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Magnetic field aligned potential drops in the magnetosphere, in the laboratory, and in Vlasov simulations

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Electric fields parallel to the magnetic fields are known to exist in the auroral zone, and they are known to contribute to the acceleration of auroral electrons. Magnetic field aligned electric fields can be supported by the magnetic mirror field, giving rise to a quasi-neutral potential drop that extends over great distances in space (*Alfvén and Fälthammar, Cosmical Electrodynamics*, 2nd edition, 1963).

Early theory included stationary kinetic models of the potential profile and the relationship between the field aligned current and the total potential drop along the field line (*Knight, Planetary and Space Science*, vol. 21, 741-750, 1973). Later fluid models have been used to study Alfvén waves, and buildup of the electrostatic field (*e.g. Rönnmark and Hamrin, JGR*, vol. 105, 25333–25344, 2000). Recently, combined approaches have also been used where particle simulations have been used to provide non-local kinetic closure of the fluid equations (*Vedin and Rönnmark, JGR*, vol. 111, 12201, 2006).

Recent observations have shown that electric double layers play an important role in auroral physics (*e.g. Ergun, et al., Physics of Plasmas*, vol. 9, 3685-3694, 2002). These are space charge layers embedded in the plasma, and constitute local violations to the assumption of quasi-neutrality.

We present results from Vlasov simulations of magnetic field aligned potential drops in a model that is one-dimensional in configuration space and two-dimensional in velocity space. The model is verified by comparison with a double layer experiment in the laboratory, and it is then applied to the auroral field lines.