

CURRICULUM VITAE: Nancy Kopell

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Cambridge, MA 02140
(617) 876-0342

Born November 8, 1942, New York City
Married

EDUCATION

9/67 University of California at Berkeley, Ph.D.
Specialty: Dynamical Systems
6/65 University of California at Berkeley, M.A.
6/63 Cornell University, Ithaca, N.Y., A.B.

PROFESSIONAL EXPERIENCE

9/13- Secondary appts to Pharmacology
9/11- Co-Director, Center for Computational Neuroscience and Neural Technology,
Boston University
7/09- William Fairfield Warren Distinguished Professor, Boston University
6/08- Visiting Senior Fellow, Institute for Mind and Biology, University of Chicago
9/07- Executive Committee, Center for Neuroscience, Boston University
1/07 - Secondary appointment, Department of Biomedical Engineering.
11/01-08 Co-Director, Burroughs Wellcome Training Program in Mathematical and
Computational Neuroscience (PMCN), Boston University
4/00-6/09 William Goodwin Aurelio Professor of Mathematics and Science, BU
1/08 - Founder and Director, Cognitive Rhythms Collaborative
9/97- 8/11 Co-Director, Center for BioDynamics, Boston University
10/92 Ordway Visiting Professor, University of Minnesota
9/86- Professor of Mathematics, Boston University
7/78-8/86 Professor of Mathematics, Northeastern University
5/80-6/84 Consultant, Scientific Systems, Inc.
10/79 Consultant, Math Research Center, Madison
9/76 Visiting Senior Research Scientist, Science Research Council (England)
9/76-1/77 Visiting Scholar, M.I.T.
4/76-6/76 Visiting Scholar, California Institute of Technology
1/75-6/75 Visiting Associate Professor of Applied Math., M.I.T.
7/72-6/78 Associate Professor of Mathematics, Northeastern University
3/70-6/70 Fellow, Centre Nationale de la Recherche Scientifique
9/69-6/72 Assistant Professor of Mathematics, Northeastern University
9/67-6/69 C.L.E. Moore Instructor of Mathematics, M.I.T.
9/66-6/67 Director, High School Students' and Teachers' Regional
Mathematics Program (Sponsored by the NSF)
9/65-9/66 Assistant Director, same program

HONORS

Elected to

National Academy of Sciences, 1996
American Academy of Arts and Sciences, 1996
Honorary Membership of London Mathematical Society (one or two such awarded worldwide/year) 2011

Fellowships and Honorary Degrees

Fellow of the American Mathematical Society
SIAM Fellow, 2009
Massachusetts Academy of Sciences, Fellow, 2008
Weldon Memorial Prize, Oxford University, 2006
Honorary Doctorate, New Jersey Institute of Technology, May 2006
John D. and Catherine T. MacArthur Fellow, 1990-1995
J. S. Guggenheim Fellowship, 1984-1985
Alfred P. Sloan Fellow, 1975-1977
N.S.F. Graduate Fellow, 1963-1967
Woodrow Wilson Fellow (honorary), 1963-1964

Special Invited Lectures and prizes

Mathematical Neuroscience Prize from Israel Brain Technologies (2 worldwide, every 2 years), 2015
Moser Prize Lecture, SIAM Annual Meeting, Snowbird 2013
Irene McCulloch Lecturer in Science and Engineering, Distinguished Lecturer, USC, 2011
Weldon Memorial Prize lecture, Oxford, 2008
Von Neumann Prize/Lecture, SIAM annual meeting, Zurich, 2007
Shih-I Pai Lecture, University of Maryland, 2006
Distinguished Lecturer, University of California, Irvine, 2006
Roslyn Silver Science Lecture, Barnard, 2004
Conference in honor of my 60th birthday, Boston University, 2003
Rainich Lectures, University of Michigan, Ann Arbor, 2003
Wasow Memorial Lectures, University of Wisconsin, Madison, 2003
Plenary Speaker, International Congress of Industrial and Applied Math, Australia, 2003
Invited Speaker, International Congress of Mathematics, China, 2002
H. Dudley Wright Prize, Harvey Mudd College, 2001
Plenary Speaker, Annual Meeting of SIAM, San Juan, 2000
NSF Distinguished Lecturer, Washington D.C., 2000
Josiah Willard Gibbs Lecturer, Annual Meeting of the AMS, San Antonio, 1999
Invited Speaker, Annual Meeting of AMS, San Diego, 1997
Issues in Modern Biology: Distinguished Lecture Series, Los Alamos National Lab., 1995
Plenary Speaker, SIAM Meeting on Dynamical Systems, Snowbird, 1995
Class of '27 Lecturer, Rensselaer Polytechnic Institute, 1995
Matthew Vassar Lecturer, Vassar College, 1994
Distinguished Lecturer, Fields Institute, 1994
University Lecturer, Boston University, 1993

KAC Memorial Lectures, CNLS, Los Alamos National Lab, 1992
Emmy Noether Lecture, AMS Annual Meeting, Baltimore 1992
Vollmer Fries Memorial Lecture, Rensselaer Polytechnic Institute, 1991
Plenary Speaker, Canadian Math Society Annual Meeting, 1990
Plenary Speaker, Annual Meeting of SIAM, Chicago, 1990
Plenary Speaker, SIAM Meeting on Dynamical Systems, Orlando, 1990
Lecturer, R. Bowen Memorial Lectures, Berkeley, 1986
Invited Speaker, International Congress of Mathematicians, 1983
University Lecturer, Northeastern University, 1980

In addition, I have given 8-12 invited talks per year at conferences, symposia and department colloquia [mathematics, physics, physiology, neurobiology]

Research Support

NSF Individual Grants, 1967 -
University Research Initiative Award, AFOSR, 1986-1989
AFOSR Support, 1984-1990
NIMH Support, 1990 -2002
NINDS Support, 2002-2007
P.I., Group Infrastructure Grant (interdisciplinary training group), NSF, 1996-2001
P.I, Support for the Center for BioDynamics, NSF, 2001-2006
P.I., Research Training Grant, NSF, 2006-2011
P.I. Burroughs Wellcome Training Program in Mathematical and Computational Neuroscience 2001- 2007
Co-PI, CRCNS Grant 2005-2009
P.I, Research Training Grant, Boston University, 2006-2010
P.I., NSF SGER Grant, 2008-2010
P.I, CRCNS (NINDS) Grant, 2009-2014
P.I., ARRA (NIH-NINDS) Grant 2009- 2011
P.I., Cognitive Rhythms Collaborative: A Discovery Network; NSF, 2010-2016
P.I. ARO support, 2014-2017

Undergraduate Honors

Phi Beta Kappa (junior year)
Graduation from Cornell U. with Distinction in All Subjects and High Honors in Math
Class Marshall of School of Arts and Sciences at Cornell Graduation (salutatorian)

PROFESSIONAL SERVICE

Advisory boards/workshops

Discussant, Brain Workshop- held by Advisory Group to NIH 2013.
Mathematical Biosciences Institutes, Board of Trustees 2012-
Panelist for working group on “Advancing Diagnoses and Treatment of Psychiatric and Neurological Disorders: Moving Functional Imaging Into the Clinic” NIH/NSF/DOD 2012-21013.
Panelist for “Maturation of Functional Brain Networks: Insights into the Origins and Course of Mental Disorders”, NIH 2011

Advisory Committee, Burroughs Wellcome Fund Career Awards at the Scientific Interface, 2007-2014; Co-Chair 2011-2013
Advisory Board, Miller Institute for Basic Research in Science, UC Berkeley, 2005-7
Advisory Board, Center for Theoretical Biological Physics, UC San Diego, 2003-6
Math Advisory Board, Carnegie Mellon University, 2003
Advisory Board, Banff International Research Station, 2002-2010
NIH Planning Workshop on Multi-Electrode Data, 2002
NIAAA Workshop on Alcohol/Neuroscience/Bioinformatics, 2001
NRC Committee Bio 2010: Undergraduate Biology Education to Prepare Research Scientists for the 21st Century; Chair of Math Sub-Panel, 2000-2
Workshop on Intellectual Opportunities in Mathematics, NSF, 2000
DARPA Focus 2000; Chair of Neurobiology Section, 2000
DARPA Workshop on Funding in the Area of Nonlinear Dynamics, 1998
Advisory Board on Interfaces between the Physical, Chemical, Computational Sciences and Biological Sciences, Burroughs Wellcome Fund, 1995-1999
Scientific Advisory Board, Fields Institute, 1995-6
Advisory Committee for Mathematical and Physical Sciences, NSF, 1992-4
Board of Science Advisors, Santa Fe Institute, 1991 - 2001; 2002-
Board of Trustees, Math Sciences Research Institute, 1990-5
Board of Governors, Institute for Mathematics and its Applications, 1986-9;
Chairman, 1988/89
Advisory Committee for Mathematical Sciences, NSF, 1983-1986; Chairman, 1985-6
Advisory Committee for Mathematical and Information Sciences, Air Force Office of Scientific Research, 1986-7
Mathematical Sciences in the Year 2000 Oversight Committee (a Committee of the National Research Council), 1988-90
NSF Workshop on the Interface of Mathematics and Biology, 1990

Review Panels, Committees

Committee of Visitors , NSF 2013.
Prize Committees: Leroy Steele Prizes, AMS, 2015, Emmy Noether Prize, 2013, 2014, Von Neumann Prize (2011, 2012), SIAM Fellows (2011, 2012), Norbert Wiener Prize (AMS, 2009), Swartz Prize in Computational Neuroscience (SFN 2008-2010), Moser Prize (SIAM 2008), Winfree Prize (SMB 2008)
Review Panel, NIH 2013, 2014
Review Panel, NSF 2011
Review Panel, NSF, Science of Learning Center at UCSD, 2008
Special Emphasis Panel on Predictive Multiscale Modeling of the Physiome in Health and Disease, NIH2008
Ad-hoc review panel, NIH2004
Computational Neuroscience Review Panel, NSF, 2000
Ad-hoc Member, Board of Scientific Counselors NIDDK, NIH, 1995
Ad-hoc Review Panel, NIH, 1994
ONR Review Panel on Future Research Options, 1993
Ad-hoc Member, Board of Scientific Counselors, NIDDK, NIH, 1992
Ad-hoc Review Panel, NIH, 1991

Site Review Panel, NSF Biology Research Centers, 1988
Site Review Panel, NIMH Training Grant, 1988
Selection Panel, Mathematical Sciences Section, Presidential Young Investigators
Award, 1984
Applied Math Review Panel, NSF, 1980

Organizing Activities

Organizer and current Director, Cognitive Rhythms Collaborative (group of over 30 labs in the Boston area interested in brain dynamics. See cogrhythms .bu.edu).
Co-Organizer, conference on Quantitative Theories of Learning, Memory and Prediction, Arlington VA, May 2014
Organizer, international conference on Brain Rhythms and Cognition. Cambridge 2013
Organizing Committee, "Toward Mathematical Modeling of Neural Disease", Fields Institute, 8 workshops June 2012
Organizer, Mini-symposium on Beta Rhythms and Cognition, Boston 2012
Co-Organizer, Workshop on Linking Neural Dynamics and Coding, Banff International Research Station, 2010
Organizer, Short Course, Society for Neuroscience, 2009
Organizing Committee, Conference in Honor of John Rinzel, NYU, 2009
Co-Organizer, Workshop on Brain Rhythms and Speech, Boston University, 2008
Organizing Committee, Workshop on Computational Neuroscience, Institute for Mathematics and Its Application, 1998
Co-Organizer, Workshop on Interaction of the Nervous System and Biomechanics, Santa Fe Institute, 1998
Organizing Committee, Computational Neuroscience (CNS*95), Monterey, 1995 (CNS*96), Boston, 1996
Organizer, Workshop on Neural Oscillations: Implications in Human Health and Disease, Santa Fe Institute, 1995
Organizing Committee of 1995 International Congress of Applied Mathematics
Committee to choose applied math speakers for 1994 International Congress of Mathematicians
Organizer, Program on Dynamic Regulation in Neural Systems, Santa Fe Institute, 1993
Organizer, 6 week Program in Mathematical Physiology, Mathematical Sciences Research Center, Summer 1992
Organizer, Annual Workshops on Central Pattern Generators, 1987-1992
Organizing Committee, Conference in Honor of S. Smale, "From Topology to Computation: Unity and Diversity in the Mathematical Sciences," 1990
Vice Chairman, Gordon Conference on Theoretical Biology and Biomathematics, 1984

Editorial Work

Advisory Board, J. Math. Biol. 1984-1999
Editorial Board, SIAM J. Appl. Math, 1976-1979, 1985-1992
Action Editor, Neural Networks 1990-
Advisory Board, CHAOS, 1991-1993
Executive Board, Network 1993-1995
Editorial Board, Journal of Nonlinear Science/Nonlinear Science Today, 1994-

Action Editor, Journal of Computational Neuroscience, 1999 -
Action Editor, Proc. Nat. Acad. Sci, 1996 -

Professional Societies

Society for Math. Biol., Board of Directors, 1988-1991
SIAM Council, 1982-1984
Committee on Human Rights, SIAM, 1983-; Chairman, 1983-1986

Graduate Students Advised: R. Ault, R. Langer, S. Laederich, W. Zhang, F. Nadim, D. Somers, C. Soto-Trevino, T. LoFaro, J. Ritt, S. R. Jones, G. Medvedev, A. Sereney, M. McCarthy, D. Vierling-Claassen, C. Diniz Behn, C. Acker, T. Kispersky, B. Hedinsson, P. Malerba, S. Lee, J. Cannon, C. Moore-Kochlacs, N. James, A. Soplata, J. Sherfey, E. Roberts, M. Romano, M. Kowalski (8 female)

Postdocs Sponsored/Advised: S. Strogatz, C. Chow, J. Karbowski, A. Bose, C. Bodelon, D. Pinto, M. Olufsen, K. Josic, D. McMillen, H. Rotstein, S. Epstein, S. Kunec, D. Pervouchine, R. Clewley, T. Netoff, A. Kuznetsov, C. Mitchell, E. Sivan, G. Soto, J. Jalics, N. Popovic, S. Folias, M. Kramer, J. Brea, A. Tort, M. McCarthy, D. Vierling-Claassen, M. Shamir, R. Osan, E. Sherwood, E. Munro, S. Ching, A. Barakat, J.H. Lee, S. Vijayan, D. Stanley, A. Singer, B. Poletta, S. Ardid, J. Haas (8 female).

Undergrad: S. Jativa (female)

PUBLICATIONS (over 16,600 citations as of May 2016)

1. N. Kopell, Commuting Diffeomorphisms. In *Global Analysis*, Symposia in Pure Mathematics, American Mathematical Society, Providence, 1970;**14**:165-84.
2. N. Kopell and L.N. Howard, Horizontal bands in the Belousov reaction. *Science*, 1973;**180**:1171-3. PMID: 17743601
3. N. Kopell and L.N. Howard, Plane wave solutions to reaction diffusion equations. *Studies in Appl. Math.*, 1973;**52**:291-328.
4. N. Kopell, Discussion paper: Dissipative and non-dissipative structure. *Ann. of the N.Y. Acad. Sciences*, 19974;**231**:106-7. PMID: 4522887
5. N. Kopell and L.N. Howard, Bifurcation under non-generic conditions. *Adv. in Math.*, 1974;**13**:274-83.
6. N. Kopell and L.N. Howard, Pattern formation in the Belousov reaction. *Lectures on Mathematics in the Life Sciences*, 1974;**7**:201-16.
7. L.N. Howard and N. Kopell, Wave trains, shock structures and transition layers in reaction-diffusion equations. In *Mathematical Aspects of Chemical and Biochemical Problems and Quantum Chemistry*, AMS-SIAM Proceedings, American Mathematical Society, Providence, 1974;**8**:274-83.
8. N. Kopell and L.N. Howard, Bifurcations and trajectories joining critical points. *Adv. in Math.*, 1975;**18**:306-58.
9. N. Kopell and G. Stolzenberg, Commentary on Bishop's talk. *Historia Mathematica*, 1975;**2**:519-21.

10. L.N. Howard and N. Kopell, Translation, with editorial comments, of E. Hopf's Abzeigung einer periodischen Losung von einer stationaren Losung eines Differentialsystems. In *The Hopf Bifurcation and its Applications*, Applied Mathematical Sciences, J. Marsden and M. McCracken, eds., Springer-Verlag, New York, 1978;**19**: 163-205.
11. L.N. Howard and N. Kopell, Slowly varying waves and shocks in reaction-diffusion equations. *Studies in Appl. Math.*, 1977;**56**:95-145.
12. N. Kopell, Waves, shocks and target patterns in an oscillating chemical reagent. In *Nonlinear Diffusion*, Research Notes in Mathematics, 1977;**14**:129-54, Pitman.
13. N. Kopell, Pattern formation in chemistry and biology: A mini-survey of mechanisms. In *Psychology and biology of language and thought: Essays in honor of Eric Lenneberg*, G. Miller, ed., Academic Press, New York, 1978;65-85.
14. N. Kopell, Reaction-diffusion equations and pattern formation. In *Studies in mathematical biology*, S. Levin, ed. MAA Studies in Mathematics, Mathematical Association of America, 1978;**15**:191-205.
15. N. Kopell, A geometric approach to boundary layer problems exhibiting resonance. *SIAM J. Appl. Math.*, 1979;**37**:436-58.
16. N. Kopell, Time periodic but spatially irregular solutions to a model reaction-diffusion equation. In *Nonlinear dynamics*, R. Helleman, ed., N.Y. Academy of Sciences, New York, 1980;397-409.
17. N. Kopell, The singularly perturbed turning point problem: A geometric approach. In *Singular perturbations and asymptotics*, R. Meyer, ed., Academic Press, New York, 1980; 173-90.
18. N. Kopell and L.N. Howard, Target patterns and horseshoes from a perturbed central force problem: Some temporally periodic solutions to reaction-diffusion equations, *Studies in Appl. Math.*, 1981;64:1-56.
19. N. Kopell and S. Parter, A complete analysis of a model nonlinear equation having a continuous locus of turning points. *Advances in Appl. Math.*, 1981;**2**:212-38.
20. N. Kopell and L.N. Howard, Target patterns and spiral solutions to reaction-diffusion equations with more than one space dimension. *Adv. Appl. Math.*, 1981;**2**:417-49.
21. N. Kopell, Target pattern solutions to reaction-diffusion equations in the presence of impurities. *Adv. Appl. Math.*, 1981;**2**:389-99.
22. N. Kopell and R. Washburn, Chaotic motions in the two-degree of freedom swing equations. *IEEE Transactions on Circuits and Systems*, Special Issue on Power Systems, Vol. CAS-29, 1982;**11**:738-46.
23. N. Kopell, Frequency plateaus in a chain of weakly coupled oscillators. In *Nonlinear partial differential equations*, Contemporary Mathematics, J. Smoller, ed., American Mathematical Society, Providence, 1982;**17**:401-4. (This is an exposition of the ideas in 25.)
24. N. Kopell and G.B. Ermentrout, Coupled oscillators and mammalian small intestines. In *Oscillation in mathematical biology*, Lecture Notes in Biomathematics, J.P.E. Hodgson, ed., Springer-Verlag, New York, 1982;**51**:24-36.
25. G.B. Ermentrout and N. Kopell, Frequency plateaus in a chain of weakly coupled Oscillators. *SIAM J. on Math. Anal.*, 1984;**15**:215-37.

26. N. Kopell, Forced and coupled oscillators in biological applications. Proc. of the 1983 International Congress, Warsaw, North Holland, Amsterdam, 1984;1645-60.
27. N. Kopell, Symmetry and coherence in a chain of coupled oscillators. In *Chaos in nonlinear dynamical systems*, J. Chandra, ed., SIAM, Philadelphia, 1984;86-93.
28. N. Kopell, Invariant manifolds and the initialization problem for some atmospheric equations. *Physica D*, 1985;**14**:203-15.
29. G.B. Ermentrout and N. Kopell, Parabolic bursting in an excitable system coupled with a slow oscillation. *SIAM J. Appl. Math.*, 1986;**46**:233-53.
30. N. Kopell and G.B. Ermentrout, Subcellular oscillations and bursting. *Math. Biosciences*, 1986;**78**:265-91.
31. N. Kopell and D. Ruelle, Bounds on complexity in reaction-diffusion systems. *SIAM J. Appl. Math.*, 1986;**46**:68-80.
32. N. Kopell, Phase methods for coupled oscillators and related topics: An annotated Bibliography. *J. Statistical Physics*, 1986;**44**:1035-42.
33. N. Kopell, Coupled oscillators and locomotion by fish. In *Nonlinear oscillations in biology and chemistry*, H. Othmer, ed., Lecture Notes in Biomathematics, Springer-Verlag, New York, 1986;**66**:166-74.
34. N. Kopell, Modelling C.P.G.'s: A robust approach, in *Neurobiology of vertebrate locomotion*, S. Grillner, P.S.G. Stein, D.G. Stuart, H. Forssberg, and R. Herman, eds., Wenner-Grenn Center International Symposium Series, Macmillan, London, 1986;**45**: 383-5.
35. N. Kopell and G.B. Ermentrout, Symmetry and phaselocking in chains of weakly coupled Oscillators. *Comm. Pure Appl. Mathematics*, 1986;**39**:623-60.
36. N. Kopell, Toward a theory of modelling central pattern generators. In *Neural control of rhythmic movements*, A. Cohen, S. Grillner, S. Rossignol, eds., J. Wiley, New York, 1987;369-413.
37. N. Kopell and G.B. Ermentrout, Coupled oscillators and the design of central pattern Generators. *Math. Biosciences*, 1988;**90**:87-109.
38. N. Kopell, Chains of oscillators and the effects of multiple coupling. Appendix to studies of the lamprey central pattern generator for locomotion: A close relationship between modeling and experimentation, by A.H. Cohen, in *Dynamic patterns in complex systems*, S. Kelso, ed., World Scientific Publishers, 1988;156-161.
39. G.B. Ermentrout and N. Kopell, Some mathematical questions concerning central pattern generators. In *Theoretical models of cell signalling*, A. Goldbeter, ed., Academic Press, New York, 1989;89-98.
40. N. Kopell and G.B. Ermentrout, Structure and function in an oscillating neural network. In *Computational neuroscience*, E. Schwartz, ed., MIT Press, Boston, 1990;201-9.
41. G.B. Ermentrout and N. Kopell, Oscillator death in systems of coupled neural oscillators. *SIAM J. Appl. Math.*, 1990;**50**:125-46.
42. N. Kopell and G.B. Ermentrout, Phase transitions and other phenomena in chains of oscillators. *SIAM J. Appl. Math.*, 1990;**50**:1014-52.
43. D.G. Aronson, G.B. Ermentrout and N. Kopell, Amplitude response of coupled Oscillators. *Physica D*, 1990;**41**:403-49.

44. N. Kopell, W. Zhang and G.B. Ermentrout, Multiple coupling in chains of oscillators. *SIAM J. Math. Anal.*, 1990;**21**:935-53.
45. T. Williams, K. Sigvardt, N. Kopell, G.B. Ermentrout, and M. Remler, Forcing of coupled nonlinear oscillators: Studies of intersegmental coordination in the lamprey locomotor central pattern generator. *Journal of Neurophysiology*, 1990;**64**:862-71. PMID: 2230930
46. G.B. Ermentrout and N. Kopell, Multiple pulse interactions and averaging in coupled neural oscillators. *Journal of Math. Biol.*, 1991;**29**:195-217.
47. N. Kopell, G.B. Ermentrout and Thelma Williams, On chains of neural oscillators forced at one end. *SIAM J. Appl. Math.*, 1991;**51**:1397-17.
48. C. Jones, N. Kopell and R. Langer, Construction of the FitzHugh-Nagumo pulse using differential forms. In *Pattern and dynamics in reactive media*, IMA Volumes in Mathematics and its Applications, H. Swinney, G. Aris and D. Aronson, eds., Springer-Verlag, New York, 1991;**37**:101-16.
49. A.H. Cohen, G.B. Ermentrout, T. Kiemel, N. Kopell, K. Sigvardt, and T. Williams, Modelling of intersegmental coordination in the lamprey central pattern generator for Locomotion. *Trends in Neurosciences*, 1992;**15**:434-438. PMID: 1281350
50. N. Kopell, Dynamical systems and the geometry of singularly perturbed equations. In *From topology to computation: Proceedings of the Smalefest*, Springer-Verlag, New York, 1993.
51. D. Somers and N. Kopell, Rapid synchronization through fast threshold modulation. *Biol. Cybern.*, 1993;**68**:393-407. PMID: 8476980
52. E. Marder, L. Abbott, A. Sharp, and N. Kopell, Electrical coupling in networks containing oscillators. In *Neuroscience: From neural networks to artificial intelligence*, Research notes in neural computing, M. Arbib, P. Rudomin, and F. Cervantes, eds., Springer Verlag, New York, 1993;33-42.
53. N. Kopell, Rhythms and clues: Mechanisms of self-organization in nature, 1993 University Lecture, Boston University, Boston MA, 1994.
54. C. Jones and N. Kopell, Tracking invariant manifolds with differential forms in singularly perturbed equations. *J. Diff. Equa.*, 1994;**108**:64-88.
55. T. LoFaro, N. Kopell, E. Marder, and S. Hooper, Subharmonic coordination in networks of neurons with slow conductances. *Neural Computation*, 1994;**6**:69-84.
56. G.B. Ermentrout and N. Kopell, Inhibition-produced patterning in chains of coupled nonlinear oscillators. *SIAM J. Appl. Math.*, 1994;**54**:478-507.
57. G.B. Ermentrout and N. Kopell, Learning of phase-lags in coupled neural oscillators. *Neural Computation*, 1994;**6**:225-41.
58. F. Skinner, N. Kopell and E. Marder, Mechanisms for oscillation and frequency control in networks of mutually inhibitory relaxation oscillators. *J. Computational Neuroscience*, 1994;**1**:69-87. PMID: 8792226
59. F. Skinner, S. Gramoll, R. Calabrese, N. Kopell, and E. Marder, Frequency control in biological half-center oscillators. In *Computations in neurons and neural systems*, F.H. Eeckman, ed., Kluwer, Boston, 1994;223-8.

60. T. LoFaro, N. Kopell, E. Marder, and S. Hooper, The effect of i_h bursting patterns of pairs of coupled neurons. In *Computations in neurons and neural systems*, F.H. Eeckman, ed., Kluwer, Boston, 1994;15-20.
61. N. Kopell and G. LeMasson, Rhythmogenesis, amplitude modulation and multiplexing in a cortical architecture. *Proc. Nat. Acad. Sci. U.S.A.*, 1994;**91**:10586-90. PMID: 7937997
62. S.K. Tin, N. Kopell and C.K.R.T. Jones, Invariant manifolds and singularly perturbed boundary value problems. *SIAM J. Num. Anal.* (special volume in honor of S. Parter), 1994;**31**:1558-76.
63. N. Kopell and D. Somers, Anti-phase solutions in relaxation oscillators coupled through excitatory interactions. *J. Math. Biol.*, 1995;**33**:261-80. PMID: 7897329
64. N. Kopell, Chains of coupled oscillators. In *Handbook of brain theory and neural networks*, M. Arbib, ed., MIT Press, Cambridge, 1995;178-83.
65. N. Kopell and M. Landman, Spatial structure of the focusing singularity of the nonlinear Schrodinger equation: A geometric analysis. *SIAM J. Appl. Math.*, 1995;**55**:1297-323.
66. D. Somers and N. Kopell, Waves and synchrony in arrays of oscillators of relaxation and non-relaxation type. *Physica D*, 1995;**89**:169-83.
67. N. Kopell, Global center manifolds and singularly perturbed equations. A brief guide to the literature. In *Lectures in applied math*, American Mathematical Society, Providence, 1996;**31**:47-50.
68. C. Jones, T. Kaper and N. Kopell, Tracking invariant manifolds up to exponentially small errors. *SIAM J. Math. Anal.*, 1996;**27**:558-77.
69. C. Soto-Trevino, N. Kopell and D. Watson, Parabolic bursting revisited. *J. Math. Biol.*, 1996;**35**:114-28. PMID: 9002243
70. D. Terman, A. Bose and N. Kopell, Functional reorganization in thalamocortical networks: Transition between spindling and delta sleep rhythms. *Proc. Nat. Acad. Sci. U. S. A.*, 1996;**93**:15417-22. PMID: 8986826
71. N. Kopell, Oscillating networks of neurons: Mathematics and function. In *Proc. of The legacy of Norbert Wiener: A centennial symposium*, American Mathematical Society, Providence, 1997.
72. J.M. Weimann, P. Skiebe, H. Heinzel, C. Soto, N. Kopell, J.C. Jorge-Rivera, and E. Marder, Modulation of oscillator interactions in the crab stomatogastric ganglion by crustacean cardioactive peptide. *J. Neurosci.*, 1997;**17**:1748-60. PMID: 9030633
73. F. Skinner, N. Kopell and B. Mulloney, How does the crayfish swimmeret system work: Insights from nearest-neighbor coupled oscillator models. *J. Comp. Neurosci.*, 1997;**4**:151-60.
74. E. Marder, N. Kopell and K. Sigvardt, How computation aids in understanding biological networks. In *Neurons, networks and motor behavior*, P.S.G. Stein, S. Grillner, A.I. Selverston, and D.G. Stuart, eds., MIT Press, Cambridge, MA, 1998;139-50.
75. M. Hayes, T. Kaper, N. Kopell, and K. Ono, On the application of geometric singular perturbation theory to some classical two-point boundary value problems. *Intl. J. Bifurcations and Chaos*, 1998;**8**:189-209.
76. J. White, C. Chow, J. Ritt, C. Soto-Trevino, and N. Kopell, Synchronization and oscillatory dynamics in heterogeneous, mutually inhibited neurons. *J. Comput. Neurosci.*, 1998;**5**:5-16. PMID: 9580271

77. G.B. Ermentrout and N. Kopell, Fine structure of neural spiking and synchronization in the presence of conduction delays. *Proc. Nat. Acad. Sci. U. S. A.*, 1998;**95**:1259-64. PMID: 9448319
78. D. Terman, A. Bose, and N. Kopell, Dynamics of two mutually coupled slow inhibitory neurons. *Physica D*, 1998;**117**:241-75.
79. N. Kopell, L. Abbott and C. Soto-Trevino, On the behavior of a neural oscillator electrically coupled to a bistable element. *Physica D*, 1998;**121**:367-95.
80. C. Chow, J. White, J. Ritt, and N. Kopell, Frequency control in synchronized networks of inhibitory neurons. *J. Comput. Neurosci.*, 1998;**5**:407-20. PMID: 9877022
81. N. Kopell, Networks of neurons as dynamical systems: From geometry to biophysics. *Quarterly Appl. Math.*, 1998;**56**:707-18.
82. Y. Manor, F. Nadim, S. Epstein, J. Ritt, E. Marder, N. Kopell, Network oscillations generated by balancing graded asymmetric reciprocal inhibition in passive neurons. *J. Neurosci.*, 1999;**19**:1765-2779. PMID: 10087088
83. T. LoFaro and N. Kopell, Timing regulation in a network reduced from voltage-gated equations to a one-dimensional map. *J. Math. Biol.*, 1999;**38**:479-533. PMID: 10422266
84. F. Nadim, Y. Manor, N. Kopell, and E. Marder, Synaptic depression creates a switch that controls the frequency of an oscillatory circuit. *Proc. of Nat Acad. Sci. U. S. A.*, 1999;**96**:8206-11. PMID: 10393973
85. N. Kopell, G.B. Ermentrout, M. Whittington, and R.D. Traub, Gamma rhythms and beta rhythms have different synchronization properties. *Proc. Nat. Acad. Sci. U. S. A.*, 2000;**97**:1867-72. PMID: 10677548
86. A. Bose, N. Kopell, D. Terman, Almost synchronous solutions for pairs of neurons coupled by excitation. *Physica D*, 2000;**140**:69-94.
87. N. Kopell, We got rhythm: Dynamical systems of the nervous system, published version of the 1998 Gibbs Lecture of the AMS, *Notices of the AMS*, 2000;**47**:6-16.
88. G. Medvedev, T. Kaper and N. Kopell, A reaction-diffusion system with periodic front dynamics. *SIAM J. Appl. Math.*, 2000;**60**:1601-38.
89. J. Karbowski and N. Kopell, Multispikes and synchronization in a large neural network with temporal delays. *Neural Comput.*, 2000;**12**:1573-1606. PMID: 10935919
90. C. Chow and N. Kopell, Dynamics of spiking neurons with electrical coupling. *Neural Comput.*, 2000;**12**:1643-78. PMID: 10935921
91. M.A. Whittington, R.D. Traub, N. Kopell, B. Ermentrout, and E.H. Buhl, Inhibition-based rhythms: Experimental and mathematical observation on network dynamics. *Int. J. of Psychophysiol.*, 2000;**38**:315-36. PMID: 11102670
92. J. White, M. Banks, R. Pearce, and N. Kopell, Networks of interneurons with fast and slow gamma-aminobutyric acid type A (GABAA) kinetics provide substrate for mixed gamma-theta rhythm. *Proc. Nat. Acad. Sci. U. S. A.*, 2000;**97**:8128-33. PMID: 10869419
93. S. R. Jones, D. Pinto, T. Kaper, and N. Kopell, Alpha-frequency rhythms desynchronize over long cortical distances: A modeling study. *J. Comput. Neurosci.*, 2000;**9**:271-91. PMID: 11139043
94. E. C. Fuchs, H. Doheny, H. Faulkner, A. Caputi, R.D. Traub, A. Bibbig, N. Kopell, M. Whittington, and H. Monyer, Genetically altered AMPA-type glutamate receptor kinetics

- in interneurons disrupt long-range synchrony of gamma oscillation. Proc. Nat. Acad. Sci. U. S. A., 2001;**98**:3571-6. PMID: 11248119
95. G. Medvedev and N. Kopell, Synchronization and transient dynamics in chains of FitzHugh Nagumo oscillators with strong electrical coupling. SIAM J. Appl. Math., 2001;**61**:1762-1801.
 96. R.D. Traub, N. Kopell, A. Bibbig, E.H. Buhl, F.E.N. LeBeau, and M.A. Whittington, Gap junctions between interneuron dendrites can enhance synchrony of gamma oscillations in distributed networks. J. Neurosci., 2001;**21**:9478-86. PMID: 11717382
 97. N. Kopell and G.B. Ermentrout, Chains of coupled oscillators in motor and sensory Systems. In *Handbook of brain theory and neural networks*, M. Arbib, ed., MIT Press, Cambridge, MA, 2002.
 98. N. Kopell and G.B. Ermentrout, Mechanisms of phase-locking and frequency control in pairs of coupled neural oscillators. In *Handbook on dynamical systems*, volume 2: *Toward applications*, B. Fiedler, ed., Elsevier, Philadelphia, 2002;3-54.
 99. D. McMillen, N. Kopell, J. Hasty, and J.J. Collins, Synchronizing genetic relaxation oscillators by intercell signaling. Proc. Nat. Acad. Sci. U.S.A., 2002;**99**:679-84. PMID:11805323
 100. O. Jensen, M. Pohja, P. Goel, G.B. Ermentrout, N. Kopell, and R. Hari, On the physiological basis of the 15-30 Hz motor-cortex rhythm. Proc. of 13th Int. Conf. on Biomagnetism, 2002.
 101. N. Kopell, Rhythms of the nervous system: Mathematical themes and variations. Proc. of the Int. Congress of Mathematicians, Beijing 2002, Springer, 2002.
 102. M. Olufsen, M.A. Whittington, M. Camperi, and N. Kopell, New roles for the gamma rhythm: Population tuning and preprocessing for the Beta rhythm. J. Comput. Neurosci., 2003;**14**:35-54. PMID: 12435923
 103. C. Borgers and N. Kopell, Synchronization in network of excitatory and inhibitory neurons with sparse, random connectivity. Neural Comput., 2003;**15**:509-38. PMID: 12620157
 104. D. Pinto, S. Jones, T. Kaper, and N. Kopell, Analysis of state-dependent transitions in frequency and long-distance coordination in a model oscillatory cortical circuit. J. Comput. Neurosci., 2003;**15**:283-98.
 105. S.R. Jones, B. Mulloney, T. Kaper, and N. Kopell, Coordination of cellular pattern-generating circuits that control limb movements: The sources of stable differences in intersegmental phases. J. Neurosci., 2003;**23**:3457-68. PMID: 12716954
 106. C. Acker, N. Kopell and J. White, Synchronization of strongly coupled excitatory neurons: relating network behavior to biophysics. J. Comput. Neurosci., 2003;**15**: 71-90. PMID: 12843696
 107. H.G. Rotstein, N. Kopell, A.M. Zhabotinsky, and I.R. Epstein, A canard mechanism in systems of globally coupled oscillators. SIAM J. Appl. Math., 2003;**63**:1998-2019.
 108. G. Medvedev, C. Wilson, J. Callaway, and N. Kopell, Dendritic synchrony and transient dynamics in a coupled oscillator model of the dopaminergic neuron. J. Comput. Neurosci., 2003;**15**:53-69. PMID: 12843695
 109. D. McMillen and N. Kopell, Noise-stabilized synchronization in populations of model neurons. J. Comput. Neurosci., 2003;**15**:143-57. PMID: 14512745

110. N.S. Sung, J. Gordon, G. Rose, E. Getzoff, S. Kron, D. Mumford, J. Onuchic, N. Scherer, D.L. Summers, and N.J. Kopell, Science education. Education future scientists. *Science*, 2003;**301**: 1485. PMID: 12970550
111. *BIO 2010: Transforming undergraduate education for future research scientists*. Committee on undergraduate biology education to prepare research scientists for the 21st century, National Research Council, the National Academies Press, Washington, D.C., 2003.
112. N. Kopell, A tree of fireflies, a flock of boson clouds. Review of *Sync* by S. Strogatz, *Science*, 2003;**300**:878-9.
113. M.A. Cunningham, C.H. Davies, E.H. Buhl, N. Kopell, and M.A. Whittington, Gamma oscillations induced by kainate receptor activation in the entorhinal cortex in vitro. *J. Neurosci.*, 2003;**23**:9761-9. PMID: 14586003
114. H.G. Rotstein, N. Kopell, A.M. Zhabotinsky, and I.R. Epstein, Canard phenomenon and localization of oscillations in the Belousov-Zhabotinsky reaction with global feedback. *J. Chemical Physics*, 2003;**119**:8824-32.
115. N. Kopell, Rhythms in the nervous system: From cells to behavior via dynamics. In Proc. of Internat. Congress of Industrial and Appl. Math, Sydney, Australia, 2003.
116. L. Rubchinsky, N. Kopell and K. Sigvardt, Modeling facilitation and inhibition of competing motor programs in basal ganglia subthalamic nucleus-pallidal circuits. *Proc. Natl. Acad. Sci. U. S. A.*, 2003;**100**:14427-32. PMID: 14612573
117. N. Kopell and B. Ermentrout, Chemical and electrical synapses perform complementary roles in the synchronization of interneuronal networks. *Proc. Nat. Acad. Sci. U.S.A.*, 2004;**101**:15482-7. PMID: 15489269
118. E. Sivan and N. Kopell, Mechanism and circuitry for clustering and fine discrimination of odors in insects. *Proc. Nat. Acad. Sci. U.S.A.*, 2004;**101**:17861-6. PMID: 15590772
119. A. Kuznetsov, M. Kaern and N. Kopell, Synchrony in a population of hysteresis-based genetic oscillators. *SIAM J. Appl. Math.*, 2004; **65**:392-425.
120. T. Netoff, M. Banks, A. Dorval, C. Acker, J. Haas, N. Kopell, and J. White, Synchronization in hybrid neuronal networks of the hippocampal formation. *J. Neurophysiol.*, 2005;**93**:1197-208. PMID: 15525802
121. C. Borgers and N. Kopell, Effects of noisy drive on rhythms in networks of excitatory and inhibitory neurons. *Neural Comput.*, 2005;**17**:557-608. PMID: 15802007
122. N. Kopell, Biased random walk: A brief mathematical Biography. In *Complexities: Women in mathematics*, Princeton University Press, 2005;349-54.
123. O. Jensen, P. Goel, N. Kopell, M. Pohja, R. Hari, B., Ermentrout, On the human sensorimotor-cortex beta rhythm: Sources and modeling. *NeuroImage*, 2005;**26**:3347-55. PMID: 15907295
124. S. Kunec, M.E. Hasselmo and N. Kopell, Encoding and retrieval in the CA3 region of the hippocampus: A model of theta phase separation. *J Neurophysiol.*, 2005;**94**:70-82. PMID: 15728768
125. H.G. Rotstein, D.D. Pervouchine, C.D. Acker, M.J. Gillies, J.A. White, E.H. Buhl, M.A. Whittington, and N. Kopell, Slow and fast inhibition and an H-current interact to create a theta rhythm in a model of CA1 interneuron network. *J. Neurophysiol.*, 2005;**94**:1509-18. PMID: 15857967

126. R. Clewley, H.G. Rotstein and N. Kopell, A computational tool for the reduction of nonlinear ODE systems possessing multiple scales. *Multiscale Modeling and Simulation*, 2005;**4**:732-59.
127. N. Kopell, Does it have to be so complicated? Editorial Focus on: "Single-column thalamocortical network model exhibiting gamma oscillations, spindles and epileptogenic bursts." *J. Neurophysiol.*, 2005;**93**:1829-30. PMID: 15774709
128. C. Borgers, S. Epstein and N.J. Kopell, Background gamma rhythmicity and attention in cortical local circuits: A computational study. *Proc. Nat. Acad. Sci. U.S. A.*, 2005;**102**:7002-7. PMID: 15870189
129. T. Gloveli, T. Dugladze, H.G. Rotstein, R.D. Traub, H. Monyer, U. Heinemann, M.A. Whittington, and N.J. Kopell, Orthogonal arrangement of rhythm-generating microcircuits in the hippocampus. *Proc. Nat. Acad. Sci. U. S. A.*, 2005;**102**:13295-300. PMID: 16141320
130. S.R. Jones and N. Kopell, Local network parameters can affect inter-network phase lags in central pattern generators. *J. Math. Biol.*, 2006;**52**:115-40. PMID: 16195924
131. E. Sivan and N. Kopell, Oscillations and slow patterning in the antennal lobe. *J. Comput. Neurosci.*, 2006;**20**:85-96. PMID: 16511657
132. A. Kuznetsov, N. Kopell and C. Wilson and, Transient high-frequency firing in a coupled-oscillator model of the mesencephalic dopaminergic neuron. *J. Neurophysiol.*, 2006;**95**:932-47. PMID: 16207783
133. H. Rotstein, T. Oppermann, J. White, and N. Kopell, The dynamic structure underlying subthreshold oscillatory activity and the onset of spikes in a model of medial entorhinal cortex stellate cells. *J. Comput. Neurosci.*, 2006;**21**:271-92. PMID: 16927211
134. G. Soto, N. Kopell and K. Sen, Network architecture, receptive fields, and neuromodulation: Computational and functional implications of cholinergic modulation in primary auditory cortex. *J. Neurophysiol.*, 2006;**96**:2972-83. PMID: 16899641
135. M.O. Cunningham, D. Pervouchine, C. Racca, N. Kopell, C.H. Davies, R.S. G. Jones, R.D. Traub and M.A. Whittington, Neuronal metabolism governs cortical network response state. *Proc. Nat. Acad. Sci. U. S.A.*, 2006;**103**:5597-601. PMID: 16565217
136. D. Pervouchine, T. Netoff, H. Rotstein, J.A. White, M.O. Cunningham, M.A. Whittington, and N.J. Kopell, Low dimensional maps encoding dynamics in the entorhinal cortex and hippocampus. *Neural Comput.*, 2006;**18**:2617-50 . PMID: 16999573
137. N. Kopell, D. Pervouchine, H.G. Rotstein, T. Netoff, and M. Whittington, Multiple rhythms and switches in the nervous system. *Proceedings of The Second International Symposium on the Frontiers of Applied Mathematics, Conference in Honor of the 90th Birthday of C.C. Lin, Beijing 2006*. Din-Yu Hsieh, Meirong Zhang & Weitao Sun. eds., World Scientific Publishing Co., 2007;1-18.
138. C.G. Behn, E. Brown, T. Scammell, and N. Kopell, Mathematical model of network dynamics governing mouse sleep-wake behavior. *J. Neurophysiol.*, 2007;**97**:3828-40. PMID: 17409167
139. J. Beshel, N. Kopell and L. Kay, Olfactory bulb gamma oscillations are enhanced with task demands. *J. Neurosci.*, 2007;**27**(31):8358-65. PMID: 17670982
140. A. Tort, H. Rotstein, T. Dugladze, T. Gloveli, and N. Kopell, On the formation of gamma-coherent cell assemblies by oriens lacunosum-moleculare interneurons in the hippocampus. *Proc. Nat. Acad. Sci. U. S. A.*, 2007;**104**(33):13490-5. PMID: 17679692

141. R. Silver, K. Boahen, S. Grillner, N. Kopell, K. L. Olsen, Neurotech for neuroscience: Unifying concepts, organizing principles, and emerging tools. *J. Neurosci.*, 2007; **27**(44):11807-19. PMID: 17978017
142. T. Dugladze, I. Vida, A.B. Tort, A. Gross, J. Otahal, U. Heinemann, N. Kopell, and T. Gloveli, Impaired hippocampal rhythmogenesis in a mouse model of mesial temporal lobe epilepsy. *Proc. Natl. Acad. Sci. U. S. A.*, 2007; **104**(44):17530-5. PMID: 17954918
143. M. Krupa, N. Popovic, N. Kopell, and H. Rotstein, Mixed-mode oscillations in a three time-scale model of oscillations for the dopaminergic neuron. *Chaos*, 2008; **18**:015106. PMID: 18377087
144. M. Krupa, N. Popovic and N. Kopell, Mixed-mode oscillations in three time-scale systems: A prototypical example. *SIADS Online*, 2008; **7**(2):361-420.
145. D. Vierling-Claassen, P. Seikmeier, S. Stufflebeam, and N. Kopell, Modeling GABA alterations in schizophrenia: A link between impaired inhibition and altered gamma and beta range auditory entrainment. *J. Neurophysiol.*, 2008; **99**(5):2656-71. PMID: 18287555
146. C. G. Diniz Behn, N. Kopell, E.N. Brown, T. Mochizuki, and T.E. Scammell, Delayed orexin signaling consolidates wakefulness and sleep: Physiology and modeling. *J. Neurophysiol.*, 2008; **99**(6): 3090-103. PMID: 18417630
147. M. Kramer, A. Tort, and N. J. Kopell, Sharp edge artifacts and spurious coupling in EEG frequency comodulation measures. *J. Neurosci. Methods*, 2008; **170**(2):352-7. PMID: 18328571
148. C. Borgers and N.J. Kopell, Gamma oscillations and stimulus selection. *Neural Comput.*, 2008; **20**(2):383-414. PMID: 18047409
149. A. K. Roopun, M.A. Kramer, L. Carracedo, M. Kaiser, C. Davies, R.D. Traub, N. Kopell, and M.A. Whittington, Period concatenation underlies interactions between gamma and beta rhythms in neocortex. *Front. Cell. Neurosci.*, 2008; **2**:1. PMID: 18946516
doi:10.3389/neuro.03.001.2008
(<http://sandbox.frontiersin.org/cellularneuroscience/paper/10.3389/neuro.03/001.2008/>)
150. M.M. McCarthy, E.N. Brown, and N. Kopell, Potential network mechanisms mediating electroencephalographic beta rhythm changes during propofol-induced paradoxical excitation. *J. Neurosci.*, 2008; **28**(50):13488-504. PMID: 19074022
151. A. Tort, M.A. Kramer, C. Thorn, D. Gibson, Y. Kubota, A.N. Graybiel, and N. Kopell, Dynamic cross-frequency couplings of local field potential oscillations in rat striatum and hippocampus during performance of a T-maze task. *Proc. Natl. Acad. Sci. U. S. A.*, 2008; **105**(51):20517-22. PMID: 19074268
152. M.A. Kramer, A.K. Roopun, L.M. Carracedo, R.D. Traub, M.A. Whittington, and N. Kopell, Rhythm generation through period concatenation in rat somatosensory cortex. *PLoS Comput. Biol.*, 2008; **4**(9):e1000169. PMID: 18773075
153. M.A. Kramer, R.D. Traub, and N. Kopell, New dynamics in cerebellar Purkinje cells: Torus canards. *Phys. Rev. Lett.*, 2008; **101**(6):068103. PMID: 18764509
154. H. Rotstein, M. Wechselberger and N. Kopell, Canard-induced mixed-mode oscillations in a medial entorhinal cortex layer II stellate cell model. *SIAM J. Appl. Dyn. Syst.*, 2008; **7**(4):1582-611.

155. S. Middleton, J. Jalics, T. Kispersky, F.E.N. LeBeau, A.K. Roopun, N. Kopell, M.A. Whittington, and M.O. Cunningham, NMDA receptor-dependent switching between different gamma rhythm-generating microcircuits in entorhinal cortex, *Proc. Natl. Acad. Sci. U. S. A.*, 2008; **105**(47):18572-7. PMID: 18997013
156. C. Borgers, S. Epstein and N. Kopell, Gamma oscillations mediate stimulus competition and attentional selection in a cortical network model. *Proc. Natl. Acad. Sci. U. S. A.*, 2008; **105**(46):18023-8. PMID: 19004759
157. A.K. Roopun, M.A. Kramer, L. Carracedo, M. Kaiser, C. Davies, R.D. Traub, N. Kopell, and M.A. Whittington, Temporal interactions between cortical rhythms. *Front. Neurosci.*, 2008; **2**(2):145-54. PMID: 19225587
158. L. Kay, J. Beshel, J. Brea, C. Martin, D. Rojas-Libano, and N. Kopell, Olfactory oscillations: The what, how and what for. *Trends Neurosci.*, 2009; **32**(4):207-14. PMID: 19243843
159. M. Shamir, O. Ghitza, S. Epstein, and N. Kopell, Representation of time-varying stimuli by a network exhibiting oscillations on a faster time scale. *PLoS Comput. Biol.*, 2009; **5**(5):e1000370. PMID: 19412531
160. D. Vierling-Claasen and N. Kopell, The dynamics of a periodically forced cortical microcircuit, with an application to schizophrenia, *SIAM J. Appl. Dyn. Syst.*, URL: <http://link.aip.org/link/?SJA/8/710>, DOI: 10.1137/080738052 June 2009.
161. P. Wulff, A.A Ponomarenko, M. Bartos, T. M. Korotkova, E.C. Fuchs, F. Böhner, M. Both, A.B. Tort, N. Kopell, W. Wisden, and H. Monyer, Hippocampal theta rhythm and its coupling with gamma oscillations require fast inhibition onto parvalbumin-positive interneurons. *Proc. Natl. Acad. Sci. U. S. A.*, 2009; **106**(9):3561-6. PMID: 19204281
162. N. Kopell, C. Borgers, D. Pervouchine, P. Malerba, and A.B.L. Tort, Gamma and theta rhythms in biophysical models of hippocampal circuits. In *Hippocampal microcircuits: A computational modeller's resource book*, V. Cutsuridis, B.F. Graham, S. Cobb, and I. Vida, eds., Springer, 2010; 423-57.
163. T. Gloveli, N. Kopell and T. Dugladze, Neuronal activity patterns during hippocampal network oscillations in vitro. In *Hippocampal microcircuits: A computational modeller's resource book*, V. Cutsuridis, B.F. Graham, S. Cobb, and I. Vida, eds., Springer, 2010.
164. A. Tort, R. Komorowski, J. Manns, N. Kopell, and H. Eichenbaum, Theta-gamma coupling increases during the learning of item-context associations. *Proc. Natl. Acad. Sci. U. S. A.*, 2009; **106**(49):20942-7. PMID: 19934062
165. S. Lee, K. Sen and N. Kopell, Cortical gamma rhythms are modulated by NMDAR-mediated spike timing dependent plasticity in a biophysical model. *PLoS Comput. Biol.*, 2009; **5**(12):e1000602. PMID: 20011119
166. N. Kopell, R.D. Traub and M.A. Whittington, Modeling rhythms: From physiology to function. Publication of Society for Neuroscience, 2009, Short Course #2, Rhythms of the Neocortex: Where do they come from and what are they good for? <http://www.sfn.org/shortcourses>

167. M.A. Whittington, R.D. Traub and N. Kopell, Diverse origins of network rhythms in cortical local circuits. Publication of Society for Neuroscience 2009, Short Course #2, Rhythms of the Neocortex: Where do they come from and what are they good for? <http://www.sfn.org/shortcourses>
168. M.A. Whittington, N. J. Kopell and R.D. Traub, What are the local circuit design features concerned with coordinating rhythms? Ms prepared for Strungman Forum: Dynamic coordination in the brain: From neurons to mind. 2009.
169. J. Brea, L. Kay and N. Kopell, Biophysical model for gamma rhythms in the olfactory bulb via subthreshold oscillations. Proc. Natl. Acad. Sci. U. S. A., 2009;**106**(51):21954-9. PMID: 19996171
170. A.B. Tort, A. Fontanini, M.A. Kramer, L.M. Jones-Lush, N.J. Kopell, and D.B. Katz, Cortical networks produce three distinct 7-12 Hz rhythms during single sensory responses in the awake rat. J. Neurosci., 2010;**30**(12):4315-24. PMID: 20335467
171. M.M. McCarthy, C. Moore-Kochlacs, X. Gu, E.S. Boyden, X. Han., and N. Kopell, Striatal origin of the pathologic beta oscillations in Parkinson's disease. Proc. Nat. Acad. Sci. U. S. A., 2011;**108**(28):11620-5. PMID: 21697509
172. N. Kopell, M. Kramer, P. Malerba, and M.A. Whittington, Are different rhythms good for different functions? Front. Hum. Neurosci., 2010;**4**:187. PMID: 21103019
173. A.B. Tort, R. Komorowski, H. Eichenbaum, and N. Kopell, Measuring phase-amplitude coupling between neuronal oscillations of different frequencies. J. Neurophysiol., 2010;**104**(2):1195-210. PMID: 20463205
174. A.B. Tort, R. Komorowski, N. Kopell, and H. Eichenbaum, A mechanism for the formation of hippocampal neuronal firing patterns that represent what happens where. Learn. Mem., 2011;**18**(11):718-27. PMID: 22021254
175. M. Desai, I. Kahn, U. Knoblich, J. Bernstein, H. Atahallah, N. Kopell, R.L. Buckner, A.M. Graybiel, C.I. Moore, and E.S. Boyden, Mapping brain networks in awake mice using combined optical neural control and fMRI. J. Neurophysiol., 2011;**105**(3):1393-405. PMID: 21160013
176. S. Ching, A. Cimenser, P. Purdon, E.N. Brown, and N. Kopell, Thalamocortical model for a propofol-induced alpha-rhythm associated with loss of consciousness. Proc. Natl. Acad. Sci. U. S. A., 2010;**107**(52):22665-70. PMID: 21149695
177. N. Kopell, M.A. Whittington and M.A. Kramer, Neuronal assembly dynamics in the beta1 frequency range permits short- term memory. Proc. Natl. Acad. Sci. U. S. A., 2011;**108**(9):3779-84. PMID: 21321198
178. M. Ainsworth, S. Lee, M.O. Cunningham, A.K. Roopun, R.D. Traub, N.J. Kopell, and M.A. Whittington, Dual gamma rhythm generators control interlaminar synchrony in auditory cortex. J. Neurosci., 2011;**31**(47):17040-51. PMID: 22114273
179. C. Borgers, G. Talei Franzesi, F. LeBeau, E. Boyden, and N. Kopell. Minimal size of cell assemblies coordinated by gamma oscillations. PloS Comp. Biol., 2012, Feb 8(2): e1002362. PMID: 22346741.

180. S. Ching, P.L. Purdon, N. Kopell, and E.N. Brown, A neuronal-metabolic model for the burst suppression electroencephalogram. *Proc. Nat. Acad. Sci.*, 2012 Feb 21; 109(8):3095-100. . PMID: 22323592
181. M.M. McCarthy, S. Ching, M.A. Whittington, and N. Kopell, Dynamical changes in neurological disease and anesthesia. *Current Opinion in Neurobiology*, 2012, *Curr Opin Neurobiol.* 2012 Mar 23. [Epub ahead of print] PMID: 22446010
182. P. Malerba and N. Kopell, Phase resetting reduces theta-gamma interaction to a one-dimensional map. *J. Math Biol.*, 2012, Apr 21. [Epub ahead of print] PMID: 22526842
183. M.M. McCarthy and N. Kopell, The effect of propofol anesthesia on rebound spiking. *SIAM J. Applied Dynamical Systems* (2012.Dec.13) 11(4):1674-1697
184. E. Munro and N. Kopell, Subthreshold somatic voltage in neocortical pyramidal cells can control whether spikes propagate from the axonal plexus to axon terminals: a model study. [J Neurophysiol.](#) 2012 May;107(10):2833-52. doi: 10.1152/jn.00709.2011. Epub 2012 Feb 29 .
185. S. Vijayan and N. Kopell, A Thalamic Model of Alpha and Its Implications for Stimulus Processing, *Proc Natl Acad Sci U S A.* 2012 Nov 6;109(45):18553-8 PMID: 23054840
186. M. Ainsworth, S. Lee, M.O. Cunningham, R.D. Traub, N.J. Kopell, and M. Whittington, Rates and Rhythms: A Synergistic View of Frequency and Temporal Coding in Neuronal Networks, *Neuron* 2012. Aug 23;75(4):572-83. PMID: 22920250.
187. P. Purdon, E. Pierce, E. Mukamel, J.L. Walsh, M. Prerau, K. Wong, A. Salazar-Gomez, P.G. Harrell, A.L. Sampson, A. Cimenser, S. Ching, N. Kopell, C.L. Tavares-Stoeckel, K. Habeeb, R. Merhar, E.N. Brown, Electroencephalogram Signatures of Loss and Recovery of Consciousness During Propofol-Induced General Anesthesia, *Proc Natl Acad Sci U S A.* 2013 Mar 19;110(12):E1142-51. doi: 10.1073/pnas.1221180110. Epub 2013 Mar 4.
188. J.H. Lee, M.A. Whittington, N.J. Kopell, “Top-down beta rhythms support selective attention via interlaminar interaction: a model”. *PLoS Comput Biol.* 2013 Aug;9(8):e1003164. doi: 10.1371/journal.pcbi.1003164. Epub 2013 Aug 8. PMID: 23950699
189. A. Sereney and N. Kopell, Effects of heterogeneous periodic forcing on inhibitory networks, *SIAM J. Appl. Dyn. Syst.*, 2013, 12(3), 1649–1684.
190. J. Mitry, M. McCarthy, N. Kopell and M. Wechselberger, Excitable neurons, firing threshold manifolds and canards. *J. Math. Neurosci.* 2013 3:12 (14 August 2013, online).
191. S. Vijayan, S. Chin, P. Purdon, E.N. Brown, N. Kopell, Thalamocortical mechanisms for the anteriorization of alpha rhythms during propofol-induced unconsciousness, *J. Neurosci.*, 2013; 33 11070-11075.
192. N. Kopell, Interview with Nancy Kopell. *Trends Neurosci.* 2013 Jun;36(6):313-4.
193. T. Dugladze, N. Maziashvili, C. Börgers, S. Gurgunidze, U. Häussler, A. Winkelmann, C.A. Haas, J.C. Meier, I. Vida, N. Kopell and T. Gloveli, GABA_B autoreceptor-mediated

- cell-type specific reduction of inhibition in epileptic mice, *Proc. Nat. Acad. Sci* 2013, Sep 10; 110(37):15073-8.
194. A. Devor, P.A. Bandettini, D.A. Boas, J.M. Bower, R.B. Buxton, L.B. Cohen, A.M. Dale, G.T. Einevoll, P.T. Fox, M.A. Franceschini, K.J. Friston, J.G. Fujimoto, M.A. Geyer, J.H. Greenberg, E. Halgren, M.S. Hämäläinen, F. Helmchen, B.T. Hyman, A. Jasanoff, T.L. Jernigan, L.L. Judd, S. Kim, D. Kleinfeld, N.J. Kopell, M. Kutas, K.K. Kwong, M.E. Larkum, E.H. Lo, P.J. Magistretti, J.B. Mandeville, E. Masliah, P.P. Mitra, W.C. Mobley, M.A. Moskowitz, A. Nimmerjahn, J.H. Reynolds, B.R. Rosen, B.M. Salzberg, C.B. Schaffer, G.A. Silva, P.T. C. So, N.C. Spitzer, R.B. Tootell, D.C. Van Essen³, W. Vanduffel, S.A. Vinogradov, L.L. Wald, L.V. Wang, B. Weber⁴², A.G. Yodh⁴³, “The Challenge of Connecting the Dots in the B.R.A.I.N., *Neuron* 2013, Oct 16;80(2):270-4.
 195. J Cannon, M. McCarthy, S Lee, J Lee, C Börgers, M A Whittington, N Kopell, *Neurosystems: Brain Rhythms and Cognitive Processing*, *European J. Neurosci*, 2013 <http://onlinelibrary.wiley.com/doi/10.1111/ejn.12453/full>
 196. C. Borgers, J. Lie and N Kopell, Approximate, not perfect synchrony maximizes the downstream effectiveness of excitatory neuronal ensembles. *J. Math. Neurosci*, 2014, 4:10.
 197. N. Kopell, HJ Gritton, MA Whittington and MA Kramer, Beyond the connectome: the dynamo. *Neuron* 2014 Sept 17; 63(6): 1319-28
 198. Santaniello S, Michelle McCarthy, Erwin B Montgomery, John T. Gale, Nancy J. Kopell Sridevi V Sarma, Therapeutic mechanisms of high frequency stimulation in Parkinson's disease and neural restoration via loop-based reinforcement, *Proc. Nat. Acad of Science*. 2015 Feb 10;112(6):E586-95. doi: 10.1073/pnas.1406549111. Epub 2015 Jan 26.
 199. Benjamin R. Pittman-Polletta, Bernat Kocsis, Sujith Vijayan, Miles A. Whittington, Nancy J. Kopell, Brain Rhythms Connect Impaired Inhibition to Altered Cognition in Schizophrenia, *Biological Psychiatry*, 2015 Jun 15;77(12):1020-1030. doi: 10.1016/j.biopsych.2015.02.005. Epub 2015 Feb 14.
 200. Justin P. Kinney, Jacob G. Bernstein, Andrew J. Meyer, Jessica Barber, Marti Bolivar, Bryan Newbold, Jorg Scholvin, Caroline Moore - Kochlacs, Christian T. Wentz, Nancy Kopell, and Edward S. Boyden A Minimalist Data Acquisition Module to Support Scalable Neural Recording, *IEEE Transactions on Biomedical Engineering (TBME)*, 2015.
 201. Jonathan Cannon, Nancy Kopell, Timothy Gardner, Jeffrey Markowitz. Neural sequence generation using spatiotemporal patterns of inhibition, *PloS comput. Bio*, 2015, Nov 4, 11(11).
 202. Jung H. Lee, Miles A. Whittington and Nancy J. Kopell, Potential mechanisms underlying intercortical signal regulation via cholinergic neuromodulators, *J Neurosci*. 2015 Nov 11;35(45):15000-14. doi: 10.1523/J Neurosci.0629-15.2015. PMID: 26558772
-

203. Sujith Vijan, Elizabeth Klerman, Gail Adler, Nancy J, Kopell, thalamic mechanisms underlying alpha-delta sleep with implications for fibromyalgia, *J. Neurophysiol* 2015, Sept; 114(3); 1923-30. doi 10.1152/jn00280.2015, Epub 2015Aug 5. PMID 26245315
 204. Jon Cannon and Nancy Kopell , The Leaky Oscillator: Properties of Inhibition-Based Rhythms Revealed through the Singular Phase Response Curve, *SIAM J. Appl. Dyn. Syst.*, 14(4), 1930–1977, 2015 DOI:[10.1137/140977151](https://doi.org/10.1137/140977151)
 205. M. Ainsworth, S. Lee, M. Kaiser, J. Simonotto, M. O. Cunningham, N. Kopell & M. A. Whittington. GABA_B receptor-mediated, layer-specific excitatory and inhibitory synaptic plasticity reorganises gamma frequency neocortical response to stimulation. *Proc Natl Acad Sci U S A*. 2016 May 16. pii: 201605658. [Epub ahead of print]
 206. Nancy Kopell, *Beginner Mind: a Scientific Autobiography*. Vol 9, *History of Neuroscience in Autobiography*, Publisher: Society for Neuroscience, eds. Thomas Albright and Lawrence Squire, **in press** 2016
 207. Krishnakanth Kondabolu, Erik A Roberts, Mark Bucklin, Michelle M McCarthy, Nancy Kopell, Xue Han, striatal interneuron activation generates beta oscillations in the corticostriatal circuit and produces motor deficits. *Proc Natl Acad Sci U S A*. 2016 May 16. pii: 201605658. [Epub ahead of print]
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