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Modeling electron-scale plasma mixing in narrow shear flows along the magnetic reconnection separatrix

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Idealized models of magnetic reconnection consist of distinct regions of inflowing and outflowing plasma. Outflows are driven by the snapping back of reconnected magnetic fields, while inflows are typically assumed to be forced by external conditions. Computer simulations and satellite observations have found narrow, high-velocity electron inflows near the reconnection separatrix. Previous investigations suggest the inflows can be accelerated by electrostatic interactions such as double-layer-like structures on the edge of density cavities (Egedal et al. 2008, 2012, 2015), or a long series of waves adding to a net potential (Graham et al. 2016, Eriksson et al. 2018). Electric fields observed in association with these inflows can reach over 100 mV/m with structure on electron scales (several λ_D parallel to B, gyro-radius ρ_e perpendicular to B). Using a computer simulation, we model the long-term evolution ($\Delta t \omega_{pe} \sim 10^3$) of electrostatic waves generated by interaction of the inflow and outflow electrons. In 1D, the model is similar to previously-published mixing simulations – an initial pressure difference leads to one population impinging on another, setting up an ambipolar electric field which in turn accelerates electrons into configurations unstable to beam-mode and acoustic waves (Ergun et al. 2016). In 2D, a magnetized velocity shear layer is considered, where scattering by electrostatic waves could enhance cross-field transport. Self-reinforced mixing of electrons at the current sheet boundary may continually renew the mixing signatures, subsequently influencing the long-term behavior of the reconnection inflow.