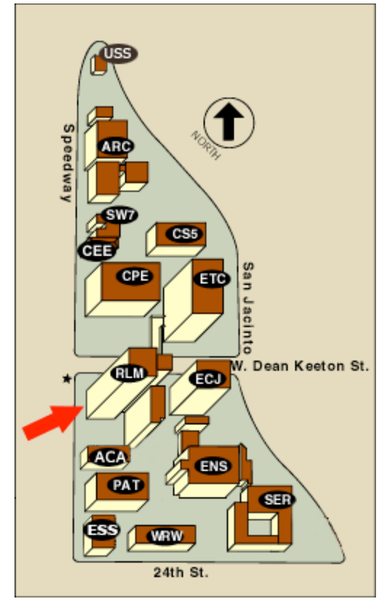
Monday, March 23, 2015

Exam 3, Skywatch 3, Friday 3/27, Review Sheet posted

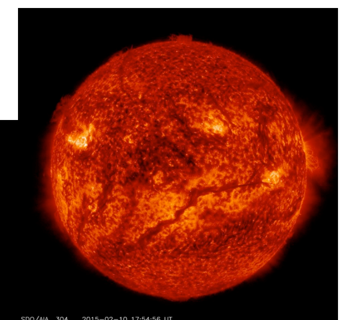
Review session, Thursday, 5 – 6 PM RLM 6.104

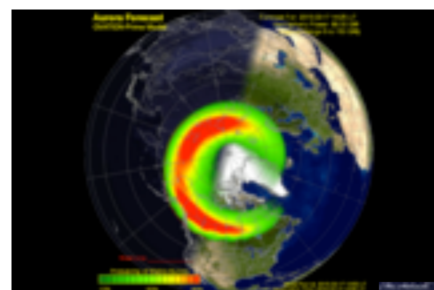


Chapter 6, end of Section 6 (binary evolution), Section 6.7 (radioactive decay), Chapter 7 (SN 1987A)

Background in Chapters 3, 4, 5.

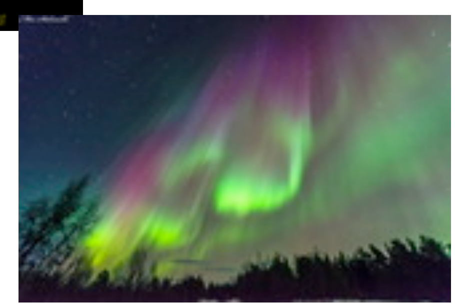
Background: Sections 3.1, 3.2, 3.3, 3.4, 3.5, 3.8, 3.10, 4.1, 4.2, 4.3, 4.4, 5.2, 5.4 (binary stars and accretion disks).





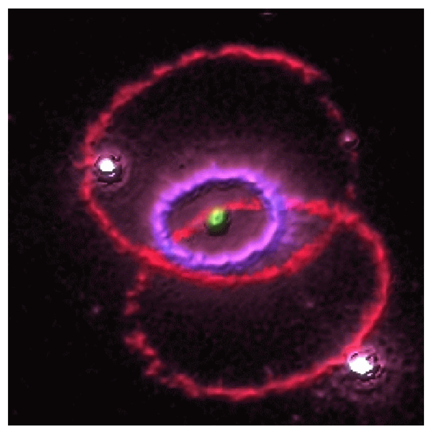
Astronomy in the news?

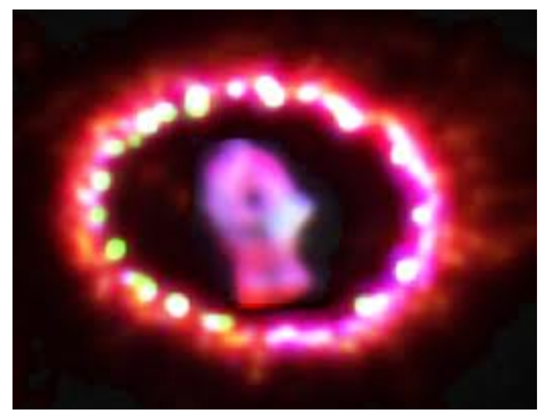
St. Patrick’s Day Solar Storm hits Earth



Goal:

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





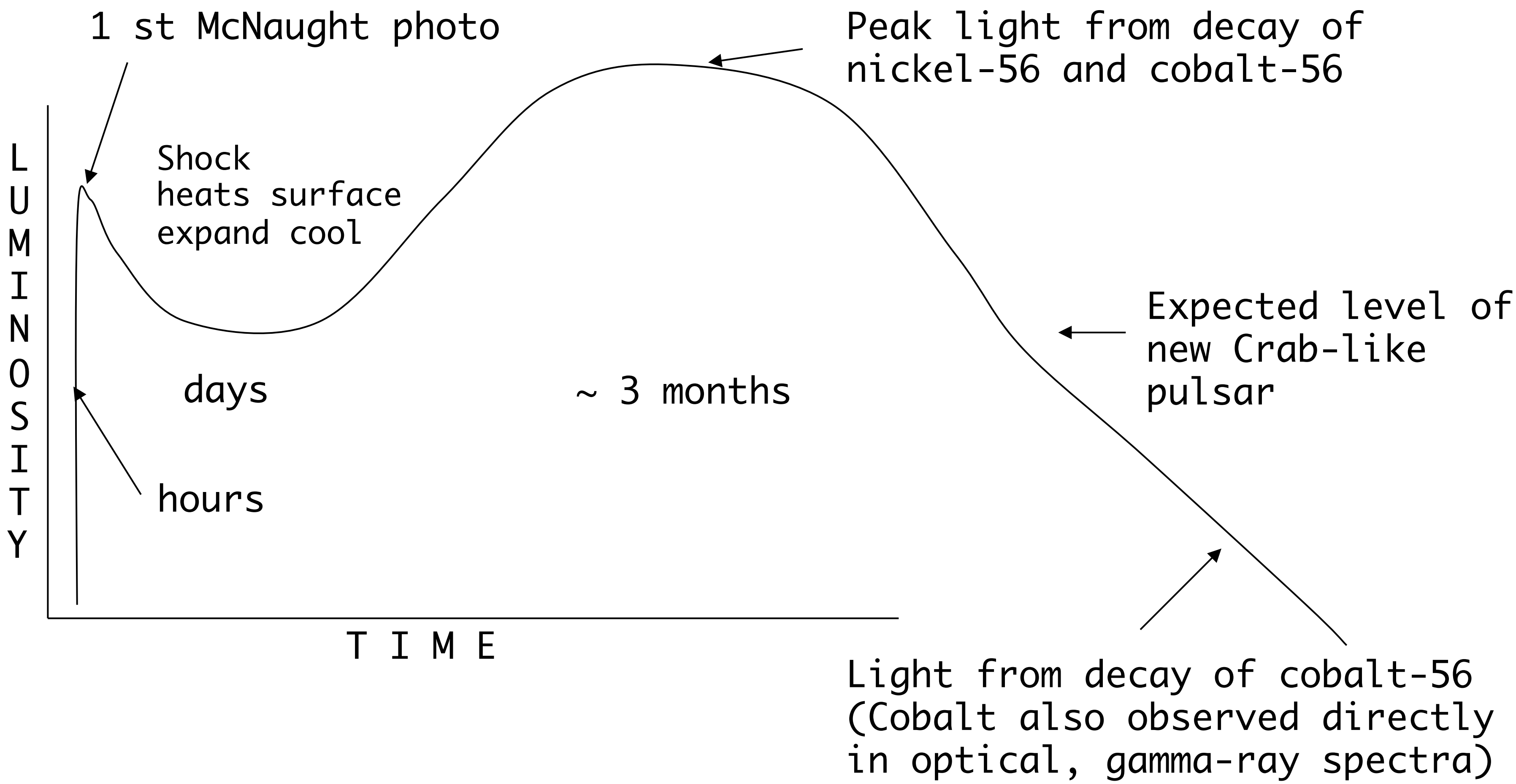
The single most important thing about SN 1987A is that we detected the neutrinos!

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!



SN 1987A had a rather peculiar light curve because it was a relatively compact blue supergiant, not a red supergiant (not sure why, maybe in binary system), brief shock heating, rapid cooling by expansion, no plateau, subsequent light all from radioactive decay.

Saw neutrinos, neutron star must have formed and survived for at least 10 seconds.

If a black hole had formed in the first instants, neither light nor neutrinos could have been emitted.

No sign of neutron star since despite looking hard for 28 years.

Whatever is in the center of Cas A, most likely a neutron star, is too dim to be seen at the distance of the LMC, so SN 1987A might have made one of those (probably a neutron star, but not bright like the one in the Crab Nebula).

Also possible that after explosion and formation of neutron star, some matter fell back in and crushed the neutron star to become a black hole.

Dim neutron star or black hole? Still do not know.

End of Material for Exam 3

Neutron stars

Alone and in binary systems

Reading Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Combination of quantum pressure from neutrons and repulsion of neutrons at very close distances by strong nuclear force $\Rightarrow$ pressure to withstand gravity.

Analog of Chandrasekhar mass - maximum mass of neutron star - uncertainty over nuclear repulsion, maximum mass ~ 2 $M_\odot$

Probably 100 million to a billion neutron stars in the galaxy, cold, tiny, and dark.

Nearest, undetected, may be only 10 light years or so away.

Vast majority of about 2000 known neutron stars are alone in space, detected as “pulsars.”

~ 20 - 30 have binary companions, ordinary stars, white dwarfs, other neutron stars, and black holes.

Goal:

To understand how isolated neutron stars are observed as "pulsars."

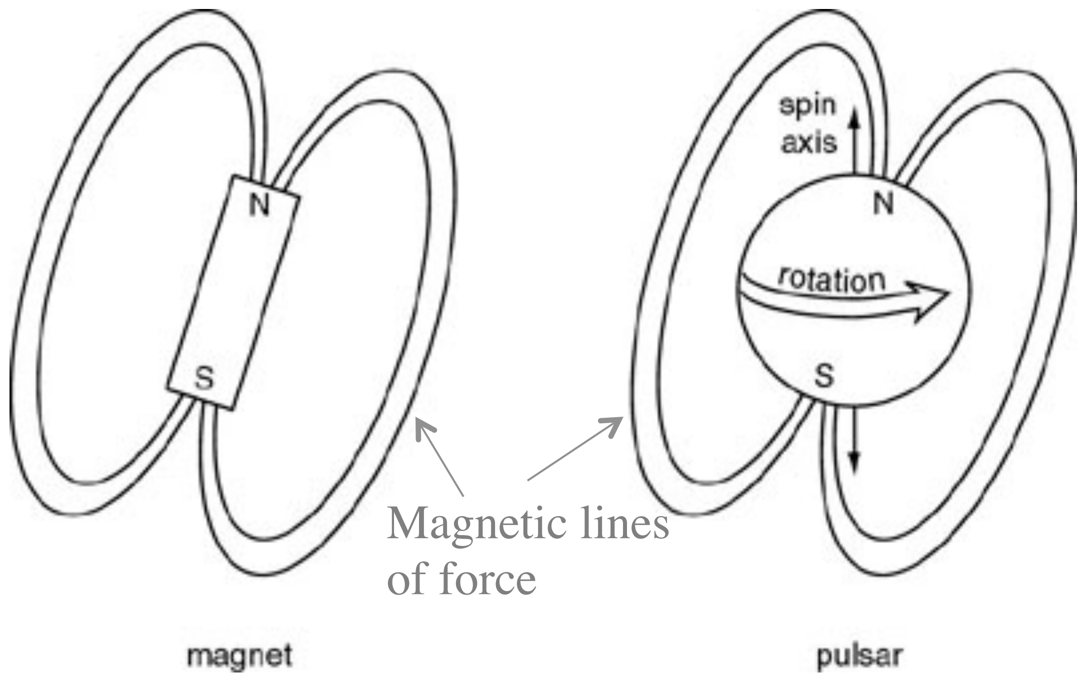
Two new principles of physics:

A moving magnetic field can can and will generate radiation.

Ionized gas, plasma, can move along lines of magnetic force, but cannot move across them. Magnetic fields will drag or channel plasma.

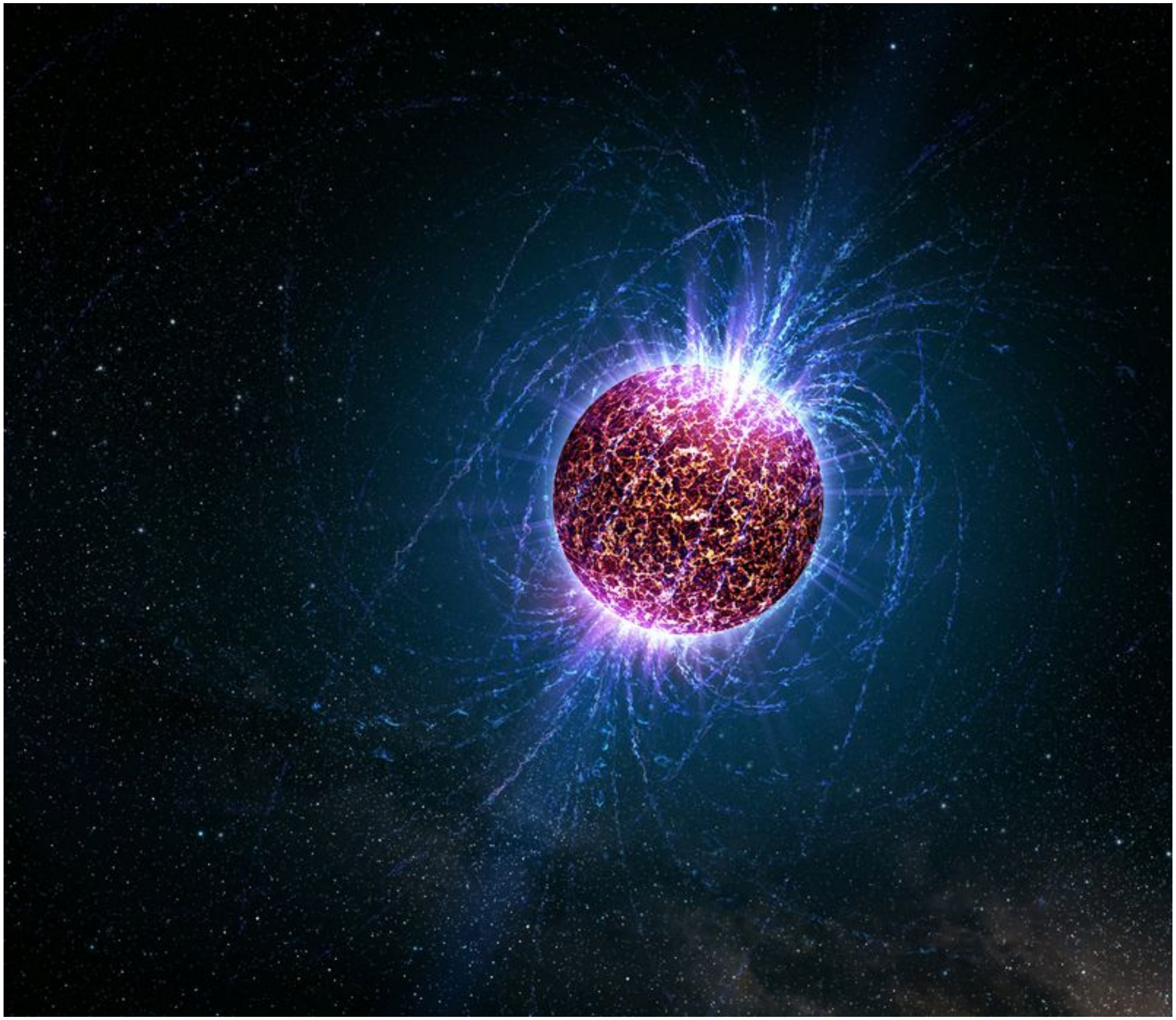
One possibility - field axis is tilted.

Radio Pulsars could be rotating, magnetic neutron stars with magnetic axis **tilted** with respect to spin axis.



Most radio pulsars rotate about once per second, young ones faster, Crab pulsar rotates 30 times per second - would rip apart anything but a neutron star

Artist's conception of neutron star with tilted magnetic field.



Courtesy Casey Reed, Penn State University.
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