Determining the composition and structure of hot Jupiter atmospheres using high-resolution spectroscopy

Studying the composition and structure of hot Jupiter atmospheres is very important not only to understand their own physics, but also the dynamics of planetary systems' formation and evolution. It may give important clues about the initial composition of the protoplanetary disk and (because molecules have their ice lines at different distances from the star) even the region within this disk where the exoplanet itself was formed, assuming it kept its primordial composition.

When observing a planetary system, the obtained spectrum is the combination of both the light of the star and of the surrounding exoplanets. However, although the star features are always much stronger, it is still possible to remove its signal and isolate the features coming just from a hot Jupiter, for instance. For that, high-resolution spectroscopy is needed, since it reveals the unique features of the molecular spectrum of the planet (such as rovibrational lines in CO).

For this specific project, I will develop a pipeline that analyses high-resolution spectra from planetary systems containing a hot Jupiter, with the goal of finding from a list of possible models for its atmosphere's composition and structure the best-matching one. My pipeline will receive, clean and align spectra from the same system measured at different times, then it will iteratively use Principle Component Analysis (PCA) to better clean the data and remove the star signal and its effects, so that it will finally end up only with the isolated hot Jupiter's features. After that, cross-correlation will be used to test which one of the possible models is the best-matching one – a match whose parameters will characterize the hot Jupiter's atmosphere, with a certain significance.

Given that my *Studiefinanciering* requires me to have a job for a minimum of 14 hours per week, the following is an approximate project timeline, which I will nominally spend 20 hours a week on.

December 2017: completed end-to-end pipeline.
January 2018: first draft of the introduction section of my report.
February 2018: refined pipeline and first draft of the observations section of my report.
March 2018: first draft of the method section of my report.
April 2018: extraction of the first results and first draft of the results section of my report.
May 2018: final version of the pipeline, assessment of the statistical significance of my results and first draft of the discussion section of my report.
June 2018: first draft of the final paper.
July 2018: thesis presentation.
August 2018: thesis report submission in its final and definite version.

Depending on the outcome of my results, I will also begin investigating ways to perform a deeper exploration of the planetary atmosphere by combining my results with other complementary measurements in the literature.