Protostars and Planets with JWST-MIRI

Dishoeck, E.F. van; Merín, B.; Brandl, B.; Böker, T.; Greene, T.; Meixner, M.; ... ; Boccaletti, A.

PROTOSTARS AND PLANETS WITH JWST-MIRI. E.F. van Dishoeck, B. Merín, B. Brandl, *Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands (ewine@strw.leidenuniv.nl)*, T. Böker, *ESA-ESTEC, Noordwijk, The Netherlands*, T. Greene, *NASA-Ames Research Center, Moffett Field, USA*, M. Meixner, *StScI, Baltimore, USA*, M. Ressler, *NASA-JPL, Pasadena, USA*, G. Rieke, *University of Arizona, Tucson, USA*, C. Waelkens, *University of Leuven, Belgium*, G. Wright, *UK-ATC, Edinburgh, UK*, C. Cavarroc, A. Boccaletti, *Obs. de Paris, Meudon, France*, and the MIRI Team.

The MidInfraRed Instrument (MIRI) is one of the instruments on board the ~6m James Webb Space Telescope (JWST) operating in the 5 to 27 μm wavelength regime (Wright et al. 2003, Rieke et al. 2005). The basic capabilities of MIRI are shown in Table 1. It consists of an imager and an integral-field spectrometer cooled to 7 K by cryocoolers. The imager has a 1024×1024 pixel Si:As array with a $1.8' \times 1.3'$ FOV with diffraction-limited image widths of $0.2''$ at 5.6 μm up to $0.9''$ at 25.5 μm, with a mix of broad and narrow-band filters. It includes low resolution ($\lambda/\Delta\lambda = R \approx 100$) slit spectroscopy and coronography in four filter bands using fixed masks.

The spectrometer has two 1024×1024 Si:As arrays and can obtain simultaneous spectral and spatial data on a few arcsec region by using four integral field units constructed of image slicers (see Table 2). A full 5–28.5 μm spectrum requires 3 exposures, with the dichroic/grating wheels moved between each exposure. The spectral resolution of $R \approx 2000 - 3700$ is well suited study both gases and solid-state material, including H_2, H_2O, organic molecules like CH_4 and C_2H_2, Polycyclic Aromatic Hydrocarbons, and a wide variety of ices, silicates, oxides, carbides, carbonates and sulfides, all of which have prominent bands at mid-infrared wavelengths.

MIRI will be limited by the zodiacal background out to 10 μm. At longer wavelengths, scatter from the sunshield and the thermal background from the telescope limit the performance. Table 3 lists examples of the MIRI sensitivity levels for point sources. For imaging, MIRI's sensitivity is 50 times better than that of the Spitzer Space Telescope at 5–10 μm at an order of magnitude higher angular resolution. Compared with ground-based 8m-class telescope, the increase in mapping speed is many orders of magnitude. Similar gains in sensitivity and spatial resolution hold for the spectrometer, which also has significantly higher spectral resolution than the Spitzer-IRS.

Table 1: Basic capabilities of MIRI

Mode	Wavelengths (μm)	$\lambda/\Delta\lambda$	FOV
Imaging	5–27	~ 5	$1.8' \times 1.3'$
Coronography	10.65, 11.3, 16, 24	10	$25'' \times 25''$
Low-res. spectroscopy	5–11	100	$5'' \times 0.6''$ slit
Medium-res. spectroscopy	5–28.5	2000 –3700	$3.5'' \times 3.5''$ to $7'' \times 7''$

MIRI is being constructed as a joint effort between US and European institutions. It has passed its preliminary design review in March 2005. The structural and mechanical models have undergone vibration testing, and the verification models are being built. The first engineering arrays from Raytheon have been delivered. MIRI will have its critical design review in 2006 and be launched on JWST around 2013.

Table 2: Characteristics of the integral field spectrometer

Channel	Wavelengths (μm)	FOV $''$	slice $''$	$\lambda/\Delta\lambda$
1	4.9– 7.7	3.7×3.7	0.18	2500–3700
2	7.4–11.8	4.5×4.5	0.28	2500–3700
3	11.4–18.2	6.1×6.1	0.39	2500–3700
4	17.5–28.8	7.7×7.7	0.65	2000–2500

Because of its versatility and sensitivity, MIRI contributes to virtually all areas of emphasis in the JWST science planning. In this poster, we focus on two JWST themes: 'Birth of stars and protoplanetary systems', and 'Evolution of planetary systems and the conditions for life'. The capabilities of MIRI will be illustrated with a number of examples including imaging and spectroscopy of protostellar objects, of protoplanetary disks, of debris disks, and of exoplanets.

Table 3: Examples of MIRI performance (10σ, 10^4 sec)

Imag. 5.6 μm μJy	Imag. 12.8 μm μJy	Imag. 21 μm μJy	Spec. 9.2 μm 10^{-20} Wm^{-2}	Spec. 22.5 μm 10^{-20} Wm^{-2}
0.19	1.4	8.6	1.0	6.0

References: [1] Wright, G., et al. 2003, SPIE, *4850*, 493. [2] Rieke, G. et al. 2005, StScI Newsletter, *22*, 11.