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Ion temperature anisotropy and related plasma instabilities in the near-Earth magnetotail

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The interaction between fast reconnection outflow jets and the ambient plasma sheet in the near-Earth flow-braking region often results in significant ion temperature anisotropy. In this paper, we present CLUSTER case studies of ion temperature anisotropy around multiple dipolarization fronts. Usually, large parallel anisotropy ($T_{par} > T_{perp}$) is observed inside fast jets or bursty bulk flows (BBFs), confirming the bubble model of BBFs. However, significant perpendicular anisotropy ($T_{par} < T_{perp}$) is found in the ambient high-β plasma ahead of and between multiple dipolarization fronts. The perpendicular anisotropy is most probably produced by adiabatic betatron acceleration through the magnetic pileup process. If the mirror instability threshold is surpassed within the pileup region, mirror mode structures are generated, which tend to remove the perpendicular anisotropy by heating the trapped ion population. Thus the kinetic energy of the fast jet is partly transformed into thermal energy. The mirror mode structures reported in corotating ineraction regions (CIRs) in the solar wind must be produced by a similar mechanism. Finally, we show a CLUSTER example where the non-linear steepening of a mirror wave resulted in a kinetic shocklet within the pileup region ahead of a jet front, leading to more efficient non-adiabatic particle acceleration.