Grand Problems, Mini Problems, and Fixing Dumb Errors

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https://www.youtube.com/watch?v=k0oNkO2YI-w&lc=UgweV6wm0OAiqOCgXkd4AaABAg

Comment on YouTube 2veritasium post:
The Climbing Magnets Mystery (ft. Steve Mould)
https://youtu.be/RnTzx78xkMc

Problems that resist resolution become "grand" over time, but that does not mean their answer is beyond the problem-solving abilities of clever folks like Oli, Hugh, Steve, and Derek.

Oli from Reading posed an interesting mini-mystery four years ago: Why do twirling magnets climb? As Hugh Hunt figured out and Steve nicely illustrated, it's because gravity biases a rotating pivot point.

Steve twice contrasted this "mini" mystery of climbing magnets with "grand" puzzles such as why quantum mechanics and relativity remain estranged from each other. However, just because a riddle is grand doesn't mean folks should assume its resolution is necessarily complex and beyond easy comprehension.

The overall history of science does not support that assumption. While new ideas in physics often seem strange and counterintuitive, they have also trended mostly towards getting simpler and fewer over time. That, in turn, suggests that even grand mysteries sometimes have simple resolutions.

For example, what if the root cause of a grand mystery is not a lack of insight but an ordinary human error?

A century ago, Hermann Minkowski arguably committed such an error by imposing an infinite-precision -- and thus *inherently* non-quantum -- interpretation of spacetime on top of Einstein's 1905 clocks-and-rulers-version of special relativity.

The pre-Minkowski Einstein defined space and time solely in terms of material clocks and rulers. At small enough scales, such material clocks and rulers necessarily become quantum. Thus any particle-level extension of Einstein's pre-Minkowski clocks-and-rulers version of spacetime would have stayed fully compatible with quantum theory. It was only Minkowski's insertion of infinitely perfect spacetime that created the gulf between quantum and relativity theories.

Since, in this case, the cause was a human error, the level of insight needed to merge quantum and relativity theories is neither grand nor profound. Hugh's "mini" insight on climbing magnets is considerably cleverer, for example. However, the century-long persistence of Minkowski's error does provide a sad commentary on how rousing, poetic speeches and the politics of research funding can sidetrack physics theory for decades or even centuries.

Fixing this well-aged, deeply entrenched error is where things get messy.

If spacetime is nothing more than a finite network of measurement relationships between particles-as-clocks and particles-as-rulers, then our view of space and time becomes sharp and well-defined only when large numbers of particle clocks and rulers form measurement relationships with each. That happens, for example, when hot atoms form myriads of Newtonian action-reaction pairs -- increasing entropy -- in plasmas, dense gases, liquids, or solids.

Condensed matter physicists thus are on nicely solid ground when they use models that assume infinitely precise fields. Cosmology, on the other hand, quickly gets a bit weird. Moving upwards in scale, modeling impacts of particle-limited, clock-and-ruler spacetime could emerge as early as in how to predict ring structures around planets. Particle-density reductions in spacetime resolution would undoubtedly have a profound modeling impact when you get to galactic scales.

The most painful impact of clock-and-ruler spacetime is on quantum field theory, where it requires rewriting of Minkowski-precise, pre-existent particle excitation fields into incremental emergences of field-like behaviors as more particles become entangled in the calculations. On the positive side, computer models of such behaviors would likely be enormously more efficient.

Quantum computing also gets flipped upside down since the entangled matter around the quantum wave function becomes the source of the calculations, not the quantum wave itself. The quantum wave becomes little more than a focal point for arranging the surrounding ordinary matter into a sufficiently powerful and noise-free configuration to complete the desired calculation.

As condensed matter creatures, we live in a sharply defined, intensely Boltzmann world in which matter is matter and space is space. (Hmm, why do I have this sudden image of Archie and Edith Bunker singing?) However, in deep space, things don't work that way. In the absence of a sufficient density of particles, there is no longer enough spacetime resolution to define precisely where the energy of that region, especially momentum energy, is located.

That last point connects to another "grand" mystery Steve mentioned: dark matter. Dark "matter" is a uniquely bad name for the non-particle four-fifths of the total energy of our universe, mostly momentum, that lacks enough entangled fermions to give it a well-defined location. Another way to say that is our classical world is just the visible one-fifth tip of a much larger quantum computer that spends the vast majority of its energy and time making sure the emerging future doesn't conflict with the established past.