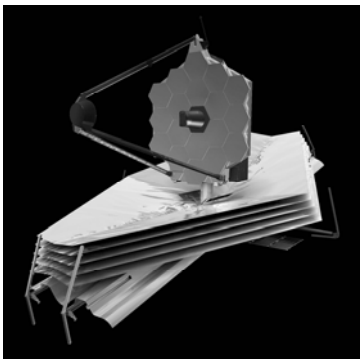
ASTR 1020: Stars & Galaxies

March 10, 2008

- Reading: Chapter 19, section 19.1-19.2.
- *MasteringAstronomy* Homework on The Milky Way is due March 19th (Wednesday).
- Extra credit (1 pt) observing opportunities at SBO. See CULearn.
- Exam 2 on Friday (covers Chapters 15.3 to 19.2).

Astronomy Picture of the Day



The James Webb Space Telescope

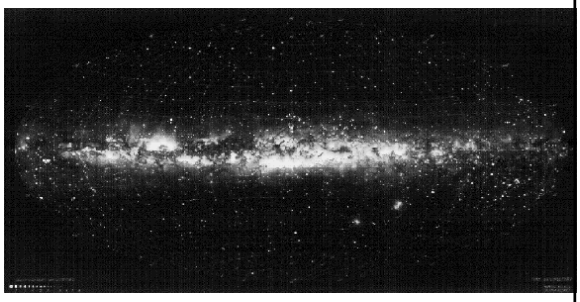
Launch = 2013

Mirror diameter = 6.5-meters (21.3 ft)

Last Week: **Star Wars**

- Battle for Gravitational Equilibrium:
  - White dwarfs: electron degeneracy pressure
  - Neutron stars: neutron degeneracy pressure
  - Black holes: gravity wins!

Today: The Milky Way



The Galactic Center

Milky Way Topics

- Basic anatomy- structure, contents
- Looking at the Milky Way at different wavelengths

Milky Way Factoids

- 100-200 billion stars
- 100,000 light years across

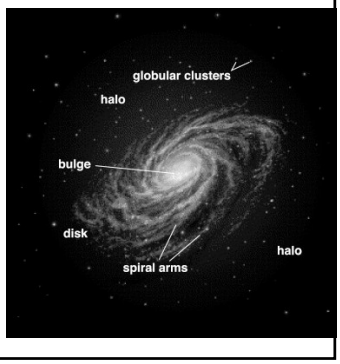
Sun is located ~28,000 light years from core, in the Orion Arm

Milky Way Anatomy

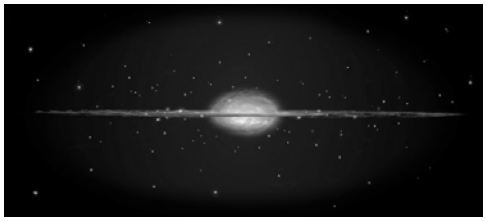
Disk: includes spiral arms

Young, new star formation

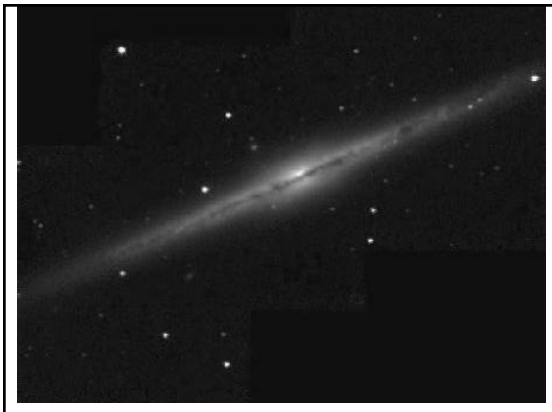
Bulge & Halo: older stars, globular clusters



Disk is very thin!



Why is this an artist's conception?



Galaxy "NGC 891" → nearly but not quite edge-on

Clicker Question: The ages of stars suggest that the bulge and halo of the Milky Way formed before many of the stars in the disk. Which would you expect to have more heavy metals (higher metallicity)?

a) Halo and bulge stars
b) Disk stars
c) No difference

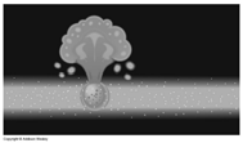
- (B) Disk stars are continually forming out of gas that is more and more "polluted" by heavy metals.
- The OLD globular clusters found in the halo were formed a long time ago before the galaxy was so polluted– they have very low "metallicities"

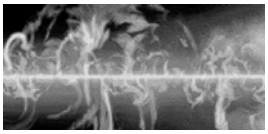
Contents: Really Hot stuff

- Bubbles of hot gas blown out by supernovae
- T= million degrees K
- Mixing with rest of galactic gas → enrichment with heavy elements

Superbubbles & Fountains

- Supernovae can burst hot gas out of the galaxy
- "Enriches" gas between galaxies
- May rain back down and mix into galaxy?





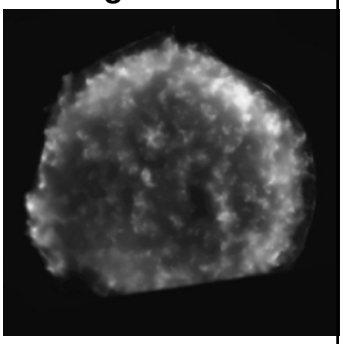
Artists' conceptions!

Fast electrons & magnetic fields

- → synchrotron emission

(prominent in X-ray and radio)

- Traces hot gas bubbles



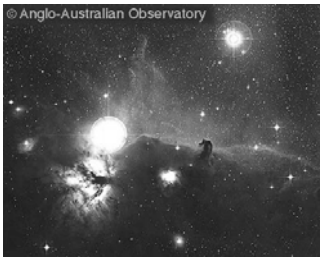
X-ray image of a supernova remnant

Warm stuff

- Gas & dust heated by stars
- Gas- emission lines from hydrogen (H-alpha) and other elements (ionization nebulae)
- T~ 10,000 near hot young stars

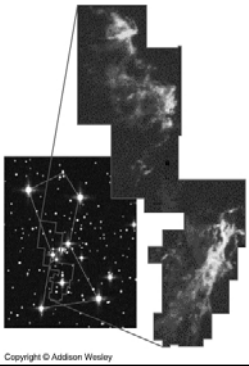
Dust

- Absorbs visible and UV light
- Transparent to longer wavelengths (red, IR, radio)
- Emits IR light (thermal spectrum)



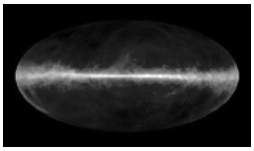
Cold stuff

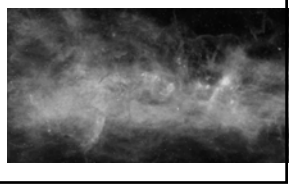
- Molecular clouds
- Dark, dusty, cold
- (10-30K)
- Emit molecular emission lines in far IR, radio

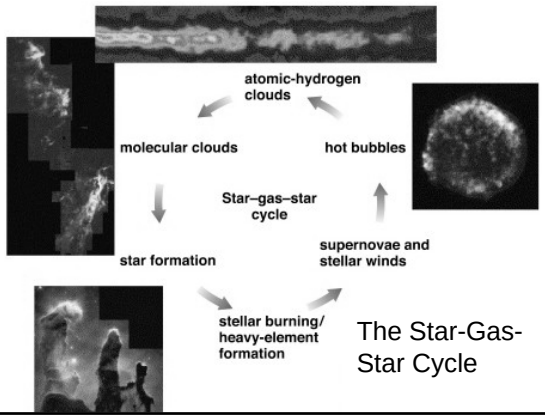


Cold hydrogen

- Even the coldest hydrogen emits a faint emission line in the radio
- Wavelength 21-cm (radio)
- Change in energy levels of nuclear configuration







The Star-Gas-Star Cycle