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PREFACE

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Special issue "Martian Moons eXploration: the scientific investigations of Mars and its moons"

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Martian Moons eXploration (MMX) marks the third sample return mission led by the Japan Aerospace Exploration Agency (JAXA), succeeding the Hayabusa and Hayabusa 2 missions. The MMX spacecraft aims to extensively observe two Martian moons (Phobos and Deimos) and Mars over 3 years, and collect samples from Phobos for return to Earth. The major scientific objectives of the MMX mission are to solve the origin of the two moons, to elucidate the early Solar System evolution, and to explore the evolutionary processes of both moons and Mars surface environment. This first special issue for the MMX mission is dedicated to the current status of the MMX mission, such as the science instruments aboard MMX, the mission plan, and the strategies to achieve the scientific objectives.

Kuramoto et al. (2022) overviewed the current design of the MMX mission, focusing on the scientific objectives and the mission requirements. To achieve those objectives, the MMX spacecraft is equipped with 7 scientific instruments, 1 rover, and 2 sampling systems. Kameda et al. (2021) described a telescopic camera, TENGOO (TElescopic Nadir imager for GeOmOrphology), and wide-angle multiband camera, OROCHI (Optical RadiOmeter composed of CHromatic Imagers). Senshu et al. (2021) presented a laser altimeter, LIDAR (LIgiht Detection And Ranging). Barucci et al. (2021) presented a near-infrared spectrometer, MIRS (MMX InfraRed Spectrometer), which is built at LESIA-Paris Observatory. Chabot et al. (2021) presented a NASA-funded gamma-ray and neutron spectrometer, MEGANE (Mars-moon Exploration with GAmma rays and NEutrons). Yokota et al. (2021) described an ion mass spectrometer, MSA (Mass Spectrum Analyzer). Kobayashi et al. (2018) described a dust counter, CMDM (Circum-Martian Dust Monitor), and its implication was presented in Krüger et al. (2021). The MMX spacecraft is also equipped with a rover developed by CNES and DLR (Michel et al. 2022) with a Raman spectrometer, RAX (Cho et al. 2021). Two independent sampling systems using coring and pneumatic samplers will be employed on the MMX spacecraft (Usui et al. 2020).

Nakamura et al. (2021) summarized the current scientific operation plan for 3 years, including the close-up observations of Phobos, rover delivery to Phobos, two touch down events for sample collection, observation of Mars (Ogohara et al. 2022), and the flyby observation of Deimos. Matsumoto et al. (2021) reviewed recent geodetic observations of Phobos, and showed the strategies for the geodetic observations during the MMX mission. High-resolution shape models of Phobos and Deimos were presented in Ernst et al. (2023). Fujiya et al. (2021) presented the design of analytical protocols for the returned Phobos samples to reveal the origin of the Martian moons as well as the evolution of the Mars-moons system.

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In addition, Miyamoto et al. (2021) reviewed the surface environment of Phobos and showed the development of simulated soil materials of Phobos. Takemura et al. (2021) summarized typical geological features of Phobos and discussed the topographic irregularities and the engineering safety for the landing sites. Sefton-Nash et al. (2021) discussed the possibility of Phobos for an exploration platform on Phobos in the future.

While JAXA leads the MMX mission, some instruments, observational planning and execution are shaped by extensive international collaborations, fostering a collective effort in advancing our understanding of Mars and its moons system. The new knowledge brought forth by the MMX mission is poised to carve out new horizons in future research and exploration activities. The pursuit of the unknown will continue to drive the journey of science and exploration.

Author contribution

All authors of this article served as guest editors for this special issue. HG drafted the manuscript. All authors read and approved the final manuscript.

Data availability

Not applicable.

Declarations

Competing interests

The authors declare that they have no competing interests.

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