First constraints on elemental abundances in inner disks of T Tauri stars from thermochemical models

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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 planetary atmospheres is expected to give valuable insight about their formation, since it is known to vary spatially and temporally due to physical (ex: pebble drift) and chemical (chemical reactions, sublimation) processes, like 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 et al. 2026), potentially highlighting chemical processes at stake, such as a variation of the C/O ratio.

I will 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 chemical network in such a warm environment plays a significant role in the predicted abundances of hydrocarbons. In particular, reactions with high activation barriers, such as hydrocarbons with H2, are crucial in the carbon chemistry, but their rates are still uncertain and need robust estimations. Finally, the models confirm that the C2H2/H2O flux ratio is a promising tracer of the C/O ratio, but limited by the uncertainty on dust properties. Still, the comparison with the MINDS sample suggests that the C/O < 1 in inner disks around T Tauri stars, which represents a relevant constraint when interpreting exoplanet atmospheres.