

10/15/07

## Exam 2, Chapters 6, 7, **This Friday**

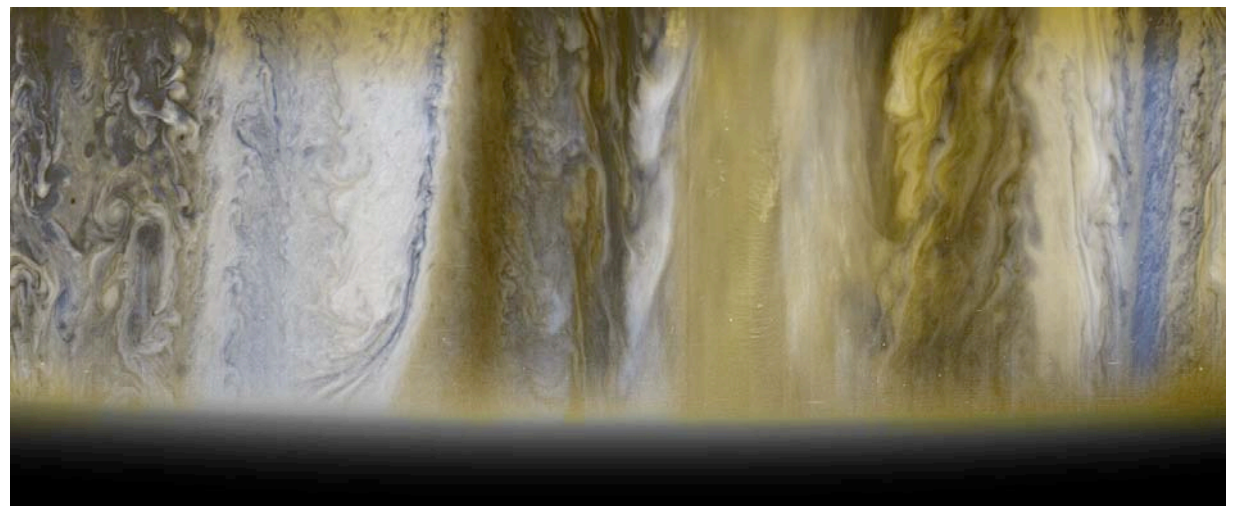
Review sheet posted this afternoon

Review session **Thursday** 5 PM RLM 4.102 [NOTE different room than help sessions].

Net Sky Watch report due on Monday

Astronomy in the News -

Pic of the day -  
Jupiter from New  
Horizons Pluto  
mission



Start of material for Test 3

Chapter 8, Neutron Stars

## NEUTRON STARS (Chapter 8)

mass of Sun

radius  $\sim 10$  km, size of a city

density like atomic nucleus (even a few times more!)

gravity at surface huge - crush human

highest “mountain”  $\sim 1$  foot

Pulsars - rotating magnetic neutron stars

~600 radio pulsars known

“active” for ~1-10 million years, then magnetic field decays or aligns → *no radiation*

Probably ~ billion “inactive” neutron stars ~1% of all stars in the galaxy

To radiate, pulsars must be magnetic:

Wiggle magnetic field  $\Rightarrow$  wiggle electric field

$\Rightarrow$  wiggle magnetic field  $\Rightarrow$  *Electromagnetic radiation*

Simplest configuration North, South poles *Dipole*

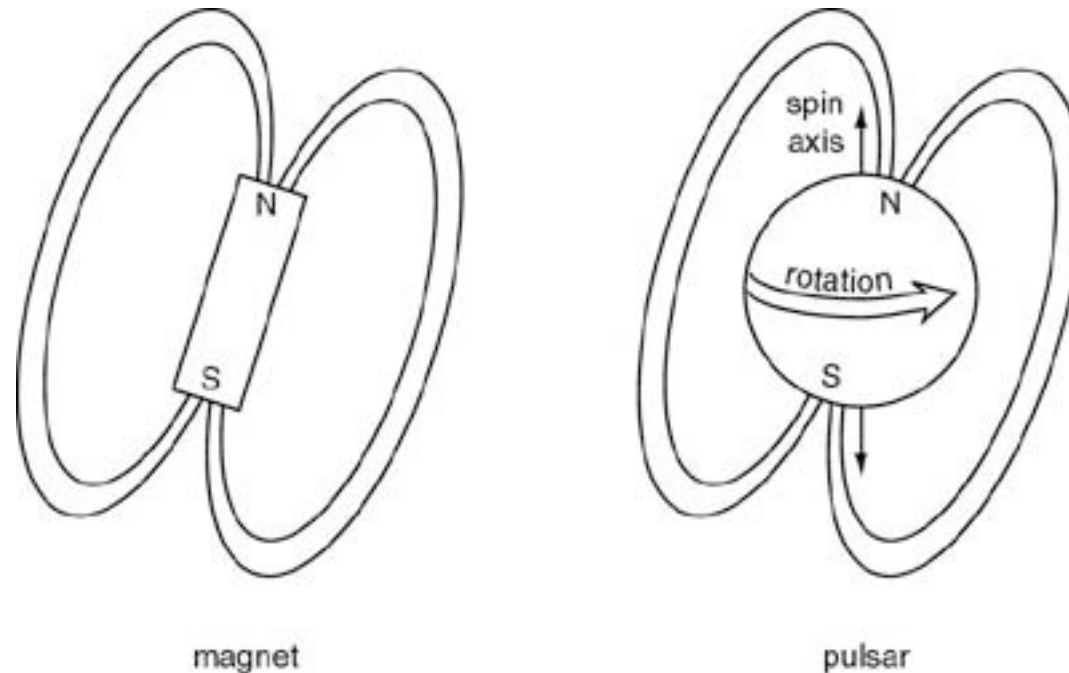
“lines of force” connecting poles

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

***Pulsars*** are rotating, magnetic neutron stars with magnetic axis tilted with respect to spin axis.



Most 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

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

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  $\sim 2 M_{\odot}$

Vast majority of 600 pulsars are alone in space  
 $\sim$  dozen have binary companions

Binaries special - use Kepler's laws to measure mass  
orbital decay  $\Rightarrow$  Gravitational Radiation - Nobel Prize 1993

Recent discovery 2 radio pulsars in eclipsing binary system, fascinating new laboratory, extra information from eclipses.

Binary radio pulsars - no mass transfer, would kill radio mechanism.  
With mass transfer  $\Rightarrow$  X-rays, another story



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

Other NS 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.

For strong magnetic field matter connects to, flows *along* lines of force

(can't flow across field lines of force)

Automatically channels matter to poles - hot X-rays (kills radio)

Rotation gives X-ray "pulses" by light house mechanism.

Nobel prize in 2002 to for this and related discoveries.