磁気リコネクションでのイオンと電子のエネルギー分配

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Ion and electron energy partition during magnetic reconnection

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Ion and electron heating and their energy partition during collisionless magnetic reconnection are investigated using particle-in-cell simulations. We analyze the time evolution of the ion and electron temperatures associated with the motion of the reconnecting flux tube, where the plasma temperature is defined as second-order moment of velocity distribution function in the center of the flux tube frame, and we show that the plasma heating during magnetic reconnection can be separated into two stages: the nonadiabatic heating stage, in which the magnetic field lines are just reconnecting in the X-type diffusion region, and the adiabatic heating stage, in which the flux tube is shrinking after two flux tubes merge. During the adiabatic heating stage, the plasma temperature T and the volume of the flux tube V follows the standard fluid-type adiabatic relation. In the nonadiabatic heating stage where the reconnecting flux tube covers not only the X-type diffusion region but also the separatrix boundary of reconnection, we found numerically that the ratio of the increment of the ion temperature to that of the electron temperature can be approximated by $Ti/Te = (Mi/Me)^{1/4}$, where Mi and Me are the ion and electron masses, respectively.