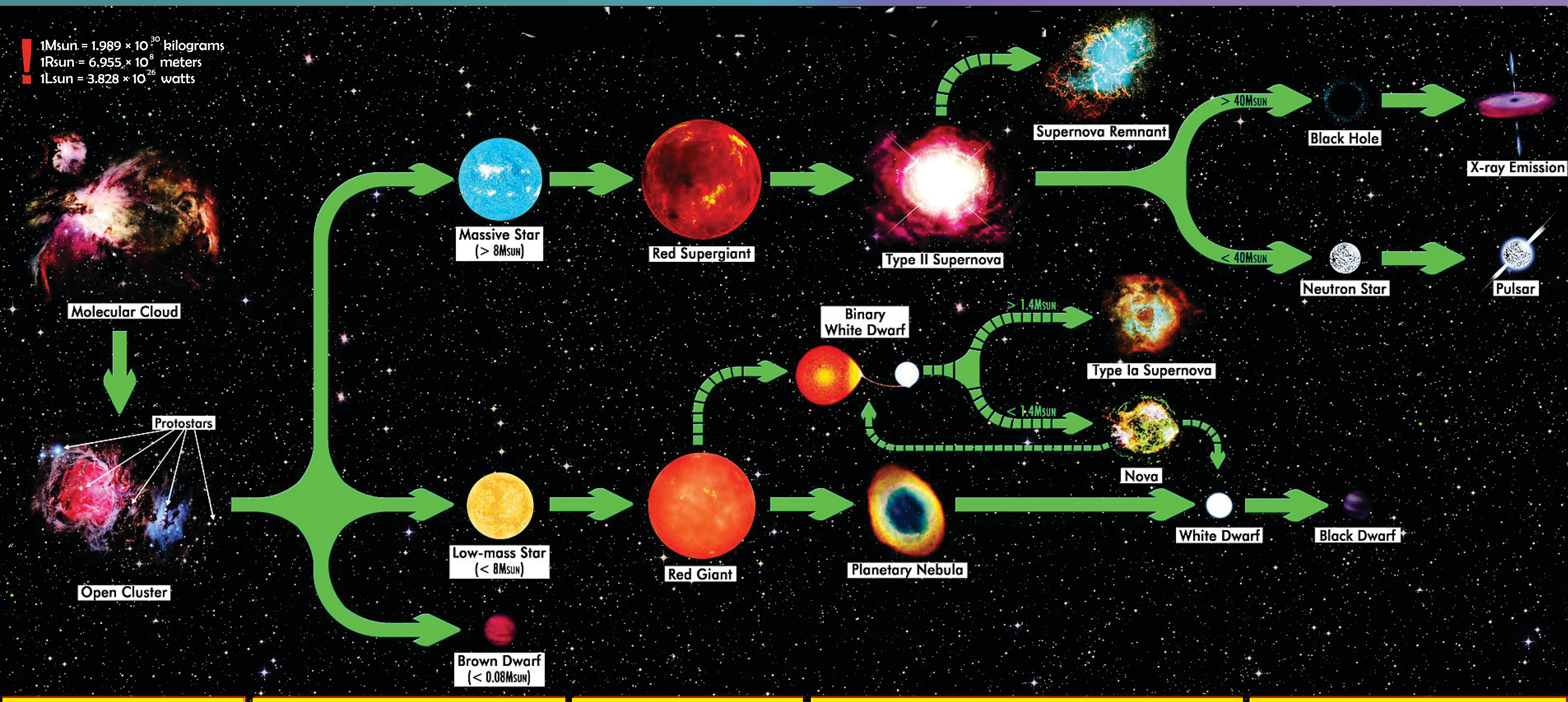
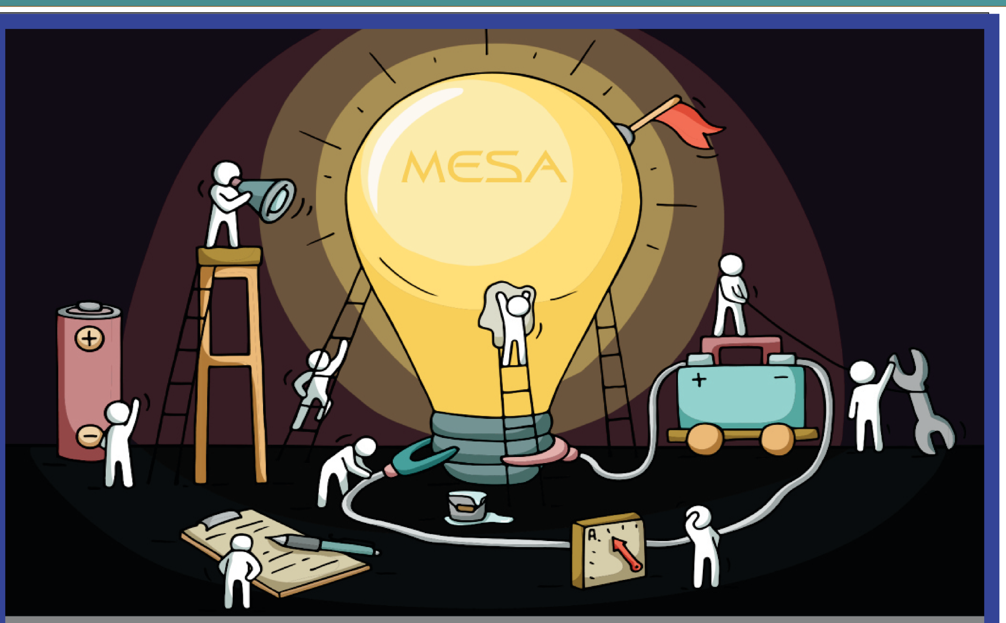
STELLAR EVOLUTION



birth	main sequence	old age	death	remnant

PROGRAMS FOR STELLAR EVOLUTION



MESA

Modules for Experiments in Stellar Astrophysics (MESA) is a suite of open source, robust, efficient, thread-safe libraries for a wide range of applications in computational stellar astrophysics. A one-dimensional stellar evolution module, MESAstar,combines many of the numerical and physics modules for simulations of a wide range of stellar evolution scenarios ranging from very low mass to massive stars, including advanced evolutionary phases.

Bill Paxton
Father of MESA

ADVANTAGES OF USING MESA

Comprehensive Modeling Capabilities: MESA (Modules for Experiment In Stellar Astrophysics) provides a robust framework for simulating a wide range of stellar phenomena, from single star evolution to complex Interactions in binary systems.

Flexibility and Customization: Users can customize various parameters and modules within MESA to tailor simulations to specific research needs, allowing for high versatility in modeling different stellar processes.

Extensive Library of Pre-built Modules: MESA includes numerous pre-built modules that simplify the modeling of different physical processes such as nuclear reactions, convection, and radiative transfer.

High-Resolution Simulations: MESA supports high-resolution simulations, providing detailed insights into the Internal structure and evolution of stars.

Active User Community and Support: The MESA community is active and supportive, providing extensive documentation, forums, and resources for troubleshooting and enhancing simulations.

Integration with Observational Data: MESA allows for the integration of observational data, enabling researchers to compare simulation results with real-world observations for validation and refinement of models.

Open Source: Being an open-source tool, MESA is freely available for researchers worldwide, promoting collaboration and the advancement of stellar astrophysics.

DISADVANTAGES OF USING MESA

Steep Learning Curve: The complexity and vast capabilities of MESA can result in a steep learning curve for new users, requiring significant time and effort to master.

Computationally Intensive: High-resolution and complex simulations in MESA can be computationally intensive, demanding significant processing power and memory, which might not be accessible to all researchers.

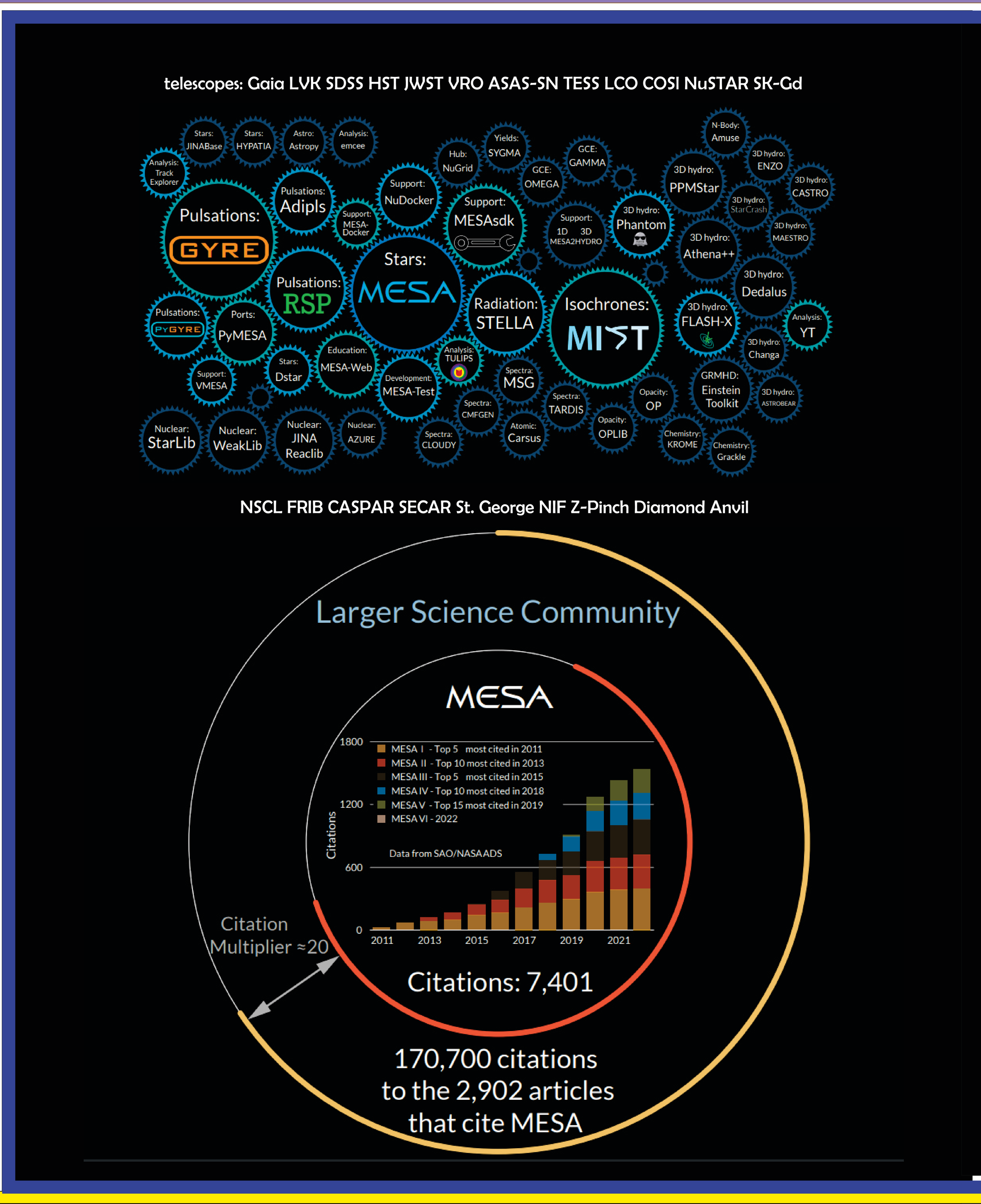
Dependence on Accurate Input Data: The accuracy of MESA simulations heavily depends on the quality and precision of input data. Inaccurate or incomplete data can lead to erroneous results.

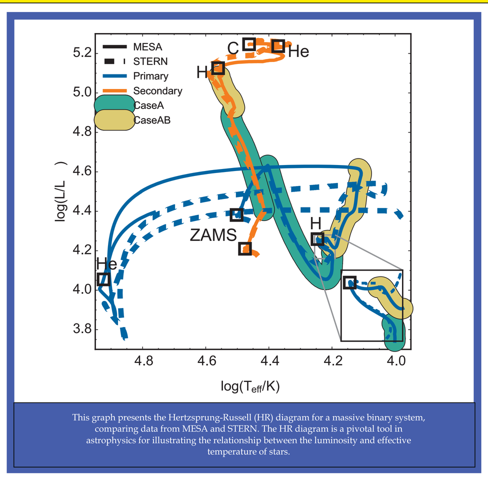
Potential for User Error: Due to the flexibility and customization options, there is potential for user error in setting up simulations, which can affect the reliability of results.

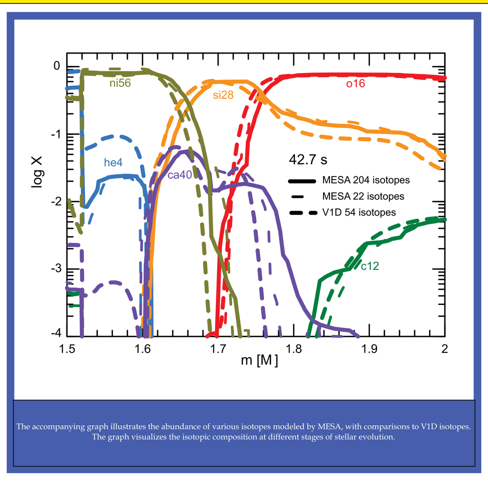
Software Updates and Maintenance: Regular updates and maintenance are required to keep MESA running smoothly and up-to-date with the latest scientific developments, which can be time-consuming.

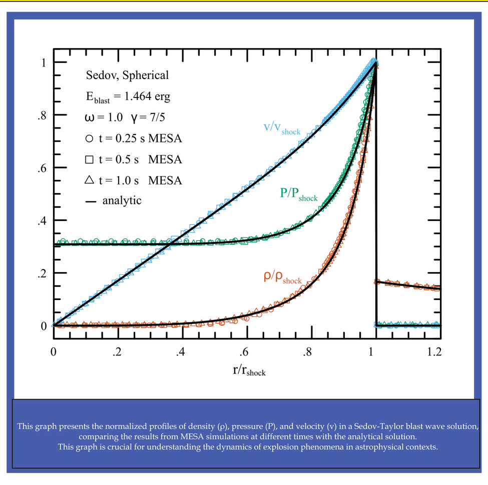
Specialized Knowledge Required: Effective use of MESA requires specialized knowledge in stellar astrophysics and numerical methods, which may limit its accessibility to researchers with different backgrounds.

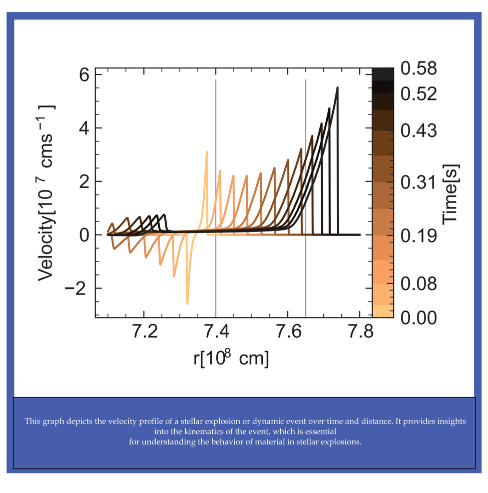
Limited by Assumptions and Approximations: Like any simulation tool, MESA relies on certain assumptions and approximations, which can limit its ability to fully capture all aspects of stellar phenomena.

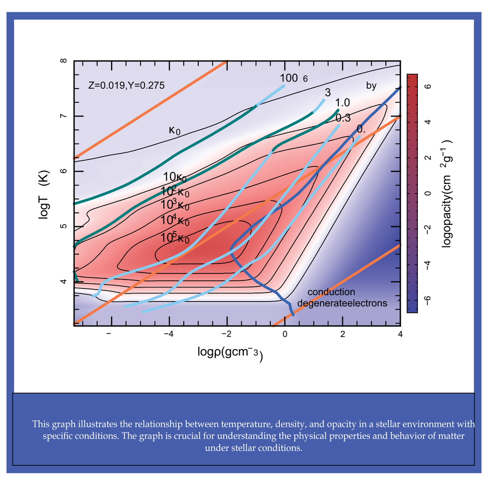


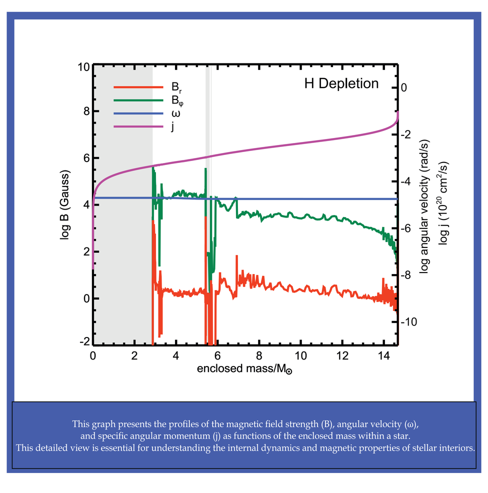












P G S T A R - Plots and Graphics for Stellar Tracks And Results

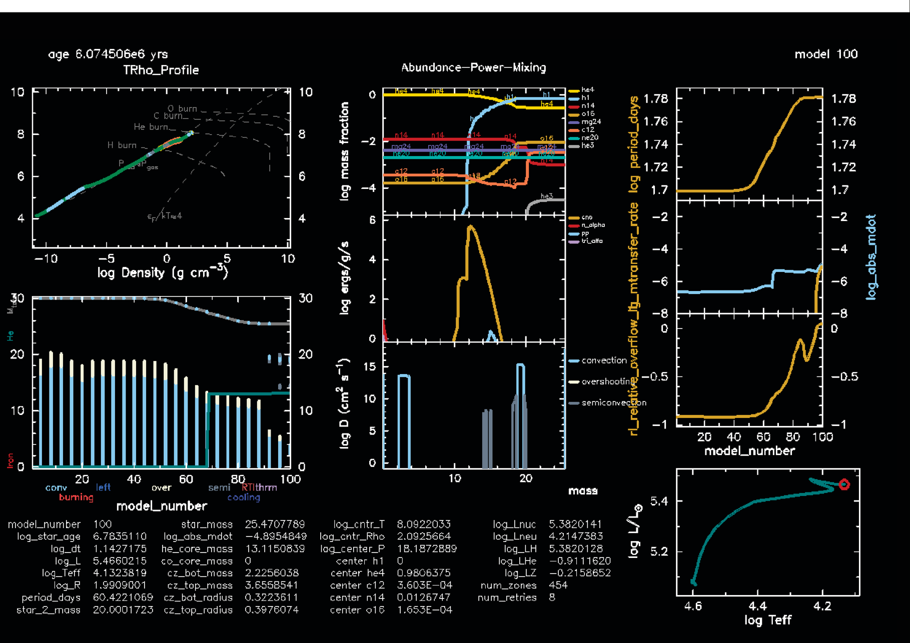
-> Data Visualization:
PGSTAR allows users to create high-quality plots and diagrams that illustrate the results of stellar evolution simulations.

-> Animations and Time Series:
PGSTAR supports creating animations that show changes in stellar parameters over time.This feature allows the visualization of dynamicprocesses such as pulsations, flares, and other temporal phenomena.

-> Stellar Parameters:
The tool allows for the visualization of various stellar parameters, such as temperature, luminosity, radius, chemical composition, density, and magnetic field.

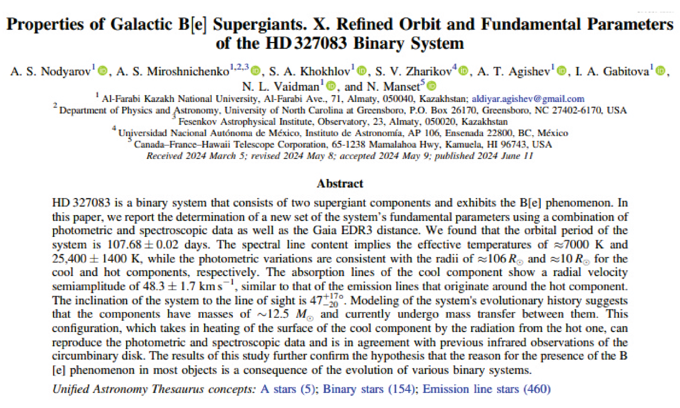
-> Interactivity:
PGSTAR provides interactive capabilities, allowing users to zoom in, pan, and explore graph details. Interactive features make it easier to analyze data and identify interesting features.

-> Integration with MESA:
PGSTAR is tightly integrated with MESA, providing easy access to simulation results and their visualization. Users can automatically generate plots after simulations are completed, simplifying data analysis and interpretation.



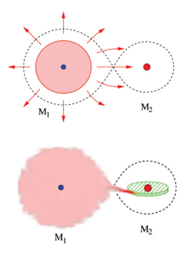
What are the advantages of these features?

MESA in our publications



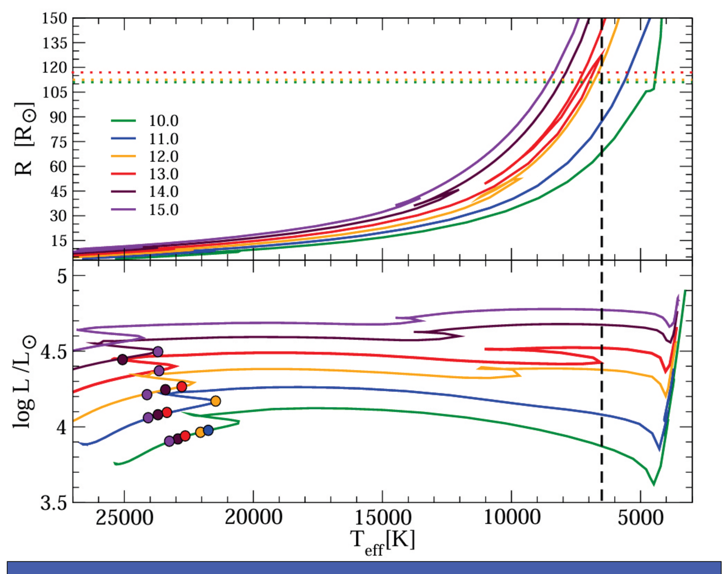
Properties of Galactic B[e] Supergiants. X. Refined Orbit and Fundamental Parameters of the HD 327083 Binary System

Unified Astronomy Thesaurus concepts: A stars (5); Binary stars (154); Emission line stars (460)

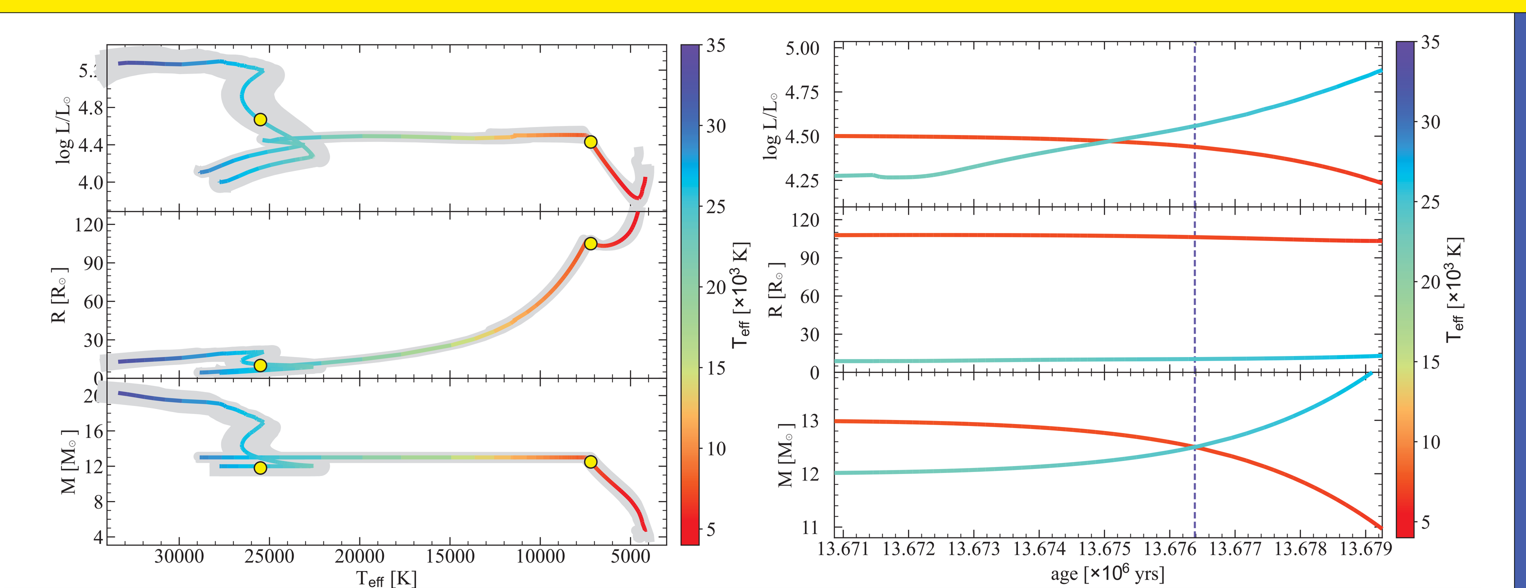


want to read more?

SCAN ME



Evolutionary tracks calculated using the MESA code for single stars with indicated initial masses shown by the colored solid lines. The starting points of all the tracks are located at the zero-age main sequence. The top panel shows radius vs. effective temperature relationships, while the bottom panel shows the HR diagram. The lines of different colors show the tracks of the masses in solar units indicated in the top panel



Left: Evolutionary tracks of a binary system with the components' masses of 13.0 M and 12.0 M and an initial orbital period of107 days. The yellow filled circles indicate the current properties of the system components. The grey area corresponds to the evolutionarytracks within ±0.1 M of the components' masses. Right: Changes of the components' luminosity (top), radius (middle), and mass (bottom) near the current state of the system (marked by thevertical dashed line). Components' effective temperatures are indicated by colors

OTHER PROGRAMS

Program	Pros	Cons
STAREVOL	Detailed modeling, useful for a wide range of stellar masses, includes magnetic fields and mixing processes.	Complex setup and learning curve, may require significant computational resources.
BSE	Specialized for binary star evolution, accounts for interactions, mass transfer, tidal forces, and gravitational waves.	Mainly for binary systems, might not be as useful for single star evolution.
EVOL	Covers a wide range of stellar masses and types, includes convection, diffusion, and mass loss processes.	Requires detailed input parameters, complex setup.
STELUM	Accurate modeling of stellar evolution, includes convection, mass loss, and magnetic fields.	Relatively new, less widely used, may lack extensive community support and documentation.

STAREVOL BSE EVOL STELUM

INSTALLING MESA

Start

Check System Requirements
- Mac or Linux OS
- 64-bit processor
- 8 GB RAM
- 20 GB disk space

Check System Requirements
- Download from MESA SDK website
- Alternative: Use ifort 14+

Download MESA
- Download latest MESA release
- Unzip to create mesa-main directory

Set Environment Variables
- Add to shell startup file (example for bash)

Compile MESA
Navigate to MESA directory
Run ./install
Confirm installation

Troubleshooting (if needed)
- Check environment variables
- Verify MESA SDK installation
- Consult FAQ or mailing list

End

Questions?