10/11/06

Exam 2, Chapters 6, 7, Friday, October 20

Chapters 6, 7 posted - revised, updated for second edition

Movies are now posted on class website, by chapter.
Check chapter 6.

News?

Pic of the day - chain of galaxies
in the Virgo Cluster

One Minute Exam

Why does a subsonic deflagration “flame” alone fail to account for the observations of a Type Ia supernova?

A) All the ejected matter would be iron.

B) A neutron star would be left behind.

C) The ejected matter would contain lots of carbon

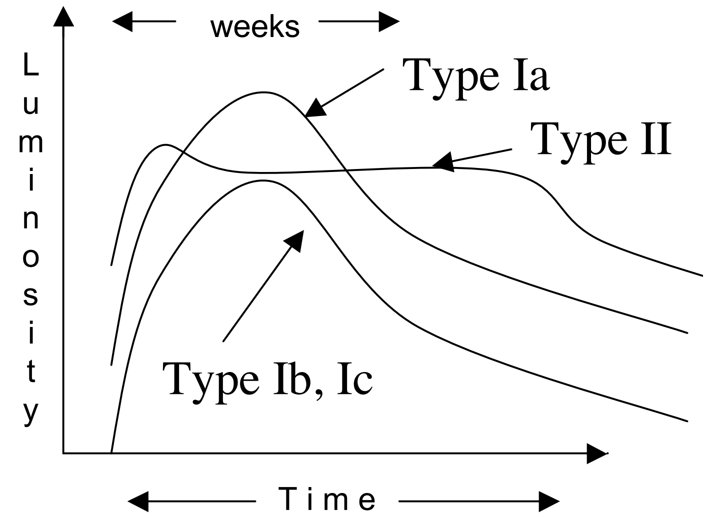
D) The ejected matter would have silicon on the outside and iron on the inside

Light Curves

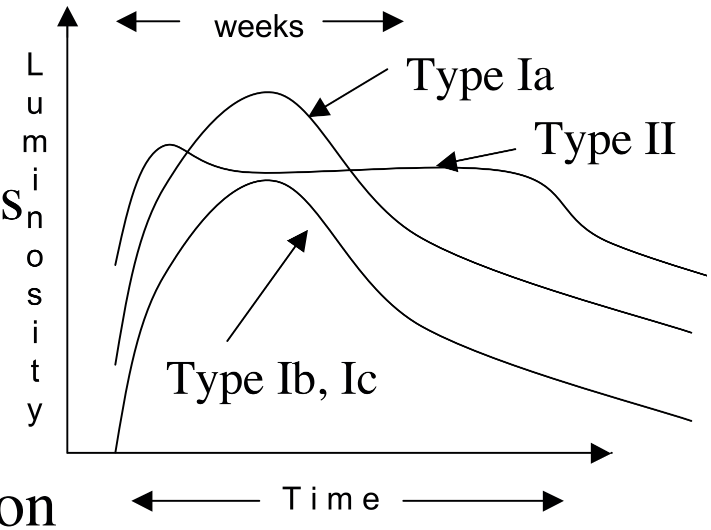
Why is the light curve different for Type II?

Why is the light curve similar for Type Ia, Ib. Ic?

Why are Type Ia brighter than Type Ib, Ic?



Light Curves



Ejected matter must expand and dilute before photons can stream out and supernova becomes bright: ***must expand to radius ~ 100 × Earth orbit***

Maximum light output ~ 2 weeks after explosion

Type II in red giants have head start, radius already about the size of Earth's orbit; light on plateau comes from *heat of original explosion*

Ejected matter cools as it expands: for white dwarf (Type Ia) or bare core (Type Ib, Ic) tiny radius about the size of Earth, must expand huge factor > 1,000,000 before sufficiently transparent to radiate.
All heat of explosion is dissipated in the expansion
By time they are transparent enough to radiate, there is no original heat left to radiate
Need another source of energy for Type I a, b, c to shine at all!

Type Ia start with C, O: number of protons equal to number of neutrons

Iron has 26p 30n ***not equal***

C, O burn too fast (~1 sec) for weak nuclear force to convert p to n (§1.2.1)

Similar argument for Type Ib, Ic, core collapse. Shock wave hits silicon layer with #p = #n, burns too quickly for weak nuclear force to convert p to n.

Fast explosion of C/O in Type Ia, shock hitting layer of Si in Type Ib, Ic make element closest to iron (same total p + n) with #p = #n

Nickel-56: 28p 28n <u>total 56</u> -- Iron-56: 26p 30n <u>total 56</u>

Ni-56 is unstable to radioactive decay

Nature wants to produce iron at bottom of nuclear "valley"
decay caused by (slow) weak force p → n

Nickel -56	γ-rays heat →	Cobalt-56	γ-rays heat →	Iron-56
28p	"half-life"	27p	"half-life"	26p
28n	6.1 days	29n	77 d	30n

Secondary heat from γ-rays makes Type I a, b, c shine

Type Ia are brighter than Type Ib and Ic because they produce more nickel-56 in the original explosion.

The thermonuclear burning of C and O in a white dwarf makes about 0.5 - 0.7 solar masses of nickel-56.

A core collapse explosion that blasts the silicon layer makes about 0.1 solar masses of nickel-56.

Type II also produce about 0.1 solar mass of nickel-56, but the explosion energy radiated from the red giant envelope in the plateau tends to be brighter. After the envelope has expanded and dissipated, the remaining radioactive decay is seen.

One Minute Exam

Type Ic supernovae are usually dimmer than Type Ia supernovae because:

A) Type Ic form neutron stars

B) Type Ic have no hydrogen or helium

C) Type Ic have binary companions

D) Type Ic produce less nickle-56