



# Parker Two Workshop

June 21 – 24, 2022

## Agenda

### Tuesday, June 21, 2022

Sessions	Contributions	Speakers	Allotted Time (min.)	Time (EDT)
Conference Opening	Welcome and Logistics	Nour Raouafi	<b>5</b>	9:00-9:05
	APL Welcome & Conference Opening	Bobby Braun	<b>10</b>	9:05-9:15
	NASA HQ Update	Nicola Fox	<b>10</b>	9:15-9:25
	Celebrating Eugene N. Parker	Boon Chye Low	<b>20</b>	9:25-9:45
Payload Updates	WISPR	Mark Linton	<b>10</b>	9:45-9:55
	FIELDS	Stuart Bale	<b>10</b>	9:55-10:05
	SWEAP	Justin Kasper	<b>10</b>	10:05-10:15
	ISOIS	Dave McComas	<b>10</b>	10:15-10:25
BREAK			<b>20</b>	10:25-10:45
Mission/ Observatory Updates	Solar Orbiter Update	Daniel Müller	<b>15</b>	10:45-11:00
	DKIST Update	Valentine Martínez-Pillet	<b>15</b>	11:00-11:15
	<i>Parker Solar Probe Science: Where Do We Stand?</i>	Marco Velli	<b>45</b>	11:15-12:00
BREAK			<b>60</b>	12:00-13:00
Connectivity and Sources Moderator: Sam Badman	<i>The Importance of Understanding the Time-Dependent, 3D Solar Corona for Accurate Connectivity and Source Determination in the Parker Solar Probe Era</i>	Nicki Viall	<b>30</b>	13:00-13:30
	The case for interchange reconnection as the driver of the solar wind	James Drake	<b>20</b>	13:30-13:50
	The First Flight 'through' the Corona: WISPR Imaging of Coronal Streamers from Within	Angelos Vourlidas	<b>20</b>	13:50-14:10
	On Flux Ropes Born in Helmet Streamers	Victor Réville	<b>20</b>	14:10-14:30
	Determining solar wind flow speed from stationary-point measurements from WISPR	Sam Van Kooten	<b>20</b>	14:30-14:50
	Mauna Loa Solar Observatory Coronagraph Observations: Connecting Parker Solar Probe Measurements to their Solar Sources	Joan Burkepile	<b>20</b>	14:50-15:10
BREAK			<b>20</b>	15:10-15:30
Poster Session P1: Poster Viewing in Gather.Town			<b>90</b>	15:30-17:00
DAY 1 END				

<b>Wednesday, June 22, 2022</b>				
<b>Sessions</b>	<b>Contributions</b>	<b>Speakers</b>	<b>Allotted Time (min.)</b>	<b>Time (EDT)</b>
<b>CMEs, Shocks, and SEP Acceleration Processes</b> Moderator: Leng Ying	<i>Modelling solar energetic particles in the era of Parker Solar Probe</i>	<i>Erika Palmerio</i>	<b>30</b>	10:00-10:30
	Magnetic field line path length variations and effects on solar energetic particle transport	David Ruffolo	<b>20</b>	10:30-10:50
	Global Modeling of Broad-Longitude SEP Events	Jon Linker	<b>20</b>	10:50-11:10
	Multi-spacecraft modelling of multi-CMEs observed by WISPR on PSP	Iulia Chifu	<b>20</b>	11:10-11:30
	Magnetic field topology of ICMEs from PSP in-situ measurements	Qiang Hu	<b>20</b>	11:30-11:50
	Numerical Simulations of SEP dropouts and the Implications to PSP Observations	Fan Guo	<b>20</b>	11:50-12:10
<b>BREAK</b>			<b>50</b>	12:10-13:00
<b>Energetic Particles</b> Moderator: Mitchell Shen	<i>How PSP observations are changing our understanding of solar energetic particles</i>	<i>Christina Cohen</i>	<b>30</b>	13:00-13:30
	Energetic Particles Associated with Sub- and Super-Parker Spirals -- Signatures of the Dynamic History of Stretched and Switched-Back Magnetic Fields	Nathan Schwadron	<b>20</b>	13:30-13:50
	Suprathermal Ion Observations Associated with the Heliospheric Current Sheet Crossings by Parker Solar Probe During Encounters 7-10	Mihir Desai	<b>20</b>	13:50-14:10
	Can the lengths of magnetic field lines be determined from velocity dispersion in the onsets of impulsive SEP events?	Edmond Roelof	<b>20</b>	14:10-14:30
	Widespread 1–2 MeV Energetic Particles Associated with Slow and Narrow Coronal Mass Ejections: Parker Solar Probe and STEREO Measurements	Bin Zhuang	<b>20</b>	14:30-14:50
	Energy partitioning from the chromosphere to the heliosphere in the October 28 2021 X flare and associated CME	Katharine Reeves	<b>20</b>	14:50-15:10
<b>BREAK</b>			<b>20</b>	15:10-15:30
<b>Poster Session P2: Poster Viewing in Gather.Town</b>			<b>90</b>	15:30-17:00
<b>Reception (Location B201 Patio)</b>			<b>120</b>	17:00-19:00
<b>DAY 2 END</b>				

## Thursday, June 23, 2022

Sessions	Contributions	Speakers	Allotted Time (min.)	Time (EDT)
<b>Heating, Acceleration, and Turbulence (modeling)</b> Moderator: Jean Perez	<i>Open problems in solar wind heating and acceleration</i>	Anna Tenerani	30	10:00-10:30
	Observations and Models of Proton and Alpha Particle Velocity Distribution in Sub-Alfvénic Solar Wind at PSP Perihelia	Leon Ofman	20	10:30-10:50
	Strategies for determining the energy transfer rate in MHD turbulence: isotropy, anisotropy, and spacecraft sampling	Yanwen Wang	20	10:50-11:10
	Anisotropic compressible MHD turbulence and comparison with Parker Solar Probe data	Senbei Du	20	11:10-11:30
	Semi-Empirical Multi-base Exospheric Model of the Solar Wind	Mihailo Martinovic	20	11:30-11:50
	Local proton heating at different magnetic discontinuities in the solar wind	Carlos Gonzalez	20	11:50-12:10
<b>BREAK</b>			<b>50</b>	12:10-13:00
<b>Heating, Acceleration, and Turbulence (observations)</b> Moderator: Kris Klein	<i>Observational Signatures of Cosmic Energy Flow with Parker Solar Probe: The First 11 Encounters</i>	Jaye Verniero	30	13:00-13:30
	Electron Distributions Observed by the Parker Solar Probe in the Near-Sun Fast Solar Wind	Jasper Halekas	20	13:30-13:50
	Observations of Sunward-Propagating Ion-Cyclotron Waves Below the Subalfvenic Surface	Kristoff Paulson	20	13:50-14:10
	Solar Wind Protons and Alphas Properties Close to the Sun: New Parker Solar Probe Observations	Parisa Mostafavi	20	14:10-14:30
	The Near-Sun Turbulence Mediated by Parametric Decaying Instability of Alfvén Waves	Zhaoming Gan	20	14:30-14:50
	The evolution of the magnetic field spectral index with heliocentric distance in the solar wind	Jack McIntyre	20	14:50-15:10
<b>BREAK</b>			<b>20</b>	15:10-15:30
Poster Session P3: Poster Viewing in Gather.Town			<b>90</b>	15:30-17:00
<b>DAY 3 END</b>				

## Friday, June 24, 2022

Sessions	Contributions	Speakers	Allotted Time (min.)	Time (EDT)
<b>Switchbacks and Origins</b> Moderator: Jon Linker	<i>Switchbacks with Parker Solar Probe</i>	<i>Ronan Laker</i>	30	10:00-10:30
	Magnetic Switchback Occurrence Rates in the Inner Heliosphere: Parker Solar Probe and 1 au	Francesco Pecora	20	10:30-10:50
	Statistical Properties of the Switchbacks Observed During the First 10 Encounters of Parker Solar Probe	Vamsee Krishna	20	10:50-11:10
	Switchbacks, microstreams and broadband turbulence in the solar wind	Tim Horbury	20	11:10-11:30
	Size Scale and Occurrence Rate of Coronal Jets and Similar Solar Features: Possible Solar Sources for Magnetic Switchbacks	Alphonse Sterling	20	11:30-11:50
	Patches of magnetic switchbacks: hints of their origins	Chen Shi	20	11:50-12:10
<b>BREAK</b>			<b>50</b>	12:10-13:00
<b>Additional PSP Science</b> Moderator: Phil Hess	<i>The View of the Corona from Within the Alfvén Surface</i>	<i>Russ Howard</i>	30	13:00-13:30
	Translational Tomography of the Solar Corona	Megan Kenny	20	13:30-13:50
	Resolving when coronal mass ejections engulf PSP	Carlos Braga	20	13:50-14:10
	First joint STIX and LOFAR Observations of a Flare Event on 06 June 2020	Malte Broese	20	14:10-14:30
	Imaging of Venus by PSP/WISPR	Brian Wood	20	14:30-14:50
	PSP/SWEAP/SPAN-Ion observations of upstream pickup protons at Venus	Ali Rahmati	20	14:50-15:10
<b>BREAK</b>			<b>20</b>	15:10-15:30
Poster Session P4: Poster Viewing in Gather.Town			<b>90</b>	15:30-17:00
<b>DAY 4 END</b>				
<b>CONFERENCE END</b>				



Gene Parker, occasion of receiving news of his award of the 2020 Crafoord Prize for Astronomy.

*Photo Credit: University of Chicago*

# Two basic properties of the corona and solar wind to discuss in celebration of



**Eugene N. Parker**  
University of Chicago

**Boon Chye Low**  
High Altitude Observatory  
National Center for Atmospheric Research\*  
Boulder, Colorado



\*The National Center for Atmospheric Research is sponsored by the National Science Foundation, USA

# Cosmical magnetic fields

3

- Magnetic fields are ubiquitous in the astronomical universe with a remarkable longevity sustained by dynamo regeneration and self-organization. The fields produce a great diversity of hydromagnetic phenomena on scales of galaxies, stars & stellar winds, planetary magnetospheres & cores, these phenomena distinct from those in laboratory experiments.
- Beginning with the spectroscopic detection of the kilo-gauss fields in sunspots by Hale (1905), the Sun and its heliosphere are a natural laboratory to observe and discover a wealth of plasma phenomena, interesting in their own rights with insights into the less readily observable physical processes taking place elsewhere in the universe.
- Gene Parker was often the central player in the drama of discovering and investigating cosmical magnetic fields. Hale's discovery of the magnetic nature of sunspots had to wait half a century for the arrival of Gene in 1955 to explain the phenomenon in terms of the solar dynamo and magnetic buoyancy.
- Then came Gene's timely 1958 concept-transforming prediction of the solar wind, at first controversial but soon confirmed by the first generation of human-made satellites. One wonders what a mess it would have been to figure out the early *in situ* observations of the wind, without the forethoughts from Gene's physical explanation of why the wind must be out there. Six decades of space and ground-based observations followed, space physics matured and magnetic fields became an essential component of astrophysical phenomena. Gene's very many single-authored papers claimed his lion's share of discovering and identifying the basic processes of these phenomena.

# The corona and solar wind.... two far-reaching consequences of high electrical and thermal conductivities

4

- The million-degree hot, X-ray radiating solar corona in its fully ionized state is an excellent electrical conductor. The corona heats itself by the spontaneous formation of localized current sheets in its  $\sim 10$  Gauss magnetic fields, the currents so intense as to dissipate significantly at the otherwise negligible coronal electrical resistivity. The formation of the current sheets is a high conductivity effect. Thus, high electrical conductivity is as much a consequence of, as it is the origin of the million-degree coronal temperature.
- The corona is also an excellent thermal conductor by virtue of the coronal free electrons, which means that heat can be conducted to the outer corona to break the confinement by the inverse-square Newtonian gravity. The compelling picture thus emerges with the heated, quasi-static, inner corona heaving outward to feed into the expanding solar wind. Sound speed decreases with the decreasing temperature in the expansion, a simple explanation for the wind to be supersonic within about  $2R_\odot$  in heliocentric radial distance.
- In conversation with Gene, he confirmed for me that he was impressed by the observational knowledge available in mid-1950s, of the interstellar pressures being 8 orders of magnitude less than coronal pressures. Thus, the wind is essentially expanding into near vacuum. In this preferred global state of wind outflow, no disturbance travels upstream in the supersonic wind flow to influence the low corona.

# The magnetic origin of the heated corona and the solar wind

5

- Temperature naturally increases with radial height in a *static*, gravitationally-stratified, thermally conducting atmosphere, in order to balance volumetric heating and optically-thin radiative loss. A downward conductive thermal flux is required to bring excess heat from the rarefied upper atmosphere to be efficiently radiated away in the dense lower atmosphere. Provided, of course, the atmosphere does not extend too far out radially. The quasi-steady solar wind is thus the natural state by the combined effects of heating, thermal conduction and the inverse-square decline of solar gravity. This conclusion was established in Gene's 1958 paper, which also examined the physical issues to suggest that heating might be of a magnetic nature distinct from Alfvén waves.
- Coronal heating by the spontaneous current-sheets was proposed in two steps by Gene in 1972. Taking the extreme case of perfect conduction to make a fundamental point, i.e., taking electrical resistivity to be zero, surfaces of magnetic tangential discontinuity are physically admissible, each such surface conducting an infinitesimally thin current sheets. Gene discovered a rigorous Magnetostatic Theorem that 3D tangled magnetic fields generally attain equilibrium by irrepressibly embedding infinitesimally-thin current-sheets created by the Lorentz force under the frozen-in condition of perfect conduction. In the corona, electrical resistivity is exceedingly small but not zero. The irrepressible thinning of a current sheet is arrested by dissipative magnetic reconnection at the otherwise negligibly small resistivity. The reconnected 3D magnetic field is also subject to the Theorem, so fresh current sheets form and the process does not end.

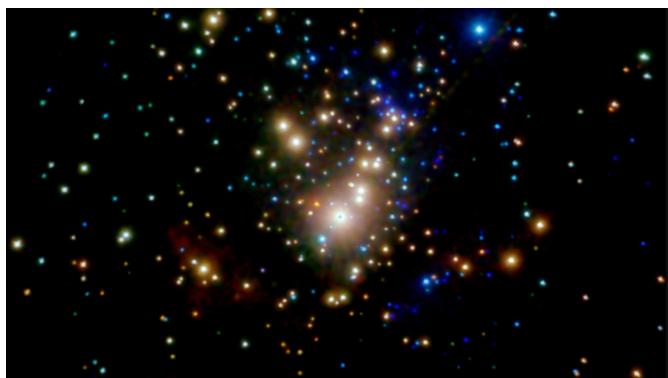
## The corona and stellar wind as a universal phenomenon

- The application of the Magnetostatic Theorem was published in 1988 to explain the heat input by the observed ubiquitous, intermittent nanoflares to account for  $10^{28} \text{ erg s}^{-1}$  radiated by the corona in soft X-ray.
- Although the magnetic field is forced and held open by the inertia of the outflowing wind, magnetic dominance in the low- $\beta$  inner corona determines the details of the heating by magnetic reconnection. The field also mechanically channels the solar-wind flow at its source, as well as the flow of heat under a highly anisotropic thermal conductivity, the cross-field conductivity being suppressed by as much as 8 orders of magnitude. Thus, the corona and the solar wind have a common magnetic origin.

# More than half a century of investigating the solar wind system

7

- The solar wind system took  $> 40$  years for Voyager I and II for us to directly observe its transition into interstellar space, and, only after that, we now directly observe the coronal transition into the wind with the NASA Parker Solar Probe, very much in keeping with the observational foundation of our science. It is a great feeling, indeed, that our good colleague and friend Gene Parker did get to see the first results of his Solar Probe from Nicky Fox and other colleagues before leaving us.
- It was always a treat to listen to a Parker lecture, giving him our full attention and enjoying his explanation of ideas in a unique, analytical clarity of where basic physics resides in a natural phenomenon. We miss him today. I have set out to celebrate Gene with two of his concept-transforming contributions, reliving the excitement of his discovering of how spontaneous current sheets form readily to heat the corona and how the solar wind is the natural state of the heliosphere. Having identified and understood the basic physical processes, the corona and solar wind are the prototype of a universal astrophysical phenomena. Stars and galaxies have X-ray coronae and by implication also have winds!



**A field of X-ray stellar coronae in the *Orion Constellation***  
NASA Chandra X-ray Observatory, 2005

# Gene Parker & the University of Chicago

8

Gene Parker joined the University in 1955 and retired in 1995 as S Chandrasekhar Professor Emeritus in the Department of Physics and Department of Astrophysics and Astronomy.

Among his many honors:

Election to National Academy of Sciences, 1967  
National Medal of Science, 1989  
Kyoto Prize, 2003  
Crafoord Prize, 2020

## Laboratory for Astrophysics & Space Research Enrico Fermi Institute

*Completed 1965 & reconstructed 2017*

Occupants of the corner Offices in 1967:

**S Chandrasekhar**, astrophysics, age 57

**P Meyer**, space physics, age 47

**E Parker**, space physics & astrophysics, age 40

**J Simpson**, space physics, Lab Director, age 51

*Photo Credit: University of Chicago*





The man and his student talking .... when they were still “not too old”.  
IAU Symposium No. 140 on Galactic and Intergalactic Magnetic Fields, Heidelberg, circa 1988.



*Note*  
The four Crafoord Prize Laureates (L. to R.):  
E. Bombieri, Mathematics 2020  
E.N. Parker, Astronomy 2020 -  
represented by E.G. Parker  
D.L. Kastner, Polyarthritis 2021  
A.H. Knoll, Geosciences 2022  
Crown Princess Victoria of Sweden

Eric Parker receiving the Crafoord Award from the Crown Princess Victoria of Sweden on behalf of his father Gene Parker, the 2020 Crafoord Laureate for Astronomy, Lund, Sweden, April 2022. On Eric's sides are three other Crafoord Laureates receiving their awards at the Crafoord Ceremony.

## Fernando offers a last word for all in space physics & astrophysics....

“Gene Parker was a giant and the astrophysical community will continue tapping ideas, results and resources from his amazing contributions for a long time.”

**Fernando Moreno-Insertis**

*Instituto de Astrofisica de Canarias*

*Universidad de La Laguna*