The ionosphere of Mars never looked like this before.

This hazy region contains the atmosphere and ionosphere of Mars.

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University of Michigan

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This is Mars

- 0.5 x R-Earth
- 1.5 AU from Sun
- Same rotation rate as Earth
- Carbon dioxide atmosphere
- 100x smaller surface pressure
- Target of many spacecraft in last 15 years
Ionospheres are schizophrenic

<table>
<thead>
<tr>
<th></th>
<th>Atmosphere</th>
<th>Ionosphere</th>
<th>Space physics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemistry</td>
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<td>Sunlight</td>
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<td>X</td>
</tr>
<tr>
<td>Magnetic fields</td>
<td>X</td>
<td>?</td>
<td>✓</td>
</tr>
<tr>
<td>Composition</td>
<td>Neutrals</td>
<td>Ions, electrons, and neutrals</td>
<td>Protons and electrons</td>
</tr>
</tbody>
</table>
Neutral atmosphere is mainly CO$_2$, O becomes significant at high altitudes

O$_2^+$ is main ion (?) at all altitudes

EUV photons responsible for main M2 layer

Soft X-ray photons and secondary ionization responsible for lower M1 layer

Transport only important in topside ionosphere

Withers et al. (2009) Decadal Survey white paper
Figure 1A: Electron density profile from orbit 2436 on 5 December 2005 at solar zenith angle of 78 degrees, latitude 67°N, longitude 235°E. The grey solid line is an exponential fit to densities between 150 km and 300 km that has a scale height of 33 km.
Figure 1B: Electron density profile from orbit 2402 on 26 November 2005 at solar zenith angle of 81 degrees, latitude 66°N, longitude 341°E. The lower and upper grey solid lines are exponential fits to densities at 150-220 km and 220-400 km, respectively, that have scale heights of 22 km and 120 km.
Figure 1C: Electron density profile from orbit 2463 on 13 December 2005 at solar zenith angle of 75 degrees, latitude 66°N, longitude 103°E. The lower, middle, and upper grey solid lines are exponential fits to densities at 150-220 km, 220-280 km, and 280-315 km, respectively, that have scale heights of 28 km, 190 km, and 21 km.
Figure 1D: Electron density profile from orbit 2445 on 8 December 2005 at solar zenith angle of 77 degrees, latitude 67°N, longitude 70°E. Electron densities are nearly uniform between 300 km and 580 km.
Figure 1E: Electron density profile from orbit 1949 on 22 July 2005 at solar zenith angle of 69 degrees, latitude 42°N, longitude 24°E. Electron densities drop below $10^9$ m$^{-3}$ by 200 km altitude.
Figure 1F: Electron density profile from orbit 9613 on 14 July 2011 at solar zenith angle of 82 degrees, latitude 82°S, 180°E. Electron densities remain above $10^9$ m$^{-3}$ to 700 km altitude.
Figure 2A: Electron density profile from orbit 4258 on 30 April 2007 at solar zenith angle of 68 degrees, latitude 46°N, longitude 278°E.
Figure 2B: Electron density profile from orbit 2416 on 30 November 2005 at solar zenith angle of 79 degrees, latitude 67°N, longitude 42°E.
Figure 2C: Electron density profile from orbit 2541 on 4 January 2006 at solar zenith angle of 66 degrees, latitude 60°N, longitude 17°E.
Figure 2D: Electron density profile from orbit 2435 on 5 December 2005 at solar zenith angle of 78 degrees, latitude 67°N, longitude 333°E.
Figure 2E: Electron density profile from orbit 2840 on 28 March 2006 at solar zenith angle of 55 degrees, latitude 15°N, longitude 217°E.
Figure 2F: Electron density profile from orbit 7344 on 23 September 2009 at solar zenith angle of 52 degrees, latitude 34°S, longitude 137°E.
Magnetic field at Mars

Based on model of Arkani-Hamed (2004)