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Article

The Hidden Harmony of Life and the Quantum

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Abstract

Life and quantum mechanics can be seen as expressions of universal harmony. From the heart beat to the DNA vibrations and neurons spikes, living systems unfold through cycles; physics, too, is built on matter waves, resonances and quantized spectra. Schrödinger envisioned life's stability in molecular vibrational modes. Here we extend that idea: information, perception, cognition as much as the whole quantum mechanics can be described as temporal cycles. Elementary Cycles Theory, validated in many peer-reviewed publications, elevates de Broglie's idea of particles as intrinsic clocks to the principle from which quantum mechanics can be fully derived. Entanglement is not "spooky action" but harmony: synchronized clocks, like two lovers whose hearts beat in unison even across distance. Life is quantum because it is woven from the same laws of harmony that underlie the universe itself.

Keywords: intrinsic periodicity (elementary cycles theory); quantum–biological coherence; biophysical oscillators; molecular vibrations (DNA/RNA/proteins); phase synchronization & entrainment; time–frequency dynamics in living systems; nonlinear dynamics & self-organization; information processing in cellular networks; thermodynamic arrow of time & irreversibility; resonance-based biological function

1. Introduction

Life is rhythm and harmony. From the beating of the heart to the biological clock that synchronize us with day and night, living systems manifest themselves through cycles. At the molecular scale, DNA vibrates, proteins fold and unfold, and neurons fire in rhythmic trains of spikes, all acting like the musical instruments of a vast symphony: the symphony of life itself. At larger scales, ecosystems pulse and resonate, and cultures evolve through recurrent and interfering patterns.

Physics too is a science of rhythm and harmony. The ancient intuition that the cosmos is harmonic and that time itself may have a cyclic character captures a fundamental aspect of nature. So far physics has only marginally grasped this metaphor into equations: every classical system admits a dual description in terms of wave-like behavior, through the Hamilton–Jacobi and optico-mechanical correspondences, which then inspired the undulatory formalism of Quantum Mechanics (QM).

Since de Broglie, we have known that every particle can be imagined as an *elementary clock*, a "periodic phenomenon" vibrating with a characteristic period given by the celebrated relation

$$T = \frac{h}{E},$$

where the energy E corresponds to a fundamental vibrational frequency $f = \frac{1}{T}$ by means of the Planck constant h (that is $E = hf$).

Elementary Cycles Theory (ECT) takes de Broglie's idea and elevates it to a fundamental principle of physics, proposing that every elementary particle is itself an *intrinsic clock*, vibrational modes in time with a well-defined periodicity fixed dynamically by its energy. In this way, both quantum and relativistic mechanics arise in a unified manner from classical mechanics, in a potentially deterministic way [1]. Quantum entanglement, for instance, emerges as the manifestation of clock synchronization [2]. Gauge and gravitational interactions appear in the same language as modulations of clock rates,

similar to gravitational redshift [3], and an extensive series of other theoretical and phenomenological results, all results validated by many [publications in reputable peer-reviewed journals](#).

2. Schrödinger's Question: What Is Life?

In his famous 1944 book *What Is Life?* [4], Erwin Schrödinger asked how a molecule could carry the stable message of heredity across generations. He introduced the concept of “aperiodic crystal” as the physical basis of genetic information. Ordinary crystals with repeating patterns encode rather regular harmonic vibrational modes. DNA, by contrast, thanks to its aperiodic and irregular lattice structure, can sustain extraordinarily rich vibrational modes that may represent the genetic information stored within it. Schrödinger emphasized the importance of the stability of these vibrational modes in the molecule carrying genetic information: the message must withstand thermal noise and fluctuations, otherwise inheritance would quickly disintegrate.

Indeed, Schrödinger also used the language of vibrations and resonance. He recognized that the stability of such a molecule was not static but dynamic: its atoms vibrate, yet the overall form resists disruption. This vision anticipated modern biophysics, where DNA is understood not only as a symbolic string of bases but also as a complex vibrating structure with a rich spectrum of oscillatory modes.

Thus, the information of life is at once textual and harmonic. It is written in the sequence of bases (A, T, G, C) but it is also dually expressed in the way the molecule vibrates, twists, and bends. This dual nature mirrors the fundamental nature of quantum physics.

3. DNA as a Music Score of Life

Imagine DNA as a non-homogeneous lattice of masses and springs, where the nucleotides A, T, G, and C correspond to elements with different masses and binding potentials. The specific sequence of bases determines, in a dual way, both the genetic message and the vibrational spectrum of the molecule. Each sequence corresponds to a unique landscape of coupled oscillators, with its own distinctive spectrum of resonant modes.

Biophysical models support this picture. The study of molecular vibrational modes is an established field of investigation. The Peyrard–Bishop–Dauxois model [5] treats DNA as a non-homogeneous lattice of oscillators, capturing local “bubbles” that open and close as vibrations propagate along the double helix. The Yakushevich [6] model describes torsional vibrations, showing how different base-pair sequences affect resonance. Experiments with terahertz spectroscopy and Raman scattering have revealed distinct vibrational signatures depending on nucleotides sequence [7].

In this picture, DNA is not merely a static code but a score of vibrations, a symphony of life played by the molecule itself. The sequence, through its interplay of masses, charges, and couplings, defines the music score of the dance performed by DNA in accomplishing its various tasks.

This dual nature—digital sequence plus analog resonance—mirrors the essence of QM. In ECT, the discrete energy levels of QM emerge from conditions of closed orbits in the time evolution of physical systems. For instance, this generalizes the idea at the heart of Bohr's atom, where electrons can only occupy modes that close after one orbital period (overlapping with themselves), corresponding to vibrational modes of a closed time orbit—similar to a violin string vibrating in time rather than in space. This framework naturally describes the atomic energy levels n . The picture of the atomic orbitals is completed by considering spherical geometry: the intrinsic time periodicity must combine with the vibrational modes of a spatial sphere (the spherical harmonics), thereby defining the quantum numbers l and m . In short, similar to *cymatics*, the atomic orbitals that determine the chemical properties of atoms—and the structure of the *periodic* table itself—are nothing but the vibrational modes of periodic time cycles (a “time ring”) combined with the vibrational modes of a spherical membrane.

In general, within ECT every elementary particle behaves as a string vibrating in time, *i.e.* the de Broglie internal clock, whose periods are dynamically modulated by the exchange of energy. The quantization of energy is directly analogous to the discretized spectrum of a system vibrating in compact

time (in general non-homogeneous if subject to a potential, such as the Coulomb potential in atomic orbitals). Similarly, in DNA, the genetic alphabet is embedded in vibrational modes determined by its non-homogeneous compact structure. In both physics and biology, the essential information—whether of chemical properties or of life itself—is stored in vibrational spectra.

4. Harmony from Chaos, Biological Clocks and Perception

The rhythms of life extend beyond molecules. Biological clocks operate as nonlinear dynamical systems. Studies of deterministic chaos in biological oscillators show that rhythms such as the heartbeat, circadian cycles, and neuronal firing can switch between regular periodicity and chaotic regimes.

These biological clocks are not isolated; they synchronize when coupled, just as Huygens' pendulum clocks align when placed on the same wall or as metronomes synchronize on a common platform. Such fascinating macroscopic phenomena illustrate how order can emerge from deterministic chaos. This may appear to challenge the second law of thermodynamics, much like the broader self-organization processes that give rise to life itself. Coupled periodic phenomena—whether biological clocks or elementary particles—when sufficiently insulated from external noise, naturally evolve in harmony with their neighbors for energetic reasons. Fireflies flash in unison, neurons fire in synchrony, and metabolic cycles resonate together to maintain homeostasis. Similarly, at sufficiently low temperatures, systems of particles form condensates, superfluids, superconductors, or even time crystals. For this reason purely quantum phenomena are always characterized by collective coherence and perfect periodicity in time.

This reveals that life thrives on the edge between order and chaos. Too much rigidity, and the system cannot adapt; too much disorder interfering with the couplings, and coherence dissolves. Stability arises when the coupling of periodic loops can sustain self-harmony against external chaotic fluctuations, such as thermal or environmental noise. This mechanism is also at the heart of the emergence of pure quantum phenomena in condensed matter, as will be discussed in the next sections in terms of ECT.

Studies also suggest a profound relationship between perception, cognition, and temporal-loop coding [6]. According to these models, perception is not a passive recording of signals but an active comparison of time loops: the brain continuously matches incoming information with internal codes stored as temporal patterns in neural networks.

These codes are realized in spike trains, where information is not carried by the average firing rate but by the precise timing between spikes—the interspike intervals similar to a sound wave. Perception emerges from the harmonic synchronization when external rhythms (spikes of sensory origin) are coupled with internal rhythms of spikes stored in neural loops. These loops constituting memory can be seen as rich vibrational spectra associated with the complex lattice of neurons, created again as adaptation of the neural network to mimik passed sensorial input.

All this can be represented in terms of the Wigner function, at the base of a formulation of QM used in quantum optics, which captures the self-overlap and recurrences of a quantum wavefunction. The neural system in fact uses time–frequency representations to compare present and stored signals. The brain, in other words, computes through interference of cycles and the comparison of vibrational spectra.

This vision connects directly with ECT. In ECT, quantum phenomena arise from the coherence in the harmony modes of elementary cycles. In the brain, cognition arises from the interference and synchronization of neural cycles. Both realms suggest that information is fundamentally temporal, harmonic, and loop-based.

5. Elementary Cycles Theory: Physics as Harmony

The idea at the heart of ECT is simple but profound: every elementary particle is an **intrinsic clock**. Each particle carries within itself a fundamental periodicity, an internal rhythm whose period T defined by its energy E through the celebrated de Broglie-Planck relation $T = \frac{h}{E}$, (that is, $E = hf$).

“To each isolated parcel of energy E , one may associate a periodic phenomenon of periodicity $T = h/E$. This hypothesis is the basis of our theory: it is worth as much, like all hypotheses, as can be deduced from its consequences.” — L. de Broglie (1924)

Matter waves, in this picture, are not abstract probabilities but physical cycles: periodic phenomena embedded in spacetime, vibrating like strings whose discretized frequency modes constitute the quantized energy spectrum of the system. In other words, by assuming that every particle is constrained on a time circle (generalizing the “particle in a box” to the time dimension), ECT promotes the semiclassical approximation of QM to a full and exact equivalence with standard QM [1]—proven for canonical quantization, the Feynman path-integral formulation, and other fundamental aspects of quantum theory. ECT is essentially a generalization, in relativistic spacetime, of the laws of sound and harmony, where elementary particles (or, in general, all possible physical systems [1]) vibrate not only in space (as violin strings produce sound) but also in time.

When we impose periodic boundary conditions to form these cycles, discrete spectra naturally emerge. Quantization—the cornerstone of QM—is nothing more than the harmonics of these time cycles, as in a vibrating string. It has been demonstrated, in multiple peer-reviewed studies, that canonical commutation relations, the familiar algebra of quantum theory and in general all the math machinery of QM follow directly and exactly from this fundamental physical principle of intrinsic periodicity (see full list of [publications in reputable peer-reviewed journals](#)).

Interactions appear in ECT as modulations of intrinsic periodicities. Just as musicians adjust the fundamental vibrational length of their instruments to stay in tune and follow the music score, particles adjust their rhythms (that is, modulate their periods T , the fundamental frequency of their “notes”) when they exchange energy. Electromagnetism and the exchange of photons—as well as the other gauge interactions that constitute the fundamental forces of nature—emerge as synchronization of cycles through phase modulation of these elementary periodicities. In other words, it appears in perfect parallelism with gravitation, which likewise encodes redshifts of clocks. ECT therefore provides a unified geometric description of all fundamental interactions of nature (gravity plus gauge interactions) as tunings of the elementary cycles of the universe [2].

This language reproduces not only the canonical quantization of fields but also offers fresh insights into the structure of fundamental physics. It recovers the Kaluza–Klein approach in a natural way, links to the AdS/CFT correspondence, and gives a new perspective on electroweak symmetry breaking or superconductivity, just to mention a few peered results. What is remarkable is that [all these advances](#) arise from the simple hypothesis that time itself has a cyclic nature at quantum scales [1].

In this sense, ECT extends Schrödinger’s intuition, not only about QM but also about the origin of life. Just as the stability of the vibrating crystal allows life to encode information, the stability of elementary cycles describe the stability of quantum states in a natural and fully classical way. Both life and matter can thus be described as harmonies of elementary cycles.

6. Entanglement Particles as Lovers

Perhaps no feature of QM has puzzled us more than entanglement. Einstein called it “spooky action at a distance.” Yet in the framework of ECT, entanglement appears natural and implicit in the principle of intrinsic periodicity, as recently proven in [8].

If particles are clocks, then every interaction—electromagnetic, gravitational, or otherwise—is an act of tuning their elementary cycles. From the very beginning of time, particles have interacted, tuning their rhythms with one another. Entanglement is simply the persistence of this original synchronization, even when the particles are later separated.

[This perspective dissolves the mystery of quantum entanglement](#) [3]. There is no need for superluminal signals or hidden conspiracies. Instead, correlations arise because the clocks were set in unison from the start. Their harmony endures across space and time, even in the presence of

simple interactions such as those associated with polarizers, which correspond to phase shifts of the elementary clocks.

Beyond the mathematics, the analogy is with *two lovers*. Love can be so deep that two people's hearts beat in rhythm at unison. They share not only their steps but also their thoughts, taking similar decisions in similar situations even when far apart, sometimes anticipating one another. Likewise, entangled particles remain bound and synchronized by the laws of harmony. Their synchronization provides exactly the "non-local" flavor apparently missing from standard classical mechanics (*e.g.* local hidden variable theories), sufficient to account for the violations of Bell's inequalities, as proven formally in [3].

This picture resonates with the spirit of superdeterminism, but without the coldness of fatalism. It is not that the universe conspires against our freedom; rather, it is that the universe is a grand orchestra in which every instrument is tuned and resonates with the others. Entanglement, then, is not spooky at all. It is the most intimate and poetic manifestation of the harmony that governs both physics and life.

As discussed in [8], this argument can finally reconcile Einstein's and Bell's views. Every isolated elementary particle is a periodic phenomenon exactly repeating itself in space and time. Bell would emphasize the apparently non-local aspect: if we know a property of a system at one point, we can predict its values at many distant spatial and temporal recurrences—even seemingly outside the light cone, provided no further interactions occur anywhere and at any time. By contrast, Einstein would stress that interactions—such as gravitational redshift, or the local effect of polarizers in Bell's experiments—imply perfectly local and causal modulations of the clocks rate (see relativistic clocks). In this way, elementary clocks can appear "non-local" in Bell's sense and "local and causal" in Einstein's sense, while remaining perfectly compatible with the laws of classical mechanics.

7. Life as Emergent Harmony and the Arrow of Time

When viewed through this lens, life appears as a cascade of cycles across scales.

At the molecular level, DNA encodes information both as sequence and as vibrational modes. At the cellular level, circadian rhythms and metabolic cycles coordinate biochemical functions. At the neural level, perception and cognition rely on synchronization and interference of temporal loops of neural spikes. At the ecological level, populations and ecosystems oscillate in predator-prey cycles, seasonal rhythms, and evolutionary recurrences.

Life is thus not merely chemistry — which itself is governed by the *periodic* table, reflecting intrinsic periodicity at the base atomic orbitals as harmonic modes in spacetime, see above — but a harmony of clocks, a nested architecture of cycles that interact, resonate, and adapt.

This image aligns naturally with ECT, which portrays the universe as a symphony of intrinsically periodic phenomena. From their interplay, the thermodynamic **arrow of time** emerges. In ECT, quantization, interference, and correlations arise from the geometry of cycles; in biology, function, adaptation, and cognition arise from the same principle.

Physics can be reformulated as the dynamics of a vast network of elementary clocks. Time is not a continuous river but a tapestry of ultra-fast microscopic cycles. Each elementary particle is an elementary clock of nature, its recurrence fixed by its energy via de Broglie's relation. This periodicity is not metaphorical but a physical constraint, implemented through periodic boundary conditions in time.

As Penrose noted:

"There is a clear sense in which any individual (stable) massive particle plays a role as a virtually perfect clock [ticking at period $T = h/E$]." — R. Penrose (2011)

At first glance, this vision seems to challenge one of the deepest intuitions in physics: the arrow of time. If everything is cyclic, would the universe not be trapped in eternal recurrence, with no distinction between past and future?

ECT shows instead that the macroscopic arrow of time emerges naturally as a statistical consequence of microscopic cycles and their modulations. Standard wave-particle duality already implies

that each particle has a time recurrence modulated by its energy. Since the universe is made of such particles, time itself is the collective behavior of their internal cycles.

Two non-correlated pendula (see [double pendulum](#)) form an ergodic system, *i.e.* a system that never passes again two times on the same configuration. We are used to describe the flow of time in terms of the ergodic system formed by the solar system (assuming no external perturbation), that is, by the cycles of the Sun, the Moon and Earth rotations, like years, months and hours. If a system is composed by many reference cycles which are, in addition, mutually modulated, it is easy to see that the resulting evolution become highly chaotic.

When many particles interact, their cycles are modulated by energy exchange. Thermal noise, quantum fluctuations, and decoherence lead to dephasing: perfect synchronization breaks down and the system evolves toward chaos or ergodicity. This dephasing is the statistical foundation of irreversibility of macroscopic systems. Like a vibrating string that loses self-coherence in a noisy environment, or because its fundamental wavelength is too long, everyday macroscopic classical systems cannot sustain perfect periodicity. It is no coincidence that the classical (non-quantum) limit emerges in black-body radiation at long wavelengths and high temperatures.

Conversely, quantum phenomena dominate at low temperatures, where coherence is preserved. Electrons in superconductors, like those in atomic orbitals, can circulate indefinitely if thermal noise is low. As Schrödinger anticipated, temperature suppresses some vibrational modes while stabilizing others.

The arrow of time can thus be seen as an emergent property of ensembles of modulated cycles. A universe built from “googols” of intrinsic periodicities transitions from microscopic recurrences to macroscopic irreversibility. Entropy increases and harmony fades: living beings age and die, even though their constituent particles continue their perfect intrinsic rhythms.

Light provides a fascinating exception. Being massless, photons have infinite internal recurrence:

“A photon [seen from its rest frame—traveling at the speed of light] would take until eternity before its internal clock gets even to its first tick.” — R. Penrose (2011)

From the point of view of light, everything happens at once.

In this framework, the flow of time is not a primitive feature of the universe. It is an emergent, relational property—a macroscopic manifestation of countless microscopic cycles interacting under the laws of statistics. ECT reveals that the arrow of time is not in conflict with cyclic time: it is born from it.

8. Conclusions

Schrödinger asked: *what is life?* His answer pointed to the stability of harmonic modes in a molecule meant as vibrating crystals, a structure capable of carrying a message across time. Life is not merely a static text code of A, T, G and C, but a vibrating harmony.

Our perception of reality, too, can be interpreted in terms of temporal loops. The brain is a system that recognizes rhythms through resonances. Perception is not only a symbolic computation, but also a form of musical resonance.

Elementary Cycles Theory reveals that this principle applies at the most fundamental level of physics. If the universe itself is made of cycles, then life, cognition, matter, and quantum phenomena are different expressions of one universal language: the language of elementary cycles.

In this view, the question “How quantum is life?” receives a simple but profound answer: life is quantum because it is woven from the same fabric of rhythms and the same laws of harmony that give rise to QM itself.

Life is not merely alive; **the entire universe is founded upon the most beautiful laws of physics—the laws of harmony. One might well ask: how could it possibly be otherwise? Life and quantum physics are simply two explicit manifestations of this vast and universal harmony.**

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