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Structure of ion flows in the magnetotail of Venus

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Introduction

The Venusian ionosphere interacts directly with the solar wind, and forms an induced magnetosphere. The interaction transfers energy from the solar wind to the ionospheric ions, and causes some ions to escape into the induced magnetotail (Futaana et al., 2017; Persson et al., 2020). In the magnetotail, the ions do not simply flow from Venus and outward to space. The ion flows have an additional component back towards Venus: return flows (Kollmann et al., 2016; Persson et al., 2018). These return flows was shown to decrease the total average escape rates from Venus for both H^+ and O^+ ions (Persson et al., 2018). In this study, we delve deeper into the structure of the ion flows in the magnetotail in order to provide further insight into these return flows.

Method

To analyse the ion flows we use the Ion Mass Analyser (IMA), a part of the ASPERA-4 instrument suite (Barabash et al., 2007b), on board Venus Express. IMA is a top-hat electrostatic analyser with an energy range of 0.01-36 keV, with $\Delta E/E=7\%$. The mass separating capabilities allows us to efficiently separate the lighter H^+ from the heavier O^+ ions. From the electrostatic deflector plates and the cylindrical symmetry the field-of-view has a resolution of 5.6x22.5° for each of the 16x16 pixels, which gives a total field-of-view of 90x360°.

We use the full dataset of IMA from 2006 to 2014 to calculate average ion velocity distributions. We combine the measurements by location in the magnetotail. As the induced magnetotail of Venus is structured by the direction of the upstream Interplanetary Magnetic Field (IMF) and the solar wind motional electric field (Jarvinen et al., 2013; McComas et al., 1986; Pérez□de□Tejada, 2001), we use the direction of the IMF to group the measurements together. The average ion distributions are then used to analyse the structure of flows in the magnetotail, in order to provide further insight in the return flow mechanisms.

Results and discussion

The structure of the magnetotail with respect to the solar wind motional electric field implies a difference in the ion flows between the hemisphere where the electric field points away from Venus (+E) and the hemisphere where the electric field points towards Venus (-E). The magnetic field draping in the -E hemisphere provides a more narrow draping near the plasma sheet, which indicates a preference for magnetic reconnection (Zhang et al., 2010). If magnetic reconnection is the main mechanism that causes the return flows, we therefore expect a preference of return flows in the -E hemisphere.

Preliminary results indicate that there is no clear dependence of the return flow with +E or -E hemisphere. In agreement with previous studies, our results show that the main anti-sunward acceleration in the magnetotail occurs in the +E hemisphere (Barabash et al., 2007a; Fedorov et al., 2011). However, the unclear relationship of the return flows with hemisphere warrants a further investigation. In this presentation, we present our results of an expanded study where we will have investigated the ion flows in the magnetotail in further detail to see if there is a preferred location or condition where the return flows are appearing.

References

Barabash, et al. (2007a). The loss of ions from Venus through the plasma wakes. Nature, 450(7170), 650–653. https://doi.org/10.1038/nature06434

Barabash, et al. (2007b). The Analyser of Space Plasmas and Energetic Atoms (ASPERA□4) for the Venus Express mission. Planetary and Space Science, 55(12), 1772–1792. https://doi.org/10.1016/j. pss.2007.01.014

Fedorov, et al. (2011). Measurements of the ion escape rates from Venus for solar minimum. Journal of Geophysical Research, 116, A07220. https://doi.org/10.1029/2011JA016427

Futaana, et al. (2017). Solar wind interaction and impact on the Venus atmosphere. Space Science Reviews, 212(3□4), 1453–1509. https://doi.org/10.1007/s11214□017□0362□8

Jarvinen, et al. (2013). Hemispheric asymmetries of the Venus plasma environment. Journal of Geophysical Research: Space Physics, 118, 4551–4563. https://doi.org/10.1002/jgra.50387

Kollmann, et al. (2016). Properties of planetward ion flows in Venus' magnetotail. Icarus, 274, 73–82. https://doi.org/10.1016/j.icarus.2016.02.053

McComas, et al. (1986). The average magnetic field draping and consistent plasma prop- erties of the Venus magnetotail. Journal of Geophysical Research, 91(A7), 7939–7953. https://doi.org/10.1029/JA091iA07p07939

Pérez□de□Tejada, H. (2001). Solar wind erosion of the Venus polar ionosphere. Journal of Geophysical Research, 106(A1), 211–219. https:// doi.org/10.1029/1999JA000231

Persson, et al. (2018). H+/O+ escape rate ratio in the Venus magnetotail and its dependence on the solar cycle. Geophysical Research Letters, 124, 4597–4607. https://doi.org/10.1029/2018JA026271

Persson, et al. (2020). The Venusian atmospheric oxygen ion escape: Extrapolation to the Early Solar System. Journal of Geophysical Research: Planets, 125. https://doi. org/10.1029/2019JE006336

Zhang, et al. (2010). Hemispheric asymmetry of the magnetic field
wrapping pattern in the Venusian magnetotail. Geophysical Research Letters, 37, L14202. https://doi.org/10.1029/2010GL044020