Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2018-109-RC1, 2018

Annales Geophysicae Discussions
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Interactive comment on "Mercury's Sodium Exosphere: An *ab initio* Calculation to Interpret MASCS/UVVS Observations from MESSENGER" *by* Diana Gamborino et al.

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Received and published: 8 November 2018

Review:

Mercury's Sodium Exosphere: An ab initio Calculation to Interpret MASCS/UVS Observations from MESSENGER

Gamborino, Vorburger and Wurz Ann. Geophys. , 2018

1. This paper concludes that thermal desorption dominates all other processes in the production of sodium in Mercury's exosphere. There are several mistakes made in coming to this conclusion.

First, on page 14 the scale height of thermally desorbed atoms at the subsolar point was listed as 57 km. However, it was already shown by Cassidy et al. (2015), and previously by Bishop, that the scale height at the subsolar point is reduced by radiation pressure by a factor of 1/ (g + mbcos(theta)) which in this case is 40%. Thus the actual scale height is 40 km. The implication of this is that MASCS would never have seen these particles even if they were there because MASCS did not scan below 50 km.

More importantly however is the use of the full number density of Na in the crystalline lattice in this calculation. It is known that thermal desorption only acts on adsorbed atoms. As discussed by Farrrell et al. (2015) an atom on the surface of a space-weathered planet will only execute a few oscillations before finding and becoming trapped in a deep potential well. Farrell et al. conclude based on observations of H and OH at the Moon that: "We point out that diffusion times of H migrating outward also apply to H migrating inward, deeper into the regolith. We have not investigated this possibility, but presume that the H trapped in a vacancy (high U) cannot easily migrate outward to space or inward to deeper locations. It is effectively trapped." This conclusion must apply to all species, not just H. "It is more likely that the loitering H retention is very mild (1% per lunation), and when it gets too large is offset by other loss processes like impact vaporization and sputtering."

W. M. Farrell, D.M. Hurley, M.I. Zimmerman, Solar wind implantation into lunar regolith: Hydrogen retention in a surface with defects. Icarus 255 (2015) 116–126

2. Thermal desorption: page 4 line 20:"The flux of thermally released Na atoms is given by n0vth, where vth is the mean speed." In fact the release must be integrated over the Boltzmann distribution.

3. Micro-meteorite vaporization

The reference to Borin et al, 2009 should be updated. I believe that this paper was revised and the flux was revised downward.

4. Sputtering; The reference to Collier et al. (2001) is mis-quoted. What they actually said was "Neutral particles in this energy range, which encompass most of the plasma in the heliosphere, can result when energetic particles charge exchange with the Earth's hydrogen geocorona."

Since Mercury does not have an extensive hydrogen corona with the density of the Earth's geocorona, this charge exchange is not going to happen at Mercury. The solar wind does not have a neutral component. The neutral's were measured inside the Earth's geocorona due to charge exchange.

5. Other comments

Page 1: The existence of oxygen: the Mariner 10 observations were generous upper limits. MESSENGER actually has a new limit of 2 R.

R. J. Vervack Jr., R. M. Killen, W. E. McClintock, A. W. Merkel, M. H. Burger, T. A. Cassidy, and M. Sarantos. New discoveries from MESSENGER and insights into Mercury's exosphere. Geophys. Res. Lett., 10.1002/2016GL071284

Page 2 line 4: MESSENGER also measured the sodium tail: McClintock, W. E. et al., Mercury's Exosphere: Observations During MESSENGER's First Mercury Flyby. Science 321, 92 - 94, 2008.

More recent observations were by Carl Schmidt et al.

Figure 2: The normalization of all sources to a column density of 1011 cm-2 at the surface is not realistic and is misleading.

Please also note the supplement to this comment:
https://www.ann-geophys-discuss.net/angeo-2018-109/angeo-2018-109-RC1-supplement.pdf

Interactive comment on Ann. Geophys. Discuss., https://doi.org/10.5194/angeo-2018-109, 2018.