

Helio Meets Astro: MMS Observations May Tell Us About Cosmic Rays in the Universe

Earth and its magnetosphere are immersed in the supersonic flow of the solar wind plasma that fills interplanetary space, and as the solar wind slows and deflects to flow around the magnetospheric obstacle, it results in the formation of Earth's bow shock. Earth's bow shock can reflect and accelerate a fraction of the incident solar wind, forming a region called the ion foreshock. In the foreshock, large-scale, transient phenomena evolve explosively, often resulting in the formation of new shocks, potentially contributing to particle acceleration.

What is the science question?

What is the underlying particle acceleration mechanism in foreshock transients?

What were your findings?

Observations showed a foreshock transient efficiently accelerating solar wind ions from $1 \sim 10$ keV up to almost 1 MeV. The acceleration mechanism is shown to be dependent on ion mass and charge-state and consistent with a well-known acceleration mechanism.

What was the impact?

The observed acceleration is more efficient than the bow shock or foreshock transient alone, and supports predictions from theory and simulation. The observation of such efficient acceleration may provide an answer for the outstanding question of the source of cosmic rays throughout the cosmos.

Why does it matter to non-scientists?

Fundamentally, scientists need to resolve shock physics to understand energetic particles in the universe. Now we have the observations that will support new theoretical work. This has broad applicability to the understanding of shocks and particle acceleration in solar flares and supernovae, as well as astrophysics in general. More specifically, this may be the best evidence yet that shocks can generate Ultra High Energy Cosmic Rays, the origin of which is a key question for astrophysics.

