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Mars-Moons Exploration, Reconnaissance and Landed Investigation

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MERLIN, the Mars-Moons Exploration, Reconnaissance and Landed Investigation, is a NASA Discovery mission proposal to explore the moons of Mars, and to conduct the first landed measurements on the surface of Phobos. Previous Mars-focused spacecraft have provided only enough information to raise fundamental questions about the Martian moons: What are their origins and compositions? Why do the moons resemble primitive outer solar system D-type objects? MERLIN answers these questions, revolutionizing knowledge of the Martian moons and providing key information to understand the evolution of the solar system. MERLIN's mission begins with reconnaissance of Deimos and investigation of the hypothesized Martian dust belts. Extensive orbital reconnaissance of Phobos occurs, followed by low flyovers to characterize a landing site. MERLIN lands on Phobos, conducting a 90-day investigation. Radiation measurements are acquired throughout all mission phases. Phobos' size and mass provide a low-risk landing environment for NASA's first dedicated small body lander. Controlled descent is so slow that the landing is rehearsed and can be repeated, yet gravity is high enough that surface operations do not require anchoring. Imaging of Phobos from past missions demonstrates the existence of regions suitable for landing, and provides knowledge for planning the orbital and landed investigations. MERLIN's payload leverages past NASA investments. Orbital multispectral imaging is accomplished by DAPHNI (Deimos and Phobos Navigation and Imaging), rebuilt from MESSENGER/MDIS. The Martian dust environment is measured by MDEX (Mars System Dust Experiment), the refurbished LADEE/LDEX engineering model, and the radiation environment by MPIRE (MERLIN-Phobos Ionizing Radiation Experiment), the flight spare of LRO/CRaTER. The landed workspace is characterized by OpsCam (Operations Camera), updated from MER/HazCam. MERLIN's arm, which guarantees successful placement of landed instrumentation, uses proven designs from MER, Phoenix, and MSL. Elemental measurements are acquired by an APXS (Alpha-Particle X-ray Spectrometer), modified from Rosetta/APXS, and S-GRS (Scintillator Gamma Ray Spectrometer), a simple low-cost instrument based on GRS experience from many planetary missions. Mineralogical measurements are acquired by M6 (MERLIN Mars Moon Microspectrometer/Microimager for Mineralogy), with heritage from M3 and developed under the MatISSE program. MERLIN delivers seminal science traceable to NASA's Strategic Goals and Objectives, Science Plan, and the Decadal Survey. MERLIN's landed compositional measurements unravel the origin of the Martian moons, addressing the goal to understand how solar system objects formed and evolved. MERLIN determines the inventory of water- and carbon-bearing materials on Phobos, addressing NASA's goals focused on the distribution of volatiles and organics across the solar system, and the origin and requirements of life. MERLIN characterizes the geology, regolith, and internal structure of Mars' moons, addressing NASA's goal of understanding the processes shaping planetary bodies and how those processes operate and interact. MERLIN's science-driven investigations also provide insight into the Martian particulate and radiation environment, Phobos' surface composition and fine-scale regolith properties, and Phobos' inventory of in situ resources, filling strategic knowledge gaps to pioneer the way for future human exploration of the Mars system. MERLIN demonstrates Deep Space Optical Communications (DSOC) from Mars orbit, further advancing NASA's human exploration goals.