Monday, March 30, 2015

Exam 3, Skywatch 3, Returned Wednesday

Reading:

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

Chapter 9: all except 9.6.3, 9.6.4

Wheeler on Travel (to DC) Wednesday – video on black holes,

Astronomy in the news?

Astronaut Scott Kelly and two Russian cosmonauts launched to the International Space Station from Baikonur Cosmodrome on Friday. Kelly will spend a year, the longest yet for an American, past Russians more. Will study long term space effects and compare with twin brother, astronaut Mark Kelly (spouse of Congressperson Gabrielle Giffords, shot in Arizona).
Wednesday video, Discovery Channel program on Black Holes narrated by Mike Rowe (dirty jobs guy).

Michio Kaku – many popular books, bit too much hype in some places here

Phil Plait – Bad Astronomy, Discovery Channel, Slate

Andrea Ghez – UCLA, big black hole in center of our Galaxy

4th person?

Good graphics – watch for asymmetric supernova explosions, accretion disks with inner material orbiting more quickly, jets.
Goal:

To understand how isolated neutron stars are observed as “pulsars.”
Goal:

To understand how neutron stars behave in accreting binary systems.
Goal:

To understand how *magnetic* neutron stars behave in accreting binary systems.
Goal:

To understand how neutron stars are observed as X-ray "pulsars."
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, again decades later.

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 that is threaded by magnetic lines of force, convert magnetic energy to heat (1998 burst) or completely rearrange magnetic field configuration, for instance by swapping north and south magnetic poles (2004 burst).

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

⇒ Magnetar - very highly magnetic pulsar.

Anomalous X-ray Pulsars (AXP) also require very large magnetic fields, 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 (2004 burst) in distant galaxies.
Skywatch Extra Credit Targets
costellations only, not all visible

Magnetar Candidates

<table>
<thead>
<tr>
<th>Name</th>
<th>Location</th>
<th>Rotation (seconds)</th>
<th>Year Discovered</th>
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<tbody>
<tr>
<td>SGR 0526-66</td>
<td>Large Magellanic Cloud</td>
<td>8.0</td>
<td>1979</td>
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<td>SGR 1900+14</td>
<td>Aquila</td>
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<td>Sagittarius</td>
<td>-</td>
<td>1997</td>
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<td>SGR 1627-41</td>
<td>Ara</td>
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</tr>
<tr>
<td>AXP 1E 2259+586</td>
<td>Cassiopeia</td>
<td>7.0</td>
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<td>AXP 1E1048.1-5937</td>
<td>Carina</td>
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<td>Scorpius</td>
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<td>Scutum</td>
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<td>AXP CXOU J010043.1-721134</td>
<td>Small Magellanic Cloud</td>
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<td>Sagittarius</td>
<td>5.5</td>
<td>2003</td>
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<td>AXP CXO J164710.2-455216</td>
<td>Ara</td>
<td>10.6</td>
<td>2005</td>
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</table>
Magnetars!

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

Reading, Chapter 9: all except 9.6.3, 9.6.4

The Science of Interstellar – through the rest of the term
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 bodies with escape velocity greater than the speed of light ⇒ light could not get out, completely dark, corps obscur.

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

instantaneous reaction ⇒ infinite speed of gravity

In physics infinity ⇒ problem

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

Need Einstein and more!