
How stellar activity affects exoplanet's parameters estimation and exoplanet's atmosphere characterization

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Abstract

Stellar activity features such as spots and plages can create complications in determining planetary parameters through spectroscopic and photometric observations. The overlap of a transiting planet and stellar spots/plages can produce anomalies in the transit light-curves that may lead to inaccurate estimation of the transit duration, depth and timing. We found that spot anomalies can lead to the transit duration be 4%, overestimated or underestimated, which can affect the planet orbital inclination estimation. The anomalies can also produce transit timing variations (TTV) with significant amplitudes of 200 seconds. Such a large TTV is similar to that induced by an Earth-mass planet on a transiting Jupiter in a three-day orbit. The transmission spectroscopy method, which is based on the measurements of the variations of planet-to-star radius ratio as a function of wavelength, is a powerful technique to study the atmospheric properties of transiting planets. Results of our simulations indicated that transit anomalies can lead to a significant underestimation or overestimation of the planet-to-star radius ratio as a function of wavelength. At short wavelengths, the effect can reach to difference of up to 10% in the planet-to-star radius ratio, mimicking the signature of Rayleigh scattering in the planetary atmosphere. Application of our calculations to HD 189733b and GJ 3470b transmission spectroscopy measurements and especially the reported excess in their planet-to-star radius ratio in the bluer part of the spectra, which were interpreted as the signature of blue sky, can exactly be reproduced by assuming that the planet occults a plage on the surface of these stars.

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