Scientific exploration of Mars by first Indian interplanetary space probe: Mars Orbiter Mission

On 24 September 2014 India became the first country to put an interplanetary space probe around Mars in her first attempt. Mars Orbiter Mission, popularly known as MOM, was earlier launched from Sriharikota using a Polar Satellite Launch Vehicle (PSLV) rocket on 5 November 2013. After a cruise phase of 300 days in the heliocentric orbit, MOM is now going around Mars in an elliptical orbit. The spacecraft is now circling Mars in an orbit whose nearest point to Mars (periapsis) is at 424 km and farthest point (apoapsis) at 77,098 km. The inclination of orbit with respect to the equatorial plane of Mars is ~150 degree, as intended. In this orbit, the spacecraft takes ~73 h to go round the Mars once. The objectives of the MOM included, design and realization of an interplanetary spacecraft with a capability to survive and perform Earth-bound manoeuvres, cruise phase, Mars orbit insertion, and on-orbit phase around the Mars. MOM is designed to explore surface of Mars and its atmosphere.

The scientific exploration of Mars is driven by key science questions such as whether Mars was, is or can be a habitable world. This requires observations on geologic, climatic and atmospheric processes acting on Mars. Considering these requirements, five scientific payloads were selected, designed and developed and are currently operating from Martian orbit. Out of these five instruments, two are providing information about the Martian atmosphere; the other two payloads are to provide information about the Martian surface and the fifth instrument will measure particle environment in exosphere of Mars.

Mars Colour Camera (MCC) is an electro-optical sensor imaging surface of Mars in three colours, varying spatial resolution between 25 m to 4 km in 16 different exposure modes, depending on its position in orbital plane and illumination conditions[1]. The camera is already beaming high-quality images of Mars surface. Figure 1 shows the full disc of the Mars captured from an altitude of 74,580 km at ~4 km spatial resolution showing various morphological features and thin clouds in the atmosphere of Mars. Important science objectives of MCC include studying morphology of landforms, dynamic processes such as dust storms and polar ice cap variability in different seasons. Figure 2 is a higher resolution image from MCC (~300 m spatial resolution) taken from 7300 km altitude, over the Syrtis Major region of Mars imaged on the first day itself. The

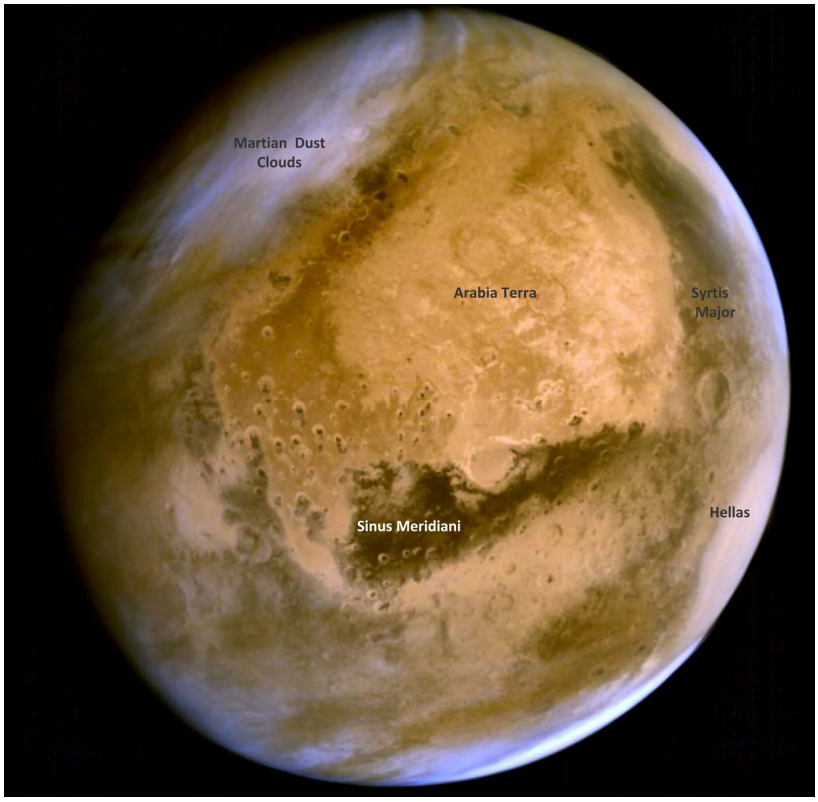

Figure 1. Full disc of Mars captured by MCC on-board Mars Orbiter Mission on 28 September 2014, showing Martian clouds, Arabia Terra, Sinus Meridiani, Syrtis Major and part of Hellas basin on the surface of Mars.

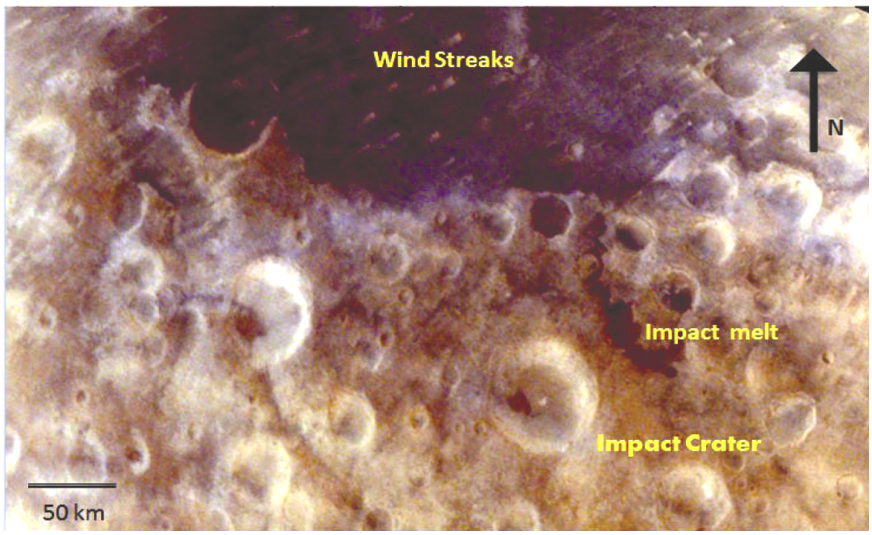

Figure 2. High resolution image of the part of Syrtis Major Planum of Mars taken on 24 September 2014 from an altitude of 7300 km showing various morphological features on Mars surface.

image shows impact craters at the southwestern edge of Syrtis Major. Syrtis Major Planum is a 'dark spot' which is considered to be a low-level shield volcano built almost entirely of lava flows and having basaltic rocks. The dark coloured regions in Figure 2 are exposures of basalts, while the red colour regions show dust-covered areas. The image also reveals streaks being blown out of craters, known as wind streaks, indicating that the wind is moving in a southwest direction. Thermal Infrared Imaging Spectrometer (TIS) instrument is aimed to observe thermal emission from Mars surface to detect its temperature and hot spot regions or hydrothermal vents on Martian surface. The TIS is designed to observe emitted infrared radiation from Martian environment in 7–13 μm region of electromagnetic spectrum using micro bolometer device.

Methane Sensor for Mars (MSM) is a differential radiometer based on Fabry–Perot Etalon filters to measure columnar methane (CH_4) in the Martian atmosphere at several parts per billion (ppb) levels. This differential signal gives a measure of columnar amount of CH_4. The possible finding of methane in Martian atmosphere will provide clues about the presence of life on Mars. Lyman Alpha Photometer (LAP) instrument onboard MOM is an absorption cell photometer. It measures the relative abundance of deuterium (D) and hydrogen (H) from Lyman Alpha emissions in the upper atmosphere of Mars. Measurements of D/H ratio will allow us to understand the water loss process from Mars surface through the atmosphere.

Mars Exospheric Neutral Composition Analyser (MENCA) is a quadrupole mass spectrometer covering the mass range of 1–300 amu with mass resolution of 0.5 amu. MENCA, weighing 4 kg, would provide *in-situ* measurement of the neutral composition and density distribution of Martian exosphere. All the five instruments will be making extensive and carefully planned measurements during the expected mission time of six months. MCC, MSM and TIS will also provide complementary information to interpret the data, e.g. MCC will be used for dust optical thickness estimation to correct for atmospheric scattering in MSM data for accurate estimation of methane. MCC will also provide context information and TIS will give information about surface temperature to analyse MSM data.

MOM instruments will have a unique opportunity to observe the closest approach of the Comet Siding Spring (C1 2013 A1) on 19 October 2014. The comet will pass around ~137,000 km from Mars during this time. The Comet Siding Spring is an Oort cloud comet discovered on 3 January 2013 and will pass through the inner solar system for the first time after its discovery. The main objective of MOM-based observations will be to study the size and shape of the comet, its brightness changes using MCC camera. MSM will be used to detect methane and CO_2 concentration within the Comet. MENCA is expected to detect changes in the neutral environment in exosphere of Mars, subsequent to the passage of the Comet Siding spring. This natural opportunity will further add to the planned science from MOM.

1. Arya, A. S. and Kiran Kumar, A. S., *Curr. Sci.*, 2014, **106**(5), 661.

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MEETING REPORT

Technological empowerment of women and scientific paper writing*

Science & Technology is the vehicle of societal development and play a vital role in the developmental activities. The Uttarakhand State Council for Science & Technology (UCOST), Dehradun has been putting its efforts to develop scientific temper in the state. Science popularization, training and workshops are prominent tools by which UCOST is inculcating science in the society and young scientist in particular. UCOST has established local chapter of the National Academy of Sciences, India (NASI) in the state.

Vijay Kumar Dhaundiyal (Department of Science & Technology, Govt of Uttarakhand) welcomed the guests and participants. R. C. Joshi (Graphic Era University, Dehradun) addressed the gathering wherein he emphasized on radical and incremental innovation. He said that incremental innovation is the contemporary thrust area of research in every field of science and technology. Illustrating the role of NASI for the nation, Manju Sharma (formerly, Dept of Biotechnology, New Delhi), spoke that in spite of being a significant contributor in growth and development of a nation, the condition of the women is still not good, particularly in the developing world. She stressed that our motto should be on ensuring maximum involvement of women in the field of S&T. She said that women are part and parcel of nation building and they themselves should come forward to take challenges. She further explained that research should be carried out keeping three P's in mind, i.e. Product development, Patent and Publication (PPP) and the developed product should be sustainable, economically viable and environmentally friendly. Finally, she said that S&T is the major vehicle for societal transformation. A. N. Purohit (NASI–Uttarakhand Chapter) told that students should not be disheartened with the rejection of research papers. He suggested acknowledging the

*A report on the two-day workshop on 'Technological Empowerment of Women and Scientific Paper Writing'. The workshop was organized by the NASI–Uttarakhand Chapter and Uttarakhand State Council for Science & Technology, Dehradun on 17 and 18 June 2014 at Graphic Era University, Dehradun.