التجربة الرابعة

اسم التجربة:- قياس الشحنة النوعية للالكترون

Specific charge measuring

The purpose of the experiment:-

1- Study of the motion of a charged particle in a magnetic field.
2- Calculating the specific charge of an electron.

Used equipment's :-

Helmholtz coils, cathode ray tube, power supply, voltmeter.

Theory :-

The cathode ray tube used in this experiment consists of an electron ejector which is a cathode and a cylindrical anode. When an appropriate potential difference is applied between the anode and the cathode, the electrons liberated from the cathode accelerate towards the anode, The greater part collides with it, but some of these electrons pass into the horizontal slit in the middle of the anode and exit from it, moving at a constant speed of (v) passing through the barrier leaving a straight horizontal line glowing on it.

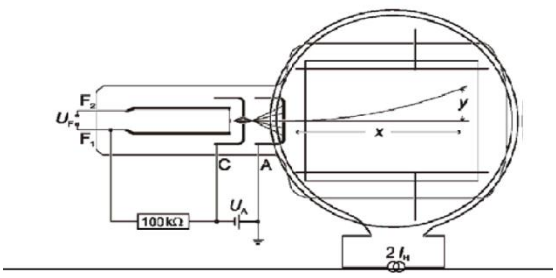

Figure (1) cathode ray tube

An regulated magnetic field is generated using Helmholtz coils and the direction of the magnetic field is controlled by the direction of the current passing through the coils. When the electron beam is fired in this magnetic field, it deviates from its path as a result of being exposed to the magnetic force. The deflection of electrons can be controlled by controlling the magnetic field.

When an electron with a charge (e) and a mass (m) moves perpendicular to the direction of a magnetic field, the intensity of its flux (B), the path of the electron is circular and with a radius (r) given by the following relationship:

$$\mathrm{r} = \frac{mv}{eB} \quad \dots\dots(1)$$

And when it was

$$\frac{1}{2}mv^2 = \mathrm{eV} \quad \dots\dots(2)$$

And squaring the equation (1), we get

$$\mathrm{r}^2 = \frac{m^2v^2}{e^2B^2} \quad \dots\dots(3)$$

The velocity of the electron (v) represents the accelerating potential difference(V) between the anode and the cathode, where

$$\therefore \qquad v = \left(\frac{2eV}{m}\right)^{\frac{1}{2}} \quad \dots\dots(4)$$

Substitute the value of (v) into the equation(3), we get

$$\frac{e}{m} = \frac{2V}{r^2B^2} \quad \dots\dots(5)$$

The magnetic flux density of the Helmholtz coil is given by the following equation:

$$B = \frac{8\mu_\circ NI}{\sqrt{125}\mathrm{R}} \quad \dots\dots(6)$$

Where:-

- (N) = Represents the number of turns of each coil.
- (R) = Radius of the coil.
- (I) = Represents the current in each coil in amperes.
- $(\mu_\circ)$ is a constant and equal to ($4\pi \times 10^{-7}$)

Work steps :-

1- Put the voltage switch and the current switch to zero.
2- Put the defection voltage on turn off and put the exciting current on clockwise.
3- Run the experiment and leave it for (5) minutes.
4- Gradually increase the acceleration voltage to the amount (100 V), then a green (luminous line) will be seen emitted from the electron ejector.
5- Turn on the loop current and install it. Then gradually increase the acceleration voltage and calculate the diameter of the ring each time.
6- Find the charge to mass ratio using equation (5) by substituting the value for (B) from equation (6):-

$$\frac{e}{m} = 9.88 * 10^6 \frac{V}{I^2 * D^2}$$
$$\frac{e}{m} = 9.88 * 10^6 \frac{1}{I^2} * Slop$$

7- Record the values in a table

V (V)	D(cm)	D^2 (cm)