Stringnoids and Topoids

Martin Pomares Calero[1]

http://orud.org/0000-0003-4994-0573

Abstract

This theoretical proposal introduces the concept of *cuerdoides*, defined as one-dimensional entities whose interaction with the topological structure of spacetime may give rise to emergent physical properties such as mass, spin, and electric charge. It is hypothesized that spin arises from the intrinsic rotation of the cuerdoide, and that the transition from a bosonic to a fermionic state occurs when angular momentum conservation is broken due to topological constraints.

A central idea is that of topological confinement: when two fermionic strings intertwine and become enclosed within a geometric envelope, a new bosonic state may emerge. This mechanism is interpreted as a topologically induced transition, analogous to processes in topological string theory, where open strings can fuse into closed strings via geometric transitions like the conifold. It is also related to concepts of quantum entanglement and entropy, where entanglement branes delimit regions of interaction and reorganize the system's degrees of freedom.

The proposal suggests that particle properties are not intrinsic but emerge from the topological configuration of the cuerdoide within spacetime. Mass, charge, and spin are thus understood as manifestations of interactions with fields such as the Higgs and with the geometric and topological environment. This framework integrates insights from string theory, topological quantum field theory, and algebraic geometry, offering a novel structural reinterpretation of fundamental physics.

Keywords

Topological confinement, Cuerdoides, Emergent properties, Quantum topology, Spin and angular momentum, Topological strings, Higgs mechanism, Charge emergence, Fermion-boson transition, Entanglement branes, Geometric transitions, Open–closed string duality, Cohomology and homology, Quantum field topology, Pseudo-spherical geometry, Quantum state composition.

Introduction

Topological Confinement and Stringoids: A Proposal for the Emergence of Mass, Charge, and Spin from Quantum Topology

Within the contemporary framework of quantum field and string theories, an increasingly robust view has emerged regarding the possibility that fundamental properties of particles—such as mass, electric charge, and spin—are not immutable intrinsic characteristics, but emergent properties linked to underlying topological structures (Baez & Muniain, 1994; Nakahara, 2003; Witten, 1989).

[1] Docent and Researcher at the Department of Physics. UNAN-Managua. Graduated as Ph. Lic. In Engineering at LTH, Lund University, Sweden. mpomares@unan.edu.ni; stringnoide@gmail.com.

In this context, this proposal introduces the concept of stringoids, understood as one-dimensional or quasi-one-dimensional entities whose dynamical topology and interaction with non-trivial spacetime manifolds determine observable physical properties. Specifically, it is proposed that spin is a direct result of the rotation of the stringoid, and that the transition between bosonic and fermionic states is mediated by topological conditions that affect the conservation of angular momentum (Frankel, 2011). This breaking of angular momentum is interpreted as a consequence of topological confinement, understood here as a mechanism that encloses the trajectories of extended entities, inducing a change in their statistical nature.

This approach is based on the notion of wave coupling, represented by superposition:

$$e^{-i\omega_1 t} + e^{-i\omega_2 t} = e^{-i(\omega_1+\omega_2)t} \tag{1}$$

where the individual contributions of two fermionic states generate, under a common envelope, an emergent bosonic state. This view finds correspondence in frameworks such as topological string theory, where open strings can merge, via a geometric transition (such as the conifold), into closed bosonic strings, under appropriate topological conditions (Gopakumar & Vafa, 1999; Vafa, 2025).
From this dynamic, it is proposed that the quantum state of a photon—and more generally of any mediating particle—can be understood as a superposition:

$$|\xi\rangle=|\varphi\rangle\otimes|\psi\rangle \tag{2}$$

where $|\varphi\rangle$ represents the state generated by coupling to the Higgs field (Weinberg, 1996) and $|\psi\rangle$ is a state defined on a topological manifold whose properties allow the emergence of charge. The latter can be modeled, for example, by the de Rham cohomology formalism, where the electric charge arises as a topological number:

$$Q = \int_\Sigma F \tag{3}$$

where Σ is a 2-surface on which the electromagnetic field F is the electromagnetic field tensor (Nakahara, 2003; Nash & Sen, 1983). In analogy to line operators in theories like Chern–Simons, where charge is associated to holonomy along non-contractible cycles (Witten, 1989), stringoids could carry charge as a consequence of their geometric configuration and their topological entanglement with spacetime.
This approach finds support in recent studies of topological quantum entanglement. For example, Hubeny, Pius, and Rangamani (2019) have shown that slicing regions in a topological string theory leads to the emergence of entanglement branes that act as boundaries for confined quantum states, allowing the generation of composite states with bosonic characteristics. Similarly, work by Vafa (2025) connects Chern–Simons theory to topological string amplitudes via holographic dualities, showing how confining geometry can define observed physical properties.
In this framework, it is proposed that stringoids can be defined over homology classes such as $H_2(M)$, and that each configuration $|\gamma\rangle \in H_2(M)$ can carry an emergent charge, thus the entanglement type or genus of the stringoid configuration can define its emergent charge:

$$|q\Sigma_\alpha\rangle = |e| \cdot exp\,\{-i\omega t\,|\boldsymbol{e_n}\rangle\}(-1)^{\delta(\omega)} \tag{4}$$

with $\delta(\omega)=\omega t|e_n\rangle$, and where each state $|e_n\rangle$ lives in a particular homology $H_2(M)$ of the manifold M that contains the chordoid.
This approach suggests a fundamental reinterpretation of the particle concept, where physical states derive from topological conditions and dynamical couplings with scalar fields, geometric manifolds, and entanglement structures. Finally, this proposal aligns with a growing body of

research that integrates gauge fields, differential geometry, and algebraic topology to explain fundamental quantum phenomena (Baez & Huerta, 2011; Freed & Moore, 2006; Atiyah & Segal, 2004).
This approach proposes a natural bridge between string theory, topological field theory, and quantum field mechanics, allowing us to reinterpret particle states in terms of geometrically confined entities, whose properties (such as mass, spin, and charge) are not axiomatic, but emergent from the very topology of space and its dynamics.
Finally, this proposal finds resonance in recent developments such as:

- Vafa's work on the connection between topological string theory and Chern–Simons theory.
- Hubeny, Pius, and Rangamani's proposal on string entanglement and entanglement brane entanglement.
- Models in QCD and condensed matter where topological confinement defines observable physical states.

In short, stringoids, as topologically confined entities, provide a new framework for explaining the emergence of particles and fields from the structures of spacetime and its broken symmetries, thus postulating a deep geometrization of quantum physics.

Theoretical Proposal:
As an initial part of the theoretical proposal for this research, the following a priori hypothesis is considered: "Spin is a condition of the rotation of the stringoid. And what causes a boson to transform into a fermion is that the conservation of angular momentum is broken, that is, it decays over time due to topological conditions."
To understand how this a priori hypothesis works, let us consider the fundamentals of the electron-positron pair annihilation phenomenon, by which we can understand that each electric particle is actually a thermionic stringoid or stringnoid that when coupled by what we will call a topological confinement or topoid allows the establishment of a bosonic string or photon (this is described in Fig. 1), where the coupling of these stringoids is based on the spins of the particles that are considered to have mass before the coupling in their fermionic state. And that subsequently the photon is formed considered without electric charge, and without mass at rest.

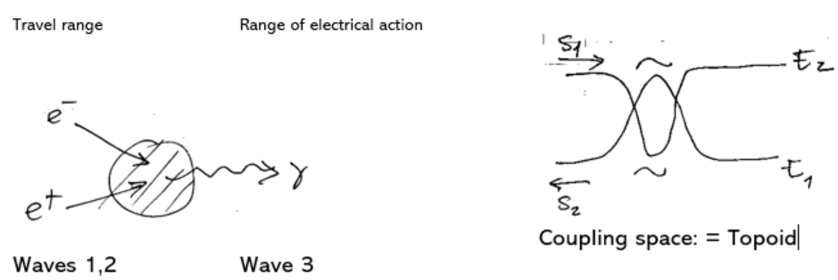

Fig. 1. Schematic figure of the coupling (Own source).

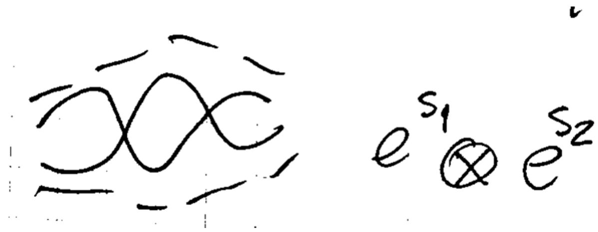

Fig. 2. Wave 3, Coupled topoid or chordoids (Own source)..

From the idea presented in Fig. 2, we can assume that the system rotates and its rotation is not observed, which we call wave coupling. Consequently, another a priori hypothesis of the author is that: Angular momentum is equivalent to the topological form of photon propagation (with a helical envelope). From this hypothesis and the assumption of coupled stringoids, it can be assumed that the state of a photon corresponds to the superposition of its mass contribution and the wave geometry, which is why a composite quantum state is proposed as:

$$|\xi\rangle = |\text{Másica}_H\rangle \otimes |\text{Topología}_{\text{ondulatoria}}\rangle \tag{5}$$

where:

- $|\text{Másica}_H\rangle$: State of the field associated with the interaction with the Higgs field.
- $|\text{Topología}_{\text{ondulatoria}}\rangle$: Quantum state defined on a topological manifold with properties that allow the emergence of charge.

This implies that the topoid corresponds to a pseudo-sphere that confines what we understand as a photon for the hyperbolic path for creation-annihilation, which is equivalent to the photon plus the geometry. Consequently, there must be a charge associated with the chordoid of the electron or positron. This charge considers that its polarity depends on the geometry of the topological confinement itself, which corresponds to the representation of an oriented surface (as shown in Fig. 3) and which is proposed by the author, corresponds to:

$$|q_0^n\rangle = \; |e| \cdot exp\,\{-i\omega t\,|\boldsymbol{e_n}\rangle\}(-1)^{\delta(\omega)} \tag{6}$$

where $\delta(\omega) = \;\omega t\,|\boldsymbol{e_n}\rangle$.

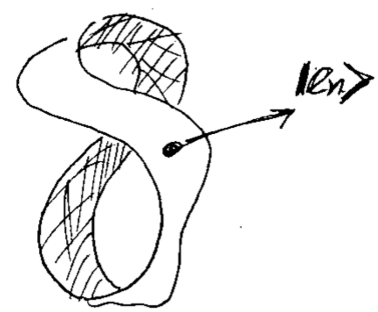

Fig. 3. Description of an oriented topological surface (Own source).

The Higgs field φ has a potential function that is defined as:

$$V(\phi) = \mu^2\phi^\dagger\phi + \lambda(\phi^\dagger\phi)^2 \tag{7}$$

with $\mu^2<0$, which leads to a degenerate vacuum and a spontaneous symmetry breaking mechanism. The coupling to a fermionic field ψ generates a mass term:

$$\mathcal{L}_{\text{int}} = -y\bar{\psi}\phi\psi \quad \Rightarrow \quad m = y\langle\phi\rangle \tag{8}$$

where y It is the Yukawa coupling. Thus, the mass emerges from the expectation value of the Higgs field.

The present theory proposes that strings or "stringoids" are extended entities that, depending on the topology of the manifold in which they are embedded, could carry electric charge.

This idea can be supported by:
a) Cohomology and charge: Electric charge can arise as a topological number (cohomology class):

$$q = \int_{S^2} F = \int_{S^2} dA \tag{9}$$

where F is the electromagnetic field tensor. In ***U(1) bundle models***, this integral corresponds to the winding number of the fiber.

b) Line and charge operators
In topological theories such as Chern-Simons:

$$S_{\text{CS}} = \frac{k}{4\pi} \int_M A \wedge dA \tag{10}$$

Charge is identified with holonomy (the circulation of the field) along non-contractible cycles. In your case, strings could carry charge as a result of the intertwining of their trajectories with the geometry of space (knots, links).

It is therefore proposed that, when considering string theory, the excitations of open or closed strings on certain manifolds (such as toroids or K3) determine their physical properties: mass, charge, spin. The stringoids proposed here could be defined as 1-dimensional entities whose topology (e.g., binding or genus) defines an emergent charge:

$$|\text{Topology}_{\text{Wave}}\rangle = \sum_\alpha c_\alpha |\Sigma_\alpha\rangle \tag{11}$$

where $\boldsymbol{\Sigma_\alpha}$ represents different topological configurations (e.g., with different homology numbers).

From all the above, it can be considered that the state could be structured as:

$$|\xi\rangle = |\text{Higgs}(m)\rangle \otimes \left(\bigoplus_{\gamma \in H_2(M)} |\gamma\rangle \right) \tag{12}$$

donde:

- ***$H_2(M)$***: second homology of the M variety where the string or chordoid resides.
- Each $|\gamma\rangle$ corresponds to a configuration with associated load.

Historical considerations regarding this theoretical proposal: There are several groups and researchers whose work connects with this proposal of topological quantum states with Higgs-generated mass and geometrically emergent charge. Here is an organized list of their most relevant contributions:

1. Topological mass generation (1-form, 2-form, etc. fields):

- • Juan P. Beltrán Almeida et al. (2020): studied how a 2-form BB field can interact with a 1-form AA field through a topological term B∧F, generating mass in a purely topological manner (en.wikipedia.org, arxiv.org). This approach aligns with the idea proposed in this article: a mass that arises from the geometric interaction between forms of different degrees (arXiv link – Topological mass generation).

2. String-net models and topological condensation

• Michael Levin & Xiao-Gang Wen (2004): defined mechanisms (string net condensation) where extended states (stringoids) configure the basis of topological order, giving rise to fermions and U(1)U(1) charges ([arXiv link – String-net condensation]).

• Xiao-Gang Wen (2018) also explored higher-order symmetries and electric charge in emerging topological phases ([arXiv link – Emergent higher symmetries]).

These works support the view of charges as geometric properties integrated into the state topology, as attempted to be shown in this research article.

3. Topological Quantum Computation and Modular Categories

- • Zhenghan Wang, Freedman, Kitaev, and Larsen developed the mathematical foundations of topological computation (anyons), identifying the capture of charge and mass within the modular category formalism ([Wikipedia – Modular tensor categories]).

4. Fracton Theories and Emergent Geometry

• Kevin Slagle and Yong Baek Kim (2017) developed a field formalism for fractons (X cube model), where the geometry (curvature or lattice structure) determines the degeneracy of the ground state and the restricted "charge" of excitations ([arXiv link – Fracton field theory]).

These approaches show how emergent properties of charge are encoded in the geometry of the quantum lattice.

5. Electric Charge in Knotted Structures

• A recent study on knotted charge distributions (2023) investigates how the path topology imposed by a wire charge influences the potential structure and electric field ([Springer – Knot-induced charge patterns]).

How do these works connect with the theoretical proposal presented here?

• The topological term "mass generator" (B∧F) connects directly with the idea of emergent mass.

• String-net and fracton geometry present wave-like states that can encode charge as an intrinsic topological property.

• Modular categories establish the algebraic framework for interpreting charge as a topological number in state spaces.

• Loop electrostatics shows concrete examples of how topology constrains and configures charge.

Other considerations regarding the connection to topological string theory shown in Figures 1 and 2:

1. Entangled and Confined Fermionic Strings: In topological string theory (model A or B), open strings terminate on D branes. When two strings become entangled and fall within a surrounding region (as in your drawing), the geometry can cause a geometric transition (e.g., conifold) in which the strings:

• Merge topologically.

• Their individual degrees of freedom disappear (as open strings).

• Emerge as a closed string, interpreted as a bosonic mode.

2. Hubeny et al. (2019): Entanglement and "Entanglement Branes": The structure enclosing your two strings could be interpreted as an entanglement brane. These types of branes:

• Act as boundaries that define regions with internal degrees of freedom.

• Enclose and reorganize internal quantum states, allowing the emergence of new collective states.

• In our case, two fermionic strings under this "topological envelope" would give rise to a composite bosonic state.

3. Chern–Simons and Topological Entanglement: From Vafa's theory (2025), entangled strings, as in your drawing, can be described by:

- Entanglement observables in Chern–Simons.
- Their fusion results in a topological invariant (like HOMFLY or Jones).
- Integrating over this topology yields an emergent bosonic amplitude.

Conceptual Model: Topological Confinement of Fermionic Strings

We can propose the following scheme for the theoretical framework to develop in further researchers:

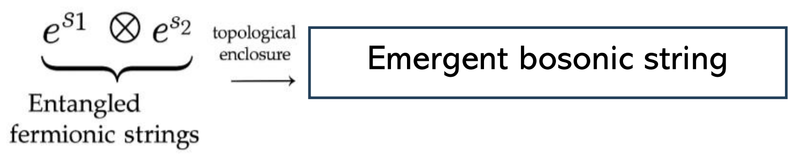

Fig. 4. Diagrammatic concept of the topological confinement model (Own source).

Emergent bosonic string impies:

• Input: Two fermionic strings with states s_1, s_2.

• Mechanism: Enclosure by a topological field or brane that generates a transition (similar to a conifold transition).

• Output: Closed string with bosonic symmetry, by fusion of fermionic states under topological rules.

Some Physical Implications form the proposal are:

1. Simulation of the topological Higgs mechanism: mass and bosons could emerge from confined fermionic string structures, without an explicit scalar field.
2. Anyon models and quantum stage fusion: in spin-liquid-like systems, something analogous occurs—two fermionic excitations merge topologically into a bosonic one.
3. Topological quantum computation: these fusion and confinement processes are represented by modular tensor categories (e.g., f×f=b fusion).

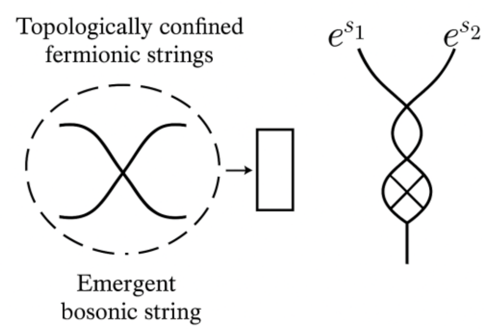

Fig. 5. Descripción representativa del confinamiento topológico (topoide) de cuerdoides (Fuente Propia).

However, we do not develop simulations in this article; these will be part of subsequent studies. One research proposal would be to develop simulations that consider graphical representations like the one shown in the attached figure (Fig. 5) to provide connectivity to equations and diagrams within simulations of strings in interaction processes similar to that of electron-positron pair annihilation.

In conclusion:

One of the central mechanisms is topological confinement: two fermionic strings can become entangled and "enclosed" in a topological envelope, giving rise to an emergent bosonic state. This dynamic has been represented graphically and algebraically and is related to similar processes in topological string theory, where open strings merge into closed strings through geometric transitions such as the conifold. This process also finds an interpretation in terms of entanglement branes and topological entropy, as proposed by authors such as Hubeny, Rangamani, and Vafa.
In mathematical terms, the quantum state of a particle such as the photon is modeled as a superposition. This charge can be associated with cohomology numbers or holonomy in topological gauge theories such as Chern–Simons, where line operators encode entanglement information.
Consequently, it is proposed that stringoids carry charge and mass as a result of their topology, rather than being point particles with intrinsic properties. Thus, their states can be written as sums over homology classes:

$$|\xi\rangle = \sum_{\alpha} c_\alpha |\gamma_\alpha\rangle, \quad \gamma_\alpha \in H_2(M) \tag{13}$$

Where each $|\gamma_\alpha\rangle$ It is a distinct topological configuration on a manifold M, responsible for the emergent quantum values. This framework allows us to reinterpret particle physics from a geometric and topological perspective, integrating developments in string theory, topological fields, and differential geometry to explain phenomena such as mass, charge, and spin from more fundamental and structural principles of space-time.

Bibliographic References:

- Atiyah, M., & Segal, G. (2004). *Twisted K-theory*. *Ukrainian Mathematical Bulletin*, 1(3), 291–334.
- Baez, J. C., & Huerta, J. (2011). *The algebra of grand unified theories*. *Bulletin of the American Mathematical Society*, 47(3), 483–552.
- Baez, J. C., & Muniain, J. P. (1994). *Gauge fields, knots and gravity*. World Scientific.
- Frankel, T. (2011). *The geometry of physics: An introduction*. Cambridge University Press.
- Freed, D. S., & Moore, G. W. (2006). *Setting the quantum integrand of M-theory*. *Communications in Mathematical Physics*, 263(1), 89–132.
- Gopakumar, R., & Vafa, C. (1999). *On the gauge theory/geometry correspondence*. *Advances in Theoretical and Mathematical Physics*, 3(5), 1415–1443.
- Hubeny, V. E., Pius, R., & Rangamani, M. (2019). *Topological string entanglement*. *Journal of High Energy Physics*, 2019(10), 1–36.
- Nakahara, M. (2003). *Geometry, topology and physics* (2nd ed.). Taylor & Francis.
- Nash, C., & Sen, S. (1983). *Topology and geometry for physicists*. Academic Press.
- Vafa, C. (2025). *Chern-Simons theory, holography, and topological strings*. *Communications in Mathematical Physics*. (preprint, Harvard).
- Weinberg, S. (1996). *The quantum theory of fields: Volume II, Modern applications*. Cambridge University Press.
- Witten, E. (1989). *Quantum field theory and the Jones polynomial*. Comm. Math. Phys., 121(3), 351–399. https://doi.org/10.1007/BF01217730
- Preskill, J. (2004). *Lecture Notes for Physics 219: Quantum Computation*. Caltech.
- Wen, X. G. (2004). *Quantum Field Theory of Many-body Systems*. Oxford University Press.
- Baez, J., & Muniain, J. P. (1994). *Gauge Fields, Knots and Gravity*. World Scientific.