Surprising Similarities: Comparing the Transit Spectra of Potential Earth-like and Venus-like Exoplanets

C. M. Ostberg[1], S. R. Kane[1], P. A. Dalba[1]
[1]University of California, Riverside | 900 University Ave, Riverside, CA 92521

Introduction: Venus is a vital resource for understanding how Earth developed and maintained its current habitable state. Venus' importance derives from its climate being the antithesis of Earth's despite being the most similar planet to Earth in the solar system. Investigating the reasons for this stark divergence in evolution has become popular among the community, which was clearly illustrated with NASA choosing VERITAS and DAVINCI+ for their discovery class missions. In-situ data from these missions will be essential for uncovering the mysteries of Venus' past. A complementary route of investigating Venus' evolution is through the study of terrestrial exoplanets in the Venus-Zone (VZ); the region around a star where insolation flux may produce a runaway greenhouse atmosphere. The Transiting Exoplanet Survey Satellite (TESS) has discovered an abundance of terrestrial planets in the VZ, and compositional information about the atmospheres of these planets may be accessible with the James Webb Space Telescope (JWST). However, the presence of Venus-like clouds and hazes, as well as the stark similarity between the transit spectra of Earth and Venus, may cause ambiguities when inferring the surface conditions of these planets. In this work, we compare the transit spectra of a variety of alternative exo-Venus and exo-Earth planets with varying atmospheric CO_2 and cloud deck heights. Our results illustrate that cloud deck height has a larger impact on the S/N of CO_2 features than the amount of CO_2 since H_2O features at similar wavelengths become prominent with less CO_2. The CO_2 features in the Venus-like transit spectra achieve a larger maximum S/N value, however the Earth-like transit spectra can have higher S/N than the Venus-like transit spectra when considering a Venus-like planet with a cloud deck that extends above 40 km. Future work will determine whether the differences in transit spectra can be resolved by JWST, and longer-term exoplanet characterization missions.