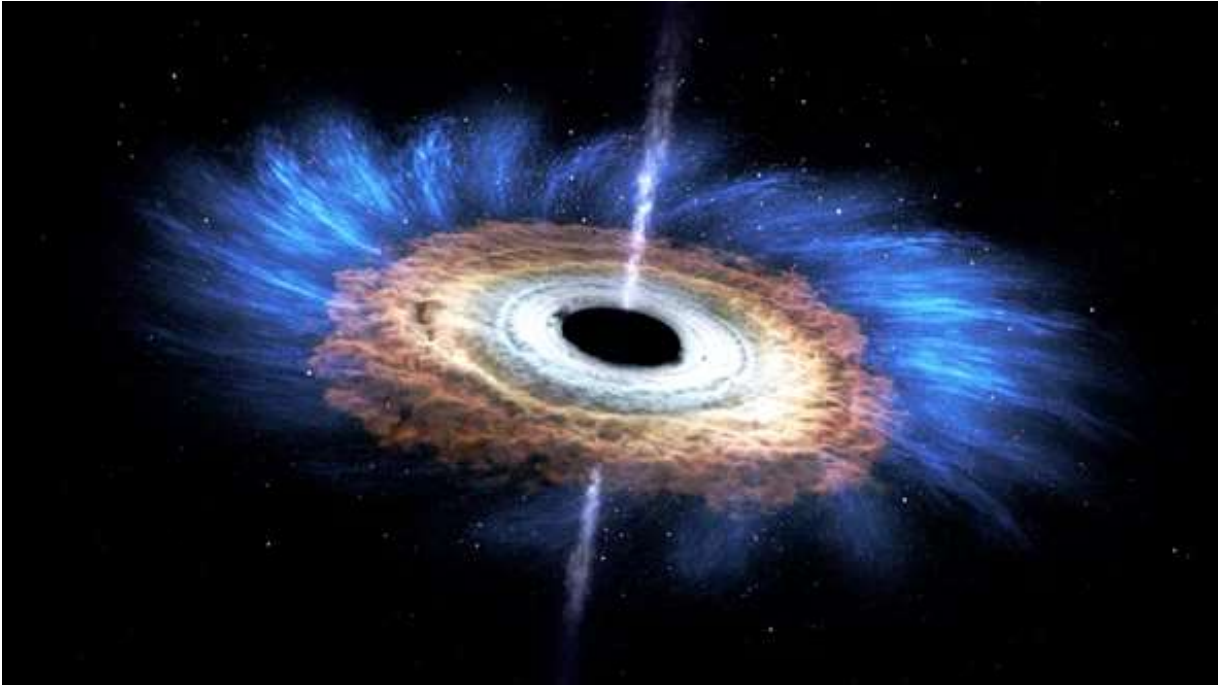


S P A C E

## Holy Cow! Astronomers Agog at Mysterious New Supernova

An event known as "Cow" that has rocked astronomy since June likely offers a close look at the birth of a neutron star or black hole

By Davide Castelvecchi, Nature magazine on November 7, 2018



An artist's rendition of a black hole shortly after tearing apart a star—the previous explanation for an enigmatic cosmic explosion observed in June. New data hint, however, that astronomers may have instead witnessed a black hole being born. Credit: NASA Goddard Space Flight Center

For many astronomers, 2018 will be remembered as the Year of the Cow—after the nickname of a spectacular stellar explosion that has kept them busy for months.

The unusual event has offered an unprecedented window on to the collapse of a star, two teams of researchers suggest in papers submitted to the arXiv preprint server on 25 October.

Contrary to the slow ramp-up of a typical supernova, Cow became stupendously bright essentially overnight, leaving astronomers perplexed.

---

ADVERTISEMENT

---

“It popped up out of nowhere,” says Stephen Smartt, an astronomer at Queen’s University Belfast, UK, who first discovered the explosion, and who named it according to an alphabetical protocol that just happened to spell out the word ‘cow’.

This is “the dream” for those who study stellar explosions, adds Raffaella Margutti, an astrophysicist at Northwestern University in Evanston, Illinois, who led one of the teams behind the latest two papers.

## CENTRAL ENGINE

.....

Through independent observations, the two groups behind the latest papers have now arrived at the same conclusion: that a ‘central engine’ has kept agitating the exploding star from the inside for months and that the energy must have come from either a newly formed black hole in the process of accreting matter, or the frenetic rotation of a neutron star.

Black holes and neutron stars are both born when massive stars reach the end of their lives. Explosions such as ‘Cow’—technically, the event AT2018cow—could provide some of the most direct evidence of this type of birth, says Mansi Kasliwal, an astronomer at the California Institute of Technology (Caltech) in Pasadena. “I think this is telling us about how to understand the most extreme incarnations of massive-star explosions.”

Iair Arcavi, an astrophysicist at the University of California, Santa Barbara, is impressed by the quality of the latest results, as well as by the strangeness of the event. “Pretty much everything about its emission is something we haven’t seen before,” he says.

---

ADVERTISEMENT

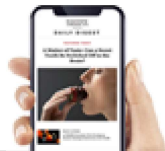
The story of how Cow came to be discovered begins on 16 June, when a colleague flagged to Smartt a bright star at a spot where there was nothing just days before.

## STELLAR ANOMALY

---

At first, Smartt discounted the effect as an unremarkable stellar flare in the Milky Way. But then, he realized that it was probably much farther off, in a galaxy called CGCG 137-068 known to be around 60 megaparsecs (200 million light years) away.

“It was 11 o’clock on a Sunday night, and I said to myself, ‘I better tell everybody about this.’” He sent out an alert through the Astronomer’s Telegram, a service for reporting and commenting on transient astronomical observations.



Sign up for *Scientific American's* newsletters.

[Sign Up](#)

---

Immediate follow-ups confirmed that the object was a distant one, and so had to be stupendously bright. (It shone brightly enough that, despite its distance, a number of amateur astronomers were able to see it, too.)

And this was no ordinary supernova: it reached its peak brightness in days, not weeks. “Everybody put down what they were doing up to that point” and started following Cow, says Daniel Perley, an astrophysicist at Liverpool John Moores University, UK.

---

ADVERTISEMENT

---

Perley and his collaborators commanded a robotic telescope on La Palma, one of Spain's Canary Islands, to observe Cow nearly every night for a month and a half. They also used a number of other telescopes around the globe that belong to a network that Kasliwal designed just for this kind of follow-up study.

The evidence that the team gathered—mostly in the optical spectrum—seemed to point to an existing black hole tearing a star apart, an observation they posted online in August. But to get a full picture of the energetic events happening, the researchers needed to look more broadly at the spectrum of electromagnetic energy, from radio waves to  $\gamma$  rays.

Just days after Smartt's discovery, Anna Ho, another astronomer at Caltech, moved quickly to observe Cow in the radio spectrum. In a stellar explosion, charged particles emit radio waves as they spiral inside strong magnetic fields, and their wavelengths stretch out as the material spreads out.

Ho realized that she might have a rare opportunity to observe short wavelengths—ones only one millimetre or less—as the material quickly spreads out, and so astronomers are unlikely to catch events early enough to see short-wavelength emissions.

Early observations in June by her group and others did find emissions in the sub-millimetre range, so she made an emergency proposal to the Atacama Large Millimeter/submillimeter Array (ALMA) in the Chilean Andes, where observing time is extremely competitive.

---

ADVERTISEMENT

---

## CURIOUSER AND CURIOUSER

---

Over the next several weeks, Ho and her collaborators watched the spectrum of the event's millimetre emissions as it evolved. Their observations revealed that matter was expanding outwards as fast as one-tenth of the speed of light.

But unlike an ordinary supernova, this short-wavelength radiation lasted for weeks revealing the presence of a central engine—a black hole or a spinning neutron star. “We were able to show that it’s not consistent with any of the usual mechanisms,” Ho says.

Margutti and her colleagues, meanwhile, took advantage of a pre-approved proposal that Margutti had made to observe ‘transient’ events using NASA’s NuSTAR X-ray telescope, in order to observe Cow quickly.

Observations on NuSTAR and other telescopes led the team to conclude that the event was highly unusual. The X-ray spectra, in particular, showed that it was being reheated from the inside. This, too, points to a black hole or neutron star powering the event—though it’s too soon to conclude which. “We have seen the formation of a compact object in real time,” she says.

Astrophysicists normally do not get to see this, Margutti adds, because the reheating is masked by a cloud of material the explosion ejected in its early days. “The advantage of Cow is that here the central engine was nearly naked.”

---

---

ADVERTISEMENT

Margutti hopes that astronomers will observe a number of these events and so begin to pin down the conditions that lead to one outcome over another. “The game begins now.”

*This article is reproduced with permission and was first published on November 2, 2018.*

---

---

ADVERTISEMENT

---

## ABOUT THE AUTHOR(S)

### **Davide Castelvecchi**

Davide Castelvecchi is a senior reporter at Nature in London covering physics, astronomy, mathematics and computer science.

---

**Nature magazine**