Tuesday, September 22, 2009

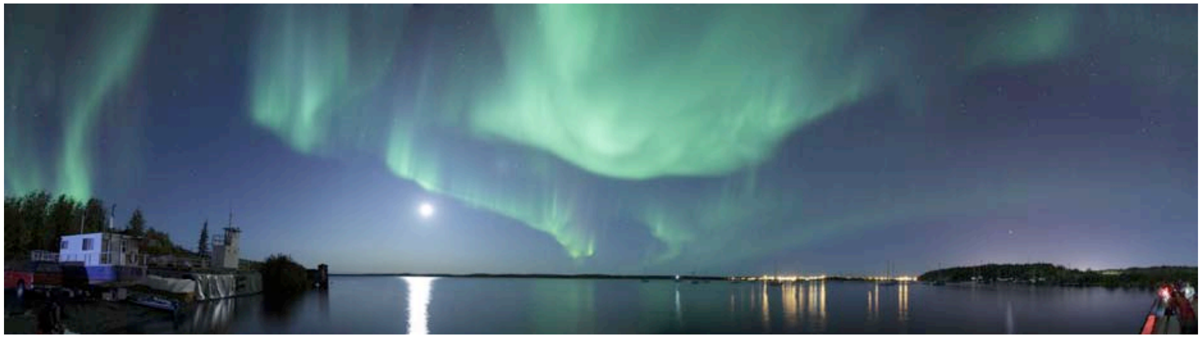
First exam, Thursday

Review Sheet posted

Review session, Wednesday, 5 - 6 PM WEL 1.308
NOTE DIFFERENT ROOM

Astronomy in the news - Today is the Autumn Equinox

Pic of the Day - aurorae, interaction of charged particles from solar wind with Earth's magnetic field



New IYA Projects

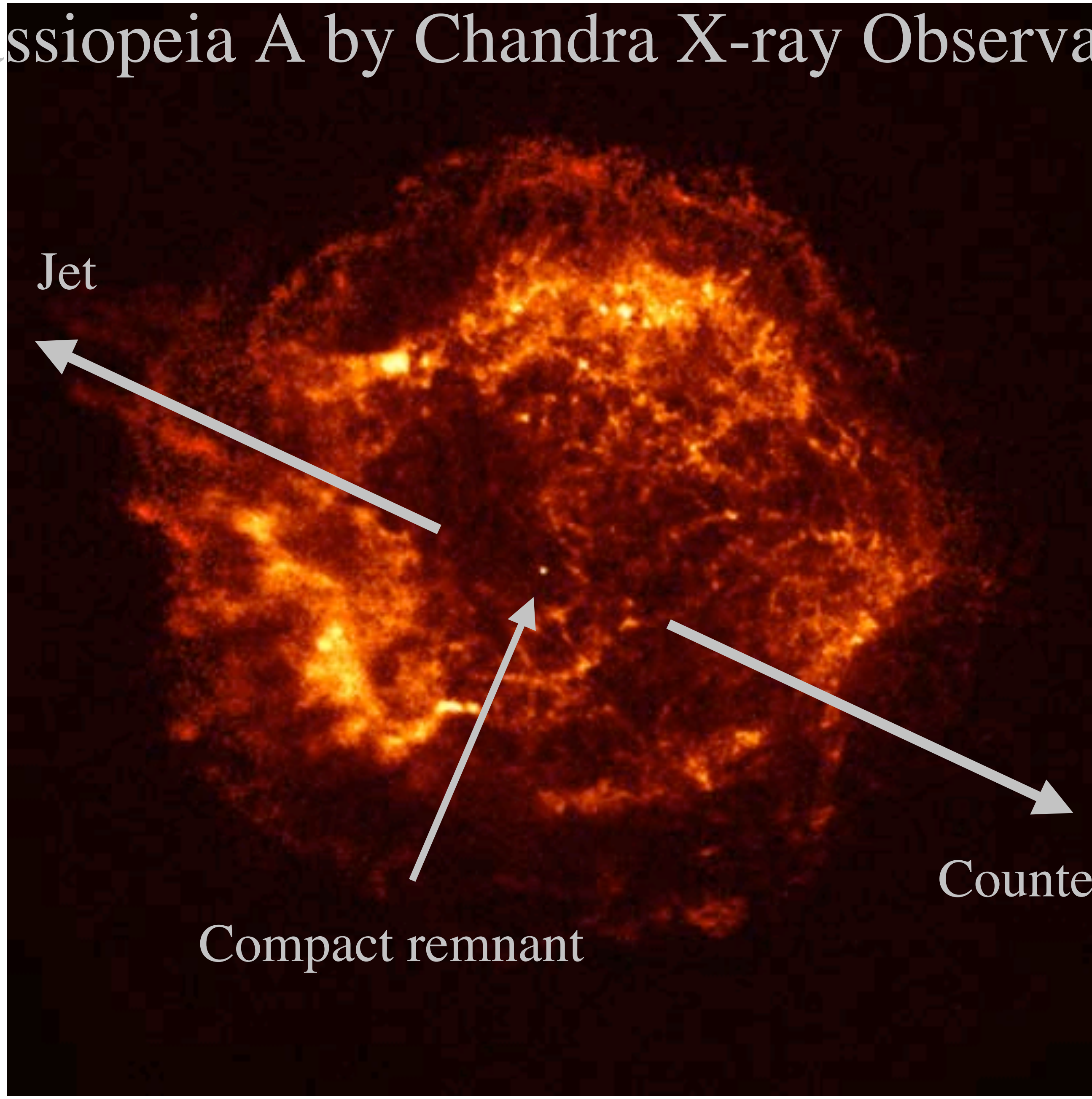
Asian Sky Stories gathering sky myths from Asian cultures

September 2009 issue of Physics Today

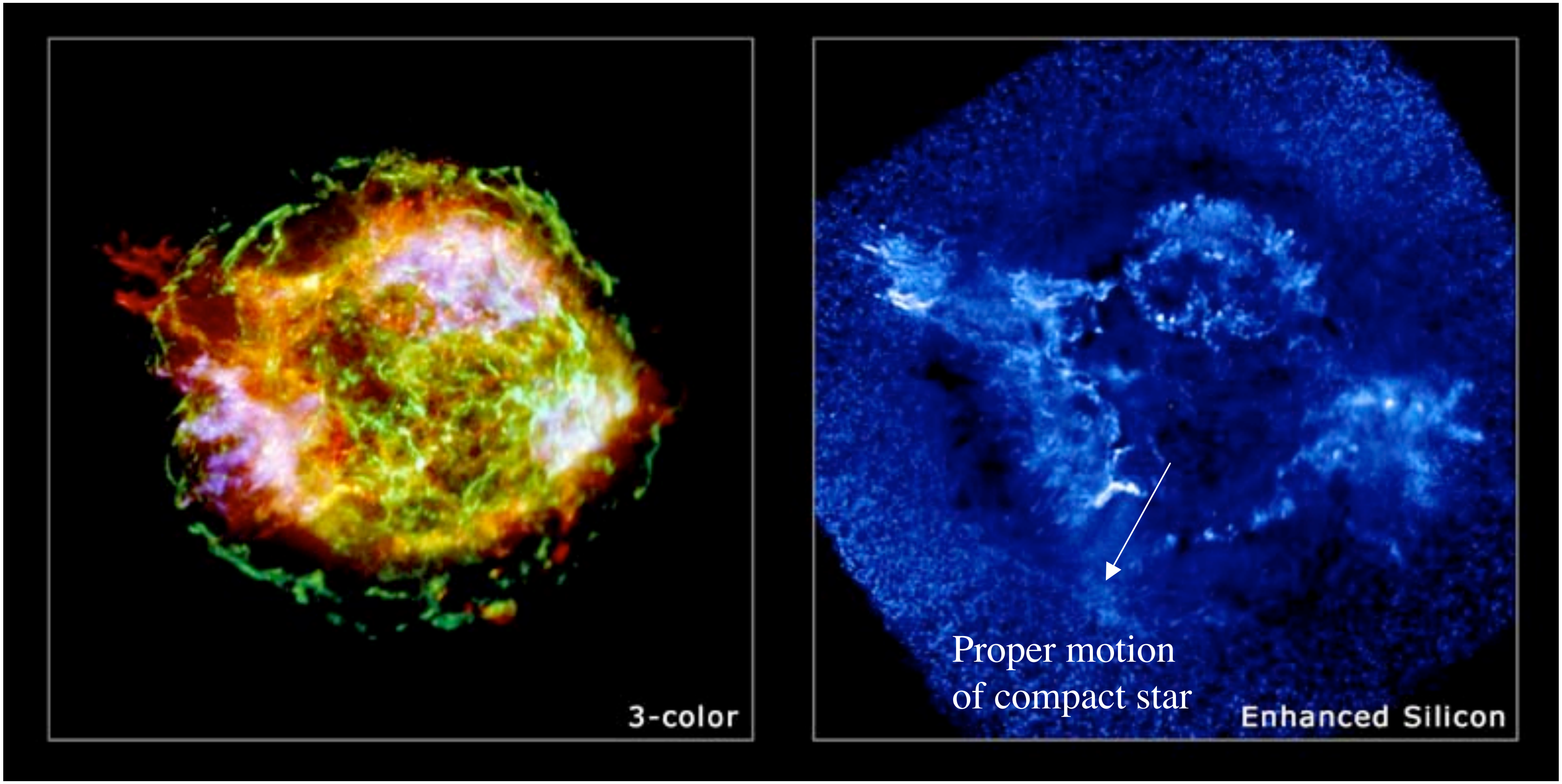
http://www-irc.mtk.nao.ac.jp/~webadm/StarsofAsia_E/index.php?Book

Lecture by MacArthur “Genius” Award winner Jeff Weeks “The Shape of Space,” 7:00 - 8:00 PM, Thursday, October 1, Thompson Conference Center. Not directly related to IYA, but potentially related to class, so will count report as equivalent to an IYA activity.

Cassiopeia A by Chandra X-ray Observatory



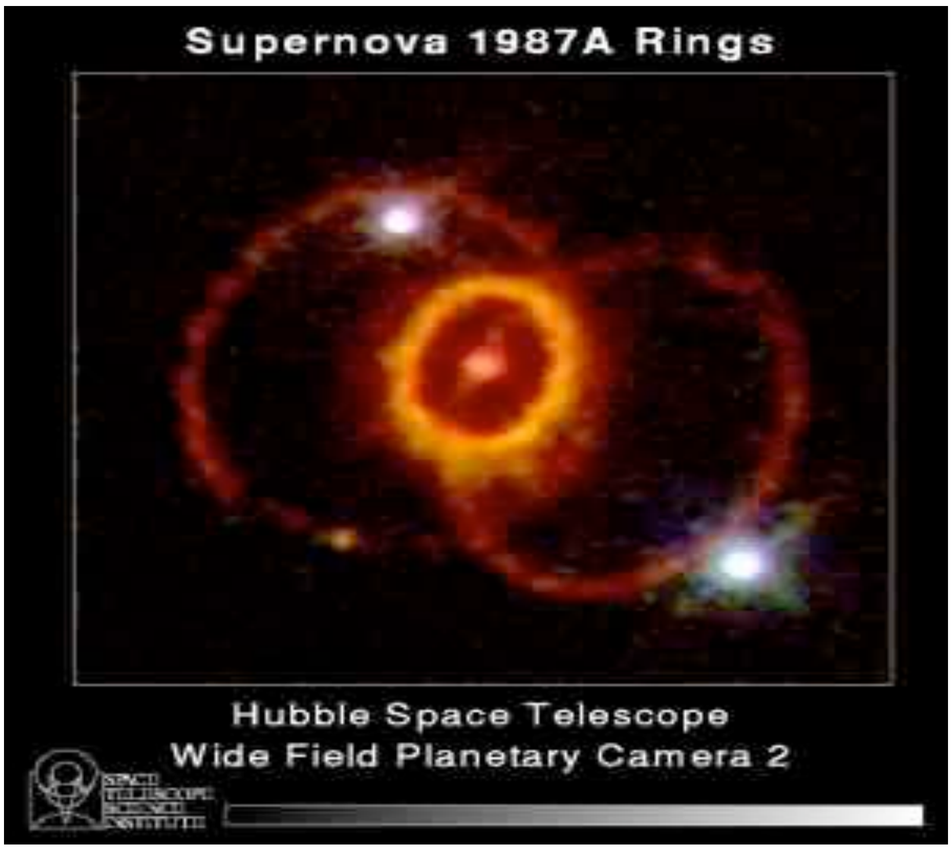
Recent Chandra Observatory X-ray Image of Cas A



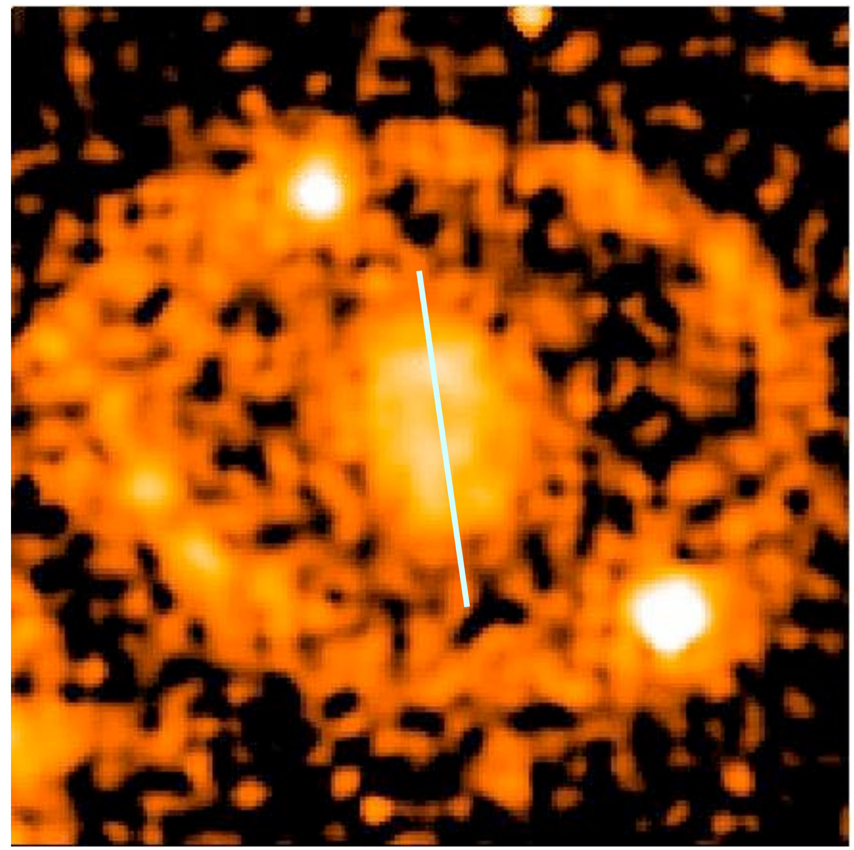
SN 1987A

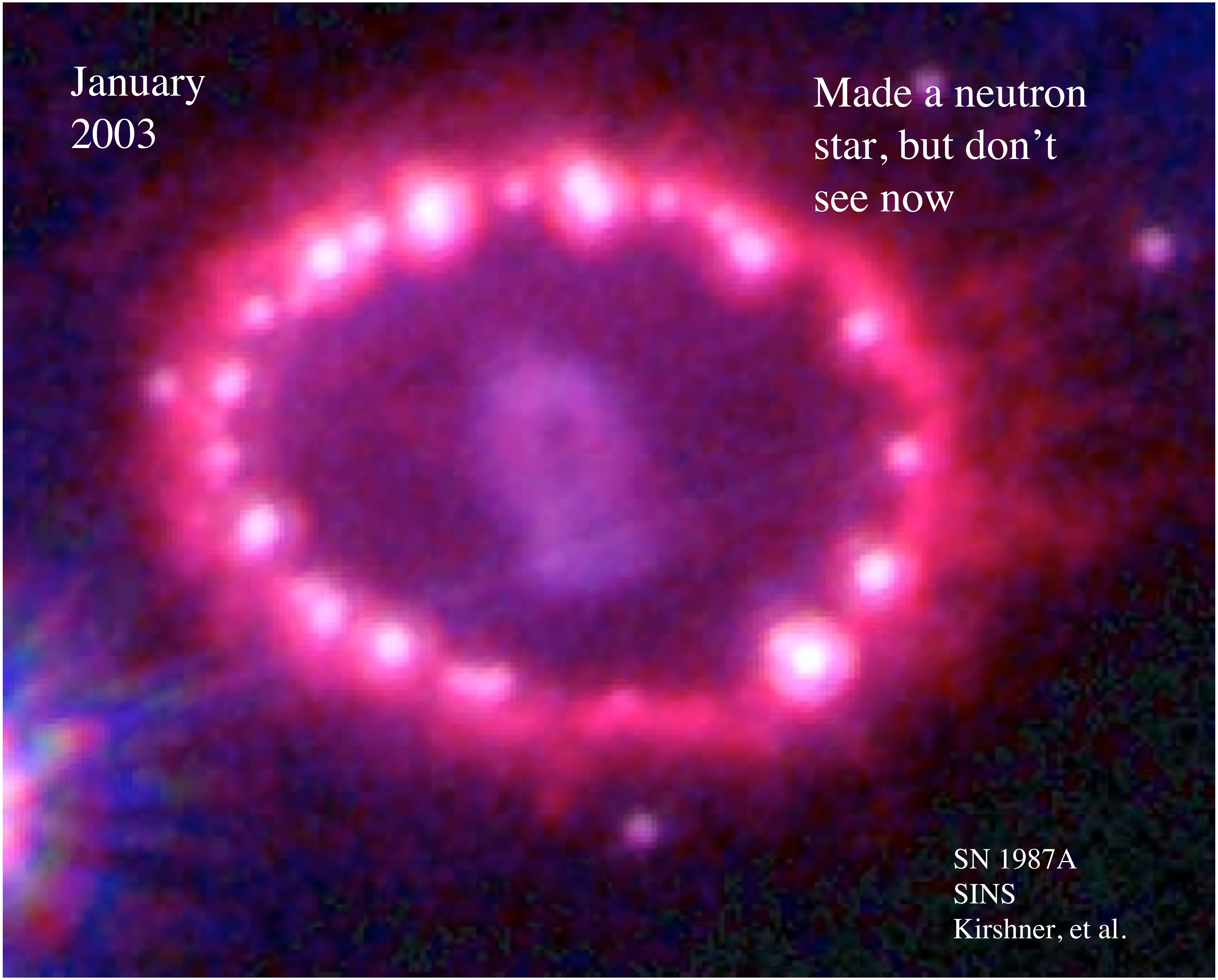
Exploded in nearby galaxy

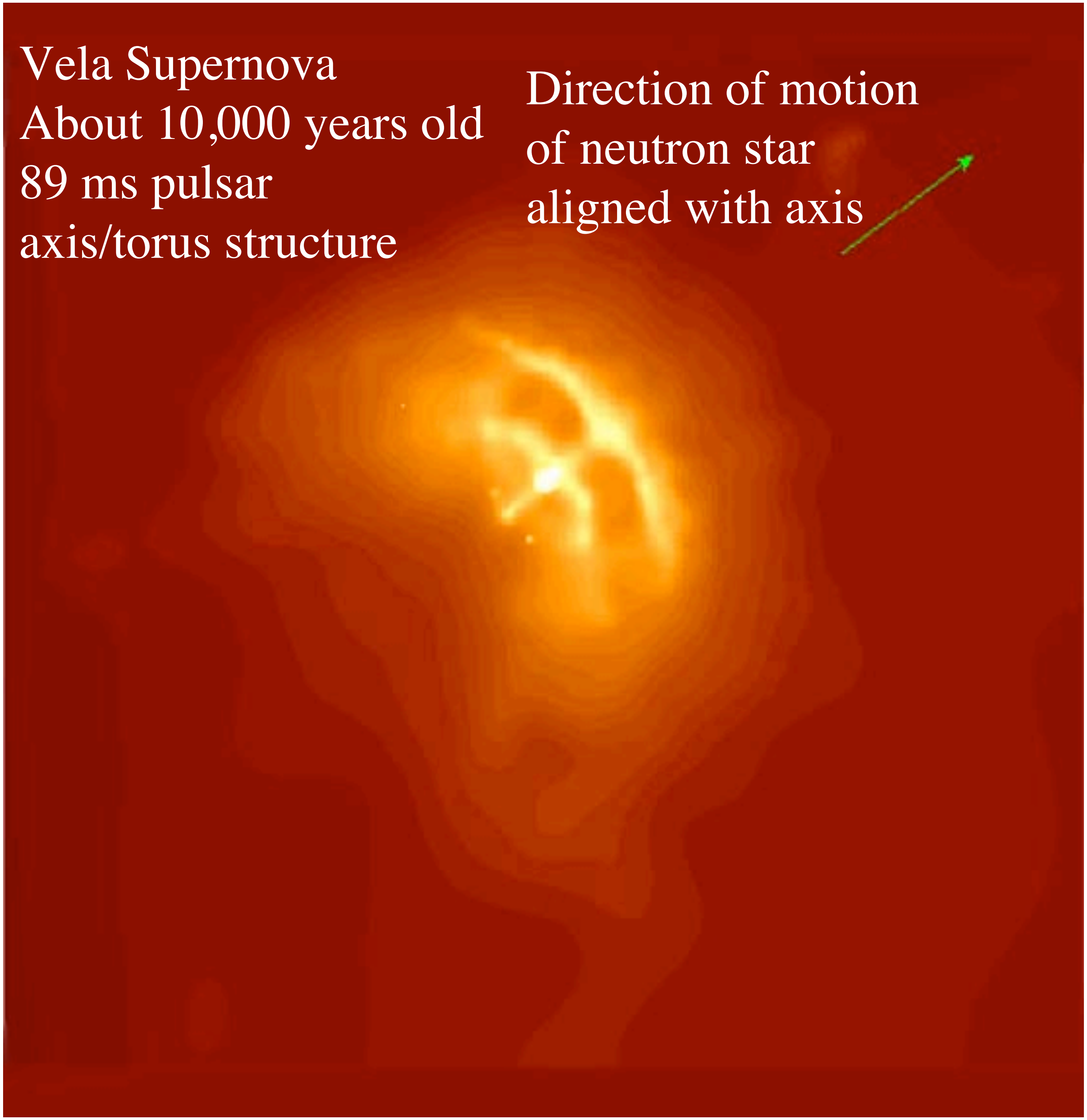
Bi-polar symmetry



Elongated debris




January
2003
Made a neutron
star, but don't
see now
SN 1987A
SINS
Kirshner, et al.


Vela Supernova
About 10,000 years old
89 ms pulsar
axis/torus structure
Direction of motion
of neutron star
aligned with axis

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

Cassiopeia A - Cassiopeia

Vela supernova - Vela

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)

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.

Our Galaxy is overdue for another!

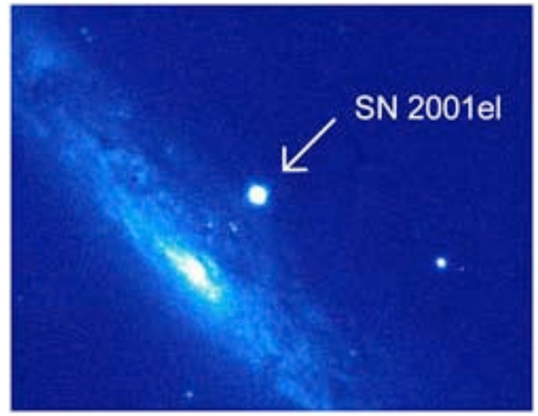
Recognition (early in the 20th century) that some “novae” were in distant galaxies and hence were 10,000 to 100,000 times brighter than classical novae in the Milky Way.

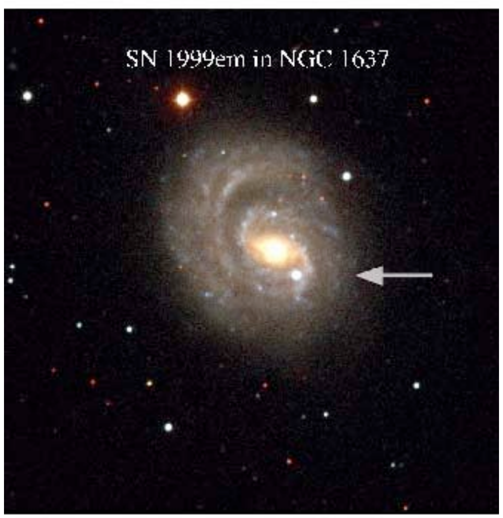
Led to the recognition and naming of “super” novae.

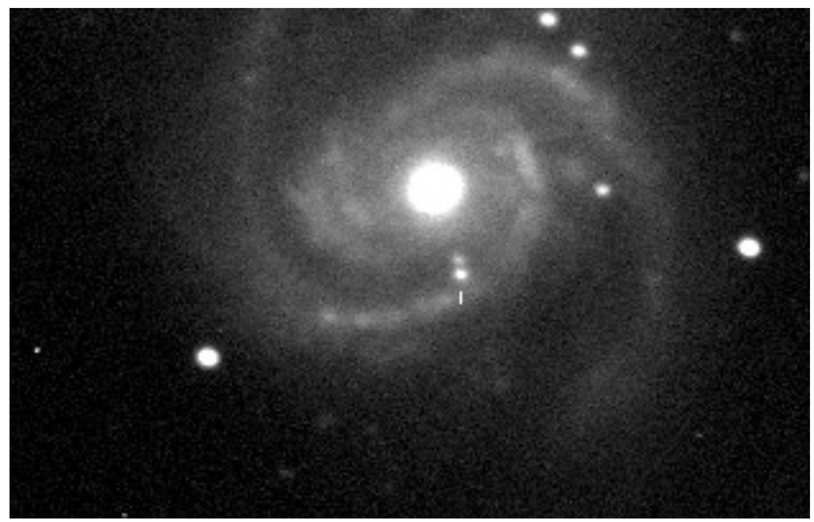
Web site of recent bright supernovae:

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

Sample of extragalactic supernovae

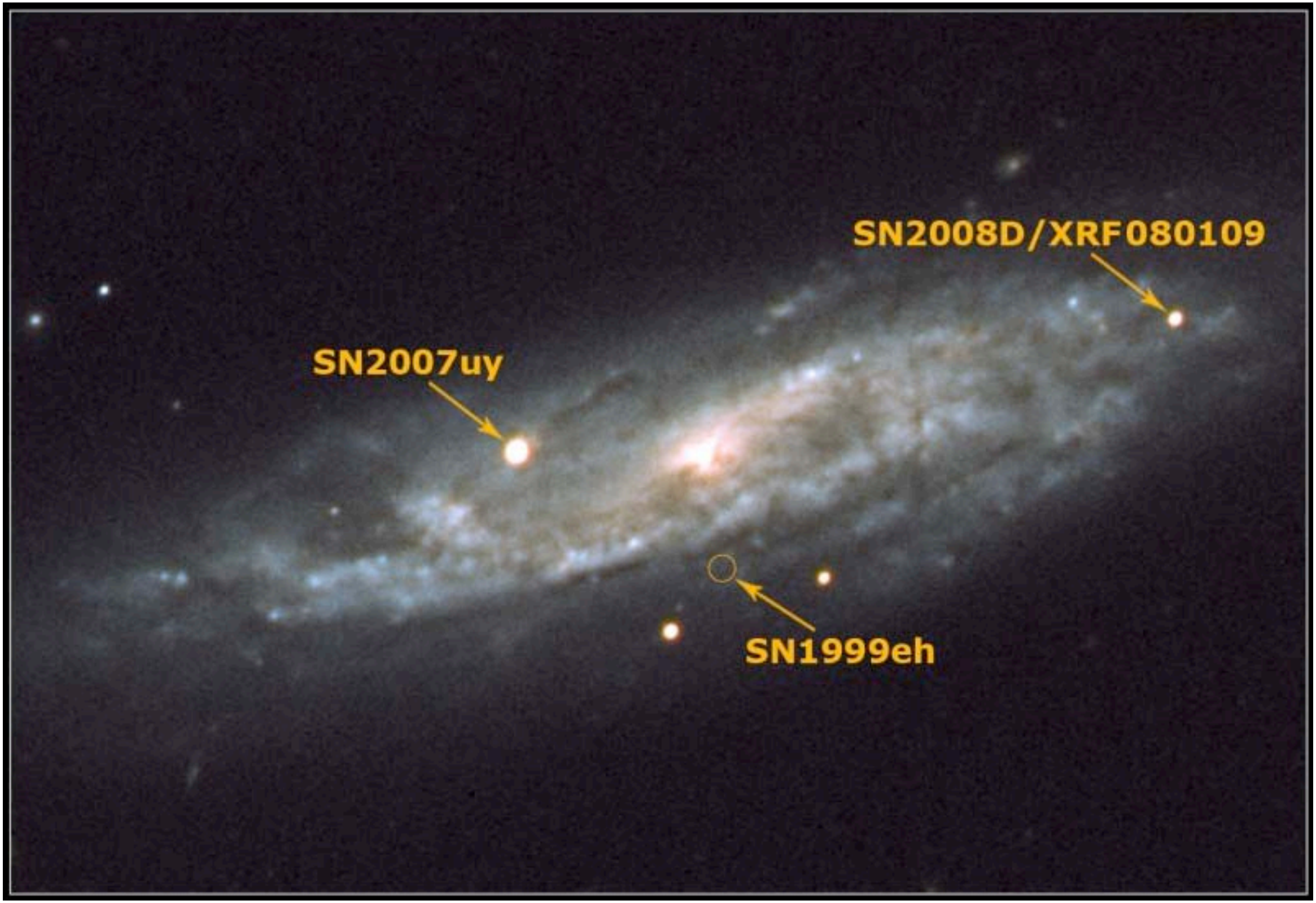






SN 2006X

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 several hundred 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’s latest, SN 2009iy, discovered September 16 - #259 so far

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

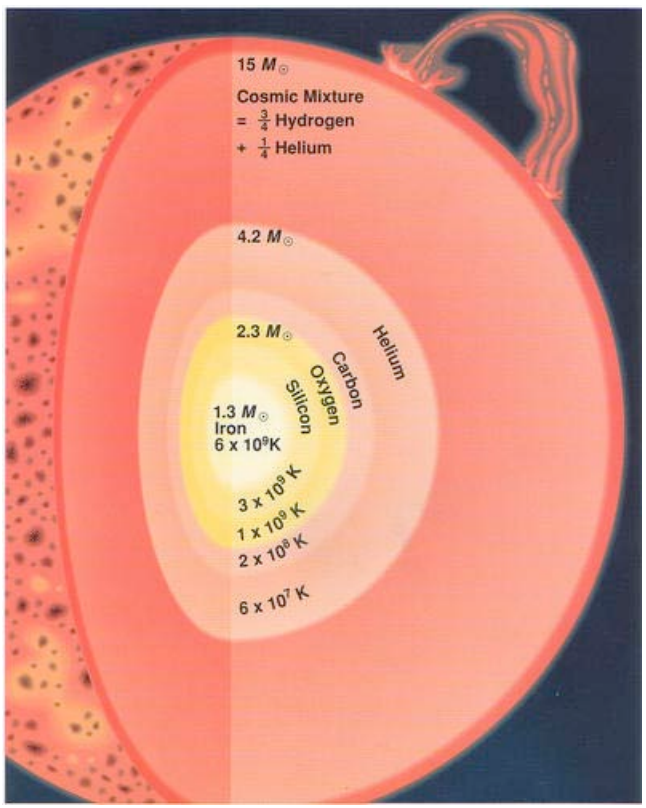
C) It was formed by an exploding white dwarf

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,

$\Rightarrow$ always supported by thermal pressure

$\Rightarrow$ 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:

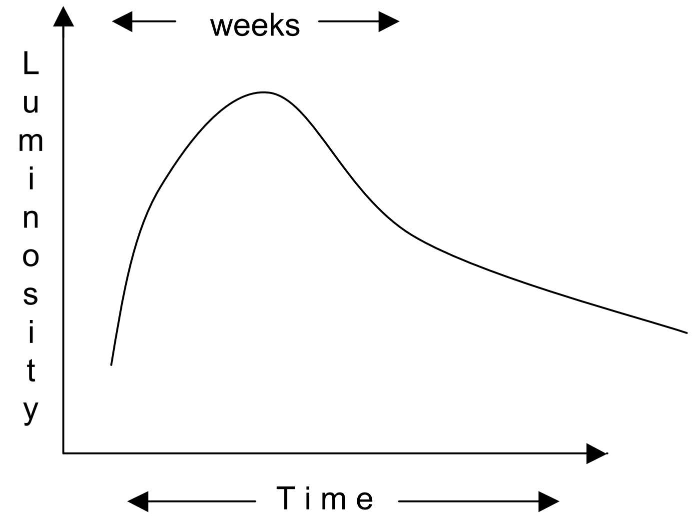
In **spiral galaxies** they tend to avoid the spiral arms, they have had time to drift away from the birth site → ***the star that explodes is old***

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

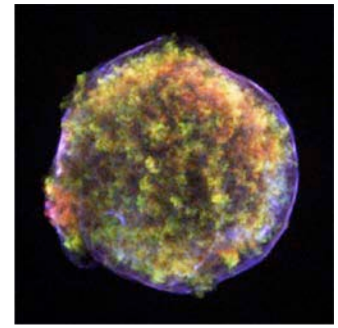


Light Curve - brightness vs. time consistent with an exploding C/O white dwarf
expect total disruption, ***no neutron star***

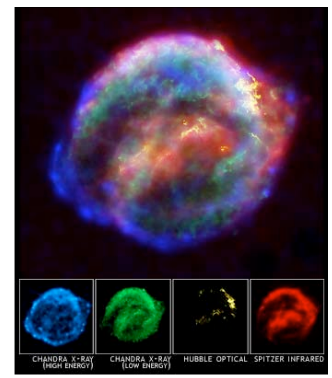
Type Ia occur in elliptical galaxies, tend to avoid spiral arms in spiral galaxies - old when explode, probably a white dwarf.

SN 1006, almost definitely Type Ia

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



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 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

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

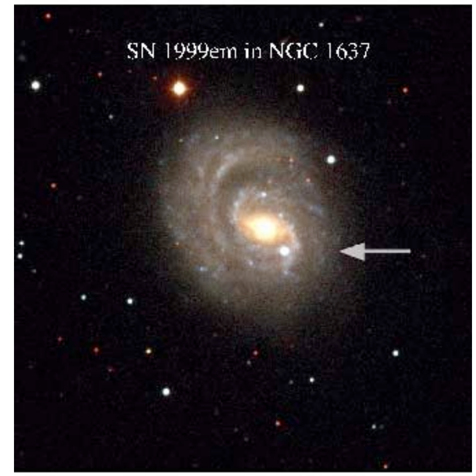
C) They are built up from the element helium

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***

→The progenitor stars are young, short-lived massive stars



SN 1999em

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