HERMES survey of post-AGB stars with disks

Nadya Gorlova
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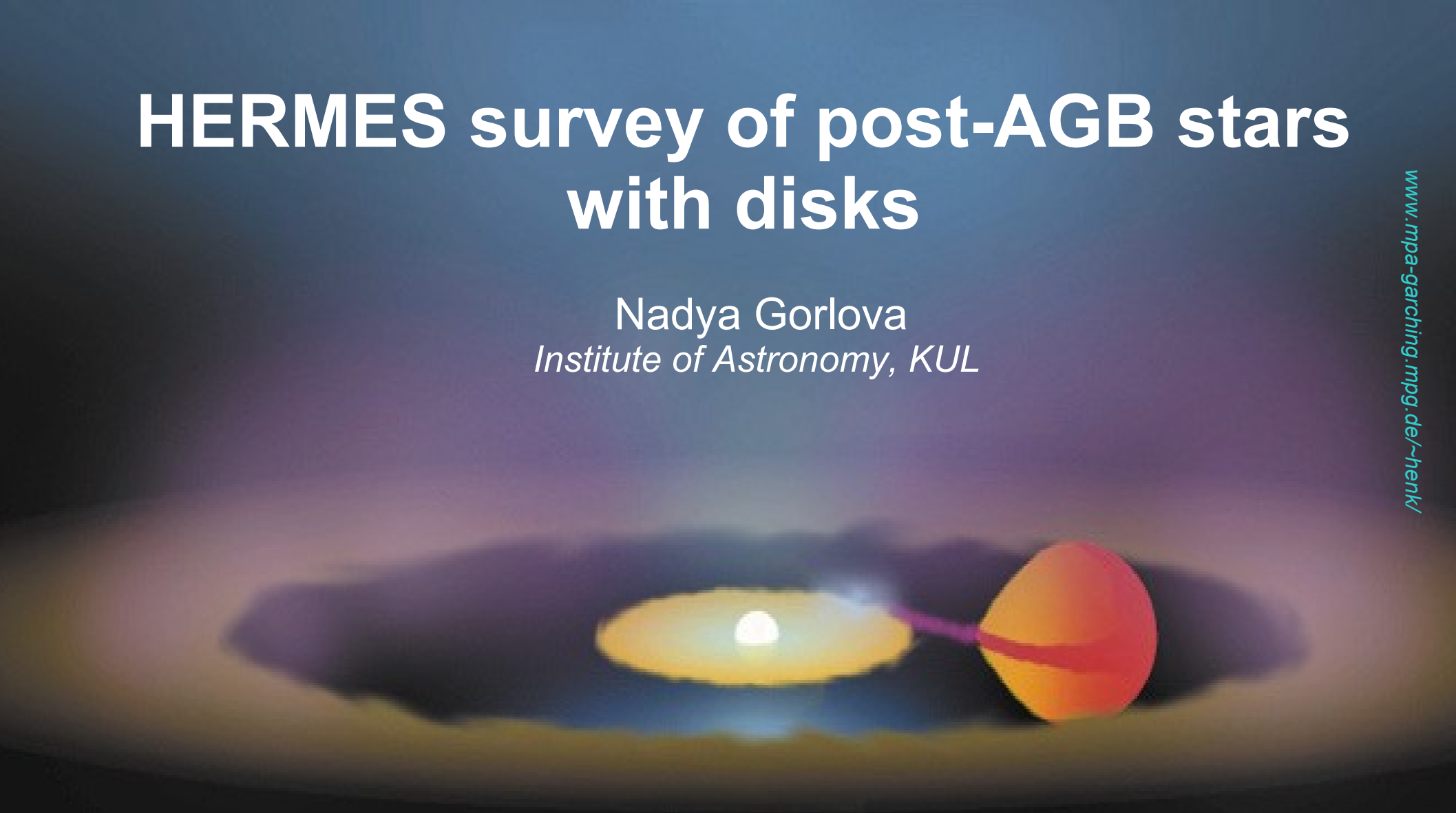
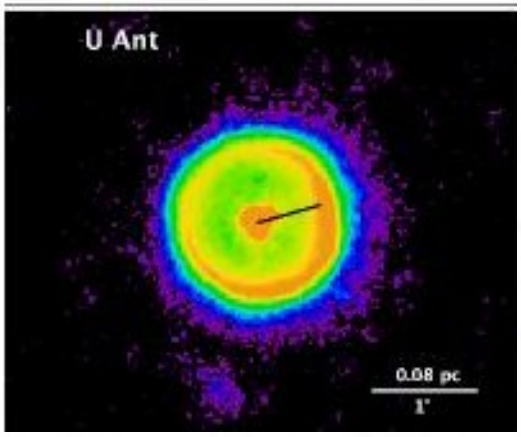


www.mpa-garching.mpg.de/~henk/

H. Van Winckel, C. Gielen, G. Raskin, S. Prins,W. Pessemier,
C. Waelkens, P. Degroote, J. Debosscher (KUL)
A. Jorissen, S. Van Eck (ULB)
Y. Fremat, H. Hensberge, L. Dumortier, G. Van de Steene (ROB)

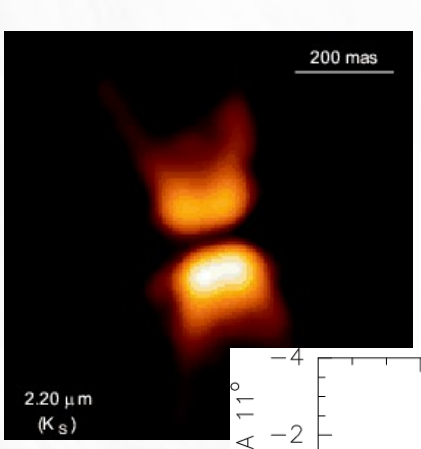
What is the mechanism of the disk formation?

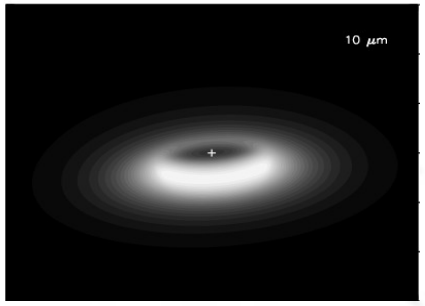
AGB: spherical winds

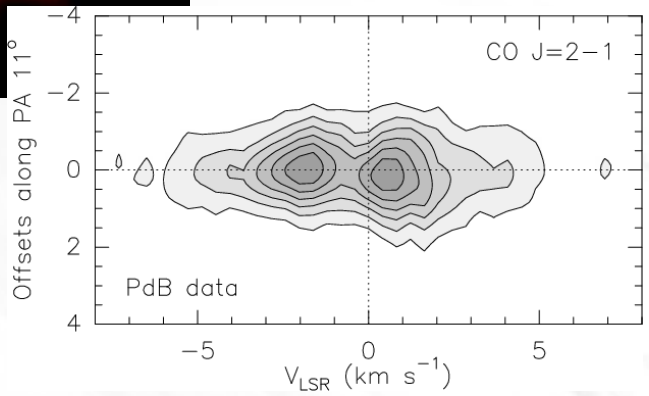


Cox et al. 2012

post-AGB: disks (50%)







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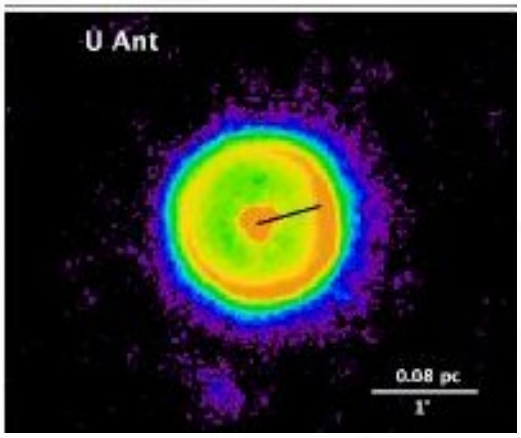

Cox et al. 2012

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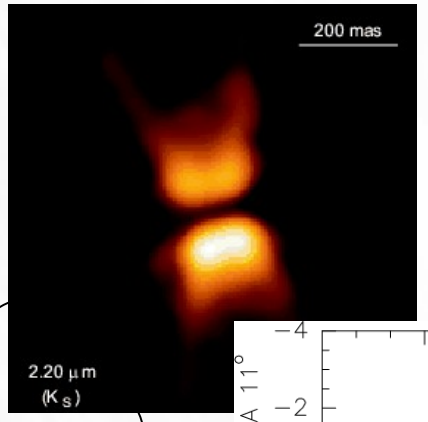
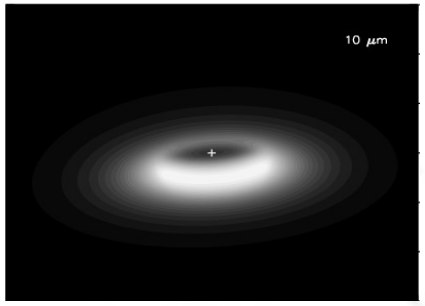
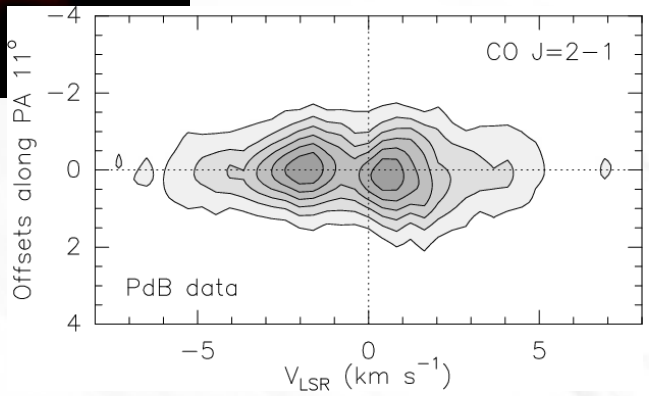
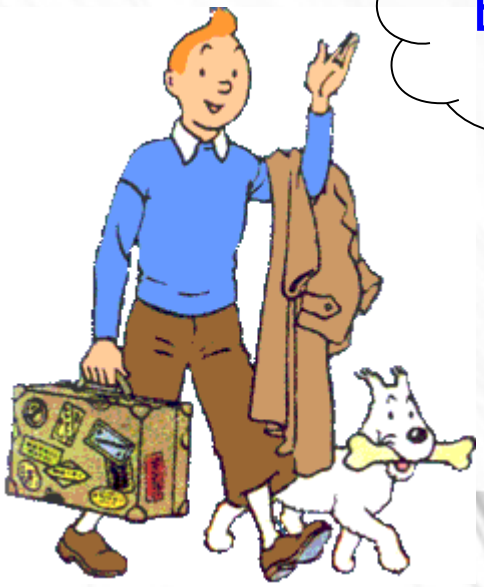


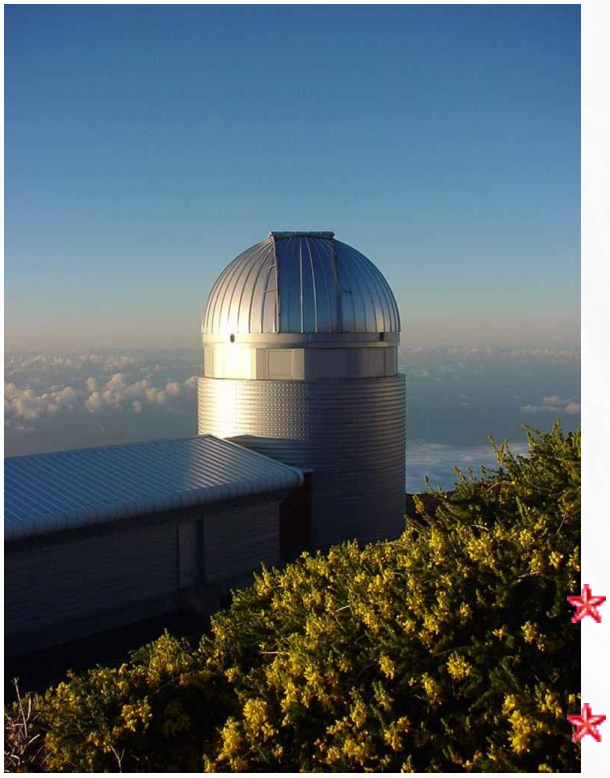


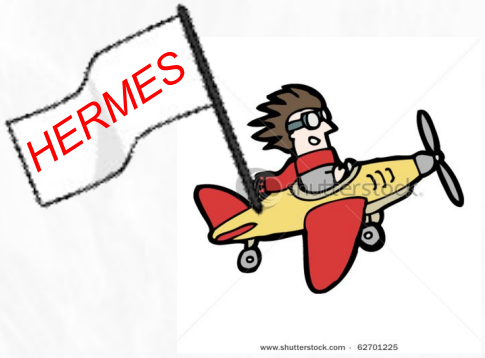


Binarity !



Mercator-HERMES Spectroscopic Survey of Disk Objects





Goals:

- Verify binarity
- Orbital parameters (P, e, asini, q...)
- Mass transfer (inflow, outflow?)
- Abundances (also: Teff, logg → instability strip)

Mercator-HERMES Spectroscopic Survey of Disk Objects

41 objects (6 known binaries)

SpT: A-K(M) I-III

R=80,000

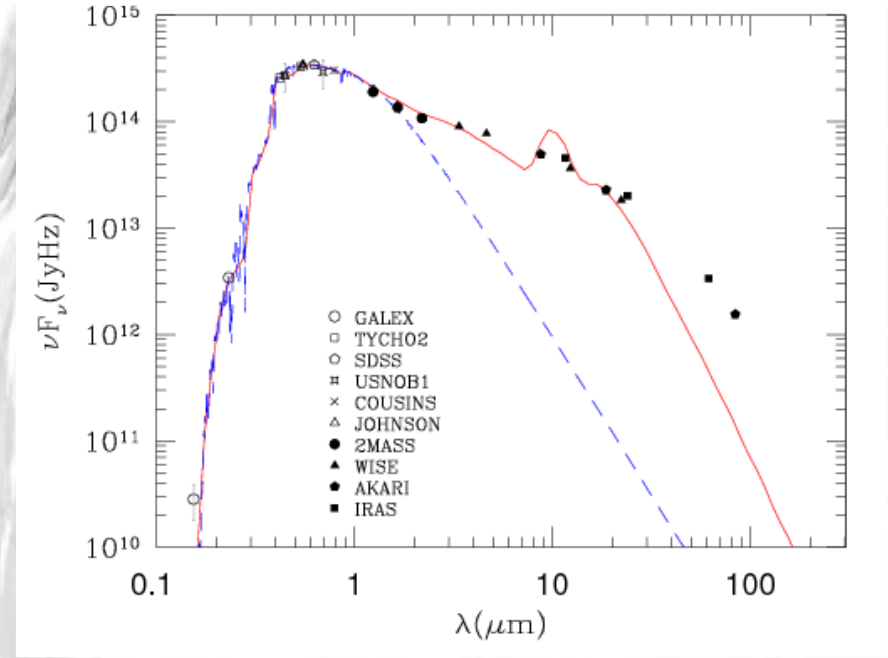
Δλ=3800-9000 A

S/N~20-170 (V<12 mag.)

ΔRV_{instr} ~ 0.2 km/s

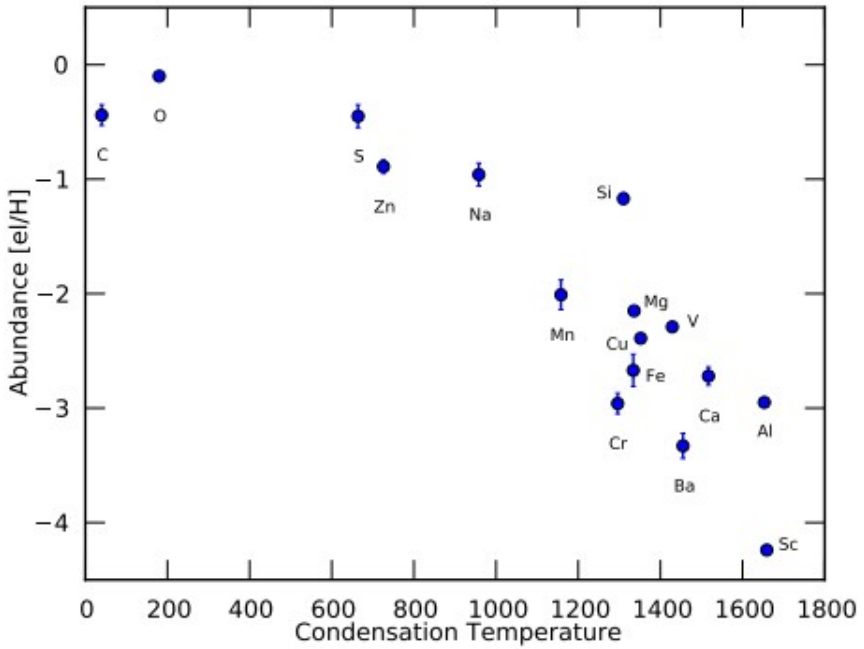
Once in a week since 2009

Sample selection criteria



IR excess

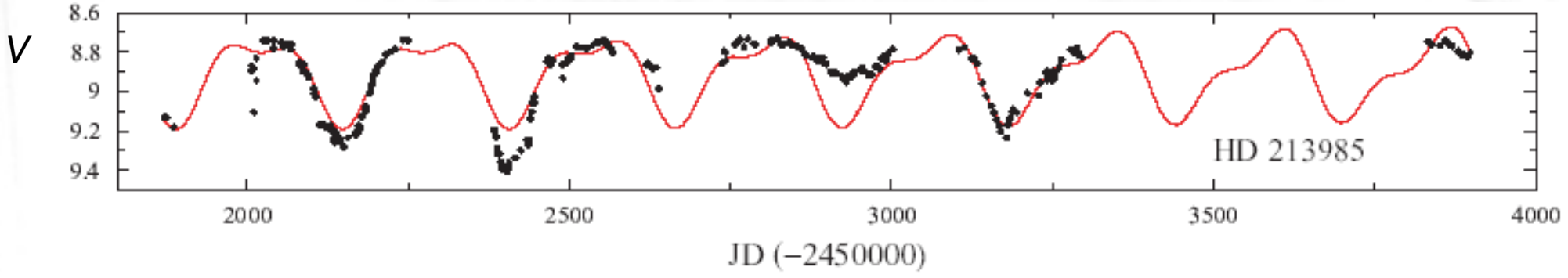
Gorlova et al. 2012
Van Aarle et al. 2012
De Ruyter et al. 2006
Gielen et al. 2008



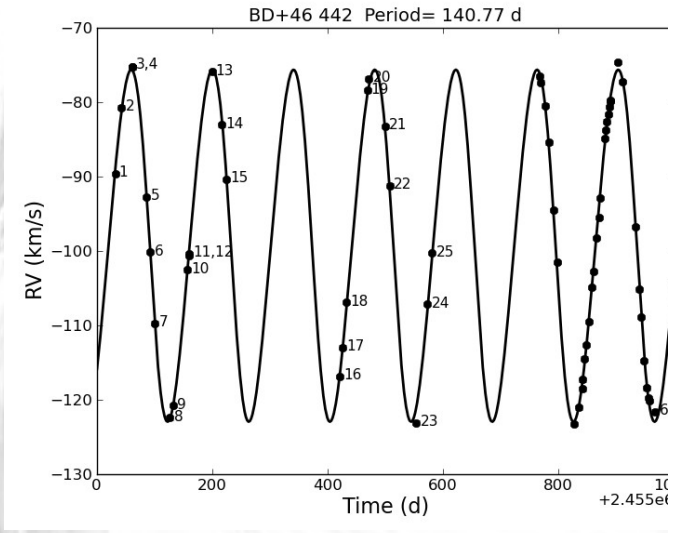
ISM-like
chem. composition
of the photosphere

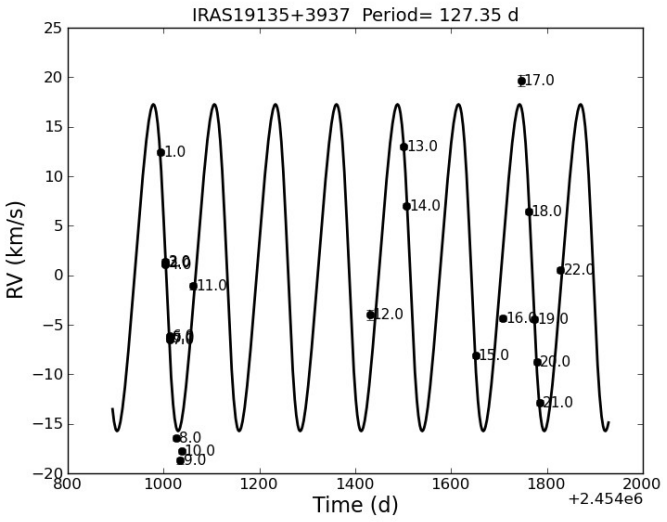
Van Winckel et al. 2012
Maas 2005
Giridhar et al. 2005

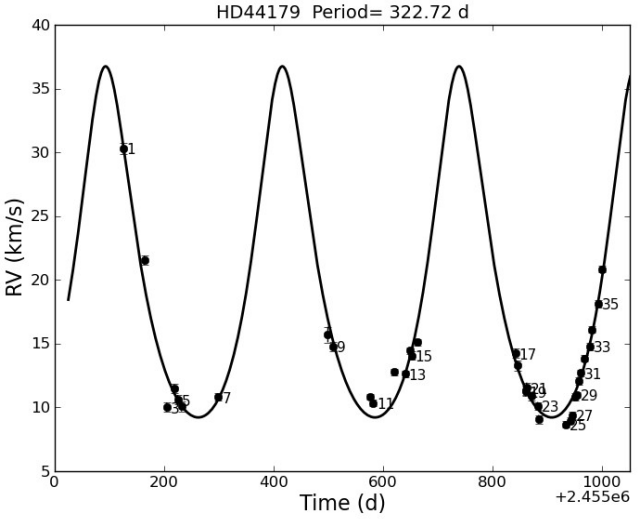
Semi-regular long-term (P>100 d) light variations *Kiss et al. 2007, Waelkens et al. 1991*

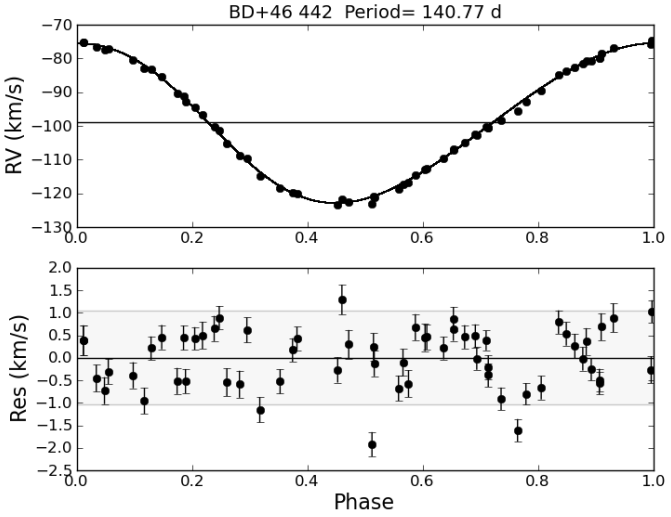


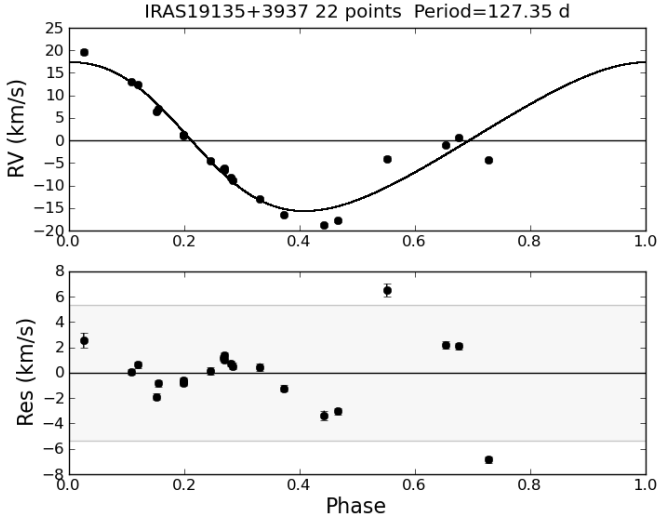
Kepler orbits from HERMES radial velocities

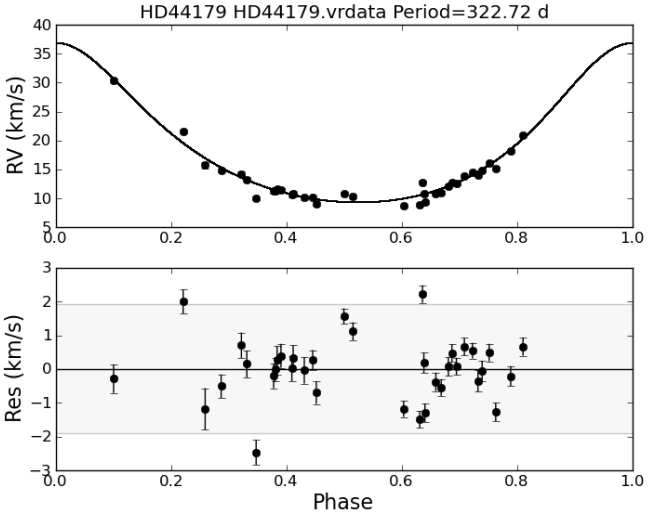












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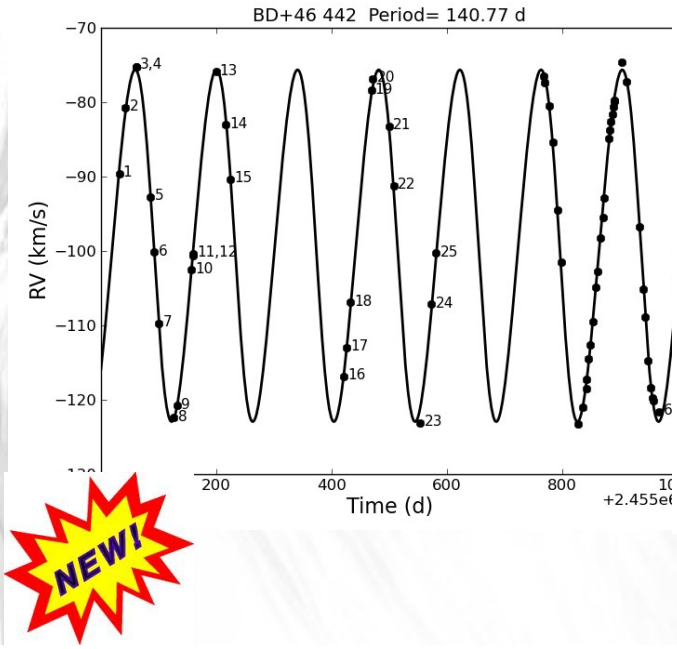
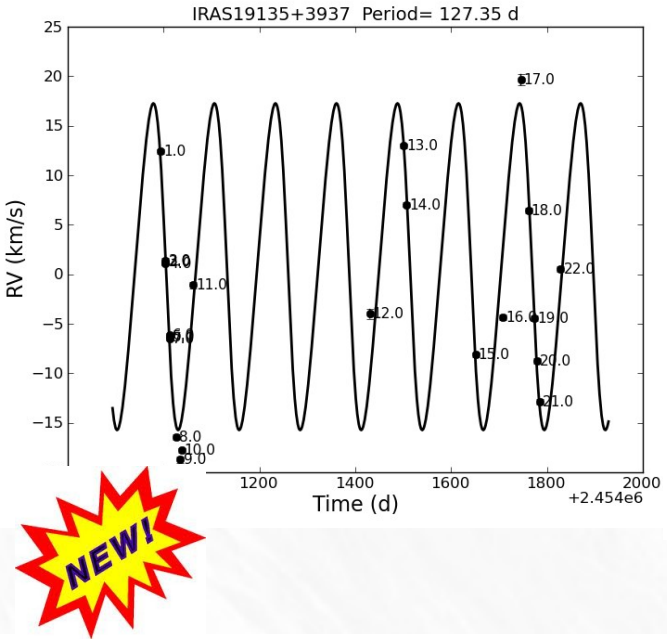
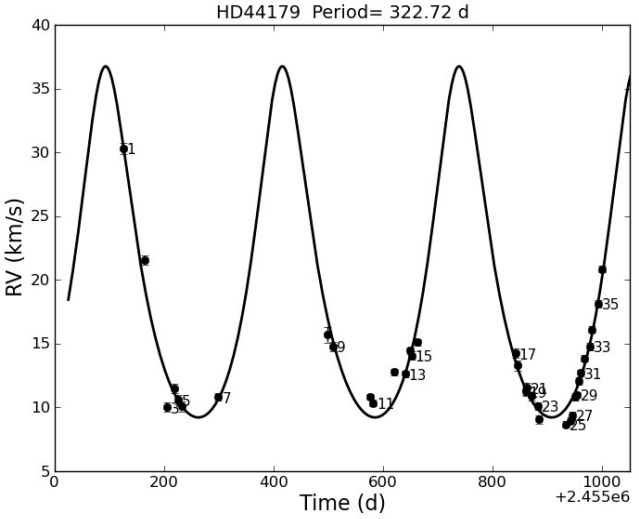
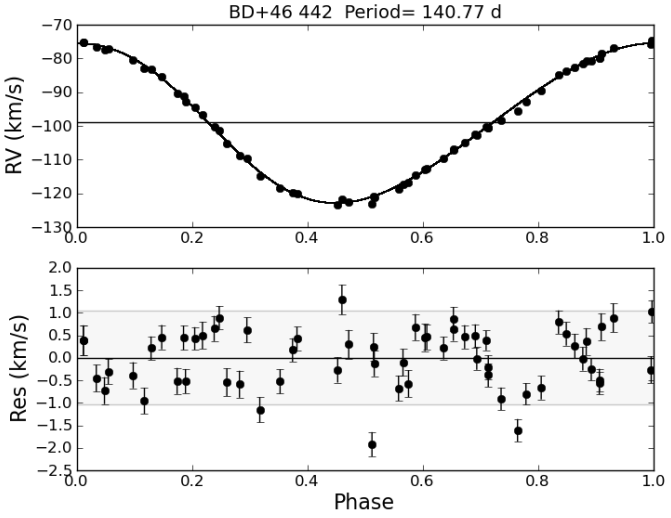
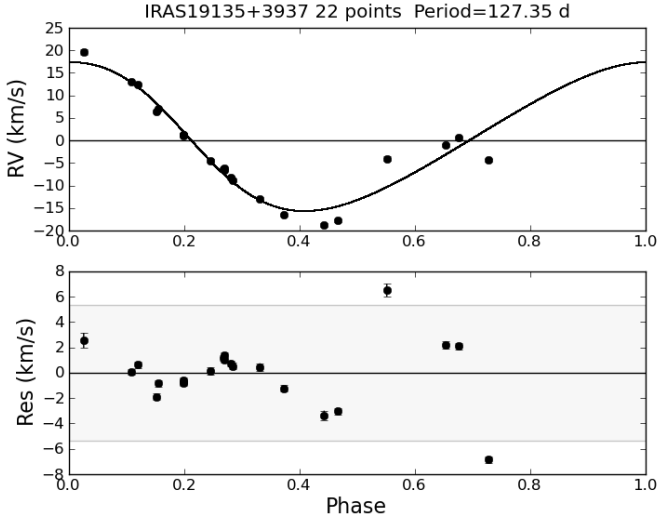
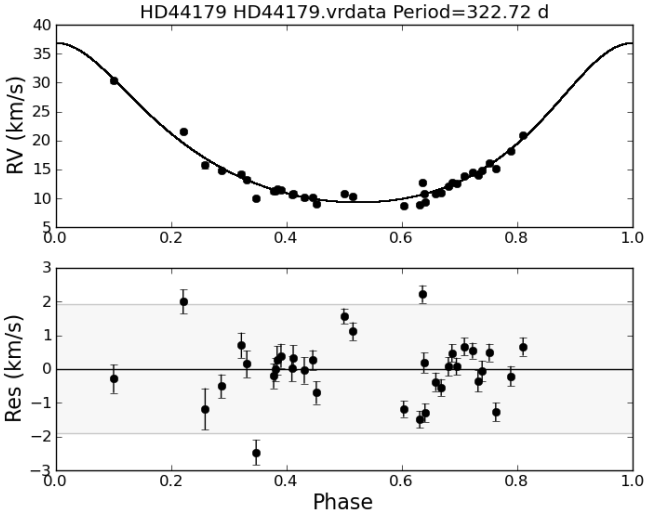




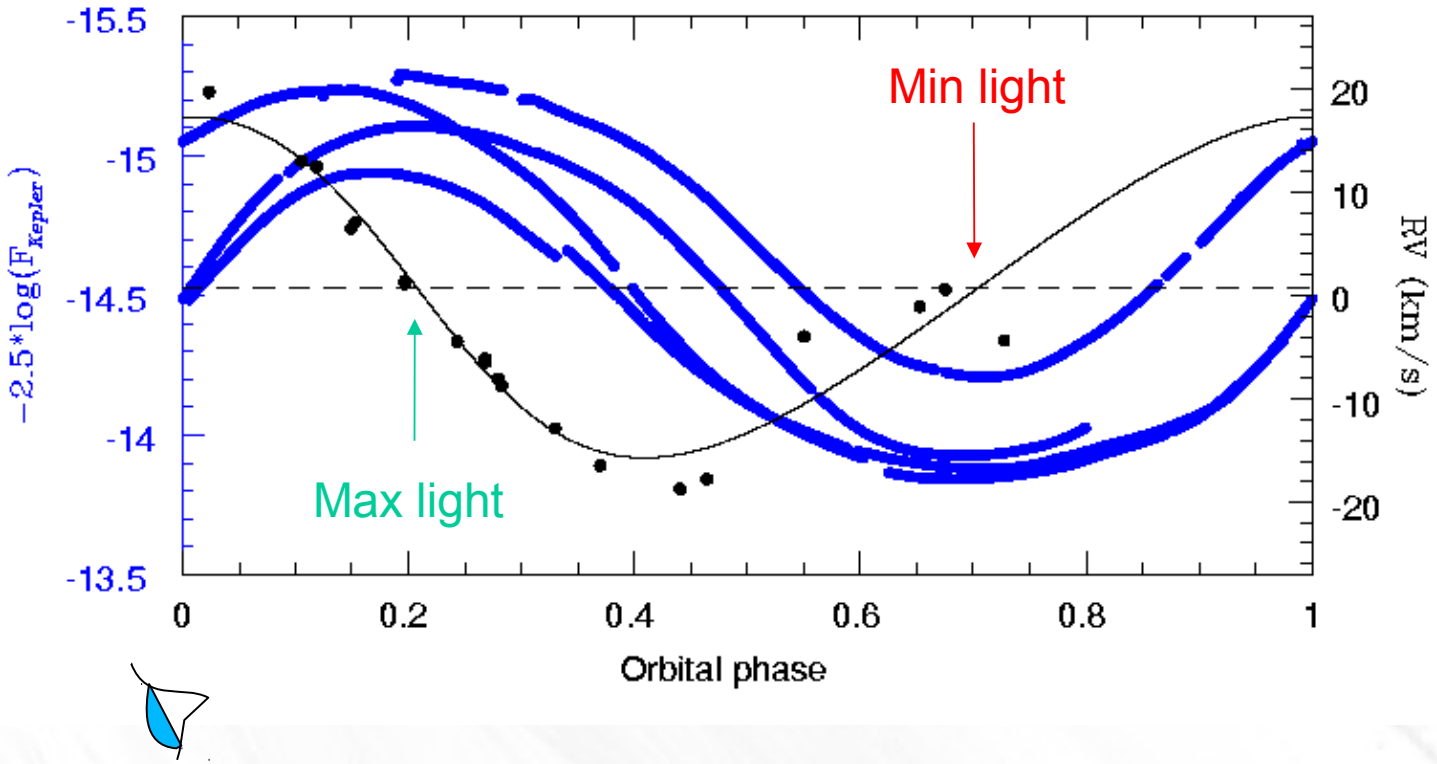


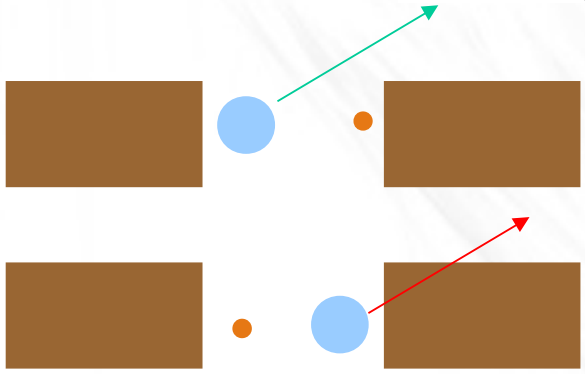






HERMES RVs help explain light curves





Φ=0.25

Φ=0.75

Obscuration by the disk

Disk formation theories in evolved binaries

Remnant of the common envelope during the AGB stage *Passy et al. 2012*

Interaction of the jet with the post-AGB wind *Akashi & Soker 2007*

Outflows through the L2, L3 points *De Val-Borro 2009*

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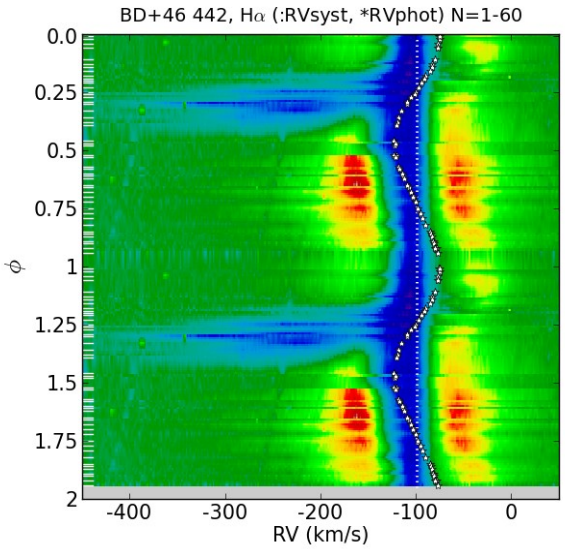
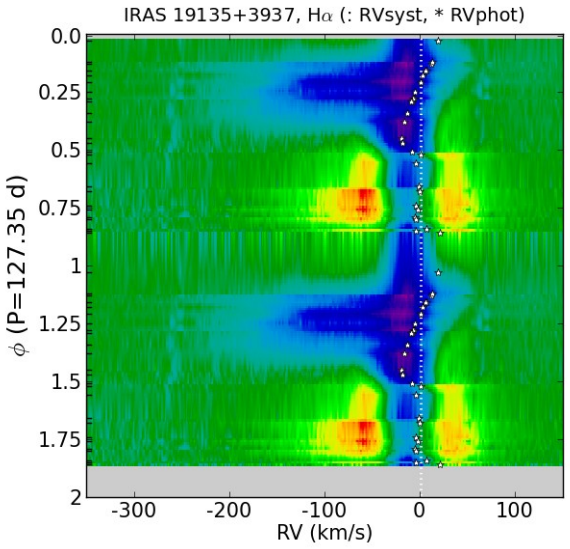
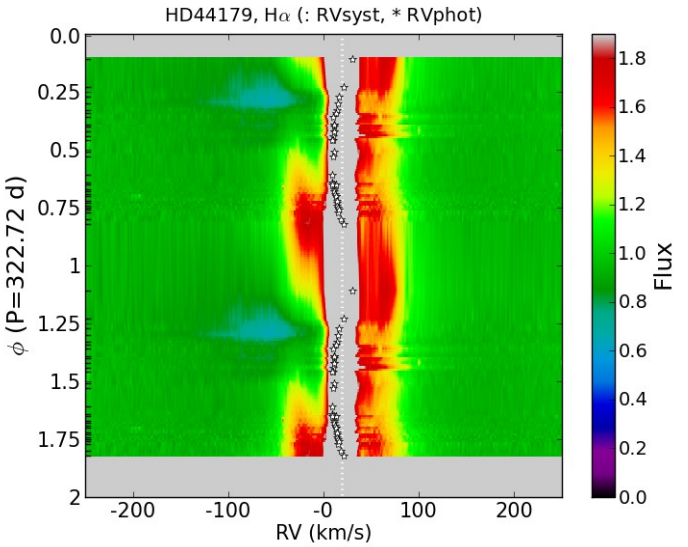
current mass transfer

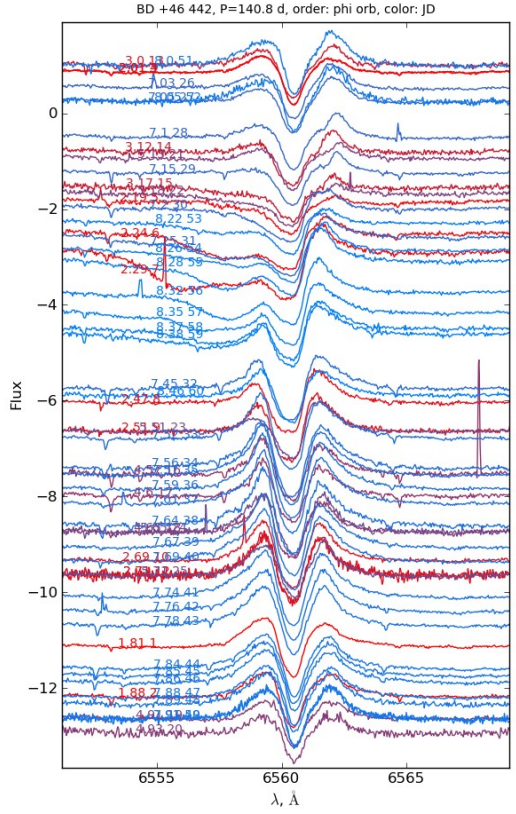
Orbital variations of Hα

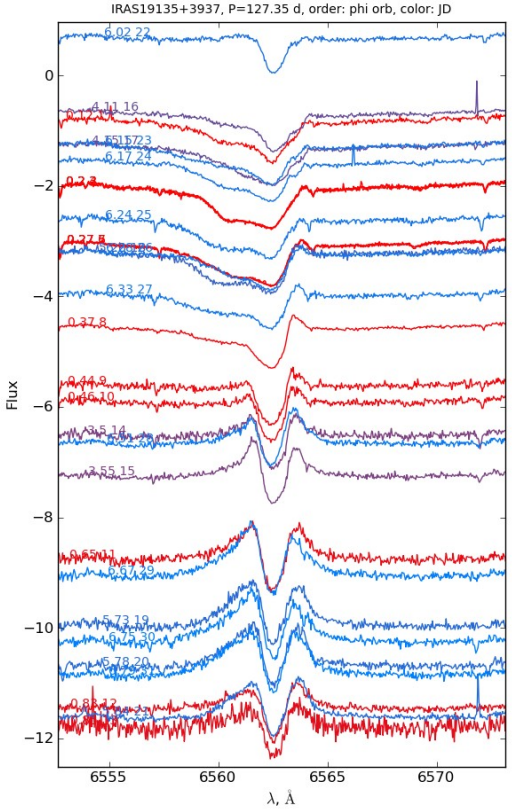


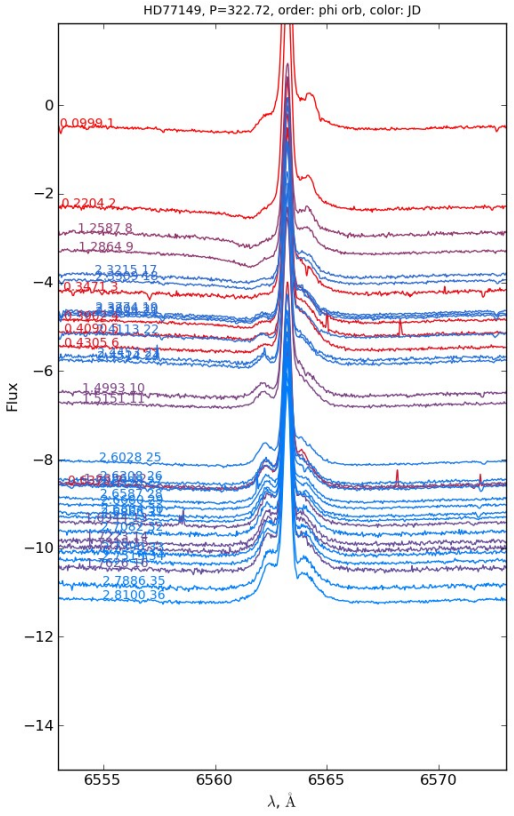




φ_{orb}







0

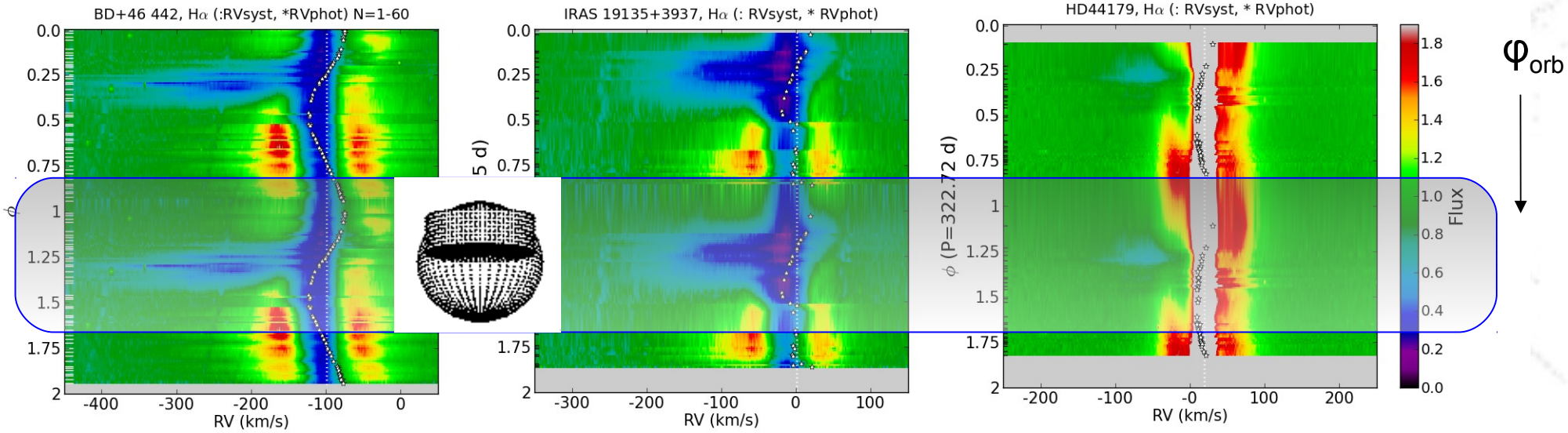
φ_{orb}

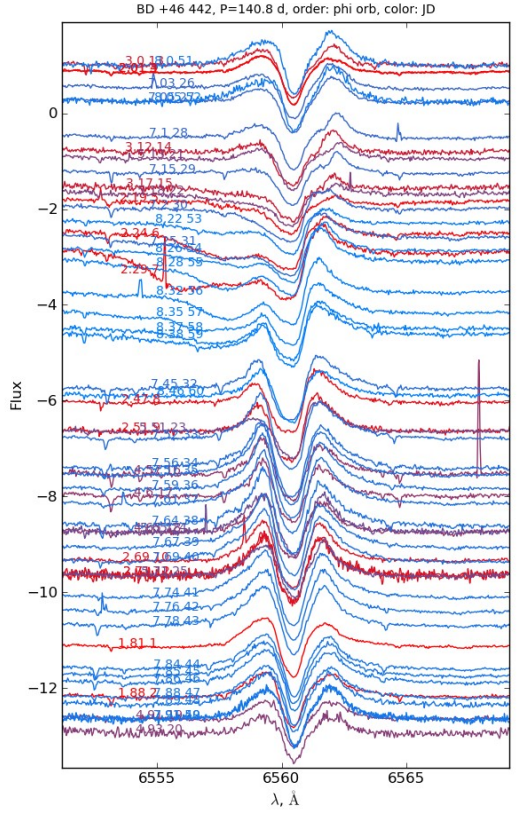
0.5

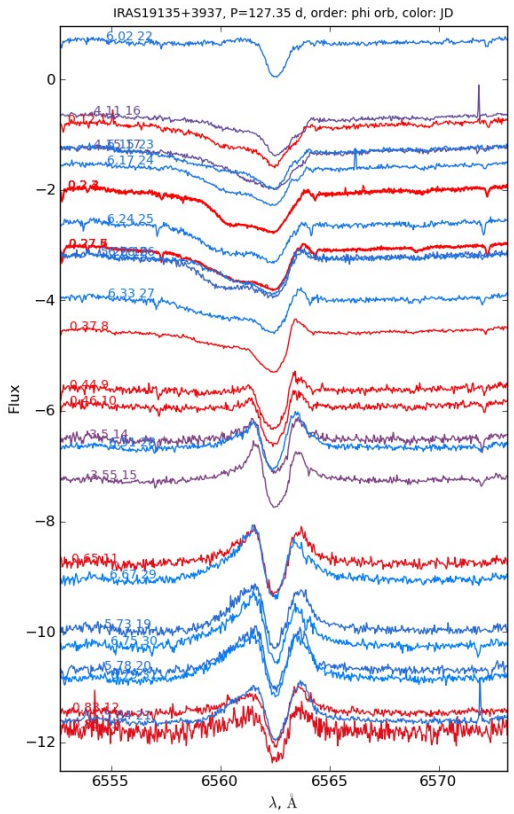
1

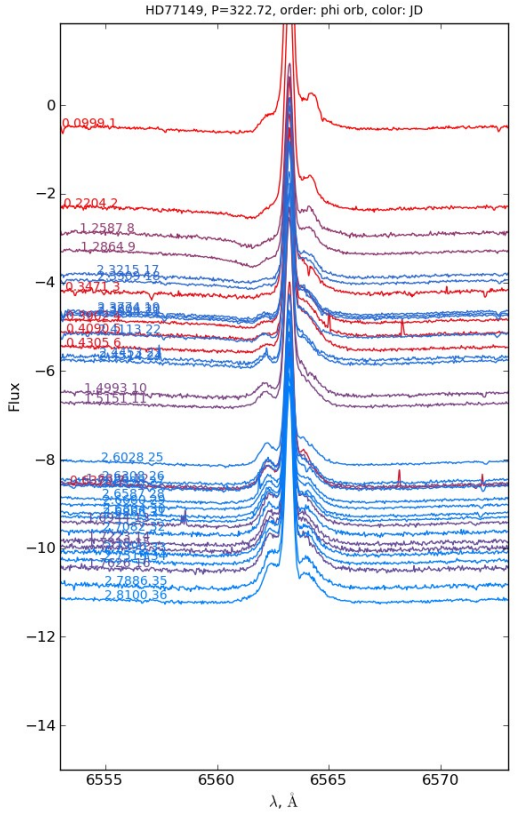
2009 2010 2011 2012

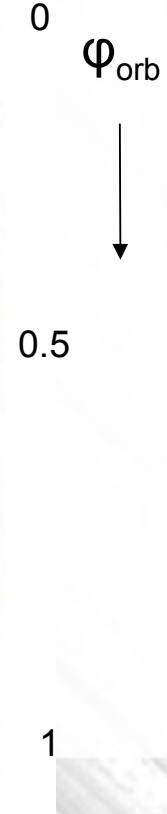
Transient blue-shifted wind in Hα





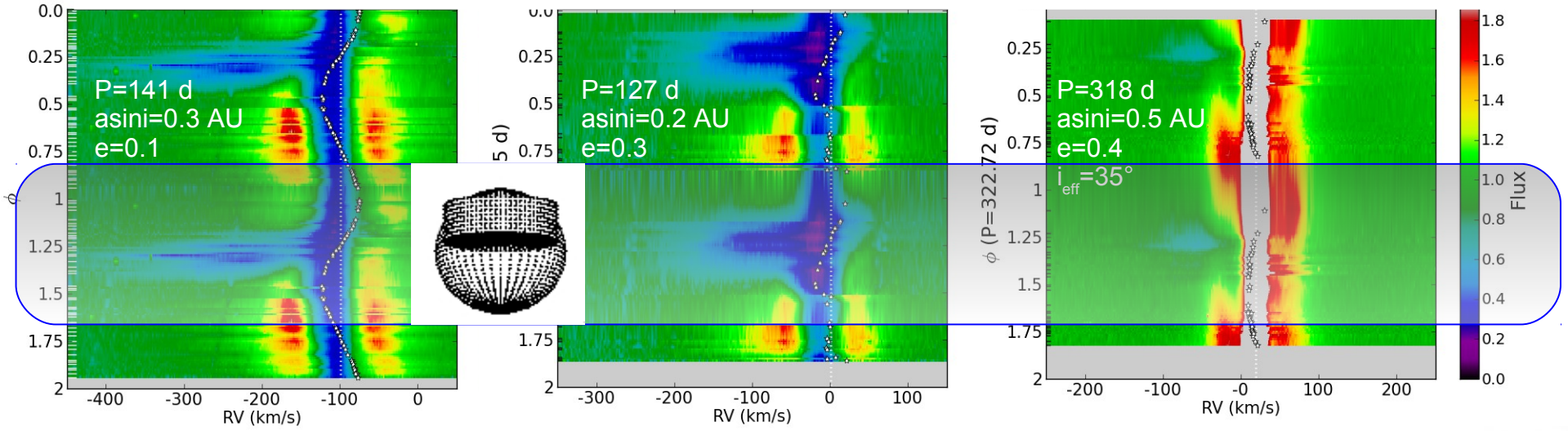


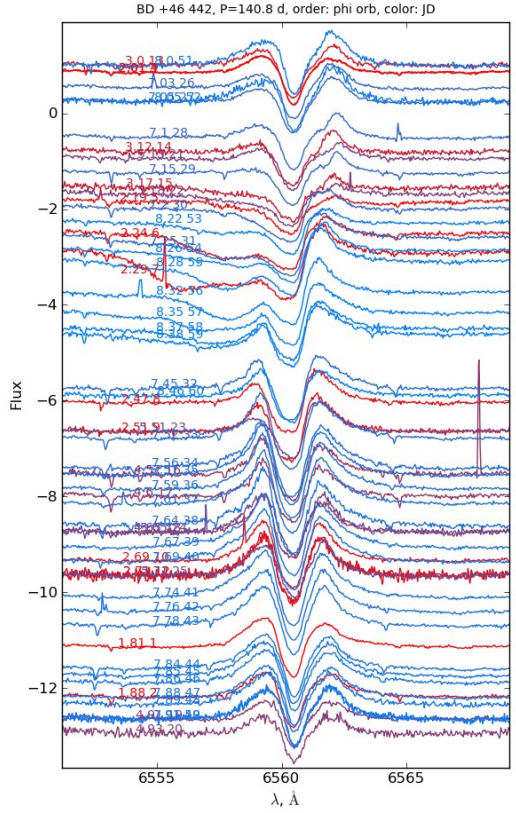


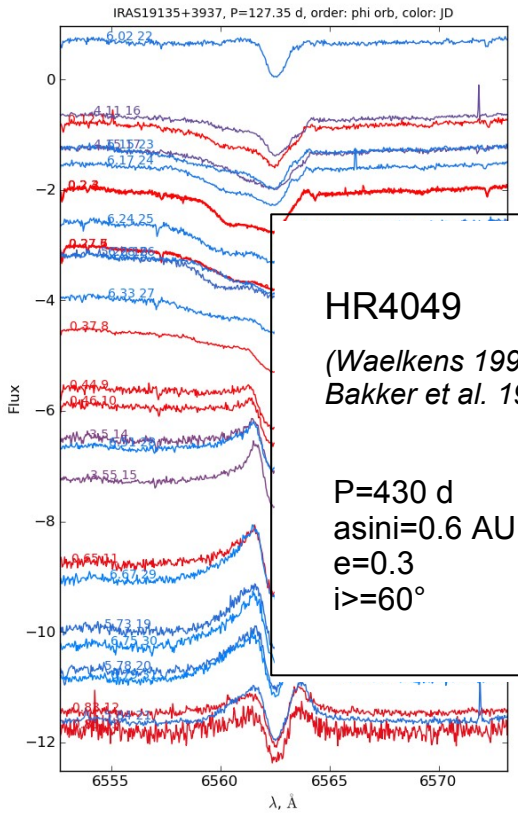


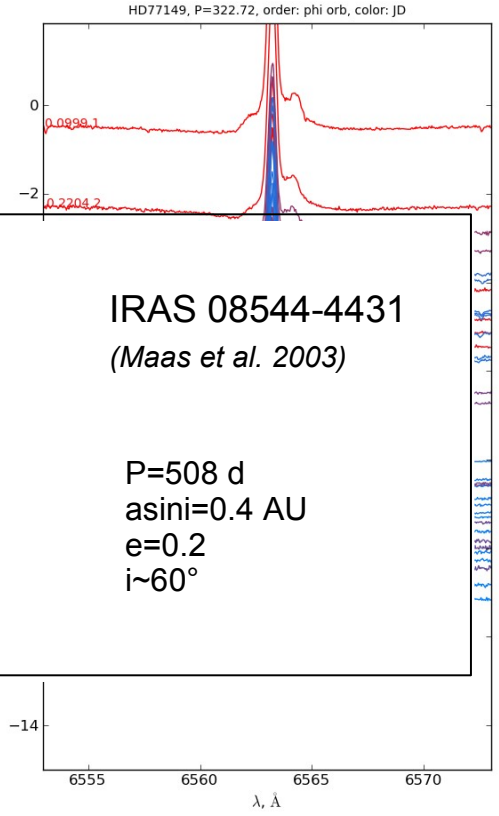
2009 2010 2011 2012

Transient blue-shifted wing in Hα: a common phenomenon?









HR4049

(Waelkens 1991, Bakker et al. 1998)

P=430 d
asini=0.6 AU
e=0.3
i>=60°

IRAS 08544-4431

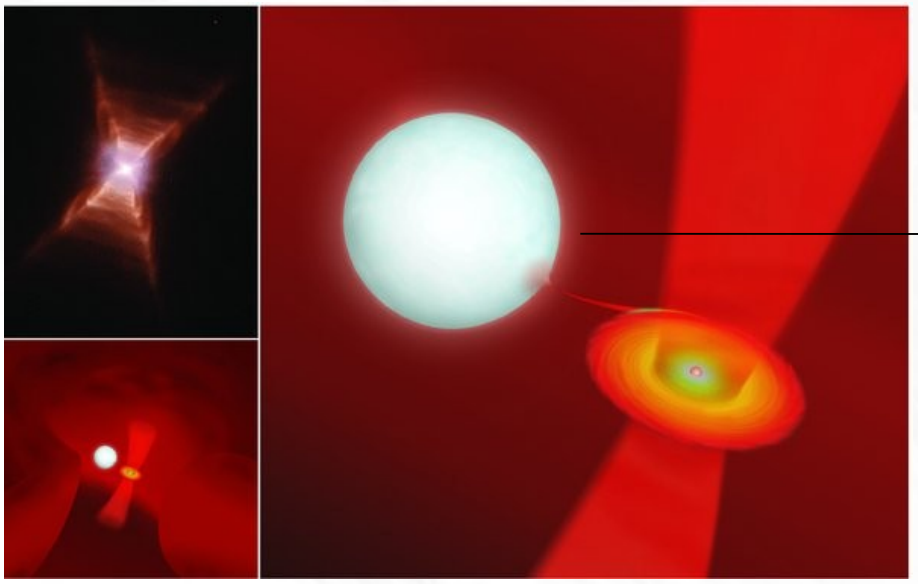
(Maas et al. 2003)

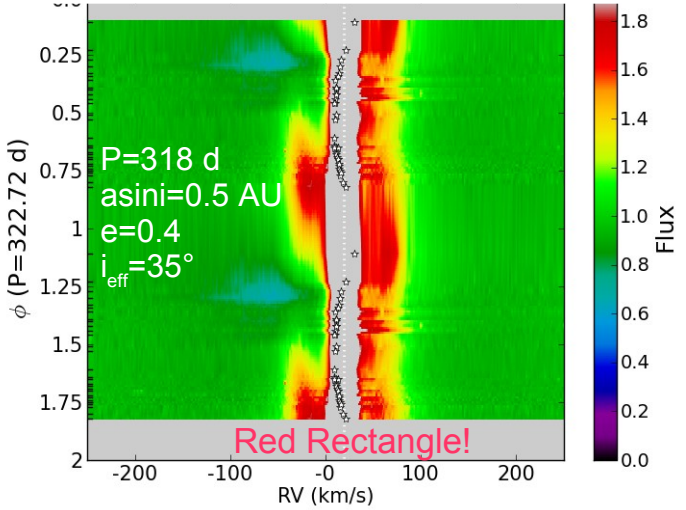
P=508 d
asini=0.4 AU
e=0.2
i~60°

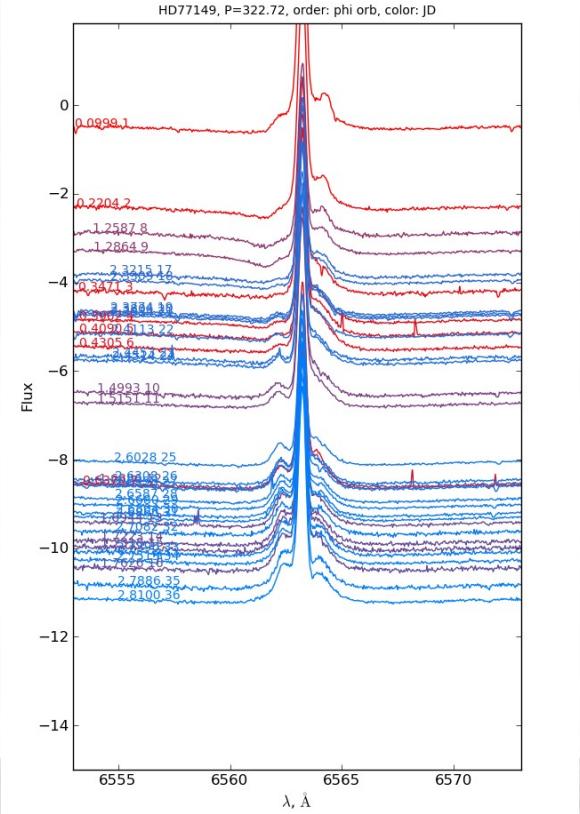
2009 2010 2011 2012

Jet model to explain Hα variations in the Red Rectangle

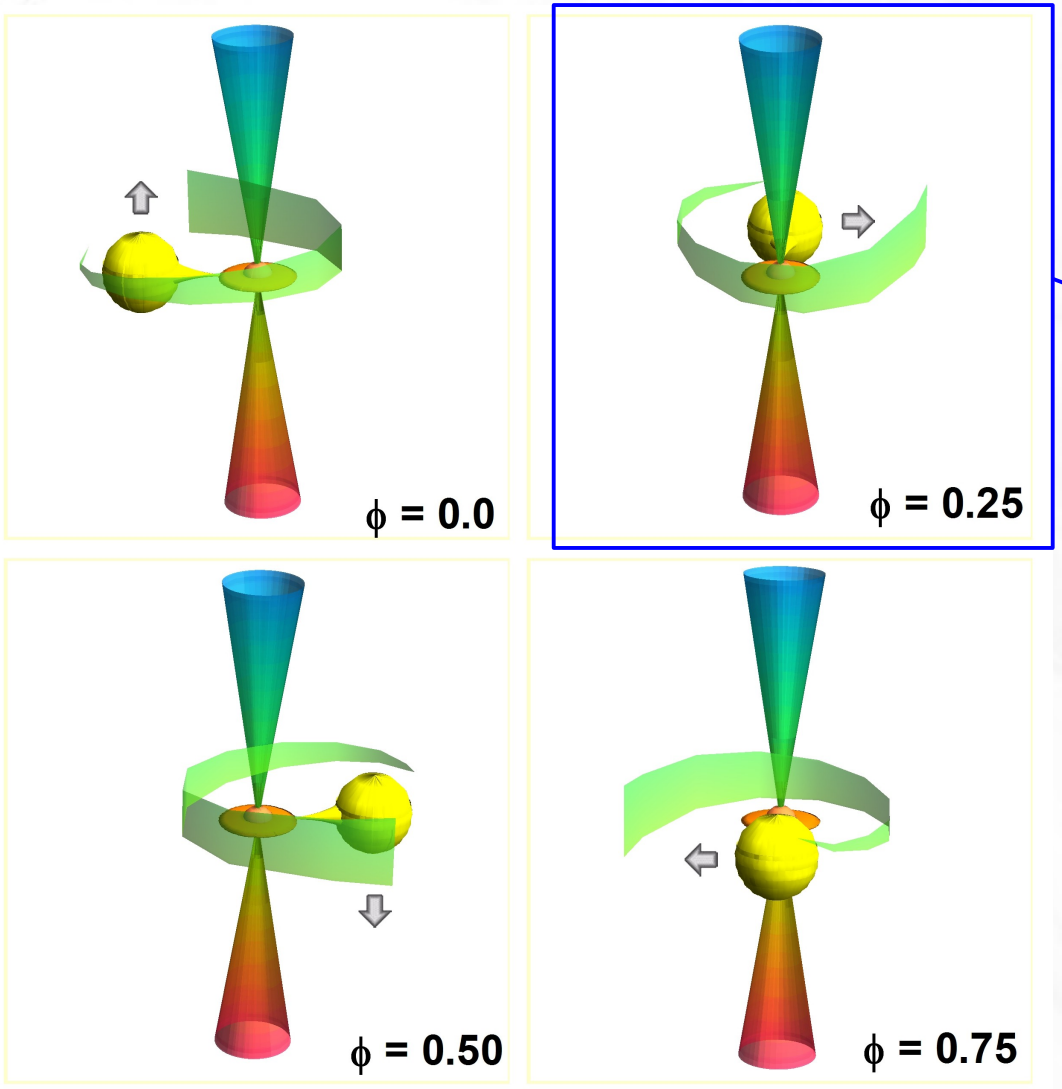
Witt et al. 2009

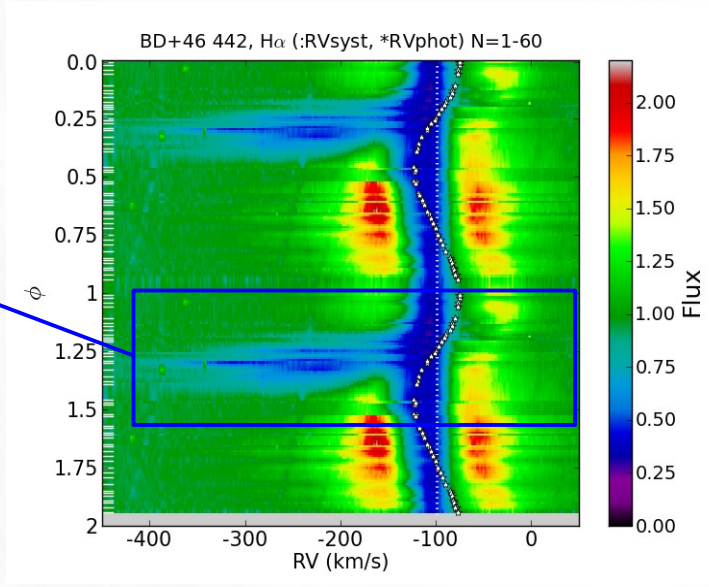




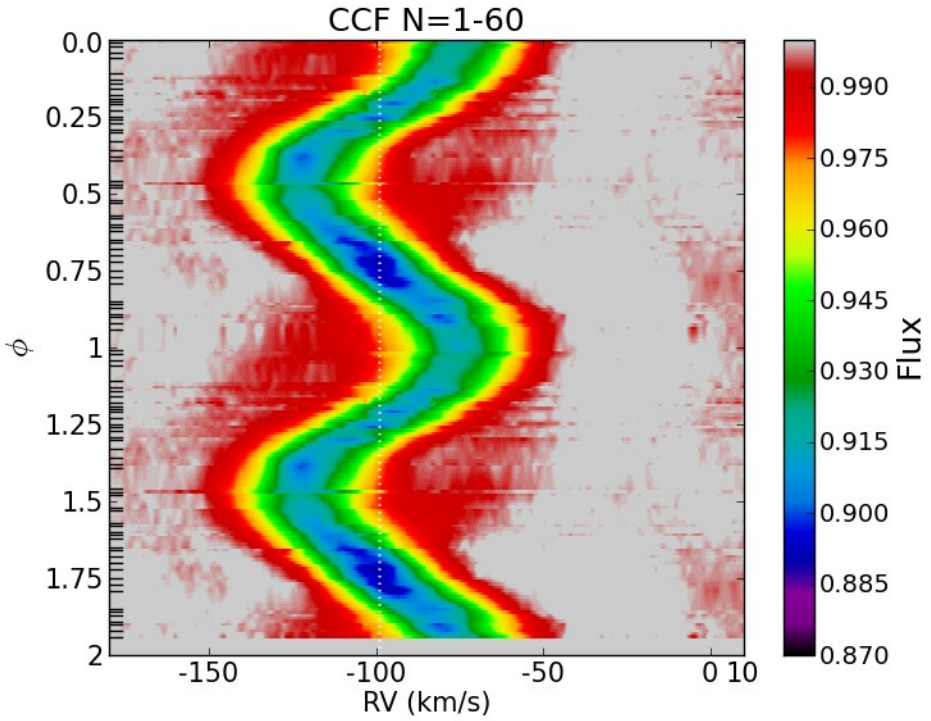


Jet model adopted for BD+46 442 *(Gorlova et al. 2012)*



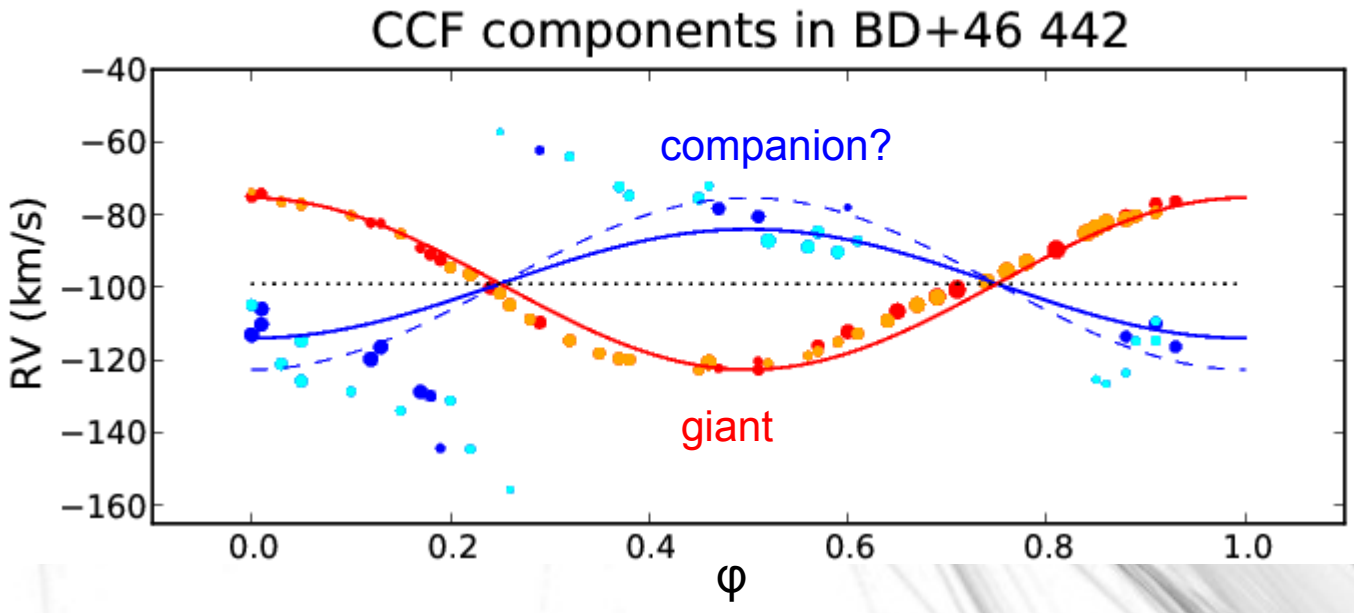


Companion sp. detected in the cross-corr. function of BD+46 442 ?



M_{comp}/M_{giant}=24 kms^{-1} / 15 kms^{-1}=0.6 , f(m)=0.19

i°	M_{giant}/M_{sol}	M_{comp}/M_{sol}
60	0.5	0.8
45	0.9	1.4
30	2.5	4.0

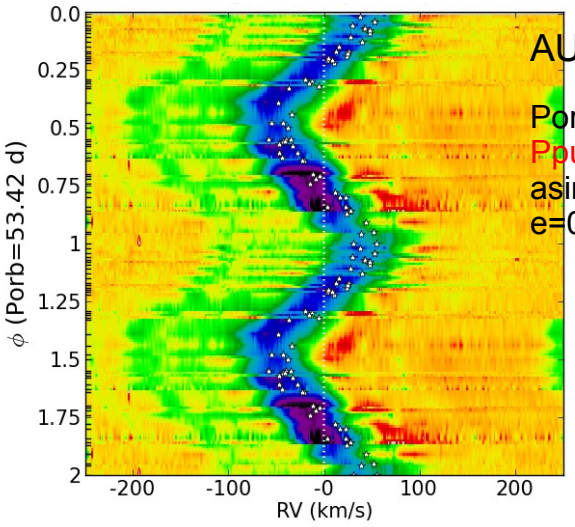


Roche-Lobe R_{giant}=

f(M_{comp}/M_{giant}, a)=60-40 R_{sol}

An on-going accretion via the Roche-lobe overflow!

Hα variations in the weakly pulsating stars

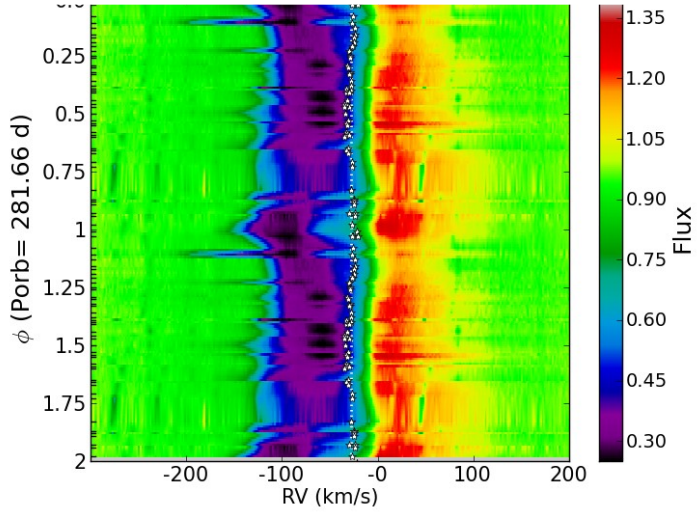


AU Peg

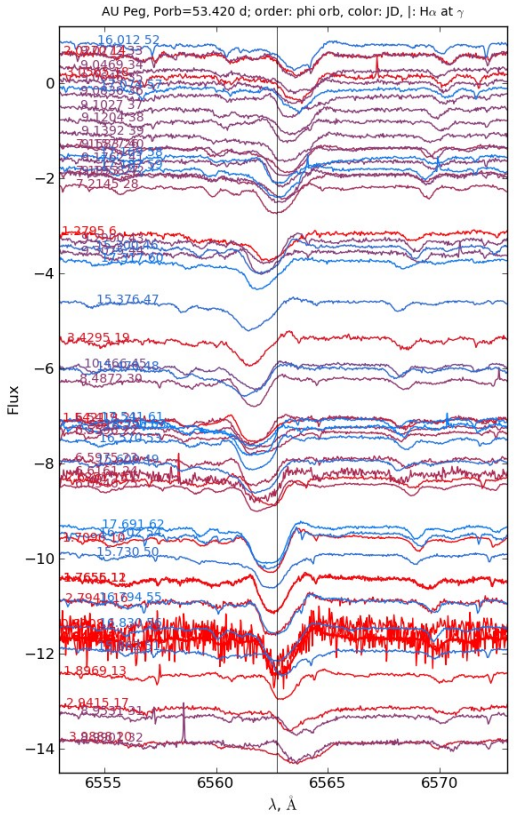
Porb=53 d
Ppuls-2.1 d (WVir/δCep)
asini=0.2 AU
e=0.07

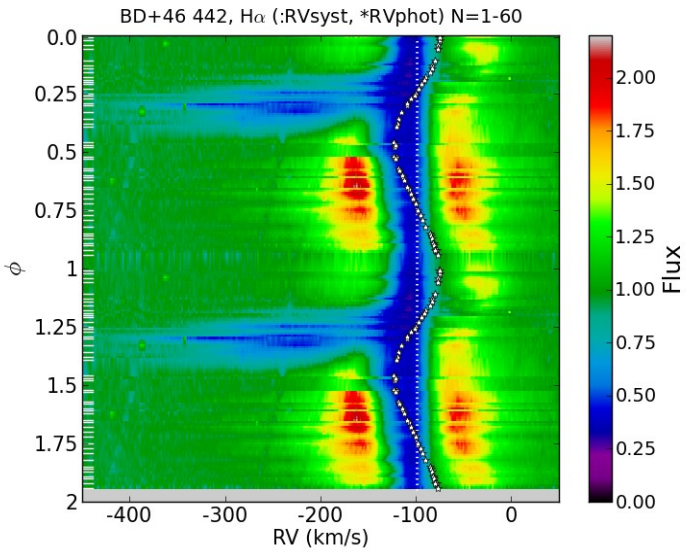
89 Her

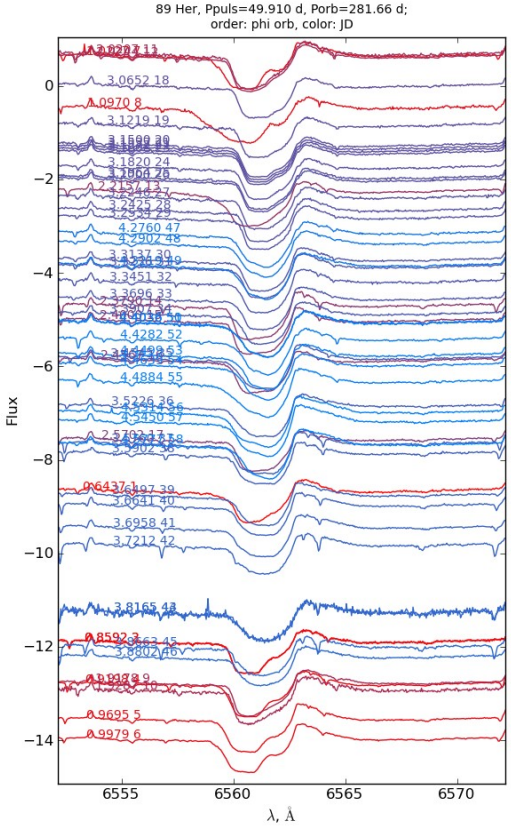
P=282 d
Ppuls-50d(SRd)
asini=0.1 AU
e=0.07
i-15°



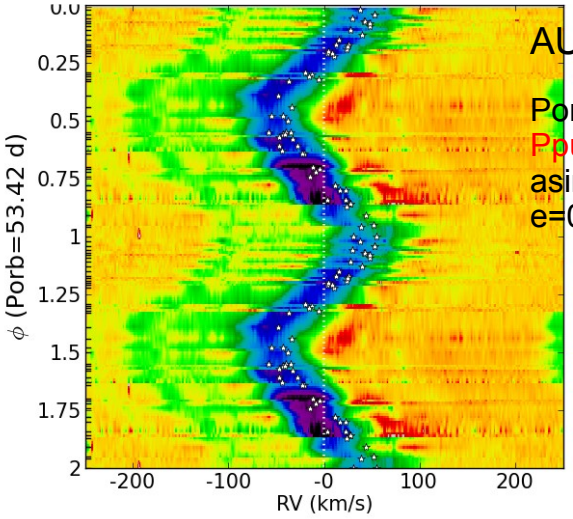
BD+46 442:
non-puls, active acc







Hα variations in the weakly pulsating stars

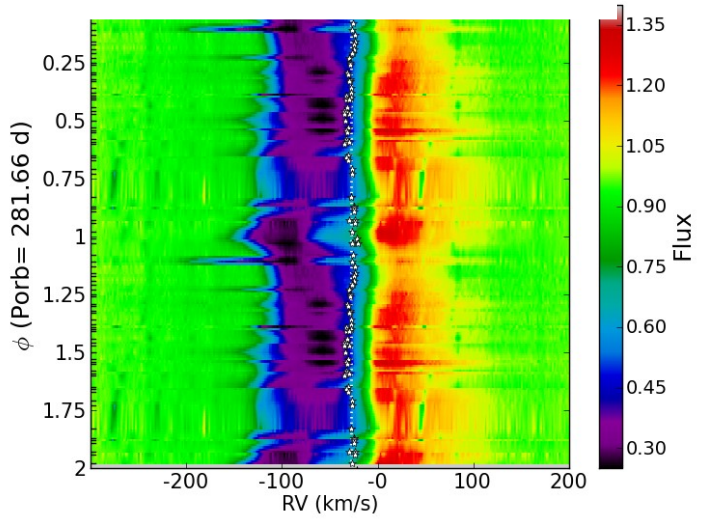


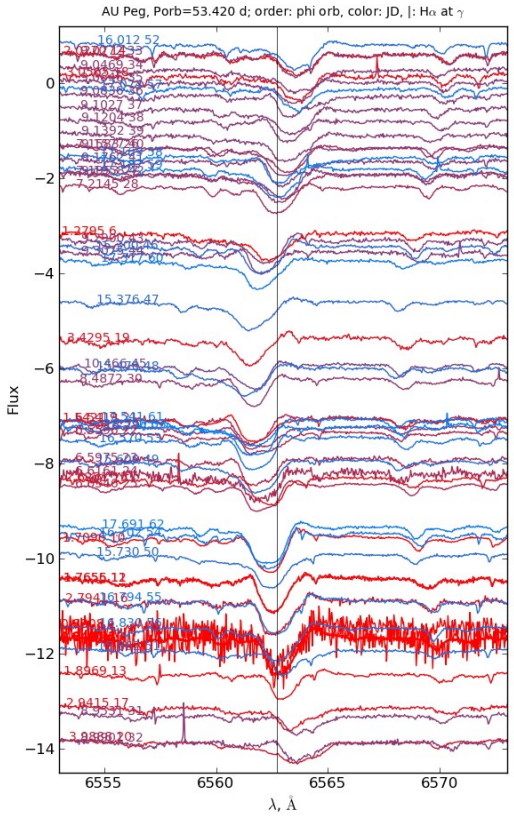
AU Peg

Porb=53 d
Ppuls-2.1 d (WVir/δCep)
asini=0.2 AU
e=0.07

89 Her

P=282 d
Ppuls-50d(SRd)
asini=0.1 AU
e=0.07
i-15°



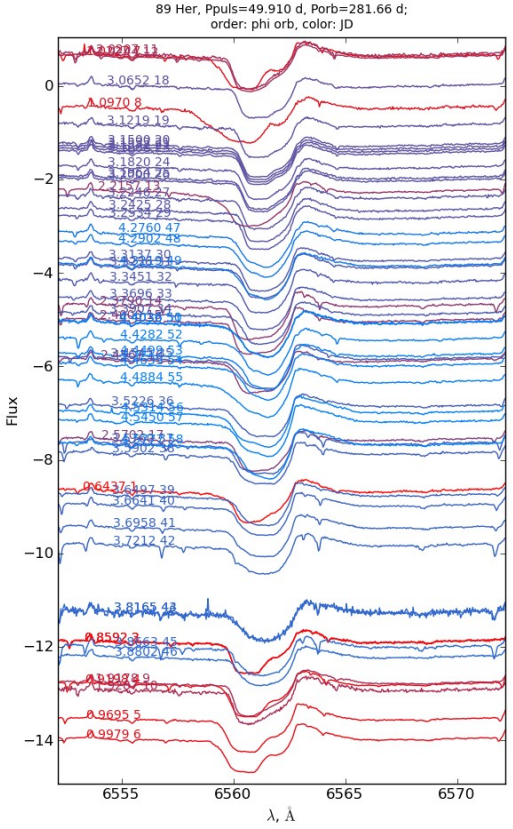


Photospheric /
weak P Cyg profile
modulated by pulsations

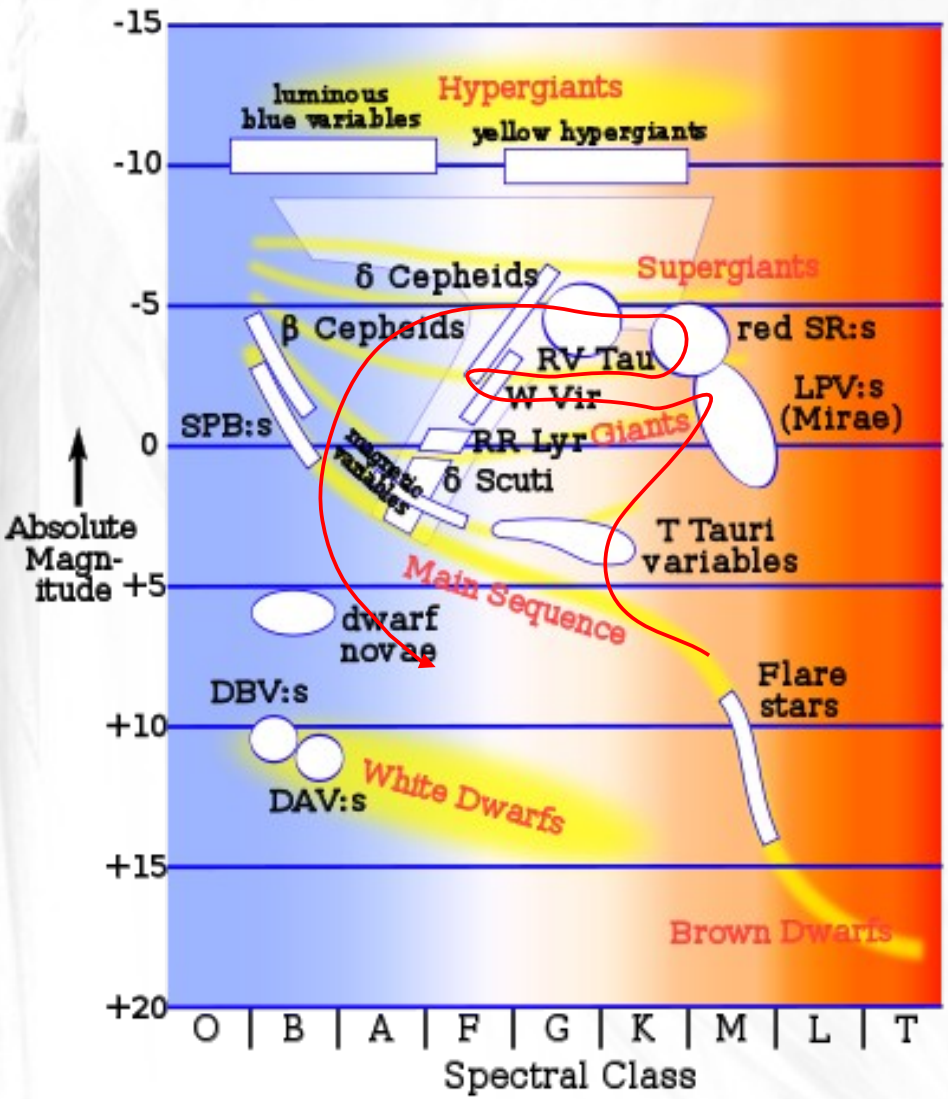
→ *no accretion*

Permanent P Cyg
with occasional
enhancements of the blue wing

→ *time-variable accretion*



The challenges of RV Tau pulsators



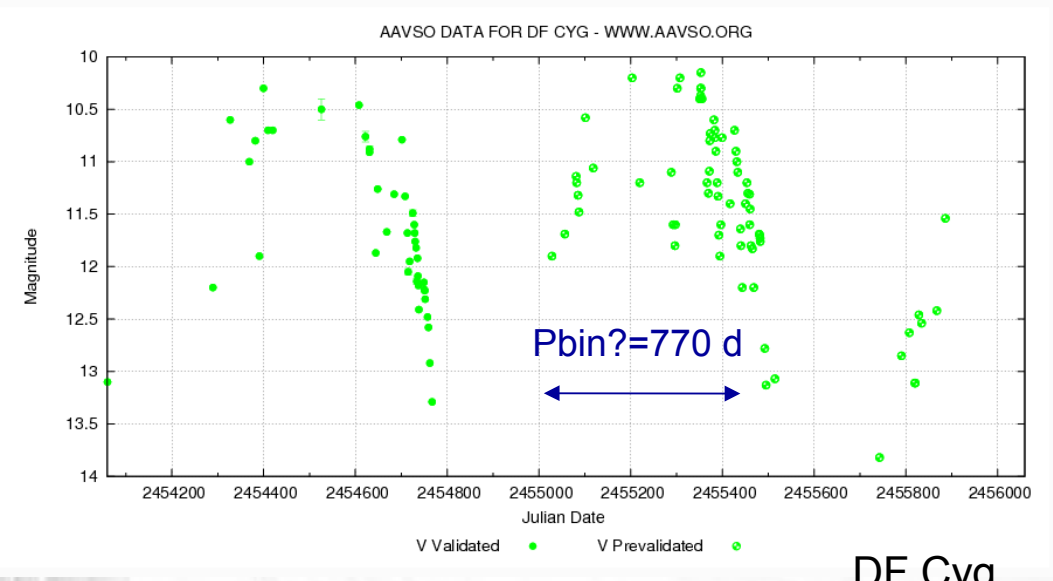
Ppuls =30-150 d

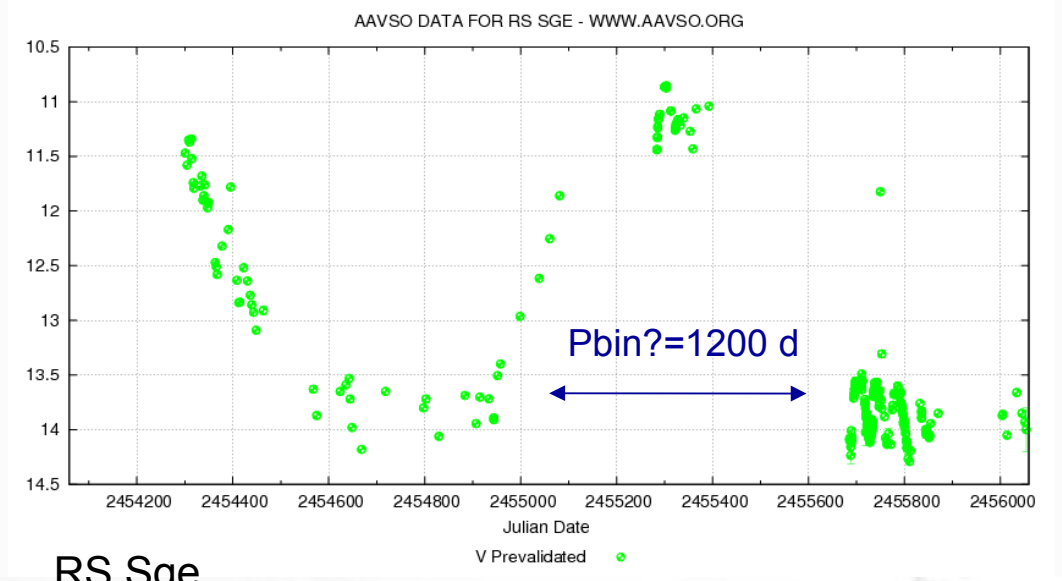
two light minima per period

velocity-stratified pulsations

variable SpT

RVb phenomenon (α Per) and binarity





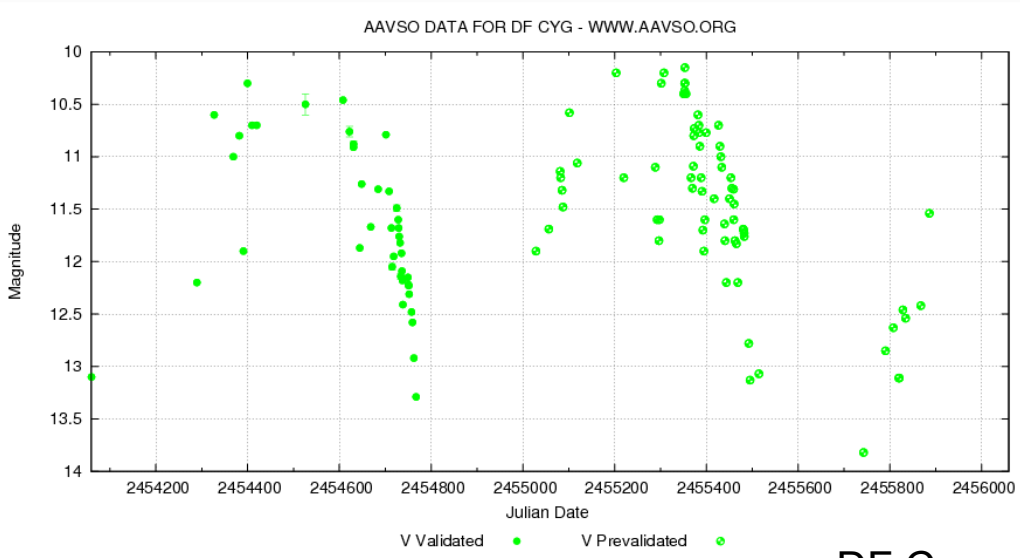
DF Cyg

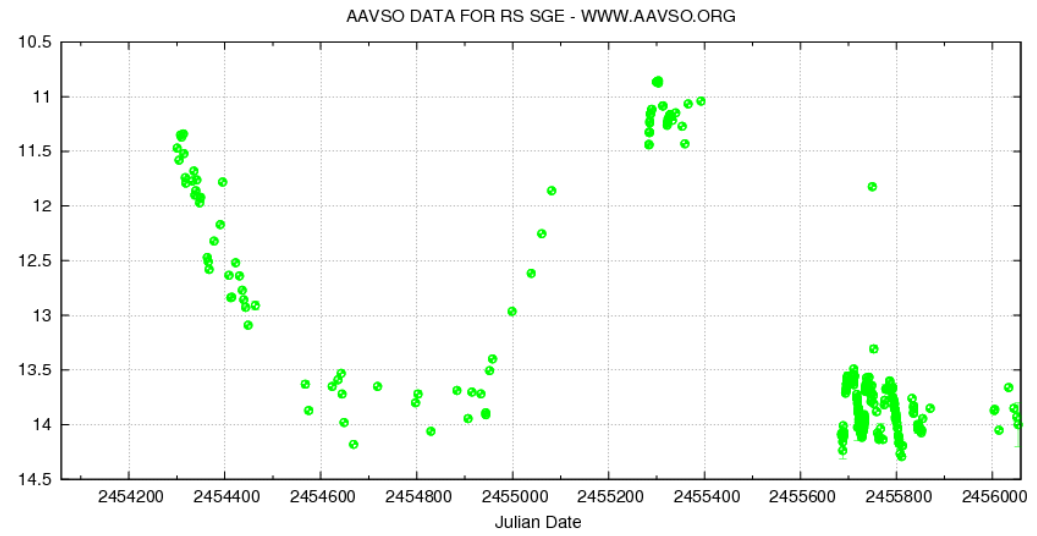
Ppuls-50 d
G7-K5

RS Sge

Ppuls-80 d
F-G

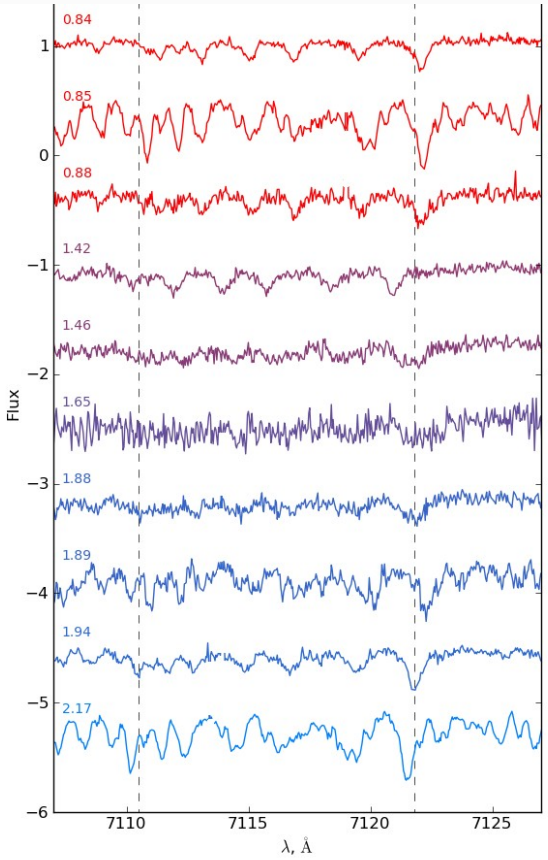
RVb phenomenon (α Per) and binarity





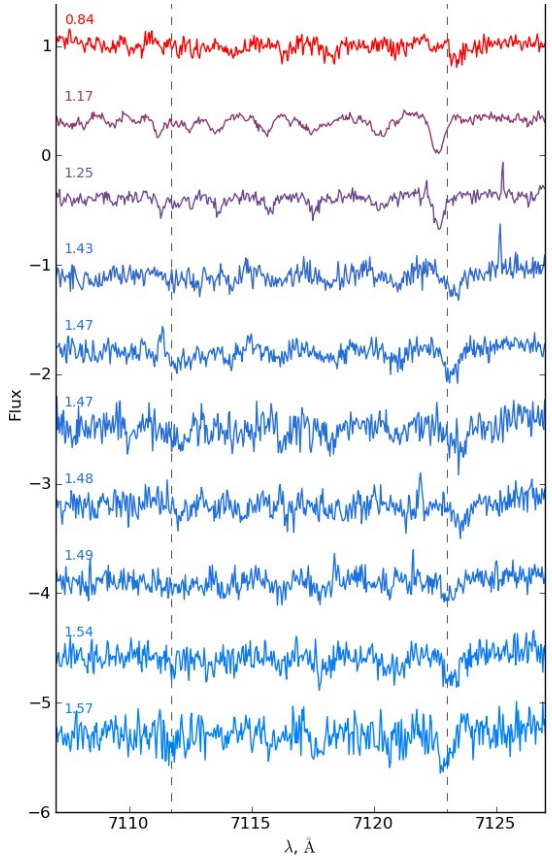
DF Cyg

Ppuls-50 d
G7-K5



RS Sge

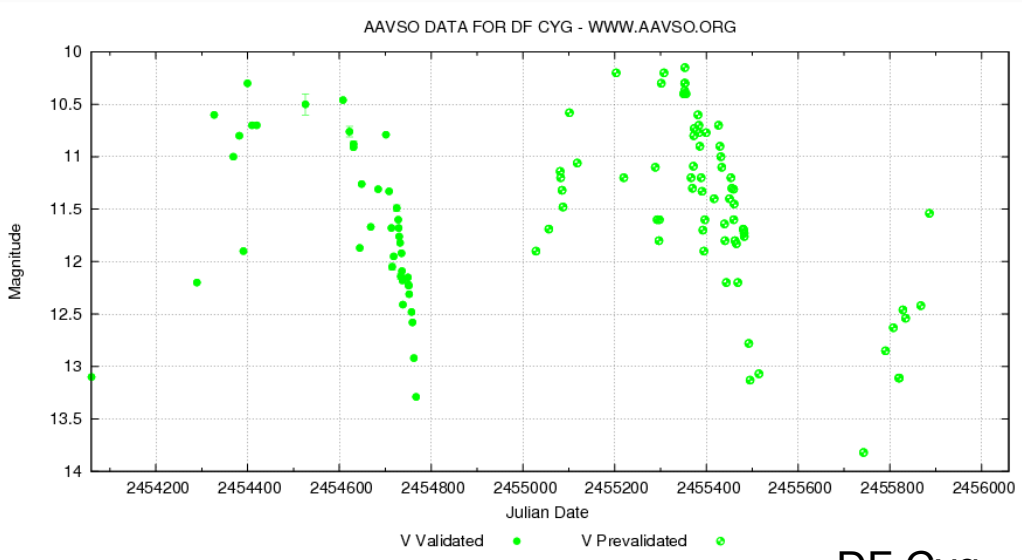
Ppuls-80 d
F-G

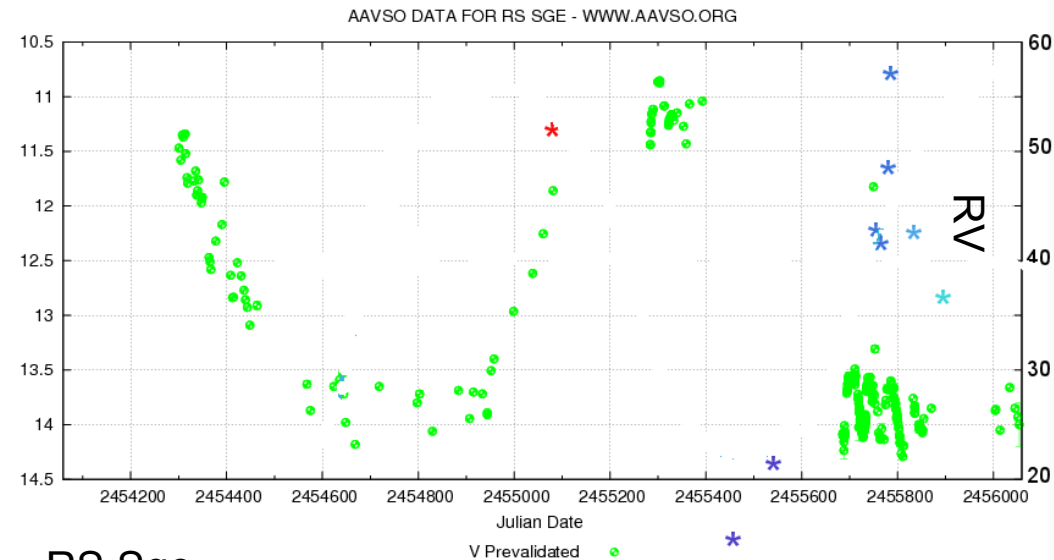


JD

2009 2010 2011 2012

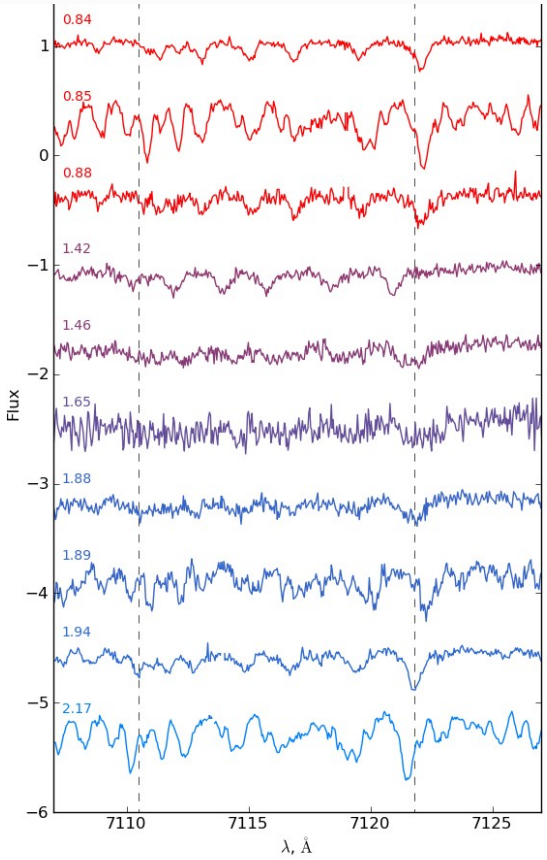
RVb phenomenon (α Per) and binarity





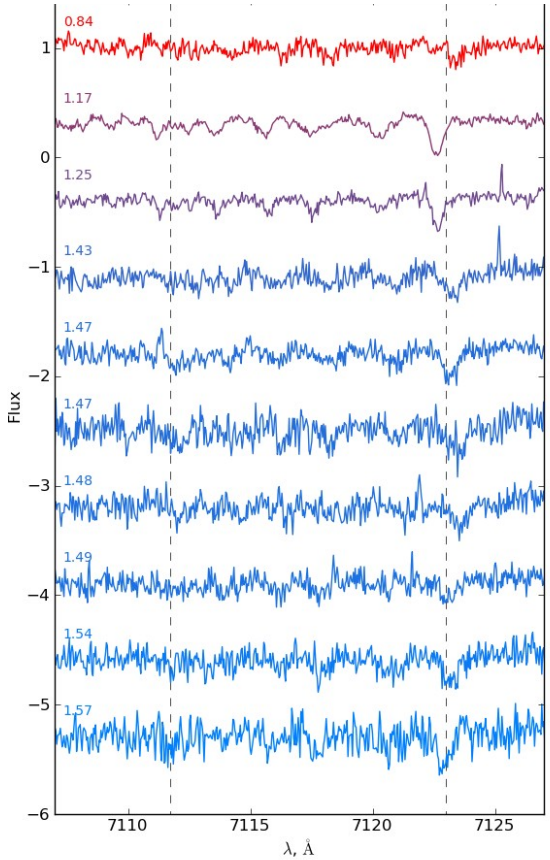
DF Cyg

Ppuls-50 d
G7-K5



RS Sge

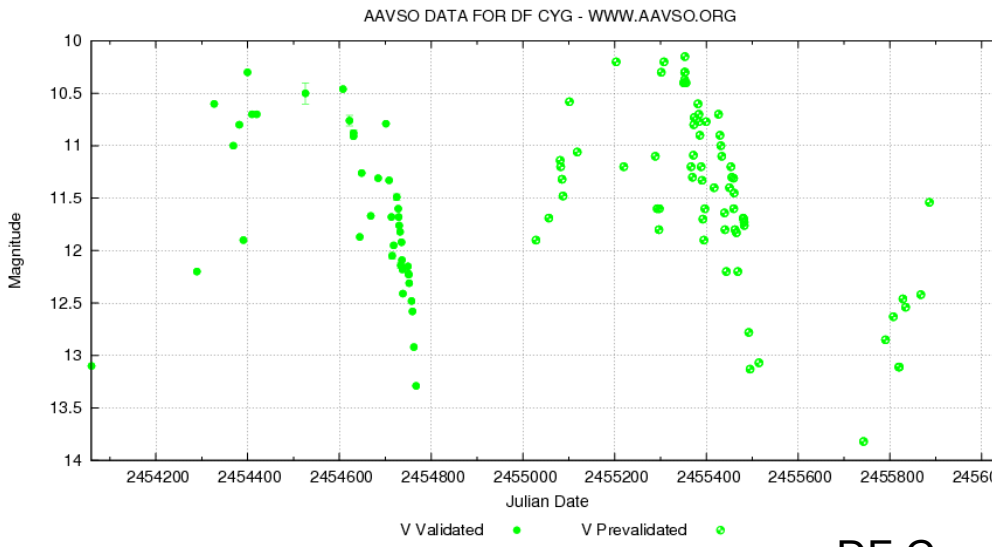
Ppuls-80 d
F-G

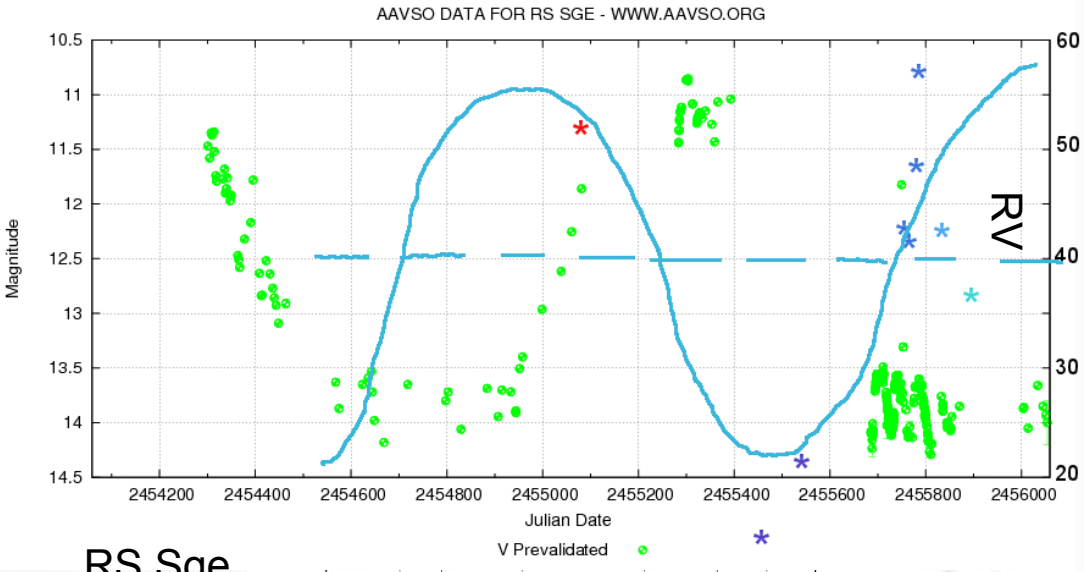


JD

2009 2010 2011 2012

RVb phenomenon (α Per) and binarity



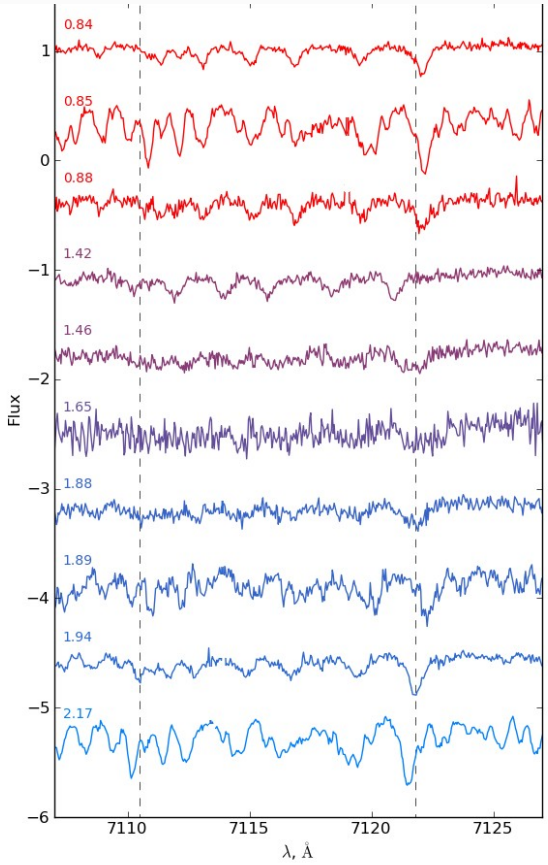


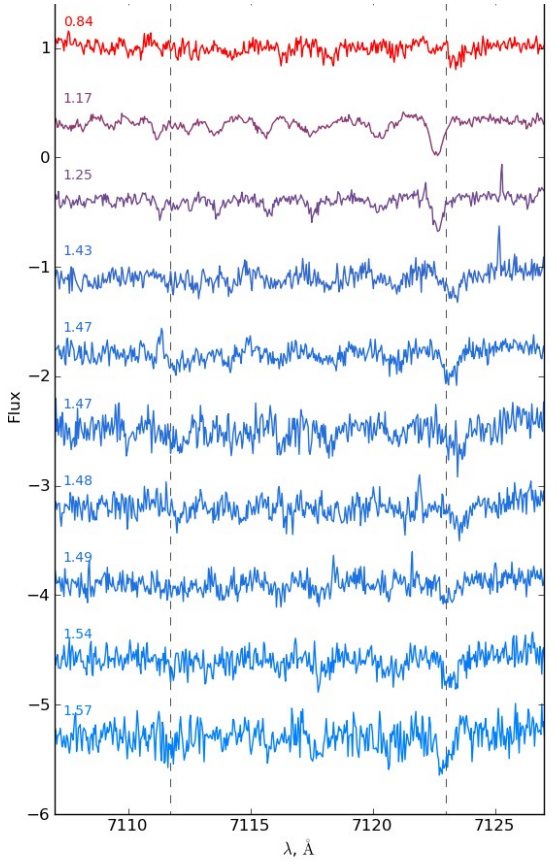
DF Cyg

Ppuls-50 d
G7-K5

RS Sge

Ppuls-80 d
F-G

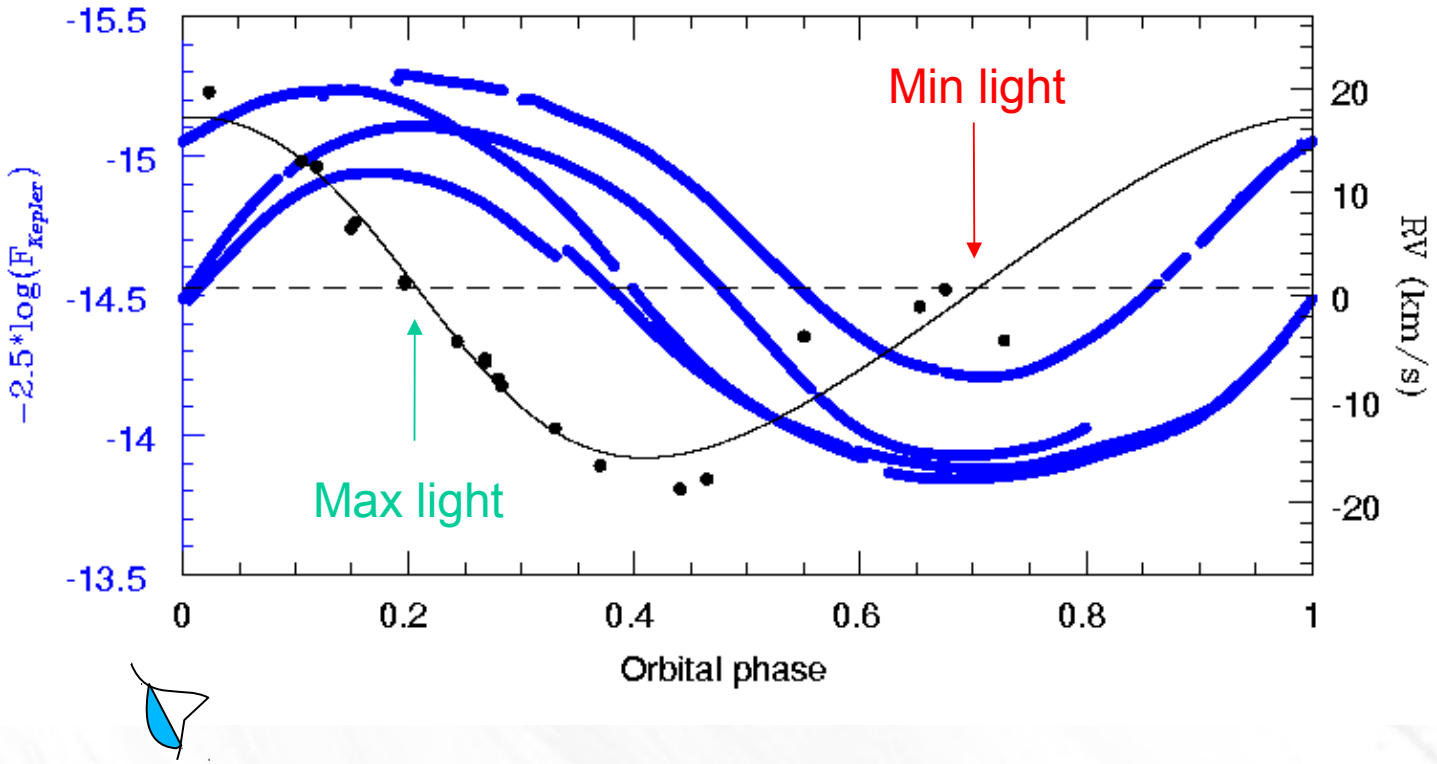


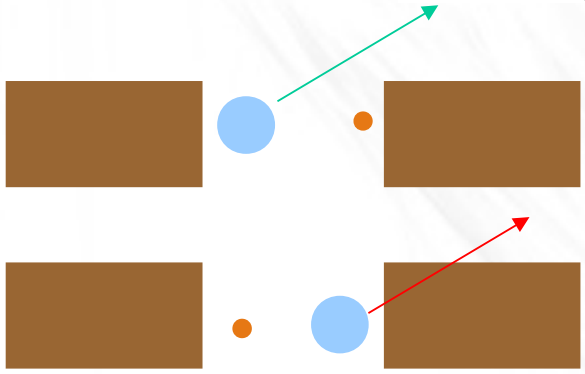


JD

2009 2010 2011 2012

HERMES RVs help explain light curves



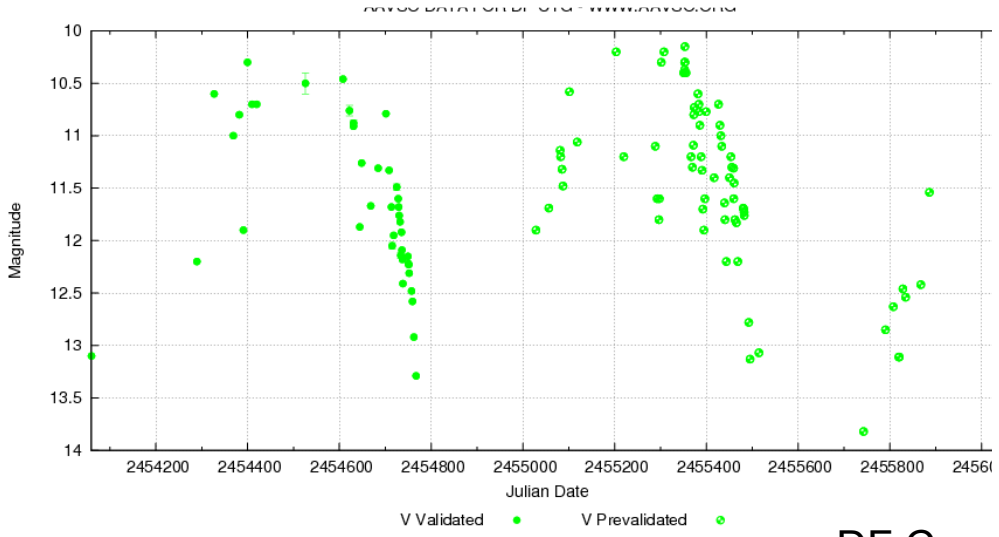


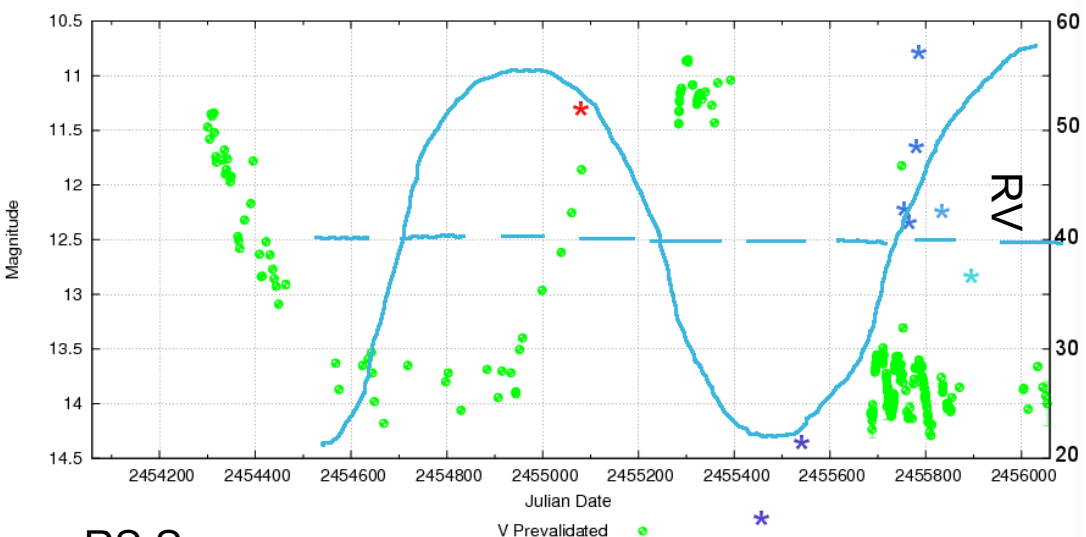
Φ=0.25

Φ=0.75

Obscuration by the disk

RVb phenomenon (α Per) and binarity

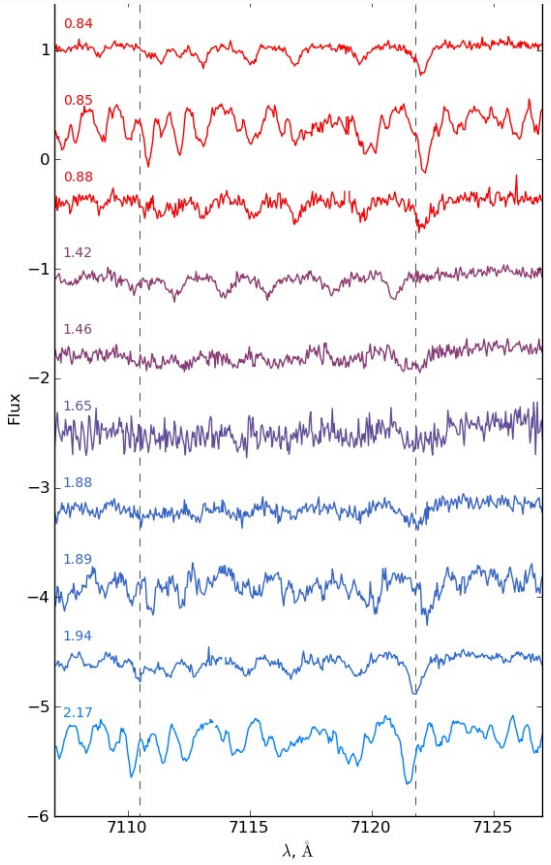




DF Cyg

Ppuls-50 d

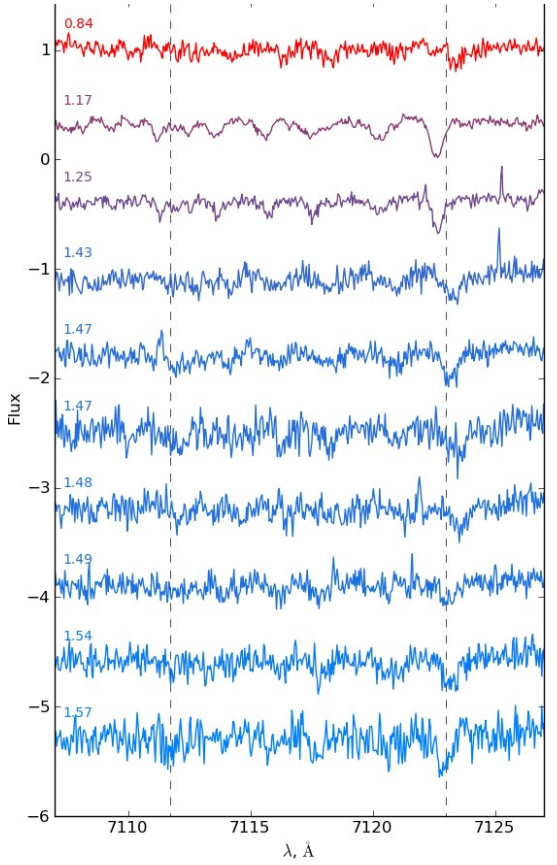
G7-K5



RS Sge

Ppuls-80 d

F-G



JD

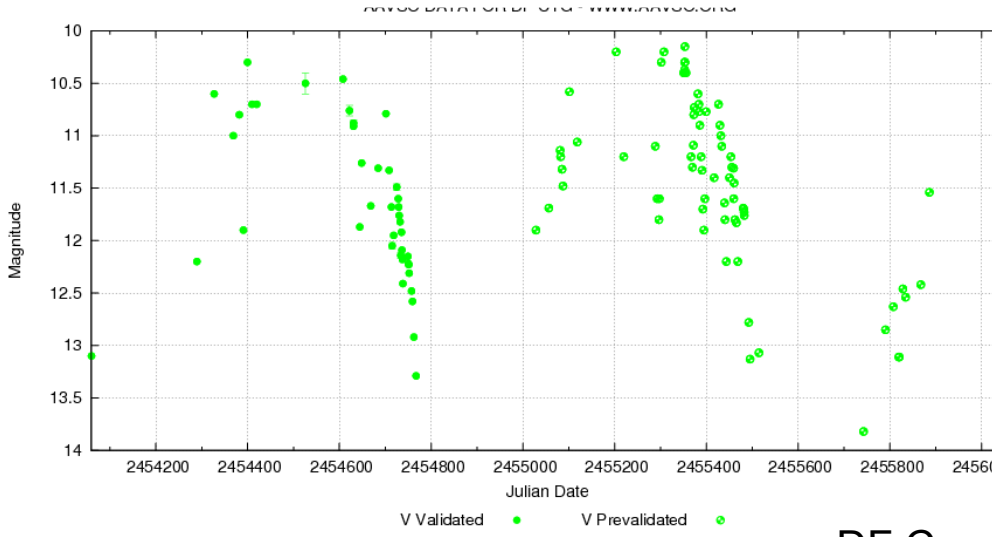
2009

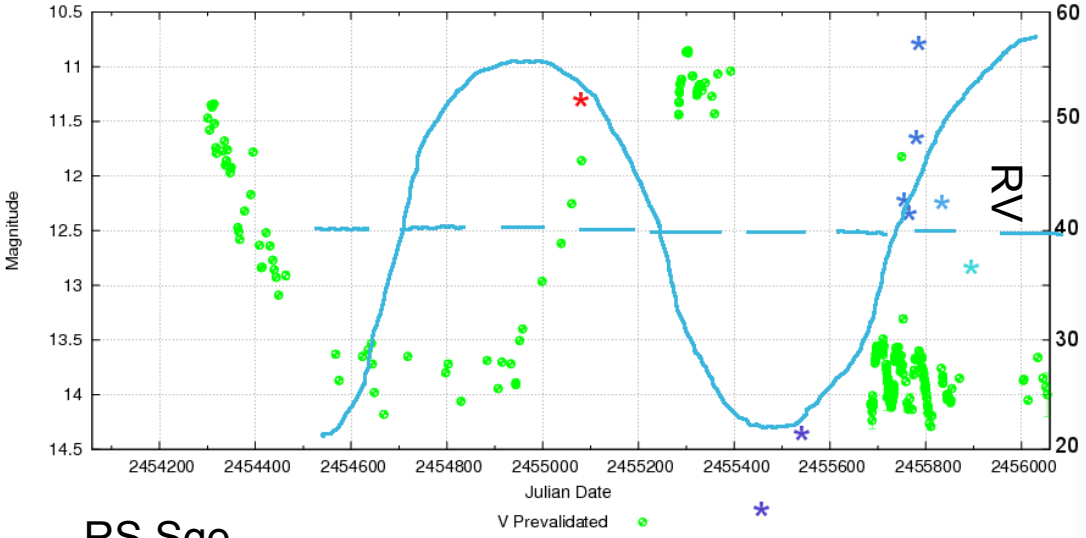
2010

2011

2012

RVb phenomenon (α Per) and binarity





DF Cyg

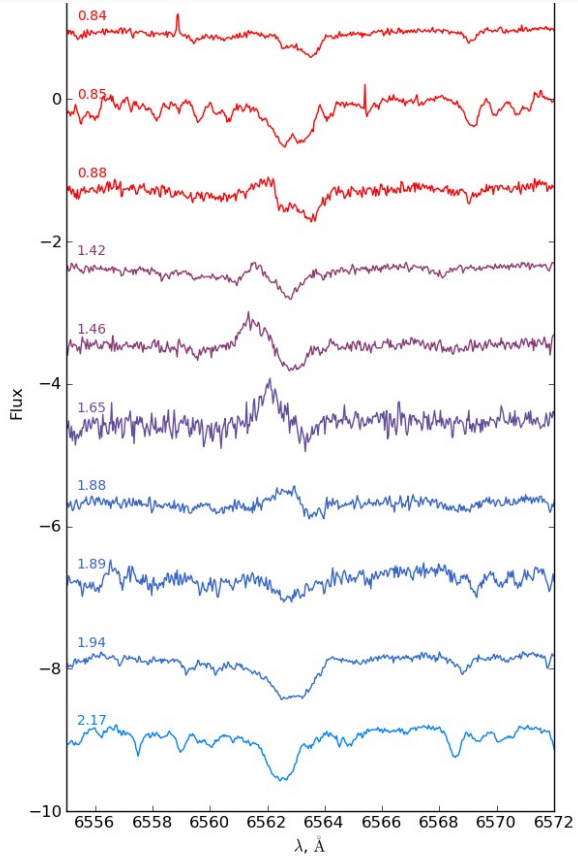
Ppuls-50 d

G7-K5

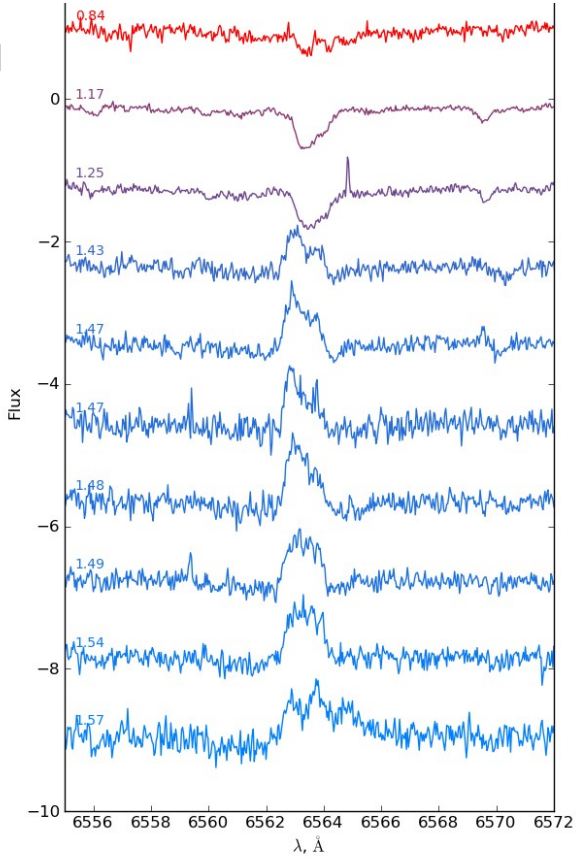
RS Sge

Ppuls-80 d

F-G



Hα



JD

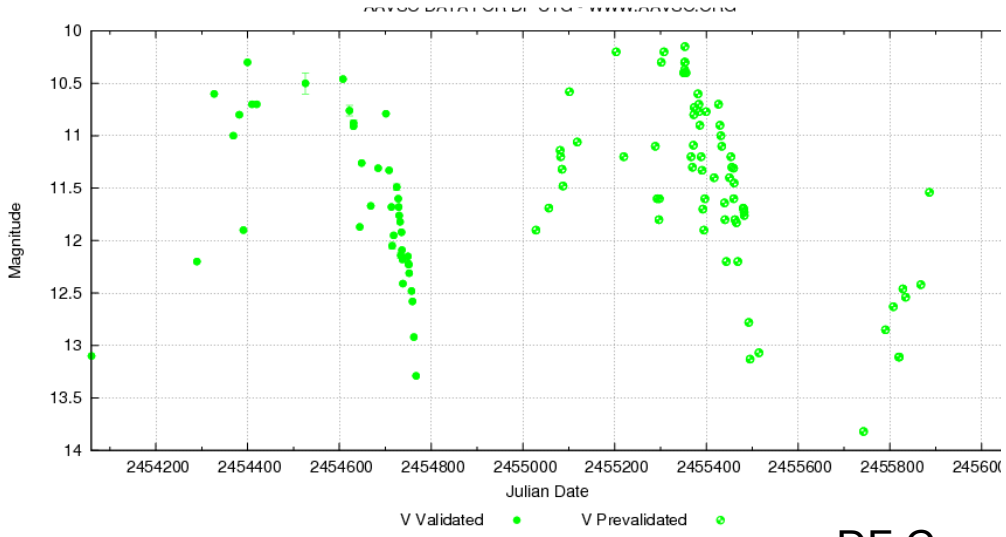
2009

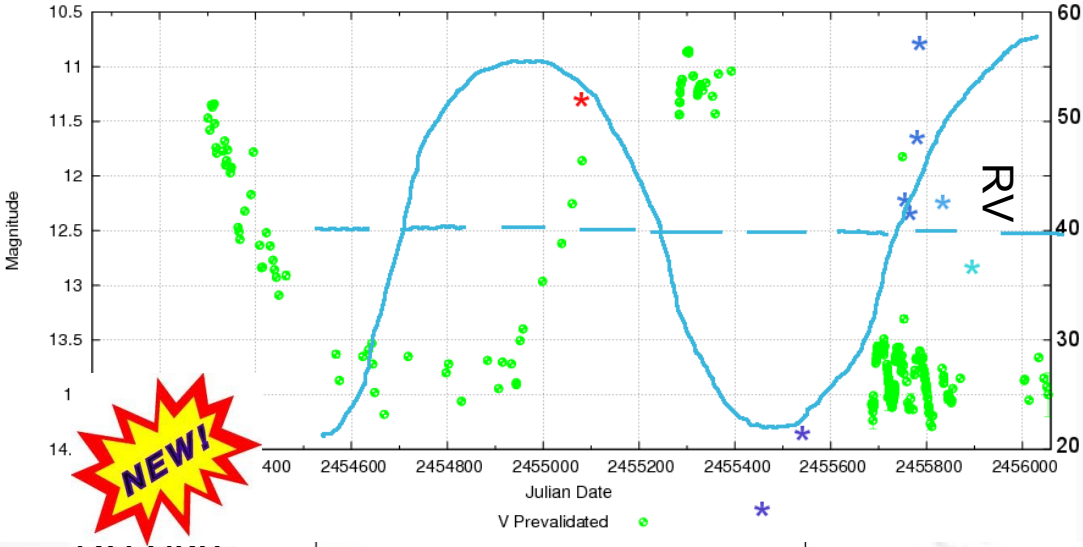
2010

2011

2012

RVb phenomenon (α Per) and binarity



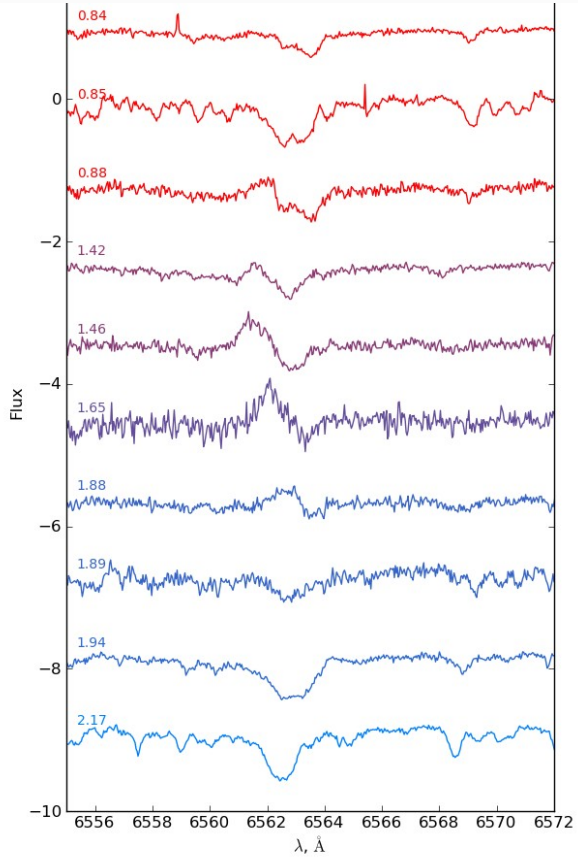


NEW!

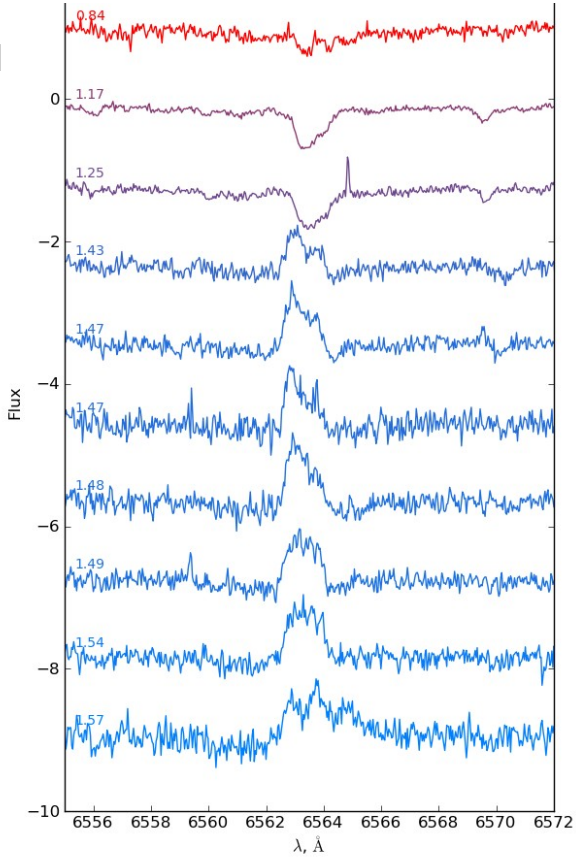
DF Cyg

Ppuls-50 d
G7-K5

Ppuls-80 d
F-G

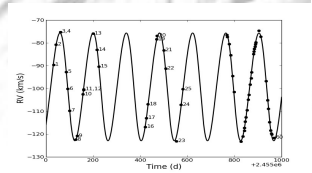
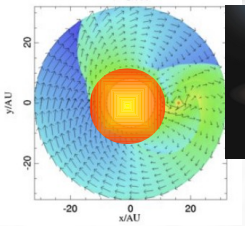
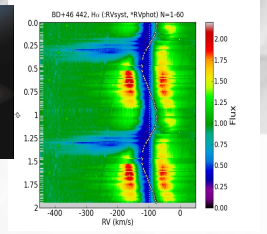


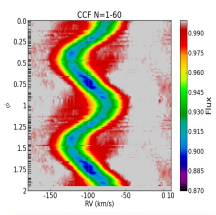
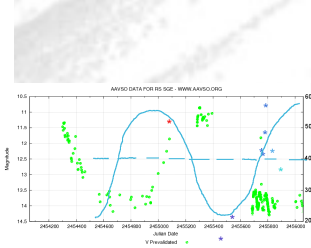
Hα



JD

2009
2010
2011
2012

Conclusions

Sample: 41 stars with the disk SEDs, RV Tau b, or depletion abundance pattern

Binarity: 2 new binaries with orbits, 1 putative companion

12 RV trends (for pulsating stars) *(Van Winckel, Hrivnak, Gorlova et al. 2012 A&A accepted)*

2 α Per & 1-2 RV Tau b type stars explained by the disk obscuration

Dynamic spectra:

5 systems with the orbital Hα variations: mass transfer with jets

(Gorlova et al. 2012 A&A accepted)

New directions

Statistics on abundances *(Gorlova 2012 JPhCS 328,208)*

Comparison with post-AGB stars with shells (single post-AGBs?)

Coronographic imaging of jets?

Fast photometry of accretion structures with Mercator-MAIA?