

Rachel E. Pepper

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EDUCATION

Harvard University (Cambridge, MA)

Ph.D., Physics, November 2009

Thesis: Splashing, Feeding, Contracting: Drop impact and fluid dynamics of *Vorticella*

Advisor: Howard A. Stone

Cambridge University (Cambridge, UK)

Marshall Scholarship; B.A., Physics, with Honors, 2004

Brown University (Providence, RI)

Sc.B., Biophysics, *Magna Cum Laude*, with Honors, 2002

Phi Beta Kappa, Sigma Xi

AWARDS AND FELLOWSHIPS

Miller Research Fellowship, 2011-2014

Life Sciences Research Foundation Postdoctoral Fellowship, 2011-2014 (declined)

University of California President's Postdoctoral Fellowship Finalist, 2011

Association for Women in Mathematics/NSF Travel Grant, 2010

NSF Interdisciplinary Graduate Education and Research Training Fellowship, Harvard University 2007-2009

NSF Graduate Research Fellowship, 2004-2007

Selected to attend Boulder Condensed Matter Summer School, University of Colorado, Boulder 2007

Harold T. White Prize for Excellence in the Teaching of Physics, Harvard University 2007

Certificate of Distinction in Teaching, Harvard University 2006

Marshall Scholarship, 2002-2004

Barry M. Goldwater Scholarship, 2001

Royce Fellowship, Brown University 2001

Undergraduate Teaching and Research Fellowship, Brown University 2000

RESEARCH EXPERIENCE

University of Colorado, 2009-2011

Postdoctoral Researcher

Physics Education Research: Understanding student learning difficulties in junior-level Electricity and Magnetism and sophomore-level Classical Mechanics/Math Methods. Transforming Classical Mechanics/Math Methods

- Observing and understanding student conceptual difficulties in class, traditional exams, and conceptual exams.
- Observed and documented student difficulties in E&M on a fine-scale including difficulties with Gauss's law, connecting mathematics and physics, and separation of variables.
- Created new material for use in junior-level Electricity and Magnetism including tutorial activities and pretests
- Creating consensus learning goals and concept survey for combined Classical Mechanics and Math Methods course
- Creating new material for use in Classical Mechanics and Math Methods course including small-group activities, "clicker questions" for peer instruction, and conceptual homework and exam questions
- Used multiple methodologies including student interviews, faculty interviews, classroom and recitation observations, analysis of student-work, student surveys, and pre/post measures of learning. Analysis of qualitative and quantitative data, including tests for statistical significance.

Harvard University, 2005-2009

Graduate Researcher

Advisor: Howard A. Stone

Thesis Research: Understanding splashing mechanism and threshold; explaining flow fields around *Vorticella*

- Determined that the often-observed eddies around microscopic filter feeders are due to boundaries using experiments, calculations, and simulations.
- Discovered that microscopic filter feeders can increase nutrient intake by feeding at an angle to the substrate of attachment rather than perpendicular using calculations and simulations.
- Showed that splashing instability is likely set at early times after impact.
- Determined the dependence of splashing threshold on substrate elasticity.
- Developed Matlab image processing software for use in droplet impact studies.
- Measured lamella thickness after droplet impact with high-speed video and custom-written Matlab software.

Brown University, 1999-2002

Research Fellow

Advisor: Xinsheng Ling

Undergraduate Thesis Research: The effect of polydispersity on the depletion interaction

- Investigated the effect of polydispersity to understand the effects of the crowded cell cytoplasm on biological reactions. Used a scanning laser tweezer.

Fellowship Research: Colloidal crystals; dendrites and memory

- Investigated the efficacy of cutting neuron dendrites with a “laser scissor” as part of a joint project with Dr. Justin Fallon’s Neuroscience lab to elucidate the mechanism of memory storage in the brain.

TEACHING EXPERIENCE

University of Colorado, Spring 2010 – Spring 2011

Guest Lecturer, Multiple Courses

Included sophomore-level Mechanics and Math Methods and junior-level Electricity and Magnetism for physics majors (~40 students, 4 classes) as well as a large class for non-science majors on Physics of Everyday Life (200 students, 3 classes).

University of Colorado, Spring 2010 – Spring 2011

Science Teaching Fellow, Classical Mechanics/Math Methods

Intermediate undergraduate class for physics majors. Organized and ran weekly homework help sessions. Evaluated, modified, and created course materials. Received 5.6/6.0 overall from student evaluations.

University of Colorado, Fall 2009

Science Teaching Fellow, Electricity and Magnetism

Advanced undergraduate class for physics majors. Organized and ran weekly tutorial sessions which facilitate problem solving in small groups. Assisted with twice-weekly homework help sessions. Evaluated and modified course material. Received 5.5/6.0 overall from student evaluations.

Harvard University, Spring and Summer 2008

Supervisor for visiting masters student

Formulated a project, instructed on experimental technique and data analysis, regularly assisted with experimental challenges, and assisted in preparation of final presentation and article for peer-reviewed publication.

Harvard University, Spring 2006

Teaching Fellow, Reality Physics

Distribution requirement for non-majors. Taught weekly recitation section, wrote and graded homework problems, designed labs for use in section, graded exams. Received 4.7/5.0 overall from student evaluations.

Harvard University, Fall 2005-Spring 2007

Tutor, Principles of Physics

Non-calculus introductory class at the Harvard Extension School. Assisted one-on-one 2-4 hours/week. Explained concepts and assisted with solving problems.

Brown University, Fall 2000

Teaching Assistant, Genetics

Advanced undergraduate class. Taught weekly recitation sections, led exam review sessions, and graded exams.

Brown University, Spring 2000

Tutor, Introduction to Relativity and Quantum Physics

Undergraduate class for physics majors. Assisted a small group with concepts and problem solving for 1 hour/week.

SERVICE AND OUTREACH

Colorado Therapeutic Riding Center, Longmont, CO, 2009-2010

Assisted with equine therapy to promote both the physical and psychological well being of people with disabilities.

Dudley House Outings Fellow, Harvard University, 2006-2009

Planned, organized, and led outings for the graduate student center which ranged from walking tours of Boston to multi-day ski trips.

Science Club for Girls, Cambridge, MA, 2004-2008

Taught after-school science club for girls in kindergarten through 4th grade. This program provides fun after-school science programs for girls in Boston-area public schools to encourage girls to enjoy and feel confident with science.

Boston Cares, Boston, MA, 2007-2009

Volunteered at a variety of one-time projects including arts and crafts with kids, GED tutoring, serving meals to the homeless, and maintaining urban wilds. Participated in a total of more than 60 volunteer hours.

Volunteer Tutor, Cambridge University, Spring 2004

Provided extra assistance in public school math classrooms.

Volunteer Tutor, Brown University, Spring 2001

Tutored a high school student weekly, teaching physics as part of a program providing private education to gifted minority students. Also worked as a tutor and mentor at a charter high school for economically and socially disadvantaged urban youth.

PUBLICATIONS

R. E. Pepper, S. V. Chasteen, S. J. Pollock, and K. K. Perkins. *Some observations on student difficulties with mathematics in upper-division Electricity and Magnetism*. In review (preprint available).

S. V. Chasteen, **R. E. Pepper**, S. J. Pollock, K. K. Perkins. *The Colorado Upper-Division Electrostatics (CUE) Diagnostic: A conceptual assessment for the junior level*. Submitted (preprint available).

R. E. Pepper, S. V. Chasteen, S. J. Pollock, and K. K. Perkins. *Facilitating Faculty Conversations: Development of Consensus Learning Goals*. PERC Proceedings 2011, AIP Press. Accepted.

S. J. Pollock, **R. E. Pepper**, and A. D. Marino. *Issues and progress in transforming a middle-division Classical Mechanics/Math Methods course*. PERC Proceedings 2011, AIP Press. Accepted.

S. J. Pollock, **R. E. Pepper**, S. V. Chasteen, and K. K. Perkins. *Multiple Roles of Assessment In Upper-Division Physics Course Reforms*. PERC Proceedings 2011, AIP Press. Accepted.

S. V. Chasteen, S. J. Pollock, **R. E. Pepper**, and K. K. Perkins. *"Thinking Like a Physicist": A Multi-Semester Case Study of Junior-level Electricity & Magnetism*. In review (preprint available).

R. E. Pepper, S. V. Chasteen, S. J. Pollock, and K. K. Perkins. *Our best juniors still struggle with Gauss's Law: Characterizing their difficulties*. PERC Proceedings 2010, AIP Press (2010).

S. V. Chasteen, **R. E. Pepper**, S. J. Pollock, K. K. Perkins. *But Does It Last? Sustaining a Research-Based Curriculum in Upper-Division Electricity & Magnetism*. PERC Proceedings 2011, AIP Press. Accepted.

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, and H. A. Stone. *Sessile suspension feeders can increase nutrient uptake by feeding at an angle*. In preparation (preprint available).

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, and H. A. Stone. *Nearby boundaries create eddies near microscopic filter feeders*. J. R. Soc. Interface **7**, 851-862 (2010).

J. de Ruiter, **R.E. Pepper**, and H. A. Stone. *Thickness of an expanding lamella near the splash threshold*. Phys. Fluids **22**, 022104 (2010).

M. Roper, **R. E. Pepper**, M. Brenner, A. Pringle. *Explosively launched spores of ascomycete fungi have drag minimizing shapes*. PNAS **105**, 20583 (2008).

R. E. Pepper, L. Courbin, and H. A. Stone. *Splashing on elastic membranes: the importance of early-time dynamics*. Phys. Fluids **20**, 082103 (2008).

INVITED PRESENTATIONS

R. E. Pepper, *Microscopic filter feeders near boundaries: feeding challenges and strategies*. February, 2011 – Mt. Holyoke Department of Physics Seminar Series.

R. E. Pepper, S. V. Chasteen, S. J. Pollock, and K. K. Perkins. *Upper-Division Electricity and Magnetism: Students' Ideas and Difficulties*. July, 2010 – American Association of Physics Teachers Summer Meeting, Portland, Oregon.

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, and H. A. Stone. *Microscopic filter feeders near boundaries: feeding restrictions and strategies*. December 2009 – University of Western Australia.

R. E. Pepper. *Student interviews as a way to identify student misconceptions*. April 2009 – University of Colorado at Boulder.

CONTRIBUTED PRESENTATIONS

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, N. Matsumoto, M. Nagai, and H. A. Stone. *Microscopic filter feeders near boundaries: feeding restrictions and strategies due to eddies*. January 2012 – Society for Integrative and Comparative Biology Annual Meeting, Charleston, SC, oral presentation.

R. E. Pepper, S.V. Chasteen, M. Dubson, K. K. Perkins, and S. J. Pollock. *Applying the results of education research to help students learn more*. November 2011 – 64th APS Meeting of the Division of Fluid Dynamics, Baltimore, oral presentation.

R. E. Pepper. *Microscopic filter feeders at an angle to nearby boundaries: Feeding restrictions and strategies*. January 2011 – Aspen Ocean Symposium: Microenvironments modulating biological interactions in the ocean, Aspen, poster presentation.

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, and H. A. Stone. *Microscopic filter feeders at an angle to nearby boundaries: Feeding restrictions and strategies*. November 2010 – 63th APS Meeting of the Division of Fluid Dynamics, Long Beach, oral presentation.

R. E. Pepper, S.V. Chasteen, S. J. Pollock, M. Dubson, P. Beale, and K. K. Perkins. *New Ways of Teaching Upper-division courses: Descriptions and Results*. November 2010 – 63th APS Meeting of the Division of Fluid Dynamics, Long Beach, oral presentation.

R. E. Pepper, S.V. Chasteen, S. J. Pollock, and K. K. Perkins. *Our best juniors still struggle with Gauss's Law: Characterizing their difficulties*. August 2010 – Upper Division Physics Education Research Workshop 2010, Crawfordsville, Indiana, poster presentation.

R. E. Pepper, S.V. Chasteen, S. J. Pollock, and K. K. Perkins. *Our best juniors still struggle with Gauss's Law: Characterizing their difficulties*. July 2010 – Physics Education Research Conference 2010, Portland, poster presentation.

K.K. Perkins, S. Pollock, S. Chasteen, S. Goldhaber, **R. E. Pepper**, M. Dubson, and P. Beale. *Colorado's Transformed Upper-Division E&M and QM courses: Description and Results*. July, 2010 – American Association of Physics Teachers Summer Meeting, Portland, oral presentation.

R. E. Pepper, M. Roper, S. Ryu, P. Matsuidara, and H. A. Stone. *Microscopic filter feeders near boundaries*. November 2009 – 62th APS Meeting of the Division of Fluid Dynamics, Minneapolis, oral presentation.

R. E. Pepper, L. Courbin, and H. A. Stone, *Splashing on elastic membranes: the importance of early time dynamics*. June 2009 – Fluid & Elasticity 2009, Carry-le-Rouet, France, oral presentation.

R. E. Pepper, M. Roper, and H. A. Stone. *Flow field around Vorticella: Mixing with a reciprocal stroke*. November 2008 – 61th APS Meeting of the Division of Fluid Dynamics, San Antonio, oral presentation.

R. E. Pepper, L. Courbin, and H. A. Stone, *Splashing on elastic membranes: the importance of early time dynamics*. November 2007 – 60th APS Meeting of the Division of Fluid Dynamics, Salt Lake City, oral presentation.

R. E. Pepper, L. Courbin, and H. A. Stone. *Tuning of a splash on elastic membranes*. July 2007– Boulder School for Condensed Matter and Material Physics, University of Colorado, Boulder, poster presentation.

R. E. Pepper, L. Courbin, and H. A. Stone. *Tuning of a splash on elastic membranes*. November 2006 – 59th APS Meeting of the Division of Fluid Dynamics, Tampa, oral presentation.