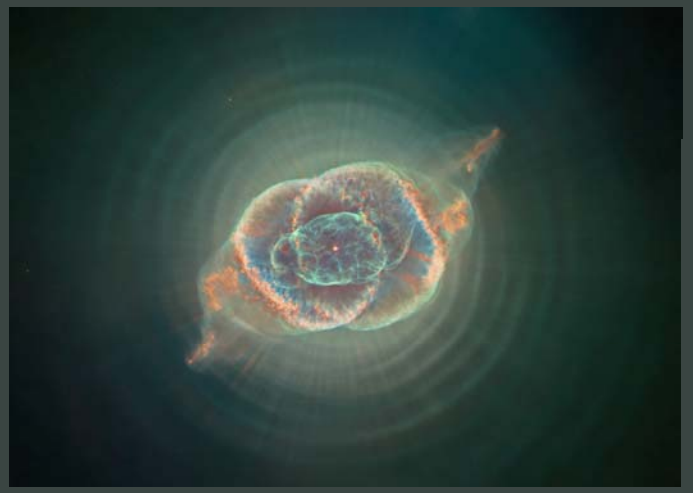
The Lives of Stars

David Cohen
Department of Physics & Astronomy
Swarthmore College

for the *International Year of Astronomy* –
Celebrating Galileo's first telescopic discoveries



Tonight is part of a Philadelphia-area celebration – *No Night Without a Telescope* – continuing through November 24

Sundays: Villanova
Mondays: Widener
Tuesdays: Swarthmore
Wednesdays: Drexel
Thursdays: Franklin Institute
Fridays: West Chester University
Saturdays: Haverford & Penn

More information at http://www.haverford.edu/iya2009/

Stellar Evolution

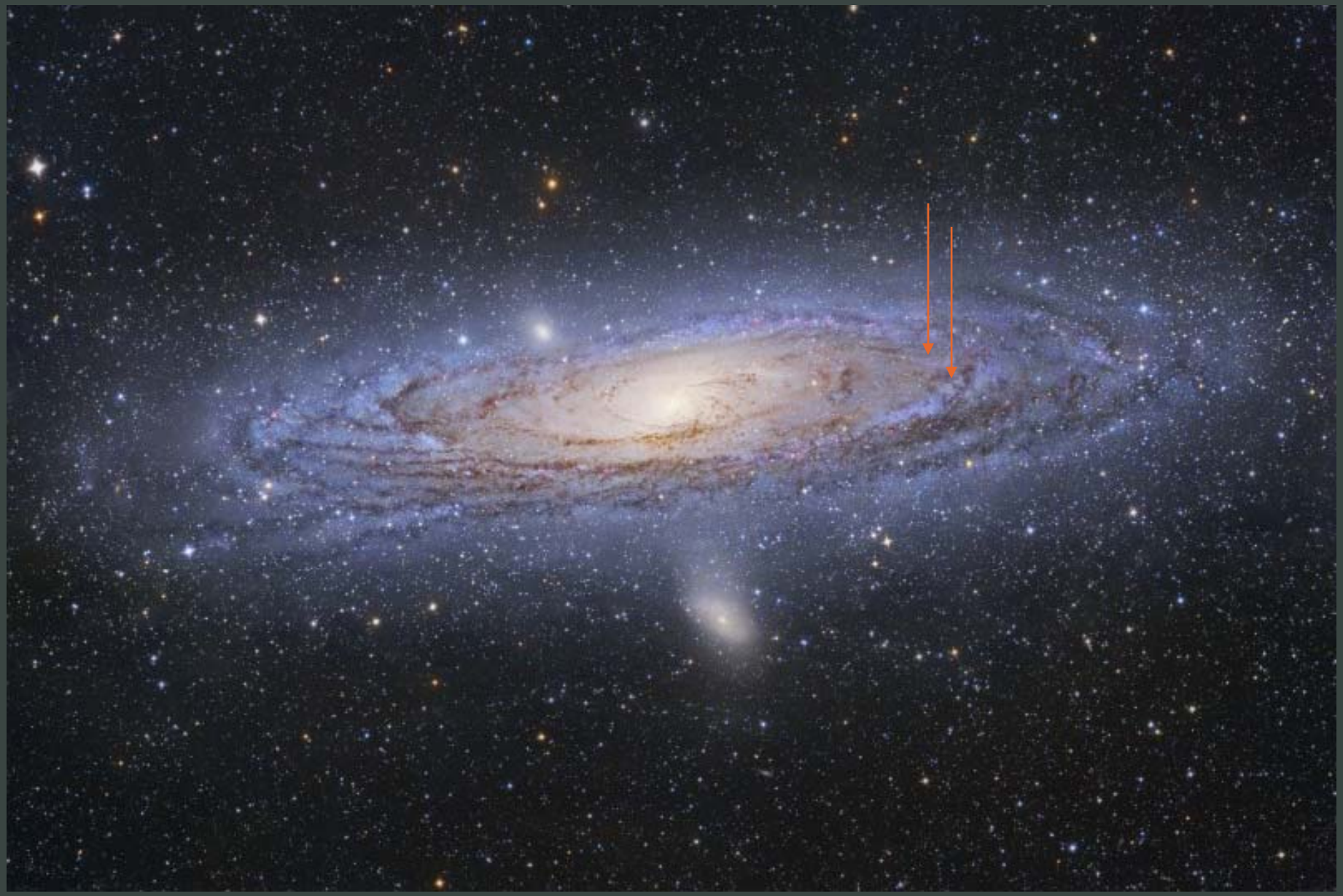
The stars we see when we look up at night haven't been here forever.

The Orion Nebula is at the center of the nearest **star formation region**

Orion Nebula ~1000 light years away

Context

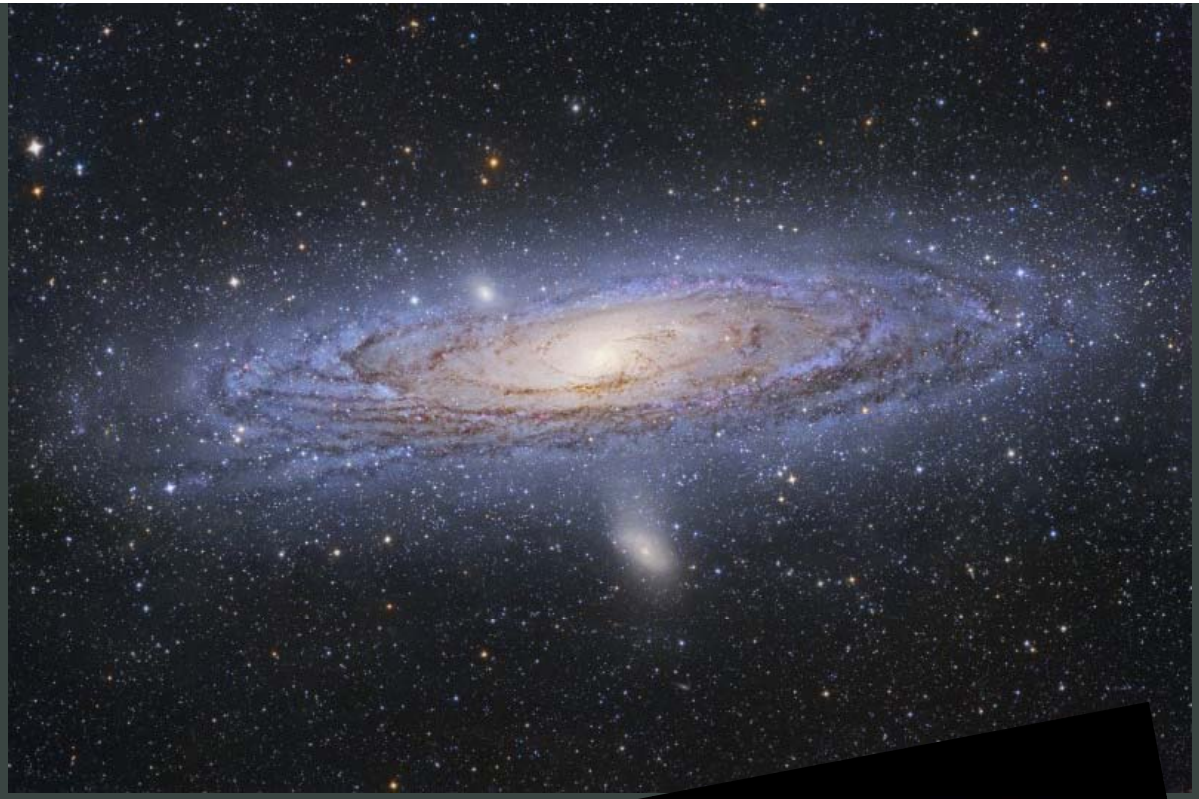
The Milky Way galaxy is the home to all the stars we see at night



The Andromeda Galaxy – our nearest big neighbor – looks like the Milky Way

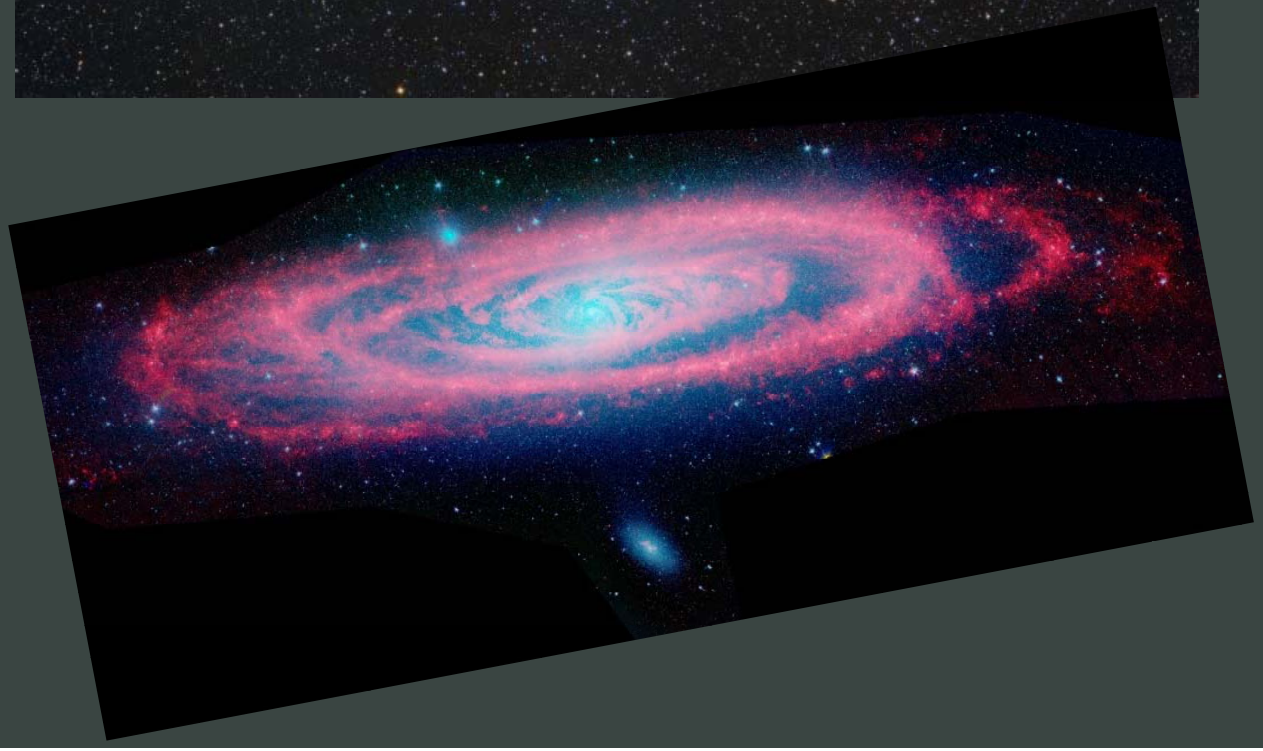
The Whirlpool Galaxy

from the Hubble Space Telescope



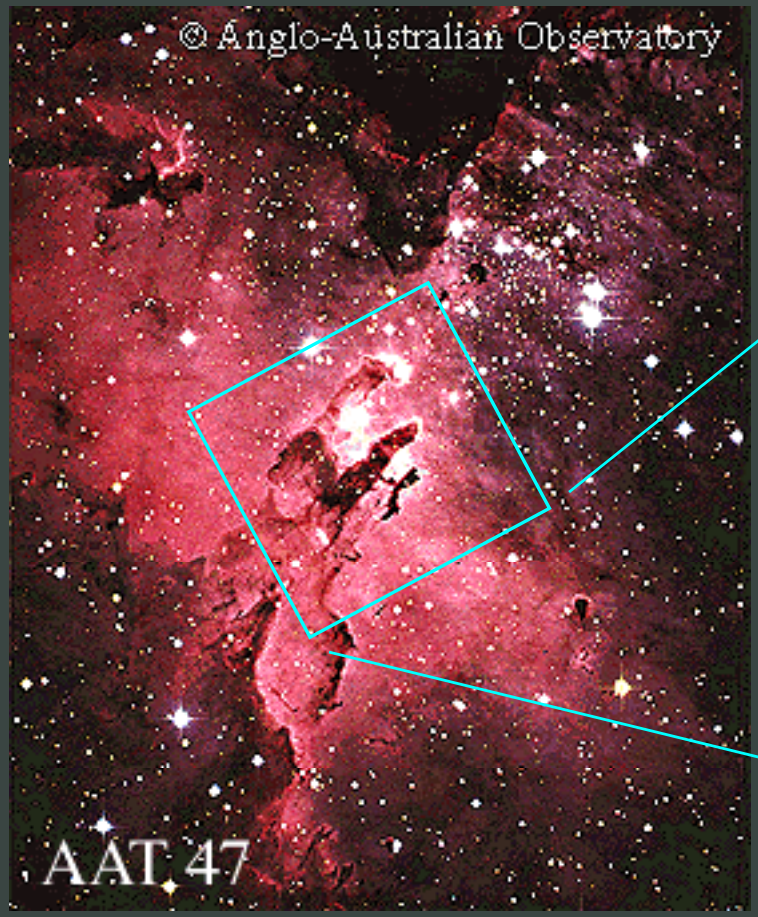
Andromeda Galaxy (again)

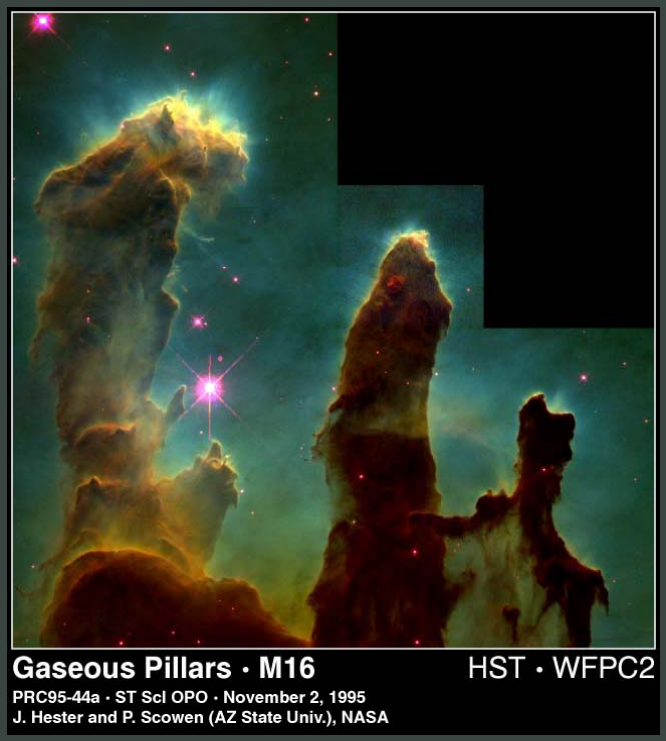
optical



infrared

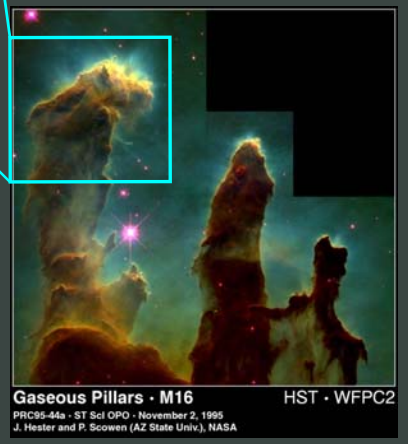
The Eagle Nebula





ground-based

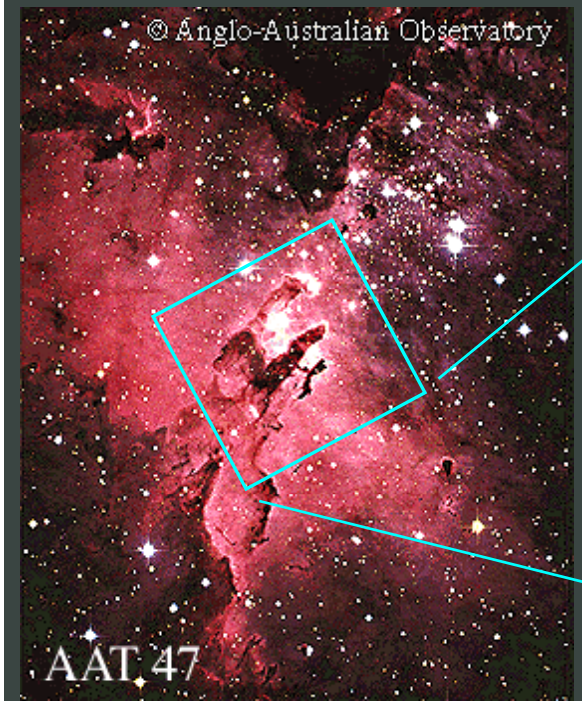
Hubble Space Telescope



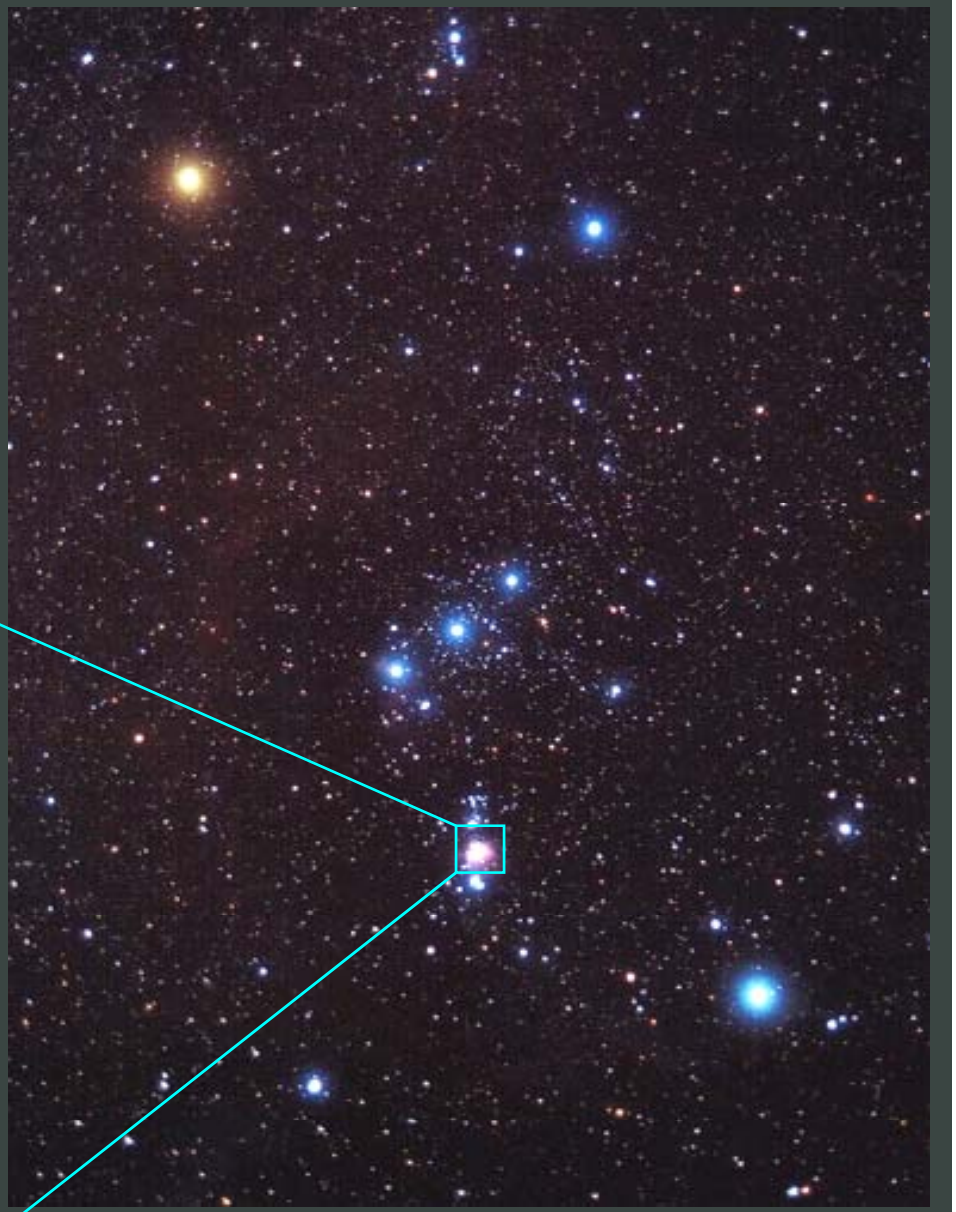
Gaseous Pillars · M16 HST · WFPC2

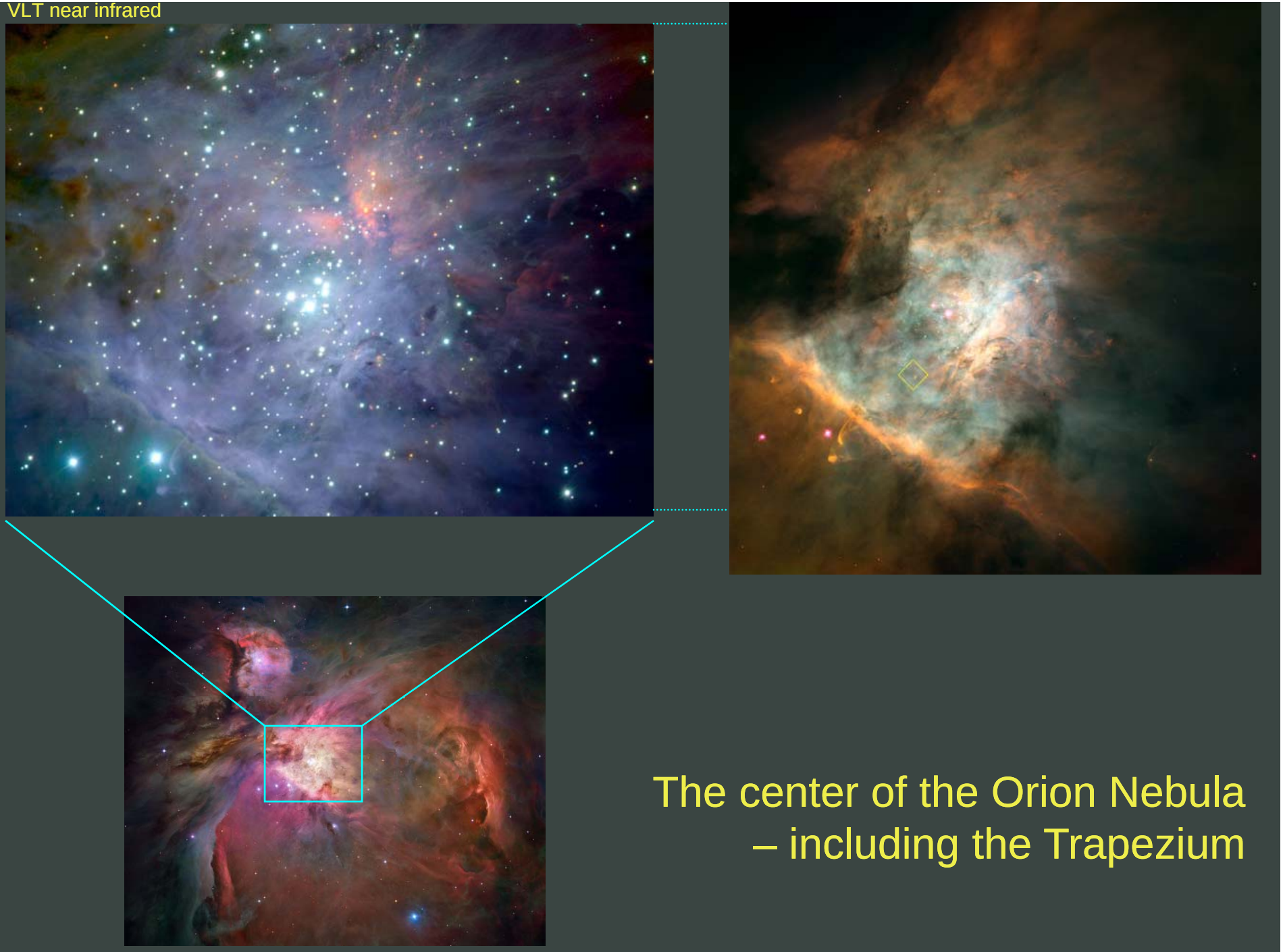
PRC95-44a · ST ScI OPO · November 2, 1995
J. Hester and P. Scowen (AZ State Univ.), NASA

Infrared light shows a different view of the Pillars (right)



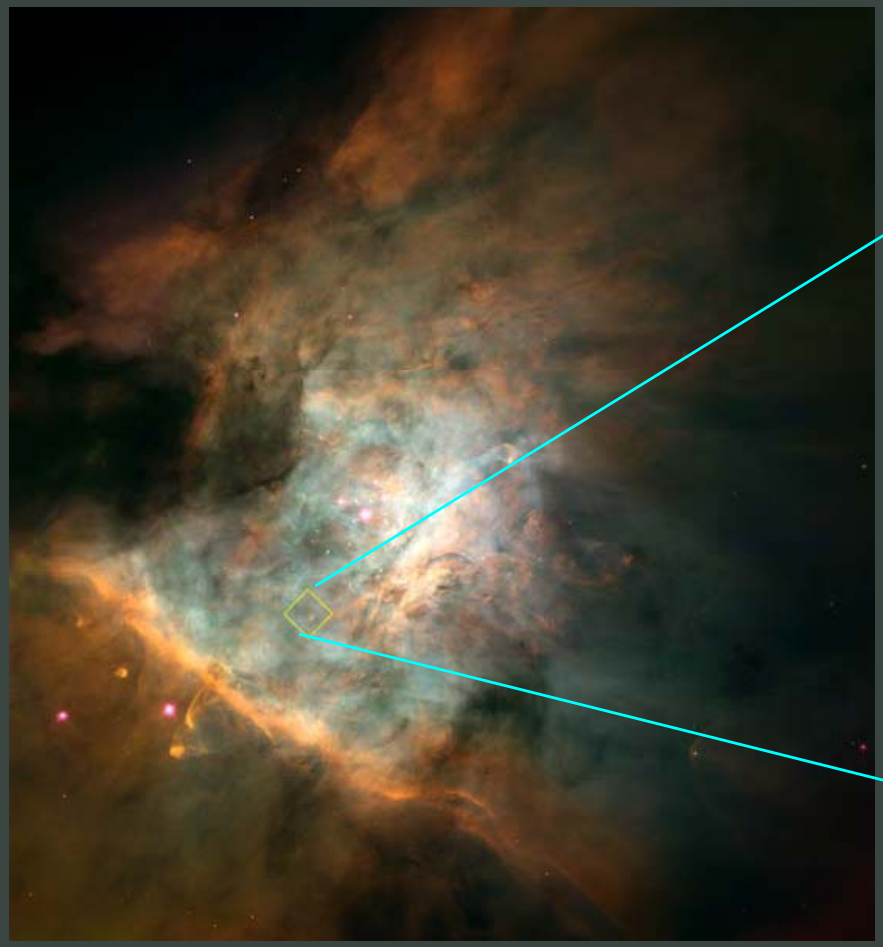
Back to the Orion Nebula

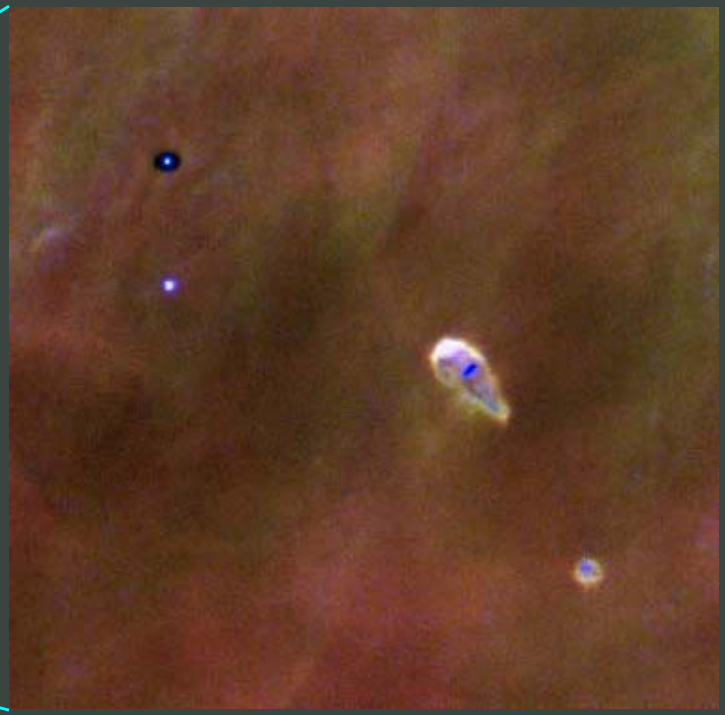




The center of the Orion Nebula
– including the Trapezium

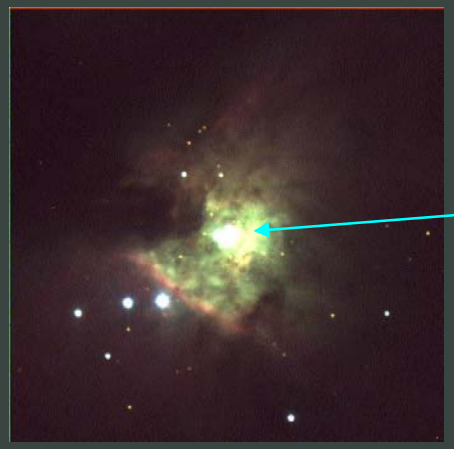
Proplyds: solar-system scale dense dust and gas clouds





seen in silhouette against the emission from the back ‘wall’ of the nebula

θ^1 Ori C: Newly formed (<1 million yr old) massive (50 M_{sun}) star

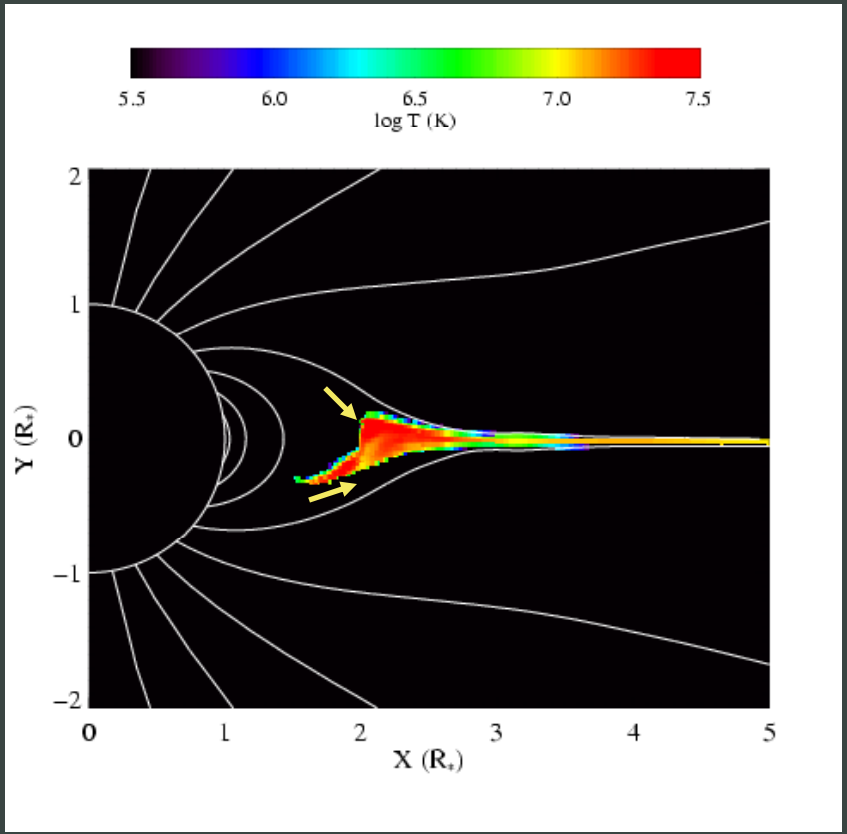


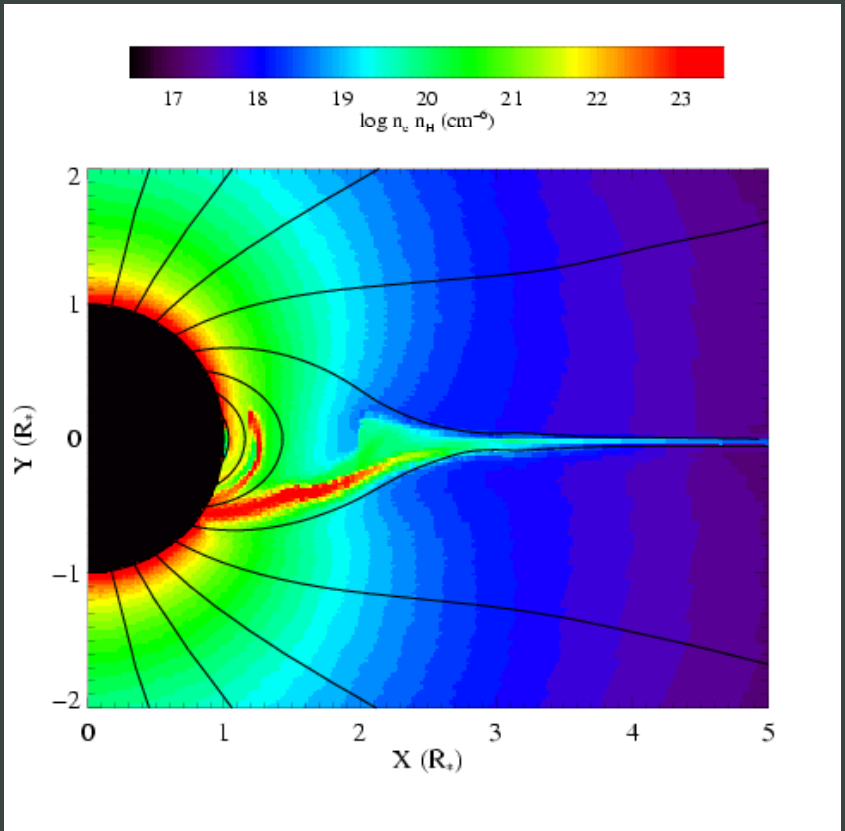
X-ray image of the Orion Nebula from the Chandra X-ray Observatory

color coded for photon energy

θ^1 Ori C is extremely X-ray bright

X-rays from magnetic massive stars



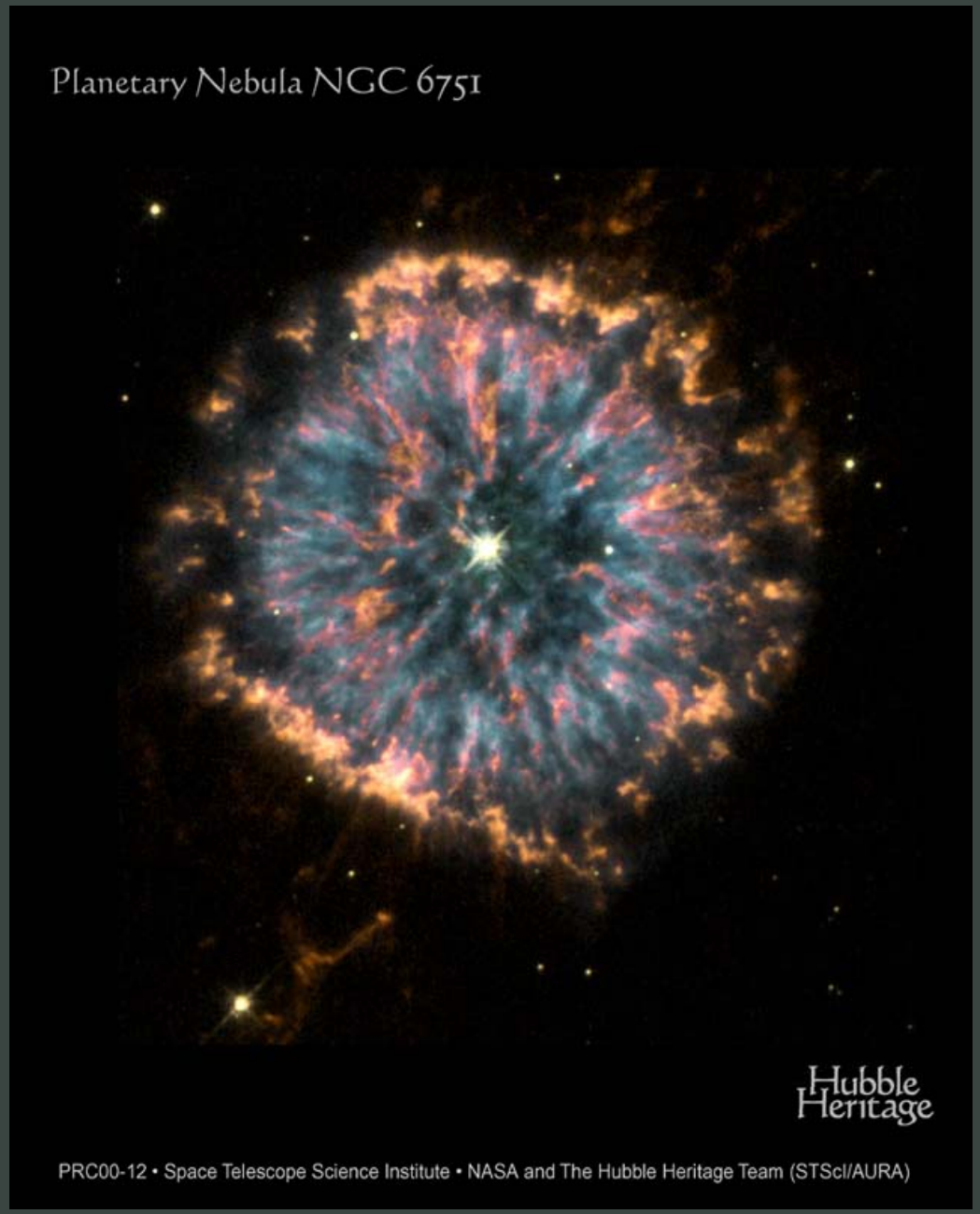


Supersonic stellar wind + magnetic field

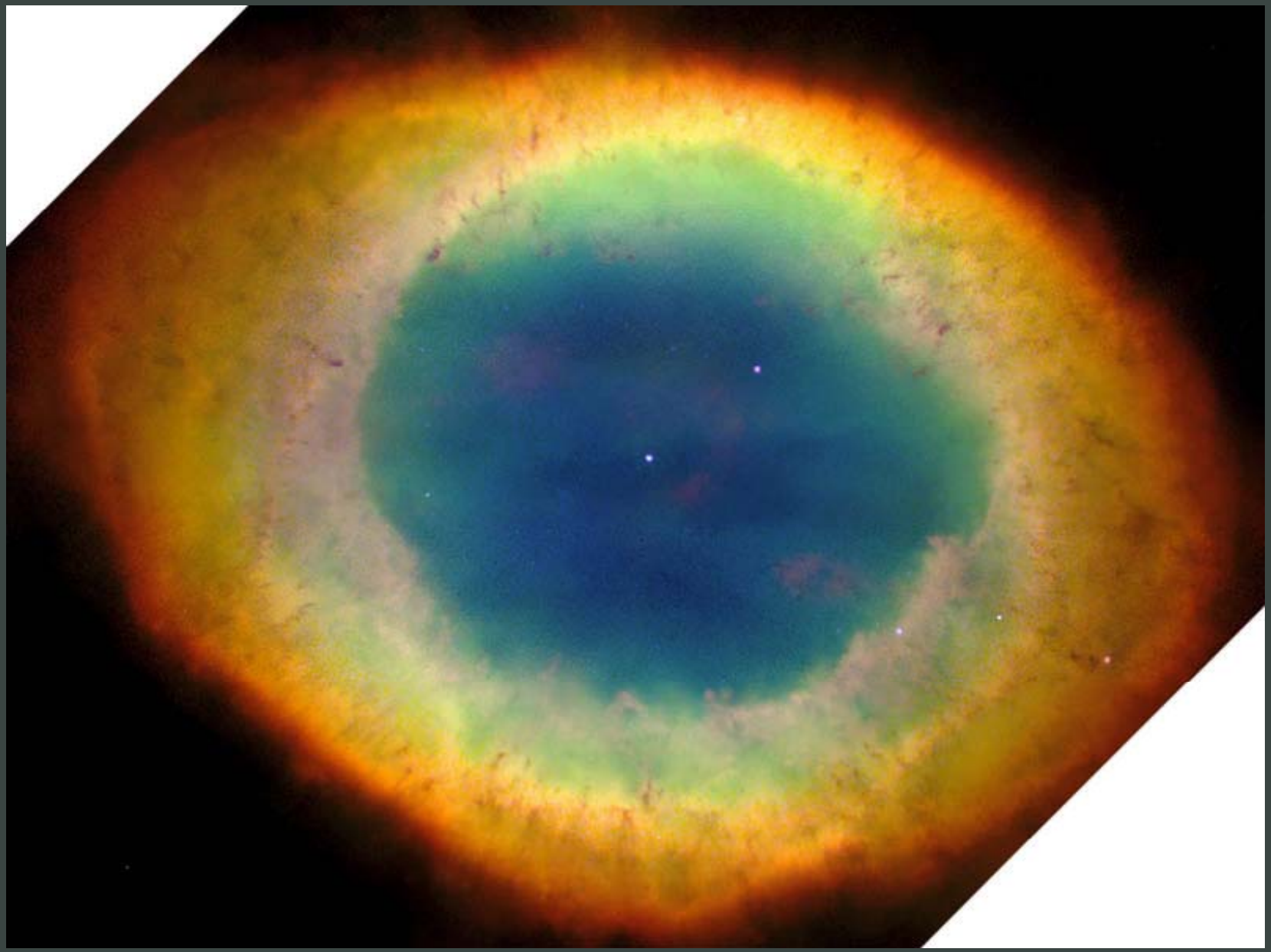
Stellar Evolution

After their formation, stars age without much change…

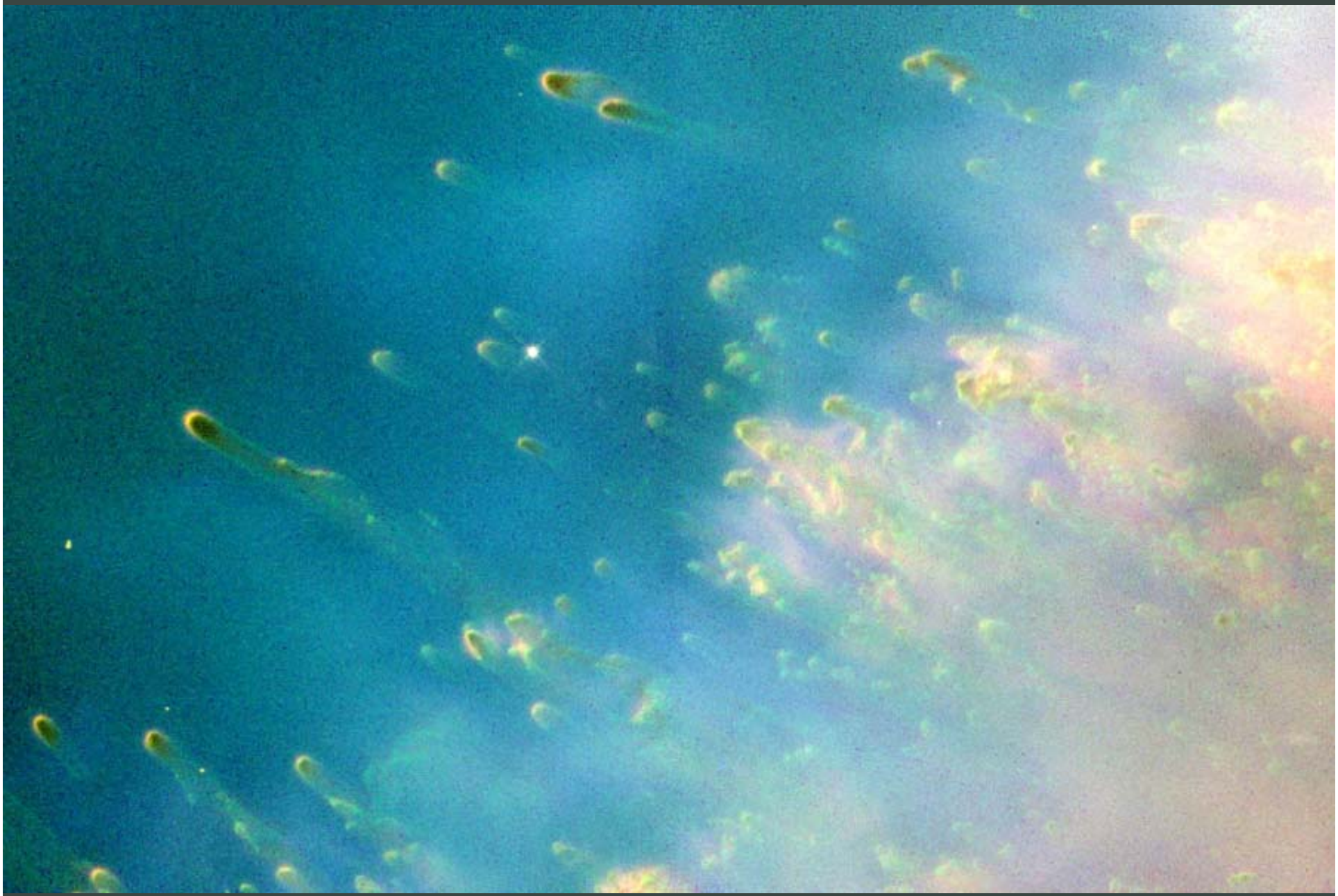
The death of a low-mass star (like the Sun)

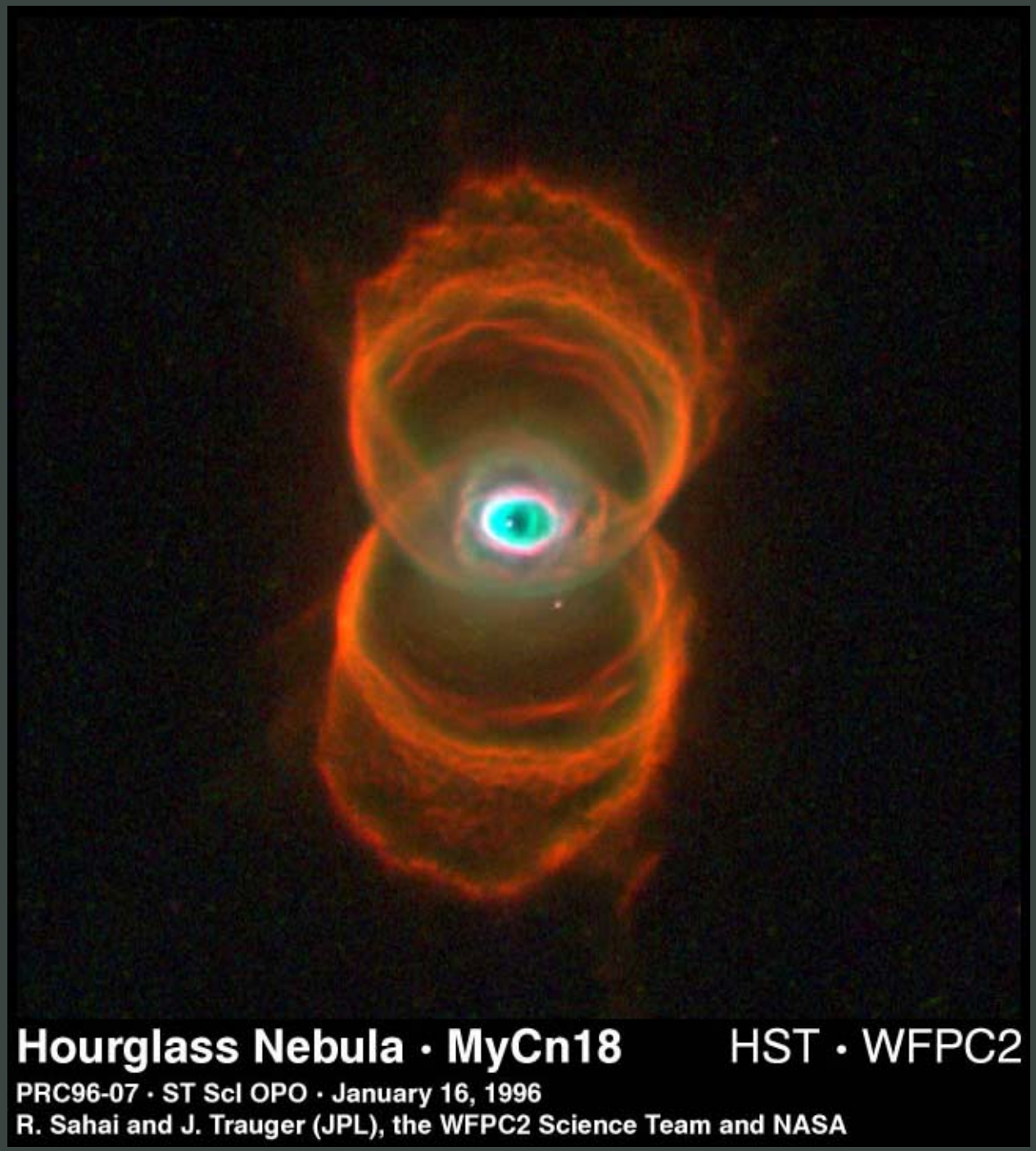


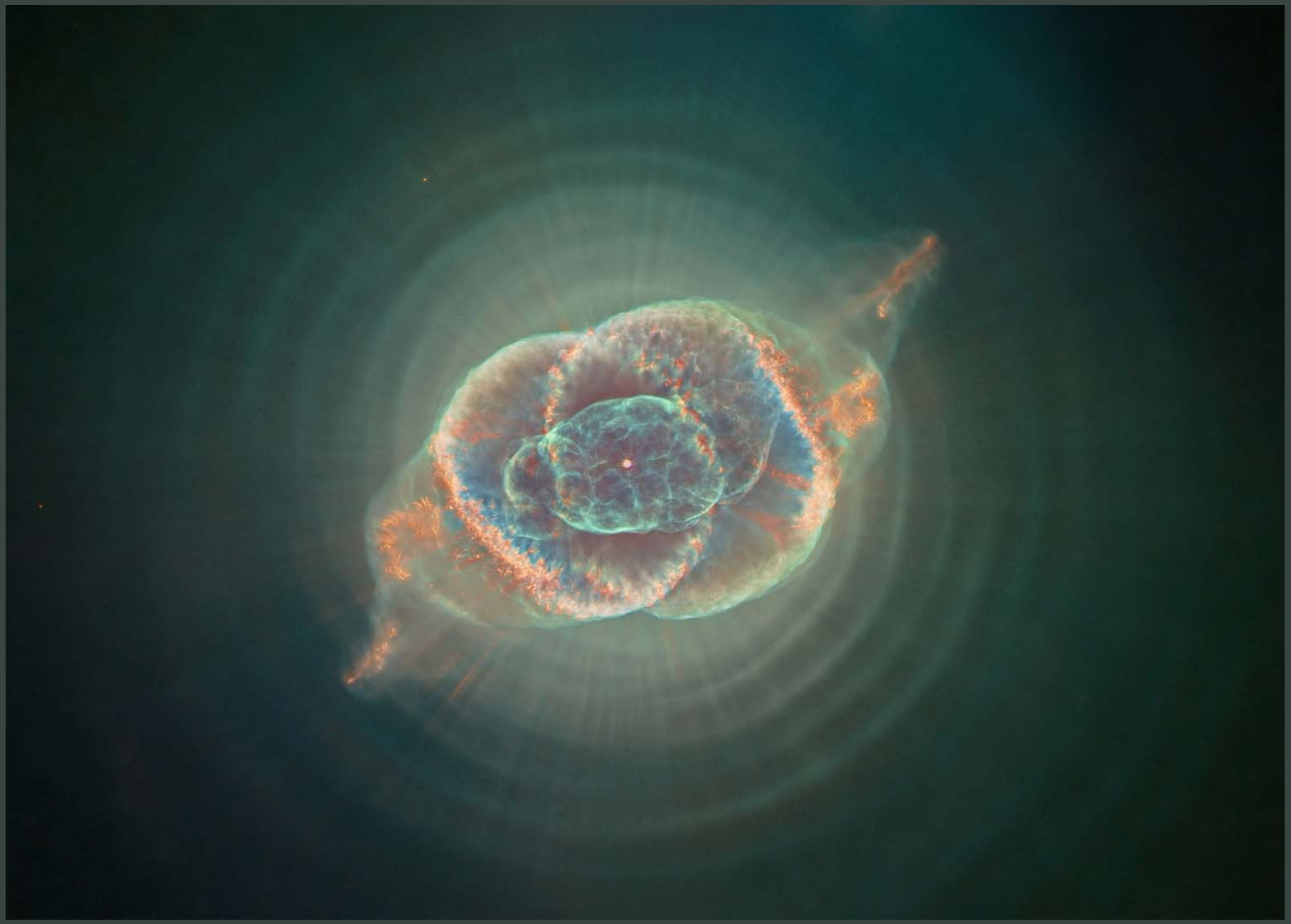
The Ring Nebula – Hubble Space Telescope



The Helix Nebula – Hubble Space Telescope




Hourglass Nebula · MyCn18
HST · WFPC2
PRC96-07 · ST ScI OPO · January 16, 1996
R. Sahai and J. Trauger (JPL), the WFPC2 Science Team and NASA



Planetary Nebula Mz3

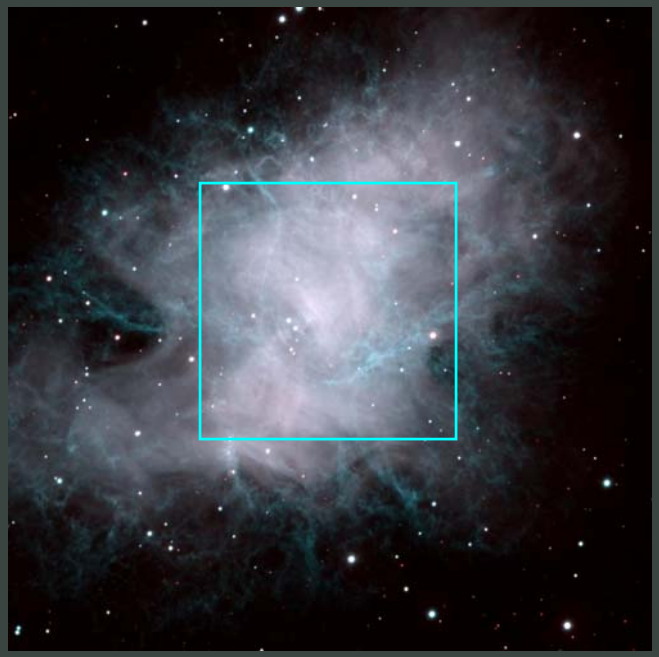
Hubble Heritage

NASA, ESA, and The Hubble Heritage Team (STScI/AURA) • Hubble Space Telescope WFPC2 • STScI-PRC01-05

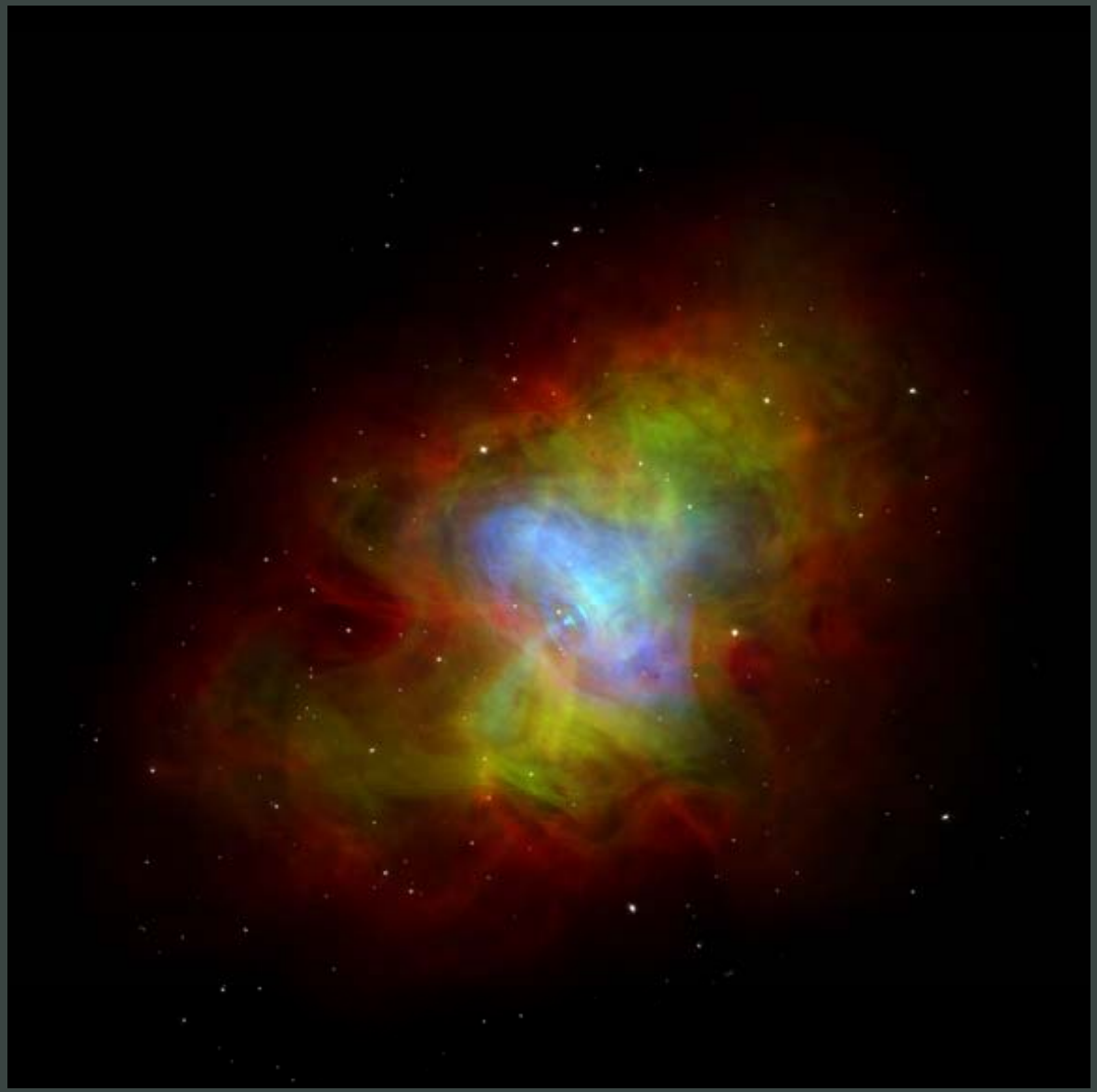
Some stars die even more violent deaths

The Crab Nebula, a supernova remnant

The center of the crab in optical and x-ray light

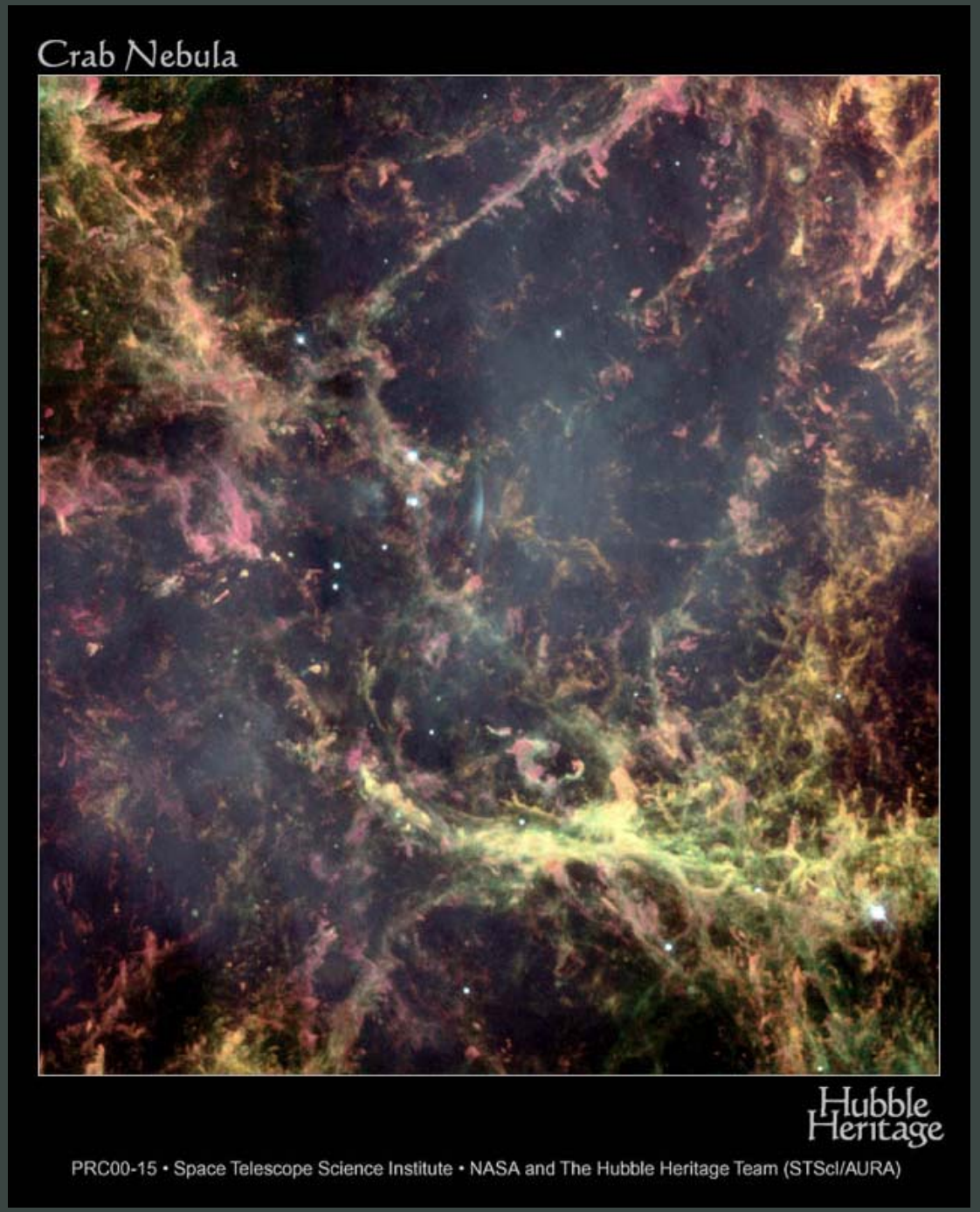


Radio is included here; it traces magnetic fields

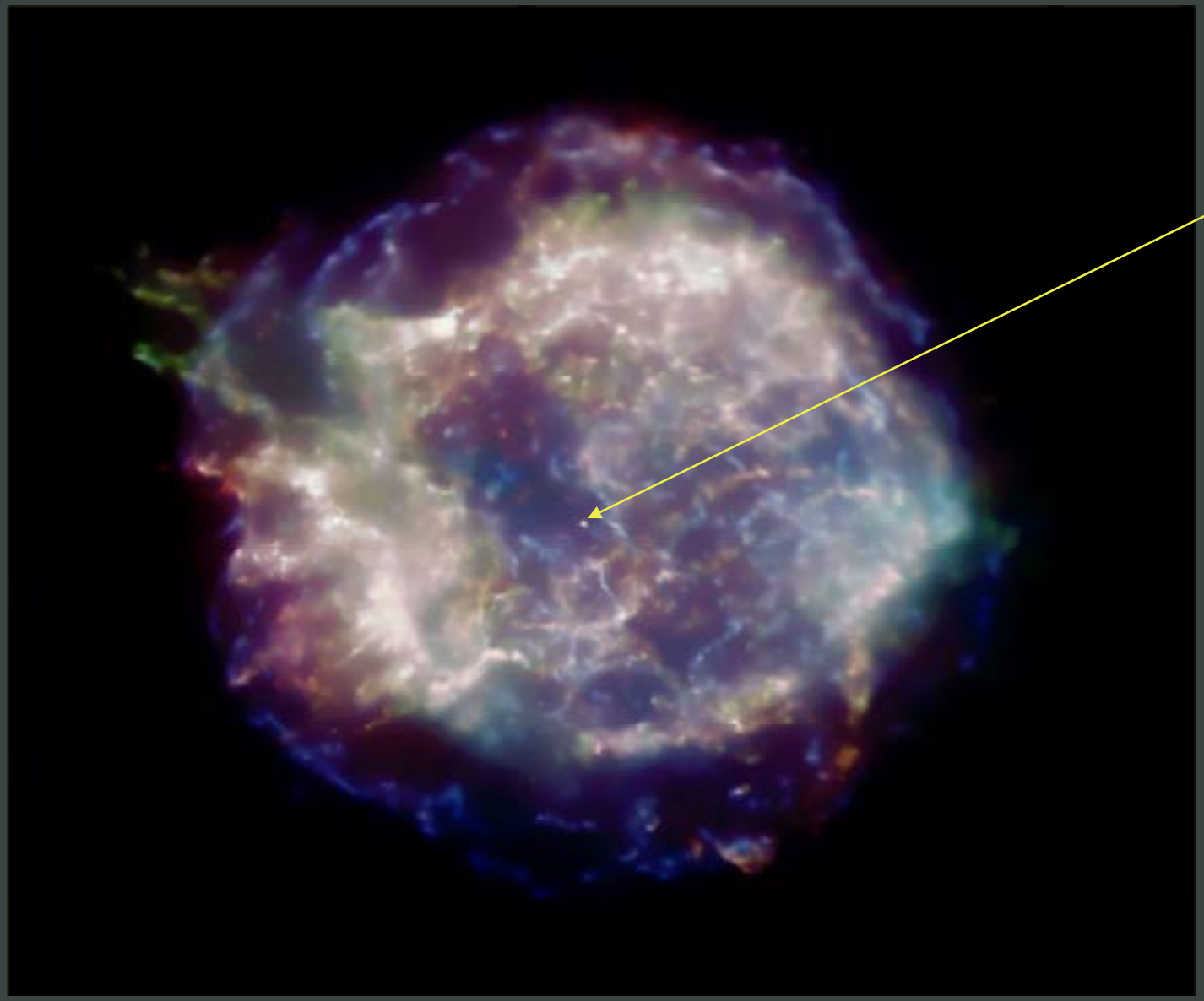


Two images of the Crab, taken ~30 years apart

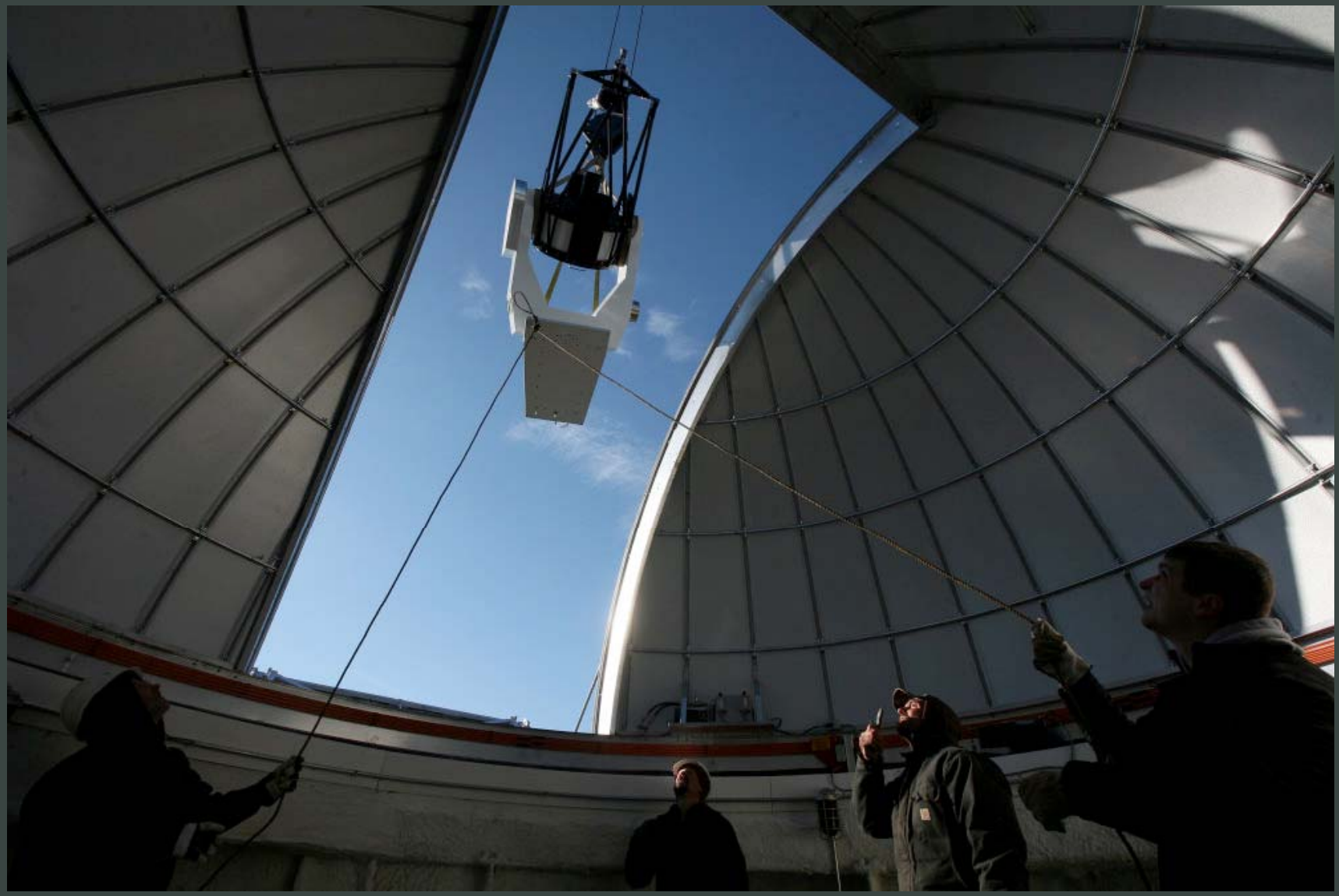
Small portion of the Crab; colors represent emission from different chemical elements

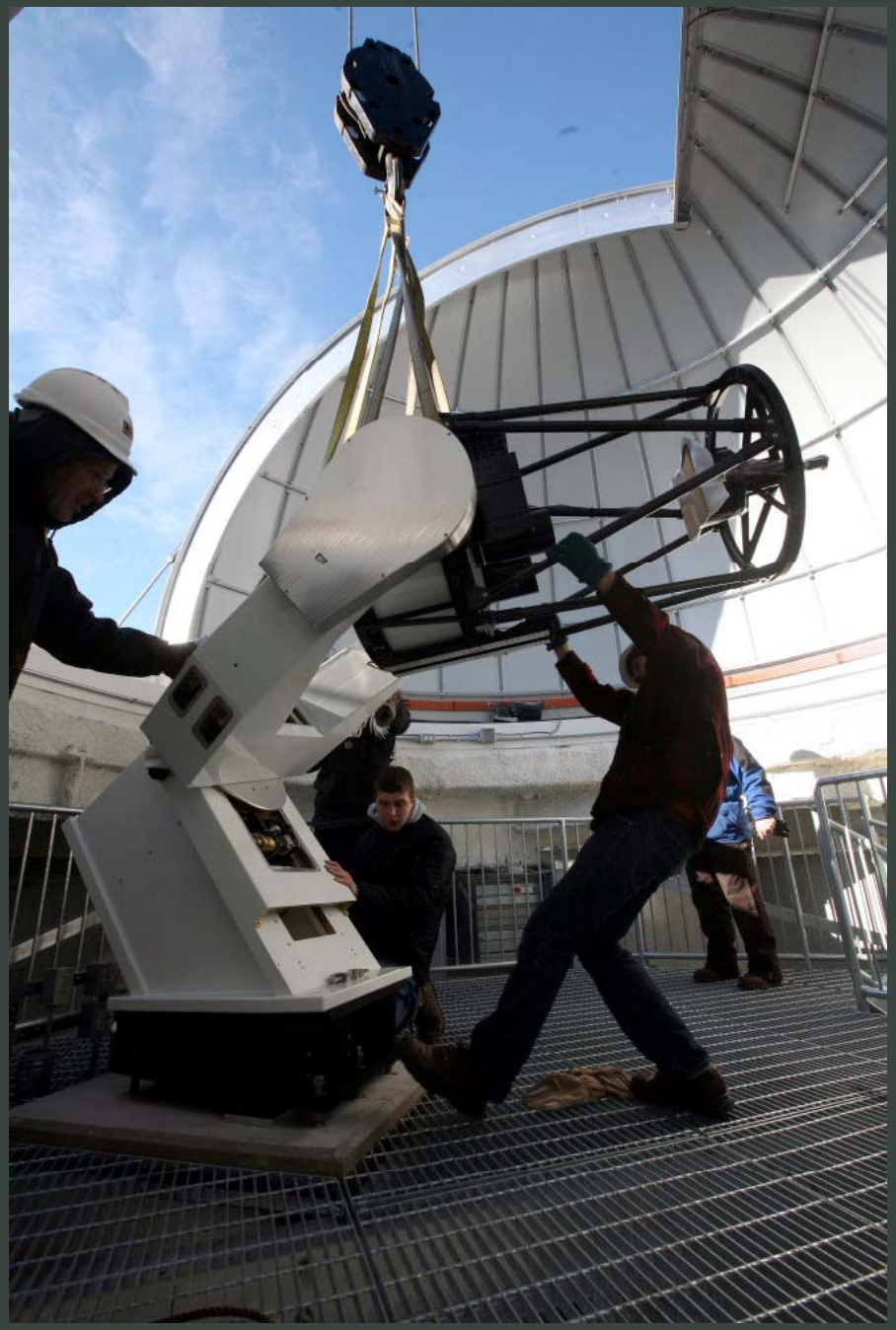


Casseiopeia A supernova remnant in X-rays



Vela supernova remnant - 10,000s years old





Tonight is part of a Philadelphia-area celebration – *No Night Without a Telescope* – continuing through November 24

Sundays: Villanova
Mondays: Widener
Tuesdays: Swarthmore
Wednesdays: Drexel
Thursdays: Franklin Institute
Fridays: West Chester University
Saturdays: Haverford & Penn

More information at http://www.haverford.edu/iya2009/