Introduction: Solar and stellar occultations provide direct measurements of atmospheric density, and are a major contributor to the current understanding of the thermal structure, composition and variability of the Mars atmosphere from the surface boundary layer to the exobase. Although recent occultations have been made by relatively large and complex instruments such as SPICAM (Spectroscopy for the Investigation of the Characteristics of the Atmosphere of Mars) onboard Mars Express, IUVS (Imaging Ultraviolet Spectrograph) onboard MAVEN (Mars Atmosphere and Volatile EvolutioN) and NOMAD (Nadir Occultation for Mars Discovery) onboard TGO (Trace Gas Orbiter), high quality occultation measurements of major species can be made by much simpler UV photometers as has been recently demonstrated [1] with MAVEN EUVM (Extreme Ultraviolet Monitor).

Concept Background and Overview: The solar occultation measurement principle is simple. The measured intensity ($I$) normalized by its value at the top of the atmosphere ($I_0$) is related to the line-of-sight (LOS) column density by $\ln(I/I_0) = -\sum N_i \sigma_i$. If most (>90%) of the absorption is due to a single species, as is generally the case in the Mars atmosphere below the exobase, measurements at only a single wavelength band are required. Each additional species can be resolved with a single, appropriately selected, band (i.e. 2 bands for 2 species, 3 bands for 3 species, ...). Additionally, occultation measurements are highly accurate and insensitive to degradation if the instrument relative bandpass is well known. This is a result of the dependence on relative (i.e $I/I_0$) rather than absolute intensity.

UV photometers significantly reduce instrument complexity and SWAP (size, weight and power) as compared to the aforementioned occultation instruments while providing necessary spectral resolution for measuring major species composition and temperature. Rather than using a grating spectrograph and 2-d detectors, as is the case with SPICAM, IUVS and NOMAD, transmission filters and ambient-temperature single-pixel detectors are used. As a rough comparison, the optics required to isolate the appropriate bandpass are reduced from being the size of 1-2 shoe boxes to that of 1-2 D-size batteries. Additionally, the simplification of the detector system, simplifies the electronics and data rate. For solar occultations, no additional front-end optics are required, although their inclusion will improve vertical resolution, while for stellar occultations, a primary mirror comparable to those on IUVS and SPICAM would be required.

In this presentation, we show examples of past UV photometer measurements of atmospheric density at Earth and Mars, review the capabilities and limitations of high-TRL transmission filter and detector technology, discuss retrieval methods and associated uncertainties, and provide example solar and stellar occultation instrument configurations for probing the Mars atmosphere.

References: