

What would happen if Earth fell into a black hole?

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Don't get too close. Credit: NASA/JPL-Caltech, CC BY-SA

Black holes have long been a source of much excitement and intrigue. And interest regarding black holes will surely grow now that gravitational waves have been discovered.

Many of the questions I am asked regard how "true" [science fiction](#) concerning [black holes](#) might be, and whether [worm holes](#), such as those

featured in [Stargate](#), are real or not. Invariably though, the one item that is almost assured to come up are the largely gruesome ways in which black holes might theoretically affect human beings and the Earth itself.

Mass, charge, spin

There are three properties of a black hole that are (in principle) measurable: their mass, their spin (or angular momentum) and their overall electronic charge. Indeed, these are the only three parameters that an outside observer can ever know about since all other information about anything that goes in to making up a black hole is lost. This is known as the "[no hair theorem](#)". Put simply: no matter how hairy or complex an object you throw in to a black hole, it will get reduced down (or shaved) to its mass, charge and spin.

Of these parameters, mass is arguably the most significant. The very definition of a black hole is that it has its mass concentrated in to a vanishingly small volume – the "singularity". And it is the mass of the black hole – and the huge gravitational forces that its mass generates – which does the "damage" to nearby objects.

Space spaghetti

One of the best known effects of a nearby black hole has the imaginative title of "[Spaghettification](#)". In brief, if you stray too close to a black hole, then you will stretch out, just like spaghetti.

This effect is caused due to a gravitation gradient across your body. Imagine that you are headed feet first towards a black hole. Since your feet are physically closer to the black hole, they will feel a stronger gravitation pull towards it than your head will. Worse than that, your arms, by virtue of the fact that they're not at the centre of your body, will be attracted in a slightly different (vector) direction than your head is.

This will cause parts of the body toward the edges to be brought inwards. The net result is not only an elongation of the body overall, but also a thinning out (or compression) in the middle. Hence, your body or any other object, such as Earth, will start to resemble spaghetti long before it hits the centre of the black hole.

The exact point at which these forces become too much to bear will depend critically on the mass of a black hole. For an "ordinary" black hole that has been produced by the collapse of a high mass star, this could be several hundred kilometres away from the [event horizon](#) – the point beyond which no information can escape a black hole. Yet for a supermassive black hole, such as the one thought to reside at the centre of our galaxy, an object could readily sink below the event horizon before becoming spaghetti, at a distance of many tens of thousands of kilometres from its centre. For a distant observer outside the event horizon of the black hole, it would appear that we progressively slow down and then fade away over time.

Bad news for Earth

What would happen, hypothetically, if a black hole appeared out of nowhere next to Earth? The same gravitational effects that produced spaghettification would start to take effect here. The edge of the Earth closest to the black hole would feel a much stronger force than the far side. As such, the doom of the entire planet would be at hand. We would be pulled apart.

Equally, we might not even notice if a truly [supermassive black hole](#) swallowed us below its event horizon as everything would appear as it once was, at least for a small period of time. In this case, it could be some time before disaster struck. But don't lose too much sleep, we'd have to be unfortunate to "hit" a black hole in the first place – and we might live on holographically after the crunch anyway.

Mind the radiation

Interestingly, black holes are not necessarily black. Quasars – objects at the hearts of distant galaxies powered by black holes – are supremely bright. [They can readily outshine the rest of their host galaxy combined.](#) Such radiation is generated when the black hole is feasting on new material. To be clear: this material is still outside the event horizon which is why we can still see it. Below the [event horizon](#) is where nothing, not even light, can escape. As all the matter piles up from the feast, it will glow. It is this glow that is seen when observers look at quasars.

But this is a problem for anything orbiting (or near) a black hole, as it is very hot indeed. Long before we would be spaghettified, the sheer power of this radiation would fry us.

Life around a black hole

For those who have watched Christopher Nolan's film [Interstellar](#), the prospect of a planet orbiting around a black hole might be an appealing one. For life to thrive, there needs to be a source of energy or a temperature difference. And [a black hole can be that source.](#) There's a catch, though. The black hole needs to have stopped feasting on any material – or it will be emitting too much radiation to support life on any neighbouring worlds.

What life would look like on such a world (assuming its not too close to get spaghettified, of course) is another matter. The amount of power received by the planet would probably be tiny compared to what Earth receives from the Sun. And the overall environment of such a planet could be equally bizarre. Indeed, in the creation of Interstellar, [Kip Thorne was consulted to ensure the accuracy of the depiction of the](#)

[black hole featured](#). These factors do not preclude life, it just makes it a tough prospect and very hard to predict what forms it could take.

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