ADDITIONAL CHARACTERIZATION OF MARTIAN REGOLITH ANALOGS USED FOR SPECTRAL IMAGING BY THE FACILITY OF OBSERVATORY MIDI-PYRÉNÉES. A. Ovcharenko¹, Yu. Shkuratov¹, P. Pinet², A. Cord², Y. Daydou². ¹Astronomical Observatory of Kharkov National University, 35 Sumskaya St, Kharkov, 310022, Ukraine, ²Laboratoire de Dynamique Terrestre et Planétaire (UMR5562/CNRS) Université P. Sabatier, Observatoire Midi-Pyrénées, Toulouse, France. E-mail: ovcharenko@astron.kharkov.ua

Introduction: A new spectral imaging facility, designed and settled at the Observatoire Midi-Pyrénées, Toulouse, France, has been used to acquire multispectral images of experimental targets with varied incidence and emergence angles, in the visible and near-infrared range [1,2]. The objectives of the studies with the facility are to model observations with spacecrafts orbiting planetary bodies [2]. The domain of geometries of observation investigated in the following is constrained by the instrument limitation. The incidence angle is selected between 0 and 55° and the emergence angle between -70° to 0 (azimuth angle 0) and 0 to 70° (azimuth angle 180°) with a minimum phase angle of 20°. This angular domain excludes opposition effect measurements. Meanwhile measurements in the range of small phase angles are important for adequate fitting calculated phase curves to experimental dependences that allows testing different theoretical models. To fill the gap in phase angle characterization of samples used for the imaging laboratory photometry, we exploit a laboratory photometer/polarimeter of Kharkov Astronomical Observatory (Ukraine) that allows investigations of the opposition effects. We choose three samples to obtain phase curves of brightness and polarization degree at small phase angles. The samples are Martian regolith analogs, which have been used for simulation with Hapke’s model [2]. This additional photometric and polarimetric characterization of the chosen samples provides useful information about their micro-texture.

Instrument, samples, and measurements: To study photometric properties of the samples we used the mentioned laboratory photometer/polarimeter [3]. This instrument allows measurements of phase curves of powdered samples illuminated by unpolarized light in the range of phase angle 0.2 – 17°. We measured the samples in two spectral bands, λ_eff = 0.63 µm and λ_eff = 0.45 µm. Albedos of the samples were determined with Halon [4], as a photometric standart at the phase angle 2°. Our polarimetric measurements have an accuracy of about 0.05%.

Three different types of basaltic materials were chosen [2]: (1) fresh unaltered basalt with some phenocrysts of olivine, pyroxene and plagioclase; (2) oxidized basaltic red-tephra containing few phenocrysts of plagioclase (the effect of iron oxidation also appears on the surface of Mars and hence this material may have spectral properties close to those of some Martian materials); (3) highly altered basalt, palagonitic-like material, labeled (this basalt has been intensively altered by low temperature water circulation, as it possibly occurs at the surface of Mars). Materials were crushed to give powders having a range of grain sizes less than 3 mm. The samples contain also small dust component.

Results and discussion: Results of our measurements are presented in Fig. 1-3. Fresh unalterred basalt, being spectrally almost neutral, has almost the same phase angle behaviors of brightness and polarization at red and blue rays. The sample demonstrates a very prominent opposition spike in the range of 0-6°. The amplitude of the spike reaches 30%. Such a value of the opposition effect is rather typical for planetary regolith and, in particular, for Martian surface [5]. The basalt sample shows a very conspicuous negative polarization branch with the inversion angle near 18° and |P_{min}| = 1.1%. This is also typical for planetary regolith, though the Martian surface has somewhat larger values of α_{inv} and α_{min}, respectively, 24° and 11° [6]. The pronounced opposition spike and negative polarization branch both are evidence of the fine internal microtexture of the sample particles, the characteristic scale of which is of the order of the wavelength [7].

Colored samples, tephra and palagonite, demonstrate appreciable difference between curves that correspond to different wavelengths. The opposition spike...
in both these cases is narrower in red light, in agreement with predictions of the coherent backscatter enhancement model that explicitly indicates decreasing the spike width with growing albedo of particulate surfaces [3]. The tephra sample has more prominent opposition effect (larger amplitude and width) than the basalt and palagonite samples. This indicates that tephra contains very small particles in large amount.

Surprising results have been obtained at measurements of the negative polarization. In red light the negative polarization branches of palagonite and tephra are shallower than in the case of blue rays. Moreover for palagonite the angle $\alpha_{\text{min}}$ shifts toward small phase angles. The values of the parameter $|P_{\text{min}}|$ for the tephra sample in red light are slightly not typical for the Martian surface and opposite for the palagonite sample $|P_{\text{min}}|$ is too high in blue rays. In general tephra has $\alpha_{\text{min}}$ appreciately larger than for the case of palagotite, approaching under extrapolation to the value for Mars, $\alpha_{\text{min}} = 24^\circ$. We note that so large value of $\alpha_{\text{min}}$ is not typical for laboratory modeling measurements. This has been obtained earlier only for very fine powders of $\text{Fe}_2\text{O}_3$ and this does not definitly occur for basalt powders [8].

\textbf{Conclusion:}
1. In general satisfactory agreement of the parameters of the photometric and polarimetric opposition effects for the Martian surface and the laboratory analogs shows that the choice of the samples was rather adequate.

2. In future these measurements will be used to additional control of the fitting Hapke’s parameters in the imaging laboratory photometry.

\textbf{Acknowledgments:} This work was partially supported by INTAS grant # 2000-0792.