Explanation of the Mysteries of Physics through a Topological Model

Part One

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Preface

From the smallest particles to the largest galaxies, physics is, at its core, an exploration of the mysteries that govern the nature of our universe. It seeks to understand the fundamental rules that shape everything that exists. Throughout history, we have attempted to unravel these rules using various conceptual and mathematical tools. However, as our understanding of the universe advances, we encounter phenomena that challenge our intuitions and whose comprehension seems elusive—every answer opens a new set of questions.

In this context, new perspectives and approaches become necessary to help us grasp the deepest mysteries of the universe—not just through instrumentalist descriptions but through real explanations. One such approach is the Topological Model of Physics (MTF), a tool we hope will help visualize and understand complex phenomena from a phenomenological and logically coherent perspective.

Modern physics has revealed a series of concepts that are often perplexing and counterintuitive. Quantum superposition, entanglement, wave-particle duality, quantum tunneling, the nature of space-time and other ideas challenge our understanding. But even the very foundations of physics—Newton's principles—remain based on experience and observation rather than on a deeper explanatory level. These phenomena, seemingly arising from different branches of physics, have generated considerable confusion among those attempting to reconcile them within a unified conceptual framework.

The Topological Model of Physics (MTF) presents itself as a tool capable of integrating these apparently disparate concepts under a single unifying idea. It seeks to unveil the mysteries underlying the vacuum, an overarching hypothesis that connects and, we hope, gives meaning to all branches of physics. By examining what the vacuum truly is, we will discover that this unifying concept can shed new light on fundamental principles. The MTF proposes that the vacuum is not merely an inert space but the very fabric in which the laws of physics manifest.

As we progress, this intellectual journey will reveal that physics is not just a set of equations and abstract principles but an adventure in which topology provides us with a map to navigate the unknown landscape of our universe. Step by step, we will unravel the threads connecting seemingly unrelated concepts, which, as we have found, may prove as fascinating as they are revealing.

Introduction

Why is the speed of light so slow relative to the dimensions of the Universe? Light is the messenger that allows us to perceive our surroundings, and thus, we should consider it an intimate acquaintance. However, light exemplifies Hegel's remark in the preface to his Phenomenology of Spirit (1807):

"The known, precisely because it is too well known, is not known at all."

Newton proposed that light consisted of tiny colored particles, or “corpuscles,” which explained geometric optics. Huygens, on the other hand, described light as a wave, allowing him to explain diffraction and interference. If light were composed of particles, it could move at any speed in space. However, as waves, its speed would depend solely on the medium in which it propagates—just like any other wave. Experimentally, the speed of light in a vacuum was measured as a maximum, well-defined, and constant value of approximately 3×10E8 meters per second, independent of the observer's reference frame. That is, the speed of light is not affected by the velocity of either the emitter or the receiver, as Galileo’s relativity would suggest.

Maxwell mathematically determined that light is an electromagnetic phenomenon propagating transversely through the vacuum at a constant speed. For such waves to propagate at a fixed speed, they would require a medium, which Maxwell called the luminiferous ether, a substance with unique properties: it had to be nearly rigid yet not interact with ponderable matter.

At the end of the 19th century, Michelson and Morley conducted an experiment to detect this ether. They attempted to measure variations in the speed of light along different directions—one aligned with Earth's motion around the Sun and the other perpendicular to it. They expected to observe an effect similar to Fizeau’s experiment, in which light was partially dragged by a moving stream of water. However, no such variation was found. The absence of an "ether drag" led to the elimination of the ether concept, leaving the speed of light in a vacuum as an unexplained constant responsible for preserving causality.

This result was perplexing to physicists of the late 19th century, as it contradicted one of the fundamental pillars of mechanics—Galilean relativity. To reconcile the laws of dynamics with electromagnetic phenomena, Lorentz introduced new relativistic transformations, which implied flexible space and time coordinates.

Shortly thereafter, in 1900, Max Planck, in his study of blackbody radiation, had to postulate that light does not propagate purely as a wave but instead as discrete packets of energy—quanta—later called photons.

In 1905, Albert Einstein built upon these new ideas for his two groundbreaking works of that year, forever changing physics. In explaining the photoelectric effect, for which he later won the Nobel Prize, he used Planck’s constant.

By explaining the photoelectric effect with Planck's idea and eliminating the ether, the speed of light in a vacuum would no longer necessarily be constant. For this reason, Einstein had to postulate its constancy and, at the same time, replace Galileo's principle of relativity with a new principle, which came to be known as the theory of relativity in a restricted sense. This idea made Maxwell's ether unnecessary.

But if light was a particle moving through empty space, what determined its maximum speed? Why is the speed of light in a vacuum so "slow" compared to the estimated size of the observable universe, approximately 4.4×10E26 meters? Why can't the photon’s speed change upon emission in a vacuum?

To address these and other mysteries of physics, we have successfully developed the Topological Model of Physics (MTF), which complements the Standard Model, relativity, and even classical physics. Among others, it seeks to answer the following questions:

Some Questions Addressed by the MTF

1. The true nature of Planck’s constant.
2. Why the uncertainty principle holds.
3. The meaning of wave-particle duality in light.
4. Space dimensions.
5. A new interpretation of the double-slit experiment.
6. Polarimeters in series.
7. Light refraction and its relation to special relativity.
8. Why the speed of light in a vacuum is constant and the same for all frequencies.
9. A causal explanation of Newton’s principles.
10. Why there are three generations of quarks and their correlation with leptons.
11. Charge and spin—why there is no charge without mass.
12. Why quarks have fractional charge and what "color charge" is.
13. Why Schrödinger’s equation describes matter.
14. Gravity—why it is always attractive. Does dark matter exist?
15. The matter- antimatter problem.
16. The possibility of exceeding the speed of light in a vacuum.
17. Why the principle of least action holds. And other questions that will emerge throughout the text.

We have proposed a final reductionism to unify classical absolute space, the vacuum with superimposed fields of quantum mechanics, and relativistic space-time into a single structured substantial vacuum, from which we attempt to explain what is observed in experiments.

By doing so, we align with Spinoza's philosophical tradition in Ethics, which considers everything that exists as a single substance that, through its modes and attributes, expresses all of existence in its evolution.

Topological Model of Physics (TMP)

By assuming that the vacuum is a superfluid, we have been able to intuitively grasp the underlying mechanism behind quantum theory, the standard model of elementary particles, relativity theories, and even some concepts of classical physics in light of this model.

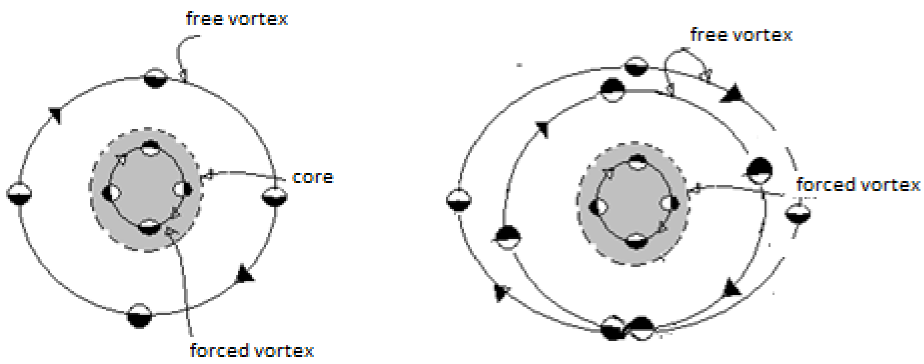
We consider that everything that exists is a superfluid, which, through its hydrodynamic motions, forms structures that necessarily—rather than arbitrarily—explain matter as we know it. These structures can be identified with many phenomena described in contemporary physics, providing explanations for their causes, which are often deemed mysterious and have led to major controversies. The model not only does not contradict existing physical-mathematical theories; rather, it serves as a phenomenological conceptual framework to ground properties that are not directly derived from current theories and have often been introduced ad hoc. This approach aims to foster a stimulating and enriching discussion.

In a superfluid, individual particles behave collectively, exhibiting phenomena such as super-fluidity, where the fluid moves without friction. That suggests that the universe displays large-scale emergent behaviors that cannot be explained merely by studying individual particles.
We will assume that the universe is a fluid composed of indivisible point particles, which we will henceforth call "atominos" (the true atoms proposed by Greek philosophers). These are identical to each other, with unitary inertial mass מ (mem), moving through space and forming everything that exists.
We are not referring to Maxwell's rigid electromagnetic ether, which Albert Einstein deemed unnecessary in his special theory of relativity. However, in his 1920 lecture Ether and Relativity in Leiden, Einstein stated:
"A more careful reflection teaches us that the special theory of relativity does not compel us to deny the ether. We may assume the existence of an ether; we must, however, give up ascribing to it a definite state of motion. To deny the ether is ultimately to assume that empty space has no physical qualities whatsoever."
Assigning all atominos the same inertial mass and a superfluid behavior implies large-scale homogeneity and isotropy in the universe, where physical properties remain the same in all directions and at every point in space. A model in which all particles have the same inertial mass suggests a deeper unification of the fundamental forces of nature.
Today, following Dirac's equation and the discovery of antimatter, the physical significance of the vacuum is no longer debated, and various theories speculate about its nature. Among them, numerous Superfluid Theories (SFT) share ideas that, while similar in some respects, differ from this model.

What Kind of Motion Would Such a Substance Exhibit?
We know that a fluid is a body whose parts yield to any force applied to it, moving freely relative to each other. Its physical characteristics can be inferred from the behavior of other fluids. As a first approximation, this would be the most ideal fluid found in nature.
A quasi-ideal fluid's primary characteristics include incompressibility and viscosity that is only nonzero in the limit of large accelerations. Due to its high Reynolds number (a dimensionless characteristic of fluids) (1), a turbulent regime develops within it, expanding and forming vortices.
Vortices arise in fluids due to the presence of minimal viscosity. In fluids with zero viscosity (the physics of "dry water"), vortices exist but cannot be created or destroyed. Viscosity (internal friction) is responsible for dissipating kinetic energy, leading to a complex and disordered motion known as turbulent flow or turbulence. Turbulence remains one of the most challenging fields of physics to study. However, partial studies suffice to achieve our objective.
Turbulence fully develops when no constraints counteract instabilities within the fluid. This applies to the universe as a whole.
The simplest way to describe a vortex is to imagine a portion of the fluid tracing a circular path, with the circle's diameter determining its size. The turbulent state results from the superposition of vortices of different sizes, multiplying their self-wrapping structures. These vortices, varying in size, propagate in different directions and interact with each other to form complex structures.
In 1941, Kolmogorov developed a theory suggesting that vortices organize themselves hierarchically based on size. Energy is transferred in a cascade process: a vortex

divides into two smaller ones, which in turn divide into two more, and so forth—continuing *until a limit determined by each fluid's viscosity*.
When viscosity is nearly zero, as in our case, the smallest vortex structures are extremely small and tend to flatten, forming a quasi-two-dimensional vortex. This consists of an outer zone that rotates freely and a small inner core that rotates in the same direction as a rigid body (Figure 1a).

Figure 1. (a & b) - Simple vortex and alternating vortex.



The outer region has a tangential velocity that increases toward the center, following the law V×R=constant, until it reaches a boundary layer that separates two different behaviors. Beyond this point, the velocity decreases toward the center and becomes zero at the core, following the law V= constant ×R, similar to the eye of a hurricane, rotating as a rigid body. This prevents the existence of a singularity where the velocity would otherwise become infinite at the center.
It is possible to understand the behavior of a fluid without knowing all its specific details, as all fluids behave similarly based on a dimensionless characteristic known as the Reynolds number:
Re=ρvLμ
where:

- ρ\rho is the fluid density,
- v is the characteristic velocity of the fluid,
- L is a characteristic length (such as the diameter of a pipe or the length of a plate),
- μ is the dynamic viscosity of the fluid.

The Reynolds number determines when a flow transitions from laminar to turbulent, and this threshold varies depending on the situation. For Reynolds numbers on the order of 10E5, the fluid is at the boundary between laminar flow and periodic turbulent flow, depending on the geometry. In this regime, vortices alternately rotate clockwise and counterclockwise, forming a structure known as a *Karman vortex street* (Figure 2), named after its discoverer, Von Kármán.
Experiments with different fluids have shown that for this Reynolds number, turbulent flows develop in all three spatial dimensions. Vortices emerge in chaotic flow because this configuration leads to a more stable and lower-energy state.

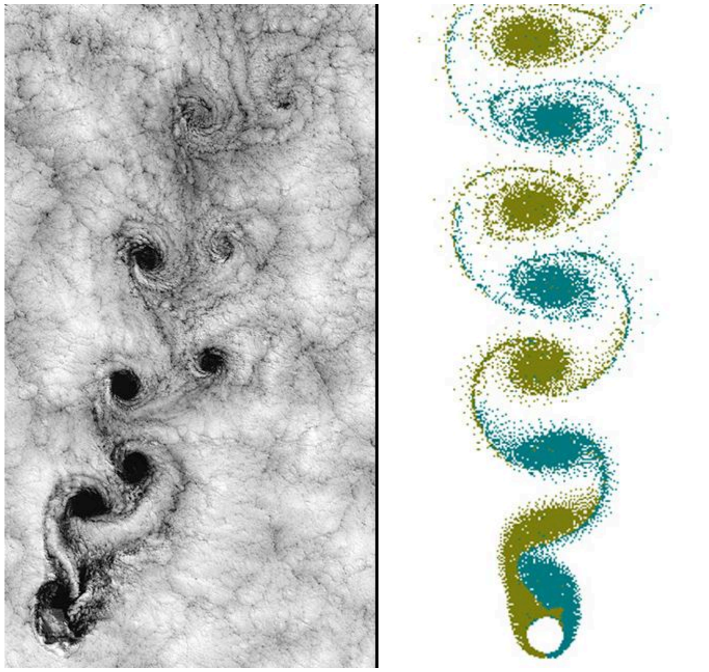


Fig.2 Karman street

Vortices have a primary rotation due to their angular momentum, but we will make the fundamental assumption that, in addition to this orbital rotation, one part of the fluid also rotates 180° relative to the other in a polar manner—alternating in opposite directions (Figure 3). This phenomenon is also observed in real fluids. This assumption will justify itself through its consequences.
Due to this rotation, the vortex boundary surface undergoes a topological transformation, changing from a two-sided surface into a one-sided surface, isomorphic to a Möbius strip (Figure 1b).
This is possible because the circulation follows the motion of a *Poinsot ellipsoid*, due to the asymmetry effects of rotating bodies in a vacuum, a phenomenon known as the *Dzhanibekov effect* (see the video *"The Bizarre Behavior of Rotating Bodies"*).
We are accustomed to things returning to their original state after a full 360° rotation. However, one-sided surfaces exhibit a peculiar property: they only return to their original state after being traversed twice, that is, after a 720° rotation.

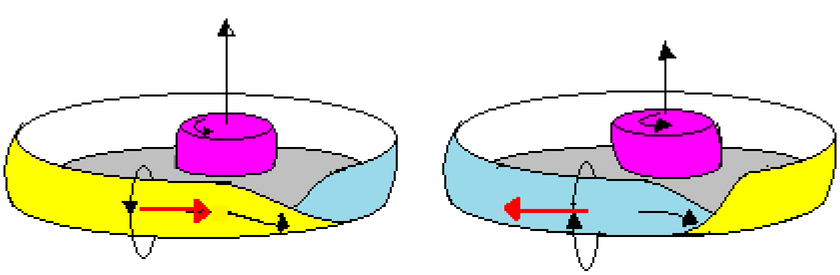


Figure3. Vortices as Mirror Opposites.

As long as viscosity and diffusion effects are minimal, the fluid within a moving vortex is carried along with it, while the fluid in the core tends to remain within it. This is a consequence of Helmholtz's second theorem, which, in summary, states that "the elements of a fluid that form a vortex in an ideal fluid will always remain in a vortex.” In other words, a ring or filament of vorticity in a fluid cannot terminate within the fluid; that is, it cannot have ends within the fluid but must form a closed loop or extend to the boundaries of the fluid.

This theorem implies that in an ideal fluid, vortices are permanent and cannot spontaneously disappear or appear within the fluid. If a vortex exists, it will continue to exist unless it interacts with the boundaries of the fluid. This has significant consequences in fluid theory and in understanding phenomena such as tornadoes and eddies in fluids. Vortices can transport mass, energy, and momentum over considerable distances compared to their size.

Only two vortices with opposite characteristics can be generated. Their defining properties are their intrinsic spin (helicity) and their polar spin (chirality). Both spins are conserved during motion. However, left-handed helicity transforms into its opposite when viewed from the opposite side, and vice versa, making it a relative property. Chirality, on the other hand, is an absolute property that remains conserved and, as we shall see, is the origin of other conservation laws. Chiral opposites are exact mirror opposites and can interact with each other without losing their individuality.

The isomorphism between the boundary zone of vortices and the Möbius strip can be considered *evidence of the three-dimensionality of space*. In a two-dimensional space, only one type of Möbius strip exists, while in more than three dimensions, a Möbius strip could transform into its opposite through an additional dimension, making the complex structures we perceive impossible.

Two or more approximately parallel vortices with opposite circulations will move closer together and eventually merge into a single vortex. However, the assumed property of chirality would keep the two opposing vortices bound together without mixing. Conversely, two vortices with the same circulation will repel each other due to the fluid motion between them. From a distance, it would appear as if they attract or repel each other: two vortices with opposite spins move toward each other, while two vortices with the same spin move apart.

Vortices contain substantial energy in the circular motion of the fluid. In an ideal fluid, this energy would never dissipate, and the vortex would persist indefinitely. Only the presence of viscosity (which we assume to be negligible except for large accelerations) would lead to energy dissipation.

At the exit of the Karman vortex street, the two opposing vortices merge, forming a unit of opposites that we call the *node*. We will henceforth represent it with the symbol <+/-> or <-/+>, where the signs + and - represent chirality, as it remains unchanged under operations, while the angled brackets represent helicity, as one spin transforms into its opposite under inversion, making it a relative characteristic.

Let us now analyze its effects by applying this assumption to various “mysteries” of physics.

1. Planck’s Constant and Vortices

Planck’s constant h, discovered in the study of the ultraviolet catastrophe and later used by Einstein to explain the photoelectric effect, is a fundamental characteristic of the microcosm. It has the units of the important physical variable called action and also coincides in units with angular momentum.

The minimal vortex formed in the substantial fluid can be described as a function of the angle traversed by the atominos within the vortex through an angular function, a solution to Schrödinger's equation (10):

$F(\theta)= \exp(i\, s\theta/ \hbar)=\cos (\theta s/ \hbar)+i \sin(\theta s/ \hbar)$

where i is the imaginary unit, s is the angular momentum of the spin, θ is the angle, and ħ is the reduced Planck's constant. Due to the isomorphism of the vortex with the Möbius strip, the boundary surface is a non- orientable surface. Therefore, after an odd number of complete 360° or 2π rotations (2n+1), it does not return to the same function but rather to its opposite:

$F[2\pi(2n+1)]= \cos(2\pi(2n+1)\, s/ \hbar) + i \sin(2\pi(2n+1)\, s/ \hbar)=-F(0)=-1$

For this to occur:

$(2n+1)\, 2\pi\, s/ \hbar = (2n+1)\pi$

since

$\cos(2n+1)\, \pi=-1, \ \ \sin(2n+1)\pi=0$

Thus:

$2s/\hbar=1$

which leads to

$s=1/2\, \hbar$

This is the characteristic of the intrinsic angular momentum, or spin, of fermions. Quantum physics considers this property almost inexplicable, as it represents angular momentum, yet quantum particles are regarded as point-like and therefore incapable of spinning.

Spin, a property of particles discovered by Pauli and later incorporated into a relativistic framework by Dirac, is defined as intrinsic rotation and characterizes all particles. Regarding fermion spin, Dirac had already recognized this topological feature, which he mathematically described as spinors. He graphically illustrated it using a chair and a pair of scissors tied with a uniquely arranged string, demonstrating behavior that matches the Möbius strip. The circulation of atominos within the vortex can be identified with the intrinsic spin of elementary particles since it shares the same topological characteristic.

Particles exhibiting this property include those proposed by Pauli around 1930 to account for energy and momentum conservation in beta radiation. Discovered twenty years later, neutrinos were initially characterized solely by fermionic spin, although recent studies suggest they may possess mass. In our model, vortices exhibit both characteristics, but their mass is purely inertial, not gravitational. This does not contradict the necessity of neutrino mass to explain their oscillations, ensuring that their speed does not exceed the speed of light in a vacuum. This identification also allows us to distinguish between neutrinos and antineutrinos based on their opposite chirality.

The vortices in this fluid are the smallest structures in the universe, their size limited by viscosity. The origin of vortices is associated with the spontaneous symmetry breaking of the fluid. That is, the universe spontaneously decayed into a lower-energy state, giving rise to vortices. This also increased entropy and marked the beginning of time.

For any given fluid, the angular momentum of the two minimal vortices is a constant. In this case, since the fluid's motion generates all that exists, the angular momentum of its minimal vortices should be a fundamental characteristic of nature—a universal constant, perhaps the only one from which all others could be derived.

Its identification with Planck's constant, now with objective existence, emerges naturally. In free vacuum, the node density is the lowest possible in nature. Inside materials, as we shall see, it increases depending on the internal molecular structure. *This suggests that if we could locally reduce the density of nodes in the vacuum, it might be possible to achieve speeds greater than that of light without violating causality*.

2- Vortex Interaction

Once vortices are formed in the Karman vortex street, they either move closer together or drift apart, depending on whether the flow lines of the *atominos* between them are parallel or antiparallel. When two opposite vortices approach each other, they form a unit that balances their properties while maintaining their individuality. From a topological perspective, the union of these two chiral vortices, rotating as opposites, develops in three-dimensional space as a Klein bottle (Figure 4). The defining topological property of the Klein bottle is that it consists of two Möbius strips with opposite chirality. This feature is difficult to visualize, but it is important to keep in mind that they are two independent, interrelated units in a state of balanced motion.

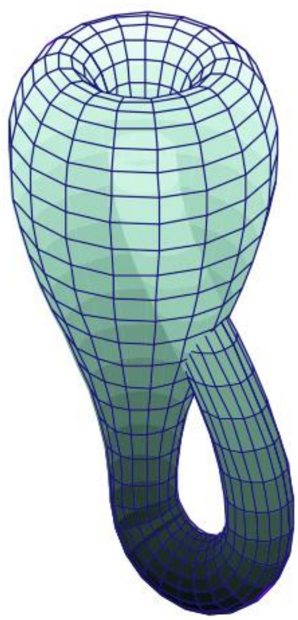


Figure 4. Klein bottle node.

Those two vortices, opposite in both chirality and helicity, form a highly stable structure that we have termed *vacuum quanta* or *nodes*, anticipating their function. We will represent them using Dirac's notation as:

<+//–> =1 node

where the symbols + and – indicate right- and left-handed chirality, while the angled brackets denote helicity. The chirality signs are absolute, whereas the brackets invert upon reflection, which will be useful when defining electric charge. As a result, we can visualize empty space as a fluid with moving structures, where spatial points are not mere geometric entities but physical points with balanced energy between two opposites.

This perspective allows us to reconsider a fundamental principle of quantum mechanics:

3.- The Uncertainty Principle
Werner Heisenberg (Nobel Prize in Physics, 1932) formulated the Uncertainty Principle, which states that, unlike in classical mechanics, it is impossible to measure simultaneously and with absolute precision the values of two complementary variables, such as the position x and momentum p of a particle. The minimum uncertainty is given by the reduced Planck constant $\hbar/2$, expressed as:
$\Delta p \, \Delta x \geq \hbar/2$
where the variation in momentum p (mass times velocity) multiplied by the variation in position x is always greater than or equal to half of the reduced Planck constant, $h/2\pi$.
In macroscopic experience, we perceive that both the position and velocity of an object can be measured exactly (determinism). However, now that we understand the vacuum as a superfluid composed of *atominos* and nodes, we see that microscopic objects interact with the physical points of space. It is inevitable for them to interact with at least one vortex, whose intrinsic angular momentum $\hbar/2$ naturally explains Heisenberg's Uncertainty Principle.
The objective existence of Planck's constant alters every observation through interaction, establishing the fundamental limit of classical physics.

3. **Light.**

Max Planck's discovery linked the discontinuous energy of light quanta to the frequency of light, in contrast to classical electromagnetic theory, which related it to the square of the wave amplitude.
This revolutionary concept introduced the idea that energy is emitted or absorbed in discrete units, known as quanta or photons, laying the foundation for the development of quantum theory.
Einstein's 1905 explanation of the photoelectric effect, for which he won the Nobel Prize, was the first to demonstrate the reality of these new concepts. The discontinuous energy packets that make up light revealed unusual properties of quanta, highlighting the dual nature of light, which behaves as either a wave or a particle depending on its interaction with matter.
This phenomenon, known as wave-particle duality, remains puzzling to this day. Light is observed to behave in one way when its trajectory is monitored and in another when it is not. The double-slit experiment, also known as Young's experiment, is one of the most paradigmatic in this regard.
The Topological Model of Physics (MTF) proposes an explanation more in line with traditional logic, and we will see that it is also applicable to other quantum mechanics concepts, such as superposition, the meaning of the wave function, measurement, or the exclusion principle, just as we did with the uncertainty principle and the meaning of Planck's constant.
Light is an electromagnetic wave that propagates in a vacuum at a constant speed, as demonstrated by Maxwell in the mid-19th century. Additionally, it propagates in indivisible unitary energy packets—particles of light known as photons. Although it is a particle, it possesses a specific frequency and an intrinsic angular momentum, or

spin. It has no gravitational mass, yet it is affected by gravity, as predicted by Einstein's general theory of relativity.
Light can slow down when entering other media, such as water or glass, supposedly due to interaction with the atoms of the material—a phenomenon known as refraction. The wave-particle duality of light allows it to behave as a wave in certain experiments and as a particle in others, which is fundamental to understanding phenomena such as interference, diffraction, and the photoelectric effect.

How Does the Photon Propagate According to MTF?
In the Topological Model, the node, being composed of two vortices that compensate for their properties, can be identified with the node of the electromagnetic wave, as the electric and magnetic fields simultaneously become zero at that point. However, the model recovers it as an independent entity, which, due to not manifesting its angular momentum and energy properties, can be visualized as a constitutive vacuum.
It is well known that when an electron accelerates, due to its electric charge, it absorbs or emits photons, which are the quanta of the electromagnetic field.
We propose that, once constituted, the nodes in our hypothesis can be propelled by the acceleration of an electric charge and that this impulse produces two effects on the node: it agitates it, causing the oscillation of one vortex over the other, and it accelerates it, leading to its propagation.
The oscillation of the node, driven by the electric charge, makes it oscillate between two extreme positions: its node state, where all its properties are compensated, and a position where the angular momenta of the component vortices align parallel and sum, producing the photon's angular momentum or spin, h, in the direction of its polarization.
The oscillation between the two extreme positions corresponds to the electromagnetic wave, where the electric and magnetic fields manifest in the plane perpendicular to the propagation direction, oscillating between a maximum value and their cancellation at the node, now understandable as the compensation between both vortices. In the photon position, the node fully manifests its action content, doing so as many times as permitted by its frequency f.
From this arises a definition of energy that is not circular with respect to other physical variables, now based on the fundamental piece: the action contained in the vortices.
Proposed by Einstein for the photoelectric effect, $E=h\times f$ (the energy of the photon equals Planck's constant times the frequency), we reinterpret this as the number of times per unit of time that the action fully manifests due to the node's agitation, revealing its energy content.
When the node is driven, it acquires its frequency, but as a particle, it is also accelerated from its position. The received impulse not only defines its frequency but also determines its velocity, as with any other particle.
However, the speed of any photon in a vacuum is the universal constant c. Have we reached a contradiction?
No, on the contrary, now we can understand the constancy of the speed of light in a vacuum. If we note that in its photon position, the connection between the vortices is minimal, and when interacting with other neutral nodes in the vacuum, it transfers its energy through elastic collisions, returning to its neutral node position. This

interaction ensures the continuity of light propagation in a vacuum, in such a way that it is proportional to the frequency.
At higher frequencies, there are more interactions with the vacuum nodes, compensating for the greater received energy and ensuring that light, across all frequencies, maintains a constant speed c in a vacuum, on average and over long distances. The speed of light in a vacuum is maximal because the average density of nodes in the vacuum is the lowest possible.
The oscillation of the node also explains the spatial extent of light, that is, its wavelength. At lower frequencies, the separation between the node's vortices lasts longer, allowing the fluid motion to reach greater distances, thereby determining a greater wavelength.
Experimentally, light has been shown to have a fixed velocity in a vacuum equal to c (celerity), independent of the reference frame from which it is emitted. However, this contradicts Galileo's principle of relativity, which is why Einstein had to postulate this speed as a universal constant. To recover the observed relativity, he had to modify space-time coordinates, making them flexible.
With the Topological Model, however, we can now explain what happens. When light is emitted from a moving reference frame with velocity v, it propagates by colliding with the nodes of "empty" space, reducing its speed by the same magnitude it was increased.
The Michelson-Morley experiment, conducted in 1887 and one of the most significant in the history of physics, attempted to measure the Earth's motion relative to the ether—a supposed medium thought to permeate space and carry light. Maxwell's ether was rigid and static. The vacuum nodes grant motion and independence to light propagation. Since no increase or decrease in speed was detected in the vacuum due to the ether wind, it was assumed that the speed of light in a vacuum is constant both in the direction of the Earth's motion around the Sun and perpendicular to it.
Directly measuring the speed of light in a single direction is theoretically and practically complicated due to the need for clock synchronization and the involved conventions. Thus, most experiments and methods opt to measure the speed of light using the round-trip time and then averaging the result.
The consequence was the development of special relativity, which provides a geometric solution to the problem by assuming that spatial dimensions contract in the direction of motion and that time, integrated into space-time, dilates.
However, we still do not know the physical cause of this phenomenon, which is why special relativity remains a principle rather than a consequence.
The Topological Model can provide the physical cause.
In the Michelson-Morley experiment, in the direction perpendicular to the Earth's motion, light undergoes a double speed increase—before and after reflecting off the interferometer mirror.
According to the model, this greater distance traveled by light is compensated for by the greater number of collisions with the vacuum nodes.
In the direction parallel to the Earth's motion, before reflection, the mirror moves away as light travels toward it, causing more collisions with the nodes, keeping the speed invariant.
After reflection, the mirror moves toward the photon, causing fewer collisions in proportion to the Earth's velocity, maintaining the constant speed.

Thus, the expected optical path difference was nonexistent, ensuring that the speed of light remains constant in a vacuum, lending credibility to the assumptions of the Topological Model. Lacking a physical cause for the constancy of light speed, Einstein had no choice but to postulate it.

4. Electric Charge

Other possible combinations in which vortices can approach each other with their spins antiparallel involve two vortices with the same chirality but opposite helicity, meaning they do not form a Klein bottle.
In the proposed nomenclature:

<+//+> represents a positive charge

<-//-> represents a negative charge

Since there are only two configurations of two identical vortices opposing each other, we identify them with the two electric charges.
However, because there are no known particles with charge and no mass, we must conclude that these configurations are not stable due to their identical chirality. They require the formation of a container with gravitational mass to remain bound and function.
The figure illustrates the arrangement of two identical Möbius strips forming a cavity through which fluid flows attract the vacuum nodes, with the opposite vortex of the electric charge oriented towards it in a rapid acceleration.

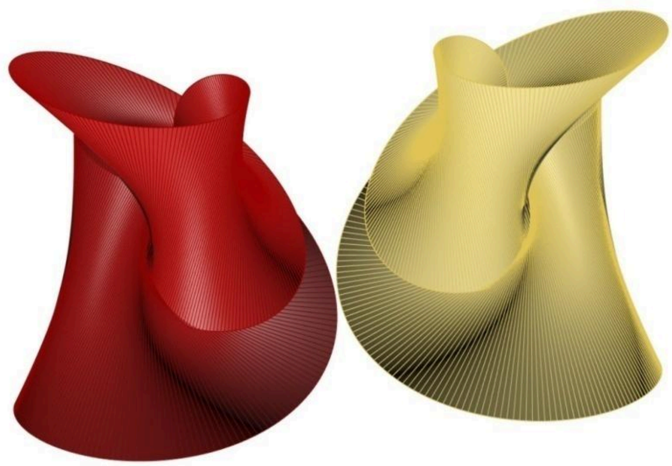


Figure 7
Opposite electric charges, two Möbius strips with the same chirality but opposite helicity (for descriptive purposes only).

How do electric charges activate the electromagnetic field in empty space?
The electric charge polarizes and orients the nodes from its position in space, and this polarization propagates to other nodes, transmitting through space as the inverse square of the distance, meaning it spreads in a solid angle.

We can represent this schematically as follows:

<–/+> <–/+> <–/+> (<–/–>) <+/–> <+/–> <+/–>

… in all directions.

Later, we will explore the effect of a moving charge, and thus, magnetism.

5. The Topological Model and Classical Physics

Newton’s principles were transformed by Emmy Noether in the 19th century into conservation principles explained by the corresponding symmetries. How does the model interact with these principles? In the topological model, we perceive empty space as composed of nodes moving within a superfluid of point particles that we have called *atominos*.

A massive body is no longer considered a material point as in classical mechanics but rather a volumetric body of mass m that interacts with the nodes of the vacuum. This interaction establishes a neutral current of nodes through the body, moving in the opposite direction to its motion. This does not modify the principles but rather explains their causes.

Classical physics is the theoretical framework developed mainly during the 17th and 18th centuries, which describes the behavior of macroscopic bodies under the influence of forces. The fundamental principles of classical physics include:

Law of Inertia (Newton's First Law): A body at rest or in uniform rectilinear motion will remain in that state unless acted upon by an external force.

Law of Force and Acceleration (Newton's Second Law): The force applied to an object is equal to the object's mass multiplied by its acceleration (F= ma).

Application of the Topological Model:

If a force is applied in a certain direction to a body of mass m, it will mobilize the nodes, creating a neutral current of nodes passing through it in the direction opposite to the applied force. This current of nodes will be processed by the mass, meaning the body will accelerate in proportion to its mass, but not instantaneously. The mass must adapt to the neutral node current as if there were a certain viscosity.

When the force ceases, the current of nodes remains constant, resulting in a constant velocity, and the motion becomes rectilinear and uniform. *Rest, therefore, is relative to another body that is traversed by the same node current*. It is this neutral current passing through the mass of bodies that explains inertia.

This implies that velocity is not the key characteristic of motion, but rather the linear momentum p=mv, the product of mass and velocity—that is, the nodes combining with mass. *The nodes are the ones responsible for transferring momentum.*

Furthermore, when acceleration increases to bring velocity closer to the speed of light in a vacuum, a relativistic increase in mass, as determined by Einstein, is observed. Now, we can attribute this to the difficulty of mass in processing the neutral current of nodes. Therefore, we have found a cause for two of Newton's principles.

Law of Action and Reaction (Newton's Third Law):

For every action, there is an equal and opposite reaction. That is, forces always occur in opposite pairs. However, the explanation for why there is an equal and opposite reaction is not clear. It is known to be true through observation and experimentation, but the underlying cause remains unexplained.
Let us analyze dynamic situations using the model. For instance, in the case of a rocket, ignition expels small masses of fuel at high velocity through the rocket's nozzle. As these masses accelerate, they are traversed by neutral node currents moving in the opposite direction to their motion—that is, toward the rocket. These neutral currents, when acting on the large mass of the rocket, create thrust in the direction opposite to the expelled fuel masses, explaining the principle.
Similarly, when firing a gun, the explosion of gunpowder propels the bullet forward, while the neutral node current passes through it in the opposite direction, producing the recoil of the gun.
The rebound of a small elastic ball will be proportional to its deformation. A larger ball behaves the same way. However, when a small ball is dropped onto a larger ball, an unexpected effect occurs: the small ball bounces to a much greater height than when it rebounds off the ground. Of course, elastic collision studies explain this, but from the perspective of the model, the neutral current of nodes passing through the larger ball enhances the motion of the smaller ball.
Another interesting example is elastic collisions in Newton's cradle. A series of five aligned pendulums are set up, where pulling back the first pendulum and releasing it causes it to strike the next one. However, neither this pendulum nor the successive ones move—only the last pendulum is ejected, as it is the only one with a degree of freedom to move. Naturally, conservation equations can be used to explain this phenomenon, but with our model, we identify a local cause consistent with other phenomena.
When the first pendulum falls, it incorporates nodes into its mass, equal to those of the other pendulums. The node current accounts for its velocity, but at the moment of collision, its mass is loaded with nodes. When it is suddenly stopped by the impact, the nodes are expelled through the other pendulums, forming a current of nodes that traverses all of them until it reaches the free pendulum, propelling it with the same linear momentum the first pendulum had.
If three pendulums are separated, the number of nodes corresponds to the three masses. Upon collision, the stationary spheres become loaded, and the third sphere does not release its nodes, continuing the motion. If the last sphere had twice the mass, the third sphere would also stop, as the nodes would have somewhere to go.
An interesting and still unexplained case is that of a small ball balanced on top of a dome or bell in a vacuum. Supposedly, the ball should not fall, yet after some time, it does. Now, we can attribute the departure from equilibrium to the presence of nodes in empty space. Quantum mechanics speaks of vacuum fluctuations, but with the *Topological Model of Physics (MTF)*, we can give substance to these fluctuations.
The presence of nodes constructs space-time and fields and is responsible for the conservation of linear momentum, energy, angular momentum, and the explanation of the principle of least action.

Principle of Least Action:

The principle of least action is a fundamental concept in physics. It refers to the idea

that in many physical systems, the path or trajectory a system takes to evolve from an initial state to a final state is the one that minimizes a quantity called *action*. This action is mathematically defined as an integral of the Lagrangian — a function that describes the difference between the kinetic energy and the potential energy of the system throughout the motion.
This principle can be considered the counterpart of entropy. Entropy is associated with the amount of energy in a system that cannot be used to perform work and, at the microscopic level, describes the number of possible states a system can adopt. Since the Lagrangian is the difference between kinetic and potential energy, it can be interpreted as the energy available in the system to perform work.
In the topological model, the action of a system traveling from point A to point B—whether it is a fermion or a photon—generally follows the path of least action. But action has units of angular momentum, just like Planck's constant. Therefore, we could say that the system follows the trajectory with minimal node disturbance.
For any other path (as described by R. Feynman in his book *QED*), the phase given by the chronograph varies rapidly, and only trajectories close to the path of least action remain valid, while the others cancel out.
That is, trajectories with minimal disturbances contribute constructively, while the others cancel out. But now, the chronograph has a specific physical meaning given by the amplitude of the node's oscillation.
We can reinterpret the principle of energy conservation in a closed system by recalling that, according to the model, energy is the number of times node action manifests—that is, the frequency of oscillation of the disturbed nodes. We could reformulate it by stating that the number of disturbed nodes in a closed system remains constant.

5° Topological Model and Gravity

We have two theories of gravitation. Both are classical, non-quantum theories.
Newton's theory, intuitive in nature, states that masses attract each other due to a force proportional to their masses and inversely proportional to the square of their distances.
Einstein's theory of gravitation tells us that the geometry of space-time determines the path that masses follow. Masses generate the curvature of space-time, and space-time, in turn, dictates how masses should move.
His theory was built on three pillars: the equivalence principle, the propagation of light in a vacuum, and a fundamental change in the geometry of space-time.
Special Relativity demonstrates that if the speed of light in a vacuum is a universal constant and relativity is a valid principle, then space contracts in the direction of motion, and time dilates, ensuring that the classical laws of mechanics and electromagnetism hold.
Paul Ehrenfest, an Austrian physicist and close friend of Einstein, observed that in a rotating disk, the circumference would contract due to relativity, but the diameter would not. This implies that the ratio between the circumference and the diameter would no longer be π, suggesting that the space-time geometry in this case ceases to be flat.
This insight led Einstein to consider non-Euclidean geometries, particularly Riemannian hyperbolic geometry.
The equivalence principle establishes the equivalence between inertial mass and gravitational mass, leading Einstein to formulate his famous thought experiment of an

accelerating elevator in a vacuum. This experiment demonstrates that such a system would be indistinguishable from a gravitational field, implying that light must bend in this reference frame, even though it has no mass.
Einstein conceived of space-time as empty space, but how can emptiness be curved? The Topological Model, by attributing a defined structure to empty space, provides a possible explanation.
We have seen, when discussing acceleration, that a neutral current of nodes is established through mass, explaining its inertia or cosmic resistance.
What would be the equivalent node current due to gravity?
Every massive body should generate a node current directed toward its center of mass—not in the direction of motion but radially toward the mass itself, which, as we have seen, is equivalent to an acceleration. This corresponds to what we perceive as gravitational acceleration.
The absorption of nodes by mass would occur locally within each portion of mass and throughout the entire volume, acting as if a curtain were absorbing space-time itself. This is what causes the curvature described by Einstein and explains why all bodies fall with the same acceleration, regardless of their volume or chemical composition, as if they were attached to a universal fabric.
However, that is not the whole story. Just as accelerating a body in a given direction depletes the node current behind the mass, in this case, the same does not happen. We propose that mass gathers nodes in pairs, producing a dynamic electric dipole <+/-><+/->, which redistributes itself in a tetrahedral configuration, creating <+/+><-/->— two electric charges in motion that are ejected from the mass into space. This structure has spin 2 (1/2 per vortex) and can be identified with the graviton.
This suggests that gravity may have two distinct sources:

1. One arising from space-time deformation, acting at small relative distances.
2. Another quantum source, due to the graviton, which acts at much greater (possibly infinite?) distances as an always-attractive electric interaction resulting from the dynamic presence of the two opposite charges in the graviton.

This means we can consider a scenario where space-time curvature dominates at short distances, while long-range interaction mediated by gravitons dominates at greater distances. This idea remains speculative but offers a different perspective on how gravity might behave across different scales.

Space-Time Curvature at Short Distances
In this scenario, space-time curvature, as described in General Relativity, dominates at short scales. This implies that gravitational effects at these distances are strong and are determined by the curvature induced by masses.

Gravitons at Large Distances
At large distances, quantum effects could become more relevant, and gravitational interaction could be mediated by gravitons. In this regime, gravitational force might decay more slowly than predicted by Newton's law, potentially accounting for observations such as galaxy rotation curves and other cosmological phenomena without invoking dark matter. (The mathematical model will be developed later.)

Application of the Topological Model of Physics (MTF) in Light Experiments

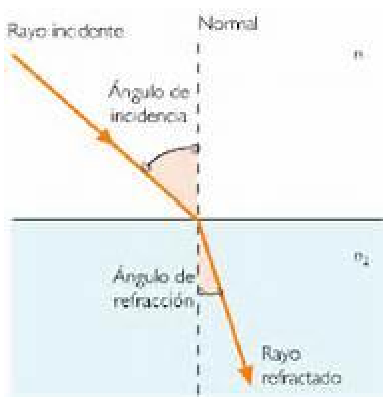
Light Refraction

6.- Light Refraction and Special Relativity

Light appears to change direction when passing from air to water or another denser medium, producing two effects: a contraction of distances in the direction perpendicular to the surface and an expansion and bending in the direction parallel to the surface. This is due to an optical illusion—the object seems to be in a different position than its actual location. This phenomenon, known as light refraction, has been studied since antiquity.

Refraction occurs when a beam of light strikes a surface at an angle, separating two different media. This change in medium causes a deviation in the direction of light propagation. If light moves from a less dense medium (such as air) to a denser one (such as water), it bends toward the normal of the surface. Conversely, if it moves from a denser medium to a less dense one, the light bends away from the normal.

In 1621, the Dutch mathematician and astronomer Willebrord Snell formulated a law relating the angles of incidence and refraction to the refractive indices of the two media. These indices are connected to the speed of light in each medium. Snell's law was not derived from theoretical reasoning but was instead established through observations of refraction experiments using geometric arguments.



Snell's Law is as follows:

n1sin i=n2 sin t

where:

i = angle of incidence (the angle formed by the incident ray with the normal N).

t = angle of refraction (the angle formed by the transmitted ray with the normal N).

n1 = refractive index of the first medium.

n2 = refractive index of the second medium.

Explanations of the Refraction Phenomenon

Don Lincoln, a physicist from Fermilab, dismisses in his videos (which we recommend watching: Why does light slowdown in water? and Why does light bend when it enters glass?) several explanations given throughout history, either because they describe but do not explain, or because the explanation is not unique. These include:

Fermat’s Principle

The analogy of the line of soldiers

Huygens’ Principle

Instead, he favors one explanation: Opposing Electromagnetic Wave.

Don Lincoln’s Preferred Explanation
An incoming electromagnetic wave in the medium acts on the electrons of the material causing them to emit an electromagnetic wave with a phase opposite to the incoming one. The sum of both waves results in a slower wave, thus explaining the reduction in the speed of light within the medium. This delay increases with frequency because the interaction becomes stronger. As a result, blue light bends closer to the normal than red light.
After passing through the surface, the light continues propagating in a homogeneous medium, maintaining its direction. If the second medium is a plate of a certain thickness, the light regains its original direction upon exiting the plate, since the opposing electric field effect disappears. However, it is still not entirely understood how an opposing electromagnetic wave is always generated, ensuring that the emerging beam remains parallel to the incident beam. This is particularly puzzling given that the electrons generating the electromagnetic wave rapidly orbit their nuclei, leading to a complex dynamic.
Even though Snell’s Law has been known for over four centuries, interpretations and models regarding the nature of refraction have yet to reach absolute consensus.

Quantum Electrodynamics (QED)
Quantum electrodynamics, known as QED, was developed by Richard Feynman and others and provides one of the most precise explanations of refraction.
In this model, light is considered to follow all possible paths from one point to another, assigning a phase to each photon—a phase Feynman calls a chronograph. Each of these paths is given a probability based on the potential energy at each point along the way. All contributions are then summed, taking into account constructive and destructive interference of probabilities.
This approach is based on the most modern theory of light and can even be applied to individual photons. If we conduct an experiment where photons are sent one by one, we observe that they cluster exactly at the angles predicted by Snell’s law.
However, the main drawback of this theory is that the calculations are extremely complex, and it lacks an intuitive explanation of the phenomenon, especially due to the necessity of considering multiple possible paths probabilistically to explain light’s behavior.

MTF explanation.
In this model, the speed of light is limited by the density of nodes in the medium, the higher the number of nodes the lower the speed of light.

In a vacuum, the density of nodes is the lowest possible, so the maximum speed of light occurs in a vacuum. However, in a material medium, the density of nodes in the intermolecular space is higher than in a vacuum, depending on the molecular structure, thus reducing the speed of light.
When crossing a surface that separates two media the node density changes abruptly, producing the observed edge effect which depends on the node density in the vacuum and in the new medium.
Different frequencies will have different speeds depending on the number of photon collisions with the nodes in the medium. Thus, blue light, which has a higher frequency, moves more slowly in the medium due to a greater number of collisions with the nodes, while red light, with a lower frequency, moves faster because it experiences fewer collisions.
It may seem paradoxical that higher-energy light bends more, unlike a projectile, which deviates less as its energy increases.
In ice, the refractive index is lower than in water because, as it expands compared to liquid water, the density of nodes in the intermolecular vacuum decreases.
All the information we have about a medium is only available through light. If we try to measure a pencil inside a glass of water, we will see that, in the direction normal to the surface, a shortening occurs. If we were to measure the length inside the medium using a ruler, it would also shorten in the same proportion. This situation is analogous to what Einstein described in his Special Theory of Relativity. Since we only know distances in a fast-moving system through light, distances in our relatively stationary system appear contracted—an effect that becomes visible in the analogous system of refraction.
One way to derive Special Relativity is as a space-time rotation, where time is converted into space by making it imaginary (ict). (See Appendix X.) In the perpendicular direction, time dilates. In refraction, an analogous effect occurs, which is why the pencil appears bent.
The reduction in the speed of light in the medium results from the way we propose that light propagates. But what happens to the change in direction of light when it enters another medium?
We propose that light does not actually bend when entering the new medium; it only appears to bend when viewed from the outside. Light follows a geodesic in the geometry of the new medium. Thus, when light exits a parallel-faced crystal, it emerges parallel but displaced from the original beam. There is no need for an additional explanation, as it simply follows its path of least action. This interpretation maintains continuity with general relativity. (See Appendix XI for a demonstration of space-time rotation.)

7. The Double-Slit Experiment

Young's experiment, also known as the double-slit experiment, was performed in 1801 by Thomas Young (12) in an attempt to discern the corpuscular or wave nature of light. This experiment is the most renowned for illustrating the quantum and paradoxical nature of light and elementary particles because it demonstrates their dual wave-particle nature.

Photons are emitted one at a time from a source toward a screen containing two small, closely spaced slits. If one slit is blocked, a particle-like behavior is observed on a second screen at some distance—a single central spot appears. However, when both slits are open, a series of alternating light and dark fringes appears, similar to a wave interference pattern. Since photons (and even electrons) are considered particles, the question arises: what is it that interferes?

Quantum physics answers that the particles pass through both slits simultaneously and interfere with themselves. In a probabilistic view, the interference of probabilities occurs a priori—that is, the locations where a particle will hit the screen are predetermined before the particle is even sent. This interpretation creates considerable confusion in language. For example, if one "observes" which slit the particle passes through, the interference pattern is destroyed and the particle behaves as if it passes through only one slit.

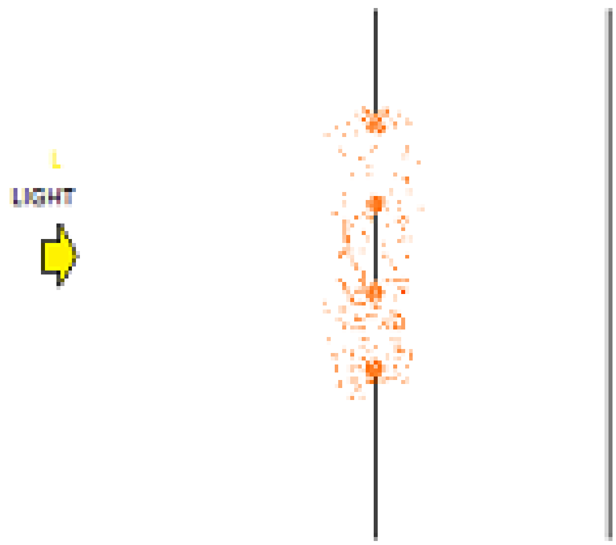
This behavior has led some to suppose that we create reality through observation, while unobserved reality remains uncertain. This is the suggestion made by Erwin Schrödinger in his famous thought experiment—the cat that is simultaneously alive and dead in a box with a radioactive particle that triggers a weapon. Once the box is opened, reality is defined and the cat is either alive or dead.

According to our hypothesis—that vortices give true objective existence to Planck's constant—we can interpret the phenomenon differently. The slits are interruptions in the continuity of a vast conglomerate of atoms. From the perspective of the MTF, in the empty space of the slits there exist nodes that are affected by the electromagnetic fields at the edges of the slits. How? These fields disrupt the perfect coupling of the vacuum nodes, polarizing them from the edges toward the center.

When a second narrow and closely spaced slit is introduced, the polarized nodes from one slit interfere with those from the other. (This is why the slits must be very close relative to the characteristic wavelength of the experiment, producing zones of occlusion and neutral zones in the vacuum through which the particle can pass.) Attempting to observe which slit the particle traverses would disturb the interference structure of the slits, thereby destroying the effect.

Thus, it is no longer necessary to assume that a particle, upon reaching the screen, splits in two, passes through both slits, and interferes with itself—a notion even more absurd in the case of electrons, given the uniqueness of electric charge. Instead, particles are able to pass only through the un-polarized regions of the vacuum in the slits. While the mathematical explanation remains unchanged, the phenomenological interpretation is very different.

Figure 5: Interference of the Nodes from Both Slits.



Quantum Zeno Paradox

The Quantum Zeno paradox, also known as the Quantum Zeno effect, originates from the ancient paradox of Zeno of Elea, in which Zeno argued that if time or space is divided into infinitely small segments, motion should never be possible. In the quantum context, the paradox takes a form related to the continuous measurement of a quantum system.

In quantum mechanics, the Quantum Zeno effect states that by continuously observing (or measuring) a quantum system, one can prevent it from changing state. This seems counterintuitive but is closely linked to wave function collapse, one of the fundamental ideas in quantum mechanics.

When a quantum system is in a superposition of states, it does not have a defined state until it is measured. If the system is repeatedly measured at very high frequency, it can be forced to remain in its initial state, preventing it from evolving or transitioning to another state.

Example:
Imagine an atom that can exist in two states: an excited state and a ground state (lower energy). If left unmeasured, the atom would naturally transition from the excited state to the ground state over time. However, if it is constantly observed, the atom "freezes" in its initial state due to the repeated interference of measurements, which collapse the wave function each time and "reset" it to its initial condition.

Quantum Explanation:
This behavior is explained by the principle of quantum superposition and the wave function collapse process. An unobserved quantum system evolves according to the Schrödinger equation, allowing it to transition to other states. However, when the system is measured, its wave function collapses, forcing it to take a definite value. If

measurements are made infinitely frequently, the system is never given enough time to evolve into a new state.

This phenomenon has been experimentally observed and has implications for how we understand the relationship between observation (or measurement) and the behavior of quantum systems. It is a clear example of how quantum mechanics challenges our classical intuition, as in our everyday world, merely observing something does not prevent its change or evolution.

Explanation within the Topological Model:
In this framework, observation mobilizes (induces oscillations in) the nodes of the lower energy state, preventing decay. If the observation of the system is infrequent, the nodes "settle" and the probability of decay increases. Conversely, the higher the frequency of observation, the greater the stability of the higher energy state.

This interpretation eliminates the illogical necessity of assuming the system exists in a superposition of all possible states simultaneously, thereby rendering wave function collapse unnecessary.

Polarimeters in Series

Another experiment that demonstrates the quantum behavior of light involves the use of polarimeters in series. If we polarize light using a polarimeter, for example, a horizontal one, and then place a vertical polarimeter afterward, the light will not be transmitted. But what if we inserted another polarimeter at a 45° angle relative to the horizontal between the two? The light will pass through the 45° polarimeter, and paradoxically, it will also begin to pass through the vertical polarimeter.

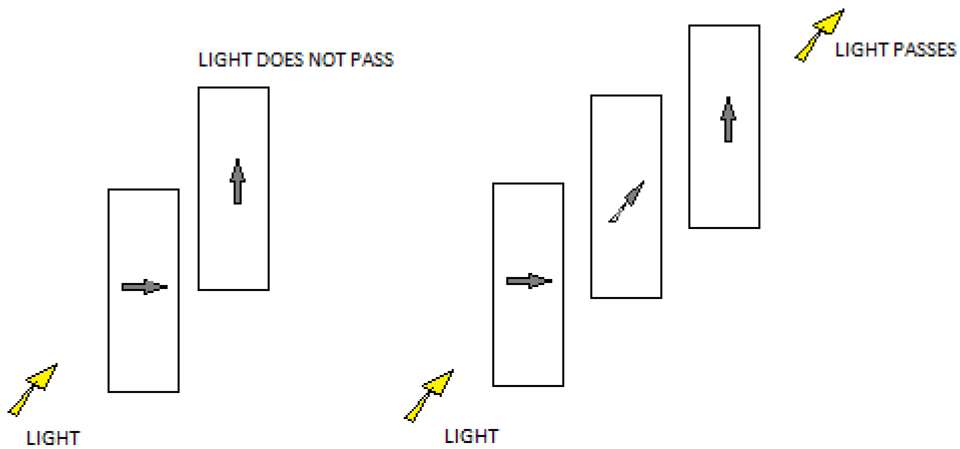
From an electromagnetic perspective, polarization is the direction of the electric field of the electromagnetic wave.
From a quantum perspective, it is the direction along which the intrinsic spin of the photon is oriented, and the described experiment occurs even for a single photon. The photon cannot be divided; it can only pass or not pass.

If, after passing through the angled polarimeter, another polarimeter with the same angle is placed very close to it, the photon will pass through with a 100% probability. However, if the second polarimeter is moved farther away, there will be a distance at which the photon no longer passes through it, as if its polarization had rotated. (Leonard Susskind, QM Lecture 9, Stanford) (13). This is a quantum effect that classical theory does not explain.

From our perspective, even within the polarimeter, the photon travels through the vacuum between atomic structures. Each time it reaches the position of a photon with its two spins aligned, it can interact with the nodes of the vacuum. However, the internal vacuum of the polarimeter favors a specific direction. If it is a horizontal polarimeter, it will cover 45° to both sides due to the chiral rotation of the vortices, allowing the photon to pass through the angled polarimeter but not the vertical one.

However, once it passes through the 45° polarimeter, the photon's spin rotates in a plane centered on the 45° angle as it moves forward. This causes it to now cover 45° to both sides, thereby including the vertical polarimeter, which it could not pass through before but can now traverse after passing through the angled polarimeter. In this way, the phenomenon is explained very simply.

Figure 6.- Interposing a Polarimeter.



Relation to Spin Rotation and Distance

If the photon propagates through the vacuum between two polarizers, its vortex structure continues to evolve. In the MTF, the vacuum is not a static space; rather, it contains fluctuations and dynamic structures that can influence the spin orientation as a function of the distance traveled.

A possible hypothesis is that the Möbius-like topology of the vortices causes the photon's spin to gradually rotate as it moves forward. This rotation can be described by a distance-dependent function.

If the spin keeps rotating with distance, then placing a second tilted polarizer after a certain distance means that the photon will no longer be aligned with the orientation that allowed it to pass through the first polarizer, reducing its transmission probability.

This would explain why, when the distance between polarizers is sufficiently large, the photon can no longer pass through the second tilted polarizer. Its spin has shifted due to its interaction with the vacuum, decreasing its probability of projection onto the new polarizer axis.

3.- **Quantum Entanglement**

Two photons originating from the same coherent source will be entangled. The system formed by both particles exists in a superposition of states that cannot be decomposed into independent states of each particle. This means that, regardless of the distance between them, the spin measurement of one photon will always be opposite to that of the other. In other words, whatever happens to one photon will immediately determine the outcome of the other, as their probability distributions are intrinsically linked by the dynamics of the system. However, since spin measurements vary, it may appear as if instantaneous communication were occurring between them.

This paradox, formulated by Einstein and known as the EPR paradox, led him to conclude that quantum mechanics is incomplete and that the apparent contradiction could be resolved by the existence of hidden variables. The effect gives the illusion of faster-than-light communication, yet genuine superluminal information transfer is forbidden. In reality, the measurement outcomes are merely revealing correlations that were established at the moment of the photons' creation.

From the perspective of the MTF, this phenomenon can be explained by the chiral rotation of vortices in the vacuum. We deduce that the spins of both photons are not only complementary in a single direction but across their entire motion. Their spins are well-defined and always opposite, yet they evolve within separate half-spaces. Consequently, what appears to be distant communication is, in fact, the natural result of their common origin and the structure of the vacuum, which governs their complementary behavior.

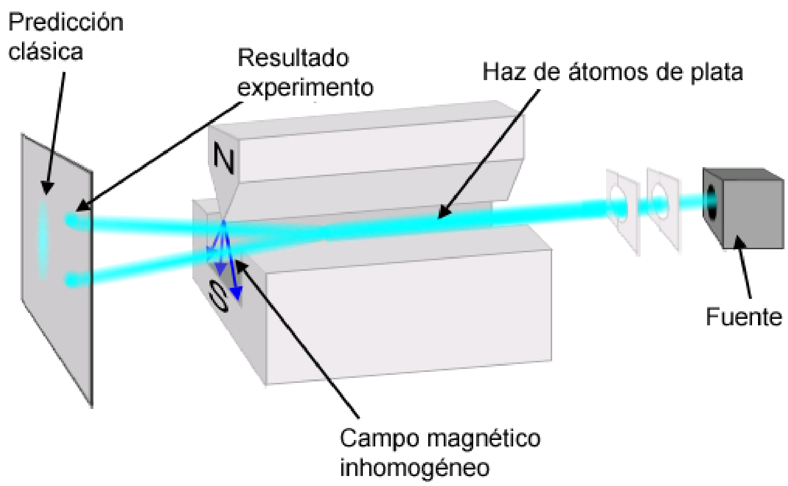
4.- Spin

In 1922, Otto Stern and Walther Gerlach conducted an experiment to observe how beams of silver atoms deflect when passing through a magnetic field, revealing an unexpected property. According to classical physics, if the atoms had a randomly oriented magnetic moment, their trace on the screen should have formed a continuous line. This is because, if the magnetic moment vector is randomly oriented, its perpendicular component—responsible for the deflection—should vary between zero and a maximum value.

However, to their surprise, they observed that the beam split into only two distinct parts, forming two separate spots on the screen.

The experiment used a beam of silver atom vapor, collimated by two slits, passing through a magnetic coil of 0.1 tesla with a maximum gradient of 10 tesla/cm.

The following figure illustrates the experimental setup:



Although the authors were unable to explain the result, their discovery paved the way for physicists Samuel Goudsmit and George Uhlenbeck to propose, three years later, the existence of a *quantized intrinsic angular momentum*, which they called "spin."
In 1925, Wolfgang Pauli formulated a fundamental principle, known as the exclusion principle, which states that two identical fermions, such as electrons, cannot occupy the same state in a quantum system.
In 1926, Fermi and Dirac developed the statistical theory for particles that obey this principle, which must have half-integer spin. Fermions.
Quantum angular momentum is expressed as:
$L=nh/2\pi$
where h is Planck's constant and n is a natural number.
A few years earlier, the Indian physicist Satyendra Nath Bose, in collaboration with Einstein, developed the theory for integer-spin particles. Bosons. These particles, such as the photon, do not obey the exclusion principle.
In 1928, Dirac formulated a relativistic version of Schrödinger's equation, which indicated that fermionic particles must necessarily have spin 1/2. It was not until 1940 that Julian Schwinger established the connection between intrinsic angular momentum (spin) and the intrinsic magnetic moment of the electron.
Successive experiments revealed surprising characteristics in quantum physics measurements. If we measure spin along a given direction (e.g., the Z-axis), we observe two distinct spots on the screen: "up" and "down."

- If we repeat the measurement in the same direction, all atoms that initially showed "up" will again show "up."
- If we measure along a perpendicular direction (the Y-axis), all atoms that initially showed "up" in Z will now have values of "forward" and "backward" along Y.
- If we then measure Z again, we once more obtain "up" and "down" values, independent of the previous Y-axis measurement.

These experiments have two crucial implications that form the foundation of quantum mechanics:

1. **Spin quantization:** Spin is an intrinsic quantum property of particles and can only take specific values.
2. **State collapse:** According to the Copenhagen interpretation, before passing through the detector, spin exists in a superposition of all possible states (in this case, two). When it passes through the detector, the spin collapses into one of those two states.

These observations led to the postulation of spin as an intrinsic property, meaning that, within the framework of current physics, it cannot be explained by a more fundamental concept.

Description with the Topological Model
In the topological model, spin is not a property that must be postulated; rather, it emerges from the characteristics of vortices.
The spin of the electron is associated with a single right-handed (dextrorotatory) vortex, while the spin of the proton is associated with a left-handed (levorotatory) vortex. This is because the chirality of the spin is opposite to that of the corresponding electric charge.
The electron’s spin can be represented as a right-handed vortex: |+>
The two quantized values that cause the beam splitting in the Stern-Gerlach experiment correspond to the possible directions of rotation, i.e., its helicity. However, since helicity can change if the vortex rotates 180 degrees, it is a relative property and is not predetermined.
Interactions caused by experiments can induce rotations that alter the spin orientation (up or down). The successive measurements in the experiment can be interpreted as follows:

- When a component is measured again in the same direction, the interaction with the experiment does not change the spin direction because both directions coincide.
- However, when measuring in another direction, the interaction with the measurement system causes a random rotation of the vortex, with a 50% probability of being up or down in both X and Y. Thus, measurements in both directions return to their initial values.

This model also explains why electrons form pairs in atomic orbitals. Both electrons correspond to right-handed chirality but with different helicities or directions of rotation.
The pairing of two spin vortices, one from each electron, *generates a virtual positive electric charge* that screens the repulsion between the negative charges, allowing their proximity. We can schematically represent two electrons in a singlet state as follows:
<+|,<−|−><−|−>,|+> → <−|−>,<+|+>´,<−|−>,
where:

- <−|−> represents the two vortices of the electron's negative electric charge.
- |+> represents the electron's spin vortex.

- <+|+>´ represents the virtual positive charge produced by the proximity of the spins.

This perspective also clarifies Cooper pair interactions in explaining superconductivity.
The left diagram represents the two electrons in the singlet state, depicted by their negative electric charges and spins. The right diagram represents the electrons screened by a virtual positive charge formed by their spin vortices.
The notation with the apostrophe and the term "virtual charge" indicate that it is not a true electric charge. Instead, at short distances, it behaves as an attractive force that counteracts the repulsion of the negative charges.
Thus, the model justifies the Pauli´s exclusion principle: two electrons can pair and form a stable singlet state with a total spin value of zero. The term "singlet" applies because both electrons share the same energy level.
The same principle applies to protons and neutrons, which can separate into two directions due to spin and share an energy level in the atomic nucleus.
For protons, there is an important medical application: Nuclear Magnetic Resonance (NMR).
In summary, the model provides an interpretation of spin based on a more fundamental concept, predicts the quantization of angular momentum into exactly two possible values, and offers an interpretation of the exclusion principle for fermions.

Entanglement.
The EPR paradox was proposed in 1935 by Albert Einstein, Boris Podolsky, and Nathan Rosen. They argued that, according to quantum mechanics, entangled particles could exist meaning that if one particle had, for example, spin “up,” the other must have spin “down.”
Thus, quantum mechanics could not be a complete theory, as it suggested that these particles could influence each other instantaneously regardless of the distance between them, which they called "spooky action at a distance."
To illustrate this entanglement, we can observe the following:

1. We generate two entangled particles, for example, two photons that we call A and B.
2. If we measure the spin of both particles in any given direction (x, y, or z), we see that they always have opposite spins in 100% of cases. If we repeat the measurements in the same direction for both particles, this correlation is preserved.
3. If we measure the spin in different directions, for example, A in the z-direction and B in the x-direction, the correlation is lost, and the results appear random for both A and B, with each measurement yielding either "up" or "down."
4. If the particle pair, after being measured as in case (3), is later measured again in the same direction for both, the results remain random because in (3), the correlation was definitively lost.

For Einstein, this seemed to violate the principle of locality, as it implied "action at a distance" without a physical medium transmitting this influence. EPR proposed that

"hidden variables" could exist to explain these effects in a local and deterministic manner, implying that quantum theory was incomplete.
Niels Bohr, one of the fathers of quantum mechanics, responded to EPR by defending the Copenhagen interpretation. Bohr argued that the problem posed by EPR was based on a misunderstanding of the concepts of reality and measurement in the quantum realm.
For Bohr, quantum mechanics does not describe an objective reality independent of observation but only predicts probabilities of measurement outcomes. According to Bohr, the properties of a particle do not have a definite value until they are measured, and quantum entanglement is a manifestation of this interdependence between quantum systems.
This discussion initiated a fundamental debate in physics, leading to John Bell's inequality theorem, which provided a framework for experiments such as those conducted by Alain Aspect and others. These experiments later demonstrated that quantum correlations could not be explained by local hidden variables, validating the nonlocal quantum interpretation proposed by Bohr.
The 2022 Nobel Prize in Physics was awarded to Alain Aspect, John F. Clauser, and Anton Zeilinger for their pioneering experiments on quantum entanglement. Their research apparently ruled out the possibility of explanations based on nonlocal hidden variables, thus confirming the validity of quantum mechanics regarding non-locality and entanglement. These experiments suggest that entangled particles exhibit correlations that cannot be explained by hidden variable influences, reinforcing the fundamental nature of quantum connections in the universe.

Interpretation of Spin in TMP.
However, in our model, spin is an isomorphic vortex of a Möbius strip, as we have proposed. Imagine that the spin of each fermion follows a Möbius strip trajectory, which implies:

- Each spin "moves" in a precession pattern that rotates along a Möbius strip.
- The strip introduces a "twist" in spin space, meaning the spin orientation continuously changes as it traverses the strip.

If fermions born together exist on Möbius strips with opposite helicity (rotation direction) and chirality (twist direction of the strip), then each spin would have a structurally opposite configuration to the other. In this case, even though their spins continuously change orientation, they would always remain correlated in an "opposite" manner at every instant.

Quantum Correlation with Opposing Möbius Strips.
When the fermions are separated, their entangled spins would maintain a correlation in their relative orientation. If each spin follows a precession along its respective Möbius strip (with opposite helicity and chirality), their "opposite" relationship remains intact, as any rotation or torsion in one spin would have its corresponding inverse reflection in the other.
This implies that regardless of the distance between them or the direction in which each fermion's spin is measured, an opposite correlation in measurements would always be observed because the structure of opposing strips ensures that the "opposition" is preserved.

With this configuration, if a spin component is measured (e.g., in a specific x, y, or z direction), we would observe that:

- The spin component of one fermion always has the opposite sign to that of the other fermion, maintaining the correlation.

It is important to note that spin cannot be represented by an arrow like a vector, as it is a spinor and is represented by a matrix. The Möbius strip has topological properties similar to a spinor in the sense that a 360-degree rotation results in a sign change, and to return to the original state, a 720-degree rotation is required.
When measuring in any given direction, what we actually measure are the spinor projections in that direction. As long as the rotation direction remains unaffected, measurements will yield opposite spin values. However, if a measurement is taken in another direction, the particle may rotate arbitrarily due to interaction with the measuring instrument, losing entanglement and producing a random distribution of values that follows the squared cosine law of the deviation angle.
In this Möbius strip structure with opposing helicity and chirality, the spins of fermions would maintain an opposite correlation in any measured spin component, even when separated. The Möbius structure ensures that this opposition remains independent of the measurement axis selected, preserving the correlation regardless of their distance.

An Alternative Explanation for Entanglement.
This idea of spins precessing on opposing Möbius structures can be interpreted as an alternative explanation for entanglement without directly invoking action at a distance in the traditional sense. Let's analyze how this might work:

- The "opposition" in their spin components is not something established at the moment of measurement but has always been defined by the opposing geometric configurations of the strips.
- The Möbius strip structure and its opposite helicity ensure that any measured spin component in one particle will have an opposite correlation in the other, regardless of spatial separation.
- This means that the observed correlation in entanglement is due to the predefined geometric structure of the spins rather than to an instantaneous communication between them.

Eliminating the Need for Action at a Distance.
In the traditional framework of entanglement, action at a distance seems inevitable: measuring the spin of one particle instantly determines the state of the other, no matter how far apart they are. However, in the Möbius strip model, the opposition in measurement results is already "encoded" in the spin trajectory structures from the moment of their creation.
This eliminates the need for information transmission at the moment of measurement:

- When a spin is measured, the result is simply a manifestation of its Möbius trajectory.

- Since the other particle has a trajectory on an opposite Möbius strip, the "opposite" correlation is guaranteed without requiring communication between the particles.

Conclusion.
In this interpretation, entanglement is a property of the geometric-dynamic configuration of entangled particles, not an interaction at a distance:

- The spins are correlated because their internal trajectories are "entangled" geometrically, following opposing Möbius configurations that reflect this correlation without any information transmission.
- This allows us to view entanglement as a phenomenon of structural connection in spin space rather than an action-at-a-distance phenomenon in real space.

5.- The Electron.

The electron is the quintessential free elementary particle. It possesses all the properties that characterize matter. It has the smallest gravitational mass, a unit negative electric charge, spin, and, being stable, it is part of the known construction of matter.

The electron is considered an elementary particle and, therefore, a point-like entity. That is, a geometric point with all its mass and charge concentrated in that single location. Moreover, it has the same spin as the vortex. But if it is considered point-like, what exactly is spinning?

Special relativity tells us that the energy contained in the rest mass is equivalent to mcˆ2, but being equivalent does not mean it is the same thing. The universe has worked extensively to construct mass and make it diverse, achieving this by endowing it with structure.

Starting from the fundamental building blocks—vortices—we can attempt constructive hypotheses to explain the structure of the electron.

First, it must contain the electric charge, which, according to our hypothesis, consists of two vortices with the same chirality but anti-parallel spin. Since it contains charge, we can assume it is a convex, homogeneous, and compact body—that is, self-contained, composed of the same elements, and more generally, a closed and bounded set within the topological space. Additionally, it develops in three dimensions and should exhibit significant symmetry to be considered point-like at a distance.

We could attempt to construct it using a sphere, but that would be like trying to build a circle with line segments since vortices—our fundamental building blocks—while developing in three dimensions, are essentially planar, as they oscillate in a plane perpendicular to the propagation direction in a photon.

The next alternative is to use the symmetry of regular polyhedra, attempting to place a vortex on each of their faces and analyzing whether the fluid circulation remains consistent.

After a detailed analysis, we conclude that the smallest regular polyhedron that could model the electron is the octahedron, but with one caveat: it should be truncated at two of its opposite vertices.

The cross cap is a homomorphism of the Möbius strip, but it is constructed from a circle. By placing a cross cap on each face of an octahedron, a Möbius strip at one vertex, and two internal structures to generate the electric charge at the other vertex (see figure), we obtain a structure with spherical symmetry but topologically multiple connectivity. This configuration, in principle, satisfies the electron's properties, and we could hypothesize that its measured mass is defined by this structure.

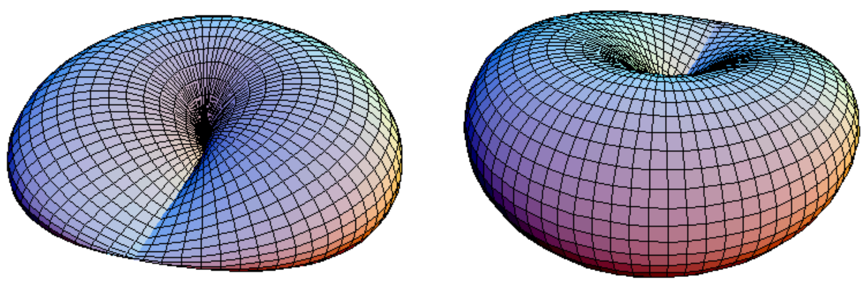


Figure 8.- Cross Cap

Since the electron's charge has historically been assigned a negative sign, we propose that the Möbius strips forming it have left-handed chirality <-/. Consequently, the positive charge carried by the proton would consist of two right-handed Möbius strips, complementary to the electron's charge <-/->.

As we will see in relation to the Pauli exclusion principle, the Möbius strip responsible for the electron's spin must be opposite—that is, right-handed. Similarly, the proton's spin should be left-handed, preserving the neutron's configuration.

In beta decay, the antineutrino produced alongside the proton and the electron should be complementary to the electron's spin and therefore left-handed, while the neutrino's corresponding structure would be right-handed.

All these definitions are, of course, relative but internally consistent.

The electron can be constructed using an octahedron of vortices for mass, two vortices for charge, and one vortex for spin.
The flows within the octahedron demonstrate consistency, leaving two opposite vertices open.

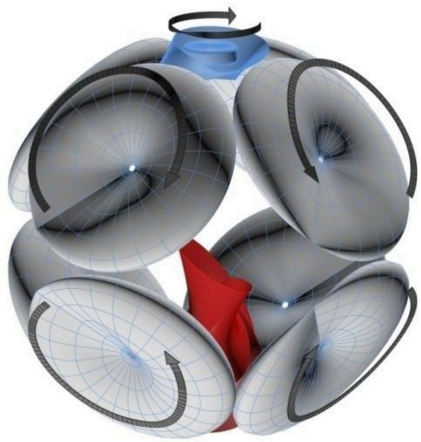


Figure 9. The Electron

The effect on the space surrounding the electron is the attraction of nodes toward the gap created by the electric charge, polarizing them. That is, the vortices align opposite to those of the electric charge, oriented toward the electron, thereby creating an electric field in space.

The opposite configuration is entirely possible, resulting in the positron.

Later, we will deduce the gravitational mass of the electron from this model.

An immediate conclusion of this model is that matter and antimatter did not annihilate each other completely but rather contributed to forming existing matter through a spontaneous symmetry breaking at the initial moment of vortex formation.

Electron-positron collisions would produce at least two photons as the vortices of both electric charges combine. The remaining vortices transform into nodes, destroying the mass and transferring their momentum content to each of the two photons.

.1 Particle Families

Within the Standard Model classification, the electron is a lepton.
Six types of leptons or "flavors" have been discovered, forming the three known generations:

- The first generation consists of electronic leptons, including the electron (e−) and the electron neutrino (ν́e).
- The second generation includes muonic leptons: the muon (μ−) and the muon neutrino (ν́μ).
- The third generation comprises tauonic leptons: the tau (τ−) and the tau neutrino (τ́ ν), along with their corresponding antiparticles.

Currently, there is no clear understanding of why three lepton families exist.

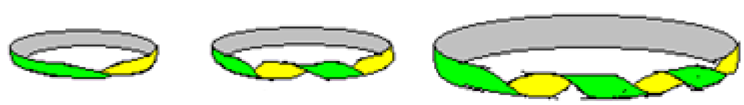
The vortex hypothesis in a fluid leads us to propose a model that could explain why only three families of leptons exist. Their neutrinos are incompatible with one another, yet they apparently oscillate and transform into each other.

The chirality property of vortices is not limited to a single 180° rotation in three-dimensional space. Any odd number of 180° rotations retains the property of being equal to itself—not individually, but in pairs of complete turns. In a turbulent fluid, the formation of vortices with multiple turns requires much higher energy jets.

Thus, the electron neutrino would correspond to a vortex with a single turn, the muon neutrino to a vortex with three turns, and the tau neutrino to one with five turns. As we will see later, this explains why each neutrino interacts exclusively with its associated lepton.

Additionally, we can infer that the energy required to produce a vortex with seven turns would be so enormous that it would not be feasible—hence, a fourth generation of leptons does not exist. However, it remains uncertain whether future experiments with significantly higher energies might eventually reveal one.

Figure 10. Möbius Strips with One, Three, and Five Turns



We have identified vortices with neutrinos. The neutrino is the most elusive particle in existence, as it passes through matter with almost no interactions. We can explain this minimal interaction by noting that when a vortex is not compensated, its motion disperses into the fluid, leaving only the core as a significant structure. This core moves as a rigid body, with a boundary surface of radius on the order of the Planck length, approximately 1.616229(38)×10E−35) meters. This scale is far too small for significant interactions with the rest of matter.

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6. The Electron in the Atom and the Exclusion Principle

The *Pauli exclusion principle* states that no two fermions (particles with half-integer spin) can share the same set of quantum numbers within the same quantum system. Wolfgang Ernst Pauli formulated this principle in 1925, and it provides the key explanation for why, despite the attractive nature of gravity and the positive electric charge of the nucleus pulling negatively charged electrons inward, matter does not collapse. This principle is particularly relevant to electrons in the hydrogen atom.

Let's analyze this from our perspective.

The atomic nucleus is an enormous concentration of mass within an extremely small space. However, we now understand that space around matter is filled with nodes, which are influenced by this mass, leading to *vacuum polarization*.

Close to the nucleus, nodes will polarize more strongly, with this effect decreasing with distance. At a certain point, the nodes compensate each other, creating a *first neutral zone*. This pattern continues outward, forming successive neutral zones, much like a vibrating string fixed at the nucleus and oscillating outward. The neutral zones become increasingly compressed as they extend until the influence of the nucleus fades.

The first neutral zone surrounding the nucleus is called the *ground state*, which corresponds to the lowest energy level electrons can occupy in the atom, characterized by the quantum number n=1. An electron in this region cannot fall into the nucleus despite the electrostatic attraction *because vacuum polarization prevents it.*

Now, consider an electron in the ground state. It moves randomly due to interactions with *virtual photons* originating from the polarized nodes in space, which are created by its electric charge. If a second electron enters the same region, one would expect a strong electrostatic repulsion due to their identical charges. However, two electrons *do* share the ground state—how is this possible?

The Pauli exclusion principle dictates that the two electrons must align with opposite spins. Our model provides a physical explanation:

- The *vortex responsible for the electron's spin* has chirality opposite to that of the vortices forming its electric charge.
- When two electron spins are anti-parallel, they generate a *virtual electric charge of opposite sign*, facilitating their pairing.

Quantum Jumps and Energy Absorption XX

Throughout its movement, the electron continuously exchanges photons with the vacuum via its electric charge. When a photon has the appropriate energy, the electron absorbs it and *jumps* to the next neutral zone. These were historically called *quantum jumps*, but in our model, what actually happens is:

1. The electron *incorporates the node* from the absorbed photon.
2. This additional node *abruptly changes the electron's quantum state,* moving it to the next neutral zone.

At this stage, n=2, and the electron's *orbital angular momentum* increases by the angular momentum of the incorporated node. This quantity is conventionally denoted by l, the *orbital angular momentum quantum number*.

While the traditional interpretation attributes this angular momentum to the *electron's orbit*, our model suggests that it represents the *number of incorporated nodes*. These nodes will later be emitted as photons when the electron returns to a lower "orbit."

A New Interpretation of Atomic Architecture

The structure of the atom remains unchanged—but its *interpretatio***n** does.

7. The Atomic Nucleus and Quarks

During the 19th century, chemistry was greatly simplified by explaining the diversity of elements in Mendeleev's periodic table using only two numbers:

1. **Atomic weight**, which turned out to be the number of heavy particles in the atomic nucleus (protons and neutrons).
2. **Atomic number**, which corresponded to the total electric charge of the nucleus, given by the number of protons.

With the addition of the electron, these three particles—protons, neutrons, and electrons—seemed to provide a simple and elegant description of matter at the beginning of the 20th century.

However, by the mid-20th century, the discovery of mesons led to a rapid increase in the number of known particles, creating a "particle zoo" with no apparent underlying pattern to simplify the problem.

By 1965, **Murray Gell-Mann** introduced a new level of simplification by proposing that nuclear particles could be described using only two fundamental constituents, which he called **quarks**. He labeled them **"up"** and **"down"** (although these names do not indicate any actual spatial direction) along with their respective antiparticles, making a total of four particles.

Later, it became necessary to **triple** the number of quarks and introduce **three complementary varieties**—which he called **colors** (red, yellow, and blue). This was required to satisfy **Pauli's exclusion principle** and to explain why quarks never appear in isolation. In nature, these color charges always combine to produce **white** in free particles, ensuring that quarks remain confined.

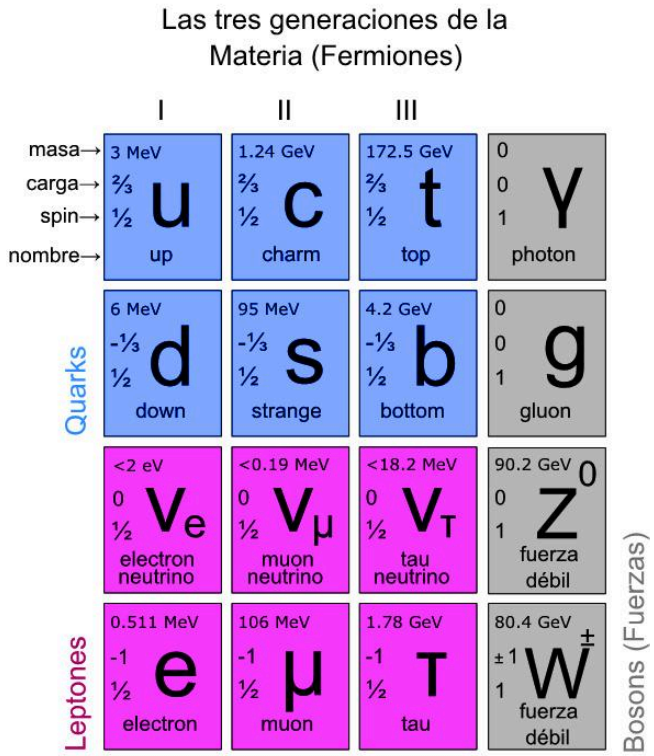


Figure 11: Table of Elementary Particles

The table in Figure 11 lists the elementary particles. These particles are called *elementary*, yet the reason behind their variety remains a mystery. In the section on the electron, we proposed that the three generations of leptons could arise from the type of vortex that defines the spin of each generation.

Additionally, we identified the node as a Klein bottle, formed by two Möbius strips of opposite chirality and opposite spins, while the electric charge was associated with two Möbius strips of the same chirality but opposite spins.

To analyze quarks from a topological perspective, we must examine a Möbius strip with *three 180° twists*.

Two Möbius strips with three twists and the same chirality, when brought together with anti-parallel flows, form two opposing Klein bottles, which we will refer to as **Klein-3**. As with electric charge, *only two and only two opposing Klein-3 structures can be constructed.*

First, we must recall that quarks exhibit a property **never observed in isolation in nature**—namely, **electric charge in thirds**.

Another essential property is spin-½, which defines fermions and requires them to obey Pauli's exclusion principle—meaning no two identical fermions can share the same quantum state. To account for this, *color charge* was introduced, leading to

Quantum Chromodynamics (QCD) as the framework that describes quark interactions.

Now, we can outline a *topological model for quarks*:

- If two **Klein-3** structures together correspond to an **electric charge of ±3**, then when balanced by an opposite charge, a *residual charge of ±2/3* remains.
- If compensated by two opposite charges, the *remaining charge is ±1/3*.

Naturally, the existence of **two Klein-3 structures** explains the presence of **quarks with different charge signs**.

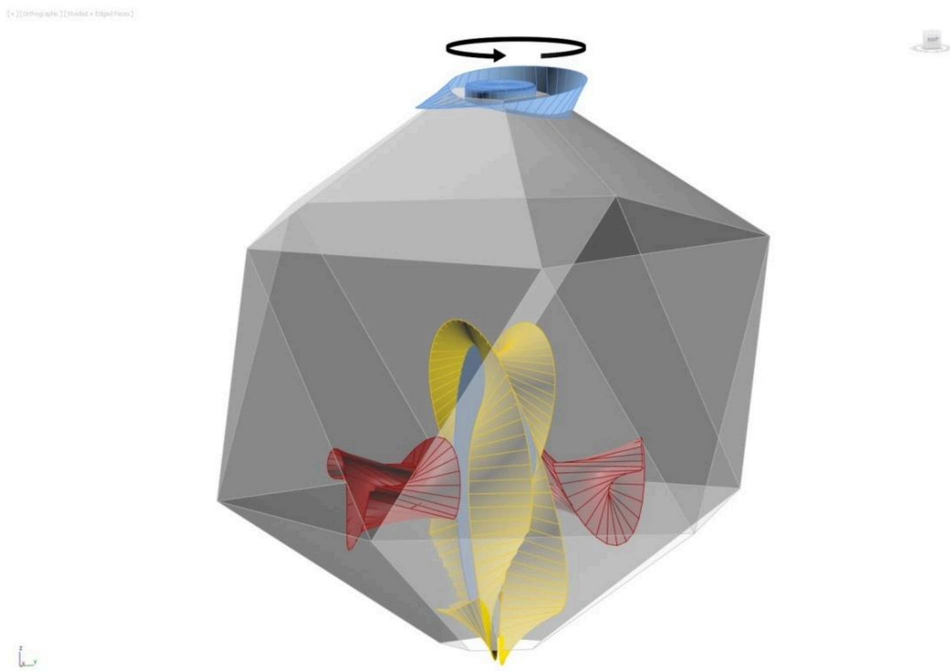


Figure 12: Example – Anti-down Quark (Charge 1/3, Spin ½)

Now that we have represented quark properties using Klein-3 bottles, we can also assign the three color charges to the three spatial directions in which quark-bound charge structures may align within particles.

To define the other two generations of quarks, we can apply the same structure as in the case of leptons:

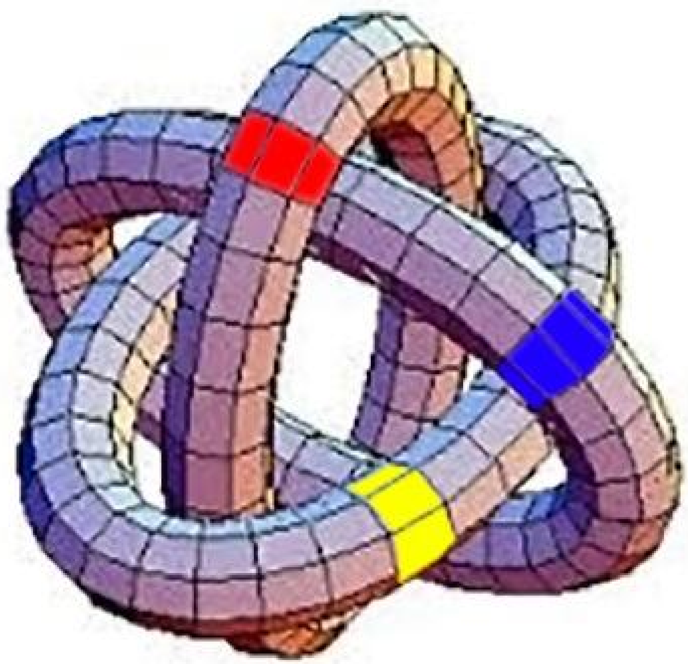
- The *u and d quarks* (and their antiparticles) would correspond to a Möbius strip with *one 180° twist*.
- The *c and s quarks* would correspond to a Möbius strip with *three 180° twists*.
- The *t and b quarks* would correspond to a Möbius strip with *five 180° twists*.

Since all quarks share the same fundamental topological structure and spin-½, this framework maintains consistency. However, determining the exact chirality of each quark exceeds the scope of this first part.

To visualize quark architecture, we construct it using the next possible convex regular polyhedron after the tetrahedron, which is the *icosahedron*—a polyhedron with *twenty faces* (16).

When analyzing the *rotational symmetries of the icosahedron*, we obtain a *coherent, closed ten-faced central body*, while the *two five-faced bases remain open*.

Figure 13: Borromean Knot – The Nucleon



Conclusion

Our proposal of a *universal superfluid* helps resolve the *controversies among great physicists* during the early 20th century.

We conclude that *quantum indeterminacy*, as observed by Werner Heisenberg, does exist. However, it arises due to the presence of a second fluid, characterized by *nodes*—the *quantum vacuum*.

These nodes explain the *strange probabilistic effects* that Albert Einstein criticized.

The *Schrödinger equation*, which uses the so-called *wave function* defined as a *probability amplitude*, is justified by the *structure of the vacuum*.

We have extended the model to classical physics and gravity, discovering that *Planck's constant* corresponds to the *fundamental object of the vacuum—the node.*

Final Conclusion

Our *universal superfluid model* not only *unifies classical and quantum phenomena* but also redefines our understanding of the vacuum as an *active and fundamental physical structure*.
