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The Advanced Small Analyzer for Neutrals (ASAN) on the rover of Chang'E-4

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1. Introduction

The Chang'E-4 mission to the Moon will be the first to land on the lunar far-side and of 2018. Chang'E-4 carries on its rover the Advanced Small Analyzer for Neutrals (ASAN), an energetic neutral atom (ENA) instrument built at the Swedish Institute of Space Physics in Kiruna, in collaboration with the National Space Science Center (NSSC) of the Chinese Academy of Sciences in Beijing, China.

2. Science background

The surface of the Moon is covered by regolith, a layer of finely powdered rock [1]. As the Moon only has a very tenuous atmosphere (or exosphere), the solar wind precipitates directly onto the surface where permitted to do so by magnetic fields. The solar wind interacts with the regolith by creating a zoo of secondary particles by different mechanisms that are then emitted from the surface: electrons, positive and negative ions and ENAs. The ENA emissions from the lunar surface have been characterized by the Sub-keV Atom Reflecting Analyzer (SARA), built by the Swedish Institute of Space Physics in Kiruna [2]. It opened a new field in remote sensing of the solar wind surface interaction. However, a ground truth measurement was missing.

3. Science objectives

The primary task of ASAN is to measure in-situ at the surface the energetic neutral atom and ion fluxes backscattered from the lunar surface. This will allow investigating the following high-level objectives:

- 1) The microphysics of the solar wind-surface interaction processes that result in the emission of ENAs and ions: An important process resulting in ENA production is direct backscattering of the precipitating solar wind. The SARA experiment revealed that the reflection coefficient for the solar wind protons neutralized on the surface is around 20% at the Moon [3]. This high ENA reflection yield from regolith and how it relates to the emission of ions is poorly understood.
- 2) The formation and maintenance of lunar exosphere: Sputtered ENAs may serve as a source for the tenuous but dynamic lunar exosphere [4]. Both the ions coming directly from the solar wind as well as energized lunar ions precipitate on Moon's surface, resulting in sputtering. Measurements of these ENAs are crucial for understanding the contribution of sputtering to the formation of Moon's or similar other solar system bodies' exosphere.

Since it is difficult or impossible to reproduce the lunar surface conditions in the laboratory, instrumentation placed on lunar landers is the only option to investigate these processes. Placed on the Chang'E-4 rover, ASAN will perform the first ENA measurements directly at the lunar surface.

4. Instrument status

On April 7, 2017, the Swedish Institute of Space Physics successfully delivered the flight model of the ASAN to NSSC. For a brief episode in January and February 2018, ASAN returned to IRF for additional environmental tests and recalibrations and was redelivered end of February 2018 to NSSC and has been reintegrated onto the spacecraft.

5. References

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