Wednesday, March 25, 2015

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

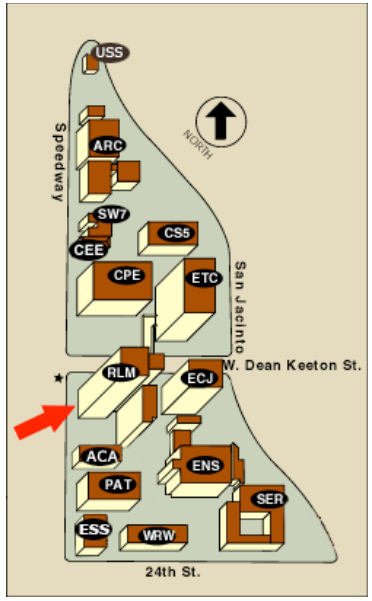
Review session, Tomorrow, 5 – 6 PM RLM 6.104

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?



Neutron stars

Alone and in binary systems

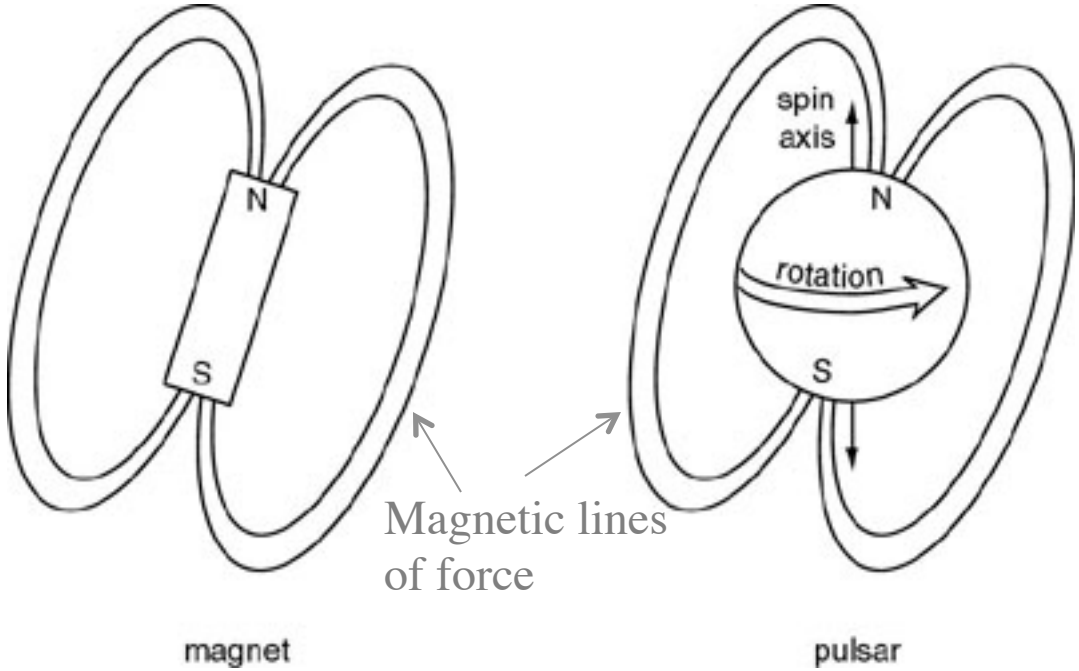
Reading Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Goal:

To understand how isolated neutron stars are observed as “pulsars.”

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

Radio emission from "sparks" "thunderstorms," blobs of plasma, perhaps at tilted magnetic poles or "speed of light" circle

Tilted Poles: whip magnetic field around ⇒ huge electric fields create huge currents, "thunderstorms" ⇒ radio "static"

Blobs of plasma locked to magnetic fields lines, like beads sliding on a wire.

Speed of light circle - distance from rotation axis at which plasma whipped around by "stiff" magnetic field would be moving at the speed of light. The field and plasma must be disrupted there.

In either case, radiation is produced steadily from off-center blobs of plasma, see "pulses" by "lighthouse" mechanism

Flashlights

The neutron star itself does not pulse!

Results from NASA ***Fermi Observatory***, launched June 2008, that detects high-energy Gamma Rays

Radio may come from magnetic poles, but most of the *power* is in high-energy gamma rays and occurs in regions beyond the neutron star, near the speed of light circle.

Goal:

To understand how neutron stars behave in accreting binary systems.

Radio pulsars are alone in space or in non-transferring binary system

Vast majority of known radio (and gamma-ray) pulsars are alone in space

~ two dozen pulsars have binary companions

Binaries special - use Kepler's laws to measure mass

Orbital decay $\Rightarrow$ Gravitational Radiation - Nobel Prize 1993

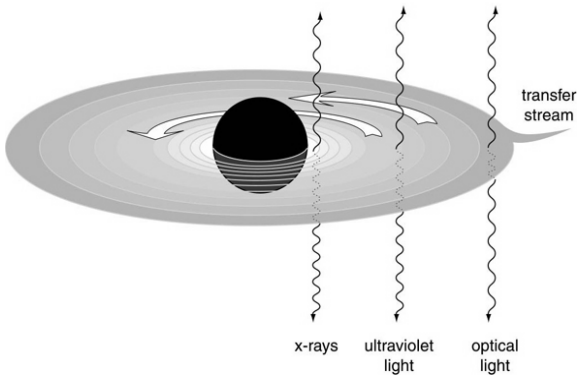
Detected by Texas astronomers in white dwarf binary in 2012.

Some neutron stars are in binaries with mass transfer

Mass transfer floods the magnetic field/poles with gas/plasma, short circuits, kills the radio (and gamma-ray) mechanism.

With mass transfer ⇒ accretion disk => X-rays, another story

High gravity of NS, rapid motion in inner disk, great friction, heat
=> X-rays from disk



Matter lands on, collides with NS Surface => X-rays from NS surface

Uhuru satellite launched from Kenya 1972 found sky ablaze in X-rays: Neutron stars and black holes in binary systems. Many satellites launched since then, including *Chandra Observatory* and the *Fermi Observatory*.

Nobel prize in 2002 for this and related discoveries.

Goal:

To understand how ***magnetic*** neutron stars behave in accreting binary systems.

For strong magnetic field matter connects to, flows *along* magnetic lines of force (can't flow across field lines of force)

Analogous to beads sliding along a wire

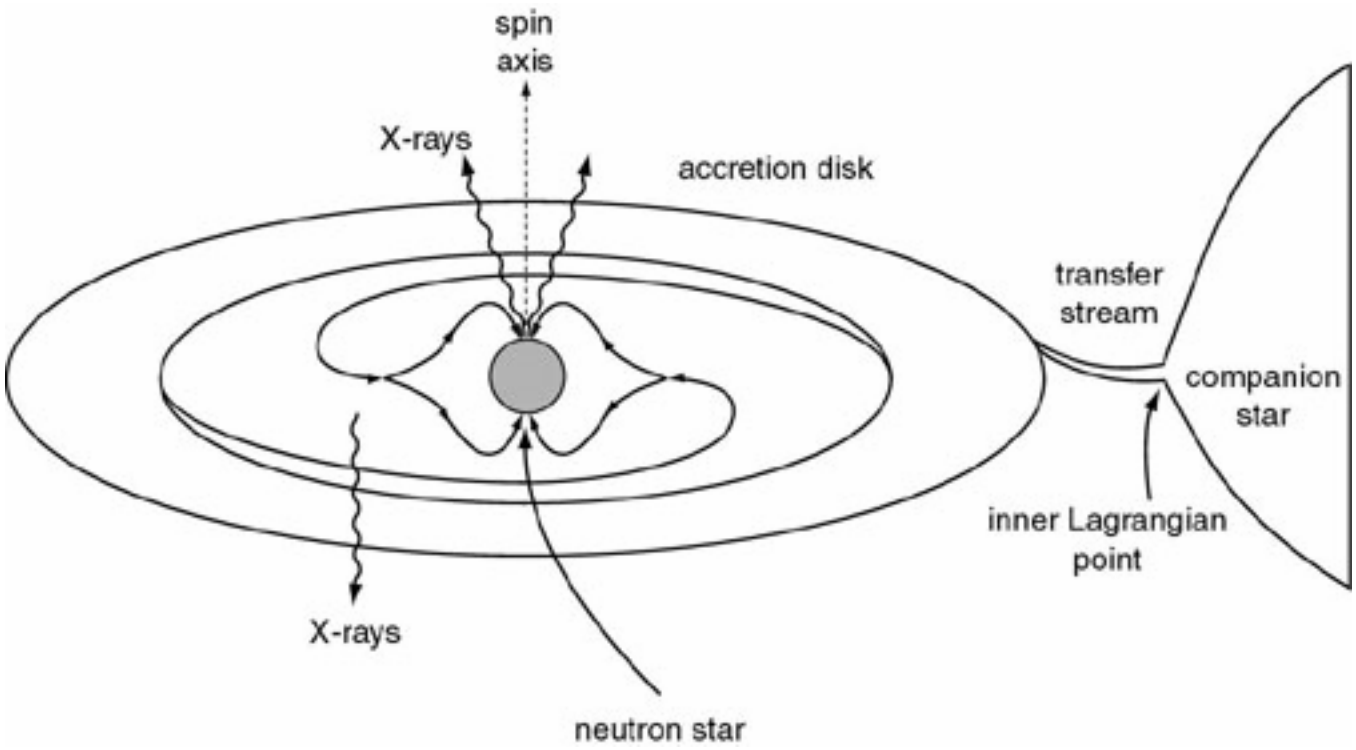
This process automatically channels matter to *magnetic* poles

Matter slams into neutron star at the poles, gets hot, emits X-rays (but kills radio, gamma rays)

Rotation with tilted magnetic field can give X-ray "pulses" by the light house mechanism.

Note that will get X-rays from poles when accreting even if the magnetic poles are aligned with the rotation axis, just won't get lighthouse "pulses" (unlike radio mechanism that requires tilted poles to radiate at all).

Figure 8.2

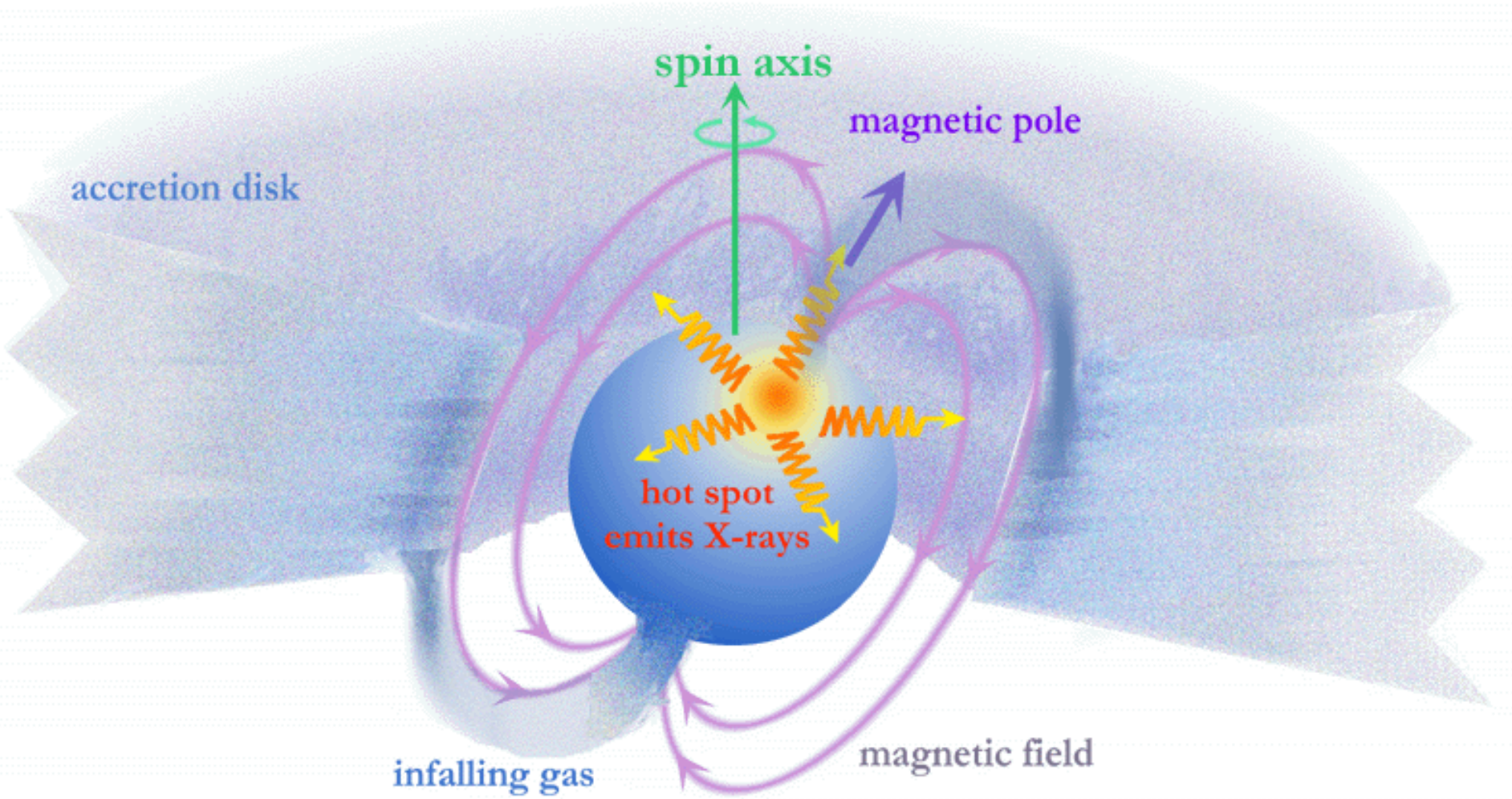


Some neutron stars are in binary systems. They accrete mass through an accretion disk and produce ***X-rays***. X-rays are produced even if the magnetic poles are aligned with the rotation axis, but do not get "pulses" from the light house effect.

Goal:

To understand how neutron stars are observed as X-ray “pulsars.”

Accretion onto *tilted* magnetic poles can give pulses of X-rays by "lighthouse" mechanism (or other "off-center" effect)



Neutron stars for Sky Watch

Single neutron stars: Geminga (Section 8.11) in Gemini

Gravitational radiation from pulsar in binary system - Aquila

X-ray pulsars, Her X-1 in Hercules, Cen X-4 in Centaurus