Milky Way

faint band of light visible by eye circling sky
galaxies kuklos milky circle to ancient Greeks via lactea milky road to Romans only in 20th century known as star system ~ 75,000 ly diameter ~200 billion stars

Harlow Shapley

studied clusters

Globular $10^5$-$10^6$ stars near center

Open in disk the Jewel Box a few hundred stars

based on work of Henrietta Leavitt

Cepheid variable stars period-luminosity relation

Shapley calibrated variable stars absolute distance mapped location of Globular Clusters in center of galaxy Mxx - Messier Object cataloged in 1800’s

11/28/2001
NGCxxxx - New General Catalogue of astronomical objects

Milky Way Galaxy:

Disk component stars
- metal-rich Population I
  - circular orbits in plane
  - faster rotation near center

Spherical component stars
- nuclear bulge at center
- halo - thinly scattered
  - metal-poor Population II
  - random elliptical orbits
  - globular clusters
  - age > 11 billion years

metal - elements heavier than Helium

Element building cycle - Nucleosynthesis

original galaxy material
- 80% Hydrogen
- 20% Helium (by weight)

higher Z elements require
- processing through
  - generations of stars
- metal-rich - younger
  - 2nd (and higher) generations
- metal-poor - older
  - 1st generation stars

galactic corona extends 7× further
- postulated from motions of stars and star clusters
  - rotating more rapidly than expected
- suggests Dark Matter (nonluminous)

Galactic formation

suggested from
- star populations
  - similar to solar system
condensed from
- spherical cloud of gas

younger stars

15-10

15-05 /predust and gas obscure center concentration at visible wavelengths

15-06

15-09a

15-09b

15-12

15-14a
Density Wave theory: spiral arms are compression waves that trigger star formation. Not completely understood:
- Star formation effects spiral arms
- Ages of clusters ~7 billion, composition, and distribution

**Nucleus of Milky Way**

- Blocked at visible λ.
- Seen in radio, IR \( \Rightarrow \) UV, X-ray, γ-ray.
- Penetrate clouds.

Radio, IR, X, γ source: **Sagittarius A**

- At very center.
- Core less than 2 AU.
- 2-3 million solar masses.
- Massive black hole?

Chandra X-ray image \( \Rightarrow \)