Why A Magnet Sticks to a Fridge

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Abstract

This report explores the properties of a permanent magnet's field and provides a detailed theory explaining why a magnet adheres to a magnetic surface, such as a fridge. Central to this explanation is the dynamic behavior of a magnet's field lines, which exhibit repulsion when parallel, tension that structures their configuration, and interaction mechanisms with magnetic or conductive surfaces. This theory uses hydrodynamic analogies, field line behavior, and established mathematical frameworks to provide a novel interpretation of magnetic attraction and its implications for broader electromagnetic phenomena.

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1. Introduction

A breif understanding of time and space is needed to understand properties of a magnetic field. Magnetic field lines are real and tangible. Therefore magnetic field lines take up space and exist therefore they take up time. The phenomenon of a magnet sticking to a fridge is often explained in classical physics through the alignment of magnetic domains in ferromagnetic materials. While this explanation does describe the general interaction, it does not delve deeply into the intrinsic properties of magnetic field lines, such as their repulsion, tension, and dynamic behavior when interacting with magnetic or conductive surfaces. This report develops a detailed theoretical framework to address these properties, offering a richer understanding of how magnets interact with their environment. By incorporating hydrodynamic analogies, exploring field line dynamics, and integrating mathematical principles, this theory provides new insights into the forces driving magnetic attraction and repulsion.

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2. Properties of Magnetic Field Lines

2.1 Repulsion Between Parallel Field Lines

- Magnetic field lines are have direction and strength to form a magnetic field. They take up time. The field lines are wrapped in a space factor. While the field lines exist they take up space. It is known that space of in harmony with other field line space repels each other which is why field lines of a different direction repel while space lines of the same direction merge.
- **Repulsion**: Field lines repel each other when parallel. This repulsion is intrinsic, preventing field lines from merging or becoming overly dense in space. They take up space.

- **Result**: Field lines maintain even spacing, creating the distinct patterns observed around magnets.

2.2 Field Line Tension

- The time portion of a magnetic field line exhibits **tension**, pulling them toward their source and creating a condensed configuration near the poles of the magnet. The space factor of the field lines prevents the field lines from merging.
- **At the Poles**: Field lines are tightly packed, resulting in high field strength.
- **Away from the Poles**: Field lines expand outward, curving around the magnet to connect the south and north poles.
- This tension-driven structure creates a combined force that is the magnetic field.

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3. Interaction with a Magnetic Surface (e.g., Fridge)

3.1 Field Line Behavior Near a Magnetic Surface

- When a magnet approaches a magnetic surface, such as a fridge, the outer field lines of the magnet extend toward the surface:
    - **Outer Field Lines**: These lines are stretched as they "seek" a magnetic or conductive pathway to complete their circuit.
    - **Increased Tension**: The stretching increases tension in the outer lines, creating a strong pull toward the surface.
- **Inner Field Lines**: With reduced pressure from the outer lines, the inner lines expand slightly to balance the field configuration.

3.2 Magnetic Surface Attraction

The attraction occurs as the magnet's field lines attempt to align with the magnetic or conductive surface of the fridge. However, since the inner magnetic domains in the fridge material cannot fully rotate to align perfectly with the incoming field lines, the lines are further stretched, creating a zigzag pattern as they navigate the misaligned domains. This stretching increases the tension in the field lines, thereby amplifying the pull of the magnet toward the fridge.

As this process unfolds, the inner field lines of the magnet, experiencing less pressure from the stretched outer lines, are able to expand outward and connect to the fridge surface as well. This redistribution of field lines results in a compounding effect: as the surfaces come closer, more field lines are pulled toward the fridge, and the overall magnetic pull increases.

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4. Hydrodynamic Analogy

4.1 Field Lines as High-Pressure Fluid Pathways

- The behavior of magnetic field lines can be likened to **high-pressure hydrodynamics**:
    - Outer field lines act like fluid pathways under high pressure, stretching toward the conductive surface to reduce tension.
    - Inner field lines act like lower-pressure pathways, expanding slightly to redistribute forces.

4.2 Dynamic Redistribution of Field Lines

- Just as fluids flow to minimize pressure differentials, magnetic field lines dynamically redistribute themselves to balance tension and repulsion:
    - Outer lines pull the magnet toward the surface.
    - Inner lines adjust to maintain the field's overall structure.

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5. Mathematical Model of Magnetic Attraction

The force of magnetic attraction at a distance can be expressed using the following principles:

5.1 Magnetic Force Between Dipoles

For two magnetic dipoles m_1 and m_2, the force between them at a distance r is given by:

$$F = \frac{3 \mu_0}{4 \pi} \frac{(m_1 \cdot m_2) - 3 (m_1 \cdot \hat{r})(m_2 \cdot \hat{r})}{r^4}$$

Where:

- μ_0 is the permeability of free space ($4 \pi \times 10^{-7} \, \text{H/m}$).
- m_1 and m_2 are the magnetic moments of the dipoles.
- $\hat{r}$ is the unit vector along the line connecting the dipoles.

This equation highlights the dependence of the magnetic force on the alignment and distance of the dipoles.

5.2 Magnetic Field Strength Near a Magnet

The magnetic field strength B of a dipole at a point in space is:

$$B = \frac{\mu_0}{4 \pi} \frac{2m}{r^3}$$

Where m is the magnetic moment of the magnet and r is the distance from the center of the magnet.

5.3 Magnetic Work and Potential Energy

As the magnet moves closer to the fridge, the work done to align the magnetic domains in the fridge can be calculated by the change in magnetic potential energy:

U=−m·BU = -m \cdot BU=−m·B

Where mmm is the magnetic moment of the magnet, and BBB is the field strength at the surface of the fridge.

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6. Implications for Magnetic and Electric Fields

6.1 Unified Field Dynamics

This theory suggests that magnetic attraction and electrostatic attraction share underlying principles. Both involve field lines that exhibit tension, repulsion, and dynamic redistribution. In magnets, the attraction to conductive or magnetic surfaces is driven by the stretching and alignment of magnetic field lines, while in electrostatics, the attraction of electrons to conductive surfaces may similarly involve the interaction and alignment of electric field lines.

This parallel implies that both phenomena may be governed by a unified set of dynamics, where the behavior of field lines—whether magnetic or electric—determines the nature of the attractive and repulsive forces. Such a connection provides a foundation for deeper exploration of the relationship between magnetic and electrostatic forces and may help unify our understanding of these two fundamental interactions.

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7. Conclusion

This theory provides a detailed framework for understanding why a magnet sticks to a fridge, emphasizing the role of field line repulsion, tension, and interaction with conductive surfaces. By integrating mathematical principles and drawing parallels between magnetic and electrostatic phenomena, this explanation offers a unified perspective on the forces governing magnetic attraction and repulsion. Further exploration of these principles could unify our understanding of magnetic and electric forces, opening new avenues for theoretical and practical advancements.