The C/O ratio in planet-forming regions of disks with JWST

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Despite the tremendous number of exoplanets detected, planet-forming scenarios are not yet able to fully explain the large diversity of planets. They form and obtain their composition from gas and dust in protoplanetary disks. The elemental composition of disks is known to vary spatially due to physical (ex: pebble drift) and chemical (chemical reactions, sublimation) processes. Thus, the elemental composition of planetary atmospheres is expected to give valuable insight about their formation, in particular the C/O ratio. However, the chemical composition of planet-forming regions of disks is still poorly constrained, making it difficult to link exoplanetary atmospheres and planet formation history. In this context, the James Webb Space Telescope opens an unprecedented observation window on the inner disks (<10 au). The MIRI Guaranteed Time Observation of planet-forming disks MINDS (PI: Th. Henning) observed more than 50 disks, and revealed an active chemistry in these inner regions by detecting plenty of new molecules, especially hydrocarbons. In particular, the JWST spectra show a large dispersion of H_2O and C_2H_2 emission in TTauri disks (Grant+ subm), potentially highlighting chemical processes at stake. We now need thermo-chemical models to understand these observations and quantify fundamental parameters of disks.

I will present an overview of several important results from the MINDS collaboration, and highlight a work based on the thermo-chemical model Dust And LInes (DALI) to investigate the relationship between the observed variation of H_2O and C_2H_2 emission and the C/O ratio. After mentioning several modelling improvements, especially a refined Carbon chemistry, I will show that the C_2H_2/H_2O line flux ratio is very sensitive to the C/O ratio, making it a promising tracer. These results could put strong constraints on our understanding of the structure and evolution of protoplanetary disks. Looking ahead, the remarkable sensitivity of JWST combined with the angular and spectral resolution of the ELT/METIS instrument will considerably enhance our picture of inner disks.