PROBING MARS' CRUSTAL MAGNETIC FIELD AND IONOSPHERE WITH THE MGS ELECTRON REFLECTOMETER

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Mars' magnetic field is dominated by remanent magnetization of the crust, which is distributed non-uniformly over the surface. In the northern hemisphere, crustal magnetic fields are so weak that the solar wind interacts directly with the atmosphere and ionosphere in a manner similar to Venus and active comets. The Electron Reflectometer (ER) onboard Mars Global Surveyor (MGS) detected a persistent boundary between the ionosphere and the solar wind as the latter is diverted around and past the planet. Above this boundary the 10–1000 eV electron population is dominated by solar wind electrons, while below it is dominated by ionospheric photoelectrons. Photoelectron energy spectra exhibit a broad feature from 20 to 50 eV, which likely results from a blend of unresolved photoionization peaks, and a feature at ~500 eV due to oxygen Auger electrons. The shape of the photoelectron spectrum remains fairly constant above ~180 km, but changes significantly at lower altitudes, probably because of approach to the exobase.
The "photoelectron boundary", or PEB, was observed at altitudes ranging from 180 km to over 800 km, with a median of 380 km. The PEB altitude is highly variable and sensitive to changes in the ionospheric thermal pressure and the solar wind dynamic pressure. Moreover, the PEB is systematically higher over crustal magnetic anomalies, which can exert significant magnetic pressure at ionospheric altitudes. Crustal fields as weak as a few nanoteslas at 400 km altitude cause a detectable bias in the PEB height. In the most strongly magnetized regions of the southern hemisphere, the crustal field is strong and coherent enough to stand off the solar wind up to altitudes of ~800 km, forming localized "magnetocylinders," which are elongated in the east-west direction following the pattern of magnetization. The ER probes the topology of these magnetocylinders by measuring the energy spectra and pitch angle distributions of electrons traveling along the crustal field lines. Ionospheric plasma is trapped on closed magnetic field lines that are anchored to the crust. Where the crustal field has a nearly radial orientation, there is a tendency for the field lines to reconnect with the solar wind magnetic field, forming cusps.