2/27/08

Exam 2, Chapters 6, 7, This Friday

Review sheet posted

Review session tomorrow, Thursday 5 PM RLM 15.216B

Next Sky Watch report due on Monday

Astronomy in the News -

Pic of the day - Eagle nebular, star formation



Start of material for Test 3

Chapter 8, Neutron Stars

Reading

Chapter 8

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

NEUTRON STARS (Chapter 8)

mass of Sun

radius ~ 10 km, size of a city

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

gravity at surface huge - crush human highest "mountain" ~ 1 foot Pulsars - rotating magnetic neutron stars

~1200 radio pulsars known "active" for ~1-10 million years, then magnetic field decays or aligns → no radiation

Probably ~ billion "inactive" neutron stars $\sim 1\%$ 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.



magnet

pulsar

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 1200 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

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.



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