Supernova reserve fuel tank clue to big parents

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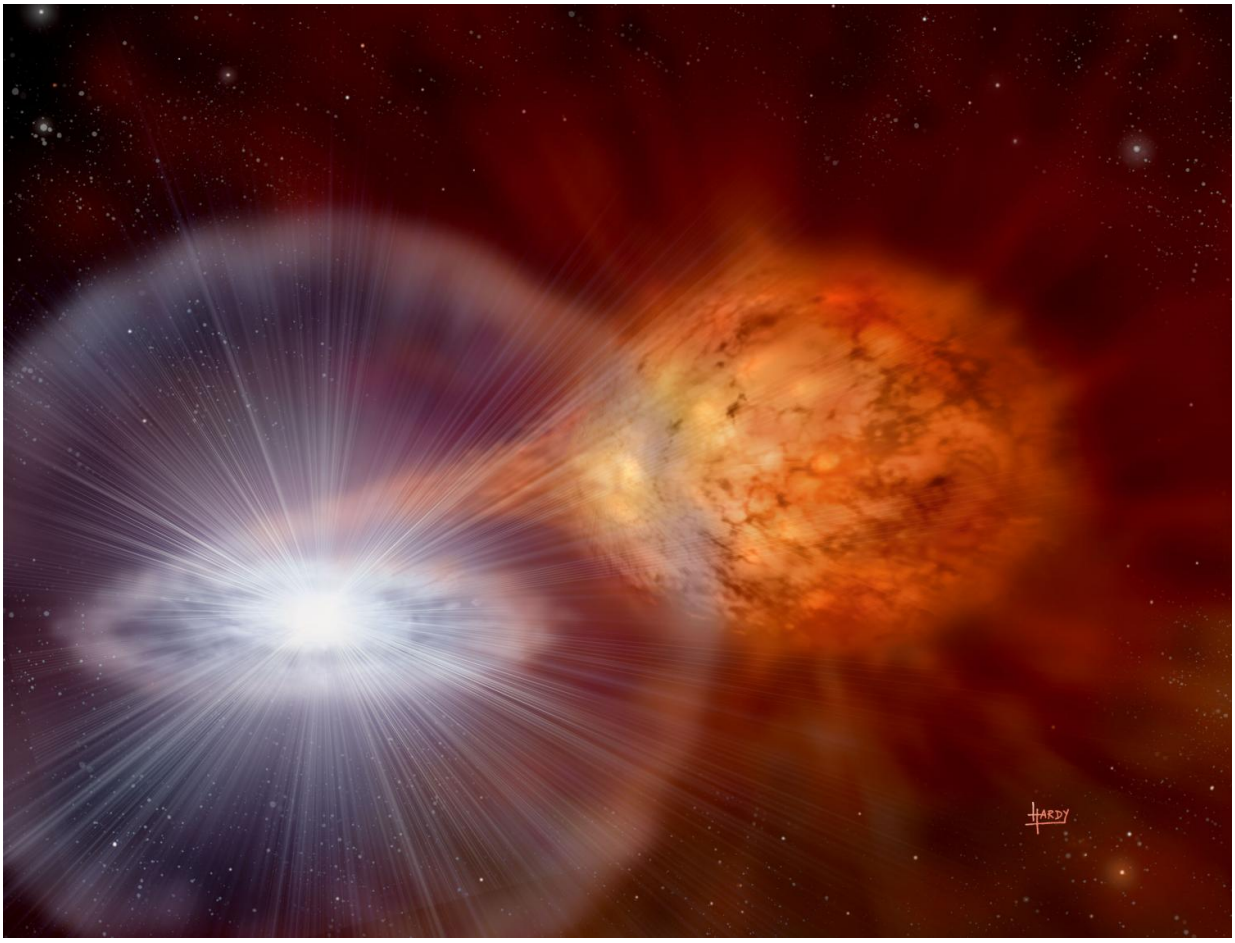

Artist's impression of a supernova. Credit: David A. Hardy & PPARC

Some supernovae have a reserve tank of radioactive fuel that cuts in and

powers their explosions for three times longer than astronomers had previously thought.

A team of astronomers jointly led by Dr Ivo Seitenzahl from The Australian National University (ANU) detected the faint afterglow of a supernova, and found it was powered by radioactive cobalt-57.

The discovery gives important new clues about the causes of Type Ia supernovae, which astronomers use to measure vast distances across the Universe.

Dr Seitenzahl said the discovery of cobalt-57 fingerprints in a Type Ia supernova gave insights into the star that exploded and suggested it was at the top of its weight range.

"This explosion suggested that it was a star stealing matter from an orbiting partner until it got so massive that its core of carbon ignited and set off the explosion," said Dr Seitenzahl, an astronomer at the ANU Research School of Astronomy and Astrophysics.

"It's exciting to work this out because there are conflicting theories about what causes Type Ia supernovae.

"It's curious to me that we still don't know exactly what these things are, even though they are so important for cosmology."

Type Ia supernovae are explosions that can be seen even in far-away galaxies and help astronomers study the large-scale structure of the Universe. For a period of weeks after they explode they can outshine the billions of other stars in their galaxy, and do so in a predictable fashion that makes them a reliable cosmic beacon.

Astronomers believe that Type Ia supernovae occur when matter falls

into an old white-dwarf star and pushes its mass over a threshold at which the carbon core ignites and triggers the star to explode.

However, it was unclear whether the star sucked in matter slowly from a companion star, or a collision between two smaller stars pushed the system over the edge.

In the case of a collision, theories suggest a white dwarf can be as small as 1.1 times the mass of the Sun when it explodes, but this finding pointed towards a heavier star, around 1.4 solar masses, supporting the slow suck model.The team, from Australia and the US, calculated the star's mass from the abundance of the cobalt isotopes created by nuclear fusion in the supernova.

When the core ignites, carbon and oxygen fuse to form lots of radioactive cobalt-56, whose radioactive decay into iron-56 with a half-life of 77 days powers the peak brightness of a supernova.

However, Dr Seitenzahl had believed traces of cobalt-57 must be created too, and the exact amount would distinguish between a 1.1 and 1.4 solar mass explosion.

"It doesn't seem like a big difference, but it amounts to 100 times higher density in the core of the star, which means a lot more cobalt-57 is created."

Even so, the amount of cobalt-57 is tiny, so the team needed patience to see it against the glare of the cobalt-56. Cobalt-57's longer half life, 270 days, means it keeps glowing after the cobalt-56 has died out after a couple of years.

The international team watched the supernova for 1,055 days after the explosion with the Hubble Space Telescope, and found a persistent glow

after the cobalt-56 had faded that matched Dr Seitenzahl's predictions, from 2009.

"I was skeptical whether clues for the presence of cobalt-57 in Type Ia supernovae would be observed in my lifetime," Seitenzahl said.

"I am absolutely thrilled that now, only seven years after our predictions, the Hubble Space Telescope has enabled us to make these incredibly faint observations and proved the theory right," he said.

More information: Or Graur et al, LATE-TIME PHOTOMETRY OF TYPE IA SUPERNOVA SN 2012cg REVEALS THE RADIOACTIVE DECAY OFCo, *The Astrophysical Journal* (2016). DOI: 10.3847/0004-637X/819/1/31

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