A re-analysis of equilibrium chemistry in five hot Jupiters

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Studying chemical composition is fundamental to model the formation history of planets and planetary systems. Before the leap forward expected with JWST and Ariel satellites, we propose here an analysis of five targets to improve the determination of their composition and the chemical mechanisms that take place in their atmospheres, combining multiple instruments and using retrieval methods. Our five targets are: HAT-P-12b, HD 209458b, WASP-6b, WASP-17b and WASP-39b, which have temperatures ranging from 1000K to 1700K and radii ranging from 0.9 to 1.9 Jupiter radius.

We use spatially scanned observations from the grisms G102 and G141 of the Wide Field Camera 3 (WFC3) on the Hubble Space Telescope, with a wavelength coverage of 0.8 to 1.7 microns. We analyze these data with the publicly available Iraclis pipeline (Tsiaras et al. (2018)). We added to our datasets Space Telescope Imaging Spectrograph (STIS) observations, reduced and presented in Sing et al. (2015), to increase our wavelength coverage from 0.4 to 1.7 microns. We then perform a Bayesian retrieval analysis with the open-source TauREx (Al-Refaie et al. (2019)) using a nested sampling algorithm. We perform the retrieval considering molecular abundances varying freely and with equilibrium chemistry ACE (Agúndez, M. et al. (2012, 2020)) and FastChem (Stock et al. (2018)). The principle is to start from a transmission spectroscopy dataset and to seek the model which characterizes the atmosphere in the most probable way, in other words the spectrum that best fits the data points.

For very hot planets, thermochemical equilibrium may be close to reality, but for less hot planets, vertical mixing and photodissociation bring these planets out of equilibrium. That's why our results will soon be extended to a non-equilibrium thermochemistry model (Venot et al. (2020)).

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