

20 minutes for a super star : Eta Car

Nice, 2020 may 26th

Florentin Millour

**E. Lagadec, M. Montarges, P. Kervella, A. Soulain, F. Vakili, R. Petrov,
G. Weigelt, J. Groh, N. Smith, A. Mehner, H.-M. Schmid
+ the SPHERE consortium !**

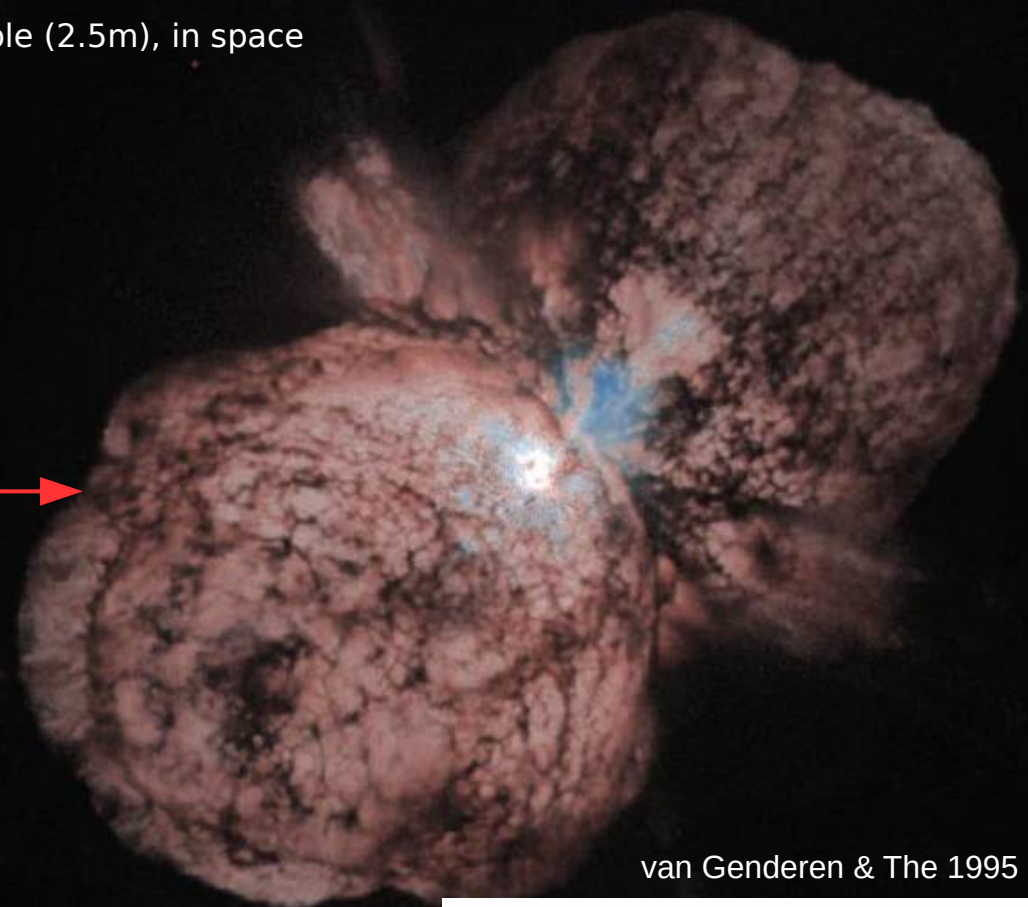


Observatoire
de la CÔTE d'AZUR

Eta Carinae

Hubble (2.5m), in space

AAT (3,9m), Seeing-limited



Nébuleuse du « trou de serrure »
AAT, D = 3,9m



Luminous **B**lue **V**ariable star

$$L = 4 \cdot 10^6 L_{\text{sun}}$$

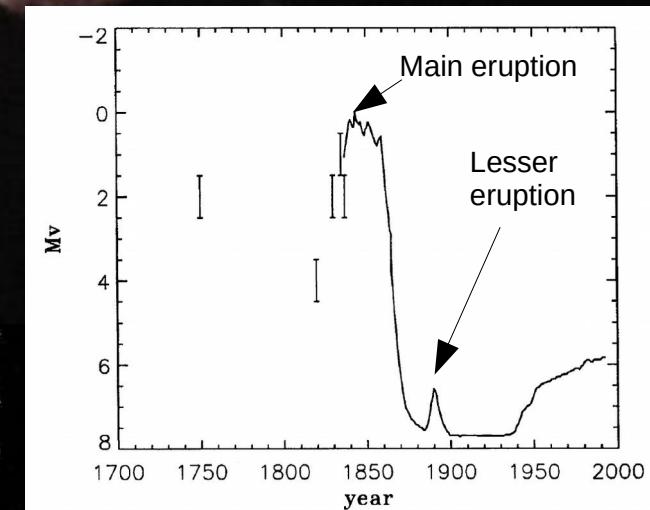
$$M_{\text{loss}} = 5 \cdot 10^{-3} M_{\odot} / \text{yrs}$$

Wind, $V > 500 \text{ km/s}$

$$M > M_{\text{eddington}} (?)$$

Homunculus nebula (1841) 20 solar masses!

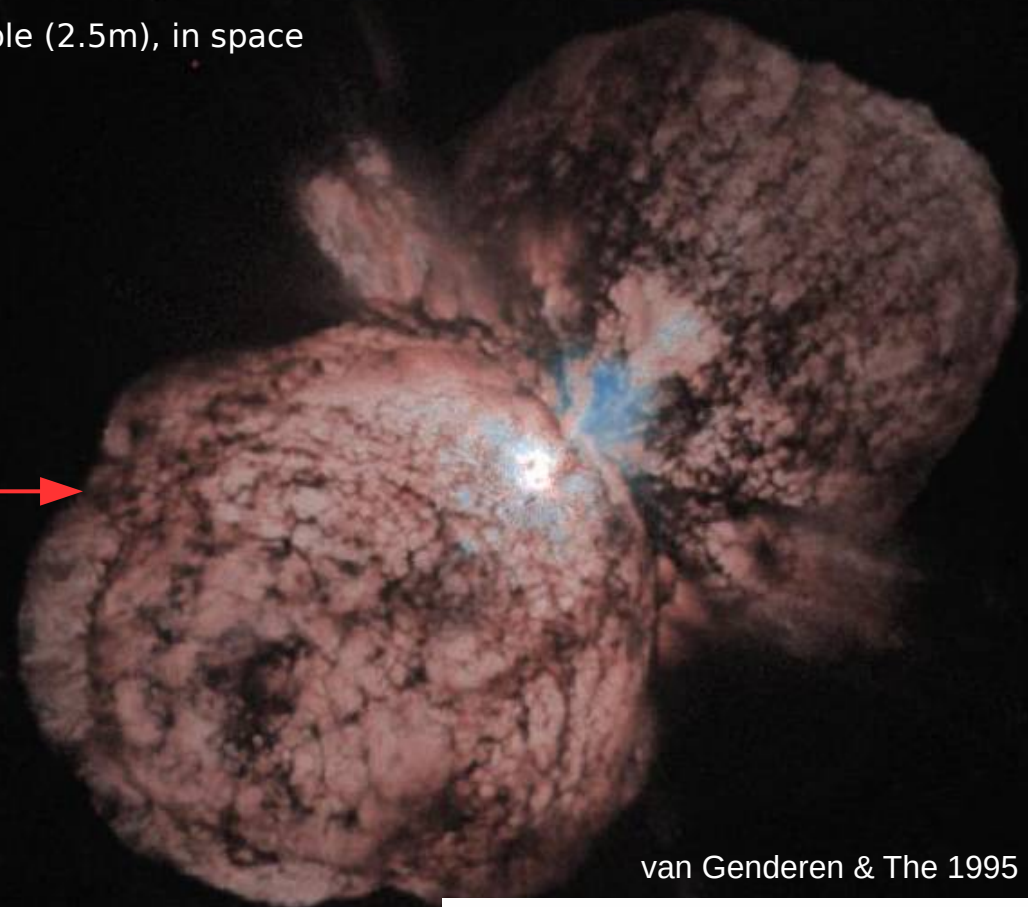
van Genderen & The 1995



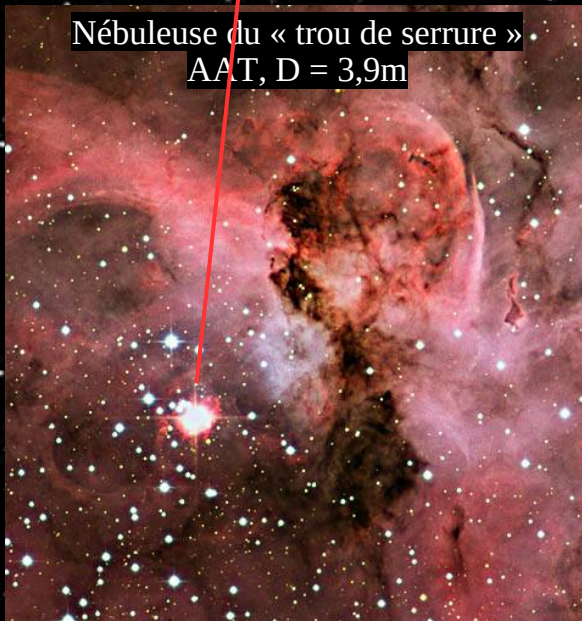
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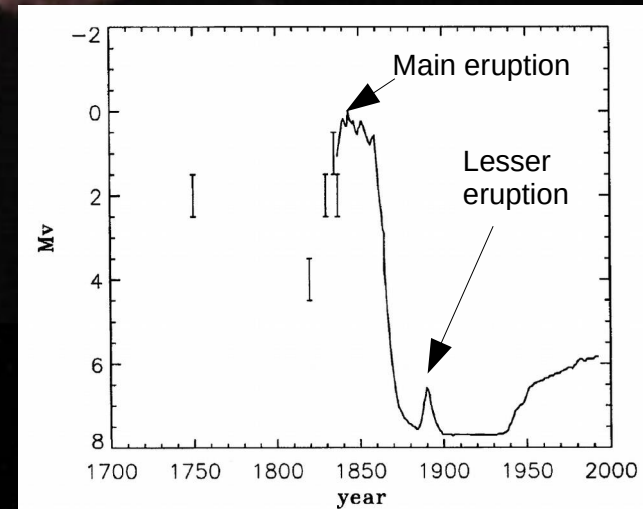
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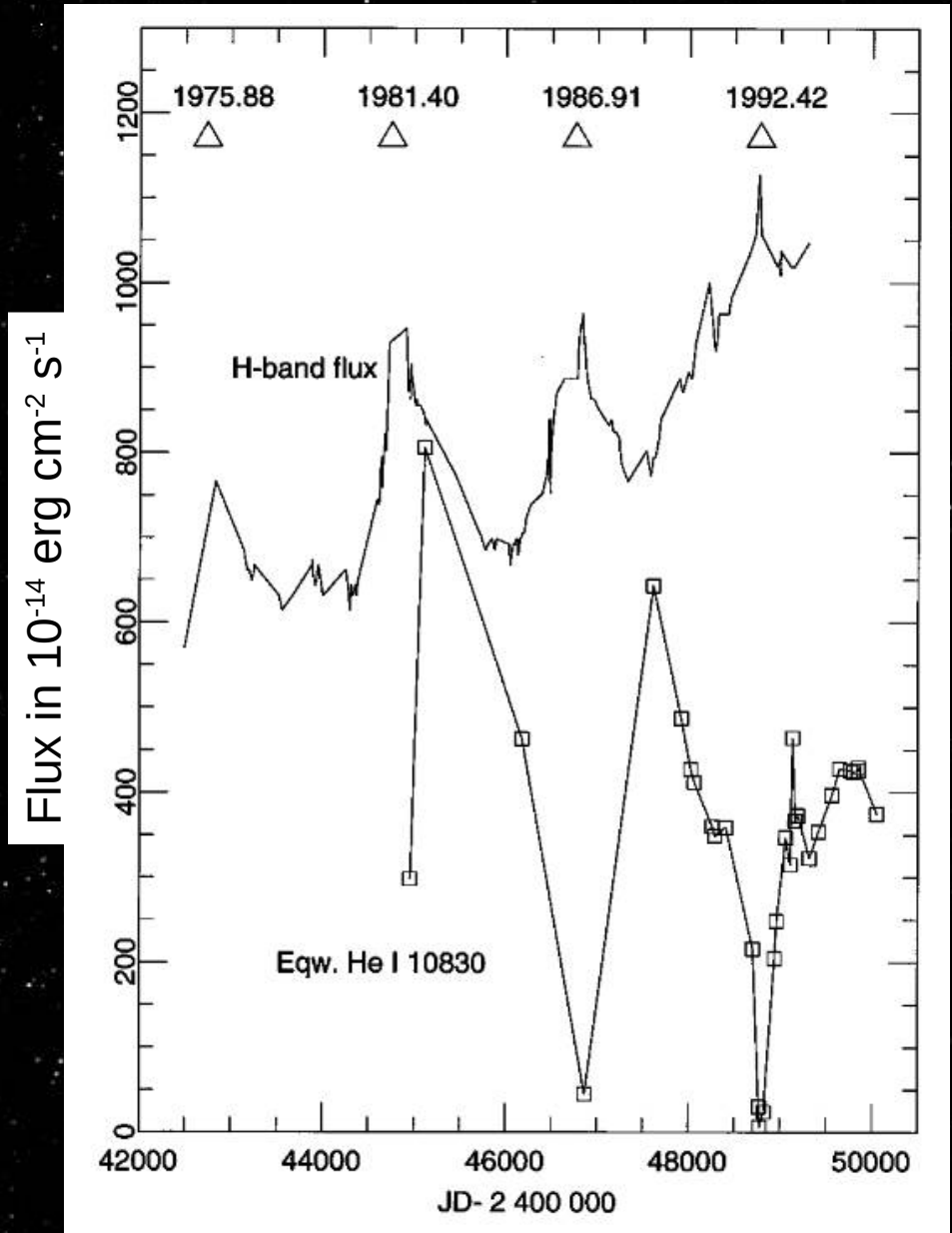
Eta Car is a binary star

5.52 years periodicity in light curve
(Daminelli 1997)
Confirmed in lines variability

An O star (20-30 solar masses) orbits a
behemoth (90-120 solar masses)

Companion star never directly detected
although many attempts

Secondary veiled by primary wind



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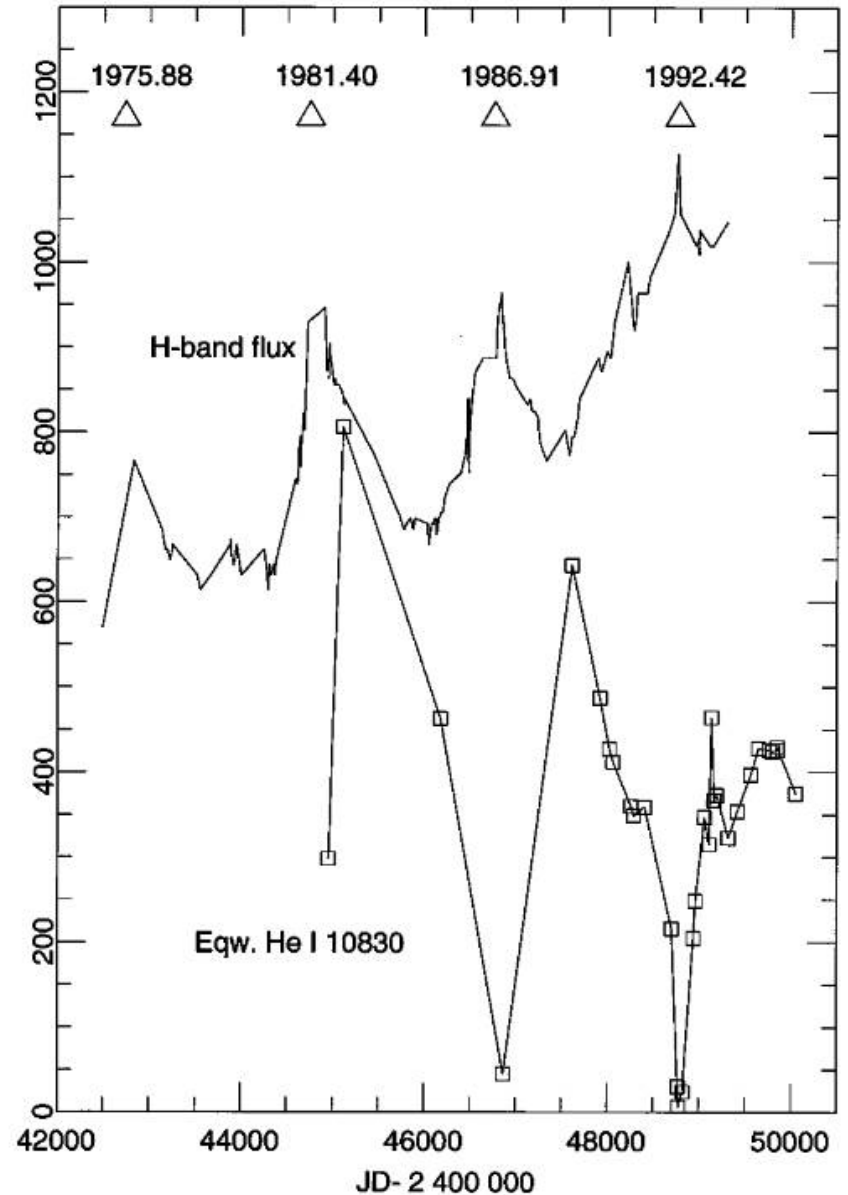
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Flux in 10^{-14} erg cm^{-2} s^{-1}



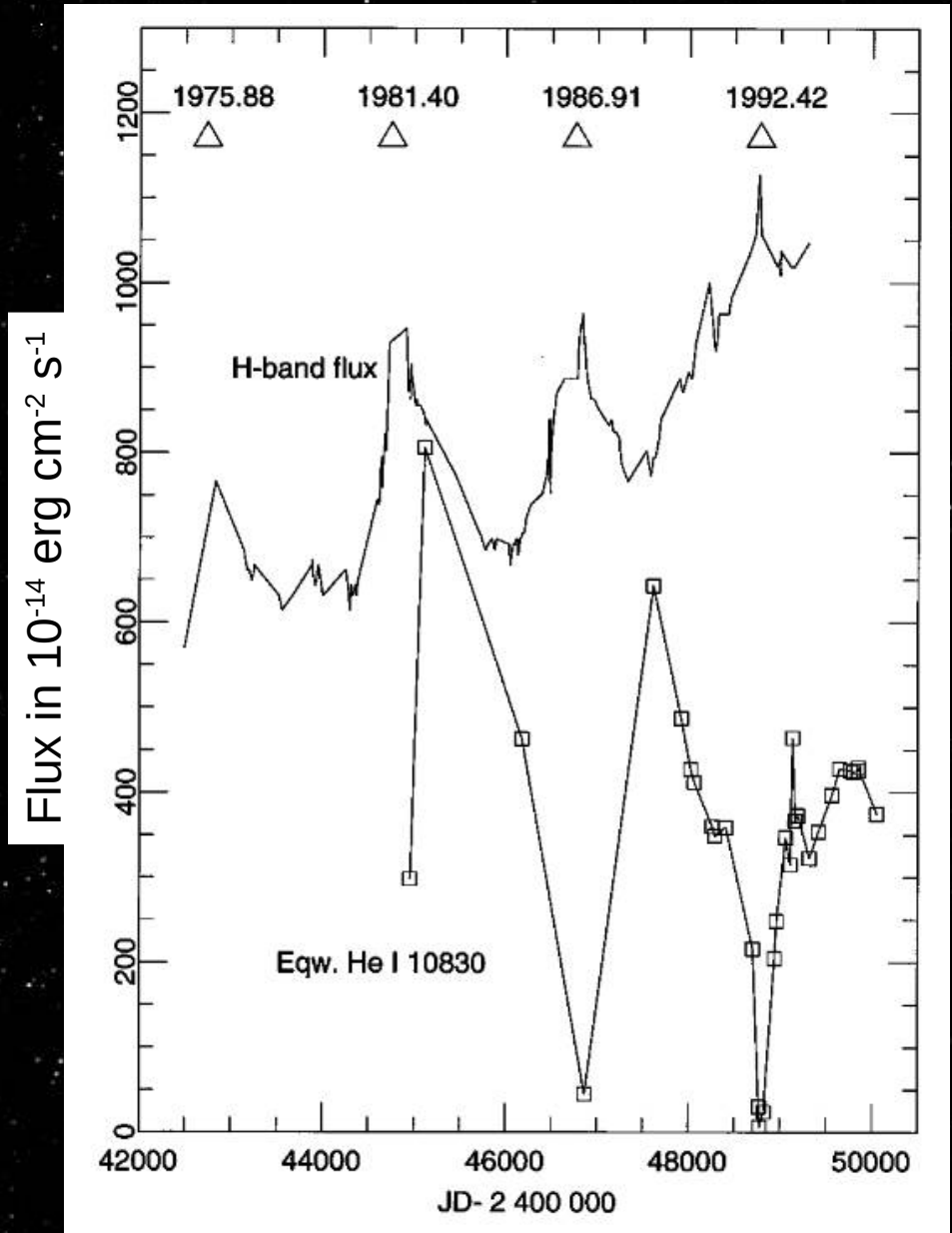
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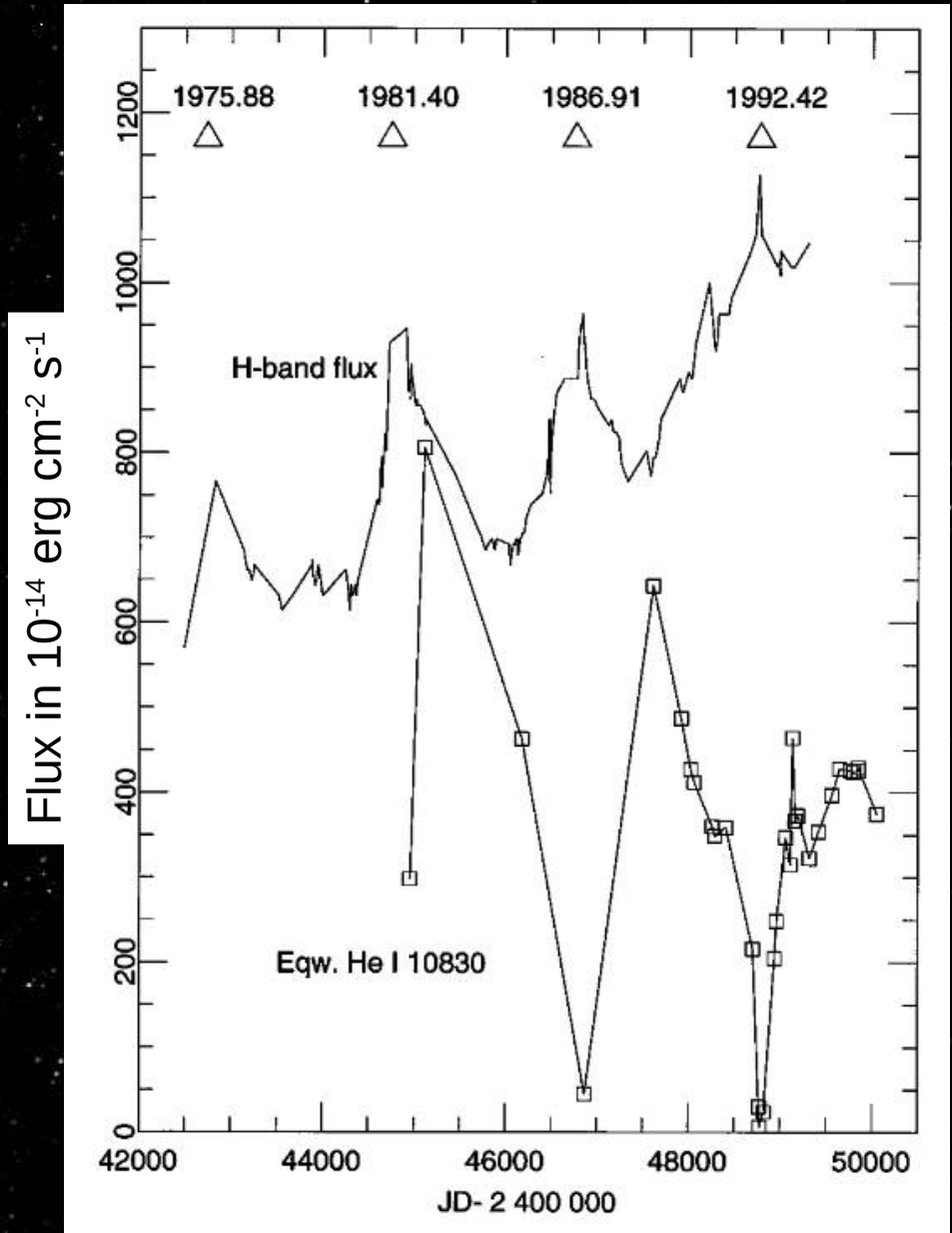
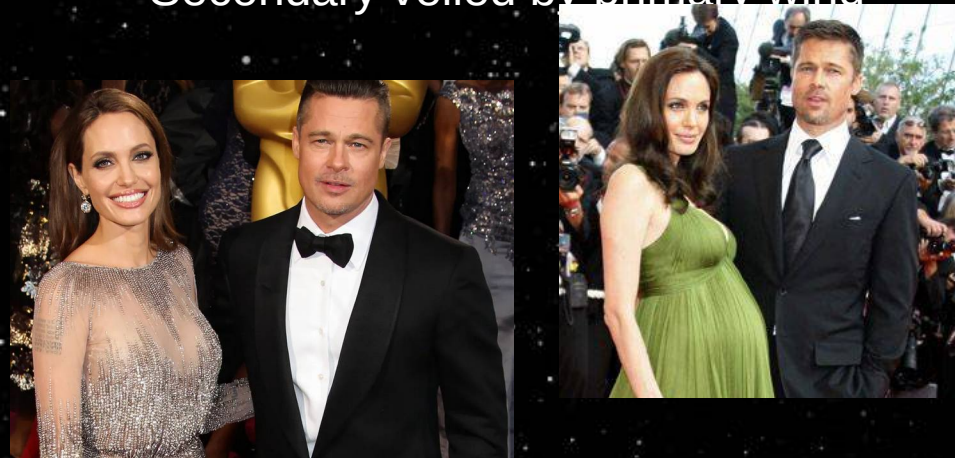
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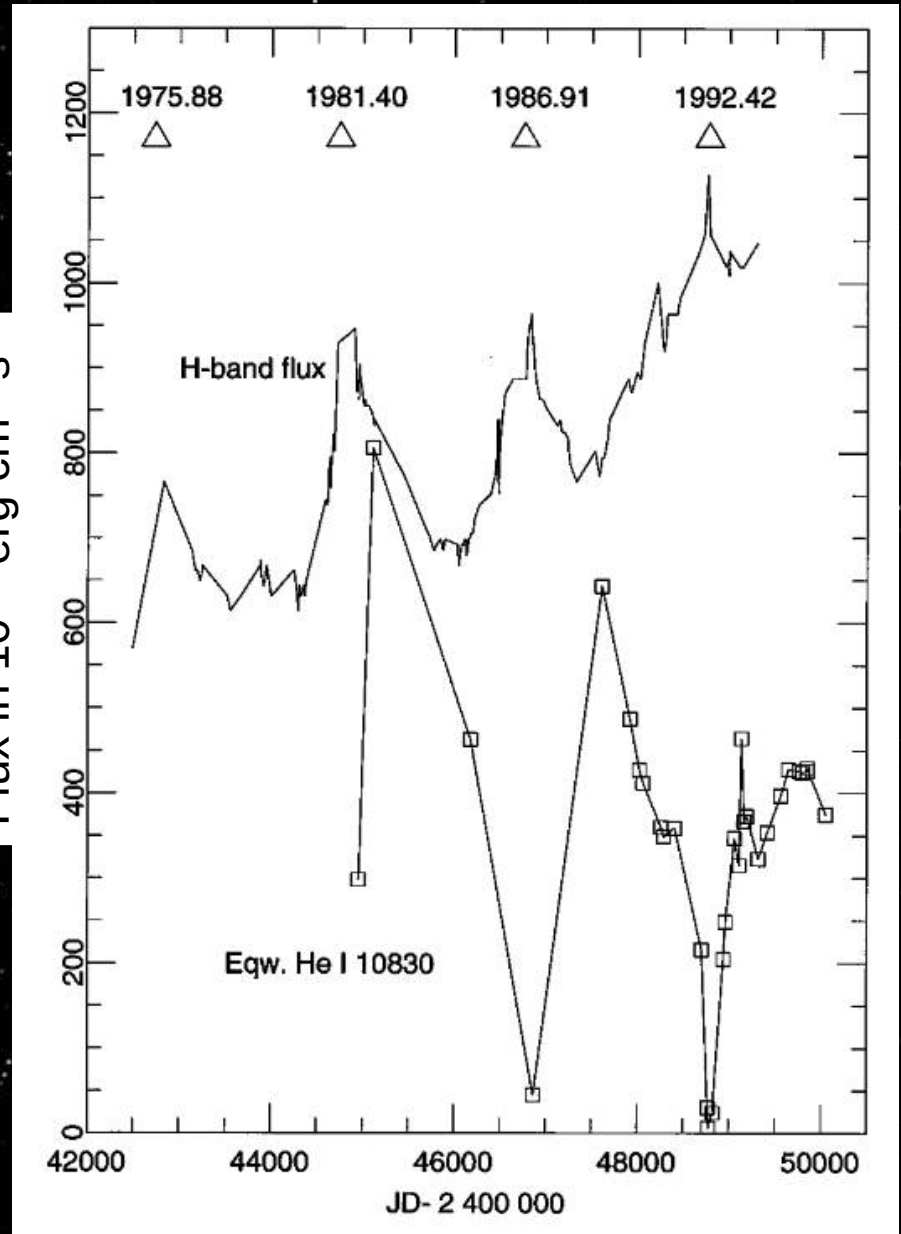
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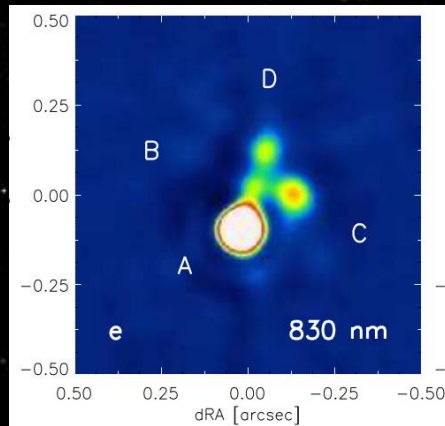
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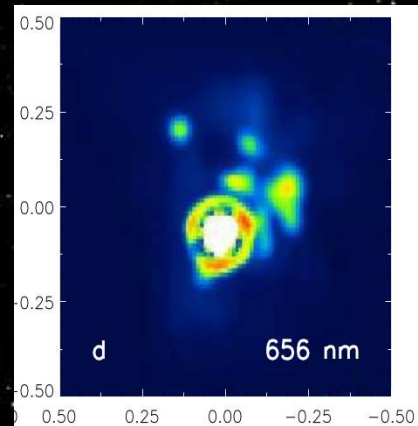


What do we know about Eta Car's inner arc-second

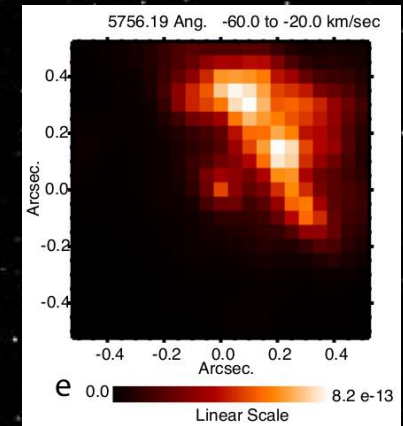
1985 / Hofmann+1988



2008 / Weigelt+2012



2009 / Gull+ 2016



Weigelt “knots” or “blobs” made of gaz and dust moving at “low” speed (~50kms)

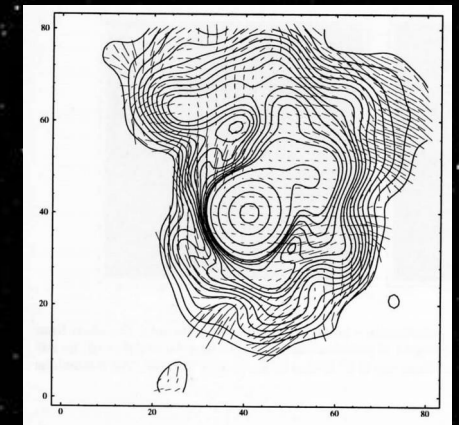
Do they come from the main eruption (1841)

or the Lesser eruption (1890) ?

Fossil shells coming from past eruptions and binary interaction

Bipolar structure seen in polarization

No direct link with the inner binary



1995 / Falcke+ 1996

What do we know about Eta Car's inner arc-second

Image NACO / VLT

The « butterfly » of Eta Car



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What do we know about Eta Car's inner arc-second

AMBER / VLTI (130m)
Weigelt et al. 2007

1 mas

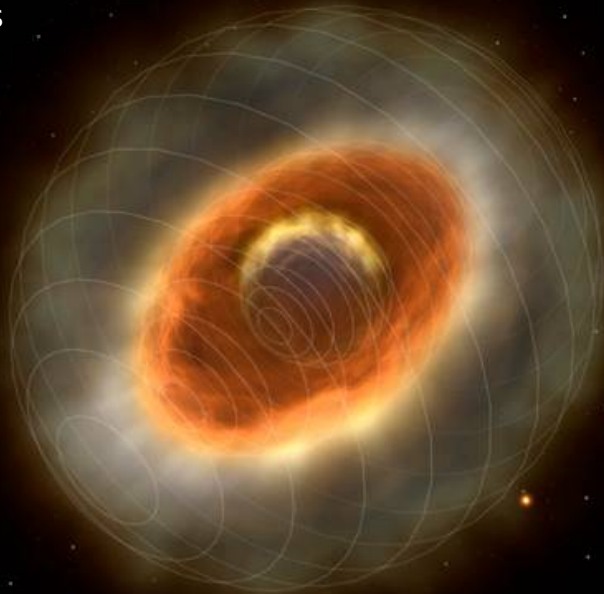
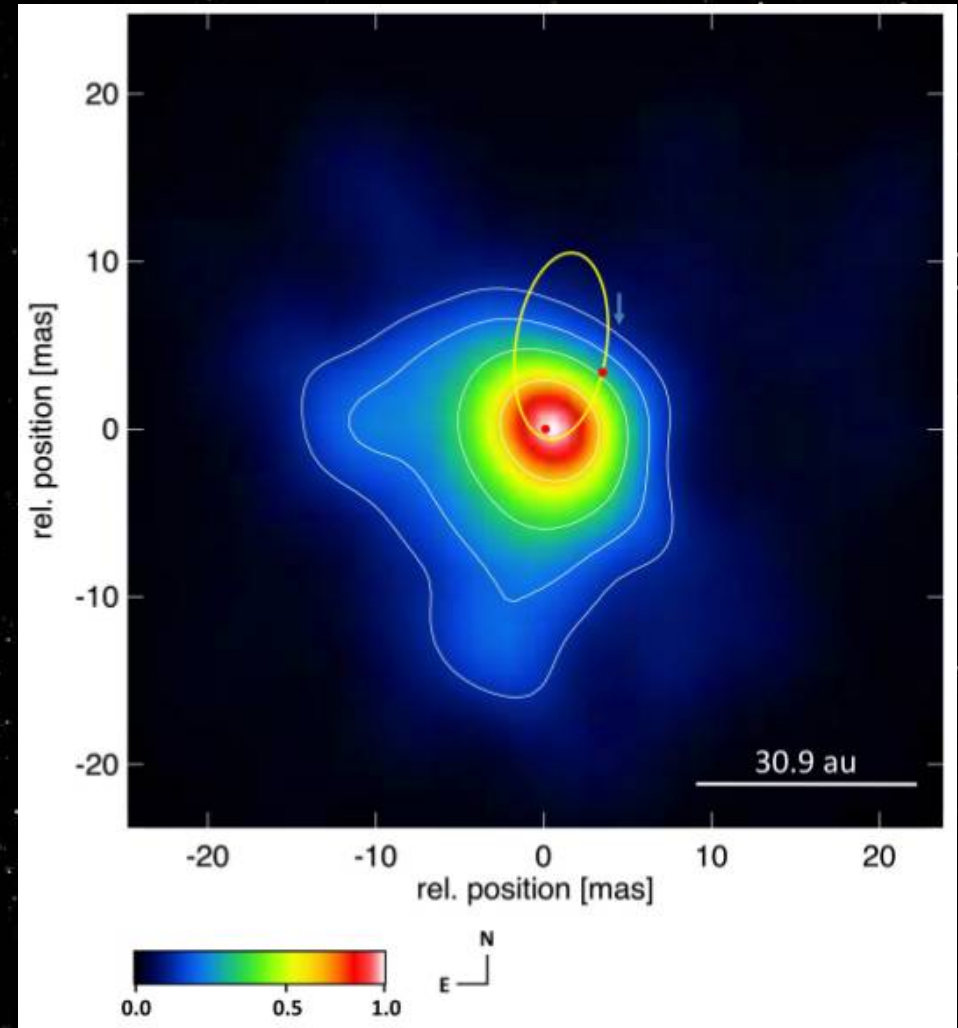
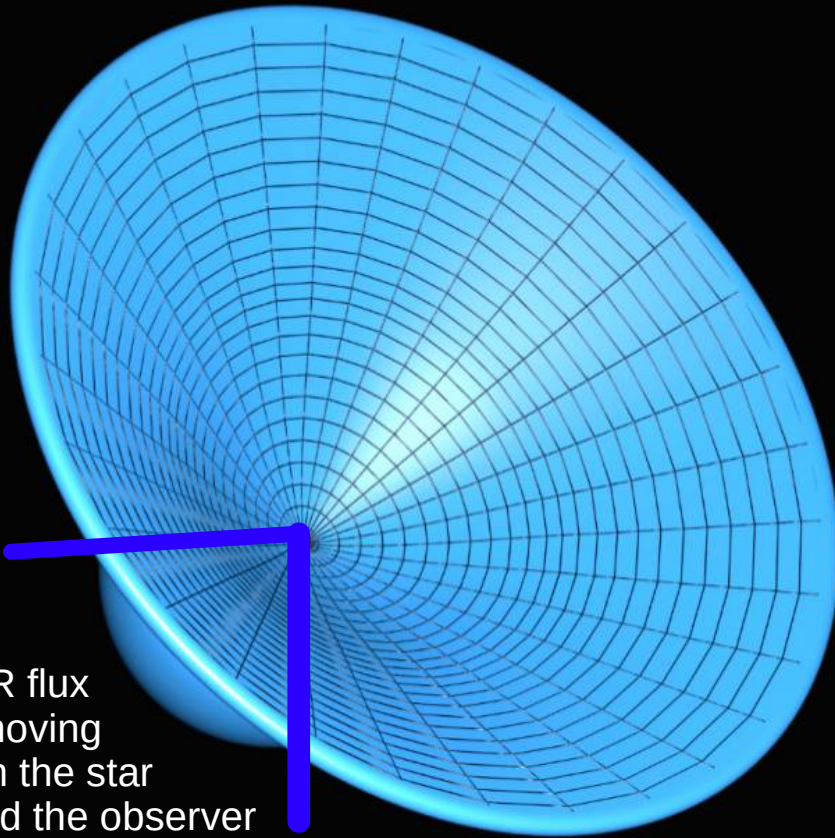


Image: PR ESO (2007)



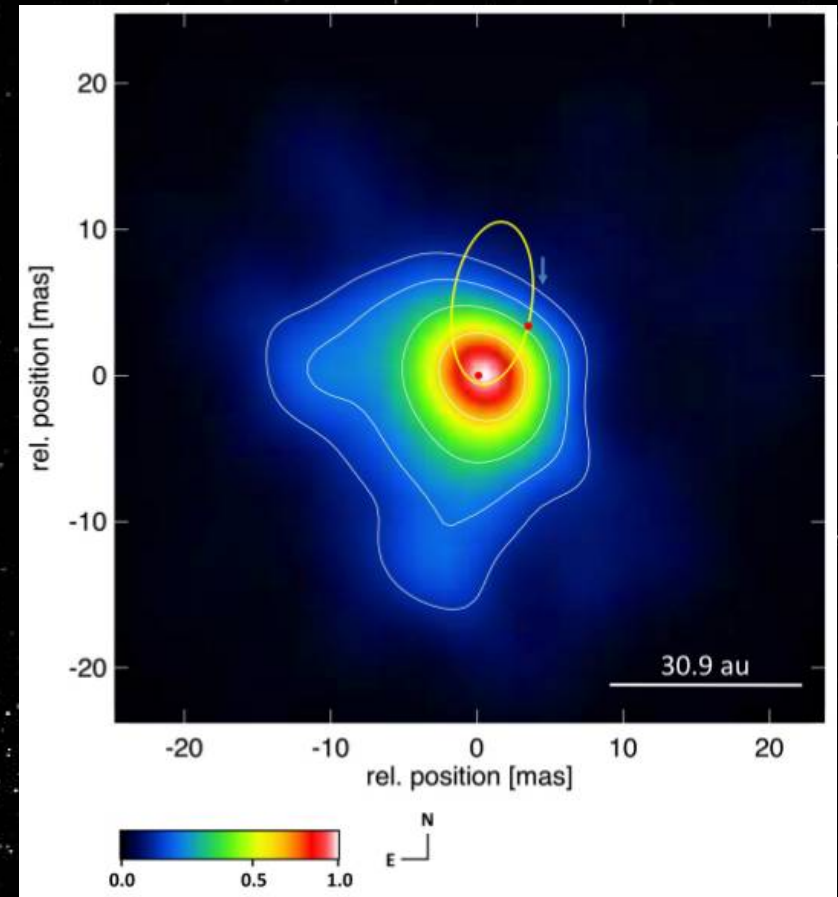
Weigelt et al. 2016 : image!

What do we know about Eta Car's inner arc-second



AMBER IR flux
Hot gaz moving
away from the star
and toward the observer
in the shock cone

Weigelt+ 2016



Eta Carinae with SPHERE

Image NACO / VLT

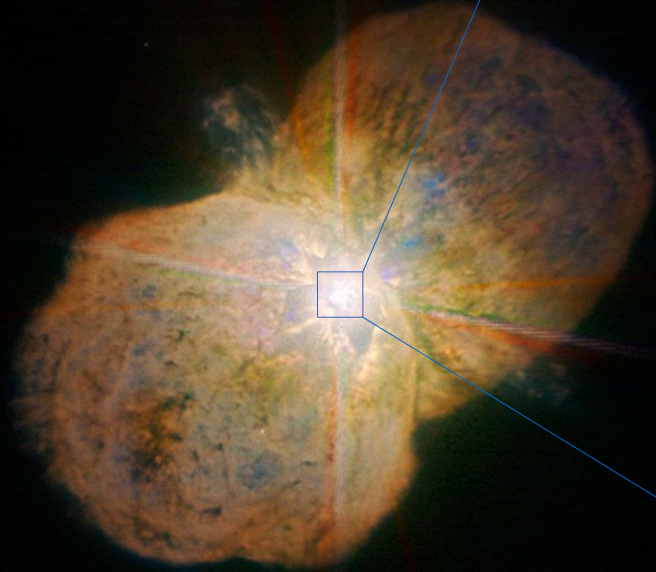


Image SPHERE / VLT

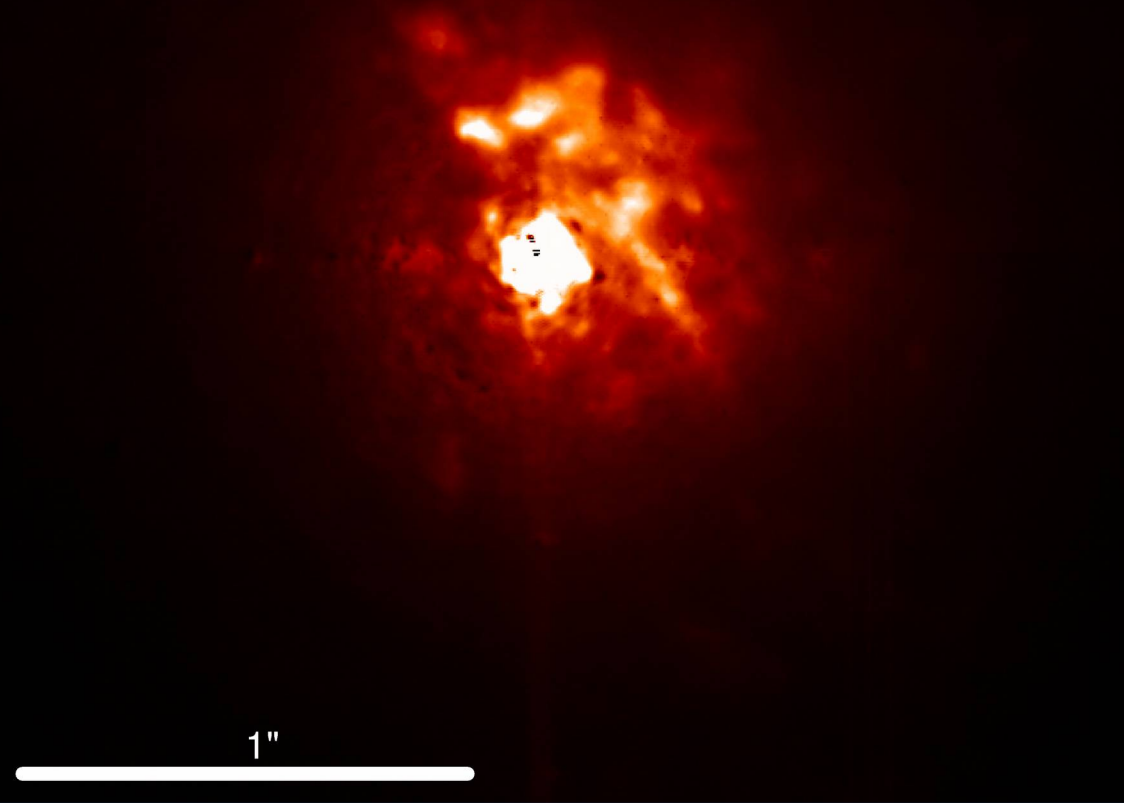
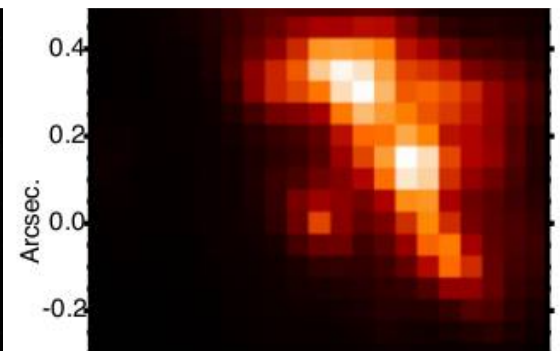
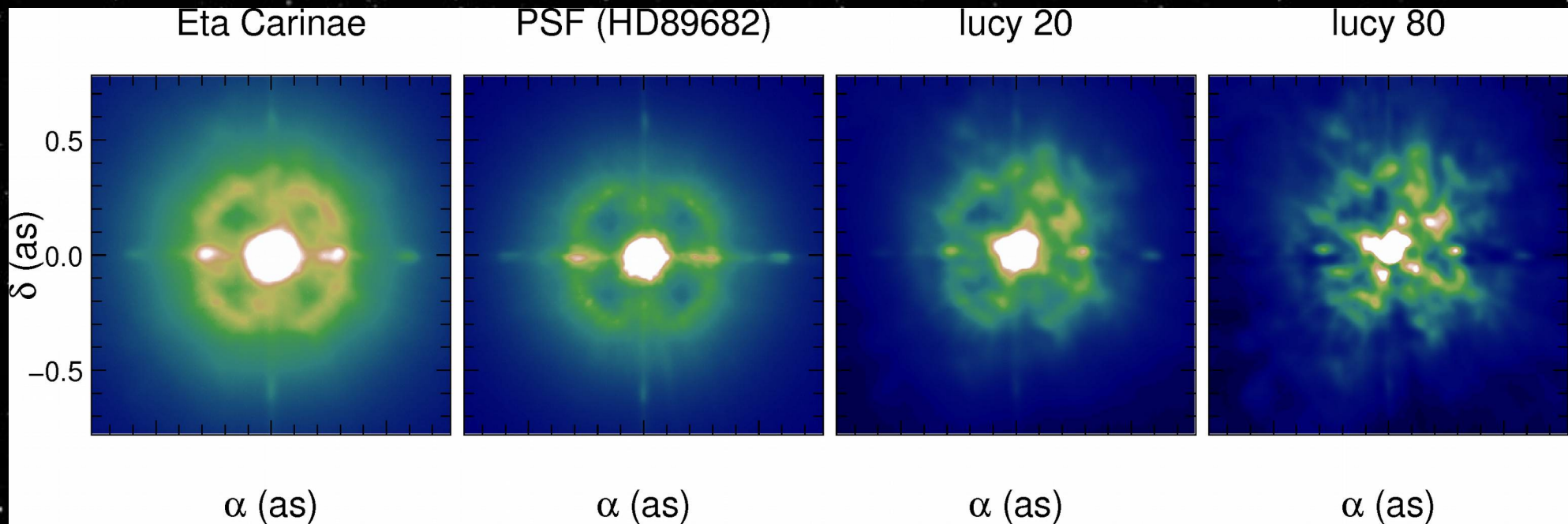


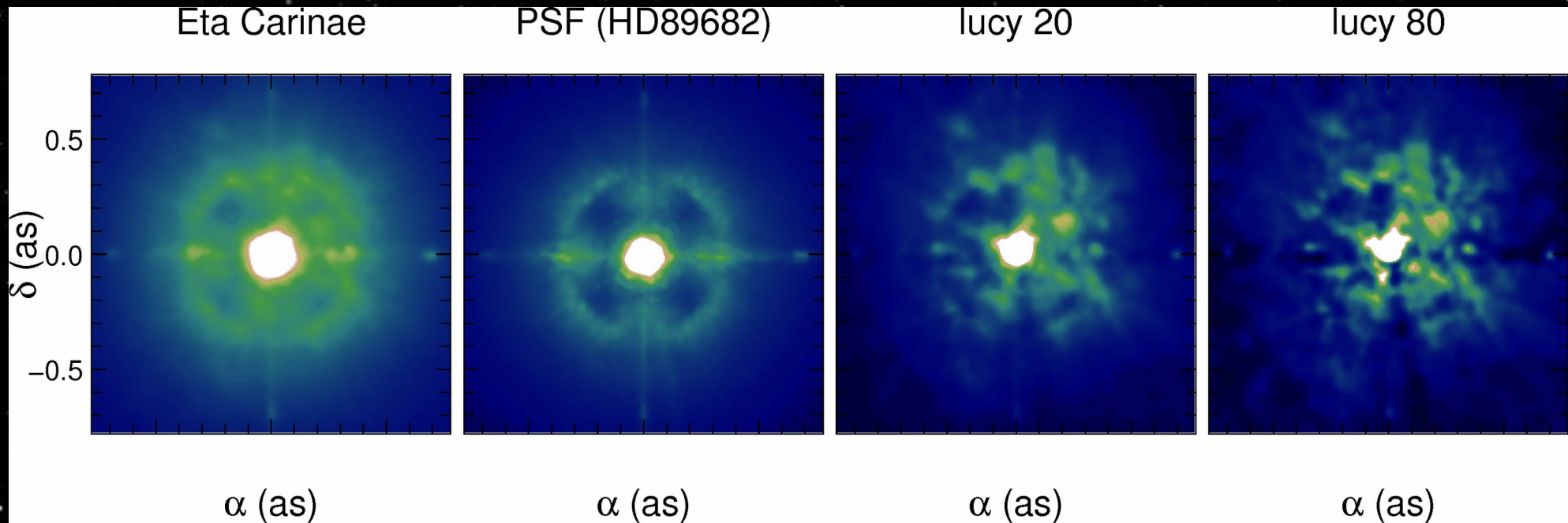
Image Télescope Hubble



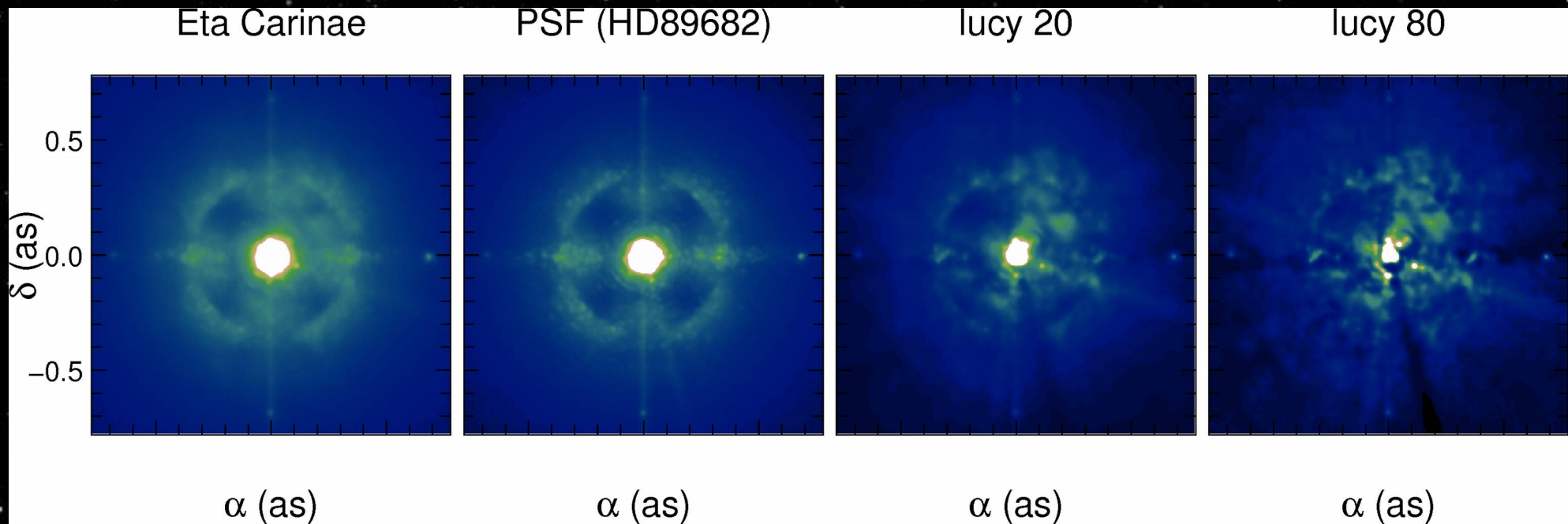
New SPHERE Eta Car images: V band



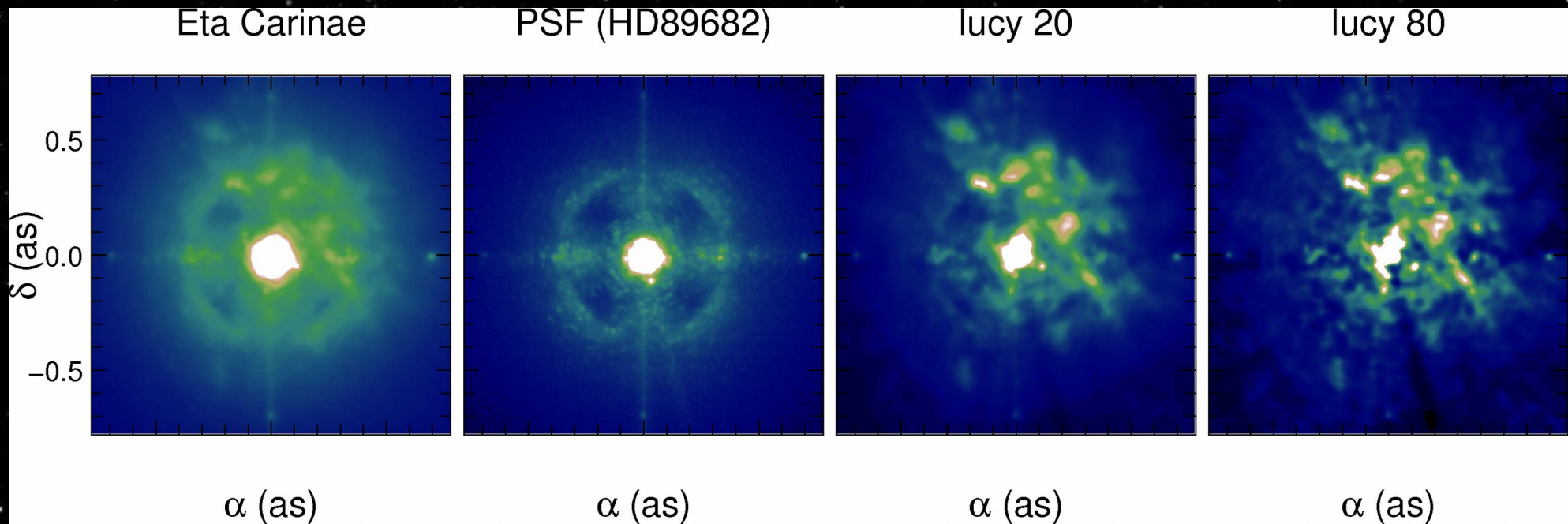
New SPHERE Eta Car images: R band



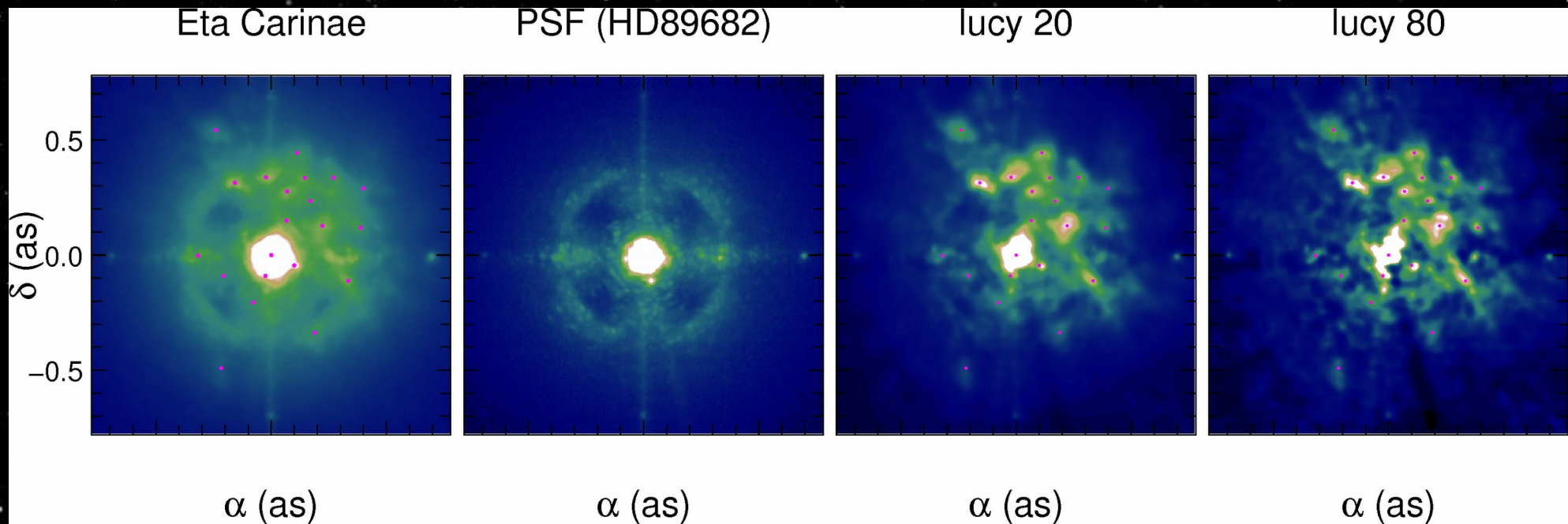
New SPHERE Eta Car images: R narrow band



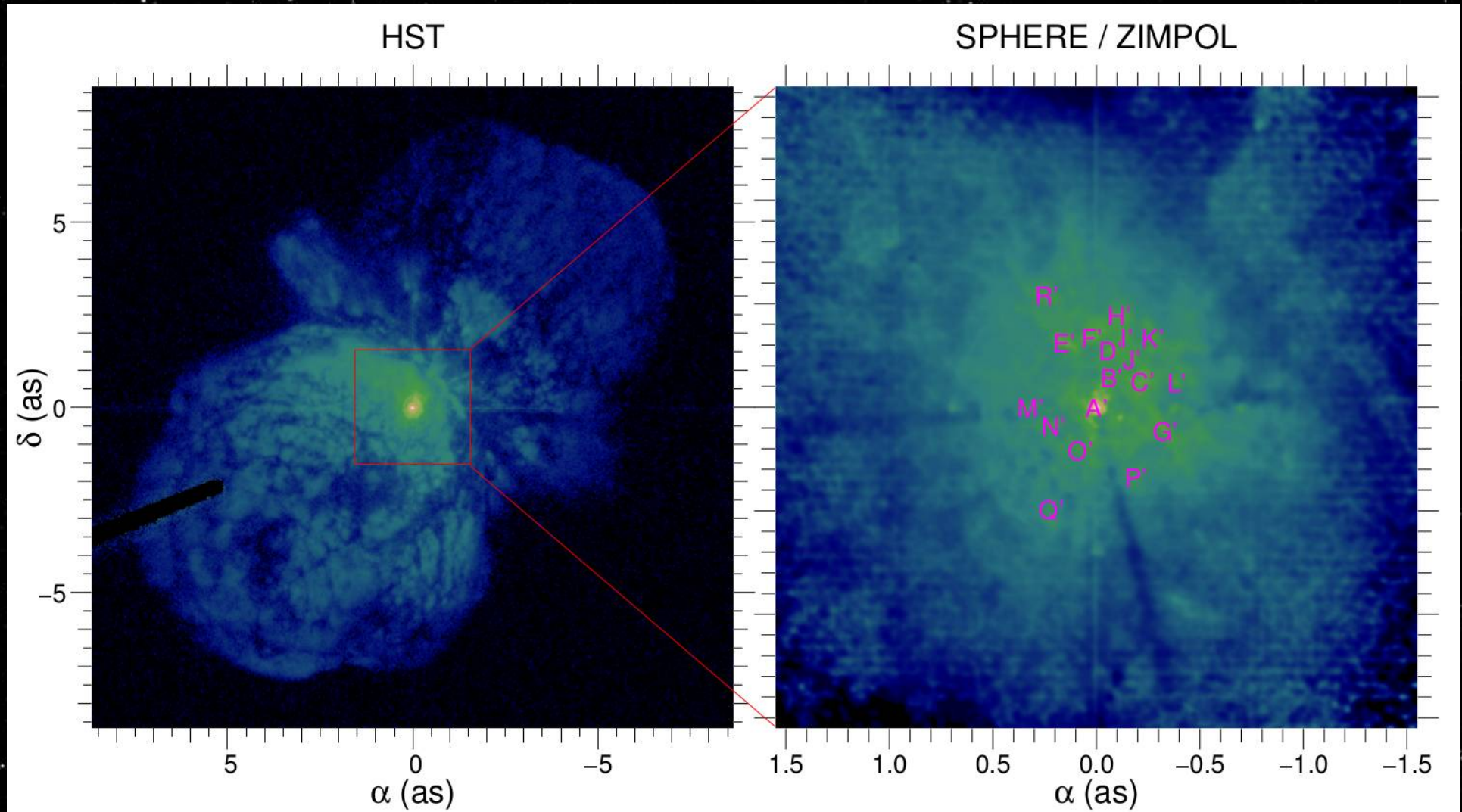
New SPHERE Eta Car images: H alpha line



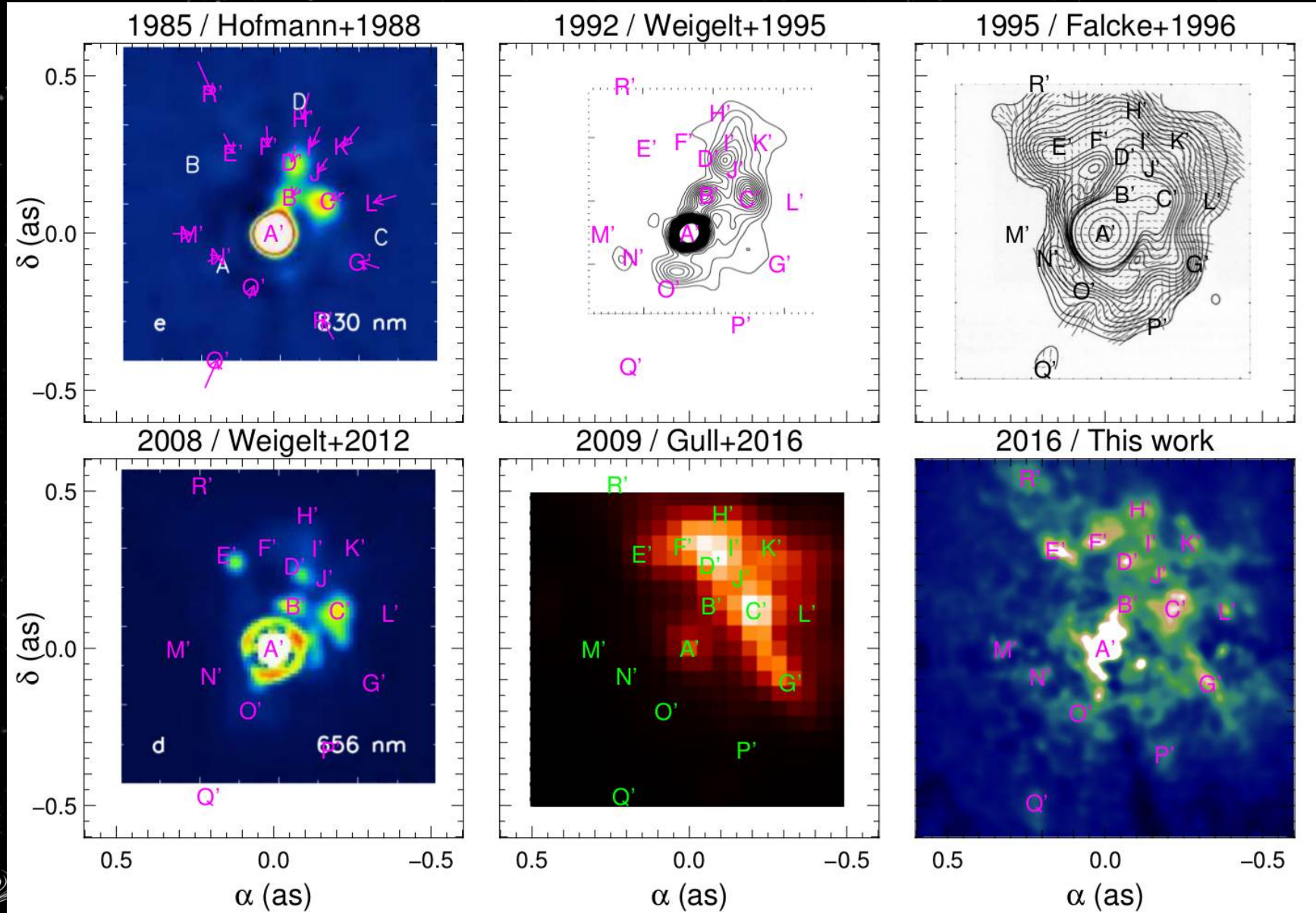
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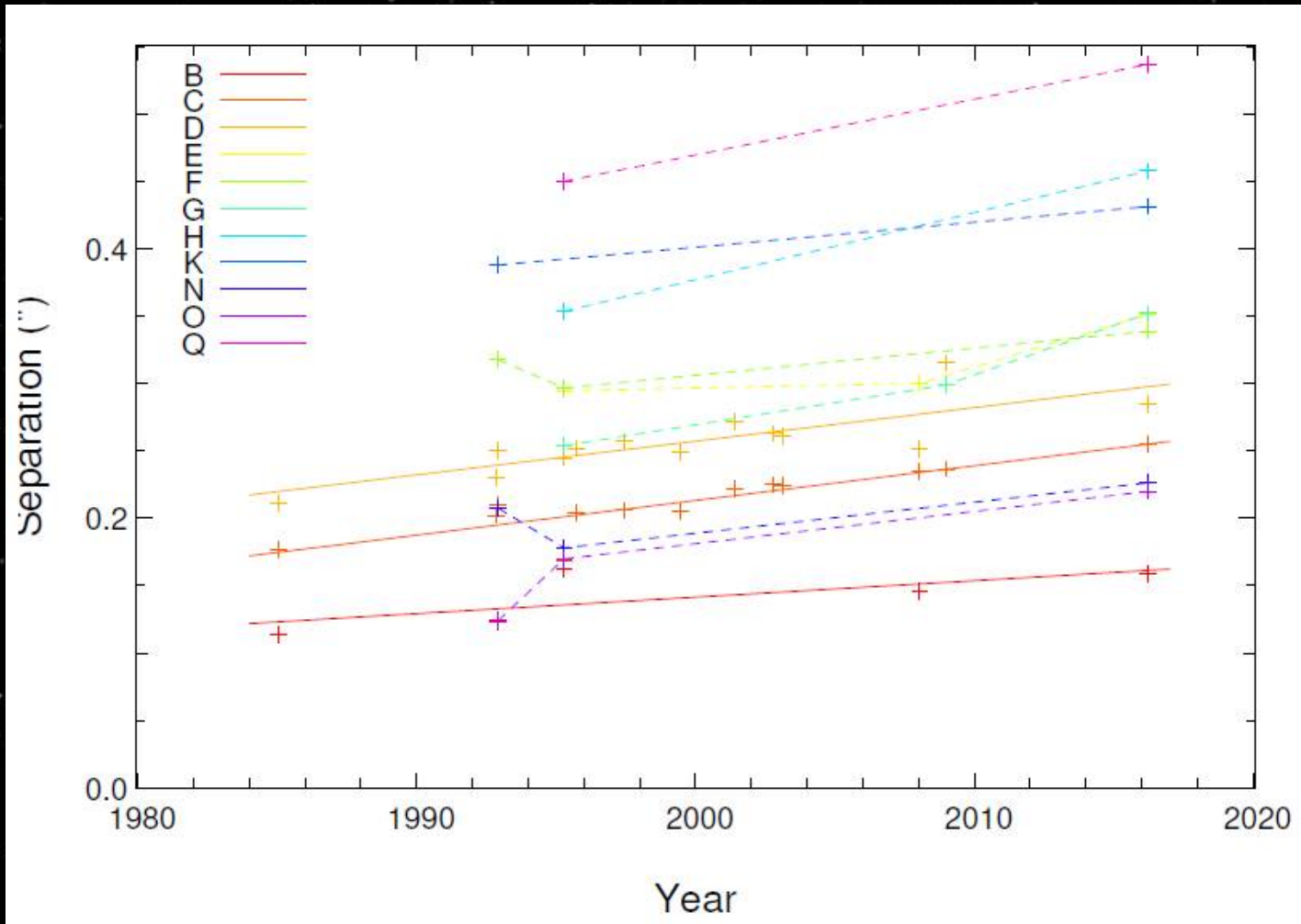
Comparison SPHERE / HST



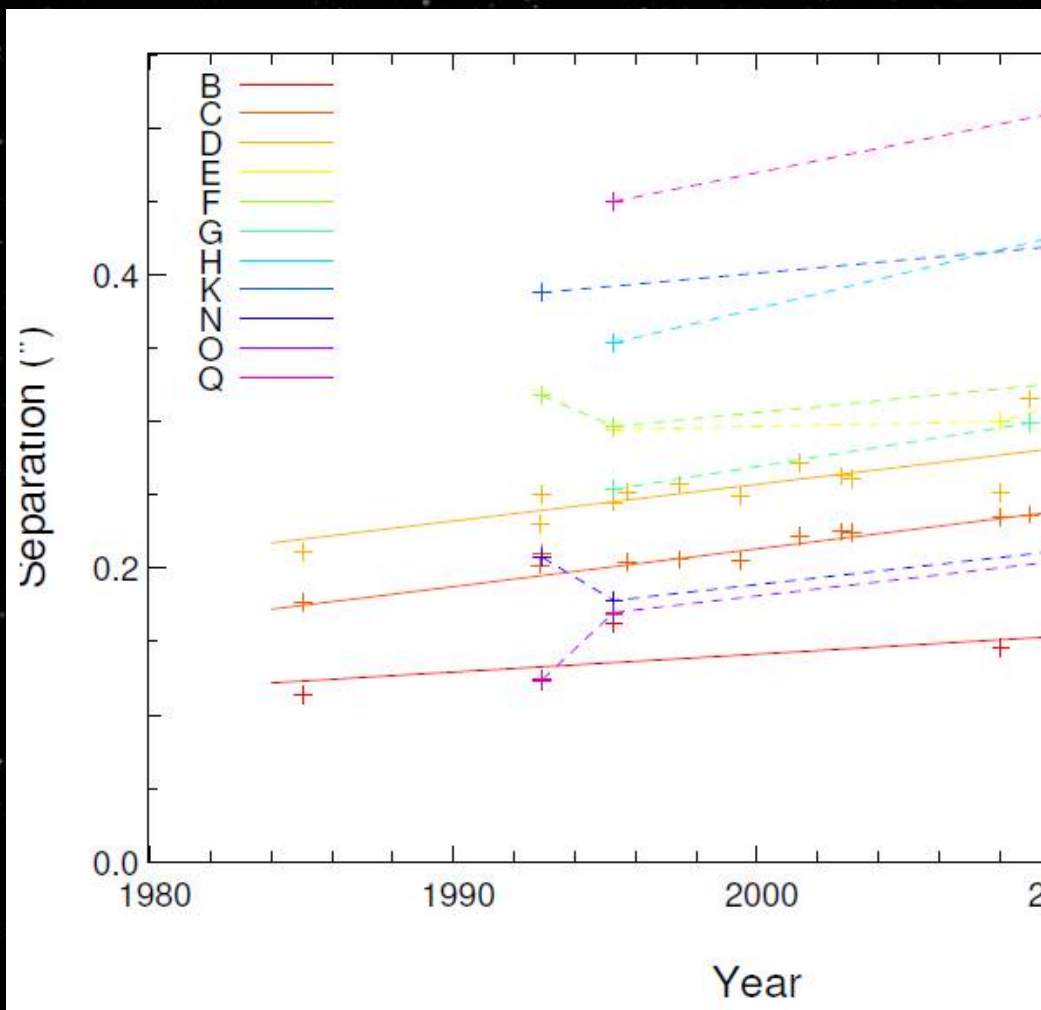
Comparing SPHERE images with previous results



Eta Car blobs motion



Eta Car blobs moti



**INDESCRIBABLE...
INDESTRUCTIBLE!
NOTHING CAN STOP IT!**

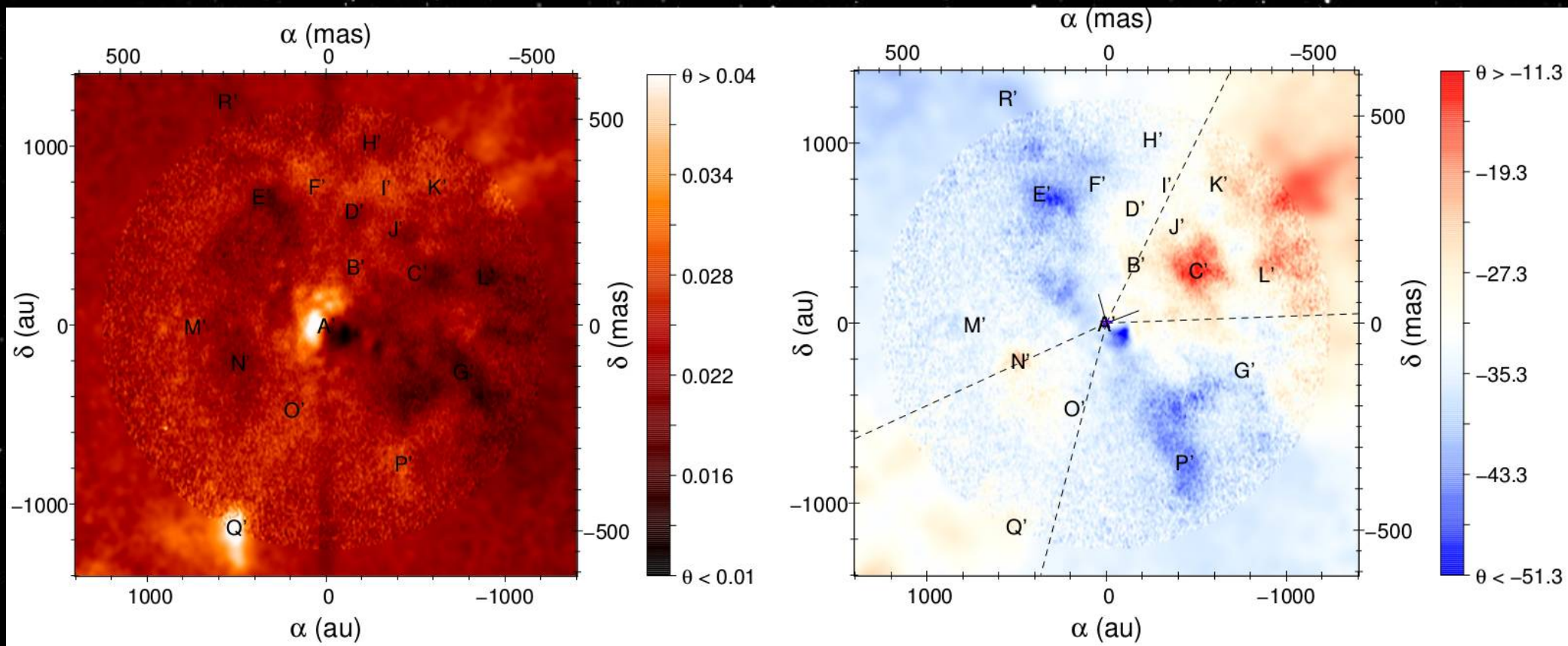
THE BLOBS

Starring **Eta Car** Also starring
 Eta Car's companion

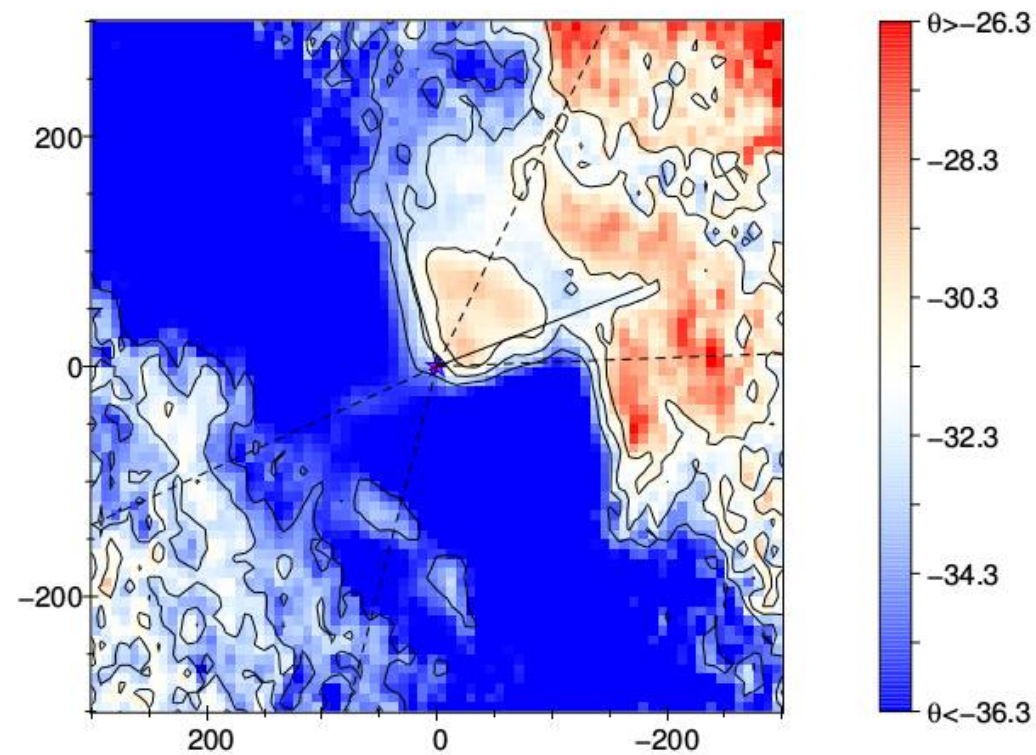
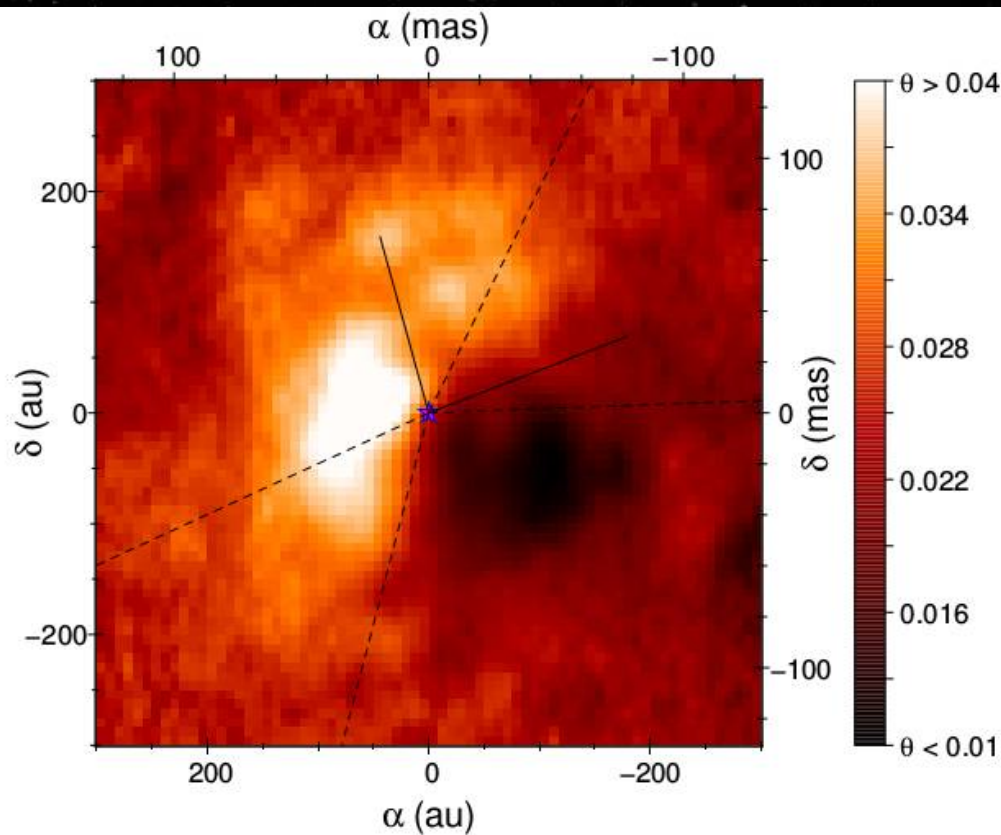
Produced by Screenplay by
 the binary company Massive stars and wind collisions

FROM AN IDEA BY IRVINE H. MILLGATE A TONYLYN PRODUCTION - COLOR BY DE LUXE

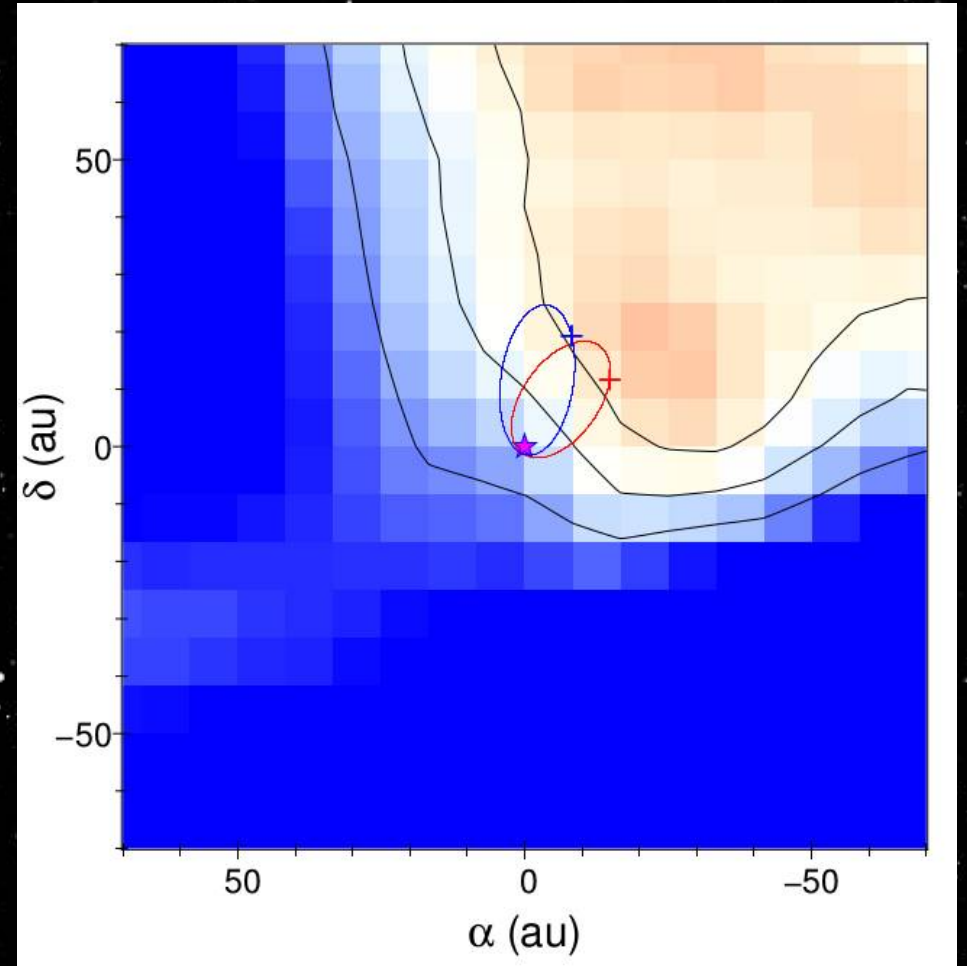
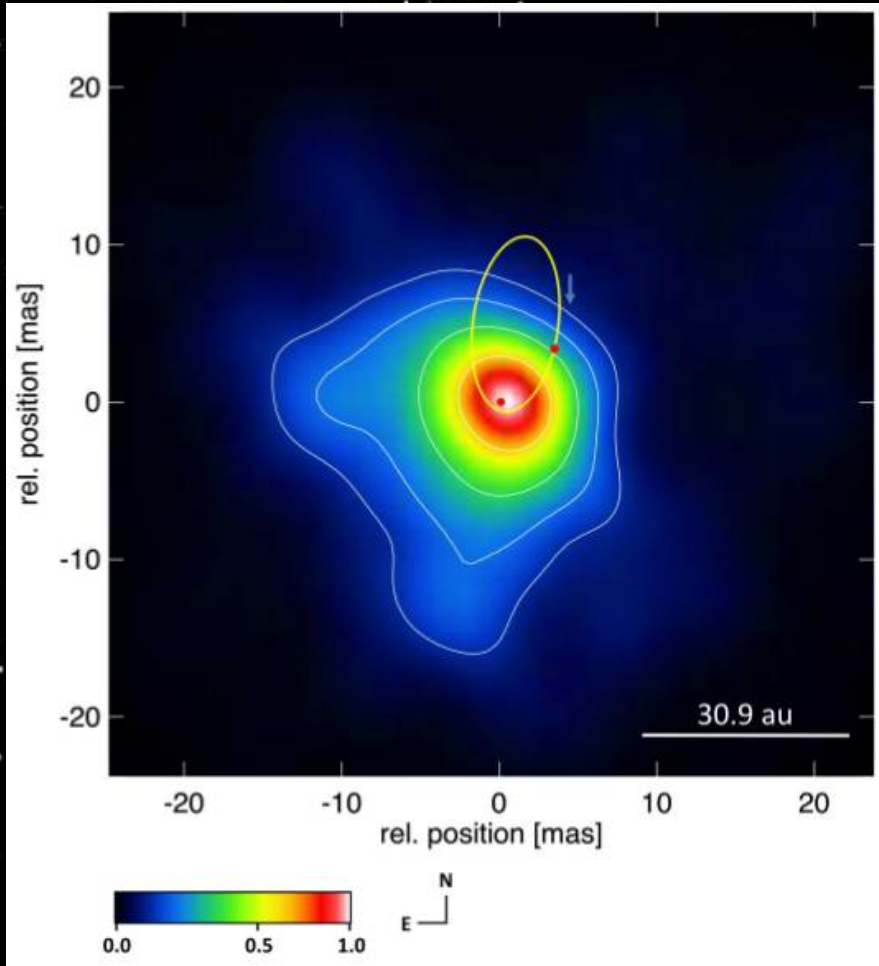
New SPHERE H α Polarization maps



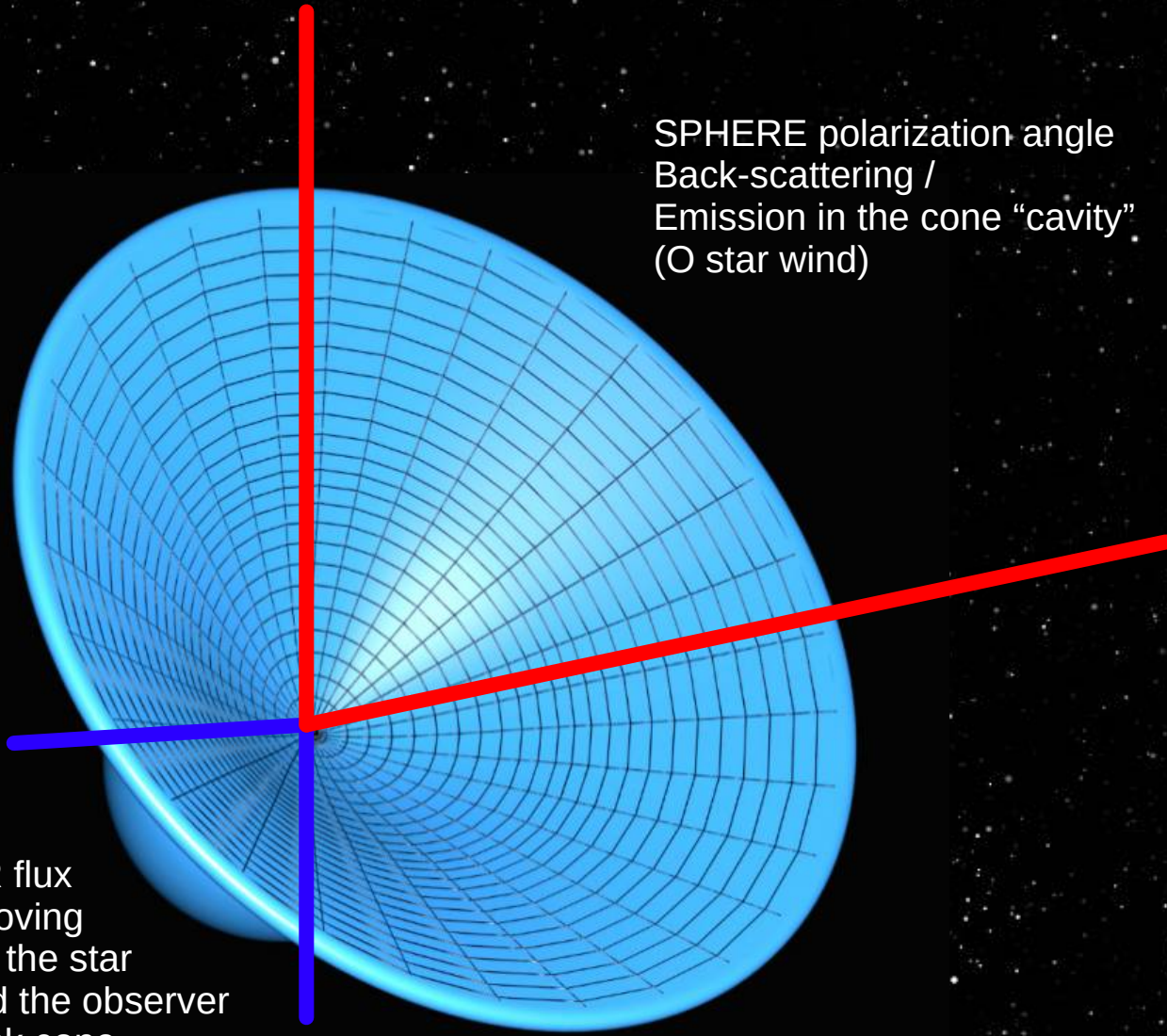
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AMBER vs SPHERE

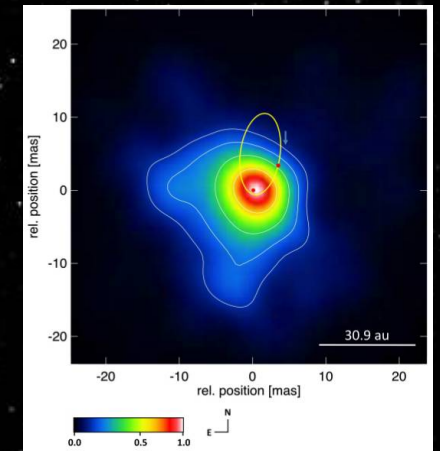
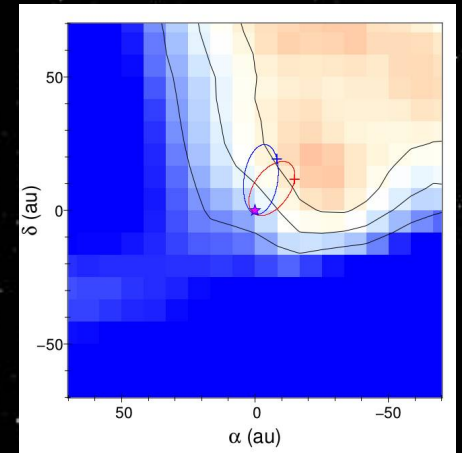


AMBER vs SPHERE



SPHERE polarization angle
 Back-scattering /
 Emission in the cone "cavity"
 (O star wind)

AMBER IR flux
 Hot gaz moving
 away from the star
 and toward the observer
 in the shock cone



Weigelt+ 2016

Conclusions / remarks

Detection of 18 knots, of which only 4 were known in the inner arc-second around Eta Carinae

A fan-shaped structure detected in polarization angle in the inner 200 au:
probably the wind of the O star or back-scattering in the shock cone.

SPHERE allows for an unprecedented resolution AND dynamic range.

SPHERE in the visible is reaching similar scales as OLBI in the IR

We should perform future observations in pupil-tracking mode (easier for deconvolution)

Merci de votre attention

