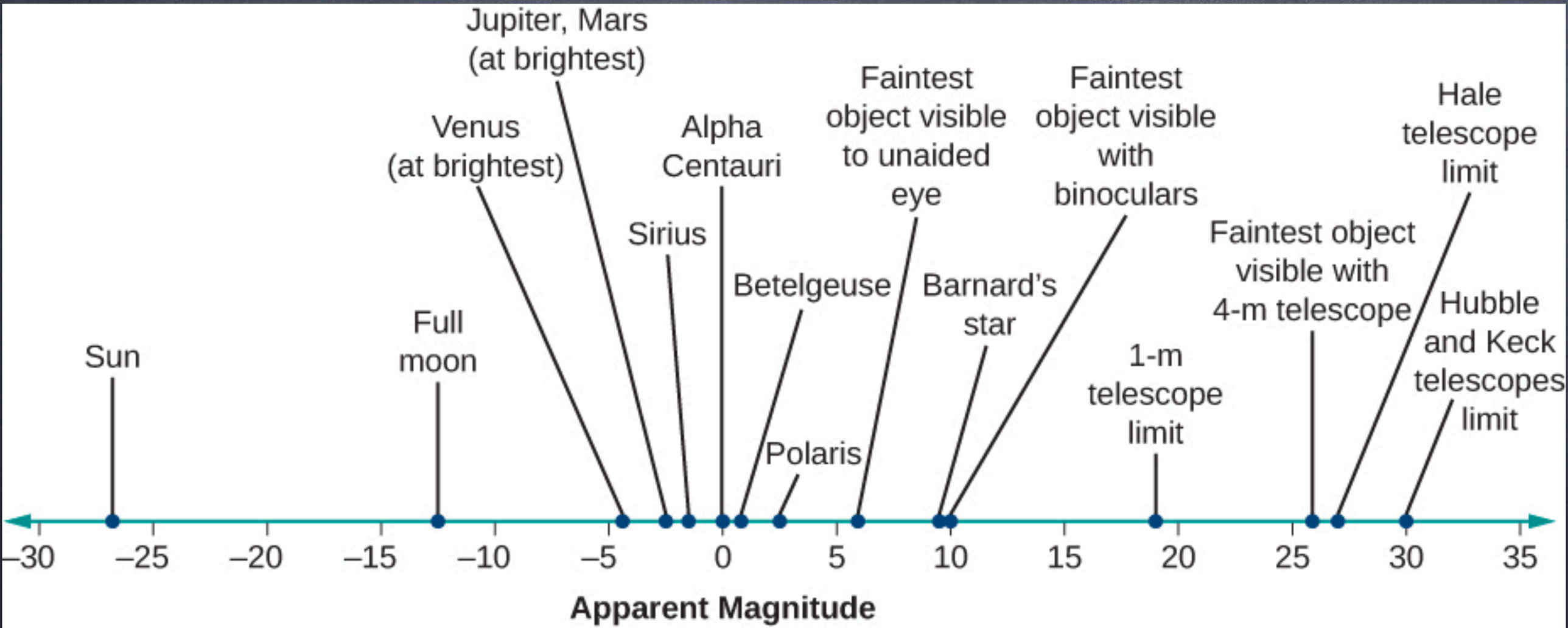
Analyzing Starlight

Chapter 17

The Brightness of Stars

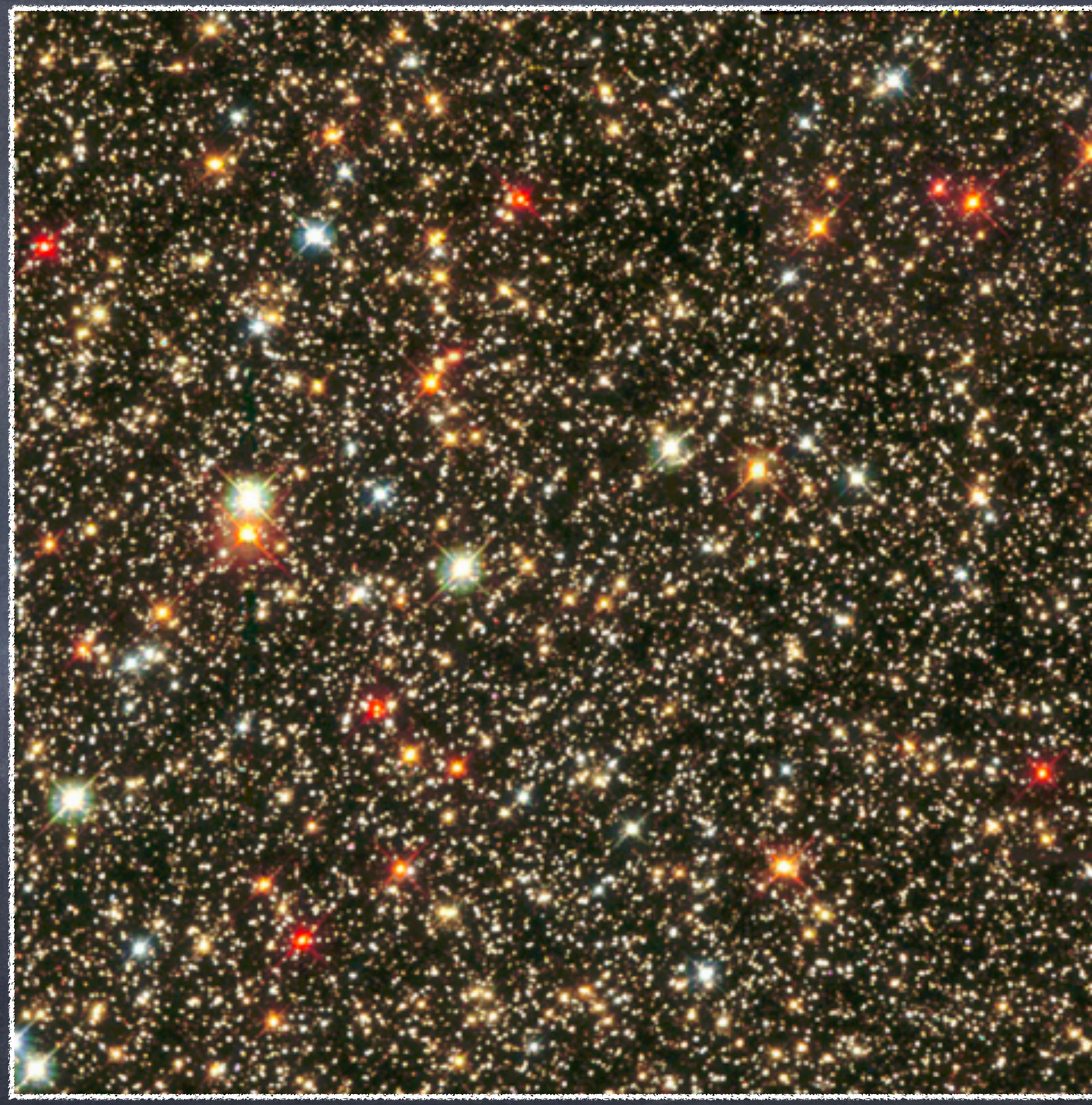
- Luminosity – this is a measure of the total energy in all wavelengths emitted by an object per time interval (Watts). We will measure in terms of the sun (L_{sun}).
- Apparent Brightness – How bright something appears to an observer. Depends on its luminosity and its distance. Astronomers measure in magnitudes which is a terrible system. If we know an object's luminosity and measure the apparent brightness we can infer its distance.

Astronomy has an ancient and terrible system of measuring brightness called magnitudes. In this system smaller numbers are brighter and every 5 corresponds to an object being 100 times brighter.



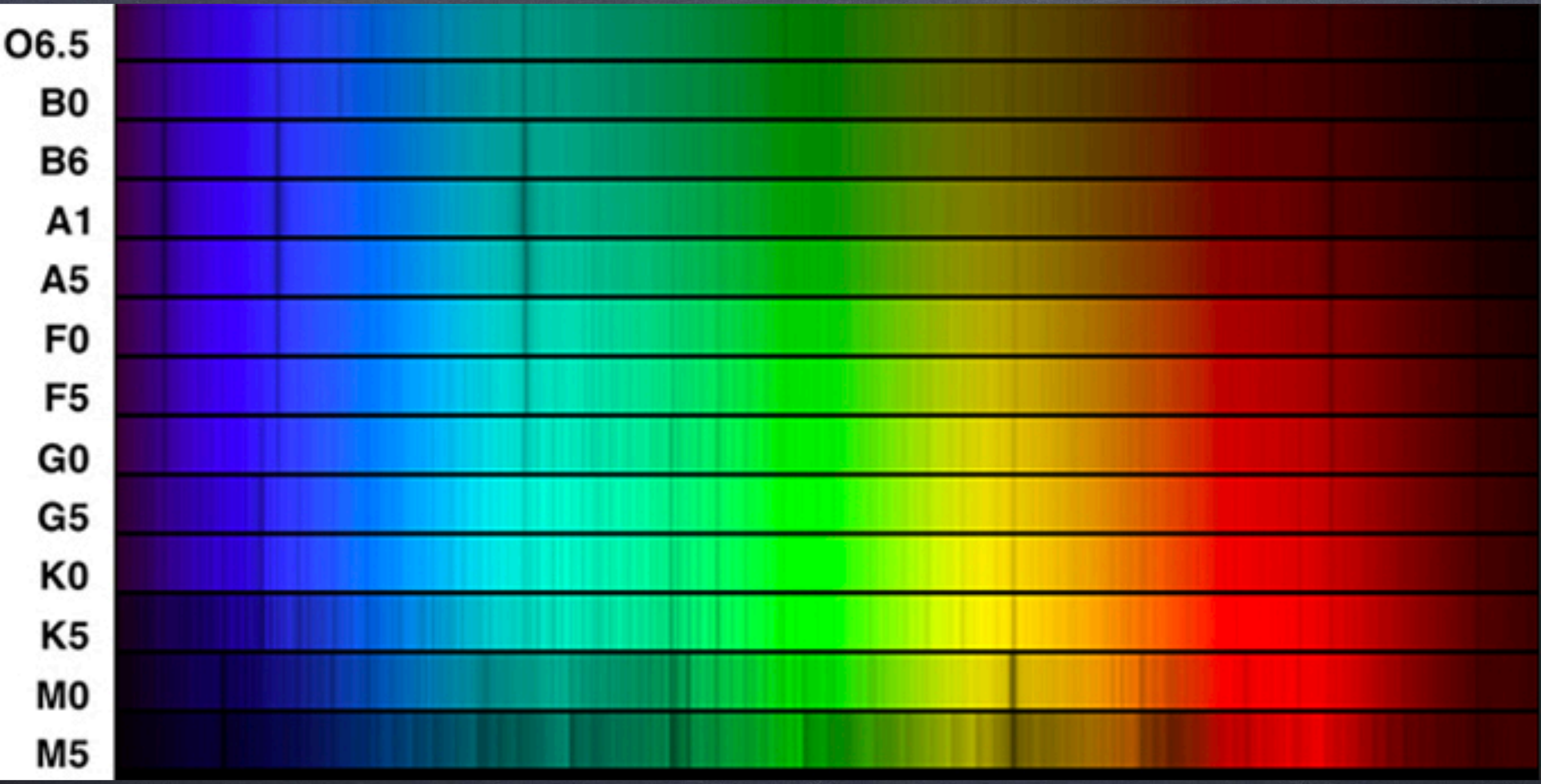
Colors of Stars

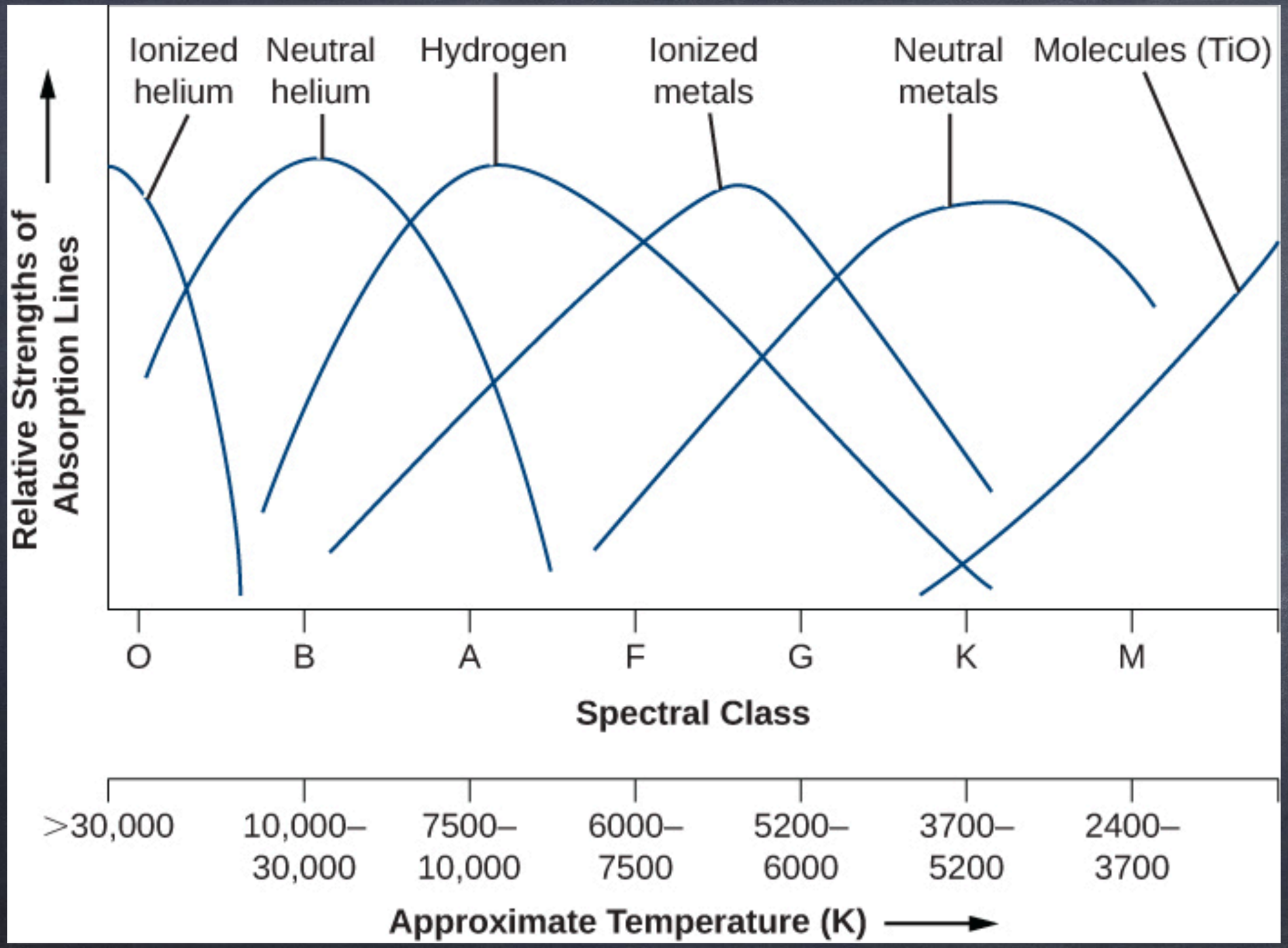
- The color of a star depends on its surface temperature. Color doesn't depend on distance.
  - Blue - 25,000K
  - White - 10,000K
  - Yellow - 6000K
  - Orange - 4000K
  - Red - 3000K



Stellar Spectral Classification

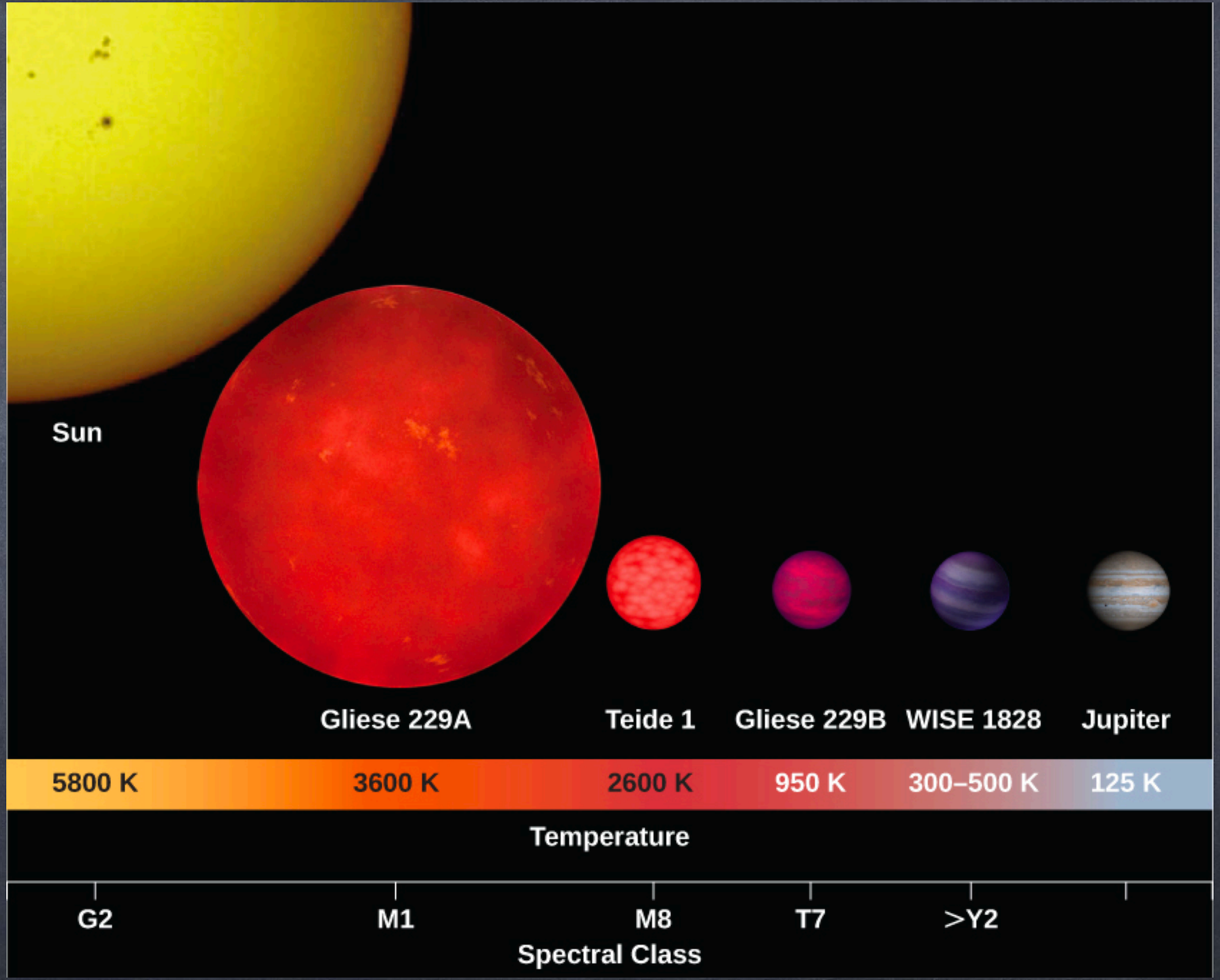
- The spectra of a star reveal more information then just their temperature. Different spectral lines are visible in different stars.
- These differences are also because of temperature as different elements are ionized at different temperatures. These lines can be a more accurate measure of the stars temperature.
- Stars are classified by their spectral lines in an archaic system that runs from hottest to coolest as: O, B, A, F, G, K, M.


O6.5
B0
B6
A1
A5
F0
F5
G0
G5
K0
K5
M0
M5



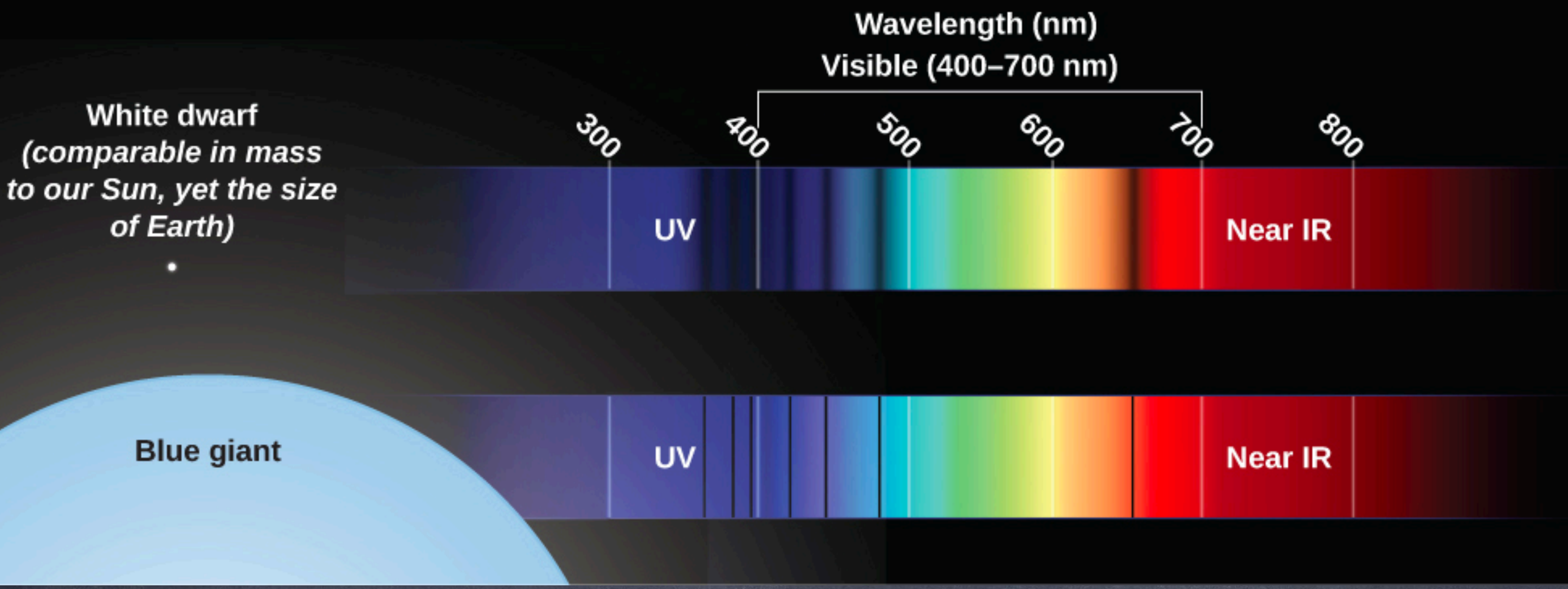
L, T and Y classes have been added for brown dwarfs. These are cooler less bright 'stars' and so weren't discovered in large numbers until the 90s

Brown dwarfs are much cooler, fainter and smaller than 'normal' stars. The smallest are only slightly bigger than a large planet. The dividing line is that brown dwarfs fuse deuterium while planets have no fusion. This line is though to be at 1.2% the sun's mass or 13 times Jupiter's mass



Spectral Information

- Spectra can also tell us a lot more about a star.
- Pressure - it can tell us the pressure in the star which tells us if it is dense or puffy.
- Radial Velocity - the speed of the star along the lines towards us.
- Rotation - the rotation rate of the star.

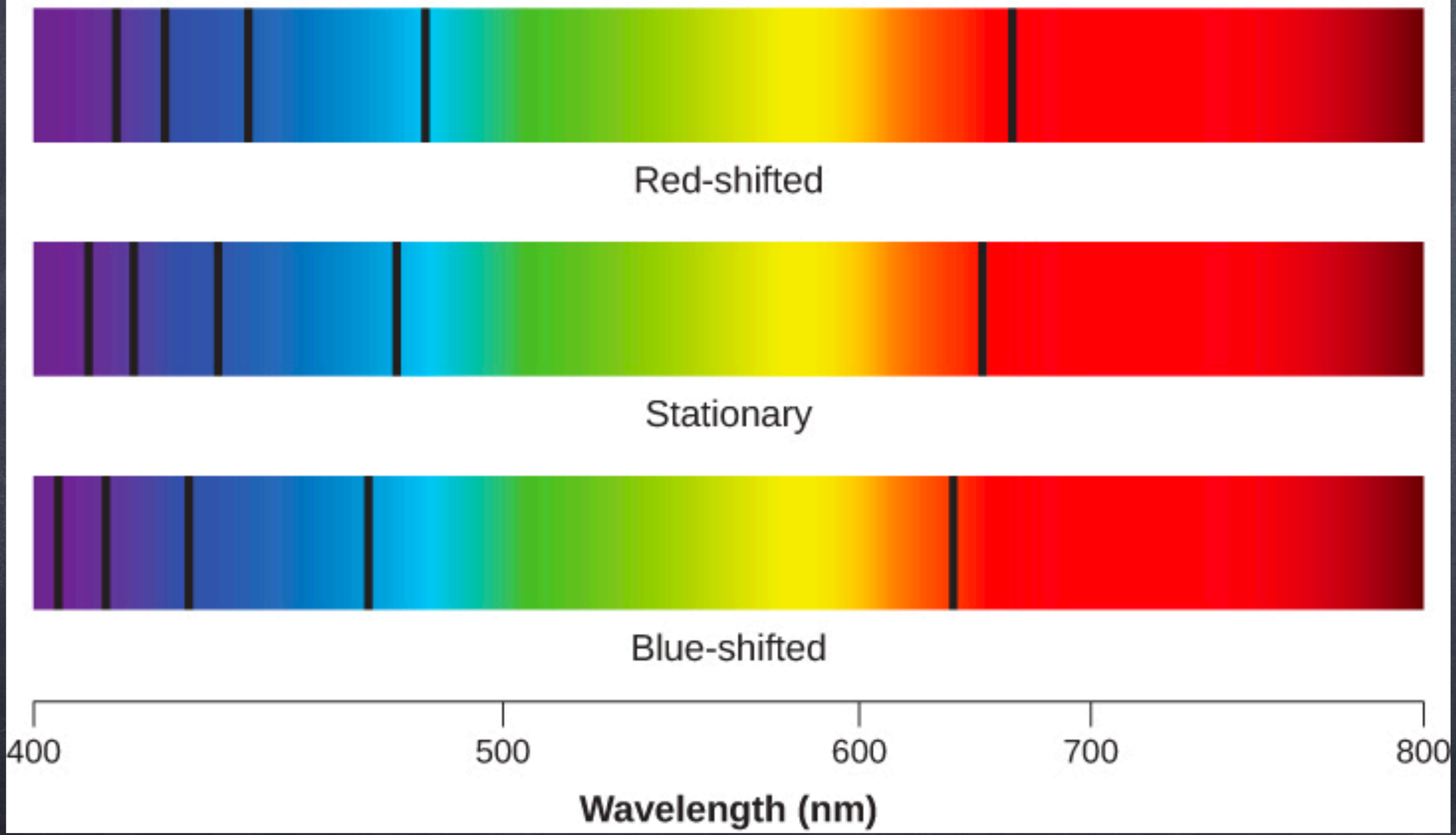


The spectral lines become thicker when the star is denser and thinner when less dense. This is called pressure broadening.

Radial Velocities

- We learned about the Doppler shift, the shift in any wave that occurs because of motion between the emitter and the observer.
- This is only motion towards or away from one another, transverse motion doesn't cause a Doppler shift.
- This shift can be used to measure the speed a star is moving toward or away from us which is called its radial velocity.

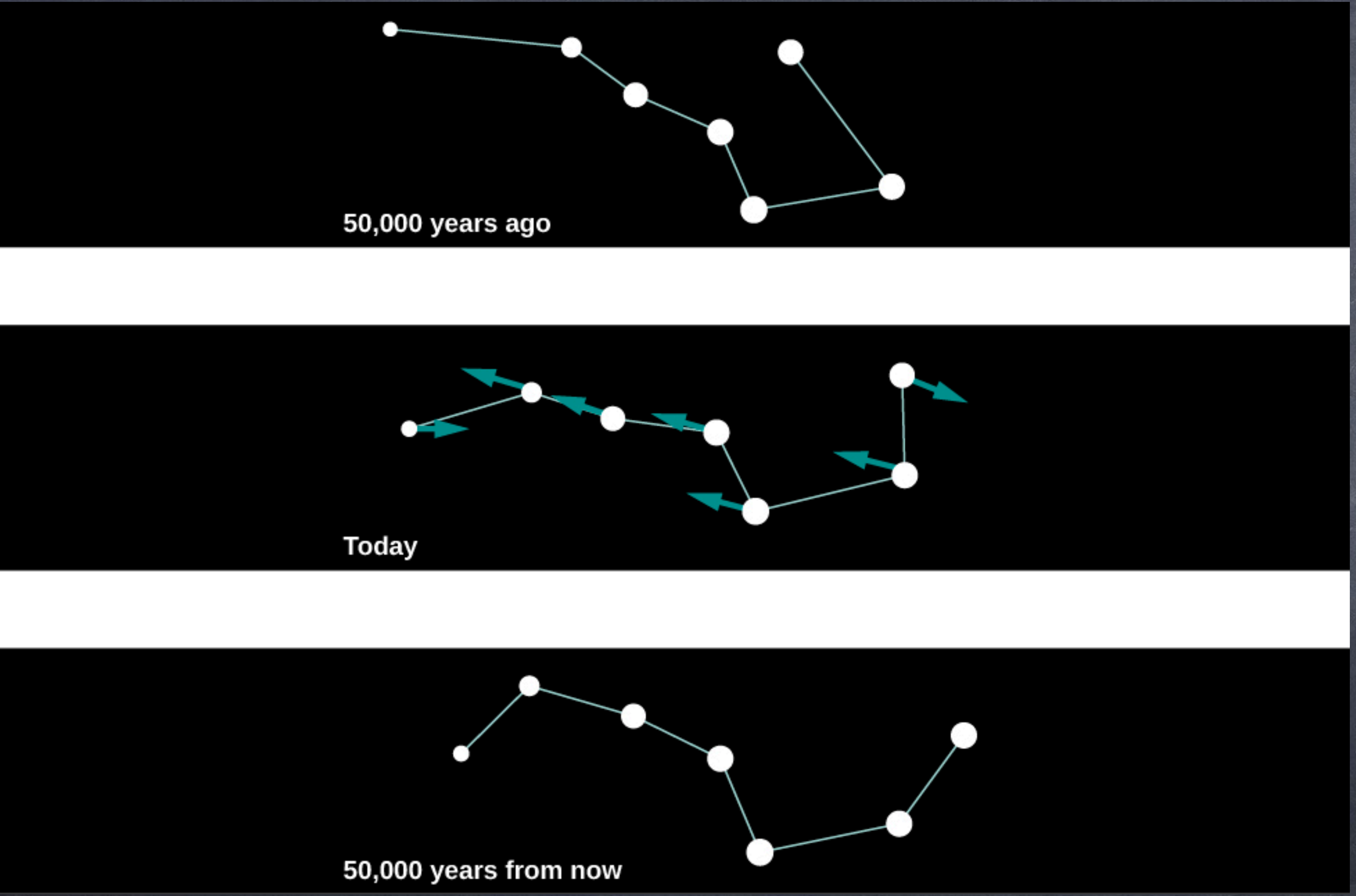
The Doppler Shift



Proper (Transverse) Motion

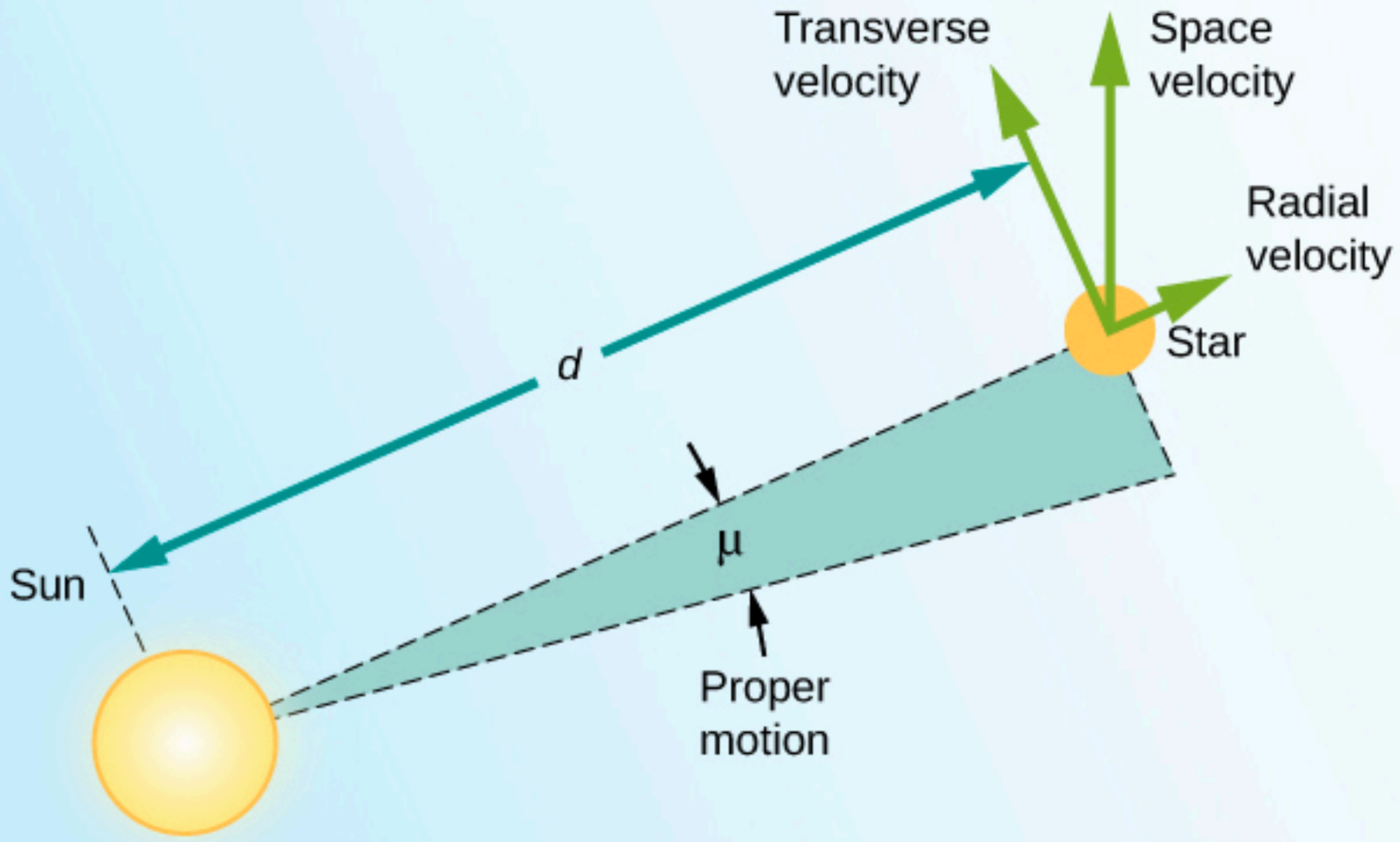
We can also measure the transverse motion (called proper in astronomy) of objects if we have images over long baselines. The problem is that stars move very slowly, in terms of angle, over the years. So we can only observe the fastest stars or need incredible precession.

(a) (b) (c)



The stars move, just slowly compared to our lives.

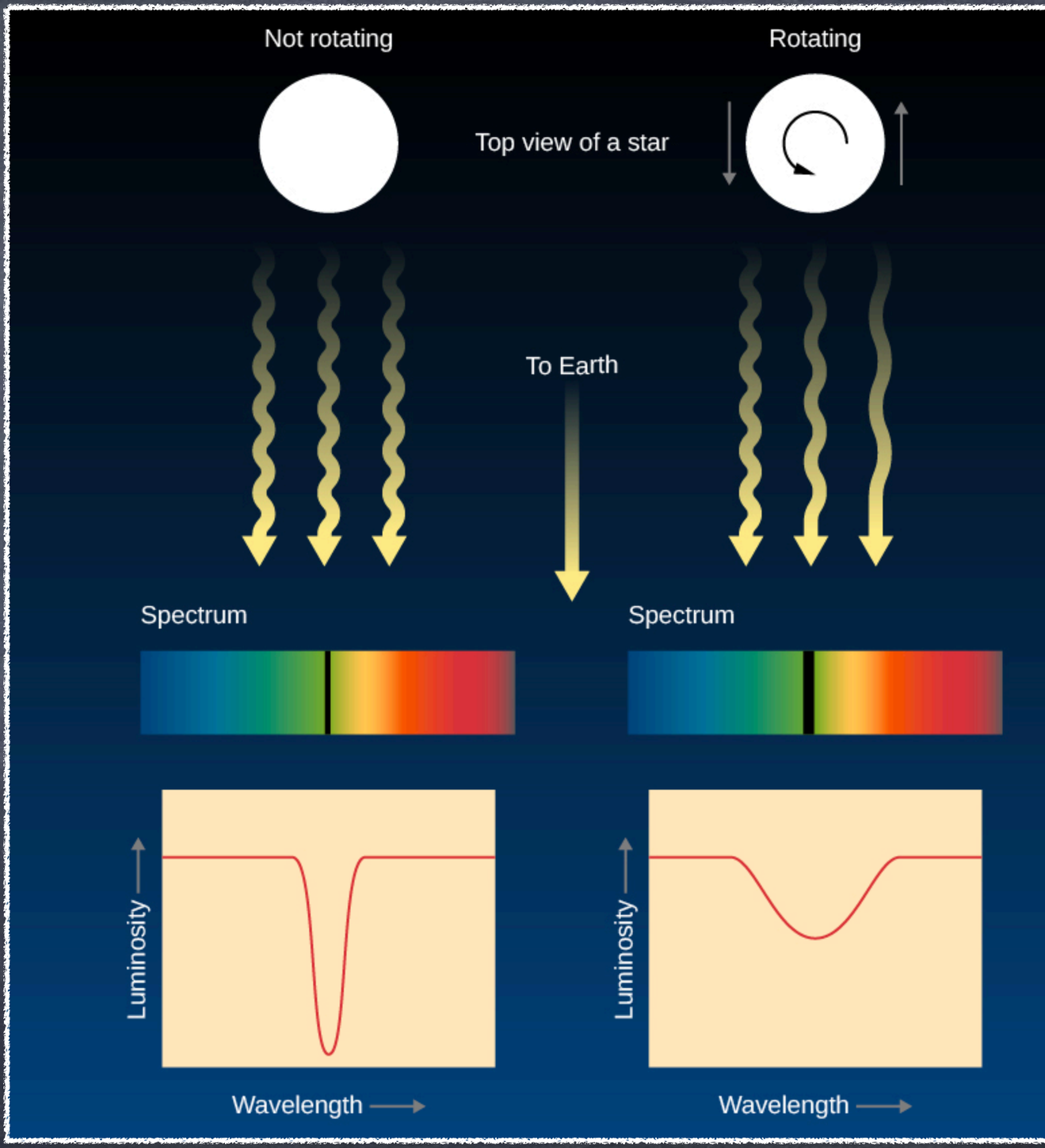
The true speed of a star is a combination of its radial and transverse velocities.



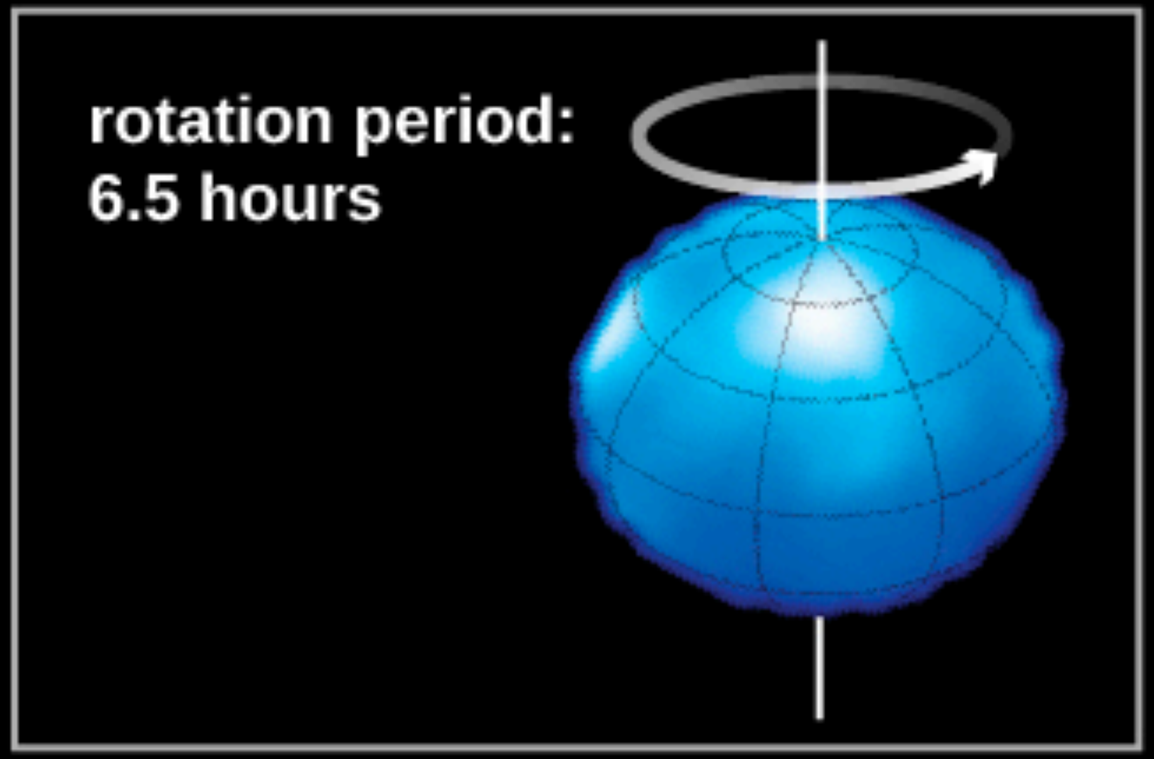
Proper Motion and Velocity of a Star

Star's Rotation

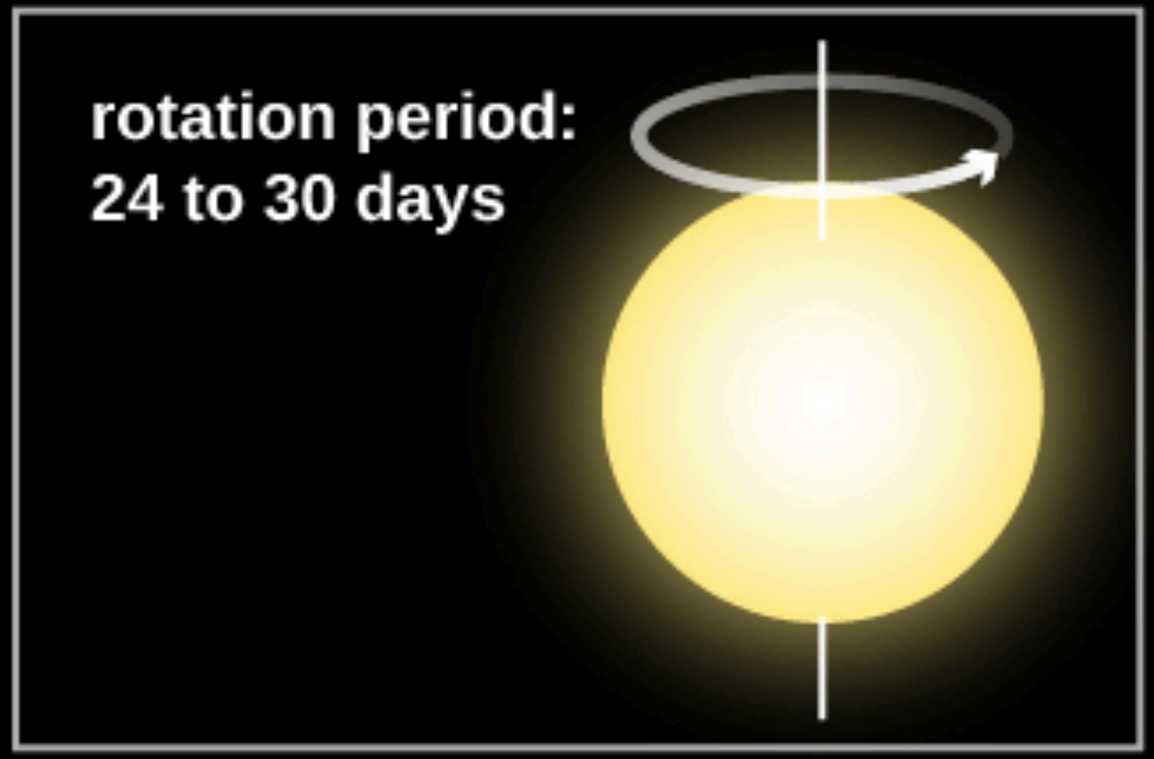
- The rotation of a star can be measured because it causes one side to be moving towards us and one side to be moving away.
- This causes Doppler shifts in both directions which spreads out the spectral line.
- The width of the line gives us the rotation. But notice just like with velocity this is rotation towards and away from us.



Altair



The Sun



From these studies we have learned that young stars rotate very fast, tens of hours instead of days. This high rate of rotation causes the star to bulge and becoming oval instead of spherical.