Tuesday, October 20, 2009

Exams back. Key posted. Histogram of grades. Exams, Sky Watch, IYA explicitly posted.

Astronomy in the News? Wheeler at Stanford over the weekend for festschrift, Astronomy meeting by/for postdocs, going on Monday/Tuesday. Next week Cosmology meeting, guest public speaker Rashid Sunyaev.

Pic of the Day - huge solar prominance: magnetic fields in action



Reading

Chapter 8

Sections 8.1, 8.2, 8.5, 8.6, 8.7, 8.10

To radiate, radio 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

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.



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 1200 known radio (and gamma-ray) pulsars are alone in space

~ dozen have binary companions

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

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

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

With mass transfer \Rightarrow 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).



Some neutron stars are in binary systems, they accrete mass through an accretion disk and produce *X-rays*.

Accretion onto *tilted* magnetic poles can give pulses of X-rays by "lighthouse" mechanism



<u>X-ray Transients</u> - flare every few years for a month or so: suspect *disk instability* like *dwarf novae*, but neutron star, not white dwarf.

X-ray Bursters - rise in about a second, decay in a minute, no "pulses," suspect low magnetic fields, Repeat in hours to months.
Analog of *classical novae*, thermonuclear burning on surface of neutron star not white dwarf
H is *thermally supported* - regulated burning H → He
He, high density, *quantum pressure* - unregulated → *flash!*little matter expelled because of high gravity

One Case Both Phenomena

