Physics Math Must Be Infinitely Smooth, But Only at a Price

Terry Bollinger
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I like your argument, but at least at first glance, I am a bit unsure if it differs fundamentally from the infinite limit-of-deltas method my texts used many years ago.

Also, here is an important point regarding the application of calculus to physics:

"… the Planck length — a hypothetical shortest length in our Universe."

Wheeler's hypothesis (of course it was Wheeler!) that spacetime turns frothy and weird at the Planck scale was soundly disproven in 2020 by the HAWC Collaboration's study of extreme cosmic gamma rays.

The quick version is this: For particles with such extreme electromagnetic frequencies to exist and travel cosmic distances, spacetime must be *at least* 1800 times smoother than Wheeler's comparatively huge, clunky Planck units.

This was not a trivial finding. I watched no less of a person than Roger Penrose express profound surprise at this finding when it came up in a live-chat Zoom session (this was back during COVID). Like the majority of modern theoretical physicists, he had accepted decades ago that Wheeler's hypothesis was inescapable, and so had assumed ever since that space has a finite granularity.

Experiment sometimes has a funny way of getting in the way of "incontrovertible" hypotheses, and the HAWC Collaboration disproof of Wheeler's Planck hypothesis was a nicely pointed example.

I'm bringing it up here because we need a calculus with no fixed limit on how small things can become. As best we can tell, the physical world is capable of producing as small of a scale as we have energy available to put into the system.

My suggestion is this: Rather than constraining continuity mathematics to discrete scales, we need to attach a cost function to the calculus. You can have an infinite limit, but only at a price.

That matches well with the physical world, since you may have noticed how I emphasize that, if you have enough energy, you can go down to any small scale you choose.

That cost qualifier is important, yet most of our mathematics treats the cost of calculation as an irrelevant detail. That casual indifference to calculation cost is a bit arrogant, since, for example, calculating the hypothesized infinite number of digits in pi is impossible in any physically possible universe. One can hypothesize that this number exists in pristine

beauty in some Platonic world, but you can never _reach_ that Platonic world using calculation. The calculation cost attached to the concept of pi prevents it from ever being a fully defined entity in any real calculation.

So why have you not heard before about Wheeler's Planck-scale hypothesis being demolished experimentally?

It's a lovely example of the irrationality that necessarily arises in sunk-cost economics. Nearly all current theories of quantum gravity, including in particular "super" strings, depend profoundly on Wheeler's disproven hypothesis. For example, the fancy multidimensional "super" strings of what is now incorrectly called "string" theory — historical string theory was an experimentally well-founded 1960s attempt to explain stringy quark orbitals — hypothesizes Planck-scale "super" strings. The experimental proof that gamma rays require about 2,000 times finer spacetime than "super" strings can provide effectively makes irrelevant half a century of: "super" string speculation, papers, careers, conferences, university groups, and even whole departments, probably in the range of a billion dollars of total federal investment, innumerable breathless glossy-graphics YouTube videos, and, worst of all Brian Greene, who is a great science writer.