

**Atomic and nuclear physics**

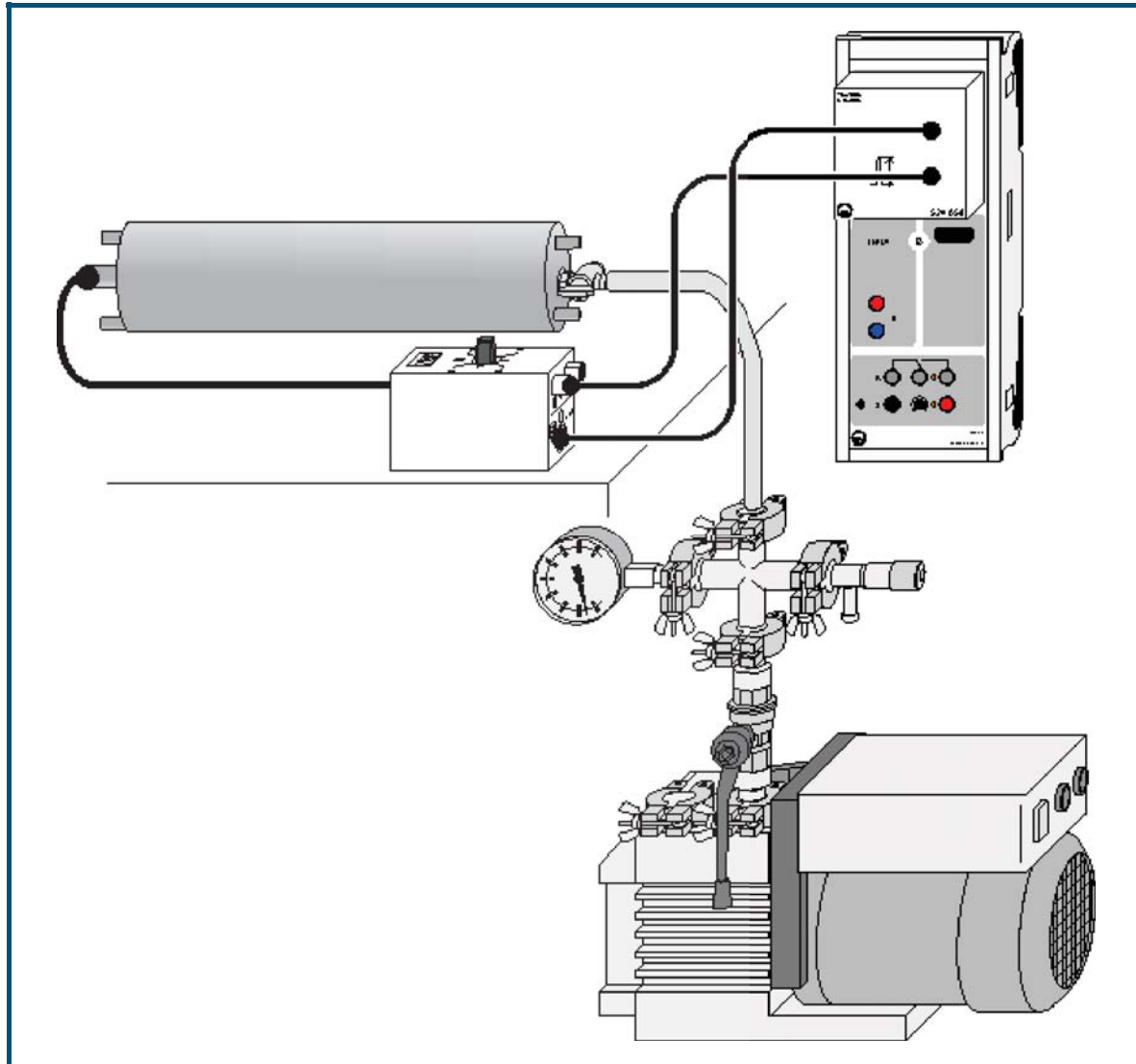
Nuclear physics  
 *$\alpha$  spectroscopy*


Determining the energy loss  
of  $\alpha$  radiation in air

**Description from CASSY Lab 2**

For loading examples and settings,  
please use the CASSY Lab 2 help.

## Determining the energy loss of $\alpha$ radiation in air (Am-241)



 can also be carried out with [Pocket-CASSY](#)

### Safety note

When handling radioactive preparations, in addition to the radiation protection regulations, state-specific requirements and the regulations of the educational authorities are also to be observed, e.g. in the Federal Republic of Germany at the very least the radiation protection regulations (StrlSchV - Strahlenschutzverordnung) and the directives on safety during school lessons. This applies even in cases where the preparation used in this experiment in itself does not require the nomination of a trained radiation officer.

Since the used preparations produce ionizing radiation, the following safety rules must nevertheless be kept to:

- Prevent access to the preparations by **unauthorized persons**.
- Before using the preparations make sure that they are **intact**.
- For the purpose of **shielding**, keep the preparations in their safety container.
- To ensure **minimum exposure time** and **minimum activity**, take the preparations out of the safety container only as long as is necessary for carrying out the experiment.
- To ensure **maximum distance**, hold the preparations only at the upper end of the metal holder.

## Experiment description

The energy loss of the  $\alpha$  radiation from the Am-241 sample is measured in the spectroscopy chamber in dependence on the air pressure. From this the energy loss at normal pressure is calculated as a function of the distance. The range of the  $\alpha$  radiation in air is obtained.

## Equipment list


1	<a href="#">Sensor-CASSY</a>	524 010 or 524 013
1	<a href="#">CASSY Lab 2</a>	524 220
1	<a href="#">MCA box</a>	524 058
1	<a href="#">Am-241 preparation</a>	559 825
1	Alpha spectroscopy chamber	559 565
1	Semiconductor detector	559 921
1	Discriminator preamplifier	559 931
1	Multicore cable, 6-pole, 1.5 m	501 16
1	HF cable, 1 m	501 02
1	HF cable, 0.25 m	501 01
1	Rotary-vane vacuum pump	378 73
1	Small flange DN 16 KF	378 031
1	Vacuum tubing, 8/18 mm dia.	307 68
1	Cross DN 16 KF	378 015
1	Variable leak valve DN 16 KF	378 776
1	Pointer manometer	378 510
2	Sets of centering rings DN 16 KF	378 045ET2
4	Clamping rings DN 10/16 KF	378 050
1	PC with Windows XP/Vista/7	

## Experiment setup (see drawing)

The preparation and the detector are placed in the spectroscopy chamber. The detector is connected to the discriminator-preamplifier via the short BNC cable. The discriminator-preamplifier is connected to the MCA box. The pump and the vacuum meter are connected to the spectroscopy chamber.

## Carrying out the experiment

### ■ Load settings

- After inserting the preparation and the detector, cautiously evacuate the spectroscopy chamber.
- When the vacuum is established, record the spectrum with  varying the gain until the [Am-241](#) line is approximately in the middle of the spectrum. This typically occurs at gains around -3.
- [Calibrate the energy](#)
- Open the variable leak valve until the pressure in the vacuum chamber is approx. 100 mbar. Record another spectrum.
- Increase the pressure in the vacuum chamber in steps of about 100 mbar. Record an  $\alpha$  spectrum at each pressure.

## Evaluation

The energy of the  $\alpha$  line is determined from the individual spectra. The air pressure is converted into an effective path in air at normal pressure. From the representation of the energy as a function of the effective path in air the range of the  $\alpha$  radiation in air is read.

## Remarks

The range in air can, of course, also be measured directly without using the spectroscopy chamber. It can be determined by varying the distance. In this case, however, the setup requires some improvisation with respect to fixing the preparation. The detector can be attached to the discriminator-preamplifier directly. In this case, it provides stronger pulses as in the spectroscopy chamber as the load of the capacitance of the BNC cable is missing.

Due to the [cover of the preparations](#) (e.g. 559 821), there is a strong offset in energy. The measured spectrum starts only at an energy of 1-2 MeV. Particles with lower energy are stopped before reaching the detector.

Do not leave a reduced pressure in the rubber tubing for extended periods of time. The oil from the vacuum pump would creep up inside the tube and possibly contaminate the spectroscopy chamber. Once the correct pressure for the next measurement is reached, close the valve and vent the rubber tubing.

## Atomic and nuclear physics

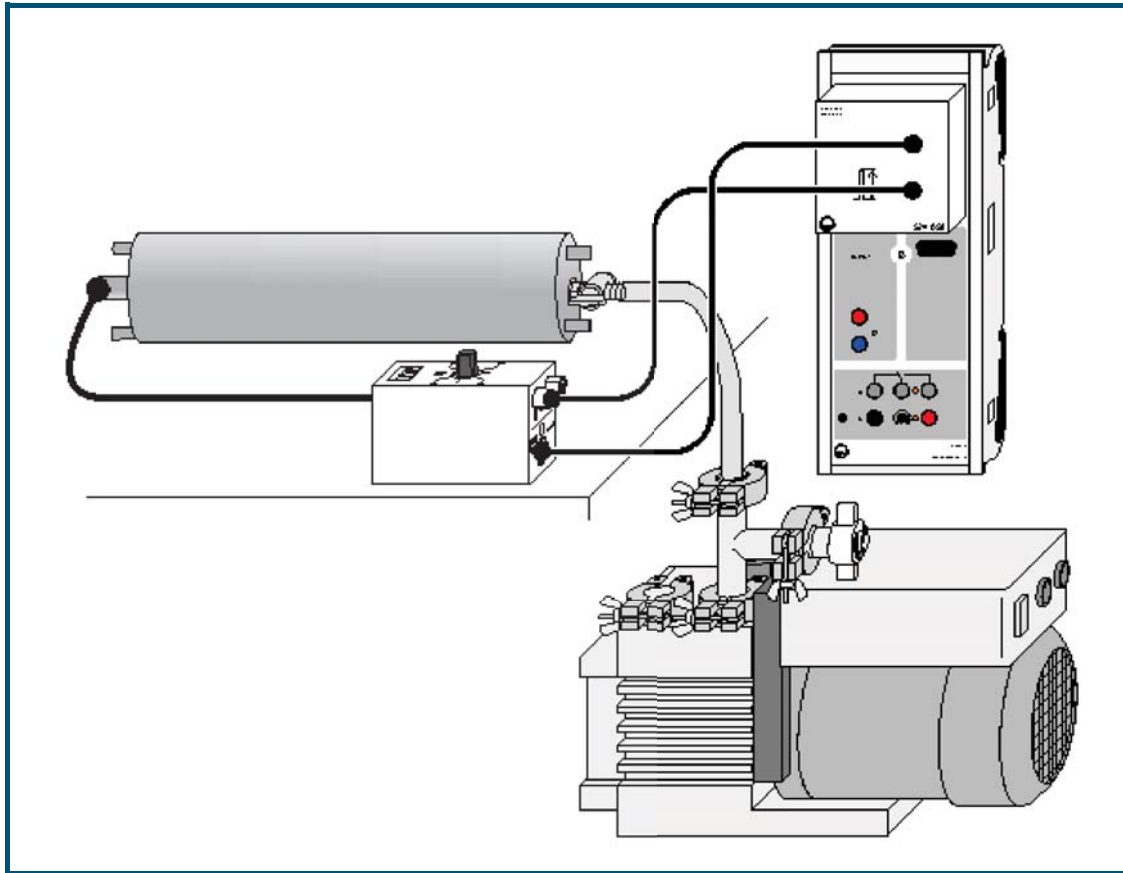
Nuclear physics  
 *$\alpha$  spectroscopy*


Determining the energy loss  
of  $\alpha$  radiation in aluminum  
and in gold

### Description from CASSY Lab 2

For loading examples and settings,  
please use the CASSY Lab 2 help.

## Determining the energy loss of $\alpha$ radiation in aluminum and in gold



 can also be carried out with [Pocket-CASSY](#)

### Safety note

When handling radioactive preparations, in addition to the radiation protection regulations, state-specific requirements and the regulations of the educational authorities are also to be observed, e.g. in the Federal Republic of Germany at the very least the radiation protection regulations (StrlSchV - Strahlenschutzverordnung) and the directives on safety during school lessons. This applies even in cases where the preparation used in this experiment in itself does not require the nomination of a trained radiation officer.

Since the used preparations produce ionizing radiation, the following safety rules must nevertheless be kept to:

- Prevent access to the preparations by **unauthorized persons**.
- Before using the preparations make sure that they are **intact**.
- For the purpose of **shielding**, keep the preparations in their safety container.
- To ensure **minimum exposure time** and **minimum activity**, take the preparations out of the safety container only as long as is necessary for carrying out the experiment.
- To ensure **maximum distance**, hold the preparations only at the upper end of the metal holder.

### Experiment description

The energy loss of  $\alpha$  radiation in an aluminum or gold foil is determined as a function of the  $\alpha$  energy.

### Equipment list

1	<a href="#">Sensor-CASSY</a>	524 010 or 524 013
1	<a href="#">CASSY Lab 2</a>	524 220
1	<a href="#">MCA box</a>	524 058
1	<a href="#">Am-241 preparation</a>	559 825
1	<a href="#">Ra-226 preparation</a>	559 435
1	Alpha spectroscopy chamber	559 565


1	Gold and aluminum foil in holder	559 521
1	Semiconductor detector	559 921
1	Discriminator preamplifier	559 931
1	Multicore cable, 6-pole, 1.5 m	501 16
1	HF cable, 1 m	501 02
1	HF cable, 0.25 m	501 01
1	Rotary-vane vacuum pump	378 73
1	T-piece DN 16 KF	378 005
1	Centering ring DN 10/16 KF	from 378 040ET2
1	Air inlet valve DN 10 KF	378 771
1	Set of centering rings DN 16 KF	378 045ET2
2	Clamping rings DN 10/16 KF	378 050
1	Small flange DN 16 KF with hose nozzle	378 031
1	Vacuum tubing, 8/18 mm dia.	667 186
1	PC with Windows XP/Vista/7	

### Experiment setup (see drawing)

The preparation and the corresponding film on the detector are mounted in the spectroscopy chamber. The detector is connected to the discriminator-preamplifier via the short BNC cable. The discriminator-preamplifier is connected to the MCA box. The pump is connected to the spectroscopy chamber.

### Carrying out the experiment

#### ■ Load settings

- Mount the [Ra-226](#) preparation in the spectroscopy chamber
- Evacuate the chamber
- Record the spectrum with , and set the gain so that the spectrum is well displayed
- Use the outer lines of the spectrum for the [energy calibration](#). When doing this, take account of the [covering](#) (literature value minus 1100 keV)
- Aerate the chamber, place the gold film (2  $\mu\text{m}$  thick) onto the detector, and carefully evacuate the chamber
- Record the spectrum with the gold film
- Aerate the chamber. Be careful when doing this otherwise the gold foil can be destroyed by the pressure difference or swirling dust particles.
- Mount the aluminum film (8  $\mu\text{m}$  thick), carefully evacuate the chamber, record spectrum
- Carefully aerate the chamber, mount the [Am-241](#) preparation and repeat the measurement for the gold and the aluminum film without changing the energy calibration

### Evaluation

From each of the spectra the energy of the lines is determined. The energy loss per path length in aluminum and gold is plotted as a function of the energy and compared with the results from the Bethe-Bloch formula.

### Remarks

Due to the cover of the preparations, there is a strong offset in energy when the energy calibration is made with values taken from the literature. The measured spectrum starts only at an energy of 1-2 MeV. Particles with lower energy are stopped before reaching the detector.

During the measurement, the vacuum pump can run either continuously or the valve of the spectroscopy chamber can be closed after a few minutes of evacuation and the pump can be switched off. The rubber tubing must be vented through the inlet valve (378 771) to prevent oil from the vacuum pump creeping back into the vacuum.