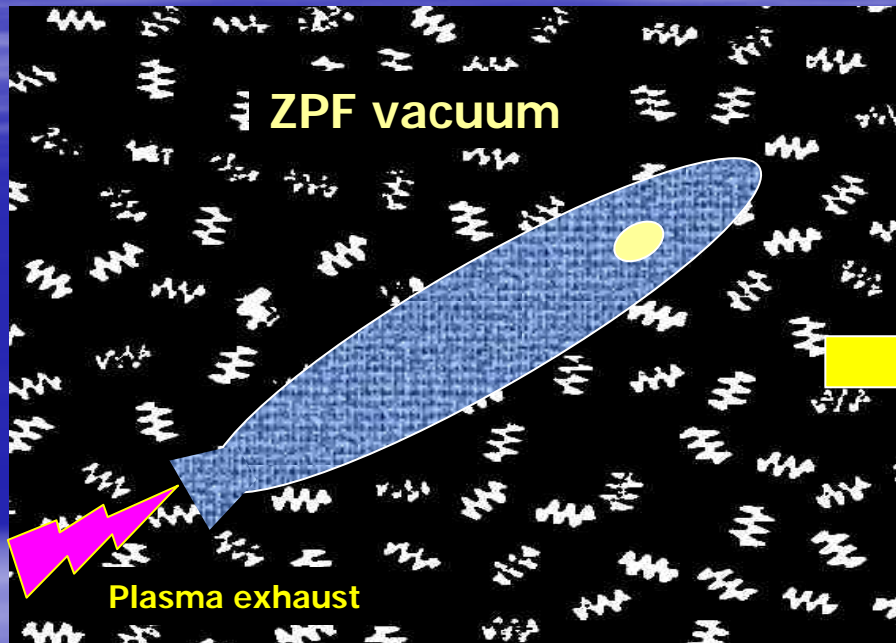


$$E_g \approx -Z\sqrt{4\pi\epsilon_r\epsilon_0G} \cdot E$$

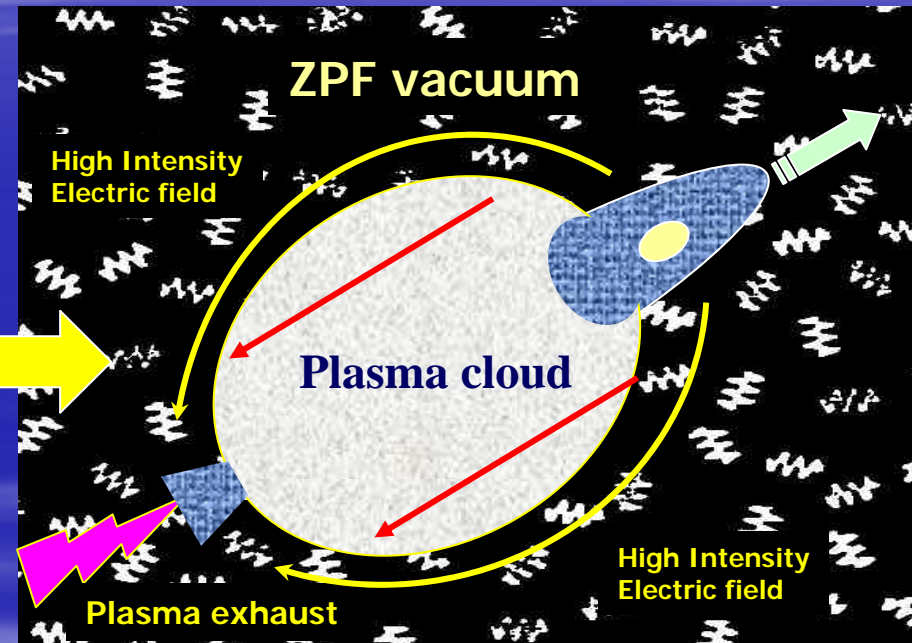
$$F = -(M + \Delta M)E_g \approx Z\sqrt{4\pi\epsilon} G \left(1 + \frac{\pi}{8} \frac{e^4 G}{\epsilon_0^2 m^2 c^8} \frac{N^2 R}{\Gamma_e \omega_e} E^2 \right) EM$$

Concept of the Electrogravitic-ZPF propulsion

Normal mode

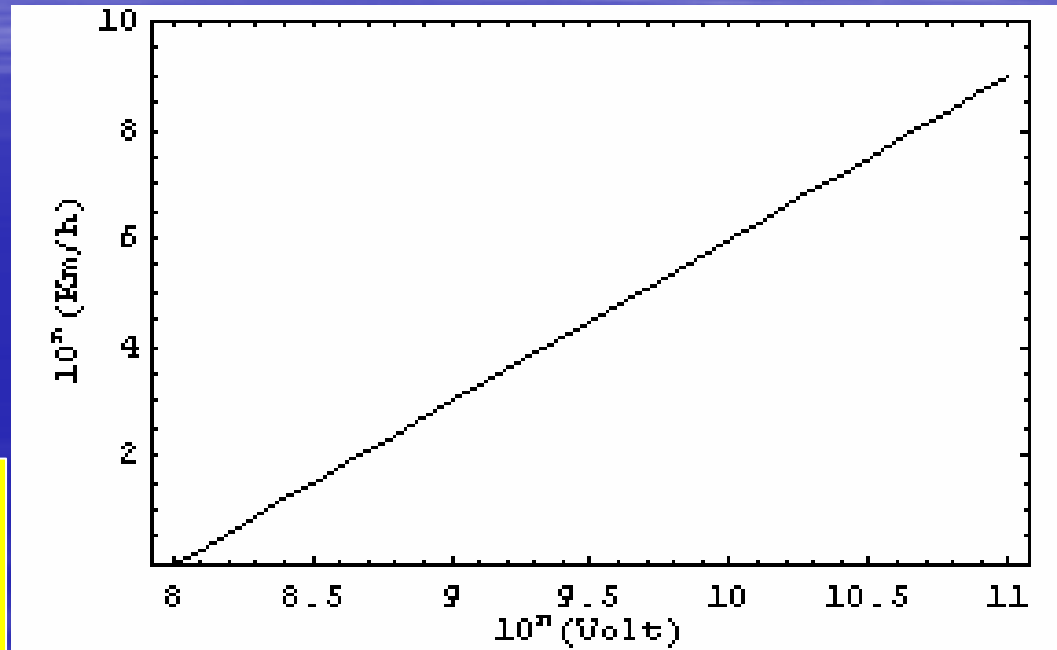


Antigravity Mode



The plasma propulsion system is mainly used for producing plasma cloud

Speed of the spacecraft generated by electrogravitic field



$$v = P_{\text{field}} / M'$$

$$\approx Z \sqrt{4\pi\epsilon} G \frac{M}{M'} \left(1 + \frac{\pi}{8} \frac{e^4 G}{\epsilon_0^2 m^2 c^8} \frac{N^2 R}{\Gamma_e \omega_e} E^2 \right) \frac{El}{v_d}$$

$l = 10$ m, $R = 5$ m, $\omega_e = 10^{15}$ rad/s, $m = 9.11 \times 10^{-31}$ kg (electron's mass),

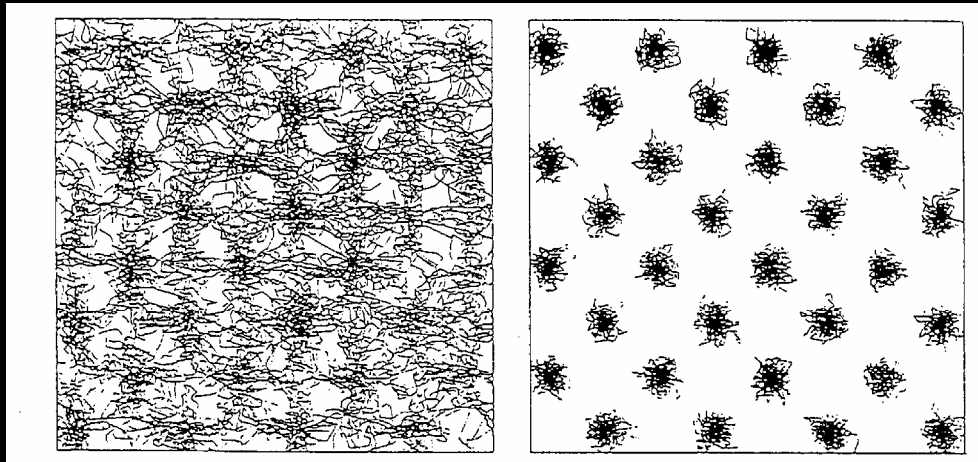
$N = 10^{26}$, $v_d = 10^8$ m/s for the value of the vacuum arc

Superstring Based Entropy Propulsion

1. The strings of superstring theory are considered as the threads of space-time fabric
2. String seems to be fundamental element of the structures of space-time
3. This indicates that strings might behave like the polymer chains of some elastic body
4. Statistical entropy is the logarithm of the number of states What kinds of state ?
5. Open strings cling to the field Disordered phase (High Temperature) and Ordered phase (Low Temperature)

Disordered phase

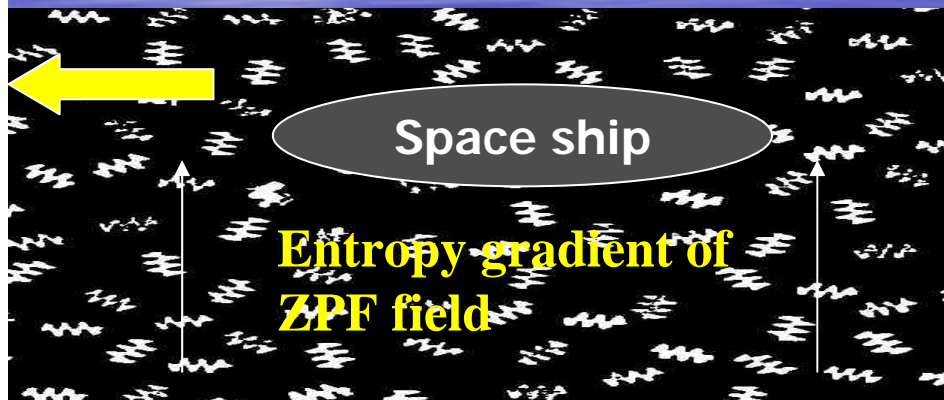
Ordered phase



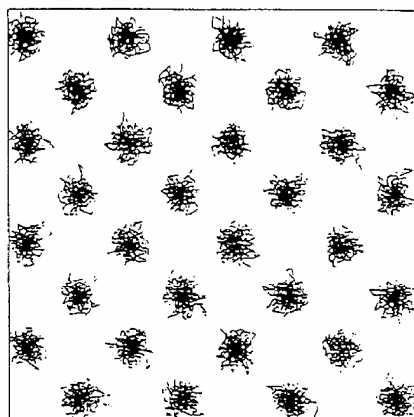
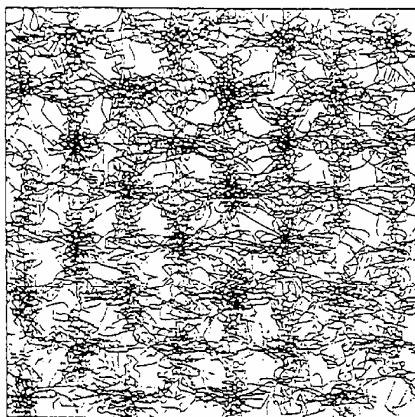
Entropy is large

Entropy is small

Entropy Gradient creates propulsive force

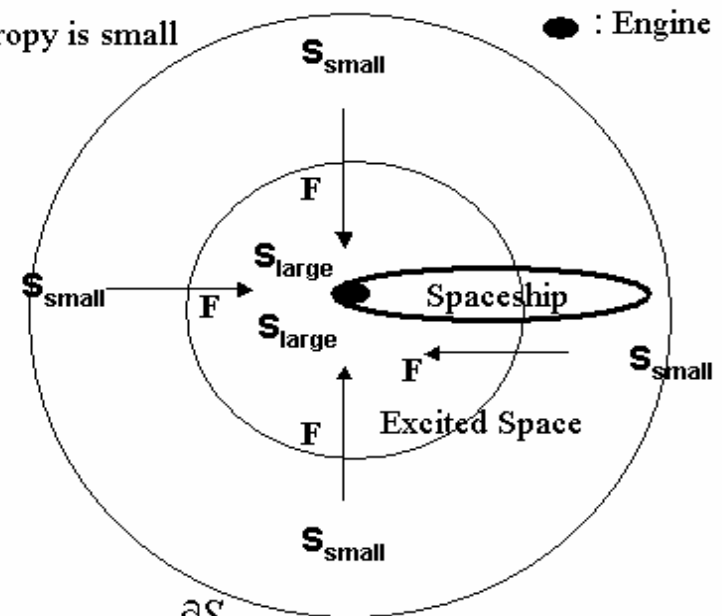


S_{large} : Entropy is large S_{small} : Entropy is small



S_{large} : Entropy is large

S_{small} : Entropy is small



$$F = T \frac{\partial S}{\partial r} \quad (T: \text{Temperature density}, S: \text{Entropy})$$

$$F = T \frac{\partial S}{\partial r}, \quad S = k \log W, \quad \Rightarrow \quad F = kT \frac{\partial \log W}{\partial r}$$

SUMMARY

- Propulsion principle of Field Propulsion is based on physical structures of space in the view of macroscopic structure



General Relativistic Field Propulsion

in the view of microscopic structure



Quantum Field Theoretical Field Propulsion

- Unbalanced pressure of field or asymmetrically interaction with the pressure of field plays a significant role for field propulsion

Field Propulsion System for Space Travel published from Bentham Science Publishers

