COLOR IN THE UNIVERSE

The nebulae and galaxies pictured on these pages have never before been seen in natural color – even through the most powerful telescopes. Closer, brighter objects like the planets have been photographed in color, but the dramatic colors of distant, faint objects have never been captured before. Now, with the advent of an ultrafast color film, a whole new field in astronomical photography has been opened. The new film, coupled with the exceptional optical speeds and long focal lengths of the 48-inch Schmidt and the 200-inch Hale telescopes at Palomar Observatory, has at last made it possible to see some of the splendors of space in their true colors. Aside from their beauty, color portraits have a rare research value in the science of astronomy. Even though the new color pictures are unexplored scientifically, astronomers have already discovered that various states of excitation can be seen in the fine details of these nebulae – and the brilliant colors immediately reveal the relative temperatures of far-off stars.

THE NORTH AMERICA NEBULA

This vast body of gas shaped like the continent of North America shines by the same mechanism of fluorescence that makes a neon light glow. The nebula appears pure red because of the filtering action of intervening dust in space, which removes the other colors radiated by the gas. Photographed with the 48-inch telescope.

THE CRAB NEBULA

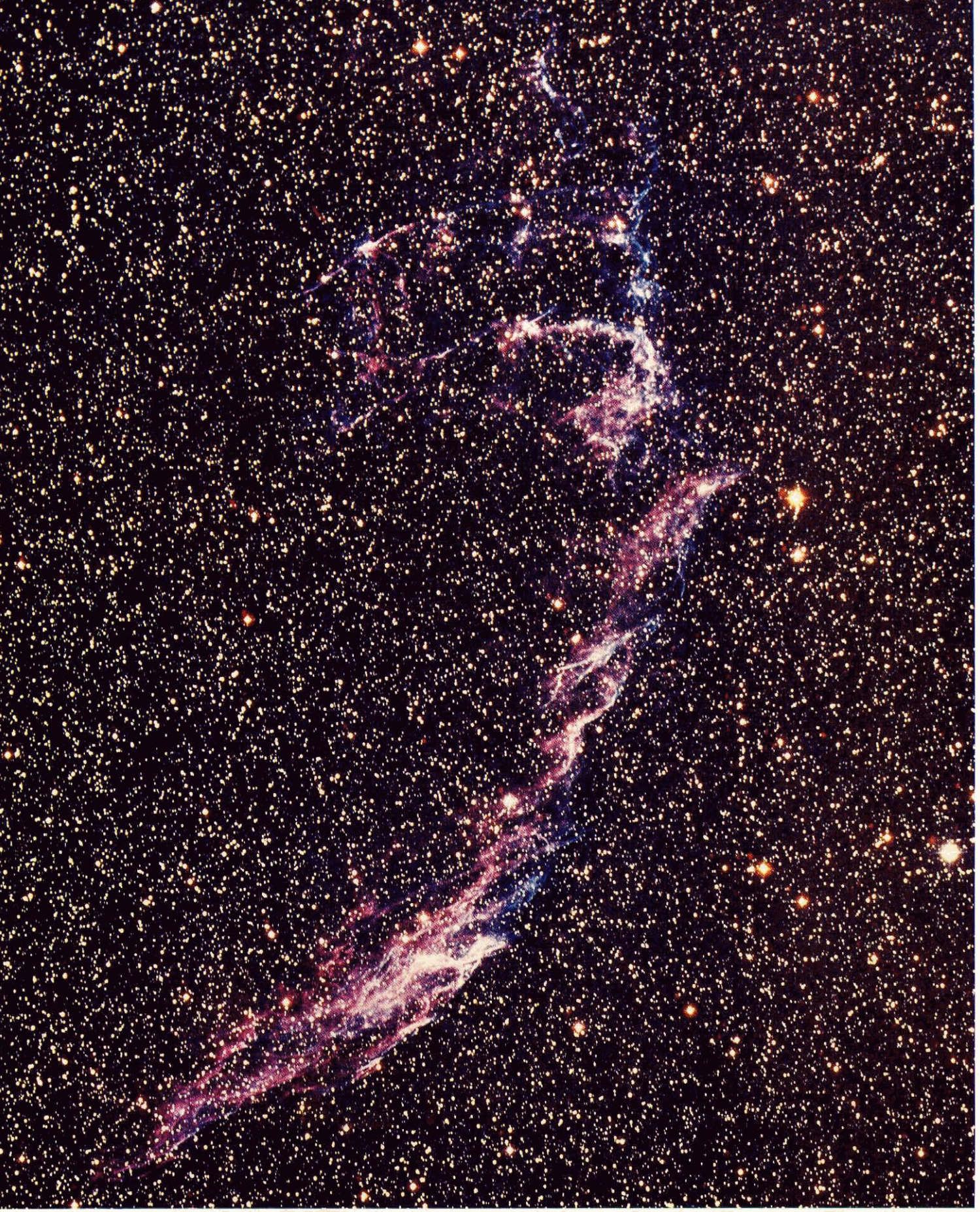
This large cloud of gas is the result of an exploding star called a supernova. Old Chinese records tell of the sudden appearance of a very bright star in 1054 A.D. and the Crab Nebula is quite probably a cloud thrown off by the supernova at the time of its explosion. High-energy electrons, still dashing about as a result of the explosion, cause the center of the nebula to glow with nearly white light. Photographed with the 200-inch telescope.

THE RING NEBULA IN LYRA

This nebula can be seen through relatively small telescopes. The blue stars at the center of the ring are the source of powerful ultraviolet light which causes the gases in the ring to radiate in their characteristic colors by fluorescence. Photographed with the 200-inch telescope.

THE GREAT GALAXY IN ANDROMEDA

This spiral galaxy, composed of billions of stars (many of them larger and hotter than our own sun) resembles our Milky Way galaxy. The outer portions of the galaxy appear bluer than the rest because the dominant stars in that region are the very young hot stars which have recently formed from the gas clouds present. The central regions are reddish because the prominent stars there are all older, cool, red giant stars. Photographed with the 48-inch telescope.



THE VEIL NEBULA IN CYGNUS

The colors radiated by these filaments of gas result from the nebula's rush through space. The gas clouds were ejected from an exploding star more than 50,000 years ago at a speed of nearly 5,000 miles a second. Because of constant collisions with atoms of gas, their speed has now been slowed to about 75 miles a second. The force of the collisions ionizes the gas and causes it to glow with color. Photographed with the 48-inch telescope.

Why there is color in the universe

The four processes that cause all bright objects in the universe to shine are also capable of producing spectacular and subtle colors. Our moon, the planets, and sometimes even clouds of dust in space, shine by reflected light – and their color is largely determined by the illuminating source. The stars (including the sun) shine as a result of their great heat – and their color is determined by their temperature; red if relatively cool, white if very hot, or blue if intensely hot. The bodies of gas called nebulae absorb invisible ultraviolet light from any very hot nearby star, then re-radiate the energy by fluorescence in visible wavelengths or colors. The colors in the nebulae depend upon the nature of the gases present, and the extent to which these gases are excited by the ultraviolet light. Nebulae can also shine as a result of collisions between atoms, or between atoms and high-energy particles such as electrons. Anyone familiar with the Ring Nebula in Lyra or the Great Nebula in Orion from telescope views, may be surprised at the strong colors shown here. But, at low light intensities, the eye loses its sensitivity to color long before it loses its sensitivity to light. So, when looking through a telescope, the eye usually gets enough light to detect these objects, but not enough to distinguish their colors. Now, with the advent of the new color film, combined with the power of Palomar's telescopes, it is possible to see some of the wonders of space in their original colors for the first time.