EPSC Abstracts
Vol. 13, EPSC-DPS2019-1466-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Revisiting the mystery of Mercury's Na-exosphere in relation with the solar wind

Melinda Dósa (1), Valeria Mangano (2), Stefano Massetti (2), Anna Milillo (2), Lilla Kalocsai (1), Károly Kecskeméty (1)
(1) Wigner Research Centre for Physics, Budapest, Hungarian Academy of Sciences (dosa.melinda@wigner.mta.hu)
(2) INAF/IAPS, Istituto Nazionale di Astrofisica, Roma, Italy

Abstract

The dynamic changes of Mercury's Na exosphere are investigated here, in relation to space weather conditions. Solar wind velocity values are propagated to the position of Mercury from nearby spaceprobes and compared with Na emission intensity. Single cases are studied qualitatively, and a longer-term quantitative comparison is shown, including further parameters (solar wind magnetic field strength and direction, TAA).

1. Introduction

Sodium plays a special role in Mercury's exosphere: due to its strong resonance line it has been observed and monitored by Earth-based telescopes for decades. Different and highly variable patterns of Na-emission have been identified, the most common and recurrent being the high latitude double-peak pattern [1]. It is clear that the exosphere is interacting with the surface and the magnetosphere under the influence of solar wind and the interstellar medium, but the role and weight of the single processes are still under discussion [2]. An overview of the main questions and the most important factors that influence Na emission are given here. Then, a new factor is regarded in this work: the intensity of Na-emission is compared with propagated solar wind dynamic pressure.

2. Factors behind Na-exosphere variability

In addition to the release processes already studied extensively in the past, we aim here to investigate more in detail the following factors: the distance to the Sun, position in relation to the ecliptic plane and solar wind magnetic field strength and direction. In order to better investigate this open issue, we have studied the intensity of Na-emission as a function of solar wind dynamic pressure and TAA of Mercury by means of the extended dataset images collected from 2009 to 2013 by Earth-based observations performed at the THEMIS solar telescope.

2.1 Propagated solar wind data

The present Na exosphere database can take advantage of the MESSENGER in-situ measurements of interplanetary magnetic field during the years 2011-2013. Unfortunately, the MESSENGER spacecraft had no in-situ measurement of solar wind parameters (velocity and density), so it is hard to interpret measurements that heavily depend on space weather circumstances. In order to overcome this difficulty solar wind parameters from other spaceprobes were shifted (in time and in space) with the magnetic lasso method to the position of Mercury [3]. Data of either the ACE or one of the two STEREO spacecraft were used, depending on which spacecraft had a smaller angular distance from Mercury.

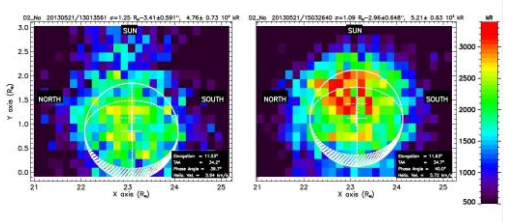

Figure 1: An increase in Na-emission. Consecutive THEMIS images of 21.05.13. 13:05 and 15:03

3. Case studies

Na-emission images during relatively calm periods of the Sun were selected from the THEMIS database. Even though in these periods an increase in solar wind dynamic pressure is usually lower than in active ones, nevertheless this choice ensures that the quality of propagation is not worsened by transient phenomena. Single cases are shown, where there seems to be a direct relationship between solar wind pressure and emission intensity of Mercury's Na-exosphere. A quantitative comparison is also carried out including a series of cases and the cross-correlation of several other factors.

4. Summary and Conclusions

The comprehensive research of Mercury's Na-emission is extended by the unknown solar wind dynamic pressure factor. Propagated solar wind parameters were used and compared with emission intensity. The study shows cases with a clear link between the two parameters.

Acknowledgements

We acknowledge use of NASA/GSFC's Space Physics Data Facility's OMNIWeb (or CDAWeb or ftp) service, and OMNI data. We also thank the ACE SWICS instrument team and the ACE Science Center for providing the ACE data, NASA/NSSDC for Messenger data. MESSENGER data analysis was performed with the AMDA science analysis system provided by the Centre de Données de la Physique des Plasmas supported by CNRS, CNES, Observatoire de Paris and Université Paul Sabatier, Toulouse. We finally acknowledge the THEMIS staff in Tenerife (Canary Islands, Spain) for their fruitful help throughout the years of observation campaign.

References

[1] Mangano, V., Massetti, S., Milillo, A., Plainaki, C., Orsini, S., Rispoli, R., Leblanc, F.: THEMIS Na exosphere observations of Mercury and their correlation with in-situ magnetic field measurements by MESSENGER, Planetary and Space Science,115, 102–109, 2015.

[2] Milillo, A., Wurz, P., Orsini, S., Delcourt, D., Kallio, E., Killen, R.M., Lammer, H., Massetti, S., Mura, A., Barabash, A., Cremonese, G., Daglis, I.A., De Angelis, E., Di Lellis, A.M., Livi, S., Mangano, V., Torkar, K.: Surface-exosphere-magnetosphere system of Mercury, Space Science Reviews, 117:397-443, 2005.

[3] Dósa, M., Opitz, A., Dálya, Z., Szegő, K.: Magnetic lasso: a new kinematic solar wind propagation method, Solar Physics 293:127, 2018.