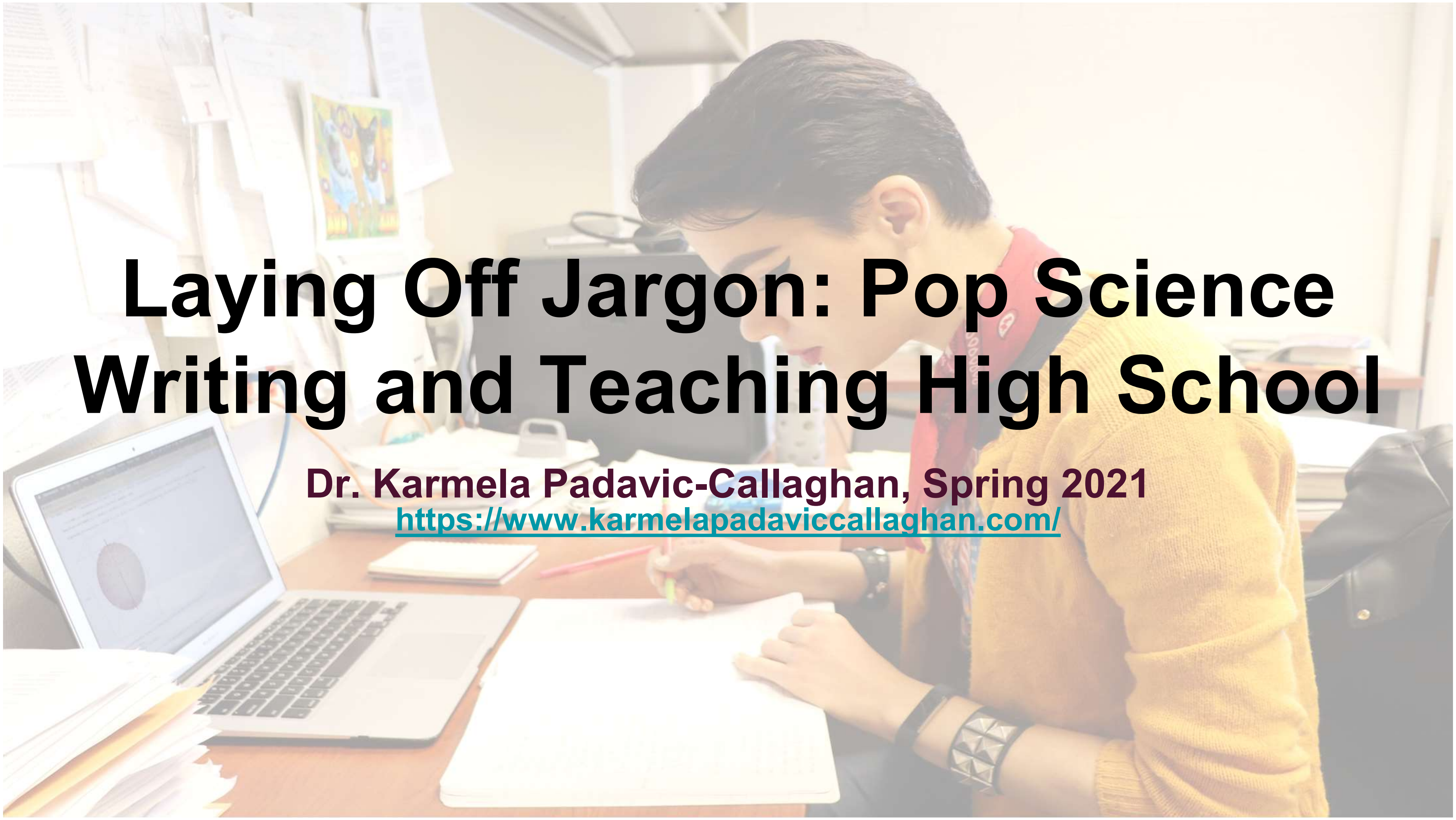


Laying Off Jargon: Pop Science Writing and Teaching High School

Dr. Karmela Padavic-Callaghan, Spring 2021
https://www.karmelapadaviccallaghan.com/

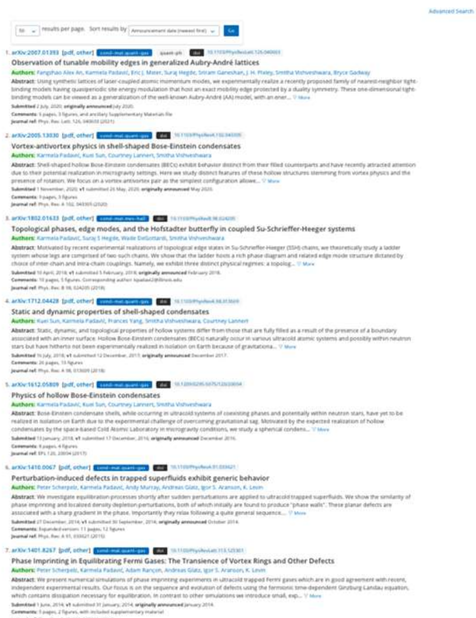
Outline

1. My work at UIUC and what happened next
2. Teaching at Bard High School Early College (BHSEC) Manhattan
3. Freelance Science Writing
4. Some tips

A caveat: I’m going to try and be very honest here. I haven’t really figured anything out and this is just what the last year has been for me + small skills I picked up along the way. Make your own judgements, take your own paths etc.

My work at UIUC

- Defended in February 2020, advisor: Prof. S. Vishveshwara, CMT and AMO theory
- Three points of focus: novel geometries for BECs, SSH ladders and topology, generalized AAH and quasiperiodicity


1. arXiv:2007.01393 [pdf, other]
Observation of tunable mobility edges in generalized Aubry-André lattices
Authors: Fangzhao Alex An, Karmela Padavić, Eric J. Meier, Suraj Hegde, Sriram Ganeshan, J. H. Pixley, Smitha Vishveshwara, Bryce Gadway

2. arXiv:2005.13030 [pdf, other]
Vortex-antivortex physics in shell-shaped Bose-Einstein condensates
Authors: Karmela Padavić, Kuei Sun, Courtney Lannert, Smitha Vishveshwara

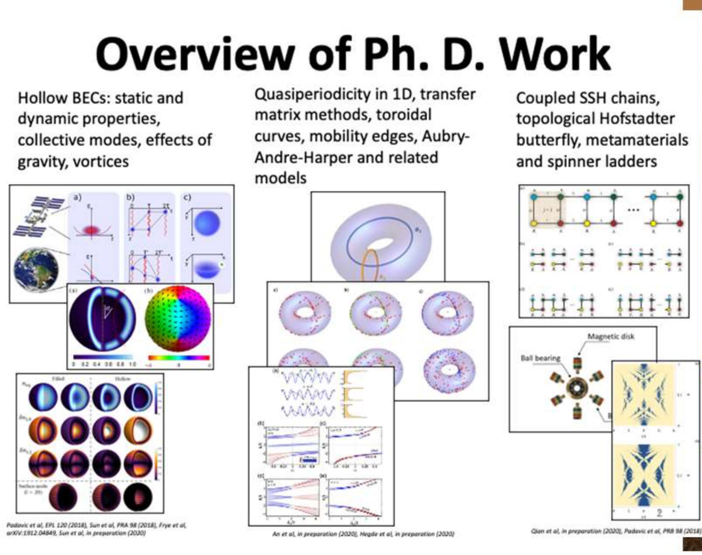
3. arXiv:1802.01633 [pdf, other]
Topological phases, edge modes, and the Hofstadter butterfly in coupled Su-Schrieffer-Heeger systems
Authors: Karmela Padavić, Suraj S Hegde, Wade DeGottardi, Smitha Vishveshwara

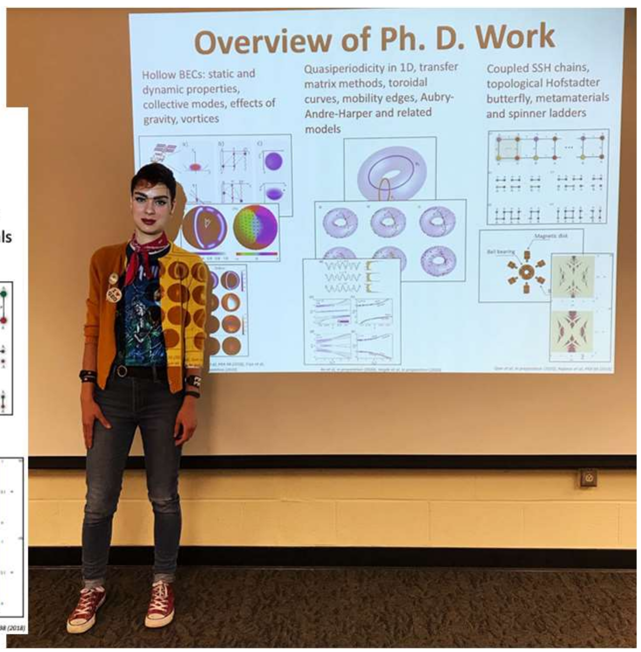
4. arXiv:1712.04428 [pdf, other]
Static and dynamic properties of shell-shaped condensates
Authors: Kuei Sun, Karmela Padavić, Frances Yang, Smitha Vishveshwara, Courtney Lannert

5. arXiv:1612.05809 [pdf, other]
Physics of hollow Bose-Einstein condensates
Authors: Karmela Padavić, Kuei Sun, Courtney Lannert, Smitha Vishveshwara

6. arXiv:1410.0067 [pdf, other]
Perturbation-induced defects in trapped superfluids exhibit generic behavior
Authors: Peter Scherpelz, Karmela Padavić, Andy Murray, Andreas Glatz, Igor S. Aranson, K. Levin

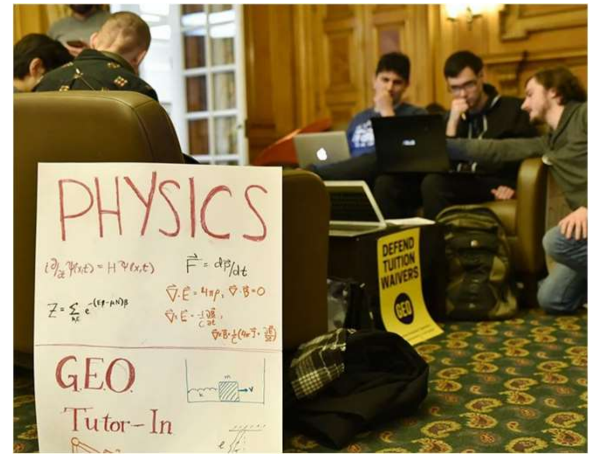
7. arXiv:1401.8267 [pdf, other]
Phase Imprinting in Equilibrating Fermi Gases: The Transience of Vortex Rings and Other Defects
Authors: Peter Scherpelz, Karmela Padavić, Adam Rançon, Andreas Glatz, Igor S. Aranson, K. Levin

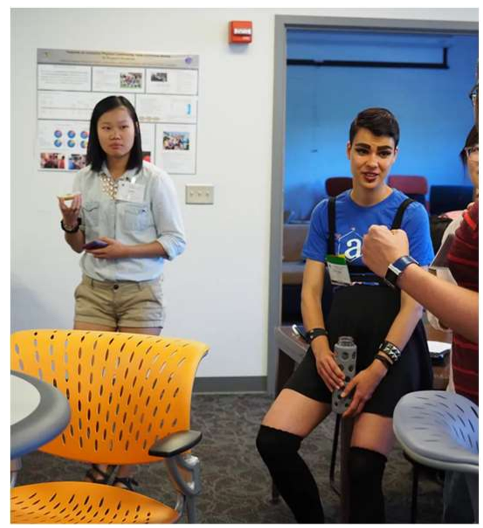




My work at UIUC

- GPS and the Access Network
- WGMPA
- GEO
- Physics/Art





What to do after defending?

Applied to a lot of postdocs in the fall of 2020 and throughout the winter.

Where	Due Date	link	Submitted?
Cornell/LASSP	9/1/19	https://academicjobsonline.org/ajo/jobs/1398	Y
UMD/JQI/CMTCPF	12/1/19	https://academicjobsonline.org/ajo/jobs/1432	Y
UCSB/KITP/EPiQS	11/1/19	https://academicjobsonline.org/ajo/jobs/1426	Y
UCSB/KITP	11/15/19	https://academicjobsonline.org/ajo/jobs/1418	Y
UChicago/IME	?	https://academicjobsonline.org/ajo/jobs/1435	Y
Harvard/ITAMP	11/25/19	https://careers.aps.org/jobs/12706974/postdoctoral-fellowship-at-the-institute-for-theoretical-atomic-molecular-and-optical-physics	Y
CalTech	11/15/19	https://applications.caltech.edu/job/burke	Y
U Alberta	12/1/19	https://academicjobsonline.org/ajo/jobs/1445	Y
Perimeter Institute	11/1/19	http://perimeterinstitute.ca/node/132482?utm_campaign=ACAD%20-%20Post%20Doctorate%20Fellows&utm_source=hs_email&utm_medium=email&utm_content=76890994&_hsenc=p2ANqtz-9JxWTQvo8JttsmpOlie3AgfUH7gArUBimXXDXEFvlVAbtPJ6Hz9Q_F_AEvr5BQXNUVMgl_gdHtSoAIIKRaIEOkqBKsBw&_hsmi=76890994	Y
UCSB	11/1/19	https://academicjobsonline.org/ajo/jobs/1468	Y
UC Berkeley	10/21/19	https://academicjobsonline.org/ajo/jobs/14764	Y
Simons Foundation/Flatiron Institute	11/15/2019	https://jobs.physicstoday.org/jobs/12839486/flatiron-research-fellow-center-for-computational-quantum-physics	Y
Rice University	11/1/2019	https://academicjobsonline.org/ajo/jobs/14639	Y
University of Florida	12/1/19	https://academicjobsonline.org/ajo/jobs/14803	Y
Florida State/National High Magnetic Field Laboratory	10/15/19	https://nationalmaglab.org/careers/job-opportunities/dirac-postdoctoral-fellowship-in-theoretical-condensed-matter-physics	Y
Princeton/Moore Foundation	?	https://puwebp.princeton.edu/AcadHire/apply/application.xhtml?listingId=13401	Y
UCSD	11/15/19	https://academicjobsonline.org/ajo/jobs/15073	Y
Stanford/EPiQS	11/07	https://academicjobsonline.org/ajo/jobs/14546	Y
Harvard/UQM	11/15	https://academicjobsonline.org/ajo/jobs/14972	Y
UChicago/Kadanoff Center	12/1/19	https://academicjobsonline.org/ajo/jobs/15141	Y
CU Boulder	11/1/19	https://jobs.colorado.edu/jobs/JobDetail?jobId=217	Y
Yale	11/17/19	https://quantuminstitute.yale.edu/apply	Y
Rutgers	11/15/19	https://jobs.rutgers.edu/postings/103548	Y
JQI	11/15/19	https://academicjobsonline.org/ajo/jobs/14548	Y
Stony Brook	12/10/19	https://academicjobsonline.org/ajo/jobs/15490	

RESEARCH STATEMENT

Karmela Padavic-Callaghan (kpadavi2@illinois.edu)

My research interests are in the intersection of theoretical condensed matter physics and atomic, molecular and optical (AMO) physics. They are reflected in my past work: I have researched Bose-Einstein condensate (BEC) in novel geometries, topological properties of coupled Su-Schrieffer-Heeger (SSH) chains and one-dimensional quasiperiodic systems.

Studying BECs in spherically symmetric geometries, collaborators and I calculated equilibrium densitities and collective mode frequencies for fully filled condensates and hollow condensate shells [1, 2]. We identified collective mode signatures of the hollowing-out transition from a sphere to a shell BEC. We concluded that BEC shells would be unstable on Earth due to destructive gravitational effects. Consequently, my work has been directly connected with expriments in the Cold Atomic Laboratory (CAL) on the International Space Station (ISS). Further, our work is a first comprehensive study of a topological change in physical space of a quantum fluid.

My studies of coupled Su-Schrieffer-Heeger chains (SSH ladders) established a close analogy with the Kitaev wire and the famed Hofstadter problem [3]. These results led to a collaboration with the experimental group of Prof. Camelia Prodan at the New Jersey Institute of Technology (NJIT). Here, collaborators and I proposed a new way to realize the Hofstadter butterfly. Namely, for quasiperiodic inter-chain couplings the topological phase diagram is the Hofstadter butterfly. Since the localized edge states marking the topologically non-trivial phases of the SSH ladder are bosonic or fermionic they are accessible in experiments. The Hofstadter butterfly structure could be obtained by imaging the edge modes of the quasiperiodic SSH ladder – localized edge modes correspond to topological regions that make up the dark parts of the topological phase diagram and thus fill-in the famous fractal.

My work on quasiperiodic one-dimensional systems has also been rooted in a collaboration with experimentalists. In this area, collaborators and I found that quasiperiodic systems that extend the Aubry-Andre-Harper (AAH) model by having long-ranged hoppings have single particle mobility edges. This conclusion was strengthened by experimental findings in the group of Prof. Bryce Gadway at University of Illinois Urbana-Champaign (UIUC) [6].

I have always engaged in collaborative research efforts and have worked with theoretical and experimental physicists alike. In the future, I wish to maintain a connection with experimental work. My advisor, Prof. Smitha Vishveshwara, has guided my training in theoretical condensed matter physics, and I have been exposed to many modern topics through advanced coursework. I completed classes on quantum field theory, topological systems, atomic physics and the AdS/CFT correspondence. In my research I have used the Gross-Pitaevskii formalism and quantum and classical superfluid hydrodynamics, I have calculated topological invariants for tight-binding systems with various symmetries, and I have extensively employed transfer matrices. My work with transfer matrices includes a novel visualization method that represents them as curves on a torus and calculations of Lyapunov exponents for uniform, periodic and quasiperiodic systems. Throughout my doctoral training, I consistently worked on multiple projects at a time and sought out a diversity of research questions. I am excited for the possibility to further expand my interests as a postdoctoral researcher.

I would be excited to be a part of the Simons Collaboration on Ultra-Quantum Matter. My research interests most overlap with the work of Prof. V. Gurarie and Prof. V. Galitski concerning many-body localization physics. As I am also eager to broaden my expertise, and further explore ultracold atomic systems as testbeds for engineering macroscopic quantum behavior, I believe working within this collaboration would be fruitful and stimulating, and that my current training and experience have prepared me well for it.

Below, I present a short overview of my work so far and my ongoing research interests.

1 Background and Current Work

1.1 Bose-Einstein Condensates in Novel Geometries

Static and Dynamic Properties of Shell-shaped Bose-Einstein Condensates. In [1, 2], collaborators and I studied filled and hollow spherically symmetric BECs. In these two published studies, we employed analytical solutions to the Gross-Pitaevskii equation within the hydrodynamic and Thomas-Fermi approximations, as well as its numerical solutions, to determine static and dynamic properties of these condensates. We considered the so-called bubble trap, currently employed in CAL experiments, that can confine a filled spherical BEC or a hollow three-dimensional BEC shell. We studied the transition from a fully filled to a thin hollow condensate – a change in physical topology of the system and a cross-over from three to two dimensions. Our work is a first comprehensive study of such a real space topological change.

Due to having a hollow core and an inner surface, BEC shells exhibit properties completely different from filled condensates. Collaborators and I identified collective-mode signatures of the topological change from filled to a hollow condensate: collective mode frequency spectra exhibit non-monotonic features across the hollowing-out transition. These signatures are the physical outcome of the emerging inner surface. By analyzing the effects of gravity on condensate shells,

we also determined critical experimental parameters (number of atoms and local gravitational acceleration) for realizing three-dimensional (as opposed to disk-like) hollow BECs. We found that realizing three-dimensional hollow BECs on Earth is not experimentally feasible at this time. Thus, our studies directly pertain to experimental efforts to engineer first condensate shells in microgravity on the ISS. In this way, our work presents fundamental theoretical discoveries concerning physics of hollow quantum fluids and opens up a new avenue for experimental work.

Physics of BEC shells is relevant for systems ranging from laboratory-based studies to neutron stars. In cold atomic systems, condensate shells are expected in Bose-Fermi mixtures and in optical lattice systems where Mott-insulating regions confine layers of superfluid shells. In neutron stars, shells consisting of superfluid and superconducting matter have been proposed as constituents of the stars' outer cores. My work on shell-shaped BECs is a first step towards understanding the physics of these more complex systems.

By working on this project, I gained competency in using the Gross-Pitaevskii and Thomas-Fermi formalisms, performed calculations in superfluid hydrodynamics, and collective mode calculations. This project was carried out with collaborators Prof. Courtney Lannert (Smith College and University of Massachusetts) and Dr. Kuei Sun (University of Texas Dallas), and my advisor.

Vortices and Effects of Rotation in Shell-Shaped Bose-Einstein Condensates. Recently, I have been studying how BEC shells respond to being stirred or rotated and what defect configurations are likely given their geometry (non-trivial curvature) and topology (hollow center). Vortex structures are ubiquitous in experimental BEC studies. Understanding their behavior also serves as a starting point for models of turbulence in ultracold quantum gases. For instance, in my undergraduate work [4, 5], collaborators and I found that a phase imprinting procedure on an elongated condensate leads to emergence of vortex rings. Understanding simple, discrete vortex structures and how their behavior depends on condensate geometry is thus important for understanding BEC re-equilibration following a perturbation.

Working with my advisor, Prof. Lannert and Dr. Sun, I have attained some preliminary results on behavior of vortices on rotating BEC shells. The topology of the system constrains vortices to always appear in pairs carrying opposite circulation. These vortex-antivortex pairs can lower the energy of the condensate by annihilating each other. We have found that fast rotation in the very thin shell regime can pin the vortex and the anti-vortex to the two poles of the BEC thus preventing their annihilation. For thicker shells, we found that vortex lines are nucleated at lower rotation speeds than in the case of a filled-sphere BEC. Further, examining the possibility of a bent vortex line we found that straight vortices aligned with the rotation axis are most stable and least energetically costly in rotating three-dimensional BEC shells. In this project, I used the Gross-Pitaevskii equation and heavily based my analytical approach on literature on vortices in classical superfluids, potential flows and studies of defects on nematic shells. A formal presentation of this work is in preparation [7] and it has been presented at conferences.

1.2 Topological phases in coupled Su-Schrieffer-Heeger systems

The Su-Schrieffer-Heeger (SSH) model is a prototypical example of a one-dimensional system supporting topological phases defined by zero energy states localized at its edges. In [3] collaborators and I showed that two coupled SSH chains can act as an analog of the Kitaev chain, a topological superconductor model having Majorana modes in its topological phases. Extending the SSH ladder model to quasiperiodic couplings, we also suggested a new way for realizing the Hofstadter butterfly in experiments as a topological phase diagram.

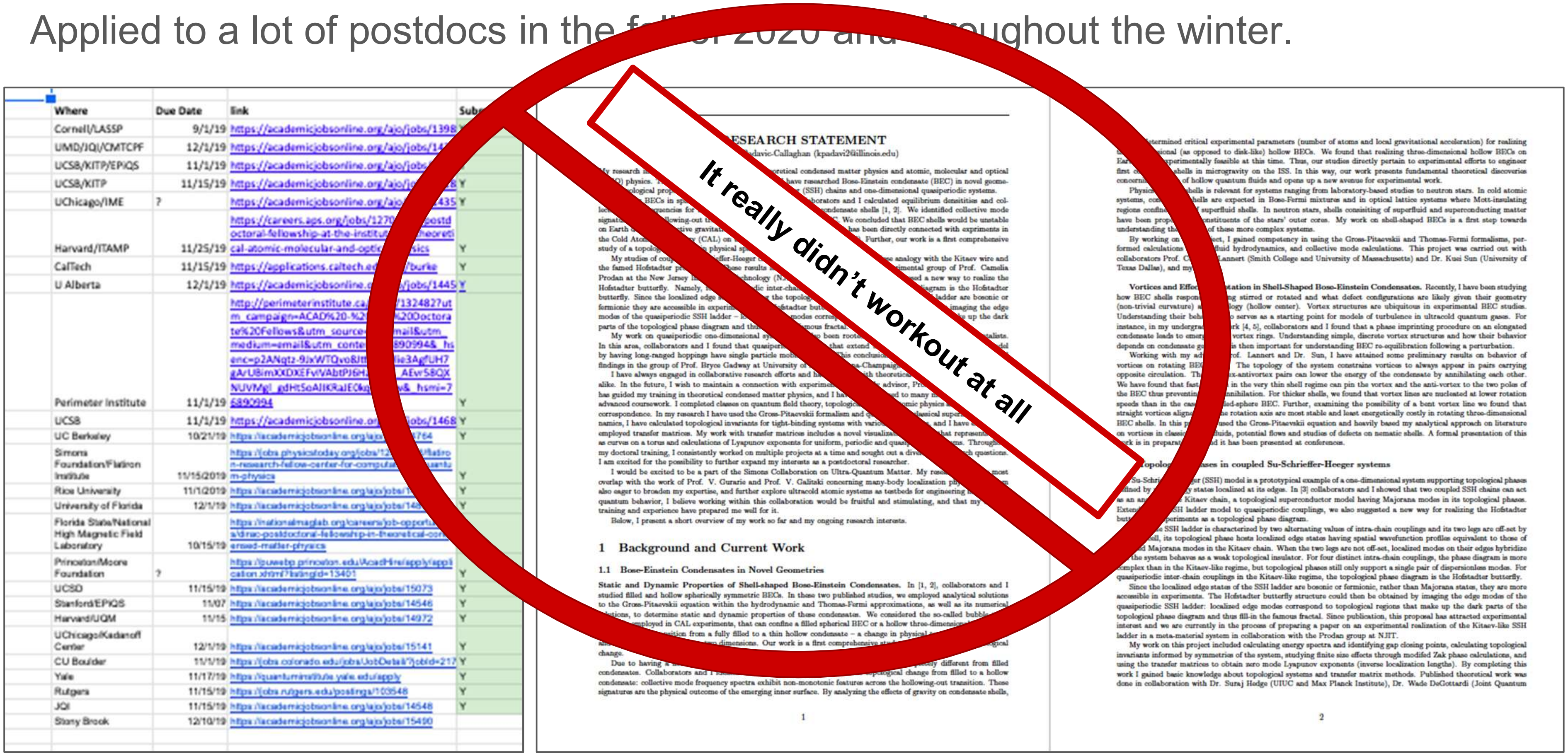
When the SSH ladder is characterized by two alternating values of intra-chain couplings and its two legs are off-set by one unit cell, its topological phase hosts localized edge states having spatial wavefunction profiles equivalent to those of localized Majorana modes in the Kitaev chain. When the two legs are not off-set, localized modes on their edges hybridize and the system behaves as a weak topological insulator. For four distinct intra-chain couplings, the phase diagram is more complex than in the Kitaev-like regime, but topological phases still only support a single pair of dispersionless modes. For quasiperiodic inter-chain couplings in the Kitaev-like regime, the topological phase diagram is the Hofstadter butterfly.

Since the localized edge states of the SSH ladder are bosonic or fermionic, rather than Majorana states, they are more accessible in experiments. The Hofstadter butterfly structure could then be obtained by imaging the edge modes of the quasiperiodic SSH ladder: localized edge modes correspond to topological regions that make up the dark parts of the topological phase diagram and thus fill-in the famous fractal. Since publication, this proposal has attracted experimental interest and we are currently in the process of preparing a paper on an experimental realization of the Kitaev-like SSH ladder in a meta-material system in collaboration with the Prodan group at NJIT.

My work on this project included calculating energy spectra and identifying gap closing points, calculating topological invariants informed by symmetries of the system, studying finite size effects through modifed Zak phase calculations, and using the transfer matrices to obtain zero mode Lyapunov exponents (inverse localization lengths). By completing this work I gained basic knowledge about topological systems and transfer matrix methods. Published theoretical work was done in collaboration with Dr. Suraj Hedge (UIUC and Max Planck Institute), Dr. Wade DeGottardi (Joint Quantum

What to do after defending?

Applied to a lot of postdocs in the fall of 2020 and throughout the winter.

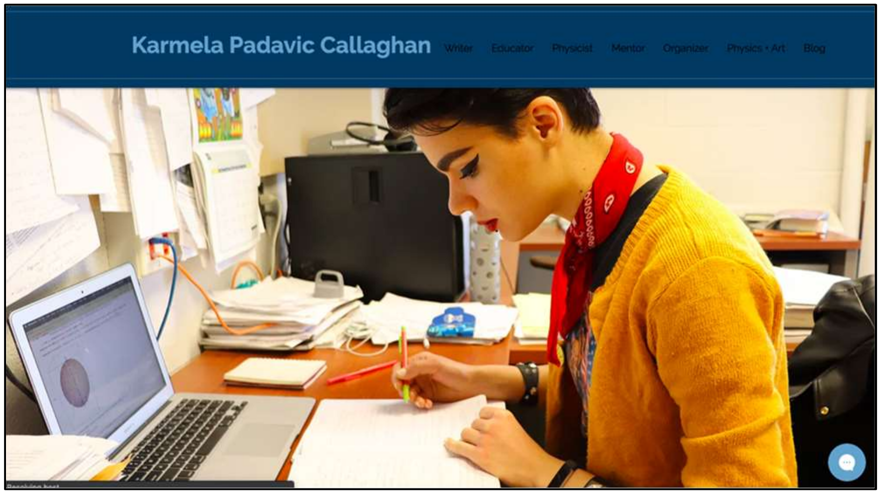


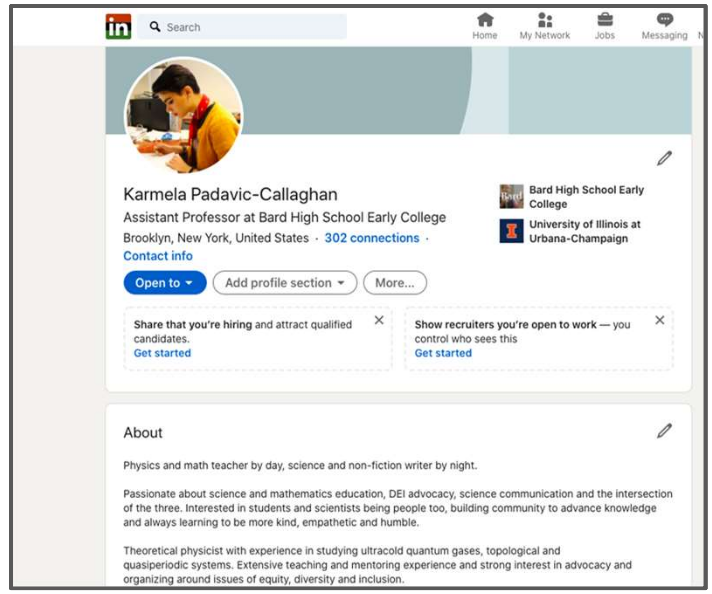
Some personal nonsense

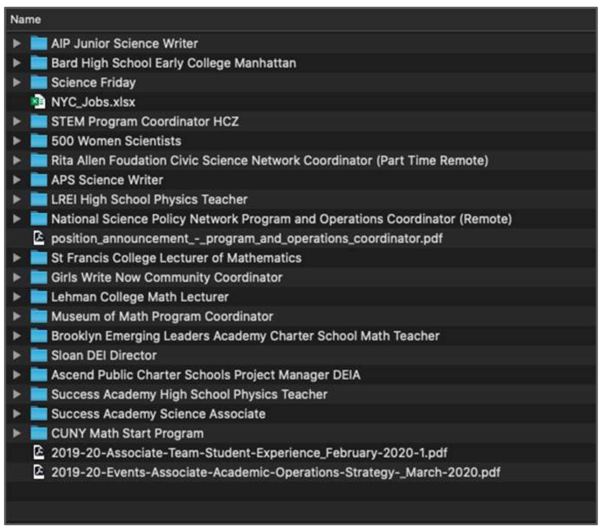
- A five year long two-body problem and my husband was about to graduate from his PhD program at Yale University too
- Unexpected illness that landed me in the ICU around Christmas 2019, after a week on a respirator and multiple surgeries I was really shaken and doing a fair amount of soul-searching
- Went to spend Spring Break 2020 in Brooklyn with my husband and his parents (they live there) when COVID-19 got really bad, basically didn't manage to return to Urbana until August when my lease expired
- In summary: things were bad and I was too sad and too tired to try and fight my way into some surprise postdoc

How did I end up at BHSEC-Manhattan?

- In Spring 2020 me and my husband were living in my in-law's basement in Brooklyn, waiting for the pandemic to be over, and applying to jobs
- My husband defended his PhD from the basement, via Zoom, and got a postdoc at CUNY Grad Center, also via Zoom
- I was applying to jobs in:
    - Education (private high schools, community colleges)
    - Science outreach (after school programs, science and math museums)
    - Science communication (science writing, public information work)







- Wrote three or four versions of my CV highlighting different experiences for different jobs
- Put a lot of time into having a few very good cover letter templates that also showcased different talents (at a suggestion of a career advisor at the grad college approached this as a writing project and tried to show a bit of individuality)

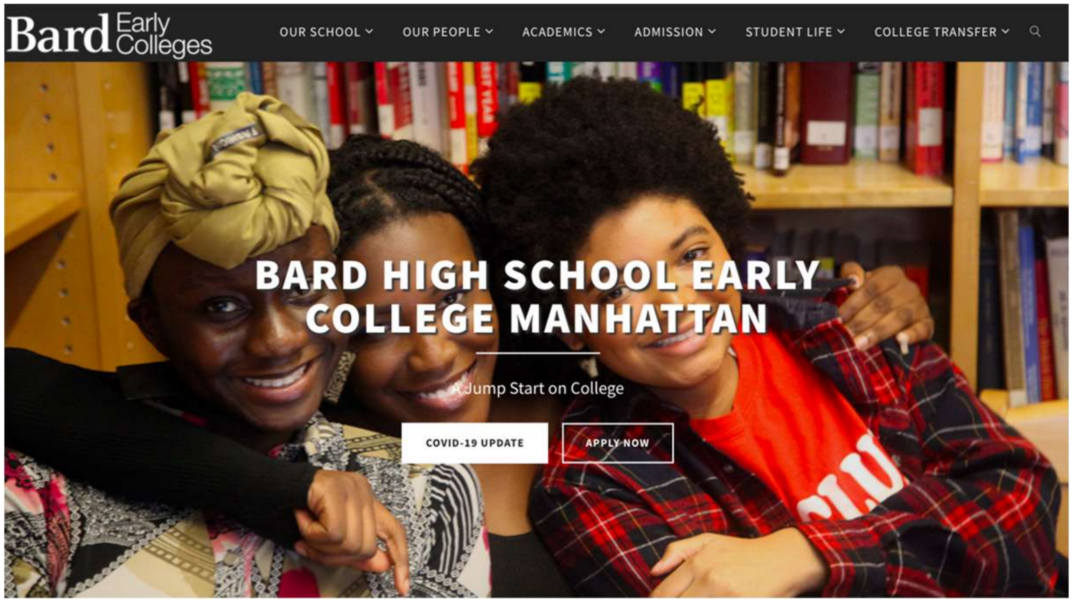
How did I end up at BHSEC-Manhattan?

- I was applying to jobs in:
    - Education (private high schools, community colleges)
        - Had a ton of experience TAing at UIUC (pretty much every semester) and from UChicago as an undergrad + completed a teaching course as a part of the Mavis Fellowship + mentoring and organizing experience helps Science outreach (after school programs, science and math museums)
        - GPS, GEO, WGMPA and Physics/Art experience helped here
    - Science communication (science writing, public information work)
        - Had some experience but not enough “clips” (more about this later)

How did I end up at BHSEC-Manhattan?

- I was applying to jobs in:
    - Education (private high schools, community colleges)
        - Had a ton of experience TAing at UIUC (pretty much every semester) and from UChicago as an undergrad + completed a teaching course as a part of the Mavis Fellowship + mentoring and organizing experience helps - **this worked out**
    - Science outreach (after school programs, science and math museums)
        - GPS, GEO, WGMPA and Physics/Art experience helped here
    - Science communication (science writing, public information work) - **I got one job offer along these lines**
        - Had some experience but not enough “clips” (more about this later) - **I had some very good interviews and am still doing a fair amount of this work freelance**

What is a High School Early College?



Essentially students at BHSEC complete high school by grade 10 then earn an AA degree or 2 years of college credits in 11th and 12th grade. Everything is free and the school is fairly diverse. Part of the NYC public school system and Bard college

"The mission of BHSEC is to provide a rigorous course of study that emphasizes thinking through writing, discussion, and inquiry. This alternative to the traditional high school is founded on the belief that many young people are ready and eager to do serious college work at age sixteen. Based on the premise that these young adults' ambition to learn must be taken seriously, BHSEC's four-year program enables highly motivated students to earn a high school diploma and a tuition-free Bard College associate's degree in four years.

Love of learning dominates the culture of BHSEC. Our rigorous curriculum allows students to fulfill all of the Newark Public Schools requirements through an engaging and demanding college-level education. Mastery of subjects at BHSEC is demonstrated by our students' reasoned analyses and by their thoughtful and well-supported arguments for their views. Ninety-five percent of BHSEC graduates successfully move on to a four-year college."

How did I end up at BHSEC-Manhattan?

Karmela Padavic Callaghan
kpadavi2@illinois.edu // 217-607-4032 // karmelapadaviccallaghan.com

May 1, 2020

Dr. Siska Brutsaert
BHSEC Manhattan
525 E Houston Street
New York, NY 10002

Dear Dr Brutsaert,

In college, I taught calculus. Most of my students were apprehensive about, or intimidated by, the subject. Having had a different experience myself – enthusiastically learning calculus in high school and jumping right into an accelerated course on real analysis as a college freshman – I was worried about teaching them. Realizing that I had to meet students where they are and teach them well even if they are not initially passionate about my course made me grow as an educator. I learned to be self-reflective about my assumptions and expectations and consciously work on my communication and presentation skills. I became passionate about helping students prepare for advanced classes by building both skills and confidence.

While pursuing a doctorate in physics, I mostly taught introductory courses. Largely, these courses served as foundation-building for students majoring in any science or entry-points into the major for physics students. I facilitated problem-solving sessions, helping students work in small groups after presenting a brief lecture. This work further taught me how to make material accessible and provide motivation and context for students encountering it for the very first time. I became a patient and well-organized instructor able to teach multiple sections, meet grading deadlines and proctor exams in the evenings. I was repeatedly ranked as excellent by my students and when I served as a mentor teaching assistant to my peers most received the same ranking.

In 2017, I completed a college teaching course and taught an advanced quantum physics class as a part of the Mavis Future Faculty Fellowship. Learning to structure a syllabus working backwards from learning outcomes and to tailor assessments to those outcomes, among other topics, helped me approach teaching in same systematic, detail-oriented manner I applied to my research. Teaching an advanced course also expanded my skill set. Here, I developed and delivered lectures, designed exams and homeworks and held office hours. Learning quantum mechanics is essential for students wanting to become physicists and they tend to be excited about it. In one-on-one meetings with students, I was often asked questions beyond the scope of the course. I was excited to discuss challenging material, aiming to be accessible while also not underestimating my students. In the same year, I collaborated with Prof. S. Vishveshwara on an interdisciplinary course on physics and art that she had been developing. The class I helped structure and designed elements off serves graduate and undergraduate students majoring in physics or art. It has been offered multiple times since and received great feedback. This succession of teaching challenges, from being a teaching student to lecturing and developing materials in specialized courses, taught me to be thorough and thoughtful in my preparation for instruction and flexible and enthusiastic in the classroom.

My doctoral training focused on research, but I held a teaching position for most of the past six years. Working in theoretical condensed matter physics expanded my problem-solving skills, exposed me to complex, new physics and allowed me to always be a learner. As a long-time student I understand the importance of teachers and mentors. This was underscored for me as I moved through higher education and was often one of the few women in the room. I credit my perseverance to teachers that had encouraged and challenged me when I was learning physics basics. Being a diversity, equity and inclusion advocate and a leader in a mentoring organization in graduate school informed my teaching in addition to training I received as an instructor and made my interactions with students having different academic or personal backgrounds more important. I would be excited to stay invested in teaching in the future and continue helping all students build their foundations, jump-start their learning and own the knowledge that excites them.

Sincerely,
Karmela Padavic Callaghan

KARMELA PADAVIC-CALLAGHAN

3660 Shore Parkway, Brooklyn, 11235 NY
(217)607-4032 ◦ kpadavi2@illinois.edu ◦ karmelapadaviccallaghan.com

EDUCATION

University of Illinois at Urbana-Champaign (UIUC) August 2014 - February 2020
Doctor of Philosophy, Physics
The University of Chicago September 2010 - May 2014
Bachelor of Arts, Physics, Honors
Bachelor of Science, Mathematics

AWARDS AND HONORS

Jordan Asketh Fellowship, UIUC August 2019 - December 2019
List of Teachers Ranked as Excellent, UIUC Spring 2019 and 2016, Fall 2018 and 2016
Renato Bobone Award, UIUC April 2018
Mavis Future Faculty Fellowship, UIUC August 2017 - May 18
Dean's List of Distinguished Students, The University of Chicago May 2010 - May 14

TEACHING EXPERIENCE

University Physics: Quantum and Thermal Physics Spring 2016, 2019, 2020; Fall 2016, 2018
College Physics: Electricity and Magnetism, and Modern Physics Fall 2014, 2015; Spring 2015
Teaching Assistant Department of Physics, UIUC

- Led a weekly discussion section for small groups of students, presenting a review of the material and directing group problem solving
- Graded weekly quizzes and provided individual instruction and feedback in office hours
- Provided remote (online) instruction in the Spring of 2020 using Zoom and Microsoft PowerPoint including preparing instructional slides, detailed problem solutions and synchronous problem solving feedback

Atomic Physics and Quantum Theory Fall 2017
Teaching Assistant Department of Physics, UIUC

- Formulated and graded homework assignments and three written examinations
- Held a weekly office-hour and prepared and delivered three full in-class lectures

Where the Arts Meet Physics Spring 2017
Teaching Assistant Department of Physics, UIUC

- Co-developed assignments and course materials including setting teaching objectives and designing assessments
- Prepared and led group discussion for a diverse group of physics and art students and guided and advised individual students on development and execution of self-proposed final projects

SESAME (Seminars for Endorsement of Science and Mathematics Educators) Program
Summer 2012 and 2013
Teaching Assistant The Univeristy of Chicago

- Instructed high school teachers in remedial mathematics or introductory computer programming through one-on-one tutoring

Young Scholars Program Summer 2012 and 2013
Teaching Assistant The Univeristy of Chicago

- Instructed advanced high school students in abstract mathematical topics at the college level and facilitated group discussions and presentations

Elementary Functions and Calculus II Winter 2014
Junior Tutor The Univeristy of Chicago

- Led small group problem-solving sessions including a brief lecture and administering and grading weekly quizzes

Calculus-1 and Calculus-2 Fall 2011 - Winter 2014
VIGRE Course Assistant The University of Chicago

- Graded weekly homework assignments and held a regular office hour to provide individual instruction and feedback to students

RESEARCH EXPERIENCE

Vishveshwara Research Group August 2014 - present
Research Assistant Institute for Condensed Matter Theory, UIUC
Adviser: Professor Smitha Vishveshwara

- Analytically study Bose-Einstein condensate in novel geometries, topological properties of coupled Su-Schrieffer-Heeger chains and quasiperiodic one-dimensional systems

Levin Research Group January 2013 - July 2014
Research Assistant James Franck Institute, University of Chicago
Adviser: Professor Kathryn J. Levin

- Numerically studied re-equilibration of trapped ultracold quantum gases following a sudden perturbation modeled after a realistic experimental technique (phase imprinting)

MENTORING

Illinois Guidance for Physics Students 2015 – present
Mentor and Leadership Member Department of Physics, UIUC

- Determine mentor-mentee matches based on written applications and support matched pairs in their relationships throughout the academic year
- Collaborate and coordinate with a team of volunteers to design, organize and realize academic, social and community events, including a three-day off-campus team-building retreat
- Provide logistical support and design guidance to program members proposing and realizing new events and activities

ADMINISTRATION AND ORGANIZING

Graduate Employees' Organization, Local 6300 IFT/AFT AFL-CIO August 2019 – present
Co-Treasurer Urbana, IL

- Ensure day-to-day functioning of the organization by managing administrative and events expenses, assisting with members' dues collection, reimbursements and financial audits
- Plan a yearly budget and propose it to the full membership and work with specific subcommittees to project and track spending for their projects
- Be a voting member on the Coordinating Committee and participate in planning for future growth and evolution of the organization

Access Network August 2019 – present
Assembly Fellow Mentor

- Support and mentor Assembly Fellows in designing and executing the three-day Access Assembly conference by creating workshop templates, providing individual feedback and addressing logistical concerns such as acquiring materials or appropriate technology
- Collaborate with other co-mentors to plan, structure and lead Assembly Fellow meetings and communicate Assembly Fellow progress to Access Network's Core Organizers

On-Site Assembly Fellow March 2019 - June 2019

- Worked collaboratively with a team of Assembly Fellows from nine different institutions to plan and execute the Access Assembly conference hosted at UIUC
- Handled logistical concerns such as food, housing and accessibility for all attendees throughout the Assembly
- Proposed, designed and executed two workshops and two large group (over 50 attendees) activities at the Assembly

ADVOCACY

Women and Gender Minorities in Physics and Astronomy 2018 – present
Leadership Member Department of Physics, UIUC

- Organize, design and co-ordinate events centering social issues or professional development for women and gender minorities
- Work in concert with undergraduate organizations, advocacy groups on campus and UIUC Physics Department to broaden the impact of organized events
- Lead a team of volunteers in planning and realizing a two-day retreat at an off-campus location

Engineering Graduate Student Advisory Committee 2018 – 2019
Underrepresented Students Subcommittee Chair College of Engineering, UIUC

- Advocated for underrepresented students in monthly meetings with administrators
- Led volunteers from different academic departments in organizing a workshop serving all graduate students within the College of Engineering

PUBLICATIONS AND CONFERENCE PRESENTATIONS

Google Scholar: http://bit.ly/2mbrUxR

Science Publications: 5 refereed journal articles

Conference Presentations: 4 oral presentations at national conferences, 1 poster presentation at a national conference, 2 poster presentations at specialized workshops, 1 poster presentation at an International conference

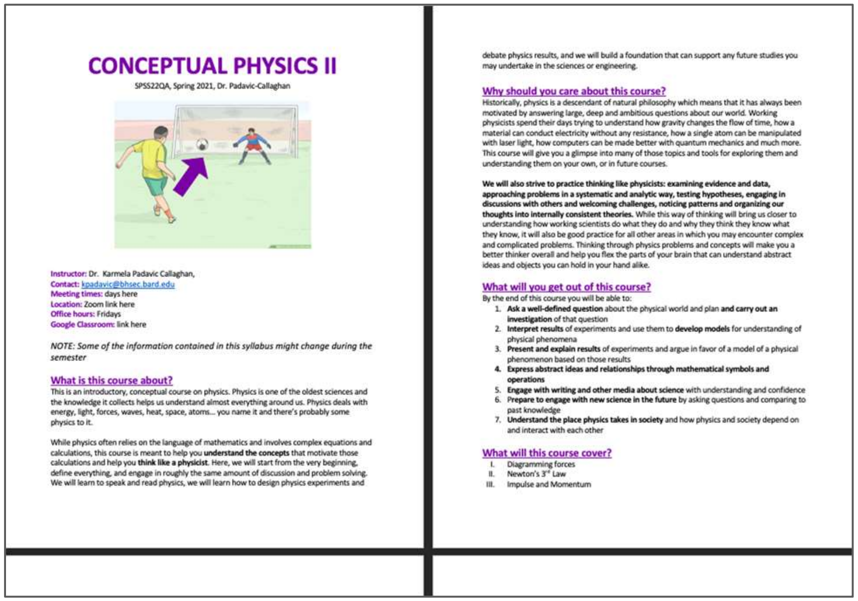
Popular Science Publications: The Coolest Physics You've Ever Heard Of, Scientific American Observations/Opinion Blog, 20 Jan. 2020, http://bit.ly/2ScXKYy

Non-fiction Publications: I'm Losing Count, The Xylom, 9 Nov. 2019, http://bit.ly/2ul9Zt7

+ Interview with the whole science department and the principal + demo class in the 9th grade (all over Zoom)

What do I do at BHSEC Manhattan?

- Since I’m not a department of education certified high school teacher, I am an employee of Bard College and my title is Assistant Professor. My current position is for three years, but were it to be extend and if I get certified I would also be eligible for tenure within Bard College
- I teach a 9th grade Conceptual Physics Class and a 12th grade college-level elective (in the fall I taught Calculus II, now I have been given freedom to design and implement a Modern Physics class)
- We had blended in-person and remote learning for about 6 weeks in September and October and have been remote ever since, I teach … from my kitchen (luckily we moved out of my in-law’s basement right around when school started, but we still live in Brooklyn)
- The work is very different than TAing and much harder (but also more rewarding when you manage to catch your breath)



CONCEPTUAL PHYSICS II

SPSS22QA, Spring 2021, Dr. Padavic-Callaghan

Instructor: Dr. Karmela Padavic Callaghan,
Contact: kpadavic@bhsec.bard.edu
Meeting times: days here
Location: Zoom link here
Office hours: Fridays
Google Classroom: link here

NOTE: Some of the information contained in this syllabus might change during the semester

What is this course about?

This is an introductory, conceptual course on physics. Physics is one of the oldest sciences and the knowledge it collects helps us understand almost everything around us. Physics deals with energy, light, forces, waves, heat, space, atoms… you name it and there's probably some physics to it.

While physics often relies on the language of mathematics and involves complex equations and calculations, this course is meant to help you **understand the concepts** that motivate those calculations and help you **think like a physicist**. Here, we will start from the very beginning, define everything, and engage in roughly the same amount of discussion and problem solving. We will learn to speak and read physics, we will learn how to design physics experiments and debate physics results, and we will build a foundation that can support any future studies you may undertake in the sciences or engineering.

Why should you care about this course?

Historically, physics is a descendant of natural philosophy which means that it has always been motivated by answering large, deep and ambitious questions about our world. Working physicists spend their days trying to understand how gravity changes the flow of time, how a material can conduct electricity without any resistance, how a single atom can be manipulated with laser light, how computers can be made better with quantum mechanics and much more. This course will give you a glimpse into many of those topics and tools for exploring them and understanding them on your own, or in future courses.

We will also strive to practice thinking like physicists: examining evidence and data, approaching problems in a systematic and analytic way, testing hypotheses, engaging in discussions with others and welcoming challenges, noticing patterns and organizing our thoughts into internally consistent theories. While this way of thinking will bring us closer to understanding how working scientists do what they do and why they think they know what they know, it will also be good practice for all other areas in which you may encounter complex and complicated problems. Thinking through physics problems and concepts will make you a better thinker overall and help you flex the parts of your brain that can understand abstract ideas and objects you can hold in your hand alike.

What will you get out of this course?

By the end of this course you will be able to:

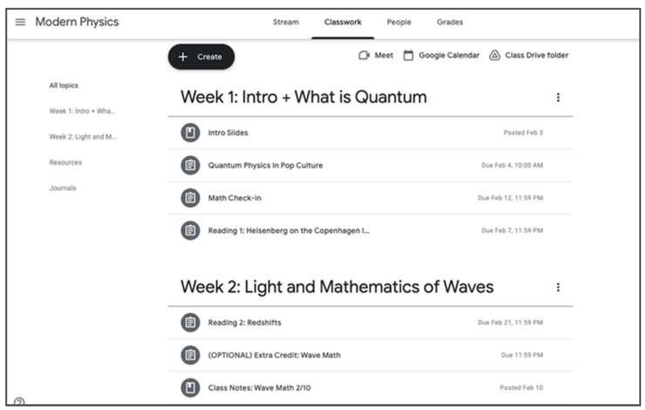
1. **Ask a well-defined question** about the physical world and plan **and carry out an investigation** of that question
2. **Interpret results** of experiments and use them to **develop models** for understanding of physical phenomena
3. **Present and explain results** of experiments and argue in favor of a model of a physical phenomenon based on those results
4. **Express abstract ideas and relationships through mathematical symbols and operations**
5. **Engage with writing and other media about science** with understanding and confidence
6. **Prepare to engage with new science in the future** by asking questions and comparing to past knowledge
7. **Understand the place physics takes in society** and how physics and society depend on and interact with each other

What will this course cover?

I. Diagramming forces
II. Newton's 3rd Law
III. Impulse and Momentum

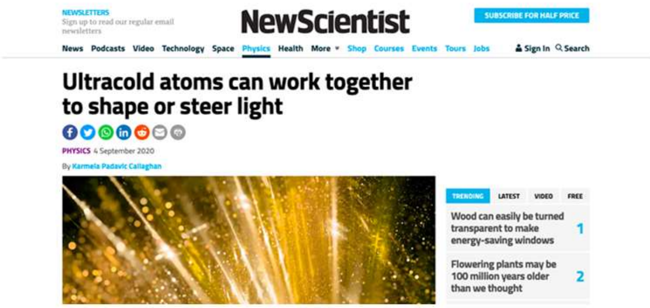
[redacted]

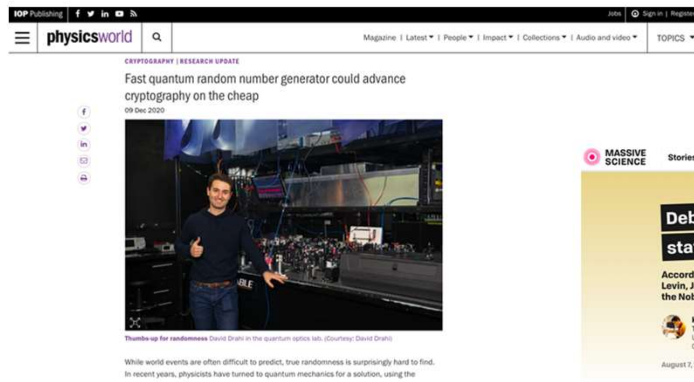
[redacted]

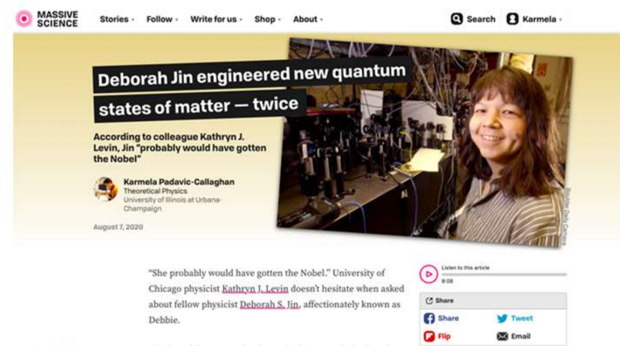


The rest of my talk will be about writing. Any questions so far?

How did I get around being a freelance science writer?







How did I get around being a freelance science writer?

- Defects may help scientists understand the exotic physics of topology, IQUIST News
- Ultracold Molecule Mystery Solved, Scientific American
- Identical Quantum Particle Pass Practicality Test, Scientific American
- Time's Arrow Flies Through 500 Tears of Classical Music, Physicists Say, Scientific American
- The Coolest Physics You've Ever Heard Of, Scientific American Observations/Opinion Blog
- Fast Quantum Random Number Generator Could Advance Cryptography on the Cheap, Physics World
- Ultracold Atoms Can Work Together To Shape Or Steer Light, New Scientist
- Deborah Jin Engineered New Quantum States of Matter - Twice, Massive Science
- Physicists plucked and collided two ultracold molecules with laser tweezers, Massive Science
- The International Space Station creates bigger, colder states of matter than are possible on Earth, Massive Science
- Hands-on at a distance: Making sense of physics with Jill, University of Illinois Urbana-Champaign Physics Department home page
- Physics learning for the future: Developing new ways of thinking with Eric, University of Illinois Urbana-Champaign Physics Department home page
- Creativity and authenticity are key ingredients for successful student-led DEI advocacy, Science on a Postcard Blog
- Amidst National Reckoning with Racial Injustice the Physics Community Reflects on Its Own Inequities, A Science Blog by Science Talk
- Quantum Physics is Easier to Understand as an Adventure, Lifeology Blog
- I'm Losing Count, The Xylom

How did I get around being a freelance science writer?

- The Xylom + newsletter (personal essay writing)
- ComSciCon-AIP + Science Talk
- Opinion piece in Scientific American that was workshopped at ComSciCon-AIP and where a mentor helped me with the pitch
- Two blog contributions (Lifeology and Science on a Postcard) based on what I learned and heard about at Science Talk
- Joined the NPR SciCommers Slack and Massive Science Consortium
- Debbie Jin piece on Massive Science (there is an internal pitching process where you get help and don’t have to search for editor’s emails by black magic)
- Started pitching to magazines: three pieces in Scientific American, one New Scientists, one Physics World (these are paid! SciAm pays ~1000$ for 800ish words).
- Public information work with IQUIST and IPaSS at UIUC
- Joined National Association of Science Writers
- Getting more freelance work by editors contacting me instead of me pitching them (but there is less and less money for freelance work at many magazines right now)
- Occasionally some company will reach out and ask for freelance work, I’m still testing the waters on this.

How did I get around being a freelance science writer?

- Hardest and most important part: pitching stories to editors
- Sometimes they don’t write back at all and sometimes you can’t find their email
  (generic emails that are pitches@publication.com instead of a name don’t get read by anyone + need to go through groups like NPR SciCommers etc and find someone who has contacted an editor before if the information is not listed anywhere public)
- Sometimes your pitch is just bad
- Mostly it takes a lot of time to do enough background research to write a really good pitch (a big challenge if you’re also, for example, teaching high school)

Hi EDITOR,

I hope you have been doing well.

I am writing with two story ideas I think you and your readers would find fascinating.. One is about a new platform for quantum computing that could lead to engineering of larger quantum computers without sacrificing the fidelity of information transfer within them and the other focuses on a recent study that used methods from nonequilibrium physics and statistics to quantify properties of over 8000 pieces of classical music. Below are more detailed pitches for both stories. I'd be happy to reach out to relevant experts when writing them.

I am a freelance science writer based in Brooklyn, NY and I hold a PhD in theoretical physics. The focus of my PhD research was in ultracold and quantum systems. I have recently written about quantum physics for Scientific American's Opinion section here and Massive Science here. I am looking to take on more freelance work and would be very excited to write about this study for Wired.

ANALYZING FIVE CENTURIES OF CLASSICAL MUSIC SHOWS THAT ENTROPY-PRODUCING TUNES ARE MOST LIKEABLE

While the thought of playing songs in reverse might make you think of conspiracies and hidden messages, scientists are using ideas about time reversibility to quantify features of music we find pleasant as listeners. In a recent study published in Physical Review Research, a team of scientists used nonequilibrium physics and statistics tools to study over 8000 musical pieces originating across five centuries and consequently pinpoint how time-reversible and non-random music really is. Using novel statistical techniques, their work offers a mathematical foundation for our common experience of music being very different than noise. In other words, this study attaches measurable quantities to the notion that a musical composition is "going somewhere" rather than being generated at random.

The notion of statistical time reversibility is associated with an "arrow of time" or a clear direction in which time progresses, allowing us to define what it means to move forwards and backwards in time. Processes that are statistically time reversible are ignorant of the arrow of time and, under a quantitative analysis, seem the same when the arrow is flipped. White noise is one example. More surprisingly, so-called pink or 1/f noise, widely accepted as a valid description of composed music, is another example. The authors of this new study find the 1/f noise description of music to be imprecise – most compositions in their sample display time irreversibility. Irreversible processes are more ordered and less random, so one implication of this finding is that composing music is an out-of-equilibrium process. In equilibrium, all musical components would be evenly distributed rather than ordered. An equilibrium distribution would also have large entropy or disorder and look the same in all time directions. The ordering process i. e. composing can then be assigned a certain amount of lost energy and a change in entropy. The authors of this study even compare famous composers on how irreversible and how energy dissipating their work is. For instance, they find that Mahler's compositional style on average produced more entropy than Paganini's. Their work then not only challenges the so far accepted idea of music as 1/f noise, but also points towards a relation between time irreversibility and attractiveness of music to the listener.

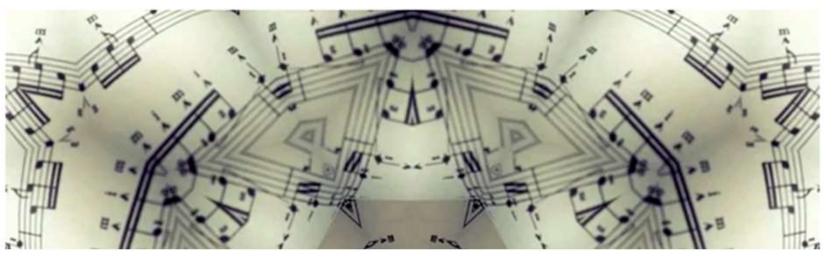
I think this article could work well at 800-1000 words. In writing it, I would start with basic explanations of how music can be quantified, how thermodynamic equilibrium is related to randomness or disorder while more ordered systems are considered out-of-equilibrium, and how entropy is related to energy loss for a physical signal. The rest of the article would recount the Physical Review Research study, briefly touch on the fact that the authors used a new statistical method particularly well-suited to musical composition and outline their results. Since this study has made strides in quantifying the "musical narrative" we experience while listening, it could be interesting to close the article by noting that there have been musicians that have experimented with more random means of generating musical compositions in the past, but their music is less widely known and less commonly enjoyed than for instance Mozart. Looking through past writing about music and science in Scientific American, there seem to have been many interesting reports on how music affects our thinking and cognition, but not necessarily as many focusing on how music itself can be studied as a mathematical and physical object. I believe your readers may be interested in this perspective of why music is pleasant not just based on how our brains take it in, but also quantifiable properties of music itself.

PHYSICS

Time's Arrow Flies through 500 Years of Classical Music, Physicists Say

A statistical study of more than 8,000 compositions shows how the flow of time distinguishes music from noise

By Karmela Padavic-Callaghan on August 19, 2020 أعرض هذا باللغة العربية



READ THIS NEXT

BEHAVIOR & SOCIETY

What Makes a Song? It's the Same Recipe in Every Culture

November 21, 2019 — Jim Daley

Things I learned about science writing

- You have to try a lot even though you will often not get assigned stories
- At the beginning it’s ok to write for free especially at places like Massive where you get training, but don’t get stuck there for too long
- Talk to people and use all the resources you can get, NPR SciCommers has a mentoring program where a real NPR editor helps edit an pitch your piece, The Open Notebook has a database of pitches
- Your pitches will be awful more often than not, other people need to look at them before you hit send (you are never as good of a writer as you think and editors are brutal)
- Interviewing scientists is really fun (and having a PhD means you speak insider language)
- You can’t use jargon and you have to be snappy, you have to be less jargony and more clever than even when you’re talking to a 9th grader

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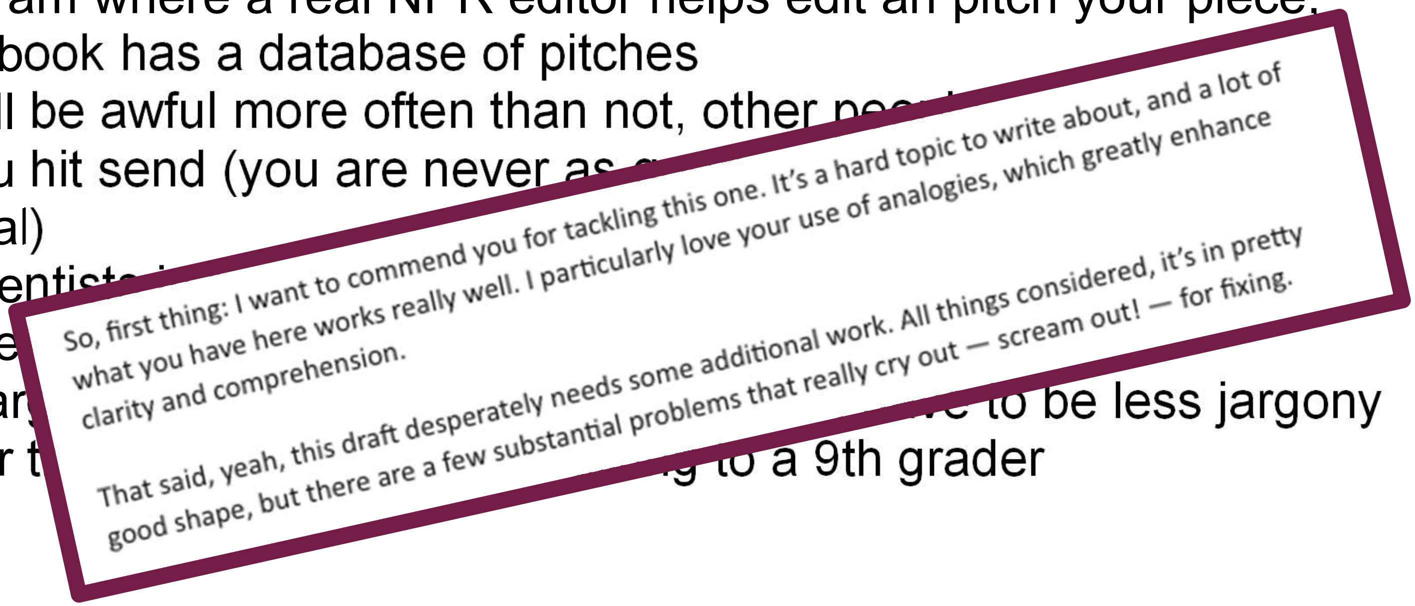
So, first thing: I want to commend you for tackling this one. It's a hard topic to write about, and a lot of what you have here works really well. I particularly love your use of analogies, which greatly enhance clarity and comprehension.

That said, yeah, this draft desperately needs some additional work. All things considered, it's in pretty good shape, but there are a few substantial problems that really cry out — scream out! — for fixing.

Things I learned about science writing

- There's a lot more public information work than there is freelance magazine work, these are more stable jobs and include some creativity, but you don't choose your own stories as much and you're working to market the university/lab you work for vs. just exploring and explaining cool science
- As a freelancer you are running yourself as a business and have to send invoices, make sure you get paid, worry about taxes etc.
- Time management and being reliable is extremely important
- Social media and LinkedIn are surprisingly important, as is word of mouth
- There are master's programs for science writing (that cost money) and the AAAS Media Fellowship which pays you and embeds you at a magazine
- It's probably possible to make a living as a freelancer but not in a year and maybe not in NYC

Thanks for bearing with me!

Questions?