Atomic and nuclear physics
Nuclear physics
α spectroscopy

Determining the energy loss of α 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 α radiation in air (Am-241)

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.

Pocket-CASSY

can also be carried out with Pocket-CASSY
Experiment description
The energy loss of the α 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 α radiation in air is obtained.

Equipment list
1. Sensor-CASSY 524 010 or 524 013
1. CASSY Lab 2 524 220
1. MCA box 524 058
1. Am-241 preparation 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
1. 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 α spectrum at each pressure.

Evaluation
The energy of the α 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 α 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.