February 14, 2011

Exams will be returned on Wednesday.

Multiple choice scores on blackboard, now.

Astronomy in the news? NASA Stardust mission doing another fly-by of the nucleus of a comet, left overs of the formation of the solar system 4.7 billion years ago.

Pic of the day: 4 million year old star cluster blows a wind that forms this heart-shaped inner region.

Goal

To understand what happens after a massive star forms an iron core

When iron core forms - star is doomed to collapse, form a neutron star (or maybe a black hole), composed essentially of all neutrons.

$p + e \rightarrow n + v$ ***neutrino***,

Action of Weak Nuclear Force (Chapter 1.2)

One v is generated for every p that is converted, a star's worth of protons

$\Rightarrow$***lots of neutrinos***

$\Rightarrow$99% of energy of collapse is carried off by neutrinos (Ch 1.2, 2.1, 2.2)

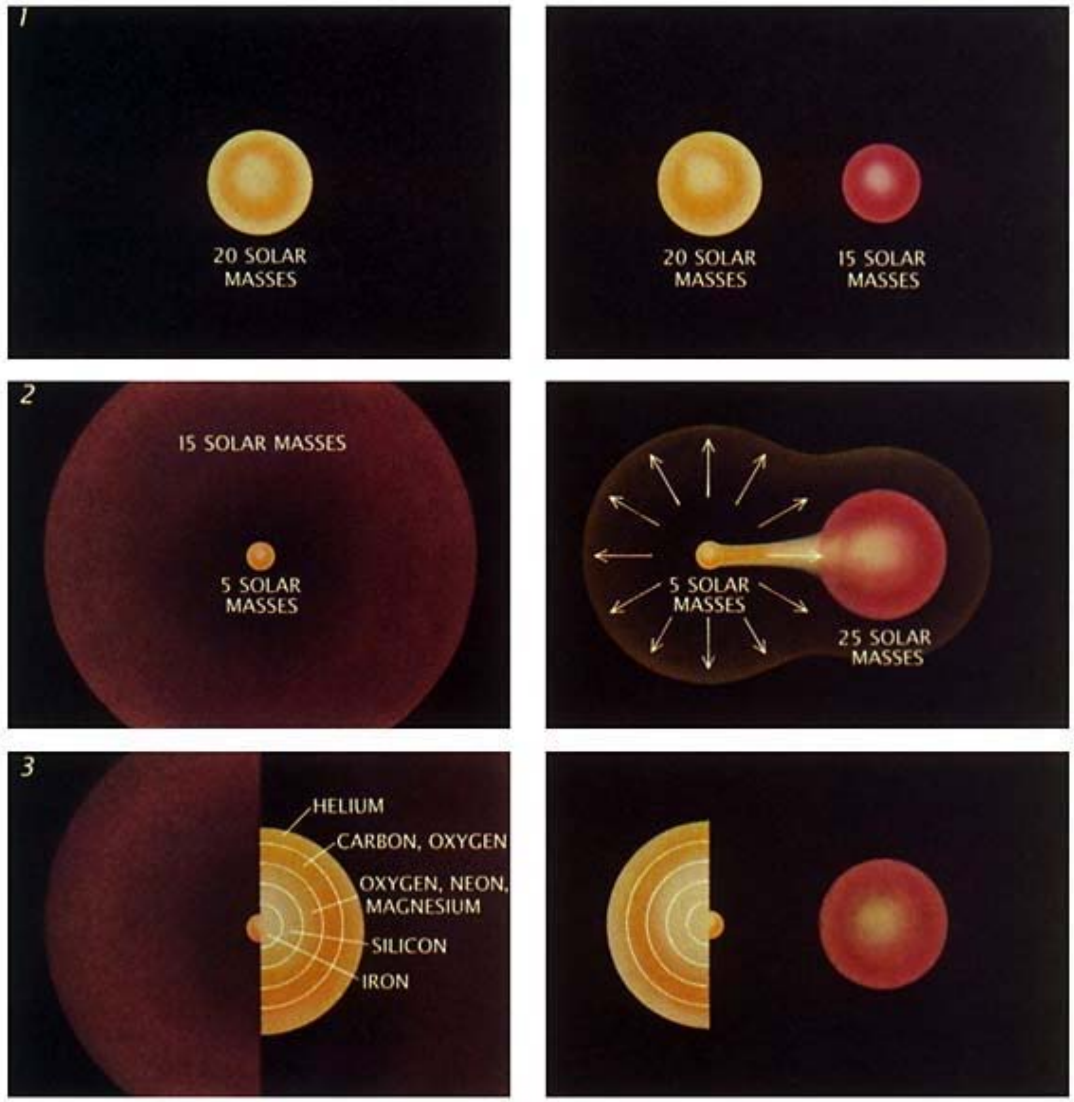
Goal

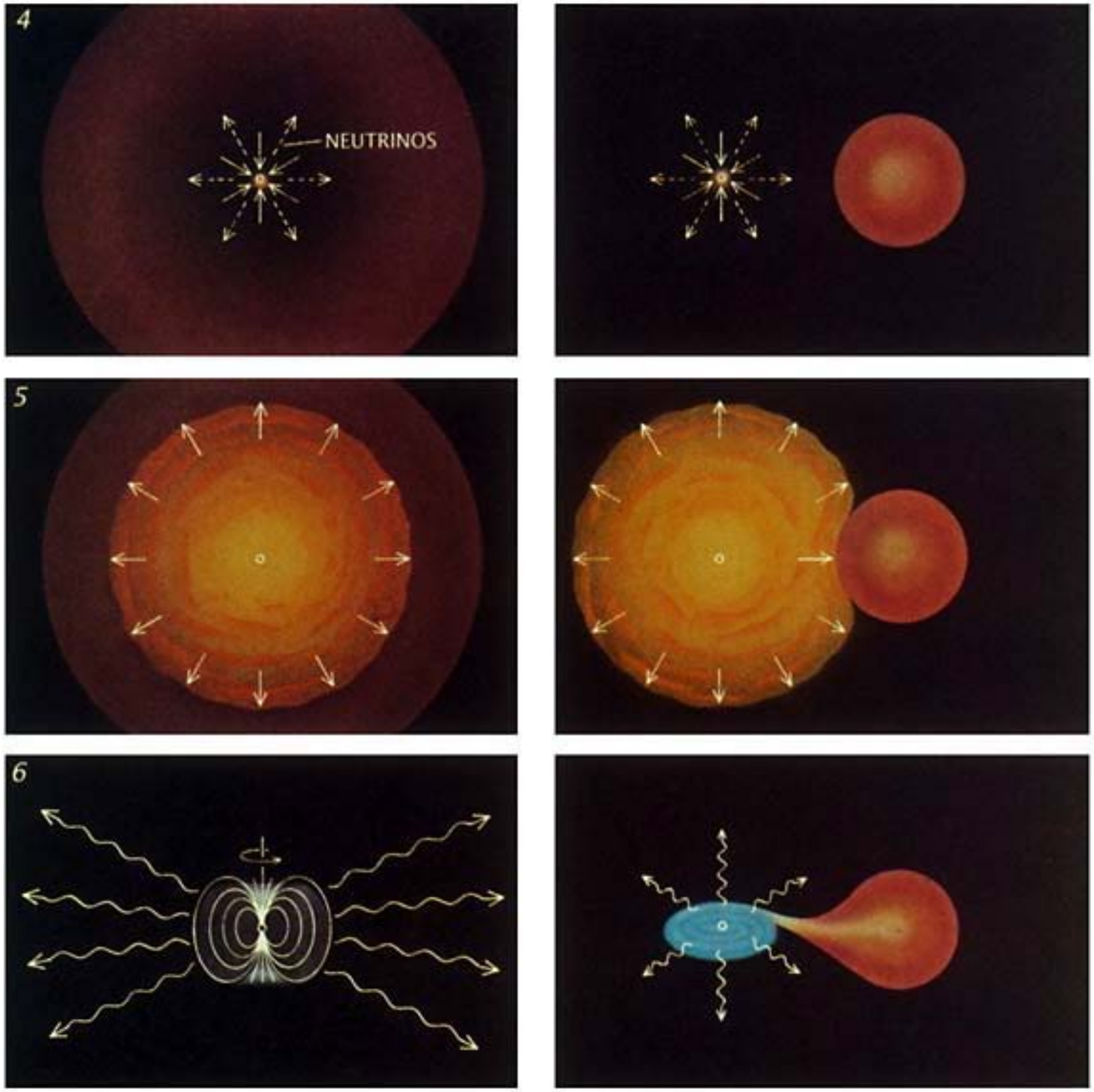
To understand how the iron core process works in Type II, Type Ib, and Type Ic supernovae.

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 envelope there or not





Rotating, magnetic radio pulsar.

Neutron star in binary system, X-ray source

One minute exam

Why do you have to heat a nuclear fuel to make it burn?

- Charge repulsion keeps nuclei apart
- The strong nuclear force keeps nuclei apart
- To overcome the loss of neutrinos
- To make neutrons

One minute exam

What is the importance of iron in massive stars?

➡ It produces a great deal of energy

⬅ It absorbs energy

⬆ It produces neutrinos

⬇ It combines with oxygen and produces rust

Goal

To understand how the collapse of an iron core can trigger a supernova explosion

Iron core of massive star absorbs energy, collapses in about 1 second to form a ***neutron star***.

Essentially all protons and electrons are converted to neutrons with the emission of a ***neutrino***, tiny mass, no electrical charge, interacts little with normal matter, only through weak nuclear force (Chapter 1.2)

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!

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!

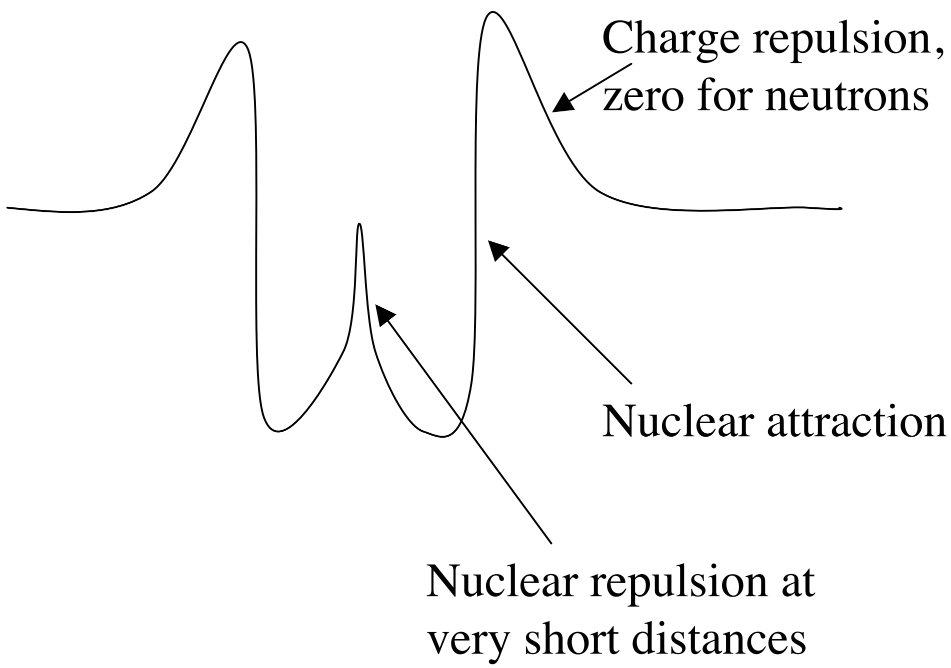
The outer parts of the star, beyond the neutron star, are ***transparent to the neutrinos***, the neutrinos flood out freely and carry off most of the energy.

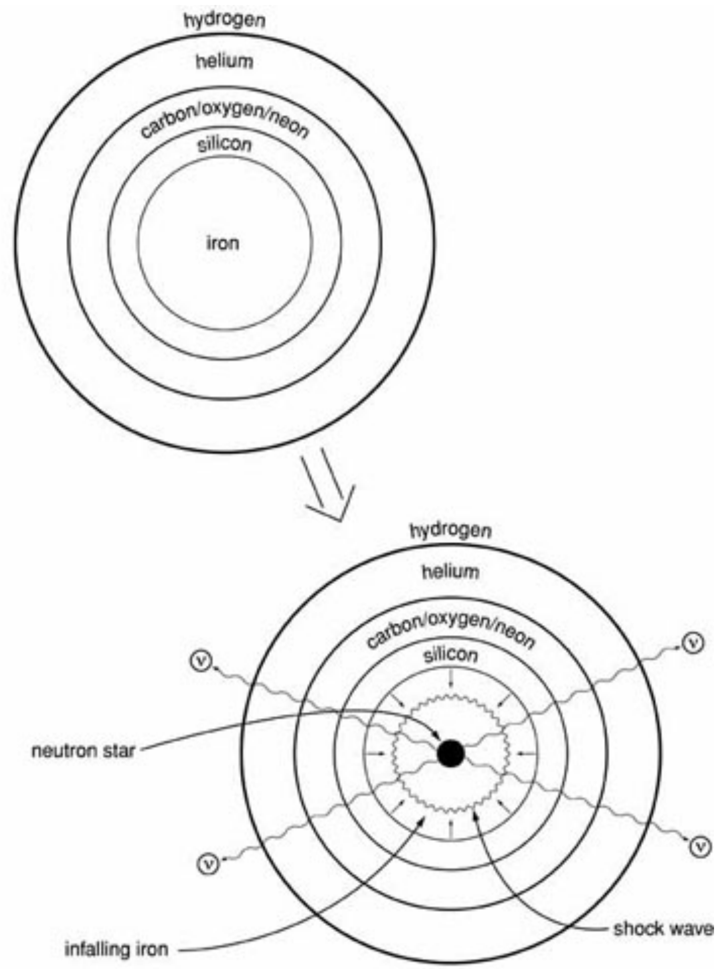
Is 1% of the neutrino energy left behind to cause the explosion?

Tough problem! 1.5% is plenty, 0.5% is too little.

Fig 6.1

Collapse is halted by the repulsive nuclear force (somewhat uncertain) + quantum pressure of neutrons





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