

Friday, March 21, 2014

Reading for Exam 3: End of Section 6.6 (Type Ia binary evolution), 6.7 (radioactive decay), Chapter 7 (SN 1987A), NOT Chapter 8 (Neutron Stars), keep for Exam 4.

Background: Sections 3.3, 3.4, 3.5, 3.10, 4.1, 4.2, 4.3, 4.4, 5.2, 5.4, binary stars and accretion disks.

Astronomy in the news:

Yesterday was the first day of spring, the Vernal Equinox.

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

Detection of gamma-rays from the radioactive decay of Cobalt-56 by the aging INTEGRAL satellite (not the new kid in orbit, NuSTAR).

Scientifically historic event!

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 the bottom of the nuclear “valley”

Decay caused by (slow) weak force $p \rightarrow n$

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

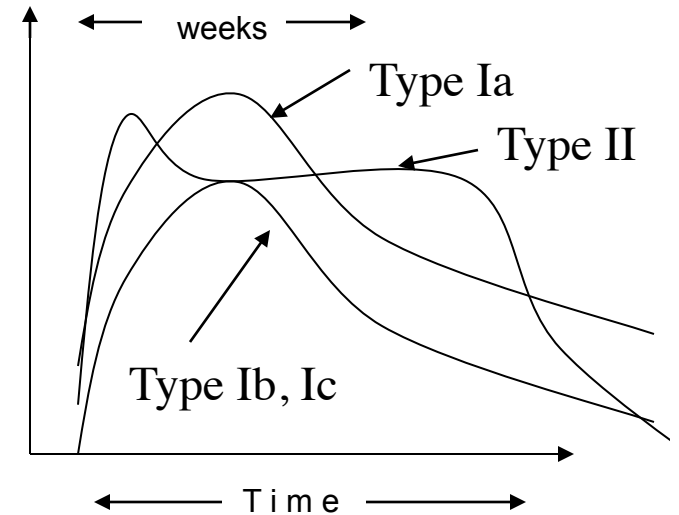
Secondary heat from radioactive decay γ -rays makes Type I a, b, c shine

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 thermonuclear burning of carbon does not produce much heat

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 nickel-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.

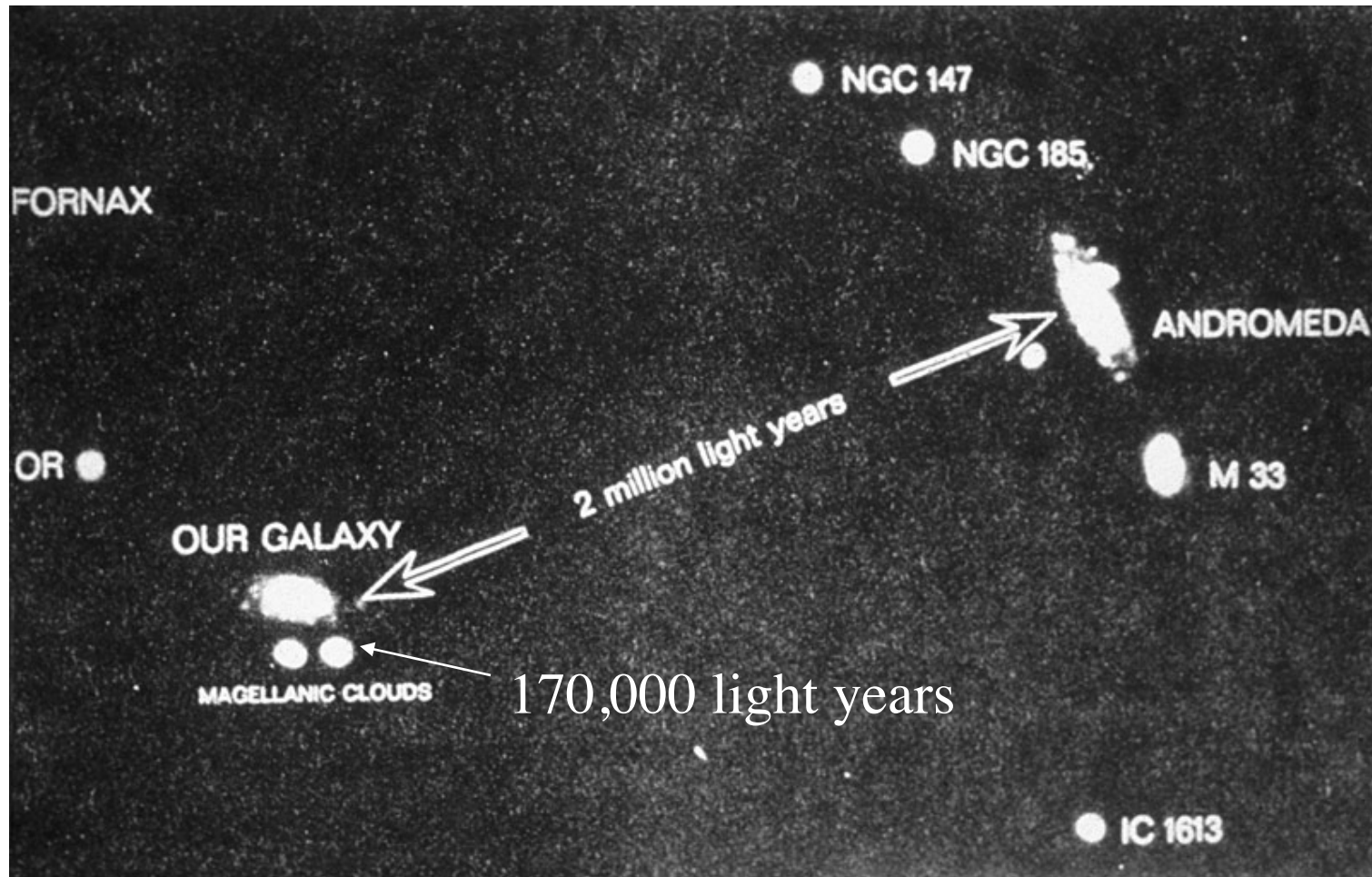
Kepler

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



Tycho

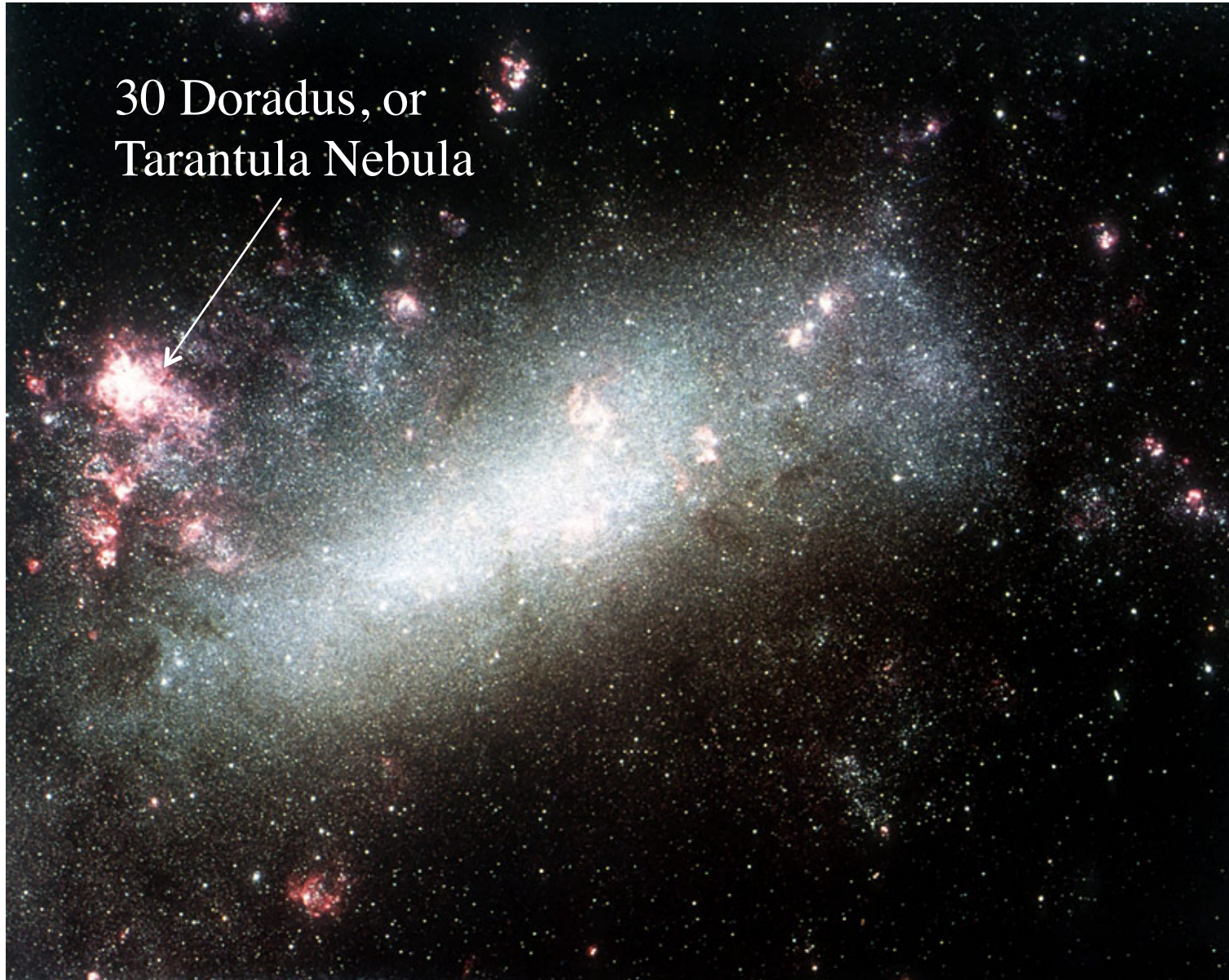
Local group



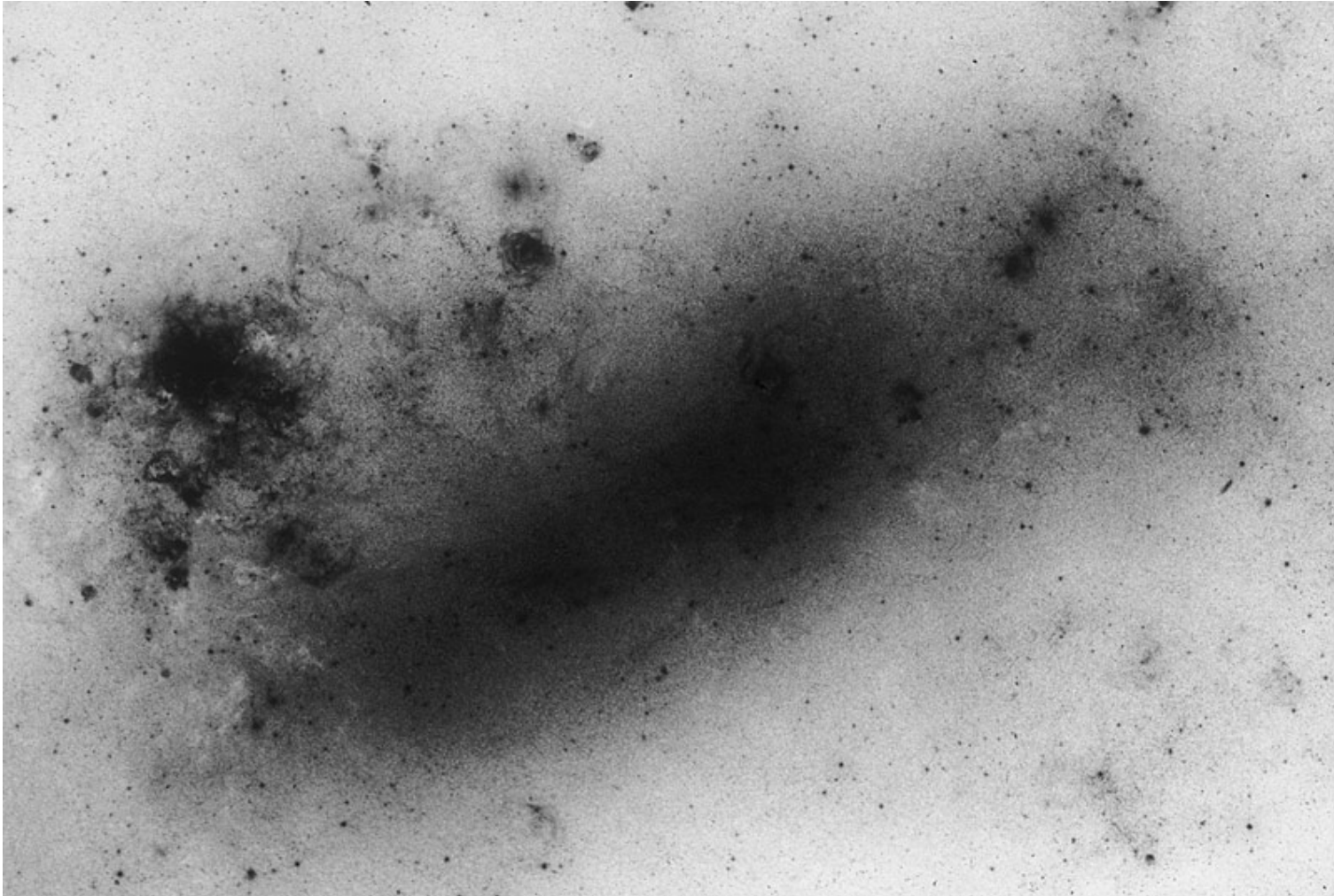
Large Magellanic Cloud, irregular galaxy, large scale



Large Magellanic Cloud, closeup (color)



LMC negative



Rob McNaught patrol photos - the day before



2-22-87

The first known photo of SN 1987A hours after shock breakout



2-23-87

One day later



2-24-87

Near maximum light



5-20-87

About when I saw it



8-23-87