

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/>

The screenshot shows the 'Astrophysics' section of the NASA Science website. At the top, there's a navigation bar with links for Home, Big Questions, Earth, Heliphysics, Planets, Astrophysics, Missions, Technology, and Science News. Below the navigation is a banner for 'NASA SCIENCE ...for the benefit of all.' with a photo of a scientist. Under the banner, there are links for NAC Science Committee, NASA Science for ..., NASA Celebrates ..., and About Us. The main content area features a large image of the Monkey Head Nebula with a caption: 'Nebula: Hubble Looks at the Monkey Head Nebula (NGC 2174). This colorful Hubble mosaic of a small portion of the Monkey Head Nebula unveils a collection of carved knots of gas and dust silhouetted against glowing gas.' Below this is a list of topics: Planets Around Other Stars, The Big Bang, Dark Energy, Dark Matter, Stars, Galaxies, and Black Holes. At the bottom, there are four small thumbnail images: Earth, Heliphysics, Planets, and Astrophysics, with arrows for navigation.

The screenshot shows the homepage of the NASA Universe of Learning. The header includes links for HOME, ABOUT US, IN ACTION, RESOURCES, and SEARCH. The main visual is a vibrant, colorful nebula. Overlaid on the image is a large, semi-transparent text area containing the questions: 'How does the universe work?', 'How did we get here?', and 'Are we alone?'. Below this, the text 'Welcome to NASA's Universe of Learning,' and 'an integrated astrophysics STEM learning and literacy program.' is displayed. At the very bottom, there is a small fine-print paragraph about the program's mission.

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. DESCRIPTION: 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

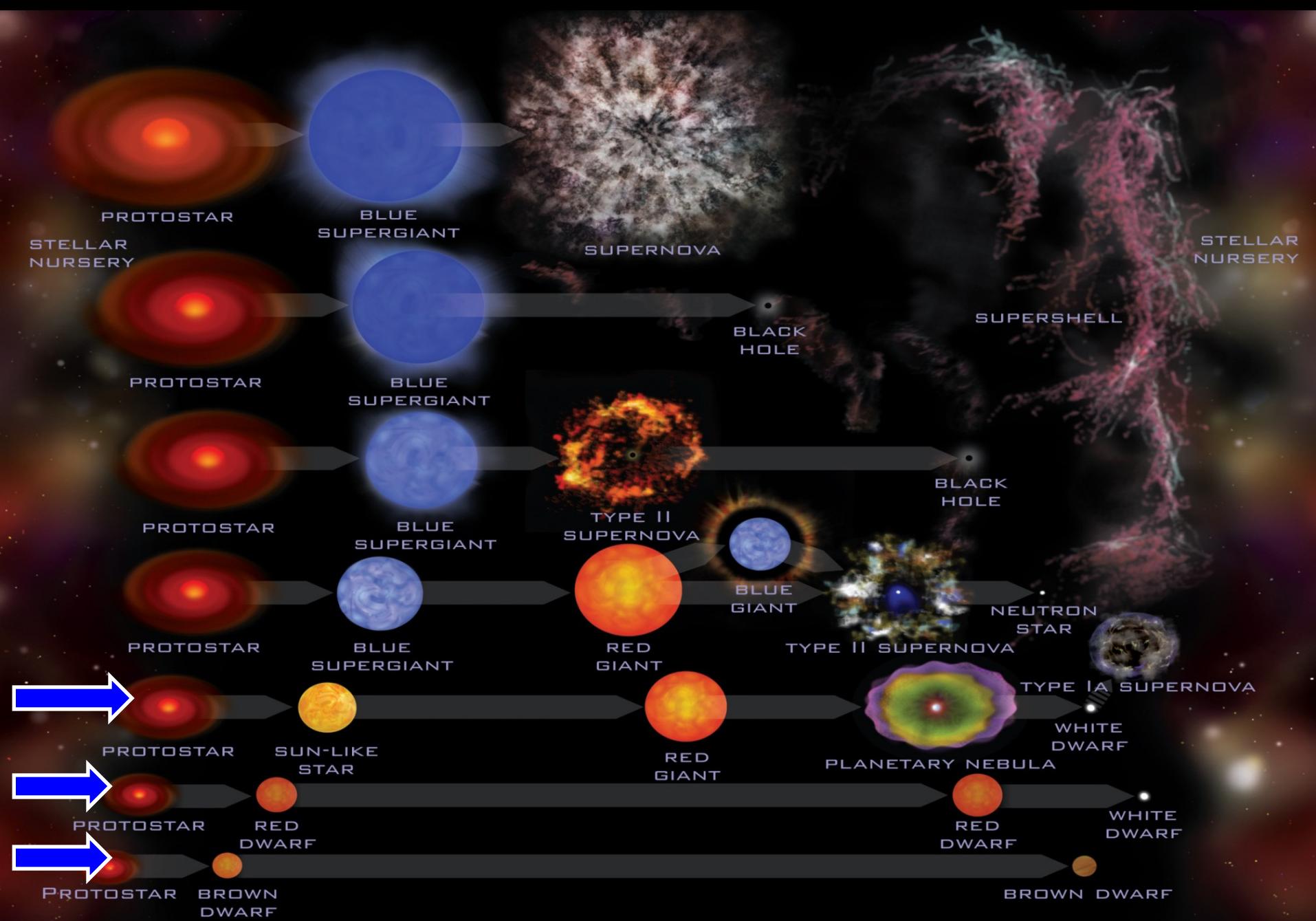
Deep Sky Objects listed above sorted by Type:

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

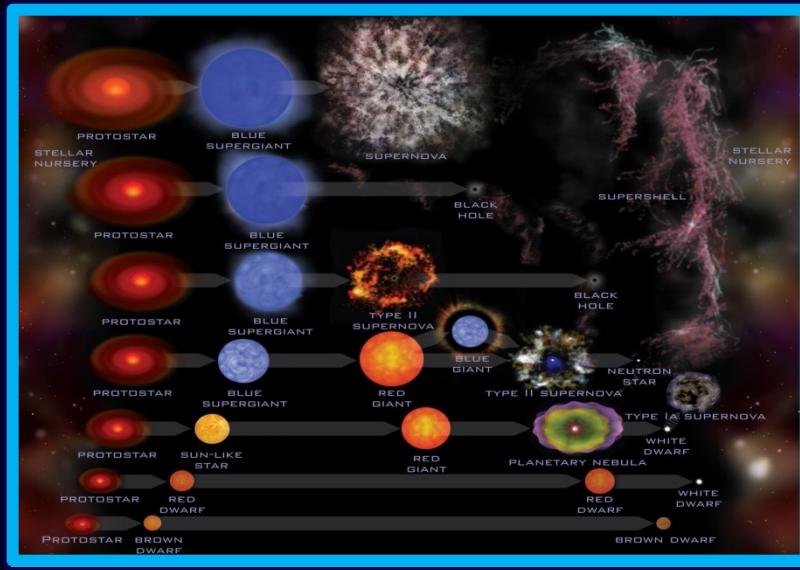
Stars: Mira (Omicron Ceti), RR Lyrae, U Antliae, Alpha Tauri

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



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:

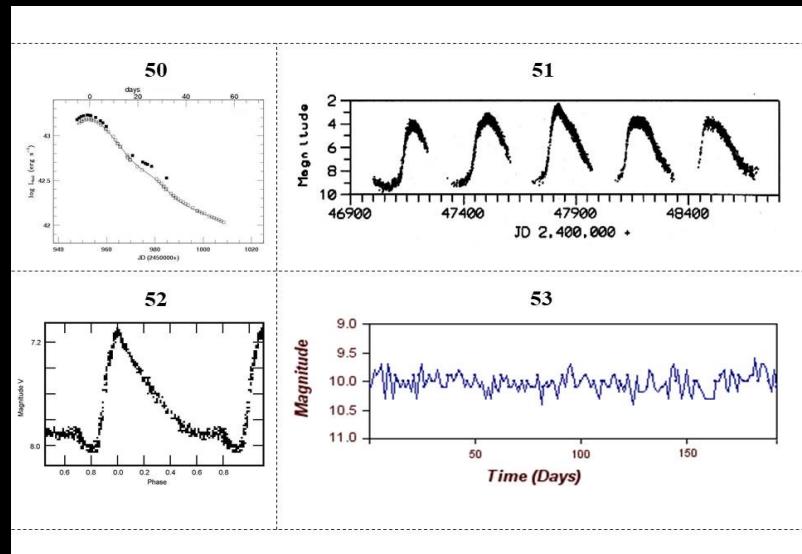
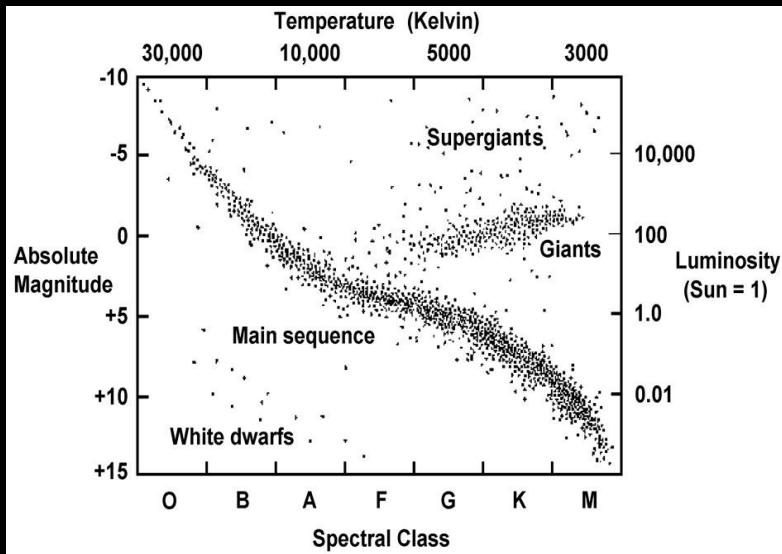
- 1) Mira (Omicron Ceti, red giant)
- 2) RR Lyrae
- 4) U Antliae (carbon star)
- 5) Alpha Tauri (Aldebaran)

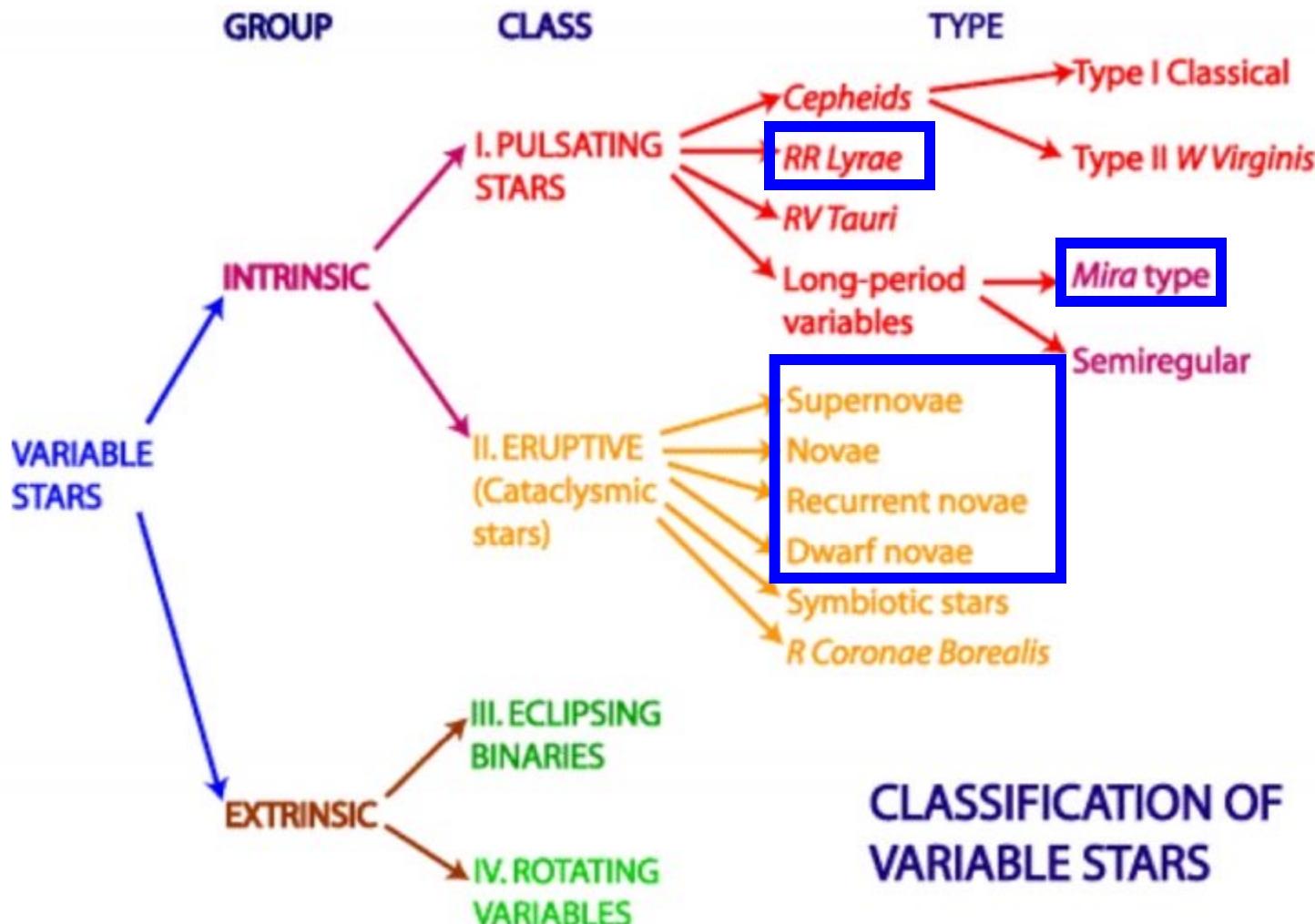
C. Binary Systems, Novas:

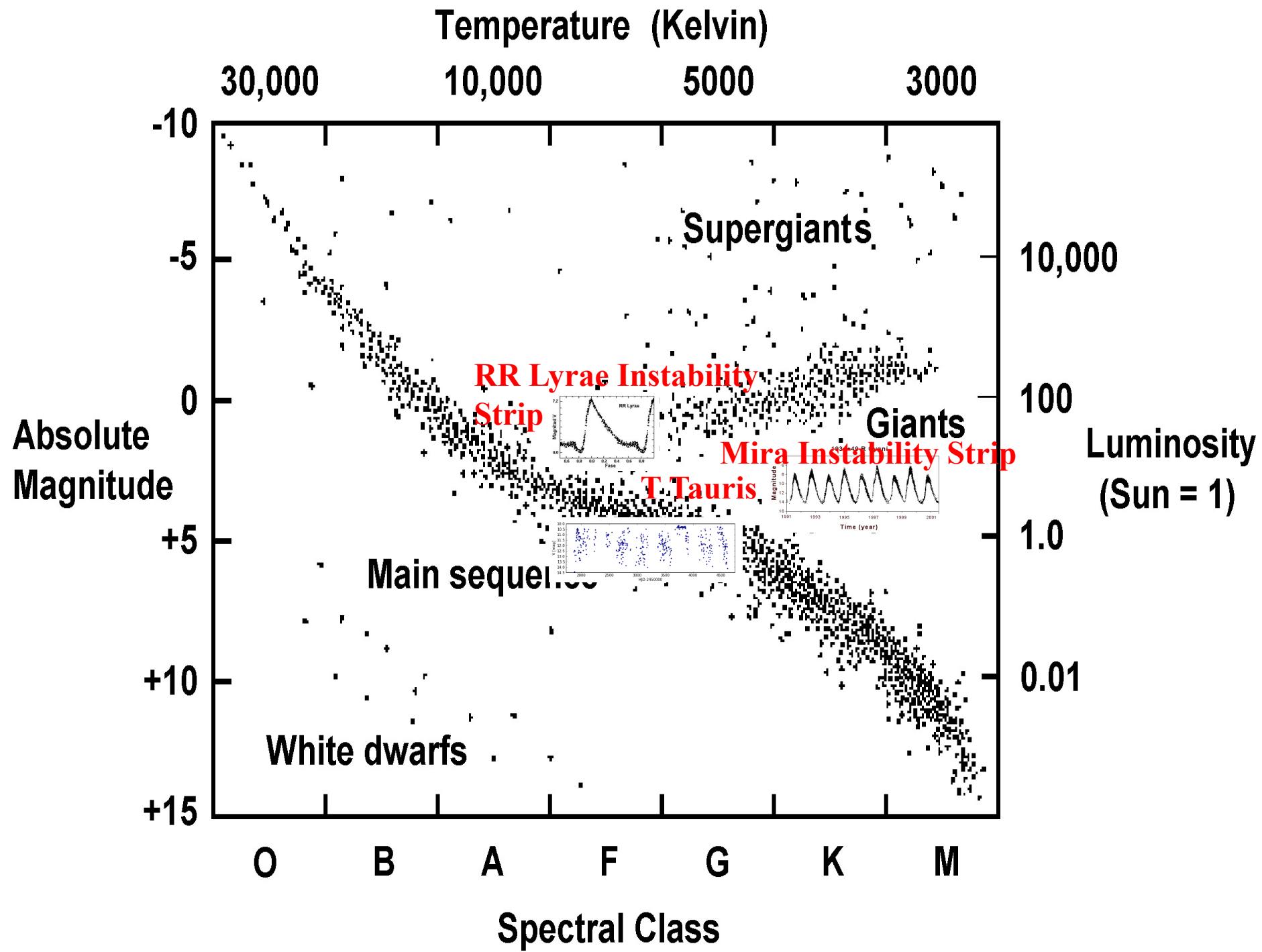
- 1) AR Scorpii (wd/red dwarf)
- 2) ASASSN 16-oh (wd/wd)
- 3) V Sagittae (star/wd)
- 4) SDSS 1035+0551 (brown dwarf/wd)

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)

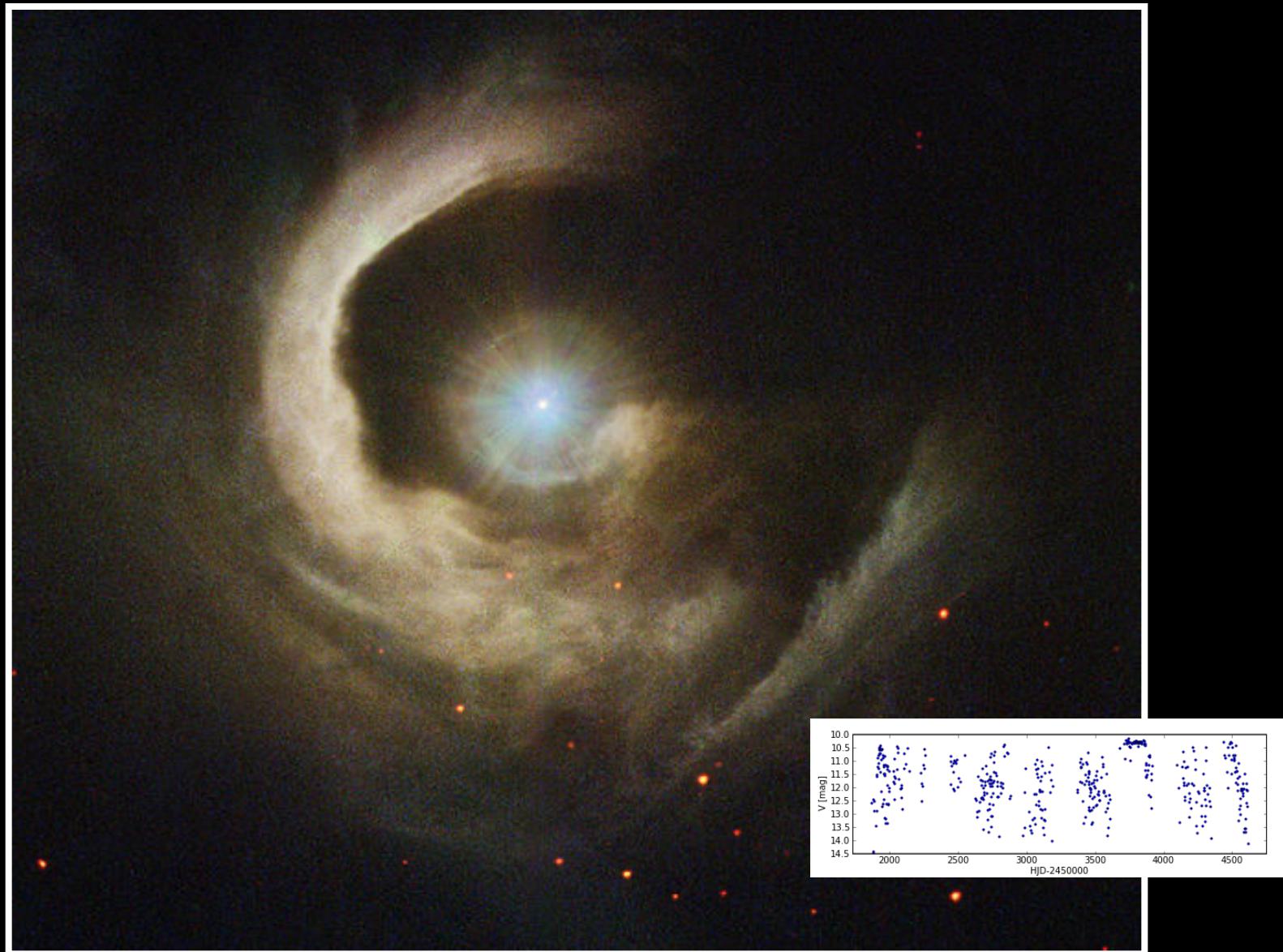




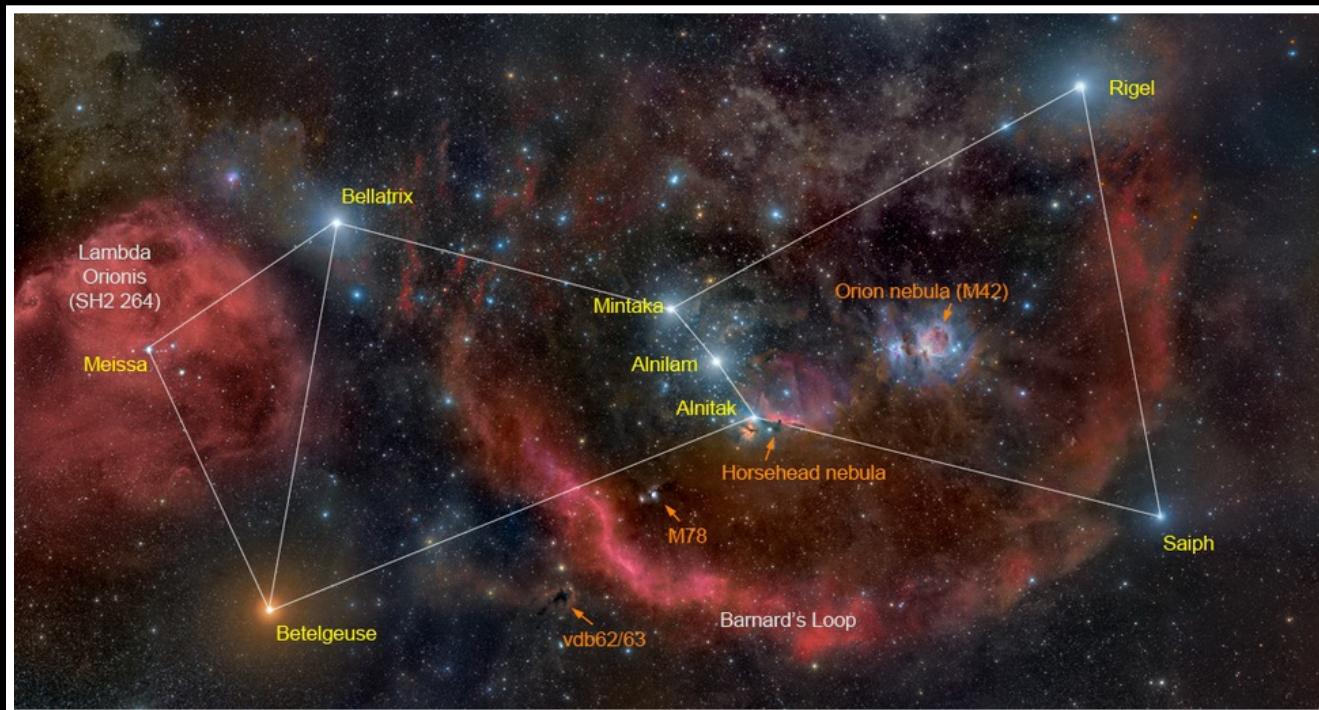


Protostars & Star Formation Regions: V 1331 Cyg - T Tauri

A young T Tauri star surrounded by a reflection nebula



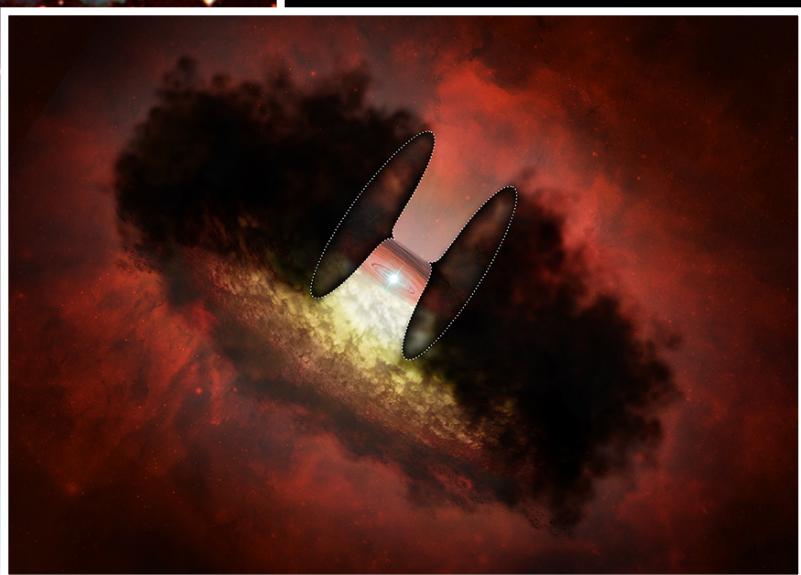
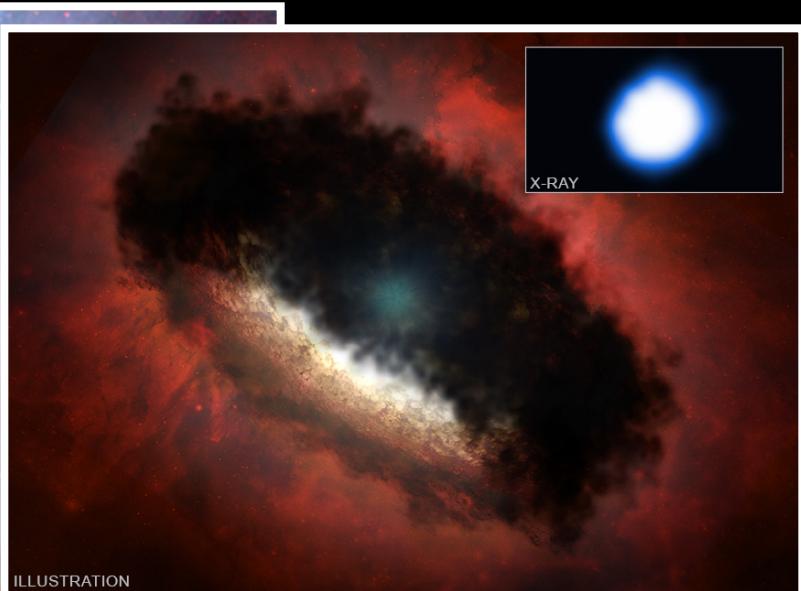
Protostars & Star Formation Regions: Orion Nebula



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



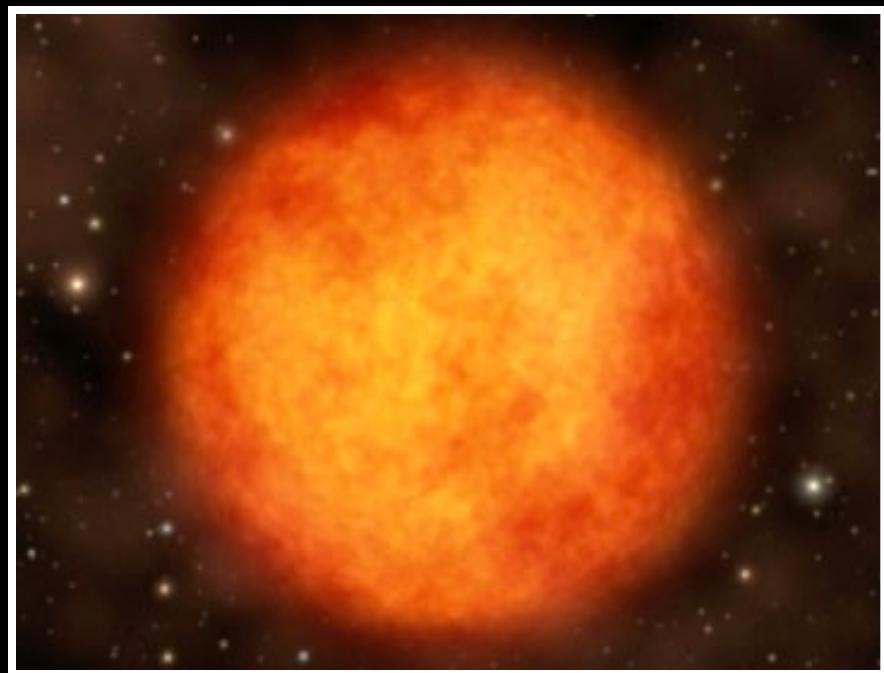
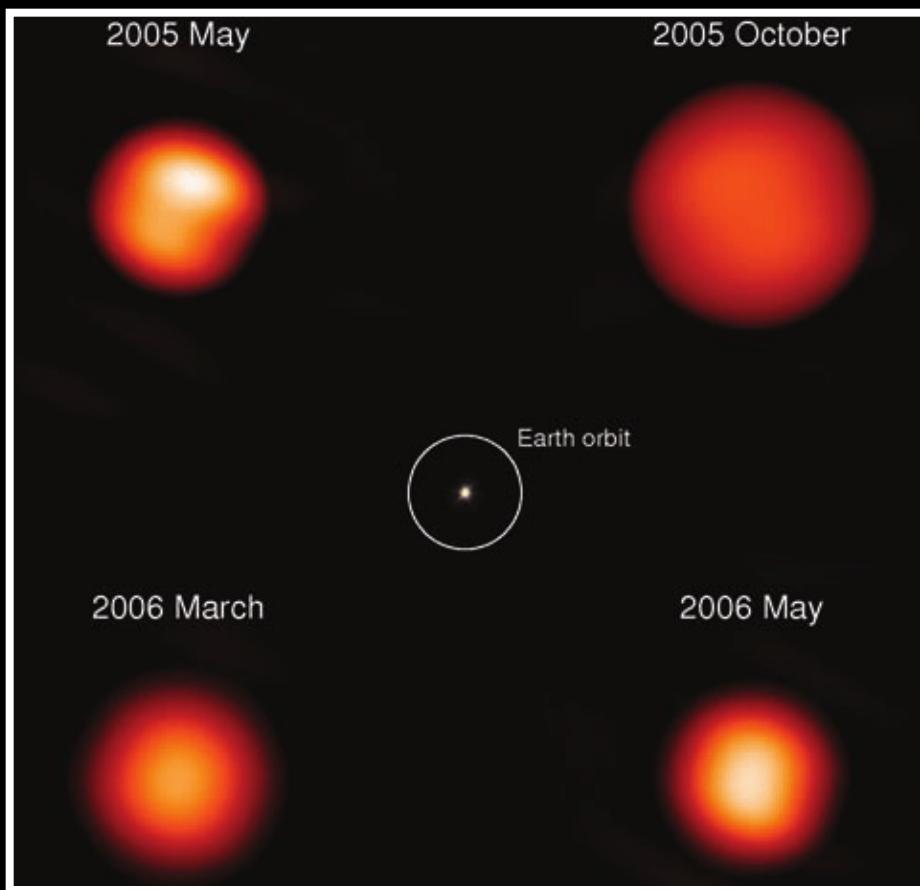
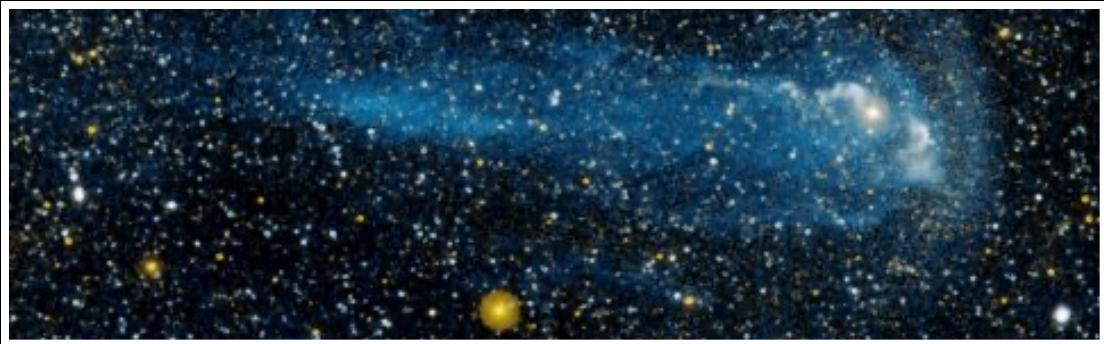
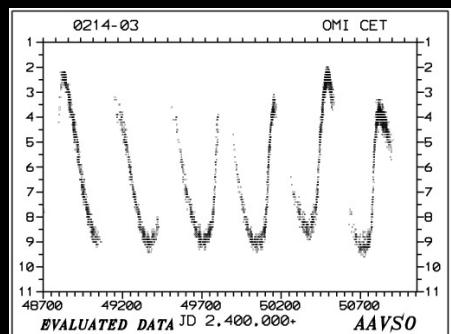
Protostars & Star Formation Regions: HOPS 383 - protostar



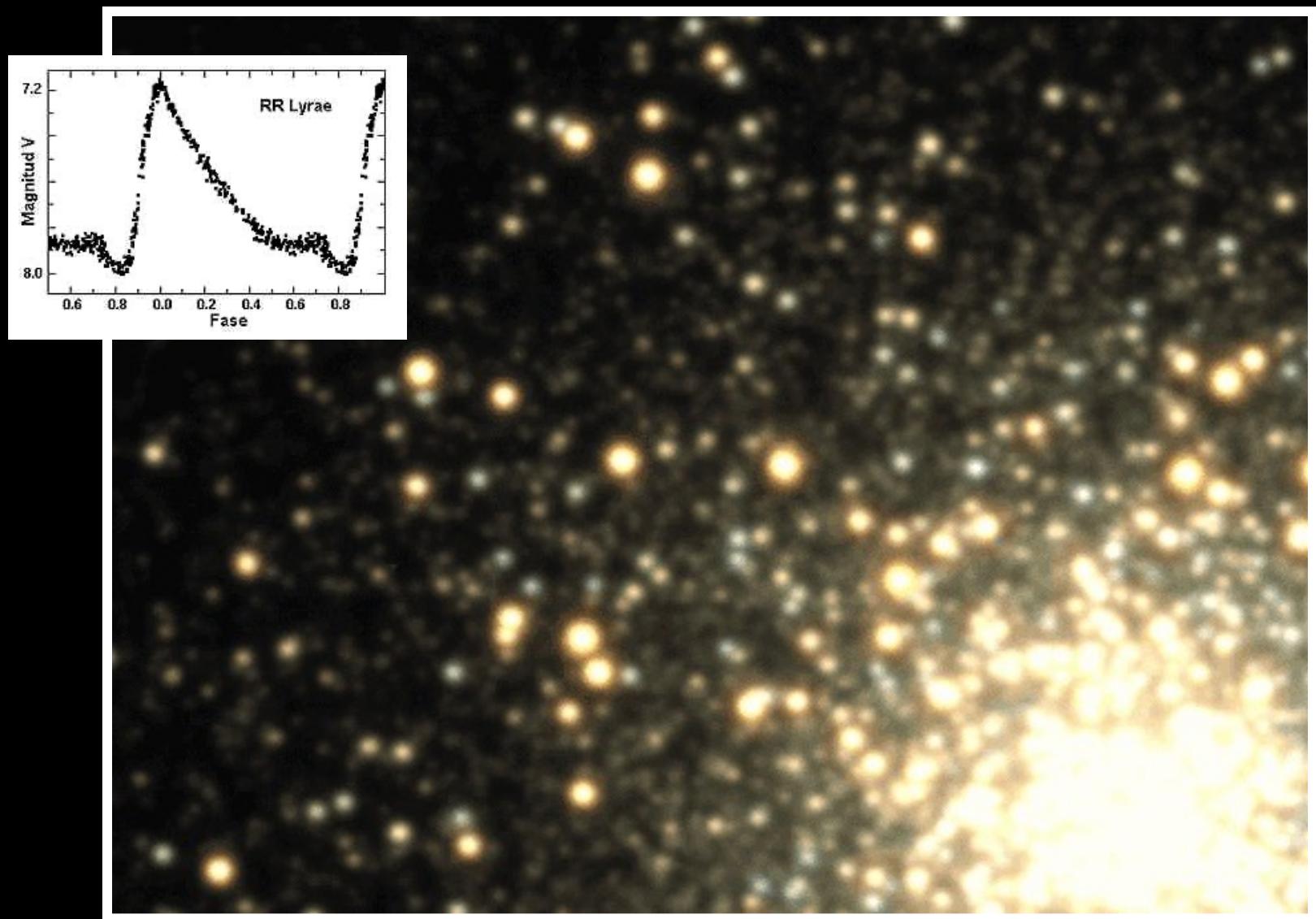
Protostars & Star Formation Regions: HBC 672 – Serpens nebula



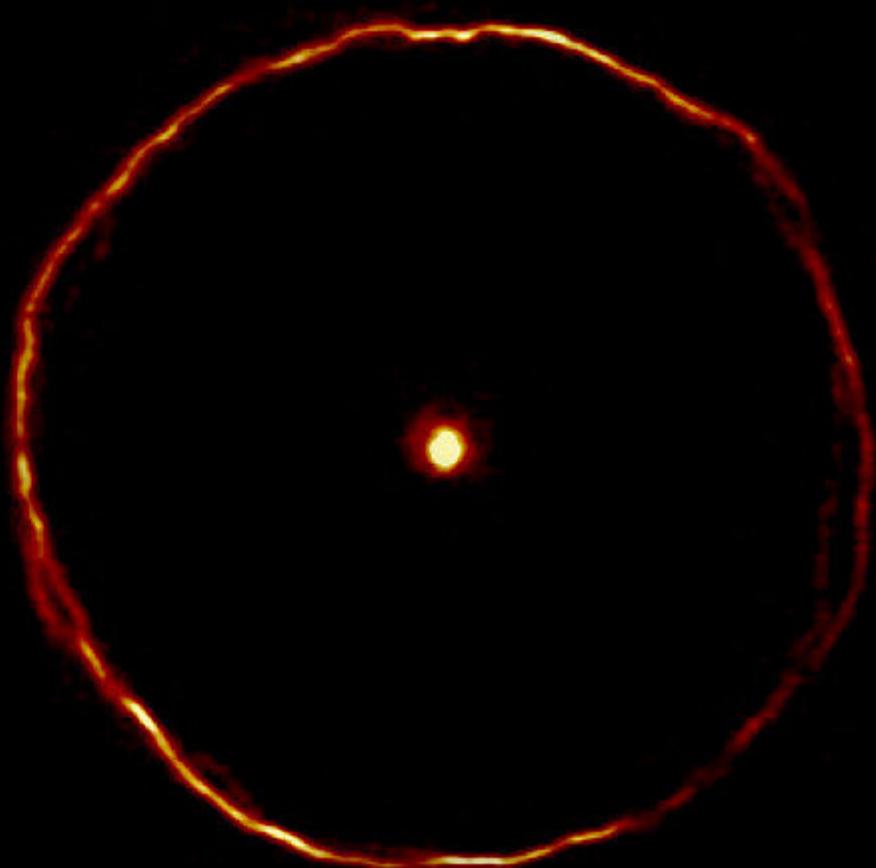
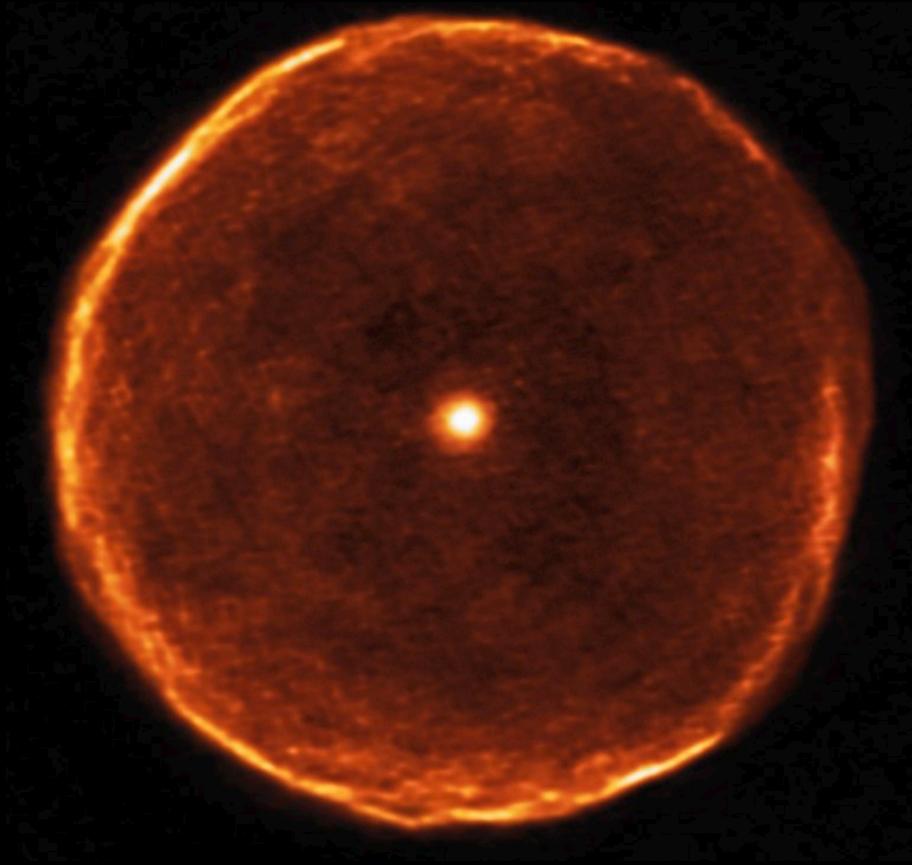
Stars: Mira – Omicron Ceti



Stars: RR Lyrae



Stars: U Antliae – Carbon Star

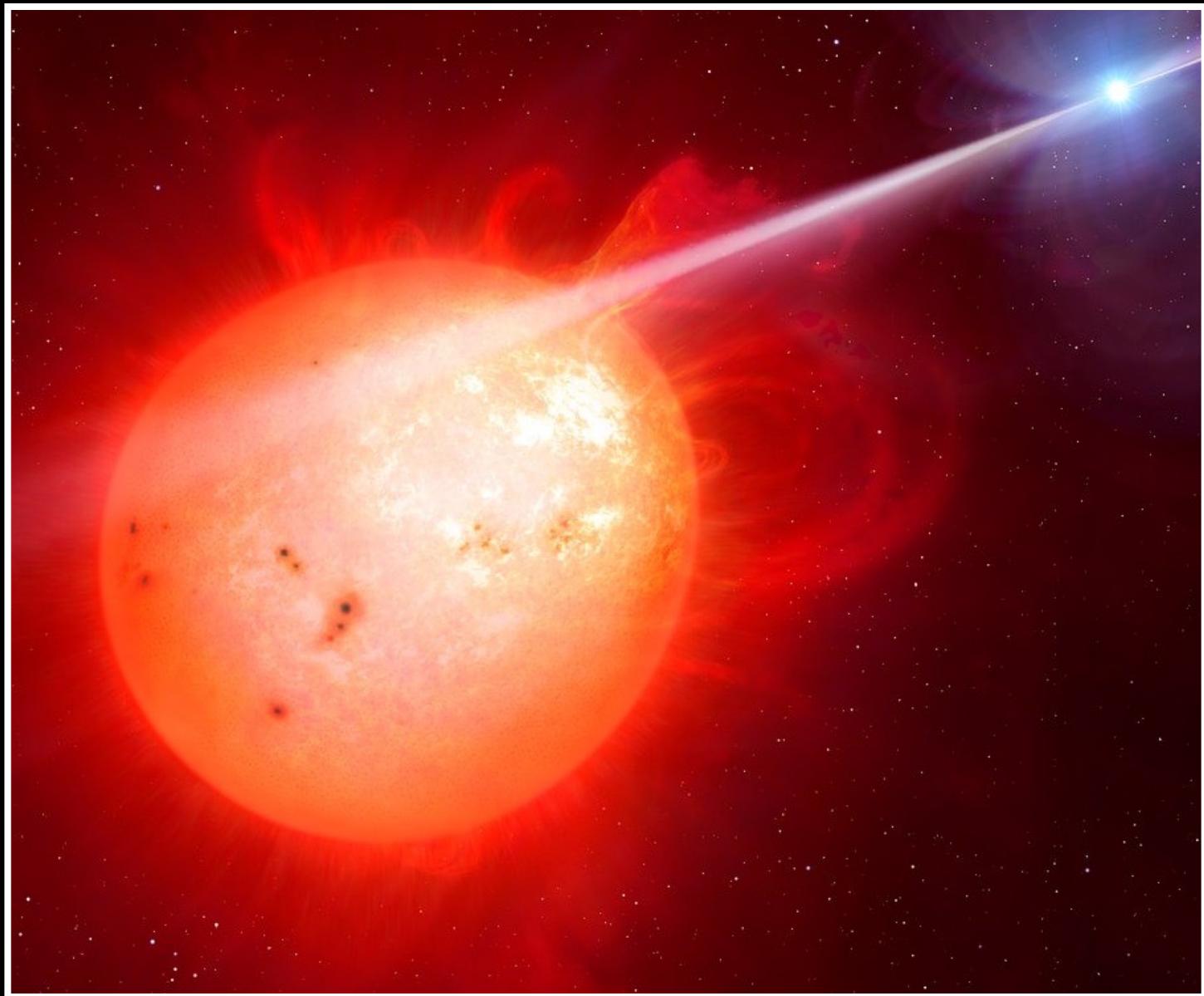


Stars: Alpha Tauri (Aldebaran) – Red Giant

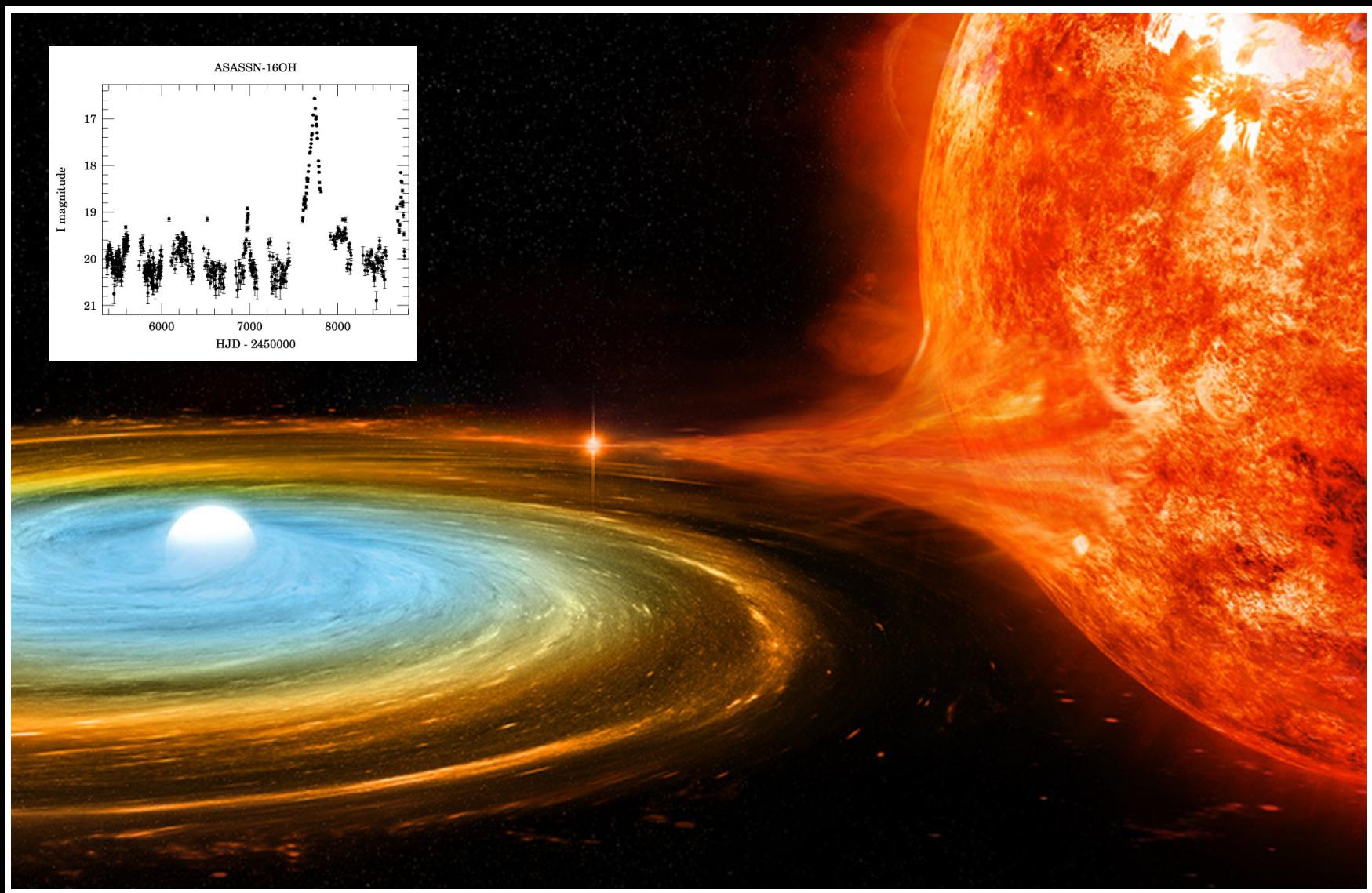


Jose Mianous

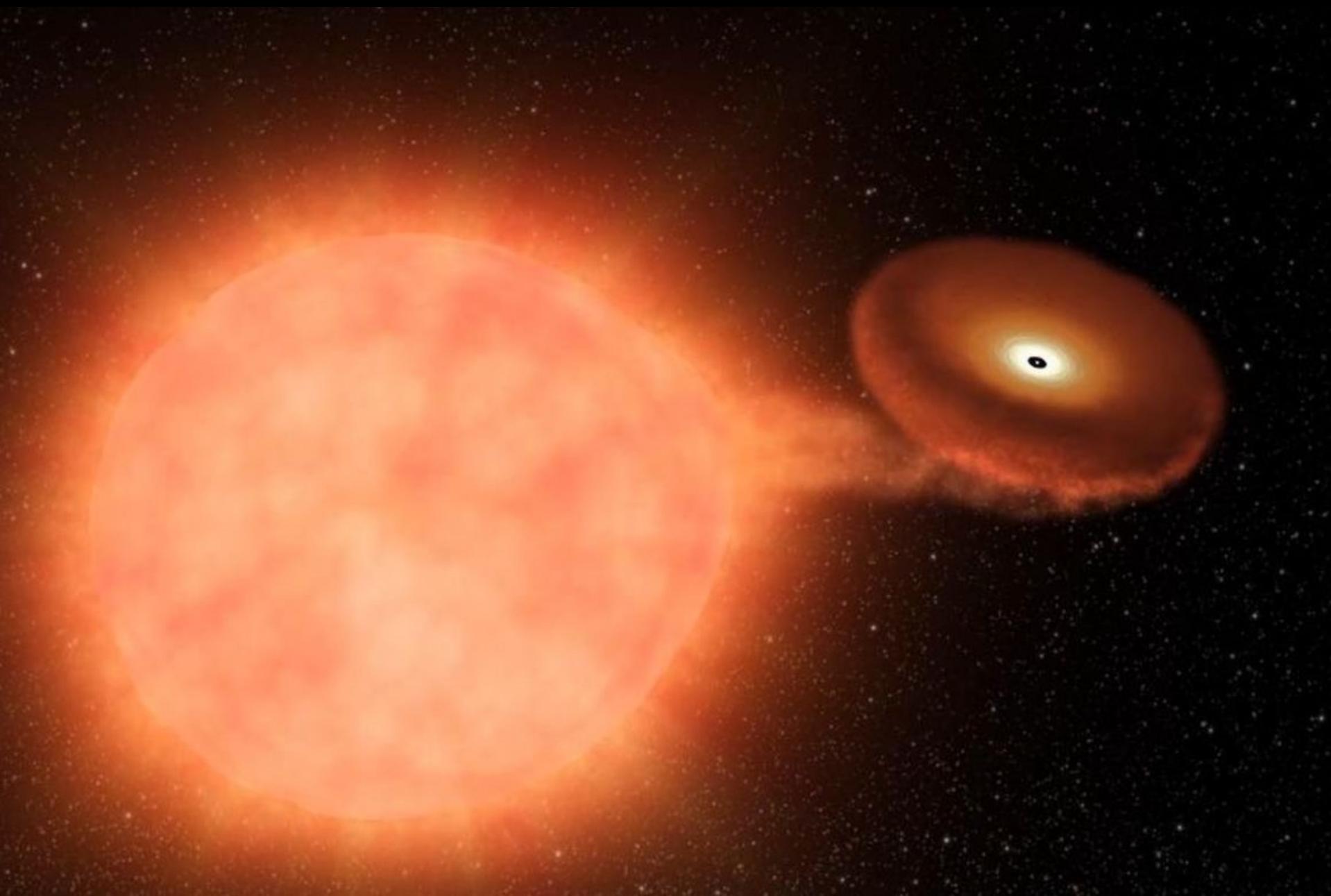
Binary Systems & Novas: AR Scorpii – White Dwarf/Red Dwarf



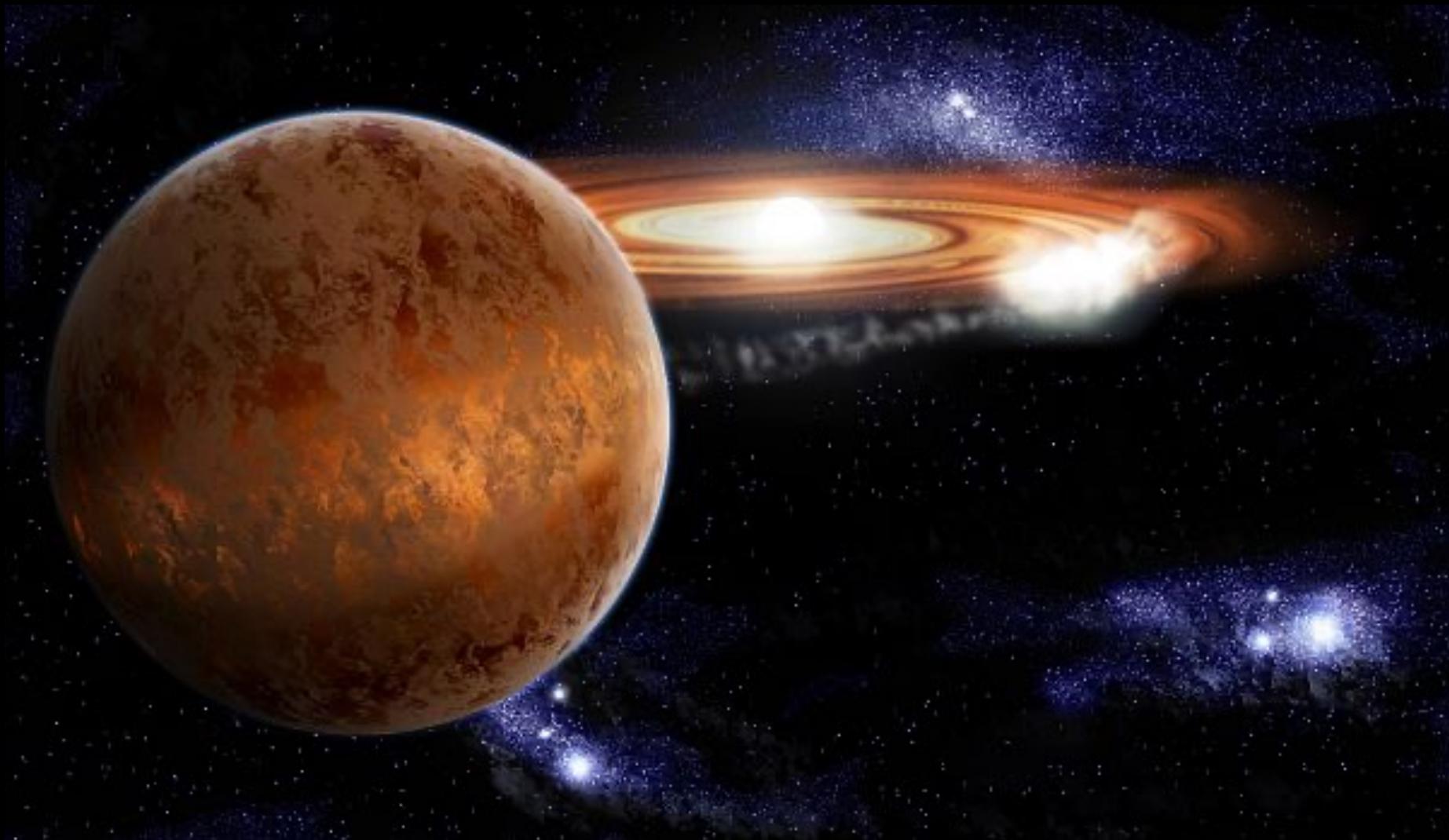
Binary Systems & Novas: ASASSN 16-oh – accreting White Dwarf



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



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



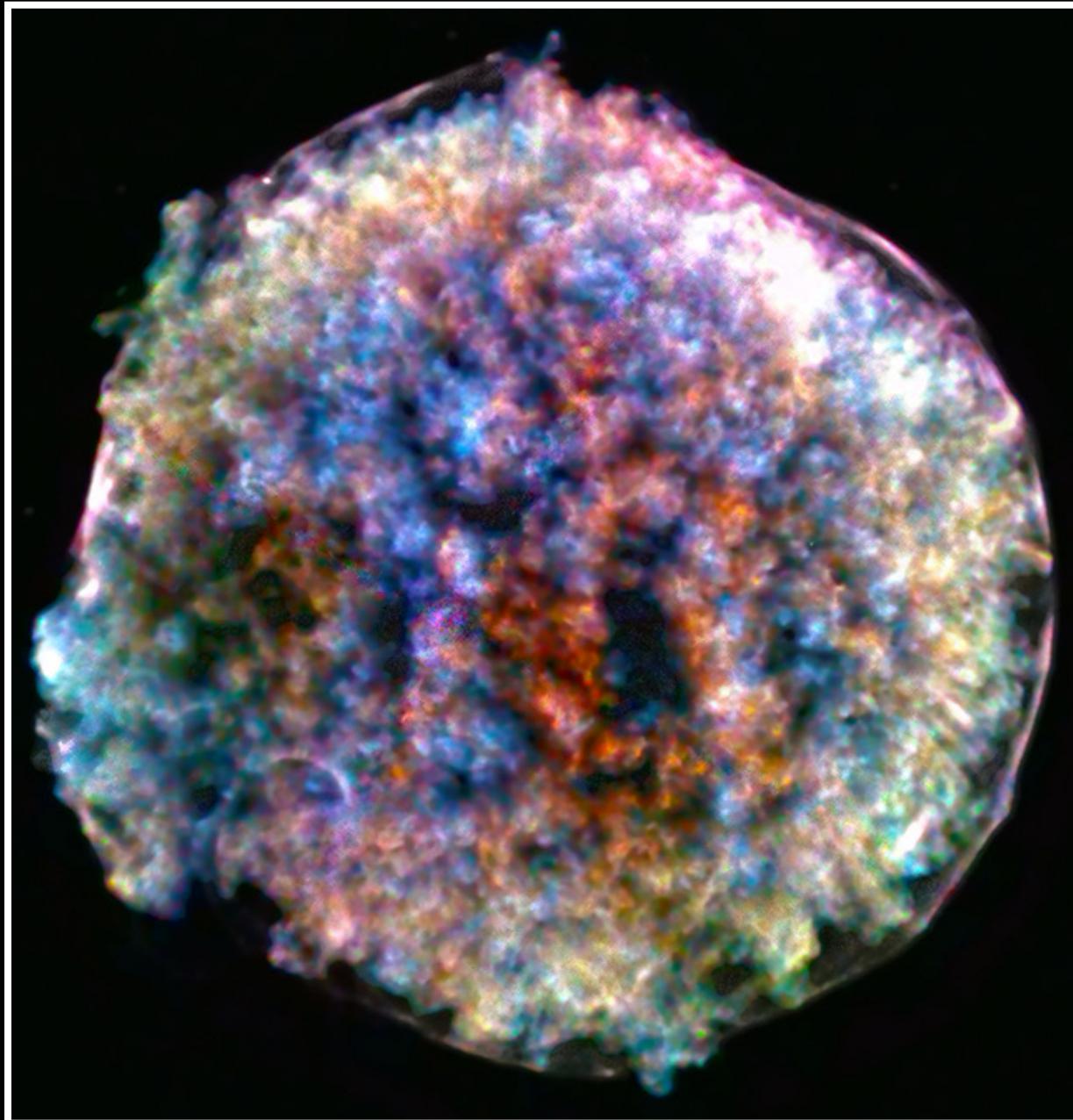
SNR Remnants & Stellar Cores: DEM L71 – Type Ia SNR



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



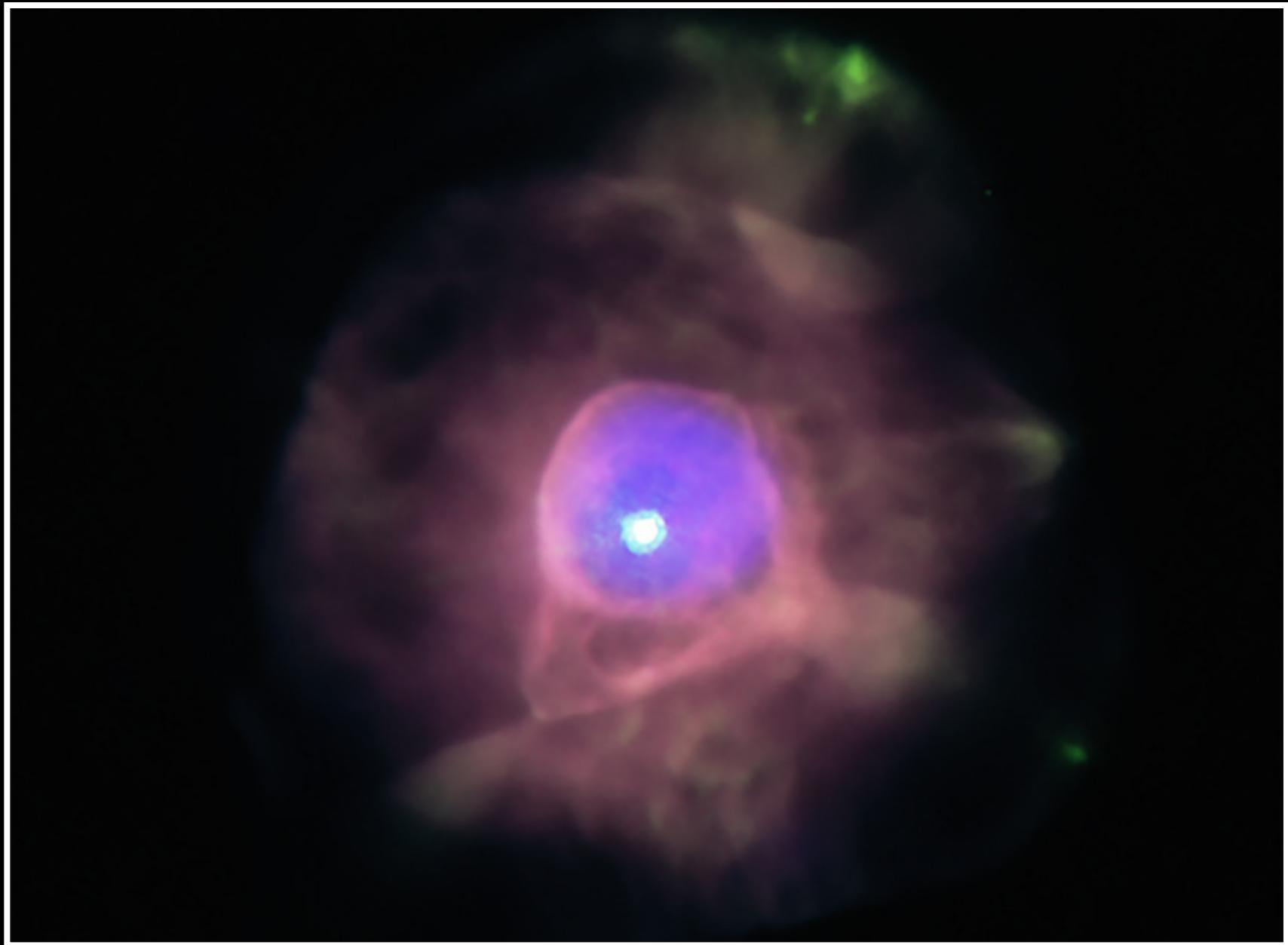
SNR Remnants & Stellar Cores: Tycho's SNR – Type Ia SNR



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.

The screenshot shows the Chandra X-Ray Observatory website. The main header features the Chandra logo and the text "NASA's flagship mission for X-ray astronomy". Below the header, there are links for Home, About Chandra, Education, Field Guide, Photo Album, Press Room, Resources, Multimedia, Podcasts, and Blog. A "Research" link is also present. The main content area is titled "Stellar Evolution 101 for National Science Olympiad Coaches and Teams Webinar". It includes a brief description of the webinar's focus on stellar evolution, a thumbnail image of a woman speaking, and a grid of astronomical images. Below this, there are sections for "Individual Movies" and "Webinars". The bottom part of the screenshot shows another section of the website with a search bar and filters for "By Definition", "By Length", and "By Date". It displays a video player for a podcast titled "PODCASTS: NORMAL STARS & STAR CLUSTERS".

The screenshot shows the JS9 application interface. The top menu bar includes File, Edit, View, Zoom, Scale, Color, Regions, WCS, Analysis, and Help. The main window displays a blue nebula against a dark background, with various astronomical data overlays. At the top of the main window, there is text: "000 23:22:55.652 +58:51:41.39 (ICRS) 4800.000 4600.000 (physical)". Below the image, there is a color bar ranging from 0.3 to 142.0. To the left of the main window, there is a sidebar with a list of features: "JS9 brings astronomical image display to your browser and desktop: display FITS images, tables, data cubes, multi-extension files; drag and drop FITS files and urls, PNG and JPEG images; retrieve and display data from astronomical archives; adjust the colormap and data scaling; pan, zoom, and blink images; perform image arithmetic, Gaussian smoothing; blend images and apply RGB image filters; configure mouse buttons and movements, touch events; create and manipulate geometric regions of interest; extend JS9 using plugins and the public API; perform data analysis (local and server-side); configure and control JS9 via HTML elements in a web page; control JS9 externally, from a command shell or Python; print images, save images and sessions, multiple displays, ... simplified desktop app for Mac".

Guided Tutorial

- GUIDE FOR USING JS9 Part 1
- GUIDE FOR USING JS9 Part 2
- Decoding Starlight
- 3 Color Composites
- X-ray Spectroscopy of Supernova Remnants
- Analysis of Two Pulsating X-ray sources
- Cartwheel Galaxy
- False Color Images
- Adopt A Supernova

Other Resources

<http://soinc.org>



SUPERVISOR GUIDES AND SAMPLE ITEMS

See the Anatomy & Physiology, Disease Detectives, Water Quality, Ornithology and Designer Genes/Heredity Pages for Sample Tests that can be used to prepare your own original tests for tournaments - use as a sample only! (Posted early winter each year)

Astronomy C

- 2019 Event Overview Power Point and [Detailed Instructions](#)
- 2019 MIT Invitational Sample [Image Set](#), [Instructions](#) and [Key](#)
- 2019 UChicago Invitational Sample [Image Set](#), [Test](#) and [Key](#)
- Sample Image Sets, Tests, Answer Sheets & Keys for [2017 Maryland Regional](#), [2017 MIT Invitational](#), [2018 Google Code Invitational](#)
- 2016 National Competition [Sample State-Level Test with Instructions](#)
- 2016 Annotated [Sample Regional-Level Test with Instructions](#)
- 2018 Regional-Invitational [Image Sets](#)
- 2018 National Competition [Image Sets](#)
- 2015 Astronomy [Answer Key](#)
- [Webinars](#) from NASA/Harvard's Chandra X-Ray Observatory

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

How does the universe work?
How did we get here?
Are we alone?

Welcome to
NASA's Universe of Learning,

<https://chandra.si.edu>

CHANDRA X-RAY OBSERVATORY NASA's flagship mission for X-ray astronomy.

Home Research Education Photo Album Press Room Resources Multimedia Products Shop

SPECTACLES The Give and Take of Stellar Flares from the Sun

The largest survey ever of star-forming regions in the sky illustrates the basic processes and conditions they could have on planets in orbit around them.

View Large

Data Sonification: Sounds from Around the Milky Way

By turning Chandra, Hubble, and Spitzer images into sounds, a new project allows users to "listen" to the center of the Milky Way and other objects.

Explore free tools to help you learn and learn more about the universe that all of us inhabit. Please sign up for activities, computer-based learning, and other science resources now! Make the Most of Your Universe.

Learn About Chemistry, Light, Solar Systems, Supernovae, Black Holes

Scientific User Support EIS Science Data Analysis Catalogs Preprocessor



SPITZER

Mission

Launched in 2003, NASA's Spitzer Space Telescope was the fourth and final addition to NASA's Great Observatories program. It has been a key component of the program since its launch, providing unique observations of the universe and helping to answer some of the critical questions about our solar system, stars, galaxies, and the search for life.

Recent News

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

NATIONAL RADIO ASTRONOMY OBSERVATORY

RADIO ASTRONOMY IS Cutting Edge Observations

Arrive at the National Radio Astronomy Observatory to see the most gigantic eyes on the sky with the largest aperture in the world. Our giant radio telescope arrays are the most accurate instruments in the world. The Very Large Array, the most powerful and most precise of them.

Explore the Amazing NRAO Telescopes

Alabama Large Millimeter/submillimeter Array
Very Long Baseline Array
Very Large Array



Copyright © 2013, The University of Arizona. All rights reserved. This image contains simulated data. It is intended solely for educational purposes and is not suitable for scientific, commercial, or artistic reproduction without the express written permission of the University of Arizona. The University of Arizona does not claim any ownership rights in images it has received from NASA. All images used are courtesy of NASA/JPL-Caltech, the California Institute of Technology, and the National Aeronautics and Space Administration.

Image Credit: M. L. Meixner (STScI) & N. Smith (University of Arizona)

Image Credit: M. L. Meixner (STScI) & N. Smith (University of Arizona)

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 scioley.org test exchange
(https://scioley.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!