October 15, 2010

Reading Chapter 7, Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10, Chapter 9: all except 9.6.3, 9.6.4, (9.1 – 9.5.1 on third exam)

Exam 3 Friday, October 22. Review Sheet Monday, review Thursday

Astronomy in the News?

Pic of the Day – star-forming region in Monoceros in the infrared

Goal:

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

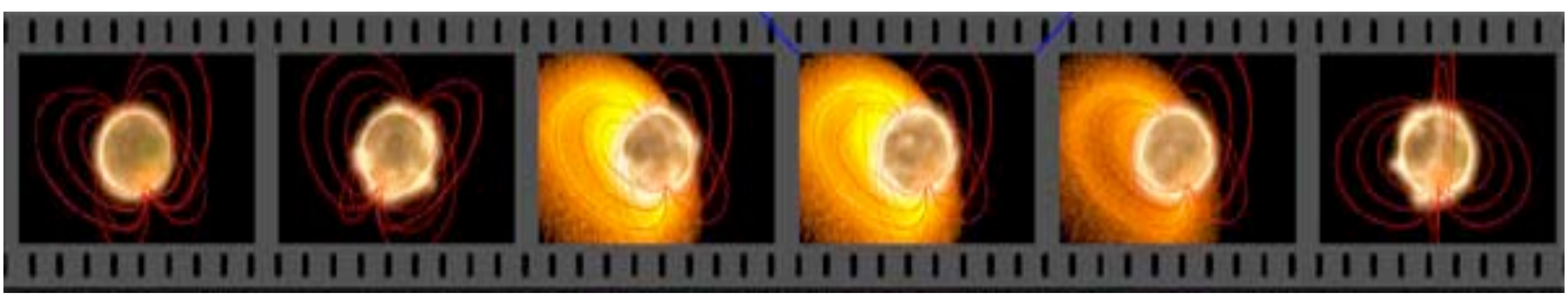
Soft Gamma Ray Repeaters - 6 known

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

$\Rightarrow$ ***Magnetar*** - very highly magnetic pulsar.

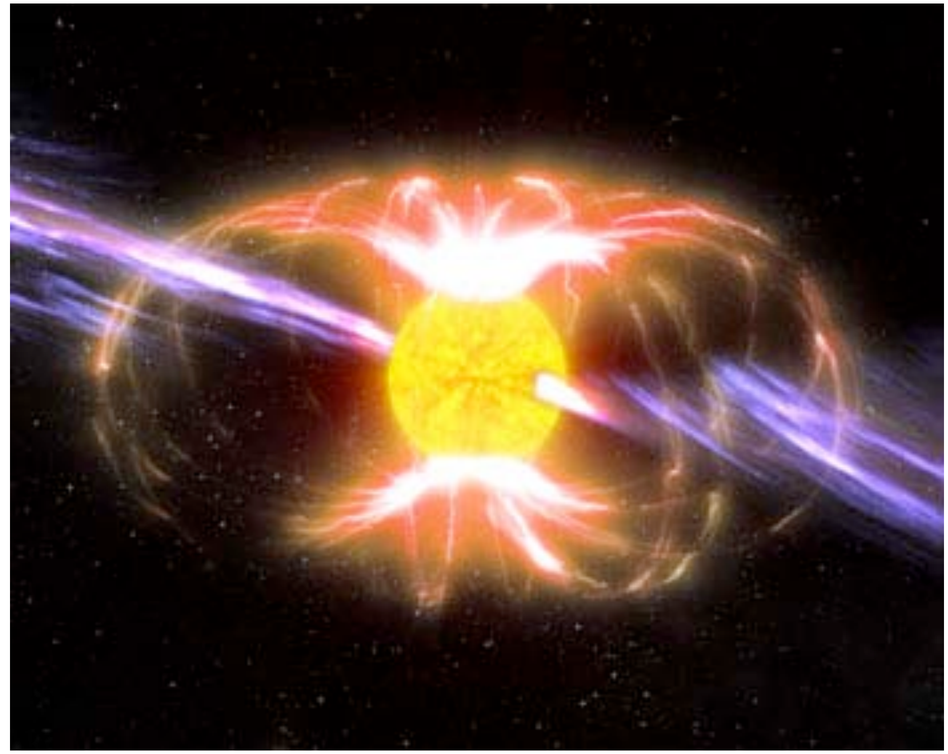
Anomalous X-ray Pulsars (AXP) also require very large magnetic field, but have not been seen to burst, maybe old magnetars.

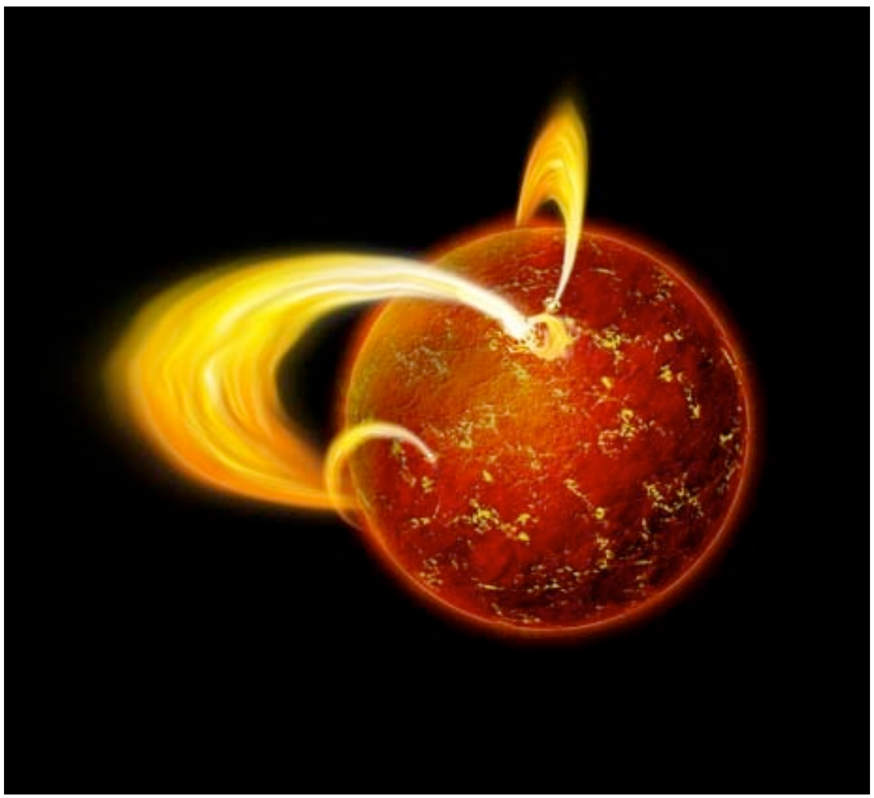
Origin of magnetars compared to “normal” pulsars not yet known.

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

X-ray, Gamma-ray satellites should see many of these brightest bursts (December 27, 2004) in distant galaxies.

Magnetars!





New Soft Gamma-ray repeater outburst, March, 2010, SGR 1833--0832, in direction of Sagittarius, center of Milky Way, is a magnetar with a "pulsar" spin period of 7.56 seconds.

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 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 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 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.

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

(9.1 – 9.5.1 on third exam)

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.

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 $\Rightarrow$ problem)

instantaneous reaction => infinite speed of gravity

Experiment – Newton's theory predicts the wrong deflection of light.

Need Einstein and more!

Great conceptual differences between Newton and Einstein on the Nature of Gravity

Newton - Force between two objects

Einstein - Mass curves space, objects move *with no force* in curved space

Need to explore curved space - use geometry in multiple dimensions

Goals:

To understand how Einstein taught us to think about space, time, and gravity.

To understand what we mean by space.

To understand how space can be curved.

SPACE - *The Final Frontier*

Dimensions - defined by the number of mutually perpendicular directions

0 D - point

1 D - line

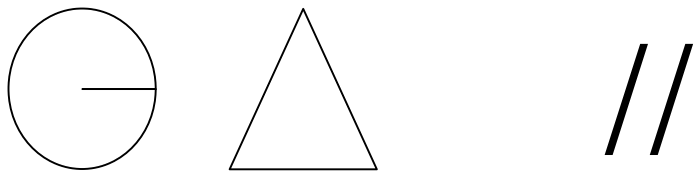
2 D - area

3 D - volume (secret hand sign)

4 D - ?

Hyperspace - space with more dimensions than the one under consideration

Euclidian - Flat Space Geometry



$C=2\pi r$ $\sum=180°$ never cross

Answers only good in ***flat space***: operational definition of flat space
NOT necessarily two-dimensional!

Non-Euclidian geometry - curved space

Both flat space and curved space use concept of “straight line”