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# THERE'S A MONSTER IN OUR BACK YARD, BUT IT'S NOTHING TO WORRY ABOUT

Not even light can escape the black hole at the centre of our galaxy. But we'll be fine... as long as we keep a safe distance

In May 2022, astronomers took the first photograph of the monster in our backyard: Sagittarius A\*, the supermassive black hole, four million times as massive as the Sun, lurking right in the middle of the Milky Way.

The Event Horizon Telescope, a global collaboration that links observatories around the world to combine data into a single ultra-high-resolution image, specialises in capturing the 'shadows' of supermassive black holes.

Rather than blocking light, a black hole makes its shadow by bending the space around it so violently that any light that passes near it – for instance, the bright glow of the matter whirling around in its accretion disc – is distorted and redirected, with some of it being pulled into the object itself.

This distortion wraps the light around the hole like a cloak, but leaves a gap in the centre, which appears to an observer as... well, a black hole. The shadow is dark, not because the light was blocked, but because it has been consumed.

The event horizon from which the telescope takes its name, is the spherical boundary around the black hole that marks the point of no return: anything that crosses that boundary is drawn inexorably into the centre of the black hole.

At the event horizon, the escape velocity (that is, the speed required to escape the hole's gravity) equals the speed of light. Einstein's theory of Special Relativity sets light speed as a hard limit: nothing in the Universe can exceed it, so nothing can escape a black hole.

The image of Sagittarius A\* further confirmed for us that not only do supermassive black holes exist, but that relativity's rules are (literally) inescapable.

Of course, Sagittarius A\* consumes more than just passing light. Like all supermassive black holes, it pulls in whatever gas, dust and superheated plasma might be lingering close to its horizon. Every once in a while, to the great delight of astronomers, supermassive black holes consume entire stars, which, when ripped apart by the tidal forces, emit bursts of X-ray light.

So far, all we've seen Sagittarius A\* eat is a couple of clumpy clouds of gas, but we know it wouldn't be picky.

So, should we be worried? Is having an insatiable four-million-solar-mass behemoth sitting in the centre of our galaxy like a drain hole in a cosmic bathtub? Is it something that keeps astronomers up at night?

No. Because, despite their reputation, black holes (of any size) are completely harmless to anyone with the good sense not to approach them. It comes down to a subtlety of how gravity works at different distances.



## “If the Sun collapsed and became a black hole right now, Earth would just keep on orbiting”

According to Einstein’s theory of General Relativity, what we experience as gravitational pull is the result of the space around a massive object being curved toward it, which alters how objects and light move through that space.

All matter (and energy) bends space to some degree, and because gravity is an infinite force, the space you’re in right now is affected at some infinitesimal level by the gravity of every other thing in the Universe.

The special thing about a black hole is that the curvature very close to the singularity at its core is so extreme that, within the event horizon, motion away from the black hole becomes impossible. In other words, any path away from the singularity curves back on itself.

Even in the near vicinity of the horizon, extreme tidal forces can destroy anything that comes too close. But once you’re outside of that danger zone, the spatial curvature looks identical to what you would

experience an equivalent distance from any ordinary star or large clump of matter.

If the Sun collapsed and became a black hole right now, Earth would just keep on orbiting, completely unaffected. It would get very cold and very dark, but we’re far enough away that there would be no gravitational measurement we could do that would tell us that the black hole was not just an ordinary (though disturbingly dark) star.

When it comes to Sagittarius A\*, the supermassive black hole at the centre of the Milky Way, its gravitational influence on our Solar System is not only non-threatening, it isn’t even particularly important for our orbit around the Galactic Centre.

The clump of stars, gas and dust at the centre outweighs it by orders of magnitude, and that’s not even counting all the ghostly dark matter filling all that space. Our galactic orbit, along with the orbits of all the other stars in the disc, remains safe.

For now, at least.

In about four billion years, the Milky Way will collide with the Andromeda Galaxy, scattering stars and planets across the cosmos in chaotic streams like tossed glitter, and likely causing the supermassive black holes at the two galaxies’ centres to spiral together and merge.

There’s no telling what will have happened to our local clump of stars by then, but, hopefully, somewhere far across the cosmos, someone will have their camera ready and capture a truly amazing view.



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