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3D instabilities connected with reconnection in full 3D PIC simulations[1]

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Kinetic reconnection is characterized by a distinct behavior of electrons and ions with regions of strong relative speeds between the species. Electrons can flow at great speed relative to ions and can be characterized by a strong non-gyrotropy and anisotropy. When studied in full three dilensions, these electron peculiar properties can drive numerous instabilities that have been investigated by the suggested speaker and his collaborators in a number of recent published papers. Two regions have received most attention: 1) the separatrices where instabilities are caused by the electron flow and the electron phase space features, 2) the downstream fronts where an interchange instability leads to strong energy exchanges and secondary reconnection. In both situations the ions are demagnitezed but the electrons are not and their behaviour is rich in full kinetic processes. At the separatrices, two types of instabilities have been observed. The electron phase space is characterized by multiple populations at relative drifts (electron beams) and the whole electron species is drifting with respect to the ions. This condition is subject to different streaming instabilities. Additionally, the separatrices are regions of intense density and flow shear, with free energy available to drive Kelvin-Helmholtz-type instabilities. In the downstream fronts of reconnection, a density gradient develops in conditions where the acceleration is directed unfavourably for stability, leading to ballooning and interchange-type instabilities. Both cases are of great importance for the upcoming Magnetospheric Multiscale Mission that is bent on finding and analyzing the regions where the electron scale physics is dominant. The processes discussed above can provide key information for the operation of the mission and the interpretation of its results.

[1]Collaboration between the University of Colorado NASA-MMSIDS team (M. Goldman, D. Newman, L. Anderson, S. Erikson) and the KULeuven Swiff team (swiff.eu: S. Markidis, A. Divin, A. Vapirev)