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News & Highlights

A New Lander on Mars

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On 26 November 2018, Mars welcomed a new visitor: the National Aeronautics and Space Administration (NASA)'s InSight lander. After barreling through the Martian atmosphere at 5.5 km·s^{-1} and withstanding temperatures of 1500 °C, the capsule containing the lander deployed its parachute. At a distance of 9.2 km from the surface, it released its heat shield, exposing the lander's legs. A couple of minutes later, the capsule dropped the lander into a free fall. With the aid of pulsed retrorockets, InSight settled onto Elysium Planitia, a flat, moderately barren patch of land 4.5° north of the Martian equator. Over the next few weeks, the spacecraft surveyed its new surroundings, checked its systems, took a selfie (Fig. 1), and got to work.

InSight will spend one Martian year (or about two Earth years) probing the depths of Mars and studying the planet's interior structure, composition, and overall properties. "This is the first mission to another planet specifically designed to look at the interior of the planet," said Paul Morgan, a geothermal geologist at the Colorado Geological Survey and a member of the InSight science team. The mission will help scientists better understand the formation and evolution of Mars, as well as other rocky planets. "Through gaining knowledge of the interior of Mars, we believe that we will learn about the early history of the Earth," he said.

One of InSight's primary tools for fulfilling this mission is its seismometer (SEIS), which is designed to detect "marsquakes," meteorite impacts, and even the gravitational effects from Mars' moon Phobos. By measuring the speed and timing of their associated seismic waves, scientists can uncover details of the planet's interior structure. After one Martian year, the researchers hope to have enough information to generate an accurate description of the planet's crust, mantle, and core, said Sébastien de Raucourt, an InSight team member and a research engineer at the Institut de Physique du Globe de Paris (i.e., Paris Institute of Earth Physics). Seismology enabled scientists to understand Earth's interior in the first half of the 20th century, he said. "Our goal is to do the same with Mars."

A few weeks after landing, InSight's robotic arm placed SEIS on the surface—a first-time task for a planetary mission—making it the first seismometer on Mars since 1976, when the Viking landers carried ones that were less sophisticated and did not directly touch the planet's surface. Exquisitely sensitive, SEIS can detect ground motions smaller than the diameter of a hydrogen atom [1].

To protect it from noise, the instrument is housed inside a vacuum-sealed titanium sphere that is, in turn, encased in an insulating box. After setting SEIS on the surface, InSight's arm covered it with a protective dome to shield it from wind and temperature variations that can swing 94 °C in a single Martian day. The instrument itself was also designed with some components that contract and others that expand with temperature, canceling out some of the effects of temperature changes [2].

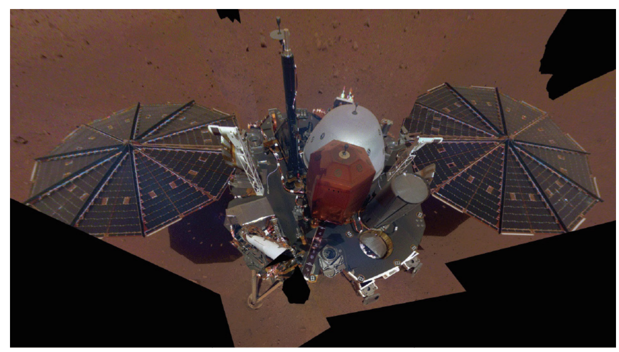

Fig. 1. NASA Mars lander InSight's first complete selfie taken on 6 December 2018, its 10th day on Mars. The image shows the lander's solar panels, science instruments, weather sensor booms, and ultrahigh frequency (UHF) antenna. Credit: NASA/JPL-Caltech.

In February 2019, InSight deployed its second off-deck instrument onto the surface, a subsurface temperature-taking tool called the Heat Flow and Physical Properties Package (HP^3) [3]. The device weighs only 3 kg and runs on a maximum of 2 W, yet it is powerful enough to hammer deep into the Red Planet's surface, up to 5 m underground [4]. Over the course of as many as 40 d, the instrument will systematically penetrate deeper into the ground, taking the planet's internal temperature and measuring thermal conductivity along the way. Mars' internal heat originates from the planet's formation and the decay of unstable isotopes of uranium, thorium, and potassium, and drives the planet's geological activity as it travels from the core outward. An accurate measurement of the heat flux escaping the core should help constrain models for the planet's past and future evolution.

To learn even more about the core, InSight will use its radio connection with Earth to track the planet's wobbling about its rotation axis. NASA's Deep Space Network, with radio dishes in Australia, Spain, and the United States (in California), will follow InSight's location to measure Mars' long-term precession and short-term

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nutations, helping scientists determine the size and density of the core—and how much of it is molten. Previously, NASA's Pathfinder and Viking landers collected data that suggest the core is quite dense, and NASA's Mars Global Surveyor orbiter detected evidence for a molten outer portion of the core. InSight will monitor Martian wobbling throughout its mission, providing the long-term tracking that is crucial for more precise measurements [1].

In addition to these three primary tools, InSight also deploys two cameras—one on its robotic arm and another beneath its deck—and carries an auxiliary payload sensor subsystem. The latter monitors the local magnetic field, wind, temperature, and air pressure, helping scientists to identify sources of noise that the main instruments may pick up. Already up and running, the subsystem also serves as a weather station that lets anyone check the Martian weather online [5].

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