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Cluster Multi-Scale Observation of MHD Shock-like Events in the Near-Earth Magnetotail

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We re-analyze the October 27, 2007 Cluster event discussed in previous studies from a new aspect. This event occurred in the near-Earth flow braking region around X_{GSM}= -10 R_E, where a significant deceleration of the Earthward flow could be detected by two Cluster spacecraft (C1 and C4). The plasma flow velocity was obtained from the E×B plasma drift velocity using high resolution electric field data and also from the timing analysis of two closely spaced spacecraft (C3 and C4). We argue that some of the observed thin structures associated with unusually high current density could be interpreted as slow-mode MHD shock-like structures. The phase velocity of Earthward propagating slow magnetosonic MHD waves was estimated to be as small as ∼77 km/s for the observed angle between the magnetic field and the normal of the discontinuity ($\theta_{Bn} = 67°$), whereas the corresponding fast magnetosonic velocity (∼1230 km/s) was found to be much higher. Thus a slow-mode shock is not unexpected where the plasma flow velocity abruptly drops from 400-500 km/s to almost zero. The rotation of the magnetic field vector across the discontinuity also supports the slow-mode shock interpretation. Unfortunately, the total pressure could not be calculated for this case due to the lack of appropriate plasma data. We suggest that MHD shock-like structures may play an important role in the particle acceleration in the near-Earth flow braking region, which needs to be confirmed by more detailed case studies of Cluster or Themis observations.