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Disentangling spectra from systematics in WFC3 observations using simulated data

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Abstract

Currently, the WFC3 camera on-board the Hubble Space Telescope is the most powerful instrument to perform infrared transit spectroscopy of exoplanets. In particular, it is the use of the spatial scanning technique that has improved the achievable precision of the observations. Due to geometric distortions, the structure of the spectra produced by WFC3 is field-dependent. To take into account this behaviour, we have introduced a new approach in characterising spatially scanned spectra where the final spectrum is described as the superposition of many different starring spectra. However, it is unclear how each of the analysis steps could potentially affect the data. In addition, the strengths of the instrumental systematics and of the planetary signal are of the same order of magnitude.

The best way to calibrate an instrument and test the capabilities and the weaknesses of the analysis processes is the use of calibrating sources, where the characteristics of the observed object are well known. In absence of such sources, simulated observations that include both the observed object and the systematics become very important. They provide a tool to investigate the effects of different instrument systematics and observing techniques on the final scientific result. Moreover, they help us understand the coupling between those effects, a study that cannot be carried out based only on real observations with unknown input signal. We can also test the ability of pipelines and reduction methods to recover the planetary signal in different scenarios, which is an important verification step in data analysis. We can, finally, validate the stability and reliability of existing data sets, by taking into account the specific configuration that each one has, and explore different possible configurations for future observations by evaluating their effect on the retrieved planetary spectrum.

In this talk, I will describe the basic functionality of the Wayne simulator for WFC3 spatially scanned observations and will present the results of using it to investigate the effect of known and unknown systematics on current exoplanet spectra. In some cases, controversial results based on the same dataset have been published in the literature. This shows the need for an instrument simulator for all instruments, where the knowledge of the input signal helps us understand which data analysis techniques are more likely to be affected by instrument systematics.