

Astrophysical Field Drive Propulsion -Its Conceptual Design for Development-

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ABSTRACT : The concept and principle of space drive propulsion have been developed step by step by utilizing the astrophysical consideration, that is, the principal mechanism of black holes and accretion disks. In this paper, as the final stage, using astrophysical phenomena, the space drive propulsion that can realize the engine and power source developed by a single technology move to the concrete development stage are presented. The basics of well-examined space drive propulsion will be systematically organized once, and the name as “astrophysical field drive propulsion” is newly introduced.

KEYWORDS propulsion, curvature, magnetic field, accretion disk, blackhole, vortex, plasma, spaceship.

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I. INTRODUCTION

The author has constructed the concept of field propulsion and introduced the relatively well-considered Space Drive Propulsion, which is a typical example of field propulsion, in international conferences, treatises, books, etc. [1-12]. In particular, the concept and principle of space drive propulsion have been developed step by step from the beginning by utilizing the astrophysical consideration, that is, the principal mechanism of black holes and accretion disks. In this paper, as the final stage, using astrophysical phenomena, we would like to move the space drive propulsion that can realize the engine and power source developed by a single technology to the concrete development stage. The basics of well-examined space drive propulsion will be systematically organized once, and the name of “astrophysical **field drive propulsion**” will be newly introduced instead of “astrophysical **space drive propulsion**”. The term “Field Drive” in Field Drive Propulsion means a field, that is, driving by a field, and represents "propulsion by a field".

As a conceptual design stage, we will introduce a concrete study of the propulsion engine and power source.

In this paper, the concept is prioritized and most of the explanations by mathematical formulas are omitted. See References for a detailed explanation using mathematical formulas [1 - 12].

Concerning the detail Space Drive Propulsion using mathematical formulas, the paper entitled “Space propulsion physics toward galaxy exploration” [2], “New Development of Space Propulsion Theory - Breakthrough of Conventional Propulsion Technology -” [4], and book entitled “STAR FLIGHT Theory: By the Physics of Field Propulsion” [5] containing the detail contents will be useful.

II. SUMMARY OF PROPULSION PRINCIPLE

Here, the necessary items are briefly listed. See the described above Reference for details.

(1). The magnetic field B curves the space and creates the curvature of the space R^{00} .

$$R^{00} = \frac{4\pi G}{\mu_0 c^4} \cdot B^2 = 8.2 \times 10^{-38} \cdot B^2 \quad (B \text{ in Tesla}),$$

$$\mu_0 = 4\pi \times 10^{-7} (H/m), \quad \varepsilon_0 = 1/(36\pi) \times 10^{-9} (F/m), \quad c = 3 \times 10^8 (m/s), \quad G = 6.672 \times 10^{-11} (N \cdot m^2 / kg^2),$$

B is a magnetic field in Tesla and R^{00} is a major component of spatial curvature ($1/m^2$).

(2). When the space curves, an acceleration field is generated inside the curved surface.

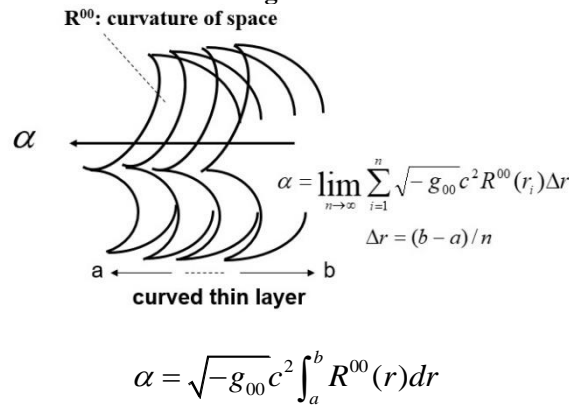


Fig. 1. The accumulation of many curved thin membrane layers creates a unidirectional acceleration field.

(3). A curved space around the spaceship is created by the spaceship engine.

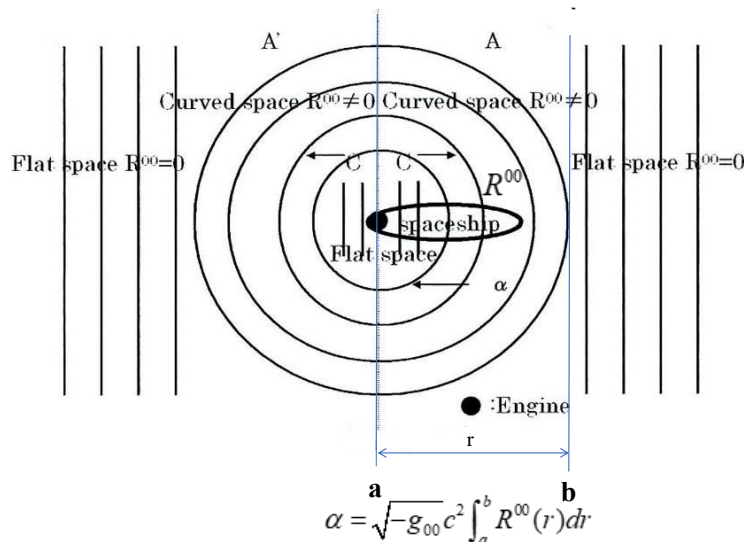


Fig.2. The spaceship is propelled in one direction by the acceleration of the field generated in the curved space. The magnitude of acceleration is proportional to the curvature of space and the magnitude of the curved space region (a-b).

In order to propel as described above, the engine “●” of spaceship is first turned on and curves the space to generate a curved space area. Space is curved by a magnetic field. During the transition time when the space-curving engine is turned off and the curved space returns to a flat space, the spaceship and the curved space are independent, so the spaceship is pushed forward from the curved space. Continuous thrust is obtained by repeating this engine on-off operation.

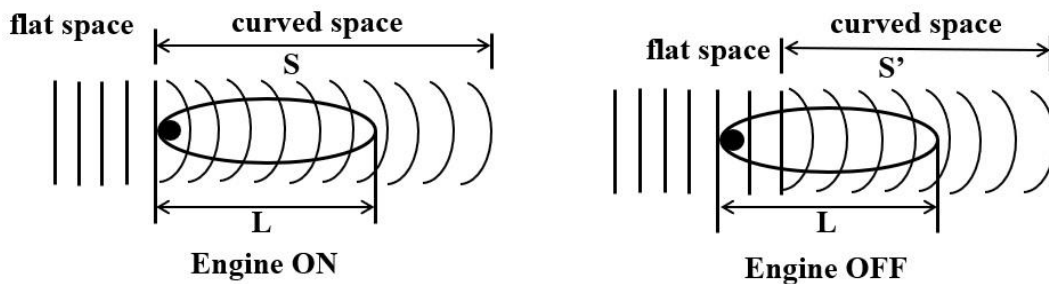


Fig. 3. Generated curved space by Engine On-Off.

In the Fig. 3, “●” indicates the engine of the spaceship, which is loaded on the front of the spaceship. When the engine is turned on (Magnetic field of engine: ON), a flat space centered on the engine changes to a curved space, and this change changes to a space around the engine like ripples. It propagates at the light velocity, which is the distortion rate (deformation rate). Conversely, when the engine is turned off (Magnetic field of engine: OFF), the curved space around the engine changes to a flat space, and this change changes to a space around the engine like ripples. It propagates at the light velocity, which is the distortion velocity (deformation velocity) of space.

(4). Omni-directional propulsion by the space curvature generation engine.

As shown in Fig.4, six engines will be placed on the spaceship in front, back, left, right, up and down so that they can move forth and back, left, right, up and down. Here, for the sake of simplicity, one engine propels in one direction (see the previous figure). In fact, it is possible to move in all directions with three engines by vector synthesis.

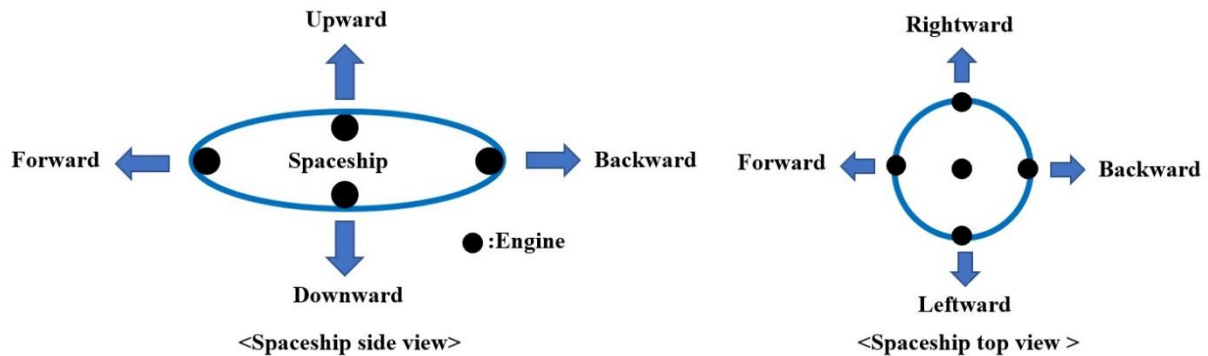


Fig. 4. Spaceship engine layout.

Start the engine placed in the front of the spaceship to move the spaceship forward, start the engine placed in the rear of the spaceship to move backward, and start the engine placed in the upper part of the spaceship to raise the spaceship. Start the engine located at the bottom of the spaceship for the spaceship to descend. Also, the engine located on the right side of the spaceship starts to move the spaceship to the right, and the engine placed on the left side of the spaceship starts to move the spaceship to the left.

III. SPATIAL CURVATURE GENERATION ENGINE BY CONVERGENCE OF MAGNETIC FIELD LINES

As a function of the engine in the previous section, a strong magnetic field is generated by confining and converging magnetic field lines. The magnetic field lines freeze in the plasma and move in conjunction with it. The magnetic field lines converge to one point by narrowing the flow of plasma at any one point in the flow path. By narrowing down the magnetic field lines, the magnetic field is strengthened and the curvature of the space is generated. That is, by narrowing down the plasma in the flow paths at the engine positions at six locations, front, back, left, right, up and down of the spaceship, the magnetic field lines frozen in the plasma are narrowed down to generate a strong magnetic field. Accordingly, the curvature of the space is generated by strong magnetic field.

It functions as an engine by controlling the flow path of the plasma flow and the route that narrows the diameter of the plasma flow. So, the flow path of the magnetic field lines frozen in the plasma and the control of the magnetic field lines density are important.

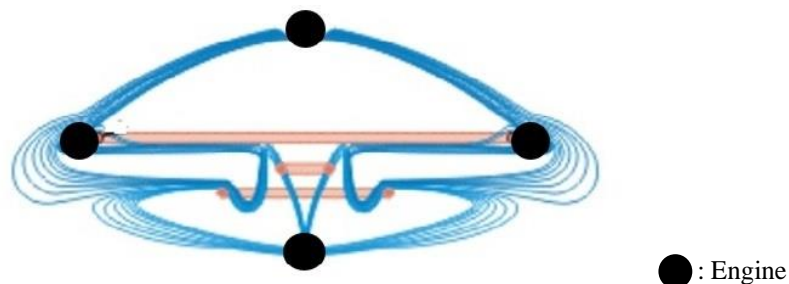


Fig. 5. Path of magnetic field lines frozen in plasma in spaceship.

Fig.5 shows the path of magnetic field lines frozen in plasma in spaceship. The blue line is the magnetic field lines frozen in the plasma flow. The plasma flow is narrowed down and the magnetic field lines are converged near the engine black circles on the top, bottom, left, right, front and back of the spaceship.

Fig.6 (a) and Fig.6 (b) show the narrowing down the plasma flow by Pinch effect of compressing plasma. For narrowing down the plasma flow, for example, the plasma confinement technique using the mirror magnetic field shown in the Fig.6 (c) can be used.

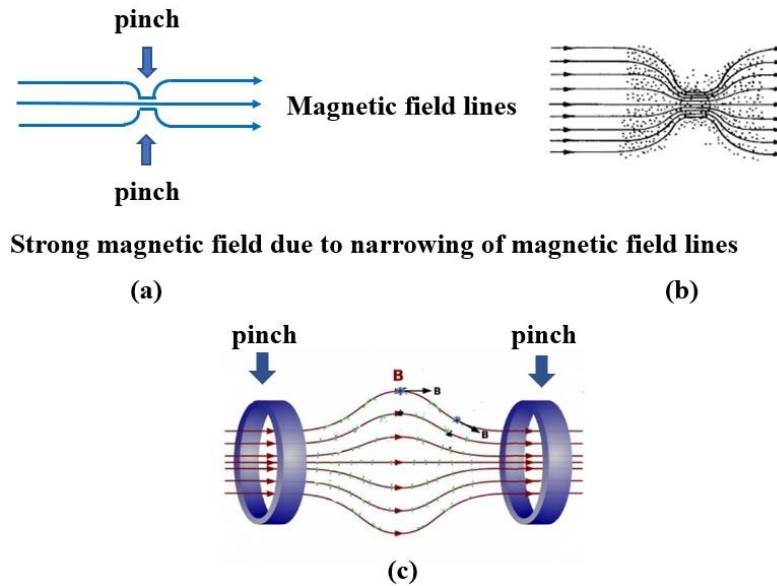


Fig. 6. Pinch effect of compressing plasma.

Fig.7. shows the path of magnetic field lines frozen in plasma in spaceship. Engine “●” described in Fig.4 implies the narrowing down the plasma flow by Pinch effect of compressing plasma. The magnetic field lines frozen in the plasma are narrowed down to generate a strong magnetic field, i.e., large spatial curvature (see Fig.2 and Fig.3).

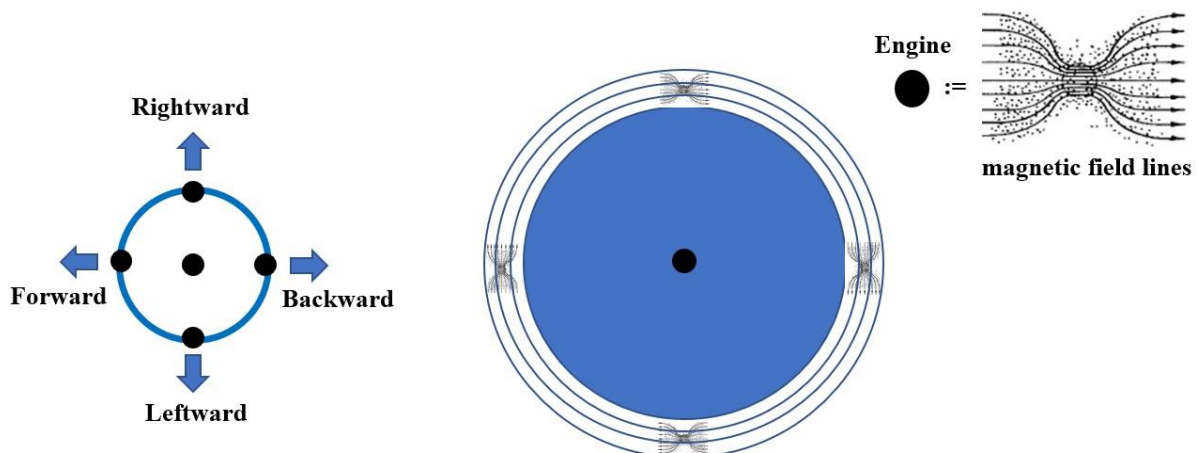


Fig. 7. Path of magnetic field lines frozen in plasma in spaceship.

IV. MASSIVE CHARGED PARTICLES GENERATION BY PLASMA BLACK VORTEX

This chapter introduces a method in which a strong magnetic field for generating spatial curvature and its power source can be solved simultaneously with only one single technology. **Massive charged particle generation by plasma black vortex (quasi-mini black hole) is the key technology: strong magnetic field generation and power source.**

The plasma black vortex has a function of electromagnetically generating a funnel-shaped vortex tornado such as a black hole for attracting charged particles. In other words, it is an electromagnetic spiral quasi-mini black

hole that functionally simulates a quasi-black hole and an accretion disk. Fig.8 shows the plasma black vortex [13]. The plasma black vortex acts as the main engine of the spaceship to operate the six engines mentioned before.

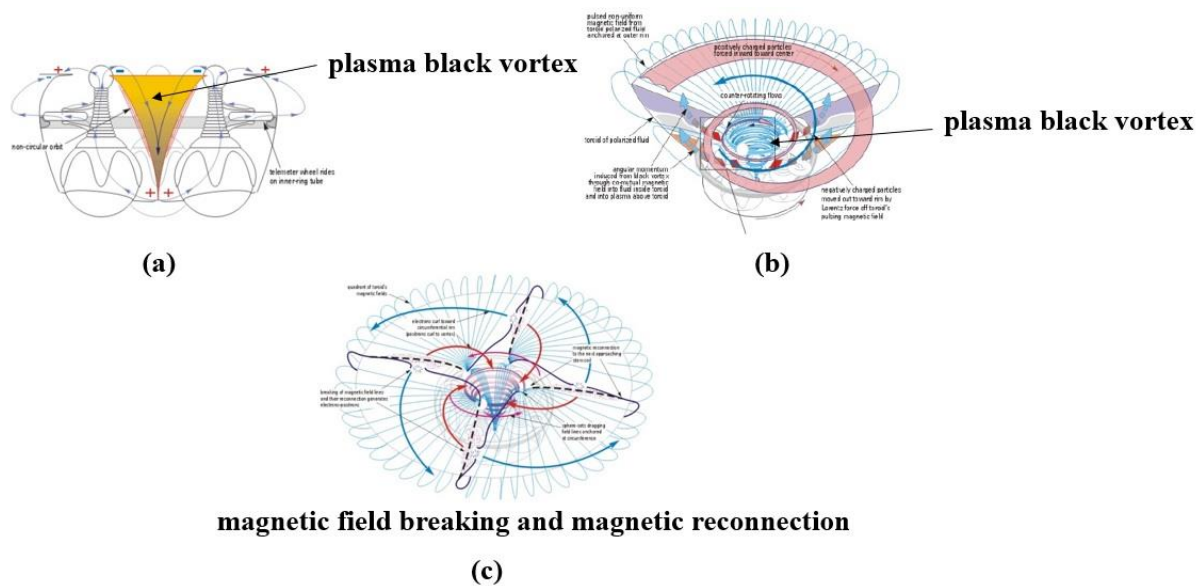


Fig. 8. Plasma black vortex, breaking and remaking of magnetic field lines (Quoted from *Gravitational Manipulation of Domed Craft*; Potter, P. E. (2008)).

The main engine (plasma black vortex) appears based on dynamics of a black hole surrounded by a reflecting sphere wall. The central part of this main engine develops an electromagnetic vortex, so that electrically charged particles are drawn into this vortex. Magnetic fields are empowered to do work on these electrically charged particles.

The plasma black vortex in the center of this figure (Fig.8. (a)) is a spiral plasma hole, and as $\mathbf{E} \times \mathbf{B}$ drift, ions of positively charged particles and electrons of negatively charged particles converge toward the bottom at the same speed in the same direction. Since $\mathbf{E} \times \mathbf{B}$ drift does not distinguish positive or negative, charged particles move at the same speed in the same direction. The $\mathbf{E} \times \mathbf{B}$ drift is an essential function for spiral vortex generation. Plasma produces a variety of vortices. Due to the viscosity of the plasma, there is a radial flow, and the radial flow will generate a spiral pattern.

By simulating the accretion disk of black hole function by plasma hole, it may be possible to generate a large amount of charged particles by dropping it while turning the plasma. A plasma hole with a deep potential structure like a black hole is in the experiment state. The plasma hole is a unipolar vortex. An important mechanism for driving a flow perpendicular to the magnetic field \mathbf{B} in the plasma is $\mathbf{E} \times \mathbf{B}$ drift driven by the electric field \mathbf{E} . This $\mathbf{E} \times \mathbf{B}$ drift has the feature that charge separation does not occur against the occurrence of a macroscopic flow of plasma since ions and electrons move at the same speed in the same direction. The $\mathbf{E} \times \mathbf{B}$ drift is the most important mechanism that makes a vortex. The external magnetic field is applied in the cylindrical axis direction of the plasma hole, and the electric field of the plasma faces outward in the radial direction from the central axis. In this case, $\mathbf{E} \times \mathbf{B}$ drift occurs clockwise in a plane perpendicular to the magnetic field [14, 15].

Also as shown in Fig.8. (a), there is a region of (-) charge at the top and a region of (+) charge at the periphery of the plasma black vortex, but the ion is accumulated heavily at the bottom “+” region, and the electrons are at the top at “-” region. Basically, it is thought that a large amount of charged particles are generated (by electron positron avalanche, magnetic flux reconnection, collision etc.), and the plasma of the charged particles is injected into the plasma black vortex to generate a strong current and generate a strong magnetic field. If the relation between “+” ion and “-” ion formation, ion flows and magnetic field lines is organized, it would be easier to understand. However, as shown in Fig.8 (b), ions of positively charged particles are directed to the lower center of the plasma black vortex, and electrons of negatively charged particles are directed to the upper direction of the plasma black vortex. Since the direction of the charged particle is reversed, it can be understood that there is a downward electric field \mathbf{E} .

The astrophysical jet formation mechanism and the energy generation method by accretion disk centered on black hole hold the possibility of applying to a new propulsion system. These mechanisms are

induced by electron-positron generation from magnetic flux reconnection, electron-positron production through the virtual energy field in vacuum space, avalanche productions of more electron-positron pairs, etc. It is interesting for energy generating means as a power source and strong magnetic field generation.

In astrophysics, a magnetic field reconnection can be working in all areas of universe at all times. It works not only on the surface of the sun and in the sun's solar flares but also the rotating fields of accretion disks. As is well known, the magnetic field reconnection will provide copious productions of electron-positron charged particles, and it will produce so much energy. The magnetic reconnection is considered to be promising as a solar flare energy release mechanism.

Around accretion disk, the shearing-reconnection of strong magnetic field produces a dynamo effect which gives a rapid amplification of any incoming and smaller electrical field of charged particles (seed field). So, they will develop into the much larger field and go on to accelerate particles which will collide with other particles, to produce more particles, and more collisions, which subsequently will lead to avalanche productions of more electron-positron pairs.

The breaking and remaking of magnetic field lines produce and then amplifies amounts of electrons and positrons from what some have called the 'empty' vacuum of space as shown in Fig.8 (c). After all, the key is energy generation by magnetic field breaking and magnetic reconnection. Because, large production of charged particles by electron avalanche phenomenon and generation of electron-positron pairs accompanying this can be utilized.

The generation of a large amount of charged particles brings about the generation of a large current, and it is possible to generate a strong magnetic field from this large current. A strong magnetic field is indispensable for energy generation and spatial curvature generation as a propulsion system.

Astrophysical Field Drive Propulsion is promising for propulsion engine and its power source. This is because the strong magnetic field and the power source for the spatial curvature generation of space drive propulsion system can be simultaneously solved by a just single technology.

V. RELEASED GRAVITATIONAL ENERGY

The essential of the accretion disk is that the role of the power generation function to extract the gravitational energy of the black hole and the role of the strong magnetic field generation can be utilized for the propulsion system. The system of a black hole and accretion disk is a gravitational power station of space. The release of gravitational energy works only when black hole and plasma gas of accretion disk exist. Energy can be extracted from the plasma gas when the plasma gas as fuel falls to the gravitational potential well created by the black hole. However, the gravitational energy cannot be released by free fall where the plasma gas mass is simply sucked into the black hole [16 - 21].

Differential rotation of plasma gas due to viscosity becomes important. When we take out the plug of the bath, water is sucked into the hole while swirling. In the same way, it is important that the plasma gas falls slowly while rotating slowly by the speed difference due to the viscosity in the adjacent gas layers.

When the plasma gas falls to the gravity well of the black hole, enormous energy can be extracted from the falling plasma gas. When the rotating plasma gas of the accretion disk loses its angular momentum due to the viscosity of the gas and gradually moves to the inner trajectory, the gravitational energy becomes excessive by the difference of the gravity gradient of the black hole. Half of the surplus extra gravitational energy is spent to increase the rotation while the other half is used to heat the plasma gas of accretion disk through viscosity (friction). Finally, it is converted into light and released from the accretion disk.

The viscosity in the accretion disk plays two important roles: transport of angular momentum and heating of the disk plasma. Here, we indicate the released gravitational energy.

Although it is impossible to manufacture a quasi-black hole or mini black hole as a device in the spaceship, it may be possible to electromagnetically produce the function of an accretion disk.

Applying the same mechanism to the Coulomb force by the electric field instead of gravitational field, the half of local potential energy dE released by accreting plasma charge dq falling in the plasma potential well from r to $r-dr$ is obtained as follows:

$$E_{rotation} = E_{radiate} = \frac{1}{2}(dE = E(r) - E(r - dr)) = \frac{1}{4\pi\epsilon_0} \cdot \frac{Qdqdr}{2r^2},$$

where Q is the electric charge of quasi-black hole model, $\epsilon_0 = 8.85 \times 10^{-12} (F/m) = 1/36\pi \times 10^9 (F/m)$.

Even in the case of electric field energy, energy release is done as well as the gravitational field of the black hole. Although the released energy is somewhat less than the black hole (it is large enough), the accretion disk by the electric field is considerably compact compared to the astrophysical scale.

<General Overview>

The curvature of space plays an important role. The strong magnetic field generation and its power for spatial curvature generation are implemented by a single technology. The following is key technology:

- ① A large amount of charged particles produced by avalanche phenomenon, and thereby strong current and strong magnetic field generation.
- ② Energy generation by magnetic field breaking and magnetic reconnection.

The basic concept is based on the astrophysics of black holes and accretion disks around black holes. The gas of the accretion disk is plasma made of ions and electrons. The release of gravitational energy does not occur if the gas does not gradually in falls (accretes) toward the center object.

The viscosity due to differential rotation between gases starts gas accretion. The viscosity generates frictional heat and heats the gas. First of all, ions in the plasma gas are heated by frictional heat due to viscosity. Friction works in the same manner for both ions and electrons, but since ions are larger in mass than electrons, ions will consequently have greater thermal motion energy.

It is necessary to electromagnetically generate a funnel-shaped vortex like a plasma hole to draw charged particles. As we initially thought, it is important how to generate the curvature of space concentrating the strong magnetic field generated by the gigantic current, which is caused by the flow of charged particles as an engine. Notice that the current is not the current flowing through the coil or wire, but the charged particles move in the space.

The detailed studies will be carried out, such as plasma black vortex simulating accretion disk by plasma hole and large quantity charged particle generation, energy generation by the breaking and reconnection of magnetic field lines. In any case, it is necessary to generate electromagnetically a funnel-like vortex tornado such as a black hole for drawing charged particles. That is, we must create an electromagnetic spiral quasi-mini black hole that functionally simulates quasi black hole and accretion disk.

VI. SPACESHIP FLIGHT PERFORMANCE AND FEATURE

The spaceship equipped with field drive propulsion system has the following features.

- a) There is no action of inertial force because the thrust is a body force. Since the body force they produce acts uniformly on every atom inside the spaceship, accelerations of any magnitude can be produced with no strain on the crews,
- b) The flight patterns such as quickly start from stationary state to all directions in the atmosphere, quickly stop, perpendicular turn, and zigzag turn are possible,
- c) The final maximum velocity is close to the velocity of light,
- d) Since the air around the spaceship is also accelerated together with the spaceship, the aerodynamic heating can be reduced even if the spaceship moves in the atmosphere at high speed (10km/s - 100km/s). However, it is expected that a plasma (ionized air) envelops the spaceship,
- e) Since it is an electromagnetic propulsion engine, there is no heat source, noise or exhaust gas associated with combustion,
- f) The engine and power source are installed in the spaceship. Therefore, it can fly in the atmosphere of a planet as well as in cosmic space,
- g) By pulse control of magnetic field, the acceleration varies from 0G to an arbitrary high acceleration (e.g., 36G),
- h) Deceleration is easy for re-entry into the atmosphere,
- i) Similar to item d) above, the seawater around the spaceship is also accelerated together with the spaceship, so the resistance of the seawater is reduced and it is possible to move at high speed in the sea. It is possible to smoothly enter the sea from the atmosphere without splashing water due to a sea surface collision.

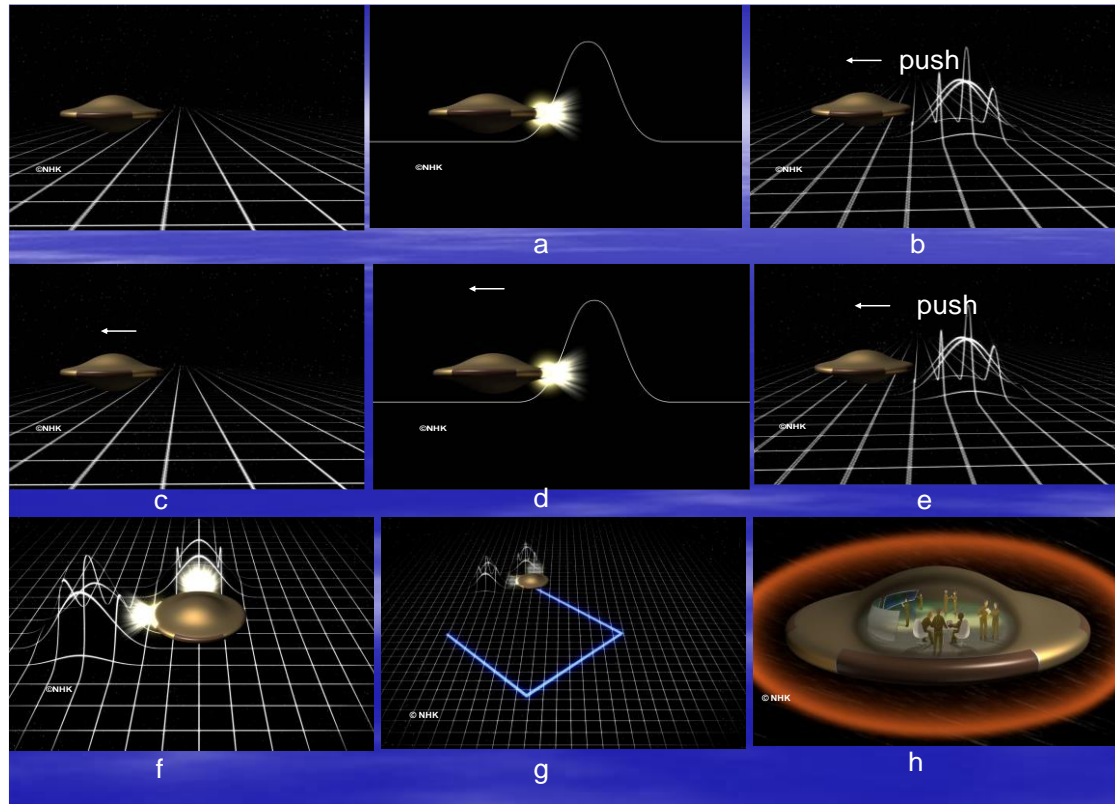


Fig. 9. A description of the flight operation of a spaceship (© NHK).

Here, we explain the motion of the spaceship in detail using computer graphics as shown in Fig.9. For the sake of simplicity, the shape of the spaceship is an omni directional disk type.

As shown in Fig.9 (a), the spaceship is able to permeate its local space with a huge amount of energy in a certain direction; this energy should be injected at zero total momentum (in the spaceship-body frame) to excite the local space. Then the excited local space expands instantaneously (Fig.9 (a), (b)). Space including the spaceship is pushed from the expanded space and advances forward (Fig.9 (b)). The expression of “moves by being pushed from the expanded space” indicates that the spaceship produces a curved space region and moves forward by being subjected to the thrust from the acceleration field of the curved space. The space including the spaceship is propelled to the forward (Fig.9 (c)). Thus, this spaceship is accelerated to the quasi-speed of light by repeating the pulse-like on/off a change of permeating its local space with a huge amount of energy operation (Fig.9 (d), (e)). Changing a place to blow up, the spaceship can move with flight patterns such as quick start from a stationary state to all directions, quickly stop, perpendicular turn, and zigzag turn (Fig.9 (f), (g)). There is no action of inertial force, because the thrust is a body force. Since the body force they produce acts uniformly on every atom inside the spaceship, accelerations of any magnitude can be produced with no strain on the crews inside the spaceship. Namely, spaceship moves with the whole space around the spaceship, then, even if the spaceship flies about it very intensely, the spaceship holds the stopping state in moving space, and the crews are not shocked at all (Fig.9 (h)).

VII. ASTROPHYSICAL FIELD DRIVE SPACESHIP CONCEPTUAL DESIGN

The basic idea is, how to make a strong magnetic field generated by a huge current due to the flow of a large amount of charged particles and generate a curvature of space as an engine. A single technology can simultaneously solve the curvature generation (as space drive propulsion principle) and power source generation. It is the plasma black vortex that fulfills this function. The main engine (plasma black vortex) appears based on dynamics of a black hole surrounded by a reflecting sphere wall. The central part of this main engine develops an electromagnetic vortex, so that electrically charged particles are drawn into this vortex. Magnetic fields are empowered to do work on these electrically charged particles. Magnetic Flux Break-Reconnection is also performed in the plasma black vortex (Fig.8(c)).

(1).

Massive electron-positron (electron and positron) generation associated with magnetic field break and magnetic field reconnection is occurred. It moves to the thermal energy of electrons by electromagnetic collision between ions and electrons called Coulomb collision. Electrons heated by obtaining thermal energy again

Coulomb collide with ions to emit energy photons (thermal bremsstrahlung), collide with magnetic field lines to emit energy photons (synchrotron radiation), collide with photons and energy loss (reverse Compton scattering): by charged particle collision avalanche to generate a large amount of charged particles, thereby generate a large current.

(2).

A large current generates a strong magnetic field. The magnetic field lines are concentrated at four places in the circumferential direction of the spaceship, and at two places on the upper side and the lower side of the spaceship to generate curvature of space and generate acceleration. The magnetic field lines are hollow paths so as not to be affected by magnetic pressure, and large currents are also routed not through the electric wire having the usual electrical resistance, but through spaces. Because, charged particles only flow in space.

Concerning Magnetic Flux Break-Reconnection, it is observed in all astronomical phenomena in space, such as solar flares and accretion disks, and the enormous energy stored in the magnetic field is released immediately by the disconnection of magnetic field lines and subsequent recombination. The magnetic field lines are cut and immediately rejoined (recombination). Magnetic field energy is emitted at the time of this recombination. During this time, a large amount of charged particles of electron-positron (electrons and positrons) are generated, and photons are generated as γ -rays by annihilation of electrons and positrons. The fact that the magnetic field lines are broken is a rapid time change of the magnetic field B , and a strong electric field E is generated. In other words, the time change of the magnetic field induces the electric field.

<supplementary explanation>

Using the moving velocity of plasma u , we obtain:

$$E = -u \times B$$

In other words, breaking the magnetic field line causes a rapid time change of the magnetic field to generate an electric field.

The threshold of the voltage potential induced between the space gaps in the vicinity of the magnetic field lines cut by the magnetic field line cutting is about 10^{12} V. The field of virtual particles in the space, which is a vacuum between gaps, becomes unstable and a vacuum breaks down, and these virtual particles (particles and anti-particles) are converted and generated as real particles. The breakdown of the vacuum generates a large number of electron and positron pairs by the avalanche effect.

It is said that electrons and positrons are emitted to the space around 1 million tons per second by this method in the chromospheric layer of the sun.

These charged particles generate more particles by collision with other particles, and while the collision is repeated, more electron and positron pairs are generated by avalanche.

The electron moves upward and the positron moves downward in the plasma black vortex direction. Both currents go to the bottom of the plasma black vortex. That is, the magnetic field by the current toward the bottom of the plasma black vortex becomes larger as it approaches the bottom like a funnel. The magnetic field becomes larger at the bottom of the plasma black vortex, thus the curvature by the magnetic field becomes larger.

At the lower base of the plasma black vortex, gravity transfer is the strongest, and a transition of gravity occurs (possibly that the magnetic field lines converge by the plasma black vortex, the curvature of the space becomes considerably large and strong gravity occurs).

The force F_{mag} exerted by the magnetic field B on the plasma gas is given by

$$F_{mag} = J \times B = \frac{\nabla \times B}{\mu_0} \times B = -\nabla \left(\frac{B^2}{2\mu_0} \right) + \frac{1}{\mu_0} (B \cdot \nabla) B$$

where J is current density.

Here we use the following relation:

$$\nabla \times B = \mu_0 J$$

The first term in F_{mag} equation indicates the gradient force of the magnetic pressure, and the second term indicates the force due to the gradient of the magnetic tension in the direction of the magnetic field line.

Another function of the magnetic field is to convert the energy stored in the magnetic field into particle energy or thermal energy by the process of dissipation.

The induction equation of the magnetic field in the dissipation process is given by

$$\frac{\partial B}{\partial t} = \nabla \times (u \times B) + \eta \nabla^2 B$$

where u is the moving velocity of plasma, η is the magnetic diffusion coefficient, and there is a relation of $\eta = 1/(\sigma\mu_0)$ with the electrical conductivity σ and magnetic permeability μ_0 .

The first term shows the process in which the magnetic field is dragged and amplified by the motion u of the plasma gas, and the second term shows the process in which the magnetic field is dissipated by the resistance η . That is, kinetic energy of the plasma gas is converted to energy of the magnetic field and stored by "freezing of the magnetic field to the plasma gas". Then, the energy stored in the magnetic field is converted into particle energy and thermal energy by the dissipation process. A phenomenon in which stored energy in the form of a magnetic field is released locally in a short time and in large amounts is well known as solar flares.

VIII. CONCLUSION

By using the astrophysical consideration, that is, the principle and its mechanism of the black hole and the accretion disk, the direction of development of the strong magnetic field generation and power source of the space drive propulsion system was clarified.

The magnetic field lines freeze in the plasma and move in conjunction with it. The magnetic field lines converge to one point by narrowing the flow of plasma at any one point in the flow path. By narrowing down the magnetic field lines, the magnetic field is strengthened and the large curvature of the space is generated. It functions as an engine by controlling the flow path of the plasma flow and the route that narrows the diameter of the plasma flow, that is, the flow path of the magnetic field lines frozen in the plasma and the control of the magnetic field line density. The function of the main engine, i.e., Plasma Black Vortex has been clarified. The first is to generate a spiral electromagnetic vortex and draw charged particles into this vortex, and the second is to produce a large amount of charged particles by Magnetic Flux Break-Reconnection.

In the future, further studies including the method of Magnetic Flux Break-Reconnection will be required, but we were able to find the direction as astrophysical field drive propulsion system.

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