

University of Rochester
Department of Electrical and Computer Engineering Colloquia
Series

Driving Electrons Hard: Nanoscale Devices Under Strong Nonequilibrium

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12:00PM – 1:00PM
1400 Wegmans Hall

Abstract: The development of sophisticated techniques for the fabrication of nanoscale semiconductor devices has opened up the possibility of exploring a new and exciting world of "high-energy physics on a tabletop". With a voltage of just 1 volt applied across the 100-nm long channel of a semiconductor device, for example, the resulting electric field strength reaches 10 MV/m, close to the breakdown field in the semiconductor. In recent years we have been exploring the novel physics that can emerge when semiconductor nanodevices are operated close to this limit, allowing us to observe new transport phenomena not normally associated with systems nearer to equilibrium. In order to perform these experiments we are forced to implement new experimental approaches, including schemes in which we "watch" the nonequilibrium dynamics of hot electrons over time through an approach of rapid (nanosecond-duration) electrical pulsing. Our experiments are performed on a variety of different nanostructured systems, fabricated in both conventional semiconductor systems, and in atomically-flat semiconductors such as graphene. I will review our recent studies of these systems in my presentation.

References:

S. Xiao, Y. Yoon, Y.-H. Lee, J. P. Bird, Y. Ochiai, N. Aoki, J. L. Reno, and J. Fransson, "Detecting weak coupling in mesoscopic systems with a nonequilibrium Fano resonance", *Phys. Rev. B* 93, 165435 (2016).

H. Ramamoorthy, R. Somphonsane, J. Radice, G. He, C.-P. Kwan, and J. P. Bird, "Freeing" graphene from its substrate: Observing intrinsic velocity saturation with rapid electrical pulsing", *Nano Lett.* 16, 399 – 403 (2016).

J. Lee, J. E. Han, S. Xiao, J. Song., J. L. Reno, and J. P. Bird, "Formation of a protected sub-band for conduction in quantum point contacts under extreme biasing", *Nature Nanotechnology* 9, 101 (2014).

Bio: Jonathan Bird joined the faculty of the UB Department of Electrical Engineering as Professor in Fall 2004, and has been department Chair since 2017. Prior to this, he obtained his B.Sc. (First-Class Honors) and Ph.D. degrees in Physics from the University of Sussex (United Kingdom), in 1986 and 1990, respectively. He was a JSPS visiting fellow at the University of Tsukuba (Japan) from 1991 - 1992, after which he joined the Frontier Research Program of the Institute of Physical and Chemical Research (RIKEN, also in Japan). In 1997, he was appointed as Associate Professor in the Department of Electrical Engineering at Arizona State University, where he spent seven years before joining UB. Prof. Bird's research is in the area of nanoelectronics. He is the co-author of more than 300 peer reviewed publications as well as of undergraduate and graduate textbooks.

Pizza and soda provided