

PHYSICS TODAY

September 2019 • volume 72, number 9

A publication of the American Institute of Physics

Random walk illuminates math problem

Fluid dynamics
inside cells

Toward greener
conferences

Sweden's nuclear
weapons program

PHYSICS TODAY

September 2019 | volume 72 number 9

FEATURES

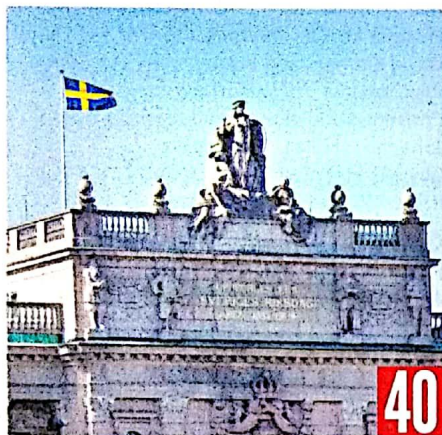


32

32 The stormy fluid dynamics of the living cell

Daniel Needleman and Michael Shelley

The flows inside cells are intricate and often counterintuitive. Measurements, models, and simulations are helping to unravel the complexities.

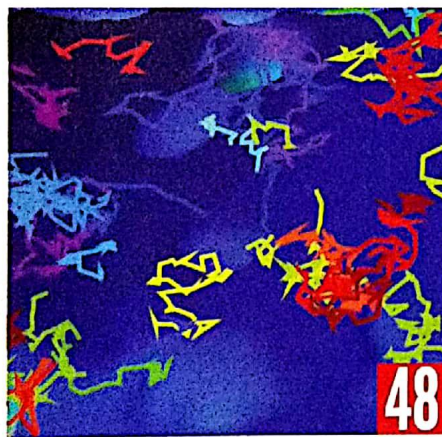


40

40 Getting rid of the Swedish bomb

Thomas Jonter

Early in the Cold War, Sweden's leaders planned to acquire nuclear weapons. By the 1960s the country was an international leader of the disarmament movement.



48

48 Strange interfacial molecular dynamics

Diego Krapf and Ralf Metzler

The motion underlying contact interactions that are vital for biology has farther-reaching implications than previously thought.



ON THE COVER: Computer scientist Manohar Vanga generated this image from a photograph by iteratively adjusting the colors of a pixel's neighbors via a random walk in color space. Random walks are the crucial ingredient in a new study that brings physical intuition to a perplexing mathematical problem. To learn more, turn to the news story that begins on page 18. (Image courtesy of Manohar Vanga, Max Planck Institute for Software Systems.)

Recently on
**PHYSICS
TODAY
ONLINE**

www.physicstoday.org



O. MASSON ET AL., PNAS 2019



► Radiation forensics

In fall 2017 air monitors across Europe detected a plume of radioactive ruthenium. To this day no one has accepted responsibility for the radionuclide's release. PHYSICS TODAY's Andrew Grant details a recent study implicating a nuclear facility in Russia that was producing a radioactive source for a neutrino experiment. physicstoday.org/Sep2019a

ARGONNE NATIONAL LABORATORY



► X-ray source upgrade

The US Department of Energy has approved an \$815 million upgrade to its Advanced Photon Source user facility outside Chicago. PHYSICS TODAY's Alex Lopatka describes the improvements that will allow for x-ray beamlines that are between 100 and 1000 times as bright as those currently in use. physicstoday.org/Sep2019b

VLADIMIR SHILTSVY



► Vodka 101

Bottles of Russian Standard vodka claim that its 40/60 mixture of alcohol and water was devised by Dmitri Mendeleev, who created the periodic table 150 years ago. Physicist Vladimir Shiltsev debunks that myth and lays out the facts about vodka and Mendeleev's research on the topic. physicstoday.org/Sep2019c

PHYSICS TODAY (ISSN 0031-9228, coden PHTOAD) volume 72, number 9. Published monthly by the American Institute of Physics, 1305 Walt Whitman Rd, Suite 300, Melville, NY 11747-4300. Periodicals postage paid at Huntington Station, NY, and at additional mailing offices. POSTMASTER: Send address changes to PHYSICS TODAY, American Institute of Physics, 1305 Walt Whitman Rd, Suite 300, Melville, NY 11747-4300. Views expressed in PHYSICS TODAY and on its website are those of the authors and not necessarily those of AIP or any of its member societies.



Copyright © 2019, American Institute of Physics. Single copies of individual articles may be made for private use or research. Authorization is given to copy articles beyond the free use permitted under US Copyright Law, provided that the copying fee of \$30.00 per copy per article is paid to the Copyright Clearance Center, 222 Rosewood Dr, Danvers, MA 01923. For articles published before 1978, the copying fee is \$0.25 per article. Authorization does not extend to systematic or multiple reproduction or to republication in any form. In all such cases, specific written permission from AIP must be obtained. Send requests for permission to AIP Office of Rights and Permissions, 1305 Walt Whitman Rd, Suite 300, Melville, NY 11747-4300; phone +1 516 576-2268; email rights@aip.org.

PHYSICS TODAY

www.physicstoday.org



DEPARTMENTS

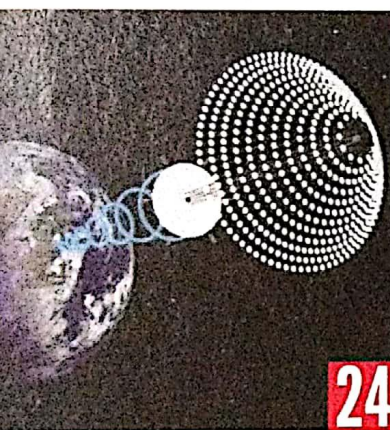
8 From the editor

10 Readers' forum

Letters

16 Search & discovery

Tropical biodiversity faces intersecting threats • Random walkers illuminate a math problem • When a novel metal alloy relieves stress, it chills out • A tiny swimmer generates rapid, far-reaching signals in water



24 Issues & events

Prospect of off-planet outposts spurs interest in space resources • Environmental sustainability goals drive changes in conference practices

56 Books

The mysteries of quantum mechanics in graphic-novel form — *Richard Healey* • Eddington and Einstein, scientists and wartime visionaries — *Jeffrey Crellin* • The significance of the 1919 total solar eclipse — *Irwin Shapiro* • New books & media



62 New products

Focus on test, measurement, and analytical equipment

66 Obituaries

Michael Pollak • David James Thouless

70 Quick study

When dense crowds act like soft solids — *Arianna Bottinelli* and *Jesse L. Silverberg*

72 Back scatter

An Example of Refractography

Senior director of news & magazines

Larry Fishbein lfishbein@aip.org

Editor-in-chief

Charles Day cday@aip.org

Managing editor

Richard J. Fitzgerald rjf@aip.org

Art and production

Donna Padian, art director

Freddie A. Pagni, art and production associate

Cynthia B. Cummings, photographer

Nathan Cromer

Editors

Melinda Baldwin mbaldwin@aip.org

Toni Feder tf@aip.org

Martha M. Hanna mmh@aip.org

Heather M. Hill hhill@aip.org

David Kramer dk@aip.org

Alex Lopatka alopatka@aip.org

Christine Middleton cmiddleton@aip.org

Johanna L. Miller jlml@aip.org

Gayle G. Parrayay ggp@aip.org

R. Mark Wilson rmw@aip.org

Online

Paul K. Guinnessy, director pkg@aip.org

Andrew Grant, editor agrant@aip.org

Angela Dombroski atd@aip.org

Greg Stasiewicz gls@aip.org

Assistant editor

Cynthia B. Cummings

Editorial assistant

Tonya Gary

Contributing editors

Rachel Berkowitz

Andreas Mandelis

Sales and marketing

Christina Unger Ramos cunger@aip.org

Unique Carter

Krystal Dell

Skye Haynes

Address

American Center for Physics

One Physics Ellipse

College Park, MD 20740-3842

+1 301 209-3100

pteditors@aip.org

[f](https://www.facebook.com/PhysicsToday) PhysicsToday [t](https://twitter.com/physicstoday) @physicstoday

AIP American Institute of Physics

Member societies

Acoustical Society of America

American Association of Physicists in Medicine

American Association of Physics Teachers

American Astronomical Society

American Crystallographic Association

American Meteorological Society

American Physical Society

AVS: Science & Technology of Materials, Interfaces,
and Processing

The Optical Society

The Society of Rheology

Other member organizations

Sigma Pi Sigma Physics Honor Society

Society of Physics Students

Corporate Associates

The American Institute of Physics is a federation of scientific societies in the physical sciences, representing scientists, engineers, educators, and students. AIP offers authoritative information, services, and expertise in physics education and student programs, science communication, government relations, career services, statistical research in physics employment and education, industrial outreach, and history of the physical sciences. AIP publishes PHYSICS TODAY and is also home to the Society of Physics Students and to the Niels Bohr Library and Archives. AIP owns AIP Publishing, a scholarly publisher in the physical and related sciences.

Board of Directors: David J. Helfand (Chair), Michael H. Moloney (CEO), Judy R. Dubno (Interim Corporate Secretary), Susan K. Avery, J. Daniel Bourland, Susan Burkett, Jack G. Hehn, John Kent (Treasurer), Kate Kirby, Allison Macfarlane, Kevin B. Marvel, Michael Morgan, Faith Morrison, Elizabeth Nolan, Nathan Sanders, Cheryl R. Stevens.

Officers: Michael H. Moloney (CEO), Steve Mackwell (DEO), Gigi Swartz (CFAO).

SUBSCRIPTION QUESTIONS? +1 800 344-6902 | +1 516 576-2270 | ptsubs@aip.org

INDEX TO ADVERTISERS

COMPANY	PAGE NO.
Amptek Inc	14, 58
Applied Physics Reviews	55
Bristol Instruments	54
Brown University Chemistry Department	25
COMSOL Inc	C3
Hidden Analytical Inc	12, 13
Indiana University	31
INRS	15
Janis Research LLC	11
Kavli Foundation	9
Mad City Labs Inc	64
Master Bond	63
Nanomagnetics Instruments	1
Nor-Cal Products	C4
OriginLab Corporation	28
Oxford Instruments Nanoscience	7
Pearl Companies	4
RD Mathis	26
Spectrum Instrumentation GmbH	47
Stanford Research Systems	3, 60
The Chinese University of Hong Kong	64
University of Minnesota	27
University of Pennsylvania	61
Zurich Instruments AG	C2

ADVERTISING SALES MANAGEMENT

American Institute of Physics

One Physics Ellipse
College Park, MD 20740
+1 301.209.3393
www.physicstoday.org/advertising

Sales and Marketing Manager

Christina Unger Ramos • cunger@aip.org

Recruitment Advertising

ptjobs@aip.org

Ad Traffic Coordinator

Unique Carter • ucarter@aip.org

ADVERTISING SALES CONSULTANTS

USA and CANADA

AL, AK, AZ, AR, CO, HI, ID, IL, IN, IA,
KS, KY, LA, MI, MN, MS, MO, MT, NE,
NV, NM, ND, OH, OK, SD, TN, UT, WV,
WI, WY

CEL Associates II

Merrie Lynch

+1 617.594.4943

merrie.lynn@celassociates2.com

CA, CT, DE, FL, GA, ME, MD, MA, NH,
NJ, NY, NC, OR, PA, RI, SC, VT, VA,
WA, and Canada

CEL Associates II

Jody Estabrook

p: +1 774.283.4528

m: +1 978.835.2013

jodyestabrook@comcast.net

INTERNATIONAL

Northern and Western Europe

John Gold

+44 208.641.7717

johnfgold@gmail.com

Central and Eastern Europe

Leo Ploner

+49 172.8231.062

leo@ploner.de

Asia/Pacific

Jake Wilson

+61(0)413 949 644

jwilson@imraust.com.au

PHYSICS TODAY

www.physicstoday.org/advertising