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Nonlinear growth of electron holes in cross-field wakes[1] IAN HUTCHINSON, C.B. HAAKONSEN, C. ZHOU, MIT — Cross-field plasma flow past an obstacle is key to the physics underlying Mach-probes, space-craft charging, and the wakes of non-magnetic bodies: the solar-wind wake of the moon is a typical example. We report associated new nonlinear instability mechanisms. Ions are accelerated along the B-field into the wake, forming two beams, but they are not initially unstable to ion two-stream instabilities. Electron Langmuir waves become unstable much earlier because of an electron velocity-distribution distortion called the "dimple". The magnetic field, perpendicular to the flow, defines the 1-D direction of particle dynamics. In high-fidelity PIC simulations at realistic mass ratio, small electron holes — non-linearly self-binding electron density deficits — are spawned by the dimple in $f_e(v)$ near the phase-space separatrix. Most holes accelerate rapidly out of the wake, along B. However, some remain at very low speed, and grow until they are large enough to disrupt the two ion-streams, well before the ions are themselves linearly unstable. This non-linear hole growth is caused by the same mechanism that causes the dimple: cross-field drift from a lower to a higher density. Related mechanisms cause plasma near magnetized Langmuir probes to be unsteady.

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