A High- Spectral Resolution Atmospheric Model

The direct imaging of exoplanets remains a formidable challenge, but new advances in high-resolution spectroscopy are transforming our ability to study them. With cutting-edge instruments like JWST/NirSpec, ESO/CRIRES+, ESO/HiRISE and ANDES/ELT we are beginning to observe wide-orbit gas giants in unprecedented detail. Observed high-resolution spectra of these planets act as Rosetta stones for understanding planetary formation and evolution, providing crucial insights into their atmospheres, chemistry, and orbital characteristics. To fully harness this potential, we need models that can match the precision of these observations.

To this end, I have been developing a new high spectral resolution model (R = 200,000) based on Exo-REM [1] –a well-established tool for simulating planetary atmospheres, though so far only at low/medium resolutions– by incorporating the latest high-resolution molecular data and investigating the effects of incorporating different isotopologue abundances. This state-of-the-art model allows us to extract key properties such as atmospheric composition, surface gravity, and rotational rates, details that lower-resolution observations often struggle to precisely capture.

In this talk, I will present this model as well as the new results emerging from applying this model to specific enigmatic exoplanets, with temperatures ranging from 200 to 2000K, demonstrating how high-resolution spectra can refine our understanding of planetary atmospheres. As we move towards bridging the gap between directly imaged and close-in exoplanets, these techniques will be crucial in paving the way for studying smaller and cooler worlds, ultimately bringing us closer to understanding the full diversity of planetary systems.

[1] "A Self-consistent Cloud Model for Brown Dwarfs and Young Giant Exoplanets: Comparison with Photometric and Spectroscopic Observations", Charnay et al. 2018