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Clive Tickner B.A. BSC;
Diploma; theoretical physics; Stanford University
clivetickner@aol.com

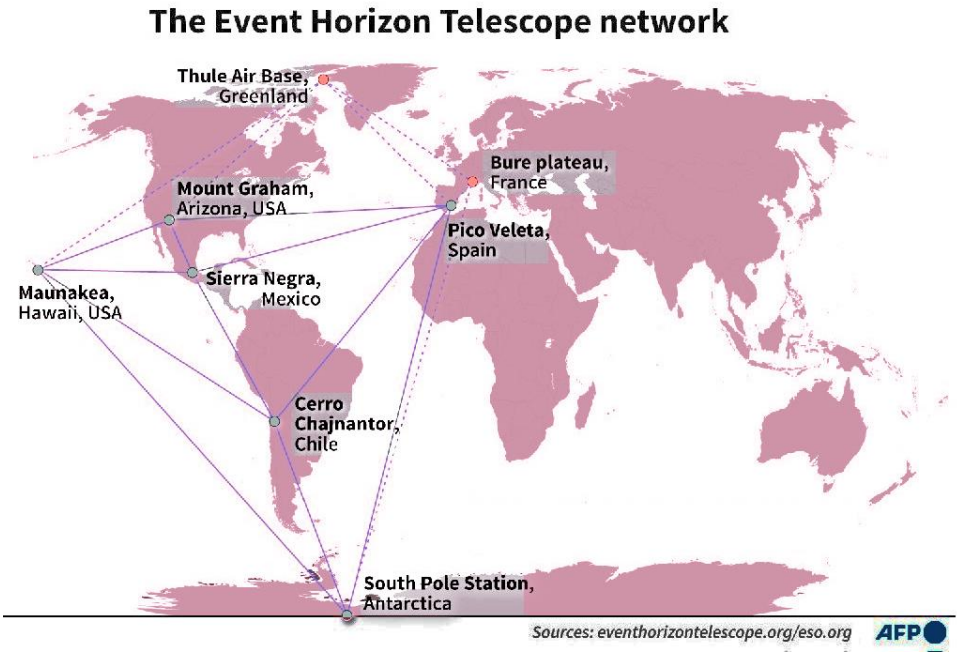
Questioning the Event Horizon Telescope's "First Image" of a Black Hole

Abstract

In April 2019, the Event Horizon Telescope (EHT) collaboration made headlines with the announcement that they had captured the "first image of a black hole", specifically the one at the centre of the galaxy M87.
This assertion was accompanied by the widespread promotion of an image of Sagittarius A*, the supermassive black hole at the centre of our own Milky Way galaxy, as a dense, swirling, orange ring with a dark centre.
Whilst this feat has been celebrated as groundbreaking, a closer examination reveals that the image in question was not a photograph in the conventional sense, but a carefully constructed illustration based on sparse and imperfect data, heavily influenced by pre-existing theoretical models.
Was this announcement promoted to enhance the scientific community's reputation, or just as a novelty for a naïve and easily impressed public?

Keywords

Algorithms, network of radio telescopes, 4.5 petabytes of data, black hole's appearance, pre-existing models, hypothetical image, Sheperd Doeleman, Hotaka Shiokawa, a reasonable image, mathematical manipulations.



The dubious process

The EHT has since admitted that the collected data was incomplete and had, therefore, to be ‘filled in’ using specially created algorithms. Those algorithms, however, were generated through assumptions that were not entirely objective.

The so-called ‘first *image’* of a black hole is, nonetheless, an *artistically conceived* reconstruction and certainly not an empirical photograph. The claims surrounding it appear, now, to be entirely overstated,

To understand the problem with the EHT’s claim, it is crucial first to examine the data they *did* collect, using a network of radio telescopes spread across the globe. The network gathered around 4.5 petabytes of data, which was shared across a team of analysts, whereby, as it now transpires, the material could be assembled or interpreted in a myriad of *different* ways.

Whilst admitting that their effective data was sparse, they suggested that what they *had* could resemble playing "broken keys" on a piano, maintaining that these isolated "notes" could assuredly be pieced together into a coherent (song) image. Thus, the scientists had to rely heavily on their sophisticated, but possibly incomplete, or even irrelevant, algorithms and, maybe, biased assumptions- to fill in these gaps.

In comparing the missing pieces of data to a "song" with deficient notes, they confidently asserted that they could "fill in the holes" to make the song recognizable. It might be possible to recognise a song with which you are *already familiar*, just hearing odd notes, but if you don't know the tune beforehand at all, you could *never* guess it.

This awkward analogy may appear useful in explaining the process, but it reveals the core issue: without knowing the full data, or the complete nature of the object being observed, the scientists were making *subjective choices* about how to reconstruct the black hole's appearance.

The influence of these pre-existing models and concepts is one of the critical concerns about the EHT's result. They not only made decisions on what the "image" *should* look like, based on this inherent set of assumptions, but also upon a hypothetical image constructed by the astrophysicist-artist Hotaka Shiokawa. (who had previously published his notion of what the black hole at the centre of the Milky Way might look like). It was this "concept" which became a template upon which the EHT based its analysis.

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Subsequent to this, the EHT physicists acknowledged that their algorithms had to "rank" the *infinite number* of possible images- based on how "*reasonable*" they looked. But the term "reasonable" is also inherently subjective. After all, what is "reasonable" or "natural" in the context of black holes.

This assumes that the scientists *already knew* what the image of the black hole *should* look like, again based on their theoretical understanding and questionable mathematical manipulations.

As the EHT's lead scientist, Sheperd Doeleman, unwittingly, admitted: "There are an infinite number of possible images that are perfectly consistent with our data." The "final" image is just *one of many* possibilities.

This subjectivity becomes even more problematic when you consider the claim that the resulting image represents a "first look" at an object, which, by definition, defies conventional observation. Especially as their proclaimed properties make them fundamentally invisible.

Regrettably, then, this image was presented to the public, through widespread media coverage, as an historic achievement, when, clearly, it was not an objective representation, as implied, but just a visual artifact created by theoretical biases.

Whilst this should not detract from the immense scientific achievement of gathering data from such a distant and difficult-to-study object, it does call into question the way this data was presented to the public, who, most probably, did not truly understand the limitations of the presentation; they being misled by the sensationalized findings.

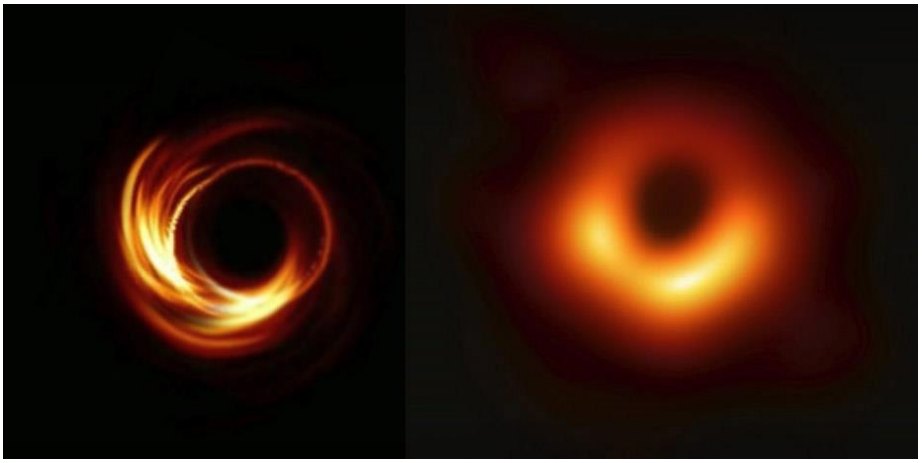
Yet the term "photograph" is still often being used in describing that famous image, implying something directly captured, as though it were a genuine photograph of a distant planet or star.

Conclusion

While the EHT's work has undoubtedly pushed the boundaries of observational astronomy, their announcement of their delivering the "first image of a black hole" is disingenuous to say the least, when transparency in physics is essential.

As we continue to explore the universe, it is crucial that we remain vigilant about the narratives we build around scientific discoveries, especially when those narratives are shaped by uncertainty and incomplete data.

Lastly, the extraordinary similarity of this claimed 'real' black hole to the earlier composite provided by Hotaka Shiokawa must surely attract some questioning remarks, especially as more recent concepts of a black hole's appearance differ greatly.



Hotaka Shiokawa's concept art-work for the EHT collaboration, and the astonishingly similar EHT discovery, created from 4.5 petabytes of data

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NOTES

(https://eventhorizontelescope.org/science) Quotes;

The broken keyboard suggestion;

Video credit: Katie Bouman

"To give you an idea of how this works, you can think about the measurements we make from telescopes in the EHT as a bit like notes in a song…… as you go on you are hear (sic) more and more notes until eventually you will start to be able to make out a (hopefully familiar) song. You may have been able to start to recognize the song— Vanilla Ice's "Ice Ice Baby." ….it's pretty amazing that your brain can fill in holes and you can start to make out the song. What your brain was doing here is very similar to what the imaging algorithms that we develop for the EHT do. Using the sparse data we collect from the telescopes, our algorithms fill in the missing gaps with the most natural looking image. In fact, you may have thought that the song was Queen and David Bowie's song "Under Pressure." If those were the only notes we heard we would be in trouble, as there are multiple songs that fit the notes we are hearing fairly well".

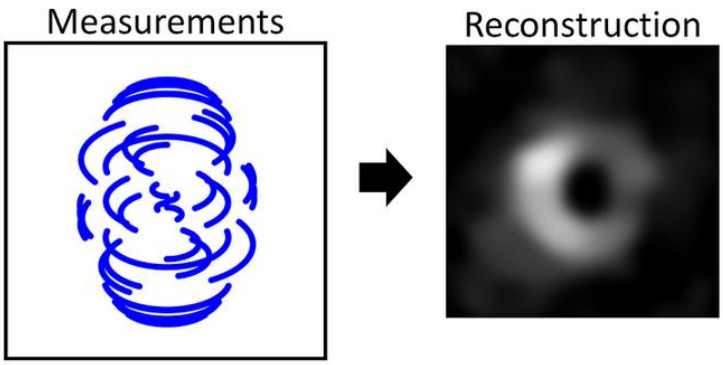

Image credit: Katie Bouman

"Similarly, for the EHT, the data we take only tells us only a piece of the story, as there are an infinite number of possible images that are perfectly consistent with the data we measure. But not all images are created equal— some look more like what we think of as images than others.

To chose (sic) the best image, we essentially take all of the infinite images that explain our telescope measurements, and rank them by how reasonable they look. We then choose the image (or set of images) that looks most reasonable."

"Using these algorithms (sic) we are able to reconstruct pictures from the very sparse measurements measured with the EHT. Below is a sample reconstruction done using simulated data generated from only 7 telescopes located around the world, and pretending to point at the black hole in the center of our own Milky Way galaxy. Although this is just a simulation, reconstructions such as this give us hope that we soon will be able to to (sic) reliably take the first picture of the black hole.

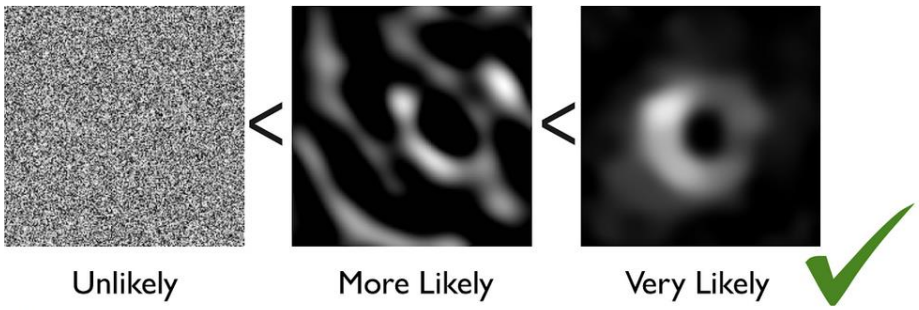

Image credit: Katie Bouman

From this rare admission we note that they are no longer claiming to have provided / discovered, the first picture of a black hole, but hope to be able to do so soon!

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