NASA's Magnetospheric Multiscale Mission locates elusive electron act

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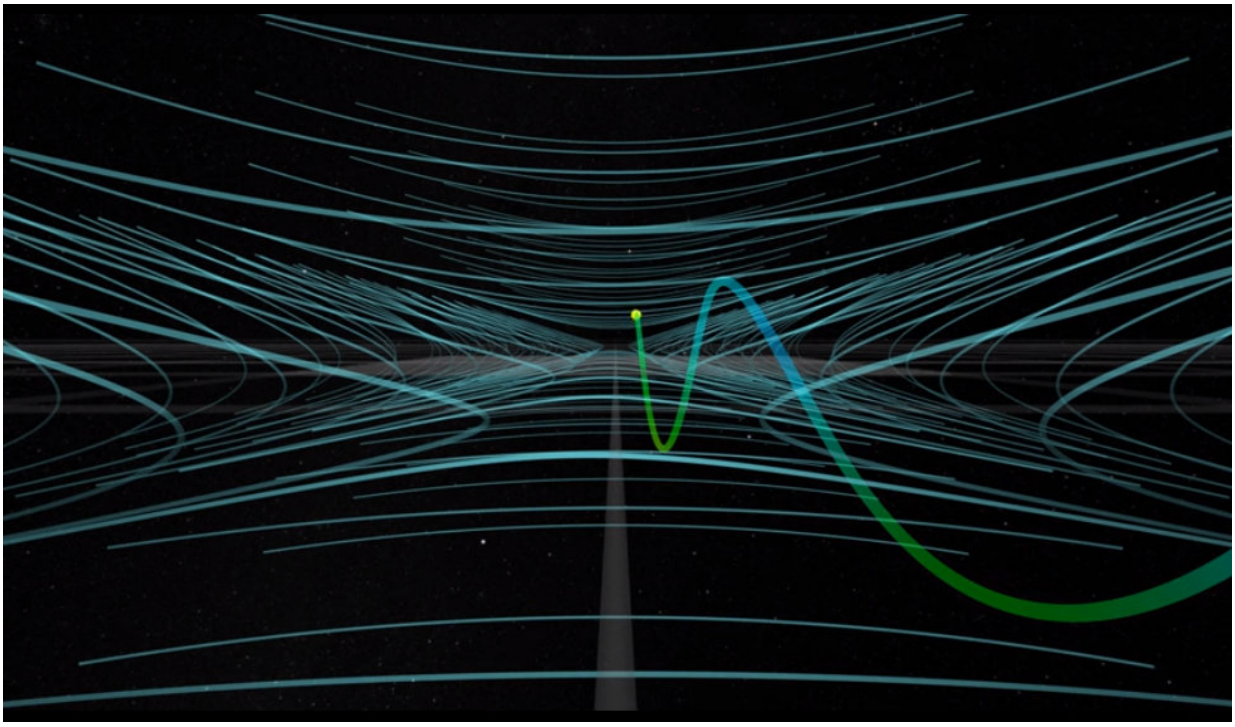

The space high above Earth may seem empty, but it's a carnival packed with magnetic field lines and high-energy particles. This region is known as the magnetosphere and, every day, charged particles put on a show as they dart and dive through it. Like tiny tightrope walkers, the high-energy electrons follow the magnetic field lines. Sometimes, such as

during an event called magnetic reconnection where the lines explosively collide, the particles are shot off their trajectories, as if they were fired from a cannon.

Since these acts can't be seen by the naked eye, NASA uses specially designed instruments to capture the show. The Magnetospheric Multiscale Mission, or MMS, is one such looking glass through which scientists can observe the invisible magnetic forces and pirouetting particles that can impact our technology on Earth. New research uses MMS data to improve understanding of how electrons move through this complex region—information that will help untangle how such particle acrobatics affect Earth.

Scientists with MMS have been watching the complex shows electrons put on around Earth and have noticed that electrons at the edge of the magnetosphere often move in rocking motions as they are accelerated. Finding these regions where electrons are accelerated is key to understanding one of the mysteries of the magnetosphere: How does the magnetic energy seething through the area get converted to kinetic energy—that is, the energy of particle motion. Such information is important to protect technology on Earth, since particles that have been accelerated to high energies can at their worst cause power grid outages and GPS communications dropouts.

New research, published in the *Journal of Geophysical Research*, found a novel way to help locate regions where electrons are accelerated. Until now, scientists looked at low-energy electrons to find these accelerations zones, but a group of scientists lead by Matthew Argall of the University of New Hampshire in Durham has shown it's possible, and in fact easier, to identify these regions by watching high-energy electrons.

This research is only possible with the unique design of MMS, which uses four spacecraft flying in a tight tetrahedral formation to give high

temporal and spatial resolution measurements of the magnetic reconnection region.

"We're able to probe very small scales and this helps us to really pinpoint how energy is being converted through magnetic reconnection," Argall said.

The results will make it easier for scientists to identify and study these regions, helping them explore the microphysics of magnetic reconnection and better understand electrons' effects on Earth.

More information: M. R. Argall et al. Electron dynamics within the electron diffusion region of asymmetric reconnection, *Journal of Geophysical Research: Space Physics* (2017). DOI: 10.1002/2017JA024524

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