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Laboratory measurements of dielectric properties of compact and granular materials, in relation with Rosetta mission.

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The European Rosetta spacecraft (s/c), launched in 2004, will be the first s/c to orbit a comet and place a lander module on its surface. In 2014, the s/c will rendezvous with the comet 67P/Churyumov-Gerasimenko and place the lander on its surface thereby allowing in situ and remote sensing of the comet nucleus. Two radio experiments, one passive (MIRO [1]) and one active (CONSERT [2]), are aboard the Rosetta s/c. MIRO, composed of two radiometers, with center band frequencies at 190 GHz and at 563 GHz to determine the brightness temperatures of the target surfaces and sub-surfaces, has already observed asteroids (2867) Steins [3] and (21) Lutetia [4]. CONSERT will investigate the deep interior of the nucleus using 90 MHz radio-waves transmitted from the orbiter through the nucleus and returned to the orbiter from the lander.

To support interpretations of MIRO and CONSERT observations, a program of dielectric properties measurements is under development on a large range of frequencies encompassing those of the above-mentioned experiments. Several instruments for dielectric constant determination are available at IMS laboratory (Bordeaux, France): impedance analyzer, coaxial sensor, resonant cavities (measuring respectively at 100 MHz, 0.5-6 GHz, 1.2-13.4 GHz). Millimeter benches are available at both IMS and LERMA laboratories (measuring respectively at 30-110 GHz and 70-230 GHz). Taking into account the possible presence of regolith layers on the surface of asteroids or nuclei and the very low density of cometary nuclei [5], the dependence of the dielectric constant on the structure and porosity of given granular materials needs also to be investigated (while the thermal and hygrometric conditions are carefully monitored).

We have already reported measurements obtained on various meteorites, possibly representative of some asteroid surfaces [6, 7]. We will also report systematic measurements obtained on a large sample of pyroclastic deposits from Etna, providing different sizes distributions (i.e. surface to volume ratios), and possibly porosities. Dielectric constant determination at 190 GHz typically suggests that the real part of dielectric constant slowly increases with grain size: 2.86 $\pm$ 0.06, 2.96 $\pm$ 0.02 and 3.13 $\pm$ 0.05 for sizes respectively lower than 50 μm, between 50 and 160 μm and between 160 and 355 μm. Additional series of measurements on compact and granular samples of meteoritic analogues, such as carbonaceous chondrites are also to take place.

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