

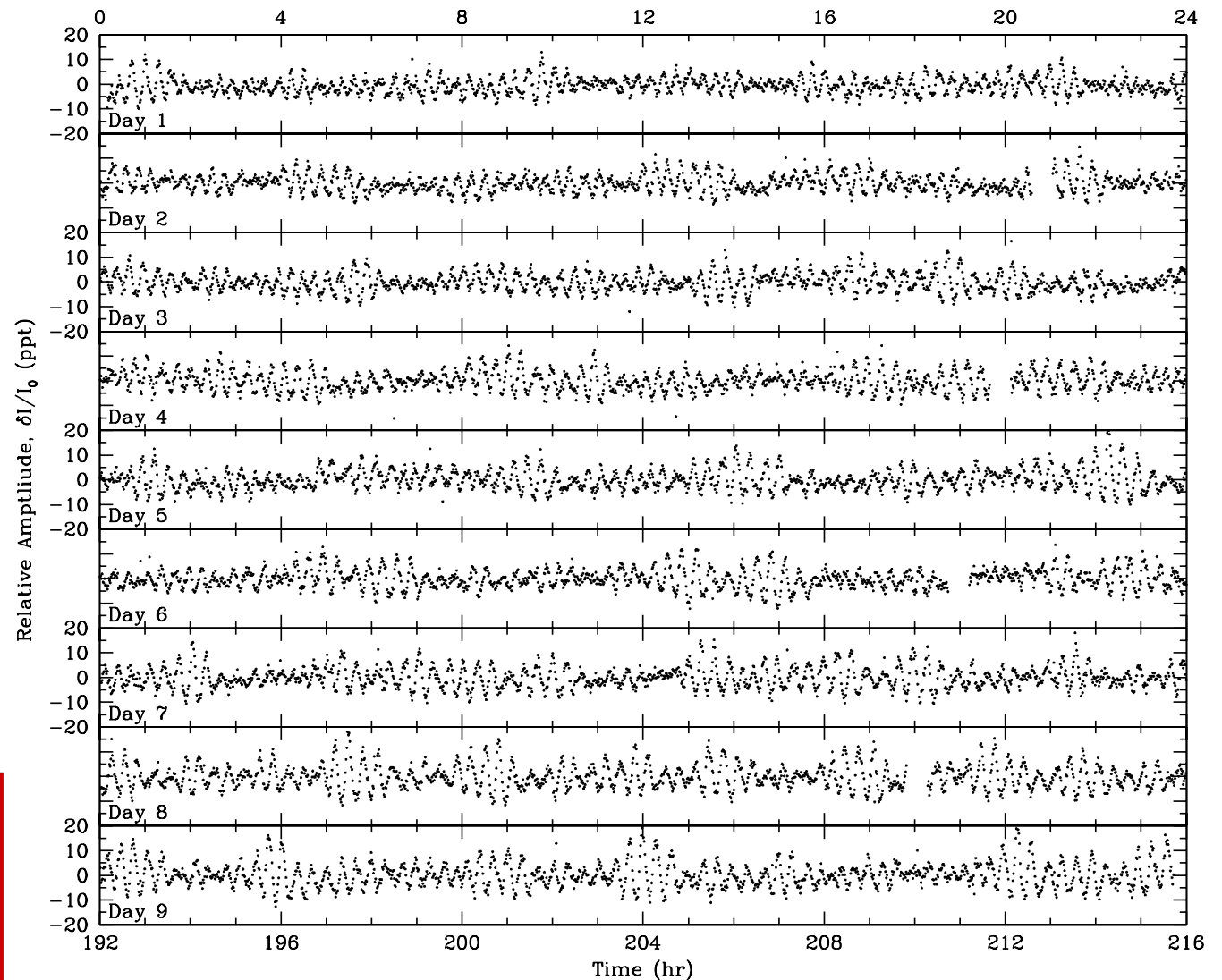
Pulsating White Dwarfs from TDA Surveys

J.J. Hermes

<http://jjherm.es>

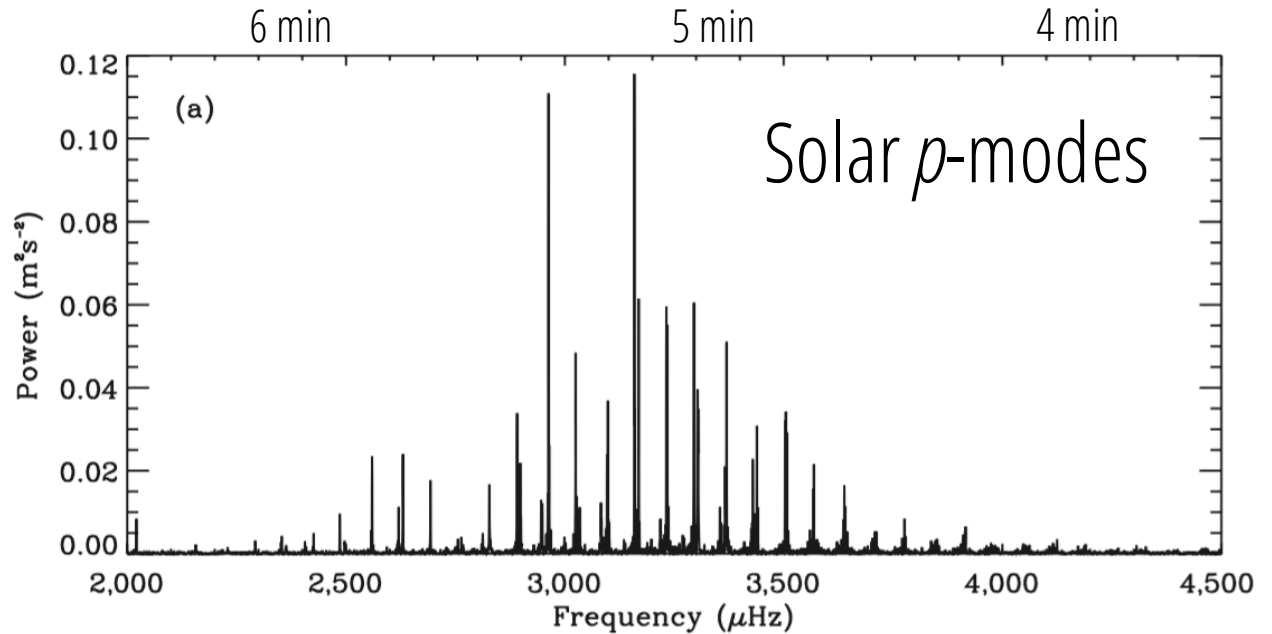
@jotajotahermes

**BOSTON
UNIVERSITY**

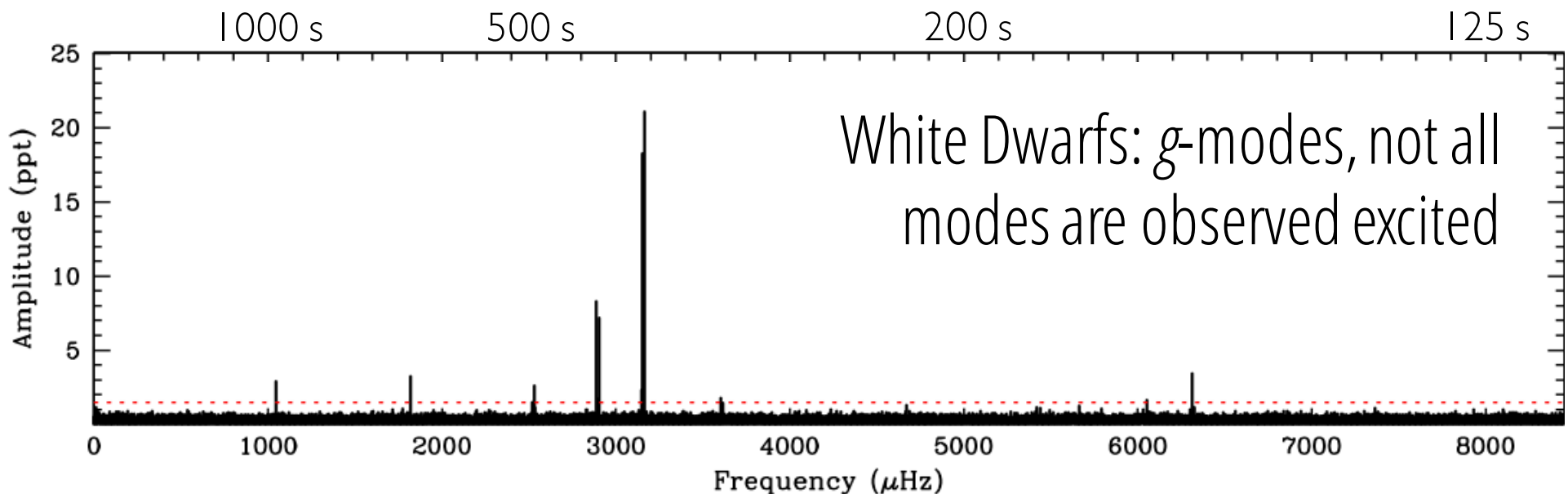


White dwarf pulsations:

Periods: 100-1500 s
Amps: 0.1-3% (and higher...)



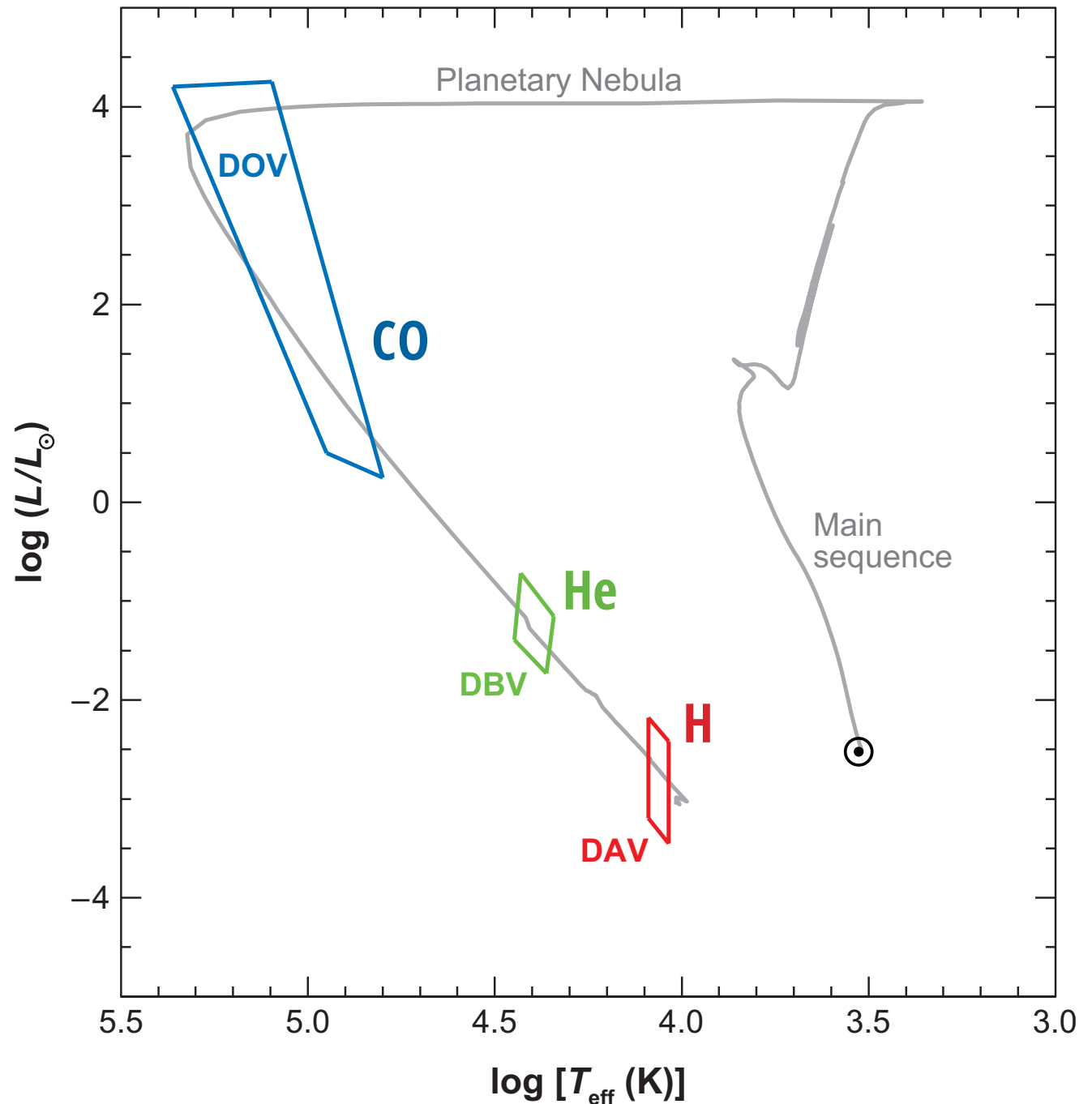
BiSON; Thompson et al. 2003



White dwarfs:

Peering 6 Gyr into
our Sun's future...

non-radial g-
mode pulsations
driven by partial
ionization of **He**
or **H**



See reviews by:

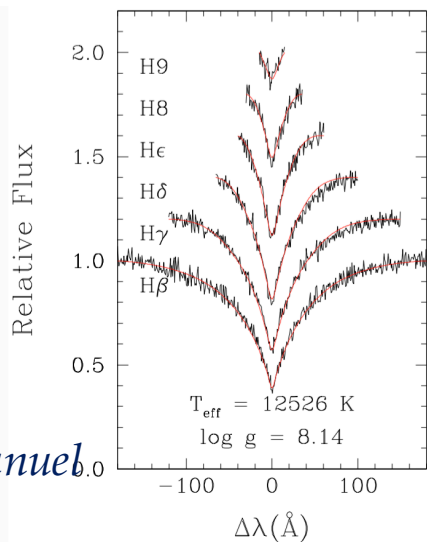
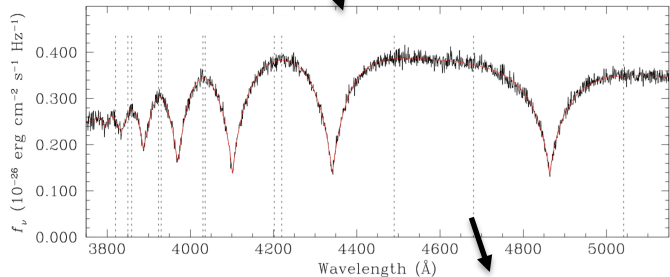
Winget & Kepler 2008

Fontaine & Brassard 2008

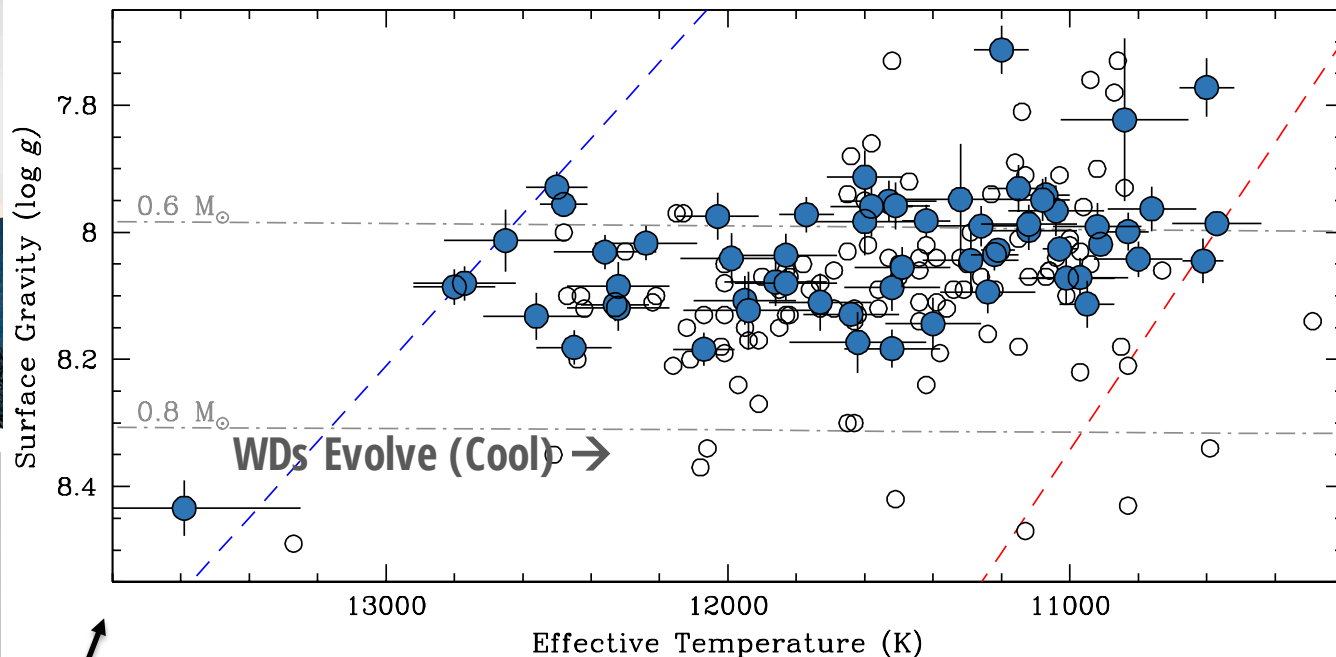
Althaus, Córscico, Isern & García-Berro 2010

Spectroscopy of DAs (H atm.) Yield Atmospheric Params.

4.2m SOAR telescope



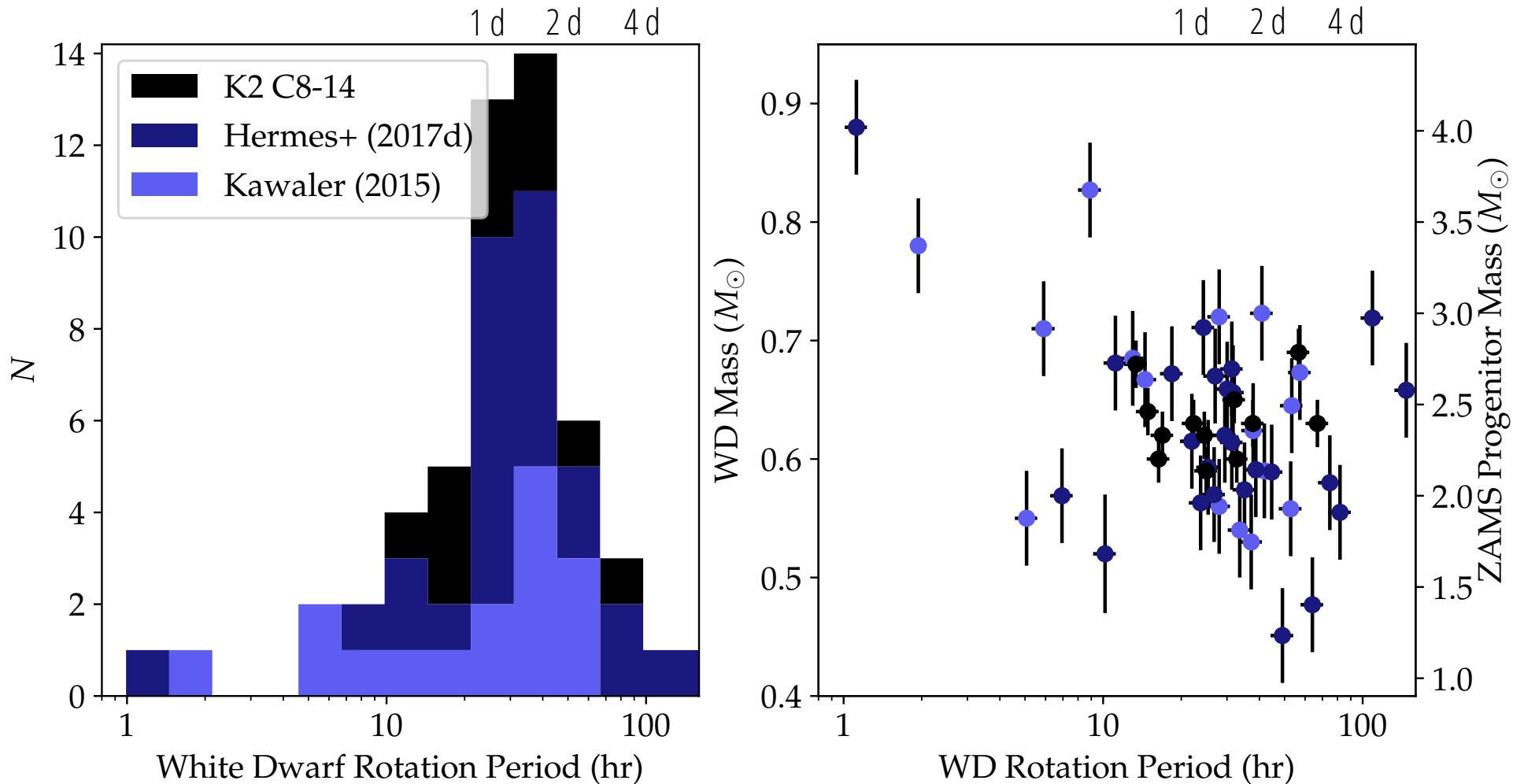
*fits via
Pier-Emmanuel
Tremblay*



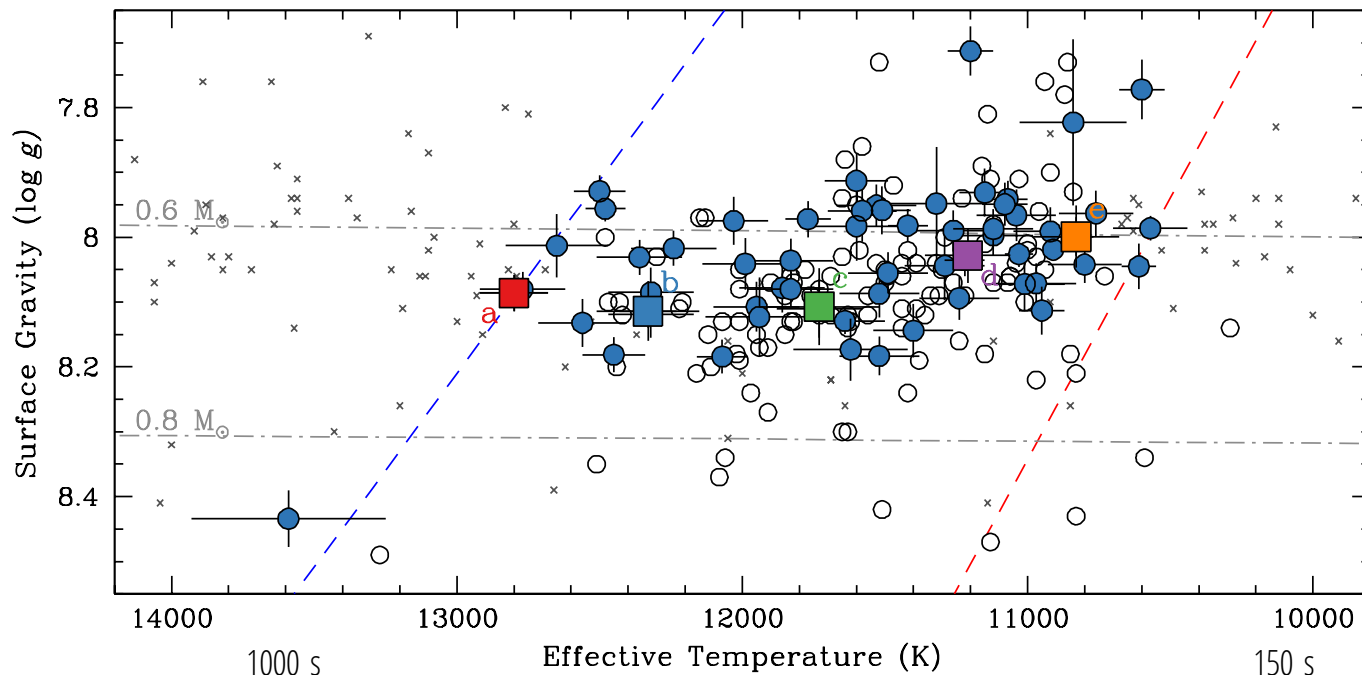
Blue: Observed by *Kepler*
Open: Ground-based

Note: Most white dwarfs: **0.55-0.70 M_{\odot}**
(evolved from 1.0-3.0 M_{\odot} ZAMS)

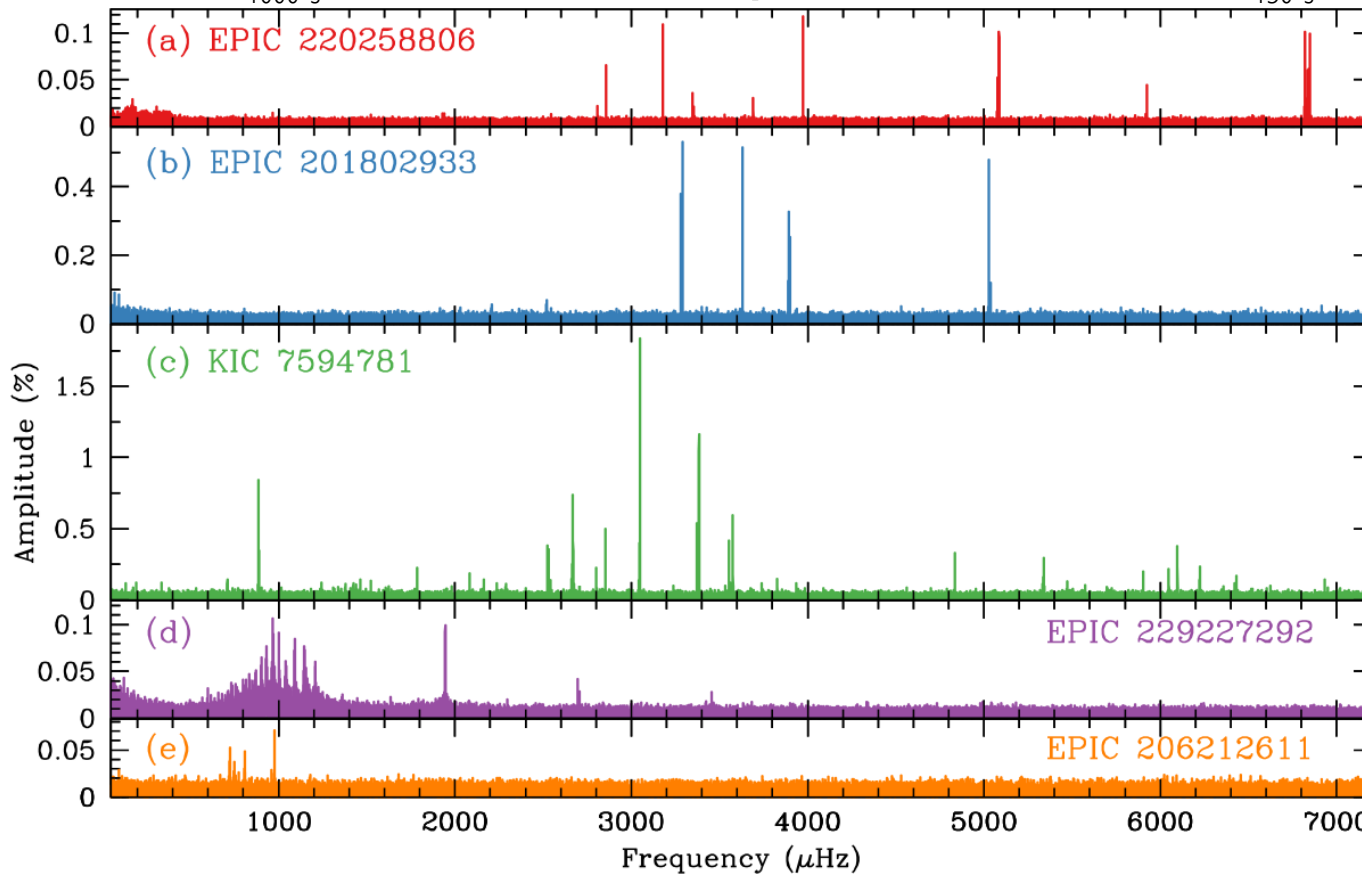
Pulsations Give Rotational Splittings; Joined w/ Spectra We Finally Have WD Rotation Rates as Function of Mass



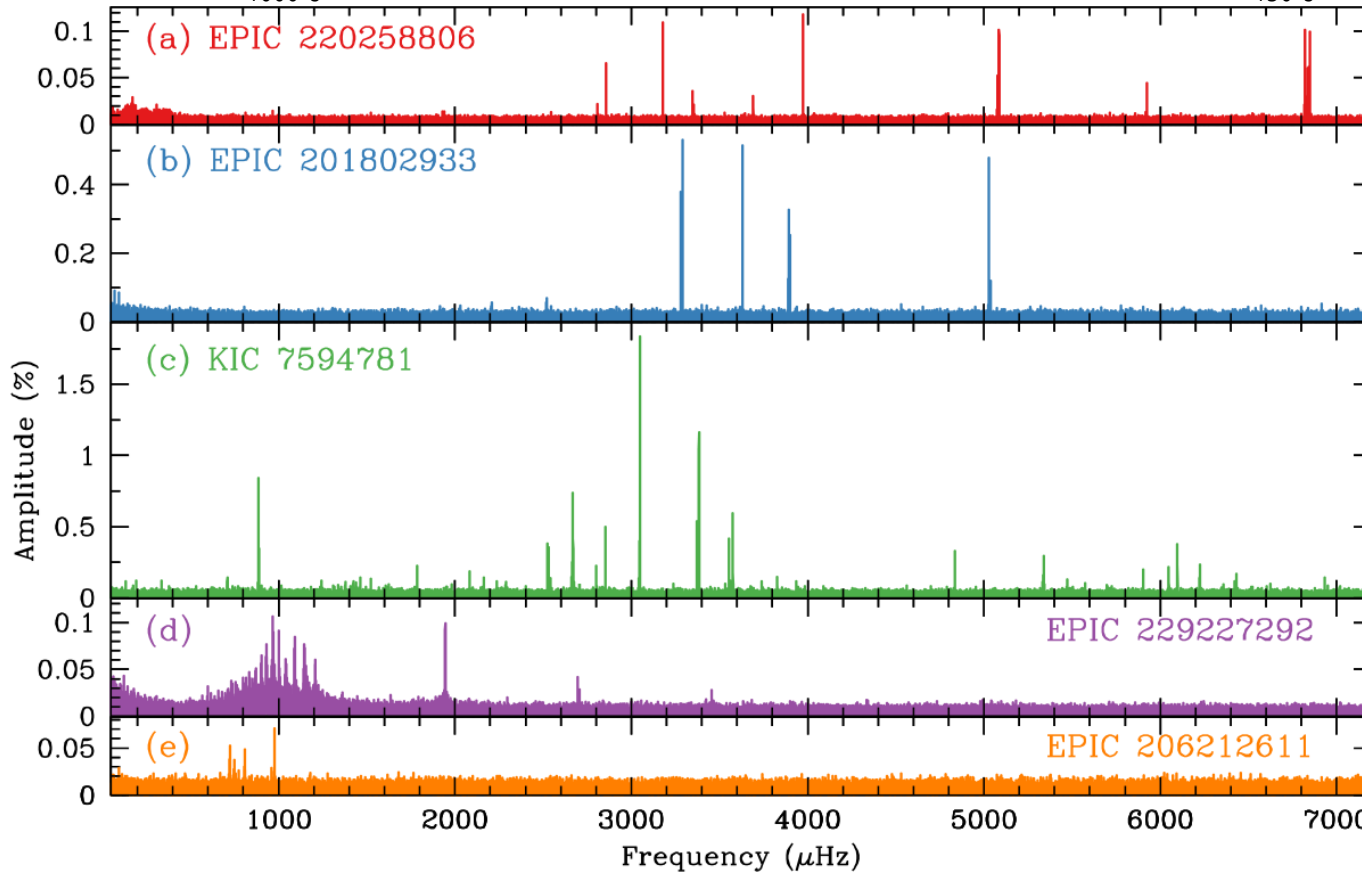
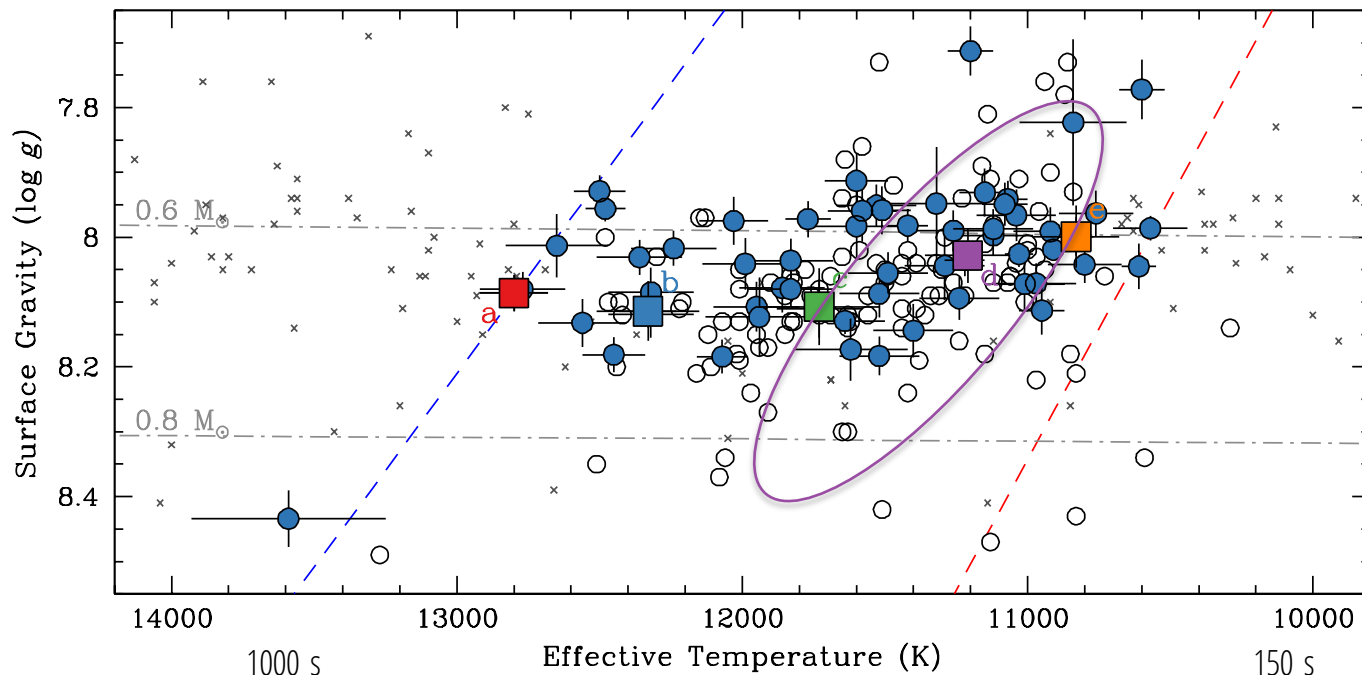
Most white dwarfs evolve from 1-3 M_{\odot} ZAMS stars,
and rotate with periods of 0.5-2.2 days



as white dwarfs
cool:



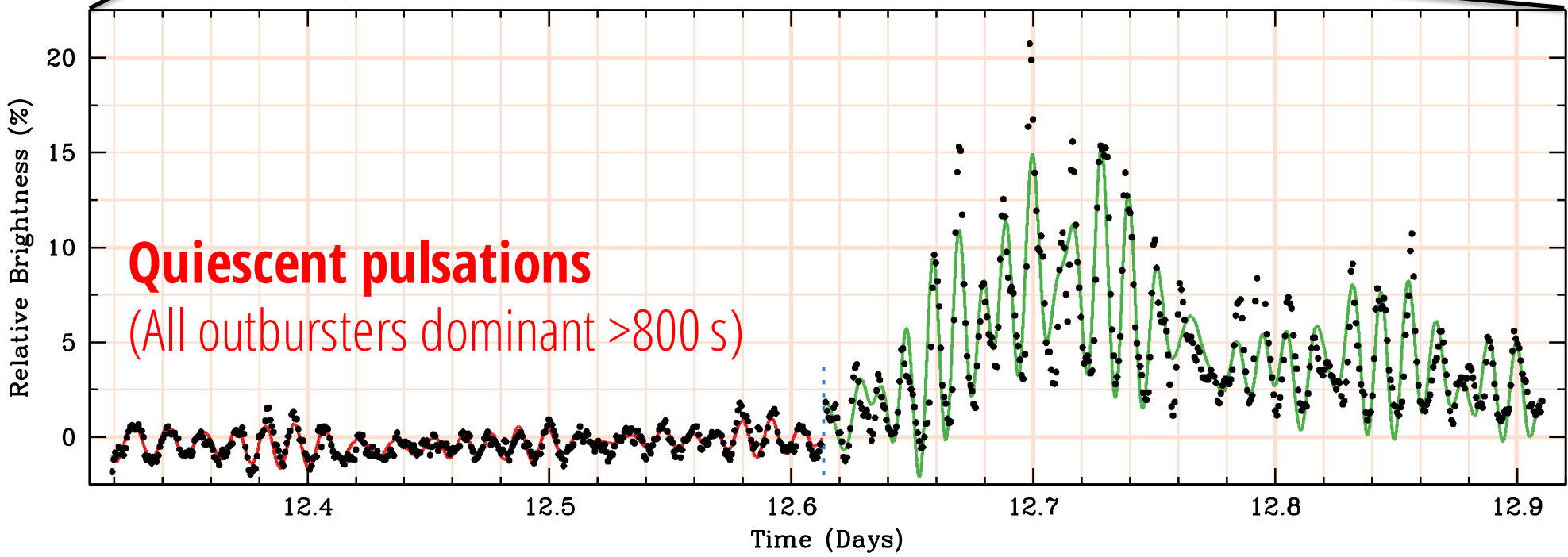
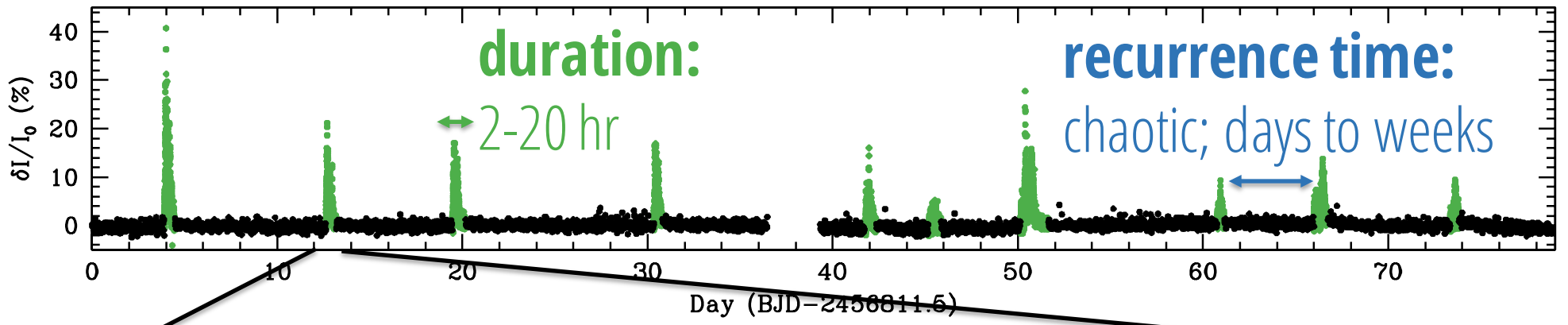
convection zone deepens and
longer-period
(higher-radial-order)
pulsations driven



as white dwarfs
cool:

**convection zone
deepens** and
longer-period
(higher-radial-order)
pulsations driven
and
mode density
rapidly **increases**

Unexpected Outburst Phenomena in Pulsating WDs

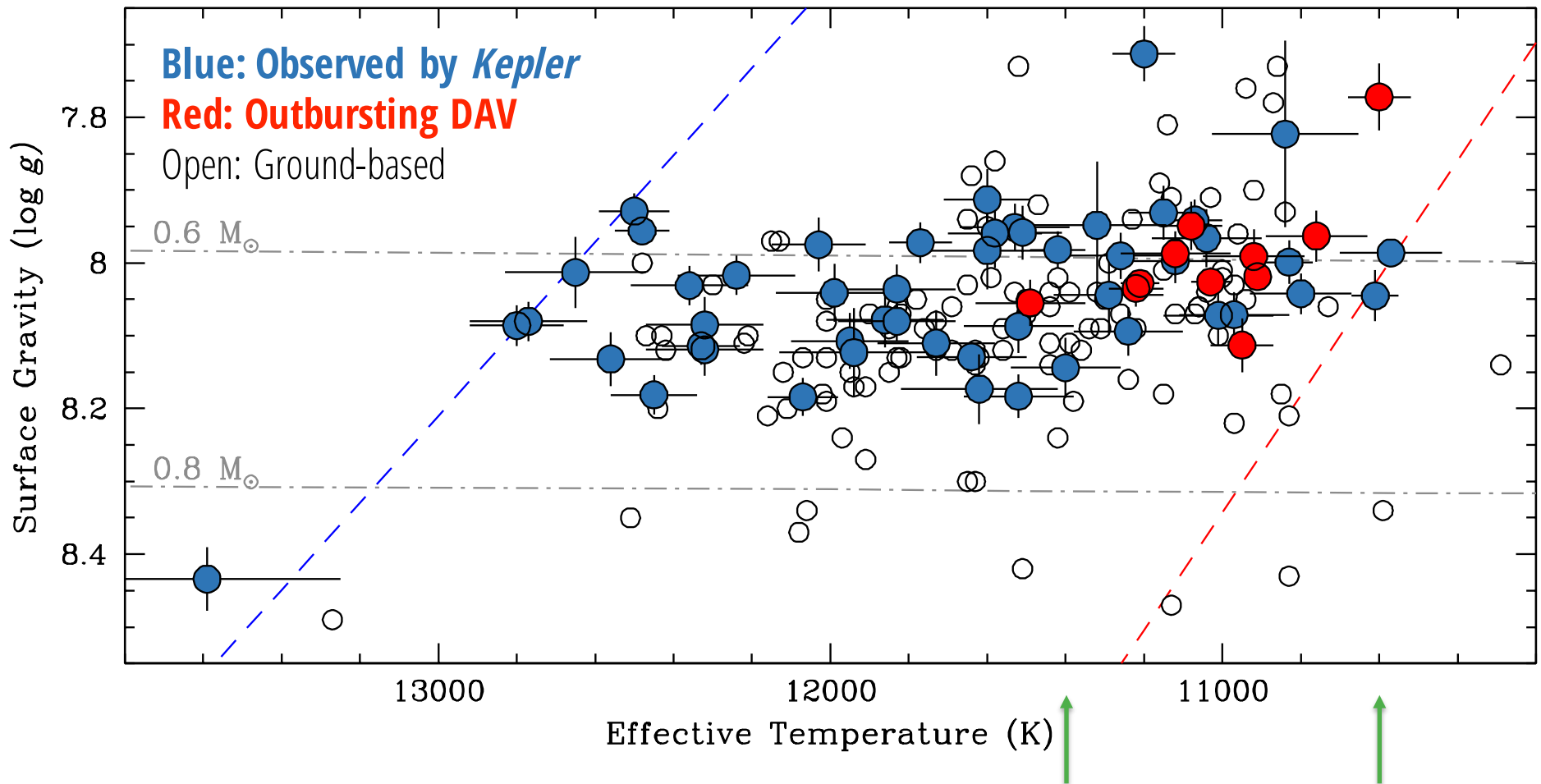


15% flux increase:
700 K T_{eff} increase

excess energy:
 10^{33-34} erg

*PG 1149+057: Hermes et al. 2015b
see also Bell et al. 2015, 2016*

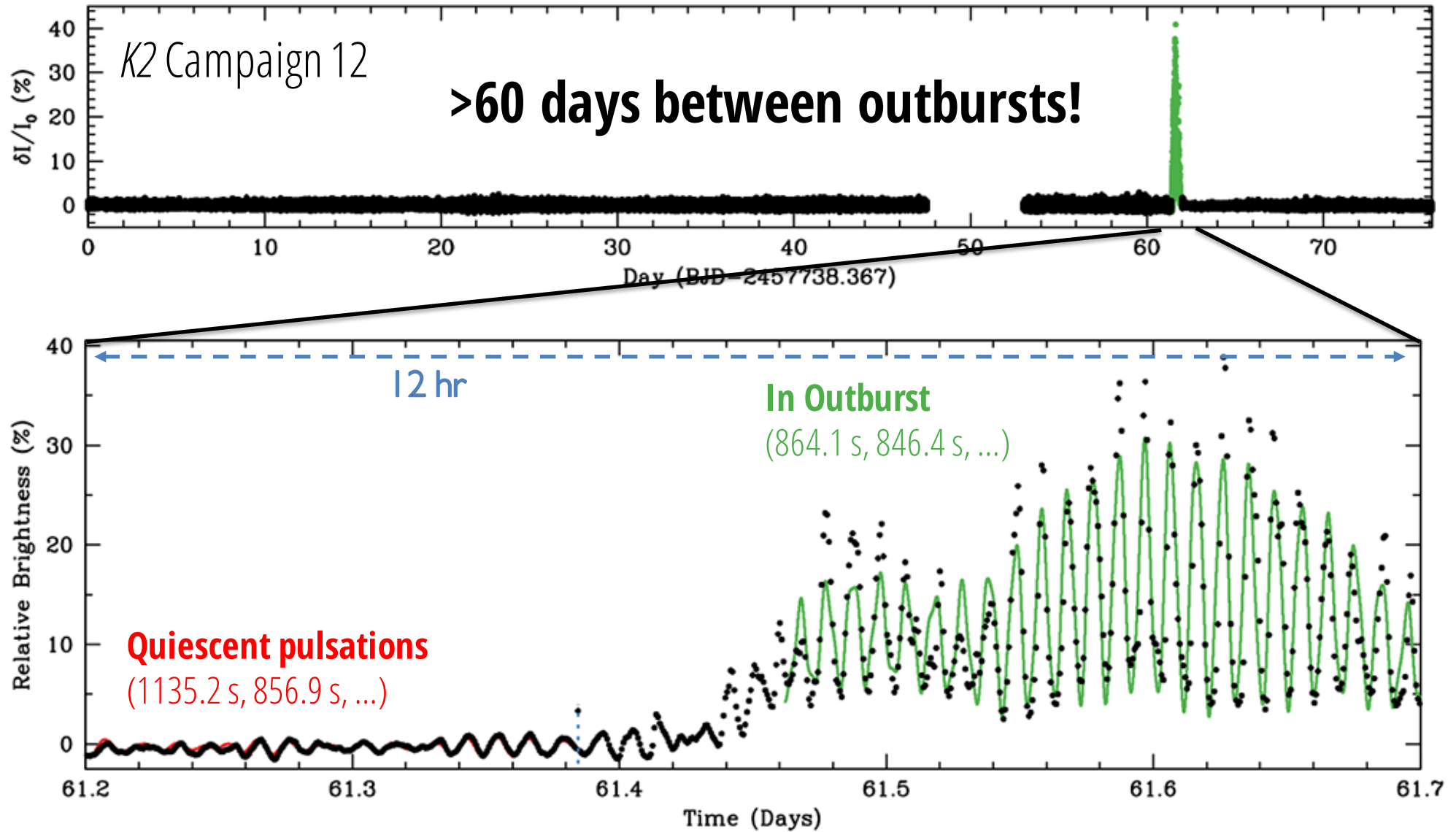
Outbursting DAVs are Among the Coolest DAVs



more than 50% of DAVs from 11,200-10,600 K show **outbursts** in ~70 days of K2 monitoring

16/71 (>20% of) DAVs with Kepler data show outbursts

GD 1212: The Brightest Outbursting White Dwarf

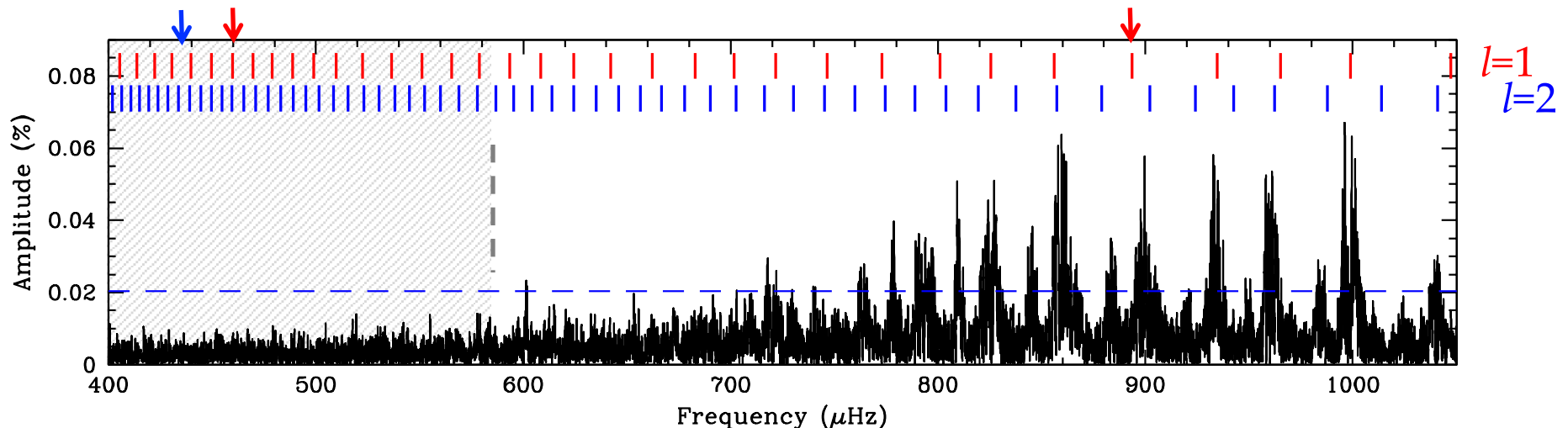


Outbursts: Mode Coupling via Parametric Resonance

outbursts are likely “**limit cycles** arising from sufficiently resonant **3-mode couplings** between **overstable parent** modes and pairs of radiatively damped **daughter modes**”

Luan & Goldreich 2018

Radiative damping \leftarrow \rightarrow Driving exceeds damping

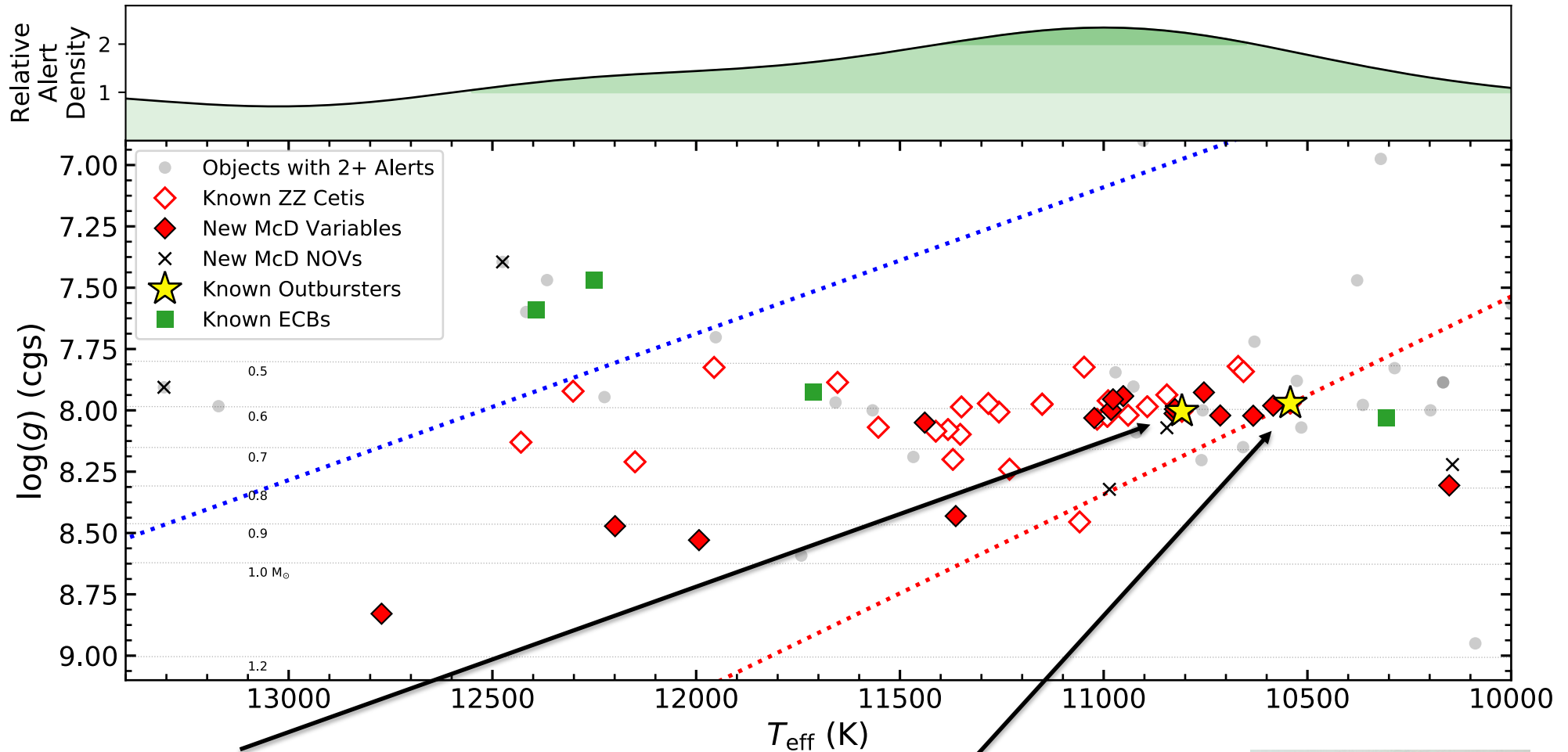


Adiabatic Model: 11,245 K, $0.632 M_{\odot}$, $10^{-4.12} M_{\text{HI}}/M_{\text{WD}}$ (Romero et al. 2012)

Observed: 11,060(170) K, $0.64(0.03) M_{\odot}$ (Gianninas et al. 2011)

What are surface temperatures and velocities in outburst?

Overdensity of ZTF Alerts Near Outbursting White Dwarfs



GD1212 ($g=13.2$ mag):

2 low-RB ZTF alerts

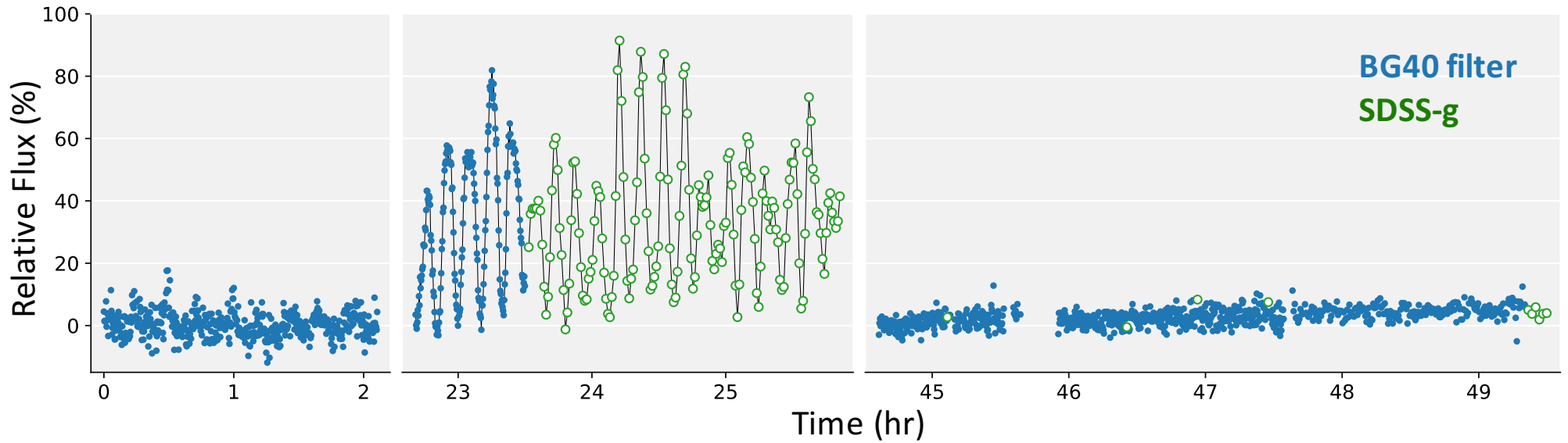
EPIC 229227292 ($g=16.6$ mag):

1 high-RB ZTF alert

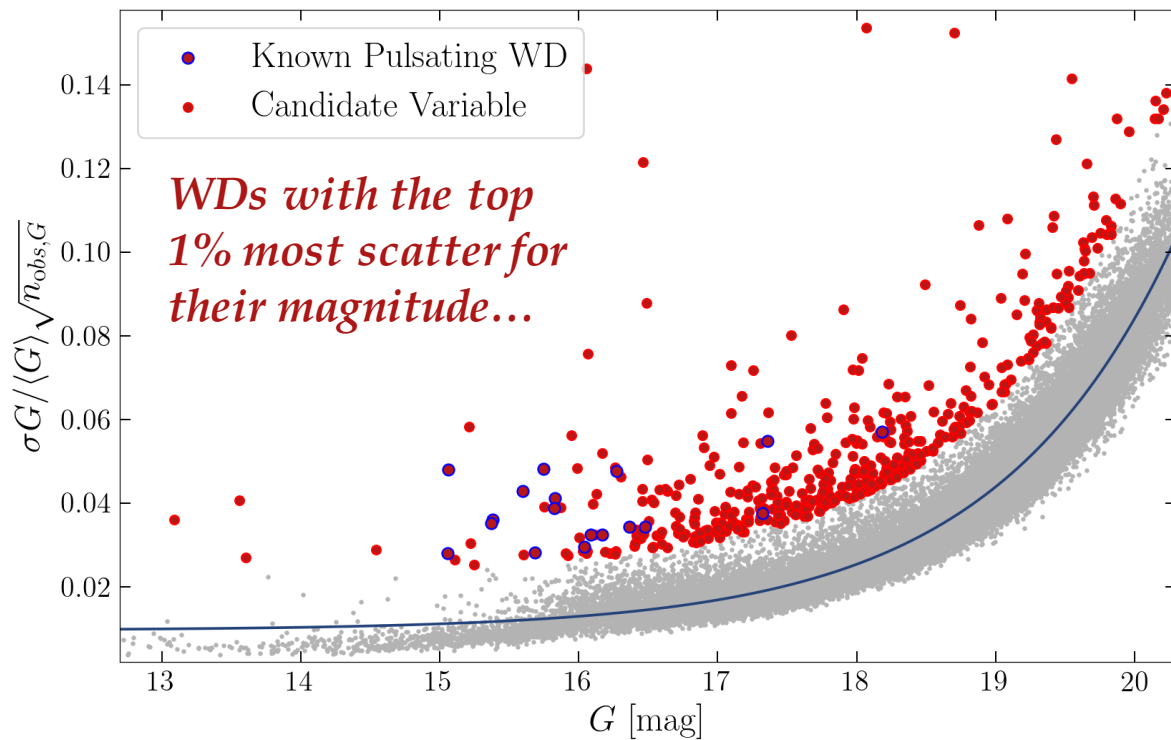


courtesy Zachary Vanderbosch (UT-Austin)

Outbursts Have Finally Been Detected from the Ground!



Vanderbosch et al. 2019, in prep.



Gaia Empirical Uncertainties Finds Variables!

>46,000 WDs within 200pc

