Dust composition and sub-structures
in the inner regions of planet forming disks

Young stars are surrounded by circumstellar disks, in which planets are forming. Rocky planets acquire most of their mass from disk material originally in the form of sub-micron sized dust grains, composed mostly of silicates, iron, and carbon. Circumstellar silicate grains can be easily detected at mid-infrared wavelengths, by their characteristic spectral features. Spectral analysis can uncover the mineral buildup of the dust, and thus we can estimate the composition of the planets forming from that material, and make valuable comparisons with our Solar System.

Planet-forming disks are relatively short-lived (<10 Myr) and in continuous change. Circumstellar dust is being processed, and forming planets also leave their imprints in the disk structure and material composition. With spatially resolved observations at milliarcsecond resolution, we can study these processes in the inner disk region ($r < 5$ au) where terrestrial planets form. This is made possible with infrared interferometric observations at the Very Large Telescope Interferometer (VLTI). VLTI’s MATISSE instrument is uniquely suited for that job, because it is able to spatially resolve the inner disk, and spectrally resolve the relevant dust emission features in the N band at the same time.

The VLTI/MATISSE Guaranteed Time Observations team, which I am part of, is conducting a multi-year large survey of about a hundred planet-forming disks, with the aim to create a systematic overview of inner disk sub-structures and dust composition. The majority of our objects are Class II Herbig AeBe and T Tauri disks. In my talk, I will present science highlights from the first five years of our survey, focusing on the results on dust.

A spectacular case is the disk of HD 144432 where VLTI's sub-au angular resolution allowed us to detect a three-ringed structure in the inner 5 au. We were able to constrain the dust composition in each ring, and we confirmed that the disk region within 1 au has a high fraction of crystalline silicates, suggesting thermal annealing taking place there. We also found evidence for solid iron grains in the disk.

Finally, in the last part of my talk, I will present a novel project to study T Tauri disks by combining JWST/MIRI and MATISSE observations. MIRI data is used for compositional analysis of both dust and gas, while MATISSE data constrains the radial distribution of the disk material. The cooperation of the two instruments allows us to extend the discovery space of MATISSE to disk studies in the faint flux regime.

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