

# Heliospheric-relevant MHD Turbulence in Laboratory Plasma



**David Schaffner**  
Bryn Mawr College/Swarthmore College



## MHD Turbulence: laboratory vs *in-situ*

### Lab Advantages:

- 1) multiple point measurements
- 2) control of plasma conditions
- 3) less expensive

However, a plasma source that generates dynamic B-fields is necessary (e.g. plasma gun)

## MHD Turbulence Research on the Swarthmore Spheromak Experiment

### Selected SSX Publications on MHD Turbulence: (Scan QR Code for PDF)

SSX as a Turbulence Laboratory  
(Brown PSST 2014, Brown JPP 2015)



Turbulence Overview  
(Schaffner PPCF 2014)



Intermittency and Helicity  
(Schaffner PRL 2014)



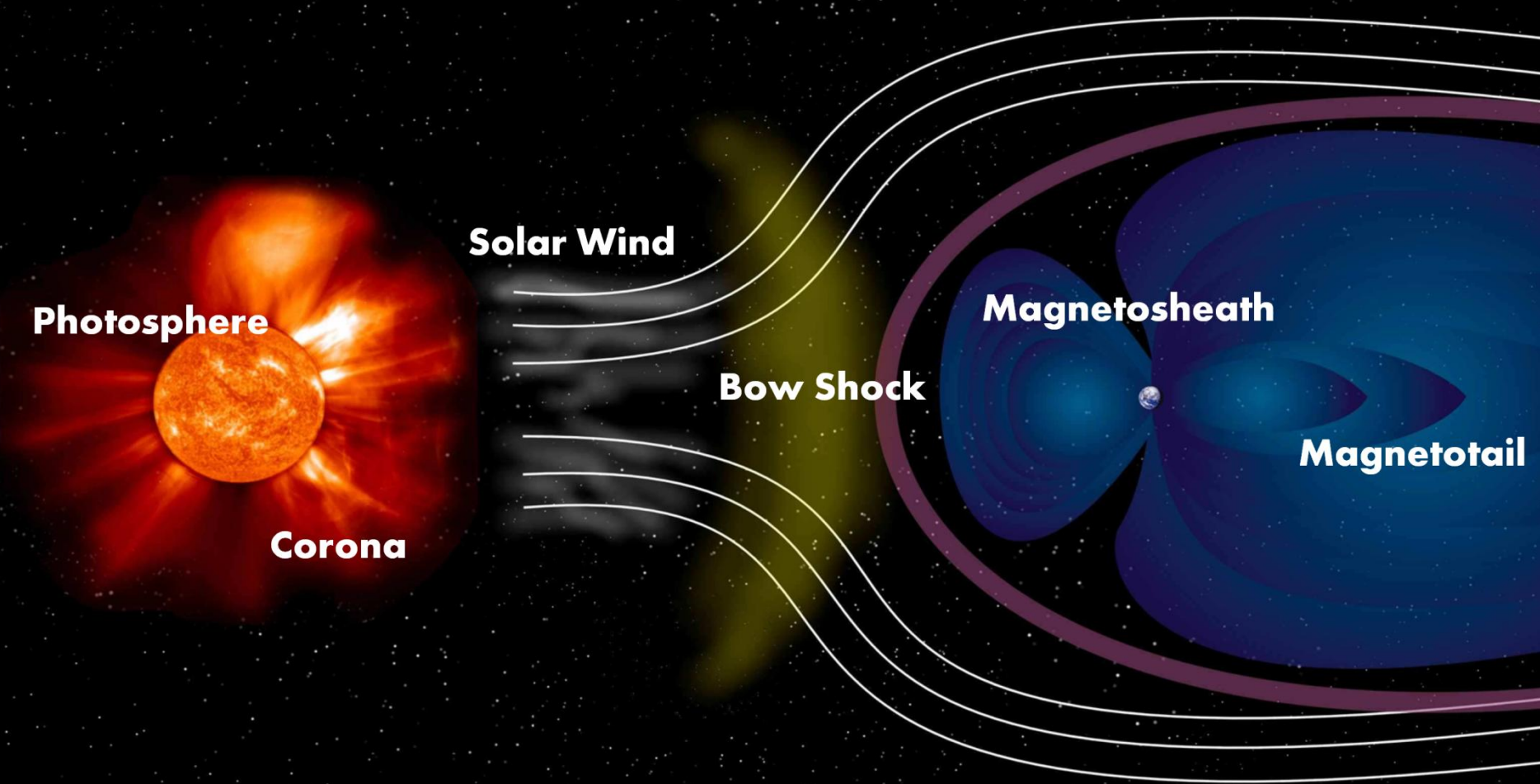
Spectra/Variance Anisotropy  
(Schaffner ApJ 2014)



SSX Website:



## The Turbulent Heliosphere



MHD Turbulence is observed in many locations and forms throughout the heliosphere

<http://sci.esa.int/jump.cfm?oid=32799>

Magnetic turbulent fluctuations are measured *in-situ* by satellites and spacecraft such as ACE, WIND, and Voyager

Despite decades of data, many questions regarding heliospheric turbulence remain

Satellite data constitutes a (generally) single-point measurement and observations remain at the whim of the sun

Andrzej Mirecki's conception of the ACE satellite

## Plasma Frontiers in Laboratory MHD Turbulence

- Is MHD turbulence universal?
- What are the mechanisms for dissipating turbulent energy?
- What role do coherent structures play in the turbulence?
- How is magnetic turbulence generated?
- How does energy flow between magnetic and kinetic turbulence?
- Can a direct correspondence between spatial and temporal spectra be achieved?

## Facility Demands for MHD Turbulence Research

- ⊖ **Small-to-Intermediate scale chamber**  
-Current devices: Swarthmore Spheromak Experiment (SSX)  
-Planned devices: Bryn Mawr MHD Experiment (BM<sup>2</sup>X)
- ⊖ **Dynamic field generating source (e.g. plasma gun)**
- ⊖ **High base vacuum (~1x10<sup>8</sup> Torr)**
- ⊖ **No background field—use structures like spheromaks, FRCs**
- ⊖ **High-bandwidth, high bit-depth data acquisition electronics and probes**
- ⊖ **Multi-point, spatially resolved probes**