

National Aeronautics and
Space Administration



Heliophysics Division

NASEM Space Science Week Plenary

Dr. Nicky Fox
Heliophysics Division Director
March 21, 2022

Remembering Dr. Eugene Parker



Credit: University of Chicago

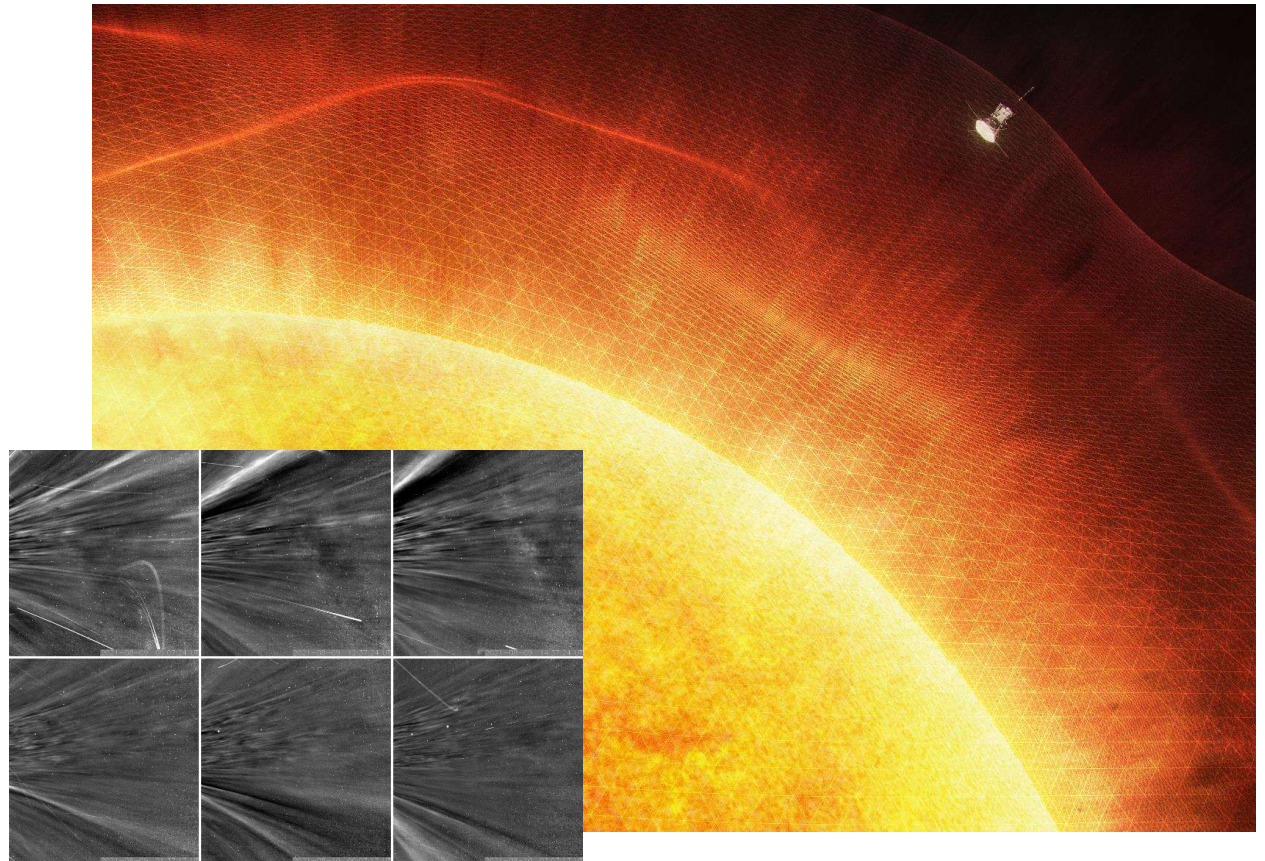
Parker Solar Probe enters the Solar Atmosphere for the first time, and heralds the dawn of new science

Touching the Sun

Parker has traveled so close to the Sun that it has entered a totally uncharted region where intertwined particles and fields are still bound to the Sun's atmosphere

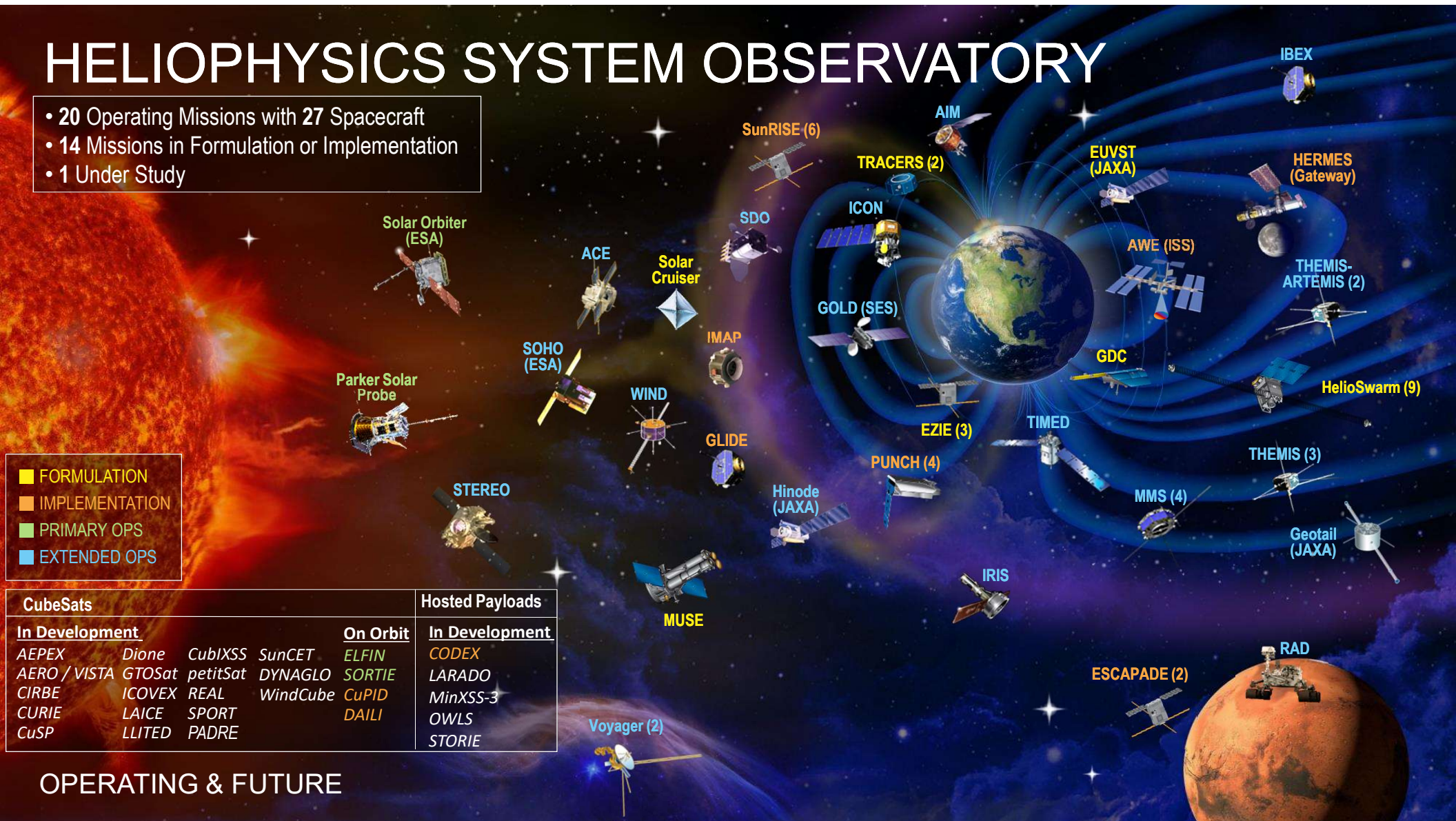


Dr. Eugene N. Parker
1927 - 2022



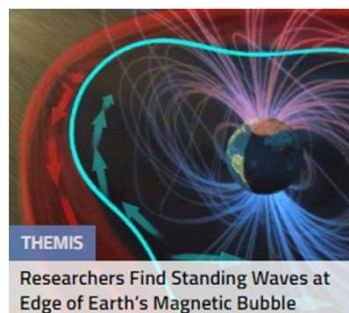
HELIOPHYSICS SYSTEM OBSERVATORY

- 20 Operating Missions with 27 Spacecraft
- 14 Missions in Formulation or Implementation
- 1 Under Study



OPERATING & FUTURE

Recent Accomplishments



Advanced priorities of 2013 Decadal and initiated planning for 2023 Decadal

- Received GDC instrument solicitations and selected Interdisciplinary Science Team
- Down selected 2 MIDEX-19 missions (MUSE and HelioSwarm) and released SMEX-22 Community Announcement to maintain Decadal-recommended cadence of PI-led missions (SMEX, MIDEX, MoOs)
- Supported “Helio 2050” and finalized Statement of Task for 2023 Decadal with National Academies
- Selected DRIVE Science Centers

Supported multiple missions through key milestones to bolster the future Heliophysics System Observatory

- Confirmed 6 missions for implementation: IMAP, PUNCH, SunRISE, ESCAPADE, GLIDE, and HERMES
- Advanced 4 missions in formulation towards KDP C: TRACERS/MAGIC, Solar Cruiser, EZIE, and EUVST

Invested in multiple high-priority, cross-cutting programs and initiatives

- Establishing Heliophysics Technology Program Office (HESTO) to enable more focused, impactful, and innovative technology investments
- Initiated investments in Space Situational Awareness/Orbital Debris technology maturation
- Space Weather Centers of Excellence (ROSES-22)
- Solicited community input via RFI for modernization of archives and enabled breakthrough heliophysics science via investments in AI/ML, theory, data analysis, and modeling

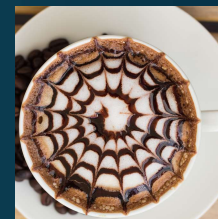
DRIVE Center Selections

DRIVE Science Centers, implemented as a NASA-NSF partnership, are part of an integrated multi-agency initiative, DRIVE (Diversity, Realize, Integrate, Venture, Educate), put forward as a high priority recommendation of the 2013 Solar and Space Physics Decadal Survey. DRIVE Science Centers are focused on grand challenge goals that are both ambitious and focused enough to be achievable within the lifetime of the center.

On March 17th, NASA selected three DRIVE Centers:

PIs and Institutions

- Hoeksema / Stanford
- Merkin / JHU/APL
- Opher / Boston University

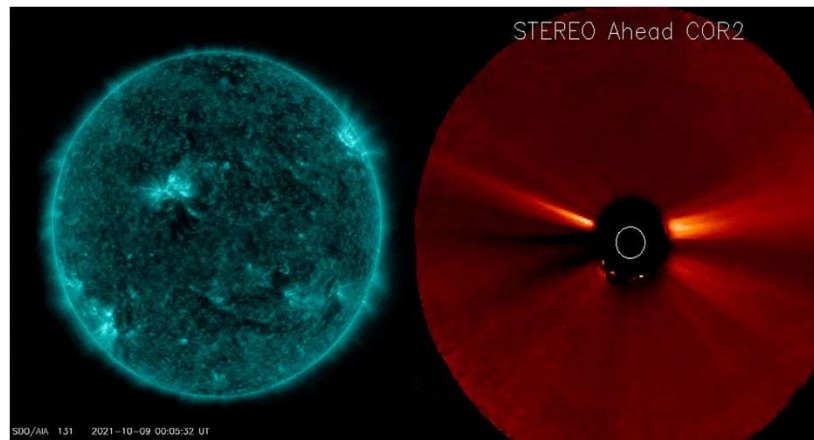


The Sun Wakes Up: Solar Cycle 25 Is Here

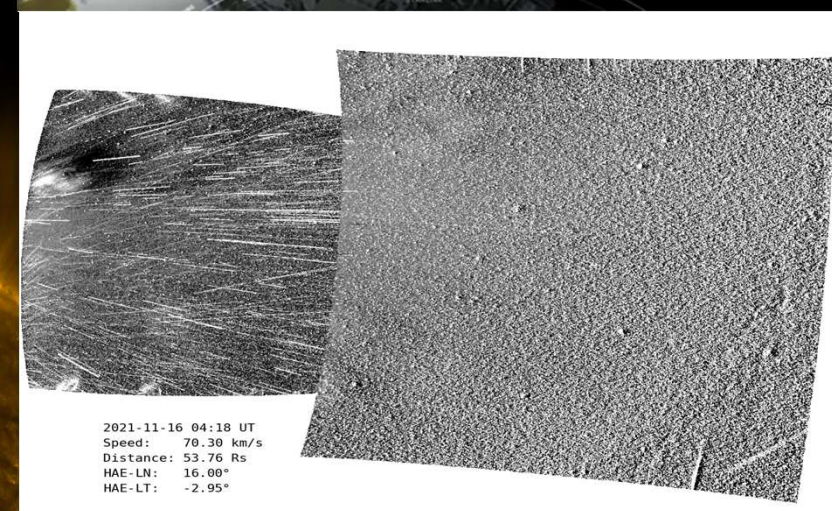
December 2019 marked the beginning of Solar Cycle 25, and the Sun's activity will once again ramp up until solar maximum, predicted for 2025.

This new solar cycle, and anticipated increase in space weather events, will impact our lives and technology on Earth, as well as astronauts in space.

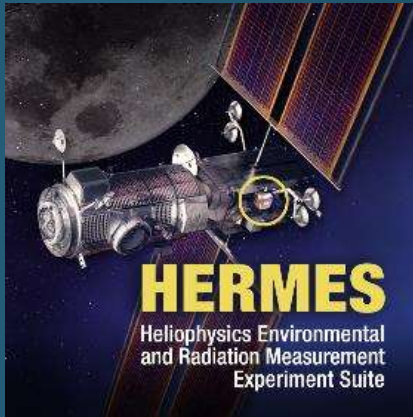
This is the first solar cycle that many new commercial and government stakeholders will navigate.



Active October 2021 Sun Emits X-class Flare



NASA Space Weather



Recent Accomplishments

- Established Space Weather Council; first meeting held March 2022
- HERMES passed KDP C in early 2022 and interdisciplinary scientists selected
- Developed a NOAA and DoD Framework to transition NASA research, techniques and technology relevant to space weather operations
- Supported the Research to Operations to Research (R2O2R) grant solicitation via Transition-Step for efforts that show promise to use in an operational space weather environment at NOAA or DoD
- Space Weather Centers of Excellence solicitation (ROSES-22)



Looking Ahead

Make selections for SWR2O2R-21

- PROSWIFT: continue with actions already underway to support interagency efforts, space weather observations, research, modeling, operational forecasting, and applications (SOHO, SWFO-L1, R2O2R)
- Develop space weather instrument pipeline for future opportunities
- Engage international partners on future collaborations: Vigil, ENLoTIS (ESA), AOM (CSA), SNIPE (KASI)

Heliophysics Big Year



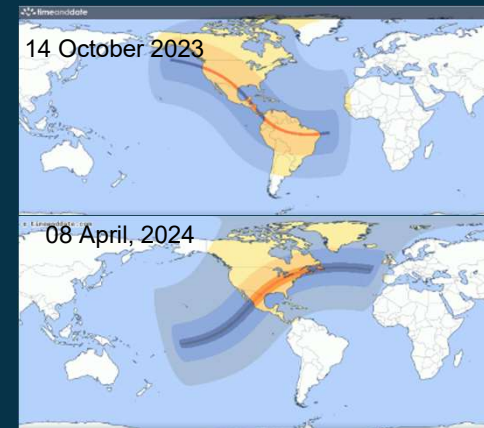
Ties together three major Heliophysics events in 2023-2025 (2 solar eclipses, solar maximum) to maximize participation in a coordinated incentivized citizen science campaign.

- NASA is developing a program to use these remarkable events to highlight and motivate solar system science
 - Two Solar Eclipses cross N. America (14 Oct 2023 and 8 April 2024)
 - The rising phase of the Solar Cycle 25 with Solar Maximum predicted to occur in 2025
- Look out for opportunities to be part of our Big Year

<https://science.nasa.gov/heliophysics/programs/citizen-science>

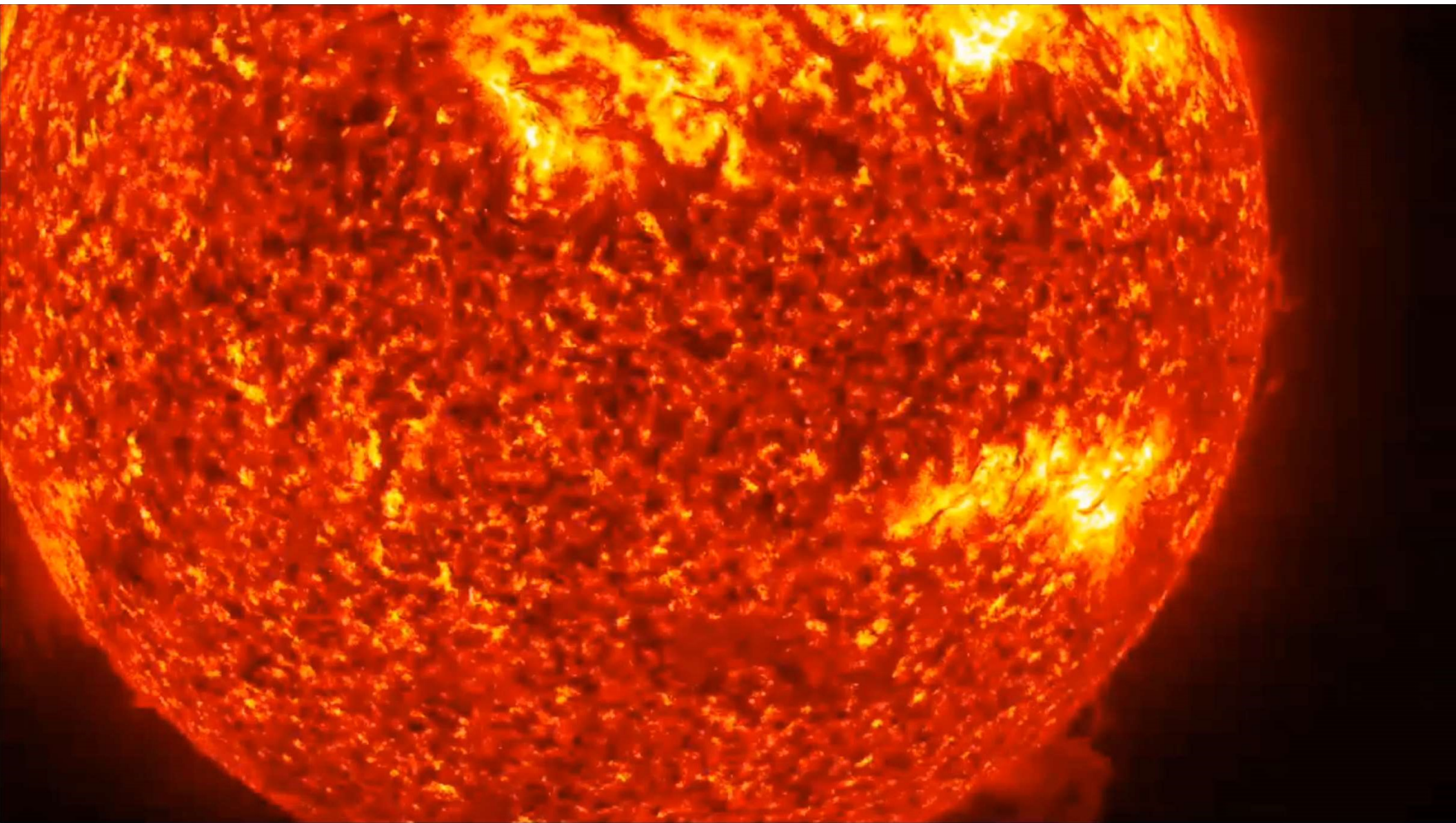


Totality during the solar eclipse in Australia's Tropical North Queensland on November 14, 2012. Getty Images.



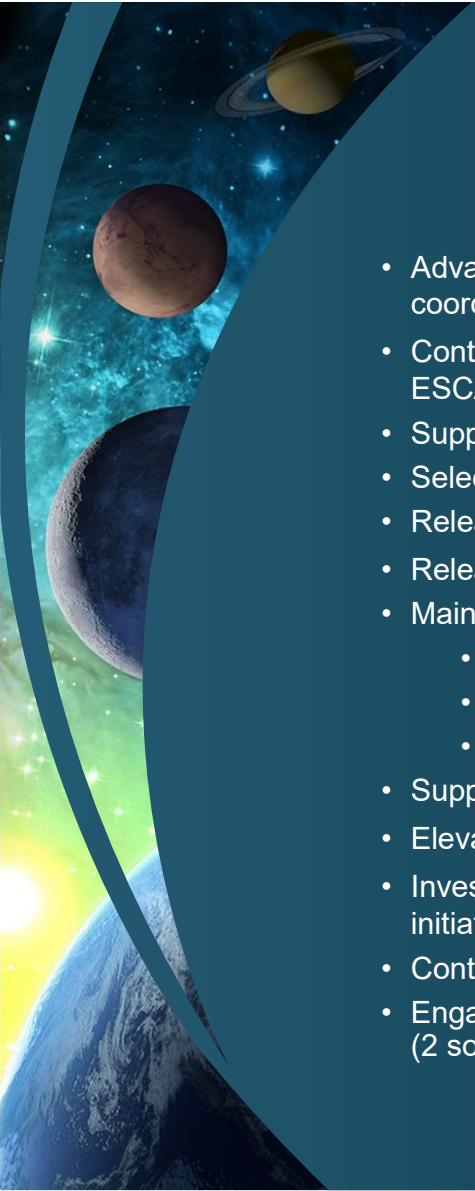
The paths of totality for total solar eclipses during the HBV.

What is a “Big Year”? A big year is a birding term for maximizing a birder’s number of species.



The background of the slide is a composite of two cosmic images. The top half features a dark space filled with numerous small, distant stars and a prominent, wispy blue nebula on the right side. The bottom half shows a similar starry field but with a large, glowing orange and yellow nebula on the left, transitioning into a greenish-blue nebula on the right. A solid dark blue horizontal band runs across the middle of the image, serving as a backdrop for the text.

#HelioRocks!



Summary: Heliophysics Division Looking Ahead

- Advance the following missions towards KDP C in 2022: TRACERS/MAGIC, Solar Cruiser, EZIE, and EUVST (in coordination w/ JAXA)
- Continued support for recently confirmed missions through KDP C and beyond: IMAP, PUNCH, SunRISE, ESCAPADE, GLIDE, HERMES
- Support recent MIDEX-19 selections: HelioSwarm and MUSE
- Select GDC instruments
- Release SMEX-22 Announcement of Opportunity
- Release call for 2023 Senior Review of operating missions
- Maintain healthy Research and Analysis Program
 - Early Career Investigator Program cadence every 2 years
 - Support robust suborbital program
 - Maintaining DRIVE initiative and implement newly selected DRIVE Science Centers
- Support 2023 Decadal Survey kickoff in coordination with NASEM
- Elevate NASA's space weather presence through new Heliophysics Space Weather Program
- Invest in modernization of data facilities and archives, including mission operations services and open science initiatives
- Continue implementing IDEA initiatives as part of the Heliophysics strategy
- Engage the public through “Heliophysics Big Year” which leverages three major Heliophysics events in 2023-2025 (2 solar eclipses, solar maximum)

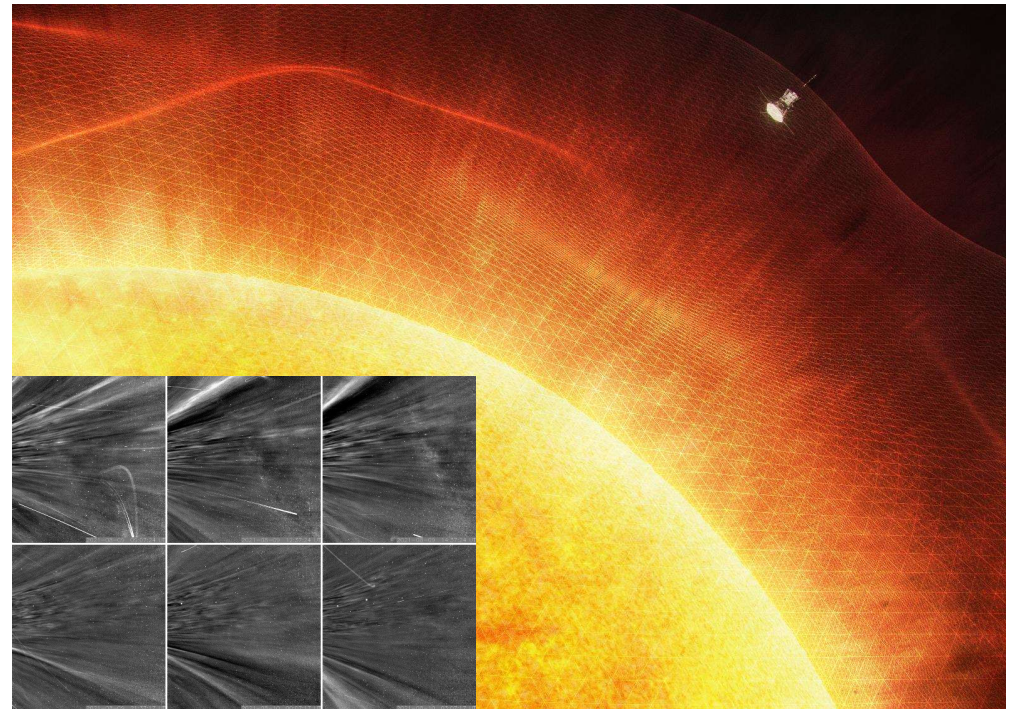
Parker Solar Probe enters the Solar Atmosphere for the first time, bringing new discoveries

Touching the Sun

- Three years after launch, Parker has now flown within the Sun's inner corona, sampling particles and fields still bound to the Sun's atmosphere.
- During Parker's eighth flyby of the Sun on April 28, 2021, the spacecraft passed within 18.8 solar radii (8.127 million miles) of the photosphere when it detected the conditions scientists had long-awaited.

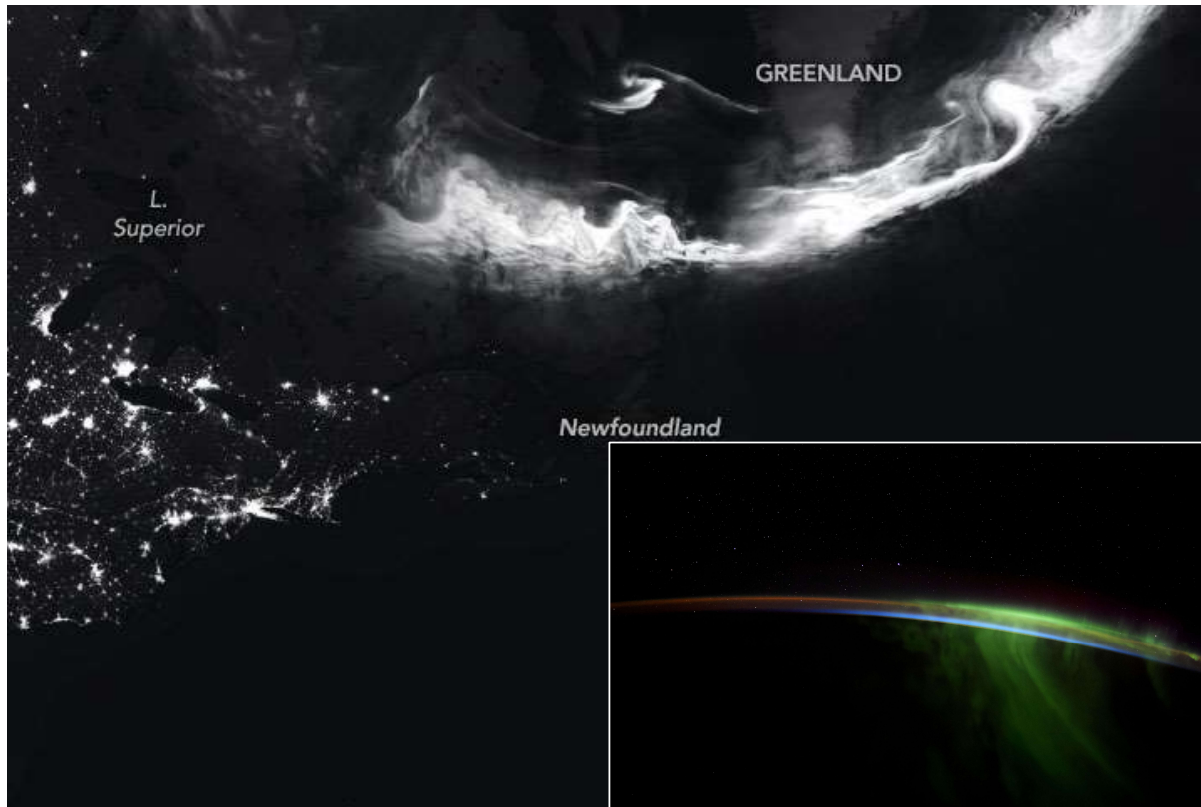
Switchbacks

- On its sixth flyby, Parker measured clusters of switchbacks and found that the percentage of helium in them matched the composition of solar material at the photosphere, the solar surface.
- During the same flyby, a different analysis showed that the switchbacks were aligned with magnetic "funnels" in the photosphere. Together, these facts suggest that the switchbacks start near the solar surface, a dynamic, roiling region of solar material and magnetic field.



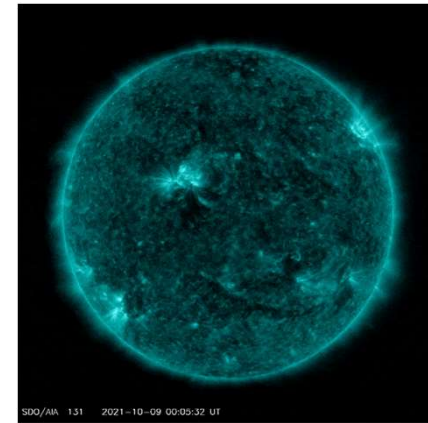
Above: As Parker Solar Probe passed through the corona on encounter nine, the spacecraft flew by structures called coronal streamers. These structures can be seen as bright features moving upward in the upper images and angled downward in the lower row. **Credits:** NASA/Johns Hopkins APL/Naval Research Laboratory

Auroras and CMEs in Solar Cycle 25

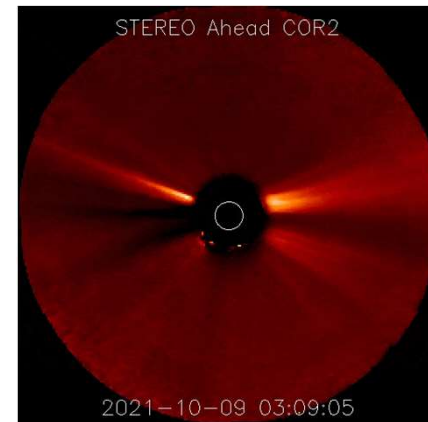


Background: Mosaic of several satellite passes showing auroras over eastern North America, the North Atlantic, and Greenland

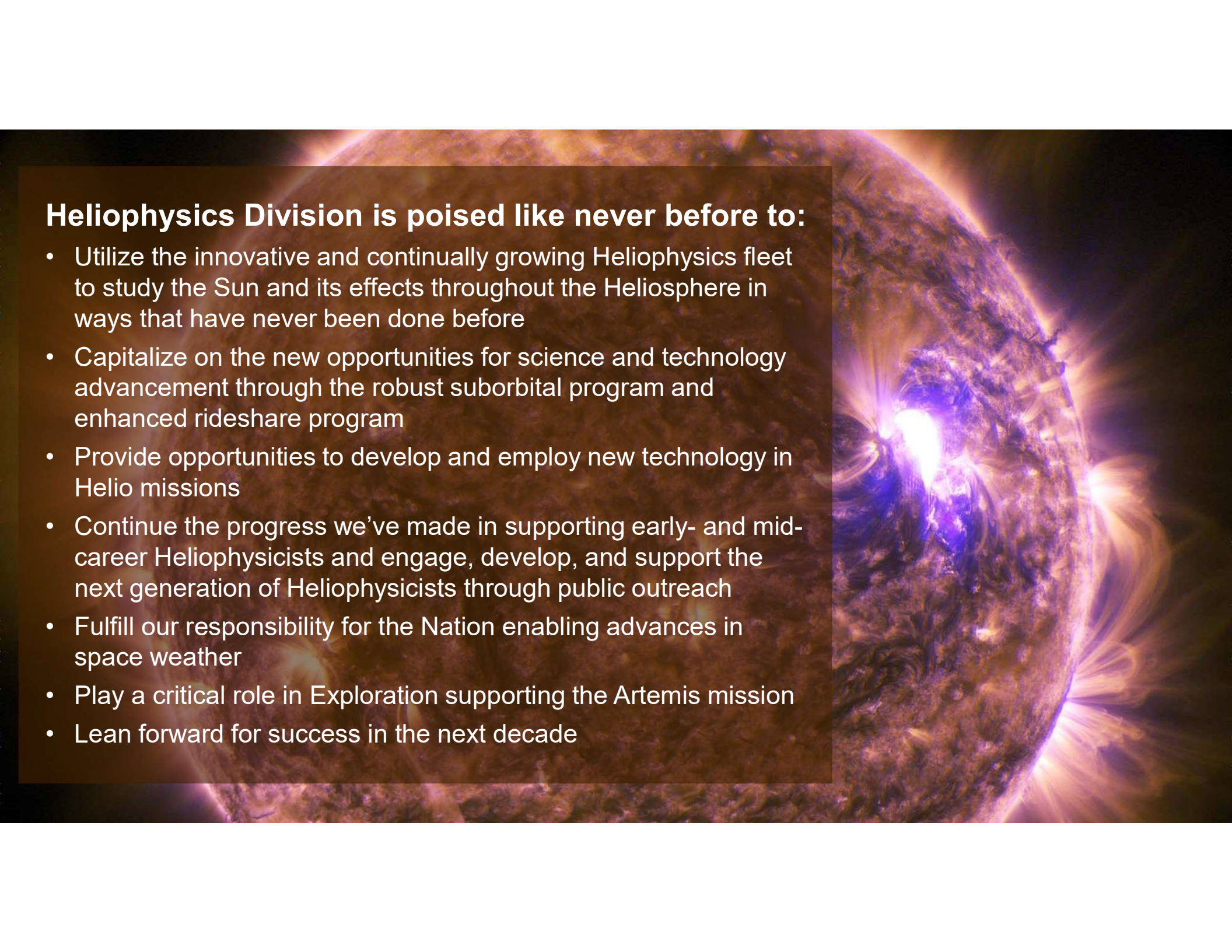
Inset: Image of aurora from ISS **Credit:** Shane Kimbrough



Left: Animated gif shows images from the 131 Angstrom channel of NASA's Solar Dynamics Observatory spacecraft/Atmospheric Imaging Assembly instrument. **Credit:** NASA/SDO



Left: The COR2 coronagraph on NASA's Solar Terrestrial Relations Observatory-A spacecraft, detected this Earth-directed CME on Oct. 9, 2021. **Credit:** NASA/STEREO



Heliophysics Division is poised like never before to:

- Utilize the innovative and continually growing Heliophysics fleet to study the Sun and its effects throughout the Heliosphere in ways that have never been done before
- Capitalize on the new opportunities for science and technology advancement through the robust suborbital program and enhanced rideshare program
- Provide opportunities to develop and employ new technology in Helio missions
- Continue the progress we've made in supporting early- and mid-career Heliophysicists and engage, develop, and support the next generation of Heliophysicists through public outreach
- Fulfill our responsibility for the Nation enabling advances in space weather
- Play a critical role in Exploration supporting the Artemis mission
- Lean forward for success in the next decade