National Science Olympiad

Astronomy C Event 2022

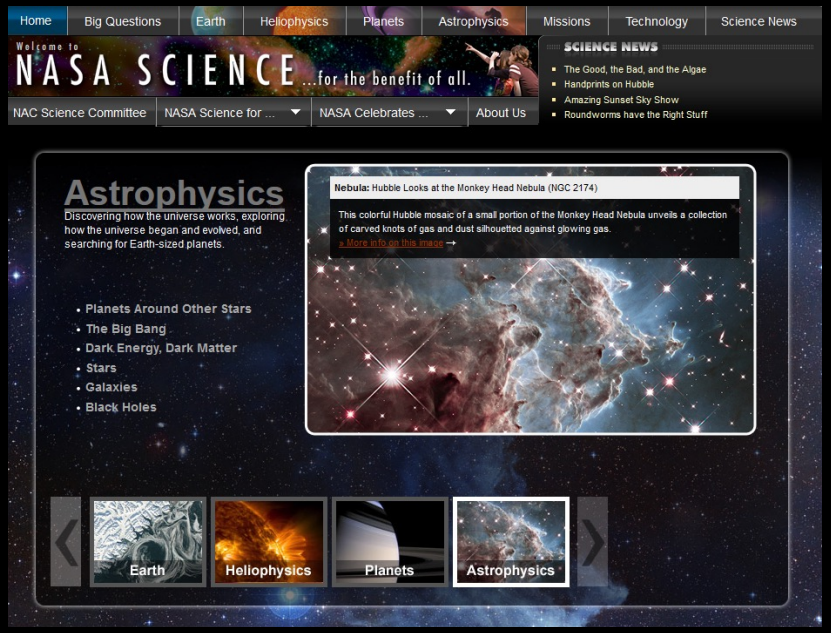
Variability in Low to Mid-Mass Stars

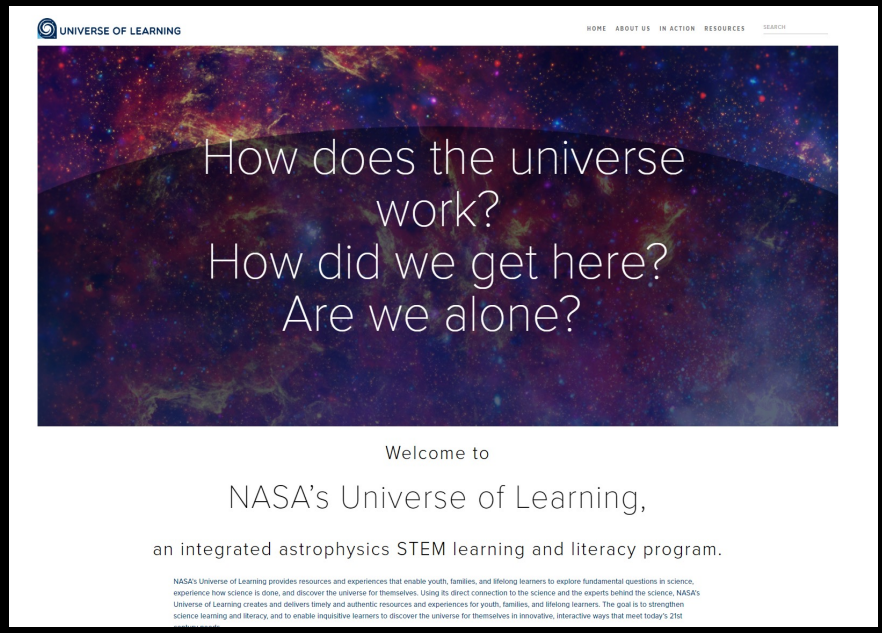
DRAFT

Supported by NASA's Universe of Learning STEM Program

NASA Astrophysics Division/CXC/NSO

https://www.universe-of-learning.org/





ASTRONOMY 2022

1. **DESCRIPTION:** Teams will demonstrate an understanding of the **Variability of Low & Mid-Mass Stars**.

2. **EVENT PARAMETERS:**

a. Each team may bring one of the following options containing information in any form and from any source:

i. a computer/tablet and a three-ring binder; or,

ii. two computers/tablets, of any kind; or,

iii. two three-ring binders.

b. If three ring binders are used they may be of any size and the information contained should be attached using the available rings. The information or pages may be removed during the event. Sheet protectors and laminated sheets are allowed.

c. Each team may bring two calculators of any type (stand alone or computer app). If the participants are using a computer/tablet they may use the calculator app or other program on their device in place of a stand-alone calculator.

d. Participants using computers/tablets as a resource should have all information stored so that it is available to them offline. However, teams may be asked to access a dedicated NASA image analysis website to answer some JS9 questions. If so, supervisors will provide an alternative (e.g., proctor-supplied computer or screen shots) for teams that did not bring a laptop/tablet.

ASTRONOMY 2022

1. **DESCRIPTION:** Teams will demonstrate an understanding of the **Variability of Low & Mid-Mass Stars**.

3. **THE COMPETITION:** Using information which may include Hertzsprung-Russell diagrams, spectra, light curves, motions, cosmological distance equations and relationships, stellar magnitudes and classification, multi-wavelength images (gamma-ray, X-ray, UV, optical, IR, radio), charts, graphs and JS9 imaging analysis software, teams will complete activities and answer questions related to:

a. Stellar evolution including stellar classification, spectral features and chemical composition, luminosity, blackbody radiation, color index and H-R diagram transitions, **proto-stars, T Tauri variables, Herbig-Haro (HH) objects, red giants, Mira variables, RR Lyrae variables, carbon stars, white dwarfs, planetary nebulas, neutron stars, dwarf & recurrent novas,** Type Ia **supernovas, magnetic cataclysmic variables (MCVs).**

b. Use **orbital mechanics,** Kepler's laws, rotation and circular motion to answer questions relating to the orbital motions of **binary and multiple star systems**; use **parallax, spectroscopic parallax, period-luminosity relations, and** the distance modulus **to calculate distances to RR Lyraes, and** Type Ia supernovas; use **hydrostatic equilibrium** and the **Stefan-Boltzmann law** to answer questions relating **to stellar structure and interiors.**

ASTRONOMY 2022

1. **<u>DESCRIPTION</u>:** Teams will demonstrate an understanding of the **Variability of Low & Mid-Mass Stars**.

c. Identify and answer questions relating to the content areas outlined above for the following objects:

HOPS 383, HH 24-26, V1331 Cyg, HBC 672, Orion Nebula, Alpha Tauri, RR Lyrae, Mira (Omicron Ceti), ESO 577-24, IC 4593, U Antliae, LP 40-365, ASASSN 16-oh, V Sagittae, AR Scorpii, SDSS 1035+0551, Tycho's SNR

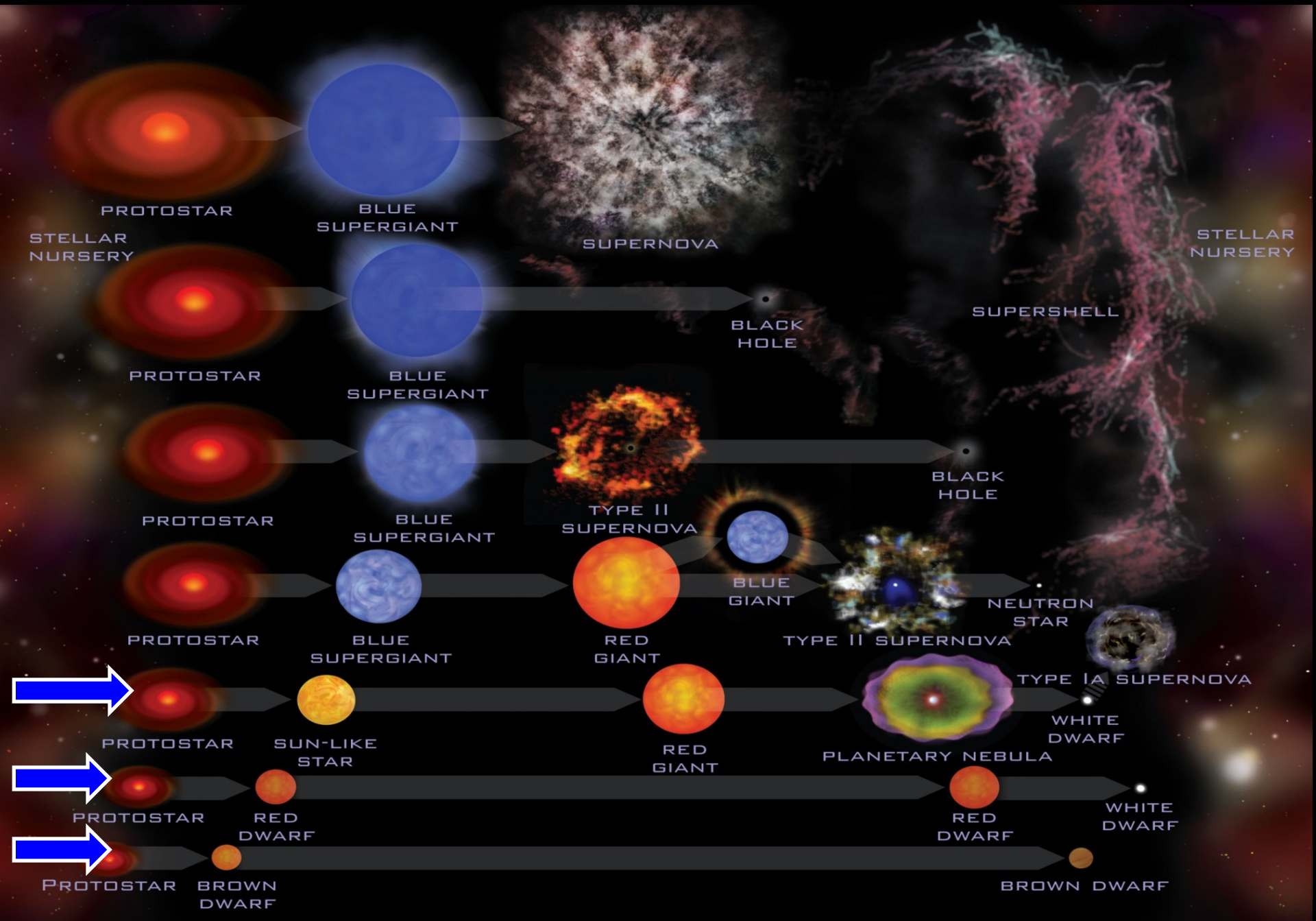
<u>Deep Sky Objects listed above sorted by Type:</u>

Protostars & Star Formation Regions: V1331 Cyg, Orion Nebula, HH 24-26, HOPS 383, HBC 672

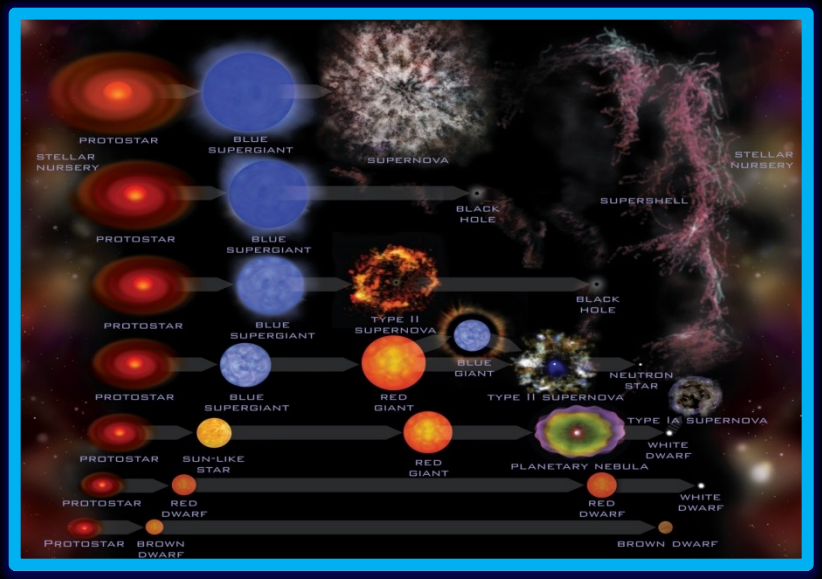
Stars: Mira (Omicron Ceti), RR Lyrae, U Antliae, Alpha Tauri

Binary Systems: AR Scorpii, ASASSN 16-oh, V Sagittae, SDSS 1035+0551

Supernova Remnants & Stellar Cores: ESO 577-24, Tycho's SNR, LP 40-365, IC 4593


PROTOSTAR
BLUE SUPERGIANT
SUPERNOVA
STELLAR NURSERY
STELLAR NURSERY
BLACK HOLE
SUPERSHELL
PROTOSTAR
BLUE SUPERGIANT
PROTOSTAR
BLUE SUPERGIANT
TYPE II SUPERNOVA
BLACK HOLE
PROTOSTAR
BLUE SUPERGIANT
BLUE GIANT
NEUTRON STAR
RED GIANT
TYPE II SUPERNOVA
PROTOSTAR
SUN-LIKE STAR
RED GIANT
TYPE IA SUPERNOVA
WHITE DWARF
PLANETARY NEBULA
PROTOSTAR
RED DWARF
RED DWARF
WHITE DWARF
PROTOSTAR
BROWN DWARF
BROWN DWARF

Stellar Evolution is a PROCESS that is explained using Specific examples (DSOs), H-R diagrams and light curves



NSO 2022 Astronomy Event Deep Sky Objects

A. Protostars & Star Formation Regions:

1) V 1331 Cyg (T Tauri)
2) Orion Nebula
3) HH 24-26 (Harbig Haro Jet)
4) HOPS 383 (protostar)
5) HBC 672 (Serpens nebula)

B. Stars:

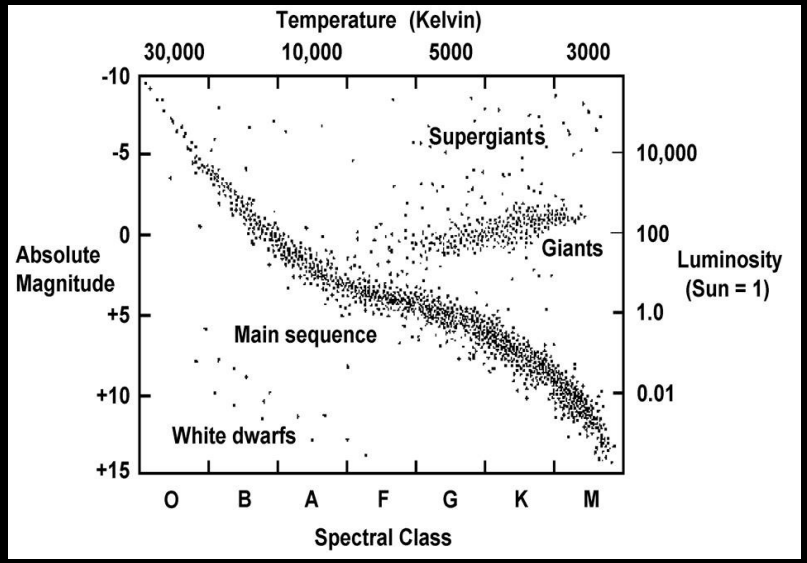
1) Mira (Omicron Ceti, red giant)
2) RR Lyrae
4) U Antliae (carbon star)
5) Alpha Tauri (Aldebaran)

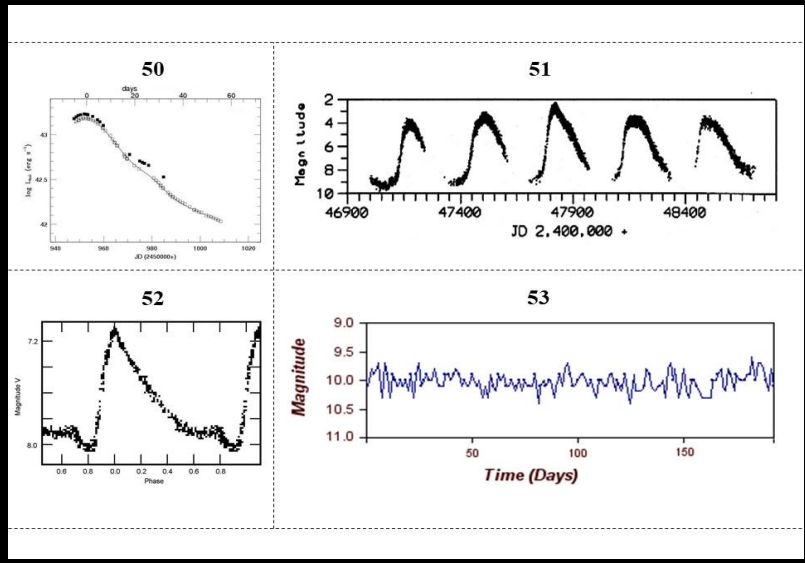
C. Binary Systems, Novas:

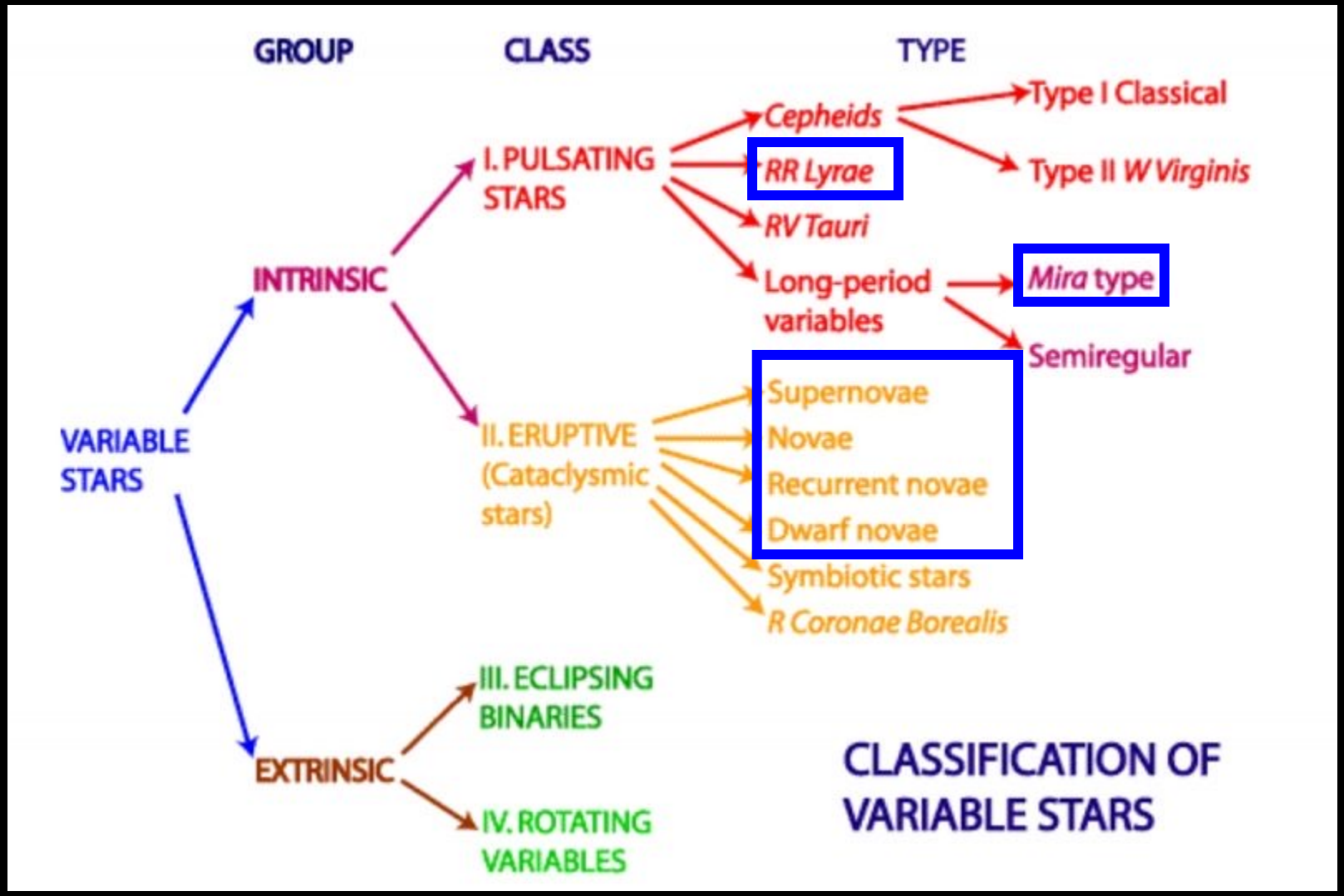
1) AR Scorpii (wd/red dwarf)
2) ASASSN 16-oh (wd/wd)
3) V Sagittae (star/wd)
4) SDSS 1035+0551 (brown dwarf/wd)

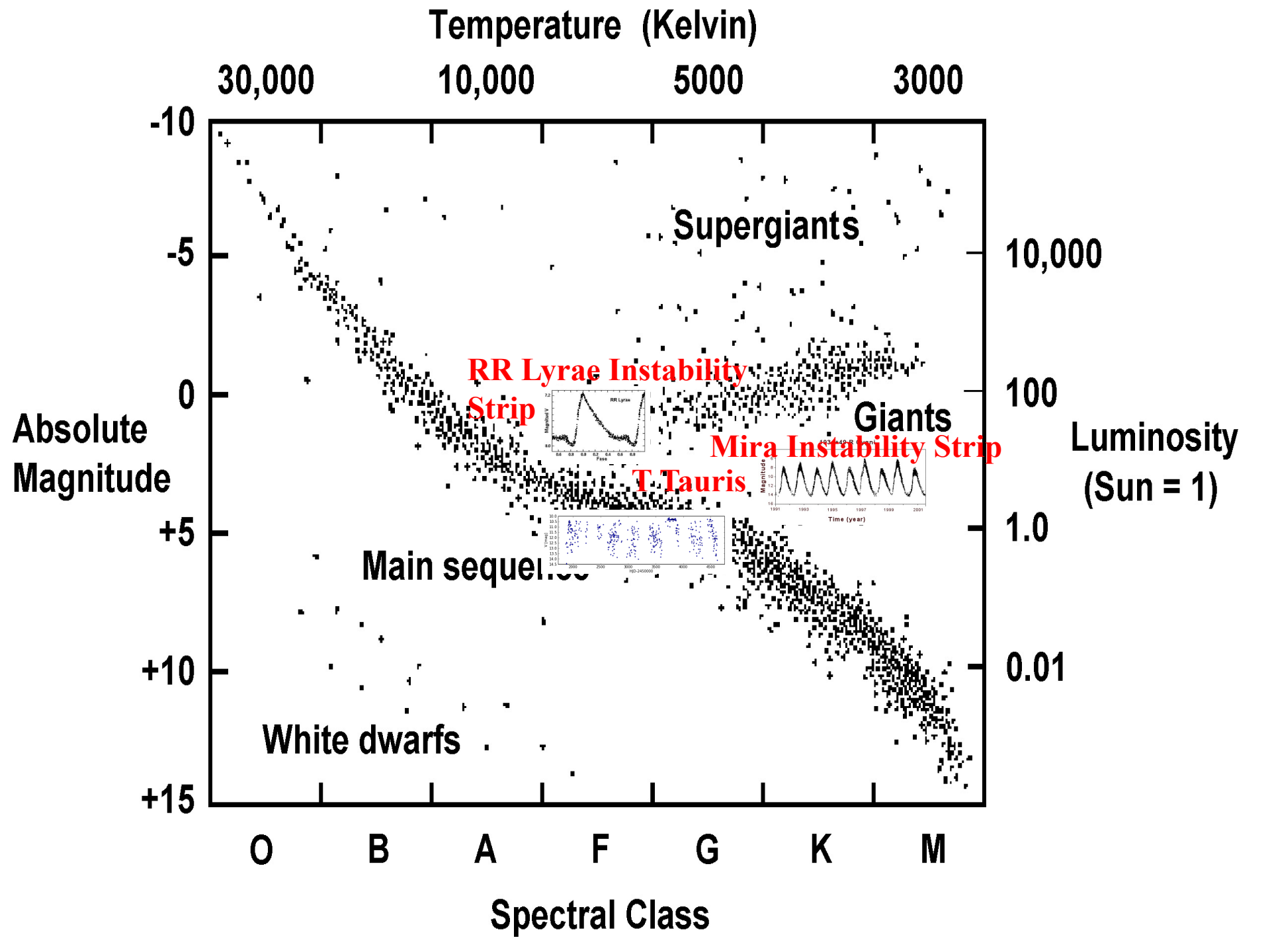
D. Supernova Remnants & Stellar Cores:

1) DEM L71 (Type Ia)
2) ESO 577-24 (planetary nebula)
3) Tycho's SNR (Type Ia)
4) LP 40-365 (solitary wd)
5) IC 4593 (planetary nebula)



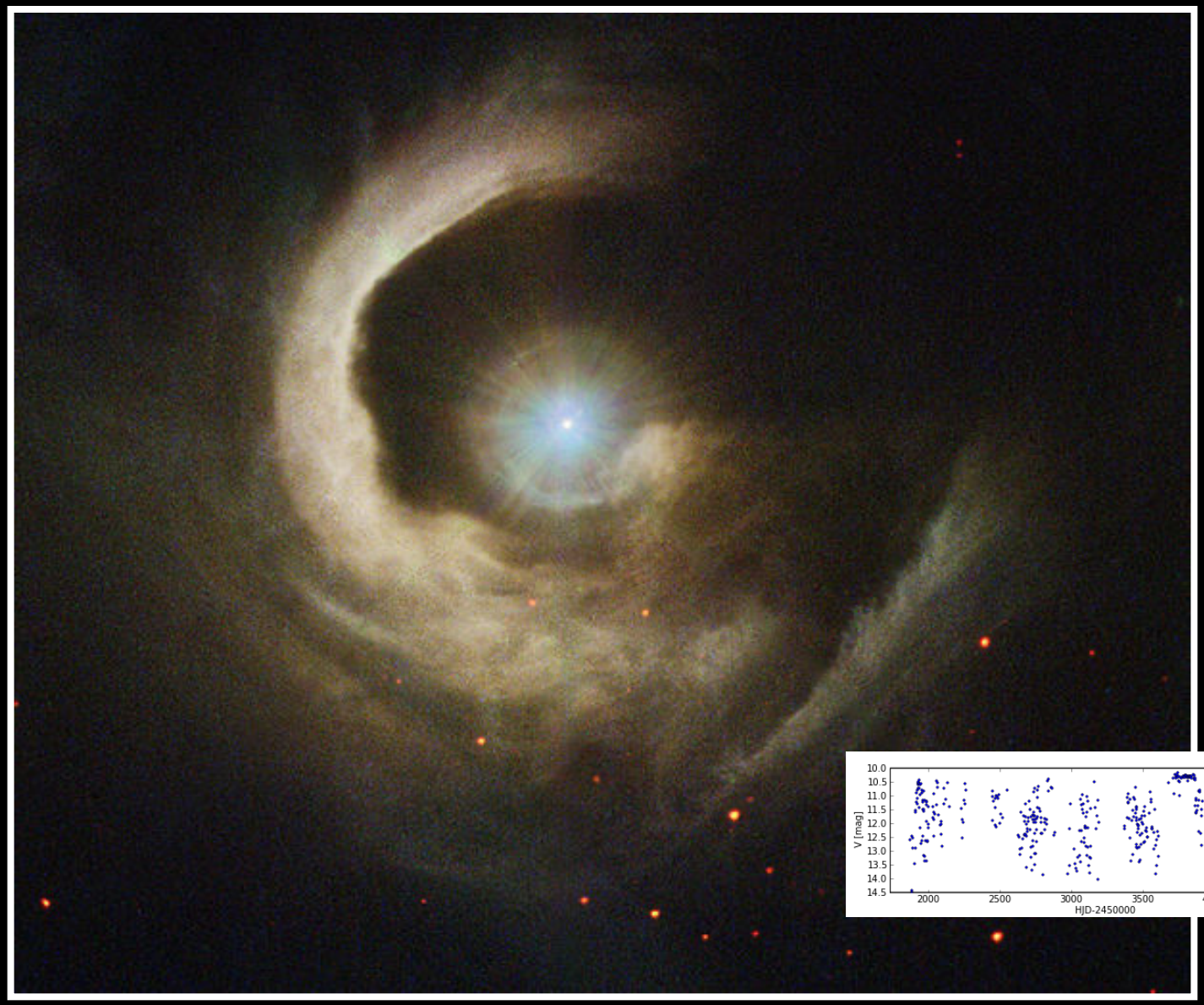



GROUP
CLASS
TYPE
VARIABLE STARS
INTRINSIC
EXTRINSIC
I. PULSATING STARS
II. ERUPTIVE (Cataclysmic stars)
III. ECLIPSING BINARIES
IV. ROTATING VARIABLES
Cepheids
RR Lyrae
RV Tauri
Long-period variables
Type I Classical
Type II W Virginis
Mira type
Semiregular
Supernovae
Novae
Recurrent novae
Dwarf novae
Symbiotic stars
R Coronae Borealis
CLASSIFICATION OF VARIABLE STARS

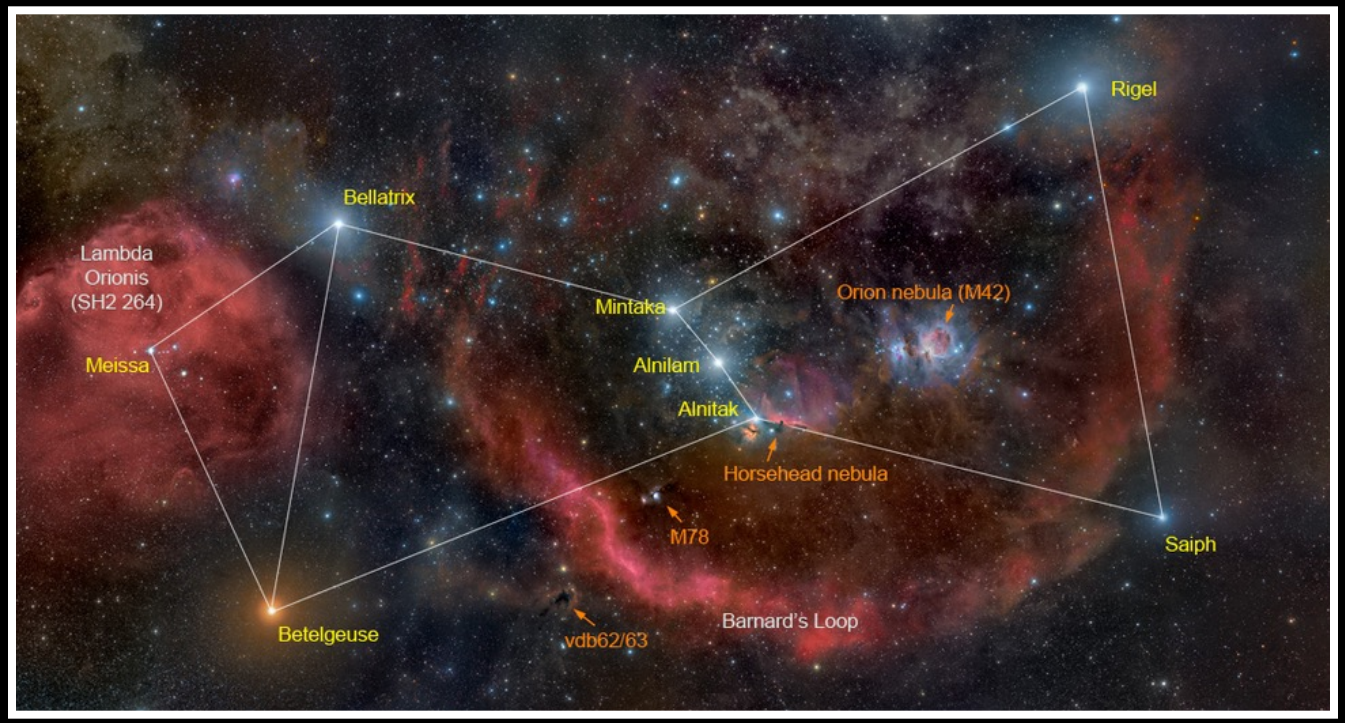

Temperature (Kelvin)
30,000
10,000
5000
3000
-10
-5
0
+5
+10
+15
Absolute Magnitude
Supergiants
Giants
Main sequence
White dwarfs
RR Lyrae Instability Strip
Mira Instability Strip
T Tauris
10,000
100
1.0
0.01
Luminosity (Sun = 1)
O
B
A
F
G
K
M
Spectral Class

Protostars & Star Formation Regions: V 1331 Cyg - T Tauri

A young T Tauri star surrounded by a reflection nebula

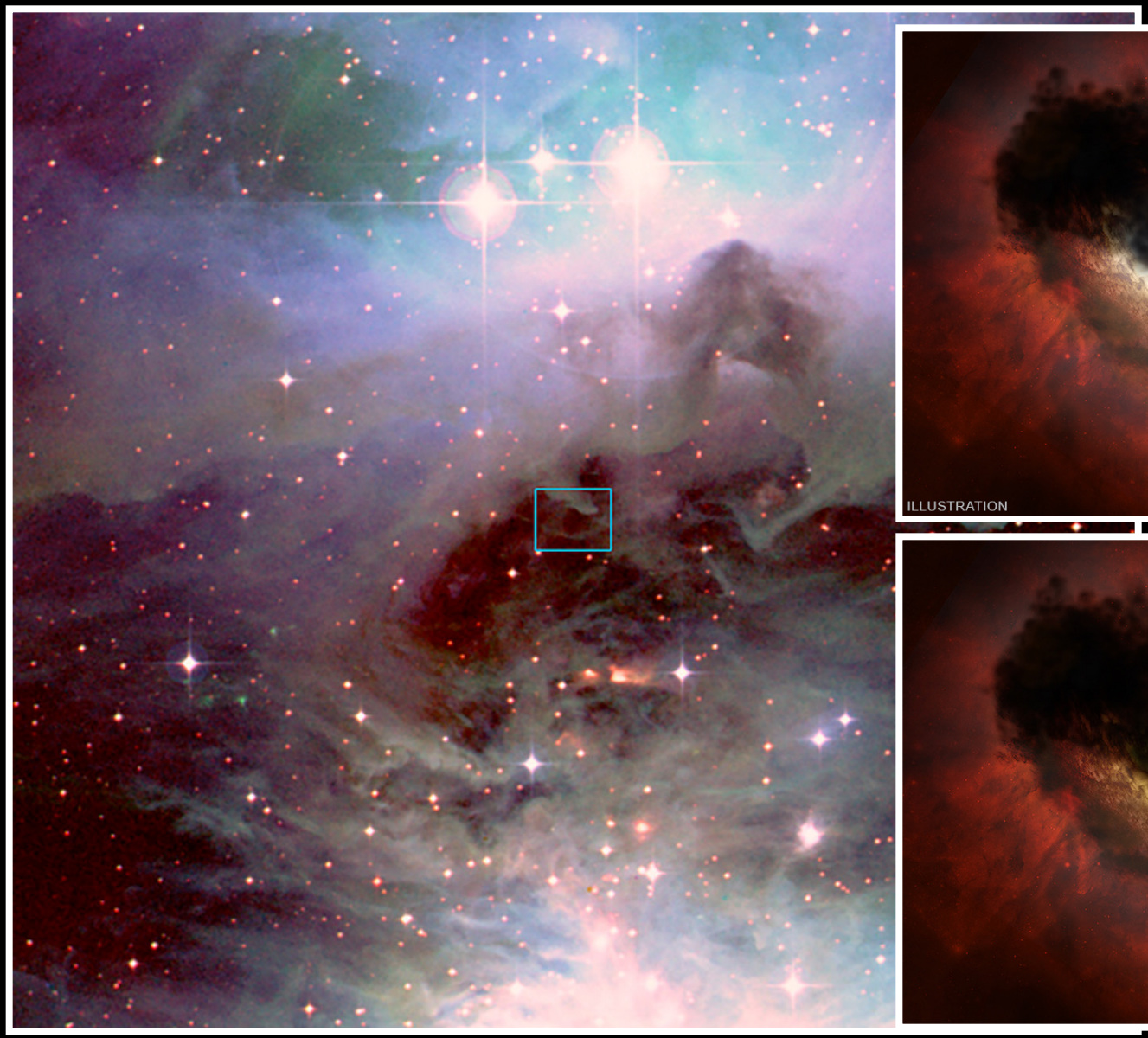


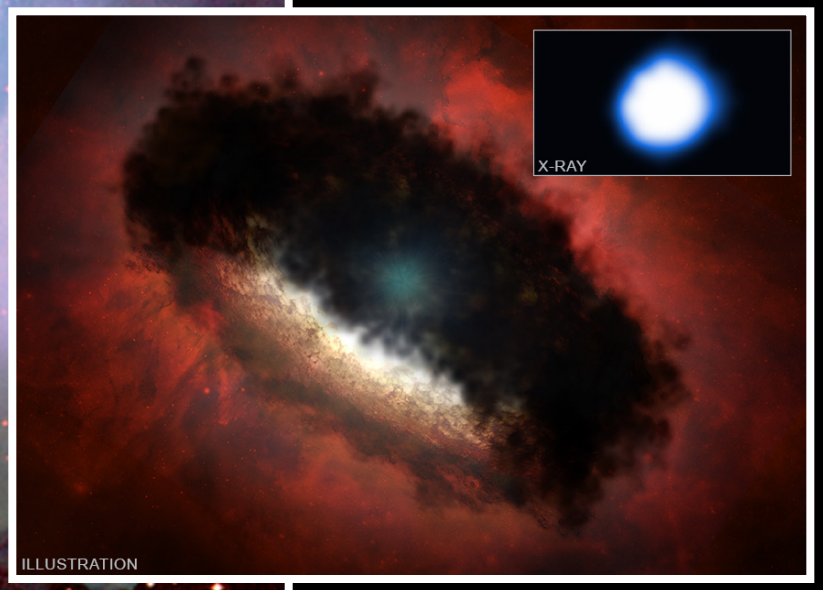
Protostars & Star Formation Regions: Orion Nebula

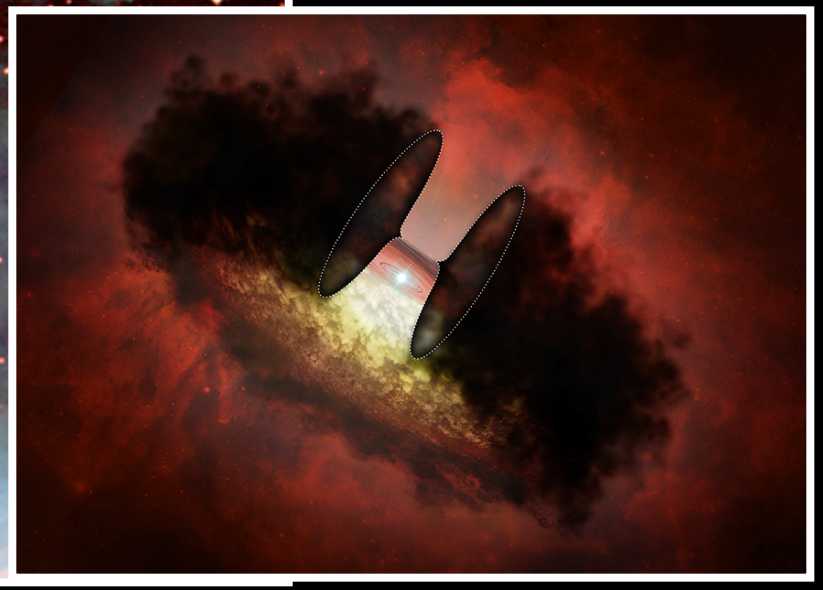


Protostars & Star Formation Regions: HH 24-26 - Herbig-Haro

Protostars & Star Formation Regions: HOPS 383 - protostar

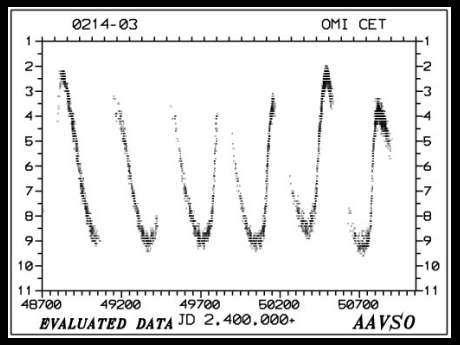


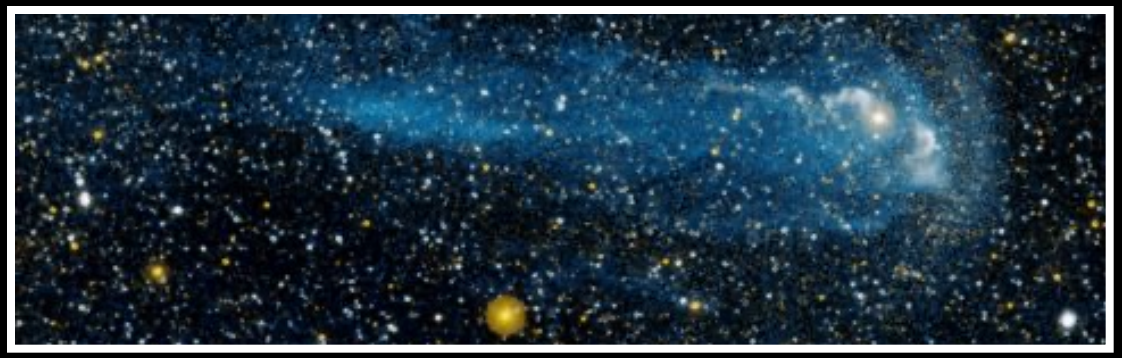


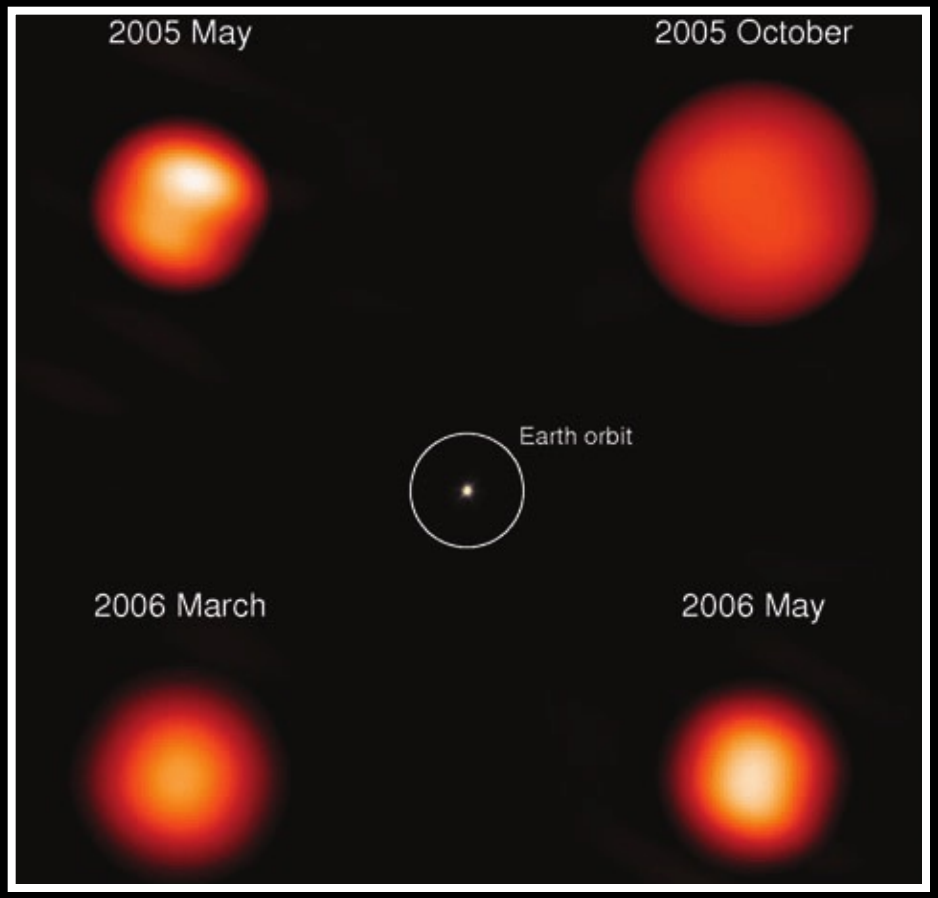


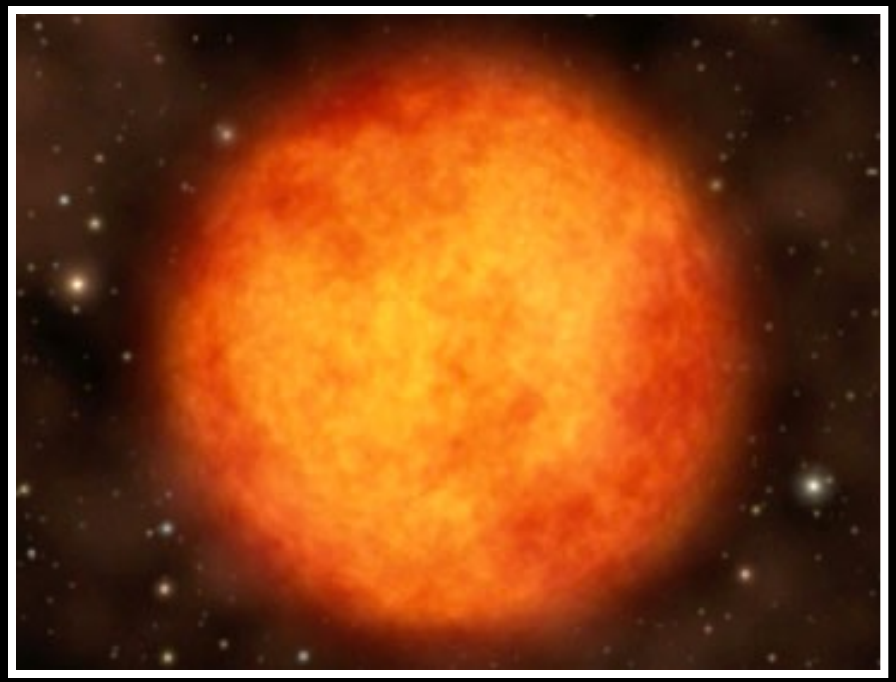
Protostars & Star Formation Regions: HBC 672 – Serpens nebula

Stars: Mira – Omicron Ceti

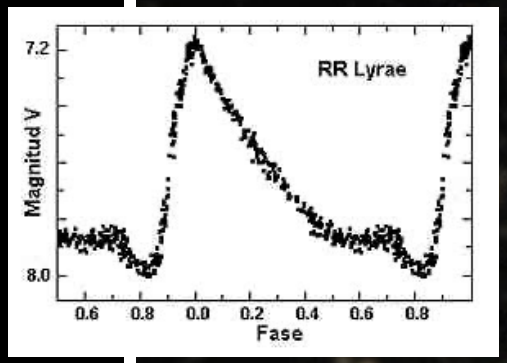




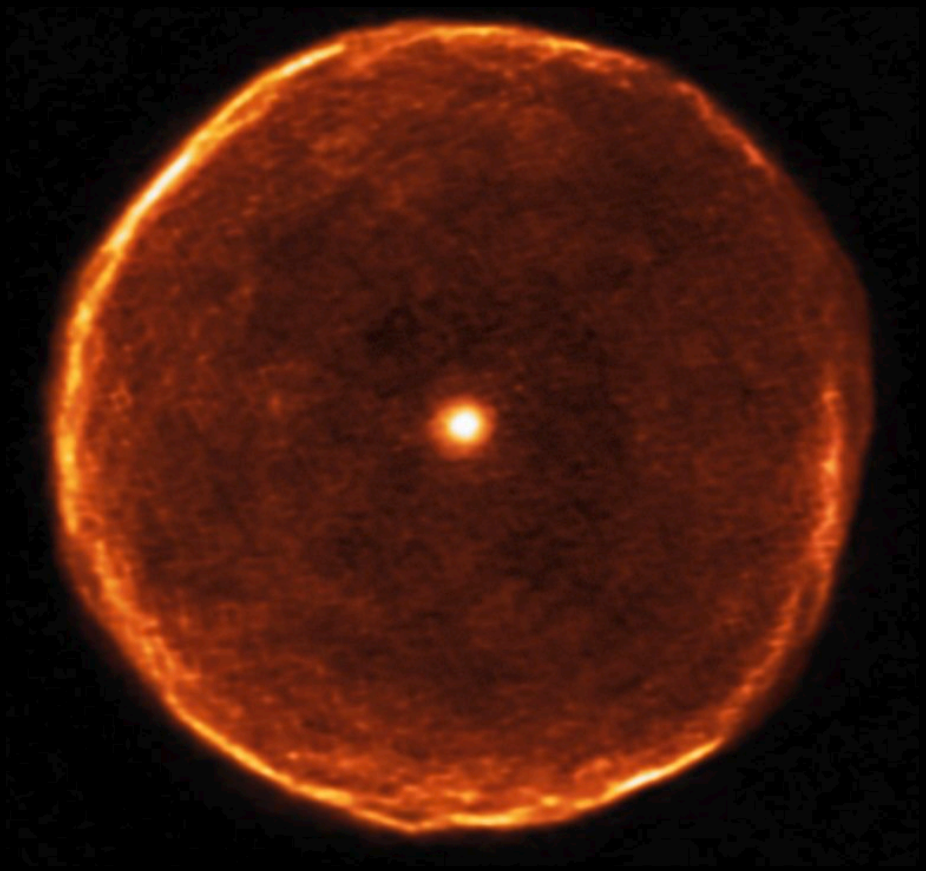




Stars: RR Lyrae

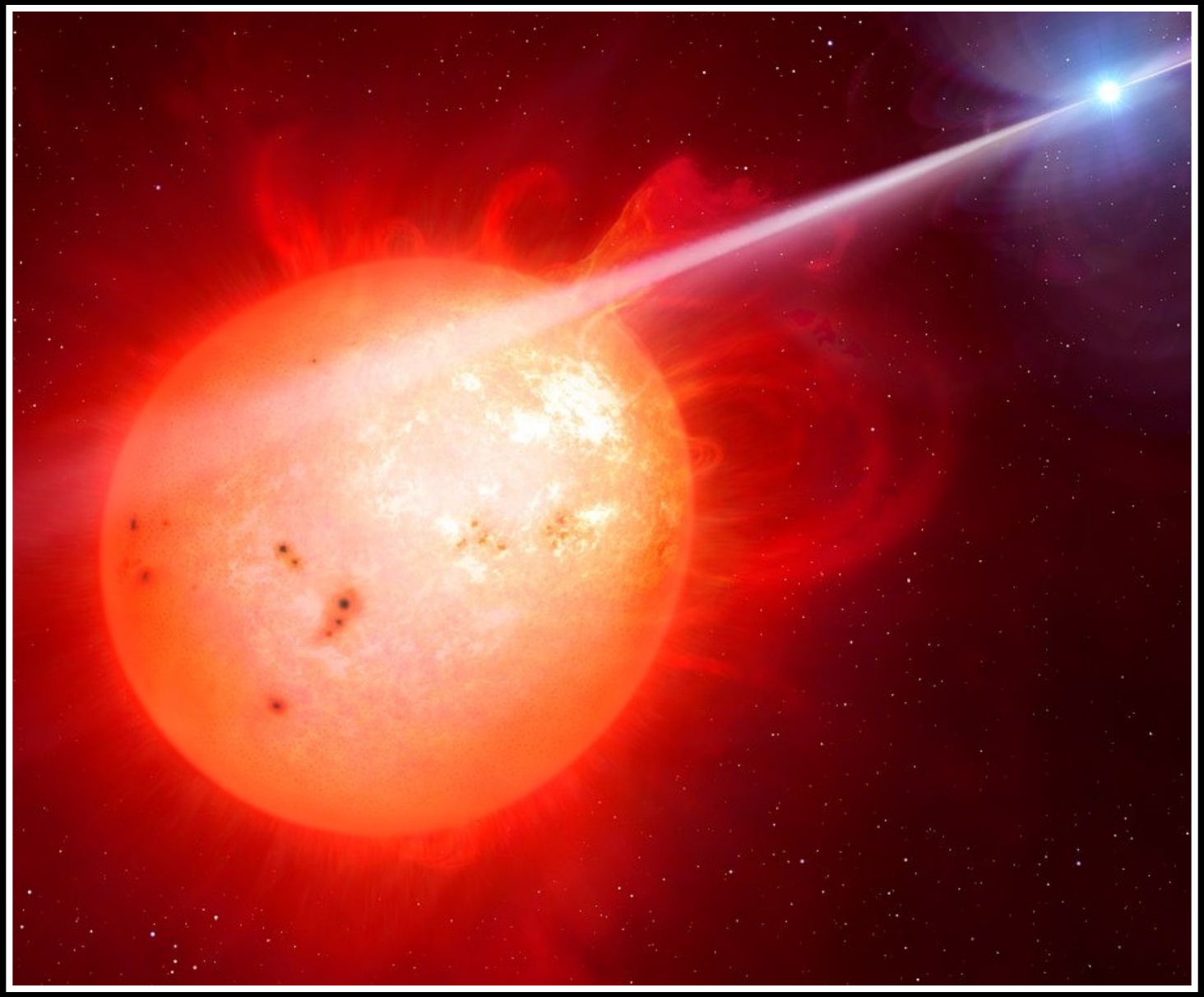


Stars: U Antliae – Carbon Star

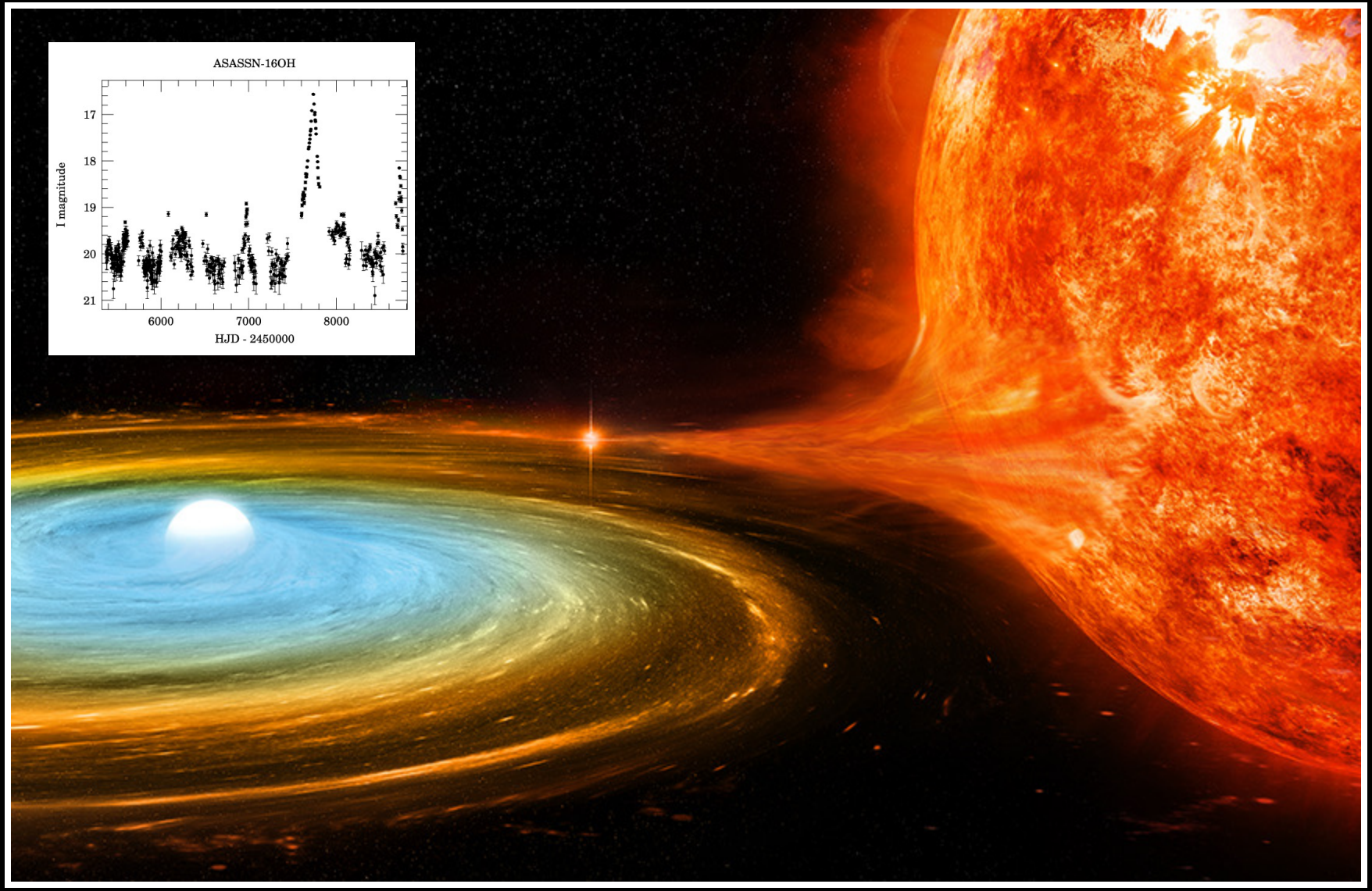


Stars: Alpha Tauri (Aldebaran) – Red Giant

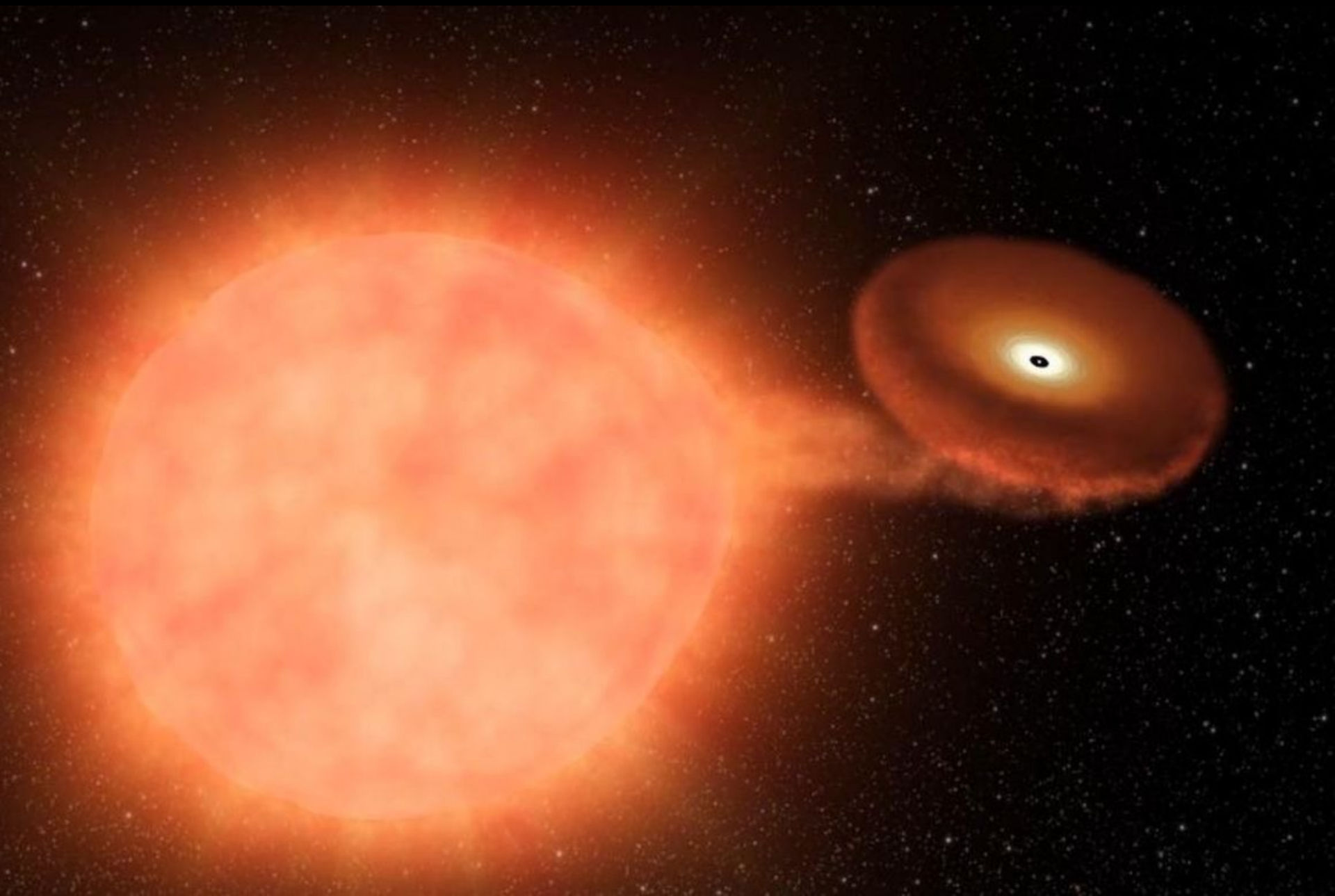
Binary Systems & Novas: AR Scorpii – White Dwarf/Red Dwarf



Binary Systems & Novas: ASASSN 16-oh – accreting White Dwarf



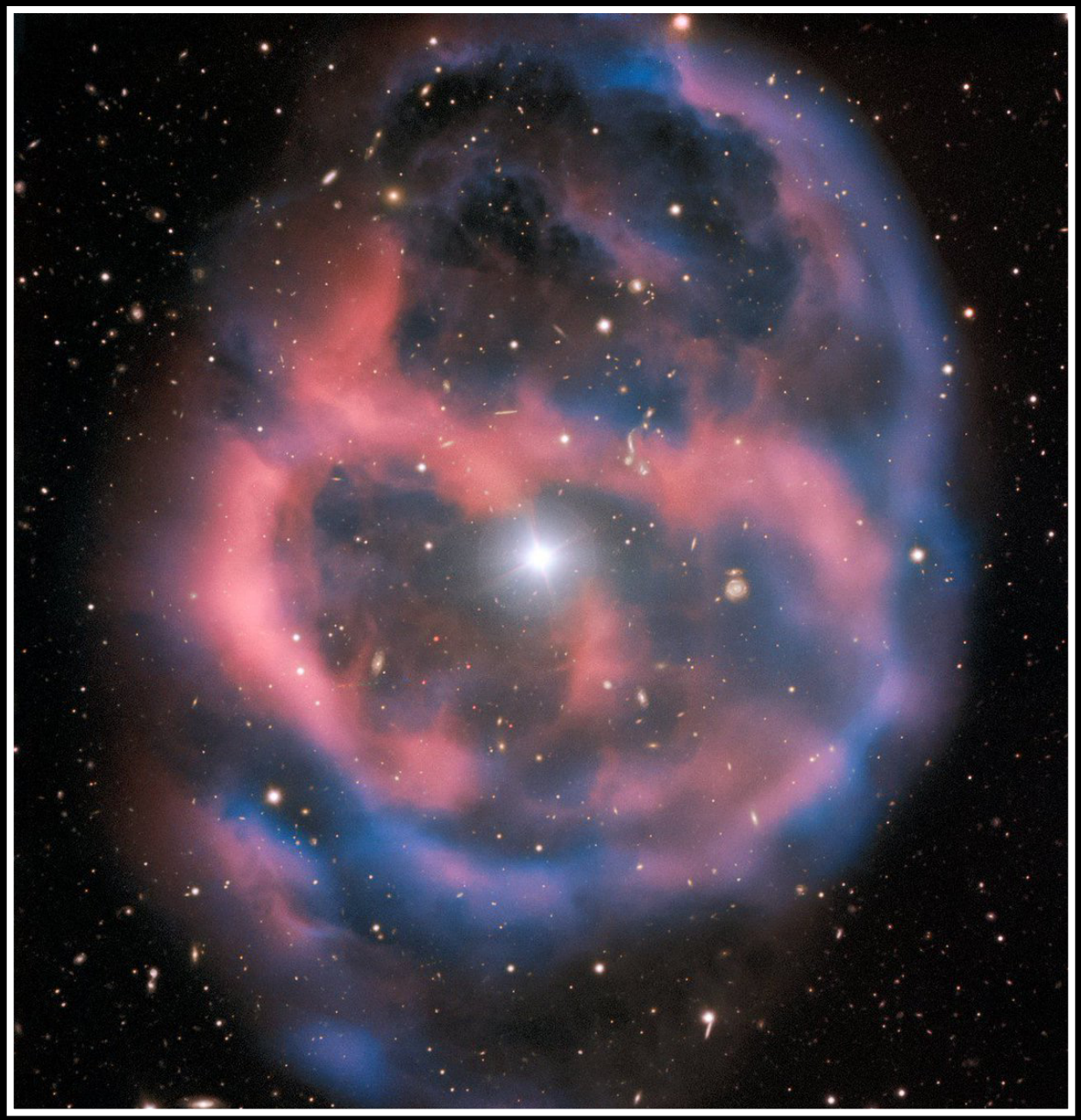
Binary Systems & Novas: V Sagittae – Star/White Dwarf



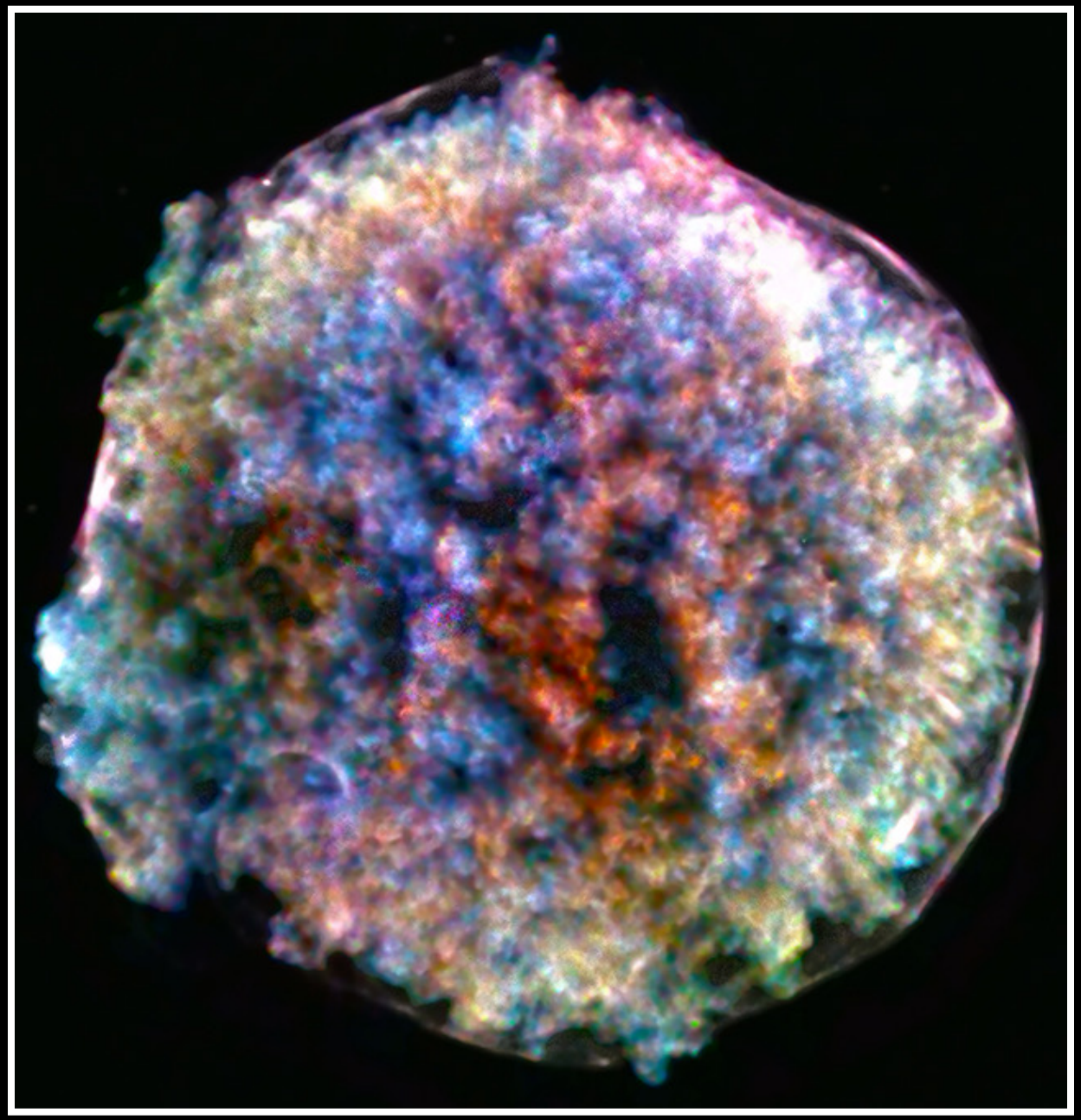
Binary Systems & Novas: SDSS 1035+0551 – Brown Dwarf/White Dwarf

SNR Remnants & Stellar Cores: DEM L71 – Type Ia SNR

SNR Remnants & Stellar Cores: ESO 577-24 – Planetary Nebula

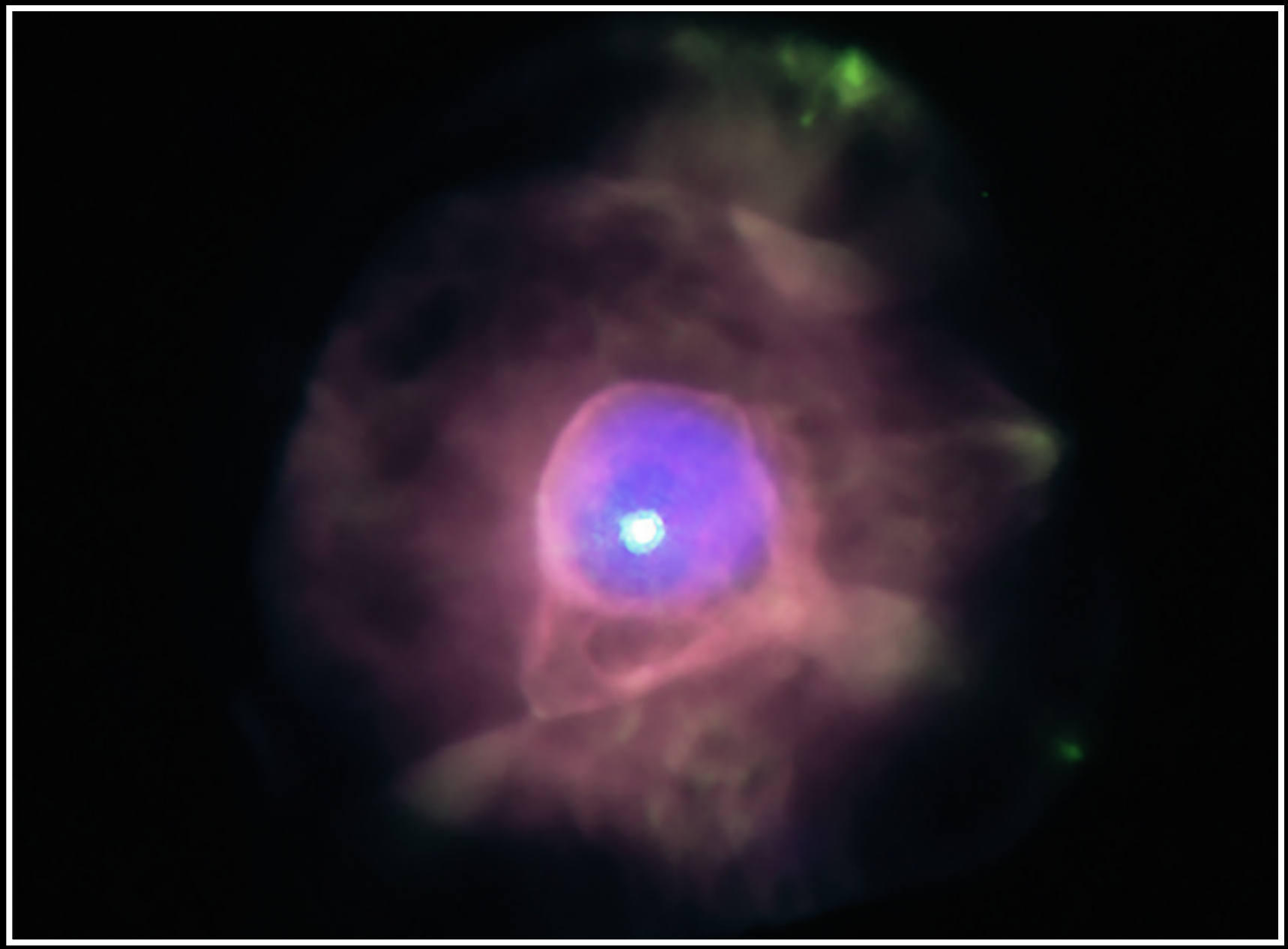


SNR Remnants & Stellar Cores: Tycho's SNR – Type Ia SNR



SNR Remnants & Stellar Cores: LP 40-365 – White Dwarf

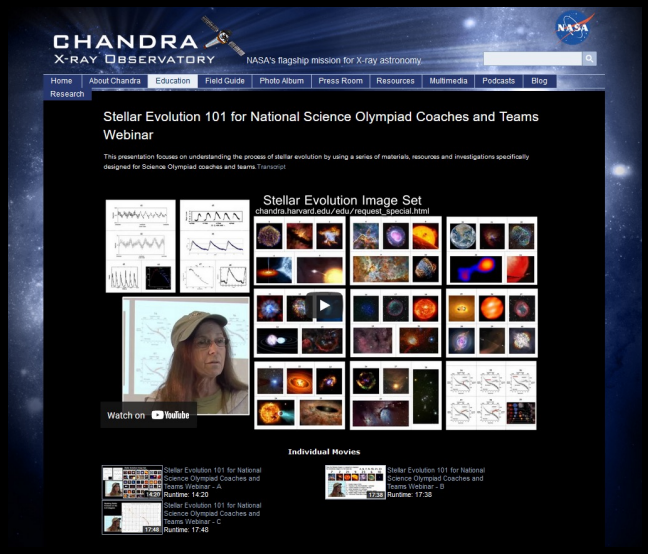
SNR Remnants & Stellar Cores: IC 4593 – Planetary Nebula

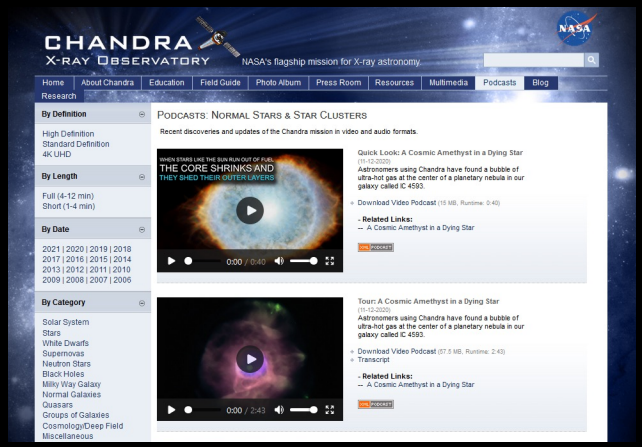


Chandra X-Ray Resources

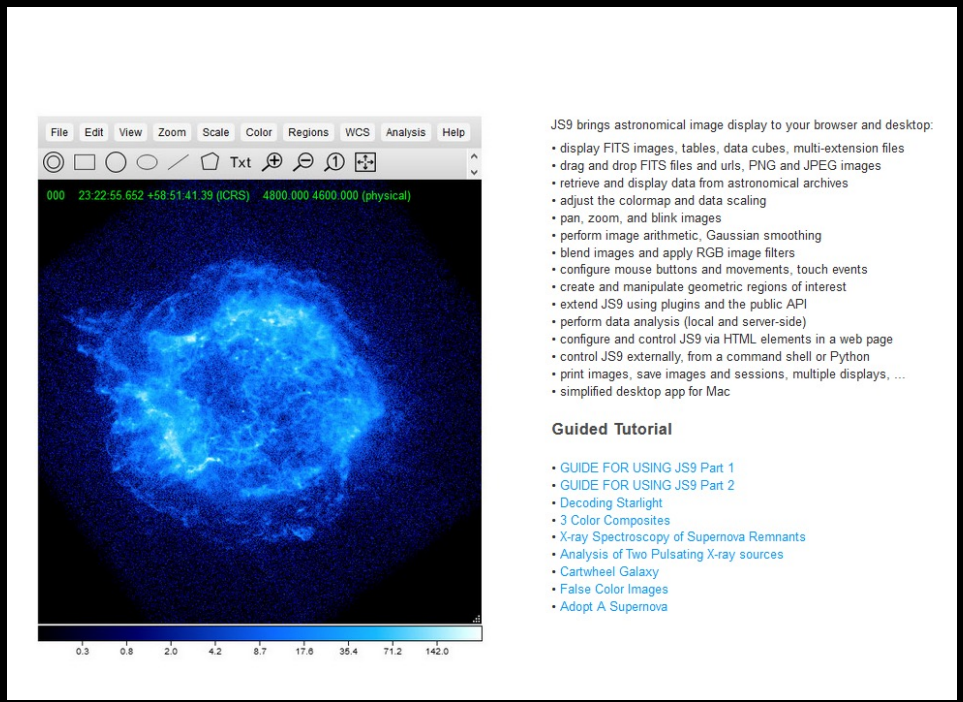
https://chandra.si.edu/edu/olympiad.html

Content webinars and presentations from SO Alumni & NASA astrophysicists will be posted during the next several months as they are developed.



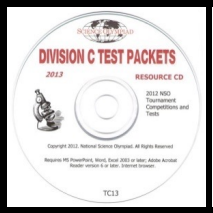


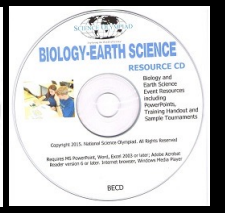
https://chandra.si.edu/js9/

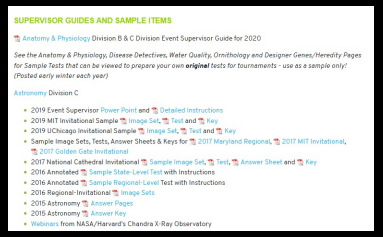


Other Resources

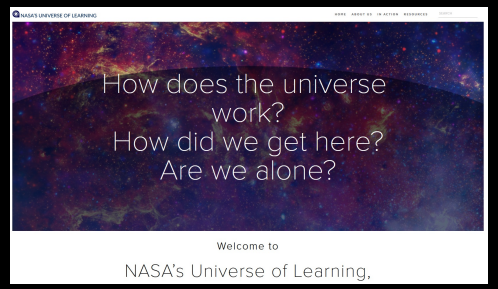
http://soinc.org





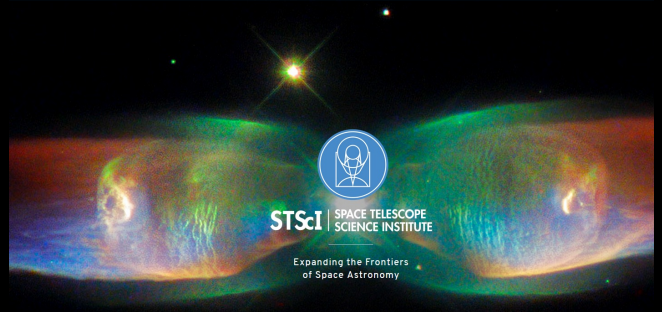


https://www.universe-of-learning.org/

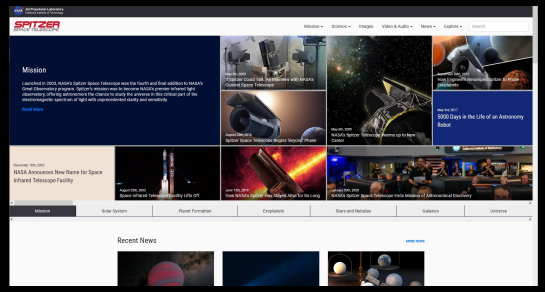


https://chandra.si.edu

http://www.stsci.edu

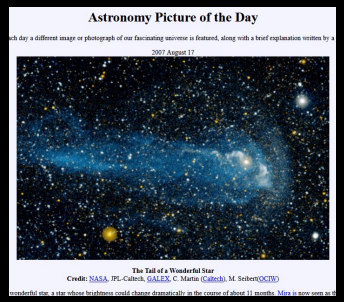


http://www.spitzer.caltech.edu/



https://public.nrao.edu/telescopes/

https://apod.nasa.gov/apod/astropix.html



Resources across the EM spectrum

National Science Olympiad	http://www.soinc.org
Chandra (x-ray)	http://chandra.harvard.edu/
Hubble (visible)	http://stsci.edu/hst/
Spitzer (infrared)	http://www.spitzer.caltech.edu/
Fermi (gamma-ray)	https://fermi.gsfc.nasa.gov/
Swift (x-ray/UV)	https://swift.gsfc.nasa.gov/
Nat'l Radio Astronomy Observatory	https://public.nrao.edu/
Astronomy Picture of the Day	http://apod.nasa.gov/astropix.html

Event Information

National Event Supervisors:

Donna L. Young (dlyoung.nso@gmail.com)

Tad Komacek (tkomacek@gmail.com)

Rules Clarifications available at soinc.org under Event Information

1.Read the Event Description for content and allowable resources.

2.Use the webinar (Chandra) and/or powerpoint (NSO) for an overview of the content topics and deep sky objects.

3.Use the Astronomy Coaches Manual (NSO) as a guide for background information.

Event Information

4. Use the resources listed in the event description for images and content.
5. Youtube has many related videos.
6. Invitationals.
7. Tests from invitationals and sample state tests will be posted on the NSO website for teams to use for practice.
8. The scioly.org test exchange (https://scioly.org/wiki/index.php/2019_Test_Exchange).
9. ASTRO 101 introductory college courses.
10. Scientific papers. Most useful parts: abstract, introduction, figures. Don’t worry if you don’t understand everything!