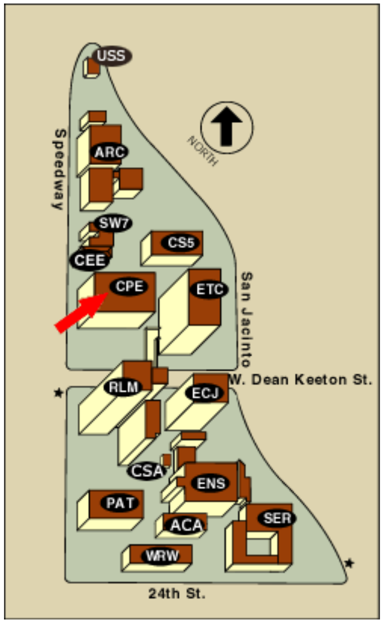
Monday, January 30, 2012

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

Reading posted under "announcements" on web page, Chapter 6 - Sections 6.1, 6.2, 6.3 (also sections 1.2.4, 2.1-2.5, and 5.1)

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

Review Session: Thursday, 5 – 6 CPE 2.214



Astronomy in the news? Kepler satellite discovers more planets.

News

Are we alone?

SETI nearly ran out of money last year despite support from Paul Allen, co-founder of Microsoft, temporarily shut down.

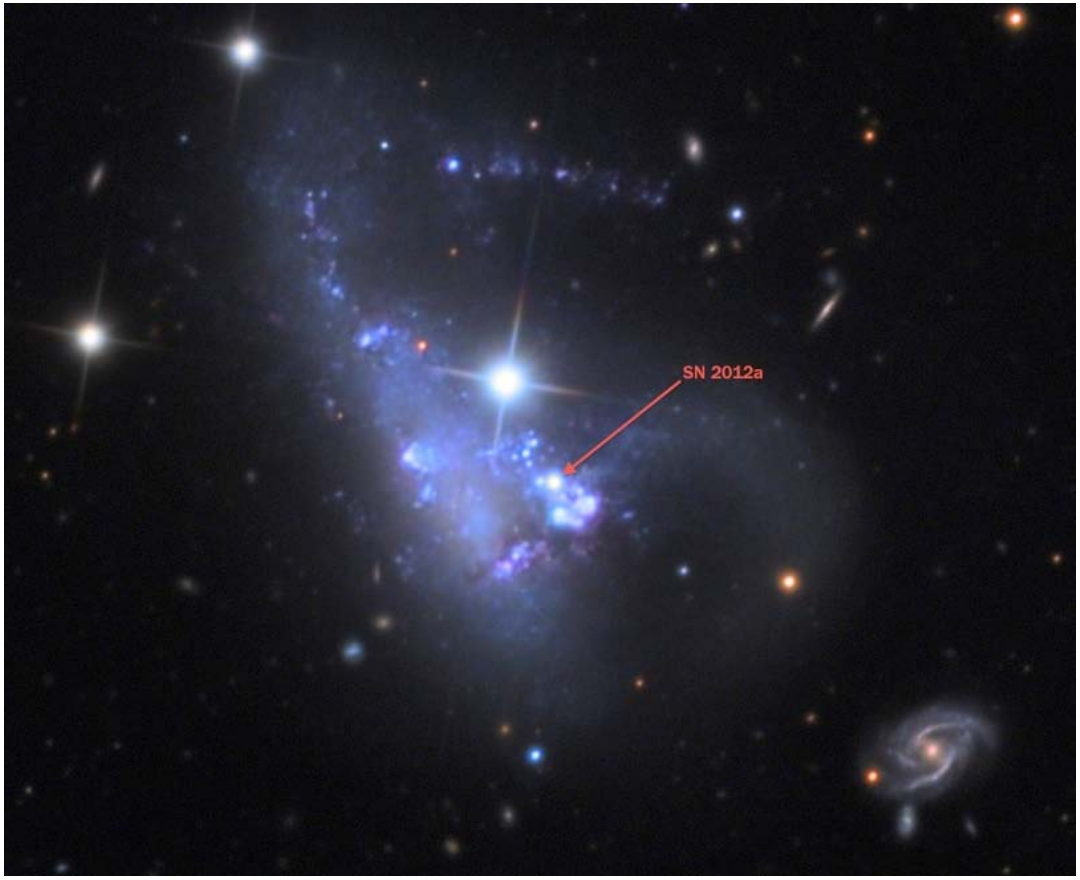
Now re-started with support from the Air Force that wants to monitor space junk with the same array of radio telescopes (the Allen Telescope Array).

Searching for signals from stars in Cygnus around which the Kepler satellite has discovered planets.

See astronomy course Extraterrestrial Life.

Goal:

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



(Image credit: Adam Block/Mount Lemmon SkyCenter/University of Arizona.)
Posting credit: [Aodhán Ånnestad]

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 2012T, discovered January 29 – How many so far in 2012? (SN 2011js in 2011, how many?)

New techniques will discover thousands per year, new nomenclature, SN 2011fe in M101 = SN PTFkly, or just by position: SN 2012T = PSN (Possible SuperNova) J14014169+3349339

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)

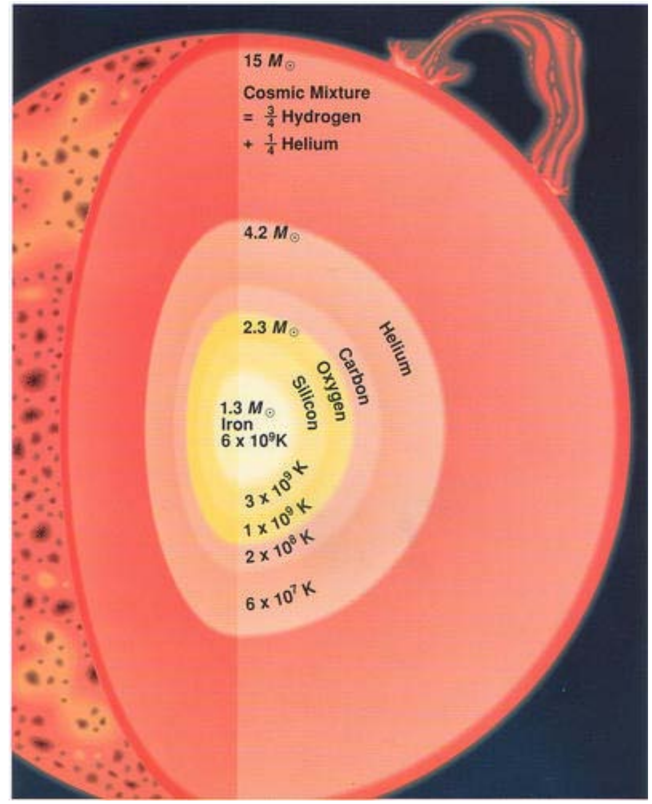
4 Helium -> Oxygen (8 protons, 8 neutrons)

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

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

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

Then Sulfur, Calcium, Titanium.



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)

Stellar Physics:

There are many more low mass stars born than high mass stars.

High mass stars have more fuel to burn, but they burn much hotter and brighter. As a result they live a SHORTER time.

A short-lived star must be massive.

A long-lived star must be of relatively low mass.

Galaxy Physics:

Star are born in the spiral arms of spiral galaxies.

Elliptical galaxies have not formed any new stars in billions of years.

Categories of Supernovae

1st category discovered

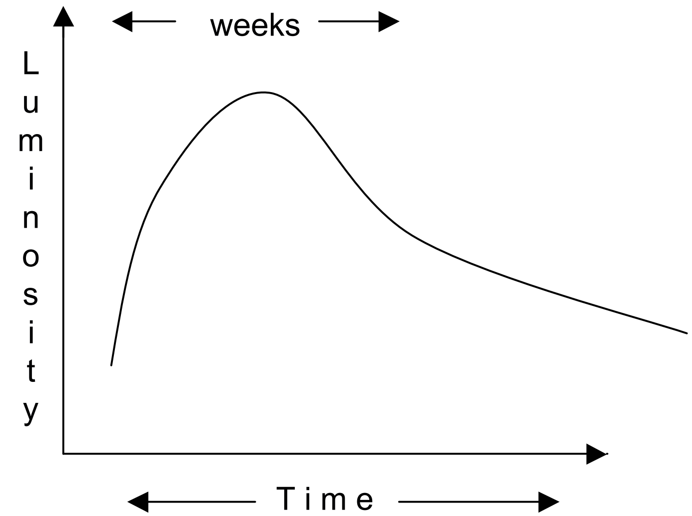
Type Ia - no detectable Hydrogen in the spectrum, rather "intermediate mass elements" such as oxygen, magnesium, silicon, sulfur, calcium. Iron appears later as the light fades.

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, billions of years***

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

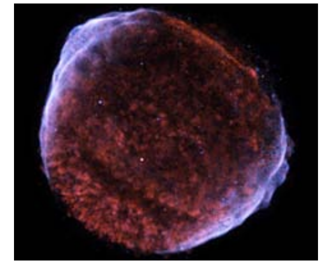
Type Ia - no hydrogen, intermediate mass elements early, iron later

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

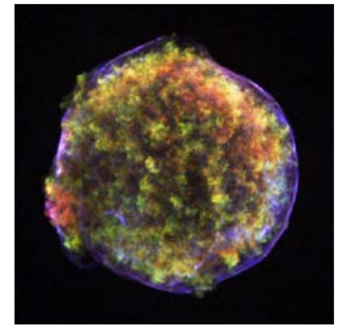


Type Ia occur in elliptical galaxies, tend to avoid spiral arms in spiral galaxies - old when explode, all evidence points to an exploding white dwarf.

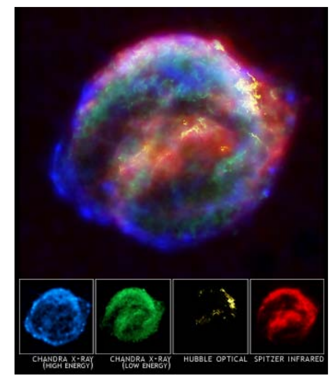
SN 1006, almost definitely Type Ia



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

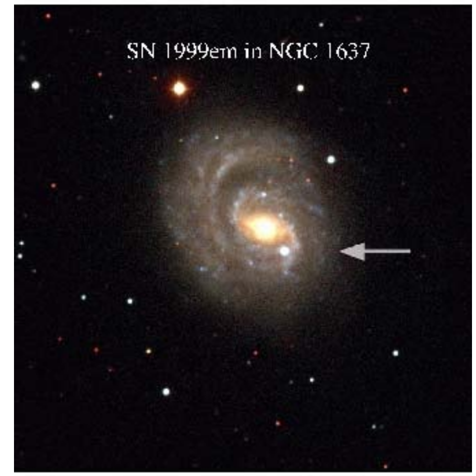
peaked light curve

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)