PROOF OF CONCEPT OF AN ADVANCED SUN PHOTOMETER FOR PLANETARY APPLICATIONS

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Instrument Properties
Appropriate for surface measurements on planetary bodies with sensible atmosphere
- Compact
- Lightweight
- Reliable with no or few moving parts
- No sun tracking mechanism required
- Robust
- Low power consumption

Instrument Design
- Uses CCD array detector
- Measures direct and diffuse solar irradiance
- Hemispherical field of view (2π steradian)
- Wavelength dependence determined by: a filter-wheel with interference filters, an acousto-optic tunable filter, and/or a grating spectrometer
- UV/VIS/NIR/IR wavelength capable
- Self-calibrating using Langley method

Background
- Dust is a major driver of the radiative balance and dynamics of the Martian atmosphere at every spatial scale (Smith, 2008)
- Dust aerosols found between 0-30 km, τv~0.4, aphelion season (Clancy et al., 2007)
- Water ice aerosols found between 15-45 km, τv~0.2, aphelion season (Clancy et al., 2007)
- CO2 and/or water ice aerosols found in a distinct layer between 60-100 km equatorial regions, τv~0.01, aphelion season (Clancy et al., 2007, Montmessin et al., 2006, 2007)
- Dust dominates the UV/VIS extinction
- Determining the characterization and distribution of Martian aerosols is essential to understanding Martian climate and weather
- The modeling of Martian dust and cloud dynamics
- The development of future Mars inhabited and uninhabited missions

Science Objective
- Characterize atmospheric aerosols (dust, water ice, and CO2 ice)
- Measure diurnal/seasonal aerosol loading
- Measure diurnal/seasonal trace gas concentrations (water vapor and ozone)
- Determine aerosol size distribution
- Determine downwelling radiative flux
- Obtain ground measurements complimentary to orbiter measurements

Advantages of Surface-based Measurement
- Continuous diurnal cycle measurement
- Continuous seasonal cycle measurement
- Little affected by surface albedo and phase function uncertainties

Data Products
- Aerosol optical depth (AOD) as a function of wavelength
- Ice haze/cloud optical depth
- Gas phase columnar abundance (H2O and/or O3)
- Direct solar downwelling flux
- Hemispherical downwelling flux
- Aerosol size distribution (r eff and v eff)

Conclusion
The measured AOD curves closely match the curves obtained by a commercial sun photometer, indicating this instrument concept can determine optical depths in a near hemispherical field of view without mechanically tracking the sun.

Above: Conceptual diagram of the sun photometer
Left: Sequence of images along an hemispheric meridian with the sun at increasing angles relative to the instrument axis (non-imaging optics)