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Modeling of photoelectron spectra observed in the Martian ionosphere

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The density profiles of ions and neutrals in the Martian exosphere determine the standoff distance of the Martian induced magnetosphere and the escape rates of matter from the planet. Because of the low speeds and temperatures of the particles, these profiles could sofar not reliably be determined by observations. The ASPERA-3 experiment onboard the European MarsExpress mission allows for the first time to determine the energy spectra of photoelectrons in the energy range 10...100 eV with high energy resolution ($\Delta E/E = 7\%$). Using a detailed model of photoionization and solar EUV absorption may allow to infer ion and neutral density profiles from these observations. We have implemented a model by Mantas & Hanson [1979] using more recent data for both Solar spectral irradiance and the various atomic properties to study the equilibrium spectra of photoelectron populations resulting from photoionization and subsequent scattering by neutral atmospheric particles. Taking into account the photoabsorption, photoionization, and electron scattering properties of the various constituents of the neutral background atmosphere, such spectra can be produced for arbitrary values of Solar zenith angle and height above the planetary surface, as well as for varying conditions of Solar irradiance. The model parameters can easily be modified to allow for an application to other planets (e.g., Venus).

The resulting spectra are compared to photoelectron measurements obtained by the ASPERA-3 instrument onboard MarsExpress at altitudes above 250 km. Finally, further model refinements, as well as possible applications to other astrophysical systems (such as planetary rings) are also discussed.