PHY 4210-01 Senior Lab
Lab N4: Rutherford Scattering

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Abstract

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1 Objective of the Experiment

2 Theory of the Experiment

When an alpha particle with impact parameter b approaches a nucleus, it is scattered at an angle θ. If the impact parameter is given an infinitesimal range of [b, $b + db$], the resulting scattering angle then has a range of [$\theta - d\theta$, θ]; the impact parameter and scattering angle are inversely proportional.

Because the alpha particle can be incident within a defined range at any angle relative to the nucleus, a ring of possible incident locations is created in front of the nucleus. This ring is illustrated in Figure 1.

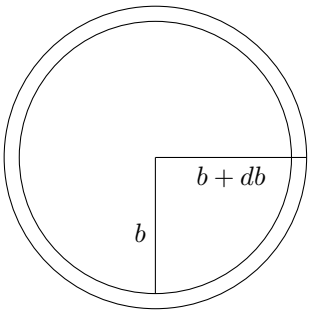

Figure 1: The ring whose area represents the possible region in which alpha particles may be incident on a target nucleus.

The area of this ring is found as the area of any ring is found:

$$\begin{aligned} A &= \pi(b + db)^2 - \pi b^2 \\ &= \pi(b^2 + 2bdb + db^2) - \pi b^2 \\ &= \pi b^2 + 2\pi bdb + \pi db^2 - \pi b^2 \\ &= 2\pi bdb + \pi db^2 \end{aligned}$$

Since db is infinitesimally small, it can be approximated to be zero. Therefore, the area of the incident ring, $\Delta\sigma$, is

$$\Delta\sigma = 2\pi bdb$$

Since $\Delta\sigma$ is the area of the full incident ring, an infinitesimal angular portion of that ring, $d\phi$, may be represented by $\Delta\sigma(\phi) = bdbd\phi$. Additionally, because the impact parameter b is related to the scattering angle θ, $\Delta\sigma$ is also a function of θ. Hence,

$$\Delta\sigma(\theta, \phi) = bdbd\phi$$

Since the impact parameter b is directly proportional to the size of the cross section and the scattering angle θ is inversely proportional to the impact parameter, the size of the cross section decreases as the scattering angle increases. Therefore, the cross section experiences a negative rate of change as θ increases. Hence,

$$\Delta\sigma(\theta, \phi) = -d\sigma(\theta, \phi) \tag{1}$$

3 Equipment Utilized

- List equipment and specifications

Figure 2: Description of schematic here

4 Procedure

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6.1 Results I: Gold

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