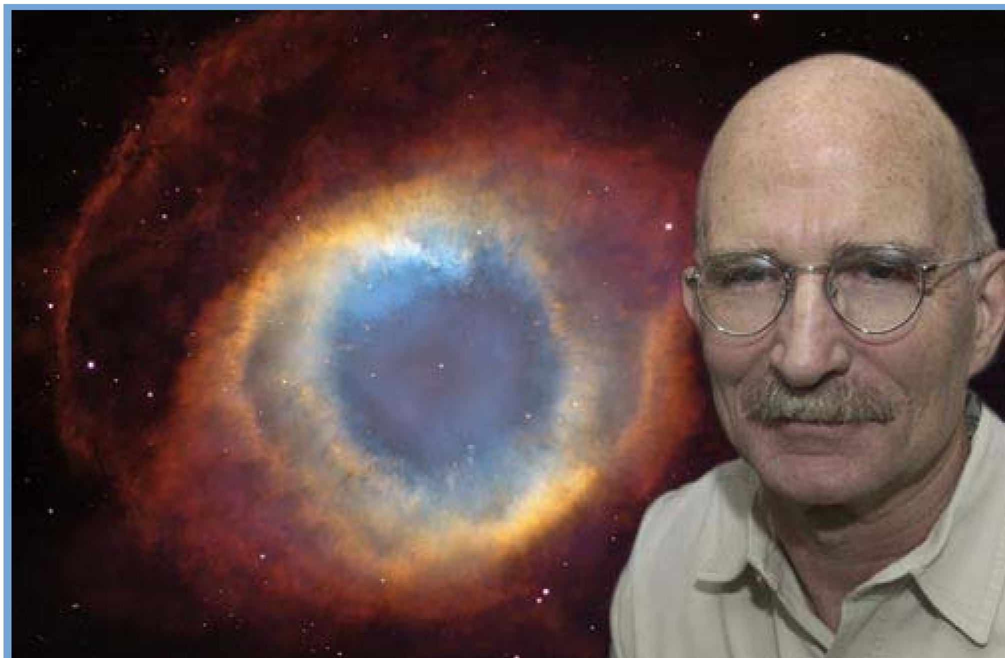

Photo by Daniel Dubois

C. Robert O'Dell with Helix nebula in the background

A new twist on an old nebula

By David F. Salisbury
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In a process comparable to that of an artist who turns a two-dimensional canvas into a three-dimensional work of art, astronomers use the two dimensional images that they capture in their high-powered telescopes to reconstruct the three-dimensional structures of celestial objects. The latest example of this reconstructive artistry is a new model of the Helix Nebula—one of the nearest and brightest of the planetary nebulae, which are the Technicolor clouds of dust and glowing gas produced by stellar explosions. Efforts of this sort are providing important new insights into the process that stars like the sun go through before they die in fiery explosions.

Courtesy of C. Robert O'Dell

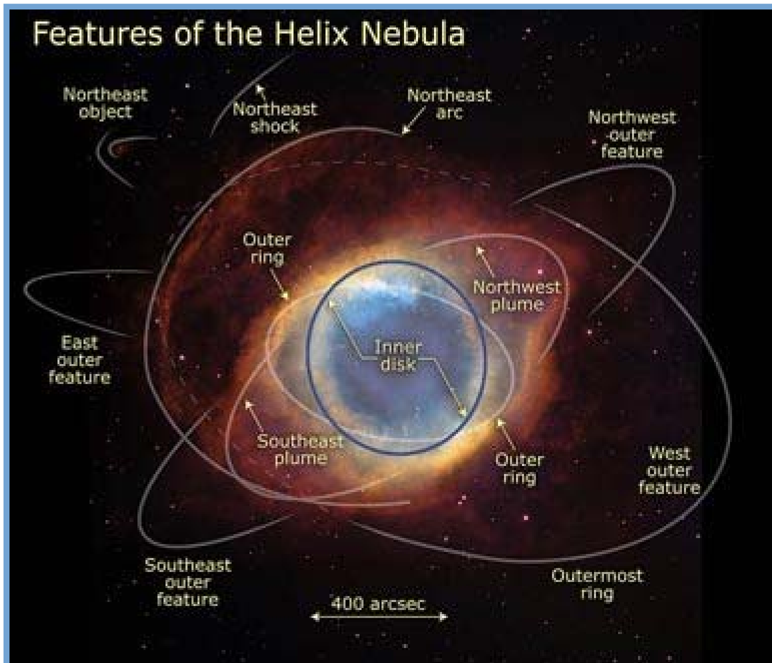
Helix nebula

The analysis, published in the November issue of the *Astronomical Journal* , was conducted by a team of astronomers led by C. Robert O'Dell of Vanderbilt University. Combining sharp new images from the Hubble Space Telescope with the best ground-based optical and radio images and spectra, the astronomers have determined that the Helix Nebula is not, in fact, shaped in a snake-like coil as earlier analyses had concluded. Instead of being structured like a helix, they have found that the nebula consists of inner and outer shells of dust and gas that are oriented at nearly 90 degrees from one another.

This new information has allowed the researchers to determine not only the relative positions of the nebula's major features, but also the speed and direction that the expanding dust and gas are moving. For example, they figured out why the larger disk is brighter on one side than on the other. It is because the nebula is moving through the interstellar medium, something like a boat plowing through water. In this case, however, the encounter compresses the colliding gases and causes them to glow more brightly than they do in other parts of the ring.

"Our new observations show that the previous model of the Helix was much too simple," O'Dell says. "About a year ago, we believed the Helix was a bagel shape, filled in the middle. Now we see that this filled bagel is just the inside of the object. A much larger disk, shaped like a washer, surrounds the filled bagel. This disk is oriented almost perpendicular to the bagel." (See 3-D animation by STScI animator Greg Bacon)

Team member Peter McCullough adds, "To visualize the Helix's geometry imagine a lens from a pair of glasses that was tipped at an angle to the frame's rim. That would be an odd-looking pair of glasses. Well, in the case of the Helix, finding a disk inclined at an angle to a ring would be a surprise. But that is, in fact, what we found." He and Margaret Meixner, both of the Space Telescope Science Institute, contributed to the study.



Courtesy of STScI

Annotated image of the Helix nebula

Astronomers suspect that these complex patterns hold important information about the conditions that existed in their progenitor stars before they exploded. “But we still don't understand how you get such a shape. If we could explain how this shape was created, then we could explain the late stages of certain types of stars," O'Dell says.

Courtesy of C. Robert O'Dell

ic418 is a good example of a non-polar planetary nebula

Currently, scientists believe that several of a star's properties may influence the way in which dust and gas is ejected when it explodes. These include the star's speed and axis of rotation; the strength and axis of its magnetic field; and, the influence of a close companion star if it has one.

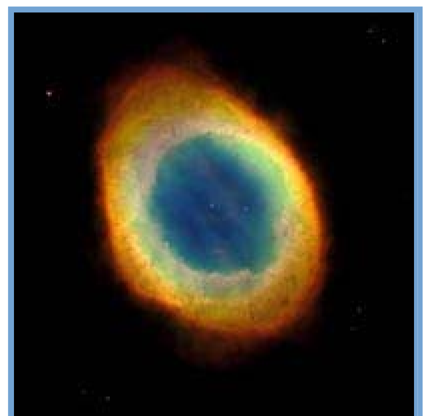
One group of astronomers argues that the gravitational influence of companion stars alone can produce these patterns and that a star's rotation and magnetic field are not important. Other scientists, however, contend that rotation, magnetic field and the influence of companion stars all play a role.

One way that astronomers classify planetary nebulae is by the number of axes that they contain. A non-polar nebula is one that has no axes: material is sloughed off the star uniformly to form a spherical cloud of dust and gas. A bipolar nebula is one that is created by ejecting material primarily in a flat disk perpendicular to a single axis of symmetry. Finally, a quadra-polar nebula possesses material expanding outward in two disks, each with a different orientations. The new study finds that the Helix nebula is quadra-polar.

Space-based X-ray observations suggest that the Helix star has a companion star and the pair are orbiting so closely together that they appear as a single image in optical telescopes. This suggests that the orientation of one disk may have been influenced by the orbit of the companion star and that the orientation of the other disk was determined by the dying star's spin axis or the axis of its magnetic field.

"The new model strengthens the argument that the star's rotation and magnetic field axes play a role because the proponents of the companion-star-only model can't explain quadra-polar patterns like this," says O'Dell.

Another discovery that surprised the researchers is that the two disks appear to have been formed at different times. The nebula's inner disk is expanding slightly faster than the outer disk leading the astronomers to estimate that the inner disk was formed about 6,600 years ago while the outer ring is about 12,000 years ago.



Courtesy of C. Robert O'Dell

ngc6720 is a good example of a bipolar planetary nebula

Why did the star expel matter at two different epochs, leaving a gap of 6,000 years? Right now, only the Helix Nebula knows the answer, the astronomers say.

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ADDITIONAL LINKS

Space Telescope Science Institute news release, images and additional information.