Stellar sources for the in-orbit spectrophotometric calibration of the Medium Resolution Spectrometer of the Mid Infra-Red Instrument onboard the JWST

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Abstract

The accurate spectrophotometric calibration of the MRS requires a list of fiducial calibrators with well-characterized spectra. Since the sensitivity of the MRS is much higher than previous infrared (IR) spectrometers, a new set of calibrators has to be constructed. This set should contain different spectral types in the appropriate flux range. Extra effort should be put in the pre-characterization of their IR spectrum.
We describe the method used to construct this list of calibrators and to predict their IR spectrum.

Technical specifications of the MIRI MRS:

- wavelength range : 5 – 27 micron
- flux range at 10 micron: 4 – 500 mJy
- field of view: 3.7"x3.7 at shortest wavelengths, 7"x7" for longest ones
- spectroscopic resolution : ~ 3000

Different spectral types

in order to avoid biases in the calibration due to the use of only one spectral type, sources with different spectral types have to be used.
This also results in a more accurate calibration, because each spectral type has its specific problems and uncertainties for parts of the modeling. By combining the different types, the most accurate spectrum can be used for every part of the MIRI wavelength range, and the highest possible accuracy for every wavelength can be achieved.

Theoretical atmosphere models

- MARCS code by Gustafsson et al. (2003) will be used to construct the spectral energy distributions (SED's)
- for objects with Teff < 10 000 K (dwarfs and giants)
- accuracy of < 5% at medium resolution (IR) is possible, if high accuracy stellar parameters can be provided for the sources
- this code has also been used for calibration of the Short Wavelength Spectrometer (ISO-SWS) and the InfraRed Spectrometer (Spitzer-IRS)

Spectral uncertainties:

A dwarfs:

- possible (10%) IR flux excess due to debris disk or circumstellar shell
- incomplete atomic line list to model spectra

late-type giants (G5 – K5II):

strong molecular absorption bands which can only be modeled if the stellar parameters (Teff, gravity, chemical composition, ...) are very accurately known

solar analogs:

both molecular and atomic lines are present in spectra, so again the stellar parameters have to be known accurately

Conclusions

through the combination of calibration sources with different spectral types, with theoretical atmosphere models, the most accurate spectrophotometric calibration possible will be obtained.

Calibration strategy

preliminary source list
- containing > 50 well known sources
- with the appropriate flux range
- different spectral types

A dwarfs, cool giants, solar analogs from IR catalogs (Carter-Meadows, Landolt) and calibration stars of space missions (Spitzer, ISO)

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observations : 24 micron photometry
needed to exclude sources with IR flux excess due to debris disk or circumstellar shell (Spitzer MIPS observations)

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reduced list
26 sources: MIPS and IRS calibrators
advantages : - well studied objects
- provide overlapping observations to check calibration of MIRI

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collect observations
- high resolution optical spectroscopy
- narrow-band photometry

to constrain the stellar parameters of the sources for construction of SED'S

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create theoretical spectra
- with MARCS code and stellar parameters
- removing the sources without accurate parameters or other problems

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final list of 15 to 20 stellar sources for the spectrophotometric calibration of the MIRI MRS

References

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