Wednesday, February 1, 2017

First exam Friday.
First Sky Watch Due (typed, 8.5x11 paper).

Review sheet posted.

Review session Thursday, 5:00 – 6:00 PM **WEL 2.308**

Reading:

Chapter 6 Supernovae, Sections § 6.1, 6.2, 6.3
Chapter 1 Introduction, §1.1, 1.2.1, 1.3.1, 1.3.2
Chapter 2, §2.1, Chapter 5 White Dwarfs, § 5.1

Astronomy in the news?

Astronomers see a quasar turn on. Supermassive black hole with an accretion disk, topics for future classes.

Goal:

To understand what we have learned from the study of “live” supernova explosions in other galaxies.

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

Type Ib: no (or *very* little) 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

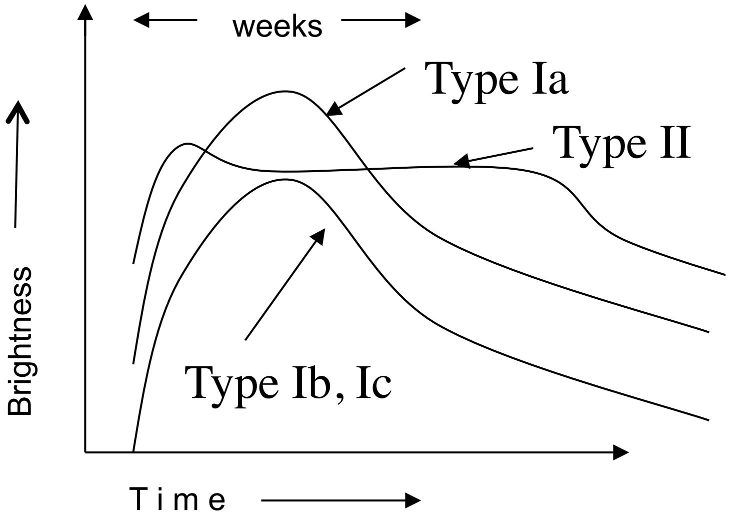
Explode in the spiral arms of spiral galaxies
Never in elliptical galaxies

⇒ massive stars, expect neutron star or black hole

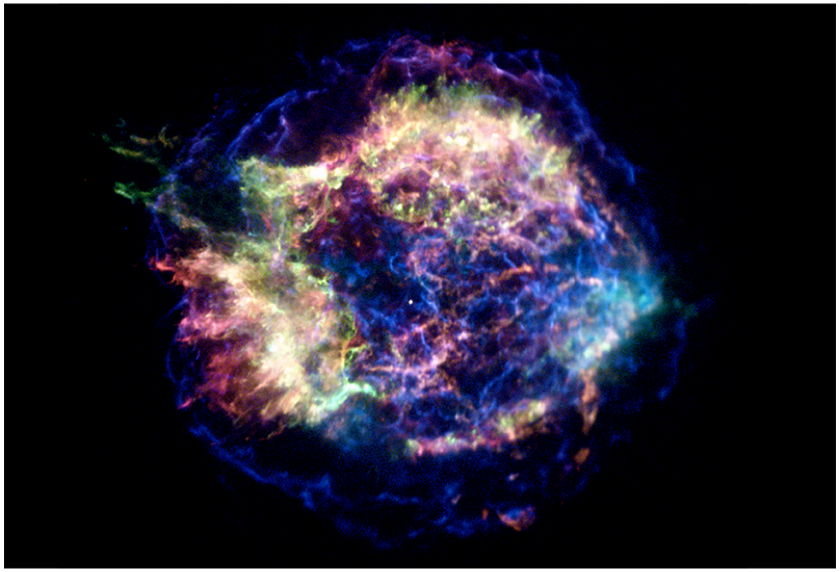
Like Type II, but have somehow lost their outer layers of Hydrogen or even Helium ⇒ wind (§2.2) or binary mass transfer (Chapter 3). [Will discuss later]

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]



Cas A seems to have been dim at explosion, some evidence for a little hydrogen in the remnant now. Recent spectrum of light from peak reflected from dust, arriving "now" shows it was closely related to a Type Ib.



Type Ia:

No hydrogen or helium, intermediate mass elements (oxygen, magnesium, silicon, sulfur, calcium; *made in the explosion*) observed early on, iron later.

Not in spiral arms, do occur in elliptical galaxies -> old when blow

Characteristic peaked light curve

All consistent with explosion in carbon/oxygen white dwarf in binary system, total disruption.

Original mass on the main sequence M < 8 solar masses.
[Explain why next, but for second exam]

Type II: hydrogen early, oxygen, magnesium, calcium (*made in the star before the explosion, then ejected*), later.

Type Ib: no hydrogen, but helium early, oxygen, magnesium, calcium later. ***H envelope lost, by stellar wind or binary star transfer.***

Type Ic: no hydrogen no helium early, oxygen, magnesium, calcium later. ***Even more mass loss, by stellar wind or binary star transfer.***

Occur in spiral arms, never in elliptical galaxies -> short lived -> massive star -> expect core collapse, neutron star or black hole (but can't see in distant galaxies).

Original mass on the main sequence M > 12 solar masses

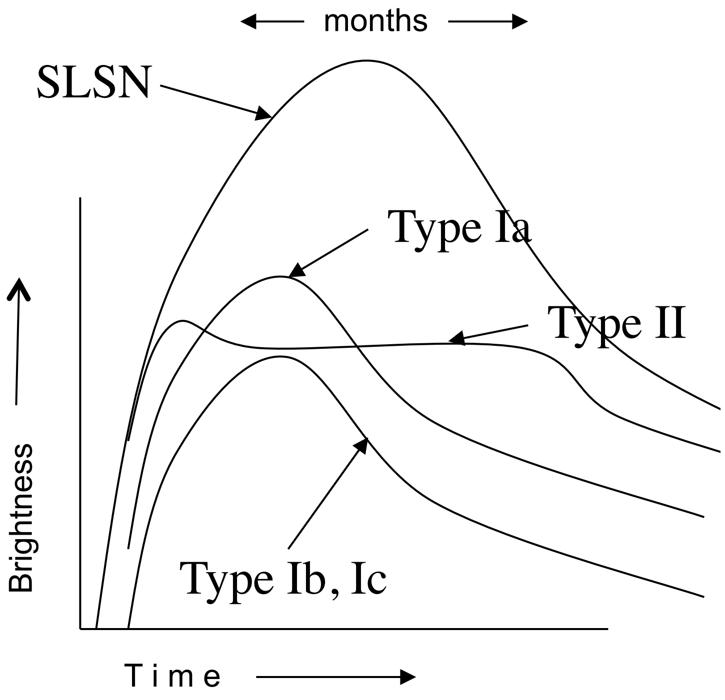
Superluminous Supernovae (SLSN)

Two “types,” one shows hydrogen in the spectrum, one does not.

They explode in small “dwarf” galaxies that nevertheless have active, ongoing star formation. The progenitor stars are short lived.

The light curves are both bright and slow. The latter suggests especially high mass of the ejecta, around 100 solar masses.

Competing theories; we do not yet know whether the star blows up completely or whether a neutron star or black hole is left behind, or both.



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

➡ Type II supernova

⬅ Type Ia supernova

⬆ Type Ib supernova

⬇ Type Ic supernova

One Minute Exam

A supernova with an especially broad light curve that explodes in a dwarf galaxy is probably a

- ➡ Type II supernova
- ⬅ Type Ib supernova
- ⬆ Type Ic supernova
- ⬇ Superluminous supernova

End of Material for Test 1

Material for Second Exam

Reading:
Chapter 6 Supernovae §6.4, 6.5
Background:
Chapter 1 Introduction §1.2.1, 1.2.3, 1.2.4
Chapter 2 Stellar Death §2.1, 2.3, 2.4, 2.5

Issues to look for in background:

What are thermal and quantum pressure and how do they work? Chapter 1 §1.2.3, 1.2.4, Chapter 2 §2.3

Why is it necessary for a thermonuclear fuel to get hot to burn? - charge repulsion Chapter 2 §2.1, 3

Why is iron important? Chapter 2, §2.4, 2.5

Discussion Points:

White dwarfs have about the same mass as the Sun and about the same radius as the Earth.

How does the gravity of a white dwarf compare to the Sun and the Earth, and why?

Gravity the same here

Gravity here much stronger

Same mass, smaller size, gravity on *surface* is larger because you are closer to the *center*.

Gravity on surface acts *as if* all mass beneath were concentrated at a point in the center -- Newton/Calculus

Goal:

To understand how pressure is created in stars, how thermal pressure controls the evolution of normal stars, and why quantum pressure makes white dwarfs liable to explode in some circumstances.

Huge gravity compresses a white dwarf --
requires special pressure to support it
(Section 1.2.4, Section 2.3)

- ***Normal pressure*** -- thermal pressure
  - Motion of hot particles -- ***Pressure depends on Temperature***
- ***Quantum Pressure*** -- Quantum Theory, particles as waves
  - Uncertainty Principle -- Can't specify position of any particle exactly. If you squeeze and "locate" a particle more precisely, its energy gets more uncertain, and larger on average.
  - Exclusion Principle -- No two identical particles (electrons, protons, neutrons) can occupy same place with same energy, but they can if one has more "uncertainty" energy.
  - ***Pressure depends only on density, not on temperature***