New Gemini Images Contrast the Late Evolution of Two Very Different Stars

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NGC 6164-5 imaged at Gemini South . Travis Rector University of Alaska Anchorage.

Two new images from the Gemini Observatory released today at the American Astronomical Society meeting in Calgary, Canada, show a pair of beautiful nebulae that were created by two very different types of stars at what may be similar points in their evolutionary timelines.

One is a rare type of very massive spectral-type "O" star surrounded by material it ejected in an explosive event earlier in its life that continues to lose mass in a steady "stellar wind." The other is a star originally more similar to our Sun that has lost its outer envelope following a "red giant"

phase. It continues to lose mass via a stellar wind as it dies, forming a planetary nebula. The images were made using the Gemini Multi-Object Spectrograph (GMOS) on Gemini South as part of the Gemini Legacy Imaging program.

GMOS was built as a joint UK / Canadian effort by the UK Astronomy Technology Centre (UKATC) in Edinburgh, the University of Durham and the Dominion Astrophysical Observatory in Canada. Its creators praise the performance of GMOS.

Professor James Dunlop of the University of Edinburgh, current Chair of Gemini Science Committee, said “The Gemini telescope using GMOS is unrivalled in its ability to take stunning images of distant phenomena in our Galaxy and beyond.”

UK membership of Gemini is funded by the Particle Physics and Astronomy Research Council (PPARC), which also operates the UK ATC.

A Rare and Massive Star

The first image shows the emission nebula NGC 6164-5, a rectangular, bipolar cloud with rounded corners and a diagonal bar producing an inverted S-shaped appearance. It lies about 1,300 parsecs (4,200 light-years) away in the constellation Norma. The nebula measures about 1.3 parsecs (4.2 light-years) across, and contains gases ejected by the star HD 148937 at its heart. This star is 40 times more massive than the Sun, and at about three to four million years of age, is past the middle of its life span. Stars this massive usually live to be only about six million years old, so HD 148397 is aging fast. It will likely end its life in a violent supernova explosion.

Like other O-type stars, HD148937 is heating up its surrounding clouds

of gas with ultraviolet radiation. This causes them to glow in visible light, illuminating swirls and caverns in the cloud that have been sculpted by winds from the star. Some astronomers suggest that the cloud of material has been ejected from the star as it spins on its axis, in much the same way a rotating lawn sprinkler shoots out water as it spins. It's also possible that magnetic fields surrounding the star may play a role in creating the complex shapes clearly seen in the new Gemini image.

The Death of a Sunlike Star–With a Twist

NGC 5189 imaged at Gemini South. Travis Rector University of Alaska Anchorage.

Just as astronomers are still seeking to understand the process of mass loss from a star like HD 158937, they are also searching out the exact mechanisms at play when a star like the Sun begins to age and die. NGC 5189, a chaotic-looking planetary nebula that lies about 550 parsecs (1,800 light-years) away in the southern hemisphere constellation Musca, is a parallelogram-shaped cloud of glowing gas. The GMOS image of

this nebula shows long streamers of gas, glowing dust clouds, and cometary knots pointing away from the central star. Its unruly appearance suggests some extraordinary action at the heart of this planetary nebula.

At the core of NGC 5189 is the hot, hydrogen-deficient star HD 117622. It appears to be blowing off its thin remnant atmosphere into interstellar space at a speed of about 2,700 kilometers (about 1,700 miles) per second. As the material leaves the star, it immediately begins to collide with previously ejected clouds of gas and dust surrounding the star. This collision of the fast-moving material with slower motion gas shapes the clouds, which are illuminated by the star. These so-called "low ionization structures" (or LIS) show up as the knots, tails, streamers, and jet-like structures we see in the Gemini image. The structures are small and not terribly bright, lending planetary nebulae their often-ghostly appearance.

"The likely mechanism for the formation of this planetary nebula is the existence of a binary companion to the dying star," said Gemini scientist Kevin Volk. "Over time the orbits drift due to precession and this could result in the complex curves on the opposite sides of the star visible in this image."

NGC 5189 was discovered by James Dunlop in 1826, when Sir John Herschel observed it in 1835 he described it as a "strange" object. It was not immediately identified as a planetary nebula, but its peculiar spectra, shows emission lines of ionized helium, hydrogen, sulphur and oxygen. These all indicate elements being burned inside the star as it ages and dies. As the material is blown out to space, it forms concentric shells of various gases from elements that were created in the star's nuclear furnace.

Source: PPARC