Visualising Potential Atmospheres on LHS 1140 b Through NIRISS/SOSS Transmission Spectroscopy for Future JWST Analysis

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Atmospheric transmission spectroscopy - a method to detect molecular signals in a planet's atmosphere - could help humankind explore how the universe has evolved to support life on exoplanets. LHS 1140 b orbits its host star in the habitable zone, and has a high possibility of retaining an atmosphere and liquid water, both necessary elements for life. Using Python, simulations of the James Webb Space Telescope's (JWST) Near Infrared Imager and Slitless Spectrograph (NIRISS) were performed on three possible atmospheric compositions and four atmospheric interference scenarios (Clear, Rayleigh scattering, a generic cloud top, Rayleigh scattering and a generic cloud top) of LHS 1140 b to produce its atmospheric absorption spectra. Afterwards, a signal-to-noise ratio analysis was conducted to determine which molecular signals could theoretically be detected in the fewest number of occultations with JWST. From the atmospheric spectra - it was discovered in all three compositions that Rayleigh scattering significantly dampened the spectra at shorter wavelengths (less than 1.0 microns) while generic cloud cover contributed to a lesser degree until 1.7 microns, when dampening effects from both became negligible. Signal-to-noise ratio analysis on prominent carbon dioxide peaks determined 17 occultations were required for a 30 ppm precision for the peak at 2.0 microns and 25 were required for a 50 ppm precision for the peak at 2.7 microns. Simulations of transmission spectroscopy can be synthesised with empirical observations from JWST in the future to improve their accuracy, and ultimately provide reliable visualisations of exoplanetary atmospheres for habitability studies.

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