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## Mars' ionosphere: from our current knowledge to the way forward

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The ionosphere of Mars is the conducting layer embedded within the thermosphere and exosphere that is mostly the result of solar EUV photoionization. It is also the layer that links the neutral atmosphere with space, and acts as the main obstacle to the solar wind. The ionosphere's interaction with the solar wind is a critical aspect that determines the Martian atmospheric evolution, and ultimately the planet's habitability. This interaction is often referred to as planetary Space Weather, the forecast of which is currently challenging due to the lack of a permanent in-situ solar wind monitor at Mars. Understanding the ionospheric response to solar wind variability is, therefore, essential in order to assess the response of the Martian plasma environment to the dissipation of energy from solar storms, and their impact on current technology deployed on the red planet.

This lecture will focus on our current knowledge of the Martian ionosphere. In particular, I will focus on our recent advances in the understanding of the Martian ionospheric reaction to different Space Weather events during the solar cycle, both from the data analysis and ionospheric modelling perspectives. Some important aspects to consider are the bow shock, magnetic pileup boundary, and ionopause characterization, as well as the behaviour of the topside and bottomside of the ionosphere taking into account the planet's orbital eccentricity. Moreover, I will show the effect of electron precipitation from large Space Weather events in the very low Martian ionosphere, a region that it is not accessible to in-situ spacecraft observations. Finally, I will conclude the presentation by giving my perspective on some of the key outstanding questions that remain unknown, and I consider they constitute the next generation of Mars' ionospheric science and exploration.