Magnetic motor for Space

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Design of a Spacecraft with Electromagnetic Fields Propulsion

The article presents a constructive solution for the design of a spacecraft propelled in space by the electromagnetic fields of the Solar System and the Milky Way Galaxy with acceleration. The necessary current strength along the circuit and the magnitude of the charge on the useful surface of the object are calculated to obtain acceleration of 1g in an arbitrary direction in space. A modified design of the magnetic motor which allows obtaining acceleration of 0.05g in an arbitrary direction in the outer space with an acceptable current strength is presented.

Keywords:

Galaxy's electromagnetic fields; Magnetic levitation; Starship; Lorentz force; Relativistic mass equation; Surface charge distribution

The issue of interstellar flights has been remaining relevant so far given the limited resources, overpopulation of the planet, demographic, sociopolitical and environmental problems on the Earth. This article presents a constructive solution for the creation of a spacecraft moving with acceleration using the electromagnetic fields of the Solar System and the Milky Way Galaxy. Previously, similar constructions were given in the works of Lemeshko A.V. [6] and Gayduk A.N. [7,8]. However, they were not presented in the peer-reviewed scientific journals.

Solution Method

As it is known [4], the Earth has a magnetic field with the induction of $30 \times 10^{-6} T$ (this is an average value, and it differs somewhat in different places on the planet). A magnetic field is also inherent to the Sun: $4000\text{Gs} = 4000 \times 10^{-4}\text{T} = 0.4\text{T}$, the Solar System and the Milky Way Galaxy (the averaged value: $3 \times 10^{-6}\text{Gs} = 3 \times 10^{-10} T$).

This prompts the idea of creating a spacecraft propelled by the magnetic fields of planets/star systems/galaxies.

Let us have a disco-shaped radio model of a starship with a weight of 0.1 kg and a useful circuit diameter of 0.1 m.

We will arrange the conductor with the current along the circuit [*Fig. 1*]:

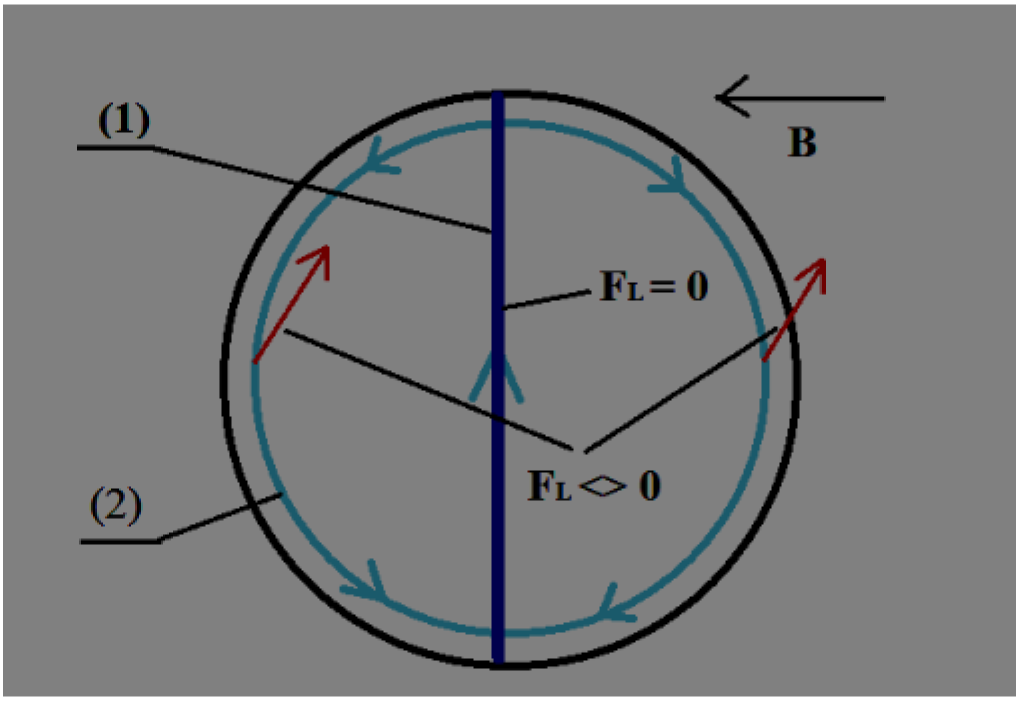

Fig. 1.

In *Fig. 1*:

B – the magnetic field vector, F_L – the Lorentz force, (1) – the part of the current-carrying conductor covered with a ferromagnetic material, (2) – the current-carrying conductor.

Thus, we get the Lorentz force directed upwards, which will allow our spaceship at a certain current strength to levitate in the Earth's magnetic field/move in the outer space.

By rotating the circuit in Fig. 1 in the plane perpendicular to the magnetic field vector B, we will obtain an arbitrary acceleration vector, but only in the plane perpendicular to the magnetic field vector B. Nevertheless, acceleration will not be obtained in the other two coordinate planes.

Let us calculate the minimum necessary current strength for levitation in the Earth's magnetic field.

Lorentz force [1]: $F_L = \mathrm{B} \times I \times \mathrm{L} = \mathrm{B} \times I \times \pi \times \mathrm{D} = \mathrm{m} \times g$ - Newton's force (gravity)

From here it follows that: $\mathrm{I} = \frac{m \times g}{B \times \pi \times D} = \frac{0.1 \times 10}{30 \times 10^{-6} \times 3.1415 \times 0.1} = 10^5 [A]$.

For vertical acceleration of $1g$, the current strength shall comprise $2 \times 10^5 A$ accordingly.

In one day, with the given current strength and with a uniform acceleration of $1g$ at zero initial speed, we will get the spacecraft speed equal to:

$V_1 = V_0 + a \times t = 0 + 10 m/s^2 \times 60 s \times 60 \times 24 = 864 [km/s]$.

Let us carry out the same calculations for the magnetic field outside the Solar System (given the magnetic field of the Galaxy and the averaged induction of $3 \times 10^{-10} T$).

In this case, Newton's force (gravity) of the Galaxy is conditionally taken equal to zero, which is not so in the general case.

Then, the achievement of the uniform acceleration of $1g$ requires the following current strength along the circuit:

$I = \frac{10^5 \times 30 \times 10^{-6}}{3 \times 10^{-10}} = 10^6 \times 10^4 = 10^{10} [A]$ or 10 billion amperes.

We can get such a current strength, for example, by taking 100 thousand parallel conductors $10^5 A$ each. In outer space, it is possible to use superconductors.

At zero initial speed, the speed of such a spaceship will be the same in a day: $864\, km/s$, and after half of the Earth's year: $864 km/s \times 183 = 158{,}112\, km/s$ or roughly half the speed of light. At this speed, the weight of the astronaut in the spaceship will be [3]:

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}},$$

or about 1.15 of the weight on Earth. That is, a man with a weight of 75 kg on Earth will have a weight of 86 kg in a ship, which is generally acceptable.

Thus, taking six months to accelerate to 0.5 of the speed of light and half a year to slow down, the one-way trip to Proxima Centauri will take around 9 years.

The task of moving in any direction in

R^3 remains unresolved, since, as we know, the Lorentz force is strictly perpendicular to the magnetic flux lines.
The magnetization of the spaceship's shell (the maintenance of a '+' and '-' potential on its surface) and the addition of magnetic field sources to it does not solve the problem of movement in an arbitrary direction in

R^3 due to the violation of Newton's 3rd law of motion.
On the other hand, the creation of potential ('+' and '-' /free electrons/) on the surface of a spaceship may make it possible to obtain acceleration in the electric field of the Galaxy. This field has been studied extremely poorly. However, according to the measurements that were carried out within our Solar System, its strength varies from unities to several thousand microvolts per meter [5]. Consequently, the construction in Fig. 2 will allow us to get acceleration in the direction of the electrostatic lines of force in the area of increasing potential (free electrons on the surface) or in the opposite direction (positive charge on the surface [*Fig.* 2]):

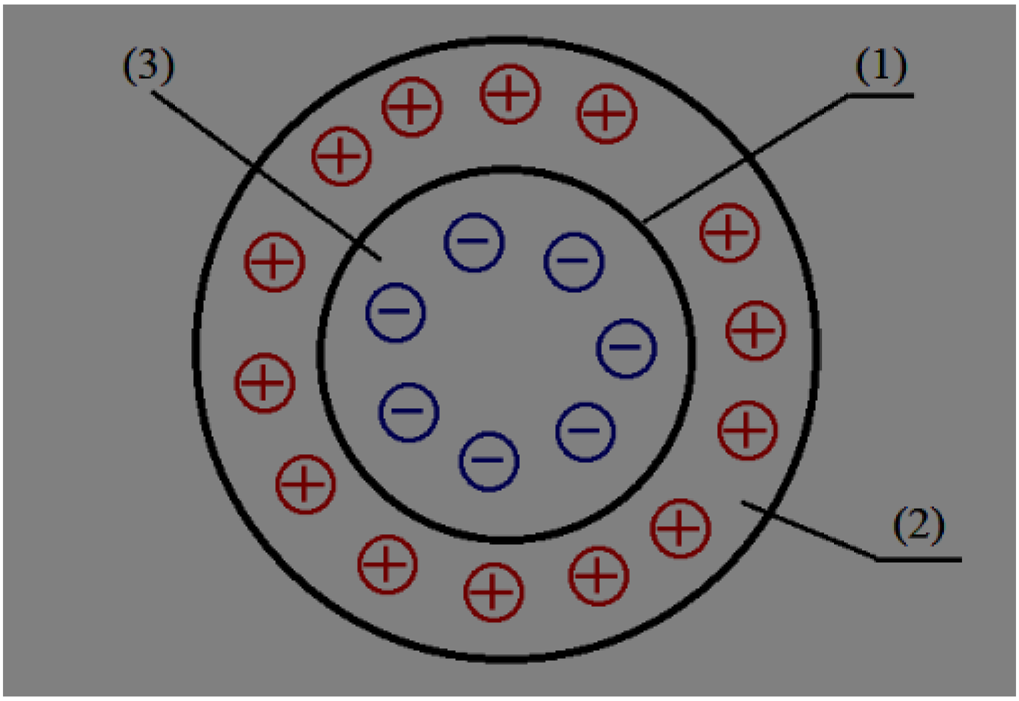

Fig. 2

In *Fig.2*:

(1) – a dielectric, (2) – a positive charge on the surface, which interacts with an electric field, (3) – a negative charge, which does not interact with an electric field thanks to a shield made of a dielectric material.

The acceleration, in this case, will be equal to [2]:

$a=q \times \frac{E}{m}$, where q – the total charge on the surface, m – the weight of the spaceship, E – the electric field strength (for example, it may be equal to $5 \times 10^{-6}\ V/m$). Thus, to obtain the required acceleration of 1g in our test model of a spaceship weighing 0.1 kg, the mandatory total charge on the surface shall be equal to $q=m \times \frac{a}{E} = 0.1 \times \frac{10}{5\times10^{-6}} = 2 \times 10^{5}$ coulombs.

When we combine the designs in *Fig. 1* and *Fig. 2* in a single model, we will obtain a starship flying in the outer space with an acceleration of 1g in an arbitrary direction (with the exception of those points in space where the electric field lines are strictly perpendicular to the magnetic field vector) in R^3 propelled by the electromagnetic fields of the Galaxy.

We may use an atomic power plant with a converter of atomic energy into electrical energy as a generator producing the energy necessary to maintain the current of the required strength in the engine in *Fig. 1* and the required charge in the engine in *Fig. 2*.

Let us consider the design in Fig. 1. A similar design can be replaced with a solenoid, where each coil of the spiral will be of the following shape:

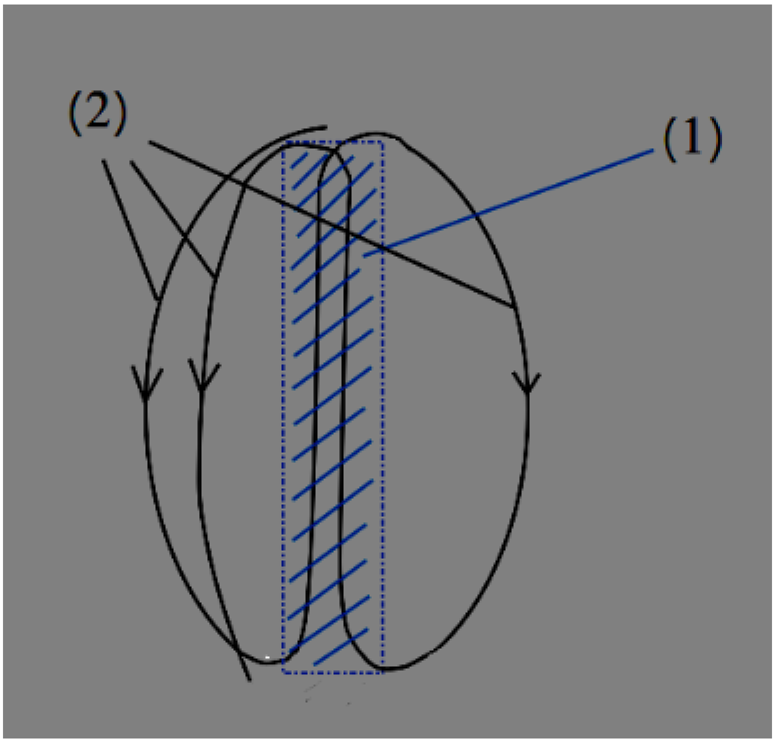

Fig.3.

In Fig. 3: (1) – the part of the current-carrying conductor covered with a ferromagnetic material, (2) – the current-carrying conductor. Then the Lorentz force acting on such a solenoid will be calculated by the formula:

$$F_L = B * I * \pi * D * N$$

, where N is the number of turns of the spiral.

It can be seen from [9] that a 1-meter long solenoid may contain 400 turns of wire. Let us consider the bottom of a spacecraft with a diameter of 3.5-4 meters. 12 solenoids with a diameter of 1 meter and a length of 1 meter may be installed there. Then, to ensure the acceleration of 1g in the Earth's magnetosphere and considering the weight of the entire spacecraft of 1000 kg, the current strength in the wires shall be equal to:

$$I = \frac{m * g}{B * \pi * D * N * 12} = 20800 [amperes]$$

This current strength may actually be obtained and maintained in the engine for a long time.

In this case, the weight of the wires alone from the same table [9] will be slightly less than 490 kilograms. This means that more than 500 kilograms will remain for the construction of the spacecraft and the payload.

Now let us calculate the necessary charge on the surface for levitation in the electric field of the Earth (vertical acceleration of 1g, which will compensate for the force of attraction). As it is known from [10], the charge of the Earth is:

$$6.6*10^5 C$$

Then according to the Coulomb law, we will get the necessary charge on the surface:

$$q=\frac{m*g*R^2}{k*Q}=70C$$

In this formula, g is the force of gravity, R is the radius of the Earth in meters, k is a coefficient equal to:

$$9*10^9 \frac{N*m^2}{C^2}$$

, Q is the charge of the Earth, m is the weight of the apparatus.

It should also be noted that in the engine of a moving object with a non-zero charge, the Lorentz force arises in addition to the declared Coulomb force, and it acts on a moving charged particle in a magnetic field. Therefore, when recalculating the velocity vector in our electromagnetic engine, three forces should be taken into account at once: the Lorentz force of the current-carrying conductor, the Lorentz force of the charged particle, and the Coulomb force.

It is known that the flight of an aircraft from New York to Sydney takes an average of 21-22 hours. When we take a flight vehicle of the proposed design and consider halfway on the acceleration of 1g and halfway on slowing down, it is easy to calculate that the path between New York and Sydney will take a little more than an hour at a maximum speed in the middle of the trip of 17.8 km/s.

Let us consider a similar ship but in the outer space. As we know, the electromagnetic fields there are much weaker than on Earth. The magnetic field induction is:

$$3*10^{-10}\,T$$

Let us consider the design in Fig. 4:

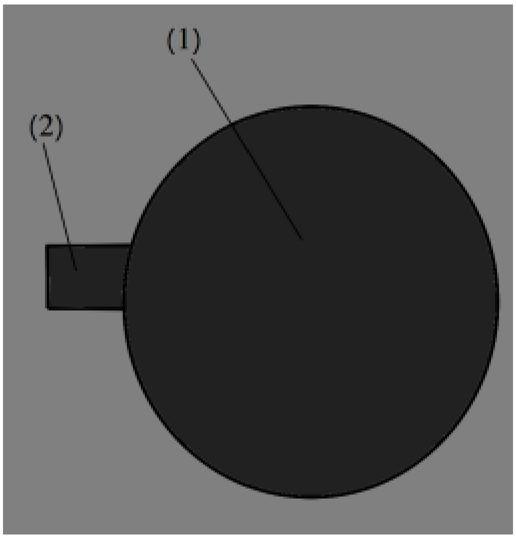

Fig.4.

In this figure, (1) is the compartment for engines generating the Lorentz force, (2) is the living compartment. Let the diameter (1) be 30 meters, the weight will comprise 50 tons, the weight (2) together with the payload will be 50 tons. Let us take the solenoid in *Fig. 3*, which is 1 meter long and 1 meter in diameter. The lightest conductors used in aircraft construction have a weight of 3 kg per kilometer of length.

Then we get the fact that the part (1) may possibly contain at least 15*15*2*15 = 6750 of such solenoids of 400 turns each. The minimum estimate of their total weight will be 6750*1*3.14*400*3/1000 = 25 tons. The remaining 25 tons will be reserved for the structure itself and the auxiliary elements.

The necessary current strength in the wires of the solenoid should be:

$$I=\frac{m*g}{B*\pi*D*N*6750}\,amperes$$

$$I = \frac{100*1000*10}{3*10^{-10}*3.14*1*400*6750}\ amperes$$

$$I = 40*10^{7}\ amperes$$

The maximum current strength obtained in the laboratory under conditions of superconductivity:

$$10^{7}\ amperes$$

This means that if it is possible to increase this result by a factor of one and a half and achieve structural integrity under the influence of high temperatures for a long time or reduce the weight of the engine by a factor of one and a half, it will be possible to create a similar magnetic engine for space.

Or, on the contrary, we may consider a section of wire 1 meter long and weighing 0.003 kg. Then at the current strength of:

$$10^{7}\ amperes$$

, the resulting acceleration of the current-carrying conductor itself in space will be equal to:

$$a = \frac{I*B*L}{m}\frac{m}{sec^{2}} = \frac{10^{7}*3*10^{-10}*1}{0.003}\frac{m}{sec^{2}} = 0.1\,g$$

If we add here a payload of 0.003 kg, then the total acceleration of the object with such parameters will be equal to:

$$0.05\,g$$

This suggests that with the correct design of the ship, we may get significant acceleration in the outer space.

For example, it is easy to calculate that with the acceleration of:

$$0.05\,g$$

the trip to Mars will take slightly over 7 days, and it will take 18 years to get to Proxima Centauri.

As we know, any galaxy has a magnetic field. It is inherent to the Milky Way Galaxy and the Andromeda Nebula, which is 2.5 million light-years away and has the size of 220 thousand light-years. Given that the diameter of the Earth is 12,742 kilometers, and the distance from the center of the planet to the boundaries of its magnetosphere is 70,000 kilometers, it can be assumed that the magnetic field of the Andromeda Nebula reaches the cosmic area where the Earth is located. This means that the magnetic field vector of the outer space, which is discussed above, is the result of a superposition of the magnetic field vectors of the Andromeda Nebula and the Milky Way Galaxy. Therefore, with a certain design of the screen from a Ferromagnetic material, we can get the Lorentz force separately for each of these two vectors.

Let us consider the following design:

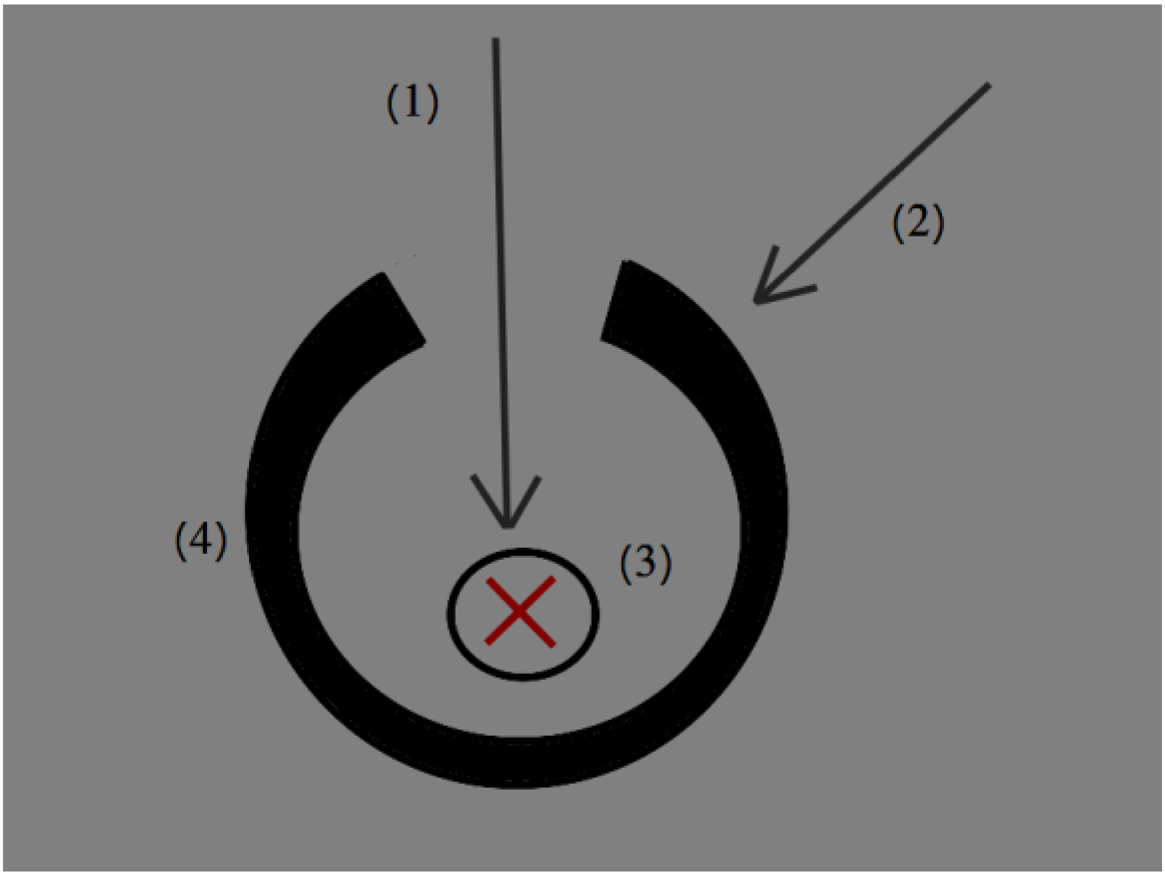

Fig.5.

In *Fig. 5:* (1) – the magnetic field of the Milky Way Galaxy with induction B_1 (interacts with the current-carrying conductor), (2) – the magnetic field of the

Andromeda Nebula B_2 (does not interact with the current-carrying conductor), (3) – the current-carrying conductor, (4) – the screen from the Ferromagnetic material.

Then the Lorentz force of the magnetic field (1) in this case is not equal to zero: $F_{L1} \neq 0$, and the Lorentz force of the magnetic field (2) is equal to zero: $F_{L2} = 0$.

Then obviously it is possible to design different positions of current-carrying conductors and holes of a ferromagnetic material separately for B_1 and for B_2 in order to obtain sets of Lorentz force vectors F_{L1} and F_{L2} in the two non-collinear planes with different values of the vectors in absolute value.

Then the sets of vector sums of vectors from the sets F_{L1} and F_{L2} will cover the entire multitude of directions, which will solve the problem of acceleration of 0.05 g in any direction in R^3 in space.

Similar considerations may be used with respect to other galaxies adjacent to the Milky Way Galaxy, for example, the Large and Small Magellanic Clouds, which will allow us to obtain more than two non-collinear planes with different values of the vectors in absolute value. A complete list of nearby galaxies is given in [11].

In addition, it should be noted that this technology may be used for the delivery of payloads to orbit. As it is known, the lines of the Earth's magnetic field in the Equator region are parallel to the Earth's surface, which means that the area of action of the Lorentz force vector is orthogonal to this surface in the Equator region. Thus, when we build a cosmodrome at the Equator, we can select the position of the solenoids at which the Lorentz force will be strictly perpendicular to the Earth's surface. Then, if we take into account the above reasoning and the fact that the indicator of the Earth's magnetic field induction is greater by a factor of 5 than that of the magnetic field in space, we can obviously propose a design of a spaceship, in which the vertical acceleration will be 0.05 g * 100 000/1000 - g = 4g with a current strength of 10 thousand amperes, or the vertical acceleration of 1g at a current strength of 4 thousand amperes, which is more optimal for the well-being of astronauts.

Conclusions

This article proposes a method of designing a spacecraft with propulsion based on the electromagnetic fields of the Galaxy, which, according to the author, will allow at a certain current value and a certain engine design to achieve speeds sufficient for interstellar flights in an acceptable time. A special issue is the practicability of such flights with the crew on board, given their duration and the difficulties associated with them.

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