Journal of High Energy Physics, Gravitation and Cosmology, 2025, 11(4), 1492-1498
https://www.scirp.org/journal/jhepgc
ISSN Online: 2380-4335
ISSN Print: 2380-4327

Magnetism in the World-Universe Cosmology

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How to cite this paper: Netchitailo, V.S. (2025) Magnetism in the World-Universe Cosmology. *Journal of High Energy Physics, Gravitation and Cosmology*, **11**, 1492-1498.
https://doi.org/10.4236/jhepgc.2025.114091

Received: July 28, 2025
Accepted: October 19, 2025
Published: October 22, 2025

Abstract

In electromagnetics, the term *magnetic field* refers to two distinct but closely related vector fields: magnetic flux density $\boldsymbol{B}$ and magnetic field intensity $\boldsymbol{H}$. These fields differ in how they account for the medium and magnetization $\boldsymbol{M}$. In a vacuum, they are related by $\boldsymbol{B} = \mu_0 \boldsymbol{H}$. In a magnetized material, this relation becomes $\boldsymbol{B} = \mu_0 (\boldsymbol{H} + \boldsymbol{M})$. Within the framework of the World-Universe Cosmology (WUC), the Cosmic Medium (CM)—comprising protons, electrons, photons, neutrinos, and Universe-Created Particles (UCPs)—acts as a universal agent governing all physical processes and is inherently a magnetized medium. UCPs, conceptualized as DIRAC dipoles formed by Dirac's magnetic monopoles, possess a magnetic dipole moment proportional to the Bohr magneton. Any local concentration of DIRACs within any material, including CM, induces both a magnetization field $\boldsymbol{M}$ and a magnetic field intensity $\boldsymbol{H}$. This approach to magnetic fields within WUC offers a framework for explaining a wide range of observed magnetic phenomena, including the *dark magnetic field*, the large-scale structure of the Milky Way's magnetic field, and other magnetic effects that are only partially correlated with objects observable in other spectral ranges.

Keywords

World-Universe Cosmology, Cosmic Medium, Universe-Created Particles, DIRAC Dipoles, Dark Magnetic Field, Magnetic Field Intermittency

1. Introduction

Maxwell's equations (ME) form the foundation of classical electrodynamics. They were published by J. C. Maxwell in 1861 [1]. He calculated the velocity of electromagnetic waves from the value of the electrodynamic constant *c* measured by Weber and Kohlrausch in 1857 [2] and noticed that the calculated velocity was very close to the velocity of light measured by Fizeau in 1849 [3]. This observation made him suggest that light is an electromagnetic phenomenon [4].

The value of ME is even greater considering J. Swain's result showing that linearized general relativity admits a formulation in terms of gravitoelectric and gravitomagnetic fields that closely parallel the description of the electromagnetic field by ME [5]. H. Thirring pointed out this analogy in his 1918 paper, "*On the Formal Analogy between the Basic Electromagnetic Equations and Einstein's Gravity Equations in First Approximation*" [6]. It allows us to use formal analogies between Electromagnetism and Gravitoelectromagnetism, first proposed by O. Heaviside in 1893 [7]. The World-Universe Cosmology (WUC) is based on Maxwell's equations [8].

2. Magnetism

Ancient people learned about magnetism from lodestones, naturally magnetized pieces of magnetite. A permanent magnet is an object made from a material that is magnetized and creates its own persistent magnetic field. In electromagnetism, the magnetic dipole moment is the combination of strength and orientation of a magnet or other object or system that exerts a magnetic field.

The classical explanation of a magnetic moment has changed over time. Before the 1930s, textbooks explained the moment using hypothetical magnetic point charges. Since then, most define it in terms of Ampèrian currents. In magnetic materials, the cause of the magnetic moment is the spin and orbital angular momentum states of the electrons, varying depending on whether atoms in one region are aligned with atoms in another.

Magnetic pole model. An electrostatic analog for a magnetic moment consists of two opposing charges separated by a finite distance. The sources of magnetic moments in materials can be represented by poles in analogy to electrostatics, sometimes known as the Gilbert model. In this model, a small magnet is modeled by a pair of *fictitious magnetic monopoles* of equal magnitude but opposite polarity. Each pole is the source of magnetic force, which weakens with distance. Since magnetic poles always come in pairs, their forces partially cancel each other: while one pole pulls, the other repels.

The magnetic force produced by a bar magnet, at a given point in space, depends on two factors: the strength $\boldsymbol{p}$ of its poles (magnetic pole strength), and the vector $\boldsymbol{\ell}$ separating them. The magnetic dipole moment $\boldsymbol{m}$ is related to the fictitious poles as $\boldsymbol{m} = \boldsymbol{p\ell}$. It points in the direction from South Pole to North Pole.

The analogy with electric dipoles should not be taken too far because magnetic dipoles are associated with angular momentum. Nevertheless, magnetic poles are very useful for magnetostatic calculations, particularly in applications to ferromagnets.

3. Analysis of Maxwell's Equations

ME varies with the unit system used. We will not rewrite well-known equations but only provide the relationships between electromagnetic quantities used in ME.

Interested readers are encouraged to consult the referenced article [8] for more details. Table 1 gives the definitions of these quantities in SI units. We stress that the electrodynamic constant c in ME is defined as the *ratio of the absolute electromagnetic unit of charge to the absolute electrostatic unit of charge*, not as a speed of light in vacuum as it is adopted now by contemporary physicists.

Table 1. Electromagnetism.

Charge	Impedance of Electromagnetic Field	Magnetic Flux
q, C	$Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = \mu_0 c, \Omega$	ϕ, Wb
Electric Current	Magnetic Constant	Electric Potential
I, A	$\mu_0, \mathrm{H} \cdot \mathrm{m}^{-1}$	U, V
Magnetic Field Intensity	Electric Constant	Electric Field
$\boldsymbol{H}, \mathrm{A} \cdot \mathrm{m}^{-1}$	$\varepsilon_0 = \left(\mu_0 c^2\right)^{-1}, \mathrm{F} \cdot \mathrm{m}^{-1}$	$\boldsymbol{E}, \mathrm{V} \cdot \mathrm{m}^{-1}$
Electric Flux Density	Electrodynamic Constant	Magnetic Flux Density
$\boldsymbol{D}, \mathrm{C} \cdot \mathrm{m}^{-2}$	$c, \mathrm{m} \cdot \mathrm{s}^{-1}$	$\boldsymbol{B}, \mathrm{Wb} \cdot \mathrm{m}^{-2}$

In ME, there are two physical sources: the total electric charge density ρ_e and the total electric current density $\boldsymbol{J}_e$. According to ME, there are two measurable physical characteristics: energy density ρ_E and energy flux density $\boldsymbol{J}_E$. There are two auxiliary field quantities:

$$\boldsymbol{D} = \varepsilon_0 \boldsymbol{E} + \boldsymbol{P}$$

$$\boldsymbol{H} = \boldsymbol{B} / \mu_0 - \boldsymbol{M}$$

The quantities $\boldsymbol{P}$ and $\boldsymbol{M}$ represent the macroscopically averaged electric dipole and magnetic dipole moment densities of the material medium in the presence of applied fields. Analysis of ME, in which all quantities introduced above are arbitrary functions of space and time, has been done in literature (see, for example, [9] [10]).

K. Brown comments on magnetic dipole fields [11]:

There do, however, exist what appear to be magnetic dipoles, analogous to electric dipoles consisting of adjacent positive and negative electric charges. It might seem as if the existence of magnetic dipoles is indirect proof of the existence of individual magnetic charges, assuming the only way to produce a dipole field is by juxtaposing two oppositely charged magnetic monopoles. However, there is an alternative way of creating a magnetic "dipole" field without actually using magnetic charges. The alternative is an electric current loop. It can be shown that a circular loop of electric current produces a magnetic field that is (outside a spherical region enclosing the loop) nearly identical to the field of two adjacent and oppositely charged magnetic monopoles (if such things existed). So, we have two possible classical models for the source of "magnetic dipole" fields, one based on *the juxtaposition of two oppositely charged magnetic monopoles, and one based on a loop of electric current. These two models might be called Coulombic and Amperean dipoles respectively.*

4. Principal Equations of Electromagnetism

Dirac quantization condition (1)

$$\frac{q_e q_m}{\varepsilon_0 h c^2} \in Z$$

where q_e is electric charge, q_m is magnetic charge, h is the Planck constant, and Z is the set of integers.

Fine-structure constant (2)

$$\alpha = \frac{e^2}{2\varepsilon_0 h c}$$

Bohr magneton (3)

$$\mu_B = \frac{eh}{4\pi m_e} = 9.2740100657(29)\times 10^{-24}\ \text{J}\cdot\text{T}^{-1}$$

ME posit that there is electric charge, but no magnetic charge (monopole) in the World. Magnetic fields arise from moving electric charges and intrinsic magnetic moments associated with spin.

According to WUC, the Cosmic Medium (CM) contains [12]:

- Ordinary particles: protons, electrons with mass m_e and charge *e*, mass-varying neutrinos, and photons.
- **Universe-Created Particles** (UCPs) including fermions: UCF1 (1.3 TeV), UCF2 (9.6 GeV), UCF3 (3.7 keV), UCF4 (0.2 eV) and bosons: **DIRAC** (70 MeV), **ELOP** (340 keV), XION (5.3 μeV).
- DIRACs with rest energy $E_0 = hc/a = 70\ \text{MeV}$, magnetic dipoles formed by Dirac's monopoles. DIRACs are the Coulombic magnetic dipoles, which represent the macroscopically averaged magnetic dipole moment density ***M***.
- ELOPs with mass $2m_e/3$ represent electric dipoles of preons with charge $e/3$. They represent the macroscopically averaged electric dipole density ***P***.

Their energy density in CM is about the proton energy density.

Considering Equation (1) with $q_e = e$, $Z = 1$ and using Equation (2), we get:

$$q_m = \frac{\varepsilon_0 h c^2}{e} = \frac{e^2 c}{2\alpha e} = \frac{ec}{2\alpha} = \mu c$$

where e is the elementary charge and $\mu = e/2\alpha$. Transforming Equation (3), we get:

$$\mu_B = \frac{eh}{4\pi m_e} = \frac{eca}{4\pi\alpha} = \mu c \times \frac{a}{2\pi} \approx 9.274\times 10^{-24}\ \text{A}\cdot\text{m}^2$$

where a is the basic size unit:

$$a = 1.7705641\times 10^{-14}\ \text{m}$$

Thus, a magnetic dipole moment of DIRAC equals μc with a distance between magnetic charges equal to a:

$$\mu_{DIRAC} = \mu c \times a$$

For a concentration of DIRACs n_{DIRAC}, magnetization $\boldsymbol{M}$ is:

$$\boldsymbol{M} = n_{DIRAC} \times \boldsymbol{\mu}_{DIRAC}$$

Magnetization of the strongest Neodymium magnets with the Fe-Fe distance approximately 0.25 nm is:

$$\boldsymbol{M} \sim 10^{6}\ \text{A}\cdot\text{m}^{-1}.$$

The calculated value of DIRAC's concentration is:

$$n_{DIRAC} \sim 1.7\times10^{28}\ \text{m}^{-3}$$

The DIRAC-DIRAC distance is approximately 0.39 nm, close to Fe-Fe distance in Neodymium magnets. We propose replacing the **magnetic pole model** with WUC's **DIRAC magnetic dipole model**.

In classical electromagnetism, polarization $\boldsymbol{P}$ is the macroscopically averaged electric dipole density. In WUC, ELOPs (as electric dipoles $\boldsymbol{d}_{ELOP}$ of preons with charge $e/3$ and separation a) with concentration n_{ELOP} give:

$$\boldsymbol{P} = n_{ELOP} \times \boldsymbol{d}_{ELOP}$$

We emphasize that $\boldsymbol{H}$ and $\boldsymbol{D}$ are not merely auxiliary quantities but represent real field components.

Summary

- Magnetic monopoles are not part of ME; magnetic dipoles DIRAC are.
- To describe electromagnetic propagation through CM, we should modify ME:
  - Consider macroscopically averaged $\boldsymbol{P}$ and $\boldsymbol{M}$ in CM.
  - Include ELOP and DIRAC current densities induced by electromagnetic fields.

5. Modified Maxwell's Equations

Most articles solve ME using steady-state solutions. Harmuth and Lukin [13] [14] highlight the deficiencies in ME and propose transient solutions based on a microscopic description of the medium. They modify ME using electric and magnetic dipole current densities rather than flux densities, treating hydrogen atoms as combinations of dipoles generating currents under electromagnetic field action.

6. Cosmic Magnetism

R. Beck and R. Wielebinski [15] discuss the omnipresence of Cosmic Magnetism: *Most of the visible matter in the Universe is ionized, so that cosmic magnetic fields are quite easy to generate and due to the lack of magnetic monopoles hard to destroy. Magnetic fields have been measured in or around practically all celestial objects. The Earth, the Sun, solar planets, stars, pulsars, the Milky Way, nearby galaxies, more distant (radio) galaxies, quasars, and even intergalactic space in* *clusters of galaxies have significant magnetic fields, and even larger volumes of the Universe may be permeated by "dark" magnetic fields.*

Voyager spacecraft, beyond the heliosphere, observed magnetic field intermittency [16].

WUC explains field and gas flow pattern similarities [17] as DIRAC flows along with diffuse ionized gas. The Milky Way's magnetic field structure [17], dark magnetic fields [18], and other related phenomena can be explained through DIRAC dynamics.

This approach offers answers to cosmic magnetic field origins, such as their appearance in young galaxies and intergalactic fields.

7. Conclusions

- Universe-Created Particles DIRAC are responsible for magnetism.
- Dark magnetic fields and Interstellar magnetic environments confirm DIRAC existence.
- We should develop a comprehensive theory of intergalactic electromagnetic signal propagation, considering WUC's Cosmic Medium.
- WUC can serve as a fundamental basis for Cosmic Magnetism.

Acknowledgements

I express deep gratitude to Academician **A. Prokhorov** and Prof. **A. Manenkov** for their pivotal influence on my scientific path. Eternal thanks to my Scientific Father, **P. Dirac**, whose visionary ideas inspire this work, and to **N. Tesla**, another extraordinary genius. I extend my sincere thanks to Prof. **C. Corda** for publishing my manuscripts in the *Journal of High Energy Physics, Gravitation and Cosmology*. I am also thankful to **H. Ricker** for valuable comments and suggestions that greatly enhanced the clarity of my model.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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