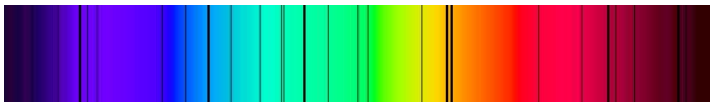
Vocabulary: Big Bang Theory – Hubble's Law

Vocabulary

- Absolute brightness – the intrinsic brightness of a star.
  - The absolute brightness of a star depends only on its *luminosity*.
- Absorption spectrum – a spectrum that contains dark lines superimposed on a bright continuous spectrum. Also called a *dark-line spectrum*.



Absorption spectrum

  - An absorption spectrum is created when light from a star passes through cooler gases surrounding the star. The dark lines correspond to colors of light that are absorbed by the atoms in these gases.
- Apparent brightness – how bright a star appears to an observer on Earth.
  - Astronomers describe the apparent brightness of a star as the ratio between the brightness of the star to the brightness of the Sun when viewed from a distance of 1 Mpc (one megaparsec).
    - For example, a star with an apparent brightness of 10 is 10 times brighter than the sun would be if viewed from a distance of 1 Mpc.
- Big Bang theory – a theory that states the universe began as an extremely dense object and then expanded rapidly.
  - The Big Bang theory was first proposed by Georges Lemaître in 1927.
  - The Big Bang theory is supported by evidence that the universe is expanding.
- Blueshift – a phenomenon in which light from a source that is moving toward an observer is shifted toward the blue end of the spectrum.
  - Light is blueshifted because light waves in front of the moving source are compressed. This is an example of the *Doppler effect*.
  - The faster a light source moves toward an observer, the greater the blueshift.
- Cepheid variable – a star that expands and contracts in a regularly repeating cycle.
  - Gas pressure builds up in a Cepheid variable star, causing it to expand rapidly. The expansion relieves the pressure, and the star gradually contracts again.
  - The greater the luminosity of a Cepheid, the longer its period. Because this relationship is well known, Cepheids can be used to measure distances in space.
    - For example, a Cepheid that has a long period must be very luminous. If it appears dim, it must be relatively far away.

- Doppler shift – the apparent change in the wavelength and frequency of sound waves that is caused by the movement of the sound source, observer, or both.

- Hubble constant – the amount that the recessional velocity of a galaxy is expected to increase as its distance increases.
    - The units of the Hubble constant are km/s/Mpc.
    - The value of the Hubble constant has been refined over time, from Edwin Hubble's initial value (500 km/s/Mpc) to the modern value of about 70 km/s/Mpc.
        - For example, a galaxy at a distance of 5 Mpc from the Milky Way would be expected to be moving away from our galaxy at a speed of 70 km/s/Mpc • 5 Mpc = 350 km/s.

- Hubble's law – the observation that most galaxies appear to be moving away from our galaxy, and that the speed at which the galaxies appear to be moving away is proportional to their distance from our galaxy.
    - Hubble's law provides a key piece of evidence that the universe is expanding. This supports the Big Bang theory.

- Luminosity – the amount of radiation emitted by a bright object, such as a star.
    - The greater the luminosity of a star, the greater its absolute brightness.

- Megaparsec (Mpc) – a unit of distance equal to one million parsecs.
    - A megaparsec is equal to $3.08 \cdot 10^{22}$ meters, or about 3.26 million light years. (A parsec is equal to about 3.26 light years.)
    - Megaparsecs are used to measure distances between galaxies.

- Period – the time required for a single cycle to occur.
    - The period of a Cepheid variable star is the time required for the star to complete one cycle of increasing and decreasing in brightness. It can be measured as the time between two maximums or between two minimums.

- Redshift – a phenomenon in which light moving rapidly away from an observer appears shifted toward the red end of the spectrum.
    - Objects become redshifted because the light waves behind the moving source are stretched out.
    - The faster a light source is moving away from the observer, the greater the observed redshift.
    - Redshift (z) is calculated by dividing the observed wavelength (λ_{obs}) by the emitted wavelength (λ_{emit}) and subtracting 1:

$$z = \frac{\lambda_{obs}}{\lambda_{emit}} - 1$$

- Spectrograph – a scientific instrument that separates light into its constituent wavelengths and records the resulting spectrum.