Gyrokinetic simulations of collisionless reconnection in turbulent non-uniform plasmas

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Magnetic reconnection, plasma turbulence, and plasma non-uniformity are present in nearly all natural plasmas. We explore collisionless magnetic reconnection in the presence of non-uniformities in the plasma density, the electron temperature and the ion temperature with nonlinear gyrokinetic simulations. Without the non-uniformities, large scale tearing instabilities lead to complete reconnection of the magnetic flux and system-size magnetic islands. We find that magnetic reconnection can be enhanced or triggered by plasma turbulence. Comparable simulations, in which the turbulence arises self-consistently from gradient-driven instabilities, have not been previously presented. We show that (1) density gradients, previously shown to stabilize reconnection, can also destabilize reconnection, and also (2) electron temperature gradients drive reconnection in a collisionless plasma - both are first time results. The addition of a density gradient has a dual role : it can stabilize large scale reconnection due to diamagnetic effects but destabilizes small-scale driftwave modes that produce turbulence and zonal flows. The electron temperature gradient triggers microtearing modes that drive rapid small-scale reconnection and strong electron heat transport. The ion temperature gradient destabilizes turbulence due to ion temperature gradient (ITG) modes and has a weak stabilizing effect on reconnection compared to the density gradient. Combinations of the three cases are discussed, as are implications for some laboratory fusion and space plasmas.