IF IT HAS A MAGNETIC FIELD WE WANT TO MEASURE IT: PLANETARY MAGNETOMETRY OF THE FUTURE. J. R. Espley[1], [1]Solar System Exploration Division, Goddard Space Flight Center, Greenbelt, MD 20771, Jared.Espley@nasa.gov

Introduction: Planetary magnetometry has had tremendous success over the past few decades of Solar System exploration (e.g. Voyager to current missions like MAVEN). Looking to the future it is clear that there are numerous science and exploration challenges that would benefit from the observations made by magnetometers. These goals include objects throughout the Solar System and across numerous major scientific themes including the workings of the Solar System, the search for life, and the characterization of resources necessary for human exploration. Some of the conceivable investigations make use of existing instrument technologies and near-term mission designs while others would require instrument miniaturization and radically new mission designs. I discuss a few of these mission designs and the associated mission goals. See the table for a summary.

Planetary subsurface sounding networks: By using networks of electromagnetic sensors such as magnetometers it is possible to probe the subsurface of planetary bodies such as Mars. Such subsurface characterization would allow the identification of aquifers and the interior structure of the object which informs the *search for life*, is vital to understanding *planetary systems*, and important for *resource identification* for human exploration. Such networked landed missions are theoretically possible now but would require mission design work to efficiently distribute the landers.

Aerial geomagnetic surveys: Similarly, by placing magnetometers on aerial platforms such as gliders or ballons, detailed geophysical characterization of the planetary surface can be conducted. This would allow us to explore of the *geophysical history* of the surface with respect to events that altered the magnetization of the crust. Examples include volcanism, plate tectonics, and impact cratering. Furthermore, such surveys are routinely used on Earth to *characterize the materials* in the near subsurface structure (i.e. for mineral prospecting) – we could do similar work at other planets. Depending on the size and scale of the aerial platform chosen, significant investment might be required to have a sufficiently robust mission plan for this type of investigation.

Multi-point measurements of planetary magnetospheres: Many phenomena in magnetospheric physics are highly dynamic and it is often difficult to distinguish between time-variable and spatially-variable phenomena. Examples include magnetic reconnection, escaping atmospheric plasma strutures, and plasma waves (which carry the energy in collisionless regimes like magnetospheres). By using multiple spacecraft with magnetometers and associated plasma spectrometers, it is possible to be able to much more fully address these questions of *how the dynamics of planetary magnetospheres* work. Similar missions have been conducted at Earth. Using groups of smallsats (e.g. CubeSats) would allow such missions to be more easily conducted at planetary targets as the spacecraft could be conveyed to their targets as secondary payloads.

Ice Giant Exploration: The magnetospheres of Neptune and Uranus have received only cursory exploration. Understanding how these truly unique (with dipoles strongly tilted from their rotation axes) *magnetospheres work* would be a major accomplishment of basic Solar System exploration. A large flagship mission to fully explore these systems would be one way to accomplish this.

Ocean Worlds Exploration: Characterizing the the global oceans on worlds such Europa is likely to be a major theme of the coming decades. Magnetometry is key part of this exploration as magnetic field measurements allow *characterization of the depth and location* of subsurface oceans which are potentially *habitable environments*. Measurements conducted from multiple-fly-by or orbital missions are best suited for identifying the global characteristics of such oceans whereas measurements from landed assests can describe the local subsurface conductivities including local aquifers and layers. The development of such missions to Europa is currently underway but numerous other targets are likely to be explored in the coming decades.

	Mission possible in the:			Mission addresses:		
Magnetometry Mission Type	**2020s**	**2030s**	**2040s**	**Solar System Workings**	**Search for Life**	**Resources**
Planetary subsurface sounding networks	?	✓	✓	✓	✓	✓
Aerial geomagnetic surveys	?	✓	✓	✓		✓
Magnetospheric multi-point measurements	✓	✓	✓	✓		
Ice giants exploration		?	✓	✓		
Ocean worlds exploration	?	✓	✓	✓		

Table 1. A variety of different types of missions making magnetic field measurements are possible in the coming decades. Each mission type addresses different types of exploration goals and each mission type has different possible timeframe for implementation. In all cases, magnetometry will continue to play a key role in exploring the Solar System.