Unveiling the composition of inner disks with JWST to enable the interpretation of the composition of planetary atmospheres

Benoît Tabone[1]*, Pacôme Estève*[1] *and the GTO-MIRI MINDS team*

[1] IAS, Paris-Saclay University, Orsay

Planets form, migrate, and obtain their elemental composition in disks orbiting young stars (a few Myrs). The elemental composition of gas and solids in disks is expected to vary with time and distance to the star due to various processes such as the radial drift of icy pebbles, chemical reactions, and sublimation of ices. One of the emerging opportunities for the exoplanet community is to constrain the formation history of planets by measuring their elemental composition. This constitutes one of the scientific grounds of the ARIEL mission. However, linking the composition of planets to their formation history can only be done if the distribution of elements between gas and solids in disks is observationally constrained. With its extensive spectroscopic capabilities in the near- and mid-IR, JWST is now providing unique access to the composition of planet-forming regions of disks (~<10 au).

In this contribution, I will review the first results obtained with JWST, which has extensively surveyed over 200 planet-forming disks with full spectroscopy from at least 5 to 27 micron (MIRI-MRS). This unique sample will eventually provide us with vital constraints on the chemical composition of gas and solids around stars of various stellar types to enable the interpretation of the composition of planets. I will highlight three results that demonstrate the unique potential but also the limitations of JWST, namely :

1) The discovery of an extremely rich hydrocarbon chemistry (benzene, C_2H_2, C_4H_2) in disks around a very low-mass star, brown dwarf, and even planetary-mass companion, hinting at the destruction of refractory carbon. This process could lead to the formation of carbon-poor rocky planets around M-dwarf (e.g. TRAPPIST 1).
2) The signature of drifting icy pebbles, which enriches the inner disk in oxygen in the gas-phase, leading to metal-rich and low C/O atmospheres of gas-giants formed inside of the water snowline.
3) The composition of the inner disks of planet-hosting disks like PDS 70, highlighting the impact of forming giant planets like Jupiter on the formation of inner planets like our own.

Along with these first results, I will present the modelling approaches we are developing to retrieve the composition of the gas and dust from JWST spectra. This talk will highlight the need for synergy between the ARIEL mission and the characterisation of inner disks.