

Philip Nelson

Vita

- Address Department of Physics and Astronomy
University of Pennsylvania
Philadelphia, Pennsylvania 19104
Phone: (215)-898-7001 (office)
Web: <http://dept.physics.upenn.edu/~pcn>
- Faculty appointments 1998– Professor of Physics, University of Pennsylvania.
1991–98 Associate Professor of Physics, University of Pennsylvania.
1988–91 Assistant Professor of Physics, University of Pennsylvania.
1987–88 Assistant Professor of Physics, Boston University.
- Other positions 2013– General Member, Aspen Center for Physics.
2000 Visiting Scientist, Weizmann Institute of Science.
1999– Director, Undergraduate Major in Biophysics, Penn.
1994 Visiting Scientist, Service de Physique Théorique, CEN Saclay.
1994 General Member, Institute for Theoretical Physics, Santa Barbara.
1984 Visiting Scientist, Institute for Theoretical Physics, Santa Barbara.
- Education 1984 Ph.D., Physics, Harvard University.
1983 A.M., Physics, Harvard University.
1981 Certificate of Advanced Study in Mathematics,
with distinction, University of Cambridge.
1980 A.B., Physics, summa cum laude, Princeton University.
- Fellowships and Honors 2009 Emily Gray Prize of the Biophysical Society, “for far reaching and significant contributions to the teaching of biophysics, developing innovative educational materials, and fostering an environment exceptionally conducive to education in Biological Physics.”
2003 Fellow of the American Physical Society, “For contributions to the understanding of soft biomaterials, quantum fields,

- and superstrings, using geometrical and topological methods.”
- 2001 Ira Abrams Award, highest distinguished teaching honor of Penn’s School of Arts and Sciences.
- 1988–94 NSF Presidential Young Investigator award.
- 1988–91 Young Faculty Award, University of Pennsylvania.
- 1988–91 Alfred P. Sloan Foundation Fellow.
- 1988 Department of Energy Outstanding Junior Investigator.
- 1984–87 Junior Fellow, Harvard University Society of Fellows.
- 1981–84 National Science Foundation graduate fellow.
- 1980-82 Winston Churchill Foundation fellowship.

Past research interests

Biological physics: mechanics of biopolymers; molecular motors; self-assembly; DNA topology and elasticity; stochastic and hidden Markov modeling; computational neuroscience.

Condensed matter physics: complex fluids; bilayer membranes; dynamical pattern formation; colloidal forces; entropic forces.

Geometrical methods in theoretical physics: classical and quantum fields; monopoles; anomalies; string theories; superspace and supergravity; Bose-Fermi equivalence; conformal field theory; random geometry.

Dissertation

“Global Conflicts”; advisor Prof. S. Coleman.

Teaching experience

Physics 514: Mechanics, Fluids, Chaos.

Physics 240/250: Einstein’s Century.

Physics 650: Minicourse on Biopolymers and Membranes.

Physics 580: Biological Physics.

Physics 516: Electromagnetic Phenomena.

Physics 280: Physical Models of Biological Systems.

For all of these see <http://www.physics.upenn.edu/~pcn/>

Dissertations supervised

- 1992 Eugene Wong. Wong is on the tenured faculty of the Department of Physics and Astronomy of the University of Western Ontario.
- 1995 Thomas Powers. Powers is Professor of Engineering and Professor of Physics at Brown University.
- 1998 J. David Moroz. Moroz is Director, International Safeguards Division at Canadian Nuclear Safety Commission.
- 2001 Yi Chen. Chen is an analyst at Tower Research Capital.
- 2010 (joint with Yale Goldman) John F. Beausang. Beausang is employed at GRAIL, Inc.
- 2012 (joint with Vijay Balasubramanian) Jason Prentice. Prentice is employed at Panjiva Inc.

Recent
Postdocs

- 1998 Martin Zapotocky; now Group Leader, Dept of Biological Physics, Max Planck Institute for Physics of Complex Systems.
- 2001–03 Cornelis Storm; now Assistant Professor, Eindhoven Technical Univ.
- 2006–07 Igor Kulić; now permanent faculty, CNRS (Institut Charles Sadron, Strasbourg).
- 2005–06 Prashant Purohit; now Associate Professor, Penn MEAM Department.
- 2007–08 Kevin Towles; now Project Leader at Boston Consulting Group.
- 2008–10 (joint with Vijay Balasubramanian) Gasper Tkacik; now Assistant Professor, Institute of Science and Technology, Vienna Austria.
- 2010–12 (joint with Andrea Liu) Timon Idema; now Assistant Professor, Delft University.

Conferences
and schools
since 2006

- 2017 “Physical Biology of the Cell” school, Marine Biology Laboratory (invited lecturer).
- 2017 “Interdisciplinary Instruction in Biological Physics,” American Association of Physics Teachers national meeting (workshop organizer).
- 2017 Mini-workshop on Physical Biology, Institute of Theoretical Physics (Chinese Academy of Sciences) (invited talk).
- 2017 Single-Cell Biophysics: Measurement, Modulation, and Modeling, Biophysical Society, Taipei Taiwan (invited lecturer).
- 2017 Koninklijke Nederlandse Akademie van Wetenschappen Biophysics Meeting, Amsterdam (main invited talk).
- 2017 American Physical Society March Meeting (contributed talk).
- 2017 Biophysical Society national meeting.
- 2016 “Physical Biology of the Cell” school, Marine Biology Laboratory (invited lecturer).
- 2016 Aspen Center for Physics.
- 2016 American Association of Physics Teachers (invited talk).
- 2016 “Using quantitative biology for broadening participation for STEM education” at Spelman College (invited talk).
- 2016 Modeling and Inference from Single Molecule to Cells, Mathematical Biosciences Institute (invited colloquium talk).
- 2015 Closing Speaker, 9th Annual q-bio Conference, Virginia Tech, Blacksburg, Virginia (invited).
- 2015 Aspen Center for Physics.
- 2015 Chicago area biophysics meeting (invited talk).
- 2015 American Physical Society March Meeting (contributed talk).
- 2015 Biophysical Society national meeting.
- 2015 AAPT, San Diego (contributed talk).
- 2014 Aspen Center for Physics.
- 2014 Gordon Research Conference on Physics Research and Education, Mt. Holyoke (invited talk).

- 2014 American Physical Society, Denver (2 contributed talks).
- 2013 Physics of Functional Biological Assemblies, Aspen.
- 2013 XXth International Summer School Nicolas Cabrera, Physics department, Autonomous University at Madrid (invited keynote lectures).
- 2012 American Society for Cell Biology meeting “Open Problems in Biology Requiring the Physical Sciences” (invited talk).
- 2012 Biophysical Society Pennsylvania Network Meeting (invited talk).
- 2012 Grand Biological Challenges for Mathematicians: From Cells and Microbes to Brains, London Mathematical Society symposium (two invited talks).
- 2012 Physics of Behavior, Aspen.
- 2011 Computation and Collective Behavior in Biological Systems, Aspen.
- 2011 How Molecules Come to Life: Biophysics Vision 2016, NSF (invited short talk).
- 2011 American Association of Physics Teachers regional meeting (keynote).
- 2011 Biophysical Society, Baltimore (poster).
- 2010 Physics Meets Biology, Oxford UK (plenary invited talk).
- 2010 Challenges in Extracellular Electrophysiology, Janelia Farm.
- 2010 Mathematical and experimental approaches to dynamics of protein-DNA interactions, Ohio State (plenary invited talk).
- 2010 American Physical Society March Meeting (invited talk and contributed talk).
- 2010 Inaugural workshop, Initiative in the Theoretical Sciences, CUNY (invited talk).
- 2009 Biophysical Society (1 invited talk, 2 contributed talks).
- 2009 American Physical Society March Meeting (invited talk).
- 2009 Single Molecule Biophysics, Aspen (contributed talk).
- 2008 Invitational Summit on Undergraduate Biology Teaching, Howard Hughes Medical Institute (Biophysical Society delegate).
- 2008 SIAM Conference on Mathematical Aspects of Materials Science (invited talk).
- 2008 Biophysical Society (invited talk).
- 2007 Biophysical Society (contributed talk).
- 2006 Molecular Motors: Point Counterpoint, Asilomar.
- 2006 New Physical Approaches to Molecular and Cellular Machines, Kavli Institute for Theoretical Physics (coorganizer).
- 2006 Interdisciplinarity and Discipline in Education, Kavli Institute for Theoretical Physics (coorganizer).

Other invited talks:

Seminars outside Penn, since 1996:

Harvard, Chicago ($\times 2$), Cornell, Princeton ($\times 2$), Duke, the Rockefeller University ($\times 2$), McGill University ($\times 2$), MIT, Boston University, Vrije Universiteit Amsterdam, TU Delft (Netherlands), Institute of Physics (Chinese Academy of Sciences).

Department Colloquia, since 1996:

MIT Applied Mathematics, Duke University Physics, Brown University Physics, University of Colorado Physics, University of Chicago Physics ($\times 2$), Boston University Physics ($\times 2$), Rutgers Physics ($\times 2$), Brandeis Physics, University of Illinois, Harvard University Physics, Emory University Physics, Temple University Physics, Caltech Biophysics, Princeton Physics, Renaissance Technology, University of Toronto Physics, Tufts University Physics, McGill Physics, MIT Physics, Yale Physics, Michigan Physics, Wayne State Physics, Institute of Physics, Chinese Academy of Sciences and Kavli Institute of Theoretical Physics, Chinese Academy of Sciences, the Forman Lecture at Vanderbilt University, Georgia Tech, and the A. O. Williams lecture at Brown University.

Other
professional
activities

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| 2017 | Vice Chair-elect, American Physical Society Division of Biological Physics. |
| 2017– | Burroughs-Wellcome Fund Career Award at the Scientific Interface review panel member. |
| 2014–16 | American Physical Society’s Max Delbrück Award committee. |
| 2011 | Review panel member, NSF Biology division. |
| 2011 | “Physics of human and superhuman vision,” Heinz R. Pagels memorial public lecture, Aspen. |
| 2007 | Boulder Summer School in Quantitative Biology (invited lecturer). |
| 2006 | Co-organizer, workshop on “New Physical Approaches to Molecular and Cellular Devices” at the Kavli Institute for Theoretical Physics, UCSB. |
| 2005,09 | Visiting Committee of the Harvard University Physics Department. |
| 2004 | NSF Workshop on the Role of Theory in Biological Physics. and Materials, Tempe, AZ (panel participant). |
| 1992 | NSF NYI Award review panel. |
| 1991 | Workshop co-organizer, Aspen Center for Physics. |
| 1987 | Convenor and chair, superunification session, American Physical Society Division of Particles and Fields meeting, Salt Lake City. |
| 1987 | Consultant to Public Broadcasting Associates for NOVA. |

Philip Nelson

Publications since 2000

Profiles:

<http://www.researcherid.com/rid/I-6251-2015>;
<http://orcid.org/0000-0002-1782-3076>; and
<https://scholar.google.com/citations?user=hgGCUoUAAAAJ&hl=en>.

H-index 51 per Google Scholar.

(P)reprints of most of the articles below are freely available via
<https://works.bepress.com/philip-c-nelson/>.

Books:

- P. Nelson and Jesse M. Kinder, *Python 物理建模初学者指南 (Python wuli jianmo chuxuezhe zhinan)* (Posts & Telecom Press, 2017).
- P. Nelson, *From Photon to Neuron: Light, Imaging, Vision* (Princeton University Press, 2017).
- P. Nelson and Jesse M. Kinder, 공학 모델링을 위한 파이썬 프로그래밍-본문 (HumanScience, 2017).
- P. Nelson, 生命系统的物理建模 (*Huó xìtōng de wùlǐ jiàn mó*), (Shanghai Scientific and Technical Publishers, 2018).
- P. Nelson, 生物物理学:能量、信息、生命 (*Sheng Wu Wu Li Xue: Neng Liang, Xing Xi, Sheng Ming*) second ed. (Shanghai Scientific and Technical Publishers, 2016).
- P. Nelson, *Physical Models of Living Systems* (W. H. Freeman and Co., 2015).
- P. Nelson and Jesse M. Kinder, *A Student's Guide to Python for Physical Modeling* (Princeton University Press, 2015).
- P. Nelson with Tom Dodson, *A Student's Guide to MATLAB for Physical Modeling* (<https://github.com/NelsonUpenn/PMLS-MATLAB-Guide>, 2015).
- P. Nelson, *Biological Physics: Energy, Information, Life: With new art by David Goodsell* (W. H. Freeman and Co., 2014).
- P. Nelson, *Física Biológica: Energía, Información, Vida* (Editorial Reverte, 2005).
- P. Nelson, *Física Biológica: Energia, Informação, Vida* (Guanabara Koogan, 2006).

Video:

“Physics of human and superhuman vision,”

<https://www.youtube.com/watch?v=0VjK4HZ2jBw&feature=youtu.be>
or <http://vimeo.com/channels/4330>.

Peer-Reviewed Journal Articles (since 2000):

- Y. Chen and **P. Nelson**, *Charge-Reversal Instability in Mixed Bilayer Vesicles*, Phys. Rev. **E62**, 2608–2619 (2000).
- C. Storm and **P. Nelson**, *The Bend Stiffness of S-DNA*, Europhys. Lett., **62**, 760–766 (2003).
- C. Storm and **P. Nelson**, *Theory of High-Force DNA Stretching and Overstretching*, Phys. Rev. **E67**, 051906-(1–12) (2003).
- P. Nelson**, *Comment on “Rotational Drag on DNA: A Single Molecule Experiment” by P. Thomen, U. Bockelmann, and F. Heslot*, Phys. Rev. Lett. **92**, 159801-(1) (2004); highlighted in the Virtual Journal of Biological Physics Research (May 1, 2004 issue).
- P.A. Wiggins, R. Phillips, and **P.C. Nelson**, *Exact Theory of Kinkable Elastic Polymers*, Phys. Rev. **E71**, 021909-(1–19) (2005); highlighted in the March 1, 2005 issue of Virtual Journal of Biological Physics Research.
- D.E. Segall, **P.C. Nelson**, and R. Phillips, *Excluded-Volume Effects in Tethered-Particle Experiments: Bead Size Matters*, Phys. Rev. Lett. **96**, 088306-(1–4) (2006).
- P.A. Wiggins and **P.C. Nelson**, *Generalized Theory of Semiflexible Polymers*, Phys. Rev. E **73**, 031906-(1–13) (2006).
- P.C. Nelson**, C. Zurla, D. Brogioli, J.F. Beausang, L. Finzi, and D. Dunlap, *Tethered Particle Motion as a Diagnostic of DNA Tether Length*, J. Phys. Chem. B **110**, 17260–17267 (2006).
- J. Li, **P.C. Nelson**, and M.D. Betterton, *Entropic Elasticity of DNA with a Permanent Kink*, Macromolecules **39**, 8816–8821 (2006).
- P.A. Wiggins, T. van der Heijden, F. Moreno-Herrero, A. Spakowitz, R. Phillips, J. Widom, C. Dekker, and **P.C. Nelson**, *High Flexibility of DNA on Short Length Scales Probed by Atomic Force Microscopy*, Nature Nanotechnology **1**, 137–141 (2006).
- P.K. Purohit and **P.C. Nelson**, *Effect of Supercoiling on Formation of Protein Mediated DNA Loops*, Phys. Rev. **E74**, 061907-(1–14) (2006).
- J.F. Beausang, C. Zurla, L. Sullivan, L. Finzi, and **P.C. Nelson**, *Elementary Simulation of Tethered Brownian Motion*, Am. J. Phys. **75**, 520–523 (2007).

- J.F. Beausang, C. Zurla, C. Manzo, D. Dunlap, L. Finzi, and **P.C. Nelson**, *DNA Looping Kinetics Analyzed Using Diffusive Hidden Markov Model*, Biophysical Letters section of Biophys. J. **92**, L64–L66 (2007).
- Y. Seol, J. Li, **P.C. Nelson**, T.T. Perkins, and M.D. Betterton, *Elasticity of Short DNA Molecules: Theory and Experiment for Contour Lengths of 0.6–7 μm* , Biophys. J. **93**, 4360–4373 (2007).
- J.F. Beausang and **P.C. Nelson**, *Diffusive Hidden Markov Model Characterization of DNA Looping Dynamics in Tethered Particle Experiments*, Physical Biology **4**, 205–219 (2007).
- I. M. Kulić and **P.C. Nelson**, *Hitchhiking Through the Cytoplasm*, Europhys. Lett. **81**, 18001-(1–6) (2008).
- I.M. Kulić, A.E.X. Brown, H. Kim, C. Kural, B. Blehm, P.R. Selvin, **P.C. Nelson**, and V.I. Gelfand, *The Role of Microtubule Movement in Bidirectional Organelle Transport*, Proc. Natl. Acad. Sci. USA, **105** 10011–10016 (2008).
- J.F. Beausang, H.W. Schroeder III, **P.C. Nelson**, Y.E. Goldman, *Twirling of Actin by Myosins II and V Observed via Polarized TIRF in a Modified Gliding Assay*, Biophys. J. **95**, 5820–5831 (2008).
- L. Han, H.G. Garcia, S. Blumberg, K.B. Towles, J.F. Beausang, **P.C. Nelson**, R. Phillips, *Concentration and Length Dependence of DNA Looping in Transcriptional Regulation*, PLoS ONE **4** e5621-(1–17) (2009).
- K. Towles, J.F. Beausang, H.G. Garcia, R. Phillips, and **P.C. Nelson**, *First-principles Calculation of DNA Looping in Tethered Particle Experiments*, Physical Biology, **6** 025001-(1–22) (2009).
- J. S. Prentice, J. Homann, K. D. Simmons, G. Tkacik, V. Balasubramanian, and **P.C. Nelson**, *Fast, Scalable, Bayesian Spike Identification for Multi-Electrode Arrays*, PLoS ONE **6**(7): e19884 (2011).
- J. F. Beausang, D. Y. Shroder, **P.C. Nelson**, and Y. E. Goldman, *Tilting and Wobble of Myosin V by High-Speed Single-Molecule Polarized Fluorescence Microscopy*, Biophys. J. **104** 1263–1273 (2013).
- K. D. Simmons, J. S. Prentice, G. Tkacik, J. Homann, H. K. Yee, S. E. Palmer, **P.C. Nelson**, and V. Balasubramanian *Transformation of Stimulus Correlations by the Retina*, PLoS Computational Biology **9** e1003344 (16 pages) (2013).
- Timon Idema, Julien O. Dubuis, Louis Kang, M. Lisa Manning, **P.C. Nelson**, Tom C. Lubensky, and Andrea J. Liu, *The Syncytial Drosophila Embryo as a Mechanically Excitable Medium*, PLoS ONE **8**(10): e77216 (11 pages) (2013).
- P.C. Nelson**, *Old and New Results About Single-Photon Sensitivity in Human Vision*, Physical Biology (11 pages) **20**:025001 (2016).

Reviews, lectures, proceedings, popular articles (since 2000):

- R.E. Goldstein, **P. Nelson**, and T.R. Powers, *Teaching Biological Physics*, Physics Today, **58:3** 46–51 (March 2005).
- H.G. Garcia, P. Grayson, L. Han, M. Inamdar, J. Kondev, **P.C. Nelson**, R. Phillips, J. Widom, and P.A. Wiggins, *Biological Consequences of Tightly Bent DNA: The Other Life of a Macromolecular Celebrity*, Biopolymers **85**, 115–130 (2007).
- P.C. Nelson**, *Colloidal Particle Motion as a Diagnostic of DNA Conformational Transitions*, Curr. Op. Colloid Interf. Sci. **12**, 307–313 (2007).
- P. Nelson**, *Advanced Theories*, letter to New Yorker Magazine (8 September 2008) p. 5.
- L. Han, B.H. Lui, S. Blumberg, J.F. Beausang, **P.C. Nelson**, and R. Phillips, *Calibration of Tethered Particle Motion Experiments*, in *Mathematics of DNA Structure, Function and Interactions* eds. C. J. Benham, S. Harvey, W. K. Olson, D. L. Summers, and D. Swigon (Springer, 2009), pp. 123–138.
- J. F. Beausang, Y. E. Goldman, and **P.C. Nelson**, *Changepoint Analysis for Single-Molecule Polarized Total Internal Reflection Fluorescence Microscopy Experiments*, Meth. Enzymol. **487** 431–463 (2011).
- J. S. Prentice, J. Homann, K. D. Simmons, G. Tkacik, V. Balasubramanian, and **P.C. Nelson**, *Spike Sorting for Multi-Electrode Array Data*, in *Encyclopedia of Applied and Computational Mathematics* ed. B. Engquist (Springer, 2015),
<http://www.springerreference.com/docs/html/chapterdbid/333735.html> .
- P.C. Nelson**, *Spare the (Elastic) Rod*, Science **337** 1045–6 (2012).
- P. Nelson, *Coding and Data Visualization in the Science Classroom*, University of Pennsylvania Almanac **63** 6 (2016),
<http://www.upenn.edu/almanac/volumes/v63/n06/pdf/092016.pdf> .