## 3/4/05

Test 2 on next Wednesday Chapter 6, Sections 1 - 4
Review Sheet will be posted (if not already)
Review Session Tuesday, RLM 15.216B 6 - 7 PM
Note change of day, time

News? Watch for appointment of new head of NASA

Pic of the day - Galaxy in motion



Iron core of massive star absorbs energy, collapses to form neutron star.

Essentially all protons and electron are converted to neutrons with the emission of a *neutrino*.

Neutron Star - mass of Sun, but size of small city,  $\sim 10$  kilometers in radius, density of atomic nucleus.

When neutron star forms, get huge energy, 100 times more energy than is needed to explode off the outer layers.

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.





Maximum mass of neutron star is 1.5 to 2 solar masses

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

DOES NOT WORK!

Rock in stream standing bow wave outer core material free-falls inward hot shocked matter falls on neutron star shock halts at some distance from neutron star hot new neutron star

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...

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



Crab Nebula

Cassiopeiae A

SN 1987A

Are jet-like flows typical? Are they important?

What is the shape of a routine, extragalactic, core collapse supernova?

Ball, Football, Frisbee?

How do you measure that for a distant supernova that only appears as a dot of light in even the most powerful telescopes?

Polarization - orientation of the electric component of the electromagnetic waves (light) that comes from the surface of the star.

Polarization = 0: intensity the same in orthogonal directions, photosphere is circularly symmetric, supernova is spherically symmetric (or special viewing angle)



 $P \neq 0$ : intensity different in orthogonal directions, photosphere is not circularly symmetric, *supernova is asymmetric* 





Polarization studies (last 5 years) show that all Core Collapse Supernovae are out-of-round.

Perhaps combination football, frisbee, or something else.

They show shapes consistent with routine jet-like flow.

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



These supernovae may be related to *gamma-ray bursts*.

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