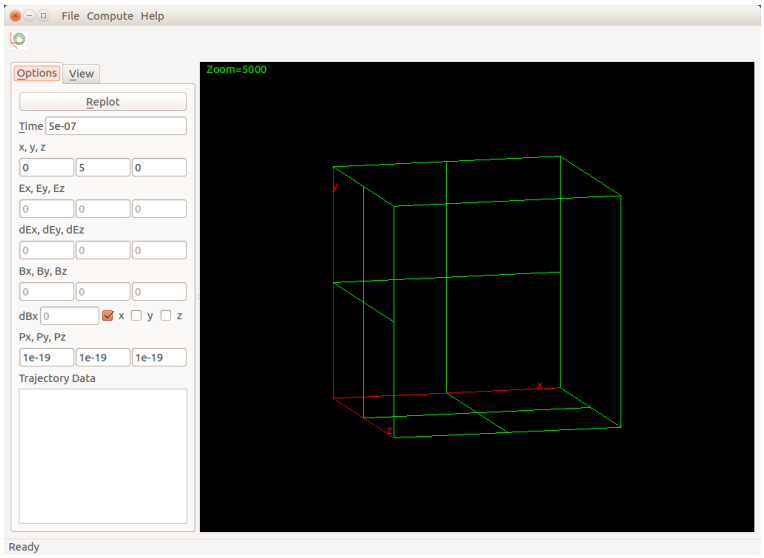
Trajecstory 0.4

User's Guide



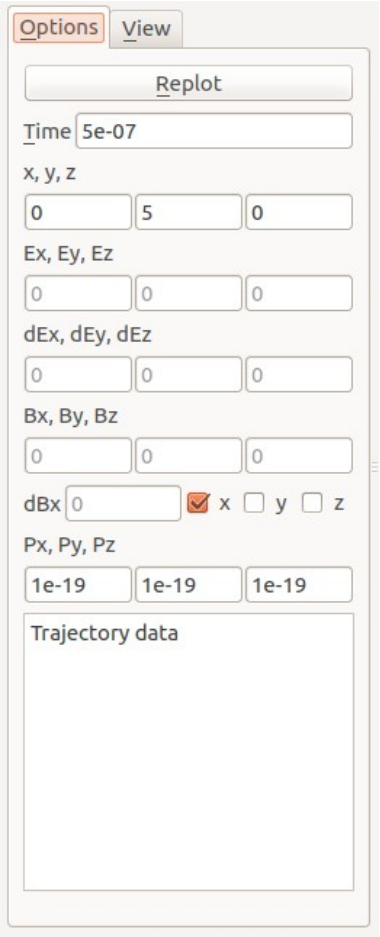
1. Introduction

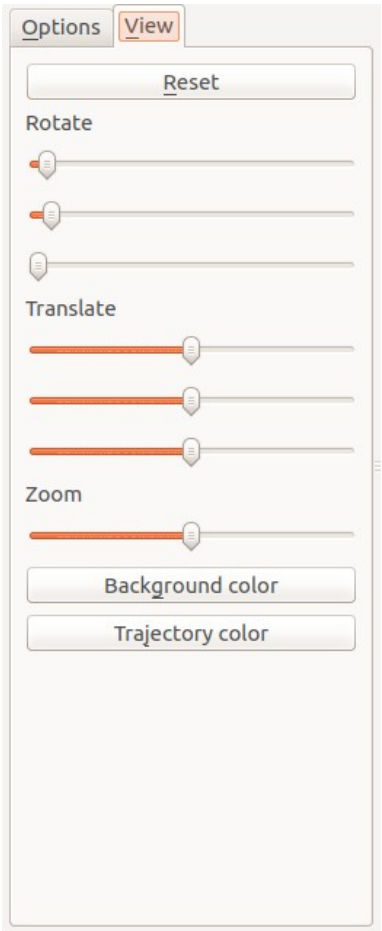
Trajecstory is a program that plots trajectories of a single electron in electric and magnetic fields. In this version the fields are kept constant.

For students of Physics, the utility of such a program is immediately obvious, and no further explanation is required. For others, it has no utility, and further explanation is pointless.

2. The User Interface

The program window, shown above, consists of two parts. On the right is a window where the trajectory is plotted. When the program starts it shows the three Cartesian axes in red, on which is superimposed the outline of a green cube of dimensions 10 cm to a side. The rear, left and bottom faces are bisected by green lines, in order to help visualize the relative depth and distances.
On the left are two tabs. The “Options” tab contains the provision to input the initial conditions of the electron and the magnitude of the field components. The “View” tab contains controls to vary the size and orientation of the image which is displayed on the right.
The units and the physical quantity required to be entered is displayed when the mouse cursor hovers above any control.
Above these is a toolbar which contains one icon labeled “Compute trajectories”. Above the toolbar is a menu bar.
Inside any control, pressing the tab-key moves the cursor to the next control in the sequence.





In the above, the electric field is in volts/cm, and the magnetic field is in Gauss.

E.xyz is the background electric field at the origin and everywhere else. The variation the electric field is specified by dE.xyz. This variation is also *per centimeter*. So, for example, if E.x = 25 volts/cm, and dE.x = 10, it indicates that the field increases by 10 volts/cm *every* cm, from the origin onwards. Thus it increases to 125 volts/cm at x = 10 cm, and correspondingly it has a negative value of -75 volts/cm at x = -10cm.

The values B.xyz specify the magnetic field in Gauss at the origin at everyelse. The variation of the magnetic field, however, is implemented *only for the x-component of B*. Further, B.x can vary only along *one* of the x, y, or z directions. This is specified via the check-boxes to the right of the dBx input box.
As in the case for dE.xyz, if dB.x is 10, it indicates that the field increase by 10 gauss *every* cm. Thus if B.x = 25 gauss at the origin x=0, and the variation is also along the x-axis, then it increases to 125 gauss at x=10. If the variation is along the y-axis, however, B.x increases from 25 gauss at y=0 to 125 gauss at y=10.

3. The Main Menu

3.1 File

This menu item is a place holder and contains only two sub-items. “Save” for saving the computed trajectory and , “Exit”, which is used to exit the program.

3.2 Compute

This item contains one sub-item which provides the same function as the “Replot” button on the “Options” tab.

3.3 Help

This item enables the display of this help file, the license under which the program is distributed and information about the Qt-toolkit used to build the user interface.

4. Key Bindings

Some of the user-interface items in the program have keys bound to them, so that the action that is produced by the clicking of the left mouse button can be performed via the keyboard. Some or all of the following can be used on the tabs.

Menus:
File menu:
Alt-f : Pops down the File menu
Alt-f-s : Saves the last computed trajectory in a text file with the name “default.dat.trajectory”.
Alt-f-x : File-Exit. Also Alt-F4 will do the same.

Compute menu:
Alt-c : Pops down the Compute menu.
Alt-c-t : Compute the electron trajectory

Help menu:
Alt-h: Pops down the help menu.
Alt-h-h : Displays this PDF helpfile, which should in the same directory as the executable.
Alt-h-a : Displays information about the author, copyright and the GPL license.
Alt-h-q : Displays information about the Qt toolkit.

Options tab:
Alt-v : Switch to the View tab
Alt-r : Replot the trajectory
Alt-t ; Move the cursor to the Time control
Alt-g : Open a color selection dialog to change the background color of the trajectory window.
Alt-j : Open a color selection dialog to change the color of the trajectory

View tab:
Alt-o : Switch to the Options tab.
Alt-r : Redraw the view to the default setting.

5. Storage and Data

If you wish you can save the most recently computed trajectory to a text file.The file is named “default.dat.trajectory” and resides in the current working directory.

This name cannot be changed, and any existing file with this name will be overwritten every time the program saves a fresh trajectory.

The first line contains thirteen (!) numbers, comprising the electric and magnetic field data in the following sequence:
E.x, E.y, E.z, dE.x, dE.y, dE.z, B.x, B.y, B.z, dB.x, Across-X, Across-Y, Across-Z

In the above, the electric field is in volts/cm, and the magnetic field is in Gauss.

E.xyz is the background electric field at the origin and everywhere else.

The last three numbers (Across-xyz) are either 0 or 1. Of the three, *two* will *always* be 0. The third may be either 0 or 1. The number which is equal to 1 indicates that the x-component of the magnetic field varies along that direction.

After the first line,subsequently, there are as many lines as there are points in the trajectory. Each line contains five numbers representing one point of the trajectory, starting from the first point which is at time=0. The numbers are as follows:

SerialNo of the point (integer, starting from 0)
Time (seconds, starting from 0)
x-coordinate (centimeters)
y-coordinate (centimeters)
z-coordinate (centimeters)

There are 20000 lines in the file, one for each data point.

6 Availability, Compilation and Installation

Trajecstory is available as source code to compile on your own machine, from the repository maintained on GitHub.

All the source files are available on Github under the following link:
https://github.com/letapk/trajecstory

The repository is public. Anyone can check out the branch onto her local machine. The current source tree compiles and runs using Qt version 5.15.3, under Kubuntu 22.04.

You will need the following:
Libraries and development files of the software toolkit from Qt (www.qt.io).

The development files and libraries of the GNU Scientific ibrary, GSL (www.gnu.org.).

The OpenGL libraries and development files.

All these are available from the depository of your Linux distribution, and can be installed using the package manager of your system. Download all the files in the repository in one subdirectory.

If you are using QtCreator, load the project file tr.pro. Select the version you want to build (debug version or release version) and hit Ctrl-B. If there are no problems, this should build the binary. The binary may be stored in a directory separate from the source subdirectory, depending on how QtCreator is configured. This location will be available within QtCreator.

If you are not using QtCreator, run the comand:
qmake tr.pro
This should create a Makefile for your system. Then, running:
make
should create a running binary.

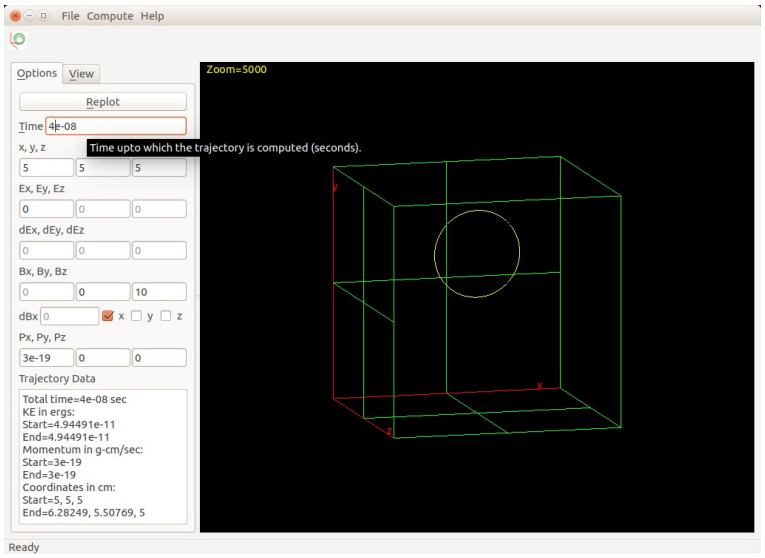
There is no particular requirement as regards installation. However, in order to see the license and help file from within the program, the files COPYING and **trhelp.pdf** should be in the same location from where the program is run.

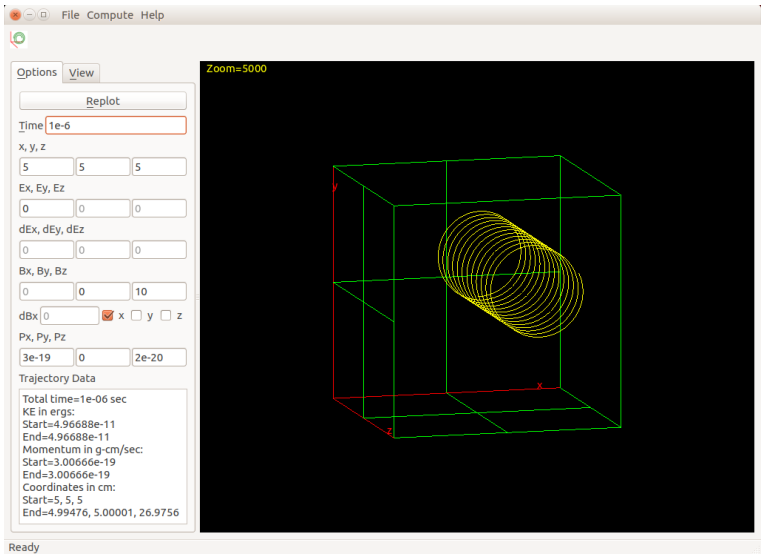
7. Units and Example Trajectories

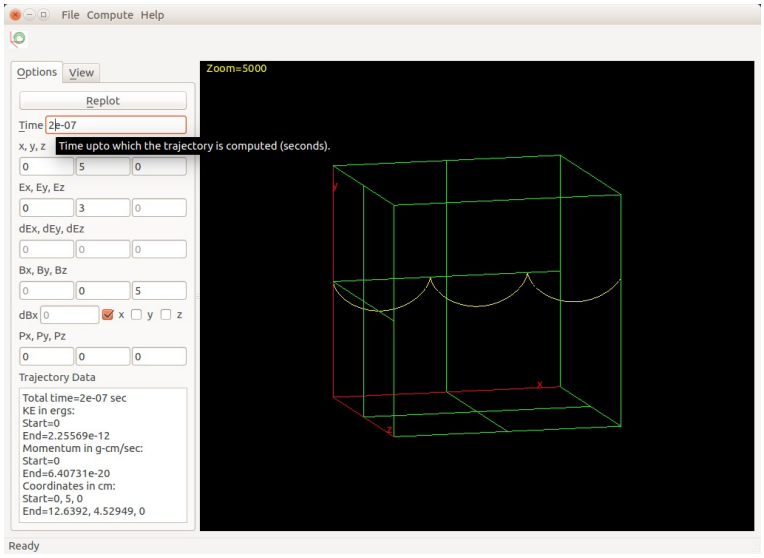
The program input uses *mixed* CGS units. The electric field is in *volts per centimeter*, the magnetic field is in *gauss*, the momentum is in *gram centimeter per second*, and position is in *centimeters*. As explained above the variation in the electric and magnetic fields is also *per centimeter*.

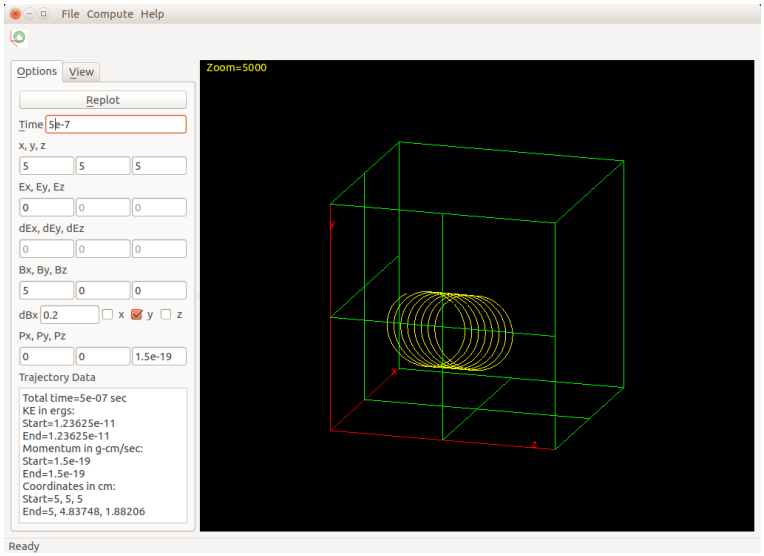
Here are some screenshots of the types of trajectories under different conditions. The picture contains the data used to generate the trajectory.

First the simple ones.

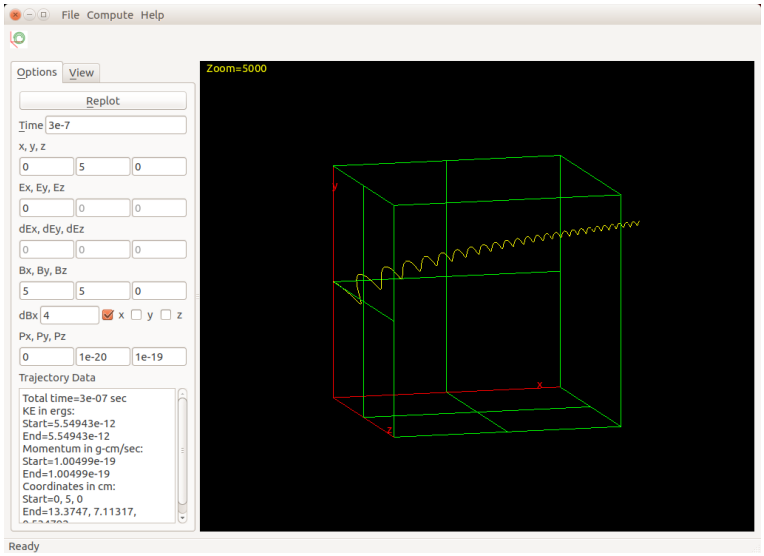


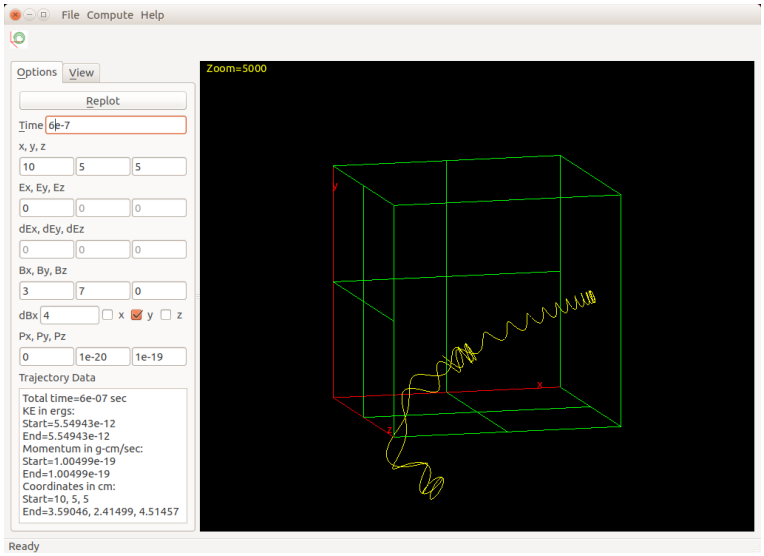


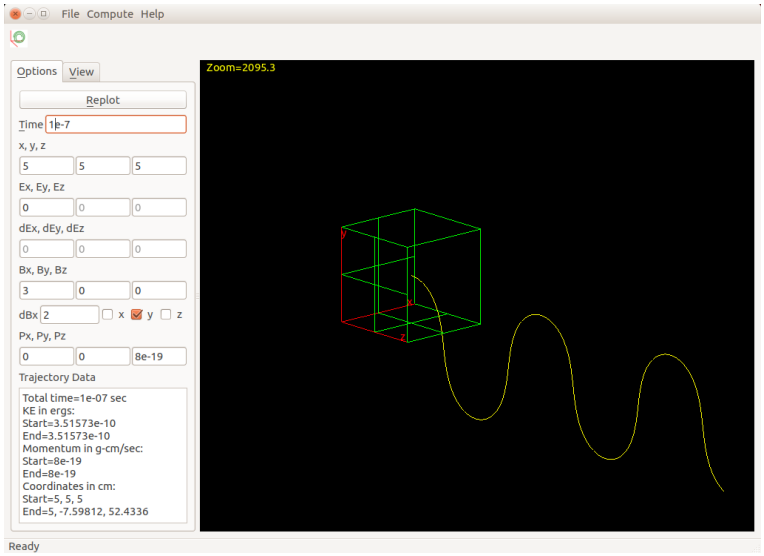


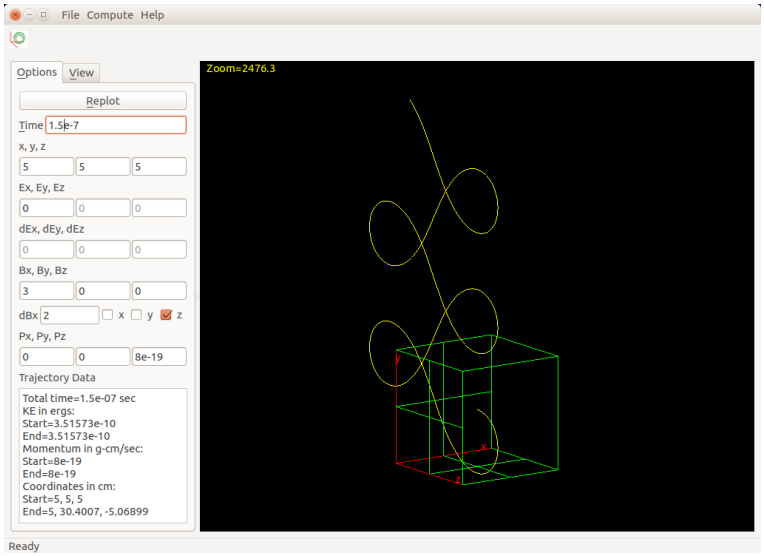


And then some complicated ones.









There are trajectories which are even more weird. Feel free to send me the craziest you can find.

8. License and copying policy

9. Contacting the author

Any feedback, bug reports, complaints, rants, abuses?
Please contact me at letapk@gmail.com
The latest version of this program will be available from: http://kpatel.x10host.com
That covers it, more or less. Email me if there is anything left out, or if you face any problems while compiling or installation.

Enjoy!