Wednesday, March 7, 2012

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

Third exam, Friday, March 23.

No lecture this Friday. I'll be here to answer questions on anything.

Astronomy in the news?

News:

Happy Birthday Kepler Satellite – 3 years old today

Tevatron at Fermilab has data complementary to Large Hadron Collider at CERN that Higgs Boson might have been found with a mass of 135 GeV (proton 1 GeV; electron 0.0005 Gev).

Higgs is the long-predicted particle (and associated field) that is supposed to give particles their mass.

Goal:

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

Pulsars were discovered in 1968 as rhythmic “pulses” of radio radiation with periods from a fraction of a second to a second.

Notion at first that might be sign of extraterrestrial civilization, but quickly proved to be natural, but not from any “nomal” star, from neutron stars.

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.

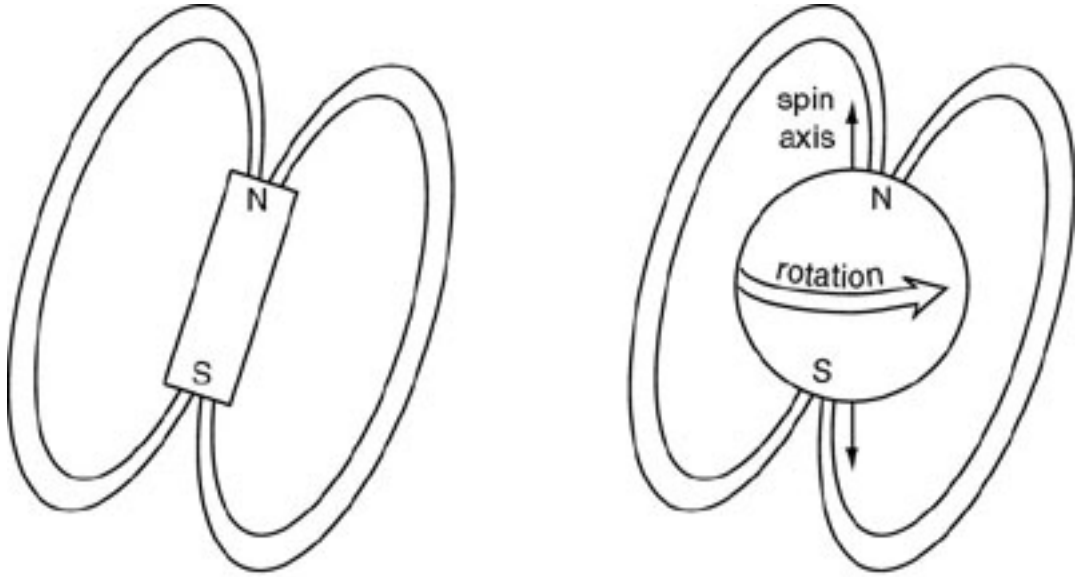
Ionized plasma can move along "lines of force," not across them. Lines of force drag the plasma around like beads on a wire.

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

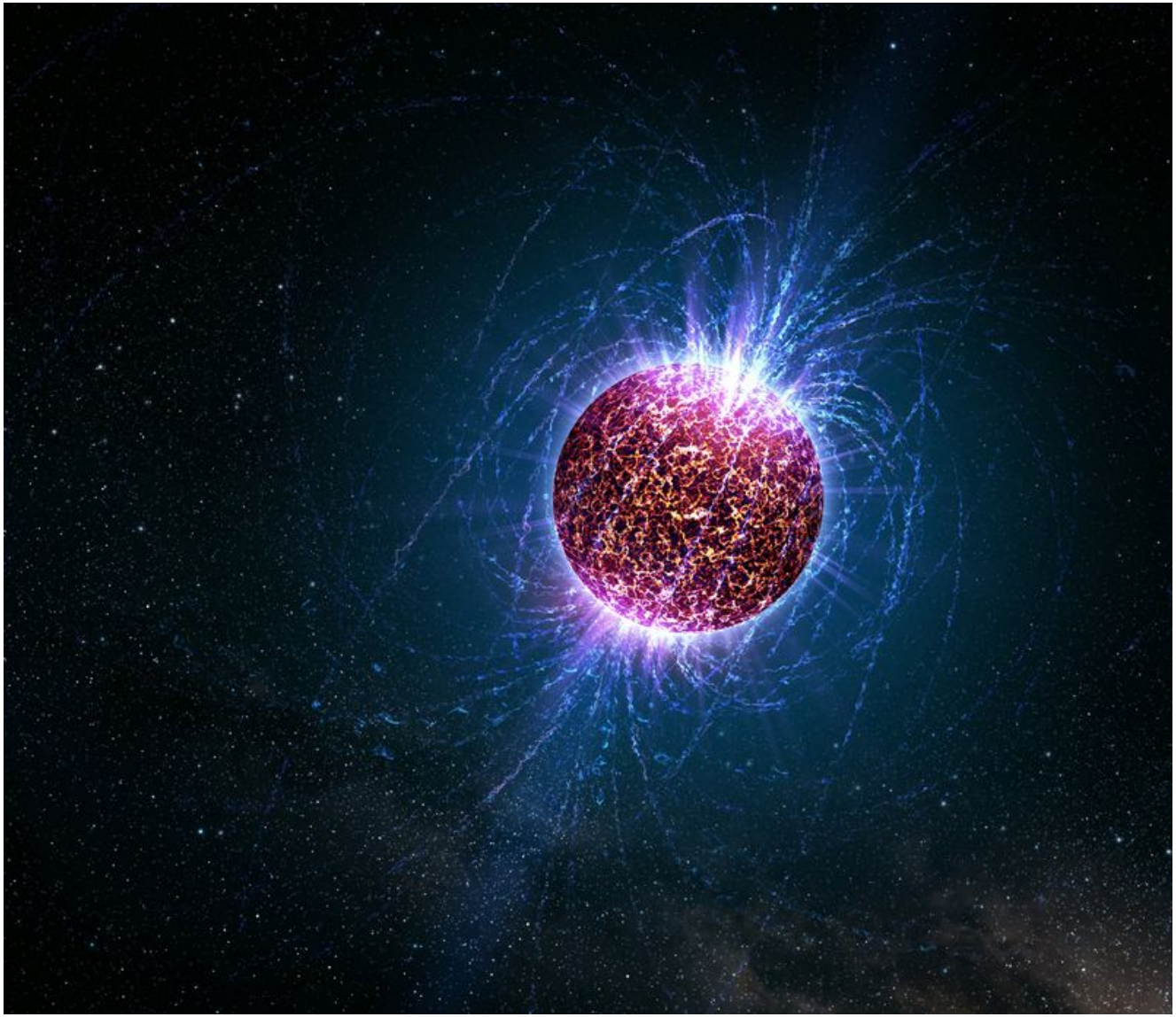
One possibility - field axis is tilted.

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, proof that neutron star involved.

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” cylinder

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

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.

In either case, radiation is produced steadily from off-center blobs of plasma, 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

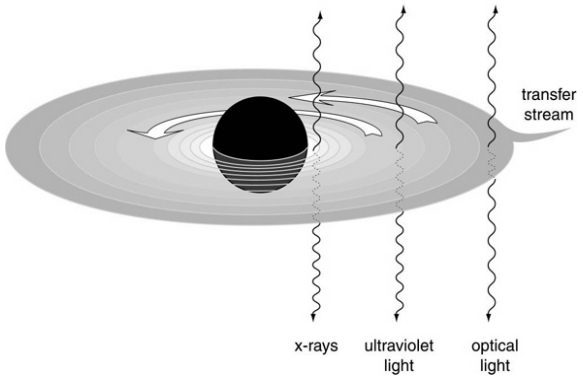
Orbital decay $\Rightarrow$ Gravitational Radiation - Nobel Prize 1993

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 ⇒ X-rays, another story

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 for this and related discoveries.