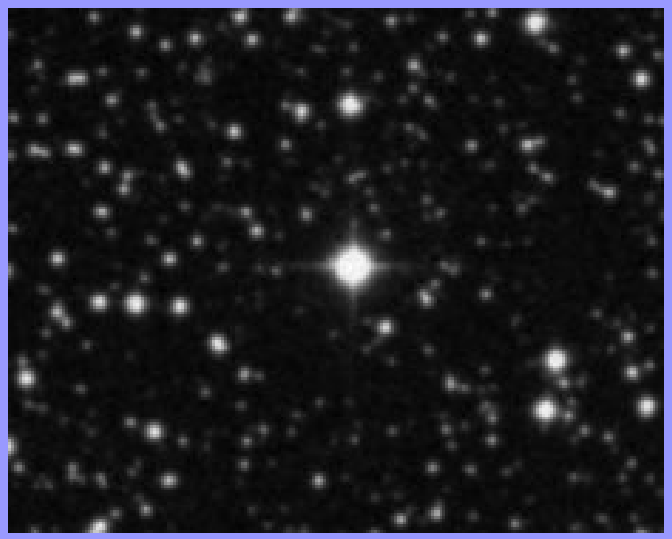
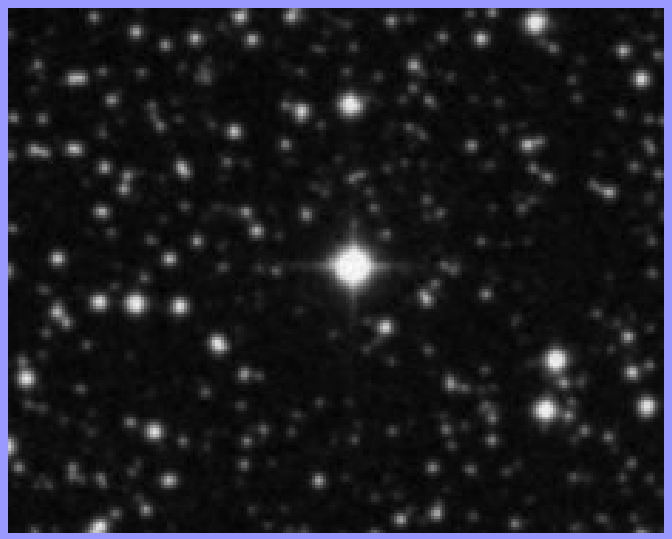
Very peculiar wind from BD+53°2790, the optical counterpart to 4U 2206+54



Pere Blay

1st NUVA Conference
SPACE ASTRONOMY: THE UV WINDOW TO THE UNIVERSE
El Escorial, May 28 – June 1, 2007

Very peculiar wind from BD+53°2790, the optical counterpart to 4U 2206+54



Pere Blay

Ignacio Negueruela, Marc Ribó, etc.

1st NUVA Conference
SPACE ASTRONOMY: THE UV WINDOW TO THE UNIVERSE
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Outline

- BD+53°2790
- The UV spectrum
- SEI method
- Genetic method
- Why do we trust the UV result?
- Conclussions

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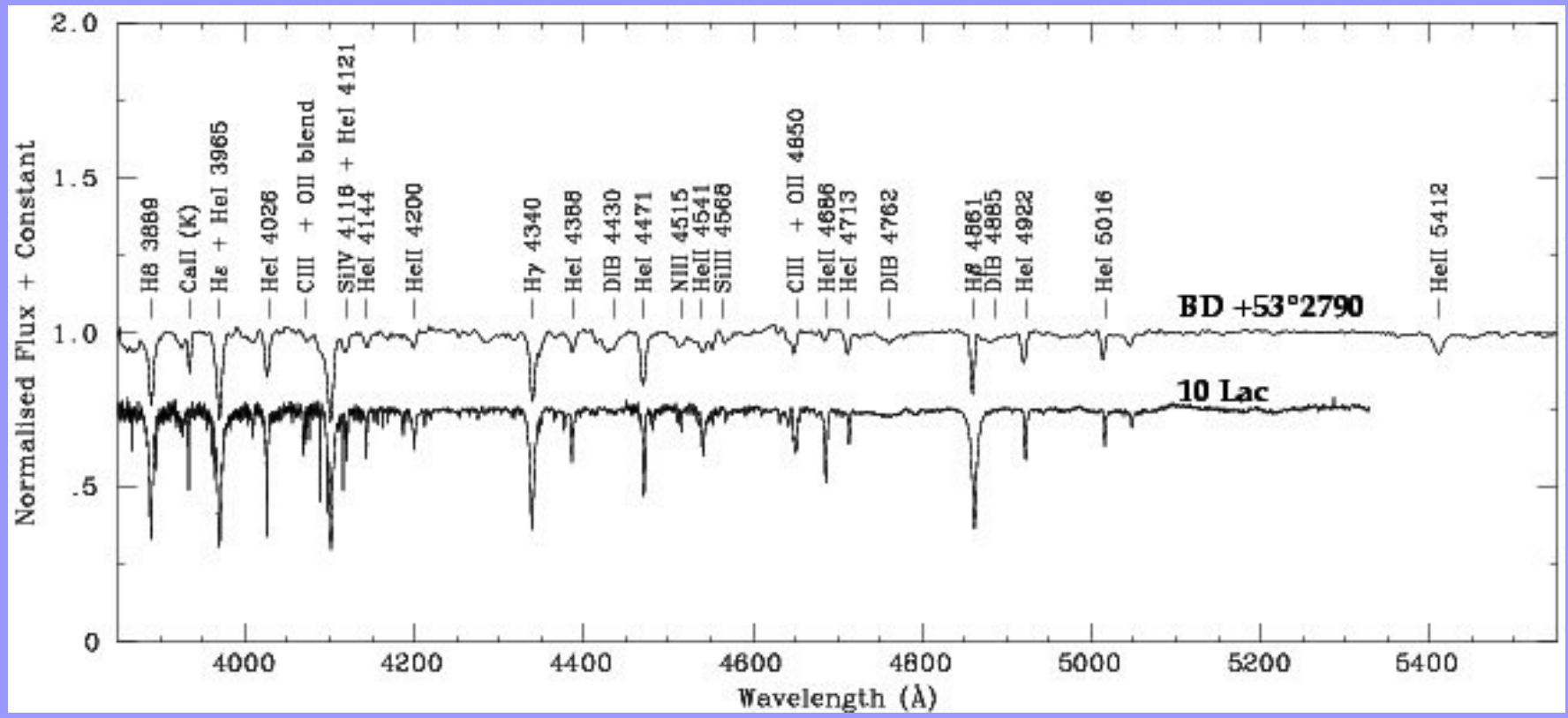
BD+53°2790

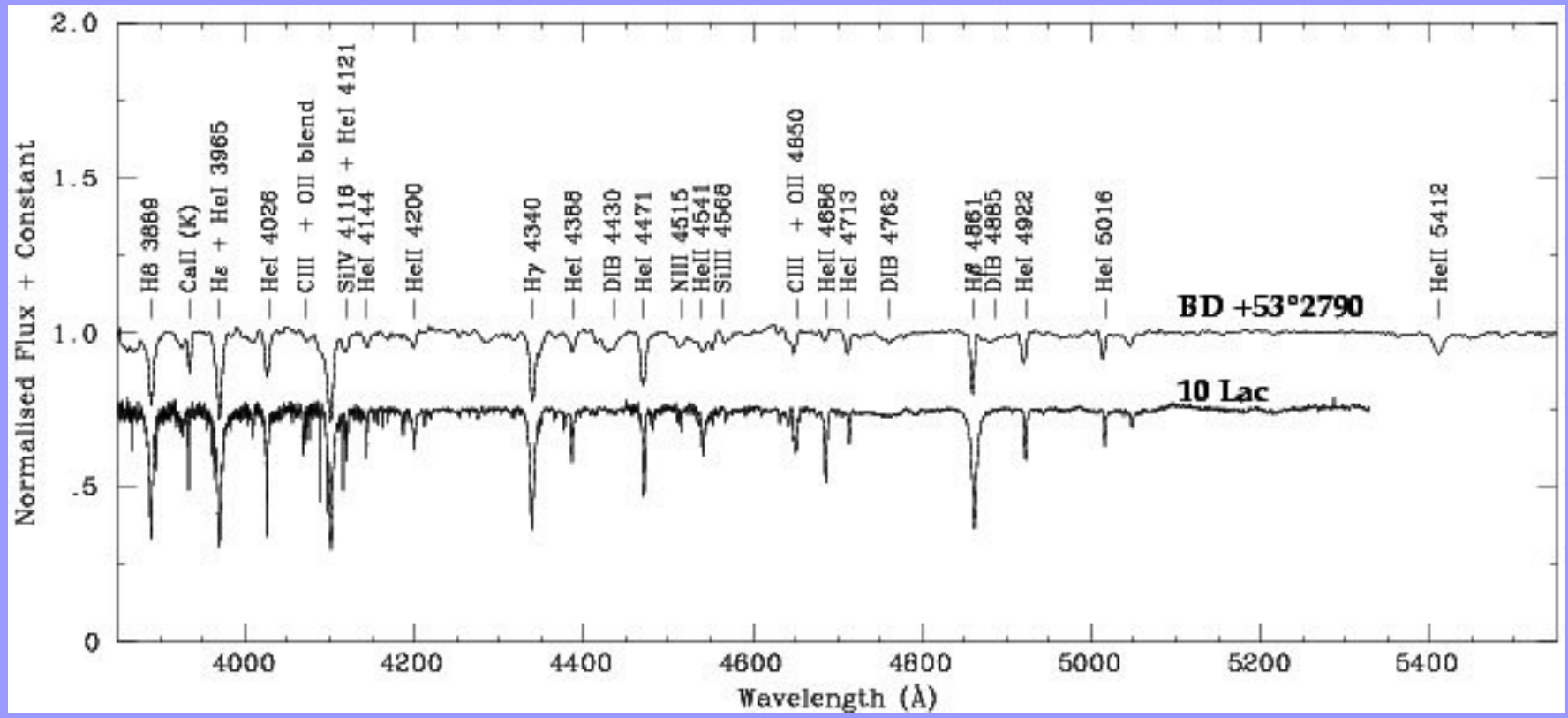
The spectrum in the classification region shows a fast rotating O9.5V star.



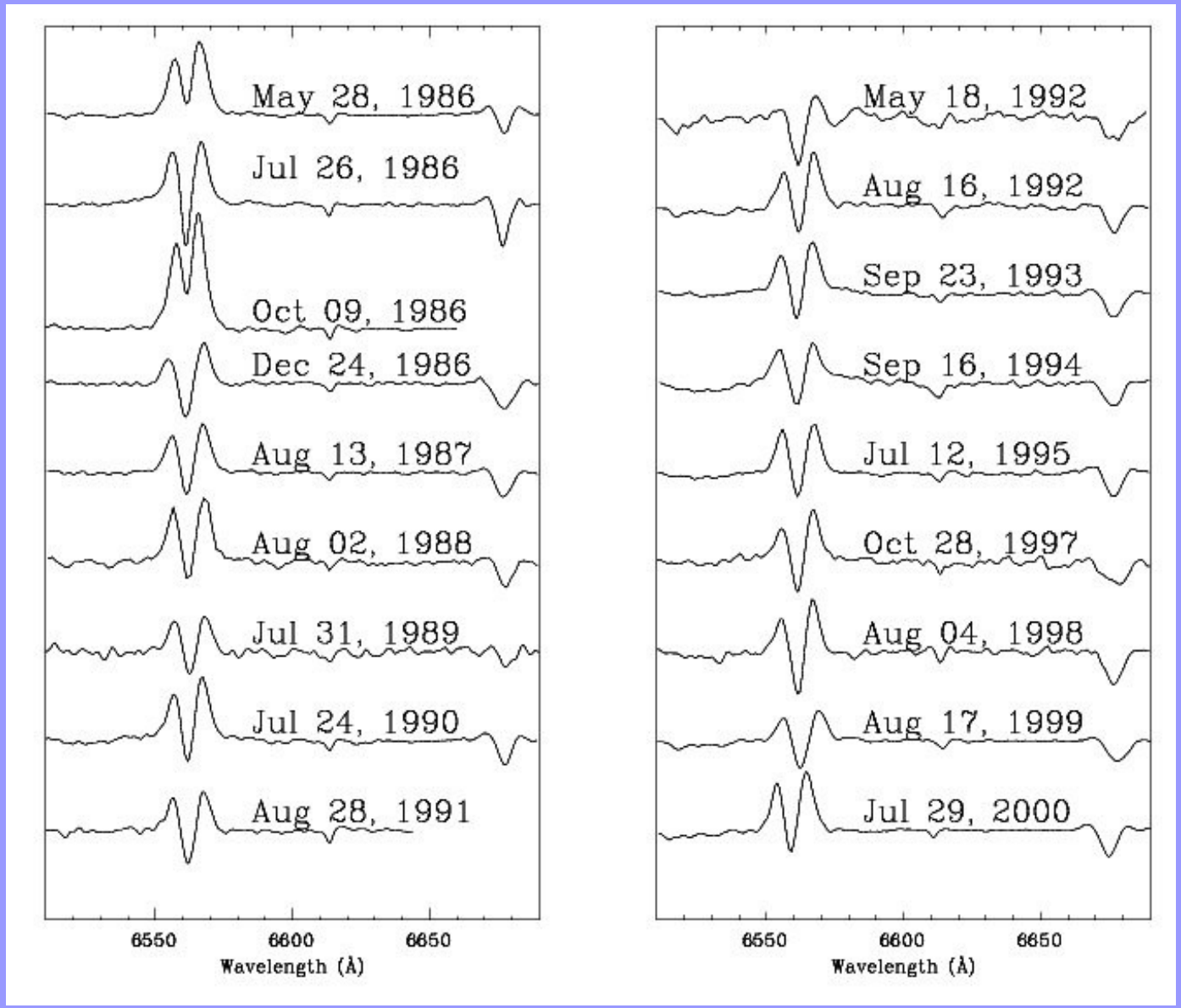
BD+53°2790

He II λ 4200 Å & λ 5412 Å N III λ 4515 Å

He II λ 4541 Å / He II λ 4471 Å



BD+53°2790


May 28, 1986
Jul 26, 1986
Oct 09, 1986
Dec 24, 1986
Aug 13, 1987
Aug 02, 1988
Jul 31, 1989
Jul 24, 1990
Aug 28, 1991
6550
6600
6650
Wavelength (Å)
May 18, 1992
Aug 16, 1992
Sep 23, 1993
Sep 16, 1994
Jul 12, 1995
Oct 28, 1997
Aug 04, 1998
Aug 17, 1999
Jul 29, 2000
6550
6600
6650
Wavelength (Å)

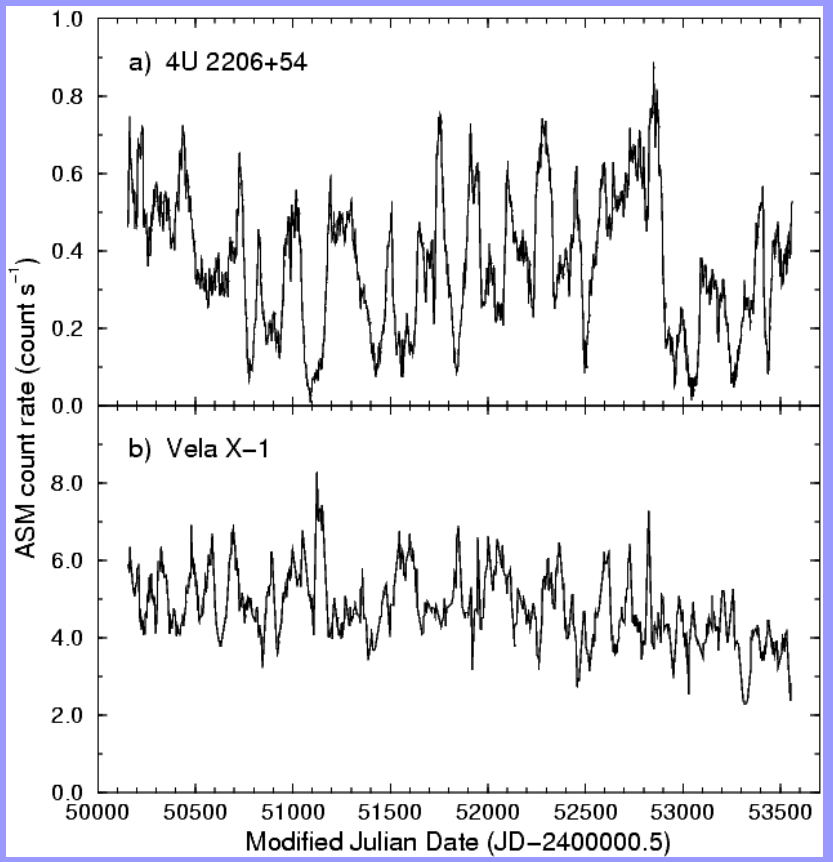
BD+53°2790

This O9.5V star is the optical counterpart to the HMXRB 4U 2206+54.

BD+53°2790

This O9.5V star is the optical counterpart to the HMXRB 4U 2206+54.

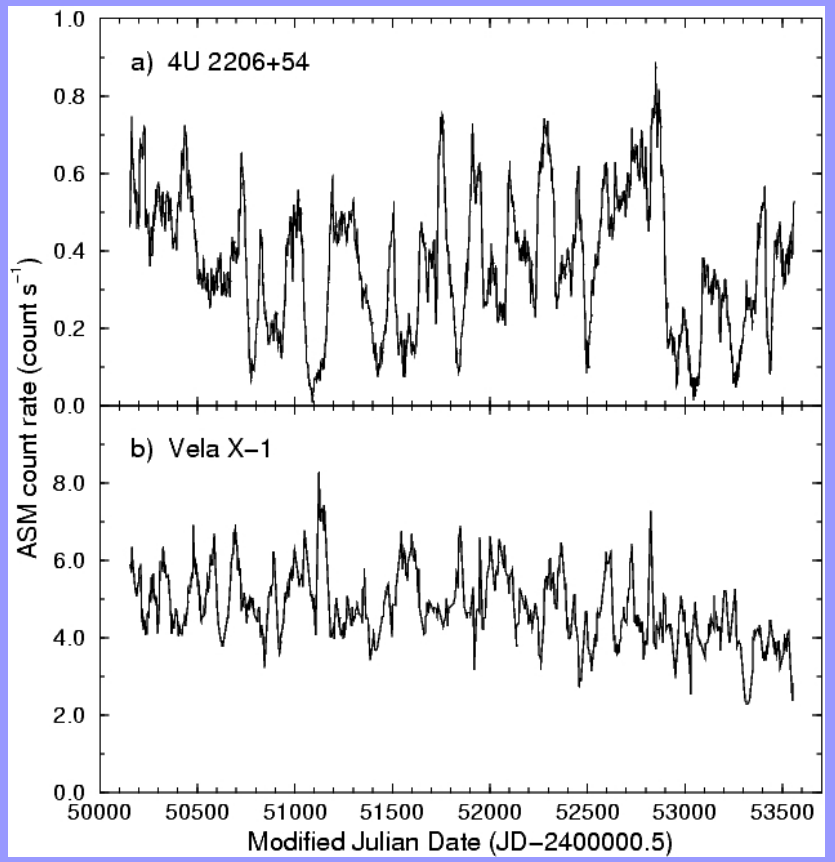
This system shows an X-ray light curve typical of accretion fed by stellar wind from the massive companion



BD+53°2790

This O9.5V star is the optical counterpart to the HMXRB 4U 2206+54.

Vela X-1 ⟶
Supergiant

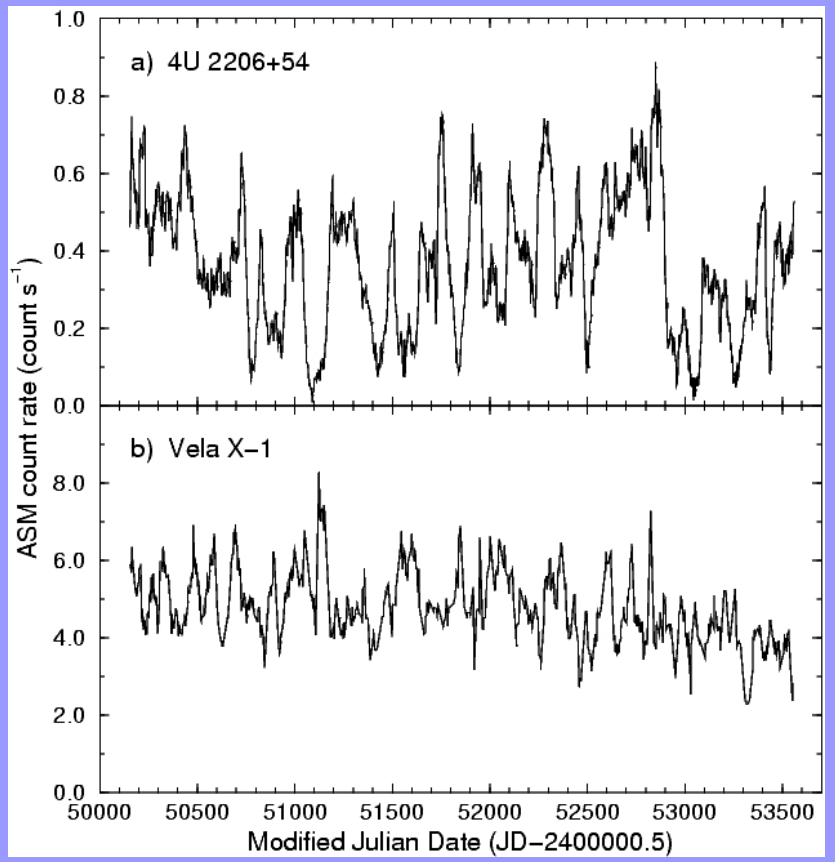


BD+53°2790

This O9.5V star is the optical counterpart to the HMXRB 4U 2206+54.

4U 2206+54 → Main Sequence

Vela X-1 → Supergiant



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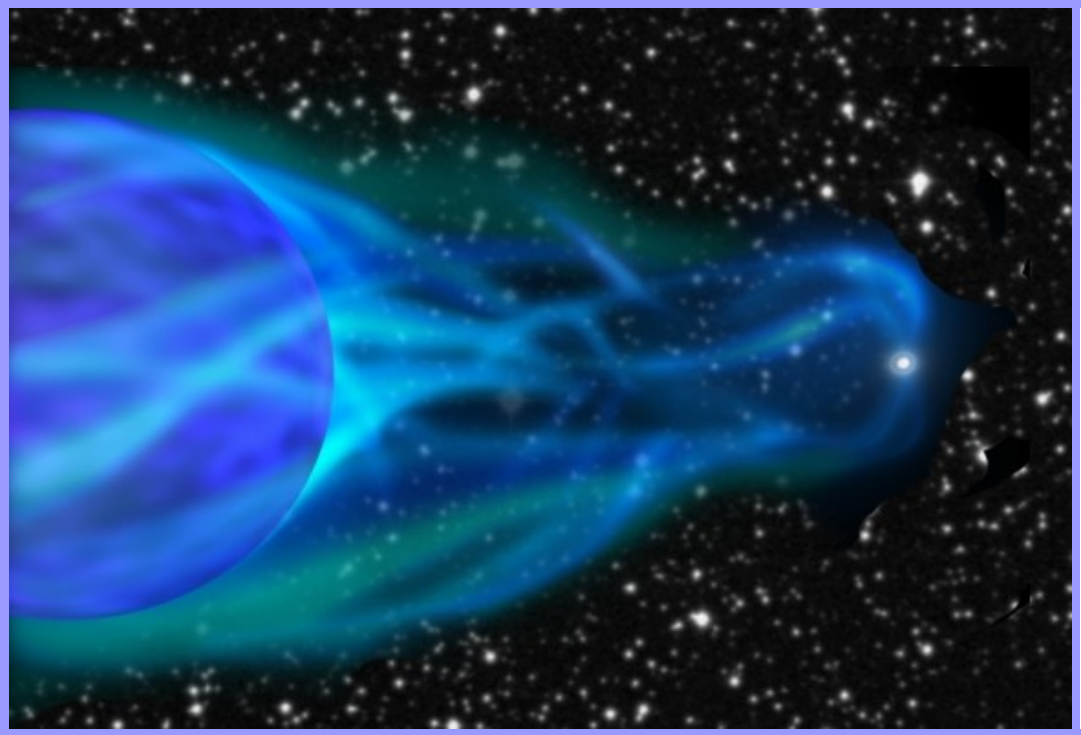

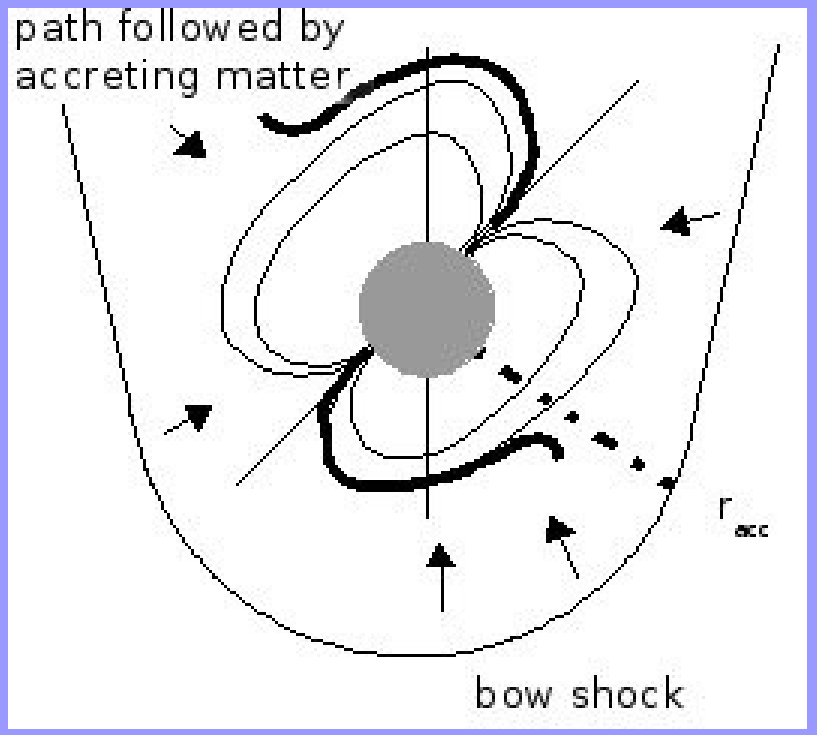

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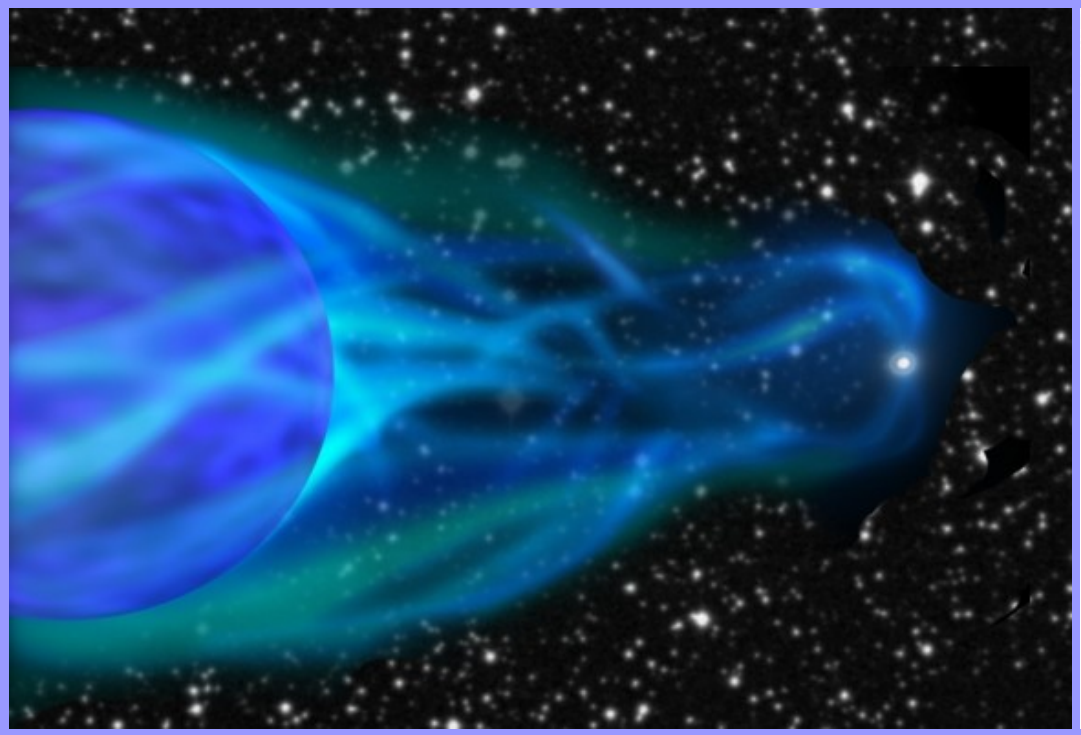
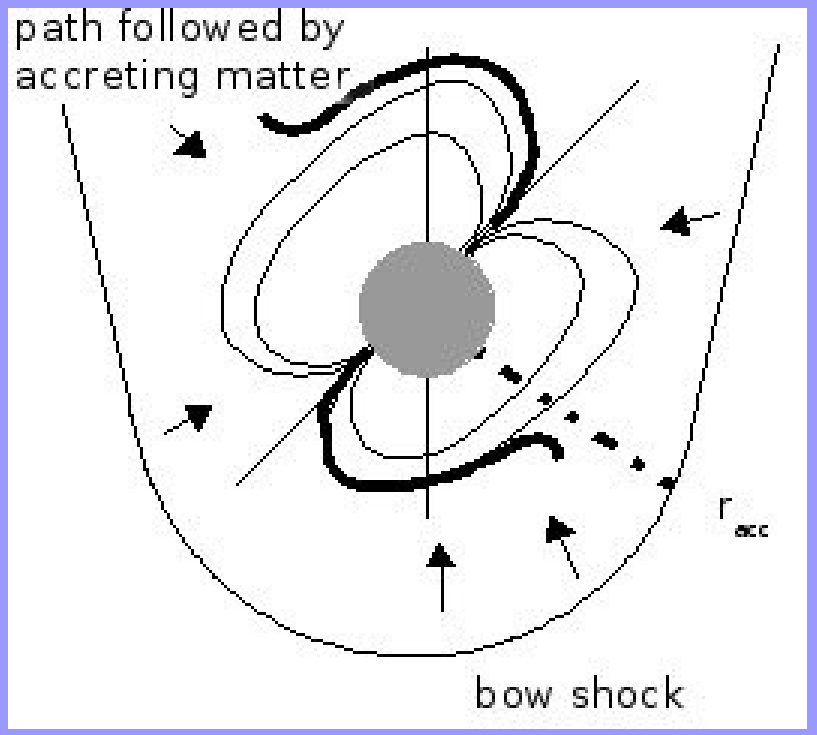
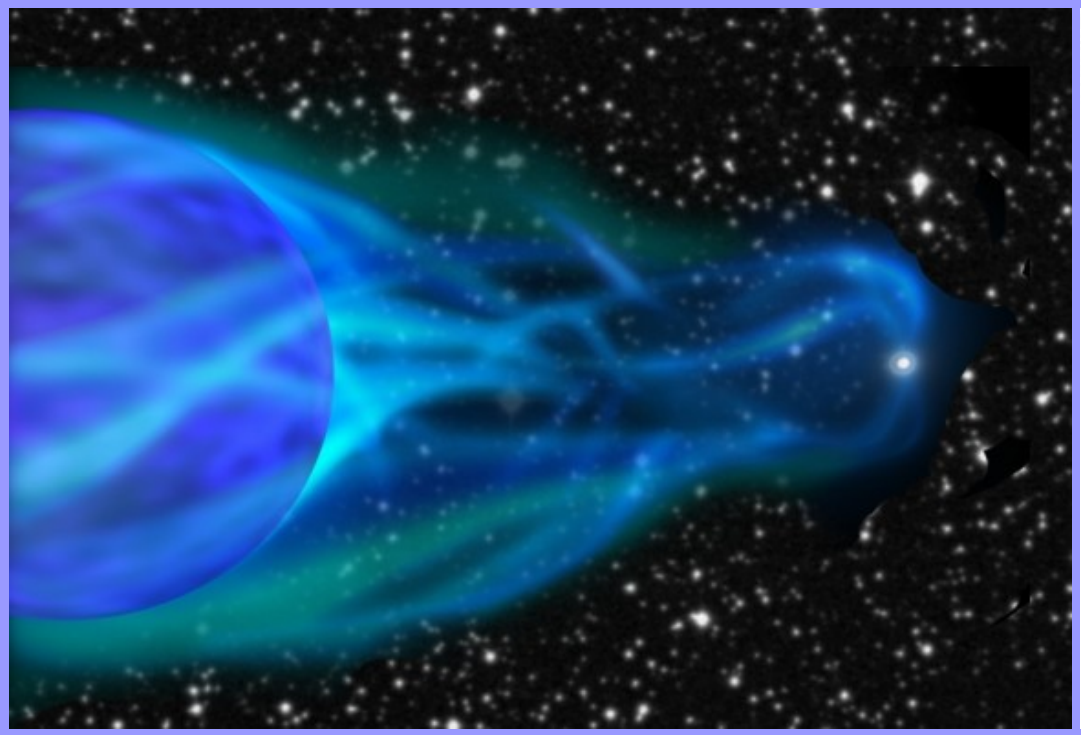


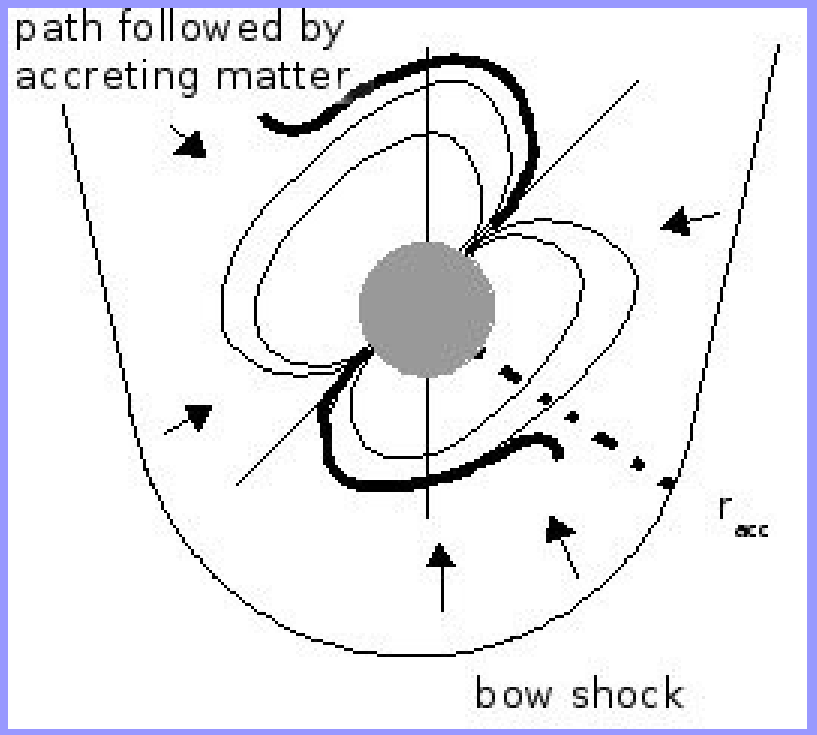


$$\dot{E}_{\rm acc} = \frac{G M_{\rm NS} \dot{M}_{\rm acc}}{R_{\rm NS}} \frac{a^2}{r_{\rm acc}^2}$$

BD+53°2790

This O9.5V star is the optical counterpart to the HMXRB 4U 2206+54.





This mechanism will provide observable X-ray luminosities only in close systems.

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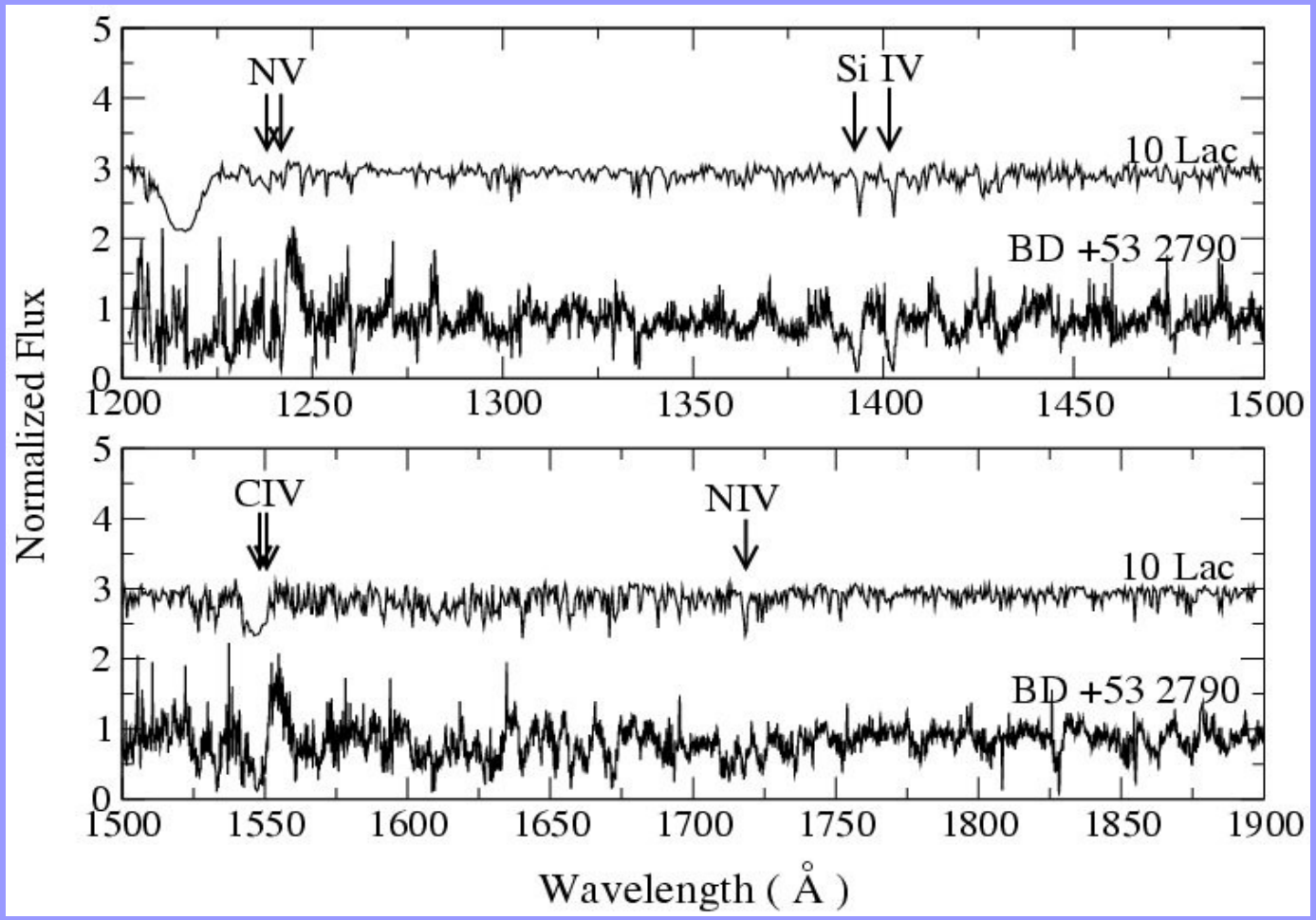
The UV spectrum

IUE spectrum SWP 39112 taken on June 18-19 1990
20 ks exposure

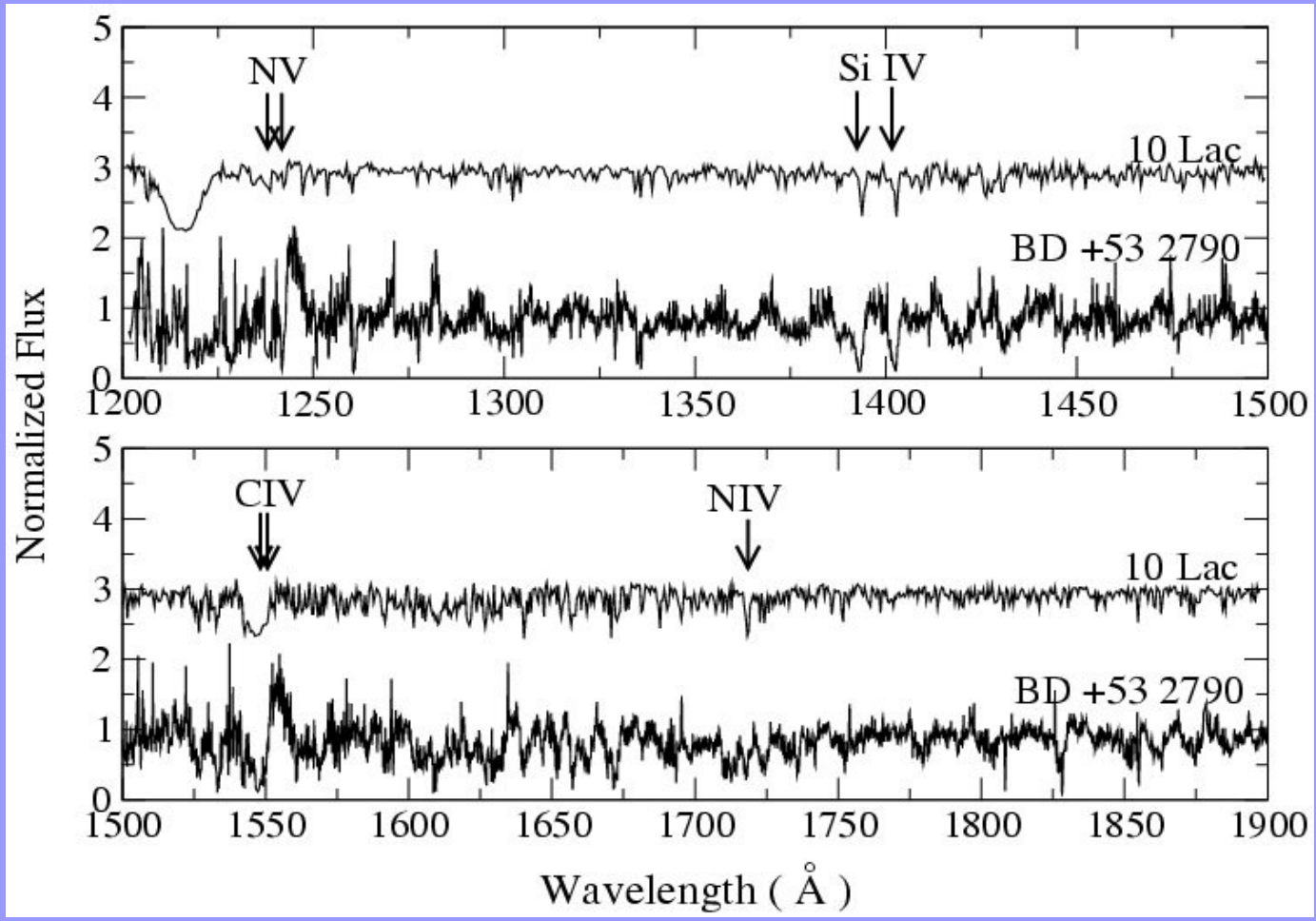


The UV spectrum

INES database ⟶ helicocentric correction of 16.37 kms^{-1}

Radial velocity ⟶ correction of -62.7 kms^{-1}

(Ribó et al., A&A, 449, 687)



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SEI method (Lamers et al., 1987, ApJ, 314, 726)

Star	Spectral type	T_{eff} (K)	$R/R_\odot$	$M/M_\odot$	v_{esc}	v_∞
HD 199579	O6 V((f))	38000	12	38	990	3300
15 Mon	O7 V((f))	35000	12	30	890	2600
HD 48099	O7 V	35000	10	33	1030	3300
10 Lac	O9 V	35000	7	23	1070	1375
HD 93521	O9 V	34500	8	24	1020	1075
ζ Oph	O9.5 V	32000	10	23	880	1640

Prinja & Howarth, ApJS, 1986, 61, 357

SEI method

$$w(x) = w_0 + (1 - w_0)\left(1 - \frac{1}{x}\right)^{\beta}$$

SEI method

$$w(x) = w_0 + (1 - w_0)\left(1 - \frac{1}{x}\right)^{\beta}$$

$$T = \frac{T_{\text{total}}}{I}\left(\frac{w}{w_1}\right)^{\alpha_1}\left\{1 - \left(\frac{w}{w_1}\right)^{\frac{1}{\beta}}\right\}^{\alpha_2}$$

SEI method

CIV λλ 1548.19 1550.76 Å

SiIV λλ 1393.755 1402.770 Å

NIV λ 1718.551 Å

NV λλ 1238.821 1242.804 Å

SEI method

CIV λλ 1548.19 1550.76 Å

CII λλ 1334.53 1335.71 Å

SiII λλ 1526.707 1533.431 Å

SiIV λλ 1393.755 1402.770 Å

NIV λ 1718.551 Å

NV λλ 1238.821 1242.804 Å

SEI method

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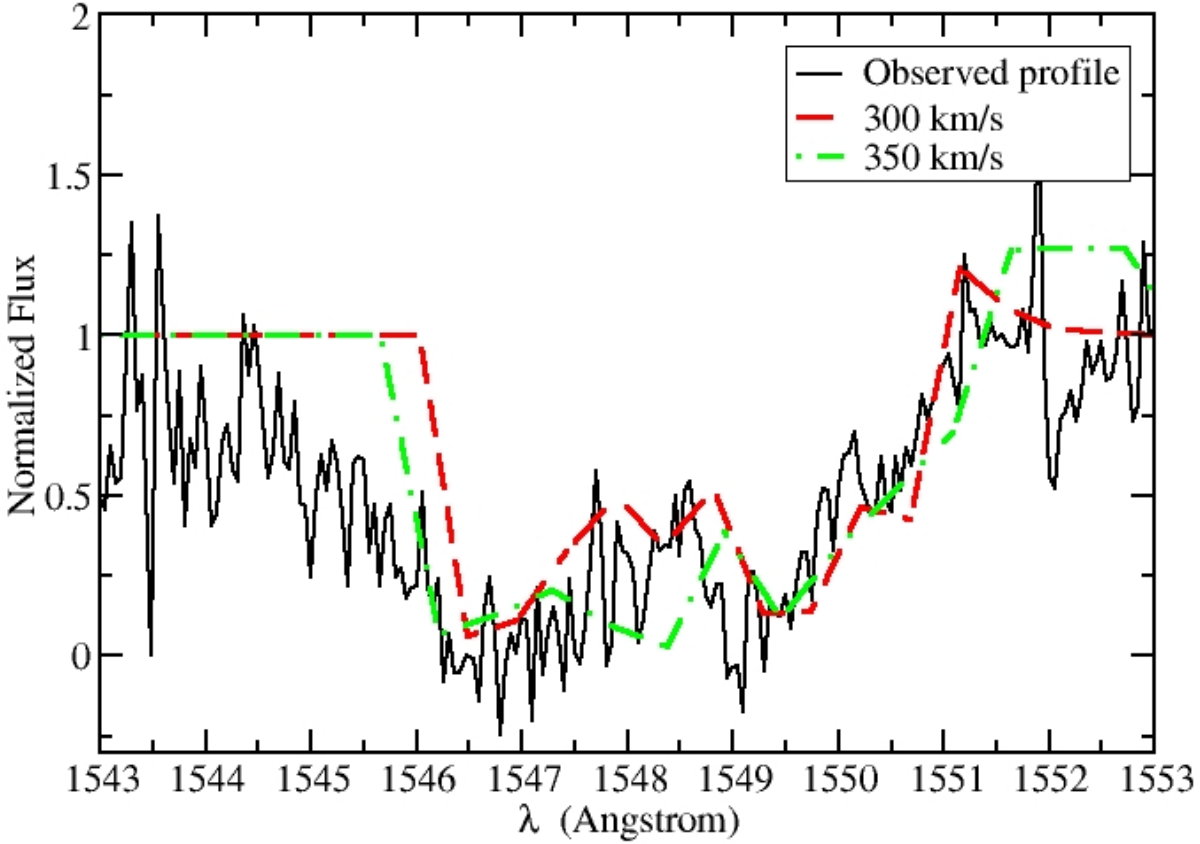

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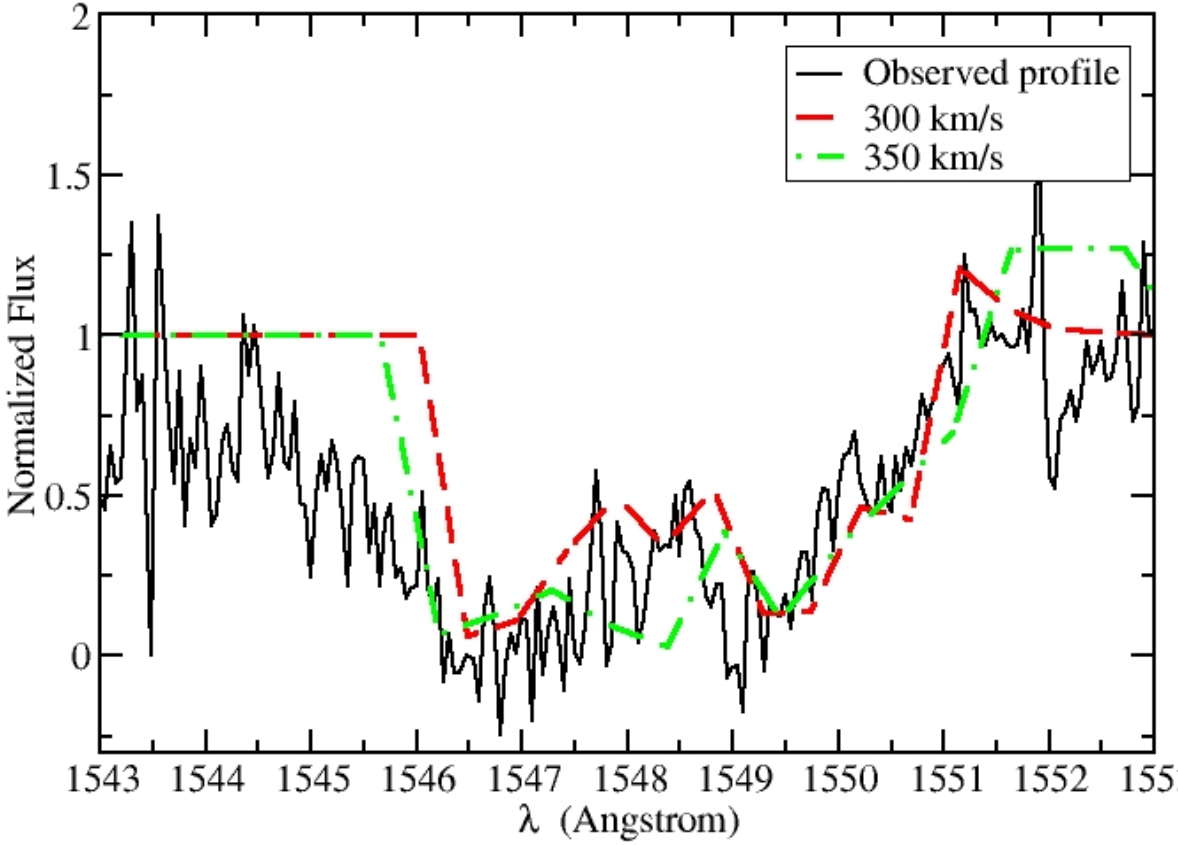
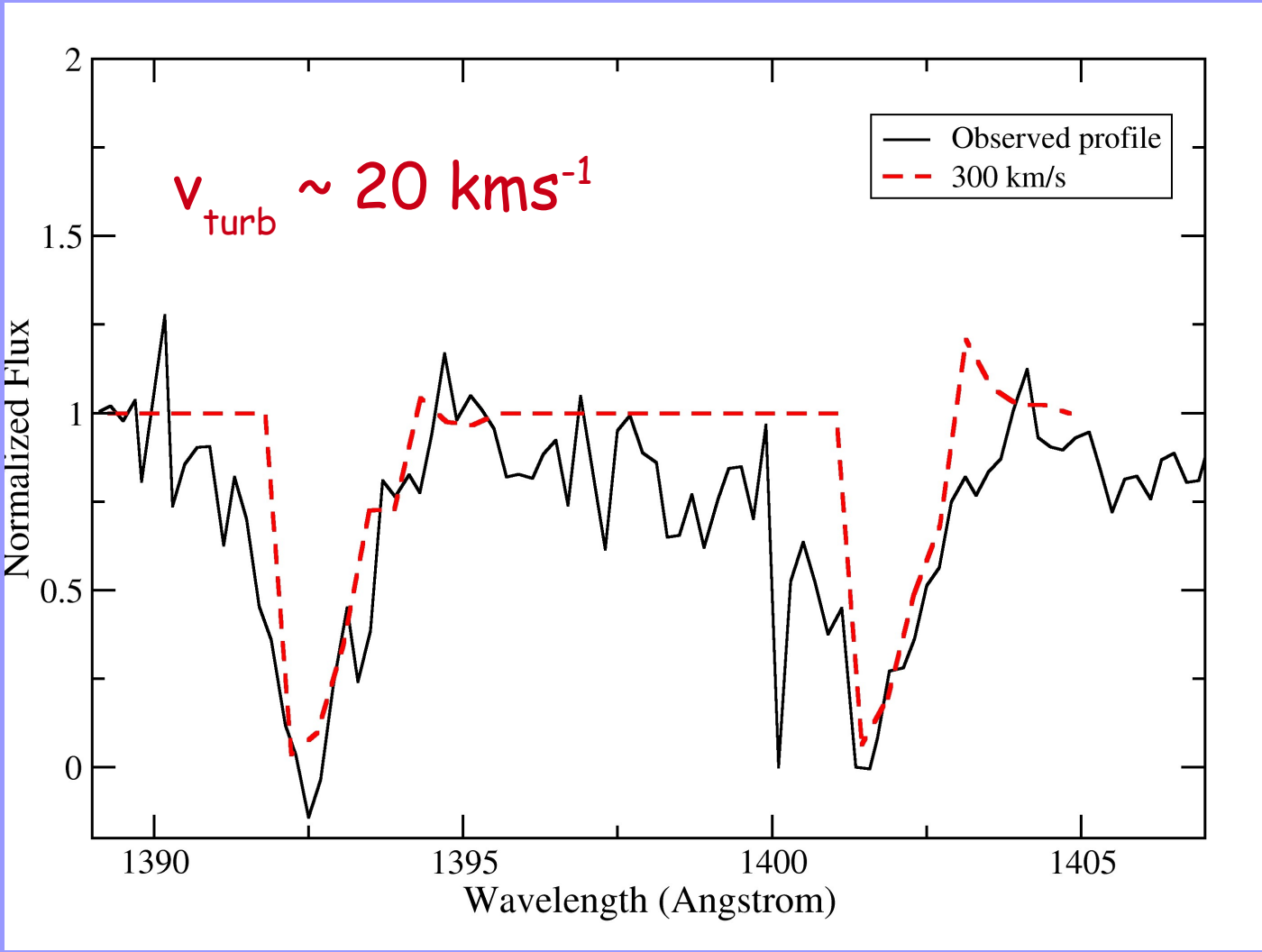


v_{turb} ~ 80 kms^{-1}

v_{turb} ~ 20 kms^{-1}

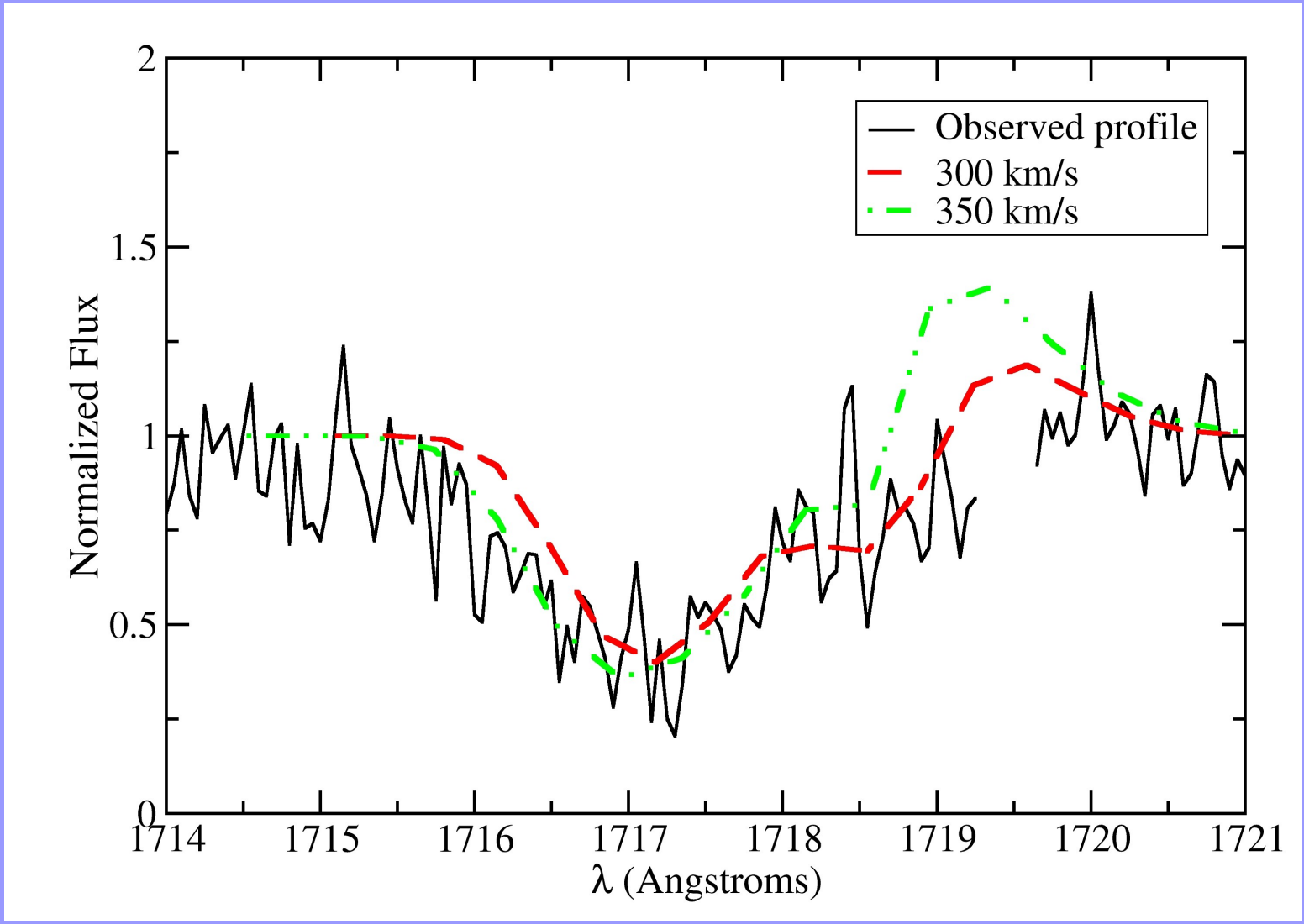
SEI method

SiIV λλ 1393.755 1402.770 Å



SEI method

NIV λ 1718.551 Å



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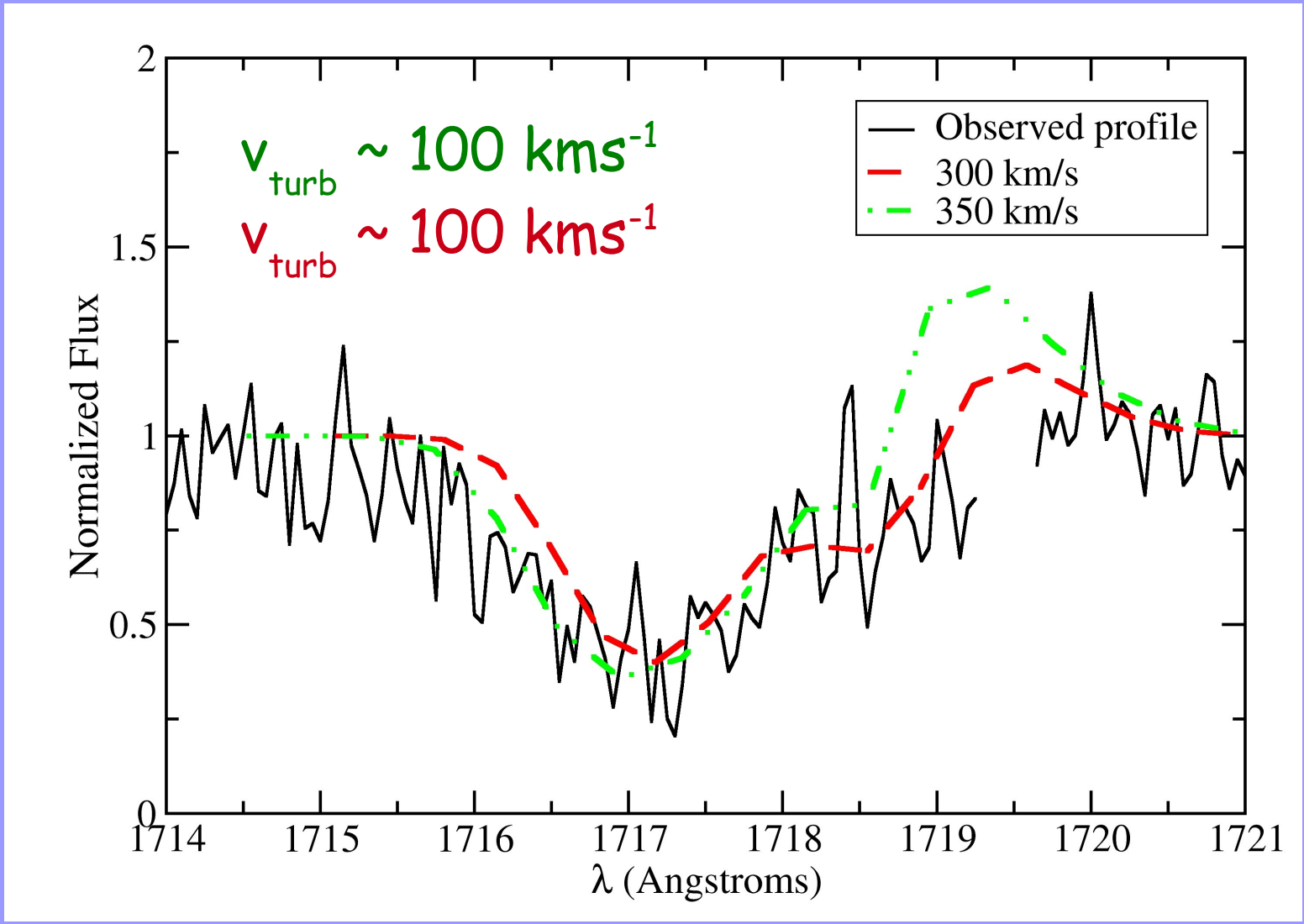
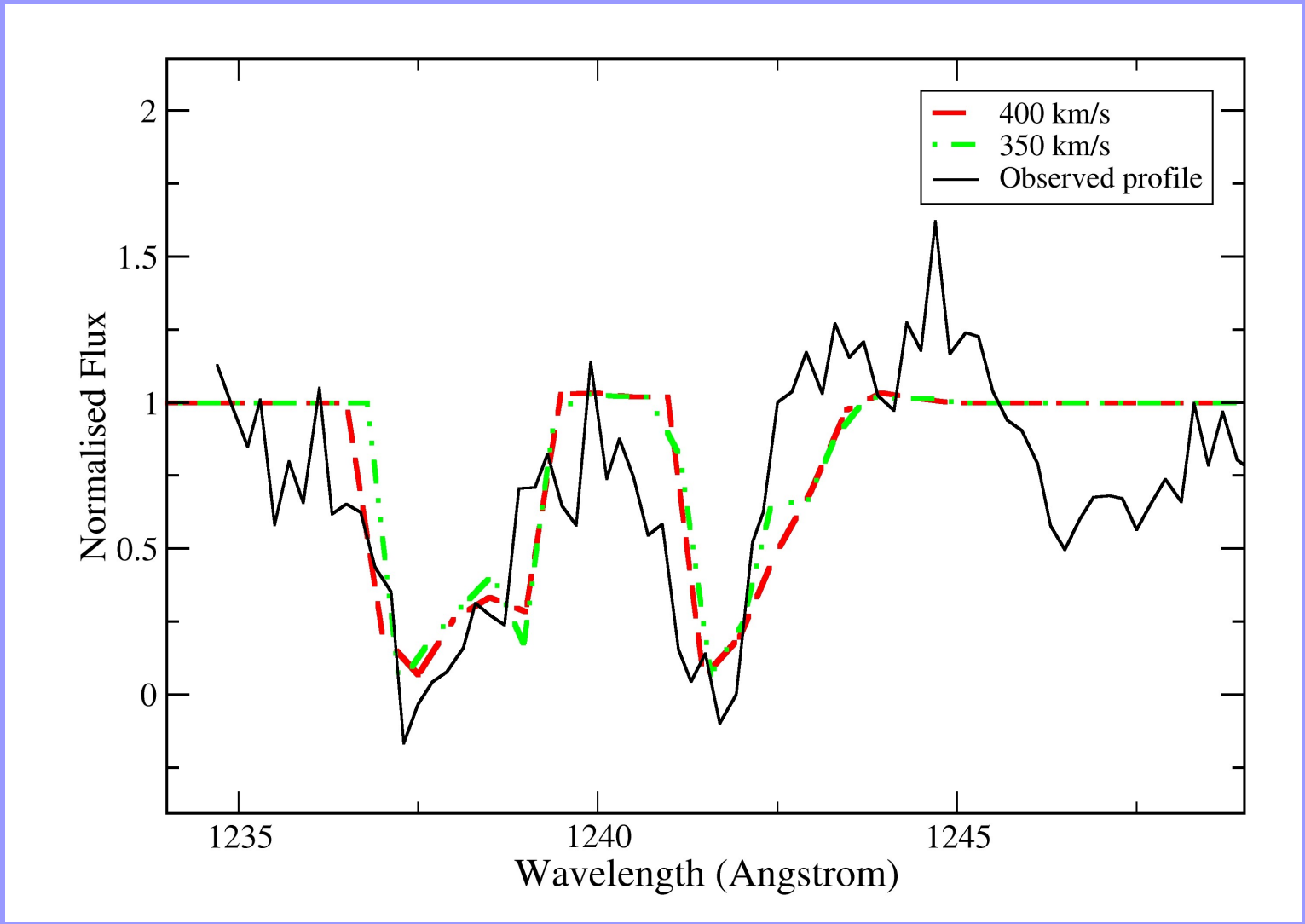
NIV λ 1718.551 Å



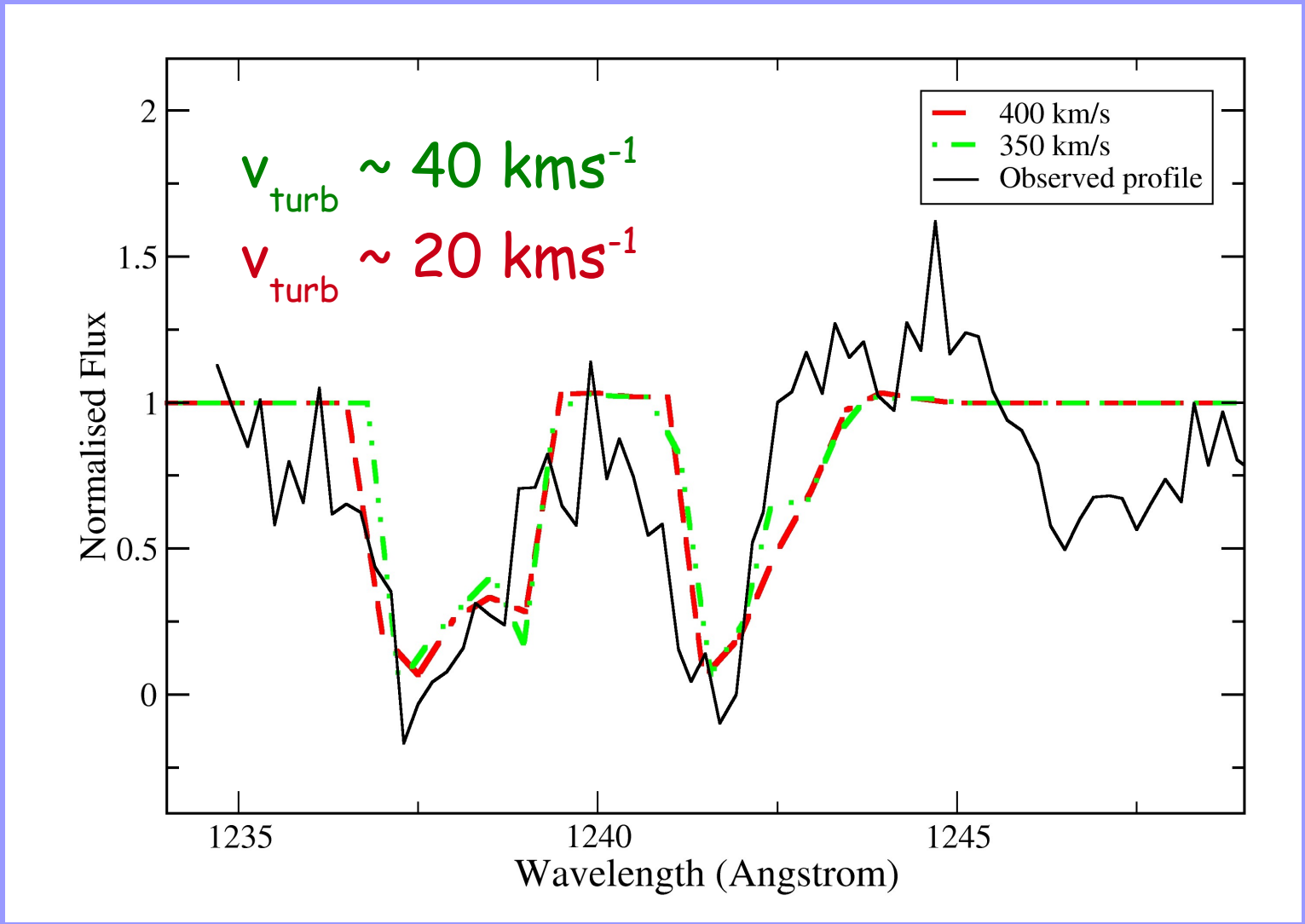
SEI method

Nv λλ 1238.821 1242.804 Å



SEI method

Nv λλ 1238.821 1242.804 Å



SEI method

Line	V_{inf} (km s^{-1})	V_{turb} (km s^{-1})
CIV λλ	300-350	20-80
SiIV λλ	300	20
NIV λ	300-350	100
NV λλ	350-400	20-40

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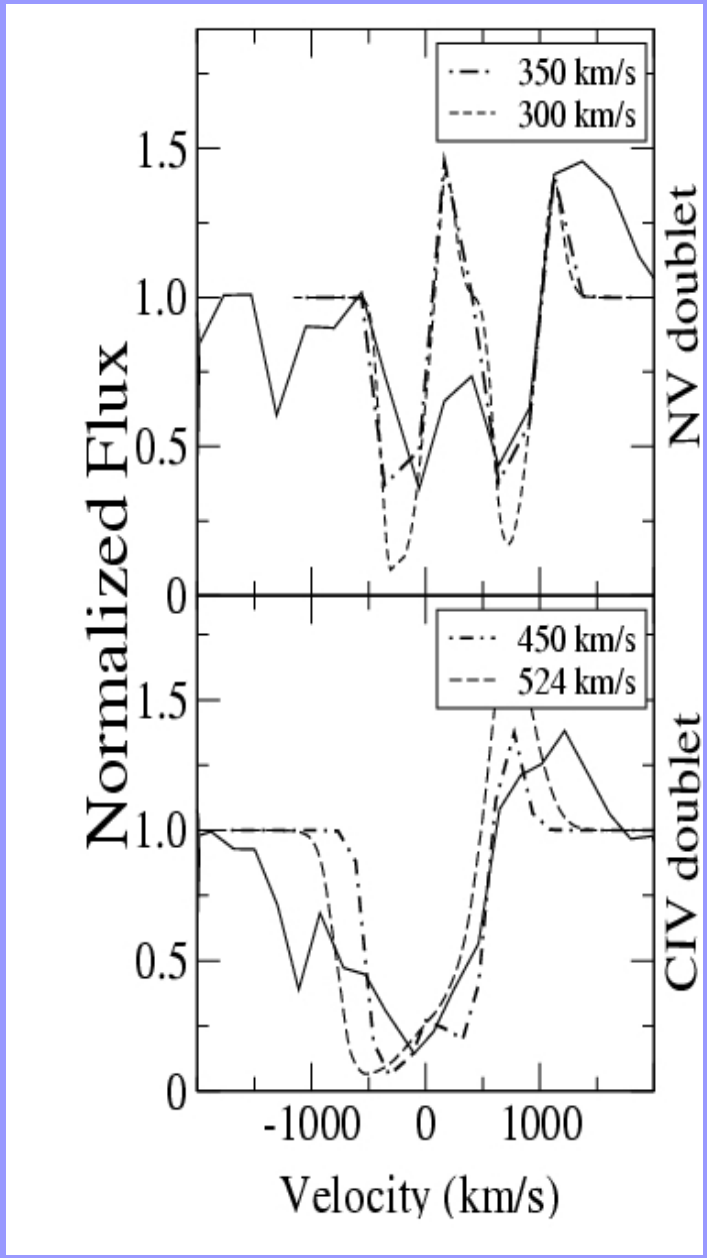
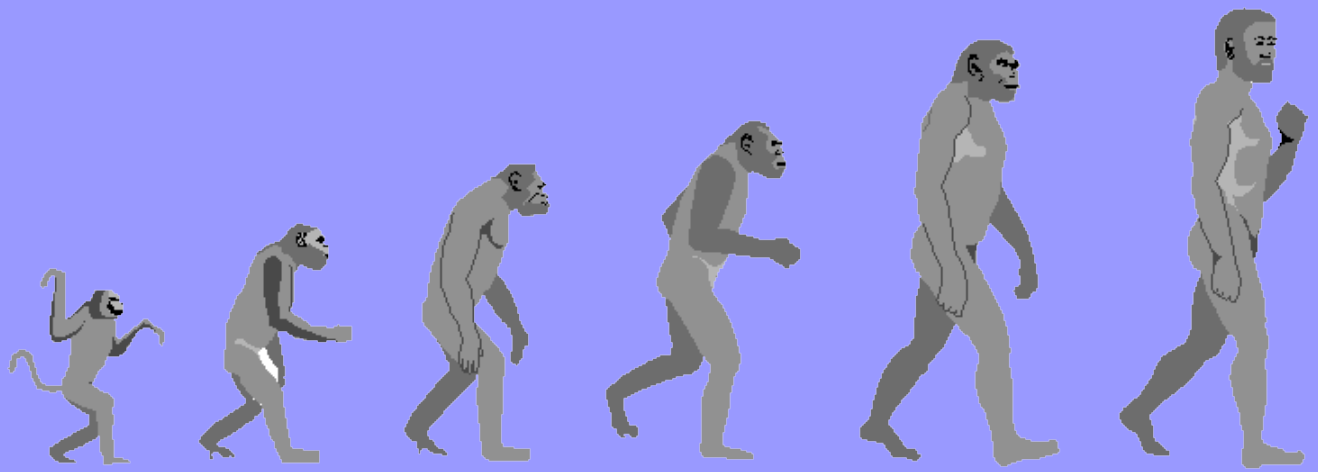
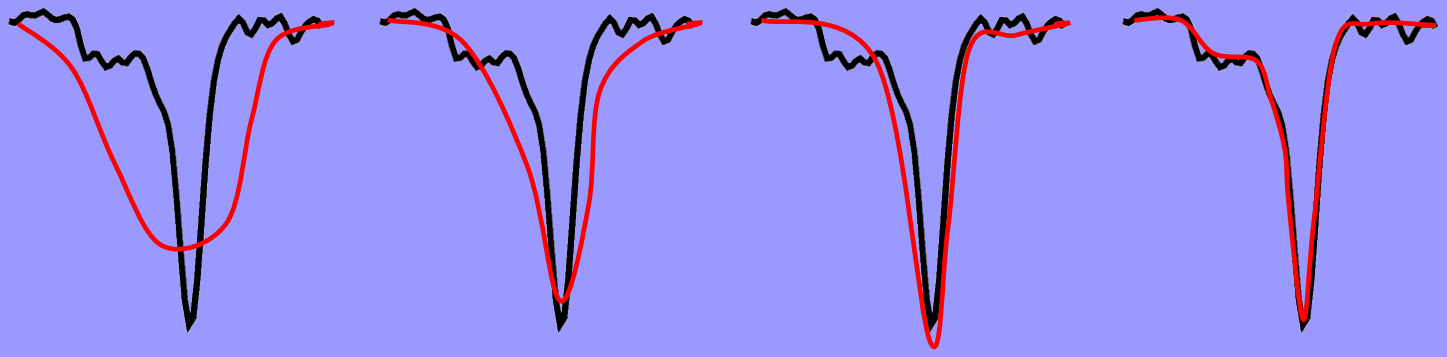
GENETIC method (Georgiev & Hernández, 2005, RMAA, 41, 121)

Automatic fitting procedure which uses a genetic algorithm. "Mutations" of the parameters are allowed in order to cover a wide range of possible values and ensure the finding of the best fit.



GENETIC method (Georgiev & Hernández, 2005, RMAA, 41, 121)





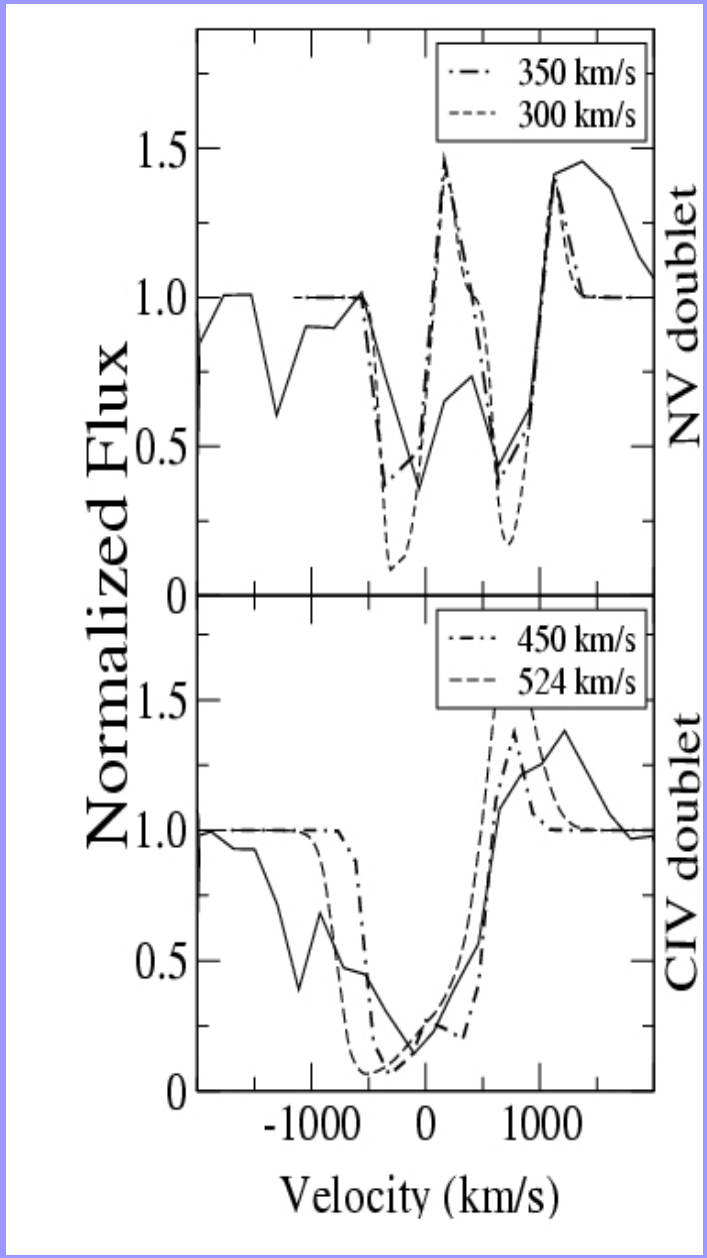
Borrowed from Alex de Koter (Univ. Amsterdam)

August 2005, Tartu, Estonia

GENETIC method

$v_{turb} \sim 100\ kms^{-1}$

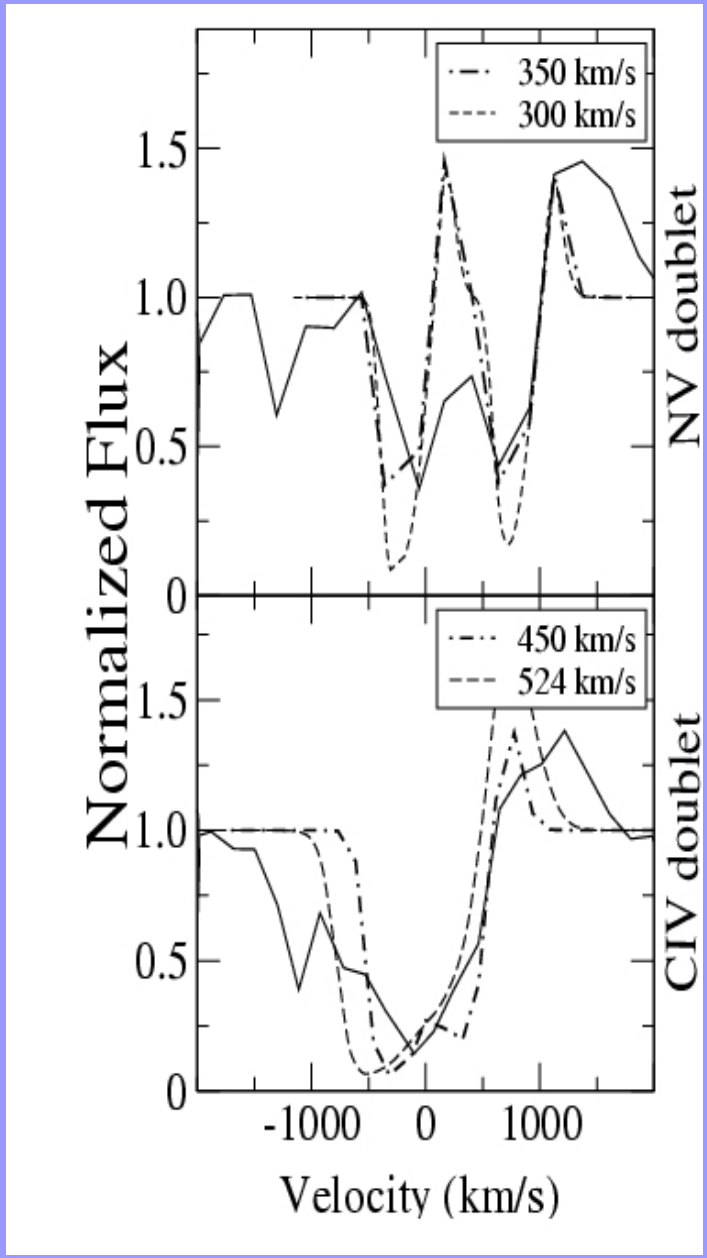
$v_{turb} \sim 80\ kms^{-1}$



GENETIC method

$\dot{M} \sim 5 \times 10^{-8}\ M\ yr^{-1}$

$C_{IV}/H \sim N_V/H \sim 10^{-4}$



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Why do we trust the UV result?

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1. V_{black}

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1. V_{black} ⟶ turn-back-to-continuum point for saturated lines

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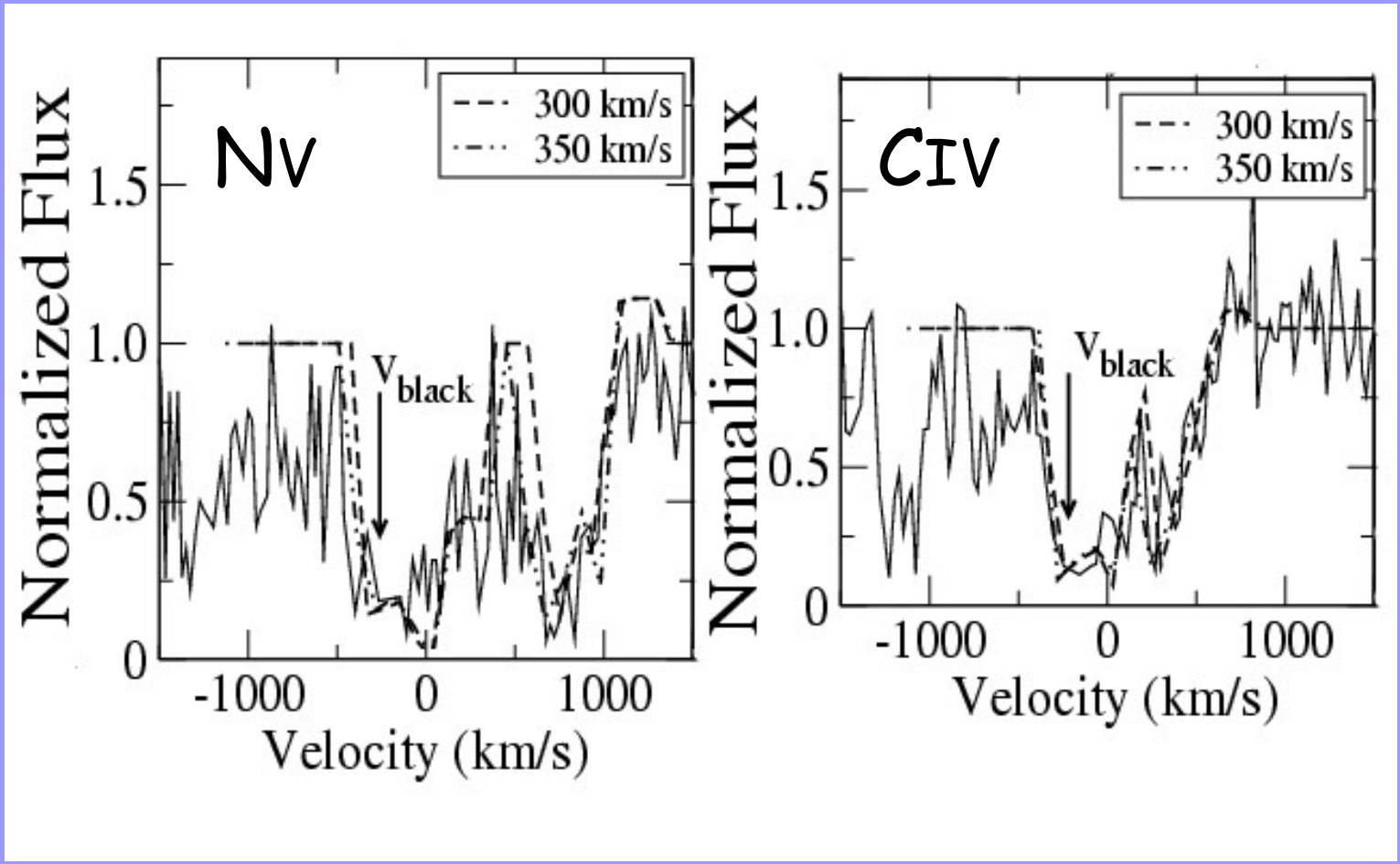
1. V_{black} ⟶ turn-back-to-continuum point for saturated lines

According to Prinja et al., 1990, Apj, 361, 307
v_{black} gives a good approximation to v_{inf}

Why do we trust the UV result?

1. V_{black} ⟶ turn-back-to-continuum point for saturated lines



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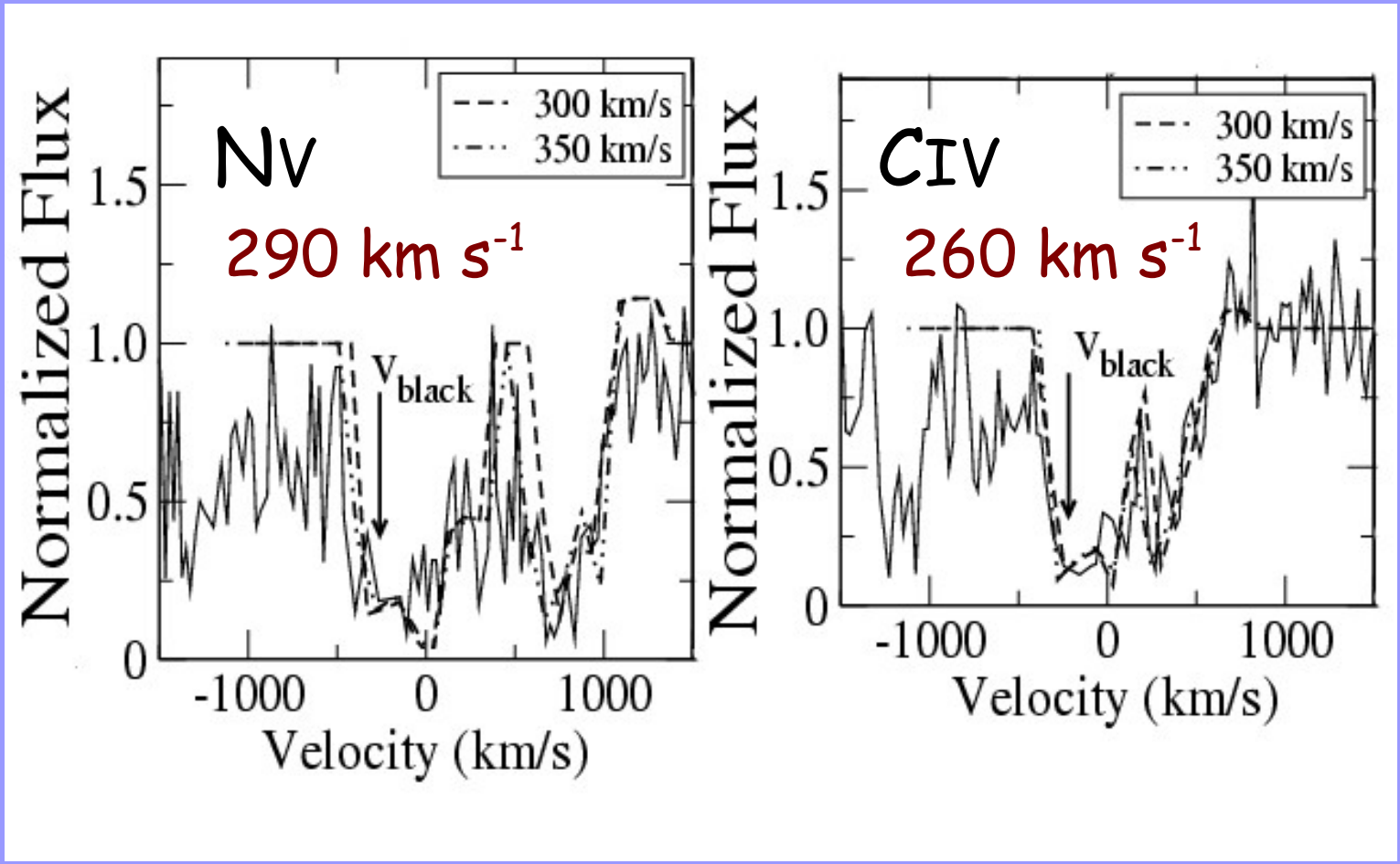

Why do we trust the UV result?

2. X-Rays measurements

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We must remember that BD+53°2790 is part of the HMXRB 4U 2206+54

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Accreting matter falling onto the compact companion to the system is supplied by BD+53°2790's stellar wind

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2. X-Rays measurements

We must remember that BD+53°2790 is part of the HMXRB 4U 2206+54

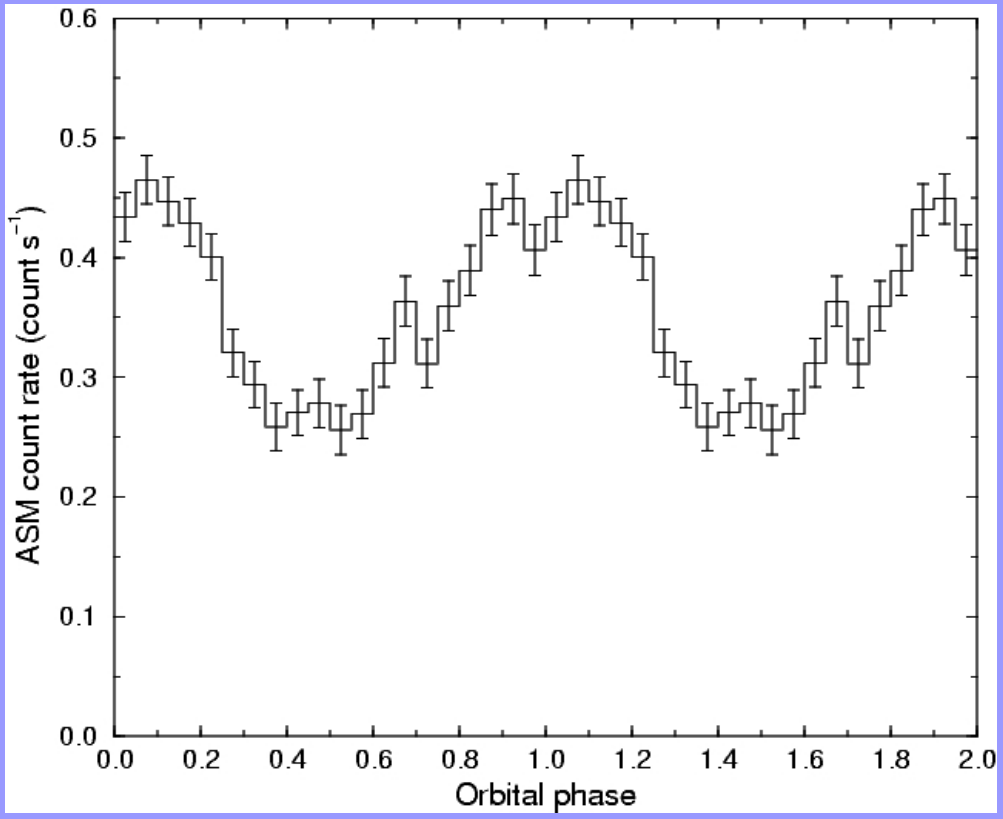
Accreting matter falling onto the compact companion to the system is supplied by BD+53°2790's stellar wind

This accretion will be modulated by the orbital period of the system, ~9.6 days in an eccentric 0.2-0.4 orbit.

M. Ribó et al., 2006, A&A, 449, 687 & P. Blay, 2006, PhD Thesis

Why do we trust the UV result?

2. X-Rays measurements



We can model this light curve according to the Bondi-Hoyle approximation

Bondi & Hoyle, 1944, MNRAS, 104, 273

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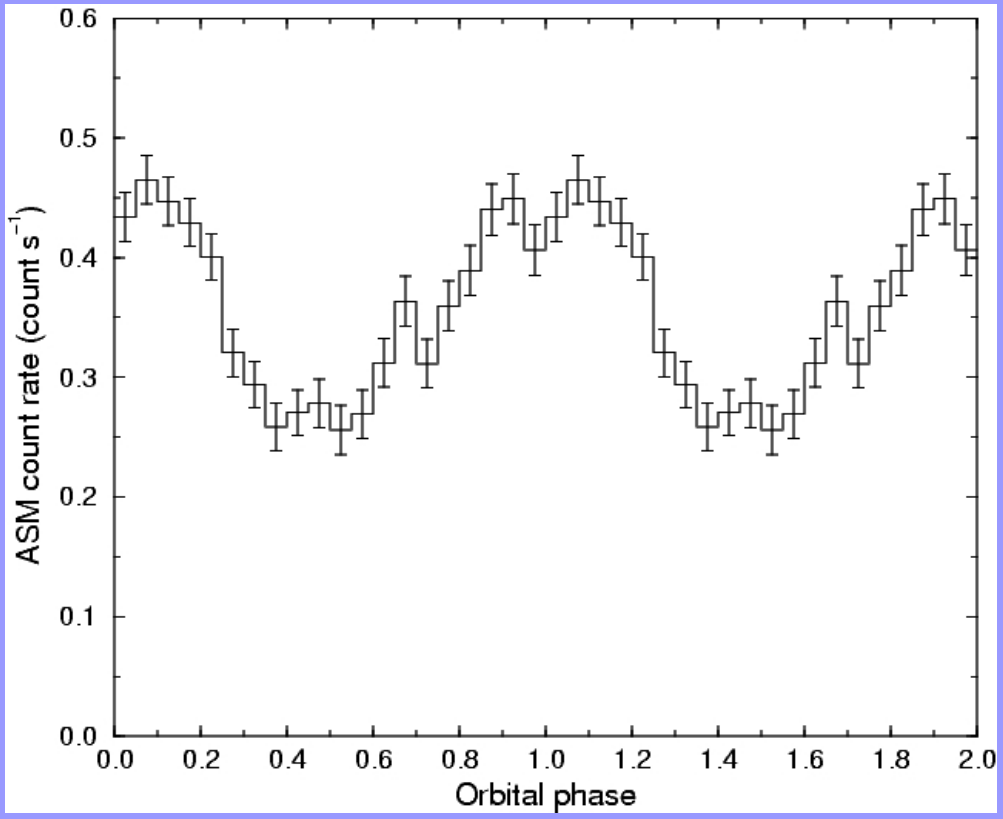
2. X-Rays measurements



We can not reproduce the observed light curve with expected wind velocities around ~1000 km s^{-1}

Why do we trust the UV result?

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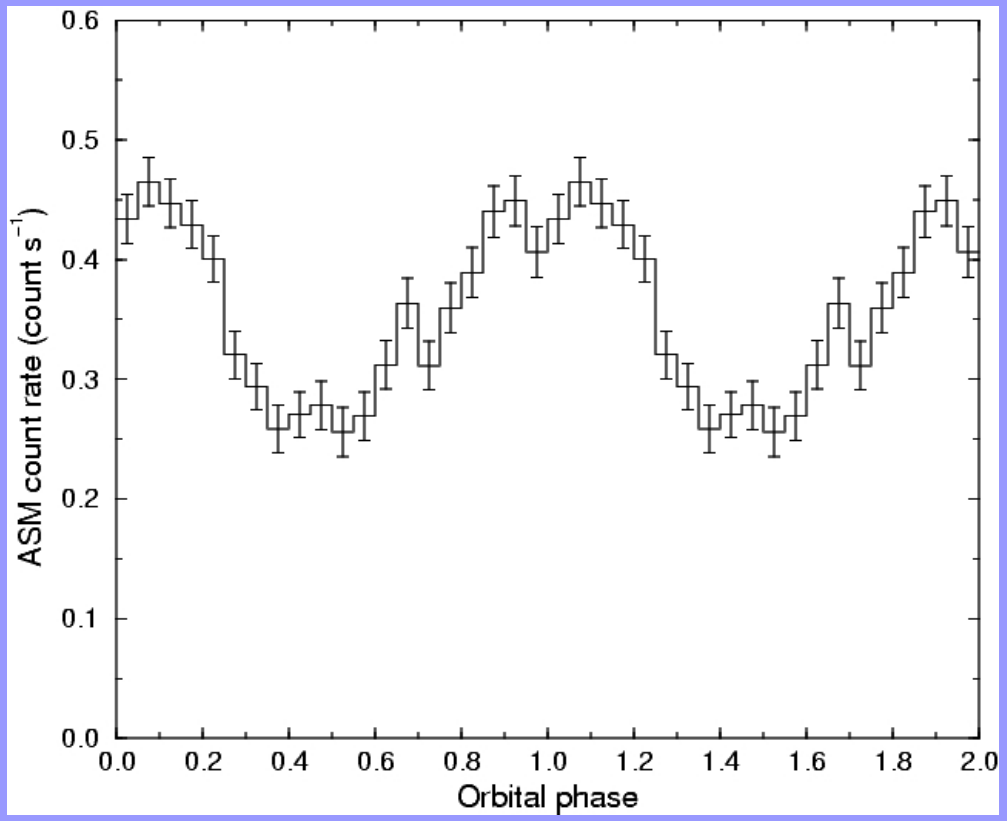

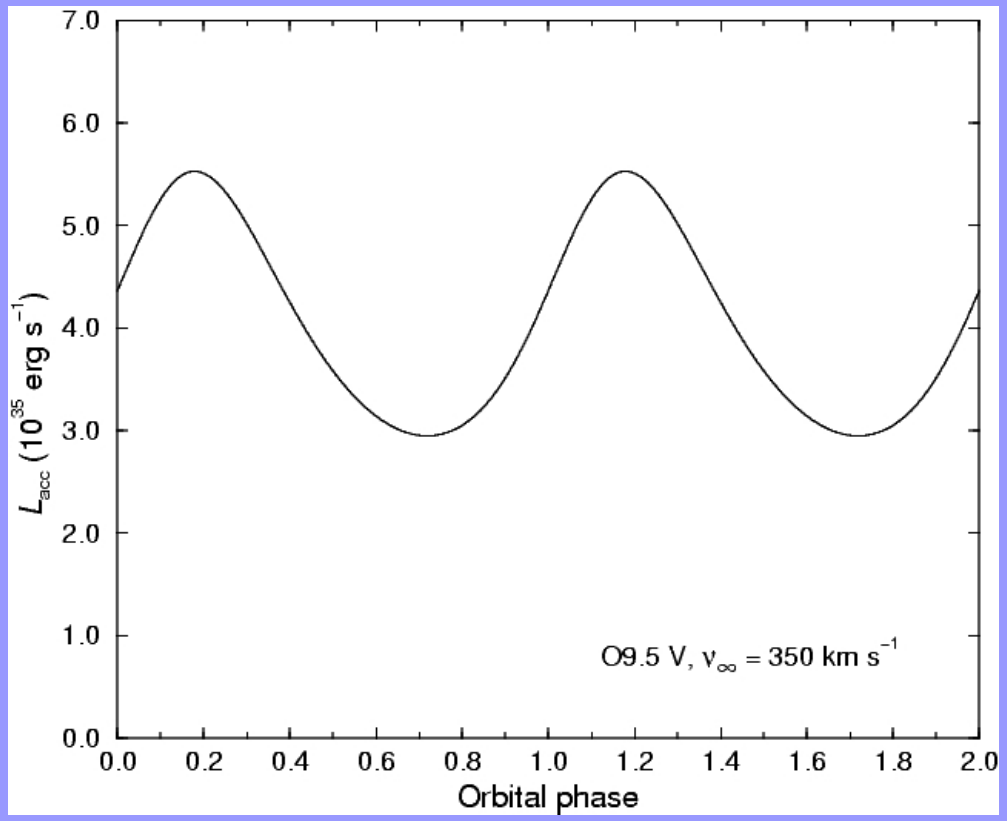

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Conclussions? & Future Work

✗ Slow and dense wind (v_{inf} < 500 km s^{-1}) in BD+53°2790

✗ Use of better codes (FASTWIND, CMFGEN)

✗ Extent the study to other HMXRBs. Example:

LS 5039 (O7V, optical counterpart to RX J1826.2-1450)

✗ UV important part of a multiwavelength study

The End?

Thank you!

HD 93521 -> high velocity polar wind + slow ecuatorial wind

(Bjorkman et al., 1994, ApJ, 435, 416)