

## **Project: Monte Carlo**

Due May 9, 2025, 11:59 PM, by electronic upload

Write an ensemble Monte Carlo code for a time-resolved analysis of electron transport in bulk intrinsic GaAs. As before, assume parabolic bands, assume room temperature, and include acoustic, polar optical phonon, and intervalley scattering in your model. Assume that a uniform electric field is applied along the z-axis.

1) Plot a histogram of the initial energy distribution and the initial momentum along the z-axis. Assume all electrons start in the  $\Gamma$  valley.

2) Plot the time evolution of the average electron velocity along the field direction, average electron kinetic energy (for each valley as well as the ensemble as a whole), and the population of each valley for the uniform electric field of 0.5, 1, 2, 5, 8, and 10 kV/cm. For the electric field of 5 kV/cm, plot the evolution of the x and y components of the electron velocity as well.

3) Plot the steady-state results for the drift velocity, average electron energy, and the valley population versus the electric field. Vary the field from 0.1 to 10 kV/cm. Extract the value of the low-field mobility for GaAs, and compare with the value found in textbooks (give reference). In your steady state calculations, make sure that all transients have died out before extracting the steady state velocity (this will usually happen after ten or a few tens of picoseconds). In order to combat noise when extracting the steady-state quantities, average each quantity of interest over a few picoseconds once you are comfortably in the steady state.

Attached are the plots of the scattering rates in the  $\Gamma$ , L and X valleys that you may find useful to check whether your generated tables are accurate.

