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Micro-scale processes of jet braking in the near-Earth magnetotail

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We investigate the microphysics of jet braking through a case study of multi-spacecraft CLUSTER observations in the near-Earth plasma sheet at $\sim$10 R$_E$ on October 27, 2007. The interaction between the earthward moving fast plasma jet or bursty bulk flow (BBF) and the high-β ambient plasma in the flow-braking region results in magnetic pileup or compression ahead of the jet and rarefaction trailing the jet, in a similar fashion as high-speed and low-speed solar wind streams interact in corotating ineraction regions (CIRs) of the heliosphere. It is shown that mirror-mode structures of ion gyroradius scale develop within the compression region due to the observed ion temperature anisotropy ($T_{perp} > T_{par}$) of the ambient plasma sheet. We suggest that the linear growth of these mirror-mode structures or magnetic holes is driven by the perpendicular kinetic pressure perturbation (Δp_{perp}) of the BBF. When Δp_{perp} becomes too large, the pressure balance within the compression region cannot be maintained by mirror-mode structures any longer, and consequently, a shocklet is formed to allow faster expansion of the plasma. The mirror-mode structures and the non-linear slow magnetosonic wave observed at the foot of the shocklet are shown to accelerate ions and electrons through the trapping and surfing mechanisms. We conclude that ion-scale magnetic holes and slow-mode kinetic shocklets, and the associated local particle acceleration are efficient means of converting kinetic energy into thermal energy, which eventually leads to the deceleration of the plasma jet on fluid scale.