S-I12

Intermittent energy dissipation by turbulent reconnection

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Abstract. Magnetic reconnection—the process responsible for many explosive phenomena in both nature and the laboratory—is efficient at dissipating magnetic energy into particle energy. To date, exactly how this dissipation happens remains unclear, owing to the scarcity of multi-point measurements of the 'diffusion region' at the sub-ion scale. Here we report such a measurement by Cluster—four spacecraft with separation of ⅕ ion scale. We discover numerous current filaments and magnetic nulls inside the diffusion region of magnetic reconnection, with the strongest currents appearing at spiral nulls (O-lines) and the separatrices. Inside each current filament, kinetic-scale turbulence is significantly increased, and the energy dissipation, $E' \cdot J$, is 100 times larger than the typical value. At the jet reversal point, where radial nulls (X-lines) are detected, the current, turbulence, and energy dissipations are surprisingly small. All these features clearly demonstrate that energy dissipation in magnetic reconnection occurs at O-lines but not X-lines.