Wednesday, February 18, 2015

Reading for Exam 2:

Chapter 6 Supernovae §6.4, 6.5, 6.6 (most of section, binary star evolution for Exam 3), Betelgeuse interlude.
Background:
Chapter 1 Introduction §1.2.1, 1.2.3, 1.2.4
Chapter 2 Stellar Death §2.1, 2.3, 2.4, 2.5

Exam 2, Friday, February 27

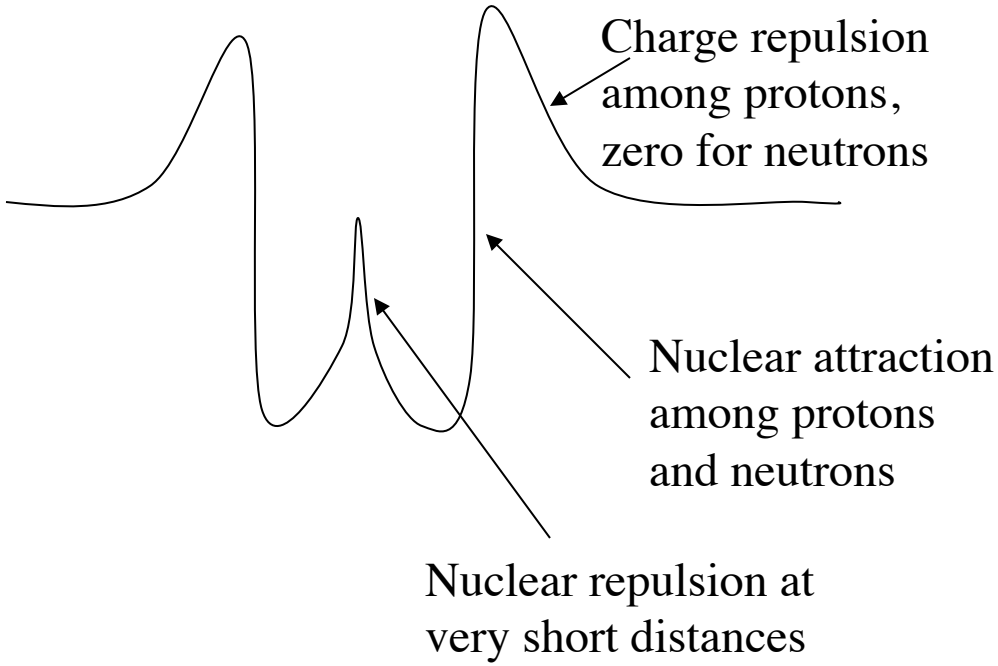
Astronomy in the news?

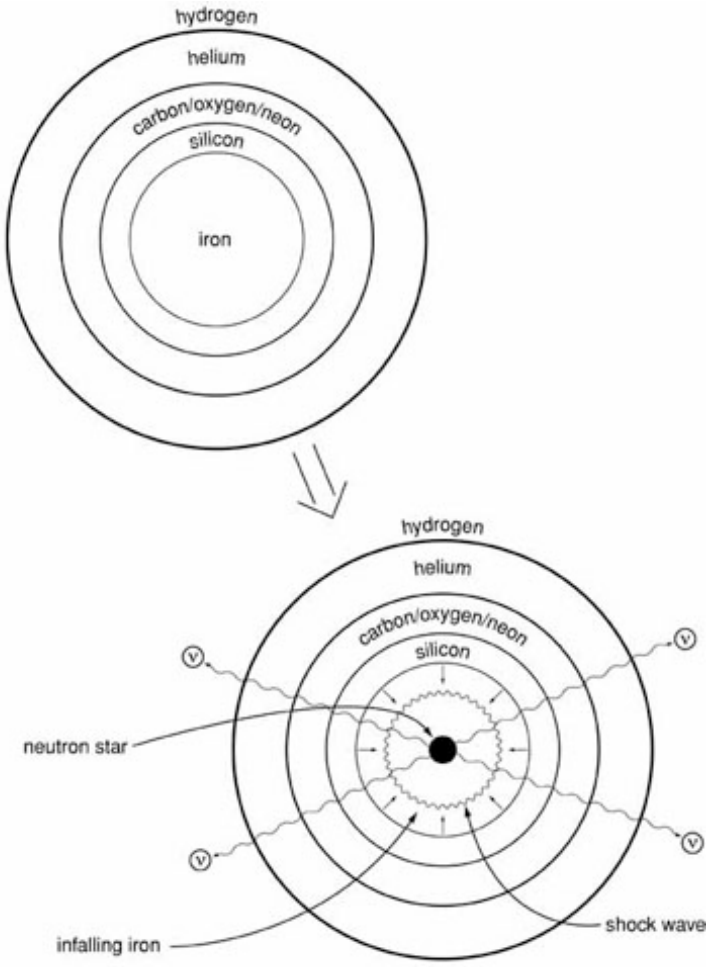
Goal

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

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

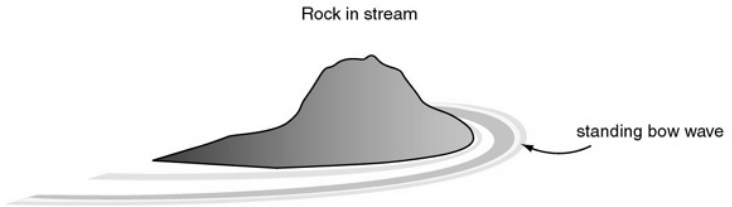




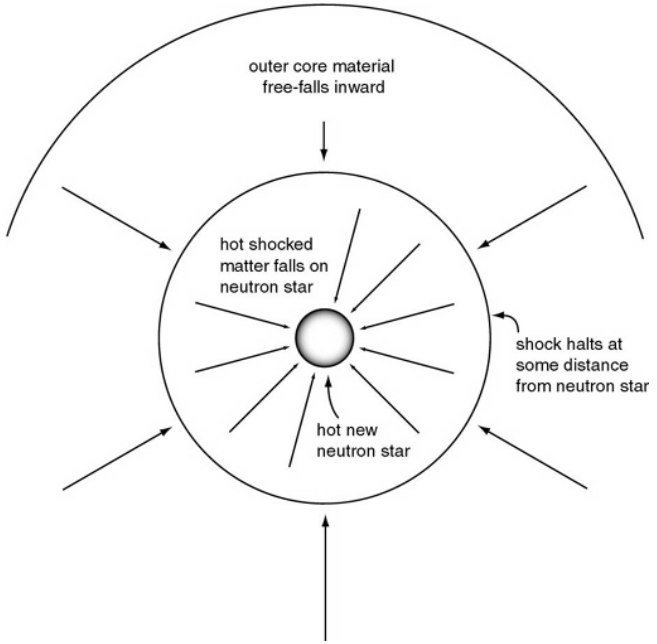
Maximum mass of a neutron star is 1.5 to 2 solar masses

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

DOES NOT WORK!



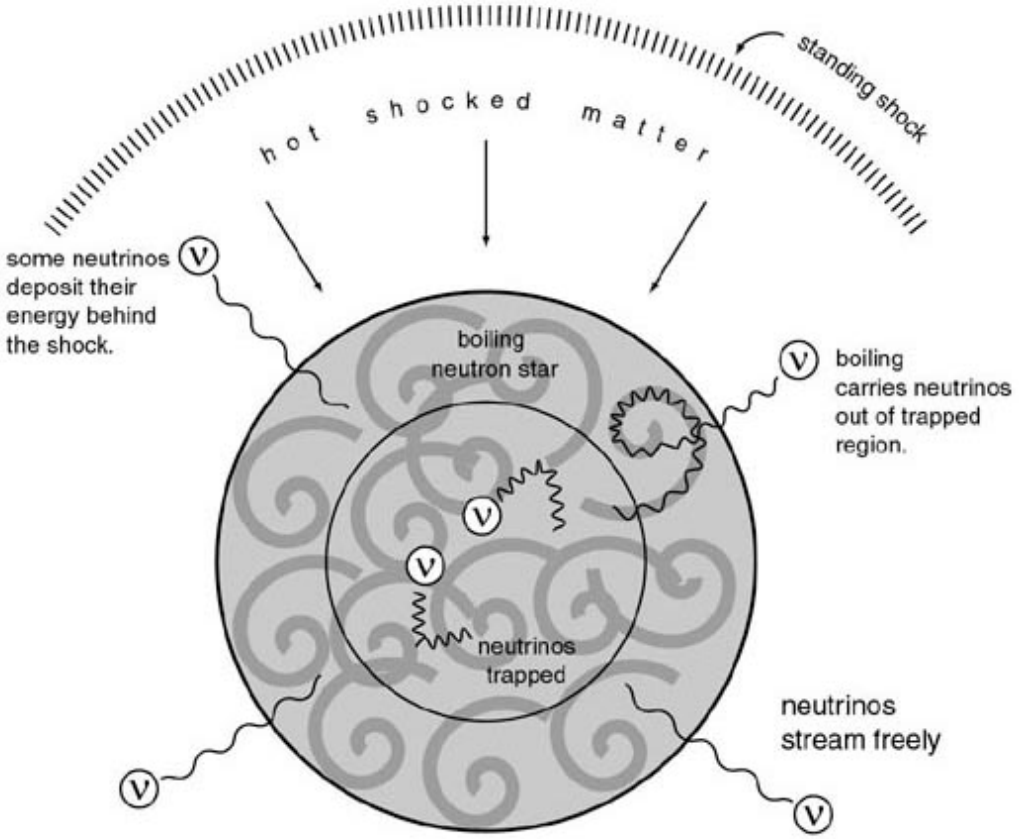
Form ***standing shock***, and outer material just continues to fall in, pass through shock front and settle onto the neutron star.



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,

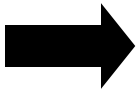
A bit like boiling a pot on the stove, the steam comes out, but lid just rattles, it does not explode to the ceiling.



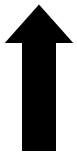
May need a new idea…

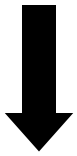
One Minute Exam:

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

 Neutrons

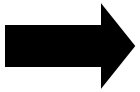
 Protons

 Neutrinos

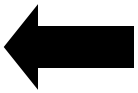
 Photons

One Minute Exam

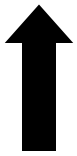
What happens to the initial ***shock wave*** produced when an iron core collapses to form a neutron star and bounces?



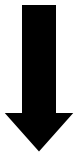
It fades away



It propagates out through the star and causes an explosion



It stalls at some distance from the neutron star

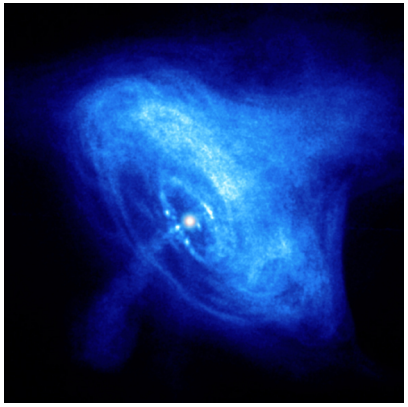


It traps neutrinos

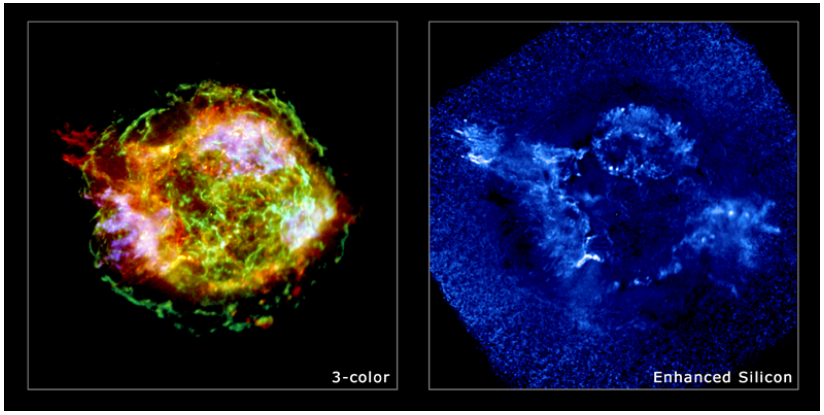
Goal

To understand how jets may trigger a core –collapse supernova explosion

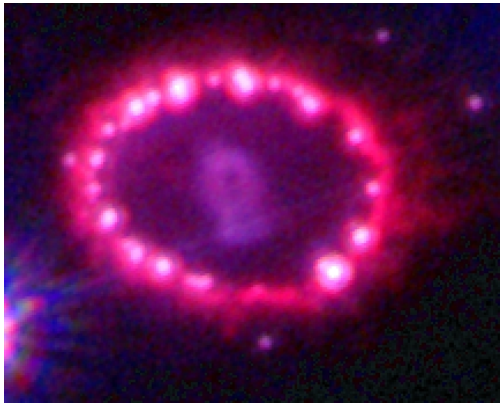
New possibility - Jet-induced supernova (Ch 6, p. 94)



Crab Nebula



Cassiopeiae A



SN 1987A

Are jet-like flows typical? Are they important?

Studies (last 25 years) show that all Core Collapse Supernovae (massive stars: Type II, Ib, Ic) are out-of-round.

Perhaps combination football, frisbee, or something else.

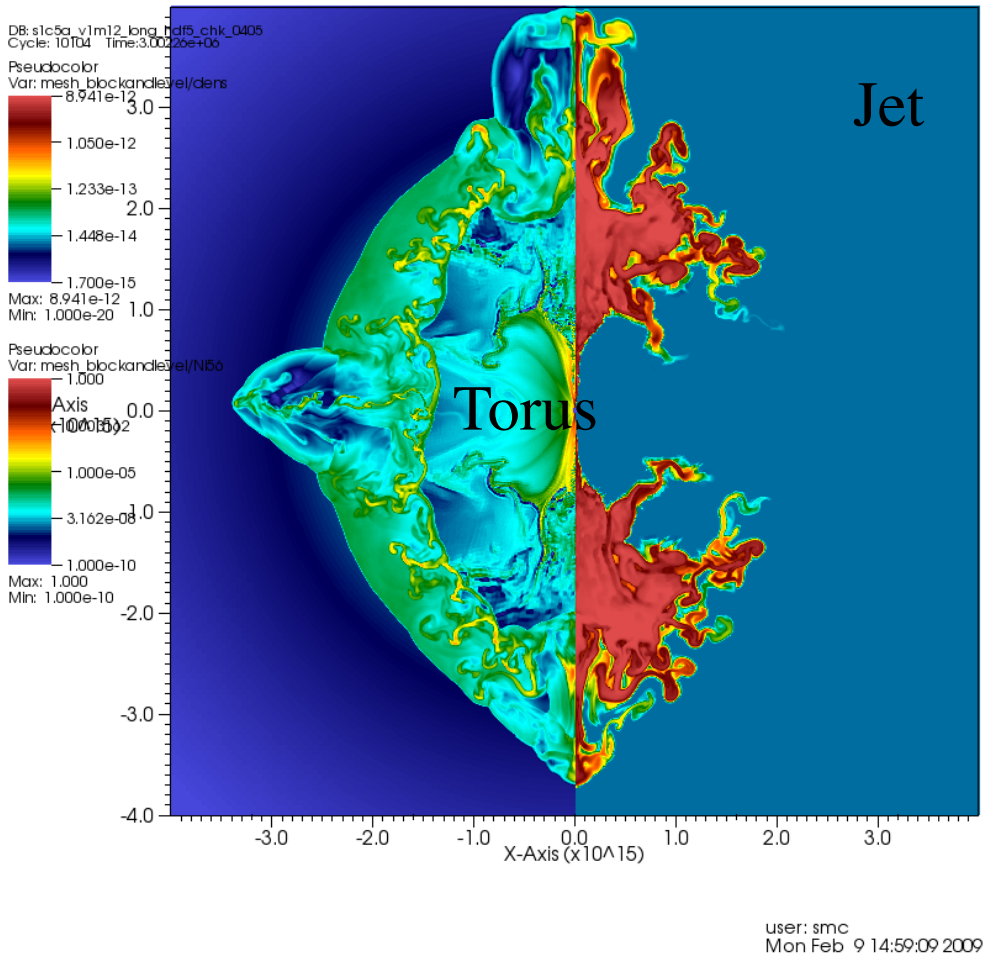
Supernovae show shapes consistent with (but not necessarily proving) jet-like flow.

Computer calculations show that jets emerging from newborn neutron star can explode the star, make it out-of-round.

Predict a jet/torus “bagel and breadstick” shape

What jets do -

Bagel and breadstick, jet/torus shape “natural.”



Explosion of two identical jets in a red giant star like Betelgeuse

Computer models predict a jet/torus, "bagel and breadstick" structure

Couch et al. 2009

This is the first new idea to understand these supernovae in thirty years.

Discussion points

How does a supernova determine a direction is space?

How does a supernova produce a jet-like flow?

How to define a particular direction in space?

Rotation - rotation axis.

How to make a jet? Some variation on squeeze and squirt (toothpaste mechanism)

Rotate magnetic neutron star, amplify the magnetic field, eject mass if field is strong enough.

Magnetic lines of force, locus of equal field strength, act somewhat like rubber bands, they are elastic and tend to rebound if deformed and can be twisted and coiled.

Twisted magnetic fields have tension along them and exert pressure sideways and along the lines of force.

Rubber band - twist moves along the rubber band.