

Hard Physics Questions: "What does an electron do when no one is looking?"

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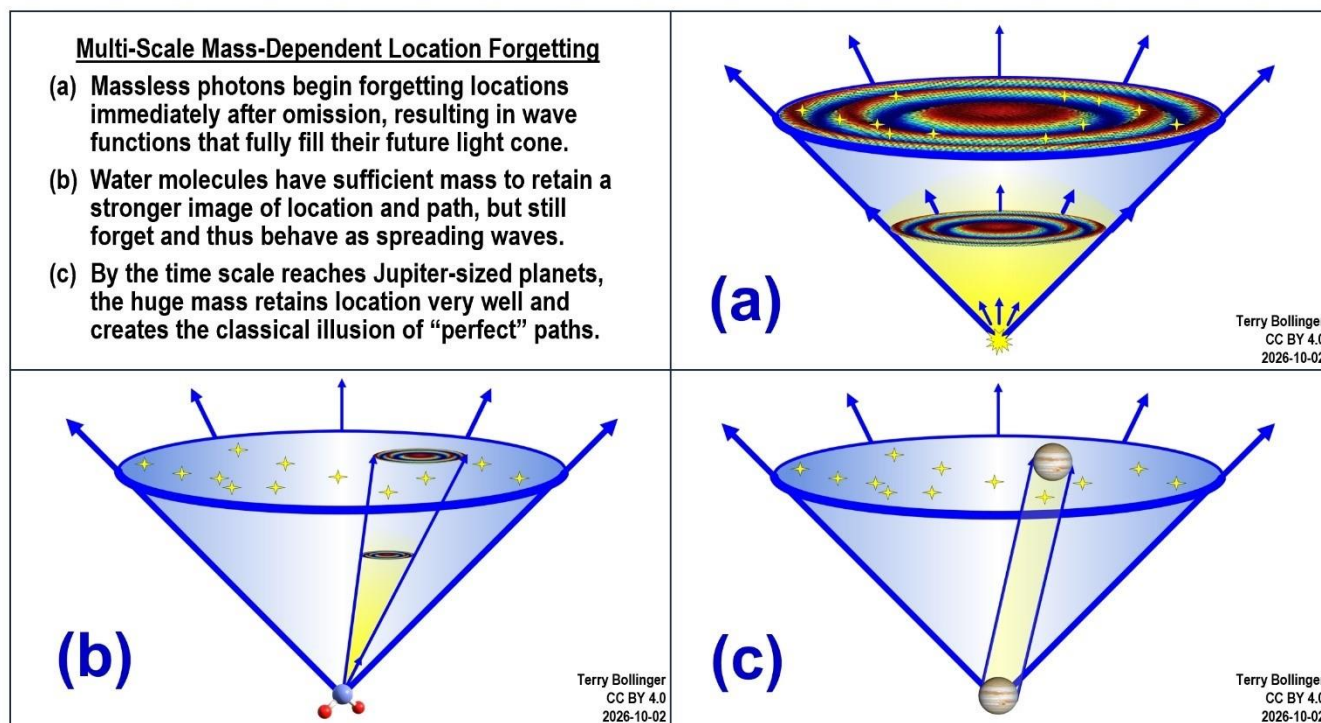


Figure 1. *Small masses mean rapidly fading location memories. Only large bodies stay nearly classical.*

It seems like a simple question: What does an electron busy do while no one is looking at it? Yet taking this simple question seriously quickly leads to unexpected and deeply uncomfortable places. These include, for example, the nature of quantum observation, the falseness of the word "superposition," the need for a radically different understanding of how metrical systems work, and the need for all of physics math to pay very careful attention to a concept that computer scientists call "binding time." What makes the question particularly tricky is that the moment you use the phrase "spacetime," you remove any chance of understanding what an electron — or an atom, molecule, or even a large dust particle — does when no one is looking.

The Most Common Model of Existence is Upside Down

The problem is that the assumptions of existence implied by the question are upside-down. A molecule remains the same molecule no matter what an outsider does or does not do. That is because its atoms keep the same relationships to each other. The rule for relationships is remarkably simple: As long as particles or atoms stay bound to each other by accelerating forces, whether anyone outside is "looking" doesn't matter: Each bound particle or atom already knows where the other is. Schrödinger's cat is never a superposition of anything. The cat simply "is," and that "is" can be either dead or alive, but never both. Only the location of the dead-or-alive cat relative to the rest of the universe is up for grabs — and, given the relatively enormous mass of a cat, even that is never much in doubt.

At the smallest end of the mass scale, even though the locally unresolvable knot of electric charge and spin we call an electron lacks enough complexity needed to “observe” itself in a way that generates additional internal information (think of the cat dying), it has more than enough complexity to persist on its own. The electron does not need an outside observer to exist. The electron always “sees” itself — self-observes, for all practical purposes — as a tight, stubborn knot of unresolvable quantum numbers. It’s not much of a memory in the broader scheme of things, and it even blurs with other electrons. But it’s enough memory to let the electron exist for billions of years.

An electron thus has just enough total mass and energy to create its own tiny bubble of existence. As far as the rest of the universe is concerned, it can only inherit the location relationship it was given when inspected from outside. That relationship deteriorates rapidly under the same rules that we, looking in, call Schrödinger’s equation. Its location doesn’t deteriorate at the speed of light, as a photon’s does, but it’s not far from it.

Spacetime is a Math-Faith Principle, Not a Physics Observation

This intensely networked, bottom-up nature of location relationship is why the very word “spacetime” is problematic. There is no spacetime “fabric,” since duration and distance metrics have no meaning without particles and energy. A far more accurate way to think of durations and distances is as entries in “location apps” (or ledgers) attached to every particle, atom, molecule, spaceship, planet, or galaxy in the universe. These ledgers form strict hierarchies, which are the deeper source of power laws. The accuracy and persistence of each location entry vary dramatically based on the total mass that binding (accelerating) forces have captured within that particular unit.

Poor little electrons have puny ledgers and thus very short memories. They lose their location details with frightening speed, though their location uncertainty can never reach outside of their light cones. Hydrogen atoms forget their last locations about 2000 times faster than electrons, but typically lose their locations more easily because hydrogen atoms lack any long-distance charges that make them more likely to bump into other entities.

The Electron Answer is Oddly Simple

So, what does an electron do when no one is looking — that is, when no one is bringing it back into communication with the rest of the universe by nudging or bumping it?

It forgets where it is. That’s all. When some of its potential paths to forgetting lead instead to detection — to the sheets surrounding two slits, for example — its final location from these restricted paths leads to location definitions that defy any strict idea of a pre-existing spacetime. The electron never “went” anywhere; the results are merely the best approximation it can give for a “spacetime” that was never anything more than a network of relationships.

Electron Orbitals

Electrons have only a tiny bit of rest mass, and thus dearly want to forget their current locations relative to the rest of the universe as quickly as possible. They don’t need to fill their entire light cone, like photons, but they also want to get lost in a much larger region of it than any heavy, location-memory-filled classical object.

But what if a relentlessly bumpy, always-inward-accelerating positive charge is nearby? What happens then?

A sufficiently cool electron that gets too near to a similarly cool proton winds up in an interesting situation. The accelerating electrical forces require both particles to almost continually acknowledge and track each other’s locations, never giving the electron time to forget. When no other matter interferes, the electron and proton can maintain this situation for billions of years as what we call a neutral hydrogen atom.

But the electron never stops forgetting! It maintains a tiny halo of stubborn forgetfulness — of trying very hard not to be stuck in only one location relative to the proton. This means it cannot be bound tighter than a limit determined by the low mass, and thus forgetfulness, of the electron.



We call this state of tiny but stubbornly resistant forgetfulness an "orbital." An orbital is the first and least specific example of the kind of bindings that become "orbits" at higher masses. No matter what this or that textbook may have told you, it is fully and almost absurdly incorrect to think of an electron orbital as a "superposition" of these higher-mass orbits, since those memory-saturated constructs cannot even exist without first adding enormous amounts of additional mass in the form of energy, such as by hitting the orbital electron with a gamma ray.

Forget Superpositions: The Real Universe Prefers Partial Specifications

A simpler, more physically meaningful view of electron orbitals and similar phenomena is to fully abandon the energetically impossible concept of "superposition" and replace it with *incompletion*. An incompletion happens when the object lacks enough memory to fill in all but the most minimal description of its relative location.

Incompletion is nothing more than a hard, unforgiving physical implementation of approximation. For example, if I write down "5□□□", there are at least two ways to interpret this notation. The first, lowest-energy option is to say my specification is incomplete due to insufficient local storage; the item literally does not have enough mass to specify the last three digits. This is a low-energy state precisely for that reason: The uncertainty indicates a lack of memory resources, rather than a superabundance of them.

The other interpretation of "5□□□" is as "the completed set of all numbers from 5000 to 5999. Notice that if every number in that set requires four full digits of the same storage used for "5", the total memory required to create such a complete set is vastly larger than that of the "insufficient precision" interpretation.

Importantly, both interpretations of "5□□□" *say* the same thing mathematically, since both lead to all and only the numbers from 5000 to 5999. The difference is in *when* you arrive at these numbers, and whether you arrive at them at all in a single or multiple attempts to interpret "5□□□". Many mathematicians lean reflexively and without much thought toward completed sets. I am honestly not sure why, since, to me at least, such fully completed sets usually represent the ultimate in pointless bloat and premature expansion. Early binding is most useful when you want to keep computation to an absolute minimum, such as in the old pre-computer method of creating books of previously calculated trigonometric functions.

Furthermore — and no matter what many mathematical models say — the physically realizable universe gives no indication of preferring pre-bound completed sets. If it did, every atom in the universe would need almost infinite mass merely to keep track of the "real," classical-like orbits hiding in each one of its electron orbitals.

Computer science is a far more cautious form of mathematics than are the continuum-fixated versions that tend to assume every pre-expansion of every concept is "free." Computer science deals explicitly with these kinds of choices by looking at a model's *binding time*. You can end up saying identical things mathematically while using vastly different binding time strategies. "Superposition" favors a greedy approach in which you elaborate all possible bindings up front, before anything physical happens. That's *early binding*.

The vastly cheaper process of incompletion, which is how electron orbitals specify huge ranges of options while using very little energy, is an example of *late binding*. That is, until you get enough energy to convert the electron orbital to a new form, the orbital stays forgetful. Not superposed; just incapable of any further localization. The electron exists in the cheapest, most minimal form of what, at much higher energy and memory levels, transforms into classical orbits.

Binding times are a vital topic in computer science. If anything, their role in cleaning up physics math will be even more important. The lack of attention to binding time issues among mathematical physicists, especially those interested in quantum mechanics, is baffling. This is especially true for quantum physics, which, by any objective assessment, is absolutely drenched in critically important binding time questions. Regardless of the historical reasons, it is well past time for physics to start paying close attention to binding times. One example is the need not just to modify the concept of superposition, but to abandon (deprecate) the word. No context exists in which this word provides positive insights into how the universe actually works.



The Unfortunate Consequences of Faraday's Premature Binding

A particularly spectacular example of how inattention to the dangers of premature binding in physics is Michael Faraday's 1852 extrapolation of how fields in memory-rich iron filings and other materials interact with magnetic and electric fields to voids empty of any matter. To be fair, no such mathematics of binding existed at that time. However, the flaw in Faraday's reasoning was readily apparent even at that time: He confused the properties of small chunks of extremely complex matter with the properties of a void that contains no matter at all. He filled every location of that void, *at every scale*, with the equivalent of a complicated Swiss Army Knife of pointers full of infinitely precise direction and power specifications. He thus inappropriately bound the memory and complexity of material particles to every point in a void defined only by metric agreements of objects in one inertial frame.

As with the case of confusing classical orbits with the incompleteness of orbits of electrons, the result was an invocation of astronomically high energies, this time throughout metrical voids with enormous scales. Faraday pre-loaded the vacuum with infinite energy, and seemed blissfully unaware that he had done it. Ironically, the problem wasn't the math, which worked spectacularly well and was immensely valuable. The problem was that his indifference to the distinction between abstract potential metrical locations and actual iron filings confused those iron filings with the vacuum itself, thus instantly making the vacuum unfathomably dense.

The Path to Modern Field Theory

After the brilliant Faraday inadvertently dropped this particularly devastating example of premature binding of non-existent matter to every possible point defined by a valid metrical system, James Clerk Maxwell expanded on it by wrapping Faraday's idea into his model. Maxwell had previously been highly conservative on this point, insisting that only material-like vortices could support actual fields. That molecular model had worked very well for Maxwell, allowing him to prove that light was a form of electromagnetic radiation. However, the simplicity of scaling down his molecular vortex concepts until they became infinitesimal points in infinitely smooth differential equations was too tempting. Oliver Heaviside later collapsed Maxwell's couple of dozen quaternion equations into the far less redundant and much more powerful set of four equations we now somewhat incorrectly call Maxwell's equations.

All of this was amazing work, arguably some of the best in physics history, in fact. Faraday, Gauss, Ampère, Maxwell, Heaviside, and many others captured real physical behaviors in exquisite detail, and thus changed the course of physics. The problem, again, is that binding time issues don't change the predictive value of the math. They only change the physical interpretation of the math, in particular how much "real" matter must exist to implement that behavior on a case-by-case basis. By treating every metrical point defined by a classical inertial frame as "already" possessing what amounted, realistically, to entire molecules of complex magnetic and electric matter, these same brilliant explorers also doomed a century and more of physics into assuming details are always free, and that metrical voids defined only by clocks and rulers were, as Minkowski once stated, full of "substance."

The premise creates the conclusion, since prematurely binding every point in an empty void to material particles necessarily creates Minkowski's "substance." And, unfortunately, since the math works much the same way whether bound early or late, the resulting infinitely bloated pre-loaded model gives an illusion of completion when it is hiding the very issues that most need to be understood: How the universe does all of this with finite resources.

The Way Forward

Simple but hard questions such as "What does an electron do when no one is looking?" are important. You pull at a small thread until you find the point where something unravels, and you relentlessly continue unravelling until the flaw is exposed. In the case of unobserved electrons, this unravelling includes the realization that quantum observation is not only common and mundane, but nothing more than bumping — mutual acceleration — that tells both parties whether the other is. They observe each other. You realize that "superposition" is a mathematical fantasy that does more harm than good, and that the entire concept must fall by the wayside. And, most surprisingly of all, you realize that "spacetime" is nothing more than an impossible fantasy created by binding math too soon.

