Geophysical Research Abstracts
Vol. 17, EGU2015-11488, 2015
EGU General Assembly 2015

Broadband permittivity measurements on porous planetary regoliths simulants, in relation with the Rosetta mission to 67P/C-G

Yann BROUET (1), Anny-Chantal LEVASSEUR-REGOURD (2), Pierre ENCRENAZ (3), Pierre SABOUROUX (4), Essam HEGGY (5), Wlodek KOFMAN (6), and Nick THOMAS (1)

(1) University of Bern, Physics Institute, Bern, Switzerland, (2) UPMC (U. P. & M. Curie, Sorbonne Univ.), LATMOS, Paris, France, (3) Observatoire de Paris, LERMA, Paris, France, (4) Univ. Aix-Marseille, Institut Fresnel, Marseille, France, (5) NASA/JPL, CALTEC, Pasadena, CA, USA, (6) UFJ-Grenoble, IPAG, Grenoble, France

The Rosetta mission has successfully rendezvous comet 67P/Churyumov-Gerasimenko (hereafter 67P) last year and landed Philae module on its nucleus on 12 November it 2014. Among instruments onboard Rosetta, MIRO [1], composed of two radiometers, with receivers at 190 GHz and 563 GHz (center-band), is dedicated to the measurements of the subsurface and surface brightness temperatures. These values depend on the complex relative permittivity (hereafter permittivity) with ε' and ε" the real and imaginary parts. The permittivity of the material depends on frequency, bulk density/porosity, composition and temperature [2]. Considering the very low bulk density of 67P nucleus (about 450 kg.m-3 [3]) and the suspected presence of a dust mantle in many areas of the nucleus [4], investigations on the permittivity of porous granular samples are needed to support the interpretation of MIRO data, as well as of other microwave experiments onboard Rosetta, e.g. CONSERT [5], a bistatic penetrating radar working at 90 MHz.

We have developed a programme of permittivity measurements on porous granular samples over a frequency range from 50 MHz to 190 GHz under laboratory conditions (e.g. [6] and [7]). We present new results obtained on JSC-1A lunar soil simulant and ashes from Etna. The samples were split into several sub-samples with different size ranges covering a few to 500 μm. Bulk densities of the sub-samples were carefully measured and found to be in the 800-1400 kg.m-3 range. Sub-samples were also dried and volumetric moisture content was found to be below 0.6%. From 50 MHz to 6 GHz and at 190 GHz, the permittivity has been determined, respectively with a coaxial cell and with a quasi-optical bench mounted in transmission, both connected to a vector network analyzer. The results demonstrate the dispersive behaviours of ε' between 50 MHz and 190 GHz. Values of ε' remain within the 3.9-2.6 range for all sub-samples. At CONSERT frequency, ε" is within the 0.01-0.09 range for all sub-samples. The single-relaxation Debye model fits relatively well the global behaviour of ε' over the frequency range, thus validating the experimental setups and measurements obtained. Furthermore, results confirm that ε' decreases quasi-linearly with the decreasing bulk density at any frequency, as expected by the mixing formulae. Taking into account possible temperature variations within 67P nucleus [8] and the linear decrease of the permittivity with the temperature, as measured by [9] on JSC-1A sample, these results indicate that, on the near-surface of 67P covered by a free-ice dust mantle at the frequencies of MIRO and CONSERT, ε' is likely to be in the 1.1–1.8 range and ε" is likely to be below 0.05.

[1]Gulkis et al. (2007) SSR, 128, 561.
[2]Ulaby. and Long D. (2014) Univ. Michigan Press.
[3]Sierks et al. (2015), in prep.
[4]Thomas et al. (2015), in prep.
[5]Kofman et al. (2007) SSR, 128, 413.
[6]Brouet (2013), PhD Thesis, Univ. P. & M. Curie.
[7]Brouet et al. (2014) PSS, 103, 143.
[8]De Sanctis et al. (2005), A&A, 444, 605.
[9]Calla & Rathore (2012), ASR, 50, 1607