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ORBITAL NEUTRON MAPPING OF WATER CONTENT IN THE SHALLOW SUBSURFACE AROUND THE LUNAR SOUTH POLE

Abstract

The current space programs of many space agencies include steps towards to establish habitable bases or even villages on the surface of the Moon. The cost of creating and operating such a base can be significantly lower if it is located in a place where the regolith is rich in water ice. Because water can be used in a wide range of ways, from rocket fuel production to direct human consumption. One of the methods of remote sensing for hydrogen-bearing compounds, such as water ice, in the upper 1–2 m subsurface regolith layer of atmosphereless celestial bodies is the spectroscopy of the neutron leakage flux from the surface. To estimate water equivalent hydrogen (WEH) in the lunar regolith, we used data from the Lunar Exploration Neutron Detector (LEND) aboard the Lunar Reconnaissance Orbiter (LRO), which has been operating almost continuously in orbit around the Moon from 2009 to the present (Ref.1).

LEND is a collimated epithermal neutron telescope that uses a passive neutron collimator to collect primary part of the neutron signal in a narrow field of view. The dataset collected by LEND up to April 1, 2015 was previously used to estimate the water equivalent of hydrogen and create maps of its distribution (Ref.2). After approximately eight years of accumulating new data, we are updating the WEH map in the Southern circumpolar region. In addition to the updated data set, a new WEH estimation method was used to create the maps. The method is based on refined modeling of the neutron flux at different altitudes of the spacecraft orbit and on a refined model of the collimator's ability to absorb neutrons of various energies. This makes it possible to refine our estimate of the WEH concentration both in the permanently shadowed regions (PSR) and in the neutron suppression regions (NSR).

References:

1. Mitrofanov I. et al. (2010) Space Sci. Rev., 150, 183–207.
2. Sanin A. B. et al. (2017) Icarus, 283, 20-30.