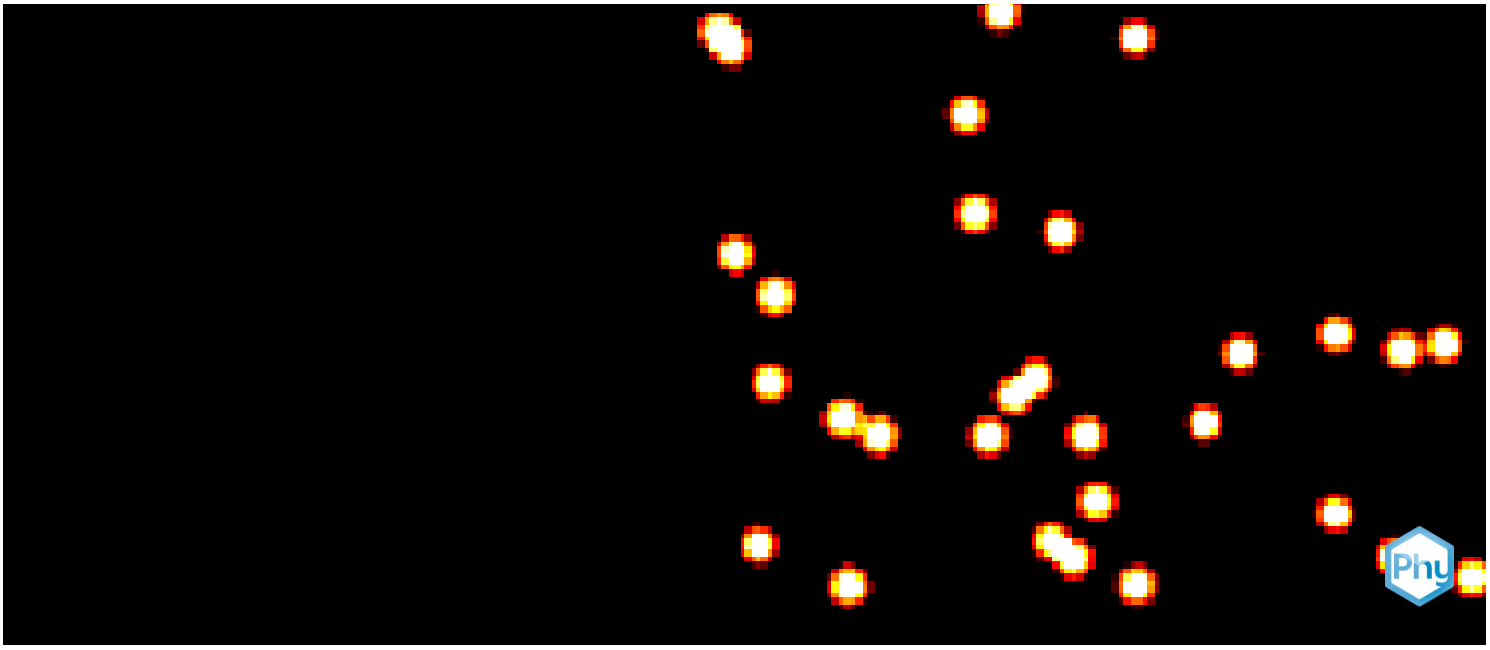
# Alpha particle shielding



P2525400

Physics > Modern Physics > Nuclear & particle physics

| Difficulty level | Group size | Preparation time | Execution time |
|---|---|---|---|
| - | - | 45+ minutes | 45+ minutes |

This content can also be found online at:

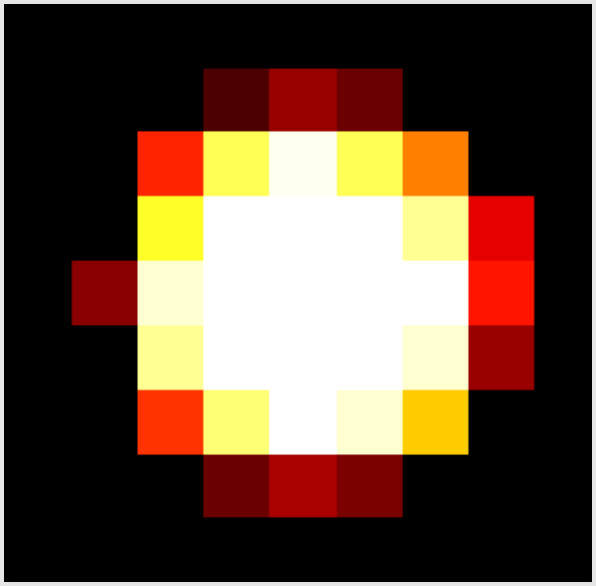
http://localhost:1337/c/6568509934fd5900023981e1

PHYWE

# General information

## Application

PHYWE



Radioactivity is a subject in our society which has been playing an important role throughout politics, economy and media for many years now.

The particular hazard when handling radioactive substances is the high-energy radiation from these substances. The hazard potential depends in particular on the type of radiation exposure: internal or external exposure; type of radiation: alpha, beta, gamma radiation, and type of handling.

This experiment demonstrat the blocking of  alpha particles from polonium-210 being by a piece of paper.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

## Other information (1/3)

PHYWE

**Prior knowledge**

The prior knowledge required can be found in the theory section.

**Scientific principle**

The range of alpha radiation depends on both the energy of the alpha particles and the material in which they move. In principle, however, the range of alpha radiation is short, especially in comparison with beta and gamma radiation.

## Other information (2/3)

PHYWE

**Learning objective**

Can alpha particles being blocked by a piece of paper?

**Tasks**

1. Start the radiation detector.
2. Collect data on shilding of alpha particles.
3. Evaluate the observations.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

# Other information (3/3)

PHYWE

## Instructions for safe use

To avoid malfunction or damage to your $MiniPIX\ EDU$ please observe the following:

- Do not expose to water or moisture.
- Do not disassemble. Wire-bonding connection may be irreversibly damaged.
- Do not insert any object into the sensor window.
- Maximum USB cable length is 3m.
- The protection provided by this product may be impaired if it is used in a manner not described in this document.

# Theory (1/5)

PHYWE

The main compositions of the primary cosmic radiations.

| Particles | Percentage |
|---|---|
| protons | about 90% |
| alpha-particles | about 9% |
| bigger nuclei | up to 1% |

**1. Natural Earth radiations**

**1.1 Cosmic rays**

Radiations of particles with a high energy content (an exception: photon rays, which are electromagnetic waves) use to come from space down to every part of our terrestrial atmosphere (the primary cosmic radiations).

The particles penetrating into the atmosphere happen to bang into nuclei of the atmosphere and provoke nuclear reactions as well as nuclear splits. Therefore, new nuclei and elementary particles are created, go on flying and lead to other interactions.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

# Theory (2/5)

PHYWE

In the atmosphere layers close to earth (less than 20 km high) one can observe only one secondary kind of radiations brought up by the numerous interaction-processes in the superior layers of the atmosphere. One must differentiate four kinds of components which have a different penetrating power (see Fig. 1):

| Cosmic secondary rays | Components |
|---|---|
| Nucleons | protons / neutrons |
| Electrons and photons | electrons / positrons / photons |
| Mesons | mesons of different charges |
| Neutrinos | neutrinos / antineutrinos |

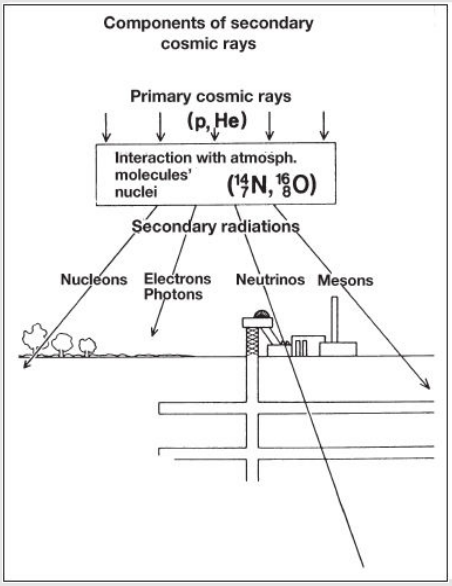



Fig. 1: Natural splitting processes

# Theory (3/5)

PHYWE

### 1.2 Terrestrial radiations

All materials on Earth (earth, water, atmosphere, animals…) contain natural radionuclides which send radiations. They have been existing since the creation of Earth (that is to say 4.5 thousand million years) or are constantly being created: U-238; Th-232; K-40 or Rb-87, for instance, belong to the natural radionuclides and have a very long radioactive period. Ra- 226; Rn-222; Po-218 or Pb-210 are constantly being created and those radionuclides have a rather short radioactive period in the three natural splitting processes. There exist also natural radionuclides with a relative short-timed radioactive period, but these do not belong to the splitting process. They are constantly being created in the upper layers of atmosphere, such as C-14 from N-14 or H-3 from N-14 or O-16, for instance.



PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

# Theory (4/5)

PHYWE

The about 100 natural radionuclides which have been existing since the creation of Earth or which are constantly being created can be found on the whole Earth in different concentrations. That is the reason why there are constant exchanges between earth, water, atmosphere and animal-life (Fig. 2).

People have therefore always absorbed natural radioactive substances into their bodies through the air they breathe and the food they eat. The radioactive gas radon and its by-products are absorbed through inhalation. Natural radionuclides from the radioactive decay series of thorium and uranium as well as potassium-40 and carbon-14 are ingested with food.

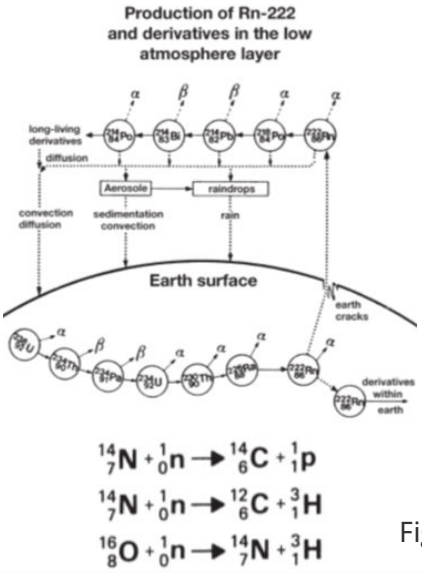



Fig. 2

# Theory (5/5)

PHYWE

**2. Radioactive substances - Polonium-210**

Polonium-210 is the most common polonium isotope in nature. It is formed as the last radioactive link in the radioactive decay chain of uranium-238. It emits alpha particles during radioactive decay, producing lead-206. Radioactive polonium can only pose a health risk if it is inhaled with food or drinking water or absorbed into the body through the skin, for example via open wounds. The quantities of naturally absorbed polonium are so small that they have practically no effect on health. Health risks can therefore only occur in the event of unintentional or intentional (deliberate) ingestion of technically produced polonium. It is used in combination with beryllium as a neutron source, in antistatic electrodes/brushes to eliminate static charges, in highly sensitive optical and mechanical measuring devices to eliminate static charges and as a lightweight thermoelectric battery in space travel.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

# Equipment

| Position | Material | Item No. | Quantity |
|---|---|---|---|
| 1 | Single photon counter MiniPIX, set | 09075-00 | 1 |
| 2 | Radioactive source Am-241, 74 kBq | 09047-51 | 1 |
| 3 | Holder for radioactive samples, used for 09075-00 | 09075-10 | 1 |



PHYWE
Robert-Bosch-Breite 10
37079 Göttingen
Tel.: 0551 604 - 0
Fax: 0551 604 - 107
info@phywe.de
www.phywe.de

PHYWE

# Setup and procedure

## Setup and procedure

PHYWE



- Min Level: 0
- Max Level: 100
- Measurement Mode: Tracking
- Frames: 100
- Exposure: 1s
- Sum: uncheck
- Color Map: Hot

- Connect the MiniPIX EDU camera and launch the software PixetBasic.
- Modify the settings such as on the left side.
- Mount the MiniPix EDU camera and polonium on the stage.
- Keep the camera and the source 1.5 cm apart and click on the play button.
- During the experiment cover half of the camera sensor with paper. **CAUTION: Make sure that paper does not touch the sensor of the camera.**
- For more information about the software and exporting of data, consult the experiment "Measurement of background radiation".



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

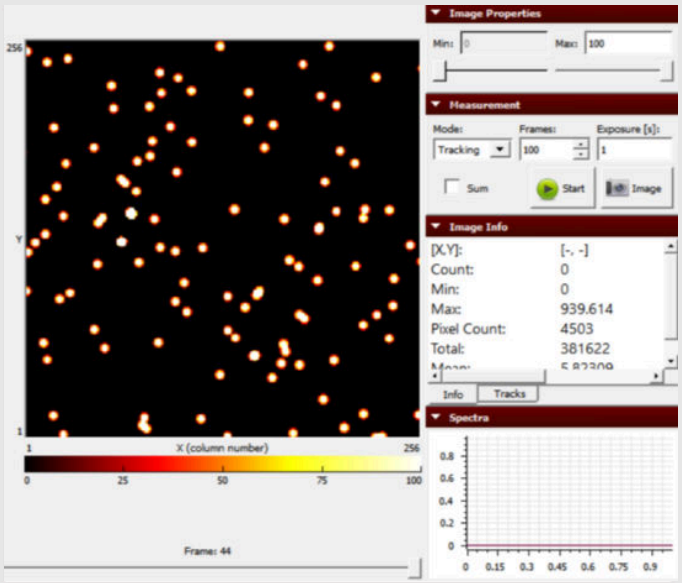
PHYWE

# Evaluation

## Evaluation (1/3)

PHYWE

Initially, we observe that the frame is full of alpha particles.






PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

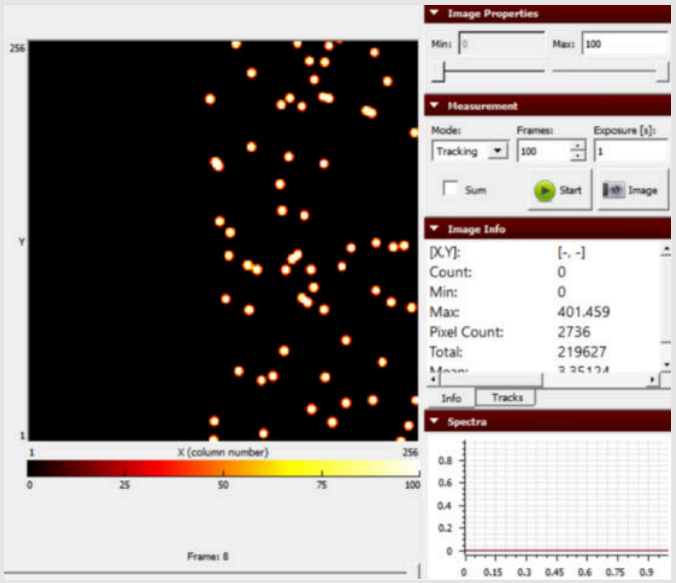
Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de

## Evaluation (2/3)

PHYWE

After covering half of the camera sensor with paper, the alpha particles disappeared from the half-covered frame showing that the alpha particles can be blocked by a piece of paper.




## Evaluation (3/3)

PHYWE

- The alpha particles being the heaviest, lose the energy quickly and thus have a very small linear range which decreases after a denser material like paper comes in the way.
- Although, we still observe the gamma photons on the frame where the alpha particles have disappeared. This is because gamma photons have more penetrating power because they have no charge and thus do not interact with the matter as much as other particles.
- Sometimes, if the piece of paper is thin enough and the source and camera are very close, the alpha particles can pierce through the paper too.
- Try using different materials like polythene bags, tissue paper, paper napkin, etc.



PHYWE

Robert-Bosch-Breite 10
37079 Göttingen

Tel.: 0551 604 - 0
Fax: 0551 604 - 107

info@phywe.de
www.phywe.de