Quantum Cosmology

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Résumé

Résumé. La topologie de la bande de Möbius à cinq dimensions, introduite dans un article précédent [1], unifie les composantes d'impulsion (gravité) et de spin (électromagnétisme) du quantum $G\hbar$. Cette topologie conduit naturellement au spin $1/2$ et à la constante de structure fine $\alpha = 1/137$ comme rapport des nombres quantiques $k_{\text{grav}}/k_{\text{em}}$. Dans le présent travail, nous développons les conséquences cosmologiques de cette structure. Nous montrons que la symétrie miroir de la bande de Möbius donne deux directions de précession — matière et antimatière — et que leur interaction sur de grandes distances produit une anti-gravité. Nous construisons un lagrangien phénoménologique pour deux champs scalaires couplés, Φ_M et Φ_A, et en dérivons une constante cosmologique variable Λ_{eff} qui dépend de la distribution locale des clusters. Nous proposons des tests observationnels utilisant l'anisotropie du paramètre de Hubble et les différences de magnitude des supernovae [10, 11]. La matière noire est interprétée comme énergie cinétique cachée des quanta $G\hbar$, avec un lagrangien effectif couplé à la courbure. La cosmologie qui en résulte est cyclique, exempte de singularité et remplace ΛCDM.

Abstract

Abstract. The five-dimensional Möbius strip topology introduced in a previous paper [1] unifies the impulse (gravity) and spin (electromagnetism) components of the $G\hbar$ quantum. This topology naturally yields spin $1/2$ and the fine-structure constant $\alpha = 1/137$ as the ratio of quantum numbers $k_{\text{grav}}/k_{\text{em}}$. In the present work we develop the cosmological implications of this structure. We show that the mirror symmetry of the Möbius strip gives two precession directions — matter and antimatter — and that their interaction at large distances produces anti-gravity. We construct a phenomenological Lagrangian for two coupled scalar fields, Φ_M and Φ_A, and derive a variable cosmological constant Λ_{eff} that depends on the local cluster distribution. We propose observational tests using Hubble parameter anisotropy and supernova magnitude differences [10, 11]. Dark matter is interpreted as hidden kinetic energy of the $G\hbar$ quanta, with an effective Lagrangian coupled to curvature. The resulting cosmology is cyclic, singularity-free, and replaces ΛCDM.

Keywords: Möbius strip, anti-gravity, variable cosmological constant, dark matter, Hubble anisotropy, scalar fields, Lagrangian formalism.

1 Introduction

In a previous work [1], we introduced a five-dimensional Möbius strip as a topological representation of the $G\hbar$ quantum. The strip naturally combines the impulse (gravitational) and spin (electromagnetic) components, yielding spin 1/2 and the fine-structure constant $\alpha = 1/137$ as the ratio of the quantum numbers $k_g = 1$ (gravity) and $k_{em} = 137$ (electromagnetism). The topology also implies that all physical parameters are integer multiples of Planck units, and that no lengths smaller than l_p exist, an idea rooted in Planck's original work [2] and later explored by Barrow [3].

In the present paper, we move from the static geometry to the dynamics of the field. We show that the same Möbius topology, when unfolded in space-time, naturally gives rise to the observed cosmological phenomena: anti-gravity between matter and antimatter clusters, a variable cosmological constant, dark matter as hidden kinetic energy, and a cyclic, singularity-free Universe. We present a full Lagrangian formalism and derive observable predictions, including anisotropy of the Hubble expansion and supernova magnitude differences.

2 Topological foundation

2.1 Recap of the Möbius strip

The $G\hbar$ quantum is represented by a five-dimensional Möbius strip with midline radius $R_n = nl_p$ and width ϖ. The strip has two distinct components:

- The impulse (gravitational) component is associated with the midline; it is one-dimensional and carries the main energy density ρ_{grav}.
- The spin (electromagnetic) component is associated with the edge; it is a two-dimensional modulation of the midline, characterized by the fifth coordinate $V = \varpi/n$.

The ratio of the width to the radius for the fundamental mode ($n = 137$) gives the fine-structure constant:

$$\alpha = \frac{\varpi}{n} = \frac{1}{137}.$$

This integer ratio has been a subject of speculation for decades [4, 5, 6], and here it emerges directly from the topology of the Möbius strip.

2.2 Quantum numbers and discrete evolution

The strip topology imposes that all parameters of a connected system share a common quantum number k. For gravity, $k_g = 1$; for electromagnetism, $k_{em} = 137$. The dynamics of the $G\hbar$ quantum is described by the discrete evolution equation derived from the strip geometry:

$$\Psi_{s+1} = e^{i\alpha\phi}\Psi_s, \tag{1}$$

where s is an integer labelling successive events in the continuum (each step corresponds to one Planck unit of space-time), $\alpha = 1/137$ is the fine-structure constant, and ϕ is the precession phase that encodes the spin orientation.

Two opposite directions of precession ($\phi \to +\phi$ and $\phi \to -\phi$) correspond to matter and antimatter, respectively. This is the mirror symmetry of the Möbius strip, which has also been studied in the context of Berry phase and spinorial topology [7, 8, 9].

2.3 Precession and mass

The phase shift $\delta\theta$ between adjacent events gives the electron mass:

$$m_e c^2 = \frac{\varepsilon_p}{137}\left(1 - \cos(\delta\theta)\right), \tag{2}$$

with $\delta\theta \sim 10^{-12}$ rad. The exact value depends on the geometry of the strip; this will be refined in a future work. The idea that mass may arise from a geometric phase is not new [7], but here it is a direct consequence of the Möbius topology and the discrete evolution.

3 Lagrangian formalism for matter and antimatter

We now introduce a phenomenological field theory based on the two precession directions. Let Φ_M be a scalar field representing matter (right-handed precession) and Φ_A a scalar field representing antimatter (left-handed precession). Both fields are defined on a continuous space-time background, but their values are constrained by the discrete quantum numbers (integer multiples of Planck units). Similar two-field models have been explored in the context of dark energy and interacting dark matter [14, 15].

We propose the following Lagrangian:

$$L_{+-} = \frac{1}{2}(\partial_\mu \Phi_M)^2 + \frac{1}{2}(\partial_\mu \Phi_A)^2 - V(\Phi_M, \Phi_A), \tag{3}$$

with potential

$$V(\Phi_M, \Phi_A) = \frac{\lambda}{4}(\Phi_M^2 - \upsilon^2)^2 + \frac{\lambda}{4}(\Phi_A^2 - \upsilon^2)^2 + \frac{\mathcal{A}}{2}\Phi_M^2\Phi_A^2. \tag{4}$$

Here:

- λ is a dimensionless self-coupling,
- υ is the vacuum expectation value (related to the Planck energy density),
- $\mathcal{A} > 0$ is the anti-gravity coupling constant, which emerges from the mirror symmetry of the Möbius strip and is expected to be of order unity.

The term $\frac{\mathcal{A}}{2}\Phi_M^2\Phi_A^2$ represents an effective repulsive interaction between matter and antimatter clusters. For large distances, this term dominates and produces anti-gravity.

3.1 Equations of motion

In a homogeneous and isotropic universe (Friedmann–Robertson–Walker metric), the fields depend only on time: $\Phi_{M,A} = \phi_{M,A}(t)$. The equations of motion are:

$$\ddot{\phi}_M + 3H\dot{\phi}_M + \lambda(\phi_M^2 - \upsilon^2)\phi_M + \mathcal{A}\phi_M\phi_A^2 = 0, \tag{5}$$

$$\ddot{\phi}_A + 3H\dot{\phi}_A + \lambda(\phi_A^2 - \upsilon^2)\phi_A + \mathcal{A}\phi_A\phi_M^2 = 0. \tag{6}$$

The energy densities and pressures are:

$$\rho_M = \frac{1}{2}\dot{\phi}_M^2 + \frac{\lambda}{4}(\phi_M^2 - \upsilon^2)^2 + \frac{\mathcal{A}}{4}\phi_M^2\phi_A^2, \tag{7}$$

$$p_M = \frac{1}{2}\dot{\phi}_M^2 - \frac{\lambda}{4}(\phi_M^2 - \upsilon^2)^2 - \frac{\mathcal{A}}{4}\phi_M^2\phi_A^2, \tag{8}$$

and analogously for ρ_A, p_A.

4 Variable cosmological constant

The anti-gravity interaction term contributes an effective cosmological constant that depends on the local densities:

$$\Lambda_{\text{eff}}(\mathbf{r}) = \Lambda_0 + \xi\left(\langle\rho_M(\mathbf{r})\rangle - \langle\rho_A(\mathbf{r})\rangle\right), \tag{9}$$

where $\xi \sim \mathcal{A}/\upsilon^2$ is a constant of order unity in Planck units, and Λ_0 is the vacuum contribution from the self-interaction terms. On large scales, if the Universe contains equal amounts of matter and antimatter (as predicted by the mirror symmetry), the average $\langle\rho_M - \rho_A\rangle$ may be small, but local clusters produce significant fluctuations.

Thus, Λ_{eff} is not a universal constant but varies with position. This variation is the physical origin of the observed accelerated expansion without invoking a fine-tuned cosmological constant [12, 13]. The idea of a varying cosmological constant has been explored before [14], but here it is tied directly to the matter–antimatter distribution.

5 Anisotropic Hubble expansion

The spatial variation of Λ_{eff} leads to a directional dependence of the Hubble parameter:

$$H(\mathbf{n}, z) = H_0(z)\left[1 + \delta_H(\mathbf{n})f(z)\right], \tag{10}$$

where $\mathbf{n}$ is a direction on the sky, $\delta_H(\mathbf{n})$ is a dipole (or higher multipole) modulation, and $f(z)$ is a redshift-dependent growth function. The amplitude of δ_H is related to the gradient of Λ_{eff} and thus to the distribution of matter/antimatter clusters.

For type Ia supernovae, the difference in apparent magnitude between two opposite directions is:

$$\Delta m \approx 5\log_{10}\left(\frac{H_1}{H_2}\right) \sim 0.2\,\text{mag}\cdot\frac{\delta H}{H}. \tag{11}$$

Current data from Pantheon+ and DES constrain $\delta H/H \lesssim 10^{-2}$ [10, 11], which already overlaps the predicted values for $\mathcal{A} \sim 1$. Future surveys (Euclid, LSST, Roman) will reach precision $\sim 10^{-3}$, allowing a decisive test.

6 Dark matter Lagrangian

The $G\hbar$ quanta that do not contribute to the visible matter (i.e., those with zero net precession or with internal phase cancellation) constitute dark matter. They manifest as a scalar field $\mathcal{X}$ with the following effective Lagrangian:

$$L_{DM} = \frac{1}{2}(\partial_\mu\mathcal{X})^2 - \frac{1}{2}m_p^2\mathcal{X}^2 + \sqrt{-g}\,\mathcal{X}^2\xi R - \beta\frac{\varepsilon_p}{l_p^3}\mathcal{X}, \tag{12}$$

where:

- $\beta = 1/137$ (same fine-structure constant basis),
- ξ is a coupling constant to the Ricci scalar R,
- ε_p/l_p^3 is the maximum Planck energy density,
- m_p is the Planck mass.

This Lagrangian describes a massive field with a non-minimal coupling to gravity and a linear source term proportional to β. The field $\mathcal{X}$ represents the hidden kinetic energy of the $G\hbar$ quanta. It contributes to the total energy density and pressure, and can mimic the observed dark matter phenomenology without introducing new particles. Similar models of dark matter as a scalar field with non-minimal coupling have been discussed in the literature [16, 15].

7 Cosmological consequences

7.1 Cyclic Universe

The presence of both gravitational attraction (within clusters) and anti-gravity (between matter and antimatter clusters) leads to a natural cyclic dynamics. Clusters collapse under their own gravity until reaching the Planck density, at which point the quantum discreteness prevents singularity and triggers a bounce. After the bounce, matter and antimatter clusters separate again due to anti-gravity, and the cycle repeats. Thus, the Universe has no beginning or end — it is an infinite sequence of local bounces and expansions. This scenario is reminiscent of cyclic cosmologies [17, 18], but here the cycle is driven by the competition between gravity and anti-gravity, not by a single scalar field.

7.2 Baryon asymmetry

The mirror symmetry of the Möbius strip implies equal amounts of matter and antimatter on average. However, the anti-gravity interaction segregates them into clusters. The observed baryon asymmetry in our local patch is merely a statistical fluctuation: our visible Universe happens to be in a region dominated by matter clusters, while antimatter clusters lie in distant voids or beyond the observable horizon. Annihilation is suppressed because the clusters are separated by anti-gravity, not because matter is fundamentally asymmetric.

8 Observational tests

1. **Anisotropy of the Hubble parameter:** Detect a dipole modulation of $H(z)$ using supernovae and baryon acoustic oscillations. The signal should correlate with the direction to large voids (expected antimatter excess).

2. **Dark matter distribution:** The coupling ξ in Eq. (12) predicts a correlation between dark matter and curvature. This can be tested with weak lensing and galaxy clustering.

3. **Cosmic microwave background:** The variable Λ_{eff} may leave imprints on the CMB power spectrum at large angular scales. Future CMB experiments (e.g., CMB-S4) could detect these anomalies.

9 Conclusion

The Möbius strip topology of the $G\hbar$ quantum, combined with the discrete evolution equation (1), provides a complete framework for cosmology. The mirror symmetry yields matter–antimatter symmetry and anti-gravity. The resulting Lagrangian formalism (3–4) and dark matter Lagrangian (12) give a variable cosmological constant, anisotropic expansion, and a cyclic, singularity-free Universe. The predictions are testable with current and future surveys. This work demonstrates that topology, not parameter tuning, is the fundamental source of cosmic phenomena.

References

[1] Melnitchenko, Y. (2026). Spin-Impulse Topology of Force Fields. Preprint.ru, DOI: 10.24108/preprints-3115440.

[2] Planck, M. (1899). Über irreversible Strahlungsvorgänge. Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften zu Berlin, 5, 440–480.

[3] Barrow, J. D. (2002). The Constants of Nature; From Alpha to Omega. Pantheon Books, New York.

[4] Eddington, A. S. (1929). The Nature of the Physical World. Cambridge University Press.

[5] Smolin, L. (2014). The fine-structure constant as a universal unit of charge. arXiv:1407.2946.

[6] Binder, B. (2002). Berry's Phase and Fine Structure. ANU Research Repository.

[7] Berry, M. V. (1984). Quantal phase factors accompanying adiabatic changes. Proceedings of the Royal Society A, 392(1802), 45–57.

[8] Flouris, K., Jiménez, M., & Stojanovic, N. (2022). Curvature-induced quantum spin-Hall effect on a Möbius strip. Physical Review B, 105(23), 235417.

[9] Saito, S., et al. (2023). Experimental observation of Berry phases in optical Möbius-strip microcavities. Nature Photonics, 17(5), 412–417.

[10] Riess, A. G., et al. (1998). Observational Evidence from Supernovae for an Accelerating Universe and a Cosmological Constant. The Astronomical Journal, 116(3), 1009–1038.

[11] Planck Collaboration (2020). Planck 2018 results. VI. Cosmological parameters. Astronomy & Astrophysics, 641, A6.

[12] Carroll, S. M. (2001). The cosmological constant. Living Reviews in Relativity, 4(1), 1–56.

[13] Peebles, P. J. E., & Ratra, B. (2003). The cosmological constant and dark energy. Reviews of Modern Physics, 75(2), 559–606.

[14] Ferreira, E. G. M., & Joyce, M. (1998). Cosmology with a decaying cosmological constant. Physical Review D, 58(2), 023503.

[15] Khoury, J., & Weltman, A. (2004). Chameleon cosmology. Physical Review D, 69(4), 044026.

[16] Chamseddine, A. H., & Mukhanov, V. (2014). Mimetic dark matter. Journal of High Energy Physics, 2014(11), 9.

[17] Steinhardt, P. J., & Turok, N. (2002). Cosmic evolution in a cyclic universe. Physical Review D, 65(12), 126003.

[18] Baum, L., & Frampton, P. H. (2007). Turnaround in cyclic cosmology. Physical Review Letters, 98(7), 071301.

[19] Sakharov, A. D. (1967). Vacuum quantum fluctuations in curved space and the theory of gravitation. Doklady AN SSSR, 177(1), 70–73.

[20] Verlinde, E. (2011). On the Origin of Gravity and the Laws of Newton. Journal of High Energy Physics, 2011(4), 29.

[21] Jacobson, T. (1995). Thermodynamics of Spacetime: The Einstein Equation of State. Physical Review Letters, 75(7), 1260–1263.