



# VARIABLE STARS

## Group Intrinsic





## VARIABLE STARS - Class Intrinsic

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### **Overview**

The group of Intrinsic variable stars covers most of the variable star classes: Eruptive, Cataclysmic, and Pulsation.

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



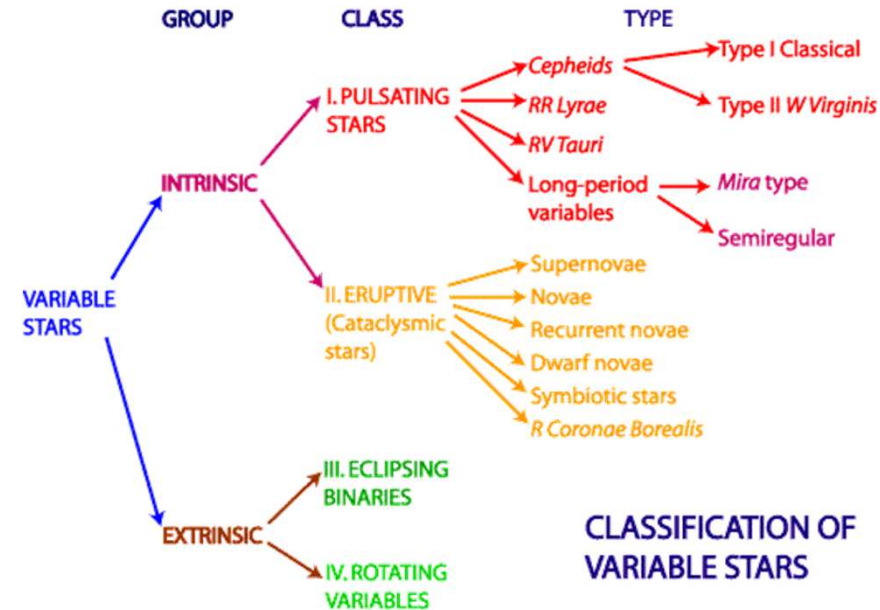
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### Pulsating Variable Stars

Pulsating variables change brightness because they change their size and/or shape. In essence, the whole star is actually “vibrating.”

Most of them simply expand and contract repeatedly, swelling and shrinking in a continuing cycle of size changes; this is known as the fundamental mode of pulsation.

Others change not only their size, but the internal arrangement of material within the star as well.





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### Cepheid Variables

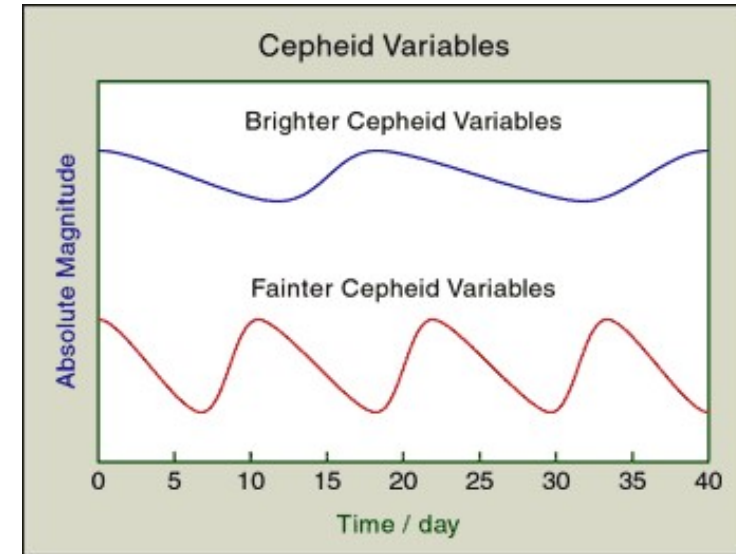
The variation in the luminosity of Cepheid stars results from the fact that they pulsate in and out with an outer envelope radius that can vary by as much as 10 or 20 percent.

This variation is directly tied to its period: The Period-Luminosity relation. This is useful because it lets you measure the distance to Cepheids which are quite far away and they can be seen to large distances.

They have a regular light curve shape showing a fairly rapid brightening, followed by a slower fall-off.

Periods range from 1-50 days and the brightness varies by 0.3-2.5 magnitudes.

There are in fact, 2 types of cepheids, classical cepheids (young super-giant stars) and W Virginis stars (old stars).

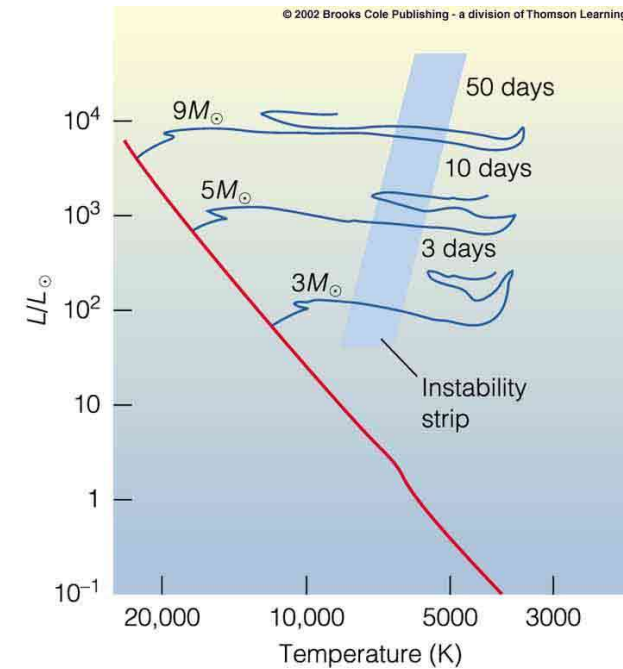
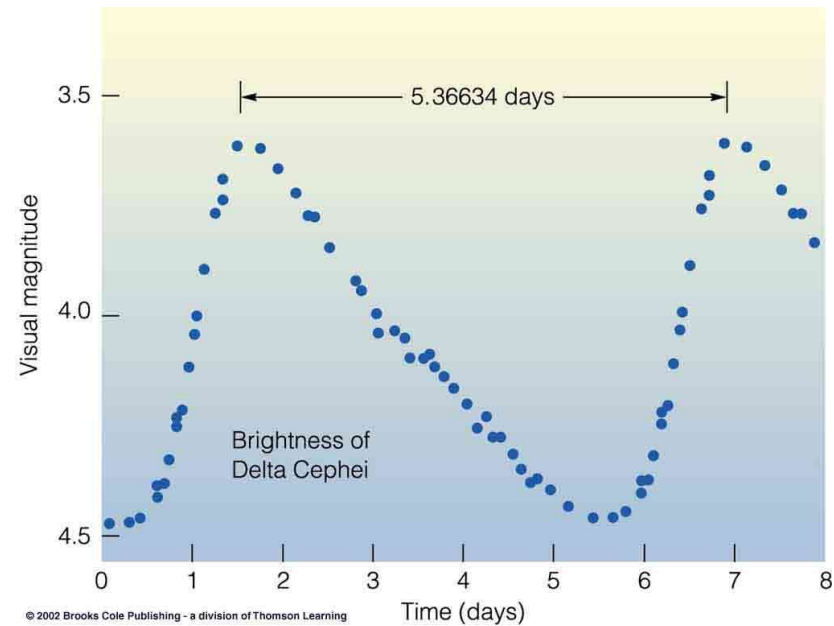




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### Cepheid Variables

These stars are aging stars. They lie in a region of the HR diagram called the Instability Strip. A star becomes a Cepheid variable star (unstable to oscillations) several times before it dies. These stars are more massive than the sun.



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### RR Lyrae

These stars have left the main sequence and are typically found in Globular Clusters.

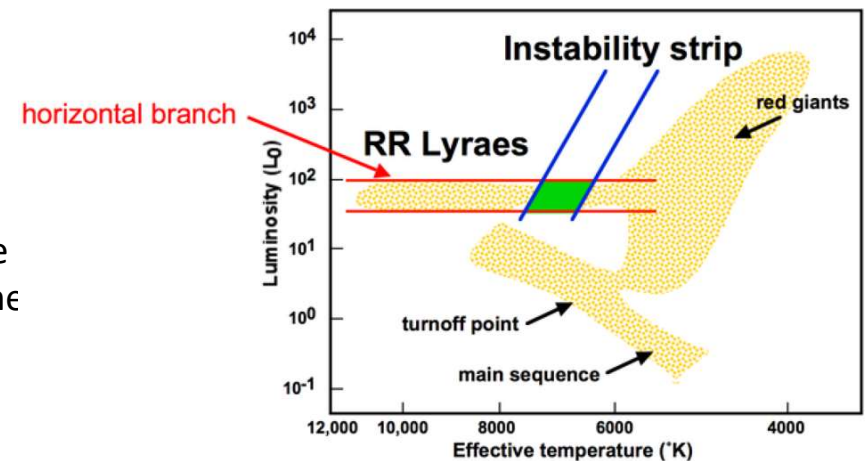
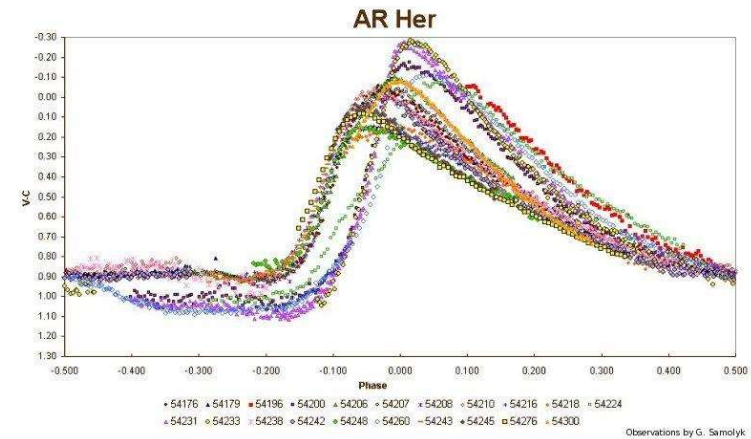
Given their HR Diagram position, along the horizontal branch, they are all roughly the same age, mass, luminosity, and at the same stage in their evolution.

They display a Period-Luminosity relationship similar to Cepheids, but on shorter timescales.

The P-L relationship has led to an understanding of their Absolute magnitude. From this, using the distance modulus, a distance to the stars can be obtained.

$$M - m = 5 \log d - 5$$

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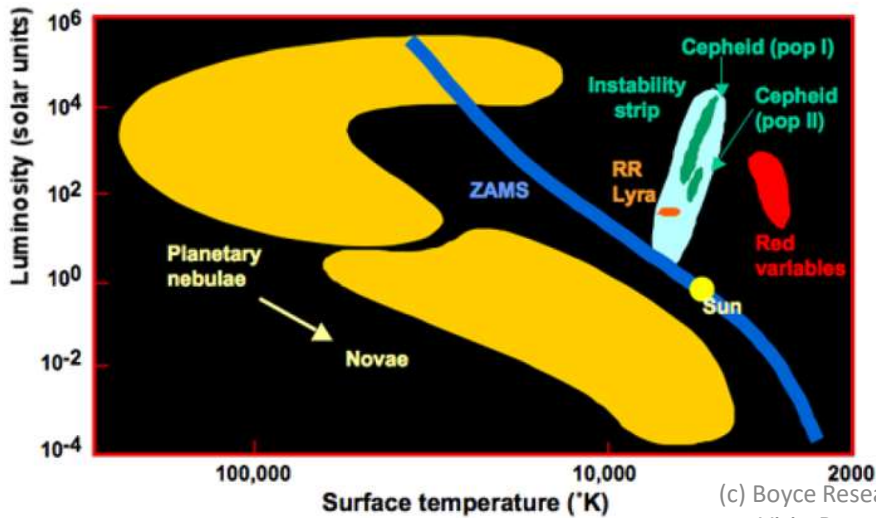




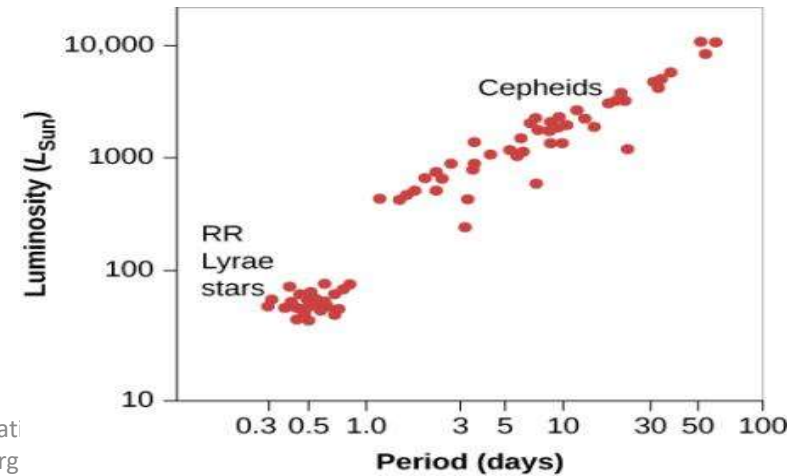
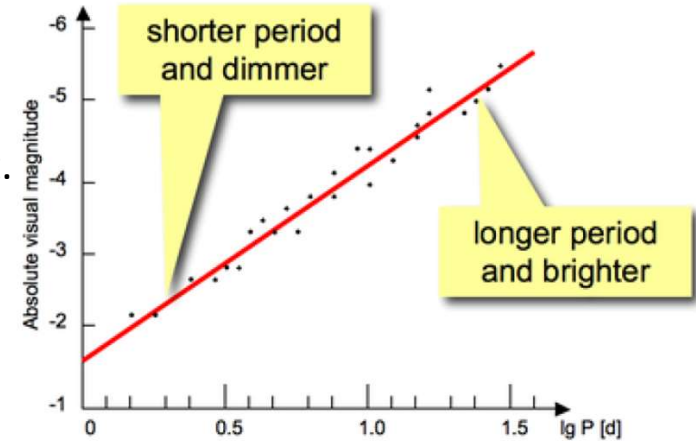
## Period-Luminosity Relationship

The first P-L was discovered for Cepheid variables by Henrietta Leavitt.

She found that Cepheids with longer periods appeared brighter than those with shorter ones. Since the stars were at essentially the same distance, the P-L was established. RR Lyrae also demonstrate a P-L.



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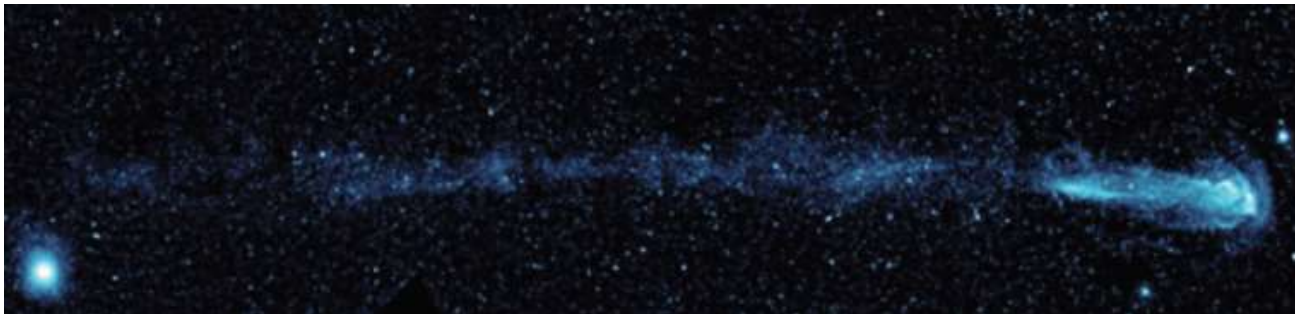
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### Long Period Variables

These are stars with irregular light curves and periods ranging from 80-1,000 days. Magnitudes can vary between 2.5 – 5.0 magnitudes.

Mira is the central case. 13-lightyear long tail found in ultraviolet wavelengths.







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### **Erupting Variables**

Stars that have occasional violent outbursts caused by thermonuclear processes either in their surface layers or deep inside their interiors.

There are no regular pulsations but instead sudden outbursts where material is ejected out into space.

Examples include: Supernovae, Recurrent Novae, and Cataclysmic Variables



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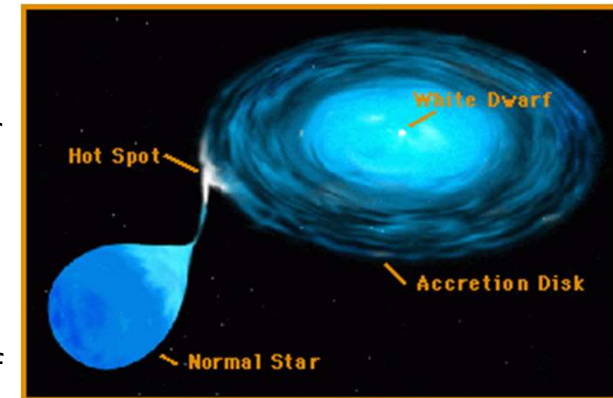
### Cataclysmic Variables

These are stars in a binary system where stellar material flows from a red dwarf star onto an accretion disk surrounding a white dwarf companion.

The flow is not constant but starts and stops. During the “quiet” periods, hydrogen-rich material from the normal star builds up on the surface of the white dwarf. When mass reaches a critical level, the material ignites as the white dwarf blows off the accreted outer layer.

Light curves show rapid outbursts followed by a calming down, and quiet period in between. The length of the quiet period is directly related to the intensity of the burst.

Luminosities can vary by as much as 17 magnitudes. Recurring Novae demonstrate less than 10 magnitudes of variation.



Source: NASA

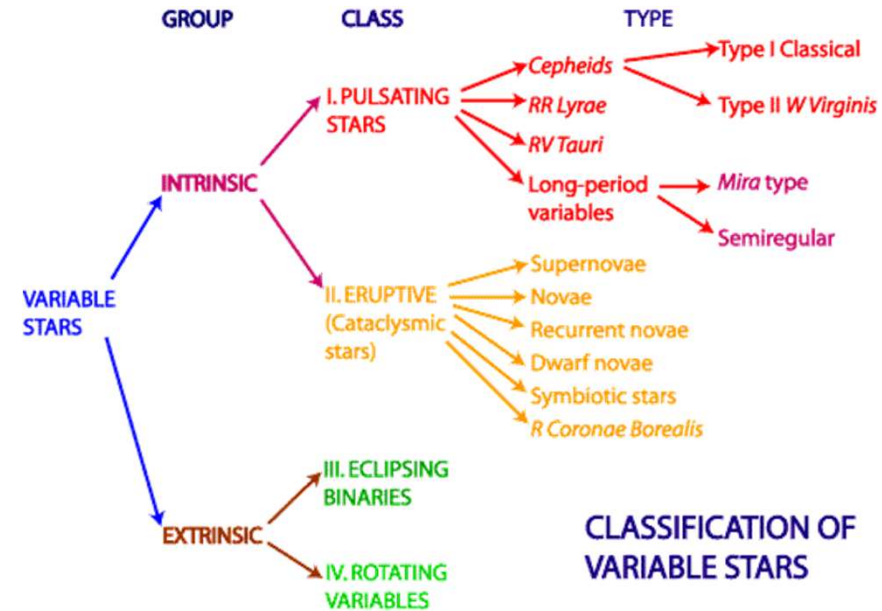


## VARIABLE STARS - Class Intrinsic

### Summary

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

The characteristics of this class is that internal processes in stellar evolution is driving the changes.





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# Questions?