Low electron temperatures observed at Mars by MAVEN on dayside crustal magnetic field lines

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The ionospheric electron temperature is important for determining the neutral/photochemical escape rate from the Martian atmosphere via the dissociative recombination of O_2^+. The Langmuir Probe and Waves instrument onboard MAVEN (Mars Atmosphere and Volatile EvolutioN) measures electron temperatures in the ionosphere. The current paper studies electron temperatures in the dayside for two regions where: (1) crustal magnetic fields are dominant and (2) draped magnetic fields are dominant. Overall, the electron temperature is lower in the crustal-field regions, namely, the strong magnetic field region, which is due to a transport of cold electrons along magnetic field lines from the lower to upper atmosphere. The electron temperature is also greater for high solar extreme ultraviolet (EUV) conditions, which is associated with the local EUV energy deposition. The current models underestimate the electron temperature above 250 km altitude in the crustal-field region. Electron heat conduction associated with a photoelectron transport in the crustal-field regions is altered due to kinetic effects, such the magnetic mirror and/or ambipolar electric field because the electron mean free path exceeds the relevant length scale for electron temperature. The mirror force can affect the electron and heat transport between low altitudes, where the neutral density and related electron cooling rates are the greatest, and high altitudes, while the ambipolar electric field decelerates the electron's upward motion. These effects have not been included in current models of the electron energetics, and consideration of such effects on the electron temperature in the crustal-field region should be considered for future numerical simulations.

Keywords: Mars, Electron temperature, Crustal magnetic field, MAVEN, Ionosphere, Atmospheric escape

