

Cosmic Holography with No Fanciful Planck Bits

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https://www.youtube.com/watch?v=3n10ovuND0Q&lc=UgyA9945_ira-t21PWJ4AaABAq

YouTube comment on Science Time post:

Is The Universe a Hologram? Brian Greene on Quantum Gravity & Black Holes (Apr 9, 2022)

<https://youtu.be/3n10ovuND0Q>

00:35 "This is not just a wild speculation." Yes, it is. Gerard 't Hooft ignited interest in 2D external-sheet holography with his 1993 fiat declaration that "One Boolean variable per Planckian surface element [of an event horizon] should suffice." [1] Realistic, physics-based bits require complex mechanisms to fight back quantum uncertainty and become *harder* to implement at sub-atomic scales, not easier.

2D holographic sheets nonetheless approximate reality because quantum mechanics has been holographic since the 1920s. The founders of quantum mechanics quickly realized that the holographic equivalent of the Schrodinger wave function, called the momentum-space wave function, is just as fundamental as the xyz version. The word "hologram" did not exist then, so they expressed the relationship in terms of Fourier transforms. The quantum holographic relationship works in both directions since the xyz view is also the hologram of the momentum-space view of reality: a two-way or dual hologram.

Quantum holography is far closer to 3D-matrix or "Denisyuk" holography than 2D planar holography. Instead of speculative external 2D branes of paradoxical bits, vast swaths of ordinary matter encode more conventional forms of information to express the hologram. A new (April 2022) PRL paper [2] explores the fascinating problem of how the universe encodes itself holographically by looking at black holes in a way that flips the 't Hooft model upside down.

No one in the 1920s knew how to integrate momentum holograms with general relativity if they even thought to try. Thus, the cosmic branch of quantum holography remained in limbo until 't Hooft reintroduced the idea, albeit in a needlessly exotic fashion. In sharp contrast, quantum holography with a different terminology quickly exploded for condensed matter physics and remains vital to that field a century later. Folks interested in cosmic quantum holography thus might want to talk more to condensed matter folks.

[1] G. 't Hooft, *Dimensional Reduction in Quantum Gravity*. arXiv Preprint Gr-Qc/9310026 (1993). See page 6, paragraph 2, sentence 4.

<https://arxiv.org/abs/gr-qc/9310026>

[2] X. Calmet, R. Casadio, S. D. Hsu, and F. Kuipers, *Quantum Hair from Gravity*, Physical Review Letters 128, 11 (2022).

<https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.128.111301>

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