Watching a 'New Star' Make the Universe Dusty

July 24 2008

(PhysOrg.com) -- Using ESO's Very Large Telescope Interferometer, and its remarkable acuity, astronomers were able for the first time to witness the appearance of a shell of dusty gas around a star that had just erupted, and follow its evolution for more than 100 days. This provides the astronomers with a new way to estimate the distance of this object and obtain invaluable information on the operating mode of stellar vampires, dense stars that suck material from a companion.

Although novae were first thought to be new stars appearing in the sky, hence their Latin name, they are now understood as signaling the brightening of a small, dense star. Novae occur in double star systems comprising a white dwarf - the end product of a solar-like star - and, generally, a low-mass normal star - a red dwarf. The two stars are so close together that the red dwarf cannot hold itself together and loses mass to its companion. Occasionally, the shell of matter that has fallen onto the ingesting star becomes unstable, leading to a thermonuclear explosion which makes the system brighter.

Nova Scorpii 2007a (or V1280 Scorpii), was discovered by Japanese amateur astronomers on 4 February 2007 towards the constellation Scorpius ("the Scorpion"). For a few days, it became brighter and brighter, reaching its maximum on 17 February, to become one of the brightest novae of the last 35 years. At that time, it was easily visible with the unaided eye.

Eleven days after reaching its maximum, astronomers witnessed the

formation of dust around the object. Dust was present for more than 200 days, as the nova only slowly emerged from the smoke between October and November 2007. During these 200 days, the erupting source was screened out efficiently, becoming more than 10,000 times dimmer in the visual.

An unprecedented high spatial resolution monitoring of the dust formation event was carried out with the Very Large Telescope Interferometer (VLTI), extending over more than 5 months following the discovery. The astronomers first used the AMBER near-infrared instrument, then, as the nova continued to produce dust at a high rate, they moved to using the MIDI mid-infrared instrument, that is more sensitive to the radiation of the hot dust. Similarly, as the nova became fainter, the astronomers switched from the 1.8-m Auxiliary Telescopes to their larger brethren, the 8.2-m Unit Telescopes. With the interferometry mode, the resolution obtained is equivalent to using a telescope with a size between 35 and 71 metres (the distance between the 2 telescopes used).

The first observations, secured 23 days after the discovery, showed that the source was very compact, less than 1 thousandth of an arcsecond (1 milli-arcsecond or mas), which is a size comparable to viewing one grain of sand from about 100 kilometres away. A few days later, after the detection of the major dust formation event, the source measured 13 mas.

"It is most likely that the latter size corresponds to the diameter of the dust shell in expansion, while the size previously measured was an upper limit of the erupting source," explains lead author Olivier Chesneau. Over the following months the dusty shell expanded regularly, at a rate close to 2 million km/h.

"This is the first time that the dust shell of a nova is spatially resolved

and its evolution traced starting from the onset of its formation up to the point that it becomes too diluted to be seen", says co-author Dipankar Banerjee, from India.

The measurement of the angular expansion rate, together with the knowledge of the expansion velocity, enables the astronomer to derive the distance of the object, in this case about 5500 light-years.

"This is a new and promising technique for providing distances of close novae. This was made possible because the state of the art facility of the VLTI, both in terms of infrastructure and management of the observations, allows one to schedule such observations," says co-author Markus Wittkowski from ESO.

Moreover, the quality of the data provided by the VLTI was such that it was possible to estimate the daily production of dust and infer the total mass ejected. "Overall, V1280 Sco probably ejected more than the equivalent of 33 times the mass of the Earth, a rather impressive feat if one considers that this mass was ejected from a star not larger in radius than the Earth," concludes Chesneau. Of this material, about a percent or less was in the form of dust.

"VLTI monitoring of the dust formation event of the Nova V1280 Sco", by O. Chesneau et al. appears today in the research journal *Astronomy and Astrophysics*.

Provided by ESO