Abstract Submitted
for the SES08 Meeting of
The American Physical Society

Bifurcations and Averaging in a Series Array of Tunnel Diodes

KEVIN J. BROWN, HUIDONG XU, STEPHEN W. TEITSWORTH, Duke University — We investigate nonlinear electrical conduction properties of a series array of tunnel diodes using both numerical simulation and experimental measurement. Tunnel diodes are negative differential resistance (NDR) circuit elements and, in a series configuration, they provide a useful model system for nonlinear transport in more complex electronic structures such as semiconductor superlattices [1]. Measurements reveal high-frequency (of order 1 GHz), small-amplitude oscillations in the current when the diodes are voltage-biased in the NDR region. For a system of N diodes, these fast oscillations are associated with Hopf bifurcations in a $3N$-dimensional nonlinear circuit model that includes intrinsic reactances for each diode. A nonlinear averaging method is applied to the full model, allowing the elimination of fast time scale behavior, and results in a reduced dynamical system of dimension N. Simulations of the reduced model are found to accurately describe the experimental circuit behavior on time scales that are much greater than the oscillatory time scale. [1] H. Xu and S. W. Teitsworth, Phys. Rev. B **76**, 235302 (2007).

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Date submitted: 11 Aug 2008 Electronic form version 1.4