

***Exploding Stars,
Cosmic Blowtorches,
and the Runaway Universe***

Dr. Jeffrey M. Silverman

jsilverman@astro.as.utexas.edu

NSF Astronomy & Astrophysics Postdoctoral Fellow

University of Texas, Austin

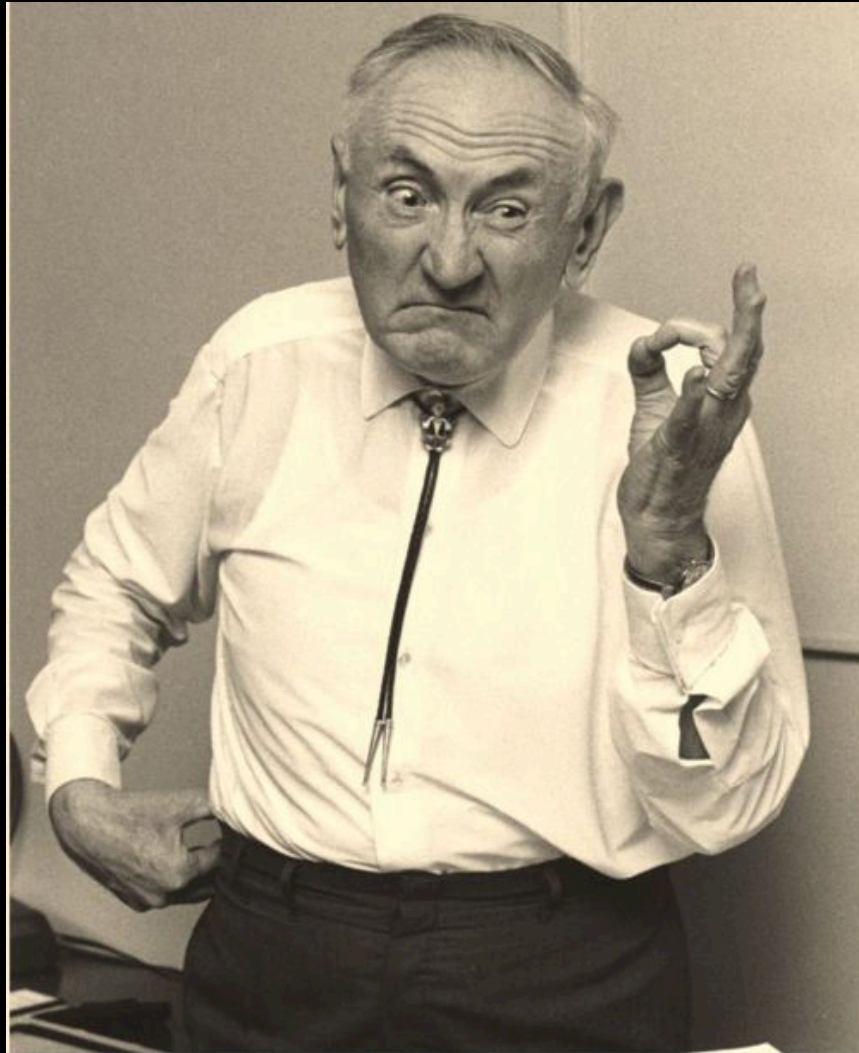
Advisor: Prof. J. Craig Wheeler

Lunar and Planetary Institute

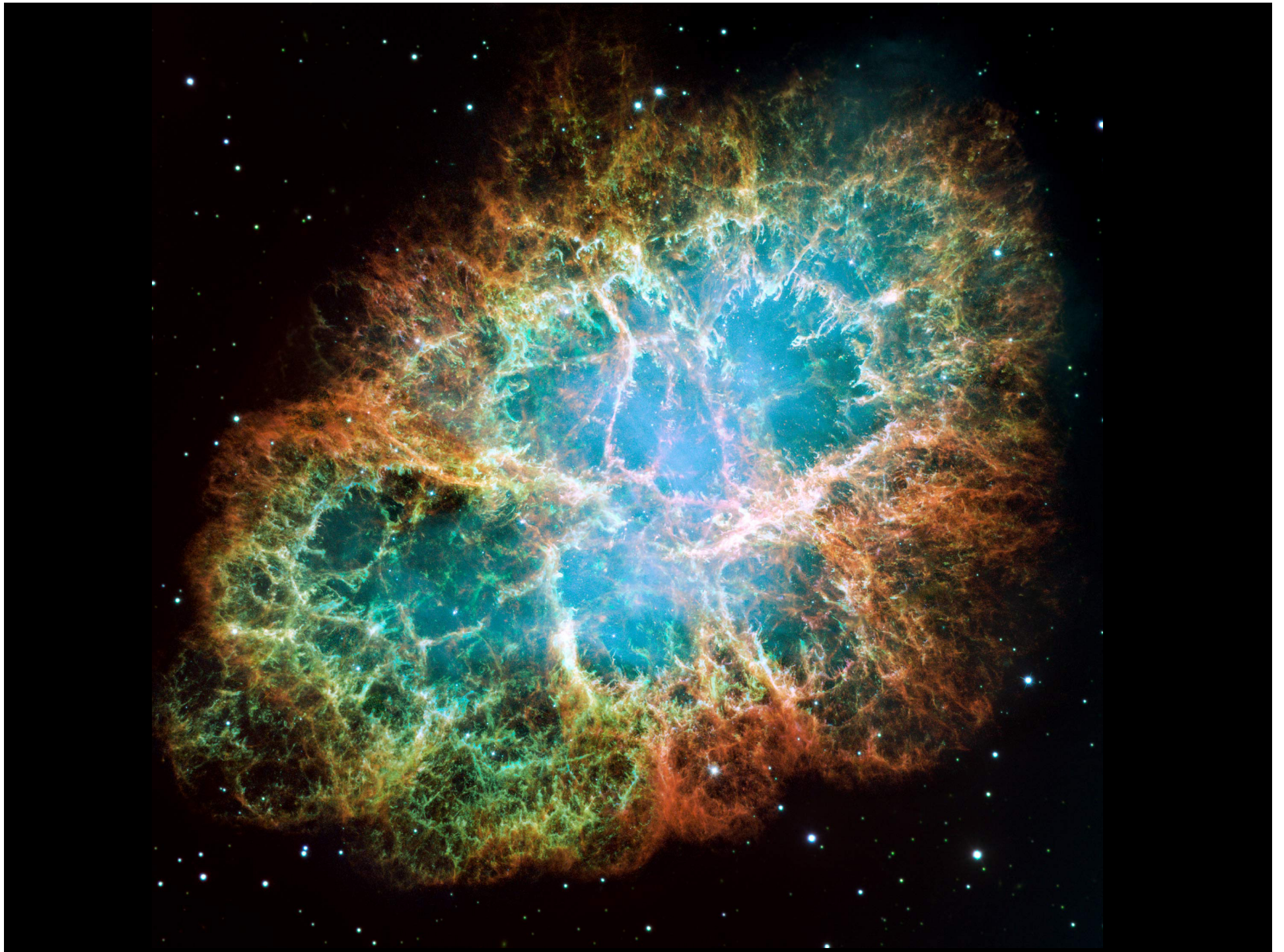
March 6, 2014



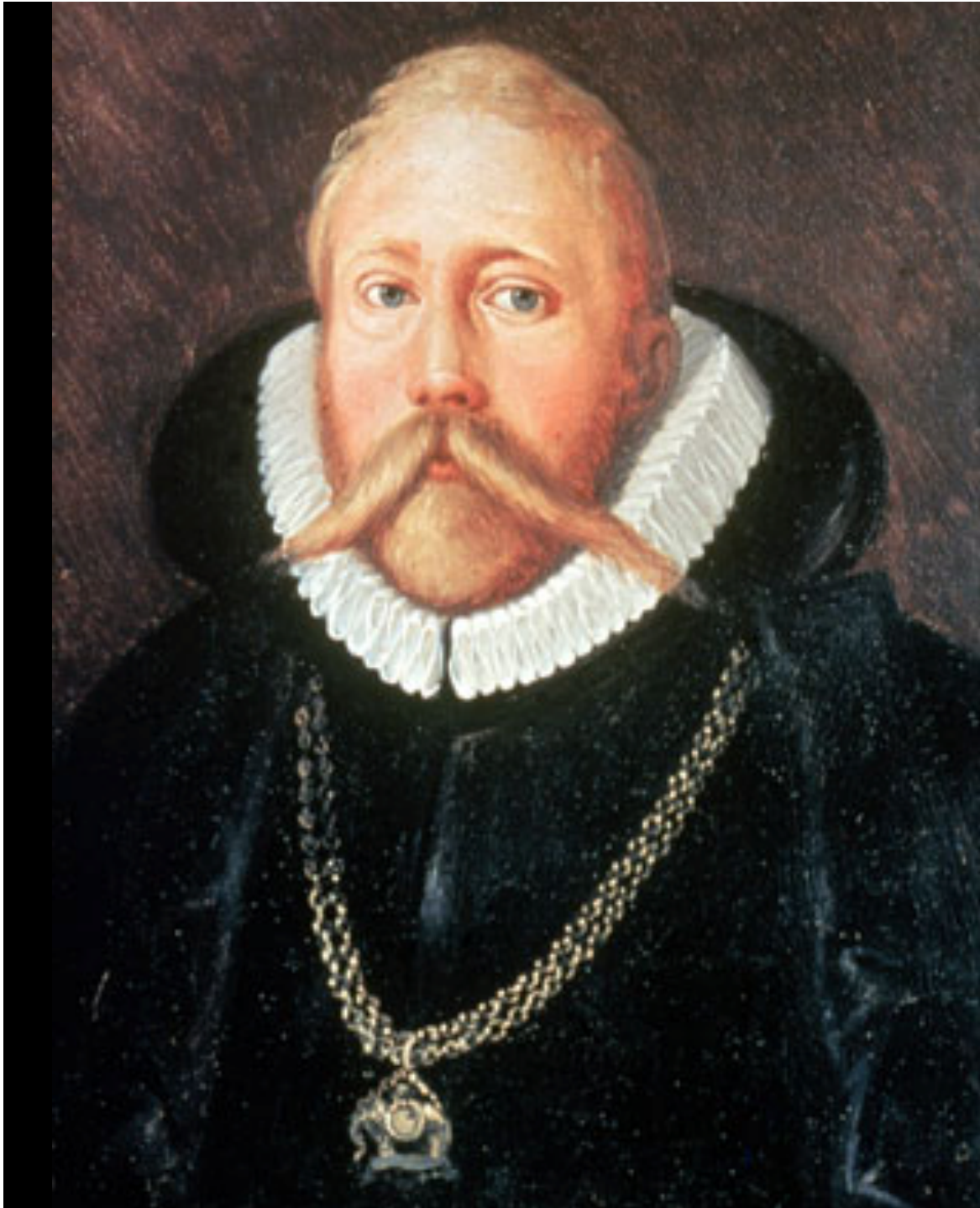
Fritz Zwicky (1898-1974)



© California Institute of Technology



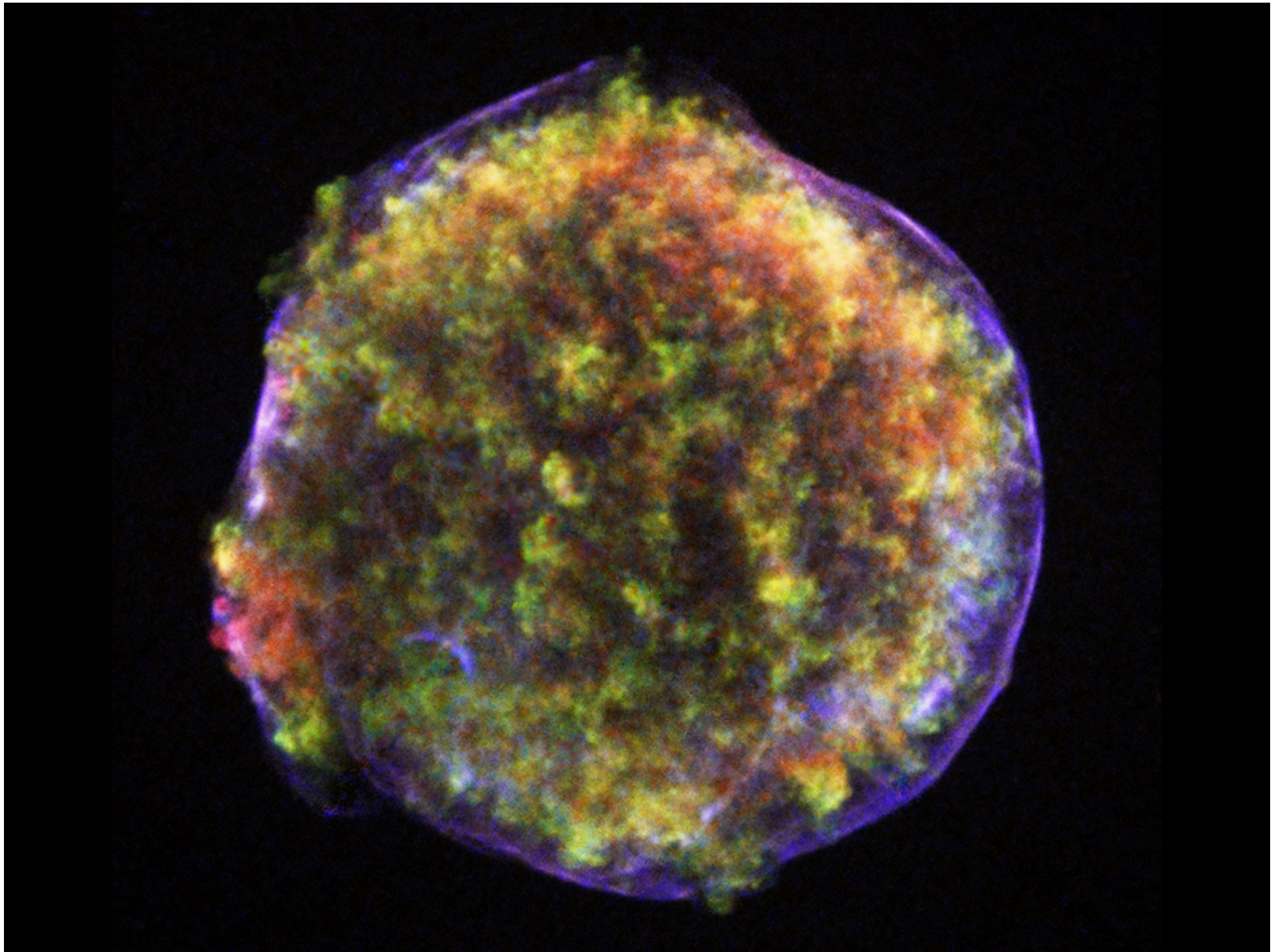




**Tycho
Brahe**

(1546-1601)

SN 1572

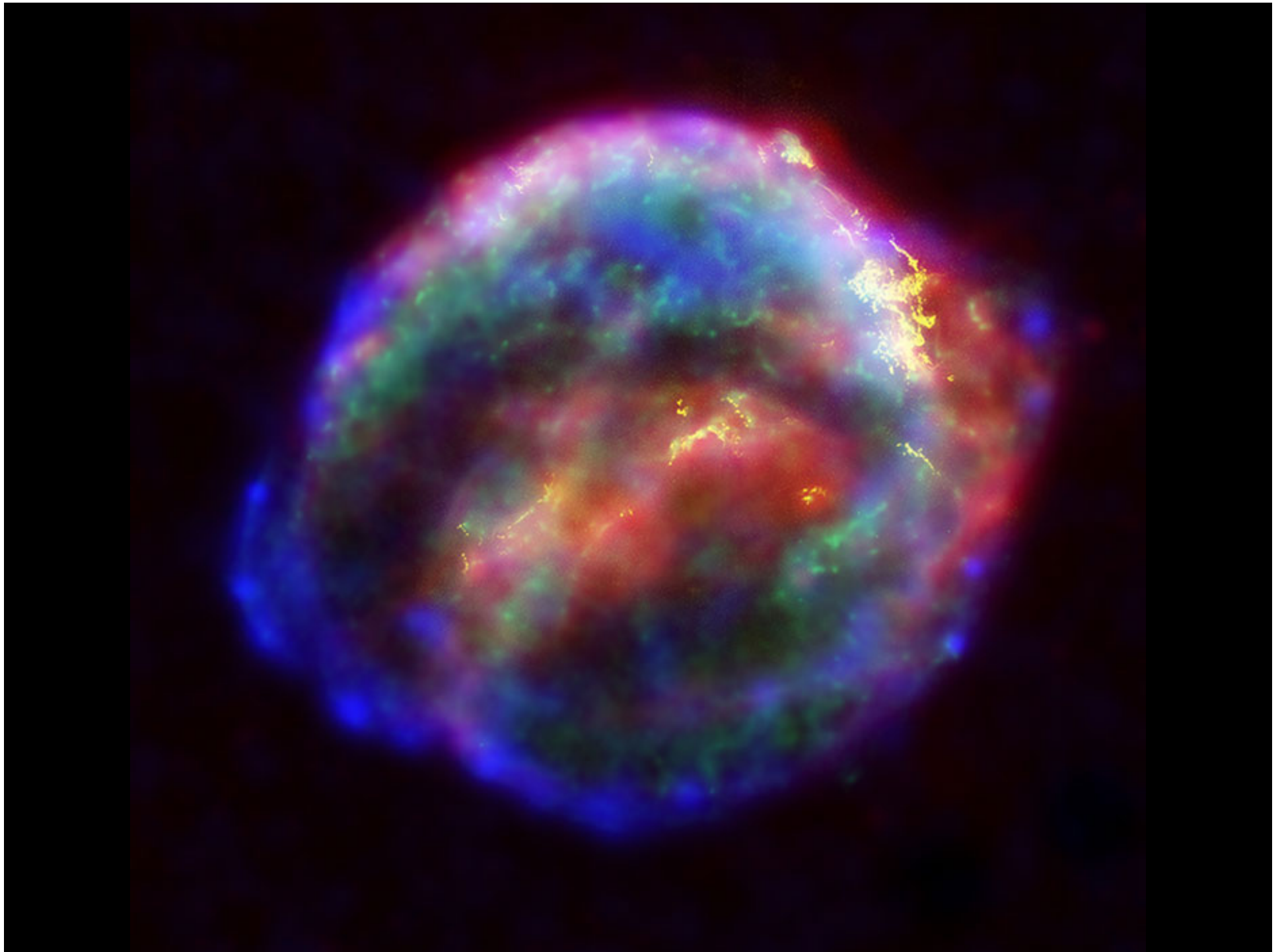


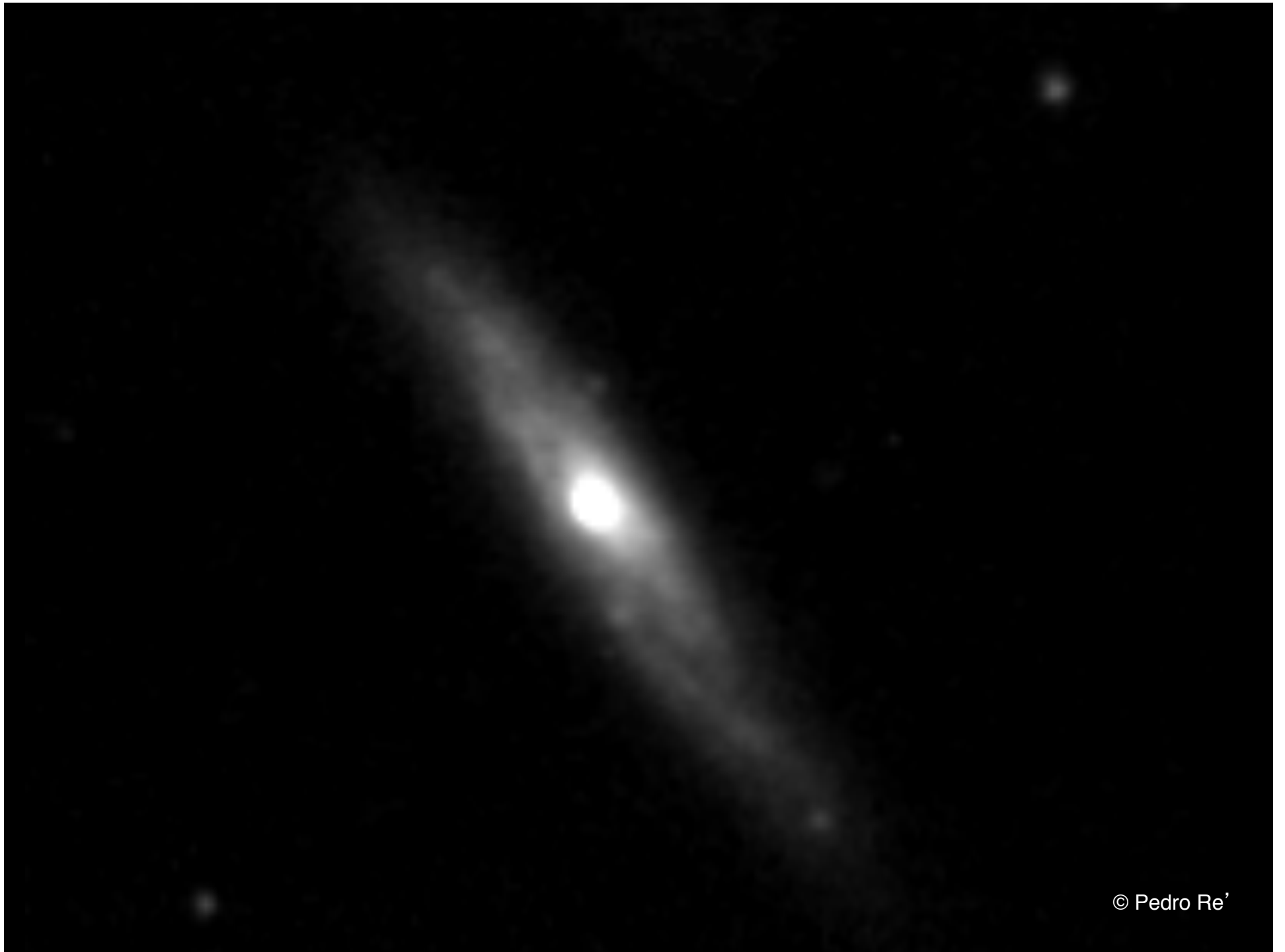


Johannes Kepler

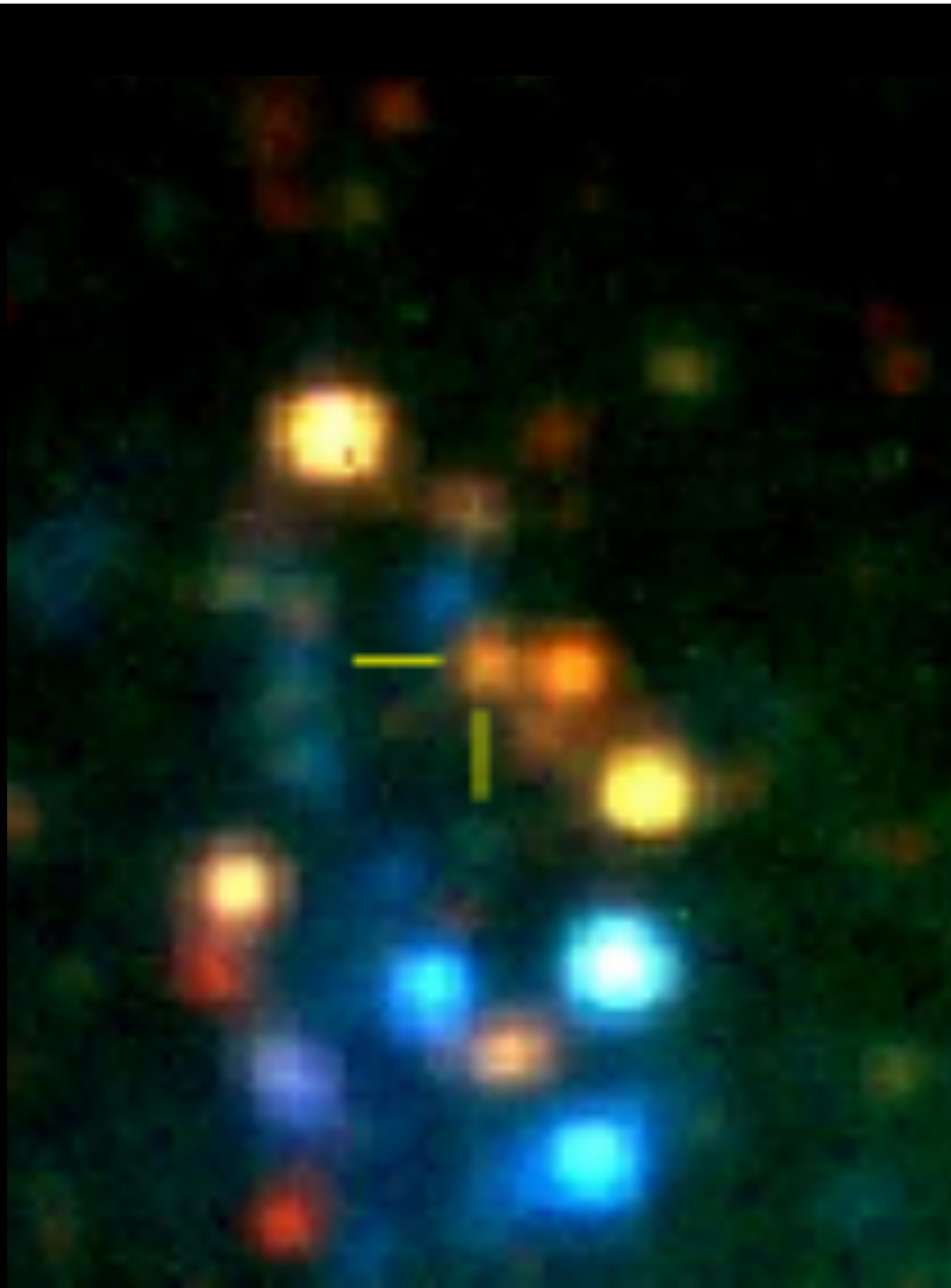
(1571-1630)

SN 1604

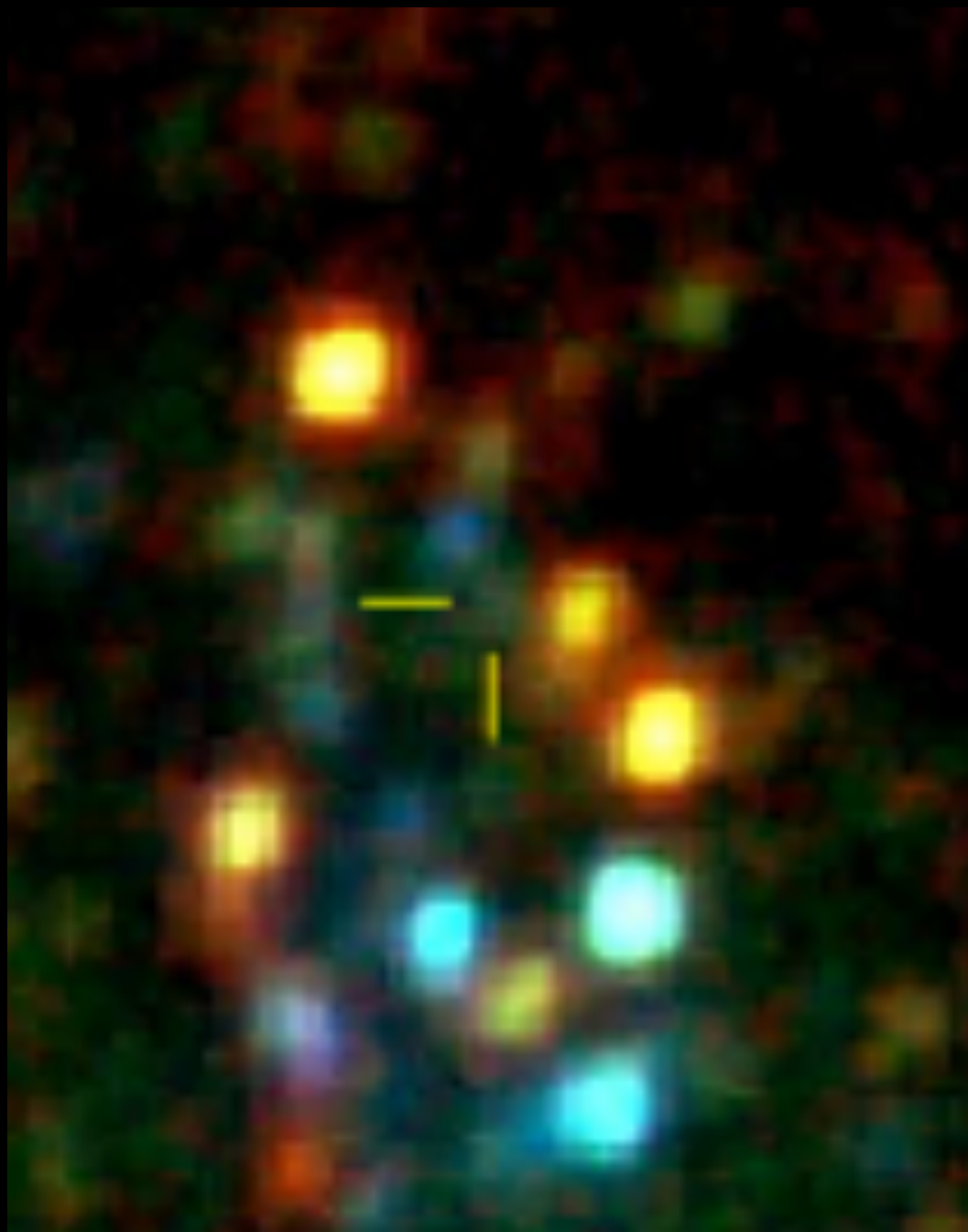




Before
SN
(2005)



After
SN
(2010)

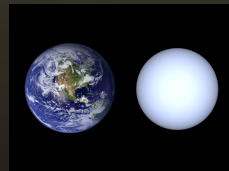


Why should we care about SNe?

- Test models/theories of:
 - Stellar evolution
 - Massive stars
 - Extremely dense stars
 - Explosion physics
 - Nucleosynthesis (*i.e.* the making of elements)
- Trigger star formation
- Disperse elements
- Track expansion of the Universe

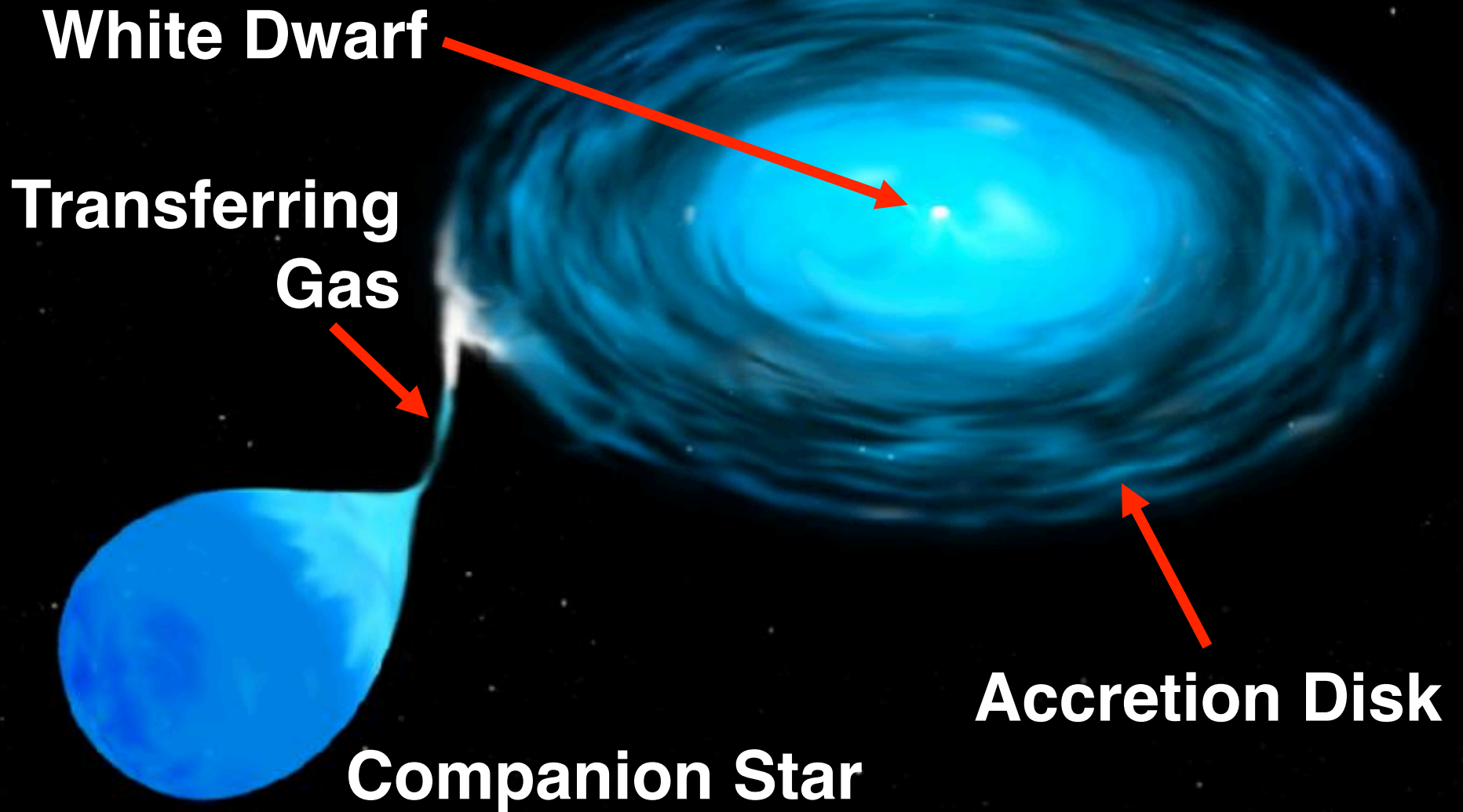
Sun

Earth

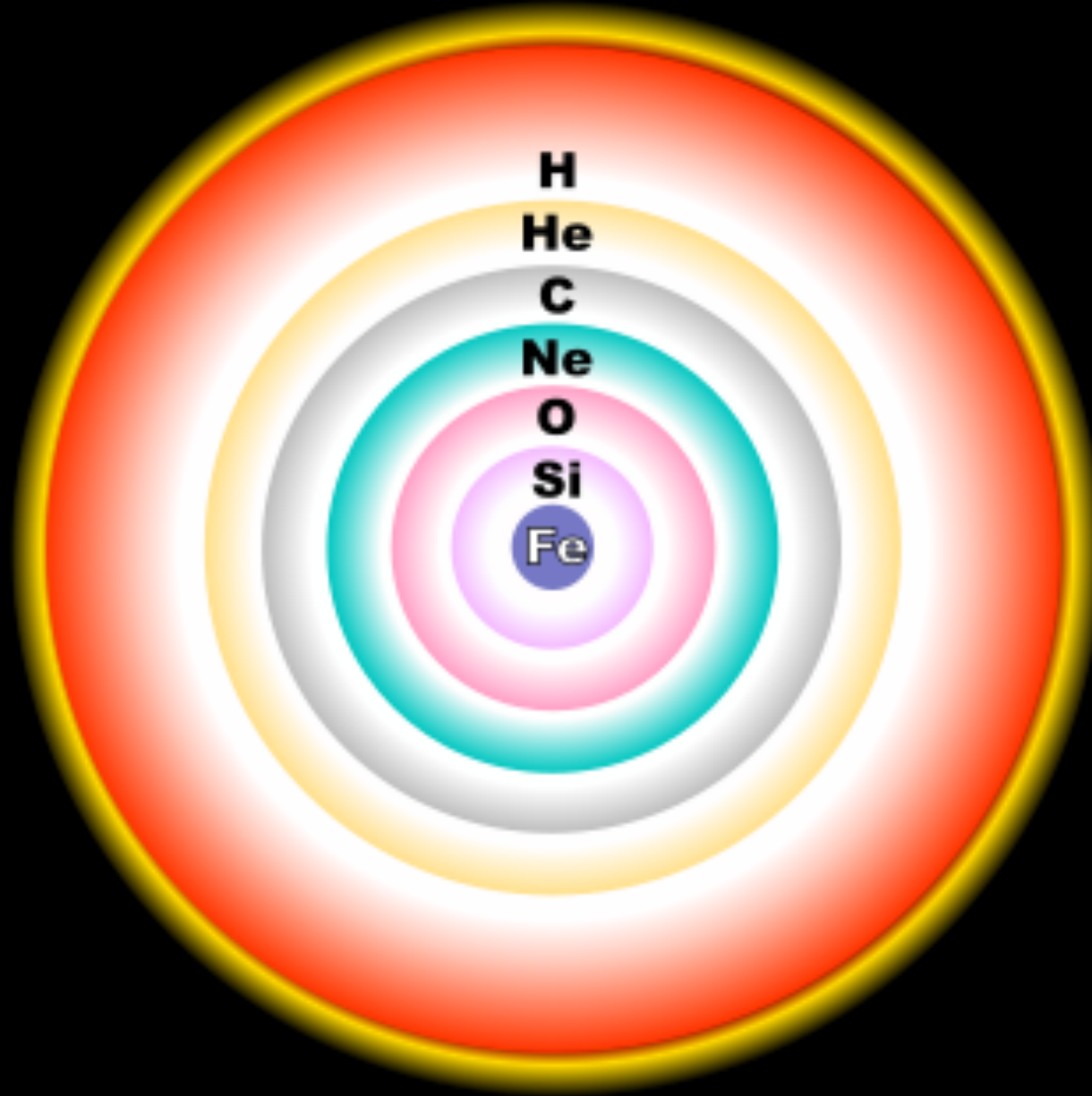


**White
Dwarf**

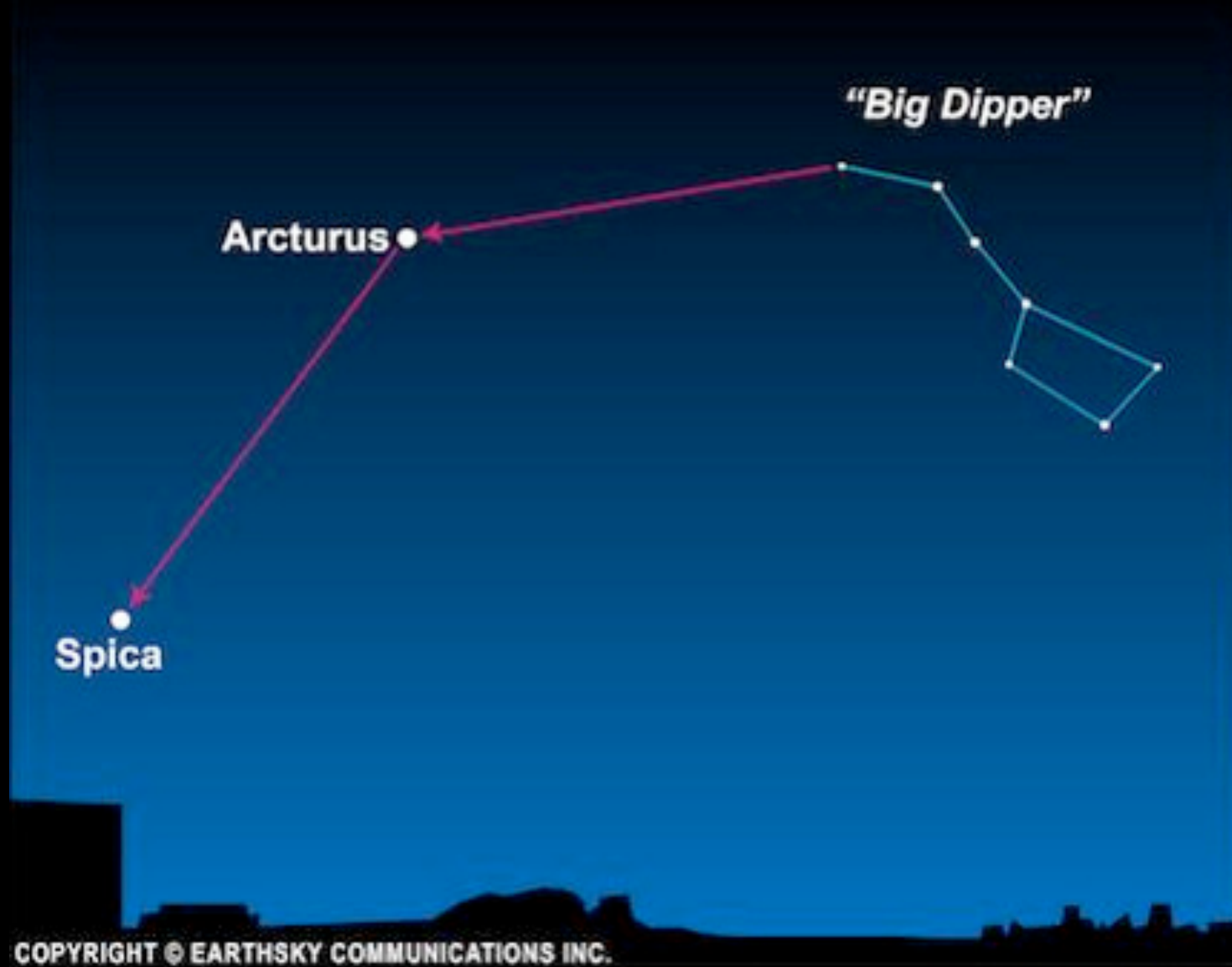
Type Ia Supernova



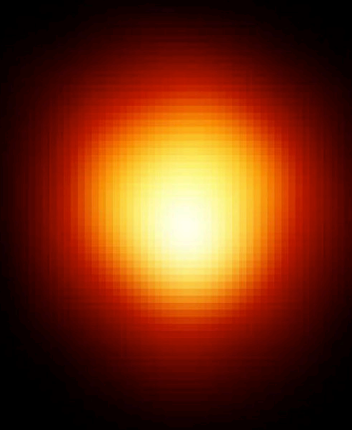
Type II Supernova



Spica



Betelgeuse



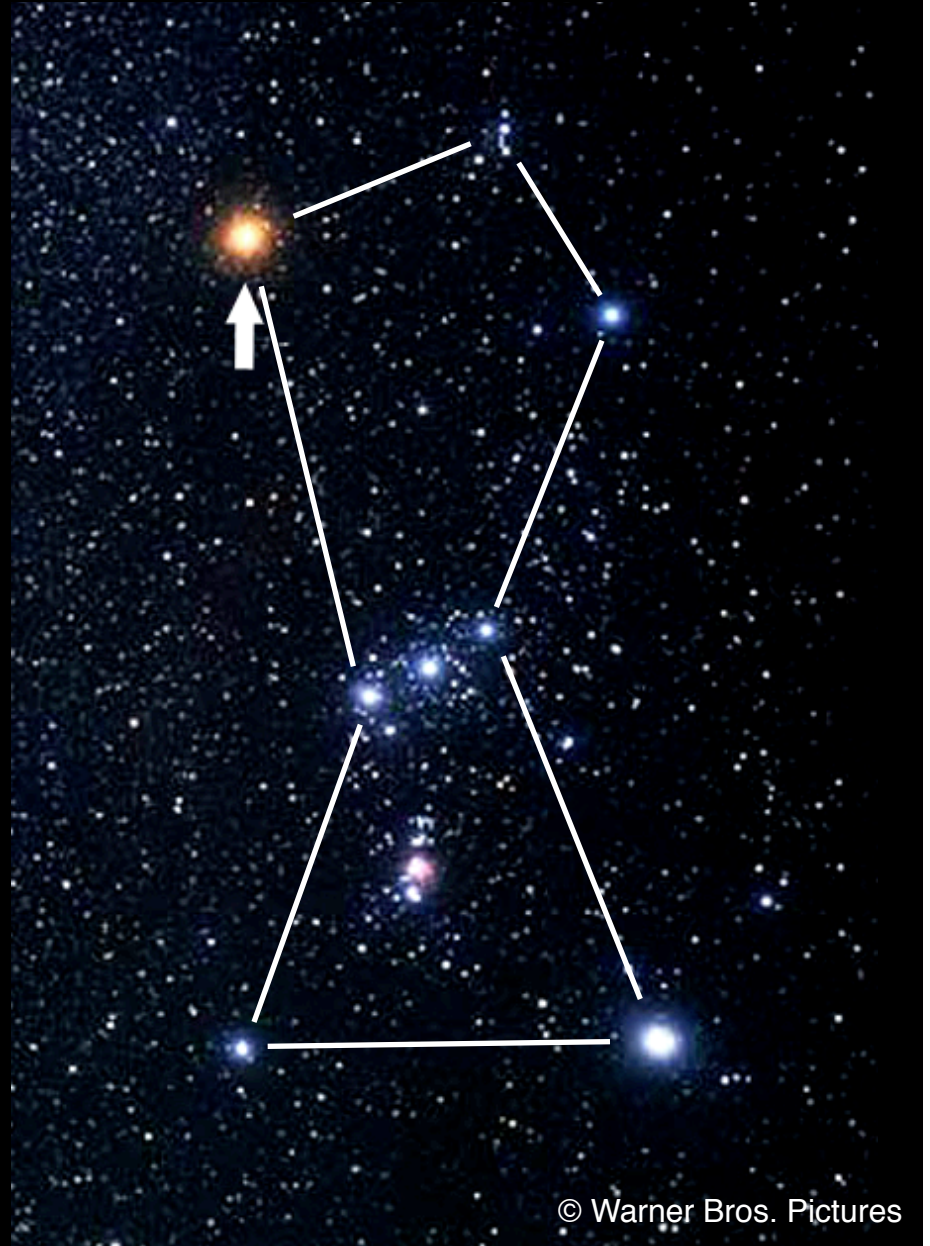
Size of Star



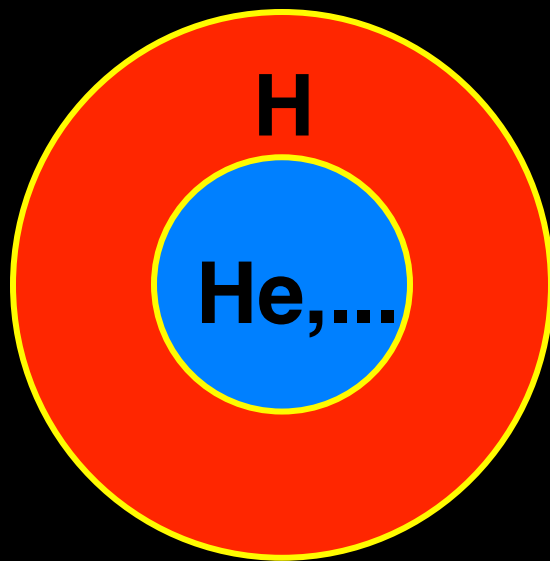
Size of Earth's Orbit



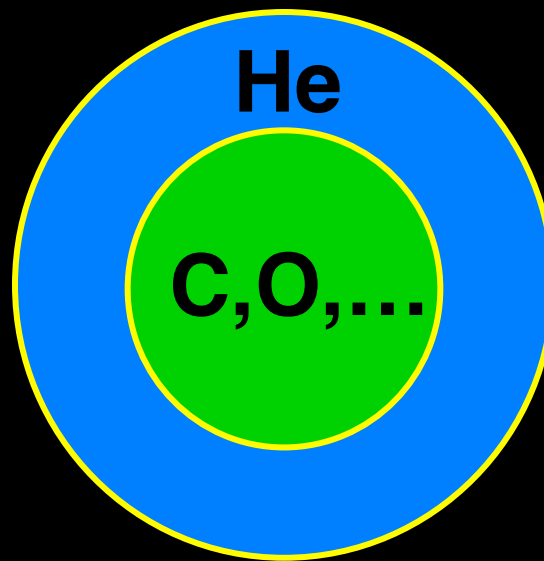
Size of Jupiter's Orbit



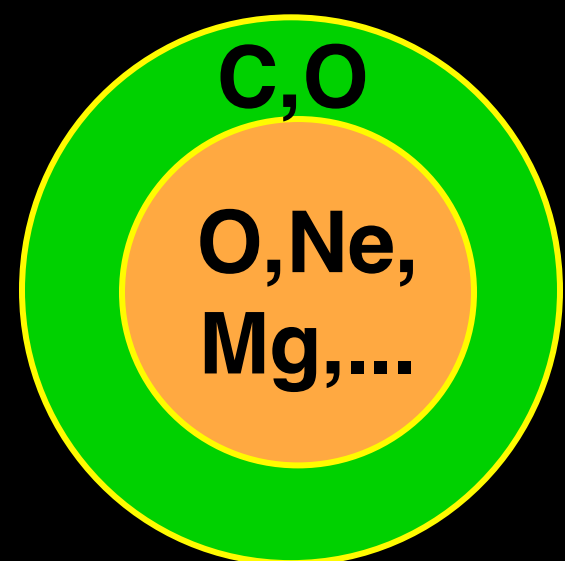
Stripped Envelope Core-Collapse Supernovae



Type II

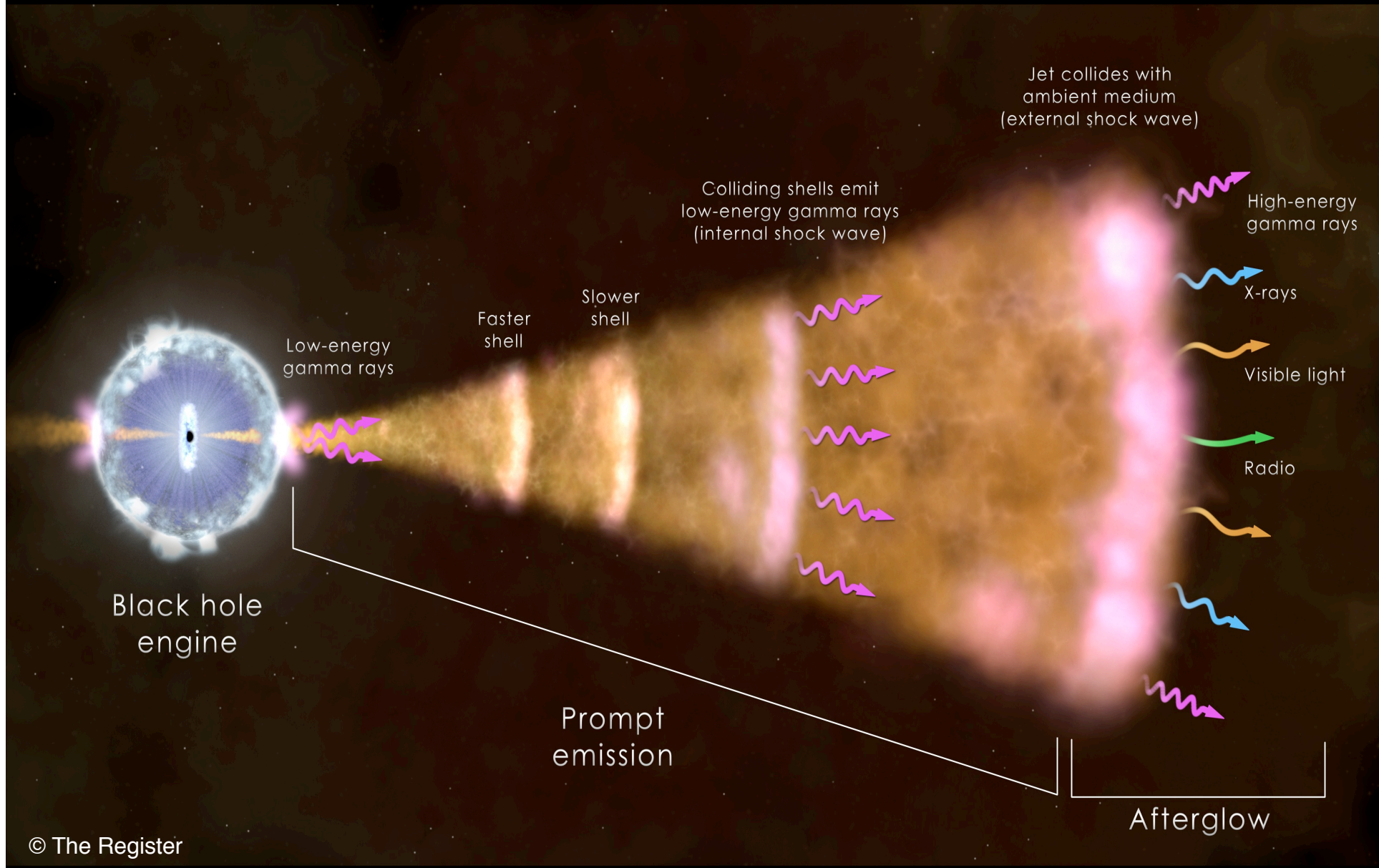


Type Ib

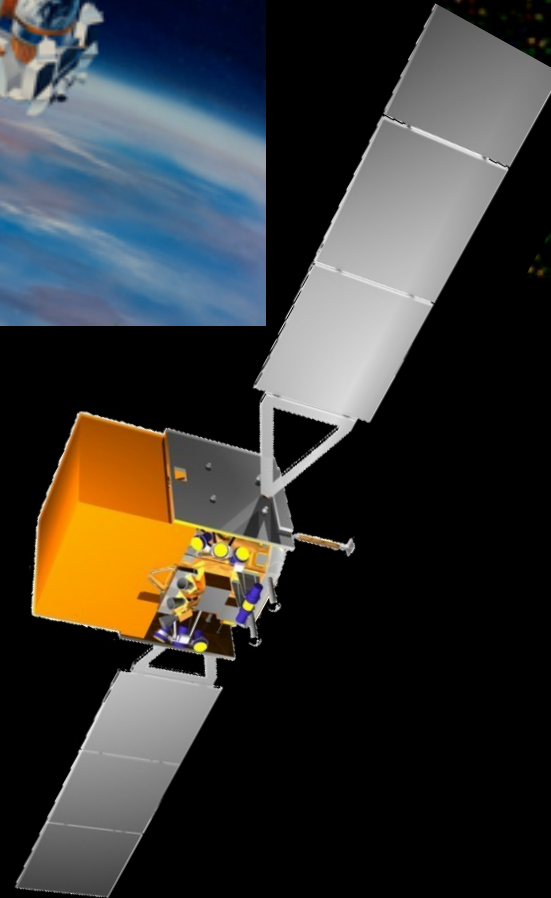
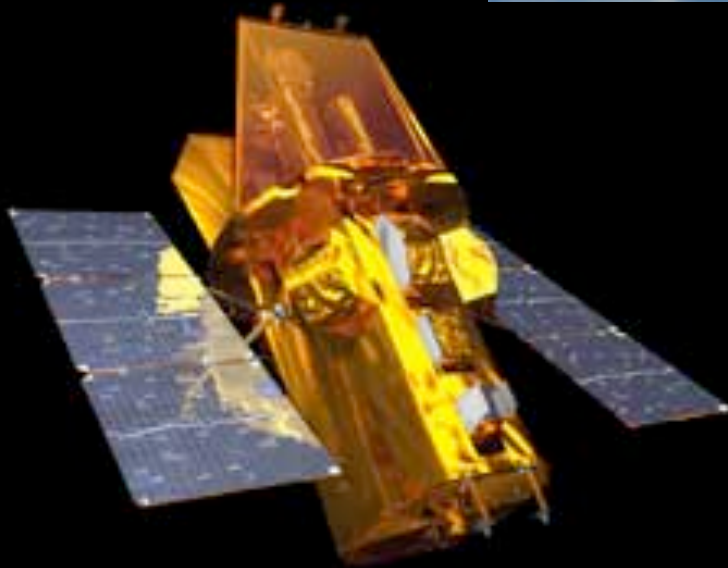
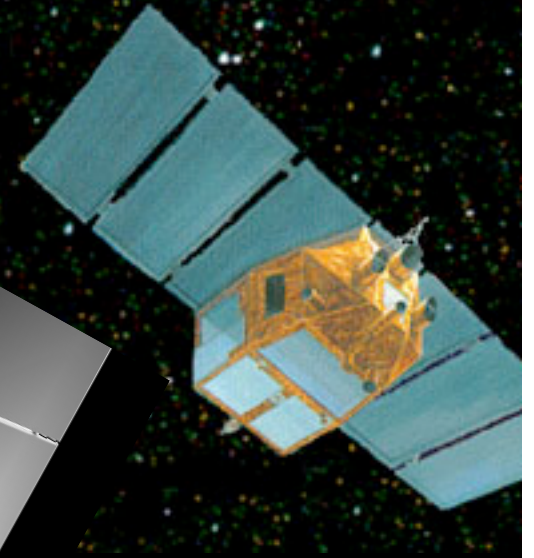
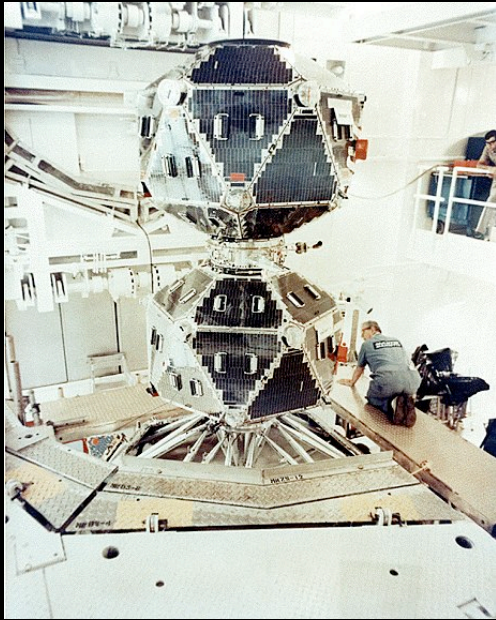


Type Ic

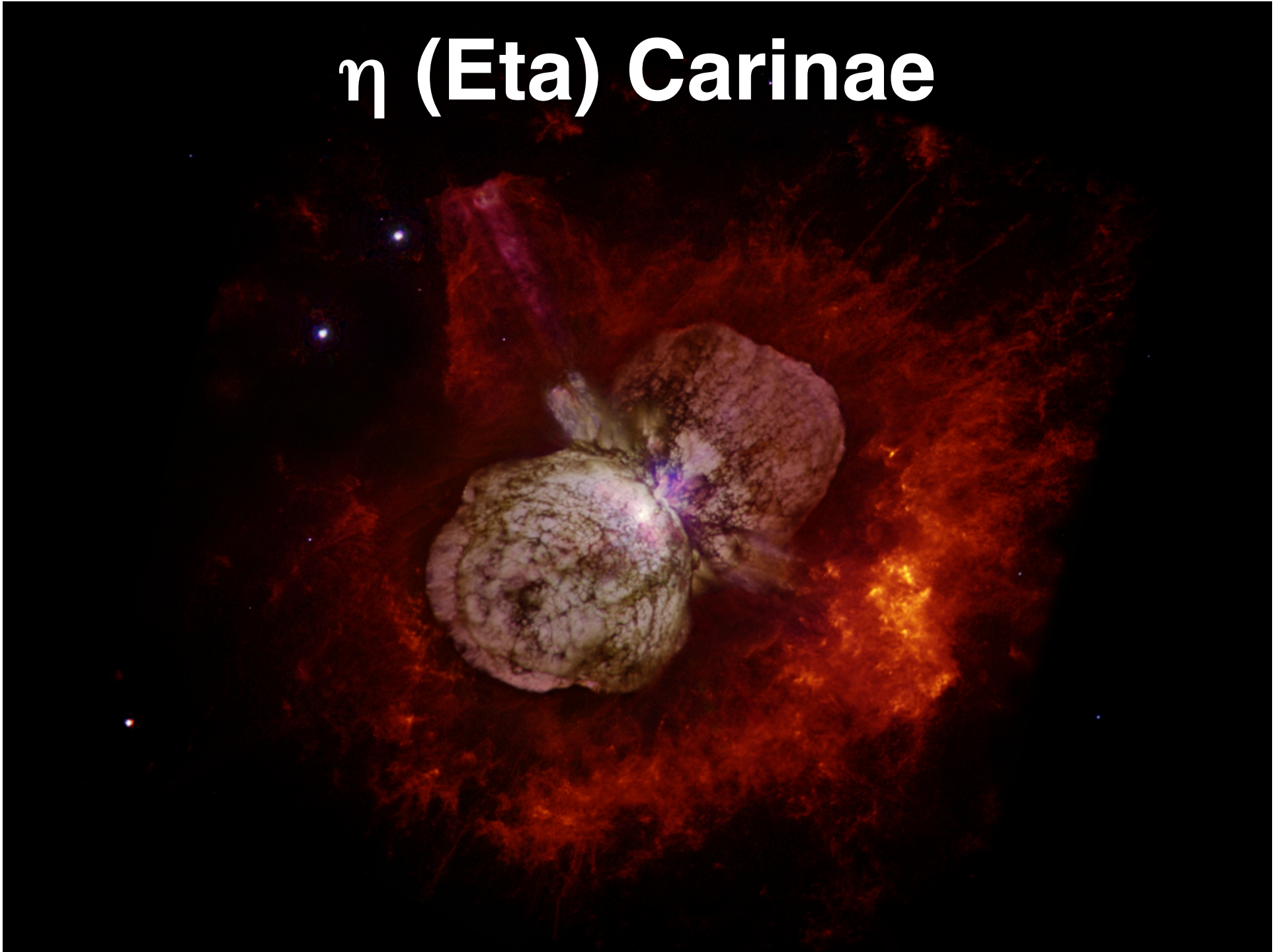
Gamma-Ray Bursts (GRBs)

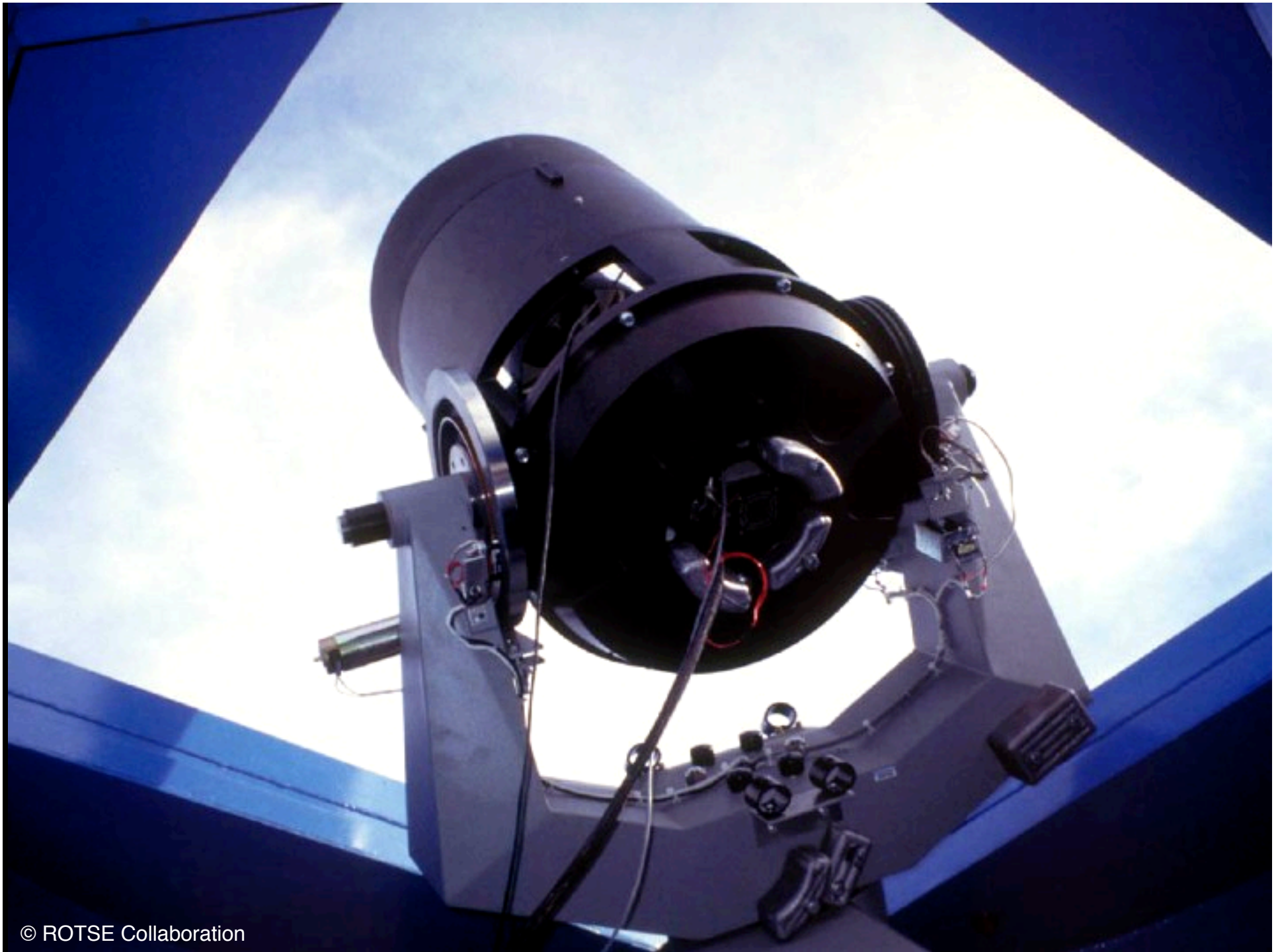


Vela, CGRO, BeppoSAX, Swift, & Fermi



η (Eta) Carinae





SN 2011fe (Type Ia)



No SN :-)



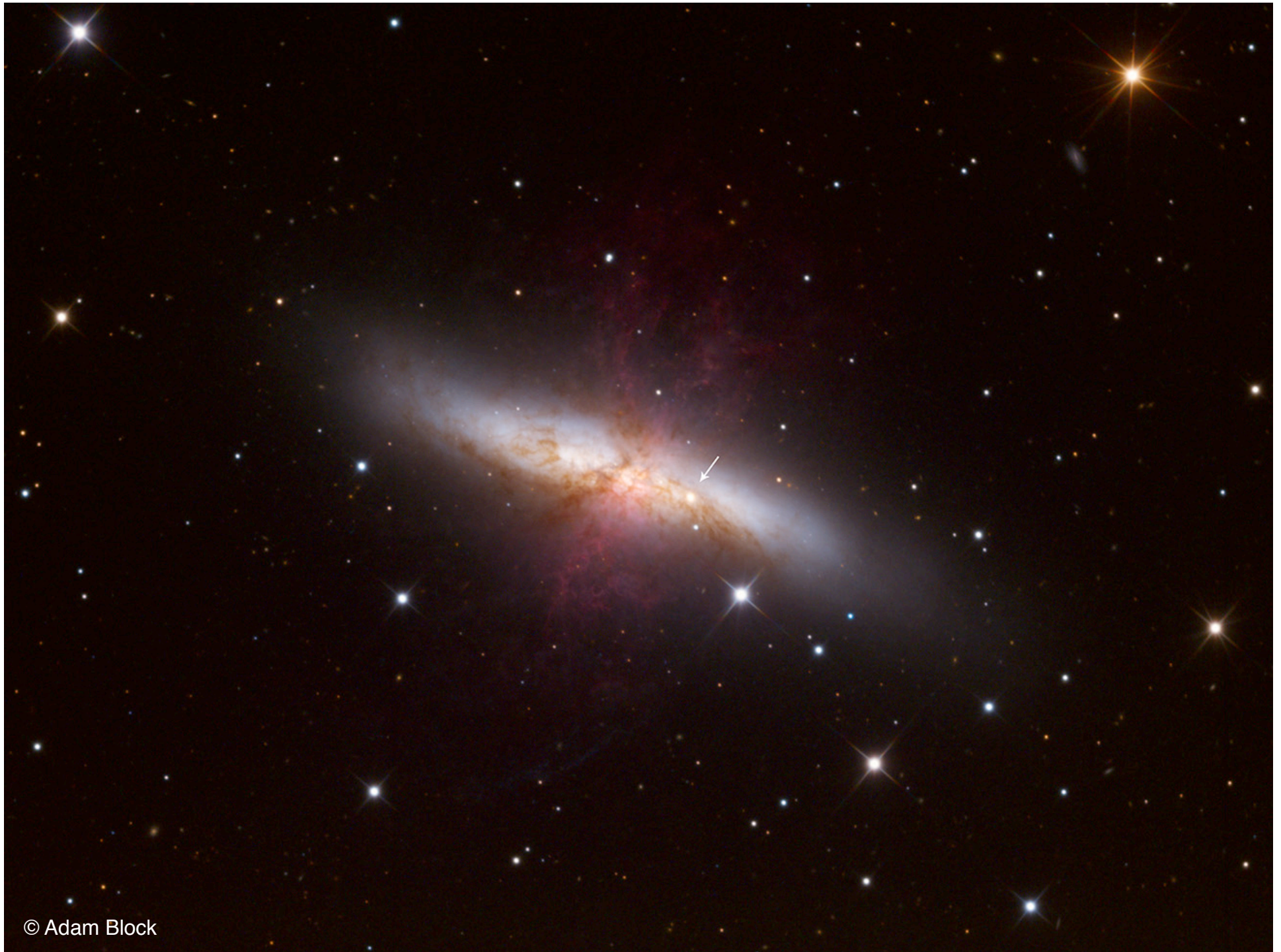
SN :-)

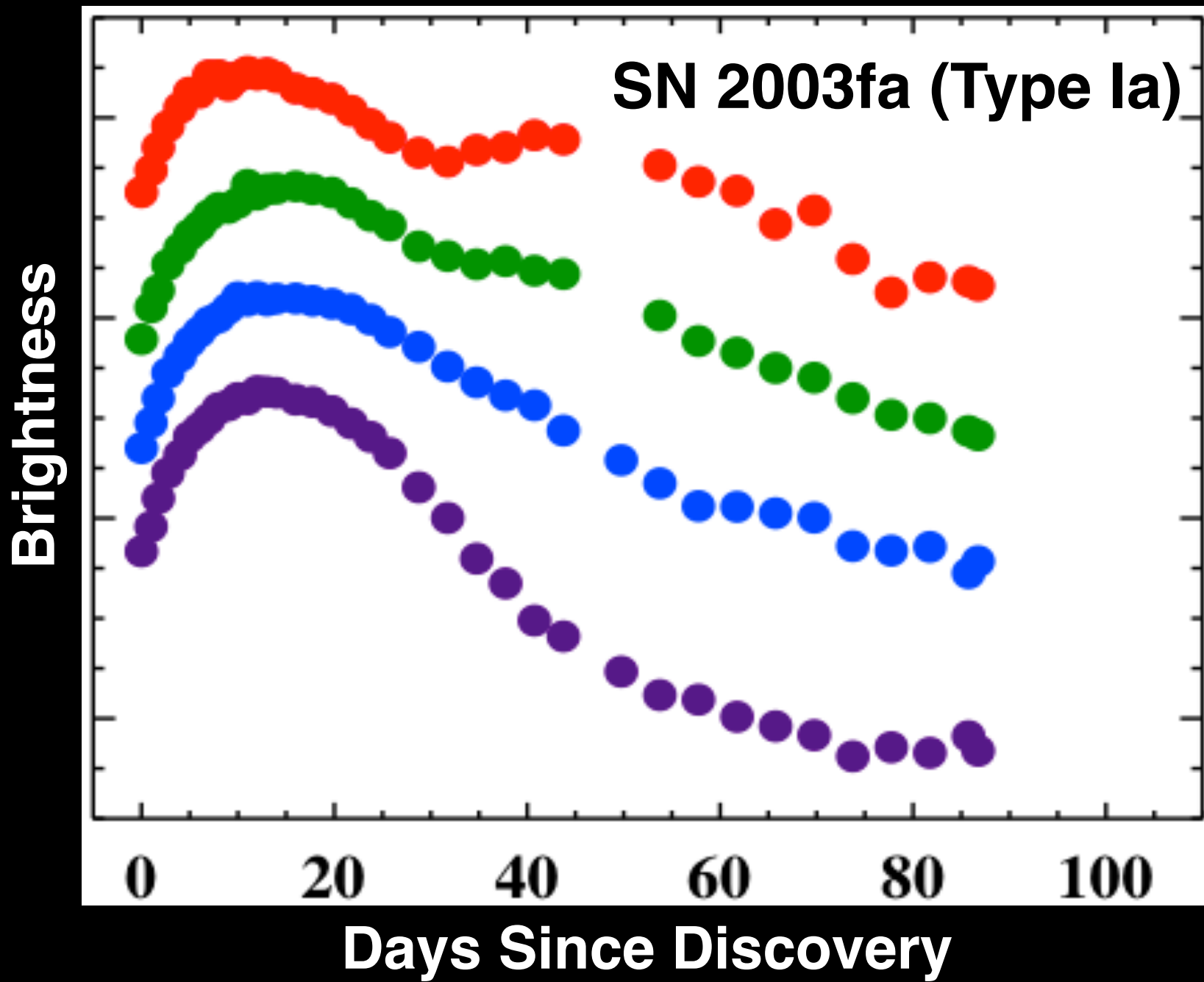
SN 2011fe (Type Ia)

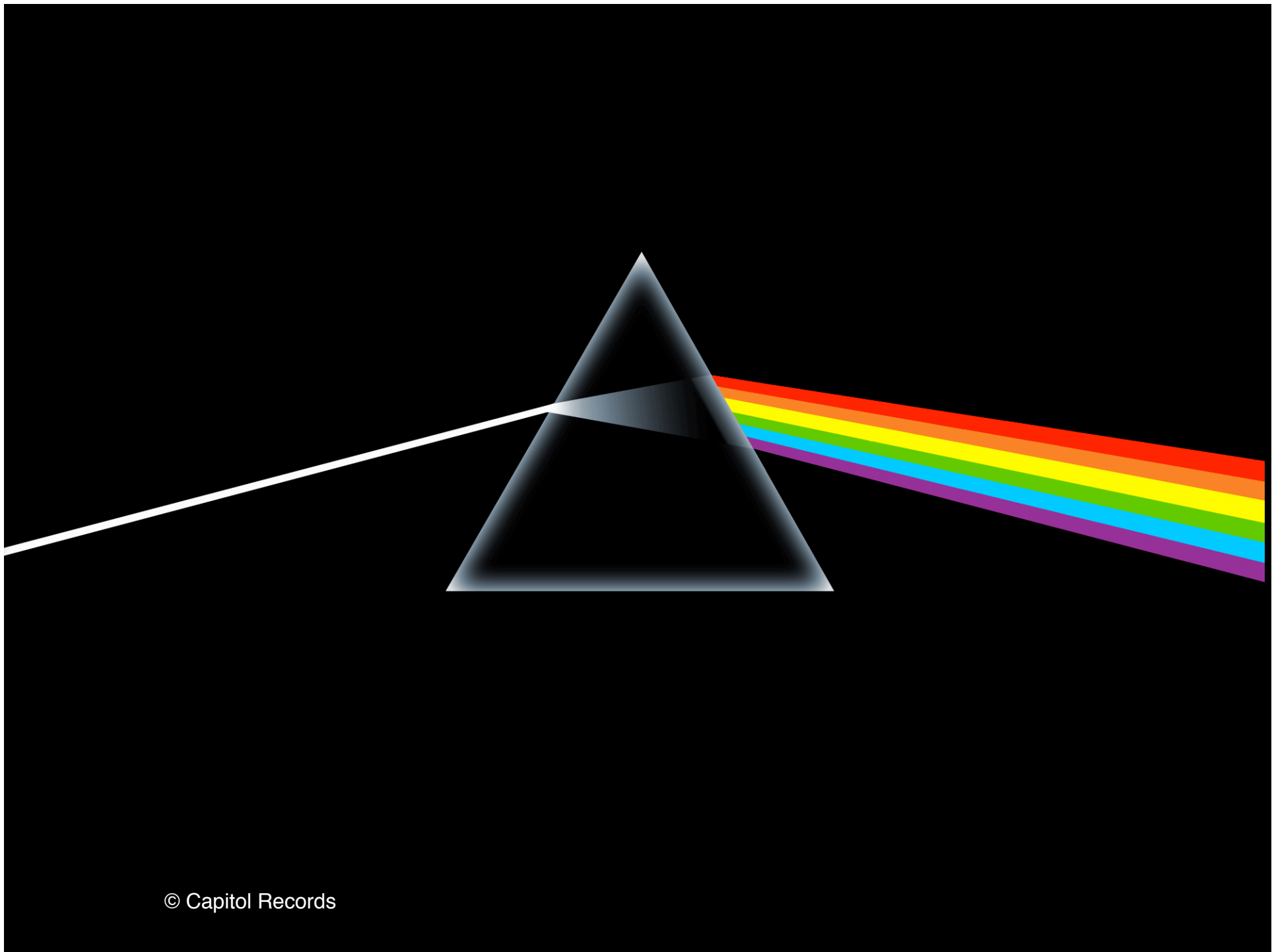


No SN :-)

SN :-)

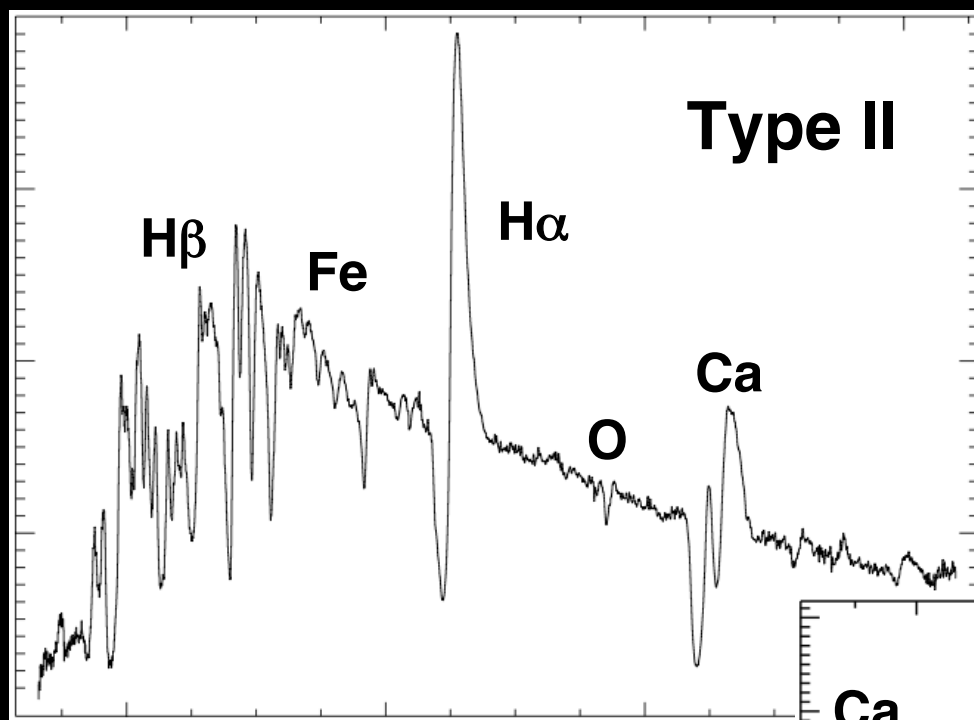






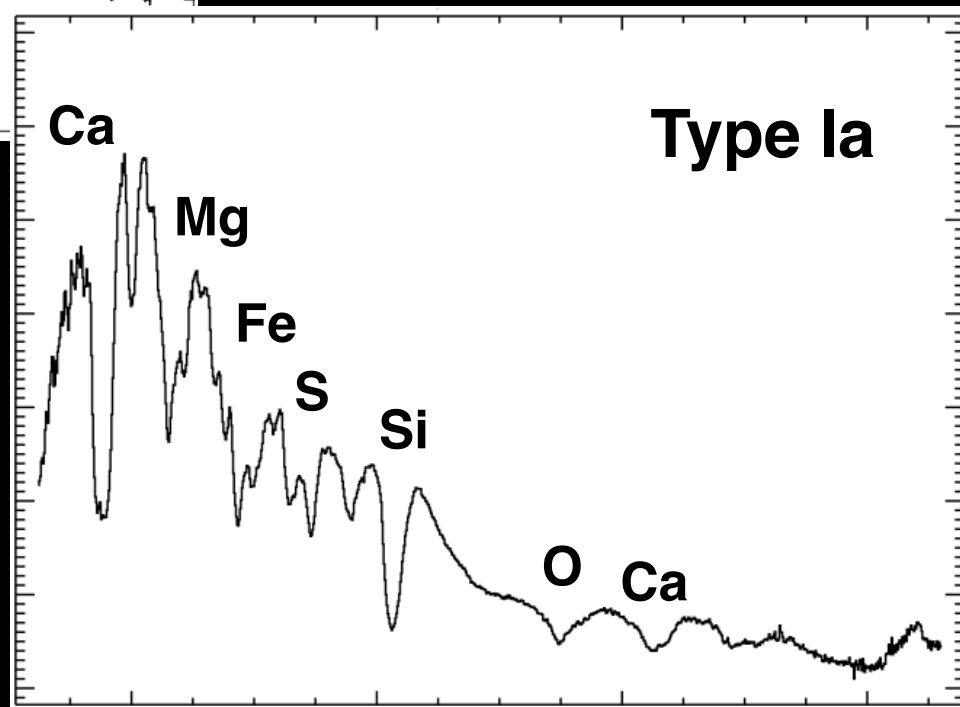
© Capitol Records

Brightness



Wavelength

Brightness



Wavelength



© Rick Peterson/WMKO





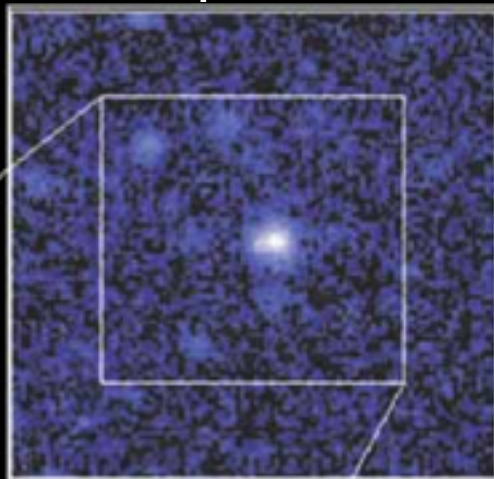
© Penn State



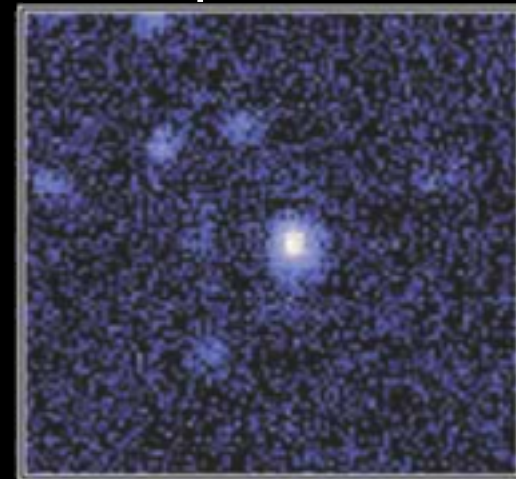


Discovery of SN 1997cj

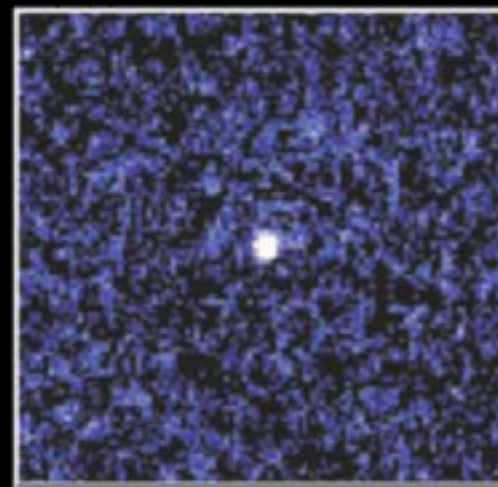
28 April 1997



7 April 1997



12 May 1997



28 April - 7 April

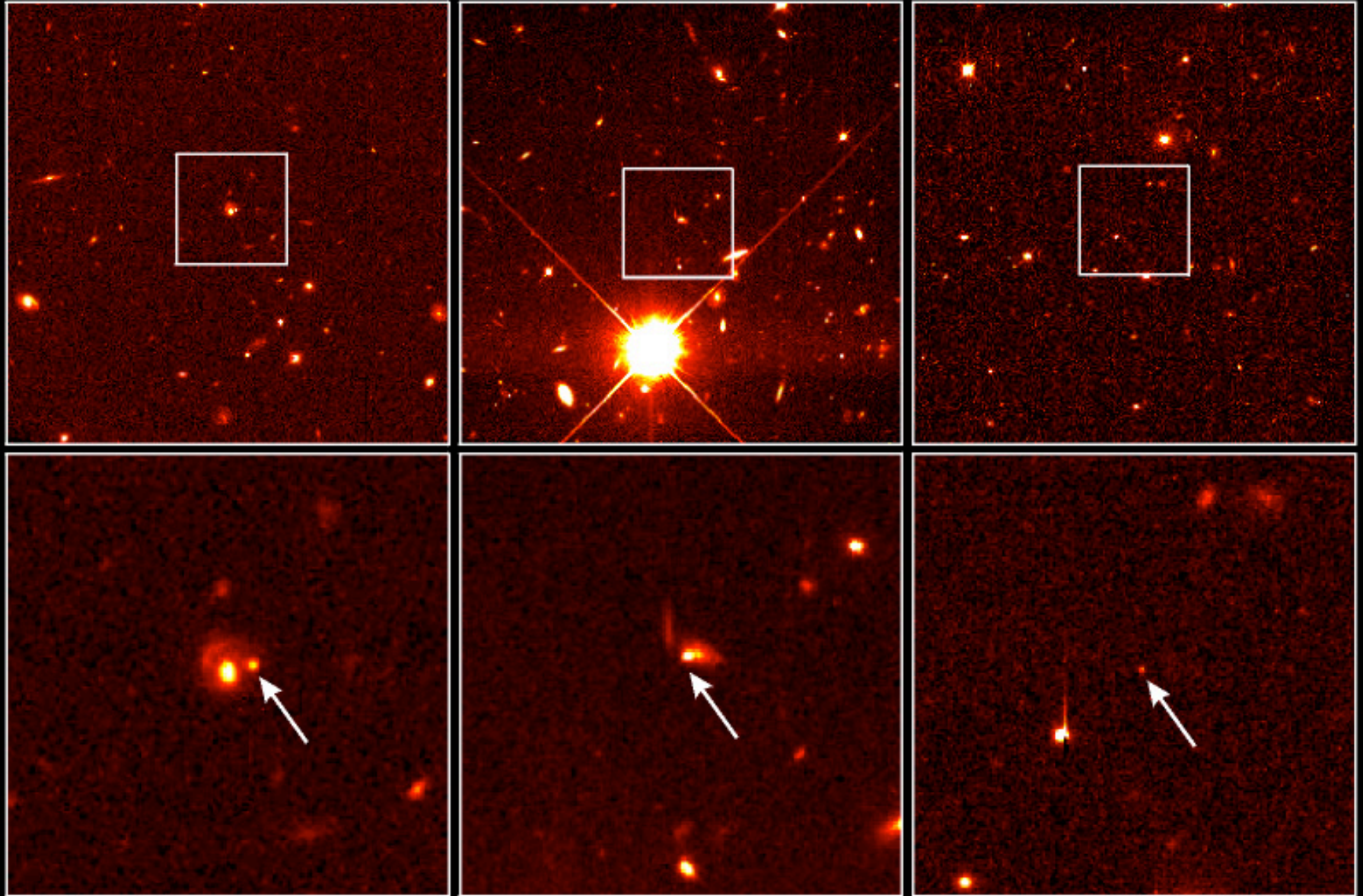
The Hubble Expansion



© Mt. Wilson Archive

- All galaxies are moving away from each other.
- All galaxies have mass and thus, gravitationally pull on each other.
- All this pulling should slow down the expansion.

HST Supernovae



2011 Nobel Prize in Physics



Saul Perlmutter,
Lawrence Berkeley
National Laboratory
& UC Berkeley



Brian P. Schmidt,
Australian National
University



Adam G. Riess,
John Hopkins
University & STScI

“For the discovery of the accelerating expansion of the Universe through observations of distant supernovae.”

Composition of the Universe

