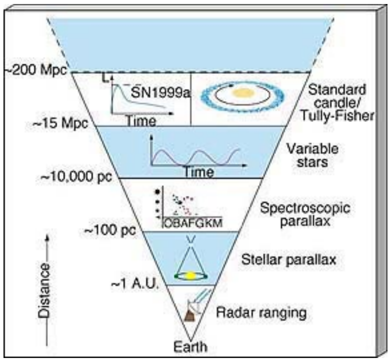
Getting the Distances to Galaxies is a "Big Industry"

$d = \text{constant} \times (L/B)^{1/2}$



1 Mpc = 1 million parsecs

The Distance Ladder

Location	Distance	Method
solar system	10 A.U.	radar ranging
Local Galaxy	100 pc	stellar parallax
Across Galaxy	10,000 pc	spectroscopic "parallax"
Nearby galaxies	15 Mpc	Variable stars
Distant galaxies	200 Mpc	Standard candle + "Tully-Fisher"

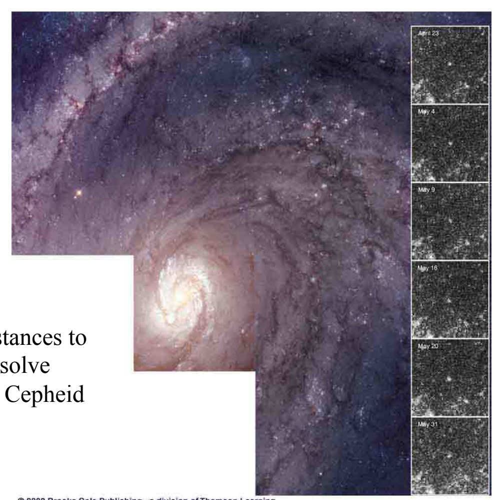
We have studied stellar parallax, and variable stars.

Spectroscopic parallax is simply comparison of brightness of identical stars.
Standard candle is comparison of brightness of identical supernovae explosions.
Tully-Fisher is a way to measure galaxy luminosity from its rotations speed. *More ...*

Hubble Space Telescope Spies Cepheid Variables

$L = \text{constant} \times \text{Period}$

$d = \text{constant} \times (L/B)^{1/2}$

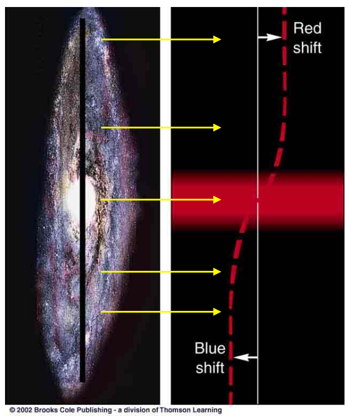


We can use Hubble to measure the distances to very distant galaxies because it can resolve individual stars. Then we can find the Cepheid variables.

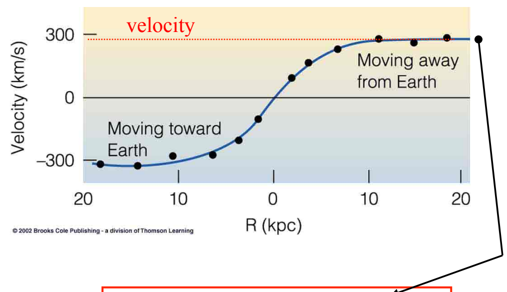
Tully-Fisher Distance Indicator

Recall, luminosity of stars scales with mass of stars… therefore, luminosity of galaxy scales with number of stars (and thus, mass of stars). Thus, luminosity of galaxy gives mass of galaxy.

Going backwards… measure the velocity to "weigh" the galaxy to obtain luminosity.



Doppler velocity map of galaxy.



$L = \text{constant x (velocity)}^4$

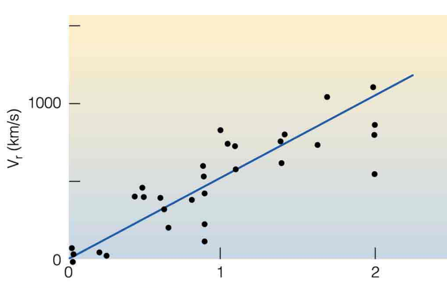
$d = \text{constant x } (L/B)^{1/2}$

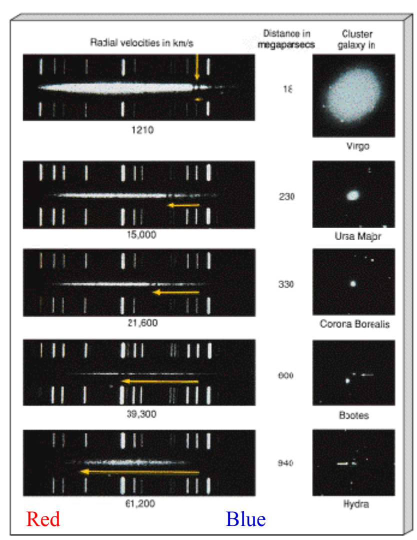
The Hubble Law

The problem is that 200 Mpc is nothing!

Well, it turns out that there is another indicator for extreme distances.

The Hubble Law
The further away a galaxy is, the greater is its redshift.

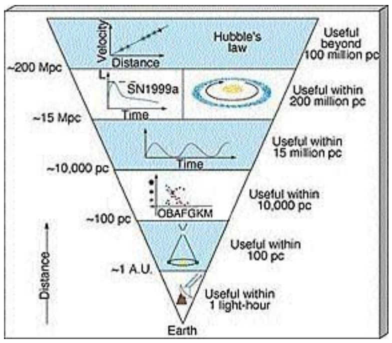




(As you can see, it is not perfect.)

Hubble Law Takes us All the Way Out

The distance scale revisited.



Implies that Galaxies are "flying away" and that the speed with which they are moving away is proportional to there distance away.

The further away the galaxy, the faster it is receding from us. (more on this later…)

velocity = constant x distance

The constant is called Hubble's constant. It is designated as **H_0**. Pronounced "H not".

velocity = H_0 x distance