

Example2: Gaussain Distribution of Protons in a Magnetic Dipole Field

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1 Example2

In this example, a Gaussian distribution of 100 protons within millimeter is moving in the presence of a magnetic dipole of $0.2T$ in the y direction. The initial kinetic energy is $1MeV$ along the direction of motion (z direction). The scaled momentum in the direction of motion \hat{P}_z is a little randomized for different protons. Their \hat{P}_x and \hat{P}_y are also randomized and they are less than 1 % of \hat{P}_z . The used accuracy was 10^{-12} , and the binning was done with 3 bins of equal time widths. The total simulation time was $\hat{t} = 200s$.

1.1 Input

The particles initial positions were read from the file "gauss.dat". The masses, charges and initial momenta were set manually in the code. The other user inputs are:

NP: 100
ORDER: 20
ACCURACY: 10^{-12}
BINS: 3
TINITIAL: 10
TFINAL: 210
BINNINGTYPE: 1
B: 1

1.2 Results

The run took about $436.6s$ of CPU time, and 1555 time steps. Figure 1 shows that the motion of the protons in the presence of the magnetic dipole required high orders to achieve the required accuracy of 10^{-12} .

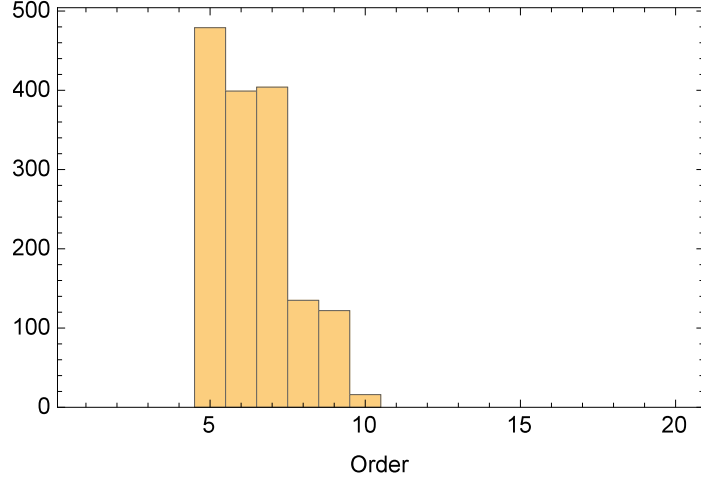


Figure 1: Maximum optimal order required by the protons in each time steps.

Histograms of the calculated optimal time *stepsizes* for all the protons at the time steps 500 and 1000 are shown in figure 2 and figure 3 respectively. Both figures show that the optimal time *stepsizes* are increasing in general as the particles move away from each other. A 3D motion is shown in the file "3d-eg2.gif".

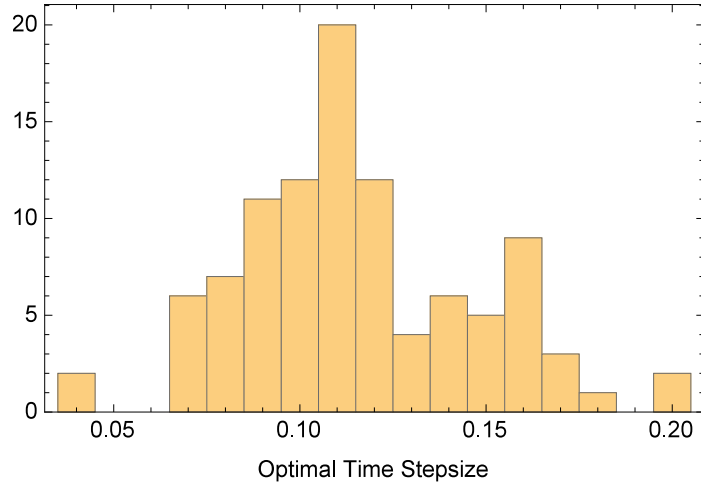


Figure 2: A histogram of the optimal time *stepsizes* of the protons at step 500.

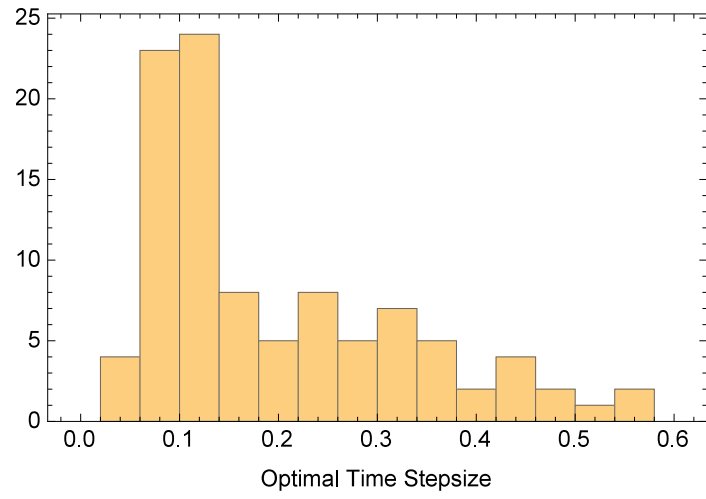


Figure 3: A histogram of the optimal time *stepsizes* of the protons at step 1000.