TC-1 observations of tailward moving thermal particles in the near-earth tail prior to substorm onsets

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By a careful analysis of data from Hot Ion Analyzer (HIA) onboard Double Star TC-1 during the period of 01 July 2004 to October 31, 2004, we find that in the time interval of about 12 min prior to auroral substorms, there are always appear tailward moving thermal particles in the near-Earth tail region (X≈-(6-15)Re). There are no instruments on TC-1 which can be used to directly measure the components of these tailward moving particles. Nevertheless, it can be seen clearly that both the number density and temperature of these particles are noticeably lower than those of the background thermal ions, consistent with the fact that they are originated form the ionosphere. Combination of TC-1 and Cluster observations tends to support this assessment. A detailed study shows that these tailward moving particles start to occur normally 1 to 2 min before auroral substorm onsets with larger tailward speed, typically a few tens of kilometers per second, then the sign of Vx may repeatedly changes prior to the onset. The tailward motion always maintains for a few min. In addition, TC-1 also observed that before the expansion phase of some substorms, tailward ion flows with Vx greater than 300 km/s appear in the near-earth tail (X $\sim$ -12 Re), which retain for about 30 min and have lower number density and temperature than those of the background thermal ions.

It is worthwhile to point out that recent 3-D MHD simulation studies (Zhang et al., 2006) have shown the appearance of these tailward flow prior to substorm onset, with an important role they play in causing the expansion onset. Evidently, the present observations are consistent with the simulation results. We concluded that the observations presented in this talk provide evidence that strongly supports the Global and multiscale “Front” model for substorm onset recently proposed by Z.X. Liu (Liu et al., 2006).

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