13.14: Galaxies, Distance, and Age

There are a number of characteristics which galactic shapes, brightness, outputs, and specifics can tell us about galaxies. **Galactic distances** are more difficult to determine for the more-distant galaxies. Methods like radar and parallax are of no use. So astronomers have developed a **standard galactic brightness** ; there is a relationship between a spiral's luminosity and how fast it rotates. Called the **Tully-Fisher Relationship**, the faster a galaxy spins, the brighter the galaxy. So once the spin rate is determined, the brightness and then distance can be determined.

Another method is to examine a **galaxy's white dwarf supernovae** luminosities. This provides another "standard" brightness with which we can compare.

Galactic Distance and Position versus Galactic Age

Most of the galaxies are moving away from each other; each with a velocity of V. This infers that the galaxies must have been closer together at one time. Recall that Hubble's Law is a relationship between velocities and distances, and is related to expansion through the Hubble Constant, H_o .

This goes back to rearranging Hubble's Law $\mathbf{V = H_o}$ **to** $\mathbf{d = v/H_o}$ and allows us to infer not only the age of galaxies, but the Universe itself, time. We have a good idea at the value of $\mathbf{H_o}$. So let's say we can determine how far galaxies are away at varying distances, **d**. We already know the velocity, **V**, from determining the distance; this is the velocity each galaxy is moving. Since you know the velocity and distance, use a simple formula and you can now calculate the time.

V = d/t t = d/VWhere: **V** is velocity | **d** is distance | **t** is time.