10/6/04

Second Exam - Chapters 6, 7, this Friday, October 8

Review sheet posted

Office hours today, 2 PM

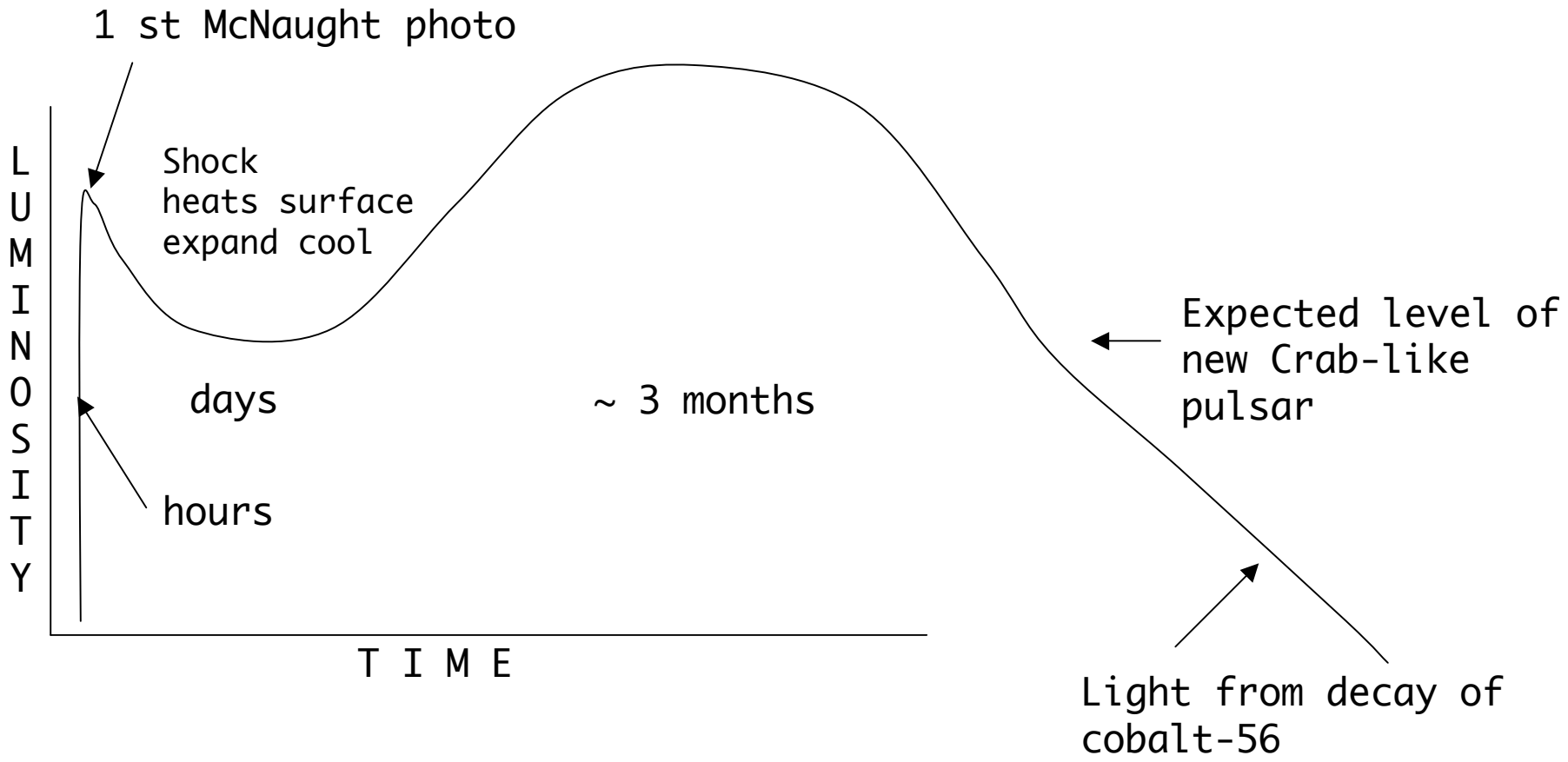
Review Session Tonight, 5 PM RLM 15.216B

Wheeler on travel next Monday, Wednesday - movie

News? Nobel Prize for Physics - how quarks are glued together to make protons and neutrons

Pic of the day

Star formation, nebula

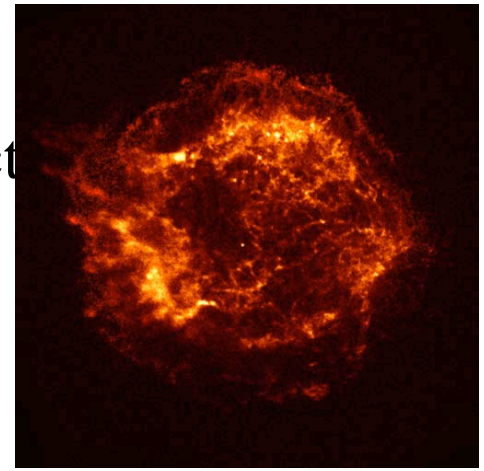


SN 1987A had a rather peculiar light curve because it was a relatively compact ***blue supergiant***, not a red supergiant, brief shock heating, rapid cooling by expansion, no plateau, ***subsequent light all from radioactive decay***

Neutrinos from SN 1987A proved a neutron star formed and lasted for at least 10 seconds while neutrinos were detected - where is it?

Expected to see it in ~ 1 year - still looking 17 years later

Any neutron star is dimmer by at least a factor of 10 than 1000 year-old Crab pulsar

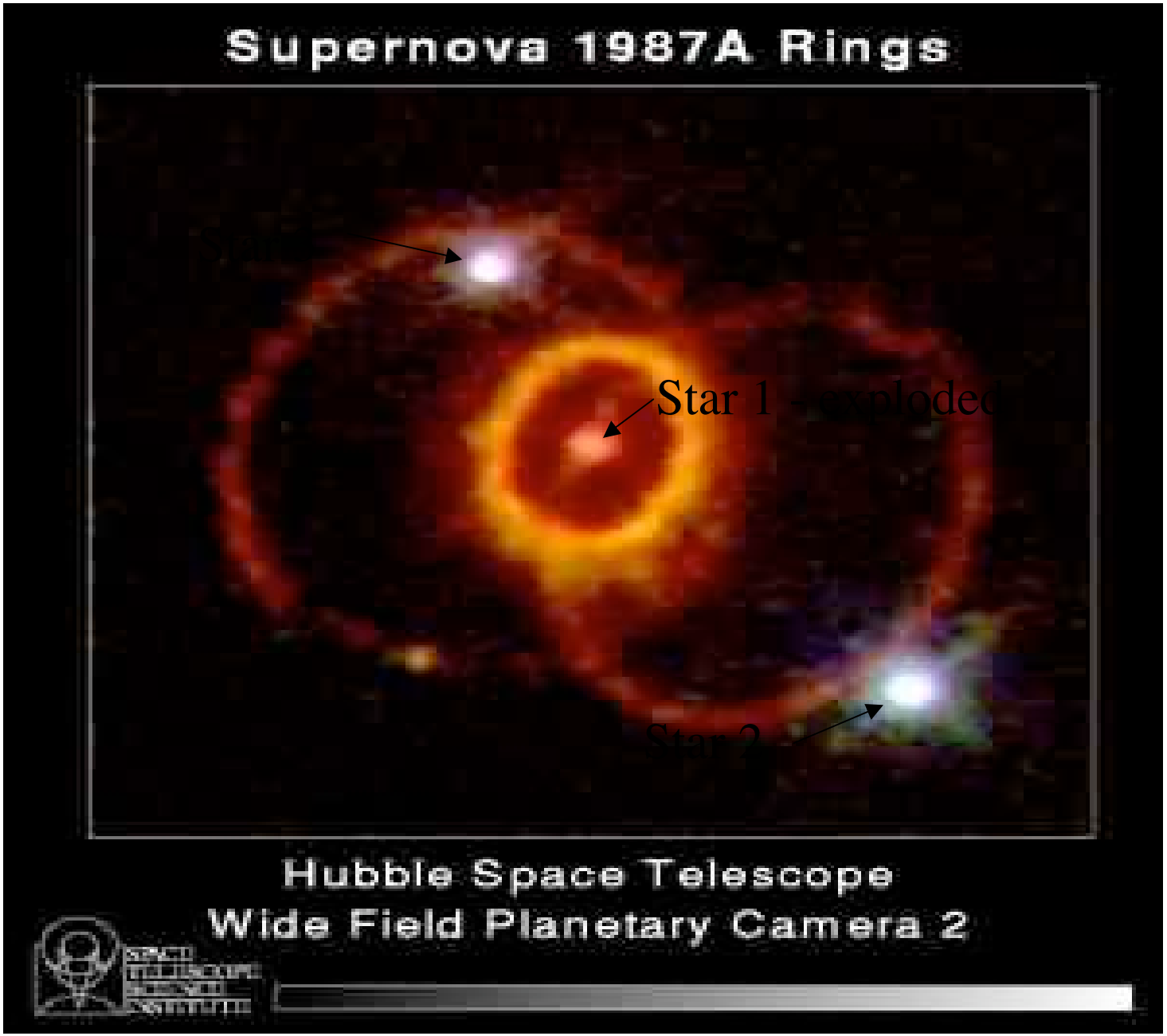


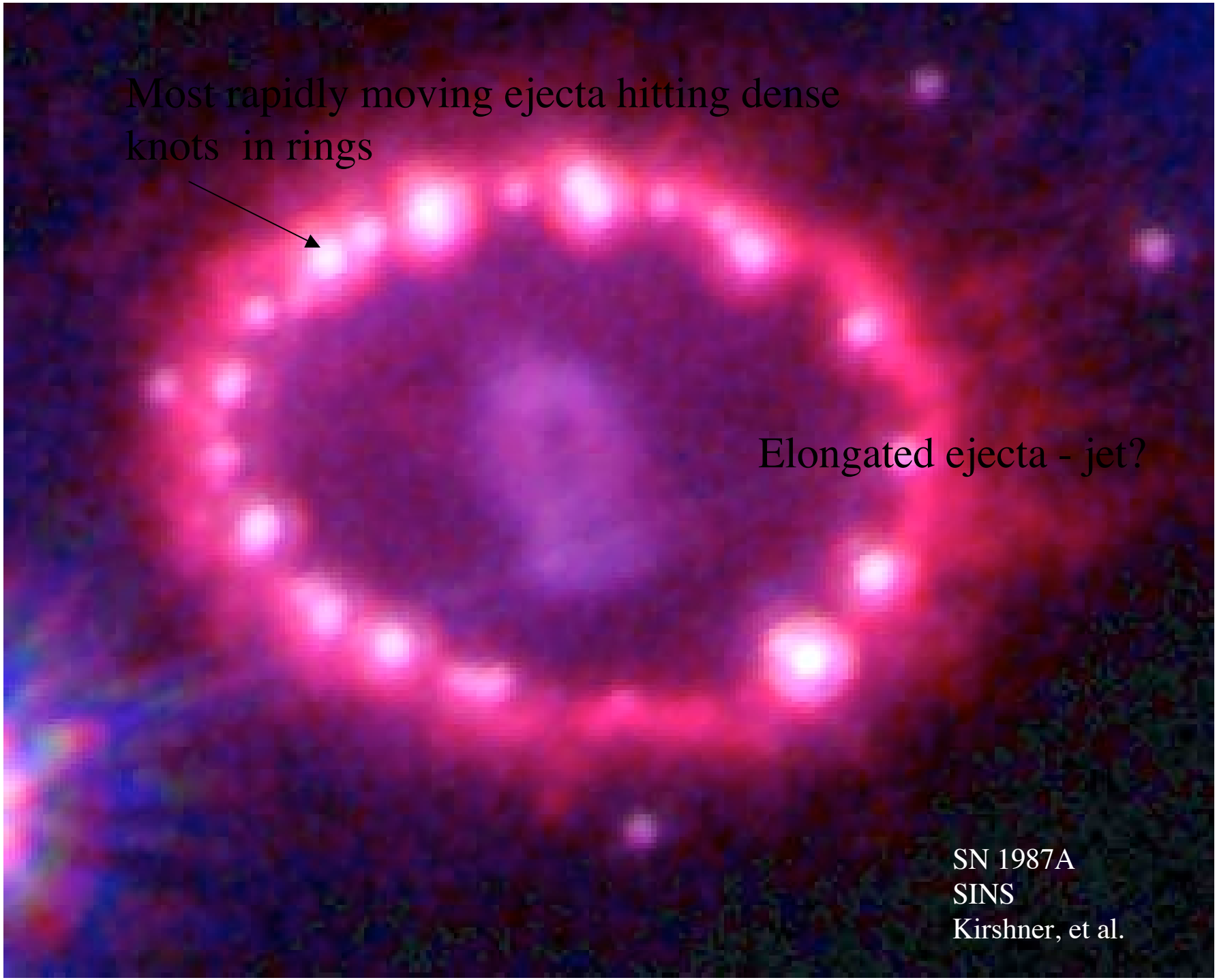
If similar to object in Cas A, much too dim to detect

100 to 1000 × dimmer than Crab pulsar

Possibly black hole, not neutron star??
Don't know. Can't rule out.

Neutron star could be "hidden," or a slow rotator, or with a weak magnetic field, but counter to notion of jet - some evidence for jet


Supernova 1987A Rings
Star 1 - exploded
Star 2
Hubble Space Telescope
Wide Field Planetary Camera 2


Most rapidly moving ejecta hitting dense knots in rings
Elongated ejecta - jet?
SN 1987A
SINS
Kirshner, et al.

Doppler shifts - motion away - Redshift
motion toward - Blue shift

Ring closer edge on top
jet should be moving *away on top,* but measured blue shift

Puzzle - then realized images show "jet" brightened by radioactive decay

Spectrum to get Doppler shift with Hubble Space Telescope examined Calcium, but Calcium is expected to be in the torus (bagel) - top *should be* moving toward us

Consistent with jet-induced picture

End of material on exam 2

NEUTRON STARS (Chapter 8)

mass of Sun

radius ~ 10 km

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

gravity at surface huge - crush human
highest “mountain” ~ 1 foot

Pulsars - rotating magnetic neutron stars

~600 radio pulsars known

"active" for ~1-10 million years, then magnetic field decays or aligns $\rightarrow$ *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***

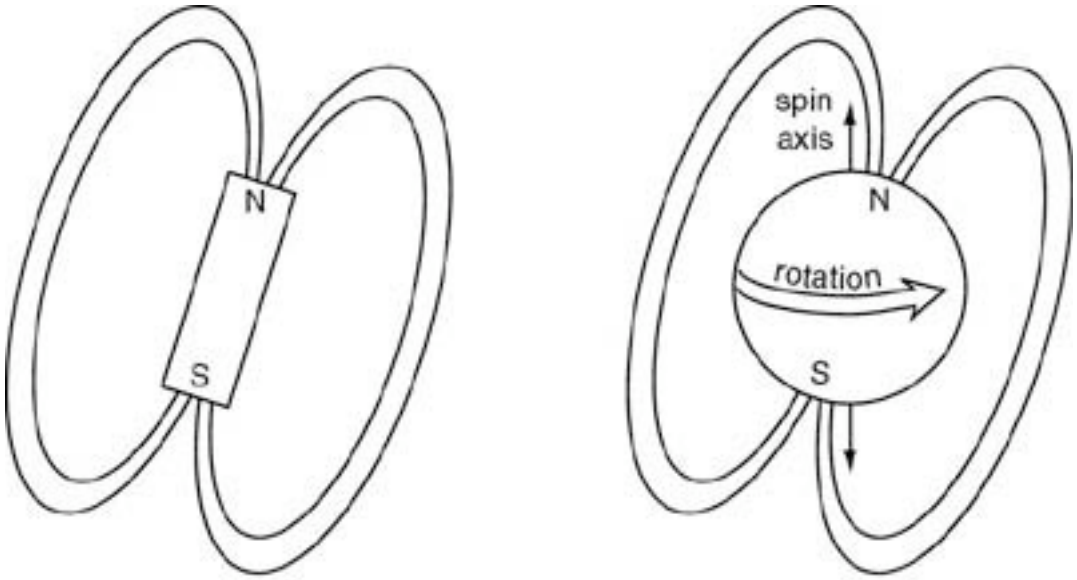
"lines of force" connecting poles

Magnetic axis must be tilted

If aligned, system is too symmetric to "wiggle"

Magnet, filings

Figure 8.1



magnet pulsar

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

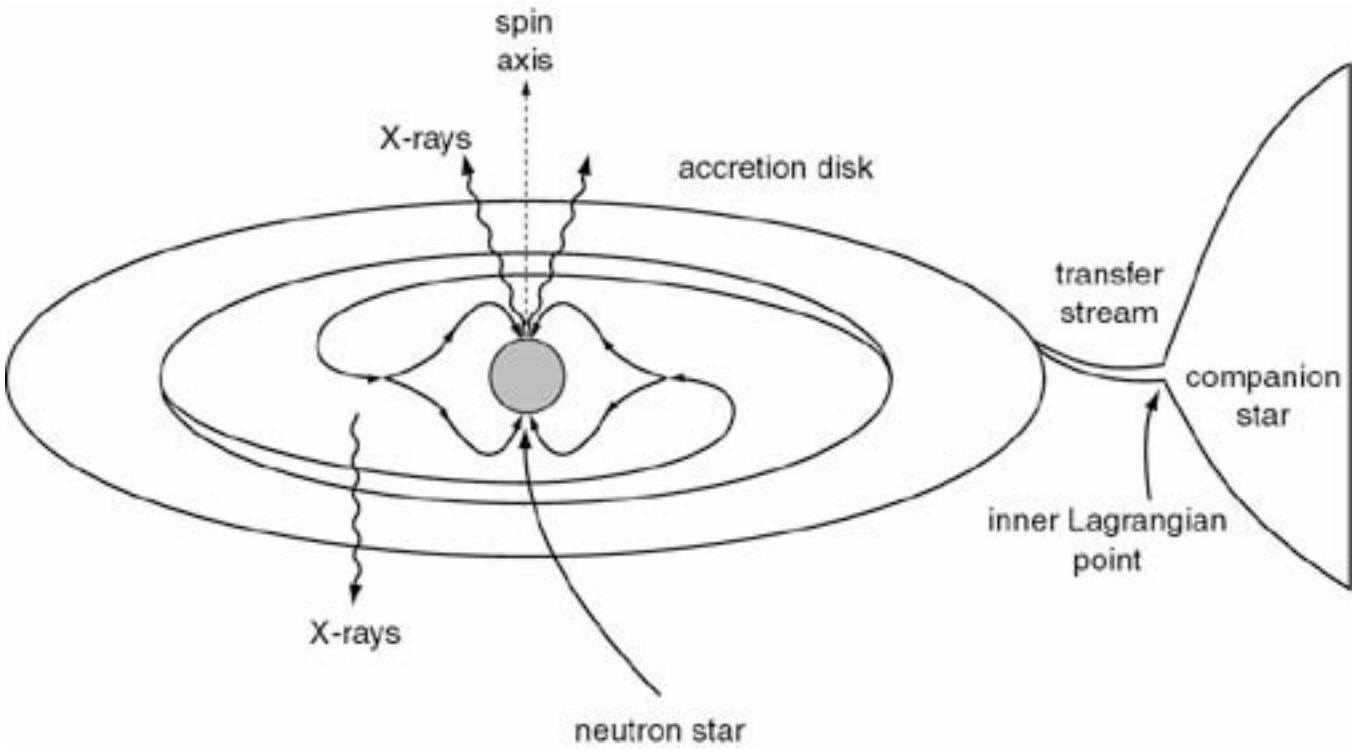
Radio emission from “sparks” “thunderstorms” at poles or “speed of light” cylinder

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~~

Figure 8.2



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

X-ray Transients - 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 ~ second, decay in a minute, suspect low magnetic fields, no "pulses"

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, high gravity

One Case
Both Phenomena