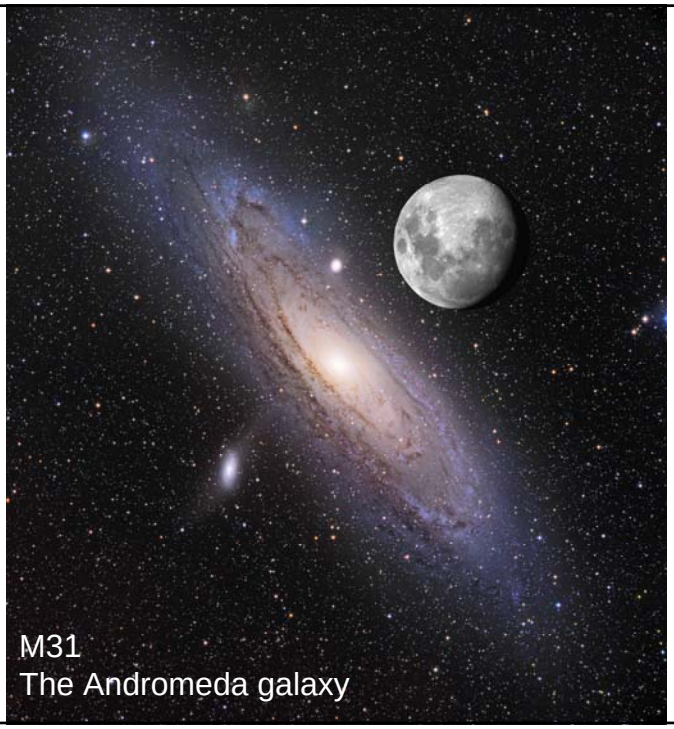
Galaxies [15]

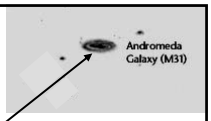
The Hubble Deep Field

- 10 days' exposure with Hubble Space Telescope.
- Only 20 stars.
- Remaining 5000 objects are galaxies.



M31
The Andromeda galaxy

The Cosmic Distance Ladder



M31

2,500,000 LY

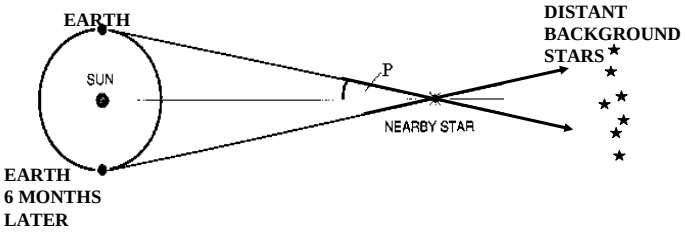
100,000 LY

The relative distances.

Milky Way

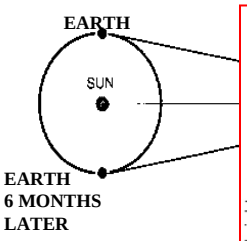
Measuring distances inside the Galaxy

- Parallax: to 300 pc = 1000 LY

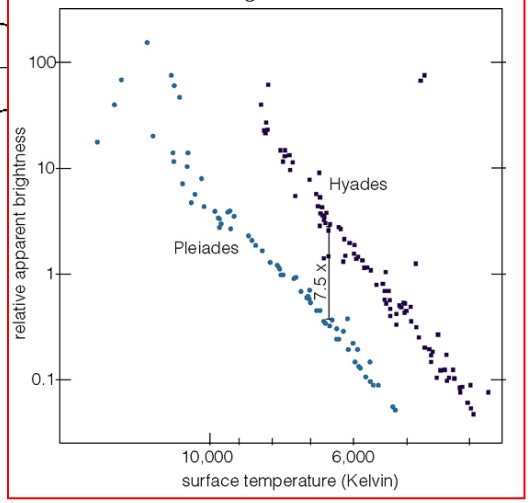


Measuring distances inside the Galaxy

- Parallax: to 300 pc = 1000 LY



[Fig. 15.10]



- Then…
  Main Sequence Fitting:

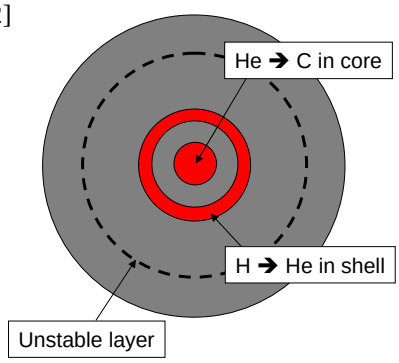
$$F = \frac{L}{4\pi r^2}$$

$$r = \sqrt{\frac{L}{4\pi F}}$$

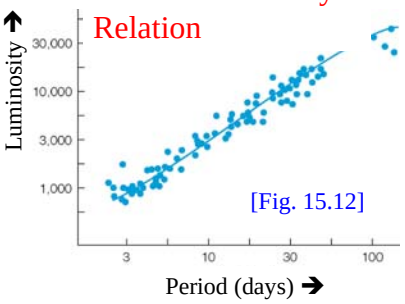
Pulsating Variable Stars [15.2]

$$F = \frac{L}{4\pi r^2}$$

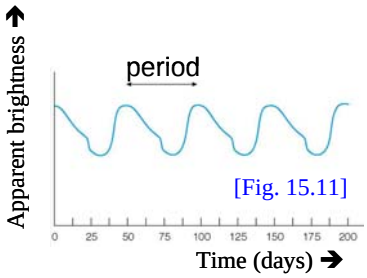
$$r = \sqrt{\frac{L}{4\pi F}}$$



Period-Luminosity Relation



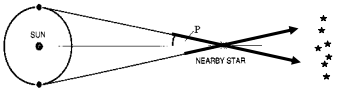
[Fig. 15.12]



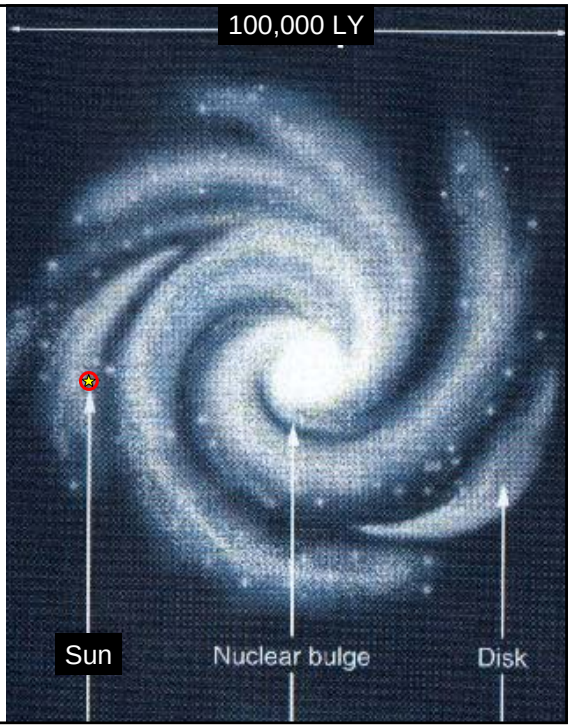
[Fig. 15.11]

The Cosmic Distance Ladder

- Parallax
  - 300 pc = 1000 LY

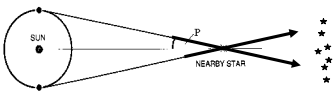


The parallax method

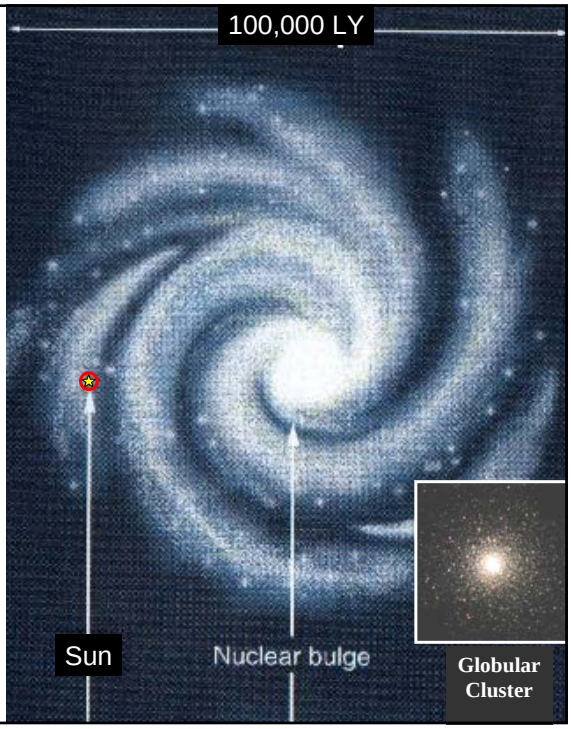


The Cosmic Distance Ladder

- Parallax
  - 300 pc = 1000 LY
  - Calibrate main sequence fitting.
  - Calibrate luminosities of Pulsating Variables
- Map rest of Milky Way

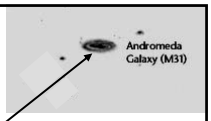


The parallax method



The Cosmic Distance Ladder

- Parallax
  - 300 pc = 1000 LY
  - Calibrate main sequence fitting.
  - Calibrate luminosities of Pulsating Variables
- Map rest of Milky Way and out to M31



M31

2,500,000 LY

100,000 LY

Milky Way

$L = (4\pi r^2) \times F$

Measure luminosities of

- Brightest stars 10,000 $L_\odot$
- Brightest globular clusters 100,000 $L_\odot$
- Brightest H II regions 100,000 $L_\odot$
- Etc.
- ➔ can now measure distances to more distant galaxies

Modern methods of determining distances

Method	Distance Range (millions of LY)
Pulsating variable stars (Cepheids)	0-65
Brightest star in galaxy	0-150
Globular clusters	0-150
Rotation velocities	0-300
Supernovae	0-8000

Calibrated with pulsating variables

But these are still calibrated with parallaxes!