Midterm 3 Review Sessions

Two choices:

- Monday: 7PM
- or Tuesday: 6PM

- Both in

  Plant & Soil Science (PSS)

  room A101

  (corner of Wilson & Bogue)

Print & bring Study Guide

- on course web site (reachable through Angel)

Computing the structure of the sun

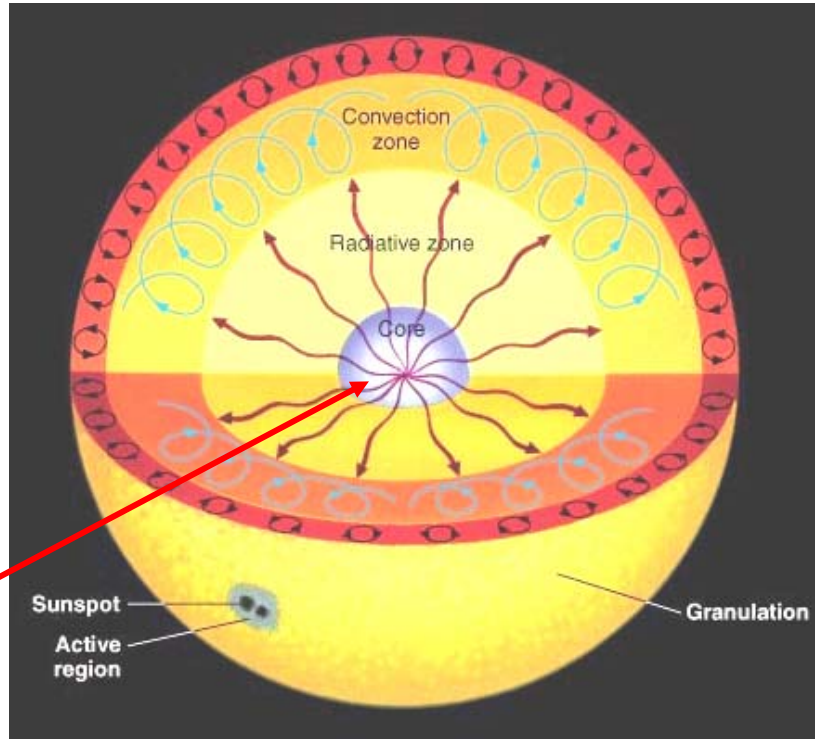
We can write equations expressing the following ideas:

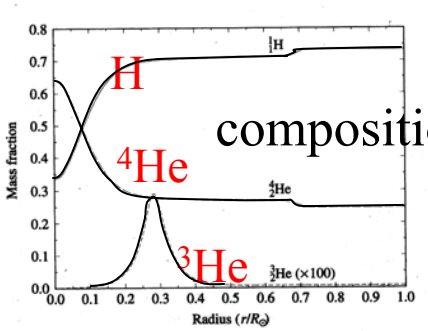
- The Sun is a gas.
- The Sun is neither contracting nor expanding.
- Each point inside the Sun stays at a fixed temperature.
- How energy generation rate depends on density, temperature, composition.
- How energy is carried outwards.

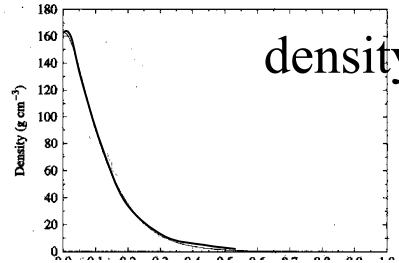
For every point in the Sun, we can then compute:

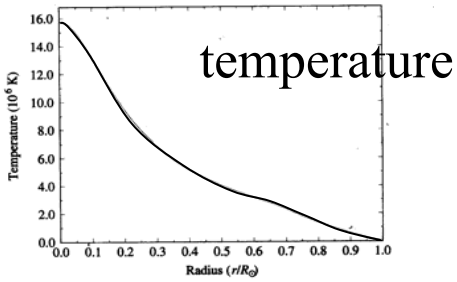
- temperature
- pressure
- density
- composition
- energy generation
- energy transport mechanism

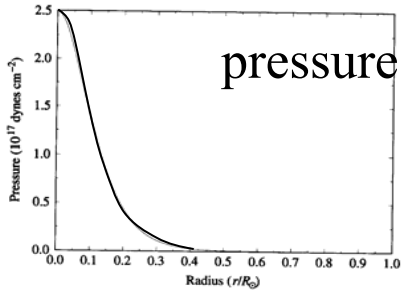
Energy source:
4 ^{1}H ➔ ^{4}He





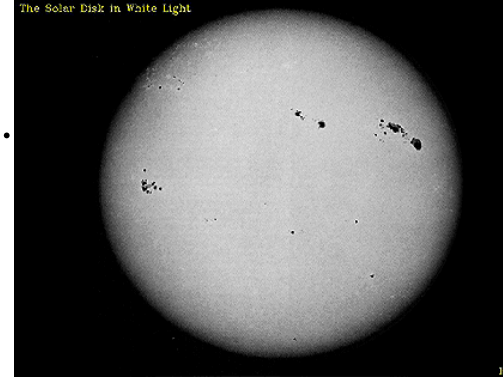


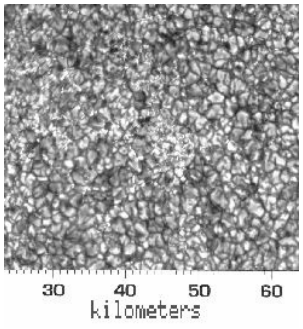




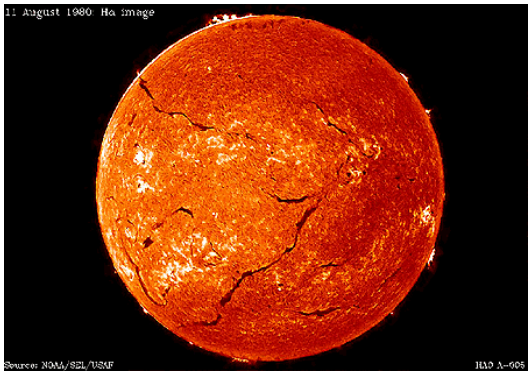
radius

- **Photosphere**
  - Deepest layer from which light directly escapes into space.
  - Low density and pressure (10^{-4}, 0.1 x Earth's surface values)
  - But *hot* (5800° K)
  - Granules (in photosphere)
    - Tops of convection currents.

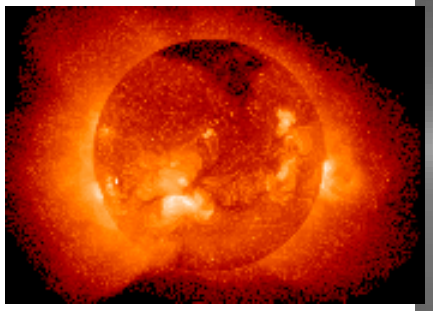


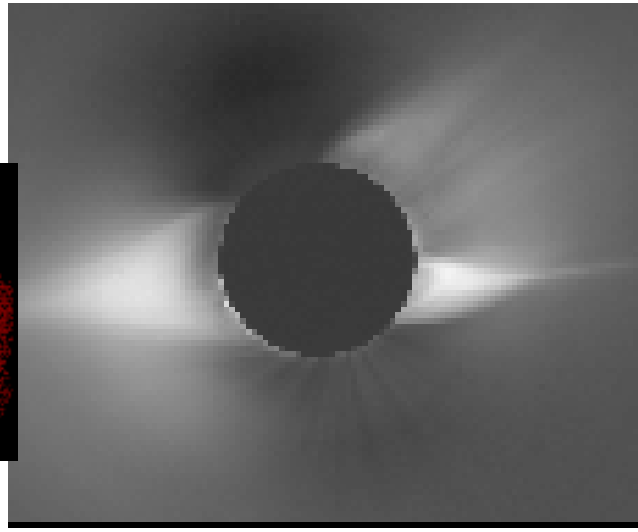


- **Chromosphere**
  - Transparent gas layer, reaches 2000-3000 km above photosphere.
  - T ~5,000-10,000° K
  - Photosphere = point we can no longer see through chromosphere.

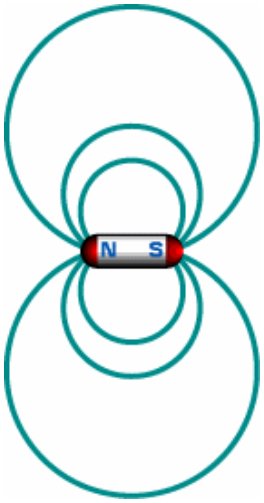


- **Corona**
  - T > 1,000,000° K
  - Very low density: 10^{-10} bar.
  - Heated by magnetic energy.
  - Several x diameter of photosphere.

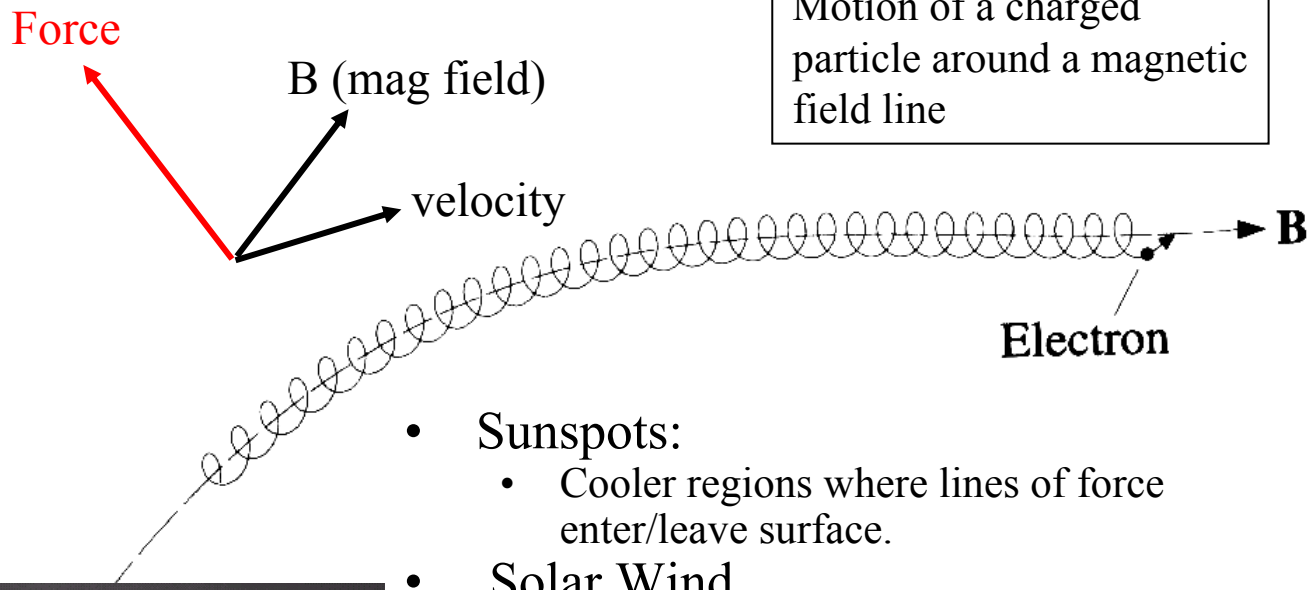




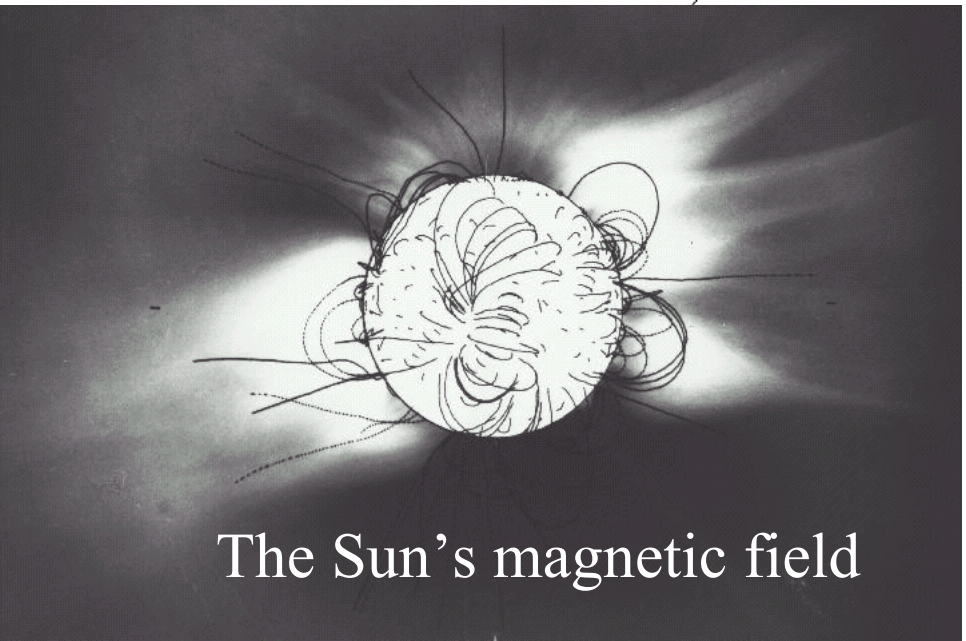
Magnetic Fields Control Much of Sun's Surface Activity



Magnetic field lines of force



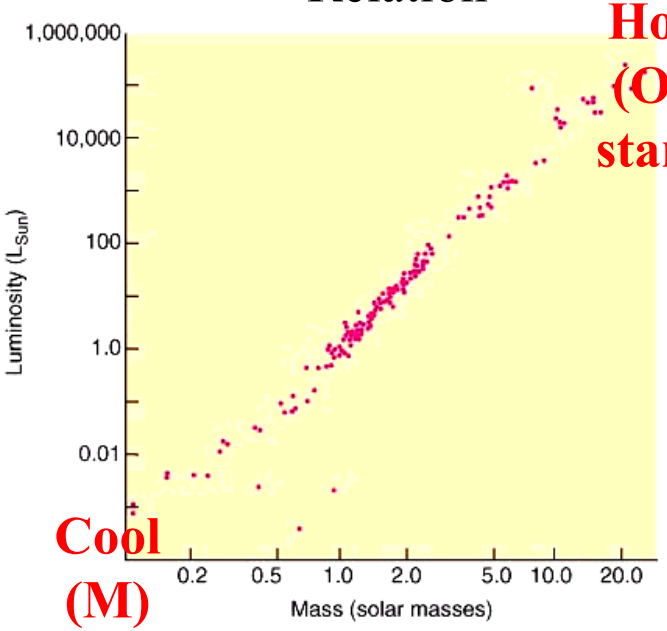
Motion of a charged particle around a magnetic field line


The Sun's magnetic field

- Sunspots:
  - Cooler regions where lines of force enter/leave surface.
- Solar Wind
  - Charged particles with greater than escape velocity, escaping through holes in magnetic field.
- Prominences
  - Charged particles following magnetic lines of force.
- Flares
  - Magnetic field lines short out ➔ Huge burst of charged particles.
- 11/22 yr. Solar cycle
  - Due to "winding up" of Sun's magnetic field.

Here's what we observe about stars.

The Mass-Luminosity Relation

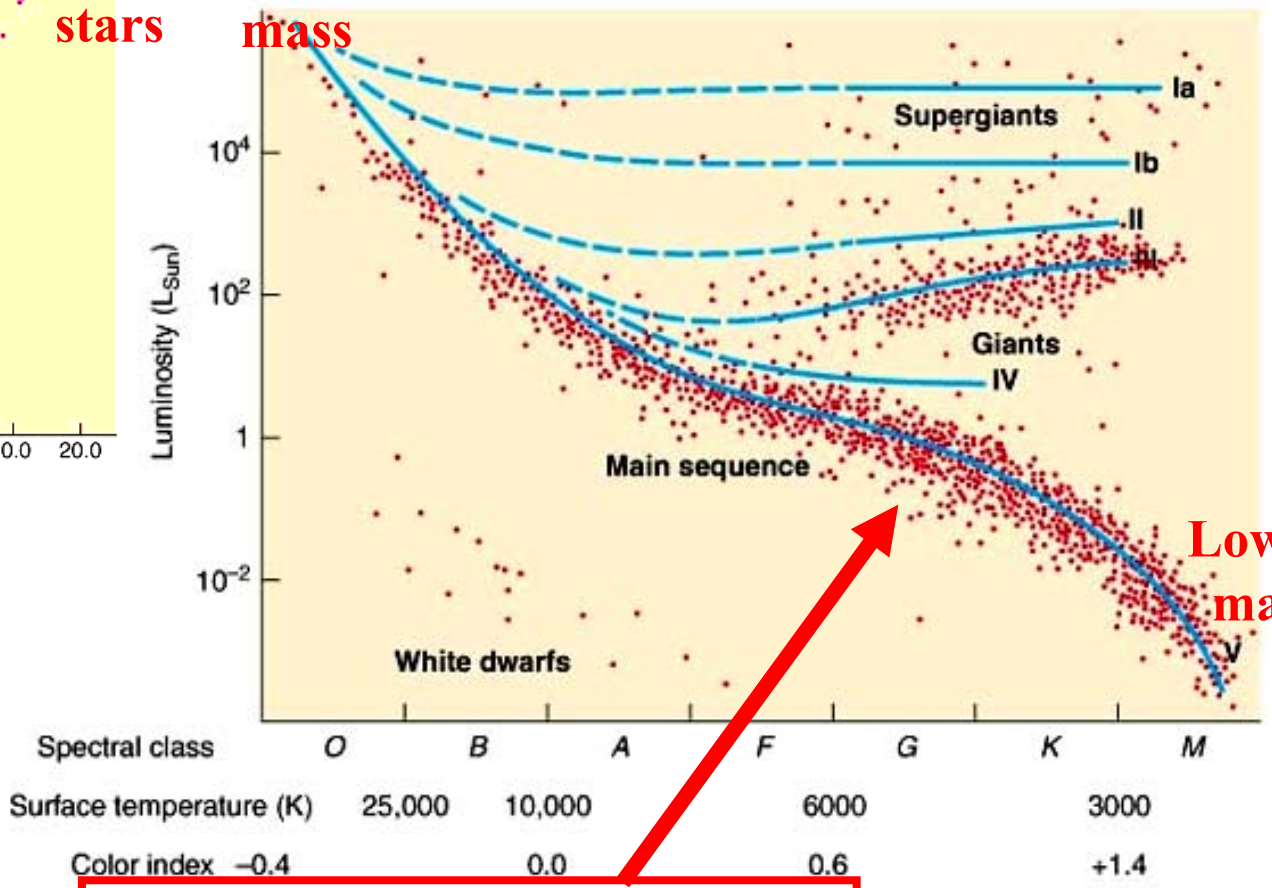


Hot (O) stars

Cool (M) stars

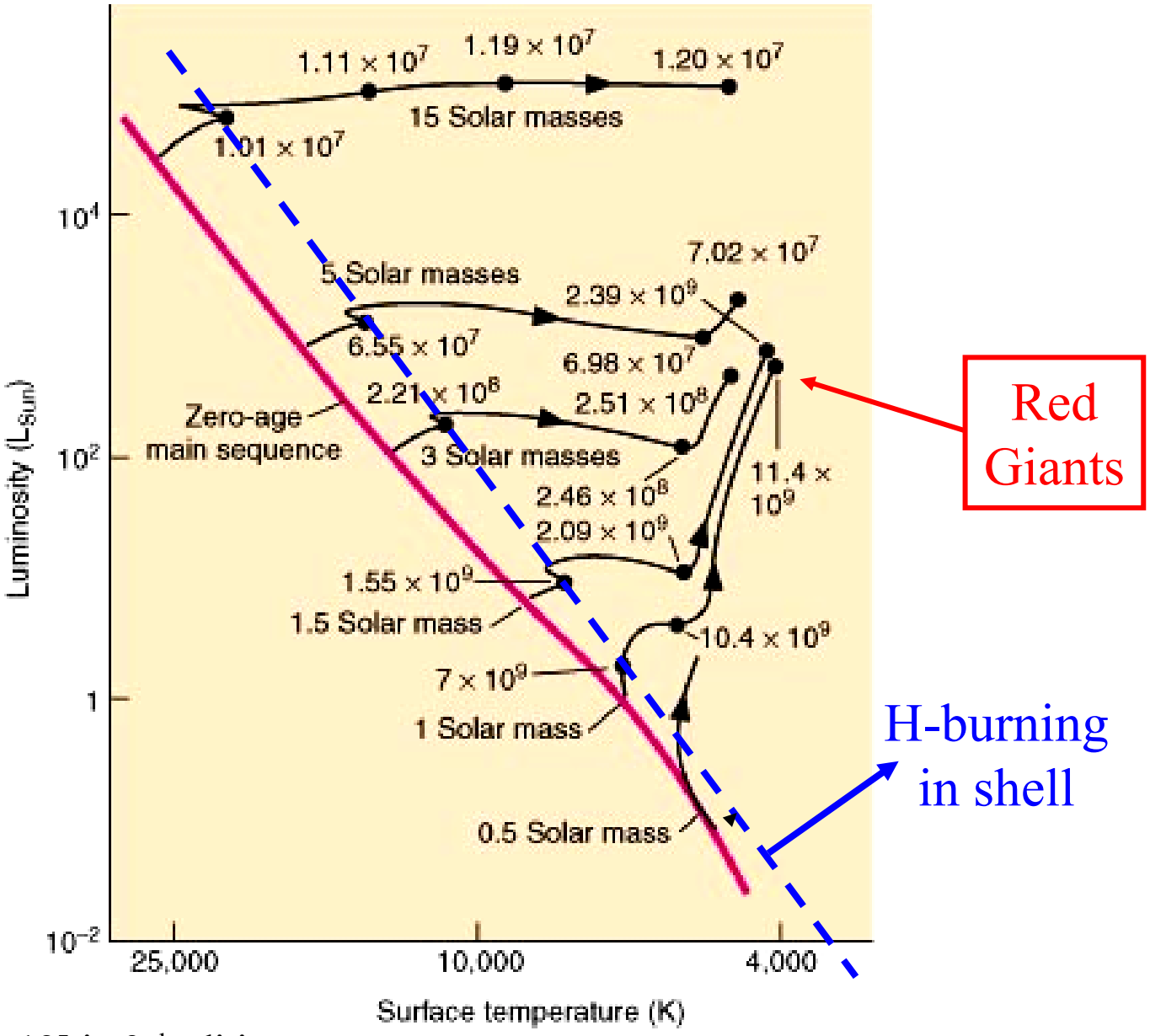
Main sequence is a mass sequence

The H-R Diagram (Luminosity, Temperature, Radius)



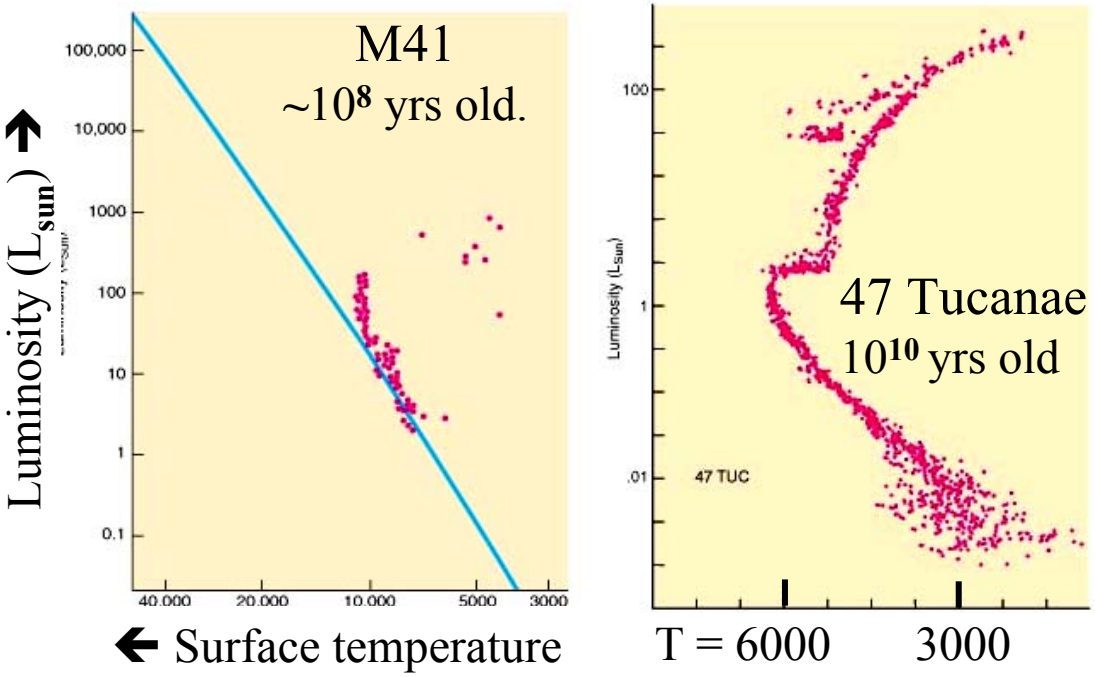
MAIN SEQUENCE:
Stars convert H into He in their cores.

Predicted paths of stars on HR diagram



[see figs. 12.10, 12.12] in 3rd edition.
[12.12, 12.14] in 4th edition.

Star clusters are snapshots of stellar evolution



- All stars in a given cluster formed at ~ same time.
- But with a wide range in masses.
- ***Main sequence turnoff*** = stars just finishing main sequence evolution.

To see how it all works, look at:

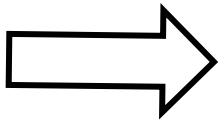
http://www.mhhe.com/physsci/astronomy/applets/Hr/frame.html

http://www.pa.msu.edu/courses/isp205/sec-1/hr.mpg

Stellar Evolution

Here: Evolution through nuclear burning.	
$M_{initial} > 2M_\odot$	**Nuclear burning all the way to iron.**
$M_{initial} < 2M_\odot$	**Nuclear burning shuts off after He-flash.**

Mass loss:



- Planetary nebulae
- Supernovae

There: Final state.	
$M_{final} > 3M_\odot$	**Black hole.**
$1.4 < M_{final} < 3M_\odot$	**Neutron star.**
$M_{final} < 1.4M_\odot$	**White dwarf.**

Telescopes

- Radio telescopes
  - Why use big arrays of them?
- Telescopes in space
  - Why spend all the $$$ to put them up there?
- NASA's Great Observatories
  - Hubble Space Telescope
    - Visible, ultraviolet
  - Chandra Space Telescope
    - X-rays
  - Spitzer Space Telescope
    - Infrared

Planets around Other Stars

- Over 200 known
- Usually detected through their effect on motion of the parent star.
- Also through transits, gravitational lensing.
- Possible sites of life

  … in our Solar System?
  - Mars
  - Europa
  - Other moons

  …elsewhere?
  - SETI
  - The Drake Equation: $N = R\ f_p\ n_e\ f_l\ f_c\ L$