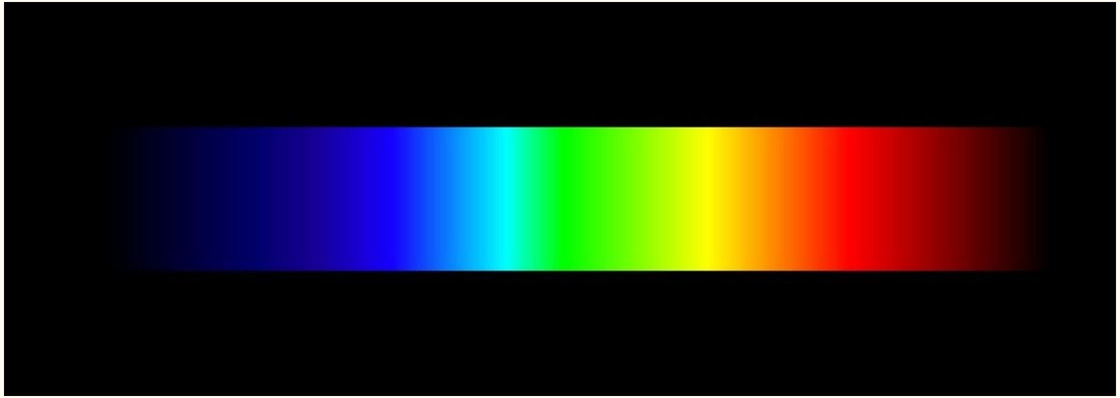
The Electromagnetic Spectrum

Sgt Song

What is the Electromagnetic Spectrum?

- The range of all light that exists. Our Sun radiates all kinds of ‘light’, but only a tiny sliver of the spectrum is visible to us



Visible Spectrum, or Continuous Spectrum

These are the types of energy that are emitted, through electric and magnetic radiation.

Frequency: the number of waves that pass through a point per second

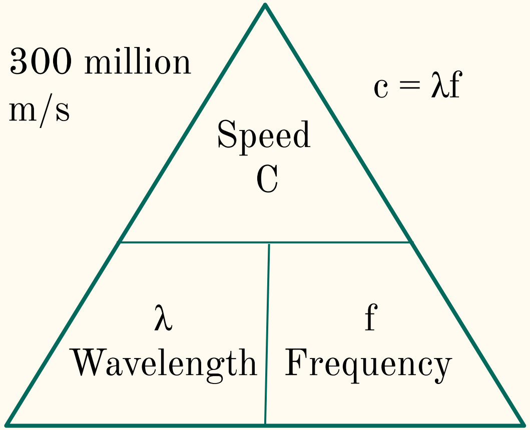
Wavelength: the distance between one crest to another

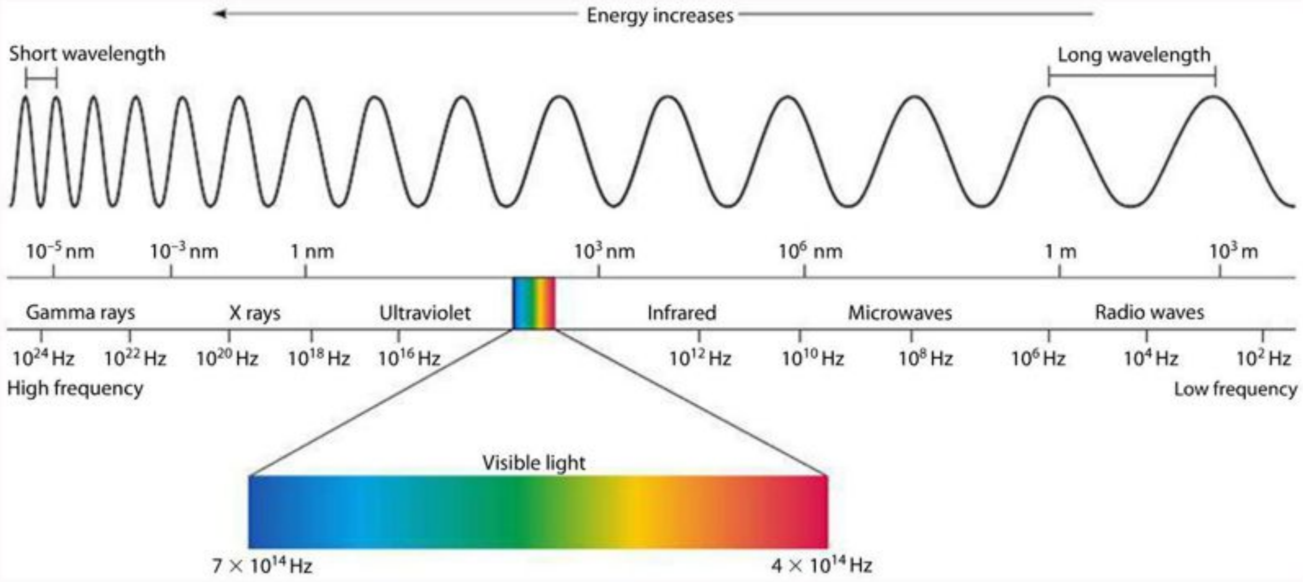
Inversely proportional: the higher the frequency, the shorter the wavelength. The lower the frequency, the longer the wavelength

Frequency*Wavelength = speed of light

300 million m/s

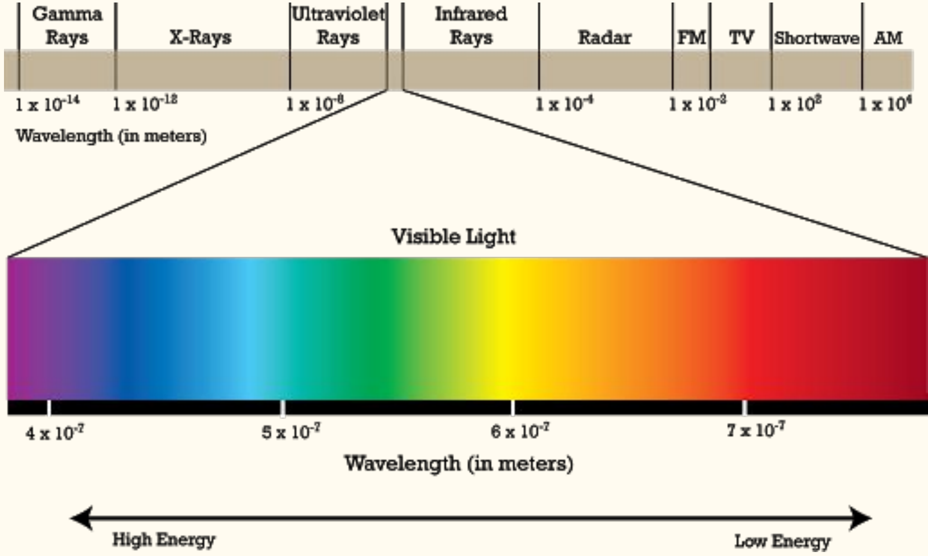
$c = \lambda f$





Types of Electromagnetic Waves

Radio Waves
Used for: Radio and TV broadcasts, remote controlled gadgets
Microwaves
Used for: Cooking food, cell phone communication
Infrared
Used for: Night vision goggles
Visible
Used for: Seeing colours
Ultraviolet
Used for: killing bacteria, getting vitamin D
X-rays
Used for: x-ray pictures
Gamma rays
Used for: Cancer treatment (radiotherapy)



Did You Know?

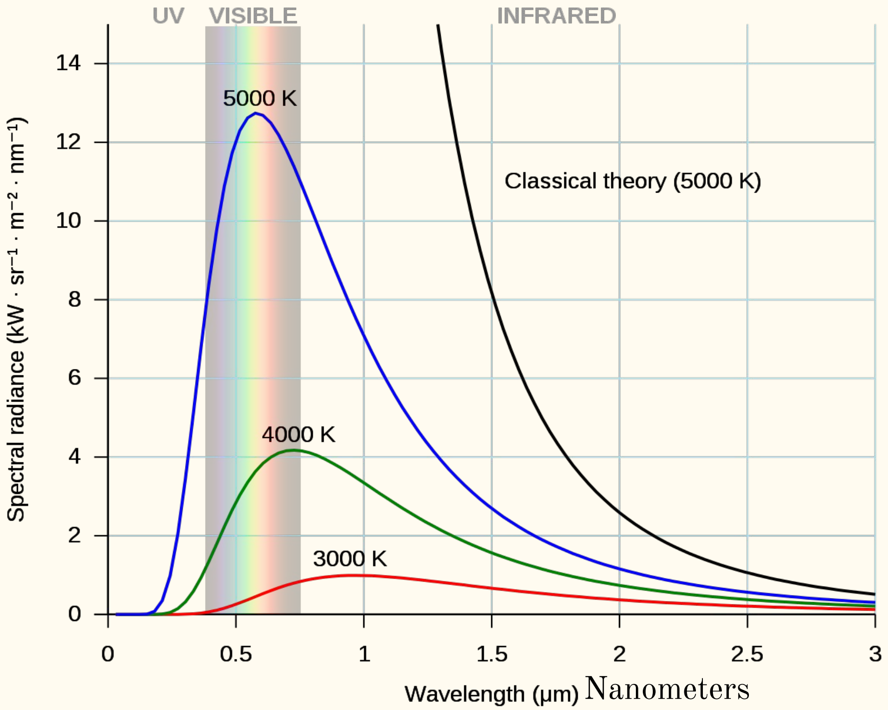
All objects including humans, emit radiation. The frequency of radiation is based on the temperature of the object.

Fire: 1900K

Humans: 310K

Sun: 6000 K

How powerful/intense it is



Nanometers

Summary

Confirmation:

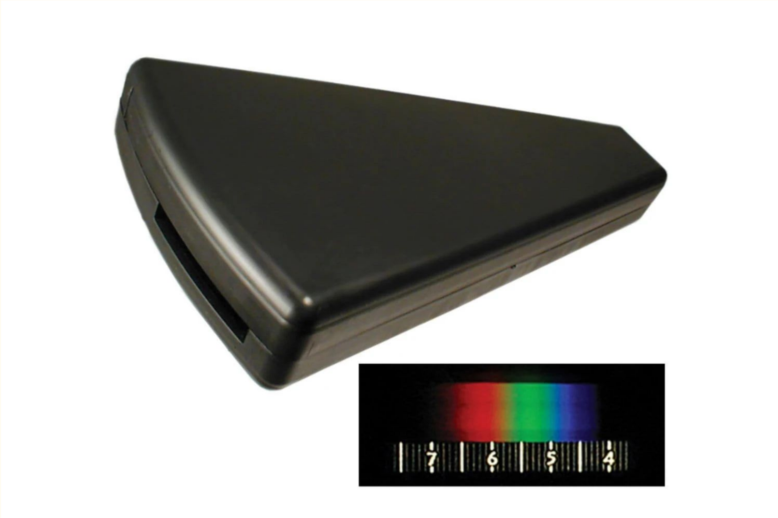
What is the speed of light?	Frequency * Wavelength (300 million m/s)
What type of radiation has the highest frequency?	Gamma rays
What type of radiation has the lowest frequency?	Radio waves
The hotter something gets, the ______ the frequency	Higher
A fire is around ____ K	1900 K
A usage of gamma rays are?	Chemotherapy

Classifying Stars Using Spectroscopy

Spectroscopy:

All about studying how matter interacts with electromagnetic radiation

We can learn all about the Composition, Temperature, Motion, and Density of stars using spectroscopy

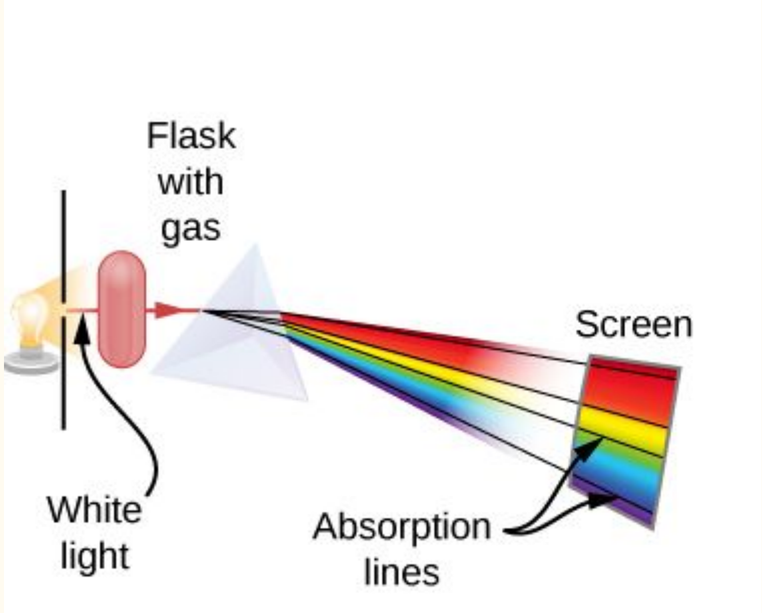


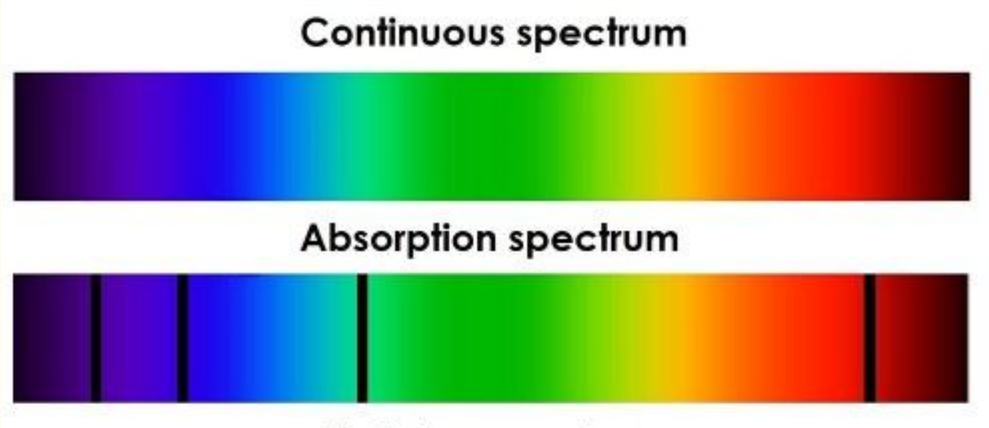
spectroscope

Composition

Composition

When white light is passed through a gas, certain wavelengths are absorbed.

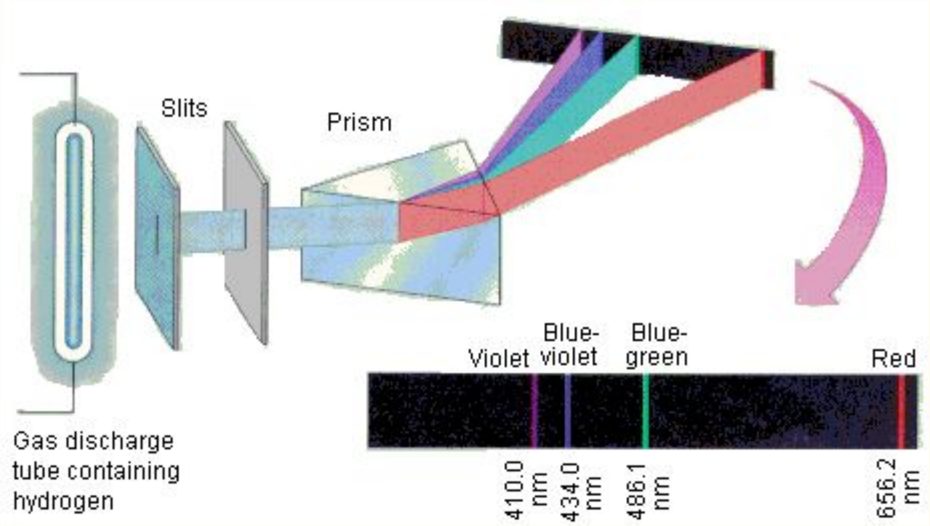


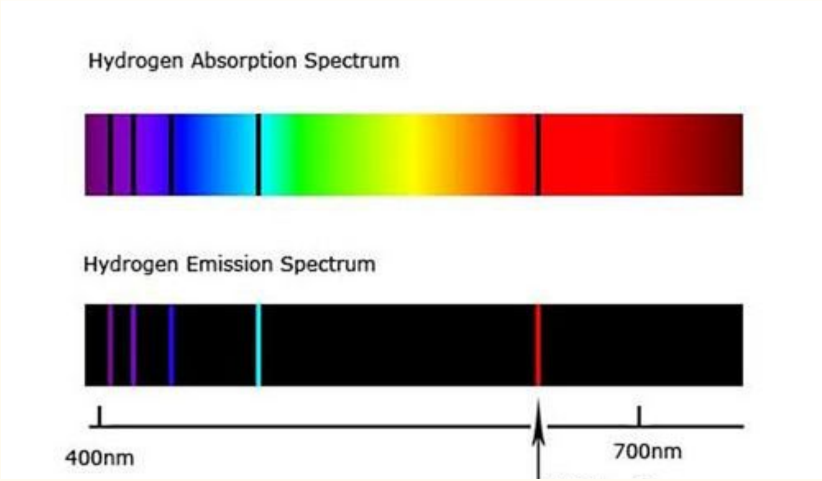


The gas has **absorbed** certain wavelengths

Emission Spectrum

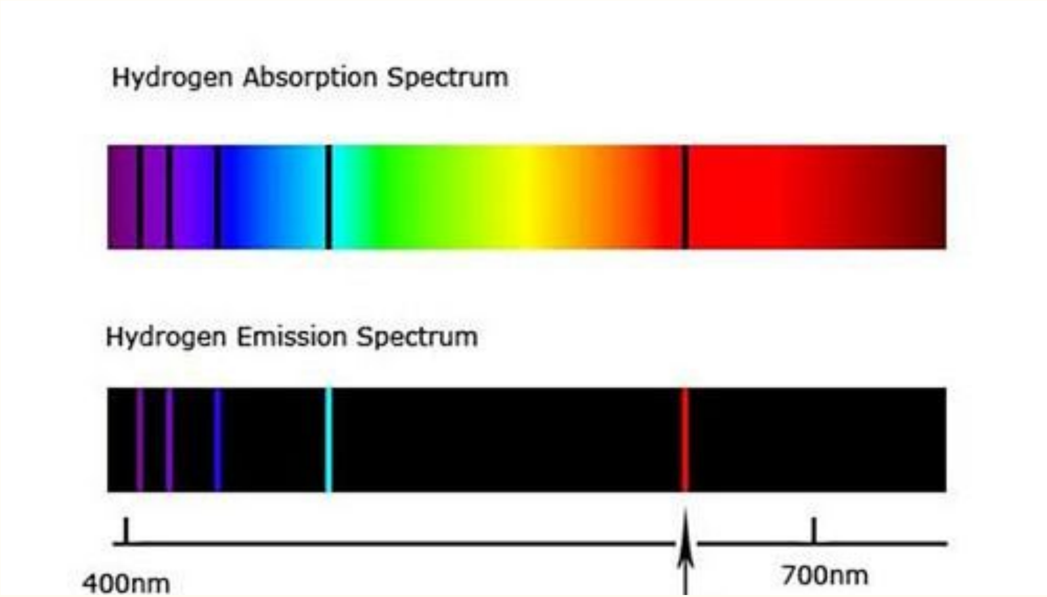
If we heated up this gas until it radiates visible light, it would emit these certain wavelengths





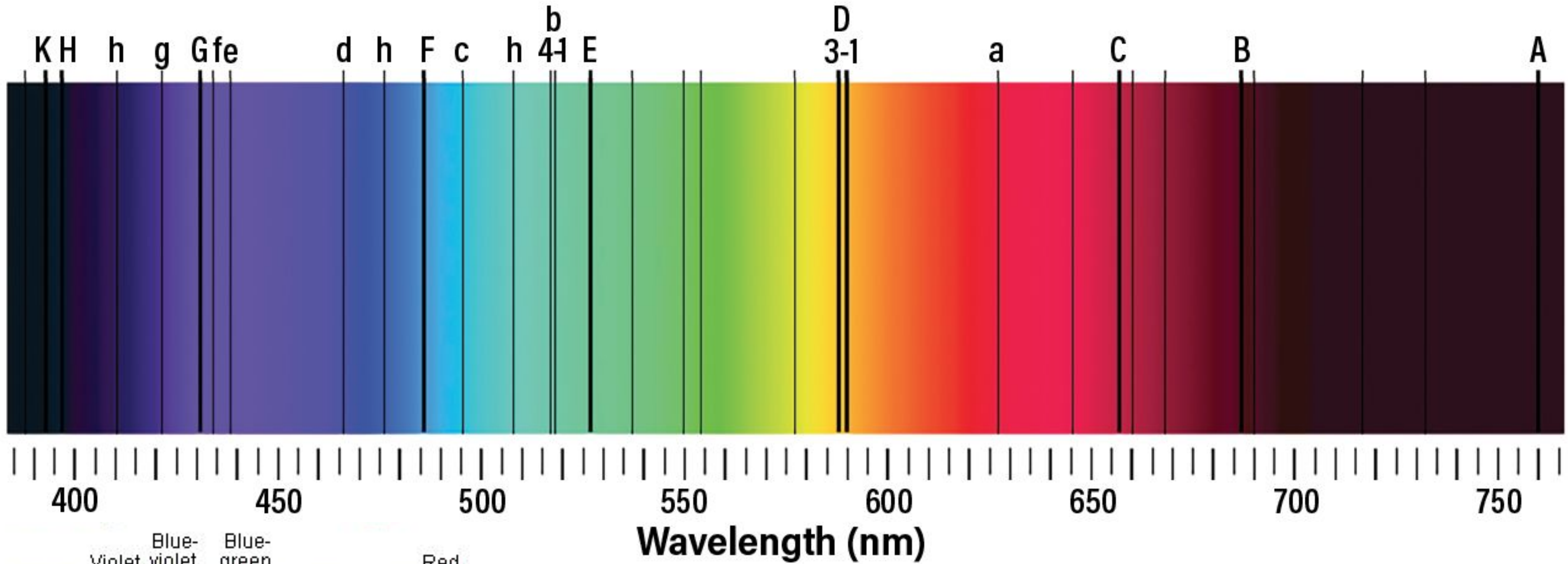
The emission lines and absorption lines correspond to each other

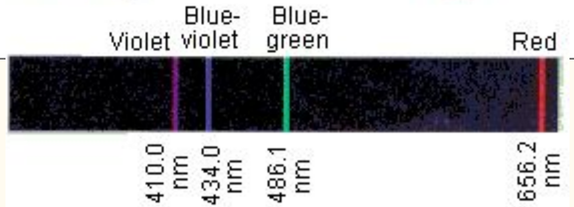
They will always be the same for the same elements



Hydrogen will always be these specific wavelengths

THE SUN'S SPECTRUM





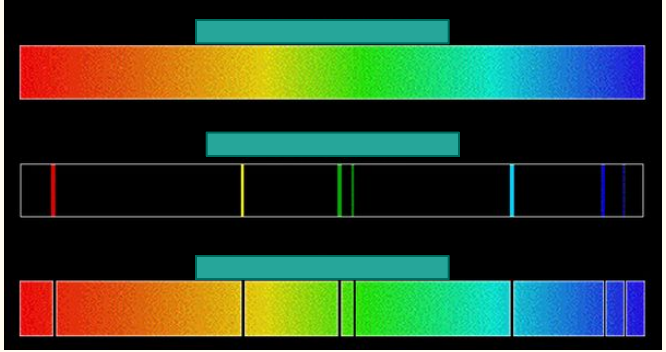
Hydrogen emission lines

Hydrogen= 410 nm, 434 nm, 486.1nm, 656.2 nm

We can prove the presence of hydrogen in the sun (h,f,F,C)

Confirmation:

Name these:



How do we get absorption lines?
Looking at the spectrum of light that has passed through a gas

How do we get emission lines?
Looking at the spectrum of light emitted from a gas

What do we use to view these lines?
A spectrometer

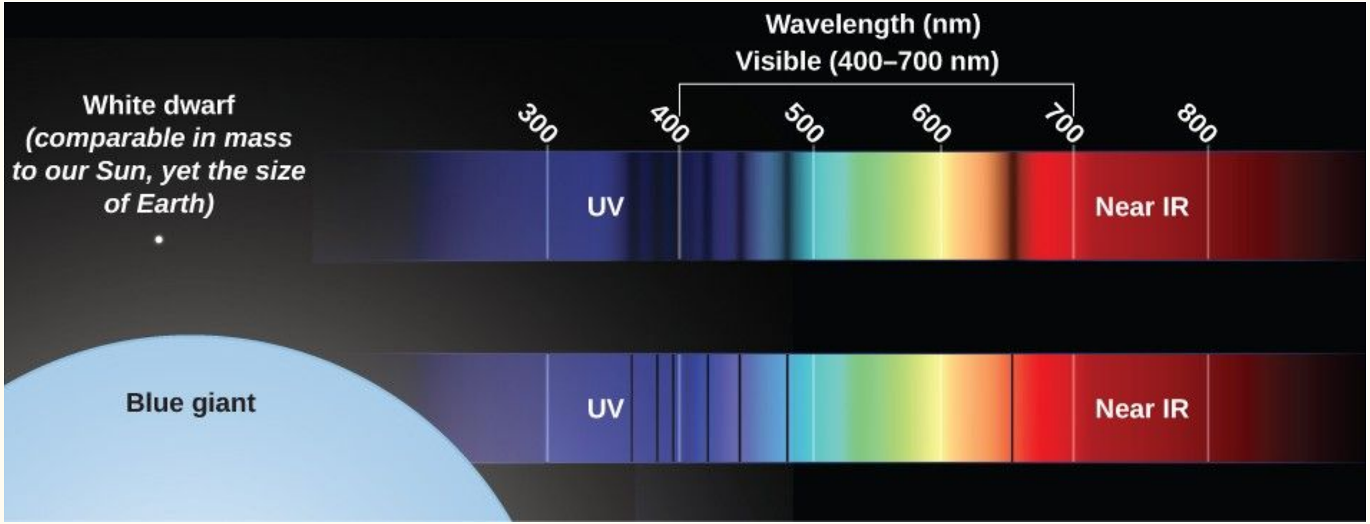
How do we find the composition of stars using this?
By taking the emission lines of different elements, and matching them to the absorption lines of the star.

Density

Density

Small, dense stars cause the spectrum lines to look “muddled”

Giant stars are not as dense, so the lines are more precise

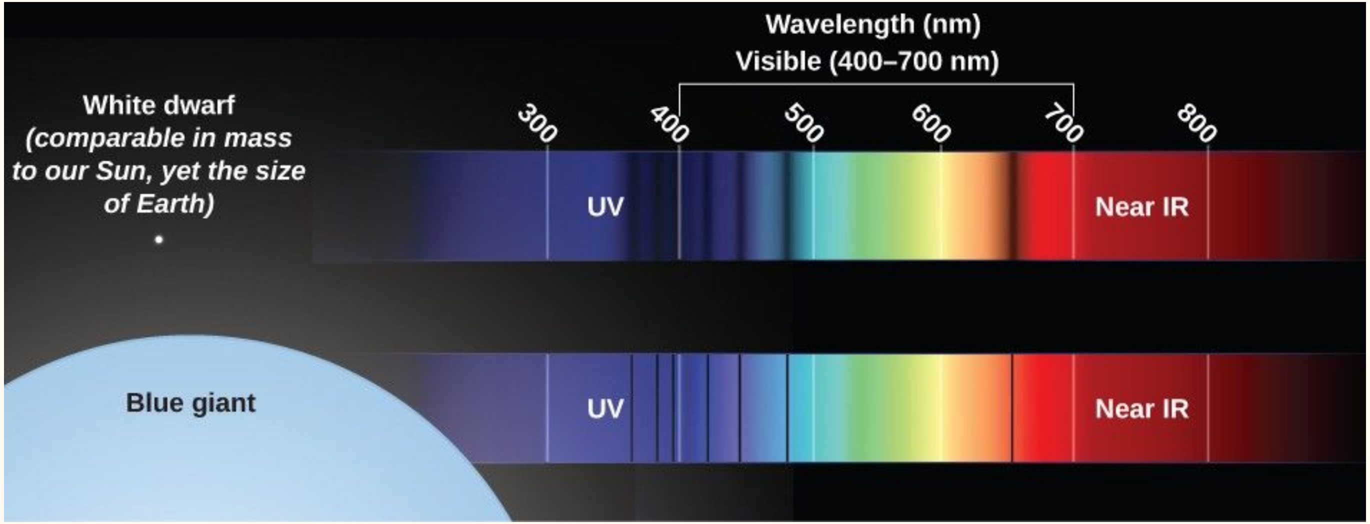


More of the wavelength is blocked when the atmosphere and gas is denser, and less of the wavelength is blocked when the atmosphere is less dense.

Confirmation:

Small, dense stars have thicker emission/absorption lines

Large, not as dense stars have thinner emission/absorption lines



Temperature

Temperature

We can tell the temperature of a star in many ways, but today we'll cover 2 of them

1st is the colour

The bluer a star is, the hotter it is

Why?

https://www.e-education.psu.edu/astro801/content/l4_p2.html

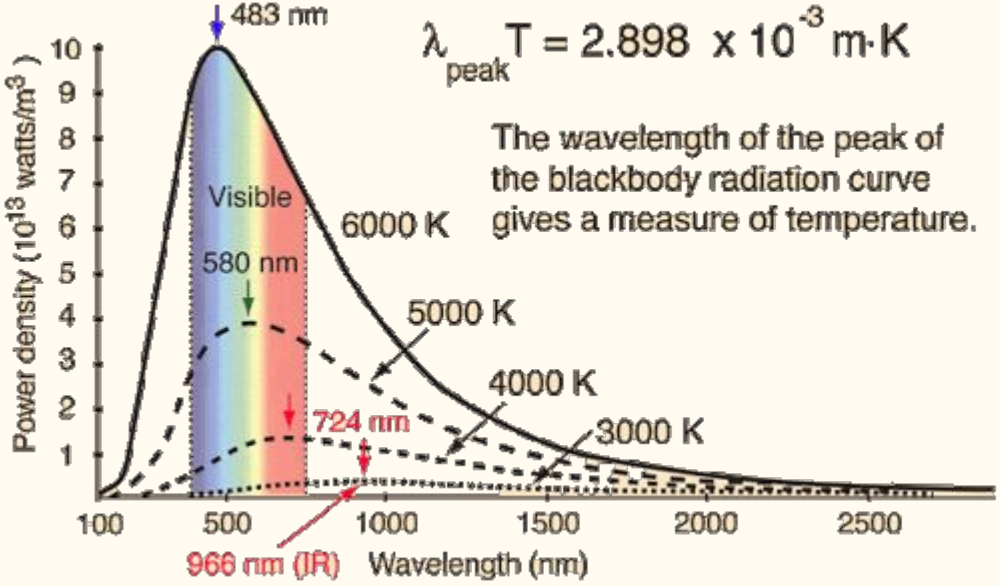
The hotter and higher energy the star is, the more the wavelengths are higher frequencies.

Temperature 2

There's also a math formula you can use to find the temperature.

$\lambda max = b / T$
$T = b/\lambda max$

The λ is the peak of the wavelengths
b is a constant
$b \approx 2898\ \mu m \cdot K$
T= the Temperature
Using this formula, you can calculate the temperature if you have this max wave point



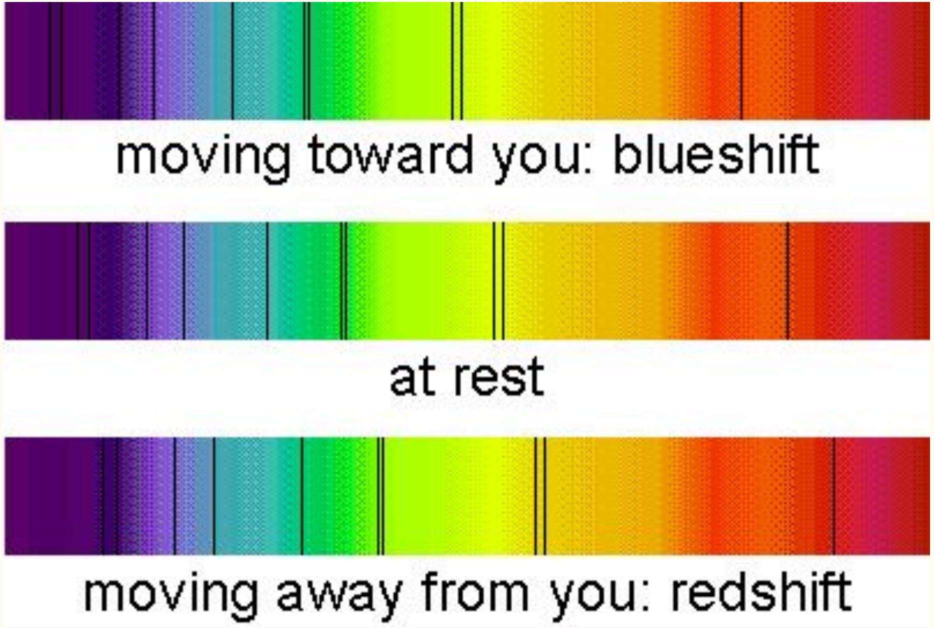
Motion

The Doppler Effect

Brief review

The frequencies of stars moving away from us are lower and red shifted

The frequencies of stars moving towards us are higher and blue shifted

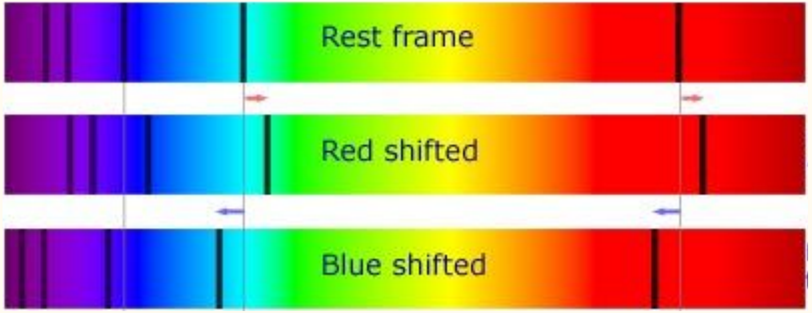


Summary

Motion of stars

The doppler effect

The absorption lines are shifted either blue or red, telling us whether it's moving towards us or away from us



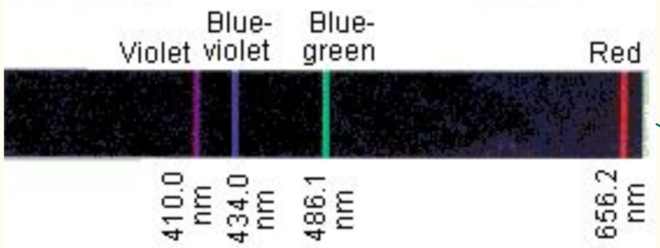
Hydrogen

Hydrogen in a star moving away from us

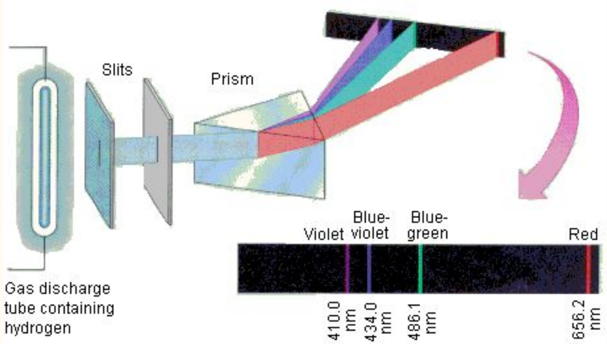
Hydrogen in a star moving towards us

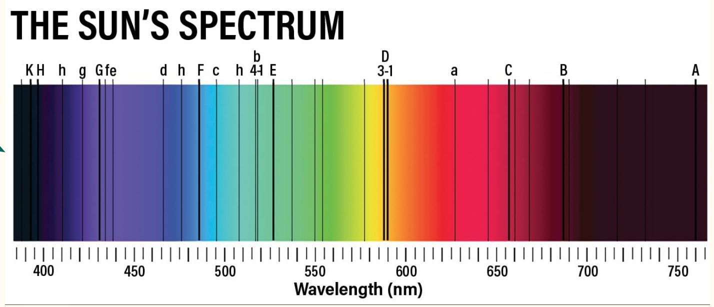
Composition of stars

Taking the electromagnetic radiation from stars and looking at their absorption spectrum, and matching them to the absorption spectrum of different elements from Earth.



Hydrogen's emission spectrum



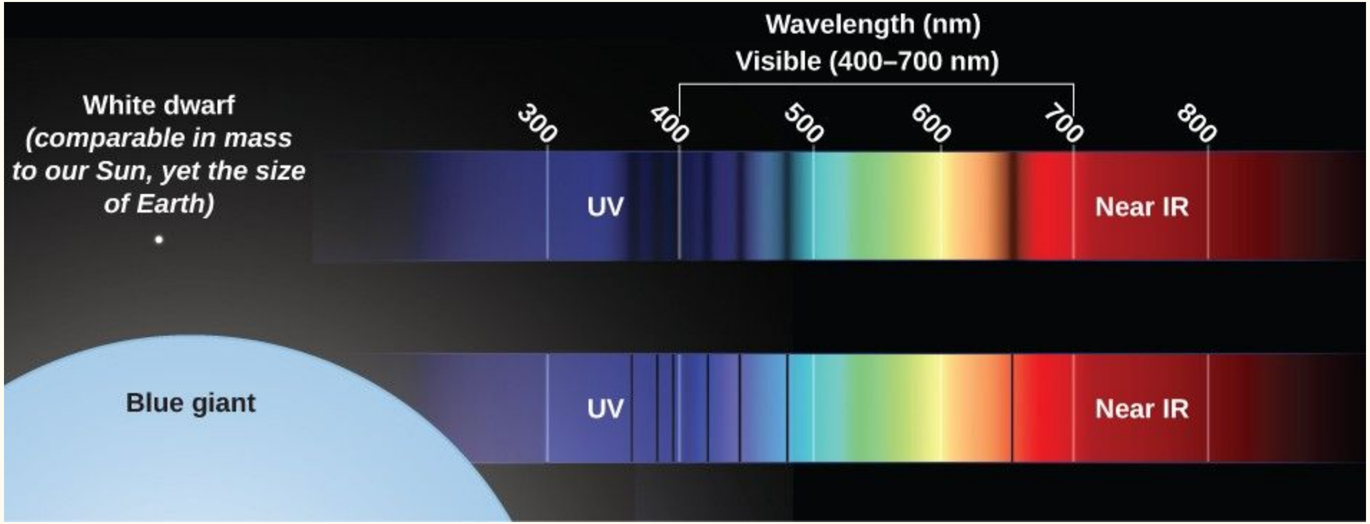


Match hydrogen emission spectrum to the sun's absorption spectrum

Density of stars

An absorption spectrum with thicker lines equals a smaller and denser star

An absorption spectrum with thinner lines equals a less dense and larger star

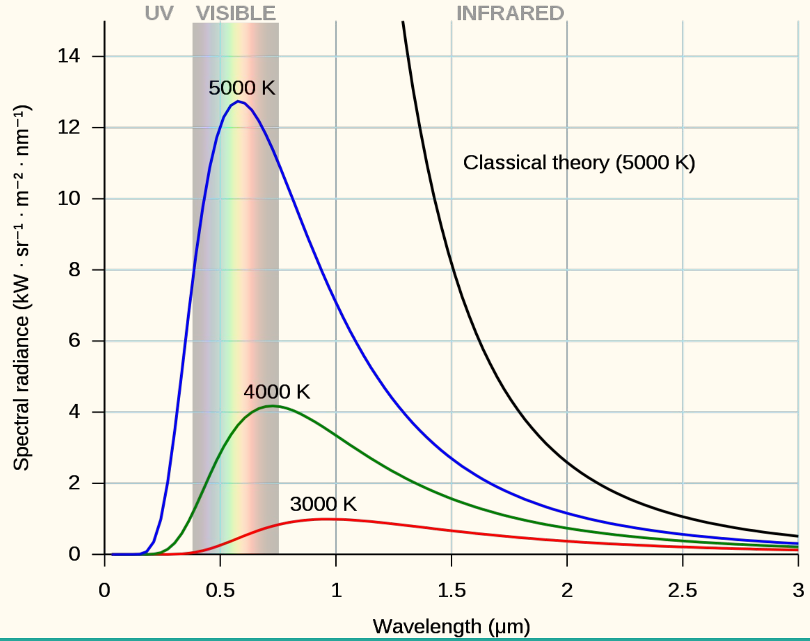


Temperature of Stars

The temperature correlates to the colour of the star.

The hotter the star, the more energy there is, the higher the frequency it emits.

Hotter→ bluer   Cooler → redder



Kahoot

https://create.kahoot.it/details/electromagnetic-spectrum-and-stellar-evolution/2b5196f7-cccb-4d15-a5e3-35fe93d33226