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Study of martian atmospheres by mid-infrared and submillimeter high-spectral resolution measurements: A search for SO2 in the martin atmosphere, and a development of the tuneable heterodyne infrared spectrometer

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With increased knowledge on our "neighbor" planets, based on recent aggressive explorations, our image on them is changing significantly. It is almost certain that Mars once had a duration warm and wet climate and that it still conserves a large amount of water (ice) under the surface. Mars is now called a "frozen water planet". Evolution of Mars is important for understanding the process to form the planetary environment for life. Japan launched NOZOMI in 1998 by the insertion to Mars orbit turned out to be unsuccessful. Recently, groups of enthusiastic people got together, to challenge the Mars exploration again. Mid-infrared and submillimeter range has a plenty of both main components and minor constituents of the planetary atmosphere (CO2,H2O,CH4,SO2,NH3,CO,H2O2), which is very important for understanding the atmospheric dynamics and variations. The common necessity is " a high spectral-resolution" (e.g., resolution power : $10\hat{7}$ = a few m/s in the velocity field).
Following recent report on ground-based observations by Krasnopolsky [2005] suggesting that currently there is no active volcanism on Mars and restricts the delivery of sulfur and other gasses into the atmosphere, we tried to verify them on the different season (Ls = 8.1) based on the ASTE submillimeter observations with a higher-spectral resolution than that in previous studies. The ASTE is located at an elevation of 4800m on the Atacama desert in the northern Chile, and consists of a 10–m diameter telescope. Our observations on 25 and 26 December from 0:00 to 5:00 UT employed the 345 Superconductor-Insulator Superconductor (SIS) Sideband Separating receivers, operating 330 - 360 GHz to observe the SO2 at a frequency of 346.5285 GHz, SO at a frequency of 346.5239 GHz, 12CO J = 3-2 at 345.7960 GHz, and 13CO J = 3-2 at 330.5880 GHz rotation transitions. A sensitive spectrum puts an upper limit on SO2 of 1 ppb. The evidence for seepage could not be found even in the season which more CH4 was detected. Additionally, to achieve highest spectral resolution and sensitivity as well as compact instrumentation in mid-infrared wavelength region, heterodyne systems are advantageous over direct-detection methods. We also report on successful development of the tuneable heterodyne infrared spectrometer. The main scientific goal of this instrument is to analyze highly resolved lineshape data of molecules to deduce physical parameters line wind velocities of height profiles of gases in either the martian atmosphere or other planetary atmosphere.