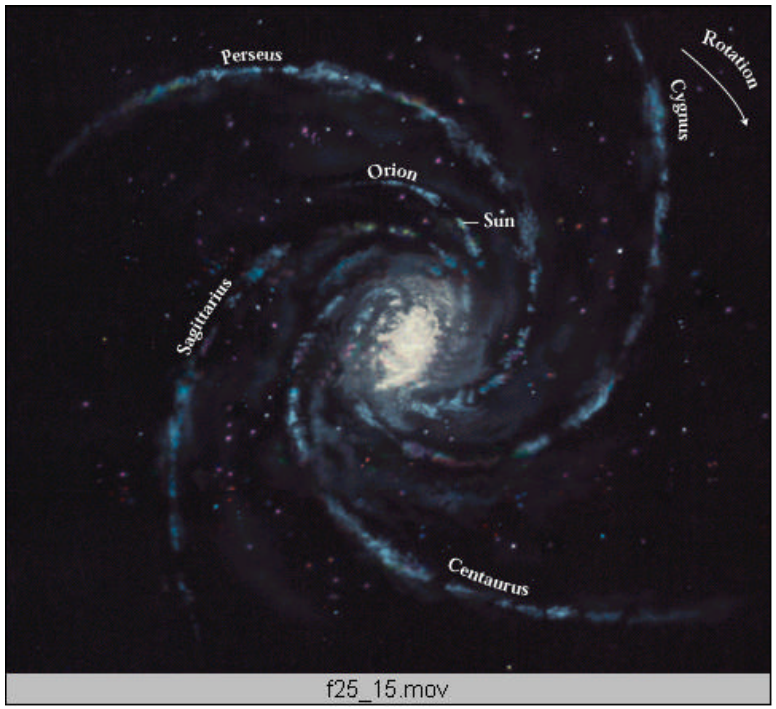
Cosmology:
The Structure and Origin of our Universe

Chapter 8

The Universe Contains over 50 Billion Galaxies

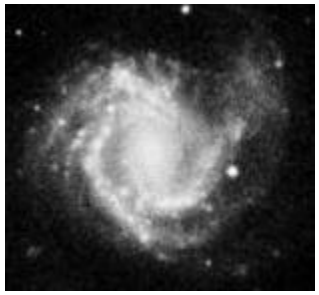
Galaxies were once thought to be nebula in the Milky Way



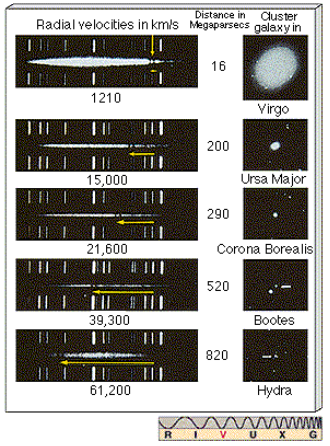
Hubble Studied Galaxies

100” Mt. Wilson Telescope

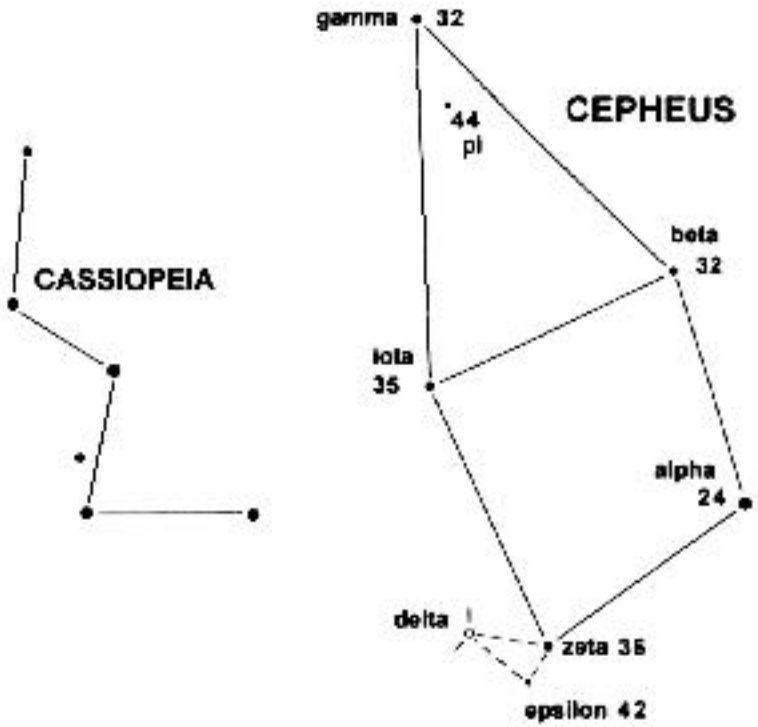
Photographed galaxies

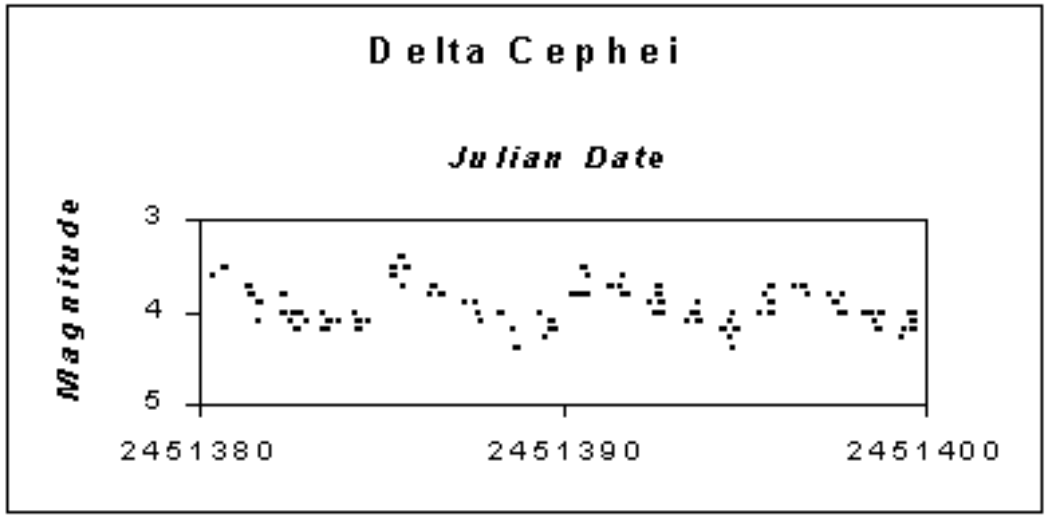


Recorded Spectra



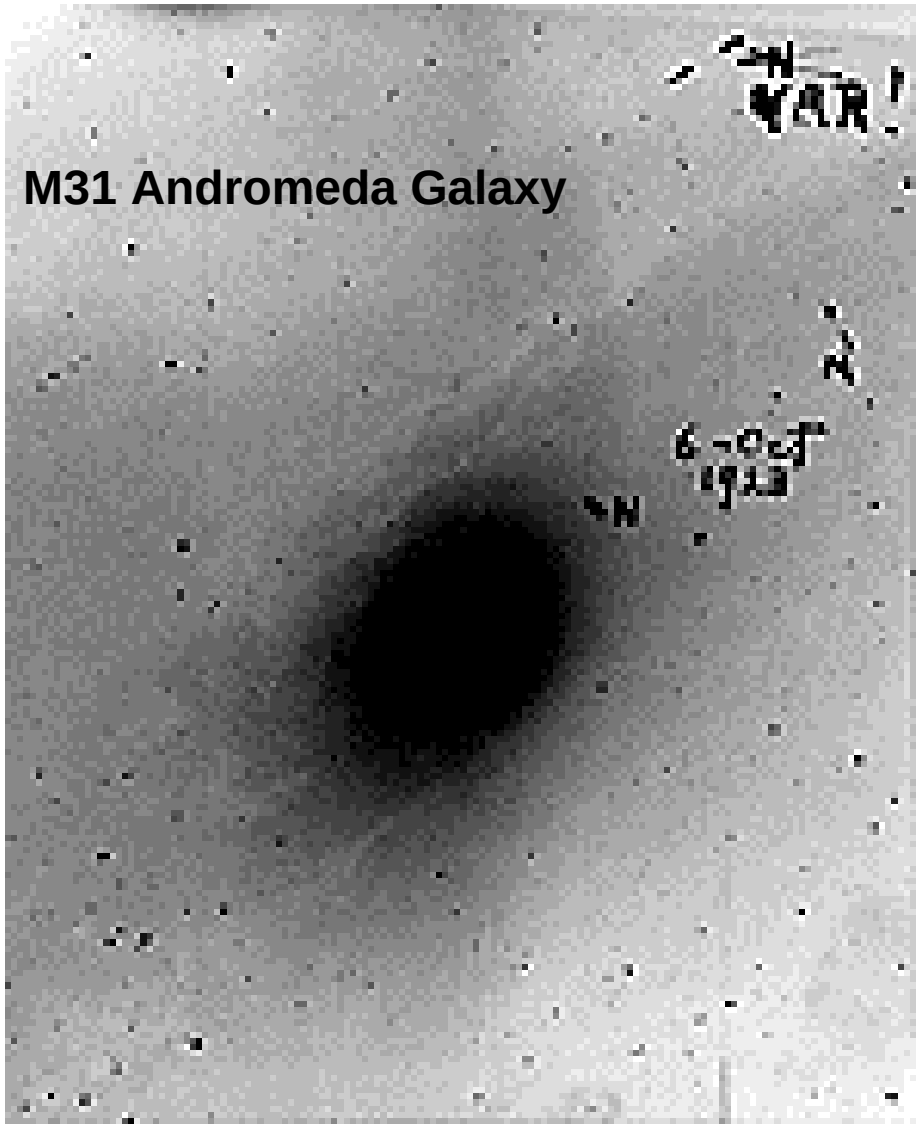
Henrietta Leavitt Discovered Cepheid Variables (1912)



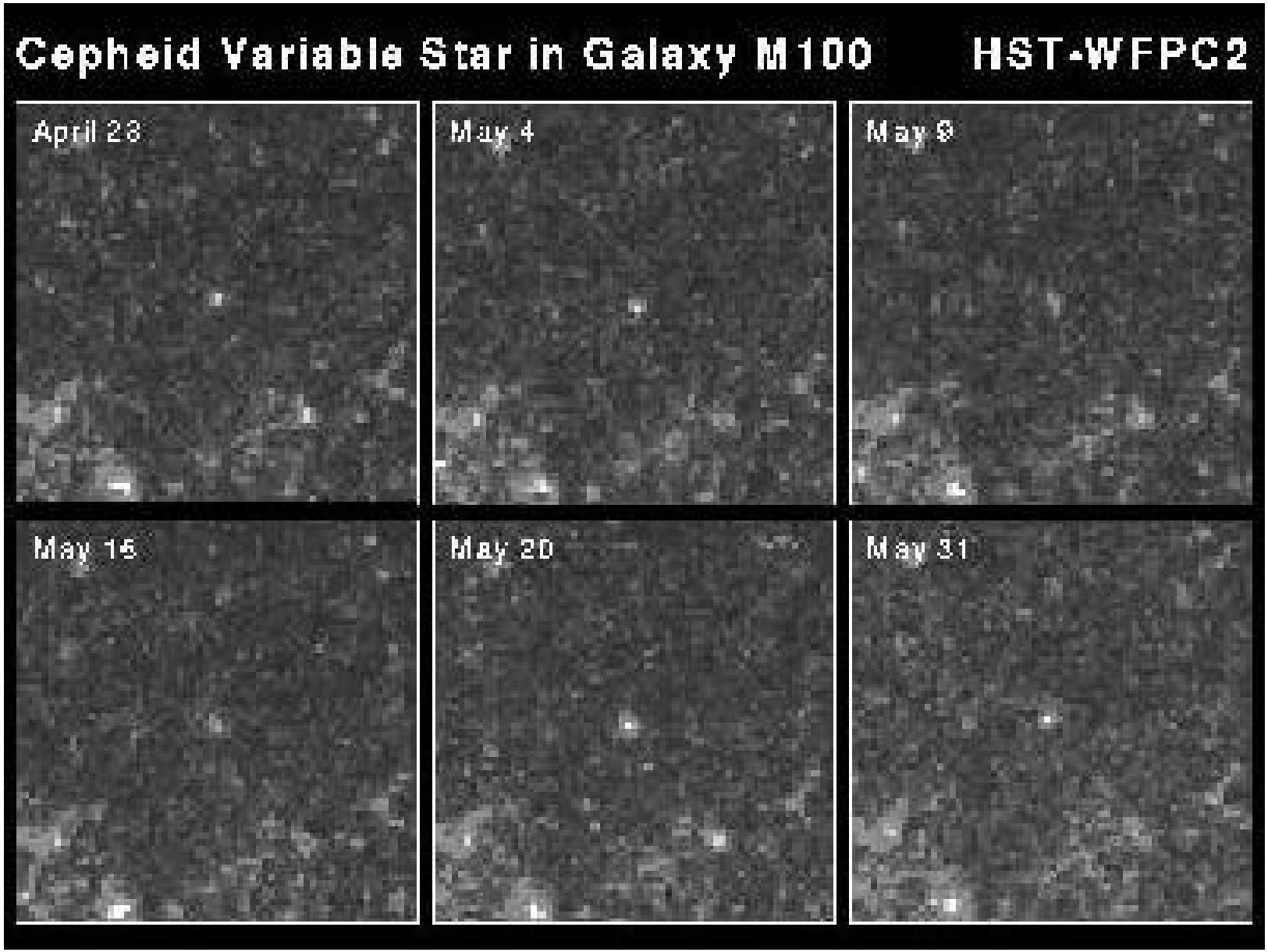


Period: 1-100 days

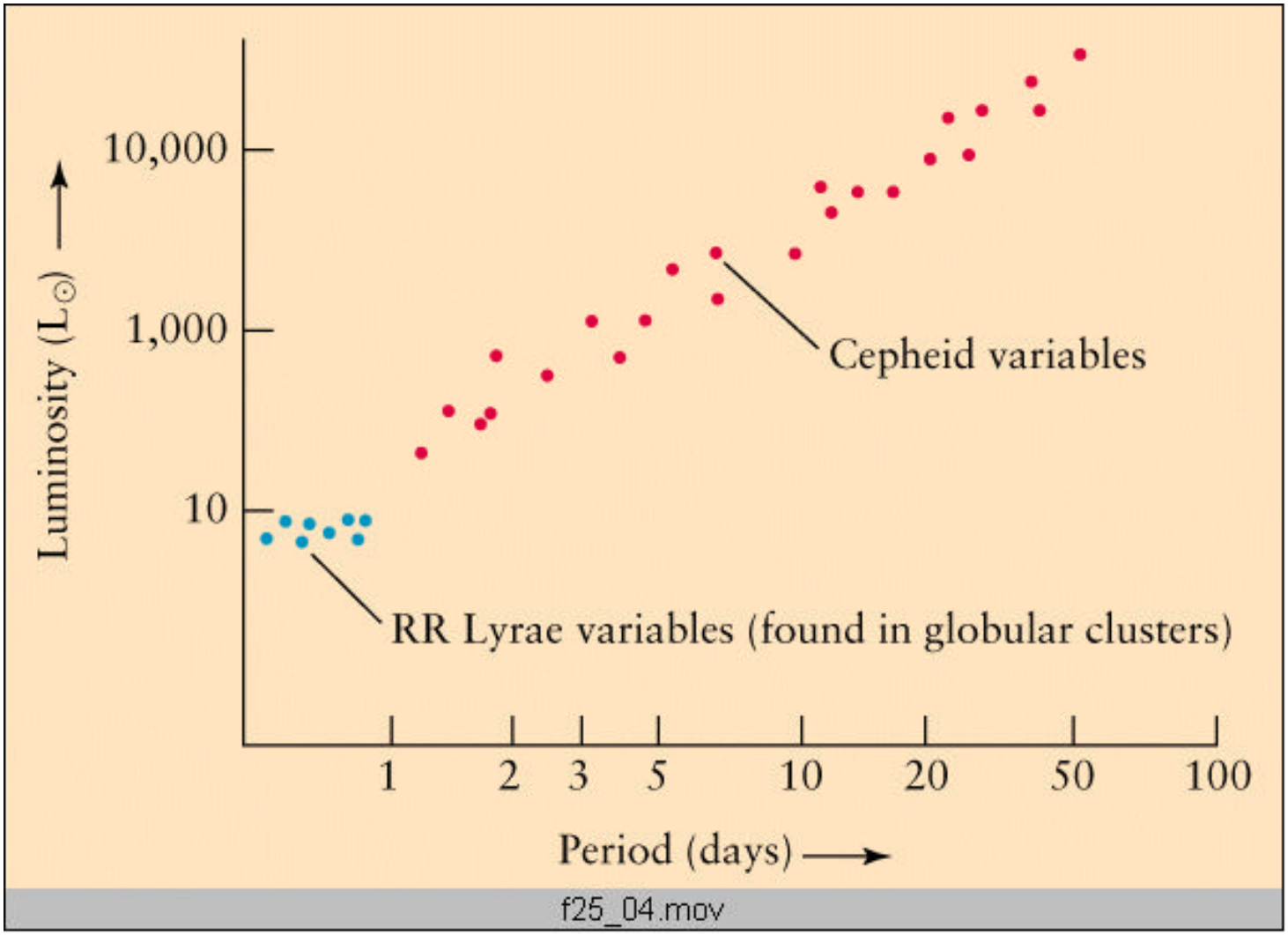
Hubble discovered Cepheid Variable Stars in Nearby Galaxies (1924)



Cepheid Variables in M100



Period-Luminosity Relationship

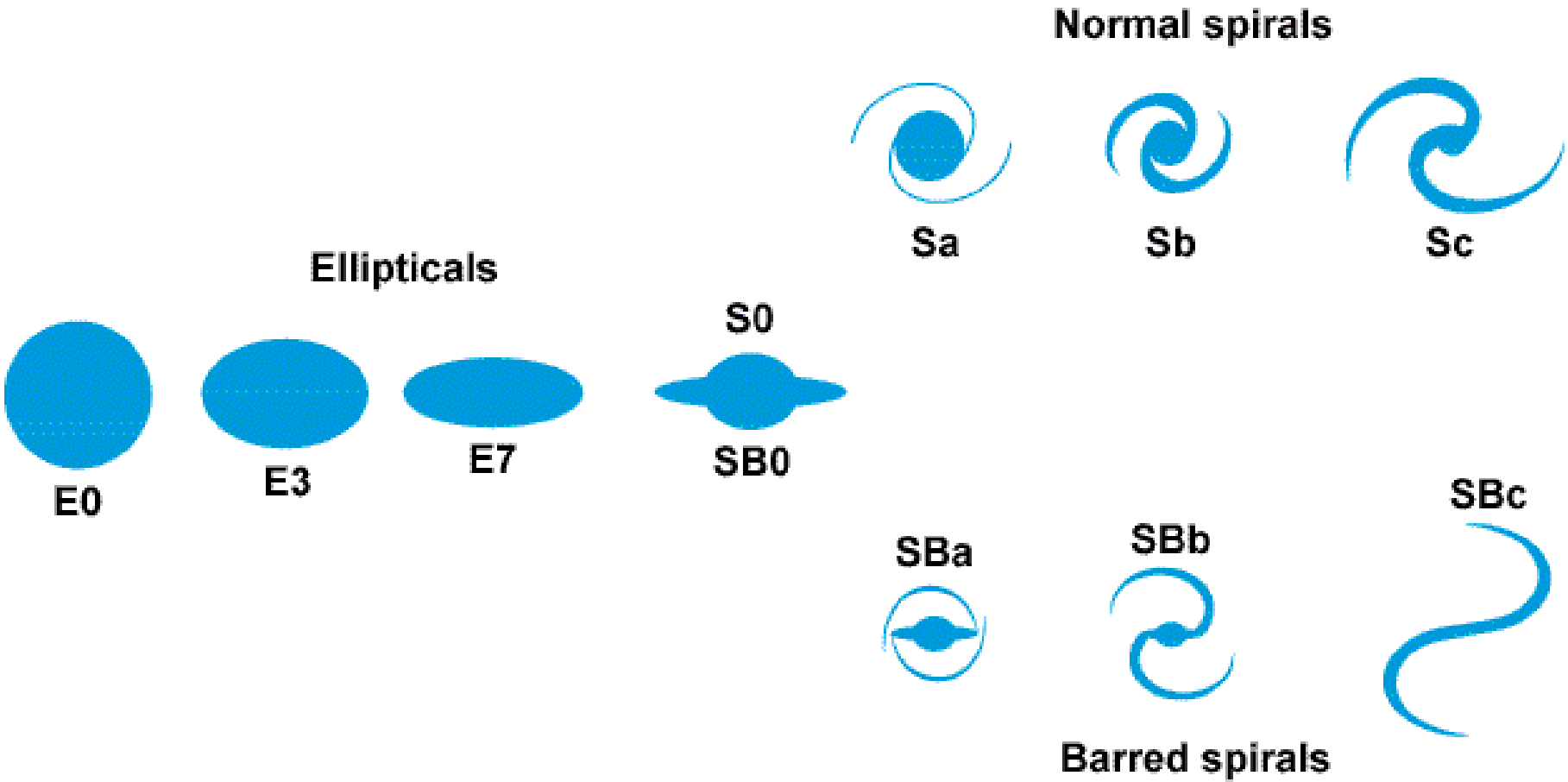


Period of Cepheid - Absolute mag. - Apparent mag. - distance

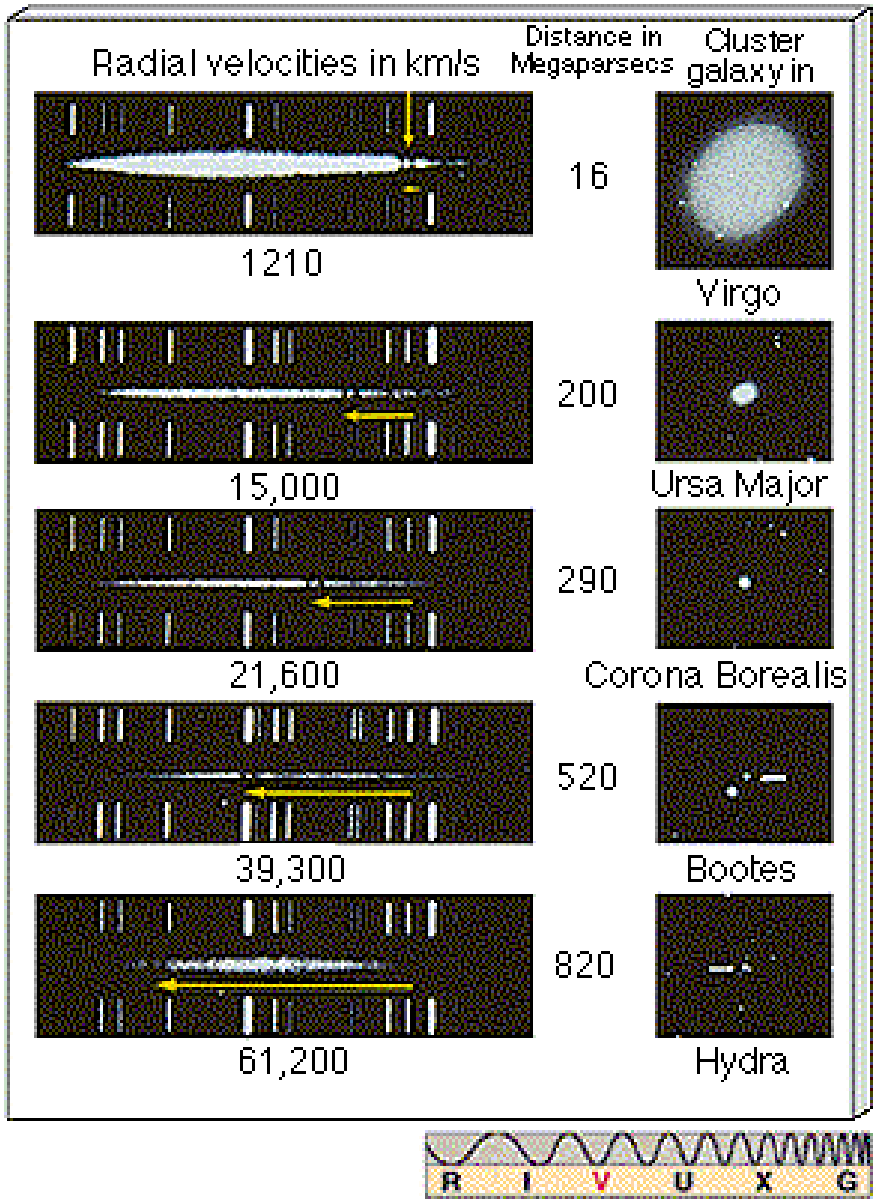
Challenge of Using Period-Luminosity Relationship

- Resolve stars in galaxies
  - Does the telescope have enough resolving power?
  - Large telescope needed to resolve stars
- Find a Cepheid
  - Cepheid stars are rare

Hubble Classified Galaxies



Hubble Recorded Spectra of Galaxies

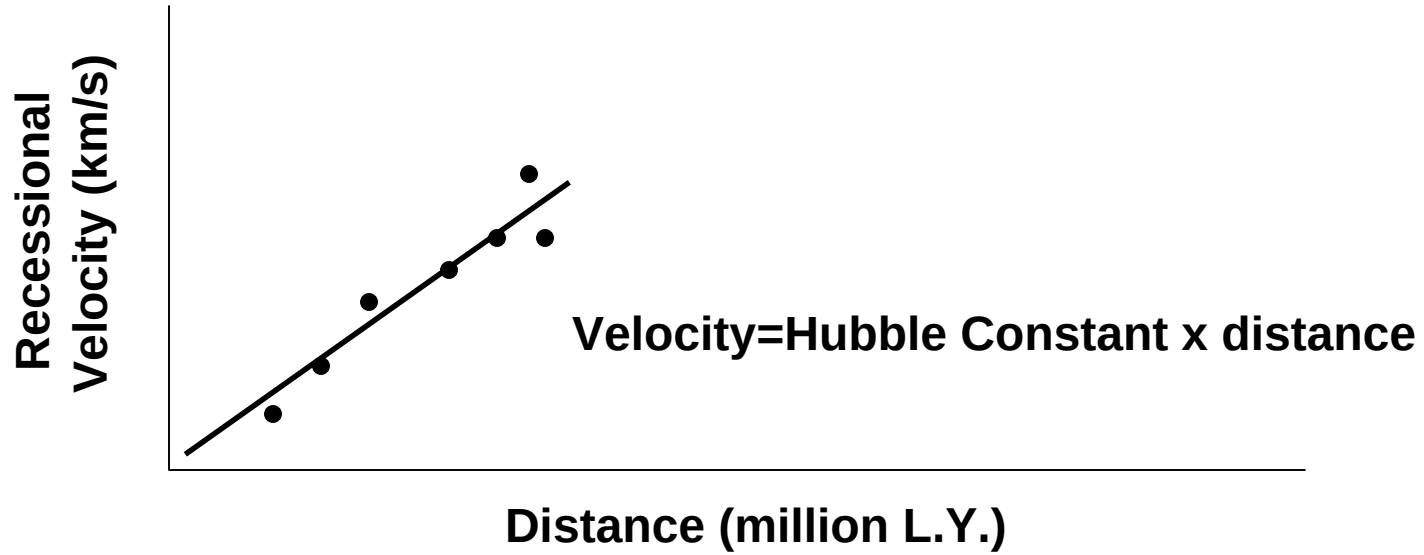


Spectra of Galaxies

- **The spectra of galaxies are red shifted**
  - **Galaxies are moving away**
- **Far away galaxies have greater red-shifts**
  - **Large red-shift = large recessional velocity**
  - **Far away galaxies have larger red-shifts**

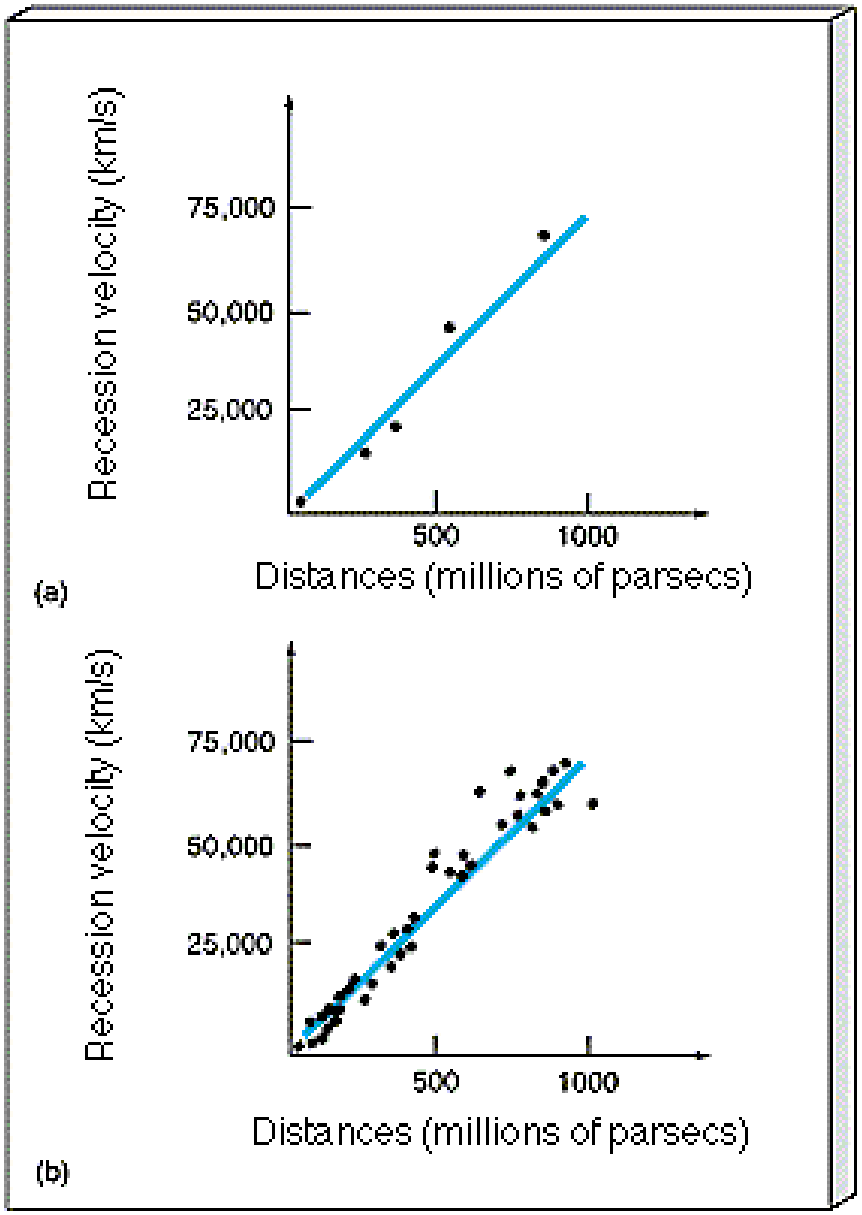
Hubble's Law 1

- **Hubble used existing distance measurements from Cepheid observations and spectra to:**
  - **Plot the recessional velocity as a function of distance**

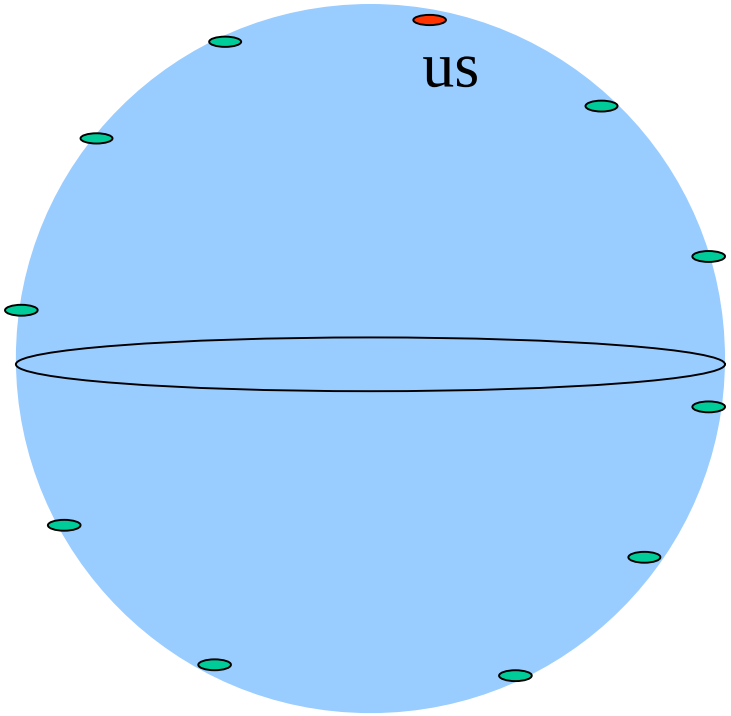


- **Distance measuring tool for far away galaxies**
- **Distance can be obtained from red-shift in the spectrum**

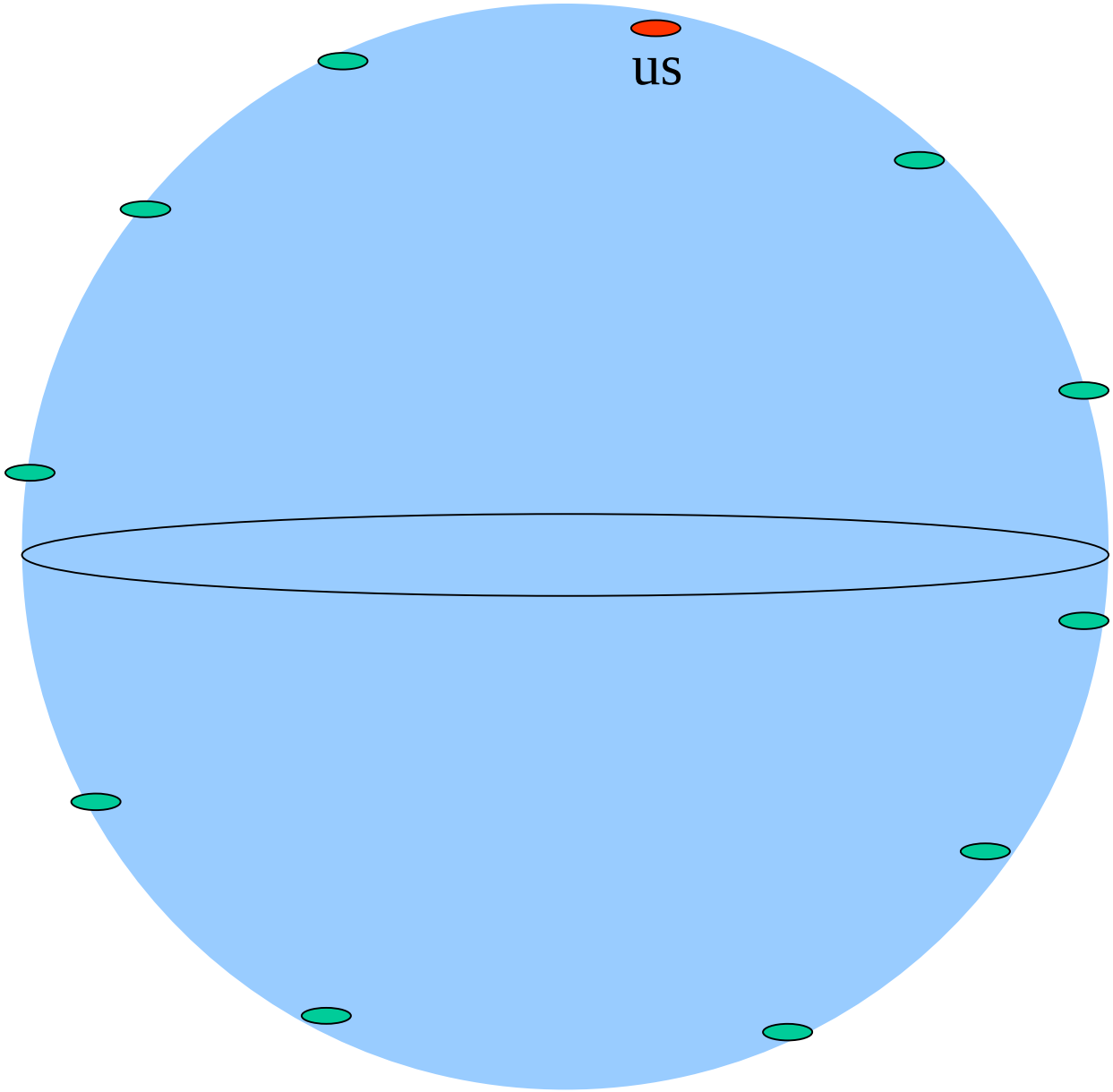
Hubble's Law 2



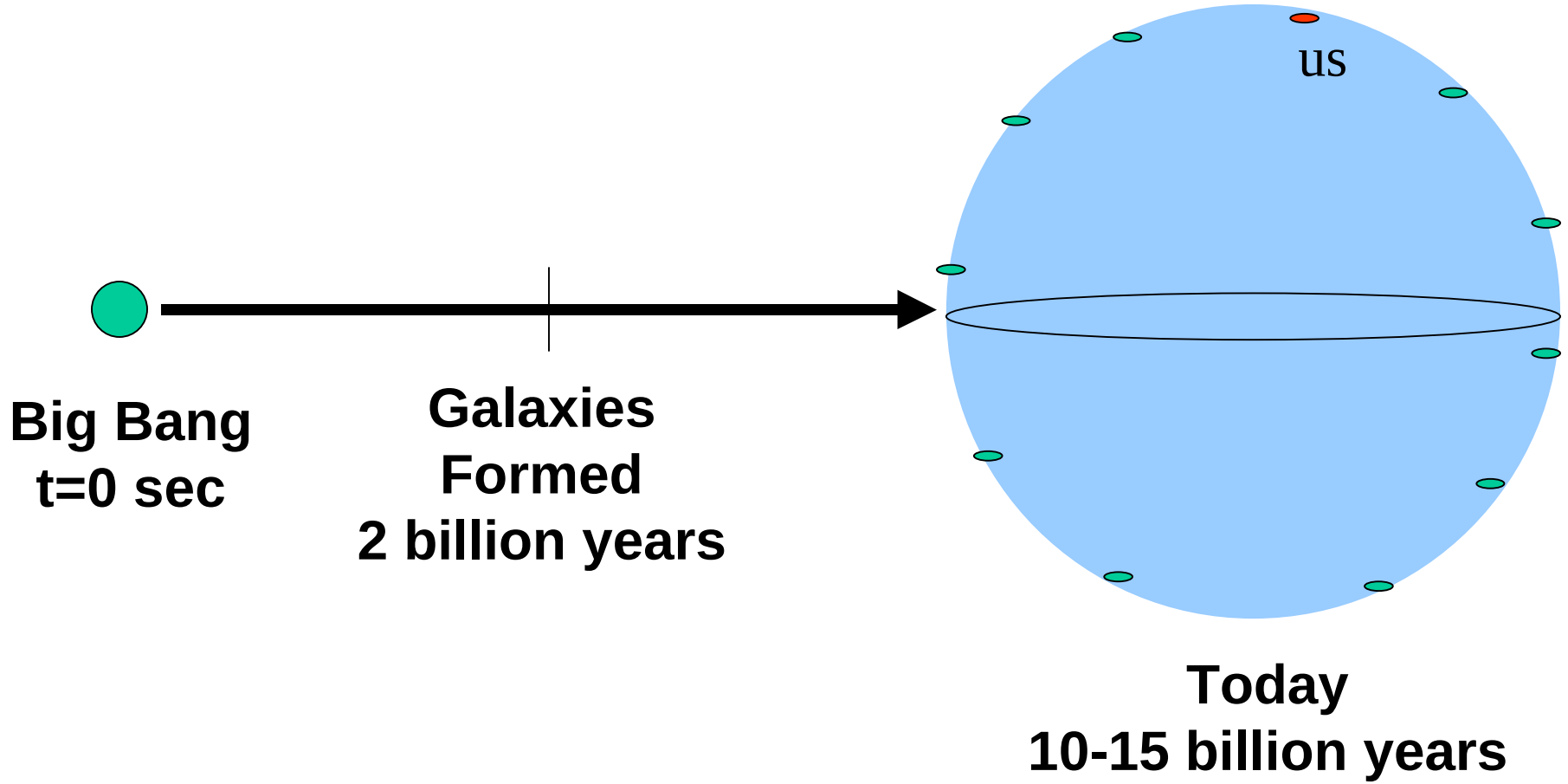
Expanding Universe
Day 1



Expanding Universe- Day 2

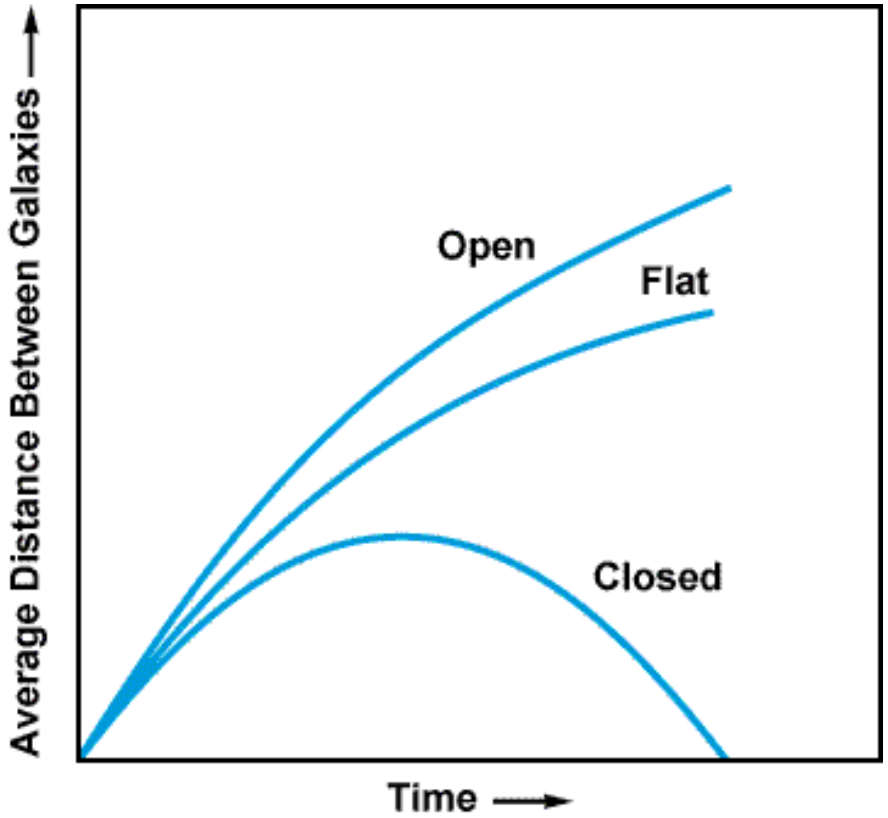


Evolution of the Universe



Future of Universe

- Open Universe
  - Expands forever
- Closed Universe
  - Stops expanding and collapses
- Steady State
  - Not expanding or collapsing



Missing Mass Problem

Summary

- Cepheid variable stars
  - Period-luminosity relationship
  - Cepheids as distance measuring tools
- Classification of galaxies
  - Spirals, ellipticals, irregulars
- Red shift
- Hubble's Law
- Current state of the universe
- Future of the universe