

Foundations of the Metamaterial Fluidic Cosmology (MFC): A Sampled Universe Model for Quantum Mechanics*

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Abstract

This paper introduces a new framework, the Metamaterial Fluidic Cosmology (MFC), which proposes a physical mechanism for both quantum and relativistic phenomena. The theory postulates that physical reality emerges from a discrete spatial lattice, the result of a "sampling" process at Planck-time intervals of a non-local and atemporal potential domain, termed the Metaverse. **By postulating a granular spacetime, the theory provides a potential physical and mechanistic counterpart to the mathematical structures of Loop Quantum Gravity (LQG). This view aligns with Digital Physics and the Simulation Hypothesis, while distinguishing itself by proposing a specific physical substrate:** a perfect superfluid with imaginary mass ("meta-matter"), generated by the collapse of tachyonic entities, which permeates our universe.

In this model, quantum phenomena such as entanglement and uncertainty are not paradoxes but direct consequences of the sampling process. Entanglement emerges as a single coherent entity within the Metaverse, while "wave-function collapse" is the registration of a potentiality into a single "frame" of reality. The theory also explains the origin of the arrow of time and entropy as an emergent and irreversible effect. Finally, it speculatively proposes a non-causal role of consciousness in the creation of reality.

This work establishes the conceptual foundations for a new ontology of physics; subsequent applications to gravity, electromagnetism, and the unification of Relativity and Quantum Mechanics will be addressed in forthcoming papers.

1 Introduction: Beyond Standard Quantum Mechanics and Relativity

Contemporary theoretical physics, despite the successes of the Standard Model and General Relativity, faces fundamental enigmas such as the nature of dark matter and dark energy, the unification of forces, and the ultimate nature of space and time. Furthermore, Quantum Mechanics, while incredibly predictive, lacks a clear physical ontology and remains incompatible with Relativity.

These challenges suggest the potential necessity for a paradigm shift. The present theory, "Metamaterial Fluidic Cosmology" (MFC), proposes a unifying vision in which the totality of physical reality emerges from the dynamics of a single fundamental substrate: a cosmic superfluid ("meta-matter"). This substrate is shared by two interacting domains: the Metaverse and the Physical Universe.

MFC positions itself as a **Theory of Everything (TOE)**, falling within the traditions of **Digital Physics** [1] and the **Simulation Hypothesis** [2], but proposes a physical and mechanistic model underlying both quantum and relativistic phenomena, including, albeit speculatively, the active role of consciousness.

This first paper outlines the fundamental postulates, develops its role in the quantum realm, and explores its predictions, proposing alternative solutions to known phenomena. A subsequent article will develop the cosmological and mechanical aspects, proposing a unifying solution between Quantum Mechanics and Relativity.

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2 The Postulates of MFC Theory

In the MKS system, the three fundamental entities are Space, Matter, and Time; all other physical quantities are derived from them. A **Grand Unified Theory** (GUT) should describe the nature of these fundamental entities and explain all physical phenomena through them. If it further succeeds in deriving them from a single Meta-entity, it can rightfully be termed a Theory of Everything (TOE).

MFC theory is founded on four key postulates from which the entire physical phenomenology is derived.

Postulate I: The Physical Substrate

The universe consists entirely of a single physical substrate: a perfect superfluid, called **meta-matter**, whose elementary components are sub-Planckian and possess imaginary mass. This superfluid is the sole fundamental entity [4], [5].

Postulate II: The Emergence of Reality

All physical phenomena—space, time, particles, and forces—are **emergent properties** of the collective dynamics of meta-matter [6].

- **Space and Time** emerge from the lattice structure and the sampling rate of the superfluid.
- **Particles** (e.g., electrons, quarks) are topologically stable vortices within the superfluid [8, 9, 10].
- **Forces** are the macroscopic manifestation of the superfluid's fluid dynamics (pressure, flow, vorticity).

Postulate III: Physical Properties of the Superfluid

The behavior of the superfluid is described by two fundamental physical properties which, on a macroscopic scale, correspond to the vacuum constants and are functions of cosmological time t . Like all ideal superfluids, it possesses no classical viscosity.

- **Inertial Density** ($\rho_m(t)$): This is the fluid's inertia to motion and flow. In its *vectorial* form, it manifests as the magnetic permeability of the vacuum (μ_0), and in its *scalar* form, as the origin of the inertia of matter.
- **Rigidity Modulus** ($K_m(t)$): This is the elastic resistance of the fluid to compression. In its *vectorial* form, it manifests as the inverse of the dielectric permittivity ($1/\epsilon_0$), and in its *scalar* form, as the origin of static gravitational pressure.

Postulate IV: The Sampled Universe

Physical reality is a succession of discrete instants ("samples") generated by a non-local and atemporal potential domain [1], the **Metaverse**. The interaction between the physical universe and the Metaverse is bidirectional and provides a physical mechanism for quantum phenomena [7].

3 Space: The Vacuum Lattice

3.1 The Emergent Structure of Space

In MFC, space and time are not a single continuum but two domains sharing a single foundation. Space is not pre-existing and independent; it emerges from the structuring of meta-matter within the superfluid; where there is no meta-matter, there is absolute nothingness. Its structure, elementary dimensions, and other characteristics are fundamentally determined by the "density" of meta-matter, which according to MFC postulates is a function of cosmic time and the ultimate cause of the universe's expansion. Locally, density is also modified by the presence of masses. This is the mechanism underlying

General Relativity: it is not spacetime that deforms, but the density of meta-matter which locally modifies the Planck dimensions (space) and the sampling frequency of the Metaverse (time).

Physical space is modeled as a **three-dimensional lattice** of elementary cells with dimensions on the order of the Planck length.

This vision of a granular spacetime is conceptually aligned with modern approaches to quantum gravity, particularly **Loop Quantum Gravity** (LQG), which describes space as a network of quantized nodes and links ("spin networks") [19]. However, MFC aims to resolve some of its open issues by providing a physical substrate for what remains an abstract mathematical structure in LQG. Specifically:

- **The Classical Limit:** While LQG struggles to demonstrate how General Relativity emerges as a low-energy limit, MFC postulates that General Relativity is the large-scale hydrodynamics of the superfluid, as will be elaborated in a subsequent work.
- **Divergences and Falsifiability:** Being a physical model, MFC offers falsifiable predictions on accessible scales (e.g., galaxy rotation) and provides a mechanistic explanation for the origin and propagation of gravitational waves.

3.2 Fields and their Propagation in Space

At the most fundamental level, MFC postulates that each lattice cell, at a given instant $t(n)$, contains information about the local state of the superfluid. Since it is a fluid, albeit ideal and lossless, the local states can be: a pressure gradient and a flux density. In the case of the electromagnetic field, pressure gradients represent the instantaneous values of the electric field (E) and flux density represents the magnetic field (B).

Unlike real fluids, pressure gradients and flux densities are orthogonal to each other due to the imaginary mass of the meta-matter entities. Electromagnetic fields thus propagate transversely and, until they interact with matter, are purely reactive in nature.

Time proceeds in discrete "steps," as postulated for the sampled universe; propagation thus emerges from an **iterative process of local updating**, analogous to **cellular automata** or **FDTD** (Finite-Difference Time-Domain) simulation methods. The fundamental rule is that the state of any cell at the next instant $t(n+1)$ is determined exclusively by the state of its immediately adjacent cells at the present instant $t(n)$.

This "relay" process is a physical realization of Maxwell's principles of mutual induction:

1. A change in the flux field (B) in adjacent cells induces a pressure field (E) orthogonally in the central cell at the next "clock" cycle.
2. Conversely, a change in the pressure field (E) in adjacent cells induces a flux field (B) orthogonally in the central cell at the following "clock" cycle.

An electromagnetic field, therefore, is not an entity "traveling" through space, but the **macroscopic and emergent pattern** generated by billions of these local, sequential information exchanges. Energy and information are transferred from cell to cell at each time step, much like a giant three-dimensional shift register updated at the Planck frequency.

The reactive nature of the fields further implies that, in a vacuum and in the absence of matter to interact with, they propagate infinitely and at the speed of light.

3.3 Causality and Acausality in the Spatial Lattice

The dynamics of this lattice operate on two hierarchically distinct levels: the state values of the cells and the evolution rules governing their update. This distinction is the key to understanding the coexistence of physical causality and acausal influence in MFC theory.

- **Causality (Modification of Values)**

Causality, as we understand it, operates at the level of state values. Every physical interaction—from the motion of a particle to the exercise of free will by a conscious being—modifies the parameters (pressure, flow) contained in the reality cells at a given instant. In accordance with the principle of bidirectionality, these new values are instantaneously "recorded" in the Metaverse, providing the initial conditions for the processing of the next sample. This is the domain of physical laws and "horizontal" interactions within the universe.

- **Acausality (Modification of Rules)** Acausality is the direct intervention of the Metaverse upon the fabric of reality. In this model, the Metaverse is not just a reservoir of potentialities, but also the "legislator" of evolution rules. Acausal influence does not act solely by changing values in the cells but can, in exceptional circumstances, alter the "score"—the local and temporary physical laws—that govern how cells are updated. A "spontaneous remission" in medicine, in this context, is not a violation of physical laws, but an instantaneous and local modification of the rules of the game originating from a higher-order domain.

This two-level model is conceptually analogous to studies of complex systems, such as Parisi's starling flights [14], where emergent and self-organized behavior arises from the iterative application of simple local rules. In both models, a global and complex order emerges from purely local interactions, without the need for a central "conductor."

In MFC, however, it is postulated that these same rules are not immutable but can be modulated by an external domain, providing a bridge between physics and metaphysics.

The Origin of Gravity and Inertia

Gravity is also a field emerging from the structure of the superfluid, but unlike periodic vector fields, its components are scalar (non-vortical) in nature and propagate longitudinally, not transversely like electromagnetic fields. In the absence of matter, the field's pressure gradient is perfectly isotropic, propagating from all directions with the same intensity and at the speed of light in a vacuum. Masses, however, interact with this field, locally modifying its isotropy in two ways: by partially shielding the pressure gradient and by "dragging" part of the flux density; a phenomenon known in General Relativity as *frame dragging*.

Gravity is thus not an intrinsic force of attraction but rather an emergent pressure and dragging effect. It manifests as a superposition of two effects: static and dynamic.

- **Static Gravity (Shielding Pressure)**

The vacuum is pervaded by a cosmic background scalar pressure $P_0(t) \propto \rho_m(t)$. Ordinary matter, interacting with this flow, partially shields it. Two bodies "push" toward each other because of the pressure shadow they mutually cast. The resulting force on a mass m due to a mass M at a distance r is:

$$F_{grav} = G(t) \frac{M \cdot m}{r^2} \quad (1)$$

This law, identical in form to Newton's, emerges naturally from the push model. The constant G is not a universal value but a parameter tracing the intensity of the fluid pressure, explaining its time dependence: $G(t) \propto \rho_m(t)$.

Gravitational scalar fields propagate longitudinally, analogous to acoustic waves. A collapsing binary system periodically modulates this shielding, generating **gravitational waves** as periodic perturbations of the scalar pressure gradient. These waves, upon hitting distant matter, imperceptibly alter their mutual positions—an effect measured by interferometers such as LIGO/Virgo. This model of gravity, naturally quantized by the spatial lattice, also resolves the problem of relativistic singularities, since the push never reaches an infinite value, even in cases of total shielding.

- **Dynamic Gravity (Fluid Dragging)**

Meta-matter, being an ideal superfluid, conserves the rotational angular momentum imprinted during cosmic formation. MFC hypothesizes that the structuring of meta-matter into slowly rotating vortices is the very cause of the condensation of protoplanetary and galactic clouds. This primordial rotation persists and generates an additional dragging force, explaining the flat rotation curves of galaxies without resorting to dark matter. By postulating an effective mass $M_{eff}(r) = k \cdot r$, the orbital velocity v of a star becomes independent of distance r :

$$\frac{mv^2}{r} = G(t) \frac{M_{eff}(r) \cdot m}{r^2} = G(t) \frac{(k \cdot r)m}{r^2} \implies v = \sqrt{G(t)k} \quad (2)$$

In planetary systems, this same effect acts as an **orbital self-correction mechanism**, stabilizing orbits on cosmological scales. A planet passing through "layers" of rotating meta-matter at different speeds is slightly accelerated or slowed down, countering orbital drifts. Dynamic gravity is at the origin of perihelion precession and other anomalous effects (e.g., Pioneer anomaly).

Inertia

Inertia is an aspect intrinsically linked to dynamic gravity and explains its fundamental mechanism. MFC postulates that the spatial superfluid possesses a **reactive viscosity**. Similar to real superfluids, it offers no resistance to motion at constant speed, but only to acceleration. Energy is required only to accelerate the body and is returned when one attempts to slow it down.

The most fitting analogy is that of a superconductive circuit: energy is needed only to establish or modify the current flow; once established, it persists indefinitely, and the accumulated energy is returned if one attempts to reduce it.

Intuitively, we can imagine that an accelerating body does not "move" the superfluid but rather "**requisitions**" a certain amount of it, providing it with momentum. It is the inertia of this portion of dragged superfluid that must be overcome by the external force. When acceleration ceases, this "trapped" meta-matter continues to move with the body without loss. If the body slows down, the segregated superfluid returns the accumulated momentum, opposing the change in velocity.

Gravity and inertia will be addressed in detail in the next work concerning unification with Relativity.

3.4 The Limit of c and the Origin of Quantization

The discrete nature of the spatial lattice and sampled time, postulated by MFC, imposes fundamental constraints on all physical processes. From these constraints, two key concepts of modern physics emerge naturally.

1. The Speed of Light Limit (c)

The properties of the meta-matter superfluid in a given region of the universe define two fundamental scales:

- The **elementary length** of the lattice, L_{min} (the cell size, analogous to the Planck length).
- The **elementary time**, T_{min} (the duration of a sampling "frame," analogous to the Planck time).

Propagation, being a state transfer from cell to cell at each time step, has an intrinsic maximum speed. Causal information cannot "skip" cells; it can only pass to an adjacent cell in the minimum possible time. The limiting speed of the universe, c , is thus not an arbitrary constant but an **emergent property of the vacuum structure**:

$$c = \frac{L_{min}}{T_{min}} \quad (3)$$

The speed of light is, literally, the **processing speed** of the cosmic "shift register." This explains mechanistically why nothing—whether matter (vortices) or energy (patterns)—can propagate causally faster than one cell per universal "clock cycle."

Acausal modification of the "rules" by the Metaverse, however, can allow matter or information to skip multiple cells (see tunnel effect).

2. The Origin of Quantization ($E = h\nu$)

The same "packet" propagation mechanism provides a physical explanation for energy quantization. In a discrete and sampled universe, energy cannot be transferred continuously but only in discrete packets, multiples of the energy carried in a sample by each individual cell. The frequency (ν) of a wave corresponds to the number of these packets delivered per second, implying a direct proportionality between energy and frequency ($E \propto \nu$).

The **Planck constant** (h) thus acquires a precise physical meaning: it is the **fundamental quantum of energy-action**, i.e., the energy contained in a single "packet" of transfer within the lattice. Quantization is no longer an abstract rule but the natural consequence of a "pixelated" reality.

This discrete nature also explains the relationship between energy and wavelength. The frequency, ν , describes the compactness of the photon pattern on the lattice. High-frequency radiation (small wavelength) possesses a more concentrated energy pattern, with a higher **energy density per cell**, resulting in higher photon energy. Conversely, low-frequency radiation (large wavelength) has a more extensive and less dense pattern; the result is that energy in low-frequency radiation, being distributed over a larger number of samples for the same total value, must have a lower elementary value.

3.5 On Vacuum Energy: Reactive vs. Active Energy

the lattice universe model allows calculating the energy containable by a single elementary cell of space. Since the cell size is the minimum possible wavelength, L_{min} , the maximum energy for a single quantum (photon) is given by:

$$E_{max} = \frac{hc}{L_{min}} \quad (4)$$

Assuming L_{min} equals the Planck Length, this energy corresponds to the Planck Energy ($\approx 10^{19}$ GeV). This result coincides with the theoretical vacuum energy estimates predicted by Quantum Field Theory (QED) but stands in sharp contrast (by about 120 orders of magnitude) with the extremely small value deduced from cosmological observations.

This discrepancy is one of the greatest unsolved problems in modern physics. MFC theory resolves this paradox, known as the "vacuum catastrophe," not through a cancellation of terms but through a redefinition of the nature of vacuum energy itself.

It is postulated that the fundamental energy of the meta-matter superfluid is **reactive** in nature. Similar to an electrical circuit with a zero power factor, this potential energy continuously exchanges between pressure (field E) and flow (field B), but produces no net work. This is because it does not consist of **virtual fluctuations** (ephemeral particles and antiparticles) but of isotropic and reactive fields.

The energy we observe on a cosmological scale (the effect attributed to dark energy), instead, is **active** or manifest energy. It represents the tiny fraction of primordial reactive energy that, over the course of the universe's evolution, has "converted" into a "resistive" component capable of performing work.

The "vacuum catastrophe" thus ceases to be a paradox and becomes the measurement of the universe's "power factor": the ratio between observed active energy and total reactive potential.

MFC theory further hypothesizes that the accelerated expansion of the universe may be an interpretive error. The cosmological value is derived assuming a constant speed of light c . As postulated in this theory, if the speed of light was lower in the past ($c(t) \propto a(t)$), light from distant supernovae took longer to reach us. This makes them appear fainter and more distant, mimicking the effect of accelerated expansion. Therefore, the apparent "dark energy" could be an illusion created by analyzing cosmological data with an incomplete physical model.

4 Emergent Vacuum Energy Effects Across Scales

MFC theory postulates that the zero-point energy of the vacuum, while being "reactive" in nature with a zero mean field, is the fundamental source of all physical phenomena. Its interaction with matter and

its large-scale dynamics produce different effects that dominate depending on the observation scale.

Quantum Scale (Laboratory)

On a small scale, the dominant effect of vacuum energy is differential in nature. As demonstrated by the Casimir effect, the presence of physical boundaries (plates) alters the field mode density, creating a **reactive potential energy gradient**. This gradient generates a measurable force, proving that although vacuum energy is globally balanced, its local gradients can produce physical work.

Astronomical Scale (Stellar Systems)

On an astronomical scale, the effect of **Static Gravity** dominates. Massive matter acts as a non-selective shield for the isotropic pressure generated by zero-point energy. This creates a **pressure imbalance** that pushes bodies toward each other. This is the mechanistic interpretation of Newtonian gravity, governing the dynamics of planets and stars.

Galactic and Cosmological Scale

On even larger scales, effects emerge that standard physics attributes to mysterious entities like dark matter and dark energy.

- **Dark Matter (explained by Dynamic Gravity):** The apparent excess of gravitational force holding galaxies together is not due to invisible matter, but to the effect of **Dynamic Gravity**. The rotational angular momentum of meta-matter, imprinted by primordial matter clouds during galactic formation, generates a tangential inertial force that adds to static gravity, explaining flat rotation curves.
- **Dark Energy (explained by Evolution of Constants):** The apparent acceleration of cosmic expansion is not caused by a repulsive energy but is an interpretive illusion. It arises from analyzing distant supernova data with the incorrect assumption of a constant speed of light c . In an MFC universe, where $c(t)$ increases over time, light has taken longer to reach us, making sources appear fainter and more distant, mimicking acceleration.

In this way, a single physical substrate—the vacuum energy of meta-matter—provides a unifying framework for seemingly disconnected phenomena, from quantum mechanics to cosmology.

4.1 The Motion of Matter and the Holographic Universe

If free fields like photons are progressive patterns propagating through the lattice at the maximum speed c , the question arises as to how massive matter can exist in states of rest or move at speeds lower than c . The solution lies in the very nature of the particle within MFC theory.

It is postulated that a massive particle (a vortex) is not a progressive wave but a **stable and localized interference pattern** within the superfluid, analogous to a **standing wave** or a "wave packet." This pattern is generated and sustained by the Metaverse through the coherent superposition of elementary waves propagating in the lattice at speed c in various directions.

- A **particle at rest** ($v = 0$) corresponds to a perfectly balanced interference pattern, whose energy "vibrates" locally but whose overall structure remains stationary.
- A **particle in motion** ($v < c$) corresponds to a slight asymmetry in the superposition of elementary waves. This asymmetry causes the pattern envelope (the wave packet) to shift with a **group velocity** v , which is lower than the phase velocity c of its components.

This view resolves the wave-particle duality in favor of a universe composed solely of wave phenomena. The "particle" is the macroscopic and localized effect of fundamental wave interference.

Furthermore, this model provides a rigorous physical mechanism for the **Holographic Universe** analogy. The Metaverse does not project a static image but a dynamic and interferential hologram. The matter particles we perceive as solid and localized objects are the stable three-dimensional "images" emerging from this fundamental interference pattern.

4.2 Finite Field Limits and Vacuum Breakdown

By postulating space as a physical lattice, MFC theory implies that an elementary vacuum cell possesses a finite capacity to sustain energy. Consequently, fields cannot grow indefinitely but are subject to absolute physical limits: a maximum pressure field (E_{max}) and a maximum flux density (B_{max}).

In the case of the electric field, this limit conceptually corresponds to the **Schwinger limit** of QED. When the pressure gradient of the superfluid exceeds the lattice's structural rigidity, a local "breakdown" is triggered. The field's excess energy is instantaneously converted into temporarily stable meta-matter vortices: a conductive plasma that neutralizes the excess field, restoring equilibrium.

By symmetry, an analogous mechanism must exist for the magnetic field, although its manifestation must differ to resolve the specific crisis. If the flux density exceeds the physical limit B_{max} , the field energy can no longer be sustained by the lattice in an orderly fashion. The excess energy thus condenses into a form of matter with properties suited to managing the flux: a **supermagnetic matter** with ultra-high permeability. The creation of vortices with a strong intrinsic magnetic moment is hypothesized; by aligning instantaneously, these transform the vacuum locally into a preferential channel capable of absorbing and diverting excess flux, re-establishing equilibrium.

This vacuum breakdown process finds two powerful analogies in physics:

- **In superconductivity**, it is analogous to the **quenching** phenomenon. When the current exceeds the critical value (I_c), the material undergoes a sudden phase transition, losing its properties and returning to the normal state.
- **In fluid dynamics**, it is the equivalent of the transition from laminar flow to a more complex state. When a flow becomes too intense, energy "breaks" the medium, creating turbulence or cavitation. In the case of the meta-matter lattice, the "vortices" created by this phase transition are not chaotic but are the stable particles of matter.

In summary, dielectric (electric) breakdown and flux (magnetic) limits are two faces of the same fundamental phenomenon: the **conversion of unsustainable field energy into the mass/energy of real particles (vortices)**. The vacuum, when pushed beyond its limits, "condenses" into matter.

5 Matter: The Condensation of Meta-matter

Ordinary matter is not an entity separate from the vacuum but a structured manifestation of meta-matter. Elementary particles, such as electrons and quarks, are complex vortices of this superfluid, whose **structural dimensions exceed the Planck scale, manifesting emergent and measurable properties such as mass and charge**. They are a kind of primordial "Ylem" that condenses and organizes to form everything we see [8, 9, 10].

As such, particles are described by a pattern of information and state values extending over many space cells. As seen in the previous section, these patterns arise through interference, like a **"material hologram"**. Therefore, they must be considered **extended and wave-like structures**, rather than point-like corpuscles.

From this perspective, an interesting analogy can be drawn with string theory: while in the latter, different particles are vibrational modes of one-dimensional strings in multiple spatial dimensions, in MFC they are the **different and complex vortical modes** of a three-dimensional structure (the superfluid) in three spatial dimensions.

6 Time: The Sampled Universe

In MFC, time is not the continuous and uninterrupted flow we perceive. As in Loop Quantum Gravity [19], it is instead a discrete quantity, proceeding in "clicks" or "quanta."

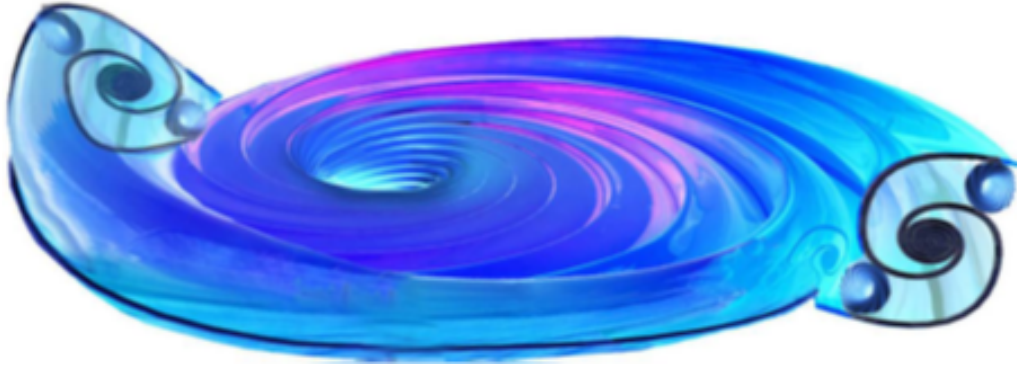


Figure 1: Artistic representation of the two vortical tubes constituting the electron.

Source: Nader Butto, "Electron Shape and Structure: A New Vortex Theory" [8]

The necessity for time to proceed discretely arises not only from quantum considerations but is also a requirement of classical mechanics. Many of the physical quantities we describe, such as force, are abstract and potential concepts. The following demonstration is inspired by Todeschini's work "The Theory of Appearances," one of the first modern researchers to postulate a fluid dynamic universe with discrete time [11].

Force F , for example, is defined by the second law of dynamics $F = ma$. However, force, understood as a static entity, is a mathematical abstraction. A force applied for an infinitesimal time ($dt \rightarrow 0$) produces no tangible effect. Physical reality manifests only when an interaction occurs for a finite time interval.

What is physically real is not force, but **impulse** ($I = F \cdot \Delta t$), which describes the change in momentum ($p = mv$). The collision between two particles, therefore, is not a continuous interaction but a series of discrete impulses.

At an even more fundamental level, MFC theory postulates that even classical impulse is an emergent quantity. The ultimate and indivisible physical event is the **Planck quantum of action** (h). This is the elementary "currency" of every interaction, the fundamental unit of "change" allowed in the universe. In the vacuum lattice, each "clock cycle" (T_{min}) allows the transfer of a **momentum quantum** across cells. A macroscopic impulse is thus the **statistical sum of an uncountable number of these elementary action quanta**.

If reality were continuous, a force applied for zero time would produce no change of state. Time could not "flow," nor could the universe exist. Therefore, the very existence of physical reality requires that time proceed in finite intervals. Only in a **Sampled Universe** at discrete time steps can impulses have physical meaning. Consequently, the only thing that truly exists in the physical universe is matter in motion and impulses through which it interacts. Even radiation propagates through a series of discrete impulses that "shift" the state of meta-matter between contiguous cells.

6.1 Sampling of the Universe

Based on the previous considerations, our physical universe can only emerge from a sampling process. For MFC, the sampled domain is the **Metaverse**, the "natural" domain of existence for meta-matter, coexisting but energetically superior. In the Metaverse, the concept of linear temporality has no meaning; there is no past, present, and future, but only one infinite "now."

The sub-Planckian and imaginary entities constituting it further travel at infinite speed, thus they can participate simultaneously in multiple spatially different samples of reality.

This vision aligns with a rich tradition of thought including **Digital Physics** [1] and the **Simulation Hypothesis** [2]. However, while these theories remain mostly at a computational or philosophical level, MFC distinguishes itself by proposing a specific physical mechanism for this process.

6.2 The Mechanics of Sampling

Reality sampling occurs at the Planck frequency. The consequence is that, between one "sample" and the next, physical reality as we know it does not exist. At the moment of sampling, a configuration of tachyonic meta-matter in the Metaverse is "photographed" and manifested until the next "flash." The frequency of this sampling is not a universal constant but is determined by the local density of Meta-matter, varying both on a cosmic scale and in the proximity of masses. Furthermore, the sampling process has a resolution limited to the size of a single cell (Planck scale).

From this sampling mechanism, three concurrent fundamental dynamics emerge, which together define the quantum nature of the vacuum:

1. **Quantization Noise (Arrow of Time):** Each sample is a finite-resolution representation of the state of the Metaverse. This introduces an inevitable "quantization error," an infinitesimal loss of information that makes the process **creative and irreversible**.
2. **Zero-Point Energy (Casimir Effect):** The act of sampling can be seen as an instantaneous impulse, a "kick" of white noise from the Metaverse to the physical lattice. The **spectral response** of the superfluid to these impulses is not flat but has a density that grows with the cube of frequency ($S(f) \propto f^3$). This response energy constitutes the **zero-point energy** of the vacuum, responsible for real effects like the Casimir force.
3. **1/f Noise (System Memory):** Due to bidirectional feedback, each sample is not completely independent of the previous one. This **temporal autocorrelation** generates low-amplitude noise with a $1/f$ spectrum, representing the system's "memory."

All three of these dynamics contribute, in different measures, to the arrow of time and quantum uncertainty.

This process is not unidirectional. Interaction is **bidirectional and reciprocal**: every action (measurement) in our universe is instantaneously reflected in the Metaverse, modifying the potential for the next sampling. It is a continuous feedback loop, analogous to a musical score that updates instantly based on how it is played. The explanation for this simultaneity lies in the fact that both domains operate on the same "raw material" but with different temporal resolutions: the physical universe modifies it at each discrete sample, while the Metaverse operates with infinite temporal resolution between samples.

The properties of meta-matter in the Metaverse (instantaneous connectivity) are what make otherwise inexplicable quantum phenomena possible, providing a physical basis for non-locality.

7 A Physical Explanation for Quantum Phenomena

The paradoxes of modern physics, from wave-particle duality to entanglement, are not intrinsic properties of reality but direct and logical consequences of a physical universe that is a discrete "sampling" of a superior potential domain (the Metaverse).

7.1 Vacuum Energy, the Cosmological Catastrophe, and the Casimir Effect

As we have seen, the lattice universe model allows calculating the energy containable in a single cell, which corresponds to the Planck Energy ($\approx 10^{19}$ GeV). This value coincides with the theoretical vacuum energy estimates of QED but stands in sharp contrast (by about 120 orders of magnitude) with the value observed on a cosmological scale.

This discrepancy, the "vacuum catastrophe," is resolved in MFC by redefining the nature of vacuum energy. It is postulated that the fundamental energy of the superfluid is **reactive** in nature. It produces no net work but exists as vacuum potential. The energy observed on a cosmological scale is instead **active energy**, a tiny "converted" fraction of the reactive one.

The physical origin of this reactive energy lies in the sampling process. At each Planck-time "frame," the physical universe receives an instantaneous impulse from the Metaverse, analogous to a Dirac impulse

(white noise), which excites the spatial lattice. Zero-point energy is the *response* of the superfluid to this excitation. Like a bell that, when struck by a hammer, resonates at its characteristic frequencies, the vacuum lattice "resonates" with an energy spectrum reflecting its physical properties. These response oscillations have a zero mean field value ($\langle E \rangle = 0$), but a non-zero mean energy ($\langle E^2 \rangle > 0$), thus constituting the reactive energy of the vacuum.

The Casimir effect offers a window into this energy, as the force emerges from its **gradient**. It is possible to derive the law of this force starting from the spectral properties of this vacuum "response." The resulting energy spectral density $S(\omega)$ from this process is the product of single-mode energy ($E_{mode} = \hbar\omega/2$) times the 3D mode density ($\propto \omega^2$), leading to a spectrum $S(\omega) \propto \hbar\omega^3$.

The Casimir force is generated by the pressure of modes excluded from the space between the plates (those with $\omega < \omega_c \propto c/d$). The net pressure is thus the integral of the spectral density over the excluded frequencies:

$$P(d) \propto \int_0^{c/d} \omega^3 d\omega \propto [\omega^4]_0^{c/d} \propto \frac{1}{d^4} \quad (5)$$

This result proves that, starting from the sampling mechanism, one derives the correct distance dependence ($\propto 1/d^4$) for the Casimir force. Finally, as already seen in the section dedicated to space, MFC suggests that apparent "dark energy" may be an interpretive illusion itself, caused by analyzing cosmological data without accounting for light speed variation over time ($c(t) \propto a(t)$).

7.2 The Physical Management of Infinities

A fundamental postulate of MFC is that infinity and the infinitesimal are mathematical concepts that do not belong to the real physical world, but only to the Metaverse. Physical reality is, by its nature, finite and discrete. This has a profound consequence on physical calculations and resolves the presumed contrast with zero-point energy.

While standard QED calculates vacuum energy starting from divergent integrals and then "regularizes" them with mathematical procedures, MFC introduces **physical and insurmountable limits (cutoffs)** from the beginning:

- **Ultraviolet Limit (High Frequencies):** Infinite energies or frequencies do not exist. There is a maximum frequency given by the Planck scale (f_p), imposed by the lattice granularity itself. Waves shorter than 4 space cells cannot exist.
- **Infrared Limit (Low Frequencies):** Infinite wavelengths do not exist. There is a maximum wavelength given by the finite size of the universe, which imposes a minimum frequency.

Vacuum zero-point energy is therefore, while immense, a **finite** quantity.

Implications for the Casimir Effect

This view does not conflict with the Casimir effect; rather, it provides a more rigorous derivation. The Casimir force does not emerge from the mathematical subtraction of two infinities. It emerges from the **physical difference between two immense but finite quantities**:

1. The pressure generated by the finite sum of energy from all permitted modes between the cosmological and Planck limits (outside the plates).
2. The pressure generated by the finite sum of energy of permitted modes in the space *between* the plates (where low frequencies are excluded).

MFC is thus in agreement with calculations leading to the Casimir force but founds them on a physically more solid basis, where infinities, being non-physical, never appear from the start.

The Lamb Shift

Standard physics (QED) explains the tiny energy difference between the 2s and 2p orbitals of the hydrogen atom as an effect of quantum vacuum fluctuations. MFC theory provides a direct physical mechanism for this phenomenon. The electron-vortex is not isolated but is immersed in the "reactive substrate" of the superfluid, which causes constant vibration (the mechanistic equivalent of *Zitterbewegung*). This fundamental "jostling" alters the average interaction between the electron-vortex and the nucleus. Since 2s and 2p orbitals are structurally different vortical configurations, their interaction with the vacuum substrate differs, leading to a slight but distinct shift in their energy levels.

The Anomalous Magnetic Moment ($g=2$)

Similarly, the deviation of the electron's gyromagnetic factor from $g = 2$ is one of the most precise tests of QED, explained as the electron's interaction with its "cloud" of virtual particles. In MFC, this phenomenon is proof that the electron is not a "naked" vortex but a **coupled system**, inseparable from the perturbation it induces in the surrounding reactive superfluid. This "dressing" (the physical equivalent of the virtual cloud) is an integral part of the particle. When an external magnetic field (a flux of meta-matter) acts on the vortex, it interacts with the entire complex object (vortex + reactive dressing). The response of this coupled system is slightly different from that of a hypothetical naked vortex, giving rise to the anomalous value $g > 2$.

7.3 Mass-Energy Equivalence ($E = mc^2$)

This celebrated relation does not describe an equivalence between two distinct entities but defines the nature of mass itself. The mass (m) of a particle is the measure of the inertial effect of its stable meta-matter vortex, while energy (E) is the total kinetic energy stored in the fluid motion constituting that vortex. The equation $E = mc^2$ thus quantifies the enormous amount of structured kinetic energy "frozen" in a particle's configuration.

7.4 Resolution of Wave-Particle Duality

MFC resolves this paradox at the root. Both "corpuscular" and "undulatory" natures emerge as distinct but interconnected phenomena of the meta-matter superfluid.

The Nature of the "Particle"

An entity like the electron (Figure 1) is not a point-like particle but a complex and structured vortex of meta-matter. Its "corpuscular" nature manifests in its stability and localized interaction.

The Nature of the "Wave"

An entity like the photon is not a wave in an abstract field, but a macroscopic and quantized energy pattern—in the form of pressure (field E) and momentum (field B)—propagating through the vacuum lattice.

Interaction (Absorption and Emission)

The interaction between these two manifestations does not occur by collision but by structured energy transfer, governed by discrete time sampling.

- **Absorption (Excitation):** A photon-pattern overlapping an electron-vortex is assimilated. If the energy is sufficient, at the next sample, the vortex instantly reconfigures into a higher energy state.
- **Emission (Decay):** An excited electron-vortex reconfigures into a lower energy state between samples. The excess energy impulse is transferred to the surrounding cells, generating a new photon-pattern that propagates.

The Compton Effect

Standard physics interprets the **Compton effect** as an elastic collision between a photon, treated as a particle, and an electron. MFC theory reinterprets this event not as a collision between corpuscles, but as a **transfer of energy and momentum** between the photon pattern and the electron vortex.

When the photon pattern overlaps the space cells occupied by the electron vortex, field interaction occurs. The photon's pressure component (its electric field E) exerts a direct force on the vortex, while the flux component (its magnetic field B) interacts with the vortex's rotational dynamics.

If the electron is free or weakly bound, this interaction transfers part of the photon's energy and momentum to the electron vortex. The result, observed on a macroscopic scale, coincides with the experimental result:

- The **photon pattern**, having lost energy, continues its propagation at a lower frequency (and thus a larger wavelength).
- The **electron vortex**, having absorbed momentum, is deflected from its original trajectory.

The Compton effect, therefore, is not a collision but an interaction between a pressure/flow wave and a stable vortical structure.

7.5 Entanglement

Two entangled particles, having shared part of their existence, become at a metamaterial level a **single coherent and non-local entity**. A measurement on one of the two particles instantly modifies the entire entity in the Metaverse, and the result manifests for the other particle at the next sample, regardless of distance.

This vision physically realizes Bohm's concept of Implicate and Explicate Order [7]: the Sampled Physical Universe is the Explicate Order, where we see two separate particles, while the Metaverse is the Implicate Order, the non-local domain where they are a single entity.

7.6 Uncertainty as an Informational Limit of Sampling

Heisenberg's Uncertainty Principle emerges as a direct and inevitable consequence of a discrete universe. Its origin is dual in nature: one linked to the potentiality of reality *between* samples, and one linked to the informational limits *of* a single sample.

1. Fundamental Uncertainty: The Regime of Potentiality

Between two successive samples, a physical entity does not exist in our space but returns to a state of **pure potentiality** in the Metaverse. This process is conceptually analogous to Richard Feynman's "**sum over histories**" formulation: the particle, in the Metaverse, potentially "explores" all possible paths but does not physically traverse them. The "calculation" of the next state consists of the constructive interference of these potentialities. In the absence of acausal interventions, the Metaverse normally chooses the most probable evolution, which corresponds to the quasi-classical trajectory.

The calculation of the next state is, however, intrinsically probabilistic. This allows the existence of phenomena like the **tunnel effect**, which ceases to be a paradox. The particle does not physically "overcome" an energy barrier; rather, its value pattern disappears from one side of the barrier at sample T_n and, at sample T_{n+1} , manifests in a new position beyond it, according to a statistically possible solution.

2. Uncertainty in Measurement

The principle manifests concretely as an intrinsic informational limit to the measurement process. The analogy of digital sampling is fitting: an instantaneous interaction (a single sample) can precisely reveal a static property such as **position** (amplitude). However, to determine a dynamic property such as **momentum** (frequency), **at least two samples per period** of the highest frequency involved are required by definition, as established by the Nyquist-Shannon sampling theorem.

MFC theory further provides a mechanistic interpretation for the numerical value $\Delta x \Delta p \geq h/4\pi$. The denominator 4π emerges from two physical properties of our sampled universe:

- The factor 2π (via $\hbar = h/2\pi$) is the signature of the inherently **undulatory** nature of every entity.
- The factor 2 (bringing the denominator to 4π) derives from the **propagation mechanism** within the lattice. As in FDTD methods, to define a complete wave cycle, a minimum cycle of **four temporal "clock cycles"** is required to complete the sequence of mutual induction between pressure (E) and flow (B).

Uncertainty is thus the fundamental physical limit in defining a wave entity within a four-step discrete propagation system. Unlike passive sampling, furthermore, quantum measurement is an invasive physical interaction that inevitably alters the system's state.

7.7 The Double-Slit Experiment and the Coherence of Histories

The double-slit experiment is perhaps the clearest demonstration of the counterintuitive nature of quantum reality. Its explanation in MFC is based on the concept of an entity's "history," in deep resonance with Richard Feynman's **"sum over histories"** formulation.

Feynman's View and the Information Problem

According to Feynman, a particle simultaneously explores all possible paths to go from A to B. Interference emerges when paths are indistinguishable. If "which-path information" is acquired, even without disturbing the particle, interference vanishes. This raises a fundamental question: where does an entity's "history" begin and end, and how can the mere possibility of information alter its behavior?

MFC Interpretation: History as a Metamaterial Entity

MFC provides a physical counterpart to what in Feynman is a mathematical description. A photon's "history" is not an abstract concept, but its **coherent and unified representation in the Metaverse**. Interference is possible only when different physical manifestations (different paths) correspond to a single, indistinguishable metamaterial history.

A photon's history **does not end with its "extinction"** on the detector. The interaction itself becomes part of the history, creating a **permanent informational record** in the Metaverse. Coherence is destroyed not by the act of "looking," but by the **creation of fundamentally different and distinguishable histories**.

Consider the experiment by Zhou, Wang, and Mandel (Figures 2 and 3):

- **Without path detector:** Both paths lead to a single type of final event: a "click" on the main detector. In the Metaverse, the two histories are indistinguishable and can interfere.
- **With path detector:** One path leads to a "click on the main detector." The other path leads to "a click on the main detector AND a click on the path detector." These are two **irreducibly different** final histories. In the Metaverse, they are separate entities and can no longer interfere.

An MFC Prediction: Information Asymmetry

Here MFC makes a radical prediction. Even if the path detector were electrically off, its mere physical presence creates an asymmetry. One path has the *potentiality* to create a history with an additional click, while the other does not. This **potential asymmetry in information** is sufficient to create two different histories in the Metaverse, destroying interference.

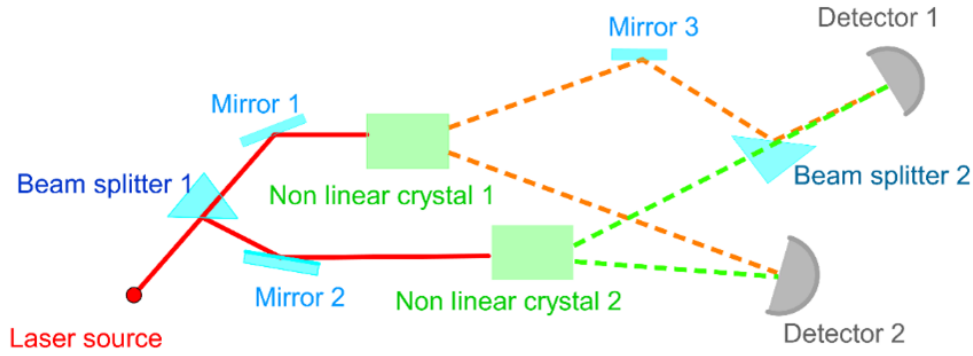


Figure 2: Diagram of a double-slit experiment with symmetric paths. Source: [www-5.unipv.it/didapls/Dispense Feynman/QM5.html](http://www-5.unipv.it/didapls/Dispense_Feynman/QM5.html)

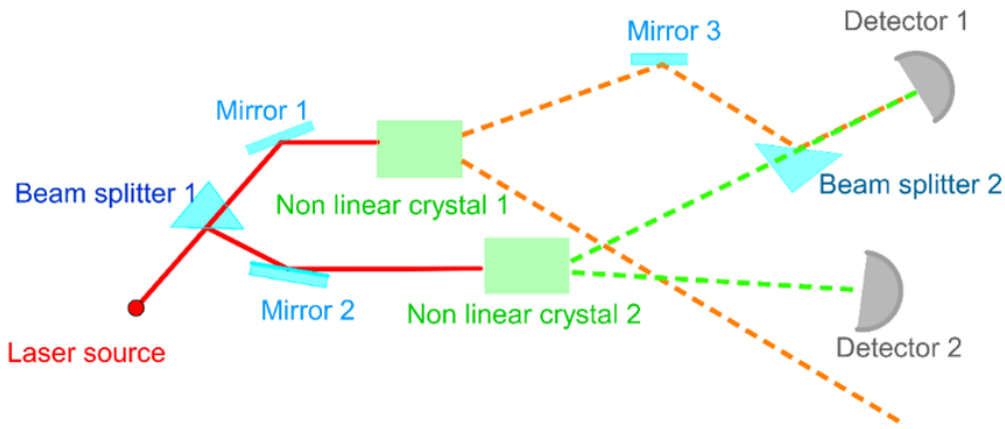


Figure 3: Diagram of a double-slit experiment with path detection. Source: www-5.unipv.it/didapls/Dispense Feynman/QM5.html

Proposal for New Experiments

This suggests that to restore interference, it is not enough to delete information; one must make the **histories symmetrical again**. Experiments could be designed where:

- **Two identical path detectors** are used, one for each slit, whose outputs are combined (e.g., with an OR logic gate) before being recorded. In this case, the final state of information would simply be "a click occurred," regardless of the path. The histories would become indistinguishable again, and interference should reappear.

MFC, therefore, explains how information is not a passive entity but the very substance of a particle's "history," whose coherence determines quantum behavior.

7.8 Quantum Zeno Effect

The evolution of a quantum system (e.g., decay) occurs between samples in the Metaverse. A continuous quantum measurement is necessarily invasive and thus modifies its energy state; this **resets its evolution process** and prevents the completion of the transition.

7.9 The Physical Nature of Spin

In standard physics, spin is often treated as an intrinsic and abstract quantum number. In MFC, spin becomes a **real and physical property** of the meta-matter vortex constituting the particle. It

represents the **quantized angular momentum** of the fluid rotating within it. Spin quantization (the fact that it can only take discrete values like $1/2$ or 1) is a natural consequence of the vortex **stability conditions**: only specific configurations and rotation speeds can form a stable and lasting structure, analogous to the harmonic frequencies that create standing waves on a guitar string.

7.10 1/f Noise and Metaverse Sampling

1/f noise (or pink noise) is a fundamental characteristic of the fabric of reality, originating from the sampling process. Two mechanisms contribute to its generation:

- **Metaverse Memory:** The bidirectional feedback loop between the physical universe and the Metaverse creates a temporal correlation between samples, which is the source of the long-term "memory" typical of 1/f noise.
- **Superposition of Fluctuations:** The quantization error of each sample is the sum of countless sub-Planckian fluctuations in the Metaverse, existing across an infinite range of timescales. Their superposition manifests as a 1/f power spectrum.

1/f noise, therefore, is not the chaotic hiss of a disturbed signal. Rather, it is the organic and realistic "vibrato" or "tremble" of a cosmic performance. It is the sound of the previous note's echo influencing the current one; the acoustic signature of a universe with memory.

This ubiquity across all timescales suggests a possible cosmological connection: 1/f noise could be the "echo" or **fossil imprint** of the primordial universe's "low resolution" and "low frequency" state, a memory of its evolution intrinsically recorded in the fabric of the vacuum.

7.11 The Universe as a Resonant Cavity and Quantum Fluctuations

Extending the vacuum-as-fluid-medium analogy, the primordial universe can be described as a giant **resonant cavity**. Before recombination, the dense plasma of matter and radiation supported the propagation of acoustic waves, generated by the competition between gravity (compressing the fluid) and radiation pressure (expanding it).

The connection with quantum physics is fundamental: the origin of these primordial sound waves is to be found in the **quantum fluctuations** of the vacuum in the very first instants after the Big Bang. In MFC theory, these would be the fundamental fluctuations of the meta-matter superfluid, originating from the sampling process.

The anisotropies we observe today in the Cosmic Microwave Background (CMB) are thus the **macroscopic and "fossil" manifestation of a purely quantum phenomenon**, amplified on a cosmological scale. The "acoustic peaks" measured in the CMB power spectrum correspond to the fundamental resonance modes of this cosmic cavity. While a detailed analysis of this phenomenon belongs to a subsequent work on MFC cosmology, it is important to note how the sampled universe model provides a natural physical substrate for the quantum origin of cosmic structures.

8 The Physical Nature of Information

In MFC theory, information ceases to be an abstract entity and becomes a physical, geometric, and dynamic property of matter. Aligned with J. A. Wheeler's "It from Bit" principle [1], physical reality ("It") is the manifestation of fundamental information ("Bit"). In this model, every particle, being a stable vortex, *is* a unit of information encoded in its topology, spin, and vibrational states.

The "programming language" governing how these informational structures interact and transform is given by **conservation laws**. A nuclear reaction is permitted only if it is "grammatically correct," i.e., if it respects the conservation of energy, momentum, charge, and other quantum numbers.

In this framework, the neutrino assumes the role of **physical messenger of nuclear information**. When a nucleus decays, the neutrino is the particle emitted to "balance the books," carrying the essential information of the transformation. It is analogous to a "gene" of **"atomic DNA"** released to

certify the change. Its **flavor oscillation** acts as a "**quantum odometer**", whose final state encodes the history of its journey through the cosmos.

It seems "designed" specifically to travel undisturbed for billions of years, interacting negligibly with matter. This makes it the ideal candidate for transporting long-term information toward black holes.

9 The Arrow of Time: Entropy and Syntropy

In MFC, the concept of "time" that flows is a perceptual illusion, analogous to motion in a film. Reality is a succession of static "samples" (T_n). The "present" is the current sample, while the "past" exists only as **memory**, i.e., as the physical configuration of matter and energy (e.g., neuronal connections, data on a disk) within the present sample. The passage of time is a cognitive phenomenon arising from the comparison between the perception of the current state and the memory of the previous one.

This view departs from the "block universe" of General Relativity, in which past, present, and future coexist. In MFC, only the present is physically real, precluding time travel and associated paradoxes at the root.

The fundamental question then becomes: why can the "film" of reality only be read in one direction? The answer lies in the interaction of two opposing cosmological tendencies.

10 The Arrow of Time as an Evolutionary Vector

The unidirectional direction of time, or "arrow of time" [15], is not an intrinsic property of time itself, but is the **vector of cosmic evolution**: the irreversible process that moves the universe from a state of low information and low resolution to one of high information and high resolution. This process is governed by the dynamics between two fundamental principles: Entropy and Syntropy.

10.1 Entropy: The Initial State and the Tendency Toward Dispersion

Contrary to the common view of "disorder," entropy in MFC represents the simplest, most symmetrical, and lowest-information state possible: **isotropy**. This state, which dominated the primordial universe, is governed by a dual tendency toward dispersion:

- **Mechanical Dispersion:** Energy (momentum) tends to disperse from organized structures into random microscopic motions [17].
- **Informational Dispersion:** The "lossy sampling" process from the Metaverse makes the cosmic calculation irreversible, generating informational entropy that grows at each instant.

"Heat death," in this view, is not final disorder, but the return to the fundamental state of **isotropic order and minimum information**.

10.2 Syntropy: The Engine of Complexity and Information

Opposing this passive tendency is the active principle of **Syntropy**: the engine driving the universe toward states of greater complexity, anisotropy, and information. As postulated by Erwin Schrödinger [25], Life is a syntropic process that organizes raw matter into complex structures. In MFC, Life is the most sophisticated expression of this principle, but the most powerful force driving Syntropy in the universe is **Gravity**.

It is gravity that fights dispersion, aggregating matter into stars, galaxies, and black holes, and allowing the universe to "gain experience" and increase its informational resolution over time.

10.3 The Fate of the Universe: Information Archiving

The arrow of time thus points toward a future of increasing complexity, not toward heat death. In this framework, black holes [16] are not just "entropic pumps" but the apex of the syntropic process: they could be the **Cosmic Archives**.

They represent the final stage of information evolution:

1. They collect the matter and information ("experience") that the universe has matured over the course of its evolution.
2. They compact it into the densest and most orderly state possible.
3. They preserve it, acting as the final, ultra-high-definition memory of the cosmos.

The ultimate fate of the universe could therefore be not dispersion, but archiving. Cosmic evolution is the process through which the universe, starting from a simple state, "learns," becomes more complex, and finally records its entire history within the hyper-ordered structure of black holes, perhaps ready to return this matured information to the Metaverse.

11 Perspectives and Metaphysical Implications

After outlining the physical framework of MFC theory and its applications to cosmology and quantum mechanics, this final section ventures into a more speculative perspective. The goal is to explore the deeper implications of the model, particularly its potential to provide a conceptual bridge between vacuum physics and the role of consciousness in reality.

The ideas presented here are not intended as falsifiable predictions in the same way as those discussed previously, but as a philosophical extension that emerges logically from the theory's postulates. An interpretation is thus proposed of how consciousness might act as an interface with this domain, offering a new key to reading phenomena at the boundary between physics and metaphysics.

Increasingly, voices in both scientific and philosophical fields suggest that mechanics alone is insufficient to explain the whole of existence. Theories on perception as a "user interface" of a deeper reality, such as Hoffman's [20], or on consciousness as a fundamental property, such as Faggini's [18], are gaining consensus in frontier scientific debate. MFC fits into this tradition, attempting to offer a concrete bridge between physics and metaphysics.

The theory hypothesizes that living beings (with increasing degrees of awareness) have a form of direct access and interaction with the Metaverse. This is not a passive relationship but a dynamic interaction concerning consciousness and the transcendent aspects of individuals. Living beings could thus act on reality in two ways:

- **From Physical to Metaphysical:** Through normal material actions and biological processes, ordinary matter influences meta-matter in the Metaverse, as described by the principle of bidirectional sampling. This is the cause-and-effect flow we know well.
- **From Metaphysical to Physical (Action of Consciousness):** Here may lie the key to otherwise inexplicable phenomena. Consciousness, by directly accessing and modulating meta-matter in the Metaverse, could influence and modify physical reality. This capability would explain phenomena "not scientifically explicable but rigorously verified," such as spontaneous remissions in medicine. Consciousness, acting at a metamaterial level, could reorganize physical reality in ways that appear "non-causal."

In this sense, consciousness would not be an emergent product of brain activity, nor the sole cause of reality's manifestation. It would rather be an entity that, operating at a meta-real level, contributes to the manifestation of reality, acting as the mechanism allowing the brain to "tune in" to the Metaverse to modulate its rules. The more evolved an organism, the more sophisticated this "antenna" is. This vision of a brain acting as a quantum "antenna" finds parallels in rigorous scientific hypotheses. The most notable is the theory of Orchestrated Objective Reduction (Orch-OR), developed by Roger Penrose and Stuart Hameroff, which postulates that consciousness arises from quantum processes occurring within microtubules inside neurons [26]. Within the MFC framework, these processes could represent the physical interface through which the brain interacts with the Metaverse.

The physical reality of living organisms would therefore be subject to a double dynamic: a chemical-physical one (on the plane of the sampled universe) and another, equally important one acting at a higher level, namely the conscious level.

A final perspective proposed to the debate is that this conscious access to the Metaverse also provides the theoretical possibility of a direct connection between individuals: a **conscious entanglement**. This concept links to C. Jung's idea of **Synchronicity**, elaborated with the physicist W. Pauli, which postulates a principle of acausal connection between events [22].

Extending the concept, if an individual's consciousness can have an effect, collective consciousness could have an exponentially greater impact. In this, the hypothesis approaches biologist R. Sheldrake's concept of **morphic resonance**, which postulates a non-local collective memory in self-organizing systems [23]. Attempts to find statistical evidence of an interconnected global consciousness have been pursued by researchers like D. Radin with his Global Consciousness Project [24].

12 Conclusions

The Metamaterial Fluidic Cosmology (MFC) theory offers a unifying framework aimed at overcoming the conceptual limits of modern physics. By postulating a single physical substrate—an omnipresent and dynamic meta-matter—the theory provides intuitive and mechanistic explanations for the nature of time and the origin of quantum phenomena. The model of a universe sampled from a superior potential domain not only resolves paradoxes like entanglement and wave-function collapse but also defines the arrow of time as an emergent consequence of an irreversible informational process.

At present, the theory precludes time travel, as only the "present" physically exists, while the past exists as recorded information and the future as potential to be expressed. Its full applications, aimed at demonstrating how this same framework can unify Quantum Mechanics with General Relativity and resolve cosmological anomalies, will be presented in subsequent works.

MFC opens a stimulating, albeit speculative, perspective: if reality is a feedback loop with a more fundamental domain, we might contribute to modifying the present and future not only in a physical-causal way but at a deeper conscious level. Our intentions, thoughts, and beliefs would not be merely internal events but could be forces actively shaping the fabric of the universe.

This vision invites us to reconsider our deepest understanding of reality, suggesting that the cosmos is not an inert void but a living ocean of meta-matter. It is a theory that aims not only to explain "how" the universe works but also to open the door to a deeper "why," inviting further debate and research.

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