

# The payloads of planetary physics research onboard China's First Mars Mission (Tianwen-1)

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Mars is not only our nearby but also the most Earth-like planetary neighbor. Scientific exploration of Mars is thus of crucial value to our understanding of the solar system. The existence of abundant evidence for the former presence of water on Mars demands further exploration for signs of life on our sister planet, and investigations that could shed light on conditions favorable to the origin of life.

For nearly 60 years, humans have conducted orbitally-based remote sensing and *in-situ* surface exploration of Mars, leading to many significant scientific discoveries. But much remains to be done before we can be sure that we truly and fully understand Mars. Key research topics include the history of water on Mars and how that history relates to the planet's habitable environment — past, present, and future; the distribution and evolution of water-bearing and evaporative salt minerals on the planet's surface; the history of volcanic activity on Mars; the Martian magnetic field and its effect on the escape of water and atmosphere from the planet; interactions between the solar wind and the Martian atmosphere and ionosphere; atmospheric characteristics and climate change on Mars; and so on (Li CL et al., 2018; Liu JJ et al., 2018). Based on the above scientific questions about life, climate, and geology on Mars, the international planetary science community has formulated ambitious Mars exploration programs.

In 2016, China announced extension of its planetary exploration program beyond the Earth–Moon system (Wei Y et al., 2018). Benefiting from the engineering heritage of China's lunar exploration program (Li CL et al., 2019), the Chinese national strategy set Mars as the next target for planetary exploration (Wan WX et al., 2020). China's first Mars mission, namely Tianwen-1, aims to complete orbiting, landing, and roving in one mission (Li CL et al., 2018; Liu JJ et al., 2018). Orbiting exploration will establish an

overall and integrated scientific picture of the planet through global, systematic remote sense observation. Landing patrol exploration, on the other hand, focuses on highly-accurate high-resolution exploration and *in-situ* analysis of key areas on the Martian surface.

To accomplish these objectives, the orbiter of China's first Mars exploration mission is equipped with seven payloads, including a Moderate Resolution Imaging Camera (MoRIC), a High Resolution Imaging Camera (HiRIC), a Mars Orbiter Scientific Investigation Radar (MOSIR), a Mars Mineralogical Spectrometer (MMS), a Mars Orbiter Magnetometer (MOMAG), a Mars Ion and Neutral Particle Analyzer (MINPA), and a Mars Energetic Particles Analyzer (MEPA). The mission's rover is equipped with six payloads, including a Mars surface Composition Detector (MarSCoDe), a Multispectral Camera (MSCam), a Navigation and Terrain Camera (NaTeCam), a Rover-mounted Subsurface Penetrating Radar (RoSPR), a Mars Rover Magnetometer (RoMAG), and a Mars Climate Station (MCS). Through independent explorations by the orbiter and the rover, as well as coordinated detections based on data simultaneously collected in orbit and on ground, scientific understanding of the Martian surface morphology, soil characteristics, material composition, water-ice, atmospheric ionosphere, and magnetic field can be realized. In terms of Mars space physics and exploration of the planet's space environment, data from the MINPA, MEPA, MOMAG, and even from the low-frequency radio receiver equipment carried by the orbiting spacecraft, can be combined with data from the RoMAG and MCS instruments on the rover to implement joint field and particle detections. In this way, we can systematically study the Martian atmosphere and ionosphere and their interactions with solar wind, and further reveal characteristics and evolution of the Martian space environment.

This EPP special issue systematically introduces the scientific goals, technical indicators, system design, calibration, and ground tests of six payloads, including the MINPA (Kong LG, 2020), MEPA (Tang SW, 2020), and MOMAG (Liu K, 2020) carried by the orbiter, and the MoRIC (Yu GB, 2020), RoSPR (Zhou B, 2020), and MCS

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(Peng YQ, 2020) mounted on the rover. We hope that publication of these technical papers describing details of China's first Mars exploration mission will facilitate production of "early, quick, and good scientific results".

**Postscript:** We are extremely sad that Prof. Weixing Wan, the Chief Scientist of Tianwen-1 and Editor-in-Chief of EPP, was unable to see this special issue through to completion, and to witness the launch of Tianwen-1. Regrettably, he passed away just several weeks before the launch date. (Chinese Geophysical Society, 2020; Wei Y, 2020). Prof. Wan was widely respected for his own scientific breakthroughs and for his leadership of an entire scientific community. The present and many future generations of the planetary community will long continue to benefit from his legacy. He will be greatly missed for his outstanding scientific achievements and his noble personality.

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