Forces, Electric Fields and Currents in the Martian magnetosphere: MAVEN Observations and Multifluid MHD Simulation Results.

G. Boscoboinik[1], C. Bertucci[1,2], D. Gomez[1,2], C. Dong[3], L. Regoli[4], C.Mazelle[5], J. Espley[6], C. Fowler[7], D. Mitchell[7], L. Andersson[8], B. Jakosky[8], J. Halekas[9]

[1]*IAFE, UBA CONICET, Buenos Aires, Argentina*
[2]*Departament of Physics, FCEyN, UBA, Buenos Aires, Argentina*
[3]*Department of Astrophysical Sciences and Princeton Plasma Physics Laboratory, Princeton University,Princeton, NJ, USA*
[4]*Applied Physics Laboratory, John Hopkins University, Baltimore, MD, USA*
[5]*IRAP, UPS CNRS CNES, Toulouse, France*
[6]*Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA*
[7]*Space Sciences Laboratory, University of California, Berkeley, Berkeley, CA, USA*
[8]*LASP, University of Colorado, Boulder, CO, USA*
[9]*University of Iowa, Iowa City, IA, USA*

Abstract: At present Mars does not have a significant global magnetic field, as a result the solar wind interacts directly with its atmosphere, leading to the escape of its constituents. In opposition to magnetised objects, this interaction generates an induced magnetosphere where the solar wind plasma magnetic fields are perturbed by the planetary charged particle environment.

In this scenario, the Martian MPB (Magnetic Pileup Boundary) is a key boundary in the Mars/Solar Wind interaction as it is here that the momentum and energy from the solar wind plasma are transferred to the planetary plasma, which lead to atmospheric escape. Since this interaction is collisionless, the transfer is mediated by electric and magnetic fields.

The Mars Atmospheric and Volatile EvolutioN (MAVEN) spacecraft has been in elliptical orbit around Mars since 2014 characterising its atmosphere and plasma environment. In a previous work (Boscoboinik et al., 2020), we used the minimum variance analysis of the magnetic field (MVAB) to derive the MPB's normal vector, its thickness and the associated current density for a crossing on March 16th, 2016. The MPB thickness is of the order of the magnetosheath solar wind proton inertial length, which suggests a demagnetisation of these protons due to the Hall electric field.

In the present work we combine MAVEN data and multifluid MHD (Dong et al., 2014) simulation results to make a more in depth study of the electric fields, currents and forces acting on the MPB for the same orbit. The simulation results are analysed and compared with MAVEN/MAG, SWIA, LPW and STATIC data for validation.

In particular, we find that the current densities obtained from MAVEN data are consistent with the values obtained in the simulation. Also, the Hall electric force points sunward in both cases. Finally, we use the simulation results to compare the electric field terms within the generalized Ohm's Law. We find that in the subsolar region the Hall electric field dominates over the solar wind convective electric field and electron pressure gradient. In summary, this electric field is responsible for stopping the solar wind protons at the MPB while accelerating the solar wind electrons into the magnetic pileup region, carrying the magnetic field lines frozen into them.

Acknowledgment: The authors would like to acknowledge ISSI for the opportunity it offered for very valuable discussions on this topic as part of the International Team 499 "Similarities and Differences in the Plasma at Comets and Mars"

References: Boscoboinik, G., et al. (2020). *The magnetic structure of the subsolar MPB current layer from MAVEN observations: Implications for the Hall electric force.* Geophysical Research Letters, 47, e2020GL089230. https://doi.org/10.1029/2020GL089230

Dong, C., et al. (2014), *Solar wind interaction with Mars upper atmosphere: Results from the one-way coupling between the multifluid MHD model and the MTGCM model*, Geophys. Res. Lett., 41, 2708–2715, doi:10.1002/2014GL059515.

Session: 4 - The interaction of the sun with the planets, and space weather

Oral or Poster: Oral