A Classroom Study of Space-Radiation

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Radiation

- There are 3 major types of radiation:
  - Gamma rays (neutral)
  - Beta Decays (mostly negative electrons, some such as Na-22 is positrons)
  - Alpha Decays (positive, it is just two protons and two neutrons)
- There are also other rare types of radiation:
  - Proton emission
  - Neutron emission
  - Neon emission
  - Heavy Fragments

Sources of Radiation on Earth

Radioactive decays of elements

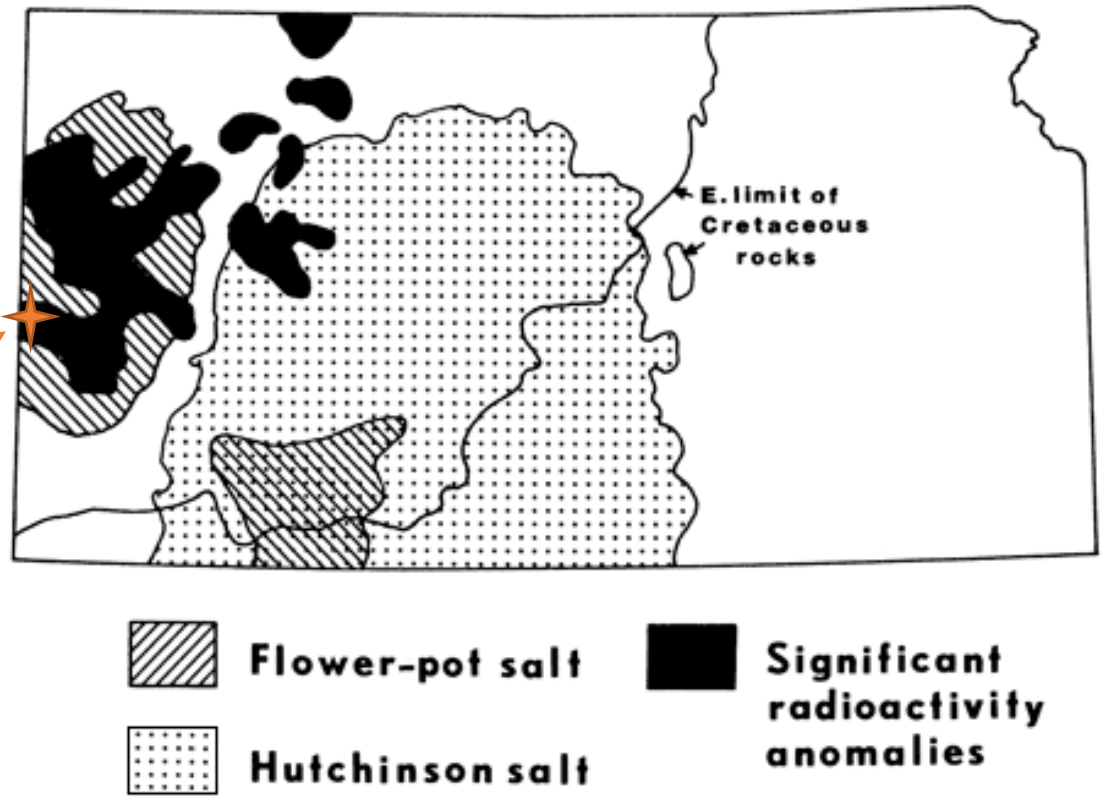
- Bananas are a major source of radiation from Potassium K-40, one banana is 1/100 of the legal limit of daily radiation exposure.
- Tomatoes are rich in Strontium and Sr-90 is a Beta decay emitter
- Bricks, Concrete and Center blocks that your house is built from contains Potassium, which K-40 is a major source of every day radiation.
- Tobacco is a major alpha emitter
- Radon seeps up from the ground, enters basements through cracks in concrete and can fill a house with Radioactive Radon gas.
- Western Kansas has a lot of rocks with Uranium, bright yellow dots or veins.
- Cosmic Radiation from deep space, in Denver cosmic radiation is 4x higher than Wichita, and airplane flight is 8x higher radiation.

  Cosmic radiation is mostly protons and photons but a small amount of He or Iron nuclei.

Radioactive rocks:

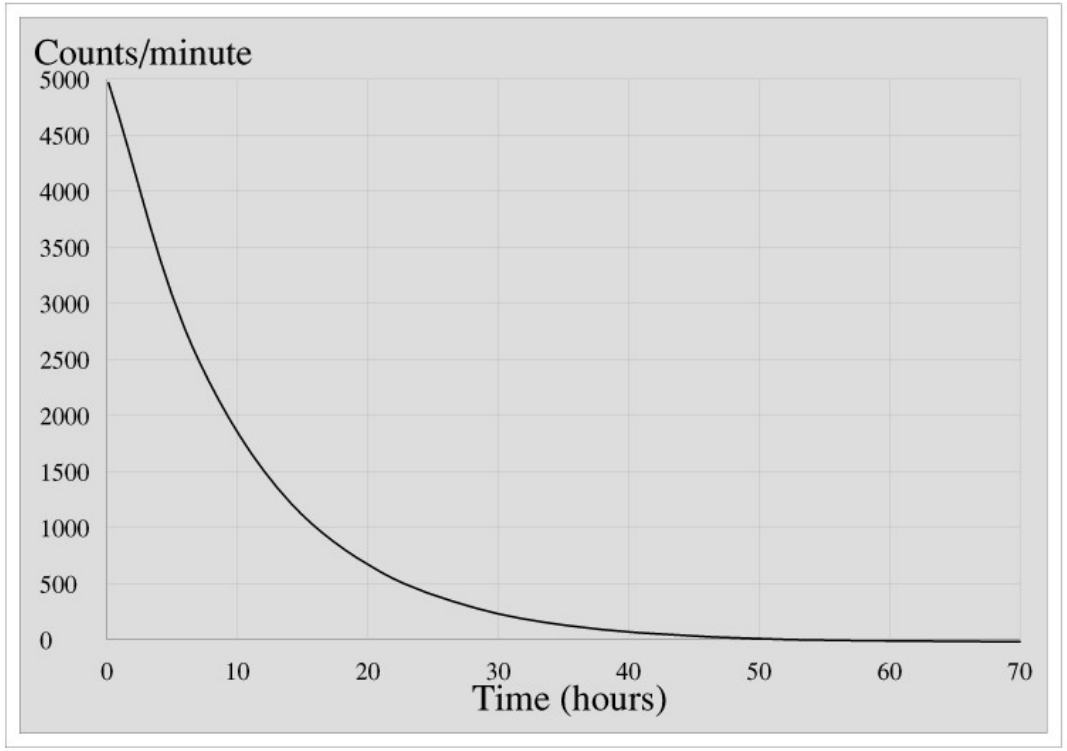
Rocks in Kansas contain:

- Uranium ore, yellows dots or veins
- Polonium black dots
- Radioactive Salts: sodium chloride, potassium chloride, magnesium chloride …

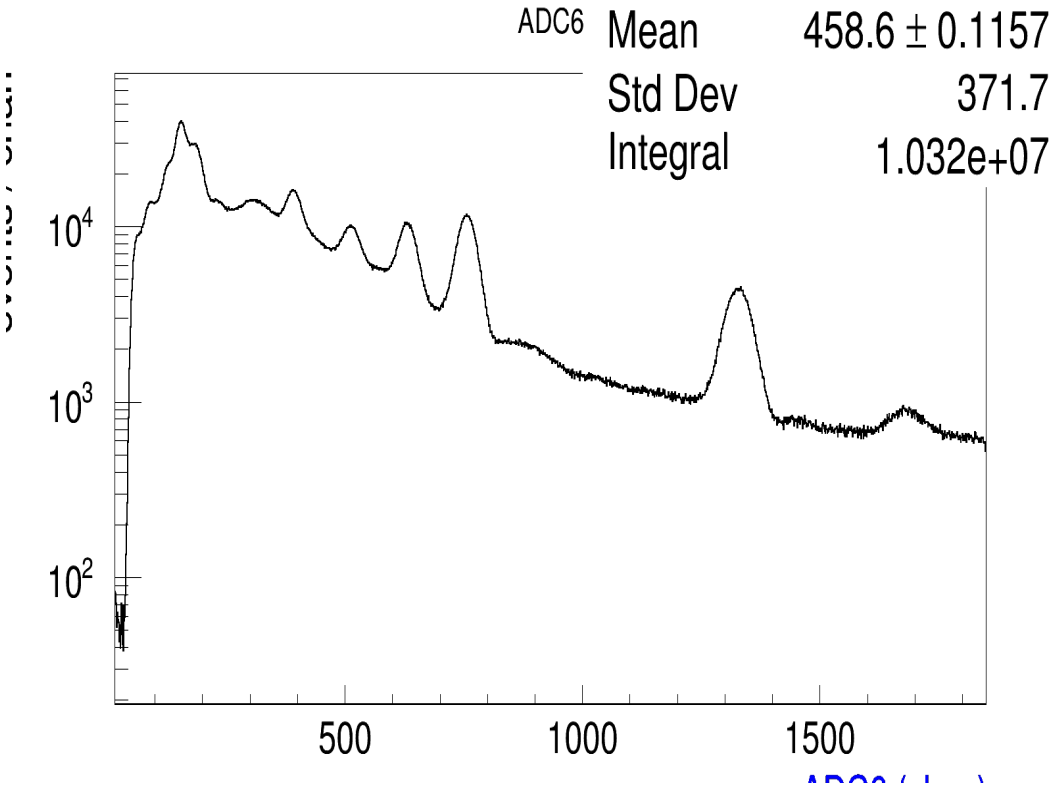


How do you tell what elements are in the Rock

Half-life measurement of decay



Energy measurement of emitted particles, is like a finger print for an element



Four ways to limit radiation exposure

- Limit the amount of time
- Keep the maximum distance away possible
- Put material between you and the source
- Magnetic fields like that of Earth or Sun sweep charged particles away

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- Limit the amount of time

Taking a shorter distance airplane flight in going from City A to B is less radiation than flying from City A to C and C to B.

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- Keep the maximum distance away possible

  The $1/r^2$ law means that going twice the distance away from the source means you get a forth of the dose.

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  Although paper can stop alpha particles, and a thin layer of aluminum foil stops beta particles to stop gamma rays you need large thickness of lead, steel, concrete or water.

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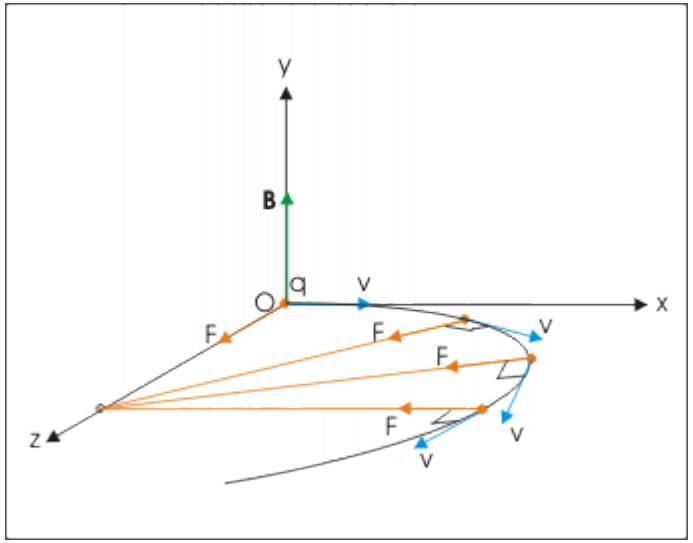

Magnetic Force

$F_m = q(\vec{v} \times \vec{B})$

In this Class room exercise we will study radiation from natural rocks and sources

- You are welcome to come and use the real Geiger counters with the Kansas radioactive rock and sources.

- The class room exercise using a virtual Geiger counter is something you can take back to your class room and have students do, we suggest using the virtual experiment:

https://www.gigaphysics.com/gmtube_lab.html

Absorption of Radiation by Material

- Using a Gamma source
- Study the absorption of radiation by different thickness of:
  - Lead
  - Plastic
  - Carboard
- If you used an Alpha source see how this changes the absorption
- Try this again with an Beta source.

Distance or Time

- Using the count timer setting on the Virtual lab show that the radiation counts are less with shorter exposure times.

- Using the real Geiger counter make radiation counts per minute above background (which means subtract off your count rate with no source present) for a source at different distances from the counter sensor.

Statistical Significance

- The error on each of your measured counts is the square root of the number of counts, often called the error bar. Plot on the graph paper provided the counts per minute above background (subtracting off the counts per minute when no source present) and put on the error bar of each point.

- Does this obey the $1/r^2$ law expected?