Team finds Type Ia supernovae parents

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Type Ia supernovae are violent stellar explosions whose brightness is used to determine distances in the universe. Observing these objects to billions of light years away has led to the discovery that the universe is expanding at an accelerating rate, the foundation for the notion of dark energy. Although all Type Ia supernovae appear to be very similar, astronomers do not know for certain how the explosions take place and whether they all share the same origin. Now, a team of researchers has examined new and detailed observations of 41 of these objects and concluded that there are clear signatures of gas outflows from the supernova ancestors, which do not appear to be white dwarfs. The research is published in the August 12 issue of *Science*.

The widely accepted theory is that Type Ia supernovae are thermonuclear explosions of a white dwarf star in a close binary system. There are two competing scenarios for supernova ancestry. In the so-called single-degenerate model, the accompanying star in the binary is a main-sequence star or evolved star. In the competing double-degenerate model, the companion is another white dwarf—a very dense star in its final evolutionary stage.

"Because we don't know what the things blowing up actually are, we don't quite understand why they should all be so similar," explained coauthor Josh Simon of the Carnegie Observatories. "That raises the possibility that Type Ia supernovae that occurred 7 billion years ago—the ones that allow us to measure the repulsive force we call dark energy—might be different in some subtle way from the ones occurring now. Maybe they are a little bit brighter than the ancient ones, for example."

Mark Phillips, also from Carnegie added, "We wanted to get a better understanding of what the stars look like before the explosion to help determine the origin of their brightness. That information will allow us to be sure that there are no errors of this type distorting the dark energy measurements."

The astronomers looked for absorption by sodium atoms in the spectrum of each of the 41 supernovae. Sodium is a telltale sign of cool, neutral gas in the vicinity of the explosion. By measuring the speed of the sodium clouds using the Doppler shift, they determined that the majority of the supernovae show sodium gas moving away from the explosion site and toward the Earth.

"If the star system originally contained two white dwarfs before the supernova, then there shouldn't be any sodium," remarked Carnegie's Nidia Morrell. "The fact that we detected the sodium shows that one of the stars must not have been a white dwarf."

The astronomers ruled out other possible sources of the sodium absorption features including interstellar clouds or a galactic-scale wind blown by the host galaxy.

"The low velocities and narrowness of the features suggest that the absorption is from material very close to the supernova that was ejected by the parent system before the explosion. Typically, gas with these characteristics is attributed to the stellar wind blown by red giant companion stars, not white dwarfs," concluded Simon.

The finding is an important first step toward understanding the details of how Type Ia supernovae explode and the origin of their immense luminosity.

Provided by Carnegie Institution