Friday, January 31, 2014

First Exam and Skywatch extra credit, Friday February 7. Get a head start on the skywatch on clear nights.

Lectures (including sky watch targets) are posted on the class web site

I've been missing some people raising their hands with questions. I've asked Jacob to nudge me. Please don't be shy with questions.

Reading: Section 5.1 (white dwarfs), 1.2.4 (quantum theory), Section 2.3 (quantum deregulation), Section 6.1 (supernovae; *not* Type Ib, Type Ic, next exam).

Astronomy in the news?

Hawking on PBS.

Asteroids came from throughout the Solar System, not a single busted up planet. Implications for "great bombardment," delivery of water.

Update on new “nearby” supernova SN 2014J in M82

First preprint posted on astrophysics server. Early rise in light, estimate of the time of explosion. Data acquired by robotic telescope before it was known supernova had exploded.

Discussion point: What's going on here?

Goal:

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

All supernovae since 1680, since invention of telescope, modern astronomy, have been discovered in other galaxies.

Galaxies like our Milky Way produce supernovae about once per century.

None since Cas A in about 1680. Our Galaxy is overdue for another!

Recognition (early in the 20th century) that some "novae" were in distant galaxies and hence were 10,000 to 100,000 times brighter than classical novae in the Milky Way.

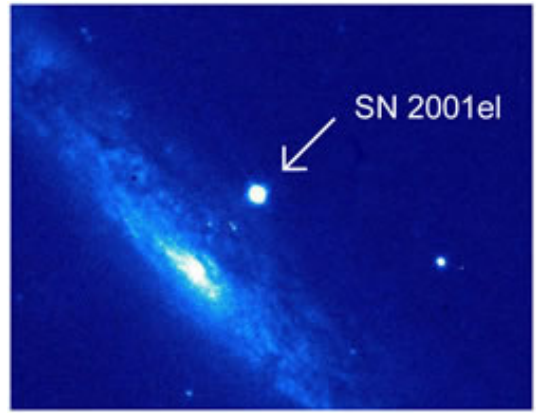
Led to the recognition and naming of "super" novae.

Web site of recent bright supernovae:

http://www.rochesterastronomy.org/snimages/

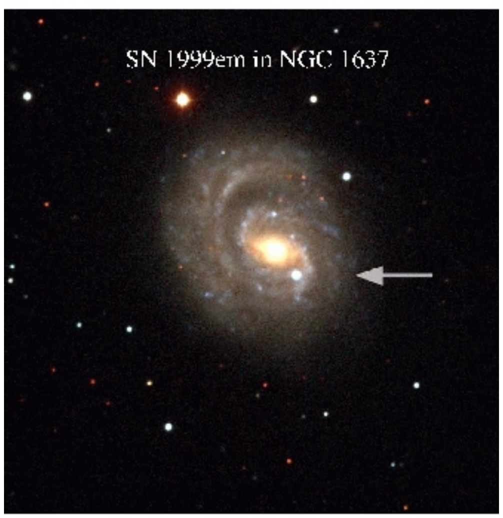
Sample of extragalactic supernovae

SN1994D



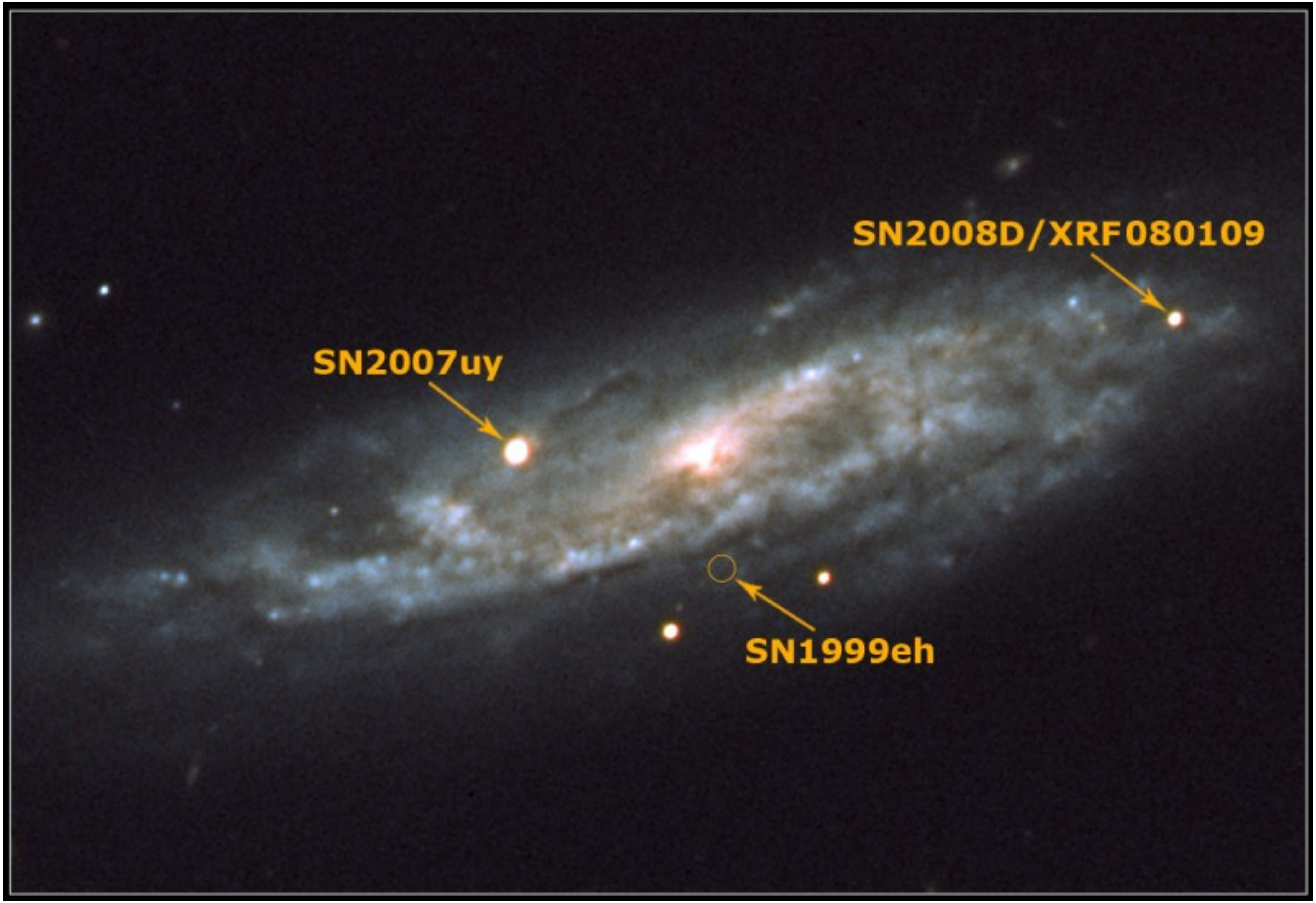
SN2001el

SN1999em



SN 2011fe

Some galaxies are rapid producers of supernovae.



Extra Galactic Supernovae: the basis for modern astronomy of supernovae.

Supernovae explode about once per second somewhere in the Universe, most unseen.

Cannot predict which galaxies will produce a supernova, so watch lots of galaxies, now days with robotic telescopes.

We found two dozen per year prior to SN 1987A, but with new attention and use in cosmology, now find several hundred per year, about one per day, most at great distances, more difficult to study.

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 2014J, discovered January 22 (but photographed, not noticed, a week earlier) – How many so far in 2014?

New techniques will discover thousands of supernovae per year, new nomenclature, position: SUPERNOVA 2013fg = PSN (possible supernova) J08212244 -1318370

Before announced, search groups use internal names. We have used characters from Star Wars and Southpark and are currently using Nepali spirits.

Discussion Point:

How would you tell that an explosion in a distant galaxy 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)

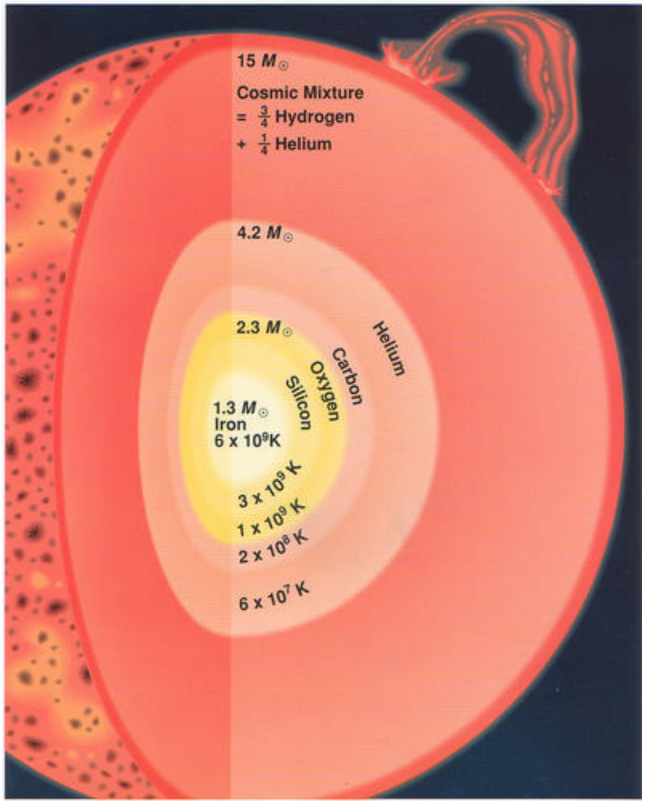
5 Helium -> Neon (10 protons, 10 neutrons)

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

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

Then Sulfur, Calcium, Titanium.

Common “intermediate mass” 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:

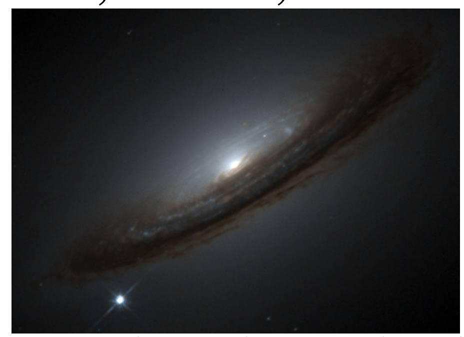
Star are born in the spiral arms of spiral galaxies.

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