



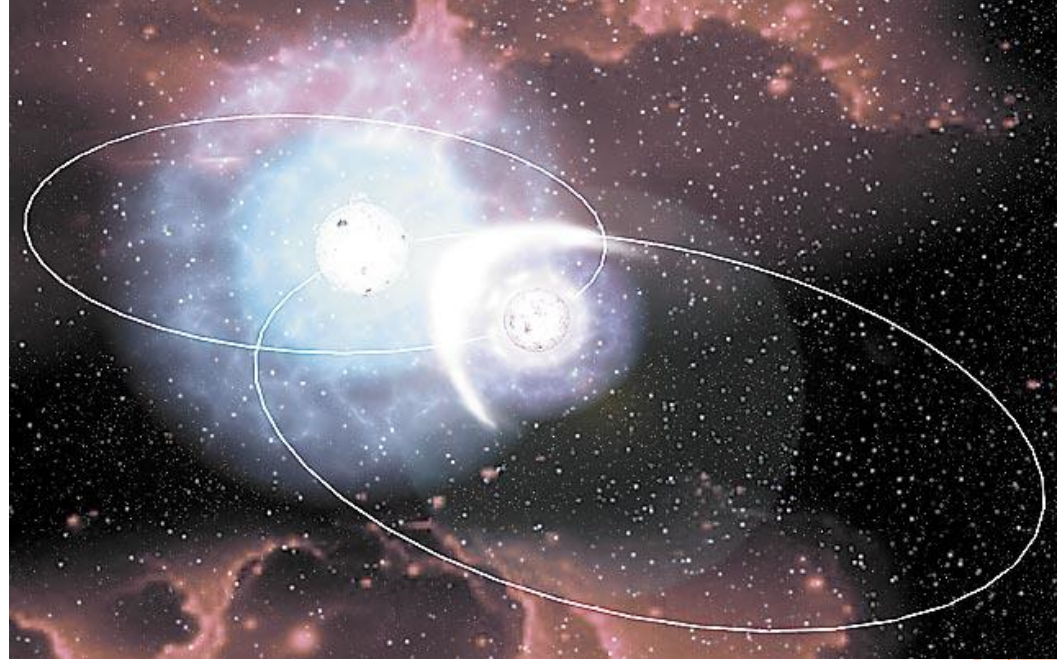
**CYG OB2 #5 AND 12,  
X-RAY AND OPTICAL MONITORING**

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# COLLIDING WINDS

- Two massive stars  
= two supersonic winds  
⇒ collision
- Surveys : significant X-ray overluminosity rare!
- Evidence ?
  - Large emission zone
  - Emission far from stars (f/i ratio)
  - Phase-locked variations if absorption or separation changes

(for a review Rauw & Nazé 2016)



*Depends on cooling !*

- *Radiative : winds still accelerating + density effects*
- *Adiabatic : winds at full  $v$ , only density effects*

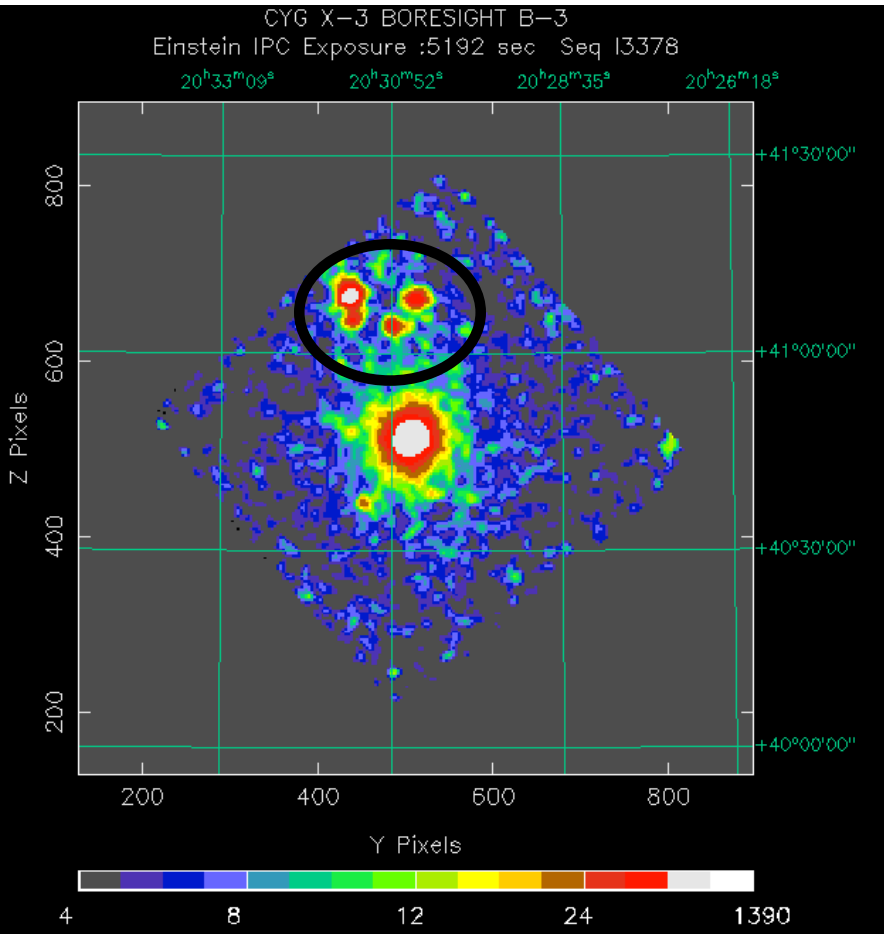
*!! \ may change over  $P_{orb}$  !*



# CYGNUS OB2

- The first massive stars detected in X-rays in Dec. 1978 (Einstein)

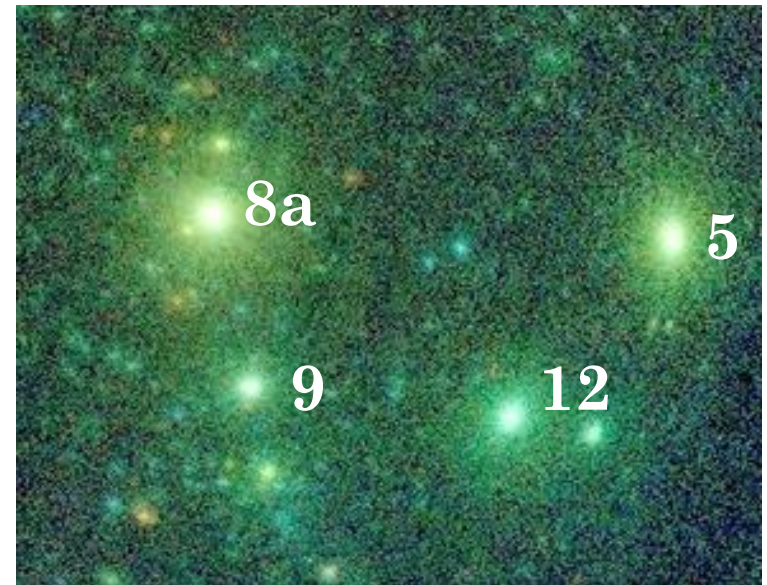
*(Harnden et al. 1979)*



# CYGNUS OB2 : PREVIOUS RESULTS

- Cyg OB2 8a  
(O6If + O5.5III(f), P=21.9d)
  - Non-thermal radio emitter
  - Radiative collision
  - Larger abs when primary in front, hard em ↑ @ apastron, soft em ↑ @ periastron, hysteresis effect ∃
- Cyg OB2 9  
(O5-5.5I+O3-4III, P= 2.53yr)
  - Non-thermal radio emitter
  - Adiabatic collision
  - $L_X \propto 1/D$

*1st O+O adiabatic case*



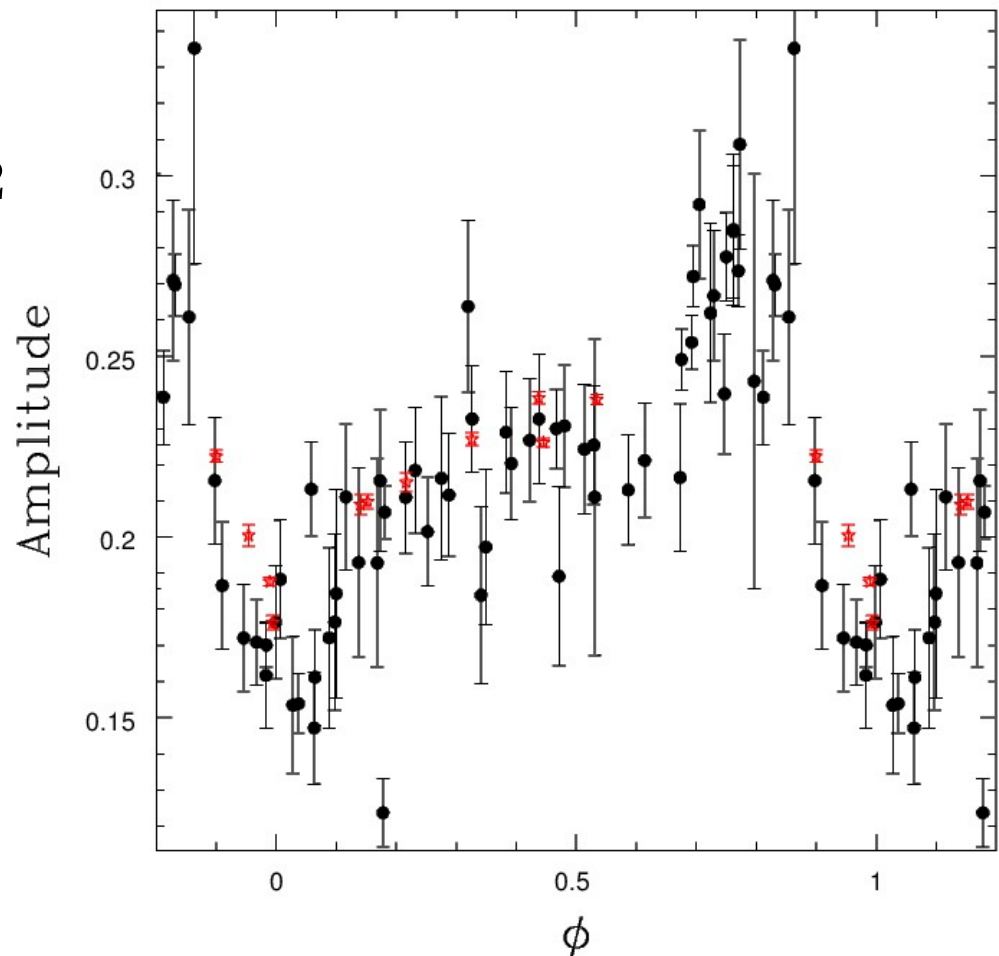
- Cyg OB2 5 & 12
  - Bright and variable...

*(De Becker et al. 2006,  
Blomme et al. 2010,  
Nazé et al. 2012,  
Cazorla et al. 2014)*



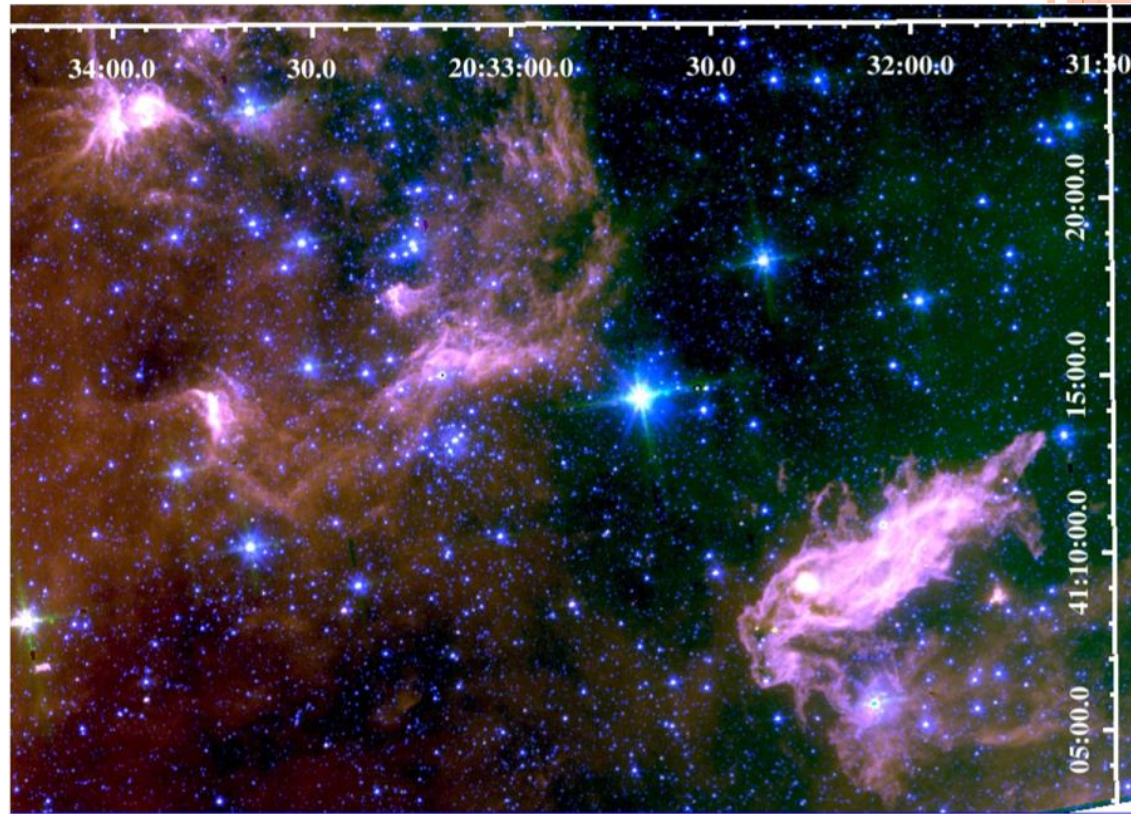
# CYGNUS OB2 : NEW DATA

- 10 obs XMM
- <300 Obs Swift
  - Most for a nearby Be+PSR (but #5 and 12 often in FOV)
- Cyg OB2 8a : confirmation of LC repeatability on  $\sim 5000$ d
- Cyg OB2 9 : nothing new



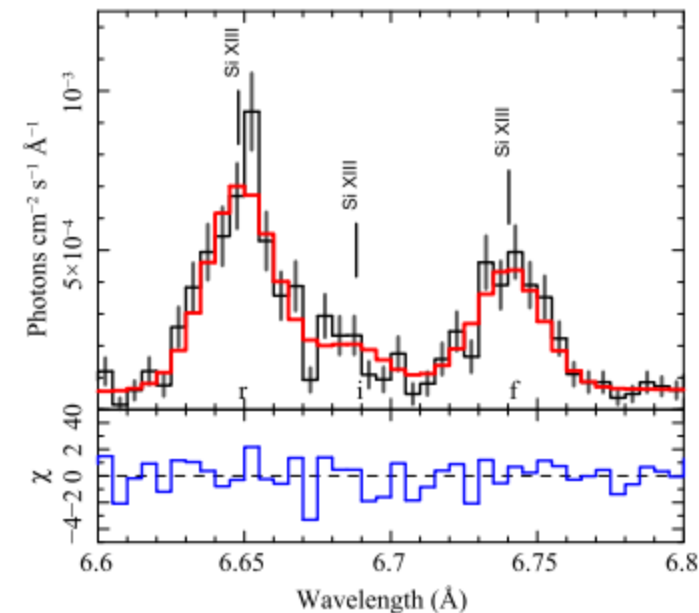
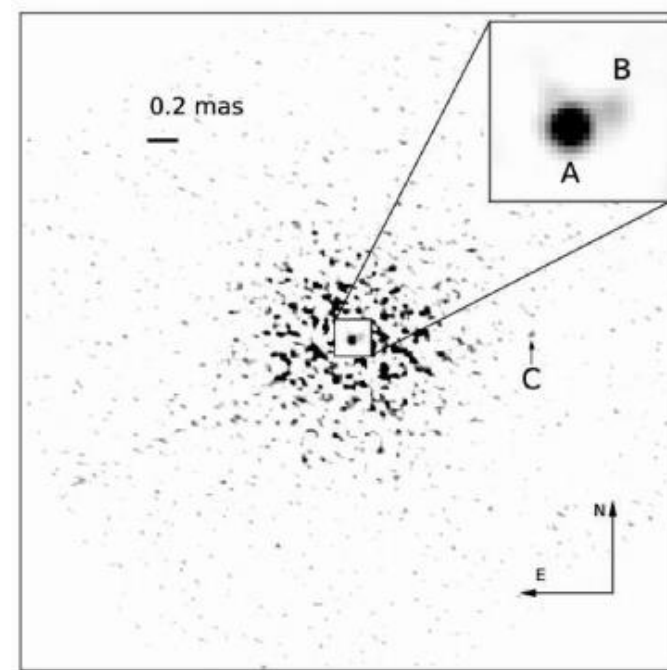
# CYGNUS OB2 12

- One of the brightest and most massive blue hypergiants in the MW
- Highly extinguished ( $2e22 / \text{cm}^2$ , twice  $N_{\text{H}}$ (others))
  - Circumstellar shell?  
(*Maryeva et al. 2016*)
- B3Ia, **LBV**
  - Above the HD limit
  - Lack of variations/neb

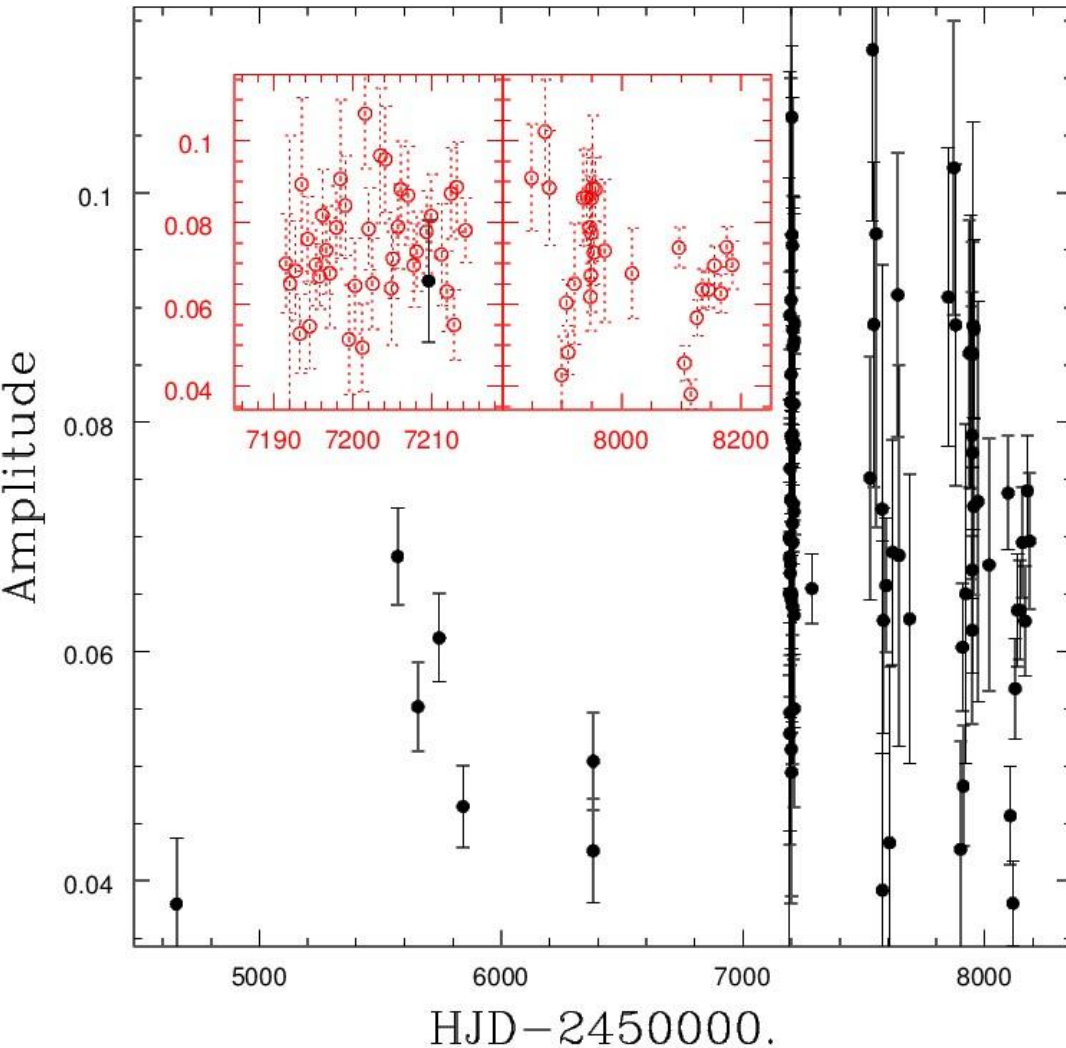


# CYGNUS OB2 12

- Bright in X-rays ( $\log(L_x/L_{bol})=-6.1$ ):  
the only such LBV with  $\eta$  Car  
 $\Rightarrow$  CWB ? *(Nazé et al. 2012)*
- Optical companion(s)  
*(Caballero-Nieves et al. 2014, Maryeva et al. 2016)*
  - B @64mas,  $\Delta V=2.3$   
 $\Rightarrow$  P~30yr or 100-200yr ; BV ?
  - C @1246mas,  $\Delta V=4.8$
- Chandra high-res spectrum :  
strong f line (CWB!) *(Oskinova et al. 2017)*
- Gaia DR2 :  $p=1.17\pm 0.13$ mas vs  
 $0.62\pm 0.06$ mas for other stars !



# CYGNUS OB2 12



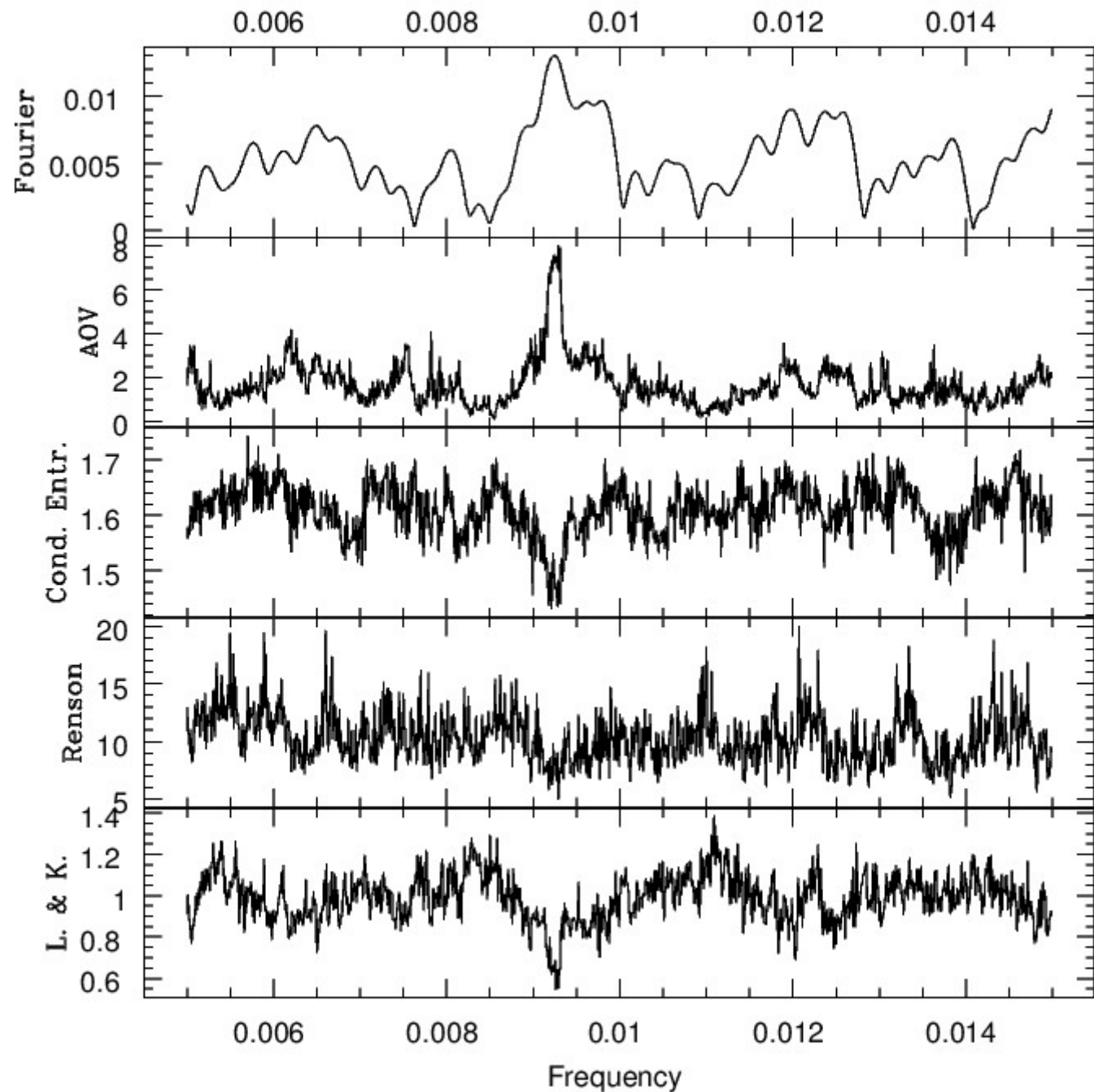
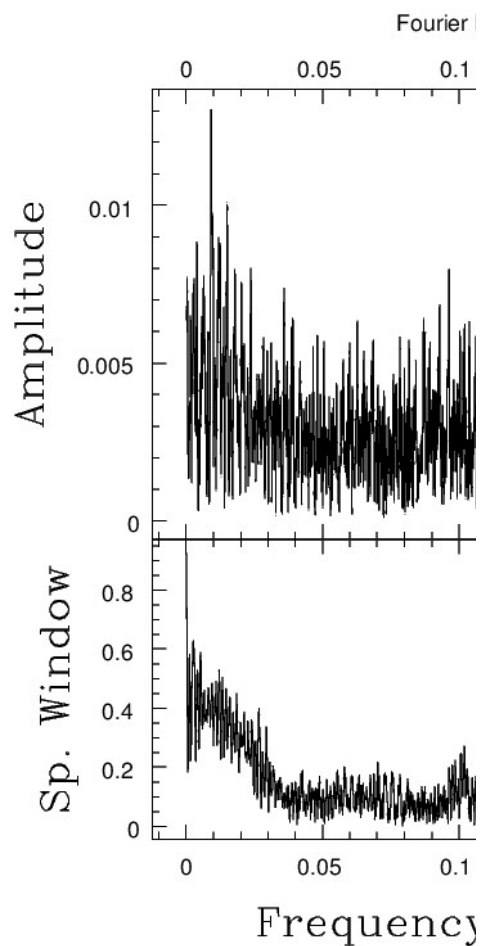
- $\sim 5000\text{d} = 14\text{yr}$   
(Swift only :  
 $\sim 100$  obs over  
 $\sim 4000\text{d}$ )





# CYGNUS O]

○ Period search



# CYGNUS OB2 12

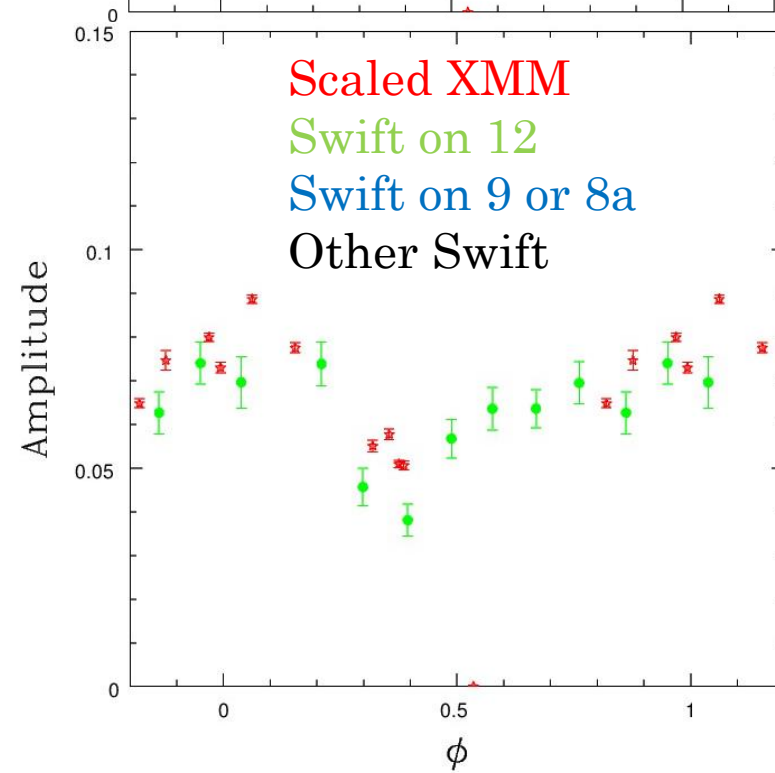
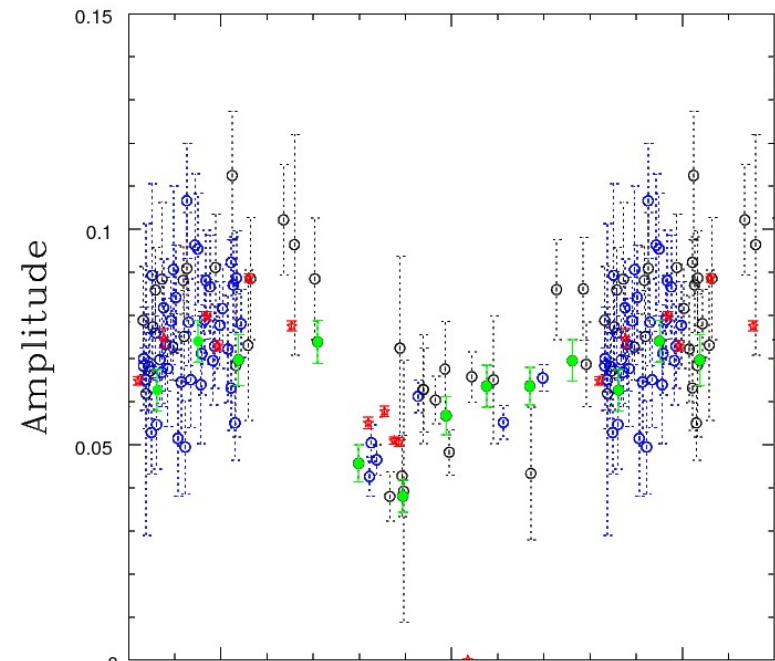
- Period search :  $108.0 \pm 0.2$  d
- In optical photometry,  
 $P = 54.0 \pm 0.1$  d

(Salas et al. 2014)

<<<< tens of yrs !

⇒ There is a close companion !

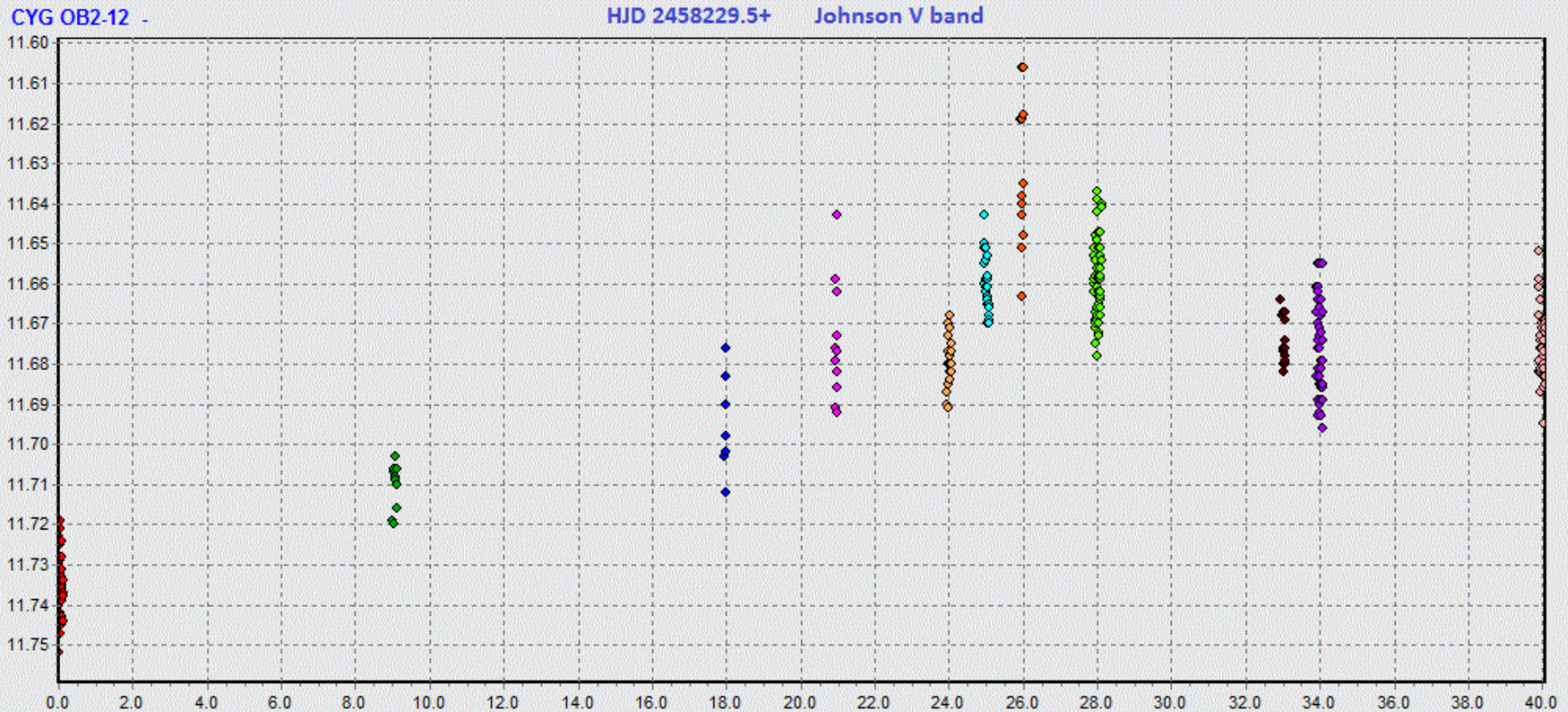
- Reminiscent of HD166734  
or Cyg OB2 8a LCs  
⇒ radiative collision in ecc.  
Binary with min= periastron?



# CYGNUS OB2 12

More data needed !

○ Optical photometry (with F. Campos)



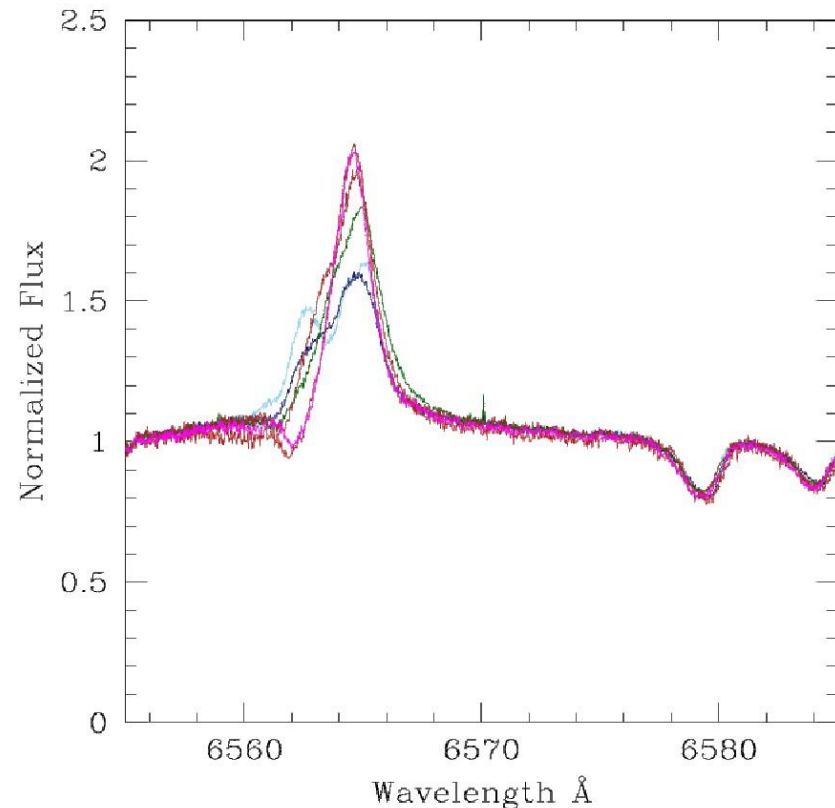
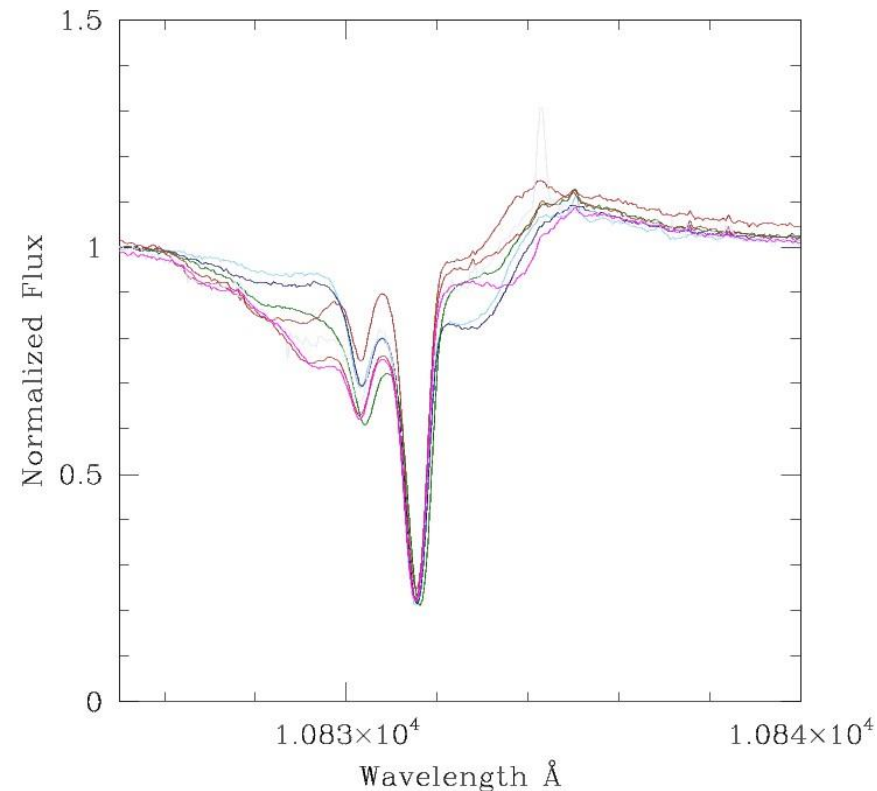
# CYGNUS OB2 12



More data needed !

- Optical/IR spectroscopy (with G. Rauw, S. Czesla, L. Mahy)

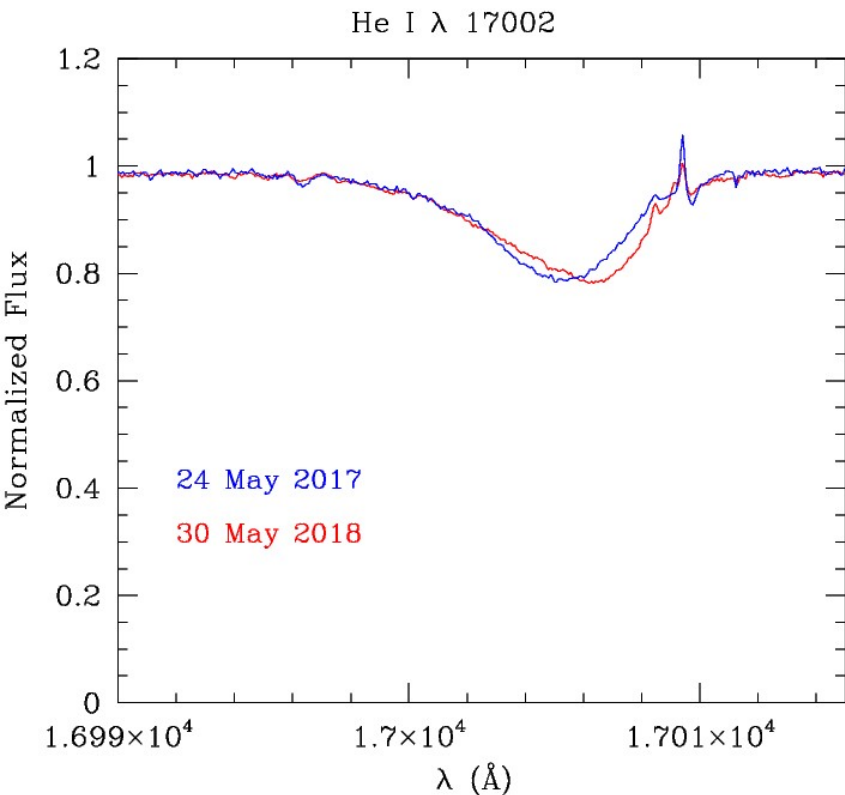
LPV and some RV change known but not interpreted in the context of binarity  
*(Chentsov et al. 2013)*



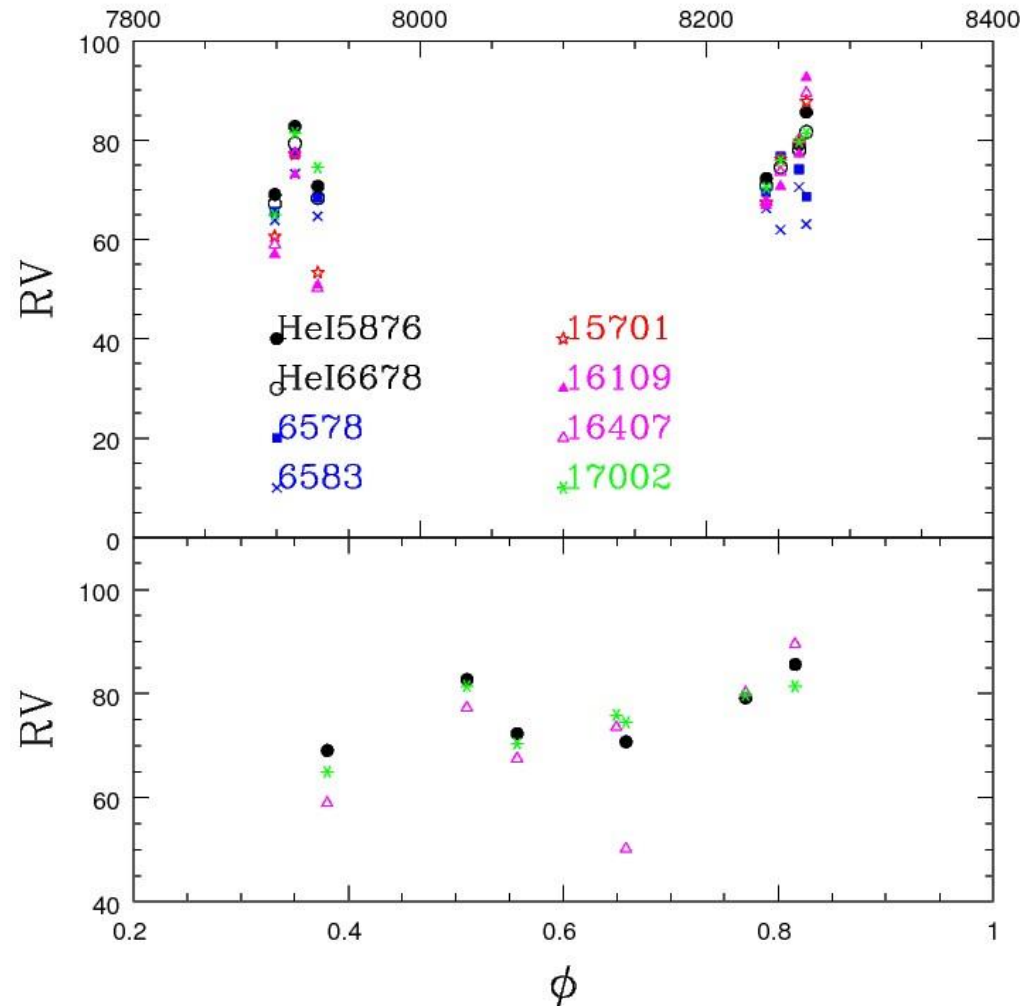
# CYGNUS OB2 12

More data needed !

- Optical/IR spectroscopy (with G. Rauw, S. Czesla, L. Mahy)



HJD - 2450000.



# CYGNUS OB2 12

TBD

- Orbital solution & opt. LC fitting  $\Rightarrow$  orbital parameters
- Interpretation of X-rays, H $\alpha$  in terms of CW
- Disentangling ?
- Tomography ?



# CYGNUS OB2 5

- Inner binary : O6.5I+Ofpe, P=6.6d, 32+10 Msol  
in contact *(Linder et al. 2009)*
- Optical companion early BIV @0.9” *(Contreras et al. 1997)*  
(P~thousands of yrs around binary)
- Bright ( $\log(L_x/L_{bol})=-6.4$ ) and variable in X-rays  
*(Cazorla et al. 2014)*
- Pdot : mass-loss ? *(Linder et al. 2009, Laur et al. 2015)*  
reflex motion ? *(maybe Cazorla et al. 2014, no Yasarsoy & Yakut 2014)*

# CYGNUS OB2 5

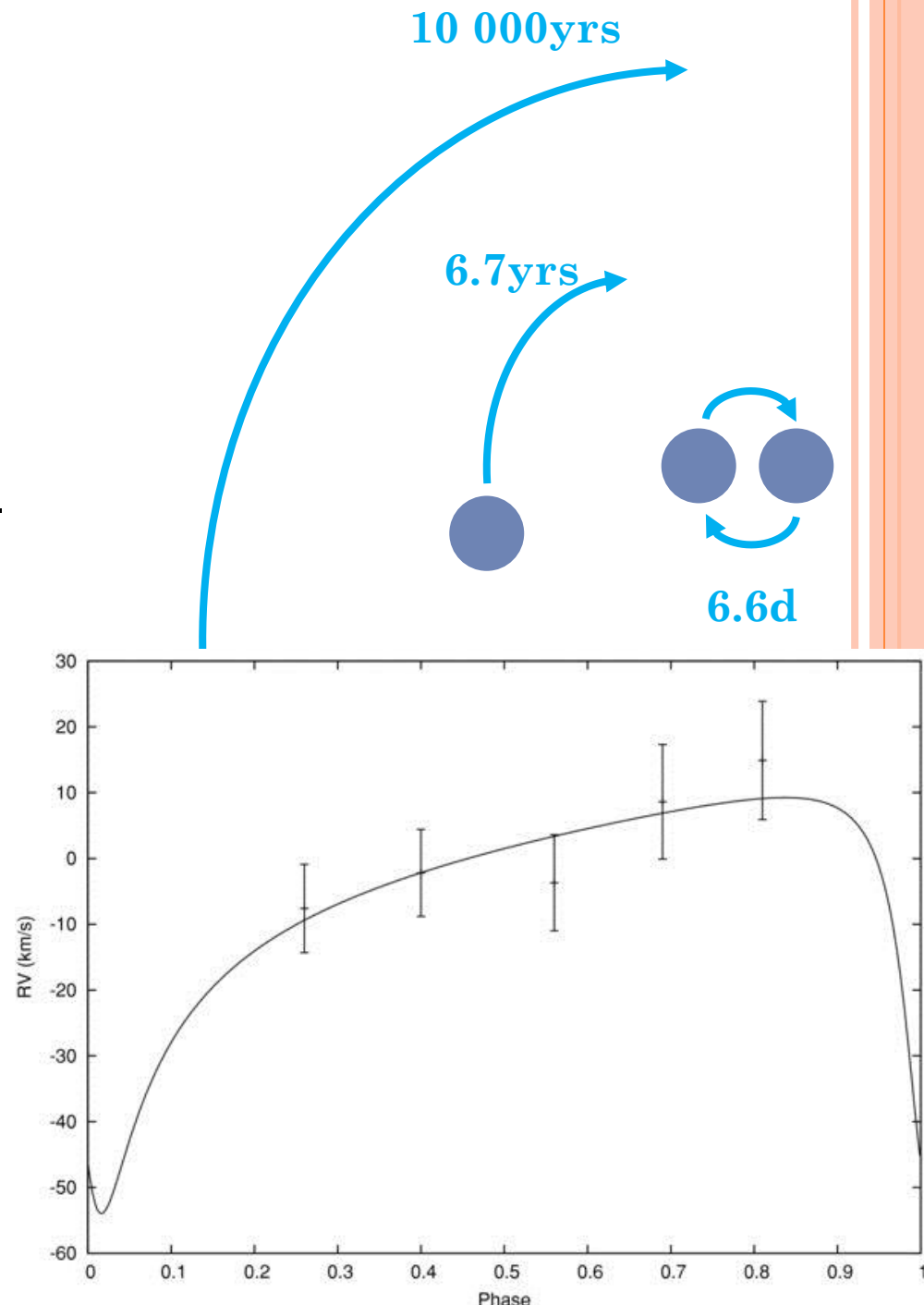
## Radio emissionS

(Kennedy et al. 2010, Ortiz-Leon et al. 2011, Dzib et al. 2013)

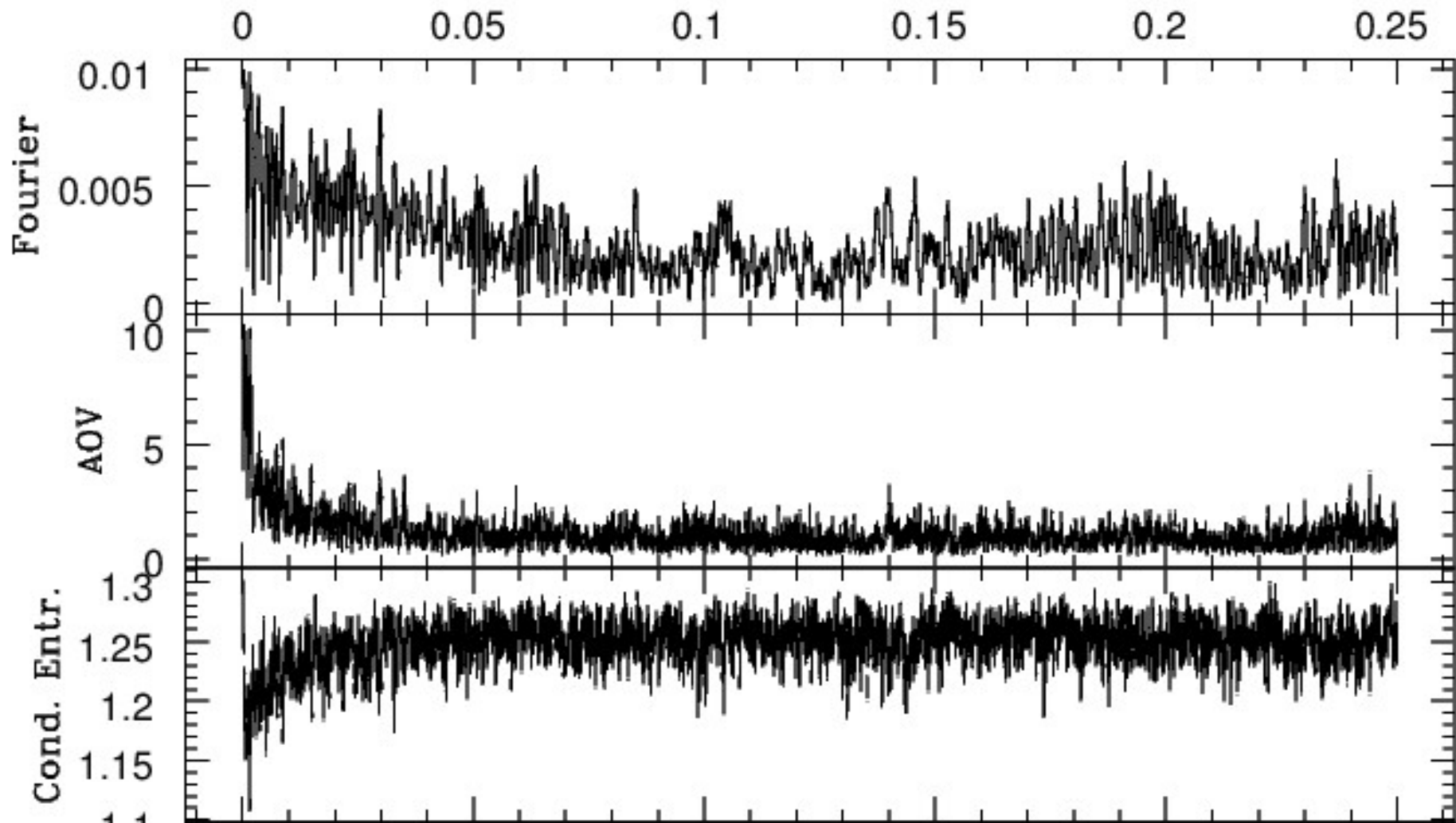
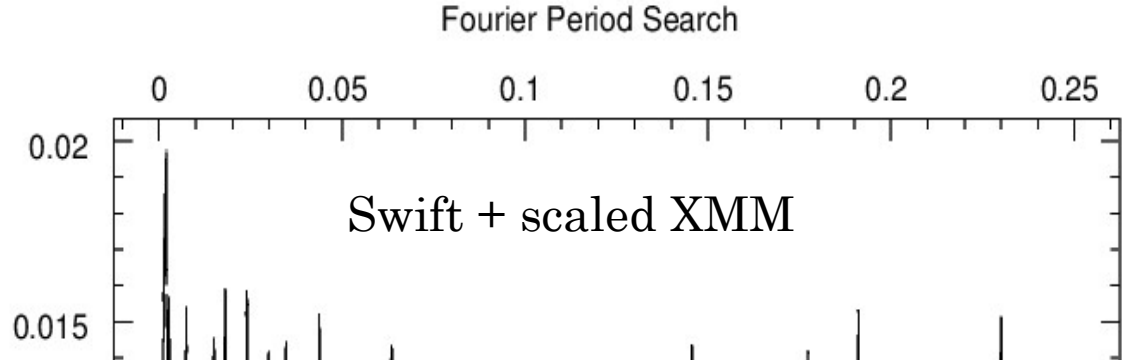
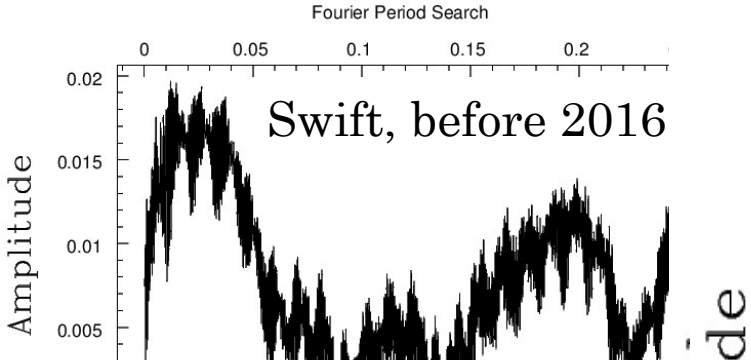
- Close to the B, cst but non-thermal = a CW between the B and the O+O binary
- @ binary, varying with  $P=6.7\text{yr}$ , thermal @ min less so @ max : due to a CW with a 4th OB star...

Hints in RVs?

Lots of uncertainties !





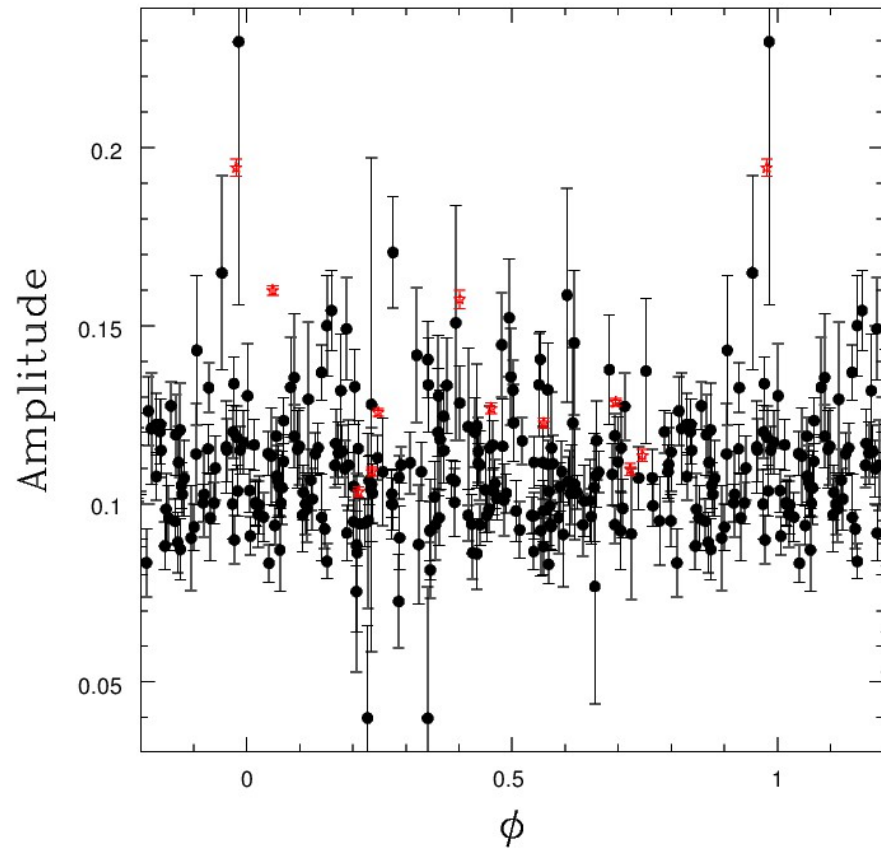


# CYGNUS OB2 5

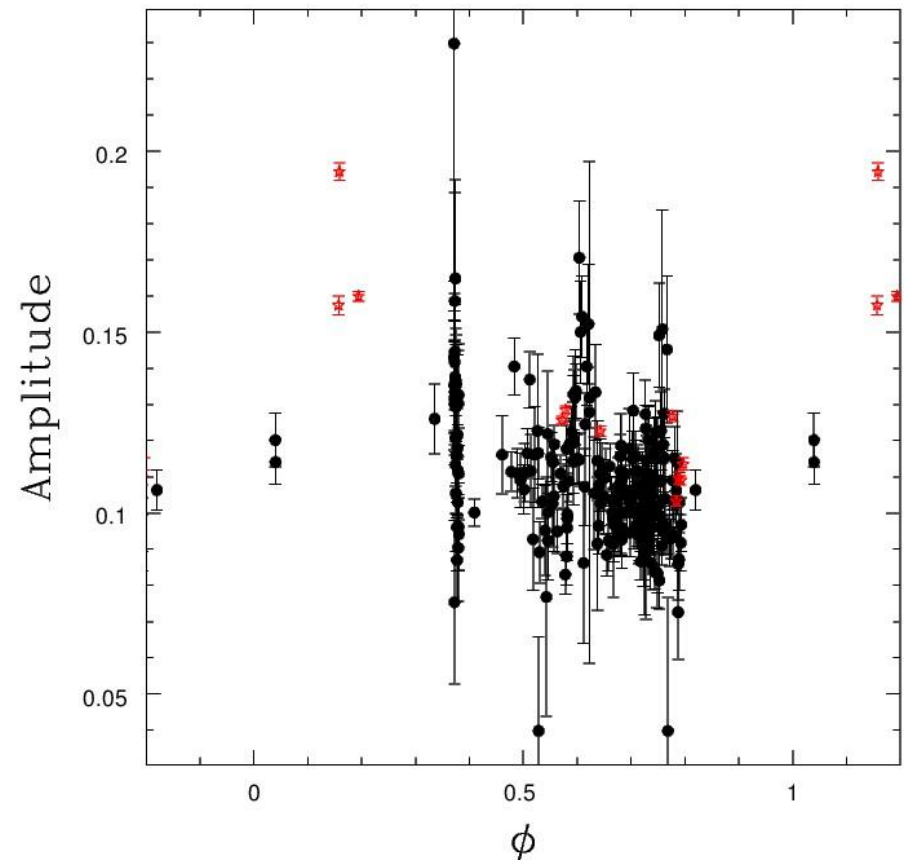
## ○ Folding :

- With 6.6d, 6.7yrs  $\Rightarrow$  NOTHING...

P=6.6d



P=6.7yr



# CYGNUS OB2 5

- Optical data :  
multi-year monitoring with Aurélie & TIGRE
  - First data : no shift *(Cazorla et al. 2014)*
  - Rest : TBD
- What's going on in this Big F... ~~R~~System ?



# CYGNUS OB2 5

**IF YOU HAVE ANY QUESTION,  
DON'T ASK ME...**

