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THE Current

November 5, 2009
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New Type of Supernova Explosion Reported; Predicted by Theoretical Physicists at UCSB

A new class of supernova was discovered by scientists at Berkeley and may be the first example of a new type of exploding star. A team of astrophysicists at UC Santa Barbara had predicted this kind of explosion in their theoretical work.

Lars Bildsten, professor at UCSB's Kavli Institute for Theoretical Physics (KITP), and colleagues, predicted a new type of supernova in distant galaxies that would be fainter than most and would rise and fall in brightness in only a few weeks.

The discovery, led by UC Berkeley postdoctoral fellow Dovi Poznanski, who is also with Lawrence Berkeley National Laboratory, is reported in the Nov. 5 Express edition of Science Magazine. Bildsten first heard from Poznanski last August when he was organizing the conference "Stellar Death and Supernovae."

"As we have talked about our work over the last years, most astronomers in the audience reminded us that they had never seen such an event," said Bildsten. "We told them to keep looking!"

Just over two years ago, Bildsten was working with collaborators when they realized that the outcome of their calculations predicted an observable explosion never seen in the night sky.

"With the sky the limit, the observers are usually ahead of theory," Bildsten said, "so I am really happy that we were able to make a prediction that allowed for a rapid interpretation of a new phenomena. Even though the supernova was observed in 2002, it took the keen eye of Dovi Poznanski to appreciate its import and relevance."

Bildsten explained that most stars end their lives gently, forming white dwarfs with the mass of the Sun packed into the radius of the Earth. Though very dense, these objects, made of either a mixture of carbon and oxygen or nearly pure helium, cool to temperatures so low that fusion reactions can no longer occur. However, in rare instances, two of these objects orbit each other so closely

–– orbiting every few minutes –– so that the helium from the lighter of the two gets pulled off by tidal forces and accumulates on the more massive white dwarf.

It is this rare occurrence that leads to unique conditions of the explosive thermonuclear ignition and complete ejection of the accumulated helium ocean. The plethora of unusual radioactive elements made in the rapid fusion leads to a bright light show from the freshly synthesized matter that lasts a few weeks.

Bright events from complete thermonuclear explosions of white dwarfs have been known for many decades, and are referred to as "Type Ia supernova." They are brighter than a whole galaxy for more than a month and are quite useful in cosmological studies. The predicted events by Bildsten and collaborators are only one-tenth as bright for one-tenth the time, leading to the clever naming by Chris Stubbs, professor at Harvard University, of these events as ".Ia" (point one a) supernova.

Regarding the June 2007 publication of the theory in the Astrophysical Journal Letters, Bildsten said: "I was worried if the journal would let us name an event not yet seen, but they did –– and the name has stuck. Marketing is a big part of success for any idea, even in science."

Despite the apparent success, more puzzles remain, and Bildsten and his collaborators, especially UCSB graduate students Ken Shen and Kevin Moore, are actively working on them. These include deep theoretical issues of how helium explodes, and whether or not the underlying white dwarf remains behind. Shen said: "We were always interested in these new possibilities, but now we have a real motivation. Where there is one, there are many, so things are going to get exciting."

In addition to Shen, KITP postdoctoral fellow Nevin Weinberg (now at UC Berkeley) and Gijs Nelemans, professor at Radboud University, Nijmegen, The Netherlands, worked on the original theory. Nelemans is a longtime collaborator with Bildsten.

This research was supported by the National Science Foundation.

Issued: 11/5/09;

Corrected: 11/6/09

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