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## **THE PROLONGED DEATH OF LIGHT FROM TYPE Ia SUPERNOVAE**

### **SUPERNOVA OBSERVATIONS REVEAL EXTENDED BRIGHTNESS, COULD HELP RESEARCHERS BETTER UNDERSTAND INVALUABLE COSMOLOGY TOOL**

Three years after its explosion, a type Ia supernova continues to shine brighter than expected, new research finds. The observations, made with the Hubble Space Telescope and published today in *The Astrophysical Journal*, suggest that the powerful explosions produce an abundance of a heavy form of cobalt that gives the heat from nuclear decay an extra energy boost. The work could help researchers pinpoint the parents of type Ia supernovae – a type of stellar explosion that is frequently used to measure distances to faraway galaxies – and reveal the mechanics behind these explosions.

“Type Ia supernovae became very important to physics, as a whole, a couple of decades ago when they were used to show that the expansion of the universe is accelerating,” said lead author Or Graur, a research associate in the American Museum of Natural History’s Department of Astrophysics and a postdoctoral researcher at New York University. “Yet we still do not know exactly what type of star system explodes as a type Ia supernova or how the explosion takes place. A lot of research has gone into these two questions, but the answers are still elusive.”

Current research indicates that type Ia supernova explosions originate from binary star systems – two stars orbiting one another – in which at least one star is a white dwarf, the dense remains of a star that was a few times more massive than our Sun. The explosion is the result of a thermonuclear chain reaction, which produces a large amount of heavy elements. The light that researchers see when a type Ia supernova explodes comes from the radioactive decay of an isotope of nickel ( $^{56}\text{Ni}$ ) into an isotope of cobalt ( $^{56}\text{Co}$ ) and then into a stable isotope of iron ( $^{56}\text{Fe}$ ). Although peak brightness is reached relatively quickly, and

most researchers stop watching supernovae after about 100 days past the beginning of the explosion, the light continues to radiate for years.

Previous studies predicted that about 500 days after an explosion, researchers should see a sharp drop-off in the brightness of these supernovae, an idea called the “infrared catastrophe.” However, no such drop-offs have been observed, so Ivo Seitenzahl, a researcher at the Australian National University and the ARC Centre of Excellence for All-sky Astrophysics and one of the co-authors on the paper, predicted in 2009 that it must be due to the radioactive decay of  $^{57}\text{Co}$ . This is a heavier isotope of cobalt with a longer half-life than  $^{56}\text{Co}$ , and it is expected to provide an extra energy source that would kick in around two to three years after the explosion.

The researchers tested the prediction directly by using the Hubble Space Telescope to observe the type Ia supernova SN 2012cg more than three years after it exploded in the galaxy NGC 4424, which is about 50 million light years away – nearby in astronomical terms.

“We saw the supernova’s brightness evolve just as Ivo predicted,” Graur said. “Interestingly, though, we found that the amount of  $^{57}\text{Co}$  needed to produce the observed brightness was about twice the amount expected. These two pieces of information provide fresh constraints on progenitor and explosion models. Stated differently, we now have a new piece in the puzzle that is type Ia supernovae, one of the most important tools in modern cosmology.”

“When we made our prediction in 2009, I was skeptical whether clues for the presence of  $^{57}\text{Co}$  in type Ia supernovae would be observed in my lifetime,” Seitenzahl said. “I am absolutely thrilled that now, only seven years later, we are already constraining explosion scenarios based on our measurements.”

There is one caveat to the results: The excess brightness measured by the researchers could be due to a phenomenon known as a “light echo” instead of  $^{57}\text{Co}$ . A light echo happens when light from an explosion interacts with a large dust cloud, which scatters the light in all directions. In that case, light from the explosion would reach Earth twice: once directly from the supernova and then many years later as the result of the echo. To rule out the possibility of the light coming from an echo, more observations will have to be made of type Ia supernovae that are closer to Earth.

Other authors on the paper include Michael Shara and David Zurek, American Museum of Natural History; Adam Riess, The Johns Hopkins University and Space Telescope Science Institute; and Armin Rest, Space Telescope Science Institute.

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*Astrophysical Journal* paper: <http://iopscience.iop.org/article/10.3847/0004-637X/819/1/31>

A video about these findings can be watched here: <https://youtu.be/t3pUbZe8wqk>

#### **AMERICAN MUSEUM OF NATURAL HISTORY (AMNH.ORG)**

The American Museum of Natural History, founded in 1869, is one of the world's preeminent scientific, educational, and cultural institutions. The Museum encompasses 45 permanent exhibition halls, including the Rose Center for Earth and Space and the Hayden Planetarium, as well as galleries for temporary exhibitions. It is home to the Theodore Roosevelt Memorial, New York State's official memorial to its 33rd governor and the nation's 26th president, and a tribute to Roosevelt's enduring legacy of conservation. The Museum's five active research divisions and three cross-disciplinary centers support approximately 200 scientists, whose work draws on a world-class permanent collection of more than 33 million specimens and artifacts, as well as specialized collections for frozen tissue and genomic and astrophysical data, and one of the largest natural history libraries in the world. Through its Richard Gilder Graduate School, it is the only American museum authorized to grant the Ph.D. degree and, beginning in 2015, the Master of Arts in Teaching degree, which began as a pilot in 2012 and is the only non-university affiliated such program in the United States. Annual attendance has grown to approximately 5 million, and the Museum's exhibitions and Space Shows can be seen in venues on five continents. The Museum's website and collection of apps for mobile devices extend its collections, exhibitions, and educational programs to millions more beyond its walls. Visit [amnh.org](http://amnh.org) for more information.

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