Stars and circumstellar environments in the LUVOIR era

Great science projects by :

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Perverted by :

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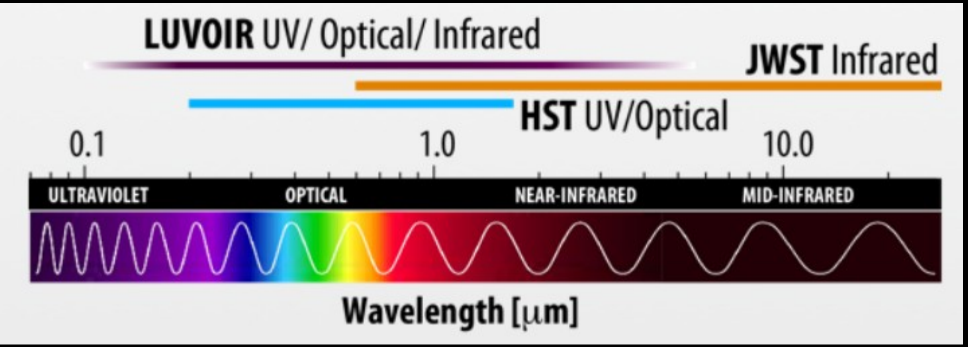
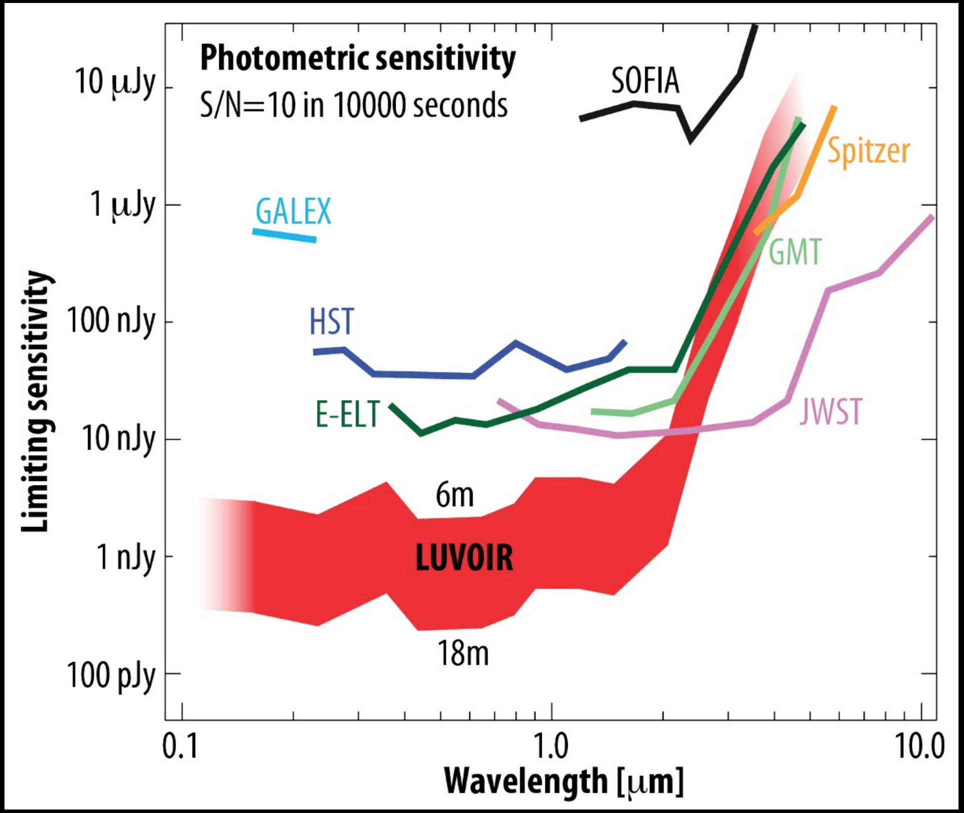
LAGRANGE

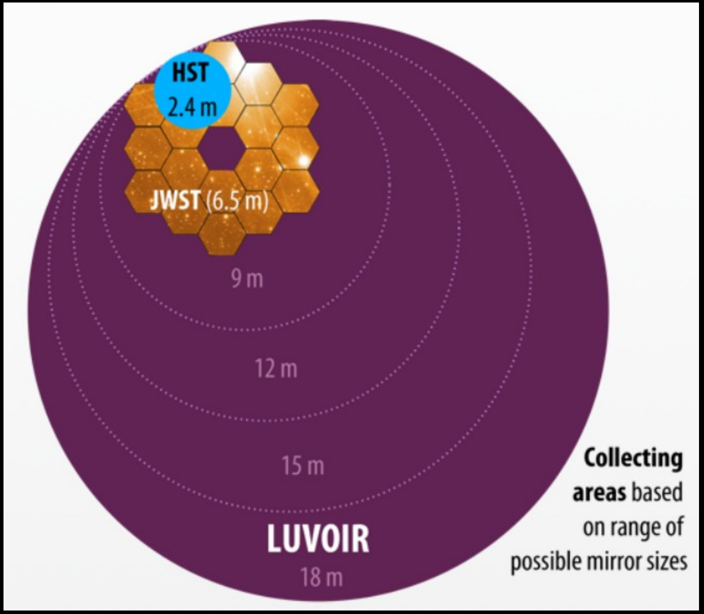
Raw appeal of a LUVOIR ?



Spectral coverage



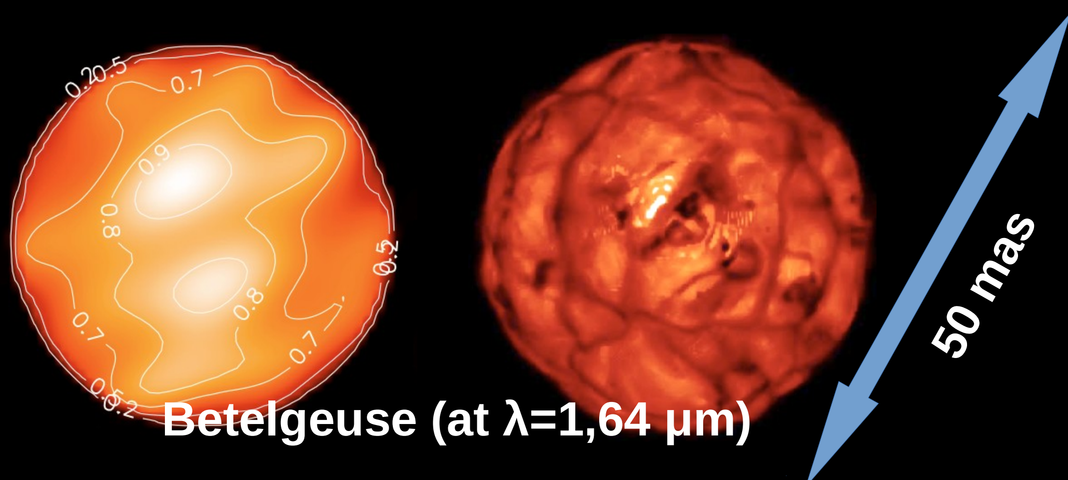
Sensitivity



Angular resolution

Observations of stars with LUVOIR : Two strategies ?

- Resolved observations of individual stars and their environment

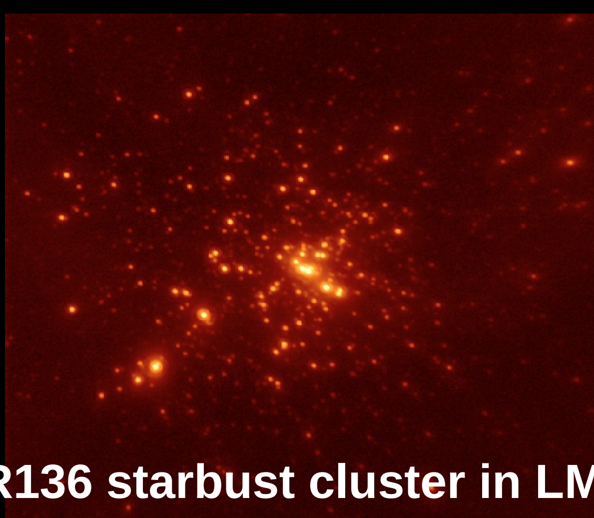


Betelgeuse (at λ=1,64 μm)

REQUIREMENTS :
Resolving power !!
Spectral coverage !

LUVOIR : λ/D ~ 2 – 20 mas

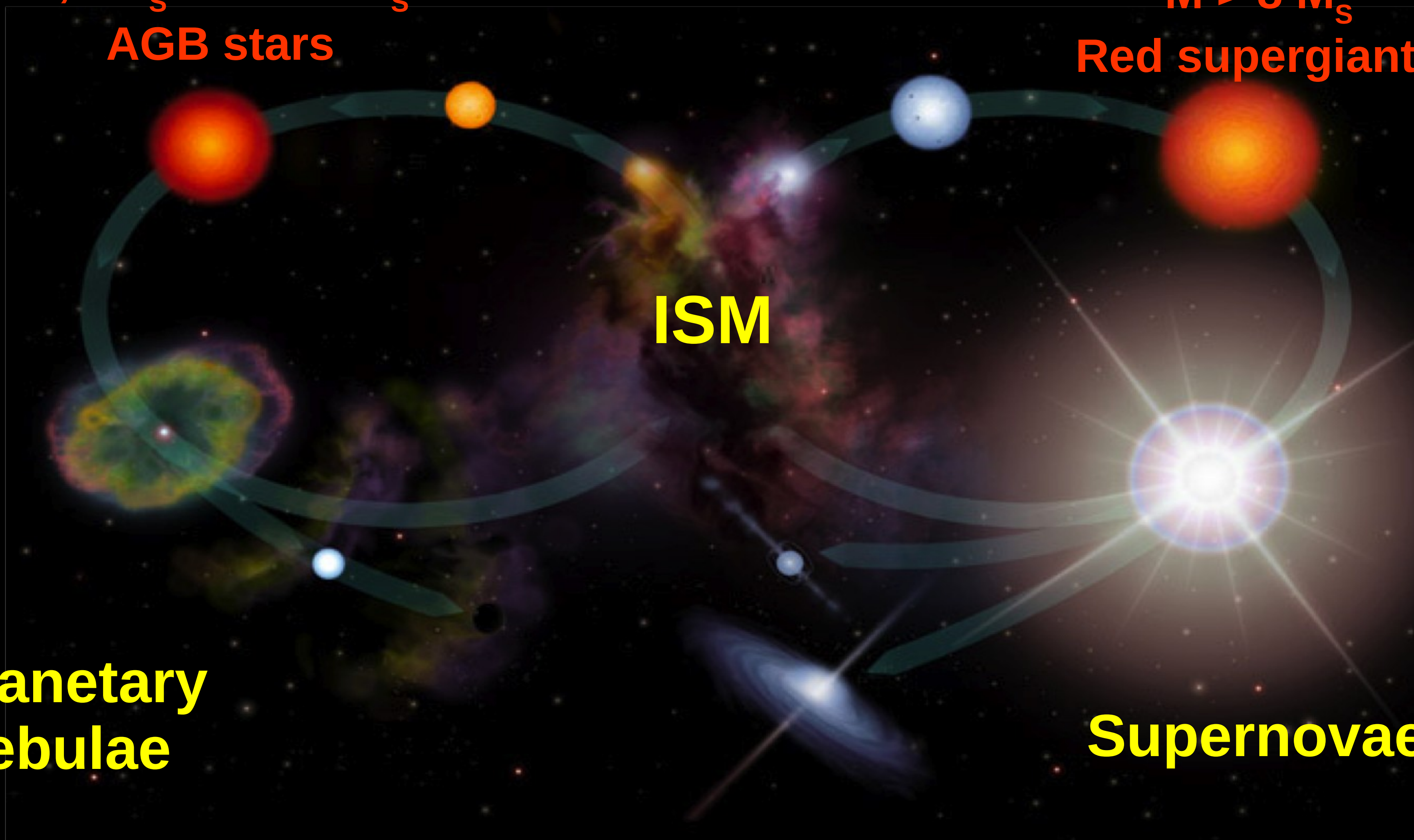
- Unresolved observations of stars as members of associations



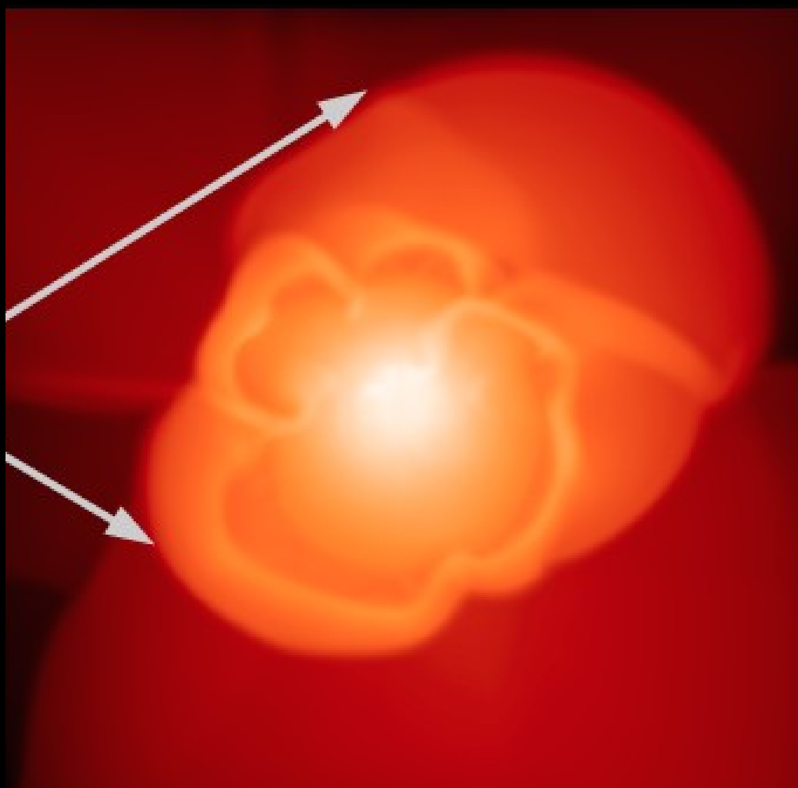
R136 starbust cluster in LMC

REQUIREMENTS :
Sensibility !!
Spectral coverage !
Resolving power !

Mass loss from evolved stars



Mass loss from evolved stars



Pulsations & convection → shock waves
Dust condensates and is accelerated by radiation pressure → wind

What can LUVOIR tell us ?

- Multi-λ observations :
  constrain grain size

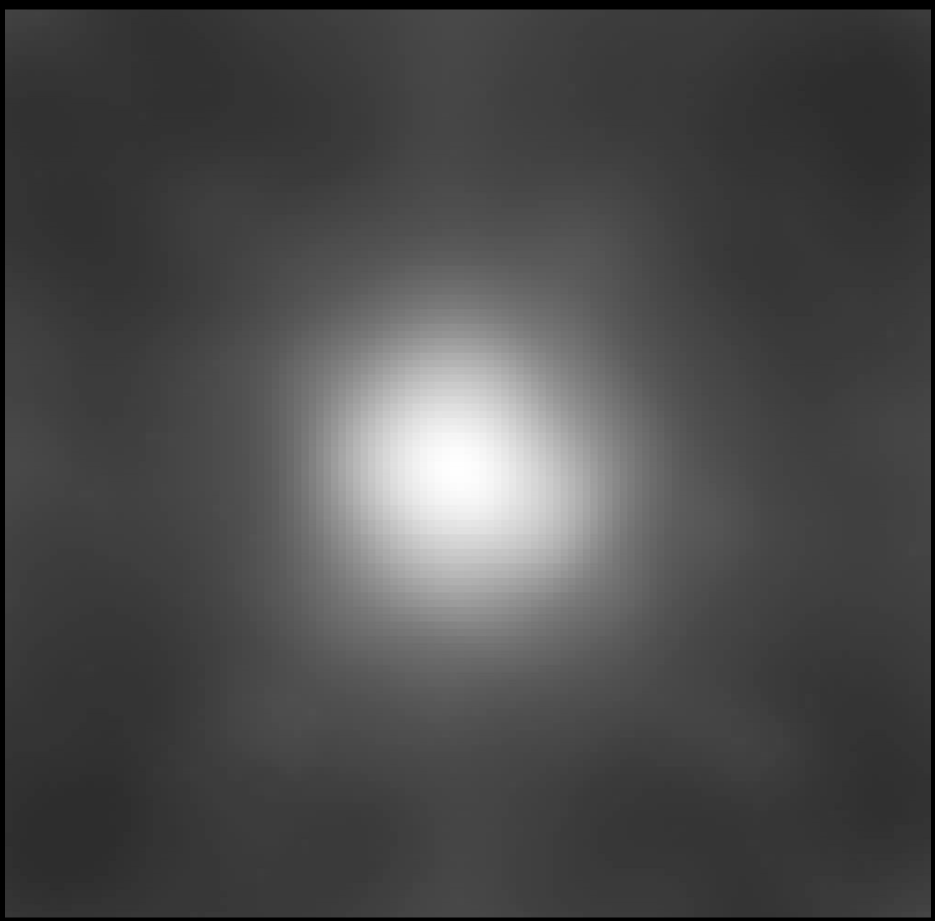
- Time series :
  resolve shocks
  follow dust formation

- Characteristic size :
  2 – 3 stellar radii

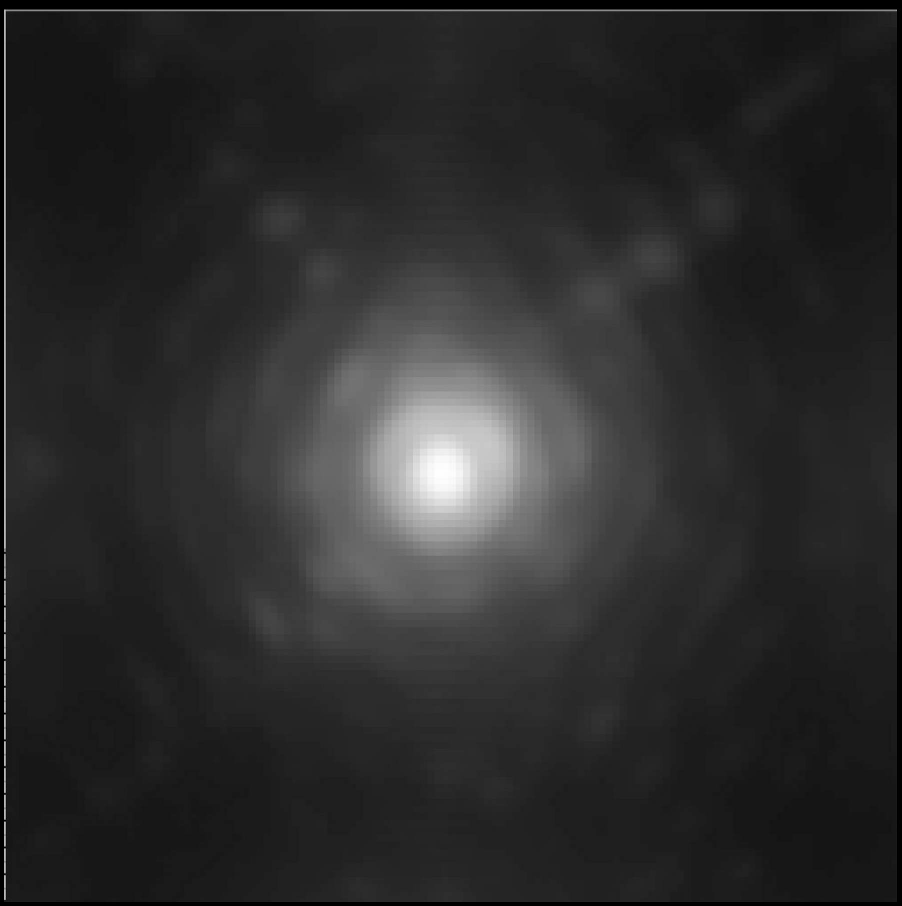
Spectral resolution
Angular resolution

Resolved stars being observed today

SPHERE V band (554 nm)
Kervella, Lagadec et al., *2015*

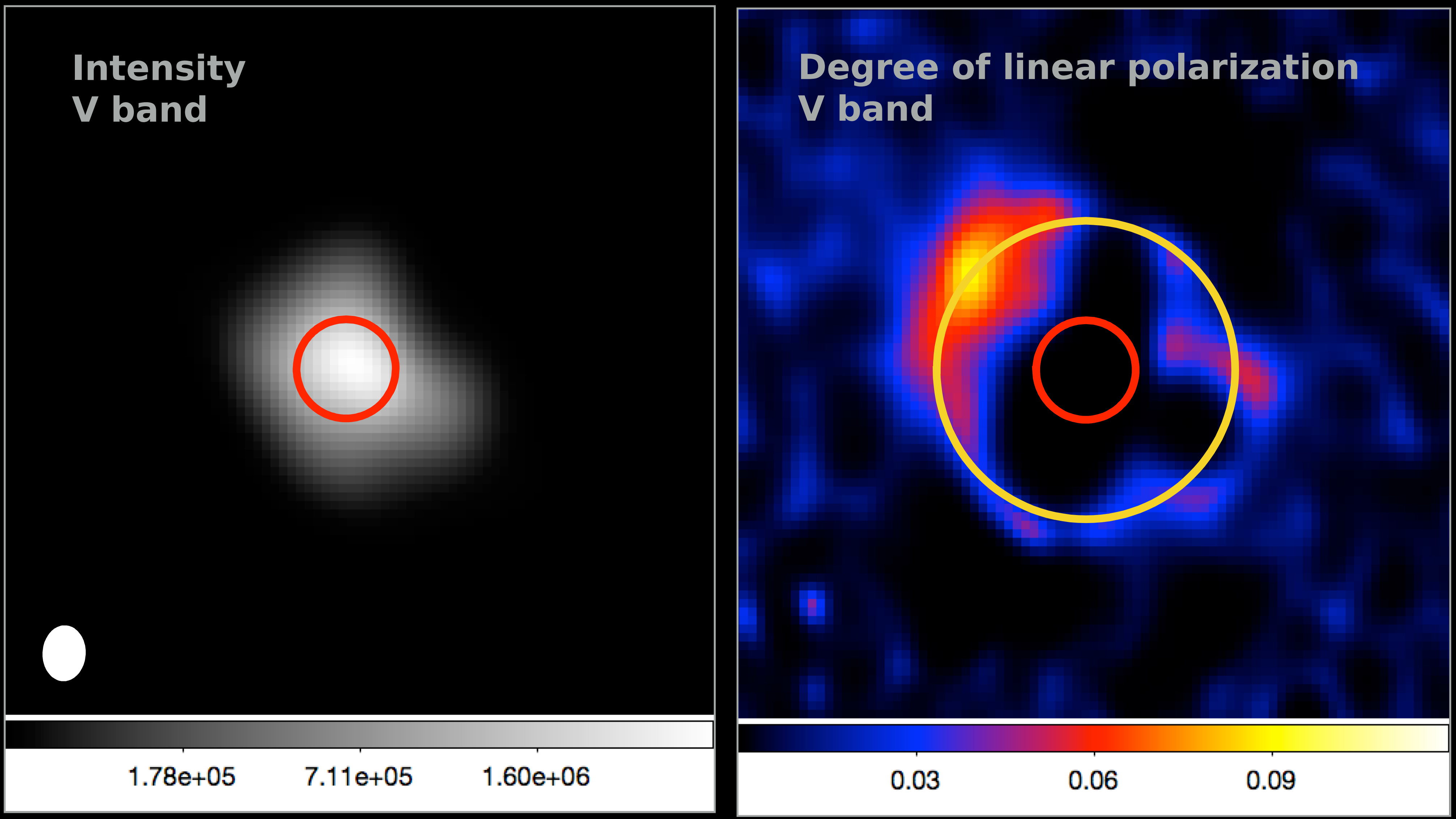


Betelgeuse



Φ Orionis (PSF)

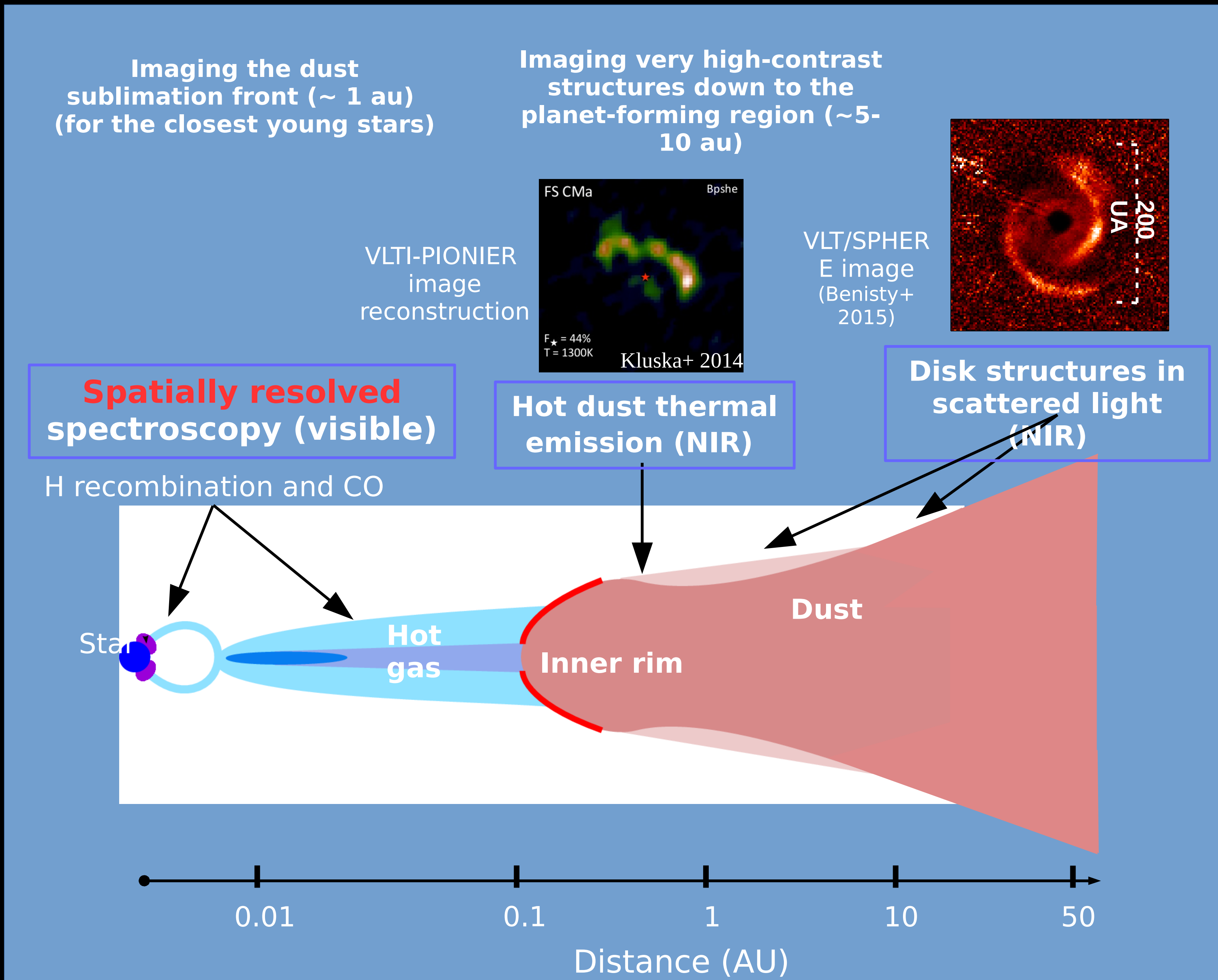
Polarimetric images of resolved stars



Dust shell within 3 stellar radii

Kervella et al., *2015*

Innermost parts of protoplanetary disks



Classical Cepheids

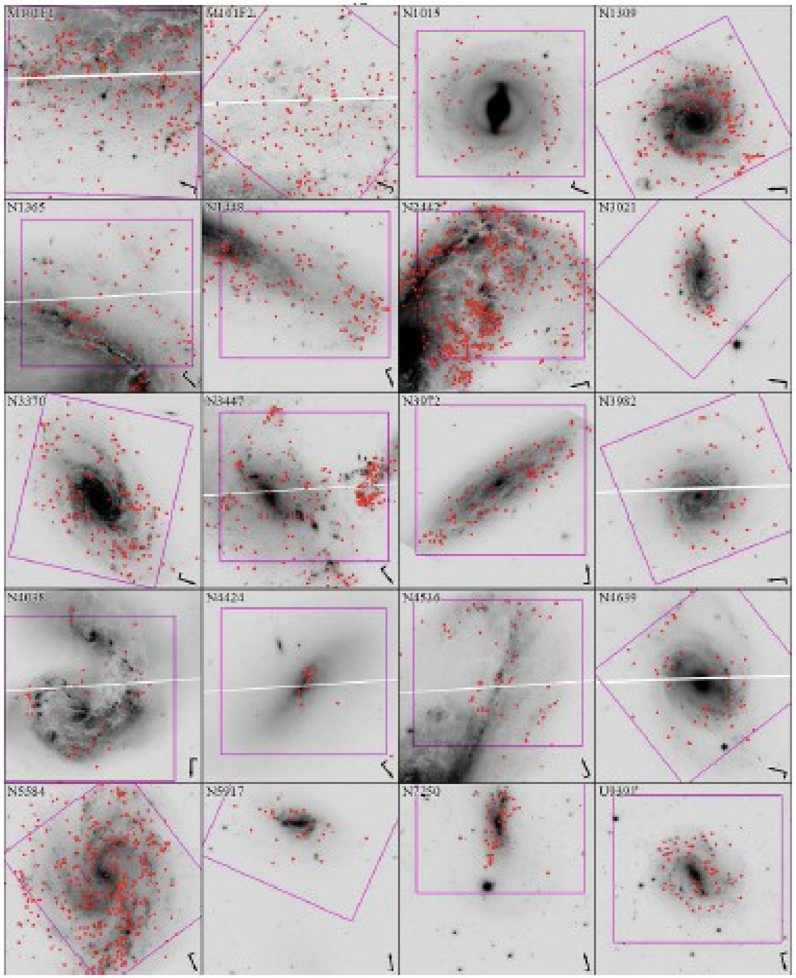
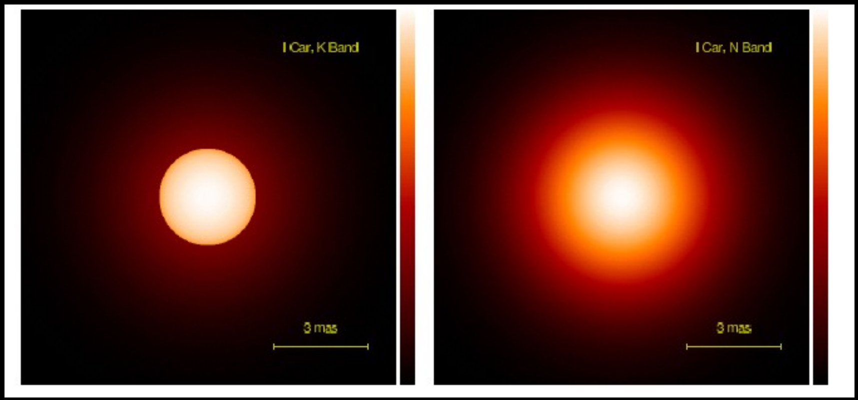


Fig. 3.— Images of Cepheid hosts. Each image is of the Cepheid host indicated. The magenta outline shows the field of view of WFC3/IR, 2.'7 on a side. Red dots indicate the positions of the Cepheids. Compass indicates North (long axis) and East (short axis).

1566 Cepheids observed with HST (WFC3-IR) in the 19 galaxies hosting SN Ia
For 0.01 < z < 0.15 (or 2 Gly)
(Riess et al, 2016)

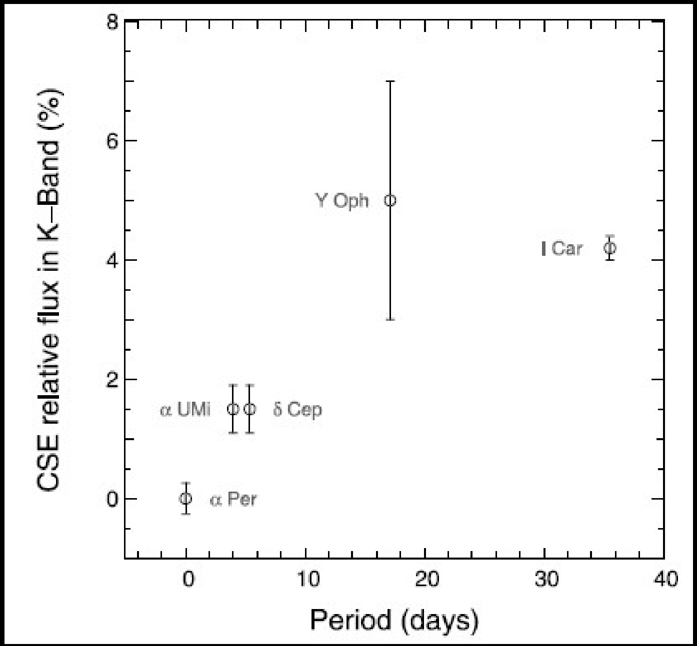
LUVOIR's enhanced sensitivity will make it possible to discover distant Cepheids and improve the period-luminosity relation.

Resolved Classical Cepheids



IR Interferometry revealed Circumstellar environment (CSE) around most Cepheids. (Kervella+ 2006, Merand+ 2007, Gallenne+ 2011)

Size : 3 stellar radii in IR, up to 6 in the visible (Nardetto+ 2016). 10 Cepheids have a radius larger than 1mas (3 mas for l Car)

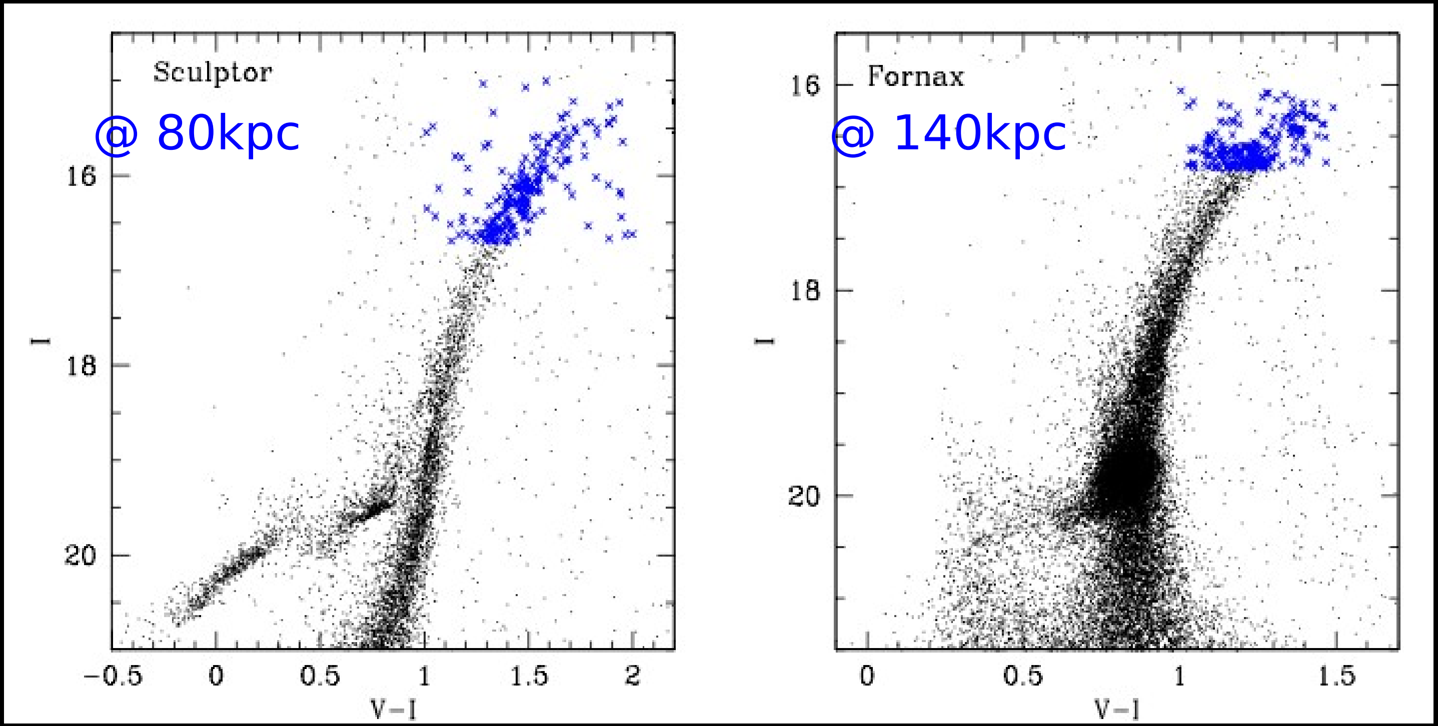


Flux contribution of few percents to 10%
A relation between between the period and the flux contribution is not excluded

LUVOIR's angular resolution will constrain the shape of CSE of Cepheids → unbias the period-luminosity relation

NRM interferometry ?

First (pop III) stars



Extremely metal-poor stars [Fe/H]<-3):

fossil imprints of the first stars

→ probe the nature of first stars (Milky-Way & Local Group).

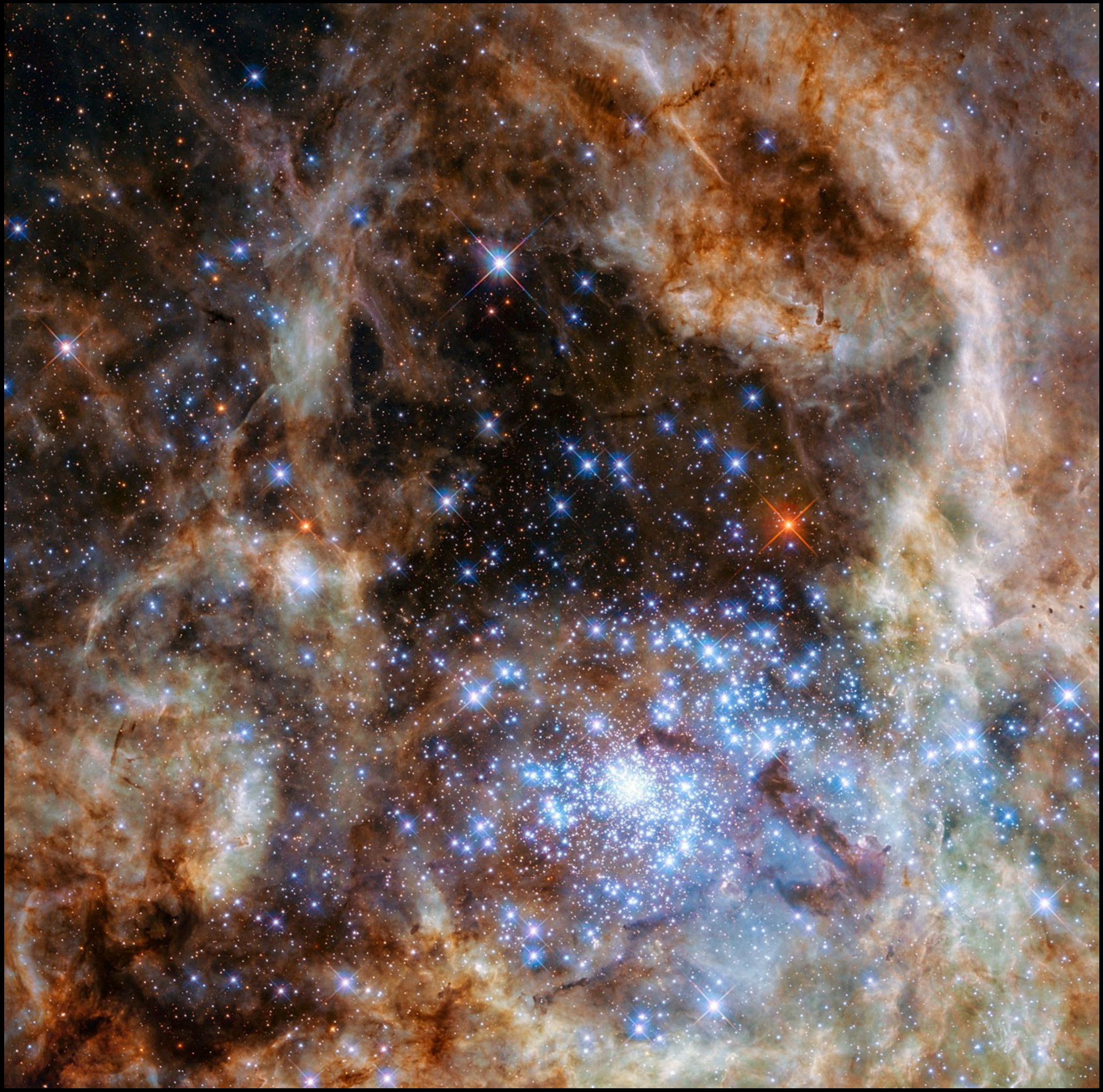
Impact of halo mass on first stars ?

Brightest EMPS : V ~ 16 (LMC) – 20

Sensitivity requirement : x100 HST

Discriminating signatures require high spectral resolution :
R > 10,000 or 40,000 in (200-400 nm)

Resolved extragalactic structures



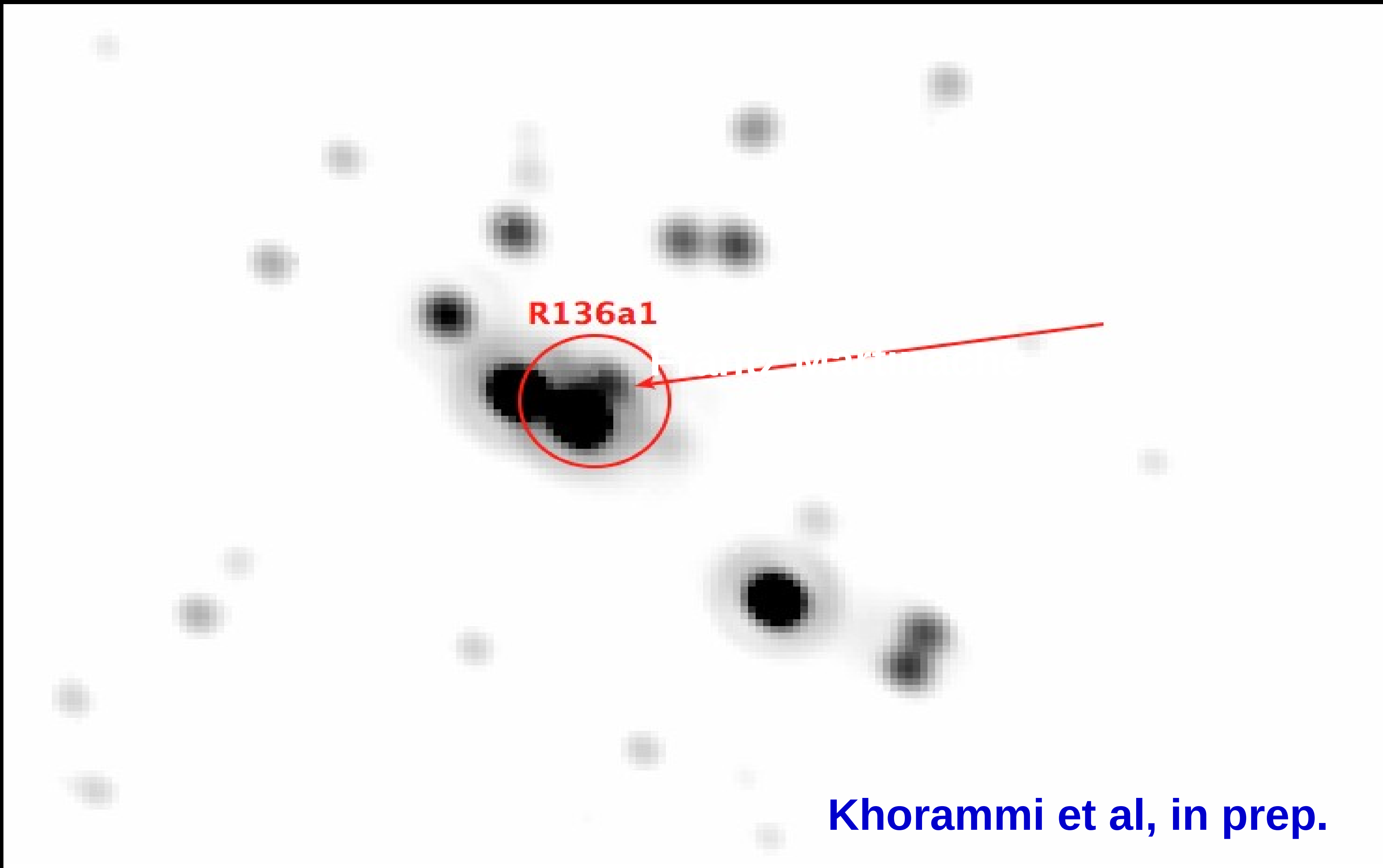
R136 a1

- Most massive star known in the universe 265 Msun

- Important for top part of the IMF (limit usually accepted: 150 Msun)

- Pair-instability SNe in the vicinity of the MW?

Resolved extragalactic structures



Khorammi et al, in prep.

Conclusion

LUVOIR... fantastic ! But with all the resolution you can get !!