HAZWOPER TRAINING
FOR THE PROFESSIONAL

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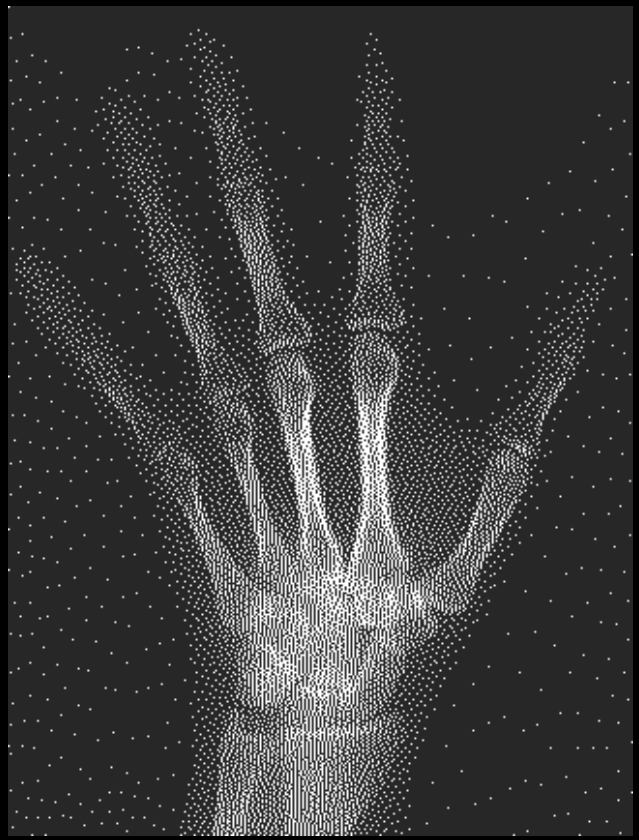
5000 B.C.

- Greek philosophers thought all the matter in the world was made of tiny unbreakable kernels they called atoms
- Nothing was smaller than an atom - it couldn’t be broken into parts

Roentgen's Discovery

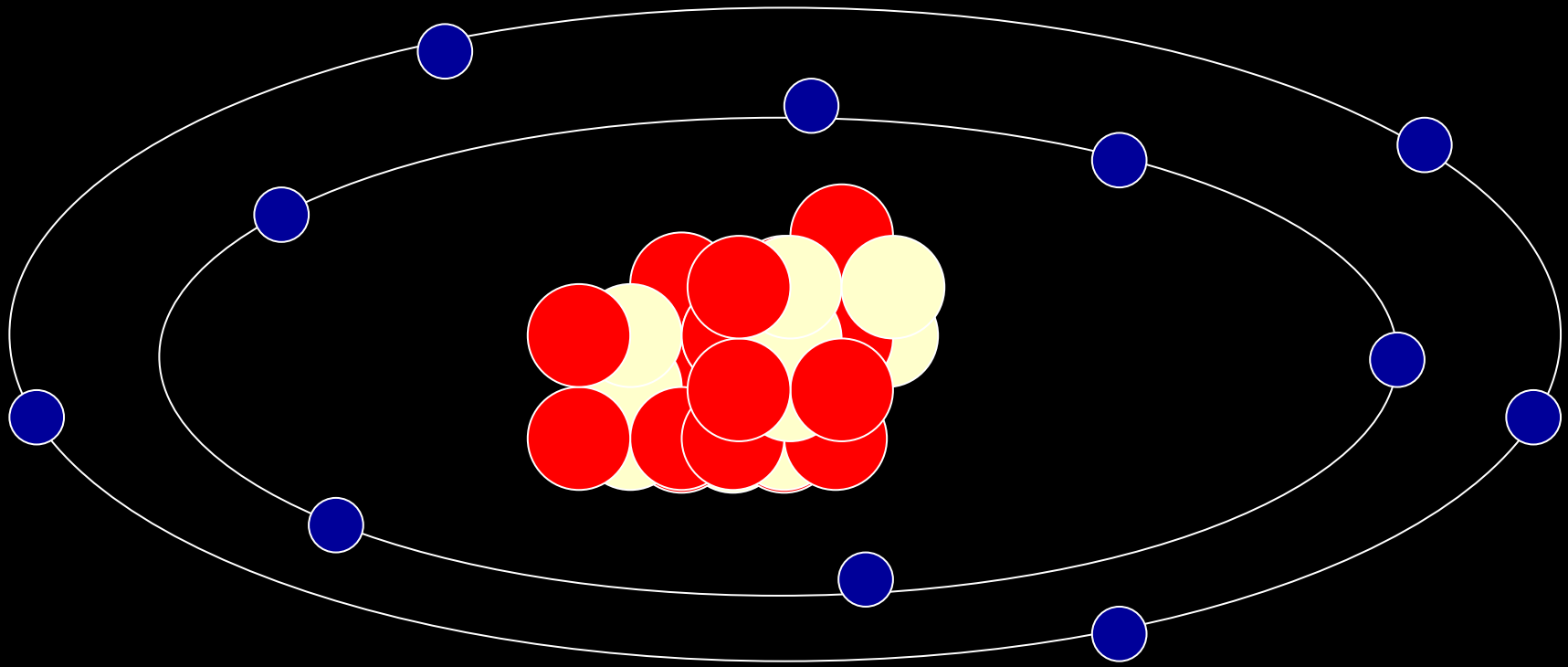


- In 1895 German physicist Wilhelm Roentgen accidentally discovered a new form of energy which he named the x-ray
- Roentgen produced first x-ray image - his own hand
- His work sparked feverish research, especially in Germany

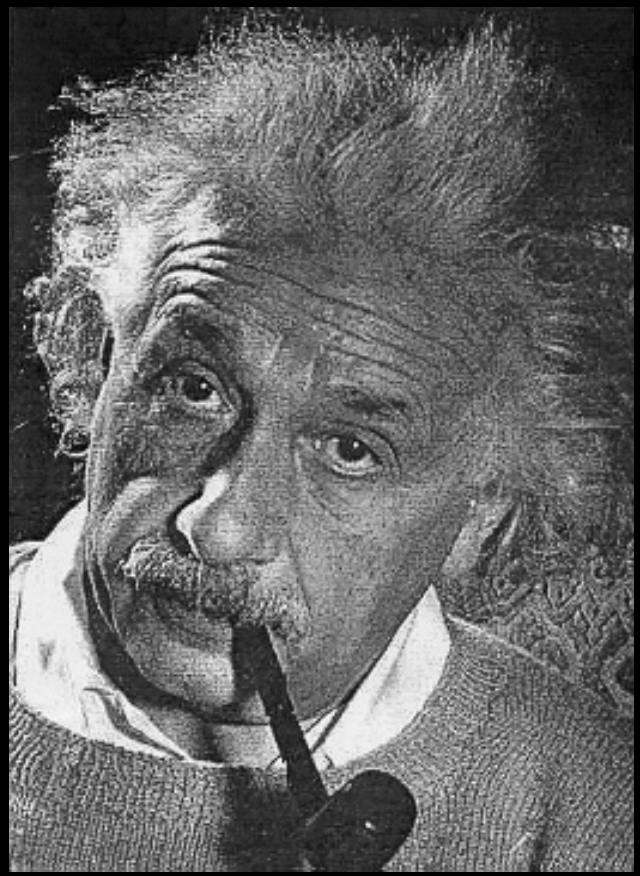
The New Understanding

- In 1913 several scientists published the theory that an atom is made of
  - a positively-charged central nucleus
  - orbited by negatively-charged particles

Bohr Model



World War II



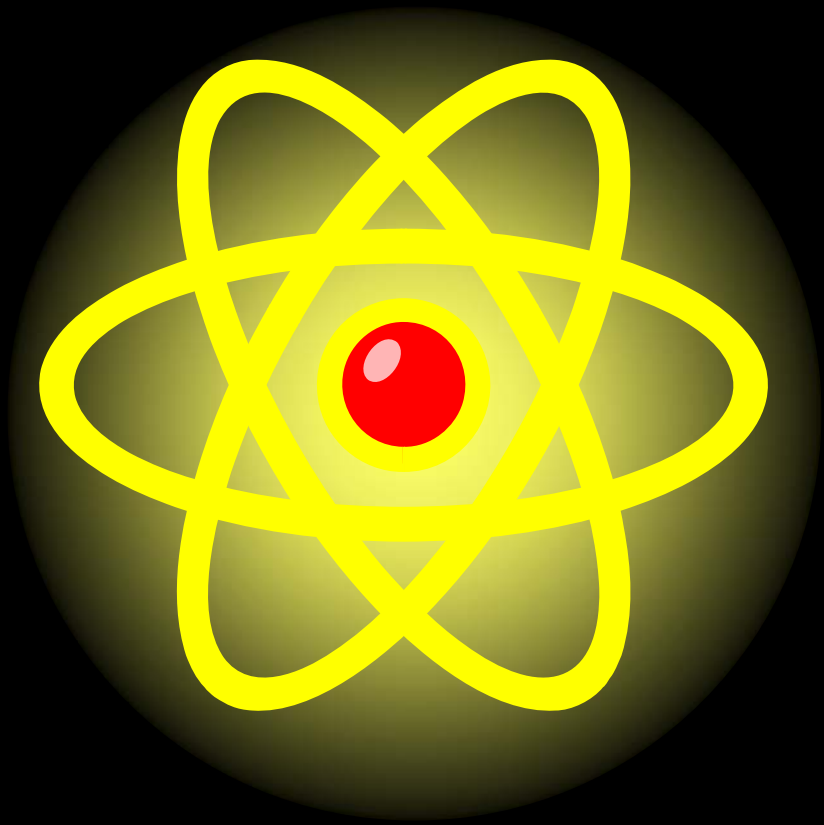
- Nazi persecution caused Jewish physicists to leave Germany
- The physicists understood that splitting the atom would release tremendous energy
- Albert Einstein and others approached President Roosevelt

Manhattan Project

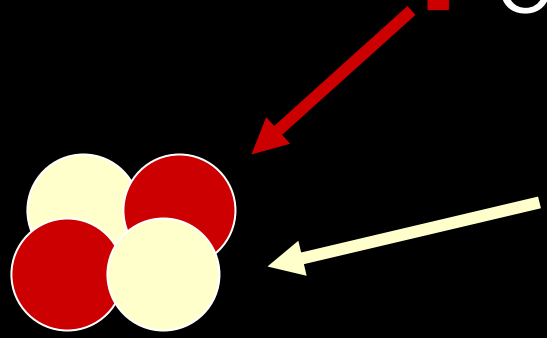
- US secret project to create atomic weapon 1942-45
- Three sites
  - Hanford, Washington (plutonium fuel)
  - Oak Ridge, Tennessee (uranium fuel)
  - Los Alamos, New Mexico (bomb production)


July 1945

Atomic Structure



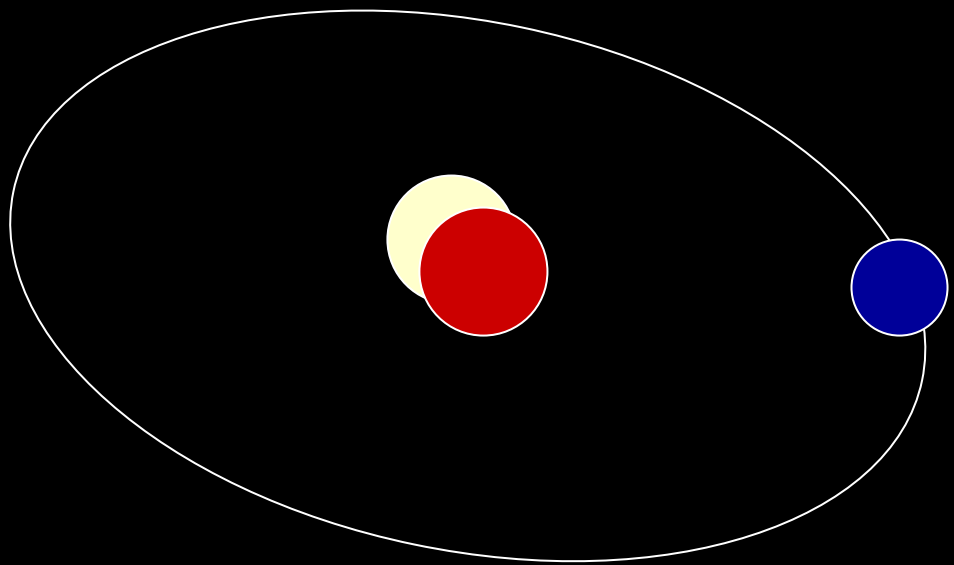
Nucleus



- Contains positively-charged protons
- Non-charged neutrons

Electrons

- Orbit nucleus
- An atom can have as many electrons as it has protons



How big is an atom?

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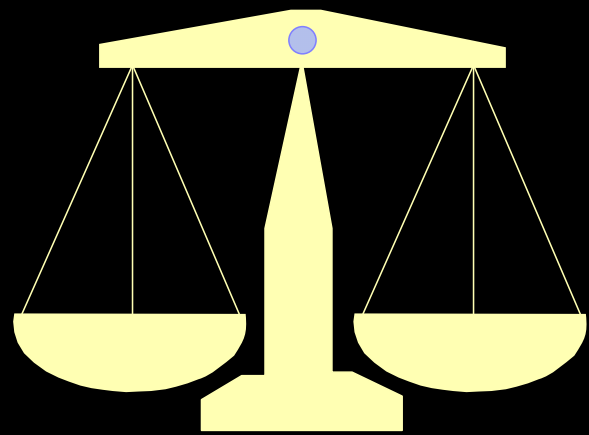
- An atom is the same size compared to a golf ball
- As a golf ball is compared to the earth

The Search for Stability

- An atom is stable based on it's proton to neutron ratio
- If there are too many or too few neutrons or protons, the atom will give off excess energy as
  - rays
  - particles
- This process is called radioactive decay



What is Radiation?

Energy in motion

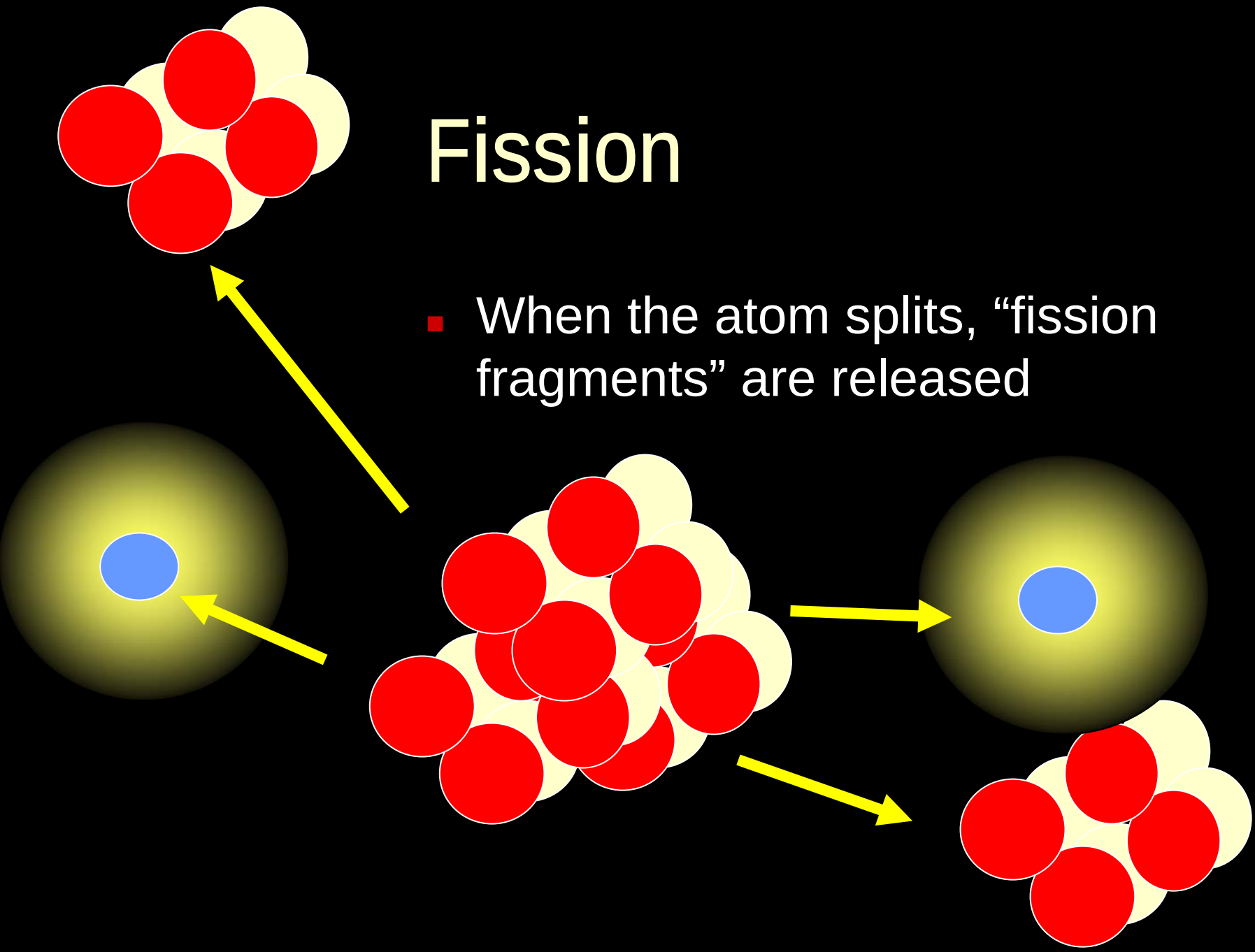
- As either particles or rays
- Two kinds: ionizing and non-ionizing

Fission

- Fission is the process by which a large, unstable nucleus splits into two nuclei
- It rarely occurs naturally

Fission

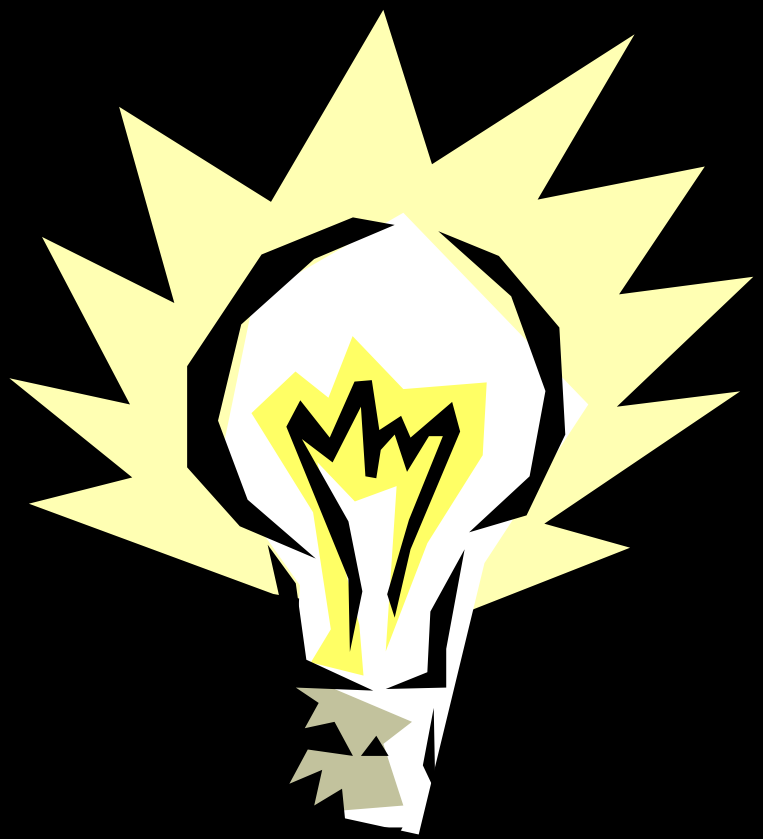
- When the atom splits, “fission fragments” are released



Ionizing Radiation

- The energy given off by the nucleus is called **ionizing radiation**
- It is strong enough to detach an electron from an atom
  - When an atom loses an electron, it has a positive charge and is called an **ion**
  - The ion and its lost electron are called an **ion pair**

Non-Ionizing Radiation



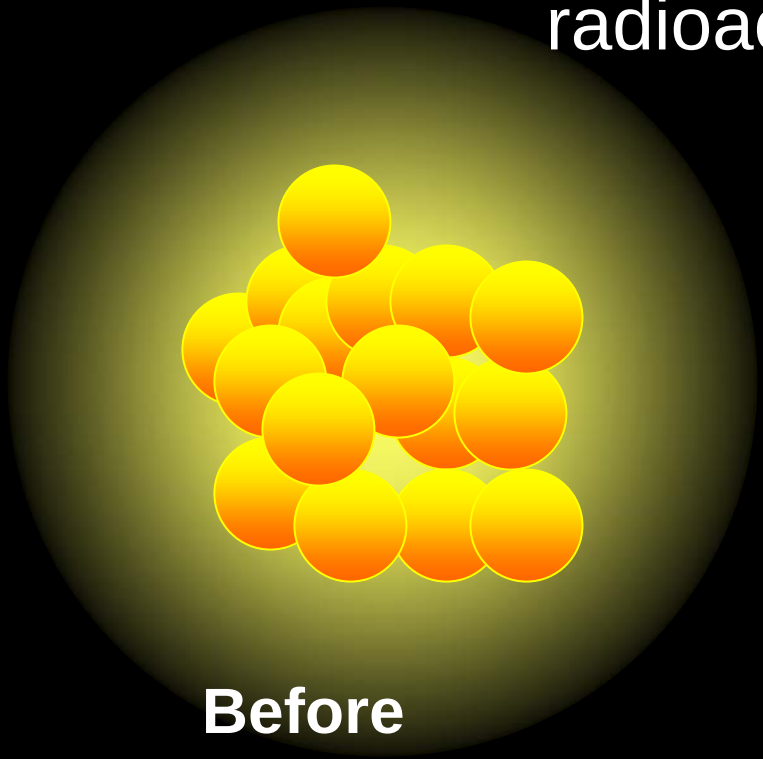
- Energy in transit that is too weak to detach an electron from another atom
- Examples
  - Light
  - Radio and television waves
  - Microwaves

Radioactive Decay

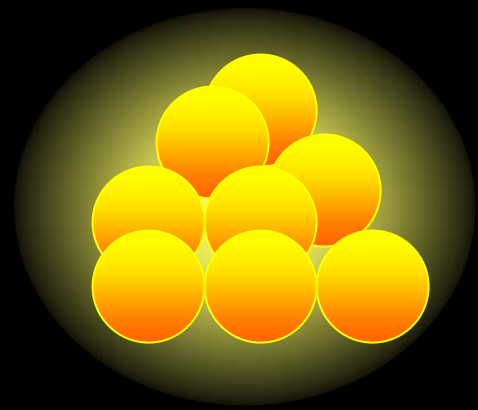
- When an atom's nucleus gives off excess energy, the process is called **radioactive decay**
- Radioactive **half-life** is the time it takes half the radioactive atoms present to decay

Half-Life

- The time it takes half the radioactive atoms present to decay



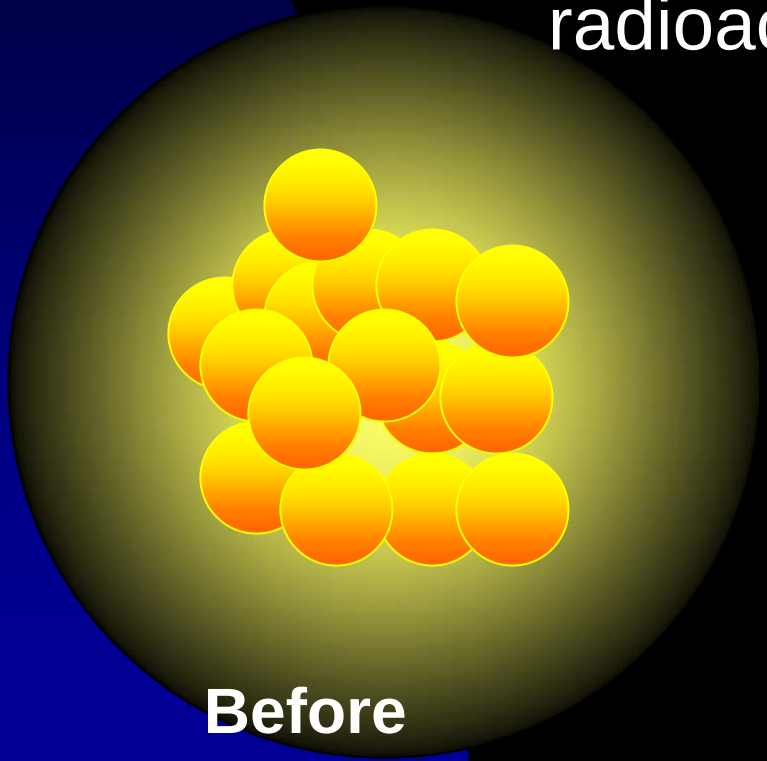
Before



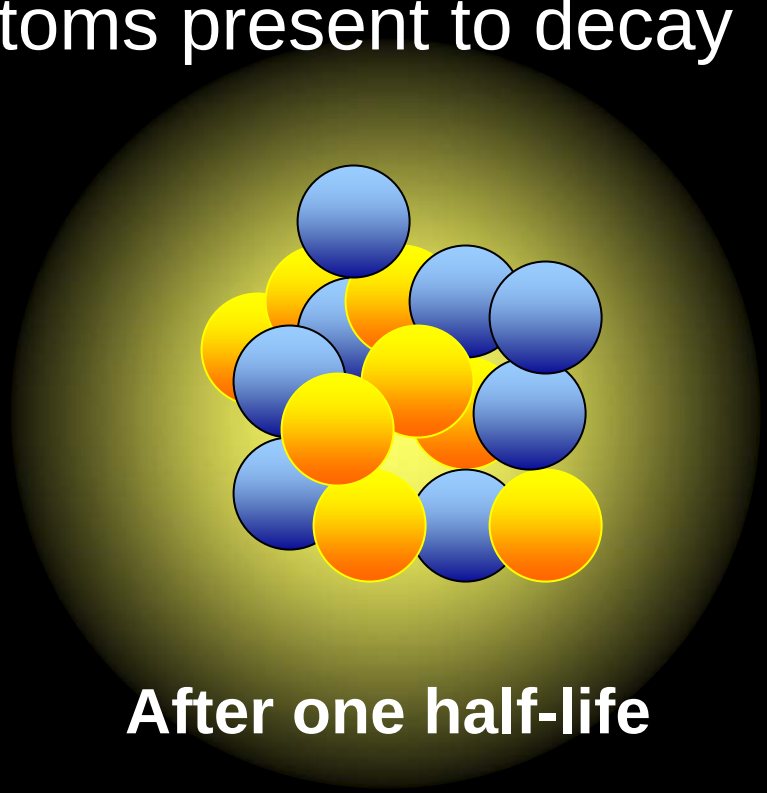
After one half-life

Half-Life

- The time it takes half the radioactive atoms present to decay



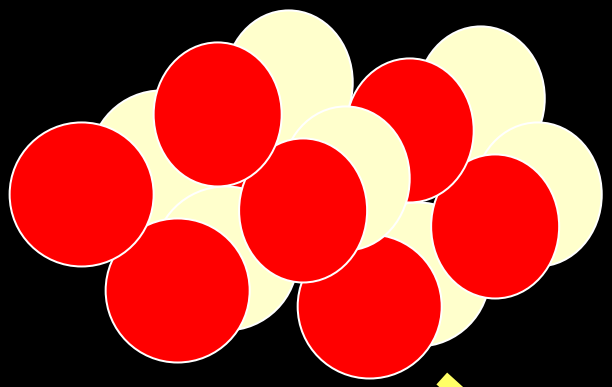
Before



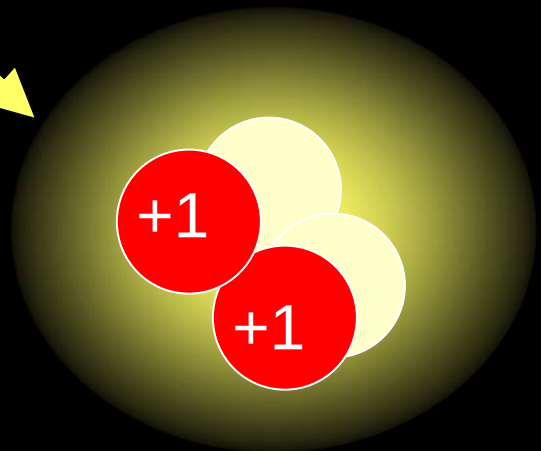
After one half-life

TYPES OF IONIZING RADIATION

Alpha Particle

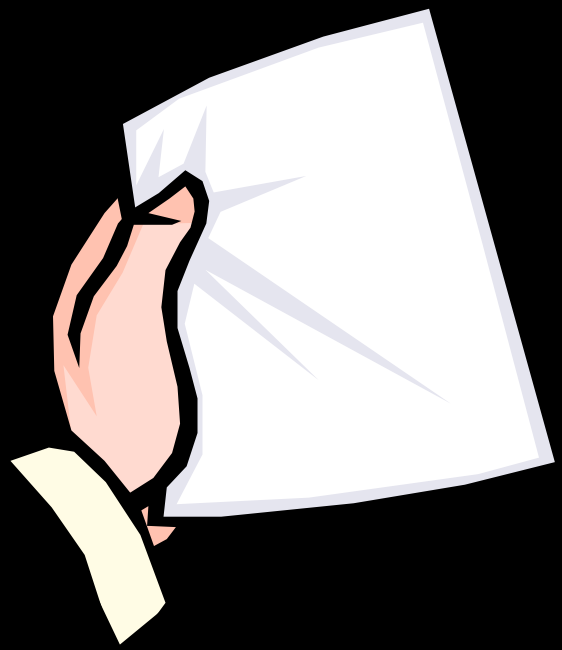


- Large mass
- Consists of 2 protons and 2 neutrons
- Electrical charge of +2
- Range in air 1 to 2 inches

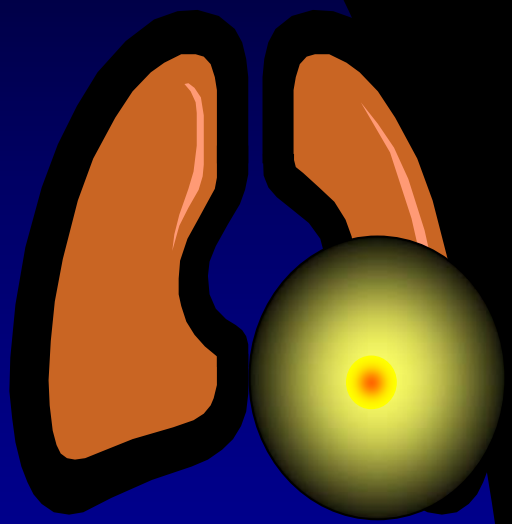


Alpha shielding

- A sheet of paper
- Outer layer of skin



Biological Hazard



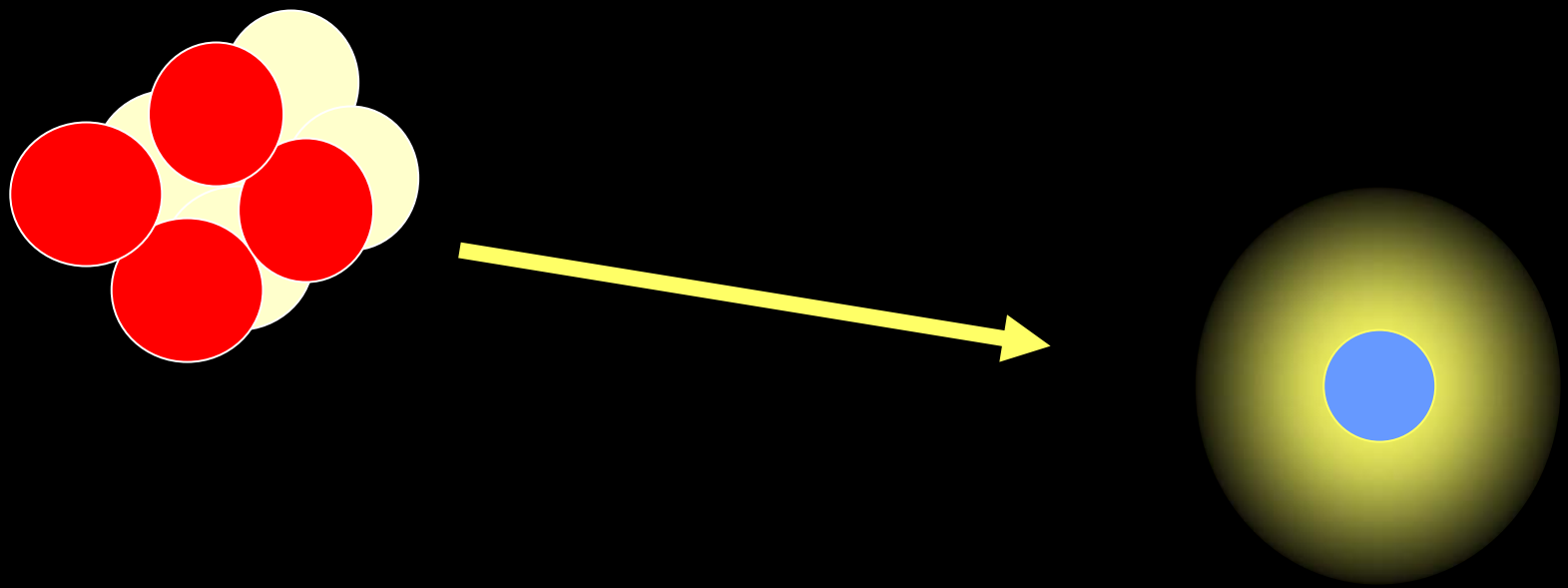
- Alpha radiation is not an external hazard, because it can be stopped so easily
- If inhaled or swallowed, the alphas emitted from an alpha emitter, can deposit large amount of energy in a small area of body tissue

Sources of Alpha Radiation

- Plutonium 238 and 239
- Uranium 238 and 235

Beta Particle - ß

- Small mass
- Electrical charge of -1
- Emitted from nucleus
- Range in air about 10 feet



Beta Shielding

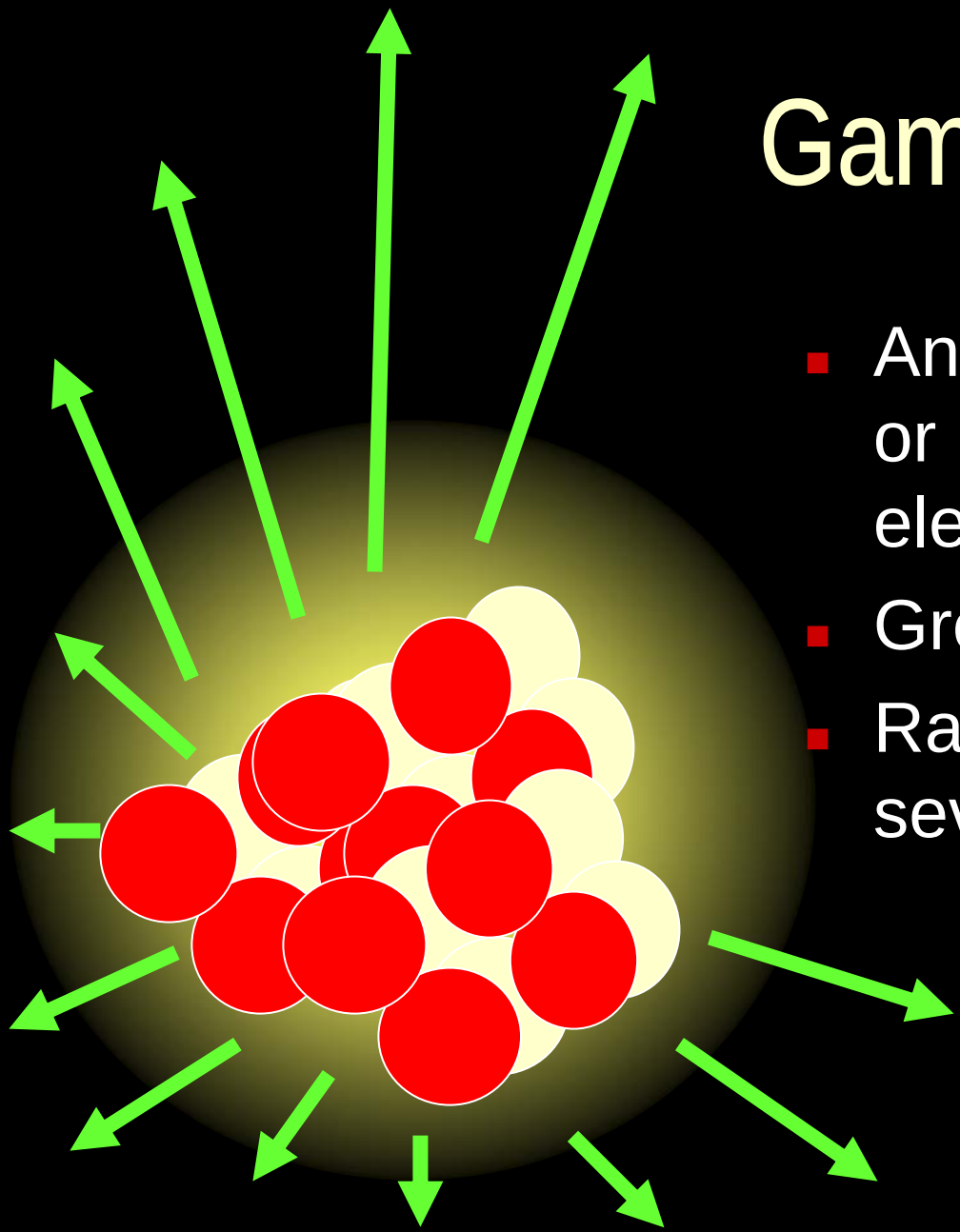
- Beta has a limited penetrating ability because of its negative charge
- Most beta particles can be shielded by plastic, glass, metal foil, or safety glasses

Biological Hazard

- If ingested or inhaled, a beta-emitter can be an internal hazard
- Externally, beta particles are potentially hazardous to the eyes and skin

Beta Sources

- Uranium decay products
- Decay of some radioactive substances (Tritium)
- Products of the fission process

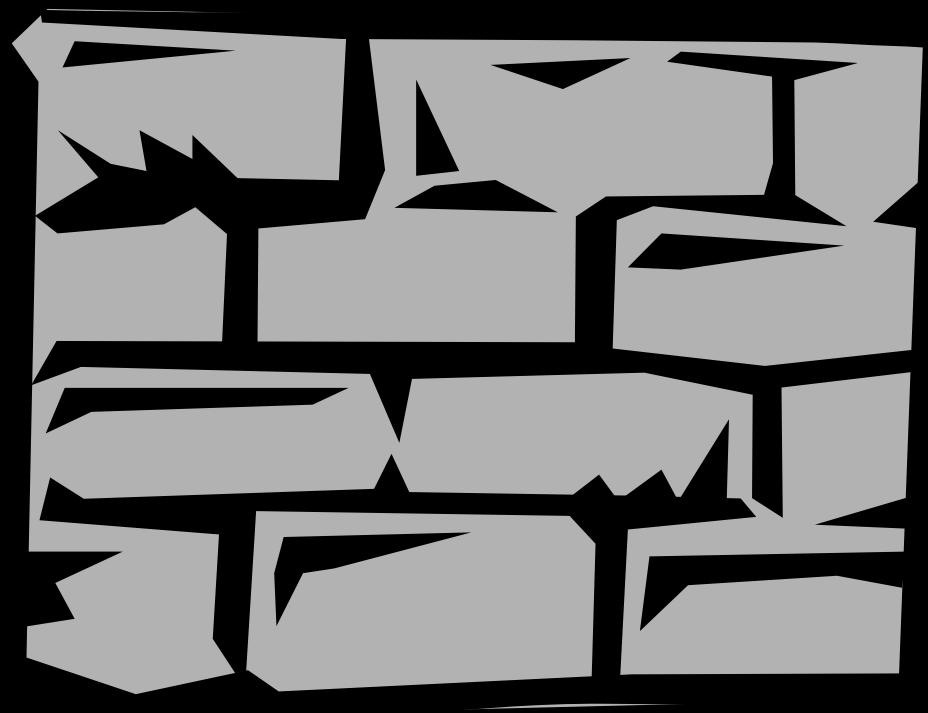


Gamma and X-Rays

- An electromagnetic wave or photon, which has no electrical charge
- Great penetrating power
- Range in air easily several hundred feet

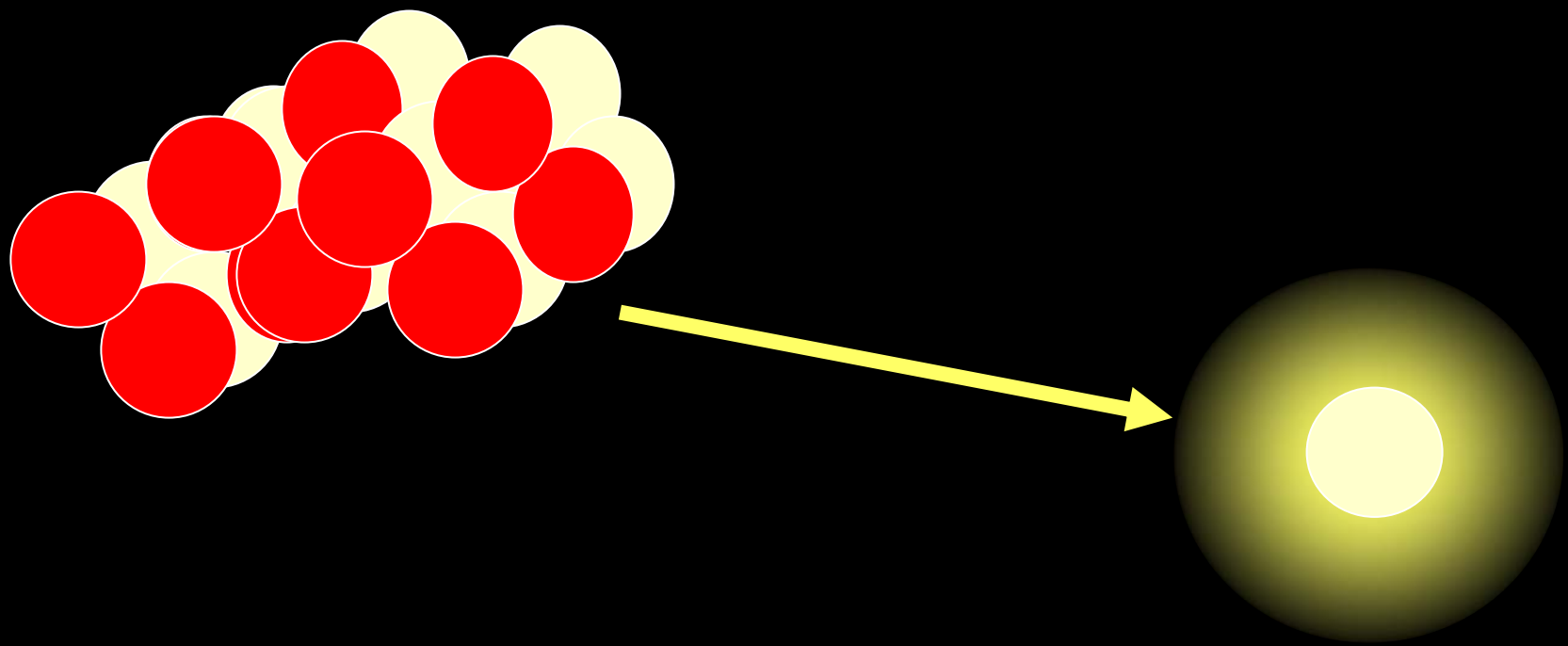
Gamma and X-Ray Shielding

- Concrete
- Lead
- Steel



Neutron

- A neutron is ejected from the nucleus
- No electrical charge
- Range in air easily several hundred feet



Neutron Radiation Shielding

- Best shielded by material with a high hydrogen content
  - Water
  - Plastic

RADIATION MEASUREMENT

Roentgen (R)

- A unit for measuring exposure
- Defined for effect in air only
- Applies only to gamma and x-rays
- Does not relate radiation to the effect on the human body

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1 R = 1000 milliRoentgen (mR)

Roentgen Absorbed Dose (rad)

- Unit for measuring the absorbed dose in any material
- Applies to all types of radiation
- Does not take into account differing effects on the human body
- 1 rad = 1000 millirad (mrad)

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Roentgen Equivalent Man (rem)

- Unit for measuring radiation equivalence
- Most commonly used unit
- Takes into account the energy absorbed (dose) and effect on the body of different types of radiation

1 rem = 1000 millirem (mrem)

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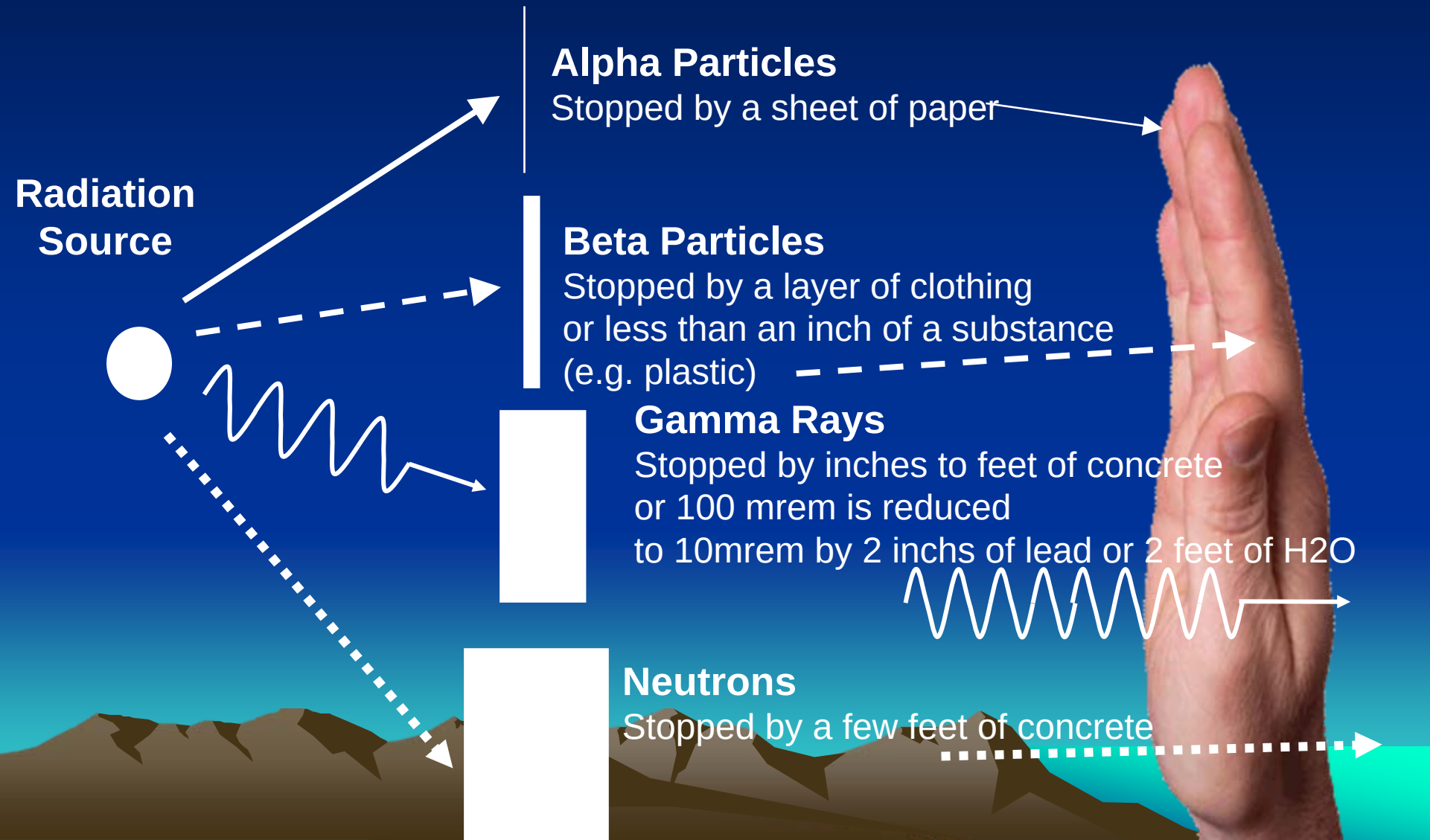
Chicago Safety Institute

Acute Radiation Syndrome a spectrum of the Disease

And

an explanation of the phenomenon of exposure contamination

Penetration Abilities of Different Types of Radiation



Exposure vs. Contamination

Exposure: irradiation of the body → absorbed dose REM

Sievert is the same as REM
(REM) Roentgen Equivalent Man
Which is the dose of radiation in a person.

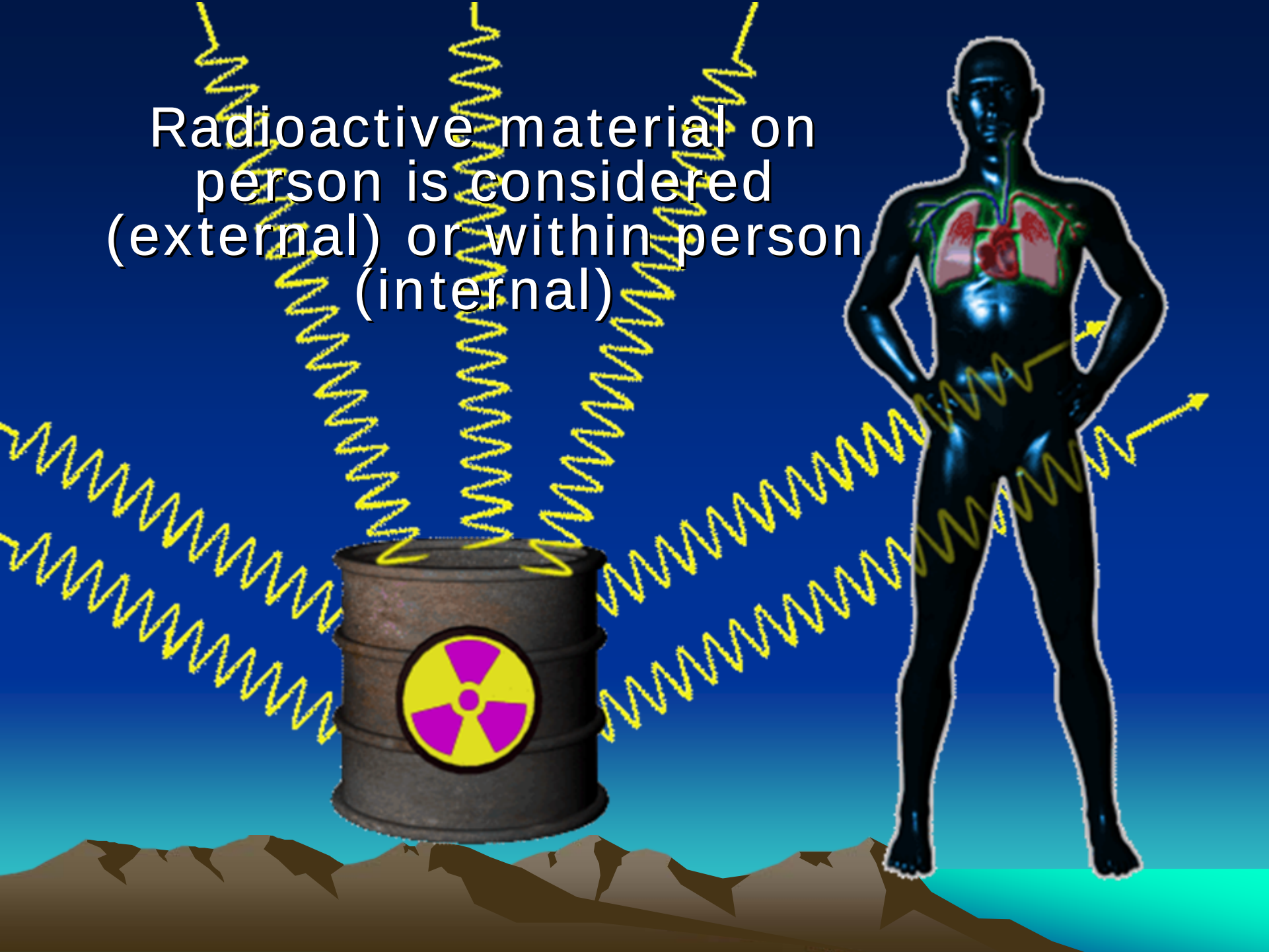
- ***sie□vert □si vərt/ [see-vert]***
- ***–noun Physics.* the SI unit of dose equivalent when the absorbed dose is measure in gray. *Abbreviation:* Sv**
- **Compare gray*2*, rem.**

- **[Origin: named in honor of Swedish radiologist Rolf Maximilian *Sievert* (1896–19**
- **Chicago Style:** sievert. *Unabridged (v 1.0.1)*, Based on the Random House Unabridged Dictionary, © Random House, Inc. 2006.

(Gray, Rad)
Gray is the same as Rad
Rad is radiation absorbed dose in any material.

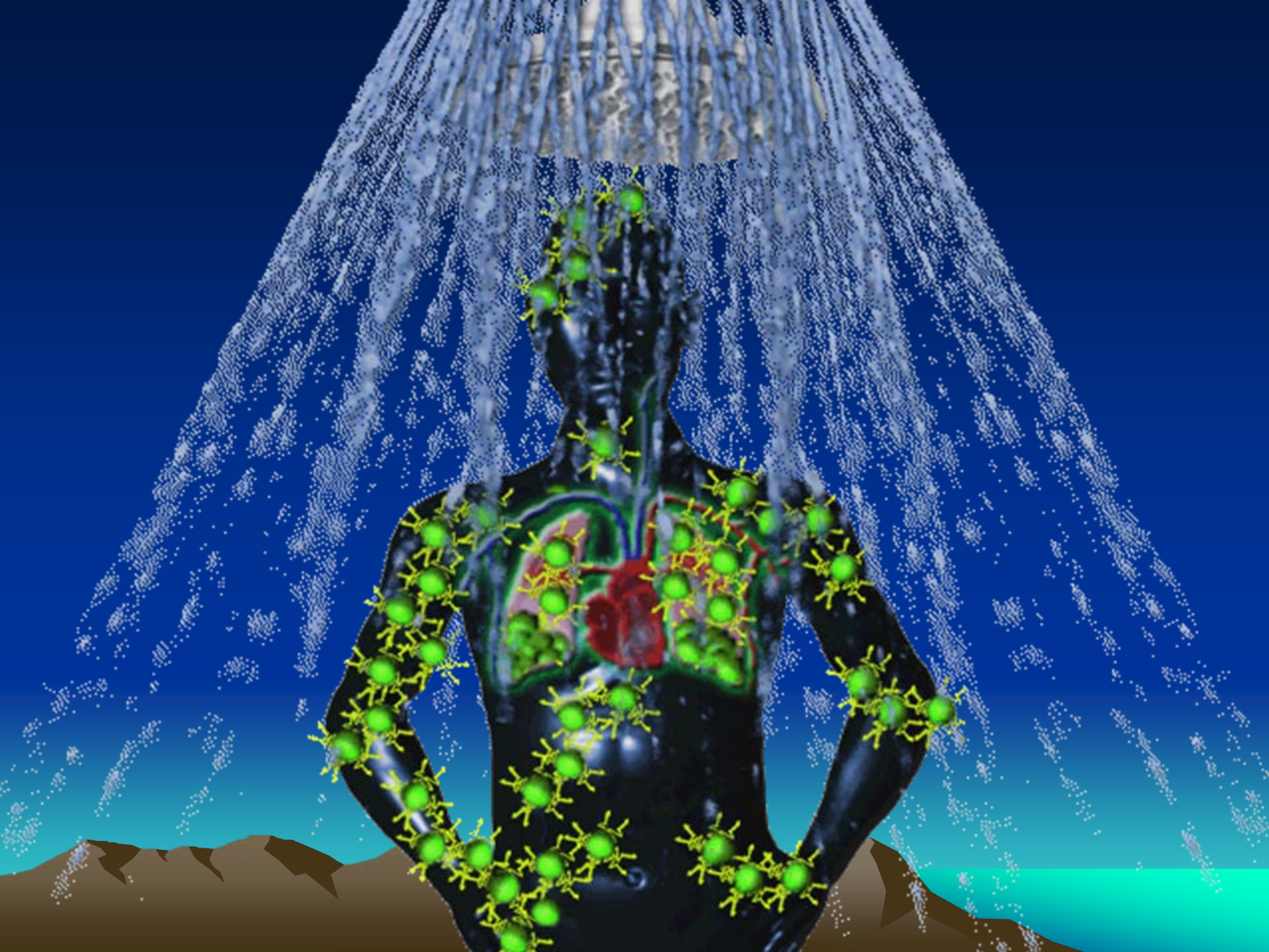
- Centigray 100th of a Rad or ***gray****2*
- *greɪ/ -] -*
  –noun Physics. the SI unit of absorbed dose, equal to the amount of ionizing radiation absorbed when the energy imparted to matter is 1 J/kg. *Abbreviation:* Gy Compare rad.
- [Origin: *1975;* named in honor of Louis Harold *Gray* (1905–65), English radiobiologist]

Contamination: Any radioactive material in an unwanted place.


Radioactive material on person is considered (external) or within person (internal)

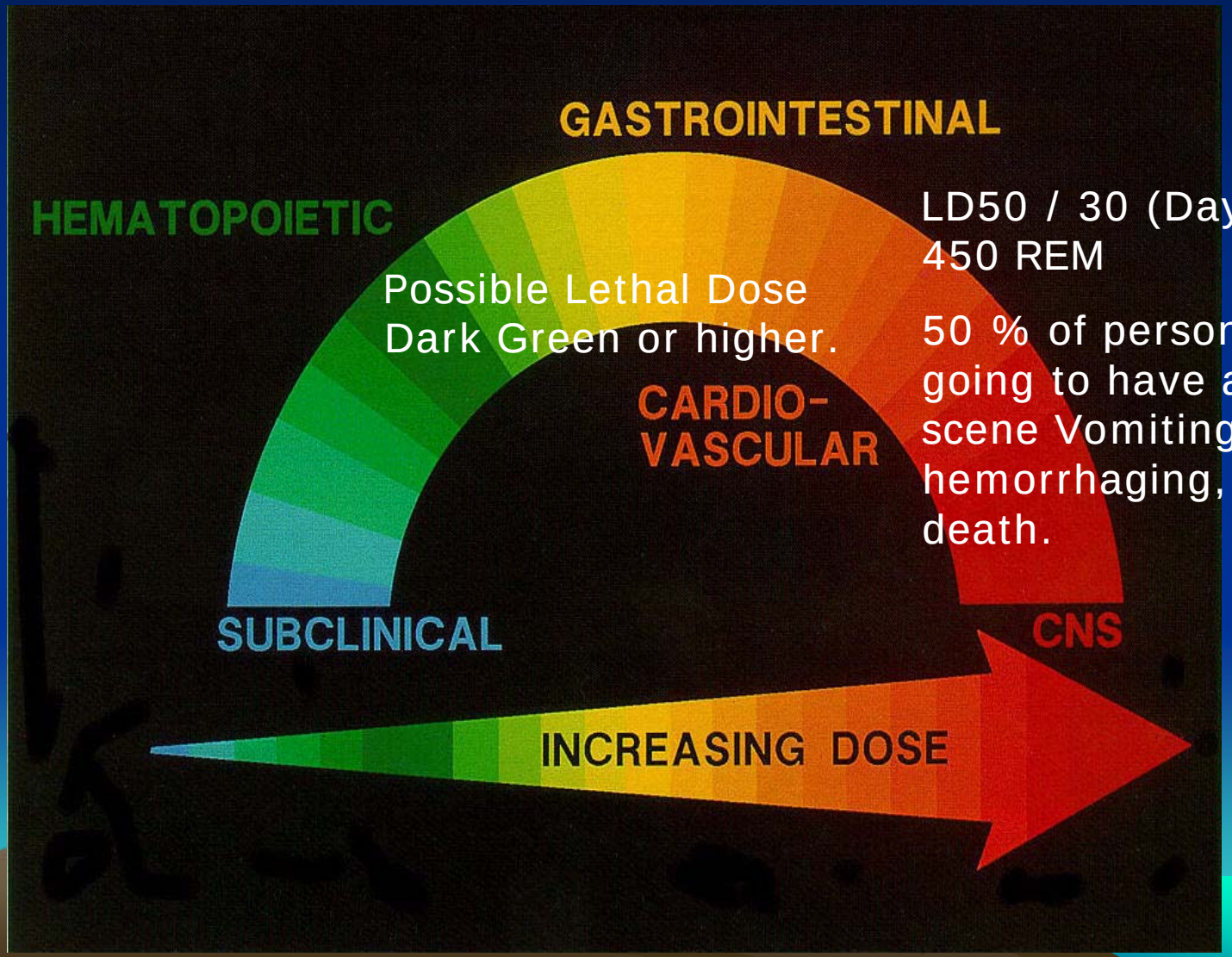

Exposure!
Trifoil
You can be exposed but not contaminated
But if your contaminated you were exposed.


Emergency Decontamination is necessary! Isolation of water & Radioactive material must be controlled and put in the appropriate waste stream.




Internal exposure can only be
dealt with time and Chelation.
DTPA
Diethylenetriamine Pentaacetic Acid
(a chelator)

Acute Radiation Syndrome (A Spectrum of Disease)



LD50 / 30 (Days)
450 REM

50 % of persons are going to have a bad scene Vomiting, hemorrhaging, or death.

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