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Photoelectron signature at Venus

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Abstract

Solar soft X-ray and EUV radiation is a significant source of energy of the upper atmosphere at Venus, Earth, Mars, and Saturn's moon, Titan. The absorption of the solar radiation yields photo-ionization, photo-excitation, photo-dissociation, and combinations of them. A unique signature of solar deposition in an atmosphere is the presence of the so-called photoelectron peaks in the energetic electron spectra. Such peaks are the result of photo-ionization of atmospheric species by strong solar lines, such as He II (30.4 nm) and Fe XV (28.4 nm). To date, photoelectron peaks have been identified on observed spectra throughout the solar system, from Earth aboard rockets and satellites (e.g., [1,2]) to Mars with MEx/ASPERA3/ELS [3], Titan with Cassini/CAPS/ELS [4], and more recently for the first time at Venus by VEx/ASPERA4/ELS [5]. They have been observed on the sunlit side where they are produced, but also on the darkside and in the magnetized environment of the planet or moon. Photoelectrons can be transported away from the production, sunlit regions, sometimes also undergoing energization. They therefore represent not only a fingerprint of photoionization processes but also can be used for identifying the presence of acceleration processes and regions magnetically connected with the sunlit ionosphere [6].

After a short review of photoelectron signatures detected in the atmosphere of Solar System bodies, we will focus on the ionosphere of Venus and present a detailed analysis of the suprathermal electron spectra observed by VEx/ASPERA4/ELS using a kinetic model describing the transport, energy degradation, and angular redistribution of suprathermal electrons. The geometry of the magnetic field lines along which the electrons are transported is constrained by the magnetic field measurements from VEx/MAG. We will discuss the importance of transport, the relevance of photoelectrons for estimating the spacecraft potential, and the contribution of solar radiation as a source of energy in the terminator ionospheric regions at Venus.

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