Monday, March 6, 2017

Reading for Exam 3:

Chapter 6, end of Section 6 (binary evolution), Section 6.7 (radioactive decay), Chapter 7 (SN 1987A), Background: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.10, 4.1, 4.2, 4.3, 4.4, 5.2, 5.4 (binary stars and accretion disks).

Astronomy in the news?

Rotating, magnetic neutron star, a pulsar, is emitting power at 1000 times the rate previously thought to be a limit, the Eddington limit.

Goal - to understand what makes supernovae shine (Section 6.7).

Fast explosion of C/O in Type Ia and shock hitting layer of Si in Type Ib, Ic make element closest to iron (with same total p + n), but with #p = #n, **Nickel-56.**

Nickel-56: 28p, 28n total 56 -- Iron-56: 26p, 30n total 56

Ni-56 is unstable to **radioactive decay**

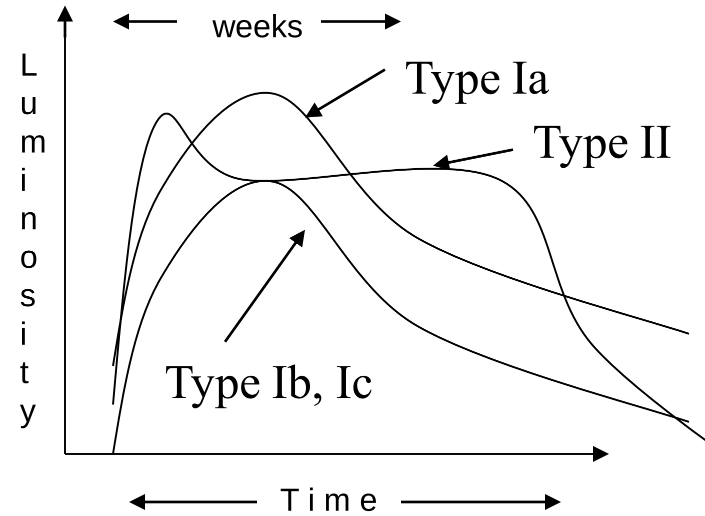
Nature wants to produce iron at bottom of nuclear "valley"
Radioactive decay caused by (slow) weak force, converting p $\rightarrow$ n

Nickel -56	γ-rays heat →	Cobalt-56	γ-rays heat →	Iron-56
28p	"half-life"	27p	"half-life"	26p
28n	6.1 days	29n	77 d	30n

Secondary heat from radioactive decay γ-rays makes Type I a, b, c shine

Type Ia are brighter than Type Ib and Ic because they produce more nickel-56 in the original explosion.

The thermonuclear burning of C and O in a white dwarf makes about 0.5 - 0.7 solar masses of nickel-56.



A core collapse explosion that blasts the silicon layer makes about 0.1 solar masses of nickel-56.

Type II also produce about 0.1 solar mass of nickel-56, but the explosion energy radiated from the red giant envelope in the plateau tends to be brighter. After the envelope has expanded and dissipated, the remaining radioactive decay of Cobalt-56 is seen.

One Minute Exam

The light from Type Ia supernovae does not come from the heat of the original explosion because:

➡ The supernova must have a size 100 times the Earth's orbit in order to radiate

⬅ Type Ia produce iron in the center

⬆ When carbon burns quickly, nickel is produced

⬇ The star that explodes is large at the time of the explosion

One Minute Exam

Type Ic supernovae are usually dimmer than Type Ia supernovae because:

- Type Ic form neutron stars
- Type Ic have no hydrogen or helium
- Type Ic have binary companions
- Type Ic produce less nickle-56

Sky Watch Objects

Lyra - Ring Nebula, planetary nebula in Lyra

Cat’ s Eye Nebula, planetary nebula in constellation Draco

Sirius - massive blue main sequence star with white dwarf companion

Algol - binary system in Perseus

Vega - massive blue main sequence star in Lyra

Antares - red giant in Scorpius

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

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

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

Castor, Rigel - massive blue main sequence stars

Capella, Procyon - on their way to becoming red giants

Sky Watch Targets

Binary Stars

Sirius
Algol, Beta Persei in Perseus
Antares, Alpha Scorpii in Scorpius
Beta Lyrae in Lyra
Rigel, Beta Orionis in Orion (triple star system)
Spica in Virgo

M82 in the Big Dipper, host galaxy of SN 2014J

SN 1006 - Lupus/Centaurus (difficult this time of year)

SN 1054 Crab Nebula - Taurus

SN 1572 Tycho - Cassiopeia

SN 1604 Kepler - Ophiuchus

Cassiopeia A - Cassiopeia

Vela supernova – Vela

SS Cygni - brightest dwarf novae in the sky, Cygnus,

U Geminorum - dwarf nova in Gemini

CP Pup, classical nova toward constellation Puppis in 1942

Pup 91, classical nova toward Puppis in 1991

QU Vul, classical nova toward constellation Vulpecula,

GK Per -Perseus, both a classical nova eruption and dwarf nova.

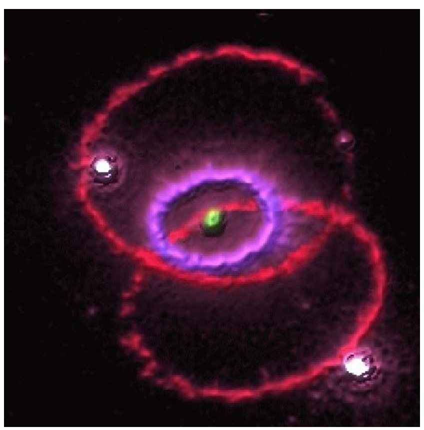
U Sco - Scorpius, recurrent nova

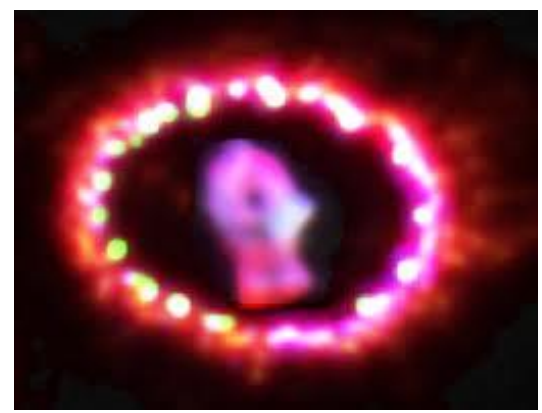
RS Oph – Ophiuchus, recurrent nova

T Pyx in constellation Pyxis.

Goal:

To understand the nature and importance of SN 1987A for our understanding of massive star evolution and iron core collapse. Chapter 7



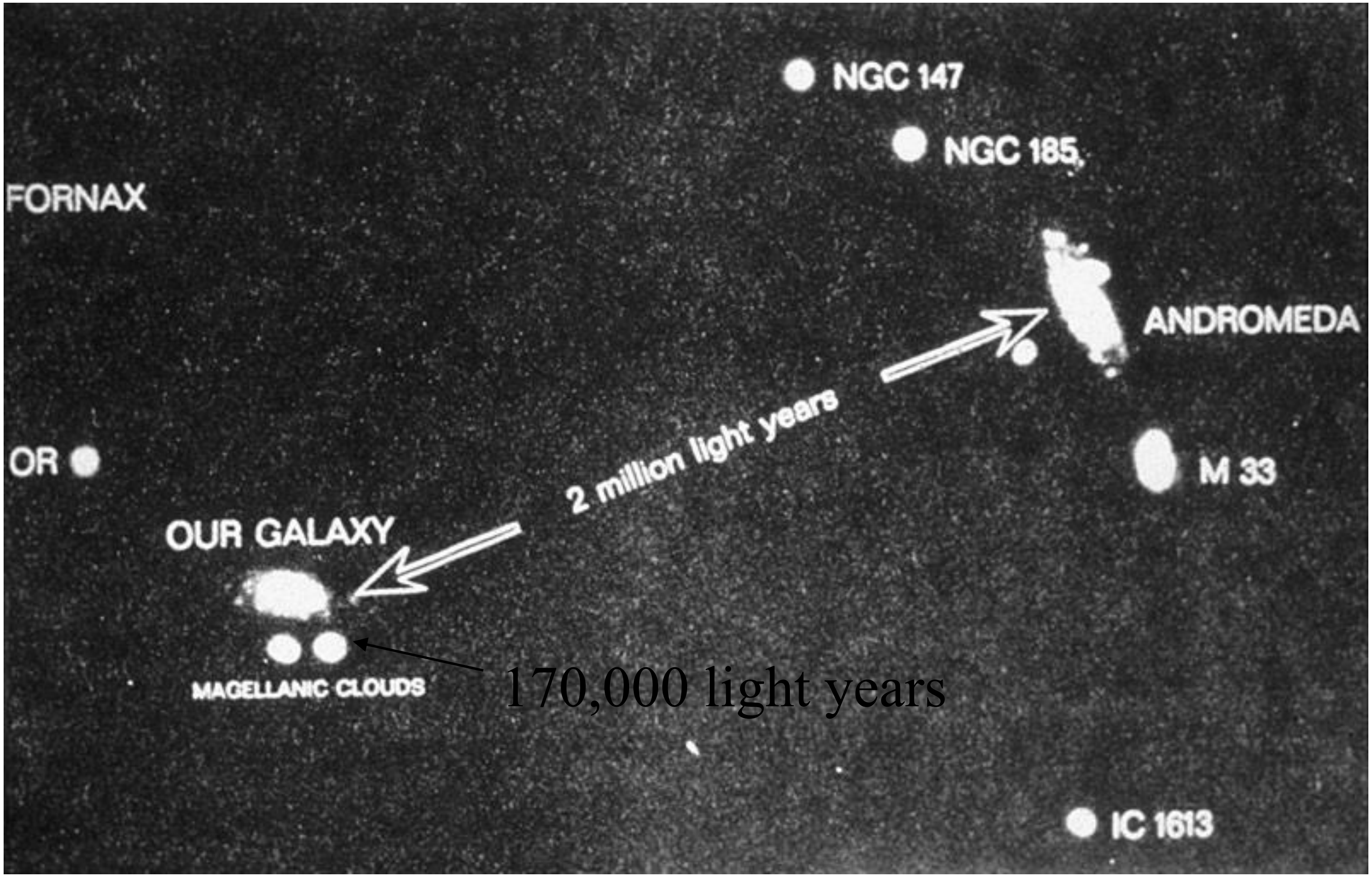


Kepler

SN 1987A
first naked eye
supernova since
Kepler's in
1604

Tycho

Local group


NGC 147
NGC 185
FORNAX
ANDROMEDA
2 million light years
OR
M 33
OUR GALAXY
MAGELLANIC CLOUDS
170,000 light years
IC 1613

The single most important thing about SN 1987A is that we detected the neutrinos!

It was definitely a core-collapse event

10^{57} neutrinos emitted, most missed the Earth. Of those that hit the Earth, most passed though since neutrinos scarcely interact.

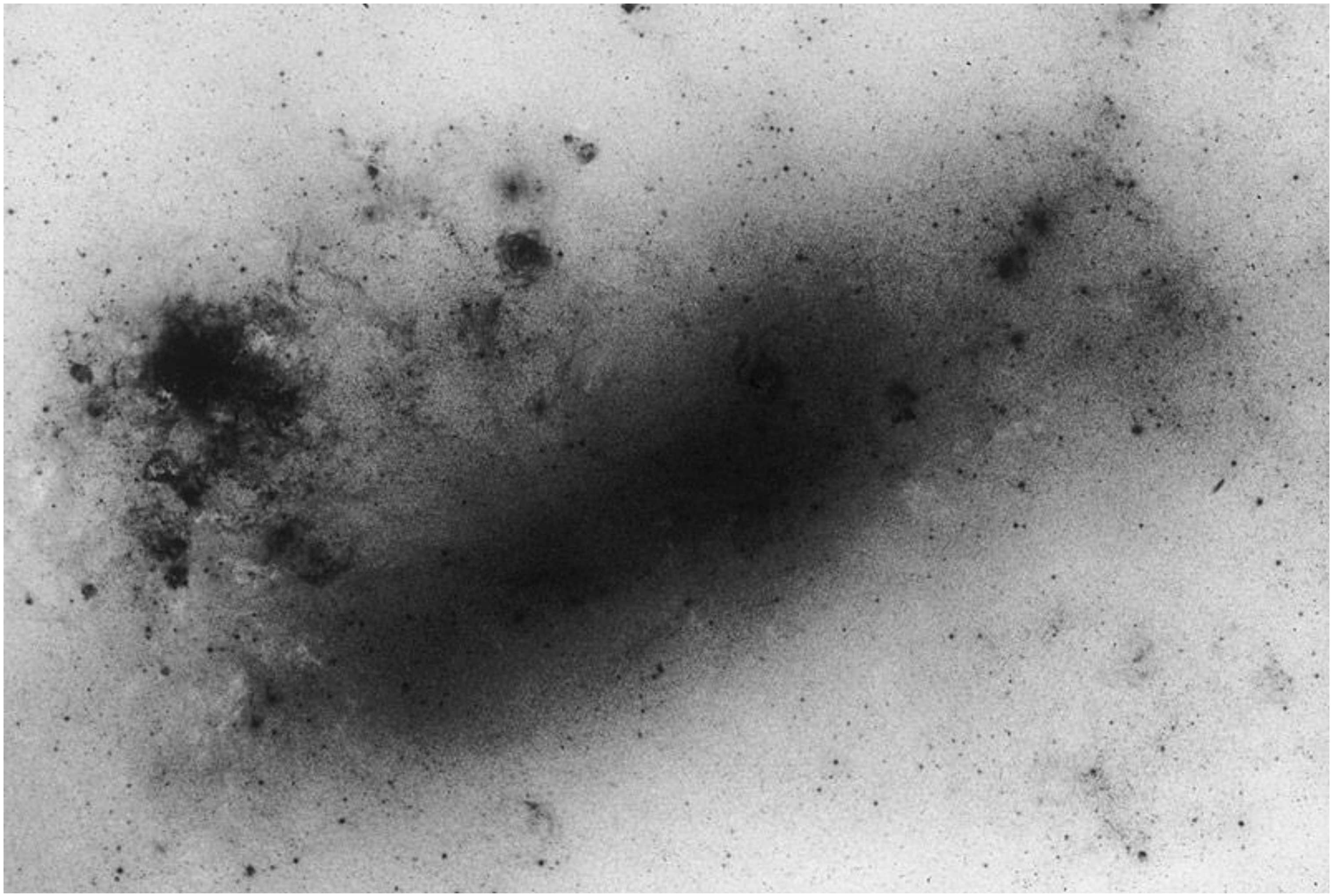
About 19 neutrinos were detected in a 10 second burst.

170,000 year history of humanity!

Large Magellanic Cloud, irregular galaxy, large scale

Large Magellanic Cloud, closeup (color)

LMC negative



SN 1987A

Perhaps first noted by Chilean night assistant, Oscar Duhalde

First reported by Canadian graduate student, Ian Shelton.

First photographed by Australian asteroid chaser, Rob McNaught.

My story…