Experiment No. 1

Absorption of alpha particles and electrons

Aim of the experiment:

Measure the dependence of alpha and beta radiation intensity on the distance traveled by the particles in various materials. Determine the range of the particles in those materials. Using an empirical range-energy relationship, determine the energy of alpha particles emitted by the ^{241}Am source. Compare the obtained results with the known values given in literature or calculated from empirical formulas. Compare the observed regularities of alpha and beta particle absorption.

Tasks:

1. Measure the dependence of the counting rate of alpha particles on the distance between the ^{241}Am (americium-241) alpha source and the Geiger-Müller counter.
2. Measure the dependence of the counting rate of beta particles on thickness of aluminum and organic glass absorbers placed between the ^{90}Sr/^{90}Y (strontium-90 / yttrium-90) source and the Geiger-Müller counter.
3. Plot the dependence of the angular density of α particle flux on the distance.
4. Plot the absorption curves of beta particles.
5. Determine the mean range in air of α particles emitted by ^{241}Am (taking into account the energy loss in the mica window of the counter). Using the empirical range-energy relation, calculate the energy of the α particles.
6. Determine the absorption coefficients and ranges of β particles in aluminum and organic glass. Compare the obtained values of the range with the value predicted by the empirical formula.
7. Discuss the observed peculiarities of absorption of α and β particles in matter.

Control questions:

1. What are the types of ionizing radiation?
2. What is the origin of energy losses of charged particles in matter?
3. What are the differences between motion of heavy charged particles (such as alpha particles) in matter and motion of electrons in matter?
4. Explain the concept of particle range and its difference from the average penetration depth.

Recommended reading:

1. Krane K. S. Introductory Nuclear Physics. New York: John Wiley & Sons, 1988. p. 193 – 198, 217 – 220.
2. Lilley J. Nuclear Physics: Principles and Applications. New York: John Wiley & Sons, 2001. p. 129 – 136.
3. Knoll G. F. Radiation Detection and Measurement. 3rd Edition. New York: John Wiley & Sons, 2000. p. 29 – 48, 118.