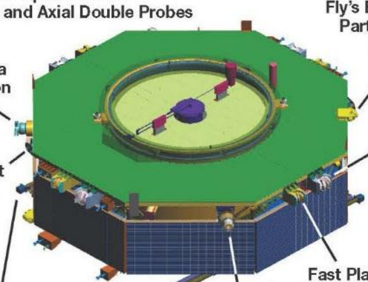
MMS Spacecraft and Instruments

The Magnetospheric Multiscale, or MMS, mission relies on four spacecraft with an identical set of 11 instruments made of 25 sensors. The four spacecraft will fly in an adjustable, pyramid formation that enables them to observe the 3-dimensional structure of magnetic reconnection.

Each MMS observatory is in the shape of an octagon, roughly 11 feet across and 4 feet high, built around a central cylindrical thrust tube. The majority of the science instruments and associated electronics are mounted on the underside of the top deck. The flight control hardware is installed on the upper side of the bottom deck. Each observatory is also equipped with six long electric antennas with science sensors on the end as part of the science experiments.

Primary power is provided by eight solar array panels, with a secondary battery for energy storage and use during eclipses. The propulsion system consists of 12 thrusters and four hydrazine propellant tanks located within the central thrust tube. The MMS spacecraft are spin-stabilized, with a spin rate of three revolutions per minute. Attitude information is provided by four star cameras, two three-axis accelerometers, and two sun sensors. The thrusters are used for attitude and orbit adjustment maneuvers. MMS is also equipped with a new navigator based on extremely sensitive GPS equipment to provide absolute position information.



The four MMS spacecraft stacked for environmental tests at NASA's Goddard Space Flight Center in Greenbelt, MD.

This image is a sneak preview of what will be the final stacked launch configuration of the MMS spacecraft. Credit: NASA

The four MMS spacecraft will be launched aboard an Atlas V 421 launch vehicle from Cape Canaveral Air Force Station, Florida.

Each spacecraft will then be inserted sequentially into orbit.

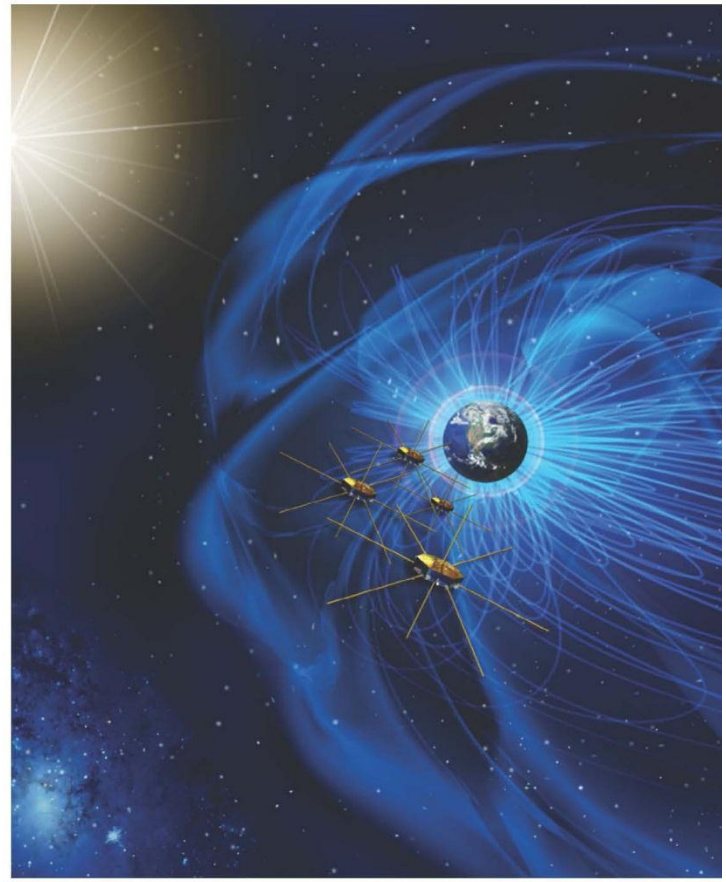
MMS is a Solar Terrestrial Probes mission within NASA's Heliophysics Division.

For more information on MMS, see: www.nasa.gov/MMS

NP-2014-10-192-GSFC

National Aeronautics and Space Administration

MMS



Magnetospheric Multiscale

Using Earth's magnetosphere as a laboratory to study magnetic reconnection

www.nasa.gov

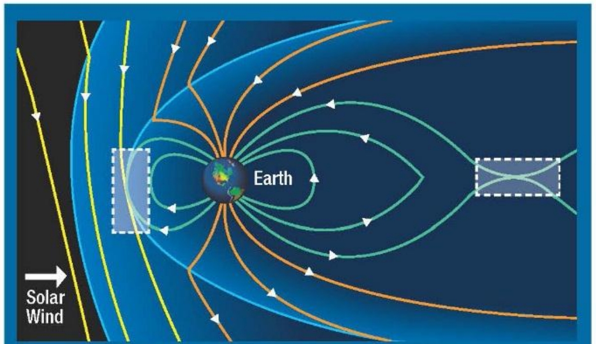
Magnetospheric Multiscale Mission Overview

In 2015, NASA plans to launch the Magnetospheric Multiscale, or MMS, mission. It consists of four identical spacecraft that will orbit around Earth through the dynamic magnetic system surrounding our planet to study a little-understood phenomenon called magnetic reconnection.

Magnetic reconnection is a universal process where magnetic fields connect and disconnect, explosively releasing energy.

MMS will travel directly through areas near Earth known to be magnetic reconnection sites. On the sun-side of Earth, reconnection can link the sun's magnetic field lines to Earth's magnetic field lines, allowing material and energy from the sun to funnel into Earth's magnetic environment. On the night side of Earth, reconnection is believed to help trigger aurora, also known as the Northern or Southern lights. MMS spacecraft will fly in an adjustable pyramid formation, to determine the size and structure of these reconnection regions.

MMS is the fourth mission in NASA's Solar Terrestrial Probes or STP Program. The goal of the STP Program is to understand the fundamental physical processes of the space environment from the sun to Earth, other planets, and the extremes of the solar system boundary.

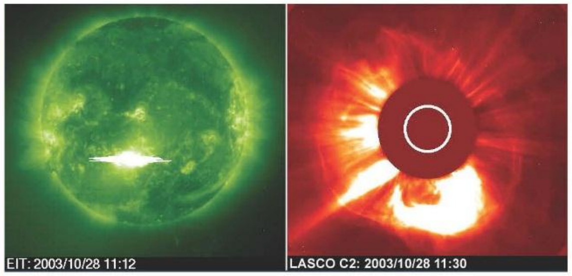


MMS will use a two-phase orbit strategy to explore two different regions where magnetic reconnection often occurs, one on the day side and the other on the night side of Earth. Credit: NASA

Magnetic Reconnection

By studying how reconnection occurs near Earth, MMS will improve our understanding of how this fundamental process works elsewhere. Reconnection is a common process in our universe; occurring in the atmosphere of the sun and other stars, in the vicinity of black holes and neutron stars, and at virtually any boundary between space plasmas, including the boundary between our solar system's heliosphere and interstellar space. Magnetic reconnection is also one of the most important drivers of space weather events. Eruptive solar flares, coronal mass ejections, and geomagnetic storms all involve the release, through reconnection, of energy stored in magnetic fields. Space weather events can affect modern technological systems such as communications networks, GPS navigation, and electrical power grids.

Magnetic reconnection is a phenomenon unique to plasma, the mix of charged particles that make up the stars, fill space, and account for an estimated 99% of the observable universe. Plasmas conduct electricity and travel with their own set of magnetic fields entrapped in the material. Sometimes, as two sets of field lines get close to each other, the plasma disconnects from the magnetic field causing the field lines to appear to break and reconfigure into a new geometry. The amount of energy released can be formidable, hurling particles into space at incredible speeds: accelerating individual particles to near the speed of light, and initiating the movement of large-scale flows of particles.



Tremendous amounts of energy are stored in the sun's magnetic fields. Magnetic reconnection releases some of this stored energy in the form of solar flares (left) and CMEs (right).

MMS Themes

- MMS solves the mystery of how magnetic fields around Earth connect and disconnect, explosively releasing energy via a process known as magnetic reconnection. MMS consists of four identical spacecraft that will provide the first three-dimensional views of this fundamental process that occurs throughout our universe.
- Like stretched rubber bands, magnetic fields store energy that is released explosively when the field lines are broken during reconnection. Unlike rubber bands, reconnection can drive particles to nearly the speed of light.
- MMS uses Earth's protective magnetic space environment, the magnetosphere, as a natural laboratory to directly observe how it interacts with the sun's extended magnetic field, which can result in reconnection.
- The four MMS spacecraft fly in varying formations through reconnection regions in well under a second, so key sensors on each MMS spacecraft have been designed to take certain measurements of the space environment 100 times faster than any previous mission.

MMS Science Objectives

MMS will improve our understanding of magnetic reconnection by answering these fundamental questions:

- ***What conditions determine when reconnection is initiated and when it ceases?***
- ***What determines the rate at which reconnection occurs?***
- ***What is the structure of the reconnection region?***
- ***How does the plasma become demagnetized in the reconnection region?***
- ***What is the role of turbulence in the reconnection process?***
- ***How does reconnection accelerate particles to high energies?***