

# Simulating Motion Of Charged Particle/Electron Through an Electric and Magnetic Field

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## 0.1 Aim

To simulate the motion of a charged particle inside an Electric and Magnetic Field.

## 0.2 Introduction

The project focuses on simulating/tracing the motion of a charged particle/electron under the influence of an external Electric and Magnetic Field. The electron trajectories can be given an desired shape by applying an Electric or Magnetic Field

## 0.3 Applications

- Radio
- Television
- CRO
- Mass Spectrograph
- Particle Accelerators

## 0.4 Motion of electron inside an uniform Electric Field

### 0.4.1 Types of motion exhibited by electron

- Parallel to Electric Field
- Perpendicular to Electric Field
- Projected at an angle to the Electric Field

### 0.4.2 Basic Calculation

When an electron is projected inside an electric field, sustained by 2 plates **A** and **B** with A being **positively** charged and B being **negatively** charged, having a potential **V** given by  $[V_a - V_b]$  at a distance of **d** the intensity of the electric field between the plate is given by

$$E = \frac{V}{d} \quad (1)$$

Force experienced by an electron at rest on plate **B**

$$F = -eE \quad (2)$$

The acceleration is given by

$$a = \frac{F}{m} = -\frac{eE}{-eE}m \quad (3)$$

The corresponding code in the project is given in:

*Basic\_Calculations* in *BasicCalc.h*

```
void Basic_Calculations(double PotentialDifference, double PlateDistance)
{
    Energy_Electron = PotentialDifference / PlateDistance; //Energy of the electron
    Force_Electron = -1 * ELECTRON_ENERGY * Energy_Electron; //Force on electron at Plate B
    Acceleration_Electron = fabs(Force_Electron) / ELECTRON_MASS; //Acceleration of Electron
}
```

### 0.4.3 Parallel to Electric Field

The velocity  $\mathbf{V}$  is given by :

$$V = V_0 + at \quad (4)$$

where  $V_0$  is the **initial velocity** of the electron or charged particle

The displacement of the electron is given by

$$S = V_0 t + \frac{1}{2}at^2 \quad (5)$$

Velocity at any given time denoted by  $V_t$  is given by

$$V_t = \frac{eE}{2m}t = \sqrt{\frac{2eE}{m}x} \quad (6)$$

parallel electric field used in project

$$X = \frac{eE}{2m}t^2 \quad (7)$$

The above equation gives the horizontal displacement of X which is depended on the value of  $t$

The calculation is done by the following code :

```
void ElectronMovement_Parallel(int Identifier)
{
float count = Misc.count = 0;
int Index = Misc.index =0;
float Time = EField.Var.TimeEpoch;
float StepSize = EField.Var.StepSize;
unsigned int mem = Misc.MemAllocFactor;

EField.CompArray.Xcomponent = (double *)calloc(mem, sizeof(double));

while (count <= Time)
{
EField.Parallel.X_Component = fabs(Force_Electron) / (2 * ELECTRON_MASS) * pow(count, 2);

EField.CompArray.Xcomponent[Index] = EField.Parallel.X_Component;
count += StepSize;
Index++;
}
}
```

### 0.4.4 Perpendicular to Electric Field

If  $\mathbf{A}$  and  $\mathbf{B}$  are two metal plates placed horizontally parallel to each other at a length  $l$

The velocity at  $\mathbf{Y}$  axis would be 0 initially, and would be  $V_0$  for  $\mathbf{X}$  axis

Therefore,  $V_y = 0$  and  $V_x = V_0$ .

The acceleration of the electron is given in y direction by

$$\alpha_y = \frac{eE}{m} \quad (8)$$

As a result, the equation for velocity along the  $\mathbf{Y}$  axis can be written as

$$V_y = \frac{eE}{m}t \quad (9)$$

The horizontal, displacement  $\mathbf{X}$  is given by the following equation

$$x = v_0 t \quad (10)$$

The time  $t$  is known as *transit time*