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Titanium debris could solve supernova mystery

NASA's Chandra X-ray Telescope has detected a stable form of titanium among the debris of the supernova remnant Cassiopeia A. The find could help resolve a long-standing mystery about how such stellar explosions occur.

Astronomers believe that when a massive star dies, the star's material falls inward and rebounds against its dense core as it becomes a neutron star. This creates shock waves that move outward through the star, ripping it apart in a supernova. But there's a snag: In computer simulations, these shock waves quickly lose momentum, stalling out inside the star's interior before they can cause a stellar explosion.

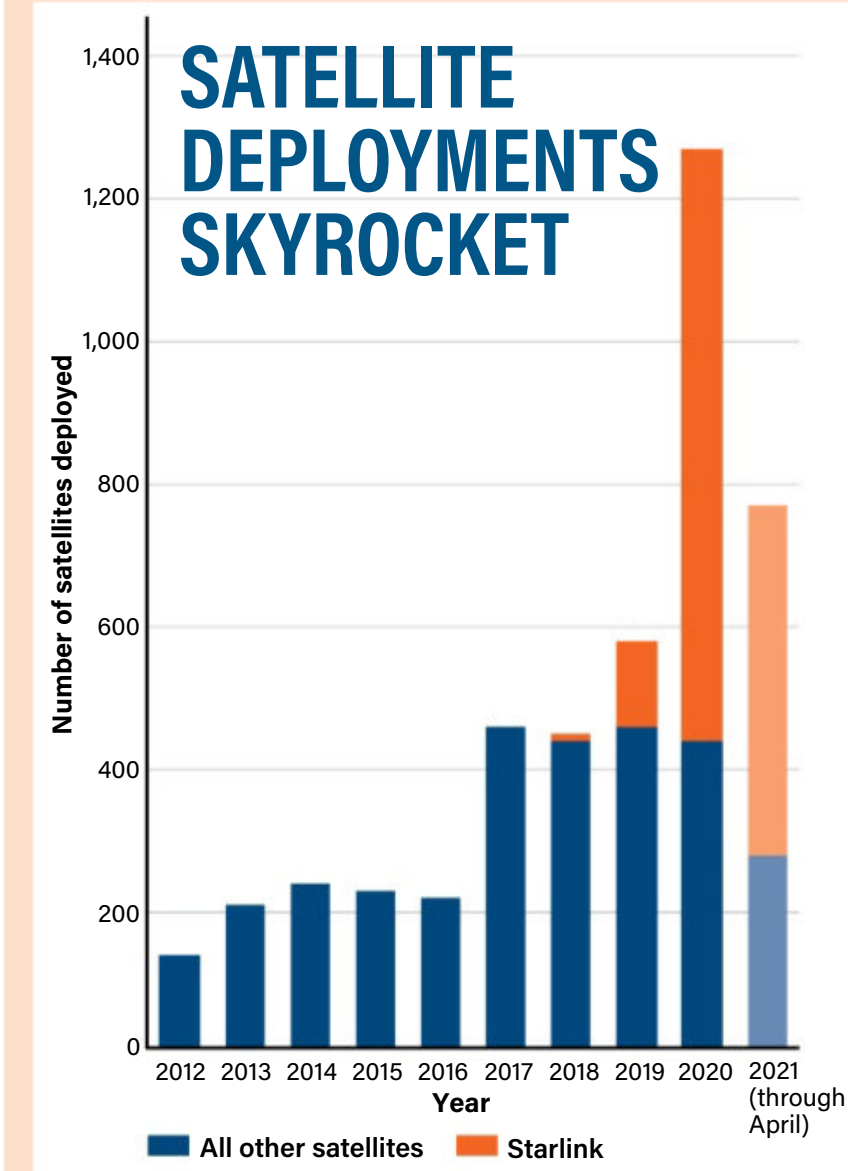
Only accounting for the effects of neutrinos — lightweight particles created in the star's collapse — solves the problem. They prompt the creation of hot bubbles of material that quickly expand away from the newly formed neutron star, providing the shock waves with the energy they need to keep going. But evidence for such neutrino-driven bubbles has been absent — until now.

Recent Chandra observations of Cassiopeia A, one of the Milky Way's youngest supernova remnants, have revealed it contains a stable isotope of titanium never before seen in any supernova. Different isotopes of a given element all have the same number of protons but different numbers of neutrons. While other unstable isotopes of titanium had previously been detected in supernova remnants, including Cas A, stable titanium had not.

What Chandra saw — stable titanium alongside elements such as chromium and iron in fingerlike structures — matches what's predicted to form in the temperature and density conditions of neutrino-driven bubbles. So, these findings provide a significant piece of evidence that the neutrino-driven supernova theory is correct, at least for explosions like Cas A. –A.K.

BLAST SITE. In this composite image of Cassiopeia A, titanium is colored blue, iron is colored orange, oxygen is colored purple, and the ratio of silicon to magnesium is colored green. Optical light is shown in yellow. The titanium shown here is an unstable isotope previously imaged by NASA's NuSTAR satellite; the stable titanium discovered by Chandra is not shown.

CASSIOPEIA A: CHANDRA: NASA/CXC/RIKEN/T. SATO ET AL.; NUSTAR: NASA/NUSTAR; HUBBLE: NASA/STSCI



ASTRONOMY: ROEN KELLY

UP AND AWAY. The number of satellites being launched into Earth orbit every year has been on a steady long-term uptick, thanks to the rise of new spacefaring nations and commercial space operators. But in the past two years, the number has grown at an unprecedented rate — almost entirely due to SpaceX and its Starlink internet-providing satellites. After the launch of a pair of test satellites in late 2018, SpaceX has increased its cadence of launches and grown the constellation to over 1,400 satellites as of May 2021. In March, Starlink had its biggest month yet, with three separate launches deploying a total of 180 satellites — more than were launched in 2012 by all nations and operators combined. –M.Z.

5,000

The amount, in tons, of extraterrestrial dust that falls to Earth each year, as determined from measurements of micrometeorites in melted snow at Concordia Station in Antarctica.