# Outreach in the Next Decade

## A summary of Decadal Survey findings and recommendations

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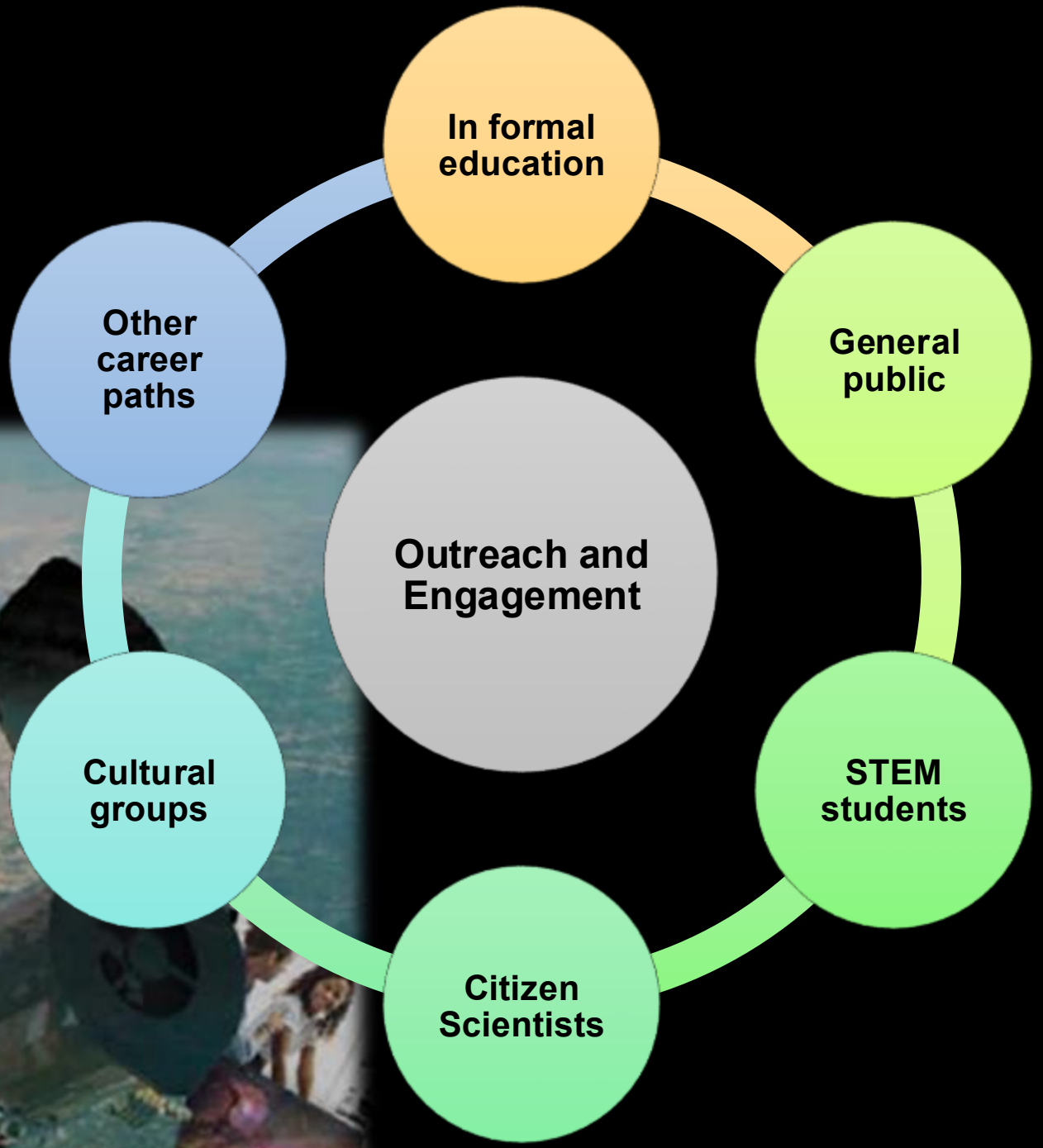
# Outreach opportunities



# Formal education settings

Solar and space physics science has not been fully incorporated into U.S. education at either the K–12 or undergraduate level in the same way that astronomy and astrophysics, Earth sciences, and planetary science have been.

- Solar and Space Physics in K–12
  - an app-based textbook developed by Big Kid Science, *Totality*, which focuses on solar eclipses
  - *Solar Science* (Schatz and Fraknoi 2016), a general solar and space science textbook aimed at middle and high school levels
  - *Solar Physics and Terrestrial Effects* (Briggs and Carlisle 2016), a PDF textbook from NOAA SWPC
  - SWUG – UNH, expanded to UAF
- Solar and Space Physics in College Education
  - Prominent astrophysics textbooks for general education classes leave out content on the foundational drivers of space weather
  - Some more advanced textbooks are available*: Introduction to Space Physics by Kivelson and Russell* (first edition, 1995). *Understanding Space Weather and the Physics Behind It* by Knipp (2011), *and An Introduction to Space Weather* by Moldwin (2008)

SWUG-UNH

# The general public

University faculty and researchers represent the fulcrum of this interaction, serving as a bridge between public and professional, education and expertise.

- Public demonstration events
- Public night-sky observing nights
- Classroom visits
- Event-specific outreach, such as events revolving around solar eclipses or space weather events

- STEAM initiatives, or STEM plus art
  - art exhibits
  - printed materials in collaboration with artists and writers
  - visual art projects

Excitement is invaluable for outreach! (e.g., the Apollo and Voyager programs) However, outreach efforts need to be sustained and expanded to have a significant influence on the public.

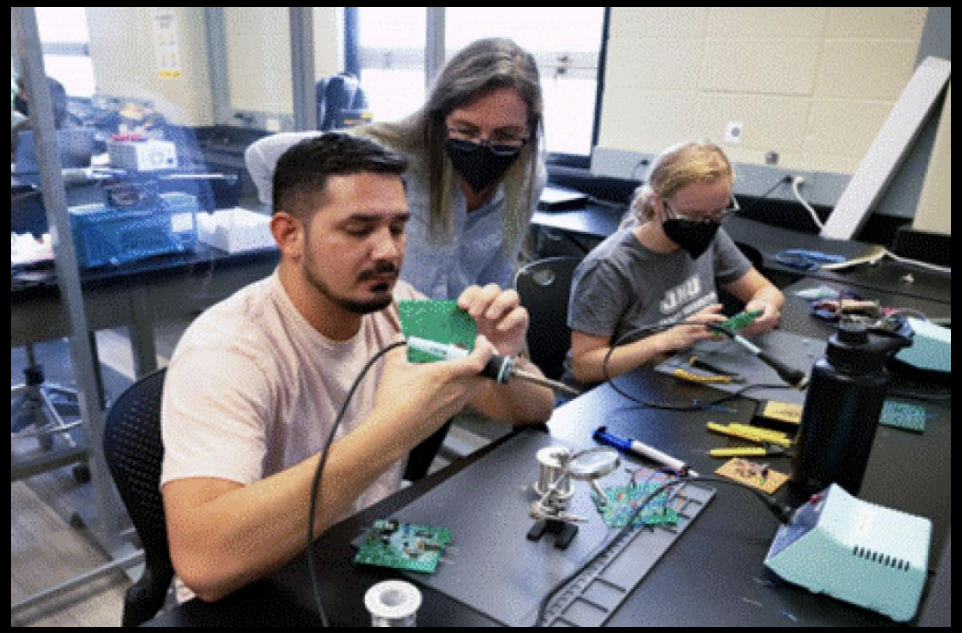
The Great American Eclipse, on April 8, 2024
(top) NASA/Bill Ingalls; (bottom) NASA/Kristen Perrin

# Inspiring STEM students

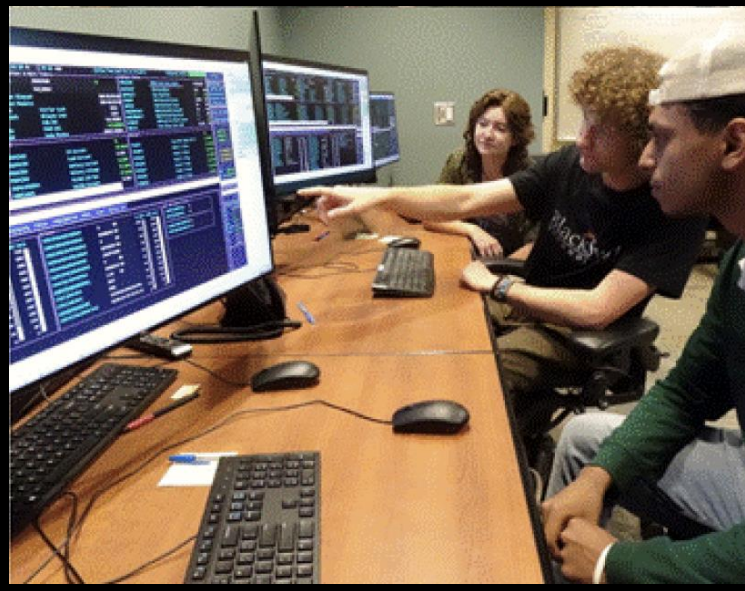
Engaging STEM students in research is the primary way we recruit and retain top talent in solar and space physics

- Long-standing hallmark programs include:
  - NSF REUs, NASA's Heliophysics Summer School, NSF's Space Weather Summer School, NASA FINESST fellowships, NSF Graduate Research Fellowships Program, NASA National Space Grant
- Summer schools, internships, research appointments, and student workshops hosted by: university PIs and government labs
  - Examples: LANL summer internships, year-long National Astronomy Consortium program
- Shorter, immersive summer experiential programs (e.g. Edge of Space Academy) are becoming more popular

The Advancing Diversity report (NASEM 2022) found that, "…early and ongoing experiences with authentic research…. is key to retaining students generally and URM students specifically"



UIowa Edge of Space Academy



CU Boulder, LASP, Science Operations student trainees

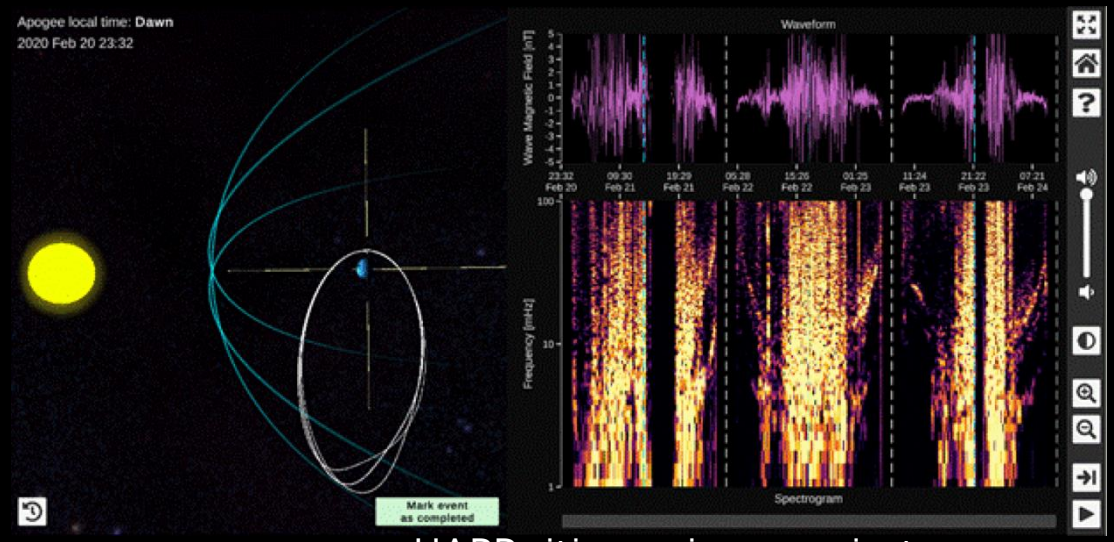
# Activating Citizen Science groups

Professional societies, together with nonprofit STEM partners, can help connect and engage those interested in and involved with citizen science to add pathways into the solar and space physics braided stream.

- "Citizen science," sometimes called participatory science, refers to collaborative work between teams of scientists and nonscientists
- Success story: STEVE, an upper atmosphere strong thermal emission velocity enhancement (MacDonald et al. 2018)
- Another impactful space physics project: NASA-funded HARP: Heliophysics Audified: Resonances in Plasma
- NASA SMD Science Activation program: starting point for these kinds of initiatives

The community is enthusiastic about participating in outreach activities but adequate funding mechanisms either do not exist or are not obvious.


Aurorasaurus card game




HARP citizen science project

# Reaching out to cultural/cohort groups

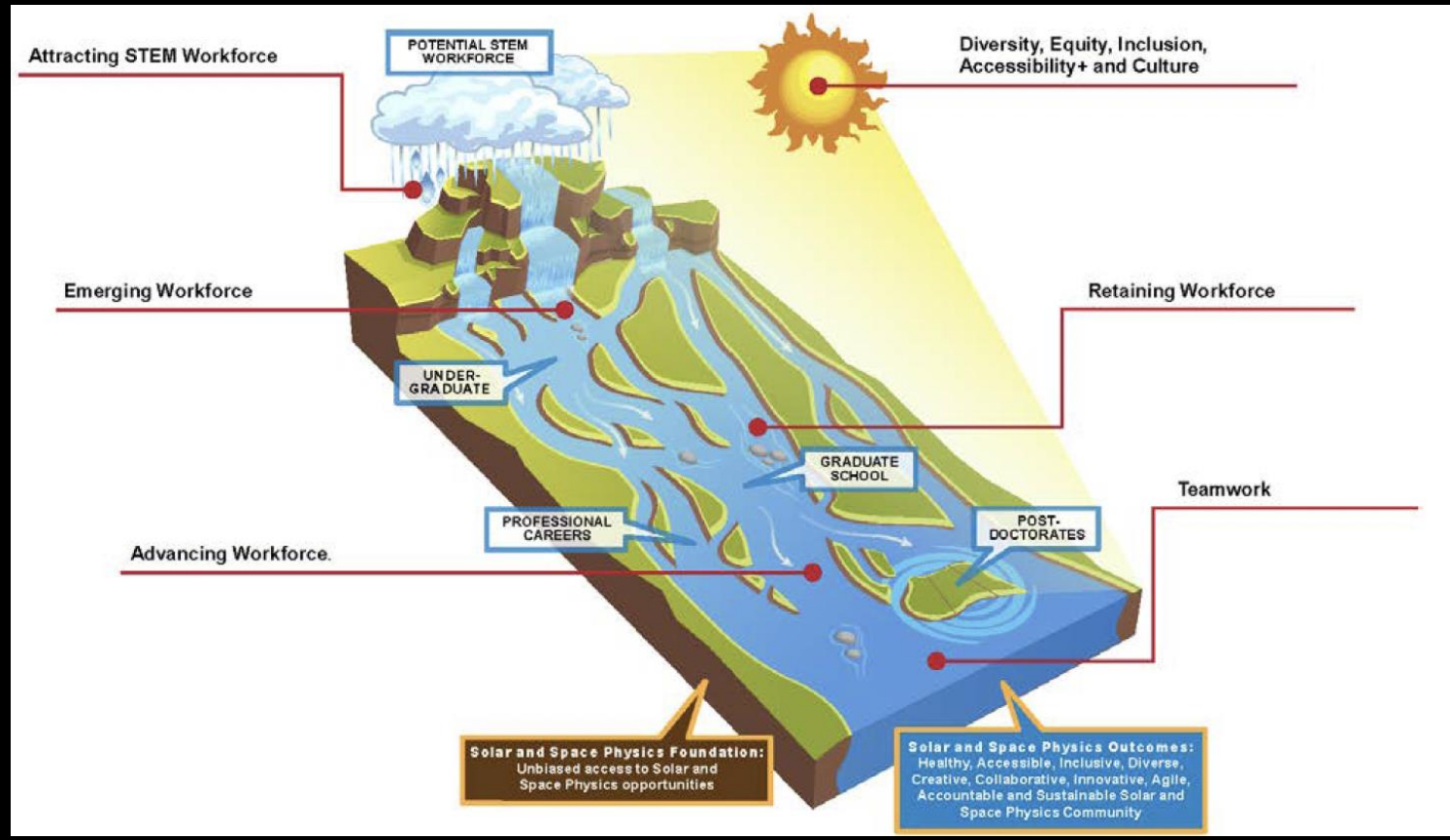
Cultural groups and institutions historically marginalized in STEM represent a major untapped resource for recruitment into the solar and space sciences.

- NSF Significant Opportunities in Atmospheric Research and Science (SOARS) program, managed by UCAR, is an example of the highly successful implementation of a bridge-style program
  - SOARS mentors students who identify as historically marginalized in science in the undergraduate-to graduate school transition phase and provide research experience opportunities.
  - Over 90 percent of SOARS program participants continue to graduate school (UCAR 2024)
- Aurorasaurus Citizen Science:
  - Learning from traditional knowledge, Culturally appropriate education and Integrating indigenous perspectives
- In preparation for IPY 5 (International Polar Year), science organizations are highlighting the impact on indigenous communities
  - Geospace science has a huge opportunity for involvement in IPY 5!

# Recruiting from other career paths

The solar and space physics workforce includes engineers, computer scientists, management personnel, and others who support and enable the science and space weather applications.

- Our fields are expanding into new areas, such as comparative studies of stars and planetary systems, that require a broad range of expertise and increased collaboration
- New needs include but are not limited to computer and data science, artificial intelligence, machine learning, big data, software development, industry-specific engineering
- Advertise to and recruit from related disciplines




Braided stream of workforce

Solar and space physics research benefits from an emphasis on interdisciplinary teams with overlapping expertise.