

# Spectroscopic Observations of V455 And 2007 Superoutburst

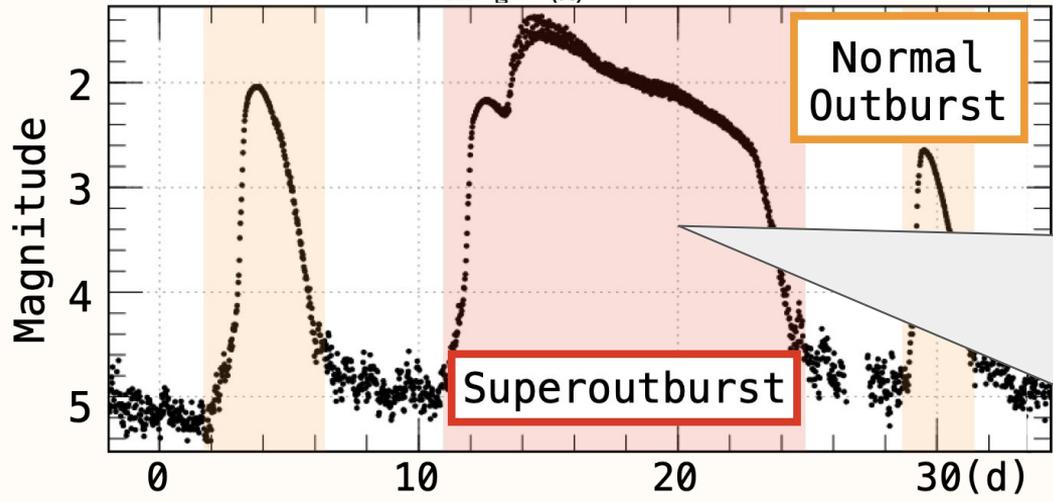
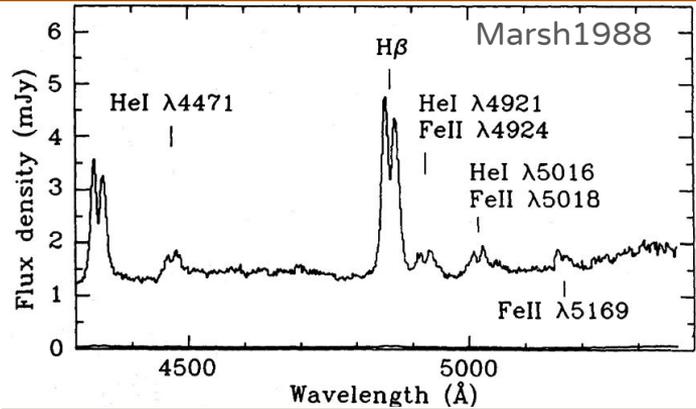
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Tampo et al., submitted in Dec. 2021

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# Dwarf Novae



Outbursts triggered by thermal-tidal instabilities in accretion disk Osaki1996

Optical spectrum : dominated by bright disk & no evidence of outflows

(Transient radio emission from jet?)  
(P Cygni profile in UV spec.) Kording+2008  
Szkody+1999

# Outburst of V455 And

“WZ Sge-type DNe”

Rare outburst

: once in >10 yrs  
(typically week~year)

Large amplitude

: ~ 8 mag  
(typically 2-5 mag)

Shows eclipse

: high inclination (75°)

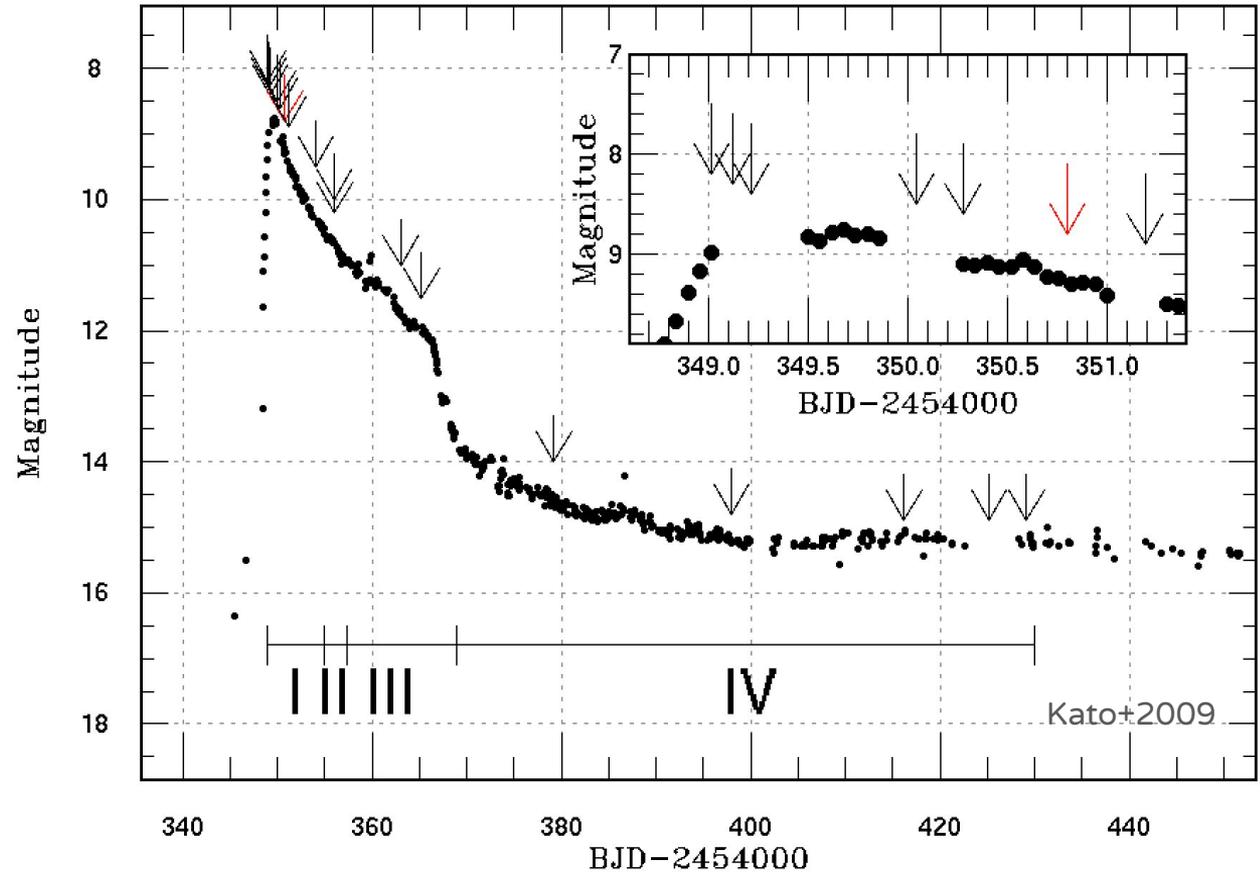
Spin Period of ~67s

: magnetized WD

Porb ~ 81 min

: most-evolved system

Araujo-Betancor+2005



# Early superhumps

In WZ Sge-type DN...

Double-peak early superhumps w/  $P_{orb}$   
in first 10 d of outburst Lin&Paparizou1979  
Osaki&Meyer2002  
Baba+2002

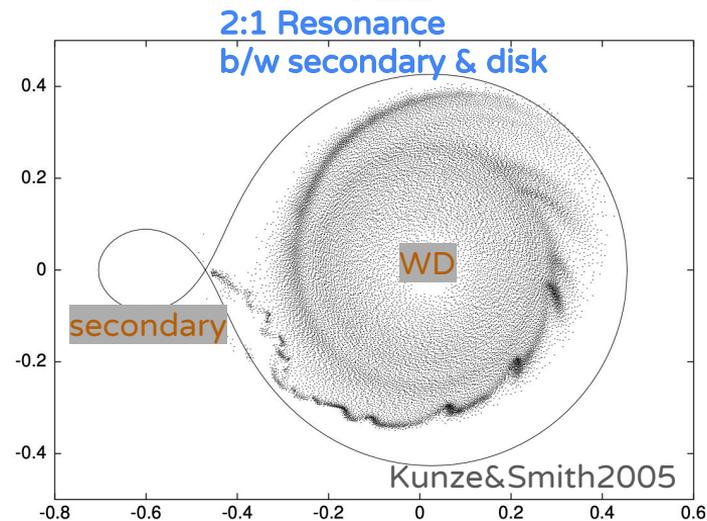
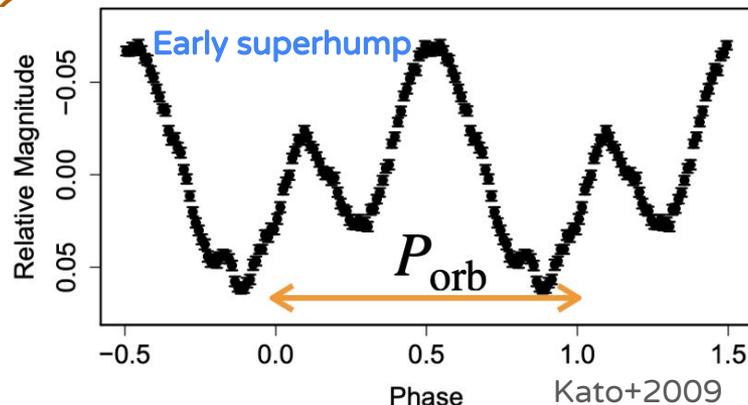
Tidal resonance  
b/w secondary & disk

⇒ vertical deformation of disk  
& spiral arm structure?

To examine the disk/system structure...

- i) : Disk height map
- ii): Line forming region

Intro. - Observation - Doppler Mapping - Discussion



# Early SH modeling

In Uemura+2012,  
to understand the height structure...

“early S.H. light curve modeling” was performed.

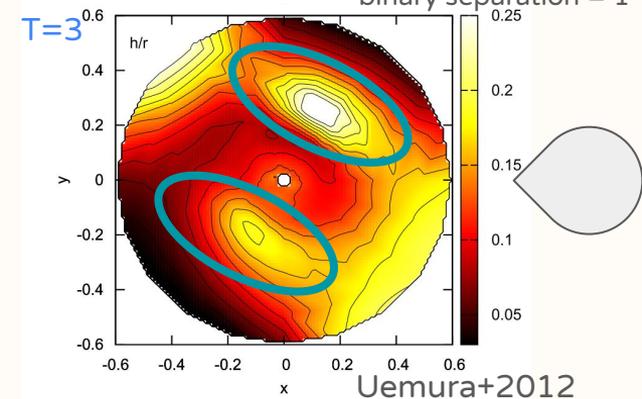
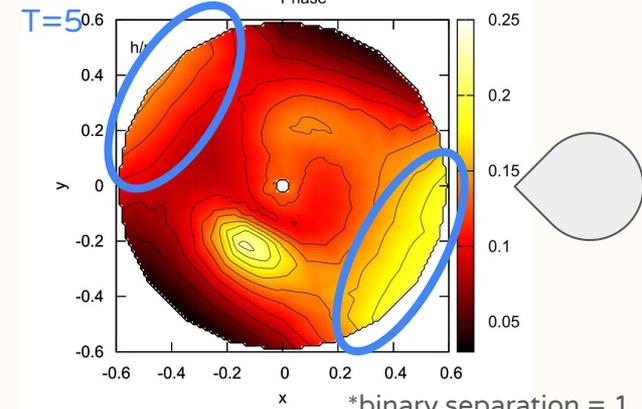
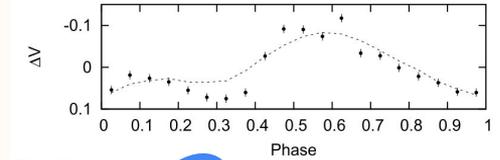
- phase of humps = azimuthal strc.
- colour of humps = radial strc.

Assuming  $T=r^{(-3/4)}$ , Blackbody, self-occultation  
Rout=2:1 RR, Tin=8.2e4 K, incl.=75°

Outermost parts correspond hump maxima

+ inner elongated structure

⇒ Spiral structure induced by 2:1 resonance



Uemura+2012

# Observation w/ Subaru

Intro. - **Observation** - Doppler Mapping - Discussion

Subaru HDS on Day 1.7 (Sep., 7th, 2007)

: R~40,000 (~10km/s)

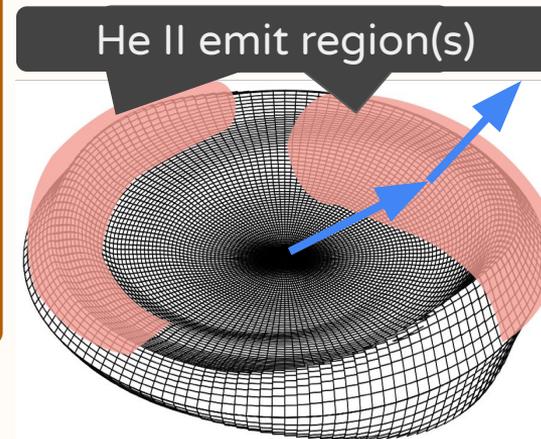
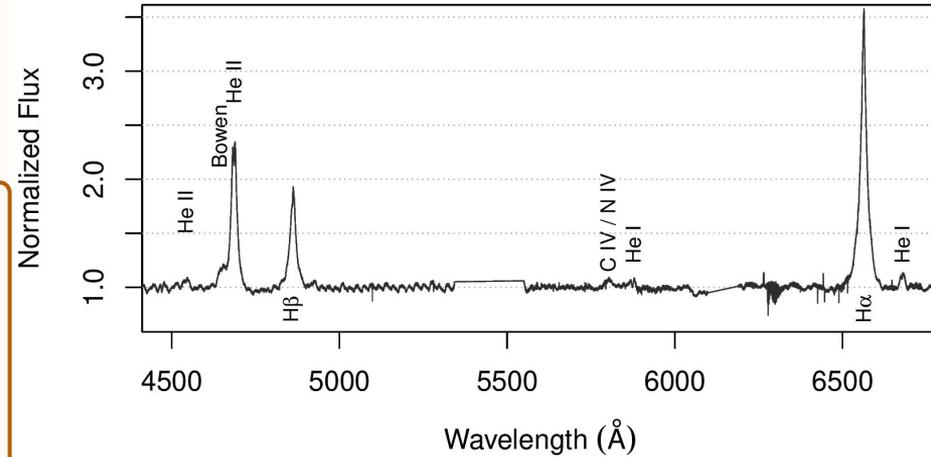
: ~1 Porb coverage, 30s exposure

: **H $\alpha$ , He II 4686,**

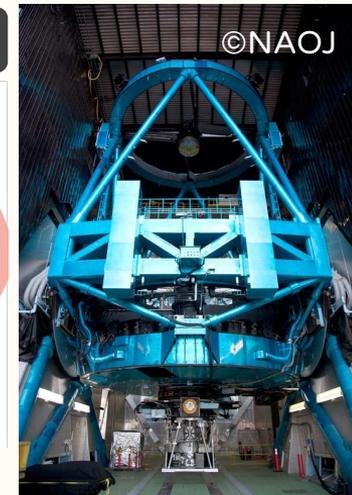
Balmer, He I, Bowen, C IV / N IV

Heated & irradiated arm structure  
will emit the strong  
He II 4686 emission ?

Baba+2002,  
Tampo+2021



Maehara+2006



# Time-resolved spectra

But in V455 And...

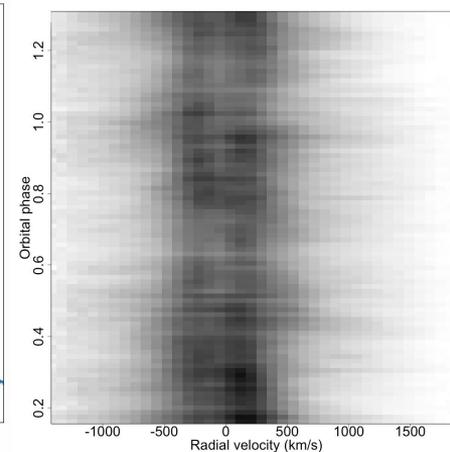
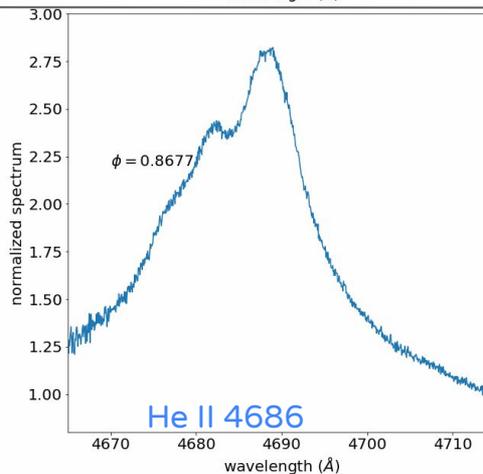
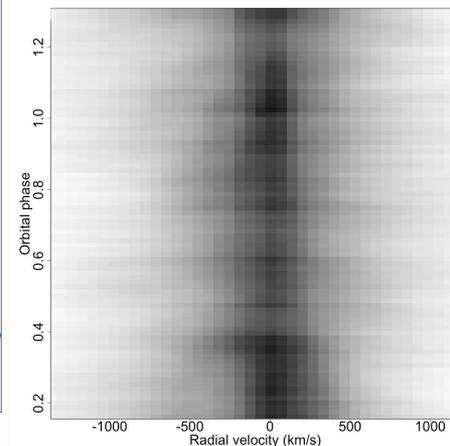
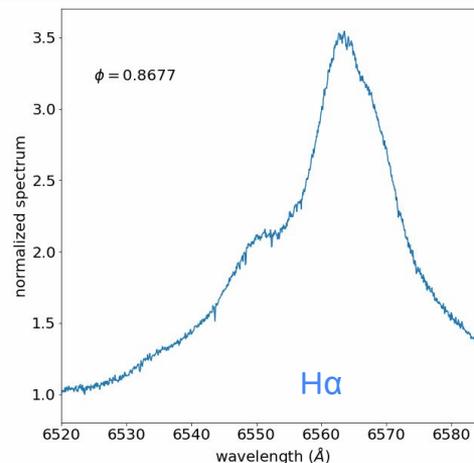
## Single-peak H $\alpha$

:NOT expected in eclipsing system  
(double-peak expected from disk)

## Double-peak He II 4686 w/ 440 km/s

: Too slow for emitted  
from Keplerian disk  
( $\sim 1,000$  km/s @incl. $\sim 75^\circ$ )

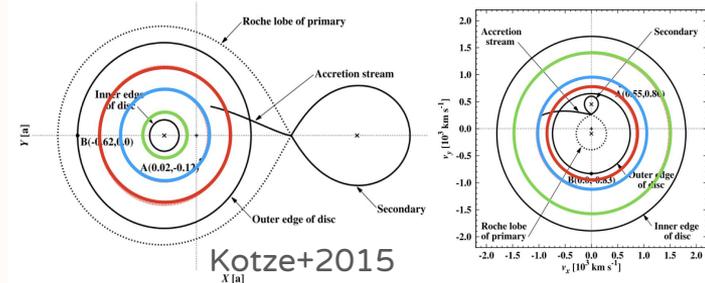
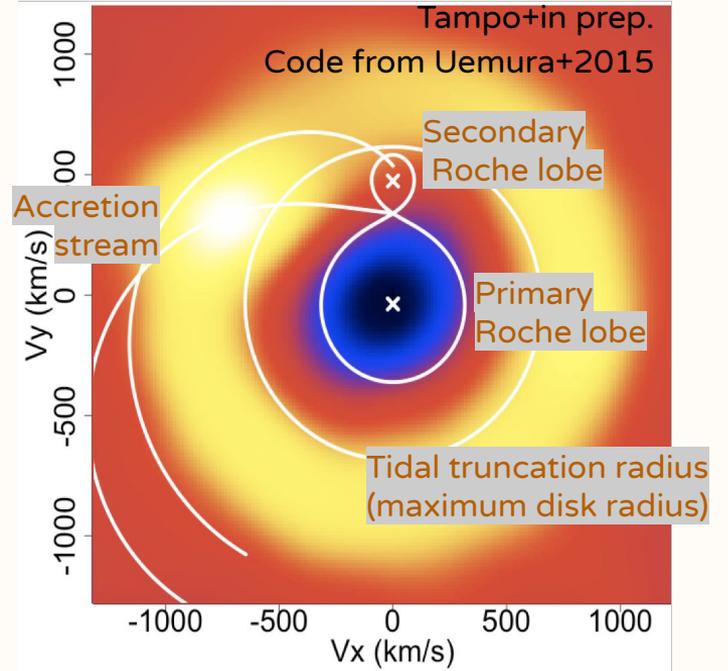
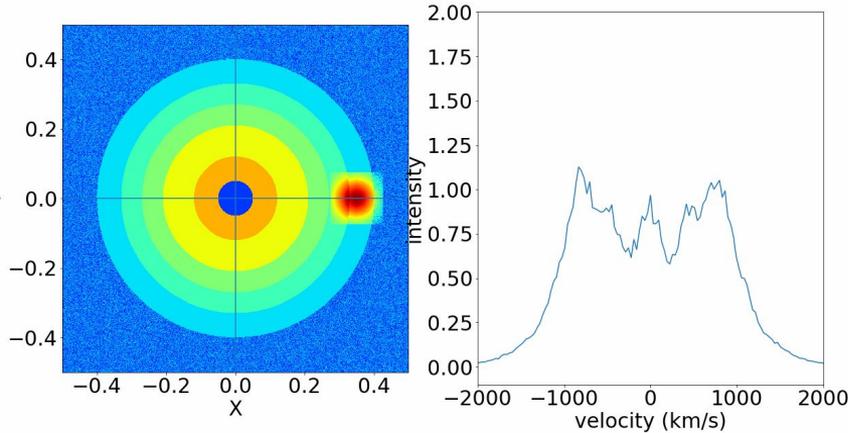
$\Rightarrow$  **Disk is not the origin of these emission**  
What structure can emit such lines?



# Doppler tomography

Marsh&amp;Horne1988

Time variation of emission line profiles  
: orbital rotation  
& variation of projected velocity  
→ line emissivity map in **velocity space**



# Doppler Map: H $\alpha$

Compact blob on primary WD  
 $\Rightarrow$  NOT likely from rotating disk

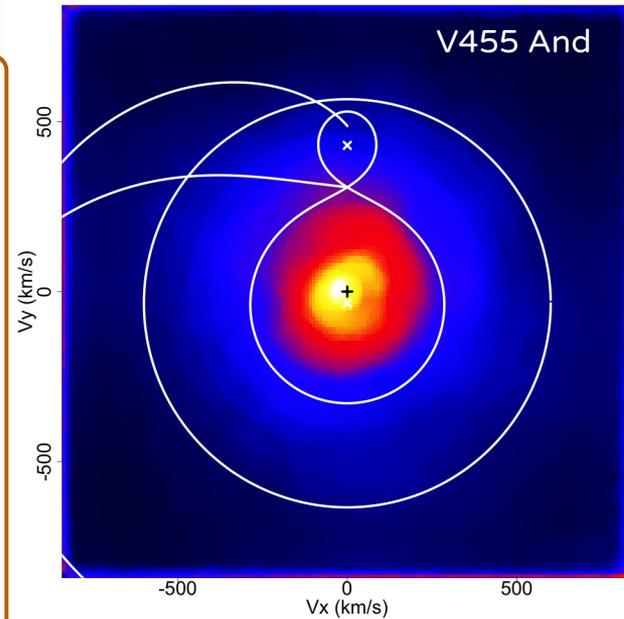
In high accretion-rate systems (novalike),  
 a blob on the WD interpreted as

1. **disk wind** e.g., Honeycutt 1986
2. **magnetic accretion column**  
 e.g., Williams 1989

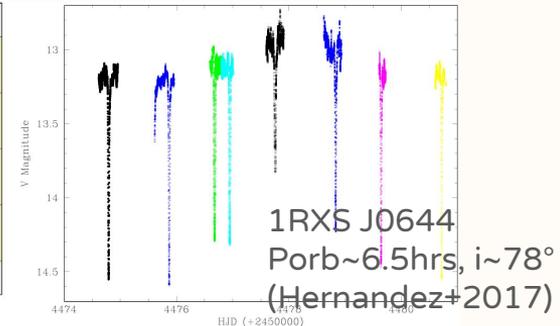
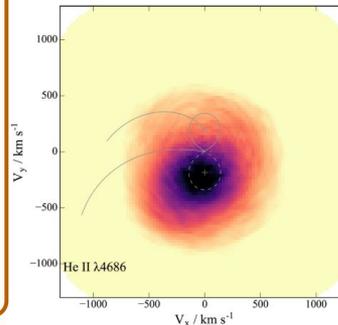
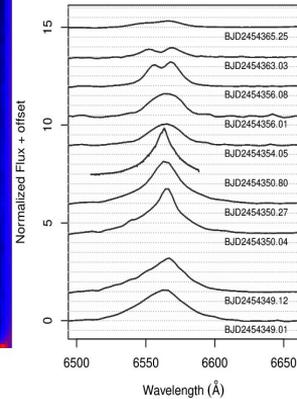
If originated from magnetic WD,  
 lower accretion rate in late phase  
 $\rightarrow$  clearer magnetic sign?

$\Leftrightarrow$  Later spectra showed double-peak

$\Rightarrow$  **Single peak emission from disk wind?**



Porb = 0.05631d  
 Incl. = 75 deg,  
 $q = 0.080$ ,  
 $M_{wd} = 0.6 M_{sol}$   
 (Araujo-B+2005)



# Doppler Map: He II 4686

Ring-like structure w/  $\sim 200$  km/s

In Keplerian disk,

:  $R \sim 2 \times$  binary separation

→ NOT from disk **but can be WIND?**

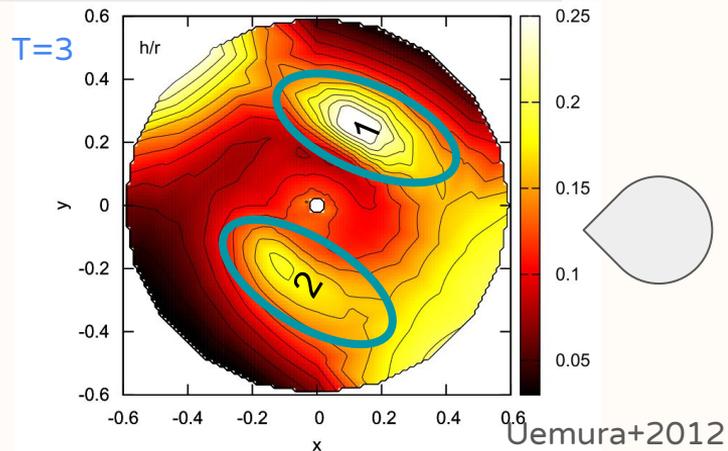
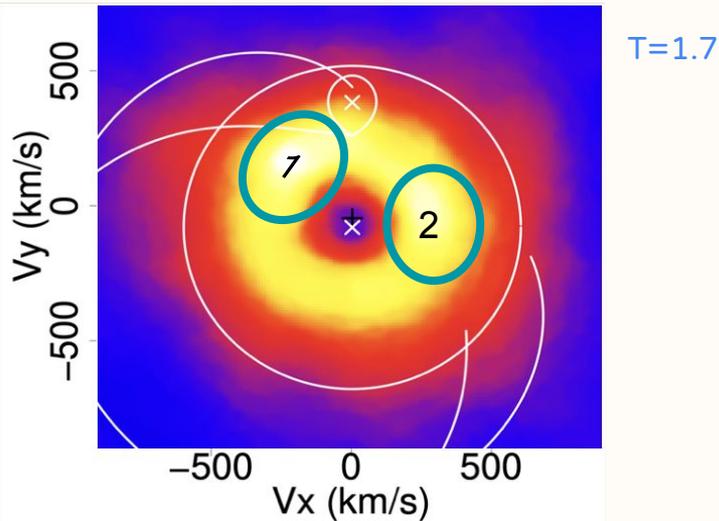
Honeycutt+1986  
Matthews+2015

2 superimposed flaring spots in Dop map

: **corresponding inner arm structure**

Considering narrow emission lines...

**Non-axisymmetric wind launch** & emission  
**from the spiral arm** resulted narrow He II line?





## Spectroscopic study of dwarf nova V455 And w/ Subaru HDS

- Balmer, He I, He II, C IV / N IV lines are detected on T=1.7
- H $\alpha$  Dop map: narrow emission originate from the disk wind
- He II Dop map : non-axisymmetric emission highlights spiral arm
- First optical result inferring the presence of wind in DN outburst