Preparing JWST and Ariel observations: from 1D to 3D models

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Abstract

Transmission spectroscopy gives the opportunity to characterize the atmospheric properties of the planets, but this is limited close to the limb. For terrestrial and relatively cold planets, such as Earth-like planets, the region probed is known to be a narrow annulus around the planet. On the contrary, recent studies shown that for hotter gaseous planets, such as hot-Jupiters, the region probed, in transmission, extends significantly toward the day and night sides of the planet. Actual retrieval tools assume an uniform limb or a linear combination of 1D models to account for heterogeneity between different regions of the limb (e.g. east against west limb). This cannot explain the 3D complexity of the planetary atmospheres and bias the given retrieved solutions.

Following the Ariel school 2022 about the impact of the 3D structure of hot exo-atmospheres on the retrieval analysis, we set up a group of retrievals on theoretical transit spectra to unravel the analysis biases for upcoming James-Webb space telescope (JWST) and Ariel observations. The theoretical spectra are computed with 3D using the 3D transmission spectroscopy simulator Pythmosp3r on 3D GCMs from sub-Neptunes to ultra hot Jupiters. They simulate, as a first step, JWST (MIRI + Nirspec) observations using the noise simulator PandExo. In collaboration with the participant of the Ariel school 2022, we analyzed those spectra as it would have been real JWST observations using the 1D retrieval code TauREx. Thanks to this work, we are able to highlight in which conditions, depending of the temperature of the planet, 1D models cannot retrieved the 3D complexity of the atmosphere and how it bias the solution. With this results we will be able to be more careful on the analysis of the upcoming hot planets observations.