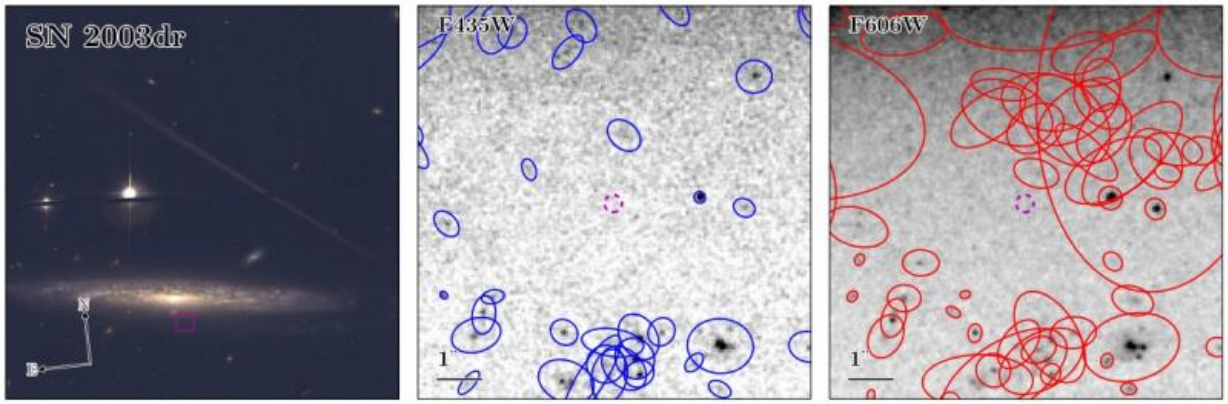
Hubble observes calcium-rich supernovae

March 2 2016, by Tomasz Nowakowski



Hubble Space Telescope imaging (blue: F435W, green: average(F435W, F606W), red: F606W) of the host, NGC 5714, and immediate environment of SN 2003dr. The host image is 200 arcsec on a side, and the sizes of the individual filter images are indicated by the magenta square. The location of SN 2003dr is shown at the center of each zoomed image, with the dashed circle having a radius of 0.2 arcsec. Kron apertures of SExtractor detected sources are marked on their respective images, which have been slightly smoothed to aid visual identification of sources. At the distance of NGC 5714 one arcsec is ~ 160 pc. Credit: Joseph Lyman et al., 2016.

The NASA/ESA Hubble Space Telescope offers a multitude of spectacular images of celestial objects and a huge amount of scientific data helpful for astronomers. A team of scientists from UK and Sweden has recently made use of Hubble to study the host galaxies and environments of five calcium-rich supernovae that could provide new

insights on the evolution of stellar systems. Their research was published online on Feb. 25 in the *arXiv* journal.

Calcium-rich supernovae, also called calcium-rich transients, are a type of supernova that eject a preponderance of calcium into space, less luminous than other supernova types and evolving more rapidly. According to previous studies, a large fraction of them are found at significant distances from the nearest galaxy, well outside the bulk of the stellar light. It is believed that this type of transient may be a major producer of calcium in the universe.

The researchers, led by Joseph Lyman of the University of Warwick, UK, employed Hubble's Advanced Camera for Surveys/Wide Field Channel (ACS/WFC) and Wide Field Camera 3 (WFC3) to obtain images of five calcium-rich supernovae, among which three exhibit large offsets and two are coincident with the disk of their hosts.

"Our sample consists of five examples of the calcium-rich supernova class, which were targeted with Hubble for two orbits each," the scientists wrote in a paper published on arXiv.

The supernovae, lying well outside their hosts, are designated SN 2003dr, SN 2005E and SN 2007ke, and were observed using ACS. The scientists found no detected sources underlying the locations of these supernovae, ruling out the presence of massive stars, dwarf galaxies and globular clusters at these locations.

SN 2003dr is the most interesting of this group as it is quite complex. It lies offset along the minor axis of the galaxy and thus off the disk light, although it is relatively close in linear distance. Hubble images also show a strong tidal feature that passes through the location of this supernova along the southern and western sides of the galaxy.

The two calcium-rich transients appearing to be in line-of-sight with the disks of late type galaxies, named SN 2001co and SN 2003dg, were imaged by Hubble's WFC3. The team discovered that they both display strong patchy star formation and significant dust lanes – typical for their morphological types.

"In each case, the transient's location appears close to regions of star formation. (…) Furthermore, the lack of distinguishable underlying sources at their locations is in agreement with the findings for the remote sample, although in these cases there is clearly an underlying stellar population from the galactic disk," the paper reads.

Thanks to the new research, almost every calcium-rich supernova located within 300 million light years has been observed in detail. The study also confirmed that the majority of host galaxies of these transients are disturbed or merging systems.

However, how these calcium-rich supernovae form is still debated. It could be due to white dwarf mergers with neutron stars due to the collapse of massive stars. According to Lyman, the mechanism of the supernova explosion could cause the neutron star to be 'kicked' to very high velocities.

"This high-velocity system can then escape its galaxy, and if the binary system survives the kick, the white dwarf and neutron star will merge causing the explosive transient," Lyman said.

The scientists concluded that as new members of the class emerge, it will be prudent to further test this apparent bias of calcium-rich supernovae production in disturbed and merging systems.

More information: arxiv.org/pdf/1602.08098.pdf