

MESSENGER Observations of the Dynamic Properties of Heliospheric Plasmas at 0.3-0.7 AU

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On 18 March 2011, MESSENGER became the first spacecraft to orbit Mercury. Prior to orbit insertion, MESSENGER spent 6.6 years on a complex trajectory in the inner heliosphere. During its cruise phase, and later in orbit around Mercury, MESSENGER made pioneering measurements of solar wind and pickup ions and the heliospheric magnetic field. Three key results obtained by this first inner heliosphere mission since the Helios space probes launched in 1974 and 1976, respectively, warrant special focus. First, MESSENGER observations of solar wind protons, alpha particles, and heavy ions between 0.3 and 0.7 AU provide critical in situ information independent of and complementary to observations by the Advanced Composition Explorer (ACE) near 1 AU. Alpha particles and heavy ions exhibit differential streaming relative to protons, and excess heating. The observed excess heating and differential velocities of heavy ions at 0.3 AU are substantially larger than those observed in the solar wind near Earth, suggesting a near-solar origin of this nonthermal behavior. Second, in situ observations of helium pickup ions at 0.3-0.7 AU, together with those at 1 AU, are yielding new insight into the geometry of the gravitational focusing cone and the transport of these ions. With MESSENGER data the location of the focusing cone can be specified to be within 76°–78.5° ecliptic longitude. Third, observations of magnetic field turbulence spectra show evidence for dissipation at frequencies larger than 1 Hz. These results provide important context for plasma measurements expected to be made by Solar Orbiter and Solar Probe Plus within the next decade.