A publication of The Forum on Outreach and Engaging the Public - A forum of the American Physical Society

Vol. 5 No. 1 March 2019

PHYSICS OUTREACH & ENGAGEMENT

Letter from the Chair

If you have even a modicum of interest in following the news, you can't help but come away with the impression that science is under assault. Climate change deniers, anti-vaxxers, and…god forbid…even Flat Earthers, get prominent coverage in highly visible media outlets.

So, what's a good scientist to do? Should you turn inwards towards your fascinating research? Or should you try to engage the public, either by debating science deniers or just spend time talking positively about science in general?

Actually, each of us must answer that question for ourselves, but – given that you're reading this – the odds are that you lean more on the engagement side of the spectrum. And perhaps you're looking for some advice on how to get involved. One way to learn some of the tricks of the trade or just network is to attend the March or April meeting of the American Physical Society, where physicists with an established record of science outreach will be there to share ideas.

The Forum on Outreach & Engaging the Public (FOEP) was formed in 2010 to bring together physicists who are passionate about disseminating knowledge of physics to the general public. We want to ensure that our friends and neighbors are aware of both the ways in which the world around us is governed by physical principles and also of the most interesting and cutting edge physics research. While there are perennial science topics, some have an ebb and flow.

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In this issue

JOIN US

To join FOEP at no cost prior to renewing your APS membership, send an email to membership@aps.org with your request to add FOEP to your membership. Please note that if you currently belong to two or more forums, FOEP will be added at no charge for the remainder of your membership term. On your next membership renewal notice, you will see a Forum subtotal that will include $10 for every Forum membership over two.

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So, what does 2019 bring? Sadly for a nation weary of politics, it brings the start of the 2020 Presidential election. Putting aside any of our individual partisan affiliations, organizations like FOEP and our sister forum Physics and Society (FPS), should work to ensure that public debate on issues with science underpinnings is based on sound scientific principles and data.

If you're not willing to wade into the world of science and society, there are other ways you can connect with the public. FOEP has lined up an exciting slate of invited speakers at both the March and April meetings.

In March, we will hear from Sean Carroll of Caltech, who will be talking about podcasting. Ben Wiehe of MIT will talk about getting involved in Science Festivals. Allison Eck, Digital Editor of the television show NOVA, will be talking about social media and writing for visible websites like hers. Chad Orzel, of Union College and author of *How to Teach Quantum Physics to your Dog*, will talk about how to write a successful book for the public. Finally, Professor Ray Jayawardhana, winner of the 2019 Nicholson Award for his highly successful outreach efforts, will give a lecture entitled "Tough crowd: Reaching beyond the usual science-interested audiences." And, of course, all of them will be available to chat about things beyond their specific lectures. They are all great people to learn from.

In addition, the March Meeting will bring an invited talk by Paula Apsell, senior executive producer of the television show NOVA and recent lifetime Emmy award winner for her science journalism. She will be both giving advice and sharing anecdotes about her experience with over three decades of high visibility science communication.

Science isn't just about learning, it can also be fun. FOEP is sponsoring a science-themed escape room for the March meeting. People can try their wits and science acumen in the escape room designed by Paul Kwiat of the University of Illinois. Will you get the fastest time?

And no March Meeting would be complete without attending the annual FOEP Happy Hour on Tuesday. There you can mingle with other people interested in physics outreach, with conversations

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Don Lincoln
Fermilab

Letter from the Chair, continued

Forum on Outreach and Engaging the Public

FOEP's goal is to increase the public's awareness of physics by providing a forum within APS for the large number of physicists currently involved in a diverse array of outreach and public engagement activities. FOEP fosters the development and dissemination of outreach activities such as blogging, multimedia, video, pop culture, popularizations, press relations, politics, "amateur" and distributed science, science cafes, and public shows and lectures. The Forum organizes and sponsors sessions at the March and April APS meetings and will issue a semiannual newsletter.

APS physics | FOEP FORUM ON OUTREACH & ENGAGING THE PUBLIC

lubricated by an adult beverage or two. It's always great fun.

For the April meeting, Chad Orzel will reprise his presentation on his experiences publishing a book. In addition, we will hear from Clifford Johnson from USC and author of the graphic novel *The Dialogues: Conversations about the Nature of the Universe*, on his experiences with science publication. And finally, we will hear from Elyse Aurbach of the University of Michigan on creating and hosting a successful Science Café. These all promise to be fascinating talks by scientists with an accomplished outreach record.

If you can't make one of the meetings, there are other things you can do. You can always contact me directly if you want ideas or direction. I may not have the answer, but I'll find one for you. Or you could reach out to others on the FOEP executive committee, all of whom have different areas of expertise in physics outreach.

I am writing this in the first few days of January. You will be reading it later than that. But, either way, I hope you will make a resolution to do a little more to help the public learn more about physics. Give a public talk. Start a Science Café. Add fun physics demos to an open house. Write that book you always wanted to write. Start a blog. Make YouTube videos. Write a letter to the editor. Run for office, if you have the stamina for it. Write an article for a public magazine or pen an Op-Ed. Chat with your neighbors, friends, and family. Contact your local public radio. Visit a local school or kindergarten. In short, physics is far too much fun to keep it to yourself. Share it far and wide!

Don Lincoln

Spotlights on Outreach and Engaging the Public with FOEP's 2018 Dwight Nicholson Award Winner

Questions and Answers with FOEP's 2018 Nicholson awardee, Ray Jayawardhana.

Ray Jayawardhana
Cornell University
Dr. Jayawardhana was awarded the Nicholson Medal for outreach "For far-reaching, multi-faceted and impactful contributions as an educator and academic leader, including authoring popular books and articles about physics for adults and children, making frequent public speaking and media appearances, developing innovative outreach programs, and founding the Science Leadership Program."

Q1. How did you get involved in doing outreach and why do you think it is important to do?
Growing up in Sri Lanka, I was active in my school's astronomy club as well as a group called the Young Astronomers' Association. It's through those organizations that I got involved in organizing outreach activities. I also wrote for newspapers from a young age. As an undergraduate at Yale, I wrote for the college newspaper and the science magazine on campus. My lucky break was to get a summer internship at The Economist. After that, I was able to write for various publications during college and graduate school. As a faculty member at Michigan and later at Toronto, I enjoyed organizing a variety of outreach events and activities, including the CoolCosmos campaign that deployed 3,000 ads, with five catchy designs to pique people's curiosity about the universe, inside Toronto's subway cars, buses, and streetcars.

Science, at its best, is a splendid human endeavor, one that enriches us in cultural as well as material ways. So, I think it's incumbent upon us as scientists to share not only our findings and insights, but also the adventures and challenges of the research process with the public at large.

Q2. In your experiences doing outreach, what do you find most rewarding about it and what do you find most difficult?
It is a pleasure to see someone's eyes light up when they learn something new; it is even more rewarding if it makes them think anew about themselves or their world.

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Ray Jayawardhana
Cornell University

Science, at its best, is a splendid human endeavor, one that enriches us in cultural as well as material ways. So, I think it's incumbent upon us as scientists to share not only our findings and insights, but also the adventures and challenges of the research process with the public at large.

In terms of more personal rewards, as a scientist and a writer, I've had the chance to visit places that I could only dream of as a child: from astronomical observatories on the arid mountaintops of Chile to the steamy depths of a South African mine accompanying geochemists to collect groundwater, from the ice fields of Antarctica where we camped out for five frigid weeks gathering meteorites, to the steppes of western Mongolia to watch a total solar eclipse. A few years ago, I even got to experience the thrill of weightlessness on a parabola-hopping aircraft high above the Atlantic.

One challenge is reaching people who have a preconceived notion that science isn't for them. That makes it difficult to open the door to engagement.

Q3. How do you find time to fit outreach in with your research?
It's not always easy for an active researcher to find time to write for a broad audience or to engage in public outreach, but I find it incredibly rewarding. Some of our research papers tend to focus on specific—some might say narrow—albeit interesting questions. Writing for the public gives me a chance to step back a bit, consider the big picture, and pull a number of threads into a compelling story. Outreach activities also provide opportunities for creative thinking and for working together with interested colleagues.

Q4. What advice would you give to others trying to do outreach?
Try to reach beyond the usual science-interested audiences to a broader swath of the public. That's not easy to do, and probably requires creative approaches, persistence and partnerships. It may also help to meet people where they are –physically and mentally– rather than expect them to come to your lecture, pick up your book, etc.
Responses have been adapted in part from *https://gsas.harvard.edu/news/stories/qa-ray-jayawardhana* *and* *http://news.cornell.edu/stories/2018/09/ray-jayawardhana-takes-reins-arts-and-sciences*

Try to reach beyond the usual science-interested audiences to a broader swath of the public.

Dwight Nicholson Medal for Outreach

The Forum on Outreach and Engaging the Public assumes responsibility for this prize. This important APS prize consists of the Nicholson Medal and a certificate that includes the citation for which the recipient has been recognized. The Medal is sponsored by the friends of Dwight Nicholson, and through a generous gift from Professor Herb Berk, the Medal will be awarded with a stipend of $2,000, beginning in Spring 2018. Up to $1,500 will be available for the recipient's travel expenses to the meeting at which the Medal is presented.

The prize shall be awarded to a physicist who either through public lectures and public media, teaching, research, or science related activities has

1. successfully stimulated the interest and involvement of the general public on the progress in physics, or
2. created special opportunities that inspire the scientific development of students or junior colleagues, or has developed programs for students at any level that facilitated positive career choices in physics, or
3. demonstrated a particularly giving and caring relationship as a mentor to students or colleagues, or has succeeded in motivating interest in physics through inspiring educational works.

Full details are at: http://www.aps.org/programs/honors/awards/nicholson.cfm

Nomination deadline is usually June 1.

Contributed by: E. Dan Dahlberg

Know someone who would be deserving of the Nicholson award or worthy of being an APS Fellow? Don't wait!!! Start the nomination process now.

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FOEP Nominations for APS Fellows

What

APS Fellowship constitutes recognition by one's professional peers of exceptional contributions to the physics enterprise. Only a small fraction of the APS members reach the level of fellows and therefore this is an important recognition.

Who

Only APS members who are members of FOEP can be nominated for fellowship through FOEP. The deadline for Fellowship nominations is usually in May. We strive to have a diverse group of nominees and encourage the nomination of members of all underrepresented groups.

How

Nomination is done entirely on-line. Complete instructions for the nomination are available at: http://www.aps.org/programs/honors/fellowships/nominations.cfm.

The process consists of: providing the nominee's contact and professional information, uploading nomination letters documenting the accomplishments of the nominee and explain why he or she is deserving of recognition. Note that it is the responsibility of the nominators to provide a compact however complete nomination.

Evaluation

Nominations are evaluated by the FOEP nomination committee, reviewed by the full APS Fellowship Committee, and finally submitted for approval to the APS Council.

Subject

Outreach is a broad enterprise, spanning academia, industry and national laboratories, as well as freelance professionals such as writers, journalists and bloggers. Outreach activities are often overlooked and undervalued. Thus it is important to think about and propose people who have an exceptional track record in this area.

Why

Nominating someone for APS fellowship takes time; however, it is a great way to emphasize the importance of reaching out to and engaging with the public. At the personal level it is very satisfactory to get recognition from your peers.

Contributed by: Ivan K Schuller

FOEP at the March and April Meetings 2019

MARCH MEETING 2019
BOSTON, MA MARCH 4-8

FOEP Invited Session
E60: Sharing Science: How to Communicate with the public
(http://meetings.aps.org/Meeting/MAR19/Session/E60)
Room BCEC 258A
Tuesday March 5, 2019 8:00AM – 1:00AM

8:00-8:36 **E60.00001 :** Science Blogs and Talking Dogs: Reflections on 17 Years in Social Media
Chad Orzel
In this talk I will discuss lessons learned about physics and science communication in the online world, drawing on my experiences since starting a weblog to discuss physics in 2002. This will include pros and cons of various media, including blogs, Twitter, and Facebook, and a discussion of the opportunities and risks these technologies offer for physicists interested in engaging with a broad public audience.

8:36-9:12 E60.00002: Science News Online: Finding the Signal in the Noise
Invited Speaker: Allison Eck
TBD

9:12-9:48 E60.00003: Adventures in Podcasting
Invited Speaker: Sean Carroll
TBD

9:48-10:24 E60.00004: Science Festivals and Face to Face Communication
Invited Speaker: Ben Wiehe
TBD

10:24-11:00 E60.00005: Tough crowd: Reaching beyond the usual science-interested audiences
Invited Speaker: Ray Jayawardhana
For those involved in science communication and outreach, engaging with audiences who usually do not seek out science events/media/venues presents interesting challenges. I will reflect on those challenges, drawing upon a few attempts to bring science content to unexpected places.

FOEP Sponsored Session (http://meetings.aps.org/Meeting/MAR19/Session/H47)
Room BCEC 213
Tuesday March 5, 2019 2:30 – 4:30

2:30-2:42 H47.00001: Lessons learned from outreach grant administration
James Roche
TBD

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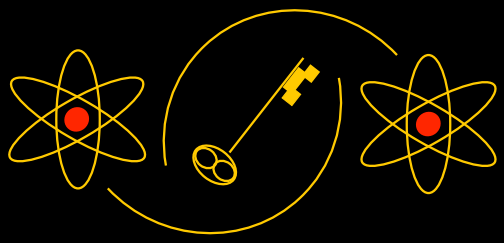
LabEscape

Escape Room *əˈskāp rōōm*

a fun recreational team-building activity in which a group of people are locked into a room, often with some goal, and attempt to escape by solving a sequence of challenging puzzles.

LabEscape: *lab əˈskāp*

the world's first science-based escape room, in which 4-6 intrepid Agents must solve the mind-blowing puzzles hiding the clues needed to complete their mission:
save the world!



LabEscape comes to the APS March meeting! We'll be running 45-min escapes from Saturday to Friday in Boston Convention Center Rm 101, FREE to APS attendees! So assemble a team of Agents, and plan YOUR escape today:

LabEscape.org/APS

PHYSICS ILLINOIS

*"Hands down the **best** escape room I've ever done!"*

Double your exposure by giving an outreach talk in addition to your science talk!

The Forum for Outreach and Engaging the Public will have contributed talk sessions at the March and April meetings. *Importantly, these talks do not count against you, so you can still submit a scientific presentation.* We look forward to hearing about your work!

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2:42-2:54 H47.00002: Physics is for Everyone: How to Market Physics for The Masses
Phoebe Sharp
Marketing science for the general public is challenging. As physics students, we understand the importance and need for science education, so reaching out to those outside of our physics and science communities is a great way to share our curiosity and excitement for how the world works. This summer, I worked on providing accessible and interesting content for patrons of the Physics Central website, a site that works to encourage curiosity in physics through comics, blog posts, and other media outlets. That included writing scientific articles about often overlooked concepts in physics, as well as researching ways to make the website more eye catching and relevant.

2:54 - 3:06 H47.00003: The US Physics Team: Training for competition and building community
Jiajia Dong
Since the founding of the US Physics Team in the mid-1980s, the team coaches have had the mission of selecting and training the top US high school physics students to compete in the annual International Physics Olympiad. Over the decades, the coaches have worked hard to encourage participation from high schools around the nation, to design challenging training materials, and to build a growing community of students who share their curiosity and passion in physics. The bond built through learning physics together remains strong when the students later find their roles in the society such as physicists, engineers, lawyers, and doctors.
Recently celebrating its 30th anniversary, the Team continues to try to broaden its impact, by reaching more students who are not only interested in learning physics, but enthusiastically embrace the challenges of problem-solving, finding efficient, elegant, and insightful solutions, and discovering new physics. We share the story of the US Physics Team, and invite your contribution to the growth of the program.

3:06 - 3:18 H47.00004: LabEscape, A Science-Based Escape Room: Where We Are, and How We Got Here
Paul Kwiat, Ian Call, Eric Hudec, Rebecca Wiltfong
Based on APS seed money, we have set up what we believe is the world's first science-based escape room: LabEscape. By interacting with physics components in the room, participants uncover clues that allow them to solve the mystery of missing quantum physicist Professor Alberta Schrodenberg, and escape! Our goal is to show that science can be useful and accessible (no prior background is assumed), as well as beautiful and even fun! The room is operated by undergraduate STEM students, and most of the puzzles were created by them as well, all based on physics phenomena, including polarization, refraction, induction, lasers, etc. Along the way the Agents directly experience some key aspects of scientific research, and are exposed to basic themes in quantum information. To date we've had nearly 4000 participants, and received near perfect reviews. For more information, see LabEscape.org; to sign up at APS, visit LabEscape.org/APS/.

3:18 - 3:30 H47.00005: LabEscape, A Science-Based Escape Room: Now What
Ian Call, Eric Hudec, Paul G Kwiat, Rebecca Wiltfong
Our science-based escape room has been operating in our local mall for over two years, and although not it's primary goal, LabEscape has been an excellent laboratory for observing group dynamics (we've had ~800 groups go through), the impact of diversity, and the roles of curiosity, communication, and collaboration. We've developed several different scenarios with varying durations and varying degrees of success. We'll discuss what has and hasn't worked, and our efforts to expand to an even wider audience, e.g., in other cities, science centers, etc. One recent addition is the inclusion of a portable version, which we debuted at the August, 2018 AAPT conference, and have now brought to the APS March meeting.
For more information, see LabEscape.org; to sign up at APS, visit LabEscape.org/APS/.

3:30 - 3:42 H47.00006: What's been happening at FunSizePhysics?
Shireen Adenwalla, Jocelyn Bosley, Leigh Smith
www.funsizephysics.com is a website created with the express purpose of advertising exciting new developments in condensed matter physics to the tax paying public. In addition, the website was designed to be a convenient place in which to collaborate on and discuss a variety of outreach efforts. The website is unique in that it incorporates research descriptions written by the researchers themselves for a broad audience, unlike numerous science blogs and/or websites. We describe the ongoing efforts to present current and ongoing NSF-funded research to the public in ways that engage a broader audience of non-experts and to make the website a resource for NSF PIs to develop best practices for outreach activities to K-12 students and the general public. We have also

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embarked on an ambitious program to impact the ability of present and future scientists to communicate with the public, using professional science writers as teachers and modelers for science communication. The ambitious aim is to change how condensed matter physicists communicate with the public.

3:42 - 3:54 H47.00007: Electron Microscopy: Building Nanoscale Knowledge and Community Connections
Sarah Goodman
Electron microscopy (EM) is not only key to solving the greatest challenges we face in the energy sphere, but it can also be a powerful tool for establishing connections between current and aspiring scientists as well as the public. The work of scientists and engineers is often portrayed as complicated and inaccessible, which can alienate the general public and deter students from pursuing the STEM fields, particularly those who don't often see role models like themselves as scientists. Here, I will present the results of three types of community outreach events that used EM to provide both the public and K-12 students an opportunity to engage in the same type of work that researchers do. In two events, the general public was invited to experience EM demos and use the tools themselves, which allowed the process and tools of research become demystified. In another event, a group of middle school students used the transmission electron microscope to image gold nanoparticles at atomic resolution. By including the community in our everyday research activities, we can work towards building trust between scientists and the public to pave the way for stronger science policy in the future

3:54 – 4:06 author not attending H47.00008: Physics for all ages: Texas A&M Physics Show
Tatiana Erukhimova
The Texas A&M Physics Show started in 2007 and has been attended by 22,000 people since then. We offer 40-50 Shows per year. The target audience for the Physics Show is preK-12. The Show lasts 90 min and consists of three parts: 45-60 min Show in the Auditorium, 20 min interactive Hands-on activities in the lobby, and the depth charge outside. Examples of demonstrations that we share with children include clouds, lightning, and magic bubbles, solid air and liquid oxygen, jet propulsion, levitating superconducting trains and flying toilet paper and many more. The presentation is tailored to groups of different ages and "attention spans". We'll discuss pros and cons of starting a similar program and what it takes to run it all year round.

4:06 – 4:18 H47.00009: How to involve citizen scientists in your research
James Freericks
Citizen science is often viewed as crowd science where citizens are employed in labor intensive data collection or in other tedious activities required for complex research. But the advent of MOOCs makes it easy to identify, recruit, and collaborate with talented citizen scientists on any research problem. The MOOC audience provides a highly educated and motivated space to recruit research partners from. I will describe a number of different citizen science projects I have been involved in in the past year which have lead to three publications and a number of ongoing projects. I will illustrate how one can recruit research partners and examine how one can find appropriate projects to collaborate on. Whether you are in need of research collaborators or just assistance in your research projects, recruiting citizen scientists provides a new resource to advance your research agenda. I recommend it as a best practice to everyone. It is a wonderful way to give back to the community, provide broader impacts of your work, and get more research finished.

4:18 – 4:30 H47.00010: Inventing the Future: How to Make Stuff that Can Change the World
Ryan Baumbach
Condensed matter physics and materials science are topics that persistently defy efforts to engage the public imagination. This is despite the fact that modern society thrives due to the development of thousands of new materials that are routine and essential parts of most people's everyday lives. In this talk I will describe progress towards creating video content that is designed to educate and entertain as it tells the story of how a material is conceived, created and embedded into our lives. I will not only present the resulting video, but will also describe the unique collaboration that has led to its production, which involves scientists and science communicators at the National High Magnetic Field Laboratory and filmmakers, actors, and artists at the Florida State University College of Motion Picture Arts. I will present insights gained from this new paradigm for producing science content for public consumption.

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Free beer and snacks for FOEP members at the APS Happy Hour hosted by APS Public Engagement

Every year at March Meeting FOEP in conjunction with the APS Public Engagement Department hosts a happy hour (free drinks!). The goal is to get people at all levels, from undergrads to tenured professors to public engagement professionals, together to talk about their work and to build relationships. The event started as a way to build a community of outreach mini grant recipients but has grown far beyond that. This year's event will be held on Tuesday, March 5th from 5:30-8, location TBD. Stop by the Public Engagement section of APS village to find out more. Last year's event was hosted at Prank Bar and featured great conversations and a few new collaborations. The event draws roughly 75 physics outreach enthusiasts each year. If you are attending 2019's March Meeting be sure to look for information on the happy hour and join us for public engagement make-and-takes, new outreach ideas, and delicious hot wings. If you are looking for collaborators or just a group to geek out on demos with, this is the place.

Double your exposure
by giving an outreach talk
in addition to your science talk!

The Forum for Outreach and Engaging the Public will have contributed talk sessions at the March and April meetings. *Importantly, these talks do not count against you, so you can still submit a scientific presentation.* We look forward to hearing about your work!

quarks Q2C cosmos

APRIL MEETING 2019

April 13-16, 2019 Denver, Colorado

April meeting FOEP sponsored session is: W01. Outreach and Engaging the Public: General, and is described in our Chair's Letter, recapped here: Chad Orzel (experiences publishing a book), Clifford Johnson (experiences with science publication), and Elyse Aurbach (creating and hosting a successful Science Café).

LabEscape, or How to Use Up All One's Available Time and Then Some, to Foster Science Outreach

by: Paul Kwiat, LabEscape Director, Professor of Physics, University of Illinois at Urbana-Champaign

"So, were we at least *close* to escaping?" I queried in my role as the now-deceased Watson.

"Not so much," our host replied.

Moriarty, the archenemy of Sherlock Holmes, had won the day. And thus ended my first attempt at an escape room, this one in Lausanne, Switzerland.

Despite our failure (note to self: don't bring 2 people to an escape room designed for 6!), I had a fabulous time and immediately determined to do better next time, and the time after that, and the time after that! I've now had the opportunity to partake in several such escape games (and by several, I mean 25), in the United States, Europe, and Singapore.

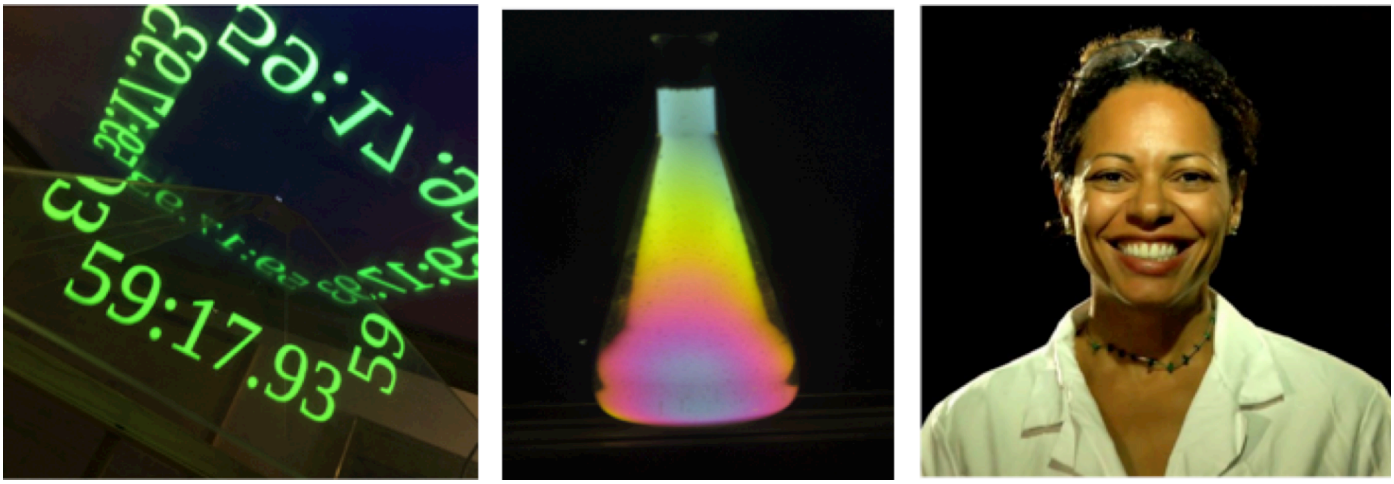

Fig. 1. a) The countdown has begun! b) A beaker filled with ordinary corn syrup becomes an art masterpiece when placed between crossed polarizers. b) The missing Professor S., played by real-life condensed matter physicist Nadya Mason.

In the last few years, a tremendous increase in the prevalence of escape games for recreation—first in Japan, then in Europe, and most recently in the U.S. [https://en.wikipedia.org/wiki/Escape_room]—is a testament to their growing popularity. A group of people are locked[1] in a room and have exactly one hour to locate the key that will allow them to escape. However, the key is locked within a safe whose combination numbers are solutions to puzzles, whose clues in turn are hidden in other locked items, requiring other puzzles be solved, and so on. Different escape rooms provide widely varied experiences—each has its own theme, a backstory explaining the particular challenge, and its own specific puzzles. But all escape rooms have in common a time constraint and challenging puzzles, so that there is both a sense of urgency and a tremendous sense of accomplishment for each puzzle solved—and for successfully beating the game.

[1] In reality, they aren't actually physically locked in—or at least shouldn't be—to prevent horrible fire accidents.

After my first (non)escape, I was—obviously—immediately hooked by the immersive nature of the escape-room experience. But more than that, I had the idea that a science-based escape room would be the perfect venue to expose a larger section of the public to the joys of physics and even scientific research (more on that later). Hence was born LabEscape. Well, not quite so immediately. It took a little time to get some seedling funding (thanks to the APS and also to the University of Illinois College of Engineering for getting us started!), then more time to find and renovate a suitable space, and still more time to design, construct, re-design and re-design again the various puzzles, all the while coming up with a storyline that would be compelling and explain why people are locked up, why there are clues, why there can be hints, etc.

After a couple of months in beta-testing, LabEscape had its official grand opening on January 28, 2017. Situated in Lincoln Square Mall (one of the oldest fully enclosed malls in the country), LabEscape is one mile east of the U of I Physics building, nestled between an art boutique and a game store. We've now had over 4000 'agents' go through, in groups of four to six people, from ages 10–~60 (sometimes it's not polite to ask), attempting to unravel the mystery of Professor Alberta Pauline Schrödenberg.

Professor S., one of the world's leading quantum scientists, disappeared three weeks ago, amidst growing fears that enemy agents were after her latest breakthrough in quantum computing technology, which could lead to a room-temperature quantum processor! Unfortunately, the previous agents sent in to search the Professor's secret lab never came out again—all communication was lost after 60 minutes. Now the newest group of agents (escape-room participants) has to determine what happened to Schrödenberg and the other agents that disappeared—hopefully without disappearing themselves!

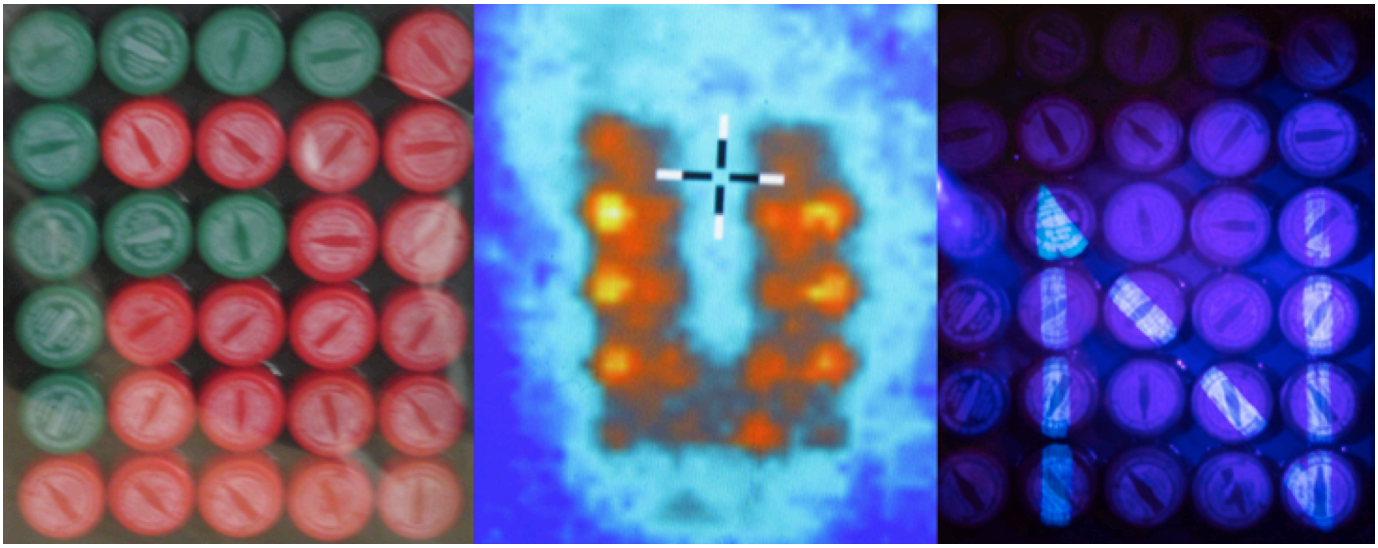

Fig. 2 a). Viewed with visible light, this odd mosaic constructed of bottle caps shows the first letter of a secret code. b) Analysis with an IR camera reveals a different letter, as does c) illumination with an ultraviolet light.

To succeed, they have to solve a series of puzzles based on physics phenomena. Fig. 2 shows one example. In their pre-briefing the agents are given some of Professor S's class notes to look at, which cover things like polarization, light spectrum, etc., all at the junior-high or high-school level, with lots of pictures. In the course of searching the room, the agents find the bottle cap mosaic, an IR thermal imaging camera (awesome!!), and a UV light, plus a message indicating that the code they need is on the cap mosaic, in visible, low-energy and high-energy photons, respectively. Using their newly gained knowledge of the spectrum (which is also available *in* the room, so they don't need to remember anything), clever agents will realize that the mosaic shows three letters depending on whether it's looked at in the visible or IR, or with a

UV light shining on it (for this puzzle we often encourage people to start with the third letter and work backwards, so they don't get stuck with just the first two! ;-)).

Apparently this process of solving physically interactive puzzles (as opposed to logic puzzles or riddles that form the basis of many escape room challenges) is as appealing to the general public as it is to scientists, as we've received nearly all 5-star reviews on various rating sites, with some people claiming that LabEscape is the best escape room they've ever done! We believe this is actually extremely important—our underlying goal is to improve people's perceptions about science, so it's critical that they have a really great time.

Our primary mission is to show people that science doesn't need to be scary, that it can actually be fun, accessible to non-scientists, and even aesthetically beautiful (Fig. 1). By completing their mission, agents also get a taste of what scientific research is like, looking for background information, trying different approaches to solve problems, and finally getting a solution, only to find that it leads to more questions. We emphasize the importance of the three C's: curiosity (being willing to explore, play around with things, push buttons, etc.), communication (exchanging information with fellow agents, so that everyone is clear on what information is relevant for a particular puzzle), and collaboration (both for brainstorming, but also as a good engineering strategy to reduce errors). Obviously, these same three C's are precisely what one needs to be a successful scientist or engineer: a driving curiosity to understand the world and how to improve it, the ability to work with other researchers to solve problems too hard for any one person, and the skill to carefully record progress for the benefit of other researchers and to reach out and engage the public.

Last August, we took a portable version of LabEscape to the annual American Association of Physics Teachers conference, in Washington, D.C. Over the course of 3.5 days we had 34 runs and 187 agents attempt to complete the mission within the allotted 45 minutes. Despite not every group being successful—the success rate was about 33 percent, similar to that of non-scientists in our room back in Urbana)—everyone seemed to have a good time (see Fig. 3), so much so that LabEscape will make another road trip in just a few weeks, this time to the APS March meeting in Boston (yikes—lots to prepare before then!). If you happen to be attending the meeting, please come by and try an escape adventure (FREE to meeting attendees – you can sign up at LabEscape.org/APS). Or if you just happen to be somewhere near Central Illinois and want to try the *original* challenge, please visit LabEscape.org to book your own adventure.

By the summer we anticipate having had ~6000 people go through, which is probably close to 'saturation' for our community of 120,000. After that, we hope to relocate to a larger venue, e.g., a science museum in some metropolitan area—maybe near YOU; please contact us if you have ideas.

Fig. 3 This group of 'agents' at the AAPT August conference was thrilled to have escaped with their physics intuition and honor intact.

Physics at the Movies

by: James Kakalios

I was asked to give a talk last summer at Convergence, an annual science fiction/comics/science convention in the Twin Cities of Minneapolis and St. Paul. The premiere of Marvel Studios' *Avengers: Infinity War* at the start of the summer suggested a title for my talk: "The Physics of the Infinity Stones." This afforded me an opportunity to describe to a general audience one of the most profound theorems in physics, proved by one of the most remarkable minds of the 20th century.

As first described in Jim Starlin's 1990 Marvel comic book *Thanos Quest*, the six Infinity Stones provide those who wield them with control over Mind, Space, Time, Power, Reality, or Soul. Any one of them alone confers indescribable power, while combined, they can make one a god. They are believed to be material manifestations of fundamental aspects of the universe and its physical properties. Superhero movie fans saw Thanos collect all six stones in *Avengers: Infinity War*. We know what the stones are, we know where in the Marvel Cinematic Universe they are, and we know who has them – but we don't know the 'why' of the Infinity Stones. Is there any scientific reason for these stones to exist? For that question we must consult not Thanos, the Mad Titan, nor any celestial being, but rather the early 20th century mathematician Amalie Emmy Noether.

Emmy Noether was one of the most creative mathematicians of her, or any, time. In 1915 unable to resolve a potentially fatal flaw in Albert Einstein's General Theory of Relativity, the mathematicians David Hilbert and Felix Klein asked for Noether's help. What is now known as Noether's Theorem, not only saved Einstein's theory, but it provided a profound insight into the physical universe. And into the Infinity Stones as well.

Emmy Noether proved that the Conservation Laws of Physics (such as Conservation of Energy, Conservation of Momentum, Conservation of Electrical Charge) are direct consequences of symmetries of the physical equations that described the universe. That is, the fact that the equations of physics do not depend on what time one does an experiment is reflected in the Principle of Conservation of Energy, and that the equations look the same regardless of one's location in space yields Conservation of Momentum. In the Marvel Universe, the physical manifestation of these symmetries and conservation principles are the Infinity Stones.

So, the fact that in the Marvel Universe there is a Time Stone implies Conservation of Energy, and there is indeed a corresponding Power Stone (Power being just the rate at which energy can be used). Similarly there is a Space Stone that can be used to teleport from one location to another. While there is no matching Momentum Stone, it is interesting that the Space Stone, when confined within the Tesseract, is the only Infinity Stone that has been weaponized, being employed to energize force beams by Hydra in *Captain America: The First Avenger*. Moreover, [spoilers for a billion dollar blockbuster that has been out for nearly a year] as soon as Thanos posesses the Space stone, Loki tries to stab him in the throat, and his upward thrust is frozen, as if all of his dagger's momentum was removed.

What about the Mind Stone, first seen as part of Loki's scepter in the *Avengers* film and used to control other's thoughts, and now residing in the Vision's forehead? What symmetry is associated with that? All mental processes are the result of ionic currents between neurons, and if one gained mastery over these currents, one could control any brain's functions. The foundation of our understanding of electrical currents is the Principle of the Conservation of Electrical Charge (that the net charge can move from place to place, but can not be created or destroyed). Noether's Theorem informs us that Conservation of Charge reflects the fact that the basic equations of electromagnetism do not change with respect to gauge transformations.

That is, if one shifts the potentials in Maxwell's Equations, the resulting electric and magnetic fields are unchanged, and this insensitivity leads to Conservation of Charge. So even the Mind Stone can be accounted for using the insights provided by Emmy Noether.

Not all symmetries and conservation principles yield a corresponding Infinity Stone (they have to eventually all fit on a single gauntlet, after all). What about the last two Infinity Stones – the Reality and Soul Stones? Here, if we are to ascribe a physics interpretation, we must leave the rigid confines of Noether's theorem, and enter the quantum realm.

Quantum Mechanics, the field of physics that describes the properties of atoms and how they interact with light, is itself a subject of probabilities. One interpretation of these probabilities was put forward by Hugh Everett III who proposed that there are an infinite number of parallel universes and that the probability of a particular quantum event is reflected in the alternate histories and futures of these parallel universes. Many of these parallel Earths are very similar to our own (with perhaps a few notable differences) while others may vary greatly from our world. Presumably the Reality Stone enables whomever wields it to change our Earth to another in the multiverse and is thus the manifestation of the quantum nature of the physical universe.

And for the Soul Stone – well, that would be the conjugate pair to the Reality Stone. It reflects the one aspect of the universe that is not described by the laws of physics. As the physicist and author Sean Carroll has argued, knowing the laws of nature, knowing what *is*, does not inform us how we *ought* to live. One could no more look to a physics textbook for guidance of how we should treat each other, or what constitutes a life well lived, than one could consult a religious tome for insight into the laws of Thermodynamics. If the Reality Stone reflects the physics of multiple possible outcomes, the Soul Stone embodies those outcomes we each choose.

My audience at Convergence realized that I was not really explaining the physics of comic book magical McGuffins, but using the talk as an excuse to tell them about Emmy Noether. They loved hearing about Noether's accomplishments, but groaned when they learned how long this mathematician, described by Albert Einstein as "the most significant mathematical genius thus far produced since the higher education of women began" had to work as a professor at Erlangen and Gottingen without pay due to her gender!

In *Avengers: Infinity War* the combined might of the Avengers, the Guardians of the Galaxy, Dr. Strange, the Black Panther and the warriors of Wakanda and others were called upon to resist Thanos as he gathered the Infinity Stones. As the remaining Avengers assemble in next summer's *Avengers: Endgame* to try to undo the effects of Thanos' "Snappening," (will make sense if you've seen the movie) we can only hope that their resolve is the equal to that of Emmy Noether, who overcame a lifetime of barriers due to religion and gender prejudices, and persevered through her intelligence and will, making the world more understandable, and better.

James Kakalios is the Chair-Elect of the Forum on Outreach and Engaging the Public, and the Taylor Distinguished Professor in the School of Physics and Astronomy at the University of Minnesota. He is the author of several popular science books, including THE PHYSICS OF SUPERHEROES (Avery, 2009) and THE PHYSICS OF EVERYDAY THINGS (Crown, 2017).

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Outreach Info & Resources

APS Physics Central has an "Outreach Guide!"
The guide provides ideas, opportunities, and information on how to conduct various types of outreach.
Check it out! https://www.aps.org/programs/outreach/guide/
And within this guide you'll find information about:

Outreach Ideas
- Physics on the Road
- Public Lectures - One Time
- Public Lectures - Series
- Open Houses
- Science Cafes
- Demo Shows (on campus)
- Working with a Museum

Outreach Tips
- Public Relations
- Working with Children and Schools

Demos List, Experts

The Institute of Physics has a website devoted to Public Engagmeent
This website provides ideas for outreach activities, how to run an event, evaluation of an event or activity, as well as sign ups for events (in the UK).
http://www.iop.org/activity/outreach/
Find out about their 3 minute wonder challenge:
http://www.iop.org/activity/3-minute-wonder/page_60438.html

The Alan Alda Center for Communicating Science
Has many resources, and classes you can sign up for at Stony Brook University. There is a "Workshops on the Road" program that visits other locations. Check out their website for ideas and information.
http://www.centerforcommunicatingscience.org/alan-alda/

Questions and Ideas

Want to get more involved?
Email someone on the executive committee. Contact info can be found on the last page of this newsletter or online at:
The Forum on Outreach and Engaging the Public at
http://www.aps.org/units/foep/governance/officers/index.cfm

Newsworthy Items?
Have an idea for something to include in the Newsletter: An outreach activity, an idea for an article, best practices, what does and doesn't work, or something else? Please send your ideas to the newsletter editor at FOEPAPSnewsletter@gmail.com

Web Sites that Engage and Inform the Public

info

Acapellascience: https://www.youtube.com/user/acapellascience/

ScienceLife: https://www.youtube.com/watch?v=-fk9tkDJ0Pk

Veritasium: https://www.youtube.com/user/1veritasium

Mathologer: https://www.youtube.com/watch?v=YuIIjLr6vUA

Physics Girl: https://www.youtube.com/user/physicswoman

PBS Space Time: https://www.youtube.com/channel/UC7_gcs09iThXybpVgjHZ_7g

Physics Tutorials: https://www.physicsclassroom.com/Physics-Tutorial

Fermilab videos: https://tinyurl.com/drdonvideo

20 best science podcasts: https://www.geekwrapped.com/posts/the-20-best-science-podcasts

APS Physics Central:
Physics in Action, Physics in Pictures, Physics +, Physics@Home, and more
http://www.physicscentral.com

OSA's Optics for Kids website:
Activities, Celebrities, Timelines, and more
http://www.optics4kids.org/home/

IOP Physics.org: http://www.physics.org

NASA Outreach Resources
http://science.nasa.gov/researchers/education-public-outreach/

Expanding your Horizons Network
http://www.eyhn.org/aboutmain

International Particle Physics Outreach Group
http://ippog.org/resources/types/activities

Let FOEP Post Your Outreach Links

Do you have a favorite web site, web article, and or video you like, or perhaps your own outreach website? Send it to us for consideration of inclusion on this page so everyone can enjoy it. Send ideas to: FOEPAPSnewsletter@gmail.com

Funding Information

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APS grants for public outreach and informing the public
APS annually awards several grants up to $10,000 to help APS members develop new physics outreach activities. Programs can be for traditional K-12 audiences or projects for engaging the public.
http://www.aps.org/programs/outreach/grants/

Marsh W. White Awards are made to Society of Physics Students Chapters "to support projects designed to promote interest in physics among students and the general public."
https://www.spsnational.org/awards/marsh-white

SPIE education and outreach grants for photonics and optics
As part of its education outreach mission, SPIE provides support for optics and photonics related education outreach projects.
http://spie.org/education/education-outreach-resources/education-outreach-grants

AAPT - American Association of Physics Teachers
Bauder Fund Grants for Physics Outreach Programs
Can provide funds to obtain and or build and support traveling exhibits of apparatus.
http://www.aapt.org/Programs/grants/bauderfund.cfm

Alfred P. Sloan Foundation
The Alfred P. Sloan Foundation offers grants toward promoting science and science understanding to the general public.
https://sloan.org/grants/apply

IOP Institute of Physics
Public Engagement Grants – open to all but only for projects that take place within the UK and Ireland
https://www.iop.org/about/grants/outreach/page_38843.html

EPS European Physical Society
Two grants that can fall into the outreach category are the EPS grant for Regional Physical Society Meetings that include items outside their usual grant categories, and EPS Award for Pre-University International Physics Competitions.
http://www.eps.org/?page=support_grants

Many institutions have their own internal outreach funding programs.

Contributed by: H.M. Doss

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PHYSICS OUTREACH & ENGAGEMENT

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The Forum on Outreach and Engaging the Public can be found on the web at http://www.aps.org/units/foep/index.cfm