Stellar Life Cycle in
Giant Galactic Nebula NGC 3603

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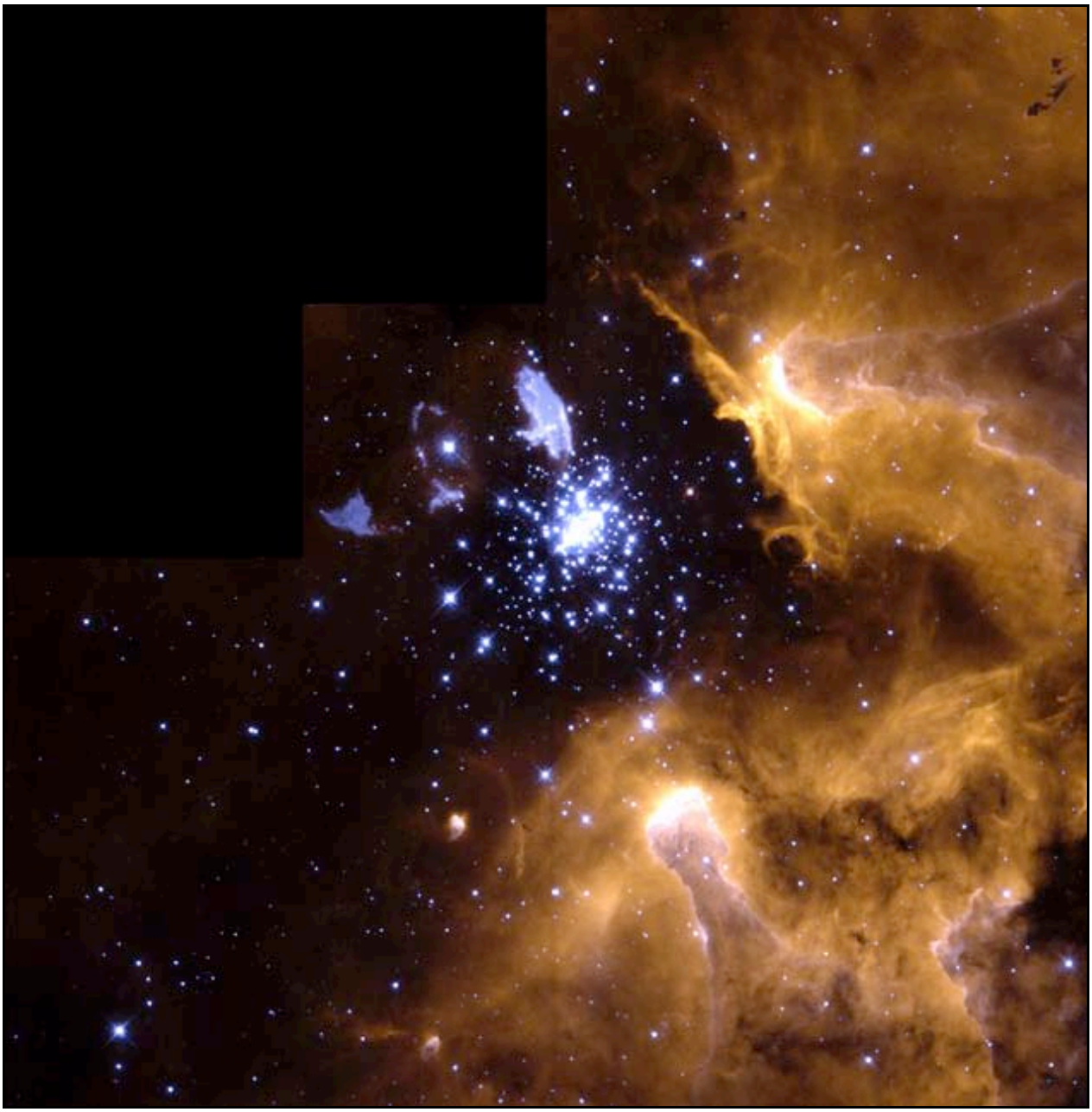
Note: In PDF format most of the images in this web paper
can be enlarged for greater detail.

Introduction

NGC 3603 is a giant HII region in the Carina spiral arm of the southern Milky Way, some 20,000 light years (6 kpc) away from our solar system.

HII stands for ionized hydrogen. Gas clouds consist predominantly of hydrogen, the lightest and most abundant element in the universe. When exposed to ultraviolet radiation from hot stars the gas becomes ionized. Hydrogen atoms are stripped of their only electron, and the proton remains. While hydrogen atoms become ionized, ions recombine with free electrons to form again neutral atoms. When recombining the electrons emit light at characteristic wavelengths.

NGC 3603 is actually only a dwarf among giant HII regions— there are other galaxies with much larger regions of this kind. But NGC 3603 is the closest giant HII region and the best resolved one. In fact it is the only giant HII region in our Galaxy that is visible at optical wavelengths. NGC 3603 has been the subject of many studies from the ground and space, but the high resolution of recent Hubble Space Telescope observations revealed a number of previously unknown features and nicely illustrates the complexity of this nearby starburst region.

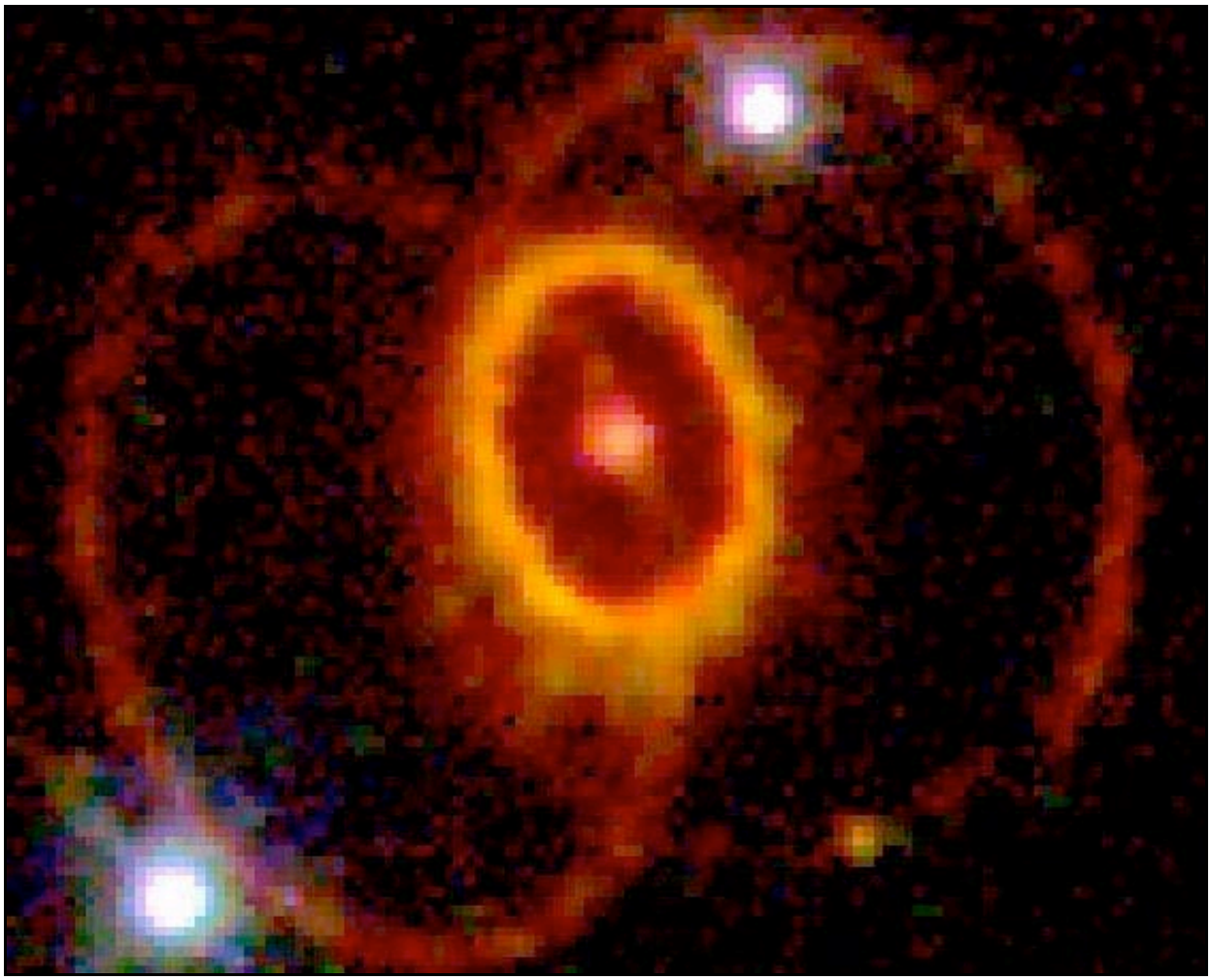


In this stunning picture of the giant galactic nebula NGC 3603, the Hubble Space Telescope captures various stages of the life cycle of stars in a single view.

NGC 3603 Image Credits—Wolfgang Brandner (JPL/IPAC); Eva K. Grebel (Univ. Washington); You-Hua Chu (Univ. Illinois Urbana-Champaign); and NASA.

Web Reference
http://hubblesite.org/newscenter/archive/1999/20/

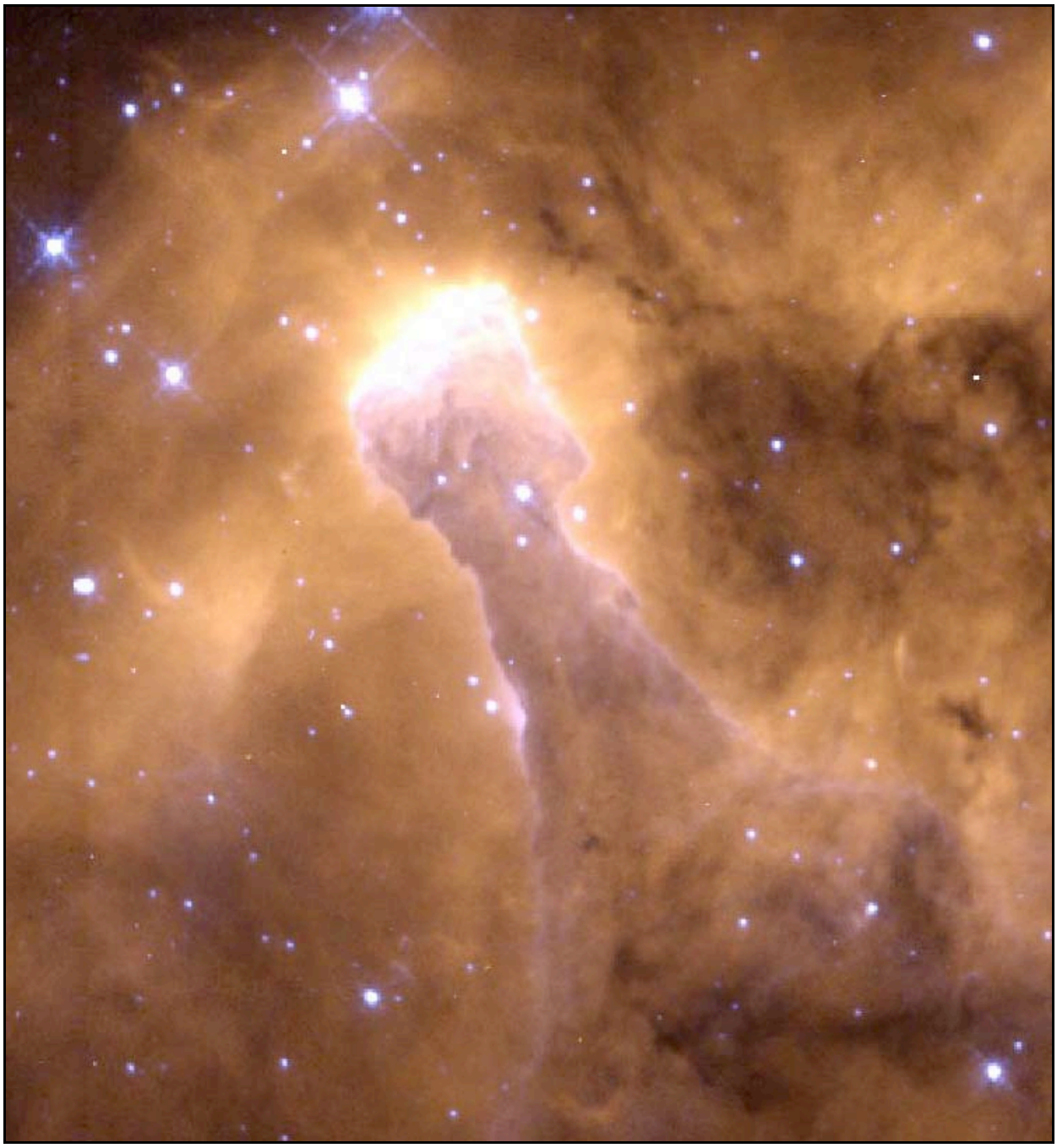
To the upper left of center in the full image (centered in this enlargement) is the evolved blue supergiant called Sher 25. The star has a unique circumstellar ring of glowing gas that is a galactic twin to the famous ring around the supernova 1987A. The grayish-bluish color of the ring and the bipolar outflows (blobs to the upper right and lower left of the star) indicates the presence of chemically enriched material.



Supernova 1987A seen in infrared.

(Image courtesy of NASA)

Near the center of view in the first full image is a so-called starburst cluster dominated by young, hot stars (upper left in this enlargement). A torrent of ionizing radiation and fast stellar winds from these massive stars has blown a large cavity around the cluster (to the right above).



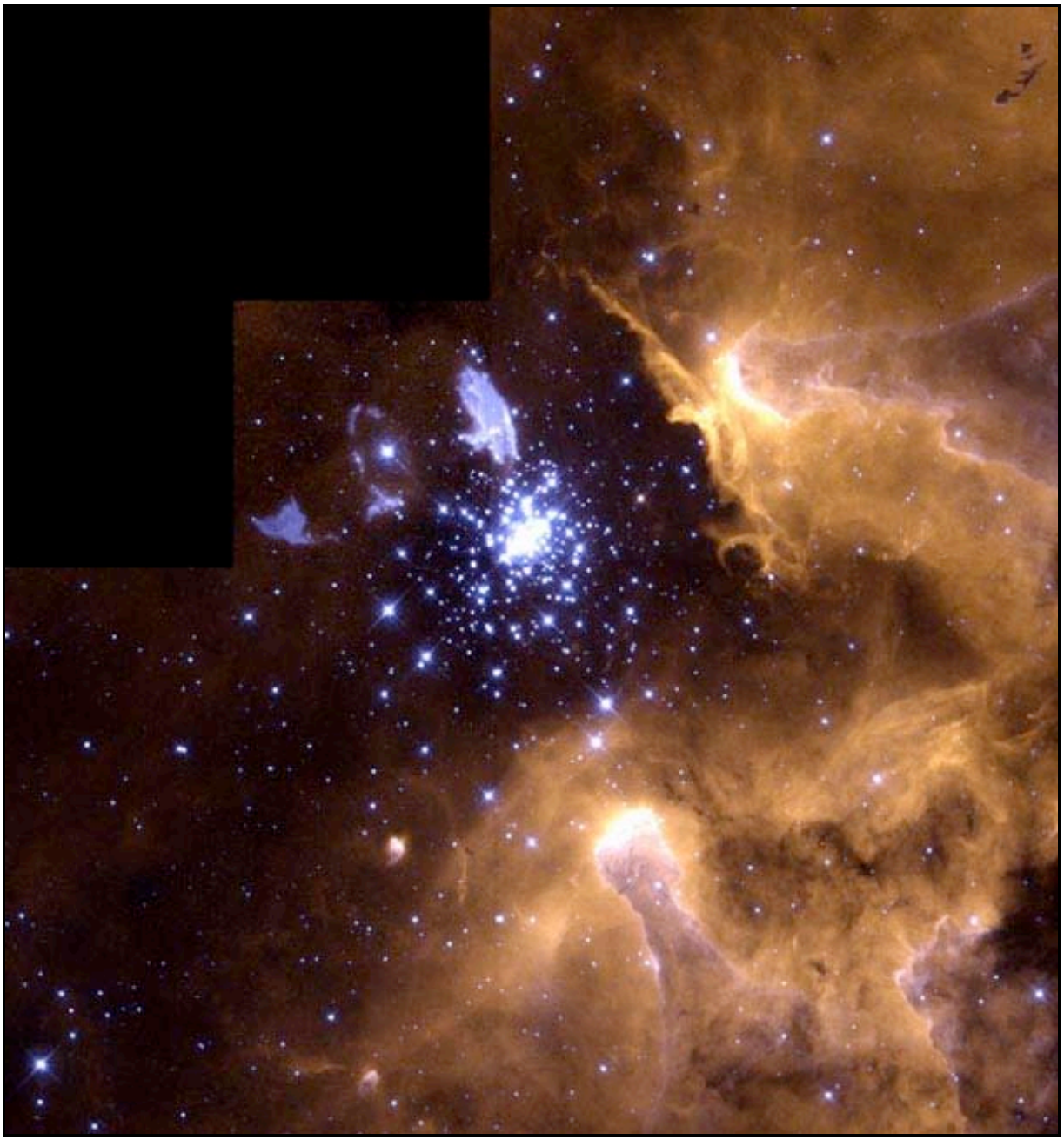
The most spectacular evidence for the interaction of ionizing radiation with cold molecular-hydrogen cloud material are the giant gaseous pillars to the right and below the starburst cluster in the full image (the lower pillar is enlarged above). These pillars are sculptured by the same physical processes as the famous pillars photographed in the Eagle Nebula.

Dark clouds at the upper right corner of the full image are so-called Bok globules (enlarged above), which are probably in an earlier stage of star formation.

To the lower left of the starburst cluster in the full image are two compact, tadpole-shaped emission nebulae (pictured above center top and bottom). Similar structures are found in the Orion nebula, and have been interpreted as gas and dust evaporation from protoplanetary disks (proplyds). The pictured proplyds have sizes of 6,000 and 18,000 astronomical units. Our solar system is ~ 80 AU across, thus these proplyds are huge in comparison. The embedded stars have masses of 1 to 2 solar masses and are still accreting material from their surrounding disks.

Shown here is a teardrop shaped protoplanetary disk or proplyd in the Orion Nebula.

(Image courtesy of NASA)



Thus the full view illustrates the entire stellar life cycle of stars, starting with the Bok globules and giant pillars, followed by proplyds and circumstellar disks, and progressing to massive stars in the young starburst cluster. The blue supergiant with its ring and bipolar outflow marks the end of the life cycle. The color difference between the super giant's outflow and the interstellar medium in the giant nebula dramatically visualizes the enrichment in heavy elements due to synthesis of heavier elements within stars.

NGC 602 and Beyond,

This Hubble Space Telescope image also captures bright, blue, newly formed stars that are blowing a cavity in the center of a young star-forming region only this time near the outskirts of the Small Magellanic Cloud, a satellite galaxy some 200 thousand light-years distant from our own Milky Way galaxy.

The relatively young star cluster NGC 602 shows fantastic ridges and swept back shapes strongly suggest that energetic radiation and shock waves from NGC 602's

massive young stars have eroded the dusty material and triggered a progression of star formation moving away from the cluster's center.

At the estimated distance of the Small Magellanic Cloud, the picture spans about 200 light-years, but a tantalizing assortment of background galaxies are also visible in the sharp Hubble view. The background galaxies are hundreds of millions of light-years or more beyond NGC 602. Released on 2007-1-8 by NASA the image was used as the APOD for 2010-4-3.

Web Reference
http://antwrp.gsfc.nasa.gov/apod/ap100403.html

For further information on related topics go to:

Cosmological Evolution
http://fire.biol.wwu.edu/trent/alles/Cosmic_Evolution_index.html

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