Using Cassini VIMS Stellar Occultations to Investigate Geostrophic Winds in Saturn’s Stratosphere

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Probing Saturn’s Atmosphere With Starlight

Cassini’s Visual and Infrared Mapping Spectrometer (VIMS) was designed to gather information about the temperature and composition of Saturn and its moons. VIMS was a 64 x 64 pixel imaging spectrometer, each pixel having 256 spectral channels between 1-5µm. VIMS Stellar occultations were performed by using a single pixel at high temporal resolution to track a star as it set behind Saturn’s atmosphere. This allowed VIMS to capture the changes in the stellar spectra as the starlight is absorbed and refracted by the atmosphere. The time series of spectra hold information about the composition, temperature, and structure of the atmosphere. During Saturn occultations, the primary sources of stellar signal extinction are refraction and molecular absorption by hydrocarbons.

Results and Future Work

From spacecraft orbit geometry, half-light times were converted to radii. When plotted vs latitude of the occultation event, these radii create a shape of Saturn. In order to isolate possible effects of zonal winds, a reference ellipsoid shape of Saturn, referred to as the “Geoid”, was subtracted from the data. The half-light radii vs latitude profiles all show a prominent equatorial bulge of 100-150 km, strongly suggesting that the zonal winds seen at the cloud-top level extend largely undiminished up into the stratosphere. Future work will include correcting radii for the effects of refraction and varying occultation geometry.

Data Analysis

With the goal of understanding Saturn’s geostrophic winds, we measured the shape of the planet in order to identify distortion in the radius caused by the winds. Using the occultation data, we assessed specific wavelength ranges to isolate the light attenuation curves caused by refraction and molecular absorption. In the VIMS λ range of 1-5µm, there are multiple hydrocarbon absorption features (methane bands) as well λ ranges where signal attenuation is dominated by refraction (continuum bands). By finding the altitudes at which stellar flux is attenuated by 50% (half-light altitude) within different wavelength bands at different latitudes via 35 different occultation measurements, we created multiple shape profiles of the planet.

Citations and Acknowledgments


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