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Net Magnetic Force Generation in Discontinuous Circuits: A Force Symmetry-Breaking Phenomenon

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Abstract

This paper explores the potential for generating a net magnetic force in circuits with open sections, where the asymmetry of interacting forces can produce a resultant force. It is shown that the forces between two wires can be decomposed into reciprocal and directional components. Reciprocal forces generally produce no net force, and directional forces vanish in closed circuits, while they may not vanish in discontinuous circuits in general. It is also shown that if the open sections are replaced with capacitors, there is a possible non-reciprocal interaction between the capacitors and the wires. The central concept behind this work stems from a nuanced idea that may have been overlooked or remained unnoticed. The proposed idea's simplicity could lead to the development of propellantless(non-chemical)¹ propulsion systems for space applications, such as the repositioning of satellites.

This paper has originated from a thought experiment. Before delving into it, let's consider the famous example of two point charges moving perpendicular to each other, both approaching a common origin with a distance far from it [1, 2]. Due to the Lorentz force and Biot-Savart law, these point charges will experience equal forces perpendicular to their moving path in distinct directions, seemingly violating Newton's third law. Regarding this violation, Feynman, in his lecture notes, volume II, chapter 27 [2], states that the field momentum balances the change of the particle momenta. He has suggested that as long as the overall balance of momentum is maintained, the violation of the third law should be less concerning, and he leaves the reader to decide the generality of Newton's third law.

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¹No mass is expelled thus propellantless in the traditional sense.

Now, imagine two wire loops carrying currents. If we neglect the retardation effect[3], Newton's third law mandates that they must exert equal and opposite forces on each other. Can we design the loops' geometry and orientation to create a scenario similar to the point charge experiment, where interaction forces act in different directions without canceling each other?

A strict physicist might immediately assert that this is impossible. Indeed, the mathematics presented in the Methods section proves that any two closed loops exert equal and opposite forces, resulting in overall cancellation. However, a question immediately arises: if two closed loops must produce equal and opposite forces, does removing part of a loop break this symmetry? As we will subsequently see, discontinuous circuits² can indeed exhibit this force symmetry breaking.

In the study by Mohammadpour [3], it is argued that Newton's Third Law is only locally applicable at the point of interaction between fields and charges, where an instantaneous exchange of momentum occurs. It is deemed inappropriate to extend Newton's Third Law to interactions at a distance where retardation effects may occur and the state of the charges may change. Sebens [5] discusses since fields exert forces on charges and, conversely, charges exert forces on fields, Newton's Third Law is preserved. Considering the locality of Newton's Third Law and using the Lorentz force as defined in equations (6) and (7), we can demonstrate that forces acting on two open wires might not always exhibit symmetry(Please refer to section Methods).

The accuracy of calculated forces using the Lorentz force is difficult to dispute. This is because the Lorentz force is deducible from Faraday's law of induction and Maxwell's equations using the Leibniz integral rule (A detailed proof is in [6, 7]). Since Maxwell's equations offer an accurate description of fields for most classical electromagnetic applications, it's reasonable to consider the Lorentz force equally accurate when representing forces within the mentioned domain of application.

Numerous concepts have been proposed that utilize electromagnetic principles for space travel. However, few of them have solid experimental or theoretical evidence. One of these exciting proposals exploit retardation and phase difference concepts for net force generation [8, 9]. The feasibility and criticisms of such propulsion systems are discussed in [10, 11]³. Despite their potential, thrust generation through retardation typically demands high frequencies or rapid current/charge changes. This often results in substantial inductive reactance in the circuits, posing a significant engineering challenge due to the

²The circuit is called discontinuous in the sense that conductors are omitted, but the electromagnetic fields are continuous. The displacement current ensures the continuity of the current and fields as first time suggested by J.C. Maxwell [4].

³These critiques are not themselves devoid of criticism. For instance, [10] assumes that the force calculated on the wires is similar to that on "point" dipoles and that the produced force results from the radiation momentum. Consequently, it is concluded that the energy expenditure to momentum gain ratio is light speed C . This assumption is only valid if we disregard the gradient of Maxwell's stress tensors in the momentum equation and only consider the change in energy flux through radiation.

necessity of high voltages⁴. Furthermore, radiative power losses increase notably with frequency, negatively impacting the thrust-to-power ratio. Despite these challenges, retardation-based force generation has been suggested to be used for testing the anisotropy of the one-way speed of light [3]⁵.

The EM drive has also undergone various experiments [12, 13]. However, regardless of the feasibility of such a thruster, the theoretical background has not yet been established to aid in accurate design.

Other types of electromagnetic engines like Plasma and Hall thrusters utilize ionized gas propellant [14, 15, 16, 17]. These are gaining traction for deep space missions due to their efficiency in comparison to chemical rocket engines [18]. However, their propellant requirement limits their range for extended journeys. Additionally, at the current stage of development, the forces produced are tiny, which limits their broader application.

Recently, a propellant-less propulsion concept based on asymmetrical electrostatic pressure has been introduced [19]⁶. It is claimed that the magnitude of thrust is geometry-dependent in the proposed propulsion system, potentially limiting its design and flexibility.

The concepts presented in this paper rely on symmetry breaking. Unlike [19], symmetry breaking of magnetic forces is utilized here. Magnetic fields can store more energy per unit volume than electric fields, making them attractive for converting electrical energy to mechanical energy, as seen in electric motors. Unlike electric fields prone to material breakdown, magnetic fields can be intensified without similar risks, especially within solid materials like metal cores. Furthermore, the force generated in this work can be enhanced through both geometric optimization and current increase, achievable via techniques like winding wires, increasing open sections, and utilizing superconductors. The theoretical aspects and discussions are presented as follows.

Methods

In the electrodynamic causality context, the magnetic field's exact solution around the wire from the Maxwell equation is presented in [20]. However, when neglecting the retardation effect and assuming a low rate of change in current, this description simplifies to the more familiar Biot-Savart law ⁷ [1]

$$\mathbf{B} = \frac{\mu_0 I}{4\pi} \oint \left(\frac{d\mathbf{l}^s \times \mathbf{r}}{r^3} \right) \quad (1)$$

where μ_0 represents the permeability of vacuum and I denotes the current. Furthermore, $d\mathbf{l}^s$ represents an infinitesimal length element of the source, r is

⁴Although we can reduce inductive reactance using an LC setup, technically, it remains challenging to maintain high current and high frequency.

⁵Note that the constancy and isotropy of the two-way speed of light may not inherently imply the same for the one-way speed of light.

⁶The theoretical aspects of this proposal is not explained fully; however, the patent report presents experimental observations claiming net force generation.

⁷The Biot-Savart law is a good approximation of the magnetic field if $\frac{1}{r^2 c} \frac{\partial I}{\partial t} \ll I/r^3$.

the distance from that source element, and \mathbf{r} is the displacement vector. The current I can be a direct or alternative. However, the Biot-Savart law is valid at low frequencies for AC currents when the rate of changes is small. The force exerted by wire A on wire B can be determined using the Lorentz force law

$$F_A^B = I_B \oint_B d\mathbf{l}^B \times \mathbf{B}_A \quad (2)$$

The convention used here, F_A^B , represents the force exerted by object A on object B. By converting the triple cross products to dot products, it follows

$$F_A^B = \frac{\mu_0 I_A I_B}{4\pi} \left[\oint \oint \frac{d\mathbf{l}^A (d\mathbf{l}^B \cdot \hat{\mathbf{r}}_{BA})}{r^2} - \oint \oint \frac{\hat{\mathbf{r}}_{BA} (d\mathbf{l}^B \cdot d\mathbf{l}^A)}{r^2} \right] \quad (3)$$

where $\hat{\mathbf{r}}_{BA} = \mathbf{r}_{BA}/r$ represents the unit vector pointing from the infinitesimal element $d\mathbf{l}^A$ toward $d\mathbf{l}^B$, and r is the distance between these elements. The second term on the right-hand side of Equation (3) implies equal and opposite forces on wires A and B. By expanding the differentials in spherical coordinates, it follows ⁸

$$d\mathbf{l}^B \cdot \hat{\mathbf{r}} = d\mathbf{r} \cdot \hat{\mathbf{r}} = dr \quad (4)$$

Using the identity (4), the force term (3) can be written as

$$F_A^B = \frac{\mu_0 I_A I_B}{4\pi} \left[\oint_A d\mathbf{l}^A \oint_B \frac{dr}{r^2} - \oint \oint \frac{\hat{\mathbf{r}}_{BA} (d\mathbf{l}^B \cdot d\mathbf{l}^A)}{r^2} \right] \quad (5)$$

The closed integral $\oint \frac{dr}{r^2}$ equals zero for a closed wire. This is because the integration is performed over a closed loop on a differential. Conclusively, two closed loops exert equal and opposite forces on each other. The second integral in Equation (5) can be named the "reciprocal force," possessing symmetry and is directionally dependent on both wires. In contrast, the first term in Equation (5) can be termed the "directional force," as its direction depends only on one of the wires and exhibits asymmetry. As previously stated, the directional force vanishes for a closed loop.

⁸We can write $d\mathbf{r} = d\mathbf{r}_B - d\mathbf{r}_A$. In the inner integral, we only move along wire B while the point on A is fixed. Hence we can write $d\mathbf{l}^B = d\mathbf{r}$

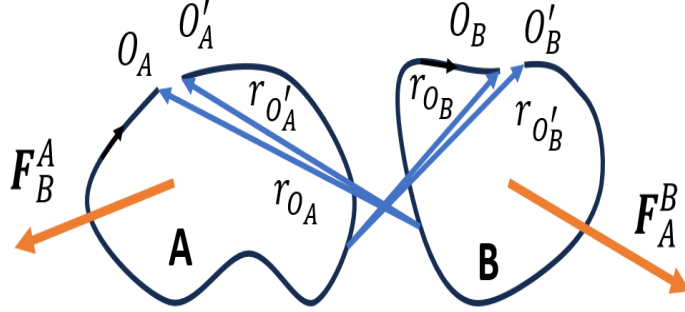


Figure 1: Diagram depicting two open-circuit wires, A and B, each with a disconnection point forming capacitive gaps (labelled as O_A and O'_A for wire A and O_B and O'_B for wire B). The $r_{O'_B}$ and r_{O_B} are the distance of any point on wire A from the open section on wire B. The interaction forces F_A^B and F_B^A may not be equal and opposite(reciprocal).

Now, consider two open-circuit wires(see Figure 1). Each wire has a specific disconnection point, with a sufficiently small gap to act as a capacitor. Therefore, this configuration allows current to flow, dependent on the applied voltage and the charge accumulated at the disconnection points. Importantly, no discharge occurs between these disconnected points. Let's denote the disconnection points for wire A as O_A and O'_A and for wire B as O_B and O'_B (moving in the direction of the current). The interaction forces on wires A and B can be expressed as follows

$$F_A^B = \frac{\mu_0 I_A I_B}{4\pi} \left[\int_A \left(\frac{1}{r_{O'_B}} - \frac{1}{r_{O_B}} \right) d\mathbf{l}^A - \iint \frac{\hat{\mathbf{r}}_{BA} (d\mathbf{l}^B \cdot d\mathbf{l}^A)}{r^2} \right] \quad (6)$$

and

$$F_B^A = \frac{\mu_0 I_A I_B}{4\pi} \left[\int_B \left(\frac{1}{r_{O'_A}} - \frac{1}{r_{O_A}} \right) d\mathbf{l}^B - \iint \frac{\hat{\mathbf{r}}_{AB} (d\mathbf{l}^B \cdot d\mathbf{l}^A)}{r^2} \right] \quad (7)$$

Here, r_O denotes the distance between point O and the infinitesimal element on the other wire(see Figure 1). The reciprocal forces cancel each other. The net force between the two wires resulting from directional forces is then expressed as

$$F_A^B + F_B^A = \frac{\mu_0 I_A I_B}{4\pi} \left[\int_A \left(\frac{1}{r_{O'_B}} - \frac{1}{r_{O_B}} \right) d\mathbf{l}^A + \int_B \left(\frac{1}{r_{O'_A}} - \frac{1}{r_{O_A}} \right) d\mathbf{l}^B \right] \quad (8)$$

It can be demonstrated that in many configurations, the net magnetic force between the open wires is nonzero. A clear illustration of this occurs when wire A and wire B lie in perpendicular planes, and the differential elements $d\mathbf{l}^A$ and $d\mathbf{l}^B$ are independent of each other.

A valid question to consider is: if we treat the open sections as a capacitor, what effect does the electric field have on the net force? It is trivial to assume that the force on the accumulated charge at both ends of the open sections cancels out⁹. There is a corresponding charge at the other end for every charge on one side of the capacitor. Another aspect to consider is the field interaction resulting from the capacitor's rearrangement and movement of charges. This movement generates a magnetic field, and the magnetic field of other wires exerts force on the capacitor. Equation (8) does not account for this effect. If the capacitance is due to a small gap between two wires with strong dielectric material in between, the electric charge predominantly accumulates close to the outer surface, as shown in Figure 2(a). In such cases, the length of the capacitor zone, denoted as l_c , can be very small. During the charging or discharging processes, the charges rearrange both radially and along the axis of l_c . For thin wires and a small l_c relative to the gap distance d , the contribution of the magnetic force due to this rearrangement might be negligible, and Equation (8) can be applicable. However, in general, the magnetic force resulting from charge rearrangement in a capacitor should not be overlooked.

⁹There is a possible asymmetrical interaction due to electrostatic pressure (Biefeld-Brown Effect), as widely discussed in [21, 22]. However, this effect is extremely small and can be neglected if symmetrical capacitors are selected. Secondly, as will be further discussed, the magnetic forces generated can be in a different direction than the induced pressure forces and are independent.

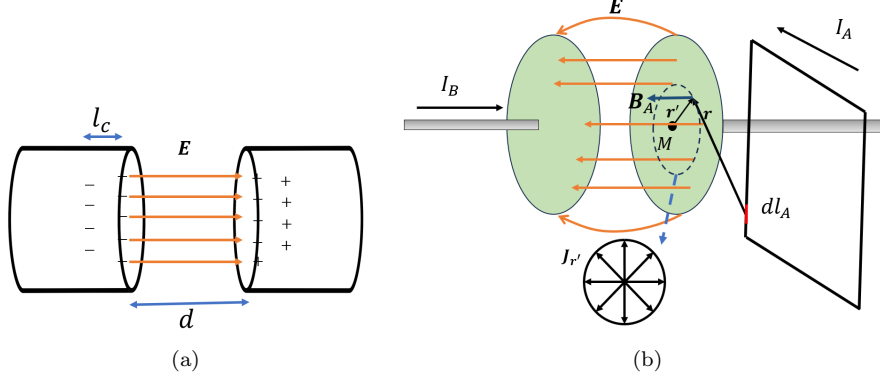


Figure 2: (a) The capacitor formation by a distance gap of d in a segmented wire, with charge accumulating on both sides of the wire. (b) Depiction of the electric field between two plates of the capacitor and the radial current density distribution in a circular capacitor. The interaction between a differential element dl_A and a point on the capacitor is depicted through the magnetic field B_A and the current density $J_{r'}$.

For simplicity, this work examines the force exerted by a closed wire on a circular capacitor and vice versa. We will demonstrate the breaking of the reciprocity of forces, which can lead to a resultant force. We assume that the charge is symmetrically distributed on the circular plate. The capacitor is sufficiently charged such that the electrostatic forces predominantly determine the charge distribution, while the influence of nearby current-carrying wires on this distribution is considered negligible. Consider that the outer radius of the capacitor is R , and the inner radius a is equal to that of the thin wire. By neglecting fringing effects, the density of the charge per unit thickness of the capacitor can be described as follows:

$$\rho = Q(t)/(\pi(R^2 - a^2)) \quad (9)$$

The Q is the charge on the plate, and the rate of change of charge on the plate is equal to the current entering the capacitor. The balance of charge in the circular plate necessitates:

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \mathbf{J} = 0 \quad \text{and} \quad \mathbf{J}(R) = 0 \quad (10)$$

Due to radial symmetry, the divergence operator $\nabla \cdot \mathbf{J}$ simplifies in polar coordinates to $\frac{1}{r'} \frac{\partial (r' J_{r'})}{\partial r'}$. With reference to the charge density equation (Equation (9)) and the continuity equation (Equation (10)), we can derive the following

relationship ¹⁰:

$$J_{r'} = \frac{1}{2} \frac{I_B}{\pi(R^2 - a^2)} \left(\frac{R^2}{r'} - r' \right) \quad (11)$$

According to [23], the conduction current primarily generates the magnetic field within a capacitor. Maxwell's displacement current cannot be the cause of the magnetic field. In fact, displacement current describes the correlation to the magnetic field. It is essential for the propagation of electromagnetic waves and the continuity of the fields, but it is not the cause. The capacitor has two leading roles. One is to ensure the continuity of the electric field in the whole wire, and it breaks the force interaction symmetry.

To calculate the magnetic field caused by the current density inside the circular capacitor, we can employ the Biot-Savart Law as follows ¹¹

$$\mathbf{B}_C = \int_0^{2\pi} \int_a^R \frac{(\hat{\mathbf{r}}' \times \hat{\mathbf{r}})}{r^3} r' J_{r'} dr' d\theta \quad (12)$$

Where $\mathbf{r} = \mathbf{r}_{MA} + \mathbf{r}'$ and \mathbf{r}_{MA} represents the distance from the center of the capacitor to wire A, and the hat symbol denotes the unit vector. The vector \mathbf{r}' indicates the distance from the center of the capacitor to a corresponding point on the capacitor (as shown in Figure 2(b)). The force exerted by closed wire A (as shown in Figure 2(b)) on one side of capacitor C can be derived from the Lorentz force equation as follows:

$$\begin{aligned} F_A^C &= \frac{\mu_0 I_A}{4\pi} \oint_A d\mathbf{l}^A \int_0^{2\pi} \int_a^R \frac{(\hat{\mathbf{r}}' \cdot \hat{\mathbf{r}})}{r^2} r' J_{r'} dr' d\theta \\ &- \frac{\mu_0 I_A}{4\pi} \oint_A \int_0^{2\pi} \int_a^R \frac{\hat{\mathbf{r}} (\hat{\mathbf{r}}' \cdot d\mathbf{l}^A)}{r^2} r' J_{r'} dr' d\theta \end{aligned} \quad (13)$$

The first integral in Equation (13) depends on the direction of the current in wire A. Meanwhile, the second term demonstrates reciprocity; its direction is independent of the currents' direction and aligns with the line connecting interaction points.

It can easily be shown that the directional force of the capacitor on a closed wire A is zero. Then, the sum of the force of wire A on the capacitor and the capacitor on wire A is nonzero (reciprocity breaks) and is given by ¹²

$$F_A^C + F_C^A = \frac{\mu_0 I_A}{4\pi} \oint_A d\mathbf{l}^A \int_0^{2\pi} \int_a^R \frac{(\hat{\mathbf{r}}' \cdot \hat{\mathbf{r}})}{r^2} r' J_{r'} dr' d\theta \quad (14)$$

¹⁰The fact that the current density in equation (11) is approximated here does not invalidate the forthcoming general proof demonstrating the non-reciprocal interaction between the wire and the capacitor.

¹¹In case we do not have symmetry, we can add the current density $J_{\theta'}$ in angular direction $\hat{\theta}'$.

¹²If the conducted current in the capacitor lacks symmetry, an angular direction term can be added to the inner integral for generality.

The capacitor can be considered analogous to open wires, where charge flows radially from the center to the edges. Consequently, we can expect that the sum of the forces will not be reciprocal, as is the case with open wires.

A wire with its own capacitor cannot produce force on itself if symmetries are considered. In other words, the net force resulting from the interactions between wire B and its attached capacitor can be demonstrated to be zero when the capacitors at both ends of the disconnection point are identical, and the wire setup is symmetrical concerning the capacitor's mid-plane. Due to symmetry, we can easily demonstrate that the sum of the magnetic forces due to the rearrangement of charges on both sides of the capacitor is zero. In a nutshell,

Examples and discussions

Consider a scenario where alternating current (AC) passes through a primary circuit with two open sections. A circular capacitor with a dielectric material is placed within these openings with no electrical discharge. The circuit voltage is sufficient to maintain the current flow in the primary circuit. Secondary circuits are positioned near the main circuit's open segments to produce a net force in the desired direction. These secondary circuits can operate in-phase or out-of-phase with the primary circuit depending on the intended force direction. System symmetries are designed to eliminate any potential net moment. Figure 3 provides a circuit schematic. O and O' denote the open section. Secondary circuits are placed near the open sections to the right and left of the primary circuit.

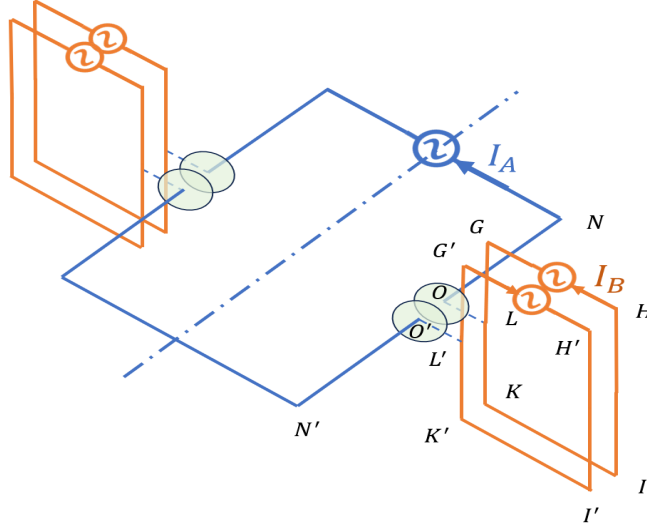


Figure 3: A simplified diagram of a novel AC-powered propulsion system. Capacitors are placed at open sections between points O and O' while secondary circuits are positioned for upward directional force generation. Secondary circuits are identical and symmetrical with respect to the main circuit plane (i.e., $GL = LK$).

The circuit design presented in Figure 3 aims to produce a net upward force. Segments GH and IK , as well as $G'H'$ and $I'K'$, negate each other's effects. KG and $K'G'$ contribute the most to the upward force, while HI and $H'I'$ have lesser contributions due to their distances, as outlined in equations (7) or (6). The Alternative current in circuit $GHIK$ is out-of-phase with that of $G'H'I'K'$ to prevent force cancellation. The selection of AC is sinusoidal here. Therefore, the average force is half of the maximum force. There are no limitations on the number of open sections or turns in either the primary or secondary circuits, allowing for scalable force generation. However, we'll consider a simple application here. An alternating current of $|I_A| = |I_B| = 1000$ amps is used for both the primary and secondary circuits. The distance between O and O' varies, and GL and LK lengths are chosen 15cm each. To minimize counteracting forces, the wire HI is positioned further away, at a distance of 25 cm . The secondary circuits are positioned opposite on each side to cancel out the moment produced in the main circuit and maintain symmetry. The capacitor radius has been set at 0.8 cm . This small size was chosen primarily to focus on the forces exerted by the wires on each other. However, there is no limitation on the size of the capacitor. The net force is computed numerically

from the Equations (8) and (14)¹³. Figure 4(a) illustrates the average net force for varying distances between point L (in the secondary circuits) and the main circuit, ranging from 1cm to 20cm . Figure 4(b) illustrates the effect of distance between the gap OO' on produced average net force. The alternative current is assumed to be sinusoidal, and consequently, the force will be proportional to $\sin^2(\omega t)$ where ω is the frequency of the alternating current. The average force produced here is independent of the frequency for the sinusoidal profile and is half of the maximum force.

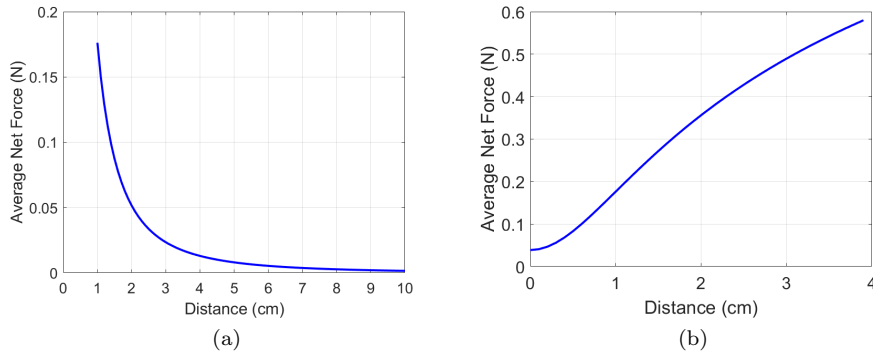


Figure 4: The average net force produced in the setup depicted in Figure 3, as a function of (a) the distance between secondary and main circuits (with a fixed $OO' = 1\text{cm}$) (b) the OO' distance (with a fixed initial distance of 1 cm between the main and secondary circuits).

To understand how open sections can break force symmetry, consider the contribution of directional force (described by the first integral in Equation (3)) exerted by a unit length at the midpoint of line KG on a unit length along line NN' . This force is plotted for continuous and discontinuous (with open sections) cases. Figure 5(a) illustrates the symmetry of directional forces in a continuous wire, leading to overall cancellation and no net force production. In contrast, Figure 5(b) demonstrates how open sections break this symmetry, resulting in a nonzero net force. In practice, when there are no open sections, fixing secondary circuits creates an electric motor that produces net torque on the primary circuit. This force is produced by coupled forces that cancel each other out. Introducing a gap breaks the symmetry by omitting the part of the wire carrying force, consequently resulting in a small thrust and rotation. The

¹³In practice, mutual coupling inherently exists between wire systems, potentially affecting the uniformity of current distribution. However, our calculation assumes weak coupling due to specific factors: secondary wire currents are perpendicular to the primary current, minimizing their impact on the produced electromotive force (EMF). Additionally, the two secondary wires are out of phase, canceling each other's influence. Based on these assumptions, the current distribution is imposed uniformly within the circuit rather than derived from solving a coupled system. While this simplifies the model, it does not undermine the fact that net force generation is possible, as outlined in the previous section.

induced moment can be canceled by introducing appropriate symmetries in the circuit setup, ultimately yielding a net thrust.

To effectively mitigate the capacitive reactance in the circuit, it is possible to use a two-element LC circuit by adding an appropriate inductor and setting the main circuit's operating frequency to match its natural resonant frequency. The design of the secondary circuit can also be modified to match this frequency. The power of proposed propulsion systems can be significantly enhanced by incorporating multiple turns and open sections. For example, using 20 turns and 20 sets of open sections instead of one can increase the forces depicted in Figure 4 by a factor of 400. For instance, by selecting a distance of 1 cm for the open section gap and the distance between the secondary and the primary circuits, we could potentially generate a force of approximately five kilograms. This force is sufficient to accelerate a probe with the mass of Voyager 1 (approximately 722 Kg) [24] such that it reaches the same distance traveled by Voyager 1 (up to January 2024) in less than a year¹⁴. This cannot be achieved with traditional propellant-based propulsion systems, as they require a vast amount of mass for constant acceleration.

Incorporating superconductors into this propulsion system could provide significant advantages and expand its potential applications to include terrestrial and aviation transportation. Unlike traditional electric motors, which lose energy through friction within their mechanical parts, this proposal eliminates such losses due to its lack of moving components. This characteristic paves the way for a highly efficient propulsion system.

¹⁴This hypothetical example assumes that the equipment providing energy is not attached to the probe. The emphasis is on demonstrating how a small but constant force, over time, can generate sufficient velocity to traverse vast distances. However, the primary challenge isn't the amount of thrust but the energy required to achieve very high kinetic energy. A probe could have thousands of open sections, and wire turns instead of the twenties mentioned in the example. The force is scalable, but ultimately, the needed energy is the limiting factor. Another proposal involves allowing the probe to orbit the sun, converting solar energy into kinetic energy by accelerating and increasing speed as it moves to orbits with higher escape velocities.

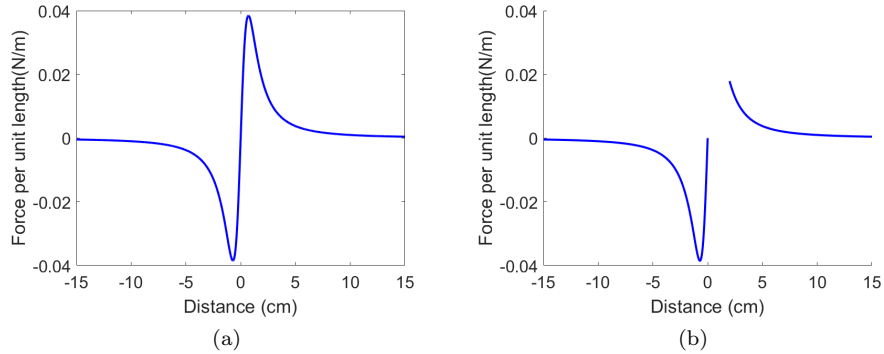


Figure 5: Directional force exerted by a unit length at the midpoint of line KG on a unit length along line NN' for two cases: (a) no open sections, and (b) a 2cm gap for the open section. The gap causes symmetry breaking. The maximum current in both main and secondary circuits is 1000 amps.

Conclusions

This research explored the breaking of symmetry in interaction forces of discontinuous circuits. It is demonstrated that in closed circuits, force interactions adhere to classical physics' expectations of reciprocity. Contrarily, this symmetry breaks in discontinuous circuits and can lead to a resultant magnetic force. This claim aligns fully with the Lorentz force and interacting fields.

MATLAB Code Availability

The MATLAB code used for plotting Figure 4(a) can be accessed and downloaded from the following GitHub repository:

Magnetic Force Generation MATLAB Code

This repository contains the full implementation of the numerical procedures described in this paper. Other plots can be generated with a slight modification of this code.

Acknowledgments

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Call for collaboration

Ideas regarding this work are developed and patented. I extend an open invitation for collaboration and support to develop these concepts further to benefit the scientific community and humanity.

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