

# 'Old smokers' and 'squalling newborns' among hidden stars spotted for first time

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Artist's impression of a cloud of smoke and dust being thrown out by a red giant star. Seen from the left the star remains bright but if viewed from the right it fades to invisibility. Credit: Philip Lucas/University of Hertfordshire

'Hidden' stars including a new type of elderly giant nicknamed 'old smoker' have been spotted for the first time by astronomers. The mystery objects exist at the heart of our Milky Way galaxy and can sit quietly for decades—fading almost to invisibility—before suddenly puffing out clouds of smoke, according to new research published in the *Monthly Notices of the Royal Astronomical Society*.

An international team of scientists led by Professor Philip Lucas, of the University of Hertfordshire, made their ground-breaking discovery after monitoring almost a billion stars in [infrared light](#) during a 10-year survey of the night sky.

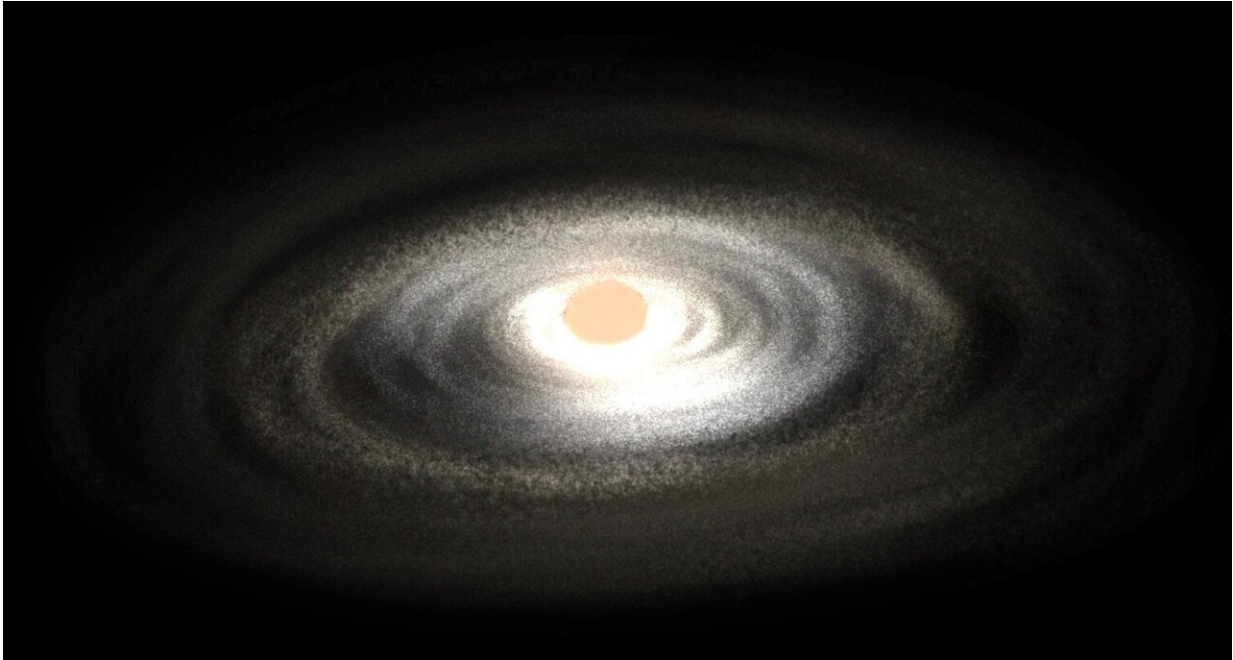
The papers, "The most variable VVV sources: eruptive protostars, dipping giants in the Nuclear Disk and others," "Spectroscopic confirmation of high-amplitude eruptive YSOs and dipping giants from the VVV survey" and "On the incidence of episodic accretion in Class I YSOs from VVV," have all been published in the *Monthly Notices of the Royal Astronomical Society*.

They also detected dozens of rarely-seen newborn stars, known as protostars, which undergo extreme outbursts over a period of months, years or decades, as part of the formation of a new solar system.

Most of these newly-spotted stars are hidden from view in [visible light](#) by large amounts of dust and gas in the Milky Way—but infrared light can get through, allowing scientists to see them for the first time.

Astronomers from the UK, Chile, South Korea, Brazil, Germany and Italy carried out their research with the help of the Visible and Infrared Survey Telescope (VISTA)—a British-built telescope high in the Chilean Andes at Cerro Paranal Observatory, which is part of the European Southern Observatory (ESO).

The team kept a watchful eye on hundreds of millions of stars and analyzed 222 that showed the largest changes in brightness.



Artist's impression of an eruption in the disc of matter around a newborn star. The innermost part of the disc becomes hotter than the star itself. Credit: Philip Lucas/University of Hertfordshire

Professor Lucas said, "About two-thirds of the stars were easy to classify as well-understood events of various types.

"The rest were a bit more difficult so we used ESO's Very Large Telescope to get spectra of many of them individually. A spectrum shows us how much light we can see at a spread of different wavelengths, giving a much clearer idea of what we are looking at."

The work was carried out as part of a long-term survey called "VISTA

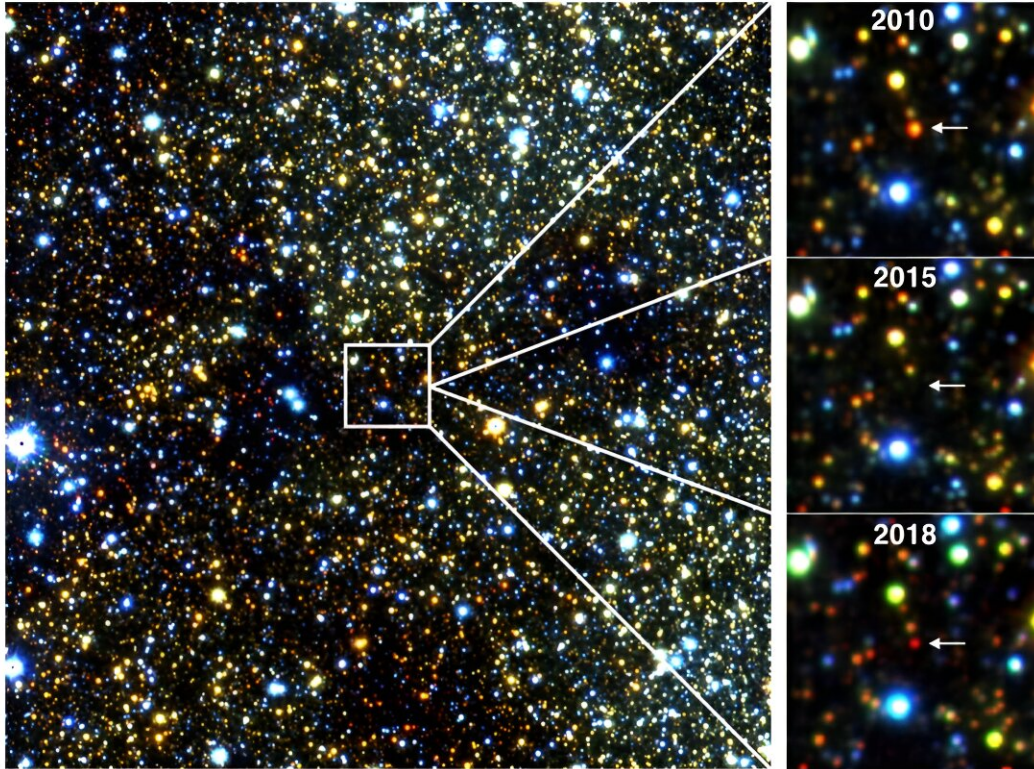
Variables in the Via Lactea," or VVV.

Dr. Zhen Guo, formerly of the University of Hertfordshire and now based at the University of Valparaiso in Chile, led the work on the spectra.

He said, "Our main aim was to find rarely-seen newborn stars, also called protostars, while they are undergoing a great outburst that can last for months, years, or even decades.

"These outbursts happen in the slowly spinning disk of matter that is forming a new solar system. They help the newborn star in the middle to grow, but make it harder for planets to form.

"We don't yet understand why the disks become unstable like this."



Infrared images of a red giant star about 30,000 light years away, near the center of our Milky Way galaxy, that faded away and then reappeared over the course of several years. Credit: Philip Lucas/University of Hertfordshire

The team discovered 32 erupting protostars that increased in brightness at least 40-fold, and in some cases over 300-fold.

Most of the eruptions are still ongoing, allowing astronomers for the first time to analyze a large batch of these mysterious events throughout their evolution—from the initial quiescent state, through the peak of brightness, and into the declining stage.

However, the study also threw up something completely unexpected.

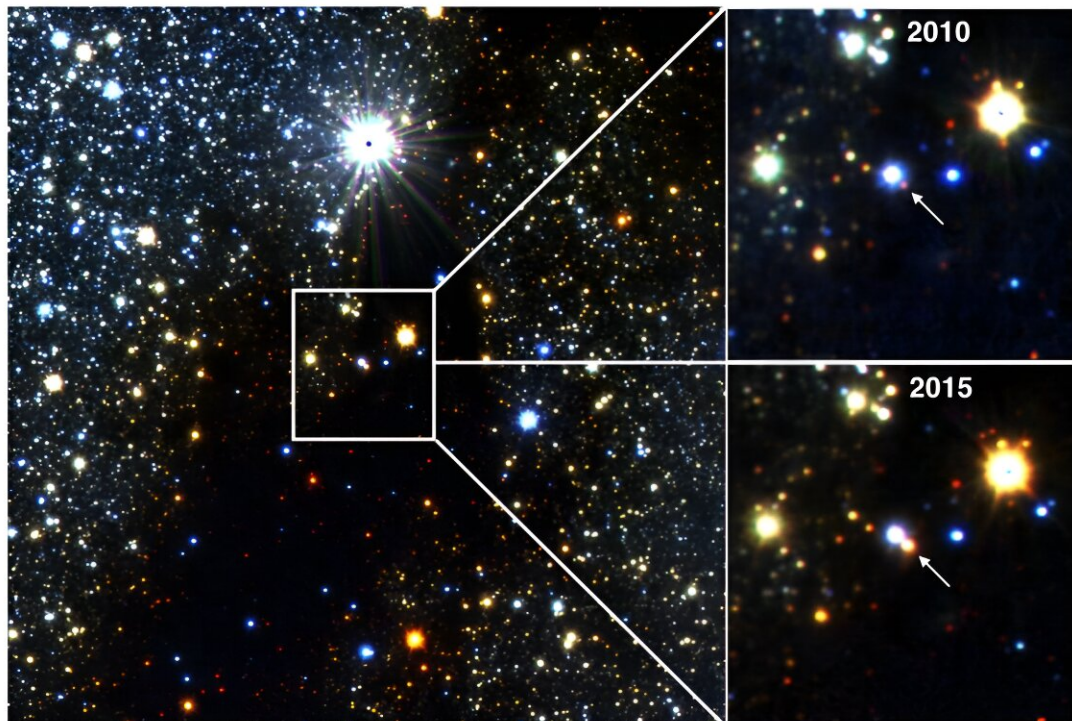
There were 21 red stars near the center of the Milky Way that showed ambiguous changes in brightness during the 10-year survey.

Professor Lucas said, "We weren't sure if these stars were protostars starting an eruption, or recovering from a dip in brightness caused by a disk or shell of dust in front of the star—or if they were older giant stars throwing off matter in the late stages of their life."

Analysis of the spectra for seven of these stars, compared with data from earlier surveys, concluded that they were in fact a new type of red giant star.

Professor Dante Minniti at Andrés Bello University, Chile, founder of the VVV survey, said, "These elderly stars sit quietly for years or decades and then puff out clouds of smoke in a totally unexpected way. They look very dim and red for several years, to the point that sometimes we can't see them at all."





Buried deep inside the dark cloud of gas and dust that fills the picture, this star gradually brightened 40-fold over the course of 2 years and has remained bright since 2015. The cause of such events is not clearly understood. This infrared image shows what we would see if our eyes were sensitive to wavelengths 3 times longer than visible light. Credit: Philip Lucas/University of Hertfordshire

A further clue about this new discovery lies in the location of these dwindling giant stars. They are heavily concentrated in the innermost part of the Milky Way, known as the Nuclear Disk, a region where stars tend to be richer in [heavy elements](#) than anywhere else.

This should make it easier for dust particles to condense out of gas in the

relatively cool outer layers of red giant stars. However, how this leads to the ejection of puffs of dense smoke that the team observed remains a mystery.

The researchers said their discoveries could change what we know about the way that elements are distributed across space, as Professor Lucas explains.

"Matter ejected from old stars plays a key role in the life cycle of the elements, helping to form the next generation of stars and planets," he said.

"This was thought to occur mainly in a well-studied type of star called a Mira variable.

"However, the discovery of a new type of star that throws off matter could have wider significance for the spread of heavy elements in the Nuclear Disk and metal-rich regions of other galaxies."

**More information:** Phil Lucas et al, The most variable VVV sources: eruptive protostars, dipping giants in the Nuclear Disc and others, *Monthly Notices of the Royal Astronomical Society* (2024). [DOI: 10.1093/mnras/stad3929](https://doi.org/10.1093/mnras/stad3929)

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Provided by Royal Astronomical Society

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