

# PHYSICS TODAY

A publication of the American Institute of Physics

## Annual careers issue

Advice on  
leaving academia

What physicists  
do at Boeing

The paths from  
PhD to job

# PHYSICS TODAY

October 2019 | volume 72 number 10



32

## Careers issue

### 32 The road taken

Anne Marie Porter and Susan White

Survey data show that PhD physicists find satisfaction in a wide range of careers, from academia to government to industry.

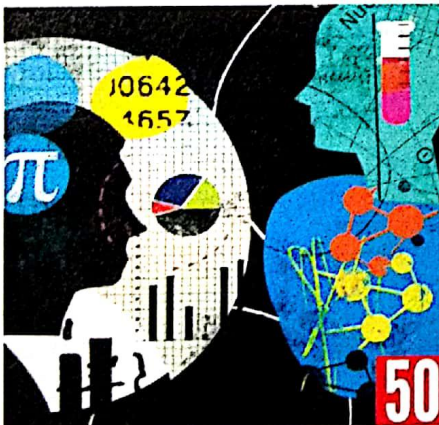


40

### 40 Teaching physics for tomorrow: Equipping students to change the world

Crystal Bailey and Douglas Arion

Why should engineers have all the fun?

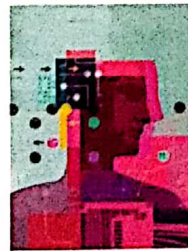


50

### 50 Cal-Bridge: Creating pathways to the PhD for underrepresented students in physics and astronomy

Alexander L. Rudolph

The Cal-Bridge program connects promising juniors and seniors from underrepresented groups with STEM faculty mentors to help smooth the transition from undergraduate to graduate programs.



**ON THE COVER:** Our first annual careers issue focuses on three aspects of becoming and being a physicist: the paths that physical scientists pursue 10 years after obtaining their PhD, the case for including innovation and entrepreneurship in the undergraduate physics curriculum, and the efforts of a consortium of California colleges and universities to boost the number of women and underrepresented minorities in graduate school. Be sure also to turn to Elizabeth Frank's commentary on **page 10** and the news stories starting on **page 24**. (Image by Stuart Kinlough/Alamy Stock Photo.)

Recently on  
**PHYSICS  
TODAY  
ONLINE**

[www.physicstoday.org](http://www.physicstoday.org)



© NOBEL MEDIA AB

#### ► Nobel season

The 2019 Nobel Prizes will be announced 7–14 October, and *PHYSICS TODAY* has them covered. Before the awards, explore an in-depth analysis of the pioneering physics papers that have garnered Nobel recognition. Then on 8 October, visit [physicstoday.org](http://physicstoday.org) for a full report on the newly announced physics laureates. [physicstoday.org/Oct2019a](http://physicstoday.org/Oct2019a)



MICHELLE MILNE

#### ► Fostering inclusivity


Nearly 75% of undergraduate women in physics experience sexual harassment, according to one study. Education in the classroom can help combat the problem. *PHYSICS TODAY*'s Heather Hill profiles efforts by physics faculty at St Mary's College of Maryland to create a welcoming environment. [physicstoday.org/Oct2019b](http://physicstoday.org/Oct2019b)



OAK RIDGE NATIONAL LABORATORY

#### ► Element hunters

The addition of new elements to the periodic table garners much publicity. Yet the technicians who produce the ultrapure ingredients that are forged together are often overlooked and underappreciated. Claire Jarvis highlights the work that makes superheavy element production possible. [physicstoday.org/Oct2019c](http://physicstoday.org/Oct2019c)

**PHYSICS TODAY** (ISSN 0031-9228, coden PHTOAD) volume 72, number 10. 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. 

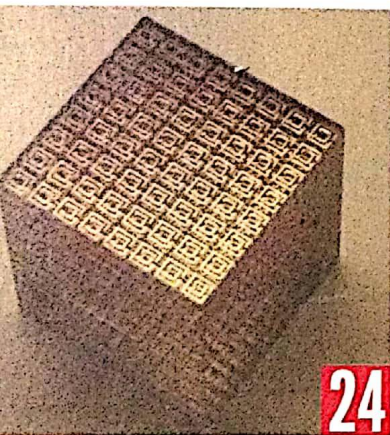
Copyright © 2019, American Institute of Physics. Single copies of individual articles may be made for private use or research. Authorization is given to copy articles beyond the free use permitted under US Copyright Law, provided that the copying fee of \$30.00 per copy per article is paid to the Copyright 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](mailto:rights@aip.org).

# PHYSICS TODAY

www.physicstoday.org



14



24



61

## DEPARTMENTS

### 8 From the editor

### 10 Readers' forum

Commentary: Lessons learned from leaving academia  
— Elizabeth Frank • Letters

### 14 Search & discovery

Wind analysis links West Antarctic ice loss to humans  
• Massive galaxies from the early universe found hiding in plain sight • A molecular clock for testing fundamental forces  
• A folding protein gets caught in the act

### 24 Issues & events

Ongoing mentorship works for retaining minorities in STEM  
• Physics at Boeing runs the gamut from lightning strikes to neuromorphic processors, with a dash of metamaterials

### 61 Books

Technological reparations in the aftermath of World War II  
— David C. Cassidy • Creating atomic nuclei on a lattice  
— Ruprecht Machleidt • The challenges and opportunities of the climate crisis — Paul Higgins • New books & media

### 68 New products

Focus on materials, semiconductors, vacuum, and cryogenics

### 72 Obituaries

Zhores Ivanovich Alferov • Charles Kittel

### 74 Quick study

A new twist on the quantum vacuum — Jeremy N. Munday

### 76 Back scatter

A microscale mouse-brain model

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](mailto:ptsubs@aip.org)

6 PHYSICS TODAY | OCTOBER 2019

#### Senior director of news & magazines

Larry Fishbein [lfishbein@aip.org](mailto:lfishbein@aip.org)

#### Editor-in-chief

Charles Day [cday@aip.org](mailto:cday@aip.org)

#### Managing editor

Richard J. Fitzgerald [rjf@aip.org](mailto:rjf@aip.org)

#### Art and production

Donna Padian, art director  
Freddie A. Pagani, art and production associate  
Cynthia B. Cummings, photographer  
Nathan Cromer

#### Editors

Melinda Baldwin [mbaldwin@aip.org](mailto:mbaldwin@aip.org)  
Toni Feder [tf@aip.org](mailto:tf@aip.org)  
Martha M. Hanna [mmh@aip.org](mailto:mmh@aip.org)  
Heather M. Hill [hhill@aip.org](mailto:hhill@aip.org)  
David Kramer [dk@aip.org](mailto:dk@aip.org)  
Alex Lopatka [alopatka@aip.org](mailto:alopatka@aip.org)  
Christine Middleton [cmiddleton@aip.org](mailto:cmiddleton@aip.org)  
Johanna L. Miller [jlml@aip.org](mailto:jlml@aip.org)  
Gayle G. Parraway [ggp@aip.org](mailto:ggp@aip.org)  
R. Mark Wilson [rmw@aip.org](mailto:rmw@aip.org)

#### Online

Paul K. Guinnessy, director [pkg@aip.org](mailto:pkg@aip.org)  
Andrew Grant, editor [agrant@aip.org](mailto:agrant@aip.org)  
Angela Dombroski [atd@aip.org](mailto:atd@aip.org)  
Greg Stasiewicz [gls@aip.org](mailto:gls@aip.org)

#### Assistant editor

Cynthia B. Cummings

#### Editorial assistant

Tonya Gary

#### Contributing editor

Andreas Mandelis

#### Sales and marketing

Christina Unger Ramos [cunger@aip.org](mailto: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](mailto:pteditors@aip.org)

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