Friday, October 18, 2013

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

Third exam, Friday, October 25.

Third Skywatch: watch the weather!

Review sheet posted Monday.

Reading: Chapter 6, Section 6.7, Chapter 7, Superluminous Supernovae not in book, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Astronomy in the news?

NASA operating

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.

Nearest, undetected, may be only a light year or so away.

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 rotating and ***magnetic***:

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

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

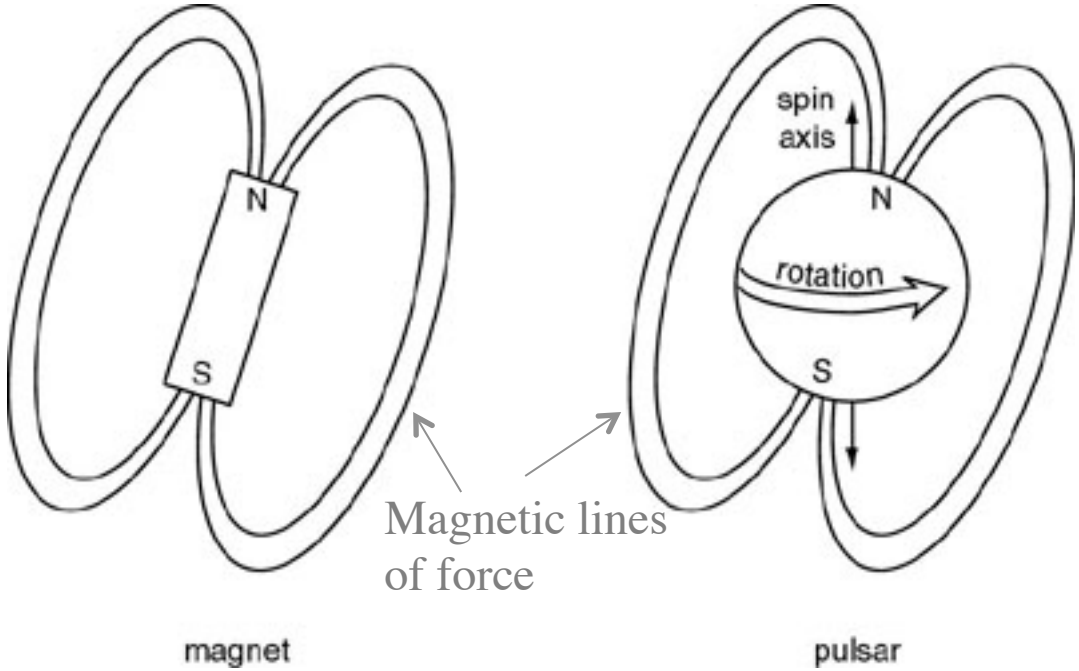
Ionized plasma can move along "lines of force," not across them. Lines of force drag the plasma around like beads on a wire.

If the plasma blobs are aligned with the rotation axis, the system is too symmetric to "wiggle."

If blobs of plasma are off-center from the rotation axis, they are whipped around by the rotating magnetic field and generate radiation. Magnet, filings

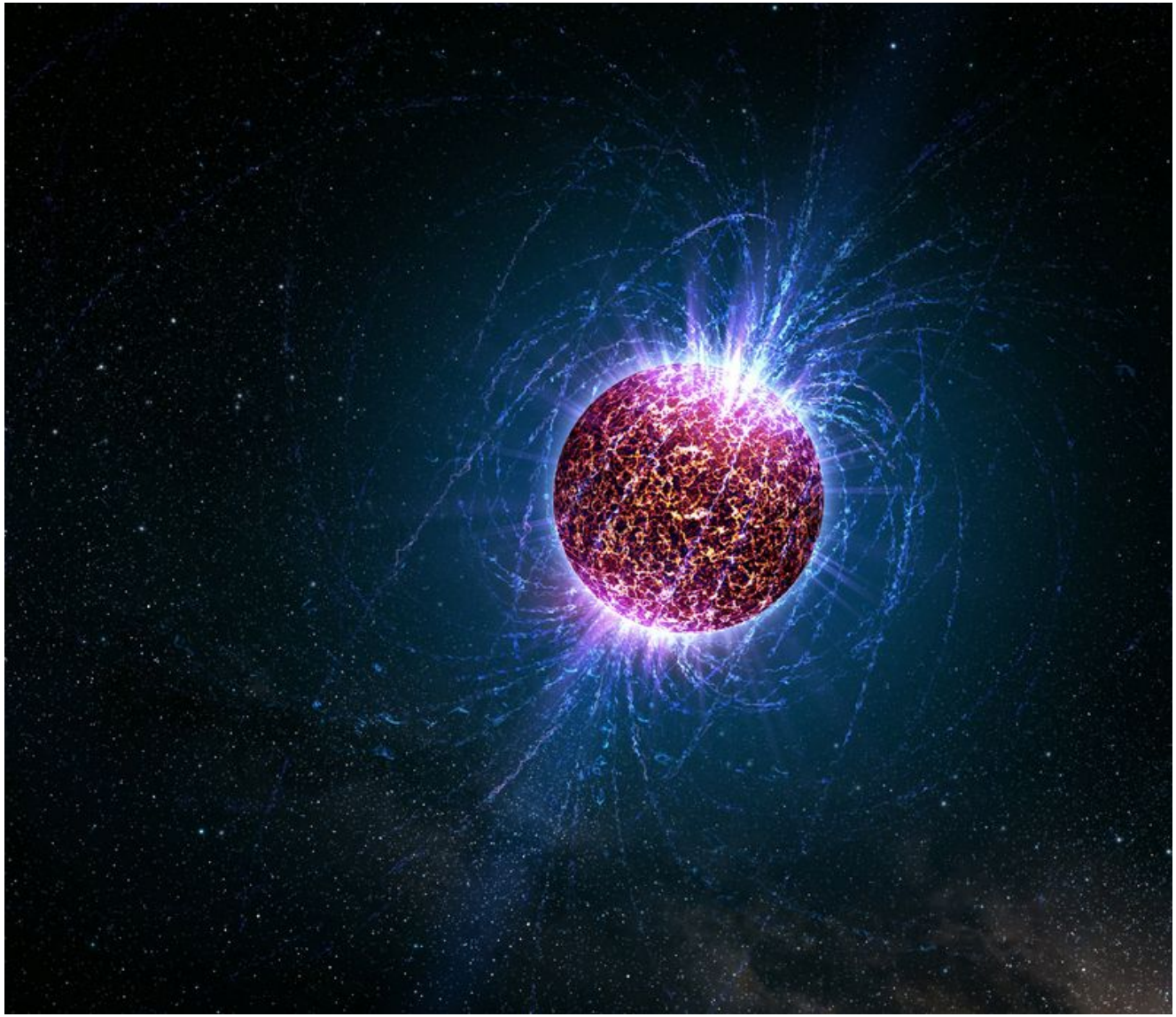
One possibility - field axis is tilted.

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

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

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

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