

APS CONGRESSIONAL SCIENCE FELLOWSHIP 2015-2016

THE AMERICAN PHYSICAL SOCIETY is currently accepting applications for the Congressional Science Fellowship Program. Fellows serve one year on the staff of a senator, representative or congressional committee. They are afforded an opportunity to learn the legislative process and explore science policy issues from the lawmakers' perspective. In turn, Fellows have the opportunity to lend scientific and technical expertise to public policy issues.

QUALIFICATIONS include a PhD or equivalent in physics or a closely related field, a strong interest in science and technology policy and, ideally, some experience in applying scientific knowledge toward the solution of societal problems. Fellows are required to be members of the APS.

TERM OF APPOINTMENT is one year, beginning in September of 2015 with participation in a two week orientation sponsored by AAAS. Fellows have considerable choice in congressional assignments.

A STIPEND is offered in addition to allowances for relocation, in-service travel, and health insurance premiums.

APPLICATION should consist of a letter of intent of no more than 2-pages, a 2-page resume: with one additional page for publications, and three letters of reference. Please see the APS website (<http://www.aps.org/policy/fellowships/congressional.cfm>) for detailed information on materials required for applying and other information on the program.

**ALL APPLICATION
MATERIALS MUST BE
SUBMITTED ONLINE BY
CLOSE OF BUSINESS
ON JANUARY 15, 2015
(5:00 PM EST).**

emphasizes improved high-spatial-resolution satellite observations of the ocean and ultrafast and powerful supercomputing as supports and complements to experimental efforts. His several predictions include a new generation of ocean and wave forecast models and better understanding of complex nearshore dynamics and the coupling of microscale-wave-related processes with various air-sea exchanges.

The Science of Ocean Waves is a truly remarkable achievement. It has a great chance to become a standard text for students, scientists, weather and ocean forecasters, engineers, climate modelers, and anyone else whose curiosity or professional interests relate to ocean waves.

Alexander Babanin
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Polarons

David Emin
Cambridge U. Press, 2013. \$110.00
(212 pp.). ISBN 978-0-521-51906-9

The polaron was proposed by Lev Landau in 1933 to describe an electron moving in a dielectric crystal whose atoms displace from equilibrium to screen the electron charge. Large polarons, whose radii are much larger than the lattice constant, are described by a Hamiltonian named after Herbert Fröhlich. Small polarons, whose radii are of the same order of magnitude as or even smaller than the lattice constant, were first studied in the late 1950s by Theodore Holstein, Jiro Yamashita, and Tatumi Kurosawa. Holstein introduced a simple model for short-range electron-phonon interactions that lead to the hopping motion of what would be identified as small polarons.

Polarons come in several varieties, including acoustic polarons, piezopolarons, and polarons in organic materials. Polaron-like states can even be found in Bose-Einstein condensates. Both the large- and small-polaron pictures are used for the interpretation of experiments on optical, thermal, and electromagnetic response in crystals.

With *Polarons*, David Emin aims to present a relatively simple, mostly empirical introduction to the relevant physics. The first section qualitatively describes the formation of several po-

laron states: large and small polarons, molecular polarons, and large and small bipolarons (bound polaron pairs). Its final subsection, on magnetic polarons, gives a nice explanation of colossal magnetoresistance in ferromagnetic semiconductors. The book's second section addresses manifestations of polarons in the physical properties of crystals. The third section treats extensions of the polaron concept, including the presently hypothetical bipolaron superconductivity.

Emin is at his best discussing small-polaron phenomena, a subject to which he has devoted most of his own research, some of it in collaboration with Holstein. But in treating large-polaron physics, the book is sometimes less accurate: In particular, chapter 9 has a flawed description of the theory of large-polaron optical absorption at strong coupling. The book fails to discuss recent optical experiments indicating that Fröhlich polarons—as well as small polarons—can act as charge carriers in strontium titanate. Emin omits some key methods and topics in polaron theory, including Richard Feynman's path-integral variational approach; Sin-itiro Tomonaga's translation-invariant description used by T. D. Lee, Francis Low, and David Pines; Nikolai Bogolyubov's field-theoretic treatment; and the diagrammatic quantum Monte Carlo method refined by Andrei Mishchenko and colleagues. Frederick Brown and coworkers' seminal experiments on Fröhlich polarons are also missing.

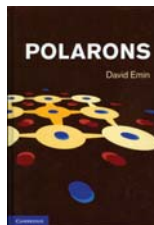
Polarons mainly addresses graduate students, but it can also be useful for advanced researchers, particularly experimentalists. I would recommend the book as a qualitative introduction to the physics of small polarons. As such, it nicely complements the existing literature.

Jozef T. Devreese
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In Search of the True Universe The Tools, Shaping, and Cost of Cosmological Thought

Martin Harwit
Cambridge U. Press, 2013. \$50.00
(393 pp.). ISBN 978-1-107-04406-7

When I was 12, my father told me that one of the best things to do when going to sleep is to rehash the day. "Go over



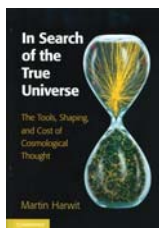
what you did, thought, and felt. No judgments, just the facts," he said, "and then tomorrow or a week later you will remember and consider what you could have done better." By reminding myself what I had done, I captured it for later reflection.

That is what Martin Harwit's new book does, not for an individual and a day, but for a field of research involving thousands of people and over a span of the past 40 years. *In Search of the True Universe: The Tools, Shaping, and Cost of Cosmological Thought* records and discusses what worked, what was inefficient, and what failed. This book is a companion to, not a revision of, his earlier *Cosmic Discovery: The Search, Scope and Heritage of Astronomy* (reprint, MIT Press, 1984), which asked how individual discoveries happen.

Rather than address what astrophysicists should do to reveal new phenomena, Harwit's latest book delves into what scientists actually do under the constraints of their own hopes and biases, the political climate, funding pressures, and just plain logistics for complex experiments. However, it goes further, to "tomorrow or a week later," to consider how all that work is combined into the cohesive picture of the universe that the field strives for and to assess what might change in the process of science.

Harwit writes eloquently. Although the book requires a rudimentary knowledge of physics and astronomy, many parts will appeal to politicians and historians. The book is organized into three sections, hinted at in its subtitle. The first describes how theory and observation are used to form the overarching human understanding of the universe. The second section details the political and even historical influences on the specific scientific questions that are posed and the methods—from long-term space missions to smaller projects—by which they are answered. Finally, in an innovative application of network theory, Harwit centers attention on the organization of the field and its economic viability.

Throughout, Harwit details the observational and experimental history of the past 40 years, a period that remained unexamined until now—at least from a coherent, field-wide perspective. Reviews of individual subfields abound, but Harwit's much broader perspective is one of the greatest strengths of the book. He writes



from the inside; he participated in much of that history and contributed to many areas. His presentation is an authoritative, if abridged, history of astronomical research over that period. His purpose is to use examples that illustrate the mechanisms of modern science, not to give a comprehensive history.

Unfortunately, the subfield with the most growth over the past 20 years in terms of funding, number of researchers, and general interest—the study of brown dwarfs and exoplanets (full disclosure: my area of research)—suffers from little attention. Brown dwarfs make a singular appearance in a short list of the 19 “most important discoveries since 1975” and “planets around other stars” are relegated to minor mentions on a few of the book’s nearly 400 pages. That is an oversight, because the issues related to those alien objects are of paramount importance to understanding our own origins. Further, their study can provide a unique view into how science is funded and how new questions are prioritized—central themes to the book’s depiction of science.

The last section of the book attempts to decipher some of the social aspects of science. There are some gems of insight, particularly in how persuasion is important in advancing both good ideas and red herrings. Harwit goes further, however, and employs network theory to demonstrate how areas of research often evolve in isolation, with certain key events causing cross-fertilization—for example, between pure mathematics and physics. This last section of the book may also be the most controversial, and Harwit’s choice of certain terms with roots in literary theory may open his ideas to criticism from social scientists.

In Search of the True Universe throws a clear and needed spotlight on the complexities of conducting science in a political world and within the funding framework of Western society. Despite my minor criticisms, the book ought to be read by every student and professor of science, all of whom are professionally obliged to understand how modern science works—a subject not explicitly taught as part of a scientist’s training. Harwit has captured the recent past to allow us to reflect on how we might do better in the future.

Rebecca Oppenheimer

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new books

condensed-matter physics

The Equilibrium Theory of Inhomogeneous Polymers. G. H. Fredrickson. Oxford U. Press, 2013. \$74.95 *paper* (437 pp.). ISBN 978-0-19-967379-7

Feynman Diagram Techniques in Condensed Matter Physics. R. A. Jishi. Cambridge U. Press, 2013. \$110.00 (400 pp.). ISBN 978-1-107-02517-2

Geometrically Constructed Markov Chain Monte Carlo Study of Quantum Spin-Phonon Complex Systems. H. Suwa. Springer, 2014. \$129.00 (126 pp.). ISBN 978-4-431-54516-3

Nanoscience with Liquid Crystals: From Self-Organized Nanostructures to Applications. Q. Li, ed. Springer, 2014. \$229.00 (420 pp.). ISBN 978-3-319-04866-6

cosmology and relativity

Advanced General Relativity: Gravity Waves, Spinning Particles, and Black Holes. C. Barrabès, P. A. Hogan. Oxford U. Press, 2013. \$89.95 (144 pp.). ISBN 978-0-19-968069-6

Foundations of Quantum Gravity. J. Lindesay. Cambridge U. Press, 2013. \$110.00 (406 pp.). ISBN 978-1-107-00840-3

Non-minimal Higgs Inflation and Frame Dependence in Cosmology. C. F. Steinwachs. Springer, 2014. \$129.00 (280 pp.). ISBN 978-3-319-01841-6

On the Topology and Future Stability of the Universe. H. Ringström. Oxford U. Press, 2013. \$125.00 (718 pp.). ISBN 978-0-19-968029-0

The Physics of Reality: Space, Time, Matter, Cosmos. R. L. Amoroso, L. H. Kauffman, P. Rowlands, eds. World Scientific, 2013. \$168.00 (526 pp.). ISBN 978-981-4504-77-5

Special Relativity in General Frames: From Particles to Astrophysics. É.ourgoulhon. Springer, 2013. \$99.00 (784 pp.). ISBN 978-3-642-37275-9

device physics

Dynamics of Underactuated Multibody Systems: Modeling, Control and Optimal Design. R. Seifried. Springer, 2014. \$129.00 (249 pp.). ISBN 978-3-319-01227-8

Exploring Memory Hierarchy Design with Emerging Memory Technologies. G. Sun. Springer, 2014. \$129.00 (122 pp.). ISBN 978-3-319-00680-2

MOSFET Technologies for Double-Pole Four-Throw Radio-Frequency Switch. V. M. Srivastava, G. Singh. Springer, 2014. \$119.00 (199 pp.). ISBN 978-3-319-01164-6

Organic Light-Emitting Diodes (OLEDs): Materials, Devices and Applications. A. Buckley, ed. Woodhead Publishing, 2013. \$325.00 (647 pp.). ISBN 978-0-85709-425-4

Piezo-Electric Electro-Acoustic Transducers. V. Sharapov, Z. Sotula, L. Kunickaya. Springer, 2014. \$119.00 (230 pp.). ISBN 978-3-319-01197-4

Rectenna Solar Cells. G. Model, S. Grover,