MERCURY SODIUM EXOSPHERIC EMISSION AS A PROXY FOR SOLAR PERTURBATIONS TRANSIT

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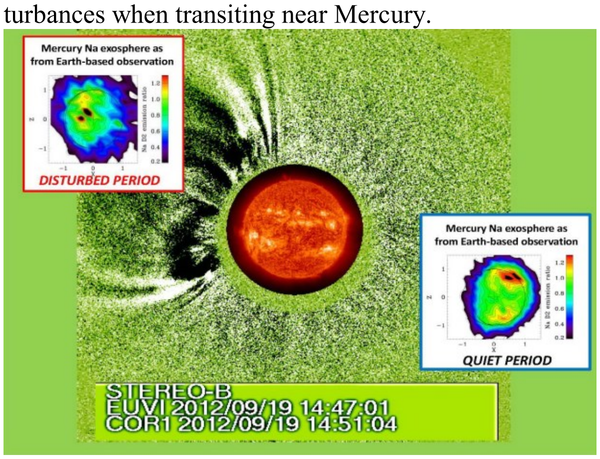
Introduction: We report here about recently published results [1] on the first evidence at Mercury of direct relation between ICME transit and Na exosphere dynamics, suggesting that Na emission, observed from ground, could be a proxy of planetary space weather at Mercury. The link between the dayside exosphere Na patterns and the solar wind-magnetosphere-surface interactions is investigated. This goal is pursued by analyzing the Na intensity hourly images, as observed by the ground-based THEMIS solar telescope during 10 selected periods between 2012 and 2013 (with seeing, σ <= 2”), compared to MESSENGER data.

Frequently, two-peak patterns of variable intensity are observed, located at high latitudes in both hemispheres. Occasionally, Na signal is instead diffused above the sub-solar region. We compare these different patterns with the in-situ time profiles of proton fluxes and magnetic field data from MESSENGER. Among these 10 cases, only in one occasion the Na signal is diffused above the subsolar region, when the MESSENGER data detect the transit of two ICMEs. These cases suggest that the Na emission patterns are well related to the solar wind conditions at Mercury, yo be be considered as a ‘natural monitor’ of solar disturbances when transiting near Mercury.



The possibility to use Mercury exosphere as a monitor would be of great profit for ICME modeling efforts. It follows that a continuous ground-observation of the planet would be desirable. Jointly with the Sun ICME emission monitoring, by allocating time and resources to the available solar telescopes.

Conclusions: In summary, the Na exospheric emission observed in the analyzed 10 sequences database (with average seeing <= 2”) leads to two alternative scenarios of particle precipitations:

1. Open field lines plasma precipitation, which originates high-latitude two-peak Na emission. This is a frequent condition induced by significant reconnection rate at Mercury (low plasma β). At ICME transits, they cause thick, low-β plasma depletion layers and even higher reconnection rates, so that the cusps extend to lower latitudes, causing open field lines broad plasma precipitation areas [2], with the two-peak Na patterns still existing, but hardly distinguishable.
2. Occasionally, at the ICME transit, the magnetopause itself approaches the planet surface. We see evidence that such a distance may be small; lower than particle gyroradii, i.e., a few hundred km, so that magnetosheath plasma may precipitate on the planet’s dayside [3] [4]. Although increases in the planetary field from core induction offset the effects of compression, they do not rule out compression of the magnetopause to near the surface at low dayside latitudes (48 – 320 km, near the subsolar point and closer in the southern hemisphere [2]). Near the subsolar point hot protons would have gyroradii of a few hundred km [5], allowing them to impact the surface at low latitudes via gyration.
3. Particle precipitation is the major driver of Na surface release, so that the observations of Na emission evidence planetary space weather features at Mercury. We have noticed that IMF components do not play a significant role with respect to the IMF magnitude itself, when IMF exceeds ~25 nT. The shown observations do not allow identification of the surface release process responsible for exospheric Na refilling. Ion sputtering yields are generally not sufficient for sustaining the observed release, but plasma impact on the surface would drive enhanced diffusion, which should be able to provide free Na atoms, then released in a short while through PSD process [6].

References: [1] Orsini, S. et al. (2018) *Scientific Reports*, *8:928,* DOI: 10.1038/s41598-018-19163-x [2] Slavin, J. A., et al. (2014) *J. Geophys. Res. Space Physics, 119*, 8087. [3] Kallio, E., Janhunen (2003) *Geophys. Res. Lett., 30, 17,* 1877. [4] Winslow, R. M., et al. (2017) *J. Geophys. Res. Space Physics, 122*, 23548. [5] Raines, Jim M. et al. (2014) *J. Geoph. Res. Space Phys*, *119*, 8, 6587. [6] Mura, A. et al. (2009) *Icarus, 200*, 1–11.