Curriculum Vitae of Jérôme Bürki

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Education

1991 - 1996	Undergraduate studies in Physics at the Swiss Federal Institute of Technology (EPFL), in Lausanne, Switzerland
March 1996	Degree in Physics (Diplôme d'Ingénieur Physicien EPF) "Fractional Statistics in a One-Dimensional Quantum Model"
July 1996 - March 2000	Ph.D. student, IRRMA and University of Fribourg
December 1999	Ph.D., University of Fribourg, Switzerland "Transport and cohesive properties of metallic nanocontacts: A free-electron model"

Postdoctoral Positions

04/2000 - 06/2000	Visiting scholar, University of Arizona, Tucson, AZ
09/2000 - 08/2001	Postdoctoral Fellow, Harvard University
08/2001 - 08/2002	Visiting Research Scientist, University of Arizona, Tucson, AZ
09/2002 - 12/2003	Postdoc at the Albert-Ludwigs-University, Freiburg, Germany
01/2004 - present	Research associate, University of Arizona, Tucson AZ

Awards & Fellowships

2000	ABB prize of the Swiss Physical Society for my contribution to research on "Cohesion and conductance of disordered metallic contacts"
2001-2002	Postdoctoral fellowship from the Swiss National Science Foundation

Graduate and Postdoctoral Advisors

Ph.D. Thesis advisors:	Dionys Baeriswyl, University of Fribourg, Switzerland; Xenophon Zotos, University of Crete, Crete.
Postdoctoral sponsors:	Charles Stafford, University of Arizona, Tucson, AZ; Bert Halperin, Harvard University, Cambridge, MA; Hermann Grabert, Albert-Ludwigs-University, Freiburg, Germany.

Professional Qualifications

- Languages: French (first language), English, German;
- Programming and scripting languages: Fortran 90, F, Perl, PHP, javascript, HTML, UNIX shell scripts
- Experience with database access using MySQL;
- GUI design, for example using Tcl/Tk and Perl, or HTML and PHP, ...;
- Basic knowledge of OO programming concepts;
- Good knowledge of Linux (installed and managed SuSE distribution on personal computer);
- Good working knowledge of Microsoft Windows;
- Experience with various numerical methods: Solution of ordinary and partial differential equations, Monte Carlo methods, Recursive Green Function method, ...
- Creation of complex figures (see publications and web site) using various programs: Xmgrace, gnuplot, Mathematica, PGPLOT (Fortran library), ...
- Creation of MPEG animations from a sequence of figures.

Publications

Refereed Journal Articles

1. "*Jellium Model of Metallic Nanocohesion.*"
C. A. Stafford, D. Baeriswyl, and J. Bürki, Phys. Rev. Lett. **79**, 2863 (1997).

2. "*Cohesion and Conductance of Disordered Metallic Point Contacts.*"
J. Bürki, C. A. Stafford, X. Zotos and D. Baeriswyl, Phys. Rev. B **60**, 5000 (1999); see also erratum in Phys. Rev. B **62**, 2956 (2000).

3. "*Comment on 'Quantum Suppression of Shot Noise in Atom-Size Metallic Contacts'.*"
J. Bürki and C. A. Stafford, Phys. Rev. Lett. **83**, 3342 (1999).

4. "*Universality in Metallic Nanocohesion: A Quantum Chaos Approach.*"
C. A. Stafford, F. Kassubek, J. Bürki, and H. Grabert, Phys. Rev. Lett. **83**, 4836 (1999).

5. "*Comment on 'Density Functional Simulation of a Breaking Nanowire'.*"
C. A. Stafford, J. Bürki, and D. Baeriswyl, Phys. Rev. Lett. **84**, 2548 (2000).

6. "*Quantum Necking in Stressed Metallic Nanowires.*"
J. Bürki, Raymond E. Goldstein, C. A. Stafford, Phys. Rev. Lett. **91**, 254501 (2003).

7. "*Jahn-Teller Distortions and the Supershell Effect in Metal Nanowires.*"
D. F. Urban, J. Bürki, C.-H. Zhang, C. A. Stafford, and H. Grabert, Phys. Rev. Lett. **93**, 186403 (2004).

8. "*Electronic Shell Effects and the Stability of Alkali Nanowires.*"
D. F. Urban, J. Bürki, A. I. Yanson, I. K. Yanson, C. A. Stafford, J. M. van Ruitenbeek and H. Grabert, Solid State Communications **131**, 609 (2004).

9. "*Stability of Metal Nanowires at Ultrahigh Current Densities.*"
C.-H. Zhang, J. Bürki, C. A. Stafford, Phys. Rev. B **71**, 235404 (2005).

10. "*Theory of Metastability in Simple Metal Nanowires.*"
J. Bürki, C. A. Stafford, D. L. Stein, Phys. Rev. Lett. **95**, 090601 (2005).

11. "*On the Stability and Structural Dynamics of Metal Nanowires.*"
J. Bürki, C. A. Stafford, Appl. Phys. A **81**, 1519 (2005).

12. "*Comment on 'Nonlinear current-voltage curves of gold quantum point contacts' [Appl.*

Phys. Lett. 87, 103104 (2005)]."
J. Bürki, C. A. Stafford, D. L. Stein, Appl. Phys. Lett. **88**, 166101 (2006).

13. "*Stability and Symmetry Breaking in Metal Nanowires.*"
D. F. Urban, J. Bürki, C. A. Stafford, Hermann Grabert, Phys. Rev. B **74**, 245414 (2006).

14. "*Discrete thinning dynamics in a continuum model of metallic nanowires.*"
J. Bürki, Phys. Rev. B **75**, 205435 (2007).

15. "*Electronic and atomic shell structure in aluminum nanowires.*"
A. I. Mares, D. F. Urban, J. Bürki, H. Grabert, C. A. Stafford, and J. M. van Ruitenbeek, Nanotechnology **18**, 265403 (2007).

16. "*Front propagation into unstable metal nanowires.*"
J. Bürki, Phys. Rev. E **76**, 026317 (2007).

Conference Proceedings

17. "*Cohesion, Conductance, and Charging Effects in a Metallic Nanocontact.*"
C. A. Stafford, F. Kassubek, J. Bürki, H. Grabert, and D. Baeriswyl, in *Quantum Physics at the Mesoscopic Scale*, edited by D. C. Glattli and M. Sanquer (EDP Sciences, Les Ulis, France, 2000), pp. 49-53, and cond-mat/0210533.

18. "*Statistics of quantum transport in metal nanowires with surface disorder.*"
J. Bürki and C. A. Stafford in *Electronic Correlations: from meso- to nano-physics*, edited by T. Martin, G. Montambaux, and J. Tran Thanh Van (EDP Sciences, Les Ulis, France, 2001), pp. 27-30, and cond-mat/0106244.

19. "*Fluctuational Instabilities of Alkali and Noble Metal Nanowires.*"
J. Bürki, C. A. Stafford, and D. L. Stein, in *Noise in Complex Systems and Stochastic Dynamics II*, edited by Z. Gingl et al. (SPIE Proceedings, 2004), vol. 5471, pp. 367-379, and cond-mat/0406374.

20. "*Nonlinear Dynamics of Metallic Nanofabrication.*"
J. Bürki, in "Modeling and Simulating Materials Nanoworld", Edited by P. Vincenzini and F. Zerbetto (Advances in Science and Technology, Vol. 44, Techna Group Srl, Faenza, Italy, 2004), pp. 185-192, and cond-mat/0406349.

List of References

Prof. Dionys Baeriswyl

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Research interests

The focus of my research is the influence and importance of quantum-size effects on various properties of nanoscopic metallic systems, and in particular of metallic nanowires. The confinement of conduction electrons in one or more spatial dimensions induces a quantization of the electronic degrees of freedom that influences not only transport properties, notably through conductance quantization, but also cohesive properties, and thus the system stability, structural dynamics, etc.

My first interest is to get a general understanding of quantum-size effects on various properties, rather than a detailled description of any particular system. With that in mind, I use the nanoscale free-electron model [1, 6, 11], which treats the electron motion exactly, thus capturing the quantum-size effects, while the atomic structure, which is taken to behave classically, is replaced by a continuum (Jellium model). This model includes the essential physics while being simple enough to allow for the study of a wide range of phenomena in systems of sizes ranging from just a few to several thousand atoms over long timescales; it is thus complementary to more detailed models, such as ab initio methods, which are limited to small systems and short timescales, of the order of a fraction of a nanosecond, while experimental timescales of interesting collective phenomena [21] can be of the order of a second or longer.

The simplicity of the model allows studies of many properties of metal nanowires, using both analytical and numerical methods, often with quantitative, or at least qualitative agreement with available experiments:

- The perfect correlation between conductance jumps and tensile force oscillations [22] is understood as coming from the elongation and breaking of extended metallic bonds formed by the conduction channels [1];

- Numerical studies of disordered nanowires [2, 3], using recursive Green function techniques, show that the observed broadening and shift of peaks in conductance histogram [23], as well as a suppression of shot-noise for wires with quantized conductances [24], are due to backscattering by impurities and/or surface roughness;

- Classically, metal nanowires are expected the undergo a Rayleigh instability due to their large surface to volume ratio. Quantum-size effects are shown to stabilize cylinders of certain "magic radii" [11], as well as a number of non-axisymmetric wires [7, 8]. The sequence of most (meta)stable wires predicted by the model is in agreement with a periodic series of peaks observed in conductance histograms for various metals [25, 26];

- Using a stochastic classical field theory derived from the nanoscale free-electron model, lifetimes of stables nano-cylinders have been predicted. The escape barrier for the most stable wires has been shown to be universal, while the escape process is found to undergo a transition from uniform to instanton-like as a function of wire length [10, 19];

- Structural dynamics through surface self-diffusion, influenced by shell effects, is found to lead naturally to the formation of long cylinders [6, 20] observed via transmission electron microscopy [27]. A discrete wire thinning dynamics is found to be similar to observations for gold wires [21], and involves a rich kink dynamics [14, 16].

Recently, we have been working on putting the atoms back in the model while keeping track of the electronic shell effects. Simulated annealing simulations lead to interesting atomic shell structures similar to those of carbon nanotubes.

Experimental papers

21. "*High-resolution ultrahigh-vacuum electron microscopy of helical gold nanowires: junction and thinning process.*"
Y. Oshima, Y. Kondo, and K. Takayanagi, J. Electron Microsc. **52**, 49 (2003).

22. "*Atomic-sized metallic contacts: mechanical properties and electronic transport.*"
G. Rubio, N. Agraït, and S. Vieira, Physical Review Letters **76**, 2302 (1996).

23. "*Conductance quantization at room temperature in magnetic and nonmagnetic metallic nanowires.*"
J. L. Costa-Krämer, Physical Review B **55**, R4875 (1997).

24. "*Quantum suppression of shot noise in atom-size metallic contacts.*"
H. E. van den Brom, and J. M. van Ruitenbeek, Physical Review Letters **82**, 1526 (1999).

25. "*Observation of shell structure in sodium nanowires.*"
A. I. Yanson, I. K. Yanson, and J. M. van Ruitenbeek, Nature **400**, 144 (1999).

26. "*Observation of electronic and atomic shell effects in gold nanowires.*"
A. I. Mares *et al.*, Physical Review B **70**, 073401 (2004).

27. "*Synthesis and characterization of helical multi-shell gold nanowires.*"
Y. Kondo, and K. Takayanagi, Science **289**, 606 (2000).