Polarimetric Methods and Instrumentation for Solar System Exploration. P. A. Yanamandra-Fisher[1] [1]Space Sciene Institute , Rancho Cucamonga, CA 91739, U.S.A..

Introduction: The overarching goals for the remote sensing and robotic exploration of planetary systems are: (1) understanding the formation of planetary systems and their diversity; and (2) search for habitability. Since all objects have unique polarimetric signatures inclusion of spectrophotopolarimetry as a complementary approach to standard techniques of imaging and spectroscopy, provides insight into the scattering properties of the planetary media.

Method: Specifically, linear and circular polarimetric signatures of the object arise from different physical processes and their study proves essential to the characterization of the object. Linear polarization of reflected light by various solar system objects provides insight into the scattering characteristics of atmospheric aerosols and hazes; and surficial properties of atmosphereless bodies. Well-known examples are the identification of spherical droplets of sulphuric acid in the atmosphere of Venus, and dust storms and ice clouds on Mars. In the case of outer planets, although the phase angles available from earth to observe are limited to a very narrow range, measurements of linear limb polarization characterizes the variation of aerosol properties across the planetary disk. Linear polarization of atmosphereless objects (the Moon, planetary satellites and asteroids) are diagnostic of surface texture, and demonstrate that most of them have their surfaces covered with a regolith of fine material, function of particle size and packing density. Many optically active materials are anisotropic and so their scattering properties differ with the object's principal axes (such as dichroic or birefringent materials) and are crystalline in structure instead of amorphous, *e.g*., the presence of olivines and silicates in cometary dust and circumstellar disks, Titan, etc.. Ices (water and other species) are abundant in the system indicated in their near – infrared spectra. Gas giants form outside the frost line (where ices condense), and their satellites and ring systems exhibit signature of water ice? clathrates, nonices (Si, C, Fe) in their NIR spectra and spectral dependence of linear polarization.

Search for habitability elsewhere in the solar and exoplanetary systems is another important science driver for the inclusion of polarimetry in future solar system exploration. Chirality or handedness is a property of molecules that exhibit mirror-image symmetry (similar to right and left hands). Right- or left-chirality is characterized by circularly polarized light. All known biological activity and all life forms on earth are chiral and pre-dominantly left-handed. The search for the emergence of habitability in the solar system and exoplanetary systems can be aided by the measurement of circular polarization of comets; planetary and satellites' atmospheres and asteroids.

Additionally, spectral dependence of polarization is important to separate the macroscopic (bulk) properties of the scattering medium from the microscopic (particulate) properties of the scattering medium. Circular polarization, on the other hand, is indicative of magnetic fields and biologically active molecules, necessary for habitability. These applications suffer from lack of detailed observations, instrumentation, dedicated missions and numerical\/retrieval methods. With recent discoveries and results of main belt comets, asteroids with ring system, lunar studies, planned exploration of planetary satellites that may harbour subsurface oceans, there is increasing need to include polarimetric (linear, circular and differential) as an integral observing mode of instruments and facilities. For laboratory measurements, there is a need to identify simulants that mimic the polarimetric behaviour of solar system small bodies and measure their polarimetric behavior as function of various physical process they are subject to and have undergone radiation changes of their surfaces.

I will review the advances in our understanding of solar system objects resulting from previous missions with polarimetric capabilities and provide a framework for the inclusion of polarimetric capability of future instrumentation for both missions and ground-based observing facilities.