

Mauna Kea, the planned site of the Thirty Meter Telescope, is sacred to many Native Hawaiians.

ASTRONOMY

# Embattled telescope scores big win

*Hawaii's supreme court rules that the Thirty Meter Telescope's construction permit is valid.*

BY ALEXANDRA WITZE

**H**awaii's supreme court has ruled in favour of building the Thirty Meter Telescope (TMT) atop the mountain Mauna Kea. The decision removes the last legal hurdle preventing the US\$1.4-billion project from resuming construction.

"This clears the way for the TMT to begin construction," says Doug Simons, executive director of the Canada-France-Hawaii Telescope, which is located on Mauna Kea. "So,

yeah, it's a really big deal."

For years, the next-generation astronomical observatory has been mired in public protests and legal challenges. Some Native Hawaiians say that building the mega-telescope would further desecrate a sacred mountain that is already home to multiple observatories. In April 2015, protesters blocked the road to Mauna Kea's summit as construction of the TMT was set to begin. That December, the state supreme court revoked the project's construction permit, saying that the state

government had granted it before opponents of the telescope could have their full say.

Hawaii's Board of Land and Natural Resources issued a fresh construction permit in September 2017, prompting opponents to appeal. The latest ruling upholds that permit.

A separate legal issue, involving the University of Hawaii's sublease of land on Mauna Kea for the TMT site, was resolved in August. The state supreme court ruled in the project's favour in that case, as well.

TMT opponents have few legal options; they include petitioning the US Supreme Court.

One of the groups opposing the TMT, the environmental advocacy organization KAHEA in Honolulu, said it was "disappointed" by the latest ruling. "Thousands of Hawaiian cultural practitioners have affirmed the sacredness of the entirety of Mauna Kea," the group said in a statement.

TMT officials have been considering an alternative site for the telescope, in Spain's Canary Islands, in case they cannot resolve the obstacles to building in Hawaii. It could take months before project leaders decide whether to go ahead in Hawaii, now that they have the supreme court's backing. Among the issues they face is how to restart construction on Mauna Kea, given the protests that broke out the last time they tried to do so.

"We remain committed to being good stewards on the mountain and inclusive of the Hawaiian community," said Henry Yang, chair of the TMT International Observatory board of governors, in a statement.

In Hawaii, the battle over how Mauna Kea is used may soon shift from the TMT to the University of Hawaii's master lease, which covers all land on the mountain that is used for astronomical observatories. The lease expires in 2033, and Shelley Muneoka, a representative of KAHEA, says that the group is considering a challenge to the lease's renewal. ■

ASTROPHYSICS

# Mystery supernova known as 'Cow' spills its secrets

*A superbright explosion in a galaxy far, far away has drawn astronomers' full attention.*

BY DAVIDE CASTELVECCHI

**F**or 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<sup>1,2</sup>. In contrast to the slow ramp-up of a typical supernova, Cow became stupendously bright essentially overnight<sup>3</sup>, leaving astronomers perplexed. "It popped up out of nowhere," says Stephen Smartt, an astronomer at Queen's University Belfast, UK, who discovered the

explosion on 16 June. He named it according to an alphabetical protocol that just happened to spell out the word 'Cow' — technically, it is the event AT2018cow.

Iair Arcavi, an astrophysicist at the University of California, Santa Barbara, says that "pretty much everything about its emission is something we haven't seen before." 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 two papers.

The two groups behind the latest papers arrived independently at the same conclusion: that a ‘central engine’ has kept agitating the exploding star 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.

Both black holes and neutron stars are born when massive stars reach the end of their lives. Explosions such as Cow could provide 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.” Arcavi is impressed by the quality of the observations and the latest results, but, he says, “there’s still no bottom line as to what this is”. For now, Cow remains a mystery.

After the initial discovery, Smartt traced Cow to a galaxy called CGCG 137-068 known to be around 60 megaparsecs (200 million light years) away. 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. 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 other telescopes around the globe that belong to a network Kasliwal designed for this kind of follow-up study.

### CURIOUSER AND CURIOUSER

The evidence that the team gathered — mostly in the optical spectrum — suggested that an existing black hole is tearing a star apart, an observation they posted online<sup>4</sup> in August. But to get the full picture, researchers needed to look 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 as the material spreads out. This happens quickly, so astronomers are unlikely to catch events early enough to see short-wavelength emissions. But with Cow, Ho realized that she might have a rare chance to observe wavelengths of one millimetre or less. Early observations in June by her group and others indeed found emissions in the sub-millimetre range, so she submitted an emergency proposal for observing time to the Atacama

Large Millimeter/submillimeter Array (ALMA) in the Chilean Andes.

For weeks, Ho’s team watched the spectrum of the event’s millimetre emissions as it evolved. The researchers found that matter was expanding outward as fast as one-tenth of the speed of light<sup>2</sup>. 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 proposal Margutti had made to observe ‘transient’ events using NASA’s NuSTAR X-ray telescope. Observations of Cow on NuSTAR and other telescopes confirmed the event was highly unusual: X-ray spectra showed that it was being reheated from the inside. This, too, points to a black hole or neutron star at the centre — although it’s too soon to conclude which. Margutti hopes that astronomers will observe more of these events and so begin to pin down the conditions that lead to one outcome over another. “The game begins now.” ■

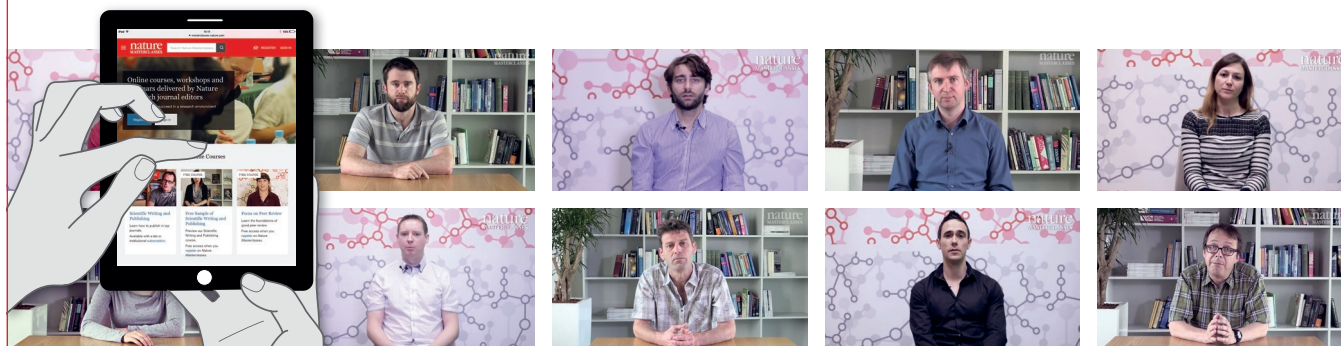
1. Margutti, R. *et al.* Preprint at <https://arxiv.org/abs/1810.10720> (2018).
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3. Prentice, S. J. *et al.* *Astrophys. J.* **865**, L3 (2018).
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**CORRECTION**

The News story 'Mystery supernova known as 'Cow' spills its secrets' (*Nature* **563**,168–169; 2018) omitted to cite an important reference for the discovery: S. J. Prentice *et al.* *Astrophys. J.* **865**, L3 (2018).