Friday, September 16, 2011

Astronomy in the news?

Two astronauts and a cosmonaut returned from the International Space Station today, leaving three on station.

NASA announced plans for new Space Launch System, larger than ever, budget, destination uncertain, maybe asteroid, Mars. Backed by Senator Hutchinson. First stage 2017(?), first manned 2021(?)

Kepler satellite discovers planet “Tatooine” with about the mass of Saturn orbiting two stars, orange (2/3 sun mass) and red (1/5 sun mass). Stars 20 million miles apart, planet at 65 million (like Venus) orbits in 229 days.

Pic of the day: Harvest Moon in September over Turin, Italy.

Goal

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

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.

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

Collapse leads to a neutron star.

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!

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

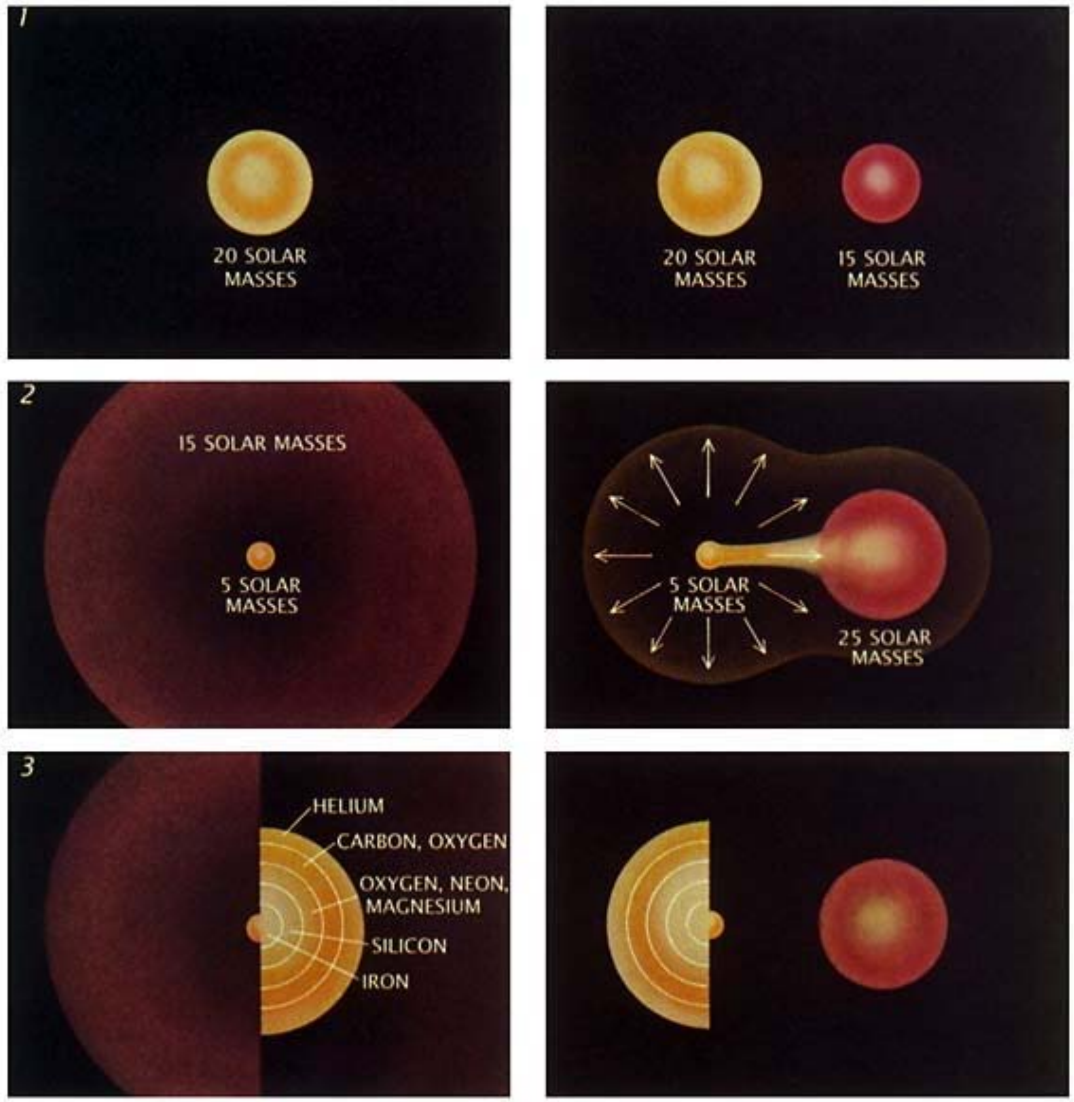
⬇ It combines with oxygen and produces rust

Goal

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

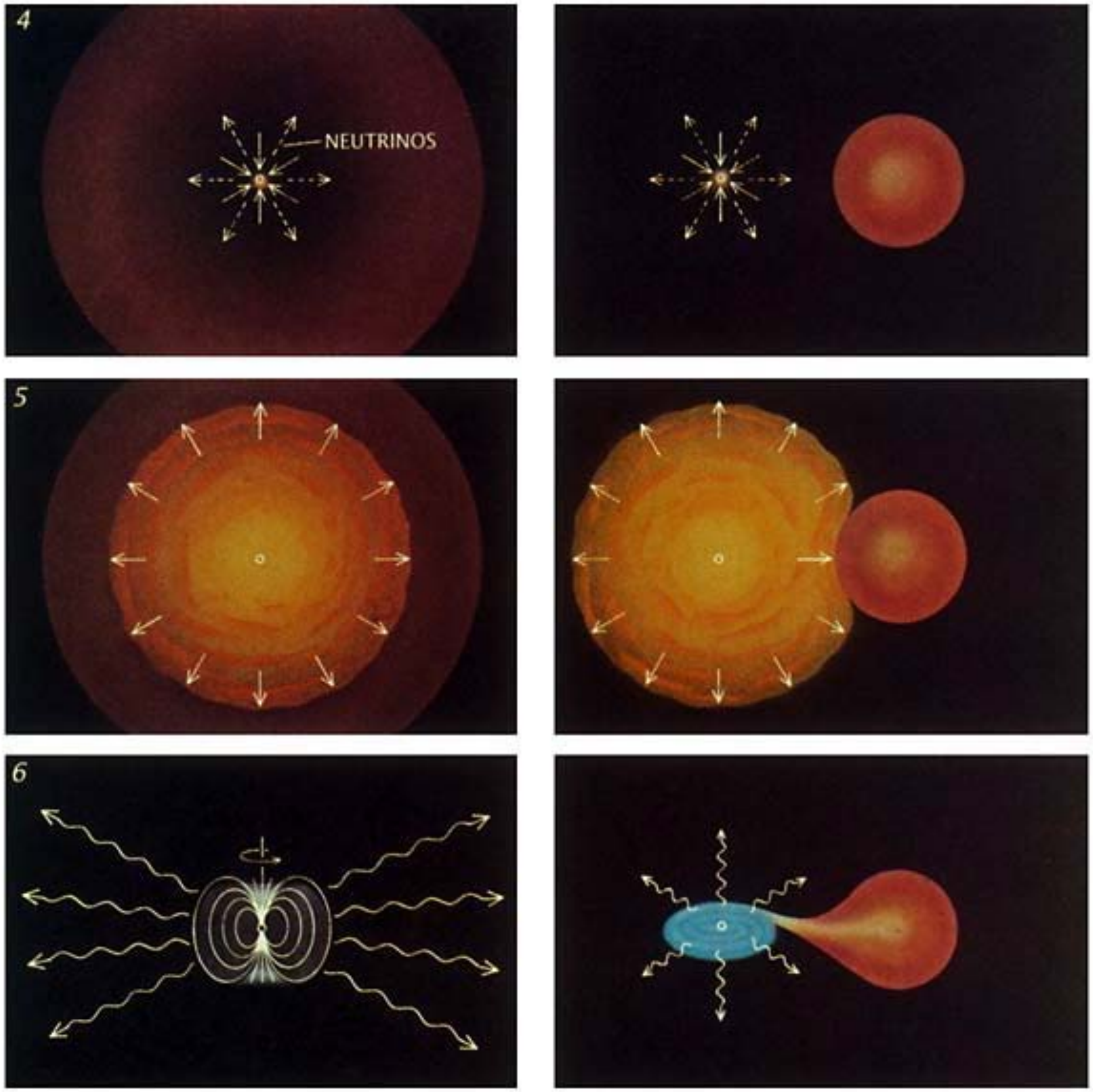
To understand how they are alike and why and how are they different.

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 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 inject energy into the explosion

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!

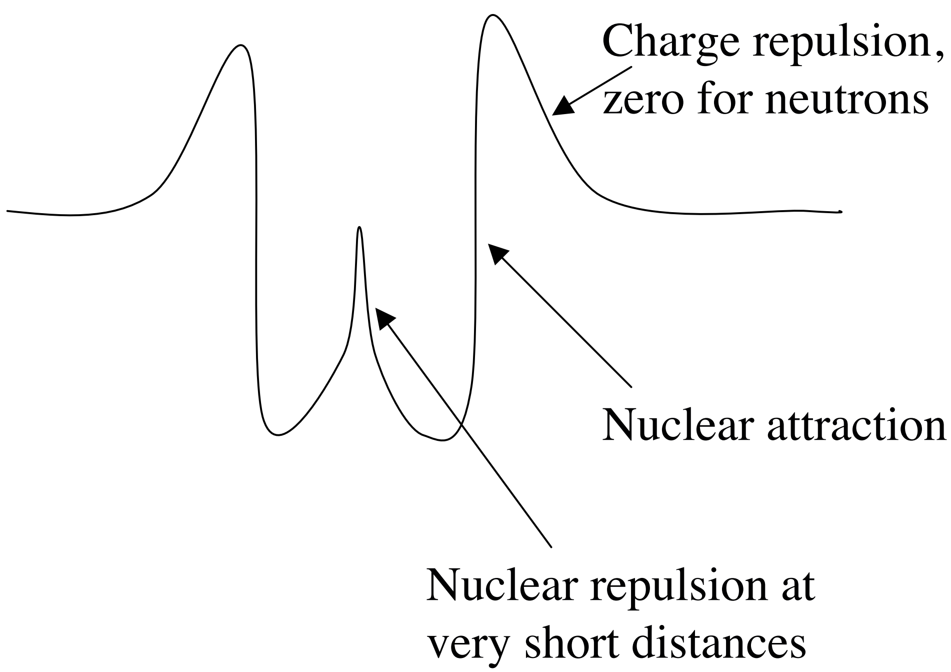
The outer parts of the star, beyond the neutron star, are ***transparent to the neutrinos***, the neutrinos flood out freely and carry off most of the energy, about 99%.

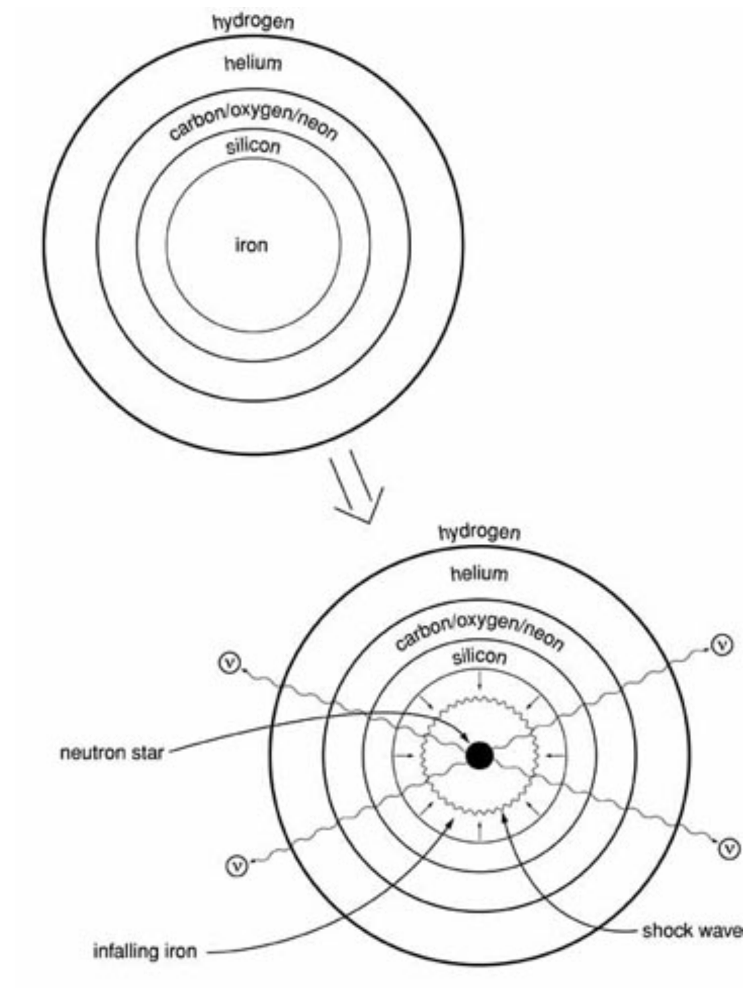
Is 1% of the neutrino energy left behind to cause the explosion?

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

Fig 6.1

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

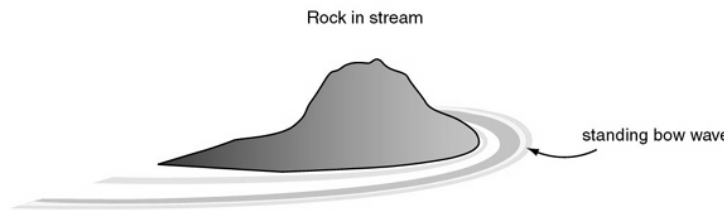




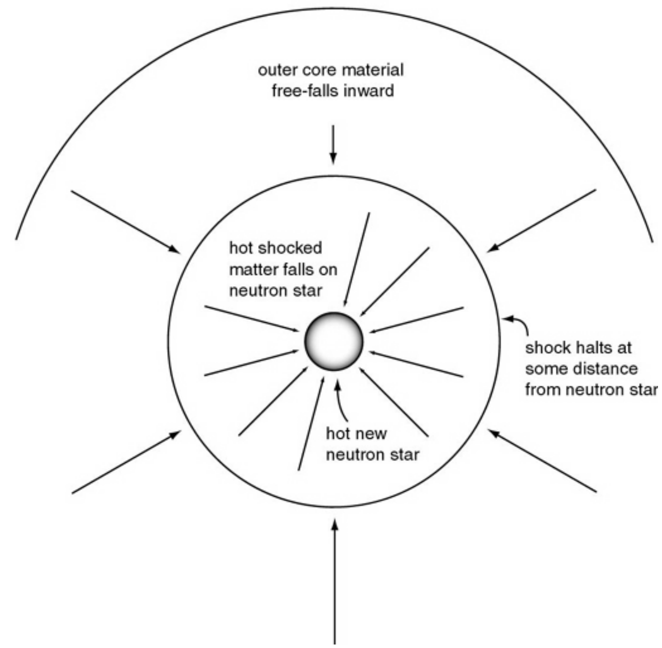
Maximum mass of a neutron star is 1.5 to 2 solar masses

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

DOES NOT WORK!



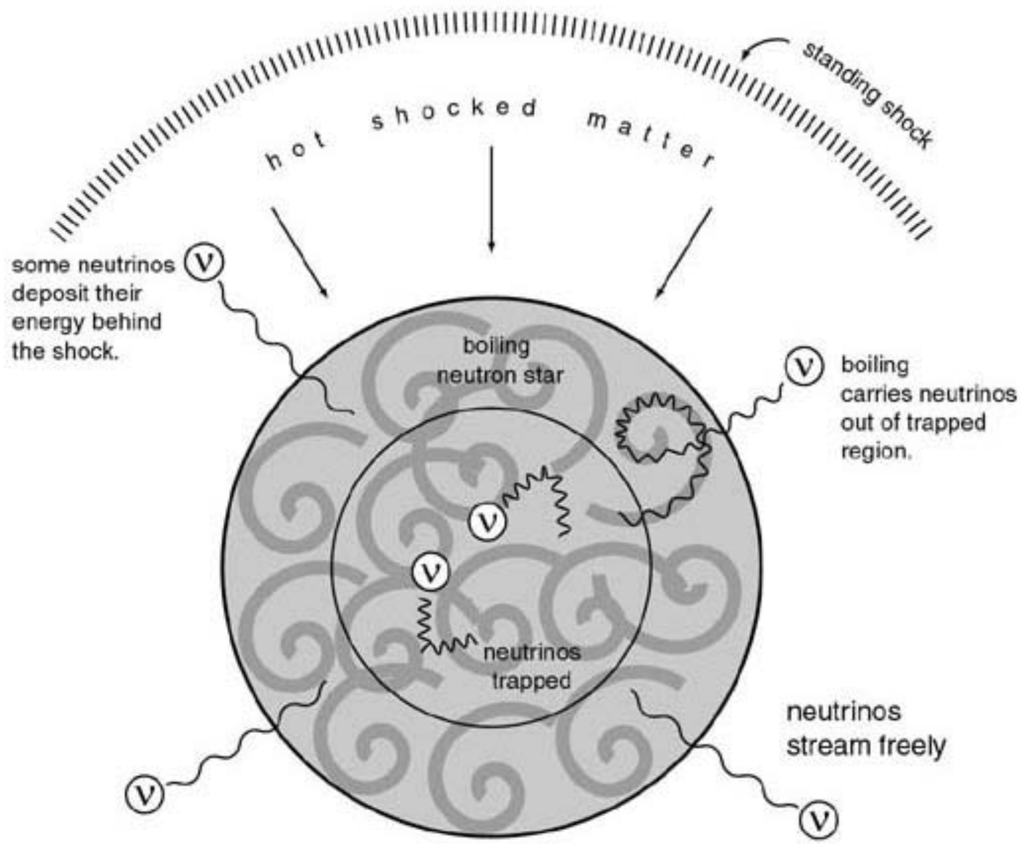
Form ***standing shock***, and outer material just continues to fall in, pass through shock front and settle onto the neutron star.



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…