Rutherford Scattering Experiment Plan (Group VII)

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1 Introduction

This document layouts the experiment plan for the Rutherford experiment, through which we aim to verify the theory of elastic scattering of alpha particles experimentally. More specifically, we aim to investigate the relationship between the thickness, density of the attenuator foil, scattering foil and the intensity detected by the count-meter.

1.1 Apparatus

For this experiment we will make use of an ESI Rutherford scattering apparatus with ESI scaler/ratemeter and manual, a rotary vacuum pump which seals the scattering apparatus, a strong magnet for moving attenuator and scattering discs for the experimental measurements and finally a Geiger-Muller counter to measure the radiation intensity of the scattered alpha particles colliding with the detector.

2 Experimental Plan

2.1 Variables

From our apparatus, we determined the following as setting of the setup we could alter:

- Detector Angle
- Choice of Attenuator Foil
- Choice of Scattering Foil
- Count Period

From the count-meter, we can measure the respective count rate per period with respect to the relative settings. For the purpose of this experiment, we decided to choose measuring period of the count-meter to be 10 seconds and this is set constant for all experiments throughout this project.

Following from the variables, we identified a number of experiments to investigate and test the theory as described in the following subsections.

2.2 Experiment 1: Vary Detector Angle

From the theory, we know the 'Cross Section' (probability of scattering) is related to the angle as follows:

$$P(\theta) \propto \frac{1}{\sin^4(\theta/2)} \tag{1}$$

where θ is the scattering angle for which we could measure using the count-meter

By plotting the count rate against the detector angle, we could observe how the probability varies with respect to the scattering angle.

2.3 Experiment 2: Varying Attenuator Foil

From the setup, we are given 5 different Gold attenuator foils of different thickness which we vary by rotating the rotary wheels using a magnet. From intuition, we assume that thickness is inversely proportional to the probability of scattering as the alpha particle would have to travel a further distance to reach the detector during which the particles lose energy, resulting in lower probability of scattering, i.e. relate to lower count rate measured.

Therefore, we will measure the count rate for a varying thickness of the attenuator foils. During which, the choice of scattering foil and detector angle is fixed. In particular, we will conclude the angle yielding the maximum count from Experiment 1 and set it to be our detector angle for Experiment 2, and later, Experiment 3 as follows.

2.4 Experiment 3: Varying Scattering Foil

In a similar fashion as Experiment 2 but instead, we will vary the scattering foil instead and set the rest of the variables to be constant. Again, we expect a lower count from a higher thickness.

3 Health and Safety

This apparatus contains a sealed radioactive source and is under vacuum. We will use implosion guards at all times in order to make sure we are protected if something goes wrong with the chamber. Magnates are also used for this experiment which can cause damage to electrical devices such as phones and computers, also mechanical devices such as watches. In order to protect both ours and the labs property we should ensure that we remove all devices from our person and clear the surrounding area as to prevent accidents. The magnets are also heavy and needed to be handled with care.

4 Workload Distribution

Osian:

- Data tabulation

Conrad:

- Data analysis
- Data plotting

Araaf:

- Experimental procedure

Following from the report, we will write a lab report collectively as well.