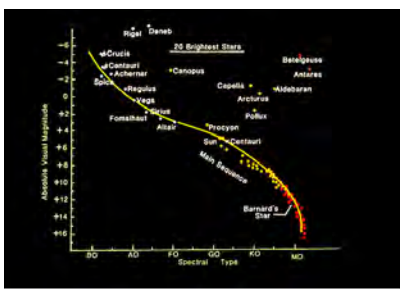
Agenda for Ast 309N, Oct. 2

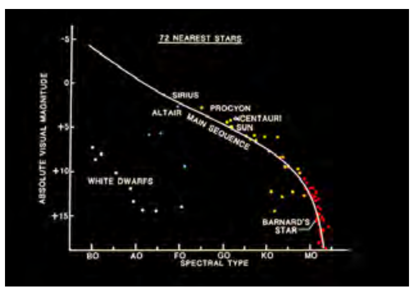
- Ground rules: Exam 1
- Feedback on Quiz 3, cards from 9/25, 27
- Red dwarfs: Low-mass Main Sequence stars
- Begin: introduction to brown dwarfs
- Reading:
  - Kaler, pp. 34 – 47; Wheeler, pp. 10 - 16

Exam Ground Rules and Format

- Bring your **UT photo ID** to get credit for the exam
- Bring pencils for scantrons; blue books not needed
- There will be 24 multiple-choice questions plus 3 short (quiz-like) essays
- You must arrive by 9:45 AM to take the test, and cannot leave until after 9:50 AM.

The Brightest Stars vs. the Nearest Stars



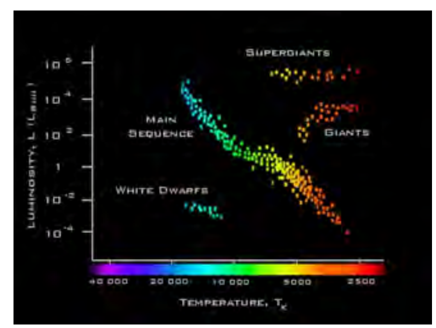


Notice the difference between the 20 stars that are apparently brightest in our sky, and the 20 that are actually nearest. We see the brighter stars over a larger distance/volume. This is an example of "observational selection" (Kaler, p. 30).

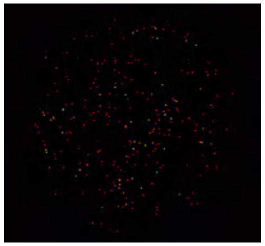
Low-Mass Main Sequence Stars

- Often called "red dwarfs" to contrast them with the much larger, more luminous "red giants."
- In fact, all Main Sequence stars are referred to as "dwarfs" meaning luminosity class V.
- … this is a different kind of beast than white dwarfs

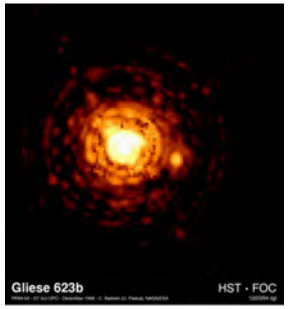
What's a white dwarf, and where does it come from?



Nearby Red Dwarfs



Low-mass, low-luminosity MS stars are more common than higher-mass ones; as of 2005, over 260 red dwarf (M Main Sequence) stars were known closer than 10 parsecs from the Sun.



Some are in binary systems, like Gliese 623 A (M2.5V) and B (M5.8Ve), at right, and are invisible to the unaided eye in Earth's night sky.

Example: UV Ceti

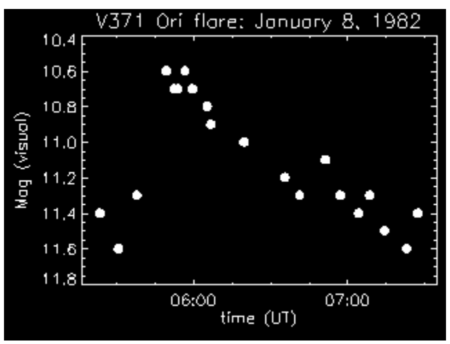
UV Ceti is the prototype for a class of active, "flare" stars (Kaler, p. 42)

Spectral Type	M 5 V
Distance	8.4 light-years
Luminosity	0.00004 L(sun)
Mass	0.15 M(sun)
Temperature	2,800 K
Lifetime	1 trillion years

Evidence for Activity in Low-Mass Stars

Starspots and outbursts are detected mainly by the dimming or sudden brightening of the star's light

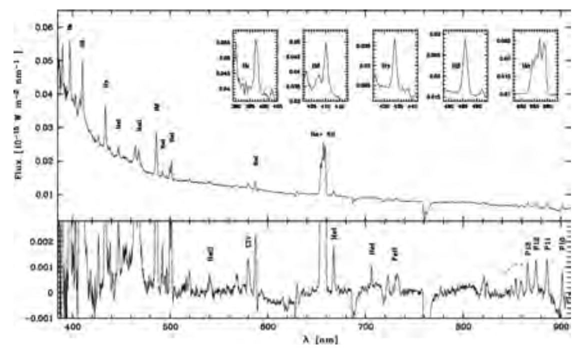
A "light curve" traces how a star's brightness varies over time



More Evidence for Activity

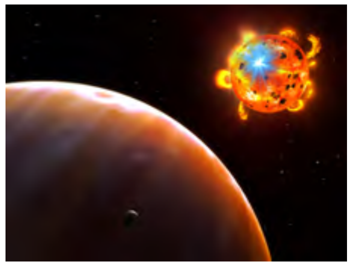
Such stars often show emission lines in their spectra

What does seeing an emission line tell us?



Flare Stars: Scaled-Up Solar Activity

The Sun has flares, magnetically confined loops, and sudden ejections of matter



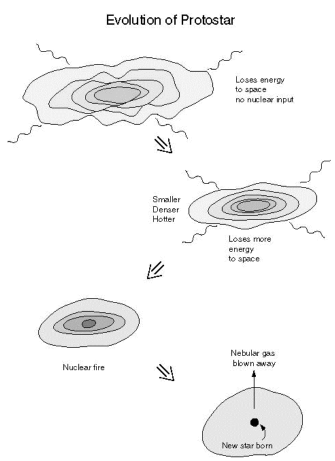
Artist's conception of a flare on a red dwarf

What's Interesting about Low-Mass Stars?

- They are much more numerous than massive stars
  … but we now know that they are not responsible for the phenomenon we call 'dark matter'
- They have very long lifetimes; there could be stars still out there that formed very early in the universe
  …. but current ideas suggest that such small stars did not form under conditions at that time
- They have a tendency to be very 'active' – in the sense of solar activity: starspots, intense magnetic fields, mass ejections, and flares
  …. especially when they are relatively young.

How the Sun became a Star

- The Sun began as a cloud of gas, contracting under gravity.
- This converted gravitational energy into kinetic then thermal energy, and heated up the central regions.
- The center eventually became hot and dense enough for thermonuclear reactions to begin: H fusion into He.
- Contraction stopped and fusion became the energy source.



Wheeler, Fig. 1.5

Why do Some Protostars "Fail"?

As a star is forming through contraction of a cool low-density cloud, the inside heats up. However, hot objects radiate, so some of the created energy is lost due to radiation, cooling the protostar. This causes gravity to overcome thermal pressure. The protostar continues contracting, so the core gets even hotter. Eventually it's hot enough for nuclear fusion to start.

If the cloud starts out with less than 0.08 solar masses (80 times Jupiter's mass), it becomes a brown dwarf, or a "failed star." Why does this happen; why doesn't it just keep contracting, going through the loop described above, until it gets hot enough?

Hint: This scenario is based on thermal pressure. Is there any other kind? For example, what supports a white dwarf?

Why is there a Minimum Mass for Main Sequence Stars?

- A cloud with smaller initial mass has less gravitational potential energy to release during the protostellar contraction phase,
- … providing less thermal energy to heat the core
- … so the central temperature doesn't rise high enough to start fusion of H into He
- Why doesn't it just keep contracting and heating until it *does* get hot enough?
- Something stops the collapse; a new form of pressure …. "quantum pressure"