

PAP301

Seminar in Particle Physics and Astrophysical Sciences

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Magnetotail jet fronts in Vlasiator

The Sun's corona is constantly releasing a stream of charged particles known as the solar wind. When the solar wind interacts with the Earth's magnetic field, it elongates the field lines forming a magnetic tail behind the Earth. This magnetotail hosts a process called magnetic reconnection, which converts magnetic energy into particle heating and acceleration.

Magnetic reconnection is thought to be responsible for creating bursty bulk flows (BBFs), short-lived plasma velocity increases in the magnetotail's central plasma sheet region. In satellite measurements, BBFs are seen as minute-timescale velocity increases along the Earth-Sun direction. Closely related to BBFs are dipolarization fronts (DFs), sudden increases in the magnetic field component aligned with the Earth's magnetic dipole axis. Despite their short timescales, both phenomena greatly affect the energy distribution and flux transport within the magnetotail.

The three-dimensional nature of BBFs and DFs is studied using Vlasiator, a simulation code utilizing a hybrid-Vlasov approach where ions are modelled using a distribution function and electrons are treated as a charge-neutralizing fluid. DFs moving away from the Earth are found at magnetic islands that form between multiple reconnection sites, while DFs moving earthward are mostly seen in finger-like structures of high earthward velocity. Events registered as BBFs in simulated satellite measurements originate from several different sources, such as localized flow channels and vertical movement of the central plasma sheet. DFs are accompanied by velocity increases, but BBFs often result in only small magnetic field enhancements.

The results imply that measurements of BBFs and DFs may have multiple different origins. However, the certainty of the study is reduced by a small dataset and a limited resolution of the simulation. The findings may still help with interpreting satellite observations in the magnetotail.