Monday, February 15, 2016

Reading for Exam 2: Sections 6.1, 6.4, 6.5, 6.6, Betelgeuse interlude.

Background: Sections 1.2.1, 2.1, 2.2, 2.4, 2.5

Exam 2, Friday, February 26

Astronomy in the news?

Report of possible burst of gamma-ray energy 0.4 s after the Gravity Wave burst, lasting about 1 second in roughly the right direction. Maximum brightness about 1% of a supernova (for comparison, not at all related to a supernova). No obvious optical counterpart.

Possible detection of the star that exploded as SN 2016ajd in Centaurus A in pre-explosion images. Centaurus too far south for Sky Watch.
Iron core collapse leads to a neutron star (or maybe a black hole).

**Neutron Star** - mass of Sun, but size of small city, 
~ 10 kilometers in radius, density of atomic nucleus.

**Huge gravity** - surface is now *much closer* to the center!

Supported by quantum pressure of neutrons and nuclear forces.
One minute exam

What is the importance of neutrinos in massive stars?

- They cause the collapse of the iron core
- They carry off most of the energy of collapse
- They convert electrons into protons
- They eject the outer envelope of the star
Goal

To understand how the iron core process works in Type II, Type Ib, and Type Ic supernovae.

To understand how they are alike and why and how are they different.
Single star: Type II

Same star in binary: Type Ib/c

Same evolution inside star, thermal pressure, regulated burning, shells of heavier elements, whether hydrogen envelope is there or not.
Rotating, magnetic radio pulsar.

Both types leave behind a neutron star

Single star: Type II

Neutron star in binary system, X-ray source

Same star in binary: Type Ib/c

Both types leave behind a neutron star

Rotating, magnetic radio pulsar.
One minute exam

What is the fundamental property that leads Type II, Type Ib and Type Ic to core collapse?

- They lose their outer envelopes
- They explode in the spiral arms of spiral galaxies
- They are supported by thermal pressure
- They produce lots of neutrinos
Goal

To understand how the collapse of an iron core can trigger a supernova explosion
When a neutron star forms, get huge energy from dropping from size of Earth or White Dwarf to size of Austin.

100 times more energy than is needed to explode off the outer layers of the massive star.

That does not guarantee an explosion!

The outer parts of the star, beyond the neutron star, are transparent to the neutrinos, the neutrinos flood out freely and carry off most of the energy, about 99%.

Is 1% of the neutrino energy left behind to cause the explosion?

Tough problem! 1.5% is plenty, 0.5% is too little.
Collapse of iron core to form neutron star is halted by the repulsive strong nuclear force at very close distances, high compaction of neutrons (somewhat uncertain) + quantum pressure of neutrons

Fig 6.1

Charge repulsion among protons, zero for neutrons

Nuclear attraction among protons and neutrons

Nuclear repulsion at very short distances

Maximum mass of a neutron star is 1.5 to 2 solar masses
New-born neutron star over compresses and rebounds - potential mechanism for explosion,

**DOES NOT WORK!**

Form *standing shock*, and outer material just continues to fall in, pass through shock front and settle onto the neutron star.
Neutron stars are dense enough to trap some of the neutrinos. Perhaps the neutron star can boil out neutrinos at a higher rate…

Possible, but still not proven,

A bit like boiling a pot on the stove, the steam comes out, but lid just rattles, it does not explode to the ceiling.

May need a new idea…
One Minute Exam:

Most of the energy liberated in the formation of a neutron star is emitted in the form of:

Neutrons

Protons

Neutrinos

Photons