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Dynamic Properties of Heliospheric Plasmas in the Inner Heliosphere: MESSENGER and ACE observations

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Abstract

The inner heliosphere connects the active solar corona with the Earth space environment and the heliosphere that extends to 100-200 AU from the Sun. There has been considerable interest in further understanding the dynamic processes that connect the heliosphere to the corona and also in determining its evolution near the Sun.

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. And second, novel compositional information from ACE provides tools to de-convolve evolutionary aspects of the solar wind near the Sun.

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 non-thermal behavior. This non-thermal behavior is also reflected in ionic charge state distributions that freeze in near the Sun. 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.