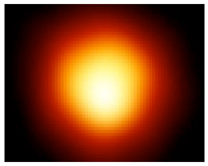
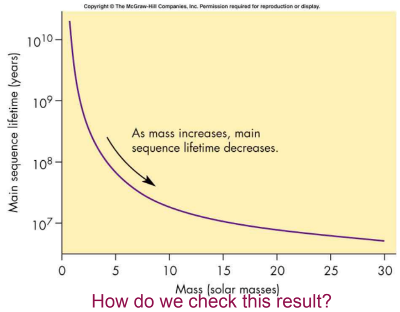
Stars after the Main Sequence. Example: Betelgeuse (Alpha Orionis)



A Hubble telescope Picture of Betelgeuse

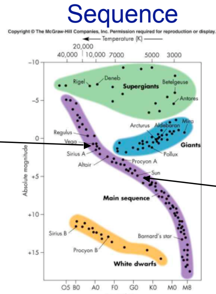
Last time, concluded that the Main Sequence lifetime of a star is strongly dependent on its mass



How do we check this result?

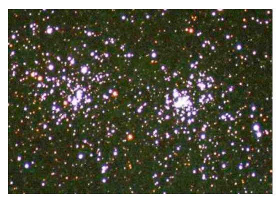
The masses of Main Sequence stars increase as one goes "up" the Main Sequence

2.40 solar masses



1 solar mass

A young star cluster and a "more mature" one



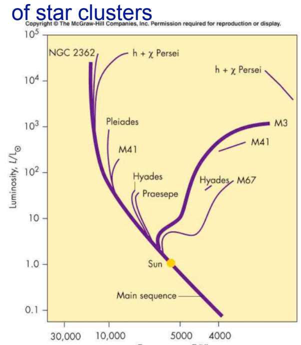
H & Chi Persei…. Contain O stars

The Pleiades…no Main Sequence stars more massive than class B

M67-the most massive Main Sequence stars not much more massive than the Sun

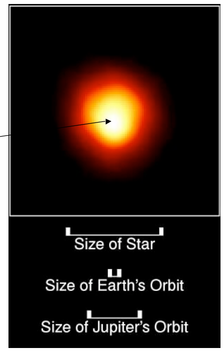
Let's look at the Hertzsprung-Russell diagrams of star clusters

These data make sense as a sequence in age, beginning with the youngest (NGC2362) and going to the oldest (M67)

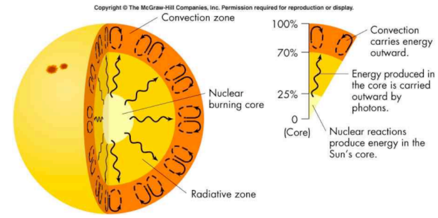


Betelgeuse is a red supergiant

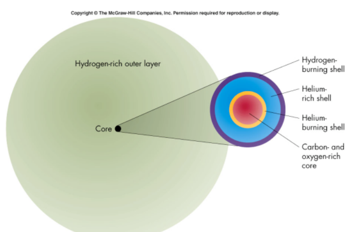
Deep in its interior is a Massive, incredibly compact Stellar remnant



When you look at a Main Sequence star, the appearance of it exterior tells you what it is like inside



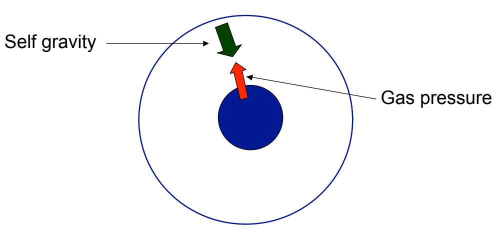
In an evolved star, the appearance of the surface is not a good indicator of its deep interior



As cores contract, the density goes to "astronomical" levels, matter acts in funny ways

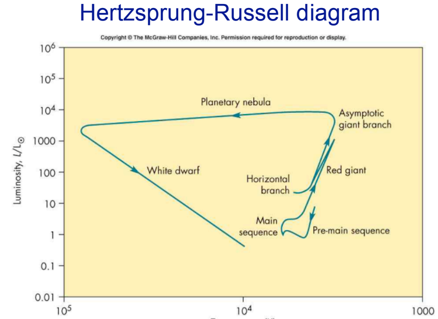
- Gas in this room, the "perfect gas law" PV=nRT. Pressure depends on both density and temperature
- Extremely dense, "degenerate" gas PV=Kn. Pressure depends only on density
- Demo

The structure of a star: a balance between gravity and gas pressure

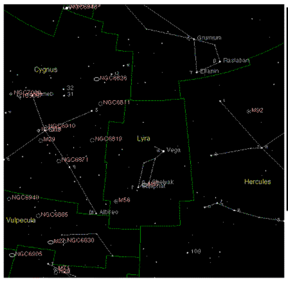


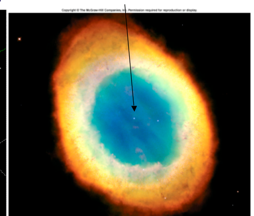
Technical term: hydrostatic equilibrium

Major result of stellar evolution: post-main sequence stars move around on the Hertzsprung-Russell diagram



Old evolved stars throw off their outer layers, producing objects called planetary nebulas, revealing the weird cores





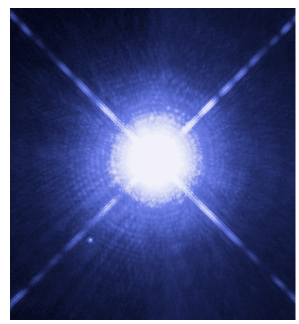
Another planetary nebula: M27 (we saw it during the field trip)

These compact cores exist….the white dwarf stars

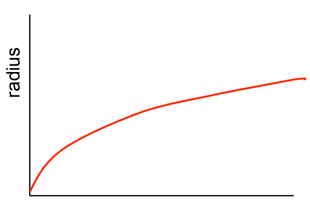
Nearby examples: Sirius B and Procyon B

The physics of white dwarf stars

- What holds them up?
- What determines their properties?

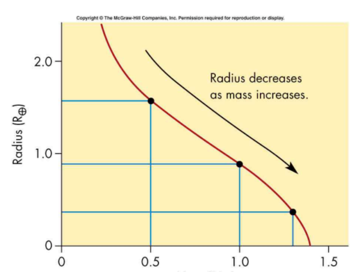


Equations give radius of white dwarf as a function of its mass



What one might expect for how R depends on M

What the solution really is for a white dwarf star



Main features to note about white dwarf solution

- Note the size: objects with masses like the sun, but radii like the Earth
- The size becomes *smaller* with increasing mass
- There is an upper limit (the Chandrasekhar mass) to the mass of a white dwarf