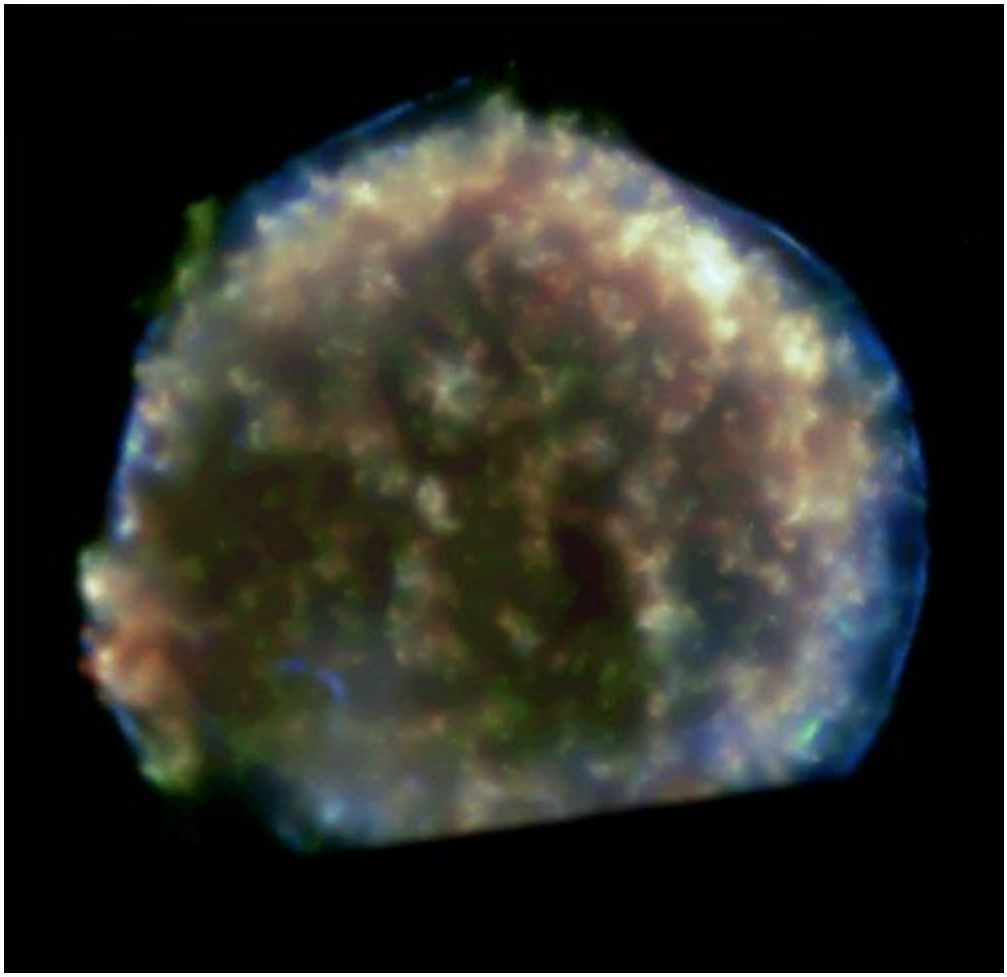
High-speed star flees Tycho's blast

A runaway sun in Tycho's supernova remnant is likely a surviving companion of the exploded star — and probably triggered the blast.

Francis Reddy



This Chandra X-Ray image shows a wide-field view of the region around Tycho's Supernova showing the expanding bubble of the supernova explosion. *NASA / ESA, CXO and P. Ruiz-Lapuente (University of Barcelona)*

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An international team of astronomers has found a Sun-like star whipping through the wreckage of a star seen to explode in Cassiopeia 432 years ago. The star is racing at nearly 304,000 mph (490,000 km/h) through the remnant of Tycho's supernova, which is named for the 16th-century Danish observer who recorded its brightness changes in unprecedented detail.

A team led by Pilar Ruiz-Lapuente of the University of Barcelona, Spain, published its discovery in the October 28 issue of the British science journal *Nature*. "There was no previous evidence pointing to any specific kind of companion star out of the many that had been proposed. Here we have identified a clear path: the feeding star is similar to our Sun, but slightly older," Ruiz-Lapuente says. "The high speed of the star called our attention to it." The runaway star is moving 3 times faster than other stars in the area.

The astronomers say this is the first direct evidence supporting the long-held belief that Type Ia supernovae originate in binary star systems where a normal star and a burned-out white dwarf

star orbit each other. The normal star spills material onto the dwarf, which accumulates mass and eventually explodes. When the white dwarf explodes, the companion star hurtles off into space like a stone thrown by a sling, retaining the velocity of its orbital motion.

This Hubble Space Telescope shows a small section of sky containing a suspected runaway companion star to a titanic supernova explosion. This explosion was witnessed 1572 by Danish astronomer Tycho Brahe. *NASA / ESA and P. Ruiz-Lapuente (University of Barcelona)* [larger image]

Tycho Brahe and his colleagues didn't know they were watching a star's demise in 1572, but the sudden appearance of a brilliant new object was clearly important. The supernova helped Western astronomers finally abandon the idea that the heavens were immutable.

For Tycho, who would become one of the leading astronomers of the time, the story began on November 11, 1572. During a walk before dinner, he noticed "directly overhead, a certain strange star … flashing its light with a radiant gleam." His candid account of the discovery gives us a sense of how radical an event this was to 16th-century astronomers.

> Amazed, and as if astonished and stupefied, I stood still, gazing … intently upon it and noticing that same star placed close to the stars which antiquity attributed to Cassiopeia. When I had satisfied myself that no star of that kind had ever shone forth before, I was led into such perplexity by the unbelievability of the thing that I began to doubt the faith of my own eyes. … And at length, having confirmed that my vision was not deceiving me, but in fact that an unusual star existed there … immediately I got ready my instrument. I began to measure its situation and distance from the neighboring stars in Cassiopeia.

The new star soon matched Venus in brightness (magnitude -4.5) and, for about 2 weeks, could be seen in daylight. At the end of November, it began to fade and change color, from brilliant white to yellow to faint reddish light, but it remained visible to the naked eye for 16 months, until March 1574.

Tycho's meticulous record of the supernova's changing brightness allowed modern astronomers to identify it as a Type Ia supernova — key players in the newest cosmological discoveries. The peak brightness among this supernova class is always very similar, which makes it an important "standard candle" for establishing distance in the far universe. As reliable distance markers, Type Ia supernovae help astronomers measure how cosmic expansion has changed over time, and so they are fundamental to understanding the behavior of dark energy, the unknown force that is accelerating the universe's expansion.

Spectra obtained with the 4.2-meter William Herschel Telescope in La Palma, Canary Islands, and the 10-meter Keck Telescopes in Hawaii show the high-speed star is an aging version of our own Sun. In the binary systems thought to produce Type Ia supernovae, the pair's more massive star ages faster and eventually becomes a white dwarf. When the slower-evolving companion star subsequently ages to the point when it swells in size, some of its matter spills onto the dwarf. Hydrogen accumulates until the dwarf reaches a critical-mass threshold, called the Chandrasekhar

limit, when it explodes as a titanic nuclear bomb.

"Among the various systems containing white dwarfs that receive material from a solar-mass companion, some are believed to be viable progenitors of Type Ia supernovae, on theoretical grounds. A system called U Scorpii has a white dwarf and a star similar to the one found here," Ruiz-Lapuente says. "These results would confirm that such binaries will end up in an explosion like the one observed by Tycho Brahe, but that would occur several hundreds of thousands of years from now."


Animation of 1572 supernova
animation of tychos supernova.mpg [file size 2786K]


Animation of 1572 supernova
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