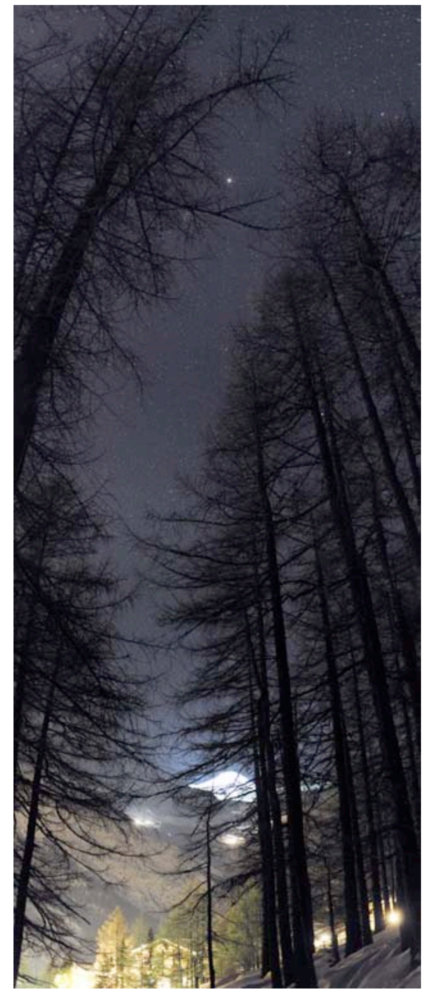
March 8, 2010

Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Astronomy in the News? Meeting here in Austin, on First Stars and First Galaxies, topics of later in the class, convocation of world-wide experts.

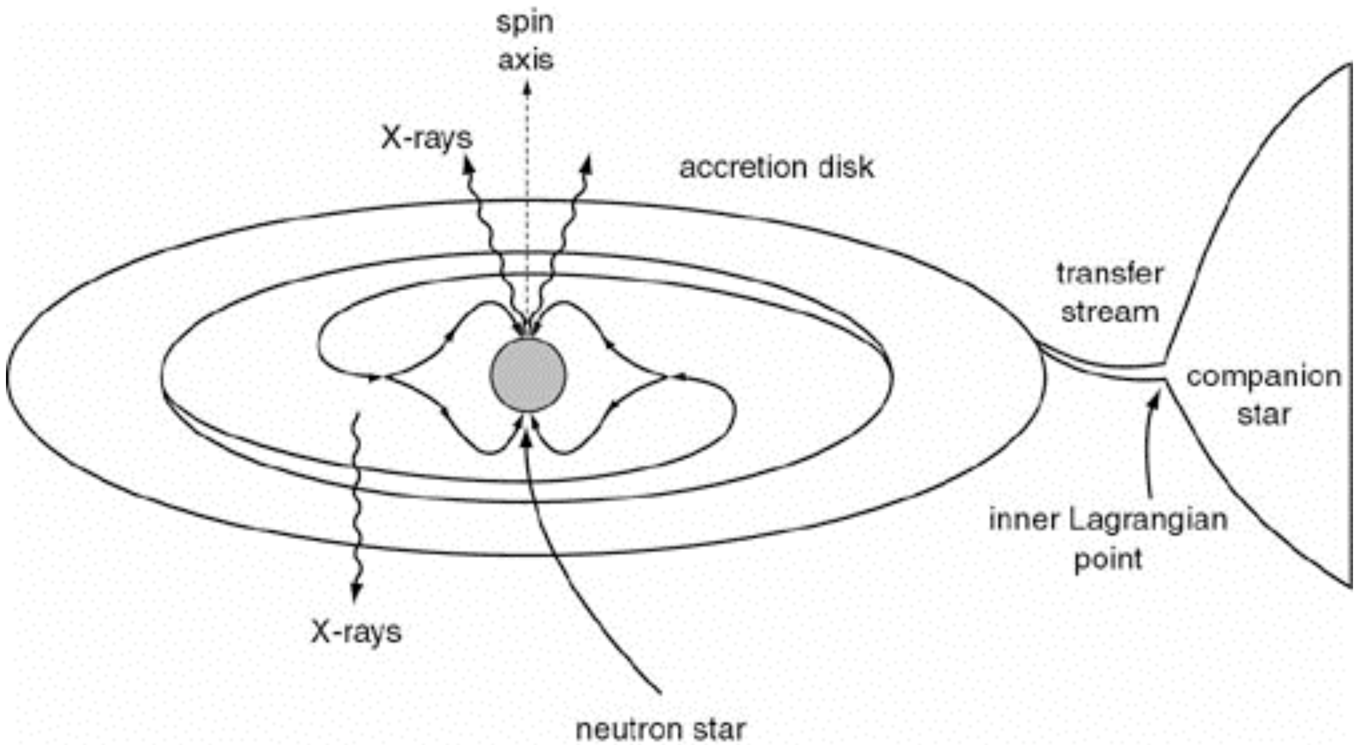
Pic of the Day - Mars over the Alps



Goal:

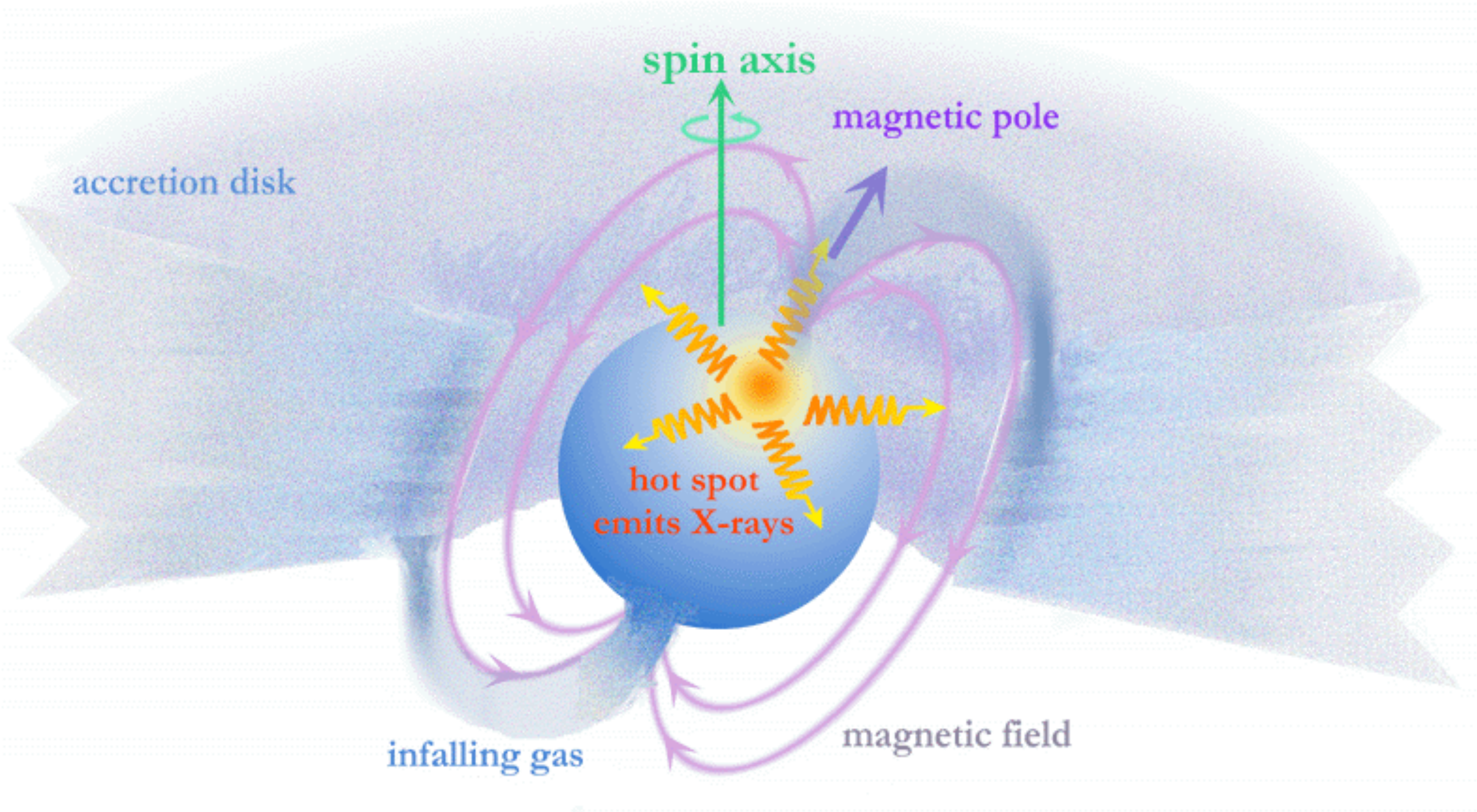
To understand how neutron stars are observed as X-ray "pulsars."

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



Neutron stars for Sky Watch

Single neutron stars Geminga (Section 8.11) in Gemini

Gravitational radiation from pulsar in binary system - Aquila

X-ray pulsars, Her X-1 in Hercules, Cen X-4 in Centaurus

Goal:

To understand the nature of neutron stars with exceptionally large magnetic fields.

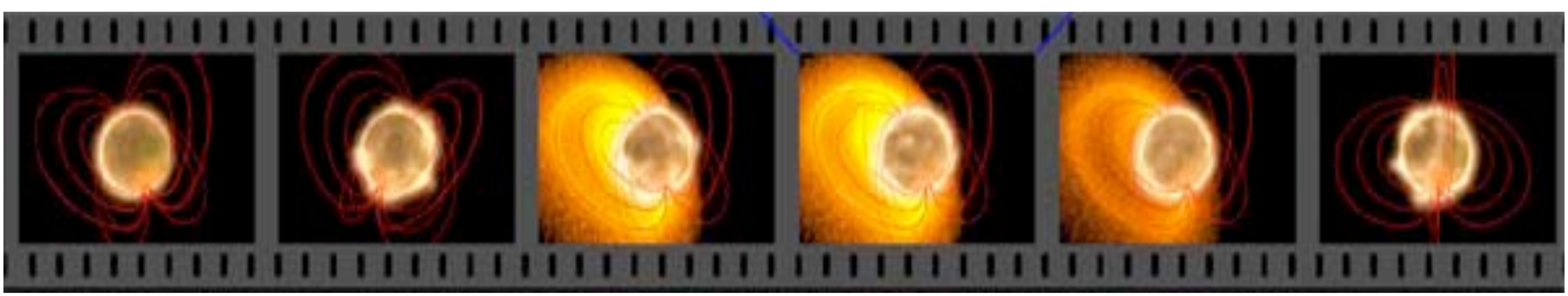
<u>Soft Gamma Ray Repeaters</u> - 4 known

One flared in the Large Magellanic Cloud galaxy, energy arrived in March 5, 1979.

Another flared in our Galaxy, energy arrived August 27, 1998, caused aurorae from 1000's of light years away.

Yet another flared in our Galaxy with energy arriving December 27, 2004, from the far side of the Galactic center, perhaps 10's of 1000's of light years away, brightest release of energy ever seen in the Galaxy, 100 times more powerful than August 1998 burst.

Magnetic eruption in neutron star [not necessarily in binary system.]



Theory - break patch of iron-like “crust” of neutron star, convert magnetic energy to heat (1998 burst) or completely rearrange magnetic field configuration (2004 burst).

Require “wiggling” of very strong magnetic fields, 100 × Crab pulsar

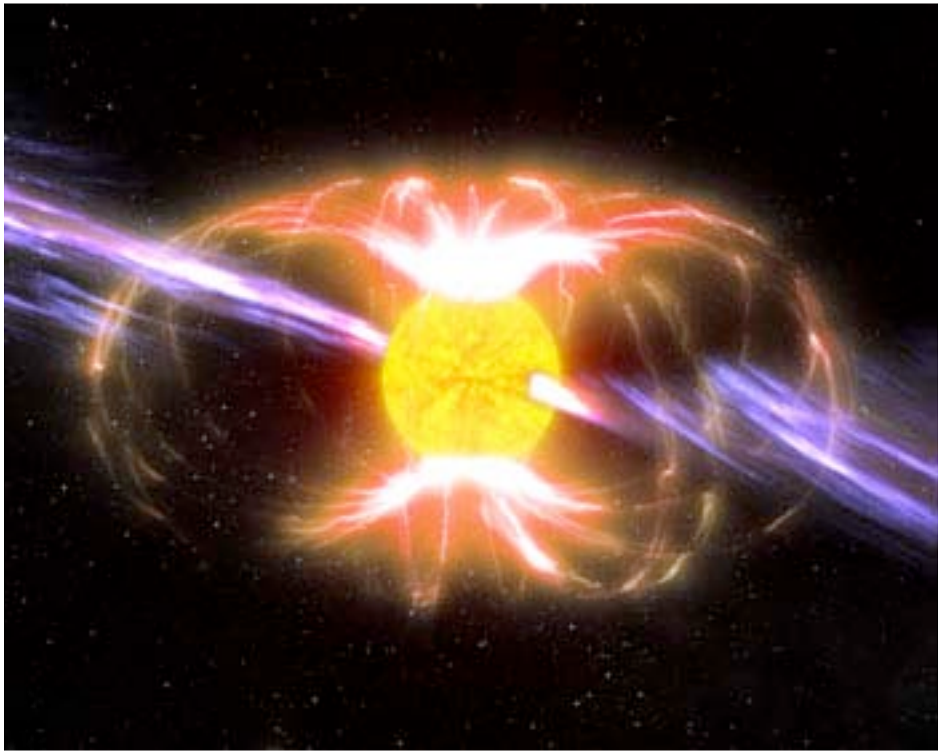
⇒ ***Magnetar*** - very highly magnetic pulsar.

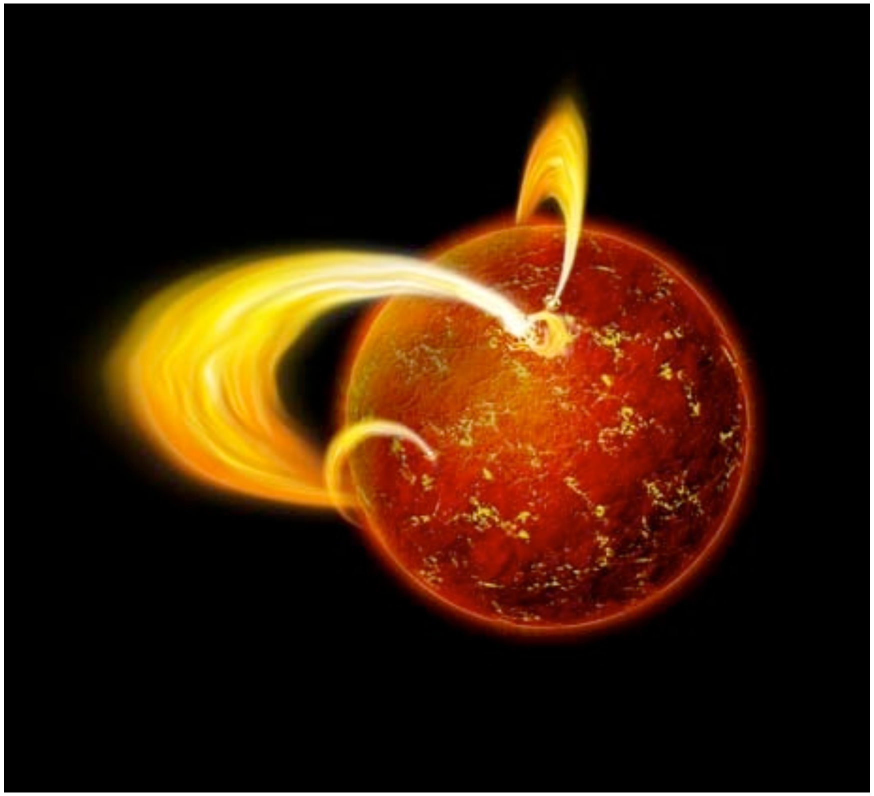
Origin of magnetars compared to normal pulsars not yet known.

Formation might be related to hypernovae or Gamma-ray bursts (Chapter 11).

X-ray, Gamma-ray satellites should see many of these brightest bursts (December 27) in distant galaxies.

Magnetars!





Skywatch Extra Credit Targets
constellations only, not all visible

Magnetar Candidates

Name	Location	Rotation (seconds)	Year Discovered
SGR 0526-66	Large Magellanic Cloud	8.0	1979
SGR 1900+14	Aquila	5.16	1979
SGR 1806-20	Sagittarius	7.56	1979
SGR 1801-23	Sagittarius	-	1997
SGR 1627-41	Ara	6.4	1998
AXP 1E 2259+586	Cassiopeia	7.0	1981
AXP 1E1048.1-5937	Carina	6.4	1985
AXP 4U 0142+61	Cassiopeia	8.7	1993
AXP 1RXS J170849-400910	Scorpius	11.0	1997
AXP 1E 1841-045	Scutum	11.8	1997
AXP AX J1844-0258	Aquila	7.0	1998
AXP CXOU J010043.1-721134	Small Magellanic Cloud	8.0	2002
AXP XTE J1810-197	Sagittarius	5.5	2003
AXP CXO J164710.2-455216	Ara	10.6	2005

One Minute Exam

Which statement is most relevant to making a radio pulsar?

➡ A solitary neutron star rotates with a tilted magnetic field.

⬅ A neutron star with an unstable accretion disk accretes matter from a binary companion.

⬆ A neutron star with a tilted magnetic field accretes matter from a binary companion.

⬇ A neutron star has a magnetic field 100 times stronger than the pulsar in the Crab nebula.

One Minute Exam

Which statement is most relevant to making an X-ray pulsar?

- ➡ A solitary neutron star rotates with a tilted magnetic field.
- ⬅ A neutron star with an unstable accretion disk accretes matter from a binary companion.
- ⬆ A neutron star with a tilted magnetic field accretes matter from a binary companion.
- ⬇ A neutron star has a magnetic field 100 times stronger than the pulsar in the Crab nebula.

One Minute Exam

Which statement is most relevant to making a soft gamma-ray repeater outburst?

- → A solitary neutron star rotates with a tilted magnetic field.
- ← A neutron star with an unstable accretion disk accretes matter from a binary companion.
- ↑ A neutron star accretes a layer of helium supported by quantum pressure.
- ↓ A neutron star has a magnetic field 100 times stronger than the pulsar in the Crab nebula.

New Topic: Black Holes

Chapter 9

What do you know about them -- When did you learn?

Reading, Chapter 9: all except 9.6.3, 9.6.4

Goal:

To understand the historical roots and basic theoretical concepts behind black holes and the huge conceptual differences between Newton's and Einstein's view of gravity.

Black Holes

Mitchell, Laplace, late 18th Century: with Newton's Gravity
could have escape velocity greater than the speed of light =>
light could not get out, completely dark, *corps obscurs*.

Now know Newton was wrong. (Historical note on Kowa Seki)

Excellent approximation for weak gravity - "true" in that case

Conceptual problems $F = \frac{G M_1 M_2}{r^2}$

infinite force for zero separation (in physics infinity
⇒ problem)

instantaneous reaction => infinite speed of gravity

Experiment - wrong deflection of light.

Need Einstein and more!