Wednesday, September 25, 2013

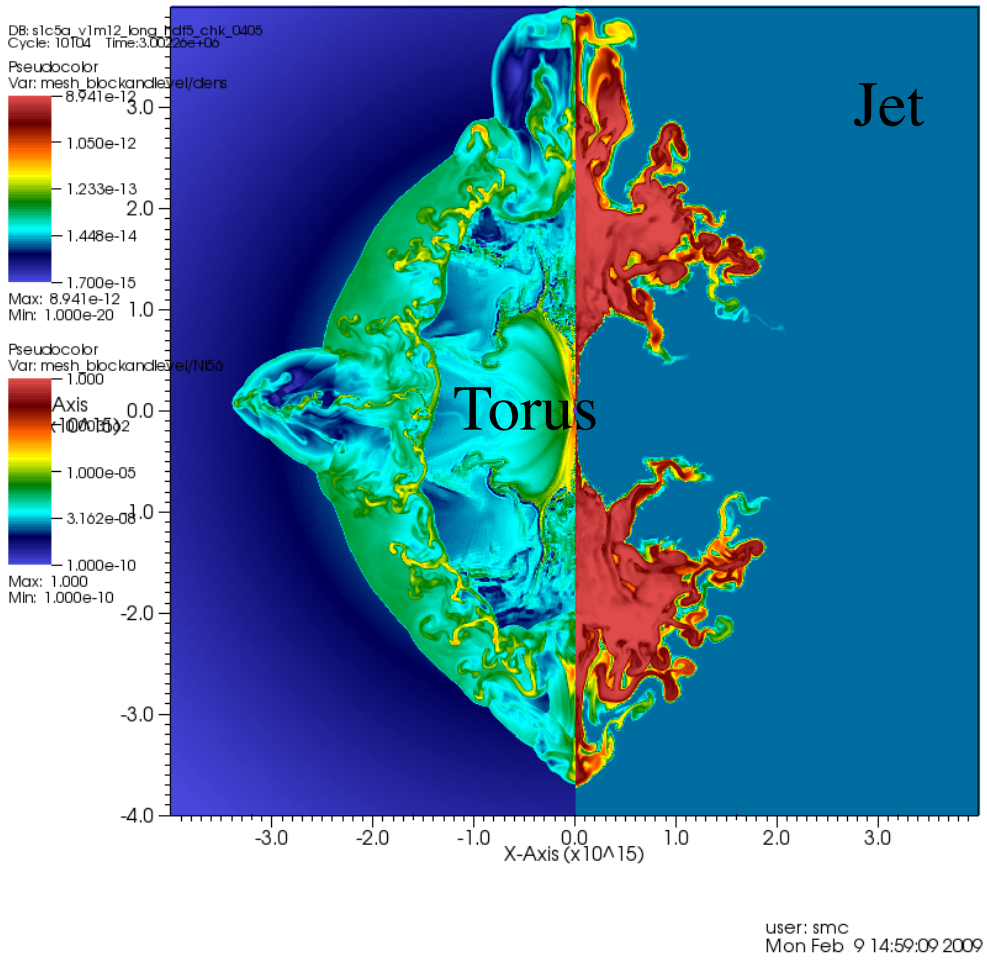
See Kevin for exams, skywatch.

Reading Chapter 6 (continued) Sections 6.4, 6.5, 6.6, 6.7
(background: Sections 1.2, 2.1, 2.4, 2.5, 3.3, 3.4, 3.5, 3.10, 4.1, 4.2, 4.3, 4.4, 5.2, 5.4)

Astronomy in the news?

Goal

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



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)

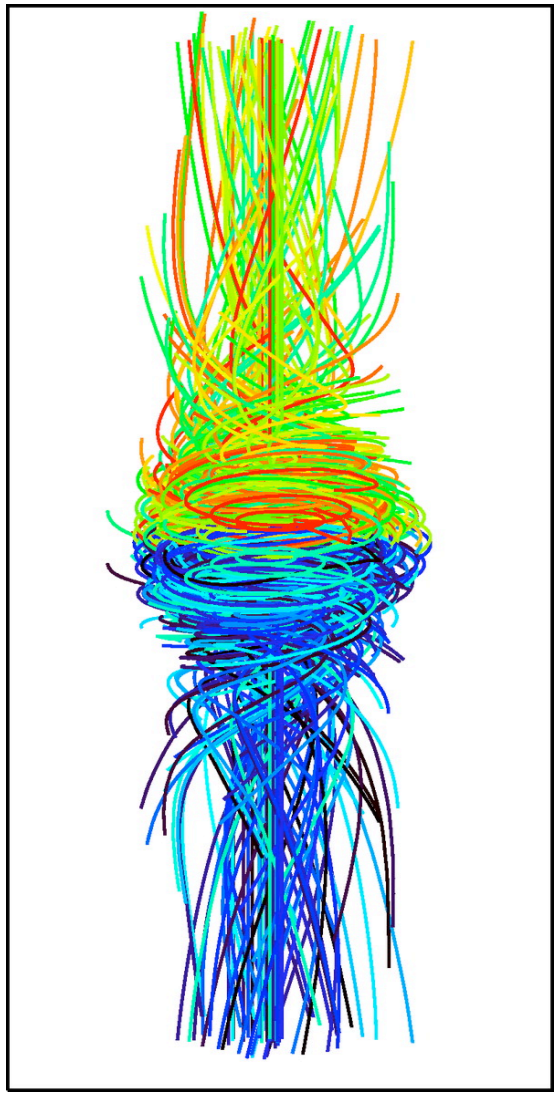
Rotate magnetic neutron star, amplify the magnetic field, eject mass if field is strong enough.

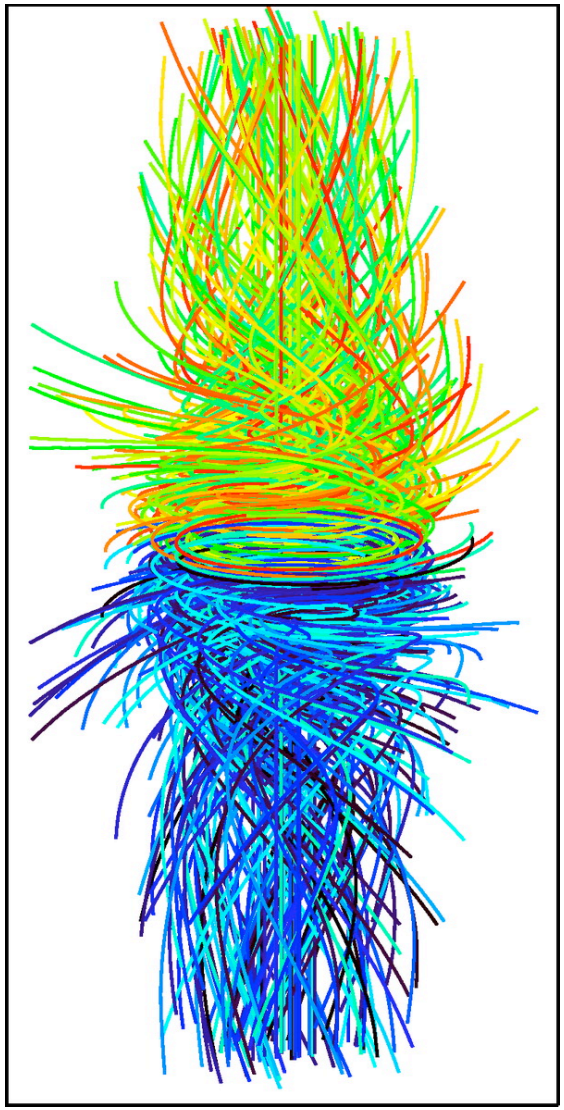
Magnetic lines of force, locus of equal field strength, act somewhat like rubber bands, they are elastic and tend to rebound if deformed and can be twisted and coiled.

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.

Twisted magnetic field lines of force making a magnetic jet during core collapse – A. Burrows et al.





What jets do -

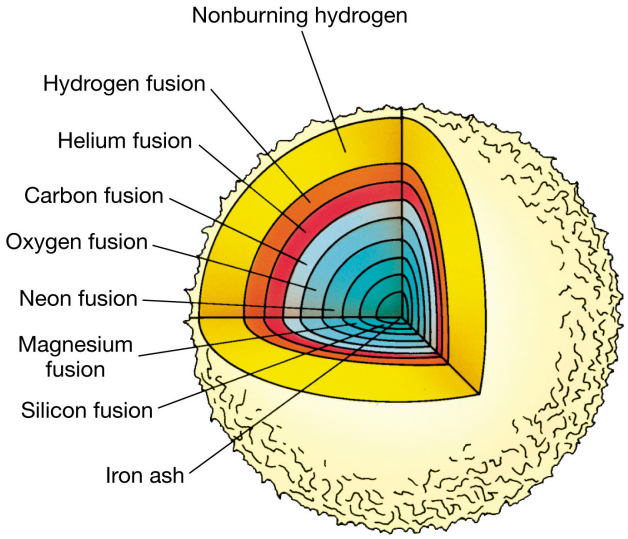
Bagel and breadstick, jet/torus shape "natural."

Strong enough jet can explode the star, but neutrinos also play a role - complicated problem!

Account qualitatively for out-of-round shapes.

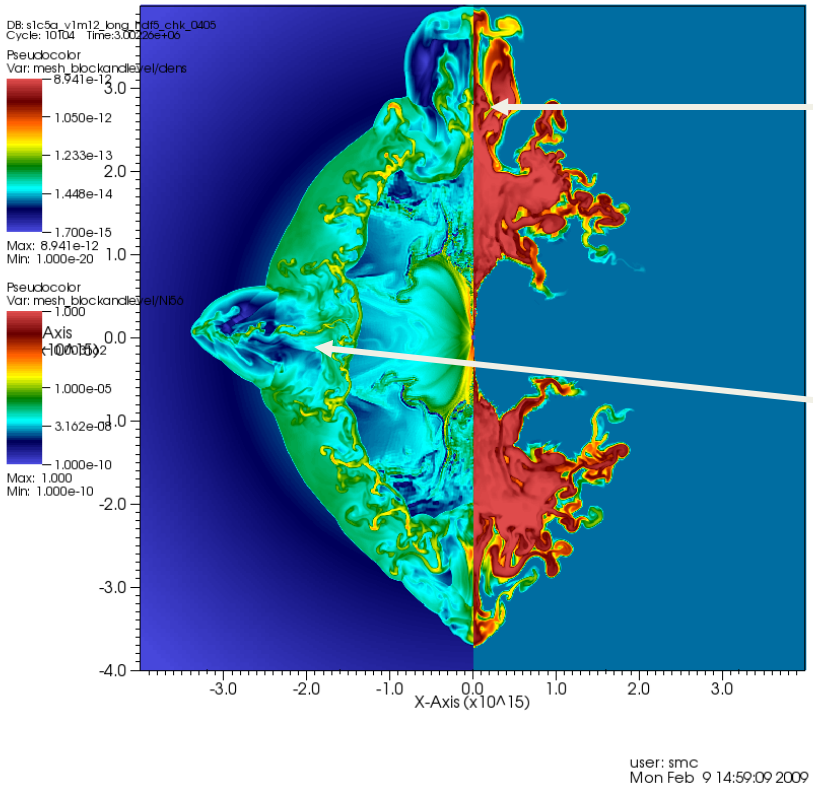
Test for shape (jet/torus), prediction of different elements exploded in different directions.

Initially spherical model,



Spherical Explosion
hydrogen, helium, oxygen, silicon, calcium, and iron would be exploded in all directions

Jet-induced Explosion axis/torus structure



Jet
iron, O bread stick

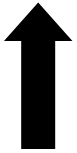
Torus
He bagel

One Minute Exam

Why do astronomers think that jets may be involved in the core collapse explosion of massive stars?:

 Iron makes jets

 Jets make iron and oxygen

 Cassiopeia A has a collapsed object in the center of the explosion

 All core collapse supernovae are out of round

Bagel and Breadstick Halloween costume, 2008,

Marquette University, Milwaukee

Understanding how magnetic fields form and behave in core collapse is on the cutting edge of research.

There is yet no general agreement as to how *implosion* of the iron core is turned into the *explosion* of the supernova.

Rebounding, boiling neutron star, standing shock, neutrinos, rotation, and magnetic fields are all important ingredients.

Still a huge challenge to simulate properly on supercomputers.

Nature does not care what astrophysicists do not understand.

Type II and Type Ib/c supernovae continue to explode!

Back to physics of Type Ia Supernovae - exploding white dwarfs

Chapter 6, Section 6 in Cosmic Catastrophes

Background in Chapters 3, 4, 5.

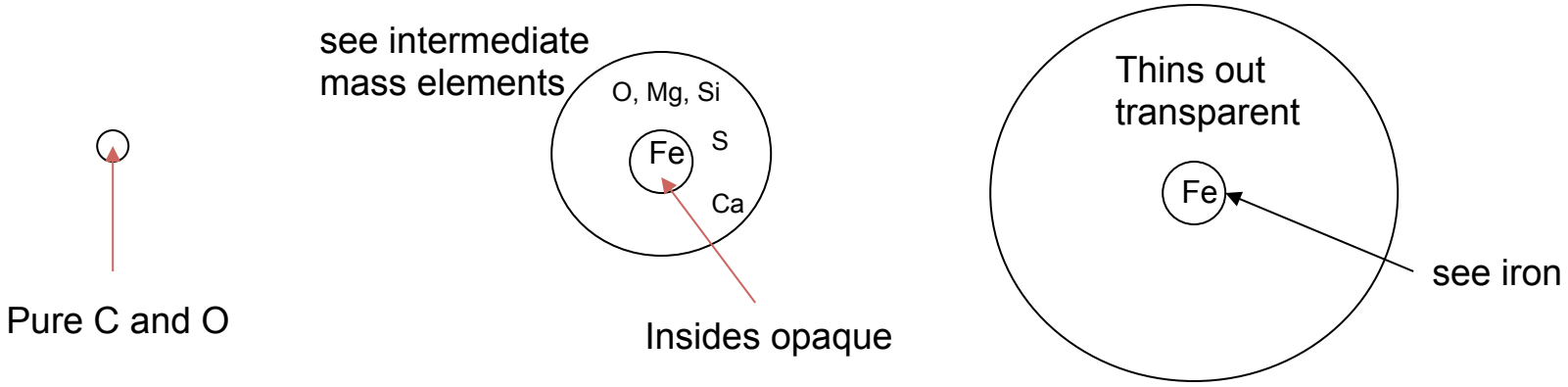
Goal

To understand the process of thermonuclear explosion in a white dwarf to make a Type Ia supernova.

Type II (Ib, Ic) energy from falling, gravity, Type Ia energy from thermonuclear explosion.

For core collapse, iron is produced BEFORE the explosion in the progenitor star and triggers collapse. For thermonuclear explosion of carbon and oxygen, iron is produced DURING the explosion.

Type Ia - see O, Mg, Si, S, Ca early on, iron later => ***iron is inside***



Initial White Dwarf Near maximum light Weeks after maximum