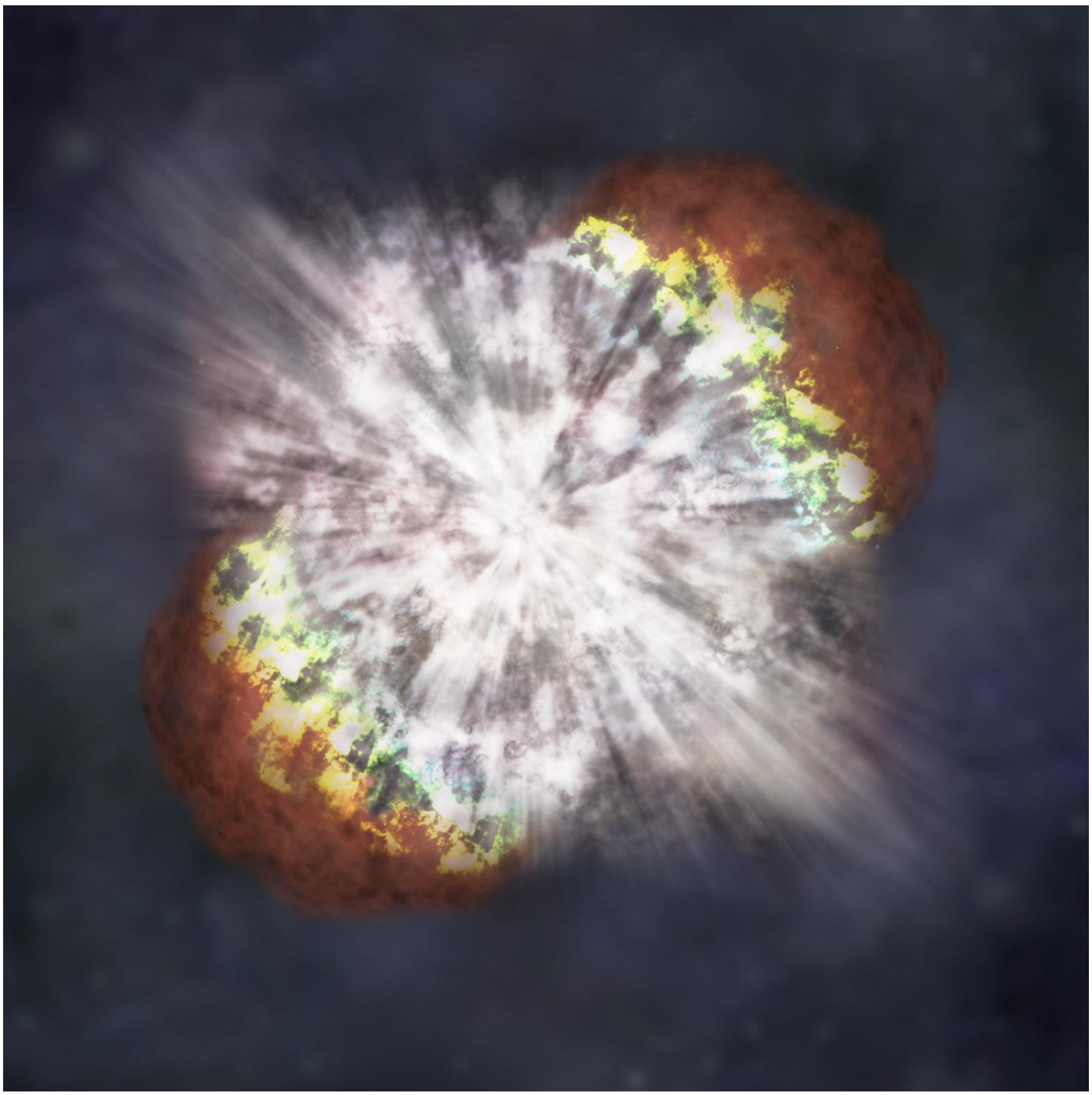
ASASSN's creed—a surprising ultraviolet rebrightening observed in a superluminous supernova

May 19 2016, by Tomasz Nowakowski



NASA's artist impression of SN 2006gy, one of the most luminous hypernovae seen. Credit: NASA/CXC/M.Weiss

(Phys.org)—An international team of astronomers, led by Peter Brown of Texas A&M University, has spotted a surprising ultraviolet (UV) rebrightening in a distant superluminous supernova known as ASASSN-15lh. The event has baffled the scientists as it doesn't show any hydrogen emission characteristic of superluminous supernovae and tidal disruption events. The research was published online on May 12 on *arXiv.org*.

Superluminous supernovae, also called hypernovae, are dozens of times more luminous than normal supernovae. ASASSN-15lh, detected by the All Sky Automated Survey for SuperNovae (ASAS-SN) in 2015, is a real 'assassin' among these explosion events. It is about 200 times more powerful than the average supernova and approximately 570 billion times brighter than our sun. It is so far the most luminous supernova ever detected.

Now, Brown and his colleagues have used the data provided by NASA's Swift spacecraft and the NASA/ESA Hubble Space Telescope (HST) to study ASASSN-15lh in detail. They found that the flux of the supernova increased strongly into the ultraviolet, with the luminosity a hundred times greater when compared to the hydrogen-rich, ultraviolet-bright SLSN II SN 2008es. According to a paper published on arXiv.org, this rebrightening is seen about two months after the peak brightness, which by itself is as bright as a superluminous supernova.

"It took a few observations to convince myself that the rebrightening was real, and then I announced it as an Astronomer's Telegram when I realized how significant it was so that other astronomers could get complementary data to understand what was going on," Brown told Phys.org.

He noted that the detection couldn't be done without Swift, as it is great at following objects for multiple observations over a long period of time. It can observe the universe in the gamma-ray, X-ray, UV and optical wavebands.

"Optical observations get you only a certain wavelength range, which in the case of ASASSN-15lh would miss most of the flux and the clear rebrightening," he added.

However, Hubble is much more sensitive, so the scientists were able to get ultraviolet spectroscopy from a special observation approved after they discovered something unusual with Swift.

Hot, energetic events like ASASSN-15lh produce most of their light in the UV, and it's at these wavelengths that we can best understand their explosion mechanisms and their nature.

"Hubble and Swift are the only telescopes that can acquire ultraviolet spectroscopy. UV spectroscopy can only be done from space, and these two old telescopes are our only means to get these data, as no future UV telescope is planned anytime in the near future," said Jeffrey Cooke of the Swinburne University of Technology in Australia, one of the co-authors of the paper.

The researchers managed to determine the shape of the explosion the UV/optical flux and the X-ray flux. However, the most puzzling finding was that the observed brightening did not show the hydrogen they would expect if caused by the explosion crashing into hydrogen around it.

According to the study, the optical spectroscopy during the rebrightening of ASASSN-15lh did not show evidence of broad H-alpha, nor did the scientists see strong or broad Lyman alpha emission in the UV spectra, which would be expected from interaction with hydrogen-rich material.

Thus, the team admitted that their research actually raised more new questions than it answered.

"If you have poor observations, you can fit it with any model. But the more data we have, the more precise the theoretical model has to be. We don't understand the main peak of the light curve and we don't understand the rebrightening, though we have some ideas. As other scientists come up with theories about what could cause it, though, our data constrains the shape of the explosion the UV/optical flux, the X-ray flux, and the lack of hydrogen, which is the most common element in the universe," Brown concluded.

The team will keep following ASASSN-15lh with Swift until it gets too faint. They do not have immediate plans for further studies of this object, though their collaborators are looking deeper into the Hubble spectra and theoretical explanations for the source.

More information: ASASSN-15lh: A Superluminous Ultraviolet Rebrightening Observed by Swift and Hubble, arXiv:1605.03951 [astro-ph.HE] arxiv.org/abs/1605.03951

Abstract
We present and discuss ultraviolet (UV) and optical photometry from the Ultraviolet/Optical Telescope (UVOT) and X-ray limits from the X-Ray Telescope on Swift and imaging polarimetry and UV/optical spectroscopy with the Hubble Space Telescope (HST) of ASASSN-15lh. It has been classified as a hydrogen-poor superluminous supernova (SLSN I) more luminous than any other supernova observed. From the

polarimetry we determine that the explosion was only mildly asymmetric. We find the flux of ASASSN-15lh to increase strongly into the UV, with a UV luminosity a hundred times greater than the hydrogen-rich, UV-bright SLSN II SN~2008es. A late rebrightening—most prominent at shorter wavelengths—is seen about two months after the peak brightness, which by itself is as bright as a superluminous supernova. ASASSN-15lh is not detected in the X-rays in individual observations or when the data are summed into two separate bins for the early phase and the rebrightening. The HST UV spectrum during the rebrightening is dominated by the continuum without broad absorption or emission lines. In particular, we confirm a lack of hydrogen emission, showing only Ly-alpha absorption near the redshift previously found by optical absorption lines of the presumed host. The UV spectra lack the broad features seen in SLSNe or tidal disruption events and the early optical spectra of ASASSN-15lh. The extreme properties of ASASSN-15lh and differences when compared to SLSNe and TDEs make its classification as a SLSN uncertain.

Citation: ASASSN's creed—a surprising ultraviolet rebrightening observed in a superluminous supernova (2016, May 19) retrieved 2 April 2023 from https://phys.org/news/2016-05-asassn-creeda-ultraviolet-rebrightening-superluminous.html