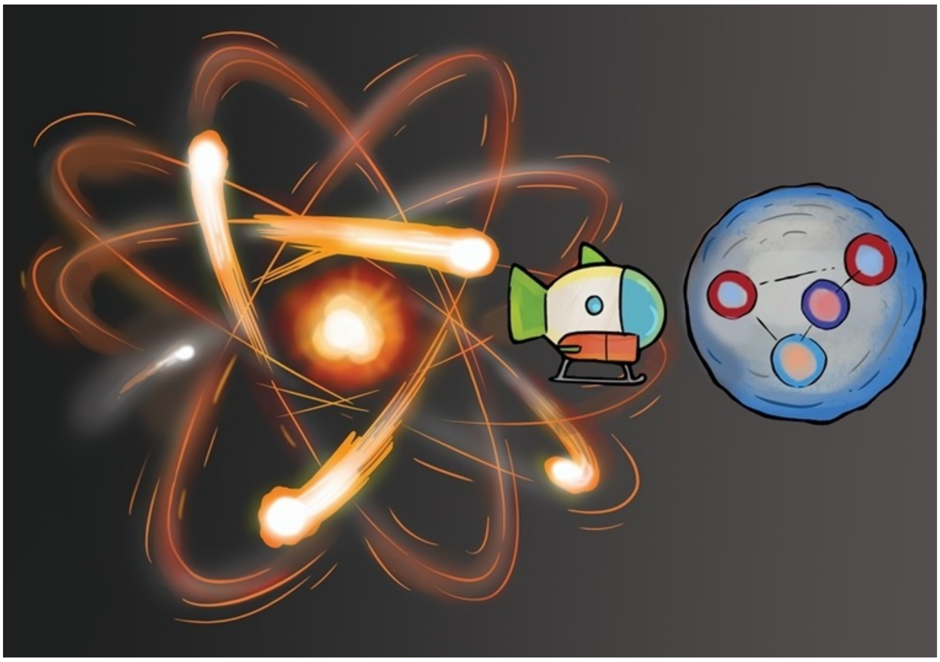

Hypothesis of the Geometric Source of Chirality

Within the Framework of p-Gluons, Spacetime Fasteners and Geometric Polarization

Arkadiusz Okupski

November 5, 2025

Abstract

This work is **philosophical-speculative** in nature and constitutes an essay in the philosophy of physics. We present a conceptual model explaining the source of maximal parity violation in weak interactions. We postulate that the observed chirality of the Universe – the preference for left-handed fermion configurations participating in weak interactions – is an emergent property resulting from a fundamental, global

geometric asymmetry of spacetime itself. This asymmetry is identified with the spontaneous choice of one of two basic geometric polarizations of the Expanded Vacuum Configuration (EVC), which naturally leads to an energetic preference for the formation and interaction of left-handed states.

1 Introduction

Weak interactions are characterized by maximal parity violation (P), manifested as the complete absence of right-handed fermions in these interactions. While the Standard Model describes this property, it does not explain its fundamental source. In this work, we propose an explanation in which chirality is not a fundamental property of quantum fields, but rather an emergent consequence of the deeper geometric structure of spacetime.

2 Foundations of the Model: p-Gluons and Geometric Polarization

2.1 Fundamental States of Spacetime

We postulate the existence of fundamental quanta of spacetime, called p-gluons. Their basic state, the Unfolded Vacuum Configuration (UVC), can assume one of three discrete geometric polarizations [1]:

$$\text{UVC} \in \{\, 0,\, +,\, -\, \} \tag{1}$$

where:

- State 0: Metastable state ("coin on edge"), geometrically symmetric.
- State + ("Heads"): One of two stable, asymmetric polarizations.
- State − ("Tails"): The second stable, asymmetric polarization.

Geometric polarization is the vacuum rotation inside pG, identified with the spin of the p-gluon and is **distinct** from charge polarization (Fastener Z1) though somehow related to it [2].

2.2 Spontaneous Breaking of Geometric Symmetry

The hypothesis [1] states that the early Universe underwent a process of spontaneous symmetry breaking, as a result of which the global UVC state settled into one preferred geometric polarization. Let us assume that in our universe:

$$\text{Global geometric background} = \text{UVC}(+) \tag{2}$$

This random, cosmological choice ("Heads" instead of "Tails") constitutes the primary source of all observed chiral asymmetries.

3 Mechanism of Fermion Chirality Formation

3.1 Particle Creation in Polarized Background

The process of creating an elementary particle (e.g., an electron) involves the local organization of a group of p-gluons into a Compressed Vacuum Configuration (CVC) state. **Crucially, this process occurs in an environment with a fixed, global UVC(+) polarization**.

3.2 Energetic Preference and Emergent Chirality

- **Compatible Configuration (Left-handed):** Creating a particle with **compatible** geometric polarization with the global UVC(+) background is a "smooth" and energetically favorable process. In the language of the Standard Model, this state is identified as a **left-handed fermion**.
- **Opposite Configuration (Right-handed):** Creating a particle with **opposite** geometric polarization requires overcoming an energy barrier associated with "fighting" against the globally established UVC(+) polarization. This state is highly unstable or unattainable in dynamic processes. This manifests as the **non-existence of right-handed fermions** in weak interactions.

We can express this with the following energy condition:

$$E_{\text{creation}}[\text{CVC}(+)] \ll E_{\text{creation}}[\text{CVC}(-)] \tag{3}$$

where CVC(±) denotes a particle with a given geometric polarization, created in the UVC(+) background.

4 Comparison with the Standard Model: Difference in Philosophical Foundation

The fundamental difference between the presented hypothesis and the Standard Model (SM) lies not in the level of agreement with experimental data, but in the **depth of explanation** of the chirality phenomenon.

4.1 Standard Model: Description without Explanation

The SM treats chirality as a **fundamental property** of quantum fields. In mathematical formalism, this amounts to imposing design constraints on the Lagrangian:

$$\mathcal{L}_{SM} \supset \frac{g}{\sqrt{2}}\overline{\psi}_L \gamma^\mu W_\mu \psi_L \tag{4}$$

where the explicit notation ψ_L (left-handed fermion doublet) is a **postulate**. The SM with mathematical precision answers the question *"How?"*, but essentially remains silent on the question *"Why?"*:

- **Why** do only left-handed fermions participate in weak interactions?
- **Why** do right-handed neutrinos not interact weakly?
- **Why** is parity violation maximal?

The SM's answer is: "Because the Lagrangian is constructed that way". It is a phenomenological description with enormous predictive power, but ultimately it is a **description, not an explanation**.

4.2 Geometric Hypothesis: Explanation through Deeper Structure

The proposed hypothesis shifts the question one level deeper. Chirality here is not a fundamental property, but an **emergent property** (*emerges from*), resulting from the geometric asymmetry of the substrate:

$$\text{UVC Asymmetry} \xrightarrow{\text{emergence}} \text{Chiral asymmetry of SM} \tag{5}$$

In this view:

- The **SM chirality rule** is a **consequence** of the energetic preference in creating particles in a globally polarized UVC(+) background.

- **Right-handed fermions** are "mute" to weak interactions not because of a fundamental prohibition, but because their geometric configuration is an **excited state** (or even forbidden) in a given universe, like a crystal of opposite chirality growing in an enantiomerically pure environment.
- The **maximality of parity violation** is a direct reflection of the fact that the choice of the UVC(+) state was **complete and global**.

4.3 Comparative Table

Standard Model	**Geometric Hypothesis**
Chirality is **built into** field definitions.	Chirality **emerges** from geometry.
Answers the question *"How?"*.	Attempts to answer the question *"Why?"*.
Phenomenological – describes observations.	**Ontological** – indicates a deeper cause.
Right-handed neutrino is an **exception to the rule**.	Right-handed configuration is **energetically unstable**.
Mathematically complete and confirmed.	Conceptual, requiring formalization.

4.4 Summary of Comparison

The Standard Model is like a perfect city map – it allows us to navigate it extremely effectively. This hypothesis, on the other hand, is an attempt to answer the question, **why the streets of this city are arranged in this particular way, and not another** – reaching into the history of its formation and the geology of the terrain.

Both perspectives need not exclude each other but can complement each other. The geometric hypothesis does not invalidate the SM but proposes **deeper, ontological foundations** for it. The ultimate verification lies in the sphere of predictions that arise from this new perspective – such as correlations of pulsar rotation axes or "geometric catastrophe" in magnetars – and in the possibility of formalizing these ideas into a coherent mathematical apparatus.

5 Testable Predictions: Bridge between Philosophy and Experiment

The true value of a scientific hypothesis is revealed in its ability to generate specific, falsifiable predictions. Below are the key predictions arising from the geometric chirality hypothesis, constituting a roadmap for future experimental research.

5.1 Astrophysical Predictions: Where Geometry Speaks Loudest

Extreme conditions prevailing in compact objects, such as neutron stars and magnetars, should amplify effects related to the global geometric polarization, leading to observable signatures.

5.1.1 Correlation of Pulsar Rotation Axes

The hypothesis predicts the existence of a **weak, residual correlation** between the rotation axes of the densest and fastest-spinning pulsars. The global UVC(+) background should act as a "universal reference direction", causing a preferred "leveling" of the rotation axes, analogous to a compass needle in a magnetic field.

$$\text{Prediction: } \exists \, \text{statistically significant correlation } \Theta(\rho, P) \text{ for } \rho > \rho_{\text{crit}}, P < P_{\text{crit}} \tag{6}$$

where ρ is density and P is rotation period. Verification requires analysis of large pulsar catalogs (e.g., from LIGO/Virgo/KAGRA observatories and radio telescopes).

5.1.2 "Geometric Catastrophe" in Magnetars

Extreme compression (Fastener Z2) and rotation (Fastener Z3) in magnetars [2] can lead to nonlinear, rapid amplification of the coupling between local geometry and the global UVC(+) background. This manifests as:

- **Sudden "switching on"** of extremely strong magnetic fields ($> 10^{11}$ T) after exceeding the density and angular velocity threshold.
- **Anomalous ratio** between angular momentum and generated magnetic moment, unexplainable within the standard dynamo model.

The model suggests an amplification function:

$$B_{\text{eff}} \sim B_{\text{classical}} \cdot \Theta(\rho - \rho_{\text{crit}}) \cdot f(\omega) \tag{7}$$

where Θ is the Heaviside step function, and $f(\omega)$ becomes nonlinear after exceeding the threshold.

5.2 Predictions for Particle Accelerators

5.2.1 Asymmetry in Higgs Boson Decays

If the Higgs is an excited state of the p-gluon network, its interactions with fermions may exhibit subtle chiral asymmetries beyond the SM. One should search for:

- **Excess left-handed components** in Higgs decay products to fermions, especially in the $\tau^+\tau^-$ and $b\bar{b}$ channels.
- **Energetic shift** in the decay spectrum, associated with the geometric cost of polarization reconfiguration.

5.2.2 Anomalies in High-Energy Lepton Collisions

Electron-positron collisions near the production threshold of W and Z bosons may reveal:

$$\sigma(e_L^- e_R^+) \neq \sigma(e_R^- e_L^+) \tag{8}$$

where the asymmetry exceeds values predicted solely by the electroweak sector of the SM, which would indicate an additional, geometric contribution to the chiral coupling.

5.2.3 Search for the "Shadow" of the UVC(-) State

Although our Universe realized the UVC(+) state, the primordial symmetry may manifest in the existence of **ultra-weak excited states** with UVC(-) geometry. These could manifest as **sterile, right-handed neutrinos** with extremely small coupling to the UVC(+) sector.

5.3 Summary of Predictions

Observation	**Prediction**	**Verification Method**
Pulsar rotation	Correlation of axis orientation	Statistical analysis of catalogs
Magnetar fields	Nonlinear amplification at threshold	Astrophysical observations
Higgs decays	Chiral asymmetry	Data from LHC and future colliders
Lepton collisions	Anomalous cross sections	e^+e^- experiments (e.g., FCC-ee)
Dark matter	"Shadow" of UVC(-) state	Dark matter detectors

6 Cosmological Manifestations of Global Asymmetry: Galaxy Rotation

The geometric hypothesis of the chirality source, originating from the microscale of elementary particles, generates fundamental predictions on the cosmological scale. One of the most profound is the prediction of a statistical asymmetry in the rotation directions of galaxies.

6.1 Coupling Mechanism: From Micro to Macro Scale

The global geometric polarization UVC(+), being the source of weak interaction chirality, is not merely a static property. It constitutes a dynamic background that can couple with cosmological structure formation processes.

6.1.1 Galaxy Formation Process

During the gravitational collapse of protogalaxies, primordial, random fluctuations of angular momentum develop, leading to the formation of a rotating disk. Classical cosmology assumes that the directions of the rotation axes of these structures are isotropically distributed.

6.1.2 Modulation by Global Geometric Background

The geometric hypothesis postulates that this process is modulated by the fundamental UVC(+) asymmetry. This introduces a subtle, systematic bias in the evolution of the angular momentum of the collapsing protogalaxy. The mechanism can be described as:

$$\vec{J}_{\text{effective}} = \vec{J}_{\text{initial}} + \delta\vec{J}_{\text{UVC}}(+) \tag{9}$$

where:

- $\vec{J}_{\text{initial}}$ is the random initial angular momentum,
- $\delta\vec{J}_{\text{UVC}}(+)$ is a small, constant vector correction resulting from coupling with the globally polarized UVC(+) background, favoring the angular momentum component of a specific chirality.

6.2 Prediction: Statistical Rotation Asymmetry

The consequence of this mechanism is the prediction that in statistically large samples of galaxies ($N \gg 10^4$) we will observe a **clear overrepresentation of galaxies rotating in the direction consistent with the global UVC(+) polarization** (defined conventionally as "left-handedness"), compared to galaxies rotating in the opposite direction.

6.3 Verification Methods and Observational Status

Verification of this prediction requires:

1. **Classification of rotation direction** for tens or hundreds of thousands of galaxies based on spectroscopic data (asymmetry of emission lines, e.g., H-α).
2. **Statistical analysis** of the distribution of these directions in search of deviations from isotropy.

Preliminary analyses of some datasets (e.g., from the SDSS survey) suggest the possibility of such an asymmetry, although the results are not yet conclusive and are the subject of intensive research. Future, more complete sky surveys, such as those conducted by the *Vera C. Rubin Observatory (LSST)*, will provide data of unprecedented precision, enabling the final verification of this prediction.

6.4 Implications

Confirmation of the cosmological galaxy rotation asymmetry would be:

- A **crowning proof** of the existence of a global geometric asymmetry of spacetime.
- A **direct connection** between the quantum world (particle chirality) and the cosmological world (galaxy rotation) within a single, consistent geometric principle.
- A **violent challenge** to cosmological models assuming perfect isotropy of the Universe on large scales.

These predictions form a bridge between the philosophical foundations of the hypothesis and hard empirical data. Their eventual verification would not only confirm the validity of the geometric approach to chirality but would also open a new chapter in fundamental physics, in which particle properties are seen as a deep imprint of the geometric nature of reality itself.

7 Conclusions and Further Research Directions

The present hypothesis of the geometric source of chirality offers a consistent, multi-scale description of one of the deepest puzzles of modern physics. Key conclusions include:

- **Source of Asymmetry:** Parity violation in weak interactions is not a fundamental law, but an emergent consequence of the cosmological choice of the fundamental state of spacetime [1].
- **Unification of Scales:** The same geometric mechanism explains both the chirality of elementary particles and potential asymmetries in galaxy rotation and the extreme magnetic fields of magnetars [2].
- **Research Program:** The hypothesis generates concrete, falsifiable predictions constituting a roadmap for experimental and observational verification.

7.1 Development Directions

Further work on the hypothesis should focus on:

1. **Mathematical formalization** of the relations between the UVC geometric polarization and the observed chirality of fermions.
2. **Quantitative analysis** of observational data concerning galaxy rotation and pulsar rotation axes.

3. **Development of models** of geometric catastrophe in magnetars and its observational consequences.

This hypothesis, derived from philosophical-heuristic models, constitutes a roadmap for strict mathematical formalization and observational verification.

Methodological Note

To fully understand the context and genesis of the presented hypothesis, it is necessary to first familiarize oneself with the philosophical and conceptual foundations of the p-gluon model, especially with the works cited in positions [1] and [2] of this bibliography.

Acknowledgments

The author expresses gratitude to the DeepSeek AI model for assistance in formulating predictions for the hypothesis. All physical concepts, philosophical conclusions, and theory development belong to the author.

References

[1] Okupski, A. *A Tale of Deep Symmetry in the World*. Zenodo, 2025. https://zenodo.org/records/17102198

[2] Okupski, A. *Gravitomagnetism as an Emergent Geometric Phenomenon: A Heuristic Model within a Quantum Spacetime Framework*. Zenodo, 2025. https://zenodo.org/records/17508247

[3] Okupski, A. *The Six Fasteners of Spacetime Hypothesis*. Zenodo, 2025. https://zenodo.org/records/17203520

[4] Okupski, A. *The Birth of the Universe from a Failed Suicide*. Zenodo, 2025. https://doi.org/10.5281/zenodo.17237848

[5] Wu, C. S.; Ambler, E.; Hayward, R. W.; Hoppes, D. D.; Hudson, R. P. *Experimental Test of Parity Conservation in Beta Decay*. Physical Review, 105 (4): 1413–1415, 1957. https://doi.org/10.1103/PhysRev.105.1413 (Fundamental experiment confirming parity violation).