High Angular Observations of interacting binaries

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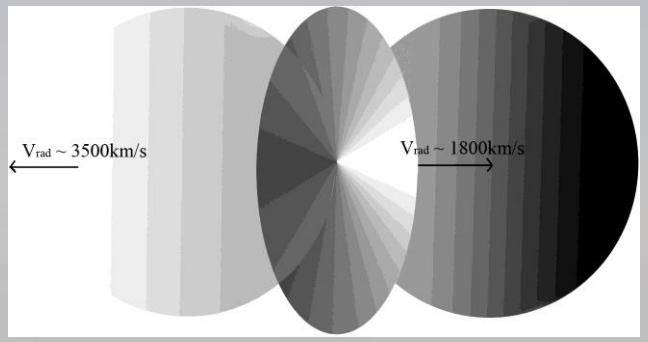
What are the goals of these observations (*ultimately*):

- Detecting (embedded) interacting binaries (some many are yet to be discovered!)
- Isolate the engines that are at the origin of bi/multipolar nebulae,
- Detect the streams that form the circumbinary disks
- Study the temporal variability of the mass-transfer or discrete mass-ejection phenomenon,

Novae: good laboratories for fast creation of highly bipolar nebulae

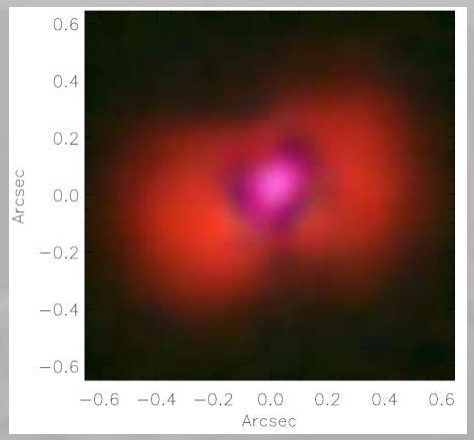


9 mas – 15 AU (HeI2.06μm) , t=5d

The recurrent RS Oph:

O'Brien et al. 2006,
Chesneau et al. 2007,
Bode et al. 2008…

Jet or shaping by equatorial overdensity?



The classical V1280 Sco:

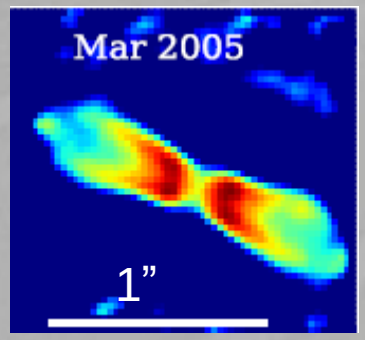
Chesneau et al. 2008,
Chesneau et al. 2012

Common envelop? Bipolar-ejection from a spun-up WD?

The recurrent T Pyx: a near-pole on bipolar nebula

Chesneau et al., 2011

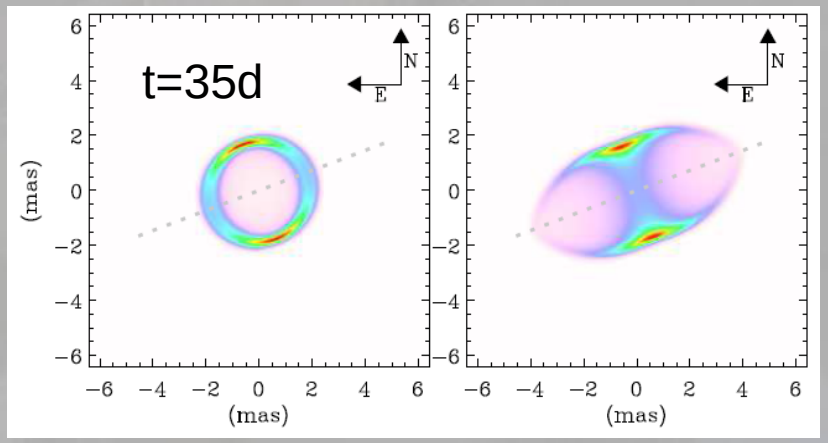
A strong magnetic field? Spun-up WD?

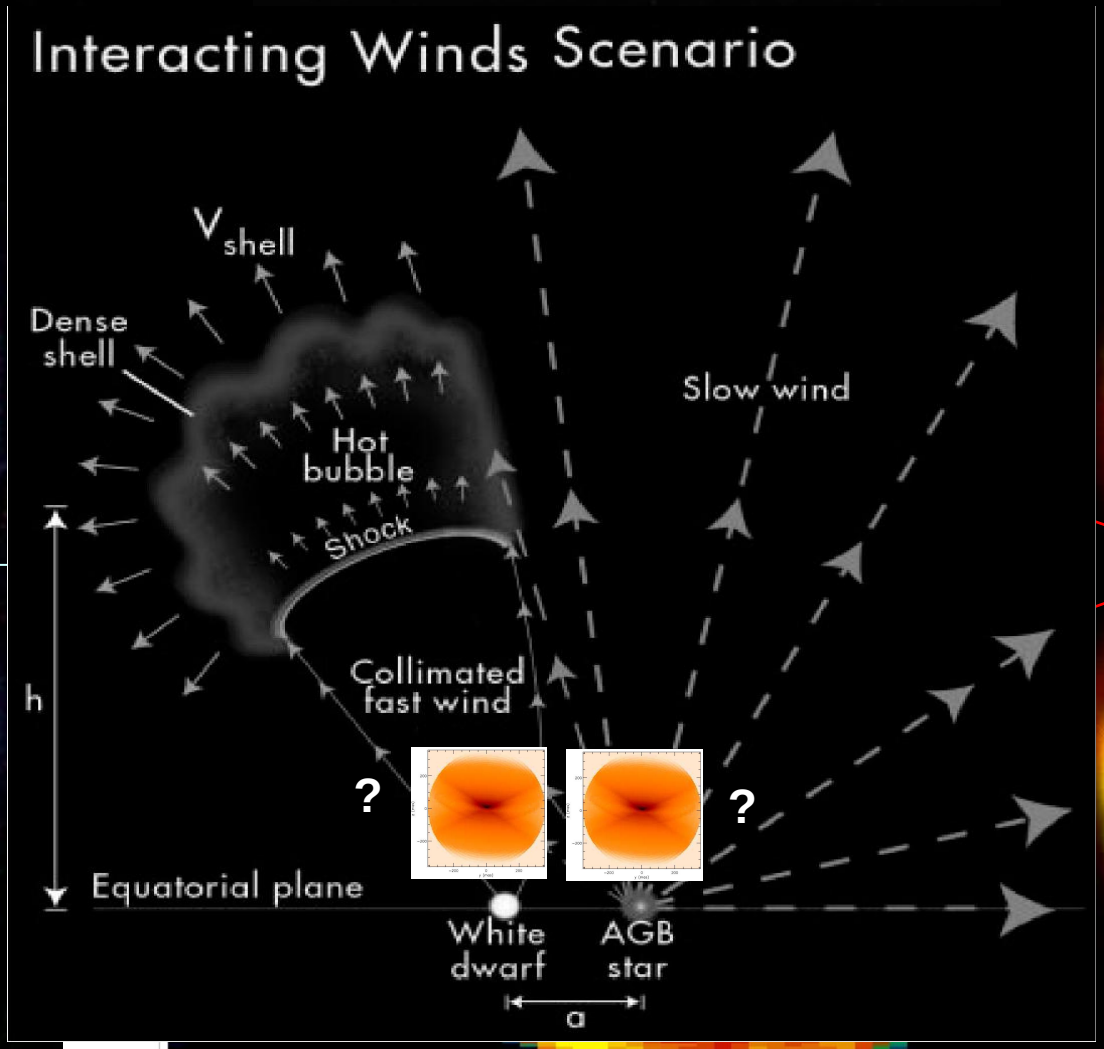


The classical V445 Pup:

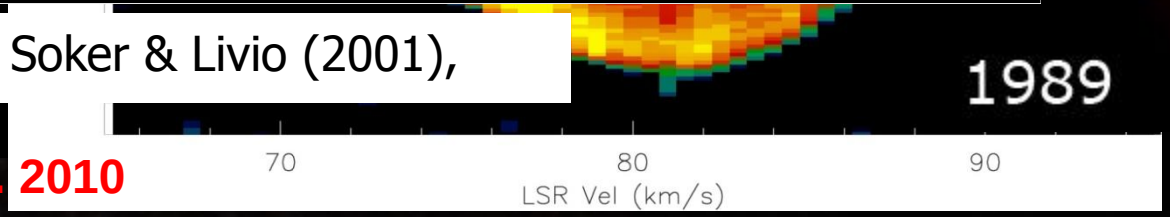
Woudt et al. 2009,

Shaping by equatorial overdensity? Jet?





Soker & Livio (2001),



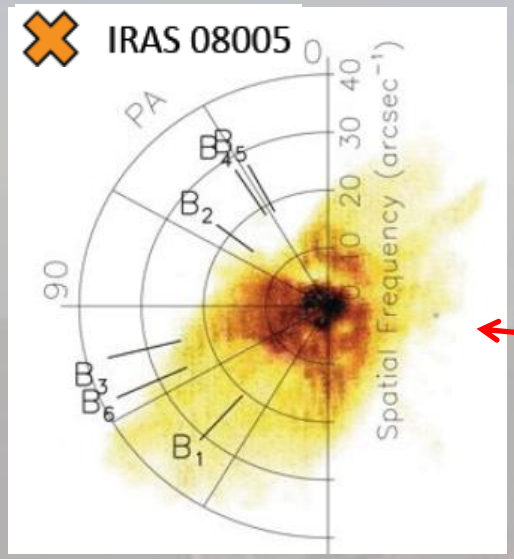
Lykou, Chesneau et al. 2010

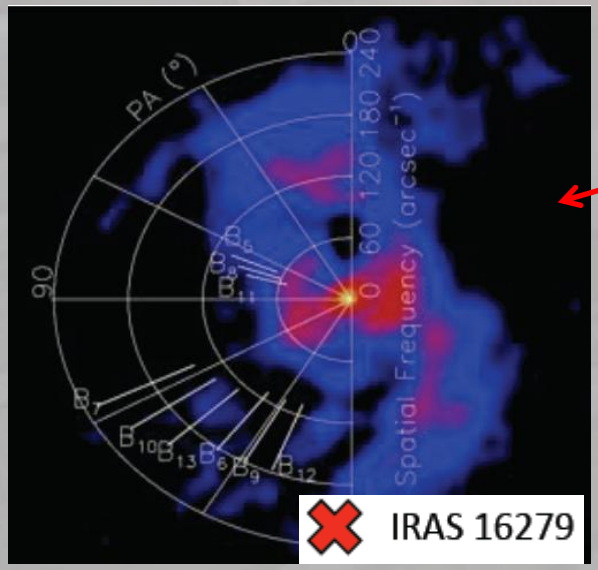
Castro-Carrizo et al. 2012

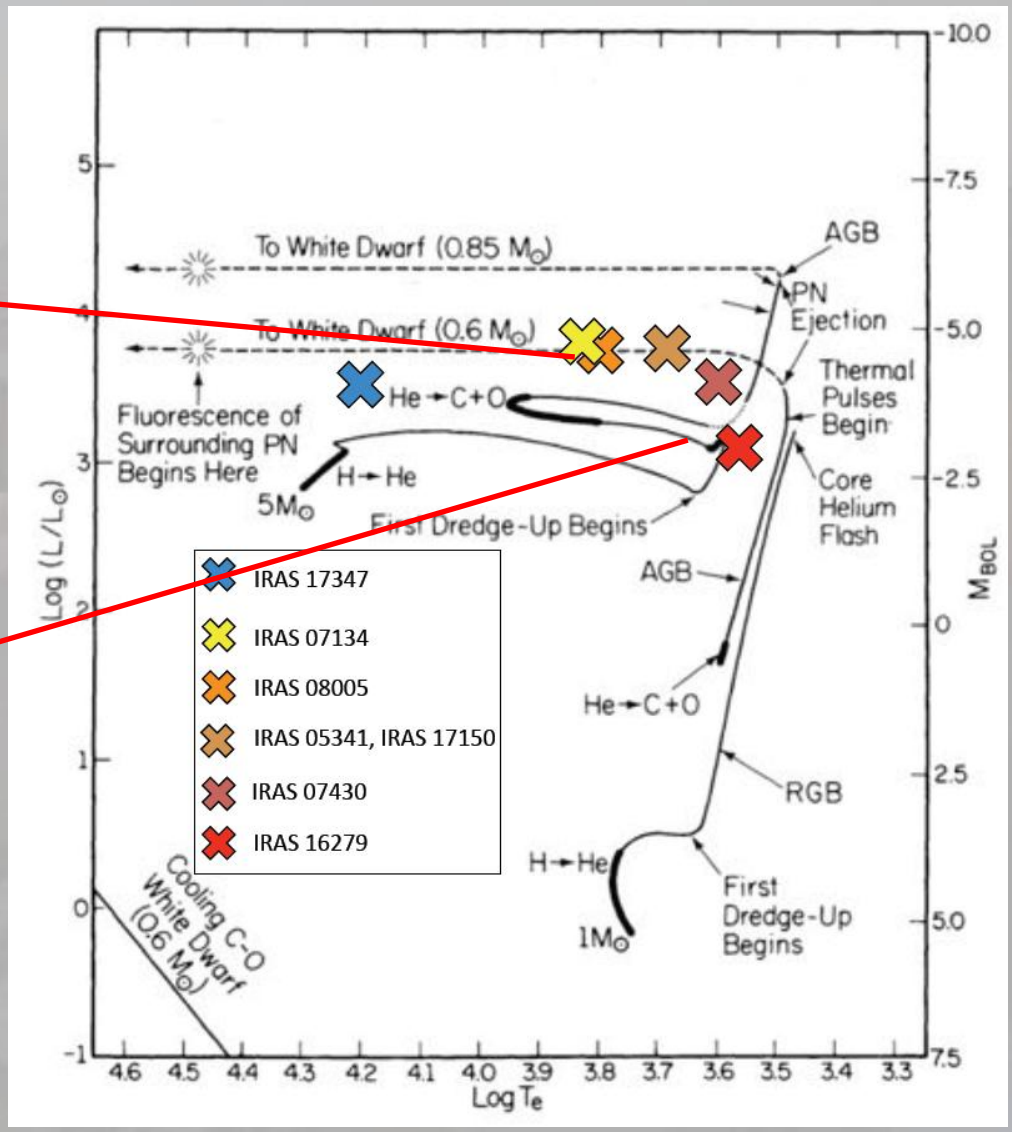
Corradi et al. 2012

Goal: detecting the engine in the core of bipolar PPNs (and symbiotics!)
PhD thesis: Stacey Bright (sup. O. De Marco/O. Chesneau)

See her poster!





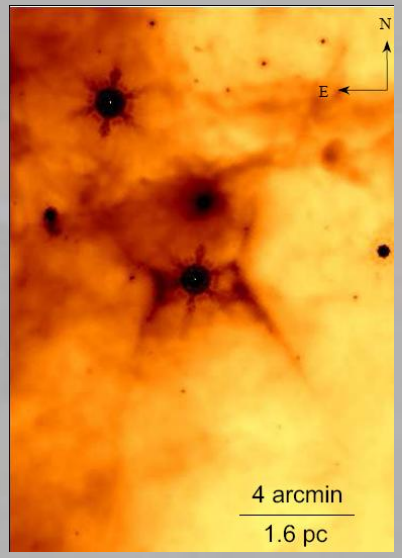


B[e] are all binaries!

Not a consistent spectral type. Mix of young and evolved sources (distance determination issue): SgB[e], HerbigB[e], PNB[e] (Lamers et al. 1998)

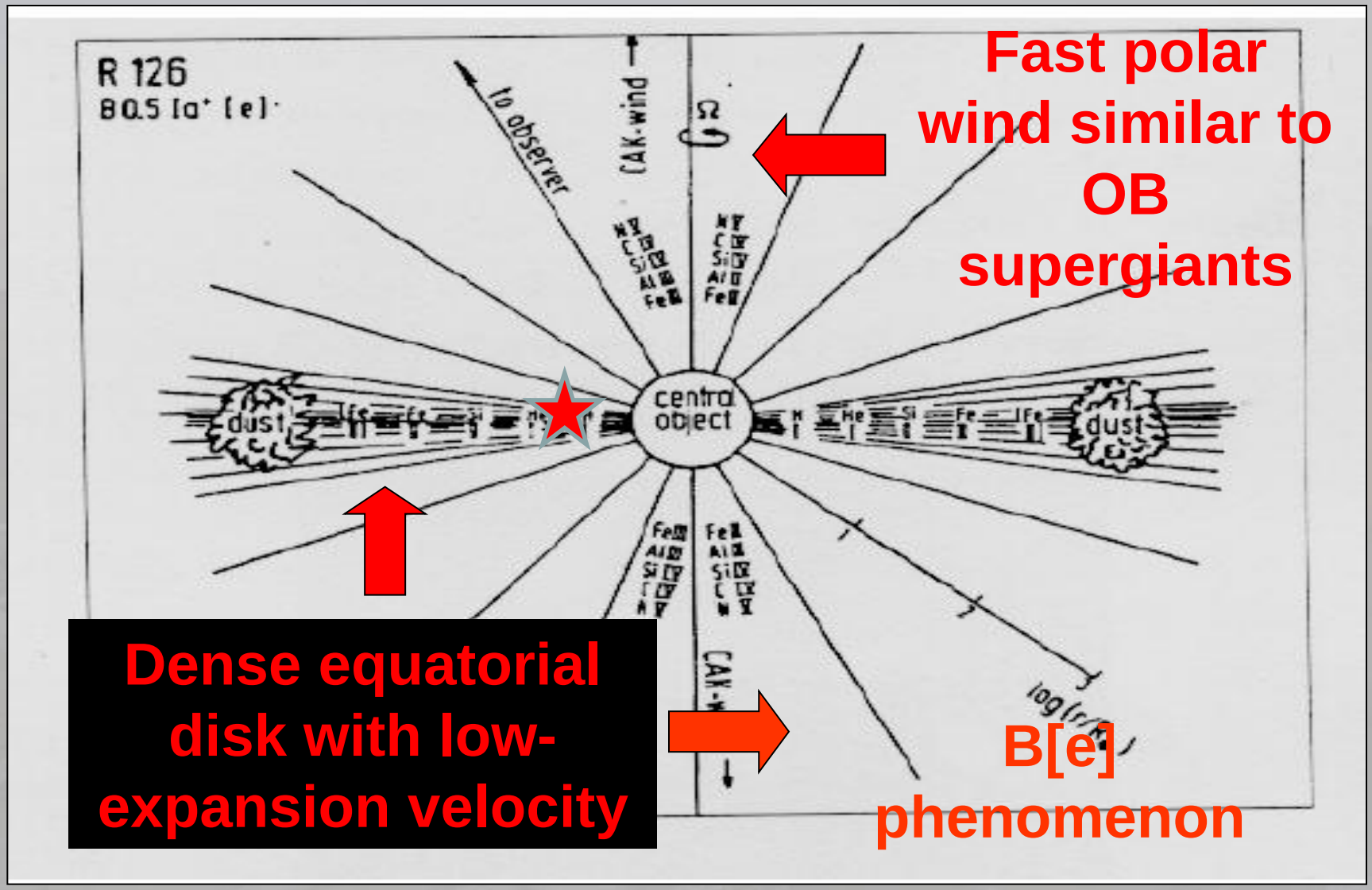
But virtually ***ALL*** the evolved sources whatever their luminosity class or status in evolution seem in binary systems!

- Miroshnichenko (2007a, b) proposal: the hot dust (1000-2000K) 'smoking gun' from a recent mass-transfer.
- MWC 300 is a binary (Domiciano et al. 2008, Wang et al. 2012), MWC 314 (binary containing a LBV Lobel et al.),
- V921 Sco, binary HerbigB[e] (Kraus et al. 2012a, b)
- B[e] from LMC, disk-like SEDs (Kastner et al. 2010).
- MWC 349, massive and evolved binary (LBV) (Gvaramadze&Menten 2012)

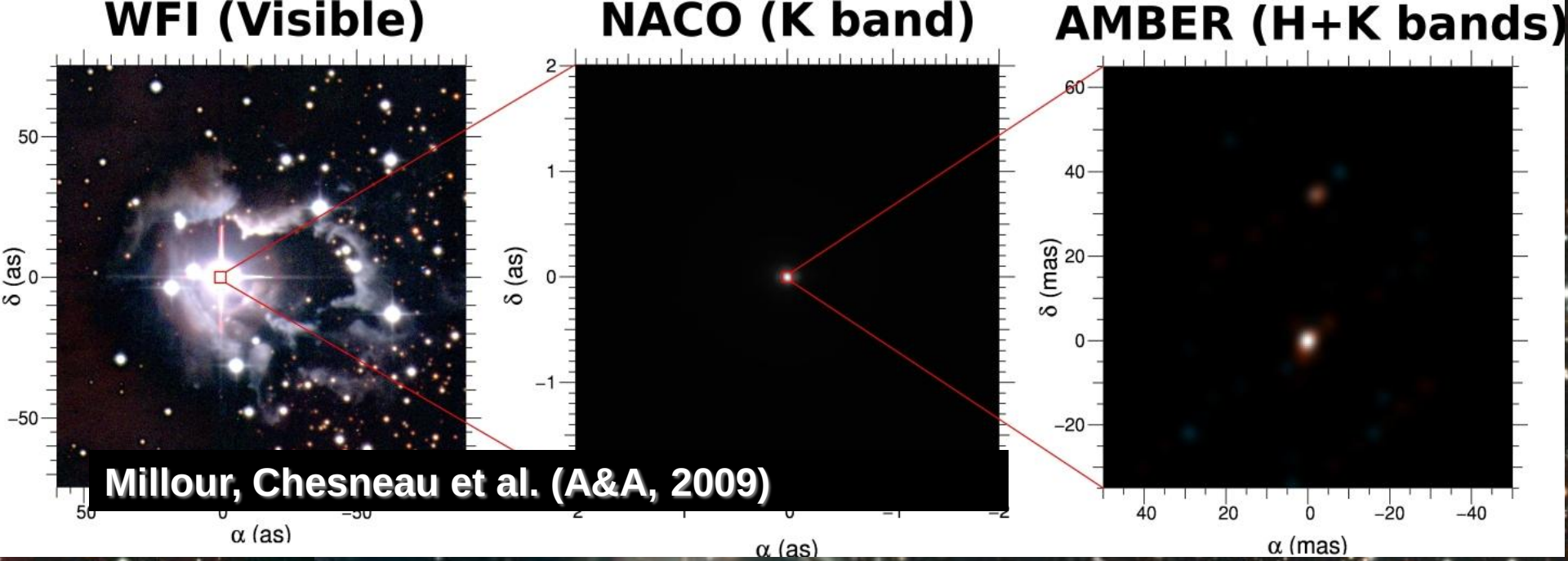


Well-defined bipolarity around evolved star is an indirect, yet clear evidence for binarity

Two-component wind (Standard Model for B[e]sg)



(Zickgraf et al., 1985)

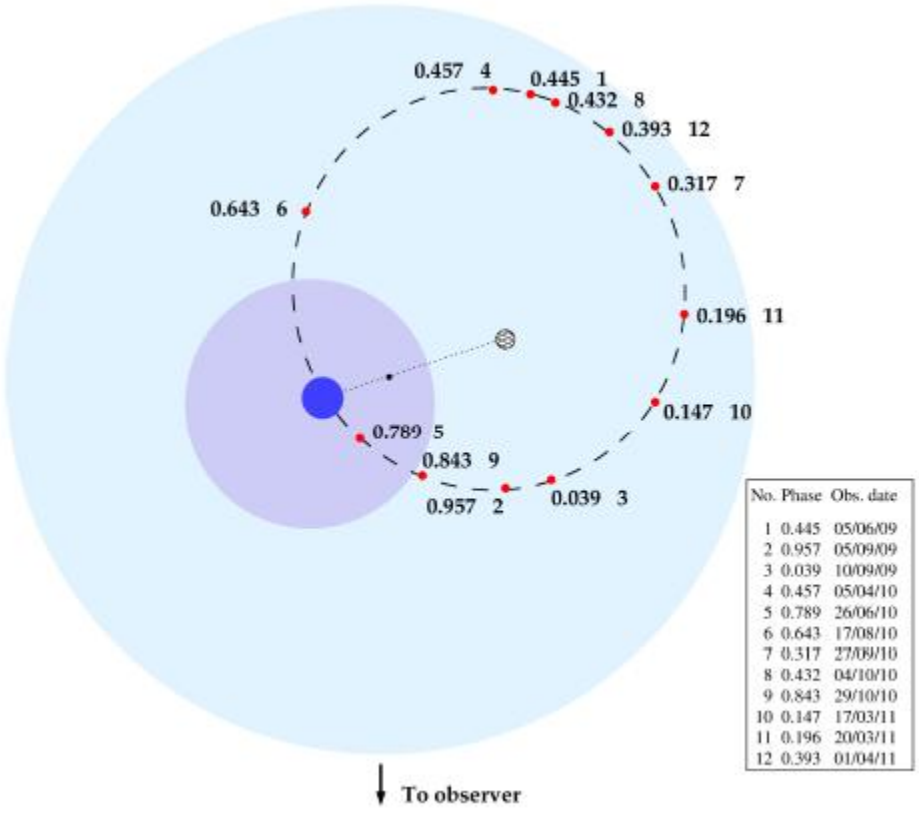


HD 87643: close to face-on bipolarity?

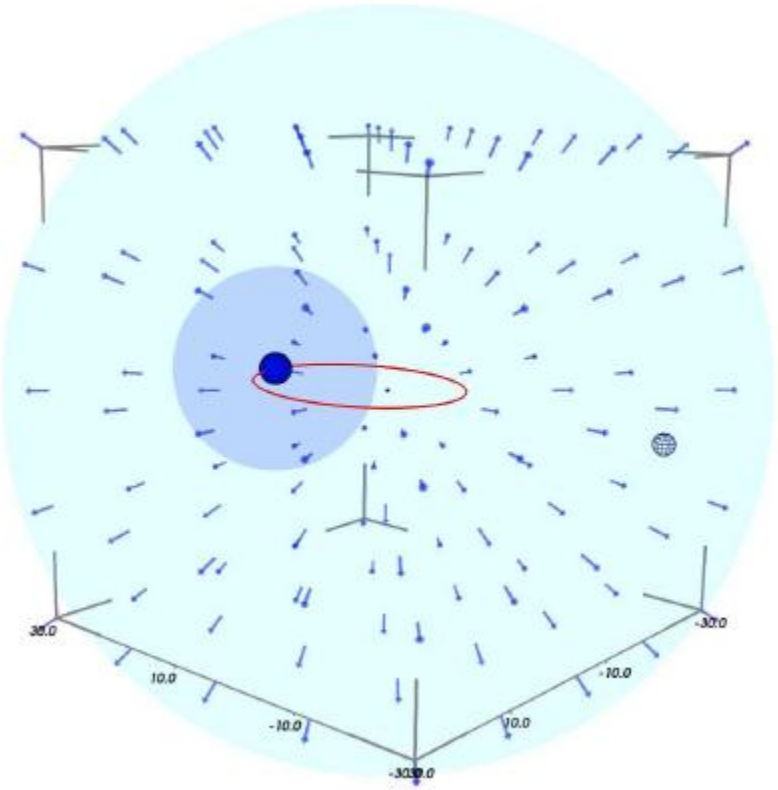
Current separation of the components: 34 mas (34-102 AUs depending on D)
Large infrared excess (large amount of dust)
Two disks!!

Best hypothesis: regular catastrophic outburst at (some?) periastrons (each 6-15yrs, depending on eccentricity).

Disks and binarity: – MWC 314 (Lobel et al. 2013)



No.	Phase	Obs. date
1	0.445	05/06/09
2	0.957	05/09/09
3	0.039	10/09/09
4	0.457	05/04/10
5	0.789	26/06/10
6	0.643	17/08/10
7	0.317	27/08/10
8	0.432	04/10/10
9	0.843	29/10/10
10	0.147	17/03/11
11	0.196	20/03/11
12	0.393	01/04/11



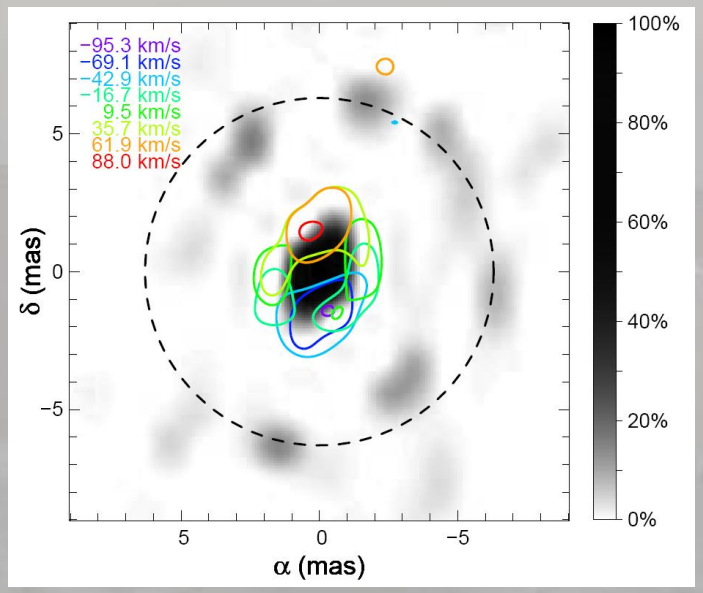
Yesterday: a B[e] star

Today: a 60d period, eccentric system (e=0.26) containing a LBV+ a less luminous supergiant

Disks and binarity: – HD62623 (A[e], an embedded Deneb)

Millour, Meilland, Chesneau, et al. 2011; Meilland et al. 2010

MIDI/VLTI → parameters of the dusty disk
AMBER/VLTI→ image reconstruction in Brγ line.



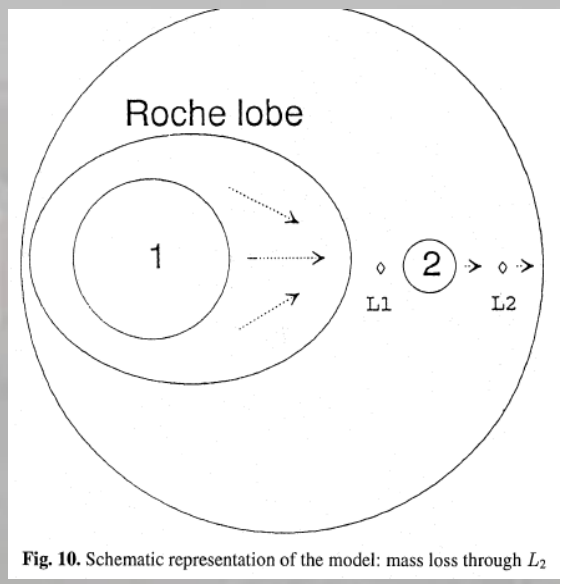


Fig. 10. Schematic representation of the model: mass loss through L_2

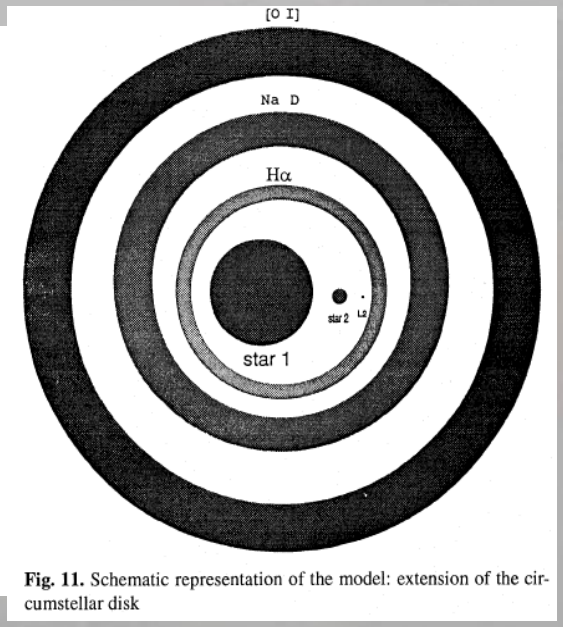
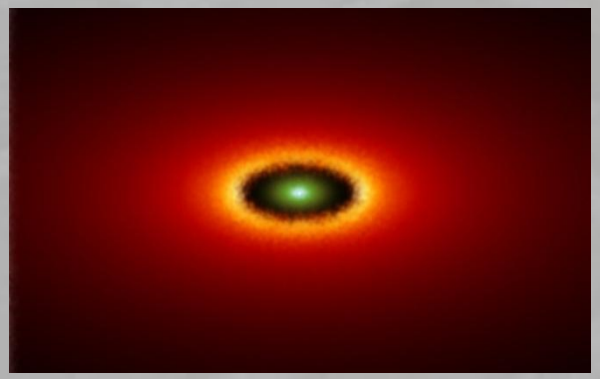


Fig. 11. Schematic representation of the model: extension of the circumstellar disk



Schematic model: Plets et al. 1995

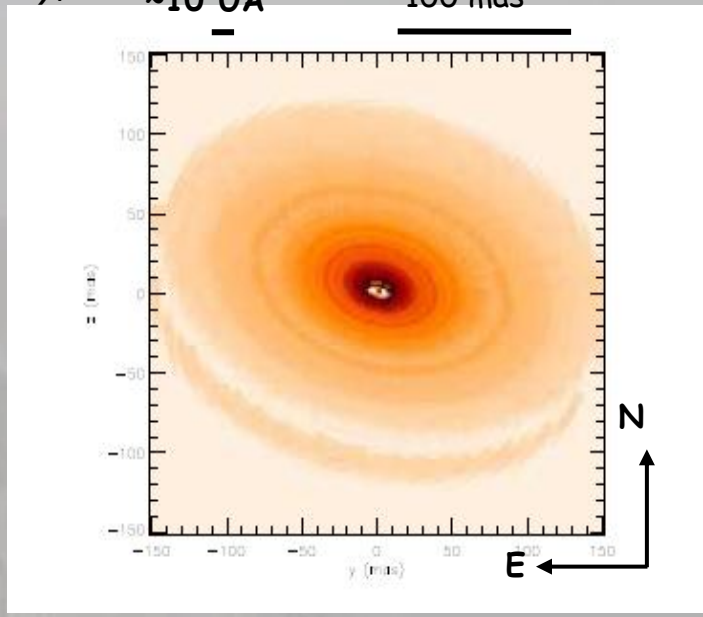
The key: A low mass companion (q<<1) near the photosphere of the A supergiant

Disks and binarity- The hydrogen deficient Ups Sgr

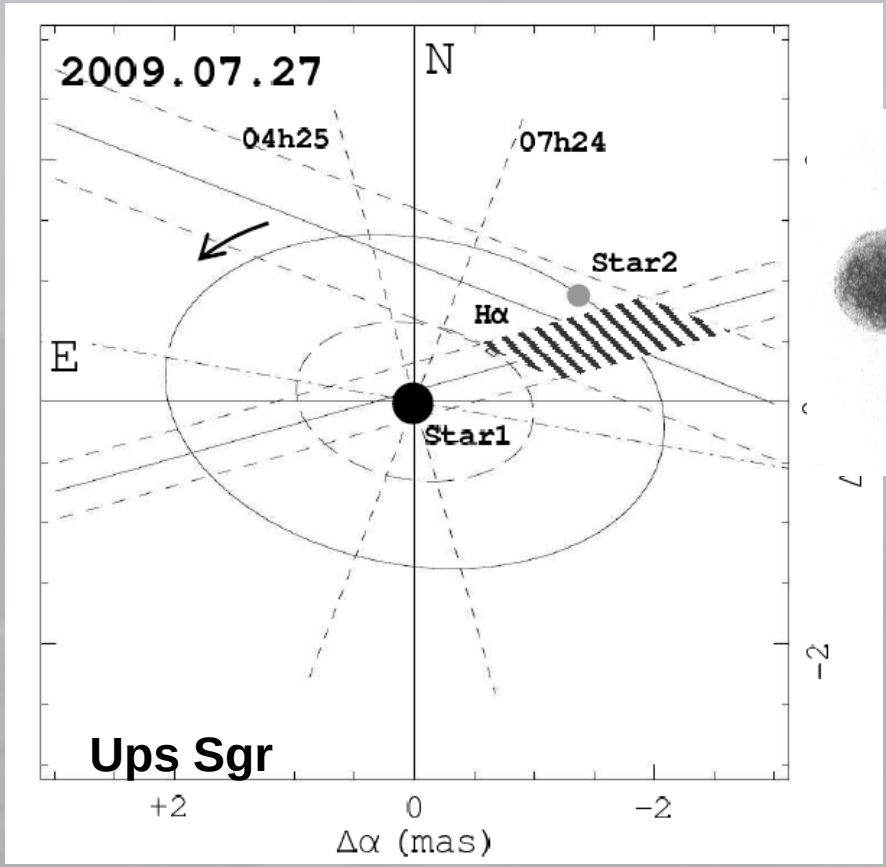
Ups Sgr:

• the brightest of the Hydrogen deficient stars (HdB stars), A supergiant, Strong IR excess!
• SB2, P ≈ 137.9 j, d*P*/d*t* = -24 s/yr
• Intense and variable Hα emission

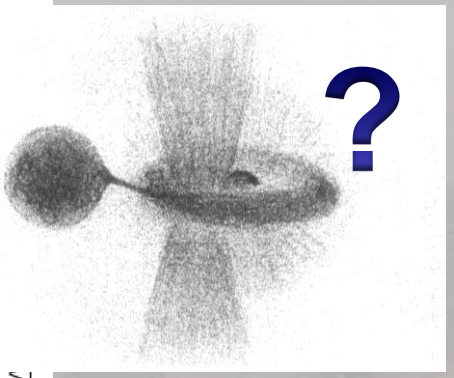
• ***MIDI/VLTI*** **mid-IR observations**: circumbary disk (Netolicky**,** Bonneau, Chesneau, Kousky et al. 2009)
  • Inclination *i* =50°
  • Total mass of the system > 15 $M_{\odot}$

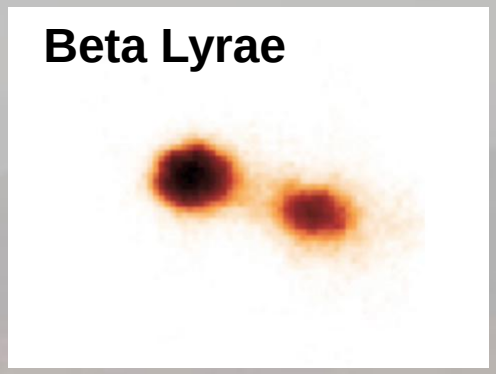


The mass-transfer constrained by VEGA/CHARA observations



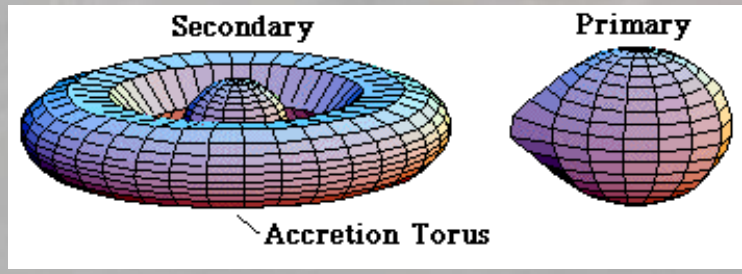
When begins the polar ejections?



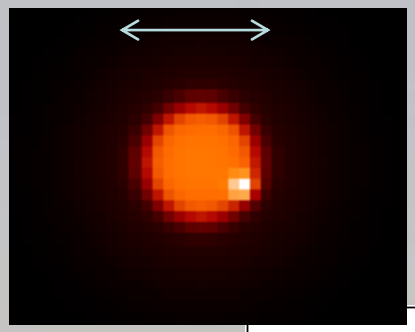


CHARA reconstructed images

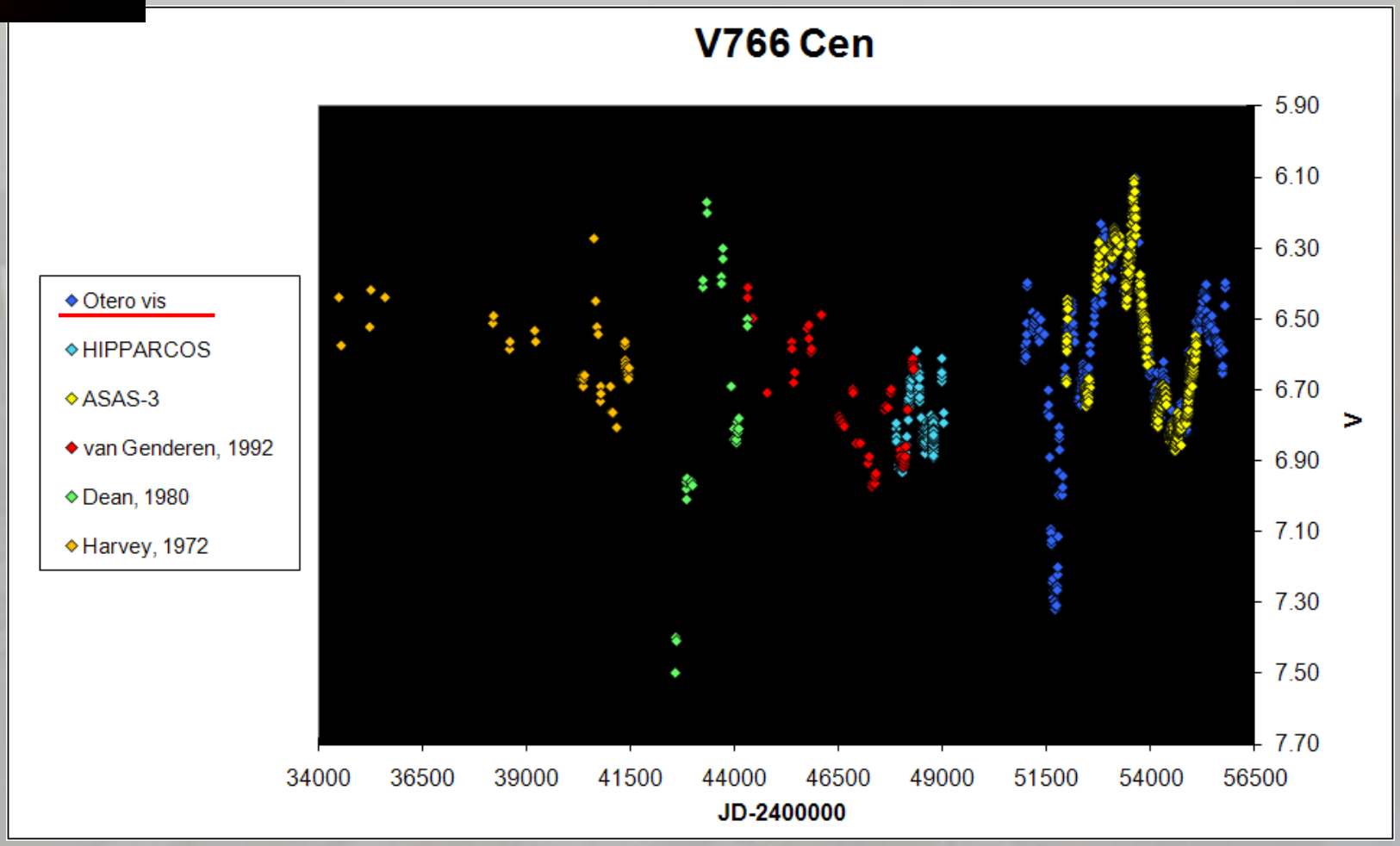
Zhao et al. 2008



***VEGA/CHARA* visible observations** → constraints on the size of the primary, flux from Hα, extended continuum flux…(Chesneau, Bonneau, Mourard et al. 2011)

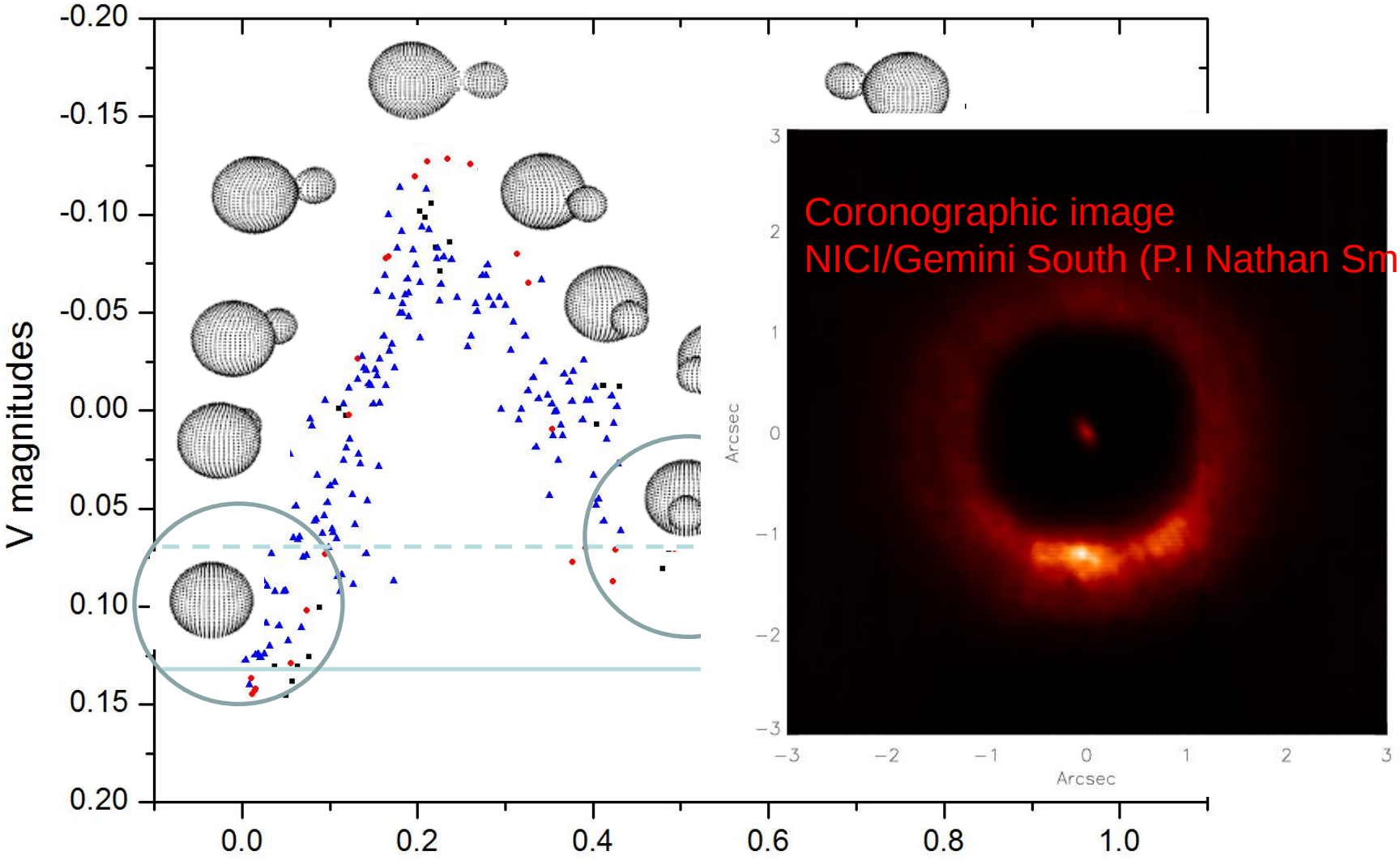


HR 5171 A (alias V766 Cen): an anonymous Yellow Hypergiant from G5Ia (~1950) → K3Ia (~1990) and now?



P=1333 d

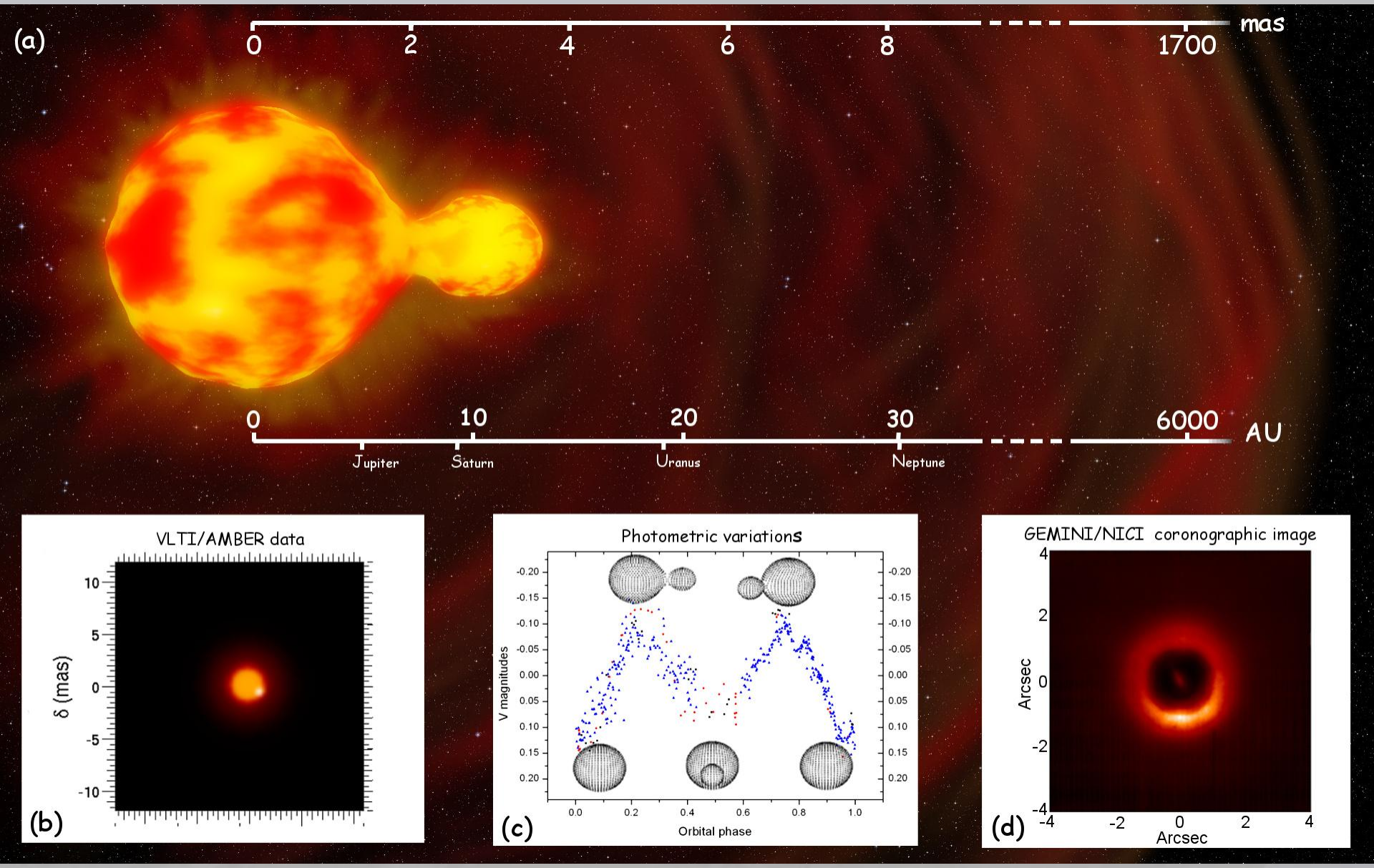
Chesneau, et al. en préparation



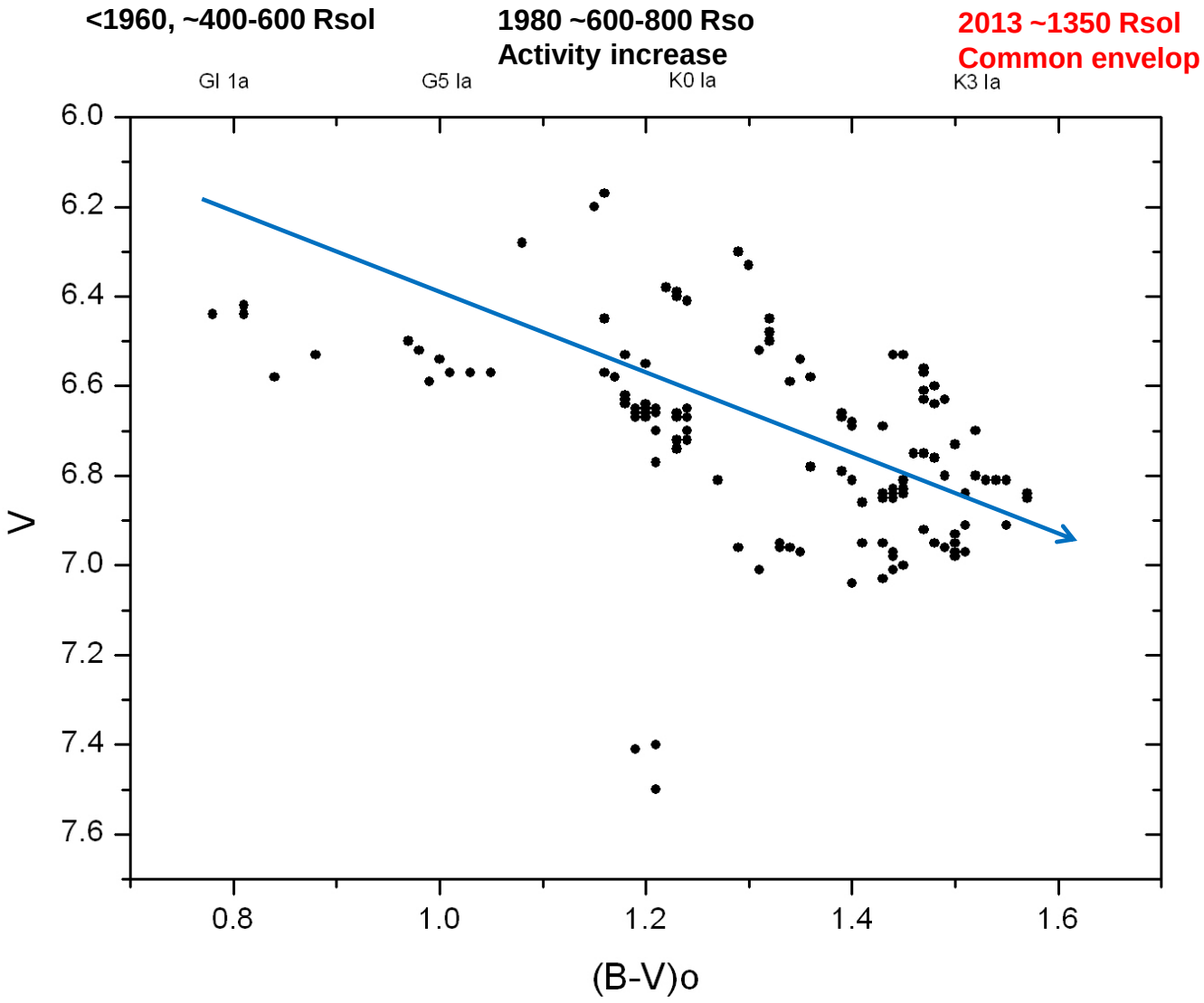
P=1333j → system mass~30-60Msol

CASE B interaction: large rotation (60 km/s! Warren et al. 1973), ‘enveloppe stripping’,

First detection of a massive common envelop system?
Future fast-rotating Wolf-Rayet star? Progenitor of a Long Gamma-ray burst?



Historical evolution



Conclusions

- High spatial resolution observations provide new way to separate binarie stars even with *complex* environments,
- One can now get closer to the interacting binary engines
- The influence of a companion, even not massive on the extended, loosely bound atmosphere of a giant can be studied directly,
- Binary interaction is not a smooth process. It can be at the origin of violent and short-lived ejections that must be caught by observations.

- *These phenomena affect deeply the fate of massive stars becoming supergiant and the class of the supernova explosion*
- *These phenomena modifies deeply our view of the end of solar-type stars*