DUST OBSERVATIONS USING COMMON MODE MEASUREMENTS FROM THE LANGMUIR PROBE AND WAVES INSTRUMENT ON THE MAVEN MISSION.

T. Weber[1], L. Andersson[1], D. Malaspina[1], F. Crary[1], R. E. Ergun[1], G. T. Delory[2], M. W. Mooroka[1], C. M. Fowler[1], T. McEnulty[1], A. I. Eriksson[3], D. Andrews[3], D. L. Mitchell[2], J. P. McFadden[2], J. S. Halekas[4] , D. Larson[2], J. E. P. Connerney[5], J. Espley[5], and F. Eparvier[1], [1]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, 80303 (laila.andersson@lasp.colorado.edu), [2]Space Sciences Laboratory, University of California, Berkeley CA 94720, [3]Swedish Institute for Spacephysics, Uppsala, Sweden, [4]Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242, [5]NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: Electron temperature and density are critical quantities in understanding an upper atmosphere. Approximately 40 years ago, the Viking landers reached the Martian surface, measuring the first (and only) two temperature profiles during descent [1]. All spacecraft that have visited the red planet thereafter have had limited plasma packages and 'high' altitude orbits, preventing those missions from gaining detailed information about Mars' upper atmosphere. Remotely, the upper atmosphere of Mars has been studied for example, by the MARSIS sounder on Mars Express (MEX) [2], but complete plasma measurements are lacking.

The MAVEN mission was designed to characterize the upper atmosphere and included the Langmuir Probe and Waves (LPW) instrument[3] to provide fundamental measurements of the basic atmospheric dynamics at Mars. MAVEN reached Mars in the fall of 2014 and the first months of data from the LPW instrument have provided exciting information from an interesting planet.

Topic of This Presentation: From early Mars missions such as *Phobos* [4], one feature of Mars that has not yet been determined is the size and distribution of dust around the planet. It is expected that the two moons Phobos and Diemos can contribute significantly to a dust 'cloud' or 'ring' around Mars [5], but so far missions and occultation studies have only produced an upper bound on the dust fluxes [6]. Based on recent experience from other planets there have also been several estimations of the flux levels and distributions of dust that could exist at Mars.

During cruise and in the transition phase the LPW instrument operated in a special dust mode and has observed dust impacts. In dust mode, LPW measures the voltage between one of the probes and the spacecraft body using the burst capture system. When the instrument is in this mode none of its normal measurements can be made. During normal operations the LPW burst capture system records the electric field between the two probes (common mode measurement), and dust impacts can also be observed in this setting. However, the common mode signals are more difficult to interpret because the signal properties vary greatly depending on where the dust impacts the spacecraft with respect to the two sensors.

Using impact signals from the common mode electric field measurement, the distribution and dynamics of dust around Mars are studied in this paper. The source of the dust and its importance to the Martian system are then discussed. The MAVEN LPW measurements represent a lower bound on dust flux, since the number of observations (burst captures) depends on the instrument's allocated telemetry.

Background: The MAVEN mission is the first satellite sent to Mars with a complete plasma package. The Particle and Fields (PF) suite consists of 7 instruments: the Langmuir Probe and Waves (LPW), an Extreme Ultra Violet sensor (EUV), a magnetometer (MAG), two ion instruments (SWIA and STATIC), an electron instrument (SWEA), and an energetic particle instrument (SEP). Together, these instruments allow the upper atmosphere of Mars to be well characterized. The LPW instrument has two sensors located on ~7 m booms that can be operated both as two separate Langmuir probes or as an electric field instrument. LPW shares a common electronics box with EUV, but on the MAVEN mission EUV is operated as a separate science instrument.

The LPW instrument makes fundamentally different measurements in Langmuir Probe mode versus Electric Field (Waves) mode. When the sensors are operated in Langmuir Probe mode, the potential is swept over a set voltage steps, and the current to the sensor at each voltage step is measured. This allows the density and temperature of the cold plasma to be measured. Data from the Langmuir probes is complex to analyze as changes such as spacecraft photoelectrons and instrument aging need to be removed from the measurement curved. Therefore, the LPW instrument was designed to also measure the plasma line (using the Electric Field mode) and hence obtain accurate information about the local electron density. The plasma line can be observed naturally but the LPW instrument also can stimulate this measurement with a weak white noise broadcast. The LPW instrument also observes low frequency waves to identify where wave-particle energy conversions occurs. Hence, the LPW instrument provides information about how energy is flowing in the Martian system together with the other PF instruments.

Finally, the LPW instrument can detect nano-size dust particles impacting the spacecraft, providing information about Phobos-Diemos-Mars-Sun interactions.

Summary: This presentation has focused on one of the multiple research areas that the LPW instrument is contributing to in understanding the dynamics of the Martian upper atmosphere. As the MAVEN orbit precesses over different latitudes and local times, the LPW observations will provide critical information to drive models that can demonstrate how the upper atmosphere varies and what processes are critical for atmospheric escape at Mars.

References: [1] Hanson, Sanatani, and Zuccaro, (1977) *JGR, 82, 4351-4363.* [2] Gurnett et al. (2005) *Science*, 310, 1929-1933 [3] Andersson et al., LPW instrument paper submitted to *Space Science Review*. [4] Dubinin et al (1990) *GRL*, 17, 861-864. [5] Horanyi et al (1990) *GRL*, 17, 853-856. [6] Zakharov et al (2014) *Planetary and Space Science*, 102, 171-175.