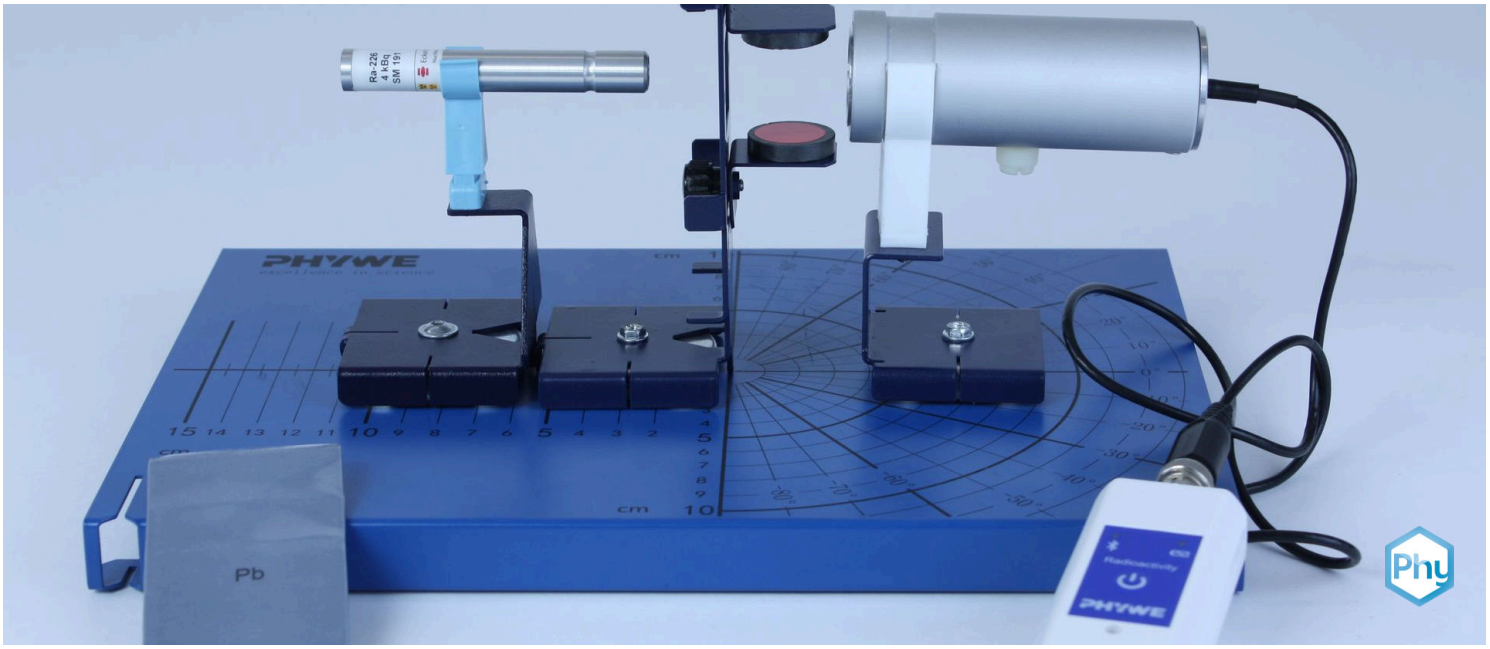
The behaviour of gamma radiation in a magnetic field with Cobra SMARTsense



Physics | Modern Physics | Radioactivity

Difficulty level	Group size	Preparation time	Execution time
medium	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/5f4c27797b2768000356b87e

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Teacher information

Application

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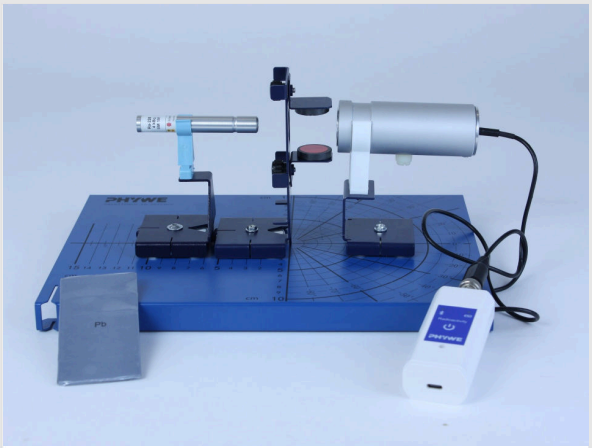

Test setup for the measurement of
γ Radiation from a magnetic field

Radiation and radioactivity are often equated with nuclear power. However, there are many different artificial and natural sources of radiation. Basically, people on earth are exposed to natural radiation, which, for example, like the noble gas radon, is absorbed through the air we breathe or through food. If one tolerates a radiation dose above the natural radiation exposure, this can have an extremely harmful effect on the body. In order to better understand the phenomenon of radioactivity, the different types of radiation are studied.

In this experiment the different behaviour of gamma radiation to alpha and beta radiation in the magnetic field is studied.

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Other teacher information (2/3)

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Prior knowledge

As previous knowledge, the students should have mastered terms such as counting rate, zero rate and the use of the Geiger-Müller counter. Furthermore, the students should be aware that radioactivity is a natural process and that it is a statistically fluctuating process. Furthermore, they should know the different types of radiation and how beta particles behave in a magnetic field. Furthermore, the magnetic field, the resulting forces in a magnetic field and moving charges in the magnetic field should be known.

Scientific principle

The behaviour of gamma rays in the magnetic field is investigated by comparing measurements with and without magnetic field. A lead plate is used to isolate other types of radiation.

Other teacher information (3/3)

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Learning objective

With the help of the experiment, the students determine the behaviour of the gamma rays in the magnetic field.

Tasks

Students study the deflection of gamma rays in a magnetic field by measuring the pulse rate with a Geiger-Müller counter tube for radiation through a magnetic field, and without a magnetic field.

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Safety Instructions (1/2)

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- The lead plate of 1 mm thickness completely absorbs the β radiation without noticeably weakening the γ radiation.
- Since every small change in the geometric test arrangement leads to strong changes in the count rates, the measurement should first be carried out with the deflecting magnets. When the magnets are removed, the risk of displacement of the radiation source or counter tube is much less than when they are attached to the plate holder.
- The general instructions for safe experimentation in science lessons apply to this experiment.

Safety instructions (2/2)

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- The activity of the radiation source used is quite low at 3 kBq, but the source should only be removed from the storage container for the duration of the experiment.
- The generally applicable rules for handling radioactive preparations according to the Radiation Protection Ordinance must be observed.

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Student Information

Motivation

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Different types of radiation in the magnetic field, made visible by a cloud chamber

In addition to the use of radioactivity for energy production, radioactive radiation is encountered every day. Every human being is exposed to natural radiation. This radioactive radiation is absorbed, for example, through food or the air we breathe, or can originate from radioactive materials in the earth's rocks. However, it only becomes dangerous when the radiation to which one is exposed exceeds the natural radiation exposure.

To better understand radioactivity, the behaviour of gamma radiation in the magnetic field is studied in this experiment.

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Tasks

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Experiment setup: Radioactive source (left) radiates through a magnetic field into the counter tube (right).

1. Records the pulse rate with the Geiger-Müller counter tube for the radiation through the magnetic field, as well as without the magnetic field.
2. Compares and interprets the results of the two measurement series.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense- Radioactivity (Bluetooth + USB)	12937-01	1
2	Base plate for radioactivity	09200-00	1
3	Holder for SMARTsense counter tube on holding magnet	09207-00	1
4	Source holder on fixing magnet	09202-00	1
5	Plate holder on fixing magnet	09203-00	1
6	Defl.magnets f. plate holder,2pcs	09203-02	1
7	Absorption material f.student exp	09014-03	1
8	Radioactive source Ra-226, max. 4 kBq	09041-00	1
9	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Structure (1/5)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

Structure (2/5)

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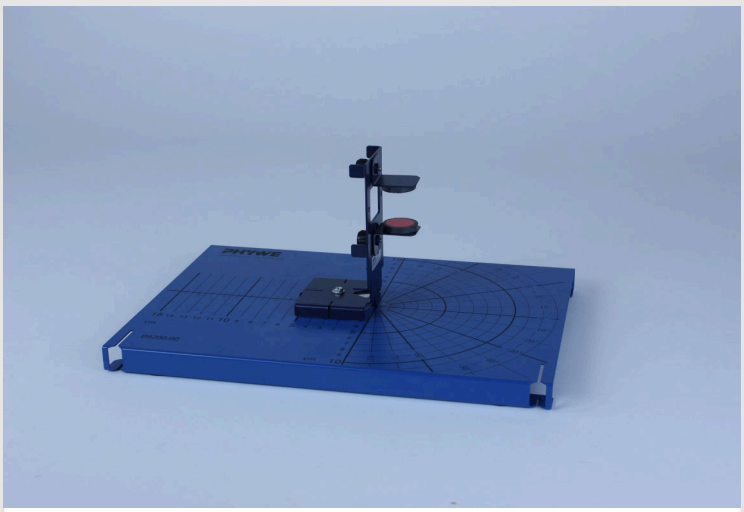

Base plate with installed magnetic holder

- Attach the deflector magnets to the plate holder using the knurled screws. The distance between the magnets should be 2 cm.
- Place the plate holder on the mounting plate. The center of the deflecting magnets should be exactly above the center of the angle scale.

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Set-up (3/5)

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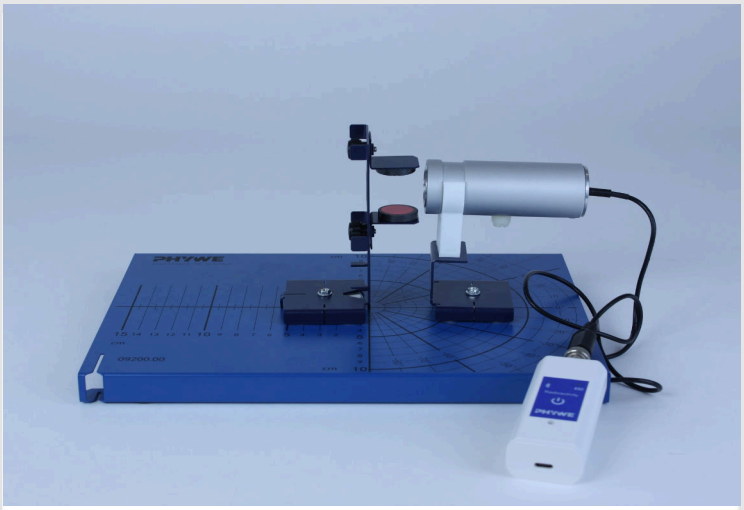

Test setup with connected detector

- Clamp the Geiger-Müller counter tube into the counter tube holder and place it on the mounting plate so that the counter tube is directly in front of the deflecting magnets.
- Connect the Geiger-Müller counter tube to the sensor unit.

Set-up (4/5)

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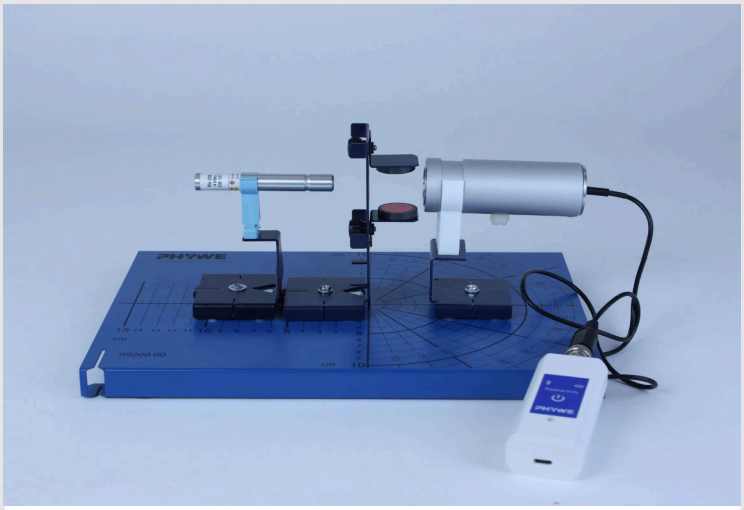

Assembled radioactive preparation in the holding device

- Clamp the specimen in the specimen holder.
- Place the specimen holder on the mounting surface and move it until the beam exit opening is exactly above the front edge of the specimen.

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Set-up (5/5)

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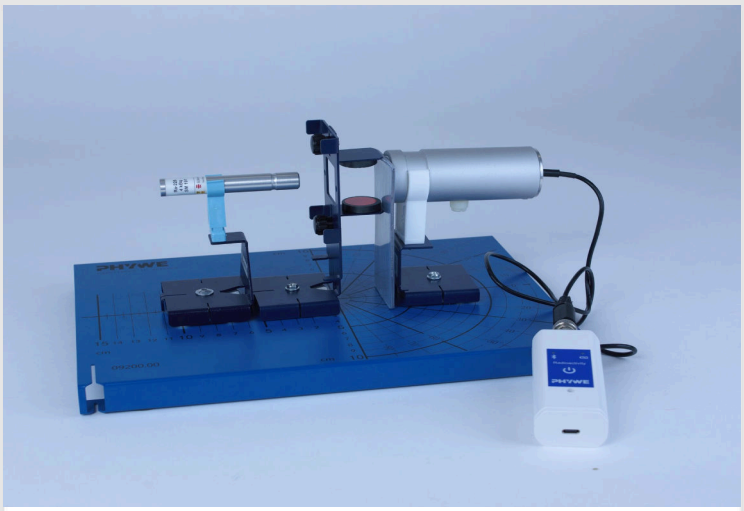

Complete test setup with installed lead plate

- Place the lead plate between the counter tube and the deflector magnet.
- Connect the sensor to the PHYWE Measure App by pressing the Bluetooth button for 3 seconds. Then the radioactivity sensor can be selected in the App.

Procedure (1/2)

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- Note five measured values with built-in deflection agent in the first column of the table in the protocol (slide 19).
- Carefully remove the deflector magnets from the plate holder. To shield the beta rays, the lead plate must not be removed. Note that the position of the radiation source and counter tube must not change.

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Procedure (2/2)

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- Determine five times the pulse rate without deflector magnet and enter the measured values in the second column of the table (slide 19).
- Put the radiation source back into the container after completion of the series of measurements.

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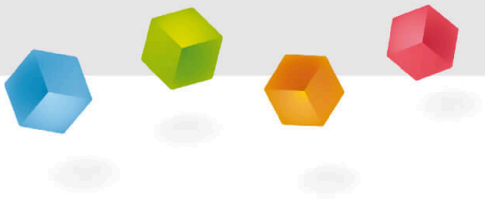

Report

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Monitoring

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Note down the measured values for measurements with and without deflecting magnets. Then determine the average value and the statistical error.

Measurei	1	2	3	4	5	Average value	Error	
Z_{Magnet}								Imp/min
$Z_{without}$								Imp/min

Task 1

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Compare the mean values of the pulse rates with and without deflecting magnets, taking into account the statistical uncertainty. Then complete the sentence:

Taking into account the statistical error, the mean value of the measurement with deflector magnet _____ is the mean value of the measurements without deflector magnet

- ○ much smaller than
- ○ much greater than
- ○ approximately the size of

Check

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Task 2

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Interpret the test result. What conclusions can be drawn about the deflection of gamma rays in the magnetic field?

- ○ The experiment does not allow any conclusion to be drawn
- ○ Gamma radiation is deflected in the magnetic field.
- ○ Gamma radiation is not deflected in the magnetic field.

Check

Slide	Score / Total
Slide 20: Comparison of the measurement series	0/1
Slide 21: Behaviour in the magnetic field	0/1

Total amount 0 / 2

Solutions Repeat Exporting text

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