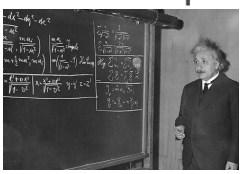
# Nuclear Radiation

## Mass-Energy Relationship

- $E = mc^2$
  - E is Energy
  - m = mass
  - c = speed of light



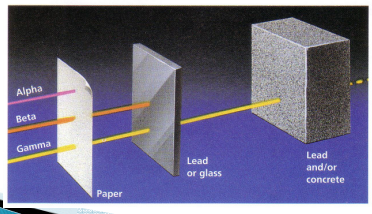
- What $E = mc^2$ says is that ***matter and energy are interchangeable***. There is a continuum between the two.
- Energy can transform into matter and matter can transform into energy. They are different aspects of the same thing.

## Radiation Exposure

- Many forms of radiation can cause damage to humans.
- Radiation can be measured in ***roentgens*** or ***rems***.
- Cancer and genetic effects caused by DNA mutations are possibly long term effects of radiation damage to living tissue.

## Radiation Exposure

- Different particle types present different levels of danger to humans.
- Gamma rays have greatest penetrating power.
- Alpha Particles have lowest penetrating power.




## Radiation Detection

- Film Badges
- Geiger-Muller counters
- Scintillation counters

## Applications of Nuclear Radiation

- Medical –
  - Radioactive tracers to diagnose diseases.
  - Xrays
- Radioactive dating
  - A process to determine the approximate age of materials based on the amount of radioactive nuclides present.

## Nuclear Waste

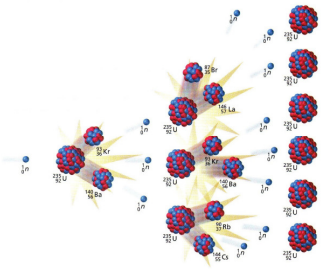
- Nuclear Fission is the primary system powering nuclear reactors.
- Containment of Waste
  - Medical nuclear waste decays in months
  - Nuclear power plant waste decays in hundreds of thousands of years.
- We must store & dispose this waste so not to contaminate living organisms.

# Fission & Fusion

Mr. Sudbury

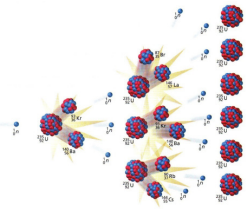
## Nuclear Fission

- In ***nuclear fission***, a very heavy nucleus splits into more stable nuclei of intermediate mass.
- Fission is a ***chain reaction***
  - When the material that starts the reaction is also one of the products and can start another reaction.



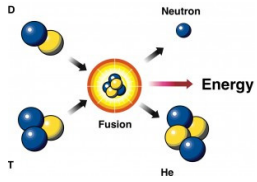
## Nuclear Fission

- Started by a neutron.
- Several new neutrons are emitted.
- A very heavy (unstable) nucleus splits into several medium-weight nuclei.



## Nuclear Fusion

- In ***nuclear fusion***, light-mass nuclei combine to form a heavier, more stable nucleus.




## Fusion vs. Fission

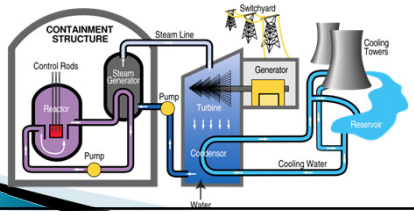
- A fusion reaction can generally produce more energy than a fission reaction.
- More energy is required to start a fusion reaction.
- Very small isotopes (less dangerous) are required for fusion.

## Nuclear Power Plants

- Nuclear power plants use heat from nuclear reactors to produce electrical energy.
- The ***nuclear fission*** reaction produces heat that warms water and turns a steam turbine.
- Uranium-235 is the fuel for the fission reaction.

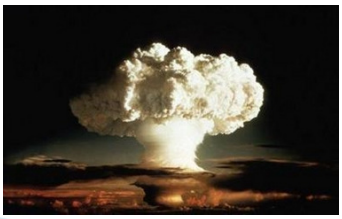
## Nuclear Power Plants

- The containment structure has a ***shielding material***, which is used to absorb radiation and decrease exposure.
- ***Control rods*** limit the number of "free" neutrons which control the speed of the reaction.



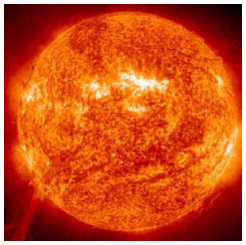

## Nuclear Bombs

- The enormous amount of energy released by a ***fusion reaction*** is illustrated by the explosion of a hydrogen bomb.



## The Sun & other Stars

- ***Fusion*** of hydrogen nuclei into more stable helium nuclei provides the energy of our sun and other stars.
- The immense pressure and a temperature of 16 million degrees C force atomic nuclei to fuse and liberate energy.
- About four million tons of matter are converted into light/heat every second.



## Nuclear Reactions

- The End
- Fission & Fusion
- More uses for Nuclear Energy