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THEMIS telescope images analysed for space weather traces

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The THEMIS solar telescope operating on Tenerife (Canary islands) has observed Mercury's Na exosphere along several campaigns since 2007. A dataset of images taken between 2009 and 2013 are analysed here in relation with propagated solar wind data. A small subset of the images shows a low level of correlation between Na-emission and solar wind dynamic pressure. The amount of data at present is not sufficient to make a clear statement on whether the correlation is a coincidence or can be explained by other factors (position of Mercury and Earth, solar activity, etc.). Nevertheless, the authors present a comprehensive study taking into account all possible factors.

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 linked to the surface and influenced by the interstellar medium and the solar wind deviated by the magnetosphere, but the role and weight of the single processes are still under discussion [2].

In addition to the surface release processes already studied extensively in the past, we aim here to investigate more in detail the effect on Na exosphere of the following factors: the distance to the Sun, position in relation to the ecliptic plane, rotation of Mercury, solar UV and X-ray radiation. Na-emission intensity data (maximum and average) are provided by the dataset images collected from 2009 to 2013 by Earth-based observations performed at the THEMIS solar telescope.

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 true anomaly angle (TAA) of Mercury.

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 space probes 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.

All Na-emission images taken between 2009 and 2013 during relatively calm periods of the Sun were analysed, with a special focus on periods lasting for 2-3 consecutive days. Ten single cases are shown, in three cases there seems to be a direct (though not strong) 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 with the aim to find the reason why the 3 selected cases show a higher correlation rate than the rest of the database.[a1] [M2]

The research of Mercury's Na-emission variability is extended by the unknown solar wind dynamic pressure factor with the goal of reaching a more comprehensive understanding of exospheric processes occurring at the planet. Propagated solar wind parameters were used and compared with emission intensity. The study shows cases with a clear link between the two parameters.

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