Tuesday, October 6, 2009

Detroit adventure, Thursday Film

Anyone see Jeff Weeks?

IYA event tomorrow: RLM Plaza, 2 - 4 PM, Human Orrery, planets in solar system, 3 PM PMA Library, Wheeler (15 min) “A Brief Time for History: 400 Years of Astronomy,” reception.

Astronomy in the news - yesterday, Nobel Prize in medicine, telomeres, cancer, aging, the origin of life, today, in physics, fiber optics, digital imaging, widely used in astronomy.

Pic of the Day - Lagoon Nebula in Sagittarius, new hot young stars.

Make succession of heavier elements

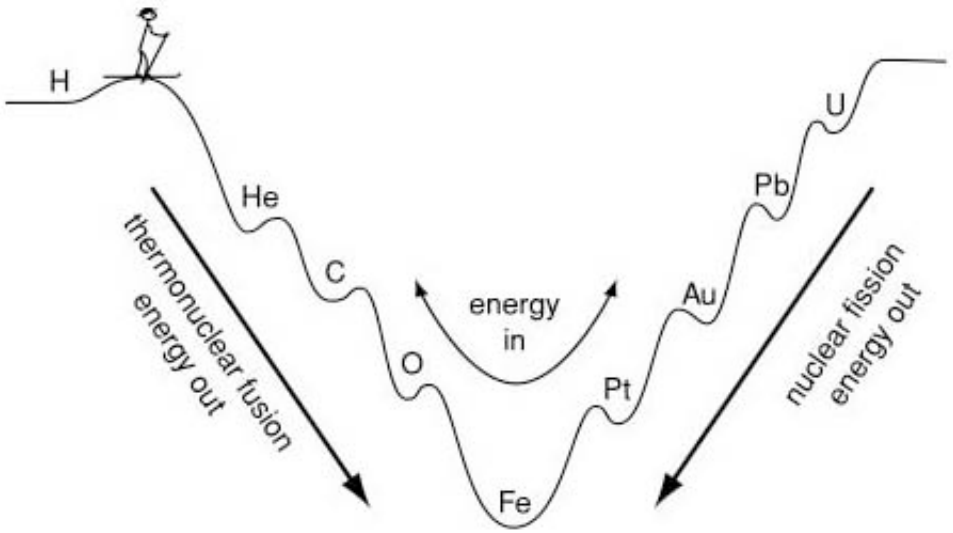


Figure 2.3

Special role of Iron - 26p, 30n

Endothermic - must put energy in to break iron apart into lighter elements or to forge heavier elements, absorb energy, lower pressure, core contracts, absorb more energy, more contraction…

=> The iron core quickly collapses! Catastrophic death of the star.

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

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

Action of Weak Nuclear Force (Chapter 1.2)

One ν is generated for every p that is converted. a star's worth of protons

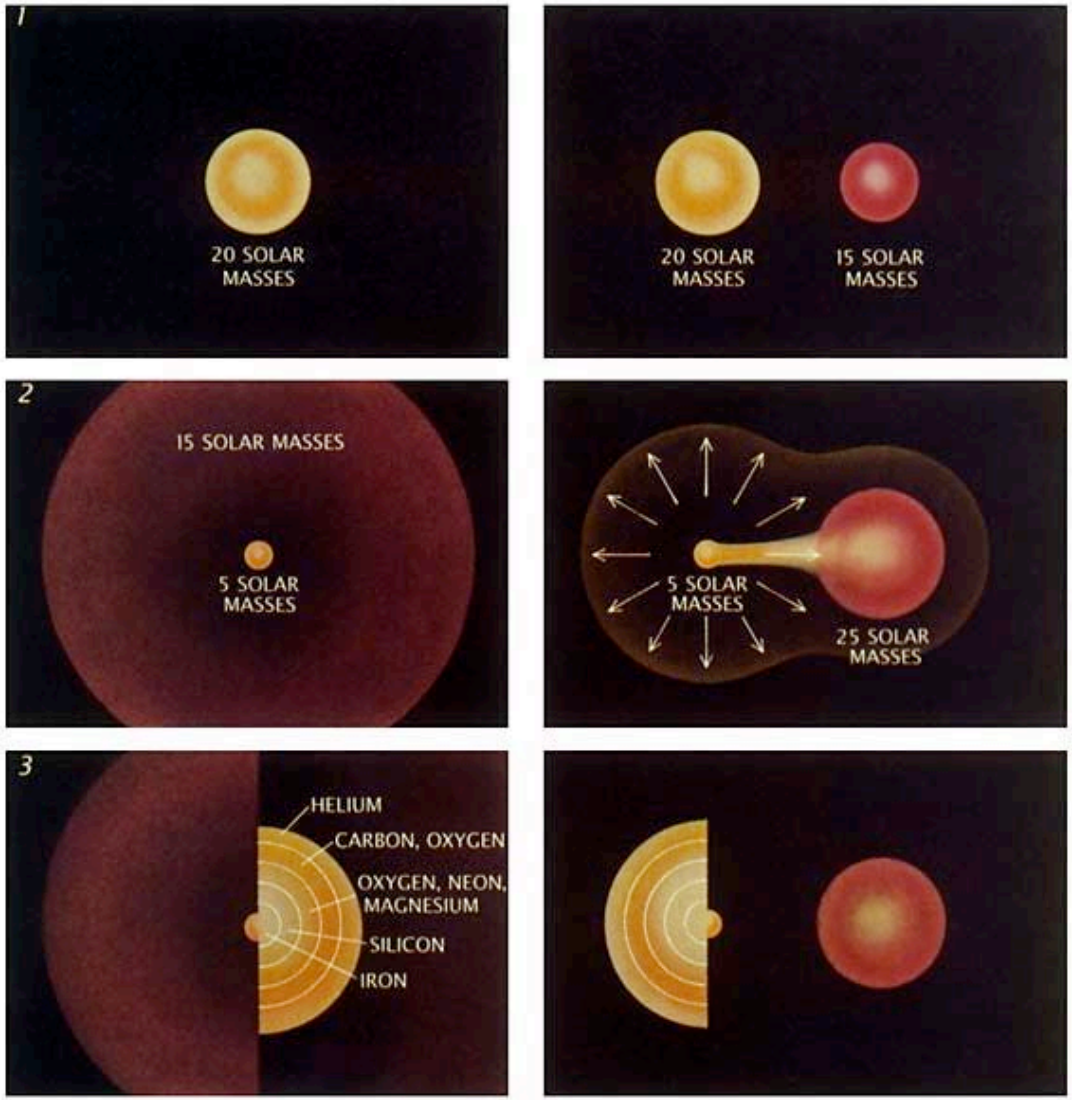
$\Rightarrow$***lots of neutrinos***

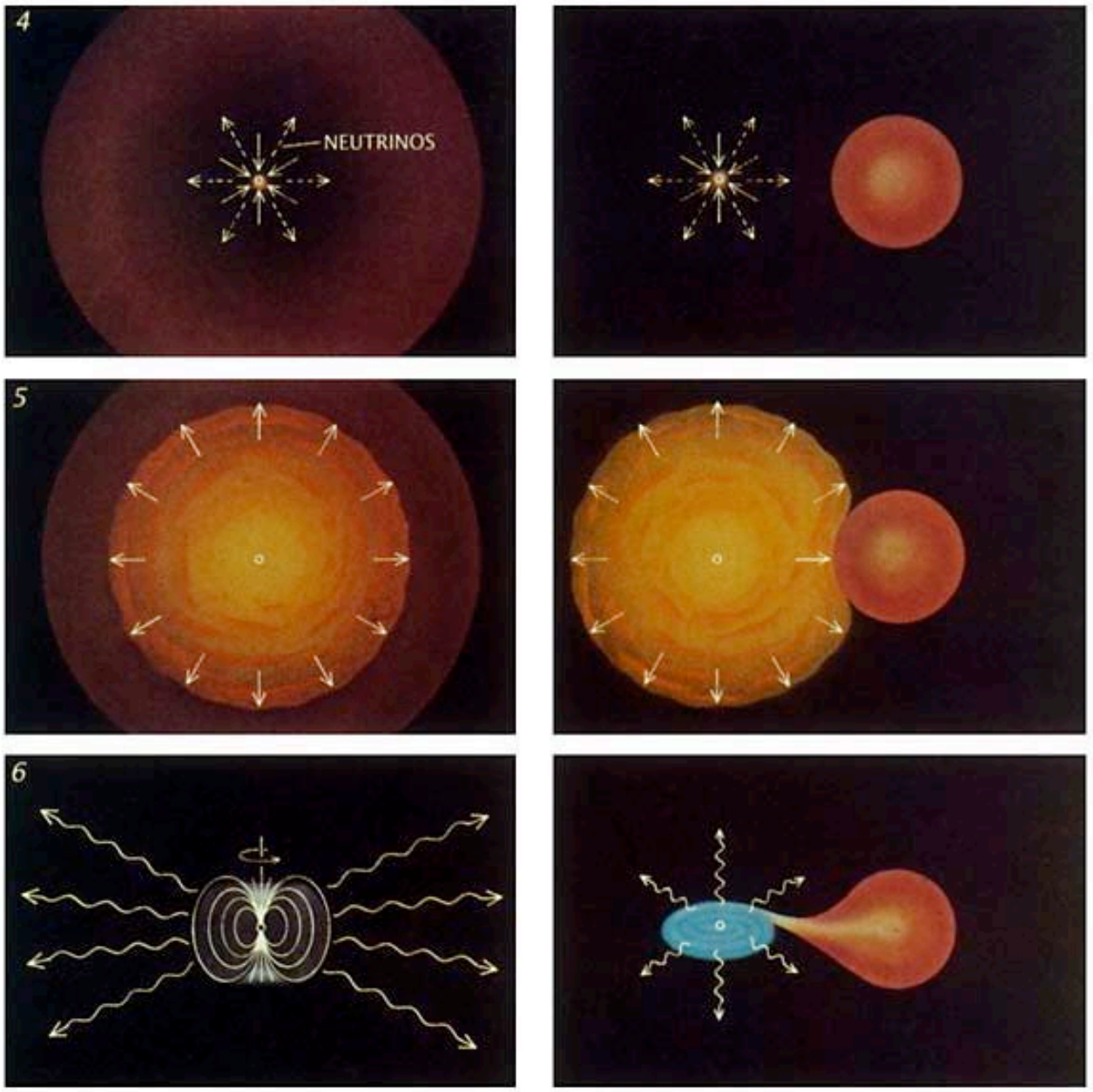
$\Rightarrow$99% of energy of collapse is carried off by neutrinos (Ch 1 2.1, 2.2)

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?

A) Charge repulsion keeps nuclei apart

B) The strong nuclear force keeps nuclei apart

C) To overcome the loss of neutrinos

D) To make protons

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)

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?

A) It produces a great deal of energy

B) It absorbs energy

C) It produces neutrinos

D) It combines with oxygen and produces rust

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!

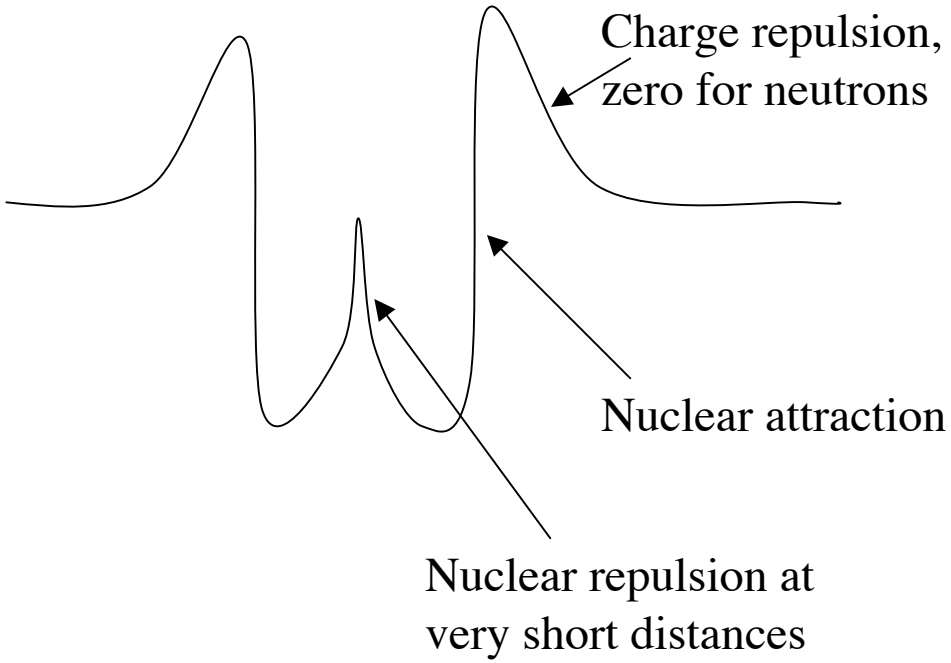
The outer parts of the star, beyond the neutron star, are ***transparent to the neutrinos***, the neutrinos flood out freely and carry off most of the energy.

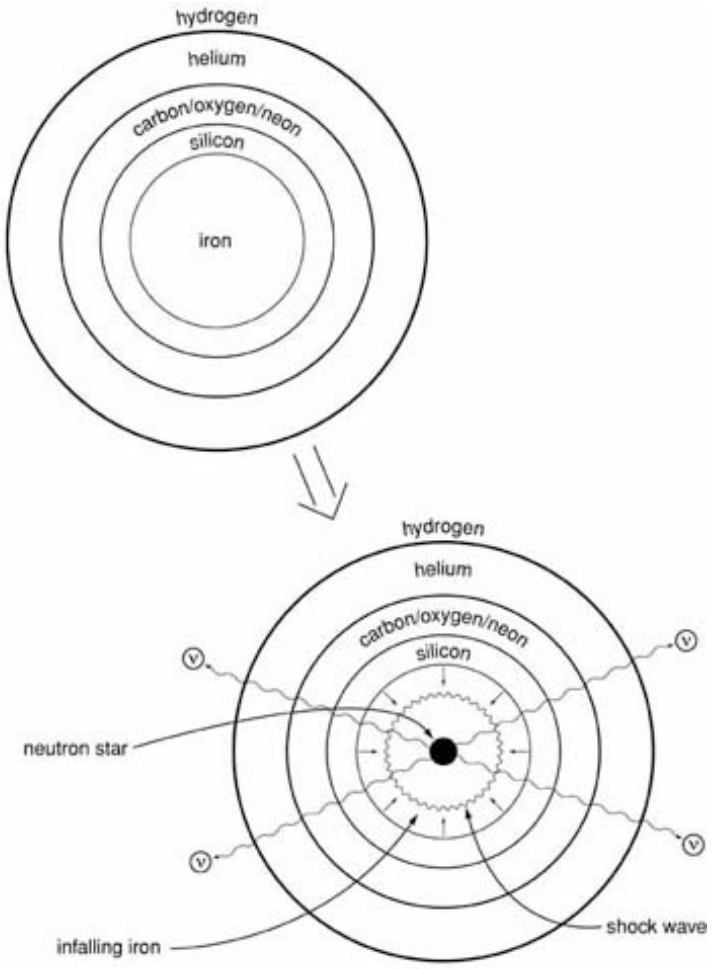
Is 1% of the neutrino energy left behind to cause the explosion?

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

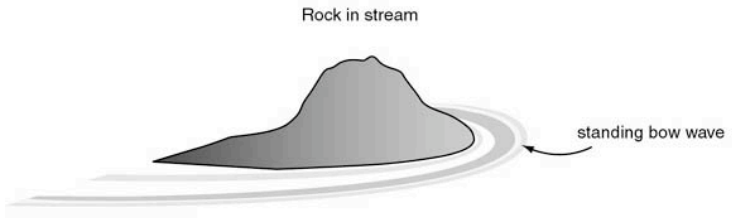




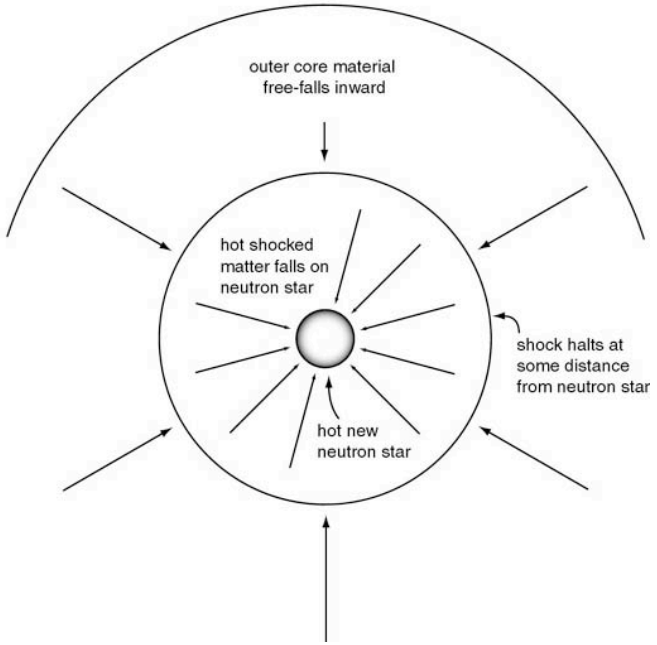
Maximum mass of a neutron star is 1.5 to 2 solar masses

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

DOES NOT WORK!



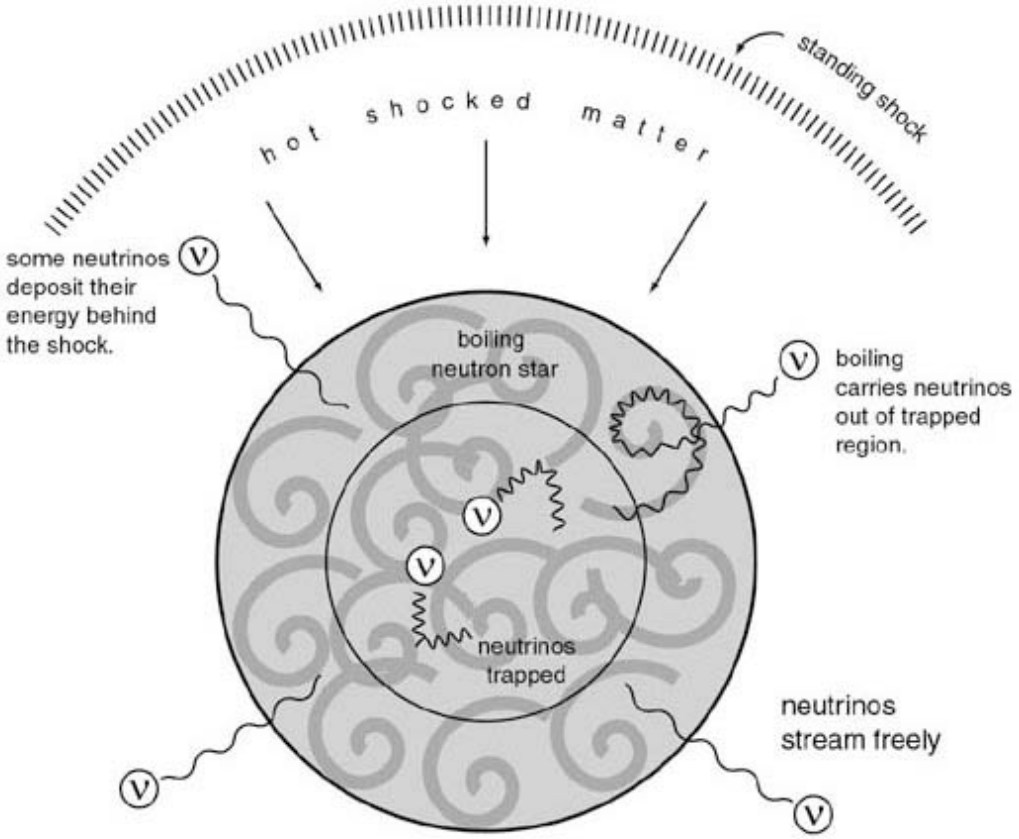
Form ***standing shock***, and outer material just continues to fall in, pass through shock front and settle onto the neutron star.



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…

One Minute Exam

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

A) Neutrons

B) Protons

C) Neutrinos

D) Photons

One Minute Exam

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

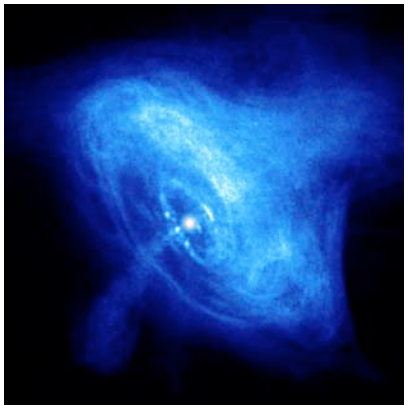
A) It fades away

B) It propagates out through the star and causes an explosion

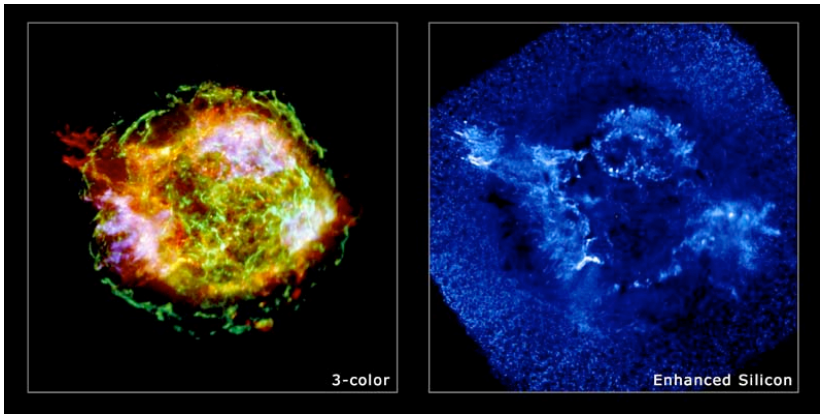
C) It stalls at some distance from the neutron star

D) It traps neutrinos

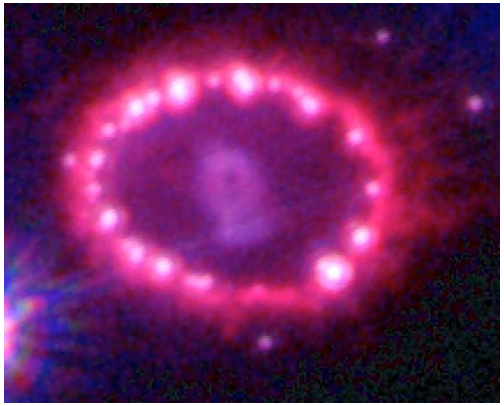
New possibility - Jet-induced supernova (Ch 6, p. 94)



Crab Nebula



Cassiopeiae A



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Are jet-like flows typical? Are they important?