

## Magnetically controlled density structures in the topside layer of the Martian ionosphere

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The Mars Advance Radar for Subsurface and Ionospheric Sounder (MARSIS) on board the Mars Express regularly detects the magnetically controlled density structures in the main layer of the Martian ionosphere when the spacecraft passes over the regions of strong crustal magnetic fields. In an ionogram these structures appear as second layer apart from the main layer. The technique of MARSIS suggests that these structure should be due to reflections from oblique directions. In a radargram, these structures appear as hyperbola-shaped features. For the first time, we observed such oblique echoes from the topside layer of the Martian ionosphere. Comparison with the crustal magnetic field model suggests that these echoes mostly occur in regions close to magnetic field anomalies. The MARSIS ionograms that show these oblique echoes are limited in number probably due to the fact that these echoes occur at the low frequency end of an ionogram where local plasma frequency lines and electron-cyclotron lines make it difficult to discern these echoes. In one case, however, we observed the topside layer with oblique echoes on several consecutive ionograms and a hyperbola-shaped feature on a radargram. The apex of the hyperbola fall in the region of vertical magnetic field. Unlike the main layer, the recurrent occurrence of the topside layer with oblique echoes over the same location is not common. More importantly, the oblique echoes of the topside layer are always associated with those from the main layer of the ionosphere, but not vice-versa. The simultaneous observation of oblique echoes from the main and topside layers are explained by considering the formation of ionization bulges at the respective layer altitudes.

Keywords: Mars, MARSIS, Ionogram, Oblique echo