

The Receding Limit: Music, Memory, and Chance

From childhood intuition to a theory of colored noise: how music led me to think about the cosmos without formulas.

I. The Origin of Sound

Arsenio was not a classroom teacher. He was a figure who arrived at homes with the same mystery as dawn: slowly, impeccably, with his hat, his jacket, and a cane that seemed to mark time's rhythm. He had played in the great orchestras that made Cuba dance in the forties, when music was sacred territory and rhythm, a form of communion. Dark-skinned and soft-spoken, Arsenio taught with an elegance that needed no authority. There were only three conditions for having him as a teacher: an instrument, interest, and discipline. That was enough to open the door to the universe.

I was six years old, barely able to write my name. But that day, in front of the upright piano my grandparents had bought with sacrifice, I heard the first definition of my life:

"Music is the art of properly combining sounds in time."

No one suspected that this phrase, spoken with the naturalness of a prayer, would plant a seed in me. In my childish mind, an equation without symbols formed: sound + order + time = emotion. And from that instant, I knew that art was a way of measuring the invisible.

For years I played without fully understanding that equation. I learned that each note was a small physical decision, a vibration obeying laws I didn't yet know. But when MIDI sequencers arrived, virtual synthesizers and the Electroacoustic Music Laboratory in Havana, I understood that what Arsenio had said—so simple, so clean—was the principle of an infinite structure. Time, patterns, waves, harmony, everything was part of the same language: synthesis.

I discovered that behind every chord hid a pattern; behind every melody, a geometry; behind every emotion, an invisible order that the ear translates into pleasure. Music was the perfect bridge between number and soul. And on that bridge I have lived ever since, trying to understand why what vibrates also moves us, why what sounds can reveal the laws of the universe.

II. The Boy Who Measured the World

While at home I studied music with Arsenio, outside the home the world opened like a laboratory. I didn't attend a conservatory: my musical education took place within my home's walls, in the same space where I learned to multiply and disassemble toys to see how they worked. And, against all odds, my favorite subjects weren't artistic but scientific: mathematics, physics, chemistry, biology, computing... and technical drawing.

Technical drawing marked me more than I suspected. Since then I write only in block letters—an aesthetic consequence of precision. I was fascinated by the fact that a well-drawn line could contain a truth, an exact measure of the world. I didn't know it then, but that obsession with clean lines was the same one that would make me seek, years later, clean harmonies, invisible proportions, architectures that breathe without seeming rigid.

During the early years, music and science ran in parallel. One taught me to hear order; the other, to measure it. It wasn't until tenth grade that chance—or destiny—introduced a third force: literature. I fell in love with my teacher, and with her, with words. I read with a fever that had nothing scholastic about it. If before I had wanted to understand music and formulas, now I wanted to understand people. That mixture—emotion, number, and form—was the true beginning of my vocation: the desire to construct meaning.

III. The First Circuits of Time

In the late eighties, the first artifact that changed my life appeared: the Kawai Q-80, a small machine capable of recording and repeating time. It was like having a tireless apprentice inside a box. Shortly after, I saw a Macintosh for the first time running musical sequences and controlling an audio console: it was 1993, and I felt the future had arrived. For the first time, the music I heard in my mind could be organized with precision.

In parallel, with the group Paisaje con Río, we analyzed hits from international charts trying to discover hidden patterns, the invisible plots that made a song memorable. That dissection exercise was my first school of conscious composition: beauty also has logic, and emotion can be measured in intervals, frequencies, and intensities.

IV. The Laboratory of Air

Past twenty, chance began to behave like a plan. I met musicians and thinkers who would be decisive on my path. Among them, Edesio Alejandro, who received me as if we had already met in another life; Eddy Cardoza, probably one of the most intelligent musicians I've known; Israel López, the skeptical bassist who analyzed every chord as if it hid a trap; and Ernesto Romero, formerly a literature professor, who had traded essays for songs and directed the group Paisaje con Río.

Among all of them, my small universe of disconnected knowledge reorganized itself. Every conversation was a class in aesthetics, acoustics, irony, life. And one day I found myself in front of the Digital Performer screen, on a computer at the National Laboratory of Electroacoustic Music.

That was more than a place: it was a collective experiment. The air was full of laughter, theoretical arguments, impossible chords, and dust suspended over a carpet that had heard more recordings than people. There I understood that the avant-garde wasn't a style, but an attitude toward possibility. Sound could be everything: structure, chaos, texture, silence.

The Leap to Cinema

It was Edesio who cast the first stone into still water. After watching me work for a while, he invited me to participate in the music for a film that had no original composition, but arrangements of classics: Nada. That "yes" I gave him was a mixture of boldness and fear. My first assignment was nothing less than Carmina Burana, by Carl Orff. A legacy of scores, a mountain. The instruction was simple and dizzying:

"Make this sound... but with other instruments."

I returned home with the scores under my arm and vertigo in my stomach. On the bus, between the exhaust smoke and the city's murmur, I looked at the notes as if they were hieroglyphics from another world. I thought: what have I gotten myself into? But at the same time I felt that spark that only comes from the danger of creating.

Thus began Nada: an adventure that consisted of reinterpreting the classics of universal music from the Caribbean shore, with limited resources, but with boundless ambition. It was my first cinematographic experience and, unknowingly, a milestone that would mark the beginning of a long sonic journey.

That stage taught me something essential: that music, even when it seems to serve an image, has its own narrative, its internal logic. Every timbral decision was an emotional equation; every mix, an attempt at balance between chaos and order. Cinema amplified my questions: what determines emotion in a sound? why does a frequency move us? how does vibration become meaning?

The artist who had begun with Arsenio, the boy who drew lines with a 2H pencil, and the young man who sought patterns in pop songs, now worked with invisible formulas: those of the soul.

V. The Weirdos

Among cables, scores, and theories, there also existed another laboratory: one without instruments, without computers, but equally noisy and necessary. It was formed by Tony, Haití, Mario, Litay, and me. They called us "Los Raros" (The Weirdos), a kind of parallel cell to high school, a group of happy dissidents.

Tony wrote with devastating irony and incredible sensitivity. Haití painted universes that seemed to have their own physics, a student of the human mind in terms of image. Mario sang badly despite being the son of a great opera singer; he criticized Tony and the quarrels were a spectacle. And Litay, poet and historian, was an emotional whirlwind with overflowing intelligence. A woman as brilliant as she was unpredictable, adorably unbalanced, capable of quoting Cioran and, in the same conversation, crying over a Silvio song.

We met to talk about everything: politics, philosophy, literature, cinema, music, or simply to observe life as if it were a rehearsal for something greater. There, in those early mornings without time or structure, another form of learning was born: the art of dissenting without breaking affection, of criticizing without losing friendship.

The conversations were infinite. The discussions, sometimes irreconcilable. But there was something stronger than ego: the awareness of building, between laughter and contradictions, our own view of the world.

If the electroacoustic laboratory taught me precision, Los Raros taught me doubt. And between both things—exactitude and uncertainty—the map I still follow was drawn.

With them I understood that every theory needs a heresy, that truth is not imposed, it's conversed, and that great ideas are born, almost always, between smoke, laughter, and a half-filled glass.

Perhaps that's my least scientific part, but also the most human. Because the weirdos—those irreducible ones—are responsible for many of my questions... and some of my answers.

VI. Resonances

Over the years I understood that not only notes resonate. So do ideas, people, silences. Everything that vibrates, somehow, organizes itself. Life seems to move by the same law that governs strings: when one frequency finds another compatible one, both amplify their existence.

"Los Raros," the musicians, the teachers, the loves, the places... all were resonators, bodies that vibrated near my frequency. And when those vibrations coincided, inexplicably full moments were born, as if the universe confirmed that meaning isn't sought: it's found in coincidence.

There began my obsession with understanding why chaos could organize itself. Why noise—in the laboratory, on the street, or in the soul—could transform into music just by finding its pattern. Music, physics, mathematics, and perception weren't different territories: they were ways of naming the same question.

The Order Behind the Tremor

At bottom, everything reduces to an intuition: reality vibrates. The electron, the heart, the applause, the word, friendship: everything oscillates. The structures we believe solid are barely averages of stable oscillations. That's why art and science touch—because both seek the exact point where disorder becomes form.

Music is the sensible version of an equation: an equation not written with symbols, but with emotions. The scientist, at bottom, composes: seeks harmonic relationships between variables that seem unconnected.

The musician orders time; the physicist, space; the mathematician, logic. But all seek the same thing: coherence amid noise.

The Invisible Echo

I began to see life as a multidimensional score: love, loss, learning... all were movements of a symphony that can only be heard once. And I understood that the human ear—that miracle of bones, air, and electricity—is nothing more than a translator of universal vibrations. To listen is a way of measuring reality. And to feel, perhaps, is the most advanced calculation we're capable of.

At that point in my life I could no longer separate disciplines. Everything that moved me was also what I wanted to understand. And everything I understood, I wanted to express until it sounded. The equation closed the circle again: the art of combining sounds in time had become the science of combining the universe's vibrations in consciousness.

VII. The Ear of the Universe

For years I believed what fascinated me was music. Later I discovered that, in reality, what attracted me was vibration itself: its nature, its journey, its effect. Acoustics revealed to me that every sound is a pattern in motion, a form of energy that shapes space as it crosses through it. And neuroscience taught me that the ear doesn't just listen—it interprets, anticipates, dreams.

The sonic experience is an act of constant prediction: the brain constructs the sound's future a few milliseconds before it occurs. Pleasure isn't born from the sound that arrives, but from the coincidence between the expected and the real. That dance between the foreseen and the unexpected is the origin of musical joy... and perhaps, of the joy of existing.

In that discovery I found a mirror: if the human ear translates physical vibrations into emotions, might not consciousness be doing the same with the universe? Might not the mind be a cosmic ear that interprets patterns of reality?

From Wave to Cosmos

It was then when I returned to my science books—Sagan, Einstein, Hawking, Feynman—and understood that the fascination was the same, only expressed in another language. Music studies relationships between frequencies; physics, relationships between forces. Both seek invisible harmonies. Both are forms of listening.

The day I read that galaxies also vibrate, that black holes emit waves, that the universe's background radiation has a "tone," I understood that everything—absolutely everything—can be interpreted as a symphony of fluctuations. The difference is in scale, not essence.

And then appeared the question that changed everything:

"What if the cosmos could be explained with the same thing I do?"

That doubt—a mixture of boldness and humility—was the beginning of a new episode. I began to look at the universe as a resonant structure, a gigantic instrument that tunes itself through laws that are also rhythms. Art had prepared me to feel it; science, to understand it.

The Turning Point

From there on there was no return. Physics and mathematics became the natural next step, not to abandon music, but to expand it toward the universal. Sound remained my language, but the message had grown to encompass the totality of spacetime.

I began to ask myself if each consciousness might not be, in reality, an instrument of observation, if by perceiving the universe we were also shaping it, like a musician who modifies their instrument's timbre by playing it.

And then, like a melody that returns, everything fit together again: Arsenio, the boy, the laboratory, the weirdos, cinema, the synthesizers... all were stages of the same attempt to decipher the pattern that sustains noise. A search for meaning, guided by vibrations. A life dedicated to listening.

VIII. The Pattern and the Mystery

There's a moment when wonder changes form. At first one marvels because one doesn't understand; later, because one begins to understand too much. And at that point something strange happens: the closer one gets to the limit of knowledge, the farther that limit moves.

The mystery doesn't dissolve: it refines itself. The limit recedes proportionally.

Every answer found opens a new unknown, as if the universe were an infinite melody that, when deciphered, composes another more complex one. Physics, mathematics, and music share that destiny: they don't seek to close the mystery, but to give it audible form.

Sometimes I think the universe is the most beautiful example of counterpoint: matter and energy, order and entropy, determinism and chaos interweave with the precision of a fugue. And we—these small carbon instruments—are only part of the general texture, resonating at a passing frequency.

Science teaches us to measure the cosmos, but beauty lies in what we cannot measure: that sensation of infinite proportion, of harmony that escapes as soon as we think we've captured it.

That's why curiosity never ends. Every time reason advances one step, poetry retreats two, and between both they trace the choreography of human understanding.

The Place of the Artist-Researcher

Sometimes I wonder if art and science aren't, in reality, the two hemispheres of the same cosmic mind. One explores the measurable, the other the imaginable. The artist and the physicist share the same gaze, only they use different languages to describe the same tremor.

The musician translates vibration into emotion. The mathematician, into relation. The physicist, into law. The philosopher, into question.

And all, at bottom, kneel before the same thing: the immensity of what they still don't understand.

The Moving Limit

Today I know that to understand is not to close, but to open. That knowledge doesn't kill magic: it transforms it. Every discovery expands the mystery, like a note that expands until it dissolves into another higher one.

Perhaps that's why we keep looking at the sky, following the traces of the ancients, trying to decipher in the stars the same geometry that inhabits a well-written melody.

And while the limit recedes, we advance, guided by the echo of a question that never ceases: why does everything vibrate? and what does it mean that we vibrate with it?

IX. The Music of Chance

When I tried to understand the universe with the same tools with which I understood music, I discovered something disconcerting: the laws of the cosmos resemble a score more than a text. They're not closed instructions, but evolving probabilities, relationships that rewrite themselves as reality unfolds.

Sound had taught me that precision doesn't exclude mystery; physics revealed to me that indeterminacy doesn't exclude order. Thus I arrived at the idea of a stochastic cosmology: a universe that behaves like a symphony of fluctuations, where harmony emerges from the unpredictable.

Music had prepared me to accept uncertainty, to recognize that between silence and noise there are intermediate zones where form suggests itself before existing. In nature the same thing happens: chaos generates structure, chance sustains stability.

The Space for Thought

In trying to formalize that intuition I sought a mathematical place flexible enough to contain it. Hilbert space was my first refuge: a place where everything can coexist, projecting itself in harmonic relationships. It was the perfect metaphor for thought: every idea is a projection onto another.

But I soon understood that the universe doesn't behave like a perfectly positive and defined space. Limits are irregular, reality curves, contradicts itself, vibrates in opposite directions. Hilbert was beautiful, but insufficient.

Then appeared the alternative: Krein space, an extension where relationships can be indefinite. That irregularity wasn't a defect: it was the condition of the real world. Complex phenomena don't inhabit clean geometries; they need zones where positive and negative coexist, like two octaves that merge in the same resonance.

The Language That Returns Wonder

That transition, from Hilbert to Krein, was like moving from equal temperament to natural temperament: a liberation. Mathematics ceased to be rigid to become organic, capable of housing the fluctuations that previously escaped.

I understood that there's no single way to describe the cosmos, just as there's no single possible tuning for sound. Reality, like music, requires modulation.

The universe isn't a finished symphony, but a statistical improvisation: a melody that corrects itself, a pattern that dissolves and reappears with another rhythm.

The Echo of Uncertainty

Thus I arrived at the edge where physics becomes philosophy. Order and chance ceased to be opposites: they revealed themselves as complementary. The cosmos doesn't seek stability: it seeks persistence in variation, a form of identity that survives fluctuation.

And in that incessant movement—where equations become music and music becomes equation—I understood that the beauty of the universe resides, precisely, in that its limit recedes proportionally.

X. The Impossible Figure

Sometimes, when theory becomes too exact, it needs a crack. A breath. A space where reason permits itself to imagine what it still cannot prove. Thus are born impossible concepts: hypothetical particles that travel faster than light, dimensions rolled up like vibrating strings, mirror universes. Mathematical fictions that don't deny reality, they expand it.

Among all of them, the idea of the tachyon was irresistible to me. A hypothetical particle capable of traveling faster than light. Not an observable body, but a logical consequence of relativistic equations when pushed beyond their usual domains.

The Echo of Imaginary Numbers

Since childhood I was intrigued by numbers that couldn't be seen. When I discovered that "imaginary" in mathematics doesn't mean unreal, but complementary, I understood that science also has its poetry. Imaginary numbers were born as a solution to the impossible: they allowed extracting roots from negative values and, in their time, were seen as logical sacrilege.

Today they sustain a good part of the world: electricity, quantum computing, digital sound, everything depends on that "fantasy" that someone once dared to write.

The tachyon is, in a certain way, the imaginary number of physics: a symbolic extension that allows exploring what happens if spacetime curves beyond the limit of light.

Faster Than Certainty

In theory, a tachyon doesn't decelerate, it accelerates. The more energy it loses, the faster it becomes. That paradox makes it the perfect metaphor for human knowledge: the more we understand, the farther we move from certainty. Every answer reduces the mystery's energy, but the mystery moves faster than us.

The tachyon embodies that infinite pursuit. It's not an object, but a question. Its existence—real or not—reminds us that physics doesn't only describe: it also imagines.

The Hypothetical Resource

As my theoretical explorations advanced, I understood that the hypothetical isn't a weakness of thought, but its breathing. Impossible ideas function as instruments of language expansion. If reality doesn't fit in our equations, then the equations must grow.

Science and art share that courage: imagining what doesn't yet exist to make it thinkable. Tachyons, dreams, impossible chords... all inhabit the same space: that where the mind defies the speed of light to reach what still has no name.

XI. The Color of Noise

Absolute silence doesn't exist, but pure noise doesn't either. In that interstice dwells reality.

White noise—that undifferentiated sea of frequencies—is an abstraction, an ideal limit. Uniform, without memory, without history. Seemingly perfect... but boring, unreal. Nothing in nature vibrates like that. Not air, not water, not the brain.

Reality, like good experimental music, is made of colored noise: frequencies that preserve traces of the past, correlations, internal rhythms, slopes. Each color of noise (pink, brown, blue, violet) represents a different form of organization: a statistical signature of the world.

The Nuance That Colors

In white noise, all frequencies have equal power. In colored noise, a small adjustment redistributes that energy. That nuance gives "tone" to chaos. When the balance is right, pink noise appears, the most similar to nature and the human brain: balance between memory and novelty. Brown noise sounds softer, almost melodic.

In experimental music, this adjustment is like the composer's emotional intention: it determines whether the sonic universe will be tense or relaxed, nervous or contemplative. The nuance colors the experience. And with it, noise ceases to be a residue: it becomes texture, form.

The Geometry of Spacetime

But the idea of color doesn't belong only to sound. Spacetime can also be "colored" if its curvature leans in a certain way. The cosmos doesn't vibrate with white noise—that would be unbearable—but with gently colored noise, a mixture that allows structure without rigidity, movement without rupture.

In that geometry, events aren't isolated points, but fluctuations with memory. And each of them obeys a delicate balance between diffusion and attraction: the tendency toward disorder and the tendency toward order, simultaneously.

The Flow of Probabilities

It can be imagined as a river of possibilities that evolves in time, influenced by ordered currents and by chance. It describes how a cloud of possible states moves, expanding or concentrating according to invisible forces.

The solution isn't a fixed point, but a distribution of options: a statistical symphony that changes with time. There, at that frontier between the predictable and the random, the universe behaves like a living composition.

Noise as Raw Material

Understanding noise is understanding the cosmos's breathing. There's no particle without fluctuation, no thought without neuronal noise. Noise isn't the enemy of form, but its seed. Life itself is a colored pattern: enough order to persist, enough chaos to evolve.

XII. Diffusion, Entropy, and Meaning

That flow of probabilities doesn't describe only particles: it describes life itself. Every cell, every thought, every decision we make is the result of a distribution of possibilities in motion. We are matter that diffuses under the influence of an invisible field, flowing between order and noise.

The universe also behaves this way: it doesn't evolve deterministically, but statistically, as if every atom obeyed a score of probability.

Entropy isn't the enemy of meaning; it's its condition of possibility. Only what can disperse can organize itself. Disorder doesn't destroy information: it transports it. That's why the universe doesn't seek perfect equilibrium, but dynamic persistence, a form of coherence that survives change.

Diffusion of Memory

In complex systems, equations aren't enough: memory appears. Matter remembers. Not in the human sense, but as statistical history: every future state depends, partially, on the past. That temporal trace is the first sign of the living.

In organisms, that memory becomes structure; in brains, consciousness; in society, culture. Each level of complexity accumulates traces of the previous and reorders them to anticipate the next noise.

We could say that consciousness is a flow of probability with memory, a river that remembers itself, a wave that preserves information about its previous form while continuing to diffuse in time.

Self-Awareness: The Observer's Feedback

The qualitative leap occurs when the system not only remembers, but perceives itself. When the cloud of possibilities includes its own position. In that instant, the observer and the observed are confused: the particle becomes witness to its own trajectory.

There is born self-awareness: the capacity of a system to model its own dynamics, to anticipate and correct itself. From music, it could be seen as a melody that listens to its own echo and reinterprets itself.

That feedback, minimal but crucial, generates meaning. Meaning isn't an attribute of things, but a consequence of perception's recursivity. The universe, by observing itself, reorganizes itself. And we are the instrument of that self-observation.

The Valley of Resilience

All this architecture—noise, memory, consciousness—doesn't lead to stillness, but to the intermediate valley where chaos and calm compensate each other. There, systems survive the excess of entropy and the excess of order. Too much chaos destroys; too much stability, extinguishes.

That valley—the Valley of Resilience—is the point where the universe preserves itself without repeating, where life persists because it learns to vibrate between disorder and structure. In that equilibrium is formed everything that lasts: a cell, a symphony, an idea, a galaxy.

And it's there where this first exploration of Stochastic Cosmology ends, or perhaps begins: a vision of the cosmos not as machine nor as miracle, but as a resonant system that remembers, fluctuates, and survives.

Epilogue The Boy and the Equation

I return to the beginning. A six-year-old boy in front of an upright piano, a teacher in a suit with a cane, a simple phrase:

"Music is the art of properly combining sounds in time."

Nothing more. But in that minimal definition there was a hidden universe. The boy heard it and, unknowingly, transformed it into intuition. An intuition without signs, without letters, without notation: only the certainty that order produces emotion, that time can be organized, that sound has structure.

Then came the years, the instruments, the computers, the friends, the rehearsals, the successes, the errors. And among all of them, the echo of that phrase kept growing, expanding like a wave that never fades. The boy became a musician, the musician became a thinker, and the thinker—without ceasing to be a boy—began to suspect that all of it was part of the same phenomenon: the universe's attempt to hear itself.

For an instant, the decades fold. Everything happens at once: Arsenio's classroom without classroom, the laboratory's cables, colored noise, the fluctuations that model chance, the memory that remembers its own form, the valley where chaos and calm balance.

And then the intuition returns, no longer as suspicion, but as evidence. The boy looks at his life compressed in an instant and understands: each note, each decision, each error and each discovery have been variations of the same function. The entire universe seems to respond to a structure that breathes, diffuses, remembers.

What if this is a law?

Ernesto Cisneros Cino

Glossary of Key Concepts

Stochastic Cosmology. A way of thinking about the universe not as a rigid mechanism, but as a system influenced by fluctuations and chance, where structure emerges from the unpredictable.

Hilbert Space. Useful metaphor: a very orderly mathematical "room" where states coexist with positive and clear rules; ideal for describing quantum systems.

Krein Space. More flexible version of the previous: admits relationships with "variable sign." Serves to model phenomena with unstable zones without breaking global coherence.

Pseudo-Hermiticity. Technique for working with non-standard operators while preserving "real" physical results. Like tuning an instrument in an unconventional way to make it sound good.

Tachyon (Tachyonic Mode). Hypothetical particle "faster than light" used as a conceptual tool to explore instabilities; comparable, in spirit, to imaginary numbers.

Ornstein-Uhlenbeck Noise. "Colored" noise with short memory: not pure chance, it tends to return to an average. Useful for modeling plausible fluctuations.

Gibbons-Hawking Temperature. Effective temperature associated with expanding spacetime; connects cosmic geometry with background "noise."

PT Symmetry. Combines mirror (parity) and time inversion. Even in unconventional dynamics, it can sustain stable behaviors.

Fokker-Planck Equation. Describes the evolution of a cloud of probabilities under forces and chance; mental image: how smoke disperses with air currents.

Valley of Resilience. Intermediate zone where a system is stable without becoming rigid; enough order to persist and enough variation to adapt.

Memory Scale. Time during which a system "remembers" its state; too much memory freezes it, too little disintegrates it.

Oscillatory Frequency. Natural rhythm of a system; its dialogue with memory determines whether there will be stability, drift, or outbreak of variability.