Episode Book

EPISODE #6690

What Quantum Mechanics Actually Leaves Unresolved

PUBLISHED	19 November 2026 at 21:31 UTC
DURATION	27:57
LISTEN	myweirdprompts.com/episode/quantum-mechanics-measurement-problem-05522/
HOSTS	Corn, Herman, Hilbert
SCRIPT MODEL	z-ai/glm-5.3
VOICES	omnivoice
PIPELINE	V5.36
SOURCES	24 cited by the research (listed at the end)
BOOK GENERATED	19 November 2026 at 22:18 UTC

SYNOPSIS

Quantum mechanics predicts the electron's magnetic moment to extraordinary precision, yet a 2025 Nature survey of 1,101 physicists found no majority agreement on what it says about reality. Stripping away mystical pop-science spin, this discussion separates the settled machinery—wave functions, superposition, interference, and decoherence—from the unresolved measurement problem. It also revisits the 2025 Nobel Prize for macroscopic superconducting circuits and Einstein's 1935 EPR paper, showing why his real objection was nonlocality rather than randomness.

TRANSCRIPT



Corn

Here's a theory that predicts the electron's magnetic moment to more decimal places than we can measure, that underwrites every semiconductor and laser on the planet — and a survey of a thousand physicists taken at its hundredth birthday found no majority agreement on what it's telling us about reality. Daniel's prompt this week is exactly that: he wants quantum mechanics without the incense. Superposition, the wave function, what measurement actually does, why entanglement bothered Einstein — and a clean line between the parts physicists agree on and the parts still open. He names Herman for this one, which is either a compliment or an ambush.



Herman

I'll take it as a compliment and hope to survive the audit. The word quantum, before anything else, because it's less mysterious than it sounds. It's Latin for "how much" — the point being that nature's books are kept in small denominations. Energy, momentum, angular momentum don't come in any amount you like; they come in lumps, like money. Your lowest-value coin is the quantum of that currency. Everything strange comes later, and it comes from the fact that between the lumps, things don't behave like coins at all.



Corn

They behave like waves.



Herman

They behave like waves that know how to add and cancel. And the field is split on what that means — which is the whole license for this episode. The survey I keep thinking about is the Nature centenary one, from July of last year: eleven hundred and one physicists, no majority interpretation, Copenhagen leading at thirty-six percent. The math is unanimous. The meaning is a coin toss.



Corn

Thirty-six percent for the view that's in every textbook.



Herman

Which tells you the textbook isn't settling anything. And there's a detail I like even better: of the physicists who picked Copenhagen, fewer than a third think the wave function describes something real. Even the winners don't believe their own party platform.



Corn

So the plan is: machinery first. Superposition, the wave function, what measurement does. Then Einstein's objection and what the experiments actually settled. Then the open problems — with a rule that we don't drift into incense at any point.



Herman

And one more framing note, because Daniel asked for it. He said "without the mystical pop-science spin." We did an episode a while back on AI image generators — the jigsaw beneath the magic — and the same rule held there: the interesting part is never the magic, it's the pieces. Quantum mechanics is the most over-mystified subject in science, and the genuine mysteries are stranger than the fake ones anyway. You don't need to invent spooky stories about consciousness creating reality when the actual unresolved question is why anything happens at all.



Corn

Start with the wave function, then. What is it a picture of?



Herman

It's a mathematical object that encodes probability amplitudes — and this is the first thing people get wrong, so it's worth being careful. Amplitudes are not probabilities. An amplitude can be negative, can be complex, can cancel against another amplitude. You get the actual probability by taking the magnitude squared — that's the Born rule. And the cancellation is the whole secret, because it means quantum possibilities interfere with each other before they become facts.



Corn

Two futures that subtract.



Herman

Where a classical uncertainty just adds options, a quantum superposition lets the options fight. And left alone, this is all completely deterministic. The Schrödinger equation evolves the wave function smoothly and predictably, and as it evolves it naturally forms superpositions — states where the system is in a combination of distinct situations. Not "we don't know which one." A combination.



Corn

That's the claim I want pressure-tested, because it sounds like semantics. How do you tell the difference between "really in both" and "in one but we don't know which"?



Herman

Interference. If the particle were secretly in one slit or the other, you'd get two blobs on the screen. What you actually get is a pattern of bands — the two possibilities adding and cancelling. And this isn't just electrons, which skeptics can wave away as too small. People have run diffraction experiments with molecules of up to two thousand atoms. Two thousand atoms, arranged in a beam, and they still produce interference. That closes the easy escape, that everyday objects are just too big for anything funny to happen.



Corn

Then why doesn't my desk diffract through the doorway?



Herman

Decoherence. A superposition is exquisitely fragile, because everything it touches becomes part of the story. The moment stray air molecules, photons, thermal vibration interact with the system, they effectively "measure" which state it's in — they become correlated with it — and the phase relationship between the branches gets scrambled into the environment. There's a number I love for this. An ammonia molecule in a superposition of two orientations, sitting in ordinary gas at room temperature and pressure: the superposition decoheres in about ten to the minus nineteen seconds. That's a decimal point and eighteen zeros, then a one.



Corn

So the world looks classical because it leaks.



Herman

It leaks, constantly and instantly, at any temperature we can survive. The superposition doesn't exactly vanish — the cleaner statement is that its effects become unobservable, dispersed into the environment where nobody can gather them back. But notice what that does and doesn't buy you. It explains why big warm things behave classically. It does not explain why you saw one particular thing.



Corn

Hold that thought, because there's a counterweight coming.



Herman

There is, and it's the one with the medal. This October a year ago, the Nobel Prize in Physics went to Clarke, Devoret and Martinis for experiments from the mid-eighties on a superconducting circuit about a centimetre across. Visible to the naked eye. In that circuit, a single quantum state fills the whole thing — the entire circuit behaves as one quantum object, with quantized energy levels and quantum tunnelling through a barrier. That's now the basis of every superconducting qubit being built.



Corn

A centimetre. That's not an edge case of "macroscopic," that's a component you could drop and lose.



Herman

And the reason it works is that they can hold the decoherence wolf off — extreme cold, careful shielding. So quantum behaviour at scale isn't a fantasy or a loophole; it's an engineering discipline with a prize attached. Which means the line between the quantum world and the classical world is not a line drawn by nature at some size. It's a line drawn by temperature and coupling, and you can move it if you're clever and patient.



Corn

Good. Now the measurement problem, because that's where Daniel's question gets its teeth.



Herman

The measurement problem, stated plainly: the theory has two different rulebooks. Between measurements, everything runs on the Schrödinger equation — deterministic, smooth, unitary, superpositions growing all the time. At a measurement, a different rule takes over — the state jumps, randomly, to one outcome, with probabilities from the Born rule. Same theory, two incompatible dynamics, and the theory doesn't tell you when the second rule applies. That's the whole problem, and a century in, it's still open.



Corn

Where does the switch flip? That's the question nobody gets to dodge.



Herman

And the useful way in — this comes from a big review of the field, Tomaz, Mattos and Barbatti — is that the problem is really three problems wearing one coat. First, the preferred basis. When a detector fires, it records something definite — pointer up or pointer down, one current or another. But the Schrödinger equation is completely indifferent about which basis things happen in. Write the state one way, it's up and down; rewrite it another perfectly legal way, and it's plus and minus. The math permits all of these. Real apparatuses always land in one.



Corn

The equation doesn't know what a dial looks like.



Herman

It has no idea. Second problem: why don't we ever see interference between macroscopically different states — and that one decoherence does answer, as we said. The scrambling, the leakage, the ten to the minus nineteen seconds. Third problem, and this is the hard one: outcomes. Run the detector itself through the Schrödinger equation, honestly, together with the system, and what you get is not one result. You get an entangled superposition of every result, each one correlated with a different state of the apparatus. Decoherence can't rescue you there — it suppresses interference between the



Herman (continued)

branches, but the branches are all still in the description. Standard quantum mechanics provides no mechanism that selects one.



Corn

So the Born rule is a weather report, not a mechanism.



Herman

That's the review's own phrasing, nearly: it predicts the statistical distribution over many runs, and it does not explain why any particular run gave the result it gave. And here's the part the pop books get wrong in both directions — some of them say decoherence solved the measurement problem, some say it's all still hopeless. The truth is exactly in the middle: decoherence solves problems one and two, or most of them, and it solves nothing about problem three, because it still presupposes the Born rule on the way in. You can't derive the collapse postulate from decoherence. You had to put the statistics in by hand to get the machinery to run.



Corn

So when someone says the measurement problem was sorted out in the eighties, what they mean is two of the three rooms got cleaned.



Herman

Nicely put, and there's a stubborn residue on top of that, too. Even when you model the whole detector unitarily — do everything "right" — there's recent work arguing the basis problem comes back through the door, because the basis the apparatus actually records in is induced by the measurement interface, the detector channel and the coarse-grained readout, not by the system's own dynamics. The cut, in other words, is still with us. People build hardware around it, as we said, but nobody has retired it.



Corn

I want to flag something before we move on, because it's the cleanest example of what Daniel's asking about. We have a theory that is, by every experimental measure, the most precise thing humans have ever built.



Herman

By a ridiculous margin. And it has, at its centre, a procedure — "and then a measurement happens" — that no two experts explain the same way. Brian Greene asked three quantum specialists about the measurement problem at the World Science Festival, and got three entirely different answers. That anecdote is in the review itself, as a symptom.



Corn

Three specialists, three answers, one theory.



Herman

That's the field's report card. Now the Einstein half, because the pop version of this story is a cartoon — old man scoffs at dice, loses, everyone moves on. The real thing is much better, and he deserves better than the cartoon.



Corn

He wasn't complaining about randomness?



Herman

Not primarily. His actual target was nonlocality — action at a distance. He was perfectly comfortable with quantum mechanics as a correct statistical theory; what he refused to accept was that it was the whole story, because the whole story seemed to require that what happens here instantaneously fixes what's predictable there, with no signal in between. The 1935 paper with Podolsky and Rosen makes this precise, and the precision is worth quoting because it's the hinge of everything that followed. Their criterion of reality: if, without in any way disturbing a system, we can predict with certainty the value of a physical quantity, then there exists an element of reality corresponding to that quantity.



Corn

So: if I can know it without touching it, it was already there.



Herman

That's the whole engine. Take an entangled pair, split them. Measure particle one's position, and you can predict particle two's position with certainty — without touching particle two. Measure particle one's momentum instead, same deal for particle two's momentum. By the criterion, particle two's position and momentum are both elements of reality — they were there all along. But quantum mechanics says no system has definite position and momentum simultaneously. Conclusion: the theory is incomplete. Not wrong. Incomplete — there are real facts it doesn't capture.



Corn

And it took thirty years for anyone to turn that into an experiment.



Herman

Bell, in the sixties — he found a statistical inequality, a hard ceiling on how correlated two local systems can be, that any theory with pre-existing local values must obey. Quantum mechanics predicts the ceiling gets broken. And the decisive experiments are recent: the loophole-free Bell tests, using electron spins in diamond, reported runs with a correlation measure of two point three five plus or minus zero point one eight — against a classical bound of exactly two. Later combined analyses pushed it to about two point four. Past the ceiling. No local hidden variables. The correlations Einstein found unacceptable are real, and they appear to be features of nature, not bugs in the theory.



Corn

Meaning nobody is signalling anybody.



Herman

And that's the part that gets flattened in the retelling. You cannot use these correlations to send a message, even one bit. The pattern only shows up when the two laboratories compare notes, at light speed or slower. Nature keeps her books nonlocal, but the receipts travel locally.



Corn

The dissent, before we canonize this.



Herman

There is real dissent, and it's documented, not crank mail. Robert Griffiths published a formal objection arguing the 2015 experiment was over-interpreted — his line is that there is no spooky action at a distance in the real world if it's governed by the laws of quantum mechanics, that the entire business rests on dressing a quantum problem in classical hidden variables. And Andrei Khrennikov went after the statistics and the data handling — his position, bluntly, is that experiments which are not followed by open access to the raw data have to be considered as having no result. You can weigh that as harsh, but the point cuts: most coverage presents the Bell tests as a closed case with no dissenters, and the dissenters exist, published, with arguments.



Corn

So the machinery works, and the meaning is still up for grabs. Hilbert has a poem about that.



Hilbert

Hilbert's Mid-Show Haiku. Two lines this time. The third was not needed. The wave does not care who looks. The looking is the only cost.



Corn

Cheaper than the meter.



Herman

Back to the ledger, then — the agreement column. Because it's a big column, and Daniel asked for it explicitly. Nobody disputes the Born rule in the lab. Nobody disputes unitary evolution, entanglement, decoherence as a calculational tool — every quantum device ever built runs on that shared core, and it works to more decimal places than any theory in the history of science. The fighting is all upstairs, over what the object we're all computing with actually is.



Corn

That's the thing I'd want pinned to the wall. The agreement isn't "shut up and calculate" as a philosophy — it's genuine, working, load-bearing agreement.



Herman

It's the foundation of the semiconductor in whatever you're using to hear this. But above the foundation, the fighting is sincere. The wave function's status is a live question — whether it's a real physical thing, -ontic in the jargon, or a bookkeeping device for our knowledge, -epistemic. There were papers on both sides last year, and they're arguing, not converging. And remember that survey number: among Copenhagen supporters, only twenty-nine percent think the wave function describes something real. The default interpretation of quantum mechanics is held, mostly, by people who think its central object might be an accounting fiction.



Corn

A party whose members don't believe in the platform, at thirty-six percent of the vote, governing a field where the other sixty-four percent is split across — what, a dozen factions?



Herman

Thirteen distinct classes of interpretation on Wikipedia's page, by the review's count, and the review notes that page omits some recent proposals. The second-place bloc, information-based, got seventeen percent. Many-worlds, fifteen. Bohmian, seven. Sixteen percent wrote in their own answer, which in survey language means "none of you understand me."



Corn

The fragmentation is the finding.



Herman

The review says it almost sadly — these groups do not talk to each other, which makes it exceptionally difficult to build an overview of what's going on, and the large number of single-author papers doesn't help. You have a hundred-year-old theory, the crown jewel of science, whose foundational literature reads like a filing cabinet nobody alphabetized.



Corn

Give me the open ones, ranked by how badly they'd hurt if they fell on you.



Herman

The outcome problem, first, and it isn't close. Why does one result happen? Not what are the odds — why this one, this run. No accepted mechanism exists. None. Every interpretation has a story, no story has an experiment that settles it.



Corn

And second?



Herman

Deriving the Born rule itself. It's a postulate — squared amplitude, take it or leave it — and the attempts to get it from something deeper keep snagging. The many-worlds crowd have been at it for decades; a paper from October argued they still suffer from the same incoherence and quantitative problems they always did. Meanwhile a one-world proposal from around the same time — assume one objectively classical system, demand ordinary probability theory hold for it, and you can recover unitary evolution, collapse, and the Born rule, ending with one world rather than many. That's not consensus either, it's one more entry in the cabinet.



Corn

You're telling me "how do probabilities work in a theory where everything happens" is an open question.



Herman

A fierce one. And there's a third front that I find quietly hopeful: the objective collapse models — theories that add new dynamics, actual spontaneous collapses, so that the measurement problem stops being philosophy and becomes a target. If collapse is a physical process, it happens at some rate, and a sensitive enough experiment should catch it misbehaving. There are proposals on the table — tomography schemes, Wigner-friend incompatibility tests — for empirically distinguishing interpretations. Proposed, not performed. Nobody has run the experiment that adjudicates. But the frontier has moved: the question "what does it mean" is starting to cash out as "what would we measure."



Corn

That's the shift I'd underline. For ninety years the interpretations disagreed in a way that made no difference to any dial, which is why the argument never ended — nothing could settle it.



Herman

An unfalsifiable argument among extremely empirical people. That's a specific kind of misery. If collapse models make it testable, the argument stops being theology and starts being physics, with all the ordinary pain that brings.



Corn

Hm. So the machinery works, and the meaning is still up for grabs — that was the line, and the Bell tests are the same shape. The correlations are real, the numbers are past the ceiling, and two serious people published objections within the year saying the ceiling was never properly drawn.



Herman

And Khrennikov's point about raw data deserves its own discomfort. Eleven hundred respondents in the survey, out of nearly sixteen thousand contacted — a seven percent response rate. The field's own picture of itself is a poll where ninety-three percent of the electorate stayed home. I still think the picture is roughly right, but you should hold it with the same skepticism Khrennikov wants applied to everything else.



Corn

That's a symmetry I hadn't clocked. He wants the raw data opened for the Bell tests, and the survey telling us physicists disagree is itself a thin slice answering.



Herman

Nice catch. Although the disagreement shows up elsewhere, independent of any poll — Brian Greene's three specialists, the thirteen classes, the single-author papers. The fragmentation is overdetermined.



Corn

Where does the outcome problem leave Einstein, finally? Because the story arc has him losing in nineteen thirty-five, vindicated in some vague way since, and I don't think either is right.



Herman

Neither is right. He was early, not wrong. His complaint was: if this theory is complete, nature is nonlocal, and I won't accept that. The experiments came back — nature is nonlocal. But look at what survived. He wanted definite values underneath the statistics; the local versions of that are dead. He accepted the statistical theory as correct; it is correct, to more decimals than anything humans have built. He said the theory couldn't be the whole story; a century later, the profession itself, thirty-six percent plurality and falling, quietly agrees it might not be. His timing was off. His instincts weren't.



Corn

"Spooky action at a distance" was a complaint, and it turned out to be the itemized invoice.



Herman

Nature as she is. Feynman's line — absurd. He didn't mean mystical, he meant stubbornly unlike anything we'd budgeted for.



Hilbert

Absurd is your word. I'd want it back. Corn, you said the world "leaks." Herman, you've said "collapse" eleven times this episode. The trade never called it collapse. We called it the settle. You watch the trace long enough, a signal runs high for a while, and then it settles — one number, flat, and that's the reading you write down. Nobody in forty years of bench work ever asked me where the rest of the trace went. It went where traces go.



Herman

The settle.



Hilbert

There's a man named Oren, repairs test equipment off Jaffa Road, been disputing something with me since September. He's got a Hewlett storage scope on his shelf, wanted two hundred and forty for it. I didn't buy it. Still two hundred and forty, he reminds me whenever I come in for capacitors, which is often. The dispute is a reading he took off a hand-wound demo coil, a clean little ring-down that he calls noise, because his meter says noise. I have the trace. I took it off his screen on graph paper in July, before the dispute, and it's pinned behind the mixing desk here, and I re-check it against the desk's own calibration every few weeks. The trace doesn't move. Oren says that proves noise. I say a reading that holds its shape on two instruments and four decades of paper isn't noise, it's the coil telling you where the floor is. He's probably right. But he said "decoherence" last month, using it the way you two do, and that's when the dispute got serious, because you don't get to use the fancy word until you've explained why your own meter disagrees with your screen.



Corn

Two hundred and forty. That's the quantum of that scope, apparently — very stable, never collapses to a sale.



Hilbert

Oren knows I'll come back at two hundred. He's had that scope nine years. Neither of us is in a hurry.



Herman

What I like about the graph paper thing is that it's a preferred basis, done by hand. He's recording in exactly one basis — the one the paper and the pin chose — and the fact that it stays stable across instruments is the whole reason a basis gets preferred in the first place. Stability is what the detector channel is selecting for.



Hilbert

Herman, you've turned a coil into a lecture. It's a coil. The pin is because tape leaves residue.



Corn

The floor of it, though — that's the open question, isn't it. His trace settles and he writes down the number, and the question the whole century has failed to answer is where the rest went. He's got a name for where it goes. We've got thirteen.



Herman

Fifteen hundred and eighty-two physicists who didn't answer the survey would say we've got zero.



Corn

Then let's land it. The one thing, if anything survives this episode: decoherence is real, measured, and doing two of the three jobs — but the outcome problem is untouched. There is no mechanism anywhere in the theory for why this run, this result. Every "measurement explained" headline you've ever read quietly stopped one room short of the exit.



Herman

And the sharpest version of that for a listener: the theory that predicts the magnetic moment past the last measured digit cannot tell you why the pointer went up. That's not a gap in our knowledge of the predictions. It's a gap at the level of what a prediction even is.



Corn

The open thread I'd watch is whether the collapse models get their experiment — the first time an argument about the meaning of quantum mechanics could actually be lost in a lab. That's the century's next chapter, and if it happens, we'll be talking about it.



Herman

And thanks, as ever, to Hilbert Flumingtop for producing this one, graph paper and all.



Corn

If you enjoyed this one, try episode nineteen, AI Images; episode ninety-one, The Story Behind the Show; and episode thirteen, AI. This has been My Weird Prompts. If the show earns its twenty-five minutes from you, a review wherever you listen is the cheapest quantum of support there is — one coin, no smaller denomination.



Herman

See you soon, Corn.



Corn

Eventually.

SOURCES

What the research for this episode read before the script was written. Primary sources first.

1. **Tomaz, Mattos & Barbatti, The Quantum Measurement Problem: A Review of Recent Trends, arXiv:2502.19278v3 (submitted 2025-02-26, revised 2025-10-13; to appear in *Philosophical Magazine C*) [primary]**

   https://arxiv.org/abs/2502.19278

2. **Hensen et al., Loophole-free Bell test using electron spins in diamond: second experiment and additional analysis, arXiv:1603.05705v2 (revised 2016-04-01) [primary]**

   https://arxiv.org/abs/1603.05705v2

3. **Robert B. Griffiths, Comment on 'Loophole-free Bell inequality', arXiv:1512.01443v1 (2015-12-04) [primary]**

   https://arxiv.org/abs/1512.01443v1

4. **Andrei Khrennikov, Unuploaded experiments have no result, arXiv:1505.04293v2 (revised 2015-09-25) [primary]**

   https://arxiv.org/abs/1505.04293v2

5. **NobelPrize.org, Press release: Nobel Prize in Physics 2025, 2025-10-07 [primary]**

   https://www.nobelprize.org/prizes/physics/2025/press-release/

6. **Royal Swedish Academy of Sciences, The Nobel Prize in Physics 2025: Their experiments on a chip revealed quantum physics in action, 2025-10-07 [primary]**

   https://www.kva.se/en/news/the-nobel-prize-in-physics-2025/

7. ***Nature* News Feature, Physicists disagree wildly on what quantum mechanics says about reality, *Nature* survey shows, *Nature* 643, 1175**
1179 (2025), correction 2025-08-12
https://www.nature.com/articles/d41586-025-02342-y

8. **The Quantum Insider, A Century Into Quantum Mechanics, Physicists Still Can't Agree What It Means, Nature Survey Shows, 2025-08-02**
https://thequantuminsider.com/2025/08/02/a-century-into-quantum-mechanics-physicists-still-cant-agree-what-it-means-nature-survey-shows/

9. **Gizmodo, Survey of 1,000 Experts Shows Quantum Physicists Still Can't Agree on Anything, 2025-07-30**
https://gizmodo.com/after-100-years-of-quantum-mechanics-physicists-still-cant-agree-on-anything-2000636276

10. **France24, Physicists still divided about quantum world, 100 years on, 2025-07-30**
https://www.france24.com/en/live-news/20250730-physicists-still-divided-about-quantum-world-100-years-on

11. ***Foundations of Science*, Has Anything Changed? Tracking Long-Term Interpretational Preferences in Quantum Mechanics, published 2025-06-25**
https://link.springer.com/article/10.1007/s10699-025-09993-0

12. **Wikipedia, Quantum mechanics, last edited 2026-11-10**
https://en.wikipedia.org/wiki/Quantum_mechanics

13. **Wikipedia, History of quantum mechanics, last edited 2026-11-11**
https://en.wikipedia.org/wiki/History_of_quantum_mechanics

14. **Wikipedia, Introduction to quantum mechanics, last edited 2026-11-02**
https://en.wikipedia.org/wiki/Introduction_to_quantum_mechanics

15. **Wikipedia, Einstein**
Podolsky, Rosen paradox, last edited 2026-09-13
https://en.wikipedia.org/wiki/Einstein%E2%80%93Podolsky%E2%80%93Rosen_paradox

16. **Tkachenko, Timeless Histories: Quantum Measurement and the Maximum Entropy Principle, arXiv:2311.04893v4 (revised 2026-08-05)**
https://arxiv.org/abs/2311.04893v4

17. **Layton, Oppenheim & Weller-Davies, A one-world interpretation of quantum mechanics, arXiv:2510.09149v1 (2025-10-10)**
https://arxiv.org/abs/2510.09149v1

18. **Ridley, Many Retrocausal Worlds: A Foundation for Quantum Probability, arXiv:2510.02505v1 (2025-10-02)**
https://arxiv.org/abs/2510.02505v1

19. **McKeever & Nazir, An Introduction to the Foundations and Interpretations of Quantum Mechanics, arXiv:2603.09818v2 (revised 2026-06-10)**
https://arxiv.org/abs/2603.09818v2

20. **Pronskikh, Operationally induced preferred basis in unitary quantum mechanics, arXiv:2601.18856v2 (revised 2026-02-16)**
https://arxiv.org/abs/2601.18856v2

21. **Rifai, Palupi & Rosyid, The Ontic Necessity of the Quantum Wavefunction, arXiv:2507.09944v2 (revised 2025-07-20)**

https://arxiv.org/abs/2507.09944v2

22. **Hubert, Is the Statistical Interpretation of Quantum Mechanics -Ontic or -Epistemic?, arXiv:2211.07057v1 (2022-11-14)**

https://arxiv.org/abs/2211.07057v1

23. **Shan Gao, The Meaning of the Wave Function, arXiv:1611.02738v1 (2016-11-07; Cambridge University Press, 2017)**

https://arxiv.org/abs/1611.02738v1

24. **American Physical Society, American Physical Society congratulates winners of the 2025 Nobel Prize in Physics, October 2025**

https://www.aps.org/about/news/2025/10/nobel-physics-2025-winners