January 31, 2011

First exam a week from Friday, February 11.

Astronomy in the news? New National Geographic program on The Known Universe starring ex-Texan Andy Howell.

Pic of the day: Japanese supply ship approaching the International Space Station

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.

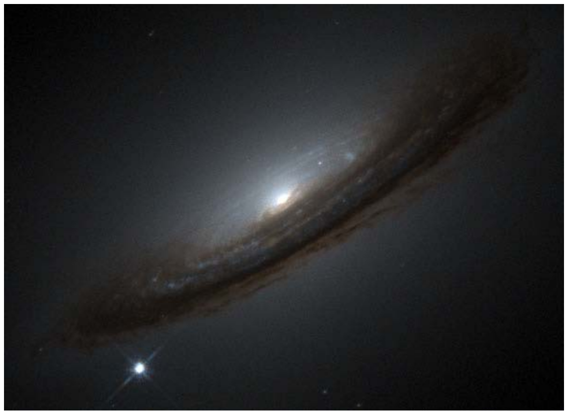
Led to the recognition and naming of “super” novae.

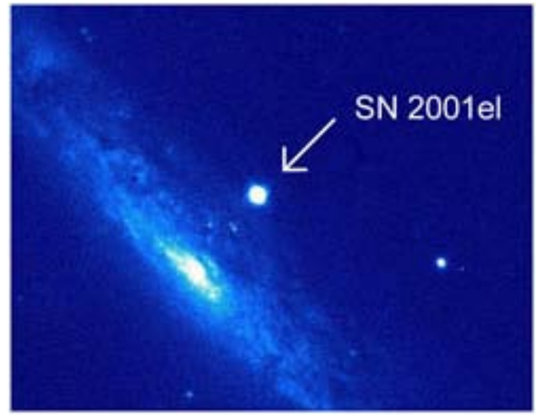
Web site of recent bright supernovae:

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

Sample of extragalactic supernovae

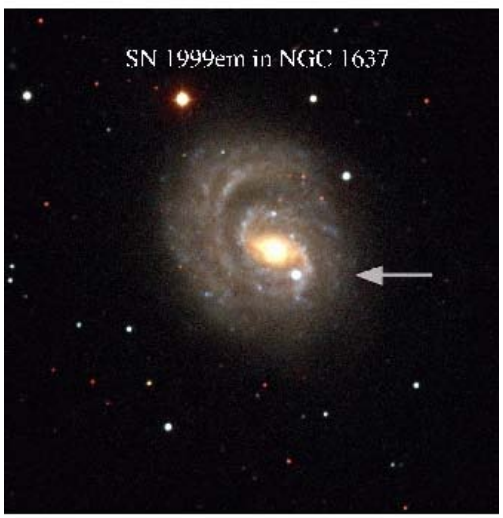
SN1994D

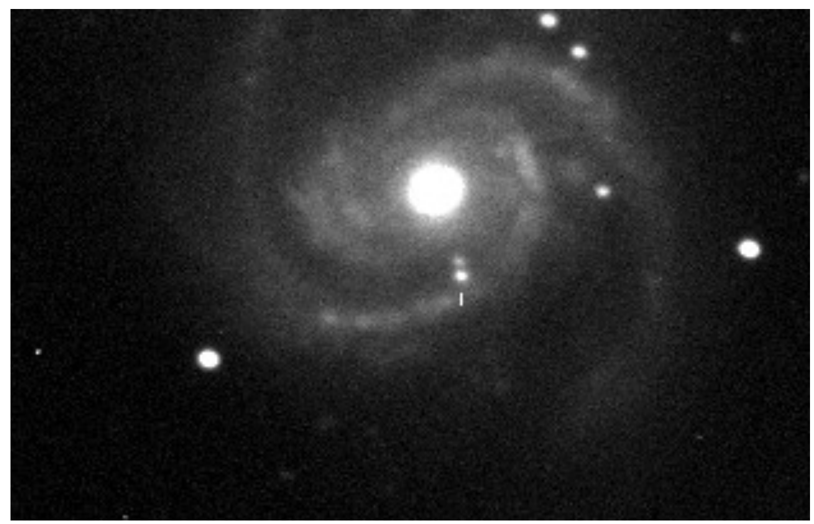




SN2001el

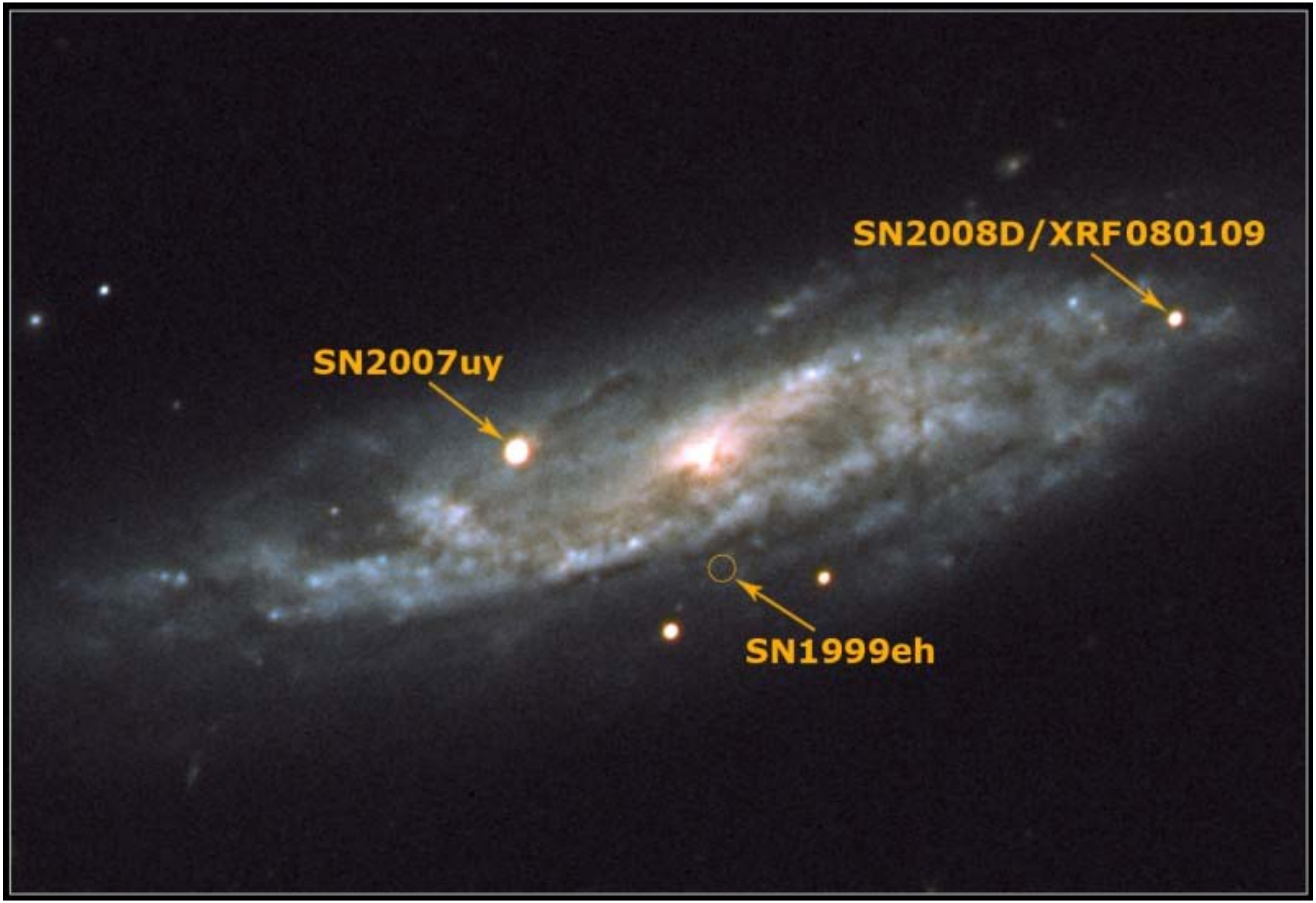
SN1999em





SN 2006X

Some galaxies are rapid producers of supernovae.



Extra Galactic Supernovae: the basis for modern astronomy of supernovae

Cannot predict which galaxies will produce a supernova, so watch lots of galaxies

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: A-Z, aa-az, ba-bz, etc.

SN1987A - 1st of 1987 (also most important, but that is not what the “A” means).

This year’s latest officially named, SN 2011O, discovered January 18 - #15 so far in 2010. Batch more not yet named.

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.

Categories of Supernovae

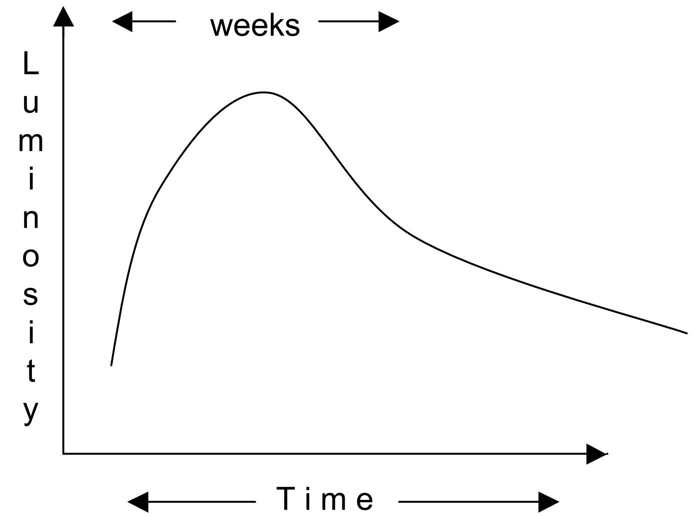
1st category discovered

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

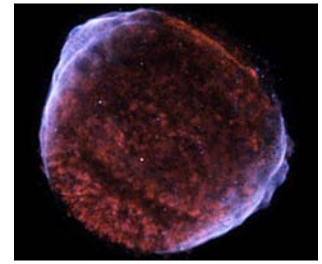
Type Ia - no hydrogen, intermediate mass elements early, iron later



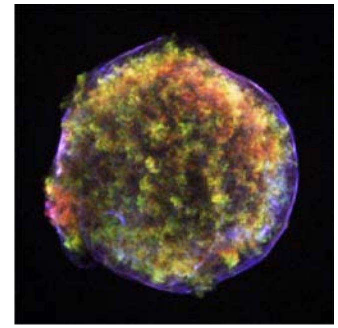
Light Curve - brightness vs. time consistent with an exploding C/O white dwarf
expect total disruption, ***no neutron star***

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.

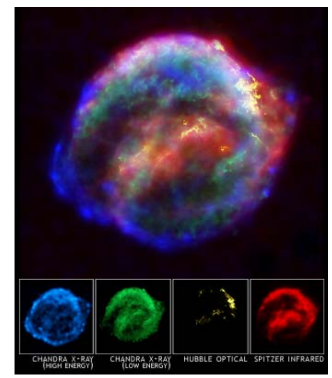
SN 1006, almost definitely Type Ia



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

all consistent with thermonuclear explosion in white dwarf that has waited for a long time to explode, total disruption

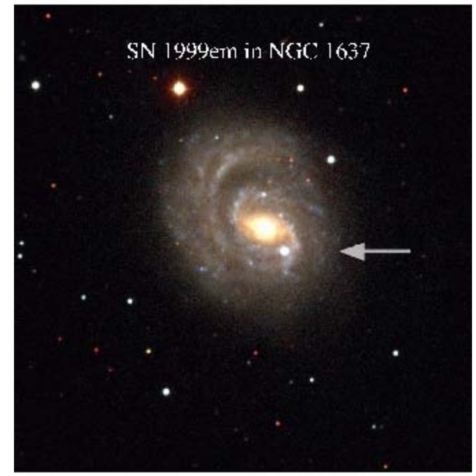
Type II Supernovae - "other" type discovered early in the study of supernovae, show Hydrogen in the spectrum early, Oxygen, Magnesium, Calcium, later

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)

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 massive stars

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



SN 1999em

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