

# Christoph Börgers

October 2010

## Employment

**1994–present** *Tufts University* (Professor of Mathematics since 1997, Chair of Mathematics 2001–2004, Adjunct Professor of Biomedical Engineering since 2004, Adjunct Professor of Computer Science since 2006)

**1987–1996** Department of Mathematics, *University of Michigan* (Assistant Professor 1987–1991, Associate Professor 1991–1996, on leave fall 1989 and 1994–1996)

**May–December 1989** Department of Mathematical Sciences, *IBM T. J. Watson Research Center*, Visiting Scientist

**1985–1987** Lawrence Berkeley Laboratory and Department of Mathematics, *University of California at Berkeley*, Postdoctoral Researcher (Advisor: Alexandre Chorin) and Visiting Lecturer

## Education

**1982–1985** *Courant Institute of Mathematical Sciences*, New York University, Ph. D. in Mathematics 1985 (Advisor: Charles S. Peskin)

**1976–1982** *University of Bonn* (Germany), Diplom in Mathematics 1982 (Advisor: Ulrich Trottenberg)

## Publications

### Refereed articles:

- 1) C. Börgers and S. MacLachlan, An angular multigrid method for computing mono-energetic particle beams in Flatland, *Journal of Computational Physics* 229, Issue 8, 2914—2931 (2010)
- 2) E. Munro and C. Börgers, Mechanisms of very fast oscillations in networks of axons coupled by gap junctions, *Journal of Computational Neuroscience* 28, No. 3, 539—555 (2010)
- 3) C. Börgers, M. Krupa, and S. Gielen, The response of a population of classical

Hodgkin-Huxley neurons to an inhibitory input pulse, *Journal of Computational Neuroscience* 28, No. 3, 509—526 (2010)

- 4) C. Börgers, S. Epstein, and N. Kopell, Gamma oscillations mediate stimulus competition and attentional selection in a cortical network model, *Proceedings of the National Academy of Sciences, USA* 105, No. 46, 18023-18028 (2008)
- 5) C. Börgers and N. Kopell, Gamma oscillations and stimulus selection, *Neural Computation* 20, 383–414 (2008)
- 6) E. Munro and C. Börgers, The axonal plexus: a description of the behavior of a network of neurons connected by gap junctions, Abstract, *BMC Neuroscience* 8 (Suppl. 2), 47 (2007)
- 7) C. Börgers, S. Epstein, and N. Kopell, Background gamma rhythmicity and attention in cortical local circuits: A computational study, *Proceedings of the National Academy of Sciences, USA* 102, No. 19, 7002–7007 (2005)
- 8) C. Börgers and N. Kopell, Effects of noise on rhythms in networks of excitatory and inhibitory neurons, *Neural Computation* 17, 557-608 (2005)
- 9) C. Börgers and N. Kopell, Synchronization in networks of excitatory and inhibitory neurons with sparse, random connectivity, *Neural Computation* 15, vol. 3, 509–539 (2003)
- 10) C. Börgers and E. T. Quinto, On the non-uniqueness of optimal radiation treatment plans, *Inverse Problems* 15, 1115–1138 (1999)
- 11) C. Börgers, Complexity of Monte Carlo and deterministic dose-calculation methods, *Phys. Med. Biol.* 43, 517–528 (1998).
- 12) C. Börgers, A fast iterative method for computing particle beams penetrating matter, *J. Comp. Phys.* 133, 323–339 (1997).
- 13) C. Börgers and E. W. Larsen, On the accuracy of the Fokker-Planck and Fermi pencil beam equations for charged particle transport, *Med. Phys.* 23, No. 10, 1–11 (1996)
- 14) C. Börgers and E. W. Larsen, Asymptotic derivation of the Fermi pencil beam equation, *Nucl. Sci. Eng.* 123, No. 3, 343–358 (1996)
- 15) C. Börgers and E. W. Larsen, The transversely integrated scalar flux of a narrowly focused particle beam, *SIAM J. Appl. Math* 55, 1–22 (1995)
- 16) C. Börgers and E. W. Larsen, The Fermi pencil beam approximation, in *Proceedings of International Conference on Mathematics and Computations, Reactor Physics, and Environmental Analysis*, Portland, Oregon, April 30 - May 4, 1995
- 17) C. Börgers and E. W. Larsen, Fokker-Planck approximation of monoenergetic transport processes, *Trans. Am. Nucl. Soc.* 71, 235–236 (1994)
- 18) C. Börgers and E. Thomann, Free molecular flow in thin domains, in

- “Proceedings of the Eighteenth International Symposium on Rarefied Gas Dynamics”, *Progress in Astronautics and Aeronautics* 160, 523–531 (1994)
- 19) C. Börgers, C. Greengard, and E. Thomann, The diffusion limit of free molecular flow in thin plane channels, *SIAM J. Appl. Math.* 52, No. 4, 1057–1075 (1992)
  - 20) C. Börgers, E. W. Larsen, and M. L. Adams, The asymptotic diffusion limit of a linear discontinuous discretization of a two-dimensional linear transport equation, *J. Comp. Phys.* 98, No. 2, 285–300 (1992)
  - 21) C. Börgers, Generalized Delaunay triangulations of non-convex domains, *Computers Math. Appl.* 20, No. 7, 45–49 (1990)
  - 22) C. Börgers, Domain imbedding methods for the Stokes equations, *Numer. Math.* 57, 435–451 (1990)
  - 23) C. Börgers, A triangulation algorithm for fast elliptic solvers based on domain imbedding, *SIAM J. Numer. Anal.* 27, No. 5, 1187–1196 (1990)
  - 24) C. Börgers and O. B. Widlund, On finite element domain imbedding methods, *SIAM J. Numer. Anal.* 27, No. 4, 963–978 (1990)
  - 25) C. Börgers, On the numerical solution of the regularized Birkhoff equations, *Math. Comp.* 53, No. 187, 141–156 (1989)
  - 26) C. Börgers, The Neumann-Dirichlet domain decomposition method with inexact solvers on the subdomains, *Numer. Math.* 55, 123–136 (1989)
  - 27) C. Börgers and O. B. Widlund, A domain decomposition Laplace solver for internal combustion engine modeling, *SIAM J. Sci. Stat. Comp.* 10, No. 2, 211–226 (1989)
  - 28) C. Börgers and C. S. Peskin, A Lagrangian fractional step method for the incompressible Navier-Stokes equations on a periodic domain, *J. Comp. Phys.* 70, No. 2, 397–438 (1987)
  - 29) C. Börgers and C. S. Peskin, A Lagrangian method based on the Voronoi diagram for the incompressible Navier-Stokes equations on a periodic domain, in “The Free Lagrange Method”, *Lecture Notes in Physics* 238, M. J. Fritts, W. P. Crowley, and H. Trease (eds.), 87–113, Springer-Verlag (1985)

Book chapters:

- 1) N. Kopell, C. Börgers, D. Pervouchine, P. Malerba, and A. B. L. Tort, Gamma and theta rhythms in biophysical models of hippocampal circuits, to appear in “Hippocampal Microcircuits: A Computational Modeler’s Resource Book” (V. Cutsuridis, B. Graham, S. Cobb, and I. Vida, eds.), Springer-Verlag (2010).
- 2) C. Börgers, The radiation therapy planning problem, in “Computational Radiology and Imaging: Therapy and Diagnostics”, *IMA Volumes in Mathematics and its Applications* 110, C. Börgers and F. Natterer (eds.), 1–15 (1999)

Book authored:

C. Börgers, “Mathematics of Social Choice: Voting, Compensation, and Division”, *Society for Industrial and Applied Mathematics (SIAM)*, 2009.

Book edited:

C. Börgers and F. Natterer (eds.), “Computational Radiology and Imaging: Therapy and Diagnostics”, *IMA Volumes in Mathematics and its Applications* **110**, Springer-Verlag (1999)

**Lectures and posters at conferences and seminars since 2005**

Dynamical properties of gamma-frequency cell assemblies in the hippocampus probed with optical neural control and computational modeling, iposter at CRCNS Program Principal Investigators’ Meeting, Johns Hopkins University, June 2010 (with G. Franzesi, A. Tort, X. Qian, M. Li, X. Han, N. Kopell, F. Lebeau, M. Whittington, and E. Boyden)

Deterministic radiation dose calculations, *Radiation Physics Seminar, Massachusetts General Hospital*, Boston, May 2010 (invited talk)

Brain rhythms and mathematics, *Tufts University, April Open House*, April 2010

Brain rhythms and mathematics, *Tufts University, CSEMS (Computer Science, Engineering, and Mathematics Scholars) program for minority and first generation college students*, March 2010

Dynamical properties of gamma-frequency cell assemblies in the hippocampus probed with optical neural control and computational modeling, contributed poster at meeting of Society for Neuroscience, October 2009 (with G. Franzesi, X. Qian, M. Li, X. Han, N. Kopell, F. Lebeau, M. Whittington, and E. Boyden)

An angular multigrid method for monoenergetic particle transport with

anisotropic scattering in Flatland, *Workshop on Multigrid Methods for Transport Problems*, Boulder, Colorado, October 2009 (invited talk)

Modeling possible roles of gamma oscillations in attention, *Gabriel Kreiman's Lab Meeting, Harvard Medical School, Boston*, September 2009 (invited talk)

Synchronization of type II neurons by inhibitory pulses, *Workshop on Brain Waves, Lorenz Center, University of Leiden, Netherlands*, June 2009 (invited talk)

The response of a classical Hodgkin-Huxley neuron to a pulse of inhibition, *Sixth Annual Conference on Frontiers in Applied and Computational Mathematics, NJIT*, June 2009 (invited talk in a minisymposium)

Protection of Neuronal Signaling Against Distractors Through Gamma-Frequency Coherence, *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah*, May 2009 (invited talk in a minisymposium)

The response of a classical Hodgkin-Huxley neuron to a pulse of inhibition, *Computational Neuroscience Seminar, Center for Biodynamics, Boston University*, April 2009

Brain rhythms and mathematics, *Tufts University, April Open House*, April 2009

Probing mechanisms of gamma rhythmogenesis with cell type-specific optical neural control, contributed poster at COSYNE meeting, April 2009 (with G. T. Franzesi, X. Qian, M. Li, X. Han, N. Kopell, F. LeBeau, M. Whittington, and E. Boyden)

Stimulus competition via transition from synchrony to asynchrony, *SIAM Meeting on Life Sciences, Montreal*, August 2008 (invited talk in a minisymposium)

Cortical rhythms, *Institute for Mathematics and its Applications, University of Minneapolis, Workshop on Mathematical Neuroscience, Minnesota*, June 2008 (two invited lectures)

Gamma oscillations and attention, *Colloquium talk in the Department of Electrical Engineering, Mathematics, and Computer Science, Universiteit Twente, Enschede, Netherlands*, November 2007

Some thoughts on deterministic dose calculation, *Radiation Physics Seminar, Massachusetts General Hospital, Boston*, July 2007

Gamma oscillations and attention, *Workshop on Mathematical Neuroscience, University of British Columbia, Vancouver, Canada*, June 2007 (invited talk)

Gamma oscillations and attention, *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah*, May 2007 (invited talk in a

minisymposium)

Gamma oscillations and attention, *Applied mathematics seminar, Department of Mathematics, University of Michigan, Ann Arbor, Michigan, October 2006*

Gamma oscillations and attention, *Conference in honor of the 60<sup>th</sup> birthday of Charles S. Peskin, Courant Institute, New York University, New York, October 2006 (invited talk)*

Reduced models of networks of electrically coupled neurons, *SIAM Meeting on Life Sciences, Raleigh, North Carolina, July 2006 (contributed talk)*

The role of neuronal coherence in attentional processing, *SIAM National Meeting, Boston, July 2005 (contributed talk)*

Background gamma rhythmicity and attention in a local cortical circuit model, *Computational Neuroscience Meeting, Madison, Wisconsin, July 2005 (contributed poster presentation)*

Persistent gamma oscillations and their possible role in attention, *SIAM Conference on Applications of Dynamical Systems, Snowbird, Utah, May 2005 (invited talk in a minisymposium)*

Computational modeling of gamma oscillations in the brain, *Colloquium, Mathematics Department, University of Hong Kong, March 2005*

## External grants

current: NIH (CRCNS program), “Interneurons mediating neocortical gamma rhythms and cell assemblies” (PIs: Nancy Kopell, Ed Boyden, Christoph Börgers; institutions: Boston University, MIT, Tufts University), approximately \$95,000 per year over a five-year period to Tufts

NSF (Division of Mathematical Sciences, Computational Mathematics program): “Fast Multigrid Solvers for Forward-Peaked Transport” (PI: Scott MacLachlan, co-PI: Christoph Börgers), \$280,000

past: NSF grant DMS-0418832, “Modeling and analysis of persistent gamma rhythms and their role in sustained attention” (PI: Christoph Börgers; institution: Tufts University), 8/1/2004 through 7/31/2008, \$205,000

NSF grant DMS-9626696, “Numerical analysis problems in radiotherapy planning” (PI: Christoph Börgers; institution: Tufts University), 8/15/1996 through 7/31/2000, \$60,000

NSF grant DMS-9204271, “Scientific computation of physical problems” (PIs: Robert Krasny, Eduard Harabetian, Christoph Börgers; institution: University of Michigan), 7/15/1992 through 6/30/1996, \$310,000

NSF grant DMS-9003965, “Scientific computation of physical problems”

(PIs: Robert Krasny, Eduard Harabetian, Christoph Börgers; institution: University of Michigan), 7/1/1990 through 6/30/1993, \$210,000

NSF grant DMS-8801991, “Computational and analytic problems in fluid mechanics” (PIs: Robert Krasny, Eduard Harabetian, Christoph Börgers; institution: University of Michigan), 6/15/1988 through 6/30/1990, \$146,600

### **Internal grants (Tufts University)**

Senior Faculty Research Semester Fellowship, fall 2010.

The Summer Scholars program provided a stipend for research student Edward O’Brien and \$1,000 in research funds in the summer of 2009.

Faculty Research Awards Committee, \$1,164.89 for travel to Nijmegen to start collaboration with Stan Gielen and Martin Krupa, June 2008.

Marshall Fund for Biomedical Research, \$2,699 for a laptop, October 2001.