

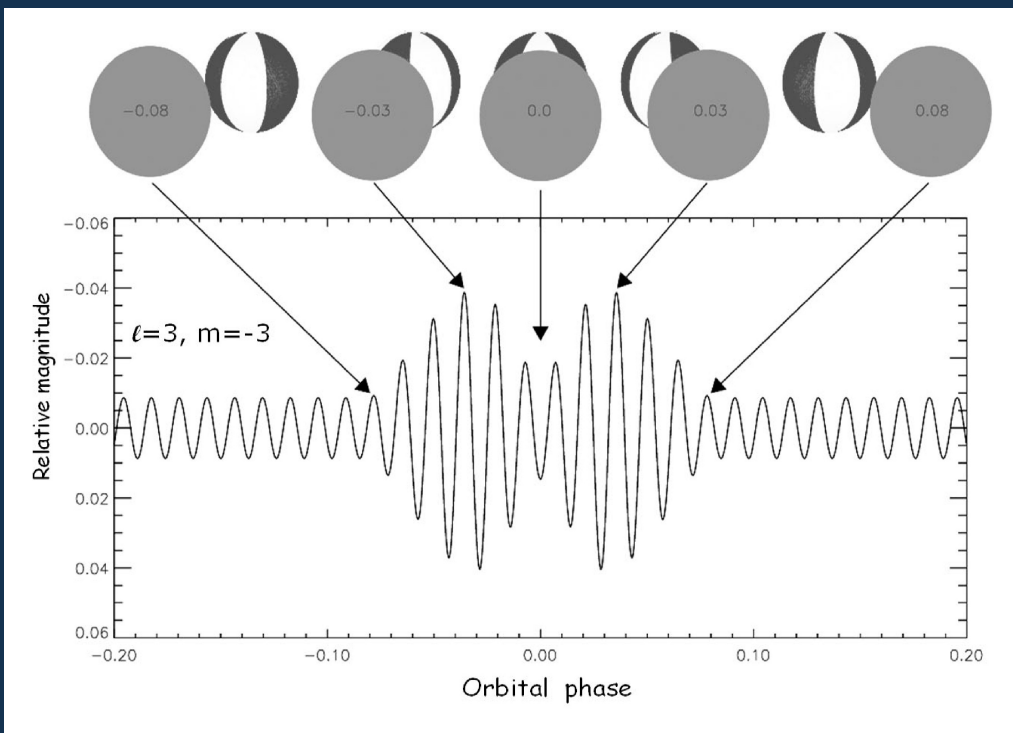
# Pulsating components of eclipsing binaries from the ASAS-3 data

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# The eclipsing binaries with pulsating components can be used for:

- determination of the stellar parameters:  
from the light curve and radial-velocity curve we can get masses and radii; they are crucial in stellar modeling
- non-radial mode identification  
the amplitude and phase of the pulsating mode change during an eclipse (eclipse mapping technique)



## Some important papers:

- Kim et al. (2003, A&A 405, 231)
- Mkrtichian et al. (2005, ASP Conf. 333, 197)
- Reed et al. (2005, ApJ 634, 602)
- Bíró & Nuspl (2005, ASP Conf. 333, 221)
- Soydugan et al. (2006, MNRAS 370, 2013)
  - catalogue of eclipsing stars with  $\delta$  Scuti star components
- Pigulski (2005, ASP Conf. 349, 137)
  - an overview of pulsating components in multiple systems

# Pulsating stars in eclipsing binaries:

~10  $\beta$  Cephei

1 SPB V539 Arae (Clausen 1996)

~30  $\delta$  Scuti (Pigulski 2005; Soydugan et al. ~2006)

0  $\gamma$  Doradus, roAp, solar-like oscillations

3 Cepheids (LMC)

3 RR Lyrae (blends?) (LMC)

1 ZZ Ceti HS 2331+3905

1 sdB PG 1338-018

~10 Miras

~20 semi-regular stars

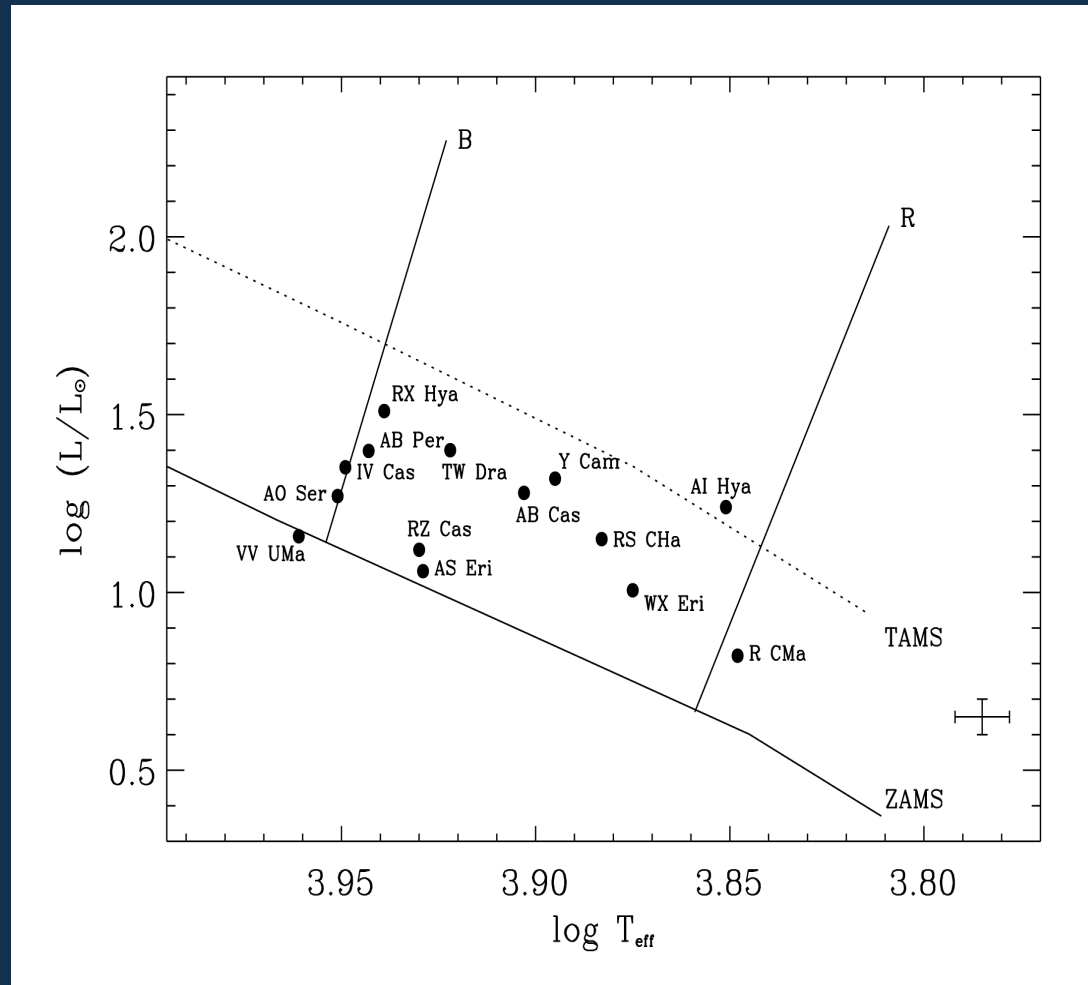
# Oscillating Algols (oEA)

Mkrtichian et al. (2002, ASP Conf. 259, 96)

- Algol-type systems with main sequence mass-accreting component
- Spectral type of pulsating star: (B)A-F

How the rate of mass accretion can influence  
the pulsating properties?

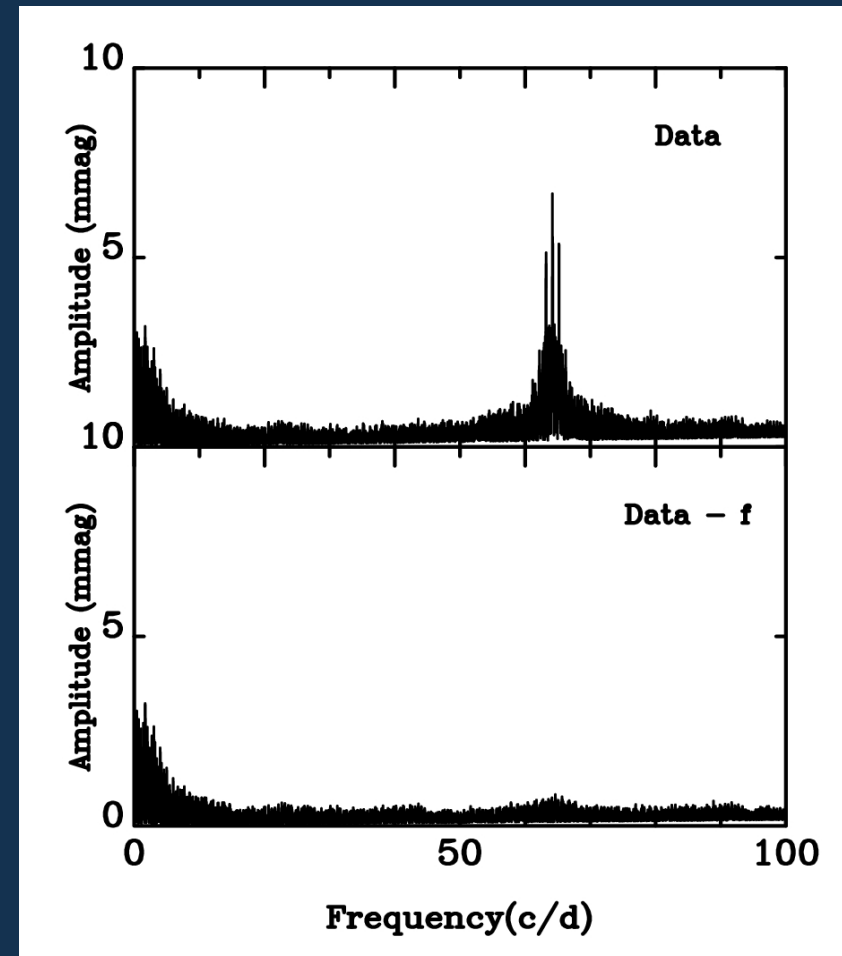
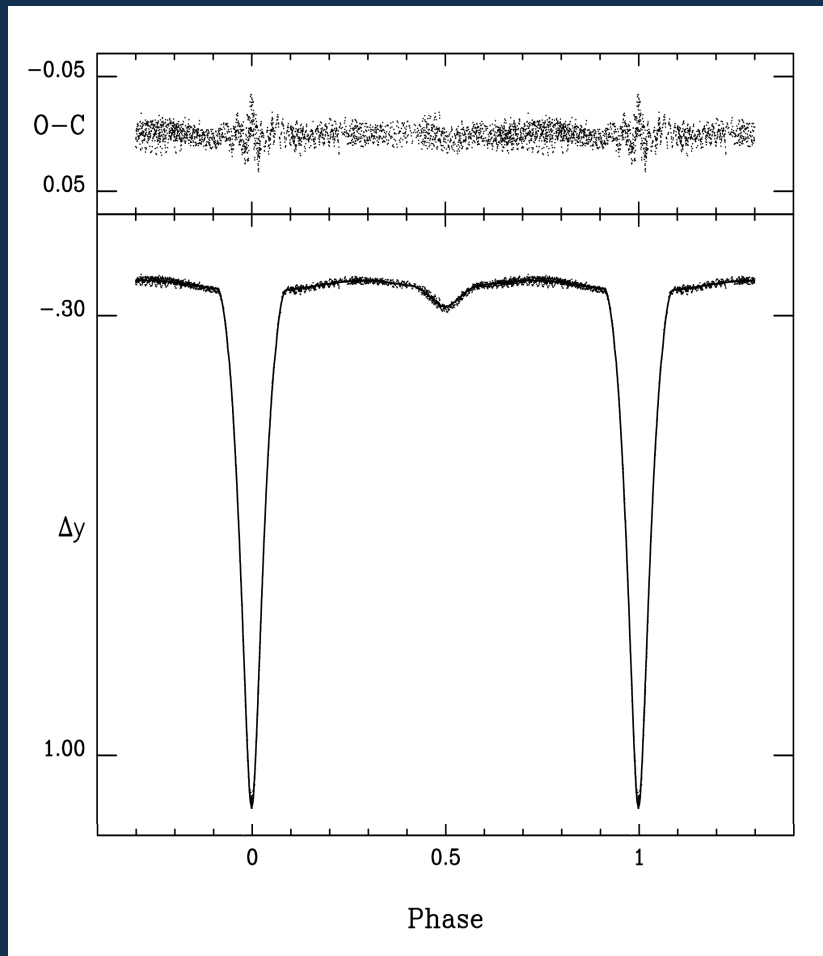
# HR diagram for $\delta$ Scuti components of the eclipsing binary systems



Soydugan et al. (2006, MNRAS 370, 2013)

# Example: RZ Cas

An eclipsing system with orbital period of 1.195257 d indicating additional variation with frequency 64.2 c/d



# An example: RZ Cas

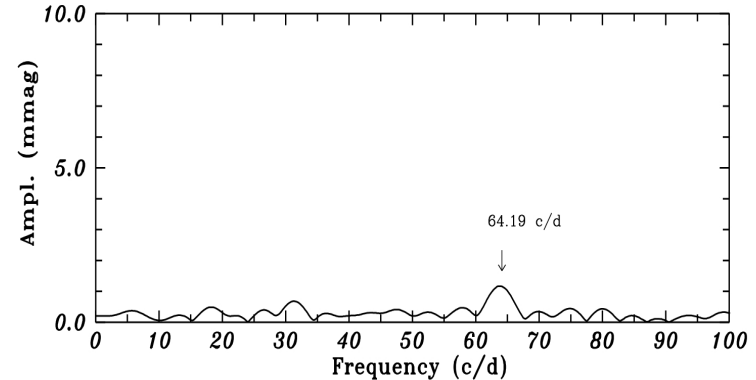
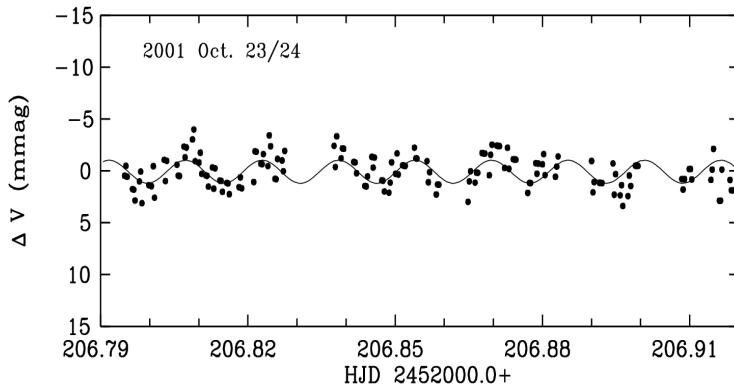
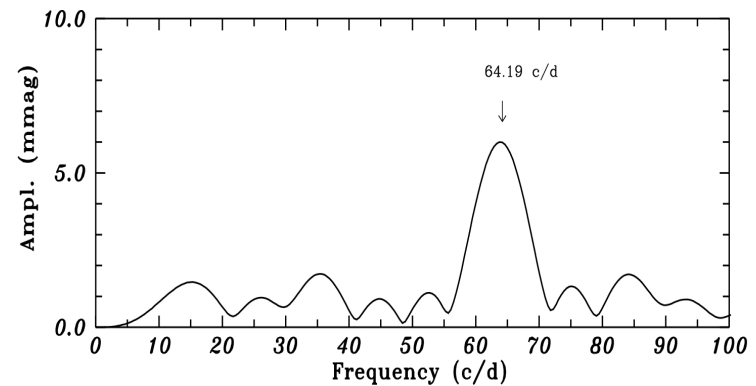
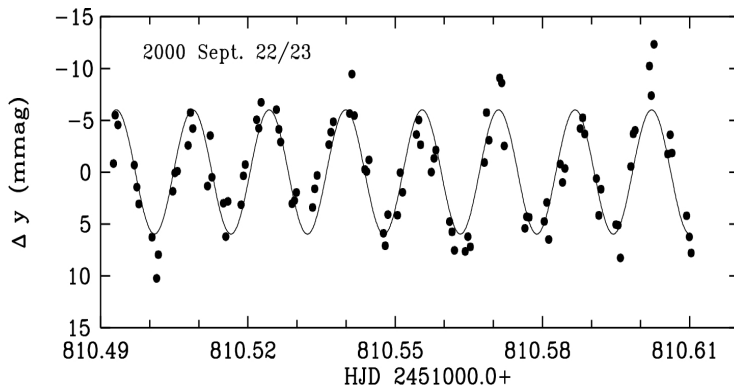
Change of the amplitude of the dominant mode  
in time

| Frequencies [c/d] | Note  |
|-------------------|---|
| 64.2              | Ohshima et al. (1998)                       |
| 64.2 +?           | Rodriguez et al. (2004) <i>uvby</i>         |
| 64.2              | <i>B</i> band data of Ohshima et al. (1998) |
| 64.2 19.9 38.2    | <i>V</i> band data of Ohshima et al. (1998) |
| 56.6 64.2         | Lehman & Mkrtichian (2004)                  |
| 64.2 12.1         | Soydugan et al. (2006) <i>B</i> band        |
| 64.2 10.6         | <i>V</i> band                               |



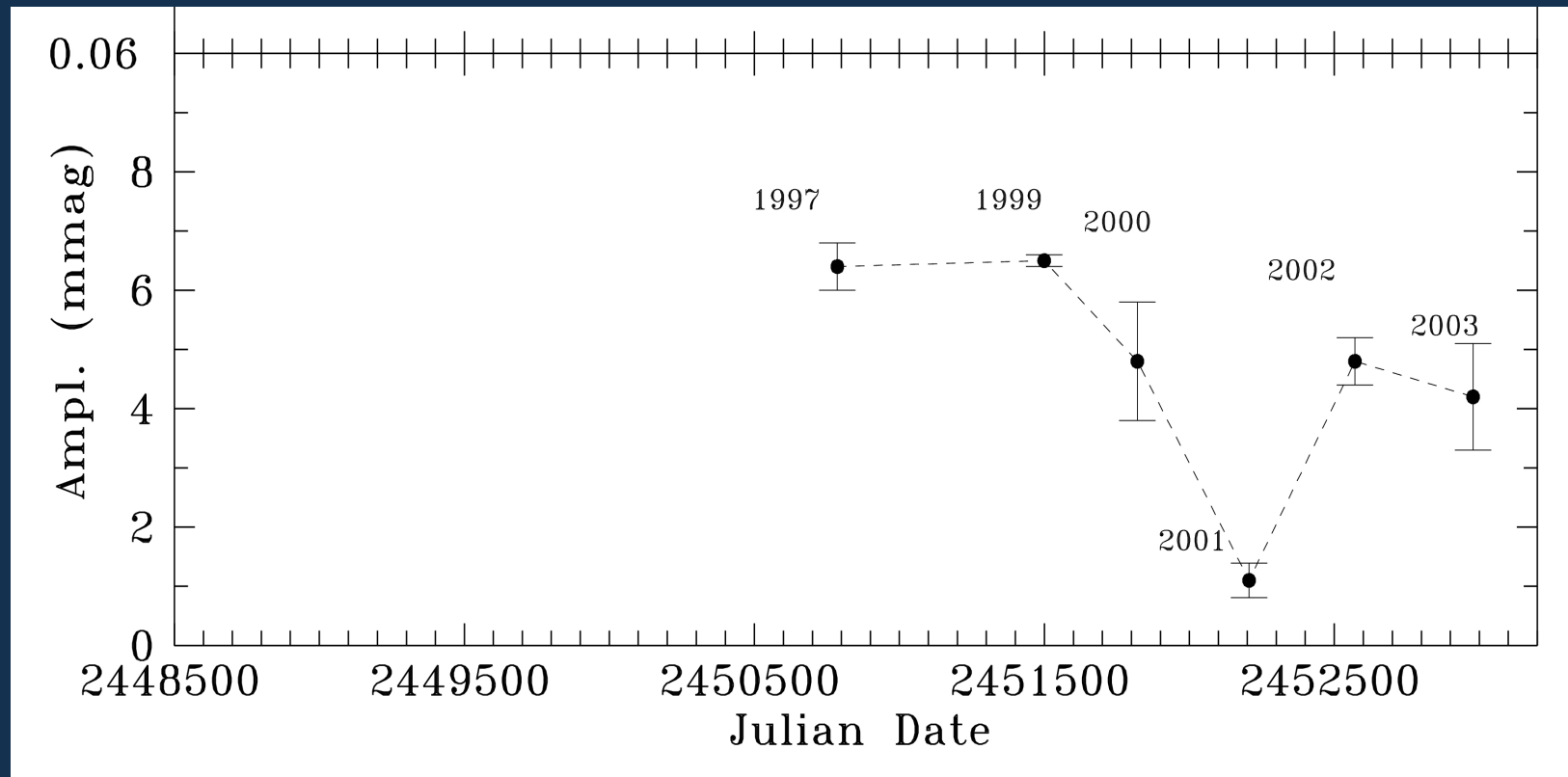
# An example: RZ Cas

Change of the amplitude of the dominant mode  
in time



# An example: RZ Cas

Change of the amplitude of the dominant mode  
in time



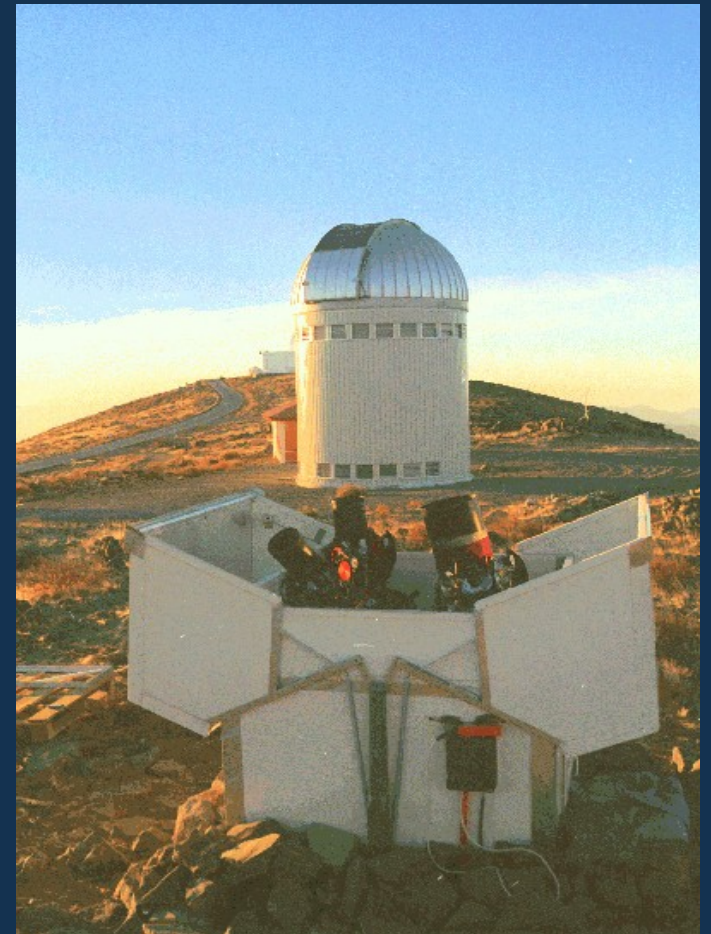
Mkrtychian et al. (2005, ASP Conf. 333, 197)

# The data

## ASAS-3 catalogue

<http://www.astrouw.edu.pl/~gp/asas/asas.html>

- Observations were carried out in the years 2000-2005 at the Las Campanas Observatory
- Four instruments:
  - 2 *wide-field* (8.8 x 8.8 deg) 200/2.8
  - 1 *narrow-field* (2.2 x 2.2 deg) 750/3.3
  - 1 *very wide field* (36 x 36 deg) 50/4each equipped with 2k x 2k CCD camera



# The data

Over 15 000 000 stars with  $\delta < +28^\circ$  were detected:



~50 000 stars were classified as variable stars



~11 000 stars were classified as eclipsing binary stars:

~5400 contact systems

~2950 semi-detached systems

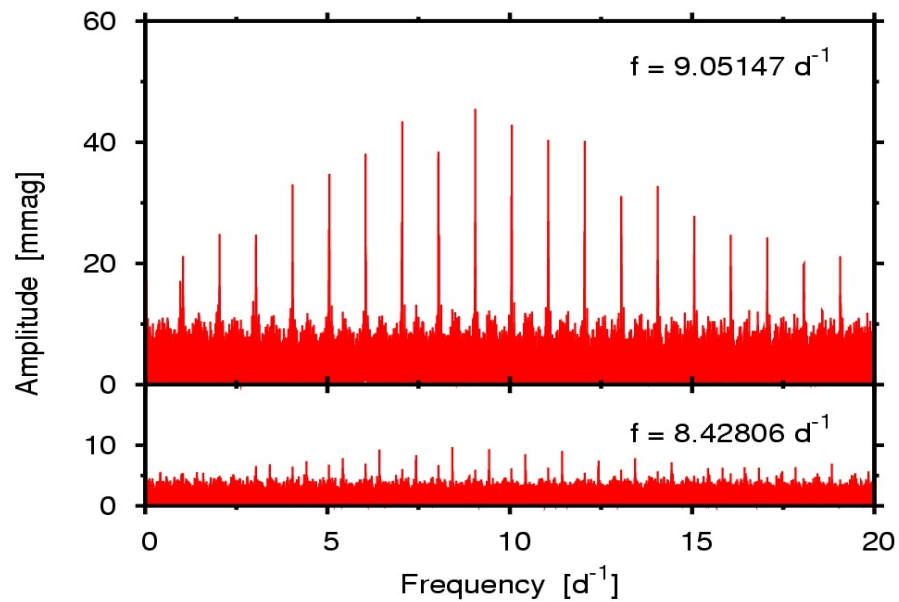
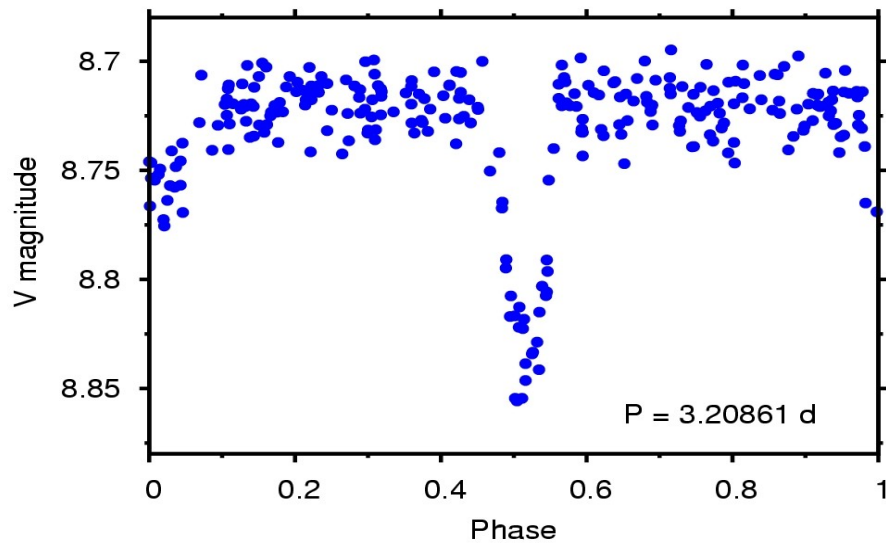
~2750 detached systems

# The results

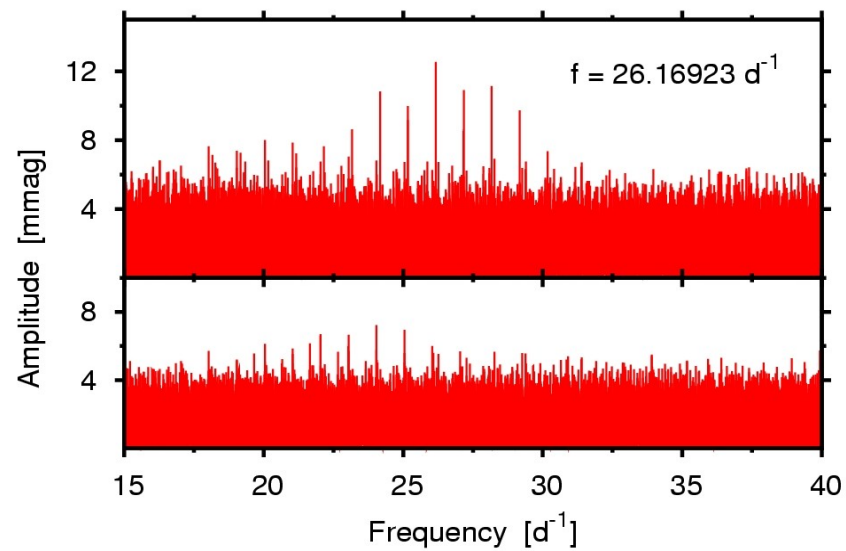
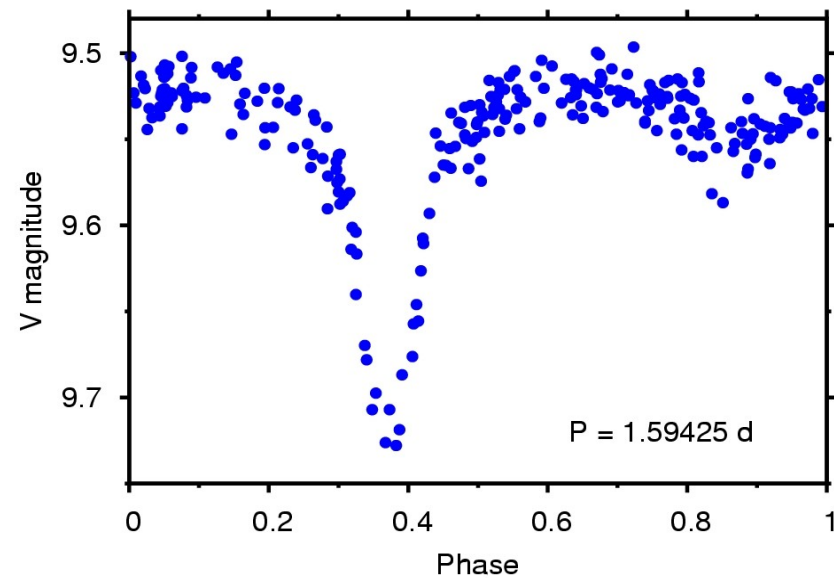
| ASAS          | P <sub>orb</sub> [d] | f <sub>puls</sub> [1/d] | V [mag] | Sp. type             | Name         | Var. type                                    |
|---------------|----------------------|-------------------------|---------|----------------------|--------------|--|
| 074422-0641.8 | 3.20851              | 9.05147<br>8.42806      | 8.73    | F0 V                 | HD 62571     | δ Sct  |
| 112733-2450.2 | 2.77877              | 14.71369                | 10.98   | A7 II/III            | HD 99612     | δ Sct  |
| 182411-6356.9 | 5.73082              | 13.22721                | 11.35   | (A5)+[K3 IV]         | MX Pav       | δ Sct  |
| 202844-5620.8 | 4.88029              | 13.55799                | 12.06   | (A8)+[G8 IV]         | IZ Tel       | δ Sct  |
| 204907-3343.9 | 4.43634              | 12.23428                | 9.47    | A4 III/IV            | VY Mic       | δ Sct  |
| 232548-1136.6 | 1.59425              | 26.16921+...            | 9.55    | A2 III               | HD 220687    | δ Sct  |
| 073904-6037.5 | 1.22096              | 4.66789                 | 10.03   | A5 II                | CPD -60°871  | δ Sct  |
| 110615-4224.6 | 2.13705              | 8.24730                 | 10.47   | ---                  | CPD -41°5106 | δ Sct / β Cep                                |
| 234520-3100.5 | 0.88343              | 5.46335                 | 10.95   | ---                  | CPD -31°6830 | δ Sct / β Cep                                |
| 084350-4607.2 | 2.75318              | 2.31095                 | 10.56   | O6 V((f))+B1V        | ALS 1135     | β Cep:                                       |
| 060412+0530.5 | 1.43294              | 1.76554                 | 10.29   | B9                   | HD 251168    | SPB:   |
| 133910-6502.2 | 3.16997              | 0.90178                 | 11.21   | (A2)+[K0 IV]         | Y Cir        | SPB:   |
| 183002-3329.7 | 1.74502              | 0.90866                 | 7.66    | B8 V                 | V4396 Sgr    | SPB:   |
| 182323-1240.9 | 3.53393              | ---                     | 10.15   | M3 Iaep +<br>O 9.5 V | FR Sct       | irregular / semi-regular<br>(VV Cephei star) |

# oEA-type binaries ( $\delta$ Scuti)

ASAS 074422-0641.8

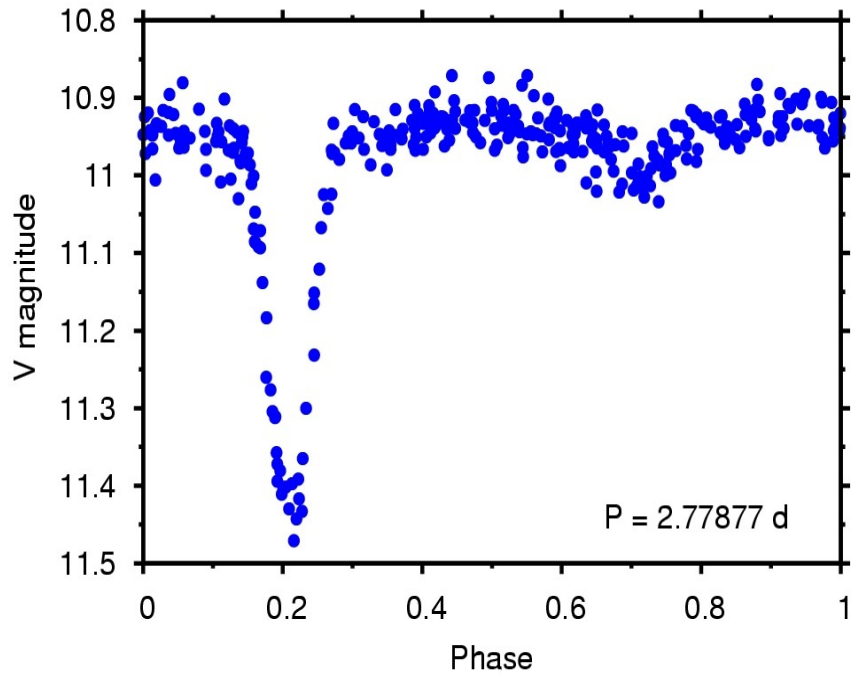


ASAS 232548-1136.6

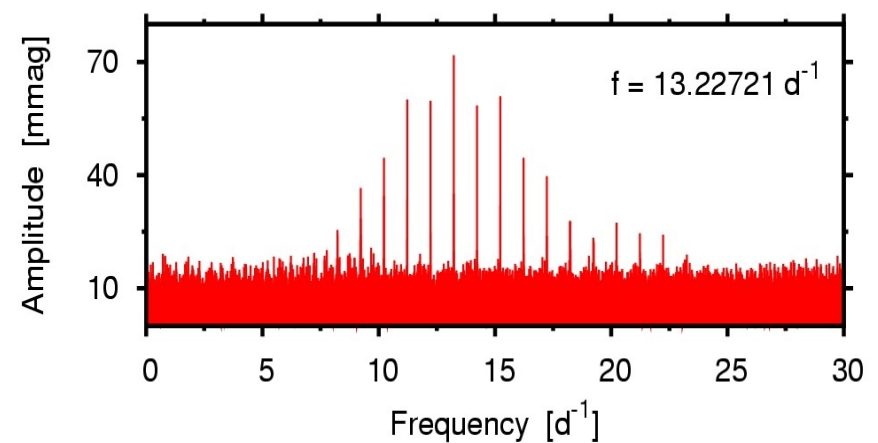
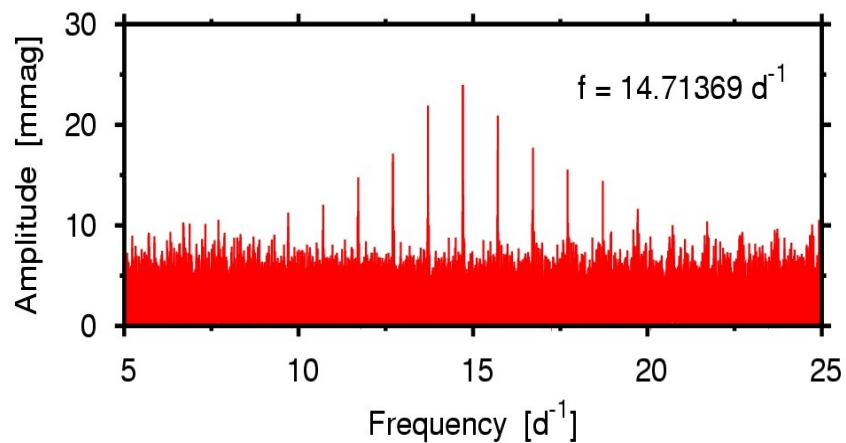
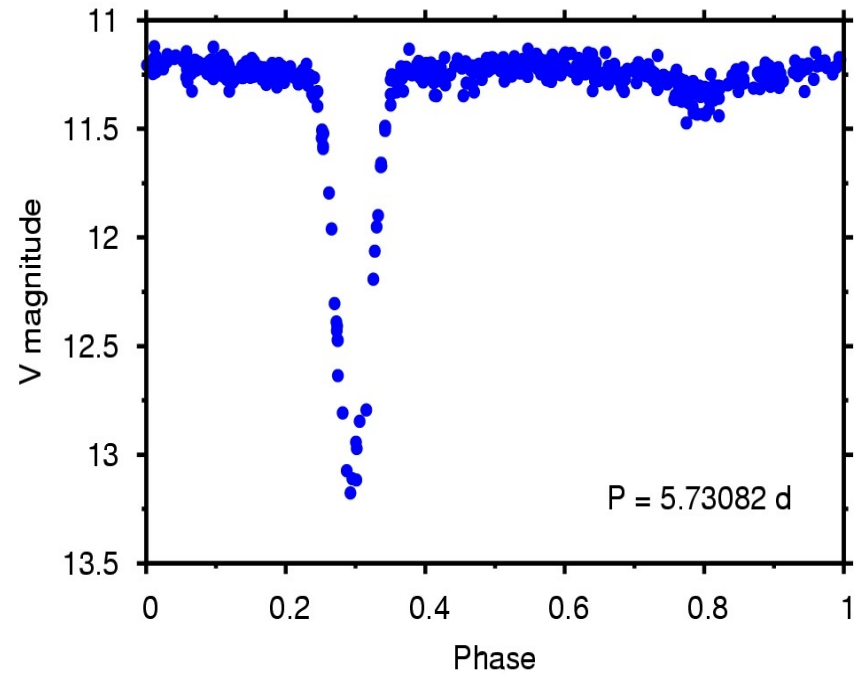


# oEA-type binaries ( $\delta$ Scuti)

ASAS 112733-2450.2

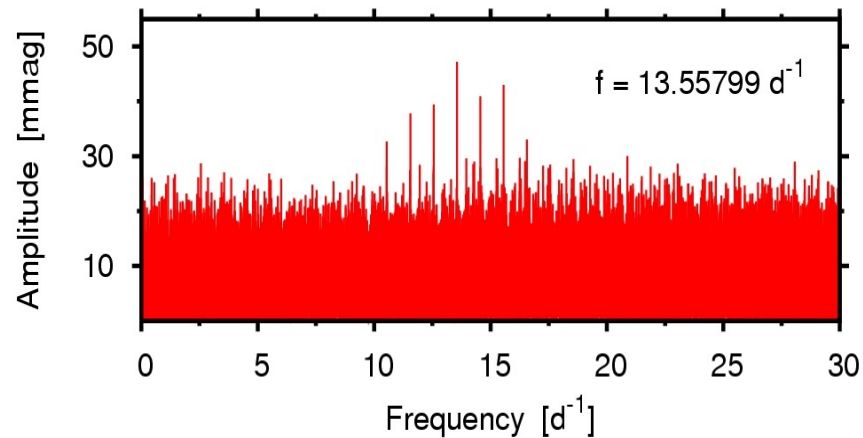
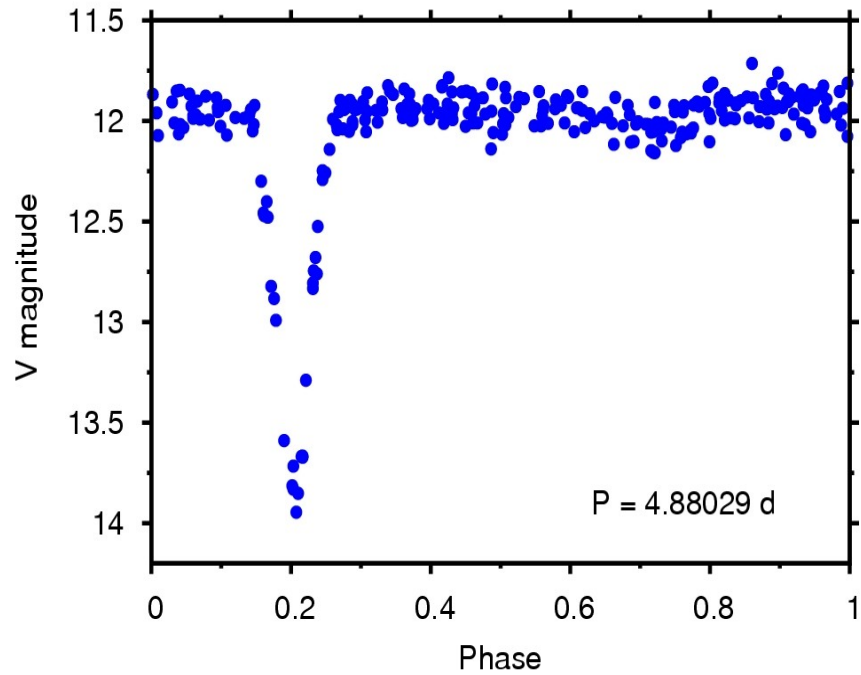


ASAS 182411-6356.9

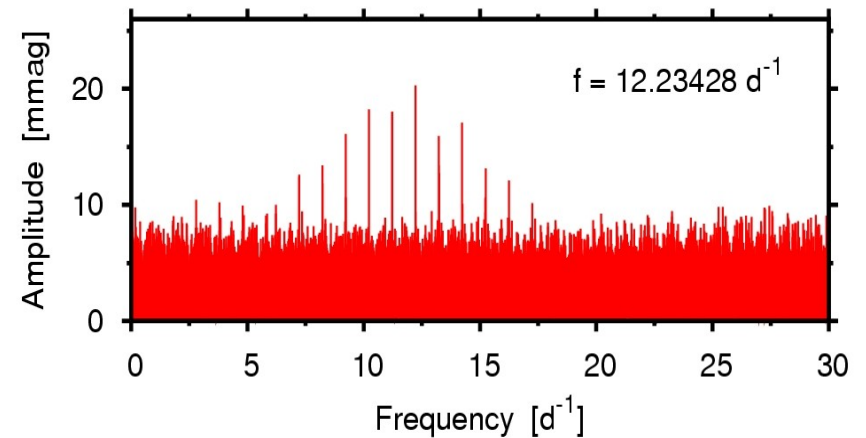
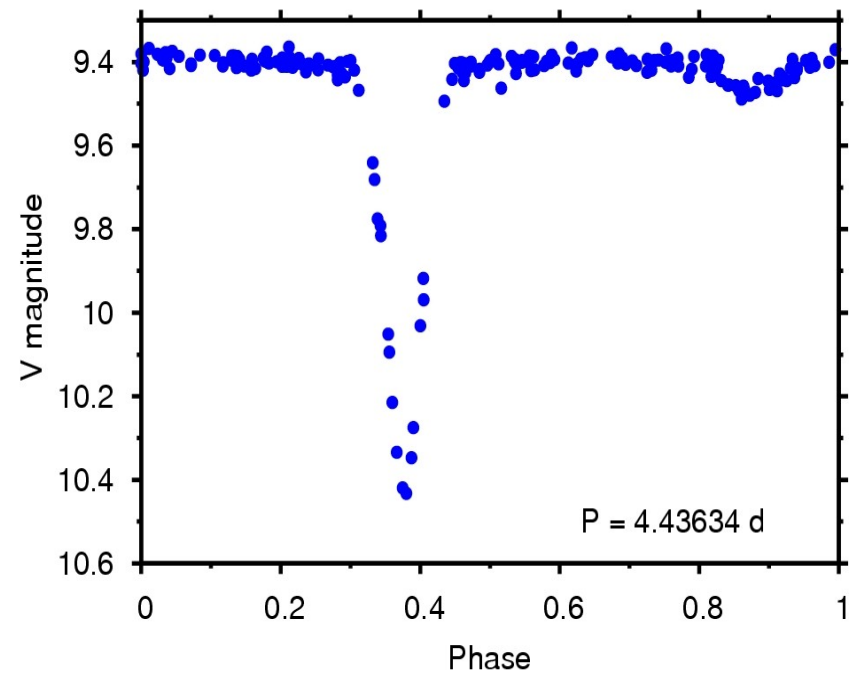


# oEA-type binaries ( $\delta$ Scuti)

ASAS 202844-5620.8



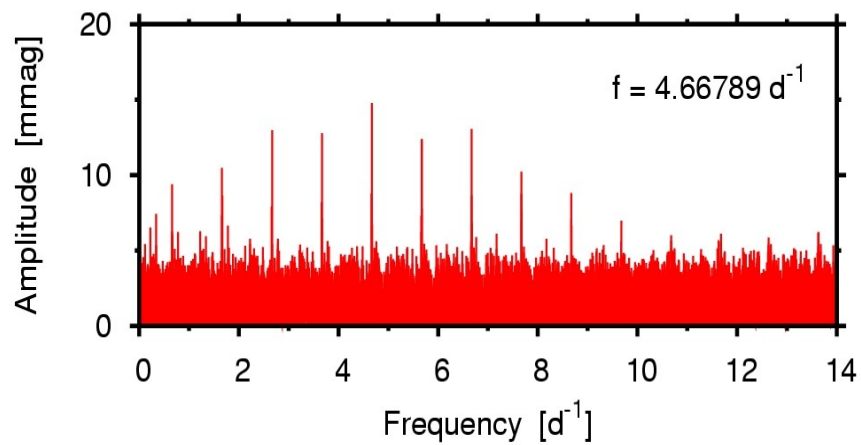
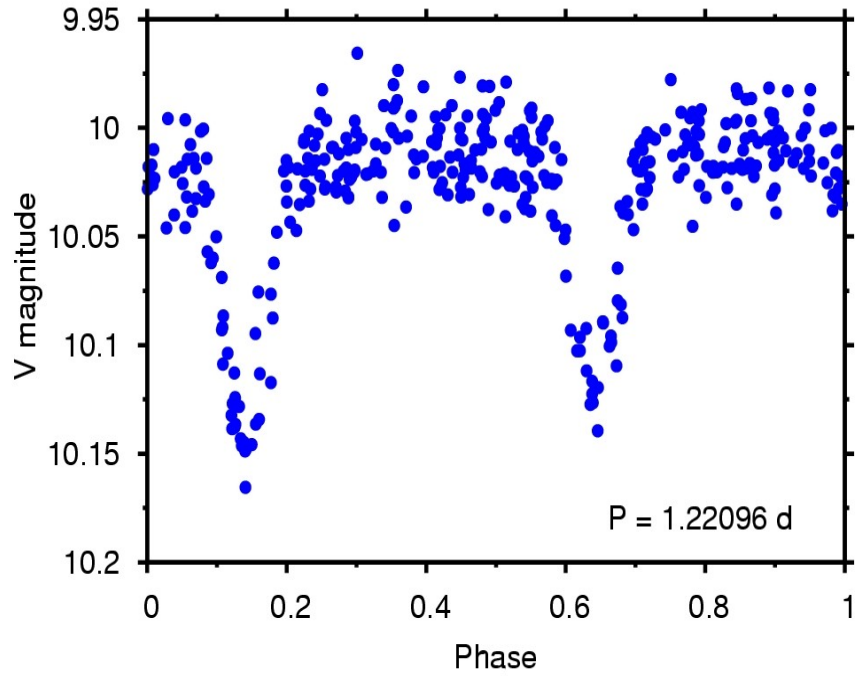
ASAS 204907-3343.9



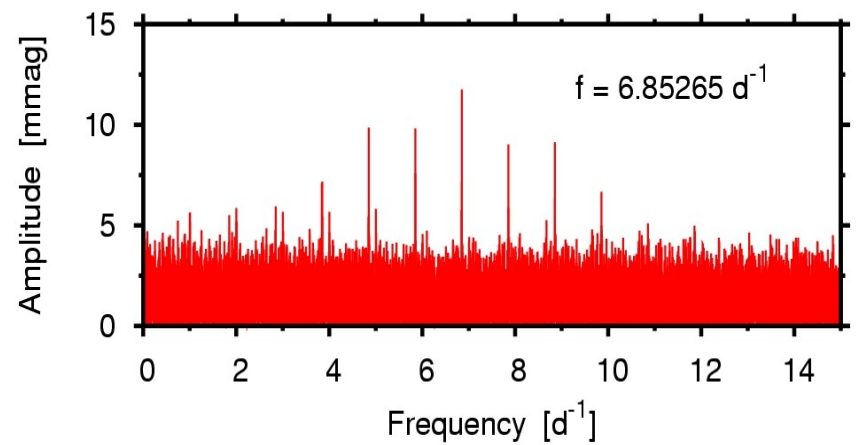
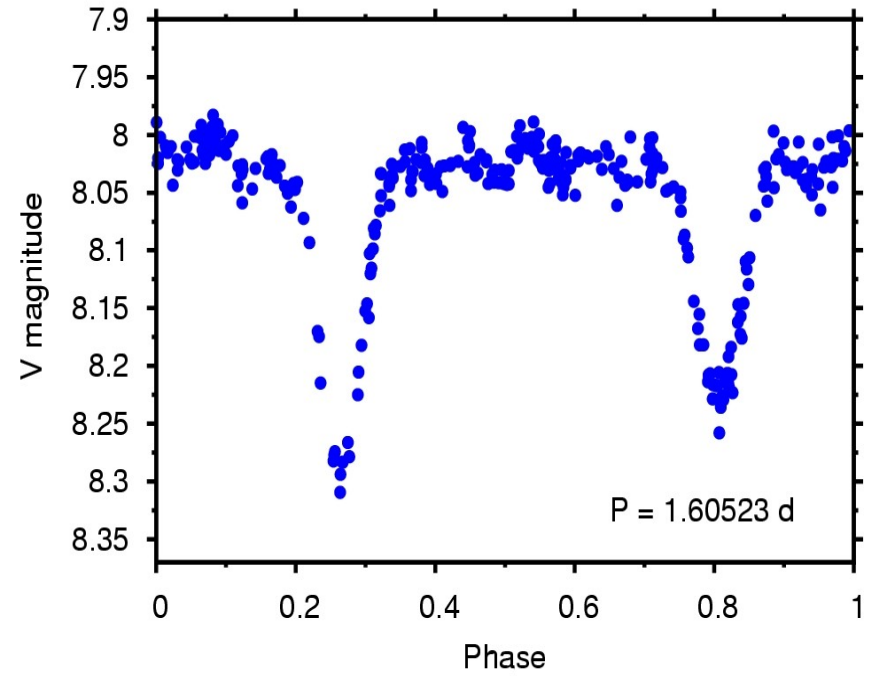


# $\delta$ Scuti

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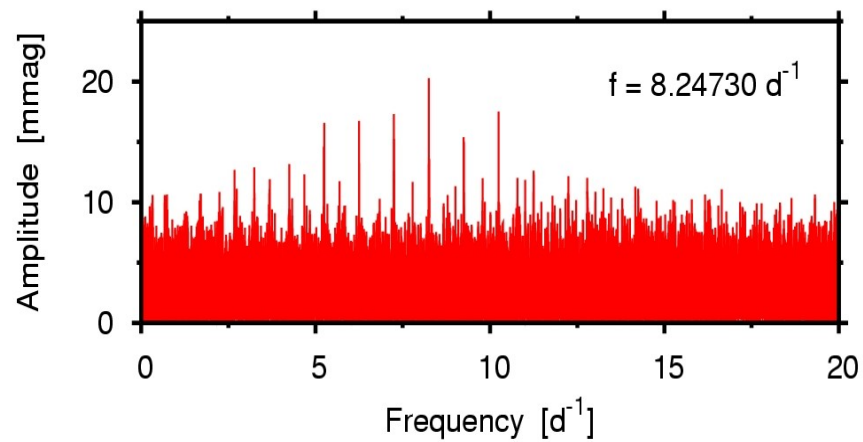
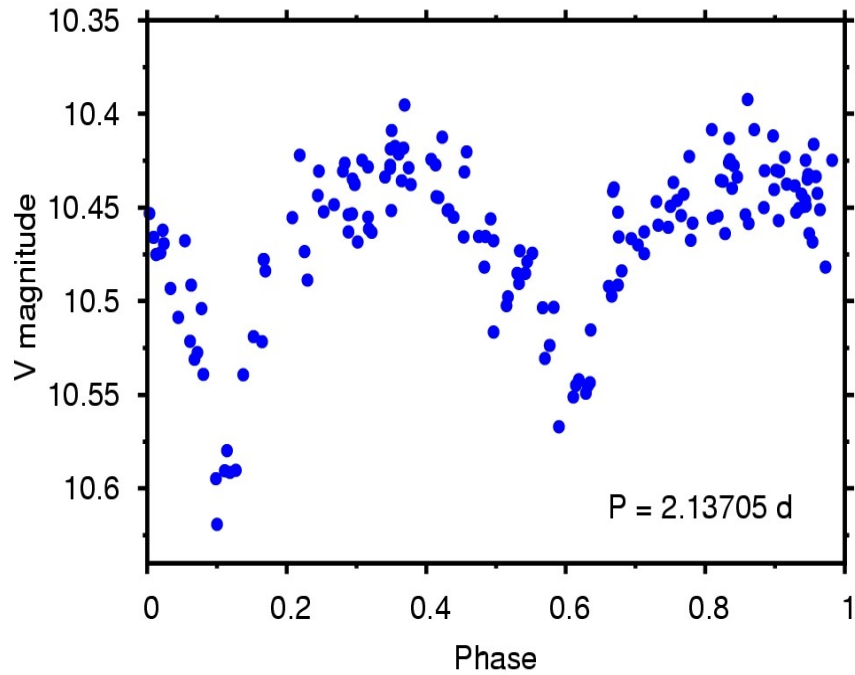


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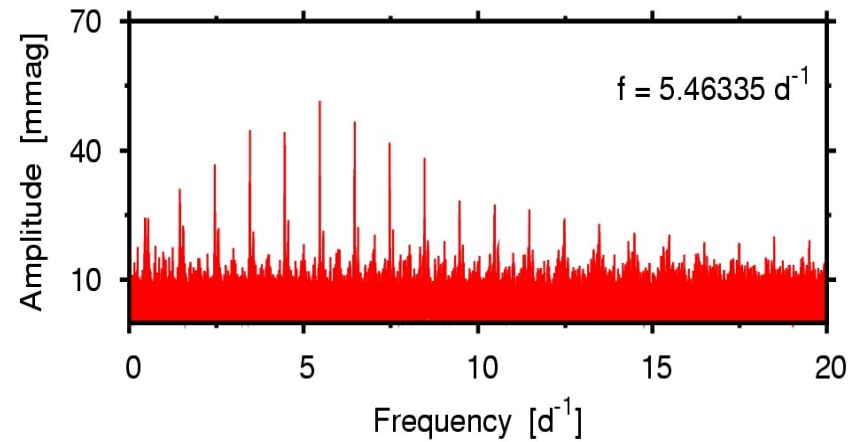
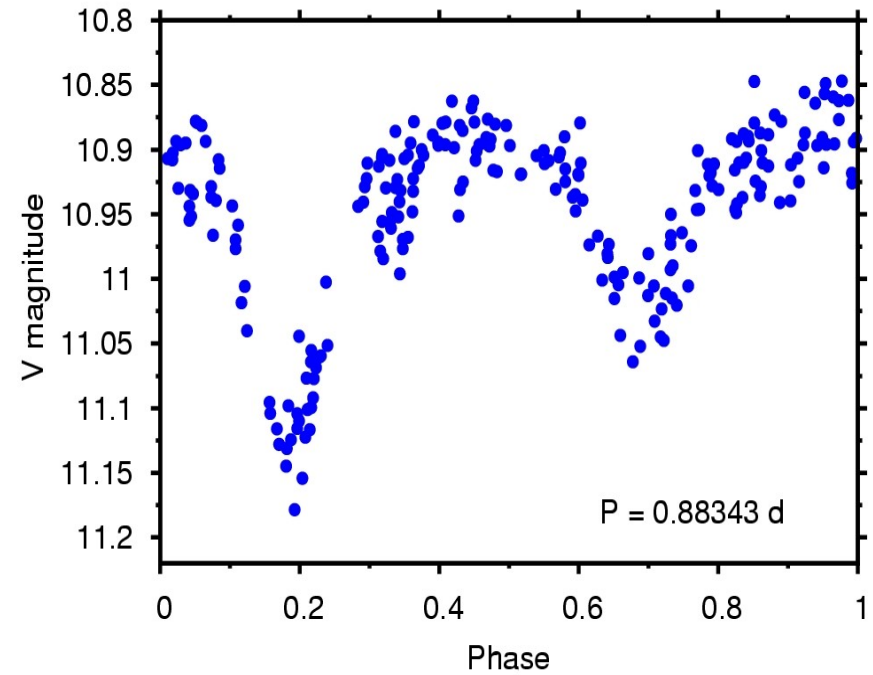


# $\delta$ Scuti / $\beta$ Cephei

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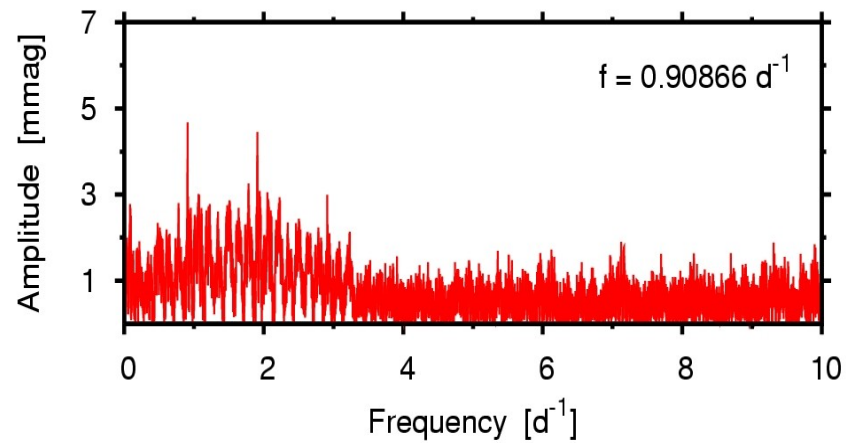
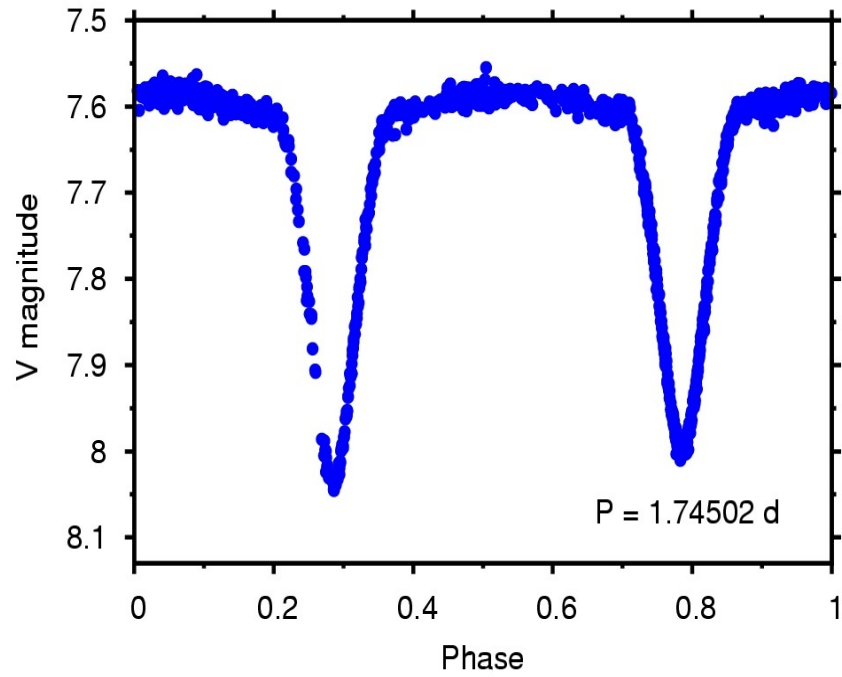


ASAS 234520-3100.5

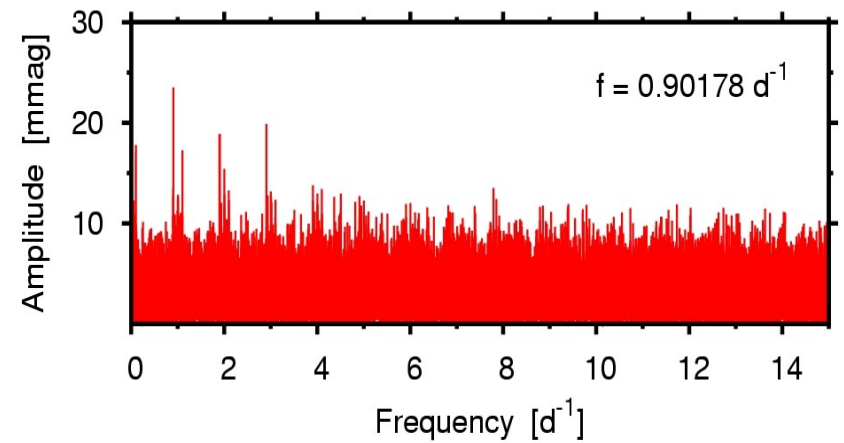
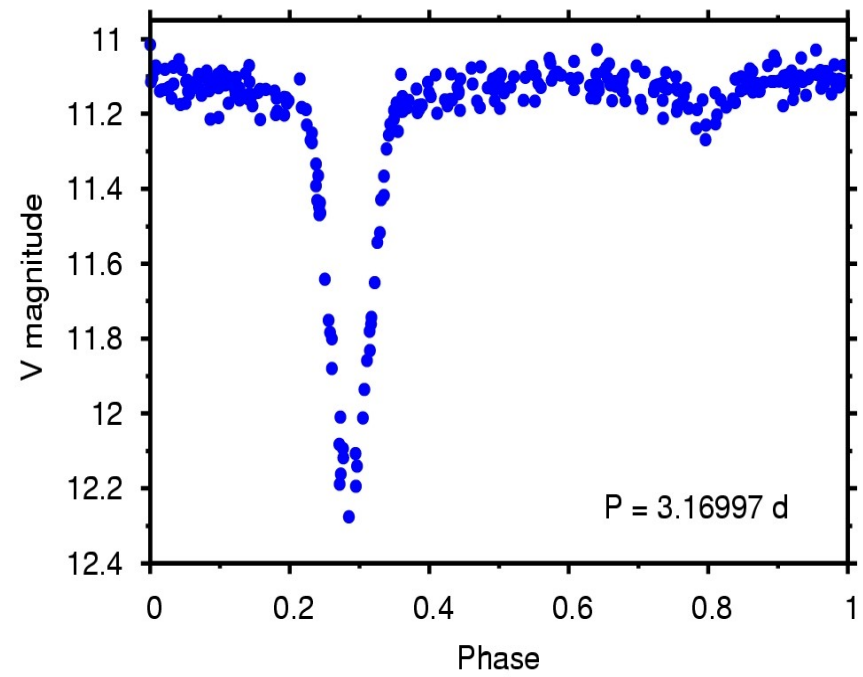


# SPB:

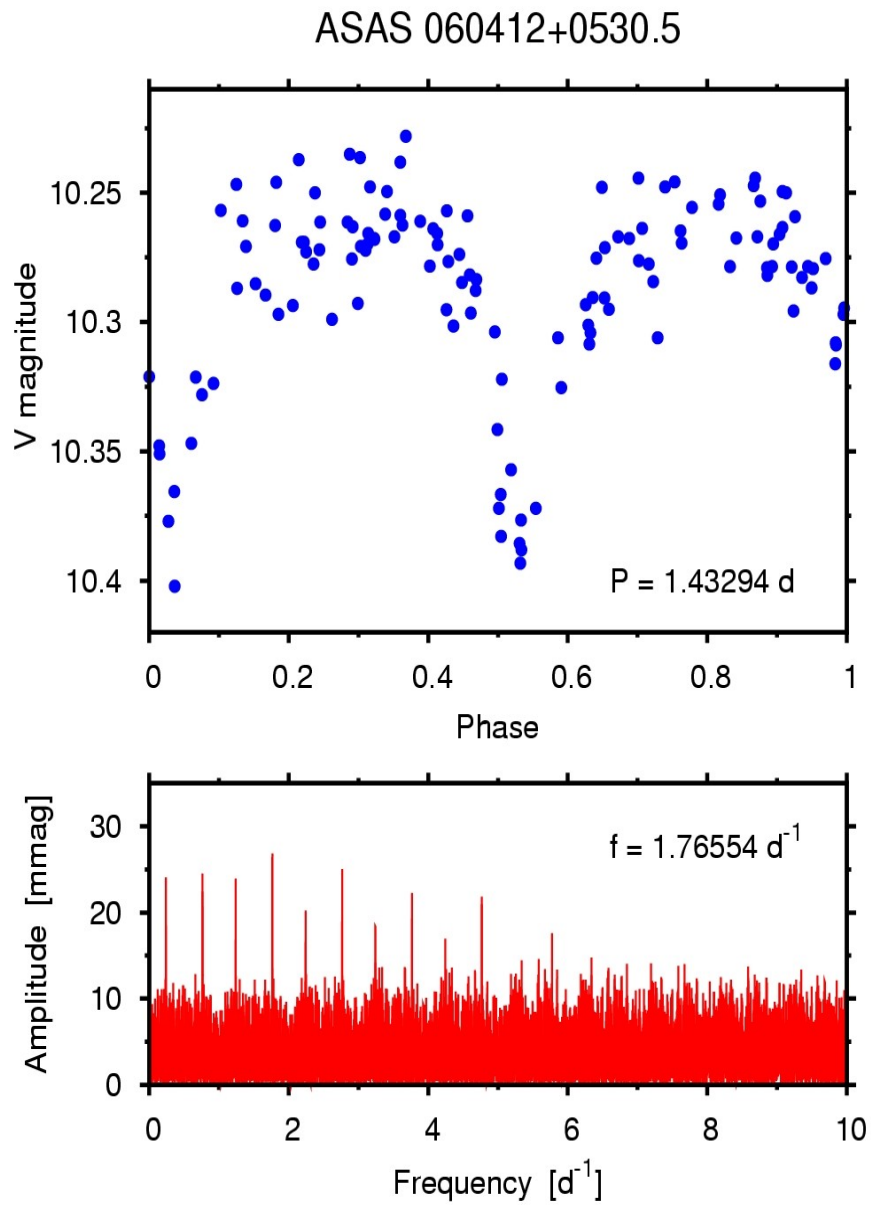
ASAS 183002-3329.7



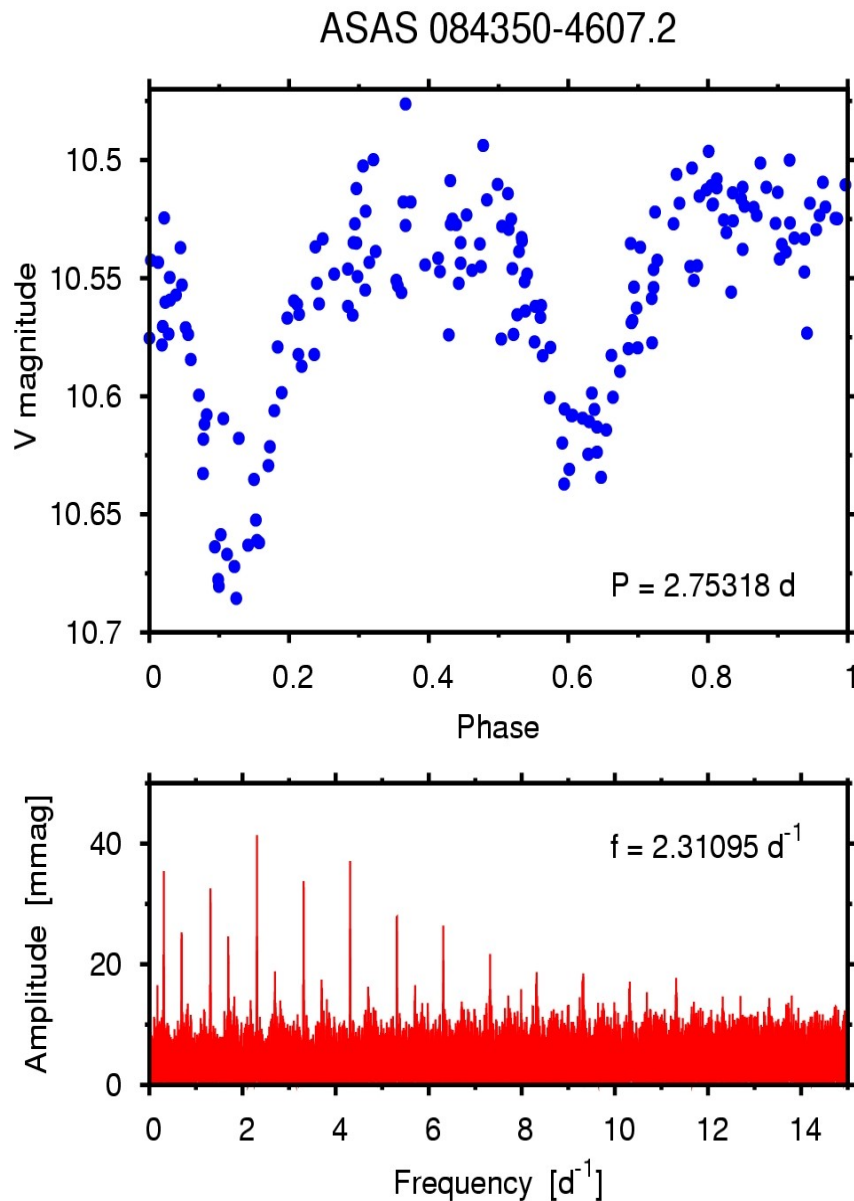
ASAS 133910-6502.2



# SPB:



# $\beta$ Cephei:



## ALS 1135

(OB Bochum 7 association)

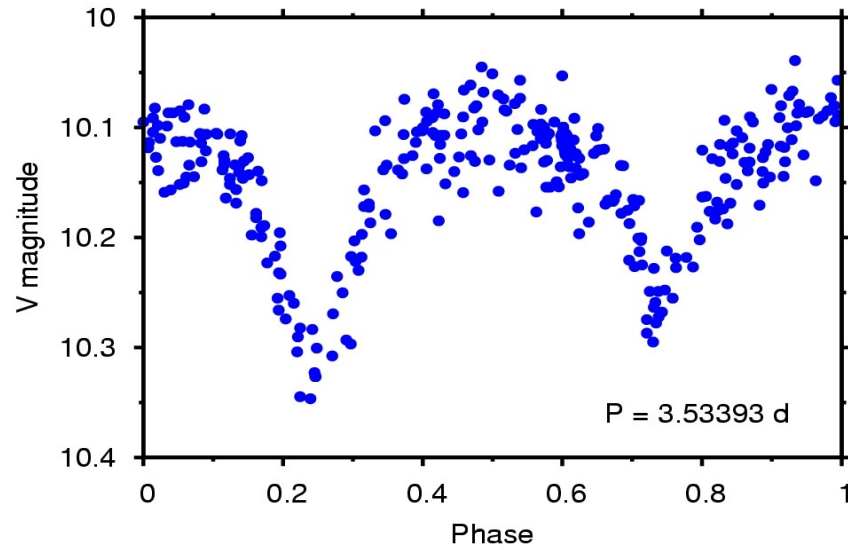
- SB1 Corti et al. (2003)
- SB2 Lajus & Niemela (2006)

O6 V((f)) + B1 V

$M_1=30$   $M_2=9$   $M_{\odot}$

# IR/SR

ASAS 182323-1240.9



FR Sct

[Fe II] [Fe III]

(VV Cephei)

M3 Ia ep + O 9.5 V

