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An envelope function expansion of the Wigner transport equation

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The Wigner function approach to quantum transport is well suited for application to nanoscaled electronic devices. However, the Wigner-Liouville equation is often formulated within the framework of the effective mass approximation. As the envelope function formalism based on k.p theory offers a more accurate description of the band structure, we have expanded the electron field operators in the corresponding envelope functions and rederived the Wigner transport equation accordingly. We obtain a set of coupled envelope-Wigner functions which enable us also to treat band- to-band transitions (BTBT) within the Wigner formalism. This way, we can provide a rigorous quantum mechanical treatment of BTBT events in phase space. Finally, we have extended this approach to the classical Boltzmann transport equation which introduces BTBT by invoking additional coupling terms on top of the classical drift-diffusion instead of ad-hoc generation and recombination terms.

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