Thursday, February 19, 2009

Astronomy in the News?

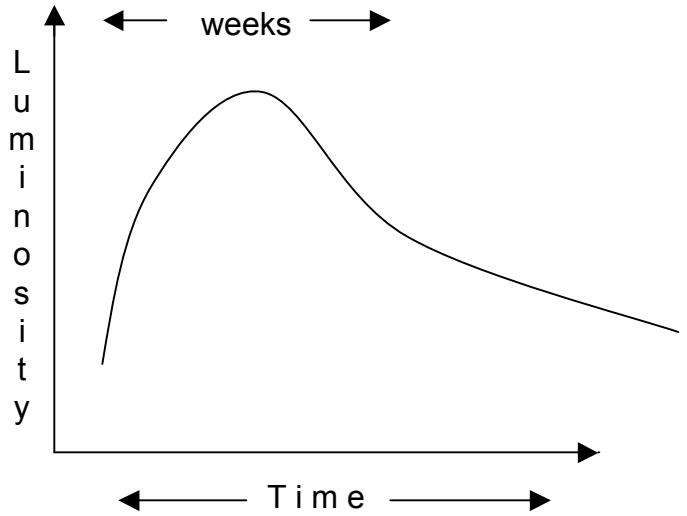
If the object that was seen Sunday morning over central Texas was a meteor, it was about the size of a basketball, not a pick-up truck.

I got to see Moon rocks and comet dust yesterday

Pic of the Day - Mauna Kea
Panorama

Type Ia - no hydrogen, intermediate mass elements early, iron later

Light Curve - brightness vs. time
consistent with an
exploding C/O white dwarf
expect total disruption, ***no neutron star***



Type Ia occur in elliptical galaxies, tend to avoid spiral arms in spiral galaxies - old when explode, probably a white dwarf.

SN 1006, almost definitely Type Ia

Tycho, SN 1572 almost definitely Type Ia

Kepler, 1604, some argue yes (no sign of neutron star, same ejected composition as SN 1006, Tycho), but some ambiguities suggesting a massive star progenitor.

If U Sco becomes a supernova it will probably be a Type Ia

One minute exam

Why do the elements carbon, oxygen, magnesium, and silicon frequently appear in the matter ejected from supernovae?

A) They are built up from the element iron

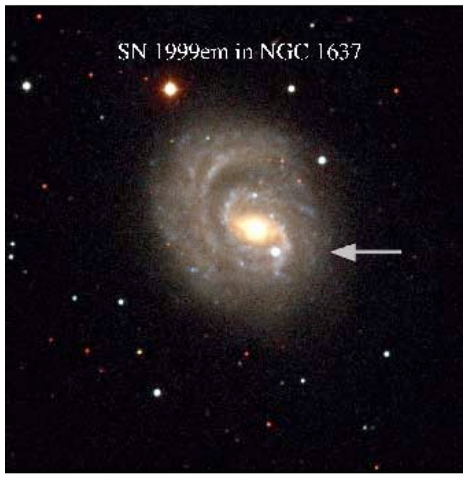
B) They are built up from the element hydrogen

C) They are built up from the element helium

D) They are built up from the element calcium

Type II Supernovae - "other" type discovered early, show Hydrogen in the spectrum early, Oxygen, Magnesium, Calcium, later

Most occur in spiral galaxies, *in the spiral arms*, ***they have no time to drift from the birth site*** sometimes in irregular galaxies
never in elliptical galaxies



SN 1999em

→The progenitor stars are young, short-lived massive stars

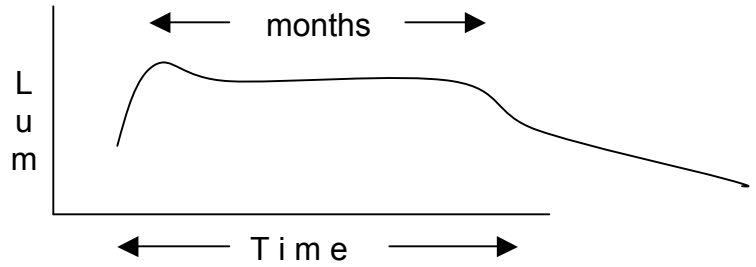
We expect such stars to evolve to form iron cores and collapse to a neutron star or black hole (physics to come)

Light curves of Type II supernovae are consistent with explosion in a Red Giant

Betelgeuse is a massive red giant, 15 solar masses: we expect it to become a Type II supernova. ***Maybe tonight!*** Rigel probably burning He to C/O, explode later.

SN 386, 1181 records are sparse, might have been Type II
Crab was a "peculiar" Type II (high helium abundance, slow explosion)
Cas A was probably something else (next topic),
SN1987A was a "peculiar" Type II.

Not obvious that any of the historical supernovae were a "normal" Type II, although Type II are common in other galaxies



Type Ia
no Hydrogen or Helium
intermediate mass elements early on, iron later
avoid spiral arms, occur in elliptical galaxies
peaked light curve
all consistent with explosion in white dwarf, total disruption

Type II
Hydrogen early on, Oxygen, Magnesium, Calcium later
explode in spiral arms, never in elliptical galaxies
"plateau" light curve
consistent with massive, short-lived star that has an explosion deep within a Hydrogen Red Giant envelope by core collapse to leave behind a neutron star (or maybe a black hole).

One minute exam

A supernova explodes in an elliptical galaxy. Near peak light what element do you expect to see in the spectrum?

A) Hydrogen

B) Helium

C) Silicon

D) Iron

New Types, blurring the old categories, identified in the 1980's, defined by elements observed in the ***spectrum***.

Type Ib: no Hydrogen, but Helium early, near maximum brightness; Oxygen, Magnesium, Calcium later on

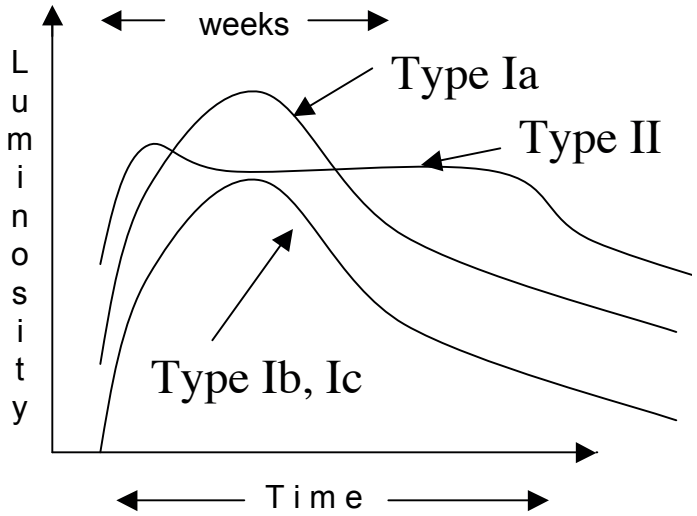
Type Ic: no Hydrogen no (or *very* little) Helium early, near maximum brightness;
Oxygen, Magnesium, Calcium later on

Explode in the spiral arms of spiral galaxies ⇒ massive stars,
Never in elliptical galaxies expect neutron star
or black hole

Like Type II, but have somehow lost their outer layers of Hydrogen or even Helium ⇒ wind (§2.2) or binary mass transfer

Type Ib, Type Ic Light Curve

Similar to a Type Ia, usually, but not always, dimmer, consistent with a star that has lost its outer, Hydrogen envelope (or even Helium for a Type Ic) [will explain why dimmer later]



Crab might have had a light curve like this, but probably too much Hydrogen to qualify as a Type Ib

Cas A seems to have been dim at explosion, might have been a Type Ib, despite some evidence for a little Hydrogen in the remnant now

One Minute Exam

A supernova that explodes within the spiral arm of a spiral galaxy and shows no evidence for hydrogen or helium in its spectrum is probably a

A Type II supernova

B Type Ia supernova

C Type Ib supernova

D Type Ic supernova

Type Ia: No Hydrogen, oxygen, magnesium, silicon, sulfur, calcium early, Iron later.

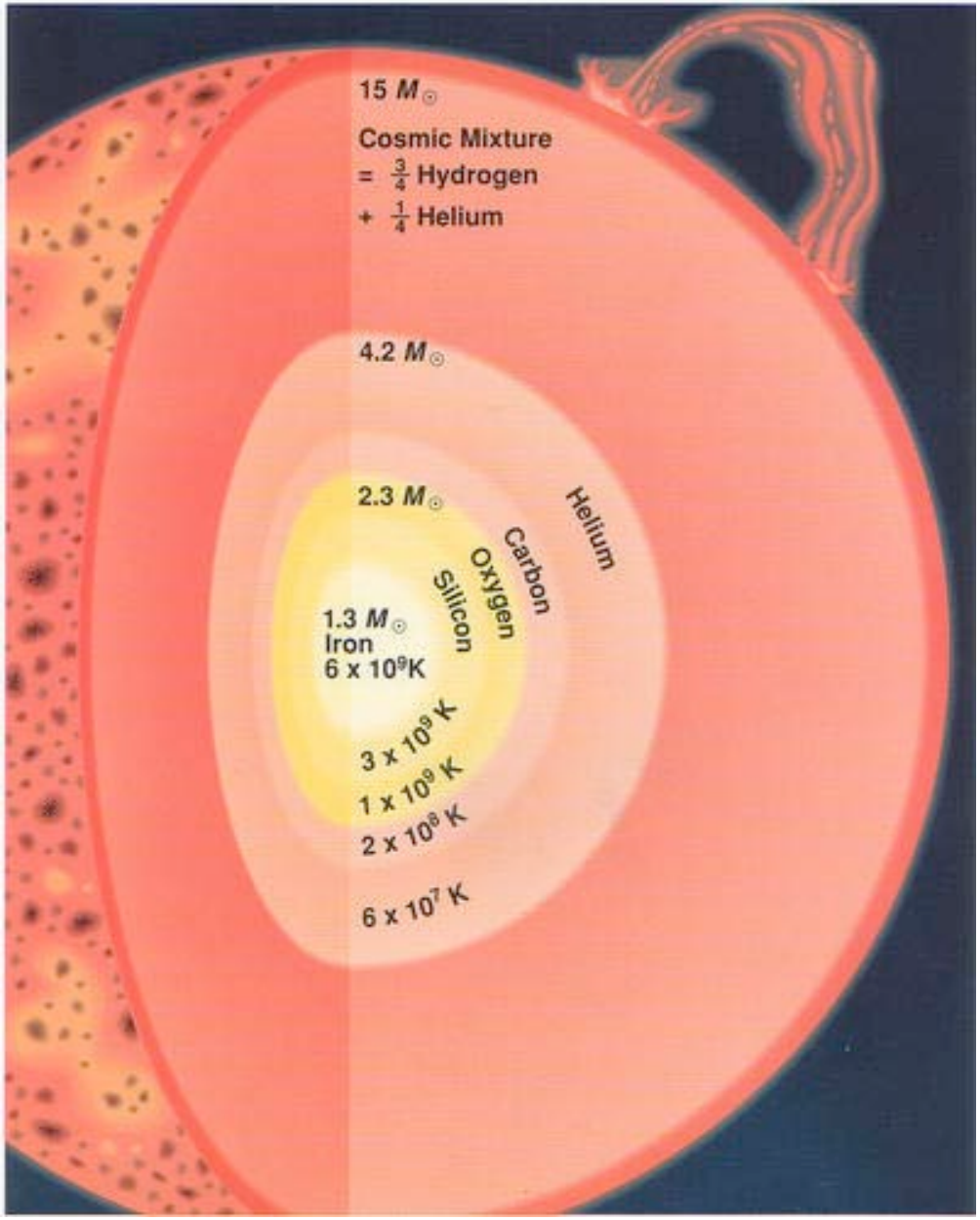
Not in spiral arms, do occur in elliptical galaxies -> old when blow -> white dwarfs, total disruption, no neutron star.
Original mass on the main sequence M < 8 solar masses

Type II: Hydrogen early, Oxygen, Magnesium, Calcium, later.

Type Ib: no Hydrogen, but Helium early, Oxygen, Magnesium, Calcium later. ***H envelope lost, wind or binary transfer.***

Type Ic: no Hydrogen no (or *very* little) Helium early, Oxygen, Magnesium, Calcium later. ***Even more mass loss, wind or transfer.***

In spiral arms, never in elliptical galaxies -> short lived -> massive star -> expect core collapse, neutron star or black hole.
Original mass on the main sequence M > 8 solar masses



Origin of Type II, Ib. Ic

How does a massive star get from hydrogen to iron, and why iron, and what then?

Make succession of heavier elements

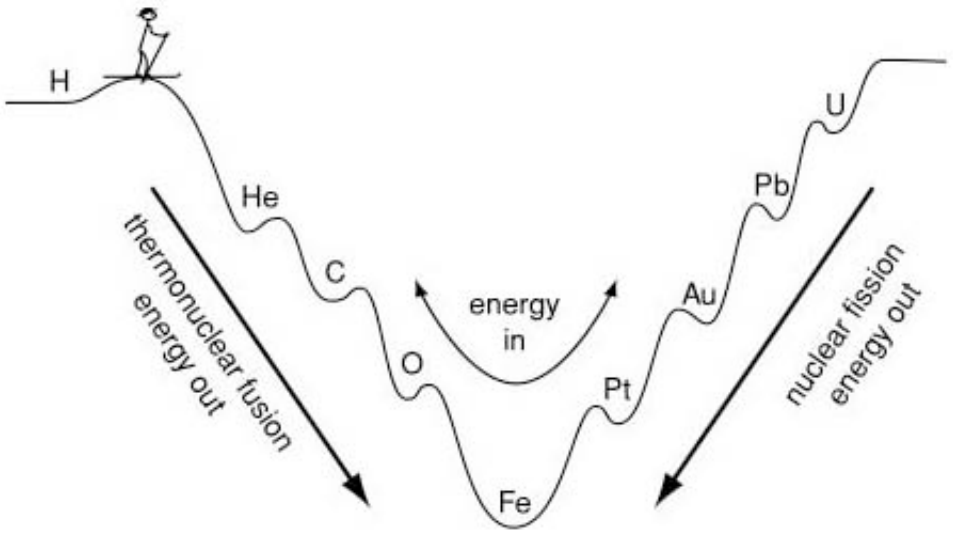


Figure 2.3

Special role of Iron - 26p, 30n

Endothermic - must put energy in to break iron apart into lighter elements or to forge heavier elements, absorb energy, lower pressure, core contracts, absorb more energy, more contraction…

=> The iron core quickly collapses! Catastrophic death of the star.

When iron core forms - star is doomed to collapse, form a neutron star (or maybe a black hole), composed essentially of all neutrons.

$p + e \rightarrow n + \nu$ ***neutrino***,

Action of Weak Nuclear Force (Chapter 1.2)

One ν is generated for every p that is convertedm star's worth of protons

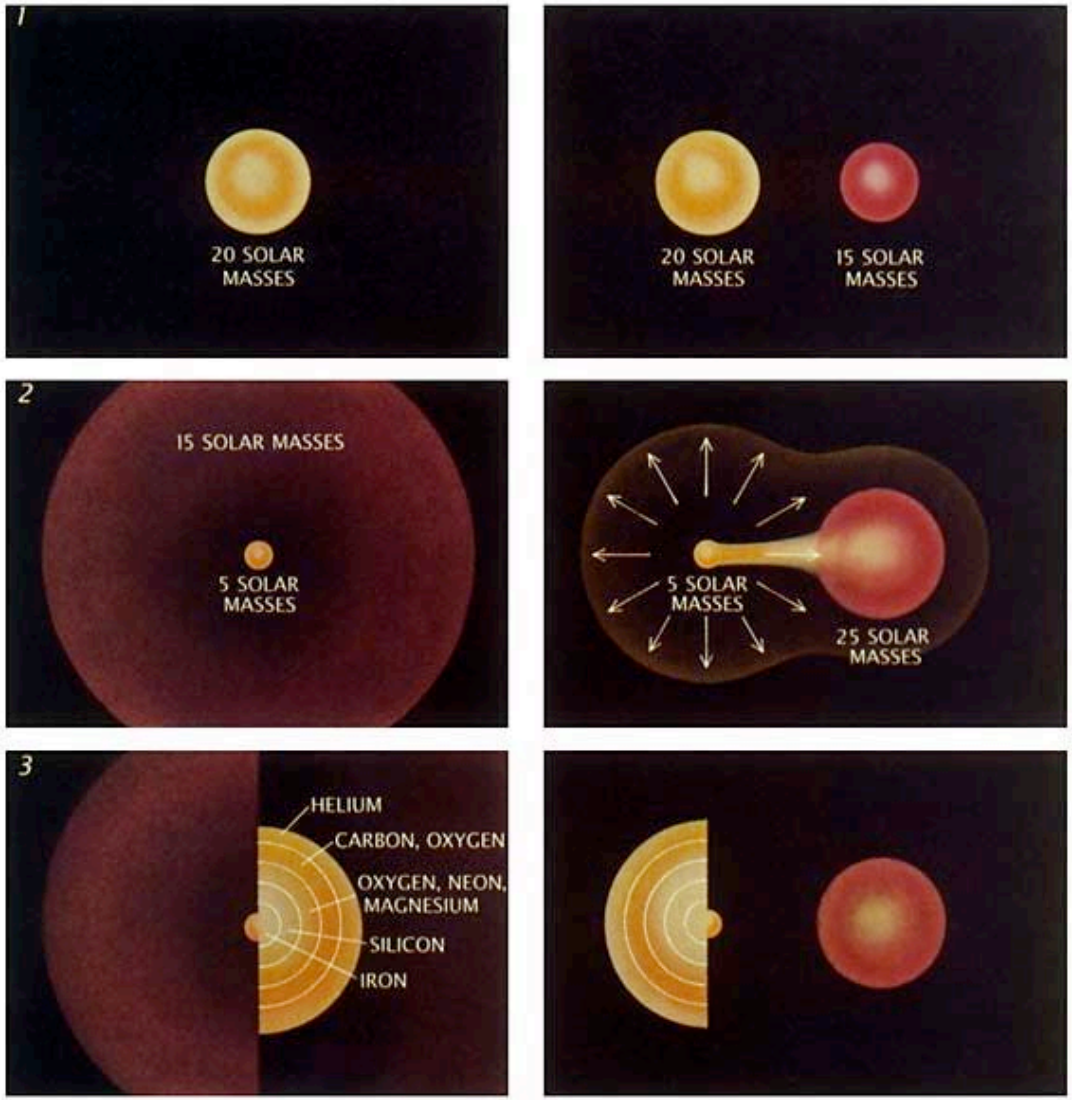
$\Rightarrow$***lots of neutrinos***

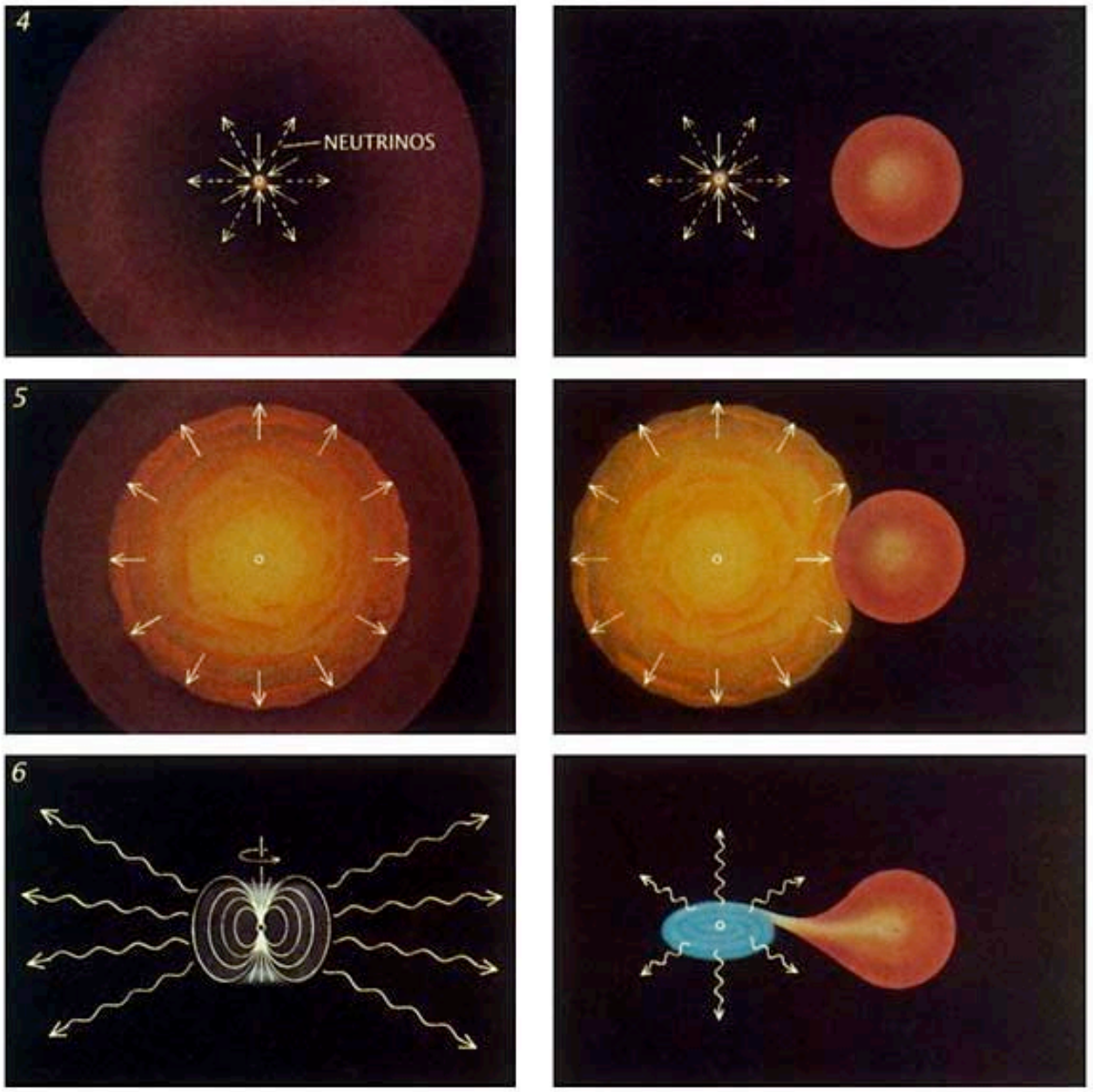
$\Rightarrow$99% of energy of collapse is carried off by neutrinos (Ch 1 2.1, 2.2)

Single star: Type II

Same star in binary: Type Ib/c

Same evolution inside star, thermal pressure, regulated burning, shells of heavier elements, whether envelope there or not





Rotating, magnetic radio pulsar.

Neutron star in binary system, X-ray source