

Curriculum Vitae: Ching-Hwa Kiang

Assistant Professor

Department of Physics & Astronomy
and Department of Bioengineering

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Education

Ph.D., 1995, California Institute of Technology.

B.S., 1987, National Taiwan University.

Research Interests

Single-molecule dynamic force spectroscopy of biomolecules. Jarzynski's equality and its application to biological systems. Equilibrium and nonequilibrium statistical physics of small systems. Protein folding pathways and dynamics. Mechanical properties of proteins.

Honors

Cram Teacher-Scholar, Chemistry & Biochemistry, UCLA, 1996–1999.

IBM Student Thesis Fellowship, IBM Almaden Research Center, 1992–1995.

Professional Experience

Assistant Professor, Physics & Astronomy, Rice University, 2002–present.

Assistant Professor, Bioengineering, Rice University, 2002–present.

Assistant Research Physicist, Physics & Astronomy, UCLA, 2000–2002.

Visiting Assistant Professor, Chemistry & Biochemistry, UCLA, 1996–2000.

Postdoctoral Associate, Physics, MIT, 1995–1996.

Visiting Scientist, IBM Almaden Research Center, 1992–1995.

Research Assistant, Institute of Atomic and Molecular Sciences, Academia Sinica
Taipei, Taiwan, ROC, 1987–1988.

Summary of Research Accomplishments

First reconstruction of free energy curves using Jarzynski's equality.

Experimental determination of phase transition in DNA-gold nanoparticle systems.

Discovery of single-walled carbon nanotubes.

Teaching Experience

Biological Physics (PHYS551), instructor
Molecular Biophysics (PHYS552), instructor
Advanced Topics in Physics: Biological Physics (PHYS600), instructor

Professional Affiliations

American Physical Society	American Academy of Nanomedicine (Founding Member)
Biophysical Society	American Chemical Society
Microscopy Society of America	Sigma Xi

Professional Services

1. Co-organizer, *2009 Boulder School for Condensed Matter and Materials Physics*, on "Nonequilibrium Statistical Mechanics: Fundamental Problems and Applications," Boulder, CO, 6–31 July 2009.
2. Chair for the focus session "K26: Single-Molecule Biophysics I," *The 2006 APS March Meeting*, Baltimore, MD, 13–17 March 2006.
3. Organizer for the focus sessions "B26: Single-Molecule Biophysics: DNA & RNA," and "K26: Single-Molecule Biophysics I" *The 2006 APS March Meeting*, Baltimore, MD, 13–17 March 2006.
4. Advisor and session chair for the conference "Large Scale Manufacturing and Commercialization Applications of Carbon Nanotubes," organized by the Knowledge Foundation, Washington DC, 22–23 April, 1999.
5. Interview with BBC Science in London on Nanotechnology. Broadcast at 9pm, 19 November 1998 on Radio4: "News: Leading Edge."

Publications

(Average citation rate per paper: 106)

(H number: 17)

1. N. C. Harris, J. M. Cowley, and C.-H. Kiang, "Global and Regional Helicity Distributions of Single-Walled Carbon Nanotubes and Its Implication on the Growth Mechanism," *J. Nanoscience Nanotechnology* (2007), *submitted*.
2. Y. Sun, N. C. Harris, and C.-H. Kiang, "Phase Transition and Optical Properties of DNA-Gold Nanoparticle Assemblies," *Plasmonics* (2007) *invited review article, accepted*.

3. N. C. Harris, Y. Song, and C.-H. Kiang, "Experimental Free Energy Surface Reconstruction From Single-Molecule Force Spectroscopy Using Jarzynski's Equality," *Phys. Rev. Lett.*, **99** (2007) 068101-1-4.
4. N. C. Harris and C.-H. Kiang, "Defects Can Increase the The Melting Temperature of DNA-Nanoparticle Assemblies," *J. Phys. Chem. B*, **110**, (2006) 16393-16396.
5. N. C. Harris and C.-H. Kiang, "Disorder in DNA-Linked Gold Nanoparticle Assemblies," *Phys. Rev. Lett.* **95** (2005) 046101-1-4. Also in *Virtual Journal of Biological Physics Research* **10**, issue 3, (2005), and *Virtual Journal of Nanoscale Science & Technology*, **12**, issue 5 (2005) [3 citations].
6. Y. Sun, N. C. Harris, and C.-H. Kiang, "The Reversible Phase Transition of DNA-Linked Colloidal Gold Assemblies," *Physica A* **354** (2005) 1-9 [6 citation].
7. Y. Sun and C.-H. Kiang, "DNA-Based Artificial Nanostructures: Fabrication, Properties, and Applications," invited book chapter in *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Vol.2, Chapter VII, pp 224-246 (ISBN: 1-58883-033-0), edited by H. S. Nalwa (American Scientific Publishers, Stevenson Ranch, CA, 2005).
8. Y. Sun, N. C. Harris and C.-H. Kiang, "Melting Transition of Directly-Linked Gold Nanoparticle DNA Assembly," *Physica A* **350** (2005) 89-94 [6 citations].
9. C.-H. Kiang, "Phase Transition of DNA-Linked Gold Nanoparticles," *Physica A* **321** (2003) 164-169 [25 citations].
10. C.-H. Kiang, "Single Particle Study of Protein Assembly," *Phys. Rev. E*, **64** (2001) 041911-1-041911-3 [1 citation].
11. J. L. O'Loughlin, C. H. Wallace, T. K. Reynolds, C.-H. Kiang, and R. B. Kaner, "Rapid Synthesis of Carbon Nanotubes by Solid-State Metathesis Reactions," *J. Phys. Chem. B*, **105** (2001) 1921-1924 [19 citations].
12. C.-H. Kiang, "Carbon Rings and Cages in the Growth of Single-Walled Carbon Nanotubes," *J. Chem. Phys.*, **113** (2000) 4763-4766 [12 citations].
13. J. M. Cowley and C.-H. Kiang, "The Structure of Near-Spherical Carbon Nano-Shells," *Carbon*, **38** (2000) 1437-1444 [1 citation].
14. C.-H. Kiang, "Electron Irradiation Induced Dimensional Change in Bismuth Filled Carbon Nanotubes," *Carbon*, **38** (2000) 1699-1701 [12 citations].
15. C.-H. Kiang, "Growth of Large Diameter Single-Walled Carbon Nanotubes," *J. Phys. Chem. A*, **104** (2000) 2454-2456 [17 citations].
16. C.-H. Kiang, J.-S. Choi, T. Tran, and A. D. Bacher, "Molecular Nanowires of 1 nm Diameter from Capillary Filling of Single-Walled Carbon Nanotubes," *J. Phys. Chem. B*, **103** (1999) 7449-7451 [58 citations].

17. C.-H. Kiang, M. Endo, P. M. Ajayan, G. Dresselhaus, and M. S. Dresselhaus, "Size Effects in Carbon Nanotubes," *Phys. Rev. Lett.* **81** (1998) 1869–1872 [82 citations].
18. S. Stevenson, P. Burbank, K. Harich, Z. Sun, H. C. Dorn, P. H. M. van Loosdrecht, M. S. de Vries, J. R. Salem, R. D. Johnson, C.-H. Kiang, and D. S. Bethune, "La₂@C₇₂: Metal-Mediated Stabilization of a Carbon Cage," *J. Phys. Chem. A* **102** (1998) 2833–2837 [21 citations].
19. M. Endo, K. Takeuchi, T. Hiraoka, T. Furuta, T. Kasai, X. Sun, C.-H. Kiang, and M. S. Dresselhaus, "Stacking Nature of Graphene Layers in Carbon Nanotubes and Nanofibres," *J. Phys. Chem. Solids* **58** (1997) 1707–1712 [15 citations].
20. A. C. Dillon, K. M. Jones, T. A. Bekkedahl, C.-H. Kiang, D. S. Bethune, and M. J. Heben, "Storage of Hydrogen in Single-Wall Carbon Nanotubes," *Nature* **386** (1997) 377–379 [1237 citations].
21. X. Sun, C.-H. Kiang, M. Endo, K. Takeuchi, T. Furuta, G. Dresselhaus, and M. S. Dresselhaus, "Stacking Characteristics of Graphene Shells in Carbon Nanotubes," *Phys. Rev. B* **54** (1996) 12629–12632 [20 citations].
22. C.-H. Kiang, M. S. Dresselhaus, D. S. Bethune, and W. A. Goddard III, "Vapor Phase Self-Assembly of Carbon Nanomaterials," *Chem. Phys. Lett.* **259** (1996) 41–47 [17 citations].
23. C.-H. Kiang, P. H. M. van Loosdrecht, R. Beyers, J. R. Salem, D. S. Bethune, W. A. Goddard III, H. C. Dorn, P. Burbank, and S. Stevenson, "Novel Structures from Arc-Vaporized Carbon and Metals: Single-Layer Carbon Nanotubes and Metallofullerenes," *Surf. Rev. Lett.* **3** (1996) 765–769 [2 citations].
24. C.-H. Kiang and W. A. Goddard III, "Polyynes Ring Nucleus Growth Model for Single-Layer Carbon Nanotubes," *Phys. Rev. Lett.* **76** (1996) 2515–2518 [75 citations].
25. C.-H. Kiang, W. A. Goddard III, R. Beyers, and D. S. Bethune, "Carbon Nanotubes with Single-Layer Walls," in *Carbon Nanotubes*, book chapter, edited by M. Endo, S. Iijima, and M. S. Dresselhaus (Pergamon, Oxford, UK, 1996) pp. 47–58.
26. C.-H. Kiang, W. A. Goddard III, R. Beyers, and D. S. Bethune, "Structural Modification of Single-Layer Carbon Nanotubes with an Electron Beam," *J. Phys. Chem. B* **100** (1996) 3749–3752 [44 citation].
27. C.-H. Kiang, W. A. Goddard III, R. Beyers, J. R. Salem, and D. S. Bethune, "Catalytic Effects of Heavy Metals on the Growth of Single-Layer Carbon Nanotubes and Nanoparticles," *J. Phys. Chem. Solids* **57** (1996) 35–39 [33 citations].
28. C.-H. Kiang and W. A. Goddard III, "Polarization Effects in the AgBr Interaction Potential," *J. Phys. Chem.* **99** (1995) 14334–14339 [5 citations].

29. C.-H. Kiang, W. A. Goddard III, R. Beyers, and D. S. Bethune, "Carbon Nanotubes with Single-Layer Walls," *Carbon* **33** (1995) 903–914 [53 citations].
30. P. H. M. van Loosdrecht, R. D. Johnson, M. S. de Vries, C.-H. Kiang, D. S. Bethune, H. C. Dorn, P. Burbank, and S. Stevenson, "Orientational Dynamics of the Sc₃ Trimer in Sc₃@C₈₂: An EPR Study," *Phys. Rev. Lett.* **73** (1994) 3415–3418 [33 citations].
31. R. Beyers, C.-H. Kiang, R. D. Johnson, J. R. Salem, M. S. de Vries, C. S. Yannoni, D. S. Bethune, H. C. Dorn, P. Burbank, K. Harich, and S. Stevenson, "Preparation and Structure of Crystals of the Metallofullerene Sc₂@C₈₄," *Nature* **370** (1994) 196–199 [88 citations].
32. S. Stevenson, H. C. Dorn, P. Burbank, K. Harich, Z. Sun, C.-H. Kiang, J. R. Salem, M. S. de Vries, P. H. M. van Loosdrecht, R. D. Johnson, C. S. Yannoni, and D. S. Bethune, "Automated HPLC Separation of Endohedral Metallofullerene Sc@C_{2n} and Y@C_{2n} Fractions," *Anal. Chem.* **66** (1994) 2680–2685 [34 citations].
33. S. Stevenson, H. C. Dorn, P. Burbank, K. Harich, J. Haynes, C.-H. Kiang, J. R. Salem, M. S. de Vries, P. H. M. van Loosdrecht, R. D. Johnson, C. S. Yannoni, and D. S. Bethune, "Isolation and Monitoring of the Endohedral Metallofullerene Y@C₈₂: On-Line Chromatographic Separation with EPR Detection (HPLC-EPR)," *Anal. Chem.* **66** (1994) 2675–2679 [31 citations].
34. C.-H. Kiang, W. A. Goddard III, R. Beyers, J. R. Salem, and D. S. Bethune, "Catalytic Synthesis of Single-Layer Carbon Nanotubes with a Wide Range of Diameters," *J. Phys. Chem.* **98** (1994) 6612–6618 [97 citations].
35. D. S. Bethune, C.-H. Kiang, M. S. de Vries, G. Gorman, R. Savoy, J. Vazquez, and R. Beyers, "Cobalt-Catalyzed Growth of Carbon Nanotubes with Single-Atomic-Layer Walls," *Nature* **363** (1993) 605–607 [1238 citations].
36. C.-H. Kiang and W. A. Goddard III, "Effective Hamiltonians for Motions with Disparate Time Scales: Application to Quantum Shell Model and Classical Statistical Shell Model," *J. Chem. Phys.* **98** (1993) 1451–1457 [3 citations].

Book Chapters

1. Y. Sun and C.-H. Kiang, "DNA-Based Artificial Nanostructures: Fabrication, Properties, and Applications," in *Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology*, Vol.2, Chapter VII, pp 224–246 (ISBN: 1-58883-033-0), edited by H. S. Nalwa (American Scientific Publishers, Stevenson Ranch, CA, 2005).
2. C.-H. Kiang, W. A. Goddard III, R. Beyers, and D. S. Bethune, "Carbon Nanotubes with Single-Layer Walls," in *Carbon Nanotubes*, edited by M. Endo, S. Iijima, and M. S. Dresselhaus (Pergamon, Oxford, UK, 1996) pp. 47–58.

Recent Invited Talks

1. C.-H. Kiang, invited lectures on *Nonequilibrium Statistical Mechanics: Fundamental Problems and Applications*, at the *2009 Boulder School for Condensed Matter and Materials Physics*, Boulder, CO, 6–31 July 2009.
2. C.-H. Kiang, “Biological Physics at the Nanometer Scale: DNA Nanoparticle Assemblies and Protein Single-Molecule Force Spectroscopy,” seminar in *Physics*, Texas A&M University, College Station, TX, 7 November 2007.
3. C.-H. Kiang and N. C. Harris, “Sequence-Dependent Phase Transition of DNA-Linked Gold Nanoparticle Assemblies,” invited talk at *Progress in Electromagnetics Research Symposium (PIERS2007)*, Prague, Czech Republic, European Union, 27–30 August 2007.
4. C.-H. Kiang, “Probing Molecular Biophysics of DNA and Proteins Through Nanobiology,” Seminar in Institute of Physics, Chinese Academy of Sciences, Beijing, P.R. China, 16 March 2007.
5. C.-H. Kiang, “From DNA Nanoparticle Self-Assembly to Protein Single-Molecule Force Spectroscopy,” Seminar in Chemistry, National DongHua University, Hualien, Taiwan, 18 December 2006.
6. C.-H. Kiang, “Experimental Determination of Protein Unfolding Free Energy Surfaces,” the *2006 NCTS December Workshop on Critical Phenomena and Complex Systems*, Taipei, Taiwan, 15–16 December 2006.
7. C.-H. Kiang, “Free Energy Surfaces from Jarzynski’s Equality,” seminar in Institute of Physics, Academia Sinica, Taipei, Taiwan, 13 December 2006.
8. C.-H. Kiang, “Nanoscale Molecular Biophysics,” Physics Colloquium, National Taiwan University, Taipei, Taiwan, 11 December 2006.
9. C.-H. Kiang, “Observation of Biological Physics at the Nanometer Scale,” Physics Colloquium, Brown University, Providence, RI, 20 November 2006.
10. C.-H. Kiang, “Direct Reconstruction of the Free Energy Surface for Mechanical Unfolding of Proteins,” invited talk at *The 2006 Carolina Biophysics Symposium: Biology from Single Molecules: Bridging the Gap between Observation and Mechanism*, Research Triangle Park, NC, 1–3 November 2006.
11. C.-H. Kiang, “Direct Reconstruction of the Free Energy Surface From Single-Molecule Mechanical Unfolding of Proteins Using AFM,” invited talk at the *European Centre of Atomic and Molecular Computations (CECAM) workshop: Theory of single molecule force experiments and simulations*, Lyon, France, 26–29 September 2006.
12. C.-H. Kiang, “Single-Molecule Studies of Human Cardiac Titin,” seminar in *Atherosclerosis and Vascular Biology (AVB)*, Baylor College of Medicine, Houston, TX, 14 September 2006.

13. C.-H. Kiang, "Mechanical Properties of Human Cardiac Titin from Single-Molecule Force Spectroscopy," invited talk at the *SCBA Texas Chapter Annual Symposium*, Houston, TX, 29 April 2006.
14. C.-H. Kiang, "Disorder and Defects in DNA-Linked Nanoparticle Assemblies," *3rd Annual Conference on Foundations of nanoscience: Self-Assembled Architecture and Devices (FNANO06)*, Snowbird, Utah, 23–27 April 2006.
15. C.-H. Kiang, "Biological Physics at The Nanometer Scale: DNA Nanoparticle Assemblies and Protein Single-Molecule Force Spectroscopy," Physics Colloquium, *The University of Houston*, Houston, TX, 7 March 2006.
16. C.-H. Kiang, "What Do We Learn from Single-Molecule Force Spectroscopy?" invited talk at the *TX-UK-IBB Workshop*, Houston, TX, 16 February 2006.
17. C.-H. Kiang, "Free Energy Landscapes from Single-Molecule Dynamic Force Spectroscopy," seminar in Physics & Astronomy, Rice University, Houston, TX, 3 February 2006.
18. C.-H. Kiang, "Single-Molecule Force Spectroscopy," invited talk at the *2005 CMB/SCBMB Research Conference*, Galveston, TX, 28–29 October 2005.
19. C.-H. Kiang, "Nanoscale Manipulation and Spectroscopy of Single Protein Molecules," invited talk at the *Whitaker Nanobioengineering Symposium, Associated Nanotechnology Congress 2005*, Houston, TX, 10–11 October 2005.
20. C.-H. Kiang, "Nanoscale Biological Physics: From DNA Nanoparticle Assemblies to Protein Single-Molecule Force Spectroscopy," seminar in Physics, Ohio State University Columbus, OH, 5 October 2005.
21. C.-H. Kiang, "Protein Unfolding Free Energies From Jarzynski's Equality," invited talk at *The 2005 Summer Symposium on Statistical and Nonlinear Physics (StatPhys-Taiwan 2005)*, Taipei, Taiwan, 31 July-6 August 2005.
22. C.-H. Kiang, "Protein Folding Pathways Studied with Single-Molecule Atomic Force Microscopy," invited talk at *The 2005 NCTS July Workshop on Macromolecules and Biological Systems*, Taipei, Taiwan, 27-29 July 2005.
23. C.-H. Kiang, "Single-Molecule Dynamic Force Spectroscopy of Protein Unfolding," Seminar in Physics and National Center of Theoretical Sciences, National Tsing-Hua University, Hsinchu, Taiwan, 26 July 2005.
24. C.-H. Kiang, "Single-Molecule Dynamic Force Spectroscopy of Protein Unfolding," Seminar in Center of Nanoscience and Nanotechnology, National Chung-Hsing University, Taichung, Taiwan, 21 July 2005.
25. C.-H. Kiang, "Mechanical Properties of Human Cardiac Titin Studied by Single-Molecule Atomic Force Microscopy," Seminar in Biomedical Engineering, National Yang-Ming University, Taipei, Taiwan, 20 July 2005.

26. C.-H. Kiang, "Single-Molecule Dynamic Force Spectroscopy of Protein Unfolding," Seminar in Physics, National Sun Yat-sen University, Kaohsiung, Taiwan, 14 July 2005.
27. C.-H. Kiang, "Single-Molecule Dynamic Force Spectroscopy of Human Cardiac Titin," invited talk at the *Institute of Biosciences and Bioengineering Annual Research Colloquium*, Rice University, Houston, TX, 7 July 2005.
28. C.-H. Kiang, "Single-Molecule Imaging of Biomolecules," Seminar in Center for Condensed Matter Sciences, National Taiwan University, Taipei, Taiwan, 14 July 2004.
29. C.-H. Kiang, "Disorder in DNA-Linked Colloidal Gold Assemblies," Seminar in Physics and National Center of Theoretical Sciences, National Tsing Hua University, Hsinchu, Taiwan, 12 July 2004.
30. C.-H. Kiang, Lectures in *International Workshop on Biological and Nanoscale Physics*, Department of Physics and Center of Nanoscience and Nanotechnology, National ChungHsing University, Taichung, Taiwan, 5–9 July 2004.
31. C.-H. Kiang, "Disorder in DNA-Linked Colloidal Gold Self-Assemblies," invited talk at *The 7th Taiwan International Symposium on Statistical Physics (StatPhys-Taiwan 2004): Biologically Motivated Statistical Physics and Related Problems*, Taipei, Taiwan, 24–26 June 2004.
32. C.-H. Kiang, "DNA-Based Nanostructures," invited talk at *Future Directions in Statistical Physics: Soft Materials and Biological Systems*, Virginia Tech, Blacksburg, VA, 6–7 March 2004.
33. C.-H. Kiang, "Phase Transition in the DNA-Gold Nanoparticle System," Physics Colloquium, Sam Houston State University, Huntsville, TX, 5 November 2003.
34. C.-H. Kiang, "The *AA* and *AB* Systems of DNA-Coated Nanogold Networks," Seminar in Physics, FOM Institute for Atomic and Molecular Physics, Amsterdam, The Netherlands, 19 September 2003.
35. C.-H. Kiang, "A DNA-Coated Nanogold Network for DNA Detection," invited talk at *First Annual SPRING Meeting*, Austin, TX, 25–27 August 2003.
36. C.-H. Kiang, "Cryo-Electron Microscopy of Protein Structure and DNA-Gold Nanoparticle Assembly for DNA Detection," Department of Biochemistry and Cell Biology and Howard Hughes Medical Institute Minisymposium on Interdisciplinary Biosciences at Rice University, Houston, TX, 10 January 2003.
37. C.-H. Kiang, "The Percolation Transition in the DNA-Gold Nanoparticle System," Physics Colloquium, National Taiwan University, Taipei, Taiwan, 29 October 2002.
38. C.-H. Kiang, "The Percolation Transition in the DNA-Gold Nanoparticle System," Physics Colloquium, National ChungHsing University, Taichung, Taiwan, 25 October 2002.

39. C.-H. Kiang, "The Percolation Transition in the DNA-Gold Nanoparticle System," Seminar in Physics, Universita di Roma "La Sapienza," Rome, Italy, 9 October 2002.
40. C.-H. Kiang, "The Percolation Transition in the DNA-Gold Nanoparticle System," Seminar in Physics, FOM Institute for Atomic and Molecular Physics, Amsterdam, The Netherlands, 7 October 2002. 5B
41. C.-H. Kiang, "The Percolation Transition in the DNA-Gold Nanoparticle System," Seminar in Physics, Technische Universität München, Garching, Germany, 2 October 2002.
42. C.-H. Kiang, "Percolation Transition of DNA-Gold Nanoparticles and Single Particle Study of Protein Assembly," Physics Colloquium, Baylor University, Waco, TX, 27 September 2002.

Popular Press

1. *Physics World*, "Microscope Unravels the Intricacies of Protein Folding," 27 July 2007, <http://physicsewb.org/articles/news/11/7/24/1>.
2. *Science News*, "Pulling Strings: Stretching proteins can reveal how they fold," 14 July 2007, Vol. 172, No. 2, p.22.
3. *APS News*, "Mapping Protein Folding," March 2007, p.3.
4. Interview with BBC Science in London on Nanotechnology. Broadcast at 9pm, 19 November 1998 on Radio4: "News: Leading Edge."