

Classical nova captured before, during and after exploding

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Artist's portrayal of a classical nova explosion. Credit: K. Ulaczyk / Warsaw University Observatory

(Phys.org)—A team of researchers affiliated with the Warsaw University Observatory has captured for the first time the events that led to a classical nova exploding, the explosion itself and then what happened afterwards. In their paper published in the journal *Nature*, the team describes how they happened to capture the star activity and why



they believe it may help bolster the theory of star hibernation.

The <u>nova</u>, named Nova Centauri 2009, exploded back in 2009, but by happenstance, the research team had been monitoring the same part of the sky while working on another project. When they noticed the explosion, the researchers went back and studied the images they had obtained earlier to build a progressive timeline.

A classical nova, unlike a supernova, does not result in the star being destroyed; instead, material it had been collecting from its nearby companion is burned off in a <u>thermonuclear explosion</u>. In this case, the nova was part of a binary star system made from white and red dwarf stars—material from the red dwarf was slowly transferred to the white dwarf until it reached a tipping point, causing the explosion. Studying what had transpired prior to the explosion, the researchers were able to see fluctuations in brightness, indicating mass being transferred up to just six days before the explosion. They were also able to see that the rate of mass transferred to the white dwarf increased dramatically immediately after the explosion is still visible, though it is diminishing.

The observation of the events surrounding the explosion has bolstered the theory that such events also include hibernation periods, the researchers suggest—because they were able to observe periodic brightening and dimming over a six-year period prior to the <u>explosion</u>. Hibernations, as their name implies, are periods during the life of a binary system during which very little activity occurs. It also implies that the events are cyclical, with explosions occurring repeatedly over millions of years. As researchers continue to monitor the binary, they will be looking for a drop in the mass transfer rate, which would offer more credence to the theory.





Upper panels: Snapshots of a nova lifecycle. Lower panel: The Milky Way over the Warsaw Telescope dome, Las Campanas Observatory. Credit: J. Skowron, K. Ulaczyk / Warsaw University Observatory

More information: Przemek Mróz et al. The awakening of a classical nova from hibernation, *Nature* (2016). <u>DOI: 10.1038/nature19066</u>

Abstract

Cataclysmic variable stars—novae, dwarf novae, and nova-likes—are



close binary systems consisting of a white dwarf star (the primary) that is accreting matter from a low-mass companion star (the secondary). From time to time such systems undergo large-amplitude brightenings. The most spectacular eruptions, with a ten-thousandfold increase in brightness, occur in classical novae and are caused by a thermonuclear runaway on the surface of the white dwarf. Such eruptions are thought to recur on timescales of ten thousand to a million years. In between, the system's properties depend primarily on the mass-transfer rate: if it is lower than a billionth of a solar mass per year, the accretion becomes unstable and the matter is dumped onto the white dwarf during quasiperiodic dwarf nova outbursts. The hibernation hypothesis predicts that nova eruptions strongly affect the mass-transfer rate in the binary, keeping it high for centuries after the event6. Subsequently, the masstransfer rate should significantly decrease for a thousand to a million years, starting the hibernation phase. After that the nova awakes again—with accretion returning to the pre-eruption level and leading to a new nova explosion. The hibernation model predicts cyclical evolution of cataclysmic variables through phases of high and low mass-transfer. The theory gained some support from the discovery of ancient nova shells around the dwarf novae Z Camelopardalis and AT Cancri, but direct evidence for considerable mass-transfer changes prior, during and after nova eruptions has not hitherto been found. Here we report longterm observations of the classical nova V1213 Cen (Nova Centauri 2009) covering its pre- and post-eruption phases and precisely documenting its evolution. Within the six years before the explosion, the system revealed dwarf nova outbursts indicative of a low mass-transfer rate. The post-nova is two orders of magnitude brighter than the prenova at minimum light with no trace of dwarf nova behaviour, implying that the mass-transfer rate increased considerably as a result of the nova explosion.

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