

## Is the Betelgeuse star about to explode?

In the constellation of Orion, something strange is afoot. In October 2019, the red star Betelgeuse – began to get unusually dim. During January and February 2020, it reached a record low – around 40 per cent of its usual brightness.

We know that Betelgeuse is a mature star, and that it will one day explode in a supernova. But this dimming has led to speculation that a supernova could be imminent. The dimming of Betelgeuse is not completely unexpected. It's what's known as a 'variable' star, whose brightness fluctuates. In Betelgeuse's case, this fluctuation follows a roughly 420-day cycle, and – in line with this cycle – there are now signs that the star is slowly brightening again.

"But even if Betelgeuse perks up, it still leaves us with questions," says Dr Emily Levesque, an astronomer who studies the physics of massive stars at the University of Washington. "It's got so much dimmer than normal – way more than we would expect."

Betelgeuse is a red supergiant – the largest class of stars in the Universe in terms of volume. It has a radius of around 600 million kilometres. Red supergiants form when a massive star runs out of hydrogen in its core and can no longer convert hydrogen into helium via nuclear fusion. At this point, the core begins to contract, which raises the star's internal temperature and ignites a shell of hydrogen fusion around the core, causing the star's outer layers to expand and cool.

The temperature inside Betelgeuse's core is so hot that the helium there has begun to fuse into carbon. Once the helium is exhausted, the core will rapidly work its way through heavier elements, all the way to iron. At this point, the star can generate no more energy, so the core will collapse. The outer layers will follow, bouncing off the core and exploding in a supernova. Levesque admits that we still know very little about what a star will do in the final days and weeks before it explodes. But she says that the best guess for when Betelgeuse will die, according to where scientists think it is in its life cycle, is in 100,000 years.

So what's responsible for the recent dimming? Betelgeuse's usual 420-day pulsation cycle – which is caused by variations in the star's size – cannot alone account for the dimming, says Levesque, so there's probably at least one other mechanism going on. One possibility is that the star is being obscured, making it appear dimmer. "We know that stars like Betelgeuse periodically shed mass from their surface, which condenses into dust around the star," she says. "This would effectively block our view." "We also know that red supergiants have big convective zones on their surfaces," she adds. Hot gas from deep inside the star rises to the surface, where it cools and sinks again. Changes in this circulation could be altering the star's surface temperature, and hence its brightness.

Whatever Betelgeuse is currently doing, there's no question that it'll explode at some point.

"It'll be absolutely unmissable," says Levesque. "The star is only a few hundred light-years away, so the light from the supernova will be incredibly bright – comparable to Venus or the Moon." We'll see it in the sky as a pinprick of light – even during daytime – and our telescopes will be able to see the nebulous 'supernova remnant' in all its glory. But don't worry: although Betelgeuse is relatively close to us, it's still far enough away that there'll be no danger from the supernova's high-energy radiation. As for Betelgeuse, it'll most likely become an ultra-dense neutron star.

In the meantime, astronomers are getting all the data they can. "As we study more of these red supergiants, we get better at pin-pointing what stage of their evolution they're in, and when they're likely to die," says Levesque. Understanding how this works will tell us more about how the make-up of the Universe evolved. These stars seeded the chemistry that made life possible."