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SPACE PLASMA PHYSICS

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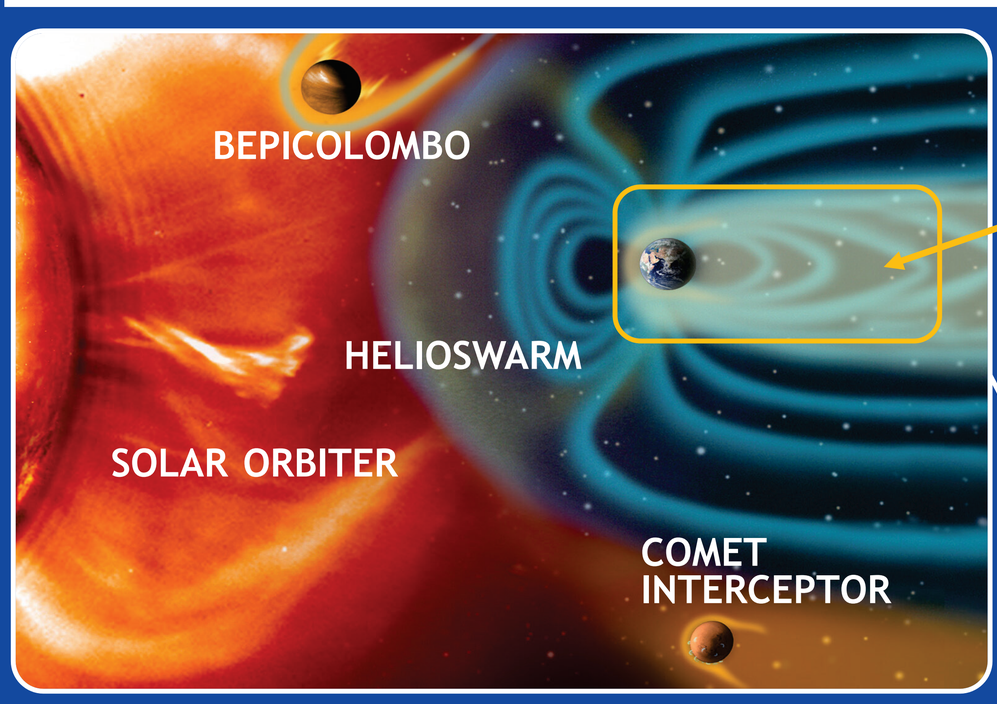
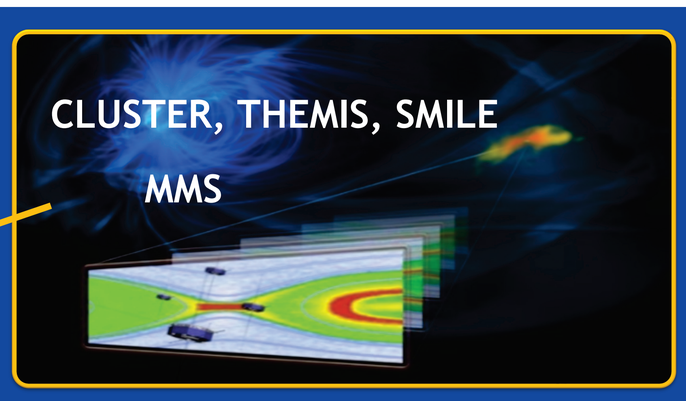
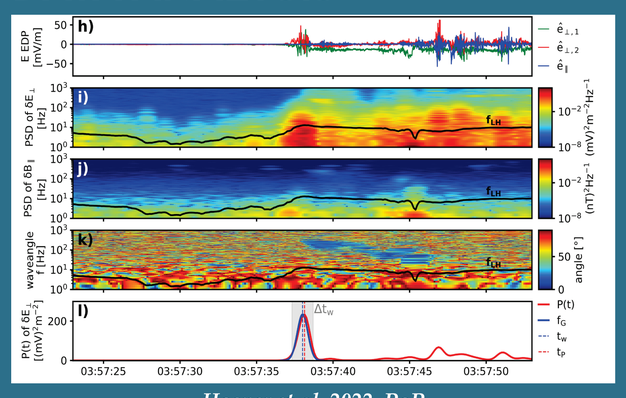
MORE ABOUT US



SPACE PLASMA MISSION INVOLVEMENT

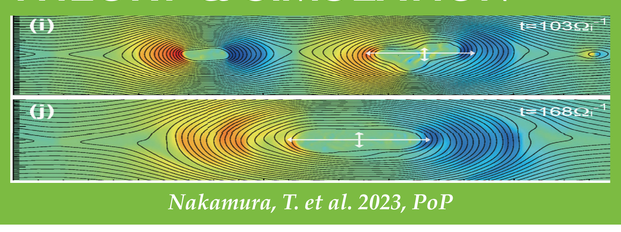


DATA ANALYSIS



Hosner et al. 2022, PoP

THEORY & SIMULATION



Nakamura, T. et al. 2023, PoP

MAIN RESEARCH QUESTIONS

- **How do fundamental plasma processes, such as magnetic reconnection, waves, and turbulences work in space?**
- **What is the role of the local, transient plasma processes in the dynamics of the magnetospheres and the solar wind?**
- **How do plasmas in geospace / near planets / around small bodies interact with the solar wind?**

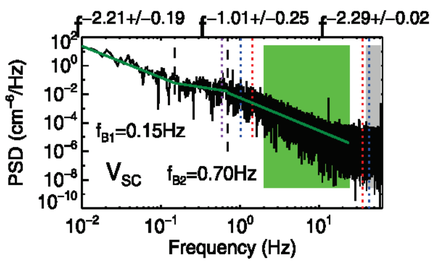
NEAR-EARTH PLASMA LABORATORY

MMS (NASA): Four-spacecraft Near-Earth mission with high-time resolution instruments to study fundamental plasma processes on small scales, i.e. down to electron scales.

- Co-I of FIELDS, Active Spacecraft Potential Control Lead.
- Data processing method developments: (1) magnetic field spin-axis offset; (2) density data produced from spacecraft potential and ASPOC ion current data

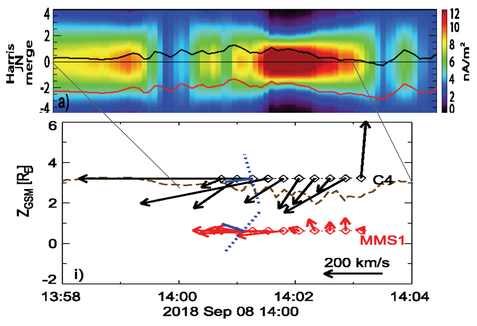
TURBULENCE IN THE SOLAR WIND

High time resolution density data from MMS enabled the study of compressive fluctuations in the sub-ion range of solar wind turbulence. The possible coexistence of kinetic Alfvén wave (KAW) turbulence and ion Bernstein wave turbulence was found.



Roberts et al., 2020, PRR

THIN CURRENT SHEETS AND FAST PLASMA FLOWS

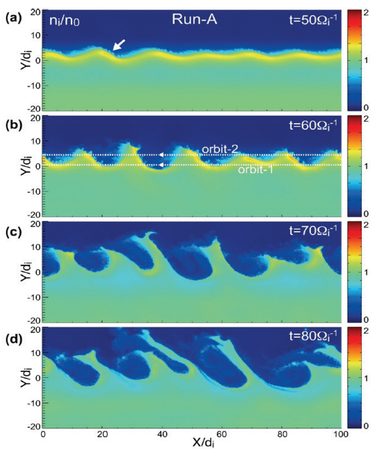


Nakamura, et al., 2021, JGR

Changes in the current sheet around a fast plasma jet in the Earth's magnetotail is empirically modeled by using MMS & Cluster data. The result suggests the formation of a thin current sheet behind the reconnection jet as a consequence of rapid magnetic flux transport.

MAGNETIC RECONNECTION IN KELVIN-HELMHOLTZ (K-H) WAVES

Kelvin-Helmholtz waves are created at the flank boundary between the solar wind and the magnetosphere. K-H waves that develop non-linearly create rolled-up magnetic fields (vortices). Secondary instabilities can be excited in these vortices, such as magnetic reconnection, and produce a mixing of the solar wind and magnetotail plasma. K-H waves are numerically modeled and compared with MMS observations and show good agreement.

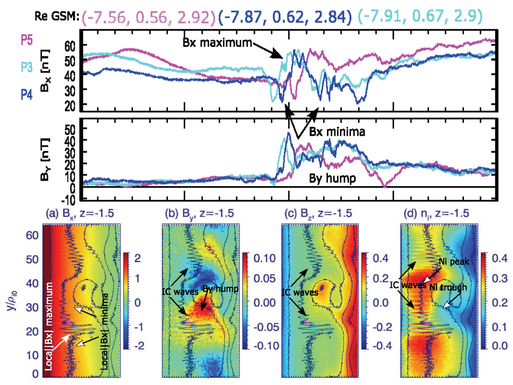


Blasl et al., 2022, PoP

MAGNETOSPHERES IN THE SOLAR SYSTEM

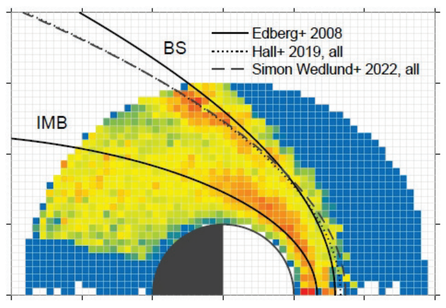
ION STRUCTURING IN THE EARTH'S MAGNETOTAIL

Fast ion flow shear in the Earth's magnetotail consistent with that produced by the kinetic ballooning-interchange instability is studied by comparing THEMIS three-point observations and simulation. It is found that the ambient current sheet can be modified by the vortical flow and by ion-cyclotron waves.



Panov et al. 2022, GRL

MAGNETIC DEPRESSIONS AT VENUS, EARTH, AND MARS



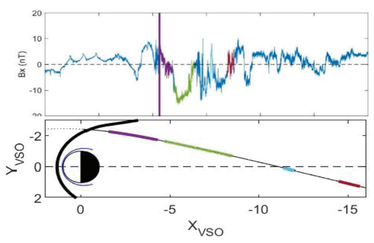
Simon Wedlund, Volwerk, 2023, Ann.Geo.

Mirror modes are structures with a decrease in magnetic field strength and an increase in plasma pressure. They are excited by an ion temperature anisotropy and found behind the bow shock or close to the planet at the magnetic pile-up region. They occur 10 times more often at Venus than at Mars.

BEPICOLOMBO (ESA/JAXA): Two spacecraft in Mercury orbit (from December 2025) that enable the comprehensive study of the Hermian plasma environment.

- PI/CoI of the two magnetometers (MERMAG)
- Calibration algorithm development; adaptation of a global hybrid numerical model and a plasma flow model to support the measurements

BEPICOLOMBO FLYBY OF VENUS'S INDUCED MAGNETOSPHERE

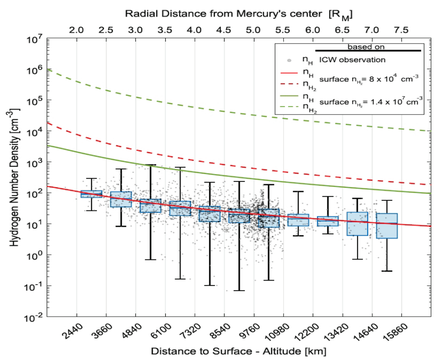


Volwerk et al., 2021, Ann.Geo.

A highly active magnetotail, with strong flapping motions was observed by BepiColombo, during the Venus I flyby. The induced magnetotail was found to be still present at a distance of about 48 Venus radii.

MERCURY'S EXOSPHERE INFORMATION DEDUCED FROM WAVES

The ion-cyclotron waves produced by the newly ionized planetary protons picked-up by the solar wind is analyzed using MESSENGER magnetic field data to deduce the local proton density. By comparing with numerical models a revised atmospheric density profile of hydrogen at Mercury is obtained.



Schmid et al. 2022, JGR

2023

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