Physics 100 - March 19, 2007

Welcome Back

- TA feedback/survey

- Presentations approacheth –

  Time to set up meetings with prof. Manly

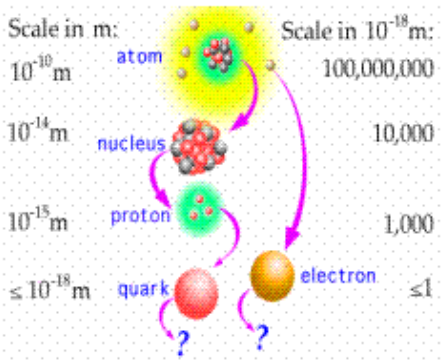
  Plans, mode(s) of presentation,
  Timing, A/V, DeMOS, questions, sources ...

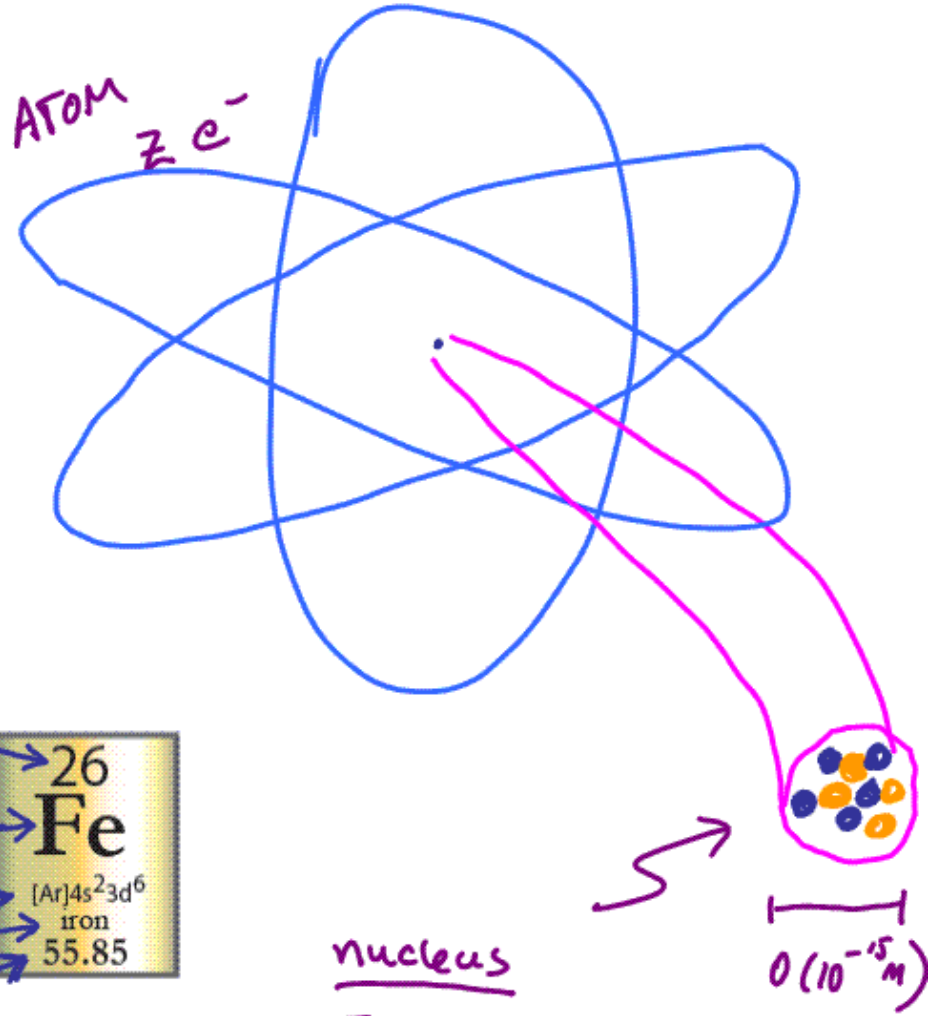
  April 11, 16, 18, 23, 25

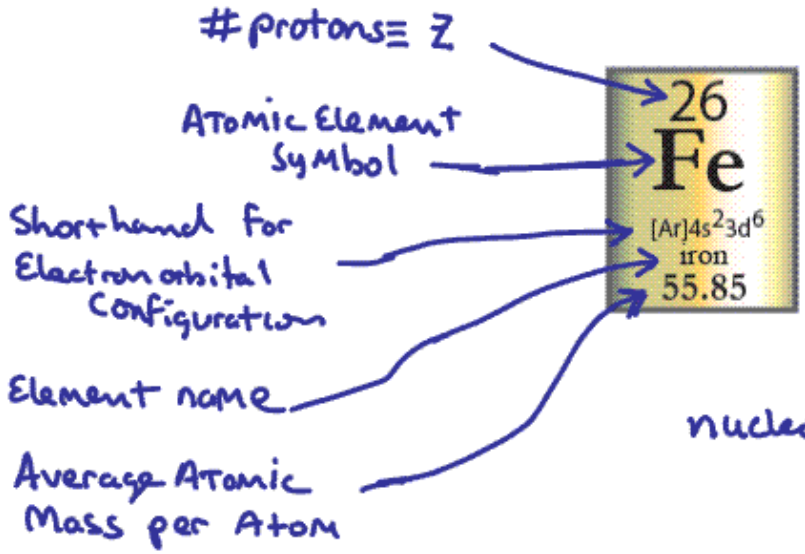
  Two per day 1st come - 1st served Scheduling

Last Time

nuclear physics







nucleus

nucleons [Z protons
A-Z neutrons

A ≡ Atomic Mass

Why does nucleus NOT Blow Apart?

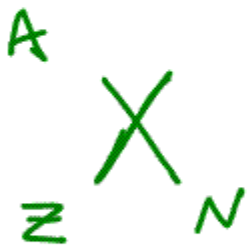
There exists a Strong nuclear force that is

Much stronger than gravitation and electromagnetism

but has a range limited to $\sim 10^{-15}$ m

$\Rightarrow$ Pop this force into Schrödinger's equation

get discrete energy levels for nucleons

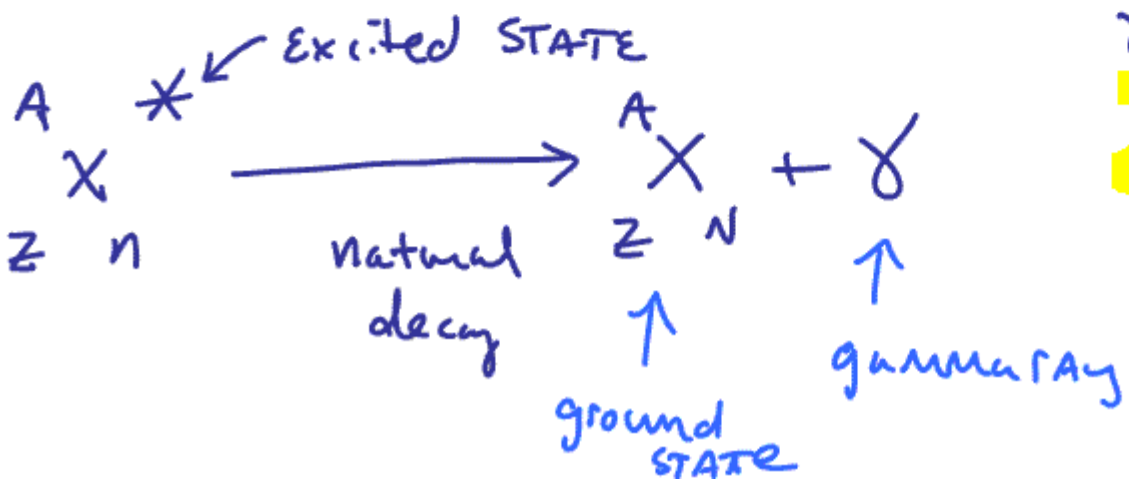


A ≡ # protons + neutrons

Z = # protons

N = # neutrons

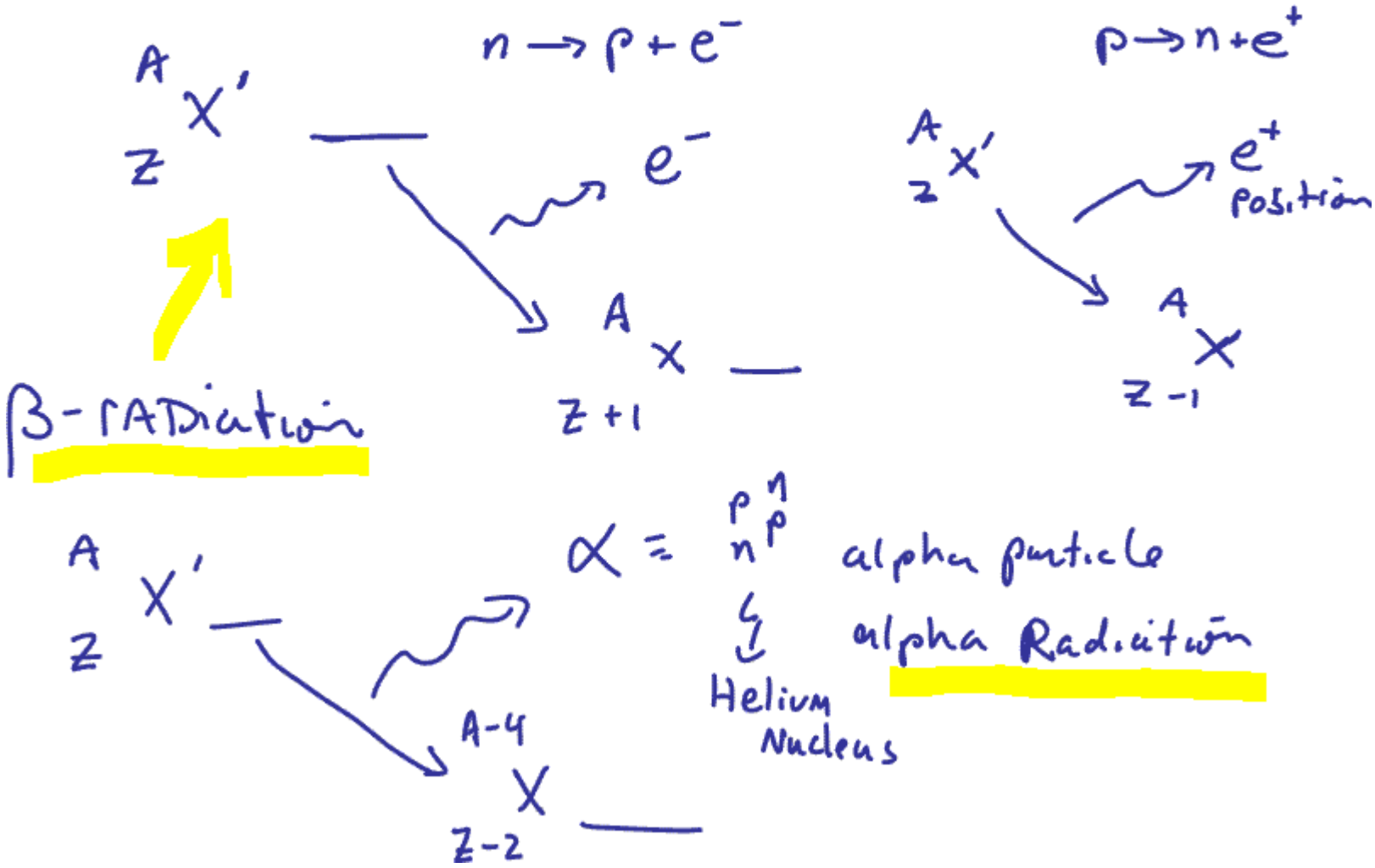
X ≡ Atomic Element Symbol



γ-radiation

Naturally radioactive substance

$E = mc^2$



N atoms in sample at time = 0

$$\text{Activity} \equiv \frac{\#\text{decays}}{\text{second}} = \frac{\Delta N}{\Delta t} = \lambda N$$

λ: decay CONSTANT

$$\text{halflife} \equiv t_{1/2} = \text{time for } \tfrac{1}{2} \text{ sample to decay}$$

$$t_{1/2} = \frac{0.693}{\lambda}$$

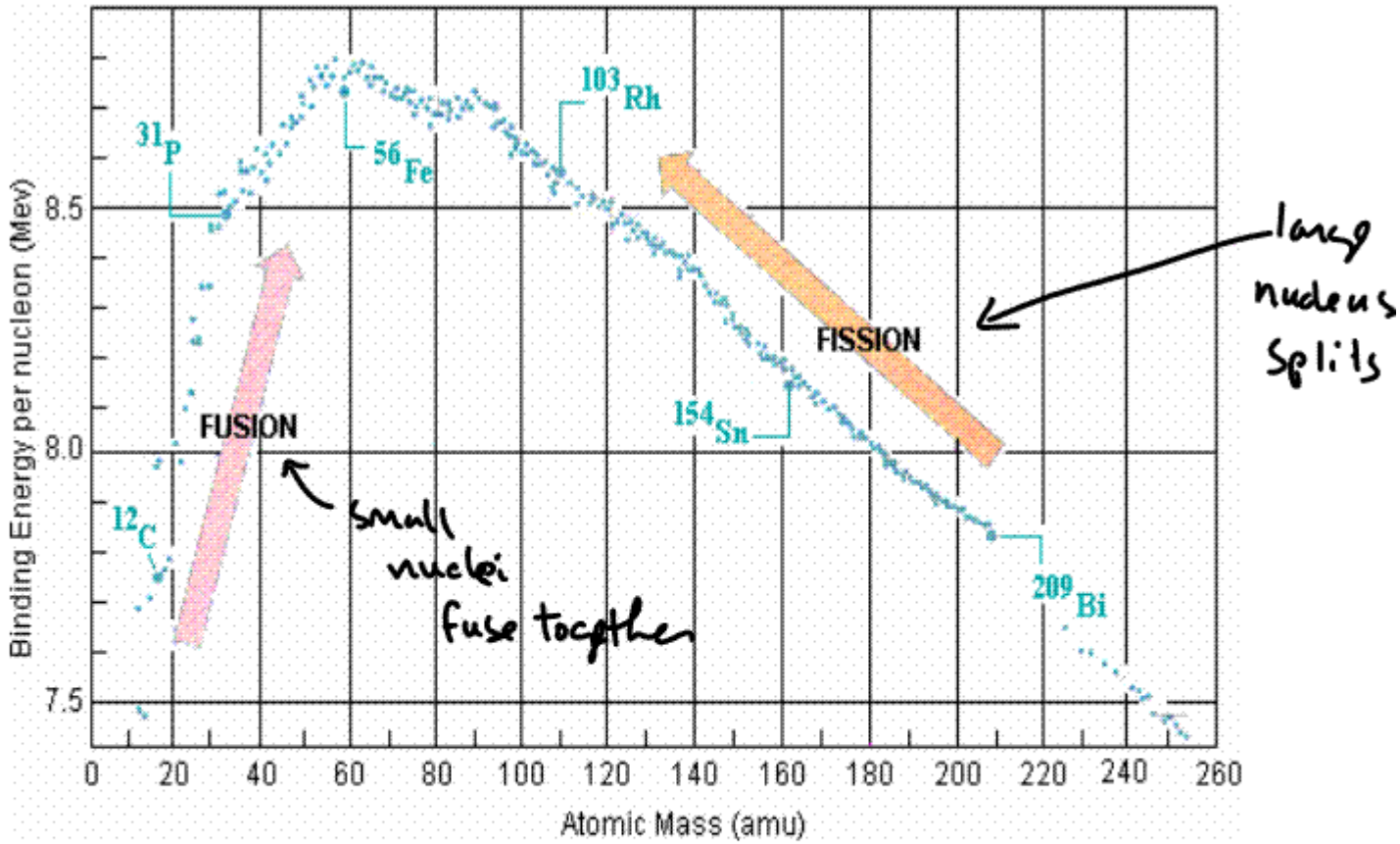
A sample of bone from an archeological dig has a ^{14}C activity that is 25% of that in a living material. How old is the bone?

^{14}C $t_{1/2} = 5730$ years

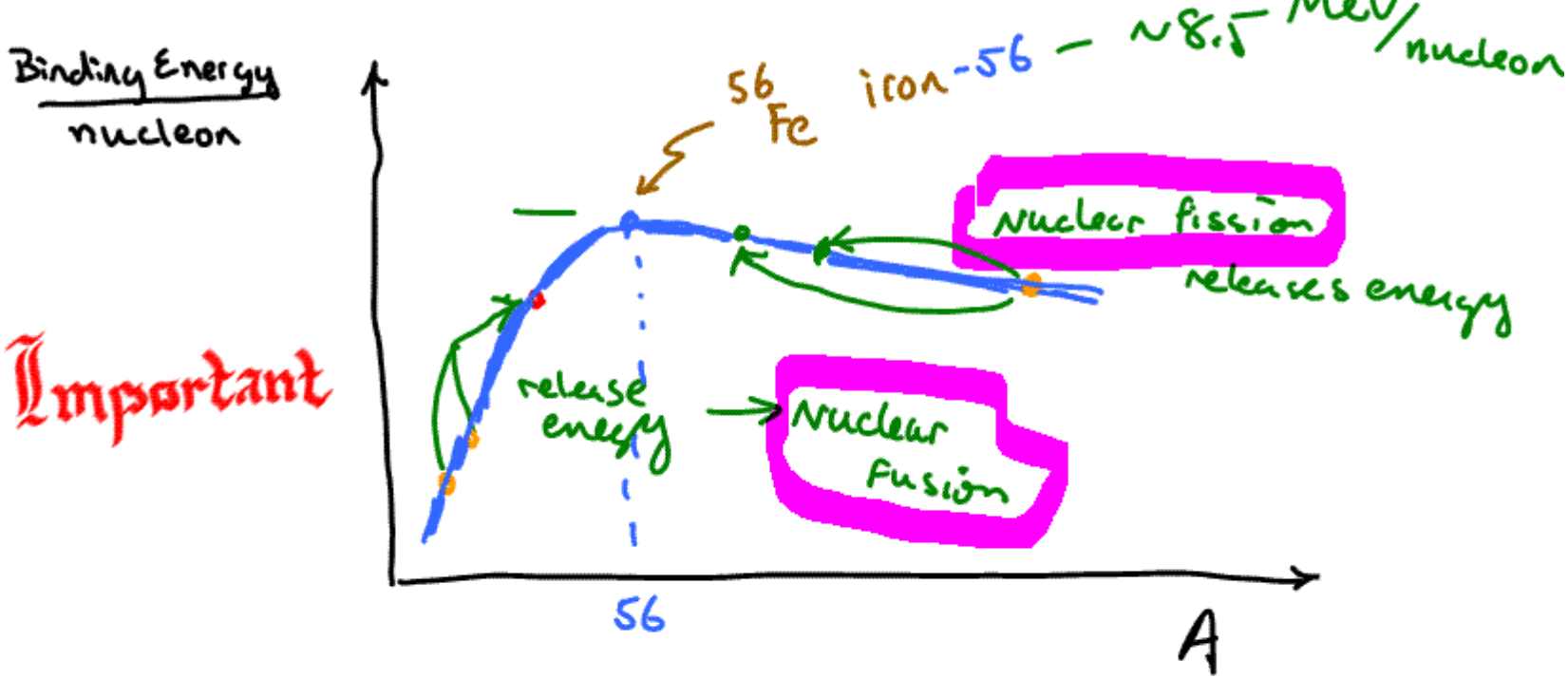
1 halflife: Activity falls to 50% of original

2 halflives: " " " 25% " "

Age $\sim$ (2) 5730 years $\sim$ 11,400 years



Binding energy/nucleon is a measure of how hard it is to remove a nucleon from the nucleus ... similar to how ionization energy is a measure of how hard it is to remove e^- from atom



Important

$$^{235}_{92}U + n \rightarrow {}^{93}_{37}Rb + {}^{141}_{58}Cs + 2n$$

cascade γ γ γ

M $\quad$ M'

$E = Mc^2$

$M > M'$

converting Mass to energy

Critical — 1 split for each split

Subcritical — <1 split for each split

Supercritical — >1 split " " "

$^{235}U \sim 0.7\%$ naturally occurring U

$^{238}U \sim 99.3\%$ " " "

Must "enrich" sample in ^{235}U to make useful for bombs or reactors

- Hard to do

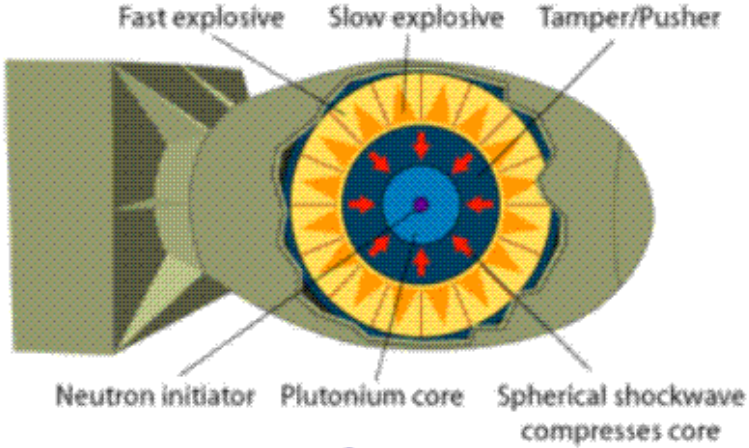
Breeder reactor

$$^{238}U + n \rightarrow {}^{239}U \rightarrow {}^{239}Np + e^- + \bar{\nu}$$

$$\hookrightarrow {}^{239}Pu + e^- + \bar{\nu}$$

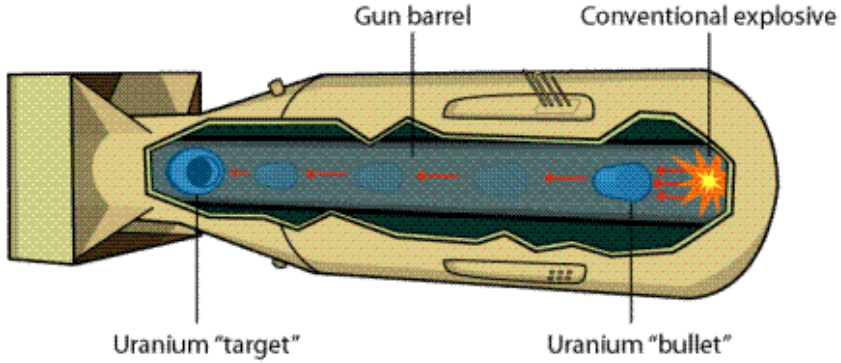
^{238}U: a not so useful isotope of Uranium

^{239}Pu: can use as nuclear fuel



Similar to Fat Man
used on Nagasaki
Aug 9, 1945

Similar to "Little Boy"
used on Hiroshima
August 6, 1945



Diagrams from Wikipedia

$$ {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}He + {}^{1}_{1}H $$

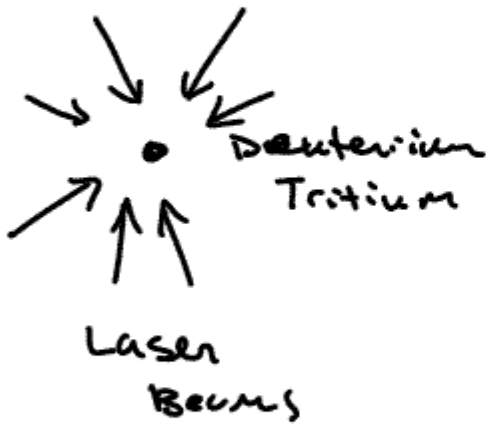
nuclear Fusion

small nuclei join to become larger nuclei

1. Releases ~1 MeV energy

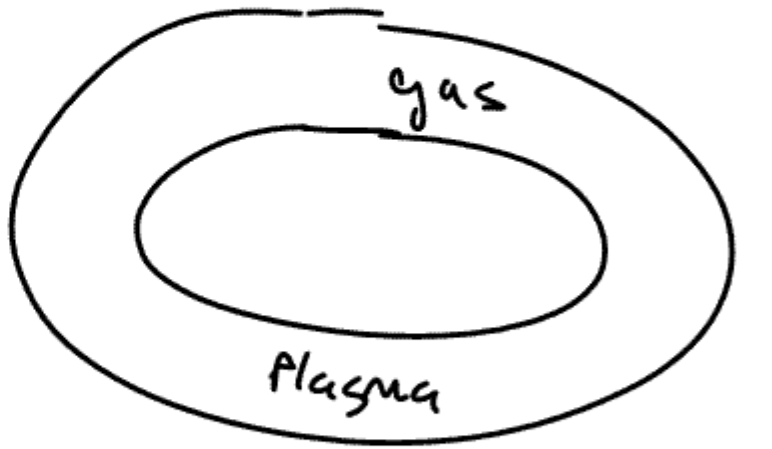
LLE

NOVA



Inertial confinement fusion

Magnetic confinement

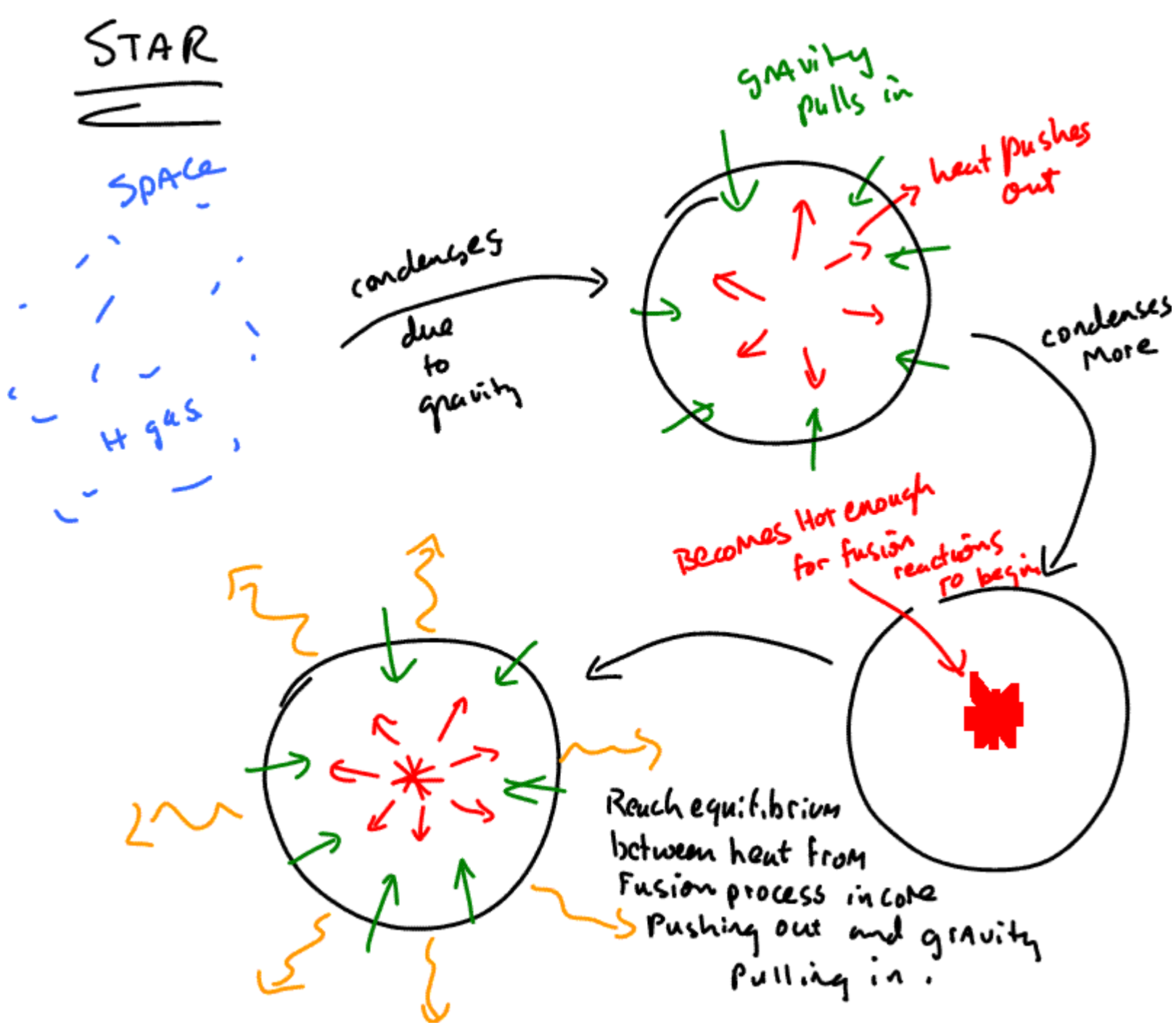


TOKAMAK

ITER

Takes a huge amount of energy or heat to force one (positive) nucleus close enough to another (positive) nucleus to fuse.

STAR


space
H gas
condenses due to gravity
gravity pulls in
heat pushes out
condenses more
becomes Hot enough for fusion reactions to begin
Reach equilibrium between heat from Fusion process in core Pushing out and gravity pulling in.