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Solar Wind Interaction with the Lunar Surface: Observations by the Advanced Small Analyzer for Neutrals on the Rover of Chang'E-4

Martin Wieser (1), Stas Barabash (1), Xiao-Dong Wang (1), Charles Lue (1), Aibing Zhang (2), Chi Wang(3) and Wenjing Wang (2)
(1) Swedish Institute of Space Physics, Kiruna, Sweden (wieser@irf.se), (2) National Space Science Center (NSSC), Chinese Academy of Sciences (CAS), Beijing, China, (3) Chinese Academy of Sciences (CAS), Beijing, China

Abstract

The Advanced Small Analyzer for Neutrals (ASAN) is one of the international payloads onboard of the Chinese Yutu-2 rover that is part of the Chang'E-4 mission to the moon. ASAN measures energetic neutral atoms that are emitted from the lunar surface due to precipitating solar wind. ASAN measures these energetic neutral atoms with energy and mass resolution. Since the landing of Chang'E-4 on the lunar far-side on 3rd January 2019, ASAN is operated typically twice per lunar day. The mobility of the rover enables ASAN to investigate angular emission profiles and mass composition of the emitted neutral atoms from pristine regolith at different locations away from the lander itself.

1. Introduction

Solar wind precipitating onto the lunar surface results in the emission of energetic neutral atoms from the surface [1,2]. Emitted energetic neutral atoms consist of neutralized and backscattered solar wind protons and of sputtered surface materials. Observing energetic neutral atoms originating from neutralized solar wind protons allows to remotely observe where the solar wind precipitates onto the lunar surface[3]. The emitted sputtered population is a source population for the tenuous lunar exosphere and, given sufficient energy, escapes directly to space. As with all remote sensing methods, a ground truth measurement is critical to interpret the data. Also measurements directly on the surface allow to investigate the dependence of the energetic neutral atom emission process on local micro topography, something that can not be done from orbit due to limited spatial resolution.

2. The ASAN instrument

The ASAN instrument (Figure 1) is an 8th generation instrument of the *SWIM family* [4]. ASAN measures energetic neutral atoms in an energy range from 10eV to 10keV with an energy resolution dE/E between 16% and 100% depending on species and energy. The mass resolution of ASAN is sufficient to separate hydrogen, helium, oxygen and "heavies". The field of view of ASAN is a single angular pixel pointing to the lunar surface. The accommodation on the Yutu-2 rover of the Chang'E-4 mission allows investigating the energetic neutral atom emission properties of pristine lunar regolith, undisturbed by the landers retro rockets, at different locations. The mobility of the rover is also used to obtain different angular observation geometries relative to the impinging solar wind. A one-time operable cover protects the instrument aperture during the landing. ASAN consumes 3.4W of power and has a mass of 970g including harness.

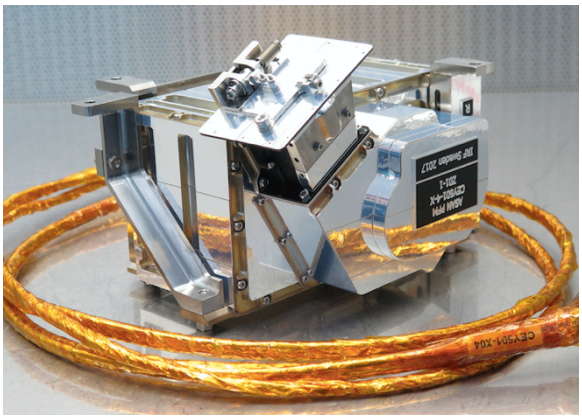

Figure 1: The ASAN instrument

The ASAN instrument was built and is operated in collaboration between the Swedish Institute of Space Physics (IRF) and the National Space Science Center (NSSC), Chinese Academy of Sciences (CAS).

3. First data

After the landing of Chang'E-4 on the lunar surface on January 3rd, 2019 in the *Von Kármán* crater on the lunar far side, ASAN was commissioned during the first lunar day and has since been operating in science mode typically twice per lunar day. An individual operation sequence lasts between 30 and 60 minutes, depending on payload operation constraints. The typical observed energy spectrum of energetic neutral atoms emitted from the lunar surface is compatible with what was observed from orbit by Chandrayaan-1 [1,3]. Analysis of the corresponding mass spectra shows that neutral hydrogen is the dominating component. So far a limited selection of angles between the instruments bore sight direction and the impinging solar wind has been covered. The full angular scattering function will be reconstructed as the mission progresses using further observations at different angular orientations. Additional observations will be used to investigate the dependence on solar wind conditions and local topography.

4. Summary

The ASAN instrument preformed the first energetic neutral atom measurements on the lunar surface-providing a crucial ground truth measurement. The instrument was at the time of writing operational for five lunar days and performs nominally.

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References

[1] Wieser, M. et al.: Extremely high reflection of solar wind protons as neutral hydrogen atoms from regolith in space. Planetary and Space Science, 57(14-15):2132 – 2134, 2009.

[2] McComas, D.J, et al.: Lunar backscatter and neutralization of the solar wind: First observations of neutral atoms from the moon. Geophys. Res. Lett., 36(12), 06 2009..

[3] Wieser, M. et al.: First observation of a mini-magnetosphere above a lunar magnetic anomaly using energetic neutral atoms. Geophys. Res. Lett., 37(5), 03 2010.

[4] Wieser, M. and Barabash, S.: A family for miniature, easily reconfigurable particle sensors for space plasma measurements. Journal of Geophysical Research: Space Physics, 121(12):11,588–11,604, 2016.