Hooks for Harnessing Radiation

…The Radiation "Signatures"

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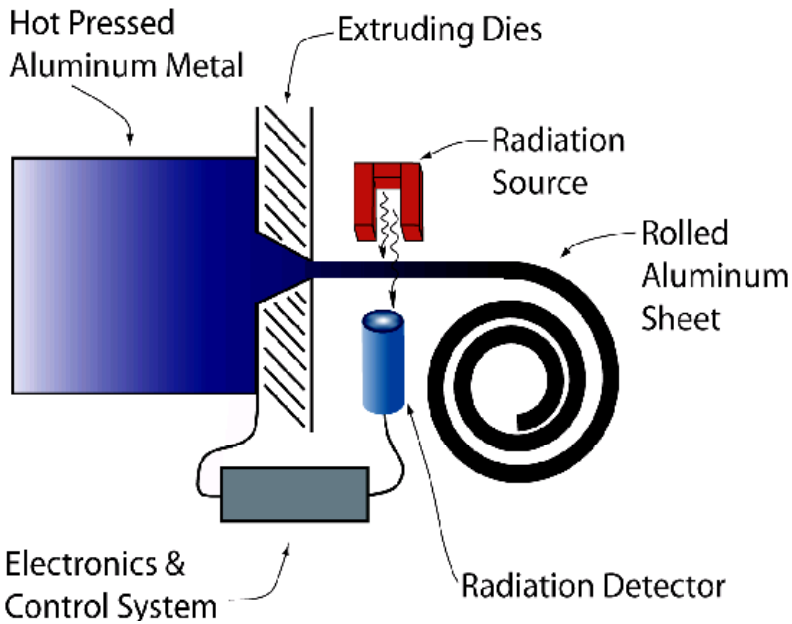
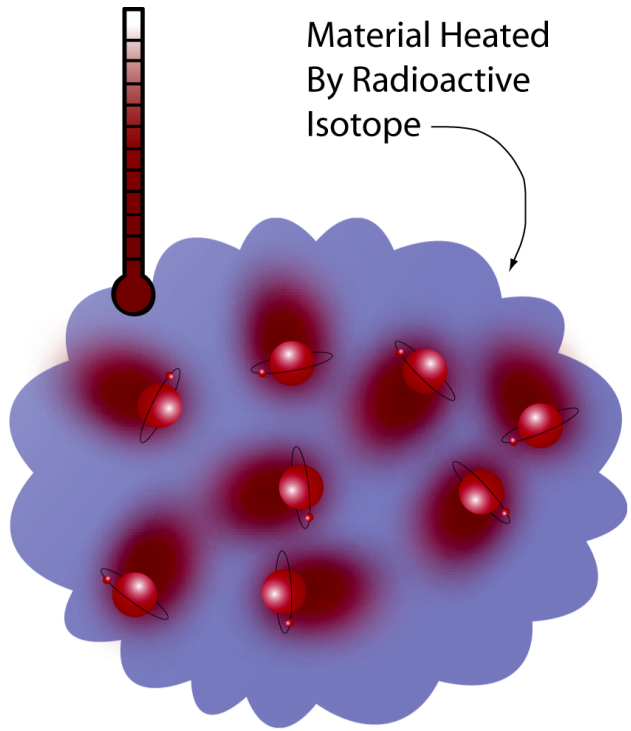
1. Material Penetration

- Degree of beam attenuation determines thickness of material
- Metal foil and paper manufactured by this process



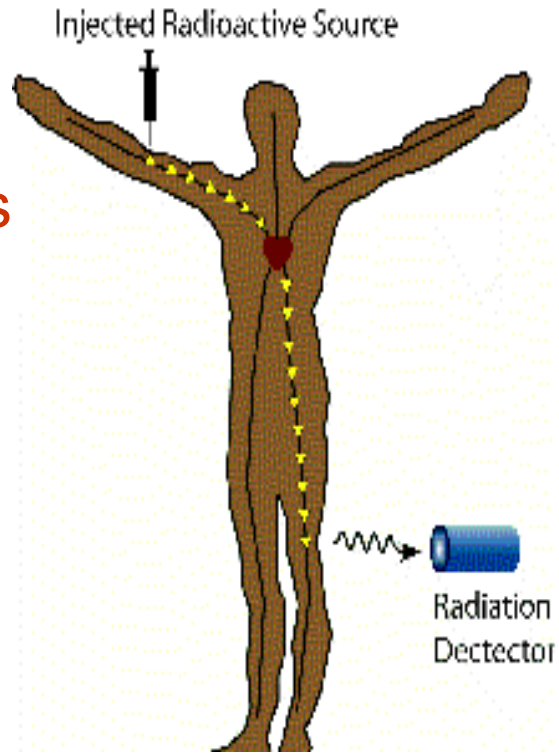
2. Heat Source

- Alpha and beta particles stop within short distances of their origins
- Substantial heat is generated in this process
- Heat can be used to generate electricity (e.g. thermoelectric effect)
- Such sources used in space probes (e.g. Viking mission to Mars)



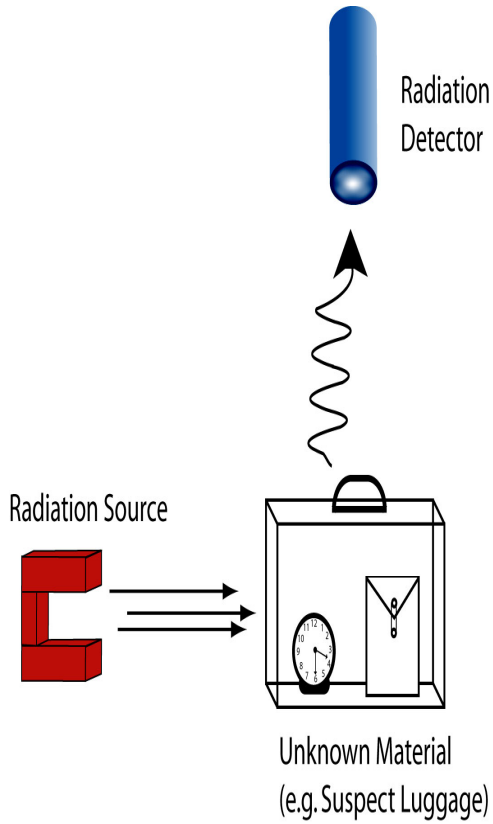
3. Particle Emission

- Gamma rays can penetrate through substantial material
- Hence, isotopes that emit gamma rays can be attached to fluid materials & then continuously monitored vs time
- Such tracing techniques are used to map groundwater movement, detect pipe leaks, & diagnose ailments in the human body



4. Transmutation/Activation

- Neutrons focused on certain materials will transmute the target material into a new radioisotope
- The target material can then be identified by analyzing the radioactivity of the newly formed radionuclide
- This technique is often used in criminology investigations and for revealing explosives in airport luggage

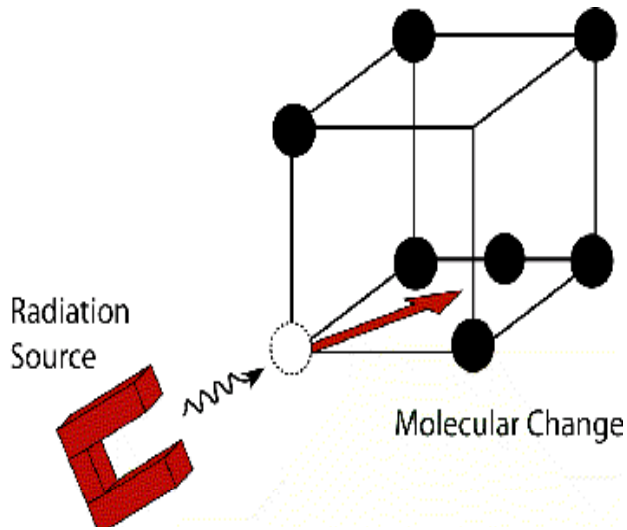


5. Change Molecular Structure

- Bombarding some materials with high enough levels of tailored radiation will break molecular bonds

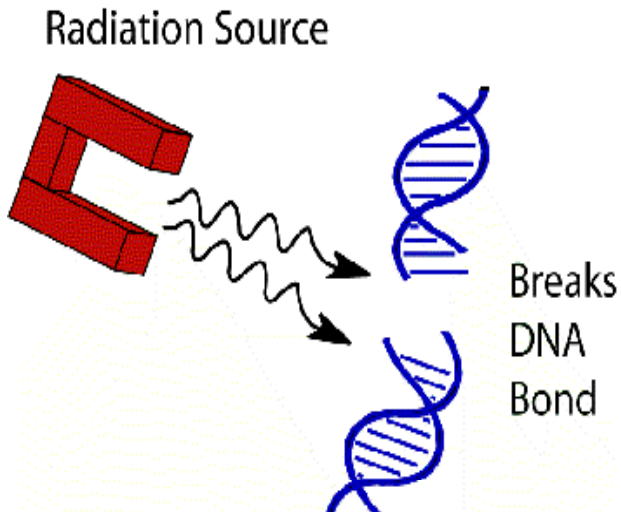
- This changes the chemistry and structure of materials

- Sample products are tough plastics & special rubber for tires



6. Cell Destruction

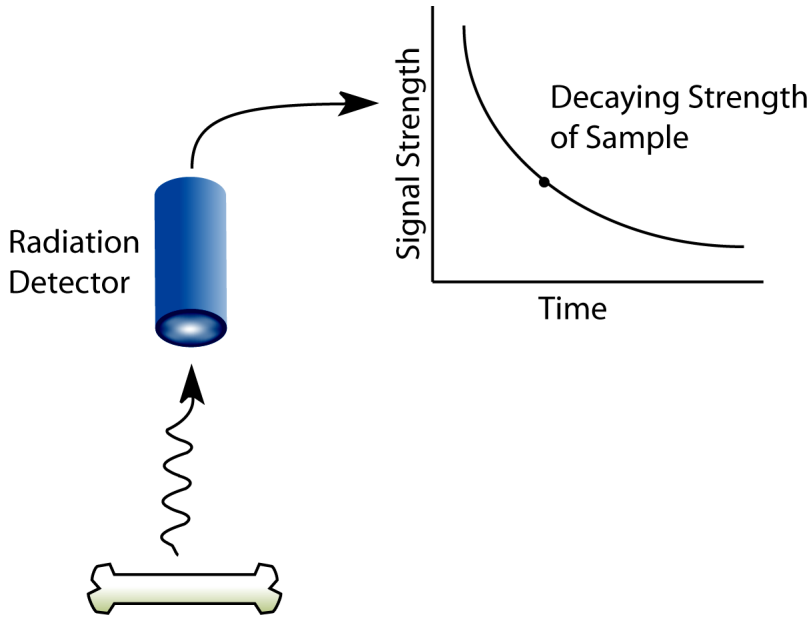
- In a more macro scale, controlled amounts of beta particles or gamma rays can be used to break DNA bonds, thereby killing undesirable cells (e.g. insects & pathogens)



- This process is used to sterilize hospital equipment, suppress sprouting in vegetables, and kill cancer cells

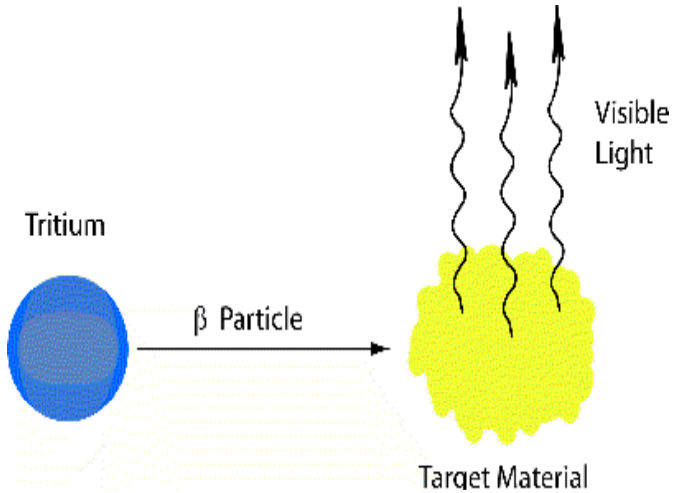
7. Decay Time

- Knowing the half-life of certain radioactive species, aging analyses are possible
  - **Archeological artifacts**
  - **Age of the earth**
  - **Prehistoric climate changes**
  - **Industrial age climate stability**



8. Luminescence

- Some radioactive materials (e.g. tritium) can produce wave lengths in target materials that are visible to the human eye



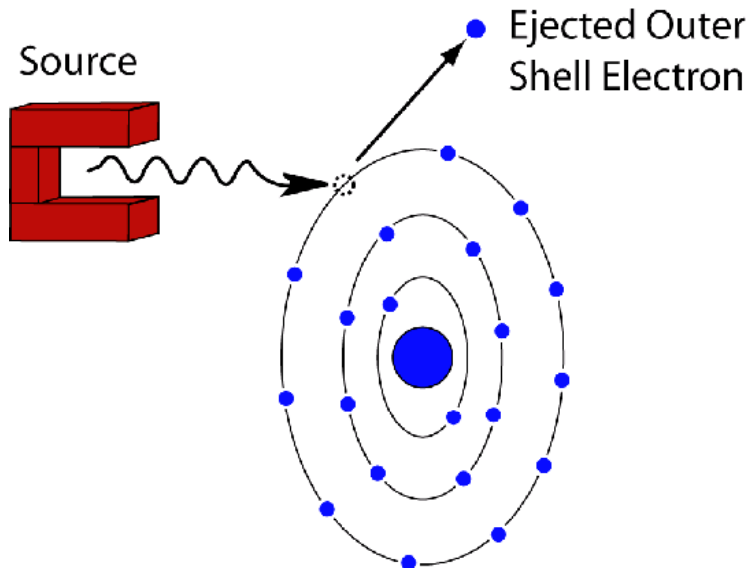
- Routine uses include lighting for airport runways

- 100% reliable & self contained

9. Ionization

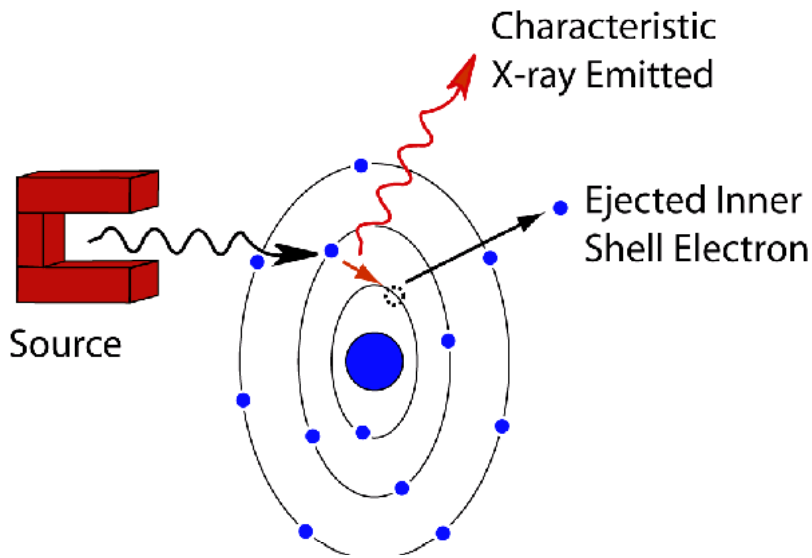
- Sufficiently high energy radiation will knock off electrons in surrounding media

- Media becomes electrically charged



10. X-Ray Fluorescence

- Monochromatic X-rays focused on a material of unknown composition
- Inner shell electron ejected
- Outer shell electrons move to inner shells, emitting an X-ray characteristic of unknown material

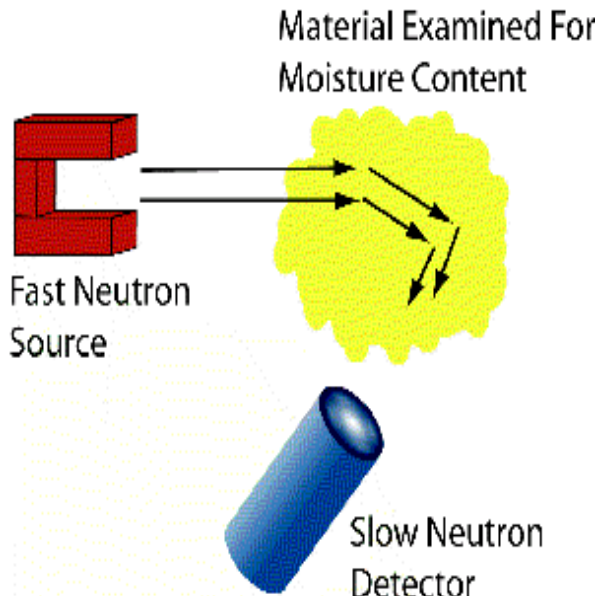


11. Neutron Slowing Down

- A burst of fast neutrons injected into a medium

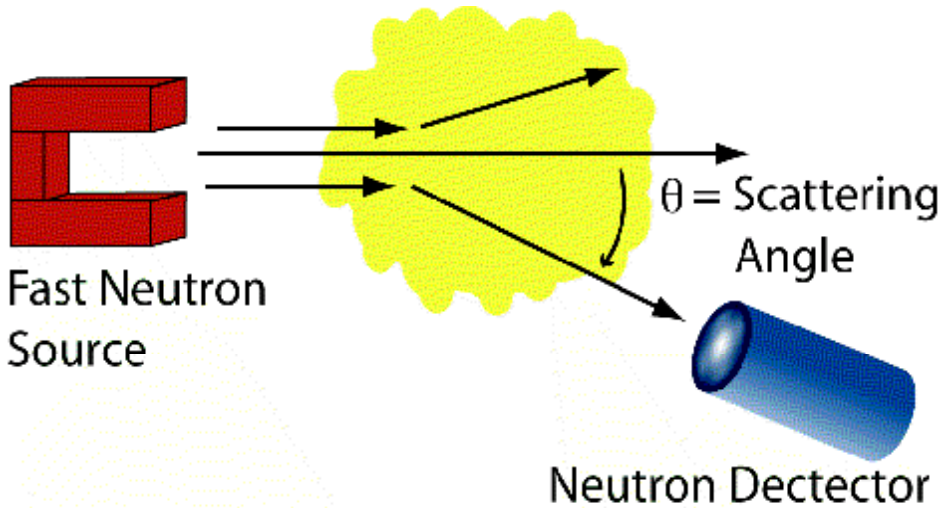
→ Neutrons will slow down rapidly if the medium is rich in protons (i.e. water)

- Excellent way to determine moisture content



12. Neutron or Gamma Scattering

- The identity of unknown material can sometimes be determined by measuring the scattering angle of a focused beam of incident neutrons or gamma rays

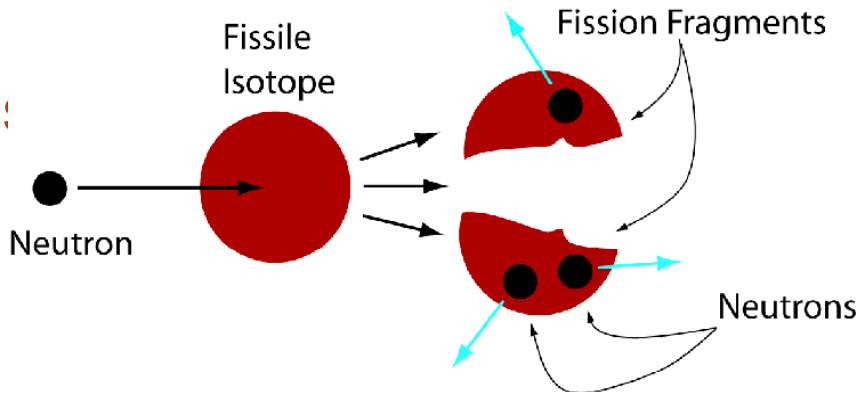


13. Fission

- Very heavy fissile isotopes (e.g. U-235, Pu-239) will likely undergo fission (i.e. break apart) upon absorbing a neutron

- The mass lost in the proces
  is converted into energy

  $E = mc^2$ (energy = mass times the speed of light squared)



- Two fission fragments usually result, along with 2 or 3 neutrons to continue the chain reaction

14. Fusion

- Very light isotopes (e.g. deuterium, tritium), if brought together at very high velocities (i.e. very high temperatures), will fuse together, forming a new element.

- The mass lost in the process is converted into an immense amount of energy

  $E = mc^2$ (energy = mass times the speed of light squared)