Monday, March 5, 2012

Office hours delayed until 3:15 today.

In my zeal to talk about superluminous supernovae on Friday, I skipped over two last slides on SN 1987A. I'll talk about them today, but am going to add them to Lecture 16 and repost that, so that everything is in proper order.

Reading: Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Astronomy in the news?

News:

Goal – to understand the nature of a new class of super-luminous supernovae

One Minute Exam

What can we say about all the superluminous supernova with some confidence?

→ They have hydrogen

← They do not have hydrogen

↑ They are bright because of the shell-shock mechanism

↓ They arise in very massive stars

One Minute Exam

What aspect is **not** a property of the Pair-Instability model?

➡ Creation of matter and anti-matter

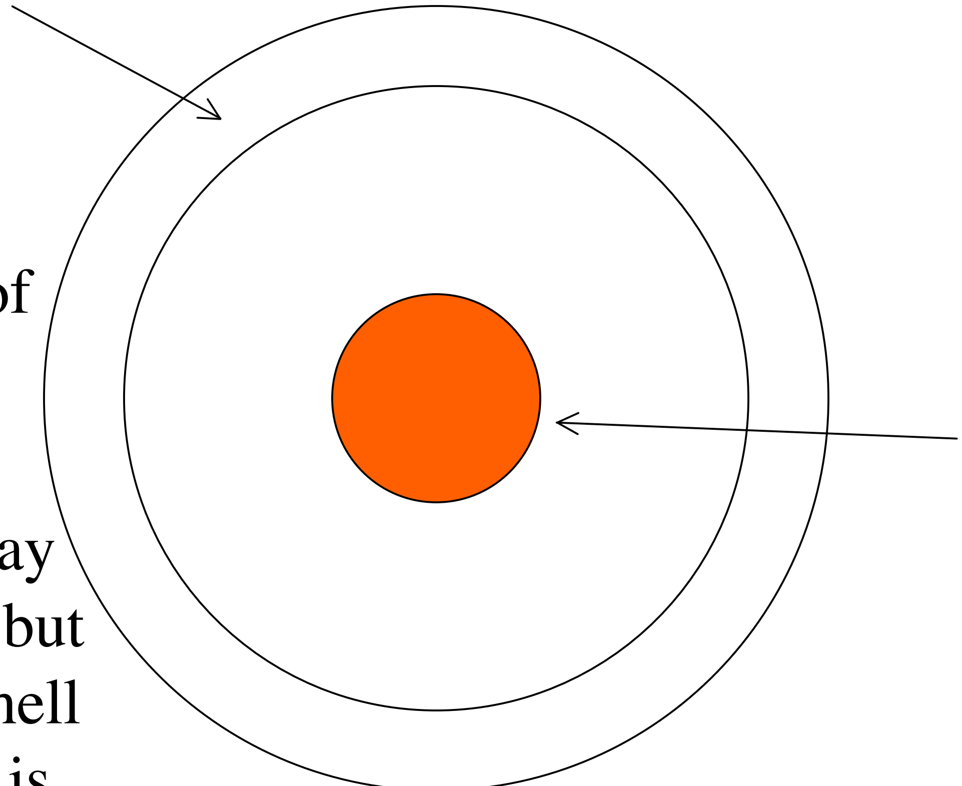
⬅ Thermonuclear explosion of oxygen core

⬆ Production of many solar masses worth of radioactive nickel-56

⬇ Collapse of the core to form a neutron star

# Simple Version of Shell-Shock Model

Shell of matter previously expelled by progenitor star with size about 100 times that of Earth's orbit



Supernova from massive star, but nature otherwise obscured by shell, so unknown

The supernova may expand and cool, but when it hits the shell its kinetic energy is converted to heat that is radiated efficiently

## *Current Status of Superluminous Supernovae*

Superluminous supernovae involve very massive stars.

They tend to occur in regions of active star formation in low mass, irregular galaxies.

Some show hydrogen, some do not.

Some show evidence for the shell-shock picture, some do not.

Some show evidence consistent with the Pair-Instability model, some are not consistent with that model.

## *Current Status of Superluminous Supernovae*

Some show no hydrogen and no evidence for circumstellar shocks, but also are not consistent with the Pair-Instability model.

Shell shock in shell of carbon and oxygen? Some very massive stars might eject their hydrogen and helium in strong winds, then eject shells of carbon and oxygen.

Some evidence for a shell rich in oxygen in one case.

If there is a single mechanism, then it is probably shell-shock, but perhaps there is more than one mechanism at work.

# Neutron stars

## Alone and in binary systems

Reading Chapter 8 - Sections 8.1, 8.2, 8.5, 8.6, 8.10

Combination of quantum pressure from neutrons and repulsion of neutrons at very close distances by strong nuclear force $\Rightarrow$ pressure to withstand gravity.

Analog of Chandrasekhar mass - maximum mass of neutron star - uncertainty over nuclear repulsion, maximum mass ~ 2 $M_\odot$

Probably 100 million to a billion neutron stars in the galaxy, cold, tiny, and dark.

Nearest, undetected, may be only a light year or so away.

Vast majority of about 2000 known neutron stars are alone in space.

~ 20 - 30 have binary companions, ordinary stars, white dwarfs, other neutron stars, and black holes.

Goal:

To understand how isolated neutron stars are observed as "pulsars."

To radiate, radio pulsars must be rotating and ***magnetic***:

Wiggle magnetic field ⇒ wiggle electric field
⇒wiggle magnetic field ⇒ ***Electromagnetic radiation***

Simplest configuration North, South poles ***Dipole*** with “lines of force” connecting poles.

Ionized plasma can move along “lines of force,” not across them. Lines of force drag the plasma around like beads on a wire.

If the plasma blobs are aligned with the rotation axis, the system is too symmetric to “wiggle.”

If blobs of plasma are off-center from the rotation axis, they are whipped around by the rotating magnetic field and generate radiation. Magnet, filings