It's the 17th century supernova that nobody saw, but telescopes in space and on Earth have teamed up to look back in time and study it today!	*Echo vid*
[Titles]	*Opening titles*
When a massive star reaches its end of days it explodes dramatically and, for a few months, can outshine anything else in the galaxy.	*Host* *Beginning of Mira animation in bg, burns out with light*
But the Cassiopea A supernova remnant is a bit of a mystery. Astronomers have concluded it should have been visible sometime in the late 17th century, but there are no clear historical references to it.	*Host* *Constellation image, Cas A callout*
Earlier supernovas had been seen by many, often shining brighter than the planets. Of course with no witnesses, and no records, it's difficult to tell exactly what kind of supernova it was.	*Host [close-up]*
A team led by astronomer Oliver Krause has, over the last few years, made a remarkable series of infrared observations of the region. These Spitzer Space Telescope images show shifting patterns of glowing dust beyond the remnant itself. These changes are so fast that they indicate motion at the speed of light!	*Data echo vid*
To get what's happening we have to remember that light moves fast, but in such a vast galaxy it still takes a while for it to get anywhere. Cas A itself is about 11,000 light-years away, which means today we're seeing what it looked like 11,000 years ago. But that's only part of the story.	*Host* *Galaxy Distance InfoGFX*

The light from a supernova can even take hundreds of years to reach surrounding dust clouds. Following the arrows of light it's clear we'll see the supernova flash first. The light echoing off of the dust clouds will later arrive at various times, delayed by hundreds of years from the original flash.	*Diagram movie*
So we're not seeing the dust move, we're seeing the light from the supernova move through the dust. Out there, the flash is about as bright as the full moon, which is enough to warm the dust slightly. Spitzer detects this brief boost in its thermal infrared glow.	*Host* *Data echo vid [inset]*
Now, knowing the location of the infrared light echo, Dr. Krause and his team went searching for a far more elusive visible-light echo. Using the powerful Subaru telescope in Hawaii they succeeded in measuring the very faint light of the supernova itself reflecting off the dust.	*Subaru still* *Overlay spectrum*
The light echo has acted like an astronomical time machine, letting us study the original supernova using instruments that were beyond imagination in the 17th century.	*Host [closeup]*
By matching its visible spectral signature to a well-studied supernova in a nearby galaxy, Krause and his team have now identified it as a so-called Type IIb supernova.	*Host* *Spectrum (animated overlay)*

A Type IIb is fainter than the earlier Type Ib supernovas noted by Tycho Brahe in 1572 and Johannes Kepler in 1604. Interestingly, the Royal Astronomer Flamsteed noted a star near Cas A in August of 1680 with a brightness consistent with a Type IIb supernova at that distance. So maybe it was seen after all!	*Multimedia of supernovas and observers*
But this light echo reveals more than just the supernova. The expanding flash also lets astronomers study the three-dimensional structure of the dust, illuminating it one slice at a time.	*Host* *Inset of diagram vid*
If we combine the images, assigning colors to the observation dates, the result is a prismatic display of the 3D dust structure. The nearest dust is blue, and the most distant is red, while everything that stays constant is grey. We can see that interstellar dust lies in sheets and filaments, not, for instance, big, puffy clouds.	*Pan through spectral still*
This remarkable light echo around Cas A has led to a better understanding of both supernovas and interstellar dust, which itself is made of elements forged in previous generations of supernovas.	*Host* *Continuation of spectral still*
This also marks the start of the third year of our Hidden Universe podcasts. On behalf of the staff of the Spitzer Science Center, I'd like to thank all of our viewers for making this and our other podcasts so successful. And keep watching, because there's a lot more to this hidden universe just waiting to be discovered!	*Host [close-up]*