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Electron heating by Debye-scale turbulence in guide field reconnection

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Magnetic reconnection is a fundamental process whereby microscopic plasma processes cause macroscopic changes in magnetic field topology, leading to explosive energy release. Waves and turbulence generated during the reconnection process can produce particle diffusion, and anomalous resistivity, as well as heat the plasma and accelerate plasma particles, all of which can impact ongoing reconnection. We report electrostatic Debye-scale turbulence developing within the diffusion region of asymmetric magnetopause reconnection with moderate guide field using observations by the Magnetospheric Multiscale mission and large-scale particle-in-cell simulations. We show that Buneman waves and beam modes cause thermalization of the reconnection electron jet, i.e. transfer jet kinetic energy into thermal energy - very efficient and fast electron heating caused by irreversible phase mixing. Our results show that reconnection diffusion region in presence of a moderate guide field is highly turbulent, and that electrostatic turbulence plays an important role in electron heating.