

2016 APS

Conference ^{for}
Undergraduate
Women
Physics

100nm

z=4.0

z=3.0

z=2.0

z=1.0

THE OHIO STATE UNIVERSITY



CUWiP at The Ohio State University

What we hope you'll take away from this conference

The Ohio State University Department of Physics is home to exceptional faculty, postdocs, students, and staff committed to diversity in physics. Gender is one of many axes along which the physics community can become more diverse and inclusive. With the Society for Women in Physics, the Department of Physics, and the Department of Astronomy, the Local Organizing Committee (LOC) looks forward to providing a welcoming environment this weekend to discuss and investigate the roots of diversity issues in physics, to provide support for students in need, and to equip participants with tools to succeed in the field.

The APS Conference for Undergraduate Women in Physics (CUWiP) has personally changed the lives and career trajectories for many of the graduate and postdoc women involved in the organization of this conference. It is now our turn to pay it forward by providing a meaningful experience to the undergraduate participants. Keeping this in mind, the LOC has included speakers, workshops

and panels that not only showcase our passion for physics, but also address the question of what it means to be a woman in a male-dominated field. We are excited to share our stories and offer advice to undergraduates who are overcoming the challenges, whether academic or personal, that we also faced.

Most importantly, we want to remind each attendee that during this conference she will build a strong support network that will extend far past this single weekend and that the skills, relationships, and memories made here will continue to serve her throughout her journey as a physicist.

The OSU Local Organizing Committee:

Jyoti Katoch
Sara Mueller
Lisa Colarosa
Blythe Moreland
Carola Purser

Cover art attributions

Manipulated image of folded nanoparticle scroll (2015)
Xiao-Min Lin et al.
(Argonne National Lab, CC BY-NC-SA 2.0)

Manipulated image of depiction of one of the largest cosmological simulations ever run (2015)
Katrin Heitmann et al.
(Argonne National Lab, CC BY-NC-SA 2.0)

Schematic of Miller indices taken from
"Notes on Crystallography and Crystallo-Physics" (1879)
(The British Library)

Cyanotype of *Cystoseira granulata* taken from
"Photographs of British Algae: Cyanotype Impressions" (1843)
(New York Public Library, The Public Domain Review)

Table of Contents



2 About CUWiP

A word from the Local Organizing Committee

4 Conference program

What's happening: when & where

6 Workshops

Descriptions of the Saturday workshops with suggested resources

8 Speakers

Learn a bit about the people giving talks and sitting on our panels

13 Networking at CUWiP

Opportunities to learn and use networking skills with speakers and panelists

14 FAQs

Commonly asked questions about applying to graduate school and REUs

16 Fields of Physics

Descriptions of the main physics sub-disciplines

18 What to do with a degree in physics

A look at the various paths a physics degree-holder can take and ways to explore those perspectives

20 Psychology and sociology of STEM

Resources and perspectives on stereotype threat and imposter syndrome

24

OSU Local Organizing Committee

Information on the LOC, OSU, and SWiP at OSU

Conference Program

Friday, January 15

- 3:00 pm Conference registration
Lab tour sign-up – departs from the Atrium
- 6:00 pm Welcome address & dinner
- 7:30 pm “The Status of Women in Physics” *Dr. Joan M. Herbers*
- 8:15 pm “How to Network” event with the OSU Society for Women in Physics (SWiP)¹
- 10:00 pm Transportation to Renaissance Hotel

Saturday, January 16

- /// 8:00 am Transportation from Renaissance Hotel
- 8:20 am Breakfast & Registration
- 9:00 am Workshops² *Entering the workforce with a Bachelor’s in Physics* HH 035
..... *Applying to graduate school* PRB 1080
..... *Applying to REUs* PRB 4138
..... *LGBTQ+ roundtable (morning only)* HH 030
..... *Stress and time management (morning only)* HH 031
- 10:30 am Coffee break
- 11:00 am Plenary talk HH 131 *Dr. Kate Kirby*
- /// 11:45 am
- 12:00 pm Lunch & Science Café³
- /// 1:30 pm
- 2:00 pm Conversation with Ginger Kerrick HH 131 *Ginger Kerrick*
Broadcast to all sites
- 3:00 pm Coffee break
- 3:30 pm Workshops² [repeats from morning session]
..... + *Imposter syndrome and stereotype threat training* HH 031
- 5:00 pm Careers in Physics panel HH 131 *Dr. Katherine Aidala*
Moderator: Renee Michelle Goertzen *Dr. Kate Kirby*
..... *Sierra O’Bryan*
..... *Dr. Ruth Pachter*
..... *Dr. Jami Valentine*
..... *Mary Battershell Whalen*

- Physics Research Building (PRB) Atrium
- Hitchcock Hall (HH)
- The Fawcett Center
- Transportation

Saturday, January 16 contd.

- 6:00 pm Plenary talk HH 131 *Dr. Jami Valentine*
- 6:45 pm Group photo
- 7:00 pm Transportation to The Fawcett Center
- 7:30 pm Networking dinner⁴
- 10:00 pm Transportation back to Renaissance Hotel

Sunday, January 17

- 8:00 am Transportation from Renaissance hotel
- 8:20 am Breakfast
- 9:00 am Underrepresented Groups in Physics panel HH 131 *Dr. Beatriz Burrola Gabilondo*
Dr. Elaine Lalanne
Dr. Laura Lopez
Dr. La'Tonia Stiner-Jones
Dr. Jami Valentine
Dr. Desiré Whitmore
Moderator: Rolando Valdés Aguilar
- 10:00 am Plenary talk HH 131 *Dr. Ruth Pachter*
- 10:45 am Coffee break
- 11:15 am Plenary talk HH 131 *Dr. Laura Lopez*
- 12:00 pm Lunch & Poster Session⁵
- 1:30 pm Graduate Student panel HH 131 *Oindree Banerjee*
Anne Benjamin
Robin Bjorkquist
Dante O'Hara
Arati Prakash
Dr. Richelle Teeling-Smith
Moderator: Nancy Santagata
- 3:00 pm Closing remarks
- 3:15 pm Transportation from PRB begins

¹ See page 13 for details

² See page 6-7 for details

^{3,4,5} See packet in registration folder for details

Workshops

Saturday, January 16th

Session 1 9:00 -10:30 am

Session 2 3:30 - 5:00 pm

Stress and Time Management

HH 031

lead by: Denise Deschenes

Psychiatrist

Counseling & Consultation Services

The Ohio State University

This session will provide education about the psychological origins of stress and provide strategies to help manage it. Students will discuss their unique challenges that contribute to increased stress levels. Further, to help balance commitments and maximize efforts, the facilitator will suggest techniques to help students prioritize and manage their time.

Imposter Syndrome & Stereotype Threat Training

HH 031

lead by: Sara Mueller

Physics Graduate Student

The Ohio State University

When you tell someone that you study physics, and they say “Oh wow! You must be so smart!” it’s easy to feel that you might not be cut out for the field. When the feeling that others overestimate your capabilities combines with the societal expectation that women are “bad at science”, it’s hard to know if we fit in. In this workshop we will discuss techniques for dealing with Impostor Syndrome (the worry that other people overestimate your abilities, despite the evidence that you are capable) and Stereotype Threat (the threat of conforming to a negative stereotype).

LGBTQ+ Roundtable

HH 030

lead by: Robin Bjorkquist

Physics Graduate Student

Cornell University &

Fermilab

This will be a discussion session focused on LGBTQ+ issues in physics. We will discuss our experiences as LGBTQ+ people in physics, resources and opportunities for students, as well as changes we would like to see at our universities and in the field as a whole. Everyone is welcome to attend the session, including allies!

Further resources

Physics Today: Singularities Series

LGBT physicists: The Interviews

This Feb 2015 article features several out physicists and their experiences in the workplace.

LGBT+ Physicists

lgbtphysicists.org/

Features several resources for LGBT+ physicists, including an OutList to help out physicists network in the community.

The Ada Initiative

adainitiative.org/

Home to several blog posts and resources for women working in technology, including Imposter Syndrome Training

Entering the Workforce with a Bachelor's Degree in Physics

HH 035

lead by: Renee Michelle Goertzen
Education Programs Manager
American Physical Society

Lindsey Thaler
Director of Undergraduate Studies
The Ohio State University

A Bachelor's degree in physics is a starting-point for a wide variety of careers. This session will have a short presentation on the jobs landscape of the typical physics undergraduate and essential steps for being prepared for the job application process. Then activities will give students a chance to assess their skills and match them to those in job descriptions.

Applying to Graduate School

PRB 1080

lead by: Kris Dunlap
Graduate Studies Program Coordinator
The Ohio State University

Applying to graduate school can be a lengthy and complicated process. Start planning early if this educational track is right for you. This session will have a brief presentation on the components of a graduate school application followed by a Q&A with Kris and graduate students for in-depth advice.

Further resources

Society of Physics Students (SPS)
Careers Toolbox for Physics Students
spsnational.org/careerstoobox

Put together by the national branch of SPS, the AIP, and the National Science Foundation (NSF), this set of resources and exercises is designed for undergraduate physics students who want to enter the science, technology, engineering, and mathematics (STEM) workforce, in particular.

American Institute of Physics (AIP)
Who's Hiring Physics Bachelor's
aip.org/statistics/whos-hiring-physics-bachelors

A state-by-state list of a sample of non-academic employers who have hired physics bachelor's degree holders recently.

Applying to REUs

PRB 4138

lead by: Michelle McCombs
Center for Emergent Materials
Education & Outreach Coordinator
The Ohio State University

The national Research Experience for Undergraduates (REU) program is a prominent opportunity for undergraduates to gain research experience at institutions outside their own during a summer term. This session will give an overview of the REU program and what components make up a successful application and personal statement. The rest of the session will be a writing workshop, which will be relevant for a variety of application processes — to other research programs, for fellowships, etc.

Conference

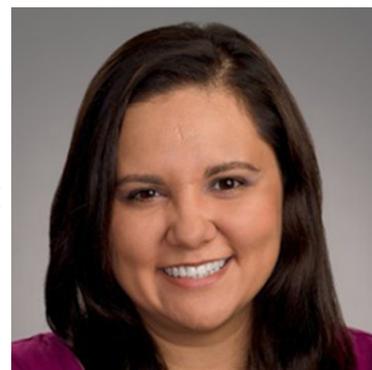


Katherine Aidala is an **Associate Professor of Physics** and the Chair of the Physics Department and Engineering Committee at **Mount Holyoke College**, a liberal arts college in western Massachusetts. She completed her undergraduate degree with a double major in applied physics and psychology at Yale University, and received her PhD in applied physics from Harvard University in 2006. She received the Presidential Early Career Award for Scientists and Engineers in 2010, was named a Cottrell Scholar from 2009, and received the NSF CAREER award in 2010. She teaches a seminar course on Gender in Science, and is the founder and host of SciTech Café, holding monthly events that bring scientists into an informal setting to discuss their work with the general public.

Careers in Physics panel

Beatriz Burrola Gabilondo: I was born in Hermosillo, Sonora, Mexico. I always wanted to be a scientist, though I did not really know what a scientist was. As a young child, I knew some people died because they were very sick and the doctors did not know what medicine to give them, and that other doctors were trying to figure out how to prevent people from dying. I wanted to be one of those other doctors, so growing up I thought I would go to medical school. I have always loved math and biology, and in high school I thought I would study molecular biology. However, participating in Math, Biology, and Physics Olympiads made me realize that I like physics even more. I got my undergraduate degree in Engineering Physics at Monterrey Tech (in Monterrey, Mexico) with minors in Biotechnology and Optical Engineering (lasers!) in December 2002. I did not even know that getting a PhD was an option until the start of my senior year, when one of my professors encouraged me to apply. I applied to several schools in the USA and Germany, and ended up going to the University of Maryland, where I got my doctorate degree in December 2010. My thesis project, on the effect of membrane-binding peptides on the mechanical properties of biological membranes using optical imaging and laser tweezers, was on **the intersection of Physics, Biology, and Optics**. After graduating, I worked as a post-doc at Georgetown University for two years, continuing research on using optical techniques to study the

mechanical properties of biological materials. After that I worked as Preceptor in Physics, which is a kind of teaching post-doc, at Harvard University. There I developed course material and worked closely with students taking the Introductory Physics course for pre-meds. I also developed new labs and mentored teaching assistants. My long-term professional goal was to become a professor at a small liberal arts college, where I could do some research but focus mainly of teaching and mentoring undergraduates, especially those who did not want to become professional physicists. Life intervened, and I got offered a job as a **lecturer at OSU**, which is not a small institution, where I currently work since January 2014. Here, I teach the **Physics by Inquiry** course, a lab-based course aimed at future K-12 teachers that also fulfills the general science requirements for many majors. I also work on outreach and education at the Center for Emergent Materials. I develop instructional materials for the courses I teach, participate in improvement efforts for other courses, and I also do research on education.



Underrepresented Groups in Physics panel

Speakers



Joan M. Herbers is Professor of Evolution, Ecology & Organismal Biology and of Women's, Gender, & Sexuality Studies at The Ohio State University. Trained as an ecologist, she studied the inner workings of ant colonies for most of her academic life. A few years ago, she developed a second career concerned with **gender equity in academia**. She is Principal Investigator of Ohio State's ADVANCE Institutional Transformation Award titled Comprehensive Equity at Ohio State (CEOS) and is author of the recently-published *Part-time on the Tenure track* (John Wiley & Sons). Herbers has served as a department chair and a Dean and also is President Emerita of the Association for Women in Science.

Talk on "The Status of Women in Physics"

Dr. Kate Kirby is the Executive Officer at The American Physical Society. Dr. Kirby earned her bachelor's degree in chemistry and physics from Harvard/Radcliffe College and her PhD from the University of Chicago. After a postdoctoral fellowship at the Harvard College Observatory she was appointed as Research Physicist at the Smithsonian Astrophysical Observatory and Lecturer in the Harvard University Department of Astronomy. From 1988 to 2001, she served as an Associate Director at the Harvard-Smithsonian Center for Astrophysics, heading the Atomic and Molecular Physics Division. From 2001-2007, she served as Director of the Institute for Theoretical Atomic, Molecular and Optical Physics (ITAMP) at Harvard and Smithsonian. In July, 2009 she was appointed Executive Officer of the American Physical Society. Kate served in that capacity until February 2015, when the APS Board of Directors voted to select her as the first Chief Executive Officer (CEO) of APS, effective February 2, 2015.



Dr. Kirby's research interests lie in **theoretical atomic and molecular physics**, particularly the calculation of atomic and molecular processes important in astrophysics and atmospheric physics. She is a Fellow of both APS and AAAS.

Careers in Physics panel

Plenary talk



Dr. Elaine N. Lalanne earned a BA in Physics from Wellesley College in 1994 and a PhD from the joint department of Applied Physics from New Jersey Institute of Technology / Rutgers University-Newark in May 2003. Her current research as a **Physicist** with the **US Navy** encompasses **underwater acoustics and sensors**. Previously, she was a research scientist at UMBC investigating quantum cascade structures and lasers using femtosecond Mid-IR source. Dr. Lalanne has actively supported diversity in STEM by being a recruiter for the NSF-ERC Center for Mid-Infrared Technologies for Health and the Environment (MIRTHE). She has also supervised summer research activities of MIRTHE REU (undergraduate) and RET (high school physics teacher) students during her tenure at UMBC. She is a member of Optical Society of America (OSA), American Physical Society (APS) and National Society of Black Physicists (NSBP).

Underrepresented Groups in Physics panel

Conference



Dr. Laura N. Lopez is an assistant professor in the astronomy department at **The Ohio State University**. Laura earned her bachelor's degree in physics from MIT in 2004, and she received her PhD in astronomy & astrophysics in 2011 from the University of California Santa Cruz. Subsequently, she was a Pappalardo Post-doctoral Fellow in Physics and NASA Einstein Fellow at MIT (2011-2014) and a NASA Hubble Fellow at the Harvard-Smithsonian Center for Astrophysics (2014-2015). Laura joined the faculty at OSU this Fall 2015.

Laura is active on the university and national level to address equity and inclusion in the sciences. In particular, she has served for a decade on the American Astronomical Society's Committee on the Status of Minorities in Astronomy, the primary professional committee charged with improving racial diversity in the space sciences.

Underrepresented Groups in Physics panel
Plenary talk



Sierra O'Bryan is an application developer at **J.P. Morgan Chase & Co.** for a cloud development team. She earned her bachelor degrees in Physics and Mathematics from Thomas More College in 2013, where she worked at the BB&T Observatory studying the orbital properties of binary eclipsing stars. She went on to receive her Master of Science in Physics from The Ohio State University in 2015. She was a member of the Agostini-DiMauro **Ultra-fast Atomic Physics Research Group**. The primary focus of her research was the design of a high energy spectrometer to be used for attosecond physics and high harmonic generation experiments.

Careers in Physics panel



Dr. Ruth Pachter is a member of the scientific and technical cadre of senior executives, appointed in 2001 as a **senior scientist** at the Materials and Manufacturing Directorate, Air Force Research Laboratory, **Wright-Patterson Air Force Base**, Ohio. She joined the Materials Directorate in 1991 from Stanford University, where she conducted research in the biophysics program. In 1994, she was appointed a physical scientist at the National Institute of Standards and Technology, co-located at Wright Laboratory, and in 1997 became a principal physical scientist in AFRL. Dr. Pachter received her undergraduate degree in chemistry and physics from the Hebrew University, Israel, and completed her graduate education in theoretical chemistry at the Technion, Israel Institute of Technology and the University of South Africa. Dr. Pachter's research interests are centered on **computational materials science and engineering methods**, with application to **optical and electronic materials** that address Air Force needs. Dr. Pachter is author and co-author of more than 150 refereed publications and book chapters, including invited articles. She presented more than 70 invited lectures, served on international journal editorial boards, conference program committees and advisory technical committees, was active in professional society communities, and was organizer or co-organizer of numerous national and international symposia and workshops.

Careers in Physics panel
Plenary talk



Speakers



Dr. La'Tonia Stiner-Jones is Assistant Dean of Graduate Programs and Assistant Professor of Practice in Biomedical Engineering at The Ohio State University's College of Engineering. As Assistant Dean her responsibilities include leadership of graduate affairs and professional development for graduate students and postdoctoral trainees for the College of Engineering. She also oversees the strategic recruitment of graduate students with a focus on increasing diversity. In her Assistant Professor role she is responsible for teaching, pursuing extramural funding and participating in service for the Department of Biomedical Engineering.

Dr. Stiner-Jones received her Bachelor's and PhD degrees from Wright State University in Dayton, OH and her MBA from Capital University. After completing her PhD in Biomedical Sciences, she went on to complete two postdocs, one in neuroimmunology and another in psychoneuroimmunology at The Ohio State University. Her work has been published in numerous scientific journals and presented both nationally and internationally. After completing her postdoctoral fellowship, Dr. Stiner-Jones accepted a faculty position in The Ohio State University College of Dentistry where she continued her research, while teaching dental students and served as Director of Minority Recruitment and DENTPATH, a post baccalaureate program to prepare educationally and economically disadvantaged students for matriculation to dental school. She joined the College of Engineering in 2012.

Underrepresented Groups in Physics panel

Dr. Jami Valentine earned her bachelor's degree in physics from Florida A & M University and has a master's degree in physics from Brown University. In 2006 Jami became the first African American woman to earn a Ph.D. in physics from the Johns Hopkins University. At Hopkins she studied the **spin properties of rare earth metals** for applications in magneto-electronic materials and devices. Dr. Valentine joined the **U.S. Patent and Trademark Office (USPTO)** in July 2006. She examines semiconductor patent applications including phase-change memory, nanoscale memory and spintronic devices. She became a **primary examiner** in 2012, and full time tele-commutes to her Washington DC area office from sunny Orlando FL.



In her spare time, she maintains a database of African American women with PhDs in Physics and related fields at AAWIP.com. The goal of the website is to honor the women who paved the way, to inspire future physicists, and to connect with all people interested in promoting diversity in Physics and other STEM fields.

Careers in Physics panel & Underrepresented Groups in Physics panel
Plenary talk



Mary Battershell Whalen has been **teaching physics** for over 20 years. She earned her BS in physics at Penn State and her MEd in Math, Science, and Technology Education from the Ohio State University. She started her teaching career with Teach For America in Arkansas. She taught **Modeling Instruction in High School Physics** summer courses for teachers for 7 years. She is active in the American Association of Physics Teachers and is an AP Physics reader. Currently she teaches physics and AP physics at **Olentangy High School** near Columbus, Ohio.

Careers in Physics panel

Conference Speakers



Dr. Desiré Whitmore began her career preparation as a community college student, where she fell in love with chemistry and physics. After transferring to UCLA and finishing her bachelor's degree in chemical engineering, she went on to graduate school at UC Irvine to earn her master's and doctorate degrees in chemical and material physics. Desiré is an accomplished scientist in **ultrafast optical spectroscopy, attosecond spectroscopy and optical measurements of nanomaterials**. She is currently a **science curriculum developer for the Learning Design Group**, where she is developing a digital science and engineering curriculum for middle school students nationwide.

As a student working full-time, she also conducted frequent exhibits, demonstrations and talks to K-12 students, parents and educators in Southern California. The eldest of 8 children, and the first person in her family to attain higher education, she serves as a role model for her siblings, community and others. She is and has

always been dedicated to mentoring and educating youth, especially those that are underserved in the current education system. She is a founding member and the current mentorship chair of the Council for the Advancement of Black Engineers (CABE), a nonprofit organization dedicated to increasing the number of black engineering PhDs. Her current goal is to become a part of the California science education policy-making process, so that she can influence the decisions that the state makes concerning science and engineering education.

A California girl through and through, Desiré loves the outdoors and can often be found on some hiking trail or at the beach with her puppy, Stella. Currently located in Berkeley, CA, Desiré enjoys the plethora of culture and cuisine found in the Bay Area. She is interested in music (many genres, but mostly jazz and classic rock), cooking, bowling, sewing, softball, and both laser and automobile maintenance.

Underrepresented Groups in Physics panel



Ginger Kerrick, as a child, dreamed of growing up to be either a basketball player or an astronaut. When neither dream came to fruition, Ms. Kerrick developed a fresh perspective – best summed up by the phrase “It just wasn’t meant to be” – and is today part of **NASA**, serving in the **Mission Control Center at the NASA Johnson Space Center as a Flight Director** who has, to date, supported 13 International Space Station and five joint shuttle missions. It was there that Ms. Kerrick, a few years earlier, became the first non-astronaut Capsule Communicator (CapCom), the Flight Control position that relays information from Mission Control to an

astronaut crew. Through her service in Mission Control, Ms. Kerrick shares in the experience of space travel; and while she may not be an astronaut, because of her support “each astronaut [is] taking a little piece of [her] with them.” But, it was only through hard work and perseverance that Ms. Kerrick arrived at this place, because to earn both a bachelor's and a master's degree in physics she first had to win academic scholarships. For Ms. Kerrick, life is an adventure and a fulfillment of her childhood dreams best summed up in her own words: “I have no idea what is next for me, but I trust I will find myself exactly where I am supposed to be!”

Conversation with Ginger Kerrick

Get to know Ginger Kerrick, who earned bachelor's and master's degrees in physics from Texas Tech University and is the first female Hispanic flight director at NASA. She pursued her dream of working at NASA since she was 5 years old. The audience will have an opportunity to learn her story in her own words. Questions will be answered from across all the 2016 CUWiP sites.

Networking at CUWiP

To make the most of this conference, we want participants to be able to interact frequently and comfortably with our assembled guests of intelligent, pioneering, and passionate women in science (including fellow students!). Here is a breakdown of our main networking and discussion events, where we plan for you to get to know more about other students and professionals in science. By the end, you'll be using your coffee breaks like a pro.

"How to Network" event with OSU Society for Women in Physics

An evening of fun and games put on by OSU's student improvisation group, Fishbowl, with participants from OSU SWiP. In small groups, Fishbowl will lead a variety of improv activities geared towards having fun, getting comfortable in a new environment, and hopefully fostering new connections between our CUWiP participants. Relax, make some friends, and have a laugh or two!

The ability to network, or make and build connections with others, has much in common with the ability to improvise. Reading audience cues and body language, staying at ease in a new situation with limited knowledge of your audience, and building off of what others bring to the table, all serve well to make a lasting impression in a limited amount of time. Practicing these techniques, one can effectively communicate, foster connections, and engage with others - be it an audience of one or many.



Science Café

This is an opportunity to have a casual lunch discussion with faculty and students who are active in academic research. The PRB atrium will be divided up based on research areas. Please take a look at the Science Café packet in your registration folder for details on what the speakers study. Ask about how they got interested in their field, what a typical day in their lab is like, or where they see their research going in the future. Feel free to move around to other tables if you see an opening!



Networking dinner

Our networking dinner is a chance to hear from professionals with science backgrounds in a wide range of job sectors. This is an opportunity to see how a physics or science education was just the starting place for developing critical thinking, curiosity, and identifying interests and passions. The banquet hall will have a set of tables with a speaker(s) assigned to each one. Take a look at your Networking Dinner packet for details on each speaker. Sign-up for a seat at a table you're interested in on the seating chart posted in each lobby. After the main dinner course, feel free to mingle at other tables. Ask how people ended up in their job, what advice they would give to their younger selves, what their typical day is like, or what they like most about their job—whatever is important to you!



Applying to Graduate School

Master's degrees & PhDs (Doctor of Philosophy)

Graduate programs typically last two (Master's) to six years (PhD) and expose students to an advanced physics curriculum, teaching experience, and extensive research that culminates in a thesis project.

- 1 **Why go to graduate school?**
Graduate school offers unique research opportunities, a chance to develop skills that make certain career options available that may otherwise be inaccessible, and represents a major intellectual achievement.
- 2 **How does funding work?**
PhD students in Physics/Astronomy programs will usually have their tuition *and* stipend funded through some combination of support offered by their department (such as a Graduate Teaching Assistant or Graduate Research Assistant appointment, or fellowship).
- 3 **What is important about my GPA?**
Higher is, of course, better! But typically a B+ or better in physics and math classes is expected. If you had a bad or low GPA semester, it is important to address that in your personal statement. Write about what you learned from that. Reviewers are looking for realistic self-appraisal and maturity.
- 4 **How do I effectively describe my research?**
Include all your research experience in your résumé. Be specific and give details about the research you have done. This is what Physics professors most want to read about. Mention equipment, programs, or programming languages you used and what you may have learned. It's great if your research contributed to a publication but certainly not necessary as an undergraduate.
- 5 **How do I choose schools to apply to?**
A website like gradschoolshopper.com is particularly good for those interested in the physical sciences. It's run by the American Institute of Physics (AIP) to help you sort through schools on a variety of axes. Also ask professors in your department where you should consider applying.
- 6 **What is important about the GRE/Physics GRE?**
Schools and professors vary widely in how much weight to put on standardized tests, therefore it is important to check different schools webpages for information about what their requirements are. Is a minimum score required? Is an average score noted? Are scores considered holistically in context with the rest of the application? If you feel your scores are lower than schools are looking for, then address that in your personal statement.
● Case Western Reserve University offers free GRE flashcards
phys.cwru.edu/flashcards/.....
- 7 **How can I stand out in my personal statement?**
Committees want to read about your background and interest in the field you are applying to. Do your research about each school! Mention the school by name and names of professors whose research you are interested in. Instead of discussing your childhood fascination with how the world works, show how you feel about science now. And if you come from a small school that may not be well known, provide context for your physics preparation by mentioning textbooks and research project coursework.
- 8 **Who should I ask for a letter of recommendation?**
Letters from professors you did research with are preferred. If you did an REU but didn't see much of the professor, do not let that stop you from asking. Include the graduate student, staff or post doc person you worked with the most closely when you contact the professor. After that, letter(s) from a research advisor are the second best option, and third are letters from academic professors that you only knew from classes.

When you ask for a letter of recommendation...

- Include your résumé with your request
- Include dates and details of interaction to make writing the letter easy
- Include information of all the schools you are applying to

Applying to REUs

What is a Research Experience for Undergraduates (REU)?

REUs are just one kind of summer research internship (and typically pay a stipend), are hosted by universities and institutions around the country, and are funded by the National Science Foundation.

1 Am I eligible?

Most programs require that you are a US citizen or permanent resident.

2 How do I choose which schools to apply to?

Look for programs that match your interests, since there will likely be several that would fit, you can also start by choosing a location where you would like to spend the summer. Keep in mind that the more desirable locations will be more competitive.

3 How do I make myself stand out in my personal statement?

Emphasize any previous relevant research experience.

- If you don't have research experience, you can mention research projects in courses, or educational/work/volunteer experiences that motivated you to seek out this research opportunity.

4 How do I construct a resumé/CV?

Each university should have resources on campus that can help with discipline-specific resúmes/CVs. Also, check with peers and disciplinary clubs as they may have workshops specifically for creating a CV/resumé.

5 How do I ask for a good letter of recommendation?

Ask faculty (not TAs) from your STEM courses, specifically those relevant to the program to which you are applying. When you ask them, have ready a list of programs and contact information to which the letter will be sent, a copy of your transcripts, CV/resumé, personal statement, and one or two other writing samples. This is likely more information than they will need, but they will have everything in front of them when they write your letter.

6 What other resources are helpful?

- More tips on applying to REUs:
Astrobits: "So you want to apply to an REU... here's how" astrobits.org
Grand Valley State University: "Tips for Submitting a Competitive REU Application"
- Searching for REUs and other research opportunities:
National Science Foundation: List of REUs by discipline, state nsf.gov/crssprgm/reu/reu_search.jsp
Pathways to Science: Searchable list of summer research opportunities including REUs pathwaystoscience.org/undergrads.aspx

Journal of Young Investigators (JYI)

JYI keeps a page of summer research programs with citizenship requirements listed jyi.org/summer-research-programs/

National labs also host a variety of summer programs, usually including ones open to international students

How do I address academic issues?

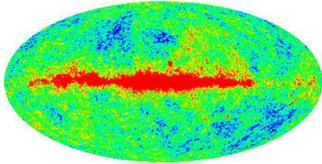
Add 1-2 sentences in your personal statement addressing academic issues.

Physics Today document templates

For a start, you can look at job document examples at physicstoday.org/jobs/document-templates

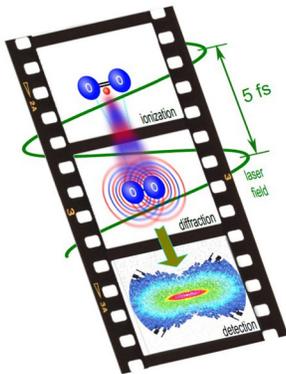
Fields of Physics

An overview of the variety of questions and phenomena that are typically explored in the primary physics sub-disciplines.



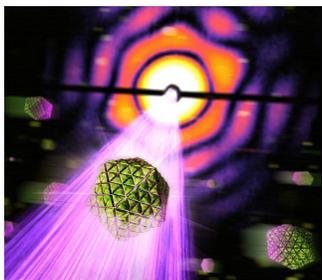
Astrophysics

Astrophysicists characterize and model celestial objects such as stars, planets, supernovae, and galaxies. From them we have discoveries of planets outside our solar system, the various life cycles of stars, and our theories of black holes. Cosmologists consider physics at the largest scales, including the structure and makeup of the universe as a whole in the past, present, and future. They map the background radiation left over from the Big Bang, and address the unknowns of the most abundant forms of energy in our universe, known as dark matter and dark energy.



Atomic, Molecular, & Optical (AMO) Physics

AMO physicists are interested in the interactions among atoms, molecules, electrons, and light. Many develop and use lasers to probe and manipulate matter with extremely short or intense pulses of light. A laser producing a pulse that lasts a femtosecond (10^{-15} s) can, for example, be used to explore the dynamics of chemical reactions. Some AMO physicists use lasers to cool down matter to “ultracold” temperatures (on the order of one one-millionth of a degree Kelvin) while others explore quantum phenomena by creating systems of single atoms and molecules.



Biophysics

While biophysics *departments* may have only arisen fairly recently, physicists have been making contributions to questions about biological phenomena for decades. Biophysicists look for patterns and the fundamental physics that underlie complex biological systems, often collaborating with scientists in the life sciences. Biophysicists have looked at the forces experienced by DNA during a cell’s life cycle, the predicted structures of folded proteins, and the micro-manipulation of individual cells.



Condensed Matter (CM) Physics

Condensed matter physicists investigate and model phenomena in liquids and solids. Through a variety of methods, these physicists design and characterize materials with unique properties, often motivated by a vast array of technological applications. They have discovered semiconductors, superconductors and 2D materials with extremely interesting electrical and optical properties. They also develop theories to describe systems of many interacting particles and exotic states of matter. “Soft matter” physicists focus on materials with interesting properties at meso- and macroscopic scales, including liquid crystals and self-assembled systems of suspended particles.

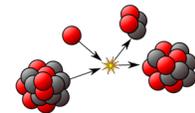
High energy physicists (or particle physicists) are concerned with the subatomic constituents of matter and energy. They formulated what is known as the “particle zoo”: an ongoing catalog of quarks, leptons, and the particles that mediate the forces of physics. The experimental touchstone of HEP is the Large Hadron Collider, an experiment operated and analyzed by thousands of physicists, but many other experiments (including naturally-occurring astrophysical processes that act like particle accelerators) also provide data against which theories of particle interactions and (maybe) string theory may be tested.

High Energy Physics (HEP)



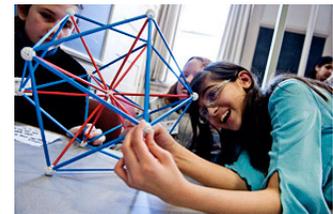
At length scales that are just slightly larger than those typically involved in HEP physics, nuclear physicists look at the interactions among the constituents of nuclei. Probing quarks and gluons, nuclear physicists develop models for strongly interacting systems of particles. Nuclear physics research also encompasses the response of nuclei to various electromagnetic stimuli. In particular, this has led to the development of important medical imaging technology such as positron emission tomography (PET). Understanding how the nucleus is held together also drives advances in nuclear energy technology.

Nuclear Physics



Physics education research (PER) develops tools for measuring and analyzing physics understanding in students, and theories and techniques for improving how students learn physics. Physicists in this area bring their understanding of physics concepts at all levels of education, and analytical skills, to enrich instructional programs and develop observational, survey, and test techniques to study learning and group dynamics in a classroom. Over the last few decades PER has emerged as a sub-discipline with a distinct perspective within education research and an essential role to play in strengthening physics departments.

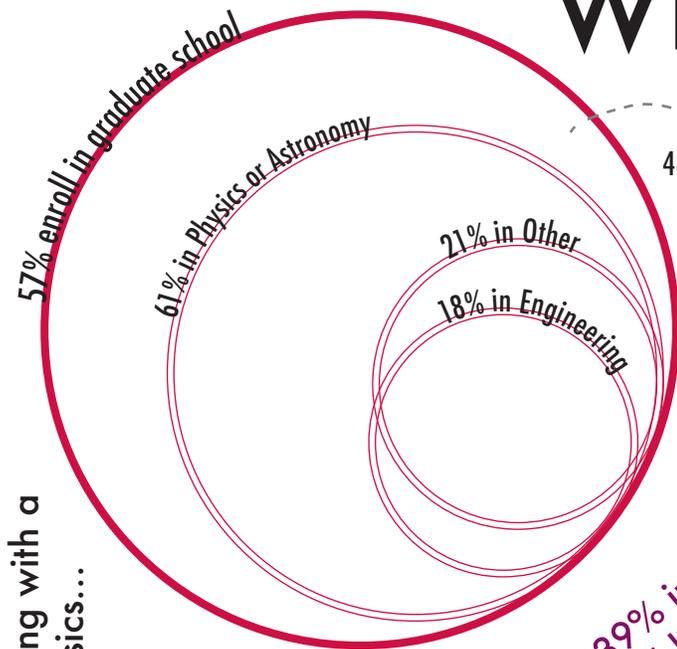
Physics Education



Experiment & Theory

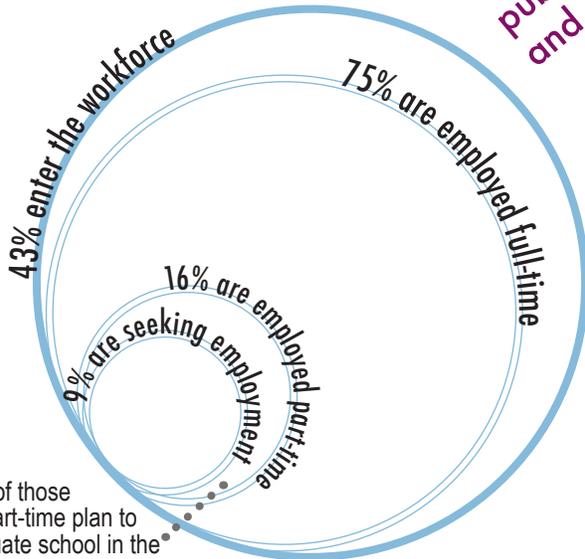
Most physics sub-disciplines use designations for “experimental” and “theoretical” physicists. Day to day work in experimental and theoretical physics typically involves different skills or addresses different problems within a given subject area. Developing mathematical models of physical systems and performing calculations and derivations by hand, or with a computer, are often associated with theoretical physics. Preparing and controlling physical systems with various instruments and developing, engineering, and operating means of observation and measurement are the essential elements of experimental physics.

What can you do...



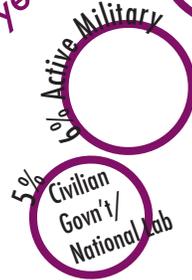
48.6% The percentage of Physics & Astronomy PhD students who complete their degree within 7 years

Within a year of graduating with a Bachelor's degree in physics...

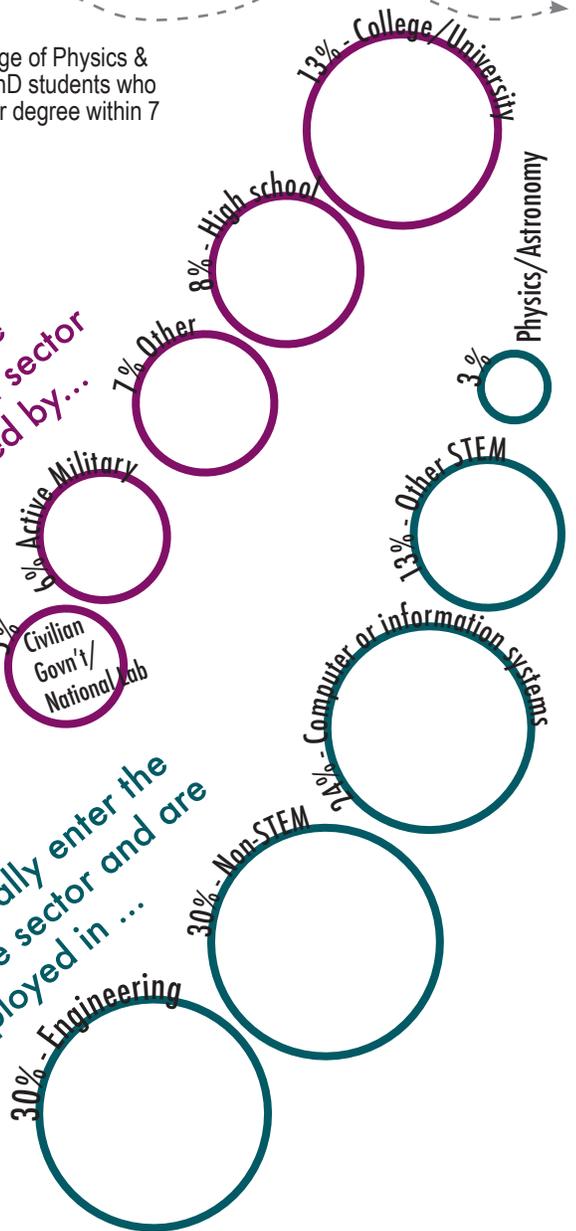


Almost half of those employed part-time plan to attend graduate school in the future

39% initially enter the public or non-profit sector and are employed by...



61% initially enter the private sector and are employed in ...



Physics Professional Societies

American Physical Society (APS) is an organization of professional physicists. Membership has many benefits, and undergraduate students are eligible for a free first-year of membership and are not charged fees for attending meetings. aps.org

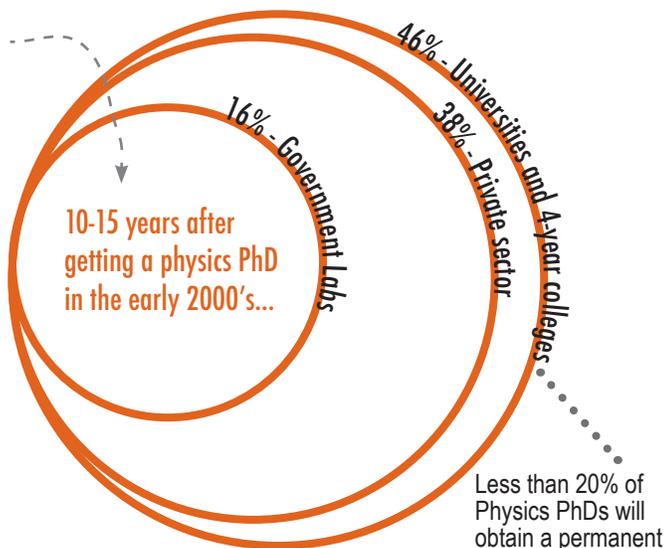
American Institute of Physics (AIP) keeps a list of companies that have recently hired Physics Bachelor's Degree holders. Since 60% of physics graduates go into the private sector, this list may be helpful for narrowing the job hunt. Few professional physicists have the title. Instead, many are called "Engineer", "Lab Assistant", "Technician", or "Analyst", so don't dismay if you can't find any "physics" jobs. aip.org

Science careers in general

Science and **Nature** magazines also carry a Careers section of their website which provides vast resources in career selection and development. From graduate program searches to general advice, ScienceCareers is a good launching point if you're asking "what can I do next?". NatureJobs features articles on different jobs that may not be visible in an academic environment.

sciencecareers.sciencemag.org
nature.com/naturejobs/science/

...with a degree in physics?



The private sector will most likely continue to support an increasing percentage of Physics PhDs

Less than 20% of Physics PhDs will obtain a permanent position at a 4-year college or university

Sources

AIP reports on...

Physics Bachelor's One Year After Degree, 2011-2012 (2014)

Physics Bachelor's Initial Employment, 2011-2012 (2014)

Common Careers of Physicists in the Private Sector:

Physicists educated in the U.S. 10-15 years earlier (2015)

aip.org/statistics

Council of Graduate Schools' PhD Completion Project

phdcompletion.org

Data science/Informatics/Finance

Your extensive math and logic training in a physics program is also incredibly useful in analyzing data sets for many different fields. Many students go on to find work in finance, computing, or informatics.

Insight Data Science:
From PhD to Data Scientist

insightdatascience.com/blog/

Occam's Typewriter

occamstypewriter.org/

Plus Magazine:
Physical Finance

plus.maths.org/content/physical-finance

Science writing/communication

Communication skills are vital for understanding the physical world. If you can explain something simply and clearly, and enjoy learning what's on the cutting edge of science, then journalism might be for you.

Council for the Advancement
of Science Writing casw.org

Discover Magazine:
"On the Origin of Science Writers" discovermagazine.org

National Association of
Science Writers nasw.org

Science policy

By working with science advocates, you can make a difference in how science and politics interact.

NatureJobs:

Making the Move Into Science Policy

American Association for the
Advancement of Science aaas.org

Union of Concerned Scientists ucsusa.org/

Patents/Intellectual Property

Assess cutting-edge science and technology while working in state and federal governments, companies, and other non-governmental entities.

Imperial College London: imperial.ac.uk
"From physics to law"

ScienceCareers:

"In Person: A Career in Biotech Patent Law"

Academia/Teaching

Don't forget the instructors and educators you may have had who inspired and challenged you. Here are resources for aspiring physics teachers at all levels.

American Association of
Physics Teachers aapt.org/

Physics Teacher Education Coalition phystec.org/

The Chronicle of Higher
Education chronicle.com/

MYTHBUSTERS

IMPLICIT BIAS EDITION

CLEARING UP THE CONFUSION SURROUNDING IMPLICIT BIAS

What is Implicit Bias?

MYTH: Implicit bias is nothing more than beliefs people choose not to tell others. They know how they feel; they just know they cannot or should not say those beliefs aloud, so they hide them.

BUSTED

Implicit bias differs from suppressed thoughts that individuals may conceal for social desirability purposes. **Implicit biases are activated involuntarily and beyond our awareness or intentional control.** Implicit bias is concerned with unconscious cognition that influences understanding, actions, and decisions, whereas individuals who may choose not to share their beliefs due to social desirability inclinations are consciously making this determination.

MYTH: Implicit bias is nothing more than stereotyping.

BUSTED

Implicit biases and stereotyping are closely related concepts that can be easily confused. Both implicit biases and stereotypes are types of asso-

ciations that can be positive and negative. While it is true that implicit associations may form as a result of exposure to persistent stereotypes, **implicit bias goes beyond stereotyping to include favorable or unfavorable evaluations toward groups of people.** Additionally, implicit biases are activated involuntarily, whereas stereotyping may be a deliberate process of which you are consciously aware.

MYTH: Having implicit biases makes me a bad person.

BUSTED

Bias is a natural phenomenon in that our brains are constantly forming automatic associations as a way to better and more efficiently understand the world around us. **No one is a “bad” person for harboring implicit biases; these are normal human processes that occur on an unconscious level.** Some implicit biases are even positive in nature. In terms of the existence of unwanted, negative implicit biases, fortunately our brains are malleable, thus giving us the capacity to mitigate their effect through research-based debiasing strategies.

How Does It Operate?

MYTH: I am not biased; I have diverse friends and I believe in equal treatment.

BUSTED

Actually, we all have **implicit biases**. Research shows that all individuals are susceptible to harnessing implicit associations about others based on characteristics like race, skin tone, income, sex, and even attributes like weight, and accents. Unfortunately, these associations can even go as far as to affect our behavior towards others, even if we want to treat all people equally or genuinely believe we are egalitarian.

MYTH: I am fully aware of my thoughts and actions, and I make all of my decisions based on facts and evidence; therefore, implicit bias does not affect my behavior.

BUSTED

By their very nature, implicit biases operate outside of our conscious awareness. Thus, it is possible that your thoughts and actions are

being influenced by implicit associations beyond your recognition. **In fact, researchers have found that sometimes implicit associations can more accurately predict behavior than explicit beliefs and thoughts.**

MYTH: I'm Black; I can't have bias against Black people. I'm also a woman, so it does not make sense that I would have implicit biases against my own sex.

BUSTED

Researchers have discovered that many Americans, regardless of race, display a pro-White/anti-Black bias on the Implicit Association Test. Similarly, some research has documented the prevalence of pro-male/anti-female implicit biases in both men and women. **This occurs because implicit biases are robust and pervasive affecting all individuals**, even children. We are all exposed to direct and indirect messages throughout the course of our lifetime that can implicitly influence our thoughts and evaluations of others.

What Can We Do About It?

MYTH: If bias is natural, there is obviously nothing we can do about it.

BUSTED

Just because bias is a natural tendency does not mean that we are helpless to combat it. Indeed, **unwanted implicit biases can be mitigated**. Researchers have demonstrated the efficacy of various intervention strategies, such as intergroup contact, perspective-taking, and exposure to counter-stereotypical exemplars. By taking the time to understand your personal biases, you can begin to mitigate their effects.

MYTH: It's a waste of time to try to mitigate my implicit biases. They do not impact anyone anyways.

BUSTED

Extensive research has documented the real-world effects of implicit biases in the realms of health care, criminal justice, education, employment, and housing, among others. For example, implicit biases can affect the quality of care a patient receives, the level of encouragement students receive from their teachers, whether or not an individual receives an interview or promotion, and more. **Implicit biases have huge implications**; thus, it is important to identify your own biases and then actively engage in debiasing techniques to address them.

“ [Stereotype threat is] the idea that in a situation where a relevant negative stereotype about your group exists, you worry about confirming that negative stereotype, and this makes your performance worse. ”

Stereotype Threat Stereotype Threat Stereotype Threat Stereotype Threat

Erika Cule

When I took my GCSE science exams, sometimes the questions were set in the context of an experiment.

John and Sarah are investigating the effect of temperature on the rate of photosynthesis.

or

A physicist was investigating this or that phenomenon.

I used to notice how the individuals who featured in these questions were scrupulously gender-balanced.

An engineer has been consulted about the design of a bridge. She has the following concerns...

That I noticed this at all says something, I suppose, about stereotypes and about women and career choices. I never thought a huge amount of it. I certainly didn't think that the gender of these characters, mentioned in passing, could affect exam performance.

I was reminded of this phenomenon, when I was listening to the All in The Mind podcast this week. (All In The Mind is a BBC Radio 4 "programme exploring the limits and potential of the human mind"). From about 16 min 30 s into the programme, Claudia Hammond interviews Jessica Good, a PhD student in the psychology department at Rutgers University, about her paper "The effects of gender stereotypic and counter-stereotypic textbook images on science performance."

Good explains that science textbooks that contain photographs are more likely to portray scientists as male than as female. Where women are featured, they are more likely to be portrayed in lower status roles – the male doctor and the female nurse; the male scientist and the female assistant. Sound familiar?

Good presented high school students with some pages of a chemistry text book to study. The students then took a comprehension test evaluating their learning and understanding. Unbeknown to the students, they had been given one of three versions of the text. In one version, the scientists in the photographs accompanying the text were male, in another the

scientists were female, and in the third photographs of both men and women were used. The hypothesis, confirmed by the study, was that female students would perform better when the photographs accompanying the text they had read were of female scientists. Male students performed better when the photographs were of males. When the photographs were of male and female scientists, there was no difference between the performance of male and of female students in the comprehension test.

Good relates this result to a phenomenon termed Stereotype Threat – the idea that in a situation where a relevant negative stereotype about your group exists, you worry about confirming that negative stereotype, and this makes your performance worse. She points out that students did not always remember the gender of the scientists in the photographs, but that their performance was nonetheless affected.

Good does not claim that making science textbooks more gender balanced would eliminate the gender gap in performance. However, as her study found that the gender of the scientists in the images does have some effect on student performance, she suggests that using mixed-gender images might contribute positively to reducing this gap.

I wonder whether we hope that science text books produced in recent years are more likely to portray scientists as women, compared to books produced longer ago.

This study made me wonder, whether the gender balance in exam questions is deliberately chosen with this phenomenon in mind? Would it be feasible to conduct this study on a country-wide scale? Print three versions of GCSE exam papers, with questions featuring either John and James, John and Sarah, or Sarah and Sue, and see whether this had an effect on student performance.

Maybe not, but anyway, I agree with Good's conclusion.

Although eliminating gender bias in textbooks will most likely not eradicate the gender gap in science interest and achievement, it will begin to chip away at an ever-crumbing foundation.

Blogging Beyond

Blog: Blogging the PhD and Beyond

Erika Cule is a statistician working in industry. Her blog, *Blogging the PhD and Beyond*, documents her graduate student experience at Imperial College London, and what happened next. The views expressed here are her own.

Erika embraces interdisciplinary ways of working, and has studied Biochemistry, Bioinformatics and Theoretical Systems Biology, Statistical Genetics and Statistics.

Erika started blogging after her essay, Birthday Surprises, won the Imperial College Science Challenge in 2008 and went on to be published in Nature Futures and to win the Daily Telegraph/Bayer Science Writer competition. You can also find Erika's writing on Occam's Corner, part of The Guardian Science Blogs.

When Erika is not doing or writing about science she likes, among other things, to swim, both inside and out.

Republished under Creative Commons Attribution 3.0 Unported License

Good JJ, Woodzicka JA, & Wingfield LC (2010). The effects of gender stereotypic and counter-stereotypic textbook images on science performance. *The Journal of Social Psychology*, 150 (2), 132-47 PMID: 20397590

OSU LOC



1

2

3

4

5

1. Jyoti Katoch is a post-doctoral researcher at The Ohio State University. She received her PhD in 2014 from the University of Central Florida, where she founded and served as president of the Physics Women Society. While at UCF, she was the recipient of the Provost's Graduate Fellowship for two consecutive years. Her research focus is on investigating the electronic and spintronic properties of novel two-dimensional materials using surface science techniques and charge/spin transport measurements. She is a supporter of gender equality and diversity in the workplace. In her spare time she likes to cook food and read novels.

3. Lisa Colarosa graduated in 2009 from OSU with a bachelor's in Engineering Physics, specialization in Aerospace Engineering. After she decided not to pursue the field further, she began her position as Program Coordinator for the OSU Center for Cosmology and AstroParticle Physics (CCAPP), a research team operated jointly between the Departments of Physics and Astronomy (ccapp.osu.edu).

5. Carola Purser received her bachelor's degree in physics from Harvey Mudd College, and she now studies nanoscale, magnetic phenomena using diamond fluorescence with Dr. Chris Hammel as a Ph.D. candidate in the Ohio State University Department of Physics. Her early interest in formal scientific investigations became serious after she completed her first high school internship at NASA Goddard Space Flight Center. Carola is passionate about diversity in STEM, serves as SWiP secretary at OSU, and is happy to have contributed to this year's CUWiP!

2. Sara Mueller earned her Bachelor's of Science in Physics at Colorado State University and is now a third year graduate student studying 2-dimensional semiconductors and magnetism with Prof. Roland Kawakami at The Ohio State University. She decided to go to graduate school after taking a year off, working in a condensed matter lab where she helped to build a new kind of cryogenic system. She's passionate about diversity in science and currently holds the Graduate Co-Chair position for OSU's Society for Women in Physics. When she isn't learning physics, Sara enjoys knitting, binge-watching Netflix, and collecting dinosaur riff-raff.

4. Blythe Moreland received her Bachelor's degree in Mathematics and Physics from the University of Michigan. After studying the structure of galaxy clusters while at U-M, she transposed her passion for complex systems to the realm of biophysics and is now a graduate student in Prof. Ralf Bundschuh's theory group studying nucleic acids. She indulges her interest in graphic design by making the promotional materials for OSU's Society for Women in Physics as their Publicity Chair, and spends most of her non-physics time baking and listening to podcasts.

For more about OSU and SWiP

Department of Physics at OSU
physics.osu.edu/

The Department of Physics at OSU is home to a great variety of research efforts, made possible by the efforts of 54 faculty, approximately 60 postdoctoral researchers and research scientists, 190 graduate students, and 320 undergraduate majors.

Society for Women in Physics
u.osu.edu/swip/

SWiP supports graduate and undergraduate women through mentoring, outreach opportunities, personal and career development workshops, and social activities.

Art credits

- pg. 1  In the early days of computing, commands and data were formatted for machine input with the use of stiff punch cards, where the pattern of holes represented the information.
 With kloth.net's punch card emulator, we represented "CUWiP" in Digital Equipment Corporation's DEC-029 code
- pg. 3 Plug plate from the Sloan Digital Sky Survey (SDSS), displayed on mezzanine level of the OSU physics department
- pg. 13 "Mercury" and "Implied Motion" - Columbus Museum of Art
"An expanding bubble in space" - NASA's Goddard Space Flight Center (GSFC)
- pg. 16 Cosmic Microwave Background - NASA GSFC, gsfc.nasa.gov
AMO film feel - Lou DiMauro, The Ohio State University, dimauro.osu.edu
Biophysics diffraction - SLAC National Accelerator Laboratory, flickr.com/photos/slaclab
STM image - Jay Gupta, OSU, sites.google.com/site/guptagroupstm/
Particle detector - ATLAS experiment, atlas.ch
Nucleus bombardment - Wikipedia, en.wikipedia.org/wiki/Nuclear_physics
Science education - WPI, wpi.edu/academics/physics/k12.html

Thank you to our gracious sponsors for making CUWiP 2016 at OSU possible!



THE OHIO STATE UNIVERSITY

DEPARTMENT OF PHYSICS



Office of Research



AMERICAN ASTRONOMICAL SOCIETY
Enhancing and sharing humanity's scientific understanding of the universe since 1899.

OFFICE OF RESEARCH

Gender Initiatives in STEM



U.S. DEPARTMENT OF
ENERGY



National Science Foundation
WHERE DISCOVERIES BEGIN

