Vol. 54, No. 2 April 2025

PHYSICS & SOCIETY

A Publication of The Forum on Physics and Society A Forum of The American Physical Society

From the Editor

Many things have changed since I wrote, last December, the "From the Editor" blurb for the January issue. One that unfortunately has not is the reluctance of many people to speak out, the increased fear to put one's name on something that later can bring unpleasant consequences. In my opinion this is much worse than the fears about funding. Money is important, and science is not cheap, but there are things that are even more important, and one of them is the freedom to speak. As the editor of this publication I pride myself in encouraging controversial points of view and I see my endeavors becoming harder. As readers may recall, an article on the equity of decarbonisation was withdrawn at the last minute from the January issue and, as of now, I have been unable to obtain a replacement on this topic which obviously covers both Physics and Society aspects. Will any courageous volunteers step up and write on this topic?

We have in this issue some news items, including the list of Forum activities that took place at the last combined March/April APS meeting. These will be in the past by the time this appears, but for those that missed them, many are available online. We are also including the list of FPS elected officers for the calendar year 2025.

A Letter to the Editor comments on the one that appeared in the previous issue and which, as predicted, proved somewhat controversial.

Oriol T. Valls, the current Physics and Society Newsletter Editor, is a Condensed Matter theorist at the University of Minnesota.

We have two articles in this issue. One is on the life and achievements of Evgeny Velikhov, a giant on disarmament issues, who died recently at the age of 89. The other is a personal article written by one of our recently appointed Fellows (see the January 2024 issue) on Physics and Ethics. And also we have a couple of book reviews.

In the next issue I hope to publish articles by our Burton and Szilard award winners (see the January 2025 issue).

Would you like to review a book? It can be a book of your choice or one sent to you by our Book Reviews Editor, Quinn Campagna (qcampagn@go.olemiss.edu) . He maintains a list of volunteers that make themselves available to review. Besides the pleasure of serving our community, you will get a free book that you can keep.

continued

IN THIS ISSUE

continued

This newsletter and its contents are largely reader driven. All topics related to Physics and Society are welcome, excluding only undiluted politics and anything containing invective, particularly of the ad hominem variety. Strong opinionated language is of course quite all right. Manuscripts should be sent to me, preferably in .docx format, except Book Reviews which should be sent directly to book reviews editor Quinn Campagna Content is not peer reviewed and opinions given are the author's only, not necessarily mine, nor the Forum's nor, a fortiori, the APS's either. But subject to the mild restrictions mentioned above no pertinent subject needs to be avoided on the grounds that it might be controversial. On the contrary, controversy is welcome.

Oriol T. Valls
University of Minnesota
otvalls@umn.edu

Physics and Society is the non-peer-reviewed quarterly newsletter of the Forum on Physics and Society, a division of the American Physical Society. It presents letters, commentary, book reviews and articles on the relations of physics and the physics community to government and society. It also carries news of the Forum and provides a medium for Forum members to exchange ideas. ***Opinions expressed are those of the authors alone and do not necessarily reflect the views of the APS or of the Forum. Articles are not peer reviewed.*** Contributed articles, letters (500 words), commentary, reviews and brief news articles are welcome. Send them to the relevant editor by e-mail (preferred) or regular mail.

***Physics and Society* can be found on the web at aps.org/units/fps.**

APS Global FPS MEETING SESSIONS

ACC = Anaheim Convention Center; M = Marriott

"March" meeting

Intersections of quantum science and society

*co-sponsored with DQI

4 speakers

Session MAR-S, room ACC 159 Livestream (Level1)

Thursday, March 20, 11:30am -2:30pm

Chair and session moderator Katie Yurkewicz

1. Tomasz Durakiewicz, Program Director, Division of Equity for Excellence in STEM, National Science Foundation
2. Abe Asfaw, Education and Outreach Lead, Google Quantum AI
3. David Awschalom, Liew Family Professor and Vice Dean for Research of the Pritzker School for Molecular Engineering at the University of Chicago, a Senior Scientist at Ar-gonne National Laboratory, and Founding Director of the Chicago Quantum Exchange
4. Sara Gamble, Physics Program Manager, US Army Research Office

Science communication in an age of misinformation and disinformation

3 speakers

Session MAR-W, room ACC 156 (Level 1)

Friday, March 21, 8:00am - 11:00am

Chair and moderator: Don Lincoln

1. Emily Connover, Senior Writer, Science News
2. Clara Moskowitz, Senior Editor at Scientific American
3. John C. Besley, Prof of Public Relations at Michigan State University

Fusion Energy - lab to grid commercial development and climate im-pacts/ramifications

*co-sponsored with DNP

11 speakers

Session MAR-L, room ACC Livestream 159 (Level 1)

Wednesday, March 19, 8:00am-11:00am

Chair and panel moderator: Jutta Escher , LLNL (DNP)

Speakers:

1. Arturo Domiguez, PPPL overall introduction
2. Stephanie Diem, U of Wisconsin, Intro to MFE
3. Annie Kirchner, LLNL, Intro to IPE

Panel 1 Decadal Vision

4. Aaron Washington, Tokomak Energy
5. Debbie Callahan, Focused Energy
6. Michael Mauel, Columbia Univ - TENTATIVE

Speakers:

7. Aditi Verma, Univ of Michigan, Fusion, Climate, Waste and Society

Panel 2: Fusion and Society Impacts

8. Kayla Miller, STEM Kings and Queens
9. Seth Hoedl, Post Road Foundation
10. Laila El- Guebaly, U of Wisc.

"April" meeting

History and physics of the Manhattan Project and the bombings of Hiroshima and Nagasaki

*co-sponsored with FHPP

3 speakers

Session APR-C room M Platinum 9;

Monday, March 17, 1:30pm-3:18pm

Chair and moderator: Bruce Hunt, FHPP

1. Alex Wellerstein (historian, Stevens Institute)
2. Sebastien Philippe (Program on science and global security, Princeton University)
3. Arjun Makhijani (Institute for Energy and Environmental Research)

Building Bridges through International Collaboration

*co-sponsored with FIP

3 speakers

Session APR-L room M Platinum 9;

Tuesday, March 18, 3:45pm-5:33pm

Chair: Rachel Carr

1. Gabriela Gonzalez, LIGO
2. Patty McBride, CMS/LHC
3. Flavio Cavanna ,DUNE

continued

Awardee Session and The Physicists Coalition Panel

Session APR-P, room M Platinum 9;

Wednesday, March 19, 10:45am-12:33pm

Awardees

- Sébastien Philippe, Princeton University

  2025 recipient, Joseph A. Burton Forum Award for accurately estimating ra-diation doses from French and U.S. nuclear tests and effectively communicating these findings to the public, as well as assessing potential radiation from nuclear attacks on U.S. ICBM silos, demonstrating the importance of addressing scientific findings and consulting affected individuals.

- Alexander Glaser, Princeton University

  2025 recipient, Leo Szilard Lectureship Award for seminal scientific contribu-tions and innovations to advance nuclear arms control, nonproliferation, and dis-armament verification, and for leading the Princeton Program on Science and Global Security and mentoring many students and young researchers over the years.

- The Physicists Coalition Panel

  Panel speakers:

  Curtis Asplund, Associate Professor, San Jose University

  Roohi Dalal, Deputy Director, AAS

  Shaghayegh Chris Rostampour, Policy and Communications Coordinator, Physicists Coalition

The Physics of Climate Change: Unraveling Aerosols, Radiation, Clouds, and Pre-cipitation for Future Projections and Societal Impact

3 speakers plus one moderator

Session APR-D room M Platinum 9;

Monday, March 17, 3:45pm-5:33pm

Chair and moderator: Mark Harvey

Speakers:

Speaker 1: Michael Jensen (BNL)

Speaker 2: Vernon Morris (ASU)

Speaker 3: Curtis Deutsch (Princeton)

RECEPTION: FPS will host an evening reception together, to greet new Fellows, with the Forum on International Physics (FIP) on Wednesday 19th March, 6:30pm and 8:30pm. Room: Session APR-EV11 Marquis Ballroom South in the Anaheim Marriott hotel

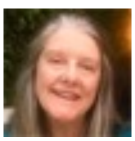
FPS Executive Committee Members

Chair: Warren W Buck (01/25–12/25)
University of Washington, Bothell

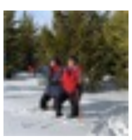
Chair-Elect: Don Lincoln (01/25–12/25)
Fermi National Accelerator Laboratory (Fermilab)

Vice Chair: Jason Stewart Gardner (01/25–12/25)
Oak Ridge National Laboratory

Past Chair: Anna M Quider (01/25–12/25)
The Quider Group, LLC



Secretary/Treasurer: Cherrill M Spencer (01/23–12/25)
SLAC National Accelerator Laboratory



Councilor: Beverly Karplus Hartline (01/24–12/27)
Montana Technological University

Member-at-Large: Katie Yurkewicz (01/23–12/25)
Argonne National Laboratory

Member-at-Large: Dylan K Spaulding (01/23–12/25)
Union of Concerned Scientists

Member-at-Large: M.V. Ramana (01/24–12/26)
University of British Columbia

Member-at-Large: Rachel Carr (01/24–12/26)
USNA

Member-at-Large: Philip (Bo) W Hammer (01/25–12/27)
University of Chicago

Member-at-Large: Mark Harvey (01/25–12/27)
Texas Southern University

POPA Representative: Savannah J Thais (01/25–12/27)
Columbia University

The above are the members of the FPS Executive committee, reflecting the result of the previous election. The newsletter editor is an "ex-officio" nonvoting memb

In the January 2025 P&S, Ashu Solo advocates that undergraduate physics students should stick to strict curricula of physics, mathematics, and engineering classes, eschewing the arts and humanities. Solo states that students who wish to take nontechnical courses should be able to, but this carries a condescending implication that any physics student who does so is wasting their time.

I could not disagree more with Solo's argument.

I was educated in a large-university setting, where elective classes were largely to be chosen from within the department according as one's interest(s) in areas such as astrophysics, electronics, nuclear physics, and so on. I learned a tremendous amount of physics from excellent professors, and enjoyed the vast majority of the courses. After graduate school I embarked on a teaching career in smaller universities and liberal-arts colleges, where all students were required to take a breadth of courses. At first I was somewhat skeptical, but soon began to see the advantages of such curricula for students who take them seriously. Many of my physics majors were pre-engineering oriented; I would encourage them to take a business or economics class so that when they got their dream job they could communicate with both their fellow engineers and managers. Michigan, where Alma College is located, is home to many multinational companies. A course in a foreign language or the history and culture of another country couldn't help but be an asset; indeed, many students took advantage of the College's semester-abroad program. Despite these unscientific burdens, they went on to solid graduate programs and a spectrum of rewarding careers.

On the flip side of this coin, I developed a class on the Manhattan Project for non-science students. History students learned some of the technical underpinnings of one of the most dramatic developments of the twentieth century. Business and political science students saw examples of unusual organizational, governmental, and management challenges, and all of the students had to struggle with the uncomfortable ethical aspects of a situation where none of the options were particularly pleasant. For myself, having to develop descriptions of how physicists deal with technical aspects such as critical mass, weapon yield, and radioactivity that were credible without oversimplifying to the point of triteness or turning the students off helped sharpen my own understanding and communications skills. I came to appreciate that it would not have unduly harmed my career had I squeezed a humanities or arts course into my background.

P&S readers will surely appreciate that the problems facing the world today are multidisciplinary. While it is not practical for students to do everything, it would seem the height of arrogance to dismiss disciplines that can contribute serious perspectives. Ultimately, we need to expose students to the tools and skill sets that will prepare them for a diversity of opportunities.

Cameron Reed
Department of Physics (Emeritus)
Alma College, Alma, MI
reed@alma.edu
December 29, 2024

How Physicist Evgeny P. Velikhov Helped End the Cold War Nuclear Arms Race

Frank N. von Hippel, Program on Science and Global Security, Princeton University
fvhippel@princeton.edu

Velikhov and Gorbachev (Kurchatov Institute of Atomic Energy, undated)

Velikhov had a distinguished career in the Soviet scientific community as: director of the Kurchatov Institute of Atomic Energy in Moscow, Vice President of the Soviet Academy of Sciences, head of the Soviet fusion program and chairman of the international program to build a demonstration fusion power reactor in southern France.

His most important contributions, however, were as nuclear-disarmament advisor to Mikhail Gorbachev.

Gorbachev's mantra for political and economic reform in the Soviet Union was "glasnost" (openness). He tried to turn the closed top-down Soviet system into a more dynamic democratic society. Ultimately, that effort led to the disintegration of the Soviet Union and new authoritarian governments in many but not all of the 15 successor states.

Velikhov took glasnost into nuclear arms control in partnership with US colleagues. His most notable achievement was in 1986, when he invited a U.S. group of academic seismologists recruited by Tom Cochran, a physicist at the Natural Resources Defense Council (NRDC), to set up seismic stations around the Soviet nuclear test site in Kazakhstan to verify the year-old Soviet unilateral test moratorium. This demonstration of willingness to accept in-country monitoring ended the impasse over in-country verification that had made it impossible for President Kennedy and Premier Khrushchev to agree on a Comprehensive Test Ban Treaty in 1963 and forced them to settle on the Partial Test Ban Treaty that allowed testing to continue underground.

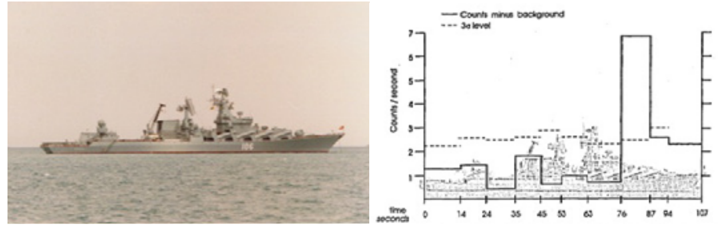
A month after it received the first seismogram from the NRDC, the US House of Representatives voted to join Gorbachev's testing moratorium for at least a year. The Senate did not agree, however, nor did President Reagan and his successor George Bush Senior. At the end of the Bush administration in 1992, however, the Senate came around and Congress forced the end of U.S. nuclear testing. Four years later, negotiaions on a Comprehensive Test Ban Treaty were completed and it was opened for signatures. It has been ratified by 178 countries but not by the U.S. and eight other countries whose radifications are required. It is therefore not in legal force but it has become a norm and only North Korea has tested since 1998.

Velikhov also arranged nuclear glasnost visits for groups including members of Congress, reporters from the New York Times and Washington Post, and arms control advocates like me to a number of other sensitive locations (I went along on all of these visits except the first):

U.S. Seismologists with portable seismometers on a granite outcrop near Kakarolinsk, Kazakhstan, about 200 km from the Soviet test site, July 1986. Tom Cochran at the right. (Thomas Cochran)

- The Krasnoyarsk early-warning radar in 1987. The Reagan Administration was correctly complaining that the radar's location and orientation violated the requirements of the 1972 US-Soviet treaty limiting anti-ballistic missile systems. Four years later, the Soviet government finally acknowledged the violation and tore the the radar down.
- The oldest Soviet plutonium-production city in 1989, where the delegation saw that plutonium-production reactors finally were being shut down. (The U.S. had already shut down its plutonium production reactors after the 1986 Chernobyl accident brought attention to their unsafe designs.).
- The Soviet ballistic missile defense testing site (also in 1989) where we inspected a laser facility with a beam director that the U.S. Defense Department pointed to as evidence for a Soviet Star Wars program. When we brought back pictures of the lasers inside, however, one of the DOD's experts exclaimed, "Toys!".
- Also, in 1989, we and several Russian teams carried out radiation measurements on a Soviet missile cruiser, from a helicopter flying over it in the Black Sea off Yalta and from another ship, to test the different ways in which inspectors could nonintrusively distinguish a nuclear armed cruise missile from one with a conventional warhead. (On April 22, 2022, that same cruiser, renamed Moskva, the command ship of the Russian Black Sea fleet, was sunk by Ukrainian cruise missiles.)

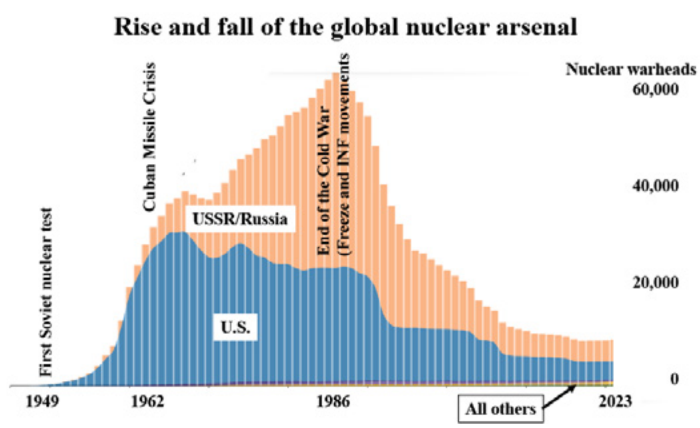
Pentagon representation of laser facility in the Soviet ballistic missile defense site in Kazakhstan (Soviet Military Power, 1985)



Left. Soviet missile cruiser Slava on the Black Sea off Yalta, July 1989 (Thomas Cochran). Right neutron measurements from a Soviet helicopter flying parallel to the ship at a distance of 30 meters detects plutonium-containing warhead in a cruise-missile launcher (S.T. Belyaev et al, Kurchator Institute)

Velikhov also arranged for Sakharov to return to Moscow after seven years of exile, away from Western reporters in the closed city of Nizhny Novgorod. Sakharov described the Reagan Administration's proposal for space-based defenses against Soviet strategic missiles as an infeasible fantasy, a "Maginot Line in space" and argued that it would be safe to ignore it and proceed to agreements on deep cuts in the Soviet and U.S. nuclear weapons. Today the estimated sum of the U.S. and Russian stocks of nuclear warheads is about 13% of the combined U.S. and Soviet stocks in 1987.

(For more details on Velikhov's story, see "How physicist Evgeny Velikhov helped end the US-Soviet nuclear arms race" by Frank N. von Hippel, Thomas B. Cochran, Richard L. Garwin and Roald Z. Sagdeev, Bulletin of the Atomic Scientists, 10 February 2025, https://thebulletin.org/2025/02/an-appreciation-how-physicist-evgeny-velikhov-helped-end-the-us-soviet-nuclear-arms-race.)



Global nuclear warheads (Bulletin of the Atomic Scientists, 1 March 2025)

What is an Ethical Scientist? An Intellectual Journey

Jeffrey Kovac
Department of Chemistry
University of Tennessee
jkovac@utk.edu

The work in scientific ethics which led to my election as an APS Fellow is an example how a teaching question led to an extensive scholarly program. In the mid-1980s, the College of Liberal Arts at Tennessee underwent an undergraduate curriculum revision. As part of the new curriculum a new category of "capstone" courses was created. These were courses for senior majors which would examine the field from a broad historical and societal perspective. The chemistry department created such a course. Because of my long interest in the history and philosophy of science I was assigned to teach it. It included a lot of history, some philosophy of science, and selected issues in the relationship between chemistry and society. At that time cases of scientific misconduct were much in the news so I decided to include a unit on ethics in chemistry.

I had long been an advocate for active learning so I decided to use what is known as the case method to introduce the students to practical ethical problems. The case method was routinely used by philosophers and theologians, although I was unfortunately unaware of that fact at the time. What I thought was an innovation had been around for centuries. I began to write cases, hypothetical scenarios that presented students with challenging ethical problems. I adapted situations that were in the news and in the books on scientific misconduct that had begun to appear. I drew on my own experiences as well as experiences of my colleagues to make the cases relevant to current research both in academia and industry. I also included educational situations such as laboratory reports and group projects. The students responded well to this approach and I began to ask whether my colleagues around the country might benefit from a collection of ethics cases to use in their own teaching, supplemented by commentaries to help guide a discussion. I understood that most chemistry faculty do not have an extensive background in ethics and would need some help.

Fortunately, the Camille and Henry Dreyfus Foundation had recently launched a program of small grants for projects like the one I was planning. I applied for and received a grant entitled "Case Studies in Scientific Ethics" in 1993. This grant provided the funding I needed to pursue the project. Over the next year, with the help of some very good undergraduate research assistants, I produced a volume entitled The Ethical Chemist: Case Studies in Scientific Ethics. The original collection was privatelyy published, the printing costs covered by the grant, and copies were distributed to colleagues around the country. Based on comments from users the book was revised and expanded in 1995. Privately published copies were distributed for a nominal cost to cover printing and mailing.

As I developed the cases as teaching materials, I realized that I needed to know more about moral philosphy. This led to decades of scholarly work in scientific ethics and moral problem solving. This research is summarized in my recent book, The Ethical Chemist: Professionalism and Ethics in Science, Revised Edition (Oxford 2018).

I think there are four characteristics of an ethical scientist:

1. Understanding the ideals and standards that govern professional ethics.

2. Understanding the moral complexity of real-world situations.

3. The ability to design solutions to complex moral problems.

4. Having the moral courage to make difficult decision, act on them, and state them and the reasons for them publicly.

Each of these deserves a long discussion which can be found in my book, but I will focus mainly on the first which is where I think I have made my most original contributions.

Professional ethics differs from what philosophers call the common or ordinary morality. Common morality is for everyone and is the basis for the day-to-day moral decisions that we all make. Almost everyone has a good intuitive understanding of the principles of common morality: don't lie, don't steal, respect human life, and the like. Professional ethics, on the other hand, applies only to people who are members of a profession. By the word professional I mean people who are members of what are often called the learned professions such as lawyers, physicians, clergy and scientists. These professions usually require an advanced degree and sometimes a license.

continued

Professionals work together to provide a unique service to society. To facilitate the practice of their craft, professionals, formally or informally, adopt standards of conduct including codes of ethics. Professional ethics go beyond the demands of ordinary morality, the requirements of law and the demands of the market. For example, both physicians and lawyers have adopted strict requirements of patient or client confidentiality which are essential to the practice of their professions, but are not required by common morality.

Following the philosopher Michael Davis, I regard professional ethics as derived from moral ideals which are at the core of the profession. The focus on moral ideals comes from the old idea of a profession as a "calling," something that is essential to your character. The moral ideal is the basis of the ideal of service that is essential to a profession. For example, the best lawyers adhere to the moral ideal of equal justice under law. Although the moral ideals of the service professions of law and medicine are relatively easy to state, the moral ideals of science are more complicated. I have spent a lot of time thinking about this question and have developed a three-part statement of the moral ideals for science.

The first part concerns the integrity of the scientific process itself, the day-to-day work of the research group. This is the ideal that I call the "habit of truth," following Jacob Bronowski. It is the idea that what science is about is finding the truth, or at least reliable knowledge, about the natural world and this pursuit makes both technical and craft demands, but also requires that scientists adhere to a strict moral code, what is often called the responsible conduct of research.

Although the center of science is the laboratory where discoveries are made, science is a form of public knowledge. Discoveries must be communicated, usually through journal articles or conference presentation, and then scrutinized by the relevant research community. A discovery becomes part of the body of scientific knowledge only after it has been accepted, at least provisionally, by the community. This leads to the second part of the ideal, the gift economy.

We all live in two economies: the familiar commodity economy and the less familiar gift economy. The commodity economy is based on mutually beneficial interactions between people: fee for services, fees for goods. We all engage in such exchanges every day. The gift economy is different. To understand it, you should ask, to whom do you give gifts and why? You give gifts to family and close friends to establish or maintain a personal relationship. In science, we use the intellectual gifts of our colleagues, past and present, to make our own discoveries. This gift exchange creates a community. In accepting the gifts from others, we incur an obligation to contribute our own gifts. The intellectual gifts are the result of human creativity. In the commodity economy, those who are most respected are those who have accumulated the most; in the gift economy, those who are most respected are those who have contributed the most. We can all think of examples in our own field. The gift economy is the moral ideal for open scientific communication. Finally, we need to find an ideal for the relationship between science and society. Clearly, science is very useful. For example, my own field of chemistry has produced life-saving medicines and amazing new materials. There are several motivations for research. Some of us are interested in fundamental science, discovering how the world works, and are not particularly interested in applications. Others, however, are involved in what is called use-inspired or applied research which is directed at solving practical problems. In thinking about this kind of research, the question is what projects should one engage in. Of course, a researcher might not have much choice. Those employed in industry have to work on projects the company finds valuable. For those working in universities or national laboratories, the choice of a research project is primarily determined by the scientist's training and abilities and on funding. Even with these constraints, we can discuss an ideal.

Science has been criticized by, among others Freeman Dyson, for a poor choice of goals. Dyson stated, rather starkly and simplistically, that science was in trouble because it was spending too much time providing toys for the rich rather than necessities for the poor. This is an extreme position but is does have merit. Part of the bargain between science and society is that scientists should contribute to the public good. Based on the work of the late philosopher Norman Care, I think that an appropriate moral ideal for this bargain should be what Care termed shared-fate individualism. Care's position is that competent individuals, like scientists, should put responsibility to others ahead of self-realization in significant life decisions. Applying this ideal to the choice of research problems, whenever possible, one should work on problems that will most benefit humanity. Clearly this is a complicated issue, but remember that shared-fate individualism is an ideal, not a rule.

Moral ideals are important because they show what we are at our best, but they need to be applied to real-life ethical problems. This is the role of codes of ethics and practical reasoning. Ethical problems are not like mathematical problems with a single solution. Instead, they are design problems where you need to develop a solution subject to a variety of constraints. Over the past twenty years I have also looked at several specific issues, primarily in chemistry, because that is what I know best, but the ideas are more generally applicable. Some issues that I have written about include the ethics of war-related research and specific ethical problems related to chemistry. I have also tried to provide an answer to the question of why one should obey a professional code.

Scholarly work in the ethics of science has taken me far from my graduate training and scientific research in thermodynamics and statistical mechanics. I have had to become both an historian and a philosopher, but this is the kind of scholarship that the Forum on Physics and Society champions and I am honored to be a Fellow chosen by FPS.

Electrify: An Optimists Playbook for our Clean Energy Future

By Saul Griffith. MIT Press, Cambridge, Massachusetts, 269 pages, 2021, Price $18.95 ISBN: 9780262545044 (paperback), ISBN: 9780262046237 (hardcover)

In Saul Griffith's book, Electrify: An Optimist's Playbook for our Clean Energy Future, the message is clear: To save our planet from climate change, let's electrify everything. The time to do it was yesterday, and there's no more time to waste. He argues this is technologically possible and even feasible, but there are political barriers that need to be overcome. The goal of 1.5/2 0F increase in global temperature is now only possible with negative emissions. We've already waited too long and can't wait any longer. Solutions need to be in place decades before the worst consequences are felt. We already have committed emissions from locked in infrastructure which is just delaying the timeline even more. There is no time to buy just one more gas car or gas furnace before going electric.

The United States has a history of doing really great things and pulling off monumental tasks when it is in an emergency. Griffith claims that climate change is an emergency that needs to be treated on the same level and dealt with the same swift action as The New Deal, World War II mobilization, the space race, the civil rights movement, the 1973 energy crisis, smoking and public health, and ozone depletion.

The 1973 energy crisis gave us tools to be informed about today's climate crisis. However, this crisis is different in that it can't be solved with efficiency. We must completely change the supply to be 0% emissions, while also reducing the demand by using more efficient electrical machines. He provides a detailed breakdown of energy supply and demand for different sectors in Sankey diagrams, and points out the large thermoelectric losses with fossil fuels and how the fossil fuel supply chain is a major consumer of fossil fuels itself. He calls for huge transformative changes for good not small changes that result in less bad. For example, replacing fossil fuels with other fuels is not an option because creating the alternate fuels needs more electricity than just running an electric car. By electrifying everything it will reduce the total need by approximately half.

The sources of electricity also need to drastically change, relying most heavily on solar and wind power. However, depending on location, a mixture of wind, solar, nuclear, hydroelectric, wave and tidal power, and offshore wind are all appropriate zero emissions options. The reliability of renewables specifically when it comes to the timing of supply and demand is a popular critique. Griffith argues again that this is a problem of organizing many things to work together, not an impossibility. If we electrify everything we will need 3-4 times the electrical energy. This will need a new grid, not a beefing up of the old one. So, let's make the new one work with renewable energies while we are at it. He suggests various battery/energy storage systems to help even out the daily and seasonal variations in supply and demand. Chemical batteries can be used for variations of hours to weeks. Thermal energy storage such as freezing or heating water when electrical generation is high and then using stored thermal energy for water heaters, HVAC, and refrigerators later when energy production is low. Various mechanical storage options exist such as pumped hydro, flywheels, and compressed gas, but they aren't grid scale. He also suggests shifting the timing of loads which is easier to do when everything is electric. Historically this was done to keep producing things at night so they wouldn't need to shut down coal plants every night and restart in the morning. This kind of restructuring can be done again, but to match renewable generation peaks.

The new infrastructure will include new personal infrastructure such as cars, furnaces, water heaters, stoves, dryers, etc. He provides a detailed energy analysis of the average household across geographic and economic ranges of America. Using the average household a cost difference is calculated. The upfront costs are big, but electrifying will have lower long-term costs for overall cheaper energy. There need to be reasonable and realistic ways for individuals to make these purchases. Griffith proposes low interest long term "mortgage-like" loans. (It is important to note that when he wrote this mortgage rates were in the 3-4% range.)

There are already many fossil fuels in reserves. This means fossil fuel companies and stockholders of these companies have money tied up in the potential future us of these fuels. Not using them would cause widespread economic decline. He suggests divesting fossil fuel companies and buying out the stocks, not for their full values but at just a small profit margin.

To make electrifying an option, rules need to be reviewed and rewritten. Many rules were made to incentivize the use of fossil fuels and/or meant to work in the context of a fossil fuel burning world. Among the list of things to be revised are electric vehicle incentives and gas taxes, rooftop solar and building codes, fossil fuel subsidies, electrical codes, and grid neutrality.

Griffiths estimates that electrifying everything will approximately double the number of jobs in the energy sector in the near term. After much of the infrastructure changes have happened there will be a 5-6 million job increase over the 12 million energy sector jobs today. The location of these jobs is also important. Most of today's energy jobs are in red states. The new jobs will be all over. For example, installing rooftop solar should happen everywhere. However, the majority of the jobs will still be in red states, because they have the land capacity for large renewable energy generation.

Electrifying everything won't solve all of planet Earth's environmental problems. The products of the electrified world need to last. When they don't, they need to be recyclable. We can't live with a throw-away mentality.

Approximately 20% of the book is dedicated to appendices that the author felt needed to be included but didn't want to distract from the main message of the book. These appendices include responses to questions you might get asked when talking about this topic at a dinner party, a list of actionable items for people in a variety of careers, an overview of climate science, instructions on how to read a Sankey diagram (there are several in the book), and links to resources to do your own investigations.

Fighting World War Zero (Emissions) will require rallying for the cause and scaling up production like the nationwide mobilization efforts of World War II. It needs to be done in a smart, efficient and everyone-on-board kind of way. It needs to be done yesterday.

Hillary Stephens
Professor of Physics and Astronomy
Pierce College Fort Steilacoom
hstephens@pierce.ctc.edu

The Blind Spot: Why Science Cannot Ignore Human Experience

by Adam Frank, Marcelo Gleiser, and Evan Thompson, (MIT Press, Cambridge (MA), 2024). vii + 307 pp. $29.95. ISBN 978-0-262-04880-4.

In their introduction, this trio of authors – professors of physics and astronomy, natural philosophy, and philosophy, respectively – write that "We believe that our perspective can help transform and revive our cherished scientific culture as it faces its greatest challenges while reshaping our worldview for a sustainable project of civilization." (p. xi) They go on to write that "We call the source of the meaning crisis the Blind Spot," (p. xi) and attribute it to "the failure to see direct experience as the irreducible wellspring of knowledge." (p. xiv)

In their opening chapter the authors describe many of the characteristics of what they call the Blind Spot but they never get around to providing a concrete definition of what it is. Among other things, they criticize the Blind Spot's bifurcation of nature (by focusing on measured rather than experienced quantities), reductionism (by attributing fundamentality of smallest parts over composites), and reification of mathematical identities (by ascribing reality to mathematical properties of objects). Throughout the book they continually refer to "four pathologies associated with the Blind Spot: (1) surreptitious substitution, (2) the fallacy of misplaced concreteness, (3) reification of structural invariants, and (4) the amnesia of experience." (p. 253)

The reification of mathematical descriptions takes particular aim at classical physics, which the authors typify as "a story of mathematical constructions that successfully built on, surpassed, and then forgot the role of lived experience." (p. 39) Instead, they look more kindly on Alfred North Whitehead's Science and the Modern World, which they characterize as an "attempt to find the right place for . . . abstractions within a full account of nature that includes our experience as an integral part of it." (p. 82) When it comes to describing things in the quantum realm, which defies direct experience, they find two interpretations which they feel are compatible with their way of thinking: (1) relational quantum mechanics (RQM), in which the wave function is a mere calculational device and the only reality is its interaction with a measuring apparatus; (2) Quantum Bayesianism (QBism for short), which is grounded in Bayesian probabilities, which "represent a state of .. . belief . . . instead of a frequency or propensity of some phenomenon." (p. 104) "QBism . . . together with elements of RQM, addresses the fundamental question posed by quantum mechanics: the relationship between properties of the world and our experiences of the world." (p. 108) Cosmologically, the authors find that inflation and a multidimensional universe with strings are based on unjustified extrapolations beyond the realm of human experience: "If what we can say of the world depends on our experience of the world, to describe what lies beyond any possibility of experimental confirmation belongs to the realm of gods, not people." (p. 137)"

This trio of authors distinguishes the living from the non-living in a trio of chapters – on life, cognition, and consciousness. Here their objection to reductionism plays a major role: "The Blind Spot perspective on life leans heavily on . . . reductionism . . . [that] life is nothing more than molecular machinery." (p. 143) "It takes life to recognize life," (p. 142) and "self-individuation, agency, and . . . autonomy . . make life unlike anything else in nature or anything we manufacture." (p. 143)

When it comes to cognition, the authors feel that "the strongest and most prominent manifestation of the Blind Spot in cognitive science . . . [is] in AI." (p. 165) "AI systems do not know anything about the world as such; instead, they detect statistical correlations in the input we give them with no understanding of what lies behind those correlations," they write. (p. 180) To the authors the key to solving a problem is determining what information is relevant to the solution: "In trying to design an intelligent system . . . how do you design or program an agent so that it considers only the relevant information without wasting time on the irrelevant information?" (p. 167) "No AI system comes close to realizing relevance." (p. 165)

n contrast to AI, the authors seem to look with favor on what they call "enactive cognitive science" for its "importance of the body and interactions with the environment for understanding the mind." (p.164). "Enactive-cognition theorists embrace the irreducible primacy of direct experience and accordingly strive to move beyond the Blind Spot in their investigations of the mind." (p.165)

The authors define the "hard problem of consciousness" as "explaining how a physical system, such as the brain, gives rise to conscious experience." (p. 192) After describing and discounting three ways to account for consciousness in the Blind Spot worldview, they replace it with "the problem [of] how the brain as a perceptual object within consciousness relates to the brain as part of the embodied conditions for consciousness." (pp. 219-220) This realization "that we inescapably use consciousness to study consciousness" (p. 218) they, along with Francesco Varela, call "neurophenomenology," which they say "represents probably the strongest effort so far to envision a neuroscience of consciousness beyond the Blind Spot." (p. 221)

All of this leads up to a discussion of the future of planet Earth in the last chapter, which the authors promised in their introduction. "Global warming, driven by the industrial activity of the richest nations, is changing Earth's climate in ways that will severely stress . . . humanity's ten-thousand-year-old global project of civilization," they write. (p. 225) "From Francis Bacon [whose goal of subjugating nature has already been cited on p. 11] on, developing the methods of inquiry we now call science was always aimed at the control of nature as at revealing reality and truth . . . . Energy was harvested and entropy generated on scales that would soon alter the function of the coupled Earth systems." (pp. 226-227) "The basic assumptions of the Blind Spot became entrenched in the economic and social systems that came to dominate the period of rapid industrialization" (p. 227) – "a new planetary state . . . called the Anthropocene . . . that is likely to be far less hospitable to our project of civilization." (p. 226)

From the work of Vladimir Vernadsky in the 1920s to James Lovelock and Lynn Margulis's Gaia to Earth Systems Science, the authors recognize that the evolution of a planet gearing life is affected by the interaction of that life with the planet. With the climate change resulting from human injection of greenhouse gases, the authors "find the Blind Spot's idea of reason, which claimed to speak for science, underpinning the political economy of the emerging Industrial Age." (pp. 238-230)

The authors point out that wedded to the reification of mathematics in physics is the mathematization of economics and the Blind Spot that goes with it. They criticize the idealities that economics posits for pure competition and seem to resist acknowledging the redeeming features of efforts to account for environmental costs, much less than making an out-and-out call for a carbon tax.

Although science has been identified with the Blind Spot, the authors acknowledge that it "strives to be a self-correcting narrative built from a communal, open-ended, inquiry-focused dialogue with experience." (p. 248) "We've already explored how [the] challenges [to the Blind Spot] have arisen in cosmology, quantum physics, biology, cognitive science, and the neuroscience of consciousness," they continue. (p. 245) Their alternative to the Blind Spot perspective is a "unique mix" of physics, biology, and the social sciences called the "science of complex systems," which are transdisciplinary nonreductionist "coevolving multilayer networks." (p. 245) Their evolution depends on their history, environment, and "possibilities available conditioned on the present" – "the adjacent possible." (p. 246) Determining the evolution of complex systems requires and is enabled by computers.

"By embracing . . . a nonreductionist perspective that focuses on the centrality of entangled, looping relations and their emergent properties in complex systems . . . complex system science offers a glimpse of what a scientific worldview beyond the Blind Spot might look like." (p. 249) But although this book has examined "possible gateways into post-Blind Spot perspectives," (p. 253), it makes no specific claim for an "alternative to the Blind Spot." (p. 253)

John L. Roeder
The Calhoun School
JLRoeder@aol.com