Reddening from ISM
Extinction from ISM
Nebulae: Dense ISM
White Dwarf Left by Planetary Nebula
More Nebulae
Spectra!
Composition of the Galaxy

![Graph showing the composition of the Galaxy with hydrogen, helium, carbon, nitrogen, oxygen, and iron labeled on the y-axis and atomic mass number on the x-axis.](Image)
“Discovery” of Galaxies

- Spiral Nebula and other objects believed to be part of the Milky Way until 1920’s
- In 1924, Edwin Hubble measured the distance to M 31 in Andromeda
- Using Cepheid variables, distance was 650 kiloparsec (2.1 million light years)
- The diameter of the Milky Way’s disk is 25 kiloparsec (80,000 light years)
- Other spiral nebulae proved to be even farther
Properties of Galaxies

• Organized based on **shape**: elliptical (E), lenticular (S0), spiral (S), barred spiral (SB), and irregular (Irr)

• Ellipticals are subdivided by apparent shape on the sky: E0 to E9, circular to elongated

• Spirals and barred spirals are subdivided by the size of nuclear bulge and shape of arms: Sa to Sd, largest to smallest bulge

• SO appear to have a disk and no spiral arms
Spirals
Ellipticals and Lenticulars
The Magellanic Clouds: Irregular Galaxies
Hubble Tuning Fork

• Evolution Theory was wrong!
• Explain why!
Local Galaxies
Redshifted Galaxies
The Hubble Law