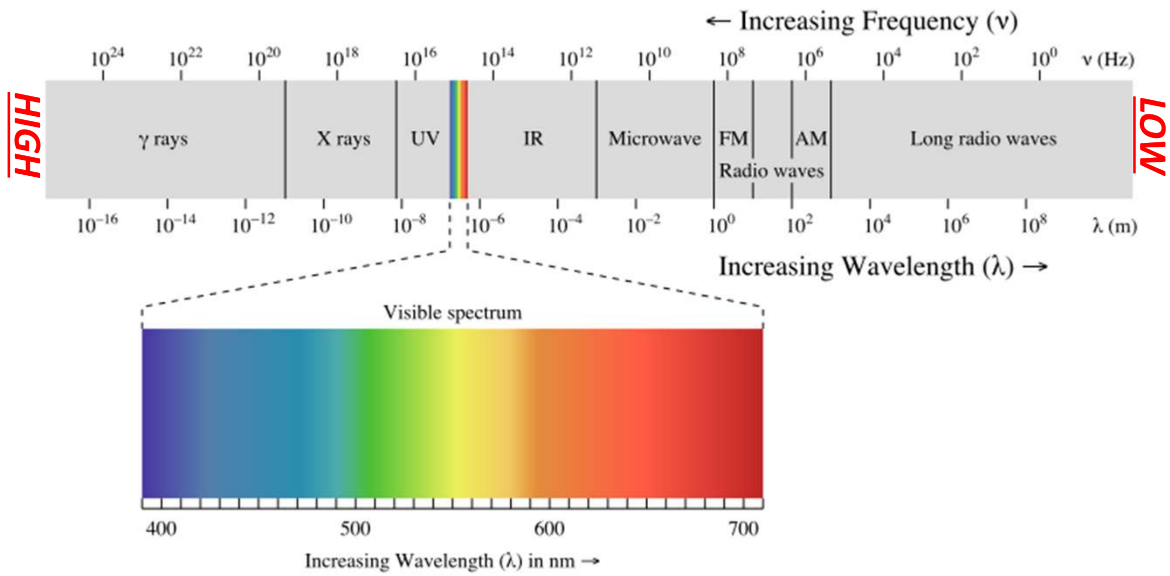
STARS
Wien's Law

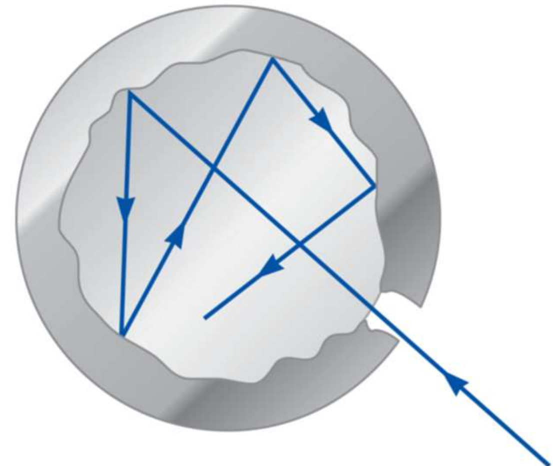
Overview

This lesson assumes some familiarity with the EM Spectrum and the basic properties of light.

Here we will take our understanding of light, with its varying wavelengths and frequencies, and relate them to temperature.

This is the next step in understanding the properties of celestial objects.





Blackbody – The Ideal Absorber

A blackbody is a theoretical object that absorbs 100% of the EM radiation that hits it. Thus, it is a surface that absorbs all radiant energy falling on it.

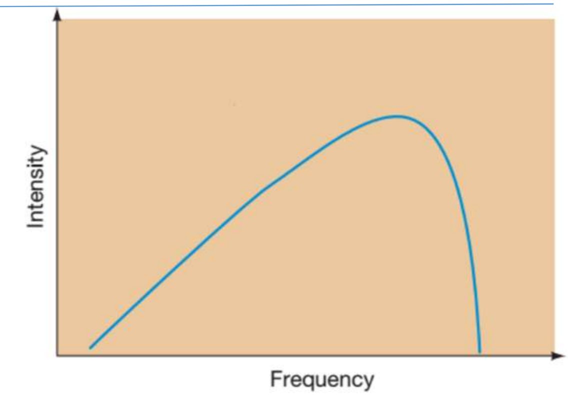
As a rough approximation, we can say that the stars radiate like blackbodys.

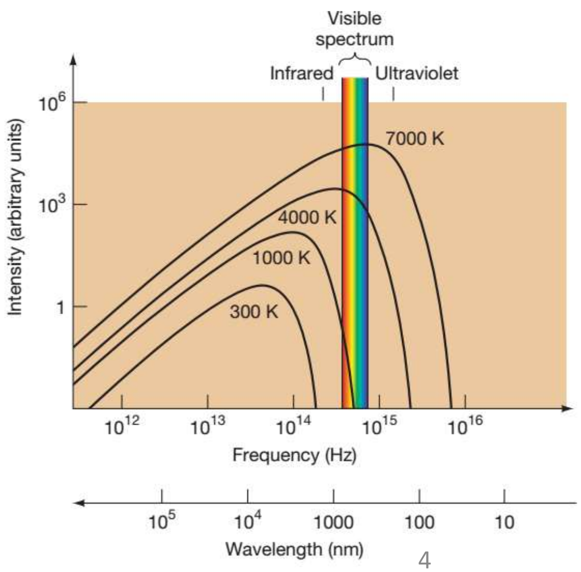
This is important because it means that we can use the theory for blackbody radiators to infer things about stars.

Blackbody – The Ideal Absorber

In a steady state, it will reemit the energy that is absorbed. This can be represented in a curve called a Blackbody Curve and its shape represents the spread of emitted radiation across a variety of wavelengths based on temperature.

As temperature changes, the intensity of the curve will change, however the shape will remain the same.

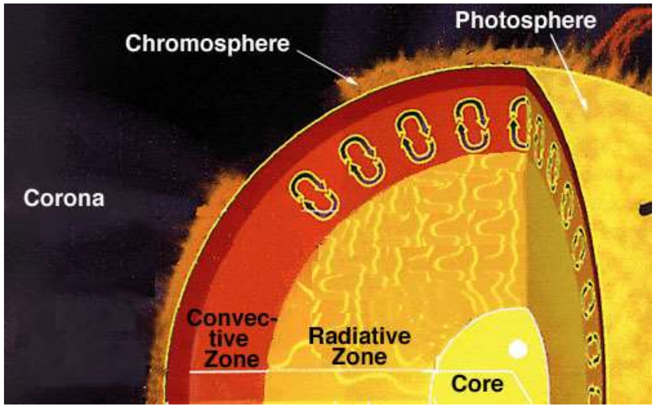




Blackbodies in Use

Stars/Blackbodies at different temperatures emit peak radiation (heat energy) at different wavelengths (colors) based on their temperature-related thermal self-radiation.

Therefore has a specific intensity that depends only on the body's temperature, which theory assumes is uniform and constant.



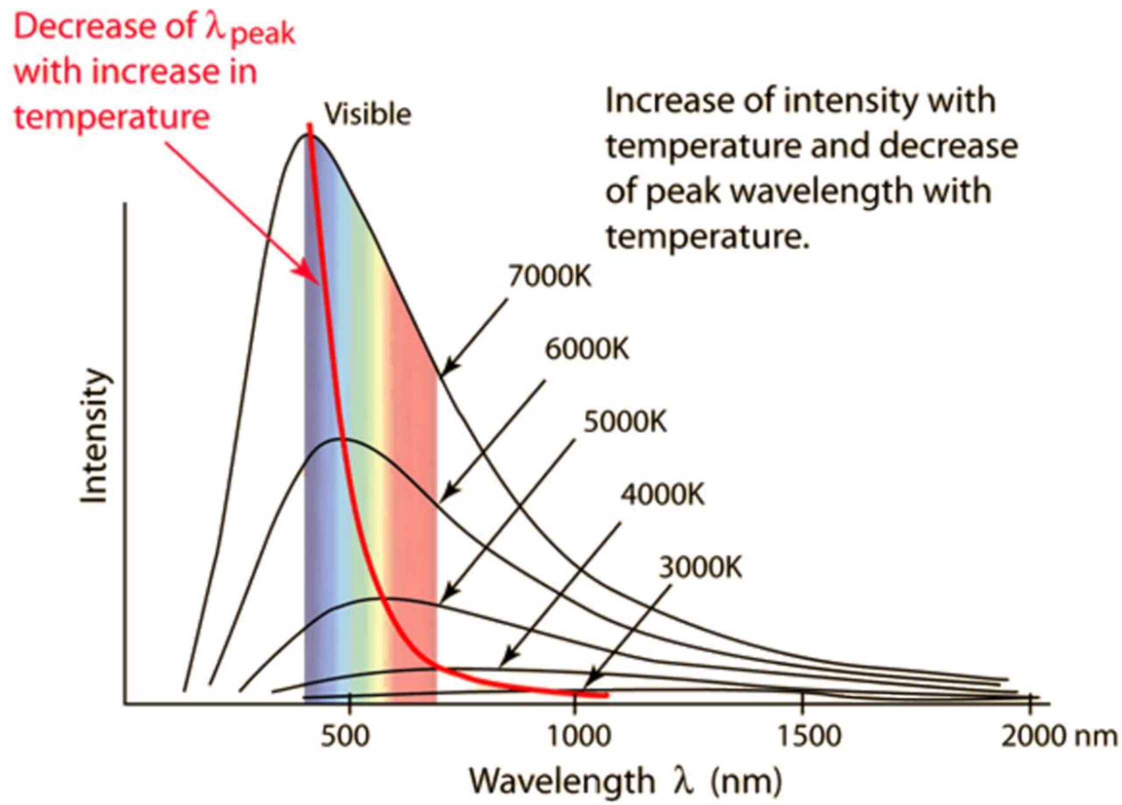
Blackbodies and Wien's Law

All matter with a temperature above 0 K, emits EM at all wavelengths.

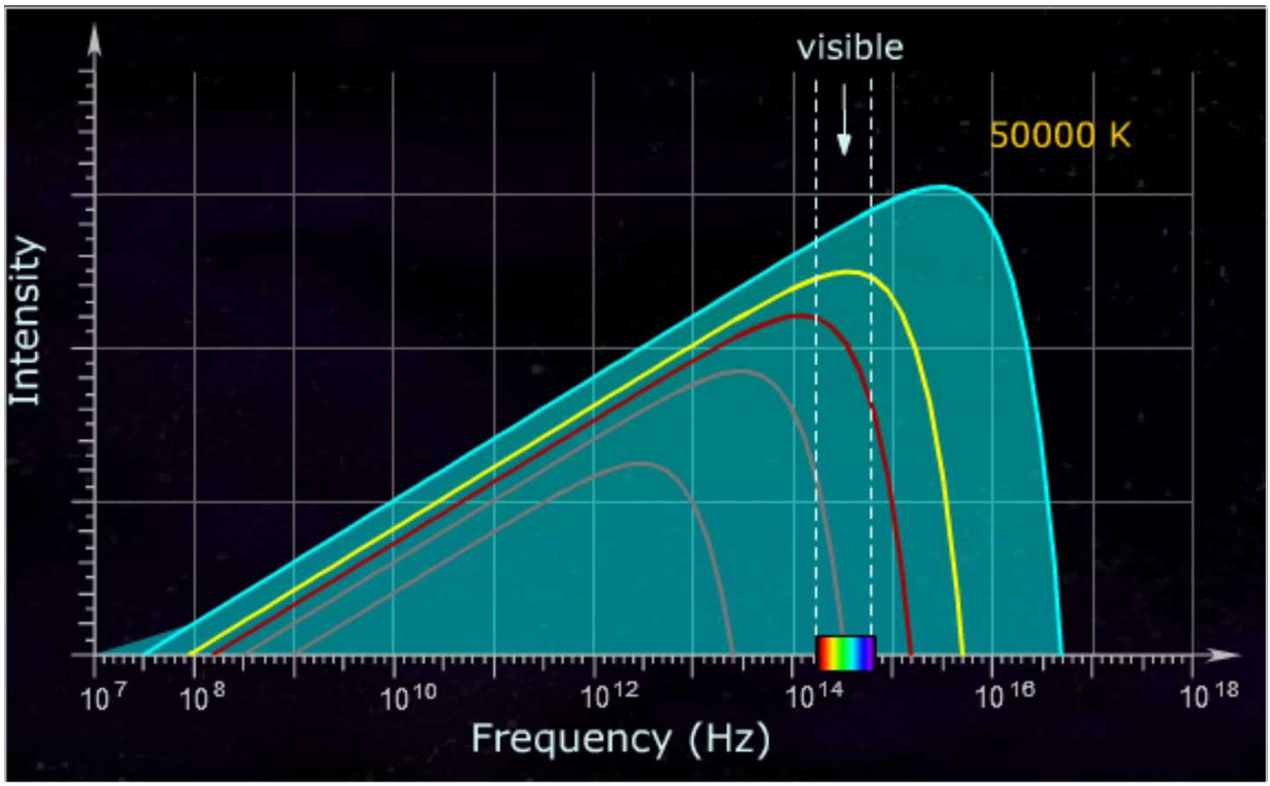
The temperature directly impacts the peak wavelength (See the plot on the right).

$$\text{wavelength of peak emission} \propto \frac{1}{\text{temperature}}$$

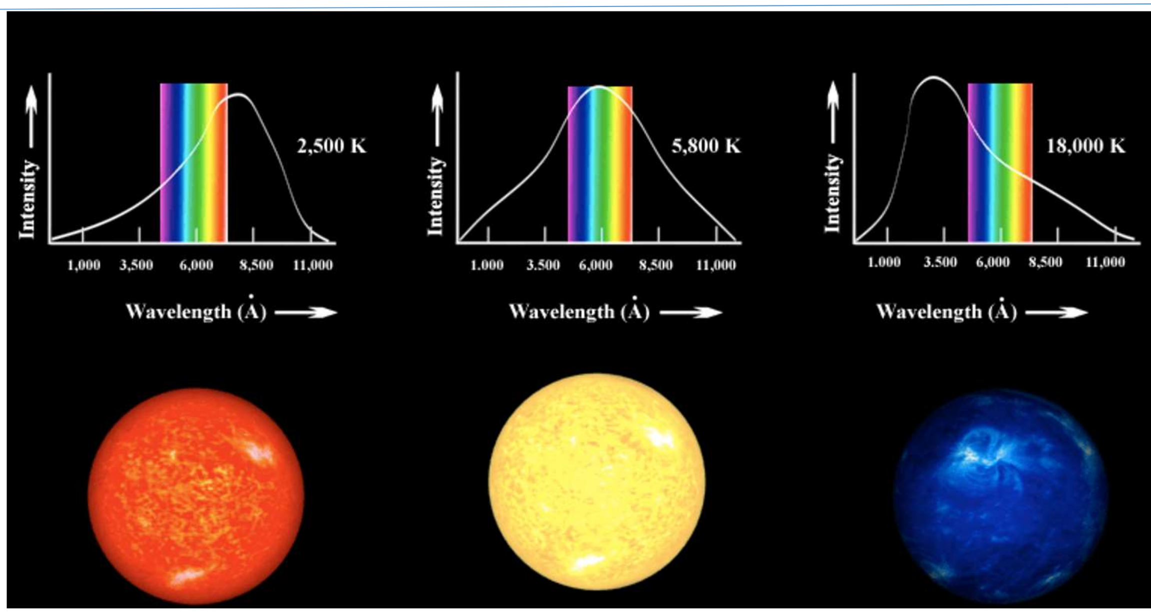
As temperature increases, the intensity increases. The converse is true.



Example


visible
50000 K
Intensity
10 7
10 8
10 10
10 12
10 14
10 16
10 18
Frequency (Hz)

In Use


2,500 K
5,800 K
18,000 K
Intensity
1,000 3,500 6,000 8,500 11,000
Wavelength (Å)


O B A F G K M

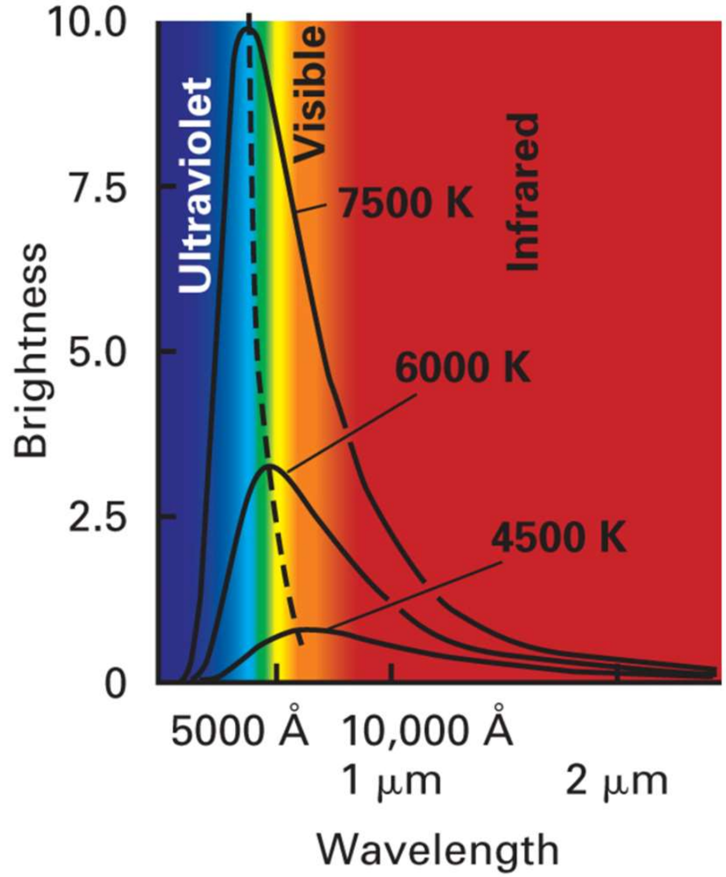
Summary

Peak wavelength is directly related to temperature

Hotter objects are Brighter at ALL wavelengths

Temperature: Measure of average speed of particles within (Kelvin Scale).

- High temp, shorter wavelengths = HOTTER IS BLUER
- Low temp, longer wavelengths = COOLER IS REDDER



Questions?

Basic Laws of Radiation

1. All objects emit radiant energy (that are above 0 Kelvin).
2. Hotter objects emit more energy than colder objects (per unit area). The amount of energy radiated is proportional to the temperature of the object.
3. The hotter the object, the shorter the wavelength (λ) of emitted energy.
4. Objects emit radiation in many wavelengths, not a single wavelength.