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Ionosphere of Mars: Role of Solar EUV and Solar Wind Interaction

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In the upper atmosphere of Mars, the first measurement of magnetic field in situ was made by magnetometer experiment onboard Mars Global Surveyor (MGS) spacecraft. The results obtained from this spacecraft show the existence of highly variable and localized magnetic field at Mars. The magnetic field as high as 400 nT at 108-113 km altitude in northern hemisphere and 1500 nT at 120-200 km altitude at some locations in southern hemisphere were observed in the ionosphere of Mars. However, the strength of magnetic field in other locations at same altitude range was much lower to be 5-15 nT. These magnetic fields are so weak that they do not significantly contribute to solar wind- Mars interaction. Thus, Mars has mainly an induced magnetosphere and solar wind is able to penetrate directly into the atmosphere of this planet. In this paper, we have studied the ionosphere of Mars due to solar EUV, X-rays and electron-proton-hydrogen atom (originated from solar wind) impacting with the atmospheric gases at solar zenith angles of 75°, 105°and 127°. These calculations are made in chemical equilibrium region using Analytical Yield Spectrum (AYS) approach at same areophysical conditions of the measurement. The calculated results are compared with occultation measurements carried by Viking ½, Mars 5 and MGS spacecrafts. The ionosphere produced by combined source (EUV +X-rays) is also compared with other model calculation made by Mars Thermosphere Global Circulation Model (MTGCM). AYS produced ionosphere represents good agreement with the measurement and other model calculation made by MTGCM. In the vicinity of ionization peak, it is found that ion production rate caused by precipitation of proton-hydrogen atom is larger than the X-ray impact ionization rate, while at all altitudes, photo ionization rate is always greater than either of two. Moreover, X -rays contributes greatly to the photoelectron impact ionization rate as compared to photo ion production rate. The dayside ionosphere produced by proton-hydrogen atom is smaller by an order of magnitude than that produced by solar EUV radiation. X-rays play an important role in the dayside ionosphere of Mars at altitude ~110 km. The solar wind electron and proton have provided a substantial source in the nightside ionosphere.