ASTR 1020: Stars & Galaxies

February 25, 2008

- Reading: Chapter 17; sections 17.1-17.2.
- *MasteringAstronomy* Homework on Stellar Evolution is due March 3rd.
- SBO observing nights (extra credit)
- Volunteers for Astronomy in the News

Astronomy Picture of the Day

Orion's Horsehead Nebula

Today's Topic: Star Birth

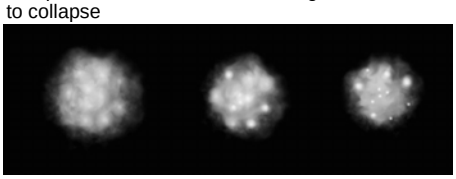
We start with clouds of cold, interstellar gas:

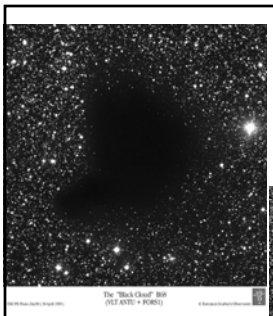
- Molecular clouds- cold enough to form molecules; T=10-30K
- Often dusty
- Collapses under its own gravity

Collapse from Cloud to Protostar

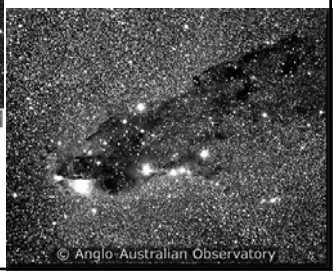
1) collapse from very large, cold cloud – cold enough to contain molecules (molecular clouds)

- Fragments into star-sized masses
- Temperature increases in each fragment as it continues to collapse



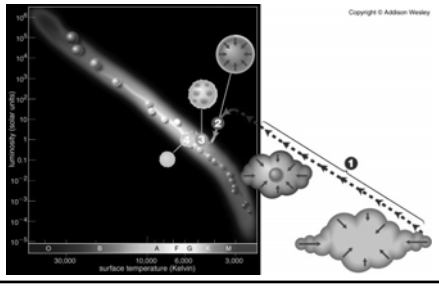


Dusty, dark molecular cloud regions



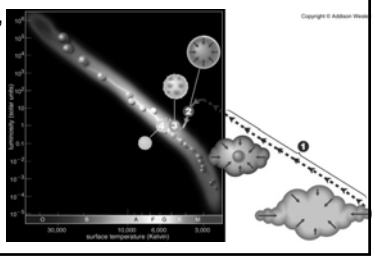
2.) Collapse continues, temperature stabilizes as convection circulates energy outwards

- On HR Diagram, moves slightly left, downwards



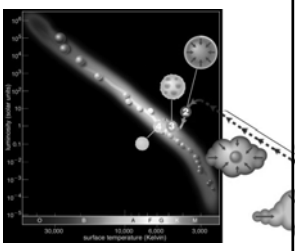
3.) As core temperatures reach millions of degrees, fusion begins

- Collapse slows but doesn't stop
- On HR diagram, movement more horizontal

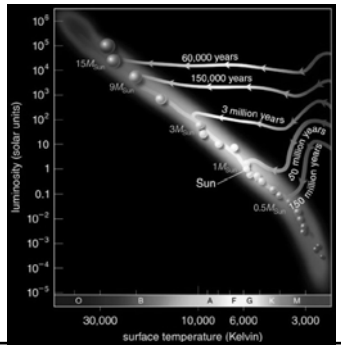


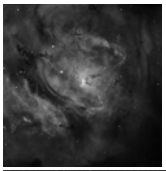
4.) Proto-star finally reaches main sequence

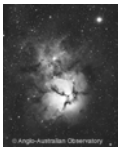
- Hydrogen → helium in the core
- Stellar thermostat keeps luminosity and temperature stable for billions of years

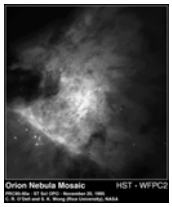


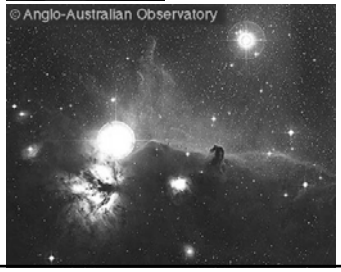
Protostars of different masses follow different life tracks towards the main sequence



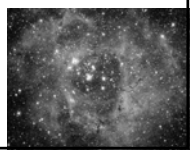








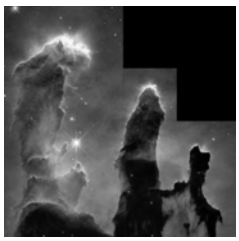
Star forming regions - NEBULAE = CLOUDY



- Note: bright new main sequence stars
- Pink hydrogen gas
- Black sooty dust
- Blue nebulae are dust reflections of starlight from massive blue stars

(blue light reflects off dust/atoms more easily than red - this is also why our sky, smoke is blue)

Eagle Nebula: cold dark clouds are eroded by intense starlight



Stars eventually heat and disperse the clouds of star forming regions

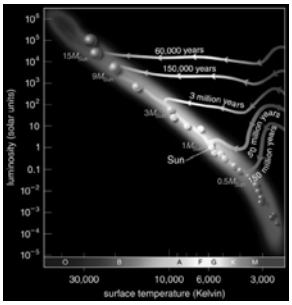
Stellar demographics

- Many more low-mass stars than high-mass stars are born
- Highest mass stars ~ 60-100 solar masses (60-100 times the mass of the Sun)
- These evolve off main sequence rapidly-most stars in the galaxy are low-mass main sequence stars

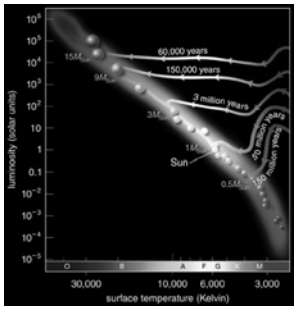
Clicker Question

Colors of galaxies:

For every massive O star that is born, there are ~100 low-mass M stars also born

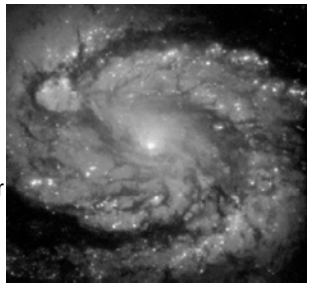


- 1 blue O → 100 red M
- Lum O = 10,000 solar luminosities
- Lum M = 0.001 solar luminosities
- What color is the starlight from the star forming spiral arms in our galaxy?
- A) Blue
- B) Red
- C) Orange



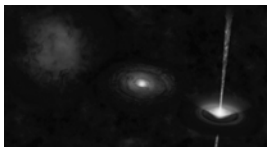
- **A) Blue**
- 100 times more M stars, but each is 1/10,000,000 times fainter than an O star

Massive blue stars dominate the light



Protostars and Planets

- Conservation of angular momentum → mass x velocity x radius = constant.
- Gas & dust are flung into a disk around the protostar. Planets?
- Some material spun up in magnetic fields as a jet



This is where planets are born

Formation process takes 50 million years for Sun; compare with 10 billion year lifetime

Eventually the disk fragments and dissipates or is blown away