

**John Eric Goff**  
Department of Physics  
University of Lynchburg  
1501 Lakeside Drive  
Lynchburg, Virginia 24501-3113 USA  
1.434.544.8856 (office)  
1.434.544.8646 (FAX)  
goff@lynchburg.edu  
<https://faculty.lynchburg.edu/goff-j/>  
<http://johnericgoff.blogspot.com/>  
<https://www.facebook.com/John.Eric.Goff.Sports.Physicist/>

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### Education

- Ph.D. in Physics, Indiana University, 1999.  
Thesis adviser: William L. Schaich.  
Thesis title: *Theory of Photon-Drag Effect in Simple Metals*
- M.S. in Physics, Indiana University, 1993.
- B.S. in Physics and Mathematics, Vanderbilt University, 1992.

### Academic Positions

- University of Lynchburg, Professor of Physics (Fall 2018 - present).
- University of Lynchburg, Chair, Department of Physics (Fall 2018 - Spring 2020).
- University of Sheffield (UK), Visiting Professor, Department of Mechanical Engineering (29-Jul-15 to 28-Jul-16).
- Lynchburg College, Professor of Physics (Fall 2012 - Spring 2018).
- University of Sheffield (UK), Associate Visiting Staff, Department of Mechanical Engineering (01-Sep-08 to 30-Jun-09).
- Lynchburg College, Associate Professor of Physics (Fall 2006 - Spring 2012).
- Lynchburg College, Chair, Department of Physics (Fall 2003 - Spring 2018).
- Lynchburg College, Assistant Professor of Physics (Fall 2002 - Spring 2006).
- Oberlin College, Visiting Assistant Professor, Department of Physics (Fall 2000 - Spring 2002).
- Kenyon College, Visiting Assistant Professor, Department of Physics (Fall 1999 - Spring 2000).
- Indiana University, Associate Instructor, Department of Physics (Fall 1992 - Spring 1999).
- Indiana University, Physics Instructor, Extended Studies Division School, Owen Hall (Spring 1998 - Summer 1999).
  - Sole instructor for roughly sixty students enrolled in one of two correspondence courses in energy and technology. Responsible for entire course, including grading, grading scale, and interacting with off-campus students.

Courses  
Taught  
(Lynchburg)

- Physics of Sports (3 times): Gen-ed science course.
- College Physics I Lab (1 time): Course for pre-med majors.
- College Physics II (2 times): Course for pre-med majors.
- College Physics II Lab (1 time): Course for pre-med majors.
- Physics I - Mechanics, Fluids, & Waves (and its associated lab) (17 times): Course for physics majors.
- Physics II - EM & Optics (and its associated lab) (17 times): Course for physics majors.
- Physics III - Thermodynamics & Modern Physics (6 times): Course for physics majors.
- Physics IV - Vibrations & Waves (8 times): Course for physics majors.
- Experimental Physics (1 time): Course for physics majors.
- Classical Mechanics (12 times): Course for physics majors.
- Electromagnetic Theory (7 times): Course for physics majors.
- Quantum Mechanics (9 times): Course for physics majors.
- Computational Physics (7 times): Course for physics majors.
- Statistical Thermodynamics (9 times): Course for physics majors.
- Optics (2 times): Course for physics majors.

Courses  
Taught  
(Oberlin)

- Classical Mechanics: Course for physics majors.
- Advanced Electromagnetism: Course for physics majors.
- Quantum Mechanics: Course for physics majors.
- Elementary Physics I: Non-calculus introductory course for non-physics majors (predominately premeds). Topics included mechanics, fluids, sound, and optics.
- Introductory Physics Lab (six sections): Calculus-based course covering most of the standard electricity and magnetism labs.
- Physics of Sports (twice): Survey course for a general audience.

Courses  
Taught  
(Kenyon)

- Electromagnetic Theory: Course for physics majors.
- Thermodynamics and Statistical Mechanics: Course for physics majors.
- Introductory Physics I: Non-calculus introductory course for non-physics majors (predominately premeds). Topics included mechanics, fluids, sound, and some electrostatics.
- Introductory Physics Lab I (one section): Standard first-semester labs. Video technology used extensively.
- Introductory Physics Lab II (two sections): Some standard second-semester labs and modern physics labs such as nuclear spectroscopy and x-ray diffraction.

**Projects**  
**with**  
**Students**

- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Finer Mesh Terrains for Modeling the Tour de France with University of Lynchburg student Michael Charecky, 2022.
- Research Project (Lynchburg): Parameter-Space Mining of 2018-2020 Tours de France to Model 2021 Tour de France with University of Lynchburg student Noah Baumgartner, 2022.
- Research Project (Lynchburg): Beam Buckling – Critical Load and Small Displacement Prediction with University of Lynchburg student Ian Grow, 2022.
- Research Project (Lynchburg): An Initial Foray Into Photon-Drag Physics with University of Lynchburg student Abigail Keenan, 2022.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Parameter Space Mining for Tour de France Modeling with University of Lynchburg student Noah Baumgartner, 2021.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Parameter Space Mining for Tour de France Modeling with University of Lynchburg student Noah Baumgartner, 2020.
- Research Project (Lynchburg): Trajectory of an American Football with Rigid-Body Modeling with University of Lynchburg student Matthew Dempsey, 2020-21.
- Research Project (Lynchburg): Golf Ball Asymmetries and Their Influence on Trajectories with University of Lynchburg student Carter Old, 2020.
- Research Project (Lynchburg): Basic Theoretical Background for Nuclear Reactor Design with University of Lynchburg student Mitch Jancse, 2019-20.
- Research Project (Lynchburg): Structural Integrity of Climbing Helmets with University of Lynchburg student Blake Scicli, 2019-21.
- Research Project (Lynchburg): Modeling the 2019 Tour de France with University of Lynchburg student Noah Baumgartner, 2019.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Tour de France Modeling with University of Lynchburg student Carl Pilat, 2019.
- Research Project (Lynchburg): Modeling the 2018 Tour de France with University of Lynchburg student Carl Pilat, 2018.
- Research Project (Lynchburg): Tread/Court Friction and Vibration Analysis with Lynchburg College student Mark Kozy, 2016-17.
- Research Project (Lynchburg): Drag and Life Coefficients for Soccer Balls with Lynchburg College student Chad Hobson, 2016-17.
- Research Project (Lynchburg): Tour de France Modeling with Lynchburg College student Chad Hobson, 2015-16.
- Research Project (Lynchburg): An Introduction to Classical and Quantum Mechanical Scattering with Lynchburg College student Brian Ramsey, 2015.

- Reading Project (Lynchburg): Friction in Sports with Lynchburg College student Chad Hobson, 2014.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Tour de France Modeling and Brazuca Trajectories with Lynchburg College student Chad Hobson, 2014.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Continuous Power Model for the 2013 Tour de France with Lynchburg College student Brian Ramsey, 2013.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Modeling the 2012 Tour de France with Lynchburg College student Brian Ramsey, 2012.
- Research Project (Lynchburg): Mathematical decomposition of consonant and dissonant piano chords with Lynchburg College student Michael Blatnik, 2010-11.
- Research Project (Lynchburg): Boundary-layer separation on soccer balls with Lynchburg College student Hunter Smith, 2010-11.
- Research Project (Lynchburg): An introduction to the finite-difference time-domain method in computational electrodynamics with Lynchburg College student Thomas Landesman, 2010-11.
- Research Project (Lynchburg): A more in-depth study of electrodynamics than that provided in the normal course with Lynchburg College student Thomas Landesman, 2009.
- Research Project (Lynchburg): Chaotic tumbling of Hyperion with Lynchburg College student Crystal M. Moorman, 2008.
- Research Project (Lynchburg): A first look at semiconductors and solar cells with Lynchburg College student Jermal Hill, 2008.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): An introduction to gravity from theoretical and computational points of view with Lynchburg College student Crystal M. Moorman, 2007.
- Research Project (Lynchburg): Golden ratio in a mechanical system with Lynchburg College student Crystal M. Moorman, 2007.
- Research Project (Lynchburg): A Computational Study of the Ising Model with Lynchburg College student Brandon Cook, 2007.
- Research Project (Lynchburg): Parameter Space for Successful Soccer Kicks with Lynchburg College student Brandon Cook, 2006.
- Independent Study Project (Lynchburg): Basic Inquiries into Fluid Mechanics with Lynchburg College student Brandon Cook, 2006.
- Research Project (Lynchburg): Modeling of 2005 Tour de France with Lynchburg College graduate Benjamin Hannas, 2005.
- Virginia Foundation for Independent Colleges Undergraduate Science Summer Research Program (Lynchburg): Parameter Space for Successful Soccer Kicks with Lynchburg College student Brandon Cook, 2005.

- Independent Study Project (Lynchburg): Wave-Packet Propagation in One-Dimensional Potentials with Lynchburg College student Stuart Farrell, 2005.
- Research Project (Lynchburg): Modeling of 2004 Tour de France with Lynchburg College graduate Benjamin Hannas, 2004.
- Independent Study Project (Lynchburg): Understanding Coupled Oscillators with Lynchburg College student Dan Hartlaub, 2004.
- Research Project (Lynchburg): Modeling of 2003 Tour de France with Lynchburg College graduate Benjamin Hannas, 2003.
- Reading Project (Lynchburg): A more in-depth study of classical mechanics than that provided in the normal course with Lynchburg College student Dan Hartlaub, 2003.
- Reading Project (Oberlin): Advanced electrodynamics, 2002.
- Reading Project (Oberlin): Theory of holography, 2001.
- Senior Research Project with Kenyon College student Ryan Depew (Kenyon): “The Physics of Pitched Baseballs.” Project included theoretical studies as well as analyzing filmed pitching, 2000.

**Courses Taught (Indiana)**

- 31 discussion sections. Class sizes ranged from twenty to forty students. Discussions taught: basic physics for non-science majors, non-calculus-based introductory physics for non-physics science majors, premed, etc., and calculus-based introductory physics for physics majors. Teaching duties included creating quiz and exam problems, grading, and one-on-one interaction with students in office hours. Implemented evening problem-working sessions to promote student problem-solving confidence. Created a web site using HTML for one semester’s discussion sections.
- 17 laboratory sections. Class sizes ranged from twenty to twenty-five students. Labs taught: basic physics for non-science majors, non-calculus-based introductory physics for non-physics science majors, premed, etc., and calculus-based introductory physics for physics majors. Experience includes using Socratic Dialogue techniques as a teaching tool, working with software such as *MacMotion* to acquire and analyze data, and using oscilloscopes. Contributions made to laboratory manual and experiments now in use.
- Physics of Sports assistant (two semesters). Class sizes were roughly fifty students who were mostly non-science majors. Duties included creating exam problems, grading, and assisting with class demonstrations. Gained experience using *VideoPoint* and *Excel* to analyze data coming from sports “movies” in this course.
- Grader for graduate course in particle physics.
- Grader for graduate course in nuclear astrophysics.

**Research Interests**

- Physics of Sports.
- Fluid Dynamics.
- Numerical Computations in Condensed Matter Physics.
  - Skills include fluency in FORTRAN, *Mathematica*, LINUX.

- Physics of Surfaces.
- Optics.

### Books

- *The Physics of Krav Maga*, The Johns Hopkins University Press (Baltimore, MD), 2019. ISBN: 9781421431611 (paperback).
- *Gold Medal Physics*, The Johns Hopkins University Press (Baltimore, MD), 2010. ISBN: 9780801893216 (hardback), 9780801893223 (paperback). Translated into Korean, 2015 (ISBN: 978-89-94025-37-7 03400).

### Research Articles

- “Parameter-Space Mining of 2018-2020 Tours de France to Model 2021 Tour de France,” Noah Baumgartner and John Eric Goff, *ISEA 2022 – The Engineering of Sport 14*, DOI: 10.5703/1288284317527 (2022).
- “Influence of Impact Location on Performance of Rock Climbing Helmets,” Mark Begonia, Bethany Rowson, Blake Scicli, and John Eric Goff, *ISEA 2022 – The Engineering of Sport 14*, DOI: 10.5703/1288284317511 (2022).
- “Rock Climbing Helmet Impact Performance Varies by Helmet Model Type,” Blake Scicli, Mark Begonia, Bethany Rowson, and John Eric Goff, *International Society of Biomechanics in Sport Proceedings* **39** (issue 1, article 29), 109-112 (2021).
- “Multiple approaches to incorporating scattering states in non-degenerate perturbation theory,” Don C. Colladay and John Eric Goff, *American Journal of Physics* **88** (number 9), 711-722 (2020).
- “Influence of Surface Properties on Soccer Ball Trajectories,” John Eric Goff, Sungchan Hong, and Takeshi Asai, *Proceedings* **49** (number 1), 143 (2020).
- “Use of Video for Teaching Sports Mechanics,” John Eric Goff and Tom Allen, *Proceedings* **49** (number 1), 112 (2020).
- “Measurements of the Flight Trajectory of a Spinning Soccer Ball and the Magnus Force Acting on It,” Takeshi Asai, Kaoru Kimachi, Richong Liu, Masaaki Koido, Masao Nakayama, John Eric Goff, and Sungchan Hong, *Proceedings* **49** (number 1), 88 (2020).
- “Effect of a soccer ball’s seam geometry on its aerodynamics and trajectory,” John Eric Goff, Sungchan Hong, and Takeshi Asai, *Journal of Sports Engineering and Technology* **234** (number 1), 19-29 (2020).
- “Effect of a soccer ball’s surface texture on its aerodynamics and trajectory,” Sungchan Hong, John Eric Goff, and Takeshi Asai, *Journal of Sports Engineering and Technology* **233** (number 1), 67-74 (2019).
- “Effect of Impact Mechanism on Head Accelerations in Men’s Lacrosse Athletes,” Lydia R. Vollavanh, Kathleen M. O’Day, Elizabeth M. Koehling, James M. May, Katherine M. Breedlove, Evan L. Breedlove, Eric A. Nauman, Debbie A. Bradney, J. Eric Goff, and Thomas G. Bowman, *Journal of Applied Biomechanics* **34**, 396-402 (2018).
- “Aerodynamic and surface comparisons between Telstar 18 and Brazuca,” John Eric Goff, Sungchan Hong, and Takeshi Asai, *Journal of Sports Engineering and Technology* **232** (number 4), 342-348 (2018).

- “Resources for sports engineering education,” Tom Allen and John Eric Goff, *Sports Engineering* **21** (issue 4), 245-253 (2018).
- “Critical shoe contact area ratio for sliding on a tennis hard court,” John Eric Goff, Luke Boswell, Daniel Ura, Mark Kozy, and Matt J Carré, *Journal of Sports Engineering and Technology* **232** (number 2), 112-121 (2018).
- “Using the 2011-16 Tours de France to refine prediction model and elicit racing strategies,” Chad M Hobson and John E Goff, *Journal of Sports Engineering and Technology* (Special Issue on Tour de France/Cycling) **231** (number 3), 232-240 (2017).
- “Creating drag and lift curves from soccer trajectories,” John Eric Goff, John Kelley, Chad M Hobson, Kazuya Seo, Takeshi Asai, and S B Choppin, *European Journal of Physics* (Focus on Physics of Sport) **38** (number 4), 044003 (12pp) (2017).
- “Investigation into surface interaction between the contact lens, the upper eyelid and cornea using optical coherence tomography,” R. Morecroft, M. J. Carré, P. Mylon, S. J. Matcher, P. Toomey, J. E. Goff and R. Maiti, *Proc SPIE* **10058**, Optical Fibers and Sensors for Medical Diagnostics and Treatment Applications XVII, 1005815 (2017).
- “Tour de France Modeling: 2015 Results and Comparisons with Elite Cyclist Power Data,” Chad Michael Hobson and John Eric Goff, *Procedia Engineering* **147**, 607-612 (2016).
- “Parametric Study of Simulated Tennis Shoe Treads,” John Eric Goff, Daniel Ura, Luke Boswell, and Matt J. Carré, *Procedia Engineering* **147**, 443-448 (2016).
- “Wind-tunnel Experiments and Trajectory Analyses for Five Nonspinning Soccer Balls,” John Eric Goff, Chad Michael Hobson, Takeshi Asai, and Sungchan Hong, *Procedia Engineering* **147**, 32-37 (2016).
- “Improving Tour de France modeling with allometric scaling,” Chad Michael Hobson and John Eric Goff, *Journal of Sports Engineering and Technology* **229** (number 3), 183-191 (2015).
- “Trying Physics: Analyzing the Motion of the Quickest Score in International Rugby,” John Eric Goff and Trevor Lipscombe, *The Physics Teacher* **53** (number 2), 72-74 (2015).
- “A Comparison of Jabulani and Brazuca Non-Spin Aerodynamics,” John Eric Goff, Takeshi Asai, and Sungchan Hong, *Journal of Sports Engineering and Technology* **228** (number 3), 188-194 (2014).
- “Predicting Tour de France stage-winning times with continuous power and drag area models and high speeds in 2013,” Brian Alexander Ramsey and John Eric Goff, *Journal of Sports Engineering and Technology* **228** (number 2), 125-135 (2014).
- “A review of recent research into aerodynamics of sport projectiles,” John Eric Goff, *Sports Engineering* **16** (number 3), 137-154 (2013) (invited).
- “Predicting Winning Times for Stages of the 2011 Tour de France Using an Inclined-Plane Model,” John Eric Goff, *Procedia Engineering* **34**, 670-675 (2012).

- “Investigations into soccer aerodynamics via trajectory analysis and dust experiments,” John Eric Goff and Matt J. Carré, *Procedia Engineering* **34**, 158-163 (2012).
- “Football boundary-layer separation via dust experiments,” J. E. Goff, W. H. Smith, and M. J. Carré, *Sports Engineering* **14** (numbers 2-4), 139-146 (2011).
- “Projectile Motion Gets the Hose,” John Eric Goff and Chinthaka Liyanage, *The Physics Teacher* **49** (number 7), 432-433 (2011).
- “Power and spin in the beautiful game,” John Eric Goff, *Physics Today* **63** (number 7), 62-63 (2010) (invited). Reprinted in Japanese for the July 2011 issue of *Parity*.
- “Soccer ball lift coefficients via trajectory analysis,” John Eric Goff and Matt J. Carré, *European Journal of Physics* **31**, 775-784 (2010).
- “Trajectory analysis of a soccer ball,” John Eric Goff and Matt J. Carré, *American Journal of Physics* **77**, 1020-1027 (2009).
- “Golden ratio in a coupled-oscillator problem,” Crystal M. Moorman and John Eric Goff, *European Journal of Physics* **28**, 897-902 (2007).
- “Parameter space for successful soccer kicks,” Brandon G. Cook and John Eric Goff, *European Journal of Physics* **27**, 865-874 (2006).
- “Inclined-plane model of the 2004 Tour de France,” Benjamin Lee Hannas and John Eric Goff, *European Journal of Physics* **26**, 251-259 (2005).
- “Heuristic model of air drag on a sphere,” John Eric Goff, *Physics Education* **39**, 496-499 (2004).
- “Turning Around Newton’s Second Law,” John Eric Goff, *The Science Education Review* **3**, 97-102 (2004).
- “Model of the 2003 Tour de France,” Benjamin Lee Hannas and John Eric Goff, *American Journal of Physics* **72**, 575-579 (2004).
- “A FUN General Education Course: Physics of Sports,” John Eric Goff, *The Physics Teacher* **42**, 280-283 (2004).
- “Theory of the photon-drag effect in simple metals,” John Eric Goff and W. L. Schaich, *Physical Review B* **61**, 10471-10477 (2000).
- “Hydrodynamic theory of photon drag,” John Eric Goff and W. L. Schaich, *Physical Review B* **56**, 15421-15430 (1997).

### Talks Given

- *Parameter-Space Mining of 2018-2020 Tours de France to Model 2021 Tour de France*, 2022 Conference of the International Sports Engineering Association, Purdue University, Indiana, 2022.
- *Collaborative Investigations into Soccer Ball Aerodynamics*, ARIHHP (Advanced Research Initiative Human High Performance) 2022 International Forum, University of Tsukuba, Japan, 2022 (invited) (Zoom talk because of COVID-19).
- *Aerodynamics in the Beautiful Game*, York University, Toronto, Canada, 2022 (invited) (Zoom talk because of COVID-19).
- *Investigations into World Cup Soccer Ball Aerodynamics*, Instituto de Matemáticas de la UNAM (National Autonomous University of Mexico), Mexico City, 2022 (invited) (Zoom talk because of COVID-19).



- *Using Sports Physics to Enhance Teaching and to Get Students Researching*, Winter Meeting of the American Association of Physics Teachers, Hilton New Orleans Riverside Hotel, 2022 (invited) (Zoom talk because of COVID-19).
- *Use of Video for Teaching Sports Mechanics*, 2020 Conference of the International Sports Engineering Association, Tokyo, Japan, 2020 (Zoom talk because of COVID-19).
- *Influence of Surface Properties on Soccer Ball Trajectories*, 2020 Conference of the International Sports Engineering Association, Tokyo, Japan, 2020 (Zoom talk because of COVID-19).
- *How Sports Physics at the University of Lynchburg Went Global*, University Lecture Series, University of Lynchburg, 2019 (invited).
- *A look Back at a Summer of GREAT Sports Science*, Marshall University, 2018 (invited).
- *Friction Challenges from the Sports World*, Marshall University, 2018 (invited).
- *Sporting Physics from the Tour de France and World Cup*, Air Force Institute of Technology, 2018 (invited as part of EN Dean's Distinguished Guest Speaker Series).
- *Great Physics from the Tour de France and World Cup*, United States Association for Young Physicists Tournament, Randolph College, 2018 (invited keynote address).
- *From the World Cup to the Tour de France to Tennis Hard Courts*, Kenyon College, 2017 (invited).
- *Friction Lessons from Across the Pond*, Lynchburg College *Science Gang* Lecture, 2016.
- *Wind-tunnel experiments and trajectory analyses for five nonspinning soccer balls*, 2016 Conference of the International Sports Engineering Association, Delft, Netherlands, 2016.
- *Parametric study of simulated tennis shoe treads*, 2016 Conference of the International Sports Engineering Association, Delft, Netherlands, 2016.
- *Tips on Writing a Good Journal Article*, University of Sheffield, England, 2016 (invited).
- *Summer Delights with Tour de France and World Cup Physics*, University of Sheffield, England, 2016 (invited).
- *How Physics Makes Sport of Engineering*, Engineering Research Symposium, University of Sheffield, England, 2016 (invited keynote address).
- *Summer Fun: Modelling the Tour de France*, Sheffield Hallam University, England, 2016 (invited).
- *Great Science on Display at the World Cup and Tour de France During Summer 2014*, Ball State University, 2015 (invited).
- *World Cup and Tour de France Physics*, Holy Trinity Lutheran Church, Lynchburg, 2015 (invited).
- *The Influence of World Cup Ball Design on Ball Aerodynamics*, Materials for Tomorrow 2014 Conference at Chalmers University of Technology in Gothenburg, Sweden, 2014 (invited).

- *Sports Physics at Lynchburg College*, Materials for Tomorrow 2014 Conference at Chalmers University of Technology in Gothenburg, Sweden, 2014 (invited).
- *Great Science on Display at the World Cup and Tour de France During Summer 2014*, Northern Michigan University, 2014 (invited).
- Sports Physics Workshop #2: Field Hockey and Soccer, Sweet Briar College, 2014 (invited).
- *Predicting the Tour de France and Soccer Ball Aerodynamics*, University of Vermont, 2013 (invited).
- Sports Physics Workshop #1: Lacrosse and Softball, Sweet Briar College, 2013 (invited).
- *Physics Forays into Tour de France Modeling and Soccer Aerodynamics*, September Meeting of the Central Virginia Section of the American Society of Mechanical Engineers, Sweet Briar College, 2013 (invited).
- *Physics Goodies from the London Olympics*, New College of Florida, 2013 (invited).
- *Physics Goodies from the London Olympics*, Sweet Briar College, 2013 (invited).
- *Physics Goodies from the London Olympics*, Randolph College, 2012 (invited).
- *Physics Goodies from the London Olympics*, Lynchburg College *Science Gang* Lecture, 2012.
- *Olympic Dreams that Make Sport of Physics*, John Eric Goff, *The Engineering of Sport 9*, 2012 Conference of the International Sports Engineering Association, University of Massachusetts, Lowell, 2012 (invited keynote address).
- *Predicting Winning Times for Stages of the 2011 Tour de France Using an Inclined-Plane Model*, John Eric Goff, *The Engineering of Sport 9*, 2012 Conference of the International Sports Engineering Association, University of Massachusetts, Lowell, 2012.
- *Investigations into soccer aerodynamics via trajectory analysis and dust experiments*, *The Engineering of Sport 9*, 2012 Conference of the International Sports Engineering Association, University of Massachusetts, Lowell, 2012.
- *Sports Physics at Lynchburg College*, Faculty Lecture Series, Lynchburg College, 2011.
- *Making Sport of Physics*, Summer Meeting of the American Association of Physics Teachers, Creighton University, 2011 (invited).
- *Soccer Ball Aerodynamics*, Oberlin College, 2011 (invited).
- *Making Sport of Physics*, National Science Teachers Association Conference on Science Education, Baltimore, 2010 (invited).
- *Making Sport of Physics*, Kenyon College, 2010 (invited).
- *Bending It Across the Pond*, Sigma Xi Lecture, Randolph College, 2009.
- *Making Sport of Physics*, Lynchburg College *Science Gang* Lecture, 2009.

- *Soccer Physics from Sheffield*, Fall Chesapeake Section of the American Association of Physics Teachers, George Mason University, 2009
  - *Mathematica examples from the LC undergraduate physics curriculum*, Fall Chesapeake Section of the American Association of Physics Teachers, Radford University, 2007.
  - *Tour de France and World Cup Modeling*, New College of Florida, 2007 (invited).
  - *Three-Year Study of Tour de France Modeling*, Fall Chesapeake Section of the American Association of Physics Teachers, American Center for Physics, 2005.
  - *Modern Application for Introductory Physics: Bloodstain Pattern Analysis*, Spring Chesapeake Section of the American Association of Physics Teachers, Lynchburg College, 2005. **I arranged for this meeting to take place at Lynchburg College, and I coordinated it while it took place.**
  - *Check on Model Robustness: 2004 Tour de France*, Fall Chesapeake Section of the American Association of Physics Teachers, Mary Baldwin College, 2004.
  - *Model of the 2003 Tour de France*, Spring Chesapeake Section of the American Association of Physics Teachers, Washington Academy of Sciences *Capital Science 2004*, National Science Foundation, 2004.
  - *A FUN General Education Physics Course: Physics of Sports*, Fall Chesapeake Section of the American Association of Physics Teachers, Radford University, 2002.
  - *Photon-Drag Effect in a Simple Metal*, Case Western Reserve University, 2001 (invited).
  - *Theory of Photon-Drag Effect in Metals*, 1999 Centennial Meeting of the American Physical Society, Atlanta, GA.
  - *Photon-Drag Effect in Metals*, The College of Wooster, 1998 (invited).
  - *Simple Models of Photon Drag in Metals*, 1996 March Meeting of the American Physical Society, St. Louis, MO.
  - *Photon-Drag in Jellium Metals and Two-Dimensional Electron Gas*, Indiana University, 1995.
  - *Hydrodynamic Model of Photon Drag in Jellium Metals*, Fall Meeting of The Ohio Section of the American Physical Society, 1995.
  - *Hydrodynamic Model of the Photon-Drag Effect*, Indiana University, 1994.
- Workshops and Short Courses**
- Gordon Research Conference entitled *Physics Research and Education* (emphasis on computational physics), Bryant University, Smithfield, RI, June, 2008.
  - Gordon Research Conference entitled *Physics Research and Education* (emphasis on electricity and magnetism), Mount Holyoke College, South Hadley, MA, June, 2006.
  - Gordon Research Conference entitled *Nonlinear Science*, Colby College, Waterville, ME, June-July, 2005.

- *Activity Based Physics Faculty Institutes* workshop focusing on introductory physics teaching, University of Oregon, Eugene, OR, June, 2005.
- *Computational Physics for Physics Educators* workshop run by the National Computational Science Institute, Centenary College, Hackettstown, NJ, July, 2004.
- Gordon Research Conference entitled *Physics Research and Education* (emphasis on classical mechanics and nonlinear dynamics), Mount Holyoke College, South Hadley, MA, June, 2004.
- Chautauqua Short Course entitled *Data Analysis and Visualization Using Mathematica*, Christian Brothers University, Memphis, TN, May, 2004.
- Chautauqua Short Course entitled *The History and Future of Aeronautics*, Dryden Flight Research Center at Edwards Air Force Base, Edwards, CA, June, 2003.
- *Workshop on Opportunities in Materials Theory*, National Science Foundation and Georgetown University, October, 2002.
- *Workshop for New Physics and Astronomy Faculty*, American Center for Physics, College Park, MD, November, 2002.

### Article Writing

- Invited writer for *Breakthrough*.
  - *World Cup soccer ball aerodynamics: How does the Qatar 2022 ball perform?* (July 11, 2022).
- Invited writer for *The Conversation*.
  - *The high-speed physics of how bobsled, luge and skeleton send humans hurtling faster than a car on the highway* (February 4, 2022).
  - *Tour de France: How many calories will the winner burn?* (June 24, 2021; updated for 2022 race in June 30, 2022 article of the same name; translated into French on July 4, 2022 – *Tour de France: combien le vainqueur aura-t-il brûlé de calories?*).
  - *Sticky baseballs: Explaining the physics of the latest scandal in Major League Baseball* (June 15, 2021).
- Blog writer for johnericgoff.blogspot.com (2011 - present).
- Invited writer for Johns Hopkins University Press Blog.
  - *Intuitive Physics is Inside Everyone* (November 27, 2019).
  - *World Cup Soccer Balls Can Be a Drag* (June 16, 2014).
  - *Predicting the Tour de France* (June 29, 2012).
- Invited writer for The Page 99 Test Blog.
  - John Eric Goff’s “The Physics of Krav Maga” (December 16, 2019).
  - John Eric Goff’s “Gold Medal Physics” (January 8, 2010).

### Other Work Experience

- Appeared on and gave physics commentary for the following episodes of *Playing with Science’s Check Down on TuneIn*:
  - *Trickeration at Lambeau Field!* (December 30, 2018).
  - *Jaylon Smith Shows SPEED on Defense!* (December 23, 2018).

- *Westbrook Takes It to the HOUSE!* (December 16, 2018).
- *Perfect Blocking Leads to a Perfect Run!* (December 9, 2018).
- *Odell Beckham Jr. Throws 2nd TD of the Season!* (December 2, 2018).
- *Josh Allen Can Sling It!* (November 25, 2018).
- *101 Yards for a Pick-Six!* (November 18, 2018).
- *A Lion Can't Tackle a Bear!* (November 11, 2018).
- *Over 100 Yards on a Double Toss!* (November 4, 2018).
- *A Powder Keg Explodes Through a Screen!* (October 28, 2018).
- *Trubisky SCRAMBLES the Patriots!* (October 22, 2018).
- *Devin Funchess MOSSES Quinton Dunbar!* (October 15, 2018).
- *A Giant of a Trick Play!* (October 7, 2018).
- *Ridley Jukes His Way to an Easy Score!* (September 30, 2018).
- *Mahomes Scrambles the 49ers!* (September 23, 2018).
- *Physics and Psychology Aid Callahan's Punt Return TD!* (December 31, 2017).
- *Gurley Outruns Titans!* (December 24, 2017).
- *A Bullet from Keenum to Diggs!* (December 17, 2017).
- *Snow Physics Helps the Bills!* (December 10, 2017).
- *Tarik Cohen's INSANE Punt Return* (December 3, 2017).
- *Wildcat Keeps Sanu Perfect!* (November 26, 2017).
- *From Saints Sandwich to Touchdown!* (November 19, 2017).
- *A Great Fake Punt!* (November 12, 2017).
- *Great Blocking for a Great Touchdown!* (November 6, 2017).
- *Great pick by Eddie Jackson!* (October 23, 2017).
- *Golden Tate TD: NFL Physics* (October 17, 2017).
- Appeared on and gave physics commentary for the following episode of *StarTalk*:
  - Season 1, Episode 41 (July 16, 2021): *Cosmic Queries – Nerd Olympics with John Eric Goff*
- Appeared on and gave physics commentary for the following episodes of *StarTalk's Playing with Science*:
  - Season 4, Episode 1 (January 30, 2019): *SEASON PREMIERE: 2019 Big Game Special, with Neil deGrasse Tyson*
  - Season 3, Episode 43 (November 21, 2018): *Tiger vs Phil – 18 Holes, \$9 Mil*
  - Season 3, Episode 34 (September 19, 2018): *Golf's 2018 Ryder Cup: Physics & Psychology at the Albatros*
  - Season 3, Episode 26 (July 25, 2018): *The Physics of the Tour de France (Repeat)*
  - *StarTalk All Access* (July 19, 2018): *Tour De France 2018 with Professor John Eric Goff*
  - Season 3, Episode 22 (June 27, 2018): *Cosmic Queries: FIFA World Cup Edition*
  - Season 3, Episode 20 (June 13, 2018): *Extended Classic: Planet Soccer, with Neil deGrasse Tyson*

- Season 3, Episode 12 (April 18, 2018): *2018 Soccer Tech: Beyond Sports & Telstar 18*
  - Season 3, Episode 11 (April 11, 2018): *Breaking the Rules – The Physics & Psychology of Cheating*
  - Season 3, Episode 4 (February 21, 2018): *Olympic Alpine Skiing, with Erin Mielzynski and Andrew Weibrecht.*
  - Season 3, Episode 3 (February 14, 2018): *The Science of Curling, with Olympians Brad Gushue and Nina Roth.*
  - Season 3, Episode 2 (February 7, 2018): *Figure Skating Physics, with Olympic Medalist Sasha Cohen.*
  - Season 2, Episode 31 (January 24, 2018): *Fight Like a Physicist (Repeat).*
  - Season 2, Episode 30 (January 17, 2018): *Season 1 & 2 Time Capsule.*
  - Season 2, Episode 27 (December 27, 2017): *Extended Classic: The Science of “The Catch.”*
  - Season 2, Episode 26 (December 20, 2017): *Extended Classic: The Immaculate Reception.*
  - Off-Season, Episode 22 (November 22, 2017): *Extended Classic: The Art of the Hail Mary.*
  - Season 2, Episode 18 (October 25, 2017): *World Series Throwback Special.*
  - Season 2, Episode 13 (September 20, 2017): *Martial Arts – Fight Like a Physicist.*
  - Season 2, Episode 12 (September 13, 2017): *The Immaculate Reception.*
  - Season 2, Episode 11 (September 6, 2017): *Cosmic Queries: Tennis Special Edition.*
  - Season 2, Episode 3 (July 12, 2017): *Extended Classic: The Physics of the Tour de France.*
  - Off-Season, Episode 7 (May 31, 2017): *Cosmic Queries: The Physics of Soccer.*
  - Off-Season, Episode 4 (May 11, 2017): *The Art of the Hail Mary.*
  - Season 1, Episode 3 (February 15, 2017): *The Physics of the Tour de France.*
  - Season 1, Episode 2 (February 8, 2017): *The Science of “The Catch.”*
  - Season 1, Episode 0 (January 25, 2017): *Welcome to Playing with Science.*
- Appeared on an episode of Smithsonian Channel’s *Sports Detectives* (May 1, 2014).
  - Appeared on and gave physics commentary for the following episode of University of Lynchburg’s *A Smarter U* podcast:
    - Episode 1 (January 31, 2019): *Football, physics, and concussions.*
  - Appeared on and gave physics commentary for the following episode of Sci’more Podcast:

- Episode 7 (September 19, 2021): *A new spin on baseball: the science behind breaking balls.*
- Appeared on and gave physics commentary for the following videos for the YouTube channel Cheddar:
  - *What The Tour De France Does To A Rider’s Body– Cheddar Explains*, July 20, 2022.
  - *Doubles Luge: Breaking Down The Internet’s Favorite Olympic Sport – Cheddar Explains*, February 9, 2022.
  - *How Ski Jumpers Keep Flying Farther – Cheddar Explains*, February 7, 2022.
- Guest Editor for Special Issues on Tour de France/Cycling, *Journal of Sports Engineering and Technology*, 2017-18.
  - Editorial, **232** (issue 1), 3-4, 2018.
  - Editorial, **231** (issue 3), 167-168, 2017.
- Editorial Board Member, *Journal of Sports Engineering and Technology*, 2013-.
- Editorial Board Member, *Sports Engineering*, 2013-.
- Book reviewer for *Essential University Physics* (4th ed) by Richard Wolfson, Pearson, 2020.
- Tutorial instructor for PHY 250-251, Department of Physics and Astronomy, University of Sheffield, England, 2015-16.
- Physics content reviewer for Pearson Higher Education, 2013-14.
- Book reviewer for Sports Illustrated for Kids, 2015.
- Book reviewer for Capstone Publishing, 2015.
- Book reviewer for Sleeping Bear Press, 2014-15.
- Book reviewer for Brooks/Cole, 2012.
- Book reviewer for Running Press, 2012.
- Wrote Appendix titled “The Physics of Falling” for the book *Redpoint: The Self-Coached Climber’s Guide to Redpoint and On-Sight Climbing* by Dan Hague and Douglas Hunter (Stackpole Books), 2011.
- Grant proposal reviewer for The Leverhulme Trust (UK), 2011.
- External Honors Examiner for Oberlin College’s Department of Physics & Astronomy, 2011.
- Book reviewer for The University of Chicago Press, 2011.
- Provided calculations and physics commentary for the following articles:
  - “Up in the Air: The forces that allow ski jumpers to soar,” *Scholastic SuperScience*, February 2022.
  - “The Science of the Winter Olympics,” *Popular Mechanics*, February 4, 2022.
  - “Baseball Spin Doctors by John Eric Goff,” *American Scientist*, September-October 2021.
  - “The not-so-hidden physics of your favorite Olympic event,” *PBS News Hour*, August 5, 2021.

- “Olympic Runners Are Fast. On Tokyo’s Fast Track, They’re Shattering World Records,” *NPR*, August 4, 2021.
- “Professor Eric Goff Breaks Down the Physics Behind Simone Biles,” *WLNI Radio*, July 28, 2021.
- “How Simone Biles Performs Her Most Difficult Gymnastics Moves at the Olympics,” *The Wall Street Journal*, July 26, 2021.
- “The physicist and the gymnast: A Q&A with Simone Biles,” *Houston Chronicle*, July 21, 2021.
- “The physics of Simone Biles and her routines,” *Houston Chronicle*, July 21, 2021.
- “The Biles: Breaking down the physics of Simone Biles’ biggest new move, the Yurchenko double pike,” *Houston Chronicle*, July 16, 2021.
- “Will conditions dilute heat of Championship battles?: The science behind winter hurling,” *Irish Examiner*, November 12, 2020.
- “Rocket launch delayed, but the science can still excite kids,” *WFXX - FOX*, May 27, 2020.
- “Episode 37: The Physics of Krav Maga with Author and Physics Professor John Eric Goff,” *Into the Impossible with Brian Keating*, March 19, 2020.
- “Major League Baseball Players Call For More Safety Measures After Foul Balls Hit Fans,” *NPR*, July 9, 2019.
- “The Aerodynamics of a Soccer Ball,” *Inside Science*, June 28, 2019.
- “Los Angeles Dodgers to extend netting after fan hit by foul ball,” *CBS News*, June 24, 2019.
- “MLBs netting dilemma: With current standards, danger is just a second away,” *The Washington Post*, June 5, 2019.
- “The Few. The Proud. The Players Who Have Been Run Over by Zion Williamson,” *The Wall Street Journal*, December 6, 2018.
- “Ski slope catwalk,” *LAST WORD, New Scientist*, November 28, 2018.
- “The physics of throwing a perfect baseball pitch,” *Popular Science*, October 4, 2018.
- “What Role Does Science Play in the World Cup?,” *LABMATE*, July 10, 2018.
- “Bend it Like Bernoulli,” *APS News*, July 2018.
- “Why the World Cup soccer ball looks so different,” *Business Insider*, July 2, 2018.
- “Wind-tunnel testing the World Cup ball,” *What the Future*, June 29, 2018.
- “Enemmän kuin pelkkä pallo – Jalkapallon MM-kisojen peliväline on voinut jopa auttaa voittamaan mestaruuden” (Finnish), *Suomen Kuvalehti*, June 28, 2018.
- “Por que o gol olímpico é tão raro em Copa do Mundo” (Portuguese), *BBC NEWS Brasil*, June 24, 2018.
- “Simply Put: A ball with plastic on it used in FIFA World Cup 2018,” *Indian Express*, June 21, 2018.



- “Melihat Bola Resmi Piala Dunia 2018, Telstar 18, dari Kacamata Ilmiah” (Indonesian), *Sumber*, June 20, 2018.
- “The Science Behind The World Cup Ball,” *NPR*, June 20, 2018.
- “How the new World Cup ball was designed to not influence the games,” *Popular Science*, June 18, 2018.
- “The Physics of the One Goal You *Won’t* See at the World Cup,” *WIRED*, June 15, 2018.
- “El balón del mundial pasó pruebas aerodinámicas” (Spanish), *NTN24*, June 14, 2018.
- “Physicists say 2018’s World Cup ball may fly shorter distances than 2014 design,” *AccuWeather*, June 14, 2018.
- “A Ciência Também Vai A Jogo” (Portuguese), *Tribuna de Macau*, June 14, 2018.
- “The technology link and the World Cup are amazed by the lovers of football” (translated Persian), *TNEWS*, June 12, 2018.
- “Russia 2018, calciatori in rivolta contro il pallone: parla Eric Goff, che lo ha studiato” (Italian), *Liberio*, June 12, 2018.
- “VM-bolden flyver kortere end forgængereren” (Danish), *Ingeniøren*, June 11, 2018.
- “Aclarando los misterios... del balón del mundial” (Spanish), *e-Duque*, June 9, 2018.
- “Bóng World Cup du h/‘anh vũ trụ” (Vietnamese), *Tiềnphong*, June 8, 2018.
- “Bend it like Einstein: Science and the World Cup,” *phys.org*, June 7, 2018.
- “Mundial Rusia 2018: el balón Telstar 18 pasó pruebas aerodinámicas y el resultado fue ...” (Spanish), *NMAS1*, June 6, 2018.
- “New 2018 World Cup Ball Passes Wind Tunnel Tests,” *Inside Science*, June 6, 2018.
- “La ciencia juega al fútbol” (Spanish), *Muy Interesante*, June 2018.
- “A physicist explains how Cristiano Ronaldo made the ball levitate for his penalty against PSG,” *i News*, February 16, 2018.
- “The Physics of Flip and Spin,” *WIRED*, February 2018.
- 2016 Summer Olympics videos on boxer Shakur Stevenson, fencer Dagmara Wozniak, and canoeist Ashley Nee for *National Geographic*, August 2016.
- “Tour de France – Wer gewinnt die Tour?” (German), *TOUR Magazine*, July 2016.
- “Did Peyton Manning REALLY reach 17 mph on run vs. Patriots?,” *Tampa Bay Times*, February 4, 2016.
- “The Stephen Curry Show,” *TIME for Kids*, January 20, 2016.
- “Stephen Curry and the Greatest Show on Earth,” *TIME*, December 21, 2015.
- “The science behind what makes Derrick Henry unique,” *Alabama Media Group*, December 9, 2015.
- “Balance of Power,” *The Ring*, December 2015.
- “Fisica del gol olímpico” (Italian), *L’Ultimo Uomo*, October 30, 2015.

- “Basketball’s Best Free-Throw Shooter Isn’t in the NBA,” *The Wall Street Journal*, October 25, 2015.
- “Uncanny predictions about the Tour de France,” *CNN International*, July 26, 2015.
- “How a Virginia physicist can predict the Tour de France’s outcome from 4,000 miles away,” *Washington Post*, July 25, 2015.
- “Physicist foresee Tour de France results,” *ResearchGate*, July 24, 2015.
- “Basketball’s Ultimate Long Shot,” *Ozy*, April 16, 2015.
- “Sports physicist says temperature could have caused football deflation,” *YAHOO! SPORTS*, January 26, 2015.
- “Deflate-gate: The science of underinflated footballs,” *Fox News*, January 23, 2015.
- “Stephen Curry’s Science of Sweet Shooting,” *Wall Street Journal*, December 17, 2014.
- “Even Under Microscope, Catch by Giants’ Odell Beckham Jr. Earns Applause,” *New York Times*, November 25, 2014.
- “47.1 mph,” *The Wall Street Journal*, June 18, 2014.
- “Science Says: Fred Flopped,” *The Wall Street Journal*, June 13, 2014.
- “Ski Jumping,” *New York Times*, February 9, 2014.
- “New York’s cold-weather Super Bowl will affect physics of the game,” *Metro – New York*, January 28, 2014. This story was redone for the January 30, 2014 *Smithsonian* and the January 31, 2014 *International Science Times*.
- “QB guru: Geno Smith struggling with mechanical flaws,” *Metro – New York*, September 17, 2013.
- “Getting on the Ball: How the FIFA 14 Soccer Video Game Finally Got Its Physics Right,” *Scientific American*, September 27, 2013 (online), December 2013 (print).
- “Bigger Tebow not a good fit for Jets,” *Metro – New York*, December 30, 2012.
- “Short White Man Can Jump,” *Outside Magazine*, August 2012.
- “The physics behind Danilo Gallinari’s amazing behind the back pass,” *YAHOO! SPORTS*, March 22, 2012.
- “Was physics the reason Wes Welker dropped Tom Brady’s pass?,” *YAHOO! SPORTS*, February 7, 2012.
- “Science says: Tim Tebow can improve as a passer,” *YAHOO! SPORTS*, December 6, 2011.
- “Joe McKnight, and the physics behind a blocked punt,” *YAHOO! SPORTS*, September 14, 2011.
- “The Science of Hitting Home Runs,” *OWL Magazine*, April 2011.
- “Humiliation Comes in Two Flavors,” *The Wall Street Journal*, August 19, 2010.
- “The Anatomy of a World Cup Goal,” *The Wall Street Journal*, June 30, 2010.
- “Messi, Like LeBron, Defies Physics,” *The Wall Street Journal*, June 26, 2010.

- “Air Abbott? Skaters Rival Sports Legends With ‘Quad’ Jumps,” *The Wall Street Journal*, February 17, 2010.
- Journal referee for *American Journal of Physics*, *The Physics Teacher*, *Physics Letters A*, *Sports Engineering*, *Journal of Sports Engineering and Technology*, and *Journal of Applied Biomechanics* 2004-15.
- Consultant for Full Flight Technology, LLC, 2013.
- Consultant for Dolmen in Dublin, Ireland, November and December 2008.
- Book reviewer for The Johns Hopkins University Press, 2007-14.
- Author for American Institutes for Research, 2006 and 2009.
- Consultant for Belvac Production Machinery, Inc. in Lynchburg, VA, July and August, 2003.
- Undergraduate member of Vanderbilt’s Free Electron Laser Group, Vanderbilt University, (Summer 1989 - Summer 1992).
  - Assisted with laser installation, performed minor electrical and mechanical tasks, and helped with experiments once installation was complete. Solved applied problems using theoretical methods in optics.
- Research Experiences for Undergraduates at North Carolina State University, Project in Theoretical Atomic Physics, (Summer 1991).

## Awards

- James A. Huston Award for Excellence in Scholarship, University of Lynchburg, 2021.
- Faculty Award for Excellence in Research Mentoring, University of Lynchburg, 2020.
- The Sigma Nu Herbert Bruce Award “for being an outstanding faculty member,” Lynchburg College, 2017.
- James A. Huston Award for Excellence in Scholarship, Lynchburg College, 2014.
- Talk given at Chesapeake Section of American Association of Physics Teachers at George Mason University won Frank R. Haig Prize for best paper from a four-year college, Fall 2009.
- James A. Huston Award for Excellence in Scholarship, Lynchburg College, 2009.
- *Bridging the Gaps* Visiting Scholar, University of Sheffield (UK), Fall 2008.
- Mednick Memorial Fellowship, given by the Virginia Foundation for Independent Colleges, 2008.
- Talk given at Chesapeake Section of American Association of Physics Teachers at Mary Baldwin College won Frank R. Haig Prize for best paper from a four-year college, Fall 2004.
- Talk given at Chesapeake Section of American Association of Physics Teachers at National Science Foundation won Frank R. Haig Prize for best paper from a four-year college, Spring 2004.

- Talk given at Chesapeake Section of American Association of Physics Teachers at Radford University won Frank R. Haig Prize for best paper from a four-year college, Fall 2002.
- Bernice Eastwood Covalt Memorial Scholarship recipient as graduate student, Spring 1998.
- Excellence in Teaching Recognition Award as graduate student, Spring 1997.

### Affiliations

- International Sports Engineering Association (2012 - present).
- Society of Physics Students (1989 - 1992, 2003 - present).
- Sigma Xi (2002 - present).
- American Association of Physics Teachers (2002 - present).
  - Chesapeake Section (2002 - present).
- American Physical Society (1992 - present).
  - Division of Computational Physics.
  - Division of Condensed Matter Physics.
  - Forum on Industrial and Applied Physics.
  - Forum on Education.
  - Forum on International Physics.
  - Southeastern Section.
  - Topical Group on Statistical and Nonlinear Physics.