

Physics 102 - March 16, 2011

Last Time



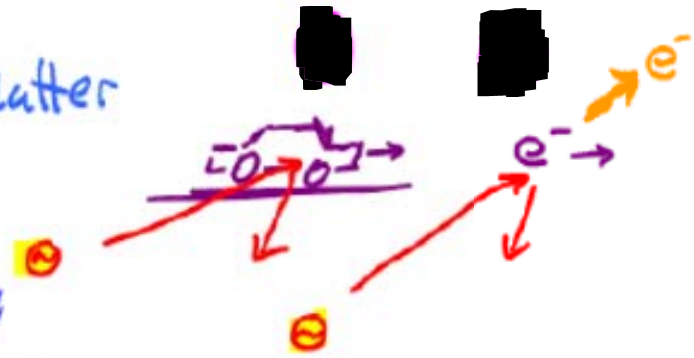
Heisenberg's
Uncertainty
Principle
~1927

$$\Delta x \Delta p \geq \frac{h}{2\pi}$$

$$\Delta E \Delta t \geq \frac{h}{2\pi}$$

Size Really DOES matter

Say goodbye to the
Deterministic
Universe



"apparent" loophole in energy conservation
holds the key to understand forces and
much of cosmology

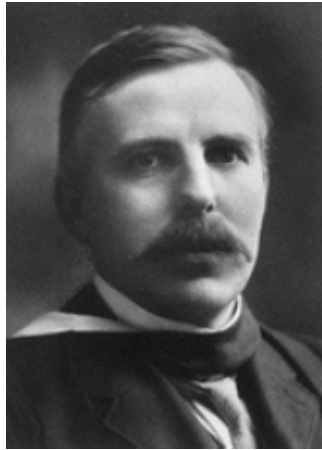
Say hello to the Harry Potter Universe

QUANTUM Field Theory \rightarrow Exchange force



We'll come back
to this ...

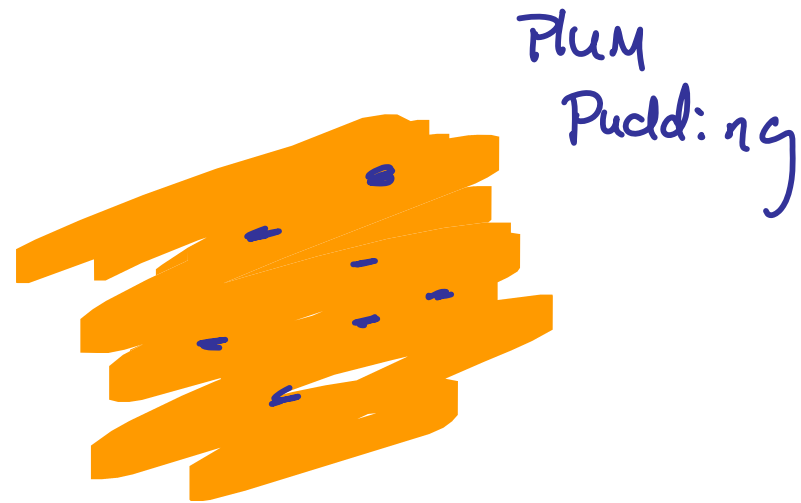
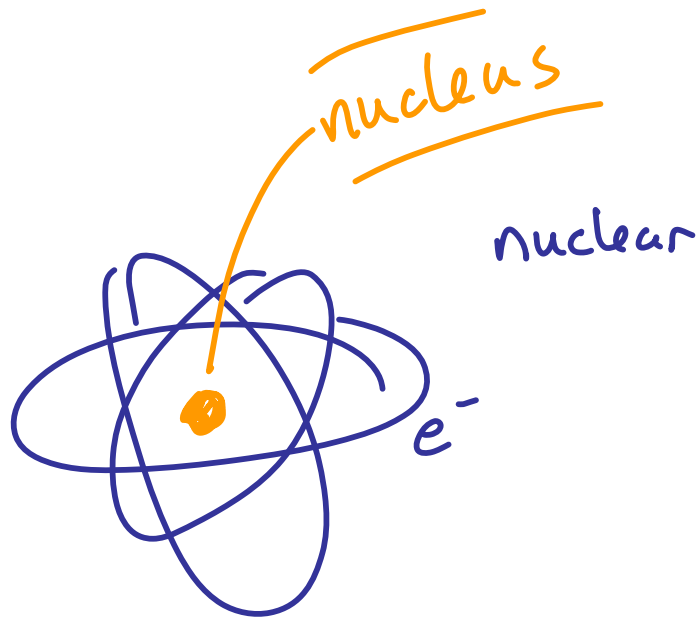
The nuclear Model of the atom

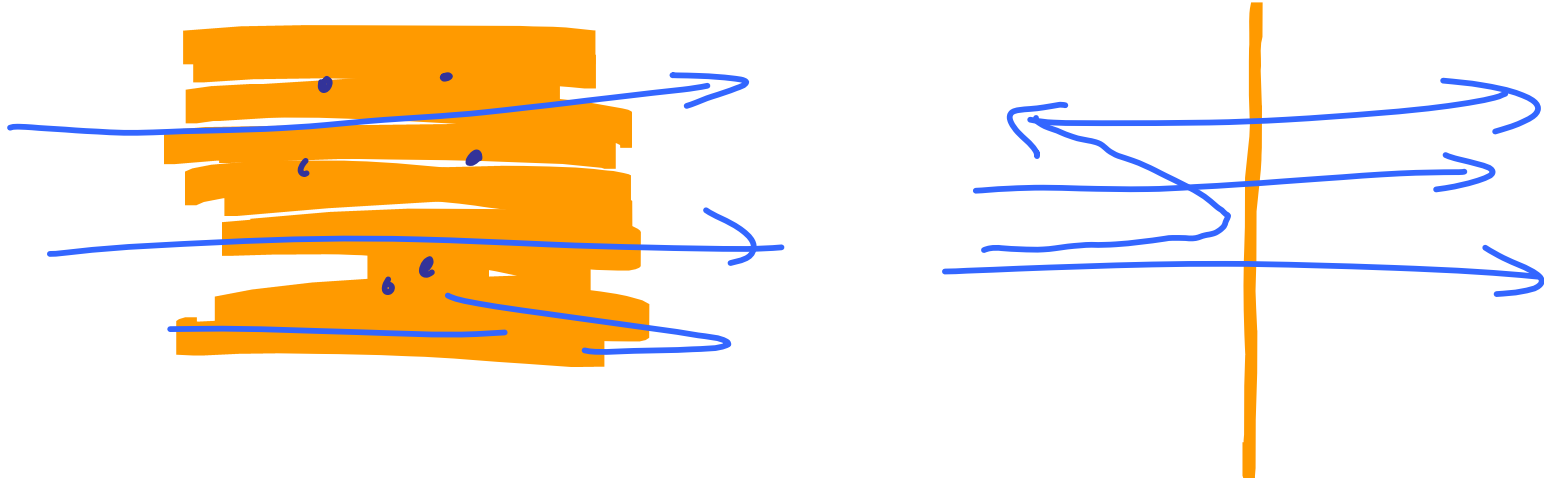
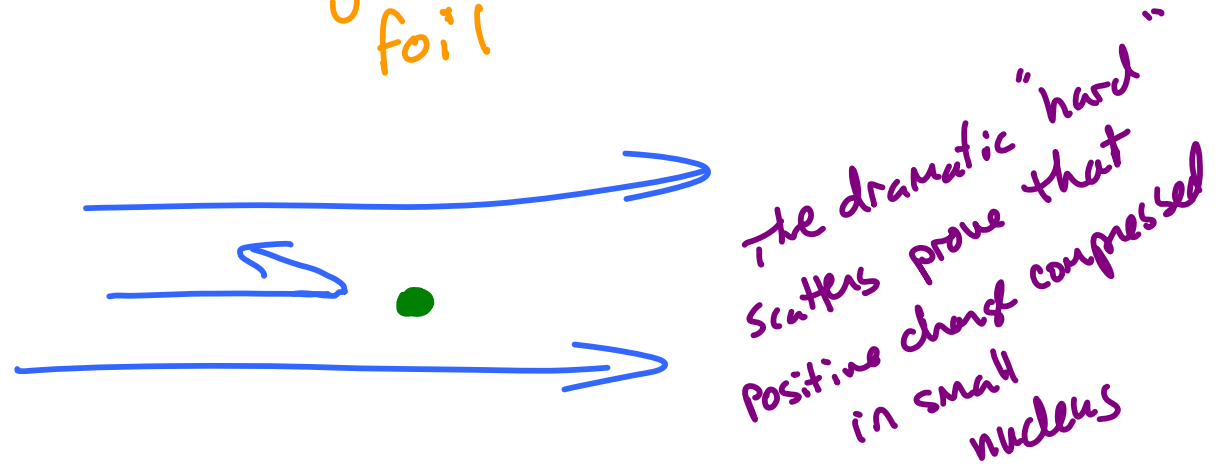
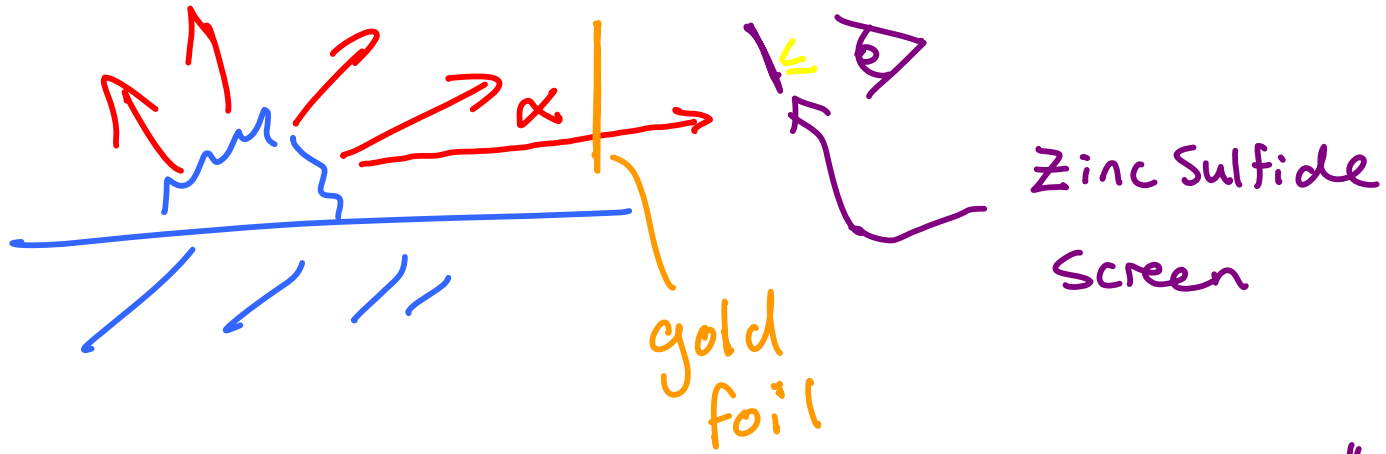


Ernest Rutherford
(1871 - 1937)

New Zealand Farm boy

↳ Manchester, England





Z protons

A - Z neutrons

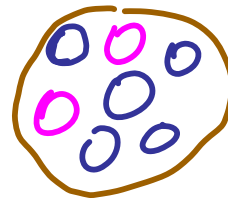
A Protons + neutrons

Z electrons

O = Protons

O = Neutrons

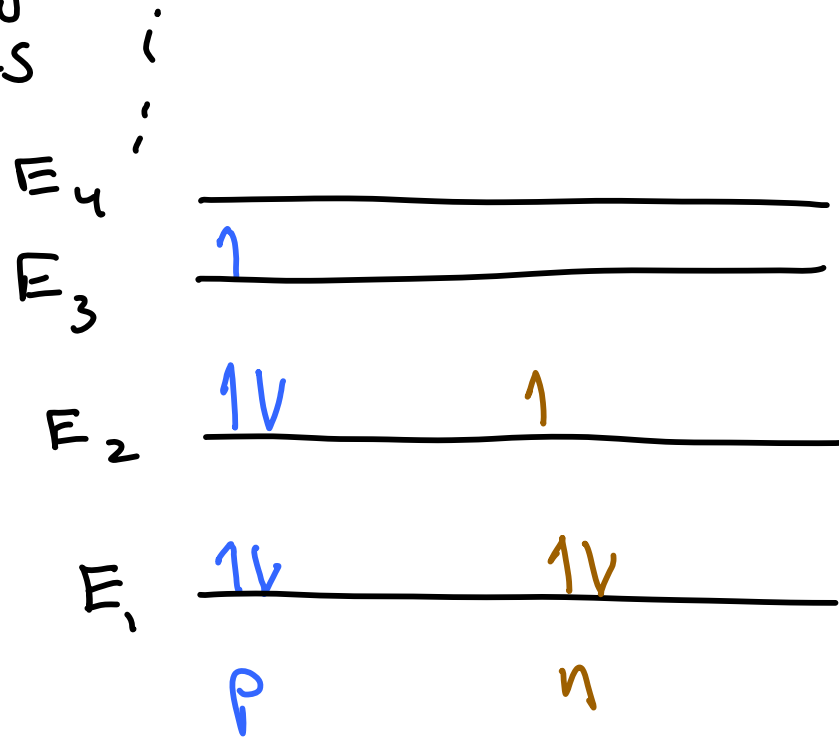
Strong nuclear force



10^{-15} meters

10^{-9} meters

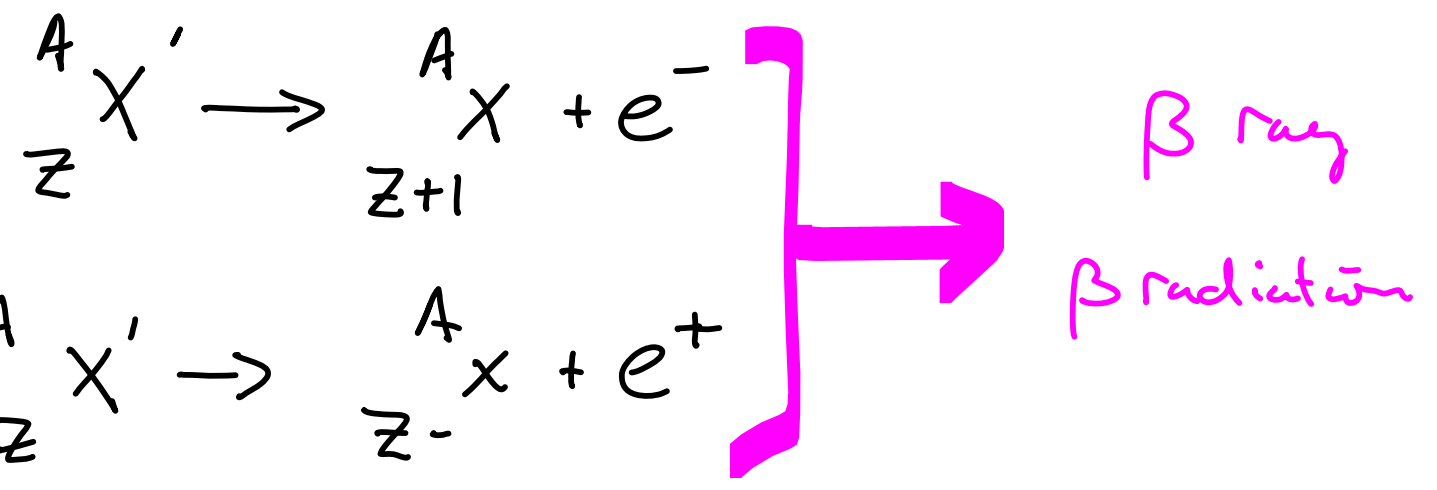
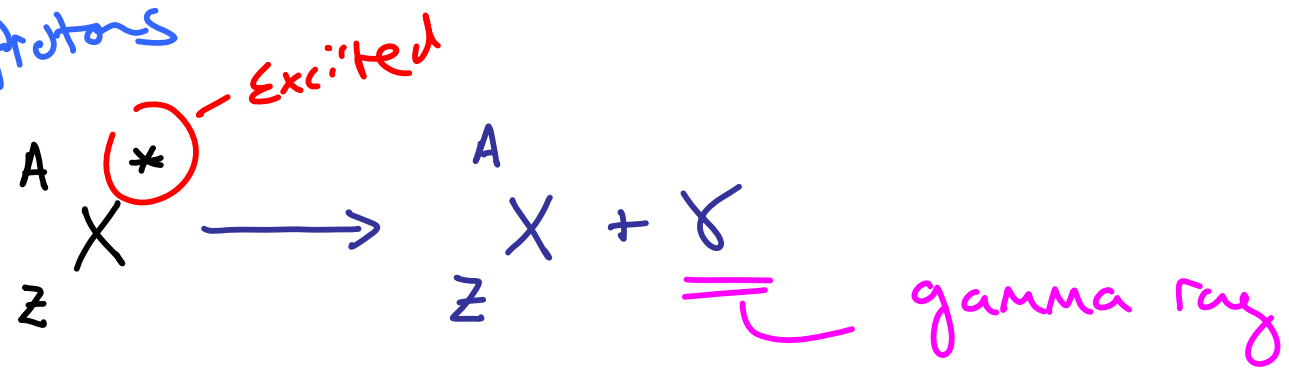
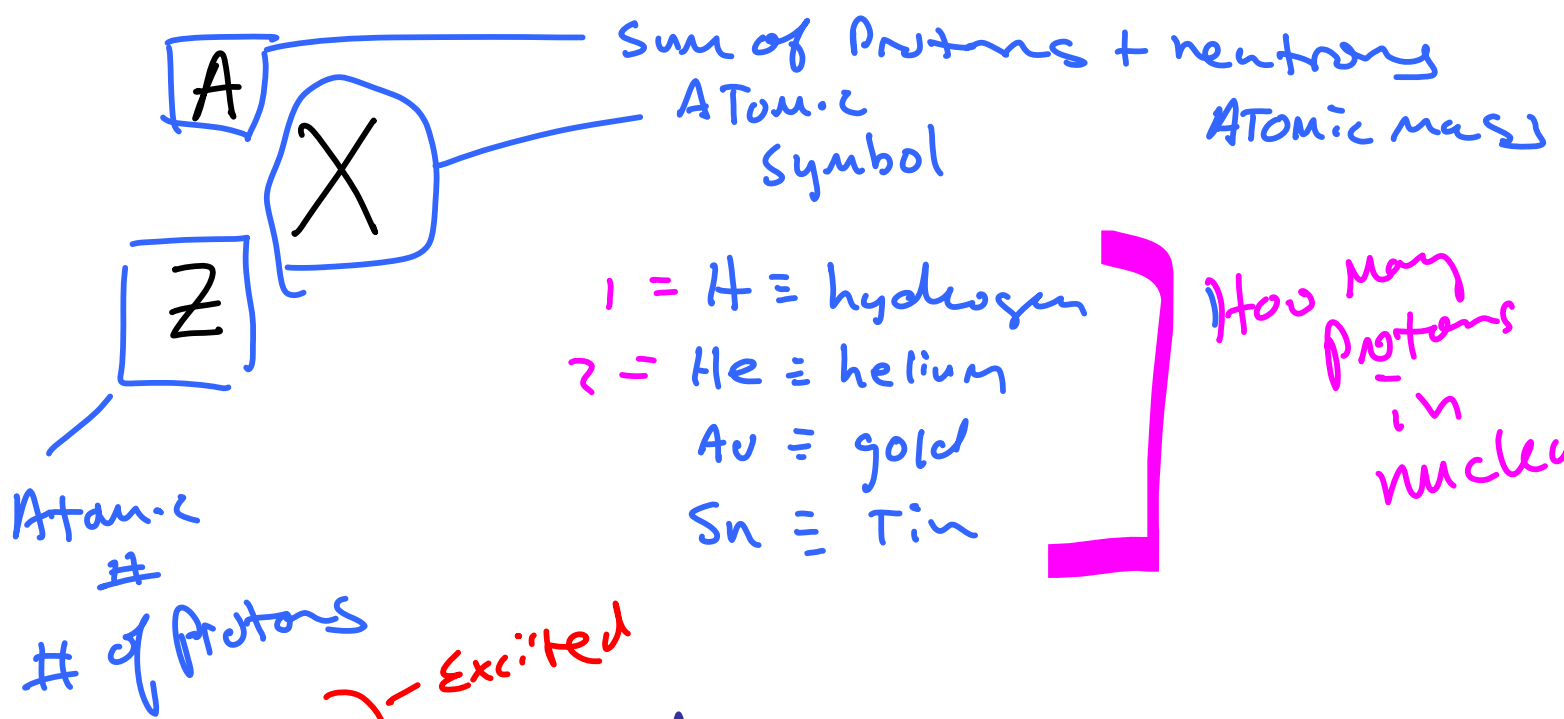
Discrete
energy
levels

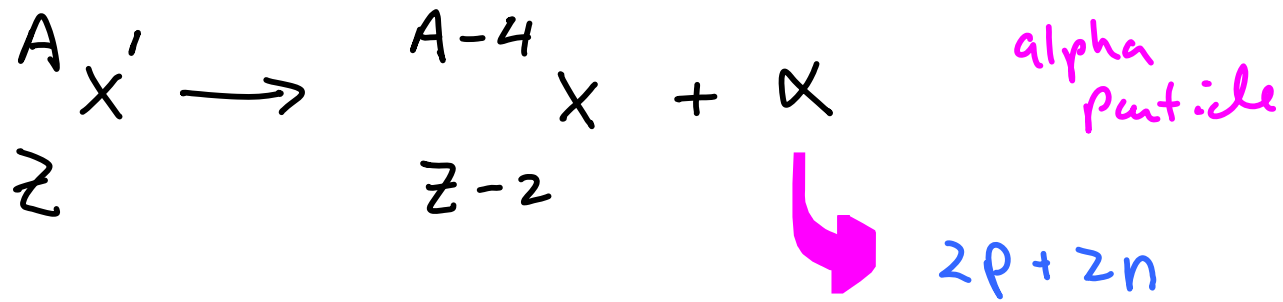


ATOMS
10's of eV

Millions
of
eV

In a fashion similar to the electron energy levels in an atom — neutrons and protons occupy discrete energy levels in a nucleus. Typical energy differences between levels is Millions of electron-volts (as opposed to tens of electron-volts for atomic levels).





Isotope = Same # protons
different # neutrons

P Hydrogen

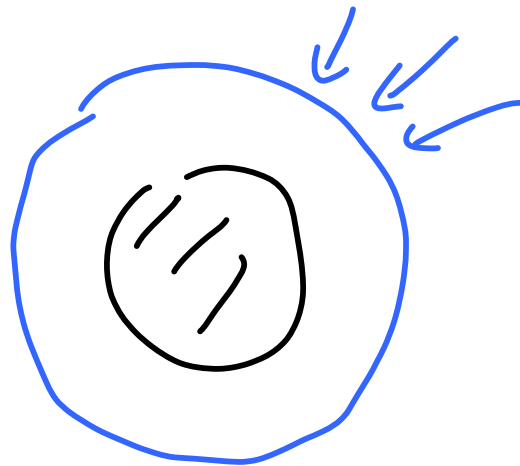
Pn Deuterium

Pnn Tritium

Half life - time it takes for $\frac{1}{2}$ the nuclei in a sample to decay

${}^{12}_6\text{C}$ normal carbon

${}^{14}_6\text{C}$ carbon-14 radioactive
Half life of 5730 years

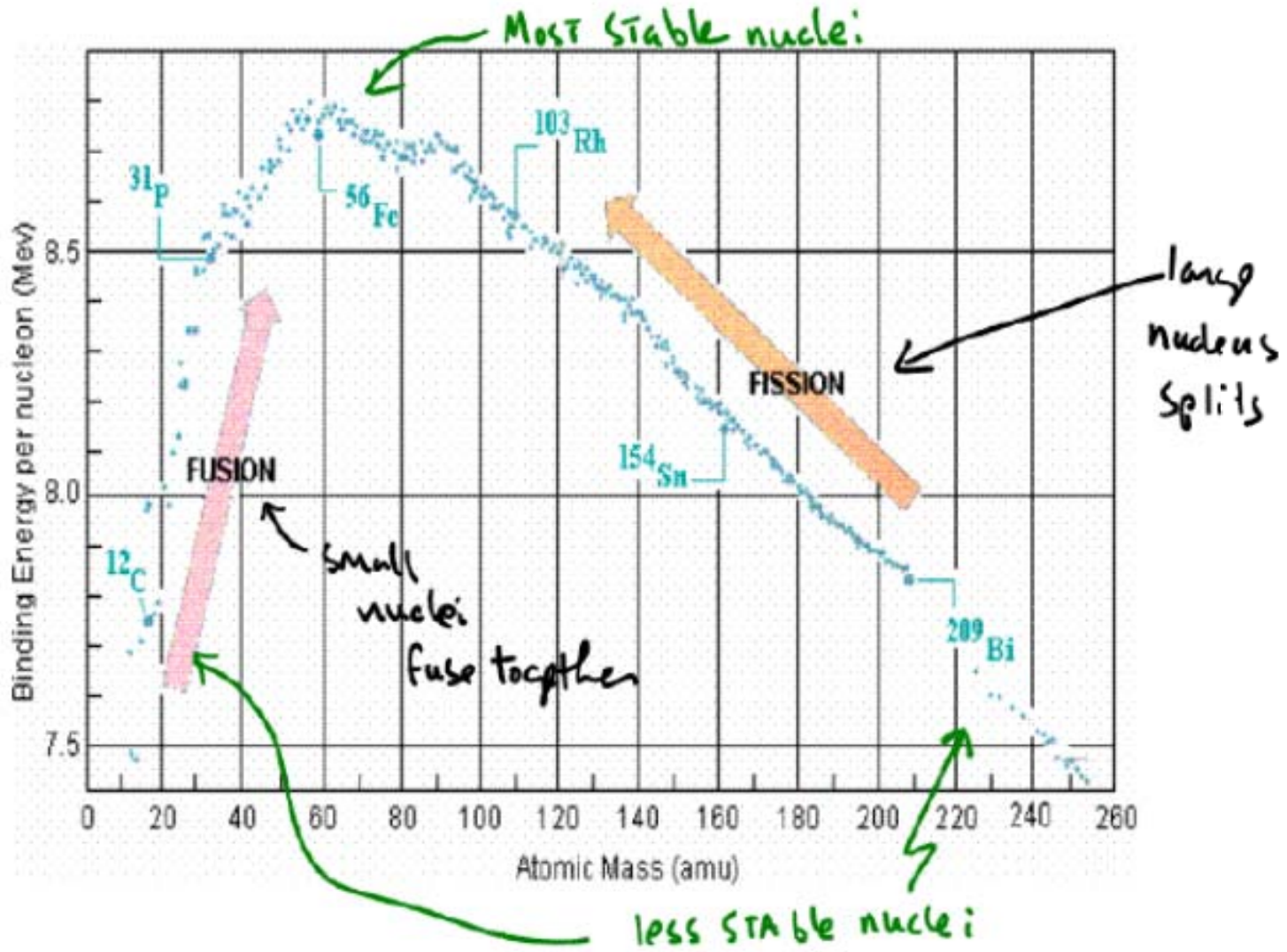


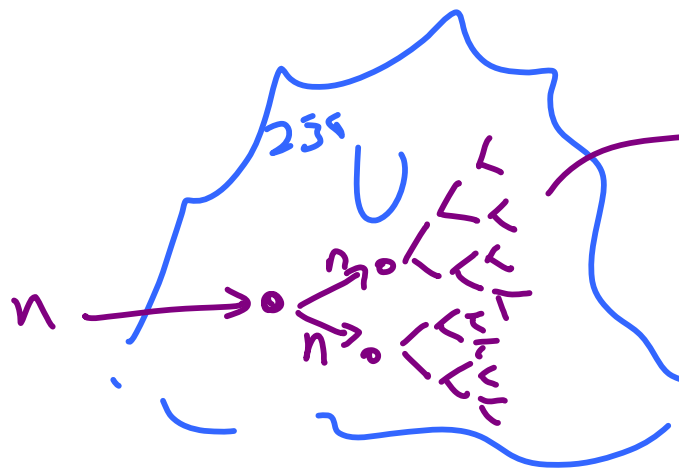
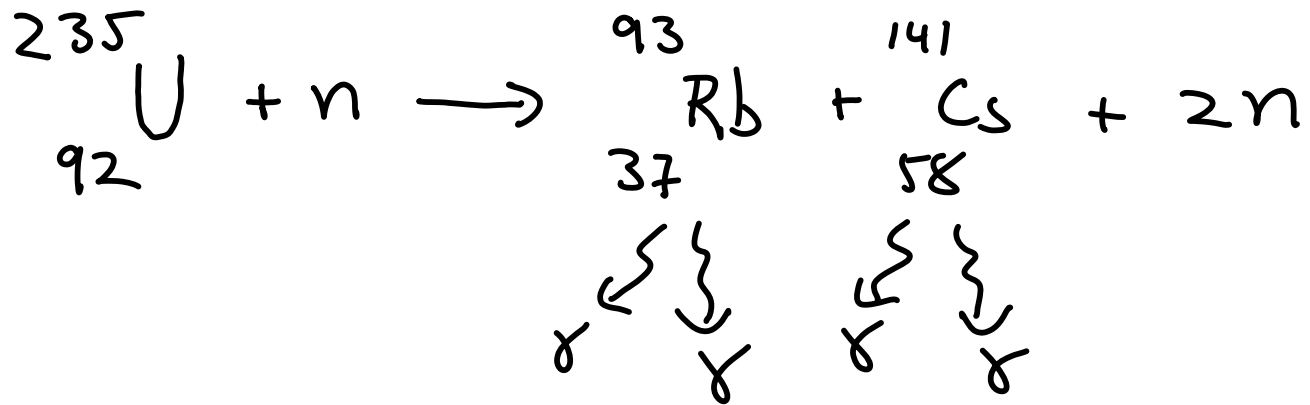
cosmic
Rays

forms a bit of carbon¹⁴
mixes in air

The secret of nuclear power ...

measure of how difficult it is to remove a nucleon (p or n) from the nucleus

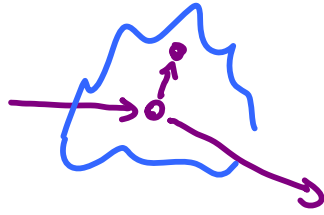




chain
Reaction

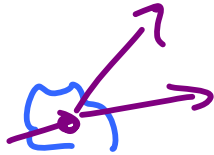
Supercritical

2 splits per split



critical

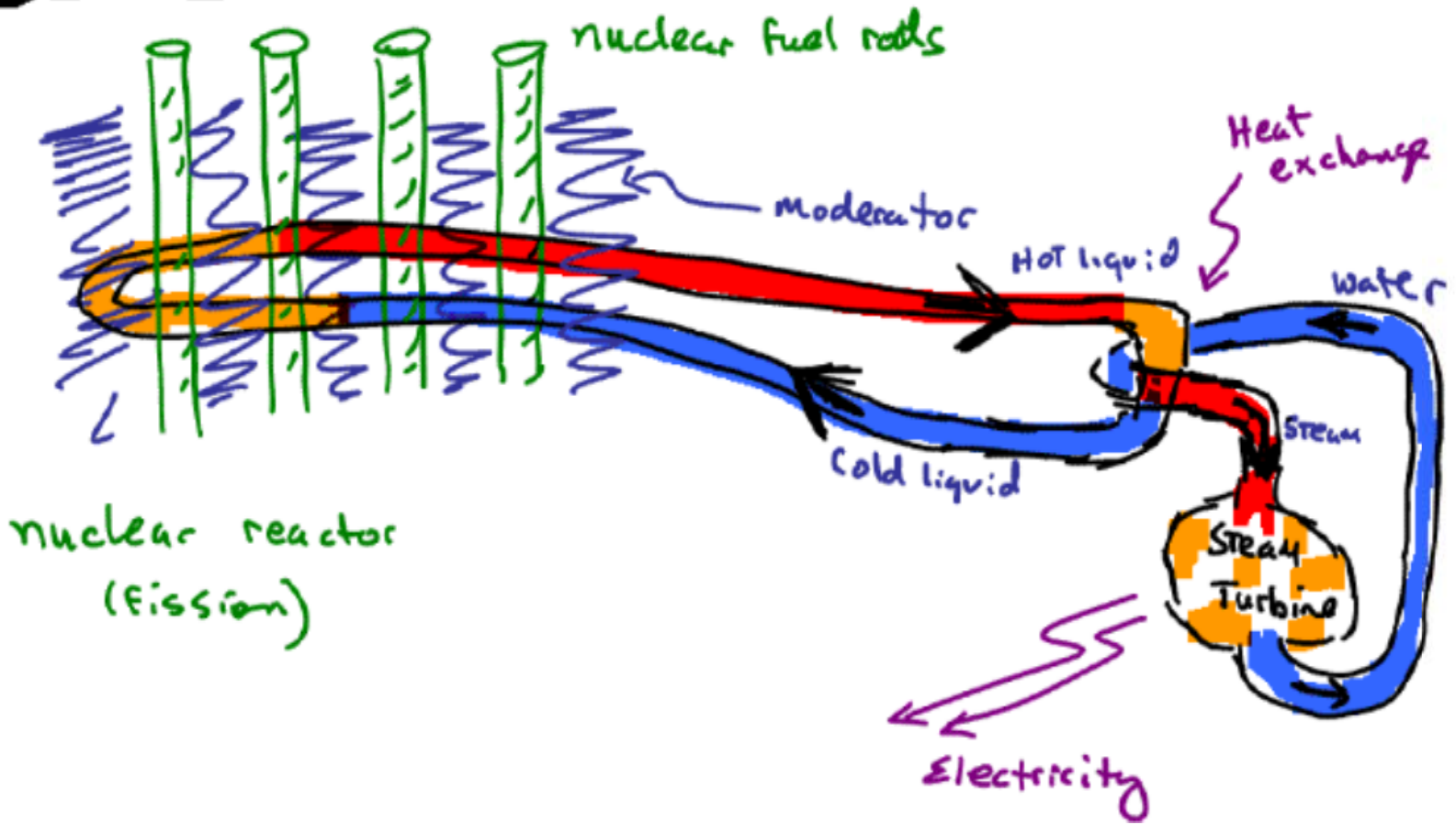
1 split per split



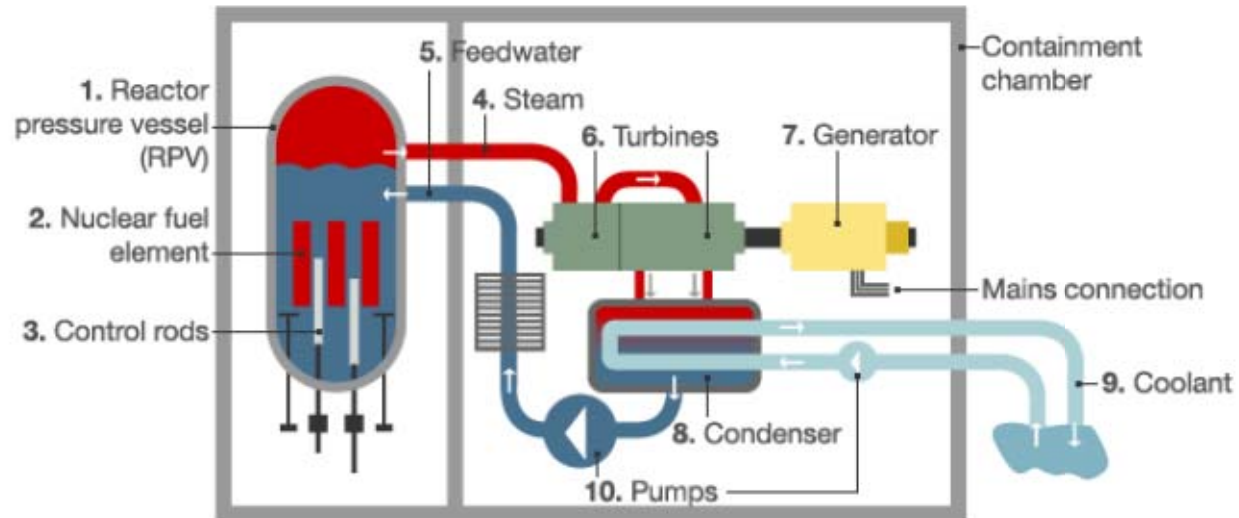
Subcritical

< 1 split per split

nuclear
Bomb
or
Meltdown

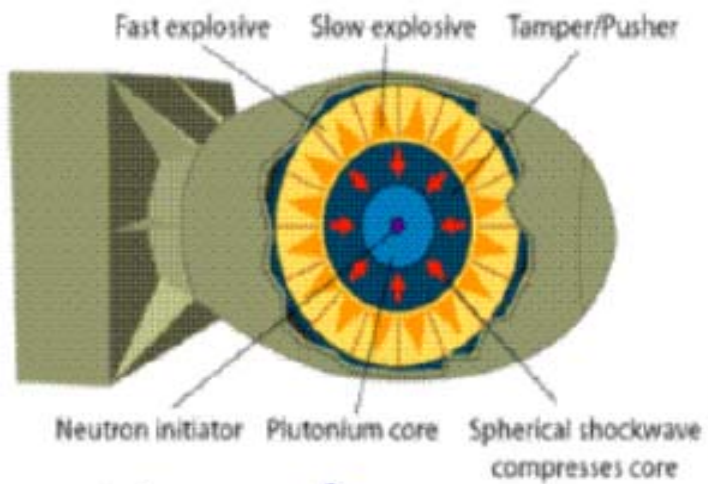


Boiling Water Reactor system



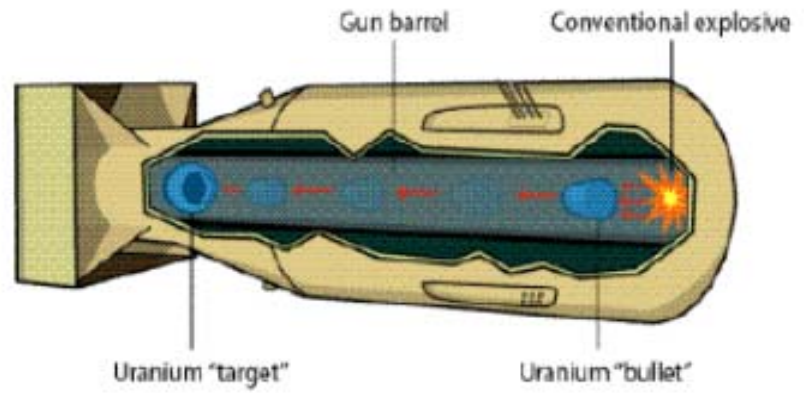
Source: RobbyBer/Wikimedia

Basic design of reactors currently involved in Japan's nuclear crisis



Similar to Fat Man
Used on Nagasaki
Aug 9, 1945

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



Diagrams
From
Wikipedia

