Using polarimetry to retrieve the cloud coverage of Earth-like exoplanets

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Clouds in atmospheres of exoplanets play a key role in understanding their climate and radiative balance. They can also complicate the detection of chemical species in the atmosphere by flattening the spectra or by creating degeneracies between observables (Kitzmann et al. 2011, Line and Parmentier 2016)

Polarimetry promises to be a powerfull tool to detect and study exoplanets (Stam et al. 2004). The polarisation of the light scattered by the atmosphere of those planets contains a lot of information about the vertical structure of the atmosphere and about the composition of the clouds (Karalidi et al. 2012) and has already been very successful in the case of Venus (Rossi et al. 2015, 2016 in prep).

We used radiative transfer models based on the doubling-adding method to simulate the disk-integrated flux and polarization of light scattered by exoplanets with patchy, subsolar and polar water clouds. We show that the degree of polarization of the light scattered by an exoplanet can be used to discriminate between the different types of cloud coverage and to quantify the cloud coverage on the planetary scale. Use of both flux and polarization allows for a resolution of some ambiguities between cloud coverage and cloud top altitudes.

We then propose an observational strategy based on an iterative process using polarization phase curves in the wavelength range 300 to 900 nm that could help retrieve both orbital parameters and cloud coverage with minor ambiguities.

We intend to test this method using GCM outputs to simulate the cloud cover and the resulting flux and polarization of some exoplanets.

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