2/4/2008

Exam 1: This Friday, February8
[First Sky Watch Reports Monday]

Chapter 5, portions of chapters 1 - 4, 40 multiple-choice questions

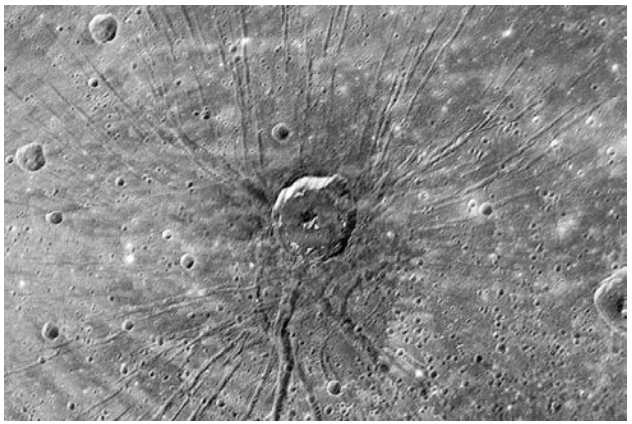
Review sheet posted on web site

Review session Thursday 5 PM RLM 15.216B

Sean Couch - NEW OFFICE - RLM 17.312

Astronomy in the news? President's new budget released today, moderately good news for astronomy

Pic of Day - crater on Mercury



Sky Watch Extra Credit

Due Monday in Class

Must be typed on 8-1/2x11 paper

See web site for more details, or ask!

See web site for star charts to help guide you where and when to look.

Sky Watch Extra Credit - location of supernovae

SN 1006 - Lupus/Centaurus (difficult)

SN 1054 Crab Nebula - Taurus

SN 1572 Tycho - Cassiopeia

SN 1604 Kepler - Ophiuchus (near Venus, Jupiter)

Cassiopeia A - Cassiopeia

Vela supernova - Vela (not this time of year)

Betelgeuse - Orion, Red Supergiant due to explode "soon" 15 solar masses

Antares - Bright Red Supergiant in Scorpius, 15 to 18 solar masses (+companion, difficult)

Rigel - Orion, Blue Supergiant due to explode later, 17 solar masses

Aldebaran - Bright Red Supergiant in Taurus, 2.5 solar masses (WD not SN)

Can only count each objects once for credit, but can do any objects missed earlier in later reports. Add relevant objects I don't specifically mention in class.

All SN 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.

Our Galaxy is overdue for another!

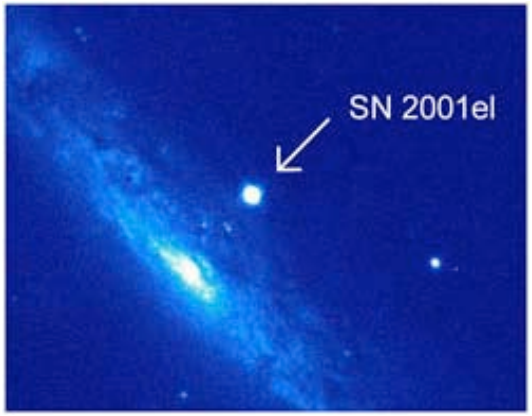
Recognition (early in the 20th century) that some “novae” were in distant galaxies and hence were 10,000 to 100,000 times brighter than classical novae in the Milky Way.

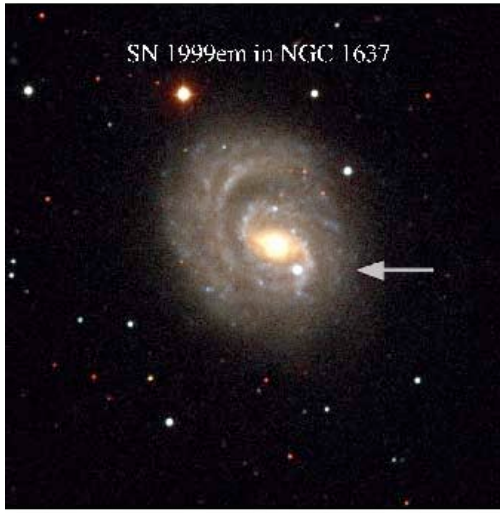
Led to the recognition and naming of “super” novae.

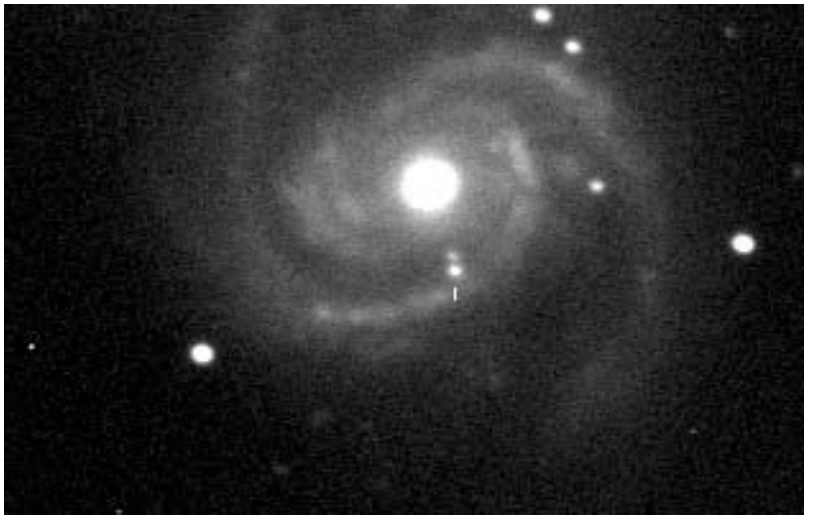
Web site of recent bright supernovae:

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

Sample of extragalactic supernovae

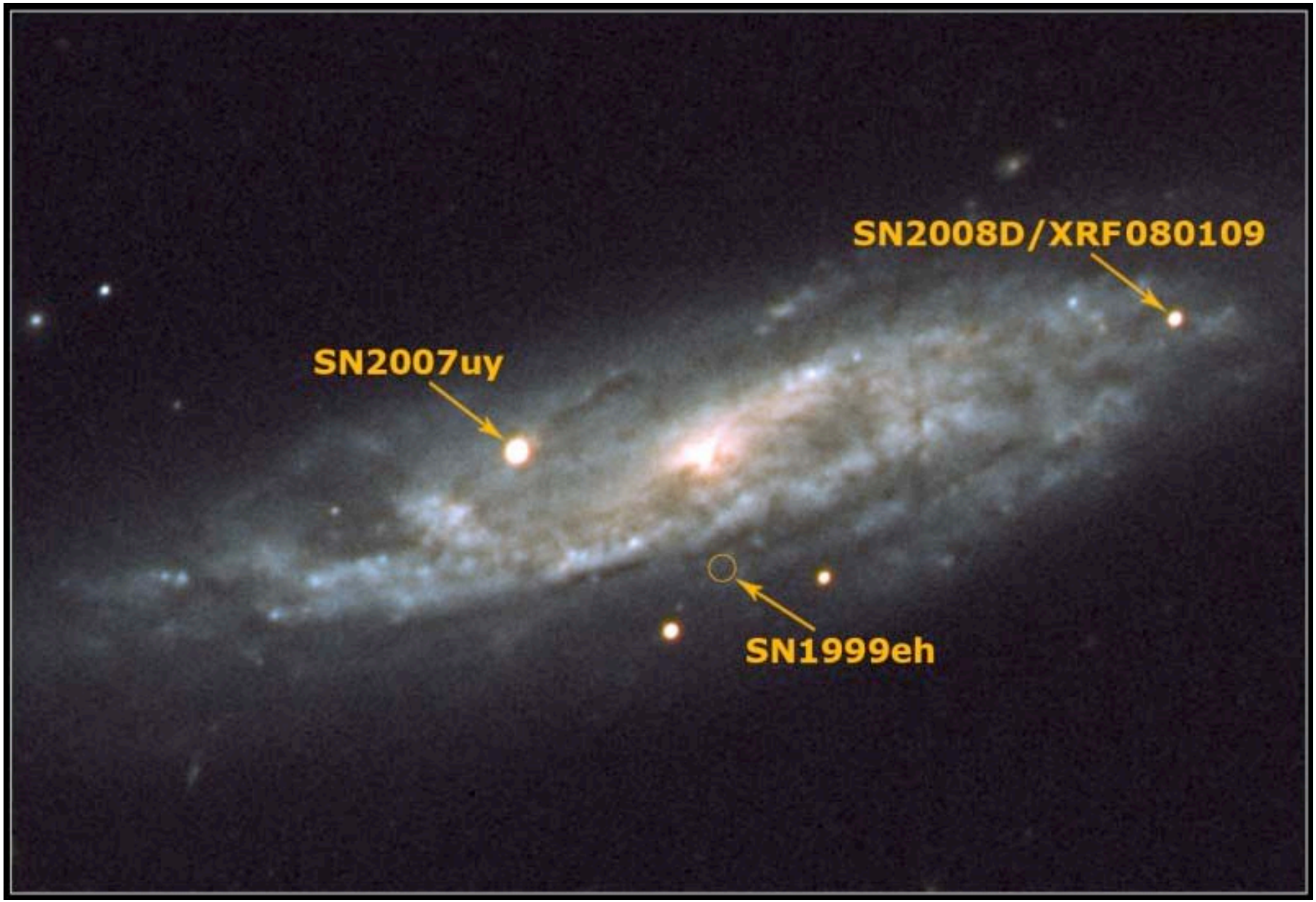






SN 2006X

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 over 100 per year, most at great distances, more difficult to study.

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

SN1987A - 1st of '87 (also most important, but that is not what the "A" means).

This year latest, SN 2008R, discovered January 27 - #18

One Minute Exam

Tycho's supernova of 1572 shows no sign of a compact object left over in its center. This suggests that:

A) It made a jet

B) It was formed by the collapse of a massive star

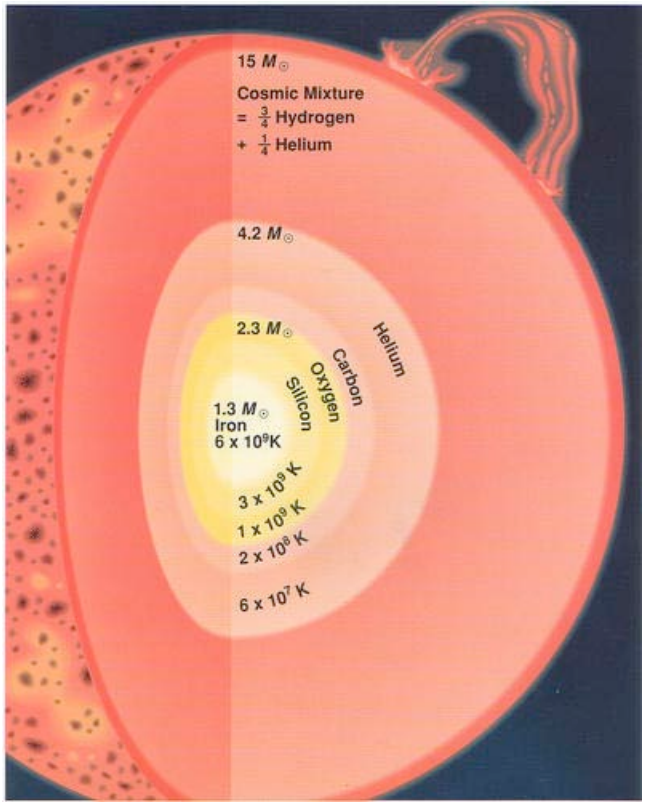
C) It was formed by an exploding white dwarf

D) It actually exploded much earlier than 1572

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,

⇒ always supported by thermal pressure

⇒ continues to evolve, whether the Hydrogen envelope is there or not.



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)

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

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

Common elements forged in stars are built on building blocks of helium nuclei

Categories of Supernovae

1st category discovered

Type Ia - no detectable Hydrogen in the spectrum, rather "intermediate mass elements" like 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***

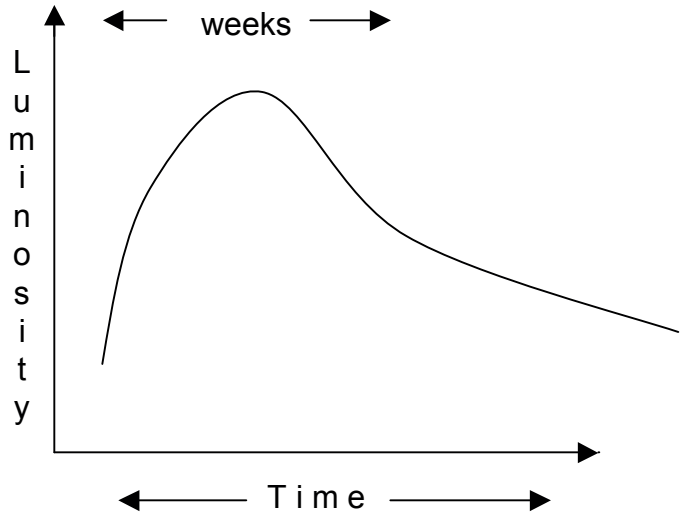
In **irregular galaxies**

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, probably a white dwarf.

SN 1006, almost definitely Type Ia

Tycho, SN 1572 almost definitely Type Ia

Kepler, 1604, some argue yes (no sign of neutron star, same ejected composition as SN 1006, Tycho), but some ambiguities suggesting a massive star progenitor.

If U Sco becomes a supernova it will probably be a Type Ia

One minute exam

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

A) They are built up from the element iron

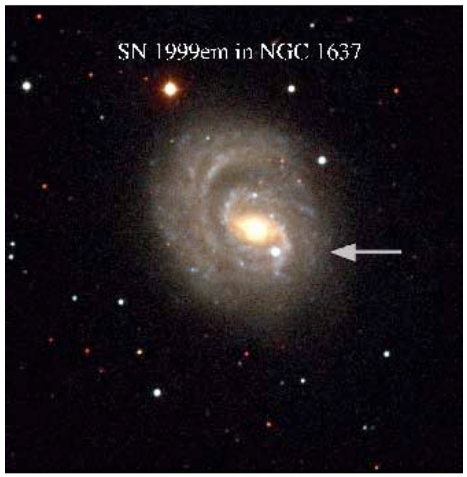
B) They are built up from the element hydrogen

C) They are built up from the element helium

D) They are built up from the element calcium

Type II Supernovae - "other" type discovered early, 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



SN 1999em

→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)

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 (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