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A Method for Transmitting Spacecrafts in Space with Velocity of at Least 0.01 of the Light Speed Using Materials with Very High Kinetic Energy in High Electric Fields

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Abstract: Many space new missions are on calendar this decade for Moon, Mars and other planets. Some of these missions are depending on simple reliable chemical thrusters and others on the nonchemical advanced propulsion techniques. In most of nonchemical techniques a nuclear source of energy is necessary as in nuclear electric rockets where the maximum velocity produced is around 20 km/s. Despite of being faster than the chemical propulsion method; the nuclear rocket has to spend one month with full burning capacity to reach Mars at its closest point to earth and years to reach the other planets. The long time consumed in these journeys is still a challenge and we are still in need for faster methods to travel in space. On finding these methods; a new horizon will be opened beyond space exploration and a new era will begin. The traditional thoughts are about how machines and engines go the distance in shorter time with different types of energies, but what if we found an object that can travel in space naturally with a great velocity? If so, we can let that object deliver the spacecraft to its destination with the same great velocity. This object must be having a mass and its velocity should not exceed the speed of light according to the general relativity. There is nothing better than the electron beam which is also known as the cathode ray to be that object as the electron has a dual nature and behaves as a particle and a wave. This is a fundamental research showing a theoretical simulation using the electron beam to transmit a spacecraft in space with a velocity of 0.01 of light speed. This simulation aims to find out the basic physical principles needed to make this possible, and then these principles will be applied on other negatively charged solid materials with better characters which are more suitable for industrial purposes.

Keywords: Aerospace Engineering, Spacecraft Propulsion, Electromagnetic Force, Classical Physics, Electron Beam

Introduction

Space Exploration

Since the launching of the first artificial satellite in 1957, man has started to explore space by travelling to Moon, orbiting instruments to discover galaxies, sending probes to other planets and landing rovers on moon and Mars. Space exploration gives us a chance to prove or disprove many scientific theories about life on earth and possibilities of life on other planets.

Many new missions are on calendar this decade for further exploration and the main controlling factor in these missions is time; how much time for the spacecraft to reach, how much time to come back and how long it will stay there. The longer the trip is the higher the cost will be.

The Known Velocities

As the time consumed in these missions depends on the speed of the spacecraft, there are several methods of programmatic spacecraft propulsion have been used for acceleration. The most common method is the chemical propulsion which is in use today where it produces thrust by creating hot gases through a chemical reaction. Although widely used, the chemical propulsion technique doesn’t provide high velocities compared to other techniques.

Table 1: Time needed to reach the other planets using the high speed nuclear rocket with nonchemical propulsion method where velocity = 20 km/s

Planet	Closest distance to Earth (Km)	Duration needed by nuclear electric rocket (days)
Mars	54.6 M (Dobrijevic, 2022)	31.5
Jupiter	588 M (Tillman, 2017)	340.0
Saturn	1.2 B (Tillman, 2012)	694.0

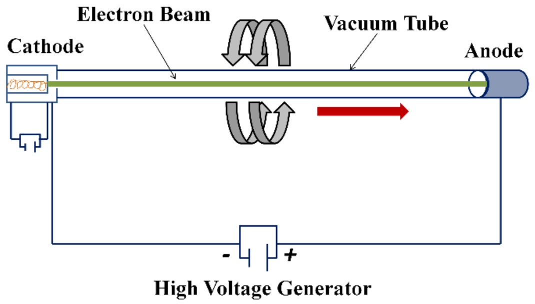


Fig. 1: Direction of the magnetic field of the electron beam. The horizontal red arrow shows the direction of the current while the circular grey arrows show the direction of the field

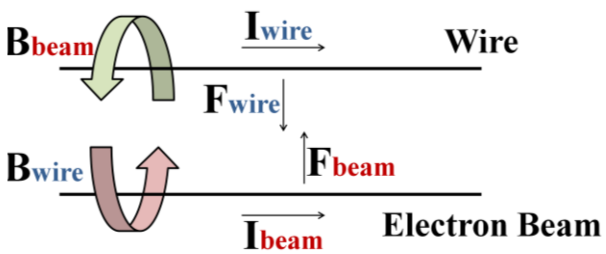


Fig. 2: The attraction force between the electron beam and a parallel wire carrying current in the same direction. I = current (ampere), F = Force of attraction (newton), B = magnetic field produced from the current (tesla)

Another method which may guarantee faster trips is the nonchemical propulsion where it uses electrostatic or electromagnetic force to accelerate the reaction mass directly. In some missions using this method the nuclear energy is necessary as in nuclear electric rockets where the maximum velocity produced is around 20 km/s. Despite of being faster than the chemical propulsion method, the nuclear rocket has to spend one month with full burning capacity to reach Mars at its closest point to Earth and years to reach the other planets, as shown in Table 1.

Although the nonchemical propulsion method provides faster trips than the chemical one, the durations are still long exceeding one year at most destinations inside our solar system besides the relative risks of nuclear thrusters and their high cost; that’s why we are in need for a faster method which enables the spacecrafts to reach Mars and other planets in hours instead of months.

When thinking about a method to travel faster in space we must think differently. The traditional thoughts are about how machines and engines go the distance in shorter time with different types of energies, but what if we found an object that can travel in space naturally with a great velocity? If so, we can let that object deliver the spacecraft to its destination with the same great velocity. This object must be having a mass and its velocity should not exceed the speed of light according to the general relativity. There is nothing better than the electron beam which is also known as the cathode ray (Wayback Machine, 2014) to be that object. This research shows a theoretical simulation using the electron beam to transmit a spacecraft in space with a velocity of 0.01 of light speed. This simulation aims to find out the basic physical principles needed to make this possible, and then these principles will be applied on other negatively charged solid material with better characters which is more suitable for industrial purposes.

The Electron Beam

The electron has a dual nature; behaves as a particle and a wave. A single electron mass is 9.1×10^{-31} kg therefore the electron beam mass is measured according to its density of electrons. The idea is based on the electron nature as a particle. Acceleration of the beam to reach high velocity can be managed by increasing the voltage difference between the cathode and the anode, as observed later.

In 1897 Thomson made many experiments and found out that cathode rays were really particles. He managed to find an accurate value for their charge to mass ratio e/m and found that e/m was the same for any cathode material. He also showed that the negatively charged particles-which he called “corpuscles”-were universal when produced by illuminated materials, heated materials or radioactive materials (Thomson, 1897).

These negatively charged particles the electrons make up the current of the cathode ray exactly like in a conducting wire, and wherever there is a movement of free electrons through a conductor an electric current is produced, so the cathode ray can be considered as a “wire” with a current passing through it.

Ampère's Force Law

According to Hans Christian Ørsted; electric current produces a circular magnetic field as it flows through a wire (Örsted, 1820), therefore the current passing through the electron beam produces a magnetic field and by applying Ampère's right-hand grip rule we can determine the direction of the field, as seen in Fig. 1.

If a conductor (a wire carrying a current) is brought closer and parallel to the electron beam, an attraction or repulsion will happen between them according to the direction of the current in both of them as Ampère's Force Law states. This force is proportional to the length and the intensity of the current passing through both of them. If the currents flow in the same direction, attraction will be produced between the beam and the conductor as seen in Fig. 2.

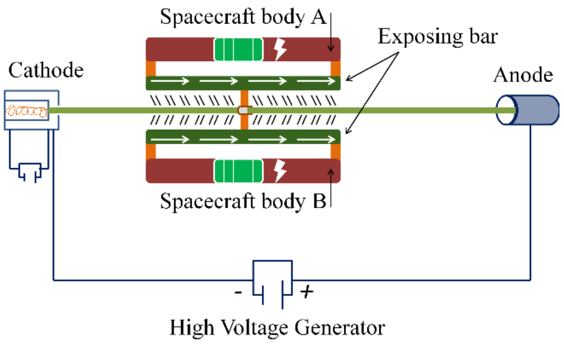


Fig. 3: The mass of the spacecraft is divided into two equal halves A and B with a connecting shaft so the attraction force between the electron beam and the spacecraft is equalized on the both sides of the beam to prevent its deflection. The white arrows show the direction of the current in the exposed bars of the spacecraft

In free space environment, i.e., there is no matter present that can be magnetized, the force of attraction F is given by: $F = I\Delta LB$ where B is the magnetic field affecting the object.

In the above case; $F_{beam} = I_{beam} \times \Delta L \times B_{wire}$. The magnetic field B is given by: $B = \frac{\mu 0\, I}{2\pi r}$ where r is the distance between the beam and the conductor and μ0 is the permeability of free space and is a physical constant that equals $1.25663706 \times 10^{-6}$ H/m. The force on the electron beam is exactly the same magnitude on the conductor but in the opposite direction, and is given by:

$$F = \frac{\Delta L \times I_{beam} \times \mu 0 \times I_{wire}}{2\pi r}$$

This attraction force can be created between the electron beam and any other parallel conductor carrying a current in the same direction. The purpose here is enabling the electron beam to drag the attracted conductor by this force with high speed in space, and by accelerating the beam this conductor speed can reach at least 0.01 of the speed of light. The dragging direction is perpendicular to the attraction force between the beam and the conductor, exactly like two magnets attract each other across a paper; one on each side, when one of them is moving on the paper surface the other magnet follows it. The following part will simulate and discuss how to apply this method on a spacecraft in space and solutions for challenges impeding this.

These challenges are; 1-design of the spacecraft and deflection of the beam, 2-calculation of the attraction force, 3-back attraction, 4-acceleration, 5-the distance between cathode and anode, 6-calculation of linear momentum.

Application

Design of the Spacecraft and Deflection of the Electron Beam

The spacecraft design relies on creating an attraction force between the electron beam which is outside the spacecraft and the spacecraft body. This force acts like a "magnetic trap" and it must be able to drag the whole mass of the spacecraft in the direction of the beam exactly like in the case of the wire and the electron beam illustrated above. The starting point is the cathode and the target point is the anode, as seen in Fig. 3.

If the spacecraft is set to be on one side of the electron beam; a deflection of the beam will happen toward the spacecraft and away from the anode, thus the spacecraft mass must be divided into two equal halves one on each side of the beam; each half has an attraction force with the beam that is equal to the other half to overcome the beam deflection. As illustrated in Fig. 3, each half is attracted to the electron beam by an exposed bar through which a current is passing in the same direction of the electron beam. The current in the exposed bar comes from a high energy source in each body half making a closed loop on each side of the electron beam.

Calculation of the Attraction Force

The basic idea is that the magnetic force acts as "glue" between the spacecraft and the beam so both of them can act as one object. According to Newton's second law $F = m \times a$ where m is constant representing the spacecraft mass; then the two variables are the force and acceleration. Acceleration of the spacecraft by a value of 1 m/s² toward the electron beam is the least required value to get the attraction effect; meaning that the numerical value of the attraction Force (F) should be ≥ the numerical value of the spacecraft mass (m). By substituting into the equation:

$$F = \frac{\Delta L \times I_{beam} \times \mu 0 \times I_{exposing\ bar}}{2\pi r}$$

$$F = m \times a = \frac{\Delta L \times I_{beam} \times \mu 0 \times I_{exposing\ bar}}{2\pi r}$$

Assuming the spacecraft mass is 500 kg, the exposing bar is 2 m length and carrying a current of 1000 amp with a distance of 0.5 m away from the electron beam:

$$F = 500 = \frac{2 \times I_{beam} \times 1.25663706 \times 10^{-6} \times 1000}{\pi}$$

So, I_{beam} = 625,000 amp which is the least required value to attract this spacecraft with the electron beam.

Back Attraction of the Electron Beam

The attraction force between the spacecraft and the electron beam is limited to only one segment of the beam which faces the exposed bar of the spacecraft and not the whole beam length; as this segment is the only portion affected by the magnetic field of the charged exposed bars. For example; if the spacecraft length is one meter and the electron beam length (cathode to anode distance) is three meters, the attraction force will occur between the spacecraft and only one meter of the electron beam (the facing segment) while the other 2 m are left unaffected, as seen in Fig. 4.

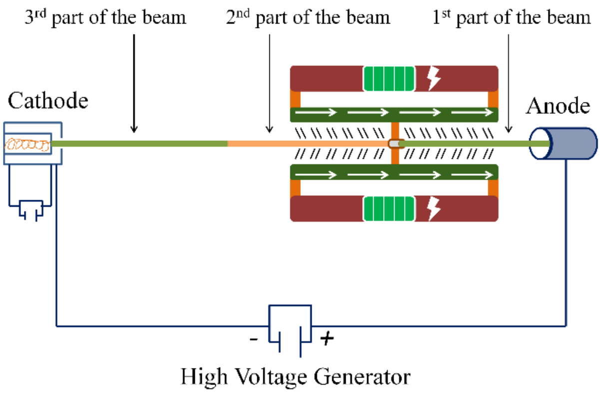
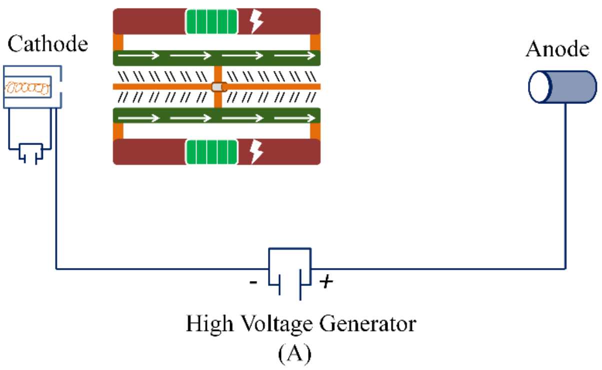


Fig. 4: The electron beam is divided into three segments with shifting of the attraction force from the passed first segment to the upcoming second one. The third segment will attract in the same way when facing the spacecraft



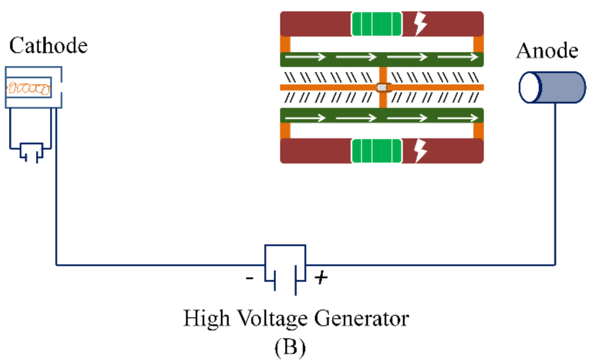


Fig. 5: (A) The electron beam is released in pulse fashion enabling the attraction force between the spacecraft and one segment of electrons; (B) The spacecraft is dragged with the beam segment toward the anode as there is no coming segment to attract with

When the facing segment exceeds the spacecraft field toward the anode, a new segment of electrons will replace it making an equal attraction force with the spacecraft instead of the previous one. This occurs due to continuous flow of electrons from the cathode, resulting in a series of back attraction effect on each coming segment. In other words, the beam segment that faces the spacecraft is considered fixed despite of being replaced by new electrons. This attraction shifting prevents the beam to drag the spacecraft which will be rather hanged.

This effect is well explained by Newton's first law which states that; an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force. The spacecraft is attracted to a segment of electrons and each electron leaves the field of the spacecraft toward the anode another electron replaces it from the cathode; hence the spacecraft is acted upon by balanced forces. To unbalance these forces, the continuity of electrons must be interrupted leaving only one segment of electrons for the spacecraft to attract with. A pulse technique must be used by the cathode to release only one segment of electron beam per second; therefore the attraction force will drag the spacecraft toward the anode, as seen in Fig. 5.

Acceleration

The electron beam acceleration is subjected to the electron kinetic energy formula: $KE = \frac{1}{2}mv^2$, and as the kinetic energy of an electron = electron charge × voltage difference, therefore:

$$eV_{olt} = \frac{1}{2}mv^2$$

where, KE = kinetic energy, e = electron charge, V_{olt} = accelerating voltage, m = electron mass and v = electron velocity, so the electron velocity:

$$v = \left(\frac{2eV_{olt}}{m}\right)^{\frac{1}{2}}$$

As the $\frac{e}{m}$ ratio is constant and equals 1.77×10^{11}, the two variables now are the electron velocity and the accelerating voltage. The electron velocity before being attracted to the spacecraft is different from its velocity after being attracted to the spacecraft as in the latter the electron beam will carry the spacecraft and the values are different. A small value of (V_{olt}) is enough to get high velocity for the electron as the denominator is extremely small and equals the electron mass which is 9×10^{-31} kg, but in this simulation the required V_{olt} should be of very high value because the mass of the spacecraft will be added to the electron mass as seen later, so giving the accelerating voltage a value of 10^5 V_{olt}, a single electron velocity before the attraction equals:

$$v = \left(\frac{2\times1.6\times10^{-19}\times10^5}{9\times10^{-31}}\right)^{\frac{1}{2}} = 1.9\times10^8 m/s$$

Back to the spacecraft example, the anode is required to attract both the electron beam segment together with the engaged spacecraft by just attracting the beam, so the mass of the spacecraft is equally divided on the number of electrons in the beam segment that faces the spacecraft. If the electron beam current is 10^6 A, and as the number of electrons in one amp/sec is 6.24×10^{18} electrons (constant); so the number of electrons per second will be 6.24×10^{24} electrons. In our example; the exposed bar length of the spacecraft is 2 m, so we need to get the number of electrons in a 2 m segment of the electron beam. As the beam moves with a speed of 1.9×10^8 m/s; thus the number of electrons in 1 m per second equals:

$$\frac{total\ number\ of\ electrons\ per\ second}{electron\ beam\ velocity}$$

$$= \frac{6.24\times10^{24}}{1.9\times10^{8}} = 3.28\times10^{16}\ electrons/m/s$$

So, the number of electrons in the facing two meter segment equals 6.57×10^{16} electrons.

Dividing the mass of the spacecraft (500 kg) on that number of electrons will give 7.6×10^{-15} kg which is the additional mass every electron should attract to its way toward the anode. To get the velocity of a single electron (after engaging with the spacecraft) where the accelerating voltage is $10^5\,V_{olt}$, the mass in the denominator will be changed into the electron mass + the additional mass for each electron as the following:

$$v = \left(\frac{2\times1.6\times10^{-19}\times 10^5}{9\times10^{-31}+ 7.6\times10^{-15}}\right)^{\frac{1}{2}}$$

So, a single electron velocity will equal 2 m/s and this will be the same velocity of the spacecraft.

This velocity can be enormously increased by increasing two values; the electron beam current and the accelerating voltage. Increasing the electron beam current produces more number of electrons; hence the additional mass each electron has to attract will be decreased. On the other hand, increasing the accelerating voltage will increase the velocity as they are directly proportioned to each other. To reach a velocity of $10^5\ m/s$; the electron beam current must be $10^8 A$ with accelerating voltage of $2.3\times10^{12}\ V_{olt}$.

At this point of electron beam simulation; it is clear to find out reaching this value of accelerating voltage ($2.3\times10^{12}V_{olt}$) is impossible for three reasons: Difficulty of reaching this value of voltage difference, and if so; the whole system stability will be doubtful, on the other hand; if this value is obtained, the electron beam velocity before getting attracted to the spacecraft will be 9×10^{11}m/s which is more than the speed of light, and this violates the general relativity.

The main reason of failure of the electron beam at this stage is densification. The marvelous value of voltage difference required ($2.3\times10^{12}V_{olt}$) is obtained only to intensify a segment of 2 m length of the beam. In other words; we need to increase the voltage difference 23 million times to only make a 2 m segment able to drag the spacecraft without any other use of this energy.

The Charged Copper Bar

To overcome this problem; a more concentrated object is needed to replace this electron beam segment, this object must be negatively charged like the electron beam, hence comes the role of a negatively charged solid material (copper bar) which will be the perfect alternative to replace the electron beam in this situation.

This bar is released from a cathode gun with high velocity to its way to anode exactly like the electron beam. Important difference between them is that the electrons are naturally negatively charged while the copper bar is neutral; therefore a high current battery is needed to give the copper bar the required negative charge, as seen in Fig. 6.

The same three principles illustrated above of deflection in part 4.1, calculation of attraction force in part 4.2 and back attraction in part 4.3 are identically applied on the charged copper bar. Being made from copper; the bar is a good conductor and so it is easy to carry a high charged value. The advantage here is being intensified-compared with an electron beam segment-so the whole given current will be concentrated to its whole mass value. The cornerstone concept of this research is based on the kinetic energy of the electron as a negative charged particle in electric field, and as the copper bar is a negative charged mass in a magnetic field; so we can use the same equation:

$$eV_{olt} = \frac{1}{2}mv^2 \longrightarrow v = \left(\frac{2eV_{olt}}{m}\right)^{\frac{1}{2}}$$

But this time (e) represents the current of the copper bar and (m) represents its mass, so it can be written as:

$$v = \left(\frac{2C_{bar}V_{olt}}{m_{bar}}\right)^{\frac{1}{2}}$$

where, C_{bar} means (charge) of the bar, v = the bar velocity and m_{bar} means the bar mass. Giving C_{bar} = 10^8 A, V_{olt} = 10^8 V and m_{bar} = 500 kg:

$$v = \left(\frac{2C_{bar}V_{olt}}{m_{bar}}\right)^{\frac{1}{2}}$$

$$v = \left(\frac{2\times10^8\times10^8}{500}\right)^{\frac{1}{2}} = 6{,}324{,}555.32\ m/s$$

By adding the mass of the spacecraft to the bar mass, velocity of the spacecraft will be:

$$v = \left(\frac{2\times10^8\times10^8}{500+500}\right)^{\frac{1}{2}} = 4{,}472{,}135.955\ m/s$$

Which is 0.01 of the speed of light.

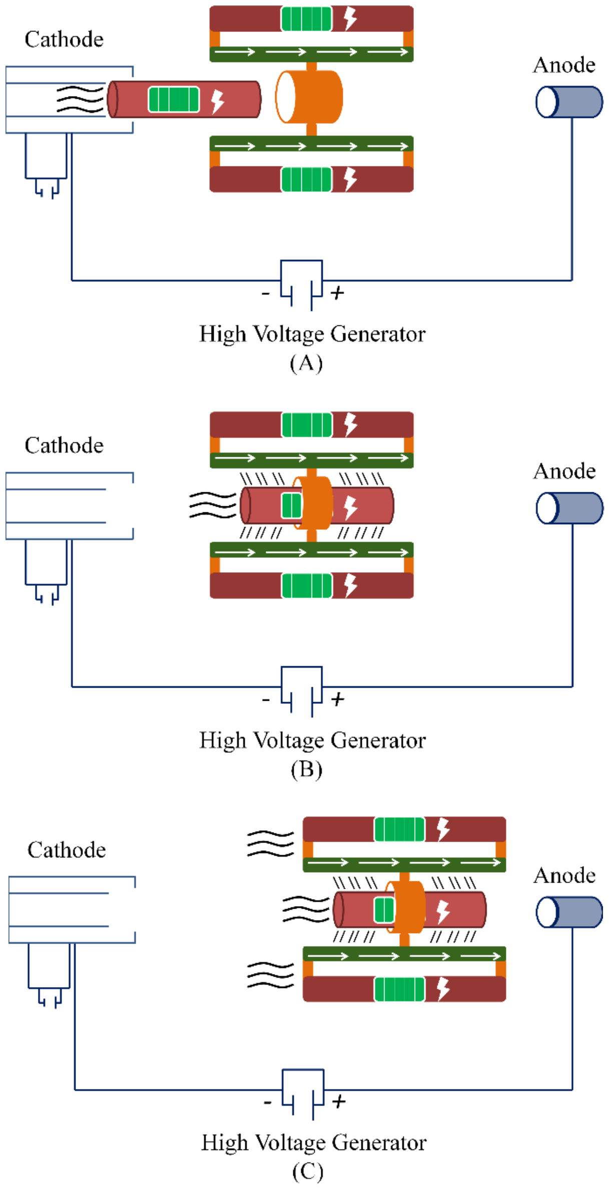


Fig. 6: A highly charged copper bar released from a cathode gun; (A-C) show the three steps of acceleration which are releasing the bar with high velocity, attraction with the spacecraft and transmitting it, respectively

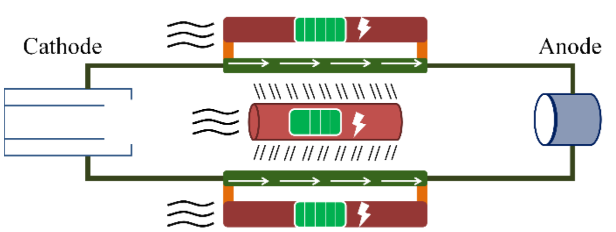


Fig. 7: The cathode and anode are attached to the spacecraft being actually parts from it. The high voltage sources are considered to be controlled from inside the spacecraft itself

These high values of the current and voltage might be achieved by energy transformation from nuclear source. As by reaching high values of electron beam current and voltage difference to 1.6 megamperes (Fleischmann, 1975) and 25.5 megavolts (Cabage, 2016) respectively in other studies; therefore creating 10^8 ampere and 10^8 volt is not impossible.

The Distance between Cathode and Anode

In the main spacecraft example; the charged copper bar together with the spacecraft move between two fixed points which are the cathode and the anode, but this can't be occurred in space anyway. If a spacecraft is required to travel from earth to Mars this means we need a huge fixed cathode on earth and a huge fixed anode on Mars with a massive electric field between them which is totally impossible. To overcome this challenge; the cathode and anode must be attached to the body of the spacecraft by letting the cathode behind the spacecraft and the anode in front of it. In other words; cathode and anode must be parts of the spacecraft itself, as seen in Fig. 7.

The question now is; how can this system produce motion according to Newton's third law?! At first glance; it seems like any motion of this system would violate the law of dynamics, more specifically the conservation of linear momentum, because any object can't move as a whole as a result of internal forces only. In fact; the charged copper bar before being attracted to the spacecraft is considered a free separate object with very high kinetic energy as it isn't attached physically to the spacecraft at all. The attraction process occurs after the copper bar is already being in motion with high velocity to the anode, so it isn't considered an internal force anymore. By this way, the charged copper bar will never reach the anode as the latter moves with the magnetically attracted spacecraft, so the spacecraft will keep moving forward by Newton's first law until unbalancing the forces either by stopping the attraction force with the charged copper bar or disconnect the anode.

Calculation of the Linear Momentum

Exerting attraction force between the charged copper bar and the spacecraft is considered a perfectly elastic collision where there is no loss in the overall kinetic energy. The right equation to be used here is:

$$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$$

where:
m_1 = Mass of the charged copper bar
m_2 = Mass of the spacecraft
u_1 = Initial velocity of the charged copper bar
u_2 = Initial velocity of the spacecraft
v_1 = Final velocity of the charged copper bar
v_2 = Final velocity of the spacecraft

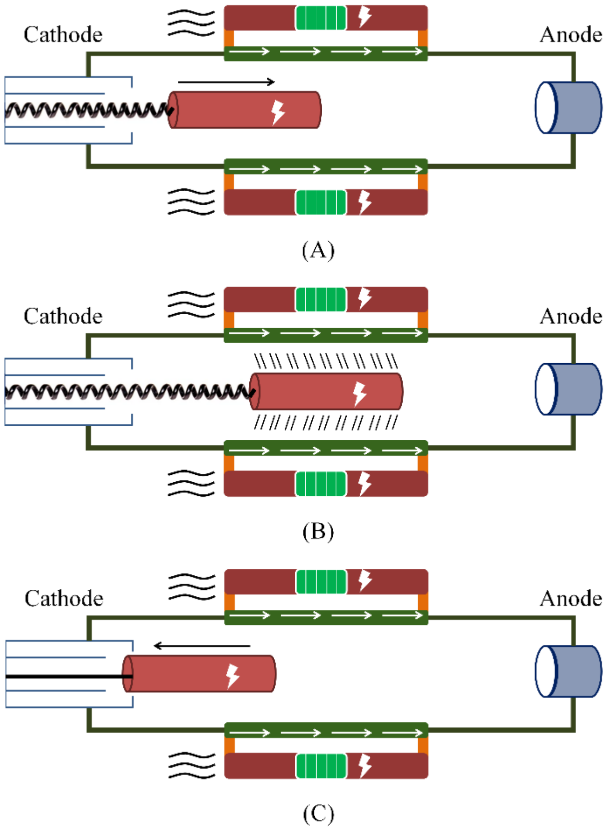


Fig. 8: (A) The charged copper bar is released from cathode and is connected with a spiral cord. The black arrow shows the direction of the copper bar; (B) The charged copper bar at collision and the cord shows no tension; (C) The spiral cord is pulling the copper bar back to cathode. The black arrow shows the direction of the copper bar. The copper bar in all steps is charged from the spiral cord

On its way to the anode; the charged copper bar experiences two phases, the first phase is before collision (attraction with the spacecraft) and it resembles the distance from the cathode to the spacecraft, while the second phase is after collision and resembles both the copper bar and the spacecraft together as one object from the site of the spacecraft to the anode. As being attracted together after collision; the velocity of both are the same, so $v_1 = v_2$ and therefore:

$$m_1 u_1 + m_2 u_2 = v\,(m_1 + m_2)$$

where, v = the velocity of both the spacecraft and copper bar after attraction (collision).
Assuming the same previous values of the charged copper bar where its mass = 500 kg, its current = 10^8 ampere and the voltage difference between cathode and anode is 10^8 volt; its velocity in the first phase will be 6,324,555.32 m/s. By substituting into the momentum equation; where the spacecraft mass is 500 kg and its velocity before collision is zero (at rest):

$$(500 \times 6{,}324{,}555.32) + (500 \times 0) = v\,(500 + 500)$$

$$\text{so, } v = 3{,}162{,}277.66 \text{ m/s}$$

At this stage and after gaining this high velocity; the spacecraft needs to keep this speed together with the charged copper bar to their infinite way to anode, but actually the charged copper bar will immediately escape the magnetic trap and detach the spacecraft to its way to anode leaving the spacecraft with this velocity till slowing down and stop. Three main reasons are responsible for this; the first reason is the preserved high kinetic energy of the charged copper bar. Despite slowing down as a result of the collision, it will immediately accelerate again to reach its initial velocity (6,324, 555.32 m/s). The second reason is the impossibility of the spacecraft to accelerate after collision or to increase its collision gaining velocity, because as being one object together with the charged copper bar they can't move as a whole as a result of internal forces only as mentioned above in part 5.1, this means the only chance for the spacecraft to accelerate is the gaining speed at the collision as the charged copper bar is a separate object. The third reason is that the attraction force between the charged copper bar and anode is much more powerful than the attraction force with the spacecraft itself.

To overcome this problem two more techniques are needed; they are repeated firing of the charged copper bar and voltage adjustment.

Repeated Firing of the Charged Copper Bar

At this point; the charged copper bar has managed to accelerate the spacecraft from static position to a velocity of 3,162,277.66 m/s and this step is "stage 1". This velocity will gradually slow down as the copper bar will detach as mentioned before. If a new charged copper bar with the same values is released or fired from cathode; it will accelerate the spacecraft to a higher velocity according to momentum change because at this time the initial velocity of the spacecraft is 3,162,277.66 m/s not zero, and this is "stage 2". The net velocity of the spacecraft after collision in "stage 2" will be:

$$v = \frac{(500 \times 6{,}324{,}555.32) + (500 \times 3{,}162{,}277.66)}{(500 + 500)}$$

$$v = 4{,}743{,}416.49 \text{ m/s}$$

Again with a new copper bar for stage 3; the net velocity of the spacecraft will be 5,533,985.905 m/s and then will be 5,929,270.613 m/s in stage 4, and so on.

Of note, despite the need for a new charged copper bar to be fired every stage; only one copper bar can do the job every time. This is done by disconnecting the anode at the time of collision and returning the fired charged copper bar back to the cathode after collision by using a spiral cord, as seen in Fig. 8.

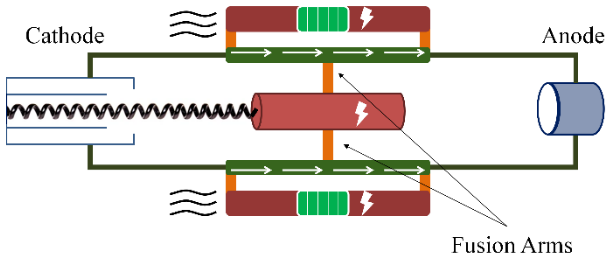


Fig. 9: The arms attaching the charged copper bar to the spacecraft at the time of collision. Of note, the attraction force between the spacecraft and the copper bar is off

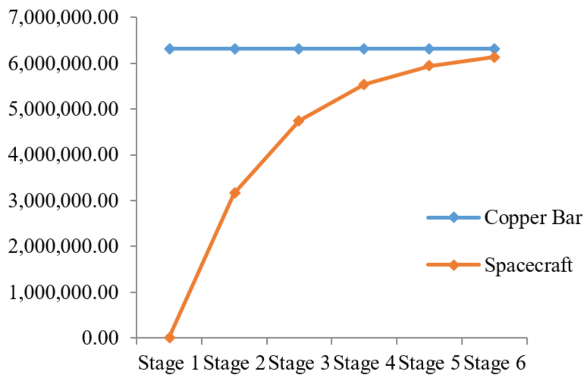


Diagram 1: Illustrates the relationship between the initial velocity of the charged copper bar (blue line) and of the spacecraft (red line). The X axis represents the stages of copper bar firing while the Y axis represents the velocity in m/s. The red line gets closer to the blue line each stage but will never touch it

The spiral cord is long enough to provide free mobility for the copper bar. In phase one and at collision; the cord doesn't exert any tension or strain therefore the charged copper bar is still considered a free separate object to do the attraction and accelerate the spacecraft. After collision; this cord is shortened to pull the copper bar back to cathode for the next stage, and so on. This spiral cord provides another important advantage in the process which is the ability to charge the copper bar from energy sources inside the spacecraft itself instead of using isolated high charged battery as in previous steps (Figs. 6-7). Disconnecting the anode at the time of collision prevents the acceleration of the copper bar beyond the spacecraft and so both of them will continue moving with the collision velocity until they slow down and stop. Preventing the copper bar from acceleration after collision also protects the spiral cord from being torn from over stretching.

It is also notable that the velocity of the spacecraft increases in every stage but will never reach the initial velocity of the charged copper bar which is 6,324,555.32 m/s despite getting so close every time as seen in Diagram 1.

At this point and according to diagram 1; the spacecraft velocity increases each stage in a pulsation like manner and a continuous firing is needed to keep the spacecraft moving. One more step is needed to gain a continuous permanent speed which is anode voltage adjustment.

Anode Voltage Adjustment

A cornerstone concept in this process is considering both the copper bar and the spacecraft to be one object after the collision thanks to the powerful attraction force between them. To keep them going, the anode is required to be still connected to the high voltage source and to exert attraction force on the copper bar, but if so as mentioned before the copper bar will escape the magnetic trap and leave the spacecraft. Therefore, both the spacecraft and the copper bar must be fused together (only at the time of collision when they have the same speed) by solid physical arms not to let the copper bar escape to the anode, as seen in Fig. 9.

This fusion only occurs after achieving the desired velocity for both of them. It will prevent the separation of the copper bar in addition to saving the energy of attraction between them after the collision happens as there is no role for it anymore. This time the anode will not be disconnected like in the previous stages but the voltage difference must be decreased to a certain value, a value that keeps the copper bar and the spacecraft at their collision speed.

To explain this; let's say the desired velocity needed for the spacecraft is 6,126,912.967 m/s which is gained after 6 stages of copper bar firing. By substituting into the equation:

$$v = \left(\frac{2C_{bar}V_{olt}}{m_{bar} + m_{spacecraft}} \right)^{\frac{1}{2}}$$

So, the voltage value needed to give this velocity is:

$$V_{olt} = \frac{v^2 \times (m_{bar} + m_{spacecraft})}{2 \times C_{bar}}$$

$$V_{olt} = \frac{(6{,}126{,}912.967)^2 \times 1000}{2 \times 10^8}$$

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$$V_{olt} = 187{,}695{,}312.5\ volt$$

Therefore, exactly at the time of collision in stage 6, the fusion happens together with decreasing the anode voltage from 10^8 *volt* to 187,695,312.5 *volt*.

Conclusion

The spacecraft new technology is based on a charged copper bar with high kinetic energy moving in high electric field, this charged bar exerts an attraction force on the spacecraft perpendicular to its axis of motion, and this force is able to drag the spacecraft in the charged bar direction. Connecting the cathode and the anode to the body of the spacecraft is crucial to guarantee high electric field with consideration of not violating Newton's third law as the charged copper bar is a free separate object before collision. Acceleration of this system depends on repeated firing of the charged copper bar till reaching the desired speed; at which the voltage difference must be adjusted to keep the collision speed.

Future extensions of this research could include more studies needed to reach the stage of application in real life. Some of these studies are about thermal and power control, designing the whole system and isolation inside the spacecraft.

The following Table 2 shows comparison between nuclear rocket and electron beam mechanism (charged copper bar) for the time needed for a spacecraft to travel in space, considering the speed of nuclear rockets is 20 km/s and that of charged copper bar technique is 6,126,912.967 m/s.

Table 2: Approximate time needed to reach the other planets using the known speed of a nuclear rocket compared with the charged copper bar technique

Planet	Closest distance to Earth (km)	Nuclear rocket (days)	Electron beam mechanism (hrs)
Mars	54.6 M	31.6	2.48
Jupiter	588 M	340.0	26.70
Saturn	1.2 B	694.0	54.40

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Ethics

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