

The Mercury Atmospheric and Surface Composition Spectrometer (MASCS)

1. Instrument Overview

The Mercury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) mission was designed to orbit Mercury following one Earth flyby, two of Venus, and three of Mercury. It launched in August 2004 and achieved orbit insertion around Mercury on 18 March 2011. Initial data collection began during the three flybys of Mercury and consisted primarily of global mapping and measurements of the surface, atmosphere, and magnetosphere composition. The nominal one-Earth-year long mission ended on 17 March 2012. This was immediately followed by the start of a one-year-long extended mission. A second and final two-year-long second extended mission ended on 30 April, 2015, when the MESSENGER spacecraft impacted the surface as expected. MESSENGER orbital observations provide data to answer questions about the nature and composition of Mercury's crust, tectonic history, structure of the atmosphere/magnetosphere, and the nature of the polar caps.

The Mercury Atmospheric and Surface Composition Spectrometer (MASCS) is comprised of a small Cassegrain telescope with a 257-mm effective focal length and a 50-mm aperture that simultaneously feeds both an UltraViolet and Visible Spectrometer (UVVS) and a Visible and InfraRed Spectrograph (VIRS). MASCS investigates Mercury's exosphere by measuring altitude profiles of known species as well as searching for previously undetected species. MASCS investigates the mineralogical composition of the surface of Mercury by obtaining maps of surface reflectance spectra on spatial scales of 5 km.

UVVS is a scanning grating, Ebert-Fastie monochromator with a focal length of 125-mm and is equipped with three photomultiplier tube detectors. The three detectors cover the wavelength ranges of the far ultraviolet (115-180 nm), middle ultraviolet (160-320 nm), and visible (250-600 nm) with an average spectral resolution of 0.6 nm. Two of the three photomultiplier tubes can be operated simultaneously; any combination of two is possible.

The UVVS instrument helps determine the composition of Mercury's exosphere by measuring the spatial and vertical distribution of known species (H, O, Na, K, and Ca) as well as previously undetected but predicted species (e.g. S, Si, Al, Mg, Fe, and OH). In addition to determining the composition and structure of the exosphere, these data provide the basis for determining exospheric processes, studying the relationship between surface and exospheric composition, and studying surface-exosphere-magnetosphere interactions.

VIRS is a fixed concave grating spectrograph with a 210-mm focal length. A beam splitter simultaneously disperses the spectrum onto two solid-state array detectors: a 512-element silicon photodiode array, with a sensitivity to visible wavelengths (300-1050 nm), and 256-element indium-gallium-arsenide photodiode array, to measure near infrared wavelengths (850-1450 nm). It is optimized to measure visible and near infrared surface reflectance, and VIRS obtains data with a resolution of 5 nm. Together, the VIRS and UVVS detectors measure surface reflectance at middle ultraviolet to visible to near infrared

wavelengths to search for ferrous bearing minerals, Fe- Ti bearing phases, and ferrous iron. These measurements are made with a spatial resolution of 5 km or better.

The MASCS instrument is described in full detail in McClintock and Lank, 2007.

2. References Cited

McClintock, W.E., and M.R. Lankton, The Mercury Atmospheric and Surface Composition Spectrometer for the MESSENGER mission, *Space Science Reviews*, 131, 481-521, 2007.