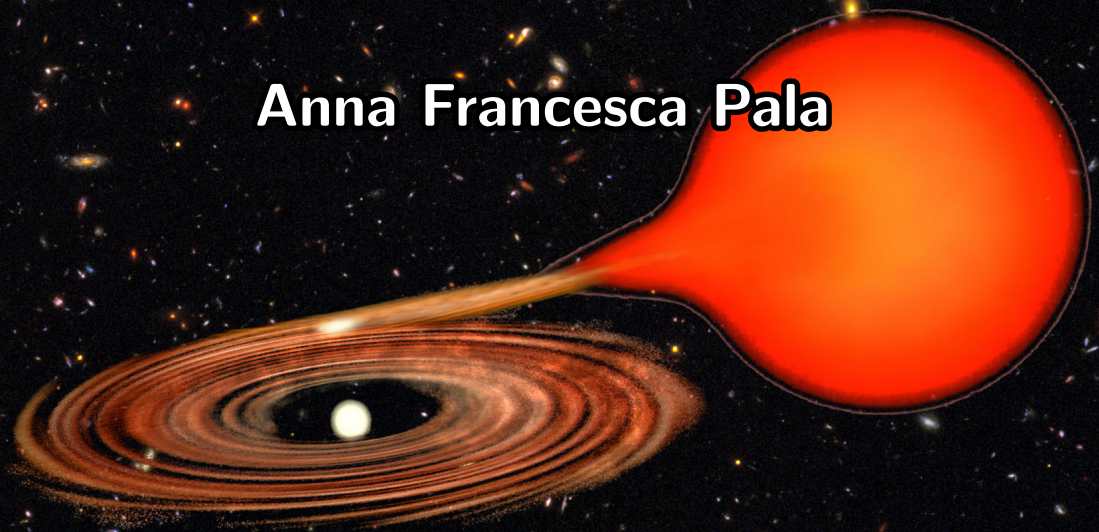
Testing the present models of binary evolution

Anna Francesca Pala



ImBaSE - July 4, 2017

THE UNIVERSITY OF WARWICK

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European Research Council
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What is a CV?

- $>$ 1100 CVs
- accretion physics
- bench test for compact binary evolution

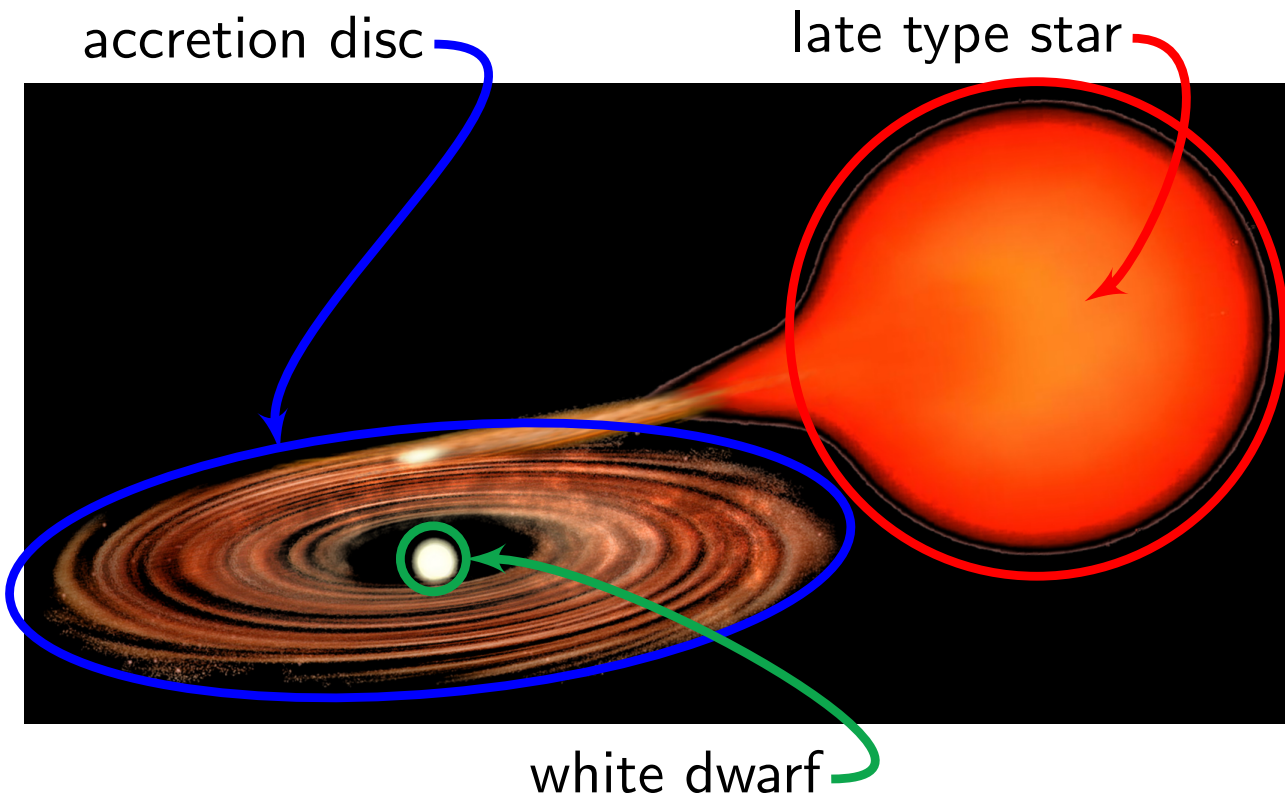
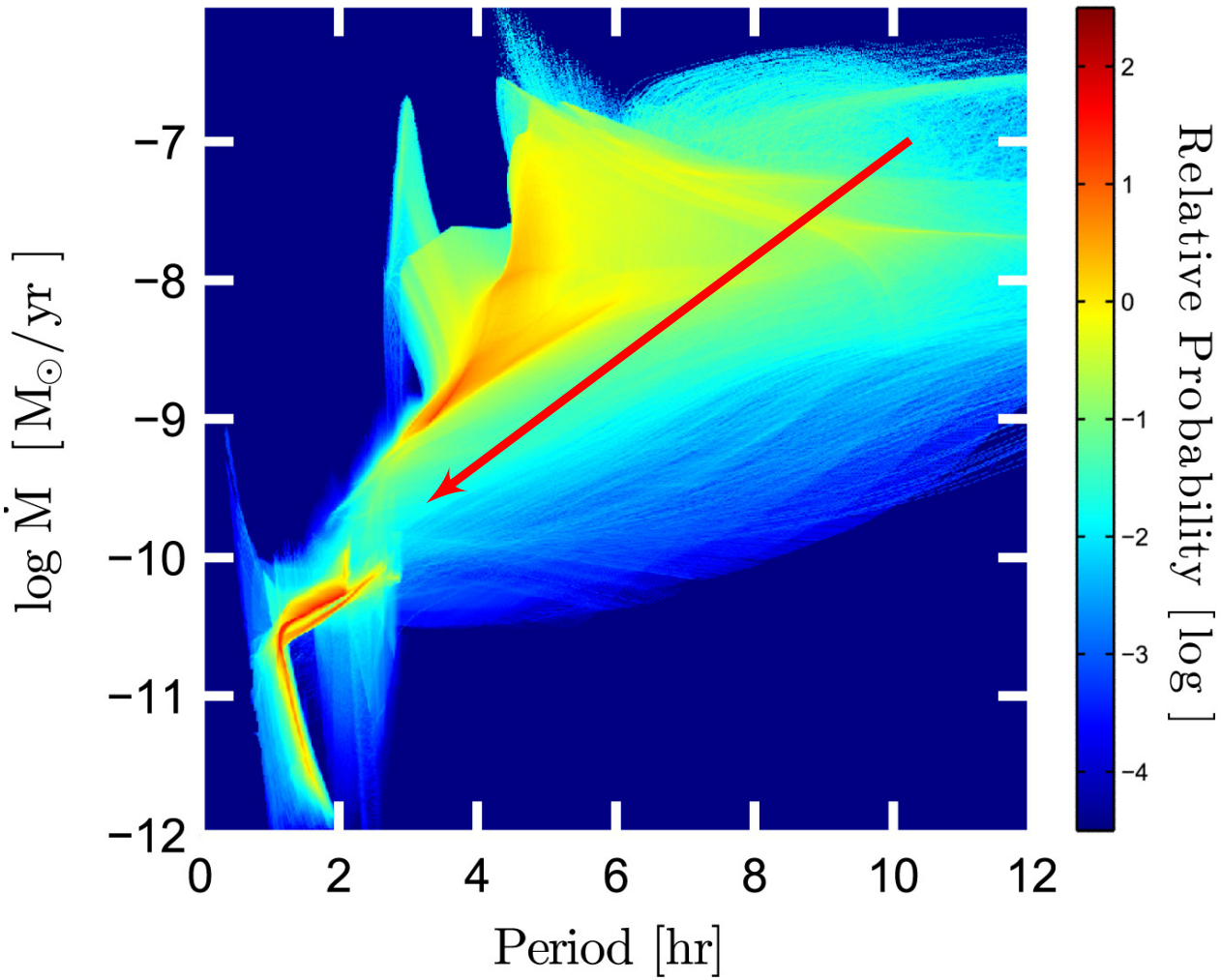


Image credit: adapted from image by P. Marenfeld/NOAO/AURA/NSF

CV evolution – Theory



Goliasch & Nelson, 2015, ApJ, 809, 80

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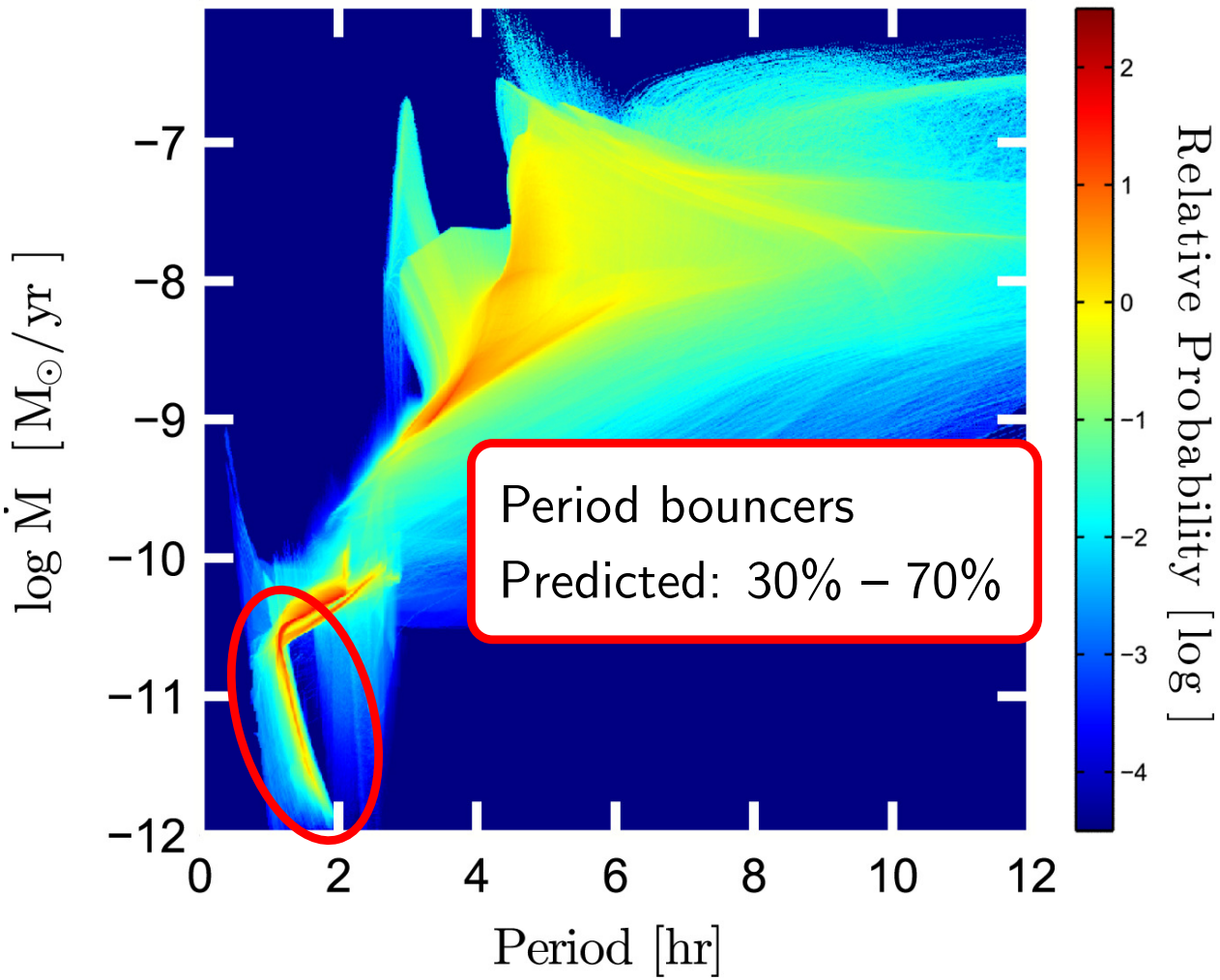

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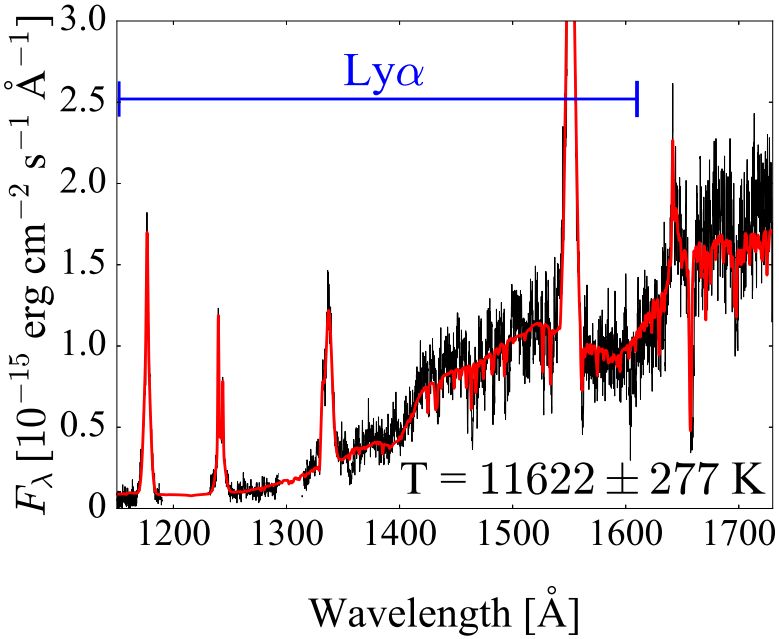
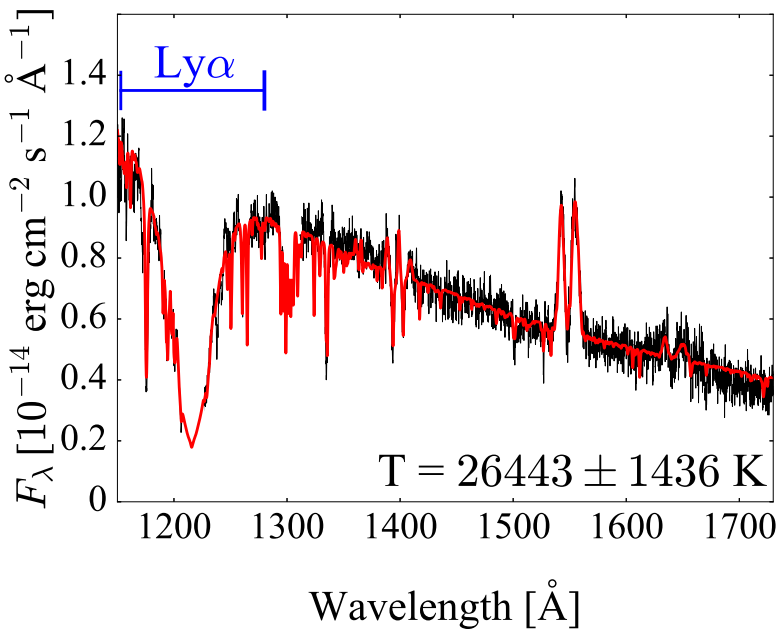
A 122 orbit HST program

Pala et al. 2017, MNRAS, 466, 2855

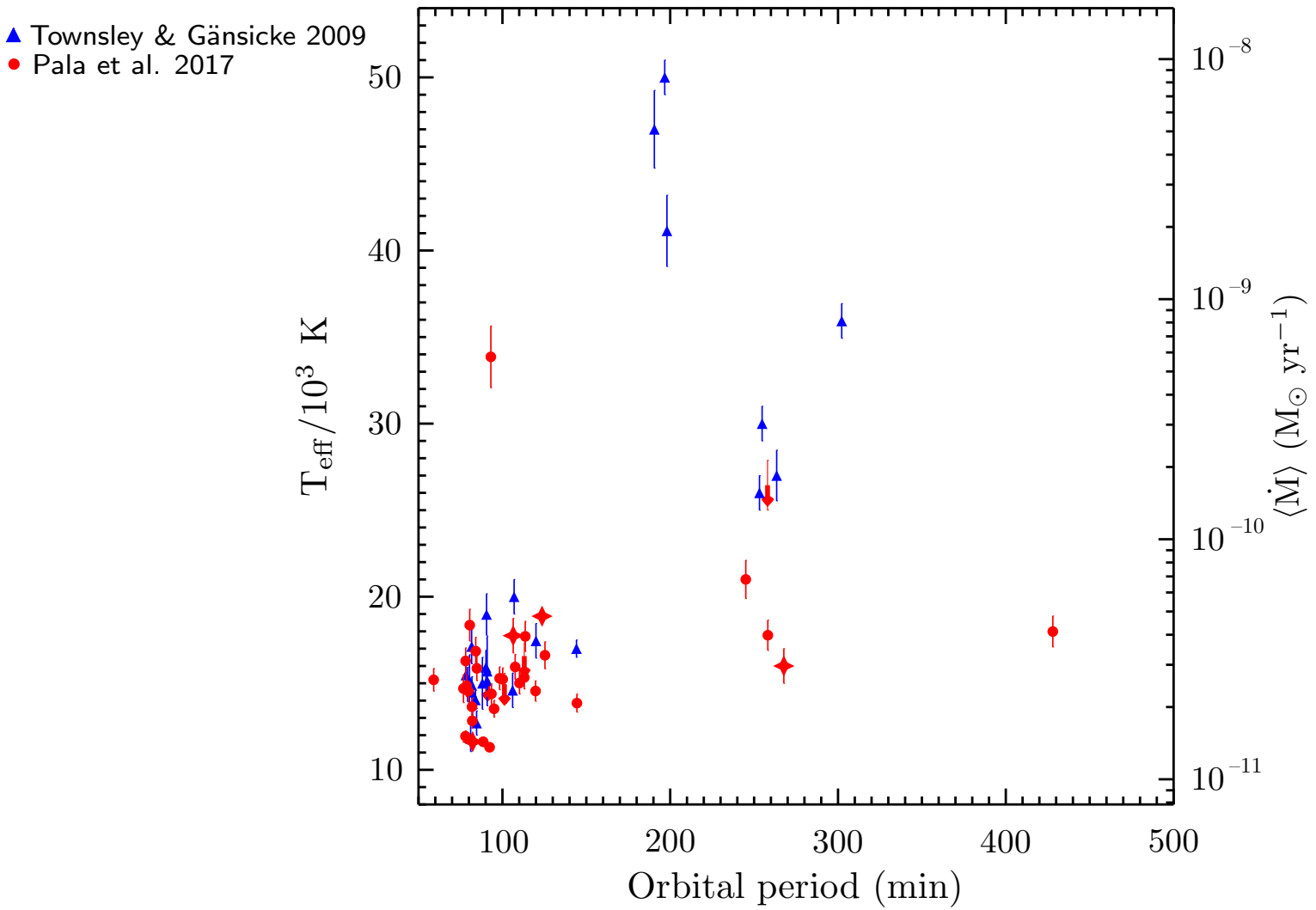




$T_{\rm WD} \longrightarrow \dot{M}$ (Townsley & Gänsicke 2009)

...also Z, $v \sin(i)$, $M_{\rm WD}$ (from *Gaia* parallaxes)

CV evolution – Observations



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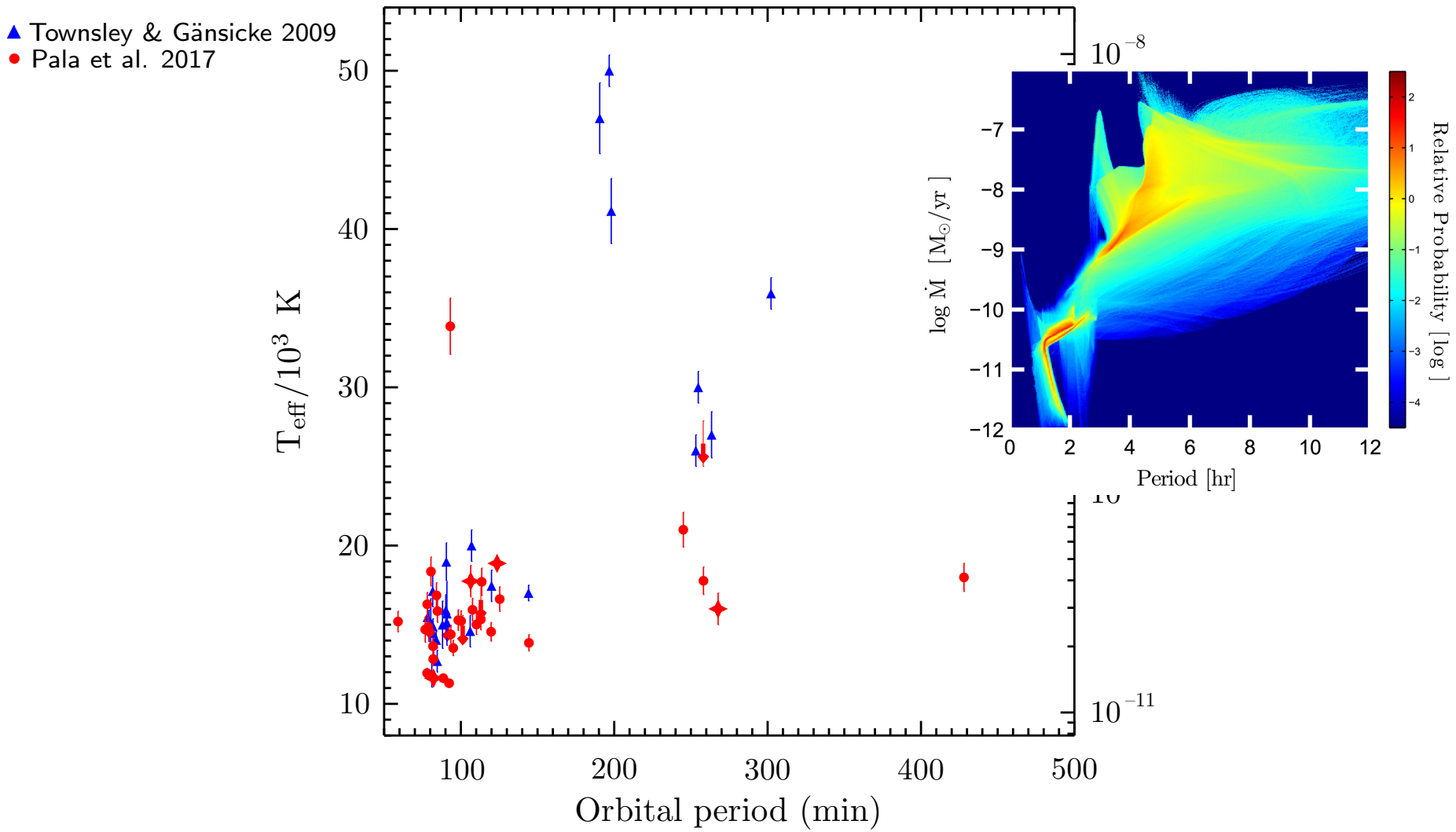

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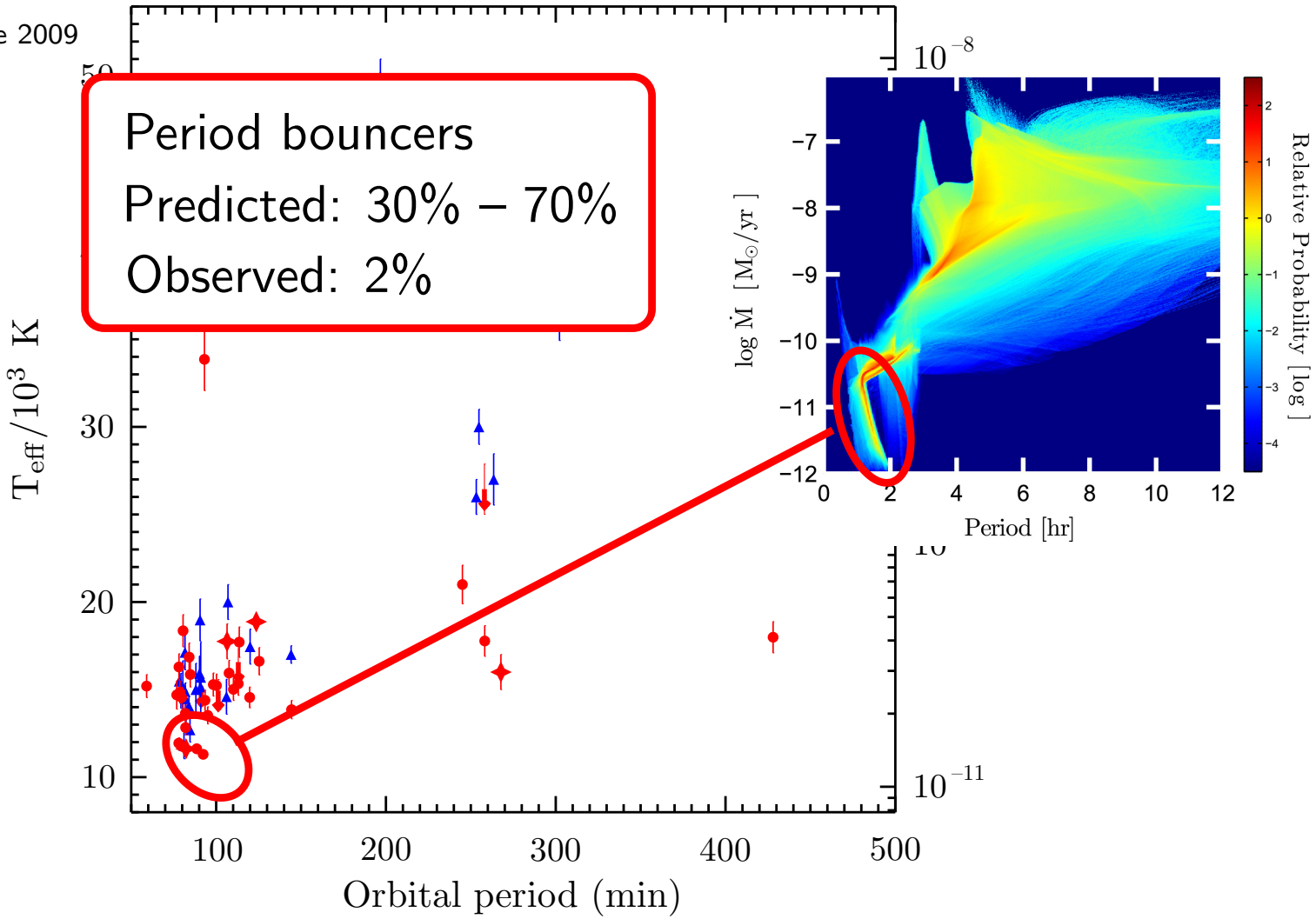
CV evolution – Observations

▲ Townsley & Gänsicke 2009
● Pala et al. 2017



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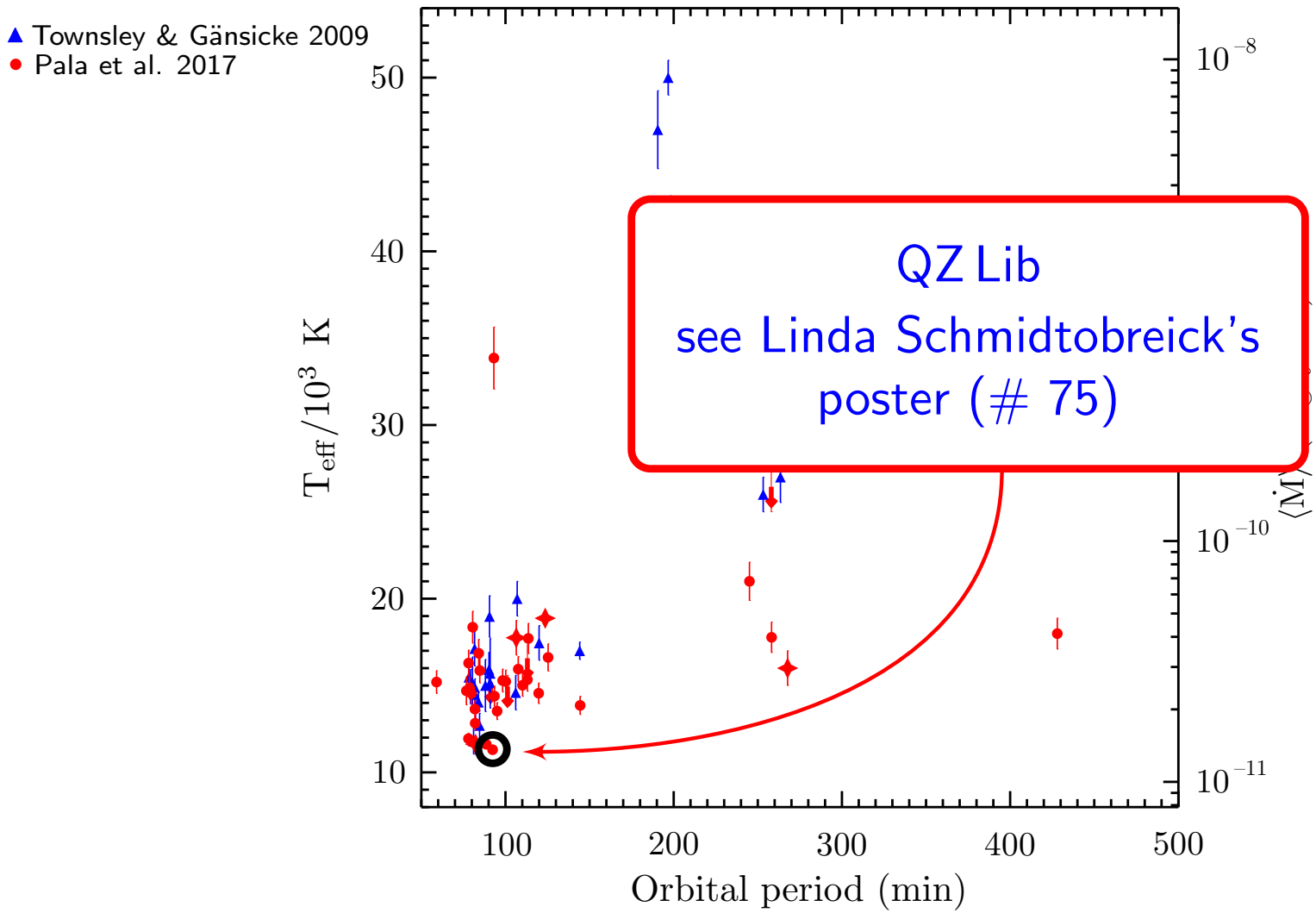

Pala et al. 2017, MNRAS, 466, 2855

CV evolution – Theory vs Observations

Major discrepancy between theory and observations

- $>$ 1100 CVs known, $\simeq$ 800 period bouncer expected
- only a handful of period bouncer detected

Can we trust the theory of compact binary evolution?

Important implications for X–ray transient, millisecond pulsars, SNe Ia...

How can we identify the missing population?

- low spatial density
- brown dwarf/accretion signature absent
- faint ($V \simeq 20.5$)

- $P_{\rm orb} \simeq 80 - 120$ min
- brown dwarf companion of Jupiter size
- $10 - 15\%$ eclipsing

- deep survey
- multi–band photometry for colour identification
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JAST/T80Cam

1. FoV: $1.4^\circ \times 1.4^\circ$
2. 1 CCD – 9.2k × 9.2k pixels (84M pixels)
3. 12 s readout time
4. Filters: u, g, r, i, z, $H\alpha$

CHiCaS

Compact binaries High Cadence Survey

Anna Francesca Pala, Alessandro Ederoclite,
B.T. Gänsicke, J. Abril, H. Vázquez Ramió, R. Raddi,
N.P. Gentile Fusillo, A. Rebassa–Mansergas

268 hours awarded over 4 semesters

136 deg^2, $|b| \simeq 15^\circ$, $E(B-V) < 0.05$

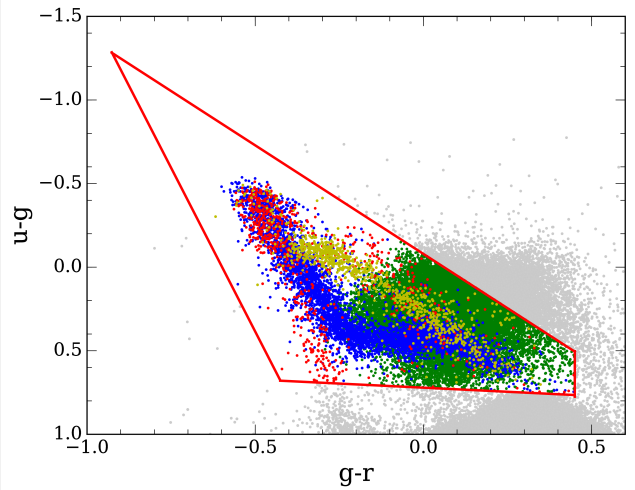
1 minute cadence – $V \simeq 21.5$

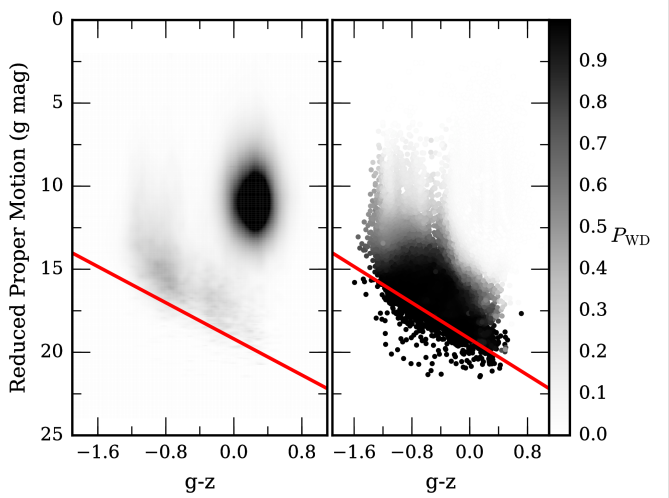
expected to find 5–10 period bouncers

Observing strategy and identification methods

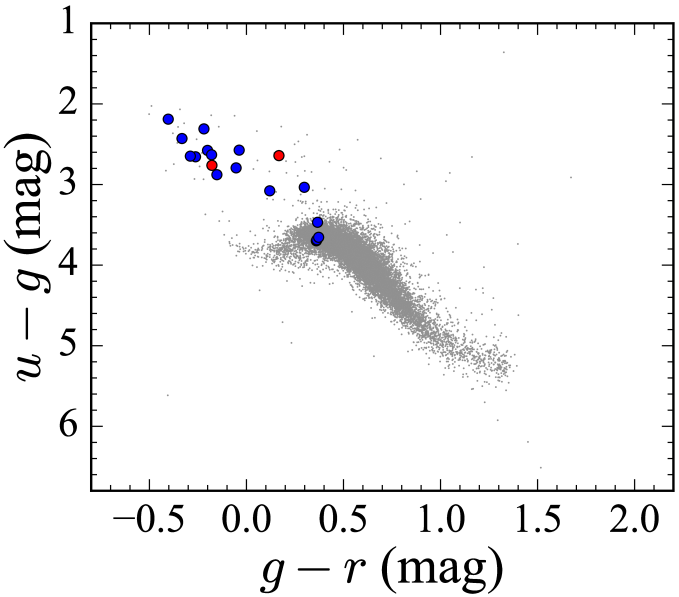
Multiband photometry + 3 hours of uninterrupted time series

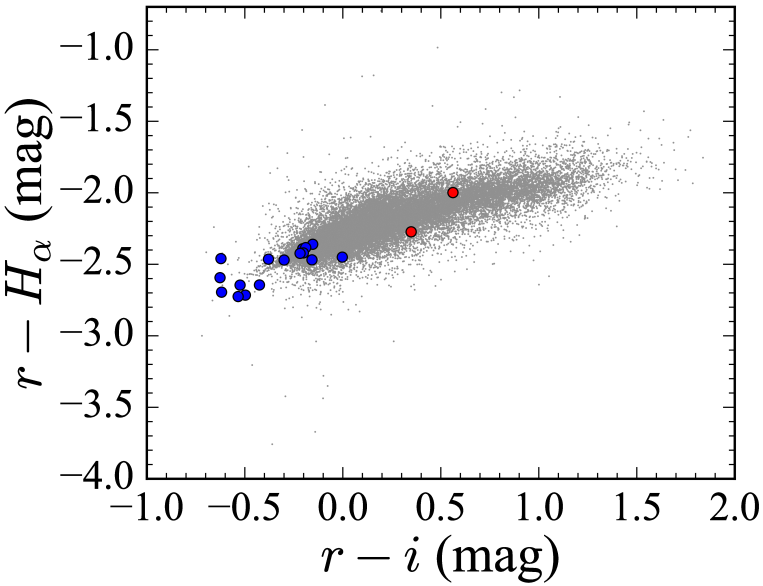
- CVs and white dwarfs identification thanks to their colours (Abril et al. in preparation, Gentile Fusillo et al. 2015)
- maximising the probability of detecting 1 eclipse per period bouncer





Colour–colour diagrams from CHiCaS J065048+230614



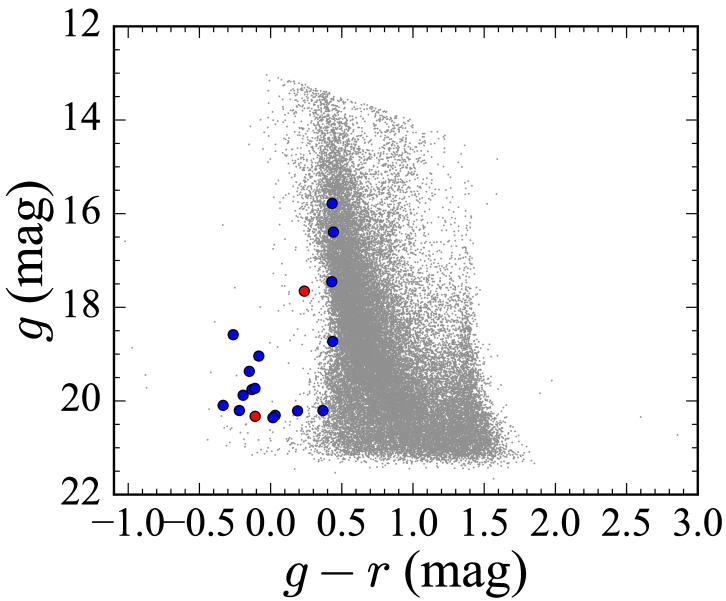


1 Field (1.5% of the total data set):

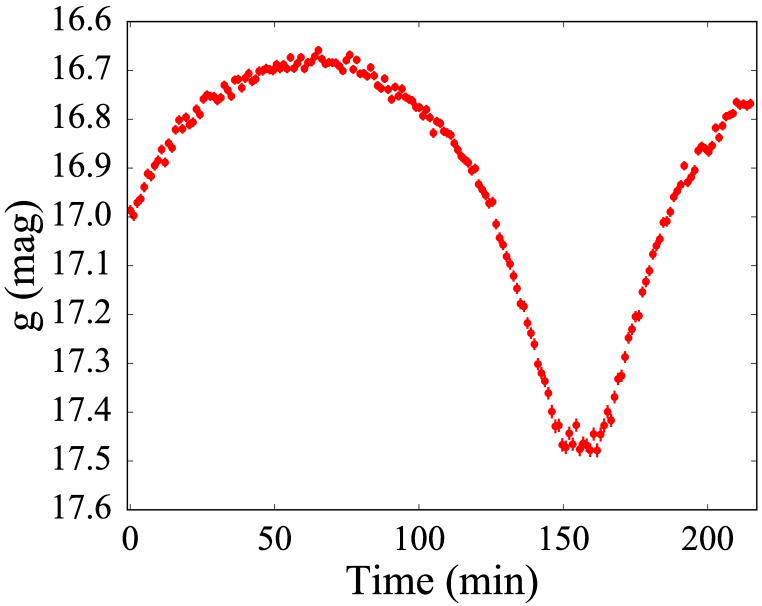
- 16 WDs – 2 CVs
- 30 000 lightcurves

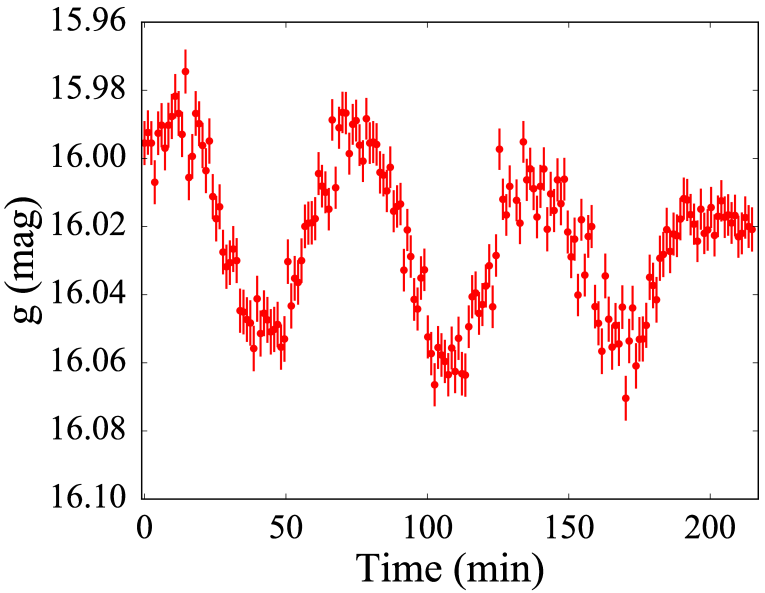
Total program:

- $\simeq$ 1 000 WDs
- 2 000 000 lightcurves

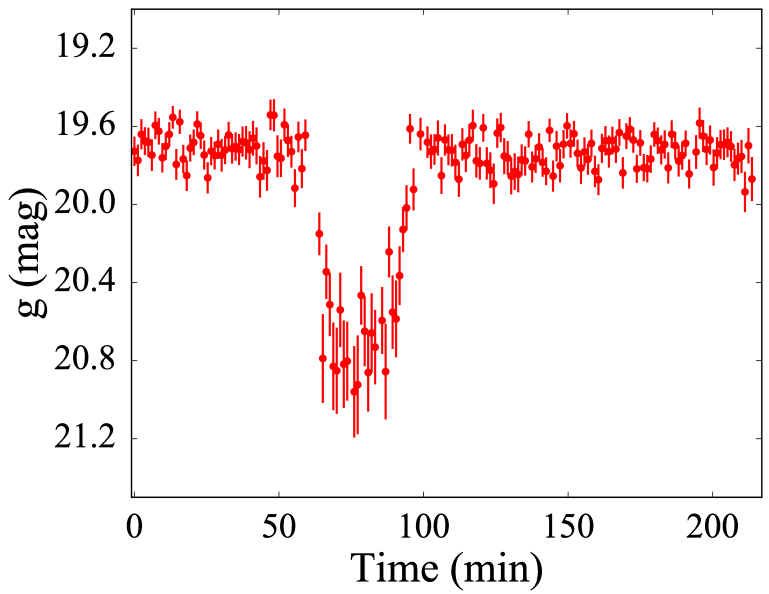


Additional science from CHiCaS





- contact binaries
- eclipsing binaries
- pulsating stars
- detached WD+MS binaries
- planetary debris around WDs (WD 1145+017)
- AM CVn



Summary

CHiCaS:

- first systematic attempt to find period bouncers
- a lot of additional science
- complete and unbiased view into short term variability
- public data

2 000 000 light curves
$V \simeq 21.5$ – 1 minute cadence
full colour information!!!

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Thank you