Contribution ID: **91** Type: **Oral presentaion**

Larmor Electric Field and Electron Temperature Anisotropy: Signatures for Magnetopause Magnetic Reconnection

Wednesday, 8 June 2016 14:15 (15 minutes)

Magnetic reconnection is a key energy converting and plasma mixing process that plays important roles in different plasma systems. However, the physics of this key plasma process is only partially understood. Recently, NASA has launched Magnetospheric Multiscale (MMS), a group of four spacecrafts that use the earth magnetosphere as a laboratory, to specifically study physics of reconnection. However, MMS cannot send all of the data back to the earth due to limited communication bandwidth. Therefore, it needs a hint whether it is already around reconnection sites so that it knows when to change the data collecting mode from low resolution to high resolution. Using fully kinetic particle-in-cell simulations of asymmetric reconnection, we have found Larmor electric field, a new feature of reconnection electric field that has its origin based on the physics of finite Larmor radius. The scaling relations for the Larmor radius structure width and the strength of the field are proposed and tested successfully for many different upstream conditions that have the ion temperature greater than the electron temperature, similar to the conditions found at the magnetopause reconnction. Effects of the guide field have also been studied. The stronger the guide field the smaller the Larmor radius and so the thinner the width of the Larmor electric field structure. The magnitude of the field gets stronger as expected as well. Furthermore, we found that in the region where the Larmor electric field exists there will also be an electron temperature anisotropy. The anisotropy comes from electrons reacting to the parallel component of Larmor electric field leading to counter streaming motion of the electrons and therefore high parallel electron temperature. The Larmor electric field in conjunction with the electron temperature anisotropy can be used as a good reconnection signature alarming MMS that it is coming close to the a reconnection site.

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Session Classification: Session X

Track Classification: Ion and Plasma Physics