Title: Modeling Carrier Transport in Nanoscale Semiconductor Devices

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Abstract

Carrier transport in modern nanoelectronic devices involves physical scales which require quantum descriptions. Basic quantum mechanics describes systems determined by Hamiltonian state vectors |Ψ>, which provide the spatial and time dependences of the physical observables. A pure state density operator |Ψ><Ψ| - as obtained by a single state vector - contains the most complete information about the spatial correlations in the system. Mixed states are introduced as linear combinations of pure states with assigned probability distributions, reflecting the fact that the knowledge of the system is incomplete as a result of interactions with other systems. This is the case for carrier transport through open systems, such as nanodevices exchanging carriers through their contacts. The carrier system is maintained in a mixed state by a competition of quantum-coherent processes of interference and correlations with processes of decoherence caused by the environment (e.g. photon/phonon interaction). Modeling carrier transport in nanoscale semiconductor devices falls into this setting and relies on the methods developed for quantum statistical mechanics. We critically compare the peculiarities of two such methods: The non-equilibrium Green's function (NEGF) formalism and the Wigner function formalism. The NEGF formalism is the most used approach for stationary coherent descriptions of quantum transport. However, the Wigner function approach has the ability to describe decoherence-aware evolution processes. We see a clear advantage in combining both formalisms to describe carrier transport for modern nanoelectronic devices. Such a coupled approach accounts for the initial coherence and the correct handling of time-dependent quantum processes.

Biography

Siegfried Selberherr was born in Klosterneuburg, Austria, in 1955. He received the degree of *Diplomingenieur* in electrical engineering and the doctoral degree in technical sciences from the *TU Wien* in 1978 and 1981, respectively. Prof. Selberherr has been holding the *venia docendi* on Computer-Aided Design since 1984. From 1988 to 1999 he was the Head of the Institute for Microelectronics. He has been an IEEE Fellow and a Distinguished Lecturer of the IEEE Electron Devices Society since 1993 and 1996, respectively. From 1998 to 2005 he served as Dean of the Faculty of Electrical Engineering and Information Technology. In 2009, he received an ERC Advanced Grant. His current research topics are modeling and simulation of problems for microelectronics engineering.