First VLTI/MATISSE observations of the core region of IRS13 in the vicinity of SgrA*

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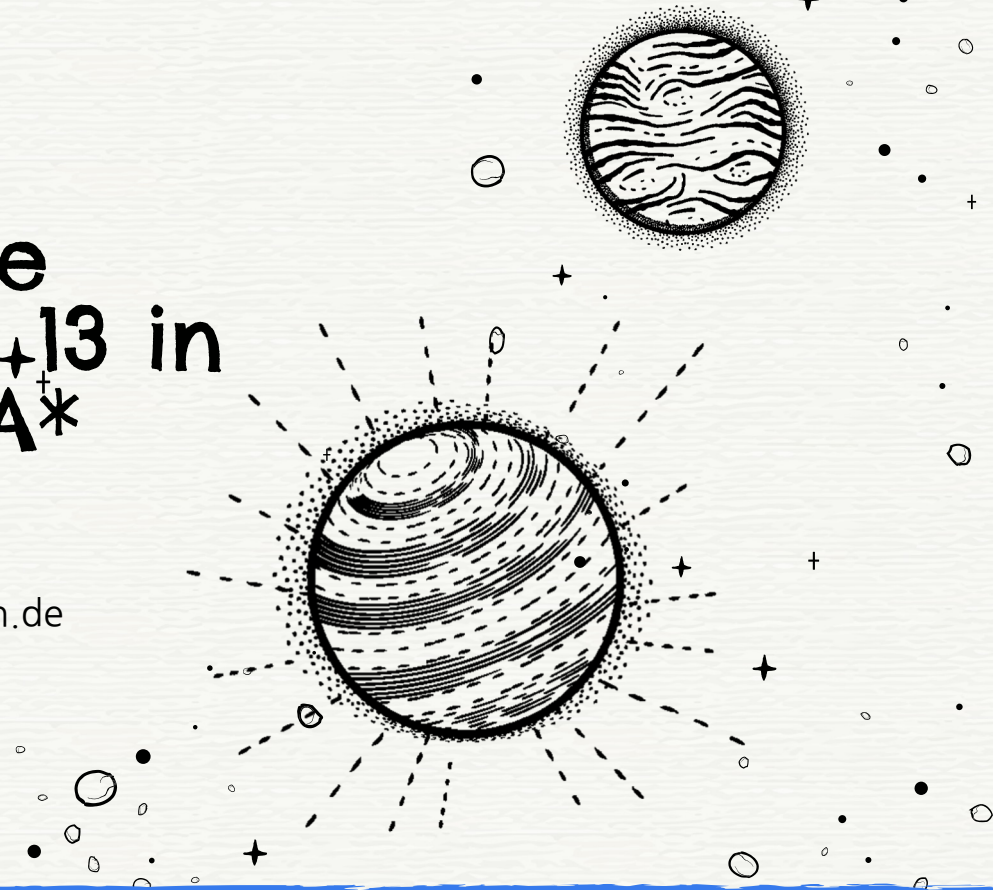


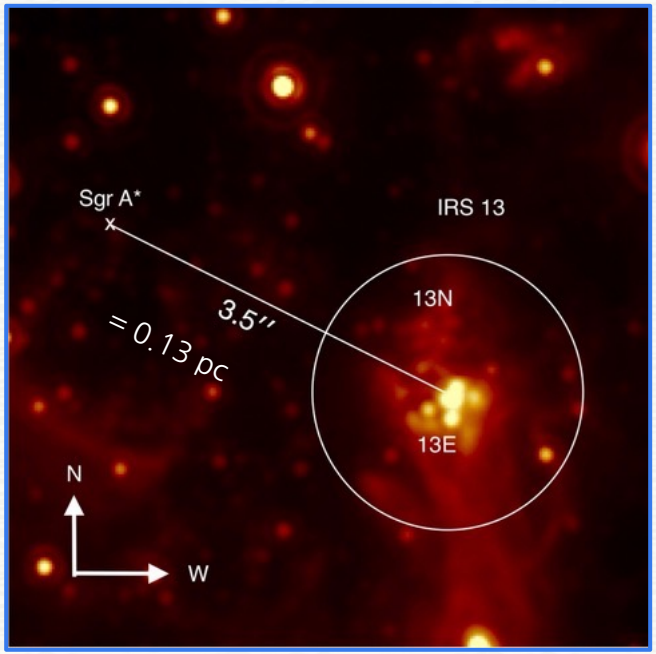
The Galactic Centre

- Distance: 8kpc
- Sgr A* is the SMBH
- Mass: $4\times10^{6}M_{\odot}$

- Incompatible with star formation?

Credit: John Colosimo/ESO

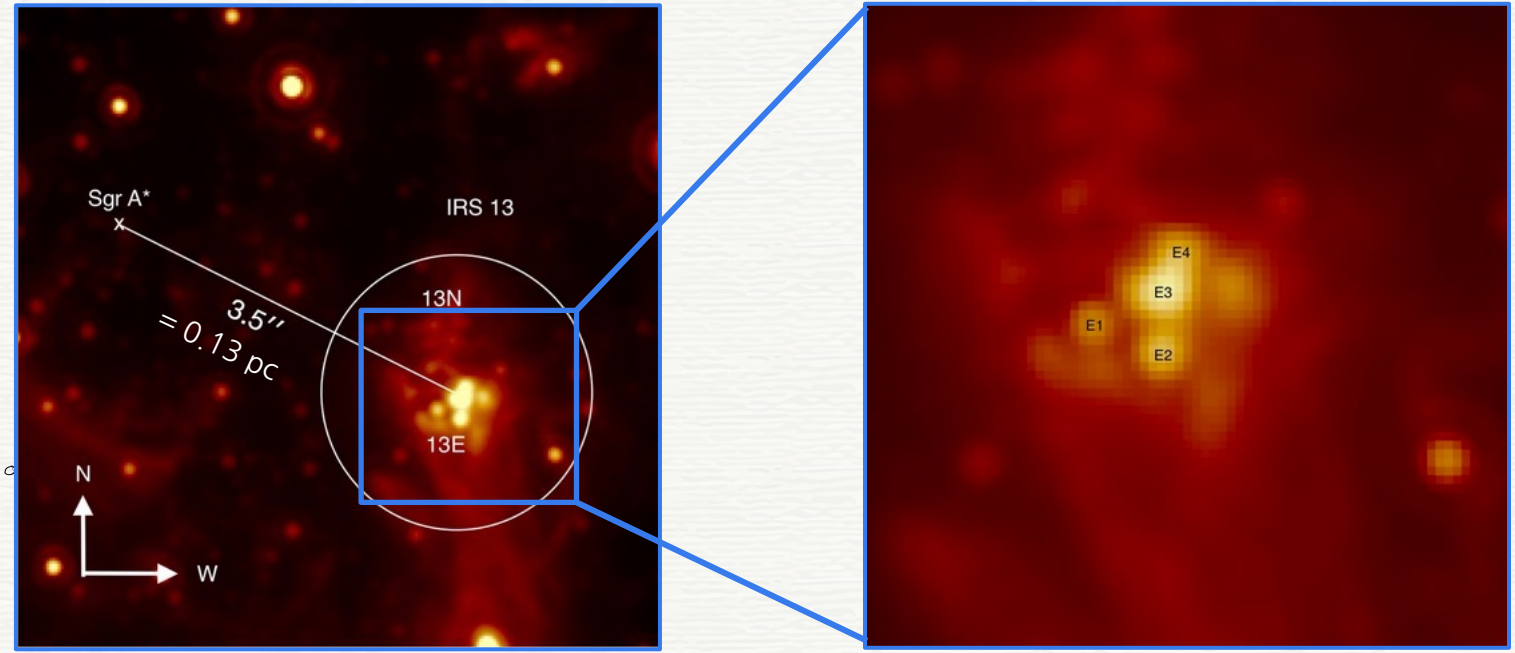
The IRS 13 cluster



2004 NACO L-band

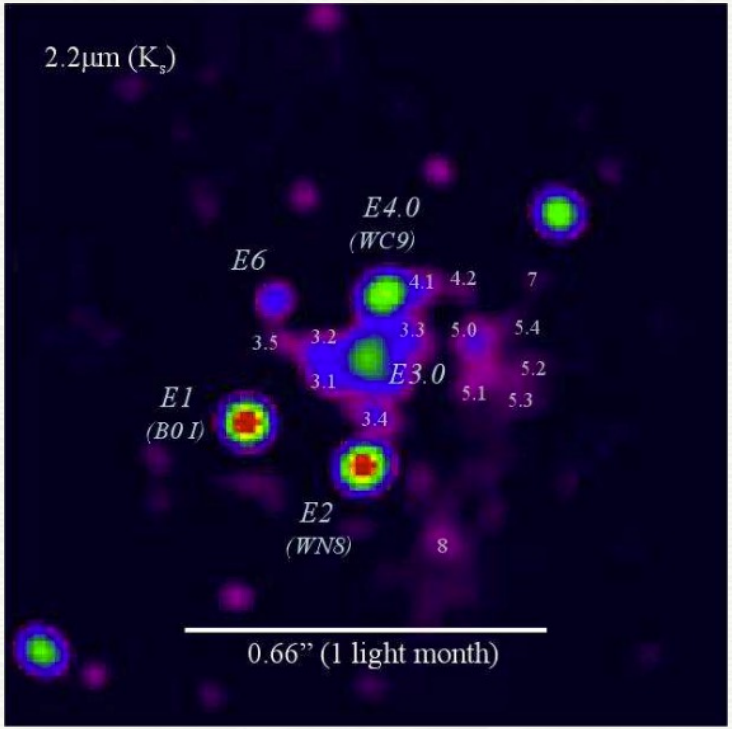
- Emits across nearly the entire electromagnetic spectrum, from X-rays to submm.
- One of the densest clusters in the GC
- Many young stars
- At just 0.13pc of Sgr A* (strong tidal forces)
- Evaporating cluster that streams towards the GC

The IRS 13 cluster



2004 NACO L-band

IRS 13 stellar content



NACO K-band Fritz et al. 2010

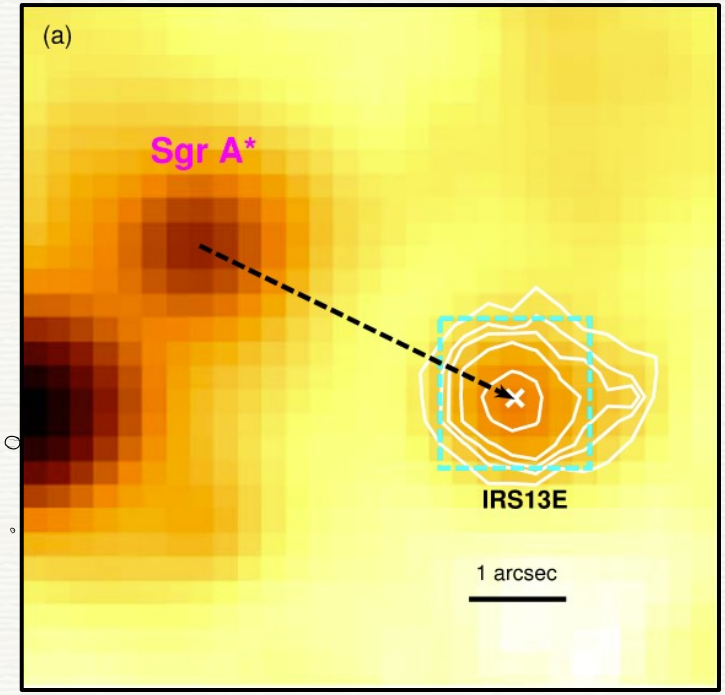
- At least 12 stars in the core region of IRS13 (Paumard et al. 2006)
- Many early type stars (young stars):

  E1: OB supergiant (O5I)
  E2: WN8
  E4: WC9

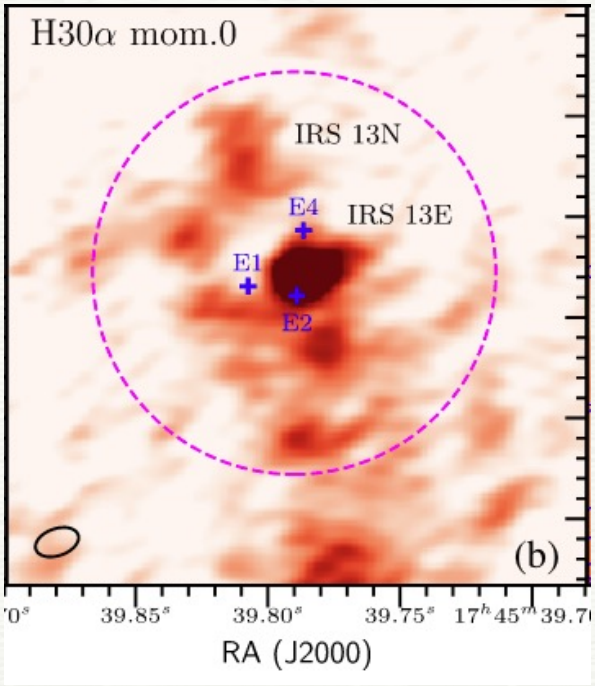
  Maillard et al. 2004

- IMBH of $10^{3-4} M_{\odot}$? (Schodel et al. 2005)
- Strong dust emission whose origin is still under debate

Nature of E3: an IMBH or colliding winds?



Chandra 2-8 keV Zhu et al. 2020



ALMA H30α Wang et al. 2020

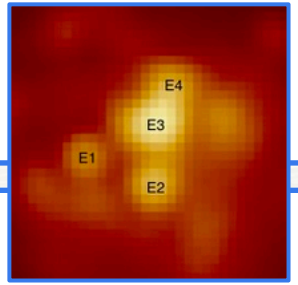
- Concentration of warm dust and gas? (Fritz et al. 2010)
- THE IMBH of IRS 13? (Tsuboi et al. 2019)
- Colliding winds from E2 and E4? (Wang et al. 2020, Zhu et al. 2020)

VLTI/MATISSE Observations

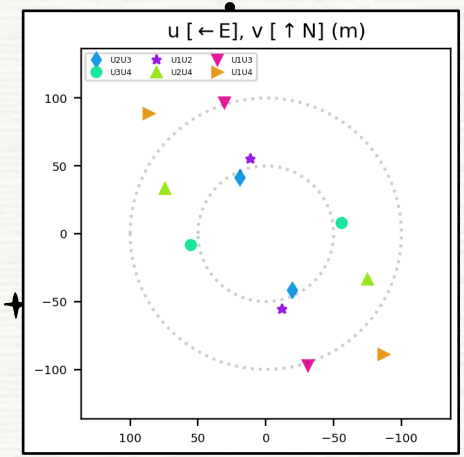
Quick overview of the data

- Observed during MATISSE technical time in 2023
- UT3 problem
- E3 not observed → E1 & E2

→ Only 3 visibilities and 1 closure phase



- Unstable weather conditions:
  Seeing ~1.5-2”
  Coherence time ~2ms.

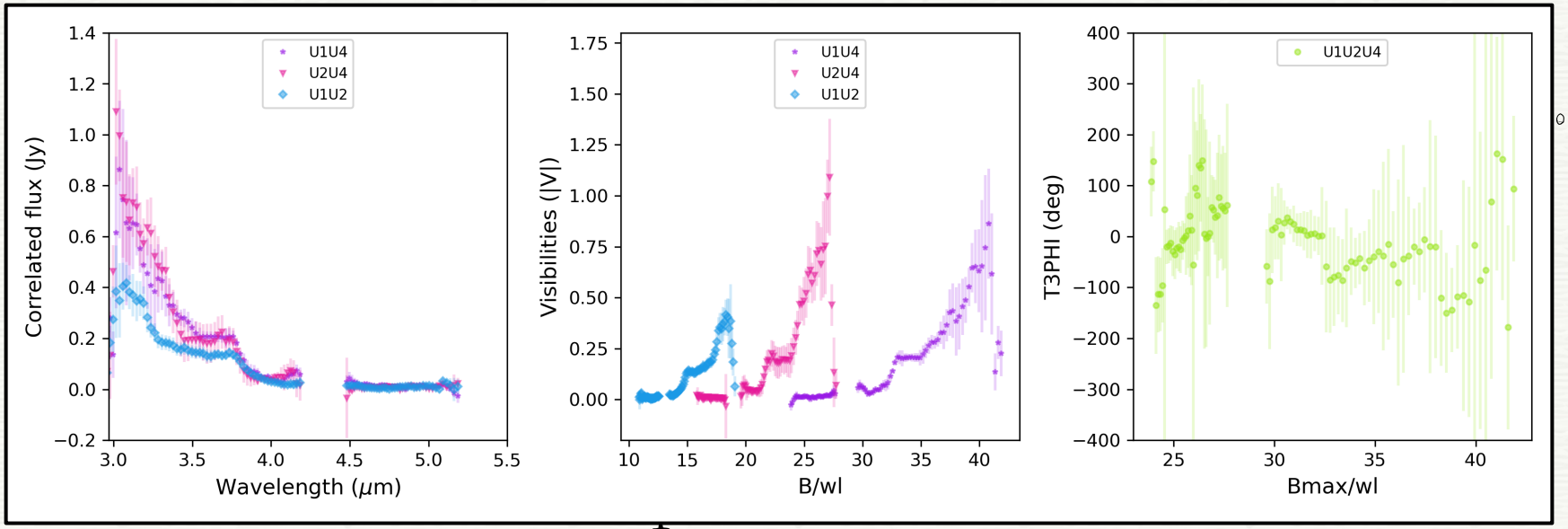


UV-plane

UT4: photometry issues

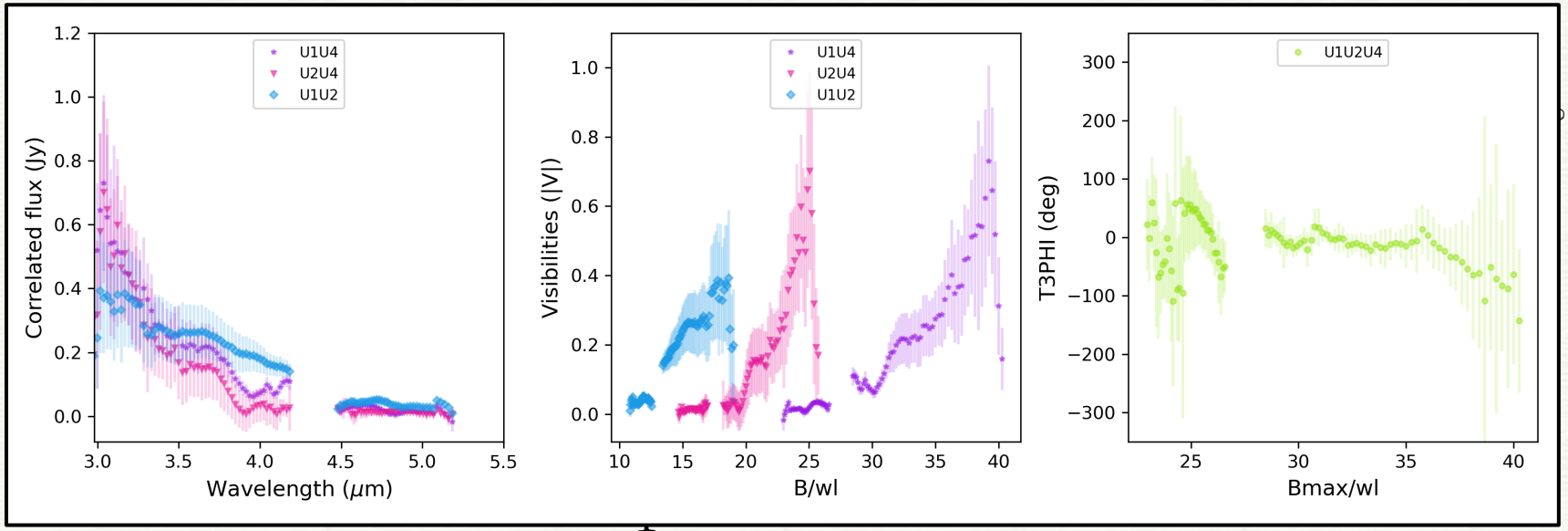
VISIBILITY and CLOSURE PHASES

E1



VISIBILITY and CLOSURE PHASES

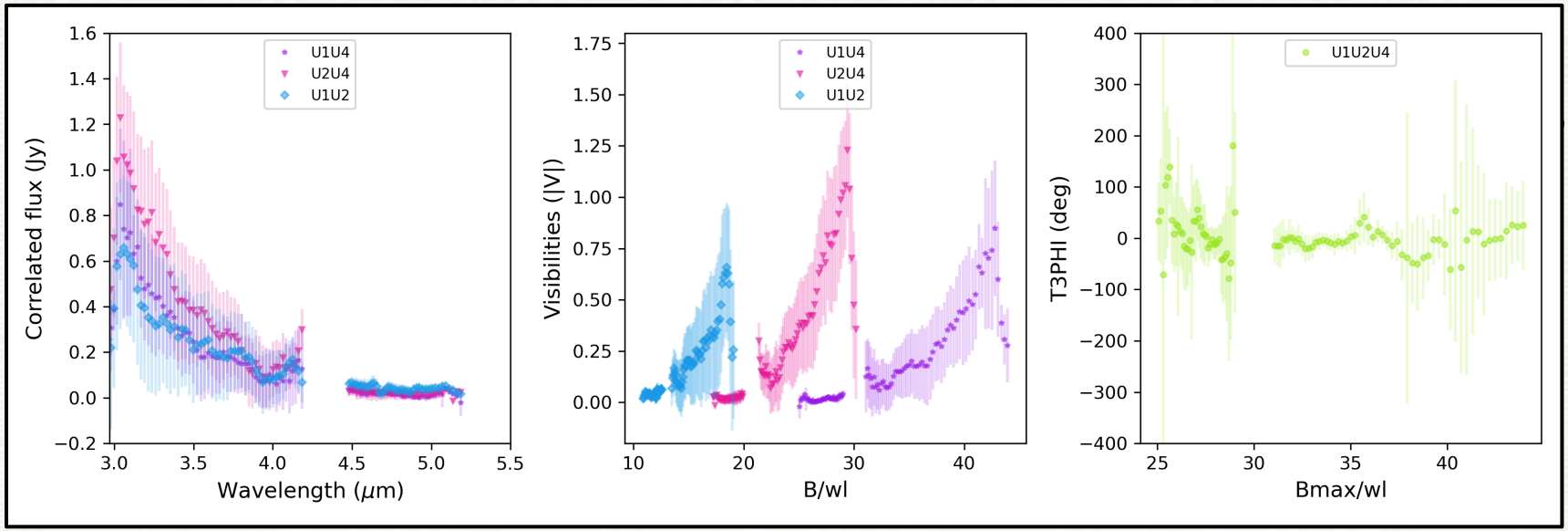
E2



VISIBILITY and CLOSURE PHASES

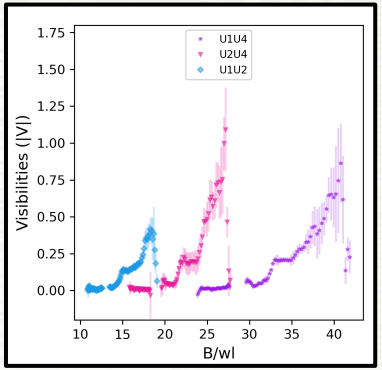
E1

2nd observation

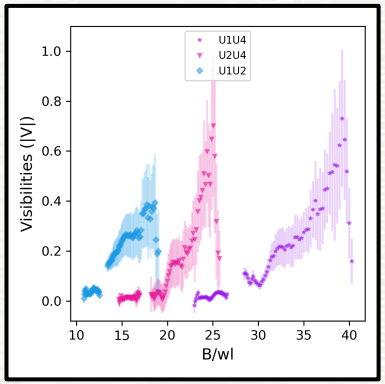


What can we tell from these observables?

E1



E2



- |V| ≠1 → the object is resolved

Stellar emission	+	Cold Dust/gas
Massive stars (O/WR) T>25,000K		Surrounding disk/envelope T~500K
Seen in the L band		Dominates in the M band

Modelling with LITPro and PMOIRED

Two parametric tools to fit geometric models to the interferometric observables

JMMC

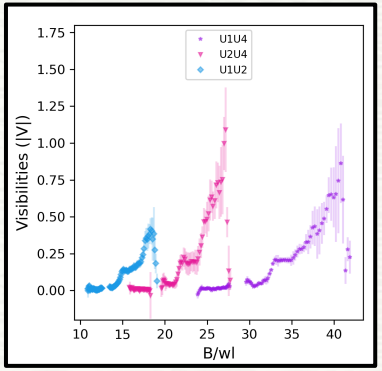
LITpro

PMOIRED

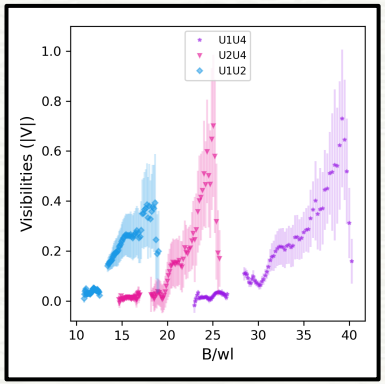
Mérand et al. 2022

What can we tell from these observables?

E1

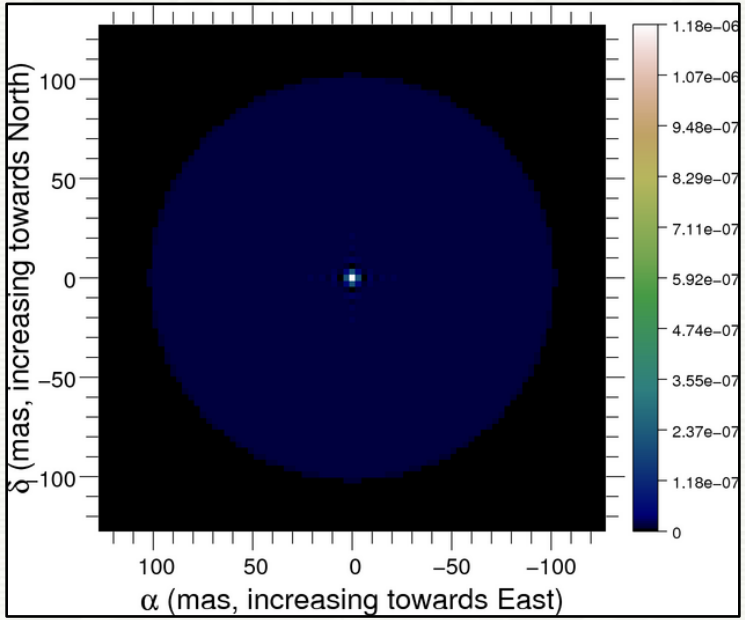


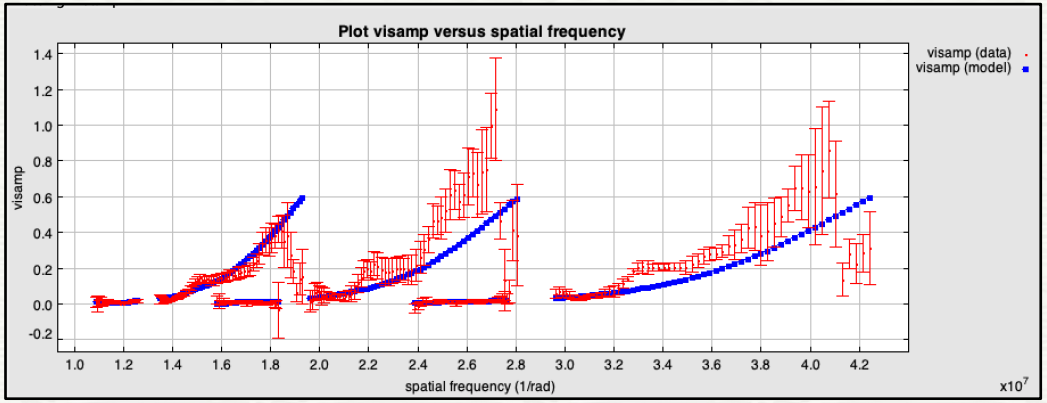
E2



Stellar emission	+	Cold Dust/gas	Physical components
Massive stars (O/WR) T>25,000K		Surrounding disk/envelope T~500K	
Unresolved punct (x,y)=(0,0) BB: T>25 kK Flux?		Gaussian/ Uniform disk BB: T~500K FWHM/diam? Position? Flux?	Model

E1 LITPro





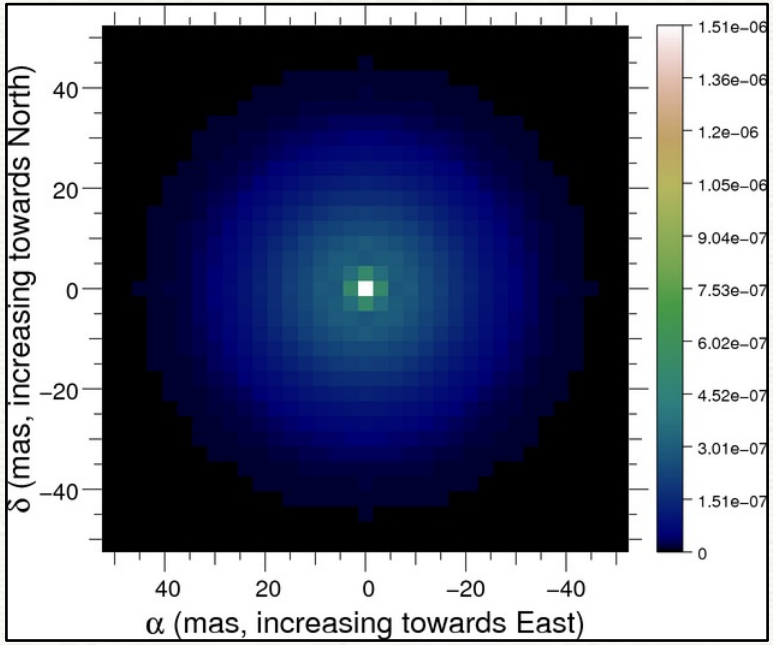
Geometric model:

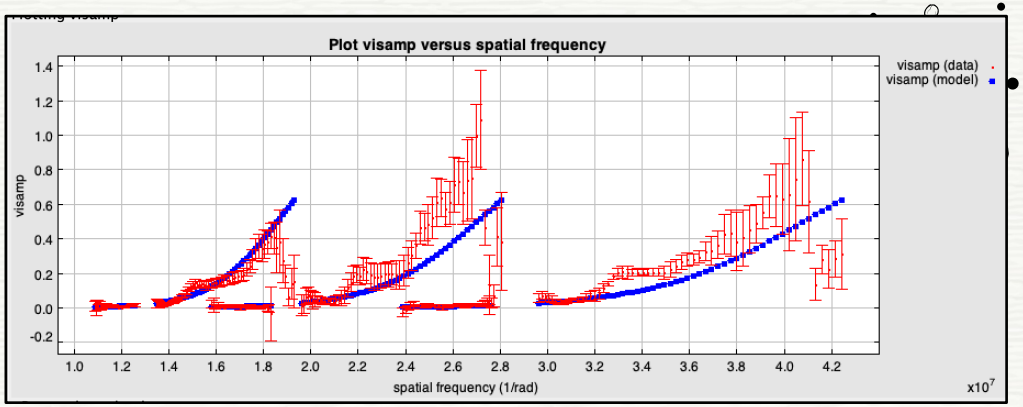
Unresolved central star
(x,y)=(0,0)
T > 25,000K

Surrounded by a Uniform disk:
Diameter > 30 mas
T ~ 350 K

By Lionel Woglo
Bachelor thesis

E1 LITPro





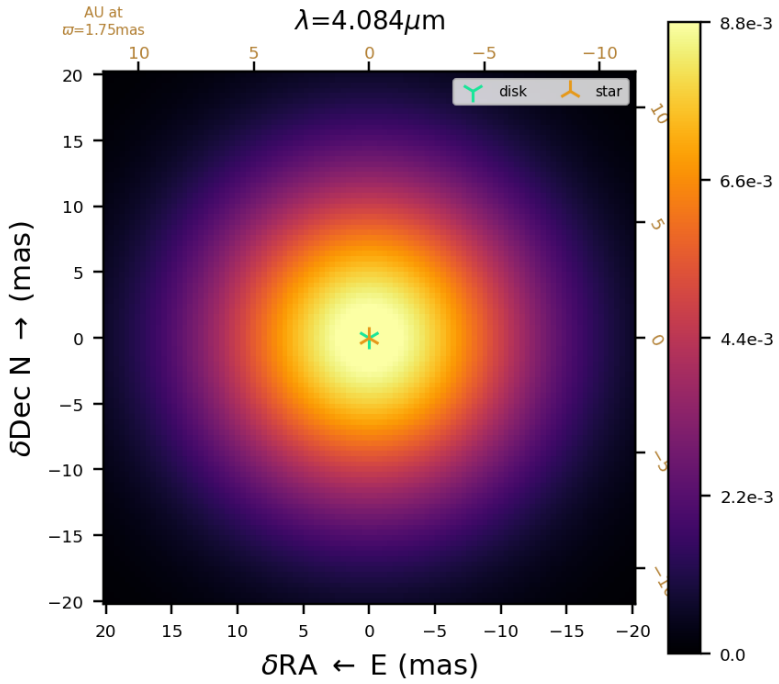
Workdone by Lionel Woglo
Bachelor thesis

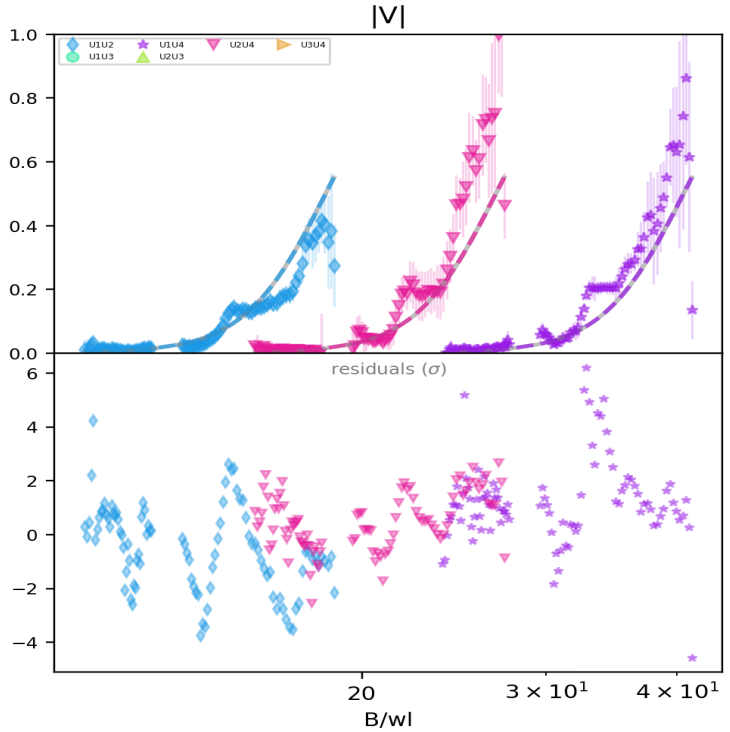
Geometric model:

Unresolved central star
(x,y)=(0,0)
T > 25,000K

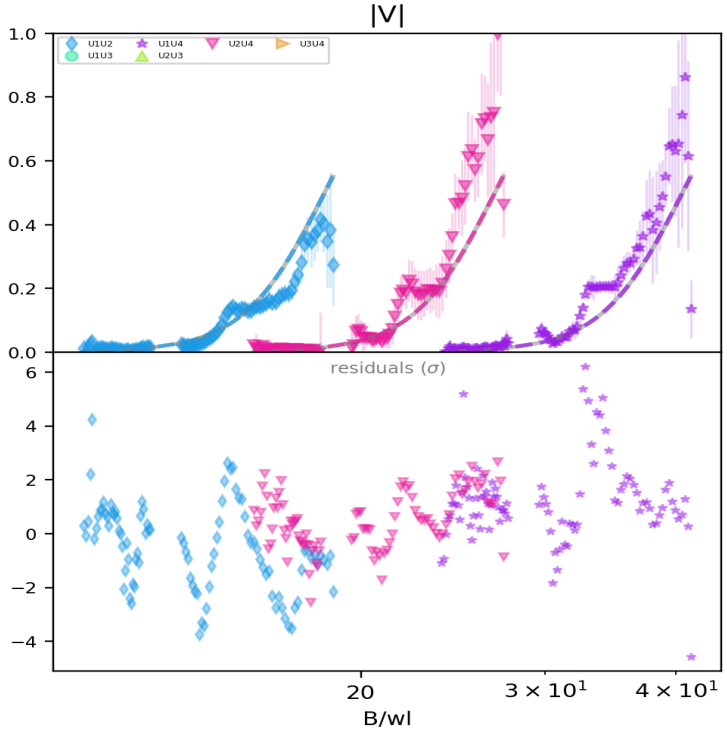
Surrounded by a Gaussian disk:
FWHM > 25 mas
T ~ 350 K

E1 PMOIRED


AU at
ϖ=1.75mas
λ=4.084μm
disk
star
δDec N → (mas)
δRA ← E (mas)
linear scale
8.8e-3
6.6e-3
4.4e-3
2.2e-3
0.0


|V|
U1U2
U1U3
U1U4
U2U3
U2U4
U3U4
residuals (σ)
B/wl

E1 PMOIRED



Geometric model: $\chi^2 = 2.12$

Unresolved central star
(x,y)=(0,0)
T > 25,000K

Surrounded by a Gaussian disk (>90% of the emission)
FWHM ~ 30 mas
T ~ 550 K

Fully resolved feature that extends above 240 au around the central star

- Dust from an envelope?
- Effects of a stellar disk?

E1 SED

From NACO observations HKLM bands

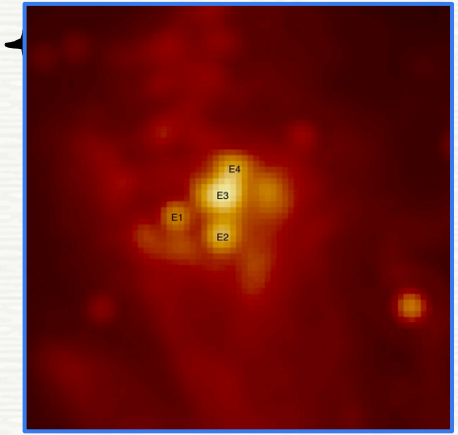
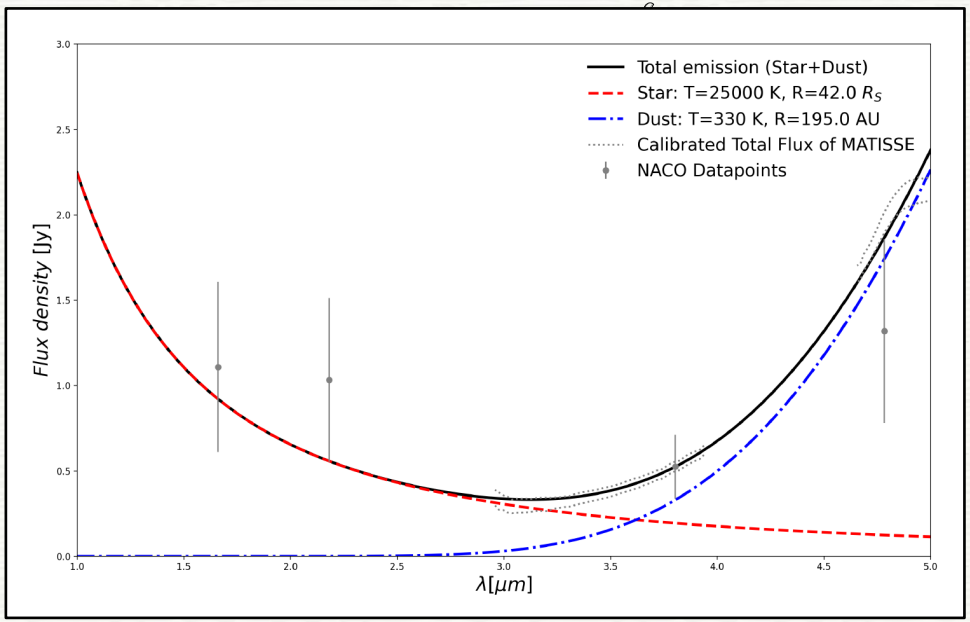


Table 3: Magnitudes and flux densities

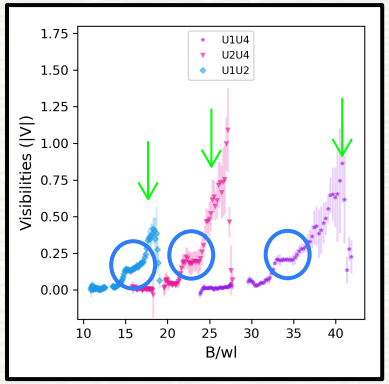
	E1		E2	
Band	Magnitude	Flux [Jy]	Magnitude	Flux [Jy]
H	12.23 ± 0.52	1.11 ± 0.50	12.38 ± 0.55	0.98 ± 0.46
K	9.97 ± 0.60	1.03 ± 0.48	9.96 ± 0.60	1.05 ± 0.49
L	8.60 ± 0.57	0.53 ± 0.19	8.05 ± 0.56	0.88 ± 0.31
M	6.99 ± 0.67	1.32 ± 0.54	6.40 ± 0.67	2.06 ± 0.86

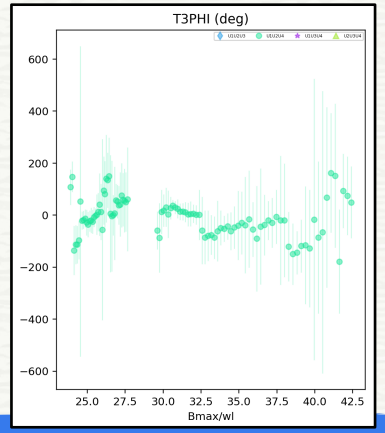
SED reconstructed with HYPERION



What can we tell from these observables?

E1





±180deg

Stellar emission

+

Cold Dust/gas

+ asym. Disk?
+ companions?

Massive stars (O/WR) T>25,000K

Surrouding disk/envelope T~500K

Unresolved punct (x,y)=(0,0) BB: T>25 kK Flux?

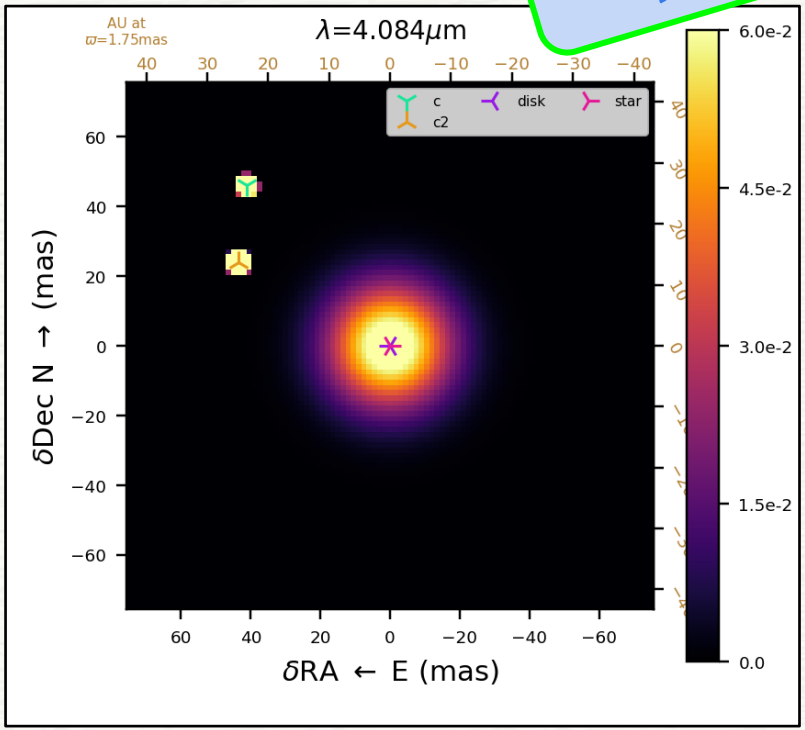
Gaussian/ Uniform disk BB: T~500K FWHM/diam? Position? Flux?

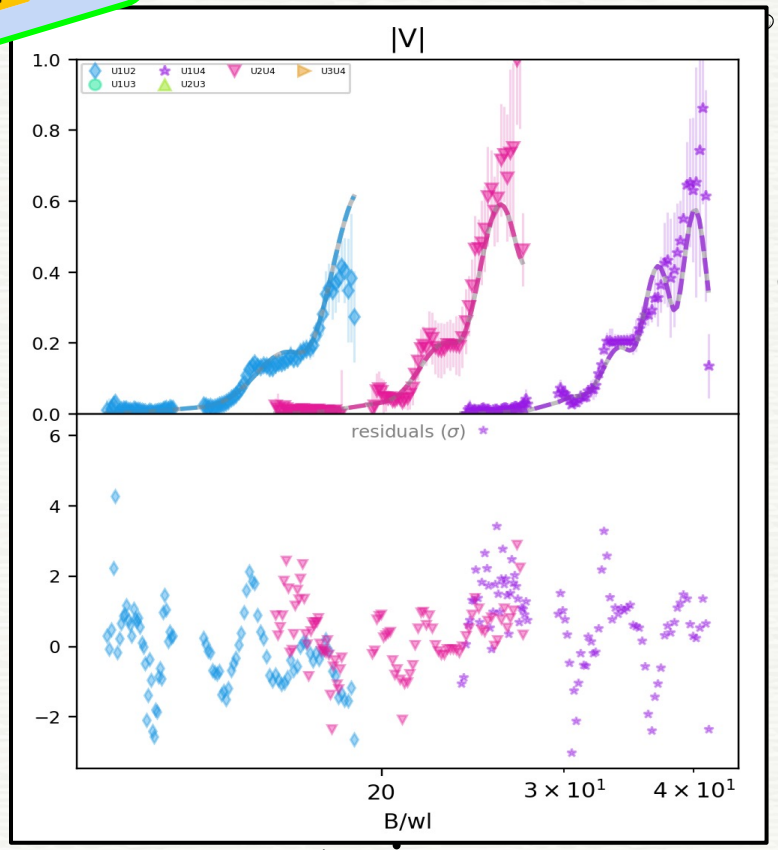
Physical nature

Model

E1 PMOIRED

⚠ Preliminary results ⚠



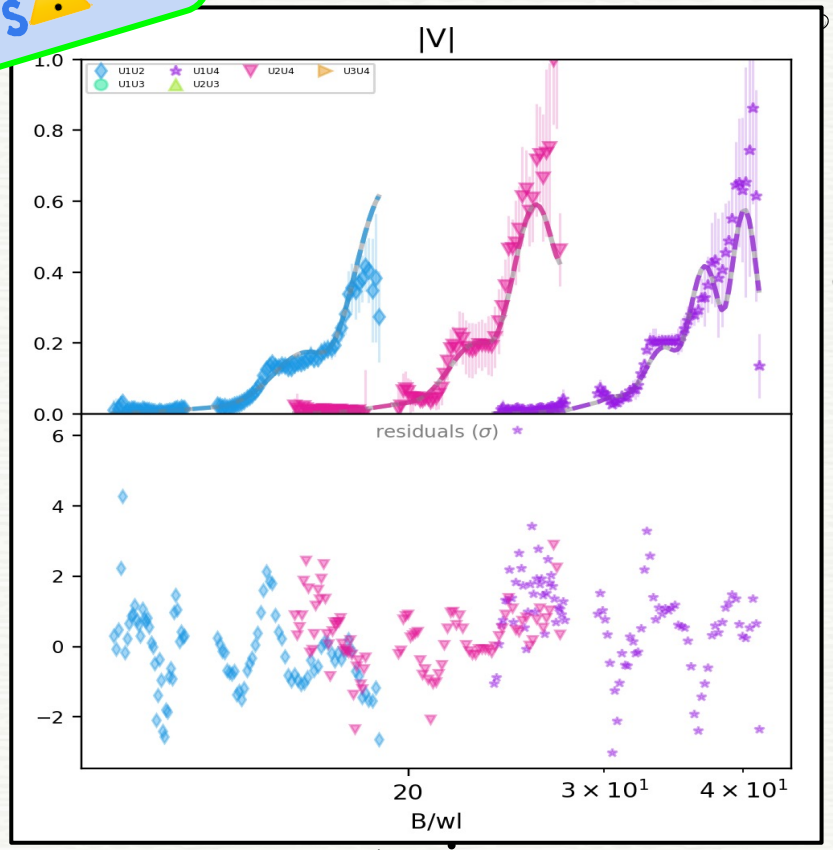


EI PMOIRED

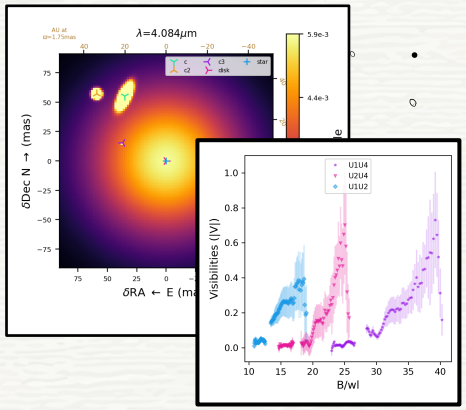
⚠ Preliminary results ⚠

Geometric model: $\chi^2 = 1.22$

- Star (unresolved punct)
- + Envelope/ Disk:
  Gaussian : FWHM = 33 ± 12 mas
  90% of the flux
- 2nd star (unresolved punct):
  T~20,000K
  diam~ 8±1 mas
  ρ~60 mas → $\tilde{\alpha}$~ 480±37 au
- 3rd star (unresolved punct):
  T~20,000K
  diam~ 7±1 mas
  ρ~48 mas → $\tilde{\alpha}$~ 370±38 au



What does it tell us about E1 and IRS13?



- VLTI/MATISSE observations: it is possible to resolve objects in this region
- Nature of the close environments of E1 & E2 in the larger context of the GC environment

- E1 is an O5I star: >90 % are in multiple systems
- IRS 13 behaves as other massive clusters?
- Are we finally detecting massive binaries in the GC? (Peissker 2024 in press).

- Success of these observations motivates further investigations: ERIS/GRAVITY(+)
- And request observations of E3

Thanks for your attention!

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