

Nuclear / Subatomic Physics

- Physics –
Chapter
25 (Holt)

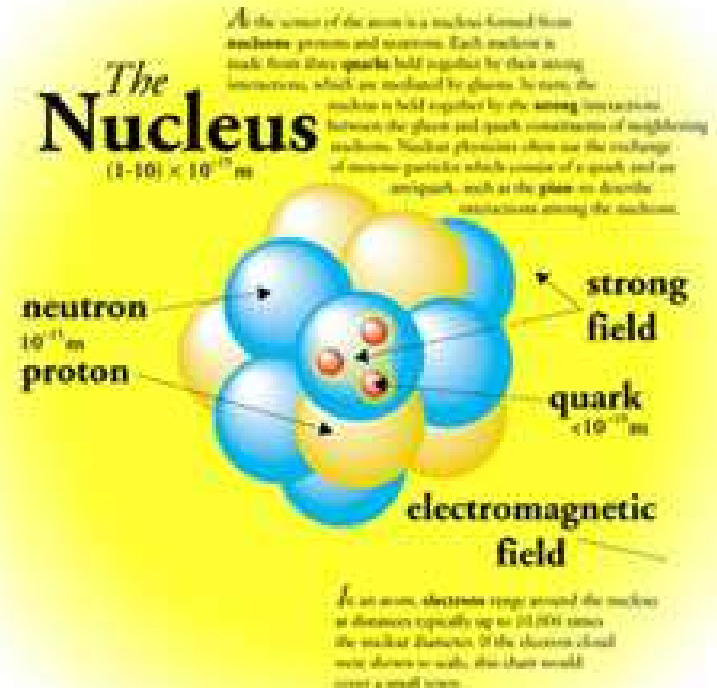


- Nuclear physics deals with how the nucleus of an atom changes, and the conversion of a small amount of mass into a large amount of energy, in a short period of time.
- The nucleus of an atom is composed of protons and neutrons.



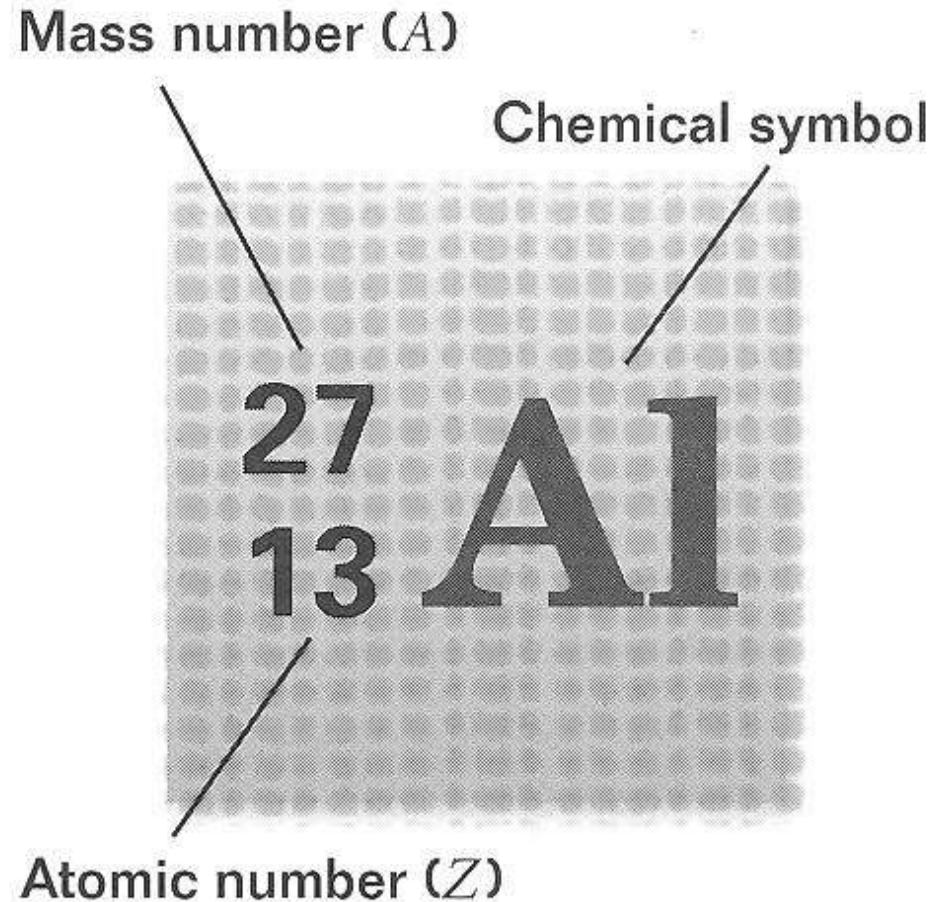
The Nucleus – Ch. 25, Section 1

- Atoms are composed of protons, neutrons, and electrons
- Protons and neutrons are called nucleons because they are found in the nucleus
- [Click here to see how the nucleus works](#)



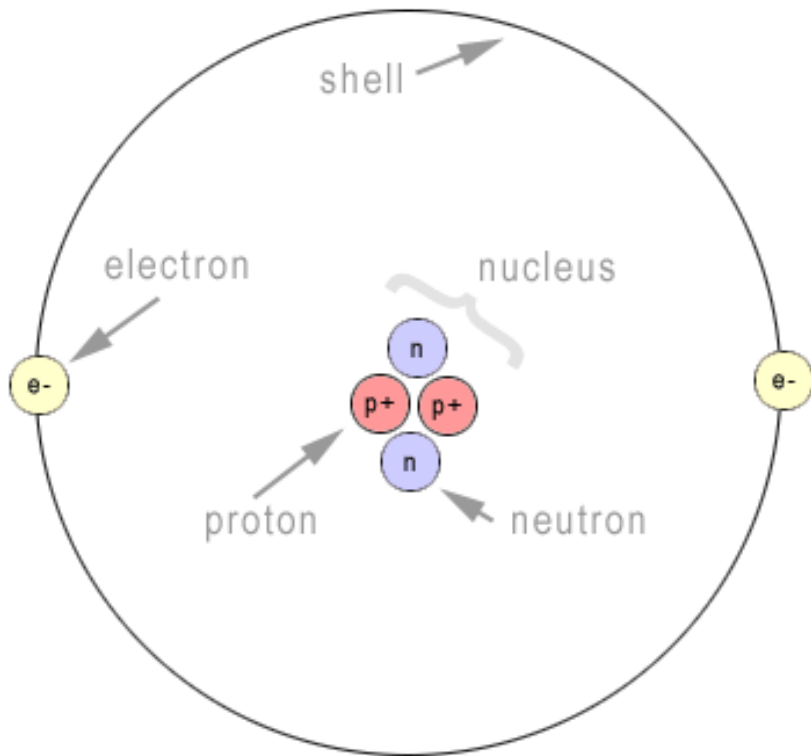
The Nucleus

- A nucleus can be specified by an atomic number and a mass number



The Nucleus

The Atom



- Mass number (A) – the number of nucleons in the nucleus

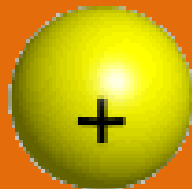
→ $A = \# \text{ of Protons (Z)} + \# \text{ of Neutrons (N)}$
- Atomic number (Z) – the number of protons in the nucleus
- Neutron number (N) – the number of neutrons in the nucleus

The Nucleus

- Isotopes – atoms of the same element (same atomic number, Z) with different neutron numbers (N) and mass numbers (A)
- [Click here to see how Isotopes work](#)

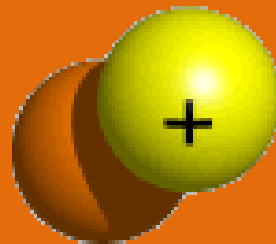
The Nuclei of the Three Isotopes of Hydrogen

Protium



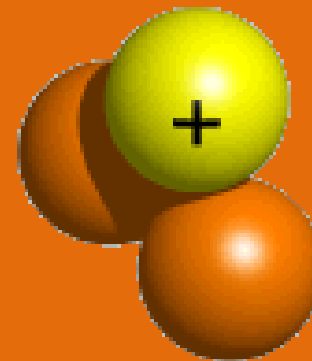
1 proton

Deuterium



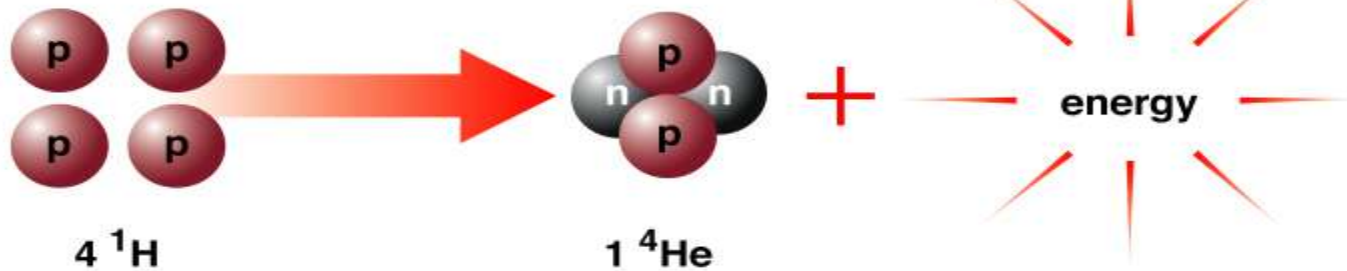
1 proton
1 neutron

Tritium



1 proton
2 neutrons

Nuclear Stability



Copyright © Addison Wesley

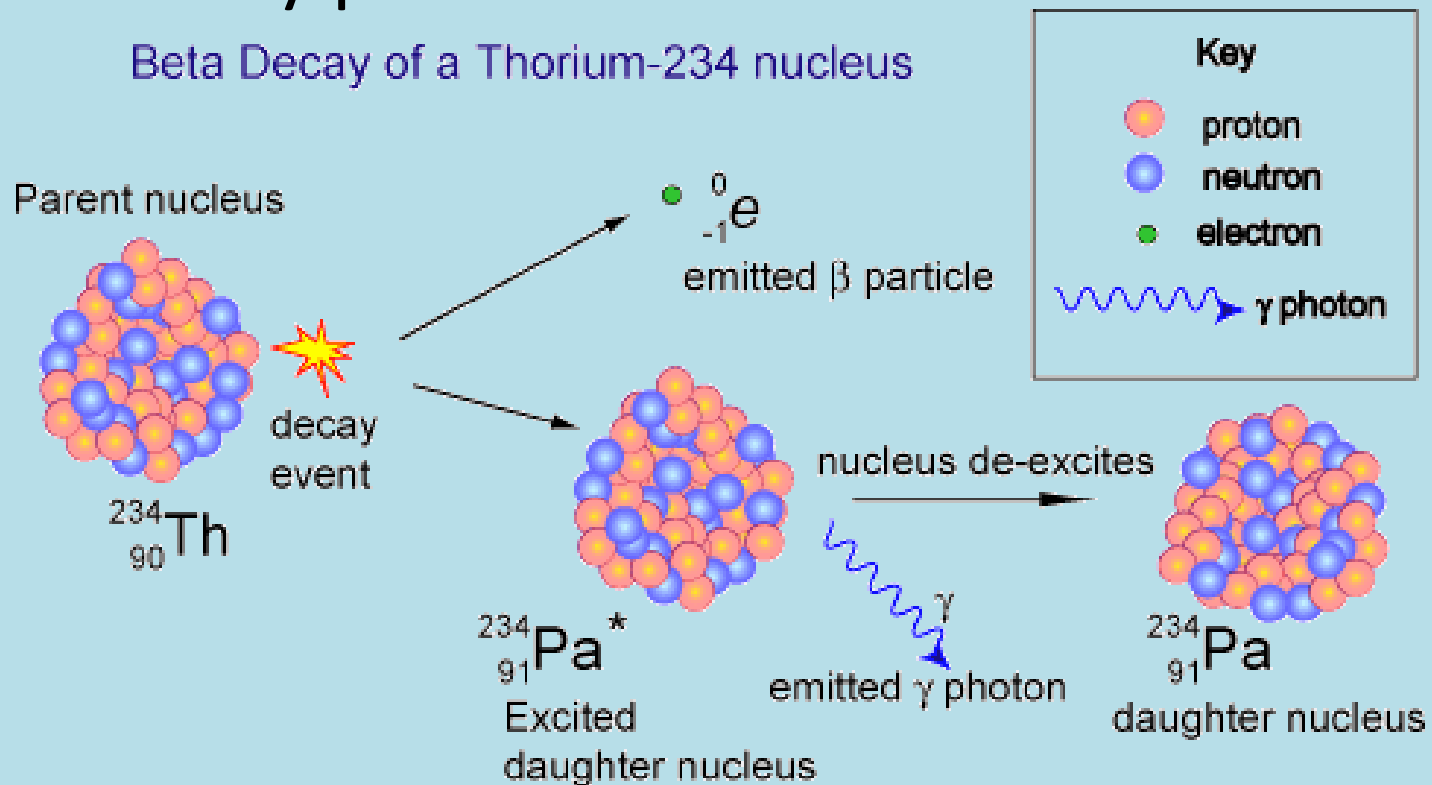
- A nucleus is a closely packed body of protons (each +1 charge) and neutrons (each is neutral), which help to stabilize the nucleus
 - There are large repulsive forces between similarly charged particles
 - “Strong force” holds the nucleus together, sometimes called the nuclear force or strong nuclear force

Nuclear Decay

- Nuclear decay – process where unstable nuclei break apart into other particles
 - This can be a natural event or induced to occur artificially
 - Radiation is emitted in the form of particles and/or energy

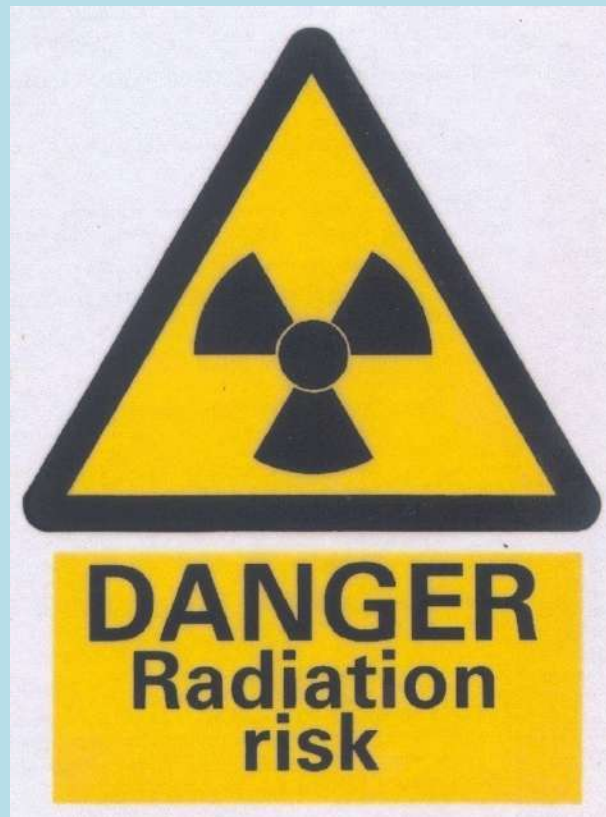
Nuclear Decay

- Parent nucleus – nucleus present before decay
- Daughter nucleus – resultant nucleus or nuclei from decay process



Nuclear Decay

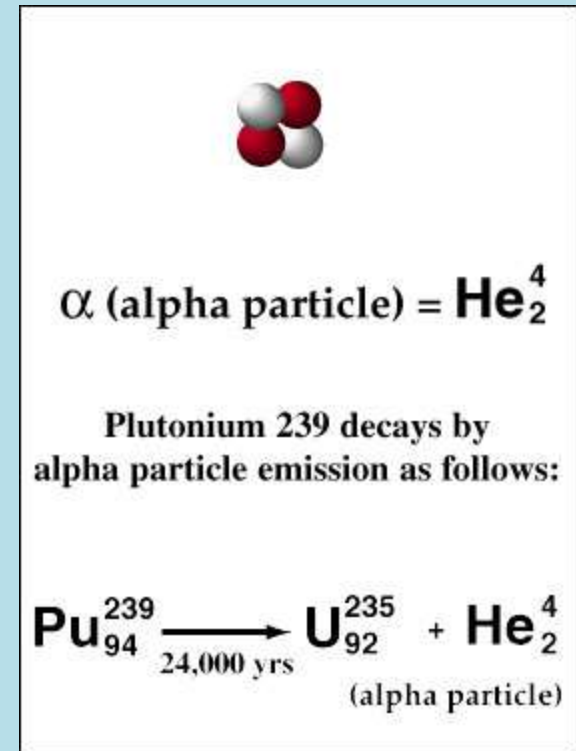
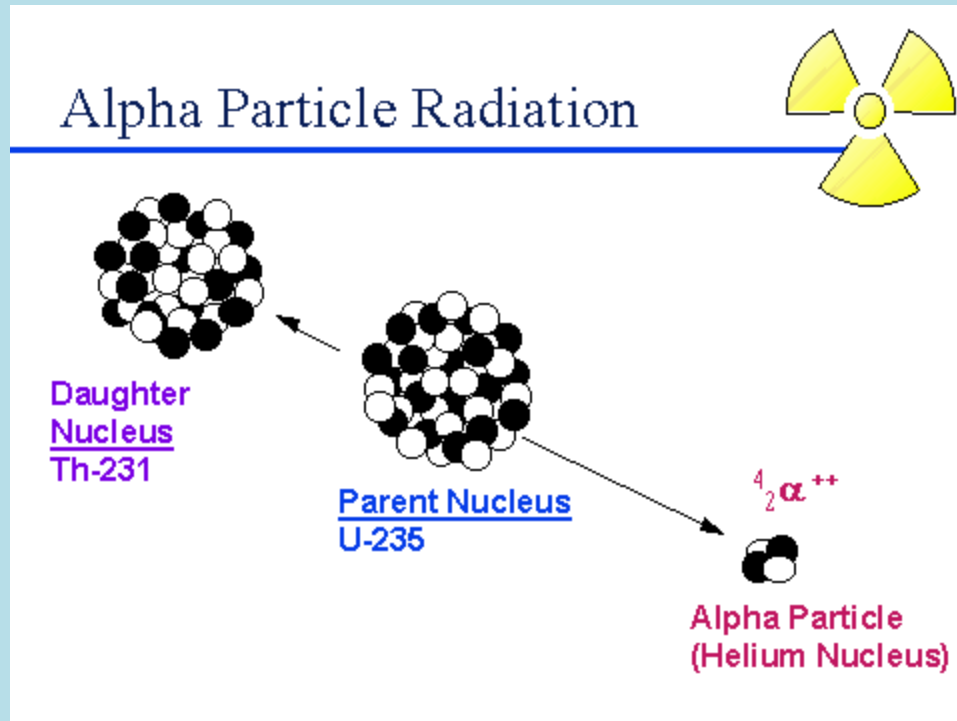
- There are four types of radiation that can be emitted as a nucleus undergoes radioactive decay



Nuclear Decay

- 1. Alpha (α) particles – helium nuclei are emitted

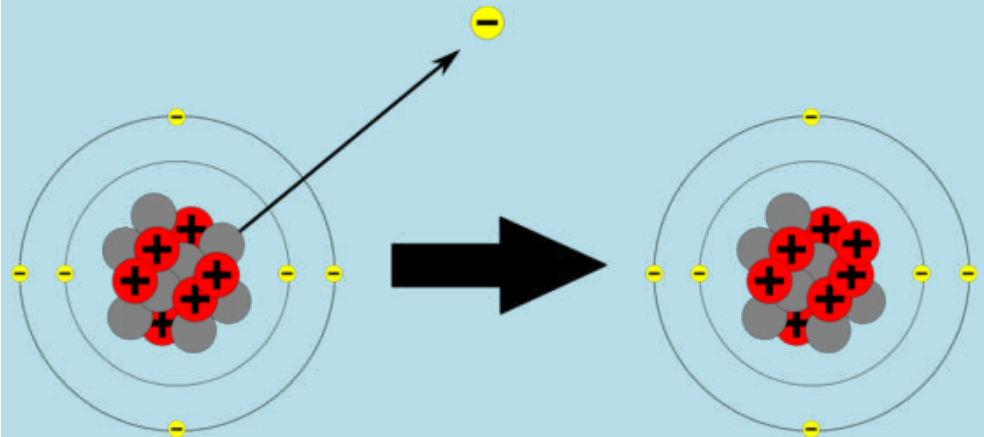
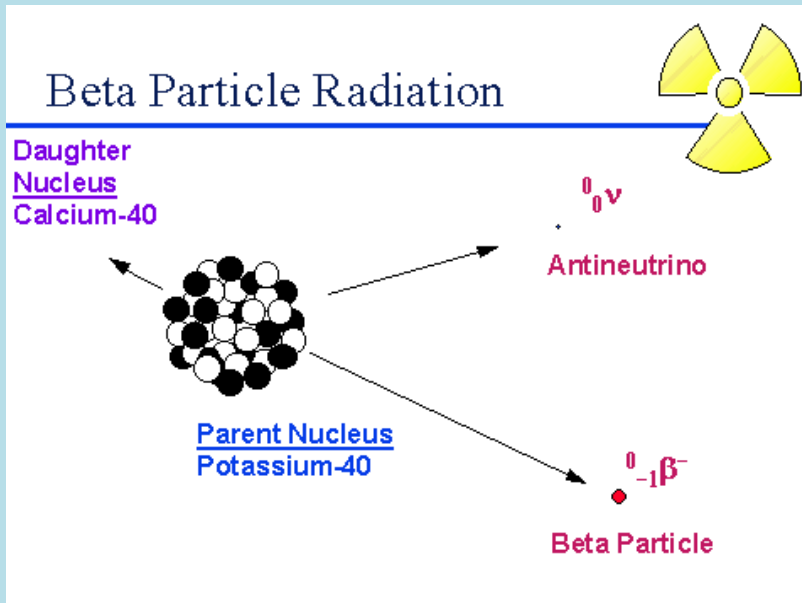
→ slow moving, stopped by a piece of paper



Nuclear Decay

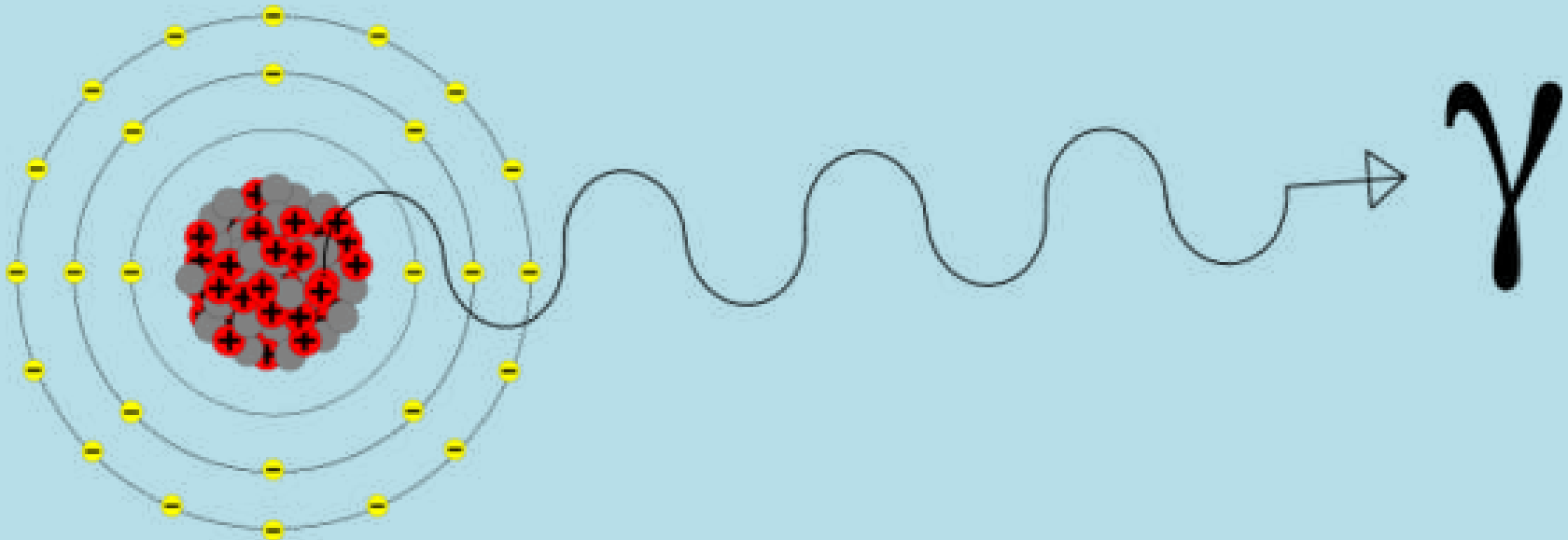
- 2. Beta (β) particles – electrons or positrons are emitted

→ fast moving, stopped by piece of aluminum foil



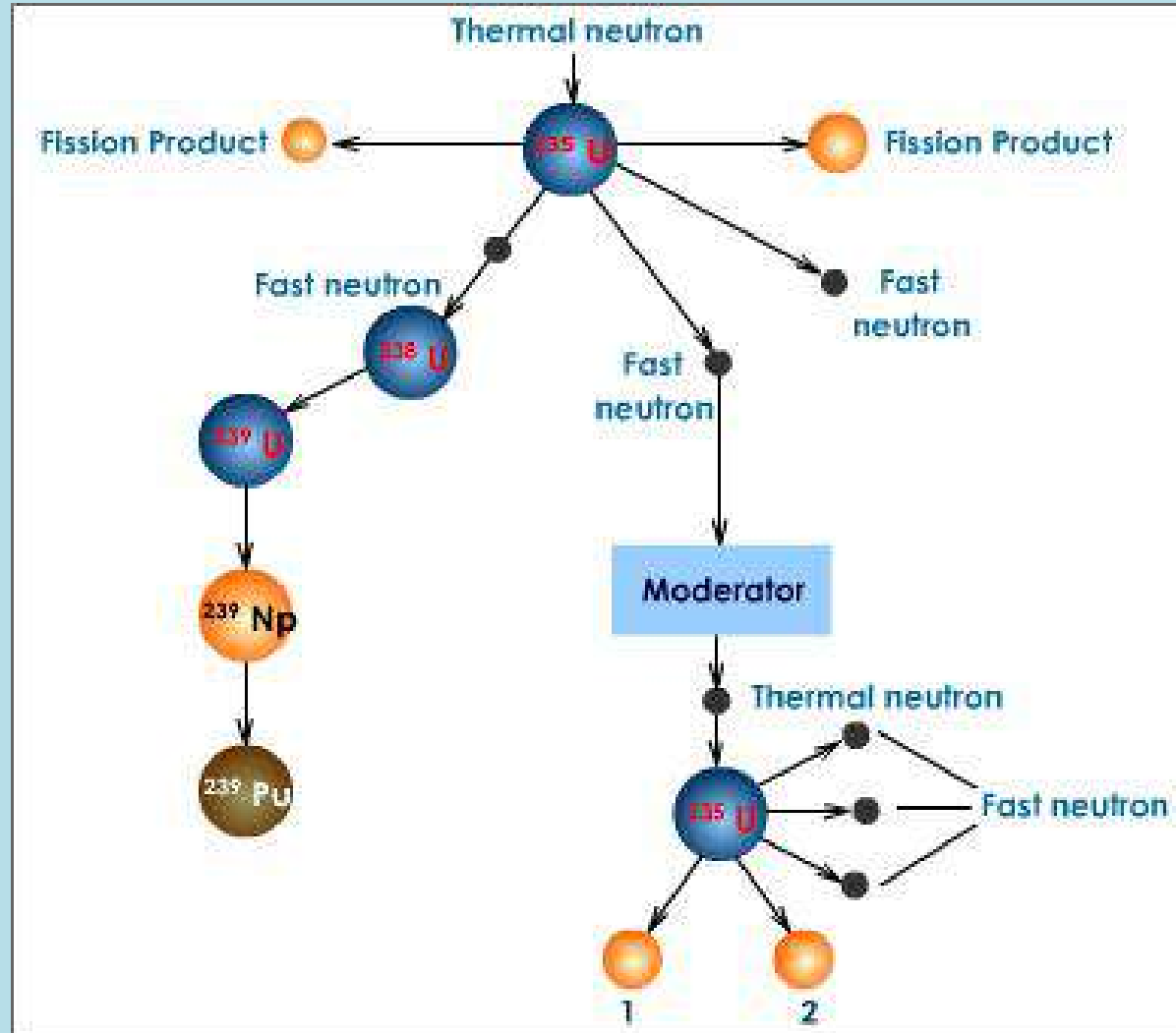
Nuclear Decay

- 3. Gamma (γ) rays – high-energy photons are emitted
- Energy only, stopped by 7 cm of lead



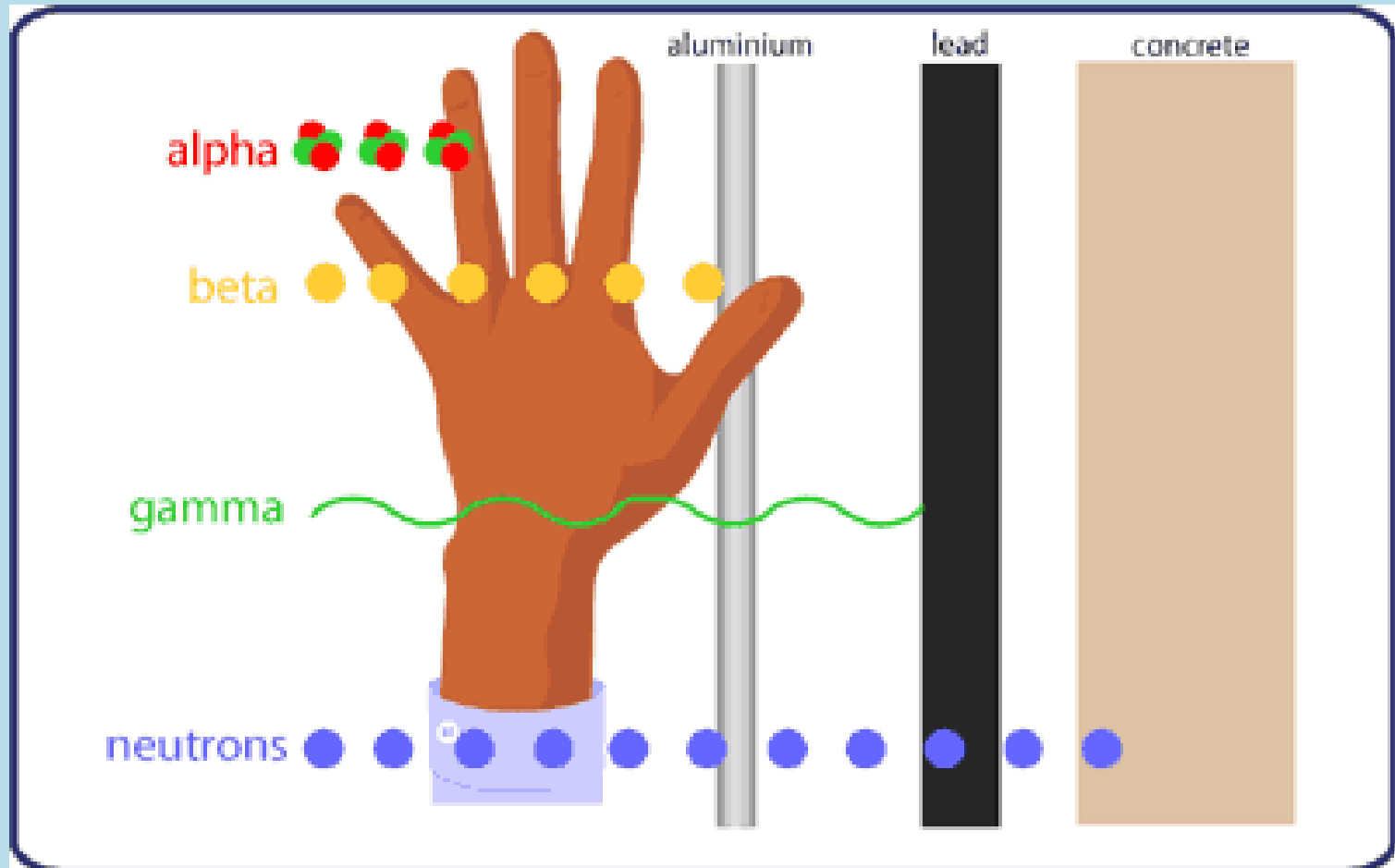
Nuclear Decay

- Neutron emission - fast moving single neutrons
- High penetrating power, stopped by 15 cm of lead



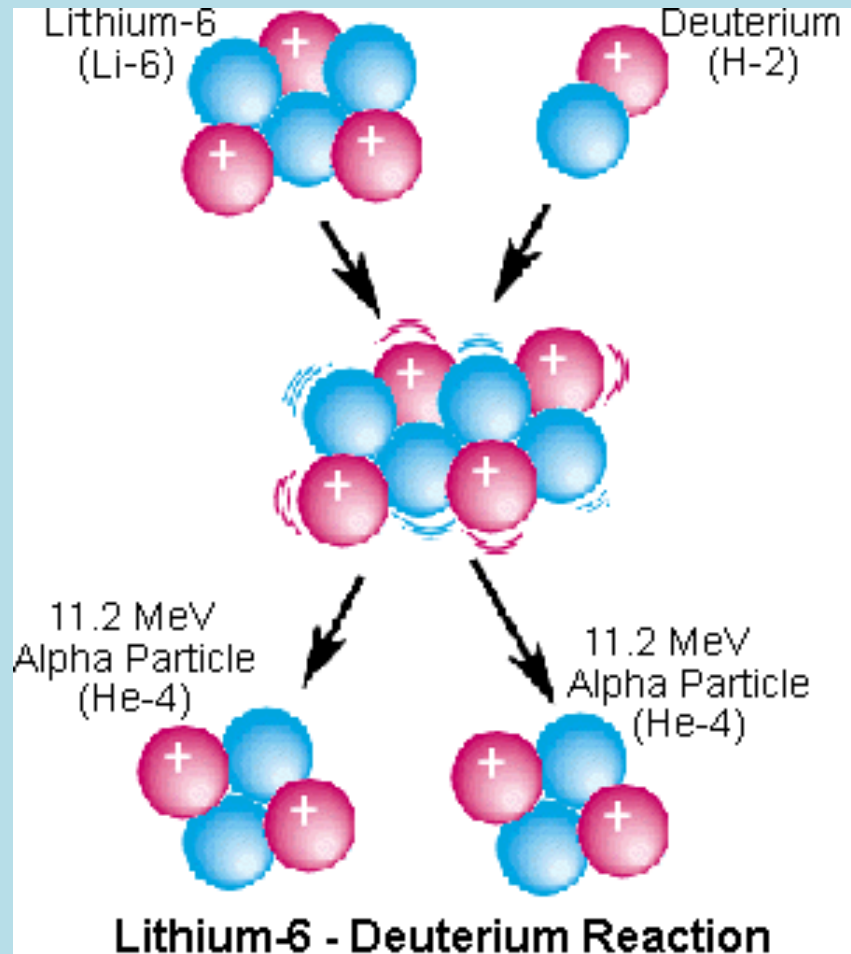
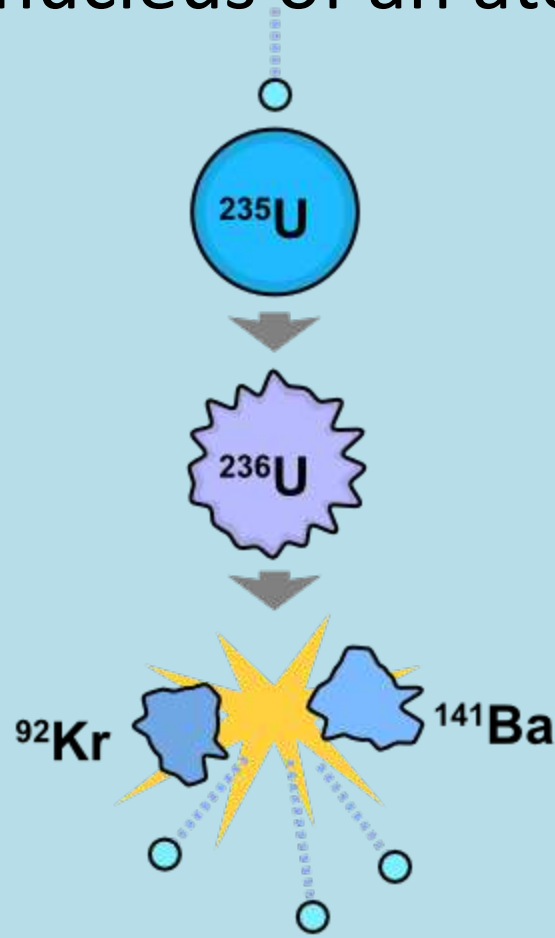
Nuclear Decay

- There can be combinations of the four types occurring simultaneously
- See table 25-3, page 903

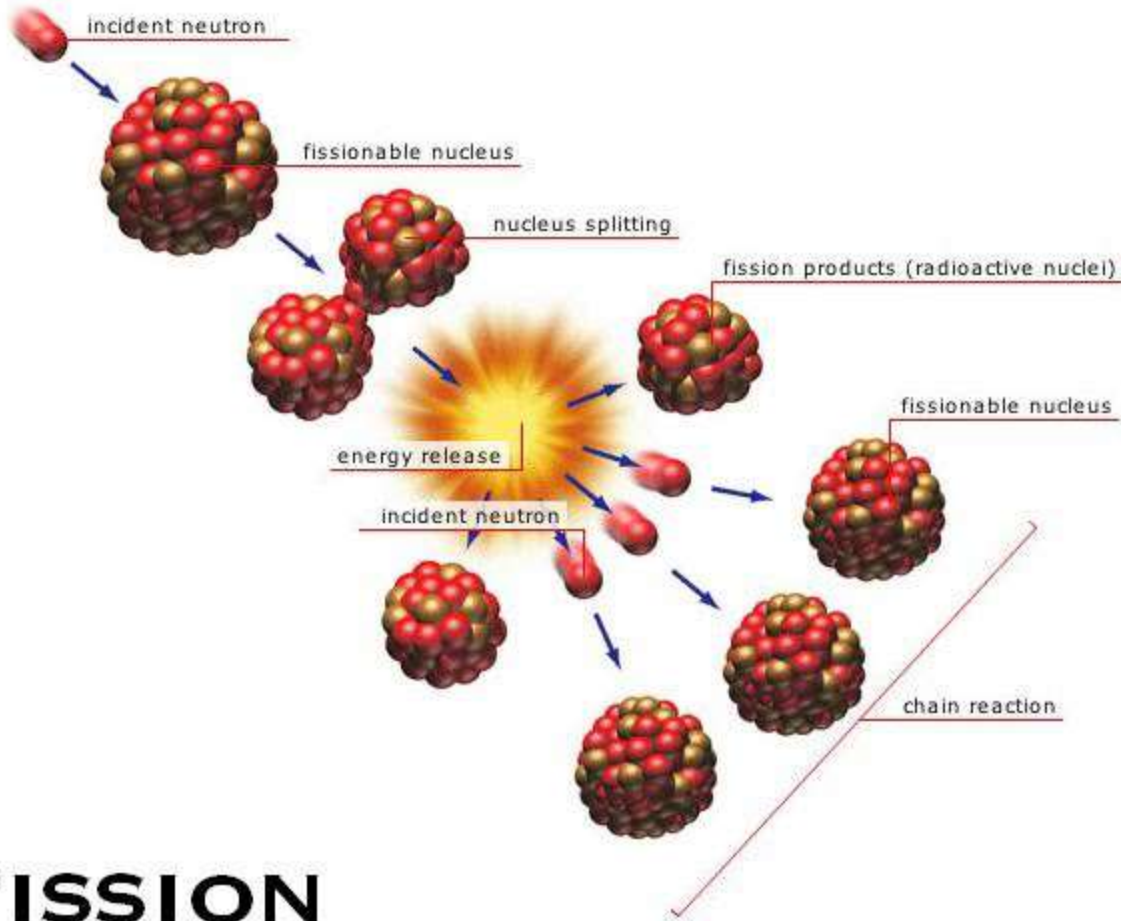


Nuclear reactions

- Any process that involves a change in the nucleus of an atom is a nuclear reaction



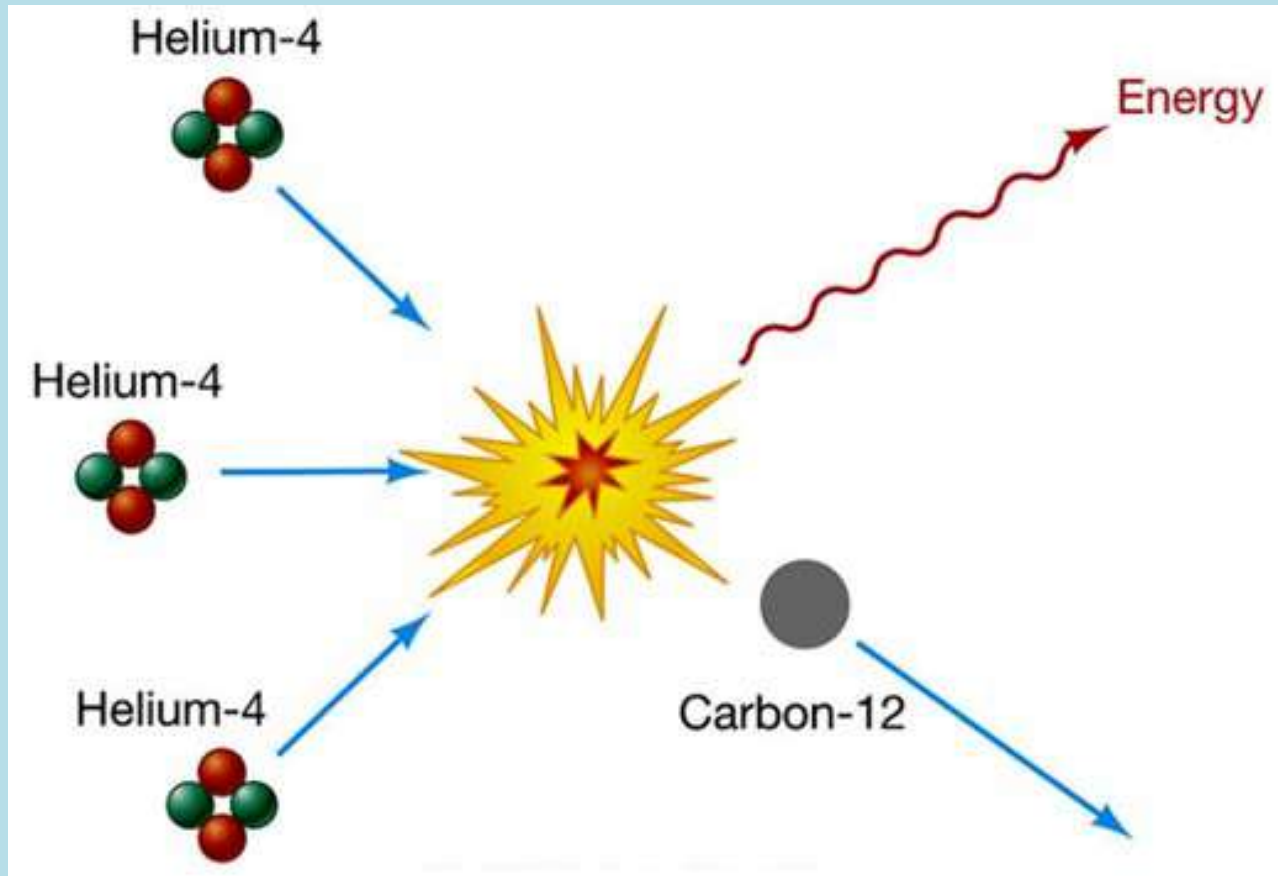
Nuclear reactions



- 1. Nuclear fission – when a nucleus splits into two or more nuclei

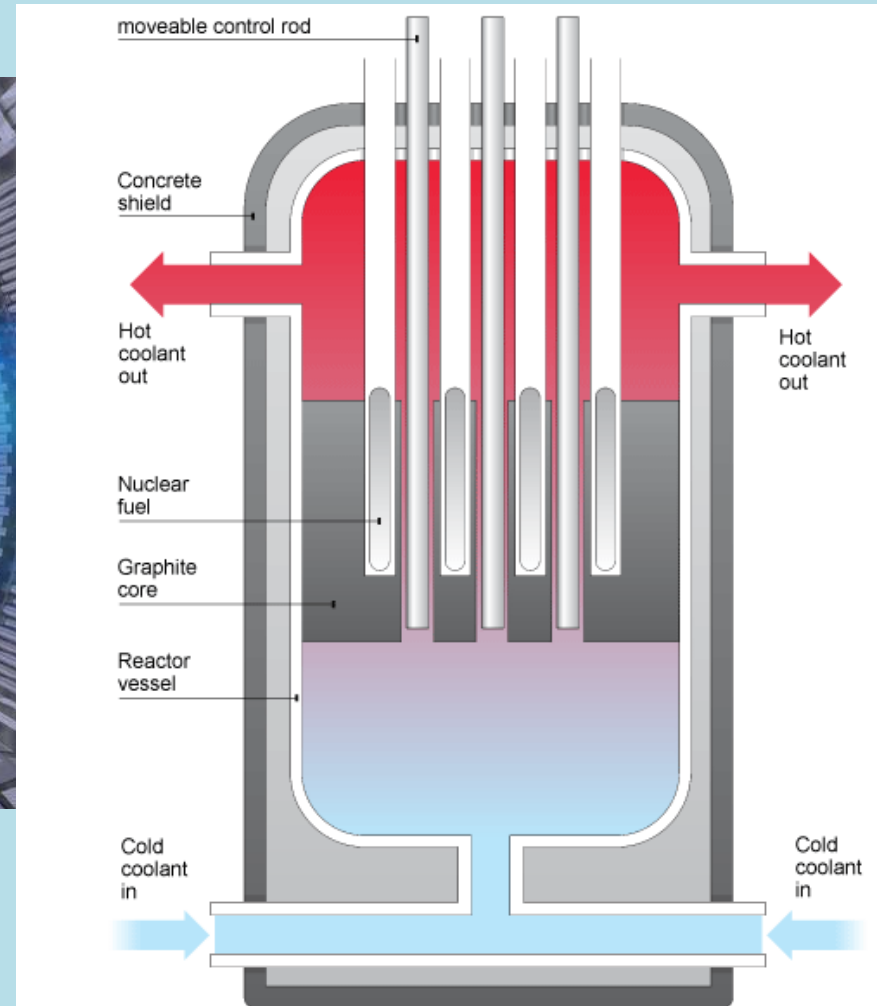
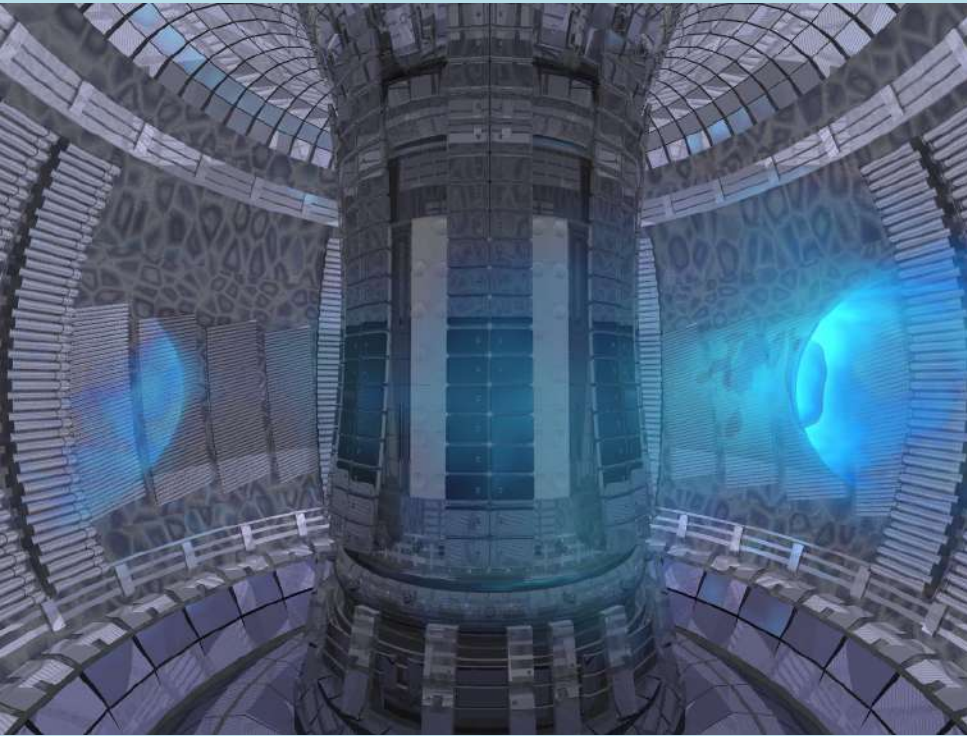
Nuclear reactions

- 2. Nuclear fusion – when two or more nuclei combine into one nucleus



Nuclear reactions

- Much energy is given off during these reactions
- Fusion reactors are being developed (page 916)



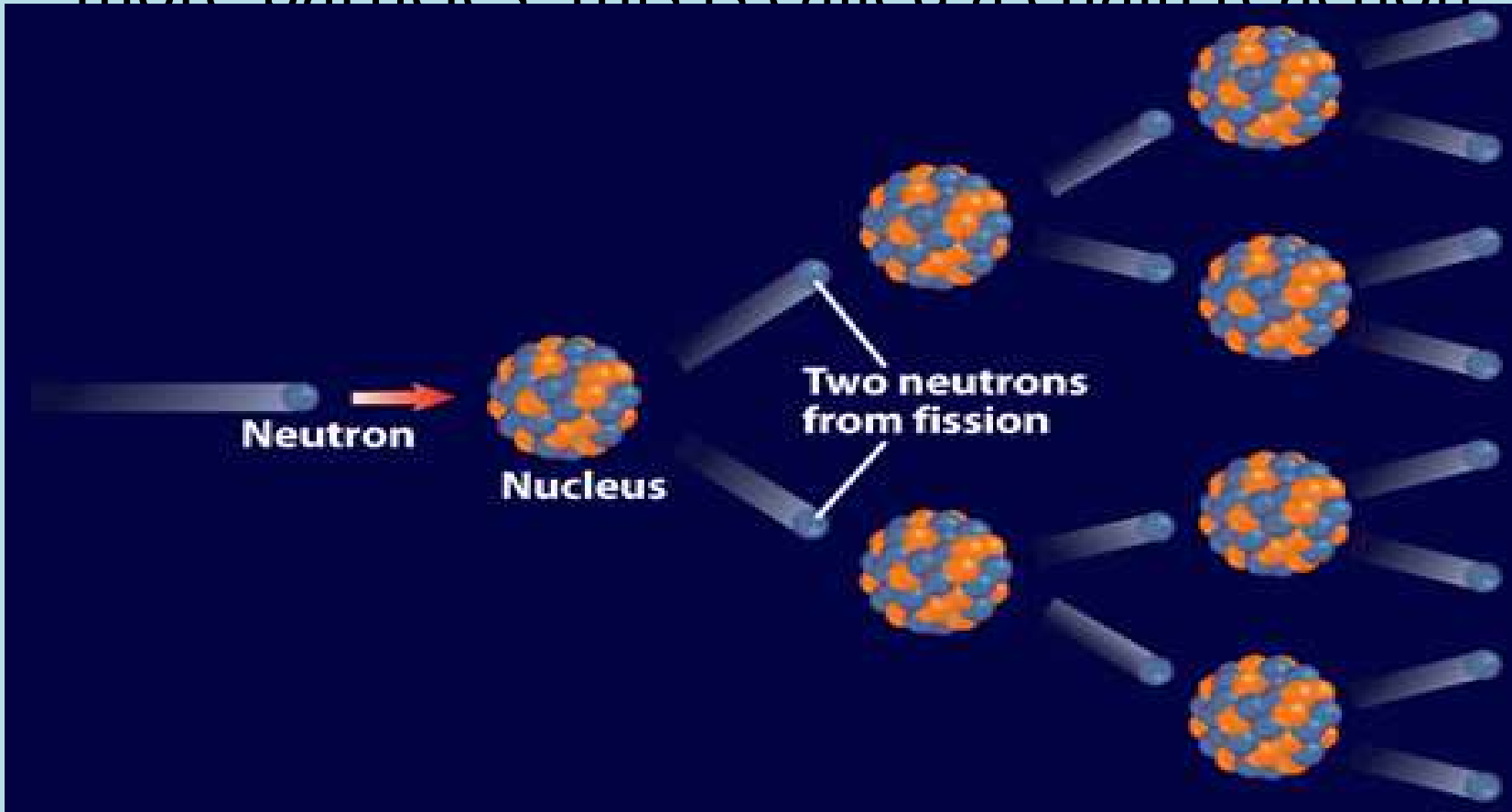
Nuclear reactions

- In a nuclear explosion (weapon), radioactive (unstable) atoms are used because their nucleus can easily be made to change and give off energy.



Nuclear reactions

- If the pieces hit another unstable nucleus, this nucleus will / can split and give off energy and more particles this is called a chain reaction



Nuclear reactions

- When this chain reaction goes on without restriction, it is called a bomb.

