ASTR 1020: Stars & Galaxies

October 7, 2013

- Reading: Chapter 17, section 17.1-17.2.
- *Mastering Astronomy* Homework on Star Birth is due Oct. 11.
- Extra credit night observing at SBO on Thursday, Oct. 10, at 8 pm.
- Volunteers for *Astronomy in the News.*

Want to be an LA?

Come to the **LA Info Session** to learn more about becoming a *Learning Assistant*.

When: **Monday, October 7, 2013, at 5:30 p.m.**

Where: Center for Community (C4C) Abrams Room

Refreshments will be served, while they last.

Applications for Spring 2014 available October 7 – 21

Goto: https://laprogram.colorado.edu/applications

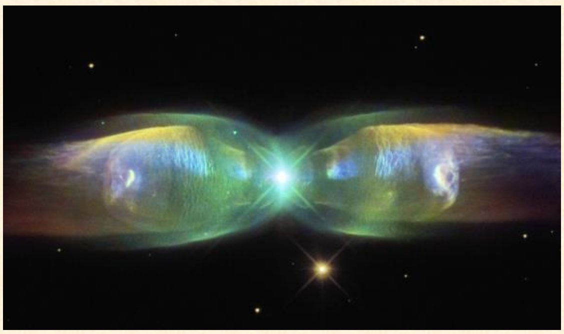
Get more information from faculty and LAs in these departments:

Applied Math	Math	Education
MCDBiology	ATOC	Chemistry
EBIO	Astronomy	Physics

Learning Assistant (LA) Model

APS will be hiring for:
- **1010: Introductory Astronomy I**
- **1020: Introductory Astronomy II**
- **2000: Ancient Astronomies**

Astronomy Picture of the Day



In the case of low-mass stars like our Sun and M2-9 pictured above, the stars transform themselves from normal stars to white dwarfs by casting off their outer gaseous envelopes. The expended gas frequently forms an impressive display called a *planetary nebula* that fades gradually over thousand of years.

Reader Clicker Question: What would happen if the core of a star like the Sun shrank a little bit?

A. The nuclear reactions would speed up
B. More hot gas would be produced
C. The core would expand
D. It would get hotter
E. All of the above

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THIS IS PRESSURE BALANCE

It explains why the Sun is stable and permits life on the Earth!

Today's Topic: Star Birth

We start with clouds of cold, interstellar gas:

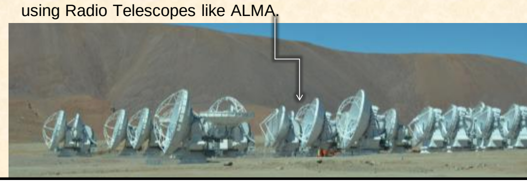
- Molecular clouds- cold enough to form molecules; T=10-30K
- Often dusty
- Collapses under its own gravity

Star-Forming Clouds

- Stars form in dark clouds of dusty gas in interstellar space.
- The gas between the stars is called the **interstellar medium.**

Molecular Clouds

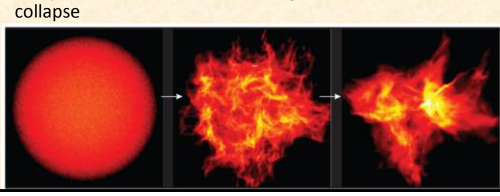
- Most of the matter in star-forming clouds is in the form of molecules (H_2, CO, etc.).
- These *molecular clouds* have a temperature of 10–30 K and a density of about 300 molecules per cubic centimeter. Observed using Radio Telescopes like ALMA.

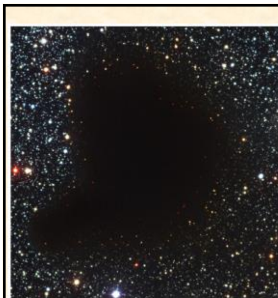


Collapse from Cloud to Protostar

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

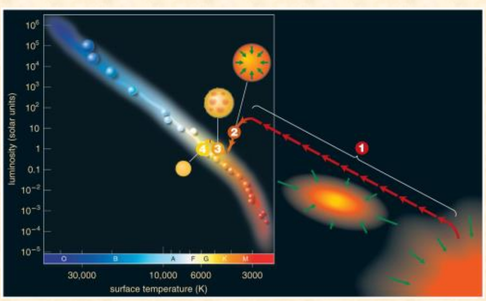




Dusty, dark molecular cloud regions

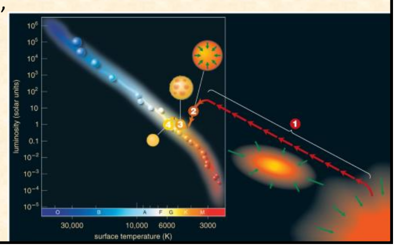
2.) Collapse continues, temperature stabilizes as convection circulates energy outwards

- On HR Diagram, moves slightly left, downwards



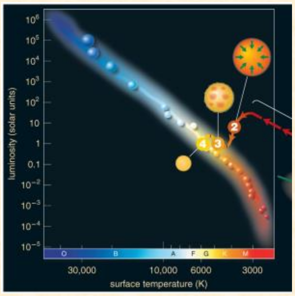
3.) As core temperatures reach millions of degrees, fusion begins

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

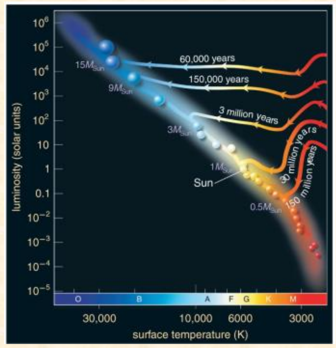


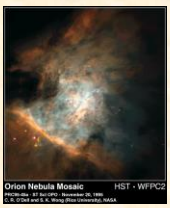
4.) Proto-star finally reaches main sequence

- 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

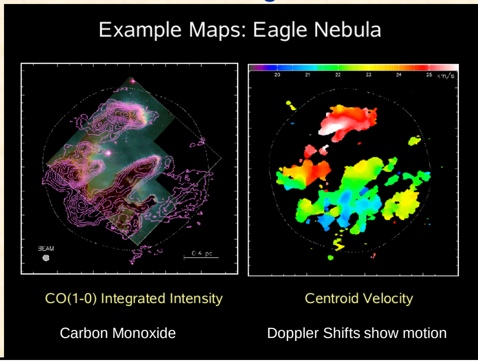
- Note: bright new main sequence stars
- Pink hydrogen gas
- Black sooty dust
- Blue nebulae are dust reflections of starlight from massive blue stars

(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

Molecules observed in IR/radio light- we can see through the dust!



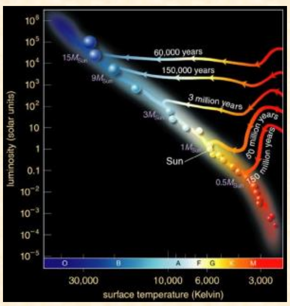
Stellar demographics

- 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



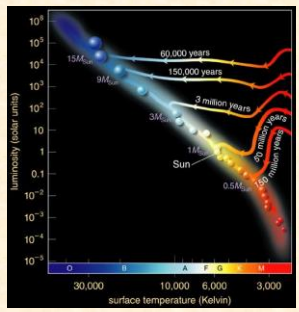
- 1 blue O → 100 red M
- Lum O = 10,000 solar luminosities
- Lum M = 0.001 solar luminosities

=>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

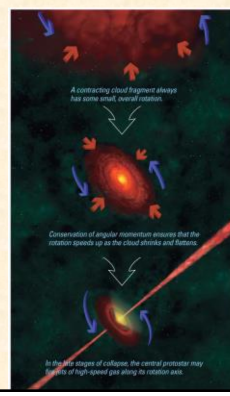
Massive blue stars dominate the light

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