Magnetic Aerospace Engine (full version)

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Abstract

We present a design solution for the construction of a spacecraft propelled by the electromagnetic fields of the Solar System and the Galaxy with acceleration. The calculation of the required circuit current and the amount of charge on the useful surface of the object to obtain an acceleration of 1g in an arbitrary direction in space was carried out. A modified magnetic engine design to produce an acceleration of 0.05 g in an arbitrary direction in open space at an acceptable amperage is presented.

Keywords

Galactic electromagnetic fields; Magnetic levitation; Starship; Lorentz force; Relativistic mass equation; Surface charge redistribution

The issue of interstellar travel remains relevant given the limited resources on Earth, the planet's overpopulation and the demographic, socio-political and environmental problems on the planet. This article presents a design solution for a spacecraft propelled by the electromagnetic fields of the Solar System and the Galaxy with acceleration. Previously, such constructions were cited in the works by Lemeshko A.V.[6], Gaiduk A. N.[7,8], have not been submitted to peer-reviewed scientific journals.

Solution method

As we know [4], the Earth has a magnetic field with induction $30 \times 10^{-6} T$ (this is an average value, it differs slightly in different places on the planet). The Sun also has a magnetic field: the $4000 Gs = 4000 \times 10^{-4} T = 0.4 T$ Solar system and the Galaxy (averaged value: $3 \times 10^{-6} Gs = 3 \times 10^{-10} T$).

An idea of creating a spacecraft that relies on the magnetic fields of planets/stellar systems/galaxies appears.

Suppose we have a disc-shaped radio model of a starship with a weight of 0.1kg and an effective circuit diameter of 0.1m.

Let's arrange the current-carrying conductor along the circuit [*Fig. 1*]:

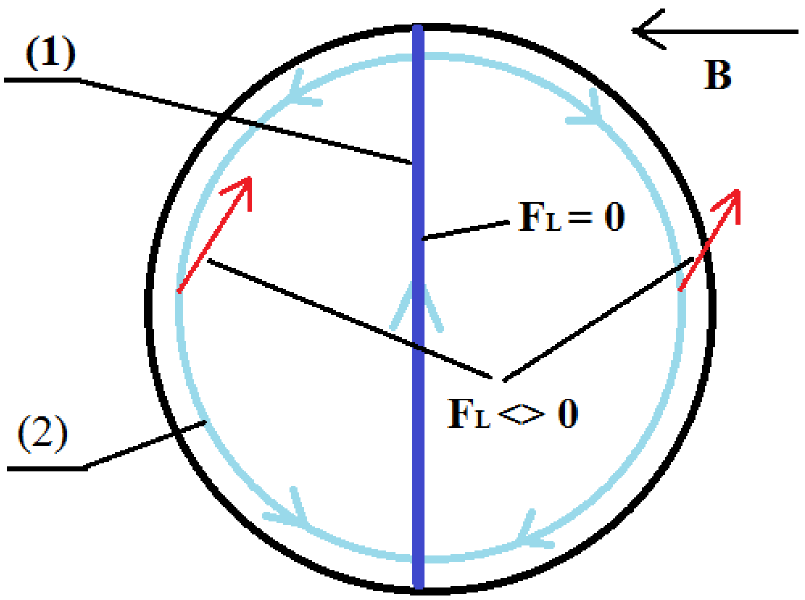

Fig. 1.

In *Fig. 1*: B- magnetic field vector, F_L - Lorentz force, (1) - current-carrying conductor section with a ferromagnet, (2) - current-carrying conductor.

In this way, we get the Lorentz force directed 'upwards', which at a certain amperage will allow our spacecraft to levitate in the Earth's magnetic field/move in outer space.

By rotating the circuit from Fig. 1 in the plane perpendicular to the magnetic induction vector B, it is possible to obtain an arbitrary acceleration vector, but only in the plane perpendicular to the magnetic induction vector B. No acceleration can be obtained in the other two coordinate planes.

We calculate the minimum required amperage for levitation in the Earth's magnetic field.

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

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

For vertical acceleration of $1g$, respectively, the amperage must be $2 \times 10^5 A$. With this amperage and uniform acceleration of $1g$, after one day, at zero initial velocity, we get the speed of the spaceshift equal to:

$$V_1 = V_0 + a \times t = 0 + 10\frac{m}{s^2} \times 60s \times 60 \times 24 = 864\left[\frac{km}{s}\right]$$

We perform the same calculations for the magnetic field outside the Solar system (the Galactic magnetic field and the averaged value of induction $3 \times 10^{-6}Gs = 3 \times 10^{-10}T$).

The Galactic Newton force (gravitational force) in this case is assumed to be zero, which is not the case in general.

Then, in order to achieve a uniform acceleration of $1g$, the following circuit current is required: $I = \frac{10^5 \times 30 \times 10^{-6}}{3 \times 10^{-10}} = 10^{10}[A]$

or 10 billion A.

It is possible to obtain such amperage, for example, by taking 100,000 parallel conductors of $10^5[A]$. In open space superconductors can be used.

At zero initial speed, the speed of such a spacecraft will still be the same after a day: $864\frac{km}{s}$, and after a half a terrestrial year: $864 \times 183\frac{km}{s} = 158112\frac{km}{s}$ or roughly half the speed of light.

At this speed, the weight of the astronaut in the spacecraft will be equal to [3]:

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

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

Thus, setting a period of six months for acceleration to 0.5 speed of light and six months for deceleration, a one-way trip to Centauri Proxima would take around 9 years.

The problem of motion in an arbitrary direction is still unresolved R^3 since, as we know, the Lorentz force is strictly perpendicular to magnetic field lines.

Magnetising the ship's shell (creating a '+' and '-' potential on its surface) and adding sources of magnetic fields to it does not solve the problem of an arbitrary direction R^3 due to the violation of Newton's third law.

On the other hand, a potential ('+' and '-'/free electrons/) on the surface of the spacecraft could allow for acceleration in the Galactic electric field. This field has been investigated very little, but according to measurements made within our Solar System, its strength ranges from only a few to several thousand microvolts per metre[5]. Thus, the structure in Fig. 2 will allow an acceleration in the direction of electric field lines towards the area of increasing potential (free electrons on the surface) or in the opposite direction (positive charge on the surface [*Fig. 2.*]):

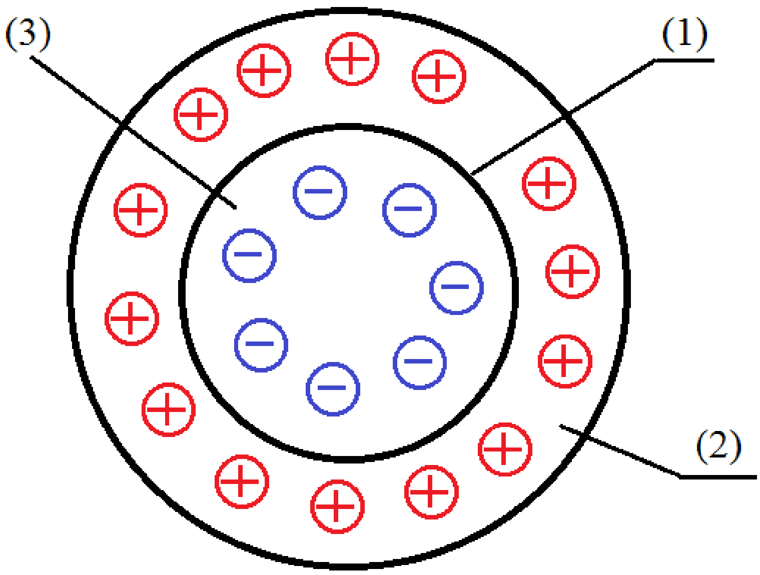

Fig. 2

In *Fig. 2*:

(1) is dielectric, (2) is positive charge on the surface, interacts with the electric field, (3) isnegative charge, does not interact with the electric field due to the dielectric shield.

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

$$a = \frac{q \times E}{m}$$

where *q* is the total charge on the surface, *m* is the weight of the spacecraft, and *E* is the electric field strength (for example, equal to $5 \times 10^{-6} \frac{V}{m}$). Thus, to obtain the required 1g acceleration, our 0.1kg spacecraft test model will require a total charge on the surface: $q = \frac{m \times a}{E} = \frac{0.1 \times 10}{5 \times 10^{-6}} = 2 \times 10^5$ C.

Combining Fig. 1 and Fig. 2 we get a spacecraft flying in space with 1g acceleration in any direction (except for the points of space where electric field lines are strictly perpendicular to the magnetic field induction vector) in R^3 supported by Galactic electromagnetic fields.

Let us consider the structure in Fig. 1. Such a structure can be replaced by a solenoid, where each coil will be as follows:

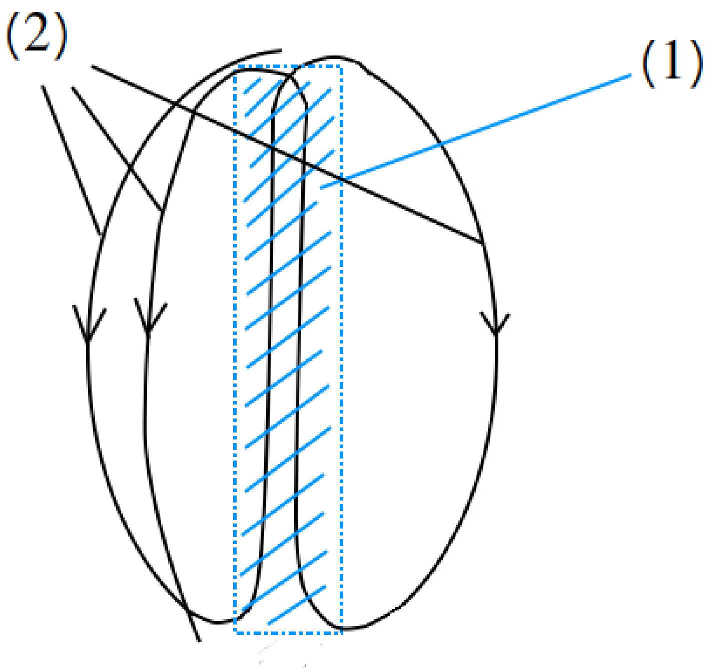

Fig. 3.

In Fig. 3: (1) is current-carrying conductor section with a ferromagnet, (2) is current-carrying conductor. In this case, the Lorentz force acting on such a solenoid will be calculated by the formula:

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

, where N is the coil-turn number.

It can be seen from [9] that 1 m long solenoid can contain 400 turns of wire. Let us consider the aircraft's bottom with a diameter of 3.5-4 meters. It can fit 12 solenoids with a diameter of 1 meter and a length of 1 meter. Then to provide an acceleration of 1g in the Earth's magnetosphere, assuming the weight of the entire vehicle to be 1000 kg, the required amperage in the wires must be:

$$I = \frac{m \times g}{B \times \pi \times D \times N \times 12}[A] = \frac{10^4}{30 \times 10^{-6} \times 3.14 \times 1 \times 400 \times 12}[A] = 20800[A]$$

This amperage can be obtained and maintained in the engine for a long time.

At the same time, the weight of the wires themselves in the same Table [9] will be slightly less than 490 kilograms. This leaves more than 500 kilograms for the aircraft's structure and payload.

Now let us calculate the necessary charge on the surface required for levitation in the Earth's electric field (vertical acceleration of 1g, which will compensate for the gravity force). According to [10], the terrestrial charge is equal to:

$$6.6 \times 10^5 [C]$$

While according to Coulomb's law we get the necessary charge on the surface:

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

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

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

, Q is the terrestrial charge, m is the aircraft's weight.

A helium compartment can be used in the design of the aircraft, in order to reduce this value.

It should also be noted that when an object with a non-zero engine charge is moving, in addition to the declared Coulomb force, Lorentz force acting on a moving charged particle in a magnetic field will also occur. Therefore, when recalculating the velocity vector in our electromagnetic engine, three forces must be considered at once: Lorentz force of the current-carrying conductor, Lorentz force of the charged particle and Coulomb force.

It is known that it takes an average of 21-22 hours to fly by airliner from New York to Sydney. By taking the aircraft of the proposed design and assuming half a path for 1g acceleration, and half a path for deceleration, it is easy to calculate that the journey from New York to Sydney would take just over an hour at a top speed of 17.8 km/sec in the middle of the journey.

Let us consider a similar craft, but in outer space. Electromagnetic fields are known to be much weaker there than on Earth. The magnetic field induction is:

$$3 \times 10^{-6} Gs = 3 \times 10^{-10} T$$

Let us consider the design of the spacecraft in Fig. 4:

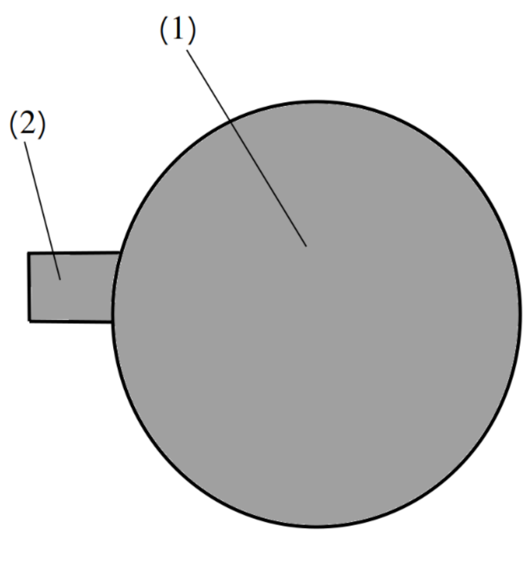

Fig. 4.

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

Then in (1) we can place at least $15 \times 15 \times 2 \times 15 = 6750$ such solenoids of 400 turns each. The lower estimate of their total weight will be $\frac{6750 \times 1 \times 3.14 \times 400 \times 3}{1000} = 25$ tons. The remaining 25 tons will be for the structure itself, and for auxiliary elements.

The required amperage in the solenoid wires must be as follows:

$$I = \frac{m \times g}{B \times \pi \times D \times N \times 6750}[A] = \frac{100 \times 1000 \times 10}{3 \times 10^{-10} \times 3.14 \times 1 \times 400 \times 6750}[A] = 40 \times 10^{7}[A]$$

Maximum amperage obtained in the laboratory under superconductivity conditions:

$$10^{7}[A]$$

This means that if this value can be increased by one and a half orders of magnitude, and the design can be maintained at high temperatures for long periods, or the weight of the engine can be reduced by one and a half orders of magnitude, a similar magnetic engine could be created for space.

Or, on the contrary, let us consider a section of wire with a length of 1 meter and a weight of 0.003 kg. Then at an amperage of:

$$10^{7}[A]$$

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

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

If a payload of 0.003 kg is added, the total acceleration of an object with these parameters will be equal to:

$$a = \frac{I \times B \times L}{m}\frac{m}{s^2} = \frac{10^{7} \times 3 \times 10^{-10} \times 1}{0.006}\frac{m}{s^2} = 0.5\frac{m}{s^2} = 0.05g$$

This indicates that, with the correct spacecraft design, it is possible to gain significant acceleration in open space.

For example, it is not difficult to calculate that with acceleration of:

$$0.05g$$

the journey to Mars will take just over 7 days, and to Centauri Proxima - 18 years.

All the galaxies are known to have a magnetic field. The Milky Way has it, as well as the Andromeda Nebula, which is 2.5 million light years away from the Earth, and the size of 220,000 light years. Considering the fact that, say, the diameter of the Earth is 12742 kilometres and the distance from the centre of the planet to the limits of its magnetosphere is 70000 kilometres, it can be assumed that the magnetic field of the Andromeda Nebula reaches the neighbourhood of space where the Earth is located as well. This means that the above discussed induction vector of the magnetic field of outer space is the result of a superposition of the induction vectors of the magnetic fields of the Andromeda and Milky Way nebulae. And, therefore, using a particular ferromagnetic screen design, it is possible to obtain the Lorentz force separately for each of these two vectors.

Let us consider the following design:

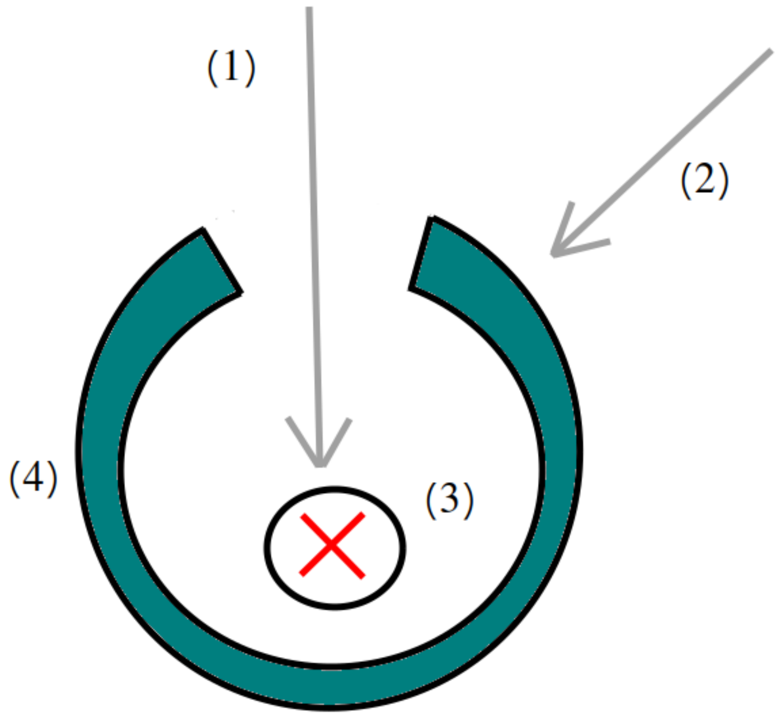

Fig.5

In *Fig. 5:* (1) is the magnetic field of the Milky Way with induction B_1 (interacts with the current-carrying conductor), (2) is the magnetic field of the Andromeda Nebula B_2 (does not interact with the current-carrying conductor), (3) is the current-carrying conductor, (4) is the ferromagnet screen.

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

Then it is obviously possible to choose different positions of current-carrying conductors and holes in the ferromagnetic separately for B_1 and separately for B_2, in order to obtain sets F_{L1} and F_{L2} of Lorentz force vectors with different modulo values in two unparalleled planes.

Then the resultants of vectors from the sets F_{L1} and F_{L2} will cover the entire space of directions, which will solve the problem of obtaining an acceleration of 0.05 g in an arbitrary direction in R^3 in outer space.

Similar considerations can be made for other galaxies close to the Milky Way, for example, the Large and Small Magellanic Clouds, which will allow us to obtain more than two unparalleled planes with different values of vectors in modulus. For a complete list of nearby galaxies, see [11].

As well, given that the induction of the Sun's magnetic field near the Earth is 15-25 nT, levitation in the superposition of the Sun's and Earth's magnetic fields can similarly be achieved by shielding. That said, it is not difficult to calculate that the peak current in the solenoids will slightly exceed $\frac{10^7 \times 1g \times 3 \times 10^{-10}}{0.05g \times 2.5 \times 10^{-8}} = 2.4 \times 10^6$ Amperes, it can be very simply achieved under superconductivity conditions. In this case levitation in the Earth's electric field can be avoided and the entire levitation process will be based only on magnetic levitation in the magnetic fields of the Earth and the Sun with the generation of Ampere force in solenoids.

In addition, it should be noted that this technology can be used for placing cargo into orbit. The Earth's magnetic field lines are known to run parallel to the Earth's surface at the equator, which means that the area of the Lorentz force vector will be orthogonal to this surface at the equator. Therefore, if a spaceport is built at the equator, it is possible to find a position for the solenoids at which the Lorentz force will be strictly perpendicular to the Earth's surface. Thus, according to the arguments suggested above and considering that the value of induction of Earth's magnetic field is 5 orders of magnitude greater than the analogous value in outer space, we can obviously propose a spacecraft design in which the vertical acceleration at amperage of 10 thousand amperes would be $\frac{0.05g \times 100000}{1000} - g = 4g$, or vertical acceleration of 1g at amperage of 4 thousand amperes, which is more appropriate for the well-being of astronauts.

In order to select the engine configuration (the orientation of the solenoids in space, their amperage and the position of the ferromagnetic shields and holes in them as shown in Fig. 5) at each point in space, a test sensor can be created with a set of all possible configurations of ferromagnetic holes on the sphere and of the solenoids inside them. By measuring the direction indicators and the value of the Lorentz force for each of these solenoids, the overall engine configuration can be selected and this configuration can be recalculated at each point of movement.

It should also be noted that this idea can be used for the practical implementation of Tsiolkovsky's idea of a space elevator. Let us consider such an elevator with a length of 1000 kilometers. Instead of the idea of centrifugal force, the idea of supporting the entire structure by Lorentz force can be taken as the basis for its construction. Let us consider such an elevator at the equator. As previously shown, it is possible to select the position of the solenoids in such a way that the Lorentz force will be directed vertically upwards. Let us consider 1 linear meter of the length of the structure. Let its weight be 10 kg, the total length of the solenoid wires in the walls of the elevator within the linear meter will be $L = 1000$, their weight will be 3 kg. Then the remaining 7kg will be for the structure itself. Then the Lorentz force required to compensate for 1 linear metre of gravity of this section will be: $F = mg = 100N$. While the required amperage in the wires will be:

$$I = \frac{F}{L \times B} = \frac{100}{1000 \times 3 \times 10^{-5}} [A] = 3333[A]$$

. Which is more than realistic to implement in practice.

Another conclusion to the article is that the technology proposed here can be used not only for flying saucers or balloon-shaped ships, but also for aircrafts of arbitrary shapes, including asymmetric ones. With the present level of computer technology it is possible to select the relative position and orientation of the solenoids, as well as the amperage in them, in such a way that the aircraft is balanced. The aircraft's symmetrical shape, on the other hand, makes it easier to balance in the electromagnetic fields of celestial bodies.

It should be noted that similar calculations are valid for other planets in the Solar system. Thus, the magnetic field strength of Mars is 500 times weaker than that of Earth and is equal to 6×10^{-8} The gravitational force is $0.38g$. This means that levitation on Mars is also possible in its magnetic field with an amperage of 3-4 million A, which is possible under superconductivity conditions. At the same time, it is also possible to place cargo into orbit at the magnetic equator of this planet at amperage of $\frac{4000 \times 500 \times 0.76}{2} [A] = 760000[A]$. . Moreover, it is also possible to create a Martian equatorial space elevator with current in the wires $3333 \times 0.38 \times 500[A] = 633270[A]$

, which can also be achieved under superconducting conditions.

The spacecraft described in this article can be schematically represented as shown in Fig. 6:

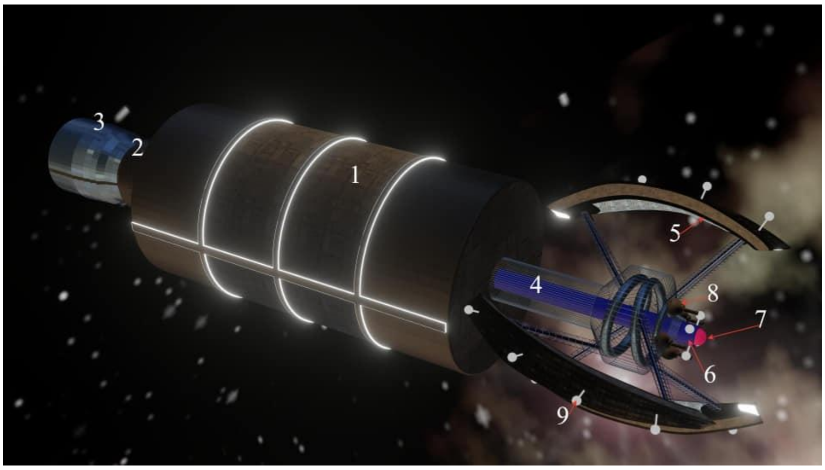

Fig.6

Fig. 6: 1. Engine compartment. The diameter is 500 meters, the length is 1 kilometer. Contents: solenoid engines with Fig. 5 The weight of the entire compartment is 10 million tons. It is the mover of the spacecraft, not 3. 2. Converter of atomic energy into electrical energy. 3. Compartment with a nuclear reactor and nuclear fuel. The weight is 1 million tons. 4. Bridge between the habitation compartment and the engine compartment. 5. Habitation compartment. The Diameter is 500 meters, the length is 300 meters. It is a centrifuge rotating around an axis. Due to this, gravity is generated. It is designed for 10 thousand crew members and passengers. The weight is 1 million tons. 6 . - Captain's bridge. The central computer is located here. The length is 50 meters. The diameter is 50 meters. The weight is 100 thousand tons. 7. Laser sensor is located at the front of the spacecraft on the captain's bridge. It is necessary for identification of obstacles on the way of the spacecraft. If an asteroid is detected at x distance in front of the spacecraft, then, given that the laser signal runs at the speed of light, it is easy to calculate that at half light speed the spacecraft will have x/3 of range left to manoeuvre. 8. Laser gun - for removing small-sized obstacles found. For all other obstacles the course will have to be changed. 9. Local magnetic field generators for the protection of astronauts from cosmic radiation.

Conclusions

In this article, we propose a method for constructing a spacecraft based on the electromagnetic fields of the Galaxy, which, according to the author, will allow for a certain amperage and a certain design of the engine to achieve speeds sufficient for interstellar flights in an acceptable time. The question of the expediency of such flights with a crew on board, given their duration and the difficulties associated with it, stands out.

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