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Fluctuations, instabilities and transport in Hall plasma devices

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Devices with stationary, externally applied, electric field which is perpendicular to a moderate amplitude magnetic field B0, are common in magnetically controlled plasmas. High interest applications involve Penning type plasma sources, magnetrons and magnetic filters, and electric space propulsion such as Hall thrusters. The electric field produces a stationary current due to the E0 $\times$ B0 electron drift, while ions do not feel the magnetic field due to their large Larmor radius. Standard drift modes doe not exist in such plasma but the ExB electron drift in inhomogeneous plasma and inertial (non-magnetized) ion response result in the so called anti-drift mode. The equilibrium electron flow destabilizes this mode and additional destabilization may come from the gradient of the magnetic field. The electron flow also result in instabilities of negative energy ion sound modes destabilized by dissipation due to collisions and sheath impedance. Sheath impedance is a result of fluctuating electric current into the sheath and further taken over by the current in the dielectric wall. Sheath impedance provide boundary conditions for ion sound wave at the boundaries of a finite length plasma. The quantitative characteristics of these instabilities and its potential ramifications for Hall devices are described.