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JOURNAL CONTENTS

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Wei-Tou Ni

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Selected Papers of the Fifth Amazonian Symposium on Physics

*Guest Editors: L. C. B. Crispino, S. R. Dolan, J. A. Font,
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SPECIAL ISSUE

*Selected Essays from the Annual Essay Competition of the Gravity Research
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Dedicated to John D. Barrow (1952–2020)*

Editor

D. V. Ahluwalia

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*Special Issue on Selected Papers from the
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Advances in materials science have made it possible for electrons in metals to exhibit exotic hydrodynamic effects.



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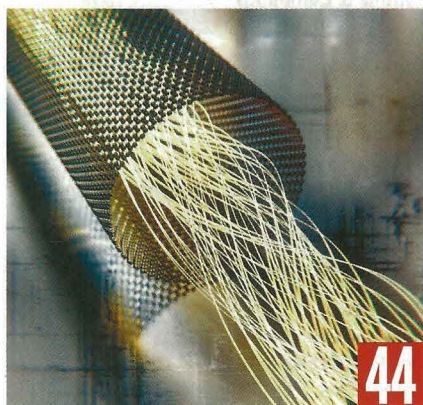
David P. Hoogerheide, V. Trevor Forsyth, and Katherine A. Brown

Modern neutron sources illuminate the complex functions of living systems.

44 Majorana qubits for topological quantum computing

Ramón Aguado and Leo P. Kouwenhoven

Researchers are trying to store robust quantum information in Majorana particles and are generating quantum gates by exploiting the bizarre non-abelian statistics of Majorana zero modes bound to topological defects.



ON THE COVER: With a height of 634 meters, the Tokyo Skytree broadcasting tower is the tallest structure in Japan. A team of researchers developing transportable atomic clocks used that height to put their clocks to the test. By placing one clock at the tower's base and the other at the observatory level, they precisely measured the relativistic frequency shift between the clocks. For more about the transportable clocks, see the story on **page 20**. (Sean Pavone/Alamy Stock Photo.)

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► Reality check

Mathematical reasoning leads to some befuddling possibilities, including the assembly of a Sun-sized sphere from a pea-sized one or a monkey churning out Hamlet on a typewriter. Alas, the real world gets in the way. Johanna Miller explains why in her latest column.

physicstoday.org/Jun2020a



► Autism ambassador

Last year physicist Daisy Shearer publicly shared her autism diagnosis on Instagram and began using social media to mentor and advocate for neurodivergent people in STEM fields. Shearer talks to PHYSICS TODAY about her experiences, her spintronics research, and her efforts to encourage inclusion.

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► Distributed review

Under a policy called distributed peer review, applicants for research grants or telescope time evaluate each other's proposals. A recent trial found that reviewers judging fellow applicants gave proposal critiques similar to those by an independent group of peer reviewers.

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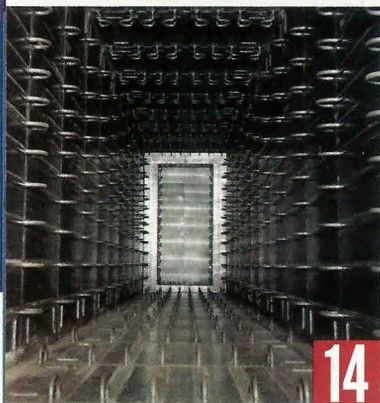
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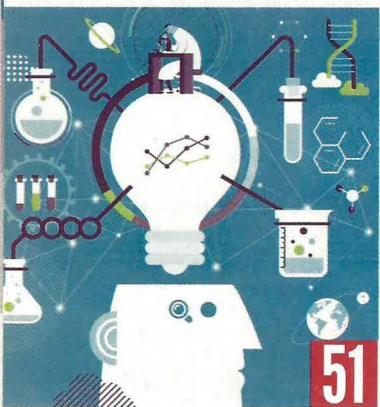
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Self-propelled, emergent vortices

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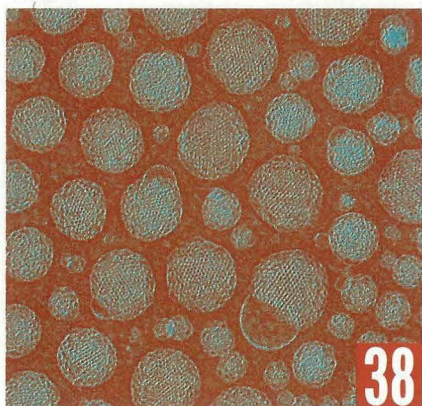
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FEATURES

30 Isaac Newton and the perils of the financial South Sea

Andrew Odlyzko

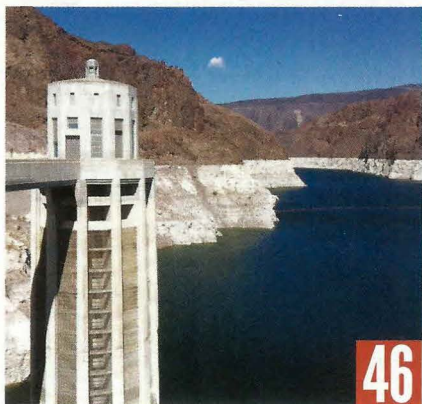
Despite Newton's general brilliance and his expertise in finance, groupthink led him to plunge into the South Sea Bubble and lose much of his fortune.



38 The physics of lipidic mesophase delivery systems

Simone Aleandri and Raffaele Mezzenga

Effectively releasing drugs in the body depends on the physical and chemical traits of a special class of liquid crystals.



46 The physics of river prediction

Sean W. Fleming and Hoshin V. Gupta

Resource managers use forecasts to ensure future access to abundant water and provide safety from river-related hazards.



ON THE COVER: Changes in rivers' flows can lead to destructive flooding or catastrophic famine. Those changes can happen over hundreds of years, like the meandering path of the Mississippi River, shown in this 1944 map, or they can take just a few hours, like in a flash flood. On **page 46**, Sean Fleming and Hoshin Gupta explain how researchers create hydrological models to understand river physics, manage water supplies, and inform public safety measures. (Harold Fisk/Army Corps of Engineers.)

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► Combating racism

On 10 June scientists responded to the Strike for Black Lives and #ShutDownSTEM initiatives by spending the day learning about and discussing anti-Black racism and what to do about it. PHYSICS TODAY's coverage includes links to resources for sustaining the push for change. physicstoday.org/forchange



► Elizabeth Fulhame

In 1794 Elizabeth Fulhame postulated the mechanism of catalysis decades before the term was coined. Yet the Scottish chemist is rarely mentioned in histories of the period. Claire Jarvis profiles the trailblazing chemist and her defiance of a society that thought little of female scientists. physicstoday.org/Jul2020b



► BECs in space

An experiment aboard the International Space Station recently produced the first Bose-Einstein condensate in microgravity. Researchers report observation times of more than a second and unexpected BEC behaviors that could prove useful for applications such as high-precision spectroscopy. physicstoday.org/Jul2020b

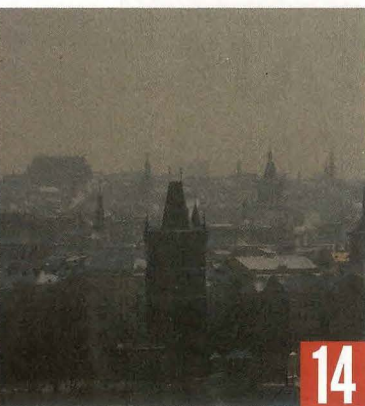
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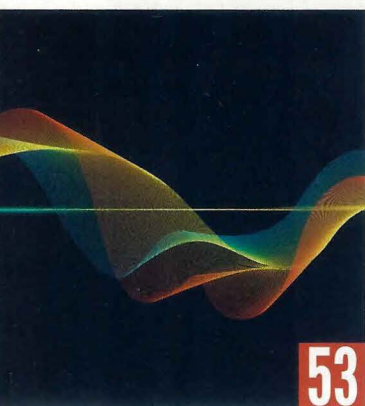


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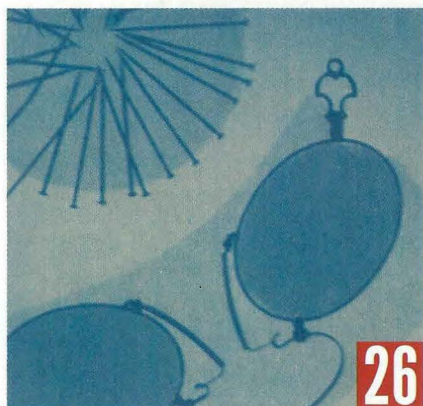
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Paul Davies

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42 Nanotubes from layered transition metal dichalcogenides

Janice L. Musfeldt, Yoshihiro Iwasa, and Reshef Tenne

The two-dimensional materials form one- and zero-dimensional hollow structures with a host of promising mechanical, optical, and electrical properties.



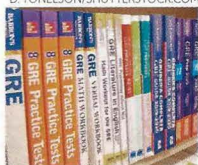
ON THE COVER: At the cellular level, various physical mechanisms allow for signaling and can lead to cooperative behavior. Slime molds, like the one shown here, provide an example: They are aggregations of single cells that self-organize and behave coherently as if they were one organism. As Paul Davies discusses in his article on **page 34**, some physicists are bridging the conceptual gulf between physics and biology by incorporating the patterns of information flow into thermodynamic models. (Photo courtesy of Audrey Dussutour, CNRS.)

Recently on
**PHYSICS
TODAY
ONLINE**

www.physicstoday.org



D. TONELSON/SHUTTERSTOCK.COM



► Going GRE-free

Many universities are temporarily forgoing graduate applicants' GRE scores due to the pandemic. Independently, some departments have been dropping the test requirement permanently because of concerns that it leads to inequity in admissions and doesn't predict grad school success.

physicstoday.org/Aug2020a

LOS ALAMOS NATIONAL LABORATORY

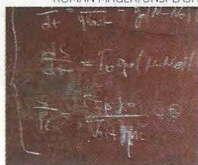


► Explosion monitor

What if the data from diverse geophysical instruments worldwide could be fused and analyzed for improved detection of explosions, particularly nuclear ones? Sarah Scoles describes the efforts of Los Alamos physicist Joshua Carmichael to create a reliable multiphysics explosion-detection model.

physicstoday.org/Aug2020b

ROMAN MAGER/UNSPLASH



► Racism in physics

Charles D. Brown II, a physicist at the University of California, Berkeley, recounts in a commentary the numerous instances of anti-Black racism and bias that he has experienced in physics and academia. He concludes with a call to hire, advocate for, and listen to Black scientists.

physicstoday.org/Aug2020c

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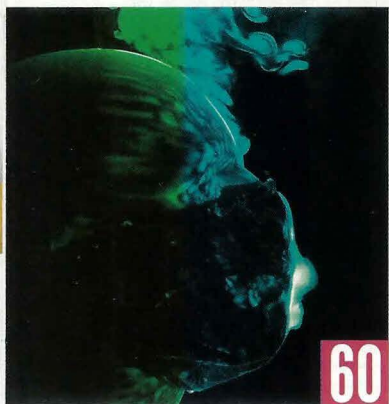
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The warmth of wind power — *Lee Miller*

60 Back scatter

Restraining respiratory droplets



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PHYSICS TODAY

September 2020 | volume 73 number 9

FEATURES

30 Dawn of the topological age?

Arthur P. Ramirez and Brian Skinner

Nontrivial electron band structures may enable a new generation of functional materials.

38 Finnish-Soviet nuclear icebreakers

Saara Matala

During the Cold War, Eastern and Western manufacturers found good reasons to collaborate, even on a technology as sensitive as nuclear vessels.

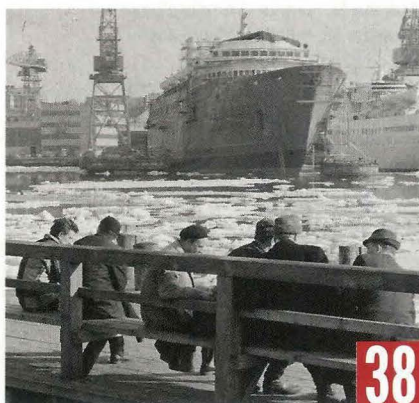
46 Graphene gets bent

Bastien F. Grosso and Eugene J. Mele

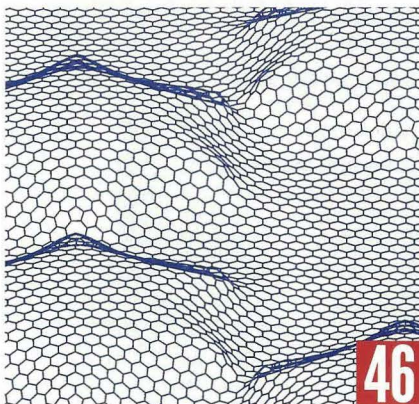
Two-dimensional nanomaterials are bending the rules of the papercraft known as kirigami.



30



38



46



ON THE COVER: In his abstract geometric works, French painter Robert Delaunay (1885–1941) conveyed a sense of constant motion through intersecting disks and rhythmic, flowing bands of contrasting colors. As described in the article by Arthur Ramirez and Brian Skinner on **page 30**, similar motifs, including winding trajectories and intersecting bands of electrons, underpin the nature and potential promise of topological materials. And to learn how periodically modulating a topological system adds a new twist, turn to **page 14**. (Detail from *Rythme n°2, décoration pour le Salon des Tuileries*, 1938, Robert Delaunay. Image from Photo 12/Alamy Stock Photo.)

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WHITE HOUSE

► ADA at 30

This summer was the 30th anniversary of the signing of the Americans with Disabilities Act. Although there is evidence of progress, science students and researchers with disabilities report having to constantly advocate for accommodations and equal access to information and spaces. physicstoday.org/Sep2020a

AWI/MICHAEL GUTSCHE, CC BY 4.0



► Icebound

For nearly a year, an icebreaker ship has floated along with the Arctic Ocean ice pack and allowed scientists to take surface, atmospheric, and undersea measurements that will become baseline data for future studies. Three participants describe the unique Mosaic project and the impact of the pandemic. physicstoday.org/Sep2020b



NTI

► Nuclear security

Improving the security of weapons-usable nuclear materials worldwide has slowed in the past two years, according to a recent report by the nongovernmental Nuclear Threat Initiative. (Its CEO, Ernest Moniz, is pictured.) PHYSICS TODAY's David Kramer outlines some of the vital gaps in security. physicstoday.org/Sep2020c

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PHYSICS TODAY

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CAREERS issue

30 Reflections on an academic job search

Omar S. Magaña-Loaiza

The road from reading a job posting to signing a contract is long and involved. Advice from a recently hired professor may smooth the path.

40 Where do new PhDs work?

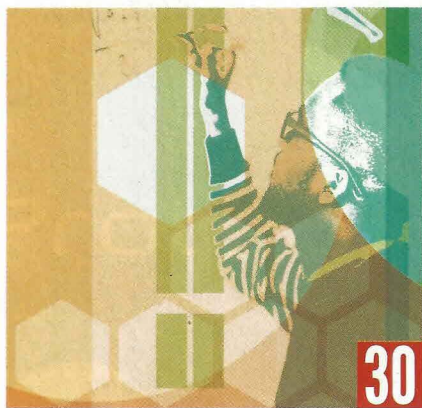
Patrick J. Mulvey

Survey questionnaire data reveal that recently graduated physics PhDs have a varied set of career options.

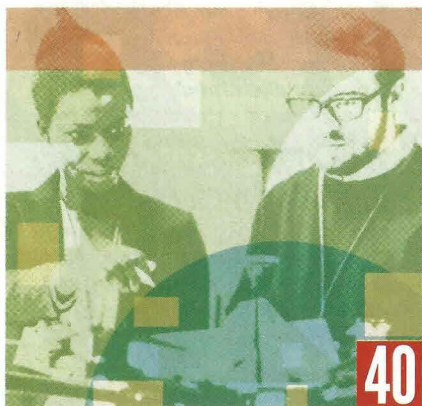
52 So you want to hire a professor!

Matthew E. Anderson

The process for finding a new educator can be daunting, yet nearly every university goes through the same procedural steps. Here's a practical guide from the faculty side.



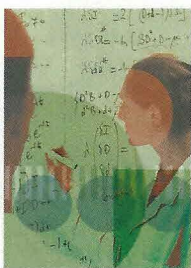
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ON THE COVER: Our second annual careers issue focuses on early careers. On **page 40**, Patrick Mulvey of the American Institute of Physics surveys the initial employment of physicists who earned their PhD in 2017 and 2018. Two other features offer advice on how to land a type of job highly sought after by new PhDs: a tenure-track professorship. Matt Anderson of San Diego State University provides the perspective, on **page 52**, of a search committee member. Omar Magaña-Loaiza of Louisiana State University provides the perspective, on **page 30**, of a successful candidate. (Image by iStock.com/virtualphoto; adapted by Donna Padian.)

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CTIO/NOIRLAB/NSF/AURA/DELVE



► Satellite trails

Light pollution from swarms of low-Earth-orbit satellites planned for launch by SpaceX and other companies could severely impede ground-based astronomical observations. A recent report from the American Astronomical Society and NSF's NOIRLab suggests measures to lessen it. physicstoday.org/Oct2020a

BJOERN PENNING



► Switching jobs

The pandemic and the attending economic downturn have added stress and uncertainty for many academic job seekers. PHYSICS TODAY's Toni Feder talks with several physicists who navigated the challenging process, including one who has yet to set foot on the campus of her new employer. physicstoday.org/Oct2020b

NASA GSFC



► Survivor planet

A Jupiter-sized exoplanet that orbits a considerably smaller white dwarf has been spotted by NASA's *Transiting Exoplanet Survey Satellite*. The discovery leads to questions about how the planet survived the turbulent past of its host star, particularly the red-giant phase. physicstoday.org/Oct2020c

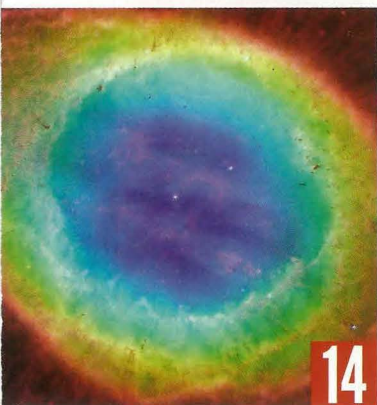
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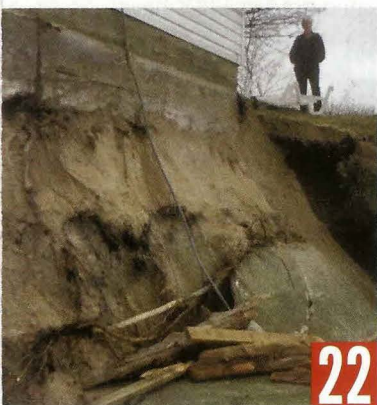
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Compressibility measurements reach white dwarf pressures

• One photon's transmission usefully controls another • Tropical soils could be accelerating global warming

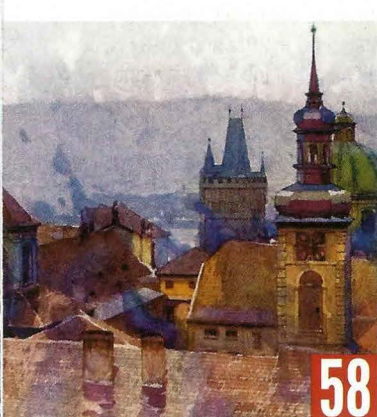


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Where does outer space begin? — *Jonathan McDowell*

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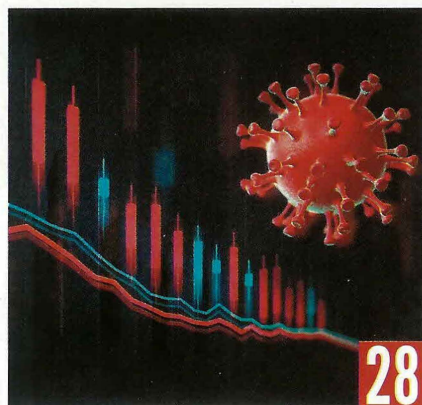
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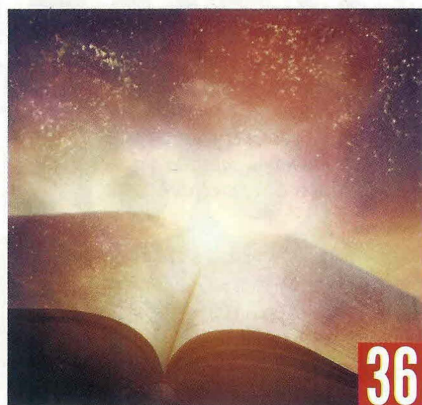
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28 The math behind epidemics

Alison L. Hill

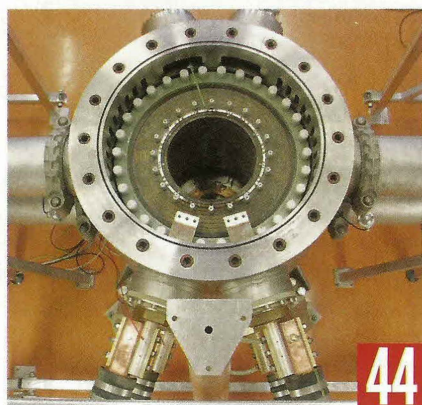
A few simple metrics characterize outbreaks like COVID-19, but calculating them correctly is surprisingly tricky.



36 James Jeans and *The Mysterious Universe*

Daniel Helsing

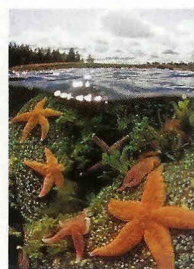
The controversial best seller heralded the end of an era in science popularizations.



44 Magnetic field–boosted superconductivity

Anne de Visser

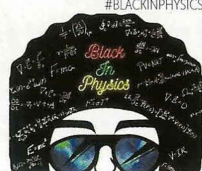
Although a magnetic field gradually destroys the superconducting state in most materials, a small family of uranium compounds bucks the trend.



ON THE COVER: Found on seabeds around the North Atlantic Ocean, the common starfish (*Asterias rubens*) is easily recognized by its familiar five-armed shape and rusty coloration. But starfish begin their lives as tiny, free-swimming larvae that look nothing like their adult form. To learn about how that life cycle makes starfish—and dozens of other species—especially vulnerable to climate change, see the story on page 17. (Image by Andrey Nekrasov/Alamy Stock Photo.)

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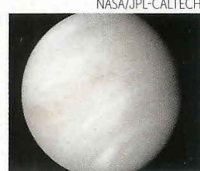
#BlackInPhysics Week

The last week of October was #BlackInPhysics Week, a series of events and initiatives hosted on social media that celebrated Black physicists and amplified their voices. The organizers of the week commissioned several essays that were published jointly by *Physics World* and *PHYSICS TODAY*.
physicstoday.org/Nov2020a



Black physicists

Jessica Esquivel, Sekazi Mtingwa, and a dozen other Black physicists in the US talked to *PHYSICS TODAY* about their work and their experiences in the field. They describe encountering racism at every career stage and having to prove themselves over and over. They also share ideas for achieving lasting change.
physicstoday.org/Nov2020b



Phosphine on Venus

In the wake of the headline-grabbing finding of PH_3 in the clouds of Venus, Rachel Berkowitz reports on the next steps for confirming the detection and for understanding how the molecule could be produced, either biotically or abiotically, in the planet's still-mysterious atmosphere.
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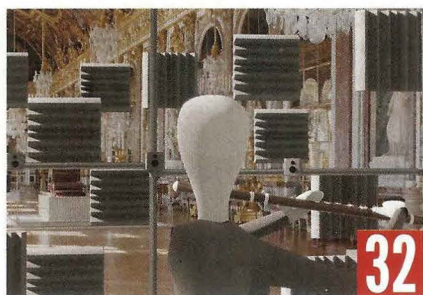
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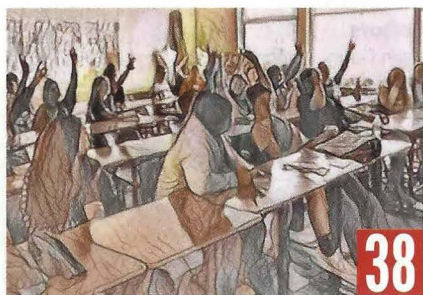
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PHYSICS TODAY

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32 Exploring cultural heritage through acoustic digital reconstructions

Brian F. G. Katz, Damian Murphy, and Angelo Farina

Simulating the acoustics of destroyed or altered amphitheaters, cathedrals, and other architectural sites re-creates their sonic grandeur.



38 Ultrasound in air

Timothy G. Leighton

Experimental studies of the underlying physics are difficult when the only sensors reporting contemporaneous data are human beings.

44 Ocean acoustics in the changing Arctic

Peter F. Worcester and Megan S. Ballard

Recent changes in ice cover and ocean stratification have been so large that acoustic measurements made during the Cold War no longer reflect current conditions.

50 Computational phonogram archiving

Michael Blaß, Jost Leonhardt Fischer, and Niko Plath

A general approach to analyzing audio files makes it possible to re-create the sound of ancient instruments, identify cross-cultural musical properties, and more.



ON THE COVER: Experiences are often shaped by the sounds that accompany them. The mural shown here captures the joyful spirit of a jazz band leading a march for peace in East London in 1983. Although the soundtrack of that day now exists only in memory, acousticians are learning to preserve other aural experiences. On **page 32**, Brian Katz, Damian Murphy, and Angelo Farina discuss acoustic reconstructions of historical sites. And on **page 50**, Michael Blaß, Jost Leonhardt Fischer, and Niko Plath describe the re-creation of sounds from ancient instruments. (Detail from *Hackney Peace Carnival*, 1985, Ray Walker; image from marc zakian/Alamy Stock Photo.)

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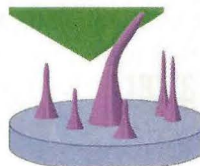
Gap year

After graduating with a bachelor's degree in physics last year, Chunyang Ding chose to pursue a job in industry rather than start graduate school right away. Ding argues in a commentary that although gap years aren't for everyone, they can provide valuable experiences for aspiring physical scientists.
physicstoday.org/Dec2020a



New APS CEO

In January theoretical physicist Jonathan Bagger will become the CEO of the American Physical Society. In an interview he talks about remote meetings, the challenges and opportunities facing the organization and the physics community, and his priorities as he begins his new role.
physicstoday.org/Dec2020b



Metallic diamond

Etching diamond into fine, 300-nm-wide needles transforms the normally inelastic, brittle material into a bendable form that can take on enormous stress. Now a study demonstrates that elastic strain can alter the bandgap of the diamond nanoneedles from that of an insulator to that of a metal.
physicstoday.org/Dec2020c

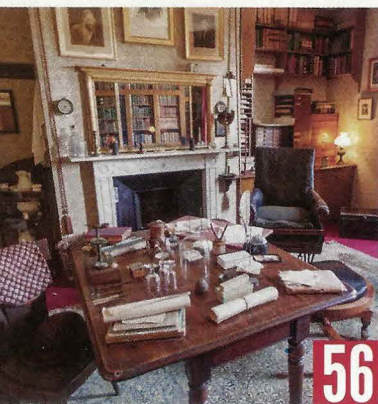
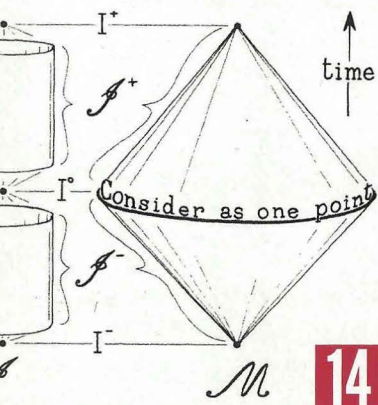
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