eta Carinae: the nature of the 5.5-yr cycle

A. Damineli + 25 collaborators

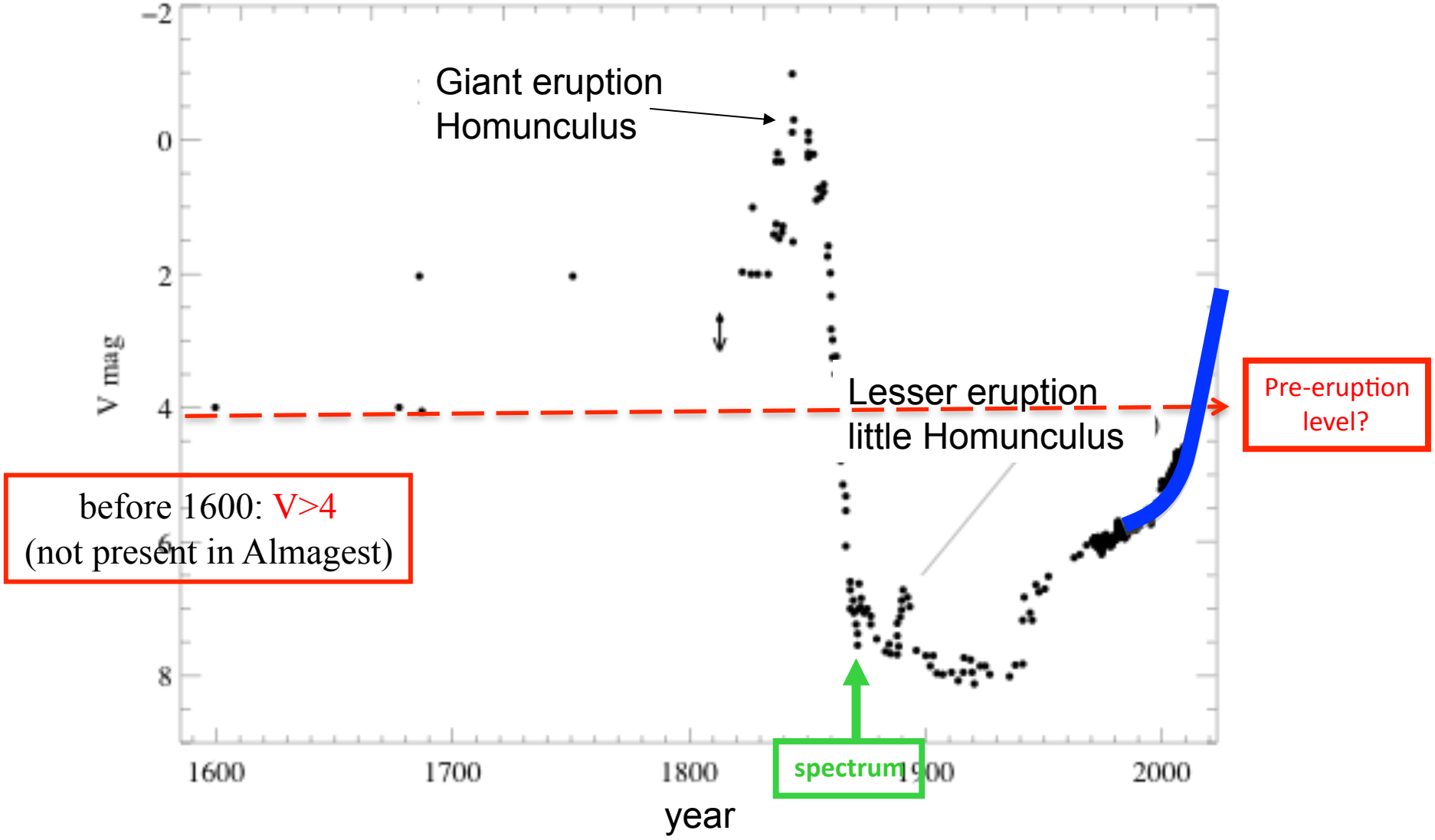
Why η Carinae is important?

Last 10 years => 181 papers
(2nd after the Sun?)

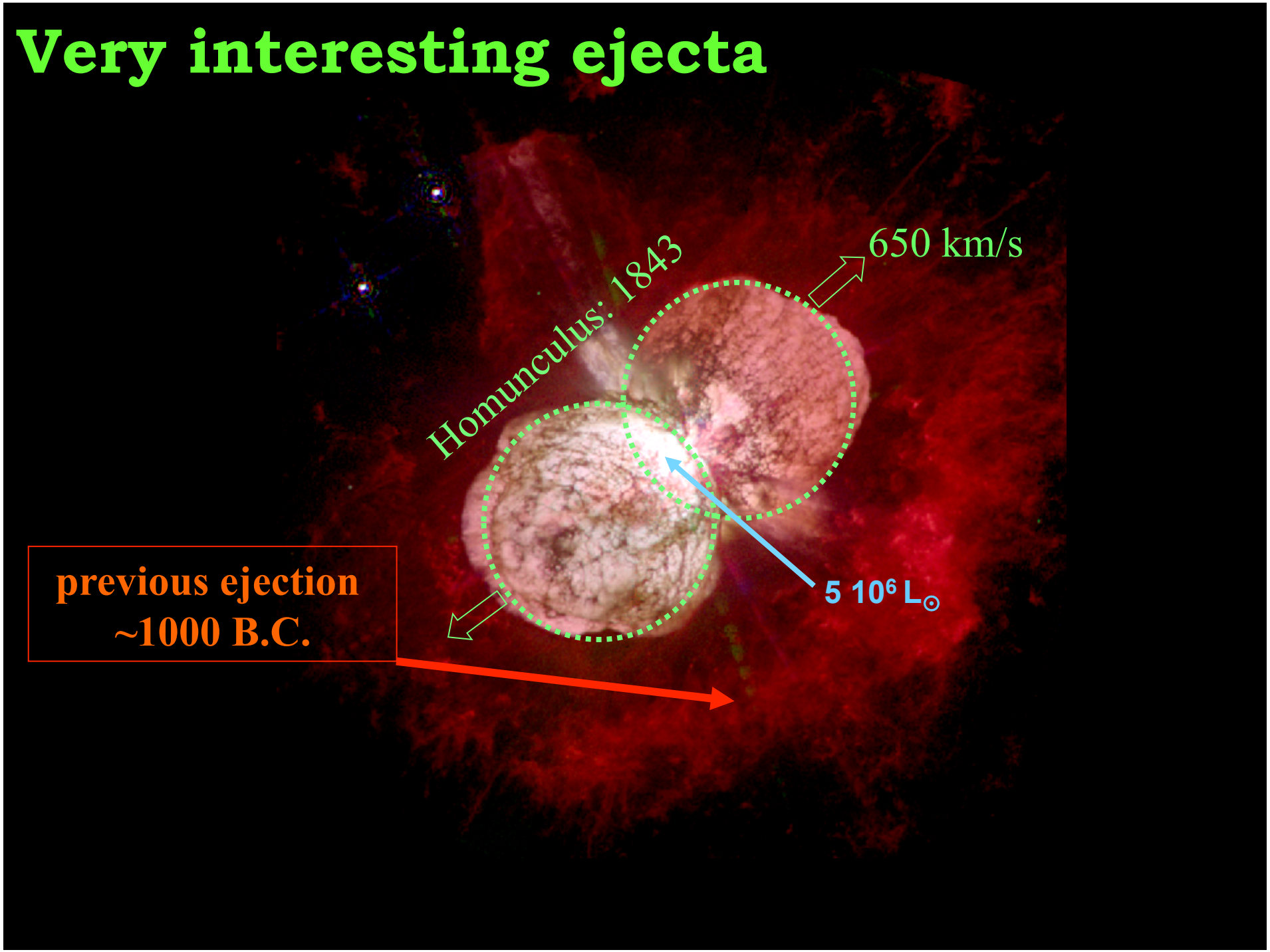
- **Representative of the very massive (> 100M_{sun}) stars**
- **Hypernova/GRB progenitor?**

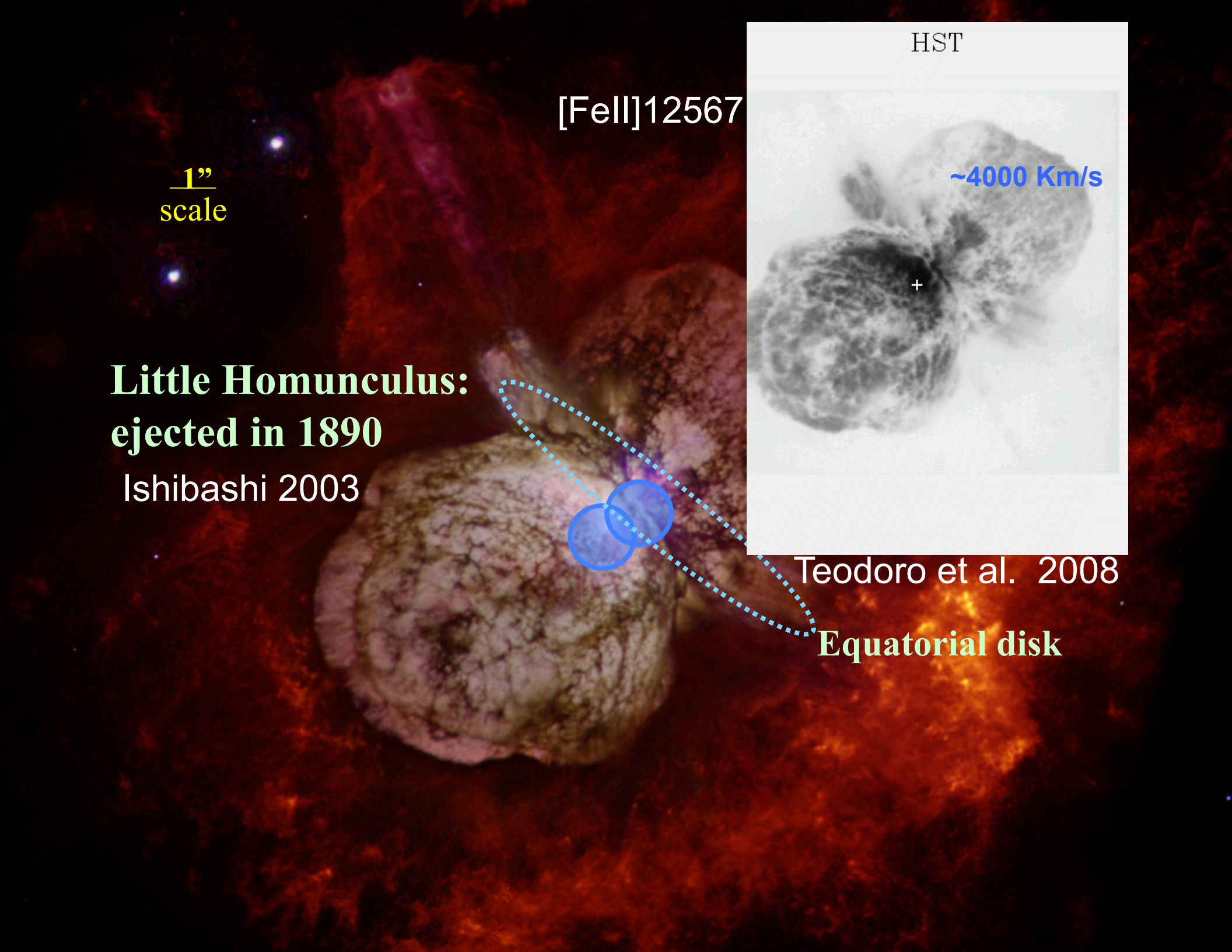
- **Very well known distance, luminosity, age, chemical composition**
- **Bright = easy to observe**

Long photometric (>400yr) and spectroscopic (140 yr) record



Very interesting ejecta




HST
[FeII]12567
~4000 Km/s
1”
scale
Little Homunculus:
ejected in 1890
Ishibashi 2003
Teodoro et al. 2008
Equatorial disk

Homunculus => 12 $M_\odot$

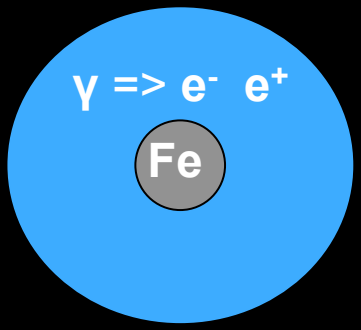
$E_k = 10^{50}$ erg

Not a SN impostor: must have been a true SN!

Smith, N. 2008

Death of a very massive star

$100\text{-}140M_{\odot}$



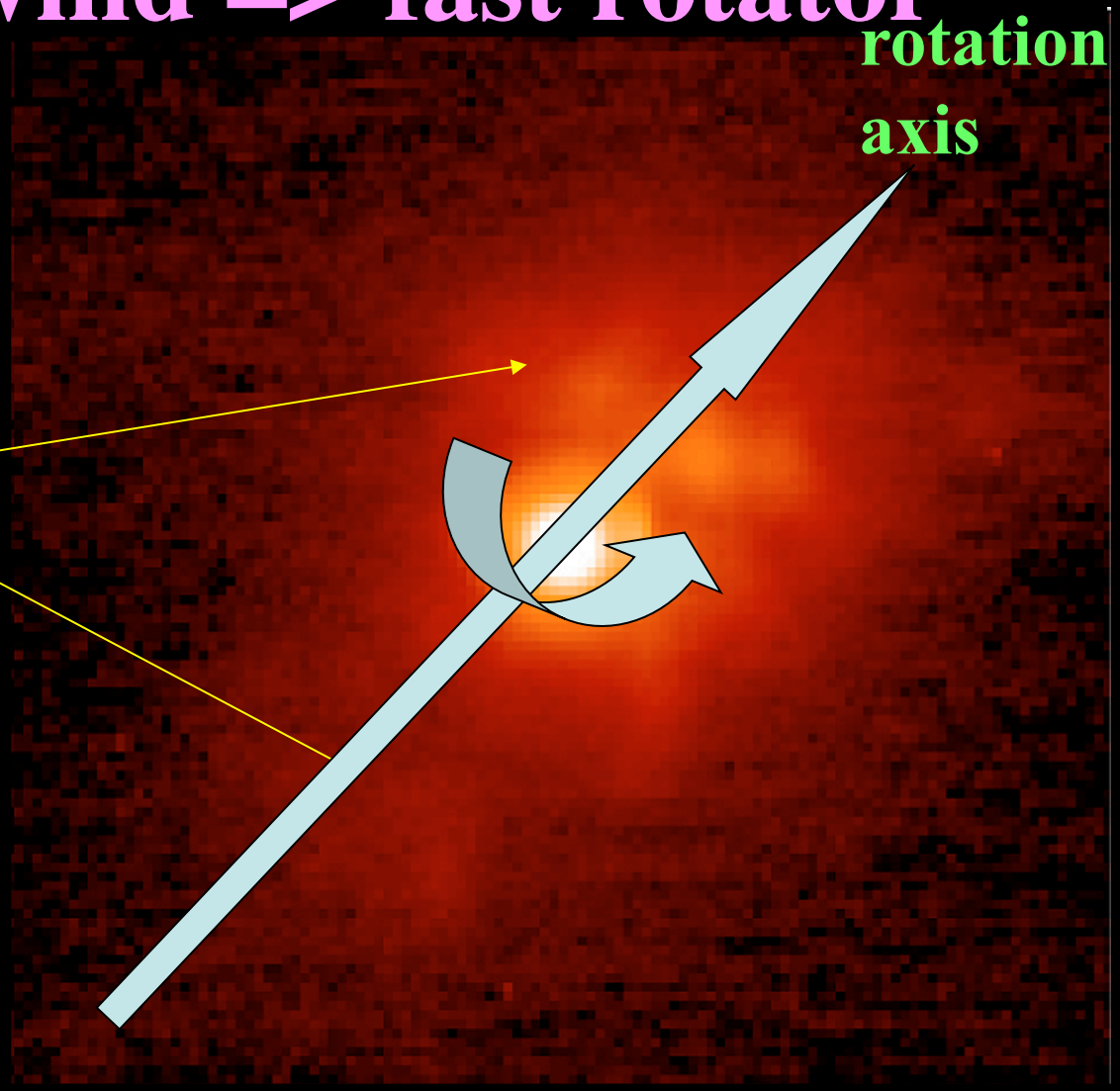
pair instability → iron-core collapse → black hole


Eta Car seems to be going
already through instability events !
Credit: N. Smith


Davidson et al. 1986
Nitrogen >> Solar
Oxigen << Solar
CNO cicled material,
but still burning H
t_{fuel} <5 10^5 years

Stellar wind => fast rotator

VLTI 2.2μm
res~0.005”



$10^{-3} M_{\odot}$/year

van Boekel et al. 2003

STIS/HST 0.1":

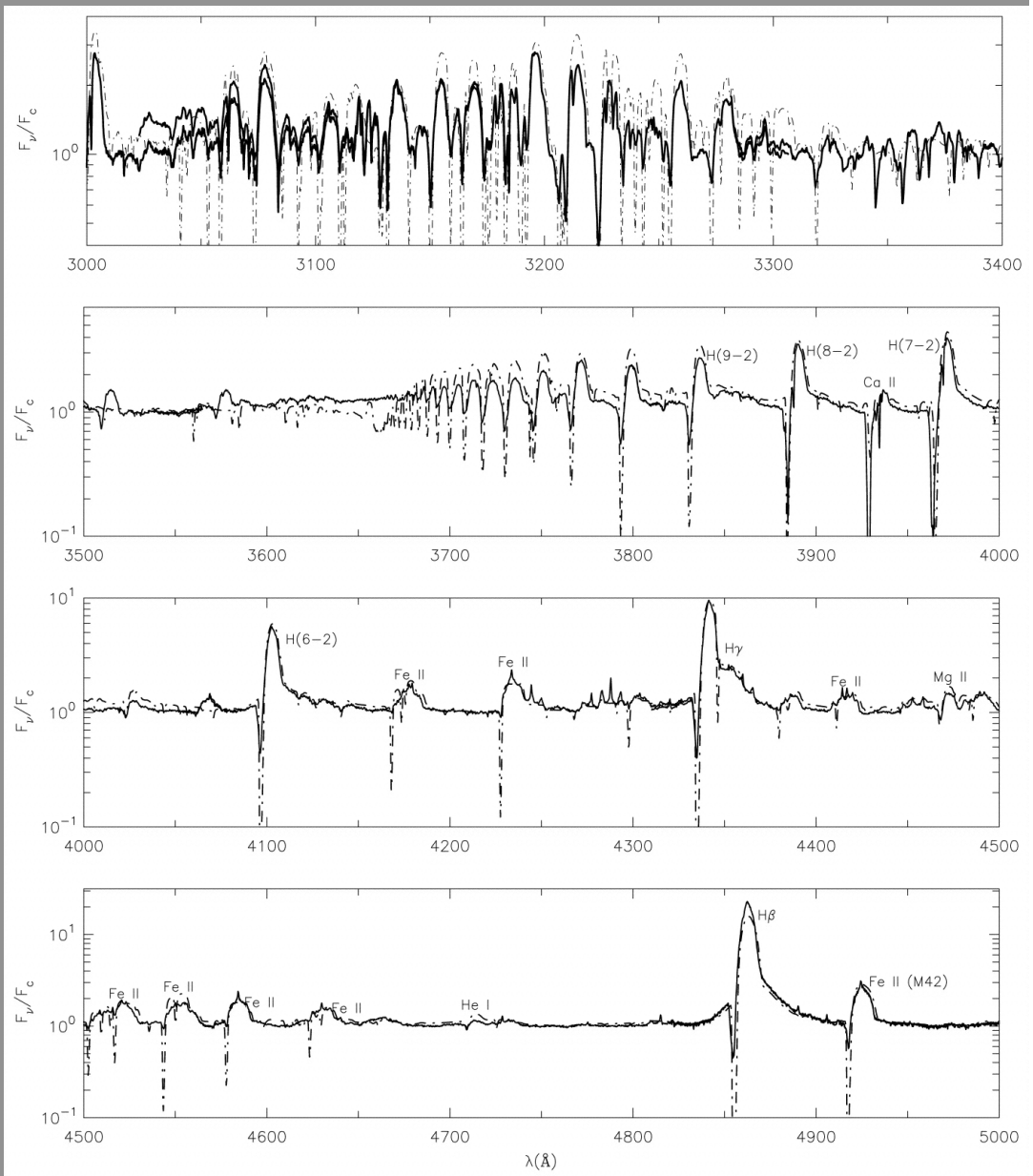
T_{eff} <20 000 K

Absence of HeII

$\dot{M} = 10^{-3}\ M_{\odot}\ yr^{-1}$

MASS?

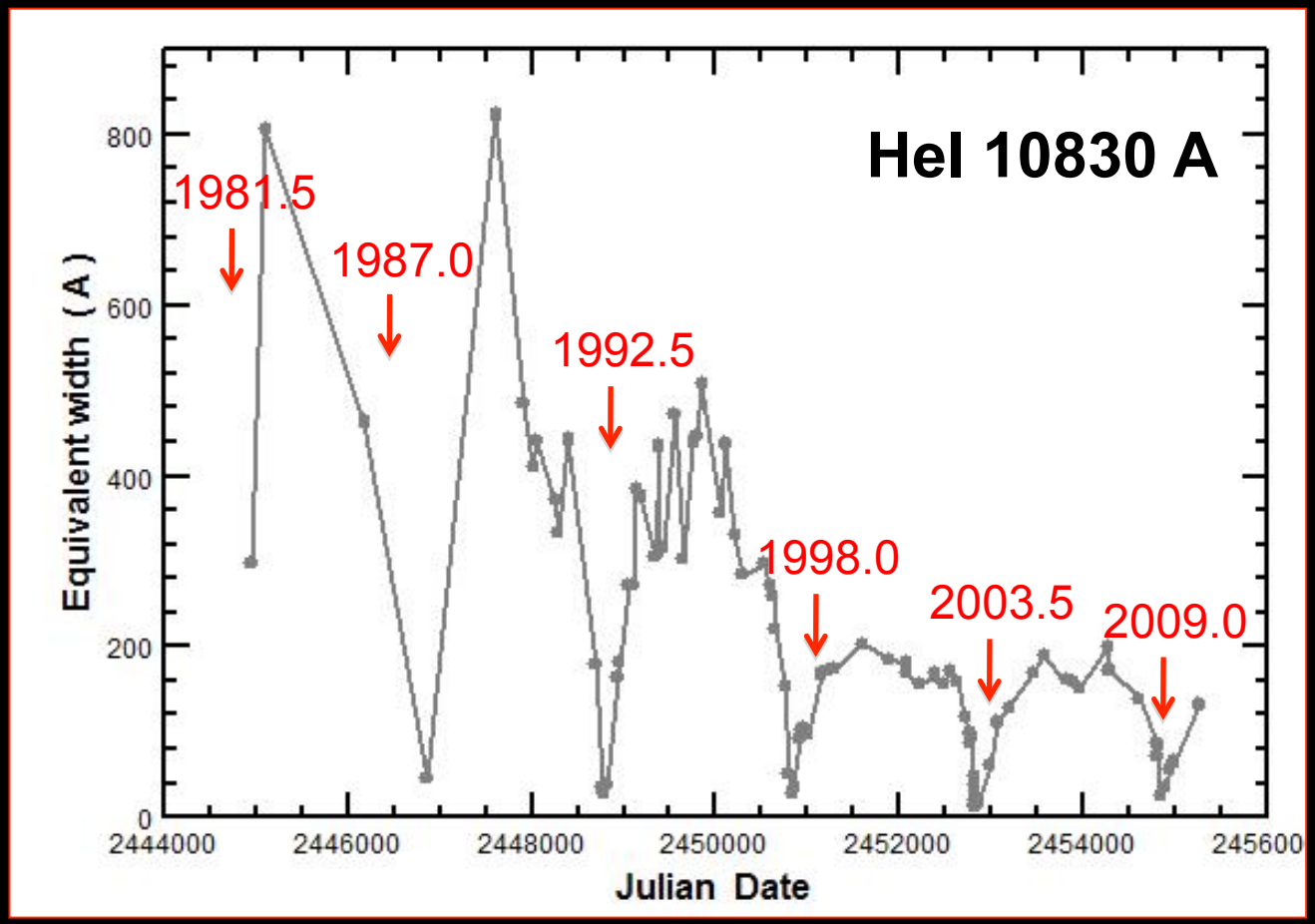
Hillier et al. 2001



Eta Carinae: a binary system Damineli et al 1996,7

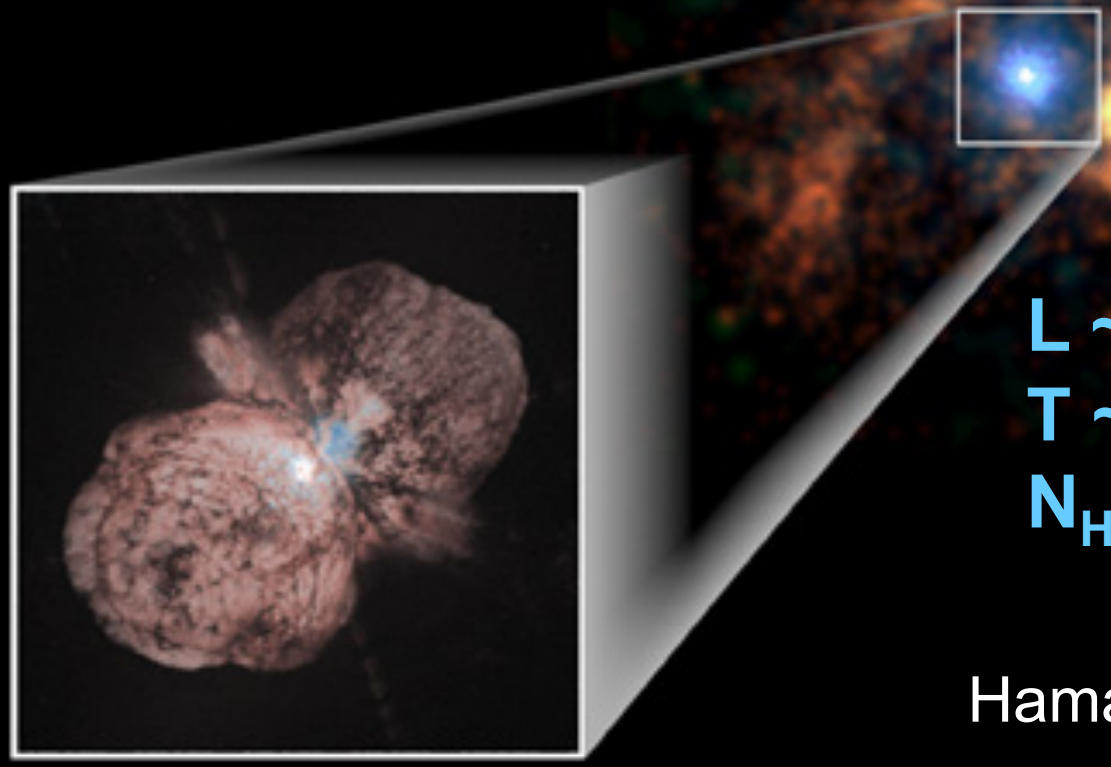
5.538-yr cycle of low excitation events => periastron

2ndary star => high excitation features INDIRECT



X-rays - Colliding Wind Binary (CWB)

Reflects mostly the 2ndary's star wind



$L \sim 10^{34}$ erg/s
$T \sim 10^{8}$ K
$N_H \sim 10^{23}$ cm^{-2}

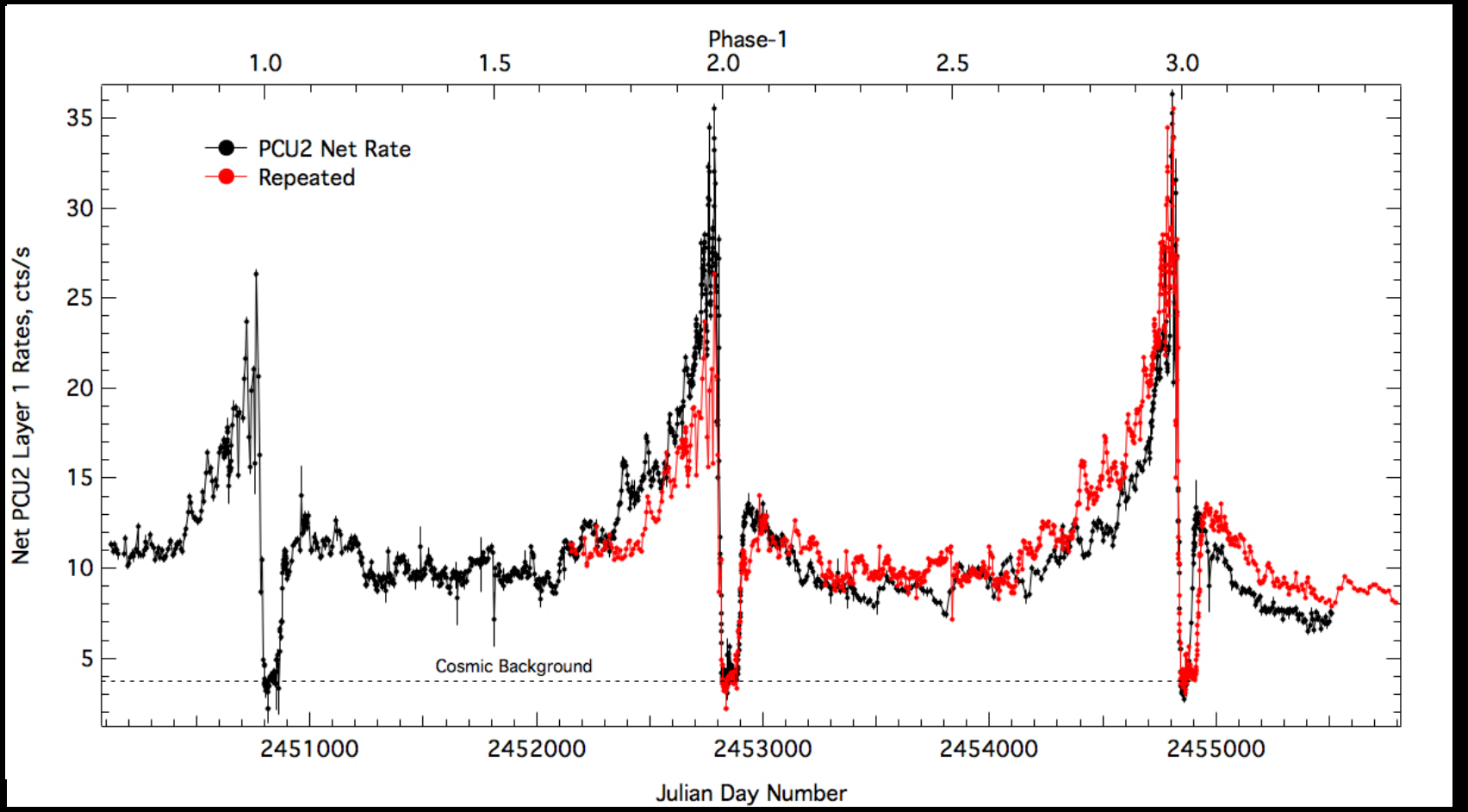
Hamaguchi et al. 2007

10 arcsec

X-ray light curve

Corcoran et al. 2010

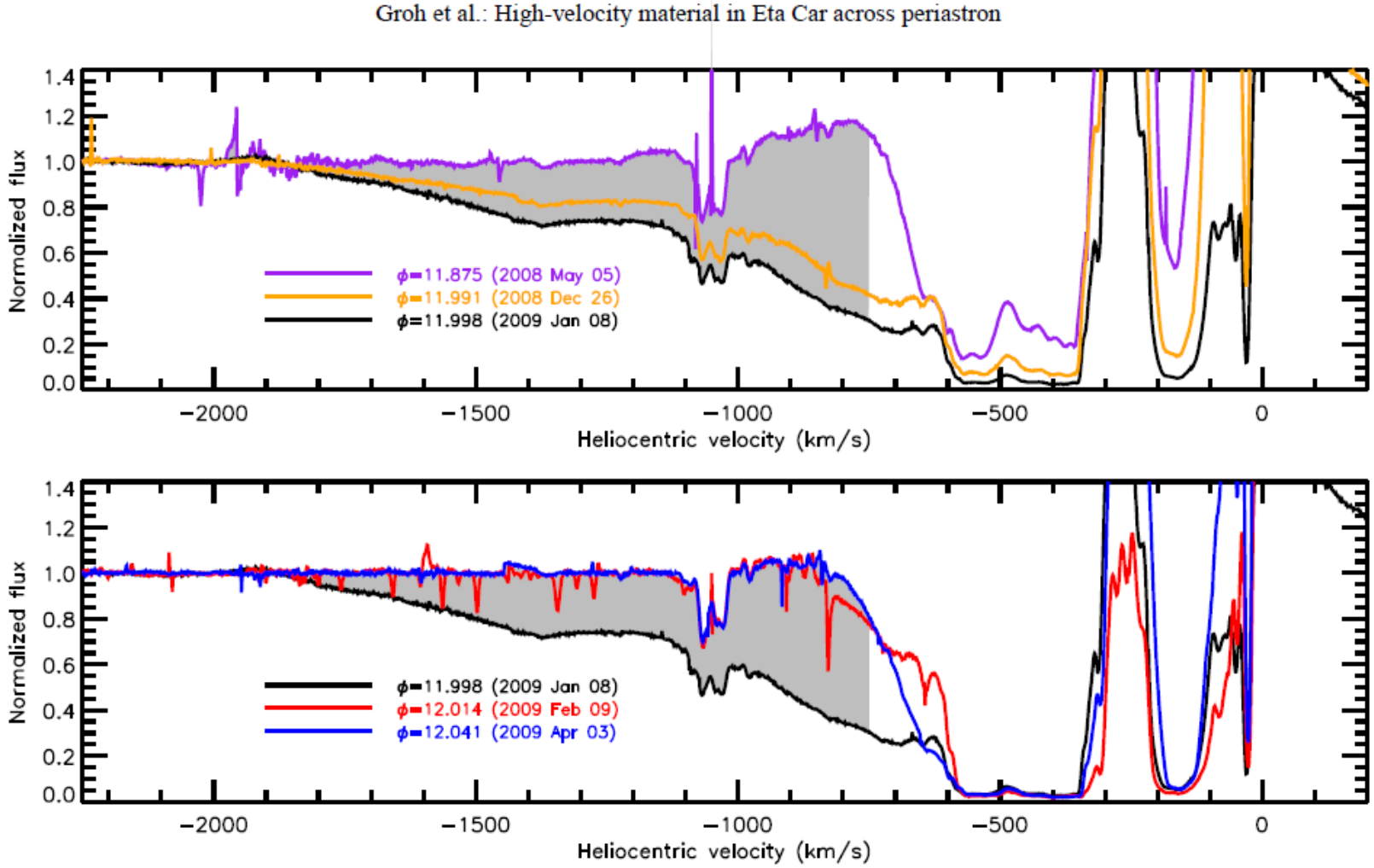
1998.0 2003.5 2009.0



Eclipses?

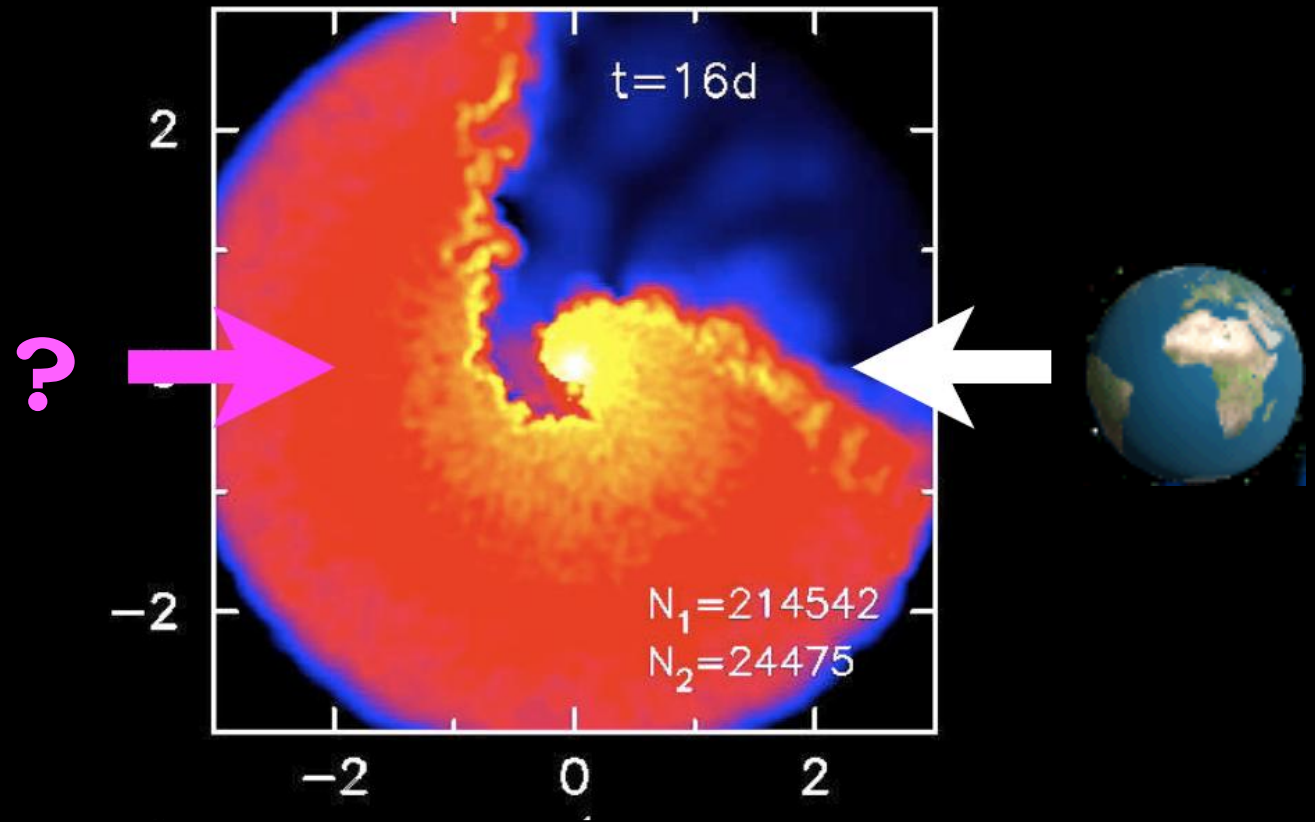
High velocity absorption in the line He I λ10830 observed at VLT+OPD/LNA

Groh et al. 2010



Wind-wind shock 3D model

Groh 2011, Okasaki - 2010

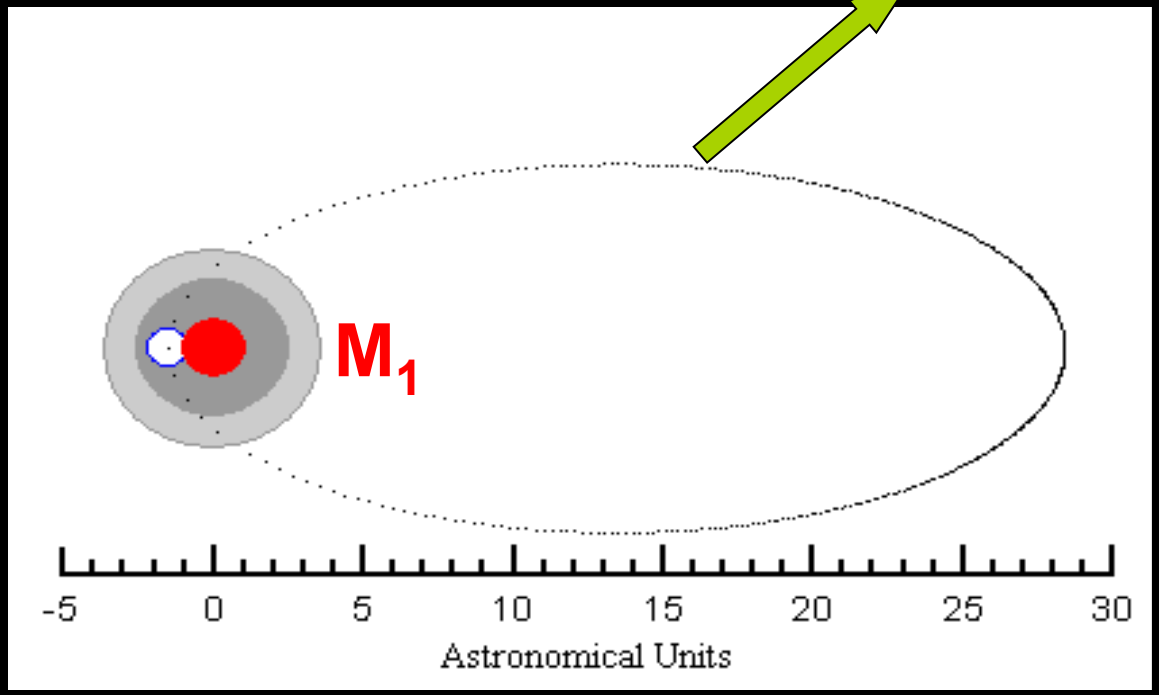


2ndary star behind, at periastron

Eta Carinae: the orbital parameters

$\omega = 240\text{-}270^{o}$

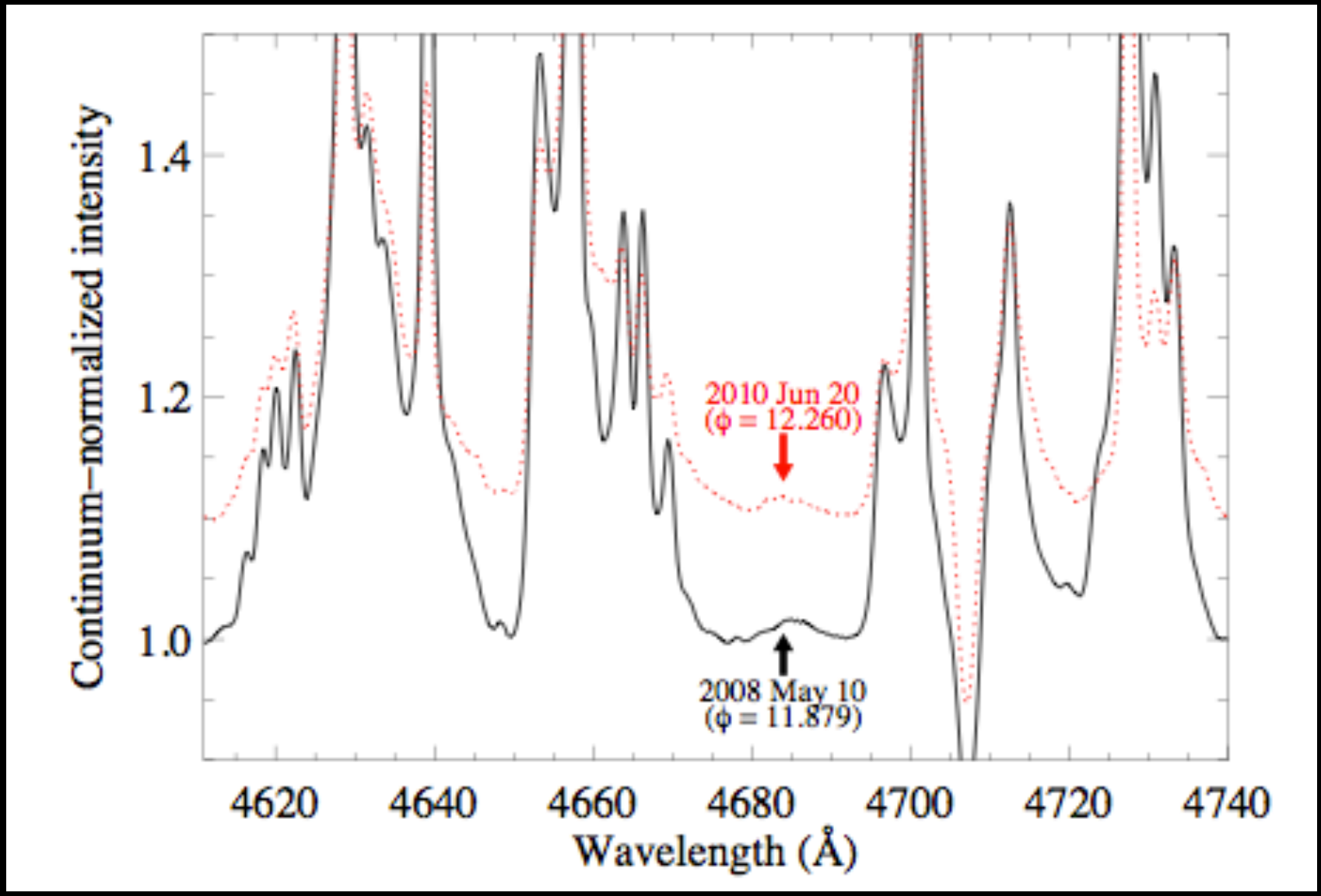
$I = 40\text{-}60^{o}$



- agree with the fact that Weigelt blobs are at our side and we see strong high excitation lines outside periastron

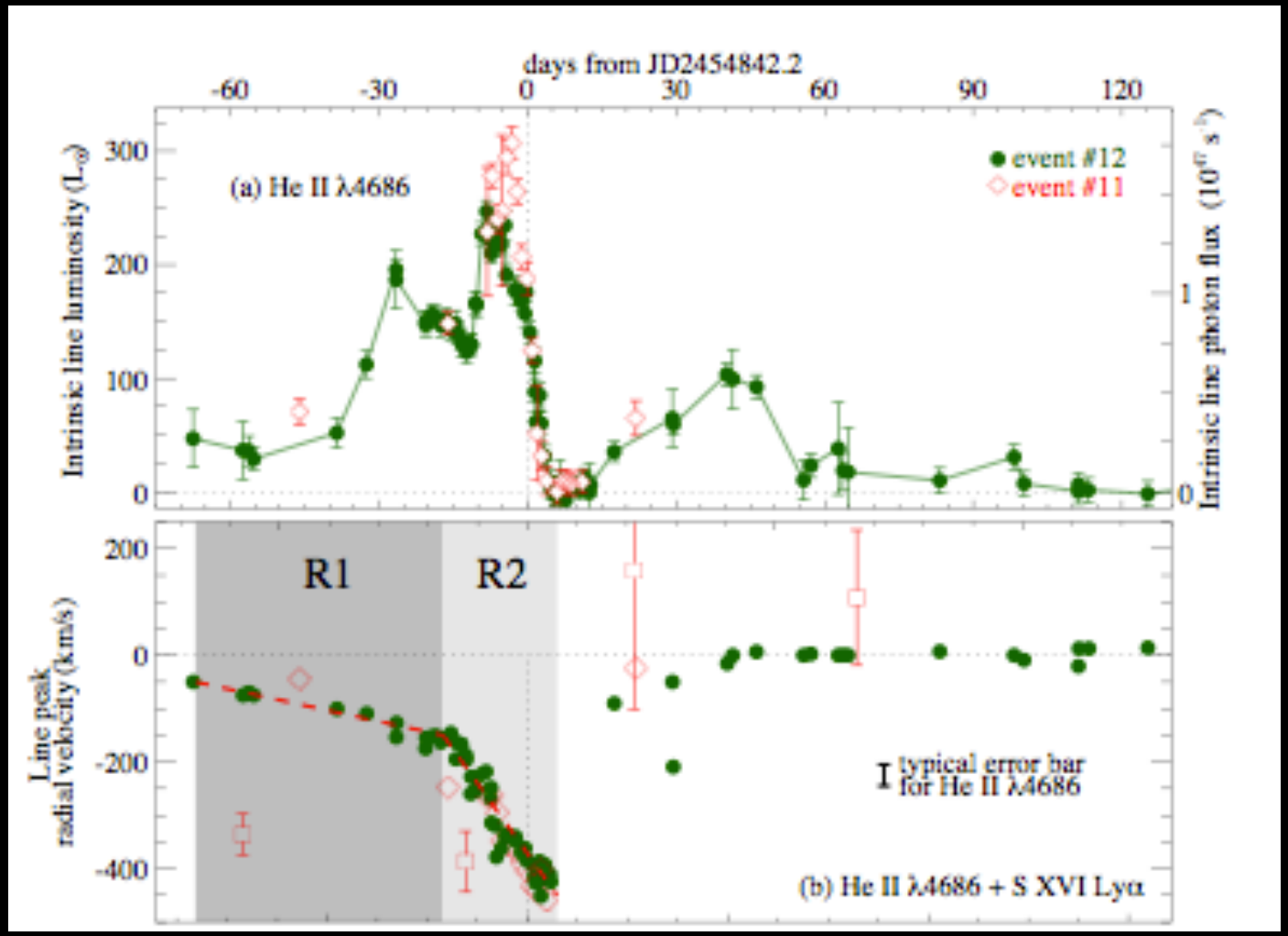
– eclipses by eta Car A => difficult

HeII 4686: a very faint line

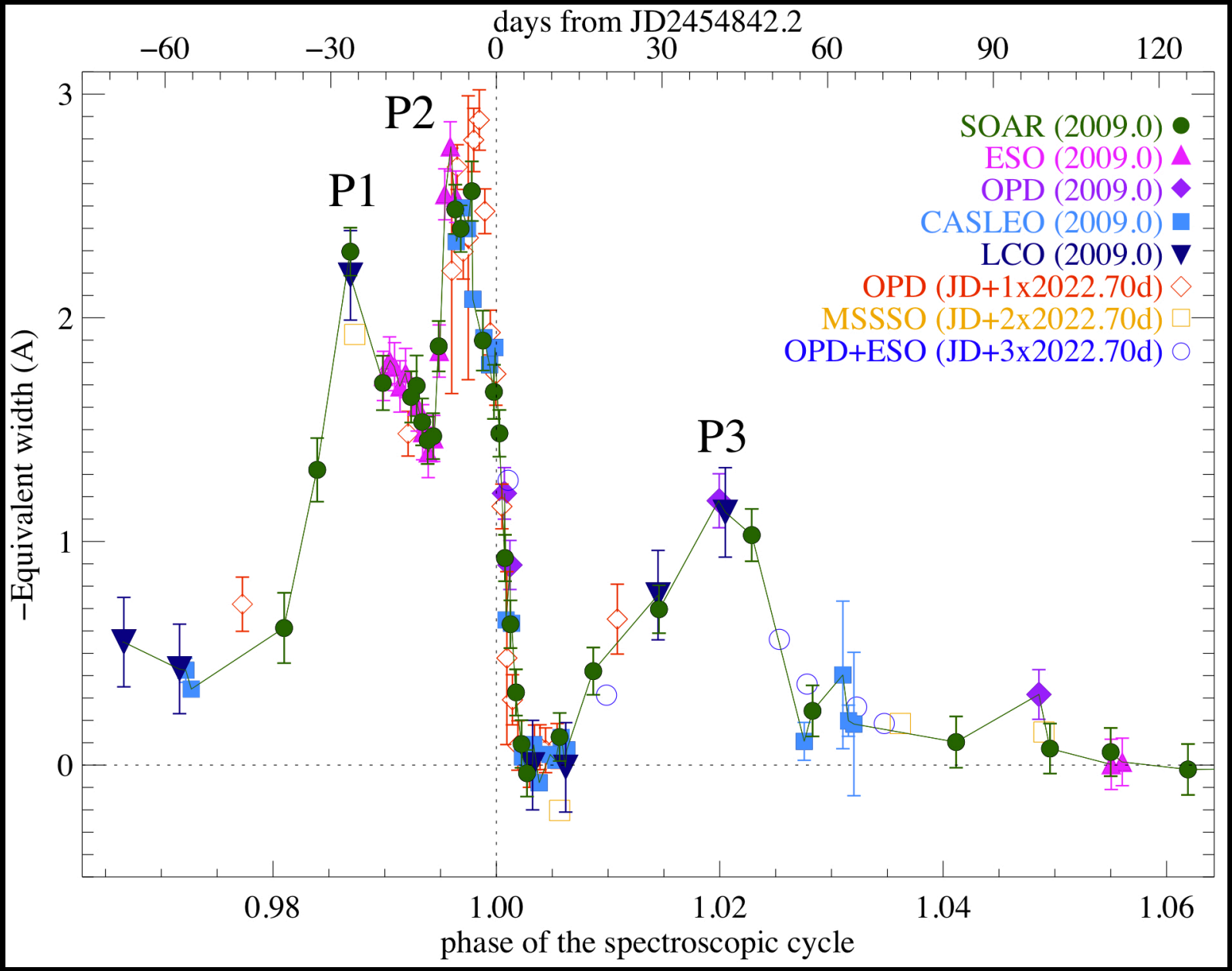


2009.0 event: SOAR/Goodman

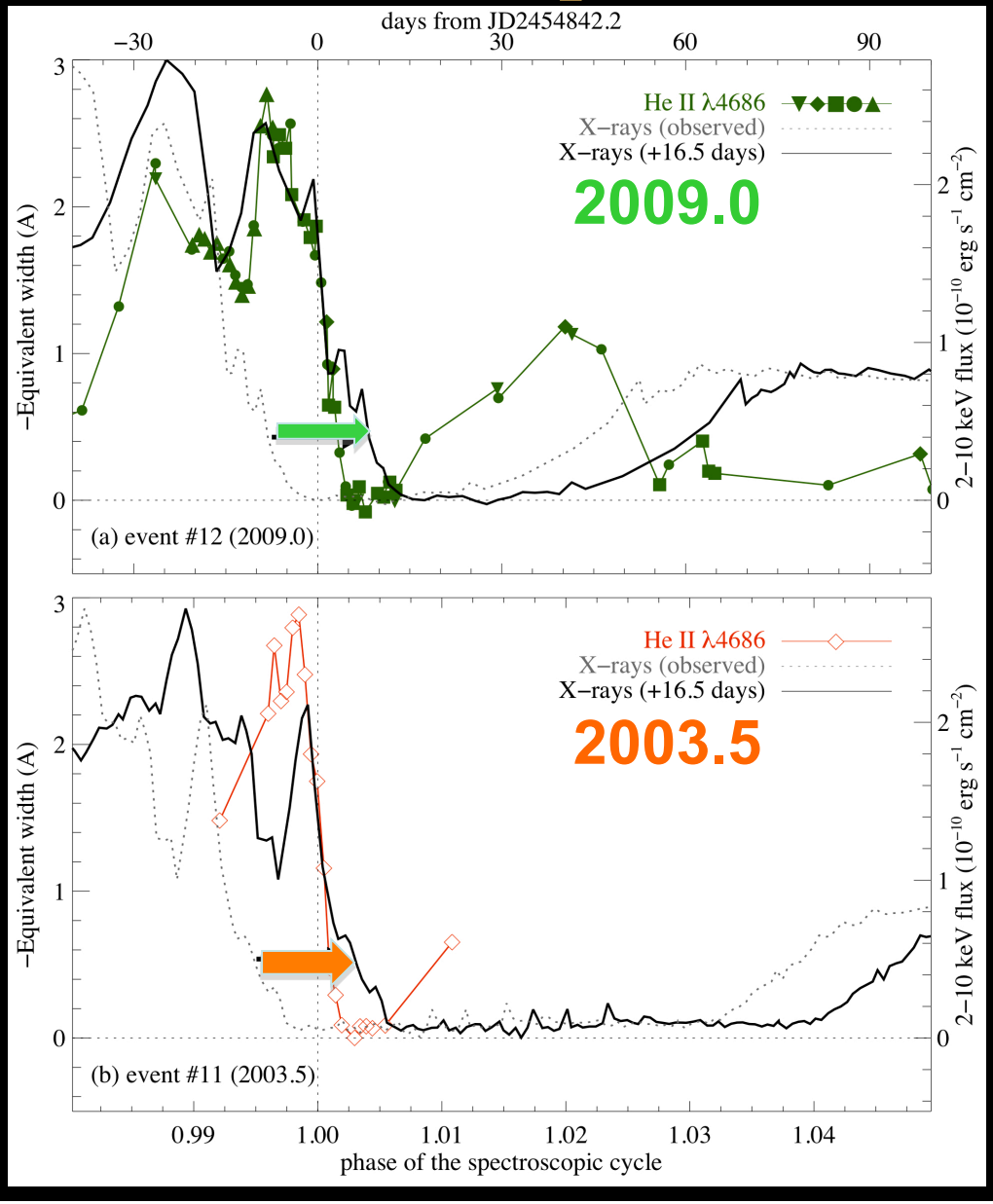
S/N>300 flat stellar continuum



Synergy X competition

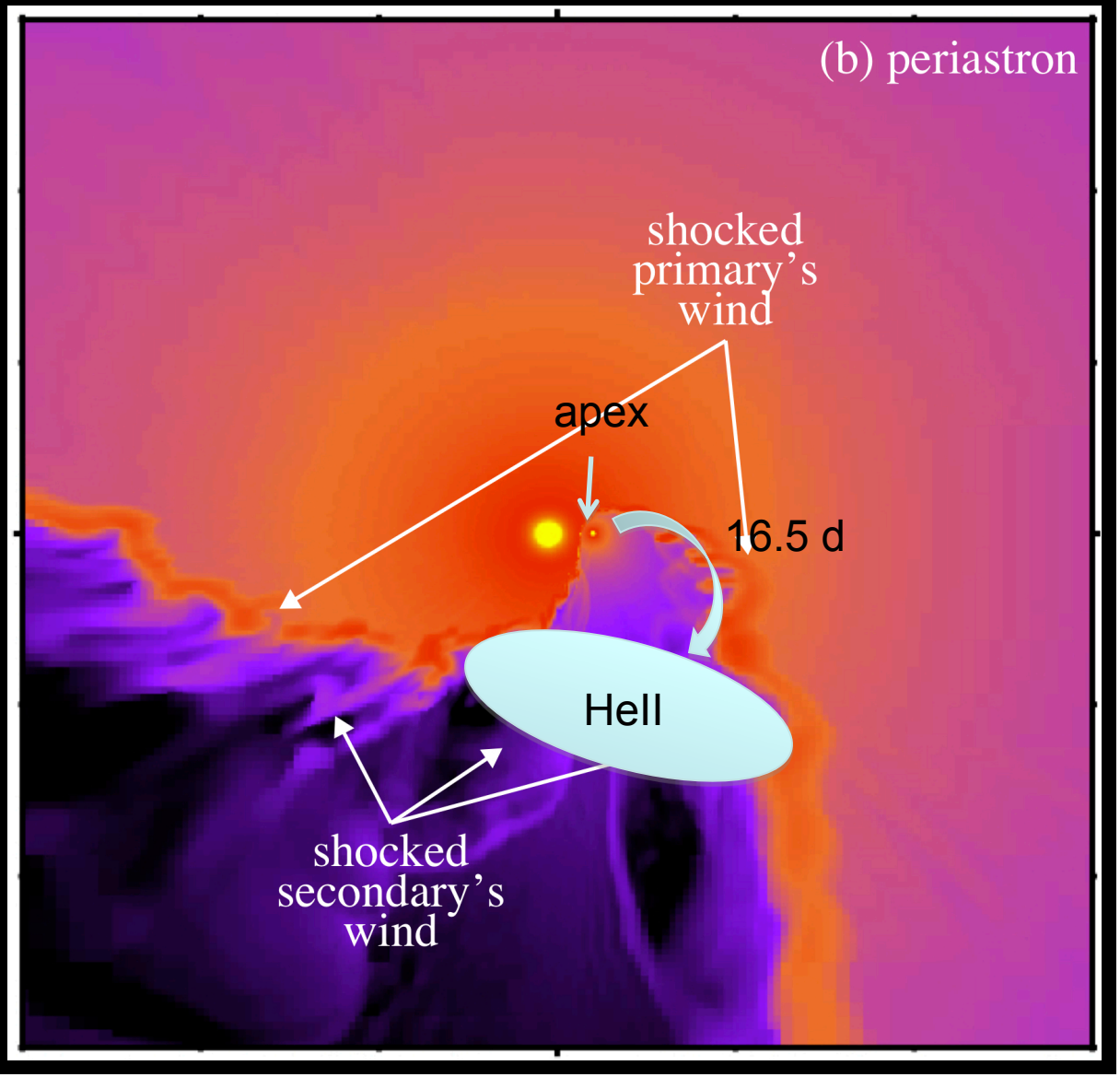


HeII fades 16.5 days after X-rays
5 A.U. downstream from the WWC apex

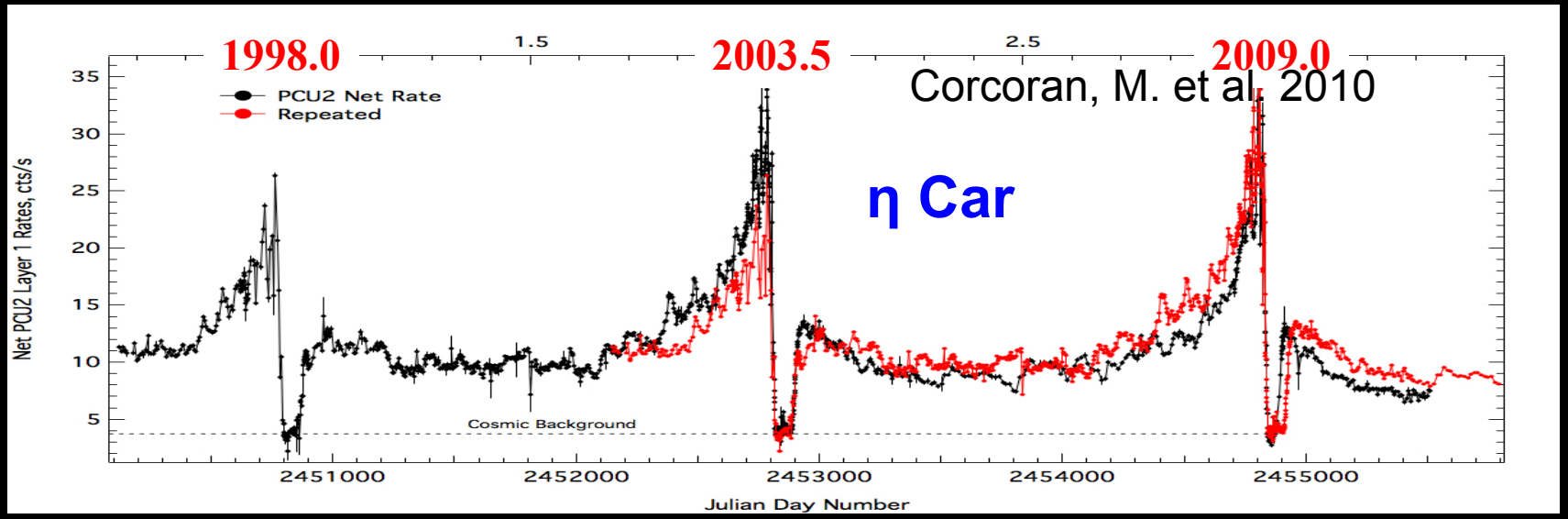


Hell – emitted in the primary's shocked wind

Can't be an eclipse

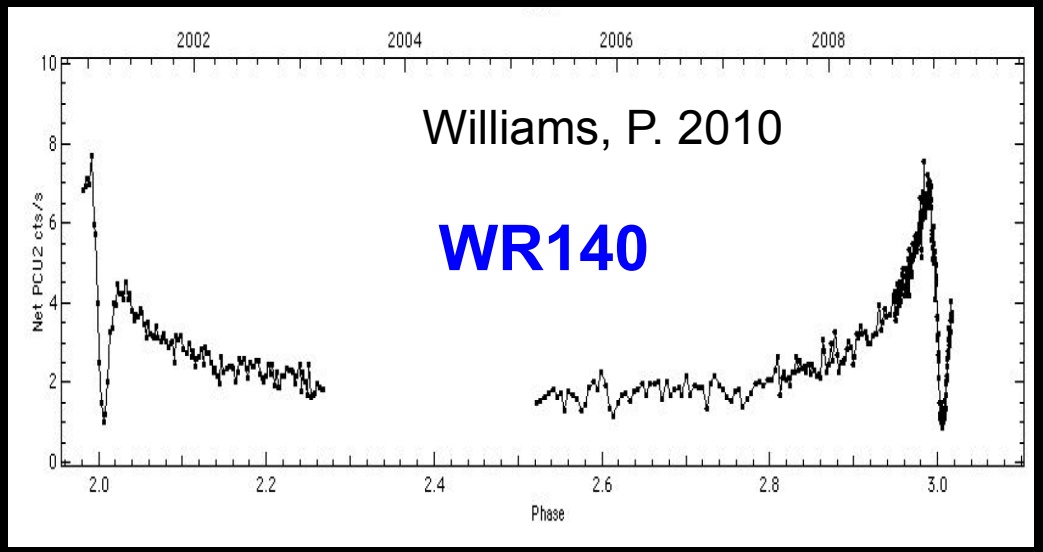


WR140 in X-rays: no (stellar) eclipse too!



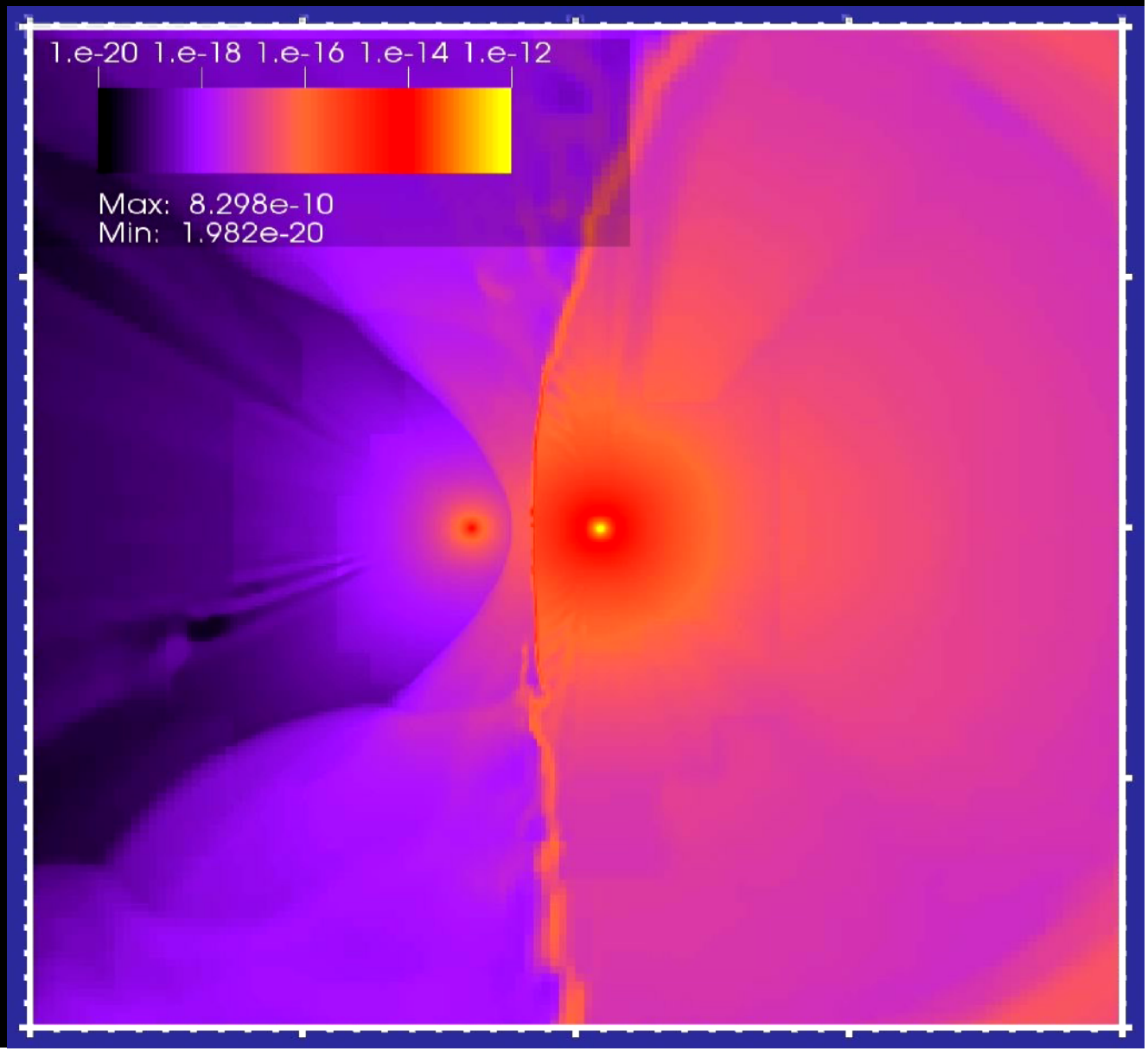
i~ 50°
e=0.9

i~ -30°
close to face-on
e=0.88

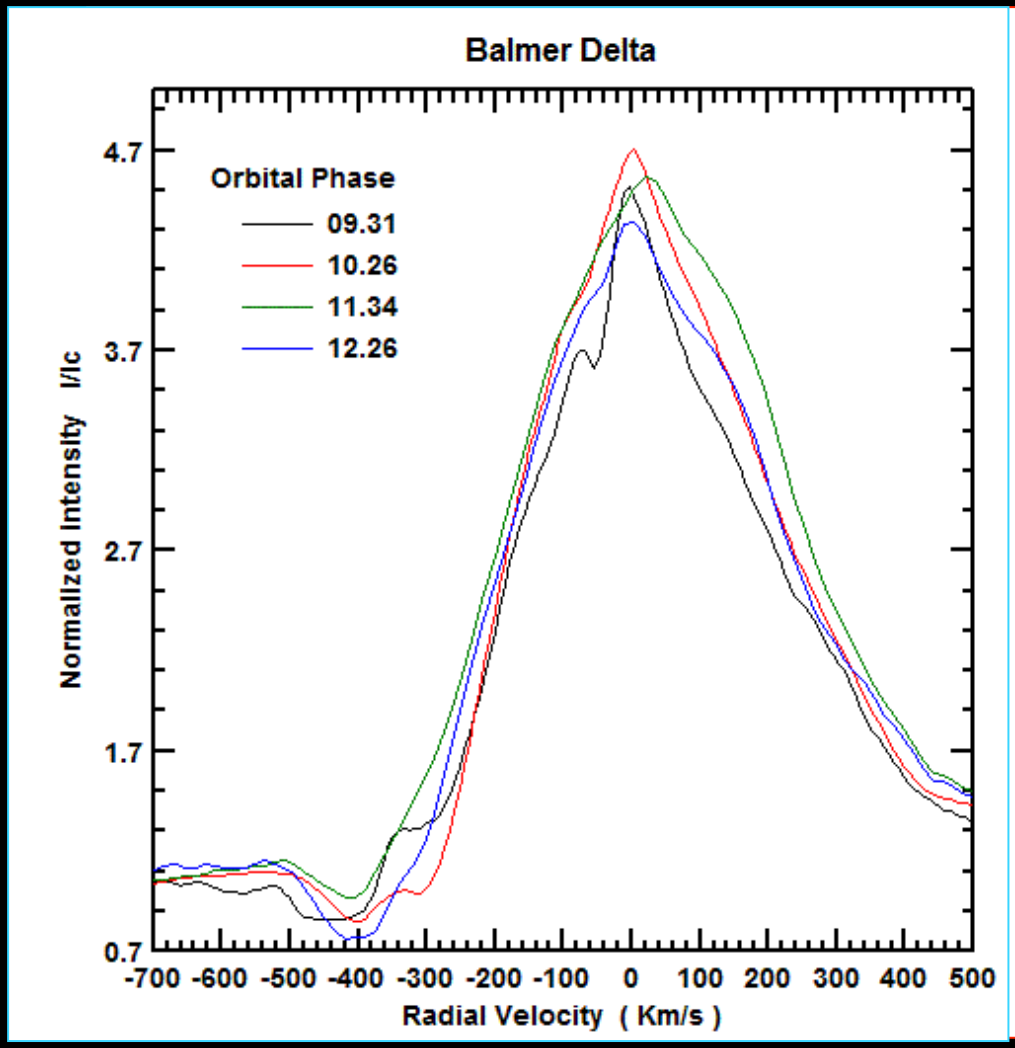


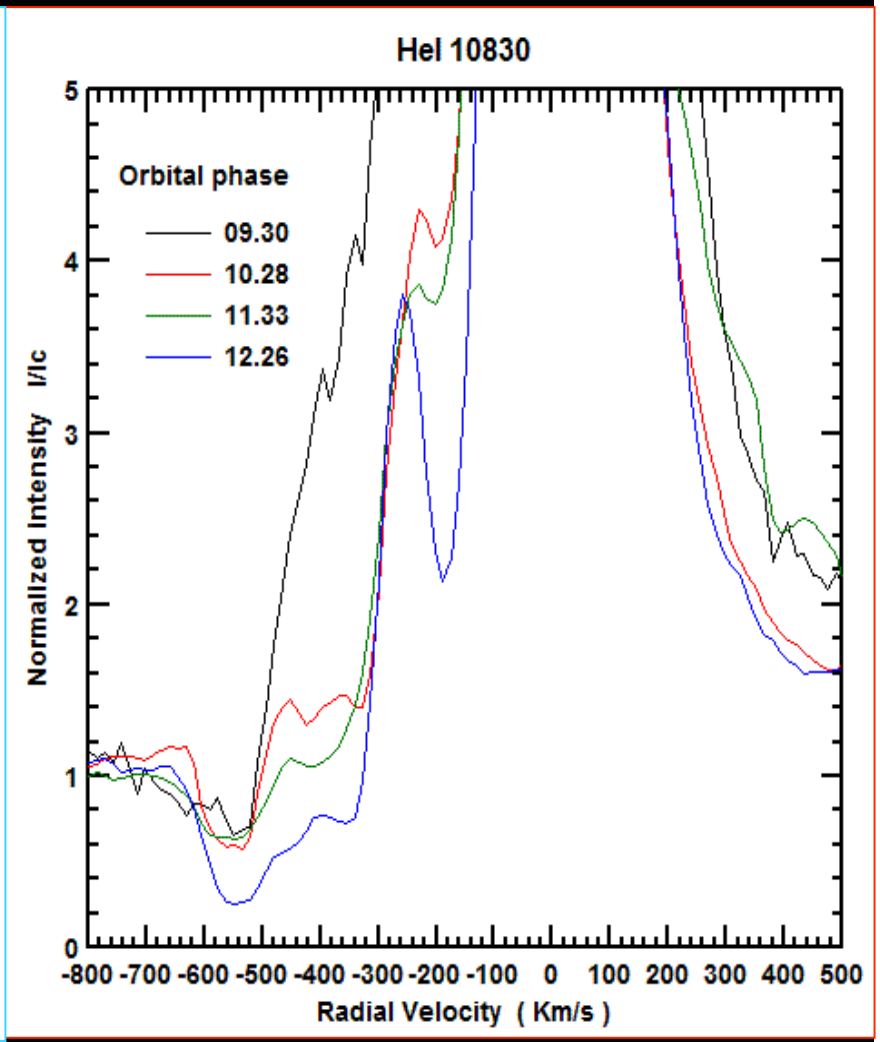
WWC collapse onto the 2ndary
by radiative braking or wind disruption

Parkin et al. 2011



Long term evolution





The primary's wind is not changing...but HeI absorption is!

Next periastron: 2014 Jul 28