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Our Galaxy has a heavy heart

Taking a look at the science behind the image of the Milky Way's black hole

Prof Chris Lintott is an astrophysicist and co-presenter on *The Sky at Night*

The Event Horizon Telescope's image of the silhouette of the black hole at the centre of the Milky Way appeared on news bulletins and front pages around the world, but the real jam in this celestial doughnut is in the series of papers released at the same time. So what have we learnt about Sagittarius A*, our local supermassive black hole?

For starters, it's slightly more massive than we thought. Instead of just producing an image, the data from the telescope must be modelled, with a computer working out what black holes of varying properties might look like and comparing the result to the observations collected from the EHT's network of telescopes. This process suggests a black hole four million times the mass of the Sun.

One of the reasons we've had to wait until now to see these images, when those of the larger but much more distant black hole in M87 were released in 2019, is that the activity observed in the material surrounding the black hole makes forming an image hard. The largest scale structures seen in the images change from hour to hour, and on smaller scales things change from minute to minute. This activity must be associated with the material surrounding the black hole, rather than the black hole itself, but it is still impressive.

> ***"The largest-scale structures seen in the images change from hour to hour, and on smaller scales, from minute to minute"***

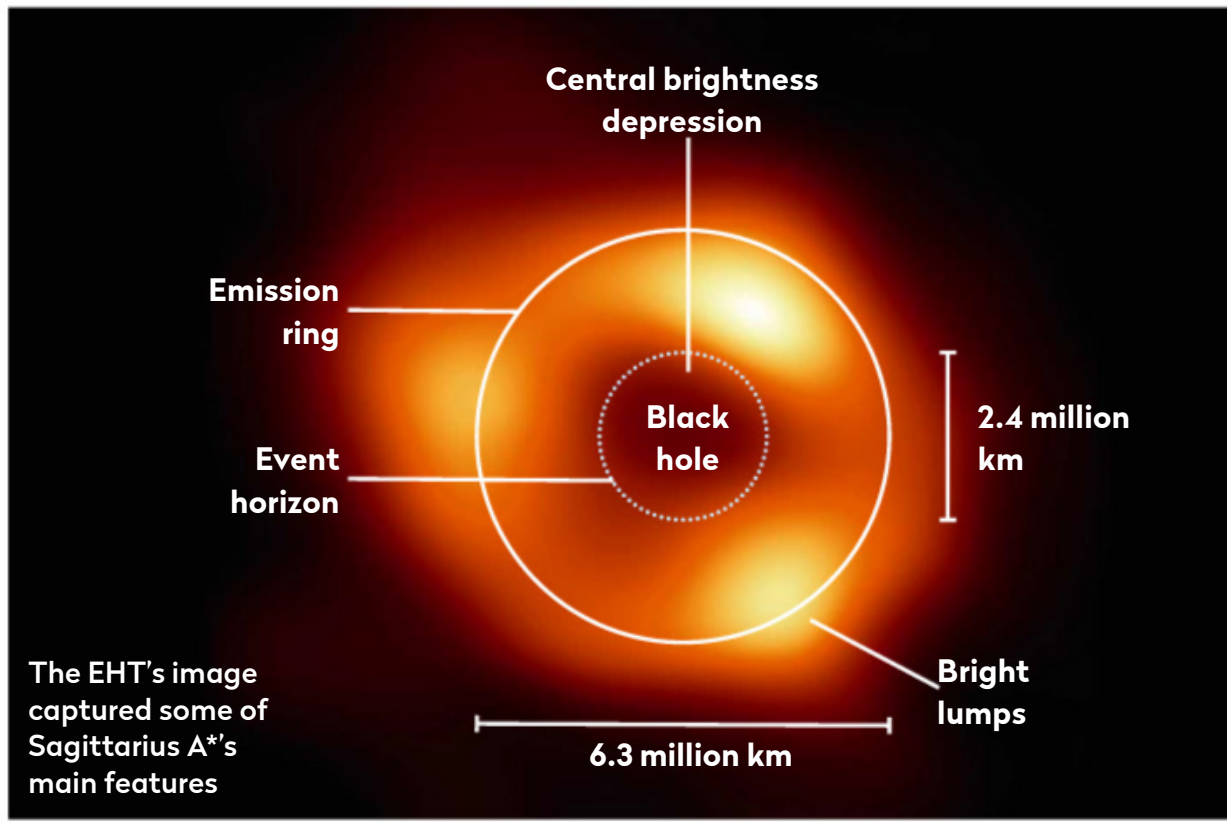
Lumpy material

Once the variability has been accounted for, a careful measurement of the size of the silhouette can be made. This is useful in testing the basic general relativistic equations that describe the black hole. It turns out all is as expected, and the data fits perfectly with what we think it should be for a slowly rotating black hole. The most distinctive feature of the images is the three lumps which surround the central shadow. The position of these is actually rather uncertain; models which place them at different points around the centre are almost equally consistent with the data collected by the telescopes. Nonetheless, there is some lumpiness in the material surrounding the black hole, presumably sculpted by powerful magnetic fields in the region. There's a hint in these images of the detail we'll see in the next phase of EHT observations, which should provide a movie showing changes around the black hole.

In the meantime, many of my colleagues were surprised that the image indicates that the accretion disc around the black hole is somewhat inclined toward us. As we're embedded in the Milky Way's disc, that means that material falling into the black hole doesn't arrange itself to align with the wider Galaxy's structure. It seems likely that the angle changes over time, as mergers and accretion of material swept into the centre change the black hole's spin. Given that jets from material accreting onto the black hole are believed to be capable of driving gas from the Galaxy, switching off star formation, the fact that they could swing around in any direction may prove to be important.

Intriguingly, the authors note that no single model of the material around the black hole can account for all aspects of the data. The doughnut at the centre of our Galaxy may surprise us yet.

▶ **Turn to page 67 for more on Sagittarius A***



The EHT's image captured some of Sagittarius A*'s main features

Chris Lintott was reading... *Focus on First Sgr A* Results from the Event Horizon Telescope, a collection of papers on the image*
Read it online at: https://iopscience.iop.org/journal/2041-8205/page/Focus_on_First_Sgr_A_Results