Evidence of the Big Bang

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Evidence of the Big Bang

- The Big Bang Theory states that the entire universe was once a tiny point (singularity) that expanded and continues to expand.
- There are three major pieces of evidence that support the Big Bang Theory
  - Cosmic Microwave Background Radiation (CMBR)
  - Composition of matter is mostly H and He
  - Red Shift spectra from distant stars

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Big Bang Nucleosynthesis

- In the earliest moments after the Big Bang, there was nothing more than hydrogen compressed into a tiny volume, with crazy high heat and pressure. The entire Universe was acting like the core of a star, fusing hydrogen into helium and other elements.
- As astronomers look out into the Universe and measure the ratios of hydrogen (75%), helium (25%) and other trace elements, they exactly match what you would expect to find if the entire Universe was once a really big star.

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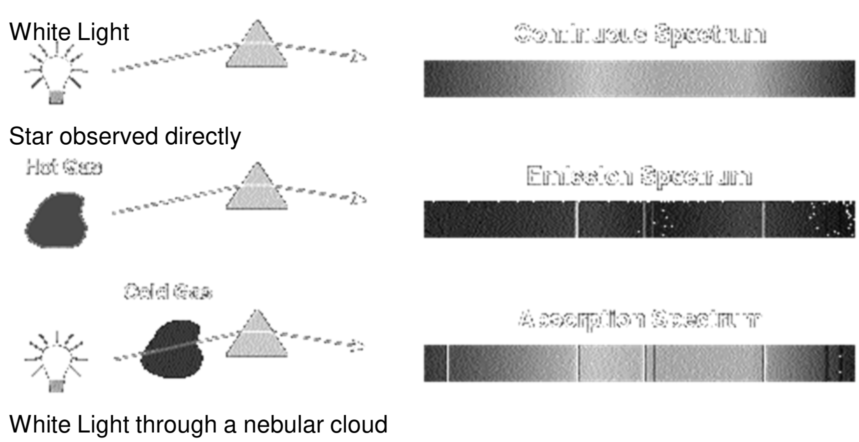
Different Light Spectrums

- There are three different types of light spectrums that can be observed.



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Doppler Effect

- Recall that we talked about the Doppler effect during our sound unit.
- It is the apparent change in frequency as a moving object moves towards or away from you.
- We experience this mostly with sound, but it happens with all waves

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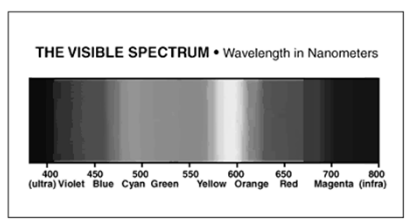
Doppler Effect and Light

- We learned that the different colors of light have different wavelength and therefore different frequencies.
- We also learned that luminous objects can give off specific wavelengths of light depending on what element is present.



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Doppler Effect and Light

- If a luminous object is moving at a large velocity, the Doppler effect will be observed in the light that it is emitting.
- If the object is moving **towards** you, it is observed as a lower wavelength or **blue-shifted**.
- If the object is moving **away** from you, it is observed as a higher wavelength or **red-shifted**.

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Red and Blue Shift

v = velocity of star / object (m/s)

c = speed of light (3.00 x 10^8 m/s)

λ = wavelength while moving (m)

λ_0 = wavelength at rest (m)

$\Delta\lambda$ = wavelength shift (m)

$$\frac{v}{c} = \frac{\lambda - \lambda_0}{\lambda_0}$$

Red Shift / Moving Away

= +$\Delta\lambda$ (longer wavelength)

Blue Shift / Moving Towards

= - $\Delta\lambda$ (shorter wavelength)

$$\frac{v}{c} = \frac{\Delta\lambda}{\lambda_0}$$

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Example Problem #1

- Light from galaxy NGC 7319 is emitted at a wavelength of 513 nm, but if the light from NGC 7319 has been shifted to 525 nm due to the Doppler effect, what is the speed of NGC 7319?

$$\frac{v}{3.00\ x\ 10^8} = \frac{525\ nm\ - 513\ nm}{513\ nm} \Rightarrow \frac{v}{3.00\ x\ 10^8} = \frac{12\ nm}{513\ nm} \Rightarrow v = 7.02\ x\ 10^8\ {}^{m}/_{s}$$

- Does this represent Red Shift or Blue Shift?
  - This represents a Red Shift

7.02 x 10^6 m/s, Positive =>Red Shift

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Example Problem #2

- Calculate the velocity of the galaxy "Newton" if the wavelength for the 434 nm red line in hydrogen is measured at 610 nm on Earth.

$$\frac{v}{c} = \frac{\Delta\lambda}{\lambda_0} \Rightarrow \frac{v}{3.0x10^8\,\text{m/s}} = \frac{610\text{nm} - 434\text{nm}}{434\text{nm}}$$

$$v = 1.22x10^8\,\text{m/s}$$

- Is the galaxy moving towards or away from Earth?
  Away from Earth

1.22 x 10^8 m/s, Positive => Moving Away

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