The Quantum-Holographic Quasar Jet Hypothesis

Terry Bollinger
2023-08-01.12:00 EDT Tue *(addendum on 3D-to-3D holography added 2023-08-06)*
https://www.instagram.com/p/CvVhcCovaVO/c/18020645665623938/

A Comment on the Closer To Truth Instagram post:
Dive deeper into the holographic principle and black holes with physicist Leonard Susskind (Jul 30, 2023)
https://www.instagram.com/reel/CvVhcCovaVO/?utm_source=ig_web_copy_link&igshid=MzRlODBiNWFlZA==

Terry Bollinger, Jul 31, 2023:
https://www.instagram.com/p/CvVhcCovaVO/c/17963956874424881/

Leonard Susskind, thank you for a beautifully stated and nicely succinct description of the entropic nature of the event horizon. A question: What do you think determines the maximum possible bit density per unit area of the event horizon?: (a) the total mass-energy of the black hole, or (b) the vastly larger Planck-scale density that Gerard ‘t Hooft proposed in the 1990s?

Terry Bollinger, Aug 1, 2023:
https://www.instagram.com/p/CvVhcCovaVO/c/18020645665623938/

Just to wrap up my question to Leonard Susskind: The answer is, of course, (a). That is, the data storage per square centimeter of an event horizon is necessarily proportional to the total mass-energy of the black hole.

The mind-bogglingly higher number that Gerard ’t Hooft — one of my all-time favorite physicists, incidentally — tossed out in the 1990s was pure, unadulterated speculation. There was a huge surge in interest by physicists at that time in “bits,” which, at that time, seemed as magical and mystical to most physicists as electricity was to Mary Shelley.

To those of us involved in building and using the phenomenally tricky and physics-heavy storage devices that approximated this abstraction of a perfect bit… wow, the magic *so* wasn’t there! Bit storage is *hard.* Notably, the up-down electron spin version of a bit, upon which qubits are based, was and remains to this day one of the trickiest and *most* difficult ways to store bits.

But what if “bits per centimeter” isn’t even the right question?

Holographic data storage is not new. There were many attempts to commercialize it, but to the best of my knowledge, they all failed. One reason why they failed is the extremely odd way they store individual bits or pixels: as *holograms* spread across the *entire* emulsion. If you cut the emulsion in half, you still get the same bits, just at half the certainty you did before. If that relationship sounds familiar, it should: It’s the same Fourier transform math behind Planck uncertainty.

Gerard ’t Hooft — the ’t stands for “het,” English “head,” the leader of Hooft — in more recent papers looked closer at momentum relations on the event horizon. To me, those look more like emulsion-style holographic data storage: Any single square centimeter of the surface ends up with *no* recognizable bits of particle information. You only get what we call bits — or particles — when you sum the *entire* event horizon together. Holography!

Another name for this kind of delocalized representation of particles is momentum space, and that presents an interesting question: Is the holographic event horizon of a black hole not much more than a curved instance of momentum space?

And that brings up something that will seem, at first, to be a complete tangent. Please bear with me for a bit (a “bit”? Heh!):

Touch a piece of metal — silver is best — and ask yourself a question: Why were your fingers not incinerated by the vast numbers of X-ray intensity electrons surging through that metal continuously? Those are the same Fermi surface electrons responsible for its reflectivity, incidentally.

Answer: Those X-ray-level electrons reside in momentum space, meaning they are delocalized over the entire metal surface. They are *holographic* electrons, ones that can return fully to the 3D space of your fingers only if an unexpected hotel vacancy opens up at the bottom of their state space. Paradoxically, they are simultaneously unbelievably hot in momentum space yet cool to the touch in ordinary space. This is possible because their existence primarily in momentum space isolates them from you in several interesting ways.

Now, returning from the tangent: Have you ever wondered how the event horizons of black holes — which by some metrics are the most energy-intense regions in the universe, e.g., at those polar jets — can simultaneously grow darker and colder in ordinary space even as the black hole grows larger and more energetic?

I’ll let you, good reader, think about that.

The bottom line for me is that even though I can see no easy justification for arbitrarily invoking the enormously more energetic Planck scale when discussing black hole event horizons, I fully agree with Leonard Susskind that black hole event horizons are very, very holographic. If anything, I would take this idea farther than he does, at least for understanding black holes better.

Finally, here’s a research question that occurred to me as I was writing all this:

Has anyone explored whether the rotating geometry of a spherical momentum space might produce quantum vortex effects at the polls that then transform into energetic outflowing jets? These would be mathematical singularities, and so could get incredibly intense. Perhaps Richard Feynman solved the quasar jets problem without realizing it: They are just a scaled-up version of his liquid helium vortices.

Vikram Poddar: *Is this similar to having an image map in space but with 3 co-ordinates instead of 2?*

Terry Bollinger on 2023-08-06.13:10 EDT Sun: (https://www.instagram.com/reel/CvVhcCovaVO/?igshid=MzRlODBiNWFlZA==)

If I'm following your question correctly, yes: The holography of the standard quantum space-momentum duality is closer to 3D or thick-film holography, that is, the use of a three-dimensional emulsion instead of a two-dimensional one. Thick film holograms are the ones that show color better and have fewer rainbow effects, giving surprisingly real-looking images.

I worry that the 1990s fascination with the stupendously high encoding densities presumed for black hole event horizons [1] unintentionally sidetracked everyone from the simpler idea of lower-resolution, flat-space holography as encoded in standard quantum theory. In the 3D-to-3D holography of standard quantum theory, you have two mutual projections whose density variations encode each other. That has a nice symmetry that is captured beautifully in the standard interchangeability of spatial and momentum space wave functions.

Planck's constant was first derived as the literal fulcrum point between these two views of the universe. In combination with Planck's constant, the degree to which an entity is compactly localized in one of these 3D universes determines how diffuse and delocalized — literally how expansive of a hologram — it becomes in the other 3D universe.

The difficulty — and opportunity — is that the simple 1920s symmetry between two fully spatial universes cannot possibly be fully correct. For example, special relativity tells us that each such encoding requires localization to the xyzt coordinates of a single inertial frame, while observation tells us that every experimentally meaningful inertial frame has finite scope and participation based on its acceleration history. If so, where are the dynamical equations that tell us how these two sets of dual holographic entities interact? We don't have them, mostly because what I have just said is a more detailed way of saying, "What, exactly, is wave collapse?"

Due to such omissions, some of the most interesting physics insights of the next few decades may well come not from particle accelerators but from gaining a deeper understanding of the local and global dynamics of how diverse, multi-scale, and overlapping two-way holographic subsets of matter and energy interact with each other. That is also where you are most likely to find a deeper definition of time.

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[1] 't Hooft's 1990s proposal of Planck-scale holographic resolution is not based on any version of experimental quantum physics. Lab physics always and only gives the simple and much lower resolution Planck resolution relationship first captured in the 1920s.

The truly stupendous, out-of-the-blue ’t Hooft encoding densities stem instead from 1970s s-matrix attempts to resurrect Pauli’s badly-failed 1930s attempt to discard Einstein’s curved space gravity and replace it with a flat-space, boson-based “graviton” force. These gravitons, which would never have explained curved space gravity anyway, required energies comparable to the Planck scale.

Despite this delightfully, almost comically dubious pedigree, the idea of a Planck-scale foam was so deliciously bizarre that it became a rock-solid “it is known!” faith assumption of mathematical physics, one that persists to this day. How could you *not* love the foamy latte of the Planck scale once you skimmed over its shaky history? Planck foam replaced boringly finite 1920s holographic transforms with infinite energies, insane uncertainties, and Marvel-comic-scale multiverses. For some, alas, it was also a tempting opportunity to bask in their possession of unique insights not available to the uninitiated.