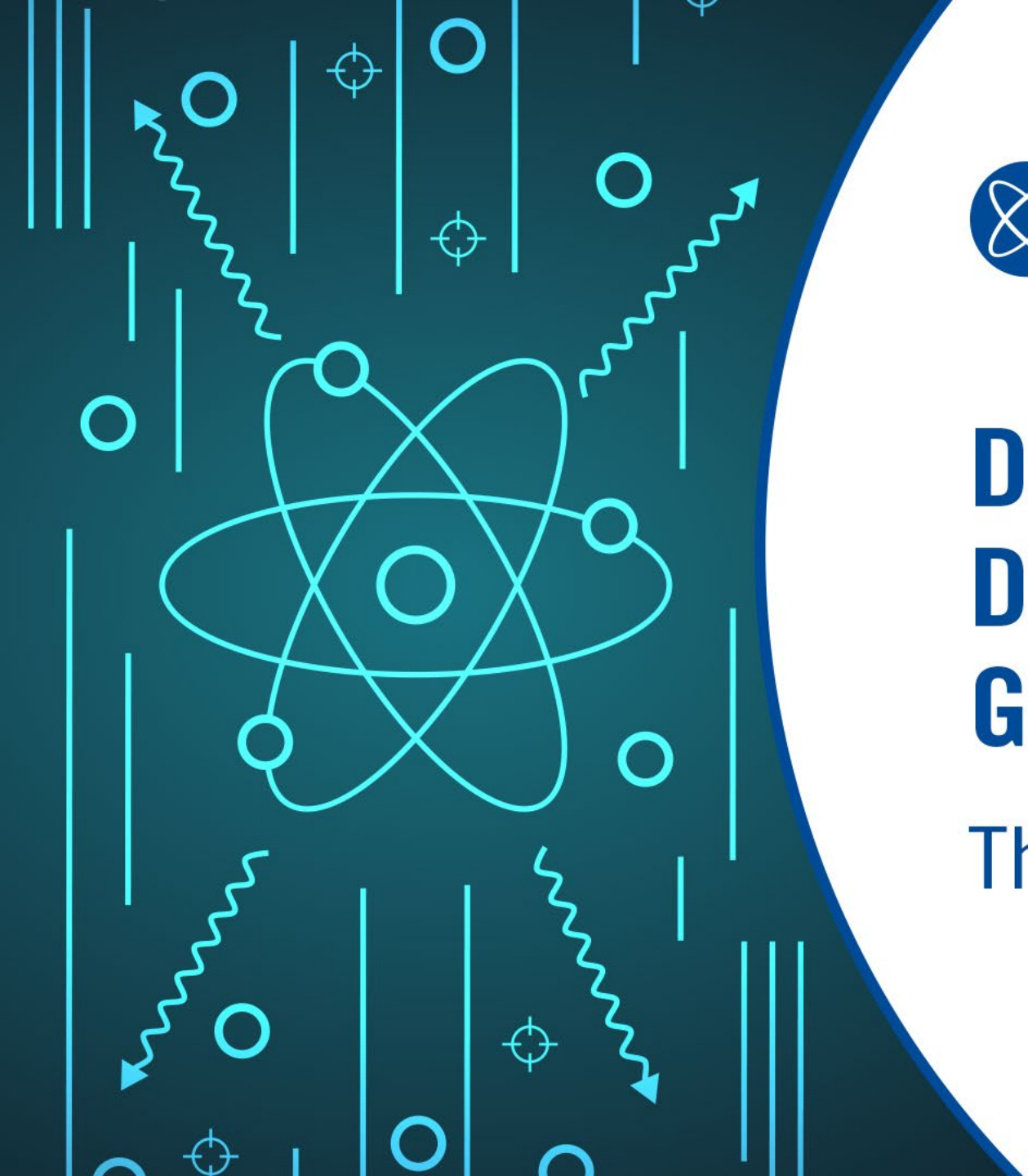

ANS® EDUCATOR TRAINING

Decoding Radioactive Decay: Alpha, Beta, Gamma, and More

Thursday, September 28

This webinar is presented by ANS in partnership with the Department of Energy, Office of Nuclear Energy.

Decoding Radioactive Decay: Alpha, Beta, Gamma and more

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Idaho State University /
Idaho National Laboratory

What do the following things have in common?

Radiologist

Perseverance

Soft Drink Can

Bugs

Each represents an application of nuclear science and technology.

What we'll cover . . .

- Atomic Basics
- What is Radiation?
  - Types
  - Characteristics
- Sources of Ionizing Radiation
- Concepts
  - Radioactivity
  - Half-Life
  - Contamination vs. Irradiation
  - Terms

100 Years of Nuclear Discovery

Wilhelm Roentgen (1845-1923)

Discovered the X-Ray on November 8, 1895. Ushering in a new age.

Henri Becquerel (1852-1908)

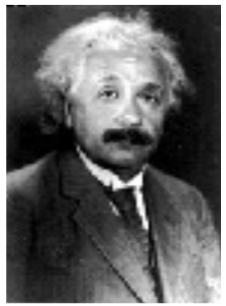
Discovered Radioactivity in 1896. The international unit of activity, the "Becquerel," is named in his honor.

Marie Curie (1867-1934)
Pierre Curie (1859-1906)

Discovered Radium and coined the term "Radioactivity." The basic unit of activity, the "Curie," was named in their honor.

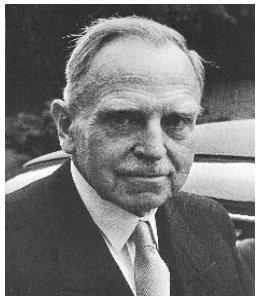
Ernest Rutherford (1871-1937)

The father of nuclear physics. Particles named and characterized by him include the alpha particle, beta particle and proton.



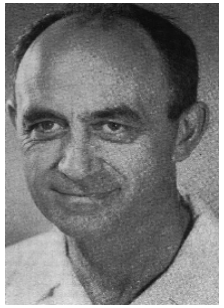
Albert Einstein (1879-1955)

His theories of relativity led to entirely new ways of thinking about time, space, matter, energy, and gravity.



Otto Hahn (1879-1968)

In 1939, he discovered nuclear fission. Preparing the way for the Atomic Age.



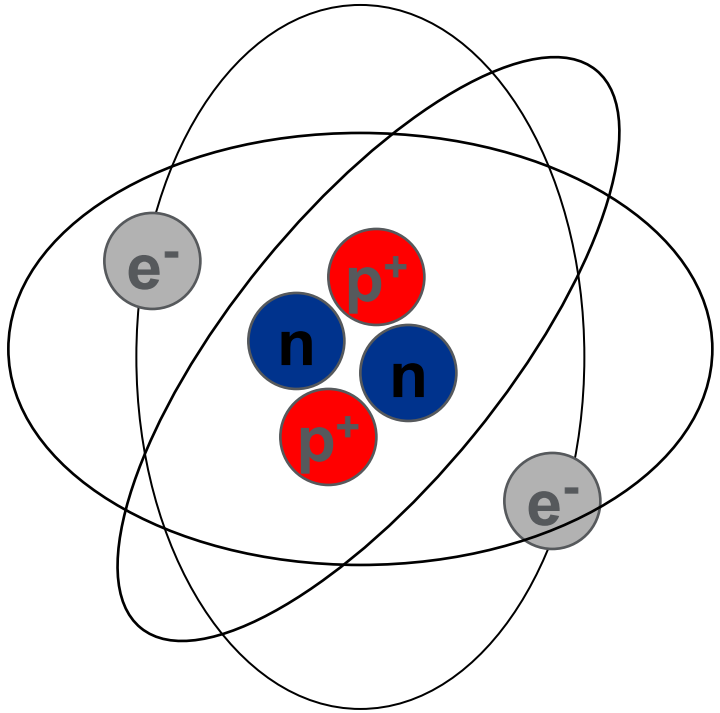
Enrico Fermi (1901-1954)

Lead the team that on Dec. 2, 1942, produced the first man-made and self-sustaining nuclear chain reaction .

Glenn Seaborg (1912-1999)

He is best known for discovering of the element plutonium in February 1941.

Atomic structure of helium



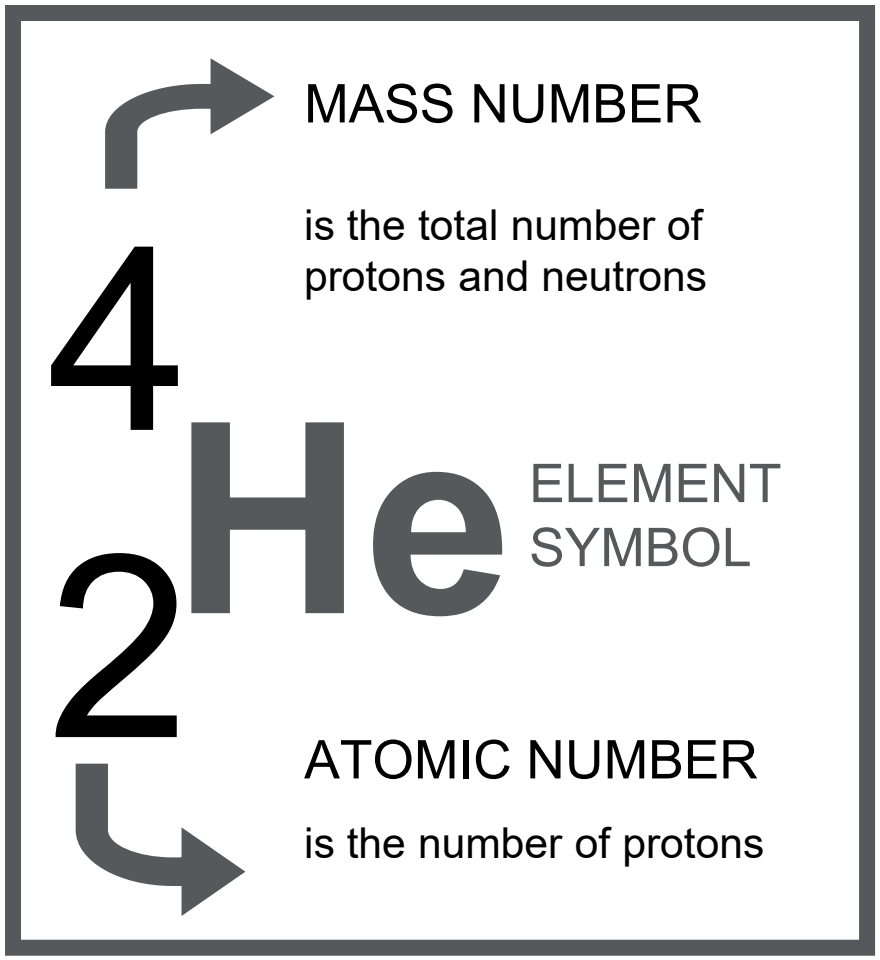
HELIUM'S subATOMIC COMPOSITION

2 Protons

2 Neutrons

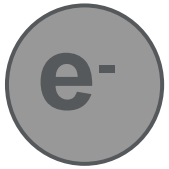
2 Electrons

More on this helium *isotope* . . .



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.

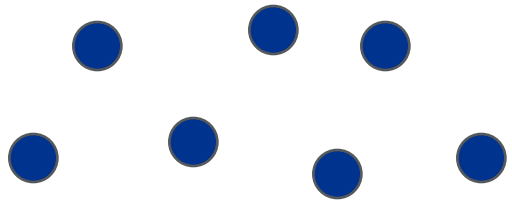


Electrons have a very small mass and a negative charge. Electrons travel outside the nucleus.

What is Radiation?

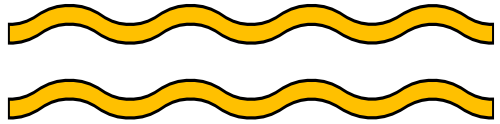
Transmission of energy via…

Particles



Or

Waves



Types of radiation

Non-Ionizing

Radio waves

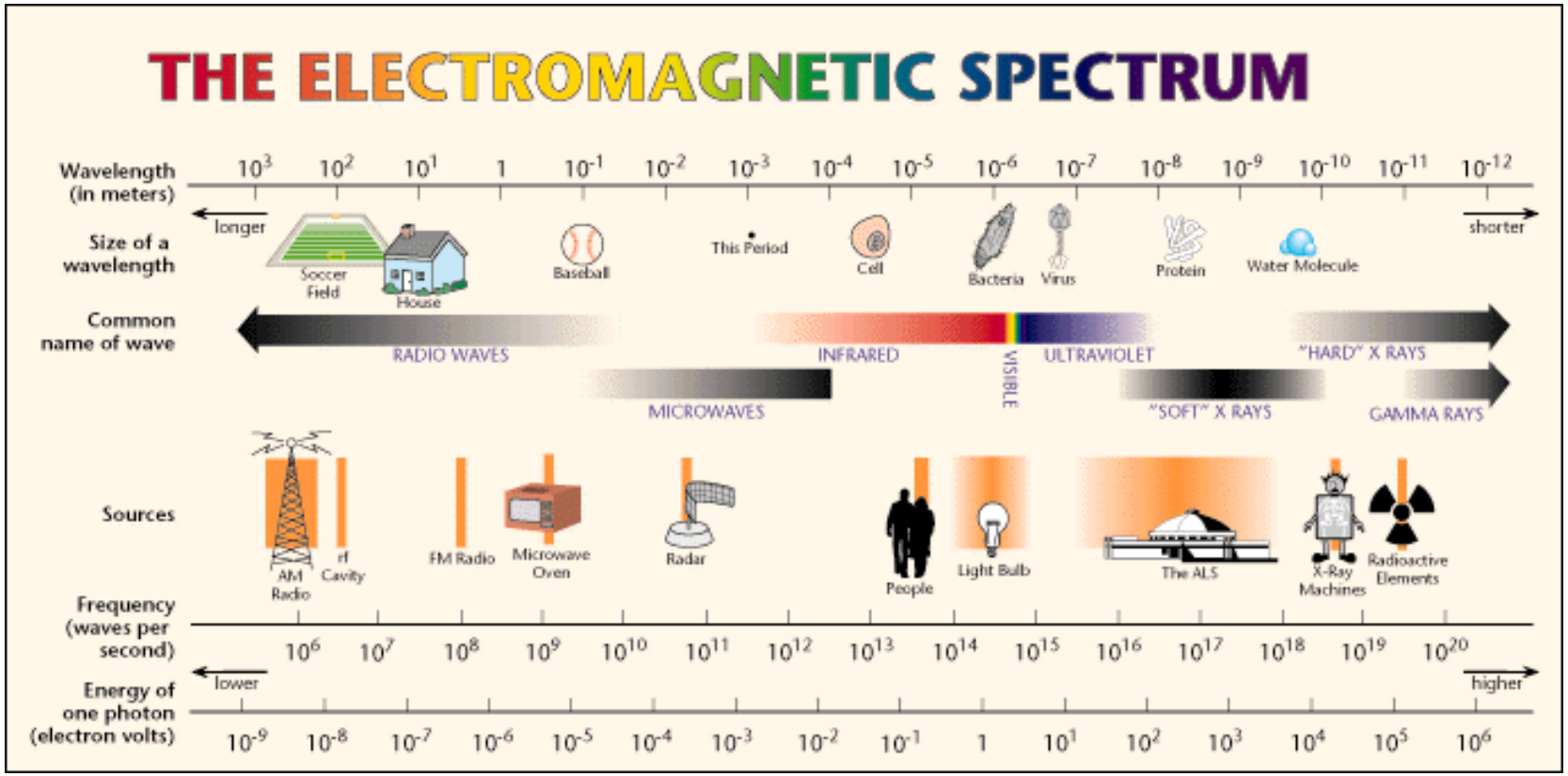
Microwaves

Infrared

Ultraviolet

Visible Light

Electromagnetic Spectrum



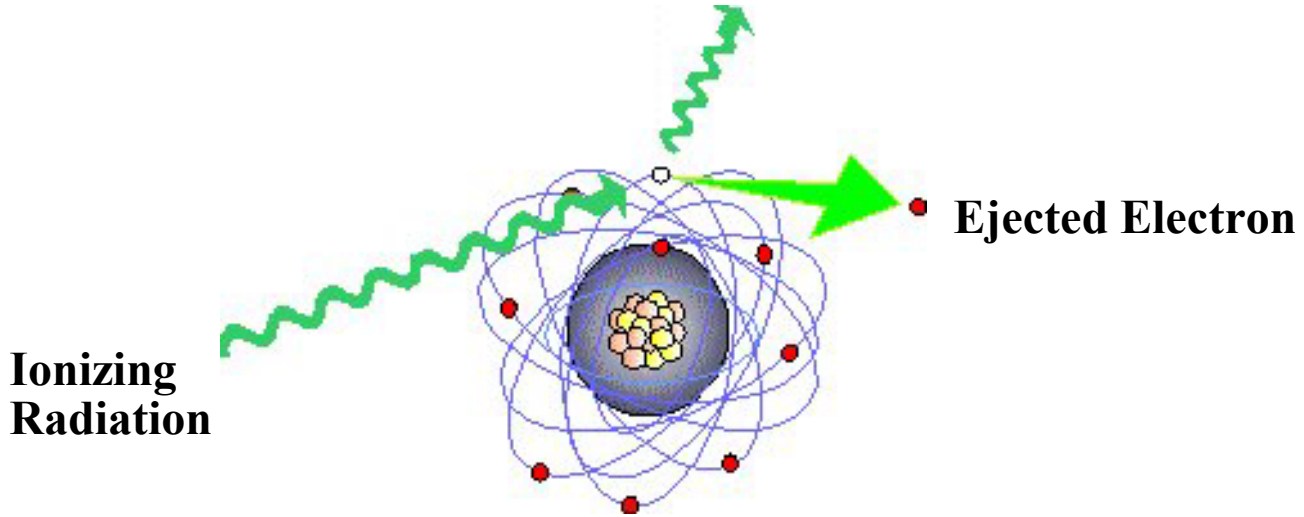
Types of radiation

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

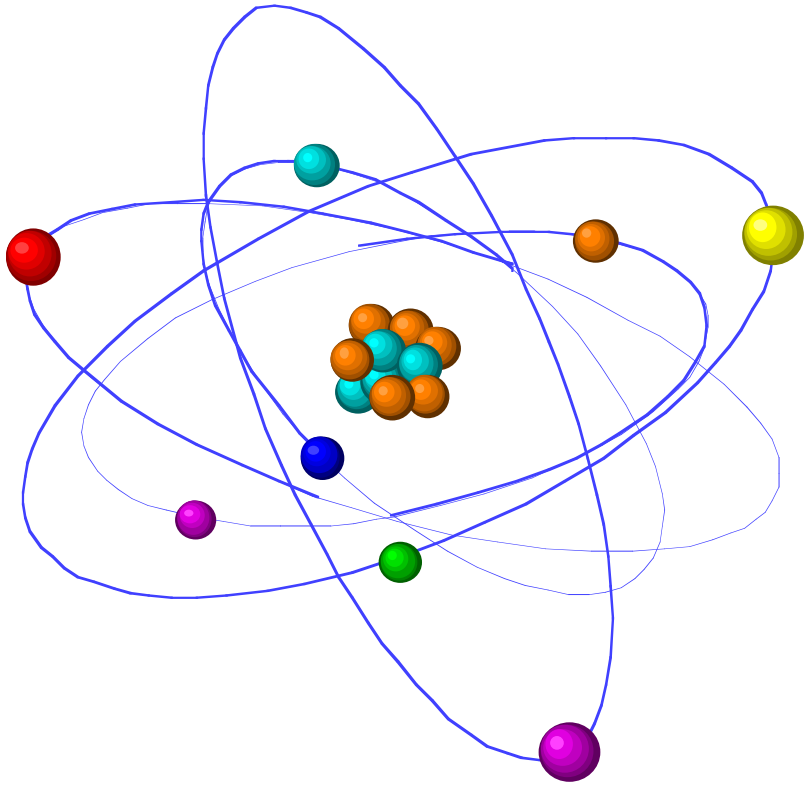
Why is it called *ion*izing?

Because it creates *ions*…

atoms with a charge.



Where does radiation come from?



Atoms . . .

from radioactive or unstable atoms

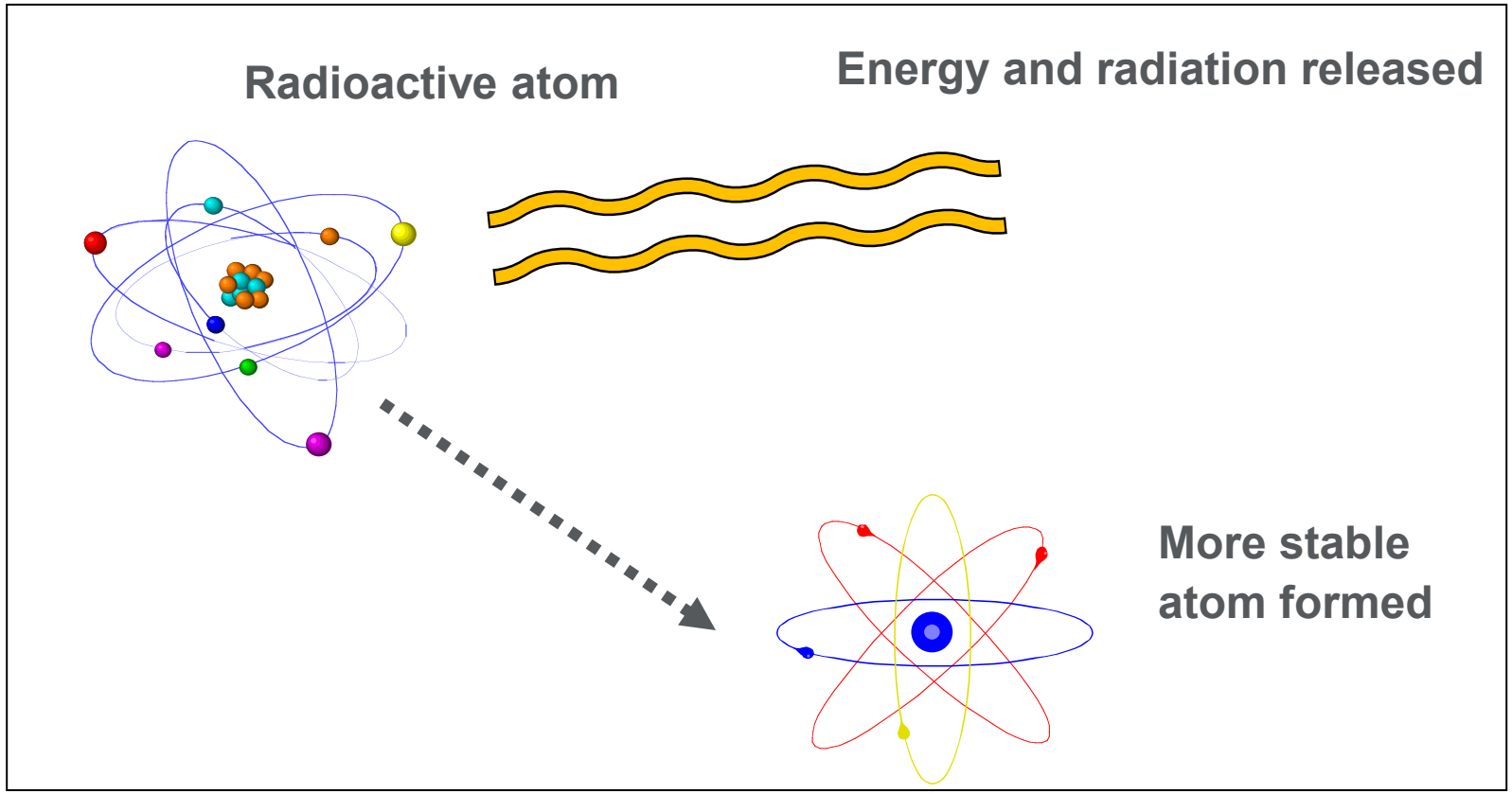
What part of atoms?

The Nucleus

Hence, we have terms such as *nuclear* science/medicine/reactors.

What is radioactivity?

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

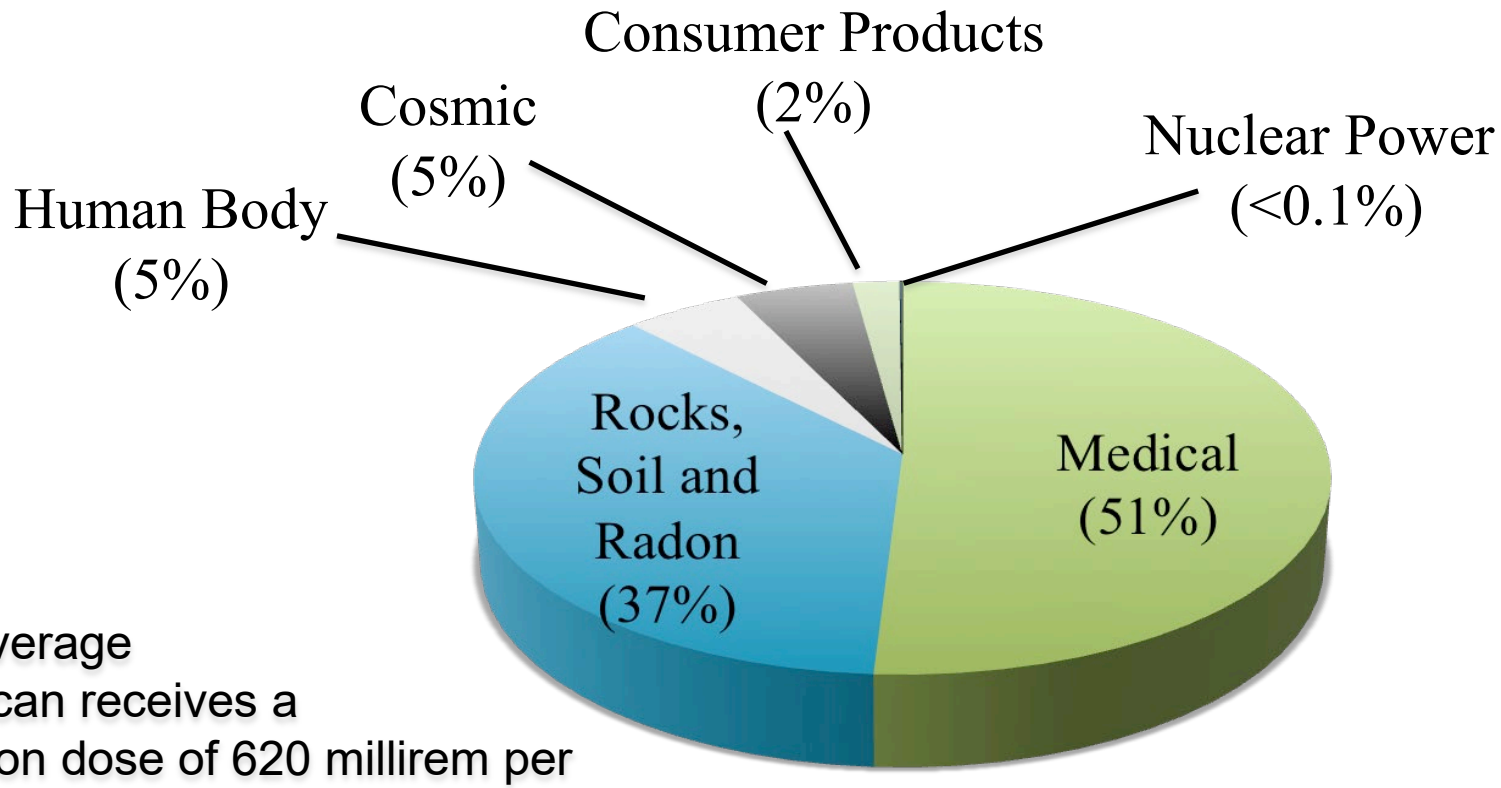


If radiation comes from atoms and everything is made of atoms, is there radiation around us right now?

You betchya!

It’s called background radiation.

Sources of radiation



The average American receives a radiation dose of 620 millirem per year.

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

Units of Dose and Exposure

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

Perspective

Dose (mrem)	Source
1	Dental x-ray
25	Round trip flight to South Africa
40	Your body
110	Head and body CAT scan
620	Average dose in U.S.
5500	Average dose in Guarapari, Brazil
10,200	Average dose in Ramsar, Iran
0 – 25,000	No observable effect

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If I’m exposed to radiation, do I become (more) radioactive?

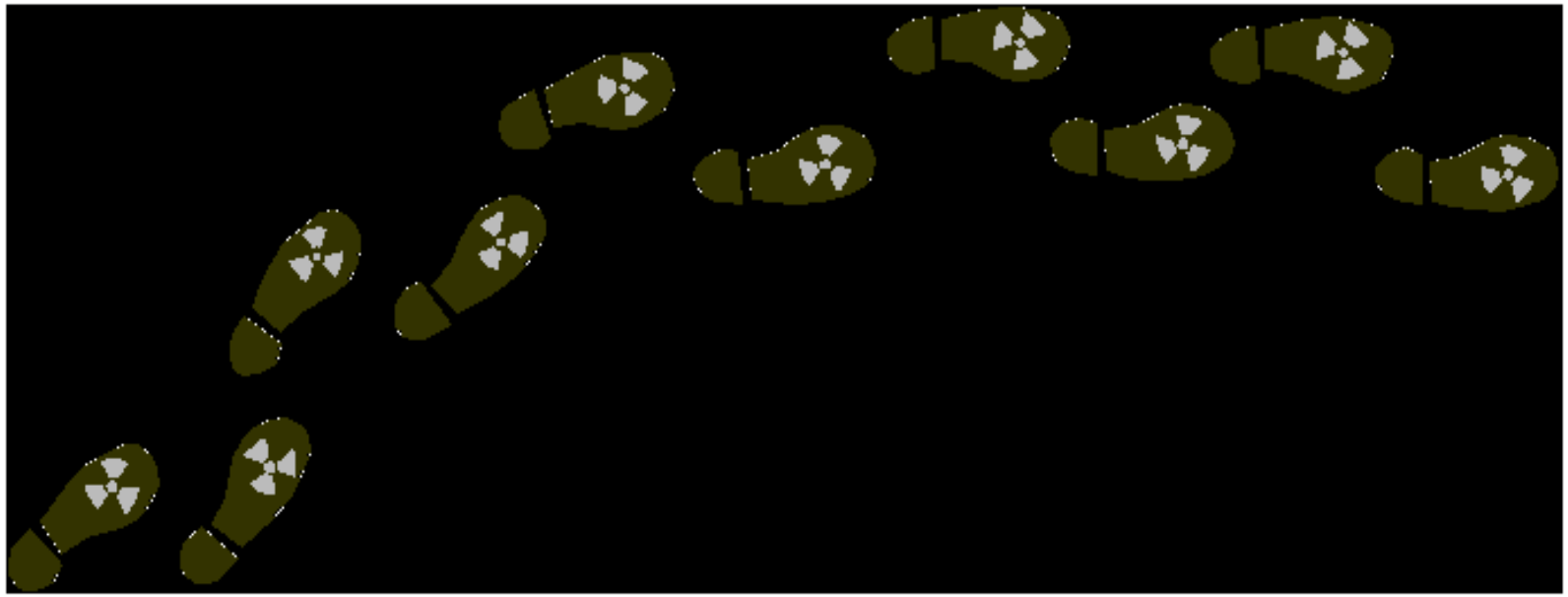
No!

You've been *irradiated*,
exposed to radiation.

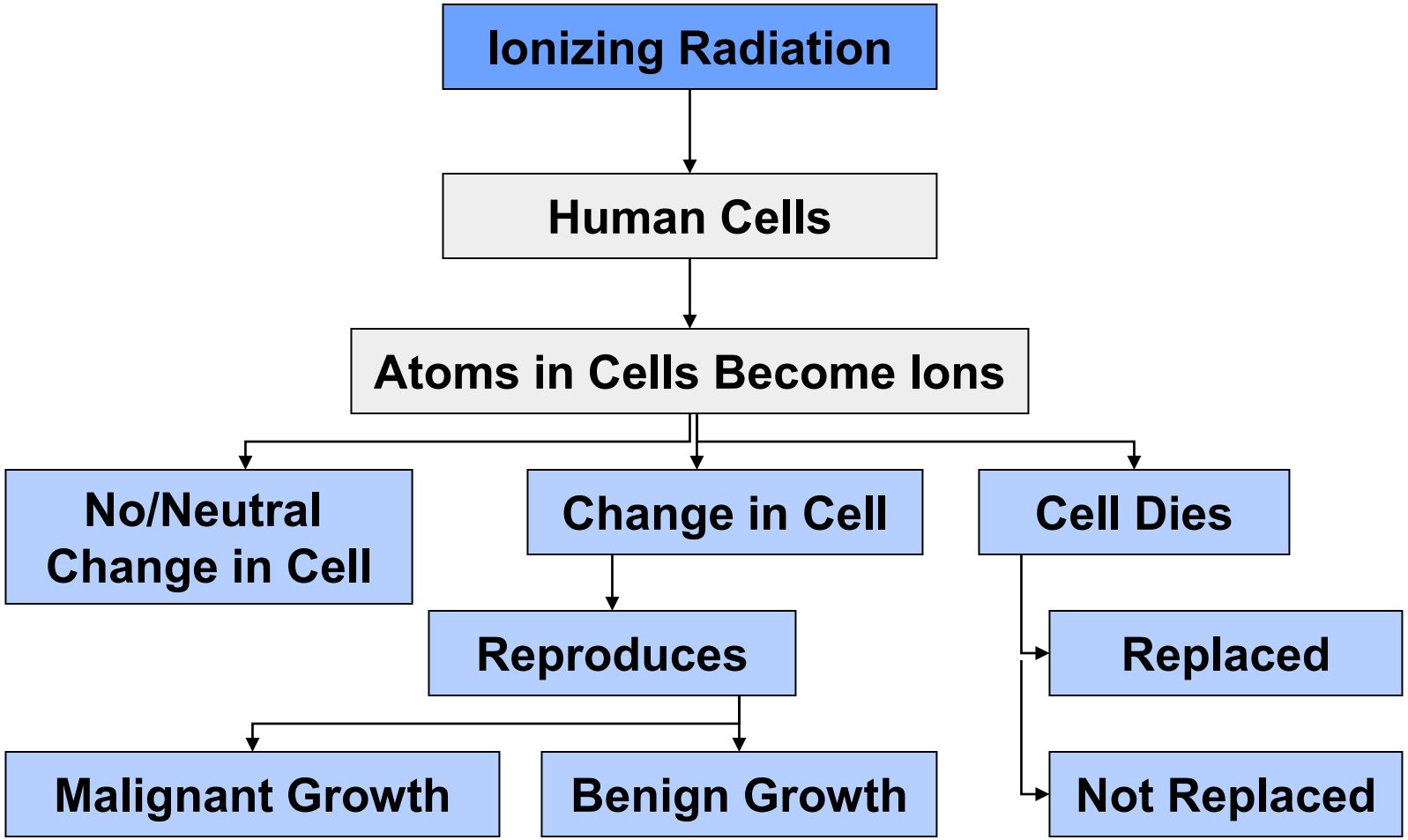
Which is not to be confused
with . . .

Radioactive Contamination

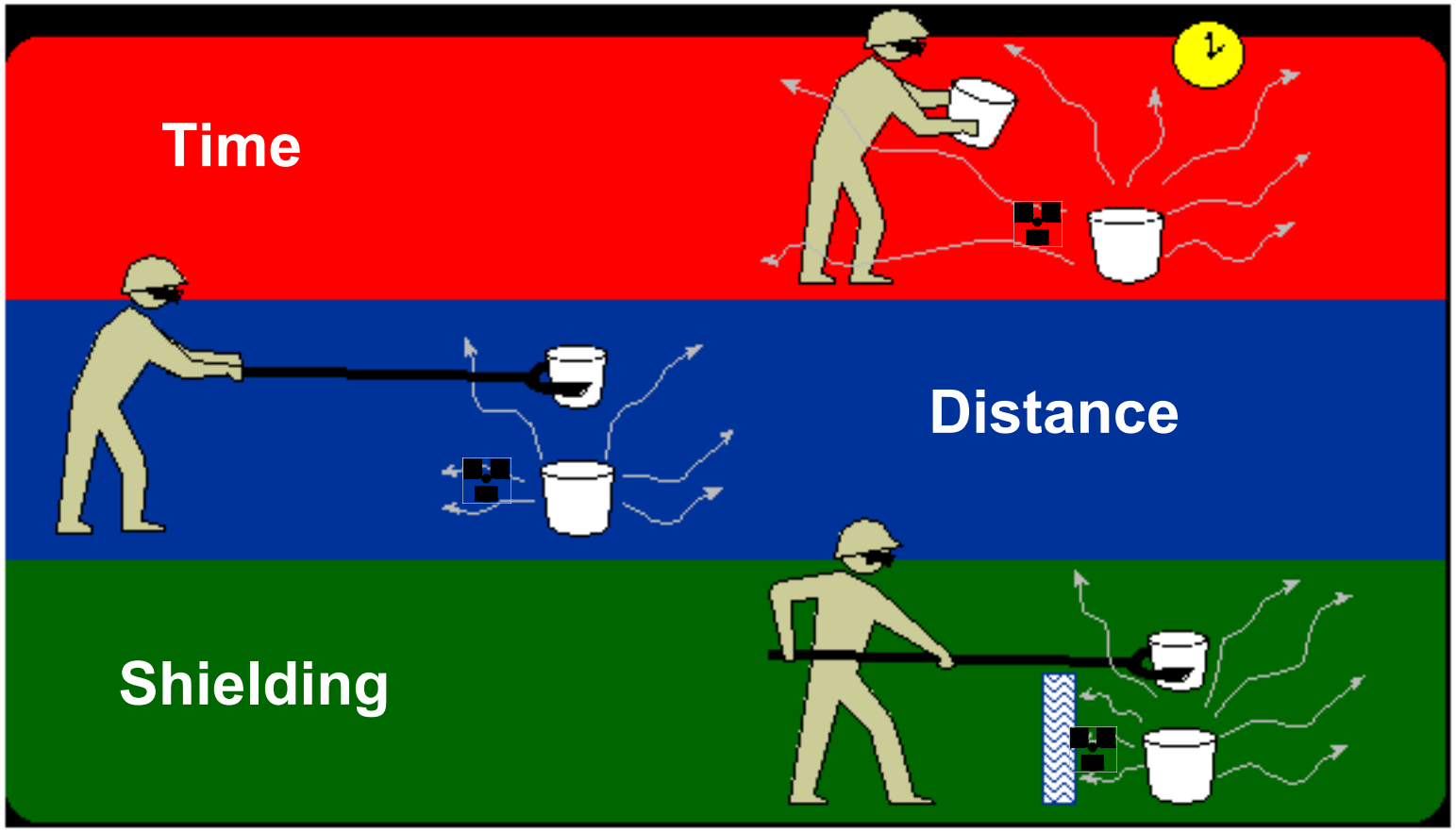
radioactive material in an unwanted place.



Why are we concerned about radiation?



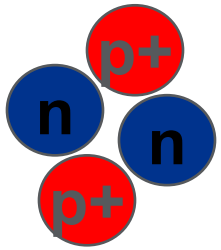
How do we protect ourselves?



Radiation Types

Alpha (α)

2 protons, 2 neutrons
Doubly positively charged particle



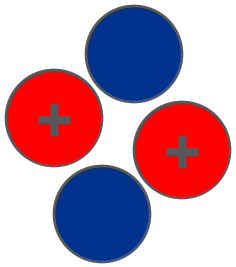
Beta (β)

Like an electron
Singly negatively or positively charged particle

Gamma (γ)

Wave energy (*not* a particle)

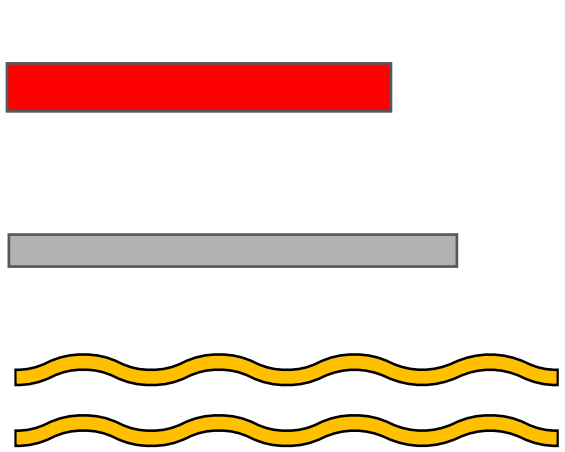
Penetrating Ability

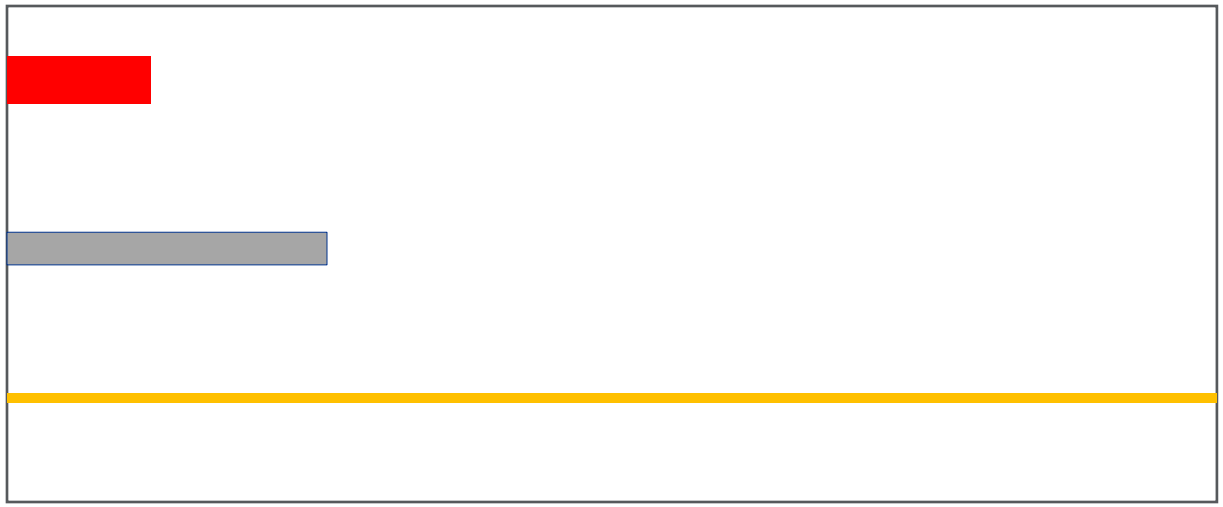


α

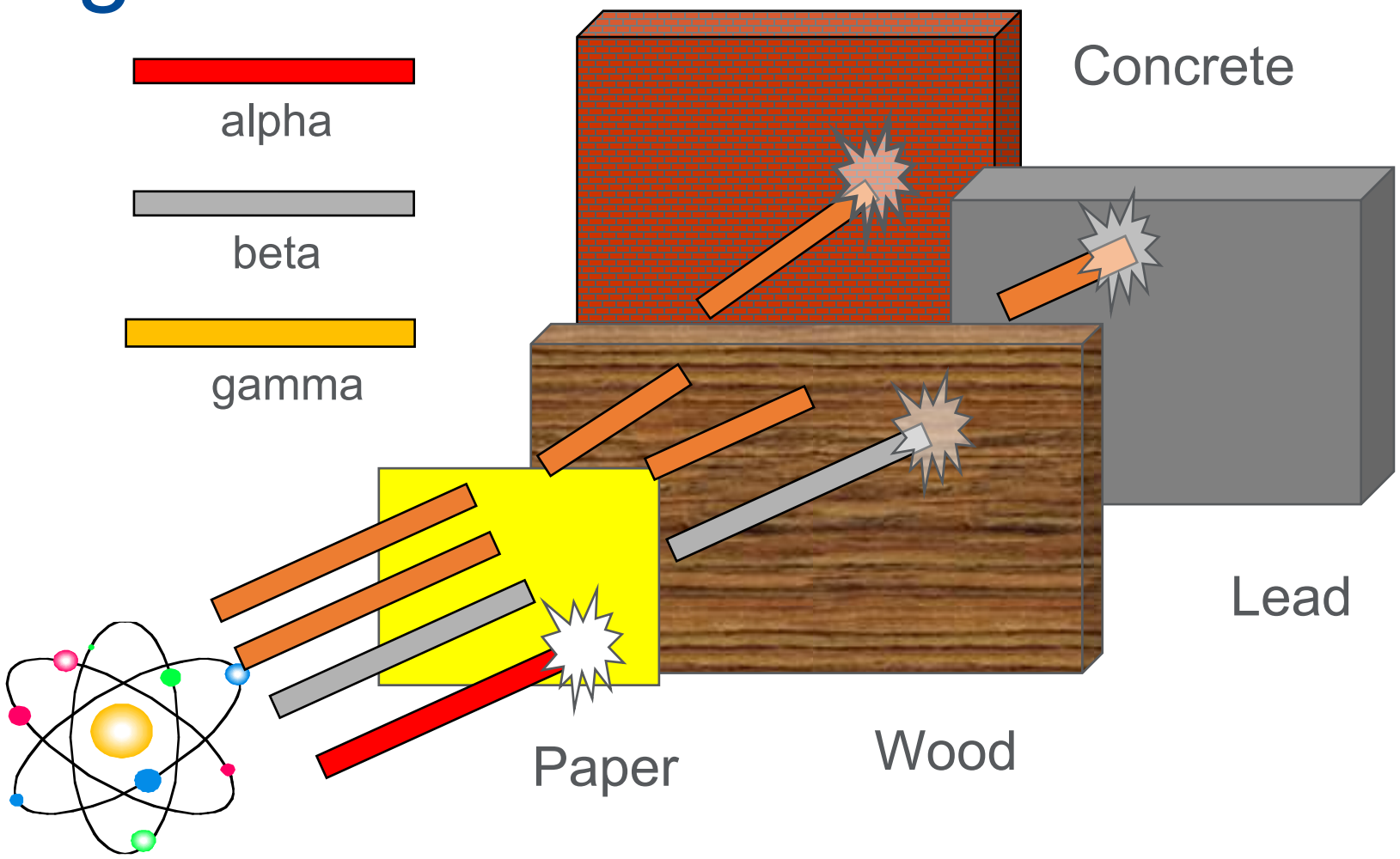
β

γ



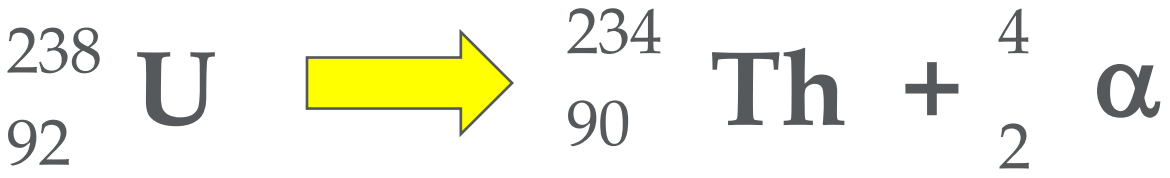


Shielding

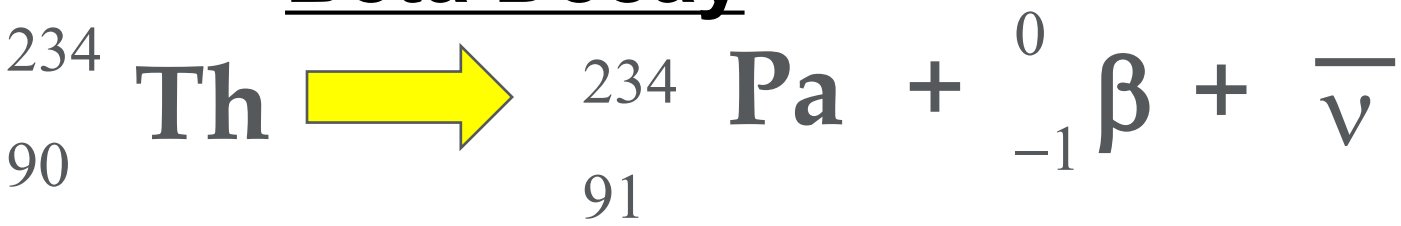


Radioactive Decay Equations

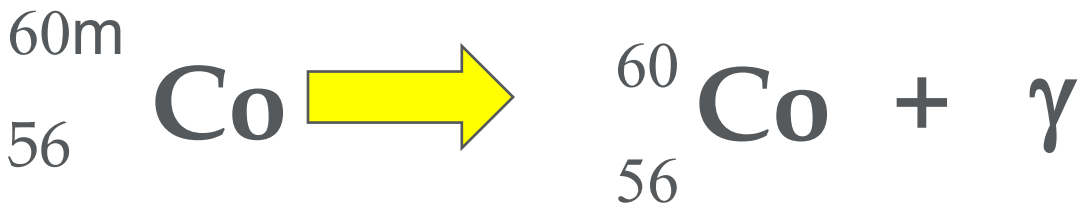
Alpha Decay



Beta Decay



Gamma Decay



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Units of “Activity”

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

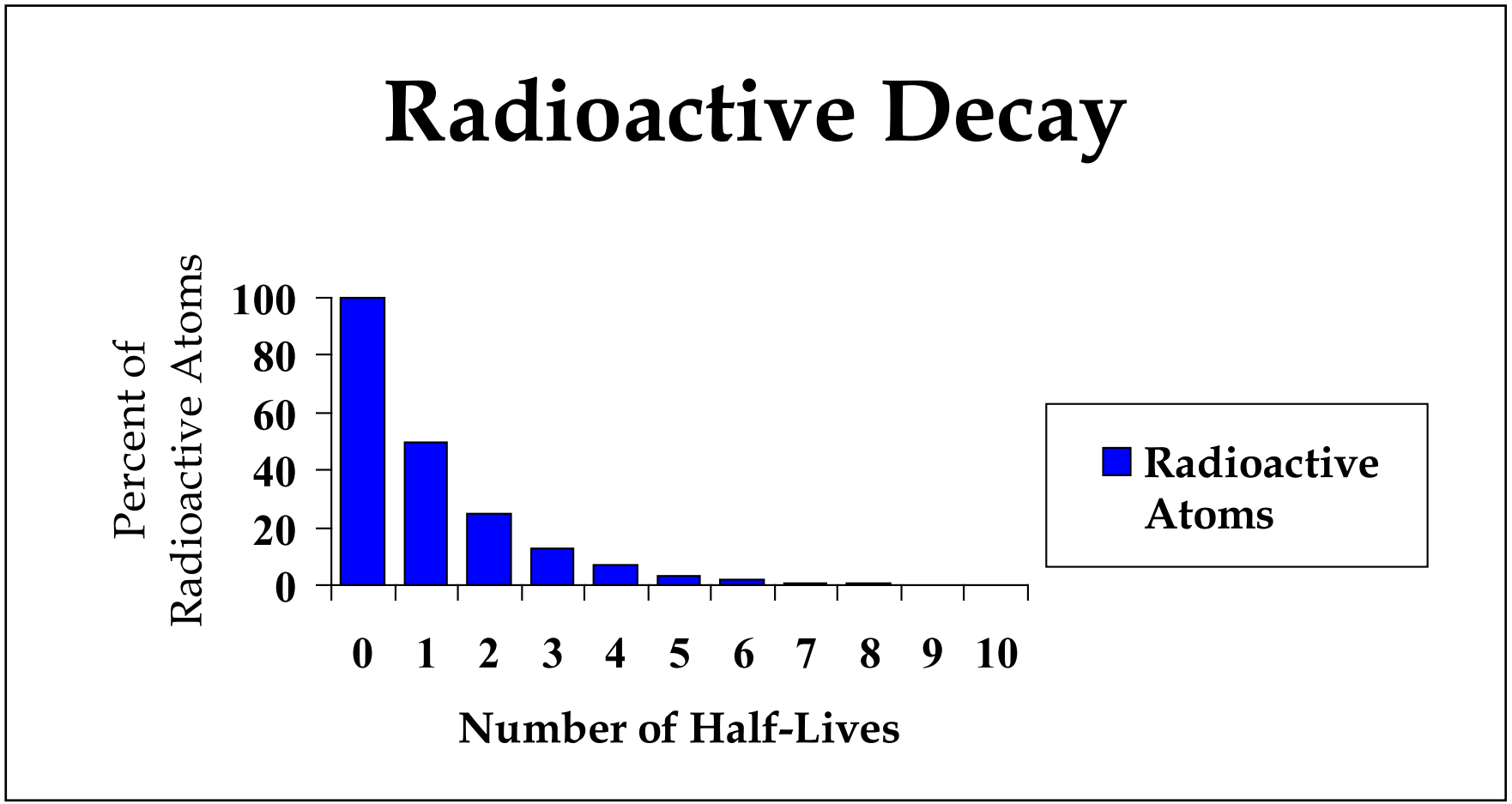
dps - disintegrations per second

Bequerel = 1 dps

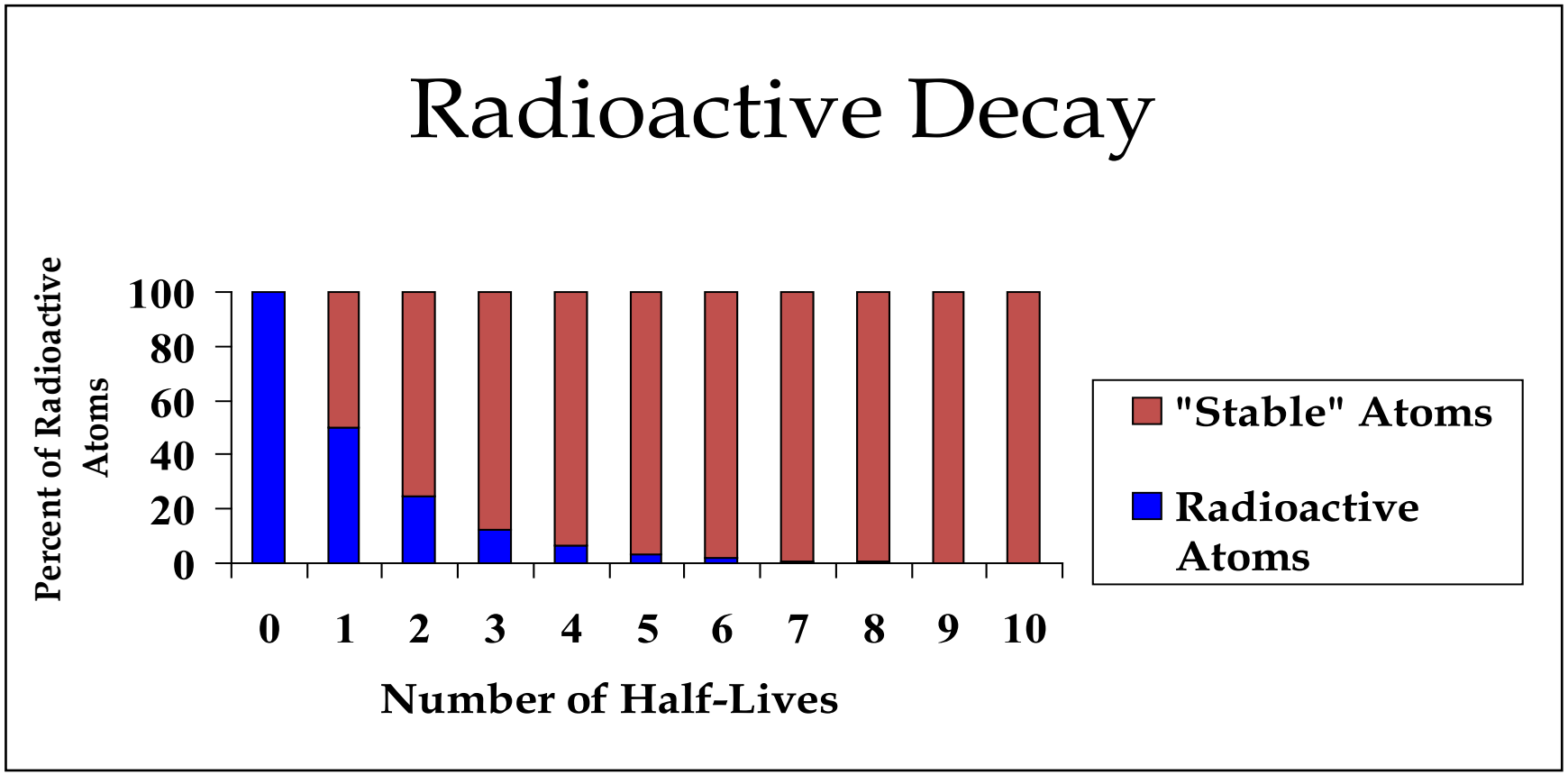
Curie = 37,000,000,000 dps

Picocurie = 0.037 dps or 2.2 dpm

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

Questions