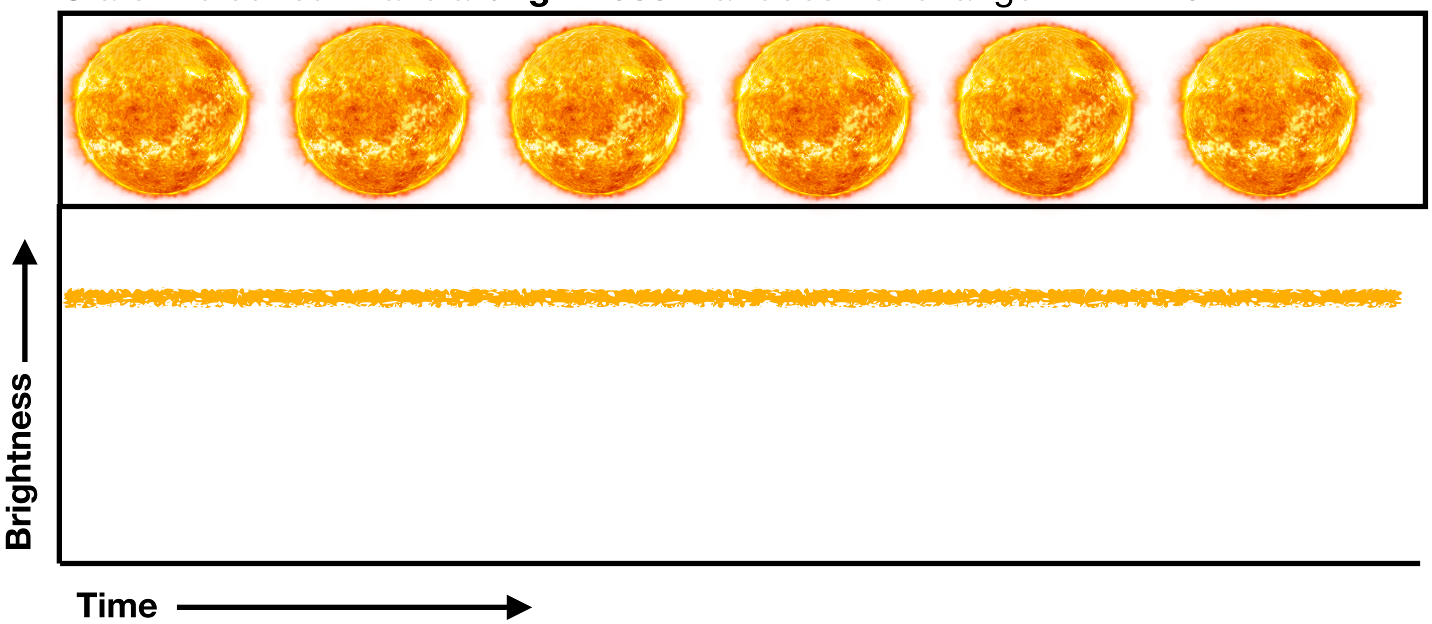
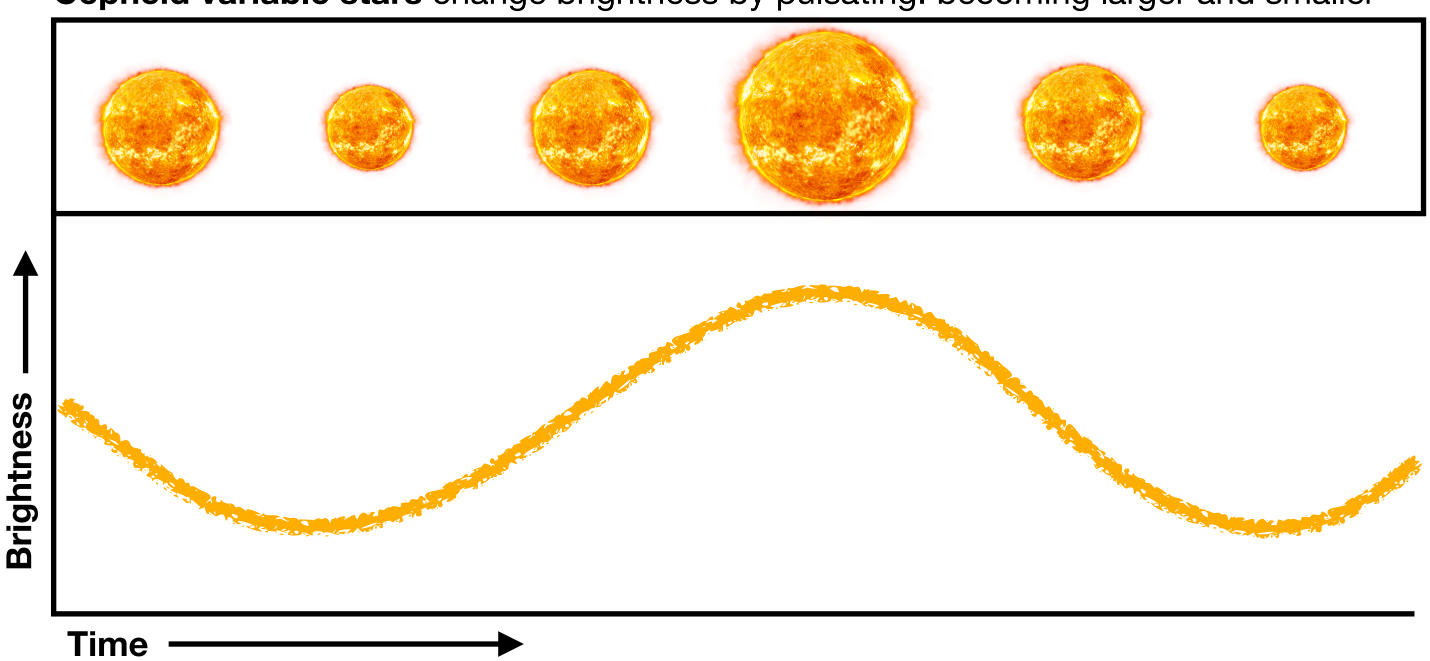
Cosmic Lightbulbs: Finding the distances to the Stars

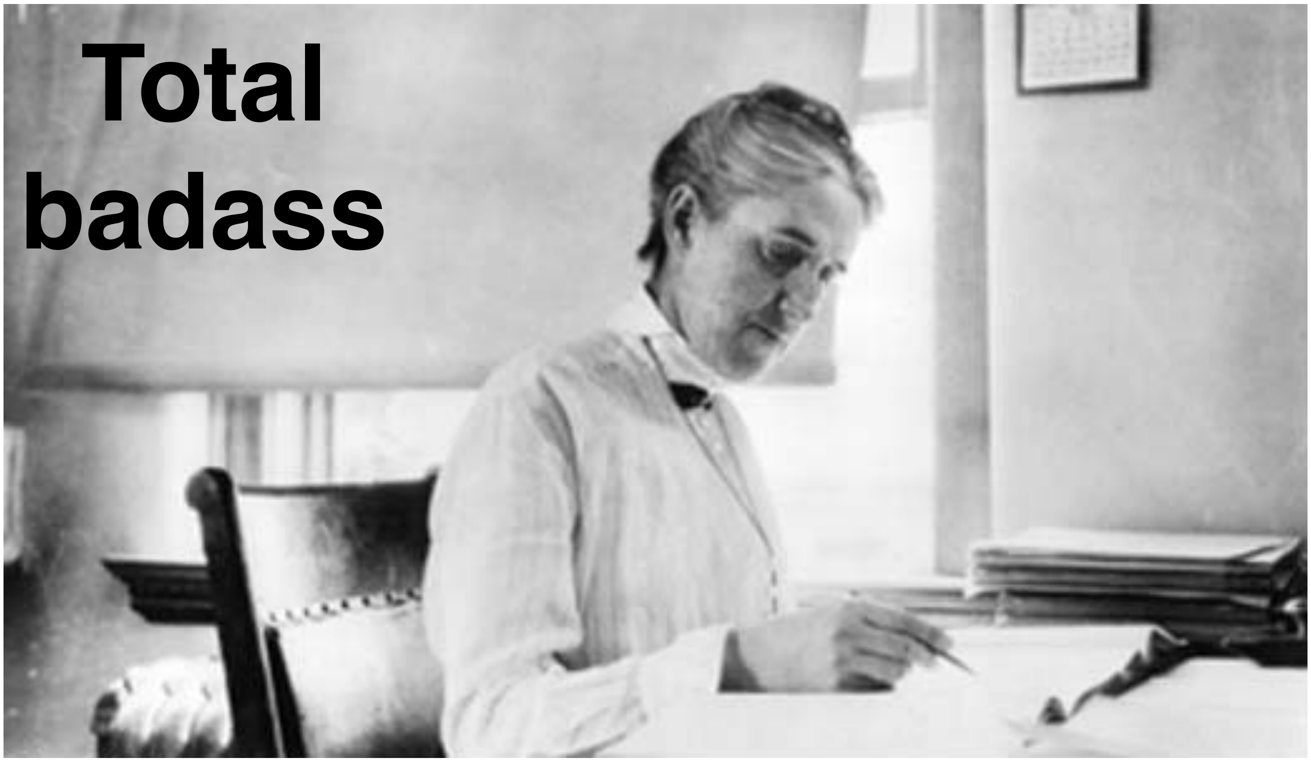
Stars like our sun have a **brightness** that does not change with **time**



However, during some stages of a stars life, its brightness can become variable.
Cepheid variable stars change brightness by pulsating: becoming larger and smaller



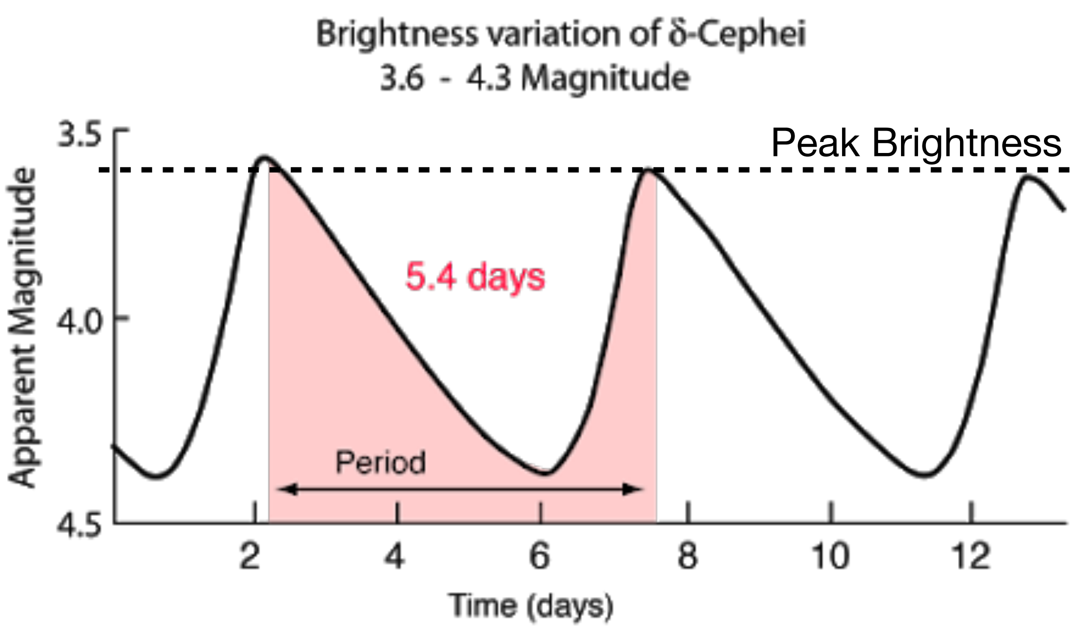
Henrietta Swan Leavitt was an astronomer at the Harvard Observatory. She studied the brightness of stars, and catalogued their properties.



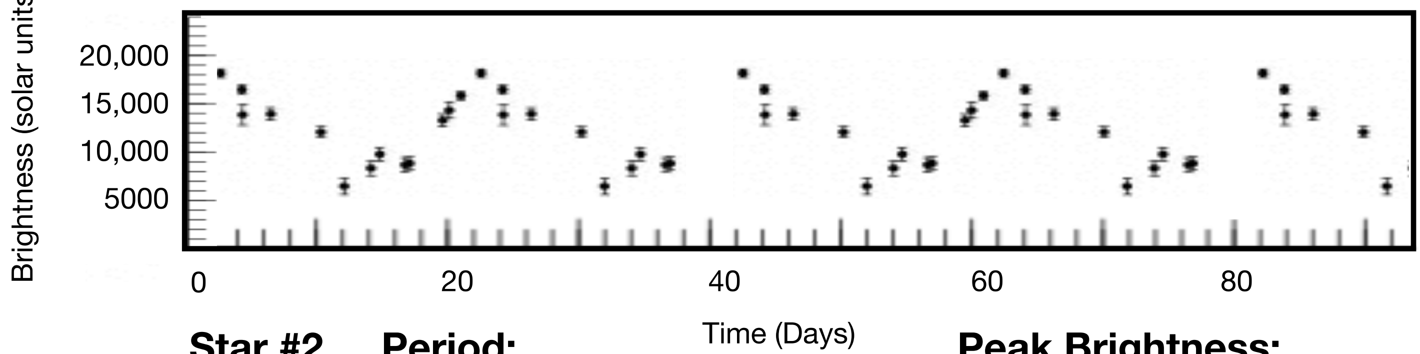
Leavitt was the first to measure and compare the overall (or peak) **intrinsic brightness** of Cepheid variable stars with their **periods** (the length of time it takes them to undergo a single pulsation).

You can think of **intrinsic brightness** as how bright a star would look if you replaced our sun with that star.

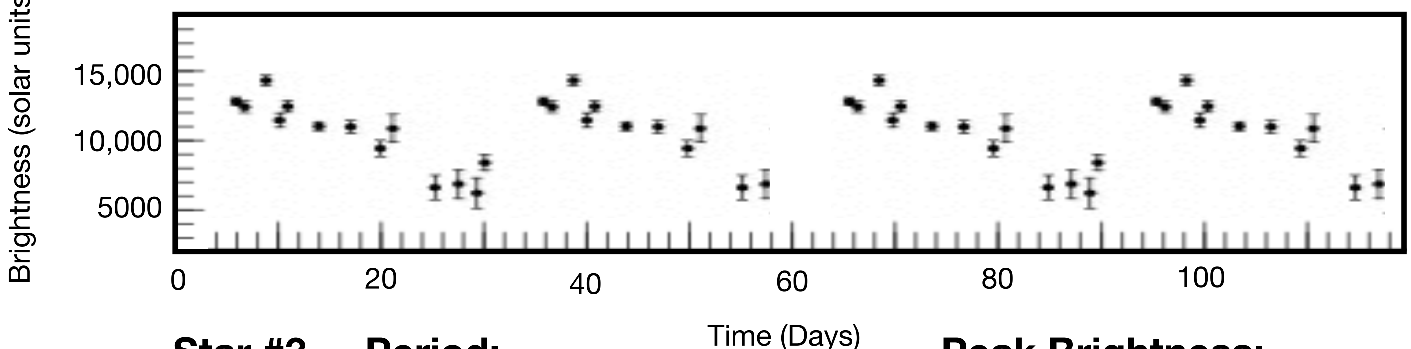
The **period** can be measured as the amount of time between peaks in brightness



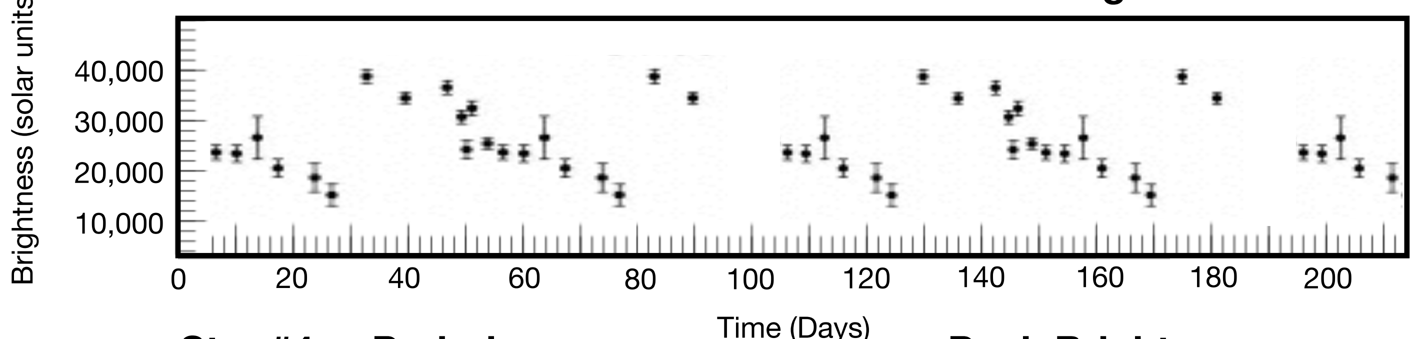
Star #1 Period: Peak Brightness:



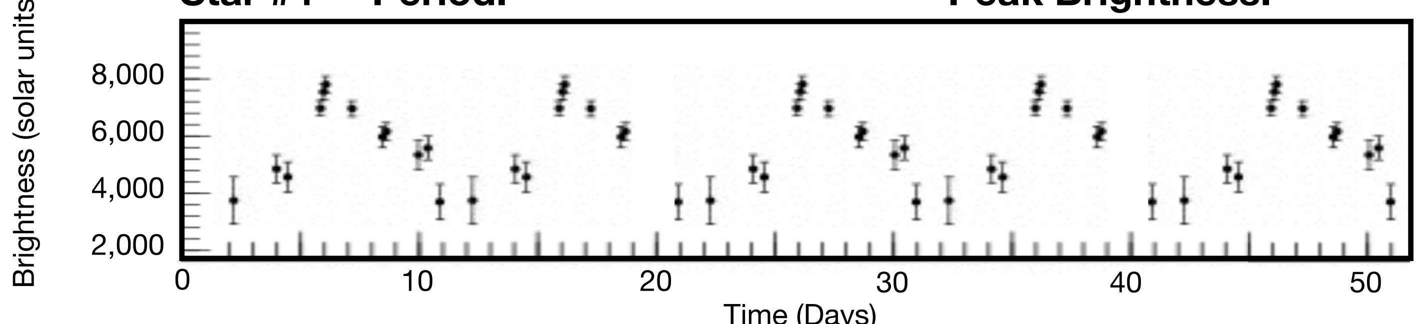
Star #2 Period: Peak Brightness:



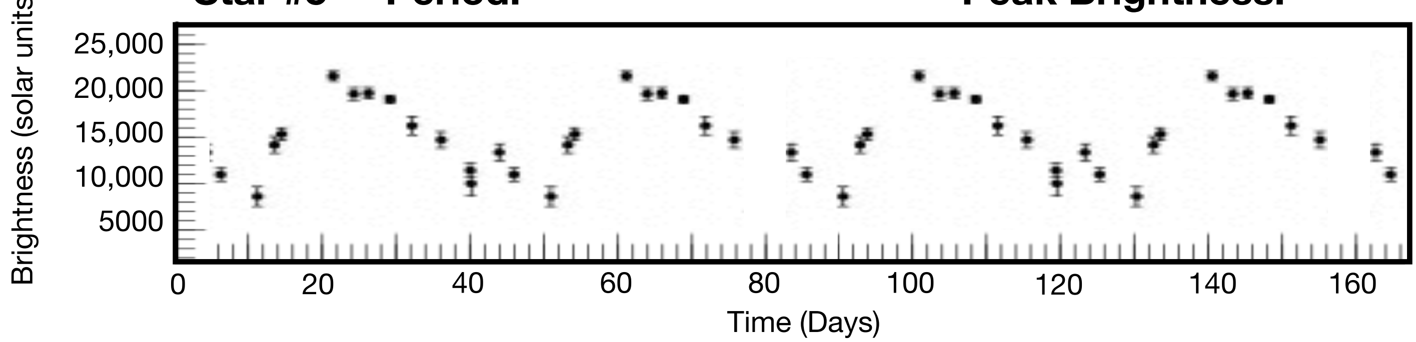
Star #3 Period: Peak Brightness:



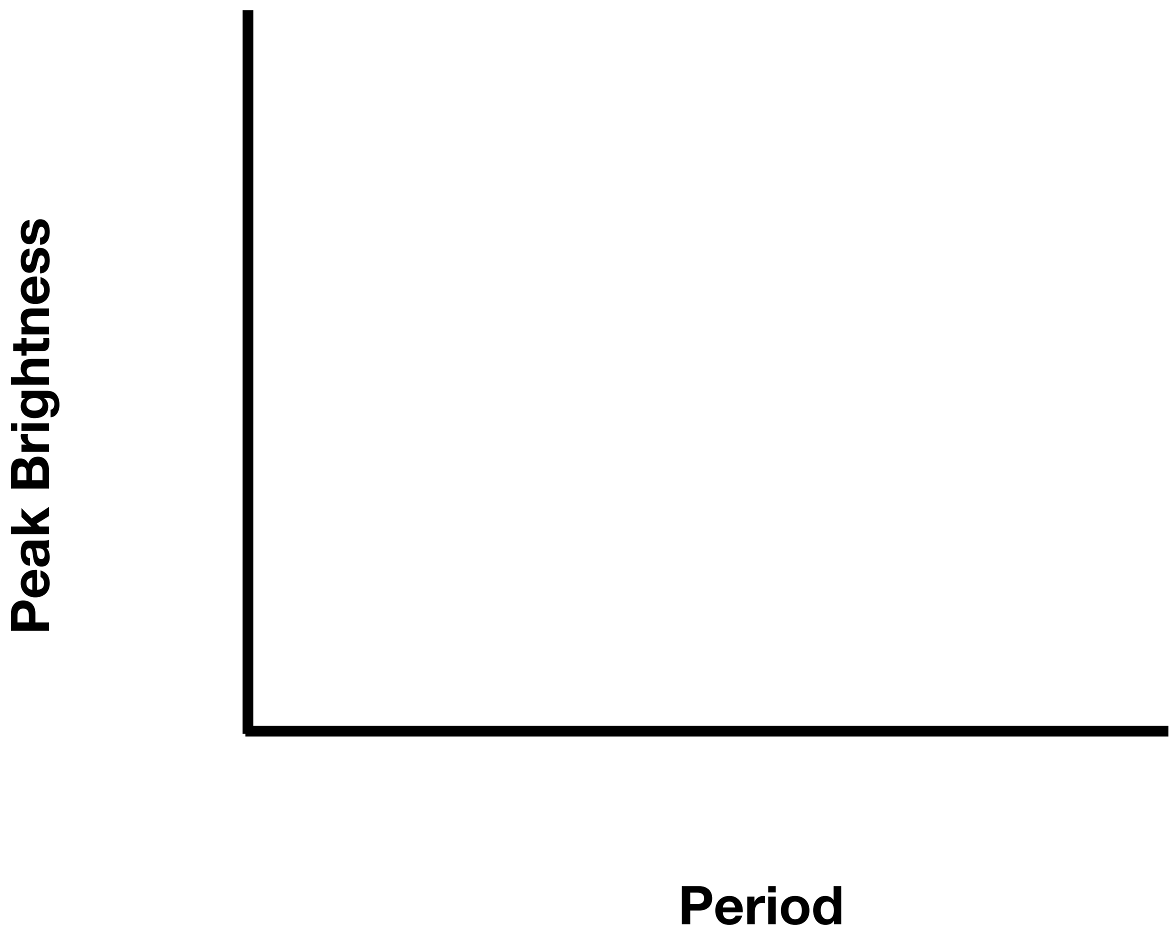
Star #4 Period: Peak Brightness:



Star #5 Period: Peak Brightness:



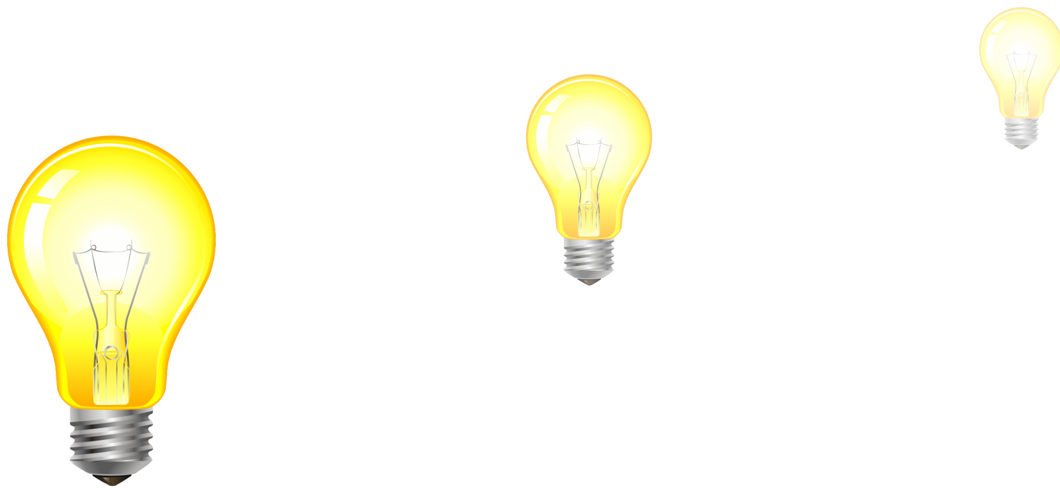
For the 5 stars above, your job is to reproduce her work, and compare the **period of variability** of these stars to their **peak brightness**.



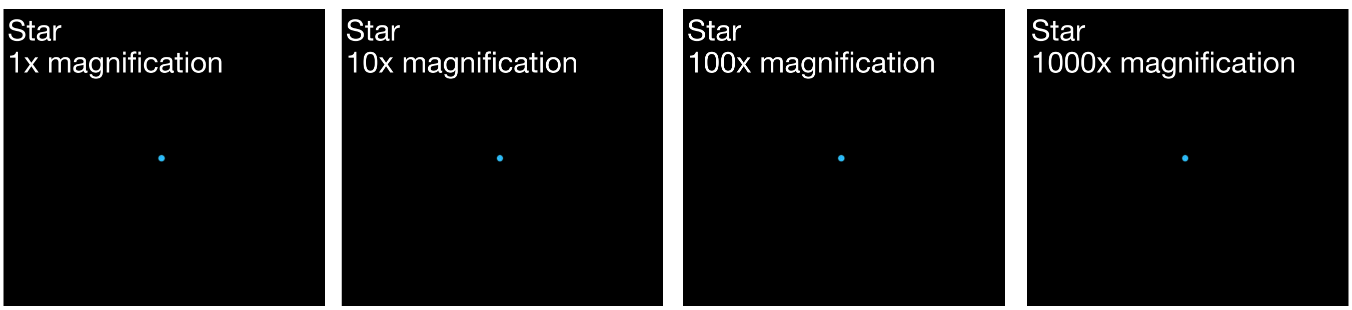
Label both axes (include measurement units!)

Draw a line through these points, and describe any trend that you see between these two quantities

Now, imagine looking at a 60 Watt lightbulb.



From our day-to-day lives, we know approximately how big this is and how much light it gives off. When the lightbulb is farther away, it appears **smaller** and **dimmer**. When it is closer, it appears **larger** and **brighter**.



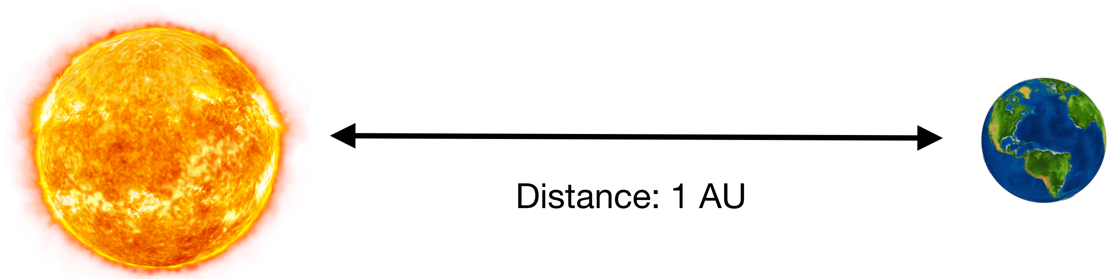
Stars are so far away and so small (cosmically speaking) that we can't really directly measure their size. Almost all stars just look like tiny specks, no matter how big a telescope we use! However, we can measure how bright they look.

Imagine that you are looking at Star #1 and Star #4 with a telescope. You measure that both stars **appear** to have the same brightness.

Which star would you say is farther away from us? Why?

We can use math to describe exactly how the brightness of an object like a star decreases as it gets farther away. This relationship can be described as:

$$\frac{\textbf{Apparent brightness at distance A}}{(\textbf{ Distance A })^2} = \frac{\textbf{Apparent brightness at distance B}}{(\textbf{ Distance B })^2}$$



Apparent Brightness:
1 solar unit

If you replaced the sun with Star #4, it would be appear 8,000 times brighter. How far away would the earth have to be moved so that this star appeared to be the same brightness as the sun?