プラズマシートにおけるスパイク的電場に関連したプラズマ・ダイナミックス

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Plasma Dynamics Associated with Spiky Electric Fields in the Plasma Sheet

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Spiky electric fields with >10 mV/m on a time scale of 1-2 min. are, at times, observed in the plasma sheet with a double-probe instrument on board the Geotail spacecraft [e.g., Tu et al., GRL, submitted, 1999]. Their nature has been puzzling quantitatively, since the resultant value of 'E + V x B' is often non-negligible and even significant, where 'V' is taken from the ion bulk velocity obtained by the velocity moment. Note that the 'E + x B' value is usually close to zero (taking into account an appropriate offset value for the electric field data), indicating that the ideal MHD usually holds. It is noted, however, that the measured data are sometimes erroneous, especially when fast flows and energetic particle acceleration are observed: For example, the ion energy distribution exceeds the uppermost energy of the plasma instrument, and background counts due to penetrating particles are, at times, significant. Both effects make the obtained bulk velocity underestimated, and hence produce the significant 'E + V x B' value. These technical problems have made it difficult to assess the nature of the electric field quantitatively.

In this paper we report a case in which both the electric field and ion bulk velocity can be regarded as reliable, but the significant'E + V x B' value is seen. We have found such an example in the case of the extremely thin current sheet, in which the cross-tail current is mainly carried by electrons, as was shown in the previous SGEPSS meeting [Asano et al.]. Here, the cross-tail current was estimated by the difference between the ion and electron bulk velocities multiplied by the number density. However, the electron velocity moments are generally subject to various spurious effects, such as due to spacecraft and instrumental photoelectrons, and generally less reliable than the ion velocity moments. Therefore, we have evaluated the electron moments quantitatively by several independent ways. As one of the evaluation tests, we compared the residual of 'E + Ve x B' with that of 'E + Vi x B', and found a remarkable result that the former is much smaller than the latter for the intense electric field. This indicates that the electron velocity moments are also reliable technically, and also that physically the Hall term in the generalized Ohm's law plays an important role in the plasma dynamics for the case of the extremely thin current sheet. The electron and ion distribution functions for such a case will be discussed in detail.