ASTR 1020: Stars & Galaxies

March 3, 2008

- Reading: Chapter 18, section 18.2; summary of key concepts.
- *MasteringAstronomy* Homework on Star Death is due March 10th.
- Exam 1 fusion question.
- **Meet Friday at Fiske Planetarium for "Dr. Einstein's Universe"!**

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

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

How would you rate the class so far?

a) Excellent
b) Very good
c) About average for similar large classes
d) Poor

Astronomy Picture of the Day

Twelve Lunar Eclipses from 1996 to 2008

Last Time

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

Supernovae

- Exploding remnant of a massive star, disperses and spreads heavy element through the galaxy

"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

Cool from white-blue through red to black

Clicker Question

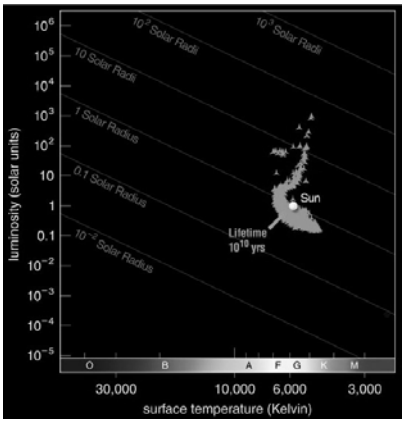
- Imagine two star clusters, one 10 billion years old, and one very young. Which is more likely to have a lot of white dwarfs?
- Hint: what mass stars create white dwarfs?

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

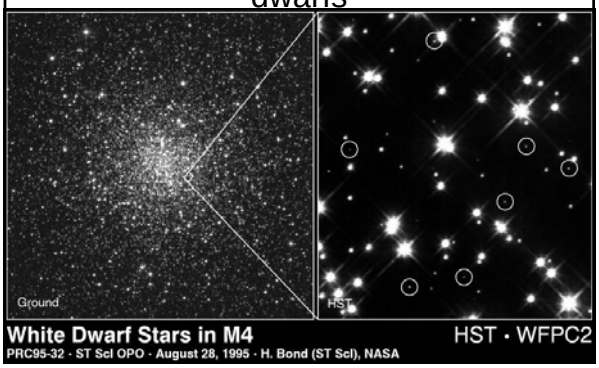
Clicker Question

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

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

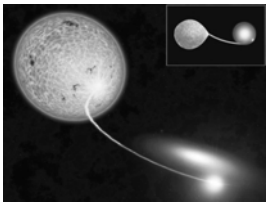


Old globular clusters have white dwarfs



White Dwarfs in Binary Systems

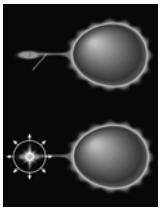
- Mass transfer from a companion red giant spirals into an accretion disk
- Inner parts become VERY hot; glow in UV, X-rays

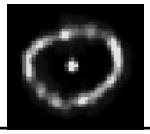


Novae (not Supernovae!)

- Gas falls onto the white dwarf, heats and fuses for while
- Star becomes much brighter → nova (new star)

Dimmer than supernova



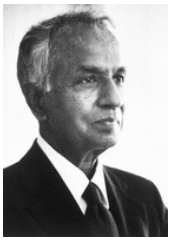


White Dwarf Supernovae

- 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….

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!

Clicker Question

What is the ultimate fate of an isolated White Dwarf?

a) It will cool down to become a cold black dwarf.
b) As gravity overwhelms degeneracy pressure, it will explode as a nova.
c) As gravity overwhelms degeneracy pressure, it will explode as a supernova.
d) Degeneracy pressure will eventually overwhelm gravity and white dwarf will evaporate.

Clicker Question

What is the ultimate fate of an isolated White Dwarf?

a) It will cool down to become a cold black dwarf.
b) As gravity overwhelms degeneracy pressure, it will explode as a nova.
c) As gravity overwhelms degeneracy pressure, it will explode as a supernova.
d) Degeneracy pressure will eventually overwhelm gravity and white dwarf will evaporate.