ESA ExoMars Trace Gas Orbiter: Current status and the relationships to our Mars mission

Y. Kasaba, H. Nakagawa, T. Sakanoi (Tohoku Univ.), T. Iwata (ISAS), S. Aoki, M. Giuranna (IAPS, Italy), A. Vandaele (IASB, Belgium), O. Korabev (IKI, Russia)

ESA ExoMars Trace Gas Orbiter is just launched on 14 March 2016. This paper introduces the current status of this mission to our community, especially the ambitious of two high-dispersion spectrometer suites, NOMAD (PI: A.C. Vandaele [IASB, Belgium]) and ACS (PI: O. Korabev [IKI, Russia]). By both teams, the most deep survey for Martian trace gas covering the vertical distributions from the ground to the mesosphere in wide longitude / latitude areas by solar occultation (and possible limb) observations in next several years. The sensitivity level for minor elements achieved by TGO might not be easily achieved again in next several decades.

Their science targets have strong relationships to our recent Martian studies using ground-based facilities (Tohoku Univ. 40/60 cm at Haleakala, IRTF and Subaru at Mauna Kea, ASTE and ALMA at Atacama), SOFIA, and ESA Mars Express PFS (PI: M. Giuranna). Those activities are related to the search of Martian trace gas, like SO2, H2O2, HDO/H2O ratios, and background planetary waves and clouds/haze/dust variations. Those can potentially describe the Martian crust activities, the production of gas from the crust, chemical synthetic and loss processes in the atmosphere, the formation of haze and snow falls, including the recent mystery of Martian CH4 stories.

As the next of TGO, in Japan, the mission study for the possibilities of remote sensing observations associated with the Mars satellite sample return mission. For atmospheric observations, the main goal will be to understand the transport processes of water and dust, from the equatorial high orbit around Martian satellites. It potentially enable us the first continuous mapping of Martian global atmospheric distributions and its variations, e.g. water and CO2 clouds, dust, H2O gas, CO, airglows. Recent success of upper atmospheric studies by MAVEN in UV light and outflowing atmospheric components can also be connected by the monitoring of global lower atmospheric disturbances propagating to and connecting with the upper layers continuing to the solar wind interaction regions.
ESA ExoMars Trace Gas Orbiter: Current status (Launch: 14 March 2016) and the relationships to our Mars mission

Y. Kasaba (Tohoku Univ.)
H. Nakagawa, T. Sakanoi (Tohoku Univ.), T. Iwata (ISAS)
S. Aoki, M. Giuranna (IAPS, Italy)
A. Vandaele (IASB, Belgium), O. Korablesv (IKI, Russia)

2008 - now
Nozomi遗产 → Collaboration with IAPS for Mars Express --- Planetary Fourier Spectrometer

* Methane ![search of]
- SO₂ (for Crust activity -- CH₄ production?)
- H₂O (for Oxidation -- CH₄ loss?)

* H₂O & Aerosol cycles ![search of]
- HDO/H₂O ratio (water cycle)
- CO₂ cloud (gravity waves)

* Local Time variations ![search of]
- Thermal tides (planetary waves)
- Dust (daily variation)

[ ] IAPS]
Vittorio Formisano
Marco Giuranna
Shohei Aoki (Nov. 2014)

2016 Launch
ExoMars
EDL Demonstrator Module (EDM)

201712-202112
201603
201611
201712-202112

2018 Launch
The Rover
Landing Platform

ExoMars Project

- Orbit circular 120 min (40 min eclipse)
- Altitude 400 km (inclination 74 deg)
- 12 eclipses per day (12 ingress+12 egress)
**ExoMars Project**

**ExoMars**

**EMCS!**

**Limb radiometer!**

**MAGIE!**

**Wide-angle camera!**

**HiSCI!**

**High-resolution camera!**

- Mapping of sources; landing site selection

**UVIS!**

UVIS (0.20 – 0.65 µm) \( \frac{\lambda}{\Delta \lambda} \approx 250 \)

**IR!**

- IR (2.3 – 3.8 µm) \( \frac{\lambda}{\Delta \lambda} \approx 10,000 \)
  - IR (2.3 – 4.3 µm) \( \frac{\lambda}{\Delta \lambda} \approx 20,000 \)

**MATMOS!**

**High-resolution FT spectrometer!**

Infrared (2 – 12 µm) \( \frac{\lambda}{\Delta \lambda} \approx 130,000 \)

**EMCS!**

**Limb radiometer!**

- Monitoring of atmospheric structure, water and aerosols

**MAGIE!**

**Wide-angle camera!**

- Monitoring of clouds and ozone

**HiSCI!**

**High-resolution camera!**

- Mapping of sources; landing site selection

**FREND!**

**Collimated neutron detector!**

- Mapping of subsurface water

---

**Our current targets for Mars ~ Observations & Simulations ~**

**Global dynamics!**

- Dust Cycles
  - GCM, Thermal Tides etc.

- Vertical coupling
  - Gravity Waves etc.

- Mesosphere: wind & temperature

**Water / CO₂ Cycles!**

- Minor elements
  - H₂O & CO₂ clouds

- H₂O/HDO

- \(^{12}\)CO₂/\(^{13}\)CO₂

- H₂O₂ (with CH₄)

**with modeling studies & the development of Radiation-Transfer code**

**by MEX/PFS with MRO, …**

**ACS/IRIM - YES!**

with Wide LT-coverage

**by VEX/Sci., ISS/AirGlow (Earth), IRTF (Jup.)**

**NOMAD & ACS in UV & IR – YES!**

with Vertical res.

**by MAVEN**

**by MIR heterodyne, mm/submm**

(ground based MIR/mm/submm + Models)

**by MEX: PFS with OMEGA**

**NOMAD & ACS - YES!**

with higher spectral & vertical resolutions

**by SUBARU, (ALMA)**

**NOMAD & ACS: PERFECT!**

complete exploration!!

---

**ExoMars → MMX (Mars Satellite Exploration)**

As the follow up, possible atmospheric observations planned by Near IR Spectrometer & Mid IR Camera / Spectrometer would be summarized in MMX mission.

**可視カメラ**

- ダスト
- 霧
- 微弱発光

**近赤外分光撮像**

- 水蒸気
- ダスト、水雲
- 地表気压

**中間赤外カメラ(+)分光**

- ダスト、水雲
- 地表温度