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Atmospheric characterisation of directly imaged exoplanets with JWST/MIRI

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Abstract

The next major space facility to characterise the atmosphere of exoplanets will be the JWST. Of particular interest is the Mid-Infrared Instrument (MIRI) which will give access, for the first time, to the 5 - 28 μm part of the spectrum of young giant exoplanets at a wide enough angular separation from their host star to be observed by direct imaging. Retrieving the precise set of parameters of these objects, such as luminosity, temperature, surface gravity, mass, and age is extremely important as it supplies information about the initial entropy of the planets and hence it allows us to shed light on their formation mechanism. The new extreme adaptive optic cameras (e.g., SPHERE, GPI) are already providing excellent constraints on these parameters, but the spectral range in which they operate is limited to near infrared so that the uncertainties are still significant. Observations taken on a longer wavelength range are mandatory for reducing them. In this context MIRI will play a key role allowing, in conjunction with shorter wavelength measurements, the exhaustive characterisation of the exoplanetary atmospheric properties. Additionally, MIRI will give us the opportunity to probe for the first time the presence of ammonia in the atmosphere of the coldest known young giants. Notice that the ammonia spectral signature is a further useful indicator of equilibrium and temperature in the planetary atmosphere. In this work we simulate the MIRI coronagraphic observations for a set of 8 known directly imaged exoplanetary systems by using the Exo-REM model. For each planet we estimated the signal-to-noise of MIRI coronagraphic observations as a function of various observing telescope conditions. Subsequently we measure to which accuracy the exoplanetary parameters can be determined when adding MIRI observations to existing near-infrared ones. Finally we provide the significance of the ammonia detection.