JWST-MATISSE synergy survey of T Tauri stars

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+ MATISSE GTO team

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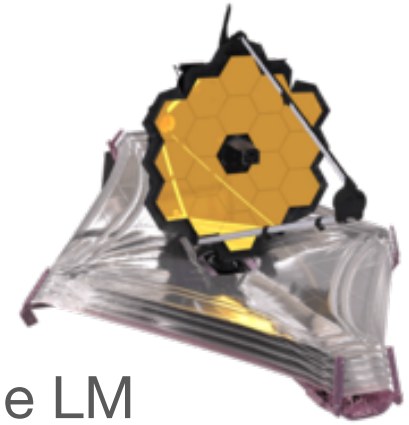
Context and Motivation

The question

- A nominal MATISSE observation contains LM & N-band spectra, both correlated and total flux
- In practice, we have observations when the total flux measurement is either missing or lower quality
- What to do with these observations?! My quick statistics: in 24/144 (17%) UT N-band total flux is missing (target or standard)

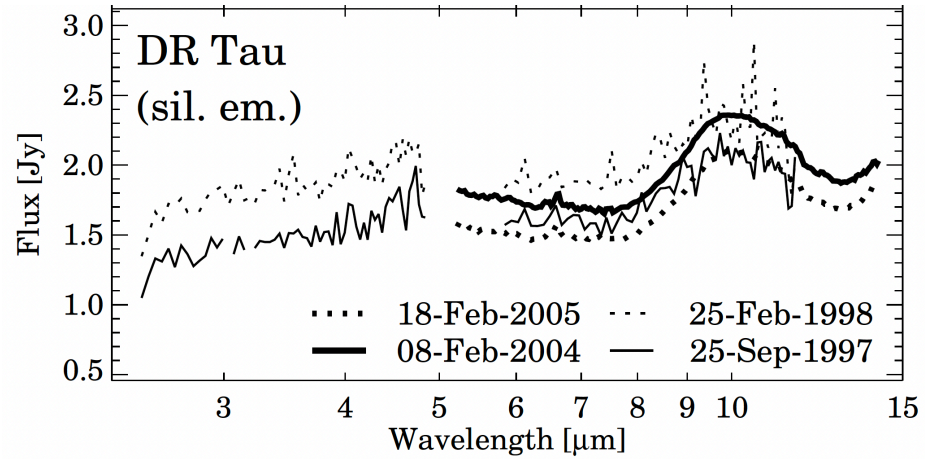


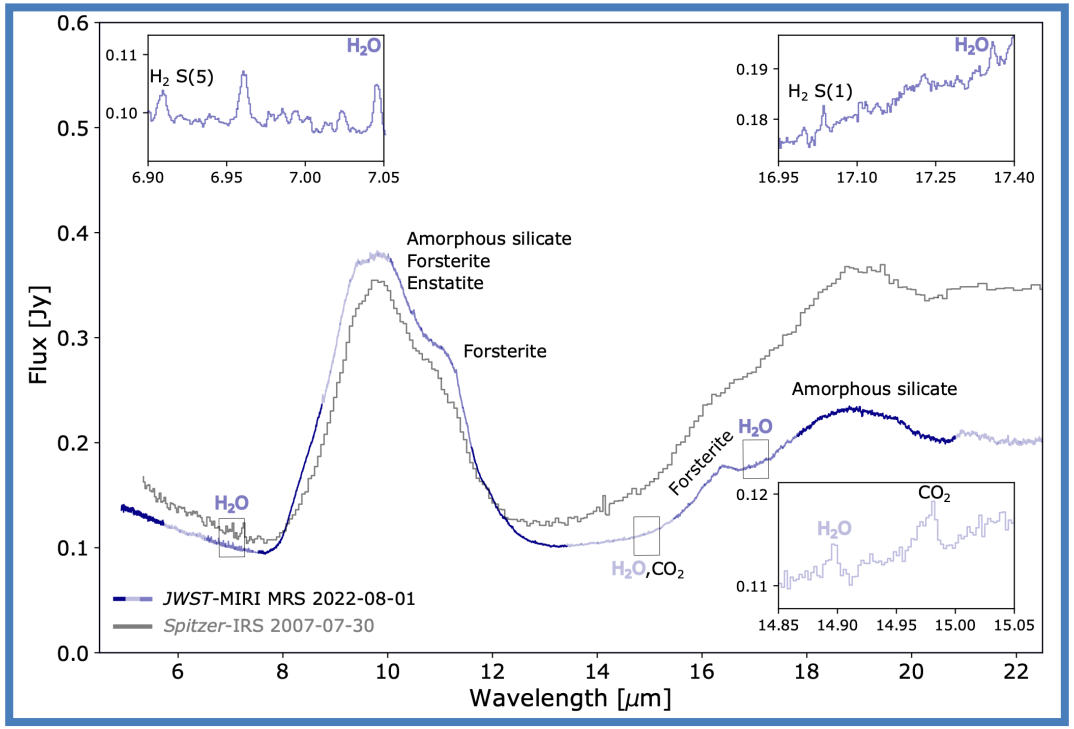
The proposal

- Substitute missing/bad total flux spectra from JWST/MIRI MRS
- Issue 1: MIRI starts at 5 micron, thus covering the N-band but not the LM
- Issue 2: YSO infrared variability

Mid-infrared variability of young stars

- Seen when comparing JWST/MIRI with Spitzer/IRS (PDS 70, Perotti et al. 2023; Sz 98, Gasman et al. 2023)
- Already hinted by comparing ISO and Spitzer (Kóspál et al. 2012)



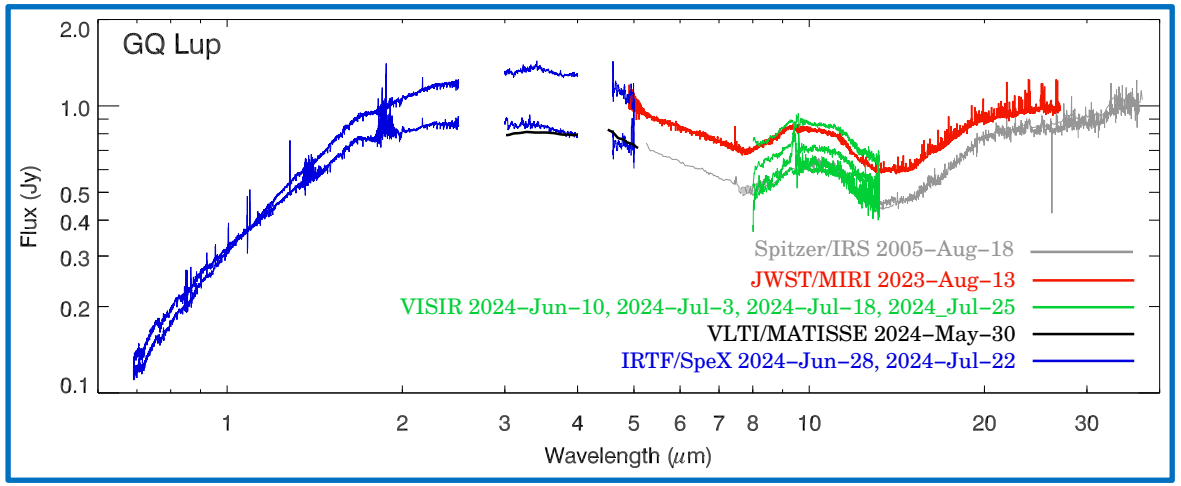


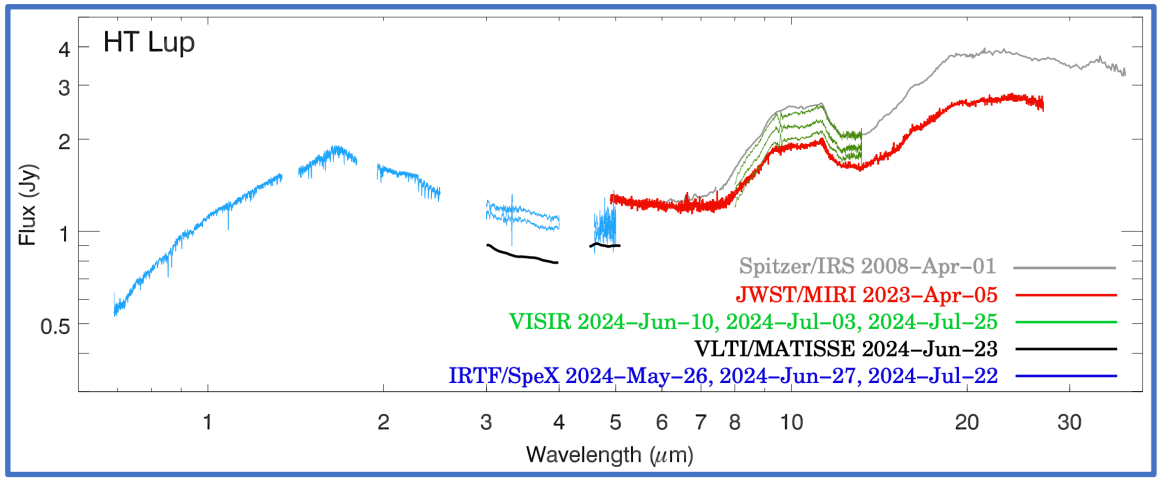
PDS 70 Perotti et al. (Nature, 2023)

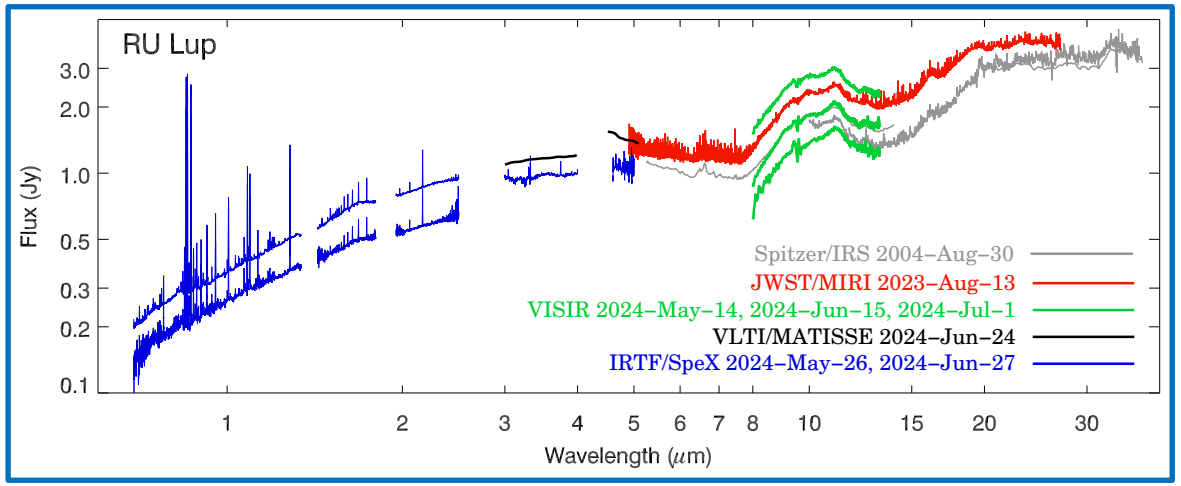
JWST-to-Spitzer statistics from the first year: 28 out of 35 YSOs exhibited spectral changes

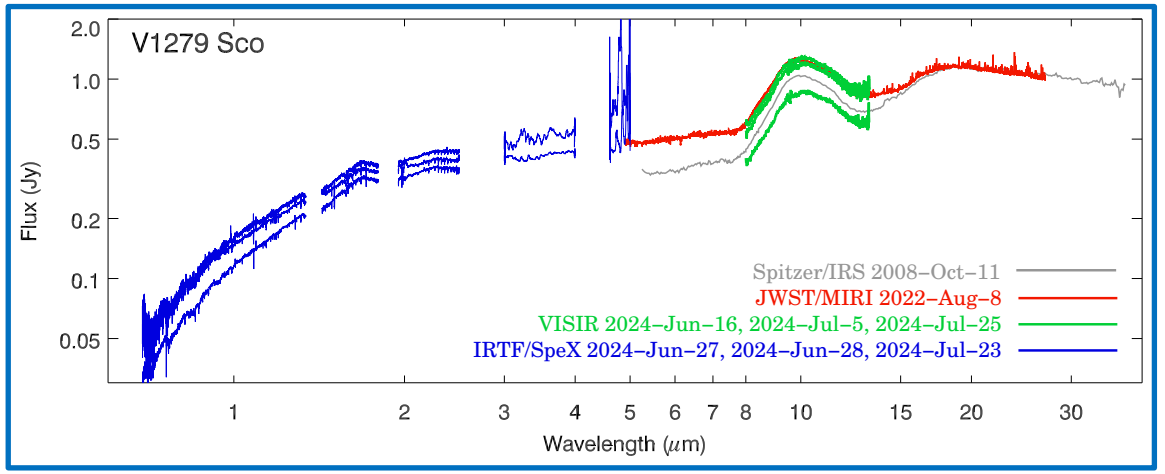
➡ MIR variability on timescales <= 15 yr (Ábrahám et al. 2024, EAS)

Mid-infrared variability of young stars



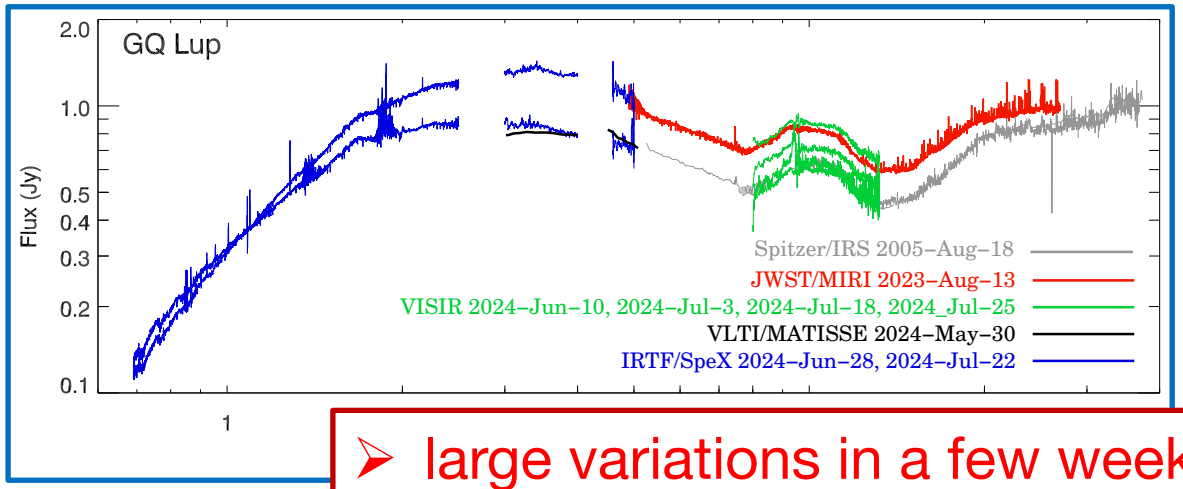


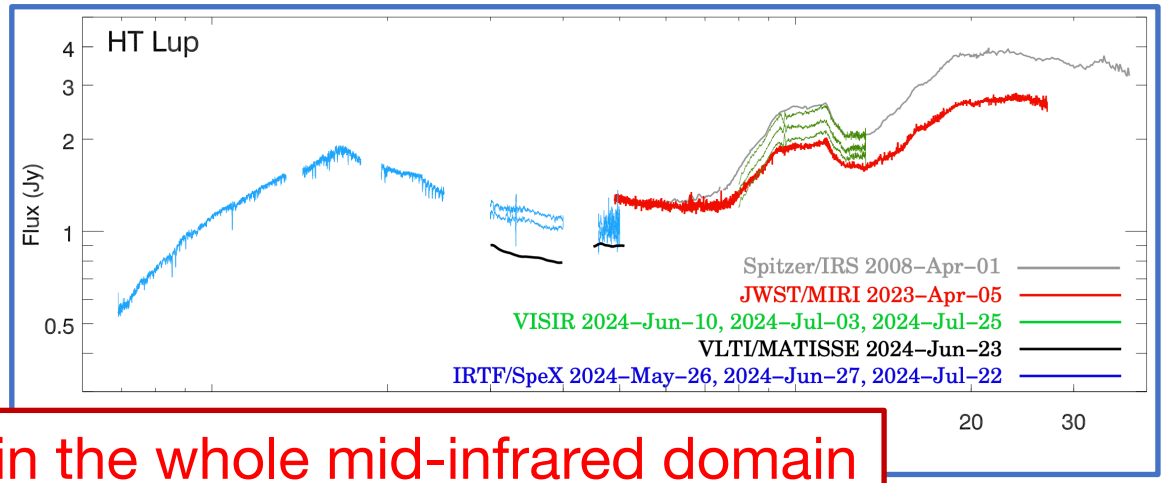




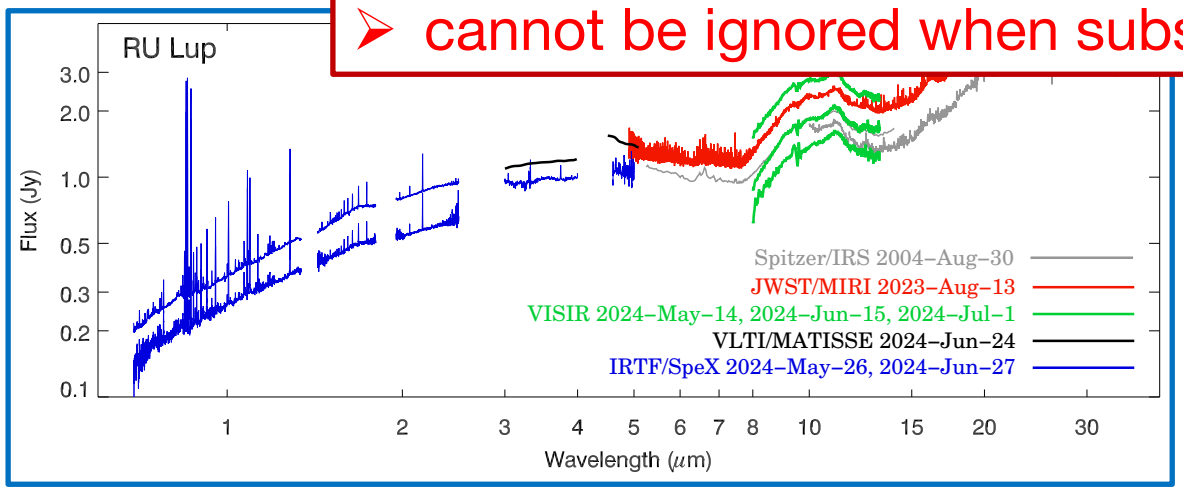
Infrared monitoring of 4 young stars in 2024 May-July. JWST/MIRI: publicly available archive data from MAST (PI: A. Banzatti, C. Salyk). IRTF/SpeX and ESO/VISIR: our own observations (PI: P. Ábrahám).

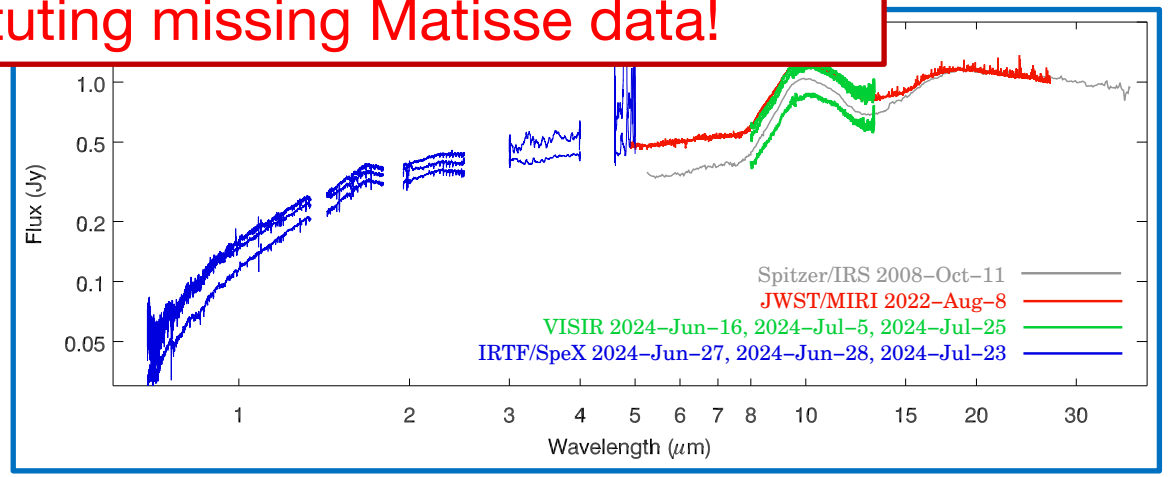
Mid-infrared variability of young stars





- large variations in a few weeks in the whole mid-infrared domain
- cannot be ignored when substituting missing Matisse data!





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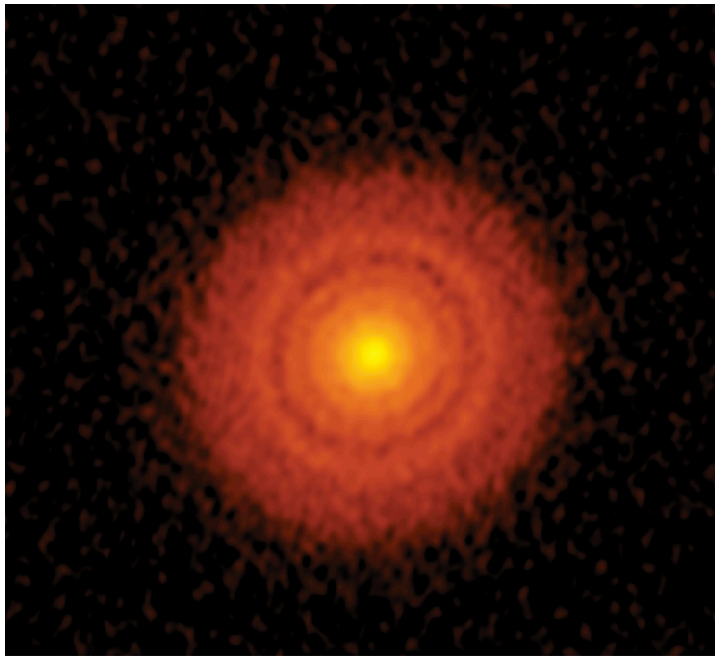
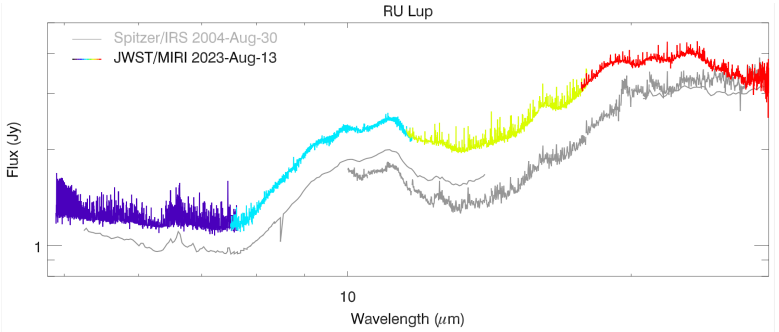
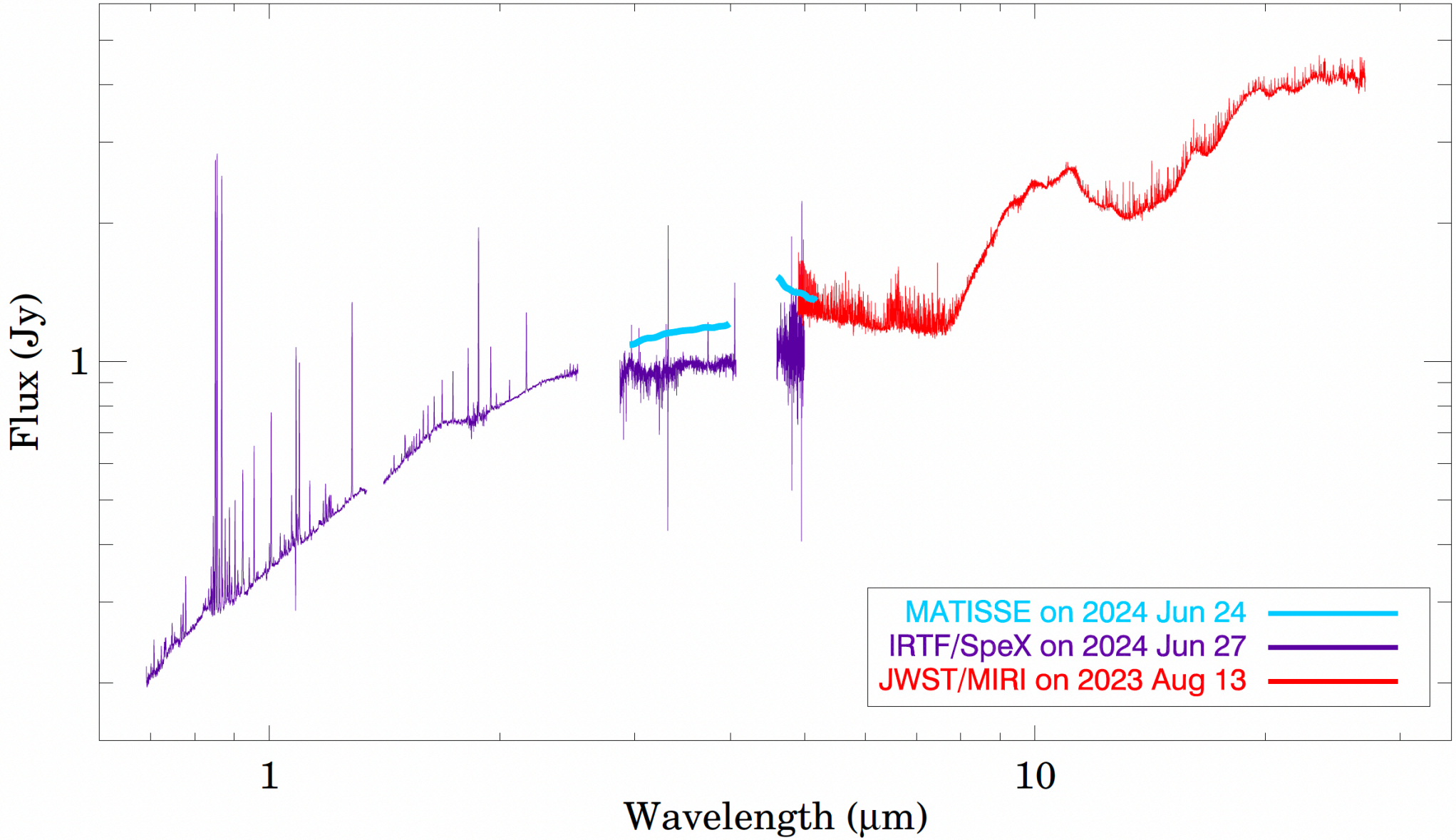
Pilot for synoptic MIRI-MATISSE analysis: RU Lup

- T Tauri star (K7/M0), single object
- ALMA continuum image (DSHARP, Andrews et al. 2018)
- Inclination: 18 deg (Huang et al. 2018)
- MATISSE : 2024 Jun 24 (OT, PI: P. Ábrahám)
  2021 Mar 27 (GTO)
- OT data: GRA4MAT mode, frame flagging issue during chopping, no N-band total spectrum
- public unpublished JWST/MIRI MRS spectrum (PI: C. Salyk) obtained on 2023 Aug 13
- 0.7-5.3 μm IRTF SpeX SXD+LXD_long on 2024 Jun 27 (PI: P. Ábrahám)





Substitute N-band spectrum



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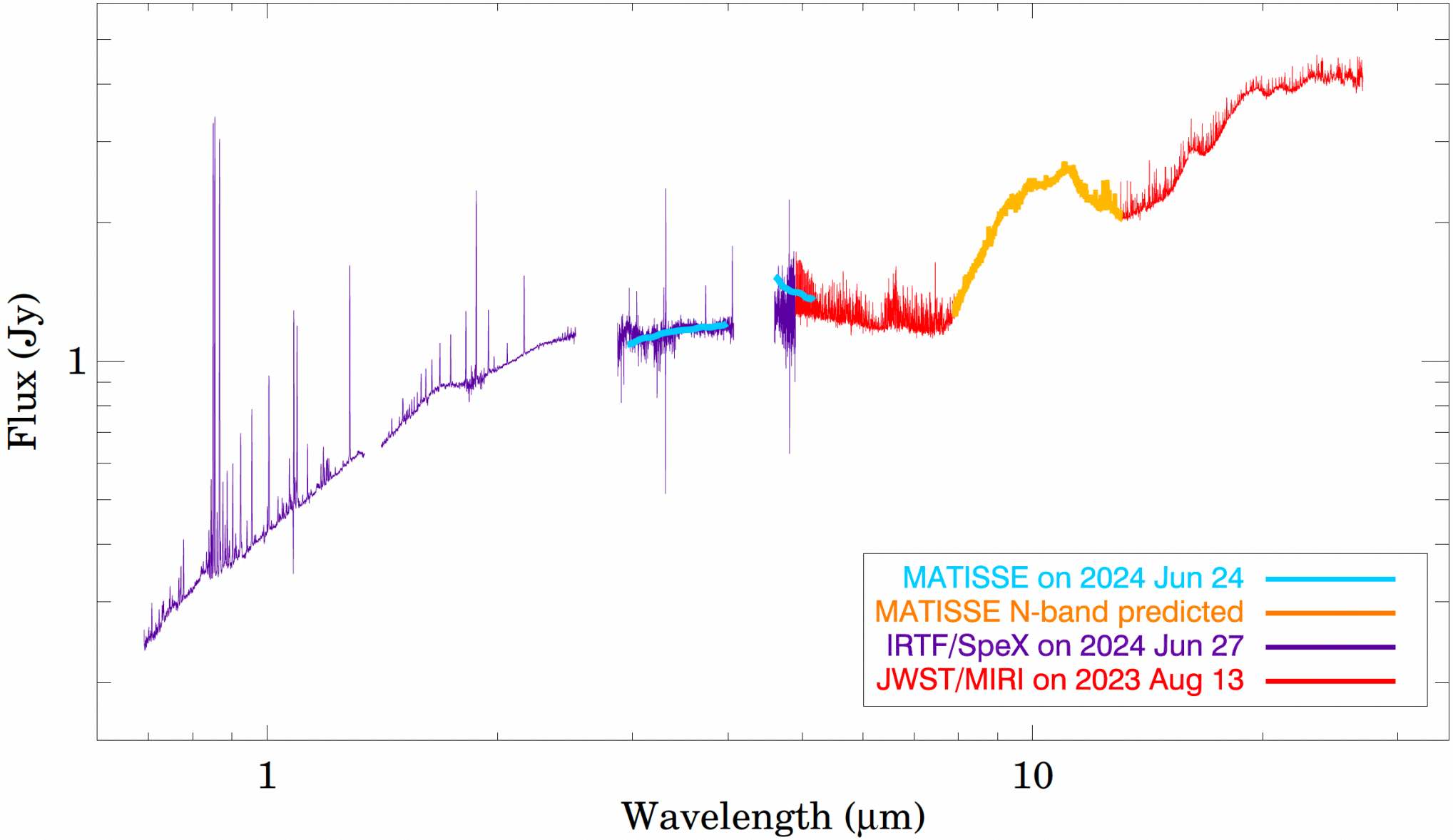
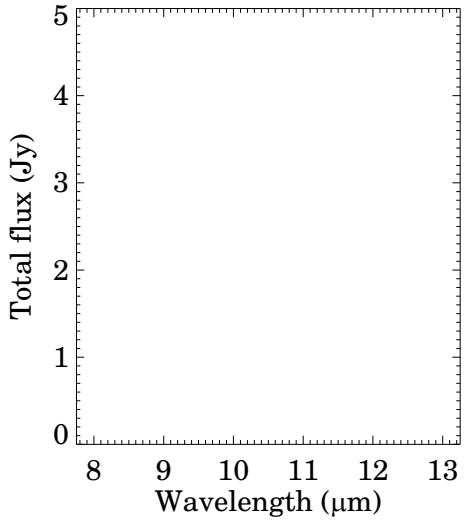


Data processing in the N-band

2024 Jun 24



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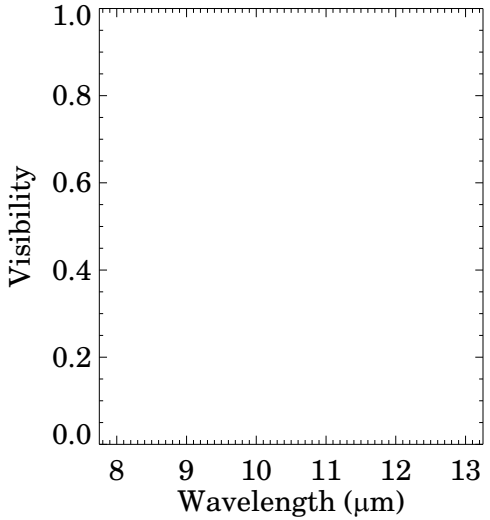

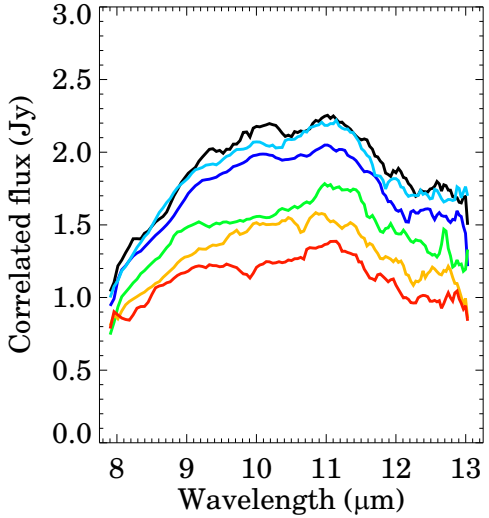

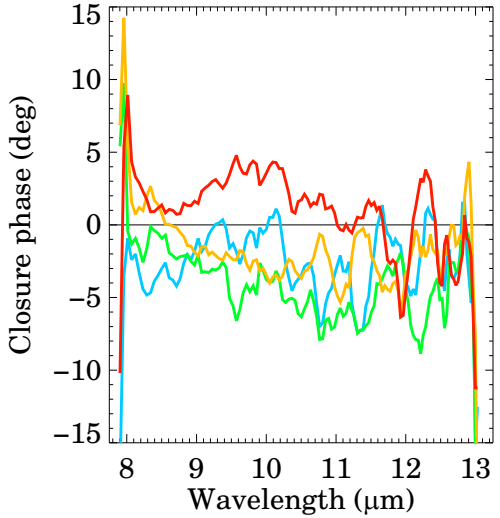

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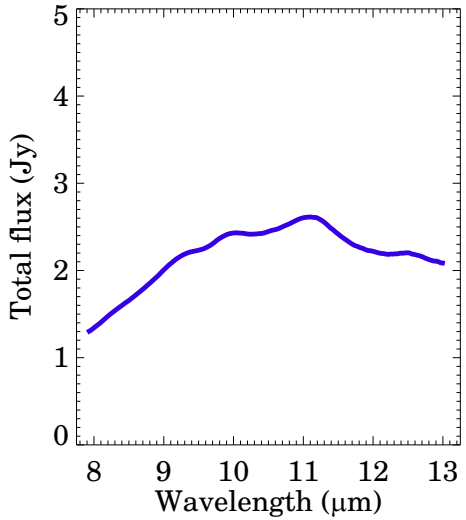

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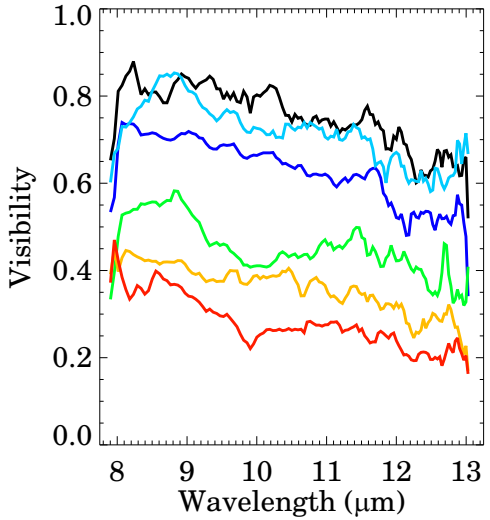

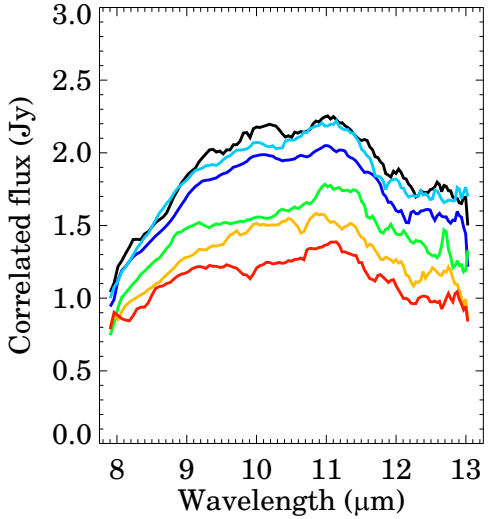

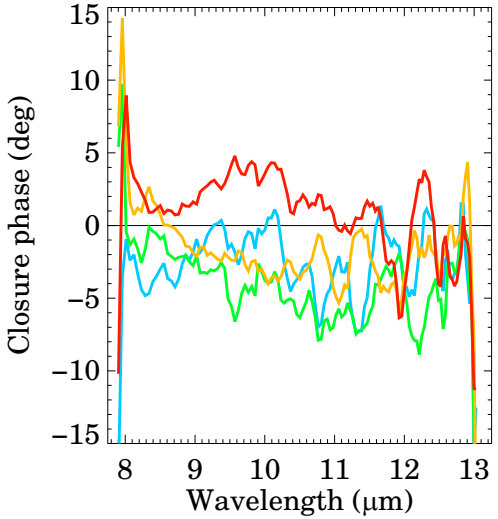

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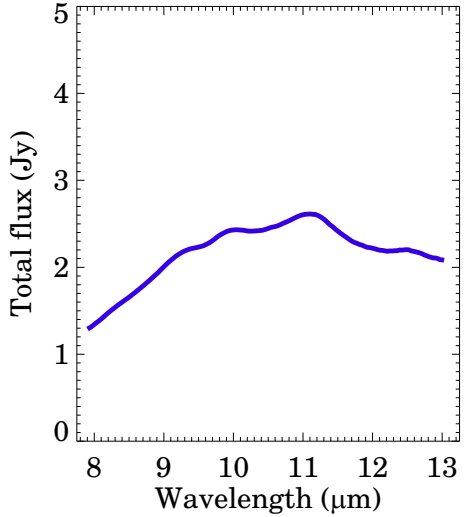

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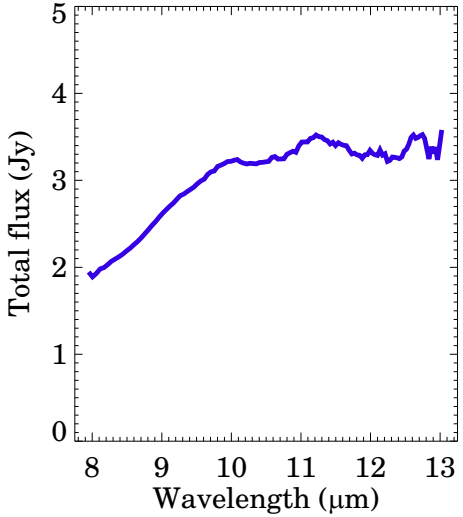

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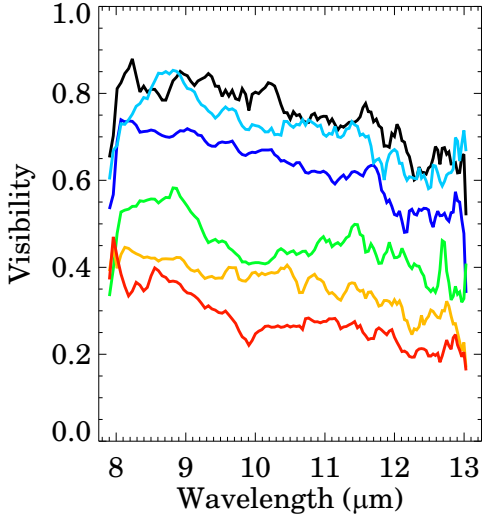

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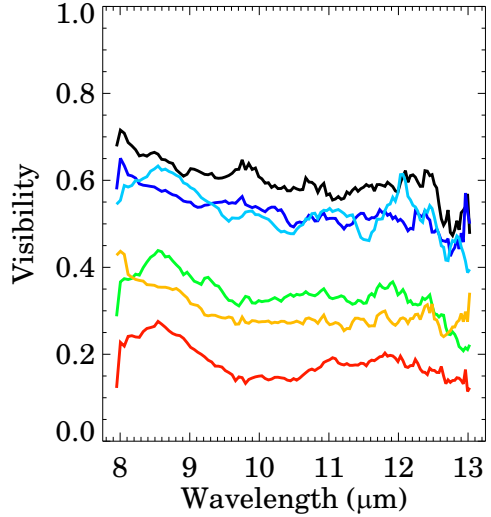
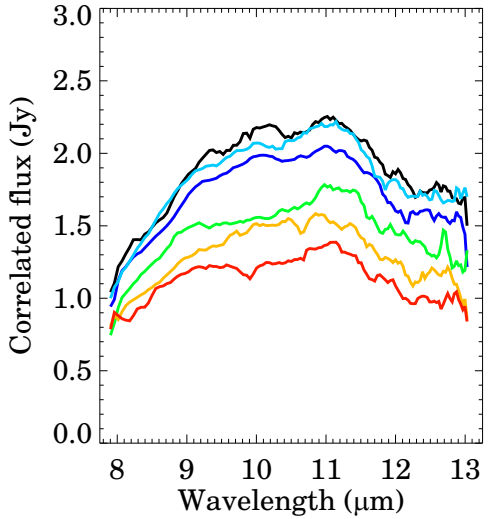
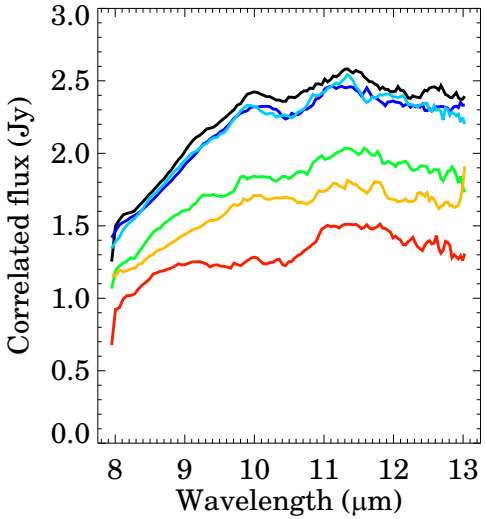
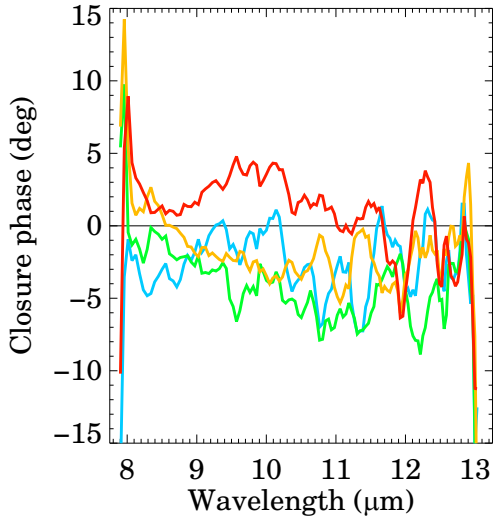
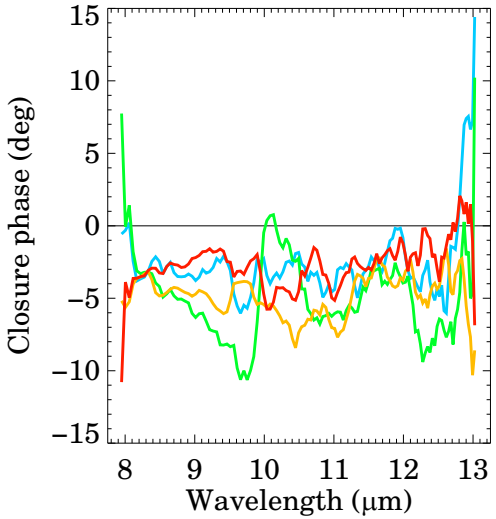


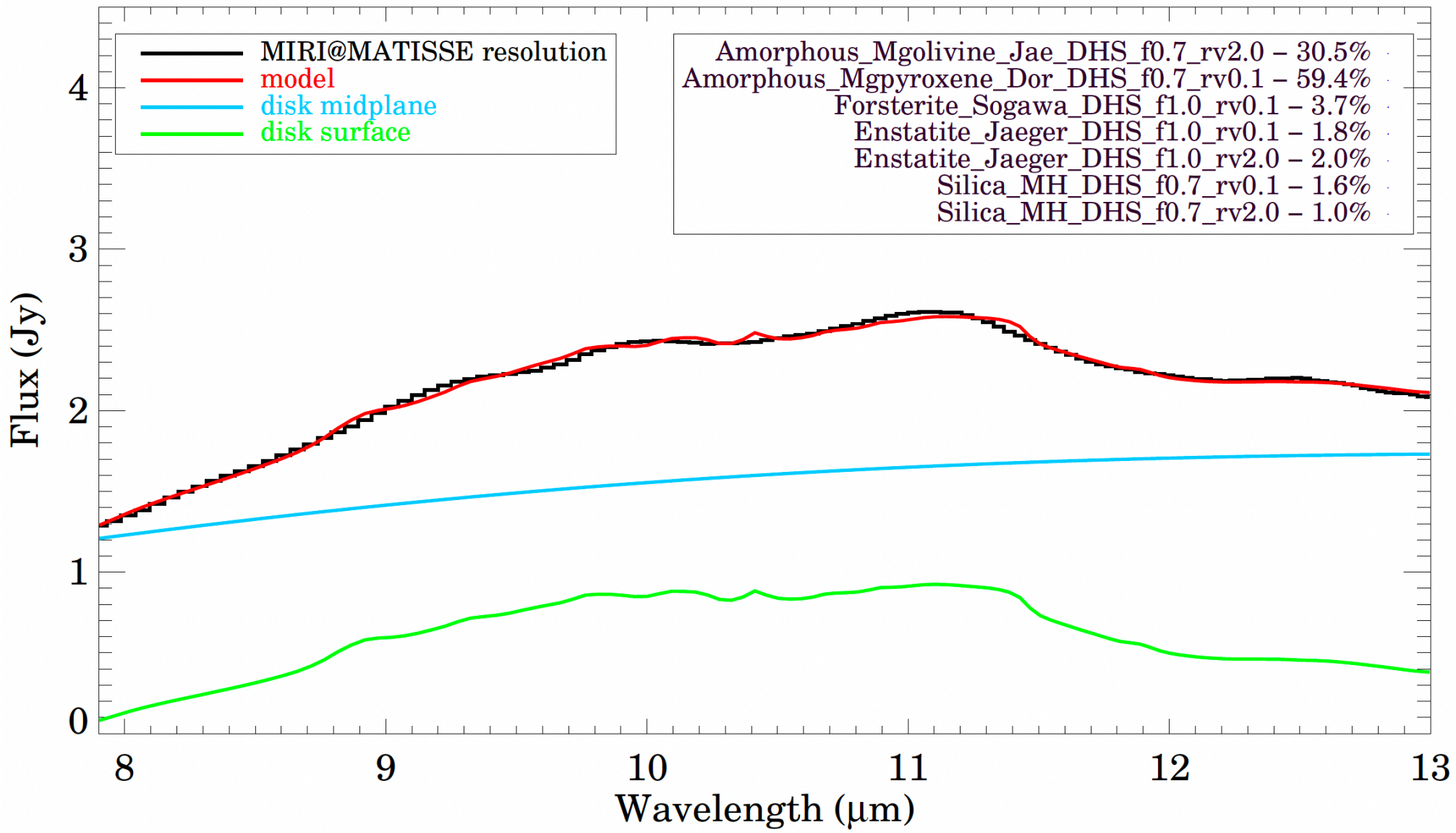








Mineralogical decomposition



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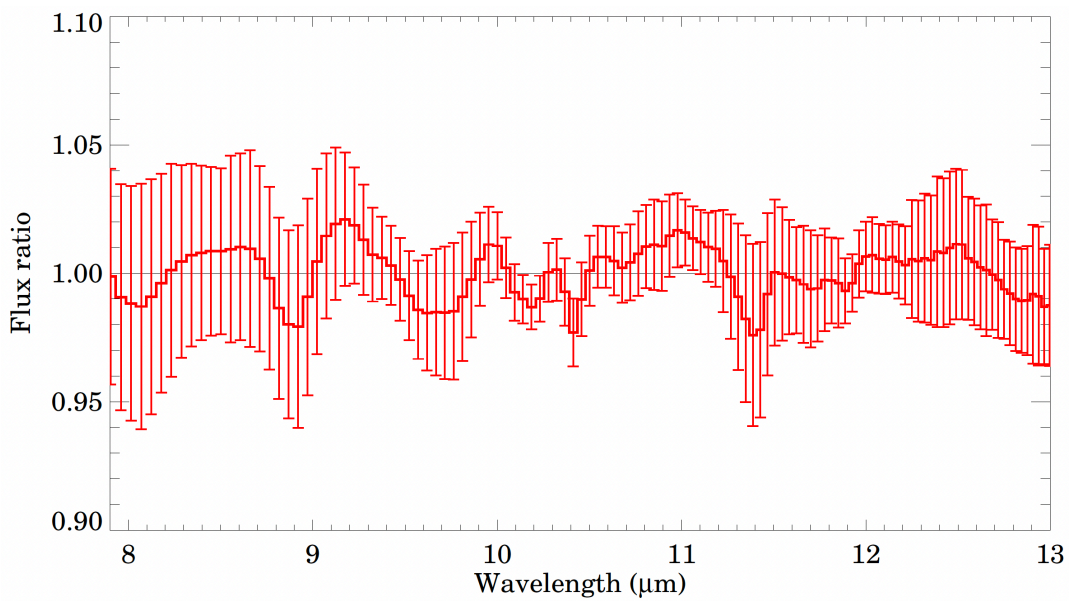

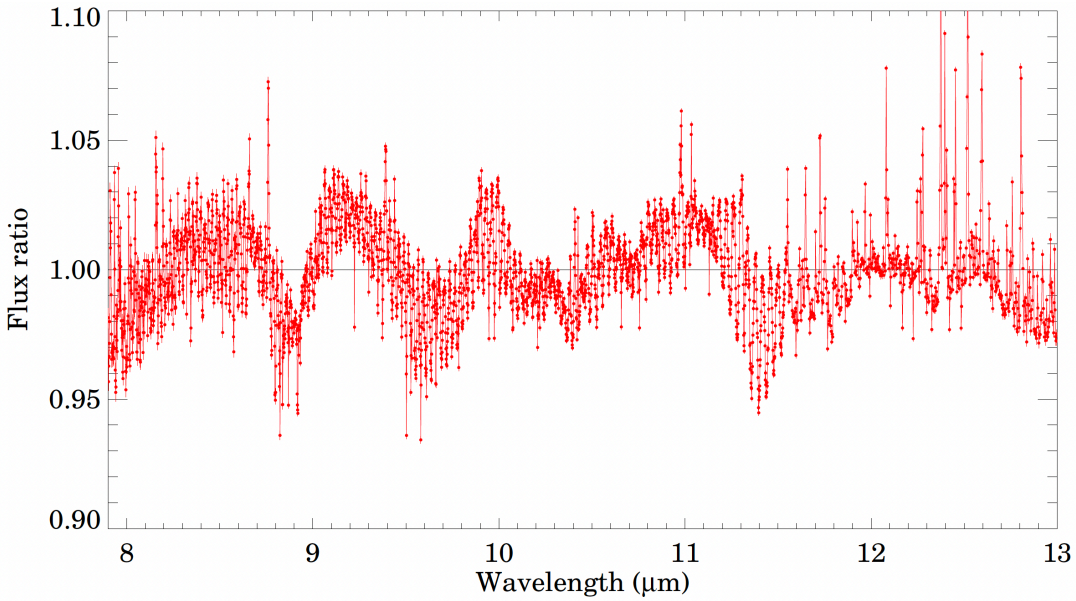

- with the MATISSE spectral resolution the few main components can be fitted
- the original JWST spectrum may reveal additional, less abundant species, too
- it may be a good trick to fit mineralogy using the MIRI total flux spectrum, make a silicate inventory, then search for the same silicates on the different interferometric baselines, and look for radial variations

The recipe: MIRI + MATISSE (+IRTF)

Similar wavelength ranges, complementary advantages.

How to use them together?

- substitute missing data (variability!)
- replace noisier MATISSE spectra
- mineralogical decomposition at higher spectral resolution
- extended disks: MIRI MRS IFU can resolve them
- **other???**

Observational issue: MATISSE works better for bright sources which would saturate MIRI. Overlapping range: 1-5 Jy @10μm.

Submitted ERC: explore possibilities, work out methods to perform the recipe.

MATISSE OT (114.27HB, B-grade, P. Ábrahám)

- MIRI MRS in Cycle 1-3: 209 YSOs
- 30 Class II sources are bright enough for MATISSE, do not saturate MIRI, bright in the R-band...
- 14 have already MATISSE measurement
- the remaining 16 will be observed in the current semester in GRA4MAT mode
- the sample will be large enough to start experimenting
- more sources to come (MATISSE-Wide, MIRI Cycle 4)

ALREADY HAS MATISSE	MATISSE in OT
CPD-36 6759	FZ Tau
AS 205 N	HQ Tau
DG Tau	CW Tau
HL Tau	DF Tau
DR Tau	HP Tau
RW Aur	V1003 Oph
HT Lup	FN Tau
RU Lup	BP Tau
RY Lup	DE Tau
SR 21A	GI Tau
AS 209	HD 35929
HD 31648	VW Cha
HD 142666	WX Cha
HD 163296	T Cha
	SR 4
	Hen 3-1258