Near infrared spectral imager MacrOmega onboard MMX to investigate martian atmosphere

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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.

Near infrared spectral imager MacrOmega will observe hydroxide or hydrated mineral absorptions on Phobos and Deimos in the wavelength of 2.7 and 3.2 micron. By analyzing the shape of the spectra, we will distinguish between water in hydrous silicate minerals, water molecules, and water ice particles. MacrOmega will also try to detect the absorption by organic matter in the wavelength range of 3.3 and 3.5 micron. These results will support efforts to answer the question of the origin of the martian moons, and identify whether they are satellites formed by a giant impact or asteroids captured by Mars. This instrument is based on MicrOmega onboard ExoMars rover and Hayabusa2 MASCOT and modified as a spectral imager.

The equatorial-orbit of the spacecraft around Mars also offers an interesting advantage to continuously observe Mars atmosphere from a global perspective. The latest space-born measurement, MAVEN/IUVS, showed unprecedented view of Mars diurnal cloud evolution within hours. Tharsis clouds begin the day much smaller than the width of the volcanoes, but merge together in the late afternoon to span up to 2000 kilometers (Schneider et al., 2017). We will aim to perform hourly-measurements for global distribution of atmospheric/surface compounds using MarcOmega, in order to investigate the cloud/dust formations, water cycle via surface-atmosphere interaction, dynamics, and compositions.

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. MacrOmega 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, adsorbed water in the regolith, 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. MacrOmega has an instantaneous FOV of 6x6 degree (corresponding to 600kmx600km) with 256x256 pixels, and uses a pivoting scan mirror for mapping. In this paper, we introduce the scientific capability and measurement sensitivity of the instrument. We expect the first weather satellite on Mars is an epoch-making to increase our understanding for Mars climatology.