ASTR 1020: Stars & Galaxies

October 14, 2013

- Reading: Chapter 18, Section 18.3.
- *Mastering Astronomy* Homework on The Lives of Stars is **due Oct. 18**.
- Volunteers needed for ***Astronomy in the News!***
- Next Class **MEET** at Fiske Planetarium: Bring CLICKERS ***Dr. Einstein's Universe.***
- Extra Credit OBSERVING **7:30 pm Thursday October 17 *(SBO)***

Quick Clicker Survey: What do like best about the class so far?

a) Lectures (including demos, planetarium).
b) Clicker questions to stimulate discussion.
c) Mastering Astronomy Homework.
d) Astronomy in the News.
e) Recitations & labs.

Quick Clicker Survey: What do like least about the class so far?

a) Lectures (including demos, planetarium).
b) Clicker questions to stimulate discussion.
c) Mastering Astronomy Homework.
d) Astronomy in the News.
e) Recitations & labs.

Astronomy Picture of the Day

Melotte 15 in the Heart. New born star cluster at center of nebula.

Last Week

Stellar Evolution:

- Low mass stars → planetary nebulae and white dwarfs
- High mass stars → supernovae and neutron stars / black holes

Review Clicker Question

Imagine two star clusters, one 10 billion years old, and one very young. Which is more likely to have a lot of white dwarfs?

(Hint: what mass stars create white dwarfs?)

a) the old one
b) the young one
c) can't tell

Review Clicker Question

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Massive Star Supernovae

- Exploding remnant of a massive star, disperses and spreads heavy element through the galaxy
- What kinds of elements?
- What does it leave behind?

"The Crab", aka Messier 1, went off July 4th, 1054 A.D. ; visible in the daytime!

The Stellar Graveyard

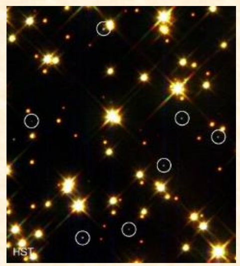
Low mass stars → white dwarfs
gravity vs. electron degeneracy pressure

High mass stars → neutron stars
Gravity vs. neutron degeneracy pressure

Even more massive cores → black holes
Gravity wins…..

Today: White Dwarfs

- For solar-mass star, a hot core of carbon (can also be oxygen for higher mass stars).
- Size ~ Earth!!
- Density – 1 cm^3 weighs about 5 tons.



White Dwarfs in Globular Cluster M4 (HST)

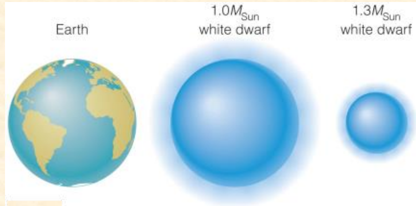
A white dwarf

A. is the core of a star like our Sun and contains most of the mass
B. is about the size of Earth
C. is supported by electron degeneracy
D. is so dense that one teaspoonful would weigh about as much as an elephant
E. all of the above

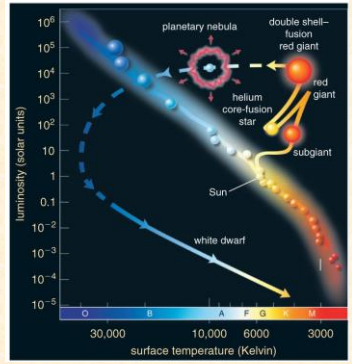
What is the mass limit of a white dwarf?

A. 0.8 solar masses
B. 1.1 solar masses
C. 1.4 solar masses
D. 2.0 solar masses
E. 8.0 solar masses

Size of a White Dwarf



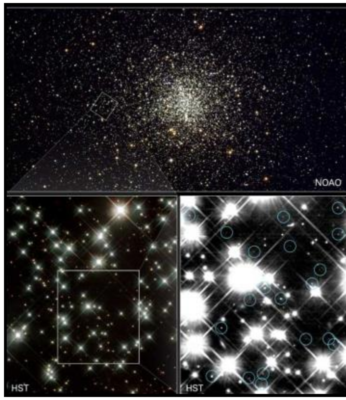
- White dwarfs with same mass as Sun are about same size as Earth.
- Higher-mass white dwarfs are smaller.



White dwarfs cool off and grow dimmer with time.

Which is oldest?

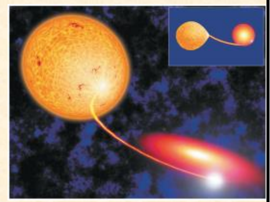
A. An M spectral type white dwarf
B. An A spectral type MS star
C. An O spectral type MS start
D. An O spectral type white dwarf
E. An A spectral type white dwarf

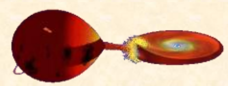


Old globular clusters have white dwarfs (M4)

White Dwarfs in Binary Systems

- Mass transfer from a companion red giant spirals into an **accretion disk**
- Inner parts become VERY hot; Peak at UV and X-ray wavelengths





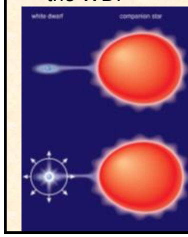
Clicker Question

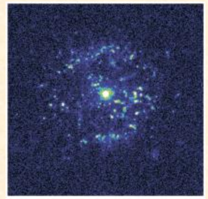
What would the gas in an accretion disk do if there were no friction?

A. It would orbit indefinitely.
B. It would eventually fall in.
C. It would blow away.

Novae (not Supernovae!)

- Hydrogen gas falls onto the white dwarf, heats up and fuses for a short time
- Star becomes much brighter → **nova** (new star); MUCH dimmer than a supernova. Does not destroy the WD.

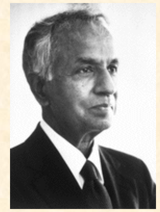




b Hubble Space Telescope image showing blobs of gas ejected from the nova T Pyxidis. The bright spot at the center of the blobs is the binary star system that generated the nova.

White Dwarf Supernovae

- If enough mass is accreted, electron degeneracy is overcome
- Limit: 1.4 Solar masses (White dwarf limit = Chandrasekar Limit)



Dr. Chandrasekar says "***Do not weigh more than 1.4 solar masses or you will collapse!***"

White Dwarf Supernovae

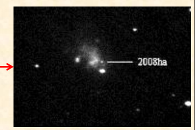
- If white dwarf accretes mass from binary companion so it is >1.4 solar masses, it will collapse and the star heats to burn carbon
- "Carbon bomb" → entire star explodes!
- Nothing remains….

What is Electron Degeneracy Pressure?

- Quantum mechanics says that electrons must move faster as they are squeezed into a very small space.
- As a white dwarf's mass approaches $1.4M_{Sun}$, its electrons must move at nearly the speed of light.
- Because nothing can move faster than light, a white dwarf cannot be more massive than $1.4M_{Sun}$, the *white dwarf limit* (or *Chandrasekhar limit*).

Compare the 2 types of Supernovae

White dwarf binary systems only
- Not much hydrogen
- Occurs in older star populations
- Nothing left inside



Massive stars
- Lots of hydrogen
- Found in young star formation regions
- Make neutron stars or black holes

We'll be looking at these again as distance measurement tools!

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