Magnetic reconnection in the bow shock

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Space plasma physics are a fundamental part of the solar system, and understanding them is important for understanding the Sun, solar wind, and its interactions and effects to the Earth. The solar wind is composed of low-density magnetized plasma, and moves with the approximate velocity range of 400-800 km/s.

When solar wind first interacts with Earth's magnetosphere, a bow shock forms in front of the magnetosphere. Downstream of the bow shock, the magnetosheath is formed. In the bow shock, the supersonic solar wind drops to subsonic speeds. The planet's regularly organized magnetic field is weak and irregular in the magnetosheath, due to the interaction with the solar wind. The magnetosheath has been observed to have turbulent plasma motion, current sheets, and magnetic reconnection. In the magnetic reconnection, the topology of the magnetic field changes and the field lines can merge.

Vlasiator is a hybrid-Vlasov plasma simulation that is run by the University of Helsinki. It simulates the global near-Earth space, including the bow shock and the magnetosphere. Vlasiator models electrons as a fluid, and ions as velocity distribution functions, meaning that the Vlasiator model can capture the ion kinetic effects. In a two-dimensional simulation on Vlasiator, magnetic reconnection was observed exceptionally in the bow shock already. Finding the cause of this reconnection will be the focus of my thesis.

Magnetic reconnection is common in the magnetosheath, but is not as commonly observed in the bow shock. Analysing the magnetic reconnection in the Vlasiator run will be done by using the Analysator tool, and first starting by finding the exact reconnection points. This is done by using a flux function - the saddle points of the flux function are the reconnection points. Further analysis of the reconnection will be performed, likely following the reconnection points and analysing the conditions that might have caused them. This has not been done yet, so I don't have results about the nature of the reconnection yet. The hypothesis is that it could be turbulent reconnection.