Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Scaling behavior of stochastically varying current switching times in semiconductor superlattices[1] HUIDONG XU, SCOTT SCHMIDLER, STEPHEN TEITSWORTH, Duke University — The stochastic switching process from a metastable state of electronic transport in a semiconductor superlattice with N periods ($N \gg 1$) is simulated using a discrete drift-diffusion model that also includes shot noise in the tunneling currents. Sequential resonant tunneling between quantum wells is the primary conduction mechanism and noise terms are treated as delta-correlated in space and time. This is a high-dimensional, non-gradient system; furthermore, the metastable state possesses stability eigenvalues with non-zero imaginary part. The distribution of metastable lifetimes is studied as a function of bias voltage V, in a regime for which the current-voltage characteristics exhibit bistability. The mean lifetime τ is fitted to an expression of the form $\ln \tau \propto |V - V_{th}|^{\alpha}$, where V_{th} denotes the voltage for which the metastable state disappears in a saddle-node bifurcation. We find that the exponent α is sensitive to the initial state preparation. Starting from the exact metastable state, the exponent is $\alpha = 1.67 \pm 0.06$. In contrast, a pulsed initial condition, of the type that is readily achievable in experimental measurements, yields larger α values. In both cases, the determined α values exceed 3/2, which is the exponent value for a typical one-dimensional system.

[1]Supported by NSF grant DMR-0804232.

Huidong Xu
Duke University

Date submitted: 27 Nov 2009

Electronic form version 1.4