MMS Observations of the Multi-Scale Wave Structures and Parallel Electron Heating in the Vicinity of the Southern Exterior Cusp

Katariina Nykyri[1], Xuanye Ma[1], Brandon Burkholder[1], Rachel Rice[1], Jay Robert Johnson[2], Eun-Hwa Kim[3], Peter A Delamere[4], Adam Michael[5], Kareem Sorathia[6], Dong Lin[7], Viacheslav G. Merkin[8], Stephen A. Fuselier[9], Jeffrey Michael Broll[10], Olivier Le Contel[11], Daniel J Gershman[12], Ian James Cohen[8], Barbara L. Giles[12], Robert J. Strangeway[13], Christopher T. Russell[13], and James L Burch[9]

[1]Embry-Riddle Aeronautical University
[2]Andrews University
[3]Princeton Plasma Physics Laboratory, Princeton University
[4]University of Alaska Fairbanks
[5]John Hopkins Applied Physics Laboratory
[6]Johns Hopkins Applied Physics Lab
[7]National Center for Atmospheric Research
[8]The Johns Hopkins University Applied Physics Laboratory
[9]Southwest Research Institute
[10]Boston University
[11]CNRS/Ecole Polytechnique/Sorbonne Université/Univ. Paris-Sud/Obser. de Paris
[12]NASA Goddard Space Flight Center
[13]University of California Los Angeles

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Abstract

Understanding the physical mechanisms responsible for the cross-scale energy transport and plasma heating from solar wind into the Earth's magnetosphere is of fundamental importance for magnetospheric physics and for understanding these processes in other places in the universe with comparable plasma parameter ranges. This paper presents observations from Magnetosphere Multi-Scale (MMS) mission at the dawn-side high-latitude dayside boundary layer on 25th of February, 2016 between 18:55-20:05 UT. During this interval MMS encountered both inner and outer boundary layer with quasi-periodic low frequency fluctuations in all plasma and field parameters. The frequency analysis and growth rate calculations are consistent with the Kelvin-Helmholtz Instability (KHI). The intervals within low frequency wave structures contained several counter-streaming, low- (0-200 eV) and mid-energy (200 eV-2 keV) electrons in the loss cone and trapped energetic (70-600 keV) electrons in alternate intervals. Wave intervals also showed high energy populations of O+ ions, likely of ionospheric or ring current origin. The counter-streaming electron intervals were associated with a large-magnitude field-aligned Poynting fluxes. Burst mode data at the large Alfven velocity gradient revealed a strong correlation between counter streaming electrons, enhanced parallel electron temperatures, strong anti-field aligned wave Poynting fluxes, and wave activity from sub-proton cyclotron frequencies extending to electron cyclotron frequency. Waves were identified as Kinetic Alfven waves but their contribution to parallel electron heating was not sufficient to explain the >100 eV electrons, and rapid non-adiabatic heating of the boundary layer as determined by the characteristic heating frequency, derived here for the first time.