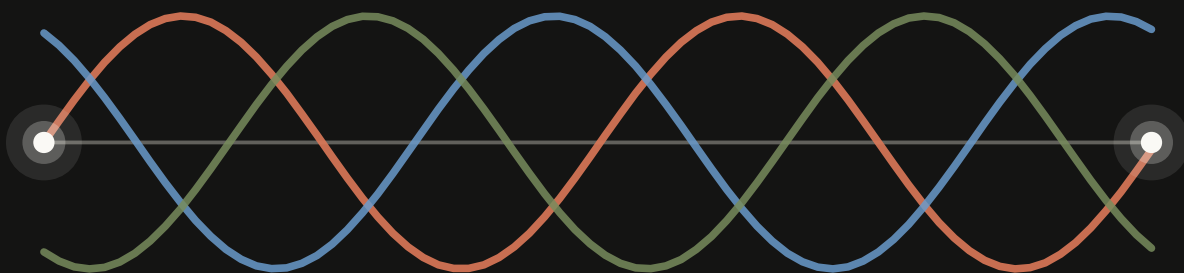


DEEP DIVE — TOPOLOGICAL QUANTUM

The Qubit That Held Its Breath for a *Minute*

Microsoft says its new **Majorana 2** chip is a thousand times more reliable than anything it has built — and that a useful quantum computer now arrives by 2029. Many physicists say the device may not hold a single real qubit. Both claims can be true at once. This issue is about why the bet is rational anyway.



- 01 Why “topological” means error-proof by *geometry* , not by brute force
- 02 The 2021 retraction that still shadows every Majorana claim
- 03 Against the Grain — the contrarian case for a chip nobody can verify

Contents

03	The Feature — Error-Proof by Geometry	OPENER
04	Lead, Atoms & an AI in the Lab	BREAKTHROUGHS
05	From Lab to Market — and a Field Guide	SO WHAT
06	Against the Grain — The Contrarian	MOVE 37
07	Signals — Space, Medicine, Robotics	DISPATCHES
08	By the Numbers	DATA
09	The Long View & Sources	CLOSE

THE DISPATCH

Editor's Note

On the difference between a result and a bet.

— THE INFLECTION DESK

The cleanest stories in technology are the ones that *work*: a rocket lands, a drug doubles survival, a model passes a test it has never seen. This week gave us all three. But the most important story is none of them. It is a chip that may not work at all.

AlphaGo's Move 37 looked like a mistake to every professional in the room. It was a mistake — until it wasn't. The lesson was that the moves that decide everything are the ones that look wrong while you are making them. Microsoft's Majorana 2 is that kind of move: announced into a wall of expert skepticism, it is either an embarrassment or the most leveraged bet in computing — and you cannot yet tell which.

So read the feature for the physics, and Against the Grain for the argument the consensus would rather you didn't finish. Throughout, we separate what was *measured* from what was *claimed* — the gap between those two words is where this field now lives.

Error-Proof by Geometry

Every other quantum computer fights noise with redundancy — thousands of fragile qubits checking each other. Microsoft is trying to make a qubit that cannot be confused in the first place. If it is real, the entire industry's scoreboard becomes meaningless.

BY THE INFLECTION DESK · QUANTUM DESK

A conventional qubit forgets almost instantly. Nudge it with a stray photon, a whisper of heat, a tremor in the magnetic field, and the delicate quantum state it was holding collapses into ordinary, useless certainty. The best superconducting qubits on Earth keep their information for a few hundred millionths of a second. That is the central tragedy of quantum computing: the machine is most powerful in precisely the regime where it is most easily destroyed. The industry's answer, for two decades, has been to out-build the problem — wrap each useful "logical" qubit in roughly a thousand physical ones, all spending their lives catching and correcting each other's errors. It works. It is also a tax of a thousand to one.

On 2 June, Microsoft proposed a different deal. Its Majorana 2 chip, the company said, holds its quantum state not for microseconds but for a mean of **20 seconds** — with some instances lasting a full minute. The comparison is almost rude: it is the difference between a phone battery that dies by lunchtime and one that lasts nearly three years on a charge. Microsoft framed it as a thousand-fold gain in reliability over the Majorana 1 chip it unveiled only a year earlier, and said the result pulls its timeline for a "scalable, practical" quantum computer forward to **2029**, cutting the original schedule in half.

The reason this is not simply a bigger number is the word *topological*. Ordinary qubits store information in one place — the spin of an electron, the energy of a circuit — where any local disturbance can reach it. A topological qubit smears a single bit of information across two points that may sit

micrometres apart, so that no local nudge at either end can read it or flip it. Only an operation that touches *both* ends at once can change the state. Noise, which is local by nature, simply has nothing to grab. The protection is built into the geometry of where the information lives, not bolted on afterward with error correction.

That is the prize. If a qubit is intrinsically quiet, the thousand-to-one tax nearly vanishes: the physical-to-logical ratio could fall toward single digits. A few thousand of these qubits might do what millions of conventional ones cannot. It would not make the leaders' machines a little better; it would make their qubit counts beside the point. Which is also why the claim has been met, this week, with something between caution and open ridicule. We will get to that. First, what Microsoft says it actually changed.

*Continued overleaf — how swapping aluminum for **lead** bought a minute of silence.*

Lead, Atoms, and an AI in the Lab

A heavier shield

The headline change is almost homely: Microsoft swapped the chip's aluminum superconductor for **lead** — the same dense metal that lines radiation rooms in hospitals. In a quantum device, a lead superconductor widens the "topological gap," the energy moat that keeps a qubit's protected state separated from the disordered states that mimic and corrupt it. "People generally want to stay away from putting lead into anything," the project's Chetan Nayak conceded. "It sounds like a crazy idea." It also, he said, "led to big, big improvements in device quality."

Built atom by atom

The qubits themselves are assembled on a planar slab of indium-arsenide that Microsoft calls a "topoconductor," patterned so that gate electrodes — not hand-placed nanowires — define where the protected regions sit. Four Majorana modes make one qubit, an arrangement the team calls a *tetron*. Each device is tuned atom by atom: a stray impurity in the wrong place spoils the crystal, so the recipe lives on a knife-edge between too little and too much.

*"Where are we relative to last year?
We're a thousand times better."*

CHETAN NAYAK · MICROSOFT TECHNICAL FELLOW

The agent in the cleanroom

The quietly radical part is *how* the chip was tuned. Setting up a topological state means fixing hundreds

of parameters, then measuring whether there is an even or odd number of billions of electrons on a wire — work that took human researchers weeks per cycle. Microsoft handed it to autonomous AI agents from its Discovery platform, which ran the voltage sweeps in parallel, built a three-dimensional map of where the device "works," and combed two decades of siloed lab data for patterns no single scientist could hold in their head. One agent caught a miscalibrated temperature sensor that had been quietly skewing results.

That is the part a CTO should not skim past. The bottleneck in topological quantum computing was never the theory, which has been elegant and stable for twenty years. It was the agonizing, artisanal search through materials and parameters for a device that behaves. Microsoft's claim is that it has wired a tireless machine into that search loop — compressing a measurement cycle from weeks to, in its telling, orders of magnitude less. Whether or not Majorana 2 holds a real qubit, the method is the news: the same agents shipped to every Discovery customer the same day.

One microsecond, one-hundredth of a millimetre

The remaining specs round out the pitch. Operations run in about a **microsecond**; each qubit is roughly **1/100th of a millimetre** across, small enough that Microsoft keeps insisting a million could one day fit on a palm-sized chip. The claim arrives, as ever, with the company's preferred verb — *could*. The measured noun is the one on the next page.

From Lab to Market

For all the noise, nothing here is a product. Majorana 2 is a research device; the 2029 date is a date for a *demonstration* of scalable computing, not a machine you can rent. What changed this week is the slope of the line. A year ago Microsoft showed an architecture that *could* host qubits. Now it claims qubits that survive long enough to be measured, read out in two complementary ways, on a fabrication process an AI can help steer. Each step is a prerequisite for the one a skeptic actually wants: a braid.

If — the load-bearing word of the decade — the topological story holds, the market consequence is not incremental. A fault-tolerant machine that needs thousands of qubits rather than millions is smaller, cheaper, colder for less time, and years closer. It would reset the cryptography clock and hand whoever owns the materials recipe a moat measured in fabrication know-how, not patents. That is the upside the share price is not pricing, because the downside — covered overleaf — is that the qubit isn't there at all.

The honest read for a technology leader is a portfolio one. Treat topological qubits as a low-probability, very-high-payoff option, and watch three gates in order: a measured topological gap, a single confirmed braid, then a two-qubit gate that beats a conventional one in the same material. None has been cleared. Until the first is, the prudent base case still runs on superconducting and neutral-atom machines that are delivering logical qubits today.

GLOSSARY

Majorana zero mode — a quasiparticle that is its own antiparticle, appearing in pairs at the ends of a topological wire; the "ends" between which a qubit is hidden.

Topological gap — the energy moat protecting the qubit state from look-alike "trivial" states; wider gap, quieter qubit.

Tetron — Microsoft's qubit: four Majorana modes wired into one protected bit.

Parity lifetime — how long the wire's even-or-odd electron count — the stored bit — survives before noise flips it.

FIELD NOTES — HOW IT WORKS

- 1 Hide the bit.** Store one unit of information across two Majorana modes at opposite ends of a wire. Neither end alone knows the value, so local noise can't read or flip it.
- 2 Widen the moat.** Use a lead superconductor, near absolute zero, to deepen the topological gap that separates the protected state from noisy impostor states.
- 3 Read the parity.** Measure whether the wire holds an even or odd number of electrons — that is the qubit — using a tiny charge sensor, without disturbing the hidden state.

The dream: a bit you correct with geometry, not with a thousand backup qubits.

WHAT TO WATCH

Gate 1 · a measured topological gap

Gate 2 · one confirmed braid

Gate 3 · a winning two-qubit gate

Buy the Move **Nobody** in the Room Would Make

Start with the consensus, because it is strong and it is correct. The Majorana 2 result lives in a preprint that has not been peer-reviewed. Its standout numbers, physicists note, come from a handful of instances on a *single device*. "You can see something amazing in one device and never see it again because it's just some random artifact," says Henry Legg of the University of St Andrews. "If this was from any other group or Ph.D. student, it would never make it through peer review."

The skepticism is earned. In 2021 Microsoft *retracted* a flagship Nature paper after outside experts showed its Majorana signature could have come from ordinary material defects. A 2025 follow-up carried an editorial note that its data did "not represent evidence" for Majorana modes at all. Thirteen years after the first claimed sighting, no one has demonstrated a single controllable topological qubit — no gate, no braid. A 2025 analysis even argues that charge noise from the very semiconductor interface that hosts the modes could erode the protection that is the whole point. "When Microsoft is mentioned these days," says Pittsburgh's Sergey Frolov, "physicists just chuckle or raise their eyebrows."

The crowd is right about the evidence and may still be wrong about the bet.

Now the move. Everyone else is racing *down* the qubit count — more physical qubits, more error correction, a thousand-to-one tax paid in silicon and cooling. Microsoft is betting the opposite direction: kill the error in the material so the tax barely exists. That is not a better horse in the same race. It is a refusal to run the race at all. If it pays off, the leaders' headline qubit numbers — the scoreboard everyone is watching — become a rounding error.

And the binding constraint just moved. The theory was never the problem; the artisanal hunt through materials and parameters was. Wiring an autonomous agent loop into that hunt is the first thing in twenty years that attacks the *actual* bottleneck. Move 37 looked like a losing move to every professional watching — and it was the move that won. This may be vaporware. It may also be the cheapest call option in computing, written precisely because the room is laughing.

WHY THE CONSENSUS DISAGREES — HONESTLY

One device, not peer-reviewed; a retraction on the record; the signature still has trivial explanations; $1/f$ noise may undermine the protection; braiding remains unproven; and Microsoft itself hedges, buying neutral-atom qubits for its near-term cloud. The honest base rate says this fails.

THE CONTRARIAN'S DISCIPLINE

Size it like an option, not a thesis. Small premium, asymmetric payoff, and a hard exit: if no topological gap is measured on many devices, walk. Conviction without a stop-loss is just the hype in a different jacket.

Three Dispatches from Elsewhere

While quantum argued with itself, these landed — and these ones work.

35

record flights · one booster

SPACE

A booster that won't retire

On 8 June a SpaceX Falcon 9 first stage, tail number B1067, flew and landed for the **35th time**, extending its own reusability record as it lofted another 29 Starlink satellites. The fleet leader is now closing on the Space Shuttle orbiter's 39-flight benchmark, and the constellation it keeps feeding has passed **10,580** active satellites. Reuse has quietly become the most consequential cost curve in spaceflight — each landing is a rocket the world didn't have to rebuild.

SOURCE · SPACE.COM

13.2

months survival · vs 6.7 on chemo

MEDICINE

A 40-year-old target finally falls

At ASCO this month, Revolution Medicines reported Phase 3 results for **daraxonrasib**, a RAS inhibitor, in previously treated metastatic pancreatic cancer — among the deadliest diagnoses in oncology. Median overall survival reached **13.2 months versus 6.7** on chemotherapy, a 60% reduction in the risk of death (hazard ratio 0.40) across 500 patients. RAS, mutated in most pancreatic tumors, was long branded "undruggable." This is the first RAS(ON) drug to move the survival needle in this setting.

SOURCE · NEJM / ASCO 2026

22

degrees of freedom · per robot hand

ROBOTICS

An open body for physical AI

On 11 June NVIDIA released the Isaac GR00T reference humanoid — an open hardware-plus-software blueprint pairing a 31-degree-of-freedom Unitree H2 body with dual tactile hands of **22 degrees of freedom each** and a Jetson Thor brain. The bet is standardization: give every robotics lab the same capable body so the race shifts from building hardware to training the intelligence that runs it. It ships through Unitree late this year.

SOURCE · NVIDIA NEWSROOM

The Week, Counted

20s

Majorana 2's mean qubit lifetime — versus the millionths of a second every rival qubit manages.

1,000×

Claimed reliability gain over the Majorana 1 chip Microsoft showed just a year earlier.

2029

New target for a scalable, practical quantum computer — half the original timeline.

1–10

Physical qubits per logical qubit if topological protection holds — against roughly 1,000 today.

13 yrs

Since the first claimed Majorana sighting — and still no confirmed, controllable qubit.

13.2 mo

Survival on daraxonrasib in metastatic pancreatic cancer — versus 6.7 on chemotherapy.

35

Record flights for Falcon 9 booster B1067, nearing the Shuttle's 39.

10^{-6}

Theorized error rate for a topological qubit — a thousand times below the best conventional ones (10^{-3}).

Every figure verified against a primary source — listed in The Long View, page 09. Where a number is a claim rather than a measurement, the label says so.

What a Minute Buys

Twenty seconds is not a long time to hold a thought. It is an eternity for a qubit — and that gap, between the human-trivial and the quantum-miraculous, is the whole drama of this week compressed into a single unit. The thing that makes Majorana 2 remarkable if true is exactly the thing that makes it suspect: a result so far beyond the field's norms that it either rewrites the rules or reflects an artifact. Good science and good betting both require sitting in that discomfort without resolving it prematurely.

Notice what tied this issue together. A rocket that flies because it stopped being thrown away. A drug that beat a target the field called undruggable. A robot body given away so the contest can move up a layer. And a quantum chip betting that the way to win is to stop playing the game everyone else is playing. The pattern is not "things got better." It is that each winner changed the *denominator* — redefined what the expensive, scarce resource even was. Reused boosters made launch mass cheap; agentic materials search makes the hunt for a working qubit cheap; an open humanoid makes the body cheap. Move 37 was never about a single brilliant stone. It was about seeing that the board had a dimension the experts had stopped looking at.

So hold both thoughts. The consensus is probably right that Majorana 2, as published, does not yet prove a qubit. And the contrarian is probably right that if you only fund what is already proven, you will never own the thing that resets the board. The job of a serious technologist is not to pick a side this week. It is to know exactly which measurement would force you to change your mind — and to be watching for it when it comes.

SOURCES & FURTHER READING

Microsoft Source — Introducing Majorana 2 news.microsoft.com/source/features/innovation/majorana-2-microsoft-discovery-agentic-ai

Microsoft preprint — 20-Second Parity Lifetime in an InAs-Pb Device aka.ms/m2-paper

SiliconANGLE — Majorana 2 claims breakthrough in qubit stability siliconangle.com/2026/06/02/microsofts-new-majorana-2-quantum-chip-claims-dramatic-breakthrough-qubit-stability

Scientific American — Experts say it never worked to begin with scientificamerican.com/article/microsofts-upgraded-majorana-quantum-computing-chip-fizzles-with-physicists

PostQuantum.com — Majorana Qubits: The Physics, the Evidence, the Debate postquantum.com/quantum-modalities/majorana-qubits

NEJM / ASCO — Daraxonrasib in metastatic pancreatic cancer (RASolute-302) nejm.org/doi/full/10.1056/NEJMod2605555

NVIDIA Newsroom — Isaac GR00T reference humanoid robot nvidianews.nvidia.com/news/nvidia-open-humanoid-robot-reference-design

Space.com — Falcon 9 booster's record 35th flight space.com/space-exploration/launches-spacecraft/spacex-starlink-10-35-b1067-ccsfs-asog

THE LENS · A RECURRING QUESTION

What are you refusing to fund because it isn't *proven* — and who will own it if it is?

Every category-defining technology spent years looking like a mistake. The discipline is not believing every long shot; it is knowing which single measurement would turn a long shot into a certainty — and watching for it before the crowd does.

NEXT ISSUE · FRIDAY

A new deep dive. A new move that looks wrong.

RESEARCHED, WRITTEN & DESIGNED WITH CLAUDE.
TYPESET IN POPPINS & LORA ON THE ANTHROPIC
PALETTE.