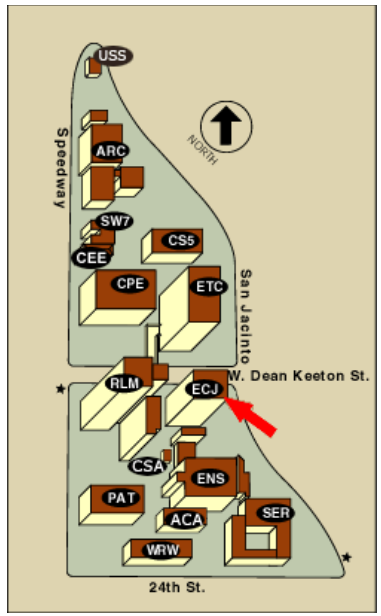
Wednesday, September 7, 2011



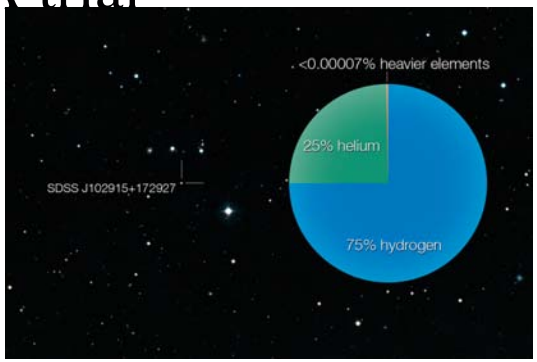
First exam Friday. First Sky Watch due. Review sheet posted.

Reading posted under "announcements" on web page, Section 5.1, Sections 6.1 – 6.3, other background.

Exam will draw on material presented in lecture. Use reading for back up, reinforcement.

Review Session: Thursday, 5 – 6 ECJ 1.202

Astronomy in the news? Jeff Bezos of Amazon.com is building a rocket, Blue Origin, and space port in West Texas near Van Horn and McDonald Observatory. A trial rocket crashed on August 24.



Pic of the day: newly discovered star in Milky Way with very few "heavy" elements, but small mass, contradicting prevailing thinking.

Nomenclature of Supernovae in other galaxies:
A-Z, aa-az, ba-bz, etc.

SN 1987A - 1st of 1987 (also most important, but that is not what the "A" means).

Currently discover roughly one per day. This year's latest officially named, SN 2011fm, discovered September 3 – How many so far in 2011?

New techniques will discover thousands per year, new nomenclature, SN 2011fe in M101 = SN PTFkly, or just by position: SN 2011fm = PSN J19065017-6141577

Before announced, internal names. We are currently using characters from South Park.

Discussion Point:

How would you tell that an explosion was from a massive star or from a white dwarf star?

Goal:

To understand the observed nature of supernovae and determine whether they came from white dwarfs or massive stars that undergo core collapse.

Goal:

Certain elements show up in supernova:

Oxygen, Magnesium, Silicon, Sulfur, Calcium, Iron.

Why those elements?

H -> He (2 protons, 2 neutrons - Chapter 1, figure 1.6)

2 Helium -> unstable, no such element

3 Helium -> Carbon (6 protons, 6 neutrons)

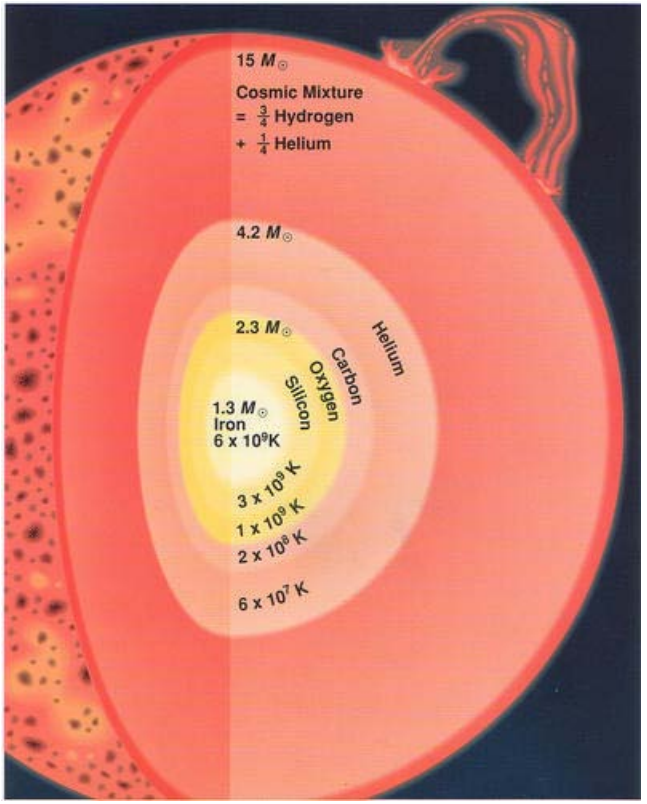
4 Helium -> Oxygen (8 protons, 8 neutrons)

5 Helium -> Neon (10 protons, 10 neutrons)

6 Helium -> Magnesium (12 protons, 12 neutrons)

7 Helium -> Silicon (14 protons, 14 neutrons)

Common elements forged in stars, and in their explosions, are built on building blocks of helium nuclei



Physics:

In massive stars (more than about 12 - 15 times the Sun) the core is composed of Helium or heavier elements, Carbon, Oxygen, Magnesium, Silicon, Calcium, finally Iron. The core continues to be hot even as it gets dense,
$\Rightarrow$ always supported by thermal pressure
$\Rightarrow$ continues to evolve, finally explodes
The intermediate-mass elements are produced in the star before the explosion and then expelled into space.

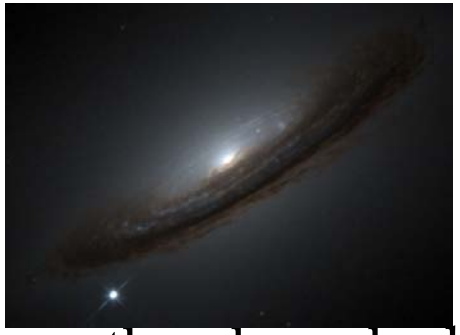
In exploding white dwarfs (arising in stars with mass less than about 8 times the Sun), the core is composed of Carbon and Oxygen, and **the explosion creates the intermediate-mass elements, Magnesium, Silicon, Calcium, and also Iron.**

(between about 8 and about 12 solar masses, different story, maybe collapsing white dwarfs)

Categories of Supernovae

1st category discovered

Type Ia - no detectable Hydrogen in the spectrum, rather "intermediate mass elements" such as oxygen, magnesium, silicon, sulfur, calcium. Iron appears later as the light fades.

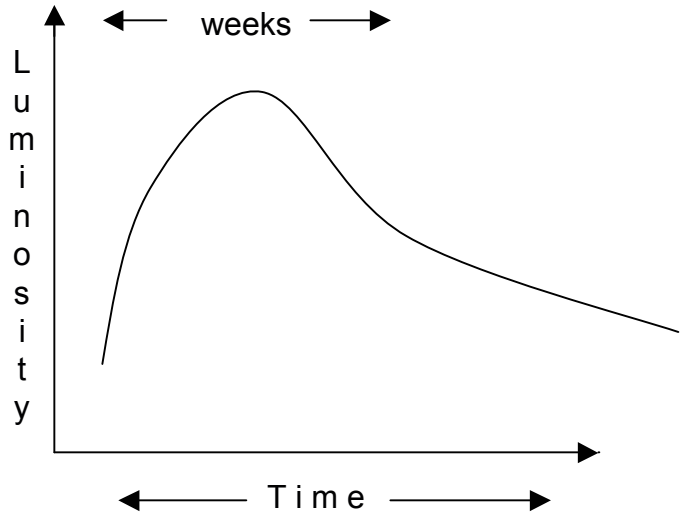


These occur in all galaxy types:
In **spiral galaxies** they tend to avoid the spiral arms, they have had time to drift away from the birth site → ***the star that explodes is old***
In **irregular galaxies**
In **elliptical galaxies** where star formation is thought to have ceased long ago → ***the star that explodes is old***

⇨***the progenitor that explodes must be long-lived, not very massive, suggesting a white dwarf.*** Sun is long-lived, but won't explode

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

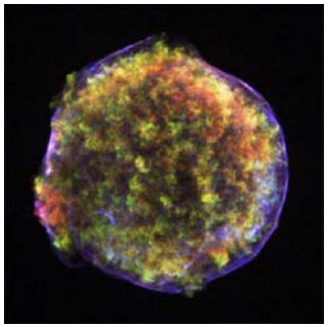
Light Curve - brightness vs. time
consistent with an
exploding C/O white dwarf
expect total disruption, ***no neutron star***



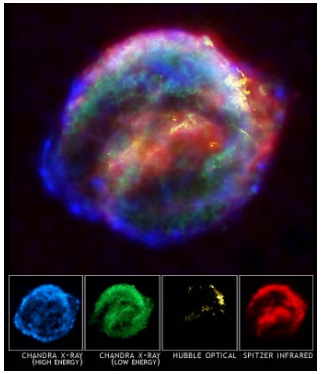
Type Ia occur in elliptical galaxies, tend to avoid spiral arms in spiral galaxies - old when explode, all evidence points to an exploding white dwarf.

SN 1006, almost definitely Type Ia

Tycho, SN 1572 definitely Type Ia - recent discovery, spectrum from peak light reflected from surrounding dust, arriving only “now.”



Kepler, 1604, probably Type Ia (no sign of neutron star, same ejected composition as SN 1006, Tycho), but some ambiguities.



If recurrent nova U Sco with a white dwarf of more than 1.3 solar masses becomes a supernova, it will probably be a Type Ia

Type Ia

no Hydrogen or Helium

intermediate mass elements (oxygen, magnesium, silicon, sulfur, calcium) early on, iron later

avoid spiral arms, occur in elliptical galaxies

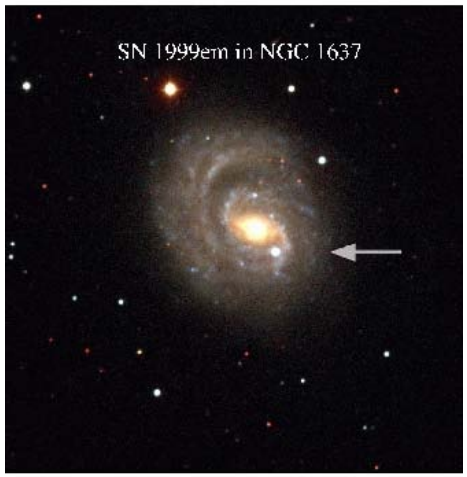
peaked light curve

no neutron star

all consistent with thermonuclear explosion in white dwarf that has waited for a long time (hundreds of millons to billions of years) to explode, total disruption

Type II Supernovae - "other" type discovered early in the study of supernovae, 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 (no young stars)



SN 1999em

Stars with more mass have more fuel, but they burn it at a prodigous rate, live a shorter time!

→The progenitor stars are young, short-lived (millions to tens of millions of years) massive stars

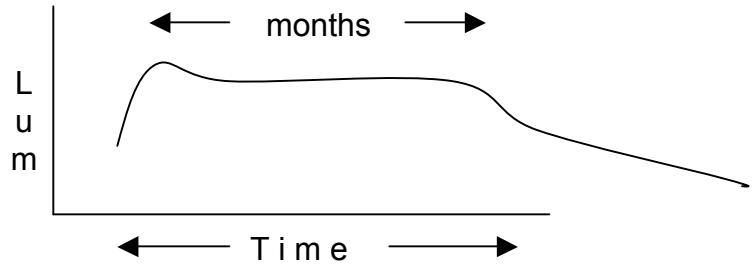
We expect such stars to evolve to form iron cores and collapse to a neutron star or black hole (physics to come)

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 with a very thin layer of Hydrogen (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



One minute exam

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

 They are built up from the element iron

 They are built up from the element hydrogen

 They are built up from the element helium

 They are built up from the element calcium

One minute exam

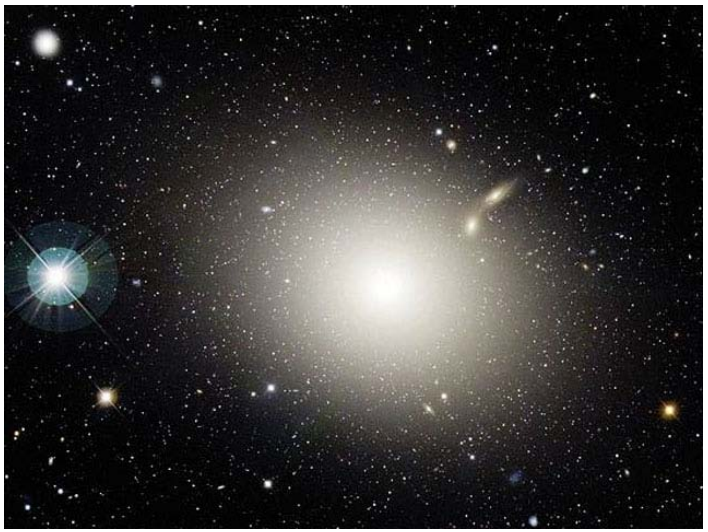
A supernova explodes in an elliptical galaxy. Near peak light what element do you expect to see in the spectrum?

Hydrogen

Helium

Silicon

Iron



End of Material for Test 1