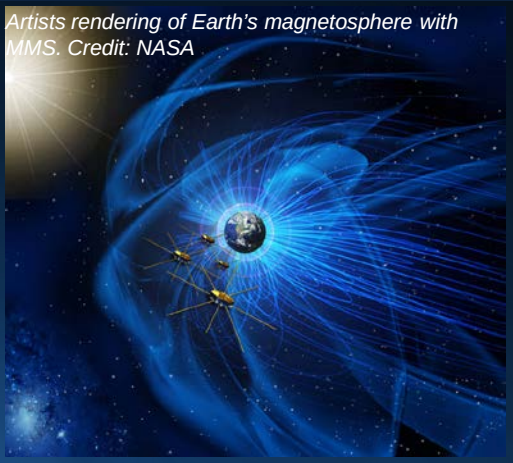
MMS Makes the Invisible, Visible: Energy Transfer in our Magnetosphere



Artists rendering of Earth's magnetosphere with MMS. Credit: NASA

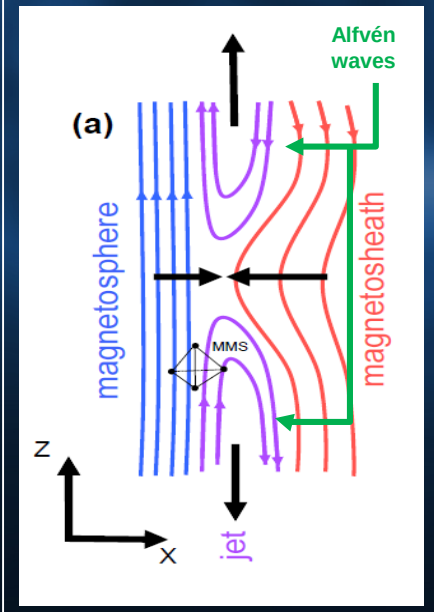
When we look up at the sky we are looking through an invisible shield and our only buffer against the hazardous effects of solar wind, Earth's magnetosphere. But, our magnetosphere isn't leak proof. Solar wind can seep in and through its interactions with our magnetosphere, can cause geomagnetic storms affecting life on Earth and our space-based infrastructure.

Understanding how the charged particles from incoming solar wind affect the energy and radiation budget of the magnetosphere will help us understand how to forecast and mitigate impacts from geomagnetic storms. MMS is leading the way, making the invisible, visible.

MMS Uses Earth's Magnetosphere as a Laboratory to Study Fundamental Space Physics Processes and Phenomena.

A new finding using MMS data dives deeper into the structure of the magnetosphere as the data allow scientists to explore energy transfer in kinetic Alfvén waves for the first time. Alfvén waves are electromagnetic perturbations, whose energy propagates along magnetic field lines. The four MMS spacecraft fly in a compact 3-D pyramid formation, with just four miles between them – **closer than ever achieved before and *near enough to fit between two Alfvén wave peaks.*** Having multiple spacecraft take observations at such small scales allow scientists to analyze high-resolution details of the Alfvén wave and to examine the mechanisms for energy exchange between Alfvén wave fields and charged particles.

Alfvén waves are not only found in our magnetosphere but are ubiquitous in other plasma environments such as in the sun's corona. Some scientists think the presence of kinetic Alfvén waves provide one answer to how the solar wind is heated to extreme temperatures. They are even thought to be in the extra-galactic jets of quasars. By studying our near-Earth environment, NASA missions like MMS make use of a unique, nearby laboratory to understand processes from across the universe. *Right image: A drawing indicating where the MMS constellation was in the magnetosphere as it collected the data on Alfvén waves. The data was collected on 30 December 2015. Credit: Gershman, et al.*



Gershman, et al. WAVE-PARTICLE ENERGY EXCHANGE DIRECTLY OBSERVED IN A KINETIC ALFVÉN-BRANCH WAVE. *Nature Communications.* Soon to be published.