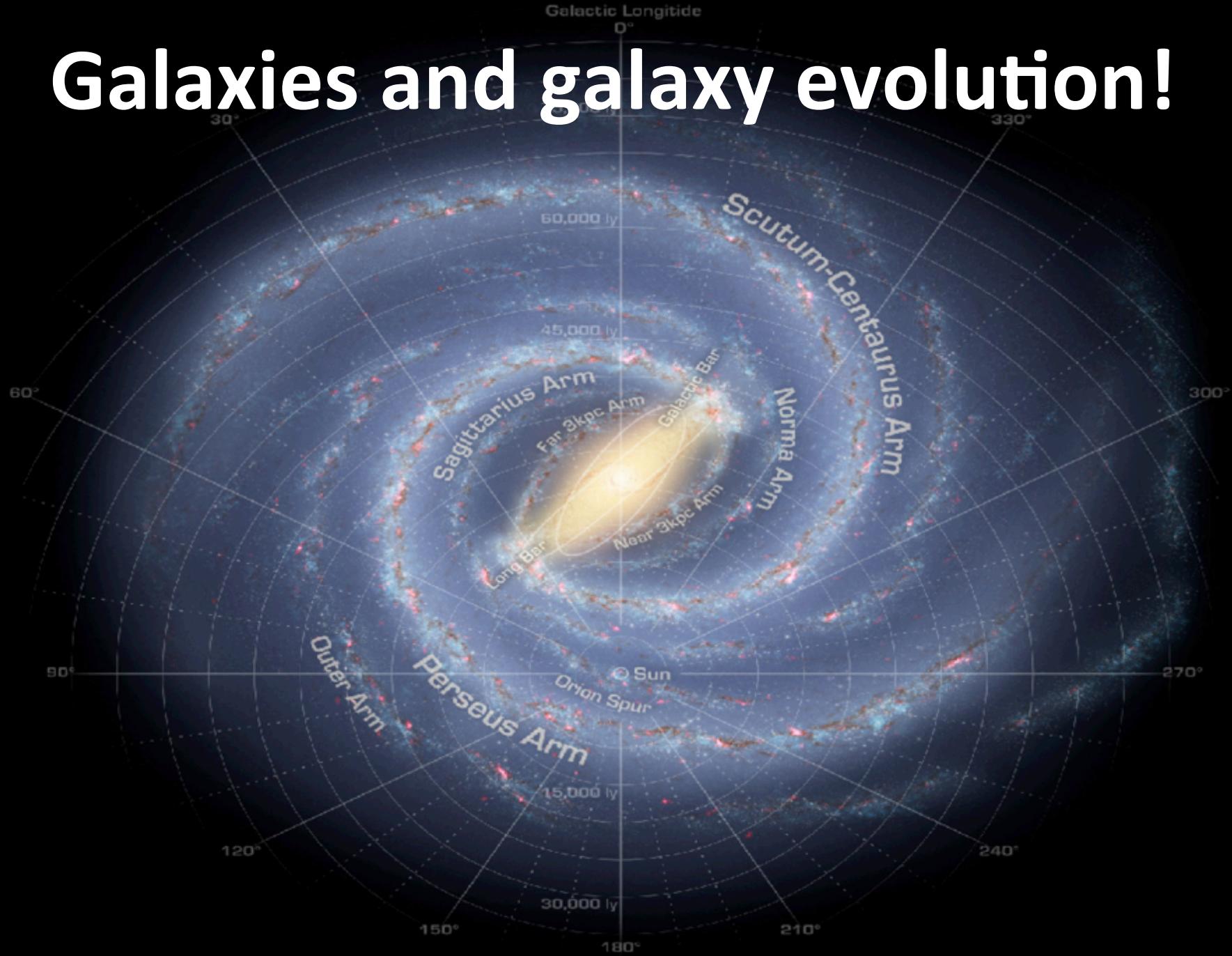


Galaxies and galaxy evolution!

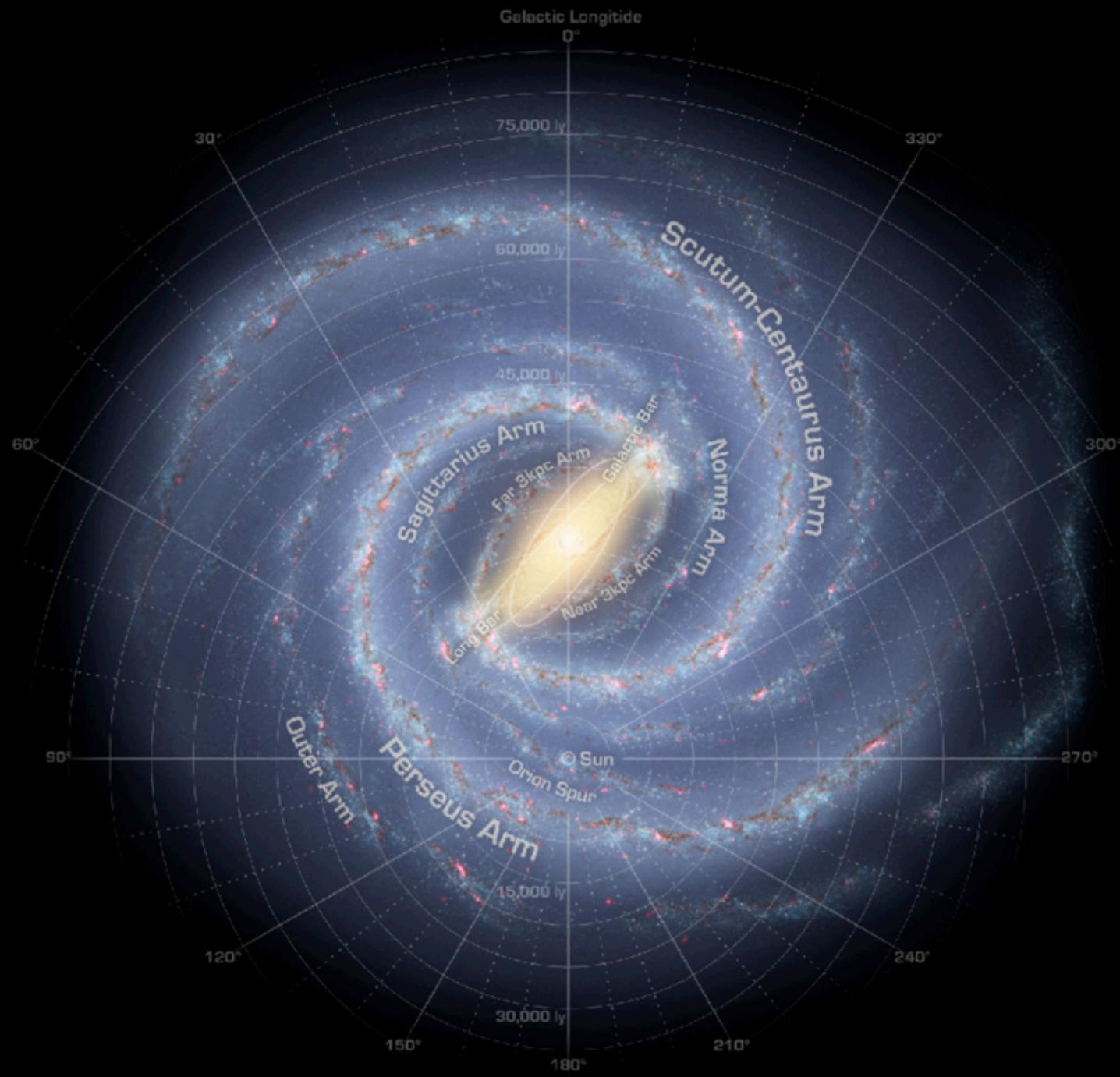


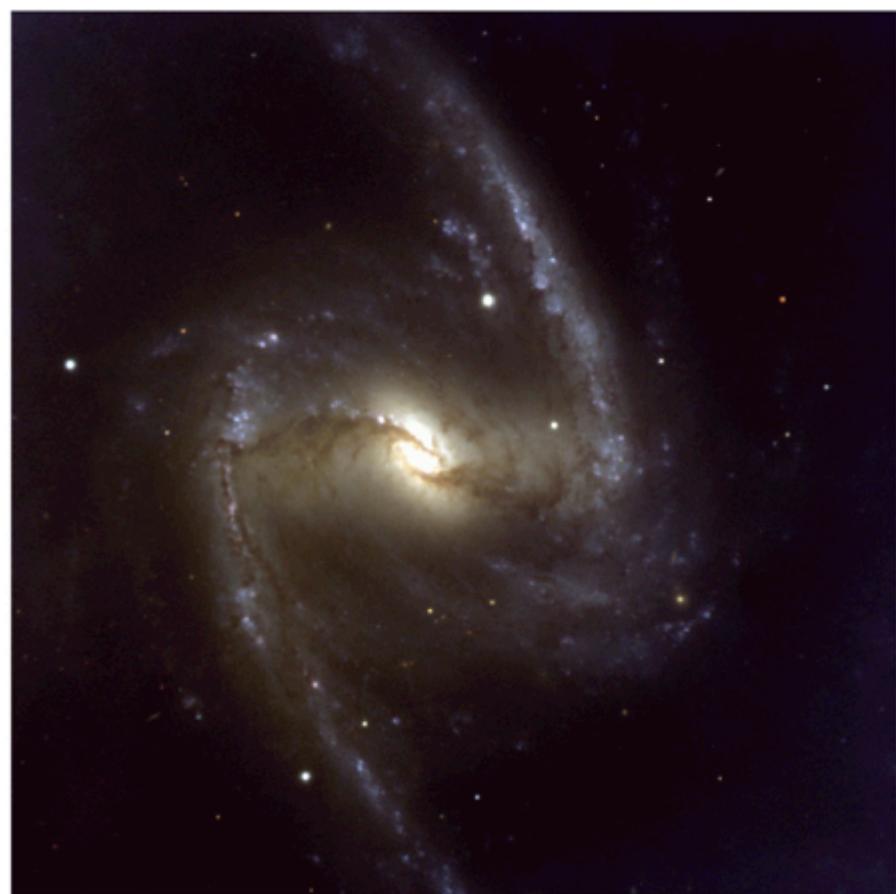
Oral Presentation

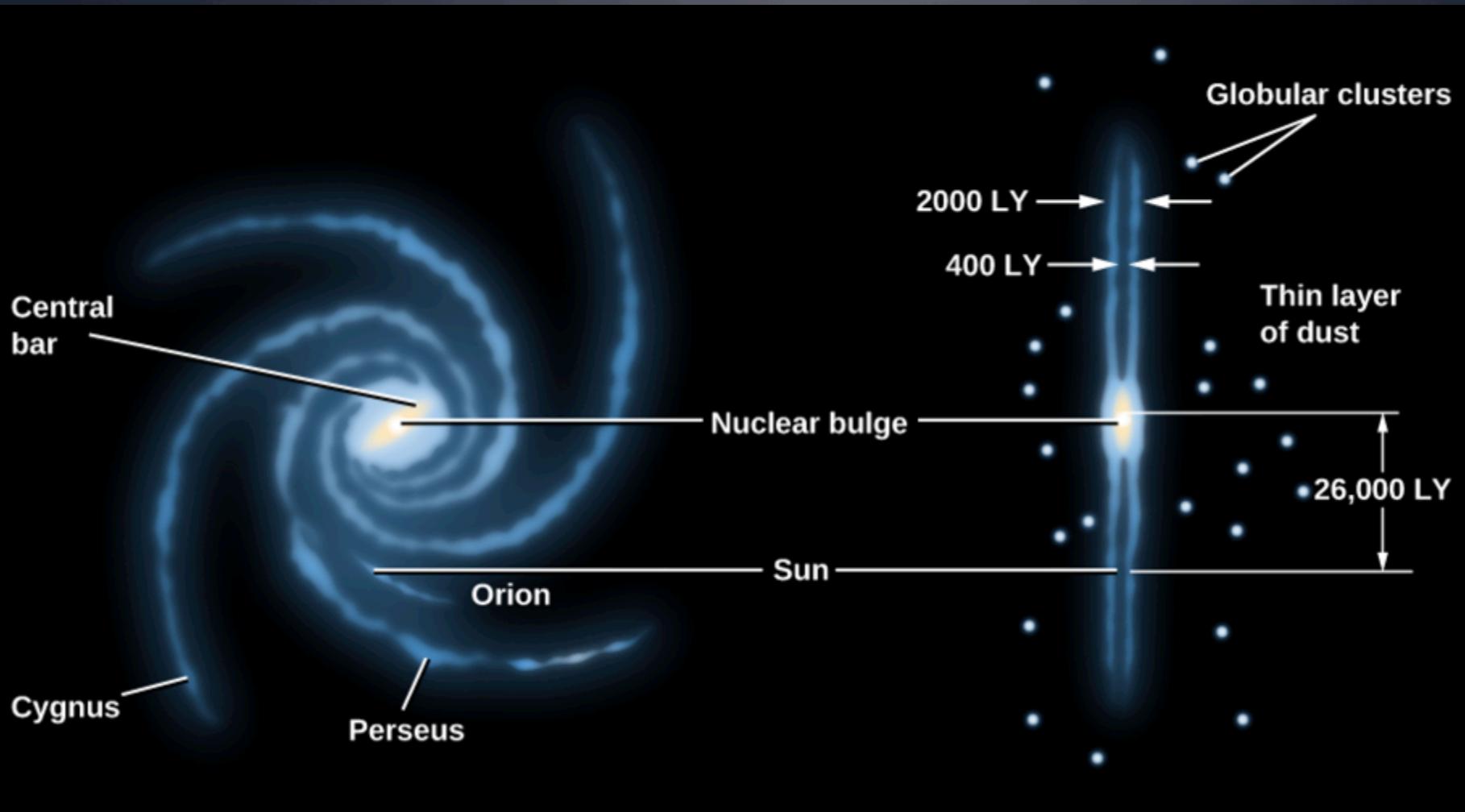
- April 11, 5 minutes
- **Slides: must be emailed in pdf on April 10**
- Homework due now. Questions?

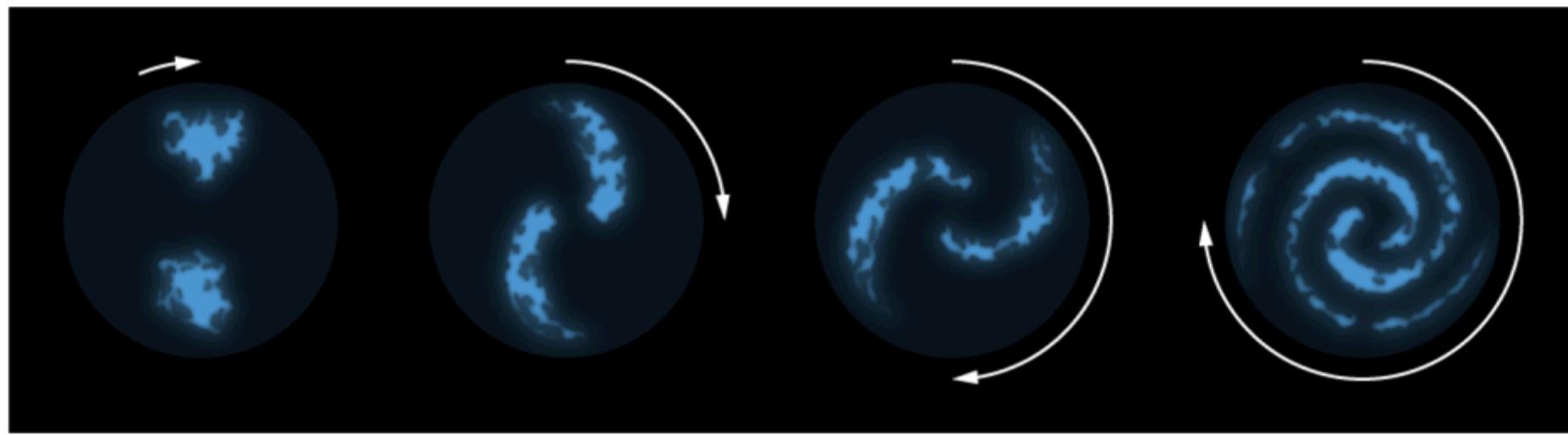
All-sky optical map

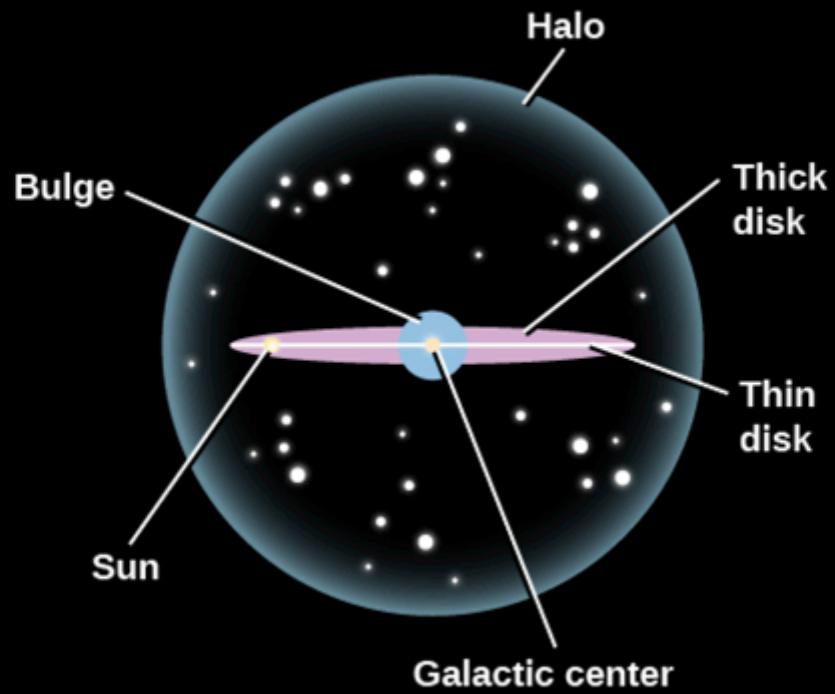




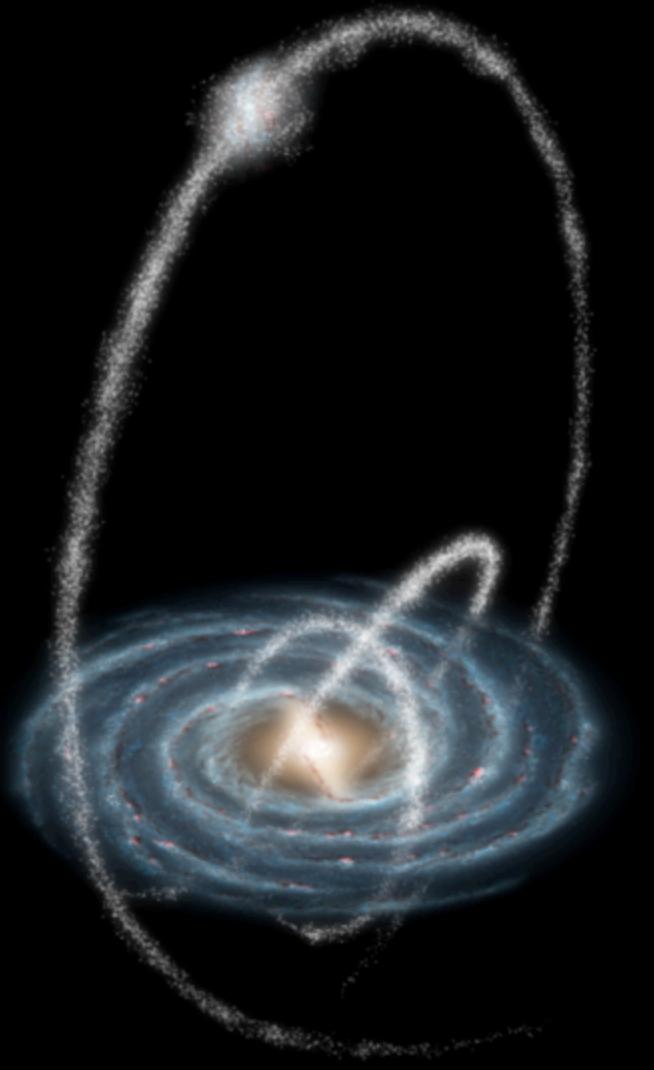


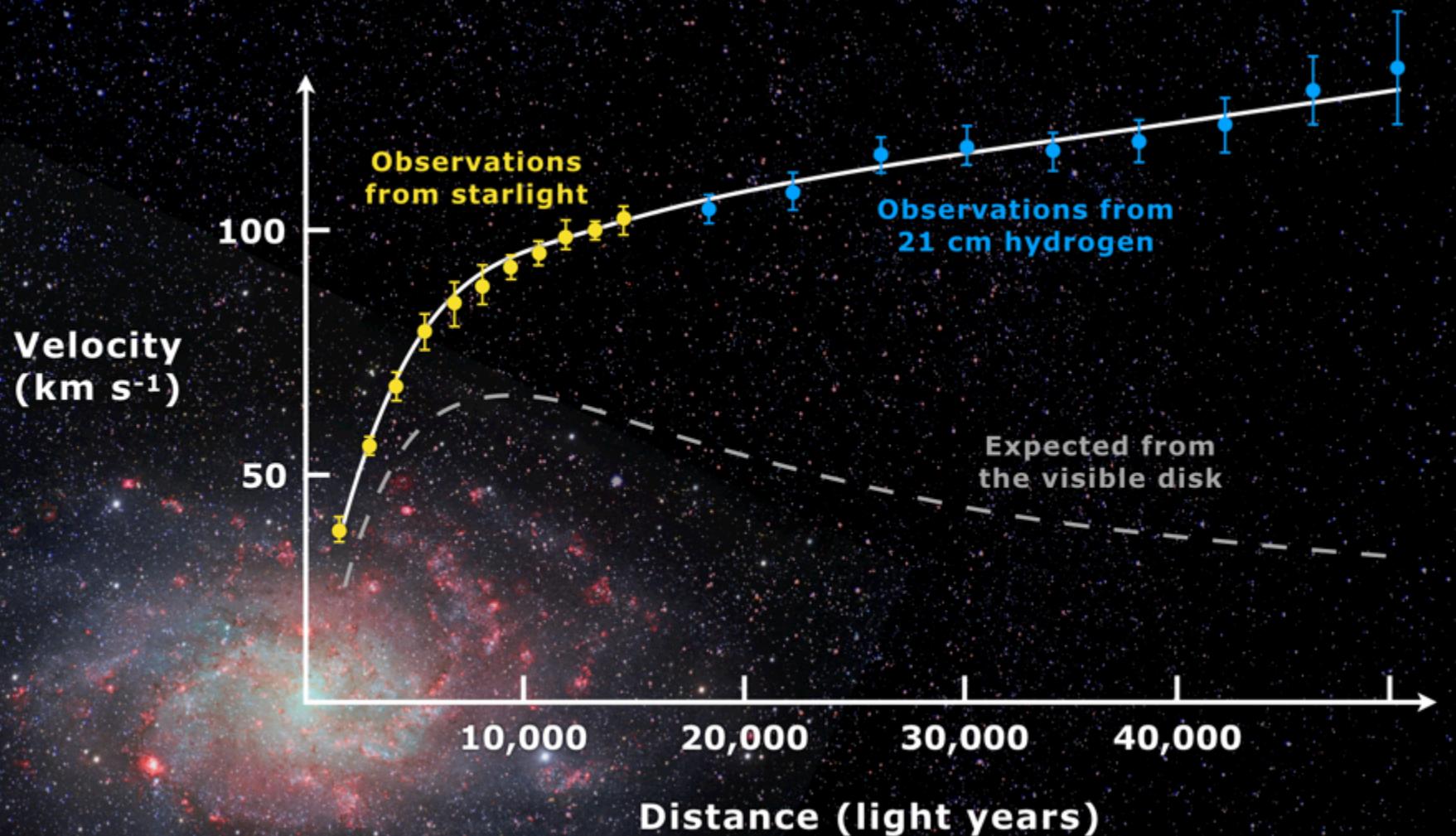












Dark Matter!

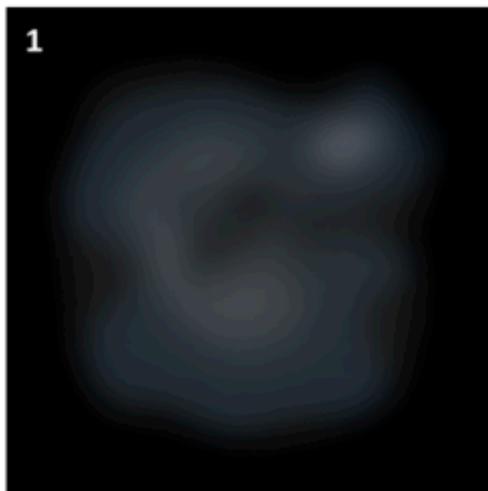
- We can measure accurately the mass of the galaxy through Kepler's Laws/gravity
- We can measure the mass of stars+gas
- Mass of stars = 0.2 x mass of galaxy

Rule out: black holes, brown dwarfs/
planets, interstellar gas

Dark matter: exotic, non-interacting particle
Dark=not interacting; 80% of mass!

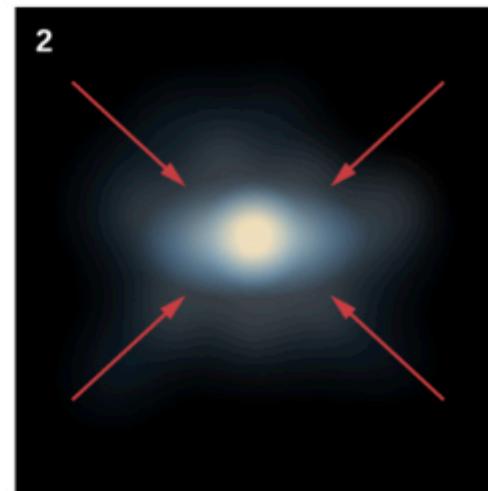
Rapid Collapse

1



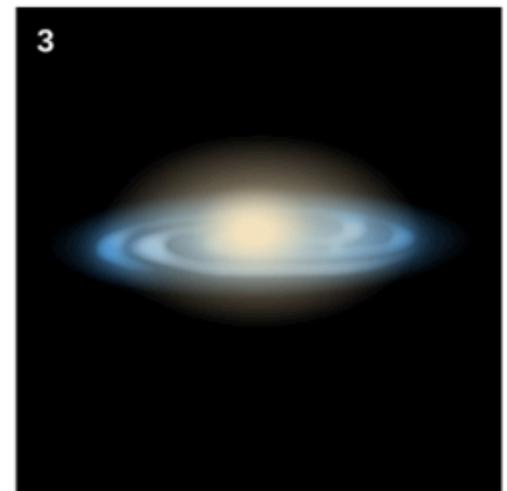
Primordial hydrogen cloud.

2



Cloud collapses under gravity.

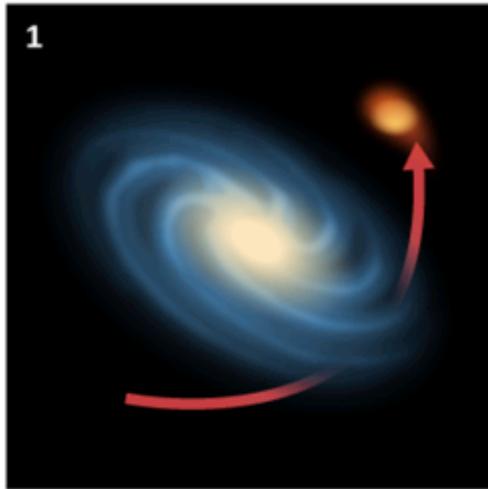
3



Large bulge of ancient stars dominates galaxy.

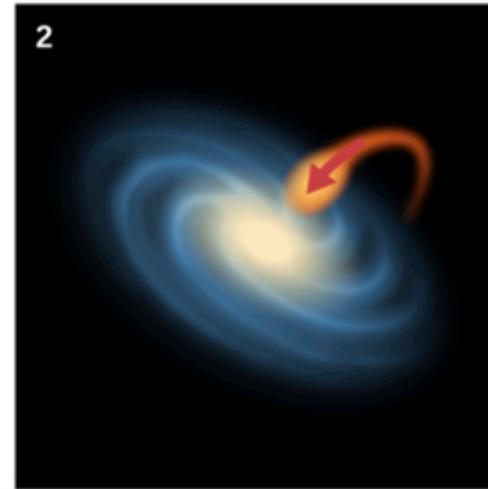
Environmental Effects

1



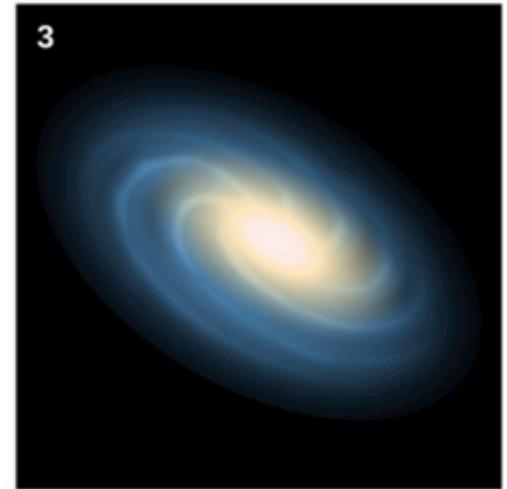
Disk galaxy and companion.

2



Smaller galaxy falls into disk galaxy.

3



Bulge inflates with addition of young stars and gas.

Milky Way: keywords

- Galaxy: gravitationally bound system of stars, gas, dust, and dark matter.
 - 1000-100,000 light years in radius
 - Many kinds of shapes and sizes
- Range: 10^8 - 10^{14} stars
 - Milky Way: 10^{11} stars (a large galaxy)
- Supermassive black hole
 - Milky Way: 4×10^6 Msun (small central black hole)

Milky Way: keywords

- **Spiral arms:** “shape” of young stars/dense gas in some galaxies
- **Supermassive black hole:** massive black hole at center of galaxy
- **Dark Matter halo:** spherical halo of dark matter around the galaxy
- **Galactic rotation:** rotation of stars/gas around galaxy
- **Central bulge:** bulge around nucleus of galaxy