Developing an integrated analysis approach to explanetary spectroscopy

Ingo Waldmann*[1]

[1]University College London - London's Global University (UCL) – Gower Street - London, WC1E 6BT, United Kingdom

Abstract

Analysing the atmospheres of Earth and SuperEarth type planets for possible biomarkers will push us to the limits of current and future instrumentation. As the field matures, we must also upgrade our data analysis and interpretation techniques from their "ad-hoc" beginnings to a solid statistical foundation. This is particularly important for the optimal exploitation of future instruments, such as JWST and E-ELT.
At the limits of low signal-to-noise, we are prone to two sources of biases: 1) Prior selection in the data reduction; 2) Prior constraints on the spectral retrieval. A unified set of tools addressing both points is required.
To de-trend low S/N, correlated data, we demonstrated blind-source-separation (BSS) machine learning techniques to be a significant step forward. Both in photometry and spectroscopy. BSS finds applications in fields as diverse as medical imaging to cosmology. Applied to exoplanets, it allows us to resolve de-trending biases and demonstrate consistency between data sets that were previously found to be highly discrepant and subject to much debate.

For the interpretation of the data, we developed a novel atmospheric retrieval suite, Tau-REx. Tau-REx implements an unbiased prior selections via a custom built pattern recognition software. A full subsequent mapping of the likelihood space (using cluster computing) allows us, for the first time, to fully study degeneracies and biases in emission and transmission spectroscopy.
The development of a coherent end-to-end infrastructure is paramount to the characterisation of ever smaller and fainter foreign worlds. In this conference, I will discuss what we have learned for current observations and the need for unified statistical frameworks in the era of JWST, E-ELT.

*Speaker