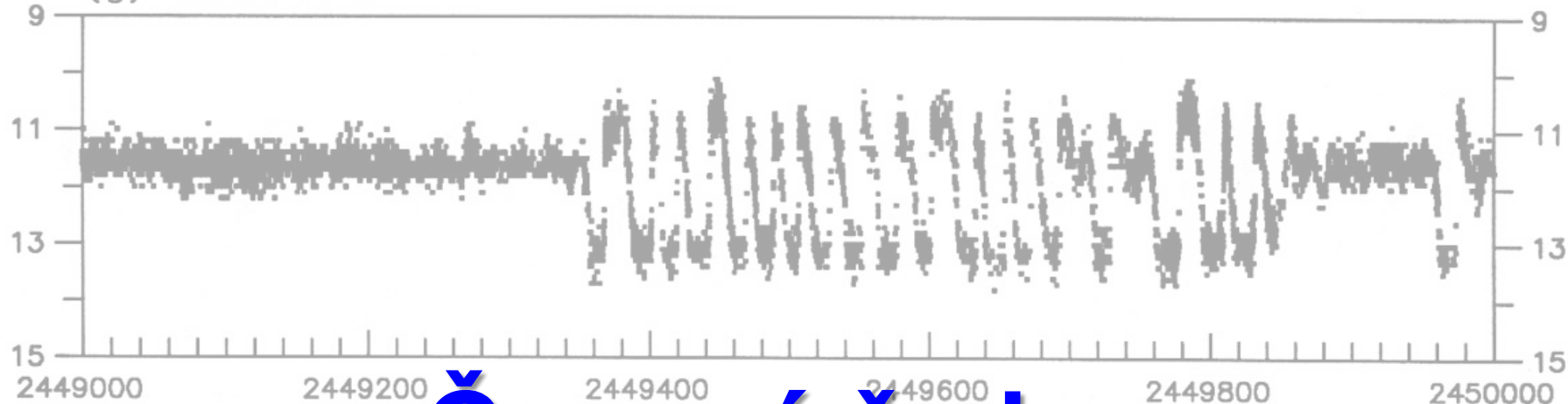
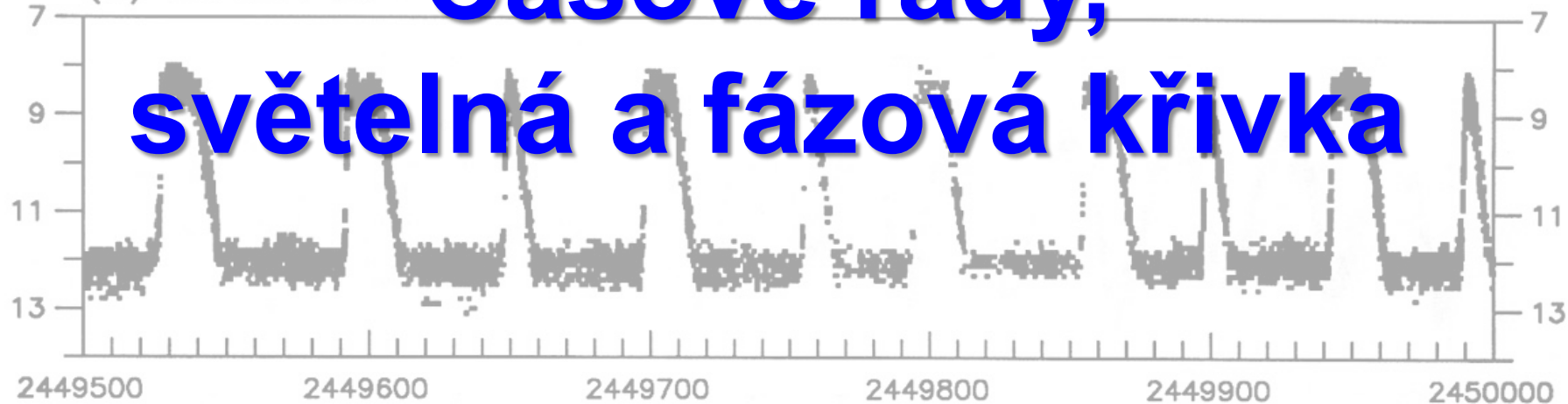


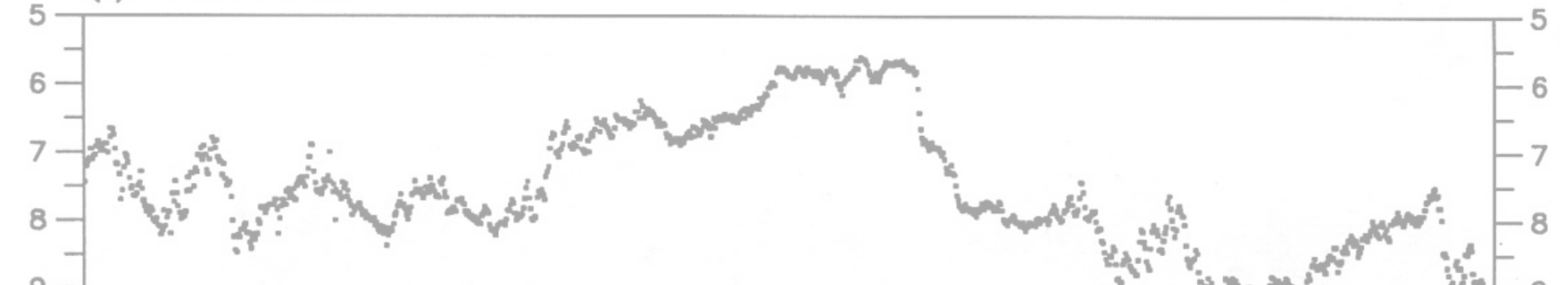
(g) 0814+73



(h) 2138+43



(i) 1921+50



Časové řady, světelná a fázová křivka

Časové řady

posloupnost uspořádaných dvojic, resp. trojic $\{t_i, y_i, w_i\}$

váha x nejistota měření $w_i = \sigma_i^{-2}$

proměnné hvězdy:

- periodické
 - ideální - (takřka) žádné změny tvaru křivek mezi cykly,
 - komplikace – přes pravidelné změny se překládají trendy, aperiodické změny nebo změny s jinou periodou
- polopravidelné,
- neperiodické,
- složené – kombinace (a)periodických dějů.

nejsledovanější – fotometrické změny, ale možné i změny jiných veličin (radiálních rychlostí, intenzity magnetického pole, intenzity spektrálních čar, ekvivalentních šířek spektrálních čar, polarizace apod.)

- světelná křivka
- křivka radiálních rychlostí
- změny intenzity spektrálních čar
- indukce magnetického pole
- polarizace

Periodicita proměnnosti

popisné veličiny:

P - perioda proměnnosti

ν - frekvence, $\nu = 1/P$

ω - úhlová rychlost, $\omega = 2\pi\nu = 2\pi/P$

A - amplituda světelných změn

tvar i amplituda světelných křivek konstantní x perioda $P(t)$ funkcí času

příčiny změn periody – změna geometrické konfigurace, změny ve hvězdě, přítomnost dalších těles v soustavě ... => **periodová analýza**

analýza příčin změn,

modely změn – fenomenologické (matematické), fyzikální,

stanovení periody,

popis chování objektu v minulosti x předpověď pro budoucnost

Popis stavu periodicky proměnné hvězdy:
 funkce času – fáze $\varphi(t)$, epocha $E(t)$

$E(t)$ - neklesající schodovitá funkce;
 počet cyklů zvoleného okamžiku $t = M_0$

$$E(t) = \text{floor} \left[\frac{t - M_0}{P} \right]$$

$\varphi(t)$ - pilovitá funkce; obor hodnot $\langle 0; 1 \rangle$;
 užití: sestrojení *fázové křivky*

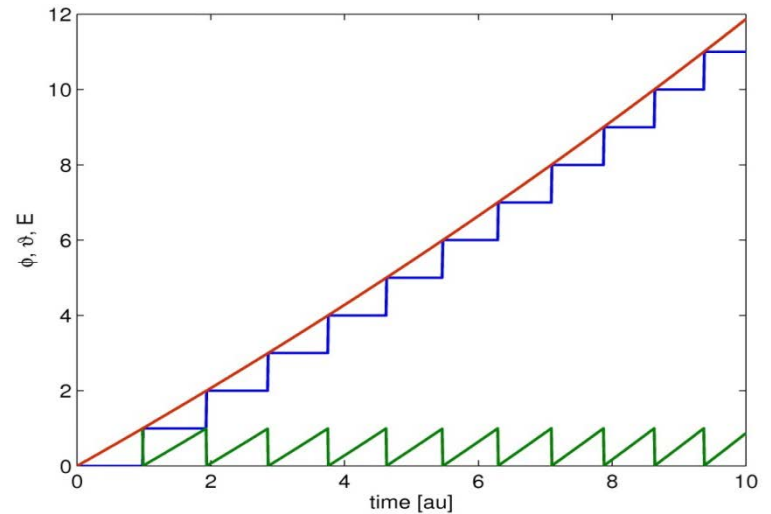
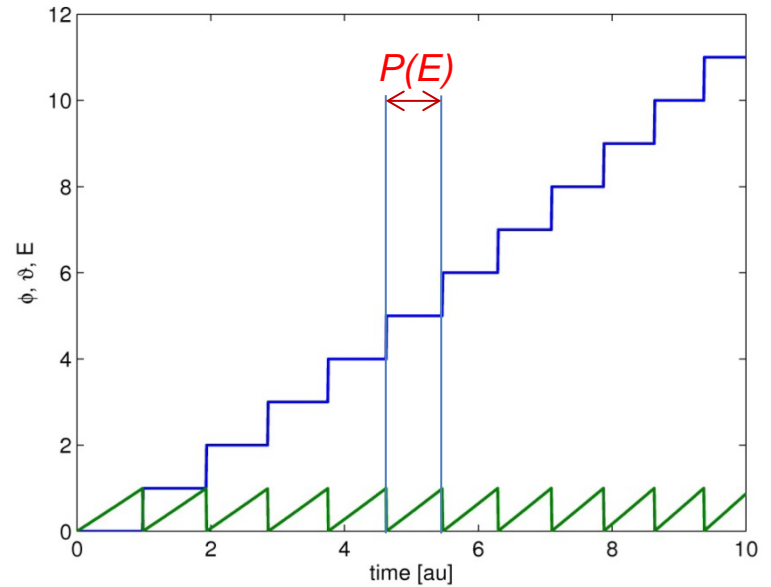
$$\varphi(t) = \text{frac} \left[\frac{t - M_0}{P} \right]$$

$P(E)$ – okamžitá perioda

$\vartheta(t) = E(t) + \varphi(t)$ - *fázová funkce*

$\Rightarrow E(t) = \text{floor}[\vartheta(t)]; \varphi(t) = \text{frac}[\vartheta(t)]$

fázová fce – monotónně rostoucí, hladká
 pro $t = M_0$ $\vartheta(t) = 0$



Světelná křivka

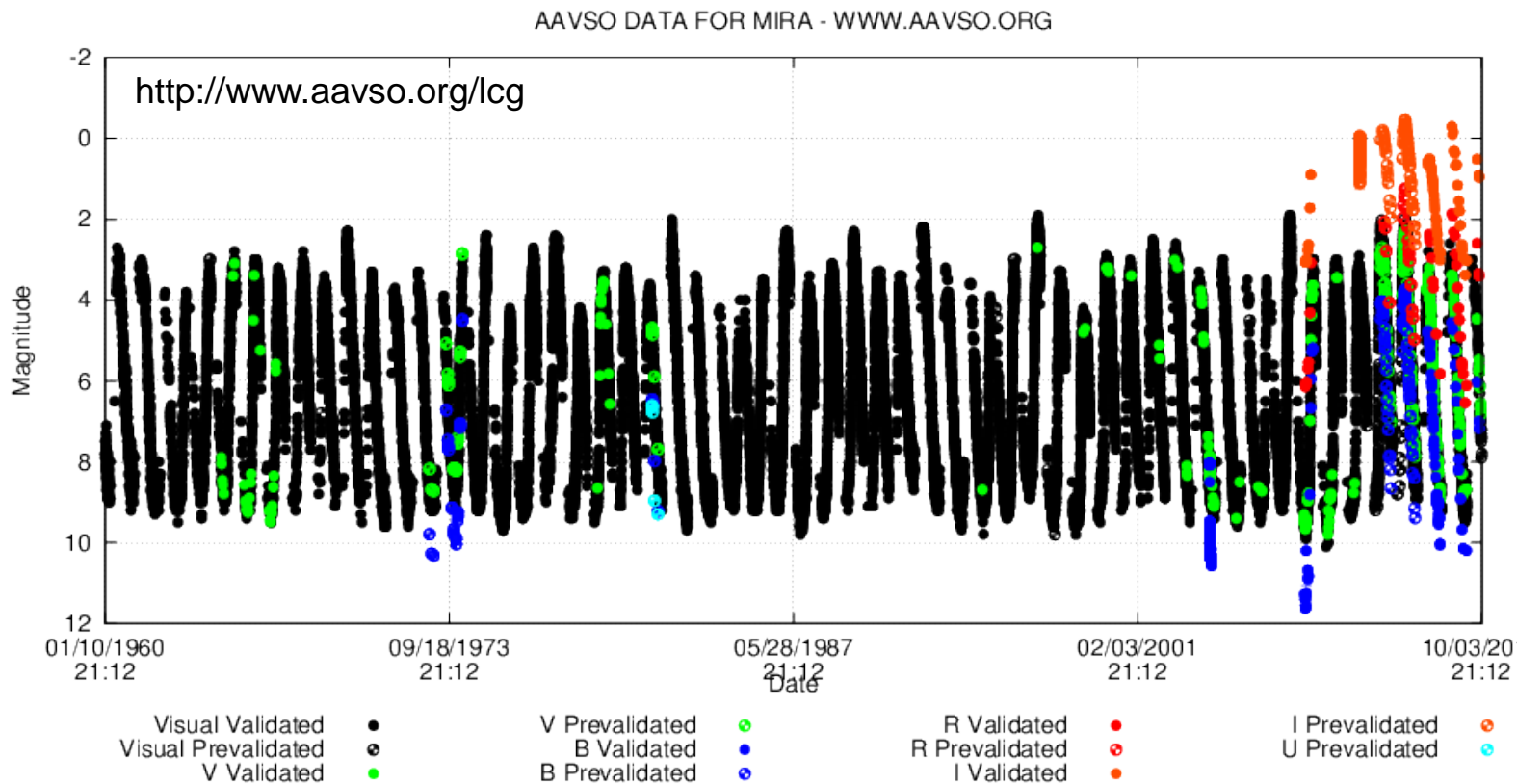
závislost hvězdné velikosti [mag, mmag], jasnosti [OS], intenzity na čase (JD)

osa y – m , Δm

relativní hvězdná velikost

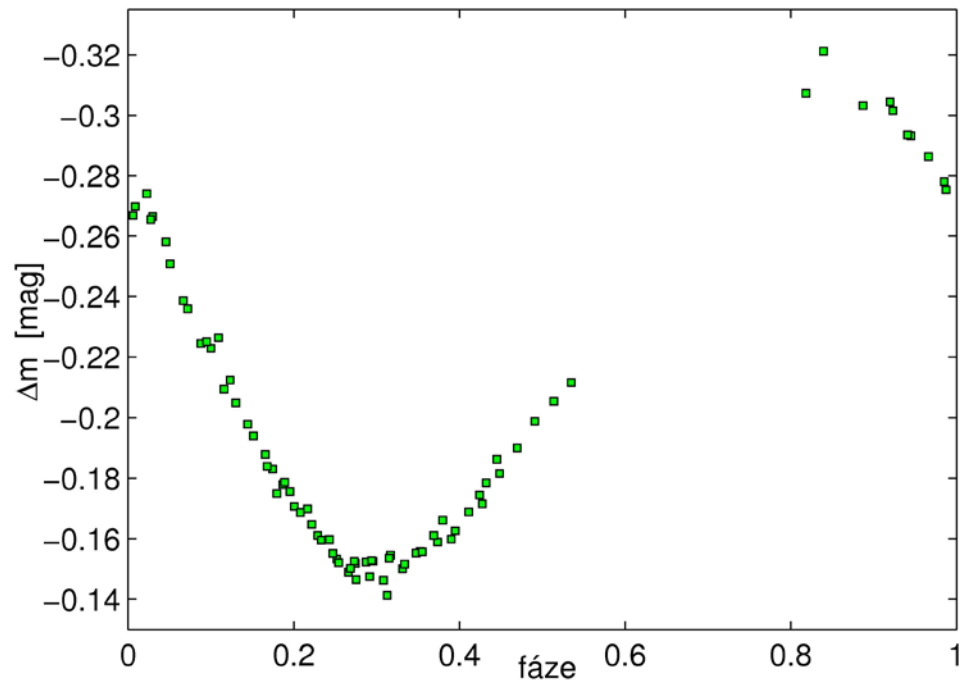
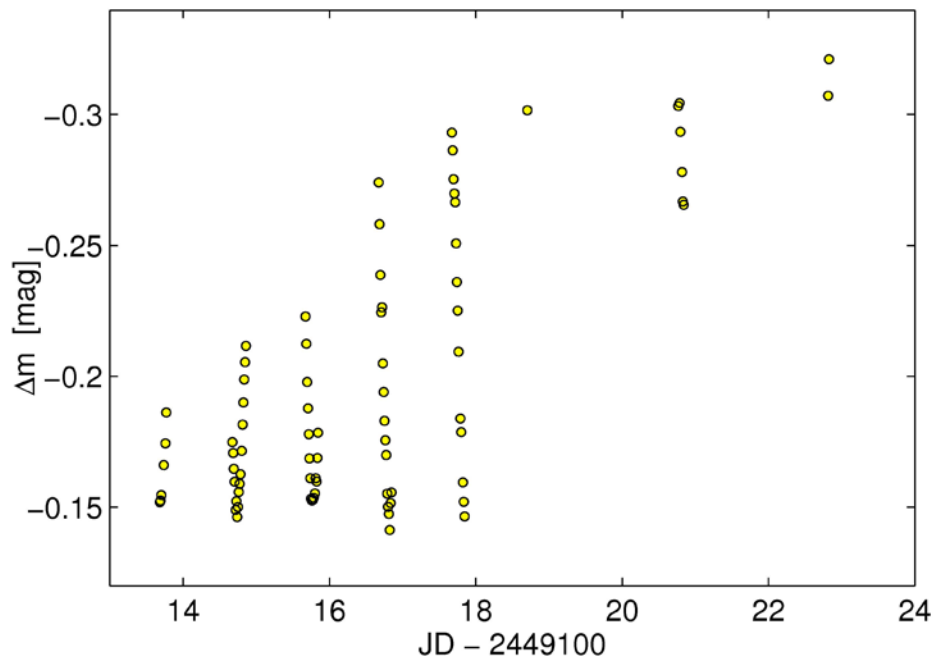
$$\Delta m = -2.5 \log \frac{j_v}{j_c}$$

(V-C), (C-C1) ...

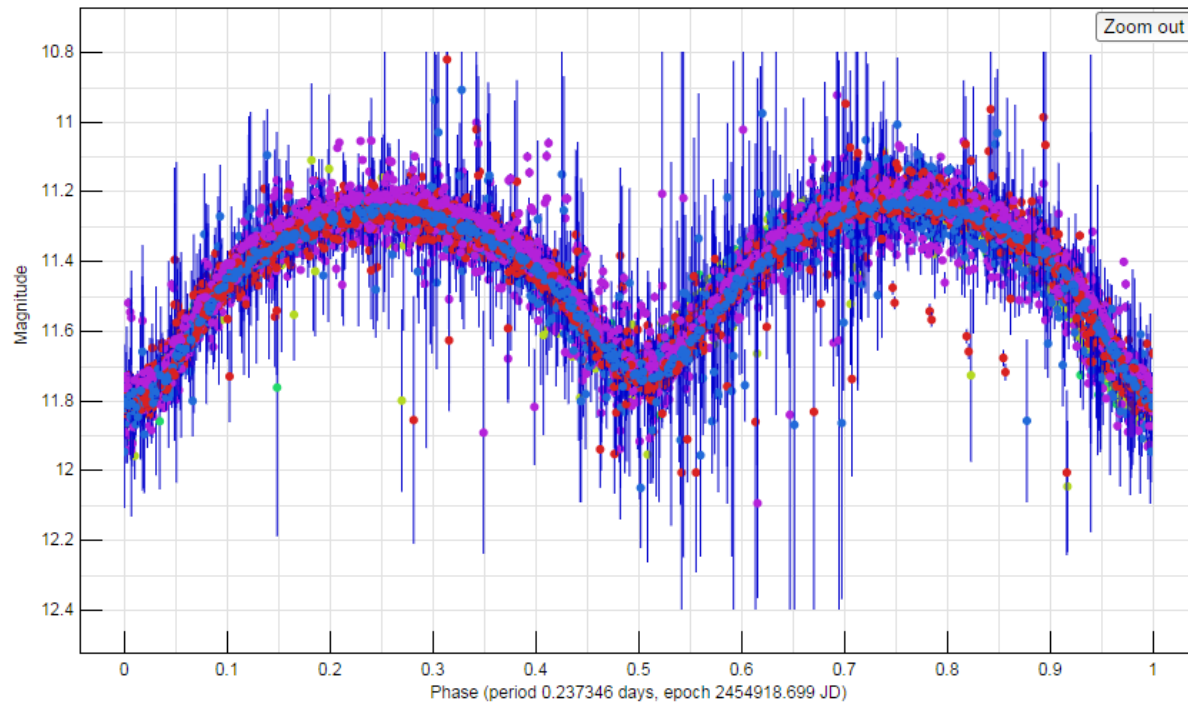
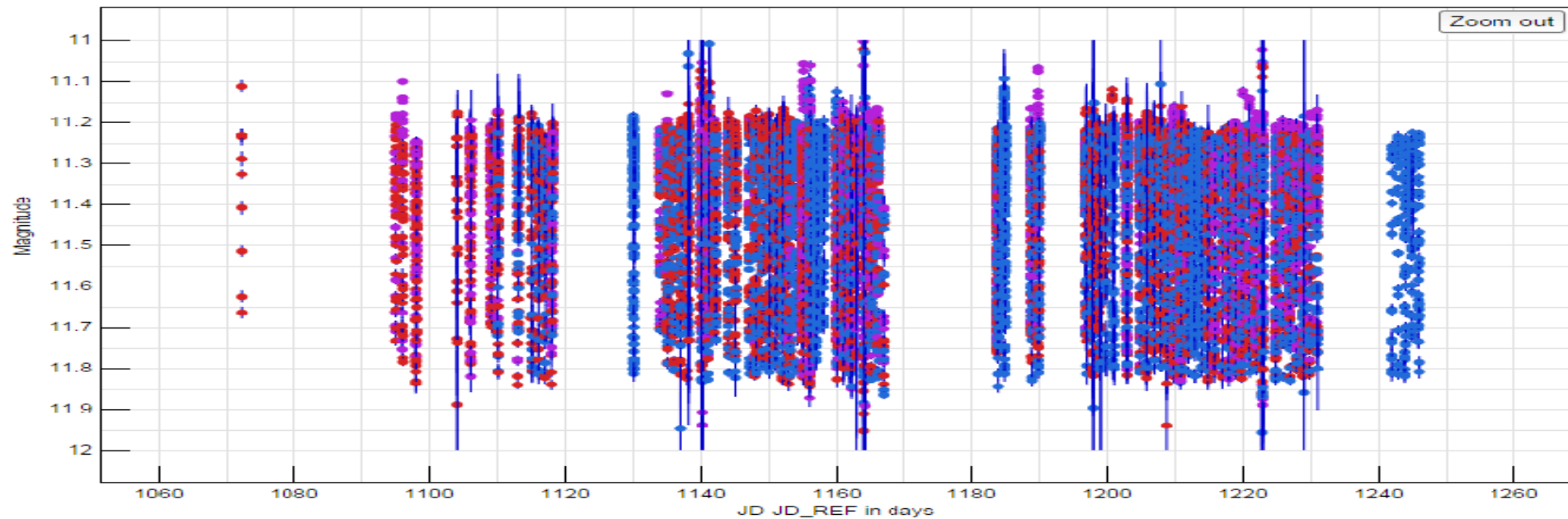


CU Vir

PE pozorování



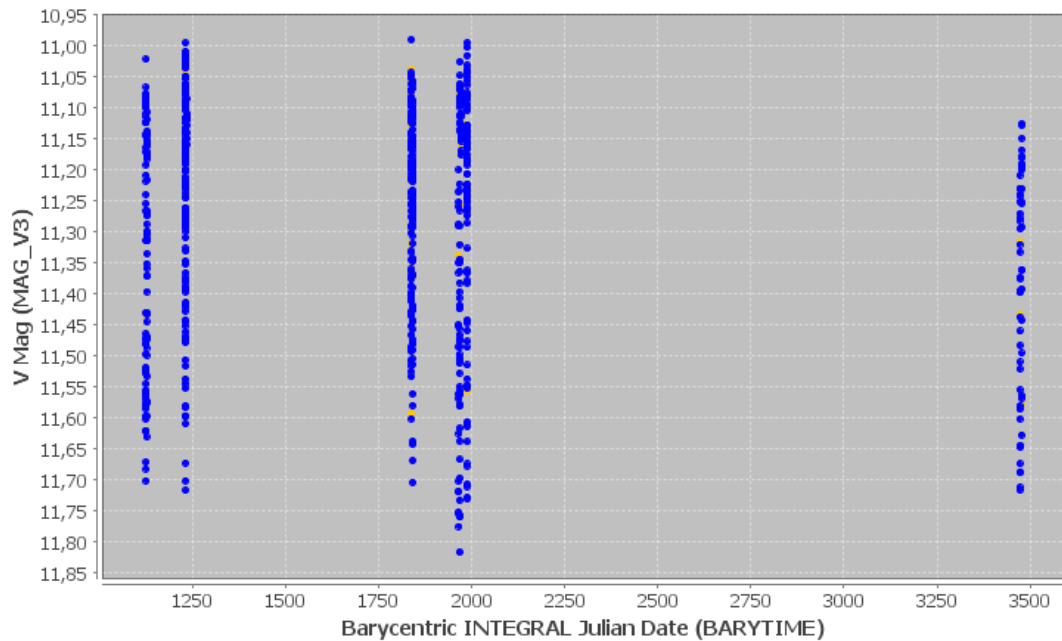
Light curve for: 1SWASP J123300.28+264258.3
JD_REF: 2453005.5



RW Com – SWASP

IOMC 1991000097

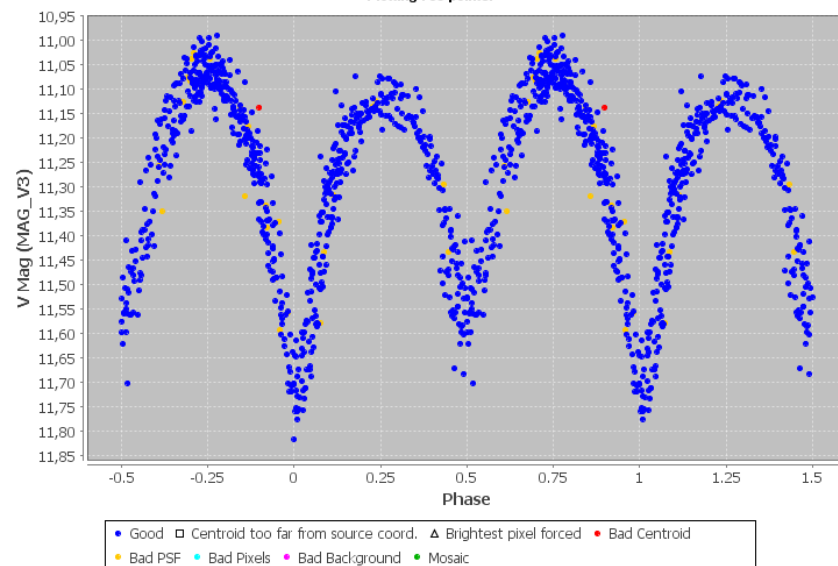
Plotting 709 points.



RW Com
OMC INTEGRAL
P=0.237346 d

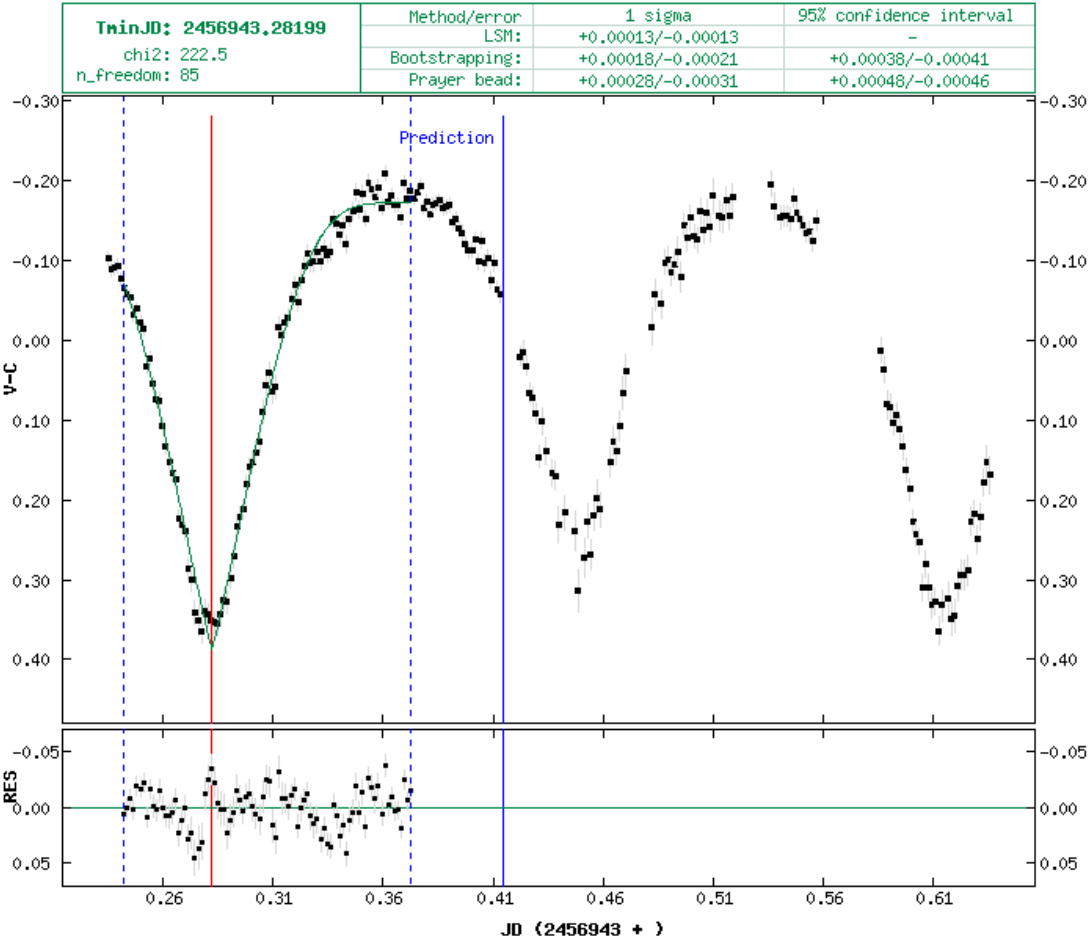
IOMC 1991000097

Plotting 709 points.








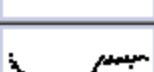



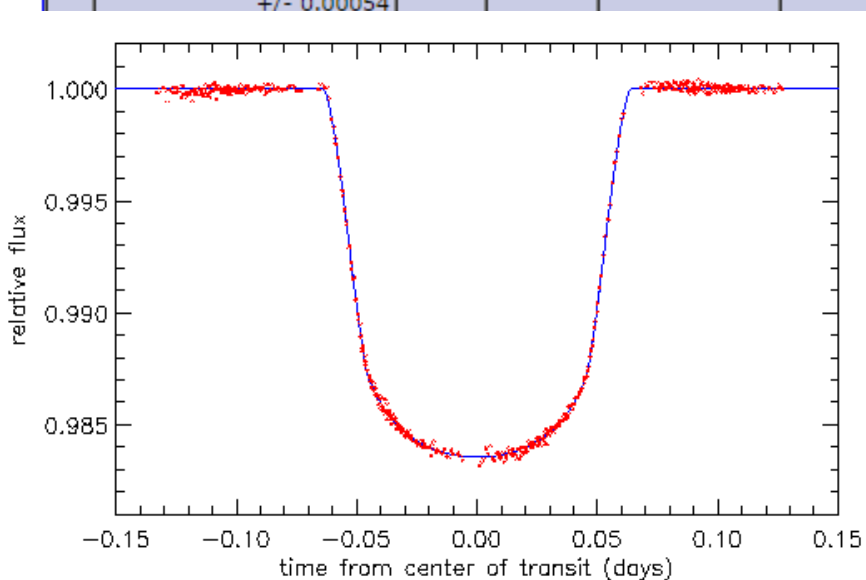
světelná křivka – celá perioda během jedné noci nebo její části – např.


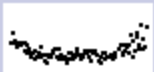




V 960 Cep
D. Hanžl

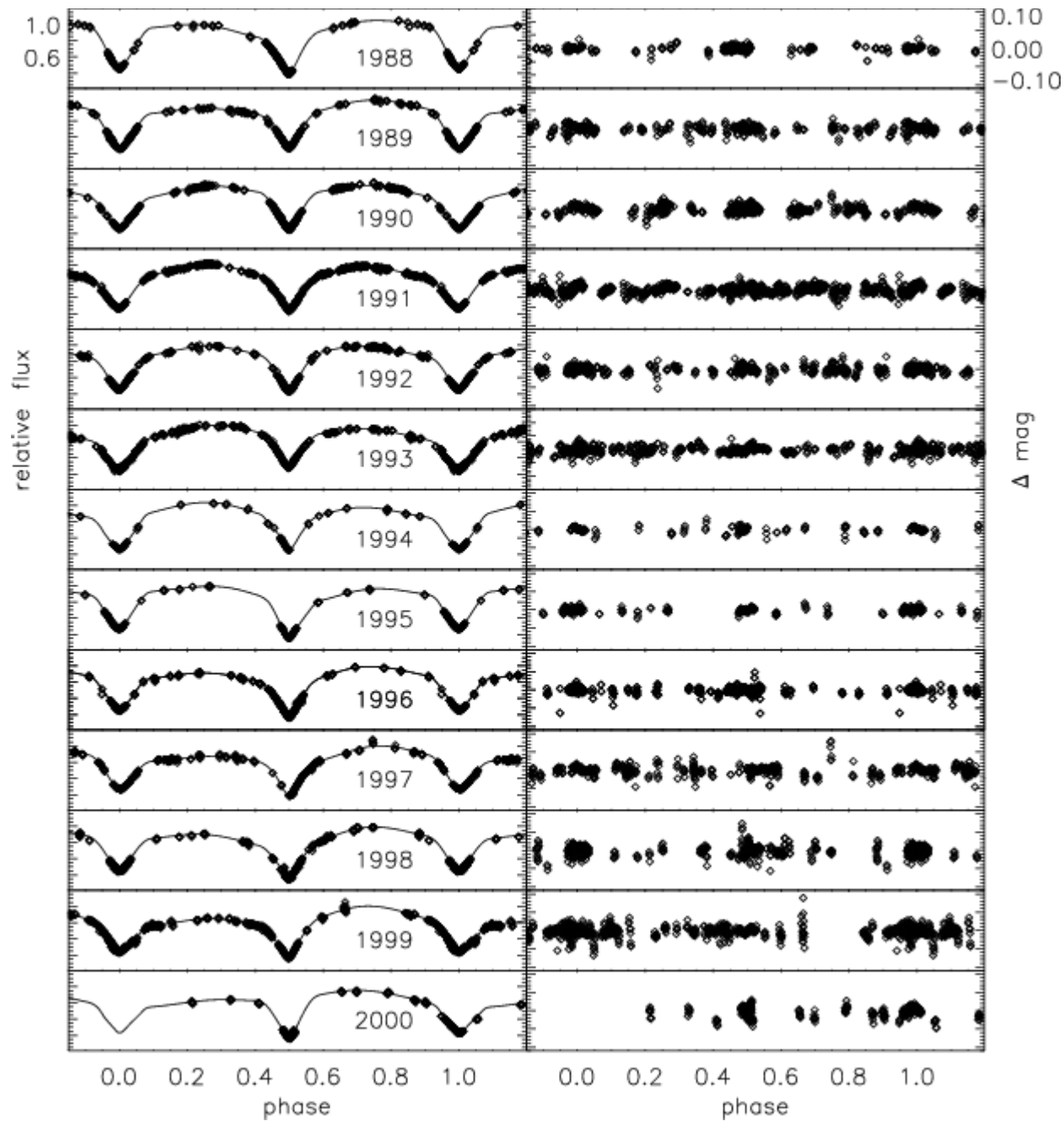


většinou – během noci jen část periody, např. [V1010 Oph](#)

| # | HJD mid (2400000 +) | Epoch | O-C (d) | D (min) | Depth (mmag) | band | DQ | LC | Author & REFERENCE | changed * |
|----|----------------------------|-------|---------|---------------|--------------|-------|----|---|--|------------|
| 20 | 56645.2821 +/- 0.00122 | 402 | -0.0097 | 175.8 +/- 4.4 | 19.8 +/- 1 | Clear | 3 |  | Marino G. TRESCA | 2014-01-09 |
| 19 | 56634.32449 +/- 0.00099 | 399 | -0.0088 | 170.6 +/- 3.5 | 23.2 +/- 1 | Clear | 3 |  | Scaggiante F., Zardin D. TRESCA | 2014-01-07 |
| 18 | 56630.67041 +/- 0.0016 | 398 | -0.0100 | 173.3 +/- 6 | 24.4 +/- 2.7 | Clear | 3 |  | Benni P. TRESCA | 2013-12-05 |
| 17 | 56627.02189 +/- 0.00118 | 397 | -0.0057 | 172.8 +/- 3.7 | 20.4 +/- 1.3 | R | 3 |  | Karavaev Y., Loginovskaj A. TRESCA | 2014-01-07 |
| 16 | 56623.36751 +/- 0.00087 | 396 | -0.0073 | 171 +/- 3.1 | 22.2 +/- 0.8 | Clear | 3 |  | Scaggiante F., Zardin D. TRESCA | 2013-12-05 |
| 15 | 56601.45042 +/- 0.00049 | 390 | -0.0074 | 170.3 +/- 1.7 | 20.9 +/- 0.5 | Clear | 1 |  | Salisbury M. TRESCA | 2013-11-12 |
| 14 | 56590.4938 +/- 0.001 | 387 | -0.0055 | 165.8 +/- 3.6 | 15.5 +/- 1.1 | Clear | 3 |  | Sokov E. N., Rusov S. TRESCA | 2013-11-04 |
| 13 | 56586.83935 +/- 0.00086 | 386 | -0.0071 | 173.9 +/- 3 | 22 +/- 1.2 | V | 2 |  | Logan V., Lewis K. TRESCA | 2014-02-18 |
| 12 | 56309.23411 +/- 0.00054 | 310 | 0.0032 | 157.7 +/- 1.9 | 14.9 +/- 0.4 | Clear | 3 |  | Gorshanov D. L., Sokov E. N., Vereshchagina I. TRESCA | 2013-01-30 |



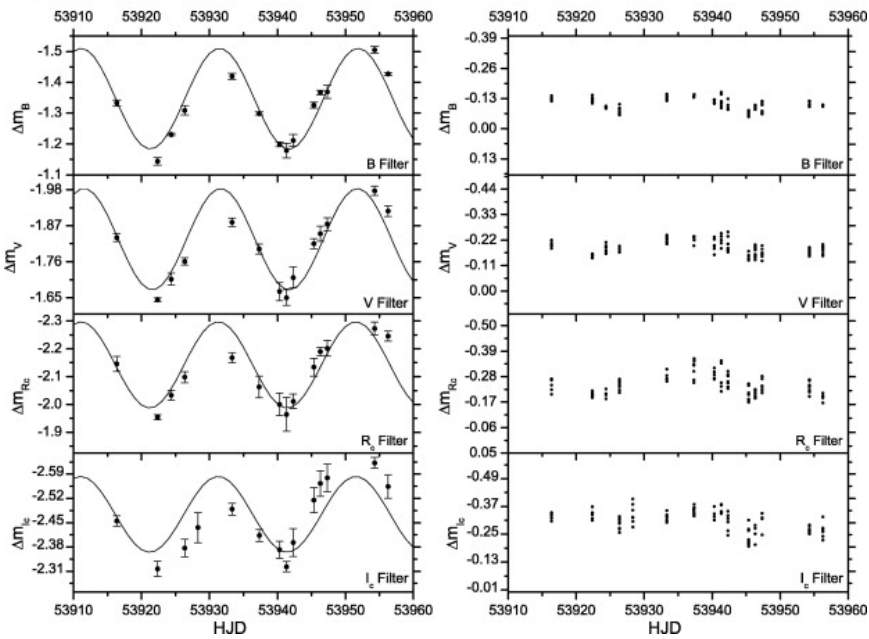
| | | | | | |
|-----|-------|---|---|--|------------|
| 0.6 | Clear | 2 |  | Ivanov A. V., Sokov E. N. TRESCA | 2012-12-17 |
| 2.8 | Clear | 3 |  | Mravik J., Grnja J. TRESCA | 2012-10-15 |
| 1.3 | Clear | 3 |  | Gorshanov D. L., Sokov E. N. TRESCA | 2012-01-26 |
| | Clear | 3 |  | Ayiomamitis A. TRESCA | 2012-01-04 |
| 1.1 | R | 3 |  | Naves R. TRESCA | 2011-12-27 |
| 1.2 | Clear | 3 |  | Audejean M. TRESCA | 2011-01-14 |



RT Lac

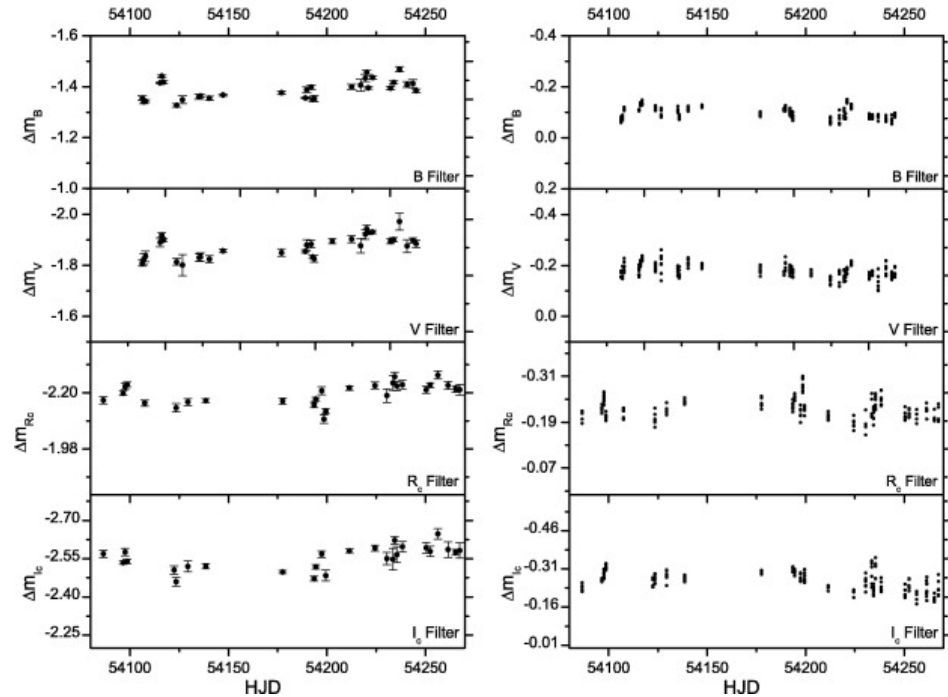
Lanza et al., A&A 386,
583 (2002)

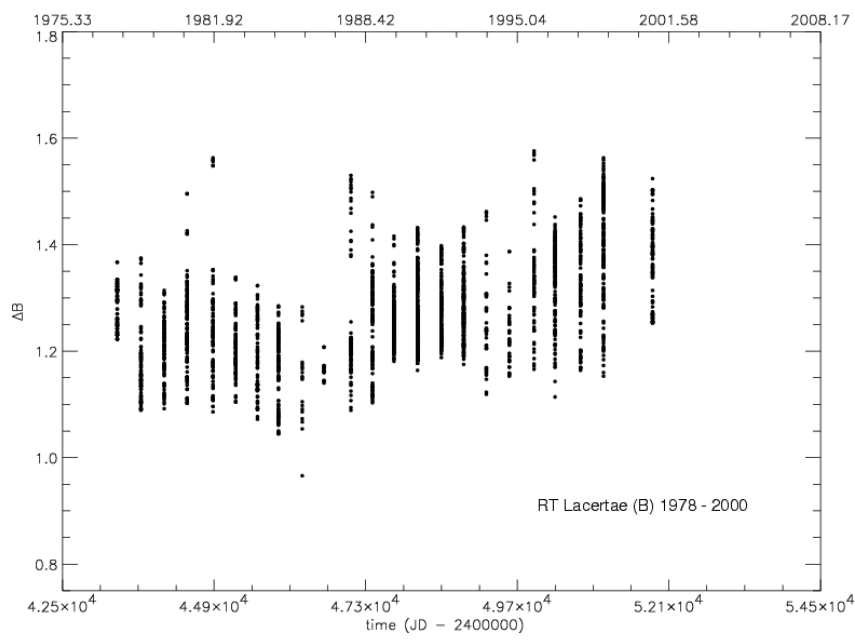
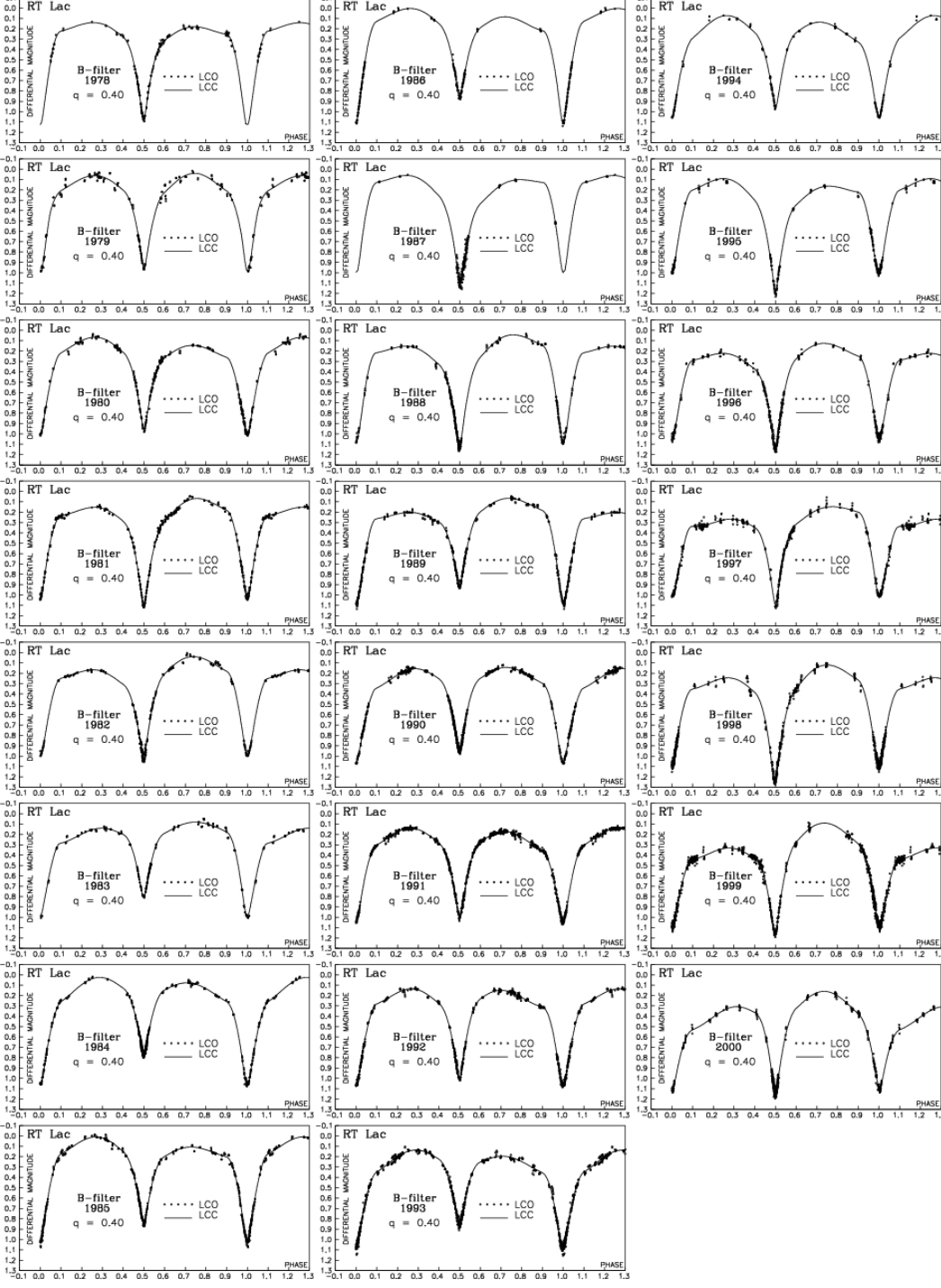
BM CVN (First Season CCD Observations)



Erdem et al., New Astr. 14, 545 (2009)

BM CVN (Second Season CCD Observations)





RT Lac

Cakirli et al., A&A 405, 733-745 (2003)

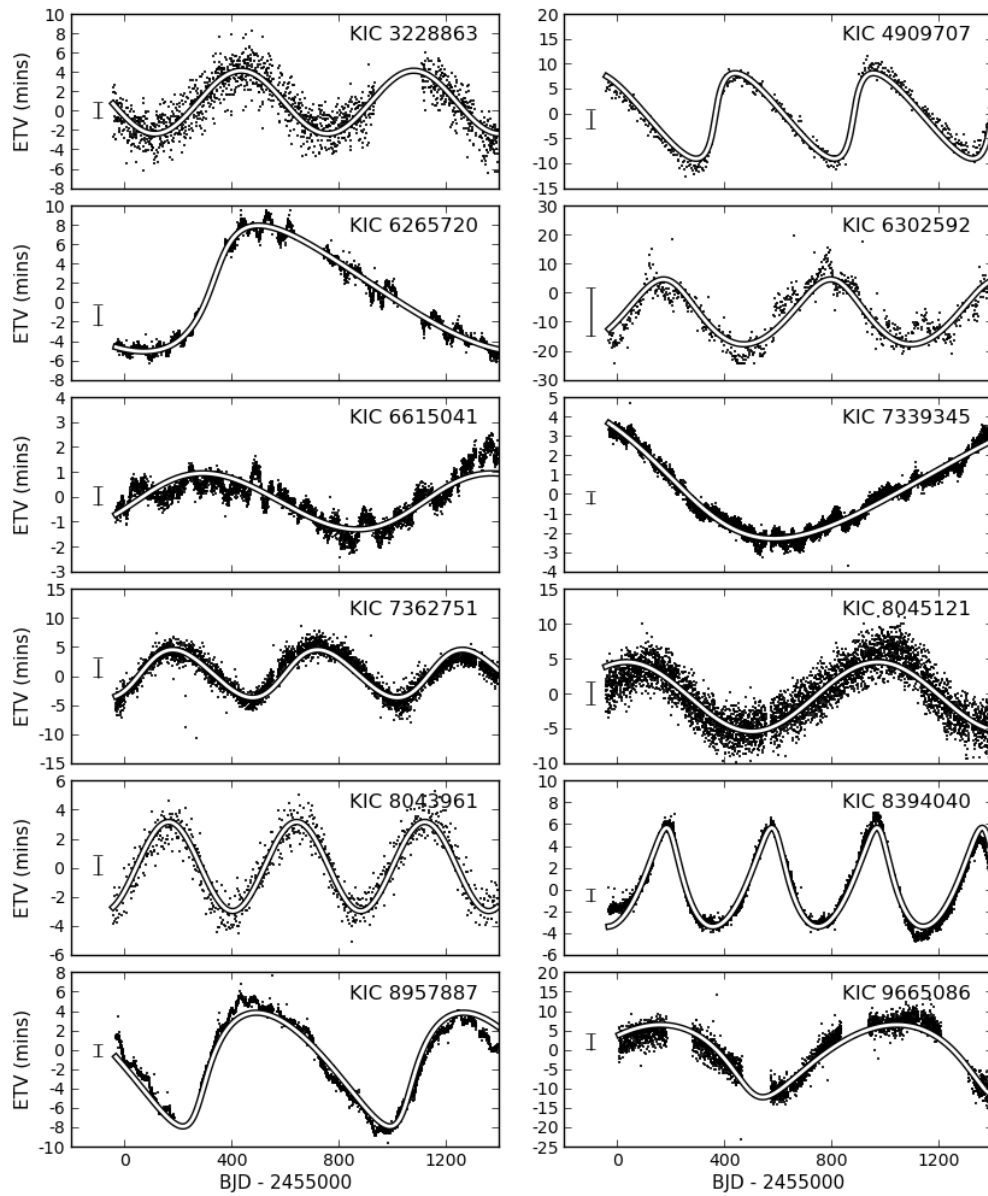


Fig. 7. Gallery of select ETV signals found in close binaries with LTTE ts. These are KIC 3228863, 4909707, 6265720, 6302592, 6615041, 7339345, 7362751, 8045121, 8043961, 8394040, 8957887, and 9665086. Typical errors for ETV measurements are shown to the left of the data.

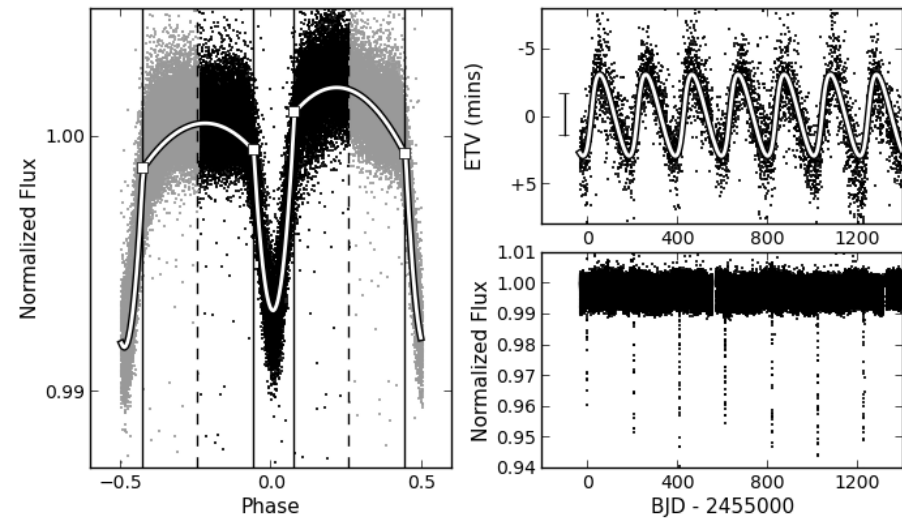
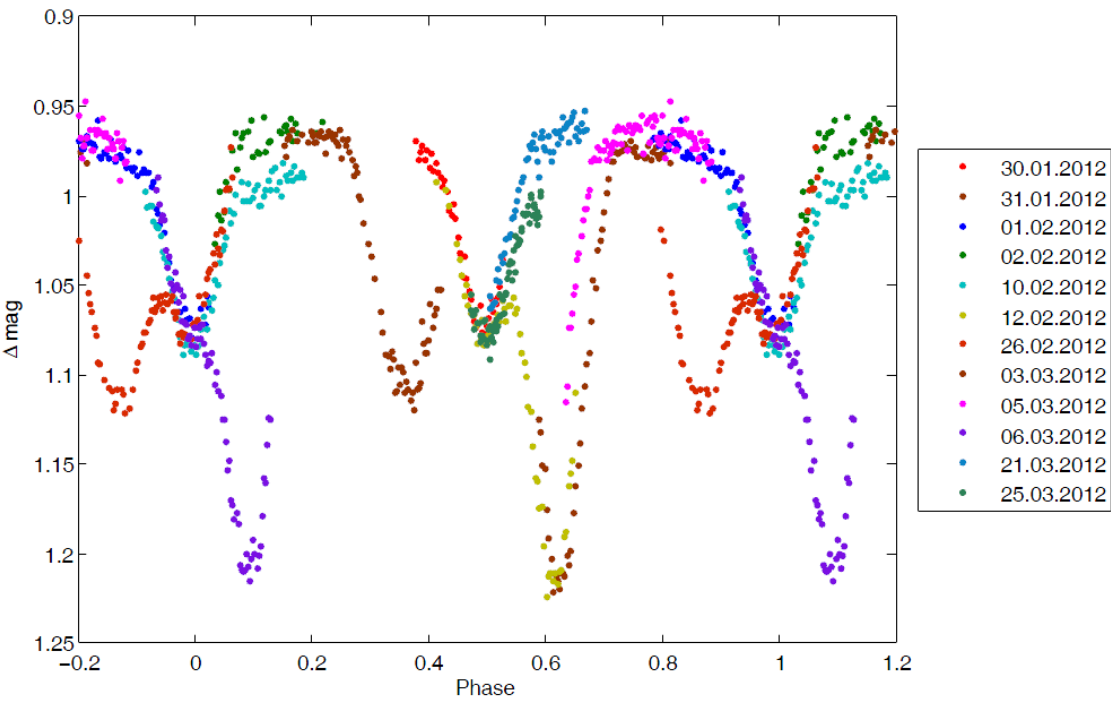
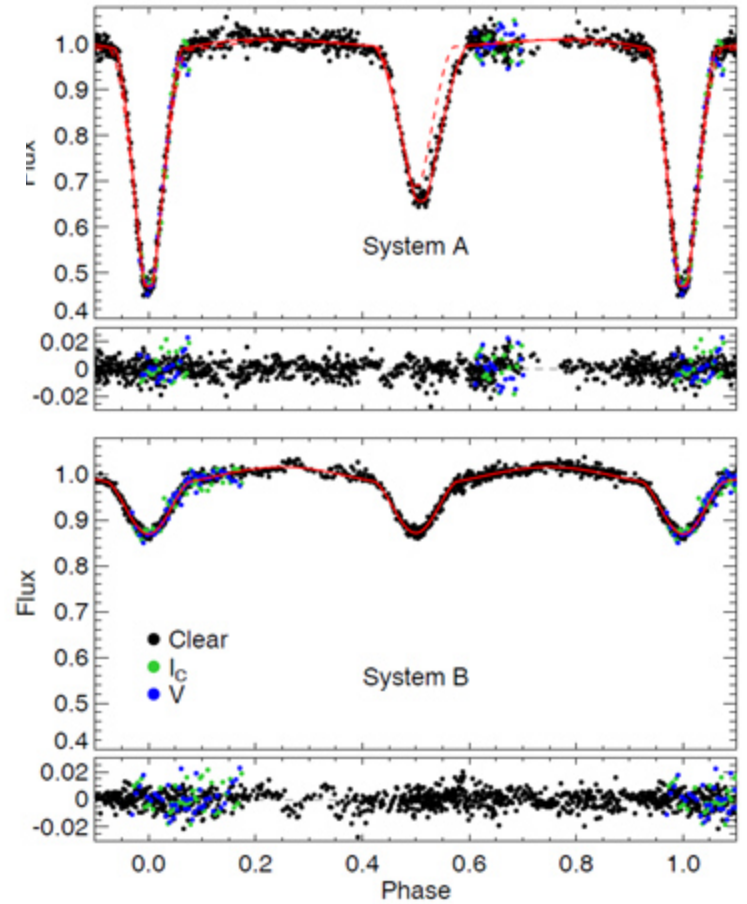


Fig. 9. A triple eclipsing star KIC 2856960. Left: the detrended light curve phased at the inner period of 0.26-d. The white line is the polyfit function, and white rectangles are the knots. Dashed lines delimit the phase space of the primary and secondary eclipse; these are used separately to obtain primary and secondary ETVs. Upper right: the measured ETVs (black points) and the best light-time travel fit (white line), yielding the outer period of 205.5 days. Lower right: the detrended light curve, with the tertiary eclipses clearly visible.

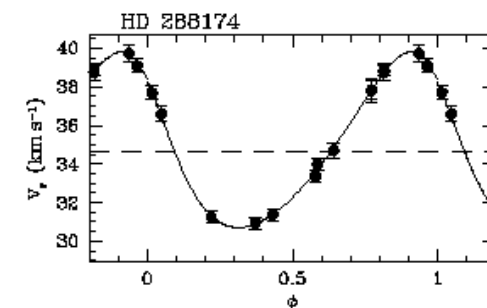
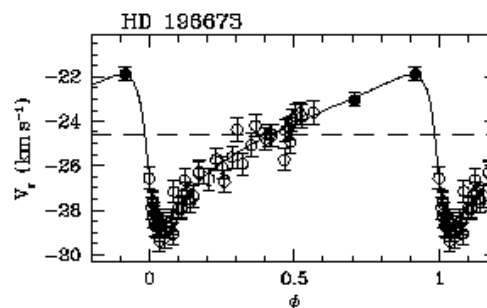
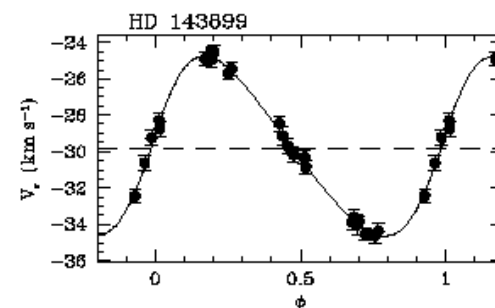
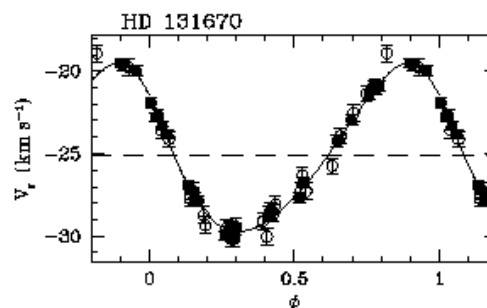
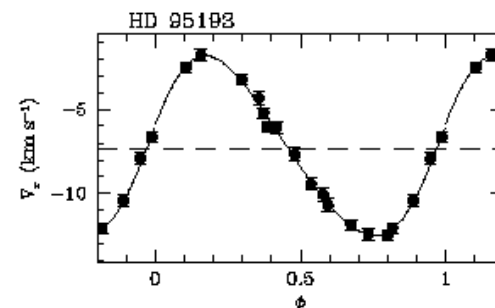
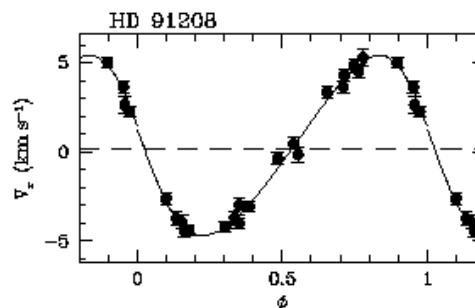
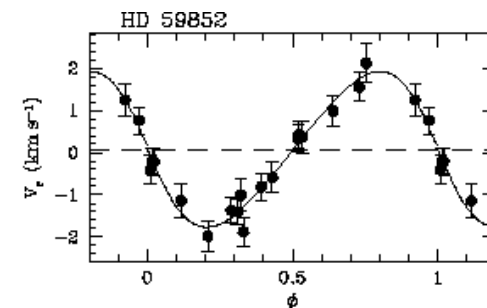
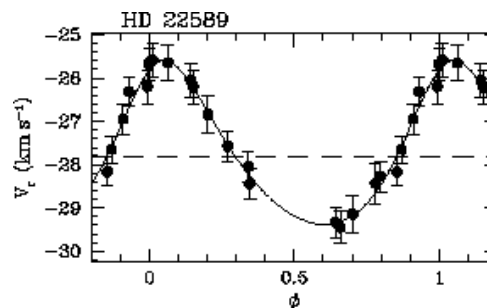
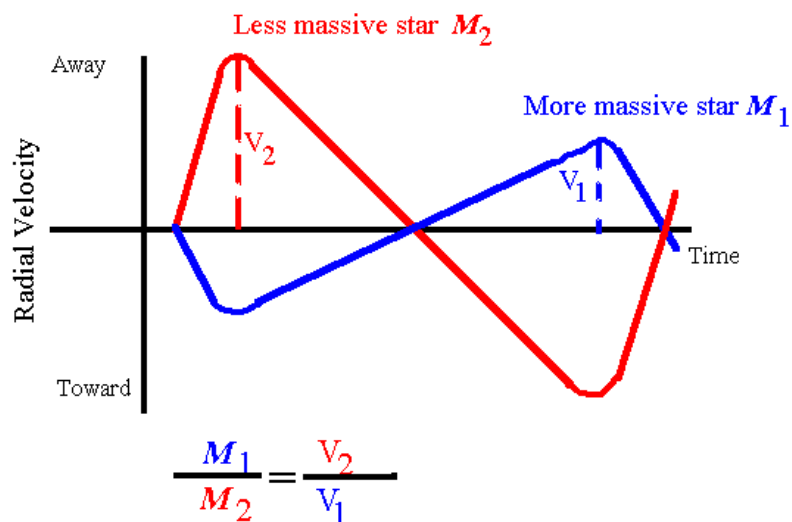
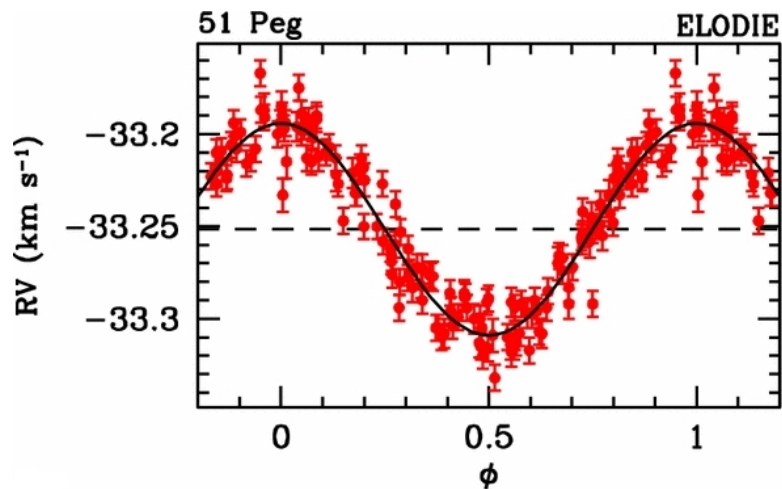


CzeV343

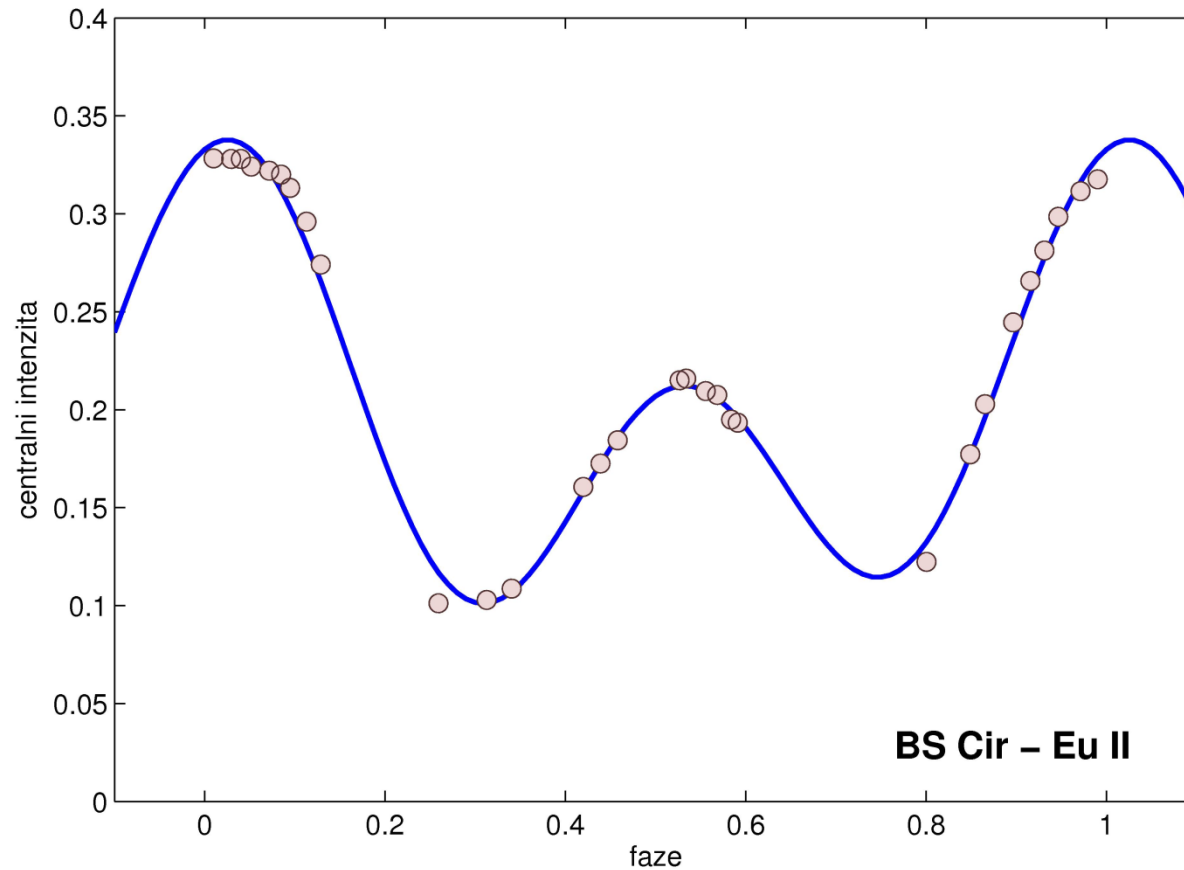
Cagaš, Pejcha,
[2012A&A...544L...3C](#)



Křivka radiálních rychlostí



Změny intenzity spektrálních čar



CP hvězda BS Cir – měření J. Janík

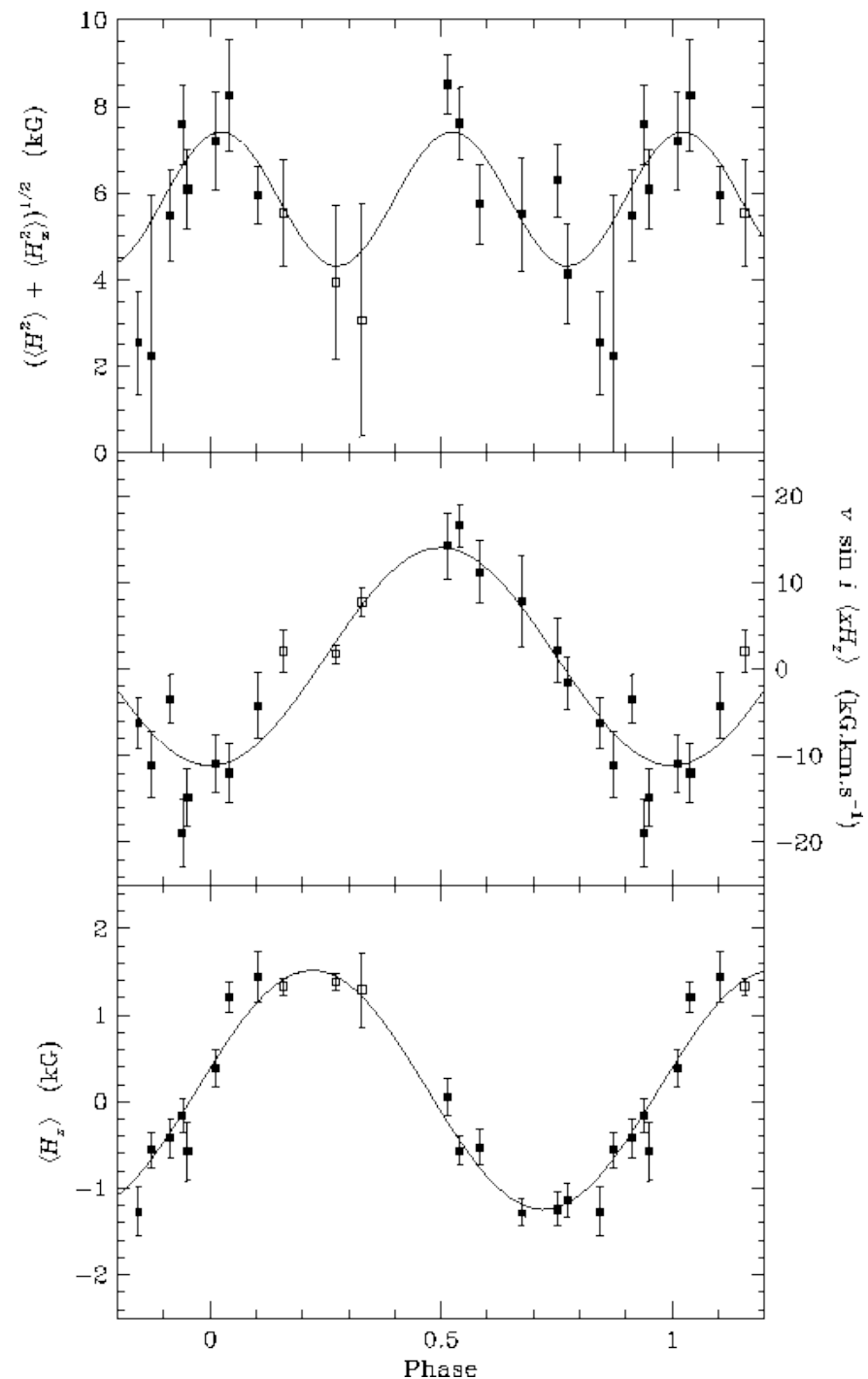
Změna magnetického pole

HD 153882: fázové diagramy intenzity mg. pole

nahoře: střední kvadratické mg. pole
(osa x: dvě rotační periody)

uprostřed: intenzita mg. pole $v \sin i \langle xH_z \rangle$
(osa x: rotační perioda hvězdy)

dole: střední intenzita podélného mg. pole $\langle H_z \rangle$



Polarimetrie

V884 Her – kataklyzmická proměnná
Szkody et al., ApJ 455, L43 (1995)

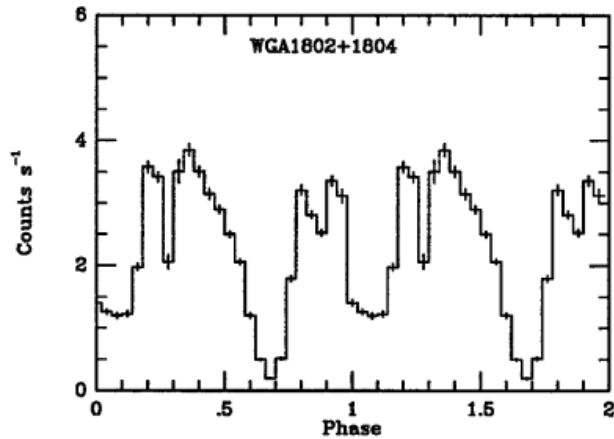


FIG. 7.—X-ray light curve folded at a period of 113.5 minutes.

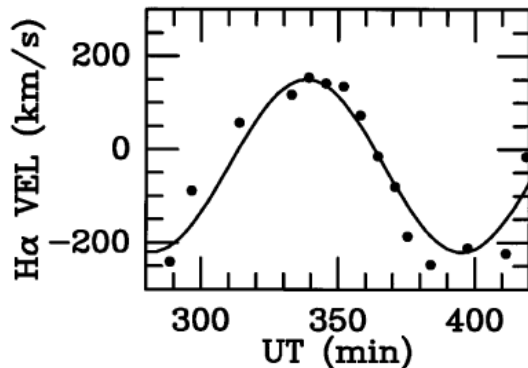


FIG. 6.—Radial velocities of the wings of H α (using a Gaussian separation of 28 Å) together with the best-fit sine curve with the period fixed at 113 minutes.

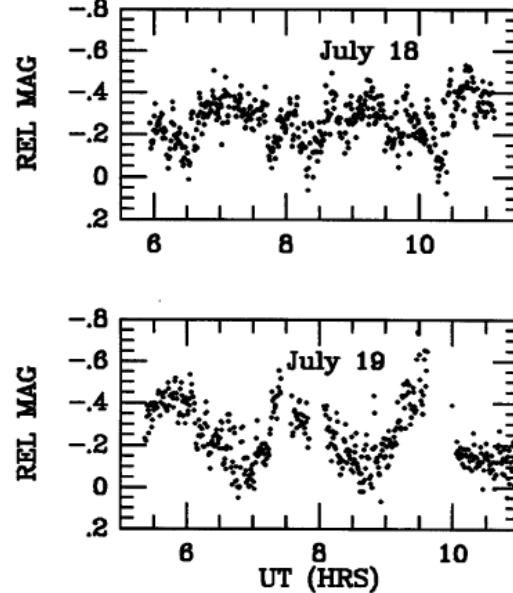


FIG. 4.—V-band CCD light curve of the candidate, relative to the 15th magnitude comparison star marked in Fig. 1, obtained at MRO on the nights of 1995 July 18 and 19. Each point is a 30 s integration with statistical uncertainty of 0.02 mag.

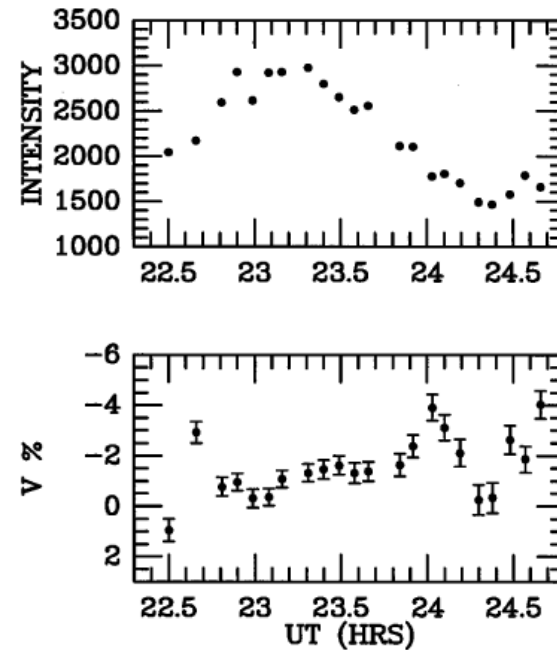


FIG. 5.—The intensity and circular polarization of the source on 1995 August 20–21 in a broad (~ 2000 Å) red spectral band centered at 6700 Å. Each dot corresponds to a 5 minute integration.