March 9, 2011

Exams back, key posted

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

Astronomy in the news? Space Shuttle Discovery on its way back to Earth for last time, huge competition by museums to acquire the three operating shuttles as they retire.

Decadal Survey for Planetary Astronomy – first priority a Mars sample return mission, second a mission to Europa, both may host life. Budget?

**Glory** satellite, a remote-sensing Earth-orbiting observatory designed to collect data on aerosols and solar irradiance for the long-term climate record, failed to reach orbit on March 4.

Pic of the day: the International Space Station.

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.

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

~ 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

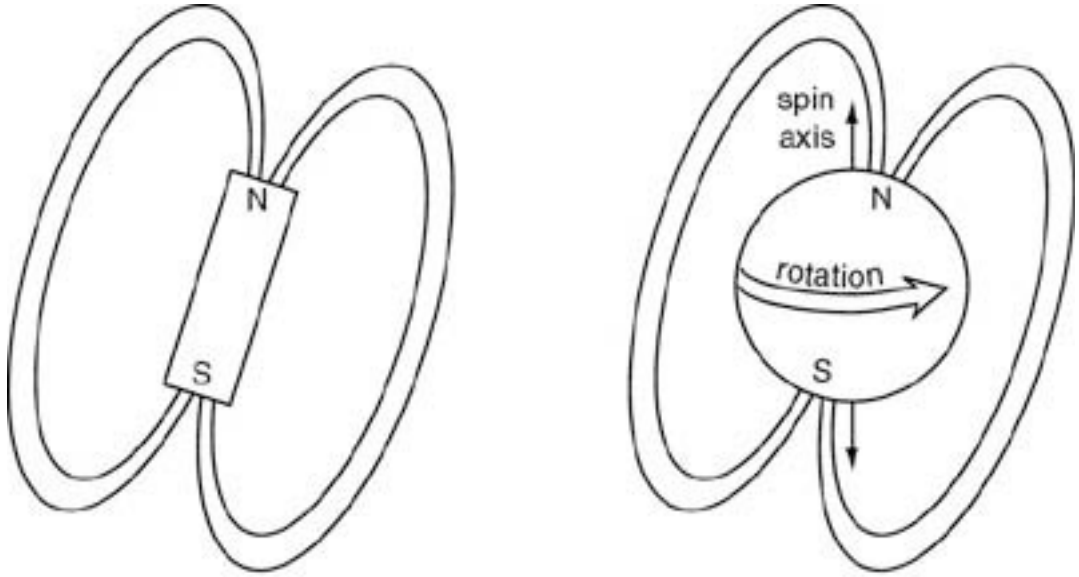
Ionized plasma can move along "lines of force," not across them. Lines of force drag the plasma around like beads on a wire.

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

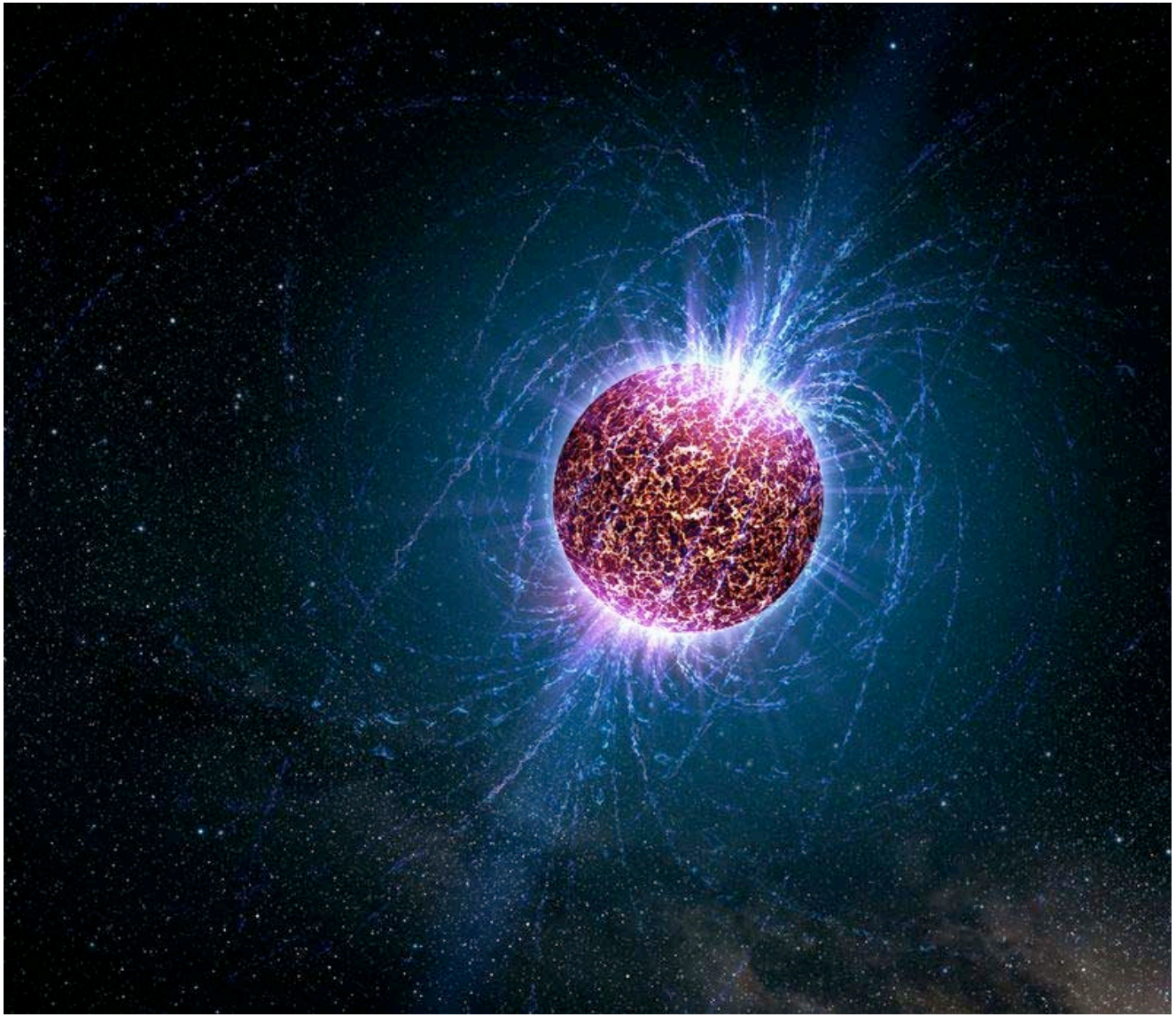
One possibility - field axis is tilted.

***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.



If anyone finds this image on the web, please let me know so I can credit it.

Radio emission from “sparks” “thunderstorms,” blobs of plasma, perhaps at titled 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.

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

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