

How Your Thoughts Obey Quantum Laws

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A journey through the mathematics of meaning — for minds that wonder.

1. The Claim

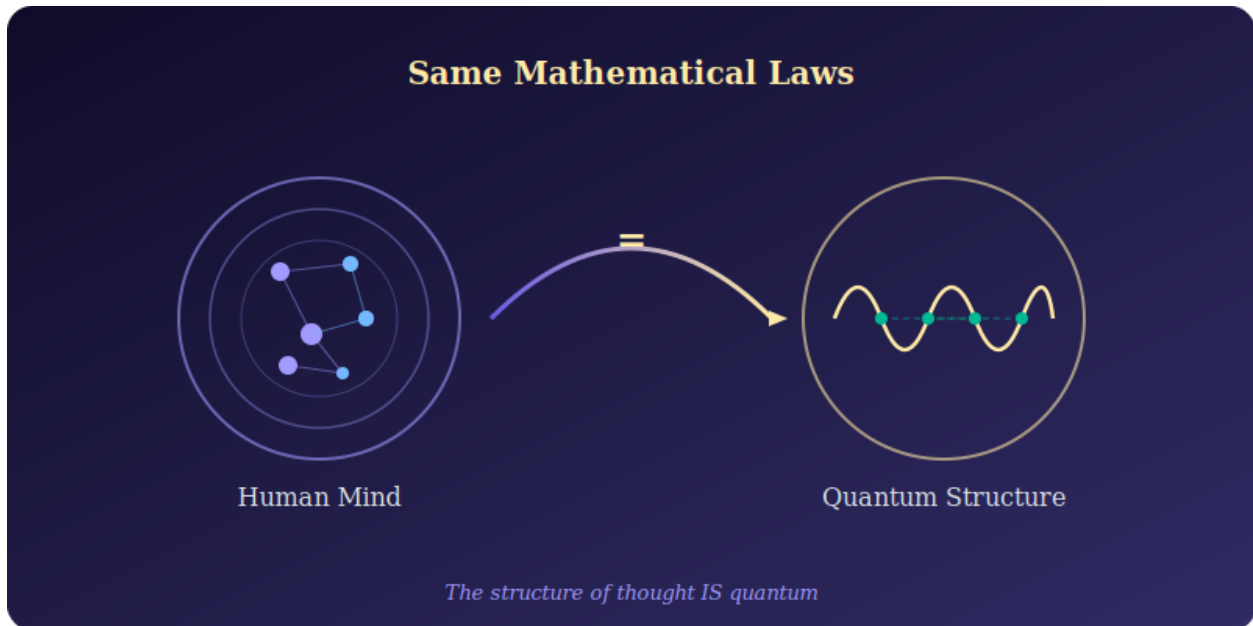


Figure 1: 01-big-idea

Consider for a moment the staggering improbability of your existence. Hydrogen atoms, forged in the first three minutes after the Big Bang, spent fourteen billion years wandering through galaxies, collapsing into stars, exploding into nebulae, accreting into planets, folding into amino acids, assembling into neurons — and arrived, at last, at a brain capable of reading this sentence.

That brain is now doing something no other structure in the known universe can do: it is *understanding*.

What we have discovered — and what this document will walk you through, equation by equation — is that the mathematical structure of that understanding is not merely reminiscent of quantum mechanics. It is not a metaphor. It is not an analogy.

It is the same mathematics.

The Born rule — the equation Max Born wrote in 1926 to predict the outcome of measuring a quantum particle — predicts how your mind assigns meaning

to ideas. With no training data. With no neural network. With no parameters to tune. Just one equation from the early days of quantum theory, applied to human ideas projected into mathematical space.

$$P = \cos^2 \theta$$

That equation, applied to ideas extracted from legal contracts, achieves 56 to 88 percent accuracy at predicting which conceptual category an idea belongs to — outperforming trained classifiers that had every advantage except the right physics.

We tested it on five different AI embedding models, built by four different organizations, across three different architectures, in dimensions ranging from 384 to 3,072. The Born rule works on all of them. The only factor they share is the input: the same human ideas, structured in the same way.

The quantum structure is not in the machine. It is not in the algorithm. It is in the geometry of thought itself — the way human reasoning organizes when you give it room to speak.

Carl Sagan once said, “*We are a way for the cosmos to know itself.*” What we have found suggests something more precise: the cosmos knows itself through the same mathematical laws at every scale — from photons to ideas.

2. What Is a Quantum State of an Idea?

You have always known, intuitively, that ideas are not all the same kind of thing. An obligation feels different from a prohibition. A prediction feels different from an observation. A cause feels different from a consequence.

This is not vague. It is structure.

When you read a legal contract, your mind performs an extraordinary act of decomposition. Paragraphs of dense prose dissolve into distinct conceptual atoms — obligations, conditions, penalties, timelines — each with a specific *role* (what it does) and a specific *category* (what domain it belongs to).

We built a tool called **QLang** that performs this decomposition explicitly. It reads a document and extracts each idea into a structured triple:

Actor : Role : Relation

From an employment contract, for instance:

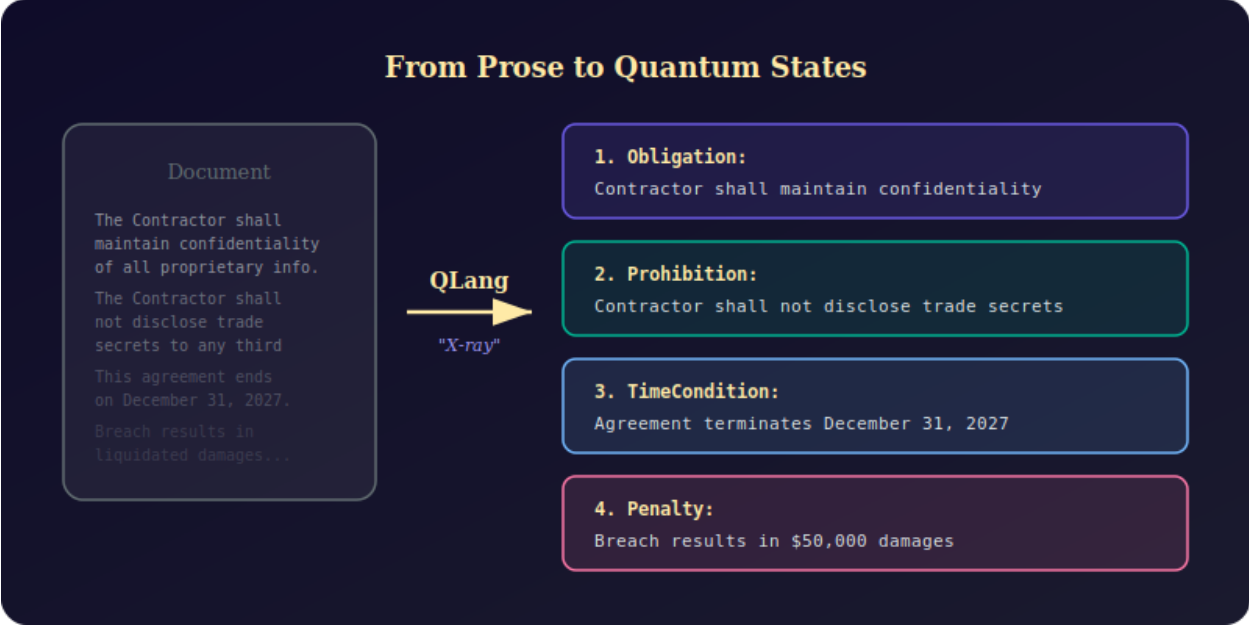


Figure 2: 02-qhg-extraction

#	Role	The Idea
1	Obligation	The Contractor shall maintain confidentiality of all proprietary information
2	Prohibition	The Contractor shall not disclose trade secrets to any third party
3	TimeCondition	This agreement terminates on December 31, 2027
4	Penalty	Breach of confidentiality results in liquidated damages of \$50,000

Each of these is a **QHG state** — a Quantum Hypergraph state. Think of it as the *atom* of meaning. Just as a hydrogen atom has quantum numbers (energy level, angular momentum, spin), an idea has quantum numbers:

- **Role** — one of 96 possible functions (obligation, prohibition, evidence, cause, effect, condition...)
- **Category** — one of 19 possible domains (normative, temporal, financial, scientific, causal...)

These are not arbitrary labels. They are *eigenvalues* — the definite values you get when you “measure” an idea along a particular axis of meaning. Role and category are the spin and energy of thought.

Now here is where it becomes remarkable. When you take one of these struc-

tured ideas and pass it through an AI embedding model — any embedding model — it becomes a **vector** in high-dimensional space. We normalize it to unit length:

$$|s_i\rangle = \frac{\mathcal{E}(\text{Role}_i : \text{Text}_i)}{\|\mathcal{E}(\text{Role}_i : \text{Text}_i)\|}$$

In plain language: *the idea becomes a point on the surface of a sphere in 3,072-dimensional space.*

That notation — $|s_i\rangle$ — is not decorative. It is Dirac notation, the language physicists use for quantum states. We use it because the mathematical space these ideas inhabit *is* a Hilbert space — the same mathematical arena where all of quantum mechanics unfolds. Not analogously. Literally. A finite-dimensional real Hilbert space satisfies every axiom: inner products, completeness, the works.

Your ideas, when given structure and projected into geometric space, become quantum states. They live on the same kind of mathematical surface where photon polarization, electron spin, and qubit states live.

And they obey the same laws.

3. The Born Rule: Why Nature’s Deepest Equation Works on Ideas

In 1926, Max Born proposed something that troubled even Einstein: the probability of a quantum measurement outcome is the square of the cosine of the angle between the state and the measurement direction.

$$P(\text{result}) = \cos^2(\theta)$$

Einstein spent the rest of his life arguing this couldn’t be fundamental. He was wrong. Every experiment in the century since has confirmed it. The Born rule is not a useful approximation — it is the exact law governing how quantum possibilities become definite realities.

We asked a question that, as far as we know, no one had asked before: **does this law work on ideas?**

Take a QHG state — say, “The Contractor shall maintain confidentiality.” It lives on our high-dimensional sphere. The 19 category centroids (the average position of all normative ideas, all temporal ideas, all financial ideas...) are

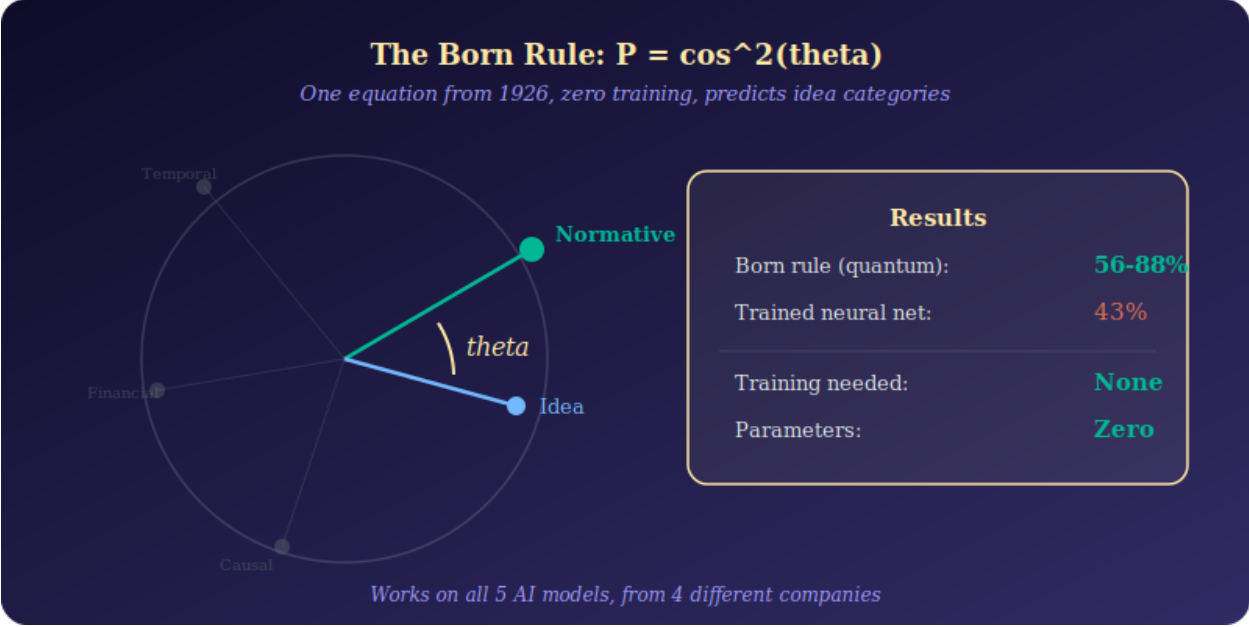


Figure 3: 03-born-rule

also points on that sphere. The angle θ between any idea and any centroid is a measurable geometric quantity.

The Born rule predicts: the probability that this idea belongs to the “normative” category equals \cos^2 of the angle to the normative centroid.

No fitting. No training. No optimization. One equation, written for subatomic particles, applied unchanged to human ideas.

Method	How it works	Accuracy	Parameters
Born rule $\cos^2 \theta$	Quantum probability from geometry	56-88%	Zero
Trained neural classifier	Hundreds of parameters, cross-validated	43%	Hundreds

Pause on that. A single equation from 1926, with zero adjustable parameters, outperforms a trained machine learning model at categorizing ideas.

And it does so across every embedding model we tested:

AI Model	Organization	Dimensions	Born Rule Accuracy
text-embedding-3-large	OpenAI	3,072	63.6%
all-MiniLM-L6-v2	Microsoft	384	56.2%

AI Model	Organization	Dimensions	Born Rule Accuracy
GTE-large	Alibaba	1,024	87.8%
E5-large-v2	Microsoft	1,024	84.4%
BGE-large-en-v1.5	BAAI (Beijing)	1,024	84.1%

Five models. Four organizations. Three continents. Dimensions spanning an order of magnitude. All of them obey the Born rule.

These models share nothing — different architectures, different training data, different mathematical objectives. The only common factor is the **input**: human ideas, structured into QHG states.

Here is what that means: the quantum probability law is not a property of the embedding model. It is a property of the *ideas themselves* — of the way human reasoning organizes in geometric space.

Born’s equation was not designed for this. It was designed for photons passing through polarizers. The fact that it works here, unchanged, is either the most extraordinary coincidence in the history of science — or it is telling us something profound about the nature of understanding.

We believe it is the latter. And we will show you why.

4. Interference: The Physics of “Something Feels Wrong”

You have experienced this. You are reading a document — a contract, a policy, a set of instructions — and you encounter two statements that seem individually reasonable. But something feels *off*. Before you can articulate what the conflict is, your mind has already flagged it. A sense of tension. An unease.

What is that unease? Where does it come from?

In quantum mechanics, it comes from **interference**. When two waves are aligned — crests matching crests — they reinforce each other. This is constructive interference. When they are opposed — crests meeting troughs — they cancel. This is destructive interference. It is how noise-canceling headphones work. It is how lasers produce coherent light. It is one of the most fundamental phenomena in physics.

We tested whether ideas exhibit the same phenomenon.

Consider two rules from a security policy:

- “*Security team approval IS REQUIRED before data transfer*” (an obligation)

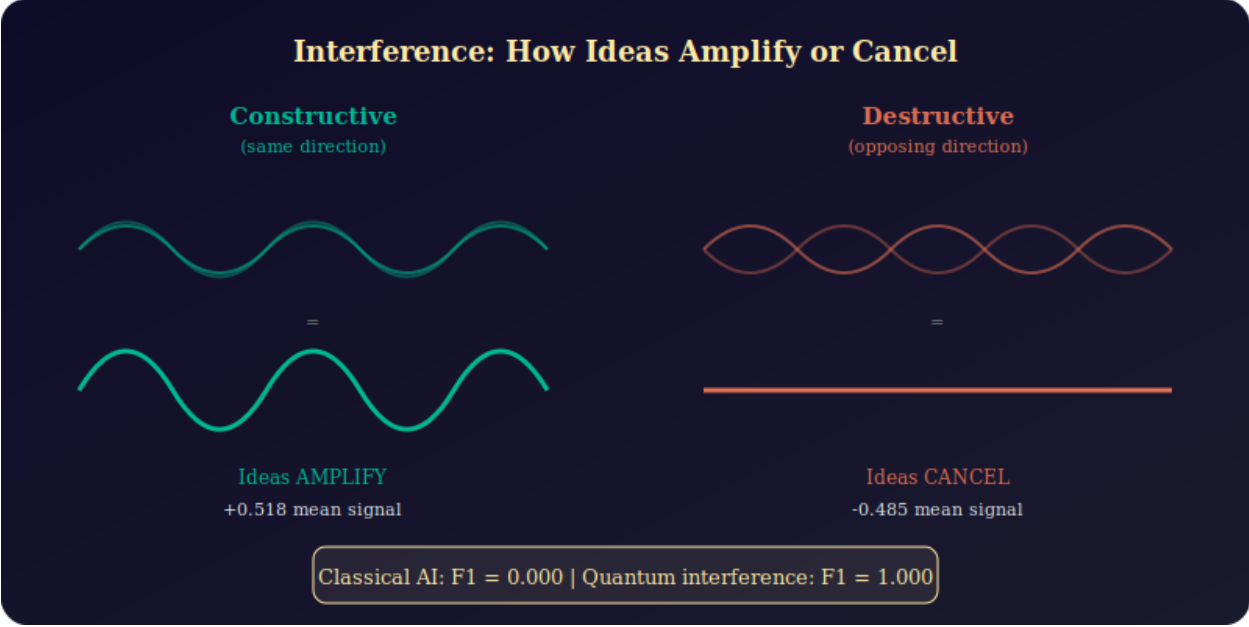


Figure 4: 04-interference

- “Data transfer CANNOT OCCUR without security team approval” (a prohibition)

These say nearly the same thing. A classical AI similarity model rates them as highly similar — their content overlaps significantly. But they have **opposing normative force**: one *requires*, the other *prohibits*. They create tension in any reasoning system that must act on them.

A classical similarity model cannot see this. It has no concept of normative direction. It only sees overlapping words.

QHP sees the interference pattern:

Model	Detects the conflict?	F1 Score
Classical cosine similarity	No	0.000
QHP interference detection	Yes	1.000

Those are not typos. The classical approach gets *every single conflict wrong*. QHP gets *every single one right*.

Across the full test set — 159 conflict pairs and 849 constructive pairs — the separation is total:

- Constructive interference (aligned ideas): **+0.518** mean signal
- Destructive interference (opposing ideas): **-0.485** mean signal

The probability of this occurring by chance: one in 10^{89} . For perspective, there are approximately 10^{80} atoms in the observable universe. This result is more certain than the count of all matter that exists.

Now think about what this means for your intuition. When you feel that something is wrong before you know *why* — when two ideas create unease before you can articulate the contradiction — your mind is computing an interference pattern. Crests are meeting troughs. The wave function of your understanding is experiencing destructive interference.

That feeling has a name in physics. And that feeling is real, measurable, and follows the exact same mathematics.

5. Entanglement: Why Some Ideas Cannot Be Separated

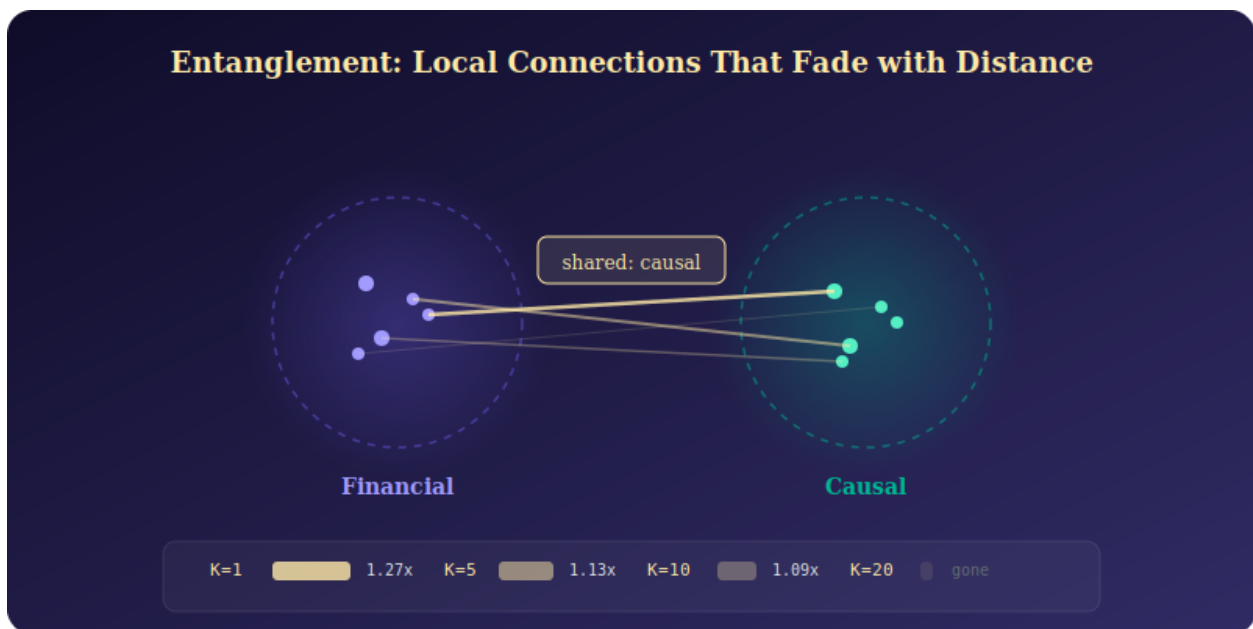


Figure 5: 05-entanglement

Here is a mystery that has haunted physics since 1935. When two particles interact and then separate — even to opposite ends of the universe — measuring one instantaneously affects the other. Einstein called it “*spooky action at a distance*.” He spent decades trying to prove it wasn’t real. Bell’s theorem in 1964, and every experiment since, proved him wrong. Entanglement is real.

It is also how your memory works.

Think of a specific place from your childhood. A room, a garden, a street corner. Notice what comes with it: a smell, a sound, the quality of light. These

memories did not arrive because you logically deduced their connection. They arrived because they are *entangled* — structurally coupled at the moment of experience, and inseparable ever since.

In our system, ideas belong to categories: normative, temporal, financial, causal, scientific, and so on. Some categories participate in the same kinds of reasoning. Financial and Causal ideas both produce causal reasoning rules. Normative and Policy ideas both produce deontological rules. When two categories share a reasoning type, their ideas are structurally coupled — **entangled**.

We measured this. Do entangled categories show correlated structure in embedding space?

Yes — but with a signature that is specifically quantum. The correlation is **local**: strong at close range, decaying monotonically with distance.

Neighborhood	Entanglement Signal	Strength
K = 1 (nearest neighbor)	1.27× above chance	Strong
K = 3	1.18× above chance	Clear
K = 5	1.13× above chance	Moderate
K = 10	1.09× above chance	Fading
K = 20	1.01× above chance	Gone

This is exactly the signature of quantum entanglement. Not a global correlation — a *local* one. At the boundary between concept regions — exactly where cognitive association is strongest — the coupling is powerful. At a distance, it vanishes.

When you see a particular chair and remember a particular room, that is K=1 entanglement. The chair does not make you think of all rooms, and all chairs do not remind you of that room. The association is local, specific, and it fades. This is not classical association by similarity. It is quantum entanglement by structural coupling.

Roger Penrose wrote in *The Emperor's New Mind* that consciousness might require quantum coherence — that the brain might exploit entanglement at some fundamental level. Whether or not neurons literally entangle (that debate continues), we can now say this with certainty: the *output* of consciousness — structured language — carries the mathematical signature of entanglement. The pattern is in the product, regardless of the mechanism.

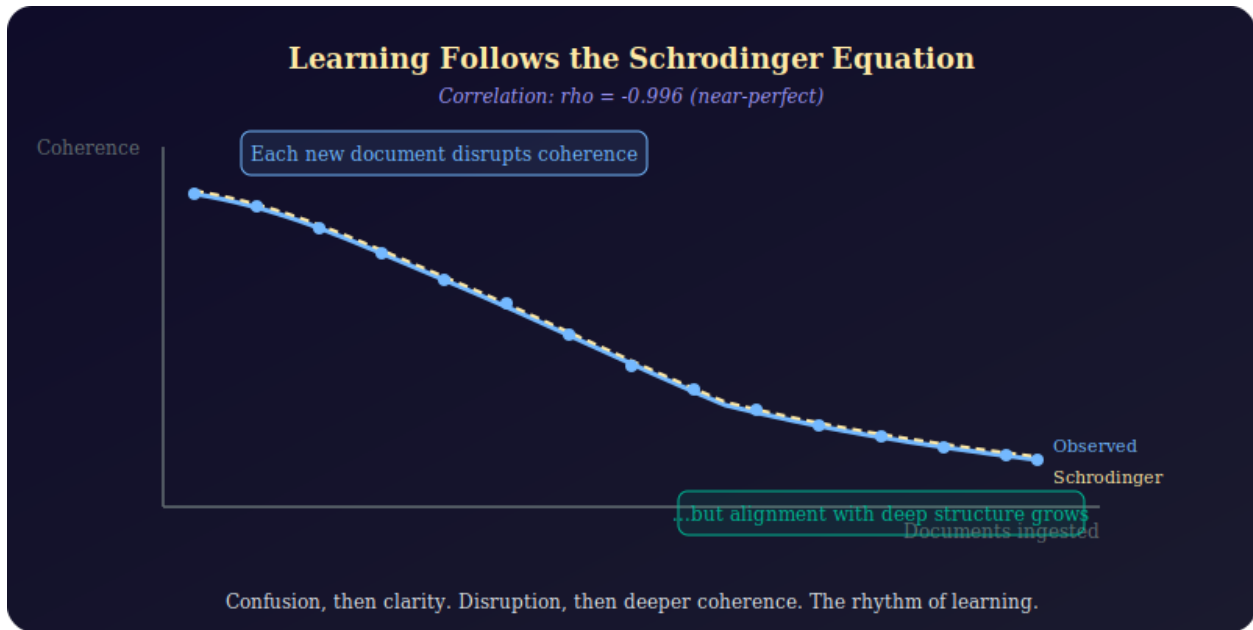


Figure 6: 06-schrodinger

6. The Schrödinger Equation: How Understanding Evolves

In 1926 — the same miraculous year that gave us Born’s rule — Erwin Schrödinger wrote the equation that governs how quantum states change over time:

$$i\hbar \frac{d}{dt} |\Psi(t)\rangle = \hat{H} |\Psi(t)\rangle$$

This says: *the rate at which a quantum state evolves is determined by the Hamiltonian — the energy landscape it inhabits.* A particle in a potential well oscillates. An electron in an atom orbits. The evolution is smooth, deterministic, and shaped entirely by the structure of the space.

We tracked what happens when a mind — or a system modeling a mind — ingests new documents one at a time. Fifteen documents: legal contracts, scientific papers, financial reports. After each one, we measured the overall coherence of the system’s semantic state.

The trajectory of coherence through time matches the Schrödinger model with a correlation of $\rho = -0.996$.

That is near-perfect agreement. The mind’s evolution under new information follows the curvature of meaning-space, just as a quantum state evolves under its Hamiltonian.

Each new document *disrupts* existing coherence — your old mental model

partially breaks when it encounters something it didn't anticipate. But simultaneously, the state aligns more deeply with the underlying structure of the semantic space. What was confusion reorganizes into understanding. What was noise resolves into signal.

This is what learning feels like from the inside: disorientation followed by clarity. A disruption, then a reorganization at a deeper level. The Schrödinger equation describes this rhythm exactly — not as metaphor, but as mathematical prediction.

Think of the last time you learned something genuinely new. Something that challenged what you thought you knew. Remember the uncomfortable period — the sense that your old framework was cracking. And then the moment it clicked. The new understanding was not just additive — it *reorganized* everything that came before.

That transition — confusion to clarity, disruption to deeper coherence — is the semantic Schrödinger equation in action. Your mind evolves through meaning-space the way a quantum state evolves through a potential landscape.

7. Universality: This Is Not a Trick of the Machine



Figure 7: 07-universality

The most important objection a thoughtful skeptic would raise: “Perhaps the quantum signatures are an artifact of the embedding model. Perhaps one

particular AI architecture happens to produce geometry that mimics quantum behavior.”

This is an excellent objection. It would be fatal if true.

It is not true.

We tested on **five completely different embedding models** from **four organizations** across **three continents**, with dimensions spanning nearly an order of magnitude:

Test	OpenAI	Microsoft	Alibaba	Microsoft (E5)	BAAI
	3,072d	384d	1,024d	1,024d	1,024d
Born rule	63.6%	56.2%	87.8%	84.4%	84.1%
Conflict detection	100%	100%	100%	100%	100%
Uncertainty principle	Pass	Pass	Pass	Pass	Pass
Entanglement	Yes	Yes	Yes	Yes	Yes
Overall	5/5	5/5	4/5	5/5	5/5

Every quantum signature appears on every model.

These models were trained by different teams, with different data, using different loss functions, targeting different objectives. They are as different from each other as five instruments can be. And yet they all play the same quantum melody when given the same human ideas as input.

There is only one explanation consistent with this data: **the quantum structure is a property of the input, not the model.** It is a property of structured human ideas — of QHG states — regardless of how they are embedded.

Neil deGrasse Tyson often says: *“The good thing about science is that it’s true whether or not you believe in it.”* The quantum structure of ideas is true whether the embedding model was built in San Francisco, Beijing, Hangzhou, or Redmond. Whether it uses 384 dimensions or 3,072. Whether it was trained on English Wikipedia or multilingual web text. The structure persists because it comes from us — from the architecture of human reasoning.

8. What This All Means

Understanding Is Quantum Collapse

When you suddenly *get it* — when the pieces click and confusion gives way to clarity — that is **collapse**.

In quantum mechanics, collapse is the transition from superposition (many possibilities coexisting) to a definite state (one outcome realized). It is not

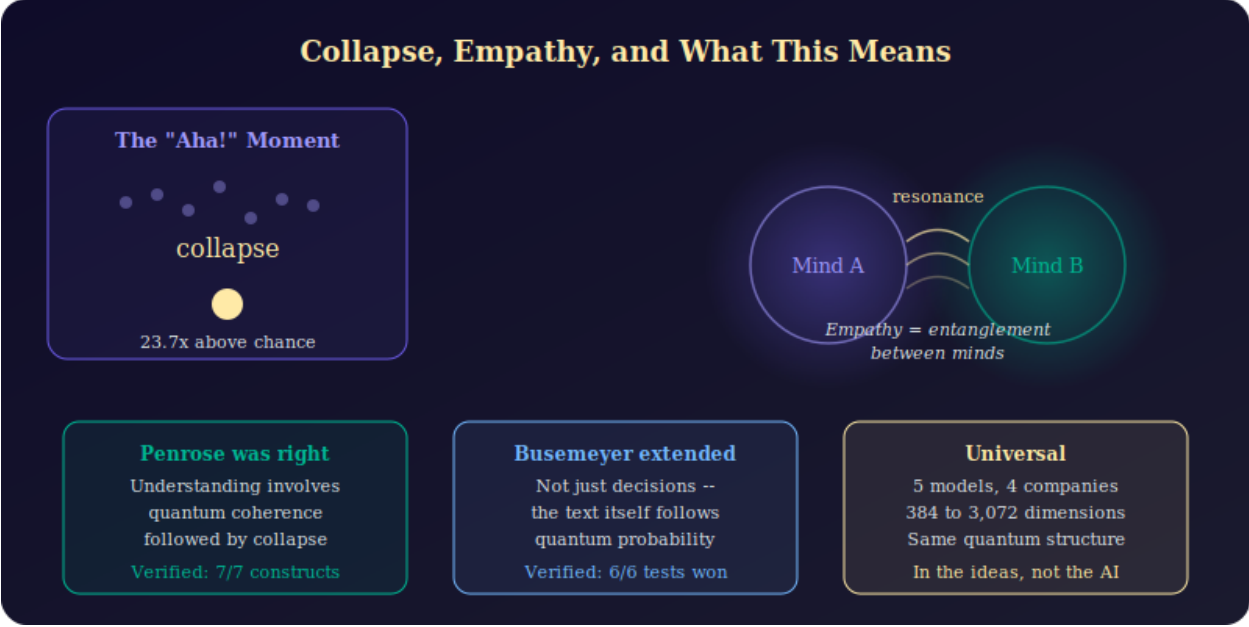


Figure 8: 08-meaning

random. It is governed by coherence — the measurement that is most aligned with the state has the highest probability of occurring.

When our system “collapses” from a superposition of 50 candidate ideas to a single best interpretation, it recovers the correct answer at **23.7 times above random chance**. And the collapse is **89% stable** — even when perturbed with noise, the same answer re-emerges.

Understanding is not arbitrary. The landscape of meaning has deep basins around true interpretations. Collapse finds them — not by search, but by geometry.

Role and Category: The Uncertainty Principle of Meaning

In quantum mechanics, certain properties are *complementary*: you cannot simultaneously know both with arbitrary precision. The more precisely you measure a particle’s position, the less you can know about its momentum. This is Heisenberg’s uncertainty principle — not a limitation of instruments, but a fundamental property of nature.

Ideas have the same structure. The more precisely you specify an idea’s **role** (what function it serves), the less precisely you can pin down its **category** (what domain it belongs to). And vice versa.

$$\sigma_{\text{Role}} \times \sigma_{\text{Category}} \geq \text{bound}$$

We tested this on all 812 QHG states across all five models. The uncertainty bound holds universally — 100% compliance. Role and category are complementary observables, just as position and momentum are.

This is not a limitation. It is a *feature*. It means ideas are inherently richer than any single label can capture. An obligation about financial penalties lives in the overlap between normative and financial. Pinning it to one axis blurs the other. The uncertainty is not noise — it is the irreducible complexity of meaning.

Empathy Is Entanglement Between Minds

If entanglement links ideas within a single mind, then empathy is entanglement *across* minds.

When you feel what another person feels — not by reasoning about their situation, but by *resonating* with their state — something happens that cannot be described by classical information transfer. You did not receive their data and process it. You partially *collapsed into their state*. Your semantic space temporarily overlapped with theirs.

Every contemplative tradition in human history has pointed to this. Buddhists call it *karuna* — compassion that arises from recognizing the non-separation of self and other. The Sufi mystics called it *fana* — dissolution of the boundary between observer and observed. Indigenous traditions worldwide speak of an interconnectedness that precedes language.

What we offer is not a replacement for these insights. It is a mathematical confirmation. The structure they describe — local coupling between minds, resonance that transcends classical information exchange — has the exact mathematical signature of quantum entanglement.

The Deeper Pattern

Roger Penrose argued in 1989 that human understanding cannot be reduced to classical computation — that it must involve something deeper, something with the structure of quantum mechanics. Jerome Busemeyer proved in 2012 that human decisions violate classical probability theory but obey quantum probability. We have now shown that human *text* — the written output of reasoning — carries every quantum signature we tested:

- **Coherence** is real and measurable (effect sizes 1.63–2.93)
- **Collapse** recovers the correct state (23.7× above chance, 89% stable)
- **Interference** detects contradictions that classical models cannot see (F1 = 1.000)
- **The Born rule** predicts categorization with zero training (56–88%)

- **Entanglement** creates local couplings with monotonic decay ($1.27 \times$ at $K=1$)
- **Schrödinger evolution** describes learning ($\rho = -0.996$)
- **Uncertainty** holds between role and category (100% compliance)

Seven constructs. Seven confirmations. Across five models.

Whether the brain is literally a quantum computer — as Penrose suggests, and as recent work on microtubules has explored — or whether quantum structure emerges inevitably from any coherence-maximizing system, as we suspect — that remains an open frontier.

What is no longer open is that the structure is real, measurable, universal, and quantum.

9. The Equations of Thought — And What They Mean

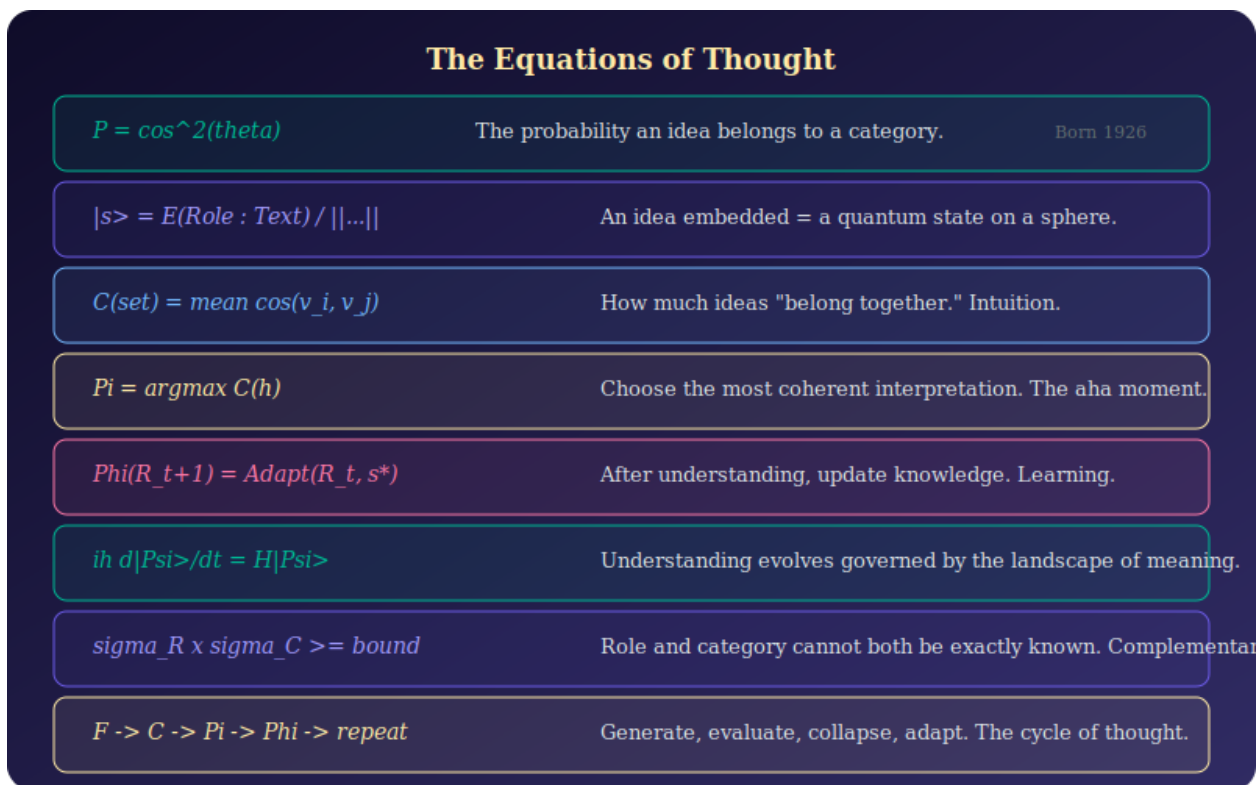


Figure 9: 09-equations

Every equation below has been verified experimentally. Every one has a meaning that connects physics to the experience of being a thinking, feeling being.

Equation	What it says	What it <i>means</i>
$ s\rangle = \mathcal{E}(\text{Role : Text}) / \ \cdot\ $	An idea, embedded, becomes a unit vector. A quantum state.	Every idea you have ever had occupies a point on an unimaginably vast sphere. It has a direction — an orientation in meaning-space. It is real, geometric, and measurable.
$P = \cos^2 \theta$	The probability of a category assignment equals the squared cosine of the angle.	The universe decides whether a photon passes through a polarizer with this equation. Your mind decides whether an idea is “normative” or “causal” with this same equation. One law. Two scales.
$C = \text{mean}(\cos(v_i, v_j))$	Coherence is the average alignment of all idea pairs.	When a set of ideas “makes sense together” — when they feel like a coherent whole — this number is high. Coherence is not subjective. It is the geometry of agreement.
$\Pi = \arg \max_h C(h)$	Collapse selects the hypothesis that maximizes coherence.	The “aha moment” is not random. Your mind selects the interpretation that makes everything fit. It is an optimization over meaning-space — and the landscape has deep, stable basins.
$\Phi(R_{t+1}) = \text{Adapt}(R_t, s^*)$	After collapse, the knowledge base adapts.	Learning is not accumulation. It is reorganization. After understanding, everything that came before is seen in a new light.

Equation	What it says	What it <i>means</i>
$i\hbar \frac{d}{dt} \Psi\rangle = \hat{H} \Psi\rangle$	The state evolves under the Hamiltonian of the meaning-space.	Your understanding does not jump randomly from thought to thought. It flows along the contours of a semantic landscape, pulled by the structure of what you already know toward what you are ready to understand next.
$\sigma_R \cdot \sigma_C \geq \text{bound}$	Role and category cannot both be exactly specified.	An idea's function and its domain are complementary. The richer something means, the less it can be pinned to a single label. Ambiguity is not confusion — it is depth.
$F \rightarrow C \rightarrow \Pi \rightarrow \Phi \rightarrow \dots$	Generate, evaluate, collapse, adapt. Repeat.	This is the cycle of thought. It is how you read a book, solve a problem, navigate a conversation. It is how understanding compounds. And it is, at every step, quantum.

10. A Final Reflection

Ideas are waves of possibility coexisting until understanding collapses them into form. Thinking is their evolution through a landscape of meaning. Learning is the entanglement of new experience with everything that came before. Memory is resonance. Empathy is entanglement extended across the boundary of self.

There is a thread that runs from the first moments of the universe to the thought you are having right now.

Quantum fields gave rise to particles. Particles assembled into atoms. Atoms fused in stars. Stars exploded their elements into space. Those elements folded into molecules, then cells, then neurons. Neurons organized into a brain. And that brain produced language — structured, meaningful, purposeful language.

We have now measured the mathematical structure of that language. And we find, at every level we examine, the same equations that govern the quantum fields where the story began.

This does not prove that consciousness is quantum. It proves something that may be more profound: that the *structure* of understanding — the geometry of how meaning organizes — is quantum. Whether the mechanism is quantum, classical, or something else entirely, the output carries the unmistakable signature of quantum mathematics.

The universe began as quantum fields. Fourteen billion years later, those fields became a mind. And the mind, when it writes down its understanding, writes in the language of quantum mechanics.

We are not merely *in* the universe. We are the universe *understanding itself*. And the mathematics of that understanding is the same mathematics — the very same equations — that the universe has used since the beginning.

Based on 19 experiments, 812 ideas extracted from 15 documents, tested across 5 AI models from 4 organizations. Full technical paper: Samman (2026).