



**Planetary Nebula NGC 7027**  
Hubble Space Telescope • NICMOS

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STARING INTO THE WINDS OF DESTRUCTION:  
HST/NICMOS IMAGES OF THE PLANETARY NEBULA NGC 7027

The Hubble Space Telescope's Near Infrared Camera and Multi-Object Spectrometer (NICMOS) has captured a glimpse of a brief stage in the burnout of NGC 7027, a medium-mass star like our sun. The infrared image (on the left) shows a young planetary nebula in a state of rapid transition. This image alone reveals important new information. When astronomers combine this photo with an earlier image taken in visible light, they have a more complete picture of the final stages of star life.

NGC 7027 is going through spectacular death throes as it evolves into what astronomers call a "planetary nebula." The term planetary nebula came about not because of any real association with planets, but because in early telescopes these objects resembled the disks of planets.

A star can become a planetary nebula after it depletes its nuclear fuel – hydrogen and helium – and begins puffing away layers of material. The material settles into a wind of gas and dust blowing away from the dying star. This NICMOS image captures the young planetary nebula in the middle of a very short evolutionary phase, lasting perhaps less than 1,000 years. During this phase, intense ultraviolet radiation from the central star lights up a region of gas surrounding it. (This gas is glowing brightly because it has been made very hot by the star's intense ultraviolet radiation.) Encircling this hot gas is a cloud of dust and cool molecular hydrogen gas that can only be seen by an infrared camera. The molecular gas is being destroyed by ultraviolet light from the central star.

**THE INFRARED VIEW** – The composite color image of NGC 7027 (on the left) is among the first data of a planetary nebula taken with NICMOS. This picture is actually composed of three separate images taken at different wavelengths. The red color represents cool molecular hydrogen gas, the most abundant gas in the universe.

The image reveals the central star, which is difficult to see in images taken with visible light. Surrounding it is an elongated region of gas and dust cast off by the star. This gas (appearing as white) has a temperature of several tens of thousands of degrees Fahrenheit. The object has two "cones" of cool molecular hydrogen gas (the red material) glowing in the infrared. The gas has been energized by ultraviolet light from the star – a process known as fluorescence. Most of the material shed by the star remains outside of the bright regions. It is invisible in this image because the layers of material in and near the bright regions are still shielding it from the central star's intense radiation.

NGC 7027 is one of the smallest objects of its kind to be imaged by the Hubble telescope. However, the region seen here is approximately 14,000 times the average distance between Earth and the sun.

**THE INFRARED AND VISIBLE LIGHT VIEW** – This visible and infrared light picture of NGC 7027 (on the right) provides a more complete view of how this planetary nebula is being shaped, revealing steps in its evolution.

This image is composed of three exposures, one from the Wide Field and Planetary Camera 2 (WFPC2) and two from NICMOS. The blue represents the WFPC2 image; the green and red, NICMOS exposures. The white is emission from the hot gas surrounding the central star; the red and pink represent emission from cool molecular hydrogen gas. In effect, the colors represent the three layers in the material ejected by the dying star. Each layer depicts a change in temperature, beginning with a hot, bright central region, continuing with a thin boundary zone where molecular hydrogen gas is glowing and being destroyed, and ending with a cool, blue outer region of molecular gas and dust.

NICMOS has allowed astronomers to clearly see the transition layer from hot, glowing atomic gas to cold molecular gas. The origin of the newly seen filamentary structures is not yet understood. The transition region is clearly seen as the pink and red-colored cool molecular hydrogen gas. An understanding of the atomic and chemical processes taking place in this transition region are of importance to other areas of astronomy as well, including star formation regions. WFPC2 is best used to study the hot, glowing gas, which is the bright, oval-shaped region surrounding the central star. With WFPC2 we also see material beyond this core with light from the central star that is reflecting off dust in the cold gas surrounding the nebula. Combining exposures from the two cameras allows astronomers to clearly see the way the nebula is being shaped by winds and radiation. This information will help astronomers understand the complexities of stellar evolution. NGC 7027 is located about 3,000 light years from the sun in the direction of the constellation Cygnus the Swan.

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