Similar ities and Differences in the Solar Wind Inter action with Mars and Venus

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Mars and Venus are both unmagnetized planets in the sense that they do not possess global magnetic field of planetary origin. Observations and numerical simulation results suggest that the solar wind directly interacts with the dayside ionospheres of these planets, compressing the ionosphere on the day side and forming a plasma tail on the night side. Because of this direct interaction, a large amount of ionospheric ions may escape into the solar wind for both the planets.

However, following qualitative and quantitative differences have been found:

(1) Because of the smaller gravity at Mars, neutral CO_2 density does not sharply decrease with altitude in the case of Mars as in the case of Venus. This leads to a larger relative abundance of O_2^+ ions in the Mars ionosphere and hence to a larger escape ratio of O_2^+ as compared to O^+.

(2) Overall, the thinner atmosphere of Mars leads to a thinner ionosphere. The average solar wind dynamic pressure exceeds the critical value that can be sustained by the ionosphere at Mars, while it does not at Venus. There will be much higher probability at Mars of the solar wind plasma penetrating into the ionosphere with frozen-in magnetic field lines.

(3) Mars has a very characteristic plasma boundary called the “magnetic pile-up boundary”. The amplitude of magnetic fluctuations suddenly drops across this boundary, and the ion composition and magnetic field orientation change. The existence and the position of this boundary have been well established, but the formation mechanism has not been identified.

(4) Mars has magnetic fields of crustal origin localized in the southern hemisphere. Magnetic reconnection between the crustal fields and IMF can be expected, but the associated flows and energization of plasma have not been observed.

(5) The stand-off distance of the Mars bow shock seems larger than Venus in a relative sense. It is not clear if the presence of the “magnetic pile-up boundary” or the crustal magnetic field is responsible for this difference.

The similarity and differences between Mars and Venus will be discussed for specific topics as listed above.

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