OPINION ARTICLE

Reevaluation and correction of Maxwell's Equations: a magnetic field has a source, a moving electric charge [version 1; peer review: 2 not approved]

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Abstract

Maxwell's Equations are considered to summarize the world of electromagnetism in four elegant equations. They summarize how electric and magnetic fields propagate, interact, how they are influenced by other objects and what their sources are. While it is widely accepted that the source of a magnetic field is a moving charge, one of the equations instead states that the magnetic field has no source. However, it is widely accepted that a magnetic field cannot be created without a moving electric charge. As such, here, after carefully reevaluating how Maxwell derived his equation, a limitation was identified. After adjustments, a new equation was derived that instead demonstrates that the source of a magnetic field is a moving charge, confirming experimentally verified and widely accepted observations.

Keywords

Maxwell Equation, magnetism, electromagnetism, field

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Introduction

James Clerk Maxwell [1831–1879] was a pioneer in studying the propagation of electromagnetic waves^{1–5}. He unified his observations with Faraday's, Gauss's and Ampere's Laws into a set of four equations, known as Maxwell's Equations (Figure 1)^{1–9}. Maxwell's Equations summarize the world of electromagnetics in four elegant equations that state: (a) an electric charge is the source of an electric field; (b) a moving electric charge results in a magnetic field; (c) a changing magnetic field results in an electric field; (d) a magnetic field has no source (Figure 1)¹. As such, Maxwell's Equations summarize the source of electric and magnetic fields, and also describe how they are interlinked. Simultaneously, Maxwell's Equations also demonstrated for the first time that electromagnetic waves and visible light have the same speed and are essentially the same^{1,2,6}. As such, the equations provide also an equation for light and its origin, making them of fundamental importance to physics and life. To illustrate their importance, the biblical quote "And God said let there be light, and there was light"¹⁰ has been jokingly altered by physicists and is also found displayed on various merchandise: "And God said [Maxwell's equations], and there was light"¹¹.

Here, I revisit one of Maxwell's Equations, which shows that a magnetic field has no source. By carefully reanalyzing how this equation was derived, I show that this equation ought to be adjusted as a substitution has not been made. After the revisions presented here, the equation now demonstrates that a magnetic field has a source, namely a moving electric charge. In fact, this adjusted equation confirms experimental observations. It is widely accepted and an undisputed experimental observation that a moving electric charge gives rise to a magnetic field^{5,6,12–14}. Without a moving electric charge, or in other words without a source, no magnetic field exists. The calculations presented here identify that an essential substitution was not made in one of Maxwell's Equations, which ought to be revised. When adjusted

for the substitution, the equation shows a different conclusion: instead of showing that a magnetic field has no source, the equation now demonstrates that the magnetic field has an actual source, and that the source is a moving electric charge.

Electric and magnetic fields can be described by different vectors

In physics, a field is a region in which each point is affected by a force^{5–7,9}. For example, objects fall to the ground as they are affected by the force of a gravitational field¹⁵. An electrical field surrounds an electrical charge and it repels or attracts other charges^{5–7,9}. An electromagnetic field is caused by the motion of an electric charge^{5–7,9}. A stationary charge will only give rise to an electric field. Only if such charge is moving, a magnetic field is produced^{5–7,9}.

An electric field can be described by two vectors: the external electric field E and the electric displacement field D , which is also known as the dielectric displacement field. D describes the vector field in a non-conducting medium, a dielectric, which is an electrically insulating material⁶. D is proportional to E , but they differ: External materials such as dielectrics change the effective electric field E , while D remains constant^{5,6}. In other words, D can be regarded as a constant of the system being studied, while E is the variable vector of the electric field in that system. The relationship between E and D is summarized with the equation $D = E \cdot \epsilon_0 \cdot \epsilon_r$, with ϵ_0 being the dielectricity constant of the vacuum and ϵ_r the dielectricity of the material^{5,6}.

Analogous to the electric fields E and D , two different vectors are used to describe magnetic fields: one is called magnetic flux density or magnetic induction, and is symbolized by B ; the other is called magnetic field strength or magnetic field intensity, abbreviated as H . B is proportional to H , but they differ; external materials such as diamagnetics or ferromagnetics

$$\begin{aligned}
 \text{(a)} \quad & \oint E \cdot dA = \frac{Q}{\epsilon_0 \cdot \epsilon_r} \\
 \text{(b)} \quad & \oint B \cdot dx = \mu_0 \cdot \mu_r \cdot I + \mu_0 \cdot \mu_r \cdot \epsilon_0 \cdot \epsilon_r \cdot \frac{d}{dt} \int E \cdot dA \\
 \text{(c)} \quad & \oint E \cdot dx = -\frac{d}{dt} \int B \cdot dA \\
 \text{(d)} \quad & \oint B \cdot dA = 0
 \end{aligned}$$

Figure 1. Maxwell Equations: four equations that summarize the field of electromagnetism^{1–9}. **a**, an electric charge is the source of an electric field^{1–9} (E : external electric field, A : area; Q : electric charge; ϵ_0 : dielectricity constant of the vacuum, ϵ_r : dielectricity constant of the material). **b**, a moving electric charge results in a magnetic field^{1–9} (B : magnetic field intensity, x : distance from current, μ_0 : permeability constant of the vacuum, μ_r : permeability constant of material, ϵ_0 : dielectricity constant of the vacuum, ϵ_r : dielectricity constant of the material, I : electric current, t : time, E : external electric field, A : area). **c**, a changing magnetic field results in an electric field^{1–9} (E : external electric field, x : distance from current, t : time, B : magnetic field intensity, A : area). **d**, a magnetic field has no source^{1–9} (B : magnetic field intensity, A : area).

change the magnetic field intensity H , while B remains constant (Figure 2b)^{5,6}. As such, B can be regarded as a constant of the system being studied, while H is the variable vector of the electric field in that system. The connection between B and H is represented by $B = H \cdot \mu_0 \cdot \mu_r$, with μ_0 being the permeability constant of the vacuum and μ_r the permeability constant of the material^{5,6}.

Even though E and B are the most commonly used field vectors to describe electric and magnetic fields, respectively, they are not equivalents. This is important to highlight. Instead, D and B are equivalents, as D and B both do not change upon the addition of external materials such as dielectrics or diamagnetics. Similarly, E and H are equivalents, as they are not influenced by such external materials (Figure 3)^{5,6}.

Flow definition of electric and magnetic fields through a surface are not equivalent

To describe the flow of an electric field through a given surface A , the electric flux ψ is used. Similarly, the magnetic flux ϕ is a measure of a magnetic field through a given surface A ^{5,6}. Both depend on the field's vectors: ψ has been defined by E through $\psi = \oint E \cdot dA$, while ϕ has been defined through B , with $\phi = \oint B \cdot dA$ ^{5,6}. Although these flux definitions might seem equivalent, they are not: ψ has been defined using the electric field

vector E that changes with external materials, while ϕ has been defined based on the magnetic field vector B , which remains constant if for example diamagnetics are introduced into the system. As such, within a given system, the flux of the electric field is defined by a variable vector of the electric field, namely E , which can change. However, the flux of the magnetic field has been defined by a constant vector of the magnetic field, B , which remains constant even if diamagnetics are introduced into the system. Hence, the flux of electricity and magnetisms are not equivalent, as ψ is based on the variable vector E , while ϕ is based on a constant vector B ^{5,6}. However, B depends on the variable vector H , with $B = H \cdot \mu_0 \cdot \mu_r$, and E on the constant vector D , with $D = E \cdot \epsilon_0 \cdot \epsilon_r$ ^{5,6}. As such, both ψ and ϕ can also be described with constant or variable field vectors:

$$\psi = \oint E \cdot dA = \oint \frac{D}{\epsilon_0 \cdot \epsilon_r} \cdot dA \quad \text{with } E \neq \text{constant and } D = \text{constant} \quad (1)$$

$$\phi = \oint B \cdot dA = \oint H \cdot \mu_0 \cdot \mu_r \cdot dA \quad \text{with } H \neq \text{constant and } B = \text{constant} \quad (2)$$

Maxwell's Equations: electric field source

One of Maxwell's Equation focuses on ψ , and shows $\psi = \oint E \cdot dA = \frac{Q}{\epsilon_0 \cdot \epsilon_r}$, that which demonstrates that an electric charge is the source of an electric field (Figure 1a)^{5,6}. This equation is derived from $\psi = \oint E \cdot dA$, and is applied onto one

Figure 2. Electric and magnetizing field intensity can change under different conditions^{5,6}. **a**, Example of an electric field along a capacitor: external factors such as capacitors and dielectrics change the external electric field (E) vector, while the electric displacement field (D) vector remains constant^{5,6}. **b**, Example of a magnetic field along a ring coil: external factors such as gaps in a coil, diamagnetics or ferromagnetics change the magnetic field intensity (H) vector, while the magnetic induction field (B) vector remains constant^{5,6}.

	Electric Field Vectors	Magnetic Field Vectors
Not changed by external materials	D	B
Changed by external materials & variable vector in a given system	E	H
Relationship	$\mathbf{D} = \mathbf{E} \cdot \epsilon_0 \cdot \epsilon_r$	$\mathbf{B} = \mathbf{H} \cdot \mu_0 \cdot \mu_r$
Dependency on Charge Q	$\mathbf{E} = \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{\mathbf{Q}}{r^2}$	$\mathbf{H} = \frac{1}{2\pi r} \cdot \frac{\mathbf{Q}}{t}$

Figure 3. Electric and magnetic fields can be both be described by two vectors^{5,6}. The vectors D and E both describe electric fields, while the vectors B and H describe magnetic fields. D and B are equivalent vectors, as both do not change upon the addition of external materials such as dielectrics or diamagnetics, respectively^{5,6}. In contrast, E and H are equivalent vectors, as they are not influenced by such external materials. The relationships between D and E, and between B and H are interlinked with permeability (μ_0 and μ_r) dielectricity (ϵ_0 and ϵ_r) constants, respectively. Both E and H depend on the electric charge Q, and its distance r away from that charge, and in the case of H also on how the electric charge Q changes over time t^{5,6}.

electric point charge Q^{5,6}: the electric field of an electric point charge is defined by radial coordinates. As such, E is proportionate to the point charge Q, but decreases with increased radial distance away from that charge. The electric field dependency on an electric charge is summarized by the following equation $E = \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{Q}{r^2}$

(Figure 3)^{5,6}. Substituting E within the ψ equation, gives rise to Maxwell's equation that shows that an electric charge is the source of an electric field^{1,2,5-9}.

$$\psi = \oint \mathbf{E} \cdot d\mathbf{A} = \oint \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{Q}{r^2} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0\epsilon_r} \quad (3)$$

Maxwell's Equations: magnetic field source

Analogous to the above, another of Maxwell's equations focuses on ϕ , and states that $\phi = \oint \mathbf{B} \cdot d\mathbf{A} = 0$ ^{5,6}. This equation illustrates that a magnetic field has no source^{5,6}. This equation is derived based on the argument that B is constant, and does not change. As such, B entering an area (B_1) and B exiting (B_2) the same area is the same. With $B_1 = B_2$, the following Maxwell equation was derived^{1,2,4-9}:

$$\phi = \oint \mathbf{B} \cdot d\mathbf{A} = B_1 \cdot dA - B_2 \cdot dA = 0 \quad \text{with } B_1 = B_2 \text{ as B is constant} \quad (4)$$

$$\oint \mathbf{B} \cdot d\mathbf{A} = 0 \quad (5)$$

Effect on Maxwell's equation when substituting variable vector with constant vector in electric flux calculation.

Both of the above equations by Maxwell are derived from the equation describing the flux of the electric or magnetic field through a surface A, as shown in Equation (3) and Equation (5)^{1,2,4-9}. However, unlike ψ , which is usually represented by the variable vector E, ϕ is most commonly represented by the constant vector B^{1,2,4-9}. However, both electric and

magnetic flux can ultimately be described by variables of the electric or magnetic fields, as shown in Equation (1) and Equation (2). As such, they also ultimately depend on such variables and have to be taken into account. If not, relationships and dependence of variables are eliminated incorrectly.

For example, as outlined above in Equation (3), Maxwell has shown that ψ can be expressed through $\psi = \oint \mathbf{E} \cdot d\mathbf{A} = \frac{Q}{\epsilon_0 \cdot \epsilon_r}$ ¹⁻⁹. To derive this equation, the variable E was replaced by the electric charge Q (Figure 3)¹⁻⁹. He applied Coulomb's law¹⁻⁹. However, what if he instead of $E = \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{Q}{r^2}$ used $E = \frac{D}{\epsilon_0 \cdot \epsilon_r}$ for the substitution, which is derived from the relationship $D = E \cdot \epsilon_0 \cdot \epsilon_r$ ¹⁻⁹. If E is substituted by $E = \frac{D}{\epsilon_0 \cdot \epsilon_r}$ in the ψ equation, the following relationship is obtained, in which ψ is only represented by constants and a constant vector.

$$\psi = \oint \mathbf{E} \cdot d\mathbf{A} = \oint \frac{D}{\epsilon_0 \cdot \epsilon_r} \cdot d\mathbf{A} \quad (6)$$

Next, following Maxwell's argument that he used in deriving his Equation (4): D, as well as ϵ_0 and ϵ_r are constants that do not change. As such, D entering an area (D_1) and D exiting (D_2) the same area is the same. Also, the material constants ϵ_0 and ϵ_r remain the same. As such, $\frac{D_1}{\epsilon_0 \cdot \epsilon_r} = \frac{D_2}{\epsilon_0 \cdot \epsilon_r}$. Following Maxwell's reasoning and calculation (4), the following conclusions could be made:

$$\psi = \oint \mathbf{E} \cdot d\mathbf{A} = \oint \frac{D}{\epsilon_0 \cdot \epsilon_r} \cdot d\mathbf{A} = \frac{D_1}{\epsilon_0 \cdot \epsilon_r} \cdot dA - \frac{D_2}{\epsilon_0 \cdot \epsilon_r} \cdot dA = 0 \quad \text{with } D_1 = D_2 \text{ as D is constant} \quad (7)$$

The above reasoning leading to calculation (7), which Maxwell applied to his calculations with ϕ ¹⁻⁹, one would obtain an equation shown below (8), which illustrates that an electric field has no source.

$$\oint \mathbf{E} \cdot d\mathbf{A} = 0 \quad (8)$$

Although Equation (8) might appear mathematically correct, it is not: ψ is experimentally dependent on the variable E , which in turn is dependent on the electric charge Q , summarized in Coulomb's law $E = \frac{1}{4\pi\epsilon_0\epsilon_r} \cdot \frac{Q}{r^2}$ (Figure 3)¹⁻⁹. Hence, because of E 's dependence on Q , $\psi(Q)$, $\oint E \cdot dA \neq 0$, if Q is not zero.

Maxwell's equation changes when substituting constant vector with variable vector in magnetic flux calculation

Overall, functions are defined by variables that cannot be ignored as otherwise wrong conclusions are drawn. However, this is what occurred when the equation $\oint B \cdot dA = 0$ was derived¹⁻⁹: Even though B is a constant, it is dependent on H , a variable of

the magnetic field. This dependence was not considered in the calculation of one of Maxwell's equations that analyzed the source of the magnetic flux ϕ ¹⁻⁹.

As such, here, the ϕ calculation is reanalyzed: ϕ is defined by B in a given area A , through $\phi = \oint B \cdot dA$ ¹⁻⁹. The magnetic field and the vector B are known to depend on an electric current I , which is a variable of B and cannot be ignored^{5,6}. Analogous to Coulomb's law that describes E ^{5,6}, the Biot-Savart law, $B = \frac{\mu_0 \cdot \mu_r}{2\pi r} \cdot I$, describes the dependence of B on I ^{5,6}: B is proportionate to the electric current I along its path x , but decreases with increased radial distance r away from I (Figure 4a)^{5,6}. This is true for B along a straight current-carrying wire. For an arbitrary shape current, for example surrounding a moving charge,

Figure 4. The magnetic induction field surrounding a wire^{5-8,13}. **a**, The magnetic induction field (B) is dependent on several variables: the electric current (I) and the radial distance away from I , as well as μ_0 , and μ_r , with μ_0 being the permeability constant of the vacuum and μ_r the permeability constant of the material^{5-8,13}. **b**, Illustration of the magnetic induction field going through a surface surrounding a point charge^{5-8,13}: the magnetic induction field (B) going through a circular surface A perpendicular to B can be described by the electric current (I) and the vectors r and dx defining the circular surface A , with $dA = 2\pi \cdot r \cdot dx$. All vectors r , x and B are perpendicular to each other.

an integral calculation can be carried out (Figure 4b)^{5,6}. Since the electric current I is defined by the rate of flow of an electric charge through $I = \frac{Q}{dt}$ ^{5,6}, B can also be defined as:

$$\phi = \oint B \cdot dA = \oint \frac{\mu_0 \cdot \mu_r}{2\pi r} \cdot I \cdot dA = \frac{\mu_0 \cdot \mu_r}{2\pi} \oint \frac{1}{r} \cdot \frac{Q}{dt} \cdot dA \quad \text{with Biot - Savart law and } I = \frac{Q}{dt} \quad (9)$$

In the integral ϕ equation over an area, the area A can be also be replaced by two vectors representing the area, r and x , with x being the vector along the path of the electric charge Q , while r is the distance between Q and the position of B (Figure 4b). All vectors are perpendicular to each other. In case of one electric point charge, the magnetic field at that point can be best described by a circular surface area $dA = 2\pi \cdot r \cdot dx$ (Figure 4b). Furthermore, since $\frac{dx}{dt}$ describe the velocity v of the electric charge Q , the following equation can be derived:

$$\phi = \frac{\mu_0 \cdot \mu_r}{2\pi} \oint \frac{1}{r} \cdot \frac{Q}{dt} \cdot dA = \frac{\mu_0 \cdot \mu_r}{2\pi} \int \frac{1}{r} \cdot \frac{Q}{dt} \cdot 2\pi \cdot r \cdot dx = \mu_0 \cdot \mu_r \int \frac{1}{r} \cdot r \cdot Q \cdot \frac{dx}{dt} = \mu_0 \cdot \mu_r \int Q \cdot dv \quad (10)$$

$\text{with } dA = 2\pi \cdot r \cdot dx \text{ and } dv = \frac{dx}{dt}$

Therefore, the following relationship for the magnetic field can be derived:

$$\phi = \oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv \quad (11)$$

The equation $\oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv$ illustrates that a charge in motion is the source of the magnetic field. As such, one could also write the magnetic field as $\phi(Q, v)$, analogous to $\psi(Q)$, which summarizes the electric field's dependence on the electric charge Q . The above equation summarizes what is already well known in physics: a moving electric charge is the source of a magnetic field^{5-7,12-14}: only when no electric charge is in motion, no magnetic field exists^{5-7,12-14}. This is what has been also experimentally verified and is widely accepted^{5-7,12-14}.

As a control for the calculations above that lead to $\oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv$ one could also consider Ampere's law: Ampere's law states $\int B \cdot ds = \mu_0 \cdot \mu_r \cdot I = \mu_0 \cdot \mu_r \cdot \frac{Q}{dt}$ ^{5,6}. As a simple control, when adding an additional dimension to Ampere's law through the addition of another vector dx , newly derived equation from above is derived, confirming Equation (11) in a different way $\phi = \oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv$.

Discussion

Maxwell's Equations summarize the electromagnetic field¹⁻⁹. One of the equation's, $\oint B \cdot dA = 0$, deduces that a magnetic field has no source¹. This is in contrast to what is experimentally known, namely that a moving electric charge gives rise to the magnetic field^{5-7,12-14}. Also, a magnetic field cannot be created without this source, hence, it has a source, namely a moving electric charge. This is essential, as without this source, no magnetic field exists^{5-7,12-14}.

Here, after carefully reevaluating how Maxwell derived the equation $\oint B \cdot dA = 0$ ¹, a shortcoming was identified: A substitution has not been made, eliminating an existing experimental finding¹. Although $\oint B \cdot dA = 0$ still applies when a charge is not in motion, Maxwell's equation ignored the dependence of the magnetic field on variables¹. Here, when taking into account such variables and making appropriate substitutions, the adjusted Maxwell's equation instead demonstrates that the source of a magnetic field is a moving charge: $\oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv$

This adjustment has consequences on science. For example, Schrödinger's Equation that describes the probability waves of small particles, has been for example applied to describe the hydrogen atoms characteristics¹⁶⁻¹⁹. It used Maxwell's Equation $\oint B \cdot dA = 0$ to derive such characteristics¹⁶⁻¹⁹. However, with $\oint B \cdot dA = \mu_0 \cdot \mu_r \int Q \cdot dv$, Schroedinger's Equation ought to be revisited, as it is only true when a moving charge is not in motion.

Overall, it is important to adjust one of Maxwell's Equations¹, to have a more complete understanding and representation of the world through formulas. After all, if "God said $\oint B \cdot dA = 0$ ", there would be no light".

Data availability

All data underlying the results are available as part of the article and no additional source data are required.

Acknowledgements

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The report presents some notes on Maxwell's equations with emphasis on the source of magnetic field and moving electric charge. The contribution of the report to the body of knowledge is significant and novel. It is noteworthy that the objectives of the research study are within the scope of your Journal. But, the present form of the report needs a revision using the comments and the technical questions/observations listed below:

1. Considering the nature of the research methodology, it would not be appropriate to title the report re-evaluation and correction. Hence, revision of the title is needed. The author may or may not consider the title below:

Notes on the moving electric charge and source of magnetic field: revised version of Maxwell equation.

2. Abstract:

It was written: "They summarize how electric and magnetic fields propagate, interact, how they are influenced by other objects and what their sources are."

The literature presents the influence of other objects, sources, propagation and interaction of electric and magnetic fields. The keywords were written as, "Maxwell Equation, magnetism, electromagnetism, field". I suggest to increase this to five keywords.

It was written: "After adjustments, a new equation was derived that instead demonstrates that the source of a magnetic field is a moving charge, confirming experimentally verified and widely accepted observations."

The phrase, "after adjustments" is not appropriate in that context. Is the research methodology all about adjustments? Note that an effective Abstract is a global paragraph that prepares the reader for the rest of the document. It is expected that the abstract should present (1) the significance of the study, (2) the aim of the study, (3) the research methodology, (4) the conclusion drawn from the study.

3. Figure 1 should be converted to written equations. Citation of figure 1 is not appropriate because of reference purposes.
4. There are some cases of wrong usage of pronoun in the manuscript which is a scientific report. For instance:
 - a) Page 2 of 9, it was written, "Here, I revisit one of Maxwell's Equations, which shows that a magnetic field has no source."
 - b) Page 2 of 9, it was written, "By carefully reanalyzing how this equation was derived, I show that this equation ought to be adjusted as a substitution has not been made."

Comment: I suggest revising this and avoid the use of the pronoun, "I".

5. All the sections and subsections should be given a number. After Eq. 3 in page 4 of 9, it was written, "Maxwell's Equations: magnetic field source". Under this unnumbered section, it was written that, "Maxwell's equations focus on ϕ ". What is phi in that context?

Page 4 of 9, before Eq. 6, it was written, "For example, as outlined above in Equation (3), Maxwell has shown that Ψ can be expressed through $\Psi = \oint \mathbf{E} \cdot d\mathbf{A} = \dots$ equation, the following relationship is obtained, in which is only represented by constants and a constant vector". This argument is not clear. Try to revise. More so, what do you mean by, "He applied Coulomb's law 1-9." Do not use any form of pronoun in a scientific report. Also, why would you write, "However, what if he instead of..." Please revise this.

6. The argument presented in this report is not guided by the objectives of the research. This may be the reason the authors write out of point in many sections of the report. Could you please write all the objectives down? Then ensure you are guided by the actualization of these objectives.
7. The report has no conclusion section? Why? In a short conclusion, state the most important outcome of the work based on the interpreted discussion. Did you just come up with any conclusion as you deemed fit? What are the objectives? I suggest listing all the objectives of the study and then showing how the conclusion relate to the research objectives.
8. After reading the entire report, it is worth noting that the author needs to revise the entire report to address the following points:
 - a) present the limitation of the Maxwell equation
 - b) show that the source of a magnetic field is a moving charge.
9. I suggest to update the introduction with the fact that the Maxwell equation is useful within the scope of fluid dynamics:
The dynamics of various fluids on inclined magnetic field by Ref. A *et al.* (2020), subject to Lorentz force by Ref B *et al.* (2022), aligned magnetic field effects by Ref. C *et al.* (2017), and magnetic flux density by Ref. D *et al.* (2022) are some of the applications of Maxwell

equation within the scope of fluid dynamics.(ref-1), (ref-2), (ref-3), (ref-4).

Sources:

- **Ref. A et al.** (2020) Case Studies in Thermal Engineering 17, 100571, 2020.(ref-1)
- **Ref. B et al.** (2022) Ratio of Momentum Diffusivity to Thermal Diffusivity: Introduction, Meta-analysis, and Scrutinization.(ref-2)
- **Ref. C et al.** (2017) Journal Article published May 2017 in Physica E: Low-dimensional Systems and Nanostructures 89, 33 - 42.(ref-3)
- **Ref. D et al.** (2022) Surfaces and Interfaces 28, 101654.
<https://doi.org/10.1016/j.surfin.2021.101654>.(ref-4)

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1. Al-Mdallal Q, Indumathi N, Ganga B, Abdul Hakeem A: Marangoni radiative effects of hybrid-nanofluids flow past a permeable surface with inclined magnetic field. *Case Studies in Thermal Engineering*. 2020; **17**. [Publisher Full Text](#)
2. Animasaun IL, Shah NA, Wakif, Mahanthesh B, et al.: Ratio of Momentum Diffusivity to Thermal Diffusivity: Introduction, Meta-analysis, and Scrutinization. *Taylor*.
3. Rashid I, Ul Haq R, Al-Mdallal Q: Aligned magnetic field effects on water based metallic nanoparticles over a stretching sheet with PST and thermal radiation effects. *Physica E: Low-dimensional Systems and Nanostructures*. 2017; **89**: 33-42 [Publisher Full Text](#)
4. Animasaun I, Yook S, Muhammad T, Mathew A: Dynamics of ternary-hybrid nanofluid subject to magnetic flux density and heat source or sink on a convectively heated surface. *Surfaces and Interfaces*. 2022; **28**. [Publisher Full Text](#)

Is the topic of the opinion article discussed accurately in the context of the current literature?

Yes

Are all factual statements correct and adequately supported by citations?

Partly

Are arguments sufficiently supported by evidence from the published literature?

Yes

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Computational Fluid Dynamics, heat transfer, nanofluids.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 06 December 2021

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The article states that, in their current form, Maxwell's equations state that the magnetic field does not have a source. This comes from the $\text{Div}(\mathbf{B})=0$ equation. Since moving charges can give rise to magnetic fields, the author claims that Maxwell's equations need to be modified. In particular the $\text{Div}(\mathbf{B})=0$ should be replaced by a source on the right hand side.

This article does not justify such a radical step.

The premise, that the magnetic field does not have a source is incorrect. The sources are the current, $\mathbf{I}$, and the rate of change of $\mathbf{D}$. They simply couple through the curl of $\mathbf{H}$, instead of the divergence. They have to be consistent with the well established observation that there are no magnetic monopoles, i.e. $\text{Div}(\mathbf{B})=0$. As noted in equation (4) this simply states that any magnetic flux line which enters a closed surface must also leave.

There are numerous mathematical errors which makes following the maths difficult. The last equation on figure 3 $H=1/(2\pi r)*(Q/t)$ cannot be correct as this would make H equal infinity when $t=0$. It is possible the author meant $H=1/(2\pi r)*(dQ/dt)$. This would be consistent with $\text{Div}(\mathbf{B})$ not equal zero.

Equation (9) has a term $(I=Q/dt)$. This is not meaningful.

There are integral signs missing in equation (7).

The bibliography contains only one recent peer reviewed article and that is a pedagogical one. It is also not clear if F1000 is the correct journal for articles about fundamental physics.

This article is not acceptable for indexing.

Is the topic of the opinion article discussed accurately in the context of the current literature?

No

Are all factual statements correct and adequately supported by citations?

No

Are arguments sufficiently supported by evidence from the published literature?

No

Are the conclusions drawn balanced and justified on the basis of the presented arguments?

No

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Mathematical Physics, Electrodynamics, Differential geometry, General Relativity.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

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