A Vibrational Paradigm of the Universe I. Foundational Assumption: Space as a Self-Synchronizing Medium

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Abstract

We present a speculative paradigm in which physical space is not an empty backdrop but an active oscillatory medium. The framework rests on a minimal set of assumptions: (1) space is composed of elementary units ("space-points"), and (2) these units oscillate intrinsically. From these assumptions, we derive a chain of consequences: self-synchronization of space, the emergence of particles as trapped wave structures, their fractal hierarchy, the interpretation of matter as condensed space, and gravitation as an effect of spatial refraction. This approach provides an alternative conceptual foundation while remaining compatible with the mathematical apparatus of General Relativity.

Keywords: Vibrational paradigm; Oscillatory space points; Synchronization of oscillators; Standing waves; Pseudo-stationary waves; Fractal quantization; Matter as condensed space; Gravitation as refraction; Electromagnetic radiation; Zero-point energy; Proper time; Wave-particle duality

1 Introduction

In modern physics, space is usually treated either as a geometric manifold (General Relativity) or as a vacuum state of quantum fields (Quantum Field Theory). In both views, space itself is passive, while matter and energy constitute the active elements.

We propose here a radically different viewpoint: *space itself is the fundamental substance of the universe, composed of oscillatory units.* Matter is then understood not as an entity distinct from space, but as concentrations of space.

Unlike many speculative models, our proposal rests on a minimal set of foundational assumptions, from which other properties are derived step by step. The goal of this article is not to provide a complete theory, but to outline the logical consequences of these assumptions and to highlight the possible physical insights they offer.

2 Foundational Assumptions

1. **Discrete space:** Physical space is composed of elementary entities, hereafter called *space-points*. These are not particles in the usual sense, but the fundamental "atoms" of space itself.

2. **Oscillatory nature:** Each space-point oscillates intrinsically. This oscillation is the most basic property of existence within this framework.

Every other statement in this paper will be derived from these two assumptions.

3 Derived Properties

3.1 Natural synchronization

If all space-points oscillate at (or around) the same intrinsic frequency, then interactions among them lead to *spontaneous synchronization*. This is a well-studied phenomenon in coupled oscillators (Kuramoto model [1] [2], Huygens' clocks [3]). The result is that the entire medium tends toward a coherent background vibration.

The propagation of synchronization between spatial points is naturally identified with the speed of light, c. This assumption is consistent with experimental evidence: all electromagnetic waves, regardless of frequency or energy, propagate at the same velocity in vacuum. It follows that synchronization of space cannot occur at a supra-luminal speed without contradicting this universal property.

3.2 Particles as trapped wave structures

A particle is not a separate entity but a localized configuration of waves within the medium. These waves are several orders of magnitude larger than the standing waves that constitute the fabric of Space itself. They can become mutually trapped, creating a persistent structure whose stability arises from feedback between emission, reabsorption, and synchronization with the waves generated by the surrounding matter, which share the same characteristic wavelengths.

3.3 Fractal hierarchy of matter

The internal structure of particles can be understood as a finite fractal nesting of wave modes [4] [5] [6]. At each deeper level:

- the wavelength becomes shorter,
- the energy density increases,
- only certain stable configurations persist.

3.4 Matter as condensed space

If particles are made of waves, and waves are perturbations of oscillating space-points, then matter is nothing but a concentration of space-points. Hence, matter and space are not two substances but two aspects of the same vibrational medium.

3.5 Dual standing-wave networks

Two distinct fields of standing waves emerge:

1. A **high-frequency synchronization field** among space-points themselves. This field is flat in the absence of matter and curved in the presence of matter. It propagates at speed of light.
2. A **low-frequency particle field**. Particles radiate at much longer wavelengths (lower frequency) as a result of their finite size, giving rise to electromagnetic fields. It also propagates at the speed of light.

3.6 Electromagnetic radiation and charges

The radiation of matter particles corresponds to electromagnetic radiation, arising from their internal wave circuits. Charges are special configurations of trapped self-sustained waves. It can be shown [4] [5] that the proton's charge corresponds to an incorporated positron (the neutron combining a positron and an electron). Thus, all matter reduces fundamentally to electrons and positrons, heavier particles with additional trapped wave modes that increase their mass.

This view excludes quarks as fundamental constituents; they only appear transiently in high-energy collisions but do not exist in stable configurations.

3.7 Gravitation as Refraction

A concentration of matter modifies the local density of space-points. Because the synchronization field prevents abrupt discontinuities, this density varies progressively. As a result, the effective refractive index of space also varies, bending trajectories of waves. This manifests macroscopically as gravitation. General Relativity's description of curvature is thus recovered as an emergent refractive effect.

Historical and related approaches. The idea of describing gravity in terms of an effective refractive index of space has a long history. Already in the 1970s, de Felice [10] showed that gravitational fields can be interpreted as optical media with variable indices of refraction. Later works by Ye and Lin [11] modeled gravitational lensing as light propagation in a graded refractive index vacuum. More recently, Edwards [12] connected the refractive interpretation with the cosmic microwave background, and Toktarbay et al. [13] extended the analogy to nonlinear electrodynamics.

These approaches demonstrate the viability of optical analogies for gravitation. However, they generally treat the refractive index as an effective mathematical tool derived from general relativity. In contrast, the present framework grounds the refractive behavior in the dynamics of the oscillatory points of space themselves. Refraction is not only an analogy but a direct physical consequence of how synchronized oscillations propagate in the medium. This refractive mechanism provides a natural link between the structure of space, the confinement of matter, and the bending of trajectories traditionally attributed to gravity.

Thus, gravitation as refraction emerges not as a reformulation of relativity, but as a new physical interpretation rooted in the vibrational constitution of space.

4 Zero-Point Energy and Vacuum Energy

In the present framework, the zero-point energy does not correspond to an arbitrary sum of independent field modes, but to the **permanent readjustment of oscillating space-points with respect to each other**.

Space-points vibrate at extremely high intrinsic frequencies, which would suggest enormous local energies. However, at the scale of matter, what becomes physically relevant is not the absolute frequency of individual space-points, but the much lower frequencies of matter particles, which correspond to *trapped wave structures*.

Particles consist of waves circulating in a small volume, constructing standing waves. Waves represent displacements of spatial points, which must therefore constantly adjust their relative distances and frequencies.

In this interpretation:

- Zero-point energy is the manifestation of these continuous micro-adjustments of the space-points due to their relative motions.
- The vacuum does not contain an infinite reservoir of independent modes, but a correlated network of oscillators constrained by synchronization.

- The apparent infinities of QFT arise from neglecting this strong correlation among space-points.
- The small effective value of vacuum energy observed cosmologically reflects the residual collective dynamics of this correlated medium.

Thus, the vacuum energy puzzle is reinterpreted: instead of an inexplicable mismatch between theory and observation, it emerges naturally from the difference between the extremely rapid intrinsic vibrations of space-points and the slower, collective pseudo-stationary waves that define the observable state of vacuum.

5 Conceptual Implications

This framework suggests:

- Unification of space, light and matter: all are manifestations of the same medium.
- Emergence of quantization from stability of wave modes.
- Gravitation as emergent refraction of space.
- Two levels of coherence: rapid synchronization of space-points and slower electromagnetic interactions of matter.

6 Conclusion

From two minimal assumptions—that space consists of oscillatory points—we propose: synchronization, closed-system balance, particles as trapped waves, fractal quantization, matter as condensed space, dual standing-wave fields, gravitation as refraction, and electromagnetic radiation from wave circuits of charges.

This framework is speculative and should be regarded as a **basis for reflection**. Its value lies not in immediate predictive power but in providing a new conceptual foundation to re-examine unresolved problems in physics.

Outlook. This article is intended as the opening contribution to a **collection of articles** devoted to exploring the vibrational paradigm of the universe. Each subsequent article will address a specific aspect that can be reinterpreted within this framework, including Light, Time and proper time, the three generations of particles, the expansion of space, the transactional interpretation of quantum processes, inertia, wave-particle duality, Young's double-slit experiment, as well as other phenomena that remain poorly understood. Taken together, these contributions aim to progressively build a coherent alternative picture of fundamental physics.

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