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 sounth for Sky Watch.

Iron core collapse leads to a neutron star (or maybe a black hole).

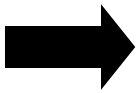
Neutron Star - mass of Sun, but size of small city,
~ 10 kilometers in radius, density of atomic nucleus.

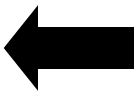
Huge gravity - surface is now ***much closer*** to the center!

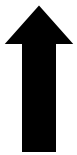
Supported by quantum pressure of neutrons and nuclear forces.

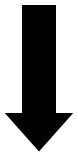
One minute exam

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

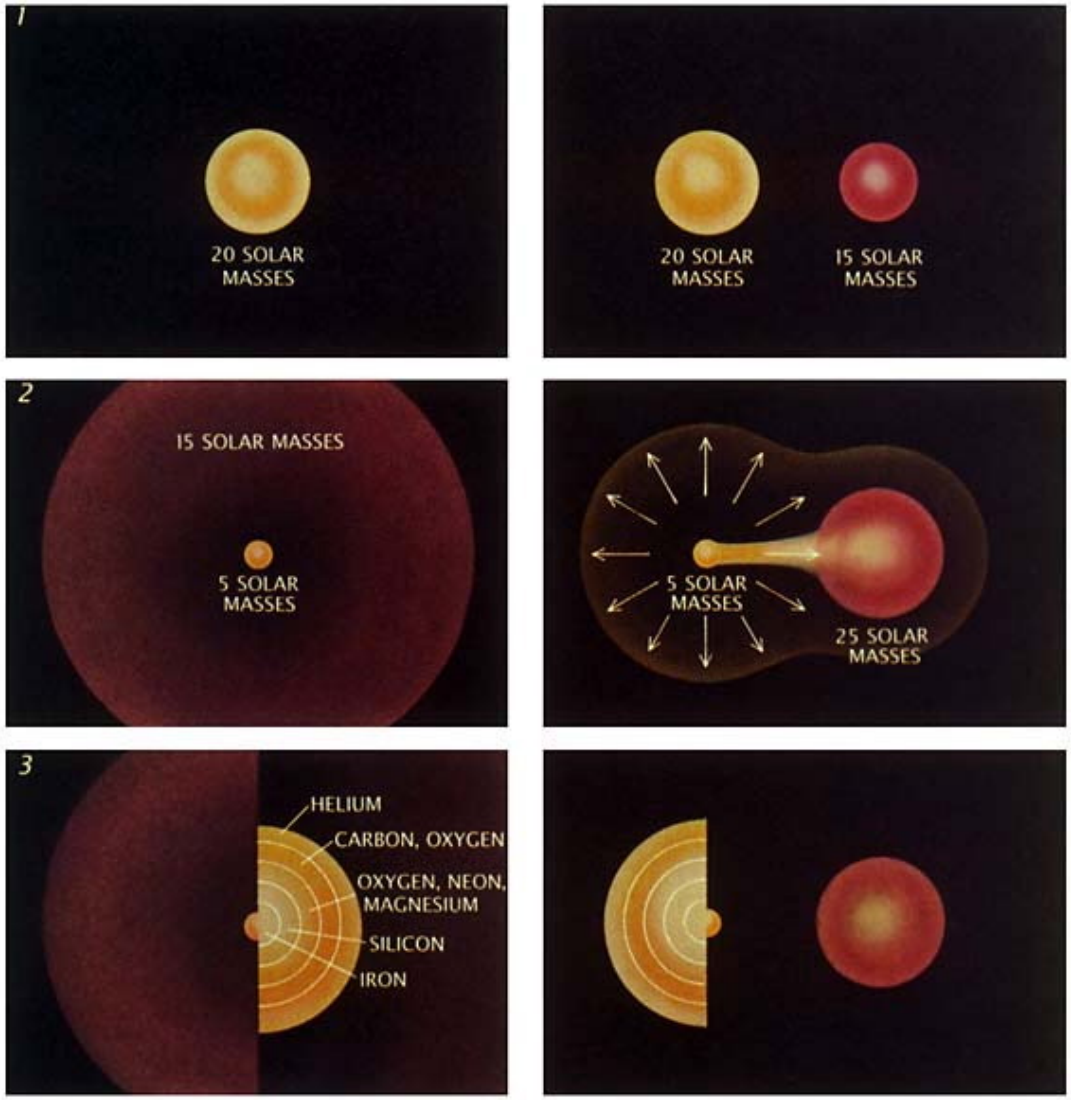
Goal

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.

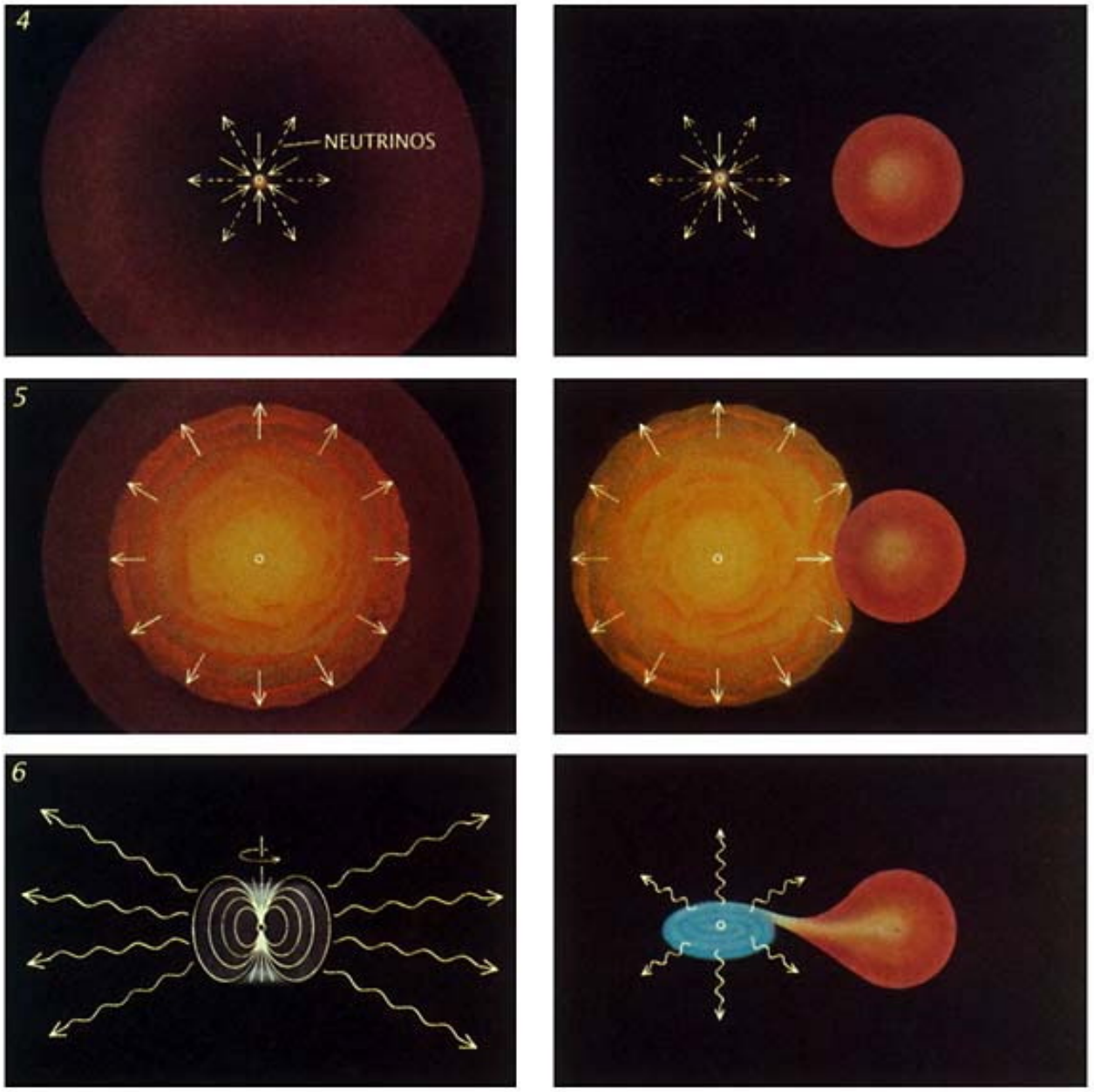
Single star: Type II Same star in binary: Type Ib/c

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



Single star: Type II

Same star in binary: Type Ib/c



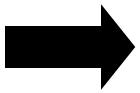
Both types leave behind a neutron star

Rotating, magnetic radio pulsar.

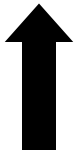
Neutron star in binary system, X-ray source

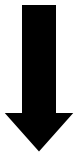
One minute exam

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!

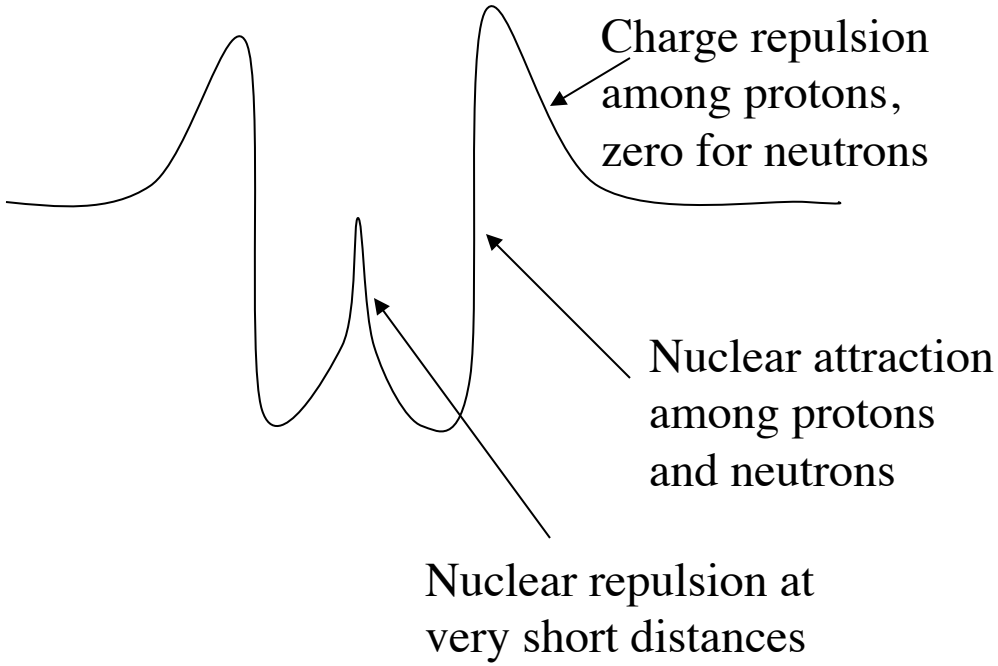
The outer parts of the star, beyond the neutron star, are ***transparent to the neutrinos***, the neutrinos flood out freely and carry off most of the energy, about 99%.

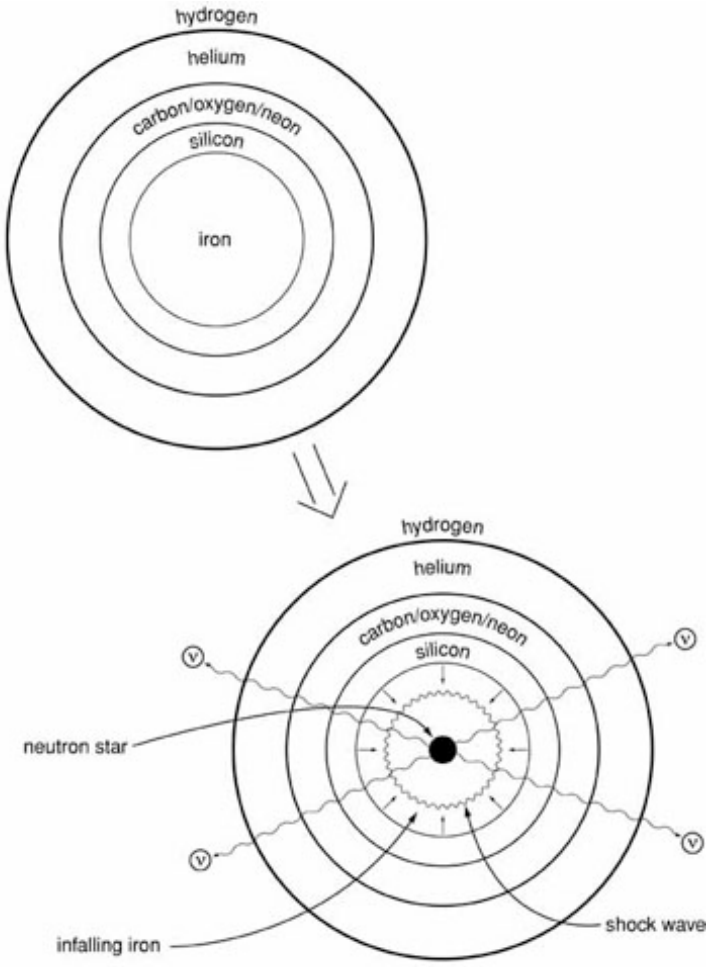
Is 1% of the neutrino energy left behind to cause the explosion?

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

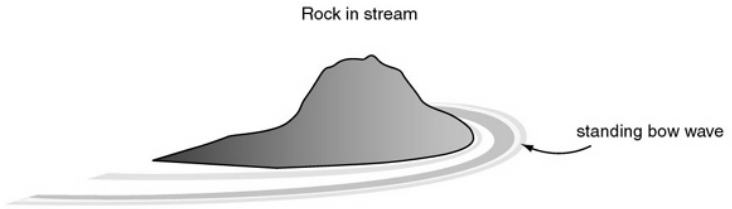




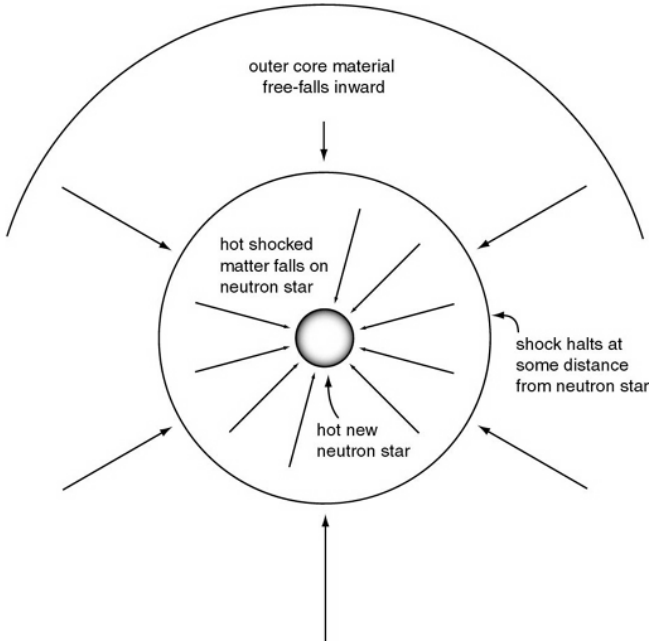
Maximum mass of a neutron star is 1.5 to 2 solar masses

New-born neutron star over compresses and rebounds - potential mechanism for explosion,

DOES NOT WORK!



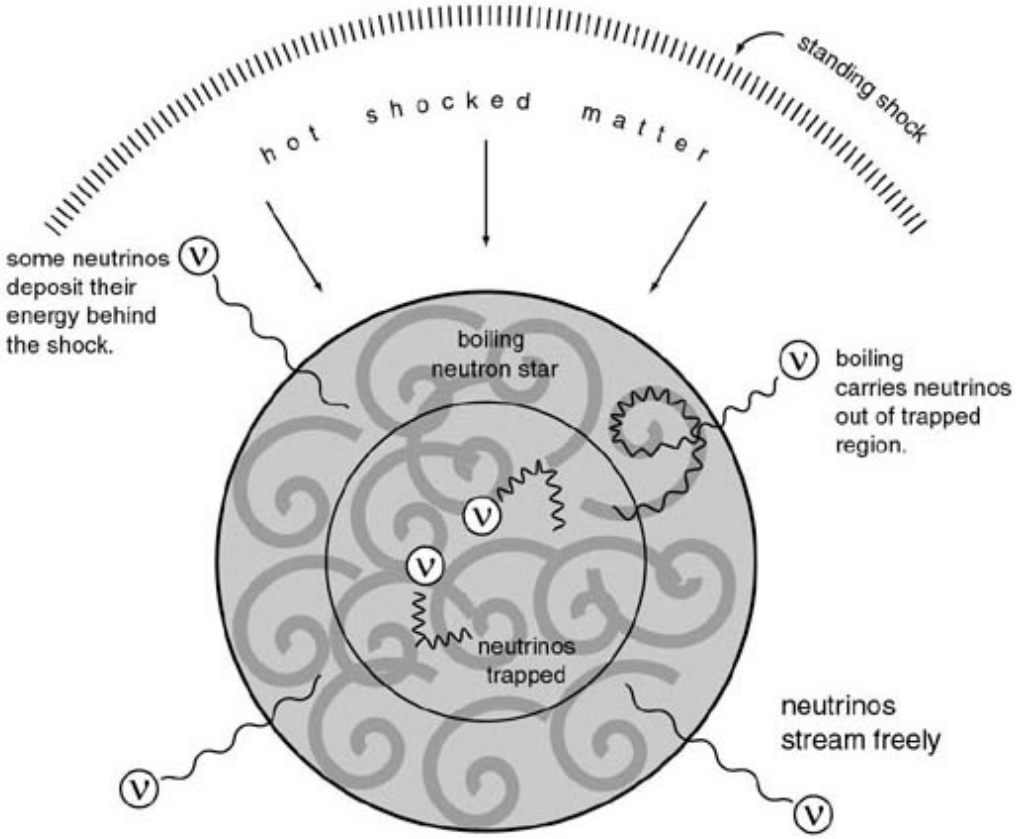
Form ***standing shock***, and outer material just continues to fall in, pass through shock front and settle onto the neutron star.



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,

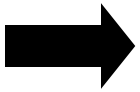
A bit like boiling a pot on the stove, the steam comes out, but lid just rattles, it does not explode to the ceiling.



May need a new idea…

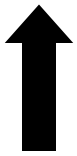
One Minute Exam:

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

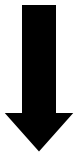


Neutrons

Protons



Neutrinos



Photons