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Sensitivity study for the submillimeter-wave atmospheric emission sounder FIRE onboard a Martian orbiter

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The Far-Infrared Experiment, FIRE, is a submillimeter-wave atmospheric emission sounder proposed as an onboard scientific instrument of the future Japanese Mars exploration orbiter MELOS. The scientific goal of FIRE/MELOS is to understand the dust suspended meteorology of Mars. FIRE will observe key meteorological parameters without being hampered by the Martian dust opacity; such as atmospheric temperature profiles, atmospheric compositions and their isotopes, and wind velocity profiles. FIRE will also provide the local time dependency of these parameters.

This paper discusses the expected sensitivity of FIRE/MELOS under the basic instrumental design. The disk-mapping observation mode will be used to obtain the horizontal distribution of temperature and water vapor (H_2O) profiles. The temperature and H_2O abundance at the first scale height of the Martian atmosphere will be measured with a precision better than 1 K and 10%, respectively. The deuterated water (HDO) will be also detected with a zonally averaged data set. The limb-scanning observation will be performed when the MELOS orbiter is passing around the periareion. Such limb observations enable us to measure the vertical profiles of temperature, H_2O, HDO, and the line-of-sight wind velocity in a wide altitude range (up to 120 km, depending on the target) with a vertical resolution of 3-10 km.

Though the current basic design of FIRE/MELOS is optimized for the temperature sounding with the disk-mapping mode, we also discuss potential capability of FIRE for an extended sense of the Martian science: Its powerful ability to measure the diurnal variation of atmospheric minor gases promises new insight to Martian atmospheric chemistry; and the high sensitivity to the upper atmosphere will help us to understand the atmospheric escape on Mars.

Keywords: Mars, MELOS, FIRE, submillimeter-wave sounder