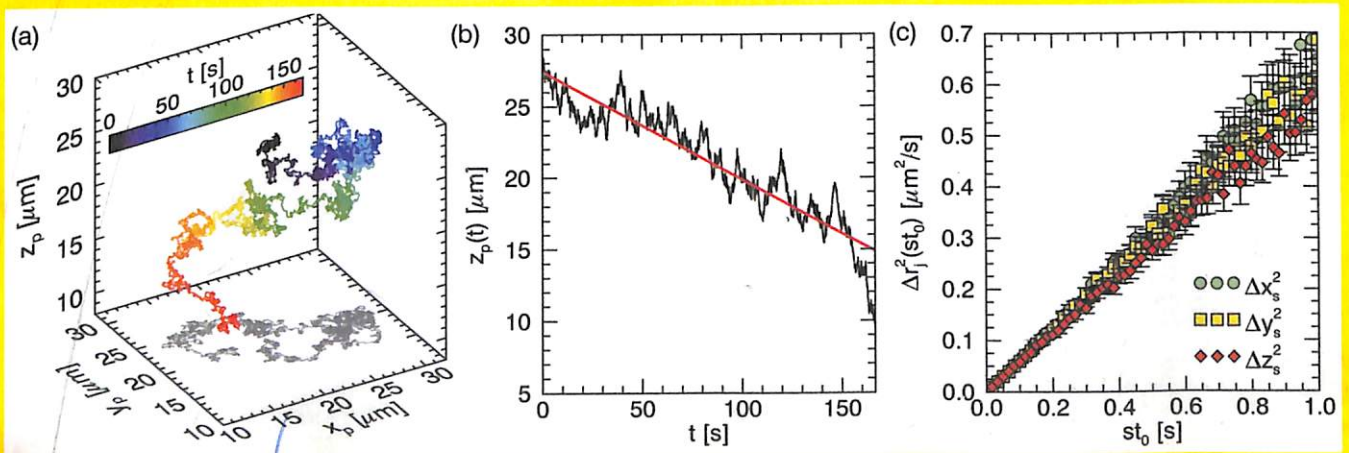


AMERICAN JOURNAL *of* PHYSICS

Volume 82, No. 1, January 2014



A PUBLICATION OF THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

Available online—visit <http://aapt.org/ajp>

Cover figure: Free diffusion of a sedimenting colloidal sphere. (a) Three-dimensional trajectory measured over 160 s. (b) Axial (z) component of the trajectory showing steady sedimentation. (c) Components of the mean-squared displacement of the trajectory in (a). See the article on page 23 to learn about the holographic video microscope constructed to obtain this data.

EDITORIAL

- 5 **The Kennedy assassination 50 years later** *David P. Jackson*

LETTERS TO THE EDITOR

- 6 **On The Discovery of The Classical Equations For Spin Motion
 In Electromagnetic Field** *V. Hushwater*
7 **Jackson Responds** *J. D. Jackson*

RESOURCE LETTER

- 8 **Resource Letter N-1: Nanotechnology** *Devin Cela,
 Mildred Dresselhaus,
 Tingying Helen Zeng,
 Mauricio Terrones,
 Antonio G. Souza
 Filho, and
 Odair P. Ferreira*

PAPERS

- 23 **Measuring Boltzmann's constant through holographic video
 microscopy of a single colloidal sphere** *Bhaskar Jyoti,
 Krishnatreya,
 Arielle Colen-Landy,
 Paige Hasebe,
 Breanna A. Bell,
 Jasmine R. Jones,
 Anderson
 Sunda-Meya, and
 David G. Grier*
32 **Anti-resonance in a one-dimensional chain of driven coupled
 oscillators** *Somayyeh Belbasi,
 M. Ebrahim
 Foulaadvand,
 and Yong S. Joe*

39 Name the experiment! Interpreting thermodynamic derivatives as thought experiments

*David Roundy,
Mary Bridget
Kustusich, and
Corinne Manogue
Bernhard Jakoby*

47 Introducing polarization and magnetization into Maxwell's equations: A modified approach

52 Everyday relativity and the Doppler effect

*Samuel Picton Drake
and Alan Purvis
Joel S. Jayson*

60 The Daniell cell, Ohm's law, and the emergence of the International System of Units

66 What should be the role of field energy in introductory physics courses?

Robert C. Hilborn

PHYSICS EDUCATION RESEARCH

72 Probing university students' understanding of electromotive force in electricity

*Isabel Garzón,
Mieke De Cock,
Kristina Zuza,
Paul van Kampen,
and Jenaro Guisasola*

NOTES AND DISCUSSIONS

80 On the unavoidability of the interpretations of quantum mechanics

*Roberto Beneduci
and Franklin E.
Schroeck, Jr.
Michael Nauenberg*

82 A paradox with the Hagen-Poiseuille relation for viscous fluid flow

BOOKS REVIEW

86 *Exploring the Quantum: Atoms, Cavities, and Photons*
by Serge Haroche and Jean-Michel Raimond

Jonathan P. Dowling

87 Books Received



Cover figure: A montage of images of various light sources studied using a simple webcam spectrometer, with the light source viewed through an optical fiber. The direct (zeroth-order) image of the fiber is visible on the right-hand side in each image and appears much larger than the fiber dimensions due to the strong intensity of the direct light. See the article on page 169 to learn how to construct such a spectrometer.

LETTERS TO THE EDITOR

- 93 **Silvered Ping-Pong Ball Bouncing Up and Down Inside
A Capacitor** *Carl E. Mungan*
- 94 **Relevant Information About Using A Mobile Phone Acceleration
Sensor In Physics Experiments** *Jochen Kuhn*

PAPERS

- 95 **Acoustic radiation force due to a diverging wave: Demonstration
and theory** *Bruce C. Denardo,
Stanley G. Freemyers,
Michaël P. Schock,
and Scott T. Sundem*
- 102 **An experimental analysis of a vibrating guitar string using high-
speed photography** *Scott B. Whitfield
and Kurt B. Flesch*
- 110 **Electromagnetic wave interactions with a conducting medium:
A graphic illustration of dispersive properties** *M. K. Shen
and K. R. Chu*
- 113 **Introducing many-body physics using atomic spectroscopy** *Dietrich Krebs,
Stefan Pabst,
and Robin Santra*
- 123 **Onsager symmetry relations and ideal gas effusion: A detailed
example** *S. N. Patitsas*
- 135 **Unraveling the mystery of the "Maoshan Bugle"** *Xu Chen, Ming Qin,
Sihui Wang, and
Huijun Zhou*

COMPUTATIONAL PHYSICS

- 142 **Wave packet scattering from time-varying potential barriers
in one dimension** *Robert M. Dimeo*

PHYSICS EDUCATION RESEARCH

- 153 Sixteen years of collaborative learning through active sense-making in physics (CLASP) at UC Davis

Wendell Potter,
David Webb,
Cassandra Paul,
Emily West,
Mark Bowen,
Brenda Weiss,
Lawrence Coleman,
and Charles De Leone

NOTES AND DISCUSSIONS

- 164 Erratum: "On trajectories of rolling marbles in cones and other funnels" [Am. J. Phys. 81, 890–898 (2013)]
164 Comment on "Unintended consequences of imprecise notation: An example from mechanics," [Am. J. Phys. 81, 313–315 (2013)]
165 Applying the principle of angular momentum to constrained systems of point masses

Gary D. White
Nivaldo A. Lemos
James Casey

APPARATUS AND DEMONSTRATION NOTES

- 169 A simple webcam spectrograph

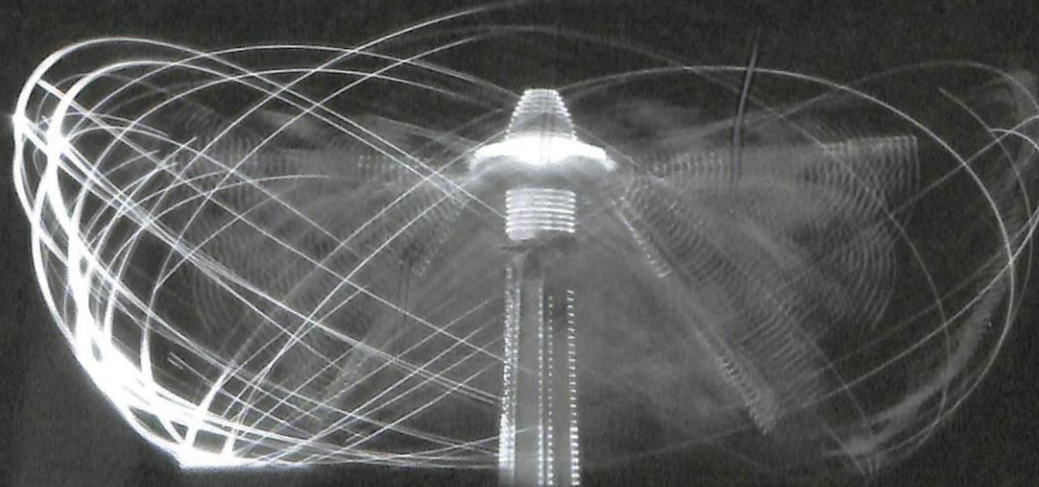
Ralph D. Lorenz

BOOK REVIEWS

- 174 *The Theoretical Minimum: What You Need to Know to Start Doing Physics* by Leonard Susskind and George Hrabovsky
175 *Feynman's Tips on Physics (2nd ed.)*, by Richard P. Feynman, Michael A. Gottlieb and Ralph Leighton
176 Books Received

Michael Dubson
Michael Dubson

AMERICAN ASSOCIATION OF PHYSICS TEACHERS



Save the Date

Abstract Submission Deadline: March 3, 2014

2014 SUMMER MEETING | JULY 26–30 | MINNEAPOLIS MN

Cover figure: Diffraction from the LCD screen of a common electronic device: (a) a Sony DSC P73 digital camera; (b) photograph of the LCD screen; (c) a microscope image of the LCD screen; (d) the central area of the transmission diffraction pattern. See the article on page 251 to learn more about how to use discarded electronics in simple optical experiments.

GUEST EDITORIAL

- 181 **The Advanced Lab: Hallmark of an Outstanding Undergraduate Program** *Jonathan F. Reichert*

RESOURCE LETTER

- 183 **Resource Letter NTUC-1: Noether's Theorem in the Undergraduate Curriculum** *Dwight E. Neuenschwander*

PAPERS

- 189 **Impact behavior of hollow balls** *Rod Cross*
196 **Capacitance-voltage profiling: Research-grade approach versus low-cost alternatives** *Neal D. Reynolds,
Cristian D. Panda,
and John M. Essick*
206 **Revisiting the Bragg reflector to illustrate modern developments in optics** *S. A. R. Horsley,
J.-H. Wu, M. Artoni,
and G. C. La Rocca*
214 **Refractive index measurement by prism autocollimation** *Chao-Chia Cheng*
217 **Isotropic photon drag: Analytic expressions for velocity (3D) and position (1D) with applications to blackbody friction** *Joseph West*
224 **Thermodynamics of bread baking: A two-state model** *Ulrich Zürcher*
231 **A model for incorporating computation without changing the course: An example from middle-division classical mechanics** *Marcos D. Caballero
and Steven J. Pollock*

PHYSICS EDUCATION RESEARCH

- 238 **Assessing the flexibility of research-based instructional strategies: Implementing tutorials in introductory physics in the lecture environment** *Mila Kryjevskaja,
Andrew Boudreaux,
and Dustin Heins*

NOTES AND DISCUSSIONS

- 251 The torque on a dipole in uniform motion
- 254 The Slinky Wilberforce pendulum: A simple coupled oscillator
- 257 Diffraction by electronic components of everyday use

David J. Griffiths
and V. Hnizdo
Matthew Mewes
Jesús J. Barreiro,
Amparo Pons,
Juan C. Barreiro,
Juan C. Castro-
Palacio, and
Juan A. Monsoriu

BOOK REVIEW

- 262 *Why You Hear What You Hear: An Experiential Approach to Sound, Music, and Psychoacoustics* by Eric J. Heller
- 264 Books Received

Daniel A. Russell



Pre-publication Sale!

Women in Physics

A collection of reprints in honor of Melba Newell Phillips

Eighteen articles on women in physics are presented in four parts:

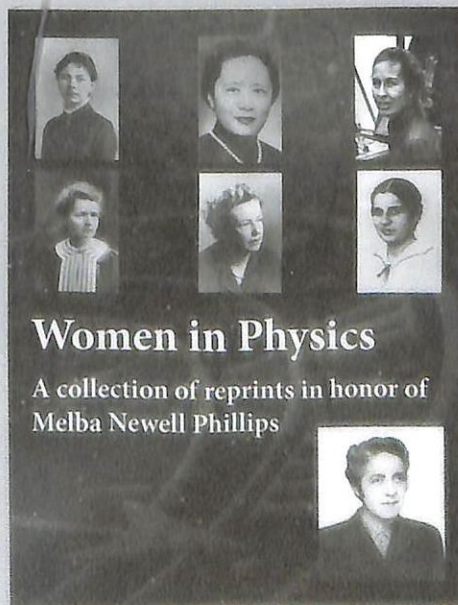
1. Gender Issues in Physics and Physics Education
2. Gender-related Physics Education Research
3. Biographical Articles
4. Analyses of the Role of Women in Science

Articles are reprinted from the *American Journal of Physics*, *The Physics Teacher*, *Physics Today*, and *Physical Review Special Topics*.

Proceeds from the sale of *Women in Physics* will support the endowment of the Melba Newell Phillips Medal.

Order your copy at The Physics Store, <http://www.aapt.org/Store>
\$25.00 (members \$20.00)

Limited print run. Order by April 30, 2014, to assure your copy.



Cover figure: Typical output signals from an experiment designed to analyze various aspects of a collision between a steel ball and a free-ended steel rod. Signal V_B drops to zero during the actual collision. Signal V_D is obtained by using the rod in one path of a Michelson-type interferometer. This signal oscillates rapidly when one end of the rod moves, which occurs in spurts as the compression wave travels back and forth through the steel rod. See the article on page 280 for details.

LETTERS TO THE EDITOR

- 269 Eclipse Pinhole Images *Jay M. Pasachoff*
269 Many-Body Physics in Atoms and Molecules *Andrew Zangwill*

AWARDS

- 270 2014 AAPT Award Citations at the Winter Meeting, Orlando, Florida *Jill Marshall*

PAPERS

- 273 Magnet traveling through a conducting pipe: A variation on the analytical approach *Benjamin Irvine, Matthew Kemnetz, Asim Gangopadhyaya, and Thomas Ruubel*
- 280 Compression waves and kinetic energy losses in collisions between balls and rods of different lengths *A. A. Freschi, R. Hessel, M. Yoshida, and D. L. Chinaglia*
- 287 Circular orbits on a warped spandex fabric *Chad A. Middleton and Michael Langston*
- 295 The Schwarzschild metric: It's the coordinates, stupid! *Pierre Fromholz, Eric Poisson, and Clifford M. Will*
- 301 Beyond Clausius–Clapeyron: Determining the second derivative of a first-order phase transition line *Matthew Krafcik and Eduardo Sánchez Velasco*
- 306 Advantages of using a logarithmic scale in pressure-volume diagrams for Carnot and other heat engine cycles *Lih-Yir Shieh and Hung-Chih Kan*
- 311 An experiment to measure the instantaneous distance to the Moon *Leonardo J. Pellizza, Mariano G. Mayochi, and Ligia Ciocci Brazzano*
- 317 Measuring the Moon's orbit using a hand-held camera *Benjamin Oostra*

- 322 Understanding current signals induced by drifting electrons
- 331 Quick and easy escape from a metastable state
- 337 The pilot-wave perspective on spin
- 349 Accurate physical laws can permit new standard units: The two laws $\vec{F}=m\vec{a}$ and the proportionality of weight to mass

Kristen A. Recine,
James B. R. Battat,
and Shawn Henderson
Anupam Garg
Travis Norsen
Wayne M. Saslow

NOTES AND DISCUSSIONS

- 354 Erratum: "The torque on a dipole in uniform motion"
[Am. J. Phys. 82, 251–254 (2014)]
- 354 The ellipse in parabolic motion: An undergraduate experiment

David J. Griffiths,
V. Hnizdo
M. A. Carrillo-Bernal,
P. E. Mancera-Piña,
H. H. Cerecedo-
Núñez,
P. Padilla-Sosa,
H. N. Núñez-Yépez,
and A. L. Salas-Brito

APPARATUS AND DEMONSTRATION NOTES

- 357 Comparing measured and calculated frequencies of a demonstration trumpet

Michael C. LoPresto

BOOK REVIEWS

- 359 *Physical Mathematics* by Kevin Cahill
- 359 Books Received



Don Lichtenberg

Pre-publication Sale!

Women in Physics

A collection of reprints in honor of Melba Newell Phillips

Eighteen articles on women in physics are presented in four parts:

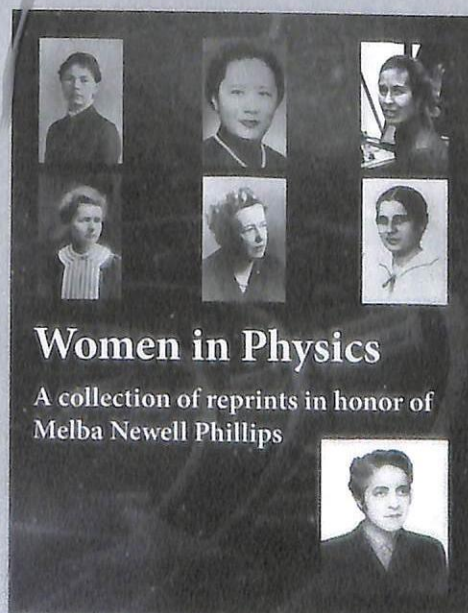
1. Gender Issues in Physics and Physics Education
2. Gender-related Physics Education Research
3. Biographical Articles
4. Analyses of the Role of Women in Science

Articles are reprinted from the *American Journal of Physics*, *The Physics Teacher*, *Physics Today*, and *Physical Review Special Topics*.

Proceeds from the sale of *Women in Physics* will support the endowment of the Melba Newell Phillips Medal.

Order your copy at The Physics Store, <http://www.aapt.org/Store>
\$25.00 (members \$20.00)

Limited print run. Order by April 30, 2014, to assure your copy.



Cover figure: A simulation of a model introduced by Turing describes the evolution of patterns on the skin of animals and can lead to a variety of different morphologies, including stripes and spots. See the article on page 442 to find out about a suite of educational software materials that are appropriate for an interdisciplinary course in biophysics.

EDITORIAL

- 365 **Research and education at the crossroads of biology and physics**

*Mel Sabella and
Matthew Lang*

PAPERS

- 368 **NEXUS/Physics: An interdisciplinary repurposing of physics for biologists**

*E. F. Redish, C. Bauer,
K. L. Carleton,
T. J. Cooke,
M. Cooper,
C. H. Crouch,
B. W. Dreyfus,
B. D. Geller,
J. Giannini,
J. S. Gouvea,
M. W. Klymkowsky,
W. Losert, K. Moore,
J. Presson,
V. Sawtelle,
K. V. Thompson,
C. Turpen, and
R. K. P. Zia*

- 378 **Introductory physics in biological context: An approach to improve introductory physics for life science students**

*Catherine H. Crouch
and Kenneth Heller*

- 387 **Toward better physics labs for future biologists**

*K. Moore, J. Giannini,
and W. Losert*

- 394 **Entropy and spontaneity in an introductory physics course for life science students**

*Benjamin D. Geller,
Benjamin W. Dreyfus,
Julia Gouvea,
Vashti Sawtelle,
Chandra Turpen, and
Edward F. Redish*

- 403 **Chemical energy in an introductory physics course for the life sciences**
Benjamin W. Dreyfus, Julia Gouvea, Benjamin D. Geller, Vashti Sawtelle, Chandra Turpen, and Edward F. Redish
- 412 **Biologic: Gene circuits and feedback in an introductory physics sequence for biology and premedical students**
S. B. Cahn and S. G. J. Mochrie
- 422 **A collection of homework problems about the application of electricity and magnetism to medicine and biology**
Bradley J. Roth and Russell K. Hobbie
- 428 **Physics and the revised Medical College Admission Test**
Robert C. Hilborn
- 434 **Bridging physics and biology teaching through modeling**
Anne-Marie Hoskinson, Brian A. Couch, Benjamin M. Zwickl, Kathleen A. Hinko, and Marcos D. Caballero
- 442 **Biophysics software for interdisciplinary education and research**
J. M. Deutsch
- 451 **Biology's built-in Faraday cages**
Maurice M. Klee
- 460 **Electrical interactions in the cell: Asymmetric screening in a watery "antiverse"**
T. P. Doerr and Yi-Kuo Yu
- 466 **Modeling discrete-variable stochastic dynamics: Ecological populations, gene networks, and a nanotube ion channel**
Robert C. Hilborn
- 476 **Mean-field master equation formalism for biofilament growth**
Thomas C. T. Michaels and Tuomas P. J. Knowles
- 484 **Interdisciplinary cantilever physics: Elasticity of carrot, celery, and plasticware**
Kenneth A. Pestka II
- 490 **Ultrasound imaging as an undergraduate physics laboratory exercise**
Timothy A. Stiles
- 502 **Lipid membranes and single ion channel recording for the advanced physics laboratory**
Yvonne Klapper, Karin Nienhaus, Carlheinz Röcker, and G. Ulrich Nienhaus
- 510 **Dielectric resonating microspheres for biosensing: An optical approach to a biological problem**
Jean-Raphaël Carrier, Maurice Boissinot, and Claudine Ni. Allen
- 521 **Bioelectrical impedance analysis as a laboratory activity: At the interface of physics and the body**
Elliot Mylott, Ellynn Kutschera, and Ralf Widenhorn
- BOOK REVIEWS**
- 529 *Revolutions that Made the Earth* by Tim Lenton and Andrew Watson
- 531 *Comparative Biomechanics: Life's Physical World (2nd ed.)* by Steven Vogel
- 532 **Books Received**
*David Schwartzman
Scott Turner*



Cover figure: Schematic diagram showing the essential components of a Kerr microscope, which is used to image magnetic domains. See the article on page 574 to learn how to construct a low-cost version of such a microscope that can be used in the undergraduate curriculum.

AWARDS

- 537 **Oersted Lecture 2013: How should we think about how our students think?** *Edward F. Redish*

RESOURCE LETTER

- 552 **Resource Letter Exo-1: Exoplanets** *Michael Perryman*

PAPERS

- 564 **Orbits of massless particles in the Schwarzschild metric: Exact solutions** *Gerardo Muñoz*
- 574 **Developing a Kerr microscope for upper-division solid-state physics laboratories** *David Neff,
Anatol Hoemke,
Adam R. Attig,
and Hector Cordova Mireles*
- 583 **Matrix mechanics of the infinite square well and the equivalence proofs of Schrödinger and von Neumann** *Jeffrey Prentis and
Bunheng Ty*
- 591 **Understanding an anomaly** *Barry R. Holstein*
- 597 **The electric field at the chargeless interface between two regions of space** *Robert A. McNees
and Asim
Gangopadhyaya*
- 602 **Is the mean free path the mean of a distribution?** *Steve T. Paik*

COMPUTATIONAL PHYSICS

- 609 **A guide to hunting periodic three-body orbits** *Milovan Šuvakov
and V. Dmitrašinović*

APPARATUS AND DEMONSTRATION NOTES

- 620 **Two-dimensional heat flow apparatus** *Patrick McDougall
and Eric Ayars*

BOOK REVIEWS

- 624 *Magnificent Principia: Exploring Isaac Newton's Masterpiece*
by Colin Pask *Michael Nauenberg*
- 625 *Renewable Energy: A First Course* by Robert Ehrlich *Cameron Reed*
- 626 *In Search of the True Universe: The Tools, Shaping, and Cost of
Cosmological Thought* by Martin Harwit *Neil F. Comins*
- 627 Books Received



Apparatus Competition

The Apparatus Competition is where teachers can share apparatus with their colleagues.

Whether developed to pique the interest of students, used in lecture and demonstration, or simply used to help teach physics in new or fascinating ways, teachers are continually engineering apparatus to aid physics instruction.

Enter your apparatus for display and judging at the 2014 AAPT Summer Meeting in Minneapolis.

aapt.org/Programs/contests/apparatus.cfm

Prizes are generously provided by **WATSCO**



2nd Place and Low Cost Award
2012 AAPT Summer Meeting, Philadelphia, PA
"Ammeter Protection Circuit"
Dan Becker, Indiana University

Cover figure: A vertically vibrated bed of sand results in sand ascending upwards through a tube and being ejected out of the top in this “granular fountain.” The photographs show the fountain: (a) at rest and vibrated at frequencies of (b) 14 Hz, (c) 18 Hz, and (d) 20 Hz. See the article on page 708 to learn more about the physics underlying this phenomenon.

GUEST EDITORIAL

- 638 Transforming the preparation of physics teachers *David E. Meltzer and Valerie K. Otero*

RESOURCE LETTER

- 638 Resource Letter HECR-1: High-Energy Cosmic Rays *Kumiko Kotera and Angela Olinto*

PAPERS

- 649 A daylight experiment for teaching stellar interferometry *M. A. Illarramendi, R. Hueso, J. Zubia, G. Aldabaldetrekue, G. Durana, and A. Sánchez-Lavega*
- 654 The rattleback revisited *William Case and Sahar Jalal*
- 659 Simulation of the active Brownian motion of a microswimmer *Giorgio Volpe, Sylvain Gigan, and Giovanni Volpe*
- 665 Calculating and visualizing the density of states for simple quantum mechanical systems *Declan Mulhall and Matthew J. Moelter*
- 674 An introduction to the inverse quantum bound-state problem in one dimension *Thomas D. Gutierrez*
- 681 Electron spin and probability current density in quantum mechanics *W. B. Hodge, S. V. Migirditch, and W. C. Kerr*
- 691 Birds on power lines *José Arnaldo Redinz*

PHYSICS EDUCATION RESEARCH

- 695 Distinguishing between “change” and “amount” infinitesimals in first-semester calculus-based physics *Joshua Von Korff and N. Sanjay Reddy*

NOTES AND DISCUSSION

- 706 Comment on “ ^{252}Cf fission-neutron spectrum using a simplified time-of-flight setup: An advanced teaching laboratory experiment” [Am. J. Phys. 81, 112–119 (2013)] *F. D. Becchetti*
- 706 Erratum: “Entropy and evolution” [Am. J. Phys. 76(11), 1031–1033 (2008)] *Daniel F. Styer*
- 707 Erratum: “The ellipse in parabolic motion: An undergraduate experiment” [Am. J. Phys. 82, 354–356 (2014)] *M. A. Carrillo-Bernal, P. E. Mancera-Piña, H. H. Cerecedo-Núñez, P. Padilla-Sosa, H. N. Núñez-Yépez, and A. L. Salas-Brito*

APPARATUS AND DEMONSTRATION NOTES

- 708 A granular fountain *R. E. Urbina, K. K. Díaz, W. Bramer-Escamilla, and I. Sánchez*
- 712 Inexpensive electronics and software for photon statistics and correlation spectroscopy *Benjamin D. Gamari, Dianwen Zhang, Richard E. Buckman, Peker Milas, John S. Denker, Hui Chen, Hongmin Li, and Lori S. Goldner*

BOOK REVIEWS

- 723 *Soft Matter Physics* by Masao Doi
723 Book Received

Francisco Solis



Give a gift of membership

AAPT American Association of
Physics Teachers

Your tax-deductible gift to your colleague goes a long way towards strengthening physics education.

bit.ly/AAPTgift

Cover figure: The second generalized coherent state of the harmonic oscillator is plotted for one period: (a) the real and imaginary parts of the wave function; (b) the probability density. In (a), the classical trajectory with the same amplitude is shown in gray. See the article on page 742 to learn more about these wave functions.

AWARDS

- 729 **Melba Newell Phillips Medal Lecture 2013: Discipline-Based Education Research—A View From Physics**
Lillian Christie McDermott

PAPERS

- 742 **Generalized coherent states**
749 **An introduction to QBism with an application to the locality of quantum mechanics**
*T. G. Philbin
Christopher A. Fuchs,
N. David Mermin,
and Rüdiger Schack
Joel Franklin and
David J. Griffiths
Xiaosun Wang
Scott Tremaine
and Tomer D. Yavetz
T. Kouh, U. Kemiktarak,
O. Basarir,
C. Lissandrello,
and K. L. Ekinci
D. A. Van Baak and
George Herold*
- 755 **The fields of a charged particle in hyperbolic motion**
- 764 **Trajectory of a projectile on a frictional inclined plane**
769 **Why do Earth satellites stay up?**
- 778 **Measuring Gaussian noise using a lock-in amplifier**
- 785 **Response of a lock-in amplifier to noise**

PHYSICS EDUCATION RESEARCH SECTION

- 798 **Traditionally taught students learn; actively engaged students remember**
*Scott V. Franklin,
Eleanor C. Sayre,
and Jessica W. Clark*

NOTES AND DISCUSSION

- 802 **Erratum: "Concepts in nuclear science illustrated through experiments with radon" [Am. J. Phys. 80, 61–65 (2012)]**
*C. T. Angell,
A. C. Kaplan,
J. D. Seelig,
E. B. Norman,
and M. Pedretti*

- 802 Comment on and Erratum: "Relation between Poisson and Schrödinger equations" [Am. J. Phys. 80, 715–719 (2012)]
- 803 Comment on "An accurate determination of the acceleration of gravity for lecture hall demonstration" [Am. J. Phys. 55, 324–330 (1987)]
- 804 Response to "Comment on 'An accurate determination of the acceleration of gravity for lecture hall demonstration'" [Am. J. Phys. 82, 803–804 (2014)]

Vasil Rokaj,
Fotis K. Diakonos,
and Gabriel González
Rod Cross

Wolfgang Rueckner

APPARATUS AND DEMONSTRATION NOTES

- 805 Design and construction of cost-effective tapered amplifier systems for laser cooling and trapping experiments

Jayampathi
C. B. Kangara,
Andrew J. Hachtel,
Matthew C. Gillette,
Jason T. Barkeloo,
Ethan R. Clements,
Samir Bali,
Brett E. Unks,
Nicholas A. Proite,
Deniz D. Yavuz,
Paul J. Martin,
Jeremy J. Thorn,
and Daniel A. Steck



BOOK REVIEWS

- 818 *Probing the Sky with Radio Waves: From Wireless Technology to the Development of Atmospheric Science* by Chen-Pang Yeang
- 819 *Electrons in Molecules: From Basic Principles to Molecular Electronics* by Jean-Pierre Launay and Michel Verdaguer
- 820 Books Received

Russell Philbrick

Gerald F. Thomas

Give a gift of membership

AAPT American Association of
Physics Teachers

Your tax-deductible gift to your colleague goes a long way towards strengthening physics education.

bit.ly/AAPTgift

Cover figure: Photographs of a soap film experiment showing the evolution of a symmetric catenoid as the aspect ratio (the ratio of ring separation h to radius R) changes. The bottom panel compares the experimentally determined (normalized) neck radius (a/R) to theory as the aspect ratio varies. See the article on page 839 to learn more about the stability of these minimal surfaces.

RESOURCE LETTER

- 825 **Resource Letter APPO-1: Acoustics for Physics Pedagogy and Outreach** *Kent L. Gee and Tracianne B. Neilsen*

PAPERS

- 839 **Influence of boundary conditions on the existence and stability of minimal surfaces of revolution made of soap films** *Louis Salkin, Alexandre Schmit, Pascal Panizza, and Laurent Courbin*
- 848 **Incompleteness of the Hamilton-Jacobi theory** *Nivaldo A. Lemos*
- 853 **The restoring force on a dielectric in a parallel plate capacitor** *L. P. Staunton*
- 860 **Near field of an oscillating electric dipole and cross-polarization of a collimated beam of light: Two sides of the same coin** *Andrea Aiello and Marco Ornigotti*
- 869 **The electromagnetic momentum of static charge-current distributions** *Jerrold Franklin*
- 876 **Incorporating learning goals about modeling into an upper-division physics laboratory experiment** *Benjamin M. Zwickl, Noah Finkelstein, and H. J. Lewandowski*
- 883 **Sommerfeld's elliptical atomic orbits revisited—A useful preliminary to the study of quantum mechanics** *Tony Deeney and Colm O'Sullivan*
- 887 **Quantum and thermal fluctuations in the harmonic chain and experimental implications** *K. Schönhammer*
- 896 **What in the (quantum) world is macroscopic?** *Gregg Jaeger*

PHYSICS EDUCATION RESEARCH

- 906 **Why students still can't solve physics problems after solving over 2000 problems** *Taejin Byun and Gyoungcho Lee*

BOOK REVIEWS

- 914 *The History and Science of the Manhattan Project*
by Bruce Cameron *Alex Wellerstein*
- 915 *Starlight Detectives: How Astronomers, Inventors, and Eccentrics*
Discovered the Modern Universe by Alan Hirshfeld *Neil F. Comins*
- 916 **Books Received**



A dark grey rectangular banner for the AAPT 2015 Winter Meeting. It features five small black and white photographs of people at a conference. The text "AAPT 2015" is prominent, with "PHYSICS EDUCATION" and "WINTER MEETING" below it. "JANUARY 3-6" and "SAN DIEGO, CA" are also present. At the bottom, the URL "aapt.org/Conferences/wm2015" is displayed in a large, white, stylized font.

Cover figure: The knuckleball in baseball is perhaps the most difficult of all pitches to hit. Here the ball is shown in a four-seam orientation (a) and a two-seam orientation (b) as the ball travels from left to right. See the article on page 921 to find out how the aerodynamic forces conspire to make the knuckleball such a challenging pitch for hitters.

PAPERS

- 921 **Aerodynamics of the knuckleball pitch: Experimental measurements on slowly rotating baseballs** *John P. Borg and Michael P. Morrissey*
- 928 **Fourier analysis of thermal diffusive waves** *Muhammad Sabieh Anwar, Junaid Alam, Muhammad Wasif, Rafi Ullah, Sohaib Shamim, and Wasif Zia*
- 934 **Brownian motion of a trapped microsphere ion** *M. J. Madsen and A. D. Skowronski*
- 941 **Unnormalized probability: A different view of statistical mechanics** *Robert H. Swendsen*
- 947 **The classical Bloch equations** *Martin Frimmer and Lukas Novotny*
- 955 **Analytic time-dependent solutions of the one-dimensional Schrödinger equation** *Wytse van Dijk, F. Masafumi Toyama, Sjirk Jan Prins, and Kyle Spyksma*
- 962 **Exploring entanglement with the help of quantum state measurement** *E. Dederick and M. Beck*
- 972 **FISSIONCORE: A desktop-computer simulation of a fission-bomb core** *B. Cameron Reed and Klaus Rohe*
- 977 **Simple calculation of the critical mass for highly enriched uranium and plutonium-239** *Christopher F. Chyba and Caroline R. Milne*

COMPUTATIONAL PHYSICS

- 980 **Diffusion Monte Carlo: A powerful tool for studying quantum many-body systems** *Tao Pang*

PHYSICS EDUCATION RESEARCH

- 989 **Preparing students for class: How to get 80% of students reading the textbook before class** *Cynthia E. Heiner, Amanda I. Banet, and Carl Wieman*

NOTES AND DISCUSSIONS

- 997 The concept of negative mass and its application to Helium-balloon-type dynamics
- 1000 Addendum to "A low cost remote sensing system using PC and stereo equipment" [Am. J. Phys. 79, 1240–1245 (2011)]

*C. J. Dias and
L. N. Gonçalves
Joel F. Campbell*

APPARATUS AND DEMONSTRATION NOTES

- 1003 Visible optical beats at the hertz level
- 1005 Simple and inexpensive stereo vision system for 3D data acquisition

*Mickey McDonald,
Jiyoun Ha, Bart H.
McGuyer, and
Tanya Zelevinsky
Samuel E. Mermall
and John F. Lindner*

BOOK REVIEWS

- 1008 *The Universal Force: Gravity—Creator of Worlds*
by Louis A. Girifalco
- 1009 Books Received

Thomas M. Helliwell



JANUARY 3-6
AAPT 2015
PHYSICS EDUCATION
WINTER MEETING SAN DIEGO, CA

aapt.org/Conferences/wm2015

Cover figure: The kugel fountain at the House of Science in Patras, Greece, is shown on the left, along with a sketch that includes the relevant physical parameters on the right. Although the granite sphere has a mass of well over a thousand kilograms, it floats gently on a thin film of water. See the article on page 1029 to learn about the details of this phenomenon.

LETTERS TO THE EDITOR

- 1017 Dangers Looming on the Advanced Lab *G. L. Lippi*
1017 On the Ultimate Range of a Speeding Disc *Gary White*

RESOURCE LETTER

- 1018 Resource Letter SPE-1: Single-Photon Experiments in the *Enrique J. Galvez*
Undergraduate Laboratory

PAPERS

- 1029 Physics of the granite sphere fountain *Jacco H. Snoeijer and
Ko van der Weele*
1040 Irreversibility in an ideal fluid *Alejandro Jenkins*
1047 Perturbation approximation for orbits in axially symmetric funnels *Michael Nauenberg*
1053 Dynamics and performance of clock pendulums *Peter Hoyng*
1062 Demystifying umklapp vs normal scattering in lattice thermal *A. A. Maznev*
conductivity *and O. B. Wright*
1067 Implementing a simple vectorial bridge with a digital oscilloscope *Rosario Bartiromo and
Mario De Vincenzi*
1077 Why not an $e \rightarrow \mu$ experiment? An extended exercise for students *J. M. Conrad,*
studying introductory particle physics *M. Williams,*
and P. Nienaber
1083 A direct derivation of the relativistic Lagrangian for a system of *Laslo J. Nádlerd,*
particles using D'Alambert's principle *Miloš D. Davidović,*
and Dragomir M.
Davidović
1087 On time and space double-slit experiments *M. Bauer*

PHYSICS EDUCATION RESEARCH

- 1093 What integration cues, and what cues integration in intermediate *Leanne Doughty,*
electromagnetism *Eilish McLoughlin,*
and Paul van Kampen

BOOK REVIEWS

1104 *Quantum Mechanics: The Theoretical Minimum* by
Leonard Susskind and Art Friedman

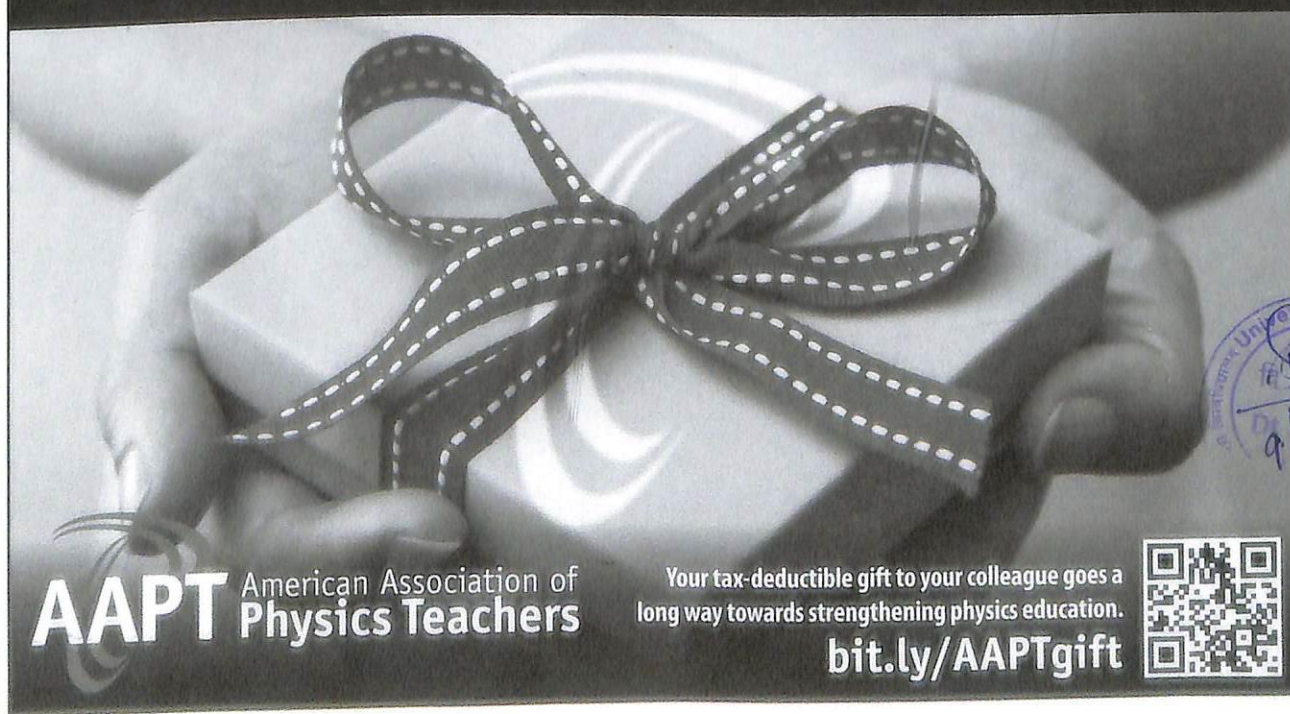
Daniel F. Styer

1105 *String Theory and the Scientific Method* by Richard Dawid

Lee Smolin


1107 **Books Received**

Give a gift of membership



AAPT American Association of
Physics Teachers

Your tax-deductible gift to your colleague goes a long way towards strengthening physics education.
bit.ly/AAPTgift



University of
Bong
9/12/2015

Cover figure: Liquid drop density profiles calculated for a fixed temperature as the strength of the surface interaction is increased. A flat film is seen to form beyond the wetting transition. See the article on page 1119 for more detail on these calculations.

EDITORIAL

1113 **AJP Reviewers**

*David P. Jackson and
Daniel V. Schroeder*

AWARDS

1115 **2014 AAPT Award Citations at the Summer Meeting, Minneapolis, Minnesota**

Gay B. Stewart

PAPERS

1119 **An introduction to inhomogeneous liquids, density functional theory, and the wetting transition**

*Adam P. Hughes,
Andrew J. Archer,
and Uwe Thiele*

1130 **Meteor orbits and impacts**

*David Garfinkle
and Alberto G. Rojo
Rafael de la Madrid,
Alejandro Gonzalez,
and George M. Irwin*

1134 **Gravitational dispersion in a torsional wave machine**

*A. Filippini
Rui C. Vilão and
Santino L. S. Melo
Jed Brody, Elena
Villhauer, and Hugo
Espirito*

1142 **A non-isochronous rocking oscillator**

1149 **Berimbau: A simple instrument for teaching basic concepts in the physics and psychoacoustics of music**

*Nico Roos
José Luis Rodríguez
Marrero*

1157 **Standing waves between a microwave transmitter and receiver**

Alessandro Petrolini

1161 **Entropic forces in Brownian motion**

1167 **Inspectional analysis to search for symmetric solutions. Applications in electromagnetism**

1178 **Linear least squares fit when both variables are affected by equal uncorrelated errors**

PHYSICS EDUCATION RESEARCH

- 1186 Analyzing the impact of course structure on electronic textbook use in blended introductory physics courses

*Daniel T. Seaton,
Gerd Kortemeyer,
Yoav Bergner,
Saif Rayyan, and
David E. Pritchard*

APPARATUS AND DEMONSTRATION NOTES

- 1198 Improved "black box" moment-of-inertia apparatus

*Joseph C. Amato,
Joshua M. Mills,
and Shannon Zachow*

BOOK REVIEWS

- 1201 *The Sound Book* by Trevor Cox
1202 *Controlled Thermonuclear Fusion* by Jean Louis Bobin
1203 Books Received

*Dennis Thomson
Irvin R. Lindemuth*

ANNUAL INDEX TO VOLUME 82 (2014)

- Index-1 Subject Index to Volume 82 (2014)
Index-9 Author Index to Volume 82 (2014)



Give a gift of membership



AAPT American Association of
Physics Teachers

Your tax-deductible gift to your colleague goes a long way towards strengthening physics education.

bit.ly/AAPTgift

