Measured first-passage-time distributions for a high-dimensional system: noise-induced current switching in semiconductor superlattices

YURIY BOMZE, Duke University, HOLGER T. GRAHN, RUDOLF HEY, Paul-Drude-Institute, Berlin, Germany, STEPHEN W. TEITSWORTH, Duke University — We report the experimental measurement of first-passage-time distributions associated with current switching in weakly-coupled GaAs/AlAs superlattices, in a regime of nonlinear electronic transport where the static current-voltage ($I - V$) curves exhibit multiple branches and bistability. Precision, high bandwidth current switching data are collected in response to sequential steps in applied voltage to a final voltage $V_f$ near to the voltage $V_{th}$ corresponding to the end of a particular branch. For initial state preparation, a double step procedure is used to insure that the system is close to the true metastable state. For a range of $V_f$ values, switching times reveal large stochastic fluctuations driven by internal shot noise. For smaller times ($< 3 \mu s$), the switching time distributions show exponential tails, as expected for activated escape from an initial metastable state. However, at larger times ($> 10 \mu s$), the distributions exhibit power law tails (with exponent ranging from -2 to -1, and dependent on $|V_f - V_{th}|$). Possible sources for the power law decay include collective effects and the presence of multiple escape trajectories.

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