Thermodynamical Properties of the Plasma Flow During the Substorm Development

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The main purpose of our present study is devoted to the investigation of thermodynamic properties of the magnetotail plasma sheet that associates complicated nature of the plasma flow especially during the substorm.This talk is focused on the change of thermodynamic quantity, the specific entropy before and after the expasion phase onset. We have used a number of substorm event that were observed actually in the plasma sheet domain (plasma beta>0.1) by virtue of the GEOTAIL plasma and magnetic field experiments. Based upon the characteristics determined here, We will argue the physical relationship that is consistently available for the thermodynamic properties and the plasma flow characteristics.

The main purpose of our present study is devoted to the investigation of thermodynamic properties of the magnetotail plasma sheet that associates complicated nature of the plasma flow especially during the substorm.We have already reported that the substorm expansion phase is characterized by drastic change of the plasma thermal pressure and the magnetic pressure, both of which vary and/or oscillate in anti-phase in the middle magnetotail(<30Re).This talk is focused on the change of thermodynamic quantity, the specific entropy before and after the expasion phase onset. The specific entropy is defined as Pthr/n^(gamma) as usual with a polytropic index gamma which amounts to 5/3 for the ideal MHD medium. We have used a number of substorm event that were observed actually in the plasma sheet domain (plasma beta>0.1) by virtue of the GEOTAIL plasma and magnetic field experiments. Characteristics determined here include the following: (1)The specific entropy exhibits a relatively constant value with the gamma close to 5/3 before the expansion phase onset, indicative of that the plasma flow almost conforms to a loss-less, adiabatic behavior as described by the ideal MHD,(2)Whereas, the specific entropy varies largely as the substorm develops into the expansion phase. At the beginning of that phase in which the plasma flow is often characterized by the bi-modal flow subsequently followed by the oscillatory motions, the gamma often attains up to as much as ~2. At the later stage in which the signatures of the bi-modal and bursty flows disappear, the gamma degenerates to a value as low as and/or smaller than~1.We will argue the physical relationship that is consistently available for the thermodynamic properties and the plasma flow characteristics.