Jet-driven bow waves as electron accelerators in the magnetosheath: Monte Carlo simulations

Laura Vuorinen¹, Rami Vainio¹, Heli Hietala², and Terry Z. Liu³,⁴
¹Department of Physics and Astronomy, University of Turku, Turku, Finland (lakavu@utu.fi)
²Blackett Laboratory, Imperial College London, London, United Kingdom
³Cooperative Programs for the Advancement of Earth System Science, University Corporation for Atmospheric Research, Boulder, CO, USA
⁴Geophysical Institute, University of Alaska, Fairbanks, Fairbanks, AK, USA

Magnetosheath jets are fast flows of plasma frequently observed downstream of the Earth’s quasi-parallel shock. Previous observations have shown that these jets can exhibit supermagnetosonic speeds relative to the background flow and develop their own bow waves or shocks. Such jets have been observed to be able to accelerate ions and electrons. In our study, we model electron acceleration by jet-driven bow waves in the magnetosheath using test-particle Monte Carlo simulations that include magnetic mirroring and pitch-angle scattering of magnetic irregularities. We compare the simulation results to spacecraft observations of similar events to understand the acceleration mechanisms at play. Our preliminary results suggest that the energy increase of electrons can be explained by shock drift acceleration at the moving bow wave. Our simulations allow us to estimate the efficiency of acceleration as a function of different jet and magnetosheath parameters. The acceleration introduced by jet-driven bow waves amplifies shock acceleration downstream of the Earth’s bow shock and may also be applicable to other shock environments.