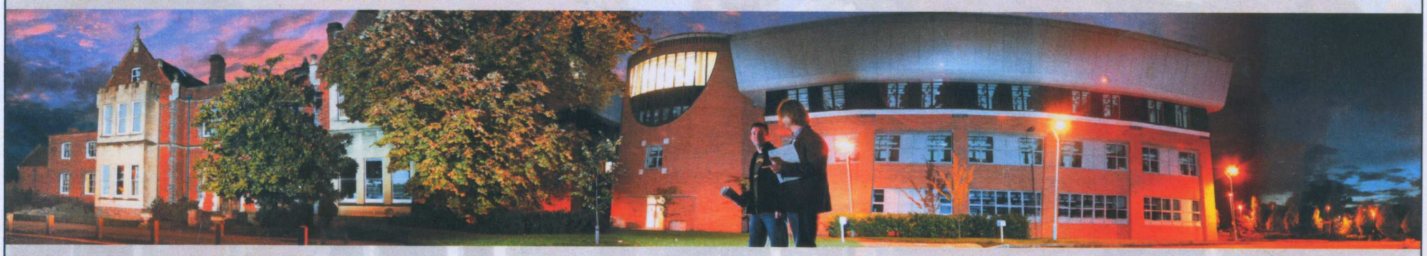
MCM2007



The Sixth International Association for Mathematics and Computers in Simulation Seminar on Monte Carlo Methods

The University of Reading

18th to 21st June 2007

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applications and are extensively used for financial computations. It may happen that a simple replacement of pseudo-random numbers by low discrepancy sequences is inefficient due to the correlation between the points, so additional techniques must be used.

In previous communications, we proposed QMC schemes to simulate Markov chains with discrete state spaces. The cases of one-dimensional [2] and multi-dimensional [1] state spaces were investigated. It was shown that, under some assumptions on the transition matrix, the method converges when the number N of simulated paths increases. We next applied the method to one-dimensional continuous state spaces [3,4].

In the present work, we extend the QMC algorithm to Markov chains with multidimensional continuous state spaces. Let $(X_n)_{n\geq 0}$ be a Markov chain and $E \subset \mathbb{R}^s$ its state space. We suppose that the chain is defined according to the stochastic recurrence:

$$X_n = \varphi_n(X_{n-1}, U_n), n \geq 1,$$

where the U_n are i.i.d. random vectors uniformly distributed over $[0,1)^d$. The steps of the algorithm are as follows: the initial distribution of the chain, i.e. the distribution of X_0, is discretized using N states. Then the method simulates N copies of the chain in parallel using a low-discrepancy sequence in dimension $s+d$ for the transitions. At each time step, the N copies are reordered according to their components. Under some assumptions on the mappings φ_n, we establish the convergence of the method when $N \to \infty$. In addition, the algorithm is validated in cases where analytical solutions are available and the results are compared with those given by a standard MC method. It is shown that the QMC algorithm outperforms the standard MC scheme.

References

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Electron-Phonon Interaction in Nanowires: A Monte Carlo Study of the Effect of the Field

A. Karaivanova [a], E. Atanassov [a], T. Gurov [a], M. Nedjalkov [b], D. Vasileska [c], and K. Raleva [d]

[a] Institut for Parallel Processing, Bulgarian Academy of Sciences
[b] Institute of Microelectronics, TU-Vienna
[c] Dept. of Electrical Engineering, Arizona State University
[d] Faculty of Electrical Engineering, Uni. of Skopje

The early time dynamics of highly non-equilibrium, confined carriers is analyzed within a Monte Carlo approach. The physical process considered corresponds to a locally excited or injected into a semiconductor nanowire distribution of heated carriers, which evolve under the action of an applied electric field. The carriers are cooled down by dissipation processes caused by phonons. Two main classical transport concepts: the assumptions for temporal and spatial locality of the carrier-phonon interaction cease to be adequate on the femtosecond evolution scale. Recently a model equation of the carrier evolution in a nanowire has been derived to account for the quantum character of the interaction. A number of quantum effects have been observed already in the field-less case. Here we investigate the effect of the field on the electron-phonon interaction - the intra-collisional field effect (ICFE). A Monte Carlo method for numerical simulation of the equation has been developed. As a rule quantum Monte Carlo simulators pose enormous computational demands due to the rapidly growing with the evolution time variance of the stochastic process. By applying variance reduction techniques we decrease the computational time to acceptable levels. The approach is described in details and error analysis is performed. Novel numerical results, achieved using Grid computing paradigm, will be presented. Simulation results for carrier evolution in a GaAs nanowire are obtained and analyzed for phenomena related to the ICFE.