Transition Regime Models for Semiconductor Devices

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Abstract: Classical drift-diffusion models are inappropriate for simulating nanoscale devices where the carrier-phonon interactions are important, but are not sufficient to bring the carriers into local equilibrium. For such so-called transition regime devices one can resort to kinetic or particle-based simulations. These however are extremely expensive to run, and therefore unsuited for carrying out parametric design studies. One approach around this problem has been to introduce moment models, sometimes called "hydrodynamic" models. Another approach has been to use a Hilbert or Chapman-Enskog type expansion to systematically compute corrections to drift-diffusion models. For different reasons both of these approaches have problems. A new approach is presented based that offers a way to overcome most of these problems.