Thermodynamics Sets the Line Between Quantum and Classical

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https://youtu.be/dIEoPZijgAU&lc=Ugwfb-HQq-BgtAaZbKV4AaABAg

A Comment on the Closer To Truth (YouTube) post:
Raphael Bousso - Physics of the Observer (Aug 23, 2023)
https://youtu.be/dIEoPZijgAU?t=6m2s

6:02 RB *"Nobody … tracks all the particles [and] light … that interact with a system [since] that would be impossible. [Yet] no one has [a] consistent theory [of] what [happens] when we* don't *keep track. … It is … irritating and disconcerting that what happens in nature might depend on how we draw that line. … A few years ago, Lenny Susskind and I [sought] a more objective way [to] divide the universe into [the seen and unseen by] drawing on … black holes [studies.]"*

There's no need for black holes, Professor Bousso. You answered your question: It's impossible to track every particle in a system classically. But why is that? It's because the energy cost of observation — of knowing where the parts of some system reside at a moment of observer time — stays very low for a vast range of low-to-medium-high nosiness, but quickly shoots to infinity if you get *too* nosy.

Where's the plane? Radar says "Here!" The passengers don't even notice. Where are the hands of their retro-mechanical watches? A brilliant flash of visible light says "Here!" This time the passengers notice but survive. Where are the electrons in every orbital of every atom in the plane? The most intense burst of extreme gamma radiation in the history of the universe says "Here!", but also vaporizes not just the plane, but the Earth and solar system, including the sun down to its core.

It's the extraordinary width of that nosy-is-okay safe zone — a zone also known as *classical physics* — that fools us into thinking the arc of a thrown baseball is a "good" model for electrons around atoms.

It isn't. No matter what our classically wired brains and classically inspired math models tickle us into believing abstractly, electron orbitals exist *only* in the absence of intense observation. They do not become "point-like" unless they are horrendously disturbed by energies far above range in which they exhibit valuable properties such as volume (being part of a black hole is *so* boring) and chemistry.

So, where should humans set the line between the seen and unseen?

The answer is that this is the wrong question. We don't set that line. It's the sea of not-too-cold, not-too-hot self-observation energies provided by thermodynamics that sets the line for us. Especially in the case of warm, Earth-like planetary surfaces, thermodynamics enables just the right mix of stable wave-like phenomena (e.g., orbitals) and emergent "tossed ball" classical behaviors to make life both possible and interesting.