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A new model for the electron pressure nongyrotropy in the outer electron diffusion region

Andrey Divin (1), Vladimir Semenov (1), Daniil Korovinskiy (2), Stefano Markidis (3), Jan Deca (4), Vyacheslav Olshevsky (5), and Giovanni Lapenta (5)

(1) St. Petersburg State University, St. Petersburg, Russia (andrey.div@gmail.com), (2) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (3) Department of Computational Science and Technology, KTH Royal Institute of Technology, Stockholm, Sweden, (4) Laboratory for Atmospheric and Space Physics (LASP), University of Colorado, Boulder, USA, (5) Department of Mathematics, KU Leuven, Leuven, Belgium

We present a new model to describe the electron pressure nongyrotropy inside the electron diffusion region (EDR) in an antiparallel magnetic reconnection scenario. A combination of Particle-in-Cell (PIC) simulations and analytical estimates are used to identify such a component of the electron pressure tensor in the rotated coordinates, which is nearly invariant along the outflow direction between the X-line and the electron remagnetization points in the outer EDR. It is shown that the EDR two-scale structure (inner and outer parts) is formed due to superposition of the nongyrotropic meandering electron population, and gyrotropic electron population with large anisotropy parallel to the magnetic field upstream of the EDR. Inside the inner EDR the influence of the pressure anisotropy can largely be ignored. In the outer EDR, a thin electron layer with electron flow speed exceeding the $\mathbf{E} \times \mathbf{B}$ drift velocity is supported by large momentum flux produced by the electron pressure anisotropy upstream of the EDR. We find that this fast electron exhaust flow with $|\mathbf{V}_e \times \mathbf{B}| > |\mathbf{E}|$ is in fact a constituent part of the EDR, a finding which will steer the interpretation of the Magnetospheric MultiScale mission (MMS) data.