workforce developments

Education and outreach

and retention

OLD DOMINION UNIVERSITY

Jefferson Lab

RAÚL BRICEÑO

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Near and dear to my heart

REYES (REMOTE EXPERIENCE FOR YOUNG ENGINEERS AND SCIENTISTS)

PYTHON 4 PHYSICS

HALES (HIGH ACHIEVING LATINX IN ENGINEERING AND SCIENCES)

ODU/JLAB REU

SULI

MEXICAN SUMMER INTERNSHIP

ENDLESS DEI COMMITTEES

ASYNCHRONOUS QFT

MFURA

PARTNERSHIPS WITH HS

NUCLEAR MENTORING PROGRAM

. . .

Outline

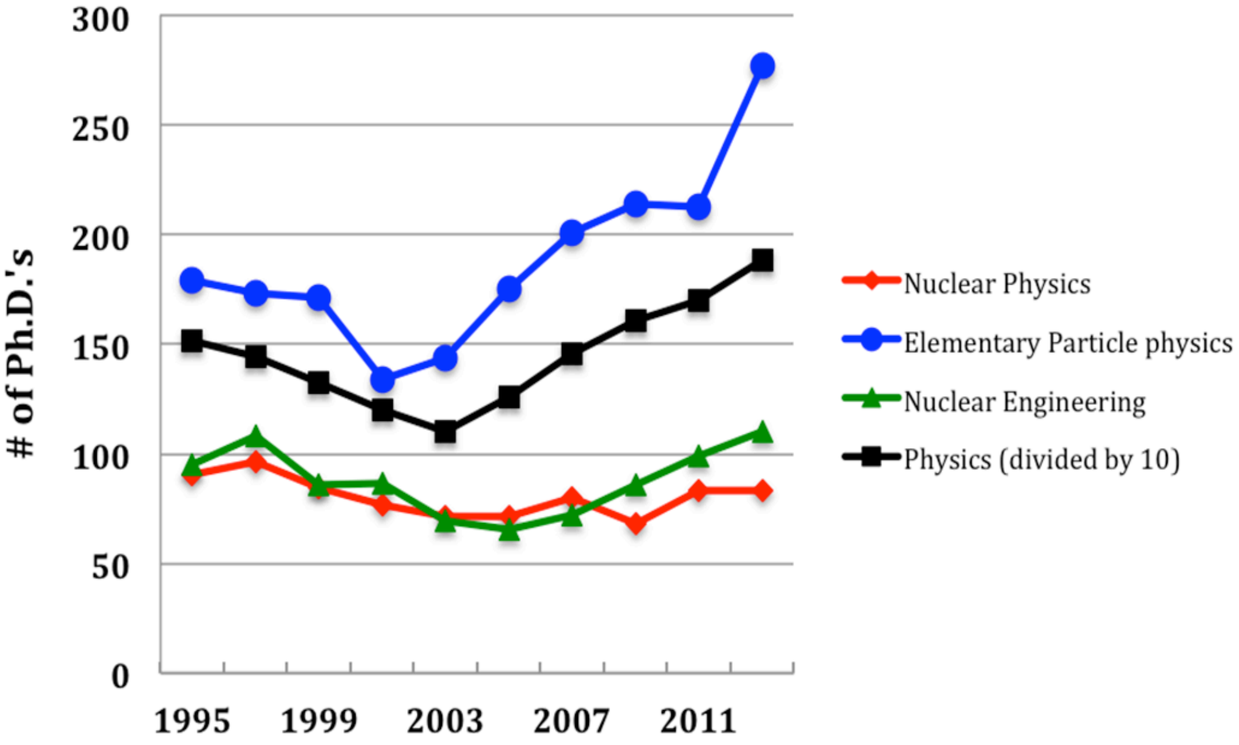
- Making the case for education,
- Making the case for outreach,
- What is being done in education,
- What is being done in outreach,
- Some ideas for improvements

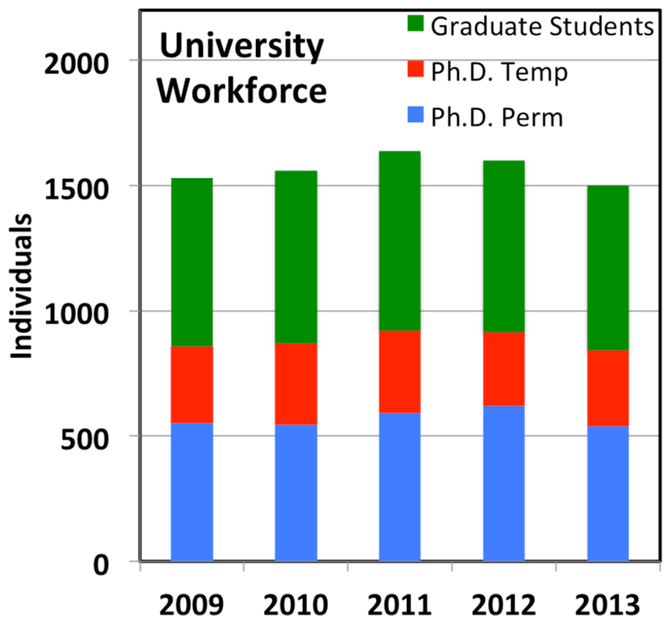
correlated with Rossi Reed's nice talk on Fri. 9am

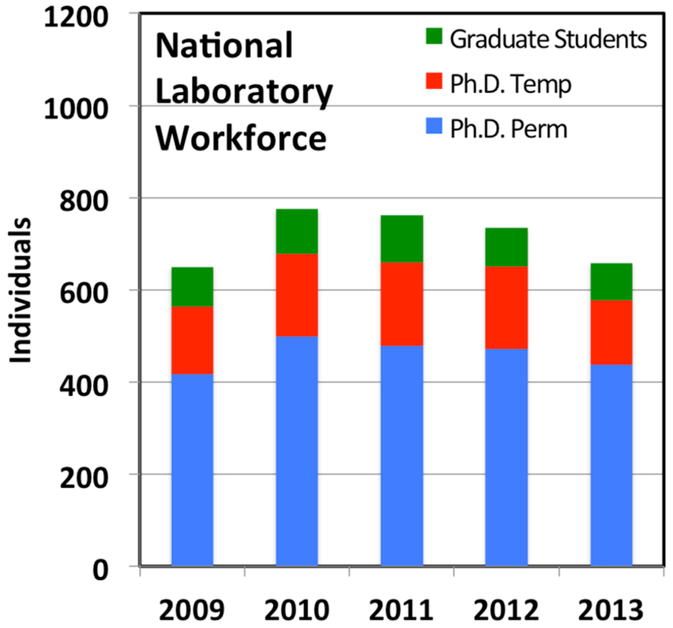
not-totally half baked

The case for education

"A highly qualified workforce trained in nuclear science is the most important element in realizing the scientific goals of the field." - LRP (2015)



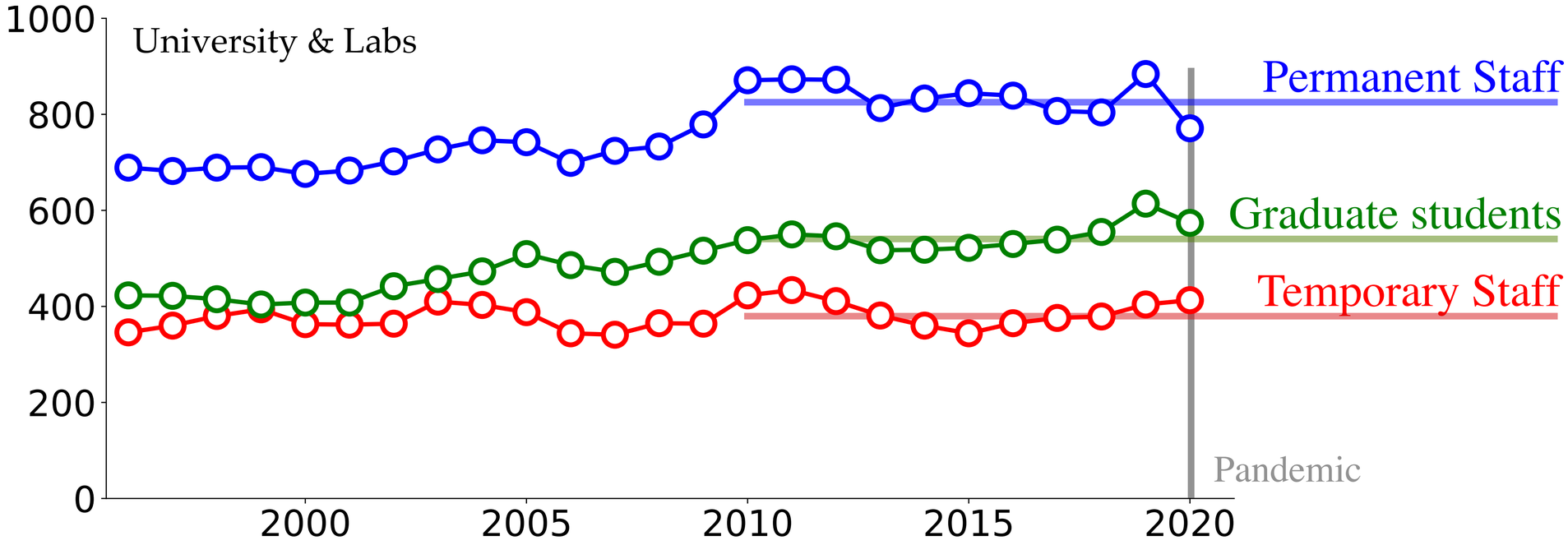




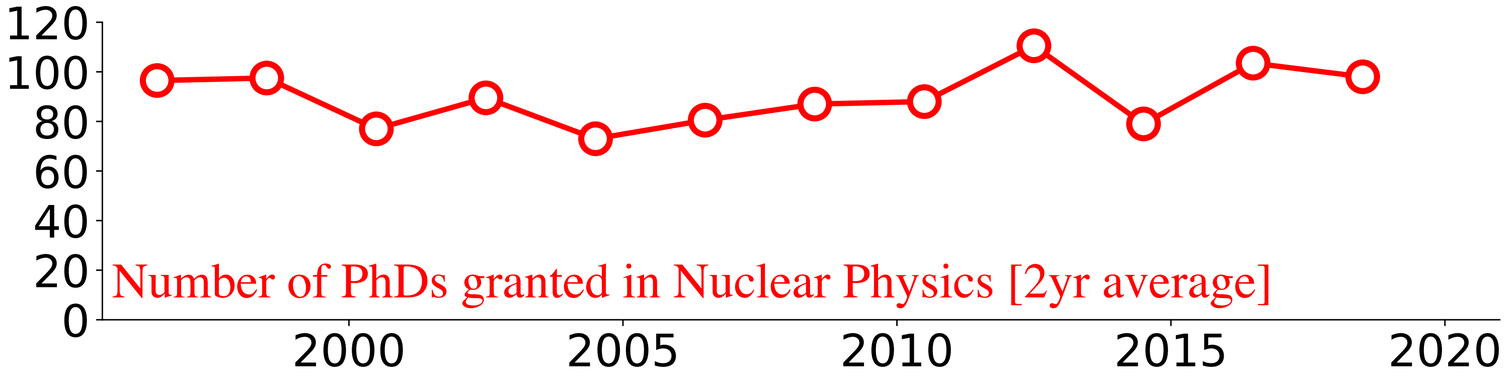
The 2004 NSAC report recommended "the nuclear science community work to increase the number of new Ph.D.'s in nuclear science by approximately 20% over the next five to ten years." - LRP (2004)

"However, the recommended increase in the annual number of Ph.D. degrees in nuclear science has not been realized." - LRP (2014)

The case for education [update]



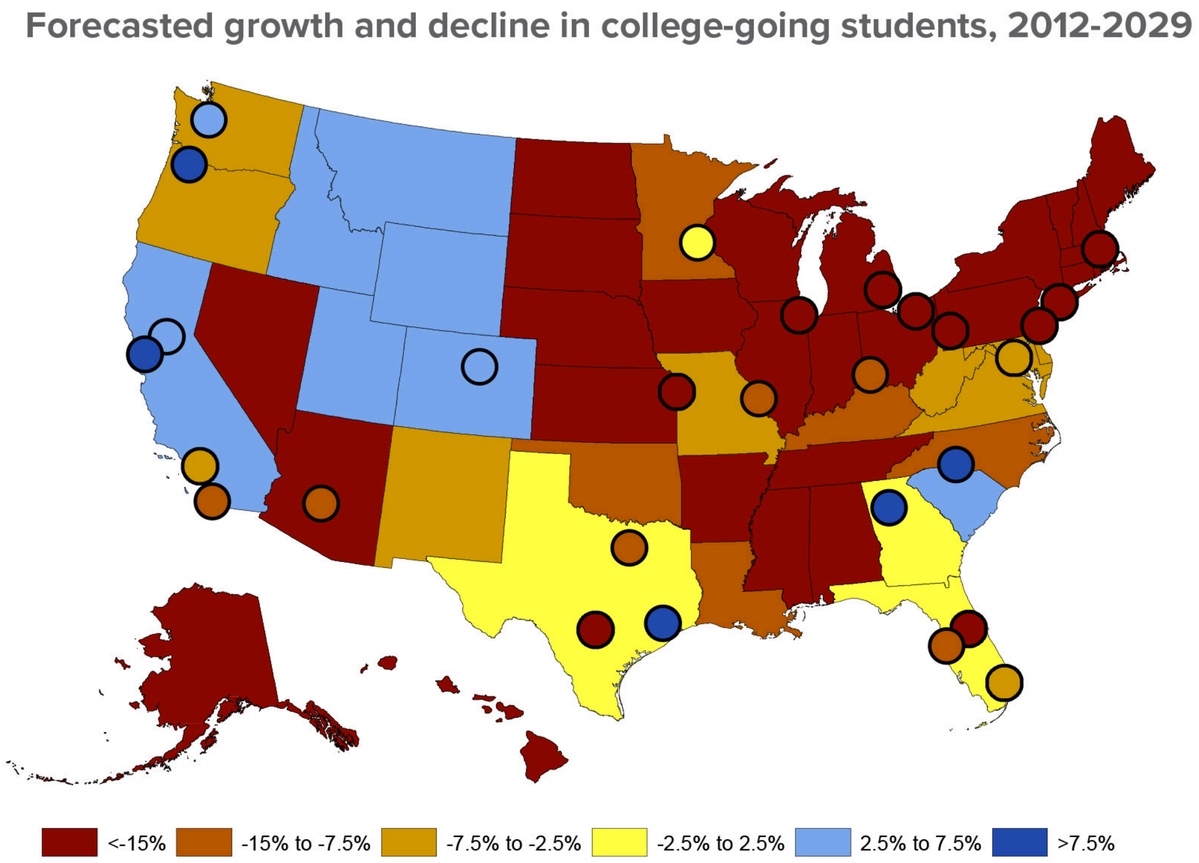
Incomplete data, but trend is consistent with previous year. **Field size is constant, despite recommendations for growth.**



DOE - FY2020 Nuclear Physics Workforce Survey [link]

Looming challenges in education

- Faculty tracks lost in Physics,
- Enrollment cliff
  - 2008 recession, climate crisis,…, immigration policies,…



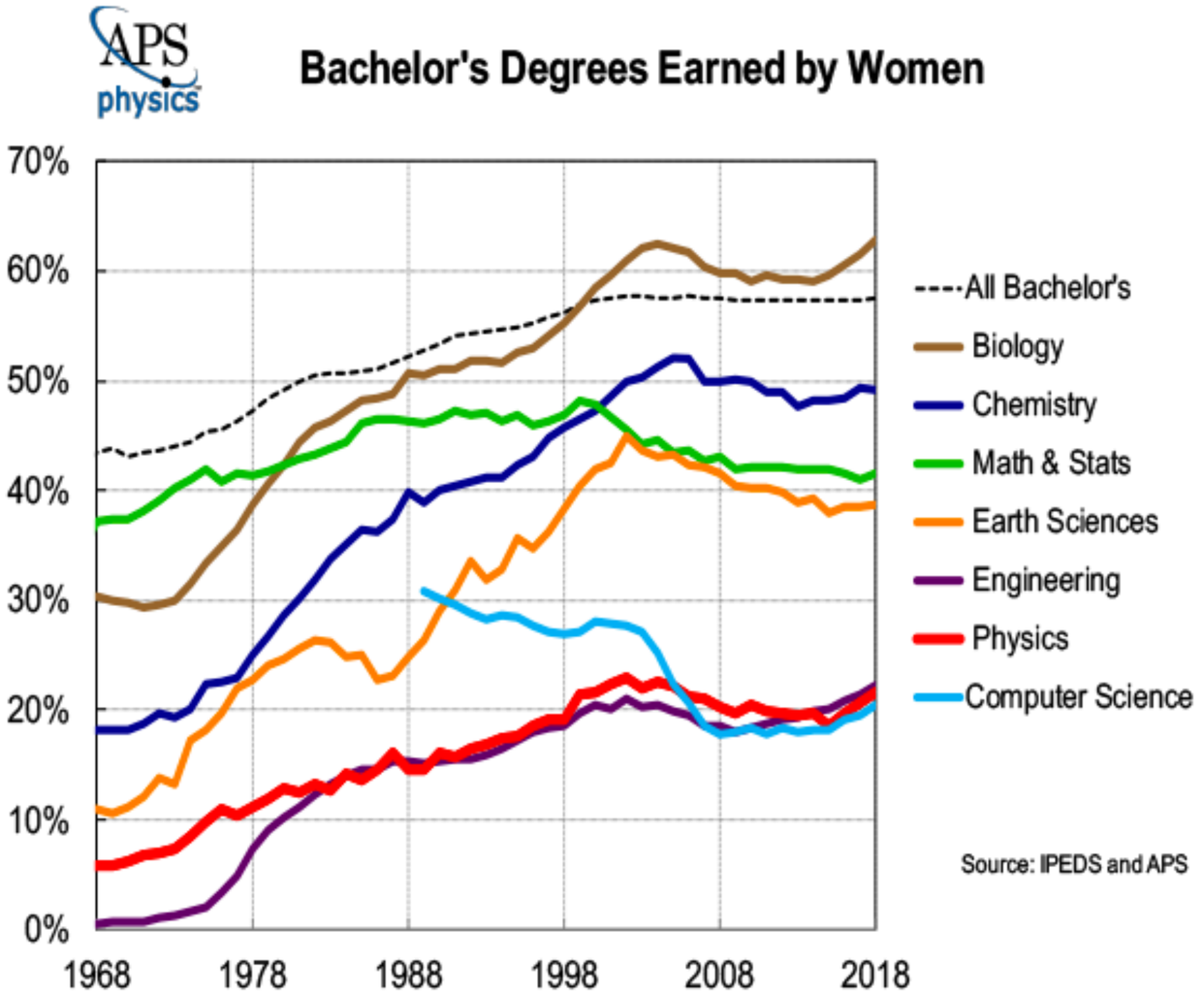
Source: Nathan D Grawe, Carleton College.pdf

Rossi Reed Fri. 9am

The case for outreach

"The document should also articulate how efforts to promote and sustain a diverse, equitable, and inclusive nuclear science workforce will be fully integrated into every aspect of the vision for the future of U.S. nuclear science."

- call letter



APS source

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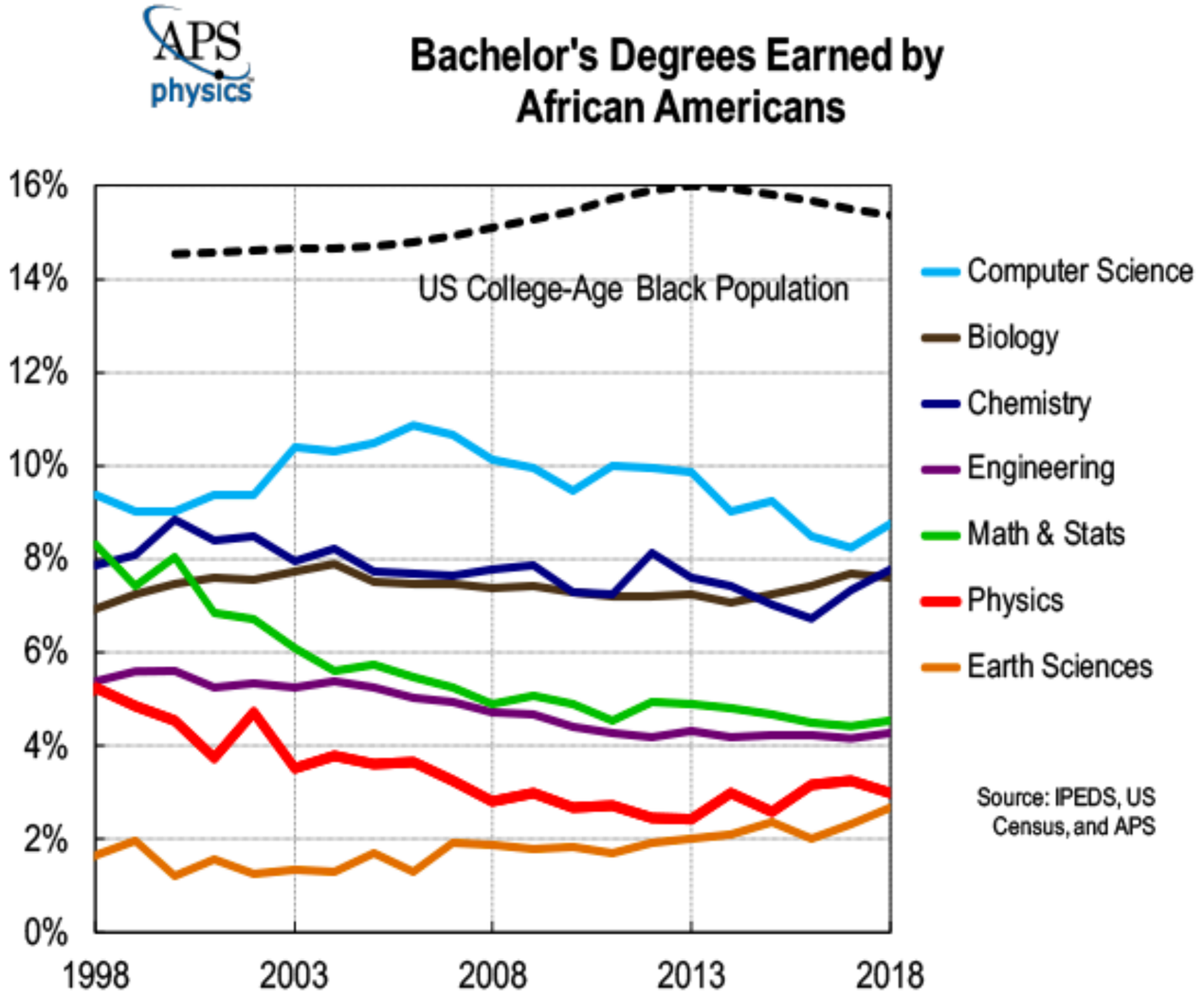

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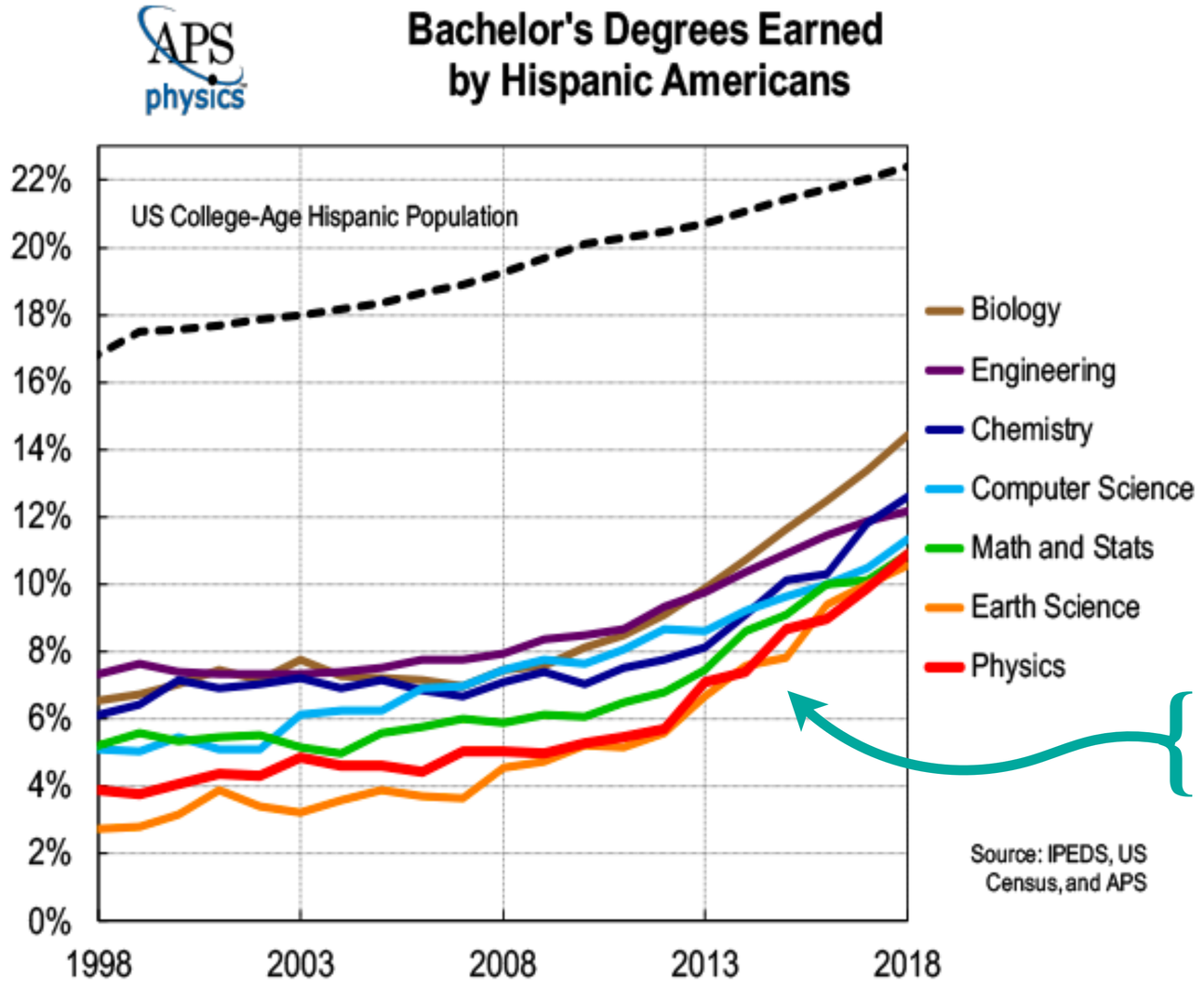

{ seems to track population of documented Hispanics }

APS source

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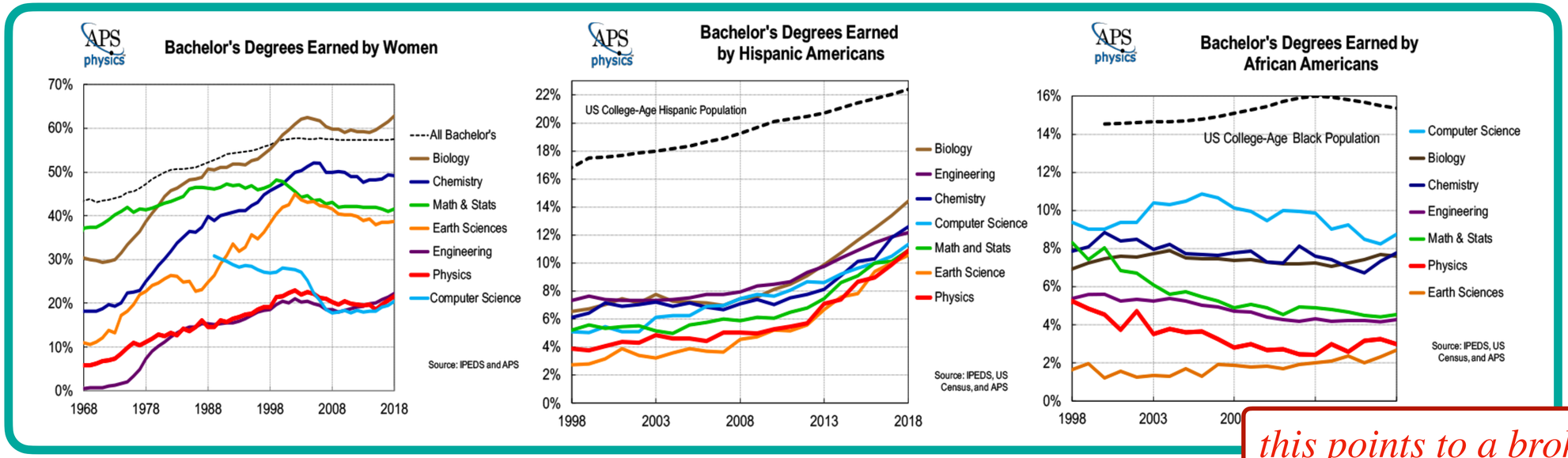


this points to a broken pipeline

"Diversifying the workforce in nuclear science requires that the **entry pathways be broadened**. "

"More broadly, outreach activities are essential to raise the recognition of the value of basic and applied nuclear research." - LRP (2015)

"Students don't typically take Physics until 11th grade, and by then they have already planned out their whole life" - HS Teacher

LRP 2014 recommendations

- ***Enhance programs**, such as the NSF-supported Research Experiences for Undergraduates (**REU**) program, the DOE-supported Science Undergraduate Laboratory Internships (**SULI**), and the **DOE-supported Summer School in Nuclear** and Radiochemistry, that introduce undergraduate students to career opportunities in nuclear science.*
  - SULI are now available in springs and fall.
  - REU is unclear to me if expanded.

- *Support **educational initiatives and advanced summer schools**, such as the National Nuclear Physics Summer School, designed to enhance graduate student and postdoctoral instruction.*
  - support was continued.
  - unclear to me if expanded.

- *Support the creation of a **prestigious fellowship program** designed to enhance the visibility of outstanding postdoctoral researchers across the field of nuclear science.*
  - unclear to me if this happened…FRIB fellows?

The 2015
LONG RANGE PLAN
for NUCLEAR SCIENCE

Strong educational recommendations.

Unclear what outreach outcomes were expected.

What role should DEI play if any?

Ongoing Educational Institutional Efforts

an incomplete lists

DOE

- ☑ DOE Science Undergraduate Laboratory Internships (SULI),
  - ☐ 17 participating DOE facilities,
  - ☐ Green card holders and citizens, *
  - ☐ 10 weeks in Summer Term; **16 weeks in Fall and Spring**.
- ☑ Science Graduate Student Research (SCGSR) Program,
  - ☐ Green card holders and citizens, *
  - ☐ 3-12 months at one of 19 DOE facilities.
- ☑ Workforce Development for Teachers and Scientists (WDTS).

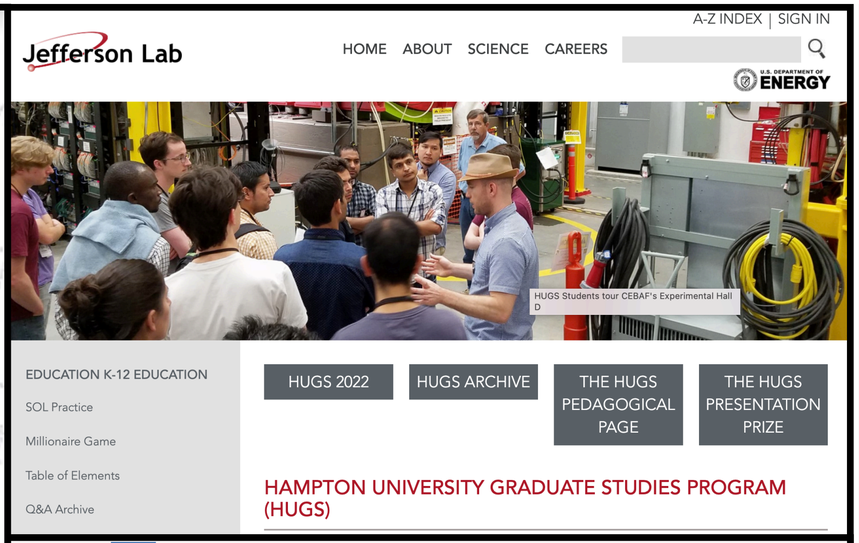
NSF

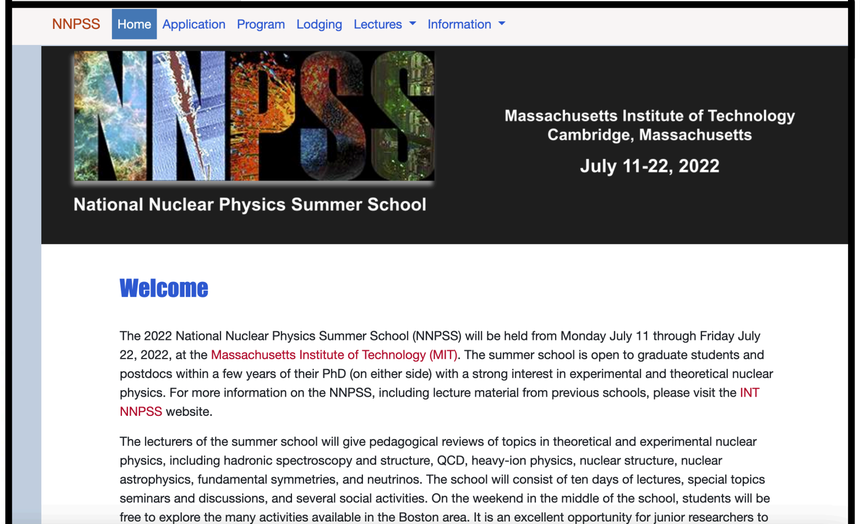
- ☑ NSF Research Experiences for Undergraduates (REU),
  - ☐ Green card holders and citizens, *
  - ☐ 10 weeks in Summer Term.

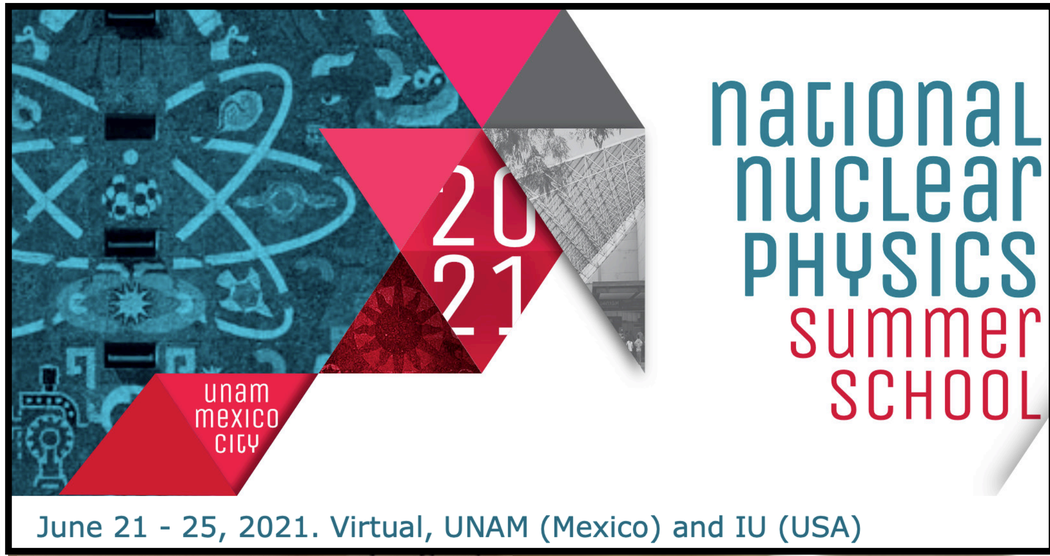
*for US citizens and green card holders

Summer schools

- ☑ Critical to compliment the disappearance of advance courses across the nation!
- ☑ Increasing repository of useful free lectures online







Outreach efforts

an incomplete lists

- ☑ DOE Lab host:
  - ☑ open house,
  - ☑ summer paid internships,*
  - ☑ K-12 programs,
  - ☑ Youtube video series, etc.
- ☑ **Research Traineeships to Broaden and Diversify Nuclear Physics**

  (announcement, 2021 FOA)

DOE

Office of Science

Department of Energy Announces $3 Million for Pilot Diversity Program

DECEMBER 16, 2020

Office of Science » Department of Energy Announces $3 Million for Pilot Diversity Program

Washington, DC--Today, the **U.S. Department of Energy (DOE)** announced a plan for a pilot program to provide $3 million for research traineeships to broaden and diversify the nuclear physics research community.

The planned funding will support training and research experiences for undergraduates, with the goal of increasing the likelihood that participants from underrepresented populations will choose to pursue a graduate degree in nuclear physics or another science, technology, engineering or math (STEM) related field.

"In a nation as racially and ethnically diverse as the United States, diversifying the nation's scientific workforce is a continuing matter of high priority," said Dr. Chris Fall, Director of DOE's Office of Science. "This pilot program will pioneer new approaches to attracting talented students of diverse backgrounds to pursue graduate study in nuclear physics and other critical STEM fields."

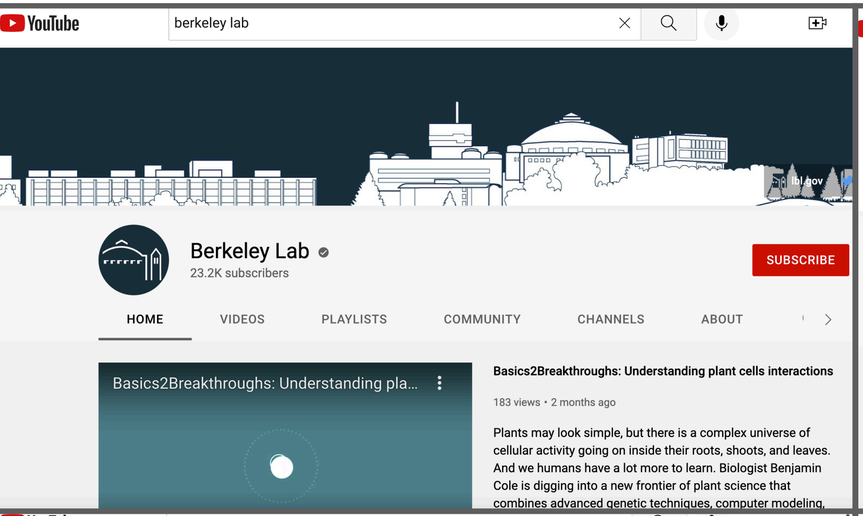
The traineeships, designed for undergraduates, aim to provide students with a hands-on opportunity to participate in actual ongoing nuclear physics research in a team under the supervision of a principal investigator (PI).

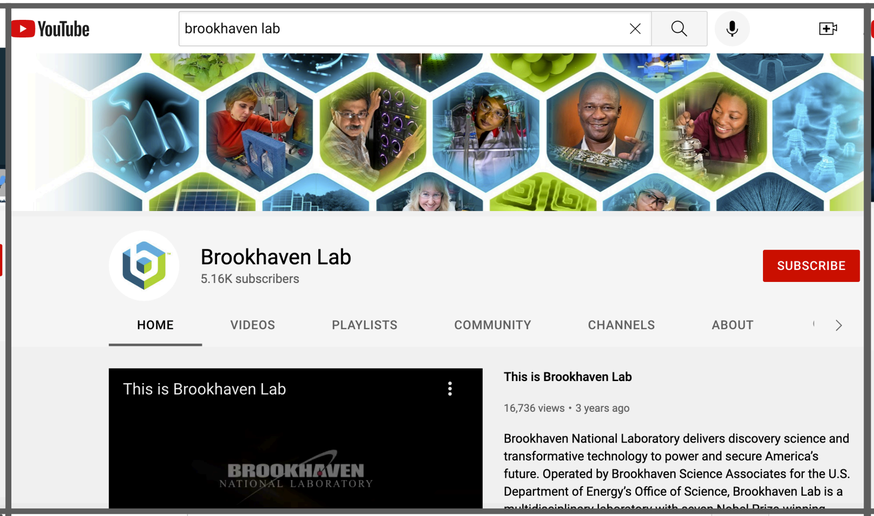
"In a nation as racially and ethnically diverse as the United States, diversifying the nation's scientific workforce is a continuing matter of high priority," Dr. Chris Fall

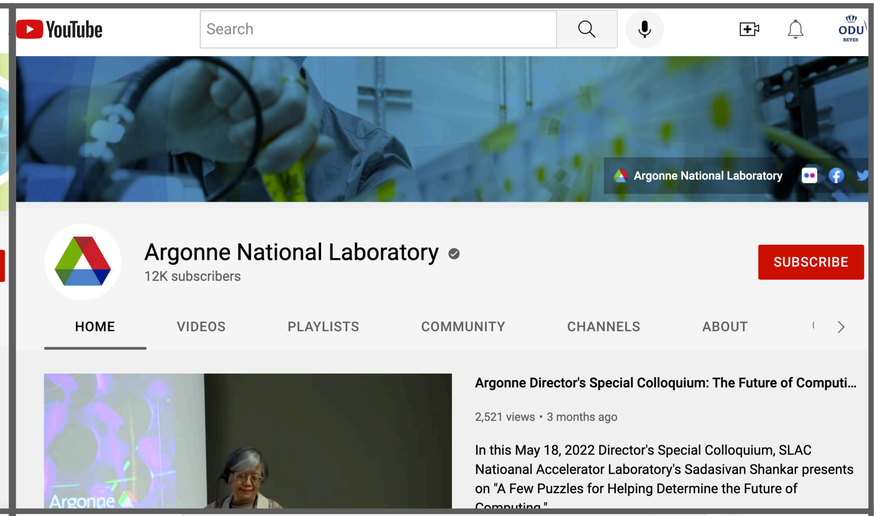
*for US citizens and green card holders

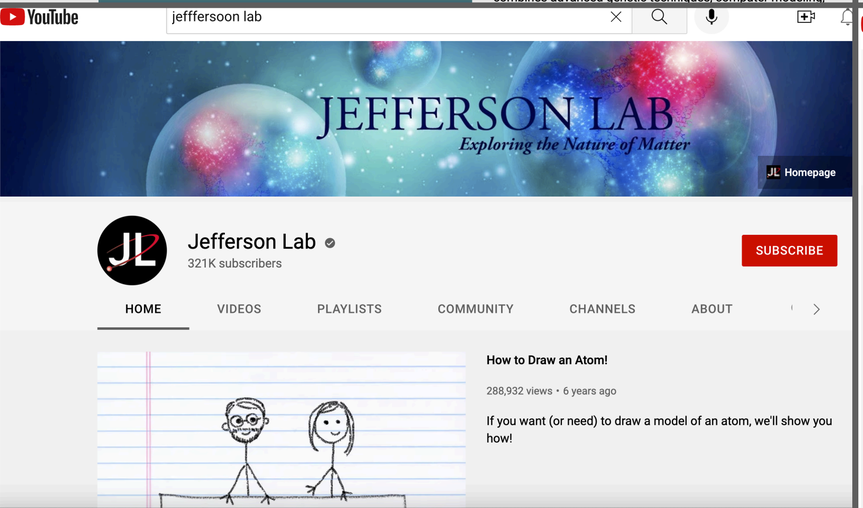
Social Media

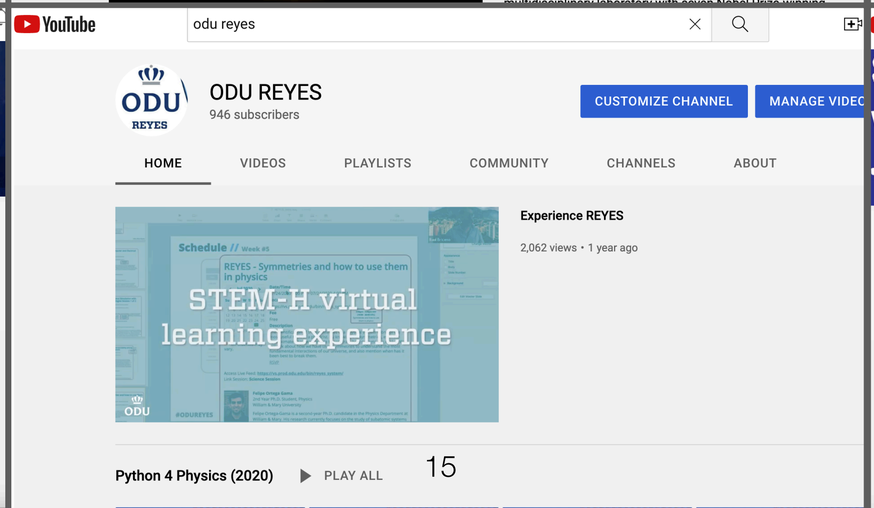
- [x] Strong YouTube, Twitter, & Facebook presence!
- [ ] Do we need to move to TikTok to reach younger folks? 🤔

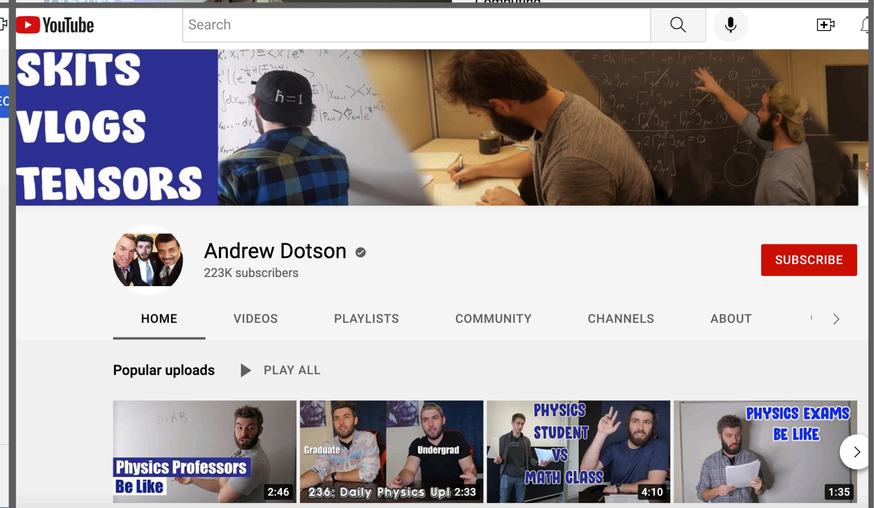








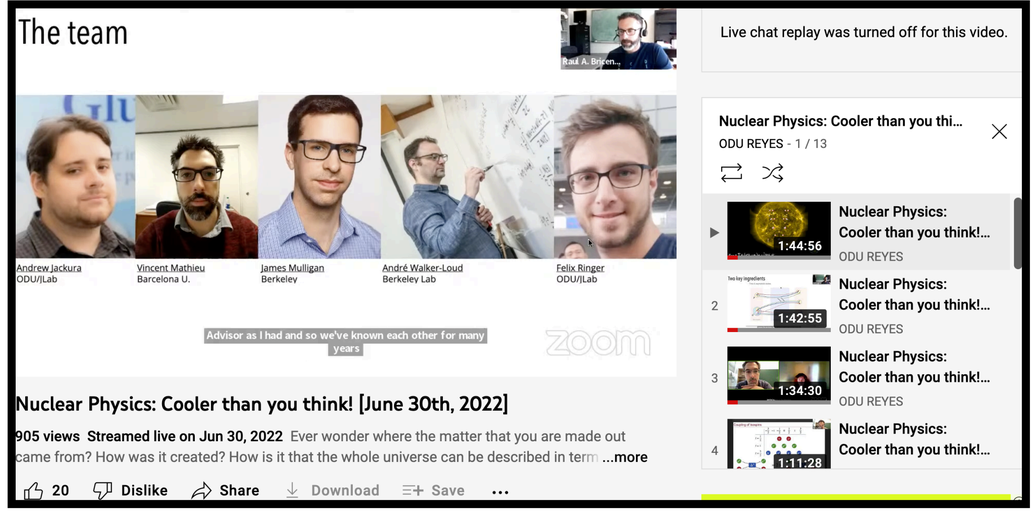


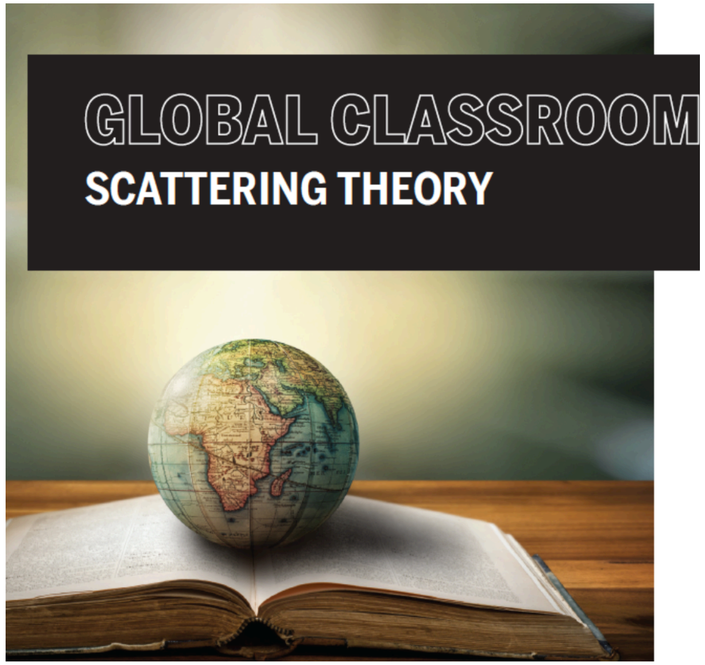


Efforts led by individuals

an incomplete lists

- ☑ Free courses for HS.
- ☑ Courses on advanced topics [Szczepaniak, Shanahan]
  - ☐ Scattering theory, AI & Physics, etc.
- ☑ Summer schools
- ☑ Mentoring programs:
  - ☐ Women in Physics, remote mentoring.
- ☑ Internships: QIS For Undergrads [Fermilab group]
- ☑ Bridge programs.
- ☑ Transferring programs from Community College:
  - ☐ UC Berkeley [W Haxton] providing funds to help train students.
- ☑ Podcast [HW Lin]
- ☑ QCD Games [HW Lin]
- ☑ Improving scientific mythology for undergrads [T Rogers]



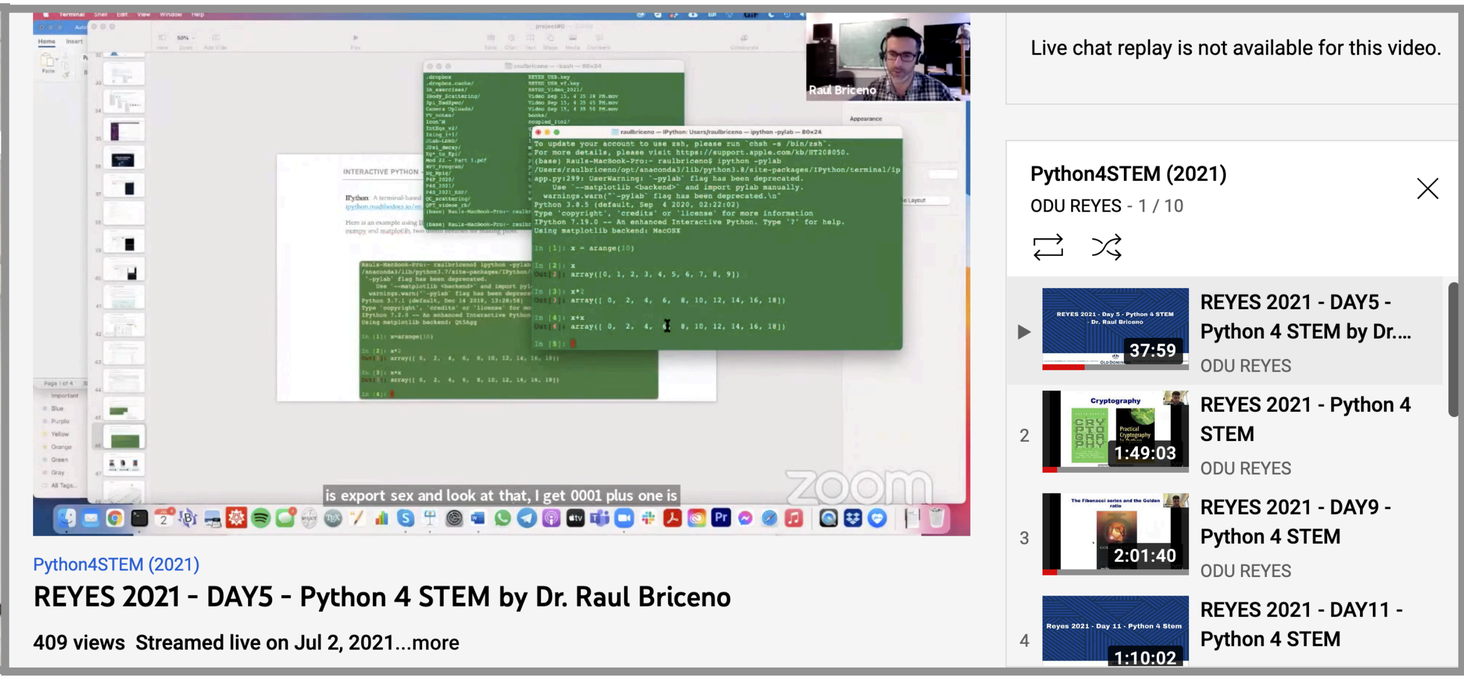


see back-up slides for more information

Python4Physics // Python4STEM

"Students don't typically take Physics until 11th grade, and by then they have already planned out their whole life", "student don't like Physics" - HS Teachers

- **Free** class aimed at making programming fun and teach some basics of data analysis and numerical problem solving.
- All ages and backgrounds [lower barriers of entry].



Remote Experience for Young Engineers and Scientists (REYES)

- 80+ STEM-H virtual sessions and classes + Q&A; broadcast live by ODUOnline
- Free and open to the public, accessible via YouTube
- Mentoring from world experts

Statistics

Over 12,000 participants from over 130 countries

STEM Inspiration

Thanks to REYES, **70%+** felt more confident and enthusiastic in pursuing a career in STEM and conducting research.

Observations [we are being asked to do more with less!]

1. Individual faculty will not fix systemic problems

well intended people get spread too thin and can hurt at the level of promotion,
unsustainable [one person leaves, and efforts collapse],
overburden with admin work,

2. Financial support is needed for smaller outreach efforts

that don't fall within the big programs

3. Shrinking departments

harder to do outreach and teach advanced courses.

4. Effective communication problem

we are not train as educators, much less as communicators to general audiences.

5. Good intension aren't enough

we don't generally understand the sources of the problems we are wanting to solve, e.g. DEI.

efforts could backfire.

Ideas/recommendations

1. Awards & recognitions for outreach efforts. Financial support

2. Fellowships/internships for students abroad to come to DOE facilities.

On going Mexico with JLab and now Berkeley internships, using individuals funds.

3. Prestigious fellowships/postdocs and/or bridges not tied to any specific effort.

Folks from diverse background respond more to broad advertisements.

Narrow searches can have unintended exclusionary effects.

"Diversifying the workforce in nuclear science requires that the **entry pathways be broadened**." - LRP (2015)

4. Travel fund award for grad students and scientists to go abroad or rural places.

"Engineers without borders" but for Nuclear Physicists.

See Sherwood Richers slide on efforts in el Salvador.

5. Nuclear physics summer schools abroad (Mexico, …, Africa…) and/or Puerto Rico

6. Teaching relief funds for faculty hosting summer schools.

7. Flexible pools of money for miscellaneous outreach efforts.

8. Remote mentoring funds.

REYES. Salary for admin, grad students, postdocs, and students. Funding international students and/or mentors?

9. Open up REU, SULI and SCGSR for non-Americans

Ideas/recommendations [cont.]

10. REU & SULI partnerships with community colleges and minority serving institutions

11. More needs for asynchronous teaching of advanced courses.

12. NSF vs. DOE grants:

Do the NSF Broader Impacts requirement have a measurable impact in the actions of the PI/groups?

[e.g. do NSF PIs have more diverse groups?].

If so, should this be incorporated into the DOE?

If not, should this requirement be replaced or changed?

Should it be required that DOE PIs get involved in existing outreach efforts?

13. Should lab bridges require faculty to spend time at lab?

If so, does this hurt individuals with family?

14. Should lab offer or help with child care?

In particular junior/temporary staff that are new to the area?

Recommendation 4: Workforce Development

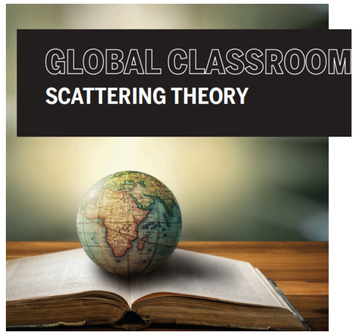
Nuclear physics has an important role to play in developing a diverse STEM workforce for the critical needs of the nation. Creating and maintaining an equitable, productive working environment for all members of the community is a necessary part of this development.

We recommend enhanced investment in the development of a diverse, equitable workforce.

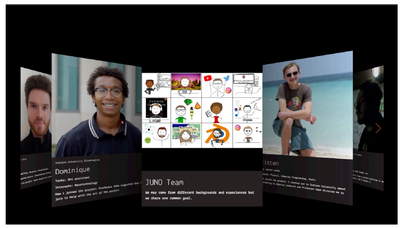
- Part of recruiting and maintaining a diverse workforce requires treating all staff with respect and dignity. We therefore recommend that the funding agencies require establishing enforceable codes of conduct (community agreements) in both experimental and theoretical collaborations, as well as conferences, workshops and at user facilities.
- We recommend development and expansion of programs that enable participation in research by students from under-represented communities at National Labs and/or Research Universities, including extended support for researchers from minority-serving and non-PhD granting institutions.
- We recommend development and expansion of programs to recruit and retain diverse junior staff at universities and national laboratories through bridge positions, traineeships, and other incentives.

Backup slides

- Workforce development is critical.
- It should include broadly accessible training sites that take advantage of distributed expertise with strong emphasis on project based learning.
- Graduate course on reaction theory (2015,2017)
- Seminar on Scattering Theory and Applications (2019-present)
- National Nuclear Physics Summer School (only second time outside the US UNAM, 2021)
- Outreach



June 21 - 25, 2021. Virtual, UNAM (Mexico) and IU (USA)



Adam Szczepaniak

Mentoring for Careers in Physics

One-on-one professional mentoring for female students in the Department of Physics at William & Mary

Goals: build STEM identity and sense of physics belonging; develop professional skills; and provide networking, internship and employment opportunities

One year pilot program launched in Dec 2021
24 female undergraduate student mentees
24 female mentors in STEM fields, with physics or engineering-physics training or in physics-related positions, drawn from organisations as diverse as NASA, leading semiconductor manufacturers, and TikTok
Mentee-mentor pairs meet (at least) monthly, with structured mentoring and social activities

On-going qualitative and quantitative program evaluation carried out in collaboration with the School of Education
Administrative assistance provided through an undergraduate Program Assistant
Website and social media presence under construction, built by undergraduate web developer
Recruitment for both mentees and mentors for the 2022-2023 cohort starting now!

Supported in part by The Society of 1918, the Office of Diversity & Inclusion through an IDEA grant, and the Department of Physics

Quantum Computing Internship For Undergrads

3-week Summer school for 15-20 Students + year-long internship for 4-5 Students
Goal to develop diverse workforce with skills needed to succeed in academia and industry

Young field provides opportunity to build inclusive community

- Students paid competitive hourly wage

Essential to enable participation by students from all socioeconomic backgrounds.

- Topical lectures by experts in the field

Quantum physics & mathematics, quantum algorithms, error mitigation & correction, quantum hardware. Self-contained and ***accessible to all preparation levels***.

- Pair programming on quantum simulators & real devices

Computational exercises in Python + Qiskit (IBM's SDK) on classical and quantum algorithms. Final project simulating 1+1d gauge theory on real devices.

- Panels and informal discussions on career opportunities

Panelists from ***both academia and industry***. Information about applying to and paying for graduate school especially important for first-generation college students.

- Year-long interns perform publishable research

Primitive Quantum Gates for an SU(2) Discrete Subgroup: BT [2208.12309]
Lattice Simulation of Z2 gauge theory on a quantum computer (*in prep*)

Fermilab

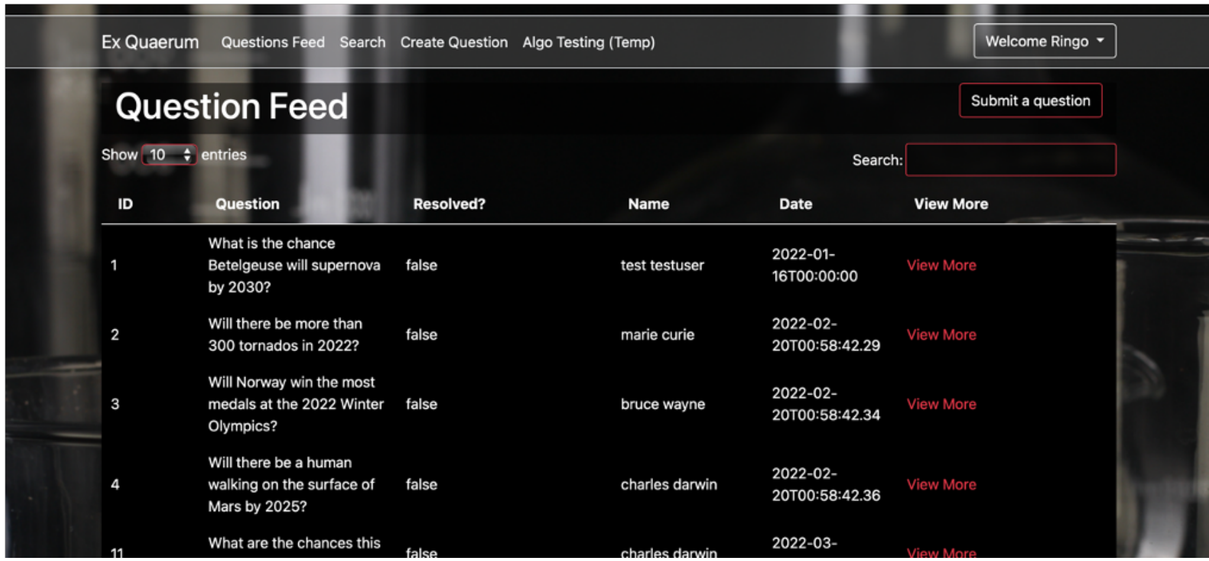
Henry Lamm
Michael Wagman
Ruth Van De Water

DOE Quantum Information Science Enabled Discovery (QuantISED)

Improving undergrad's scientific methodology

- Motivation: Development of a massive online scientific prediction engine (MOSPE)
- A database of predictions to assess scientific progress

- Current project: Simulate the effect of different reward algorithms



T.C. Rogers, *A self-governing, self-regulating system for assessing scientific predictive power,* https://arxiv.org/abs/2205.04503

- We need more support for this and similar projects that simultaneously aid the nuclear science program while training new generations in good scientific practice

NSF AI Institute for

Artificial Intelligence & Fundamental Interactions (IAIFI)

IAIFI Fellowship Program

- 3 postdoocs / yr
- Currently, 7 postdocs ranging from astrophysics to neutrinos

Interdisciplinary PhD in Physics, Statistics, and Data Science

- Launched Fall 2020; 5 students enrolled, +4 graduated
- Particularly beneficial to international students
- Utilizes existing structure of MIT's Interdisciplinary Doctoral Program in Statistics

MITx Course in Physics & AI

- Based on Computational Data Science in Physics course,
- will launch on MIT's digital learning platform,
- Applies statistical/AI methods to real-world experimental data sets from LHC, LIGO, and astrophysics
- Modular, open access resource for physicists interested in computational data science

IAIFI Summer School & Workshop

- Held first in August 2022: ~80 Summer School and >100 workshop attendees
- Covered topics at the intersection of physics and AI, attendees from both fields
- About 200 applications for the Summer School, included virtual option

Project 1 :
Gravitational Wave Data
From LIGO

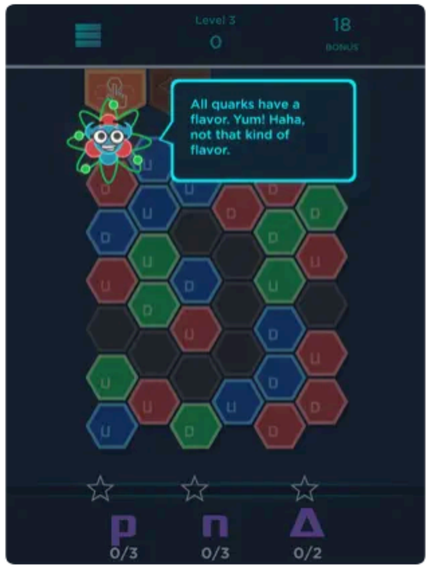
Project 2 :
Collider Physics Data
from the Compact Muon Solenoid
on the Large Hadron Collider

Project 3 :
Cosmic Microwave Background
(simulated) Data

Phiala Shanahan

Everyone Should Learn QCD!

- Free app designed to teach kids the quark content of hadrons.



- Available at: Google Play and Apple Store

- The app has also been used in the intro to physics and nuclear physics undergraduate class
- Link to story about app

Podcast for Students

- Podcast aiming to humanize physicists,
- On each episode, a different physicist discusses:
  - their research,
  - what got them interested in physics,
  - obstacles they overcame,
  - what their typical day looks like,
  - tips and suggestions for students.

Physicists are people with lives outside of the lab. Guests share about their interests and hobbies outside of research. Be sure to listen if you are interested in becoming a physicist too!

Lattice QCD Summer School

- Flipped classroom model
- Students learn in advance with pre-recorded lectures
- Pre-class questions to test their understanding
- During the class
- Q&A
- Test students' understanding with in-class activities & problem solving
- Peer learning among small groups
- More chance to interact with lecturers and TAs
- Slack channel for post-class discussions

Astronomy in El Salvador



- Sherwood Richers travels to El Salvador annually to forge connections with Salvadoran universities.
- Public and research talks
- Portable solar observing
- University workshops
- Teacher education
- Remote research advising

- Communication requires in-person presence.
- University students are very eager to do research but have poor understanding of the system and little access to opportunities.
- School teachers are as thrilled as school students to look through a telescope and learn about astronomy.
- Physics/astronomy are not generally viewed as useful degrees.

Sherwood Richers

N3AS Network for Neutrinos, Nuclear Astrophysics, and Symmetries
PHYSICS FRONTIER CENTER

NSF

Berkeley
UNIVERSITY OF CALIFORNIA

N3AS-PFC Program in Support of Transferring Undergraduates

Motivation:

- *Public research universities have traditionally been at the forefront in keeping university education asccessible and enabling economic mobility*
- *2009 recession led to widespread cuts in state support that have proven permanent, causing large tuition increases, cutting off access**
- *UC system in 2016 created UC Transfer Pathways to address this issue, coordinating community college programs with university curricula, so that the most talented CC students could successfully transfer*
- *about 1/3rd of Berkeley physics juniors now enter through this portal*
- *this student group is significantly more diverse than their four-year cohort: race, ethnicity, immigration status, age, work experience, economic independence*
- *STEM disciplines the most popular, but the transition has proven very difficult for many students: course articulation difficulties, social isolation on joining a new group. Many students give up, leave Physics for less challenging areas*

N3AS program: *Two years of postdoc- and faculty-led individual mentorship, paid introduction-to-research appointments, to support, encourage, and motivate the students. Peer interactions provide a sense of identity, belonging. Designed by and led by N3AS postdocs. 16 students in 2022.*

Now: *Seeking private support to extend this program*

N3AS Network for Neutrinos, Nuclear Astrophysics, and Symmetries
PHYSICS FRONTIER CENTER

NSF

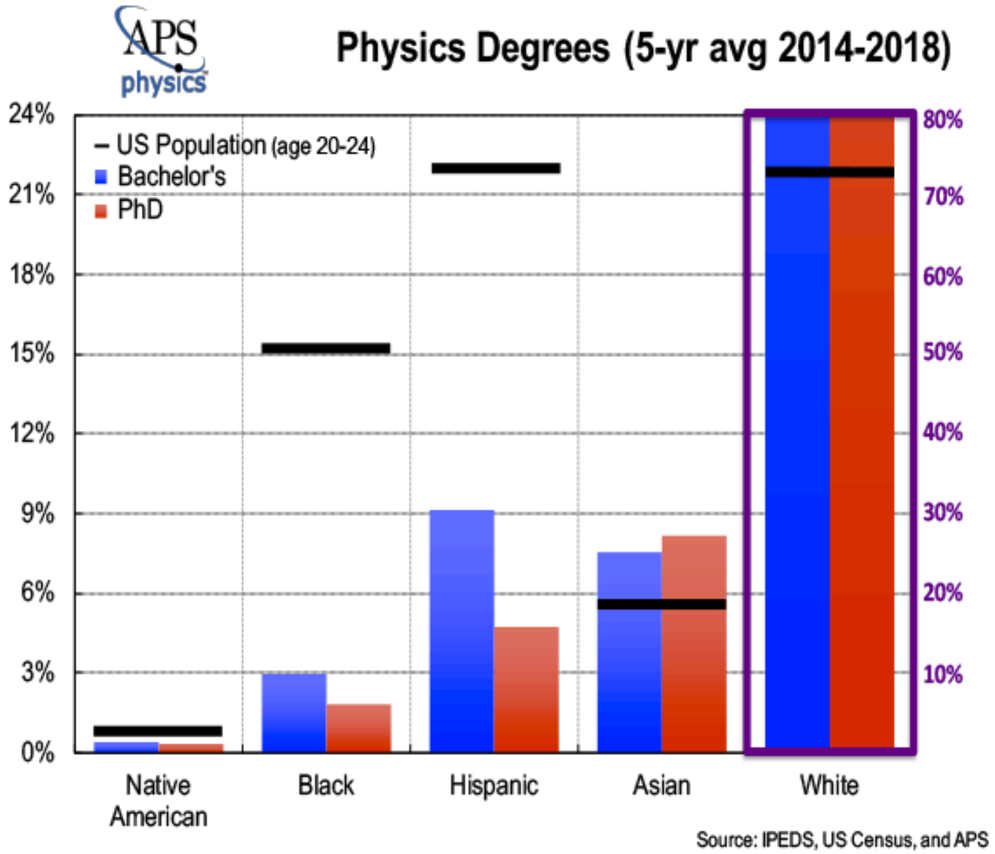
*American Academy's Lincoln Report

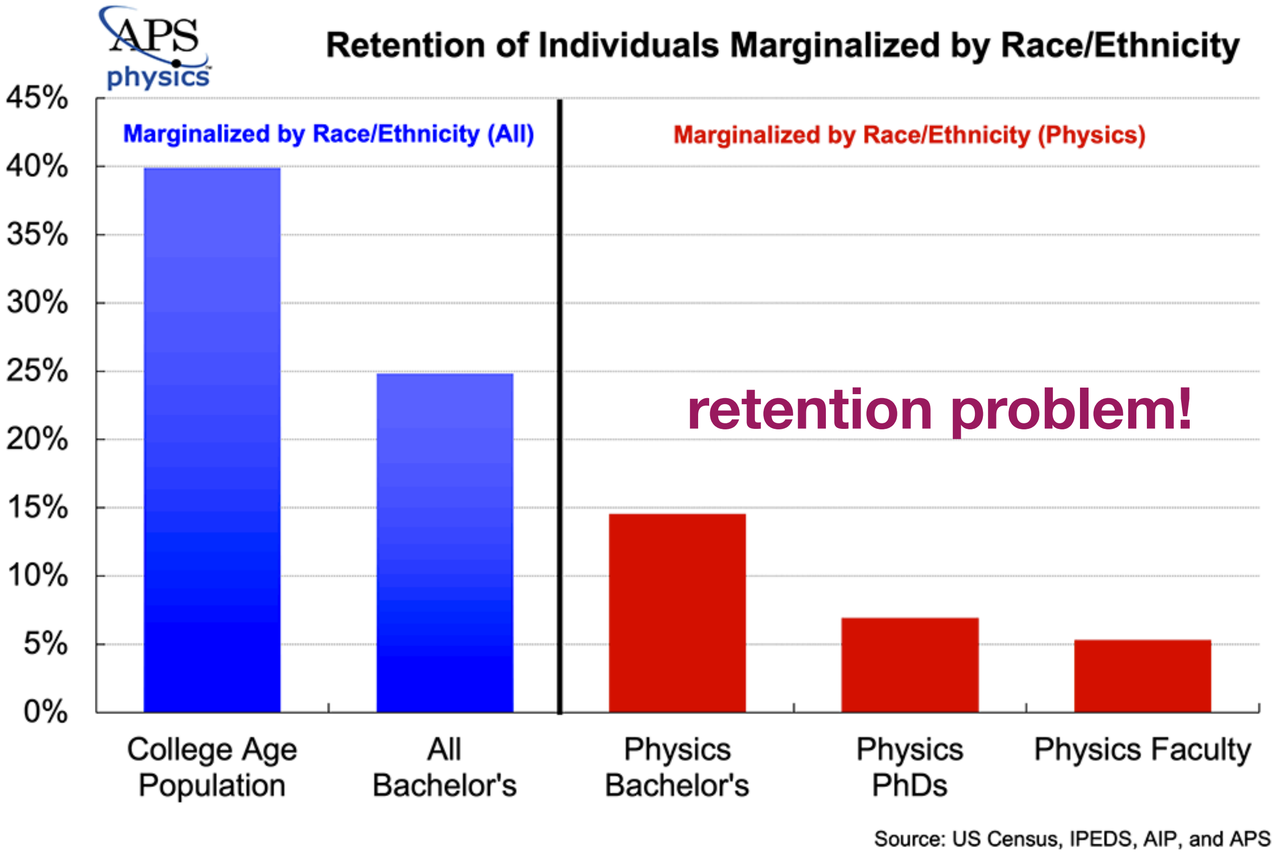
Wick Haxton

Berkeley UNIVERSITY OF CALIFORNIA

BERKELEY LAB

More demographics





APS source: https://www.aps.org/programs/education/statistics

More demographics