Near Infrared Hyperspectral Imager NIRS4/MacrOmega onboard MMX to investigate water cycle on Mars

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The water cycle on Mars and its response to environment variability such as temperature changes and dust activities are of prime importance on Mars environment. We already have plenty data for water vapor including horizontal/vertical distributions and seasonal changes through several Martian years, observed using the Thermal Emission Spectrometer (TES) onboard the Mars Global Surveyor (MGS), Planetary Fourier Spectrometer (PFS) onboard Mars Express (MEX), Spectroscopy for Investigation of Characteristics of the Atmosphere (SPICAM) onboard MEX, and Compact Reconnaissance Imaging Spectrometer for mars (MCS) onboard the Mass Reconnaissance Orbiter (MRO). All of these data sets were, however, often limited by the instantaneous field-of-view (FOV) of the instrument and the orbital motion of the spacecraft. The monitoring capability is still limited to their polar orbital periods (~7.5-hours in the case of MEX). It is noteworthy that Imaging Ultraviolet Spectrograph (IUVS) onboard NASA's Mars Atmosphere EvolutioN (MAVEN) recently showed unprecedented global view of Mars cloud formation and its rapid/extensive change during 7-hours. Hourly monitoring of global distribution is essential to understand the Mars climatology.
Important findings of recent studies are the significant water isotopic anomalies in Mars lower atmosphere. Strong water isotopic anomalies are unexpected from our current theories. This means a lack of our knowledge of water interaction between surface and atmosphere, and another water reservoirs in the subsurface. In fact, recent findings from space-born measurements, e.g. MRO, provide the strong evidences that liquid water flows intermittently (in a short time-scale) on present-day Mars. Questions about their global contributions still remain to be addressed.
We start a study on a sample return missions to a Martian moon to be launched in early 2020s (Mars Moon eXploration (MMX) mission). With this mission, we will give a boost to planetary science by adding new information on planetary formation and evolution processes in the part of the solar system linking its inner- and outer-part. Sample analysis/Remote sensing allows us to unveil the migration history of the small body that behaved as a capsule which carried water and organic compounds into the inner-solar system. The equatorial-orbit of the spacecraft around Mars also offers an interesting advantage to continuously observe Mars atmosphere from a global perspective. We aim to perform

hourly-measurements for global distribution of water vapor and water-ice cloud on Mars using Near Infrared Hyperspectral Imager NIRS4/MacrOmega onboard MMX, in order to identify the global circulation, subsurface-atmosphere-aerosol interactions, and its reservoirs of water.
After reaching Mars, the MMX spacecraft will enter an equatorial Phobos-orbit, a 9376 km altitude (2.76 Mars radii), and a ~7.6-hours duration. The equatorial orbit allows a wide global view of Mars disk and continuous monitoring over the three-years mission. NIRS4 provides the two-dimensional map with spectral features in the wavelength range between 0.9 and 3.6 micron, in which there are the attractive objectives of atmosphere, including water vapor, water-ice cloud, CO2-ice cloud, dust, carbon monoxide, molecular oxygen airglow, and carbon dioxide. The wavelength selection is performed using an Acousto Optical Tunable Filter (AOTF) located at the entrance optics. The spectral resolution depends on the bandwidth of the AOTF (~ 20 cm-1), which is suitable to retrieve the narrow feature of the atmospheric compounds. NIRS4/MacrOmega has an instantaneous FOV of 6°×6° (corresponding to 600km×600km) with 256×256 pixels, and uses a pivoting scan mirror for mapping. In this paper, we introduce the scientific capability and measurement sensitivity of NIRS4/MacrOmega. We expect "the first weather satellite on Mars" is an epoch-making to increase our understanding for Mars climatology.

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