Welcome

Science Update:
Parker Solar Probe Close Up View of the Sun's Environment

November 18, 2021
7:00 PM ET

nsta
National Science Teaching Association

NSTA Virtual Program Norms

The National Science Teaching Association strongly supports diversity, equity and inclusion in the classroom, and in all of our programs. We are committed to providing a welcoming, safe, productive, harassment-free environment for all participants of our events and programs, regardless of their gender, gender identity, sexual orientation, ability, ethnicity, race, color, age, marital status, veteran status, socioeconomic status or religion.

We ask that all attendees be mindful of their surroundings and of their fellow participants. All participants are expected to exercise consideration and respect in their speech and actions, and to refrain from demeaning, discriminatory, or harassing behavior and speech.

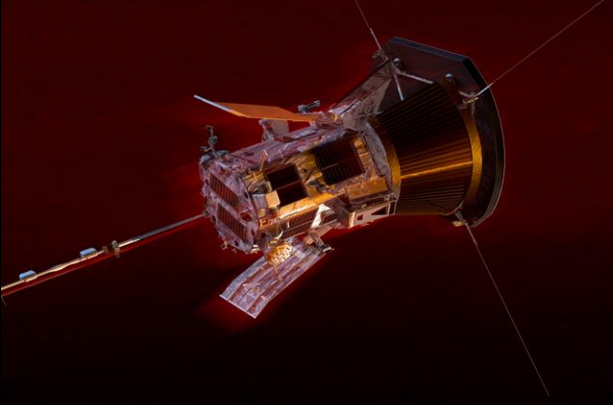
NSTA does not allow promotion of other products in our chats during web seminars. We ask that attendees keep the conversation on topic, use positive language and remain courteous of others throughout the event, and allow everyone time to participate in the chat.

Meet Today's Presenter…

Dr. Nour E. Raouafi
Project Scientist
NASA Parker Solar Probe
Johns Hopkins Applied Physics Laboratory

PARKER SOLAR PROBE

A MISSION TO TOUCH THE SUN



Parker Solar Probe

Ushering a New Frontier in Space Exploration

NOUR E. RAOUAFI

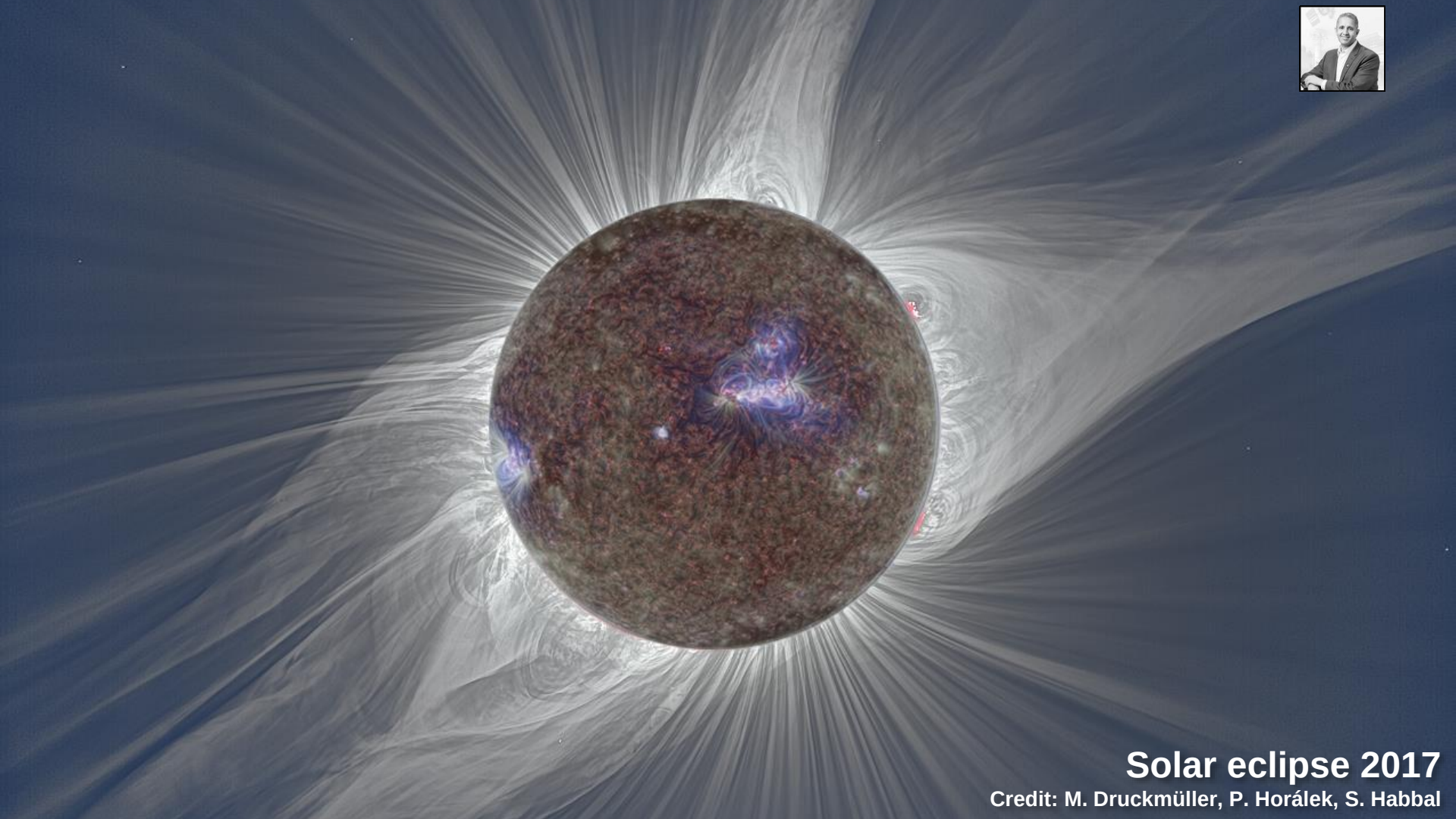
Parker Solar Probe – Project Scientist

Johns Hopkins Applied Physics Laboratory

Nour.Raouafi@jhuapl.edu


NASA/Hubble


NASA/SDO

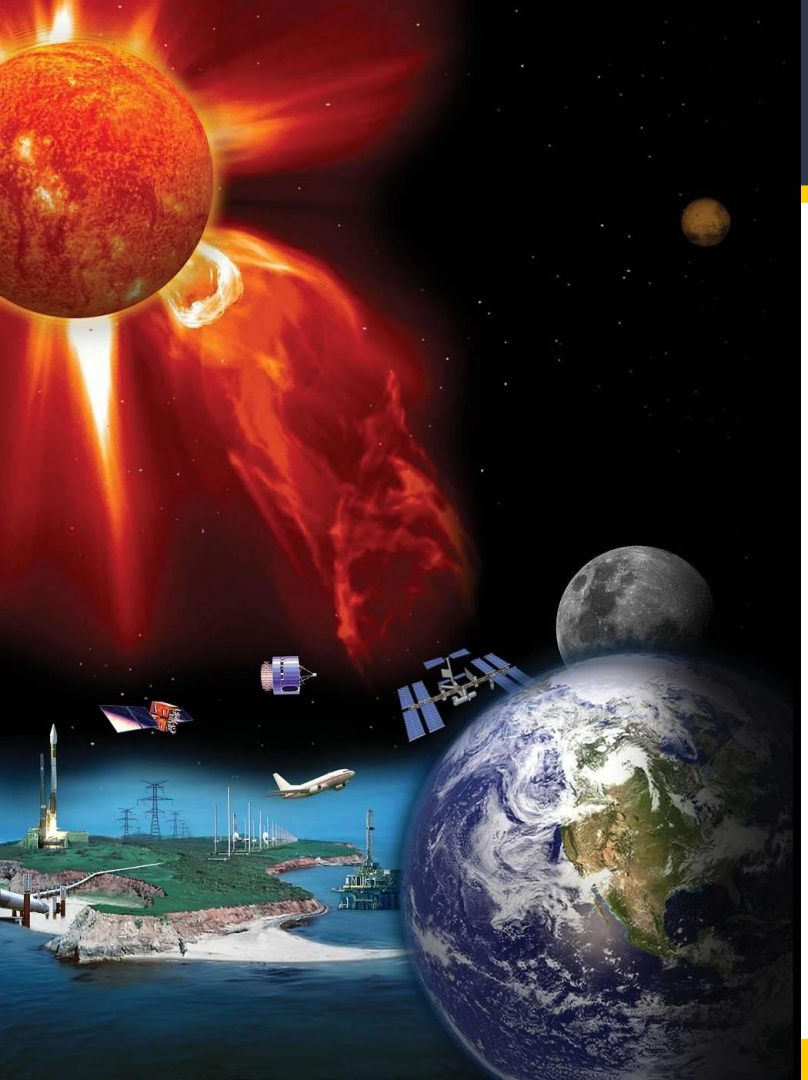


Solar eclipse 2017

Credit: M. Druckmüller, P. Horálek, S. Habbal

Why do we need to understand how the solar corona works?

Because we live in the extended solar atmosphere

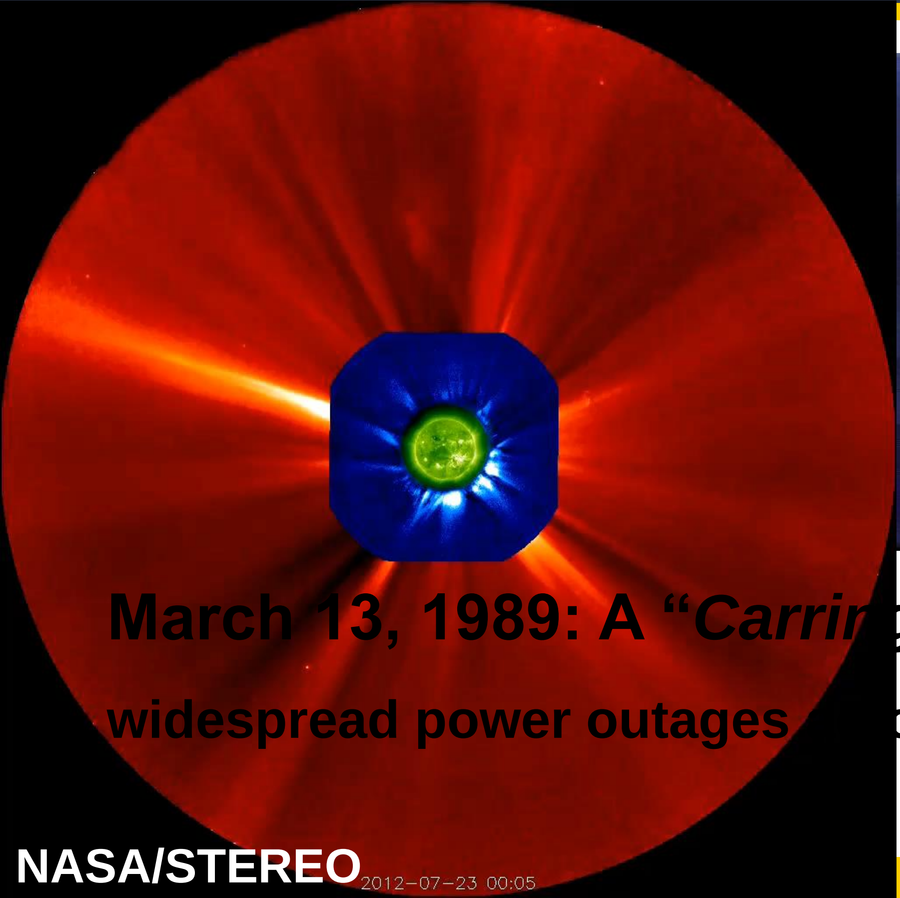


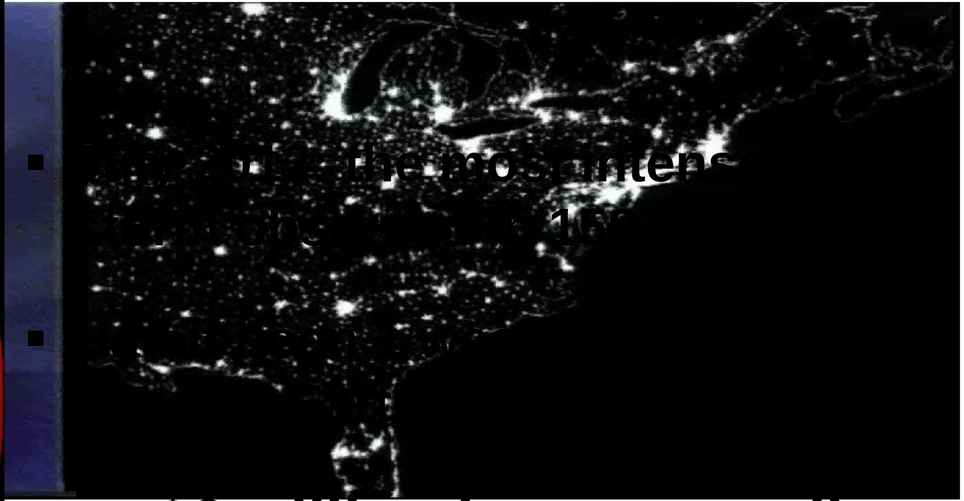
Why Do We Care?

Physics of the corona and inner heliosphere connect the activity of the Sun to the environment and technological infrastructure of the Earth

- Drive the fundamental physics of the heliosphere, aurora, and magnetosphere of the Earth and other planets
- Satellite communications, power grid issues, pipeline erosion, radiation exposure on airline flights, astronaut safety
- Until we can explain what is going on up close to the Sun, we will not be able to accurately predict space weather effects that can cause havoc at Earth

Importance of Space Weather





➢ $2 trillion loss to us all

March 13, 1989: A "*Carrington*"–like event

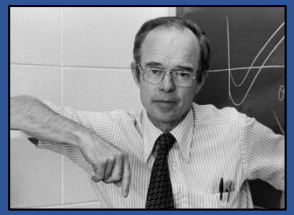
widespread power outages across the Northeast USA and Canada

Long-Standing Mysteries of Solar Physics

- Why is the corona much hotter than the solar surface?
- Where does the solar wind originates and how is it accelerated?
- How are solar energetic particles accelerated and transported?

A New Opportunity
1958

Eugene Parker (1958)
Predicts the existence of the supersonic solar wind



Simpson Committee Report to Space Studies Board (1958)

"Solar Probe: specially designed payload, capable of withstanding high temperatures; to be aimed close to the Sun."

Special Probes

a. Solar probe: specially designed payload, capable of withstanding high temperatures; to be aimed close to the Sun.

Experiments:

Payload Group 1		(whole group)
"	"	2 part of the experiments
"	"	7a nuclear processes
"	"	4a gamma rays
"	"	4b primary neutrons
"	"	6e transport of particles and fields from the Sun
"	"	3c solar magnetic field

Stabilization is required

b. Outer solar system probe: to be aimed away from the Sun in the plane of the ecliptic. (It is hoped that motion away from the Sun to the extent of 5 or 6 astronomical units per year could be accomplished by 1965)

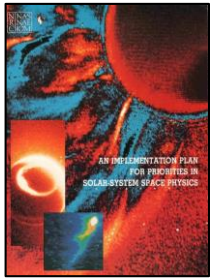
Experiments:

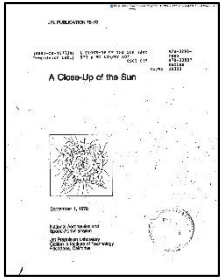
Payload Group 6c		scale size of the 11 year cosmic ray modulation
"	"	6e transport of particles and fields from the Sun
"	"	1 (whole group)
"	"	2 (whole group)

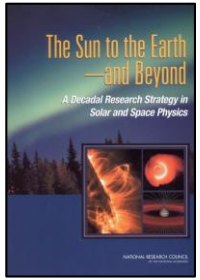
Stabilization is required

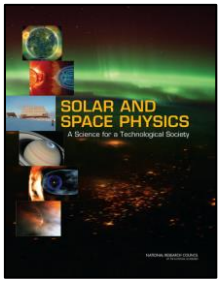
c. Probe "perpendicular" to the ecliptic. Here an increased velocity is needed and it may be necessary to compromise and accept a trajectory which has a strong component perpendicular to the field and thus moves in a spiral out of the plane of the ecliptic. This is probably the most difficult shot.

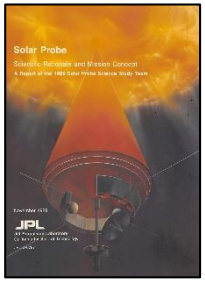
50 Years of Studies
1959 – 2007

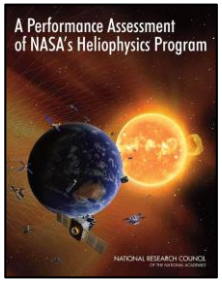


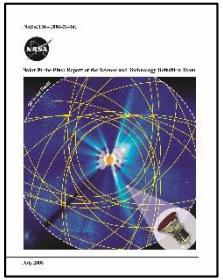




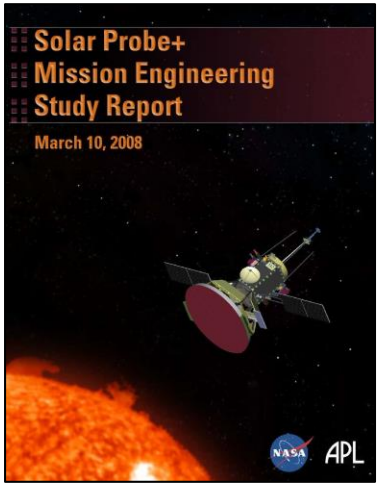


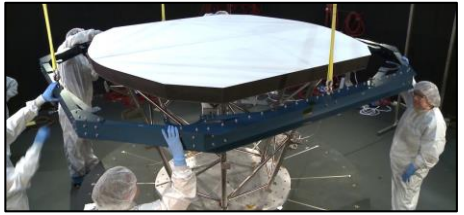


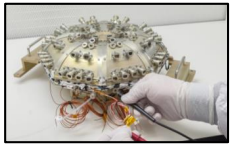


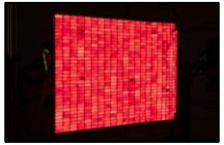


APL Led Innovation
2008 – 2018

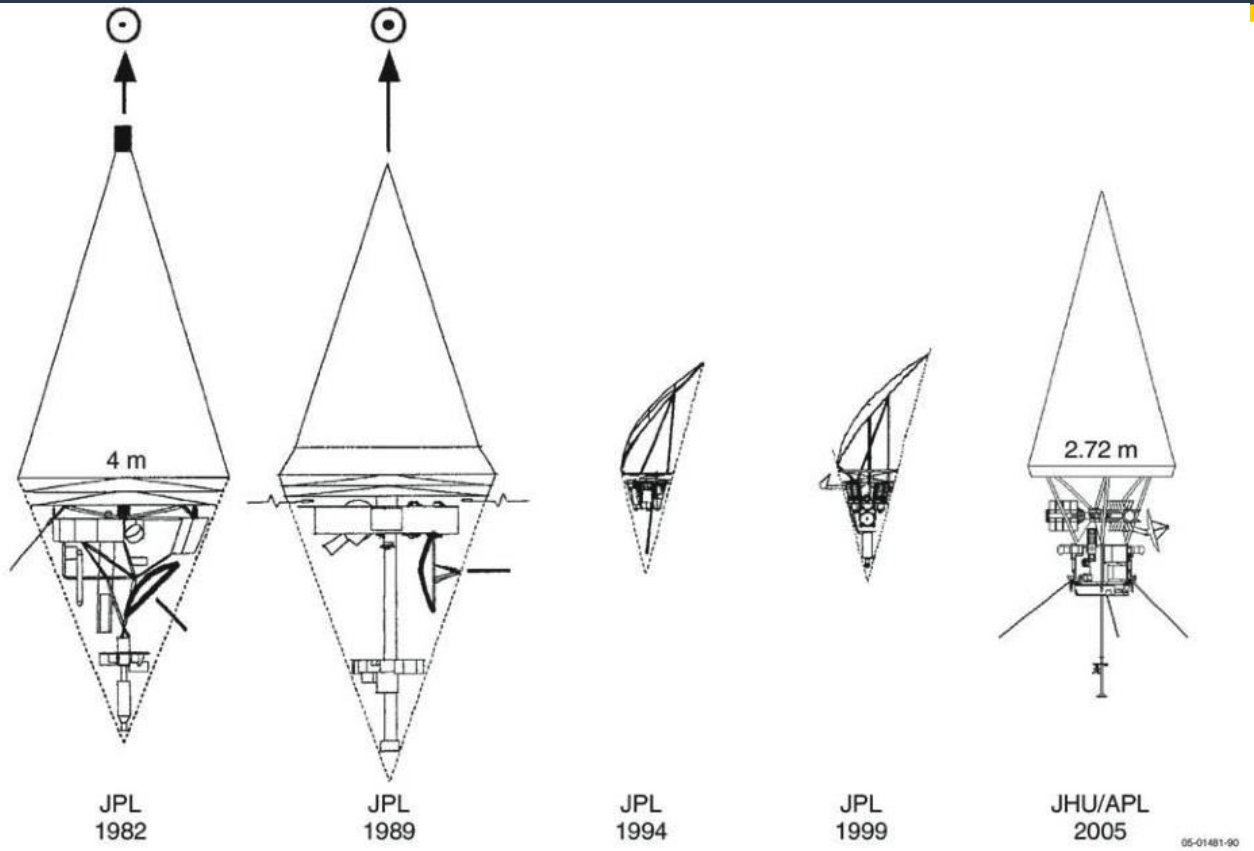




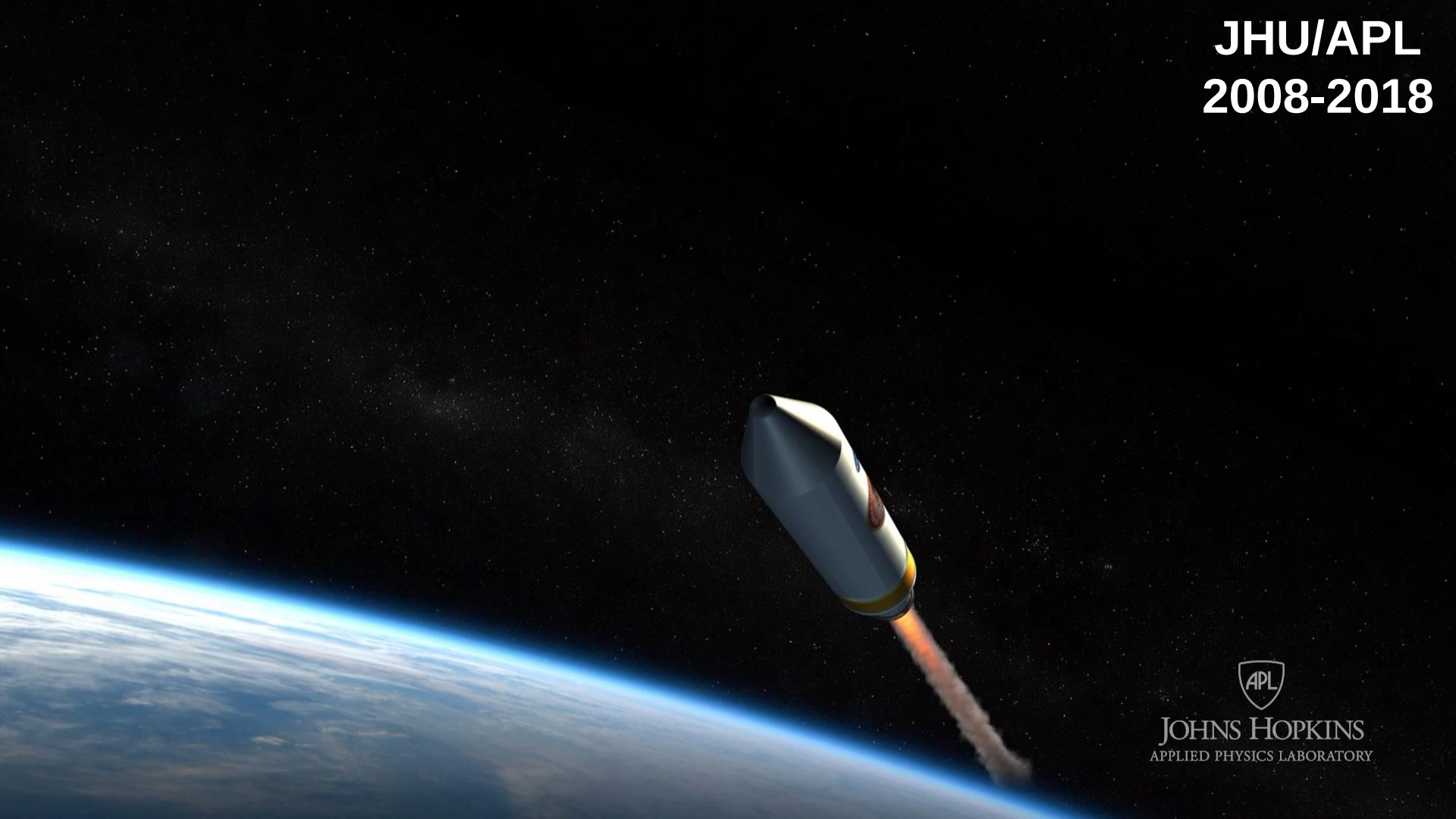




Solar Probe Concepts

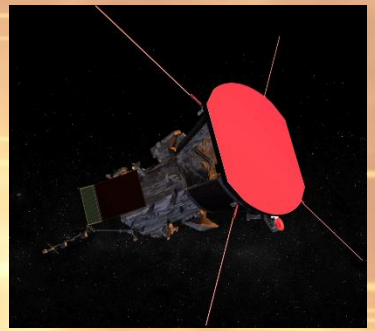


Solar Probe design evolution, 1982–2005.


JHU/APL
2008-2018
APL
JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Transformational Innovations

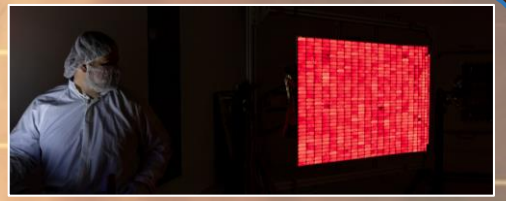
Thermal Protection System



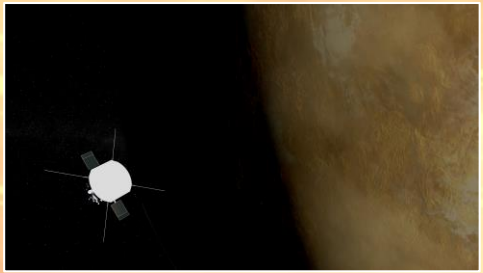
8ft-wide and 4.5in-thick Carbon composite shield Reaches 2,500 deg F

Actively Cooled Solar Panels

2 – 17 sq ft
Water cooled thermal management
First system used on a space mission

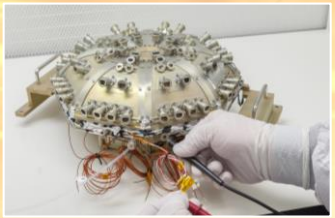


Venus Flyby #1



Navigation Technology

VFB-1: 350 m from ideal target point



State of the Art Instrumentation

Exposed Solar Probe Cup
Special material w/ M.P. 4,260 deg F
Wiring suspended in sapphire crystal tube

The Journey to Touch our Star

Venus

Mercury

Earth

Mars

2018 Jun 30

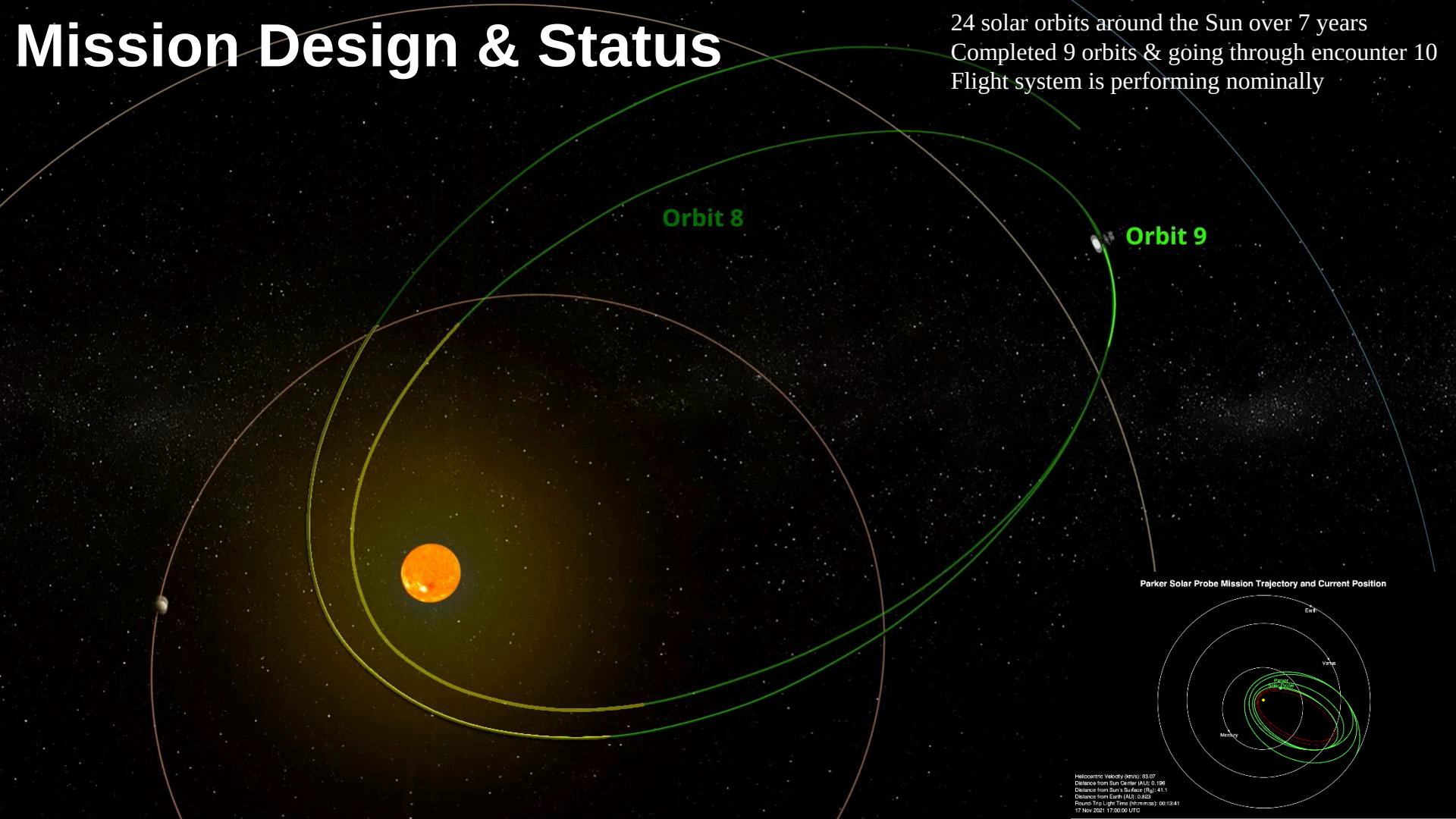
2024

8.86 $R_\odot$

3.8M Miles from the solar Surface

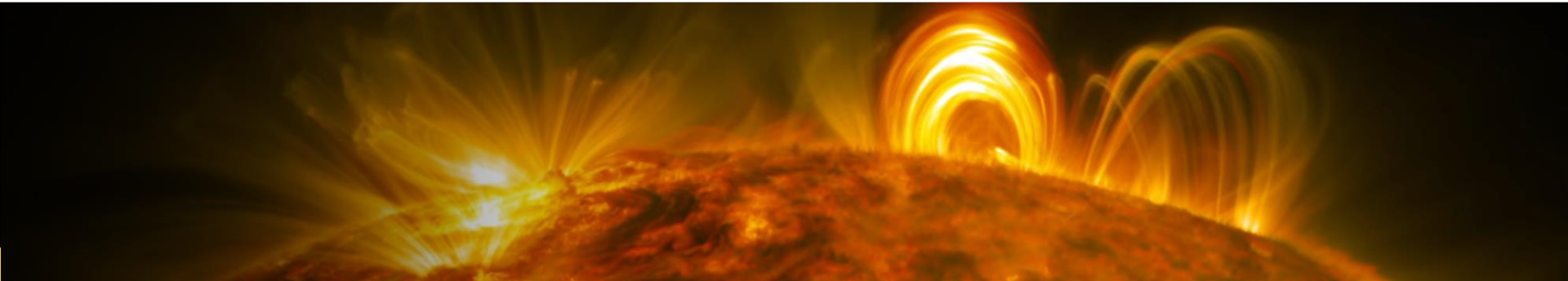
Mission Design & Status

24 solar orbits around the Sun over 7 years
Completed 9 orbits & going through encounter 10
Flight system is performing nominally



Science Investigations

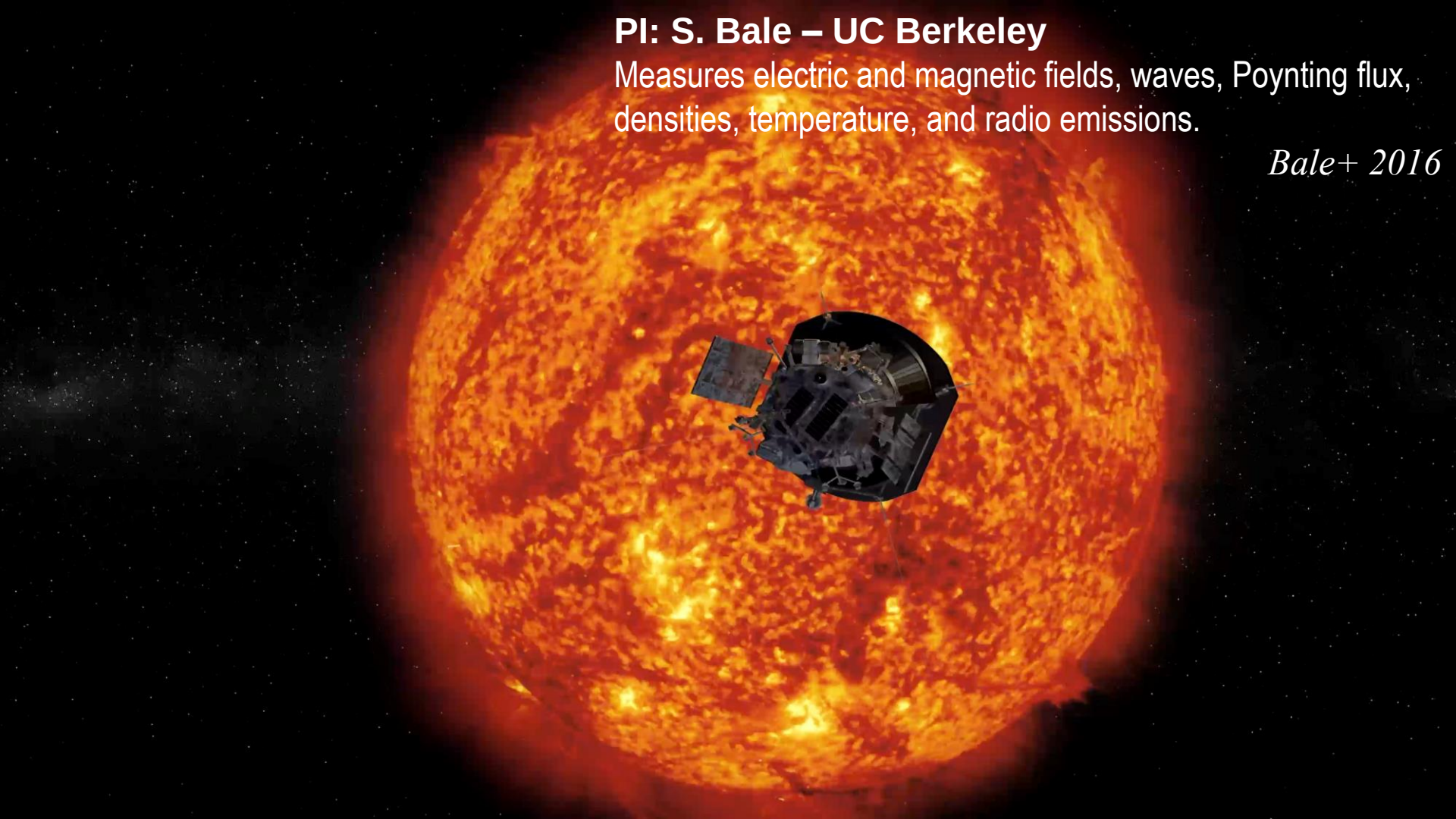
Four Suites of Instruments



PI: R. Howard – NRL

Images of the solar wind, CMEs, shocks and other structures as they approach and pass the spacecraft.

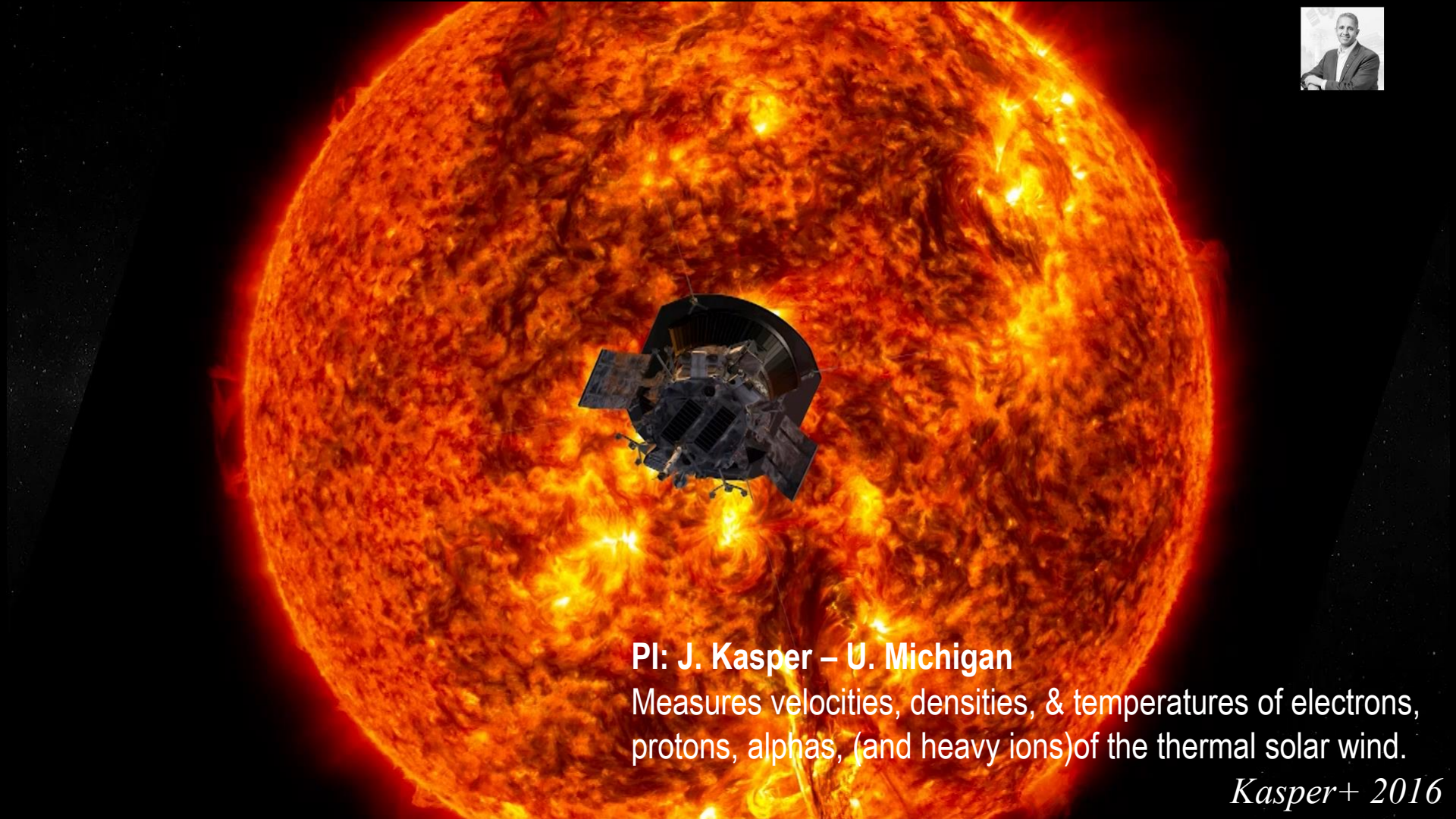
Vourlidas+ 2016



PI: S. Bale – UC Berkeley

Measures electric and magnetic fields, waves, Poynting flux, densities, temperature, and radio emissions.

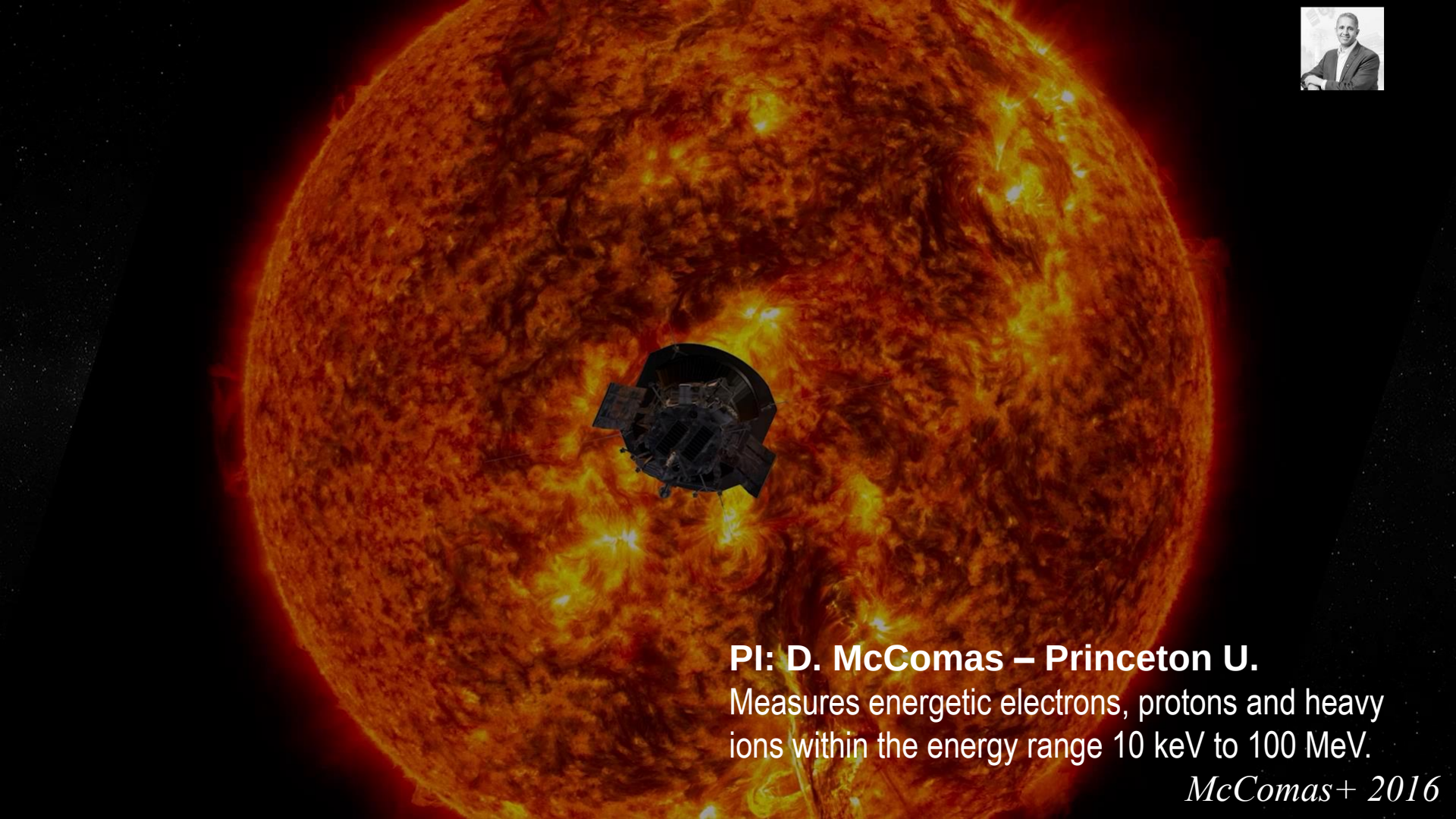
Bale+ 2016



PI: J. Kasper – U. Michigan

Measures velocities, densities, & temperatures of electrons, protons, alphas, (and heavy ions)of the thermal solar wind.

Kasper+ 2016



PI: D. McComas – Princeton U.

Measures energetic electrons, protons and heavy ions within the energy range 10 keV to 100 MeV.

McComas+ 2016

Parker launch

Solar Minimum

End of prime mission

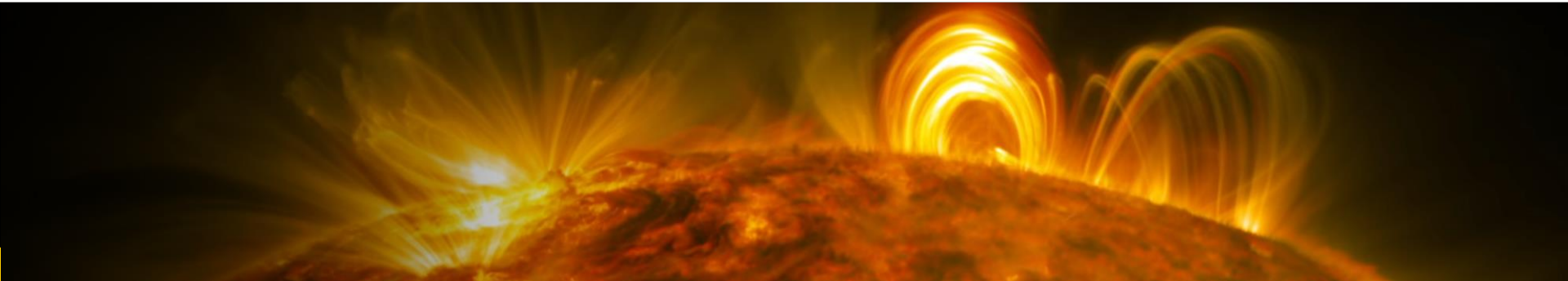
Solar Maximum

Let’s pause…

Let’s pause for two questions
from the audience.

Please share your questions in the chat window.

Parker Solar Probe Science Discoveries

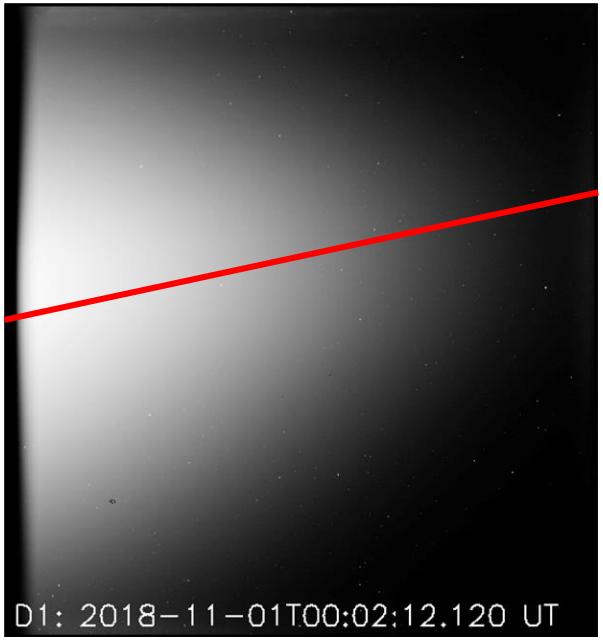


Dust-Free Zone

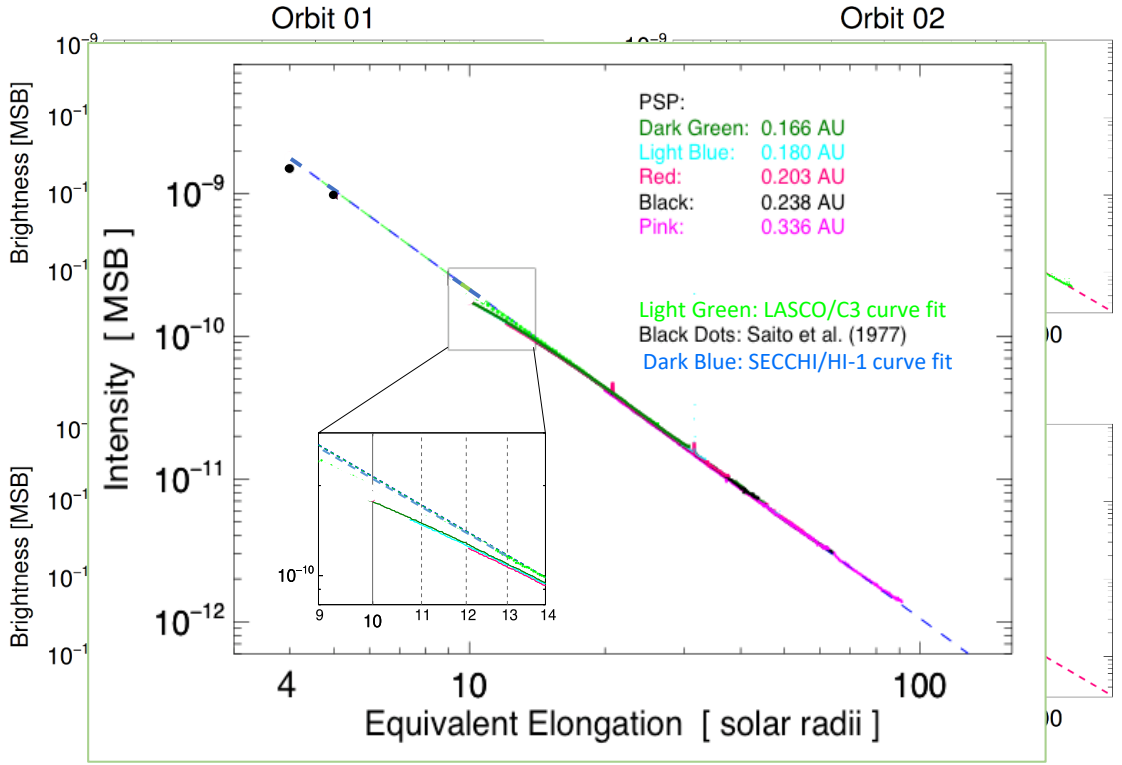
Predicted by H. N. Russell, 1929

Credit: NASA

Evidence for the Existence of the Dust-Free Zone

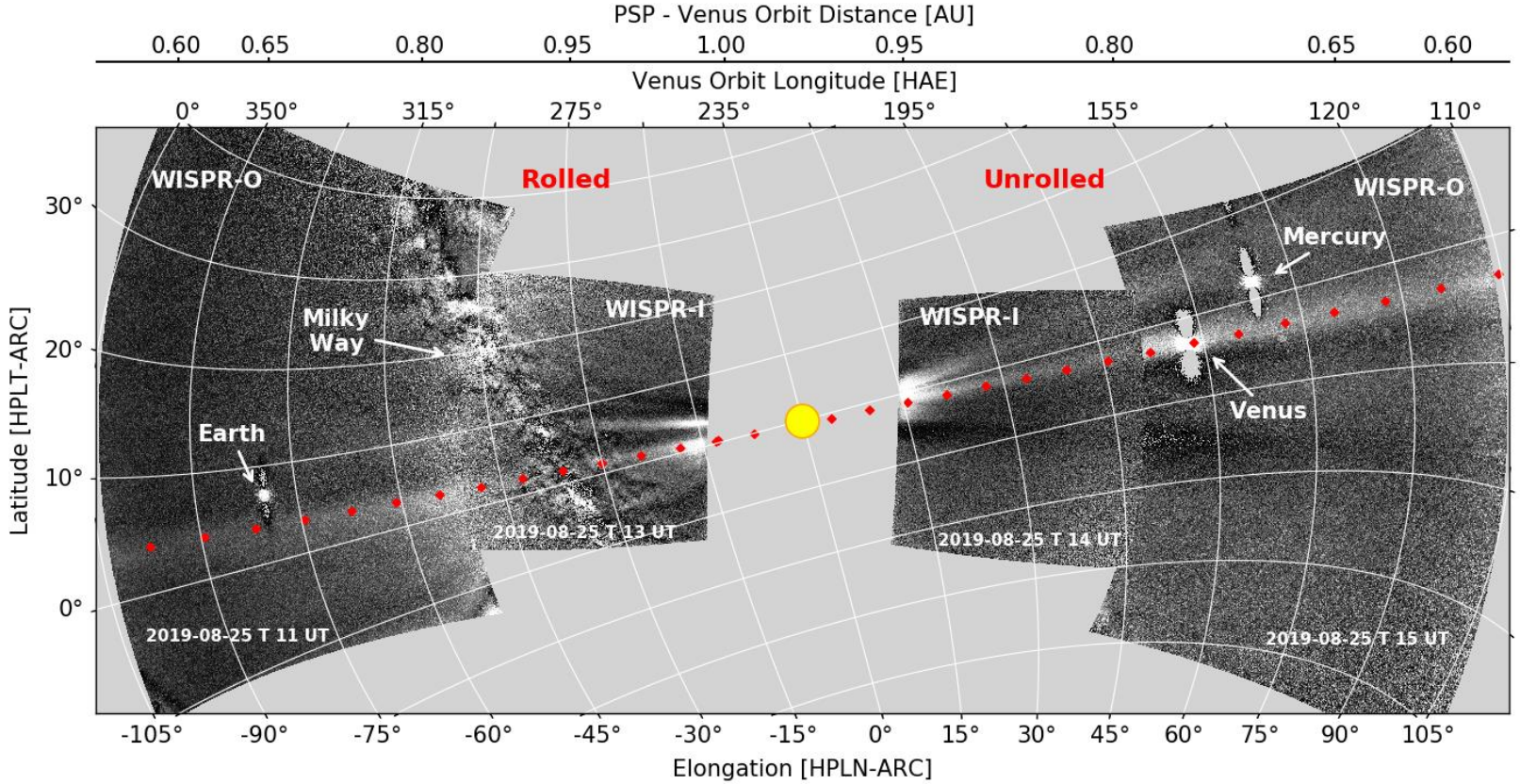


Encounter 1

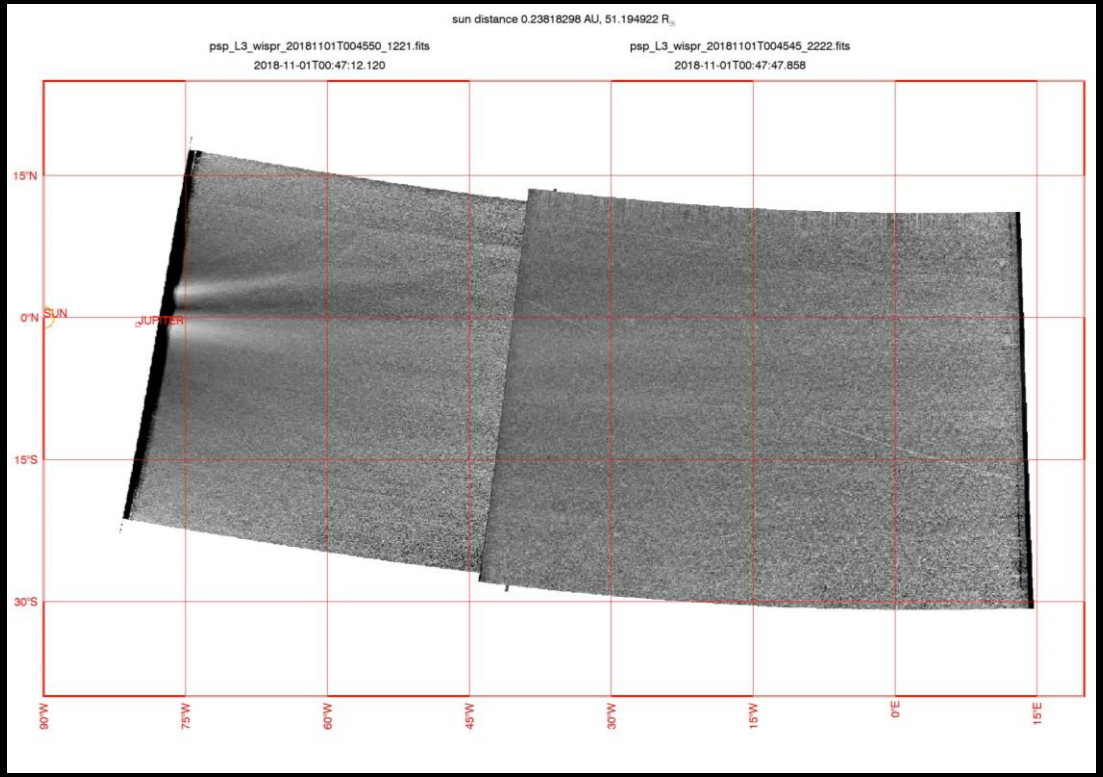


Howard et al. (2019) & Stenborg et al. (2020)

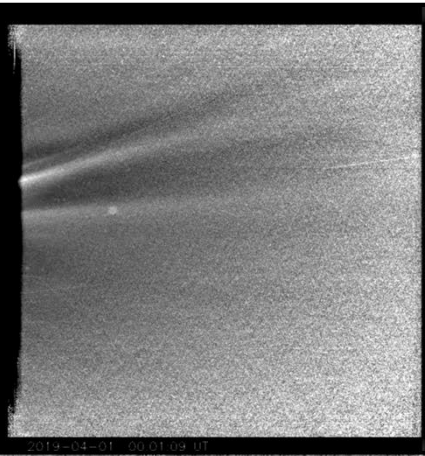
Dust Ring Along the Orbit of Venus



Gallery of CMEs in WISPR

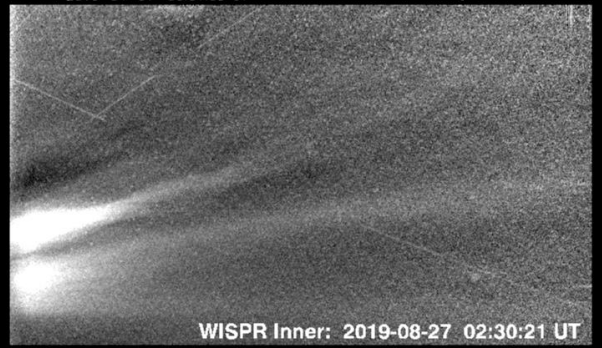


E1

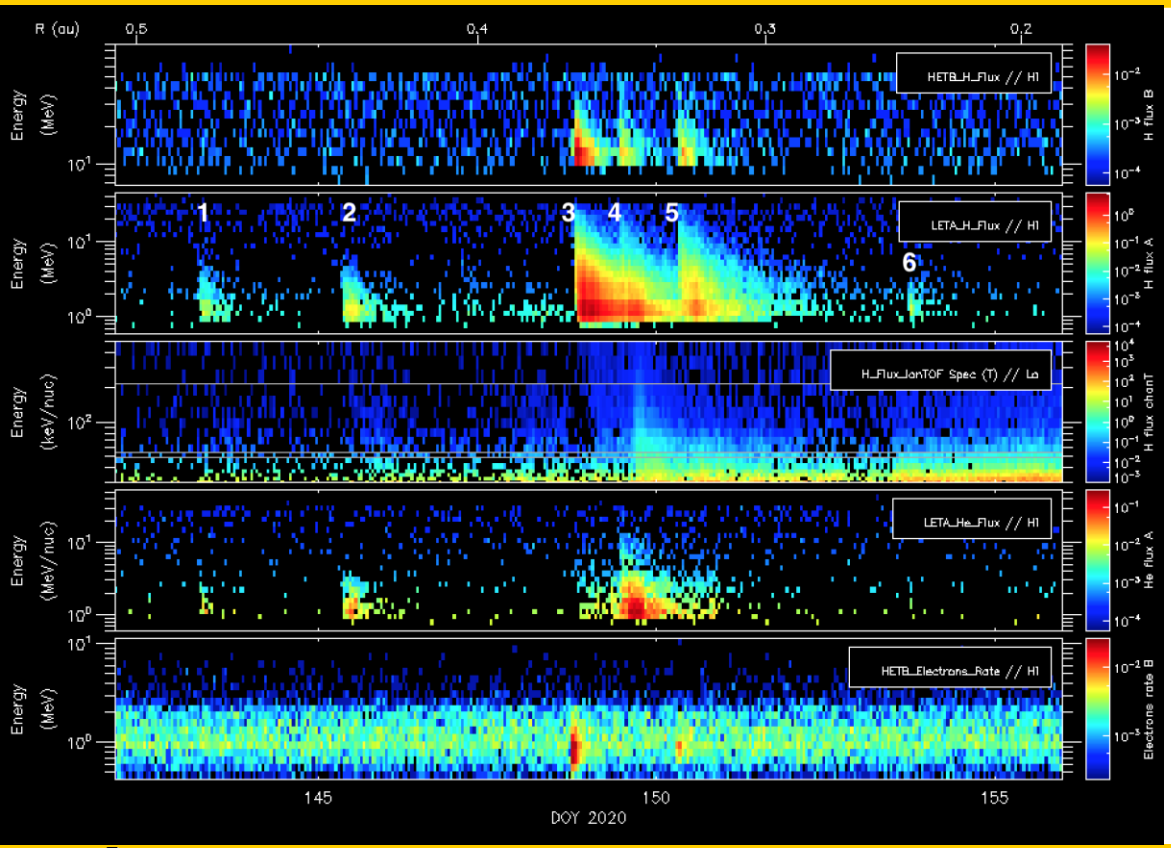


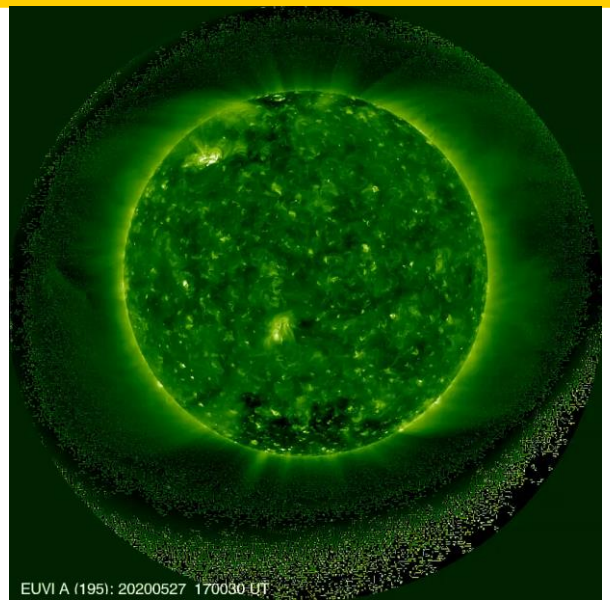
E2

E3



Energetic Particle Environment





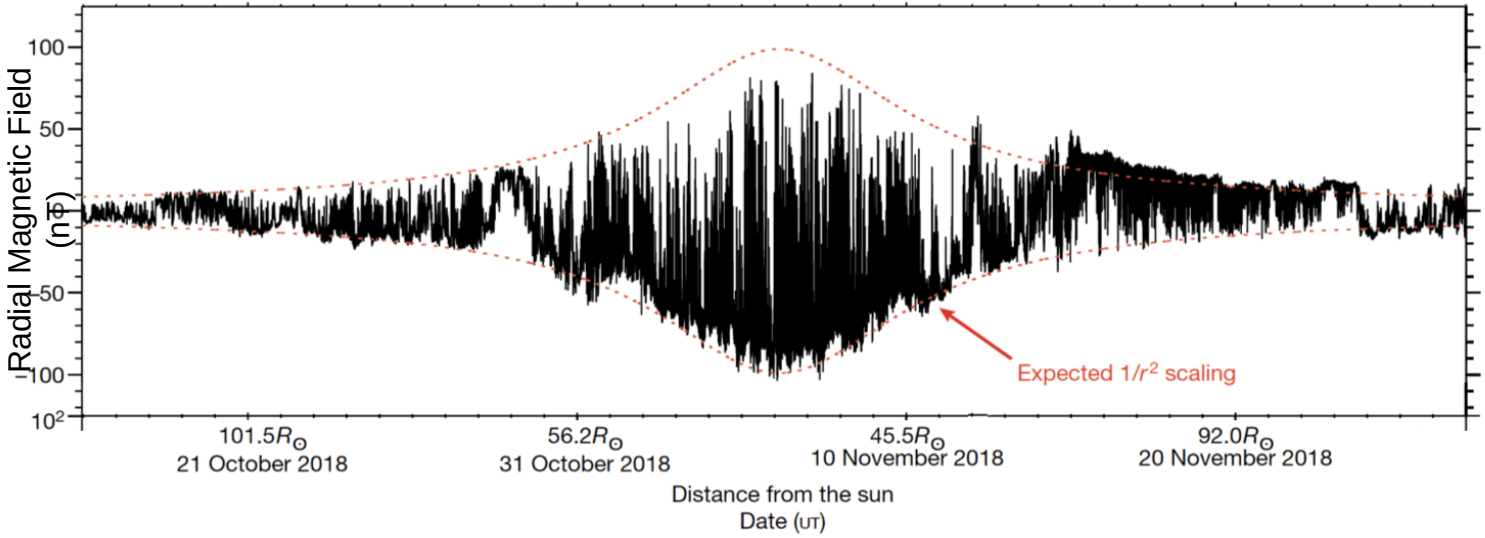
SEP events 3-5 separated by <24 hours

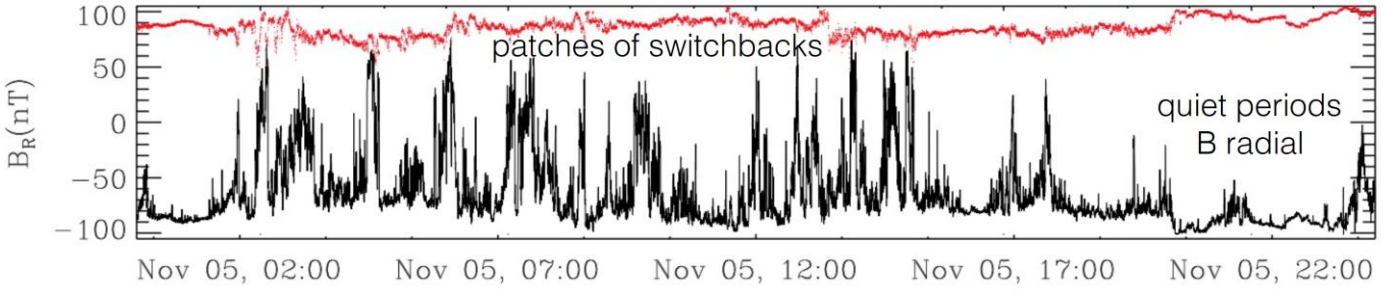
- May have the same source
- Have different composition

Cohen et al., A&A, 2020

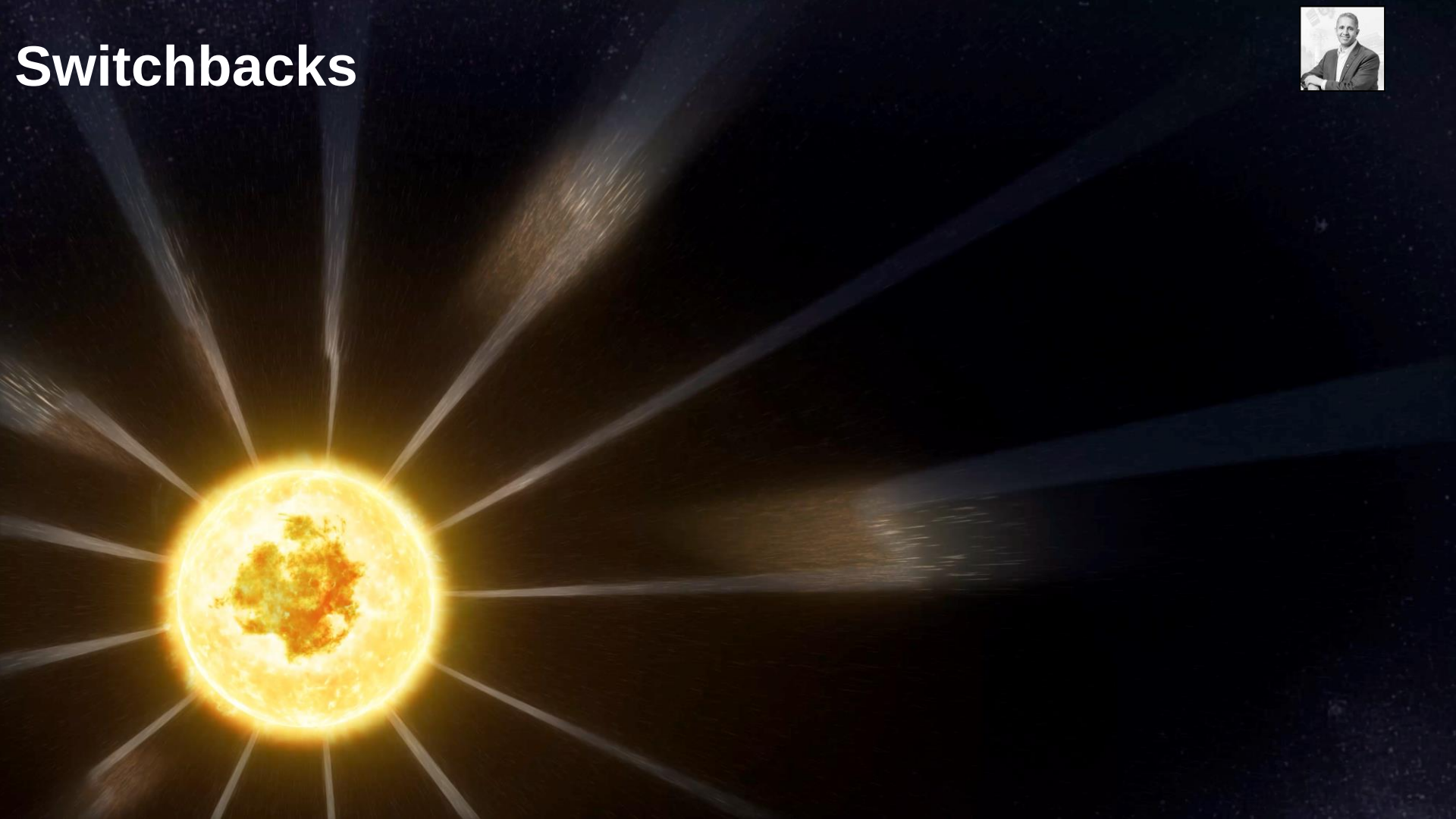
Switchbacks: Energy Source for the Corona Heating

Bale et al., Nature (2019); Kasper et al., Nature (2019)

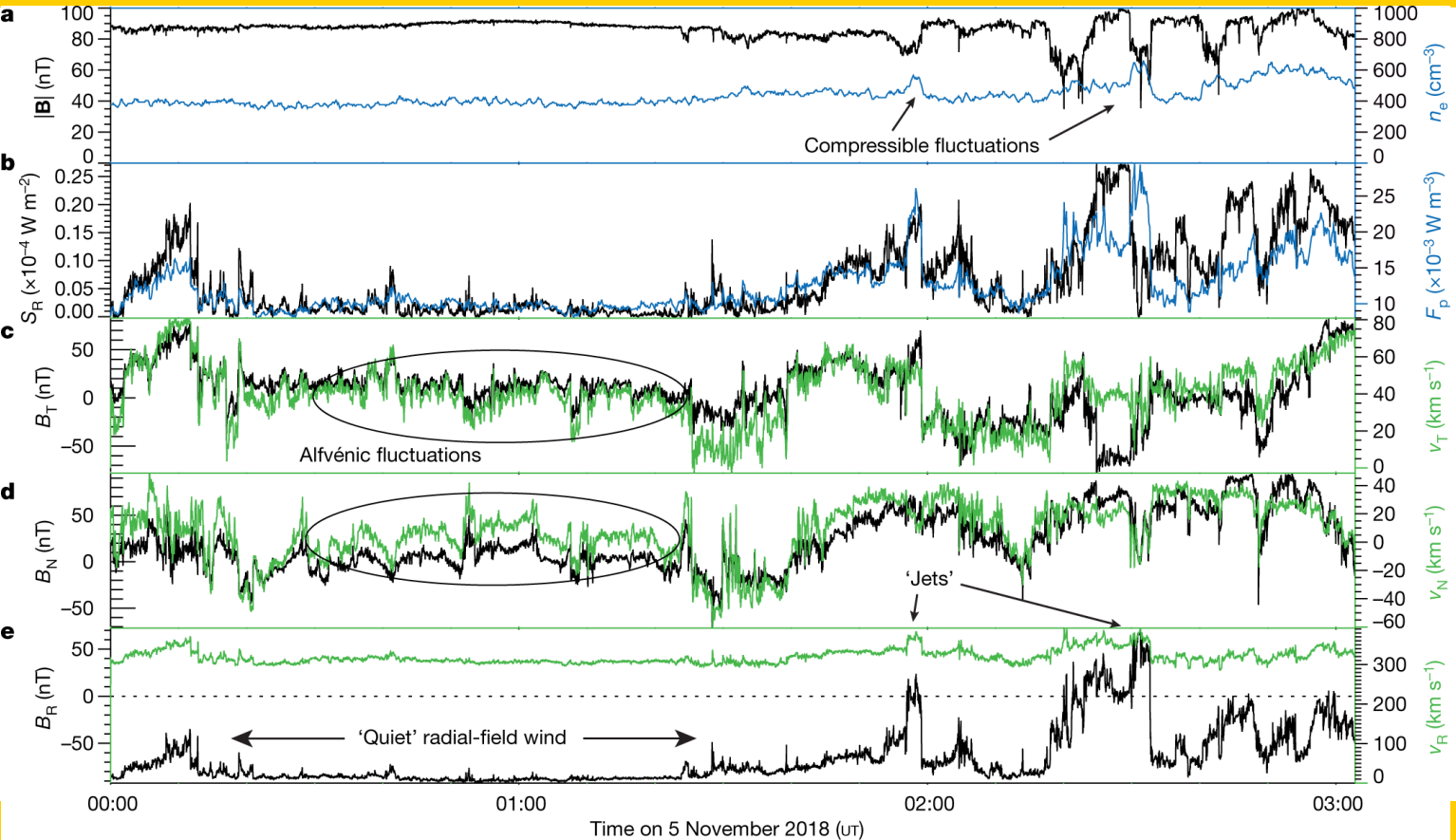




Switchbacks



Switchbacks
Energy Source for the Corona Heating

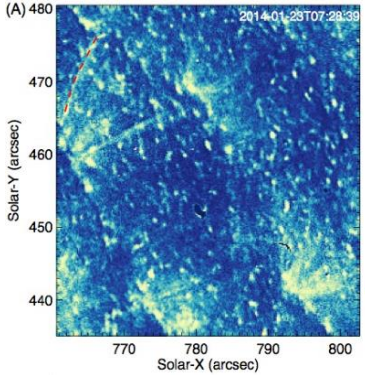


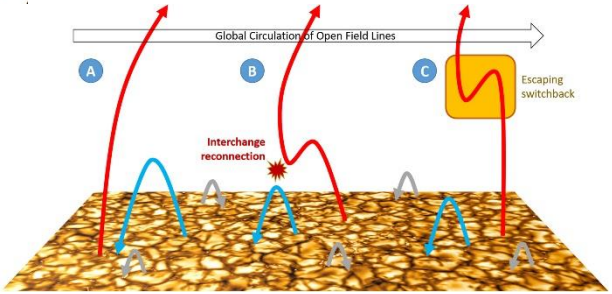
Bale et al. (2019)

Switchbacks: Reconnection vs. Turbulence

Where how do switchbacks form?

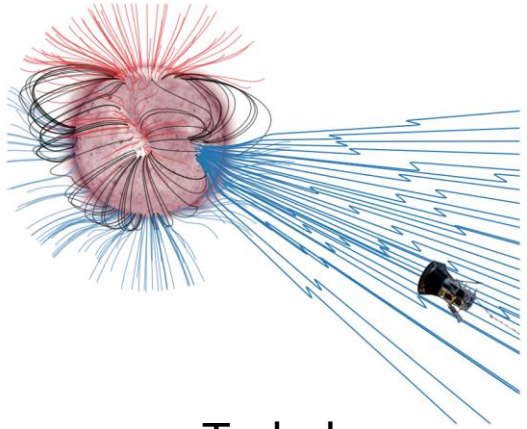
How do they evolve? ➔ Dissipation: plasma heating and acceleration.





Magnetic field reconnection
at the base of the solar corona

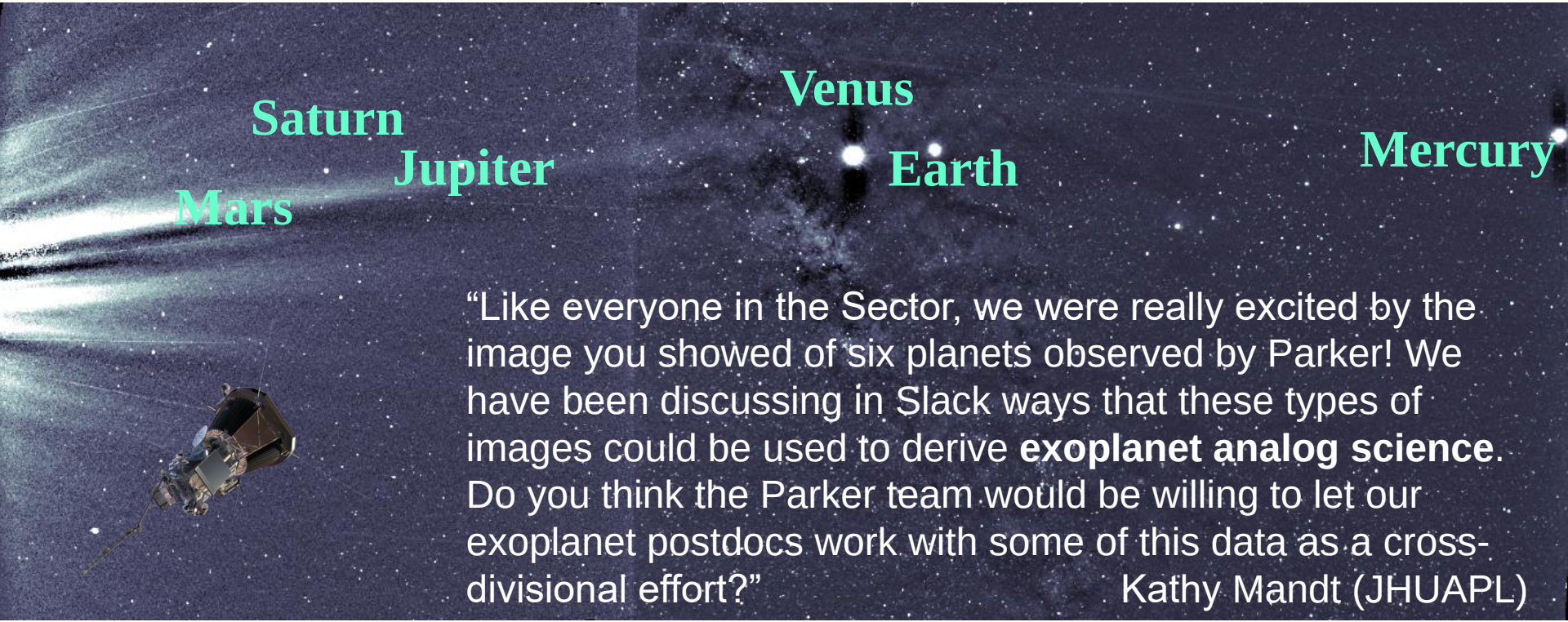
vs.



Turbulence
In situ

Switchback phenomenon: a discriminator between solar wind theories

The Family Portrait: An Incredible Image
PSP/WISPR – June 7, 2020



"Like everyone in the Sector, we were really excited by the image you showed of six planets observed by Parker! We have been discussing in Slack ways that these types of images could be used to derive **exoplanet analog science**. Do you think the Parker team would be willing to let our exoplanet postdocs work with some of this data as a cross-divisional effort?"

Kathy Mandt (JHUAPL)

Let’s pause…

Let’s pause for additional questions from the audience.

Please share your questions in the chat window.

Thanks to Today's Presenter…

Dr. Nour E. Raouafi

Project Scientist

NASA Parker Solar Probe

Johns Hopkins Applied Physics Laboratory

Thank you for participating!

nsta

Collection of Resources

This collection includes the slides (as PDF), handouts and other resources.

Link to the collection:
https://my.nsta.org/collection/t!plus!nCq9Jg7dg_E

Post Program Survey

We value your feedback!

Please stay with us to the end of the program. The post-program survey link will be shared after the recording is stopped.

Your completed survey confirms your attendance which allows us to award you a certificate of participation.

NSTA Web Seminars

Transforming Science Learning: Part 2: Building Science Ideas Using Multiple Modalities and Talk ***(Member Web Seminar)***
December 1, 7:00 PM ET

Science Update: Protecting the Elusive & Endangered Hawaiian False Killer Whale
December 2, 7:00 PM ET

Sponsored Web Seminar: Preparing Students for Engineering Careers
December 7, 7:00 PM ET

Science Update: Unfold the Universe with NASA's Webb Space Telescope
January 20, 7:00 PM ET

Teacher Tip Tuesday: Elevating Science Learning through Read Alouds!
January 25, 7:00 PM ET

Transforming Science Learning: Part 1: Multilingual Learners in Science Classrooms: Theory and Policy Foundations ***(Member Web Seminar)***
January 26, 7:00 PM ET

https://my.nsta.org/webseminars

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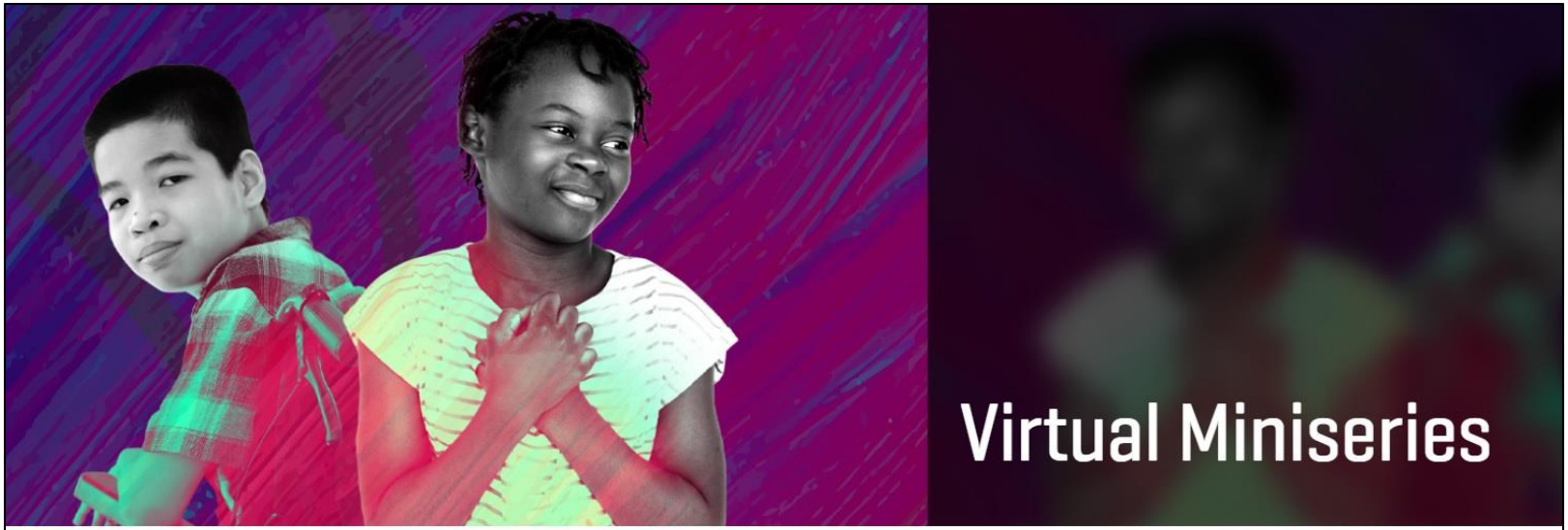
NSTA Virtual Miniseries



Promoting Equity/Diversity/Inclusion Through Science and STEM Teaching

Nov. 6 · Nov. 20 · Dec. 4 · Dec. 18

https://my.nsta.org/event/equity-diversity-inclusion-series

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NSTA Virtual Miniseries

Web Seminar Series

Web Seminar Series

Tue Feb 08, 2022 | 7:00 PM - 8:30 PM Eastern
Tue Feb 15, 2022 | 7:00 PM - 8:30 PM Eastern
Tue Feb 22, 2022 | 7:00 PM - 8:30 PM Eastern
Tue Mar 01, 2022 | 7:00 PM - 8:30 PM Eastern

Presenters


Kate Soriano


Tricia Shelton

Sponsors

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https://my.nsta.org/event/nsta-web-seminar-series-prioritizing-relationships-and-equity-leveraging-studen

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Thanks to the NSTA Virtual Learning Team

National Science Teaching Association

Tricia Shelton, Chief Learning Officer
Flavio Mendez, Assistant Executive Director
Kate Soriano, Standards Implementation Specialist
Wendy Binder, Program Director
Laura Jackson, Project Manager
Michelle Phillips, eLearning Engagement Specialist
Patrice Scinta, Curriculum Writing Specialist
Eddie Hausknecht, Senior Manager Web Development
Don Boonstra, Technical Coordinator

This concludes today's program.