Geodesic Quantum Theory

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[Message Excerpt]

>… "Gravity as the path of least quantum collapse" — interesting! So you mean this is a hunch you have without any mathematical outline yet?

Geodesics in Quantum Theory

I should have said, "the *geodesic* is the path of least quantum collapse," since gravity is just an aspect of that. Once you say "geodesic," things get specific quickly. An entity with rest mass — from an isolated particle to a star to a galactic black hole — stays quantum only as long as the general relativity geodesic equation holds exactly:

$$a = \frac{d^2x^\mu}{ds^2} + \Gamma^\mu_{\alpha\beta}\frac{dx^\alpha}{ds}\frac{dx^\beta}{ds} = 0 \tag{1}$$

The tensor equation is, of course, just the relativistically precise way of saying that an object stays quantum only as long no acceleration occurs, $a = 0$. Any form of acceleration ends that geodesic and starts a new one from a new xyz location. That's the deeper story, but you could also say it "collapses the wave function." Another way to describe it is geodesic quantum mechanics. For xyz space, wave collapse becomes a question of when the entity gets bumped by an acceleration, no matter how minute, that knocks it off of its current geodesic and starts initiating a new one. Notably, the geometry of these new geodesics is described *not* by general relativity with its fixed, hyper-classical (and thus fictitious) world lines but by the Schrödinger wave equation.

Size Matters: Smaller is Better

The phrase, "no matter how minute," is essential. Unlike angular momentum, linear momentum does not quantize, meaning that entities can exchange asymptotically small doses of linear momentum. When the doses are tiny compared to the mass of the receiving entity, we relabel it "information." As shown by the astronomically minute doses of linear momentum that individual photons impart to solar sails, this transfer is entirely real and, more importantly, strictly conserved. A solar sail is *not* magic, so no matter how small the doses of momentum become, the universe remains infinitely strict about ensuring they stay conserved overall.

In terms of the geodesic equation, this means that even an acceleration as mind-bogglingly tiny as one photon falling into a galactic black hole is sufficient to *remove* the black hole from its current geodesic path. That, in turn, "observes" the black hole and makes its xyz location a bit better known to the rest of the universe. In such situations, the point to keep in mind is that asymptotically small momentum transfers are, at least in the universe's strict books, never the same thing as *no* momentum transfer. Not understanding this difference is a classical-thinking fallacy that makes understanding the momentum-based nature of "observation" extremely difficult, if not impossible.

Since Newtonian action-reaction accelerations always come in pairs, *observations* also always come in pairs. However, as in the example of a photon falling into (or emitted by) a black hole, these action-reaction pairs can be mind-bogglingly asymmetric in mass and energy. Nonetheless, absolute momentum conservation means a photon interaction between, for example, a human observer and an electron accelerates *both*, causing both to leave their current geodesic. As classical entities, our "current geodesic" — the length of our geodesics before something else bumps us — is so short-lived that we never notice the acceleration. Only lightweight entities achieve geodesic segments long enough to make the quantum and, thus, statistical nature of the geodesic paths obvious.

The Surprising Role of Gravity in Quantum Collapse

One fantastically effective way to keep quantum geodesic segments extremely short is to stand on the surface of a planet. In that situation, Pauli exclusion (mostly) and a mix of other forces almost continually alter and update our free-fall geodesic. They become so brief that, in most situations, they become unmeasurable. Even folks doing extreme-altitude skydiving undergo rapid geodesic updating due to air resistance and, for that matter, photon absorption and emission.

Sir Roger Penrose is on the right track in claiming that gravity collapses quantum wave functions. However, he also got sidetracked by the dominant classical-centric view that wave collapse is rare. The geodesic connection between gravity and quantum collapse is both more straightforward and upside down: It's not the *gravity* that collapses wave functions, but the Pauli exclusion of the earth equivalence-acceleration into the geodesics of objects on its surface that makes it impossible for such objects to become quantum. It's worth noting that even though Pauli exclusion is considered a pseudo-force, in this context, it is fully capable of accelerating surface objects and, thus, of collapsing wave functions. That's a fascinating relationship that needs further exploration.

At the atomic and molecular level, acceleration due to linear or angular acceleration is the *most* common form of interaction in the classical universe. It's what makes us classical! Amusingly, one of the most dominant geodesic breakers in condensed matter is the humble phonon — the quantum of heat or sound — although the photon, the quantum of electromagnetics, also plays a role. Heat happens! When it does, it keeps relative molecular and atomic locations well-defined, preventing effects like superfluidity.

Enabling Quantum by Blocking Acceleration

Fortunately for those of us whose internal chemistry relies on quantum mechanics, free-fall is not the only way of preventing acceleration.

For example, conduction electrons inside a metal resist further acceleration *within that piece of metal* (not outside of it) by filling up all possible conduction band momentum states. Band filling leaves no room for an electron to accelerate into a new state, allowing it to become quantum across the metal unit. Gravity still localizes the *metal* and all of the electrons inside the boundaries of the metal. However, inside that localized chunk of metal, the electrons get a second chance to "go quantum" by filling bands that forbid further acceleration.

Additional Levels of Quantization?

This hierarchical, acceleration-blocking quantization could provide an alternative path to second or many-body quantization. If so, it might provide a new approach to explaining second quantization, one different from the usual focus on electron indistinguishability. That might open up new "acceleration blocked" paths to higher-order quantum effects. For example, do ceramic superconductors exhibit higher-order forms of acceleration blocking that enable new types of quasiparticle bonding? I have no idea, but it's an idea that might provide a new approach to what has proven to be a remarkably intransigent and decades-old quantum theory problem.

No Cat Superpositions Allowed!

Notice that in geodesic quantum mechanics, *every* entity has its reality. That is, it has its causality, clocks, time, space, and history up to the limits of state data imposed by its total complexity. The overall causality of the universe becomes nothing more than a bottom-up amalgamation of all of these independent causality threads. For example, in a geodesic quantum model of Schrödinger's cat, the cat is always either 100% dead or alive. There's *never* any superposition of cat states, only a lack of information (momentum) exchanges between the cat and the amalgamation of causal states that is the rest of the universe.

Similarly, the electron in a double-slit experiment only sees a lack of acceleration while it's in free fall. Its quantum oscillations proceed, just as a small clock in the same situation would keep ticking. Only when the electron encounters the final barrier does the issue of how it got there turn into an enigma, one whose resolution requires a closer look a the very definition of what space is and means.

But why should a newly created geodesic take the form of a Schrödinger wave in the first place?

That gets to your second question:

>... is this related to [QFT's] minimisation of the path integral?

Yes, in the sense that it's QFT path minimization that structures the quantum behavior of the geodesic and leads to the emergence of the Schrödinger wave function.

Why Should Geodesics Be Quantum?

Schrödinger had it right: Everything *is* a wave, which means all versions of mass-energy, even the packages we call particles, constantly attempt to spread. Fortunately, our universe nicely provides a neat little set of forces that *accelerate* mass and energy in exciting ways, including enabling angular momentum that amounts to self-observation. Angular momentum is also the starting point where geodesic quantum theory gets into Standard Model turf.

Once isolated from outside acceleration, all those wavy little entities manage (mostly) to keep each other in check internally via short-range application of quantum field theory, which, surprise, restarts every time two particles accelerate each other.

However, any such entity has finite mass-energy, meaning it has finite resolution. Just as a laser beam dissipates around the edges due to the lack of mutual interference, a solid body can't keep its overall location indefinitely precise. It just doesn't have enough information capacity to do so, though adding more mass helps.

That edge boundary — the limit at which QFT ceases to encounter *internal* accelerations and instead sees… well, nothing… is the boundary where the Schrödinger equation emerges.

The Role of Entanglements

The final point is that no matter how isolated the entity is in terms of *accelerations*, it remains profoundly entangled — in the quantum sense — with the rest of the universe via entanglements. Each entanglement left a signature — the other half of a momentum pair — in the outside universe. One of the early quantum greats — alas, I can't recall which one — noted that the Schrödinger wave function is simply the maximum knowledge we can have about the particle.

If we are tricky enough, we can collect quite a bit of that originating information and use it to create our model of what the isolated systems is "thinking" at its rather ratty QFT edges, the summary of which becomes its Schrödinger geodesic. No matter how carefully we collect that information, it remains probabilistic because it is nothing more than an *image* of what is going on inside the independent entity.

Enough for now. Many of the above items are, no surprise, in transit. However, the quantum geodesic part is, I think, quite solid.

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