A prospective Ukrainian Lunar Orbiter Mission "Ukrselena"

Yu. G. Shkuratov[1,2], L. M. Lytvynenko[2], Ya. S. Yatskiv[3],

[1]*Astronomical Institute of Kharkov V.N. Karazin National University, 35 Sumskaya St, 61022, Ukraine*
[2]*Radioastronomical Institute, NASU, 4 Chervonopraporova St, Kharkov, 61002, Ukraine*
[3]*The Main Astronomical Observatory, NASU, 27Akademika Zabolotnogo St, Kiev, 03680, Ukraine*

Participation of Ukraine in lunar exploration is considered as a prospective scientific goal. Ukraine has launched vehicles, which are able to deliver about 300 kg to lunar orbit. This means that at least 20-30 kg can be used for scientific payload. As a first step of the future Ukrainian lunar program, a lunar polar orbiter ("Ukrselena") could be proposed (Shkuratov et al. 2003). We consider here objectives of this prospective mission and its possible scientific payload.

After successful Clementine, Lunar Prospector, and Smart-l missions and planned missions to the Moon, like Lunar-A, Selene, Chandrayaan-1, and LRO a new polar orbiter should fill principal gaps in our knowledge on the evolution and geological history of the lunar surface and provide really new views of the Moon. We believe that such missing views can be provided by global radar studies of the Moon with supporting optical polarimetric observations from a nearly circular lunar polar orbit with an altitude of about 100 km. These new views are very important to understand structural properties of the lunar surface with implications to its geological evolution. We propose two main instruments for the prospective lunar orbiter. They are (1) a synthetic aperture imaging radar working in mm-range and (2) an imaging optical spectropolarimeter. Study of the Moon with these instruments addresses several important objectives.

One of the main purposes of the mission is to study the global distribution of surface roughness in mm-cm scales. This includes studying permanently shadowed areas in the lunar polar regions. These areas are cold traps for volatiles and have resource utilization potential. Unlike previous lunar missions (e.g., Clementine or Lunar Prospector which studied mainly chemical and mineral composition of the lunar surface, the Ukrainian spacecraft "Ukrselena" would aim to investigate structure properties of the lunar surface, which includes determination of average particle size of the regolith and examination of the arrangement of the regolith in mm-scales.

Photogeological studies with the synthetic aperture imaging radar working in mm-range have been never carried out from lunar orbit. The radar images give information about the surface density distribution of mm-cm debris and roughness. From a nearly circular polar orbit with a height of about 100 km a synthetic aperture imaging radar can potentially provide a uniform imaging the entire lunar surface with spatial resolution of about 50 m. Reliability of geological interpretation of synthetic aperture imaging radar data should be very high, as some lunar regions will be supplied with photopolarimetric optical data that can be used for comparison. In particular, the imaging will reveal sites with fresh rocky topography associated with recent impacts. Imaging with a synthetic aperture radar allows a restoration of 3-D lunar topography with high resolution, if radar data are obtained from different azimuthal angles for a given lunar region. This condition will be often met in the polar regions of the Moon.

Photometric properties (dependence of the surface brightness on illumination/observation geometry) are controlled by the centimeter- to submillimeter-scale structure of the uppermost regolith layer. Polarization degree at large ($\approx 90°$) phase angles bears the information about the characteristic size of the regolith particles (Shkuratov et al., 2007). In particular, there is a close correlation between the average size of particles of the lunar regolith and polarimetric parameters. This correlation can be used for calibration of polarimetric data in terms of the regolith particle size and maturity degree. We note that polarimetry of the lunar surface has never been carried out from spacecrafts. High resolution polarimetric and photometric imaging of the lunar surface could provide data on regolith maturation processes as well as on a consequence of different geological events.

Shkuratov, Yu. G., Lytvynenko, L. M., Shulga, V. M., Yatskiv, Ya. S., Vidmachenko, A. P., and Kislyuk, V. S. Objectives of a prospective Ukrainian orbiter mission to the moon. *Adv. Space Res*. 31, No. 11, 2341-2345. (2003).
Shkuratov, Yu., Opanasenko, N., Zubko, E., Grynko, Ye., Korokhin, V., Pieters, C., Videen, G., Mall, U., and Opanasenko, A. Multispectral polarimetry as a tool to investigate texture and chemistry of lunar regolith particles. *Icarus*, 187. 406–416. (2007).

PRINCIPAL AUTHOR'S BIO (~50 WORDS)

Yuriy G. Shkuratov graduated from Physics Department of Kharkov State University in 1975. He received his Ph.D. in mathematical physics and his Doctor of Sciences degree in physics and mathematics from Moscow and Kharkov State Universities in 1980 and 1993, respectively. His works devoted to photopolarimetric laboratory studies of particulate surfaces, theoretical investigations of shadow-hiding effects for the randomly rough surfaces, and planetary physics. He is professor and director of Astronomical Institute of Kharkov V.N. Karazin National University. He has over 500 publications.