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Laboratory experiment simulating Martian surface observation with submillimeter-wave polarimetric radiometry

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Energies and materials exchange between the ground and atmosphere on Mars play important roles in the Martian general circulation. It is necessary to observe the spatial and temporal variability of the Martian surface from orbiter. However, it has been quite difficult to continually monitor the Mars surface in optical observation due to opaqueness of the Martian dust. Millimeter/submillimeter radiometers enable to observe the Martian surface through dust, though such measurement has never been conducted in planetary exploration. We assess the effectiveness of this observation method by laboratory experiment.

By observing millimeter/submillimeter emission from the Martian surface in several emission angles and two polarizations, we can derive physical temperatures, permittivity and roughness of the surface from brightness temperatures. In order to estimate each property from polarized brightness temperatures, we need to know relationship between emissivity or/and reflectivity in millimeter/submillimeter wave region and the parameters of surface.

We developed an experiment system to examine millimeter/submillimeter scattering and emission characteristics of the simulated Martian surface in a chamber. Measurement samples in the chamber are coolable at Martian surface temperature. The chamber is designed to measure emission of samples using a receiver and reflection of samples using a transmitter and a receiver. We can also obtain arbitrary-polarized emission with arbitrary incident angle by controlling mirrors in our system.

To discuss relationship between emission and surface parameters on the Martian surface, it is necessary to know influences of permittivity and surface roughness on the reflectivity. Therefore, we measured reflectance of Acrylic plate and Alumina grain at millimeter/submillimeter waves region. We discuss effects of permittivity and roughness on measured reflectivity of measurement samples in known polarization and incident angle. Moreover, we retrieve the permittivity and the roughness of sample from measured reflectivity. Using this measurement results, we expect a step closer to explanation of relationship between emission and surface parameters in the Martian surface at millimeter/submillimeter waves region.

Keywords: Mars, surface observation, submillimeter-wave