SMALLSAT MISSIONS TO MAKE MULTI-POINT MEASUREMENTS OF THE MARTIAN MAGNETOSPHERE, IONOSPHERE, AND CRUSTAL MAGNETIC FIELDS.

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Mars-Bound SmallSats Are Possible: Recent advances in propulsion technology and interplanetary navigation theoretically allow very small spacecraft to travel directly to planetary destinations from near-Earth-space. Because there are currently many launches with excess mass capability (NASA, military, and even commercial), we anticipate a dramatic increase in the number of opportunities for missions to planetary targets. Spacecraft as small as 12U CubeSats can use solar electric propulsion to travel from Earth-orbit to Mars-orbit in approximately 2-3 years.

Important Science Can be Done with Multi-Point Particles and Fields Instruments: World-class instruments that require only modest mass, power, and telemetry resources (e.g. Goddard's mini-fluxgate vector magnetometer) can be easily accommodated on such missions. Mission scenarios that place SmallSats in Mars orbit combine the novelty of SmallSat design philosophies with comparatively conventional orbital mission requirements (vs. missions that require unusual mission design requirements, e.g. landers). Making use of the comparatively modest resources required for such mission architectures allows multiple SmallSats to be deployed which allows fundamental science questions to be addressed. The broad importance of multi-point measurements for space science is emphasized by the numerous Earth-based multi-point missions such as MMS, THEMIS, Cluster, and Swarm.

Magnetic Gradiometry Allows Investigation of the Geophysical History of the Martian Surface: The geophysical history of the martian surface and interior is at least partially recorded in the pattern of crustal magnetic fields that are present on the surface. By using magnetic measurements from multiple spacecraft it is possible to make such spatially enhanced crustal field maps. This technique is known as magnetic gradiometry. The difference between two near-by orbital measurements gives a much more accurate estimate of the actual field geometry emanating from the surface. By conducting multi-point magnetic gradiometry measurements, we will be able to address the fundamental geophysical history of Mars**.**

Investigating the Time-Variable Martian Magnetosphere and Ionosphere: MAVEN has confirmed that Mars is currently experiencing atmospheric loss due to its interaction with the solar wind. However, the details of the physical processes driving this loss and the time variable nature of this loss (time variability at the short time-scale, at the solar cycle time-scale, and at the billion-year time-scale) are both unconstrained. These are particularly complicated issues because of the difficulty of disentangling time-variable phenomena from spatially-variable phenomena with just one spacecraft. These details are important not just for understanding the nature of climate change at Mars but also in the wide variety of planetary environments that are beginning to be explored in exoplanets. Making measurements with world class space plasma physics instruments from two or more spacecraft in the uniquely hybrid martian magnetosphere will drastically improve our understanding of these phenomena.

These Science Objectives Are Part of the MEPAG Goals: Both of these science objectives (the geophysical history of the martian surface and the time-variability martian magnetosphere) are directly important to MEPAG science goals. Specifically, Goal II (Understand the process and history of climate on Mars) and Goal III (Understand the origin and evolution of Mars as a geological system) are both addressed by these objectives. Making important progress on these goals with modest SmallSat missions would be an important part of the Mars Exploration Program portfolio of missions for the coming decade.