

Colloquium Notice

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High-field properties of a semiconductor

A general introduction to elements of semiconductor physics is presented, including discussions of E-k diagrams as well as the four fundamental electron-phonon interactions. The quantum-generalized Boltzmann equation is reviewed and applied to high-field transport in a semiconductor. From this analysis a new kinetic equation for the electron distribution function is derived which includes terms corresponding to the four electron-phonon interactions. In the quasi-classical limit, it is found that the acoustic strain interaction dominates, which gives rise to a reduced kinetic equation. In the steady-state limit this equation yields a second-order nonlinear differential equation for the perturbation distribution. The exact solution of the related nonlinear equation represents a significant new result. The distribution function is a generalized Fermi-Dirac distribution which contains the electric field explicitly and is found to reduce to correct forms in various limits.** The analysis is then extended to Silicon, where 'equivalent' intervalley scattering comes into play. Drift velocity obtained from the approximate solution of resulting equations is found to agree with observed values for electric fields up to 105 V/cm. A criterion is described discerning between linear and nonlinear electric field effects. * This research includes results from four publications:

1. Phys. Rev. B34, 7063 (1986)
2. J. Appl. Phys. 62, 177 (1987)
3. J. Appl. Phys. 63, 5363 (1988)
4. Phys. Rev. B40, 5624 (1989)

** This 'SL Distribution,' appears in the 4th edition of B. Ridley's book, Quantum processes; in semiconductor.

Monday
November 14, 2005
Starts at 12:15 PM
Coffee at 12:00 PM
Physics Conference Room, SB B326