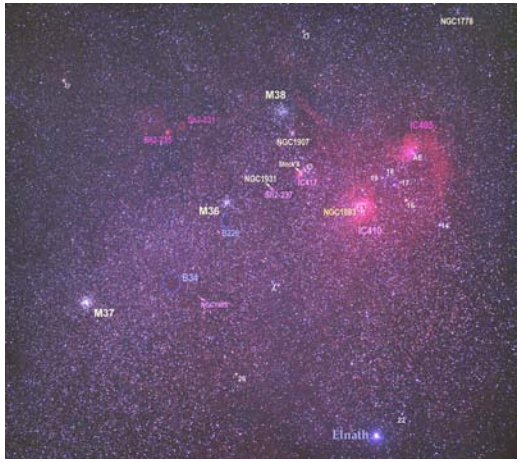
March 5, 2010

Sky watch returned.

Reading Chapter 7, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Astronomy in the News? China is scheduled to launch the first module of its manned space station, called Heavenly Palace, in 2011.

Pic of the Day - Galactic plane in Auriga



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 $\sim 2\ M_{\odot}$

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

Vast majority of about 2000 known neutron stars are alone in space.

$\sim$ 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.”

To radiate, radio pulsars must be ***magnetic***:

Wiggle magnetic field ⇒ wiggle electric field
⇒wiggle magnetic field ⇒ ***Electromagnetic radiation***

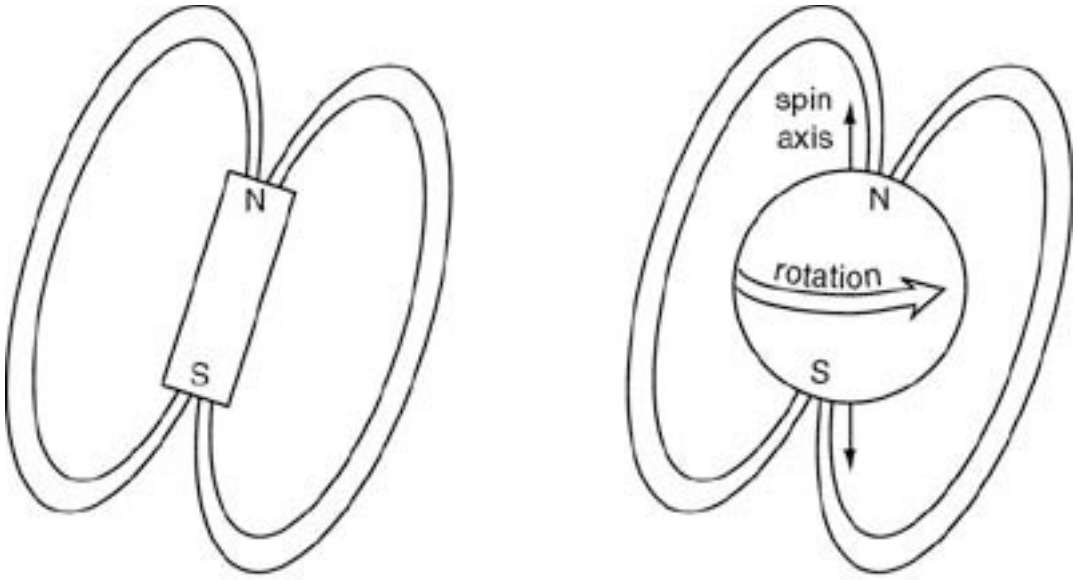
Simplest configuration North, South poles ***Dipole***
"lines of force" connecting poles

Magnetic axis must be ***tilted*** with respect to the rotation axis

If the magnetic axis is aligned with the rotation axis, the system is too symmetric to "wiggle"

Magnet, filings

Radio Pulsars are 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” at poles or “speed of light” cylinder

Speed of light cylinder - 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.

Poles: whip magnetic field around $\Rightarrow$ huge electric fields create huge currents, “thunderstorms” $\Rightarrow$ radio “static”

Radiation is beamed from magnetic poles, see “pulses” by “lighthouse” mechanism

Flashlights

New 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 have binary companions

Binaries special - use Kepler's laws to measure mass

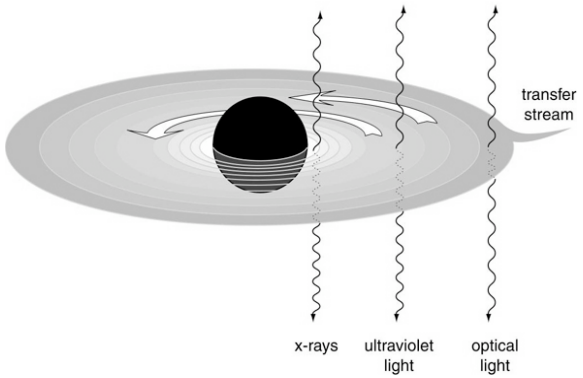
Orbital decay $\Rightarrow$ Gravitational Radiation - Nobel Prize 1993

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

With mass transfer ⇒ X-rays, another story

Some neutron stars ***are*** in binaries with mass transfer

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



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

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 to for this and related discoveries.

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

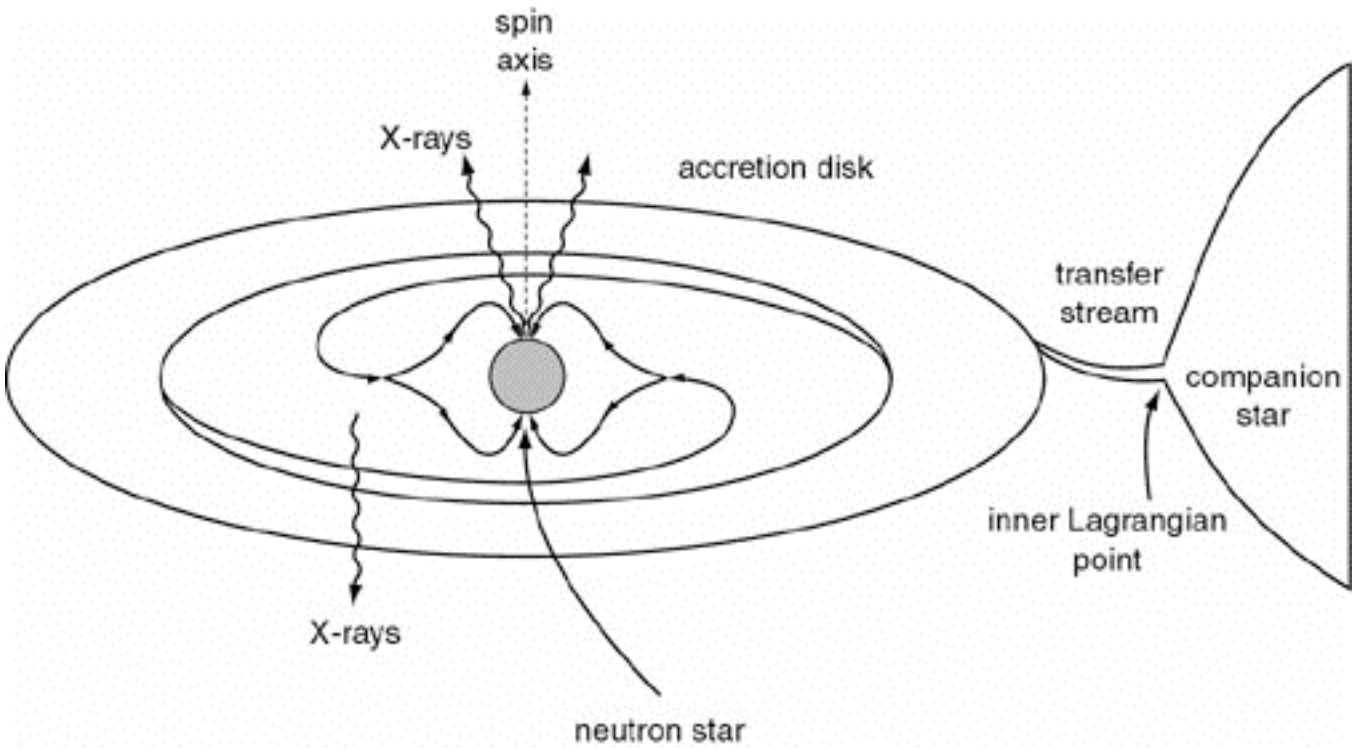
This process automatically channels matter to *magnetic* poles

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 not lighthouses "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***.