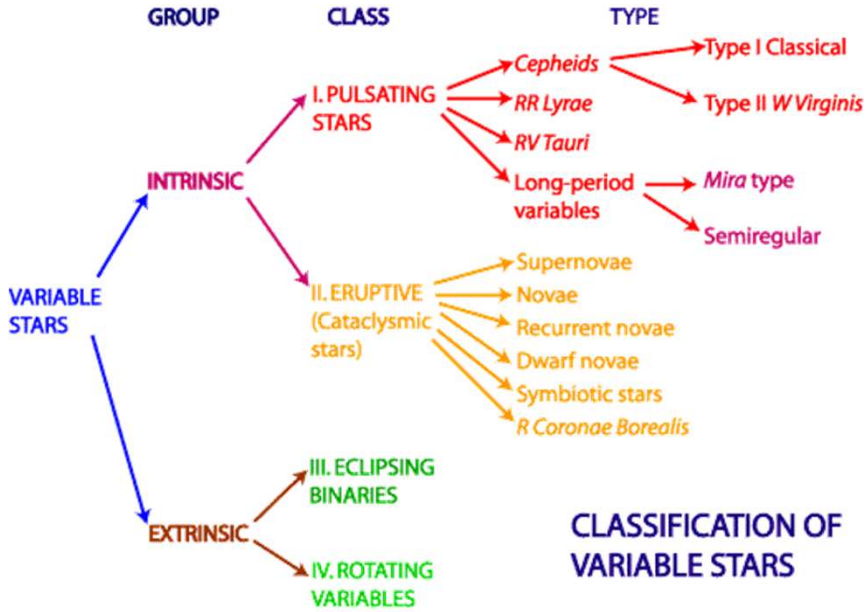
BRIEF

VARIABLE STARS
Group Extrinsic

Overview

The group of Extrinsic variable stars covers the variable star classes: Eclipsing, Rotation, and Microlensing.

This group of stars is classified based on external factors causing the changes to the star, and thus the variability to their flux.



Eclipsing Binaries

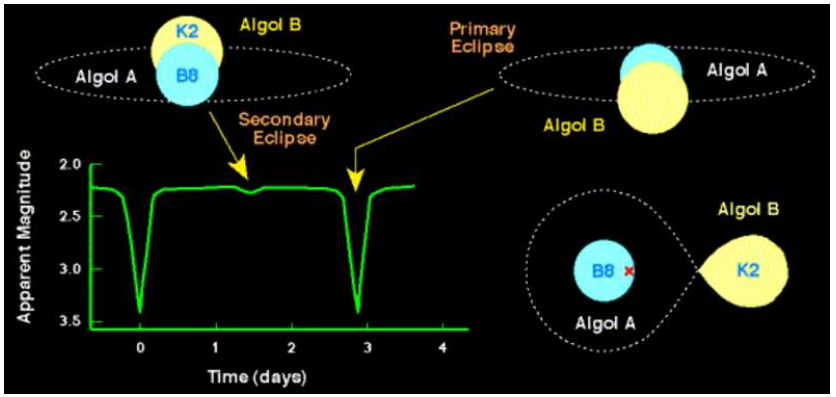
Eclipsing binaries are binary star systems whose members eclipse each other, blocking one another's light, causing the system to look fainter to observers on Earth.

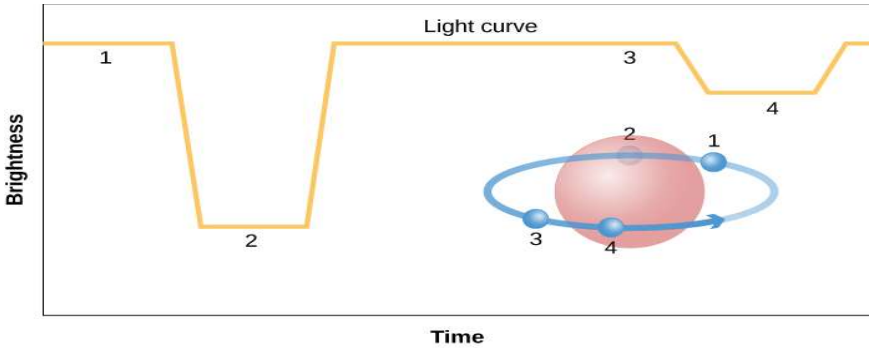
The light curve of an eclipsing binary depends on the sizes and brightnesses of the stars, separation from each other, and the geometry of our view from Earth.

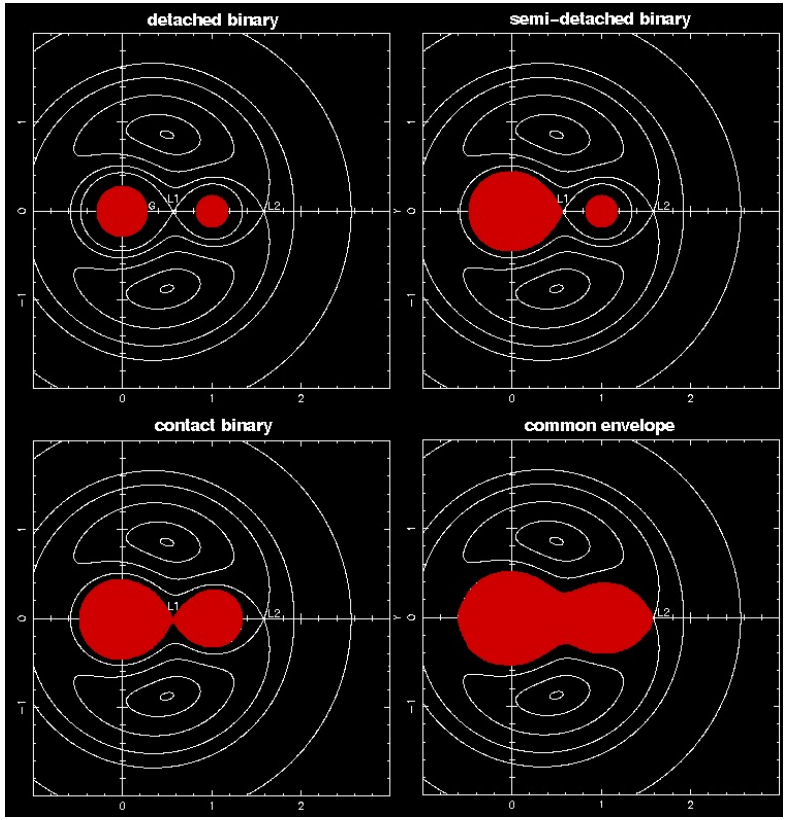
If one star is larger, it may totally eclipse the second, while the second only partially eclipses the first.

The time between primary eclipses is the orbital period of the binary system.

Detailed analysis of the light curve shape yields much information about the size, mass, and shape of the stars, and the shape of their orbits.







Roche Lobes

Modern classification schemes of binaries, including eclipsing binaries, are based on the concepts of Roche lobes and Lagrangian points.

Detached binaries are systems where both components are well within their Roche lobes. The stars remain nearly spherical and tidal distortion is minimal.

Semi-detached binaries are systems where one star fills its Roche lobe and is distorted. It is probably losing mass through accretion at the Inner Lagrangian point onto its companion star.

Contact binaries occur when both stars fill their Roche lobes and are essentially in contact with each other. In some cases a common envelope of material that blurs the distinction between individual stars may also surround the pair. These are often referred to as *common envelope* or *over-contact binaries*.

Algol variables (EA)

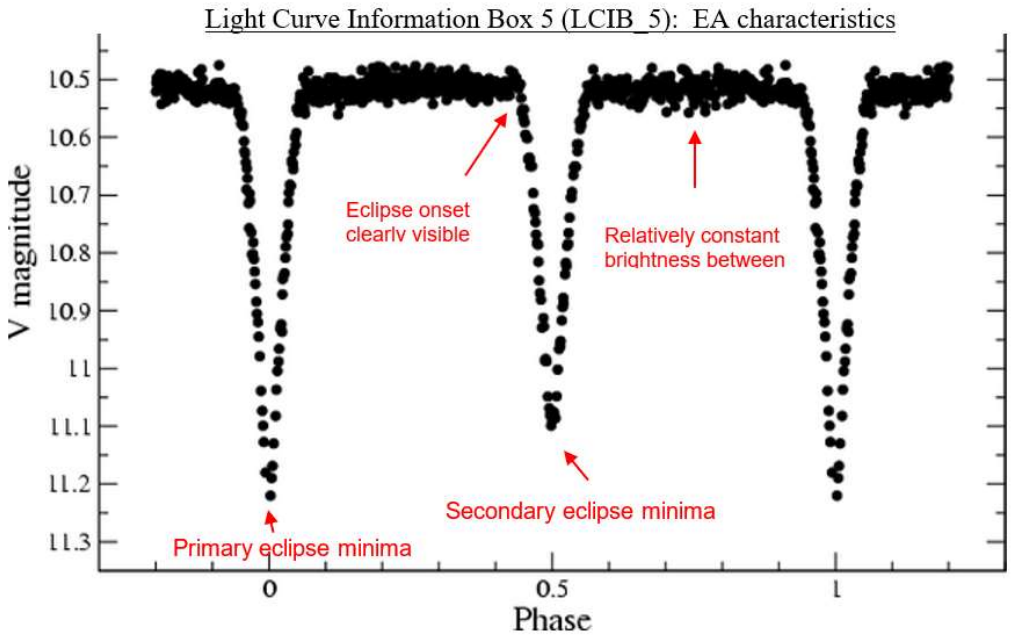
Eclipsing systems containing spherical or slightly ellipsoidal components.

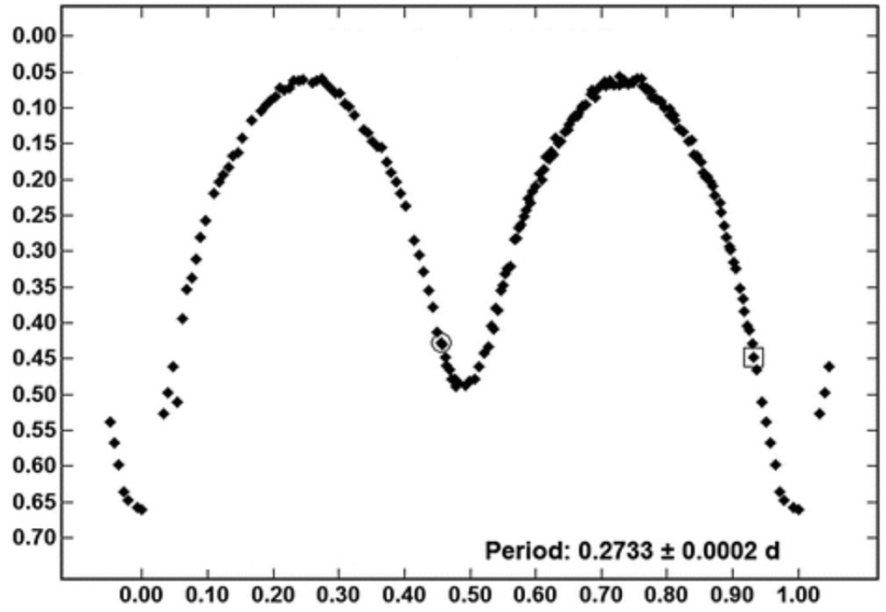
The precise moments of the beginning and ending of eclipses are well defined in their light curves.

The light curve is essentially flat between eclipses or may vary slightly due to ellipsoidal or physical variability of the components, or due to reflection effects.

Reflection Effect: If two stars orbit each other very closely, some of the energy from each star will strike its companion, be absorbed and then re-emitted.

The side of the star facing its companion is hotter and thus slightly brighter than the side facing away.





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Eclipsing variables containing ellipsoidal components nearly in contact as they orbit a common center of mass.

Exact times of onset and end of eclipse are impossible to determine.

Characteristics:

- Expanded beyond Roche Limit
- Contact or overcontact binary
- Spectral Class F or cooler

Light Curve:

- Periods less than a day
- Minima of near equal depths
- Depths can change over time and/or cycle to cycle

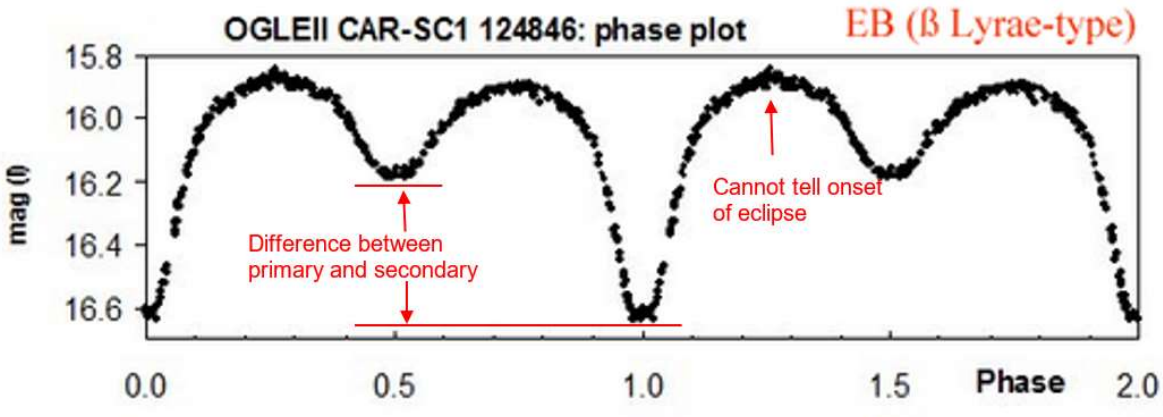
Beta Lyrae type variables (EB)

Eclipsing variables containing ellipsoidal components.

The exact times of onset and end of eclipse are impossible to determine because the brightness of the system is continuously varying.

There are always secondary minima. The depth of these secondary eclipses is usually considerably shallower than the primary eclipse.

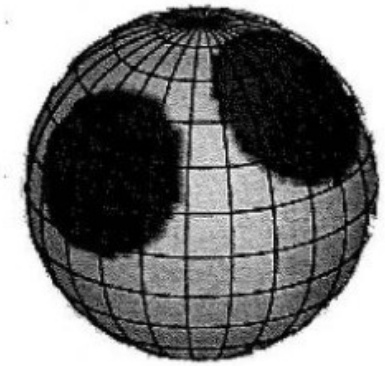
The current picture of beta Lyrae is that it is an eclipsing binary in a stage of mass transfer between the components.

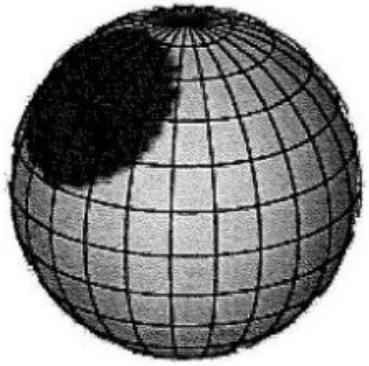


Rotating Variables

Rotating variables are rapidly rotating stars, often in binary systems, that undergo small amplitude changes in light which may be due to dark or bright spots on the star's surface, similar to sunspots on our own Sun.

Stars with sizeable sunspots may show significant variations in brightness as they rotate, and brighter areas of the surface are brought into view. Bright spots also occur at the magnetic poles of magnetic stars. Stars with ellipsoidal shapes may also show changes in brightness as they present varying areas of their surfaces to the observer.



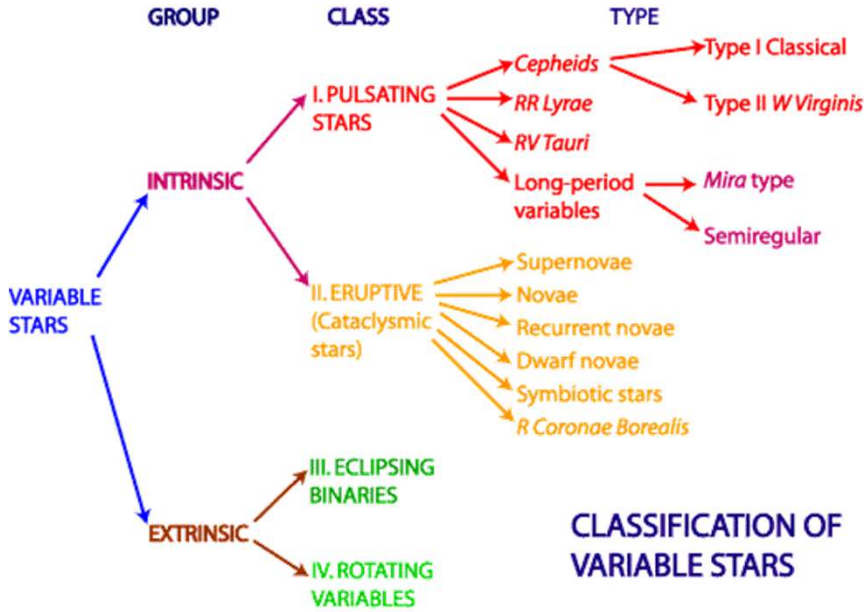


Summary

In this lesson we have reviewed the class of variable stars known as Extrinsic.

The characteristics of this class is that there are external factors causing the flux variations.

This group is a much smaller group than Intrinsic variables, but just as important to astrophysics.



Questions?

Eclipsing Binaries Characteristics

By examining the shape and spacing of these dips in the light curve, we can deduce some properties of the binary pair:

- If one of the two dips in the light curve is not as deep as the other, then the two stars have unequal surface brightnesses and therefore different surface temperatures. The eclipse of the hotter star by the cooler star produces a deeper minimum.
- If the binary orbit is exactly edge-on, and the stars have unequal sizes, then we would expect the dips to have "flat" bottoms. If neither dip reaches a flat minimum, then the binary orbit is not exactly edge-on to our line of sight, and the occultations are partial instead of perfectly aligned (or perhaps both stars have exactly the same size...).
- The dips are briefest and sharpest for stars that are widely separated compared to their sizes. Broad dips mean that the two stars have large diameters compared to their separation distance. Very close binaries may even be "touching" - gas may be feeding from one star onto the other, called a ***contact binary***. This very close proximity distorts the stars from spheres into teardrop shapes, making the occultation dips even broader. Beta Lyrae is one such example of a contact binary, where mass is being torn from one star and accreted onto the other. The brightness of the accreting star can even flare up or change unexpectedly as a big clump of matter gets tranfered to it.