Vlasov Simulation of Nonlinear Electron Evolution in the Inertial Alfvén Regime

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Alfvén waves in the high-latitude auroral acceleration region become *inertial* when the perpendicular wavelength is much shorter than the parallel wavelength. A typical ordering of frequencies in the inertial Alfvén regime is

$$\Omega_e > \omega_e > \omega_i > \Omega_i > \omega_{ESW} > \widetilde{\omega}_A$$

where $\Omega_{e,i}$ and $\omega_{e,i}$ are the cyclotron and plasma frequencies for electrons and ions, $\omega_{ESW} = \omega_e k_{\|}/k_{\perp}$ is the *electrostatic whistler* frequency, and $\widetilde{\omega}_A = k_{\|}\widetilde{V}_A$ is the *inertially modified* Alfvén frequency, with $k_{\|}$ parallel to $\mathbf{B}_0$. The smallness of the ratio $k_{\|}/k_{\perp}$ has several important consequences: it lowers the natural frequency of a pure electron response ($\omega_{ESW} << \omega_e$); it lowers the Alfvén frequency through the requirement $\widetilde{\omega}_A < \omega_{ESW}$ while allowing a parallel electric field to develop; and it scales the ratio of the electron drift velocity to the parallel electric field ($v_d/E_{\|} \propto k_{\perp}/k_{\|}$), thus allowing for locally large electron drifts.

2-D Vlasov simulations (in the strong-electron-magnetization limit) will be used to study the nonlinear evolution of particle distributions expected to be driven by inertial Alfvén waves. In particular, small-scale structures parallel to $\mathbf{B}_0$ (e.g., electron holes or double layers) can evolve on a faster time scale due to the increase in $k_{\|}$ relative to $k_{\perp}$ (thus increasing ω_{ESW}). The development of steep velocity gradients perpendicular to $\mathbf{B}_0$ can also have interesting consequences, such as the generation of shear-driven *interface* modes in the vicinity of magnetic field lines separating oppositely directed electron flows.