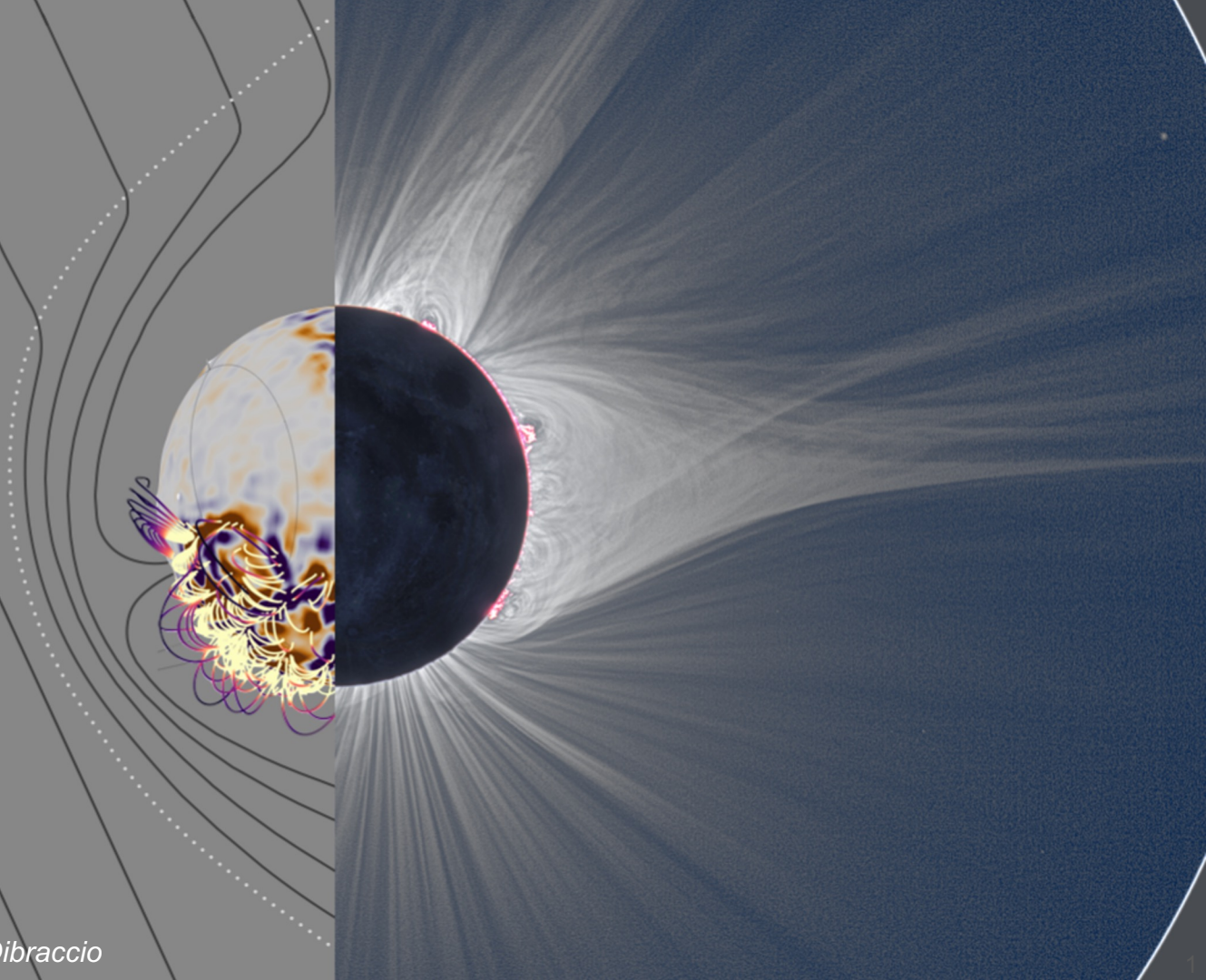


# A Martian Visits the Solar Corona

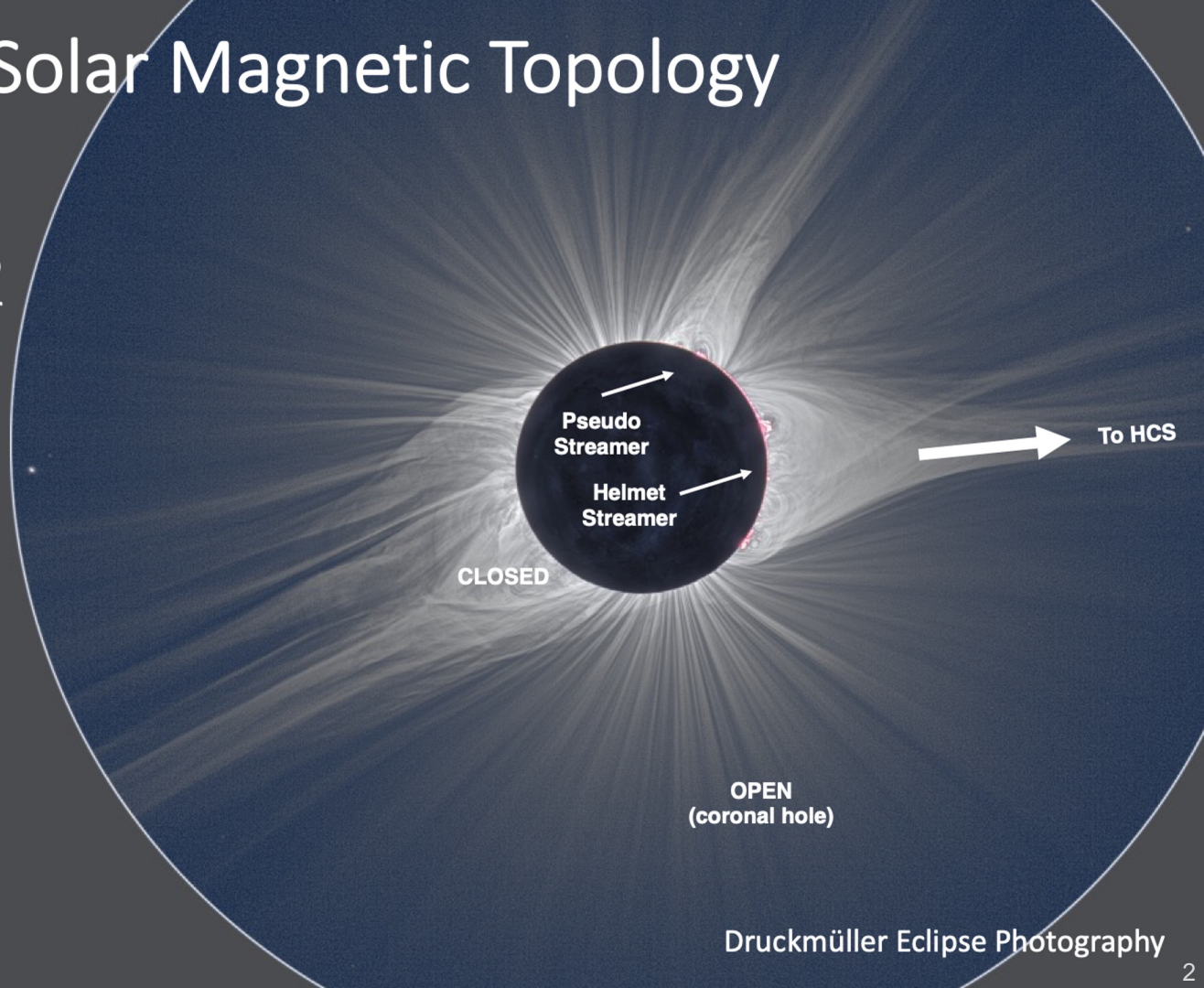
*Cross-divisional comparisons of  
magnetic fields at Mars & the Sun*

*Aleida Higginson, Tristan Weber, Gina Dibraccio*



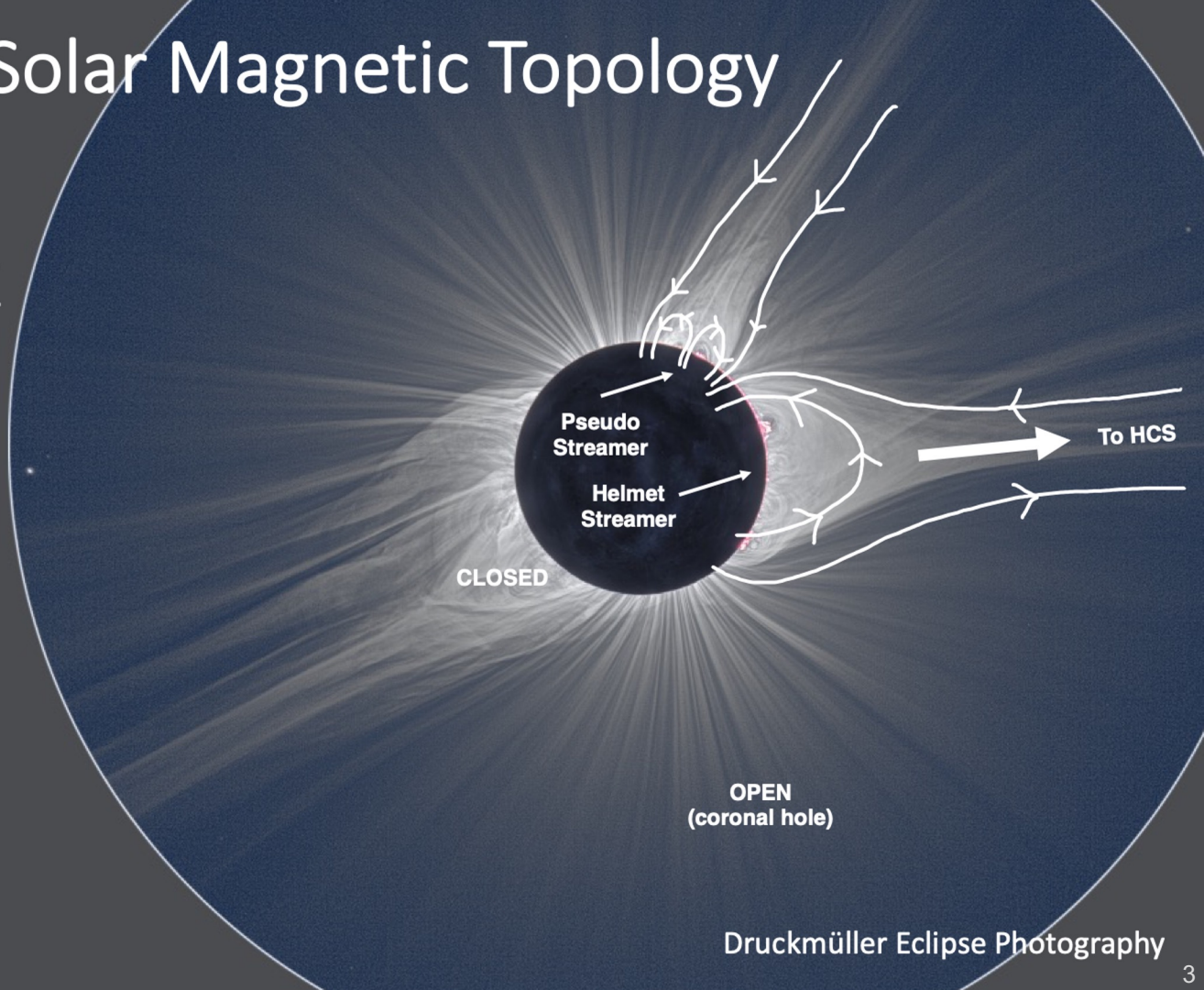
# Introduction to Solar Magnetic Topology

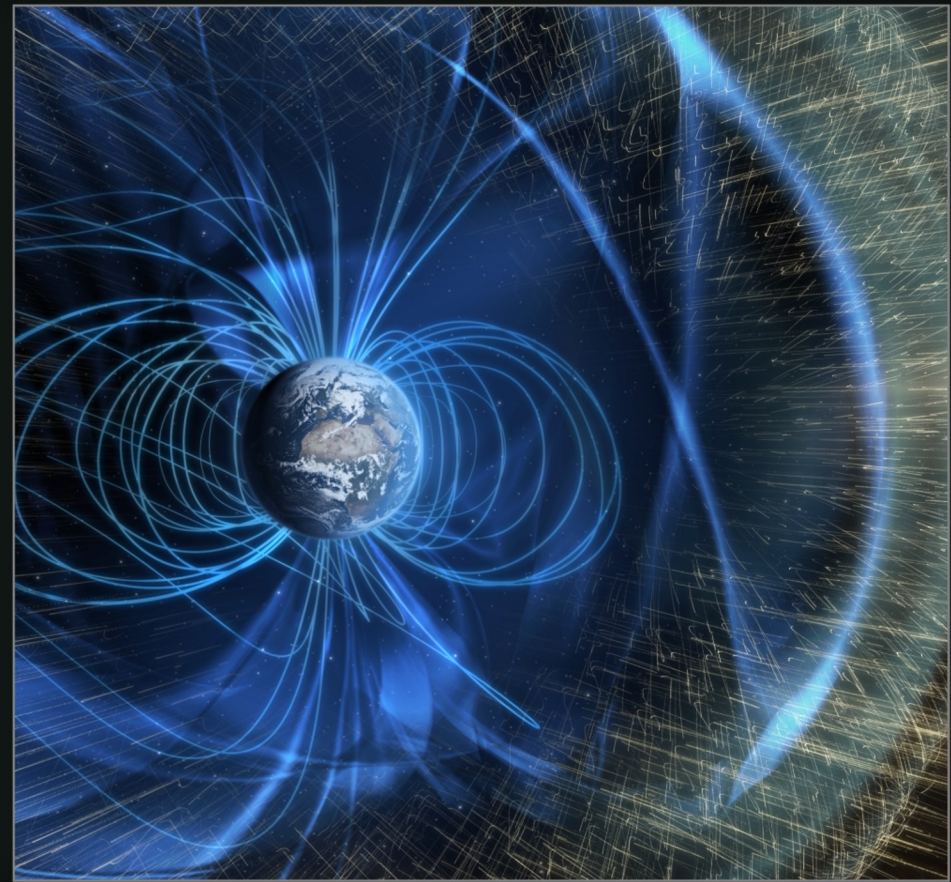
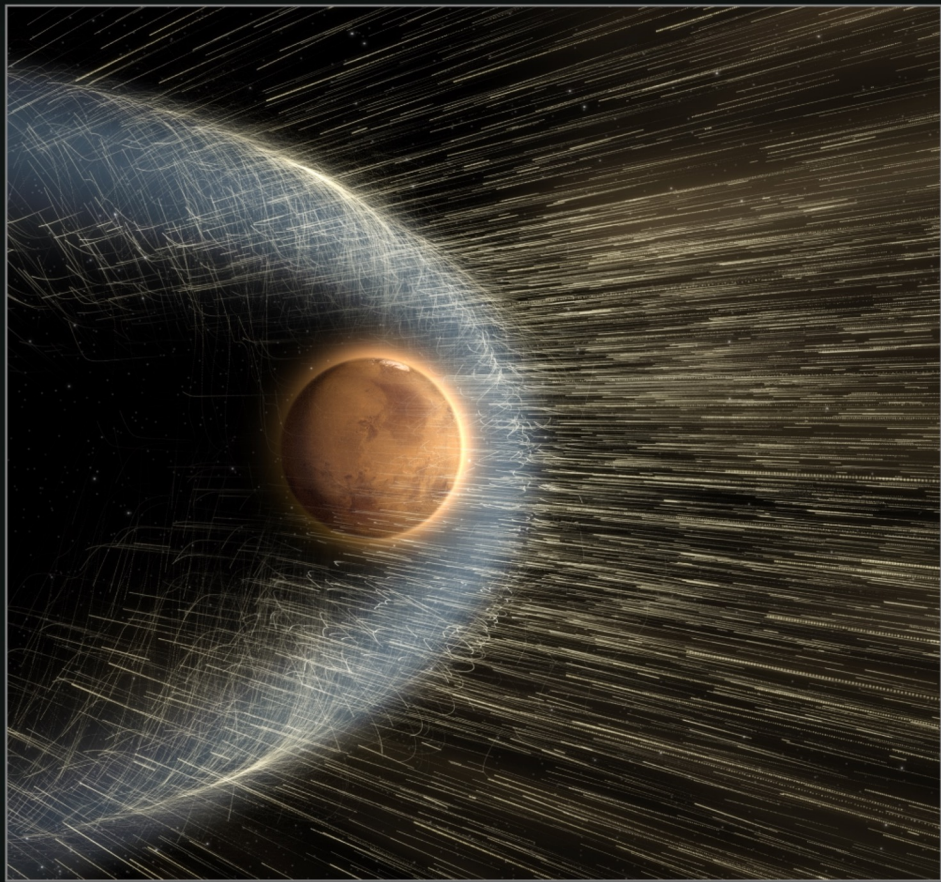
- Two types of field lines
  - **Open magnetic field** lines allow plasma to escape into the heliosphere as the solar wind.
  - **Closed magnetic field** lines confine plasma to the solar corona.
- Two types of large-scale magnetic topologies
  - **Helmet streamers** have a current sheet “above” them, which is in fact the heliospheric current sheet.
  - **Pseudostreamers** are surrounded by unipolar flux.

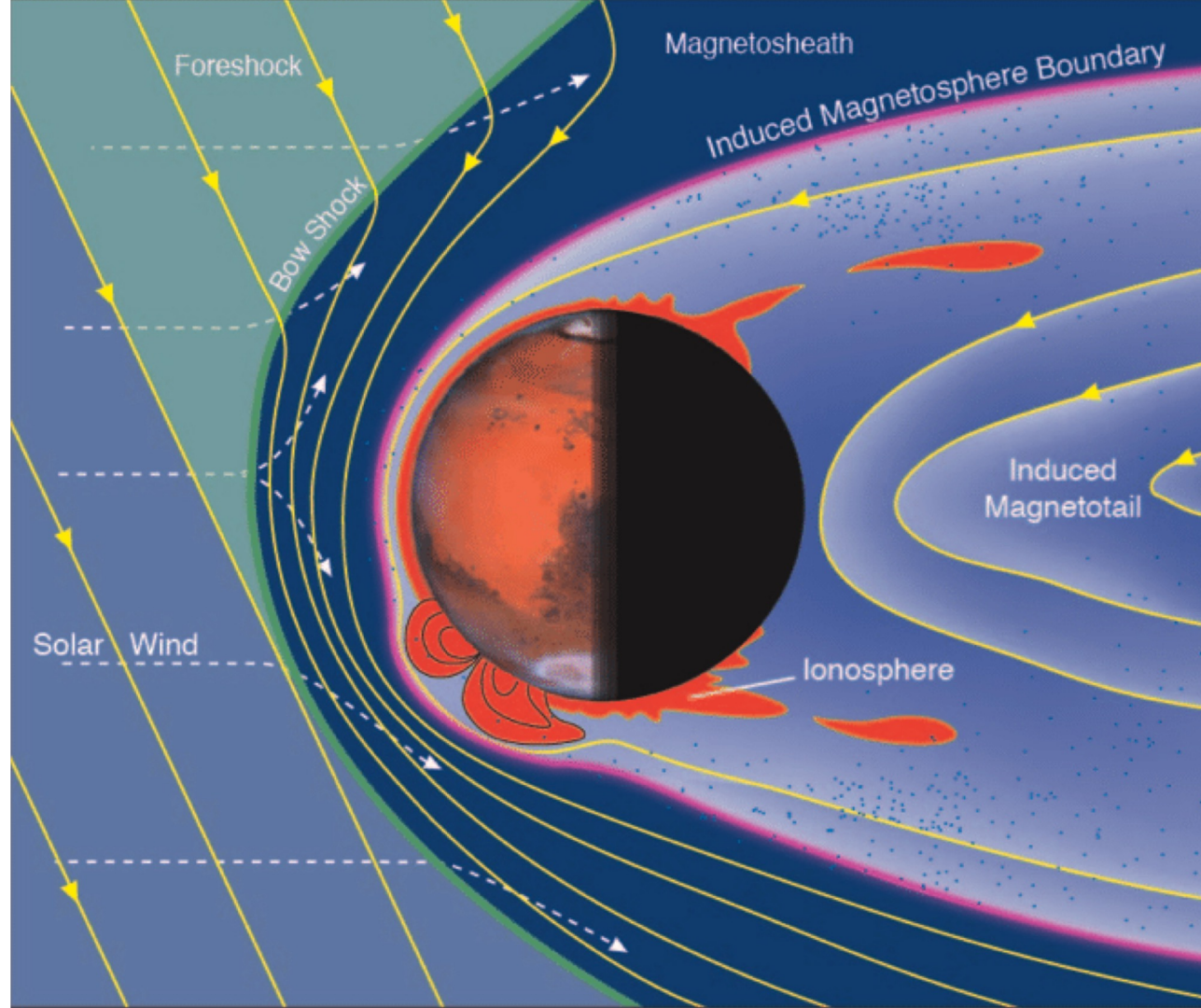


# Introduction to Solar Magnetic Topology

- Two types of field lines
  - **Open magnetic field** lines allow plasma to escape into the heliosphere as the solar wind.
  - **Closed magnetic field** lines confine plasma to the solar corona.
- Two types of large-scale magnetic topologies
  - **Helmet streamers** have a current sheet “above” them, which is in fact the heliospheric current sheet.
  - **Pseudostreamers** are surrounded by unipolar flux.

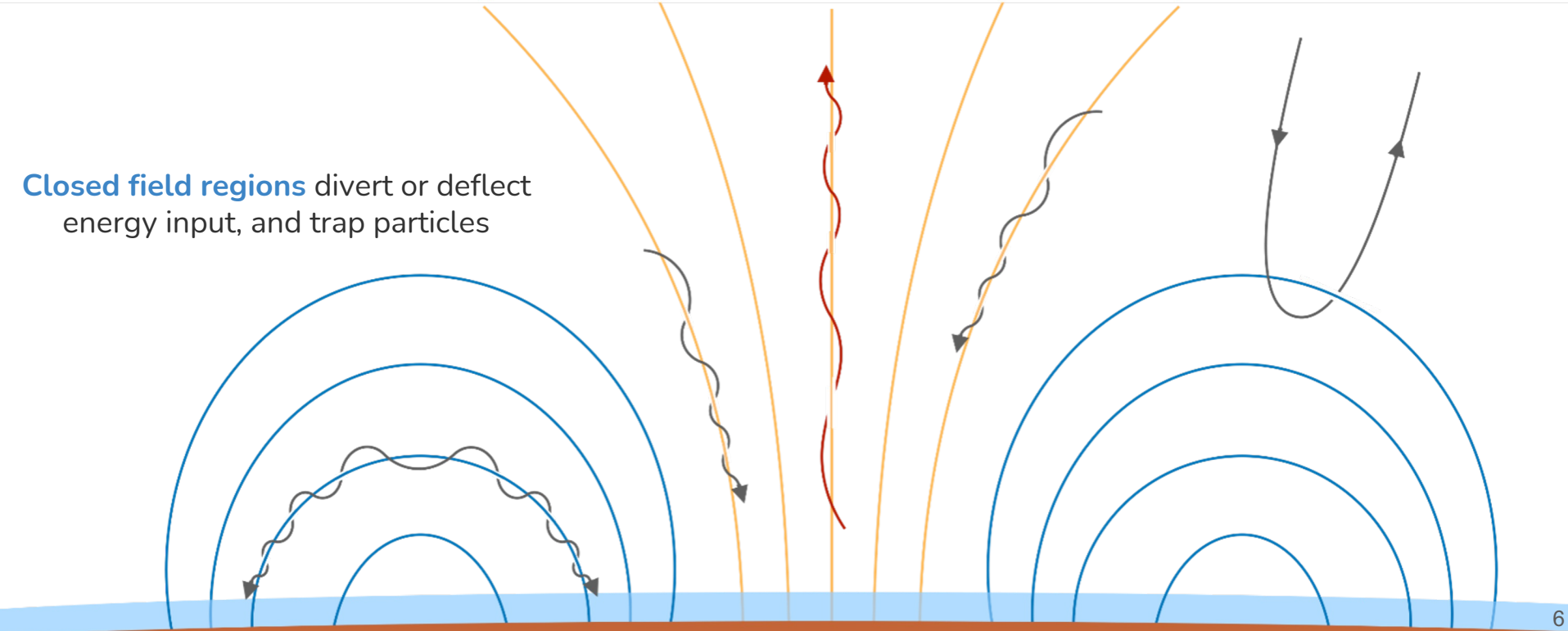






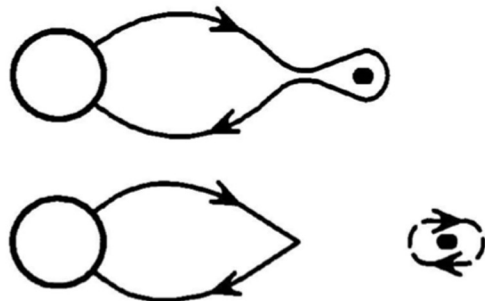
**Open cusp fields** focus energy input  
and enhance escape

**Closed field regions** divert or deflect  
energy input, and trap particles

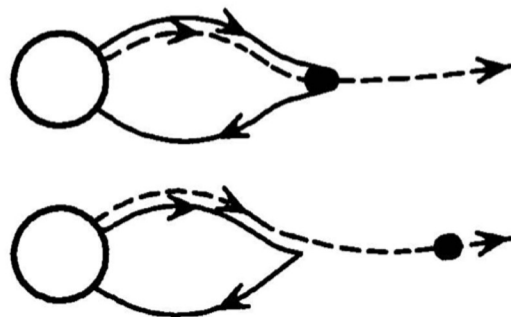


# Two Types of Coronal Reconnection Lead to Solar Wind Release

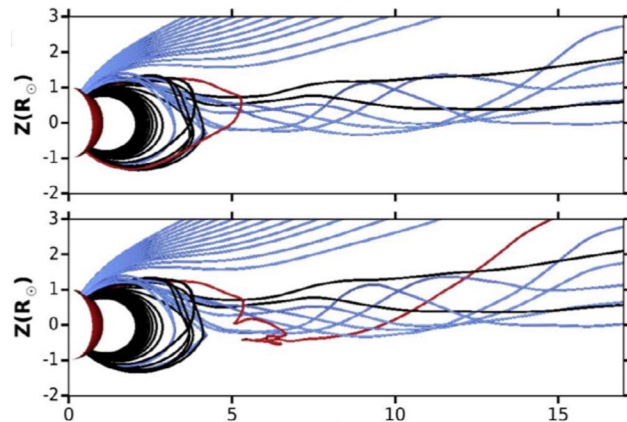
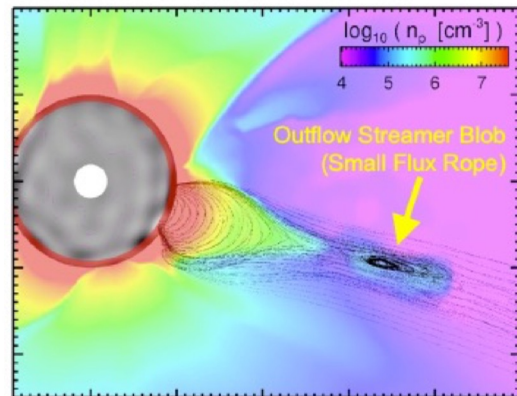
**pinch-off reconnection** occurs at helmet streamers (aka heliospheric current sheet)



**interchange reconnection** can occur at any boundary between open/closed (inherently 3D, stitches together field lines)



(cartoons via Wang et al. 2000)

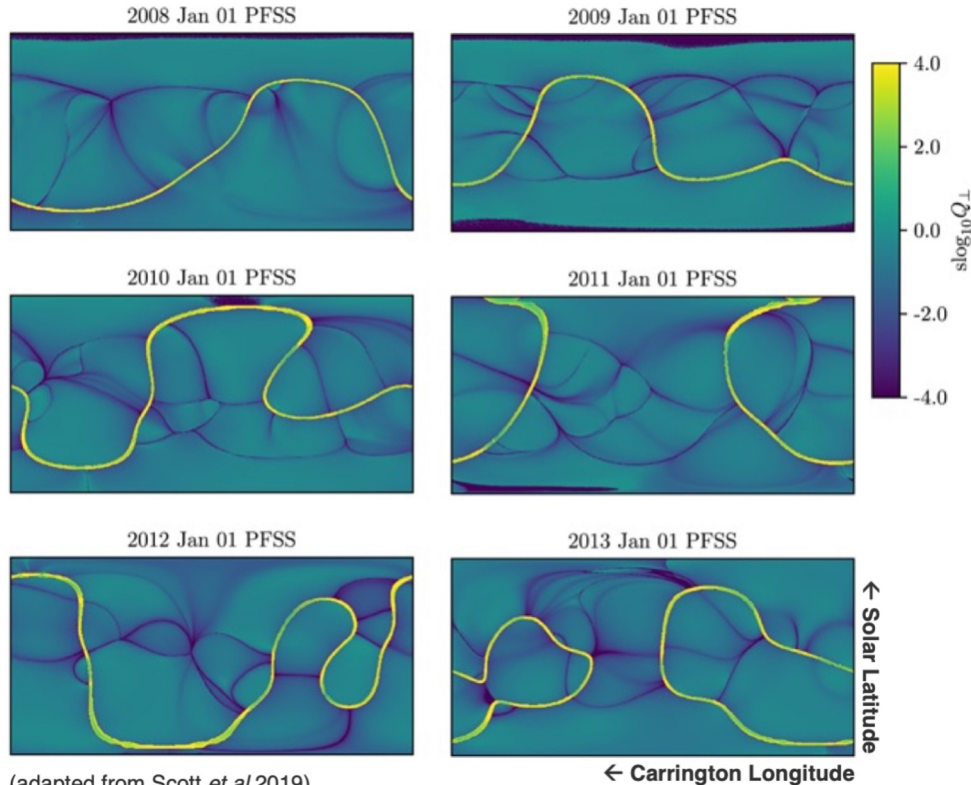


Lynch et al. 2020

Higginson et al. 2018

# Using Separatrix-Webs to Visualize Magnetic Reconnection

$\log_{10} Q_{\perp}$  just below 2.5 solar radii



(adapted from Scott *et al* 2019)

- calculated by tracing magnetic field lines between 2 surfaces and computing the “squashing factor ( $Q$ )” of the flux tubes (described in depth in [Titov et al. 2007](#))
- highlights gradients in the mapping of the magnetic field between two surfaces, i.e. where reconnection is likely!

- Yellow curves show the heliospheric current sheet above helmet streamers
- Purple curves show separatrix-web arcs above pseudostreamers

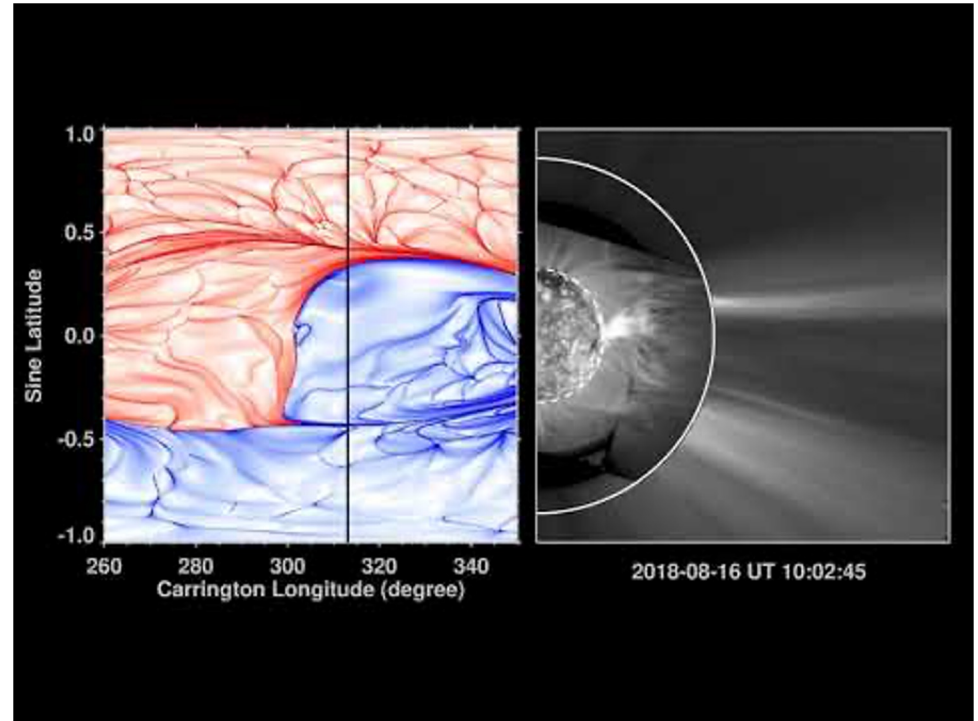


# Coronal Separatrix-Webs and Observations

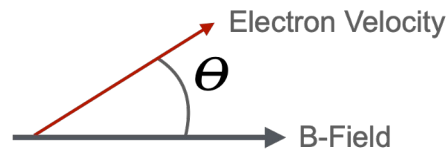
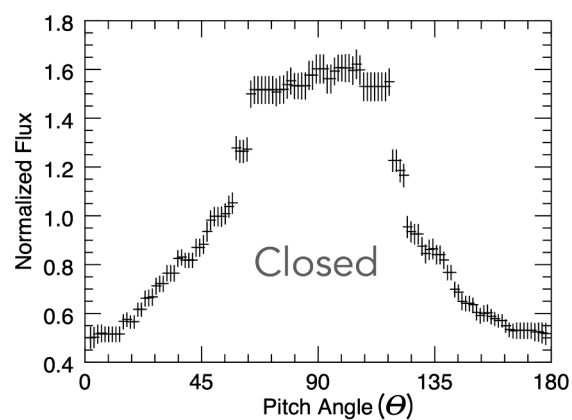
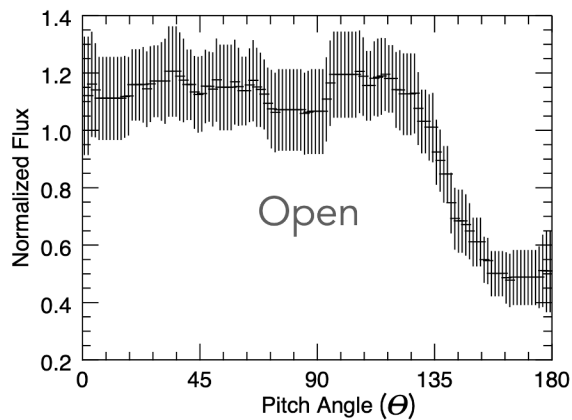
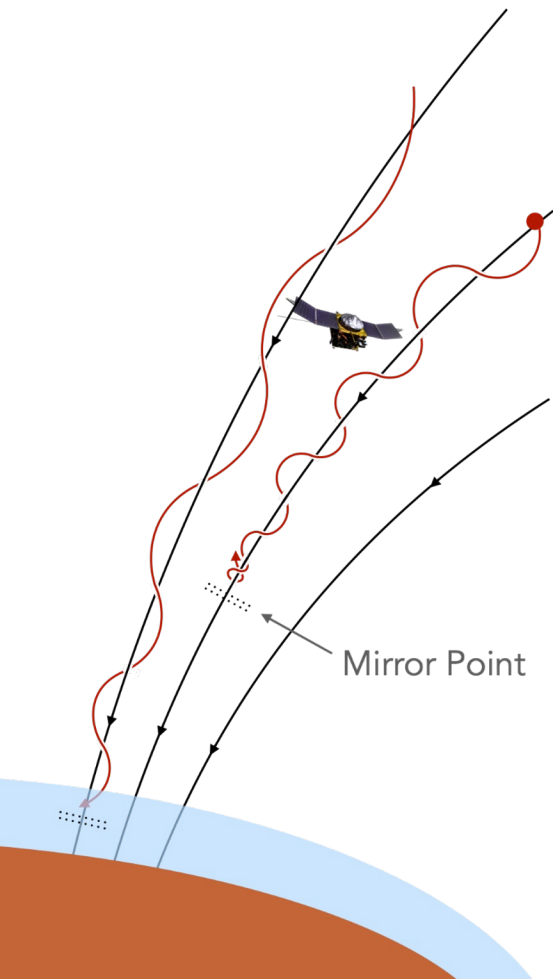
Separatrix-web with slider showing location of solar limb as viewed from Earth  
GOES/SUVI (EUV) and SOHO/LASCO (white-light) observations from near-Earth

Red/Blue Boundary  
Heliospheric Current Sheet and Underlying Helmet Streamer

Red/Blue Arcs  
Locations of Pseudostreamers (and other smaller, fine structure where reconnection is likely)

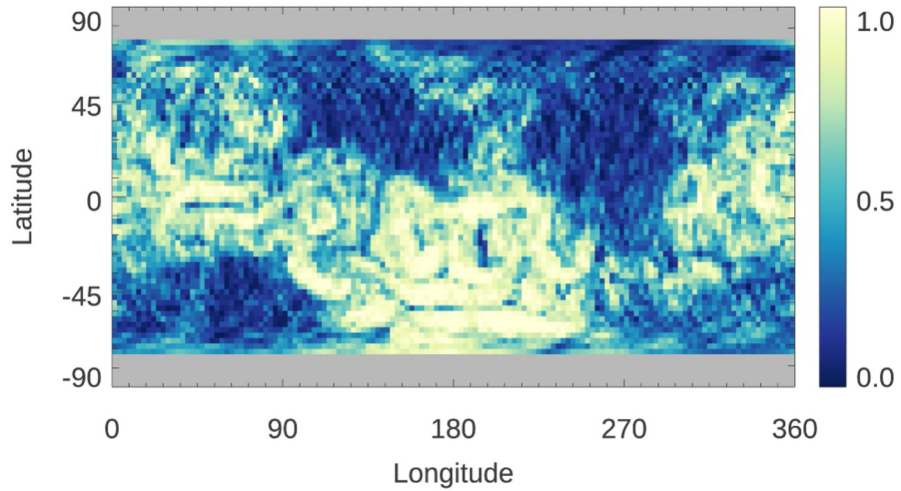


# We can identify magnetic topology by measuring the flow of electrons

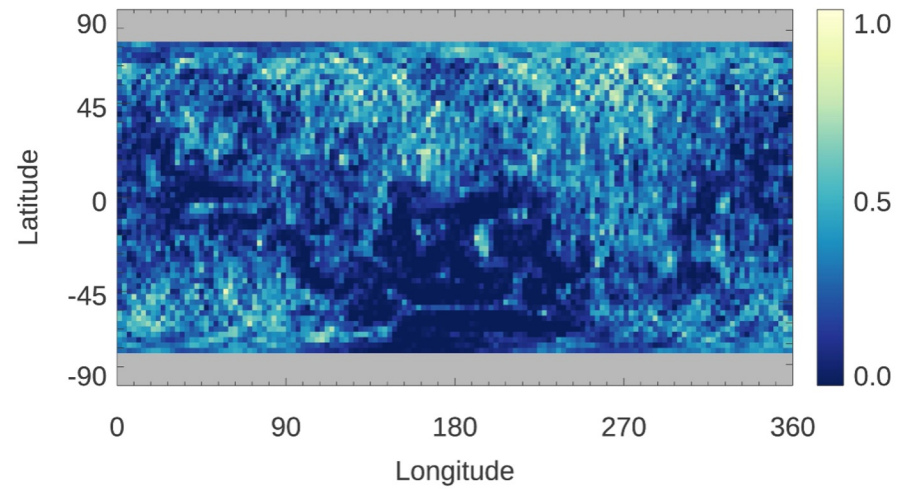


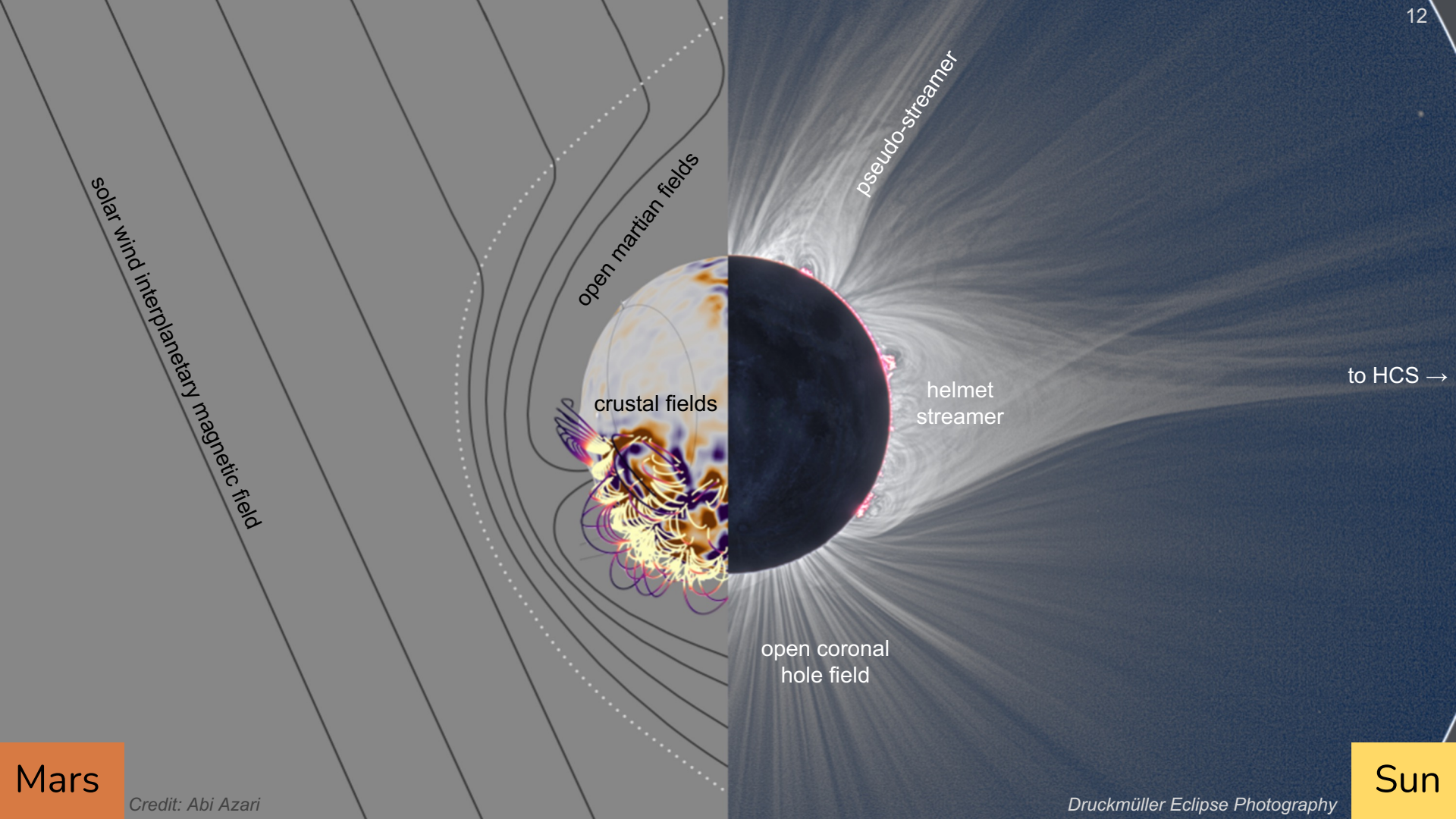
Using years of data, we can compile maps of magnetic topology

Closed Field Frequency - Nightside



Open Field Frequency - Nightside





solar wind interplanetary magnetic field

open martian fields

crustal fields

pseudo-streamer

helmet streamer

to HCS →

open coronal hole field

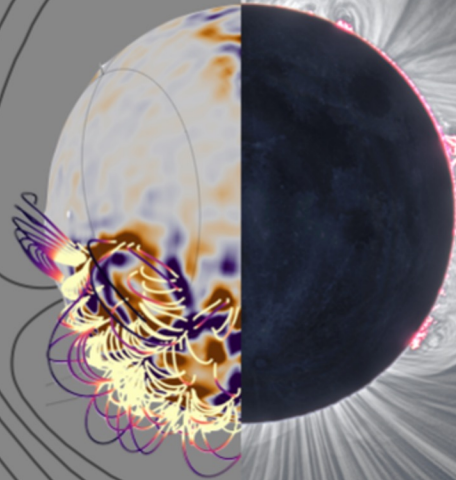
Mars

Credit: Abi Azari

Druckmüller Eclipse Photography

Sun

- ✓ – Closed Fields – ✓
- ✓ – Open Fields – ✓
- ✓ – Draped Fields – ✗



$10^3$  km – System Size –  $10^5$  km  
 $10^2$  nT – Field Strength –  $10^6$  nT  
 $10^2$  eV – Particle Energy –  $10^2$  eV