

GALAXIES

Galaxies are giant collections of stars held together by their mutual gravity

- size: 10,000 - 10^7 light-years across; 100,000 lt-yr is common.
- these are incredibly huge distances!
- contain millions to trillions of stars; 100 billion is common (10^{11})
- may also contain a lot of gas and dust (nebula)
- mostly empty space - stars almost never collide – the distances are too enormous

Three types: spiral, elliptical, and irregular

Structure of Spiral Galaxies

Center is called the "nucleus"

- **Disk:** flat; spiral arms; lots of gas & dust; stars orbit on nearly circular orbits.
- **Bulge:** slightly flattened sphere; little gas or dust; high density of stars on random orbits.

The Milky Way

- a spiral galaxy; about 200 billion stars
- about 100,000 lt-yr across, 1500 lt-yr thick in the disk
- Sun takes about 230 million years to make one orbit
- Sun is in the disk, about 27,000 light-years from the nucleus; no place special.

Structure of Elliptical Galaxies

- contain almost no dust or gas.
- all the stars are old.
- spheroidal shaped.
- stars move on random orbits; no net rotation.

Galactic Rotation

Spiral galaxies rotate: most stars are moving in the same direction on circular orbits.

By measuring the distance of a star from the nucleus, and its velocity (via Doppler shift), we can derive the semi-major axis of the orbit (a) and the orbital period (P). Then by using Kepler's III law we can measure the mass of the galaxy.

For those interested:

For circular motion, the distance a star travels is the circumference: $d = 2\pi r = 2\pi a$

Since distance $d = vt$, $t = d/v = 2\pi a/v$

The time to make one orbit is the period P .

So $P = 2\pi a/v$

Plug into Kepler's III and solve for $(M+m)$ and note that m (the mass of the star) is negligible compared to M (the mass of the galaxy).