MATISSE

Multi AperTure Mid-Infrared SpectroScopic Experiment

for the ESO VLTI

MATISSE Science Team*

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MATISSE is a mid-infrared, spectro-interferometric instrument proposed for ESO's Very Large Telescope Interferometer (VLTI). MATISSE will be able to combine up to four UT or AT beams of the VLTI. It will measure closure phase relations and thus offer an efficient capability for image reconstruction. In addition to this, MATISSE will open 2 new observing windows at the VLTI: the L and M band in addition to the N band. Furthermore, the instrument will offer the possibility to perform simultaneous observations in the separate bands. MATISSE will also provide several spectroscopic modes.

MATISSE can be seen as a successor of MIDI by providing imaging capabilities in the mid-infrared domain.The extension of MATISSE down to 3μm as well as its generalisation of the use of closure phases make it also a successor of AMBER. Thus, in many respects MATISSE will combine and extend the experience acquired with two first-generation VLTI instruments - MIDI and AMBER.

Science with MATISSE

Thanks to its capability to allow image reconstruction, MATISSE will address qualitatively new questions for a large variety of astrophysical topics, such as Star and Planet Formation, Evolved Stars, Solar System minor Bodies, Extrasolar Planets, Active Galactic Nuclei, and the Galactic Center.

Star and Planet Formation

Low-mass Star and Planet Formation

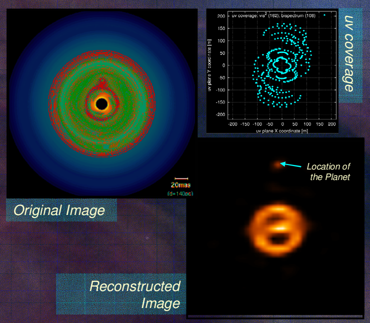
- Connection between complex disk structures on large (~100 AU) and small scale (~1 AU); Inner disk clearing?
- Mineralogy of proto-planetary disks; Evidence for dust grain growth and sedimentation
- Characteristic structures in disks: Evidence for the presence of giant proto-planets
- The binary mode of star formation: Circumbinary and circumstellar disks; Disk alignment and early evolution of binary systems
- Nature of outbursting YSOs: Structure of young accretion disks

Late Stage of Planet Formation - Debris Disks:

- The outcome of planetesimal collisions and exo-comets evaporation: Dust grain properties and disk geometry
- Complex spatial disk structure - direct indicators for the presence of planets
- Characterization of Darwin/TPF targets

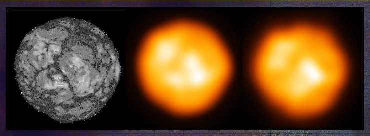
Massive Star Formation

- Spatial distribution of the gas (carbon monoxide and hydrogen) and dust (silicates/graphite and CO ice) in typically complex and distant high-mass star-forming regions
- Link between low and high-mass star formation?: Search and characterization of accretion disks around young massive (proto)stars



Simulation of MATISSE N band observations of a circumstellar disk with an embedded planet.

[3 x 4ATs; B~150m; Brightness ratio Star:Planetary Accretion Region=200:1; FOV: 104mas; 1000 simulated interferograms per snapshot considering photon and 10μm sky background noise; average SNR of visibilities: 20]



Simulation of MATISSE L band observations of a Betelgeuse-like star.

[Left: Original image (Chiavassa priv.comm.); Middle: Ideal image with a 150m telescope; Right: Reconstructed MATISSE image: 3x4 ATs, B=150m]

Simulation of MATISSE observations of a clumpy AGN torus (4 UTs, λ=3.4μm; 15pc x 15pc).

[FOV: 43mas, 1000 interferograms per snapshot with photon noise and background noise; average SNR of squared visibilities: 50]

Active Galactic Nuclei

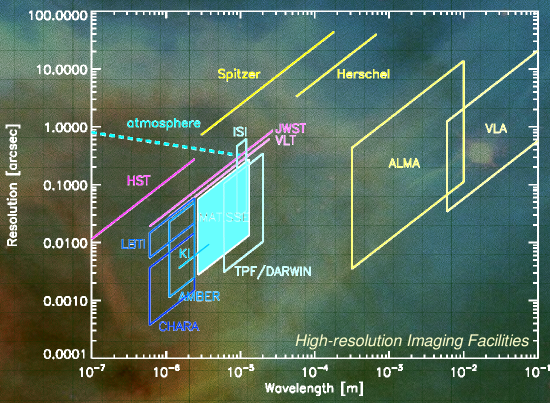
- Is the torus just the inner, AGN-heated part of the central molecular disk in the host galaxy or is it a decoupled feature, mainly governed by the (young) central star cluster?
- To which extent is the torus structure regulated by outflow phenomena (supersonic winds, jets) which seem to be connected with most kinds of AGN activity?
- What fraction of the dust emission from within the inner few parsecs of an AGN is emitted by the torus and what by dust entrained in the outflows?
- Can we find direct evidence that tori are clumpy or filamentary structures?

Evolved Stars: Direct link between shock waves and dust formation?; Spatial structure of molecular layers; Molecular abundances; Origin of the anisotropy in Planetary Nebulae; Dust geometry in carbon WR stars (WC) binaries; Conditions of dust formation in B[e] stars; Influence of the binary companion on the development of azimuthal asymmetries in binary B[e] systems; Dust core of the massive star Eta Car; Impact of the eccentric orbit of the companion on the recurrence of dust formation

Solar System Minor Bodies: Early evolution of the Solar System: Surface structure of Asteroids as tracers of collisional processes as a fundamental process in the young Solar System; Binary Asteroids; Direct measurement of sizes and shapes of Asteroids

Extrasolar Planets: Observation of Pegasi planets via color differential interferometry; Constraints on the mass (from orbit) and temperature / radius / atmosphere composition (from spectrum)

Galactic Center: Imaging the jet and lobe structures surronding the central black hole; X-ray / infrared binary flar stars in the vicinity of the Galactic Center



In most astrophysical domains which require a multi-wavelength approach, MATISSE will be a perfect complement of forthcoming high angular resolution facilities such as the Atacama Large Millimeter Array (ALMA). With the extended wavelength coverage from the L to the N band, MATISSE will not only allow one to trace different spatial regions of the targeted objects, but also different physical processes and thus provide insights into previously unexplored areas, such as the investigation of the distribution of volatiles in addition to that of the dust.

Instrument Characteristics

Spectroscopic Resolution

Bands	Spectral Resolution	Application
L&M / N	30 / 30	Amorphous dust emission features
L&M / N	500/ 250	Crystalline dust emission features
L&M	750 – 1500	Molecular bands; Selected atomic lines

Maximum Spatial Resolution

Band	Usage of ATs	Usage of UTs
L	3 – 4 mas	6 mas
M	5 mas	8 mas
N	10 mas	16 mas

Correlated Flux Sensitivities (performance goals)

Band	Usage of ATs	Usage of UTs
L	0.5 Jy	0.1 Jy
M	1.0 Jy	0.2 Jy

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