Filamentary Currents in Turbulent Magnetic Reconnection

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Magnetic reconnection and turbulence are the two most important energy conversion phenomena in plasma physics. Magnetic reconnection and turbulence are often intertwined. For example, reconnection occurs in thin current layers formed during cascades of turbulence, while reconnection in large-scale current sheet also evolves into turbulence. How energy is dissipated and how particles are accelerated in turbulent magnetic reconnection are outstanding questions in magnetic reconnection and turbulence. Here we report MMS observations of filamentary currents in turbulent outflows in the Earth’s magnetotail. We found sub-ion-scale filamentary currents in high-speed outflows that evolved into turbulent states. The normal direction of these current filaments is mainly along the $X_{GSM}$ direction, which is distinct from the neutral sheet. Some filamentary currents were reconnecting, thereby further dissipating the magnetic energy far from the X line. We notice that turbulent reconnection is more efficient in energizing electrons than laminar reconnection. Coherent structures composed of these filaments may be important in accelerating particles during turbulent reconnection.