Dead star's cannibalism of its planetary system is most far-reaching ever witnessed

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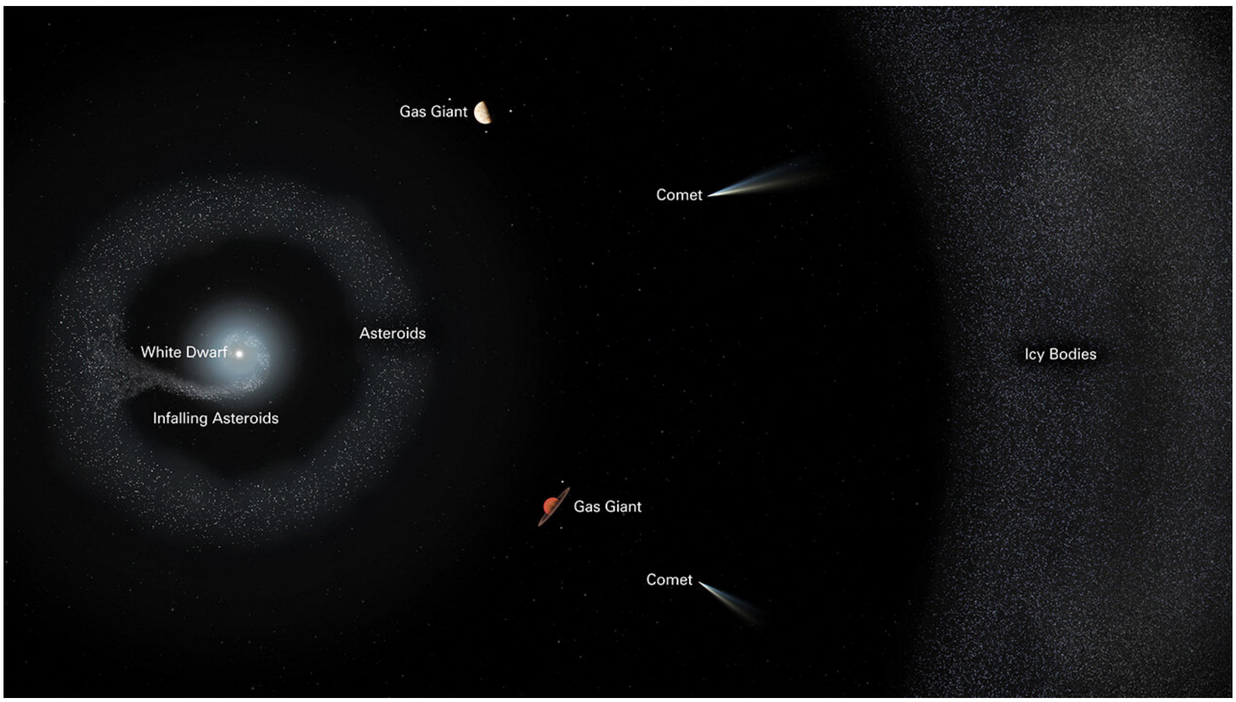

Diagram illustrates the slow destruction of G238-44's planetary system, with the tiny white dwarf at the center, surrounded by a faint accretion disk made up of pieces of shattered bodies falling onto the dead star. Remaining asteroids form a thin stream of material surrounding the star. Larger gas giant planets may still exist in the system, and much farther out is a belt of icy bodies such as comets. Credit: NASA, ESA, Joseph Olmsted (STScI)

The violent death throes of a nearby star so thoroughly disrupted its planetary system that the dead star left behind—known as a white dwarf—is sucking in debris from both the system's inner and outer reaches, UCLA astronomers and colleagues report today.

This is the first case of cosmic cannibalism in which astronomers have observed a white dwarf consuming both rocky-metallic material, likely from a nearby asteroid, and icy material, presumed to be from a body similar to those found in the Kuiper belt at the fringe of our own solar system.

"We have never seen both of these kinds of objects accreting onto a white dwarf at the same time," said lead researcher Ted Johnson, a physics and astronomy major at UCLA who graduated last week. "By studying these white dwarfs, we hope to gain a better understanding of planetary systems that are still intact."

The findings are based on an analysis of materials captured by the atmosphere of G238-44, a white dwarf some 86 light-years from Earth, using archival data from the Hubble Space Telescope and additional NASA satellites and observatories. A white dwarf is the burned-out core that remains after a star like our sun sheds its outer layers and stops burning fuel through nuclear fusion.

As surprising as the white dwarf's wide-ranging diet is, the findings are also intriguing because astronomers believe icy objects crashed into and irrigated dry, rocky planets in our solar system—including Earth. Billions of years ago, comets and asteroids are thought to have delivered water to our planet, sparking the conditions necessary for life. The makeup of the material detected raining onto G238-44 implies that icy reservoirs might be common among planetary systems, said research co-author Benjamin Zuckerman, a UCLA professor of physics and astronomy.

"Life as we know it requires a rocky planet covered with a variety of volatile elements like carbon, nitrogen and oxygen," Zuckerman said. "The abundances of the elements we see on this white dwarf appear to have come from both a rocky parent body and a volatile-rich parent body—the first example we've found among studies of hundreds of white dwarfs."

Chaos and destruction: From living star to red giant to white dwarf

Theories of planetary-system evolution describe the demise of a star as a turbulent, chaotic event, one that begins when it first balloons exponentially into what is known as a red giant and then quickly loses its outer layers, collapsing into a white dwarf—a super-dense star about the size of Earth, with a mass of our sun. The process dramatically disrupts the remaining planets' orbits, and smaller objects—asteroids, comets, moons—that venture too close to them can be scattered like pinballs and sent hurtling toward the white dwarf.

This study confirms the true scale of the chaos, showing that within 100 million years after the beginning of its white dwarf phase, the star is able to simultaneously capture and consume material from its nearby asteroid belt and its far-flung Kuiper belt–like regions.

Though astronomers have cataloged more than 5,000 planets outside our solar system, the only planet whose interior makeup we have some direct knowledge of is Earth. Because the materials accreting onto G238-44 are representative of the building blocks of major planets, this white dwarf cannibalism provides a unique opportunity to take planets apart and see what they were made of when they first formed around the star, said UCLA astronomy researcher Beth Klein, a member of the team.

The team measured the presence of nitrogen, oxygen, magnesium, silicon and iron, among other elements, in the white dwarf's atmosphere. Their detection of iron in very high abundance is evidence for metallic cores of terrestrial planets, like Earth, Venus, Mars and Mercury, Johnson said. Unexpectedly high nitrogen abundances led them to conclude that icy bodies were also present.

"The best fit for our data was a nearly two-to-one mix of Mercury-like material and comet-like material, which is made up of ice and dust," Johnson said. "Iron metal and nitrogen ice each suggest wildly different conditions of planetary formation. There is no known solar system object with so much of both."

The researchers say the ultimate scenario for our own sun some 5 billion years from now will likely be quite similar to what has been seen with G238-44. During the sun's red giant phase, the Earth might be completely vaporized along with the inner planets, they predict.

The orbits of many of the asteroids in our solar system's main asteroid belt will be gravitationally perturbed by Jupiter and will also fall onto the white dwarf remnant that the sun will become, he said.

For more than two years, the research group at UCLA, along with colleagues at UC San Diego and the University of Kiel in Germany, has worked to unravel the mystery of G238-44 by analyzing the elements detected on the white dwarf star.

Their analysis included data from NASA's retired Far Ultraviolet Spectroscopic Explorer, the Keck Observatory's High Resolution Echelle Spectrometer in Hawaii and the Hubble Space Telescope's Cosmic Origins Spectrograph and Space Telescope Imaging Spectrograph. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency.

The team's results were presented at an American Astronomical Society press conference on June 15.

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