Friday, February 14, 2014

Grades posted on Blackboard, Keys on Web site.

New exam schedule for 2, 3, 4 on MONDAYS, 3/3, 3/31, 4/14. 5th still on Friday, 5/2. Reviews will still be on previous Thursdays.

Reading for Exam 2: Sections 6.1 (end, Type Ib/c) 6.4 (collapse and explosion), 6.5 (jets; but not detail on polarization), 6.6 (Type Ia), Betelgeuse interlude.

Background: Sections 1.2.1 (strong and weak nuclear forces, neutrinos, 2.1 (massive star evolution), 2.2 (stellar winds), 2.4 (core collapse), 2.5 (core collapse), 3.3, 3.4, 3.5, 3.10 (binary star evolution), 4.1, 4.2, 4.3, 4.4 (accretion disks), 5.2 (cataclysmic variables), 5.4 (cataclysmic variables)

Evolution of 2 white dwarfs, end of Section 5.4 and Section 6.7 will be on Exam 3.

Astronomy in the news?

China's Jade Rabbit lunar rover is awake, but malfunctioning.

National Ignition Facility in Livermore CA, has produced more energy by thermonuclear burning than input by lasers. Implode tiny ball of deuterium (heavy hydrogen, one proton and one neutron) by focussing 172 super-powerful lasers in an array the size of a football field.

Workshop report: Type Ia supernovae at the Institute for Advanced Study in Princeton. Participants from US, Germany, France, Israel, Japan, Chile, Denmark. Will apply to upcoming lectures.

Commentary on movie, the making of *Supernovas* on the UT campus. The role of Robert Quimby, superluminous supernovae.

Update on new “nearby” supernova SN 2014J in M82

Observed near maximum light with 16 inch telescope on top of RLM a week ago. I was in my office late, but did not think to go up to the telescope!

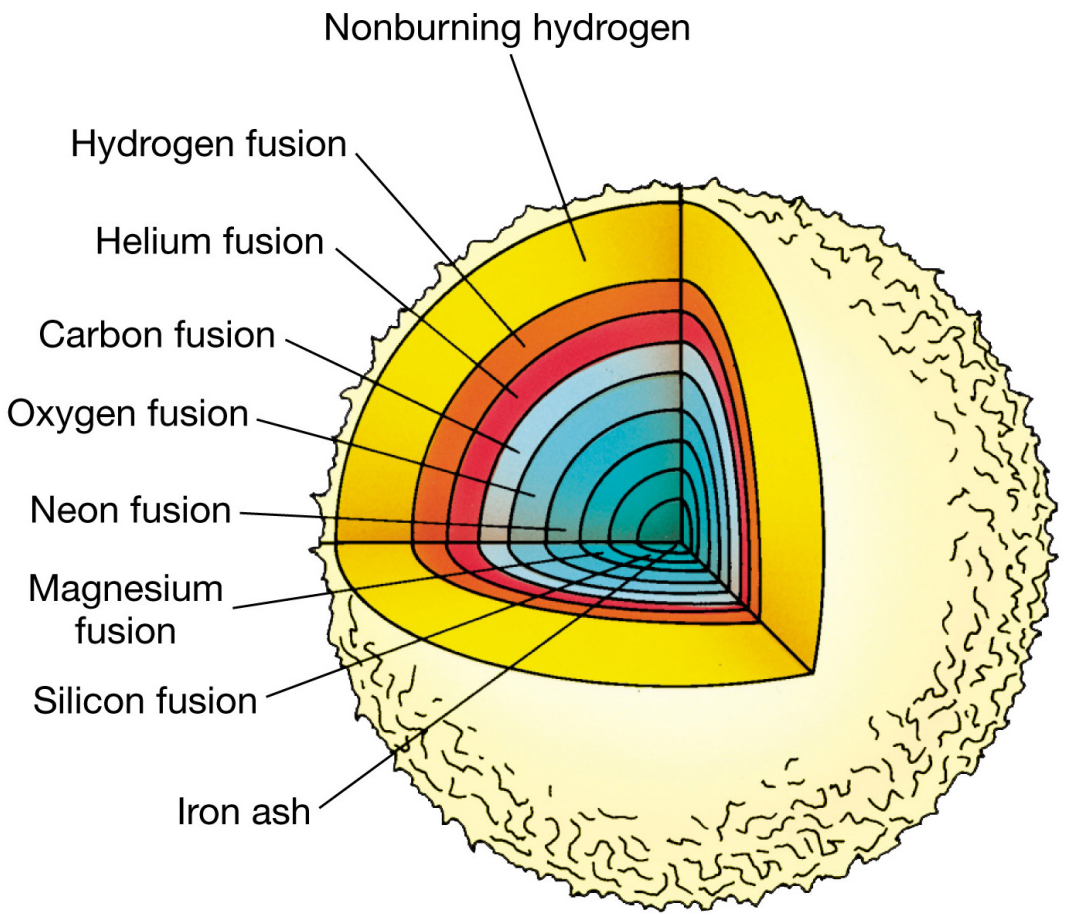
Public talk in Princeton, but too crowded around the telescopes afterward, so still have not seen.

Astronomers have predicted, but never seen high energy gamma-ray radiation from a Type Ia supernova. Rumor has it that a new orbiting satellite, NuStar, may have detected it. Very important for determining nature of the explosion (lectures to come).

Goal: to understand the origin of Type II, Ib, Ic

How does a massive star get from hydrogen to iron, and why iron, and what then?

Reading: Section 2.1, 2.4, 2.5, 6.4 – 6.5



Make succession of heavier elements

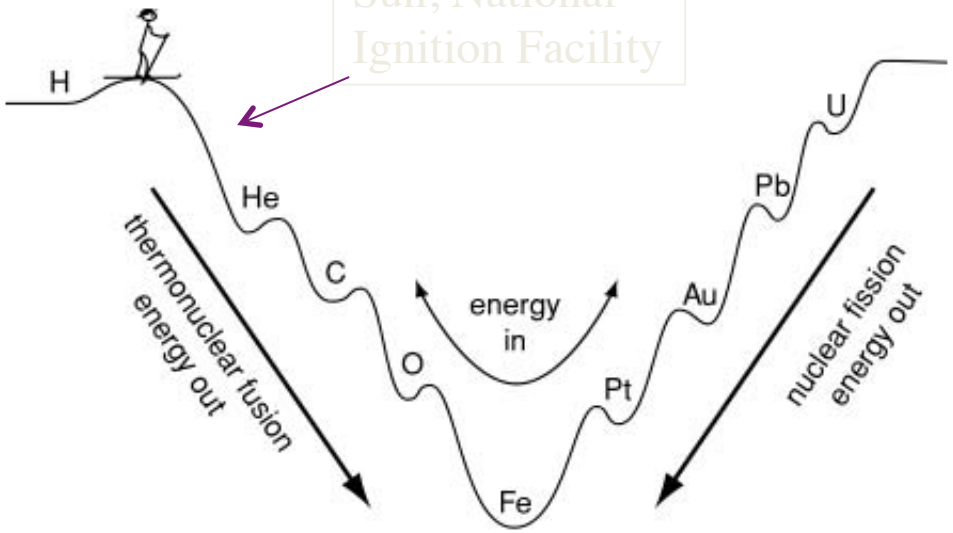


Figure 2.3 measure of binding energy of protons and neutrons in the atomic nucleus

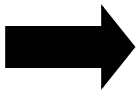
Special role of Iron - 26p, 30n, most tightly bound arrangement of protons and neutrons.

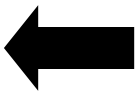
Endothermic - must put energy in to break iron apart into lighter elements or to forge heavier elements. Irons absorbs energy, lowers pressure, core contracts, iron absorbs more energy, more contraction…

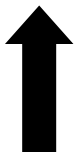
=> The iron core quickly collapses! Catastrophic death of the star.

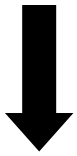
One minute exam

Why do you have to heat a nuclear fuel to make it burn?

 Charge repulsion keeps nuclei apart

 The strong nuclear force keeps nuclei apart

 To break chemical bonds

 To break apart iron

Goal

To understand what happens after a massive star forms an iron core

Iron core of massive star absorbs energy.

When iron core forms - star is doomed to collapse.

Iron core collapses in about 1 second to form a ***neutron star*** (or maybe a black hole), composed essentially of all neutrons. Neutrons are formed when protons and electrons combine.

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

Action of Weak Nuclear Force (Chapter 1.2)

One neutrino is generated for every proton that is converted, a star's worth of protons

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

During iron core collapse, essentially all protons and electrons are converted to neutrons with the emission of a ***neutrino.***

Neutrinos have a tiny mass, no electrical charge, interact little with normal matter, only through weak nuclear force (Chapter 1.2).

Normal stellar matter is essentially *invisible* to neutrinos.

⇒99% of energy of collapse is carried off by neutrinos
(Ch 1.2, 2.1, 2.2)

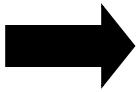
Collapse leads to a neutron star.

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

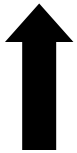
Huge gravity - surface is now ***much closer*** to the center!

One minute exam

What is the importance of iron in massive stars?

 It produces a great deal of energy

 It absorbs energy

 It produces neutrinos

 It combines with oxygen and produces rust