**Explanatory writeup**

At the first part of the MATLAB code, the user is required to enter total of 9 parameter as shown:

-the magnitude of voltage applied

-the magnitude of charge of the particle

-the magnitude of magnetic field applied

-the mass of the particle trapped

-the minimum axial distance for characteristic trap dimension

-the minimum radial distance for characteristic trap dimension

-the amplitude of modified cyclotron motion

-the amplitude of magnetron motion

-the amplitude of axial mode

All the parameter entered are in SI unit.

The Penning trap is occurred if q\*V is larger than 0. Therefore, a while loop is used in the code to ensure that user enter the value of q\*V is larger than 0, otherwise the user will always prompt to re-enter the value until a non-zero positive number is obtained.

For the second part of coding, the following parameter have calculated:

-characteristic trap dimension

-axial motion frequency

-cyclotron frequency

-modified cyclotron motion frequency

-magnetron motion frequency

All these parameter is required to produce the animation of the motion of charged particle in Penning trap based on the 9 user-defined parameters in the first part of coding.

The frequencies must real for the motion to stay bounded, hence the second condition must have obeyed which is . Hence, the coding will terminate and return if this condition is not followed.

After all the parameters are calculated and no inappropriate value are found, then the coding deploys the trajectory found (x, y, z axis).

The time defined in the coding is from 0 to 1 with the step of 0.00075. The time is set in this interval to allow the computer to produce the animation in desirable duration (too short duration resulting in the animation of motion not obvious to observe; too long duration resulting in computer required up to few minutes to produce only one animation)

As a result, the animation of the motion of the charged particle in Penning trap is produced.

Additional note:

The calculation part is referred and make use of article *First-order perturbative calculation of the frequency-shifts caused by static cylindrically-symmetric electric and magnetic imperfections of a Penning trap* (link: <https://arxiv.org/pdf/1305.4861.pdf>)

Animation coding is referred and make use of MATLAB note available in NTULearn (link: https://ntulearn.ntu.edu.sg/bbcswebdav/pid-1357298-dt-content-rid-5090941\_1/courses/17S2-PH2102-LEC/Animations%20in%20MATLAB.pdf)