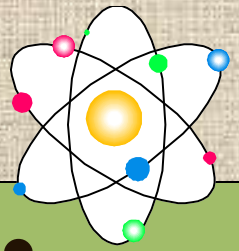


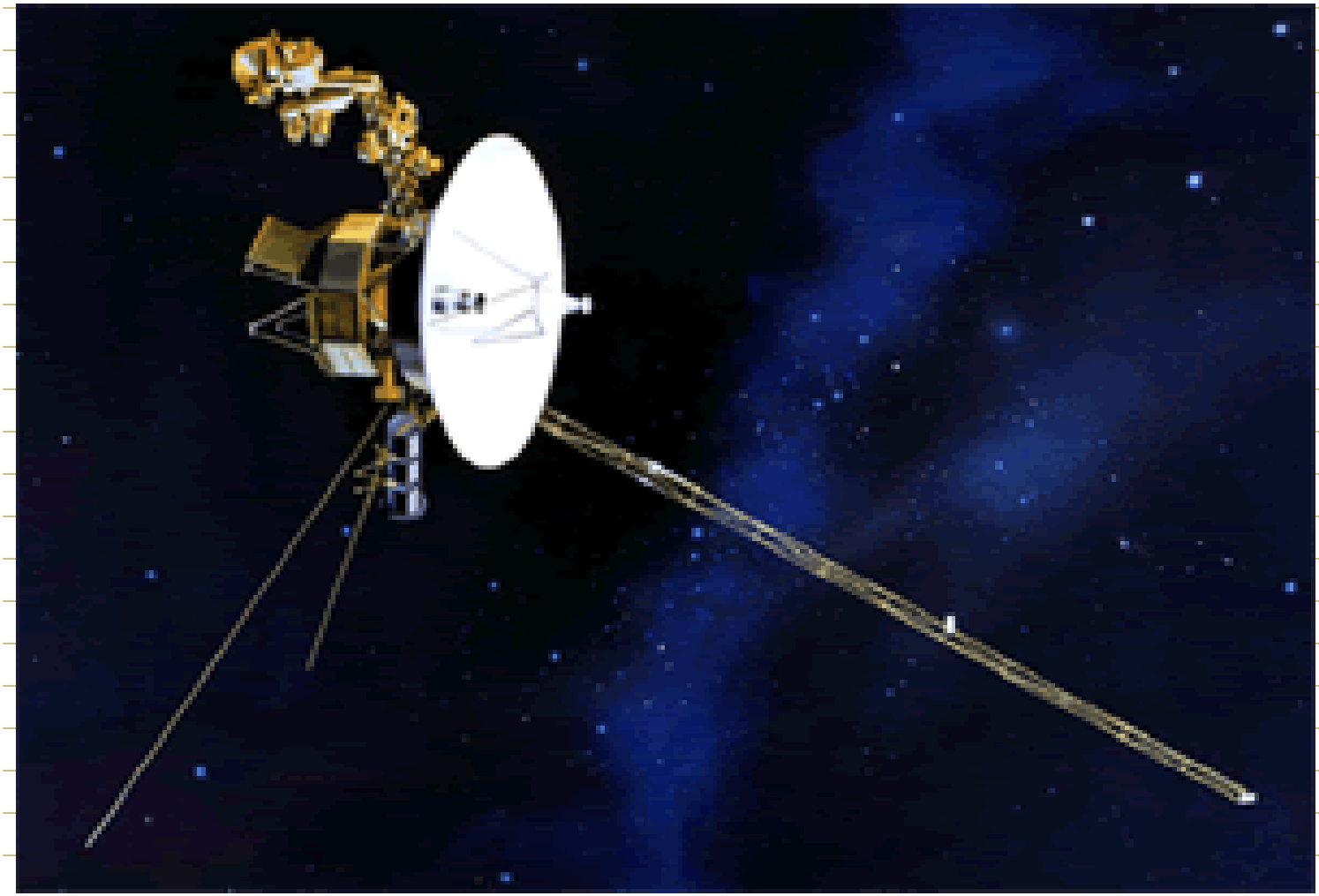
Radiation Basics

Mary Lou Dunzik-Gougar, PhD
Idaho State University/Idaho National Laboratory

ANS Teachers' Workshop
Reno, NV 2014

Medicine/Health

Voyager



Soda Can

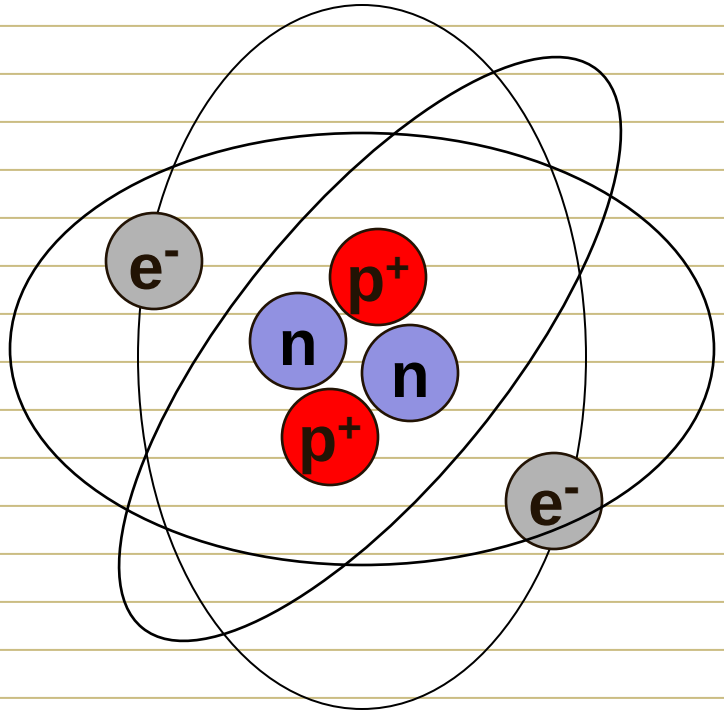
Bugs

What we'll cover . . .

- Atomic Basics
- What is Radiation?
  - Types
  - Characteristics
- Sources of Ionizing Radiation
- Concepts
  - Radioactivity
  - Half-Life
  - Contamination vs. Exposure
  - Protection and Biological Effects

Atomic Structure of Helium

THE HELIUM ATOM



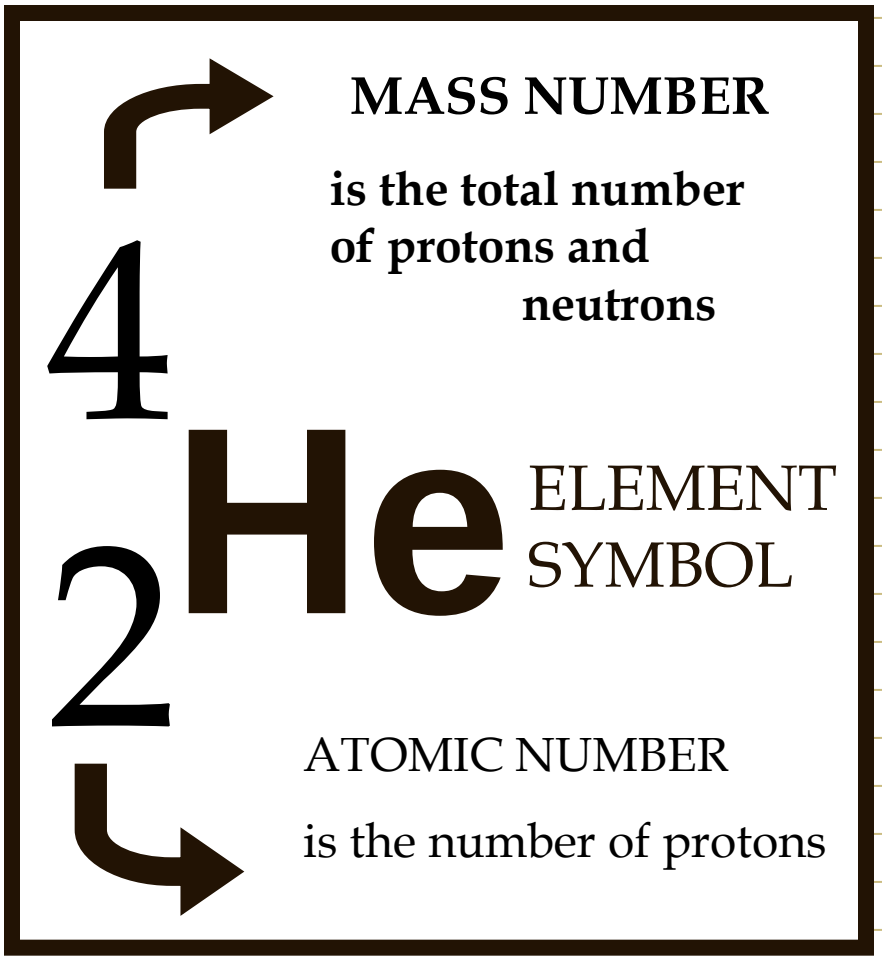
HELIUM'S subATOMIC COMPOSITION

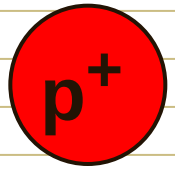
2 Protons

2 Neutrons

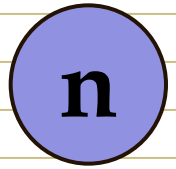
2 Electrons

More on helium . . .





Protons have a large mass and a positive charge. The number of protons identifies an element.



Neutrons have a large mass approximately equal to a proton's mass. Neutrons have no charge.

Electrons have a very small mass and a negative charge. Electrons travel outside the nucleus.

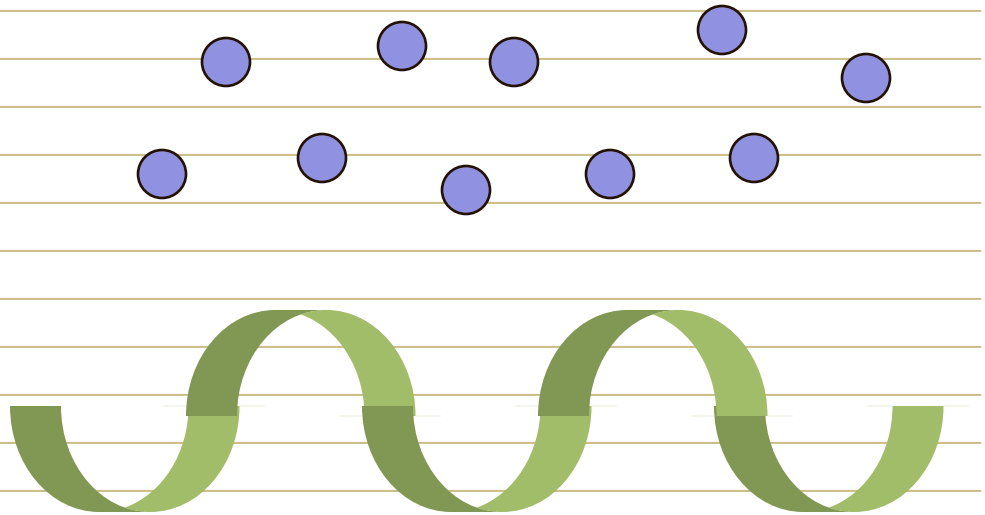
What is Radiation?

Transmission of energy via . . .

Particles

or

Waves

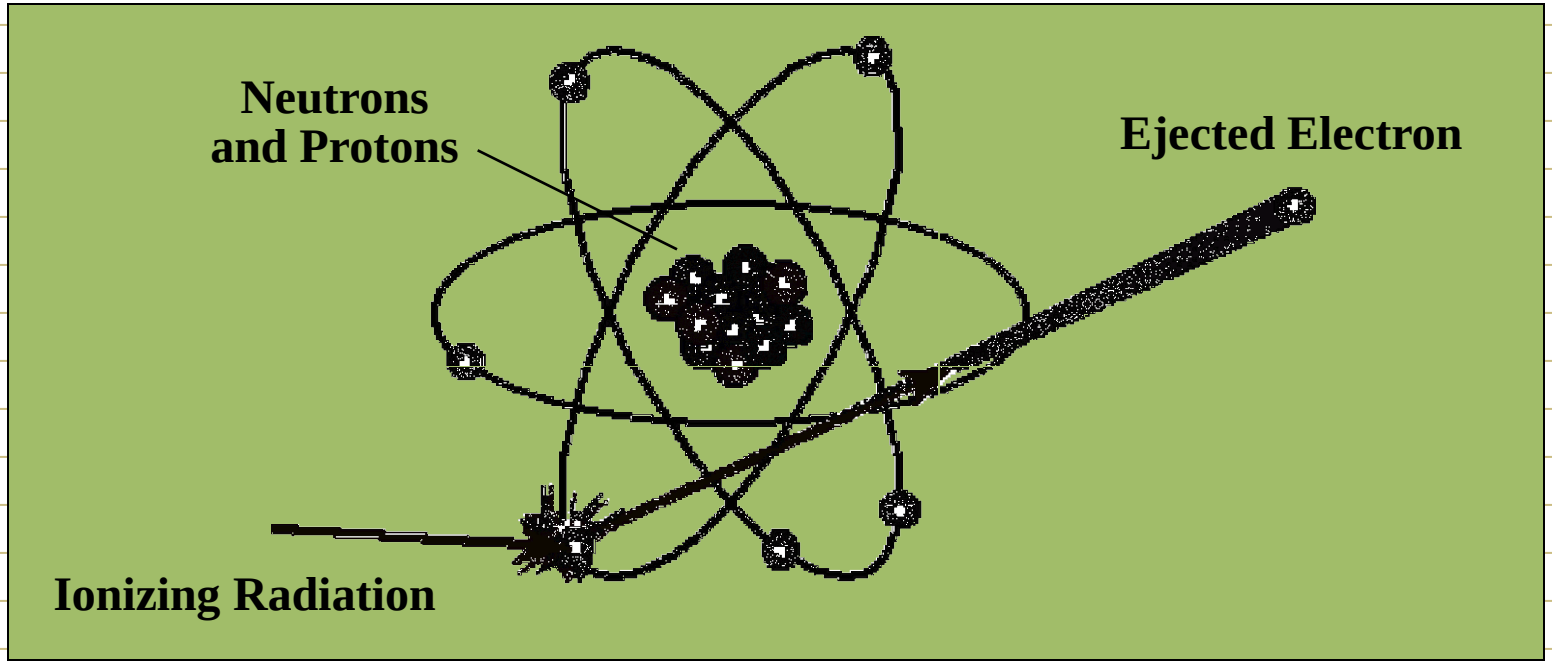


Types of radiation

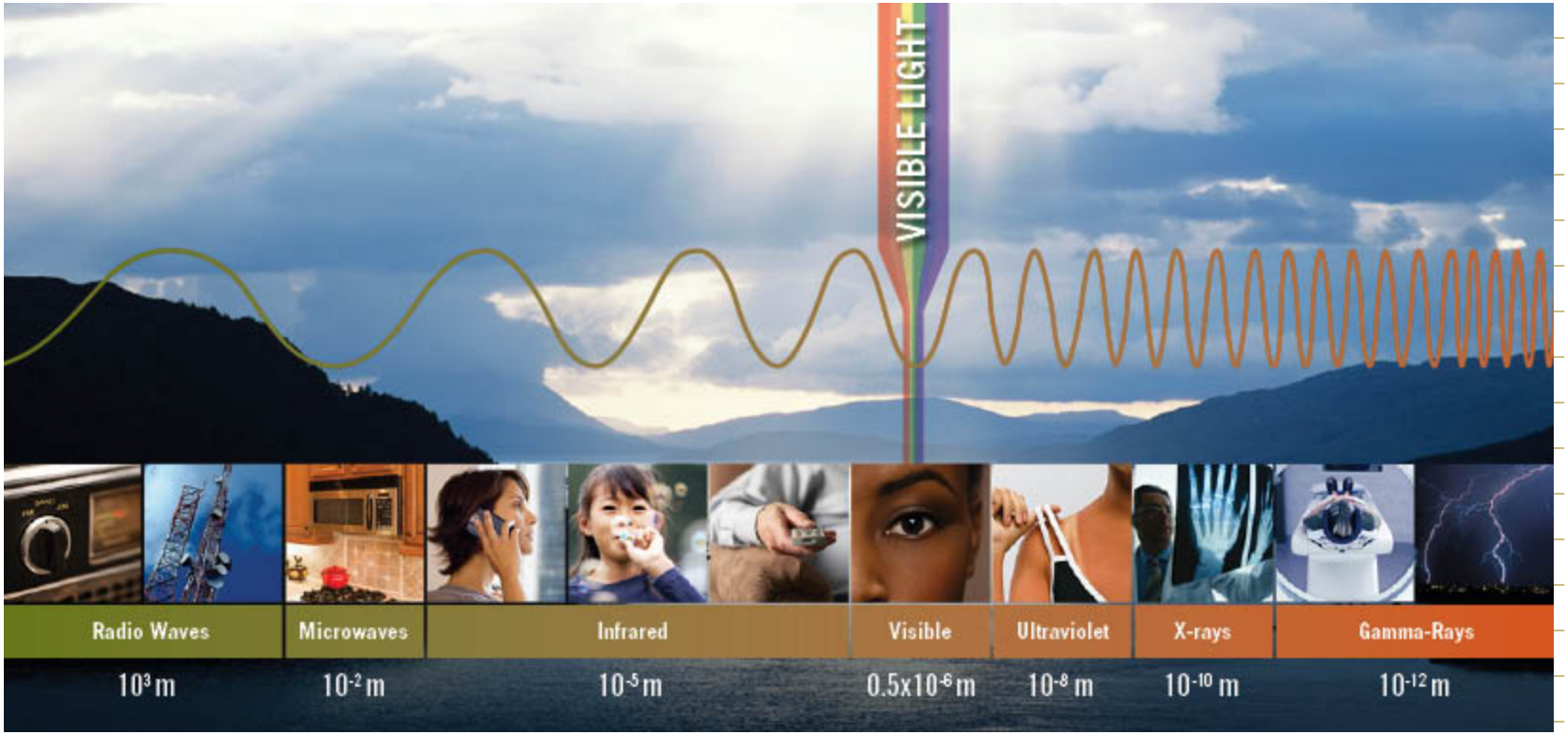
Non-Ionizing	Ionizing
Radiowaves	*Alpha*
Microwaves	*Beta*
Infrared	*Gamma*
Ultraviolet	*X-Rays*
Visible Light	*Neutrons*

Why is it called *ion*izing?

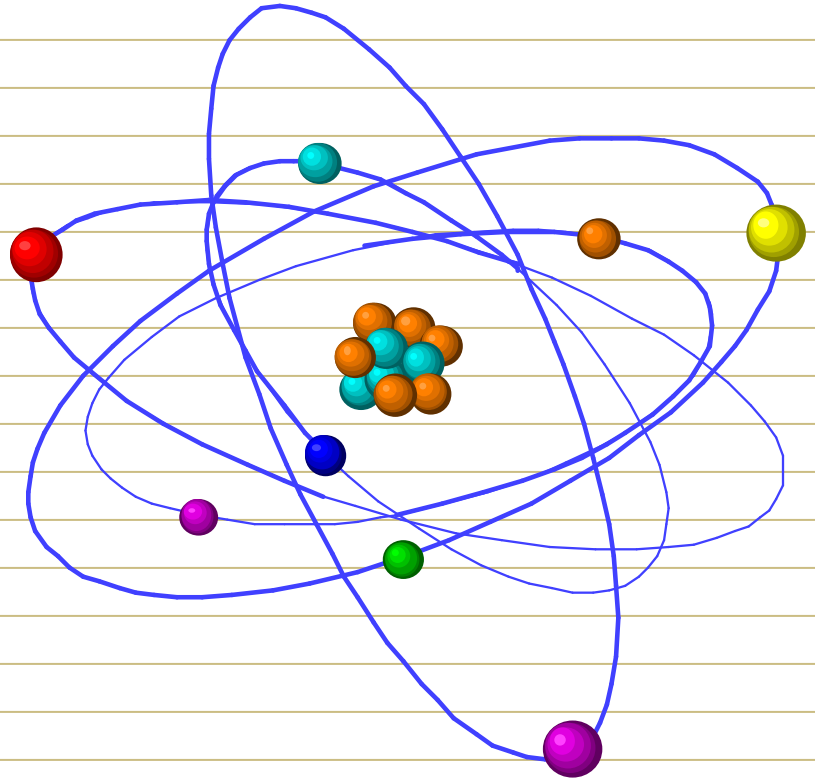
Because it creates *ions* -- atoms with a charge.



Electromagnetic Spectrum



Where does radiation come from?



Atoms . . . from radioactive or unstable atoms

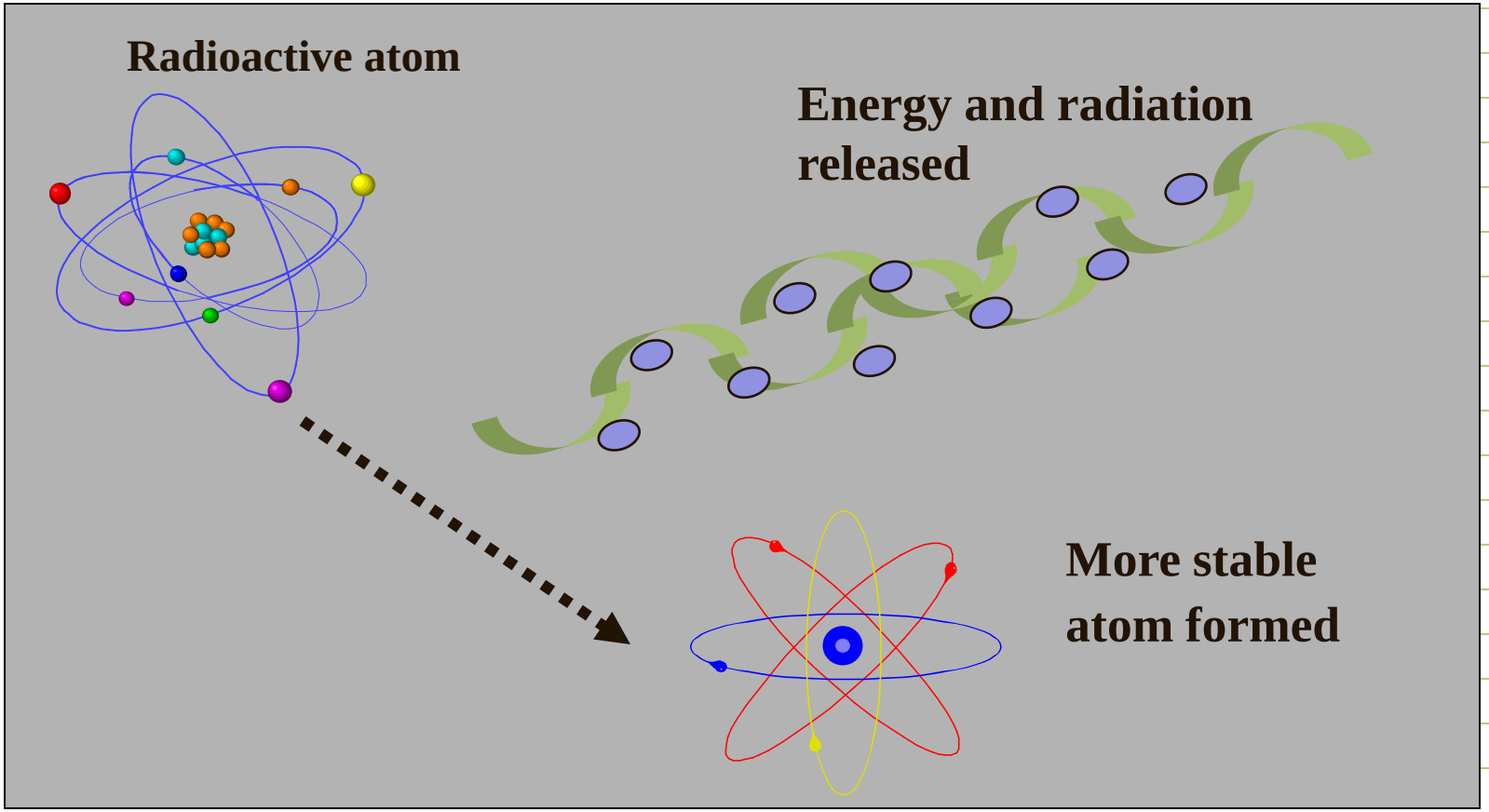
What part of atoms?

The Nucleus

Hence, we have terms such as *nuclear* medicine.

What is radioactivity?

The spontaneous emission of “fragments” or “bundles” of energy from energetic nuclei creating more stable nuclei.



If radiation comes from atoms and everything is made of atoms, is there radiation around us right now?

Absolutely!

It’s called background radiation

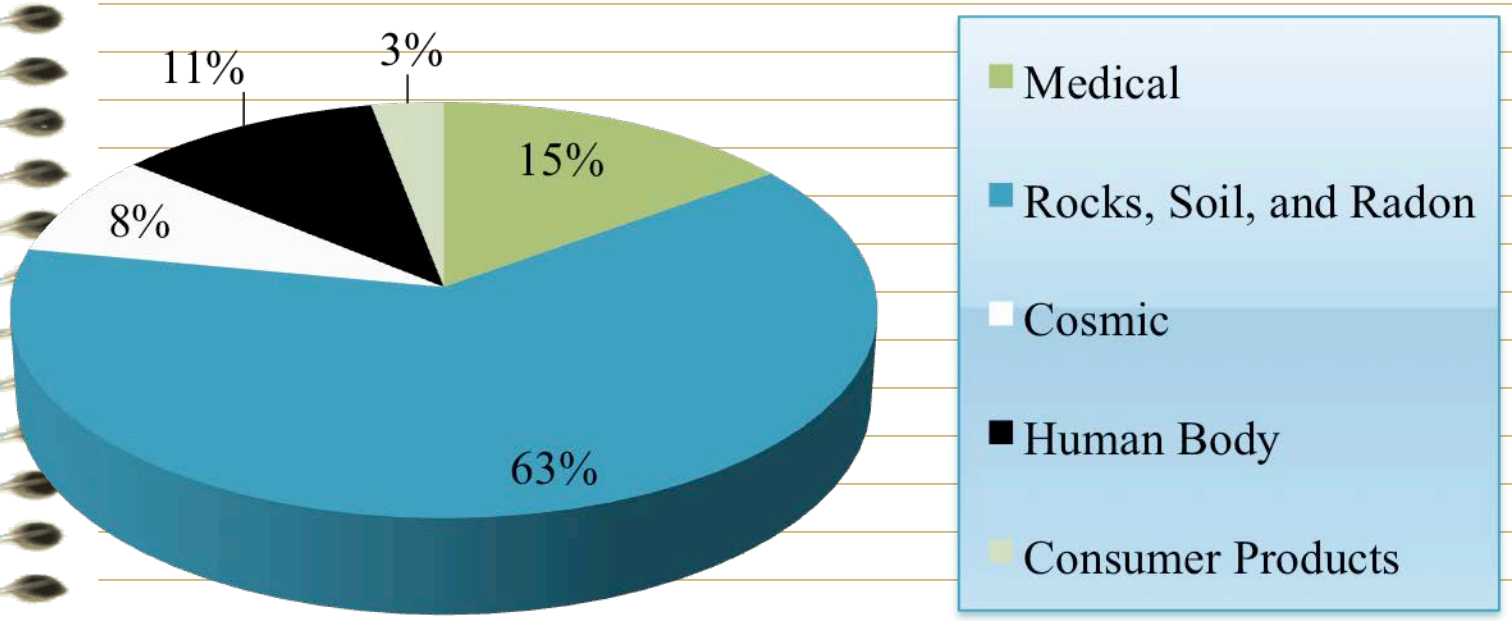
SOURCES OF RADIATION

Samuel Brinton

Kansas State University

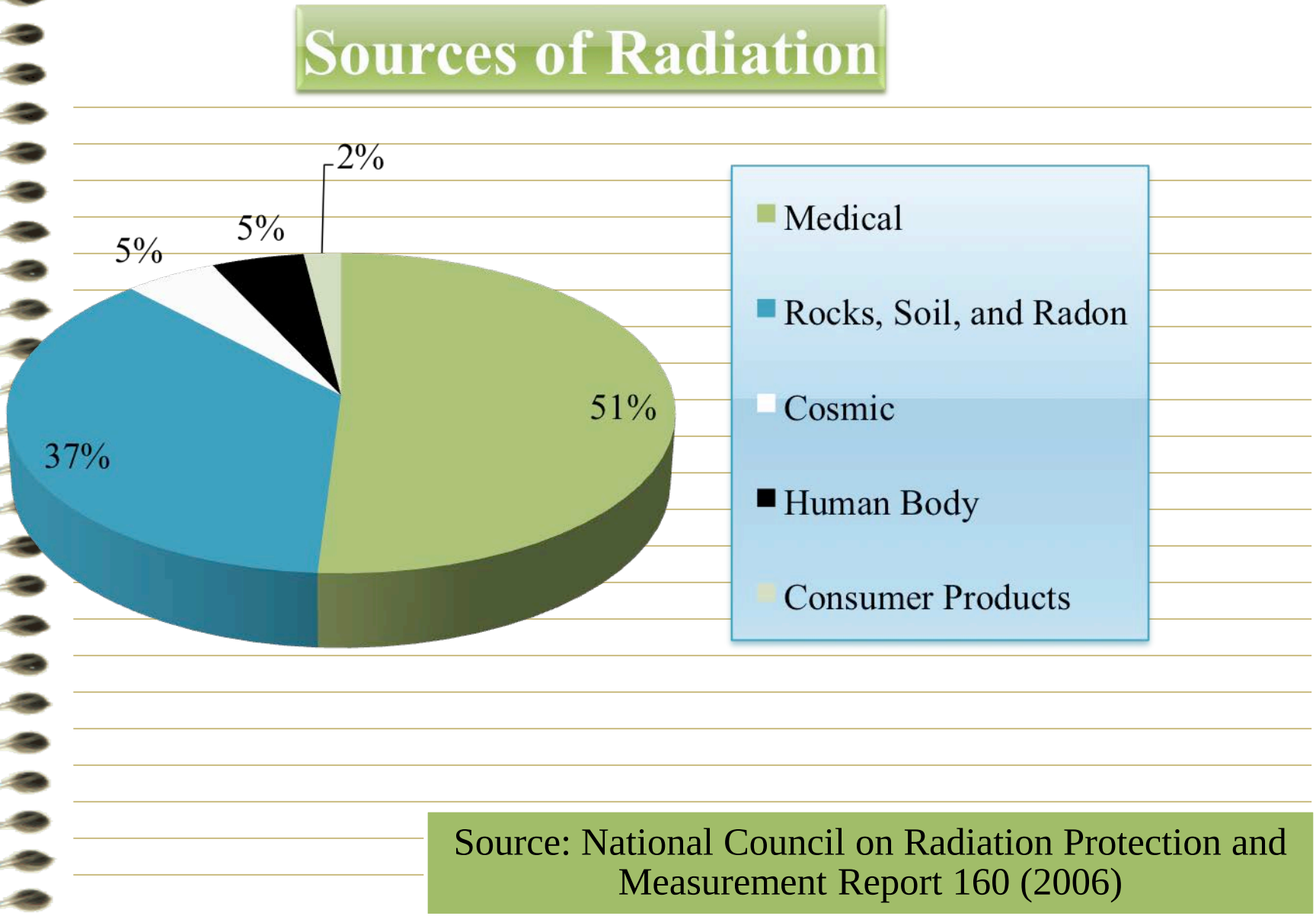
In 1987 the average American received 360 millirem of radiation per year

Sources of Radiation



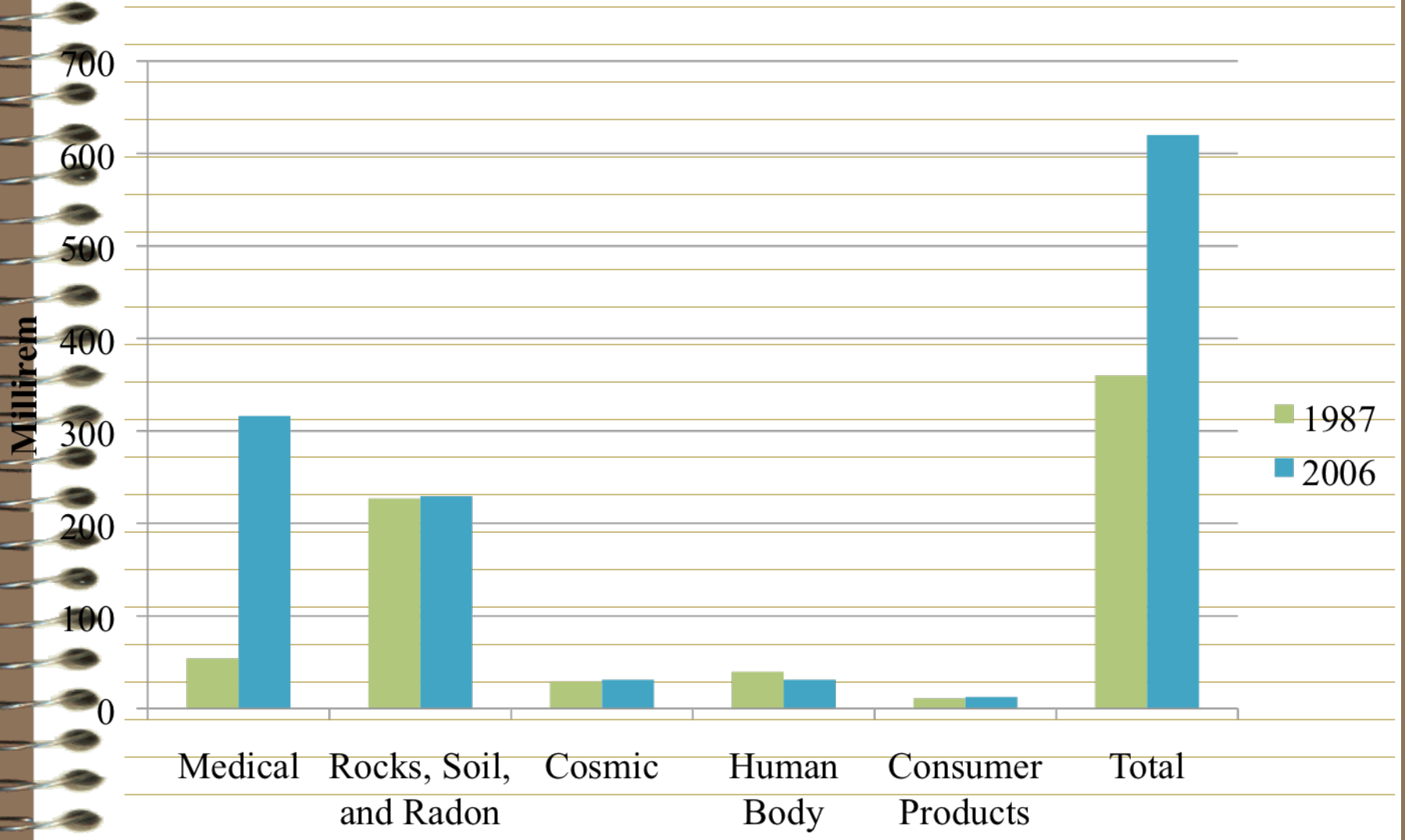
Source: National Council on Radiation Protection and Measurement Report 93 (1987)

The average American now receives 620 millirem of radiation per year



Source: National Council on Radiation Protection and Measurement Report 160 (2006)

A Comparison of the Sources



The Reason for the Change

1980s to 2006

- Radiation from medical procedures increased 7 times.

- Increase in medical imaging procedures
  - computed tomography (CT)
  - nuclear medicine

Source: http://www.ncrponline.org/Publications/160press.html

Terms

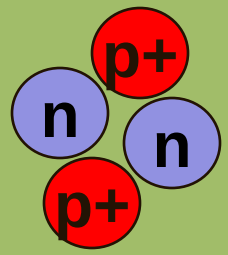
- **<u>Roentgen (R)</u> -** unit of exposure - ionization of air by *x* or gamma rays
- **<u>RAD (Radiation Absorbed Dose)</u> -** energy deposited in material
- **<u>rem</u> - (Roengten Equivalent Man)**
  – unit of dose equivalent

Radiation Types

Alpha (α)

2 protons, 2 neutrons

positively charged particle



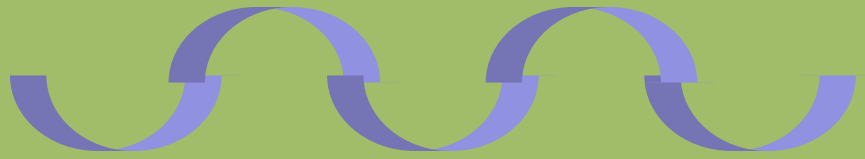
Beta (β)

like an electron

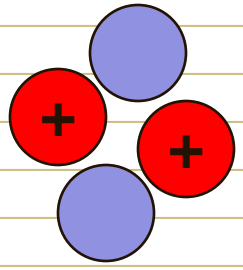
negatively charged particle

Gamma (γ)

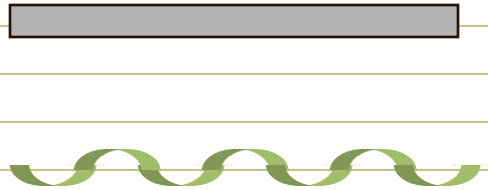
Wave energy (*not* a particle)

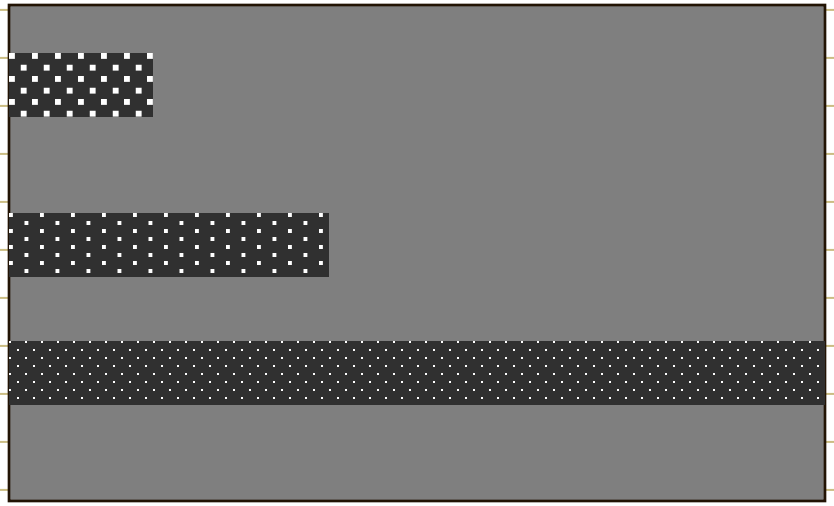


PENETRATING ABILITY

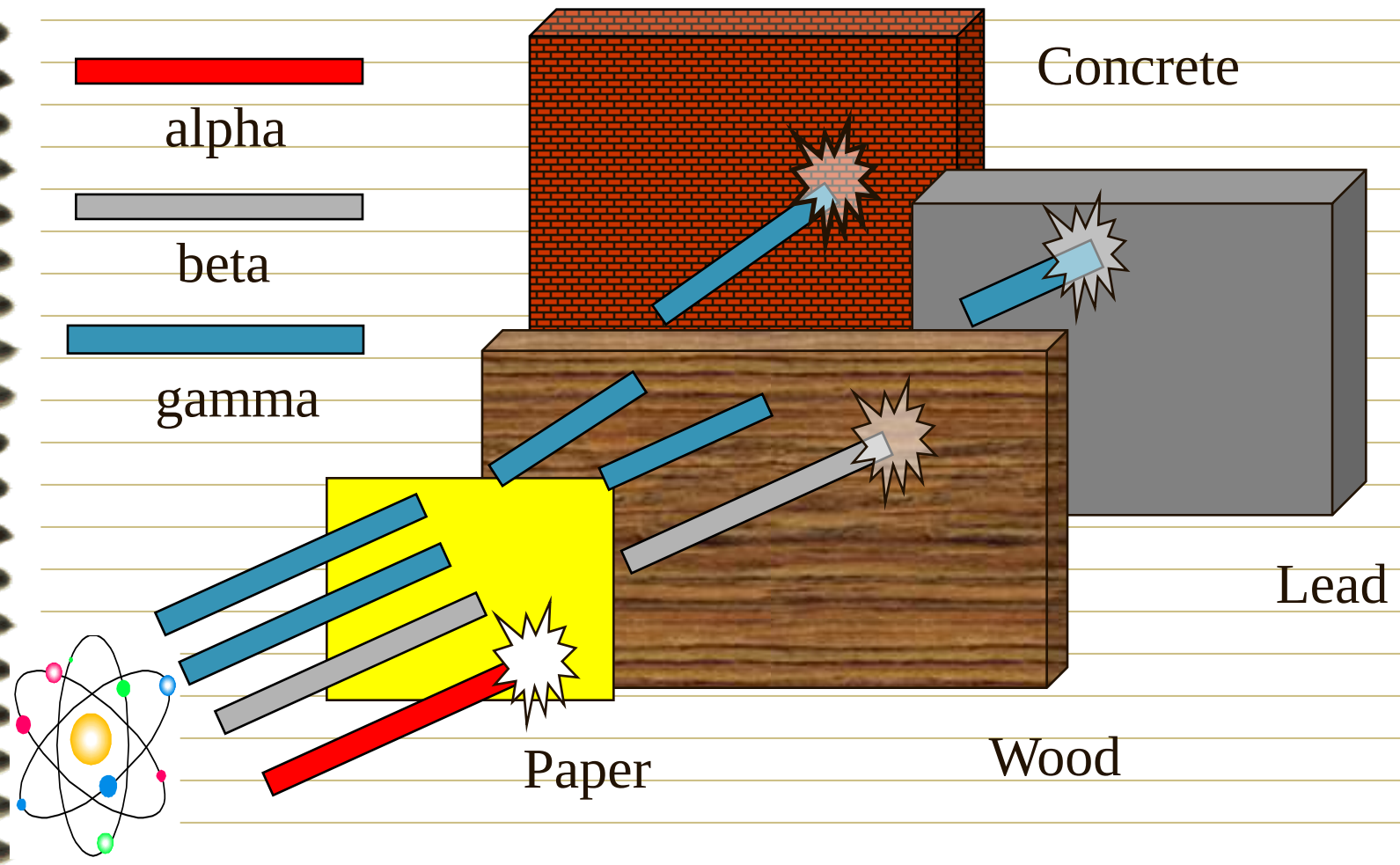


α β γ



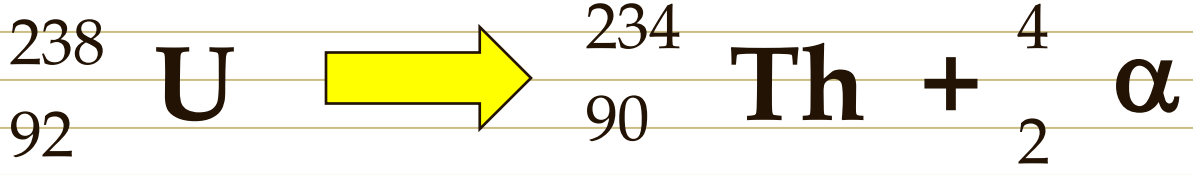


SHIELDING

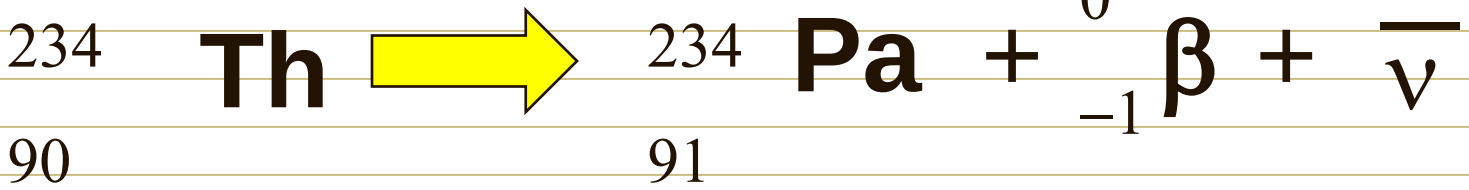


RADIOACTIVE DECAY REACTIONS

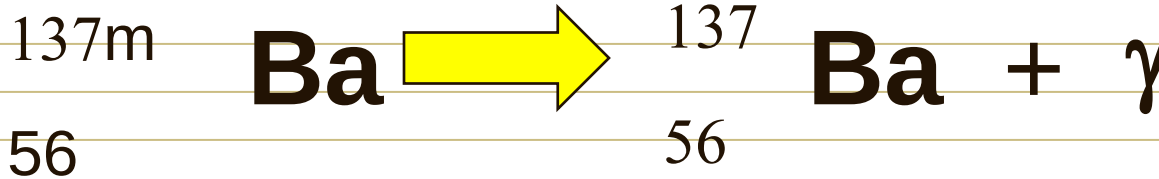
ALPHA DECAY



BETA DECAY



GAMMA DECAY



Units of "Activity"

Activity - a rate; the number of emissions (of radiation) per unit time.

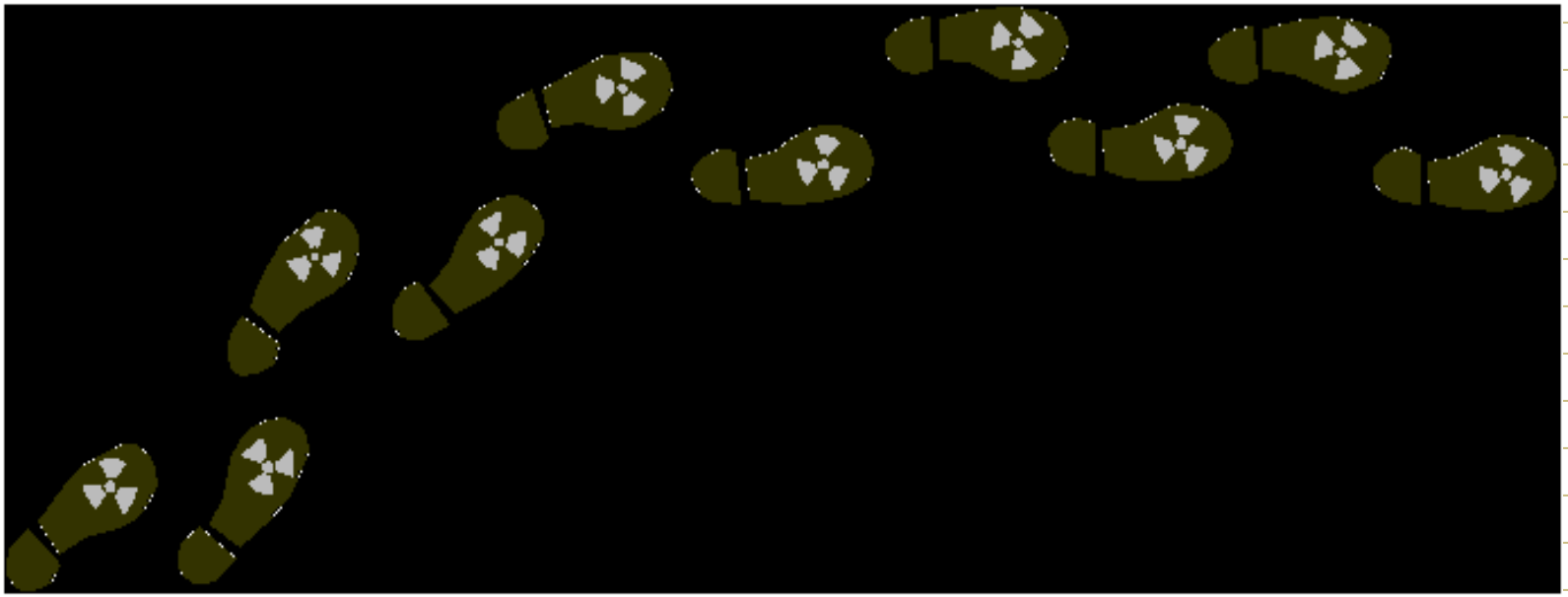
dps - disintegrations per second

Bequerel = 1 dps

Curie = 37,000,000,000 dps

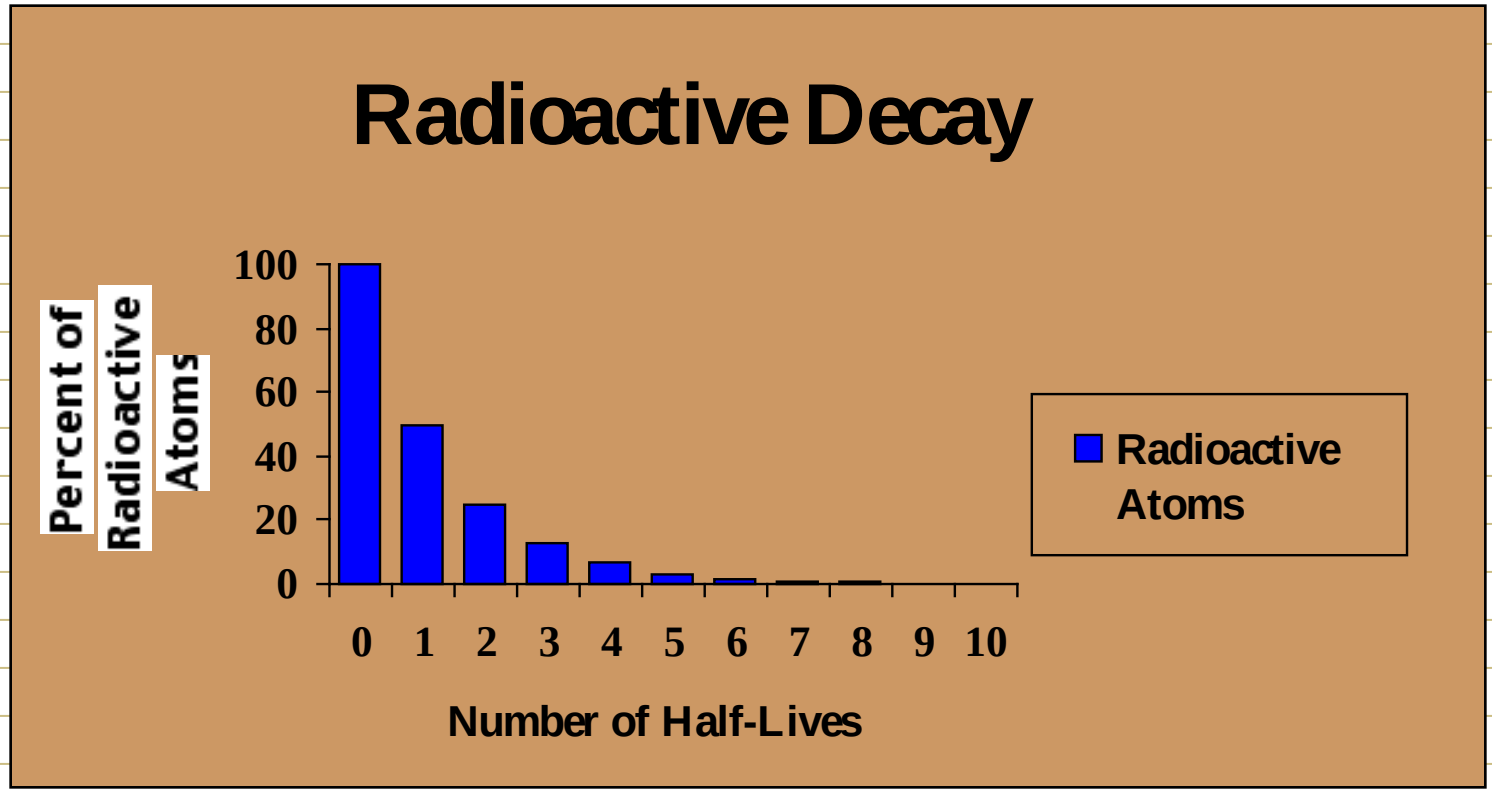
Picocurie = 0.037 dps or 2.2 dpm

Radioactive Contamination

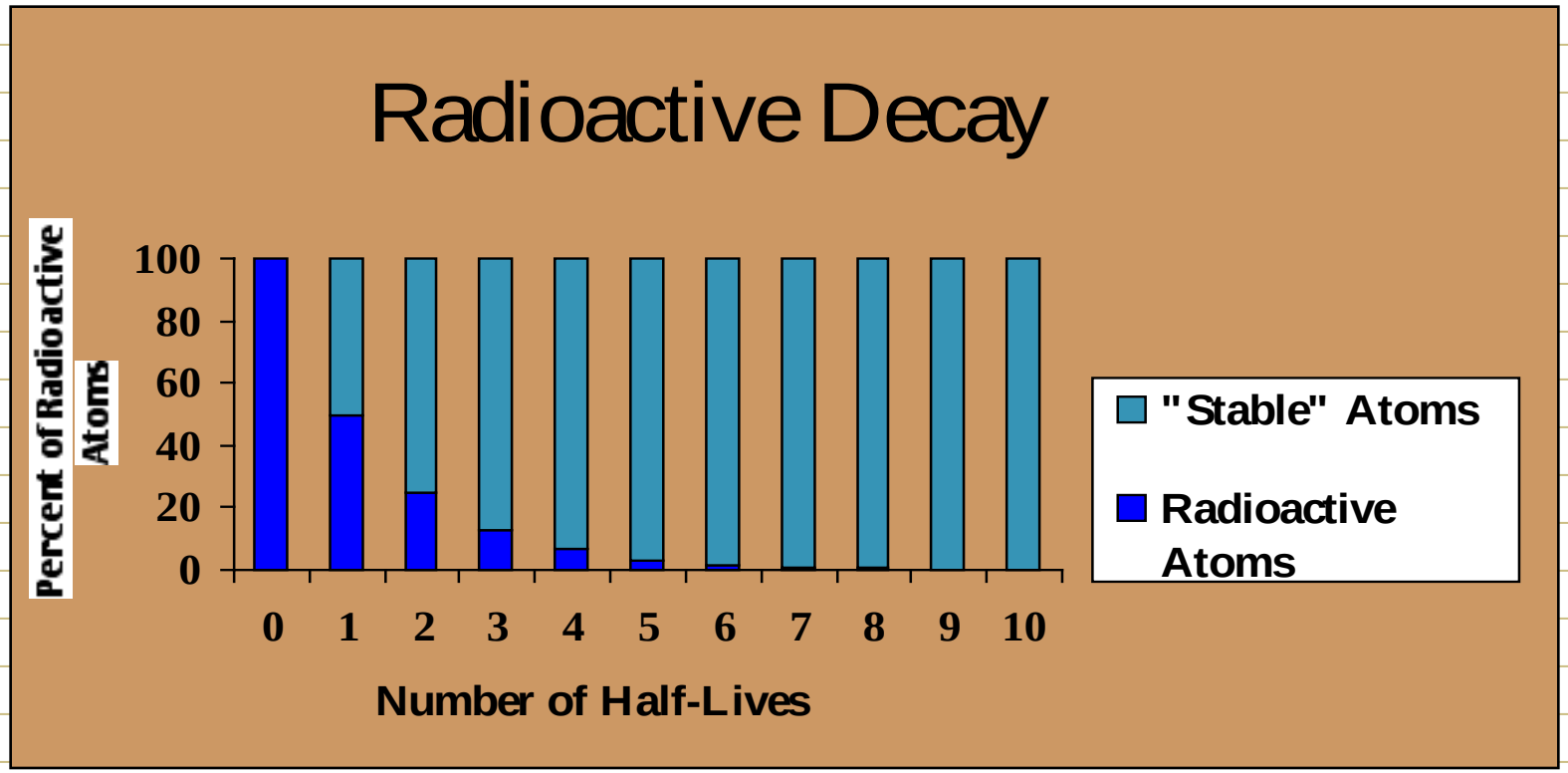


Radioactive Contamination - is radioactive material in an unwanted place.

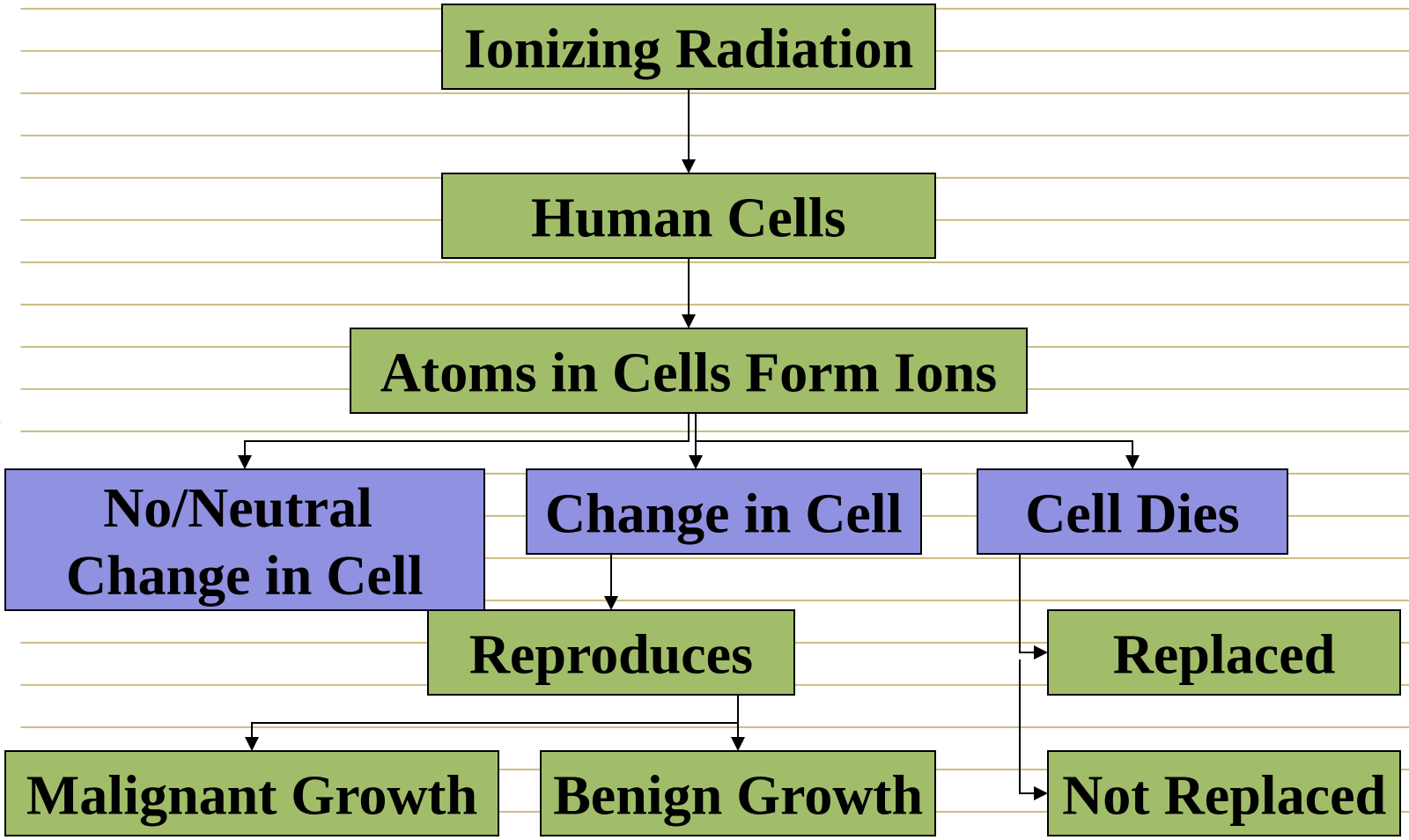
Half Life


Radioactive Decay
Percent of Radioactive Atoms
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10
Number of Half-Lives
Radioactive Atoms

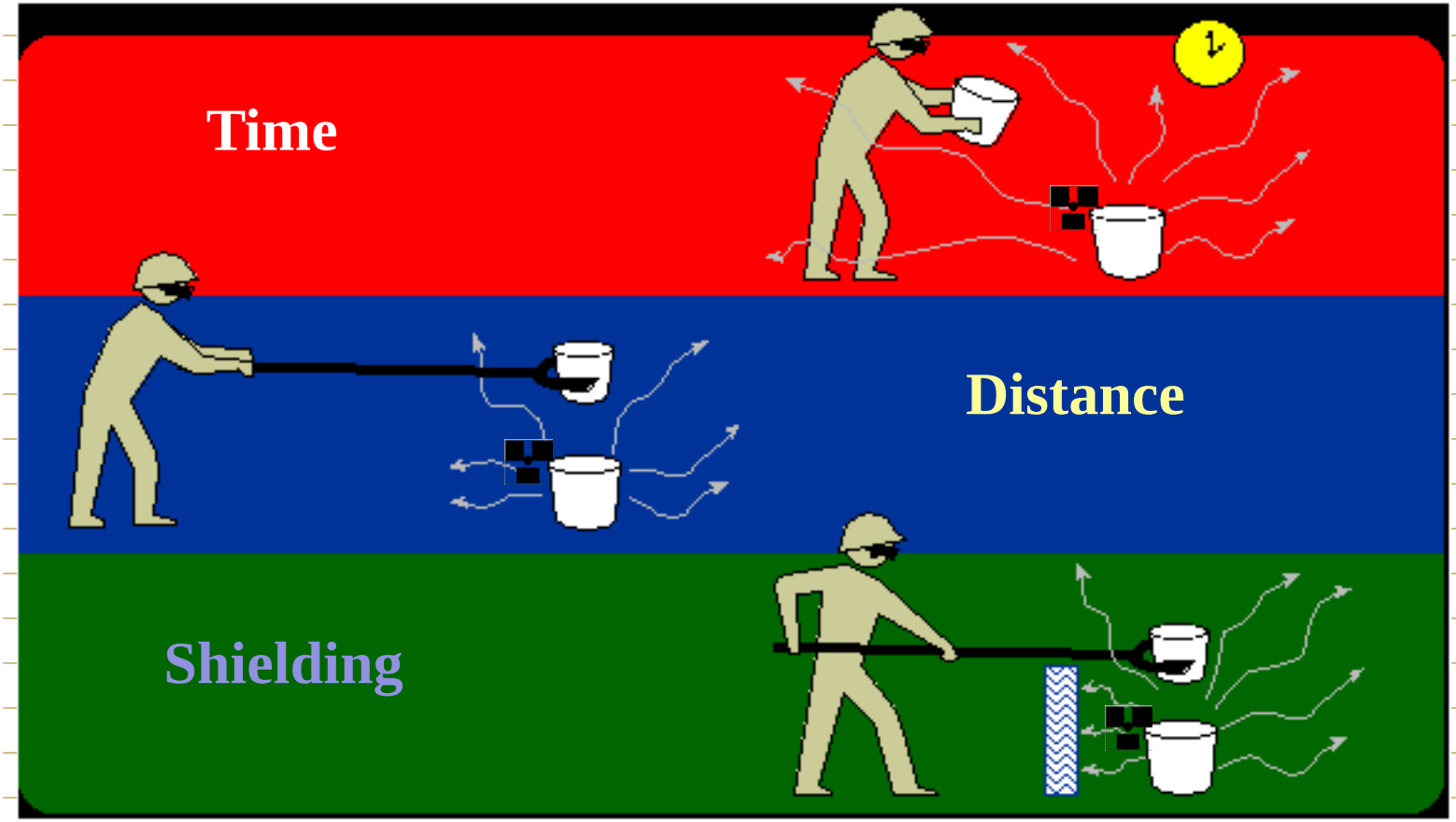
Half Life


Radioactive Decay
Percent of Radioactive Atoms
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Number of Half-Lives
"Stable" Atoms
Radioactive Atoms

Why are we concerned about Radiation?



How do we protect ourselves?



The End . . .