MAVEN Observations of Large-amplitude, Quasi-periodic Sawtooth-like Magnetic Field Oscillations Associated with Kelvin-Helmholtz Instability

Gangkai Poh\textsuperscript{1,2}, Jared Espley\textsuperscript{1}, Norberto Romanelli\textsuperscript{1,3}, Jacob Gruesbeck\textsuperscript{1}, and Gina DiBraccio\textsuperscript{1}

\textsuperscript{1}Solar System Exploration Division, NASA Goddard Space Flight Center, Greenbelt, Maryland, United States of America
\textsuperscript{2}CRESST II, Catholic University of America, Washington, D.C, United States of America
\textsuperscript{3}CRESST II, University of Maryland Baltimore County, Baltimore, Maryland, United States of America

In this study, we present a preliminary analysis of large-amplitude sawtooth-like magnetic field oscillations observed by the Mars Atmosphere and Volatile EvolutioN (MAVEN) spacecraft at Mars. Initial survey of these quasi-periodic magnetic field oscillations (with periods of \textasciitilde3 – 4 minutes) shows distinct sawtooth-like magnetic field signatures with steep increase in $B_Y$ of \textasciitilde20 – 30 nT, followed by a gentle, but turbulent, return to background magnetic field values. The extrema in the $B_Y$ component generally coincide with an extrema of opposite polarity in the $B_X$ component. Quasi-periodic magnetic field signatures can also be observed in the z-component of the magnetic field vector. Ion and electrons measurements shows corresponding increase in ions and electrons with energies greater than 30eV and 10 eV, respectively, during observations of these sawtooth-like oscillations, indicating some mixing of plasma. We interpret these observations as Kelvin-Helmholtz (KH) waves in the non-linear stages because the plasma and fields signatures are consistent with non-linear KH waves observed at Earth and other planetary environments. KH waves are developed as a result of flow shear-driven KH instability occurring between the boundary separating two moving fluids. In the non-linear stage of the KH instability, rolled-up KH vortex can developed along the boundary, allowing the mixing of plasma between the two plasma regions. Occurrence of KH waves had been observed at Venus’ ionopause and the induced magnetopause, contributing to loss of planetary ions in the form of plasma clouds. Earlier simulations and observational studies have also explored the possibility of non-linear KH instability occurring at Mars. We will discuss the conditions required for the development of KH instability, its growth rate and implications on mass loss at Mars. Comparison with simulations will also be conducted and discussed.