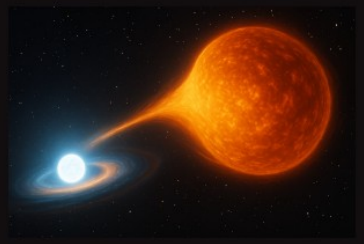
Peculiar evolved stars and binaries:
Non-pulsating stars within the Cepheid instability-strip and the short-period symbiotic system V840 Cen



Cezary Gałan

Annual Report 2025,
February 05, 2026

Papers

PUBLISHED/ACCEPTED:

”Surface brightness-colour relations of dwarf stars from detached eclipsing binaries - II. Extension of calibrating sample", Graczyk, D.; Pietrzyński, G.; Gałan, C.; et al., 2025, A&A 694, 65

”Blending-induced beating and emission in the symbiotic star Terz V 2513”, Merc, J.; Mikołajewska, J.; Gałan, C.; et al., 2025, MNRAS.545f2094M

”HALO I: Photometric continuum reverberation mapping of Fairall 9”, Mandal, A. K.; Pozo Nuñez, F.; Jaiswal, V. K.; et al., 2025, A&A, arXiv251213296M

Papers

PUBLISHED/ACCEPTED:

”Surface brightness-colour relations of dwarf stars from detached eclipsing binaries - II. Extension of calibrating sample", Graczyk, D.; Pietrzyński, G.; Gałan, C.; et al., 2025, A&A 694, 65

”Blending-induced beating and emission in the symbiotic star Terz V 2513”,
Merc, J.; Mikołajewska, J.; Gałan, C.; et al., 2025, MNRAS.545f2094M

”HALO I: Photometric continuum reverberation mapping of Fairall 9”,
Mandal, A. K.; Pozo Nuñez, F.; Jaiswal, V. K.; et al., 2025, A&A, arXiv251213296M

IN PREPARATION:

”Non-Pulsating LMC Stars in the Cepheid Instability Strip: Possible Binary Barium Stars",
Narloch, W.; Gałan, C.; et al., A&A, in preparation

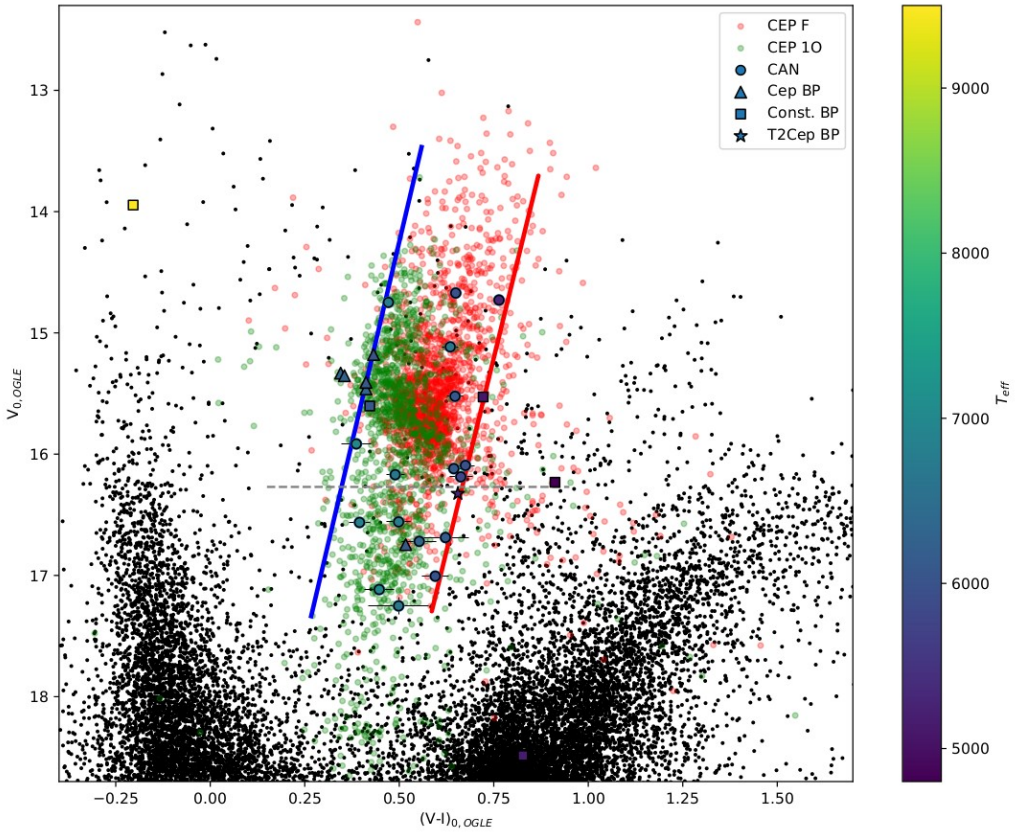
”The Symbiotic System V840 Cen: An 8.1-Day Orbital Period and a Massive White Dwarf Companion”,
Gałan, C.; Mikołajewska, J.; et al., ApJL, in preparation

Candidates for non-pulsating stars in the Cepheid instability strip

Candidates among LMC Cepheids.

Parameters from Strömgren photometry:

T_{eff}, [M/H], log g



MIKE spectrograph

6.5 m Clay telescope (Las Campanas)

Slit 0.7", R_{blue} ~ 41000, R_{red} ~ 32000.

Name	No. of obs.	Dates	Radial Vel. [km/s]	S/N
Can-01	1	2019-12-23	267.92 ± 0.30	45
Can-03	2	2019-12-23	271.47 ± 0.38	70
		2020-02-24	271.36 ± 0.43	
Can-07	1	2019-12-24	241.66 ± 0.26	40
Can-08	1	2019-12-23	252.96 ± 1.26	43
Can-09	1	2019-12-24	268.21 ± 0.34	45
Can-10	3	2019-12-23	285.74 ± 0.97	95
		2020-02-24	285.28 ± 0.99	
		2021-12-08	284.81 ± 1.09	
Can-11	1	2019-12-23	244.08 ± 0.29	48
Can-13	1	2019-12-24	265.43 ± 0.34	43
Can-14	2	2019-12-23	259.37 ± 0.38	65
		2020-02-24	259.70 ± 0.40	
Can-16	1	2019-12-24	278.71 ± 0.78	40
Can-17	3	2019-12-23	263.62 ± 0.60	90
		2020-02-24	263.33 ± 0.60	
		2021-12-10	263.12 ± 0.48	

Photometrically stable ~ few mmag!

Spectroscopic Analysis: Methods and Results

Spectrum synthesis

GSSP code (Tkachenko 2015)

SynthV RT code (Tsymbal 1996)

ATLAS atmospheres (Kurucz 1993)

MEASURED: T_{eff}, log g, [M/H], ξ, V_{rot}, [X/H]

EW method

MOOG v2019 (Sneden 1973),

ARES v2 (Sousa 2015)

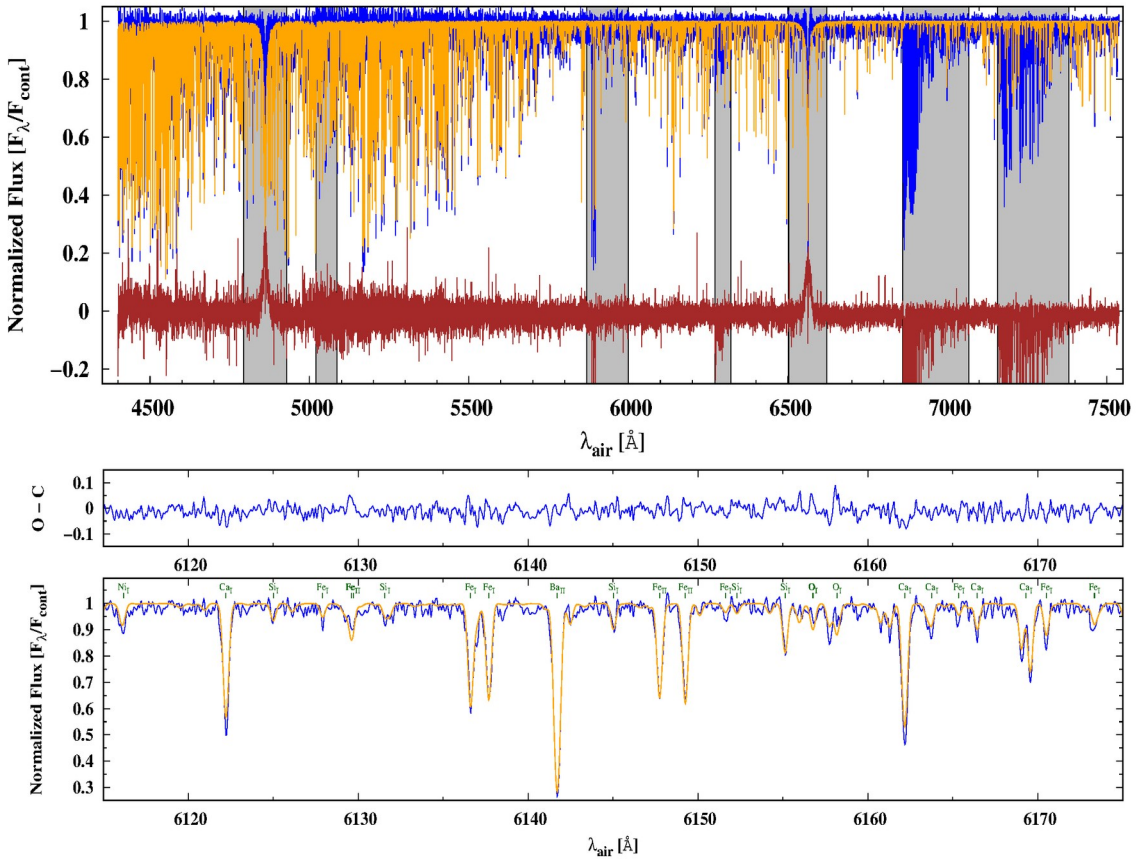
Best fit parameters for CAN-11:

T_{eff} = 6512 ± 84 K log g = 1.48 ± 0.18 dex

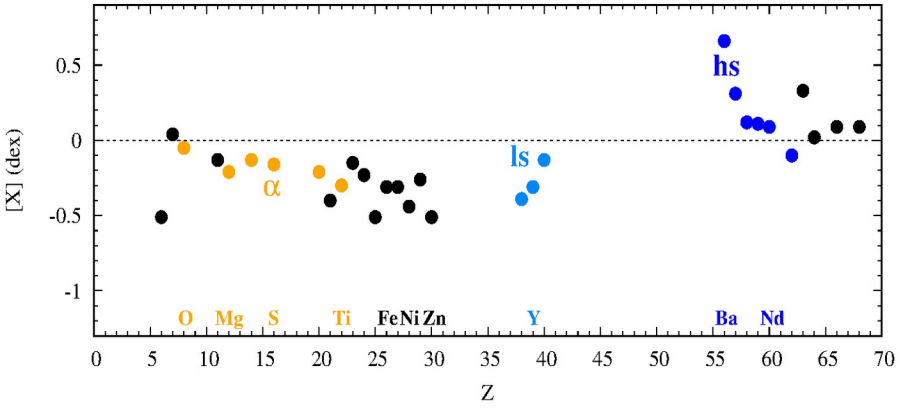
[M/H] = -0.30 ± 0.07 dex ξ = 4.22 ± 0.15 km/s

V_{rot} sin i = 8.32 ± 0.99 km/s

Synthetic fit compared to the observed spectra:



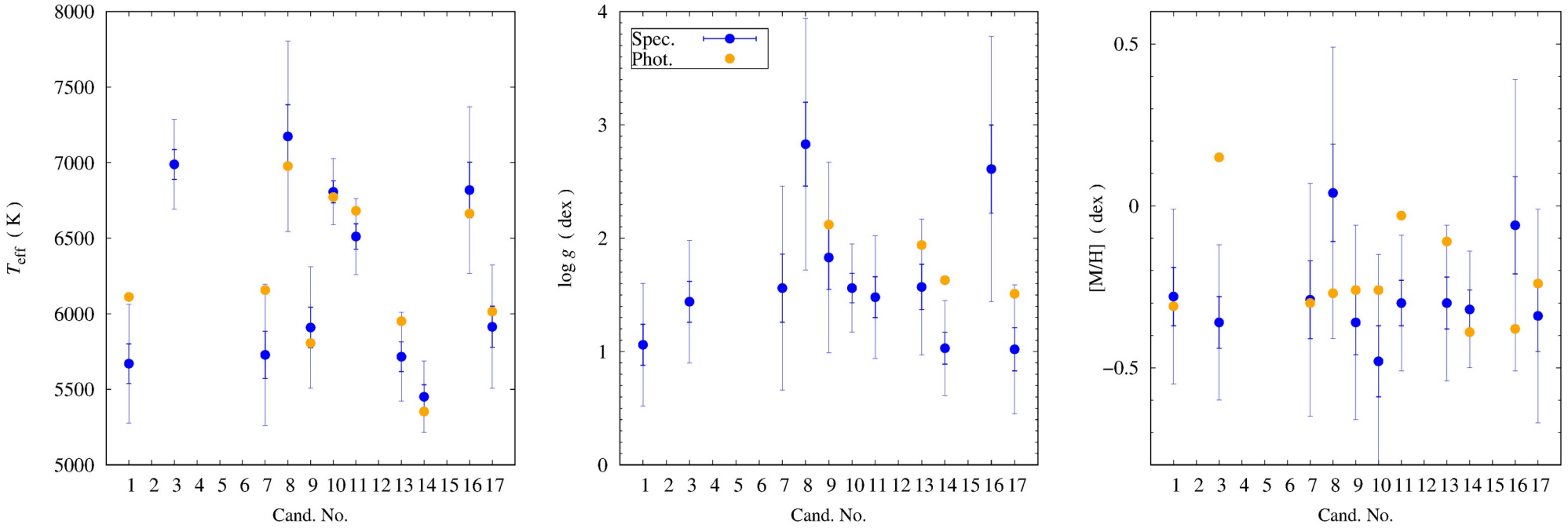
Abundances of chemical elements in CAN-11:



Enhanced heavy s-process elements!

Consistency of spectroscopic atmospheric parameters with Strömgren photometry

$T_{\rm eff}$, log g, [M/H]: Strömgren photometry vs. spectral synthesis:

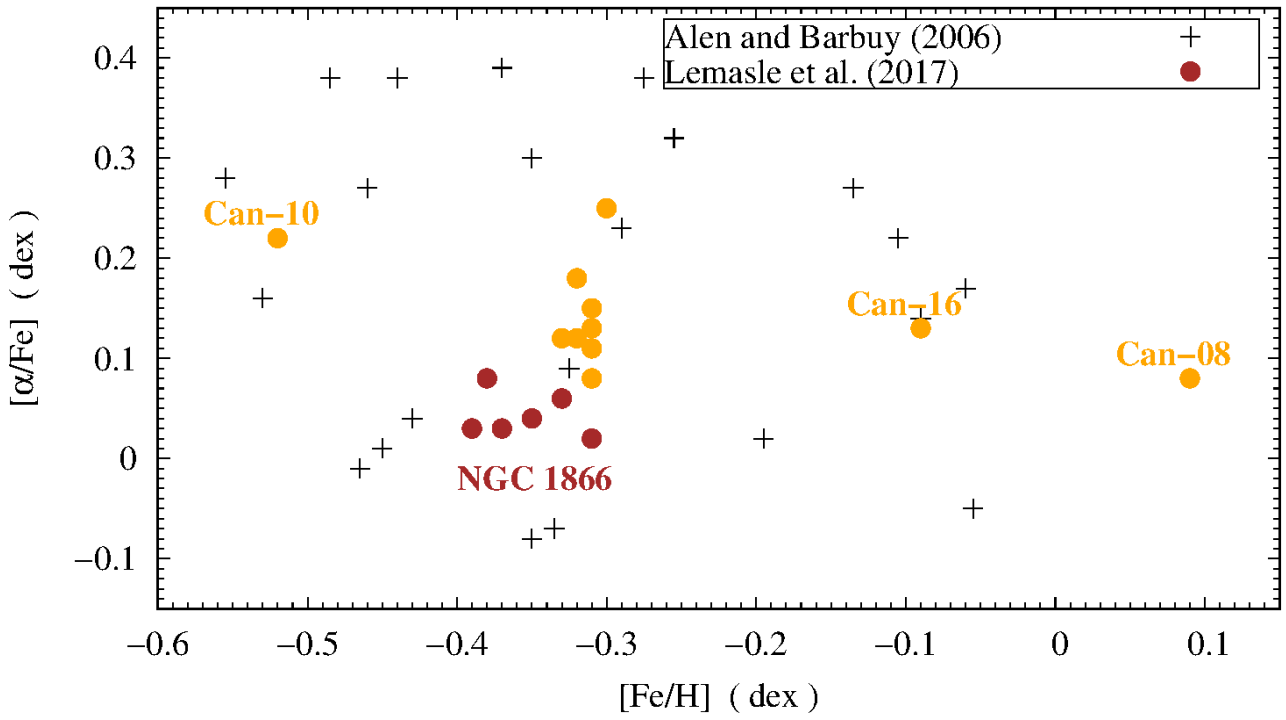


[M/H] ≈ -0.3 dex – in agreement with typical values for LMC Cepheids (Romaniello et al., 2022; Hocdé et al., 2023)

Similarity to classical Cepheids

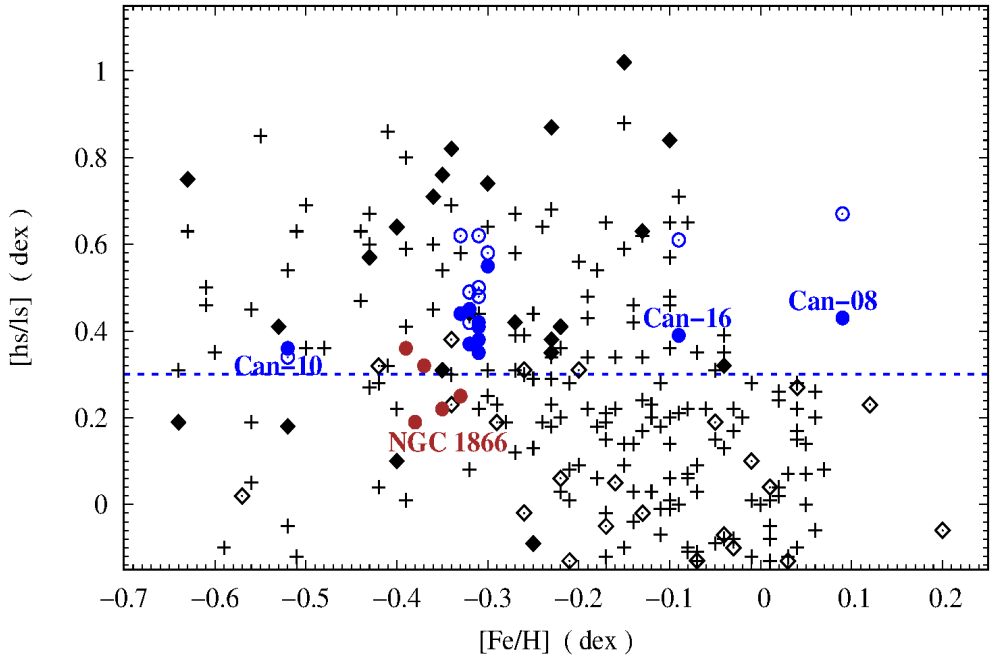
- T_{eff}, log g, [M/H], ξ consistent with LMC Cepheids (NGC 1866) (Lemasle et al., 2017)
- log g consistent with binaries in Cepheids (Pilecki et al., 2018)
- [α/Fe] consistent with barium stars at similar [Fe/H] (de Castro et al., 2016)

[α/Fe] - mild supersolar trend:

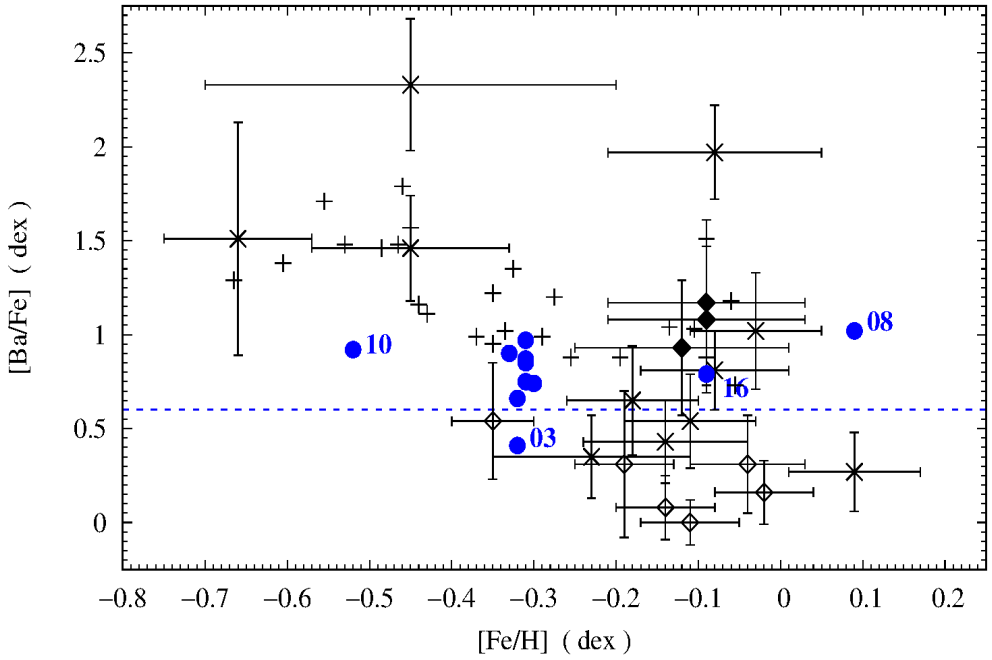


Barium-stars chemical signature

[hs/ls] vs. [Fe/H]:



[Ba/Fe] vs. [Fe/H]:



Empirical boundaries separating strong- and mild-barium stars:

[hs/ls] > +0.3 dex

[Ba/Fe] ≳ +0.6 dex

Spectroscopic draft ready; paper in preparation.

V840 Centauri.

An extreme short-period yellow symbiotic system

SALT/HRS: ~3700 - 8900 Å; R ~40000

„HRS monitoring of yellow symbiotic systems"

Programs:

2018-2-SCI-021,
2019-1-MLT-008,
2025-2-MLT-004

(PI: C. Gałan; ~7 yr +)

Sample: 21 yellow SySt

Cerro Murphy Observatory / 'Zibi' 0.8m

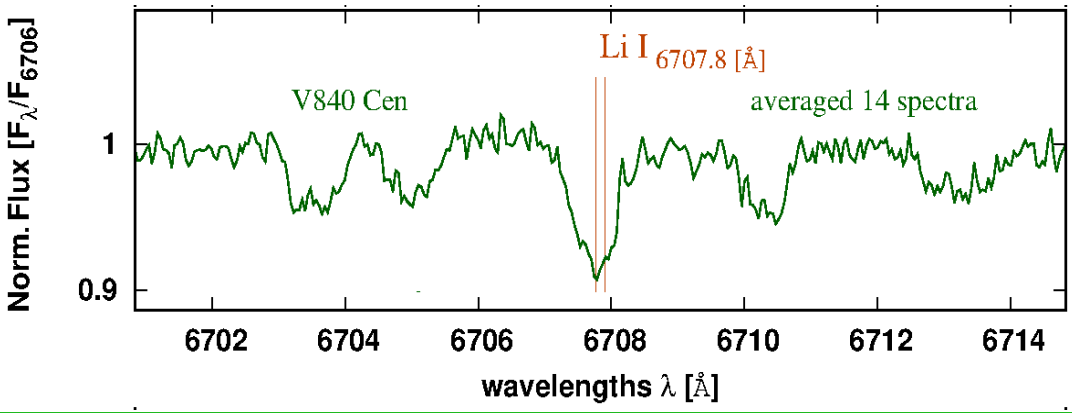
2024.03.17 – 08.07

V, I_C photometry:

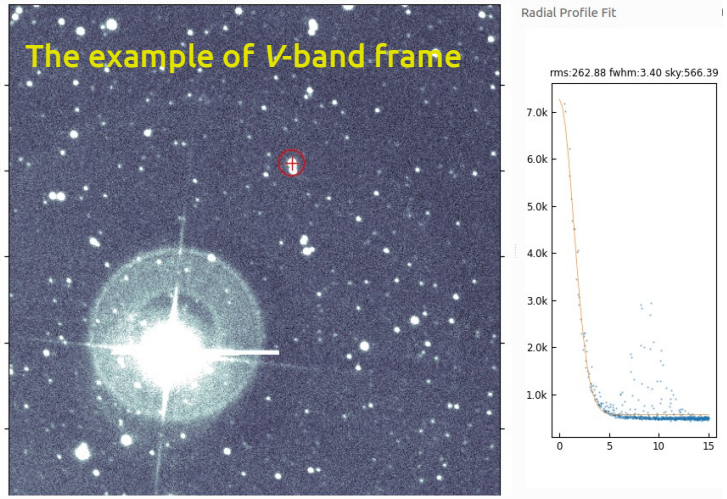
seq=2/V/110,2/Ic/90

V840 Cen

- Shortest P_{orb} ≈ 8.1 days among known SySt.
- One among 4 objects with a strong Li I 6708 Å.

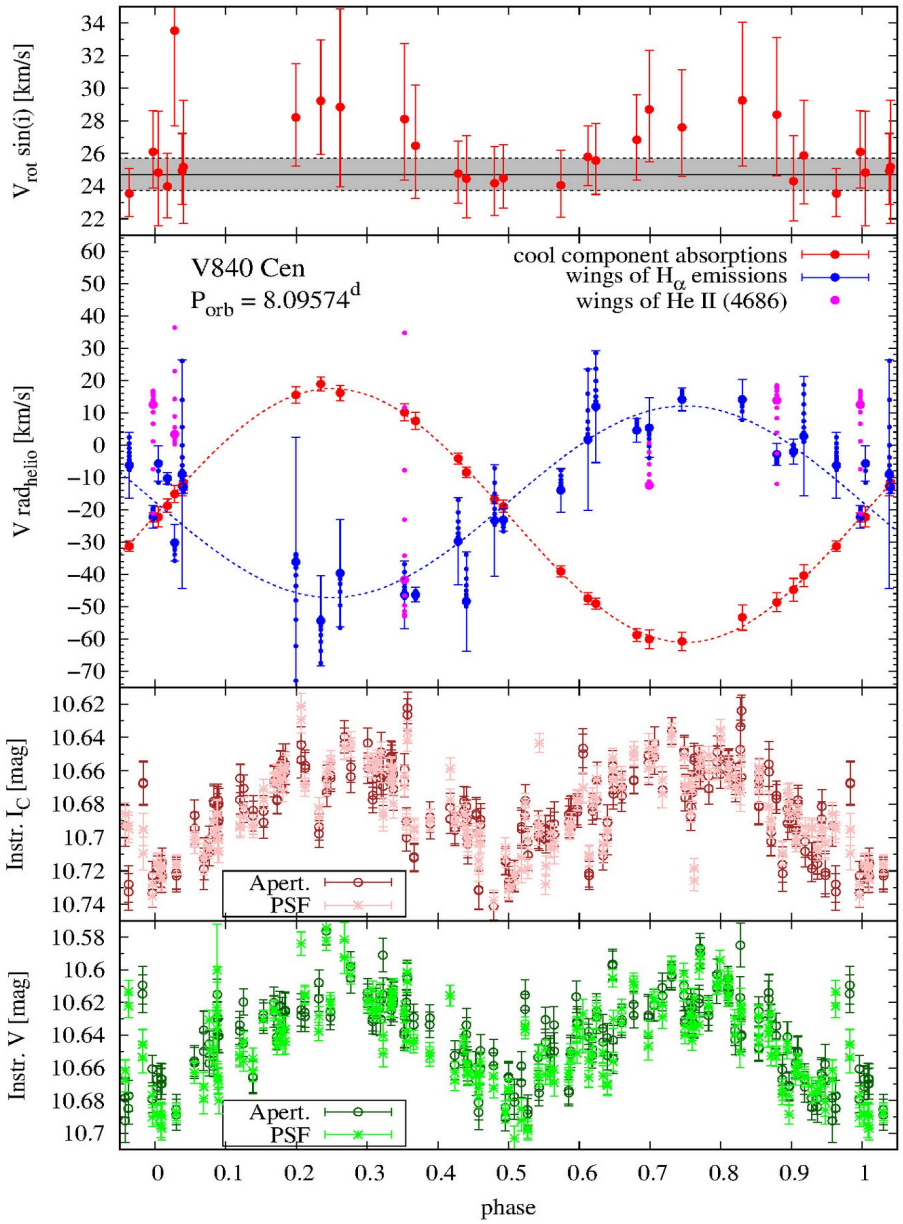


Blending with a nearby field star:
required excellent CMO conditions



V840 Cen:

tidally distorted RG with a massive WD in a circular orbit



$V_{rot} \sin i$ = 24.7 ± 1 km/s

Circular orbit (e < 0.0086)

P_{orb} = 8.095740 ± 0.00079 days

K_G =39.28 ± 0.32 > K_{WD} = 29.66 ± 2.36 km/s

R_G = 4.28 ± R⊙/sin i

M_G = 0.92 ± 0.12 M⊙; M_{WD} =1.18 ± 0.20 M⊙

Nova eruptions observed (5 < t2 < 22 days)

Atmospheric parameters of RG:

T_{eff} = 4864 ± 75 K,

[M/H] = -0.62 ± 0.08 dex,

ξ = 1.00 ± 0.13 km/s,

[α/Fe] ≈ +0.2 dex,

[hs/ls] ≈ +0.4–0.7 dex

A manuscript for ApJL is in preparation.

Thank you