The Properties of Binary Systems Containing RR Lyrae Variables

Problem: Binary star systems are common, and despite this RR Lyrae Variables are rarely found in binary systems.

What is an RR Lyrae variable? It is a Population 2 star that is helium burning, located on the instability strip of the HR Diagram. They have a mass range of 0.5 to 0.8 solar masses.

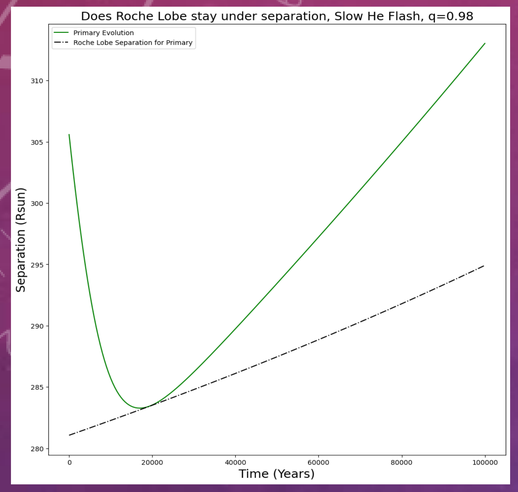
Dynamic Astronomical Binary Orbit Model

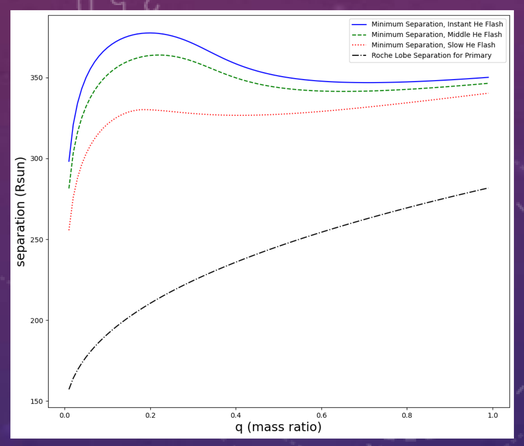
A Python model designed to find the closest separation possible before the progenitor red giant before it evolves into an RR Lyrae. This is done to determine what separations should not be possible for these systems.
The following plots are for a 100 solar radii, 1 solar mass red giant, and evolves over 100000 years.

To the right is a single Track for a 0.98 solar mass companion. The dotted line is the Roche Lobe Separation. If the separation decreases past this, mass transfer occurs and the red giant can no longer become an RR Lyrae.

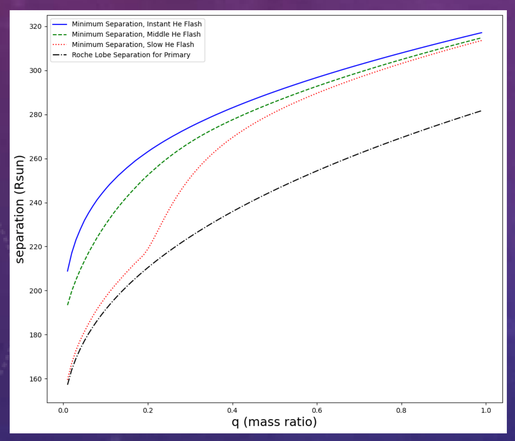
The Helium flash in this example occurs over the entire 100000 year evolution, as an extreme case. The other loptions in the model are instant, and over 2000 years.

Note that the tidal interaction causes the separation to decrease, and then the constant mass transfer causes the separation to increase once the tidal interaction stops.





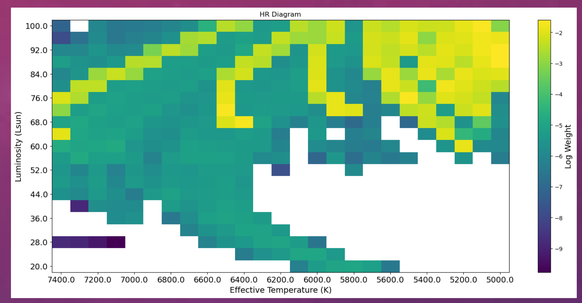
The above plot shows the mass ratio dependence for the systems that evolve without tidal interaction.



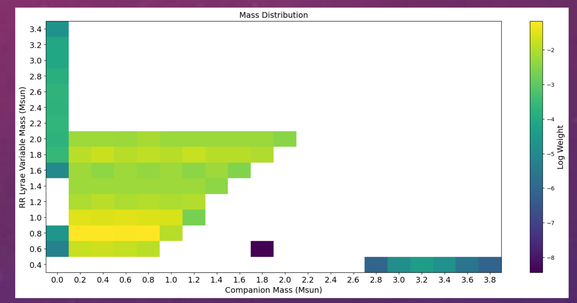
This plot shows the mass ratio dependence for the systems that evolve with tidal interaction .

Binary C

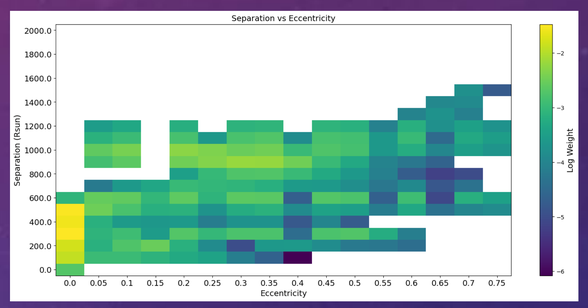
A Binary Synthesis Code which simulates populations of binary star systems and evolves them through time.



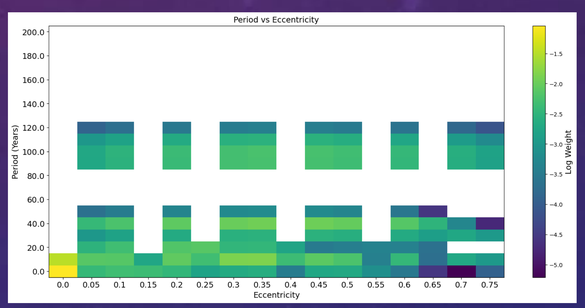
HR Diagram showing the luminosity and effective temperature of the RR Lyrae variables produced in the simulation



Mass Distribution of the RR Lyrae variables and their companions. Note that some of the RR Lyrae variables are more massive than 1 solar mass, greater than that found in nature.



Separation vs Eccentricity distribution. Note that the majority of systems have smaller separations and circular orbits, with a peak at 1000 solar radii and e=0.3



Period vs eccentricity distribution, showing the majority of systems have short periods and circular orbits. Note that the shortest orbital periods found in nature are 4 years.

Research References

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