Monday, February 16, 2015

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,

Astronomy in the news?

Goal

To understand what happens after a massive star forms an 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.

During iron core collapse, essentially all protons and electrons are converted to neutrons with the emission of a ***neutrino.***

Neutrinos have a tiny mass, no electrical charge, interact little with normal matter, only through weak nuclear force (Chapter 1.2).

Normal stellar matter is essentially *invisible* to neutrinos.

100x more energy is created in iron core collapse to a neutron star than is needed to explode the star

But

⇒99% of the energy of collapse is carried off by neutrinos
(Ch 1.2, 2.1, 2.2)

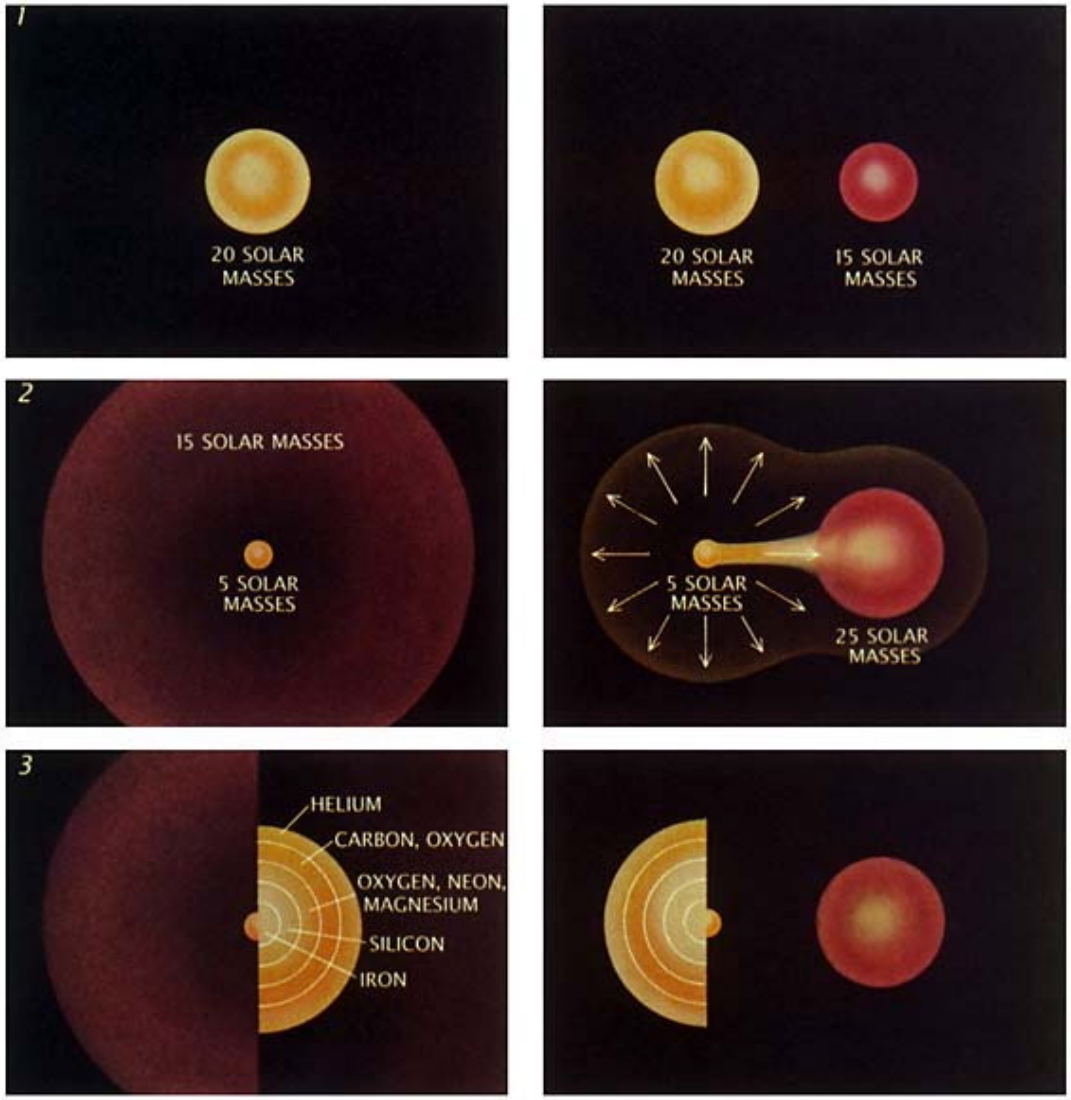
Goal

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.

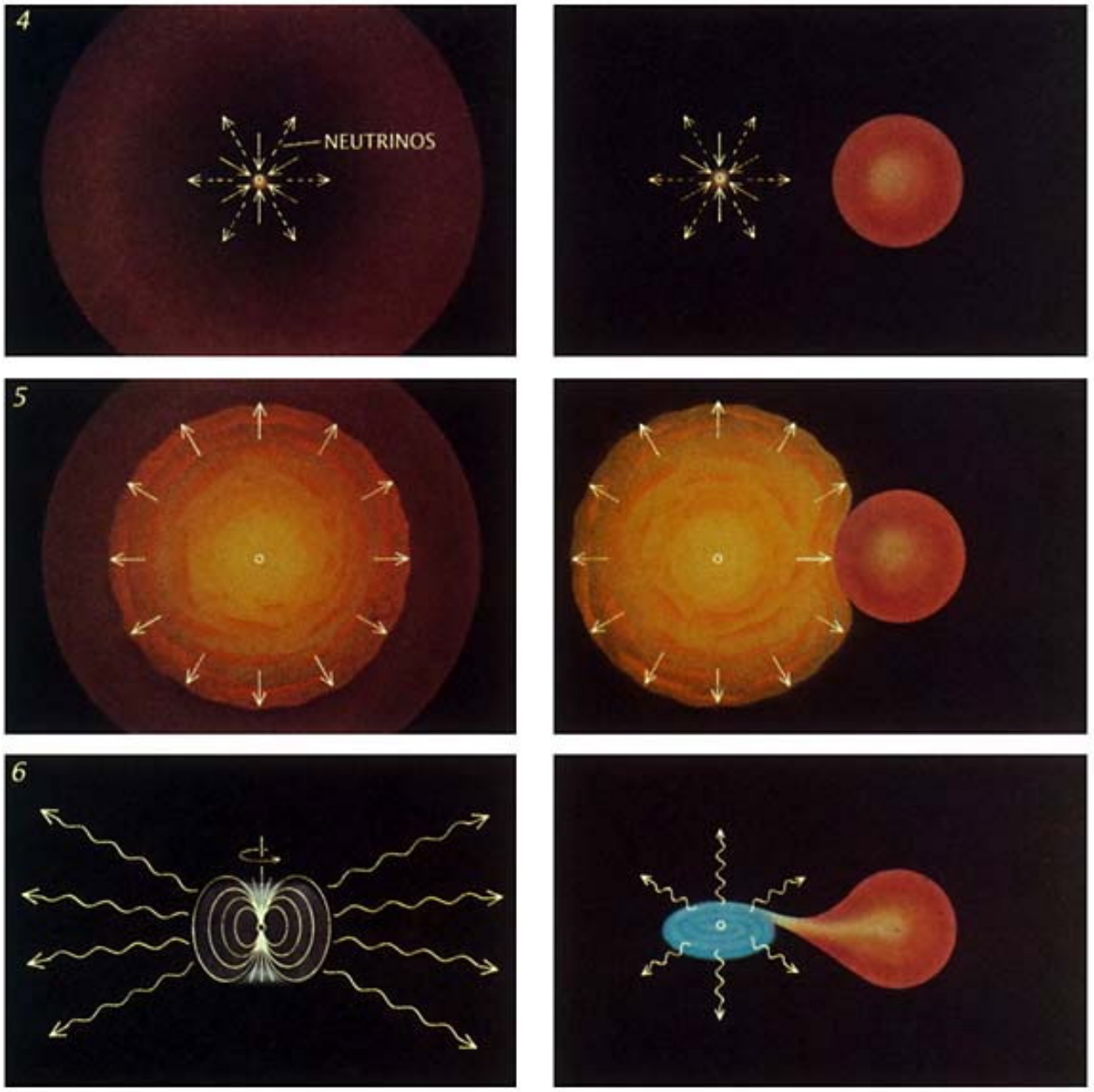
Single star: Type II Same star in binary: Type Ib/c

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

Sky Watch Targets

Binary Stars

Sirius, if you have not already done it.

Algol, Beta Persei in Perseus

Antares, Alpha Scorpii in Scorpius

Beta Lyrae in Lyra

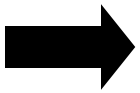
Rigel, Beta Orionis in Orion (triple star system)

Spica in Virgo

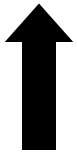
Other binary star systems

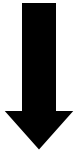
One minute exam

What is the importance of iron in massive stars?

 It produces a great deal of energy

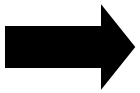
 It absorbs energy

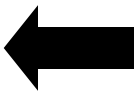
 It has more gravity than lighter elements

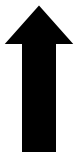
 It combines with oxygen and produces rust

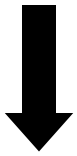
One minute exam

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 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!

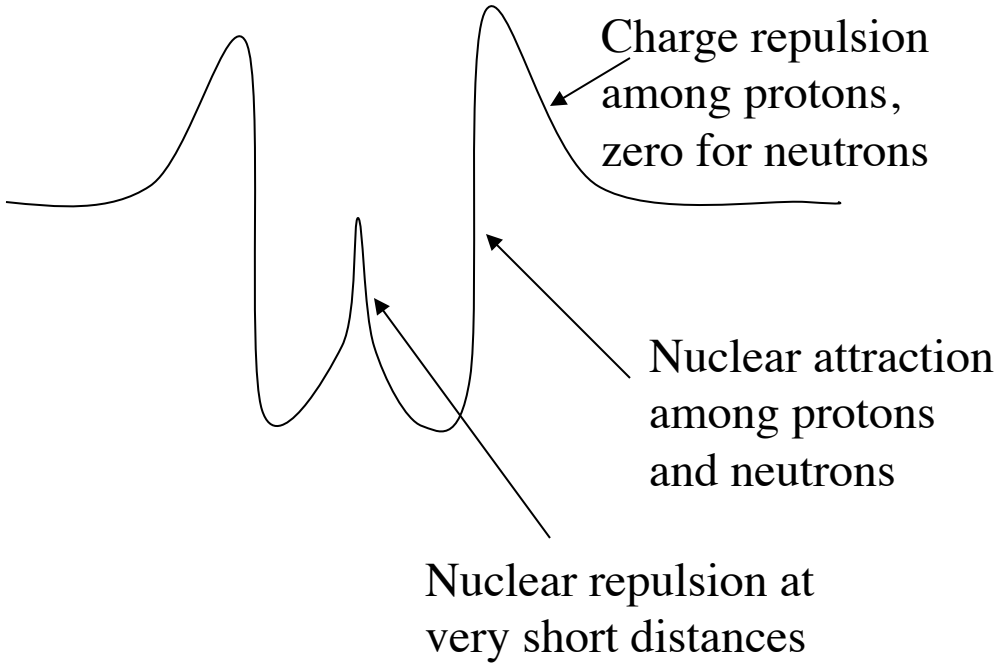
The outer parts of the star, beyond the neutron star, are ***transparent to the neutrinos***, the neutrinos flood out freely and carry off most of the energy, about 99%.

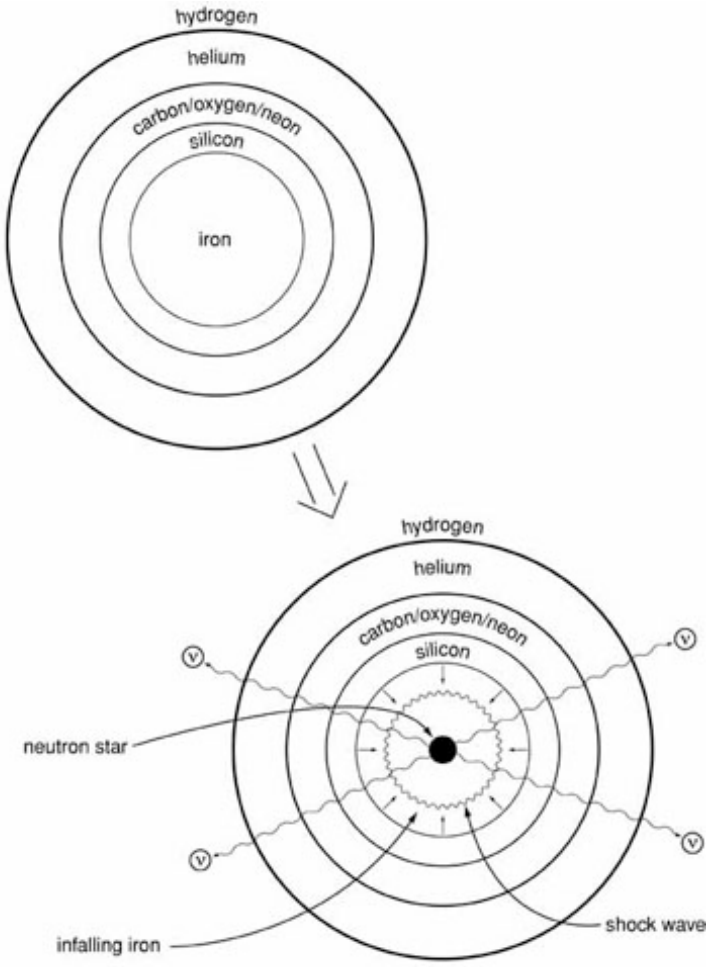
Is 1% of the neutrino energy left behind to cause the explosion?

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