Techniques

Observational strategy:

We are using a ‘photometry style’ approach to spectroscopy by sampling the transiting eclipse feature with as many spectroscopic exposures as possible

Spectra extraction:

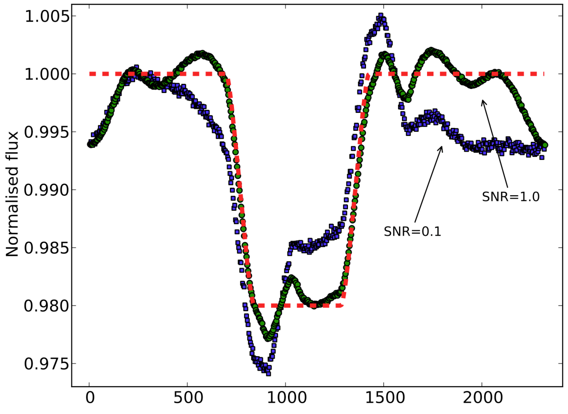
Having obtained a timeseries data-set per spectral channel, we compute the self-coherence.
Self-coherence is defined as the convolution (in time domain)

$$(X_i * X_{i+1})[n] := \sum_{t=1}^{n} X_i[t]X_{i+1}[n-t]$$

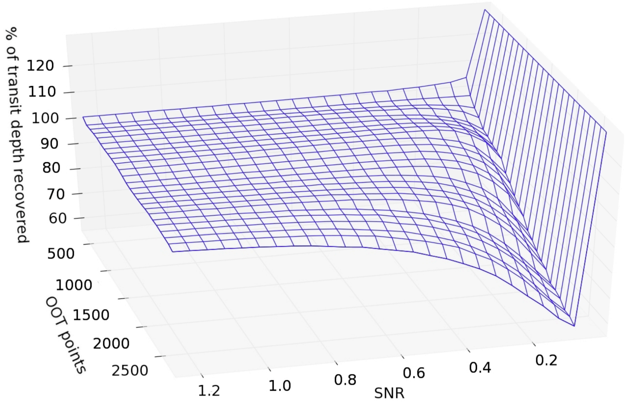
or multiplication (in frequency domain)

$$f_\lambda(t) = \mathcal{F}^{-1}\left[\left(\prod_{i=1}^{m}\mathcal{F}[X_i(t)]\right)^{1/m}\right]$$

of several similar timeseries sets. This achieves repeated filtering of the data, allowing us to extract the eclipse signal at very low signal to noise (SNR << 1.0) conditions.



Self-coherence results for different SNRs. The visible distortions are now well understood and can be modelled.



Self-coherence is very reliable in extracting transit depths down to a SNR of ~ 0.35 without further calibrations.

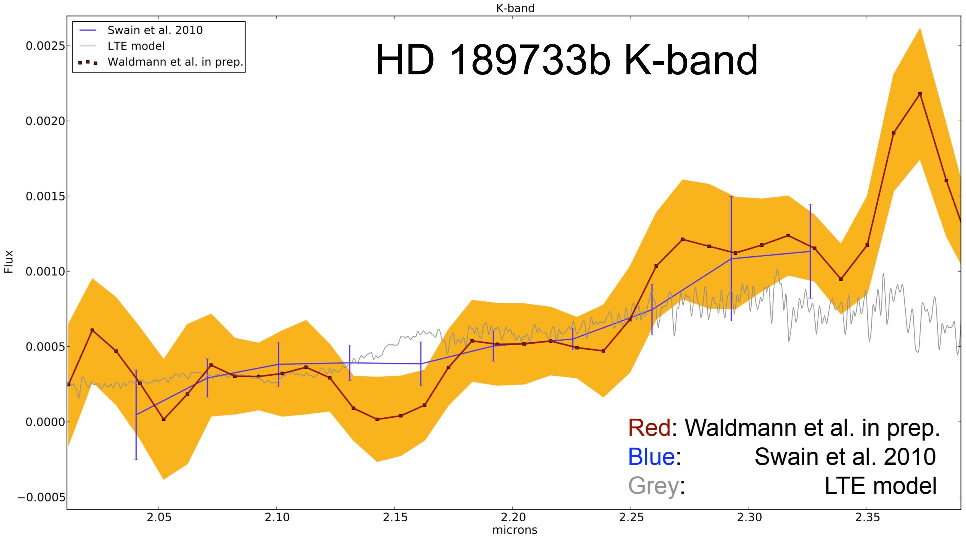
Ground-based spectroscopy of exoplanetary atmospheres

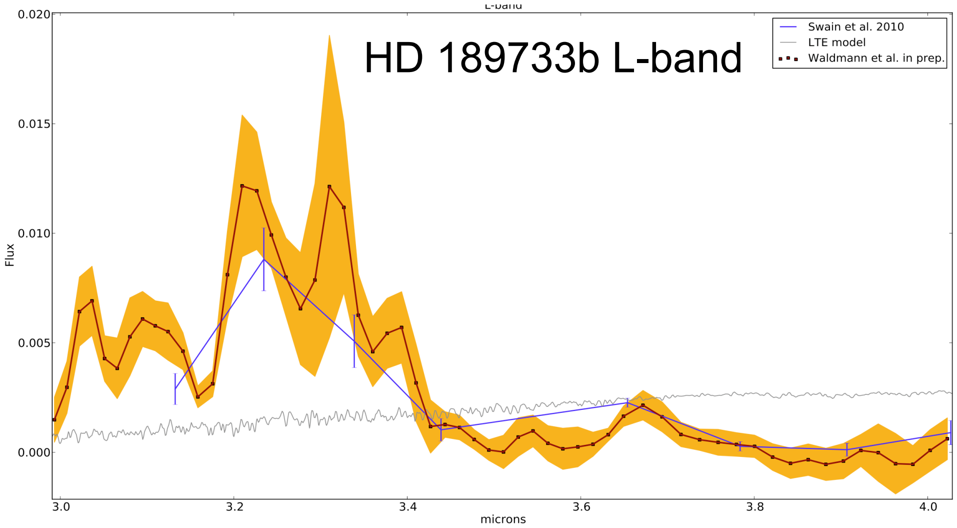
Results

K and L-band data for the exoplanet HD189733b was obtained using the IRTF/SpeX instrument. In the initial publication of the data (Swain et al., Nature 2010), excellent agreement between ground-based and HST data was found in the K-band and a strong non-LTE methane emission in the L-band was observed.

Using the improved understanding of the self-coherence spectral extraction (Waldmann et al. submitted), we are now able to extract a higher resolution spectrum of the exoplanet's atmosphere (Waldmann et al. in prep), showing very good agreement with Swain et al. (2010).

This improvement of techniques allows us to study the atmospheric composition of exoplanets in unprecedented detail.





(Waldmann et al. in prep.)