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The European Robotic Exploration of the Planet Mars

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The ESA Mars Express mission was launched in June 2003 and has been orbiting Mars for over seven years providing data with an unprecedented spatial and spectral resolution on the surface, subsurface, atmosphere and ionosphere of the red planet. The main theme of the mission is the search for water in its various states everywhere on the planet by all instruments using different techniques. The mission is still a huge success, helping rewrite our understanding of the evolution of Mars.
Mars Express will be followed by the joint ESA-NASA Mars Exploration Programme, starting in 2016 with the Trace Gases Orbiter focusing on atmospheric trace gases and in particular methane. ESA's ExoMars together with NASA's MAX-C rovers will follow in 2018 to perform geochemical and exobiological measurements on the surface and the subsurface. Then in 2020 and beyond, a Network of 3-6 surface stations would be launched (possibly including other space agencies), in order to investigate the interior of the planet, its rotational parameters, its atmospheric dynamics and the geology and mineralogy of each landing site.
Such Mars Network (combined with an orbiter) represents a unique tool to perform new investigations of Mars, which could not be addressed by other means. In particular, i) the internal geophysical aspects concern the structure and dynamics of the interior of Mars including the state of the core and composition of the mantle; the fine structure of the crust including its paleomagnetic anomalies; ii) the rotational parameters and dynamics (axis tilt, precession, nutation, etc) that define both the state of the interior and the climate evolution; iii) the atmospheric physics aspects concern the general circulation and its forcing factors; the time variability cycles of the transport of volatiles, water and dust; surface-atmosphere interactions and overall meteorology and climate; iv) the geology of each landing site concerns the full characterization of the surrounding area including petrological rock types, chemical and mineralogical sample analysis, erosion, oxidation and weathering processes to infer the geological history of the region, as well as the astrobiological potential of each site. To complement the science gained from the Martian surface, investigations need to be carried out from orbit in a coordinated manner, such as i) global atmospheric mapping to study weather patterns, opacity and chemical composition; ii) a detailed map of the crustal magnetic anomalies from lower orbit (150 km); iii) study of these magnetic anomalies need to be studied in light of the magnetic field induced by the solar wind interaction with the upper atmosphere of the planet. The Network Mission concept is based on the fact that some important science goals on any given terrestrial planet can only be achieved with simultaneous measurements from a number of landers located on the surface of the planet (primarily internal geophysics, geodesy and meteorology) coupled to an orbiter.
The long-term goal of Mars robotic exploration in Europe remains the return of rock and soil samples from the Martian surface before eventually Humans go to Mars in this century.