Differential Electron Flux Spectra Measured by the Magnetospheric Multiscale Mission (MMS) Show Strong Field-aligned Electron Population of Ionospheric Origin

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Ionospheric outflow is the process in which neutral atoms in the Earth’s atmosphere are first ionized and then accelerated so that the component ions and electrons can transport from regions of low altitude ( into the magnetosphere, reaching distances ranging up to and beyond. It is an important process in atmospheric loss that is only partially understood and refinements of the theory by experimental observation is crucial to developing a better understanding its role in the loss of the Martian atmosphere as well as the long-term fate of the Earth’s. In addition, it is a source of various plasma populations (in particular ) whose influence on the interaction between the magnetosphere and the solar wind must be accounted for in order to get an accurate picture of the relevant plasma dynamics.

In this study, fast survey measurements () from the Fast Plasma Investigation (FPI) electron spectrometers onboard the MMS spacecraft are used to construct differential electron flux, , spectra over the energy range from 10 eV to 30 KeV. The time period of the study is from 04:00 to 06:00 UTC on Oct. 26, 2015, when the MMS formation was approximately at and at a local time of about 14:00. Using the 32x16 angular resolution (angular bins of 11.25 degrees) of an FPI skymap, these spectra are further refined by binning pitch angles, , every 20 degrees. The resulting spectra show a very large population of cold electrons () at low energies (10-60 eV) that are strongly aligned with the magnetic field (~3 times larger than the perpendicular population). The distribution, which falls off rapidly with increasing energy, exhibits a knee at about ~100 eV, indicative of where the magnetospheric population becomes dominant.