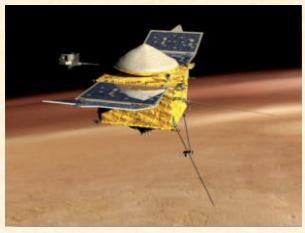
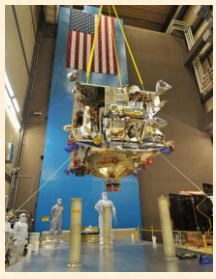
ASTR 1020: Stars & Galaxies

October 25, 2013

- Reading: Chapter 19, Sections 19.1-19.2.
- *Mastering Astronomy* Homework on Milky Way is due next Friday, Nov. 1.

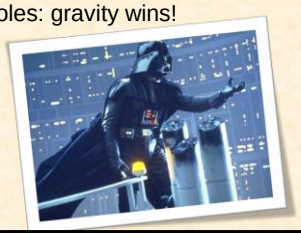
Astronomy in the News:
MAVEN (Mars Atmospheric and Volatile EvolutioN)
Michael Nothem





Stellar Grave Yard: **Star Wars**

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



Today: The Milky Way

Reading Clicker Question: How long does it take the Sun to complete one orbit of the Milky Way?

A. 100,000 years
B. 12 million years
C. 230 million years
D. 1.2 billion years

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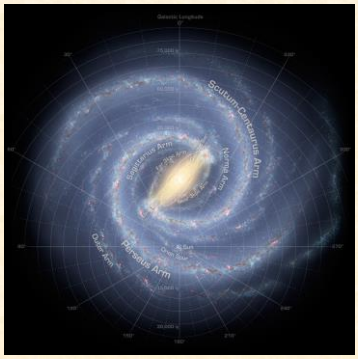
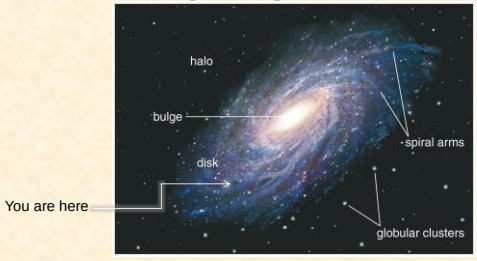
Milky Way Topics

- Basic anatomy-structure, contents
- Different temperature components.



Milky Way Factoids



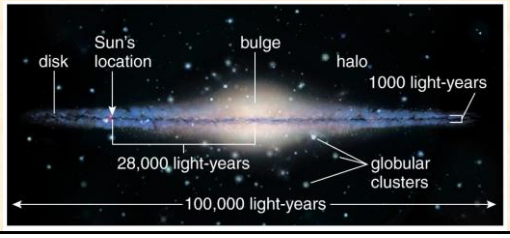
- 100-200 billion stars.
- 100,000 light years across.
- Sun is located ~28,000 light years (8.5 kpc) from core, in the Orion Arm.

Milky Way Anatomy

Disk: includes spiral arms

=>Young, new star formation

Bulge & Halo: older stars, globular clusters



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

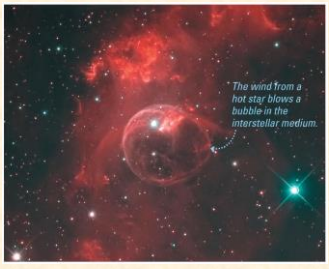
Clicker Question: The ages of stars suggest that the bulge and halo of the Milky Way formed before many of the stars in the disk. Which would you expect to have more heavy metals (higher metallicity)?

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"

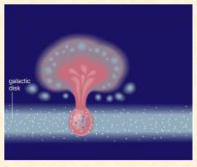
Contents: Really Hot stuff

- 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?



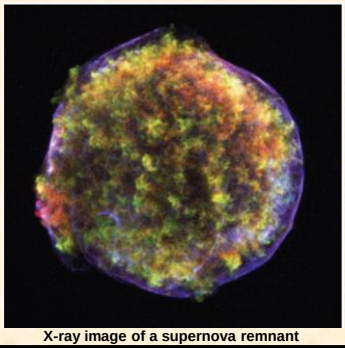
Artists' conceptions!

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 K near hot young stars

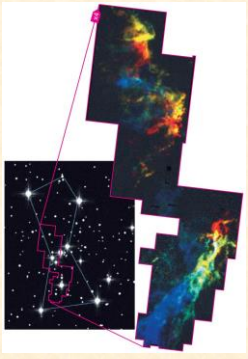
Dust

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

(Demo)

Cold stuff

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

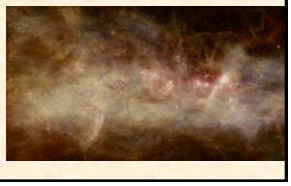


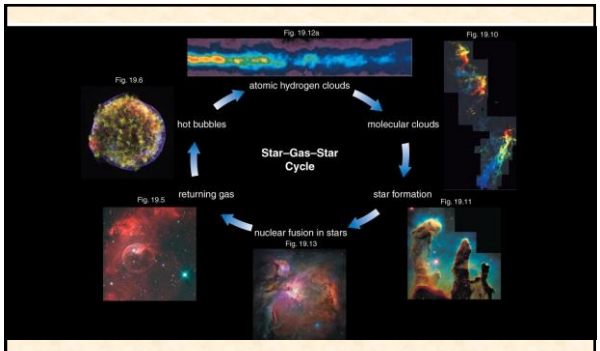
The CCAT Submillimeter Telescope in Chile

To be built on an 18,500-ft elevation mountain in the Atacama desert in northern Chile. 25-m aperture. Partners include CU, Caltech, Cornell, Canadian & German university consortia.

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

Recycles gas from old stars into new star systems.