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PHYSICS & SOCIETY

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From the Editor

The main event to report in this issue is undoubtedly the cancellation of the March meeting, the largest APS meeting. About ten thousand participants were affected, many were already on their way to Denver or actually already there. Most of them sustained some personal financial loss. Although the talks were eventually put online, the March meeting is always the time where people renew many acquaintances and talk to other researchers that are not exactly in the same subfield, and do not attend the same specialized conferences, but are nevertheless important to talk to. The April meeting has now officially been canceled as an in person meeting, but this time, with much longer notice. Virtual sessions will take place.

What will be the consequences in the long run, not just for Condensed matter Physics, but for Physics, and the APS, at large? Will meetings change their structure permanently?

I would very much welcome contributions (letters to the Editor or articles) on these events and what they may imply for scientific communication.

This issue is heavy on news: invited talks that had been scheduled, newly elected APS Fellows from our Forum, results of our elections, etc. Congratulations to all award, Fellowship, and election winners.

Contributions from all of you readers are always welcome. Articles and suggestions for articles should be sent to me, and also letters to the editor. Book reviews should go to the reviews editor directly (ahobson@uark.edu). **Content is not peer reviewed and opinions given are the author's only, not necessarily mine, nor the Forum's or, a fortiori, not the APS's either.**

Oriol

Oriol T. Valls, the current P&S newsletter editor, is a Condensed Matter theorist.

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IN THIS ISSUE

Princeton Summer School on Science and Global Security

ANNOUNCEMENT AND APPLICATION

Princeton University's Program on Science and Global Security will host an international Summer School on Science and Global Security from 8–11 August 2020.

The main focus of the Summer School will be technical perspectives on understanding, reducing and ending the threat from nuclear weapons. It will include potential impacts for nuclear arms racing and disarmament of emerging technologies such as cyber, machine-learning, and space-based sensors. The meeting will include presentations, interactive learning experiences and tutorials, including on how to engage with nuclear weapon policy-making processes.

The goal of the meeting is to help encourage and train-next-generation scientists and engineers from around the world to work on the global security issues stemming from the existence of nuclear weapons, and to foster an international community of such researchers. It follows on from the annual Summer Symposiums on Science and World Affairs that originated at Princeton in 1989 and were organized by the Union of Concerned Scientists since the mid-1990s.

Who Should Apply: Ideally, participants should be graduate students or post-doctoral researchers in natural or applied sciences, engineering, or mathematics. Postdoctoral applicants typically will have received their PhD within the last three years. To strengthen diversity in the science and global security policy field, the Summer School encourages applicants of every gender, race, ethnicity, religion, sexual orientation and socioeconomic status.

How to Apply: Applicants must submit a two-page CV including a short description of their background and interests in security issues, and a 1000-word essay on a relevant policy issue with a technical dimension.

This material is due by **15 April 2020** by email to summerschool@princeton.edu. Applicants can expect to be notified of the results by 30 April 2020.

What to Expect: At the Summer School, each participant must give a talk on research that is underway or proposed related to technical aspects of a nuclear-weapon policy issue. Each talk will be 20 minutes with 20 minutes of Q&A. The title of the presentation as well as a 200-word abstract are both due by June 15. Please note that the talk need not be on the same subject as the application essay.

Participants are expected to stay for the entire meeting and attend all sessions.The meetings are structured to encourage the active engagement of all participants, to educate and help participants new to the field formulate research projects, and to foster strong relationships between participants. The meeting is conducted in English.

Princeton University's Program on Science and Global Security will cover cost of travel, visa, accommodation and meals for all participants.

Book Reviewers Wanted

Interesting Work! No Pay!

If you enjoy reading and writing, *Physics & Society* needs you on its team of reviewers of books about physics-related social topics. Email Art Hobson, books editor, ahobson@uark.edu, with a few sentences about yourself and the kinds of physics-related social topics that interest you. There's no pay, but there's a perk: You get to keep the books you review.

FPS Invited Speaker Sessions at 2020 March and April Meetings

1. **These are the invited talks in sessions sponsored or co-sponsored by the Forum** which were scheduled to be given at the canceled March Meeting:

AI and Humanity: Governance, Design, and Ethics

- "AI and its Computing Landscapes: Water Data, Climate Control, and Agricultural Technology" – *Theodora Dryer*
- "The role of tech companies in governing and designing ethical systems" – *Melissa Hall*
- "An Ecological Approach to Data Governance, Design and Ethics" – *Jasmine McNealy*

Outreach and Public Science Communication

- "The PBS Space time experiment, surprising insights on public science engagement" – *Matthew J. O'Dowd*
- "Science communication – For the geek in everyone" – *Jeanna Bryner*
- "Outreach to policymakers" – *Francis Slakey*

Communicating Science to the Public

- "Joseph A. Burton Forum Award talk: Physics, Truth and the Crisis of Science Denial" – *Adam Frank*
- "Andrei Sakharov Award talk: Scientific espionage, open exchange, and American competitiveness" – *Xiaoxing Xi*
- "The role of news journalism" – *Dennis Overbye*
- "The National Academy of Sciences Goes to Hollywood: Employing Creative Engagement Strategies to Connect with Broad Audiences" – Invited Speaker: *Ann Merchant*
- "The art of interviewing scientists" – *Ira Flatow*

2. **April Meeting Invited Talks**
(Forum Sponsored or Co-sponsored)
These are expected to take place in some virtual form:

Science and National Security

- "Arms control and national security" – *Steve Fetter*
- "Climate change and national security" – *Rod Schoonover*
- "Cyber issues and national security" – *Herb Lin*

2020 Leo Szilard Lectureship Award

- "2020 Leo Szilard Lectureship Award" – *France Cordova*

Ethics in Physics and Science: Remembering John Ahearne

- "Ethics in policy advice risk assessment, and national security" – *Micah Lowenthal*, National Academy of Sciences

"The survival imperative: critical components of the ethical education of scientists and engineers" – *Stephanie Bird*

"Creation and charge of the APS ethics committee" – *Michael Marder*

Science and International Relations

"Challenges and imperatives of international scientific cooperation – *Cherry Murray*"

"Challenges in large scale international scientific cooperation" – *Arthur Bienenstock*

"Current challenges in international scientific cooperation" – *Rebecca Keiser*

Intersection of Science and Politics

"Science and politics in the US Congress" – *James Jensen*, National Research Council

"Role of non-governmental scientific organizations in science and politics" – *Ellie Dehoney*

"Role of universities in science and politics" – *David Goldston*

3. **Congratulations to these forum nominated 2019 APS Fellows.** Remember the Nominations for 2020 are due June 1st 2020:

Budil, Kimberly Susan [2019] Lawrence Livermore National Laboratory
Citation: For extraordinary leadership in developing national security partnerships between laboratories, academia, and governments, and for promoting diversity in science.

Dickerson, James H. [2019] Consumer Reports
Citation: For longstanding contributions to physics diversity through mentoring, outreach, championing the APS Bridge Program, and helping launch the Fisk-Vanderbilt Bridge model, as well as leadership to assure quality science underpins Consumer Reports' product evaluations.

Perc, Matjaz [2019] University of Maribor
Citation: For seminal theoretical contributions to the physics of social systems which have strengthened the ties between physics and society through the promotion of human cooperation, the provisioning of public goods, and the maintenance of biodiversity.

White, Marion M. [2019] Argonne National Laboratory
Citation: For tireless efforts to increase the participation of women and minorities in physics, especially through one-on-one mentoring and educating minorities in elementary school through college about opportunities in the field.

4. 2019 Forum Election Results

Vice-Chair: Henry C. Kelly

Councilor: Bev Hartline

Member-at-Large: Cherrill Spencer

Member-at-Large: Sebastien Philippe

5. Executive Committee for 2020

Chair: E William Colglazier (01/20 - 12/20)
AAAS

Chair-Elect: Stewart Charles Prager (01/20 - 12/20)
Princeton University

Vice Chair: Henry C. Kelly (01/20 - 12/20)

Past Chair: Joel R. Primack (01/20 - 12/20)
University of California, Santa Cruz

Secretary/Treasurer: Anthony Fainberg (01/19 - 12/21)
National Academy of Sciences

Councilor: Beverly Karplus Hartline (01/20 - 12/23)
Montana Technological University

Member-at-Large: James H. Dickerson (04/18 - 12/20)
Consumer Reports

Member-at-Large: Jorge A. Munoz (04/18 - 12/20)
Intel Corp - Santa Clara

Member-at-Large: Juliette M. Mammei (01/19 - 12/21)
University of Manitoba

Member-at-Large: Savannah J. Thais (01/19 - 12/21)
Princeton University

Member-at-Large: Dr. Cherrill M. Spencer (01/20 - 12/22)
SLAC - National Accelerator Lab

Member-at-Large: Dr. Sebastien Philippe (01/20 - 12/22)
Princeton University

Staff Advisor: Laura Grego (01/19 - 12/21)
Union of Concerned Scientists

ARTICLES

An Earlier 9/11: Nuclear Lessons for Today

B. Cameron Reed, Alma College.

This year's quinquennial Nuclear Non-Proliferation Treaty Review will be occurring at a difficult time for advocates of that important agreement. Since the last such review, the United States and Russia have withdrawn from the Intermediate Nuclear Forces treaty, the Iran JCPOA seems grievously imperiled, no successor to the New START agreement is in the offing, and the various nuclear powers of the world are undertaking expensive and potentially destabilizing expansions of and/or upgrades to their weapons systems. While the current nuclear landscape may look grim, more trying circumstances were overcome in the past. Looking back can provide us with some perspective, and suggestions for the future.

In the aftermath of World War II in the fall of 1945, President Harry Truman, barely five months in office, faced a totally new and uncharted nuclear world. On September 11 of that fateful year, the Secretary of War, Henry L. Stimson, sent him a six-page memorandum summarizing his thoughts on how to deal with Russia and the new "atomic bomb" [1]. Stimson, a model of selfless public service, was 78 years old, exhausted, in failing health after serving for over five years, and about to retire. He was also deeply concerned with the future course of civilization. Remarkable for its clear-headedness, appraisal of the world situation, prescience, and humanity, his memo still has lessons for today.

Stimson opened by recognizing that " … the introduction of this weapon has profoundly affected political considerations in all sections of the globe." Seeing the bomb as " … a first step in a new control by man over the forces of nature too revolutionary and dangerous to fit into the old concepts" and considering "the problem of our satisfactory relations with Russia as … virtually dominated by the problem of the atomic bomb", he went on to propose a remarkably liberal approach to forestall what he feared could be a " … secret armament race of a rather desperate character." The essence of his proposal was that the United States, after discussions with and perhaps the involvement of Britain, directly approach Russia with the idea that " … we would stop work on the further improvement in, or manufacture of, the bomb as a military weapon, provided the Russians and the British would agree to do likewise. It might also provide that we would be willing to impound what bombs we now have in the United States provided the Russians and the Brit-

ish would agree with us that in no event will they or we use a bomb as an instrument of war unless all three Governments agree to that use."

Stimson was not naïve as to the nature of Russia. In a covering letter accompanying his memo, he wondered " … whether we could be safe in sharing the atomic bomb … while she was still a police state and before she put into effect provisions assuring personal rights of liberty to the individual citizen." However, he had " … come to the conclusion that it would not be possible to use our possession of the atomic bomb as a direct lever to produce the change", and that " … this long process of change in Russia is more likely to be expedited by the closer relationship in the matter of the atomic bomb …". His best advice appeared on the third page of the memo: "The chief lesson I have learned in a long life is that the only way you can make a man trustworthy is to trust him; and the surest way to make him untrustworthy is to distrust him and show your distrust."

Tragically, Stimson's vision foundered against the growing paranoia of the Cold War. The world of today is much different than that of 1945: Multi-polar, China ascendant, nine nuclear-weapons states, some former or once-near nuclear-weapons states, and yet other aspirant ones. The nuclear cat has been out of the bag since 1945 and will likely never be impounded, but it can be more tightly corralled. Our philosophy now would be "trust but verify" as opposed to simple trust, but Stimson would have understood and considered it worth a try. Multiple means of verification are available, and trust can be rebuilt. Seventy-five years after Hiroshima and Nagasaki, delegates to the NPT review should give his old-fashioned advice a fresh look.

[1] A scan of Stimson's memo can be viewed at trumanlibrary.gov/library/research-files/henry-stimson-harry-s-truman-accompanied-memorandum

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Media, Politics, and Climate Change, a Response to Wang and Hausfather

Wallace Manheimer, wallymanheimer@yahoo.com

In the January issue of FPS, Seaver Wang and Zeke Hausfather presented their response, *Climate change: Robust evidence of causes and impacts*, to my essay in the October issue, *Climate change, media perceptions and misperceptions*. Their critique was considerably longer than my essay. I certainly realize that my essay was controversial and likely would trigger a response.

The goals of my essay were modest. It was certainly not to resolve the climate dilemma or controversy. I am a professional scientist with more than 50 years of experience. However, I am not a climate scientist and am in no position to take on Wang and Hausfather, who are obviously experienced climate scientists, regarding the details and subtleties of climate science. That role is for extremely qualified climate experts like Dick Lindzen (youngest person elected to NAS), William Happer (leading member of NAS), Roy Spencer and John Christy (in charge of the NOAA/NASA/UAH space based temperature data collection), Patrick Moore (originator of Greenpeace, resigned when he thought it became too extreme), Judith Curry (former chairwoman of the earth an atmospheric science department at GA Tech), Ivar Giaever (Nobel Prize winner in physics, resigned from the American Physical Society because of its stand on climate change), Fred Singer, (retired professor University of Virginia, designed many of the space based instruments used for environmental measurements), Freeman Dyson (long time scholar at Princeton Institute of Advanced Studies, probably the greatest physicist who has NOT won a Nobel Prize), and many, many others, who are perfectly capable of taking them on and have done so in many arenas. While it is obviously impossible here to go through their arguments here, Dick Lindzen summarized it well:

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 (up to 2500 words), letters (500 words), commentary (1000 words), reviews (1000 words) and brief news articles are welcome. Send them to the relevant editor by e-mail (preferred) or regular mail.

Editor: Oriol T. Valls, ***otvalls@umn.edu***. **Assistant Editor:** Laura Berzak Hopkins, ***lfberzak@gmail.com***. **Reviews Editor:** Art Hobson, ***ahobson@uark.edu***. **Media Editor:** Tabitha Colter, tabithacolter@gmail.com. **Editorial Board:** Maury Goodman, ***maury.goodman@anl.gov***; Richard Wiener, ***rwiener@rescorp.org,*** Jeremiah Williams, ***jwilliams@wittenberg.edu***. **Layout at APS:** Nancy Bennett-Karasik, ***karasik@aps.org***. **Website for APS:** ***webmaster@aps.org***.

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

"What historians will definitely wonder about in future centuries is how deeply flawed logic, obscured by shrewd and unrelenting propaganda, actually enabled a coalition of powerful special interests to convince nearly everyone in the world that CO_2 from human industry was a dangerous, planet-destroying toxin. It will be remembered as the greatest mass delusion in the history of the world- that CO_2, the life of plants, was considered for a time to be a deadly poison."

My goal was to emphasize the media and politicians, how both get it so wrong, how they abetted this 'shrewd and unrelenting propaganda'. It certainly was not to resolve the climate controversy. The media's job is to present an unbiased view of a scientific dilemma of which they have little understanding. Instead they present only one side, pretending the other side either does not exist, or is corrupt. One does not have to be a climate scientist to examine climate data. A great deal of data from reliable sources is available on the Internet; it is not only for the high priests of climate science. It is available to anyone, anywhere, any time. The media should routinely be examining it. If they did, they would get a much more balanced view.

This Internet data shows the claims of imminent disaster are, at the very least, controversial, they are certainly not settled science; more likely it shows that they are bogus. My essay, and many others pointed this out, the media and politicians ignore it. I certainly stand by all of the data in my essay, data from very reliable sources (i.e NOAA, IPCC, EPA, NASA, UAH, National Hurricane Center, National Weather Service, congressional testimony, but more on NOAA ground based temperature data shortly). The data is presented in a way that anyone can understand, there is no need for a climate expert to guide us. Furthermore, I would say that these journalists, politicians, and even scientists who ignore actual data are members of a long and dishonorable tradition of 'chicken littles'. The sky is always falling, whether cooling, warming, overpopulation, acid rain, crop erosion, famine, dead oceans, dead great lakes, ….. They have nearly always been wrong. Here are two links:

cei.org/blog/wrong-again-50-years-failed-eco-pocalyptic-predictions

nypost.com/2020/01/10/the-telling-tale-of-glacier-national-parks-gone-by-2020-signs/

My essay concentrated only on the media and politics, and the implied role of the research community, not on the details or subtleties of climate science. For instance, Wang and Hausfather say "The research community neither suggests total cessation of fossil fuel use…" Are they suggesting that politicians, media and some scientists do not suggest exactly this? Seriously? Have they looked at the media lately? Watched TV news? Have they watched any Democrat presidential debates or read any of their campaign web sites? Many of these candidates are absolutely certain that we must terminate fossil fuel use in about 10 years. And these people

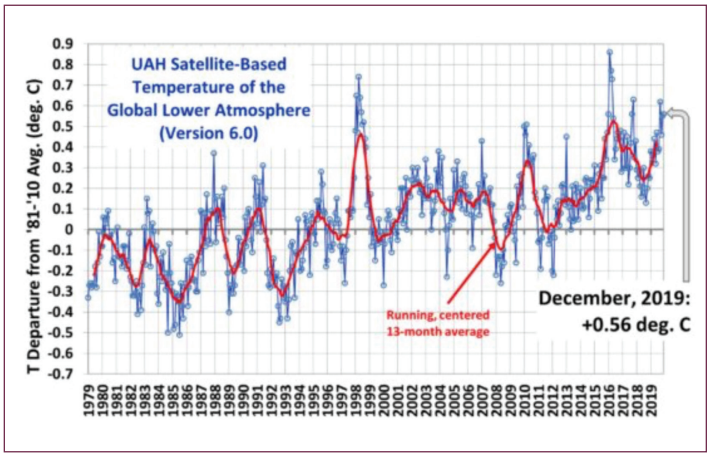

Figure 1: Space-based temperature measurements from UAH up to December 2019 showing the effect of the strong el ninos around 1998 and 2016. These were the hottest years. It also shows that once the el nino receded, temperature also relaxed.

are serious candidates for *president!* Where did they get these ideas if not from the research community? That is where *they* say they got them. For instance, here is a quote from Bernie Sander's 2020 campaign web site:

"The scientific community is telling us in no uncertain terms that we have less than 11 years left to transform our energy system away from fossil fuels to energy efficiency and sustainable energy, if we are going to leave this planet healthy and habitable for ourselves, our children, grandchildren, and future generations."

If Wang and Hausfather's claim is true, that the research community does not suggest a cessation of fossil fuel, somehow their message got garbled on the way to the media and politicians.

I will briefly comment on a few of Wang and Hausfather's assertions. Commenting on all 18 of them would obviously not be appropriate, other than to reiterate that I stand by the data quoted.

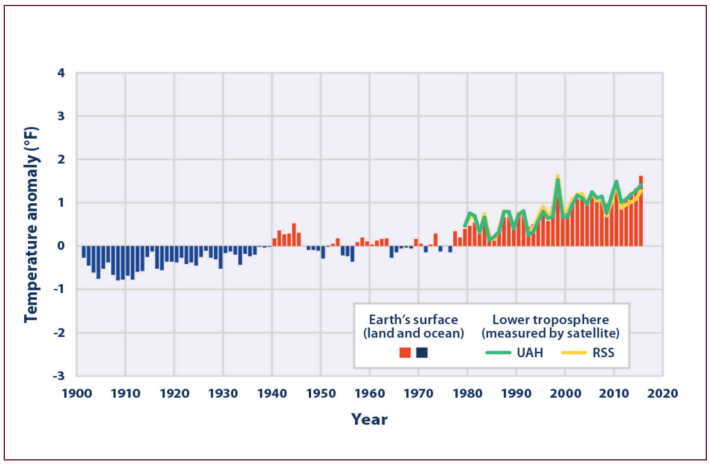

Figure 2. Worldwide temperature as measure both ground-based, space-based, and with high altitude balloons 1900-2015. Averaging over peaks and valleys, this temperature has been about constant since about 1998.

The NOAA ground-based temperature graphs deserve a bit of explanation. Figure 1 of my essay was a NOAA graph of world temperature showing a plateau between about 1998 and 2014. Unfortunately, NOAA has presented changing and contradictory measurements. For 15 years, their measurements showed a constant world temperature. Then, (whoops!); after 15 years of their original graph and methodology, they reconsidered. There is no temperature plateau after all, but only a constantly rising temperature, a temperature graph much more pleasing to their political bosses at the time. So which NOAA graph does one use, the one that for 15 years stood the test of time with little controversy; or the new one which generated enormous controversy, with congressmen demanding answers, and with NOAA refusing to present the new methodology? I used the original, believing it is more likely correct. It is still featured prominently on a Google Images search. This author believes such a NOAA U turn represents a serious problem for the agency. A further discussion of this is in Sec 6.6 of ijeas.org/download_data/IJEAS0407025.pdf, and also see Jeff Tollefson, *Nature News* October 28, 2015, nature.com/news/us-science-agency-refuses-request-for-climate-records-1.18660

However these NOAA measurements ultimately shake out, Wang and Hausfather are correct in one assertion. There was a strong el nino in about 2016 which did indeed give a temporary spike in world temperature which was absent in my graph. Some of my correspondents have interpreted this as greatly accelerated climate change. However, this is not the case; as soon as the el nino receded, the temperature quickly relaxed, but back to a somewhat higher value. This is apparent in both the ground-based and space-based measurements. Figure 1 shows confirming data from the UAH space-based measurements. drroyspencer.com/latest-global-temperatures/

Figure 2 shows basically the same thing, this graph from the EPA and showing several different measurements. epa.gov/climate-indicators/climate-change-indicators-us-and-global-temperature

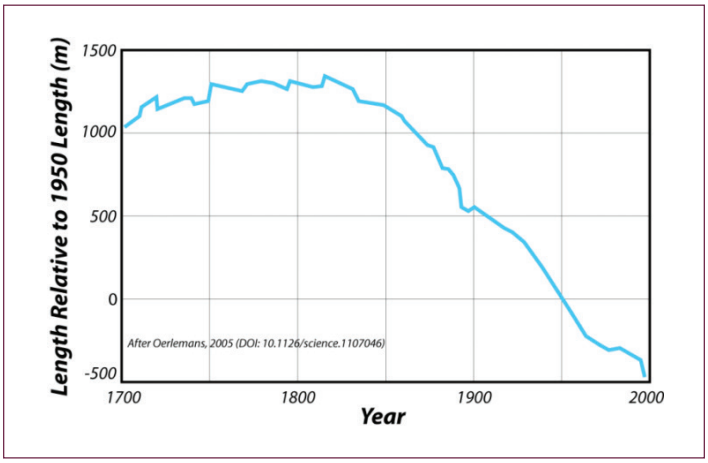

Figure 3: One measurement of the length of glaciers as a function of year. This graph shows no acceleration of melting after 1960 when CO_2 began to accumulate in the atmosphere.

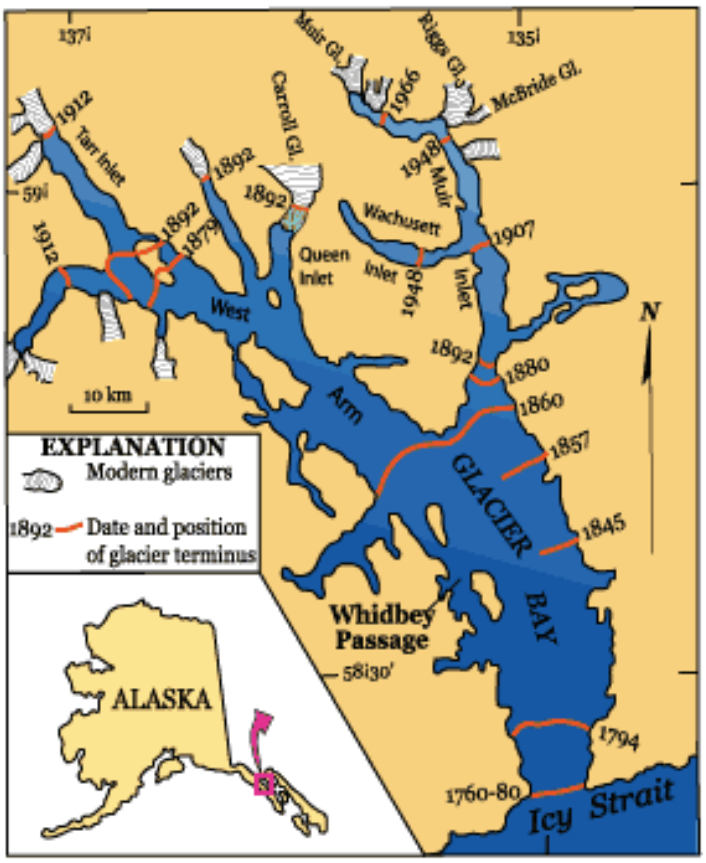

Figure 4: The red lines are positions of the glacier edges at various years. In about 1780 when Captain Vancouver sailed there, entire bay was impassable. Virtually all of the melting took place before 1907, well before additional CO_2 in the atmosphere could have played any role.

Neither of these graphs indicate a climate emergency, at least in the view of this author.

Glaciers have definitely been receding for past 200 years. Some Internet sources claim the melt has increased since 1960, when CO_2 began to be added to the atmosphere, others do not. In either case, the science is certainly not settled. An example of the latter, from Penn State University is in Figure 3: e-education.psu.edu/earth103/node/767

In my original submission for the October 2019 FPS essay, was a map of the glacier edges in Glacier Bay AK at various years. This is an example of one well documented glacier, whose shrinkage was fastest well before 1960. Perhaps it is typical. It was deleted to shorten the manuscript. Figure 4 is that map provided by the US Geological Survey. en.wikipedia.org/wiki/File:Glacierbaymap.gif

Wang and Hausfather deny that Mooney (my reference 3) made a claim of a 30-foot ocean rise. Here is the headline of Mooney's article:

"At this rate, Earth risks sea level rise of 20 to 30 feet, historical analysis shows"

Finally, if Wang and Hausfather really believe fusion, solar, wind or carbon capture can make any sizeable impact in the next 10, or even the next 20 years, as they indicate in their Claim 18, I would say that they are living in a dream

world. The facts are simple and undeniable, these 'sustainable' sources cannot, for at least the next 20 years, replace fossil fuel on anything like the scale and price necessary for powering civilization; no matter what their proponents and publicists claim. As Richard Feynman said regarding the Challenger disaster:

"For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled."

See the first two sections of ieeexplore.ieee.org/document/8502757 where the experience with, and potential of 'sustainable' energy is carefully documented. It also shows the tens of billions of dollars the world's tax payers each year shovel into climate science and related subsidies, dollars that certainly finance a 'coalition of powerful special interests'. It is a refereed paper in a very prestigious journal. In fact, the referee insisted on including this analysis.

Eliminating or greatly reducing fossil fuel in the next 20 years would cause worldwide poverty and starvation for billions. There is no disputing this. It would cause the end of civilization as we know it. It would create a world holocaust.

REVIEWS

A Review of Manual for Survival: A Chernobyl Guide to the Future

Kate Brown, ISBN: 978-0-393-65251-2; 384 pages; $27.95 hardcover.

As a professor in an undergraduate physics department, I welcomed a Chinese atmospheric nuclear test and the radioactive cloud it produced that would pass over Muncie, Indiana in a few days, providing an opportunity to demonstrate the practical uses of nuclear physics to my undergraduate students. I borrowed a giant filtered vacuum cleaner from friends in the Environmental Sciences Program, recruited a crew of undergraduate physics students from my class, mounted the vacuum cleaner on the roof of the physics building and began scanning filters with gamma detectors as the cloud from the Chinese test dropped radioactivity. We proudly determined that the fission explosion had come from a plutonium core, not a uranium core and presented our results to the Indiana Academy of Science. Until I read this book, it never occurred to me that the radioactivity from the cloud might pose a risk to me and my students and more importantly the people of Muncie, Indiana.

The Manual for Survival is first and foremost a history of the response of the collapsing Soviet Union under Gorbachev to the Chernobyl disaster of 1986. At that time the medical effects of radiation were known to very few members of the medical community in the U.S.S.R. Essentially the Soviet government orchestrated a massive underestimation of the damage done to citizens even far from the destroyed reactor particularly in Belarus and the Ukraine as well as to people in the vicinity of the reactor explosion which Brown points out may have been a nuclear explosion and not just a result of the reactor over-heating. Responses both in the U.S. and the U.S.S.R. were heavily shaped by the nuclear arms race of the Cold War. Brown uses this to make the point again and again that people absorb radioactive isotopes from their environments by many pathways if the isotopes are present in the first place. For example, she sites workers who handled raw wool from sheep who were exposed to fallout from Chernobyl. The workers came down with radiation sickness although they themselves had escaped exposure to fallout.

The major error made by most of those (both Soviet and western experts assessing the effect of Chernobyl on local populations) was to depend on measures of gamma ray intensity in the atmosphere. But this ignored the effects of fallout on fields which contaminated the food eaten by most of the population and it ignored the isotopes which they inhaled. In particular, studies ignored the outbreak of thyroid cancers in children whose bodies, starved for iodine (which was lacking in the area around Chernobyl), readily absorbed radioactive iodine and concentrated it in their thyroid glands. These studies also leaned on the massive and lengthy Life Span Study of the Japanese survivors of Hiroshima and Nagasaki by the US Atomic Energy Commission begun in1950, five years after the last nuclear detonation there. According to Brown, General Leslie Groves suppressed evidence that fallout after the main blast affected Japanese soldiers and civilians as well as American soldiers. Thus, his $20 billion investment (the

author fails to tell us what year dollars these were) in a nuclear weapon would not be wasted due to nuclear weapons being banned as chemical and biological weapons had been because of their effects on civilian populations, and Americans would not seem to be morally bankrupt. Because Soviet, UN and other foreign studies used the resulting study in their work, they made casualty estimates that were a factor of 100 lower than those of Greenpeace and local medical personnel.

Brown, a historian, visited the areas in the former USSR affected by the Chernobyl accident. She studied archives at the national and local levels and interviewed survivors, both those evacuated from the vicinity of the reactor and those still living in areas that received heavy fallout. She also interviewed medical personnel at all levels who would talk to her. She has based this book on her interviews and work in the archives of various Soviet towns and republics. All of these are carefully documented in her bibliography. Unfortunately, Brown makes no effort to present the case in favor of the use of nuclear reactors for the production of civilian power. She seems to have had better luck obtaining interviews with scientific leaders in the U.S. but does not present much information about other nuclear events except for Chernobyl. Perhaps this is not surprising as the *Survival Manual* is actually a history of the reactor accident and its effect on local populations as well as the Soviet government's attempts to mitigate (or cover up) its effects. These attempts employed measures such as seeding fallout clouds to protect citizens in large cities despite negative effects on rural areas and populations due to radioactivity deposited on fields where crop plants, first eaten by farmers and then shipped to cities, absorbed radioactive isotopes. Fields also produced dust that put radioactive isotopes into the air breathed by people and animals.

The accident at Chernobyl has recently been the subject of an HBO series, which has claimed 19 Emmy nominations including best limited series and three of its leading actors. It has also sparked a wave of tourism to the exclusion zone around the reactor and the contaminated city of Pripyat which is safer since the Ukrainian government built a new, well-designed dome over the reactor. It is now 40 years since the reactor exploded, and physicists and physicians around the world should apply new knowledge to Chernobyl and its consequences.

This book is the result of Brown's heavy investment of time, and it is not a joyous or quick read, nor does it present or pretend to present a balanced discussion of nuclear power and potential accidents. However, it questions assumptions physicists commonly make that should probably be questioned. It is thoroughly researched and well documented. On the whole, it makes for heavy and troubling reading but it asks questions that most physicists, including me, should ask themselves. This makes it worth the effort involved in reading it.

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Interplanetary Robots: True Stories of Space Exploration

Rod Pyle, Prometheus Books, 2019, 376 pages, $18, ISBN 978-1-63388-502-8

Rod Pyle's book *Interplanetary Robots* is a detailed account of all of the major and some minor robotic spacecraft missions that have explored our solar system. Each chapter describes the goals, technical and political challenges, and scientific accomplishments of a mission or set of missions. Pyle's intimate personal connections and thorough research brings the reader into the control room of each mission, capturing the excitement.

The book starts at the Center of the Universe (also known as the Jet Propulsion Laboratory Headquarters) on the eve of the Curiosity Rover landing on Mars. Pyle is there along with other members of the press and brings readers along with his backstage pass to the event. He introduces the reader to the place and the people that created many of the robot explorers. It is not Pyle's first time to the Center of the Universe, nor will it be his last. Similarly, the book comes back to this place and the people who work there several times.

After this brief introduction to the heart of it all, Pyle follows a rough chronological sequence starting with the early days of the space race. Although the peak of the race was humans landing on the Moon, much of the race was run using robotic craft. Pyle reminds readers that the space race at its heart was really a show of military might. Rockets that propel robots into space are descendants of Nazi military missiles. Initial plans were not to land humans on the Moon, but to use nuclear weapons on its surface. Adverse public reaction, ruining the pristine lunar environment, and the chance of an accidental misfire in Earth's atmosphere changed that outcome. Pyle captures the stresses and tensions involved with many failures before success as well as the public acclaim following each success. On the robotic front, the Soviets were far ahead of the US. They were the first to crash (purposefully) into the Moon, take pictures of the far side (using stolen US film), land softly, and operate a rover. To date, the Soviets are the only ones to have successfully landed on Venus, although the US did better at Mars. With the background of the cold war, Pyle tells of espionage: the US covertly stealing Soviet Luna technology and Soviets shooting down a US spy balloon to steal film and take the first pictures of the far side of the Moon.

As the space race, and consequently funding, starts to wane, missions are dictated by money. Everything sent into space requires a cost-benefit analysis. For many of the early missions, cameras were large and expensive and therefore considered unnecessary. Yet, cameras are the singular instrument that captured people's hearts. Pyle explains that the presence of a camera on a spacecraft was evidence that someone (usually at the Center of the Universe) had won a difficult fight with NASA to get it included. It was first realized in 1965 that a special once-every-175-years planetary alignment of the outer planets would happen in the late 1970s, allowing for flybys of each of the outer planets. A grand tour was proposed and quickly rejected because of its expense. However, NASA quickly learned the wisdom of proposing smaller projects and then adding on later. They used this technique to eventually approve and fund the grand tour and the ongoing interstellar mission of the two Voyager spacecraft. Similarly, other missions such as Cassini (at Saturn) and the Spirit and Opportunity rovers (on Mars) were extended years past their original mission plans using the same à la carte idea.

In addition to covering the missions that did happen, Pyle covers several missions that didn't happen. Several of these got well past the initial planning stages. These asides help provide insight to what could be possible in the future. Furthermore, every few chapters Pyle connects the missions of the past to future missions with a "Flashforward." These include:

- missions to look for frozen water on the lunar surface,
- using a fleet of miniaturized satellites, "cube sats", to improve communication at Mars,
- private entities landing rovers on the Moon,
- generating O_2 on the surface of Mars,
- future robots utilizing steam-powered machinery rather than advanced technology for a landing on Venus and other extreme environments,
- nano-probes accelerated with lasers destined to go interstellar distances.

In addition to these flashforwards peppered throughout the book, the penultimate chapter provides an annotated list of projects to look for in the next few years. Although the space age started as an international competition, it is now progressing with the help of collaboration.

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