The surface and environment of evolved stars with the ELT

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ESO / L. Calçada

Why evolved stars ?

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- Evolved stars are central contributors to the increase of cosmic metallicity
- As star formation, mass loss ("star destruction") is a complex and fascinating phenomenon
- Their close environment (1-100 R*) is where the action takes place (convection, molecules, dust formation)

Betelgeuse

- Nearest red supergiant
  - IR photosphere angular diameter: 42 mas
  - Structure of the envelope (1 - 10000 R*)
- Results from the VLT and interferometry + Simple simulations of ELT observations

Photosphere

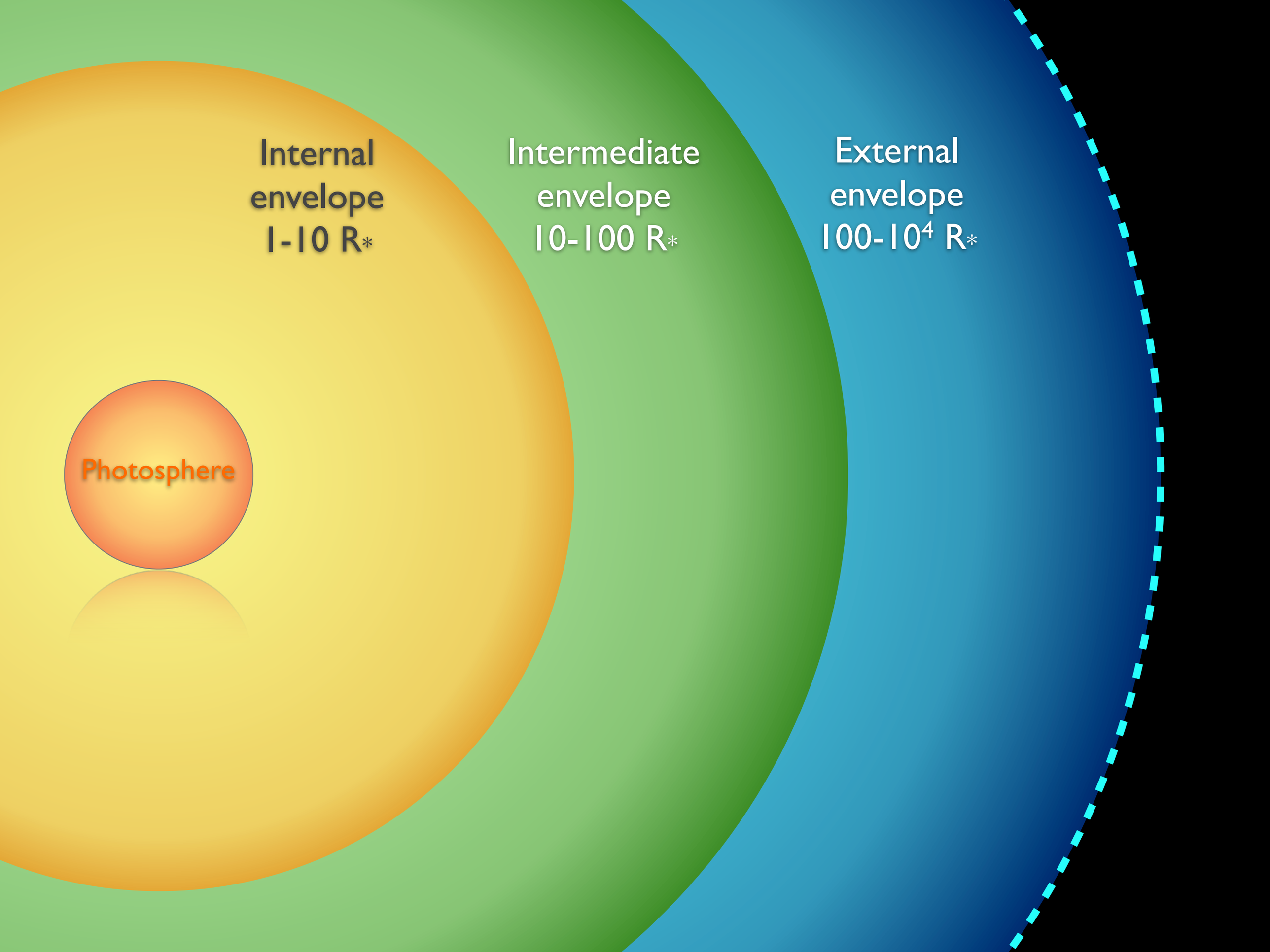
Internal
envelope
1-10 R*

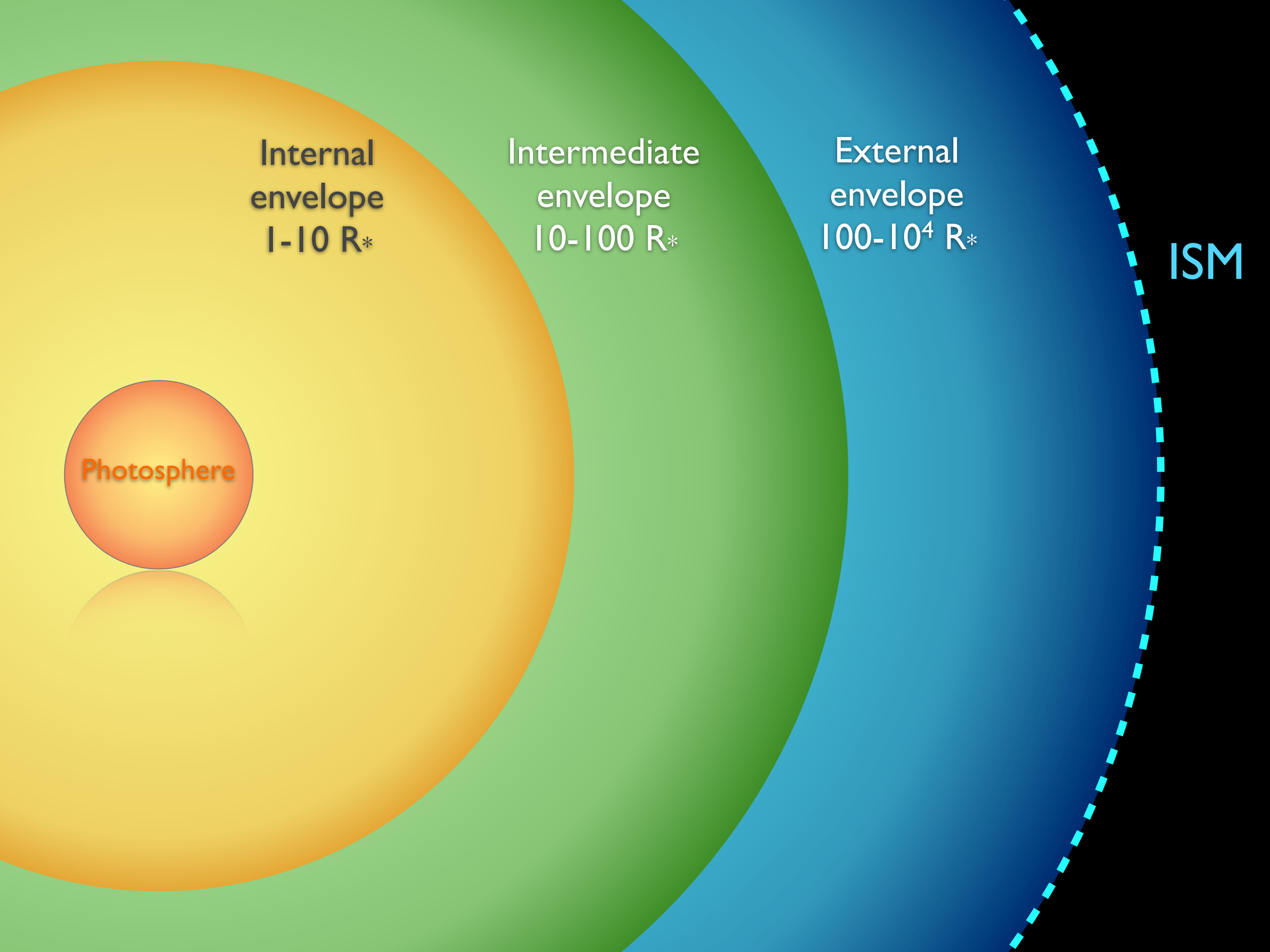
Photosphere

Internal
envelope
1-10 R*

Intermediate
envelope
10-100 R*

Photosphere


Internal
envelope
1-10 R*
Intermediate
envelope
10-100 R*
External
envelope
100-10⁴ R*
Photosphere


Internal
envelope
1-10 R*
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envelope
10-100 R*
External
envelope
100-10⁴ R*
ISM
Photosphere

Betelgeuse

0.025"

0.25"

2.5"

4 arcmin

Internal envelope 1-10 R*

Intermediate envelope 10-100 R*

External envelope 100-10^4 R*

ISM

Photosphere

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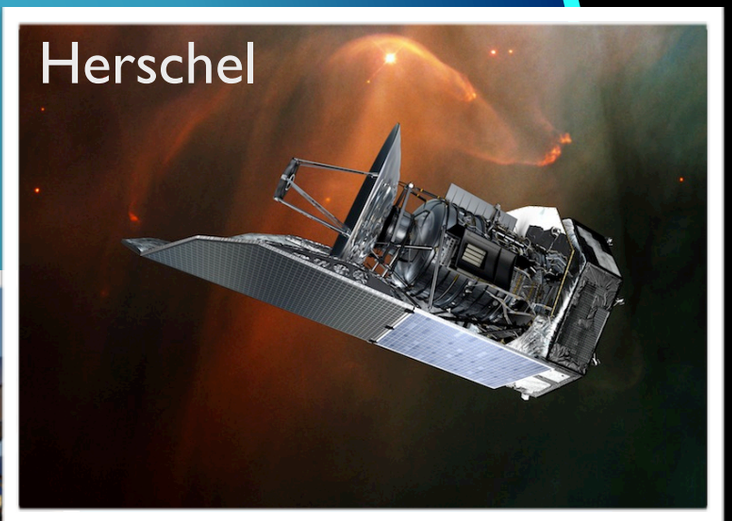

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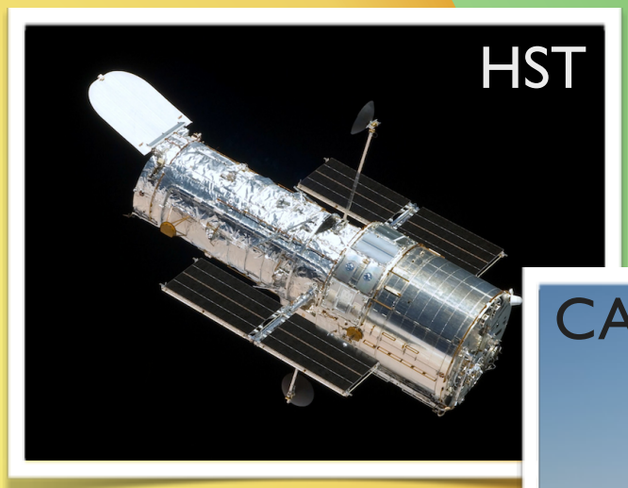

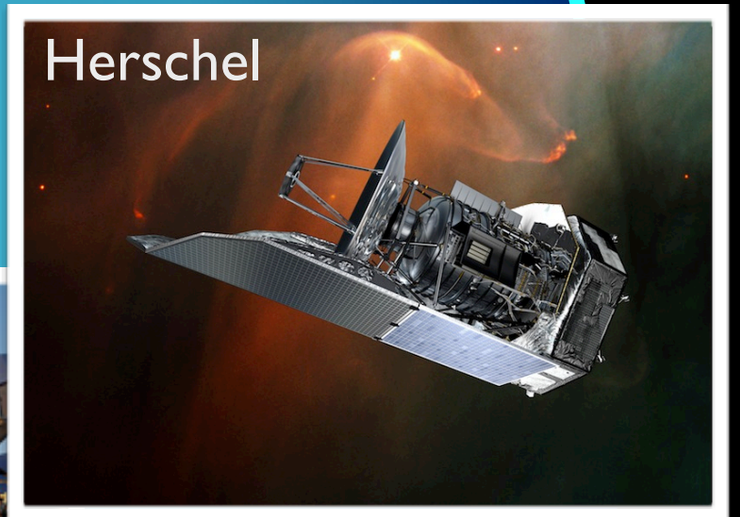

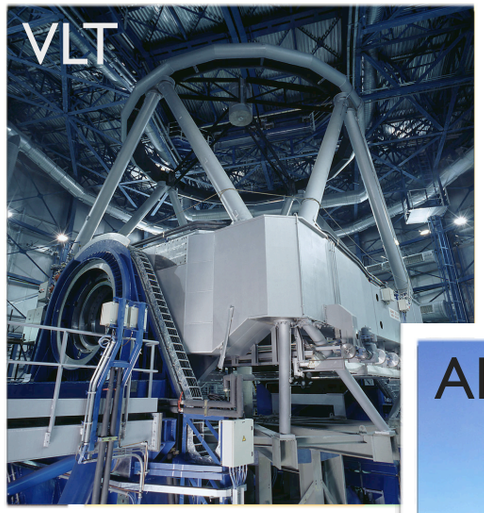

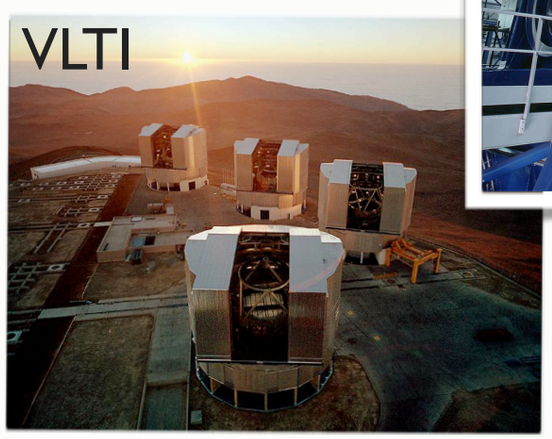

Betelgeuse

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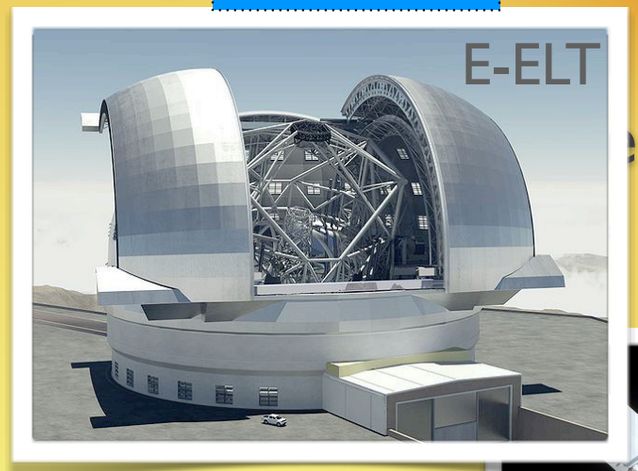
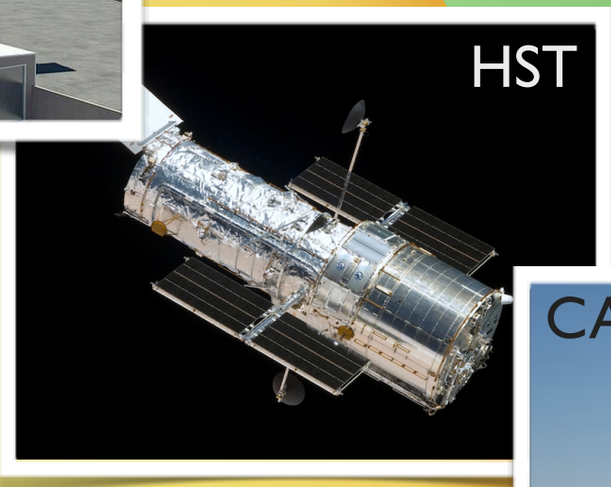


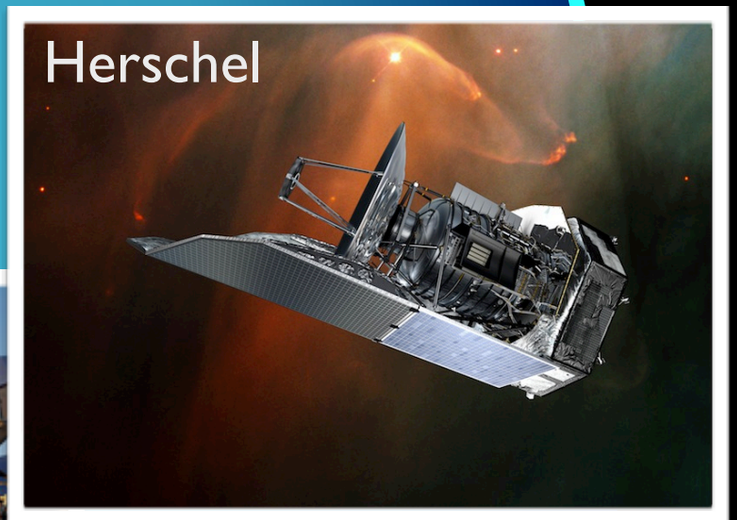
Intermediate envelope
10-100 R_*

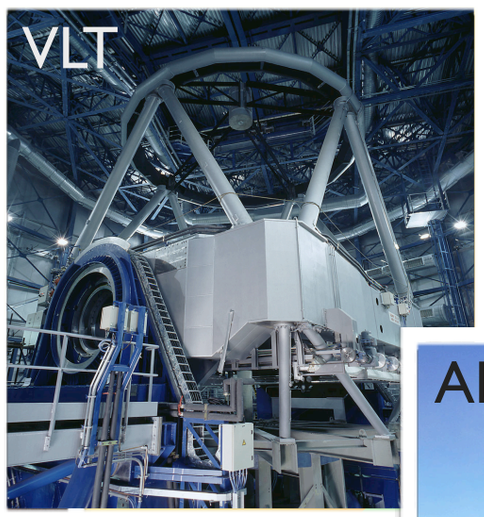
External envelope
100-10^4 R_*

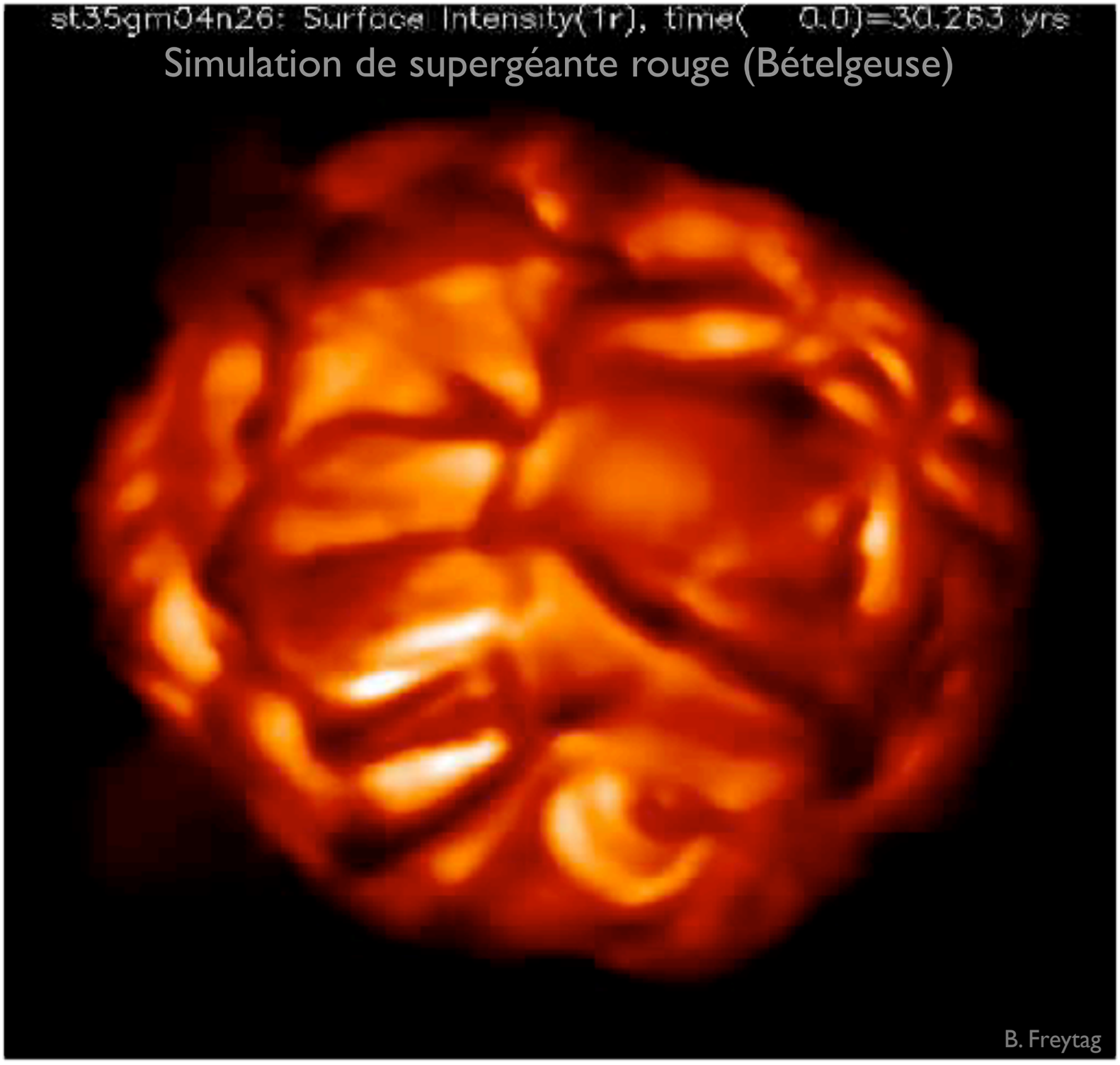
ISM

Photosphere

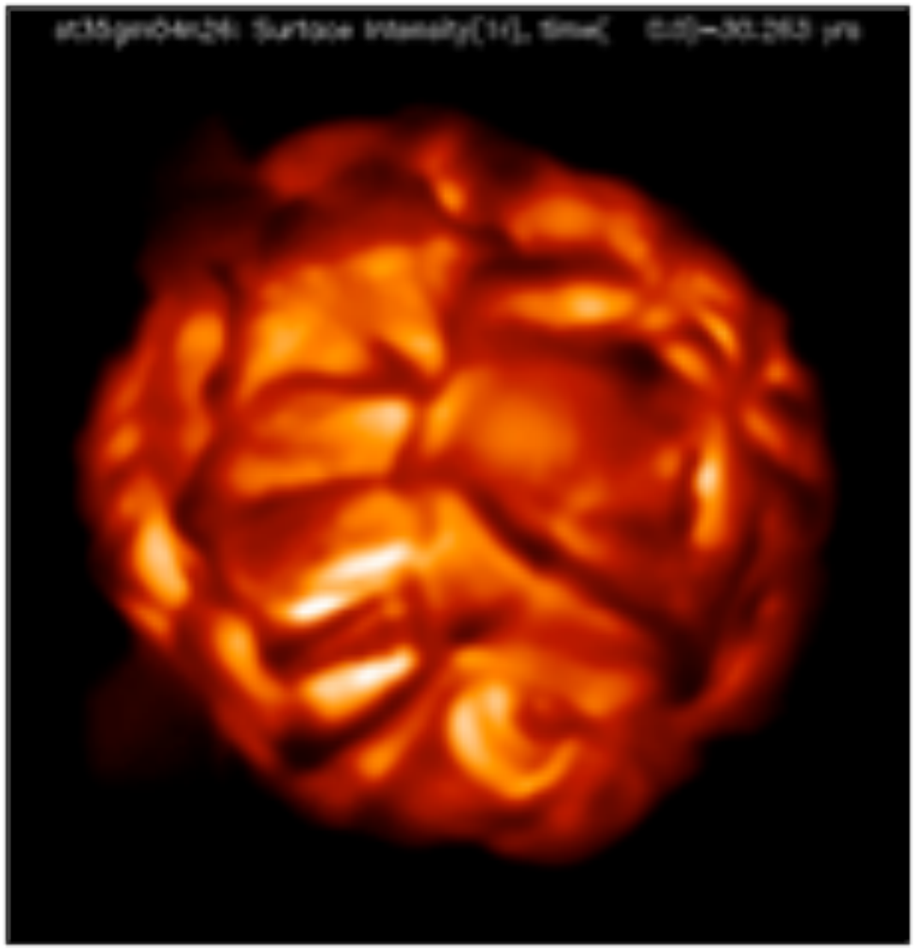






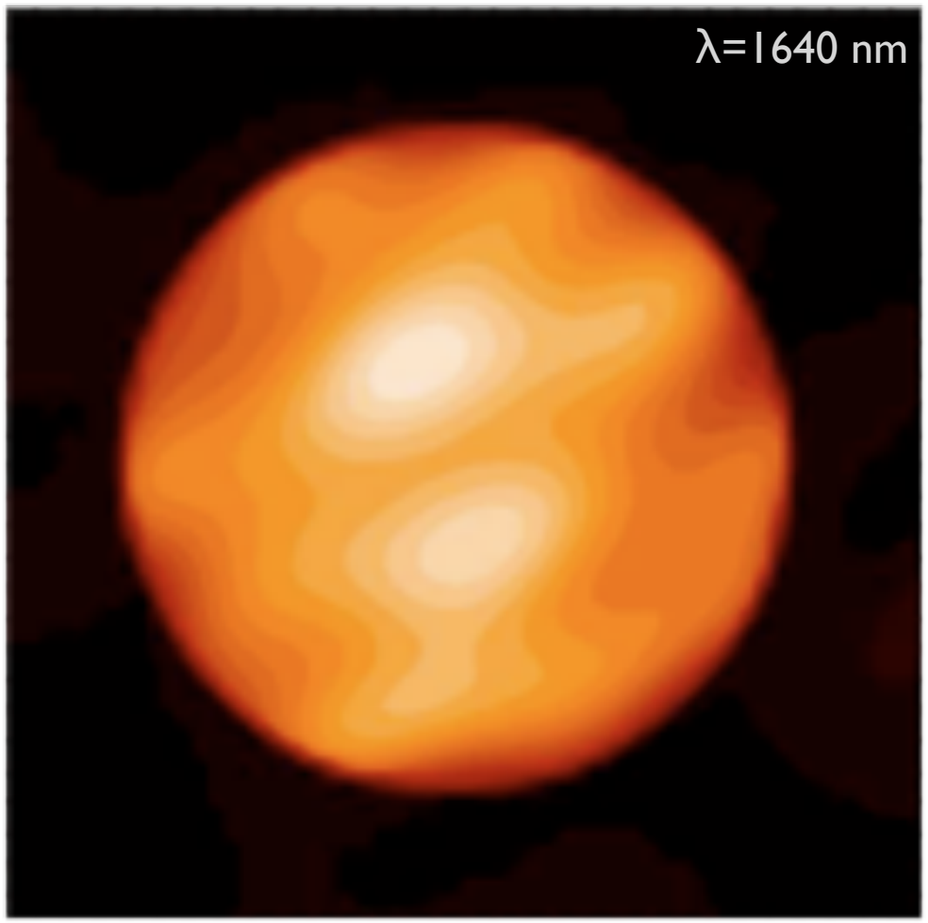


Simulation de supergéante rouge (Bételgeuse)



Model

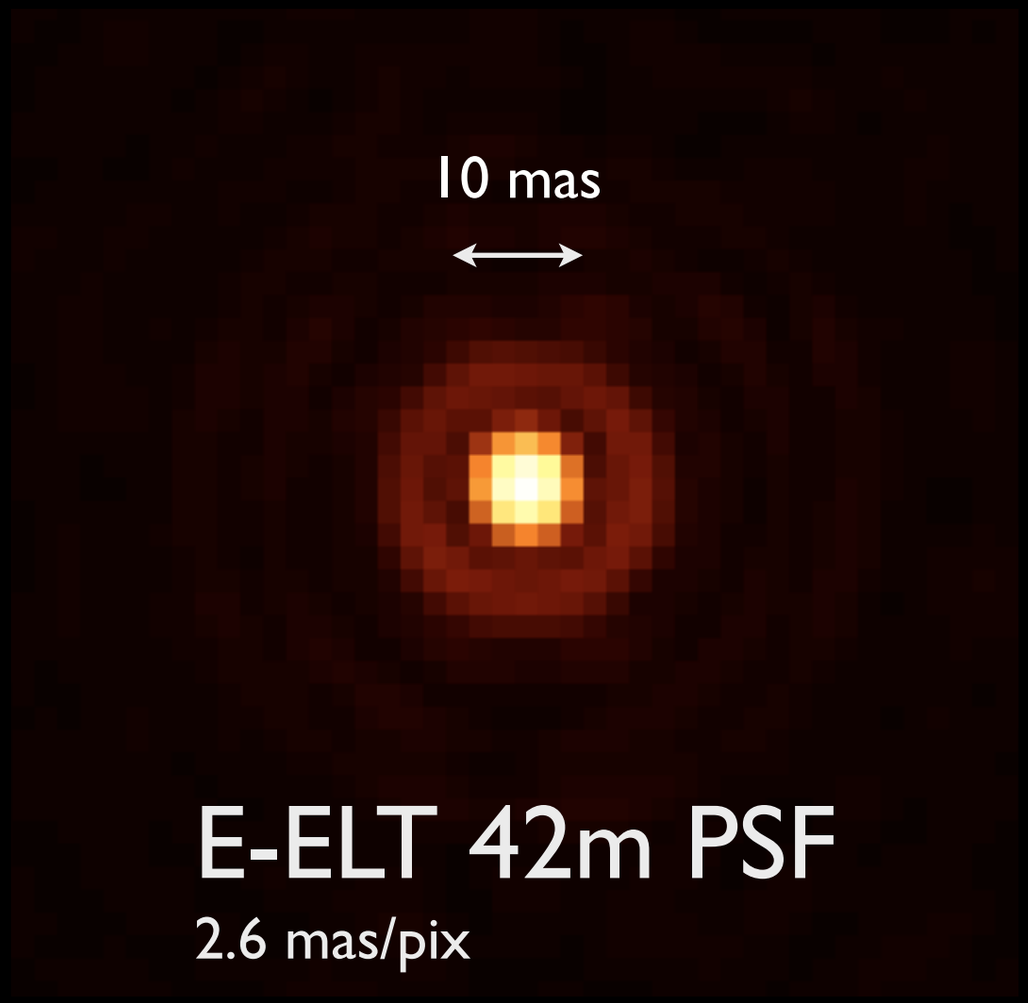
Freytag et al. (2002)



Epoch 2005 image

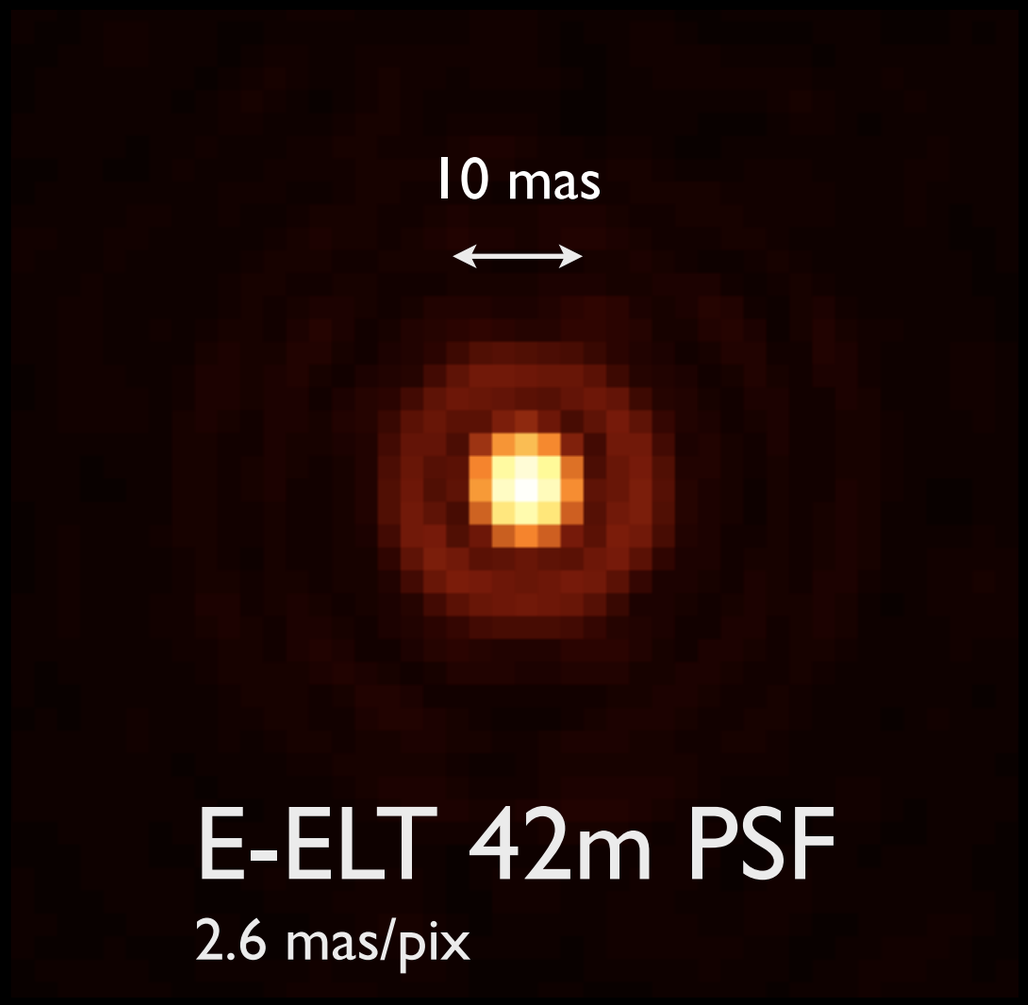
Haubois et al. (2009)

E-ELT H band



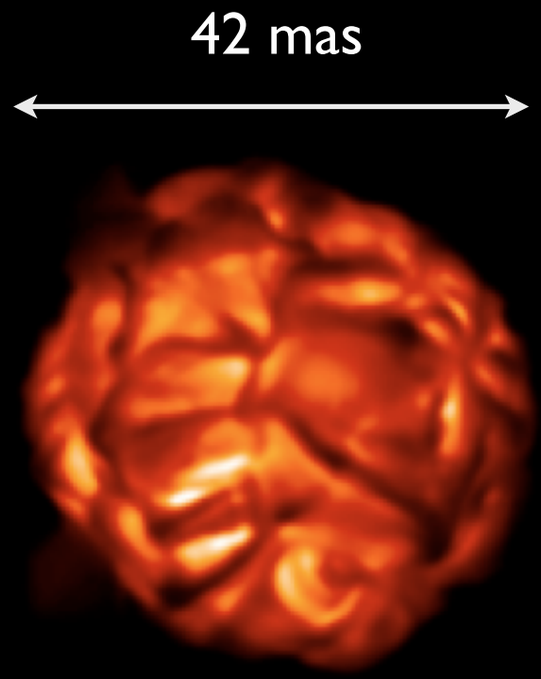
Le Louarn et al. (2005)
http://www.eso.org/sci/facilities/eelt/science/drm/tech_data/ao/

E-ELT H band



E-ELT 42m PSF

2.6 mas/pix



Betelgeuse

Le Louarn et al. (2005)
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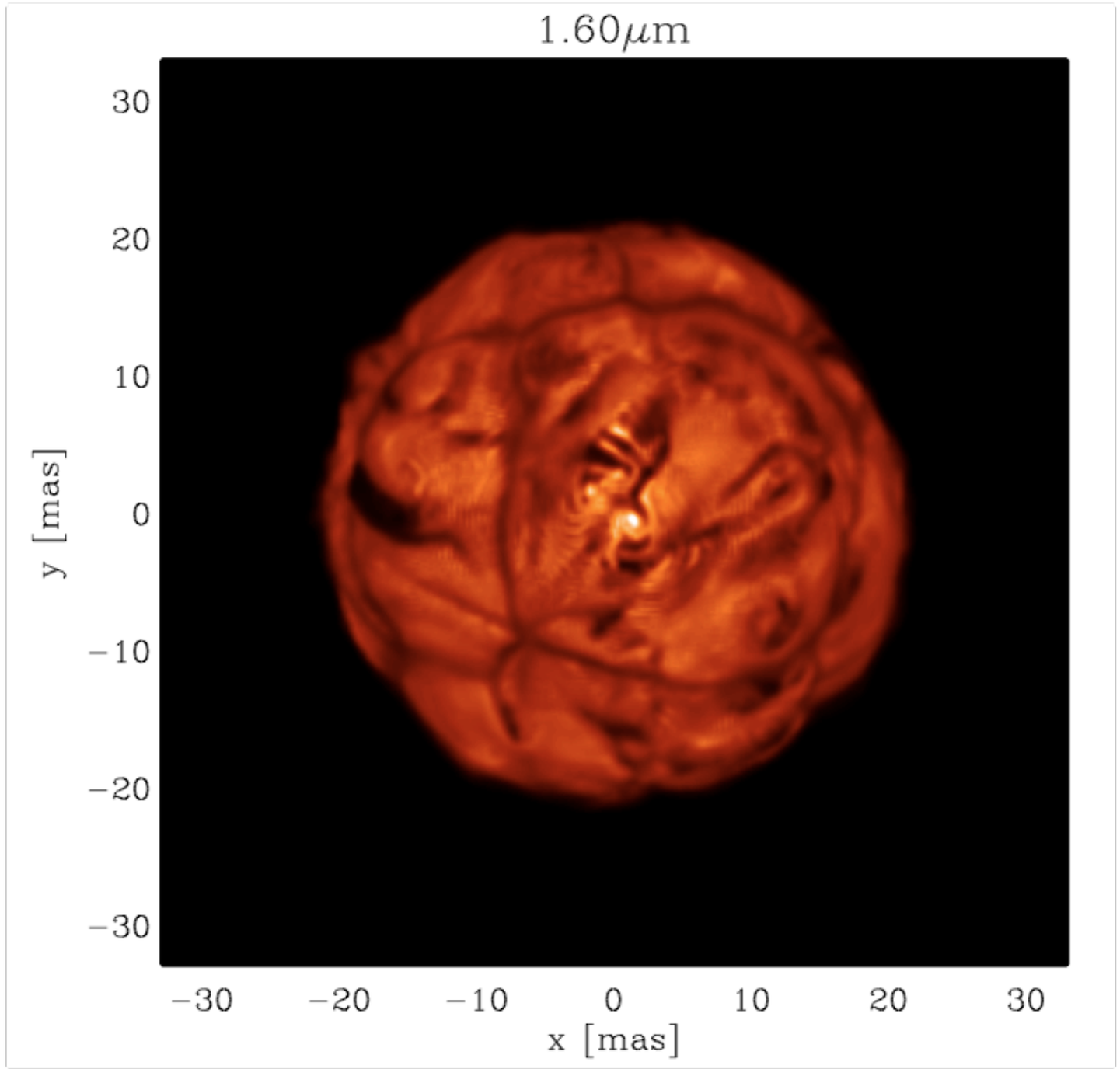
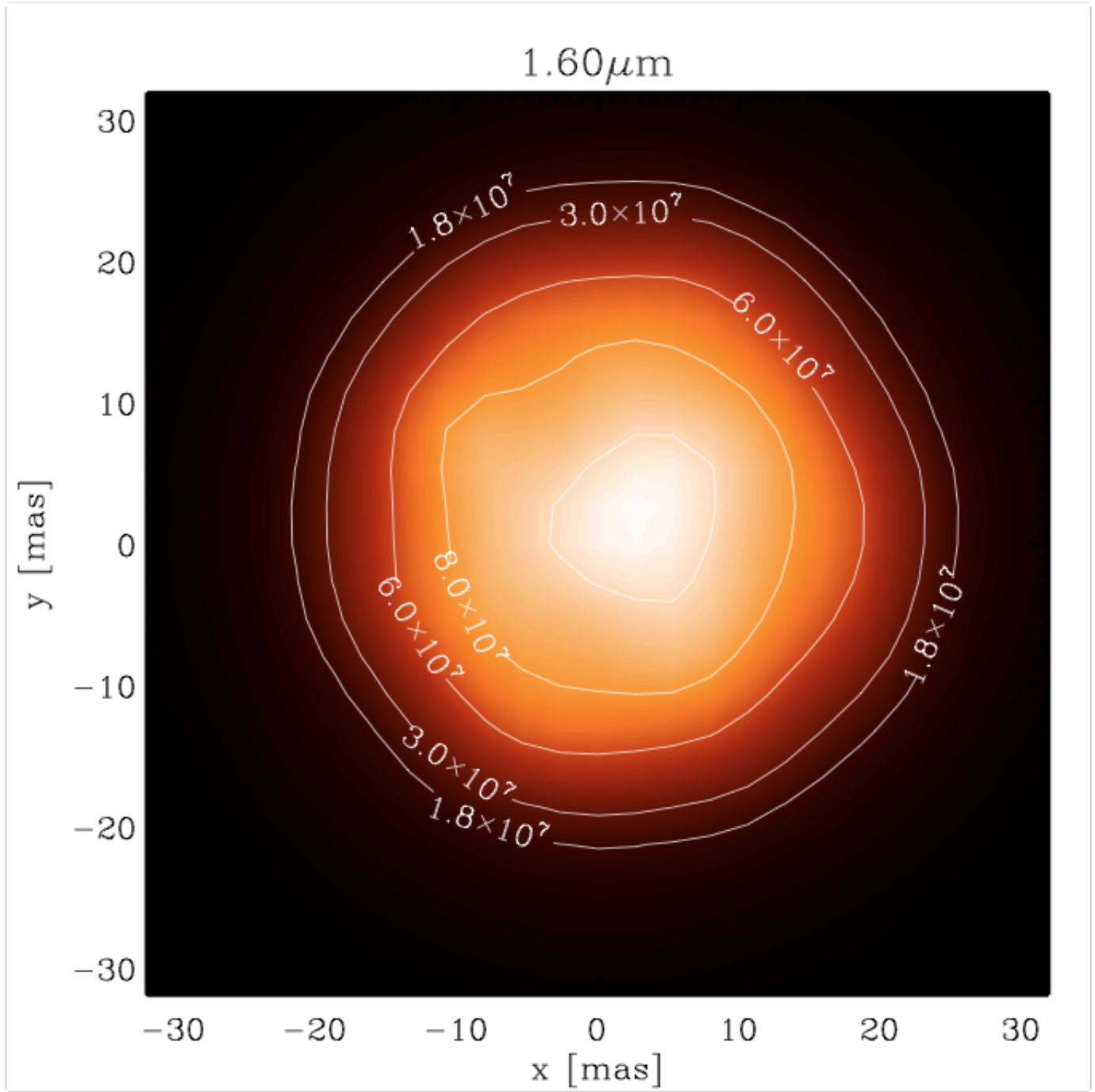
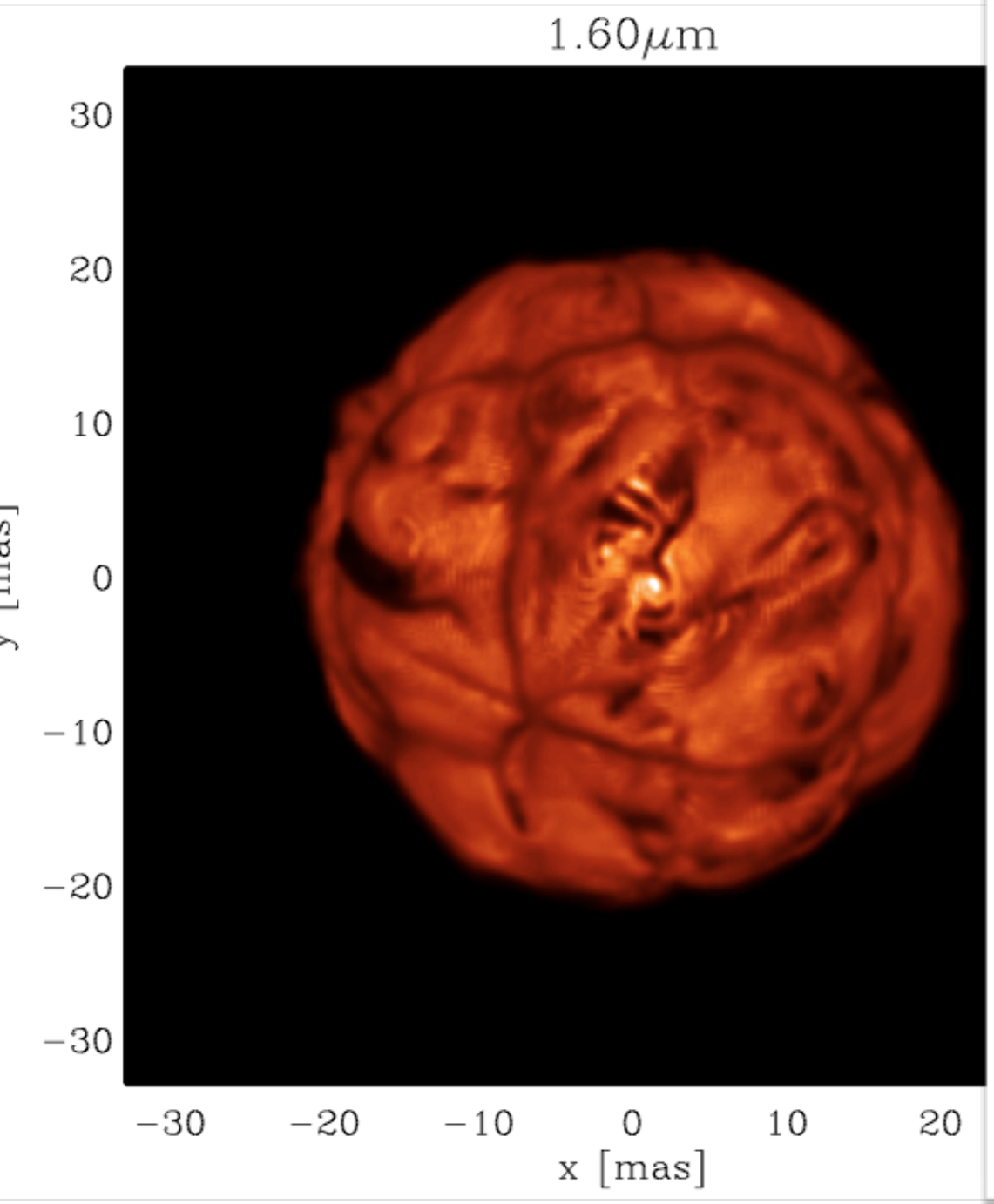
E-ELT H band

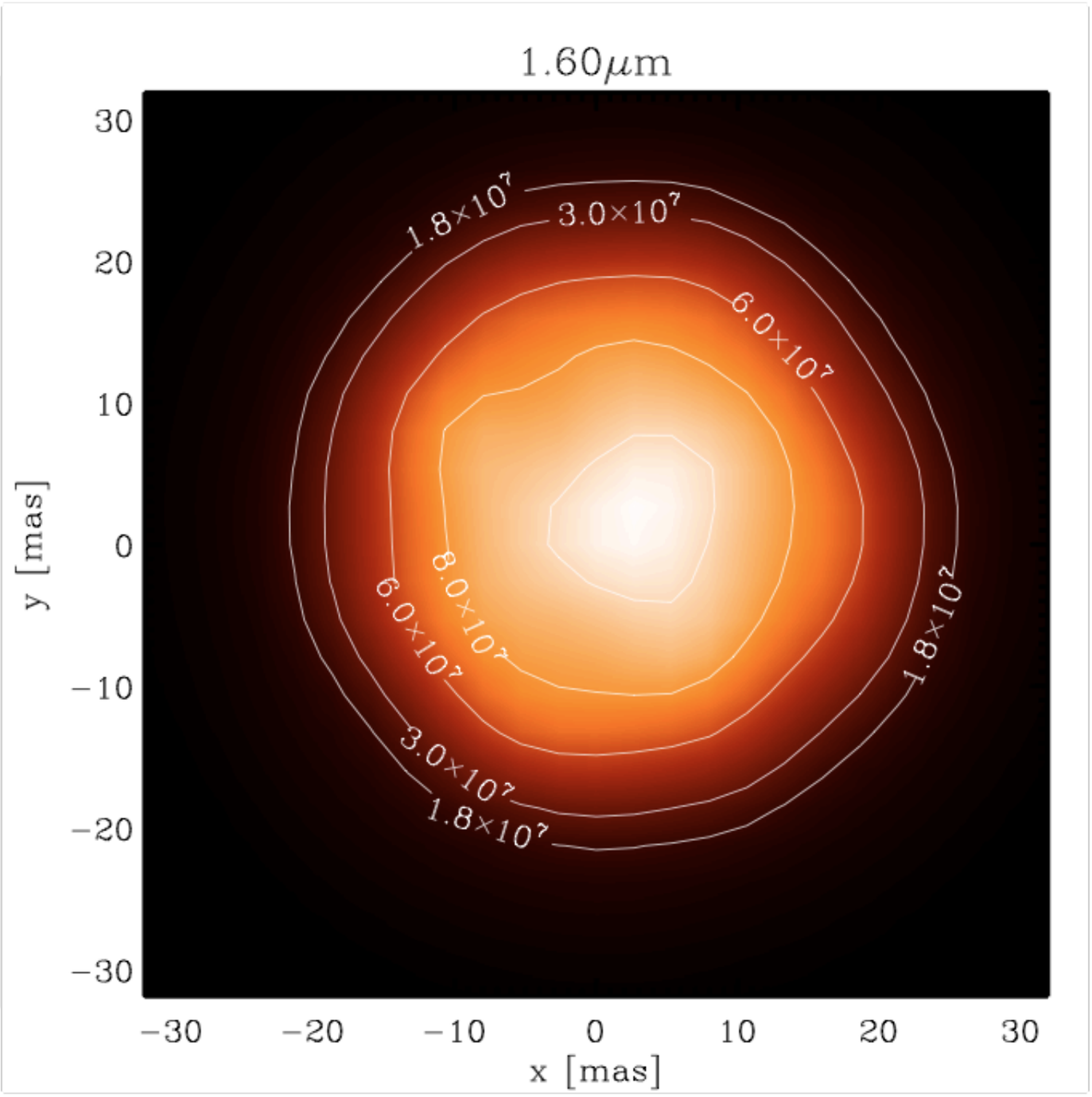


E-ELT H band


1.60μm
1.8×10⁷
3.0×10⁷
6.0×10⁷
8.0×10⁷
6.0×10⁷
3.0×10⁷
1.8×10⁷
1.8×10⁷
30
20
10
0
−10
−20
−30
y [mas]
−30
−20
−10
0
10
20
30
x [mas]

E-ELT H band


1.60μm
30
20
10
0
−10
−20
−30
y [mas]
−30
−20
−10
0
10
20
x [mas]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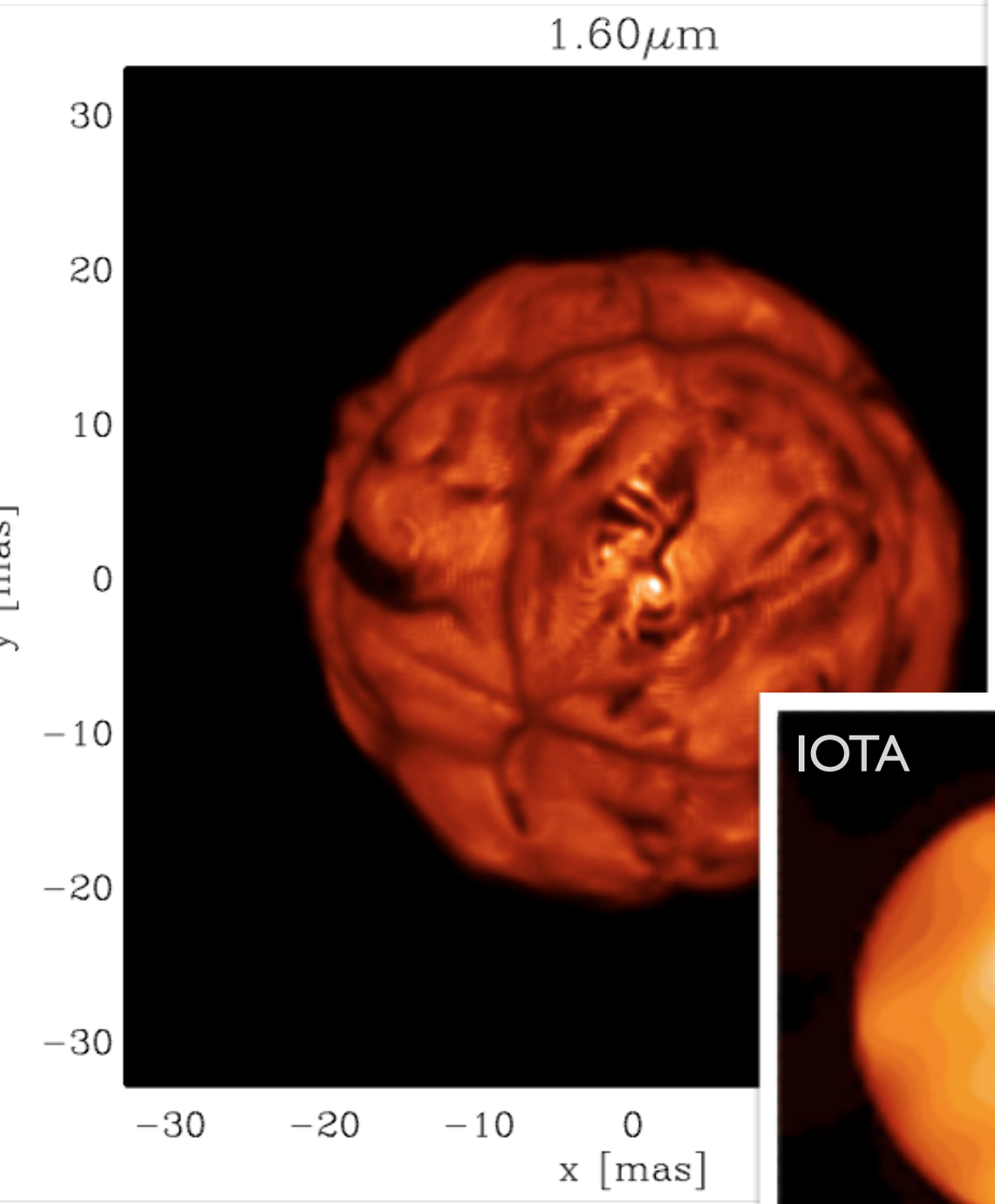
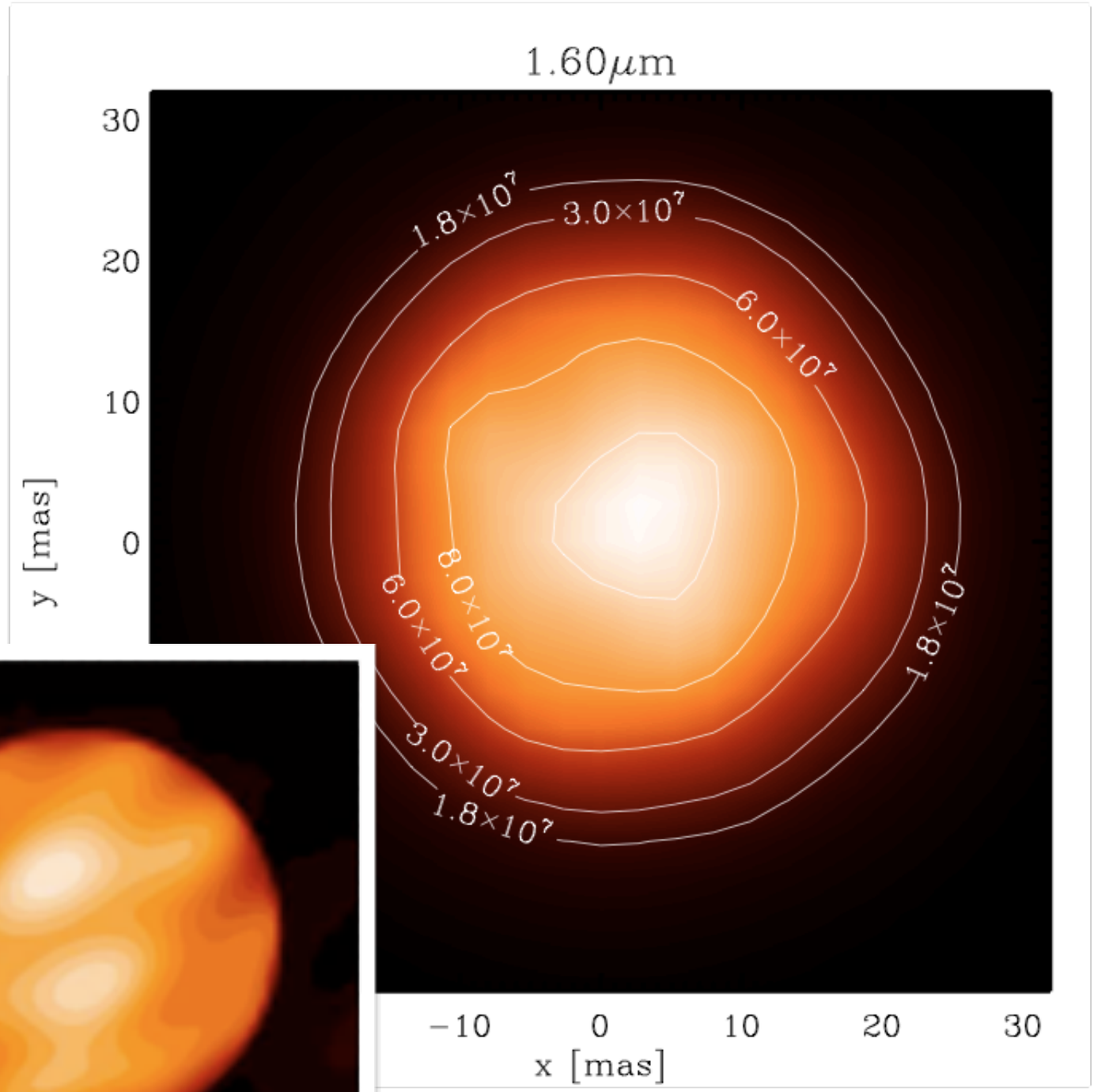
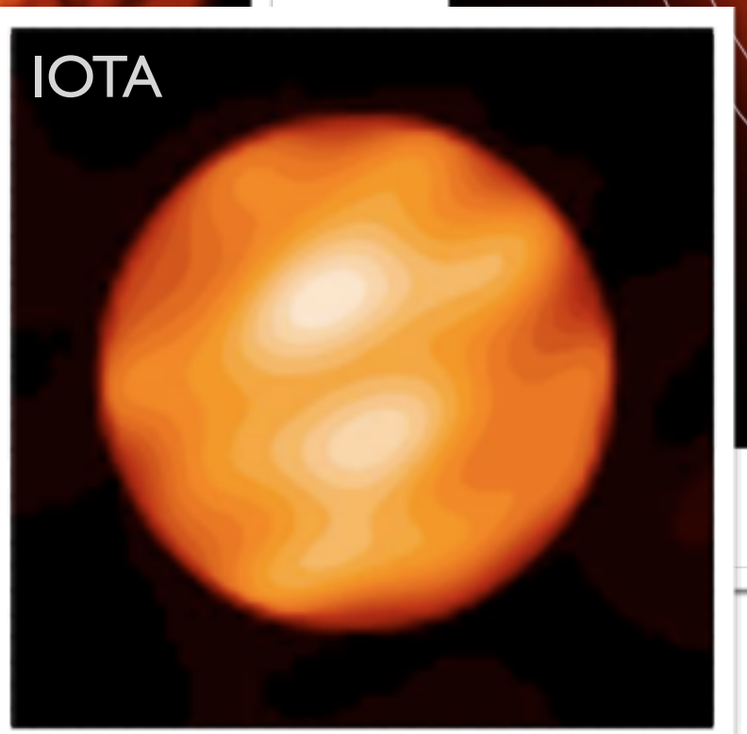
1.8×10⁷
30
20
10
0
−10
−20
−30
y [mas]
−30
−20
−10
0
10
20
30
x [mas]

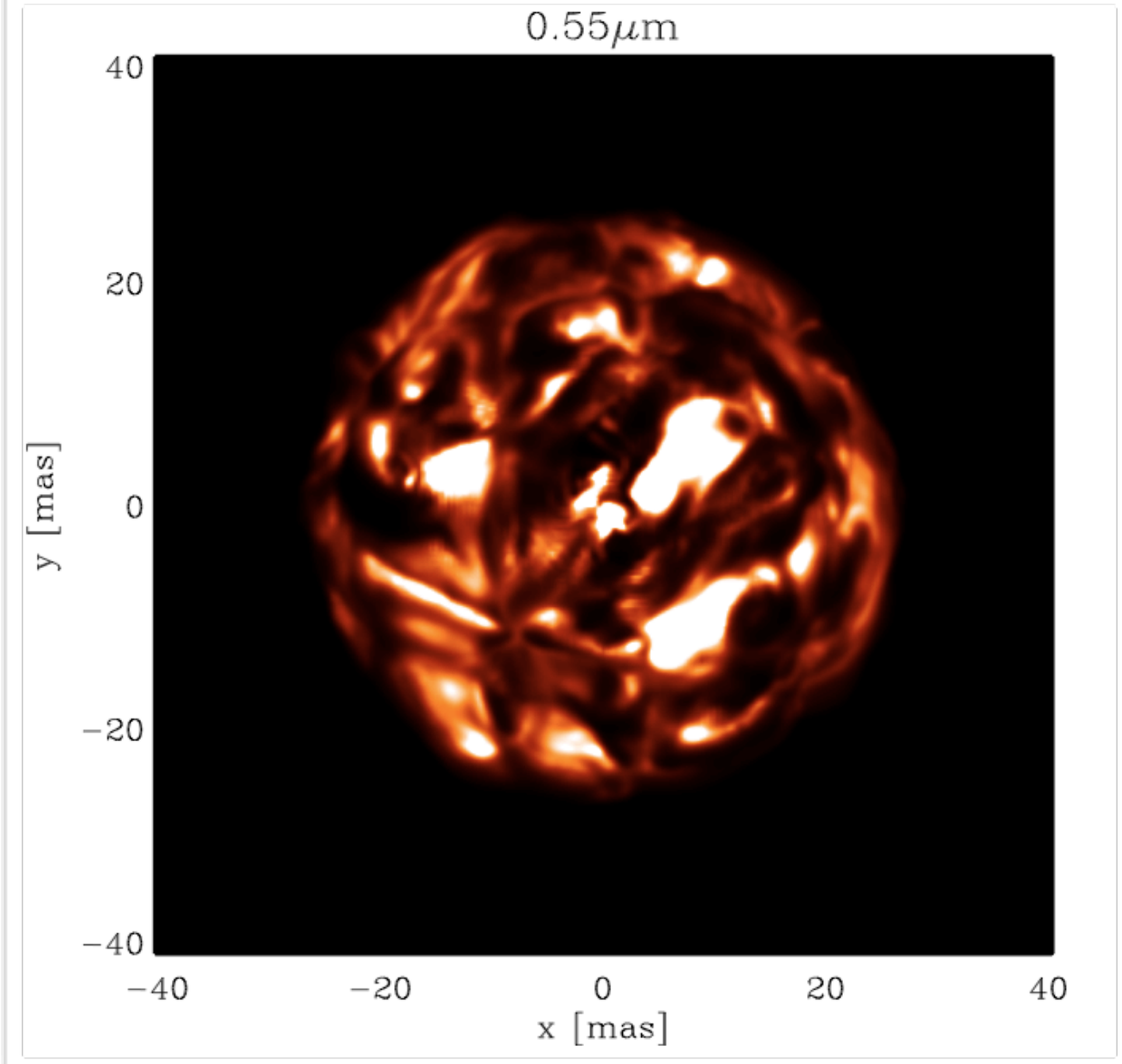
E-ELT H band


1.60μm
30
20
10
0
−10
−20
−30
y [mas]
−30
−20
−10
0
x [mas]

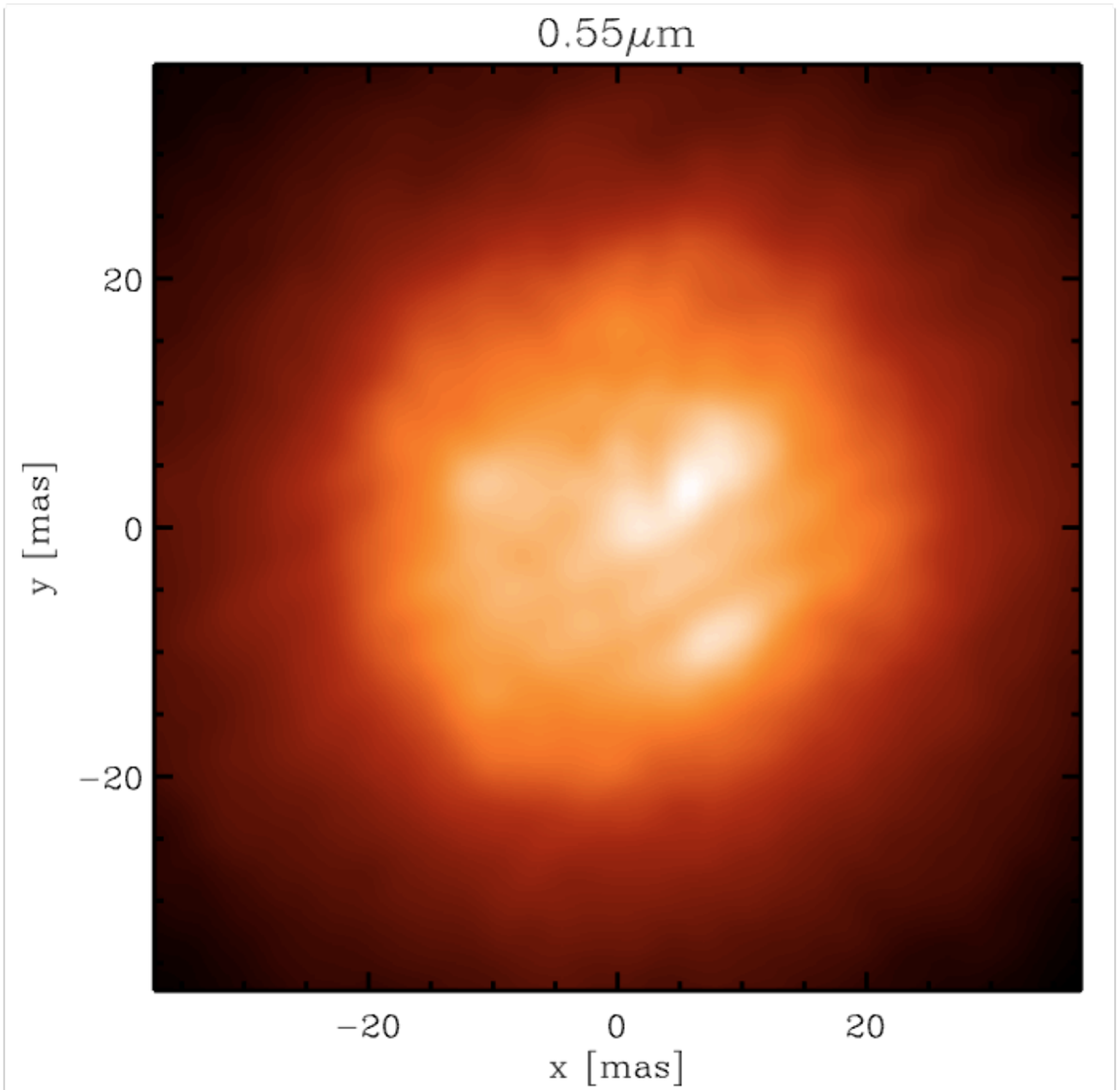

1.60μm
30
20
10
0
y [mas]
1.8×10⁷
3.0×10⁷
6.0×10⁷
8.0×10⁷
6.0×10⁷
3.0×10⁷
1.8×10⁷
1.8×10²
−10
0
10
20
30
x [mas]


IOTA

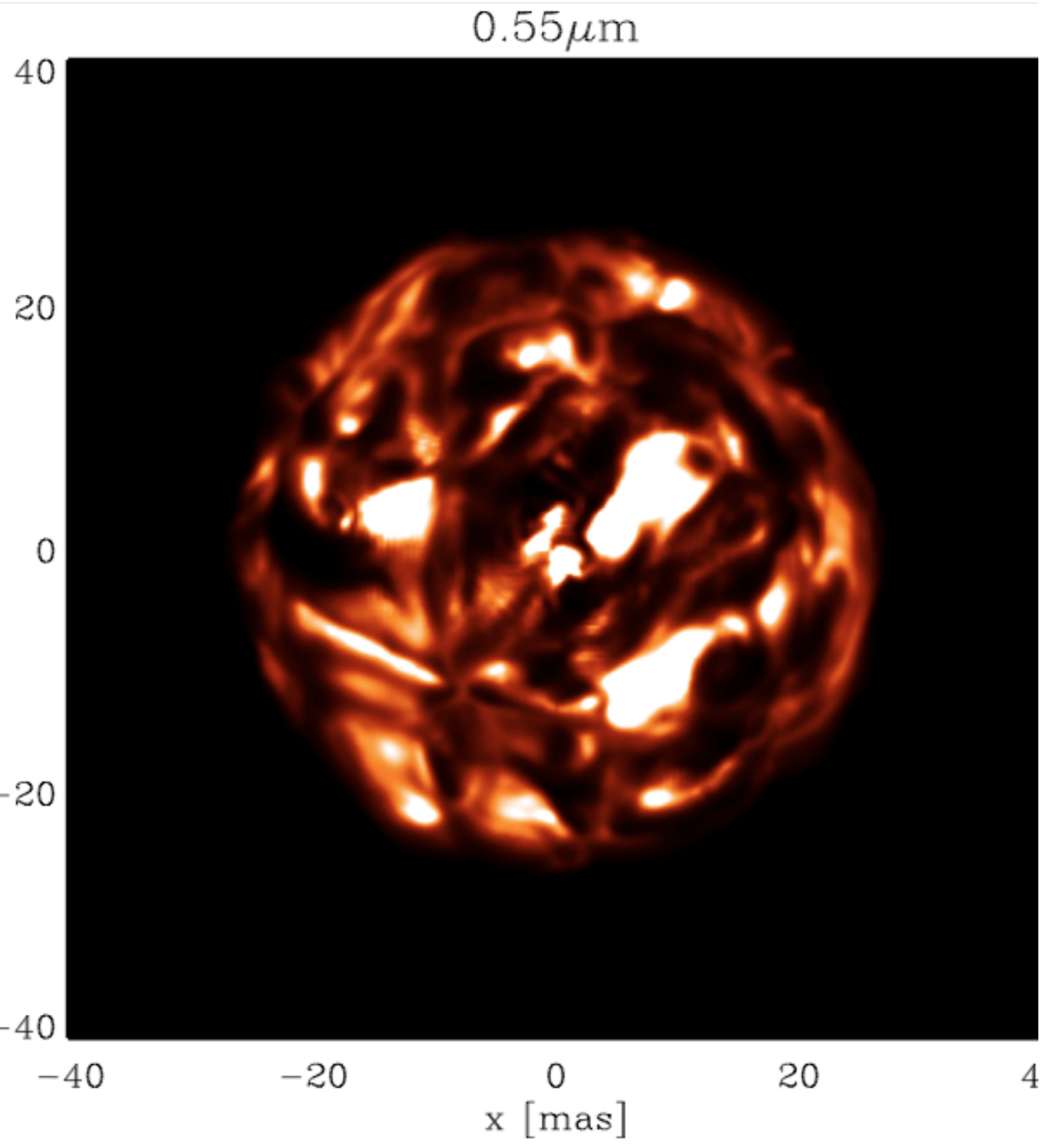
E-ELT V band

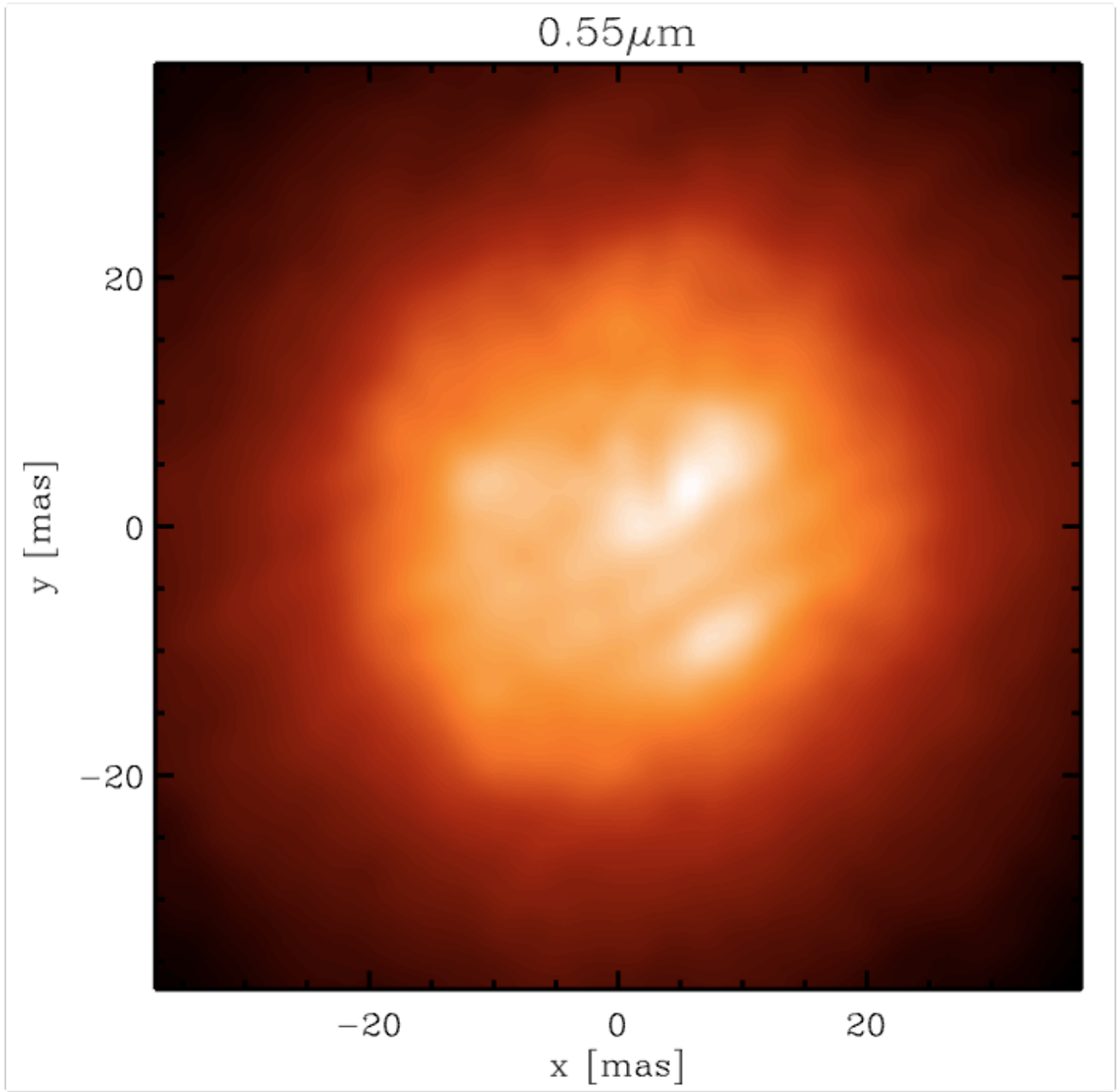


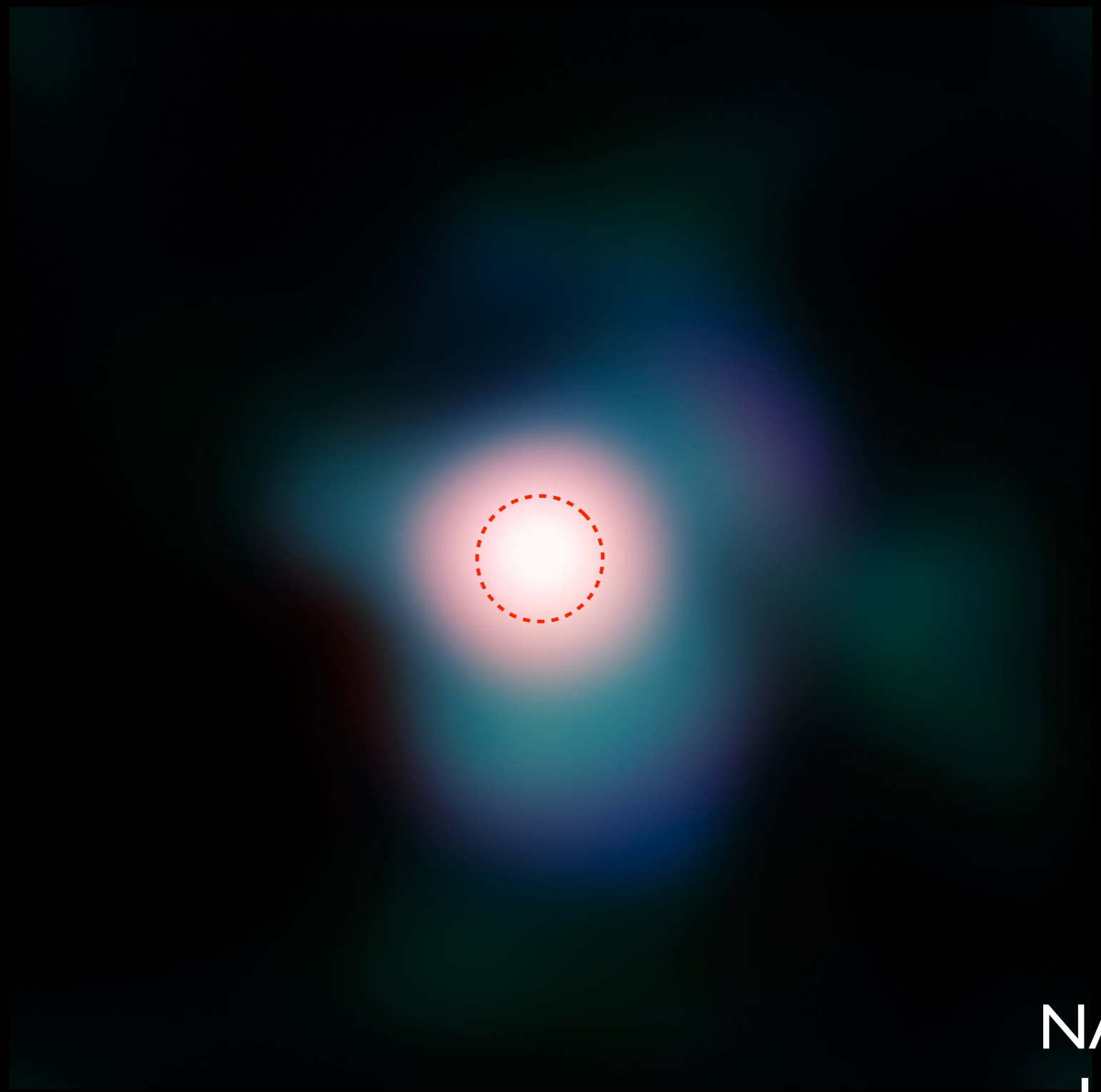
E-ELT V band



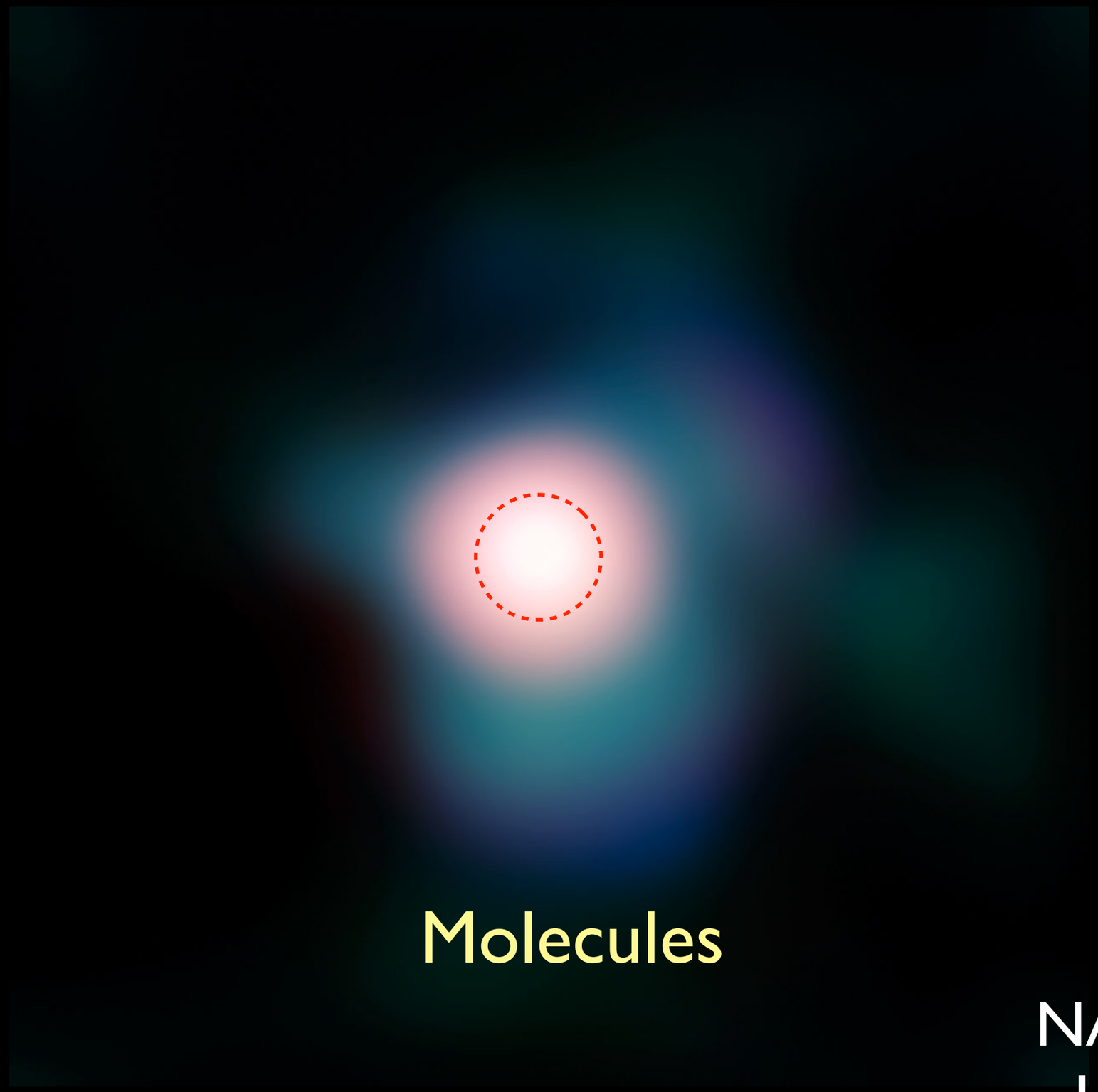
E-ELT V band



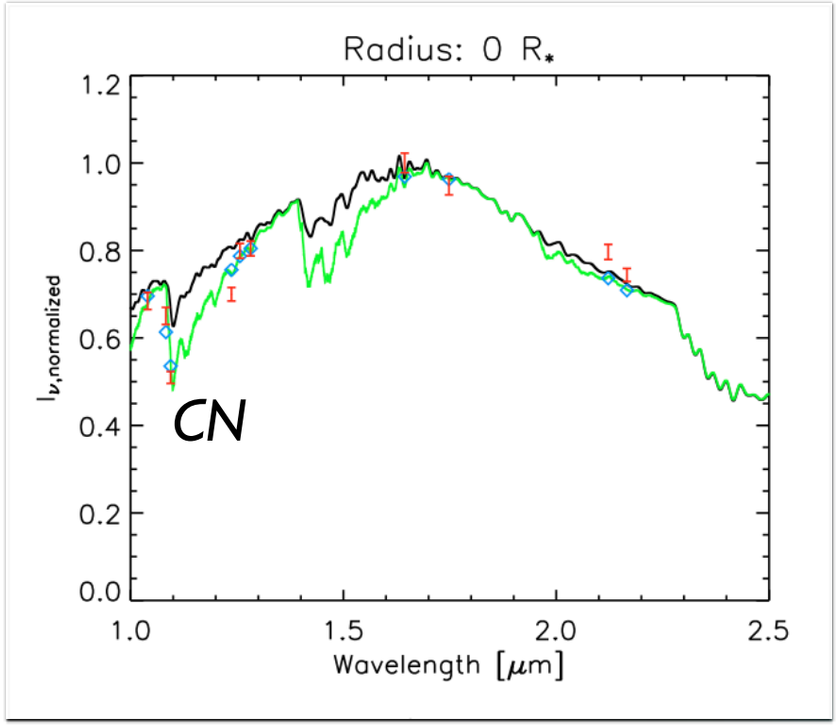




Kervella et al. 2009, A&A, 504, 115



Kervella et al. 2009, A&A, 504, 115

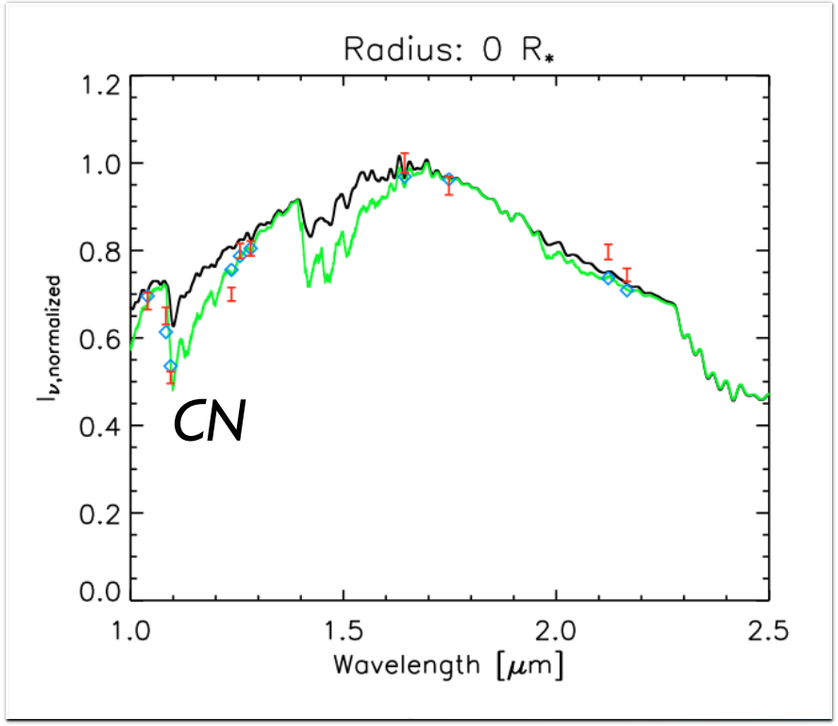


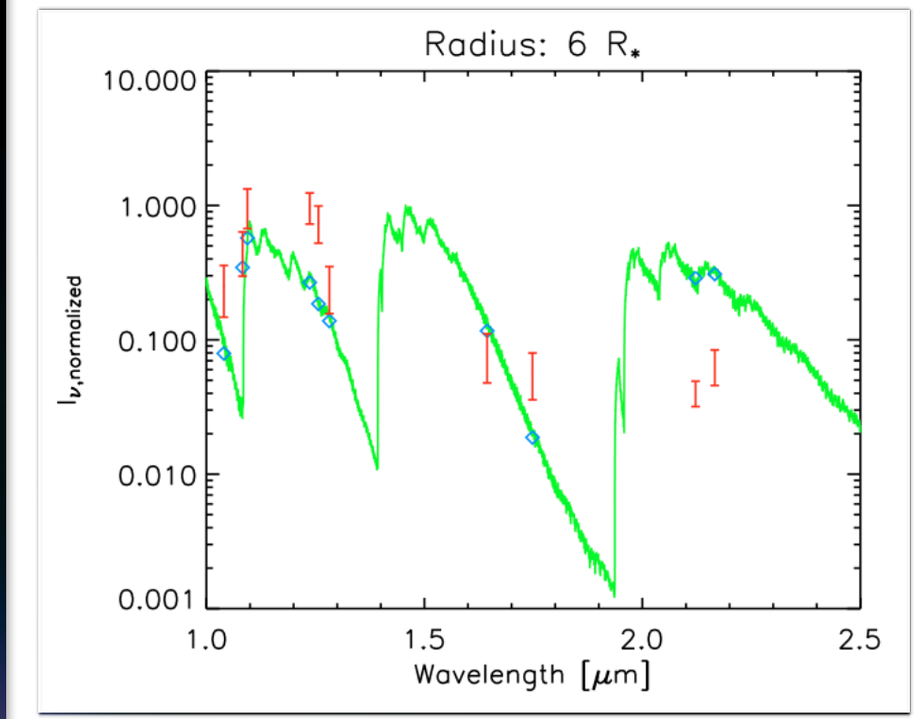
Molecules

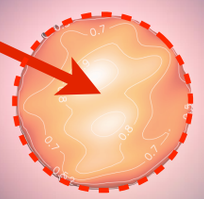
100 mas

NACO (2009)
1.0 - 2.2 μm

Kervella et al. 2009, A&A, 504, 115







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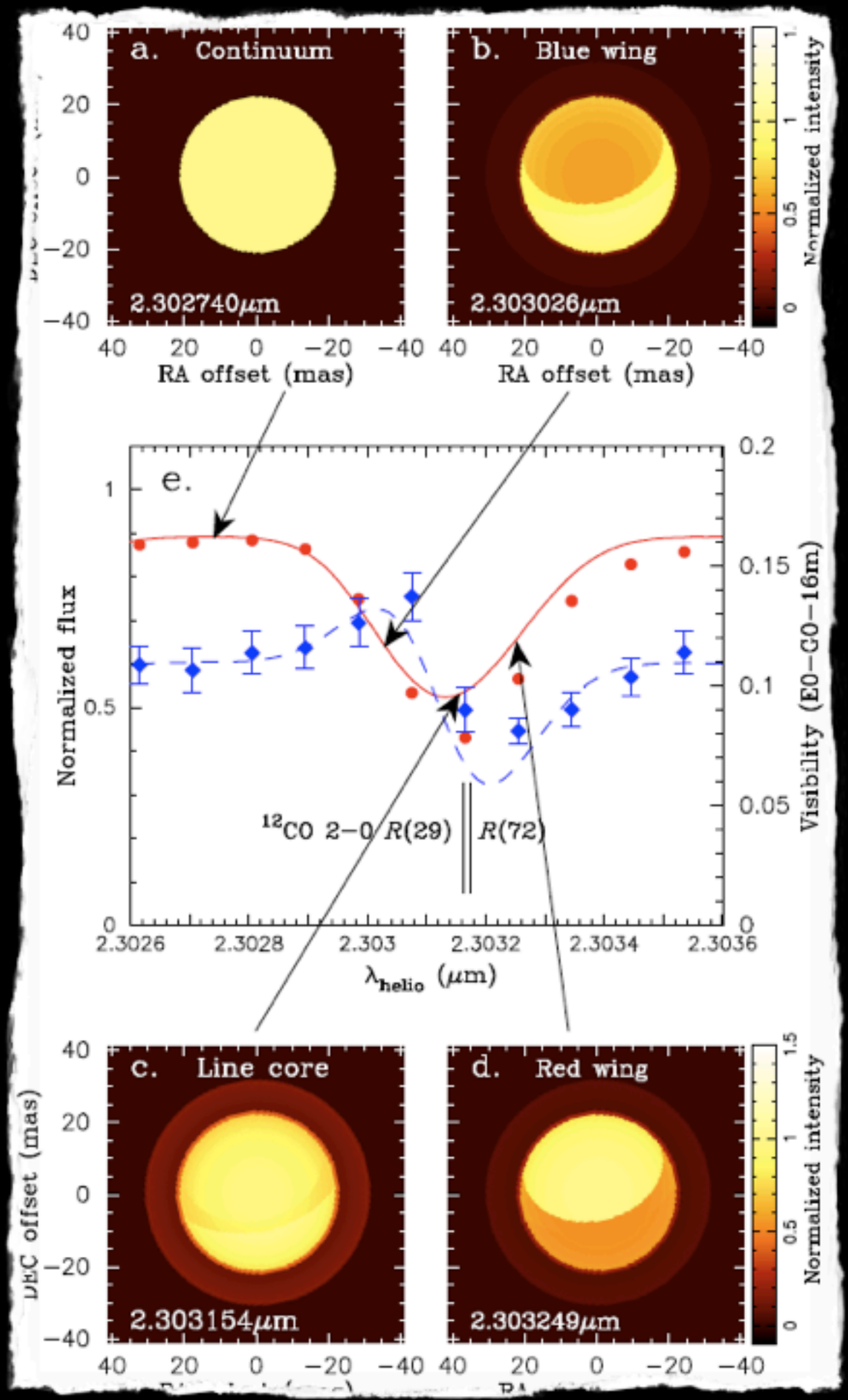
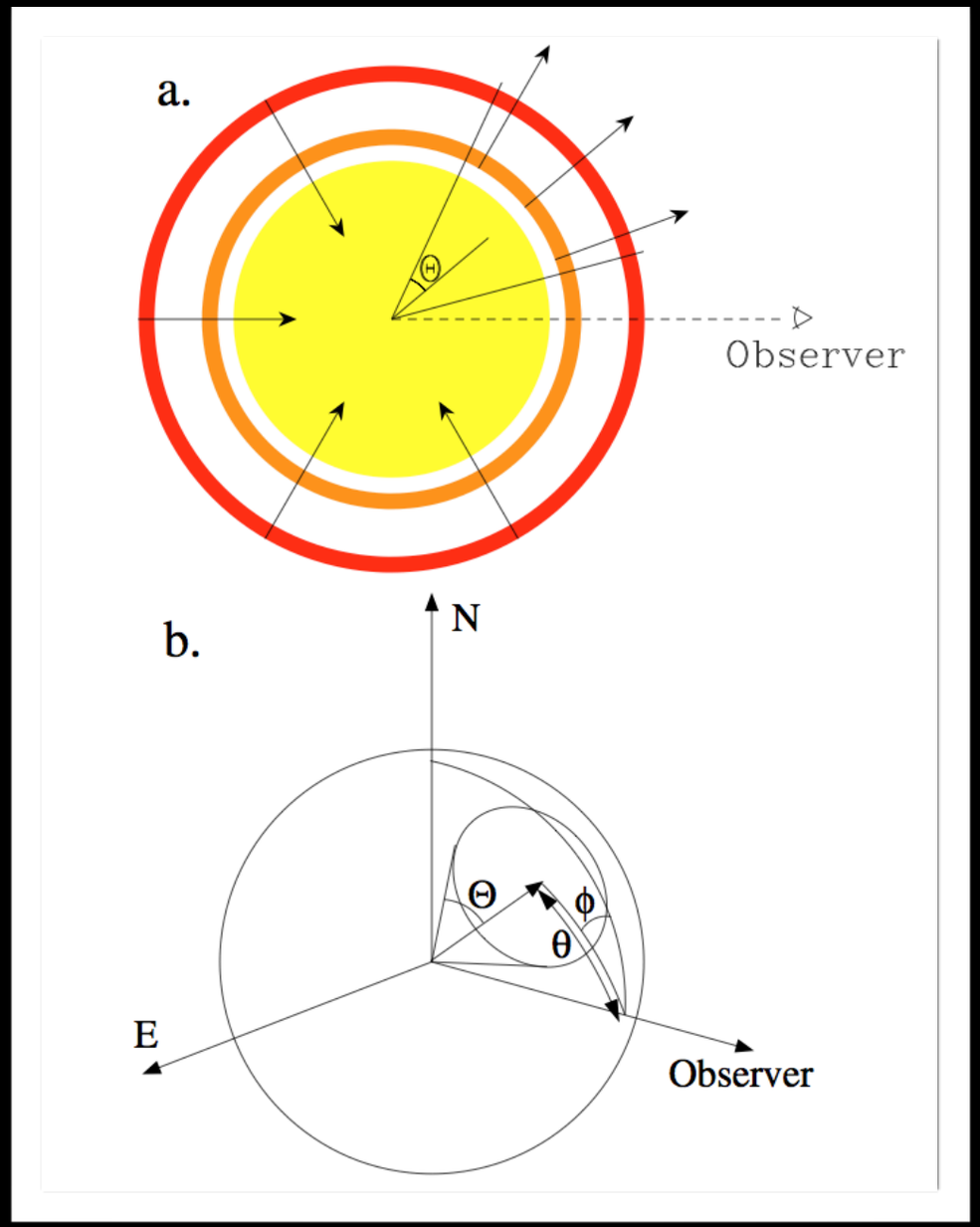
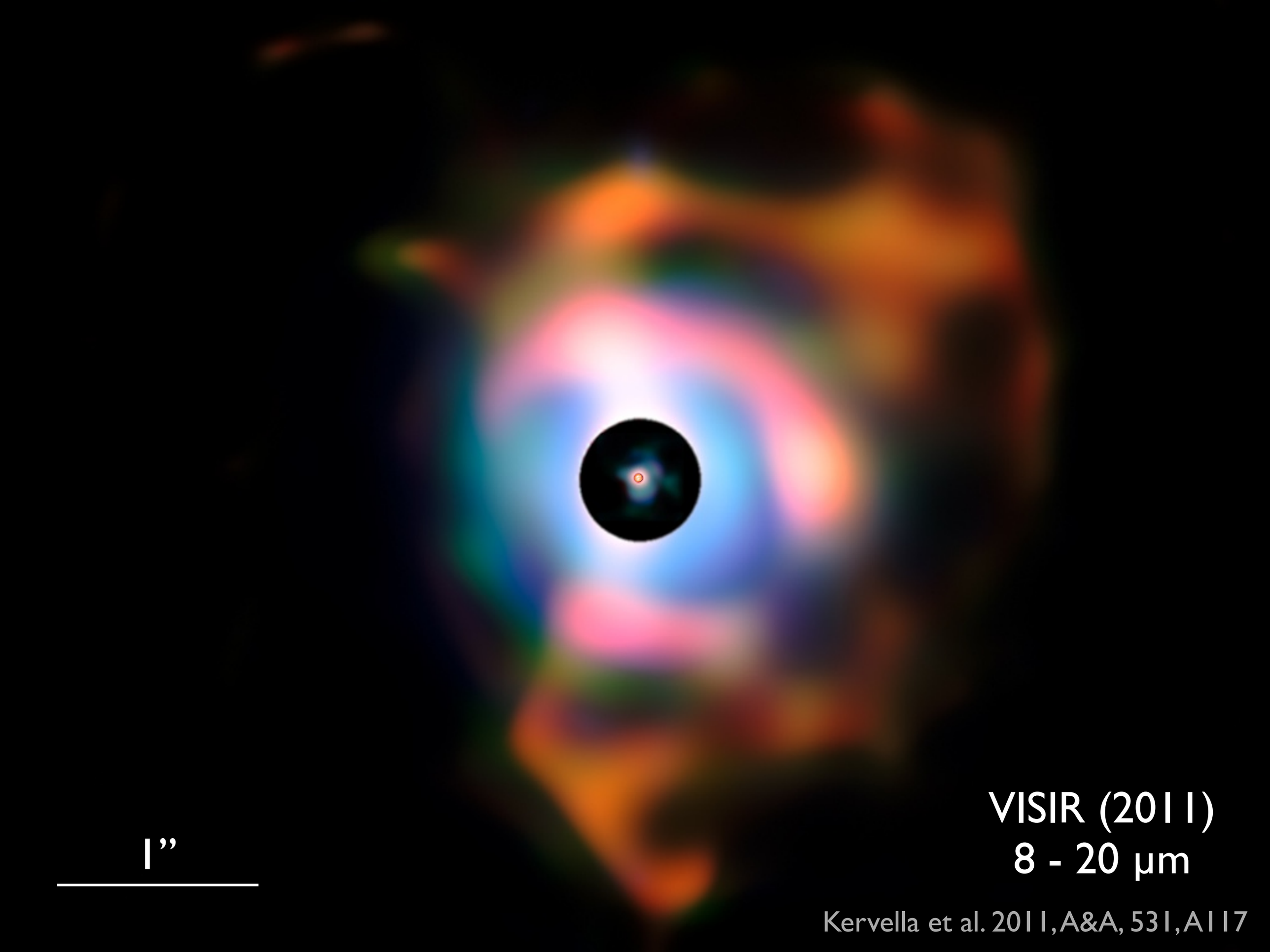
CO gas in motion

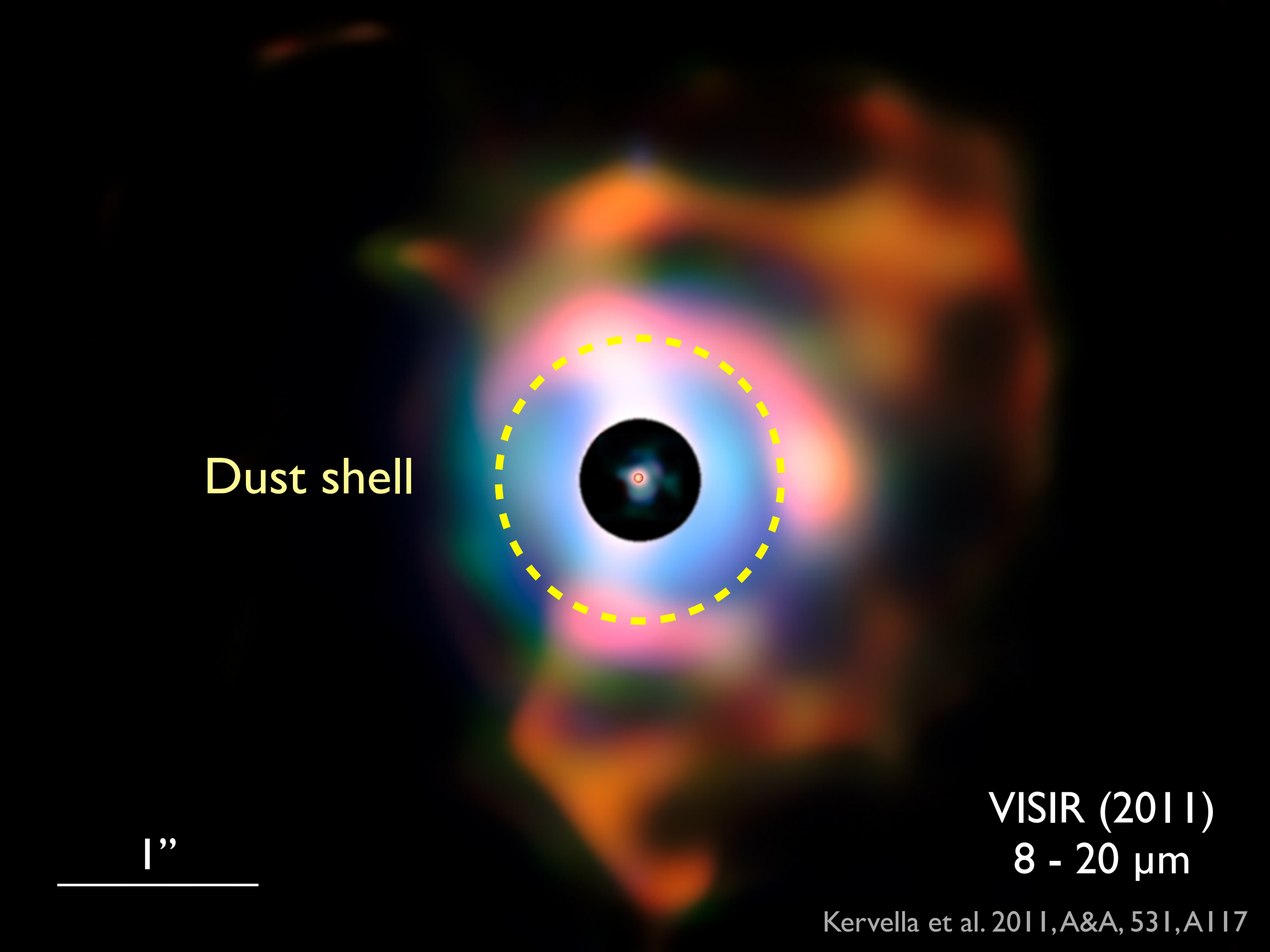




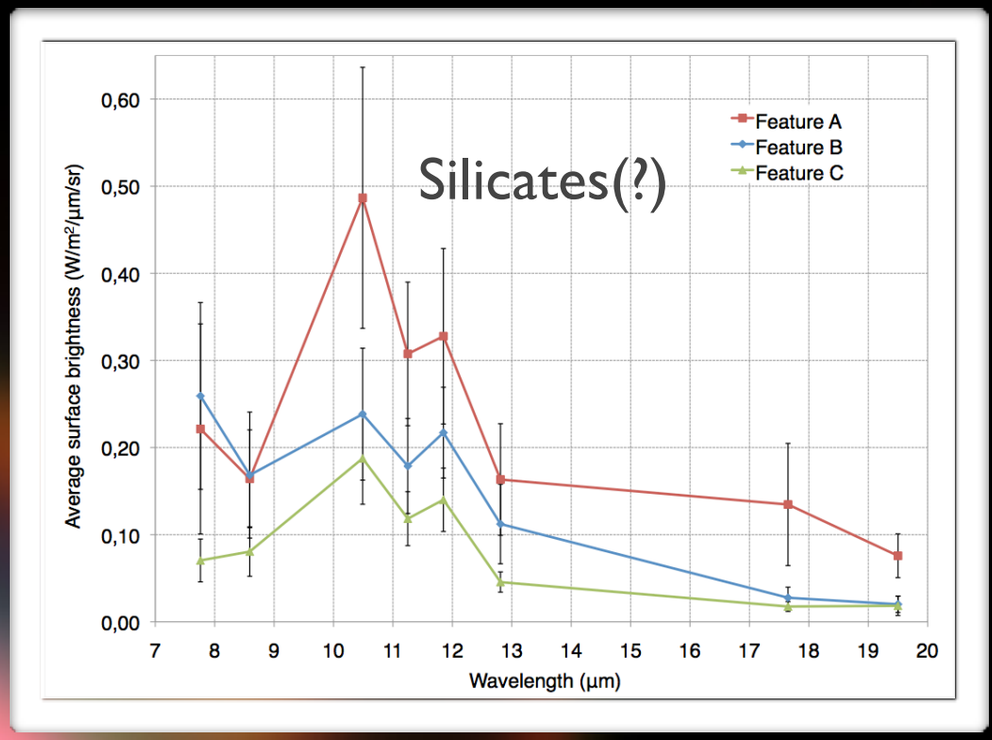
Ohnaka et al. 2009, A&A, 503, 183



Kervella et al. 2011, A&A, 531, A117



Kervella et al. 2011, A&A, 531, A117



Dust shell

A

1”

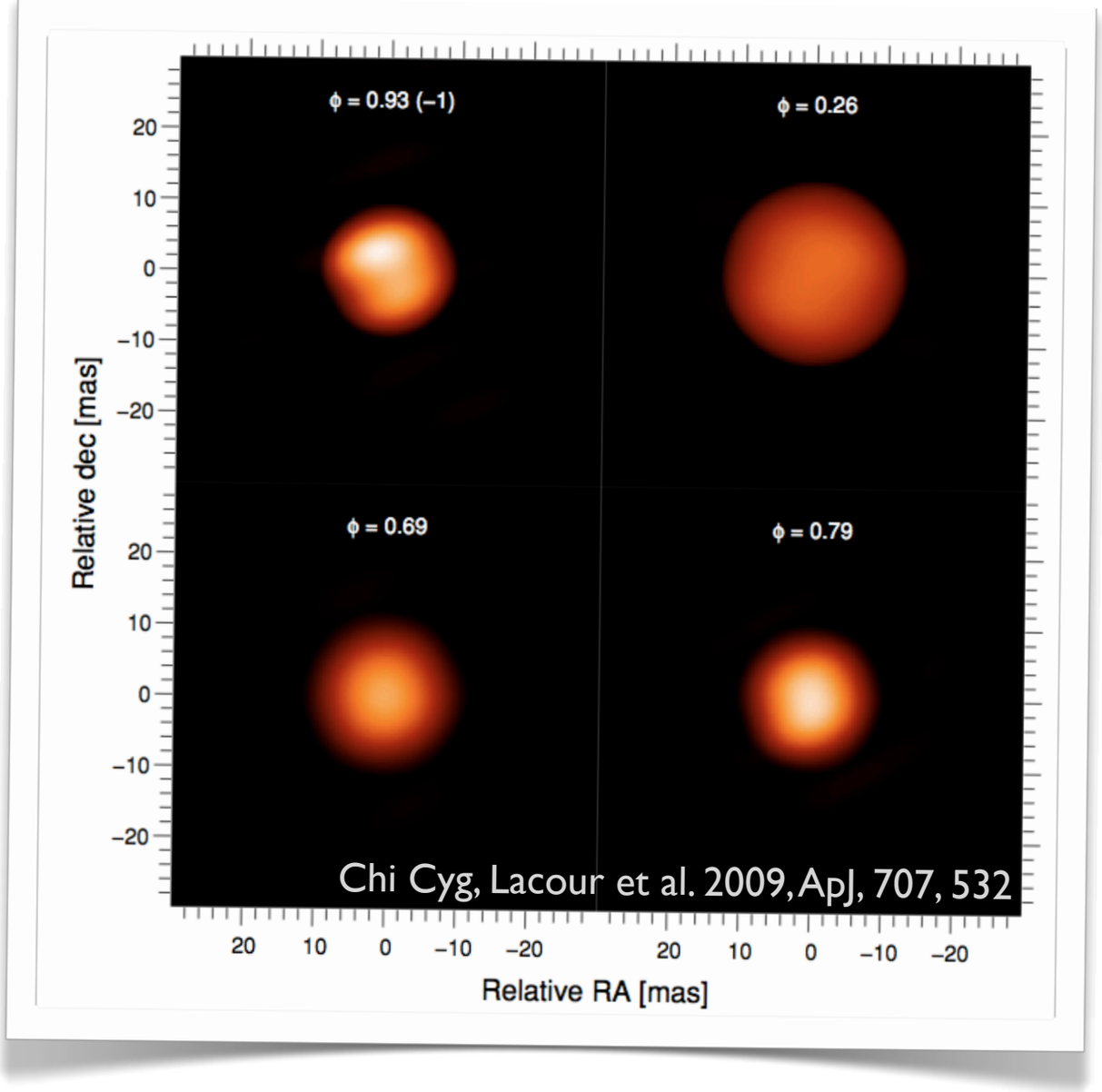
VISIR (2011)
8 - 20 µm

Kervella et al. 2011, A&A, 531, A117

Other targets

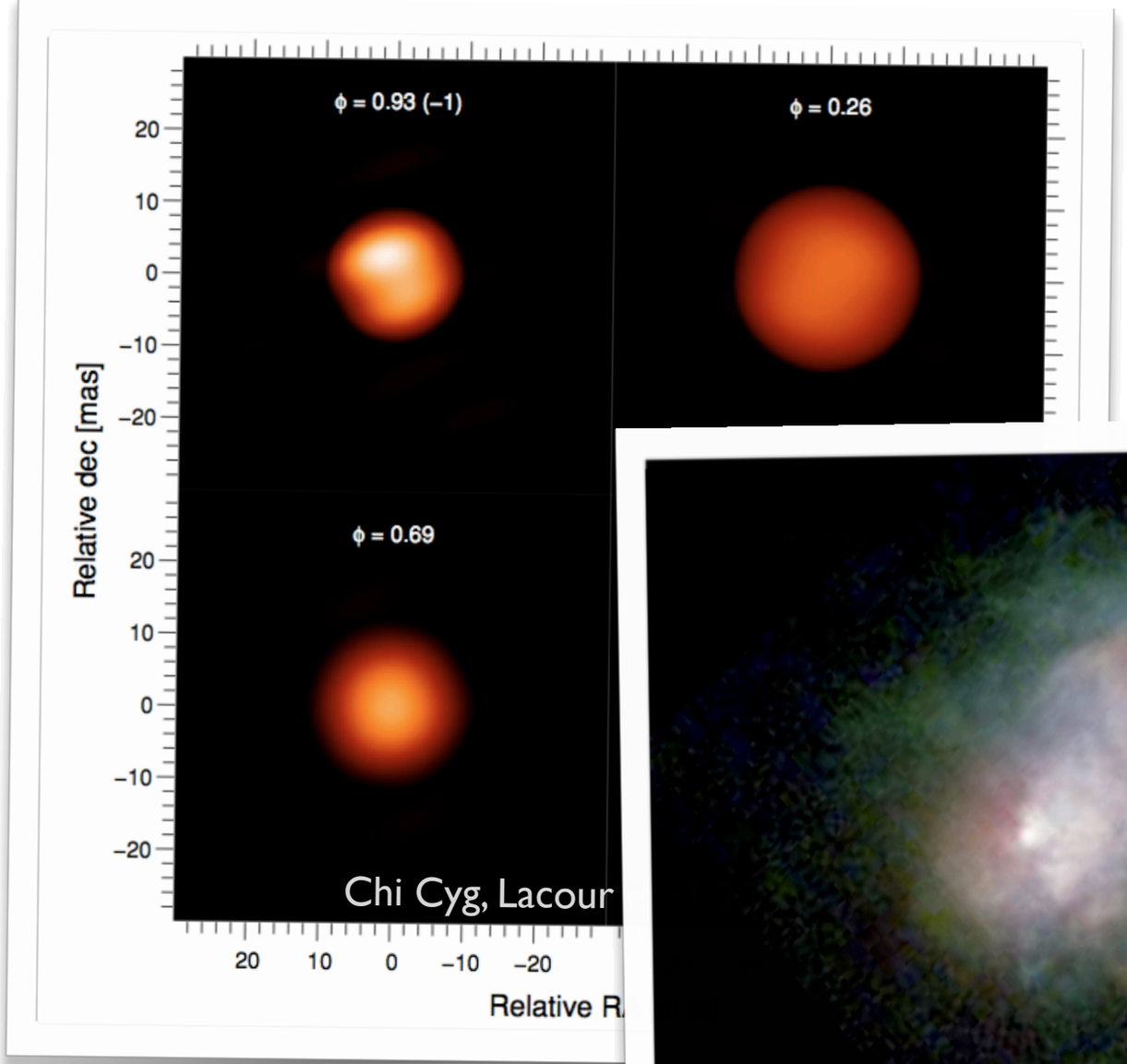
Other targets

- Mira stars



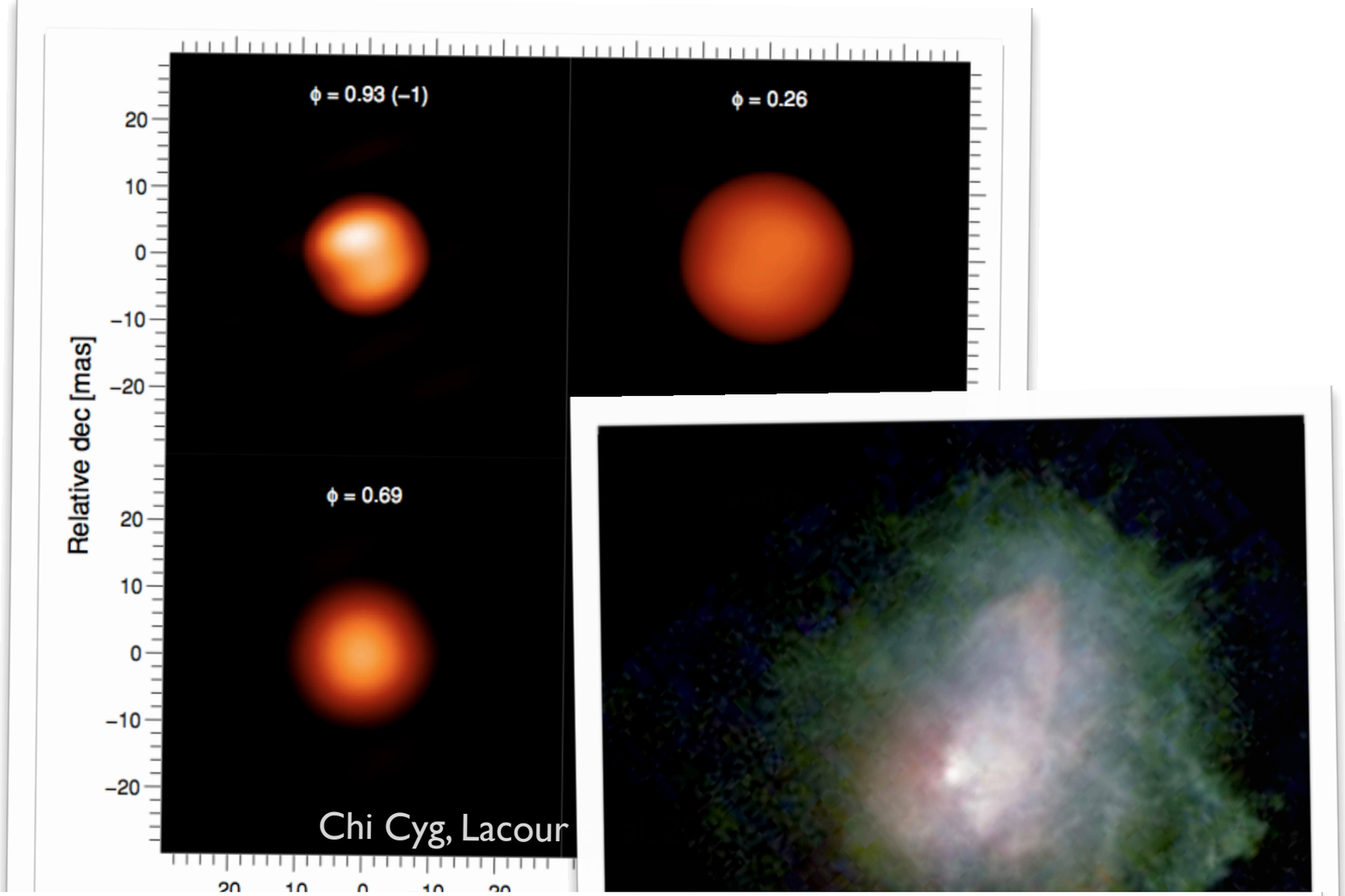
Other targets

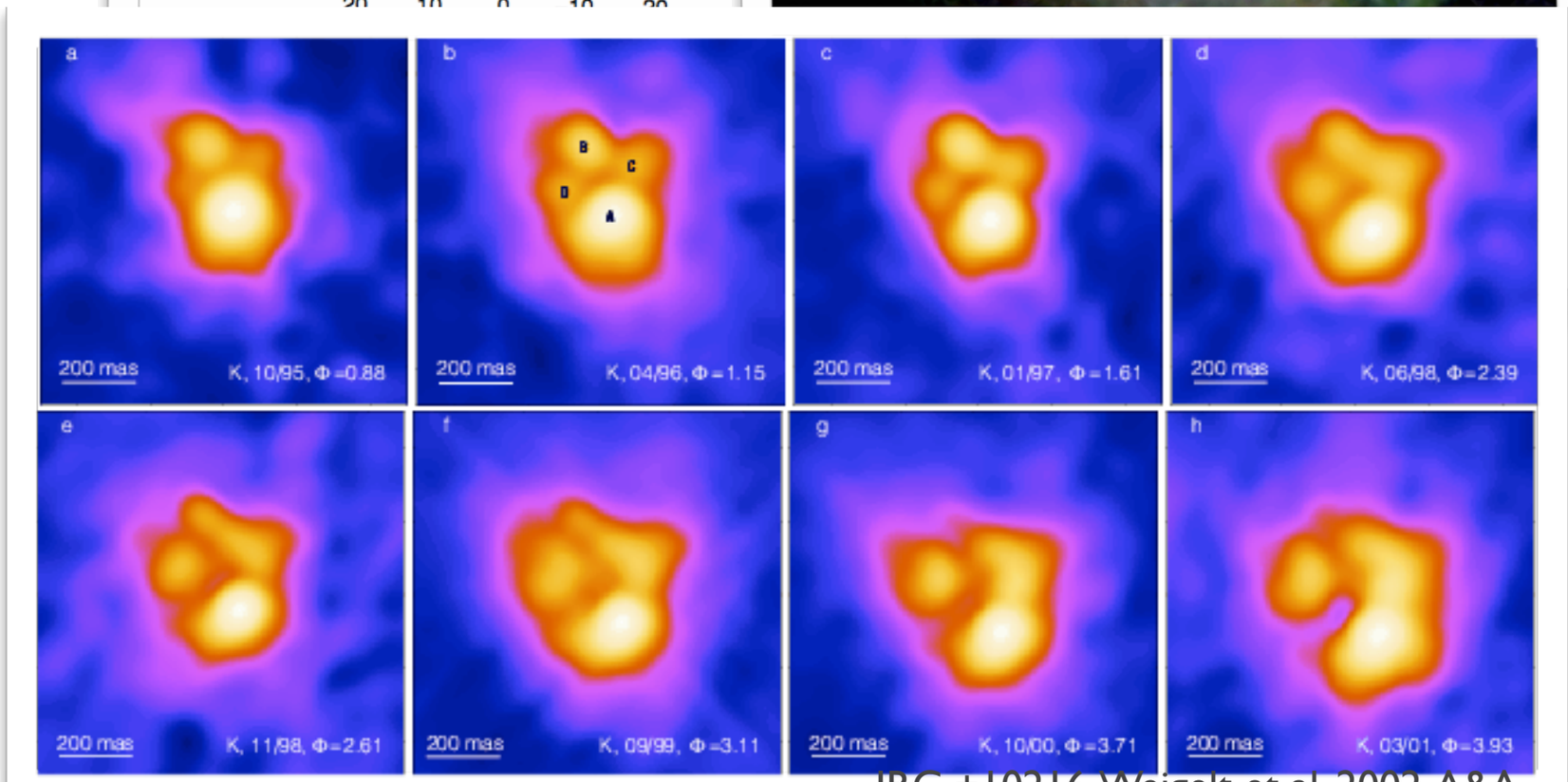
- Mira stars
- VY CMa



Other targets

- Mira stars
- VY CMa
- IRC +10216

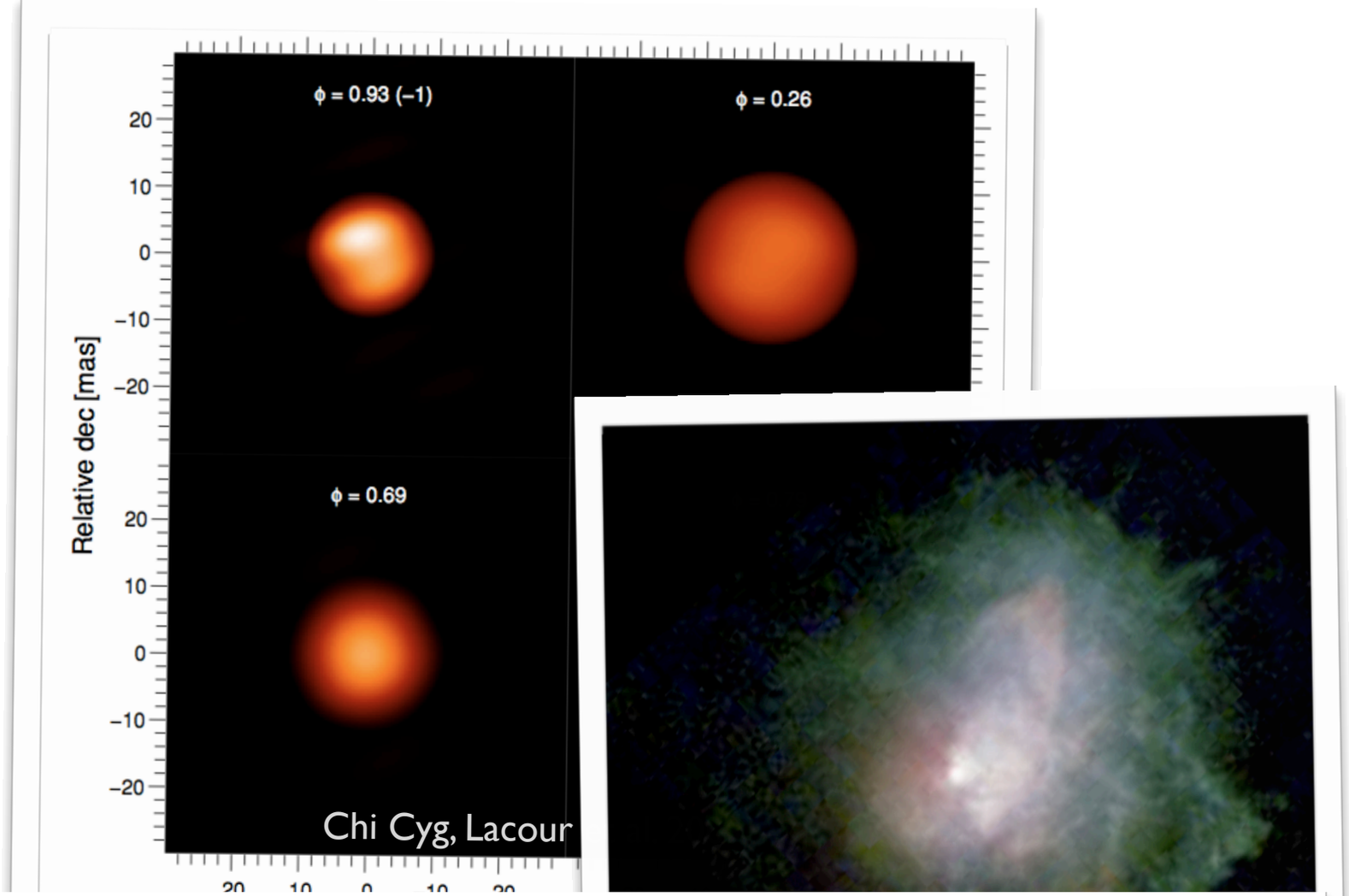


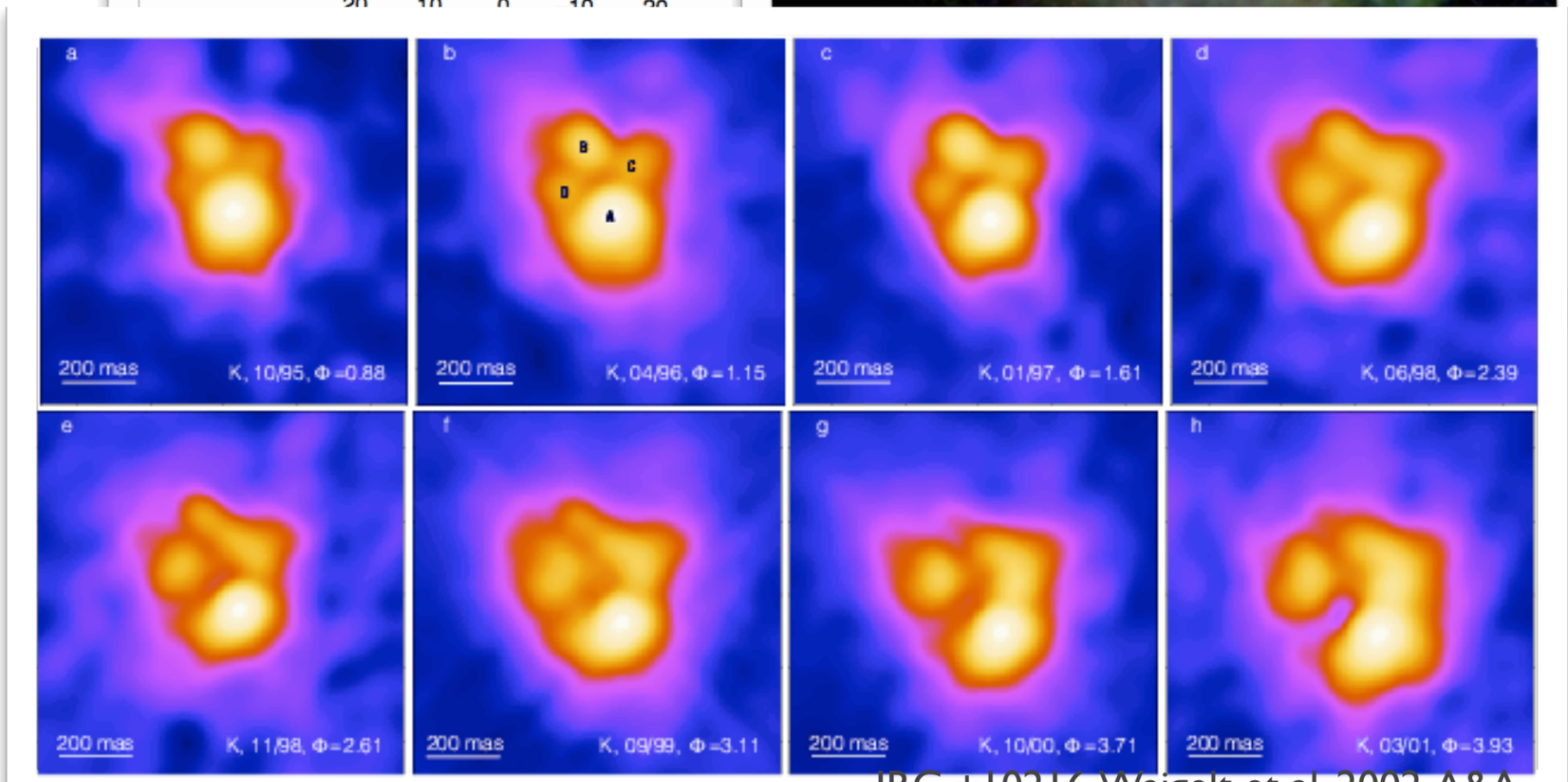


IRC +10216, Weigelt et al. 2002, A&A

Other targets

- Mira stars
- VY CMa
- IRC +10216
- R Dor

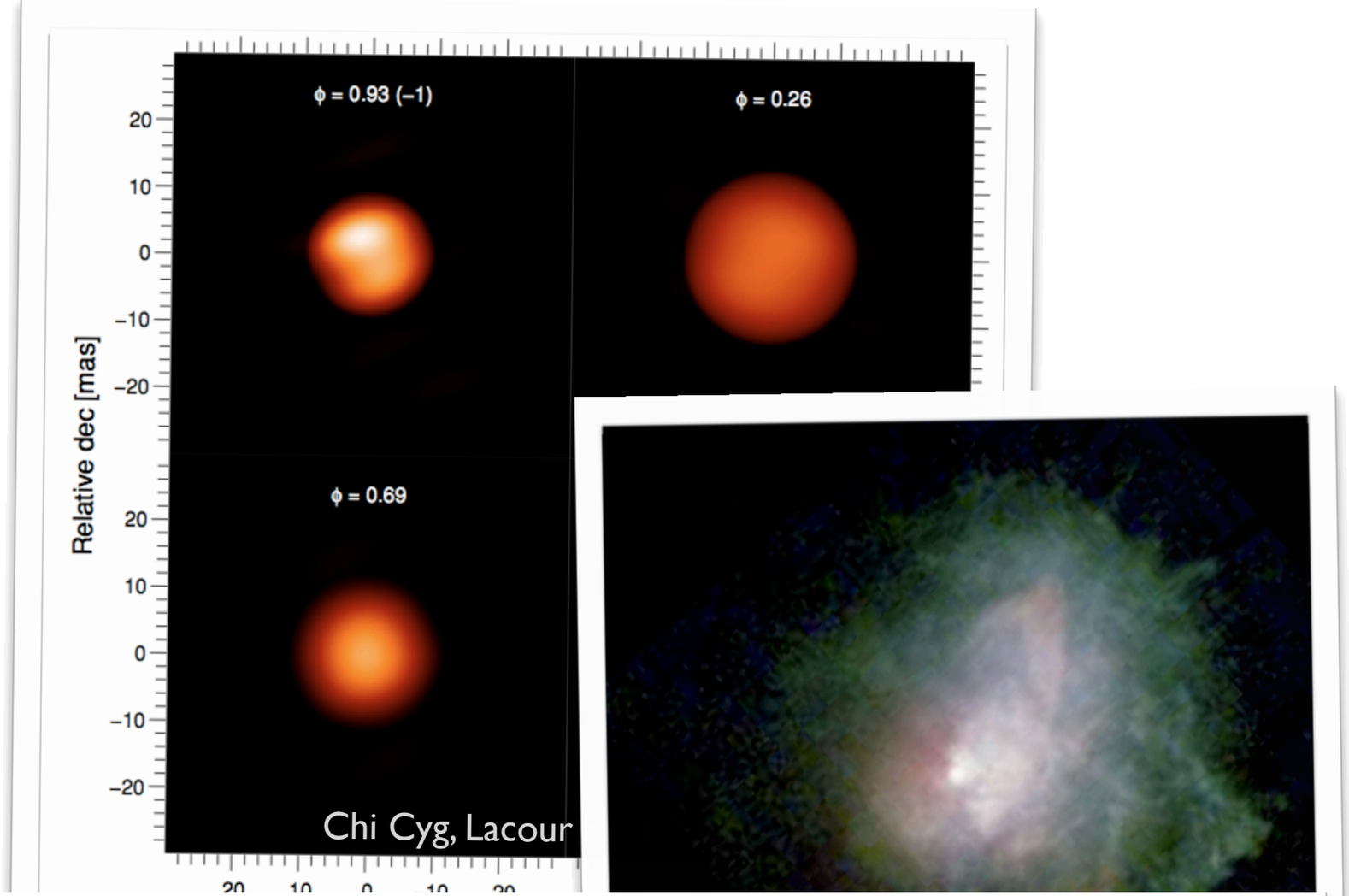


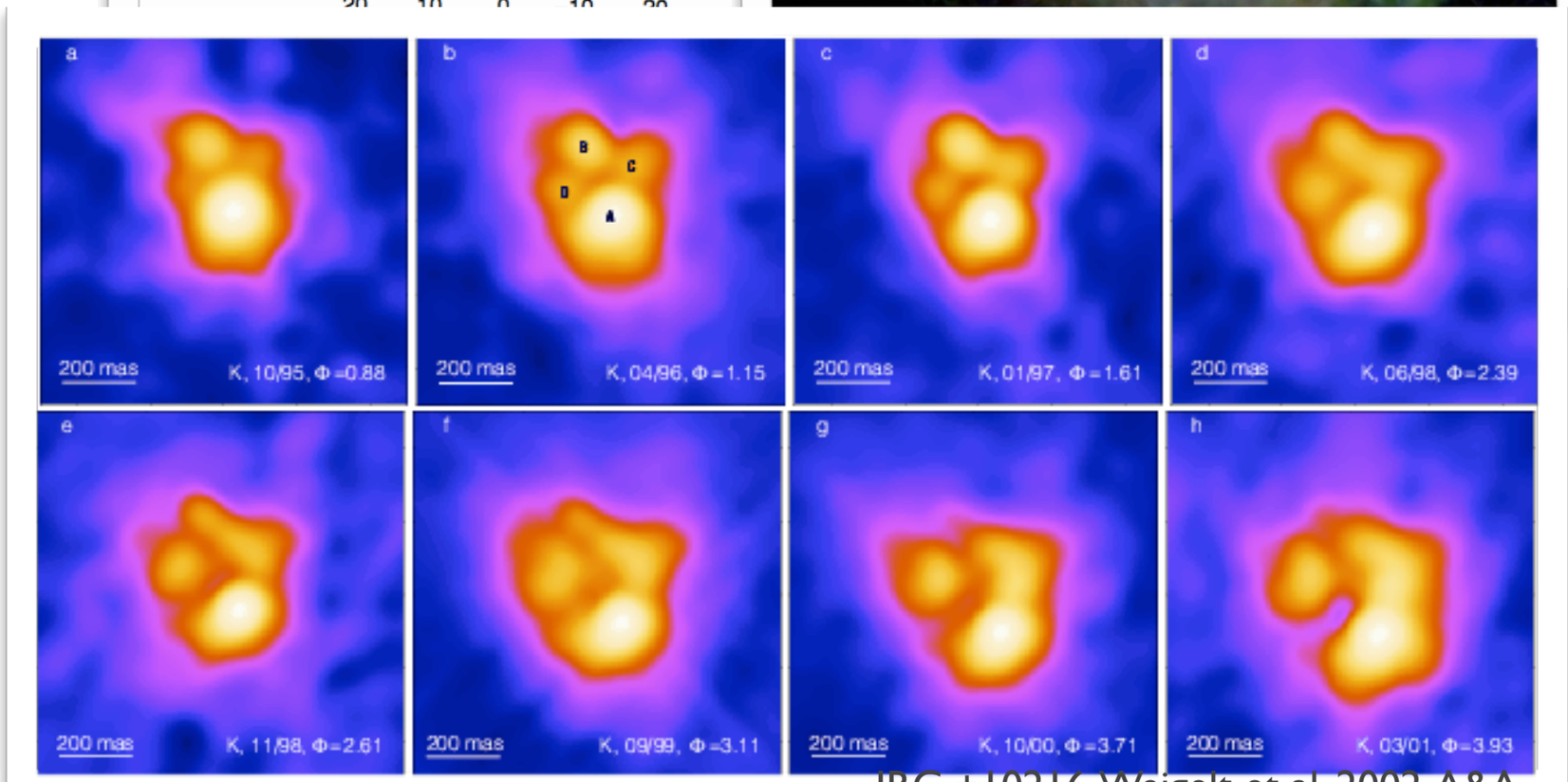


IRC +10216, Weigelt et al. 2002, A&A

Other targets

- Mira stars
- VY CMa
- IRC +10216
- R Dor
- Eta Car

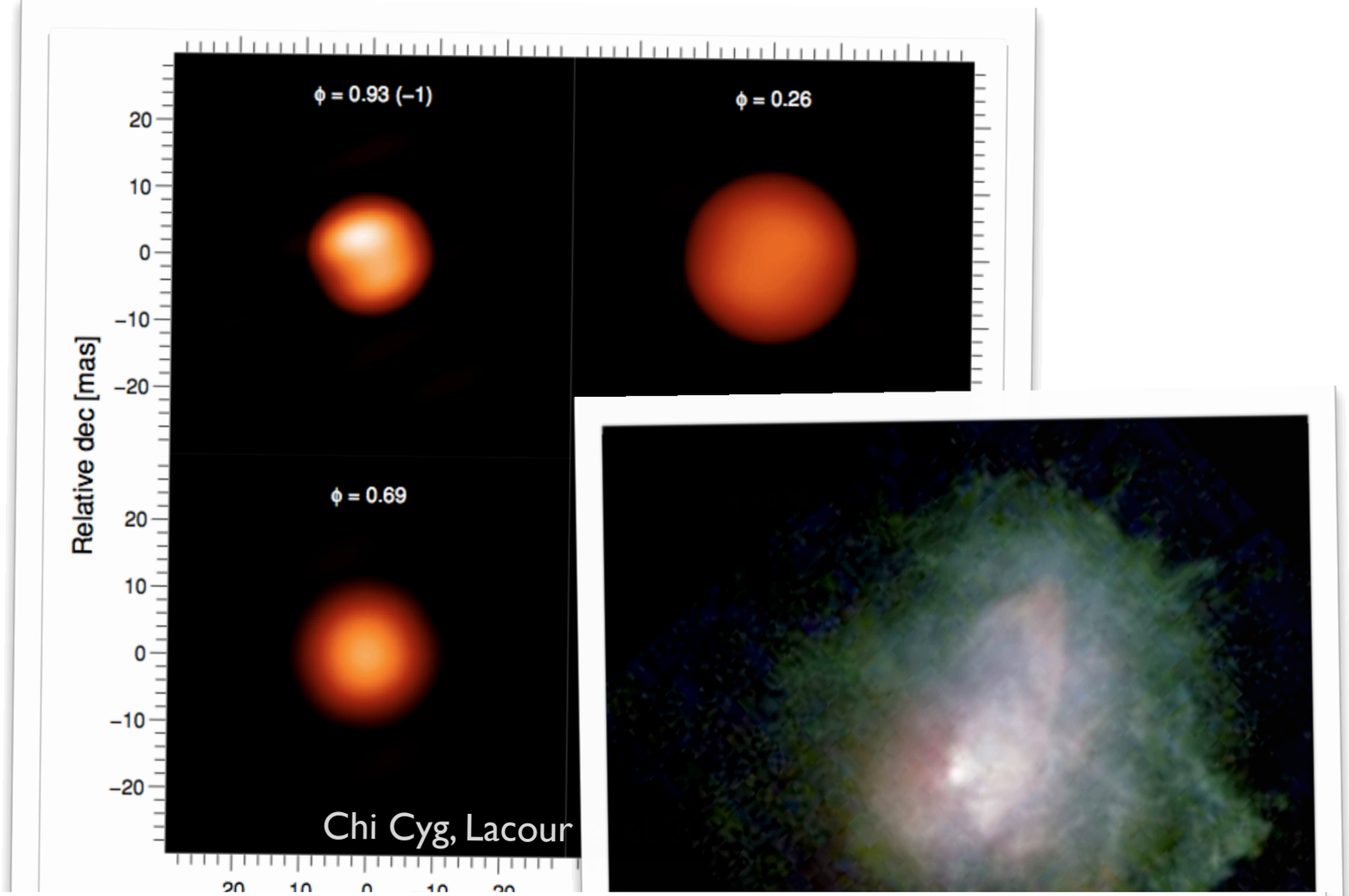


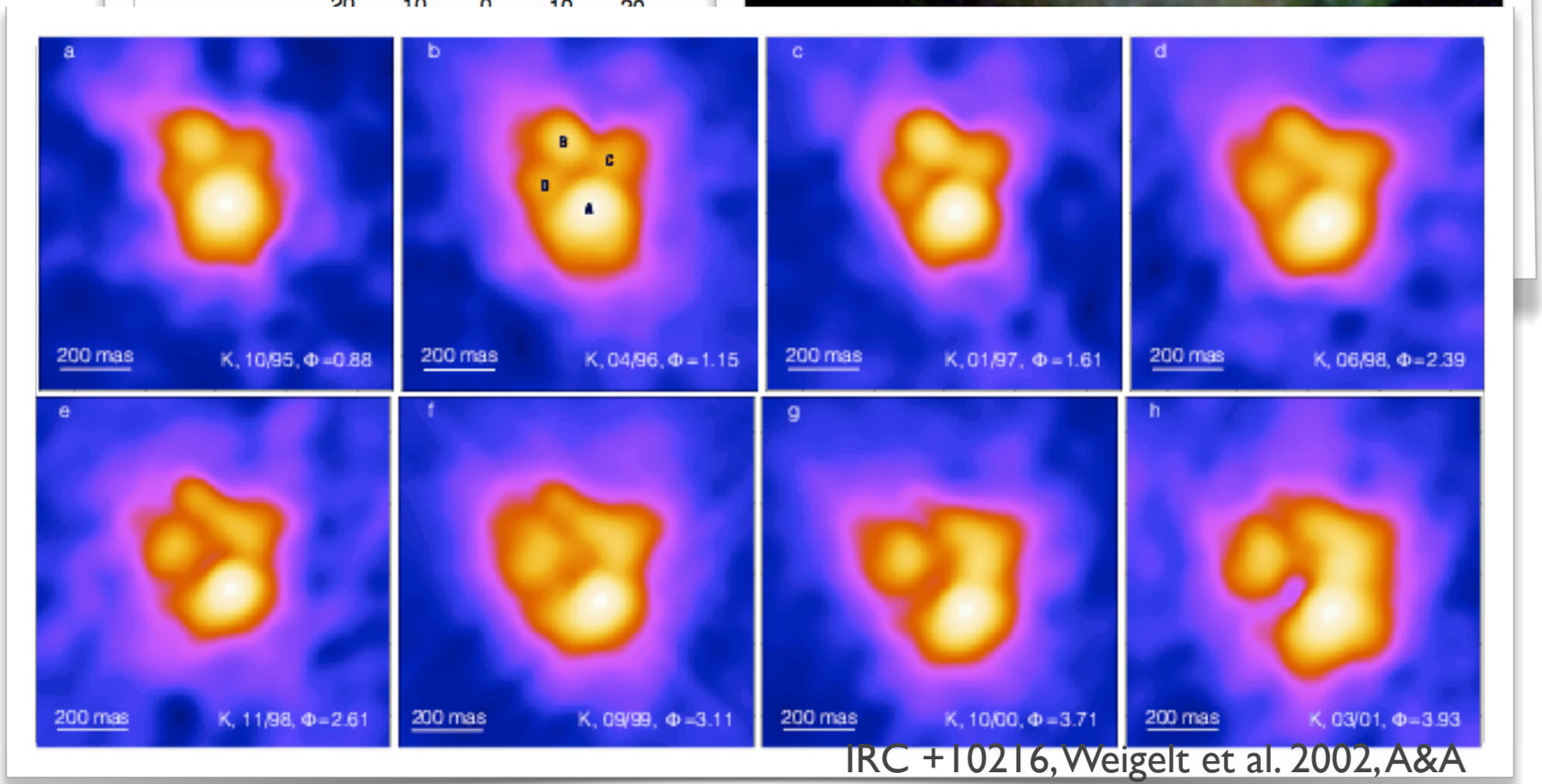


IRC +10216, Weigelt et al. 2002, A&A

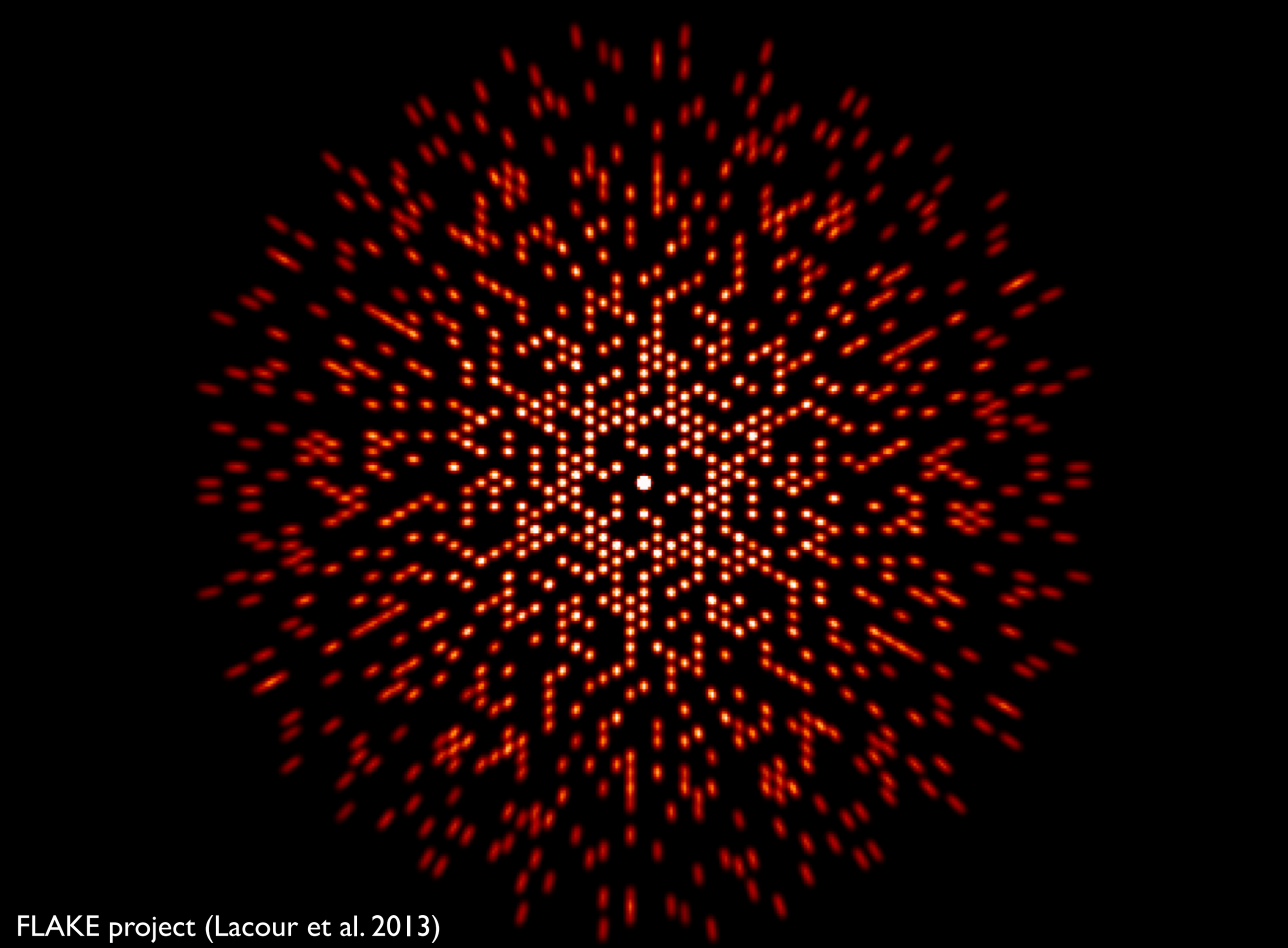
Other targets

- Mira stars
- VY CMa
- IRC +10216
- R Dor
- Eta Car
- ...





IRC +10216, Weigelt et al. 2002, A&A



FLAKE project (Lacour et al. 2013)

Attenuation filters
WFS + Instruments

Fast readout detectors

Aperture masking

Please do not forget bright targets !

FLAKE project (Lacour et al. 2013)