Cloud chamber Experiment

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Introduction

Goal: detect α- and β-particles and from that measure the activity and half-life of radioactive sources.

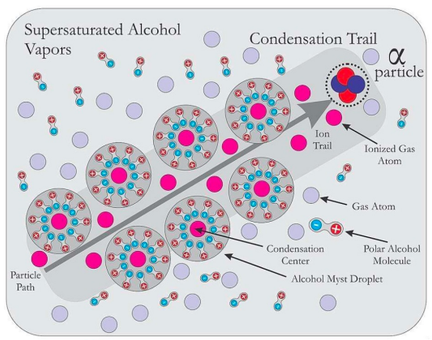
Method: Use a cloud chamber to make the trails of α- and β-particles visible to the human eye. From the amount of trails we count we can calculate the activity.

Half-life: The half-life of a radioactive material is the time it takes until half of it has decayed. This is described by an exponential decay: $\mathrm{N}(t) = N_0 e^{-\lambda t}$. N_0 is the initial amount of radioactive material, $\mathrm{N}(t)$ is the amount after the time t and $e^{-\lambda t}$ describes the exponential decay.

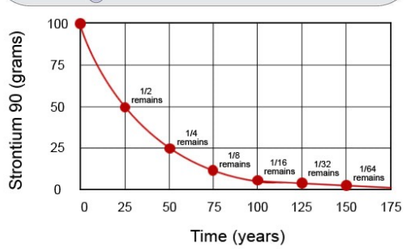
α- and β-particles:

α-particles consist of 2 protons and 2 neutrons and are identical to Helium nuclei. β-particles are electrons or positrons.

How a diffusion cloud chamber works

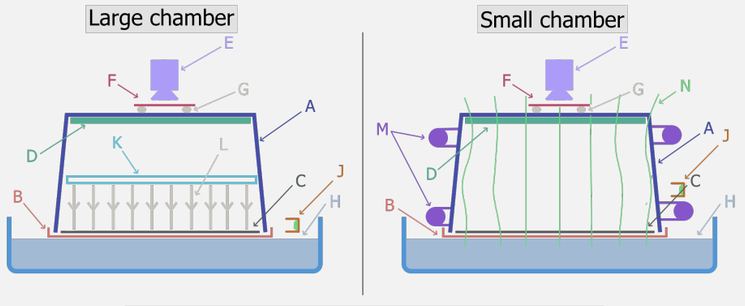


α- and β-particles shoot through the alcohol and leave an Ion-trail, which we can see as condensation after the atoms re-ionize.



The exponential curve for the amount of Sr-90 with respect to time. The activity of the source is the amount of decays per unit time.

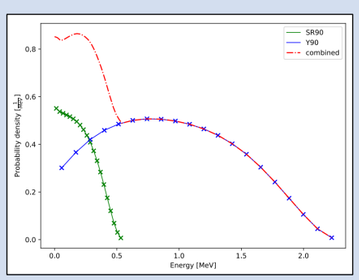
Setup



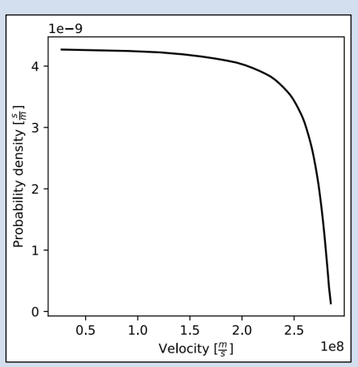
A: Transparent container	B: Crimped aluminium plate
C: Black sheet	D: Ethanol soaked felt
E: Camera	F: Transparent Plexiglas sheet
G: Plastic gasket	H: Dry ice
J: Dimmable LED strip	K: Copper grid
L: Electric field	M: Helmholtz coils
N: Magnetic field	

Strontium-90 source (β-particles)

Energy spectrum outside chamber:



Velocity spectrum inside chamber:



Data and Results

Decay trails inside the cloud chamber:

Decay trails inside the cloud chamber (with ^{90}Sr source):

Automated trail detection using AI: