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ELT-METIS: estimating the constraining power of high-resolution exoplanet spectra with Bayesian inference

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Ground-based high-resolution spectroscopic observations of exoplanet atmosphere is a rapidly-evolving field with already significant successes, mainly in species detection using a cross-correlation approach. Since a few years new techniques are developed to tackle down the obstacles to not only detect species, but also retrieve abundances and other properties (e.g the temperature profile), a deed that was so far essentially reserved to low-resolution (R ~100) observations.
The Mid-infrared Extremely Large Telescope (ELT) Imager and Spectrograph (METIS) features a high-resolution (resolving power of ~100,000) spectrograph in the L- and M-bands (2.90 to 5.30 μm). For exoplanet atmospheric characterisation, this instrument will represent a major leap forward. It will enable the observation of fainter and smaller objects and will drastically improve the quality of data from brighter objects due to the dependence of the Signal-to-Noise Ratio in the background-limited regime on the square of the telescope diameter. At these wavelengths the obscuring effects of hazes and/or clouds are much reduced.

We present here realistic simulated observations of several exoplanets of interest with METIS. We notably included telluric lines, and time-dependent airmass and Doppler shift of the planet spectra relative to the instrument. We also included realistic noise and uncertainties from the METIS dedicated radiometric code. We performed Bayesian analysis (using PyMultiNest) of these observations with a newly developed extension of petitRADTRANS, our atmospheric modelling software. We investigated which species could be retrieved, and how well, on these selected targets. We will also discuss the detection and abundance retrieving of trace species and isotopologues, as well as the retrieving of other key atmospheric properties. Finally, we will briefly introduce the new and robust atmospheric retrieval framework we developed for petitRADTRANS, which we tested on existing high-resolution data.