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Particle heating and acceleration during collisionless reconnection in a laboratory plasma[1]

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Particle heating and acceleration during magnetic reconnection is studied in the collisionless plasma of the Magnetic Reconnection Experiment (MRX). For ion heating and acceleration, the role of the in-plane (Hall) electric field is emphasized. An in-plane electrostatic potential profile is established by electron acceleration near the X-point. The potential profile shows a well structure along the direction normal to the reconnection current sheet that becomes deeper and wider downstream as its boundary expands along the separatrices where the in-plane electric field is strongest. The Hall electric field ballistically accelerates ions near the separatrices toward the outflow direction. After ions are accelerated, they are heated as they travel into the high-pressure downstream region due to an effect called re-magnetization [1]. Electrons are also significantly heated during reconnection. The electron temperature sharply increases across the separatrices and peaks just outside of the electron diffusion region. Classical Ohmic dissipation based on the perpendicular Spitzer resistivity is too small to compensate for the energy loss by parallel heat conduction, indicating the presence of anomalous electron heating. Finally, a total energy inventory is calculated based on analysis of the Poynting, enthalpy, flow energy, and heat flux in the measured diffusion layer. More than half of the incoming magnetic energy is converted to particle energy during reconnection.

[1] Yoo *et al. Phys. Rev. Lett.* **110**, 215007, 2013

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