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Occultation and limb Observations of Terrestrial Atmospheres: Mars and Venus as Case Studies

Many celestial bodies in the Solar System have been studied extensively using limb and occultation techniques, which have proven to be powerful tools for retrieving detailed information about the composition and dynamics of planetary atmospheres. These methods date back to the early 1970s, when NASA first deployed missions around Mars to investigate the planet's atmospheric components.

Since then, both limb and occultation observations have become standard techniques in planetary science, consistently revealing critical insights into atmospheric structures and constituents. In recent years, solar occultation in particular has emerged as a highly effective approach, taking advantage of the Sun as an exceptionally bright and stable light source. This method has enabled researchers to conduct unprecedentedly sensitive measurements, especially of trace gases, in the atmospheres of Mars and Venus.

One of the most notable advancements in this field comes from the European Space Agency's Trace Gas Orbiter (TGO), launched in 2016 as part of the ExoMars program. Designed to improve trace gas detection capabilities by a factor of 100 to 1000 compared to previous missions, TGO aimed initially to resolve the ongoing debate over the presence of methane on Mars. However, it far exceeded expectations. Not only did it place stringent new limits on methane, but it also achieved the first detection of hydrogen chloride (HCl) in the Martian atmosphere—a key species that had long eluded detection. Furthermore, TGO provided unprecedented insights into the behavior of water vapor on Mars, including its seasonal variability and its role in atmospheric escape processes.

This presentation will offer an overview of historical and contemporary atmospheric measurements obtained via limb and solar occultation techniques across the Solar System. It will then focus on the groundbreaking discoveries made by TGO, highlighting how this mission has reshaped our understanding of the Martian atmosphere.

Topic

Atmospheric composition (Earth and planets), chemistry and transport

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