XM78HT: MULTICOLOUR PHOTOMETRIC STUDY OF THE NEW WZ SGE TYPE VARIABLE

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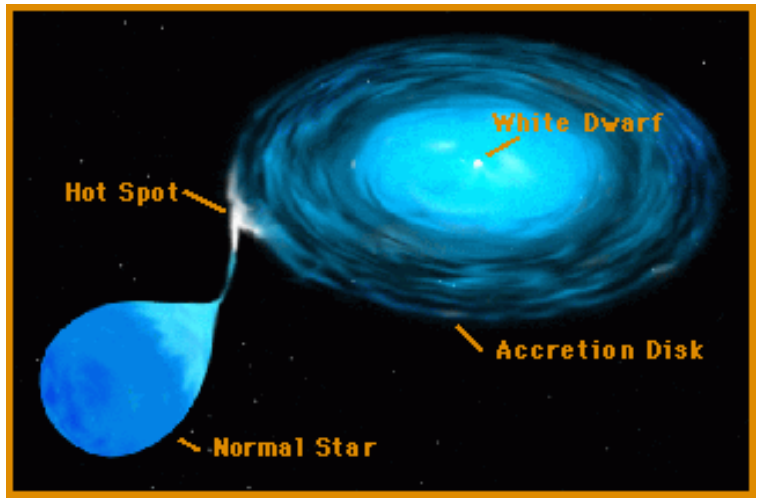
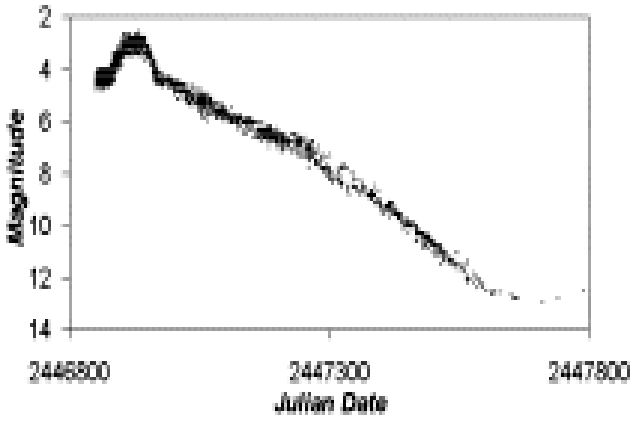
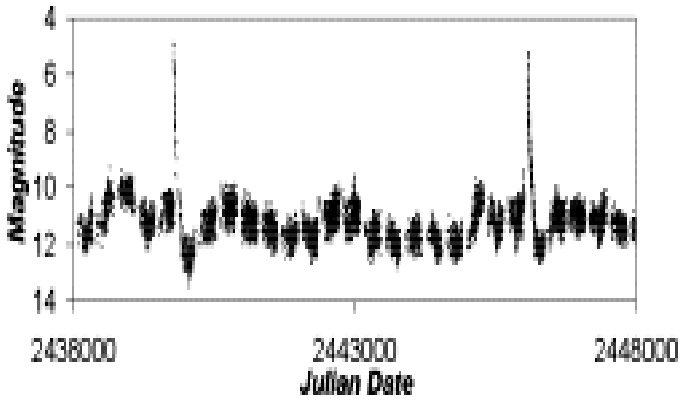
Novae and dwarf novae

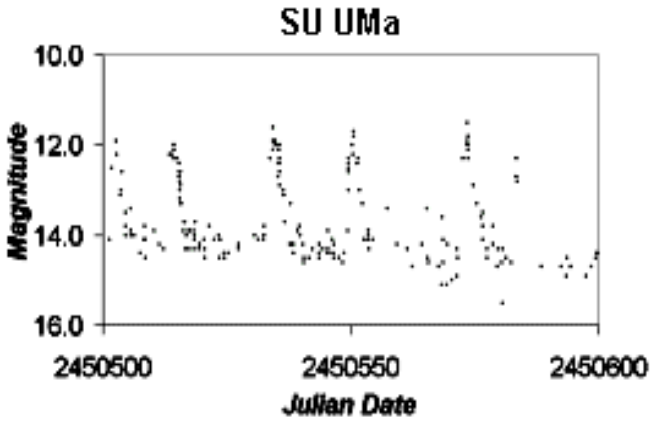




Classical nova

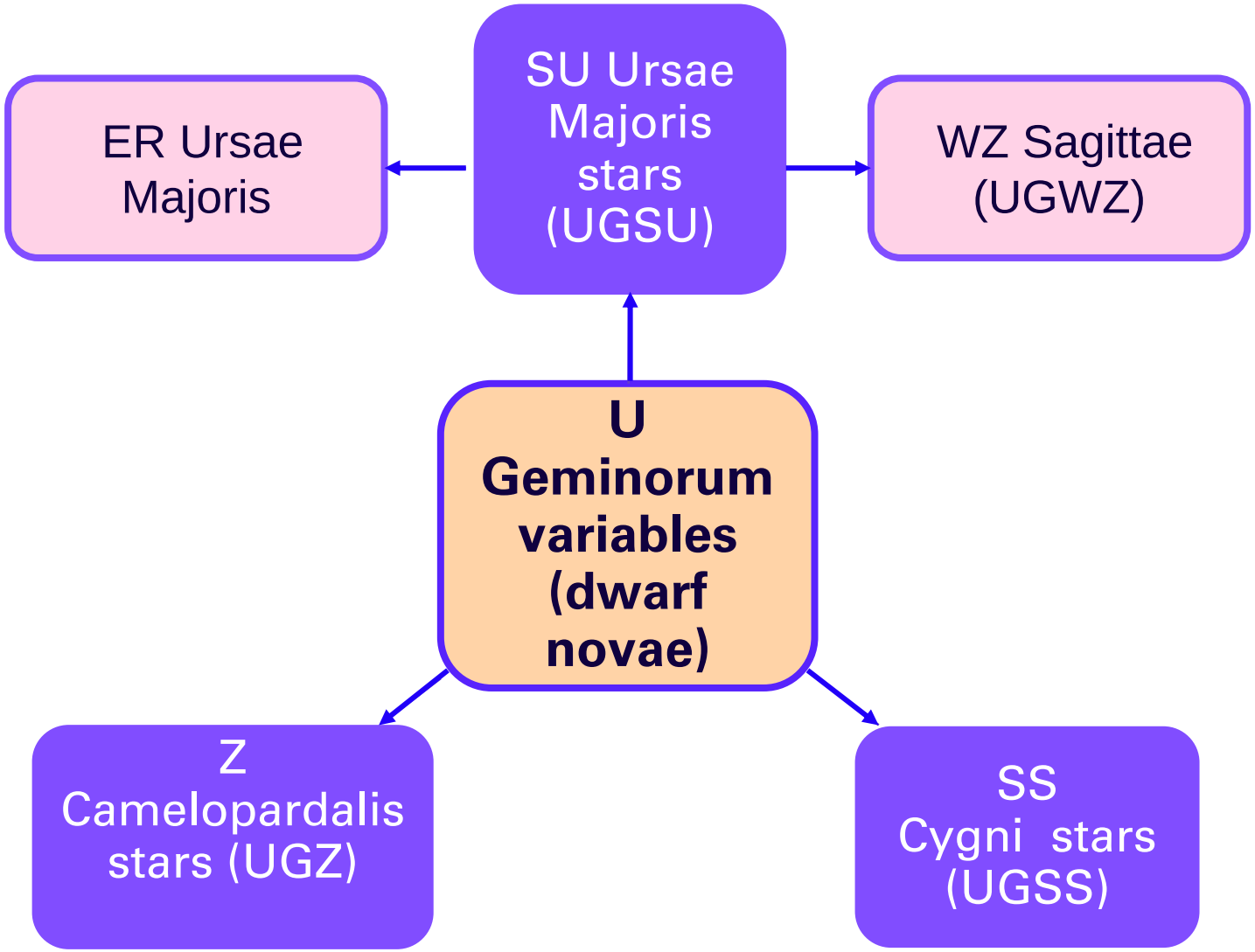


Recurent nova



Dwarf nova (U Geminorum)

WZ Sagittae variables



WZ Sagittae variables: effects

Superoutburst

- Amplitude is about 8-9^{m}. There are no normal outburst like SU UMa (2-4^{m}).

Superhumps

- Early superhumps after superoutburst with small amplitude
- Stage A (amplitude increases, period is stable and longer than at stage B)
- Stage B (stable amplitude, superhumps are most pronounced, O-C is parabolic)
- Stage C (amplitude decreases, period is stable and shoter than at stage B)

Irregular brightness changes after superoutburst

- Rebrightenings
- Deep darkenings

Period and amplitude variations of superhumps

$$\frac{1}{P_{SH}} = \frac{1}{P_{Orb}} - \frac{1}{P_{Prec}}$$

Some causes of UGWZ variability:

- Elliptical accrection disc (a.d.)
- Elliptical and circle orbits in a.d.
- Different locations of bright region at a.d.
- Resonanses between orbital motion and a.d. rotation
- Precession and nutation of a.d.

Kato et al., 2009, Publ. Astron. Soc. Japan, 61, S395

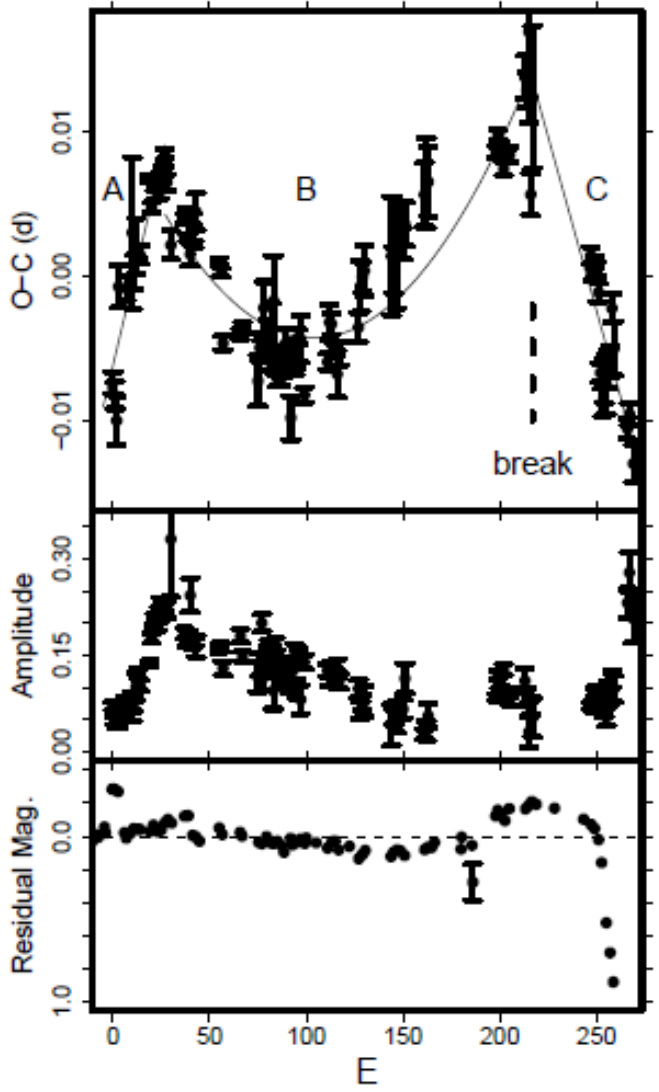
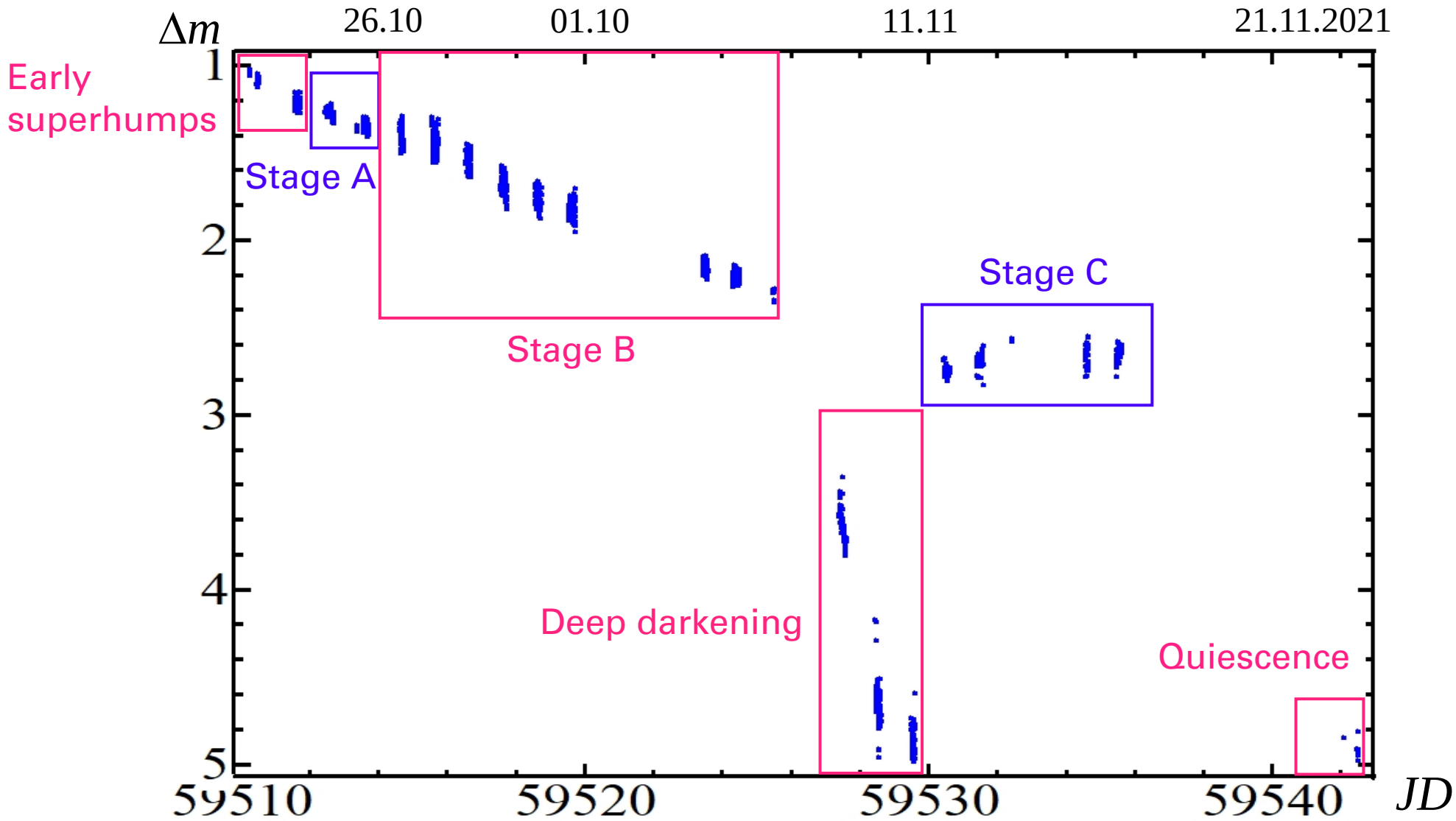


Fig. 3. Representative $O-C$ diagram showing three stages (A–C) of $O-C$ variation. The data were taken from the 2000 superoutburst of SW UMa. (Upper:) $O-C$ diagram. Three distinct stages (A – evolutionary stage, B – middle stage, and C – stage after transition to a shorter period) and the location of the period break between stages B and C are shown. (Middle): Amplitude of superhumps. As shown in Soejima et al. (2009), the maximum amplitudes of superhumps coincide with transitions between stages (A to B and B to C). (Lower:) Deviations from linear decline during the superoutburst plateau. As seen in Soejima et al. (2009) and Kato et al. (2003c), rebrightening during the terminal plateau also corresponds to the transition from stage B to C.

Stara Lesna observations, R+C (corrected to R)



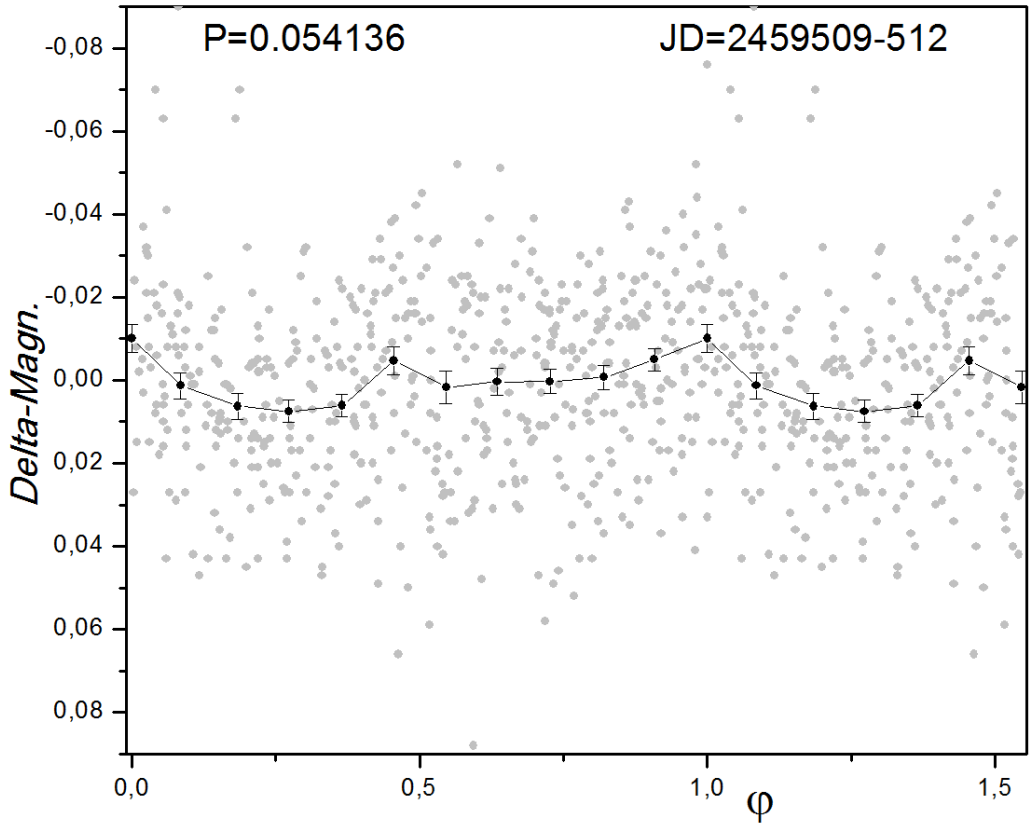
Phase light curves of superhumps

(B+V+R magnitudes after the detrending)

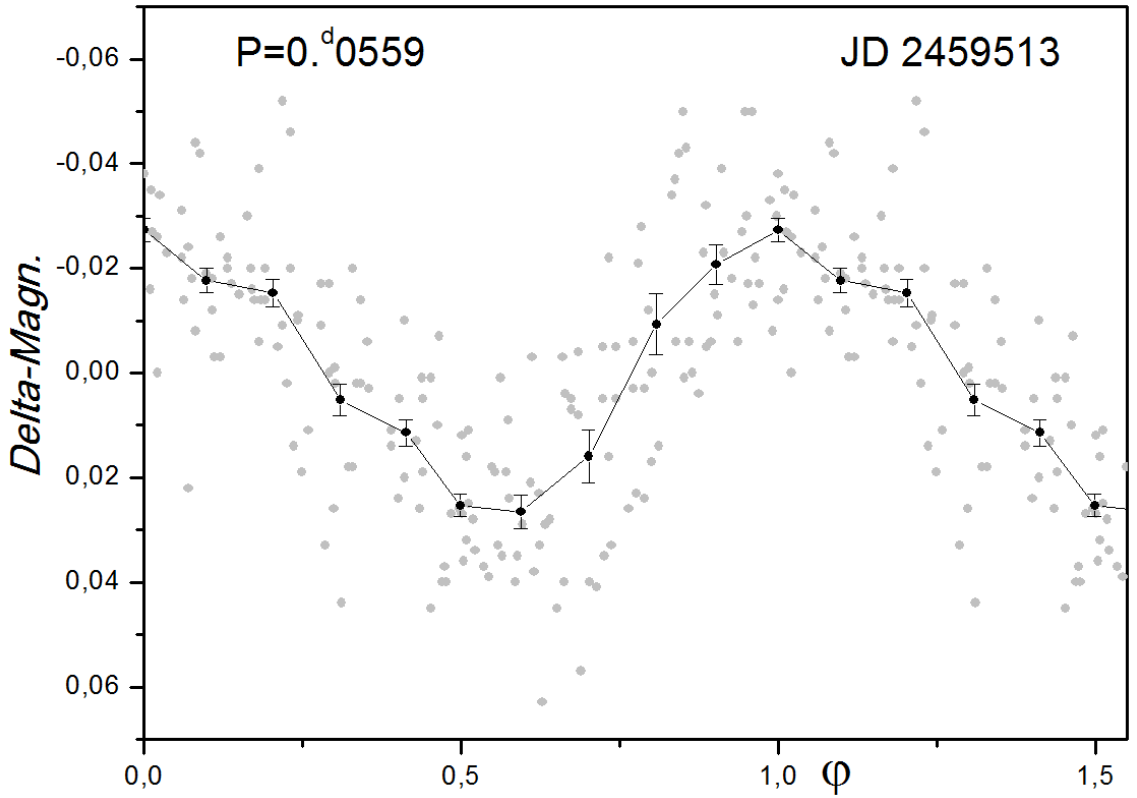
Period excess:

$$\varepsilon = \frac{P_{SH}}{P_{Orb}} - 1 \simeq \frac{P_{SH(A)}}{P_{EarlySH}} - 1 = 0.033$$

Early superhumps



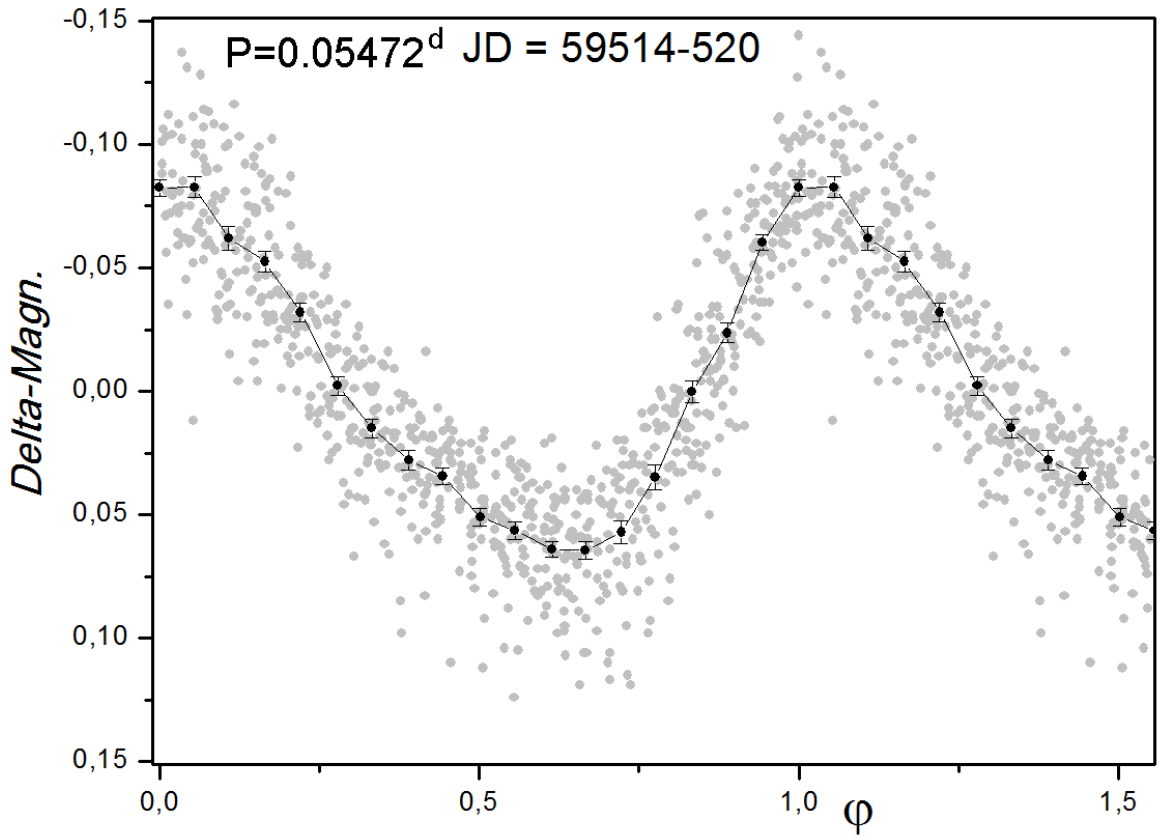
Stage A



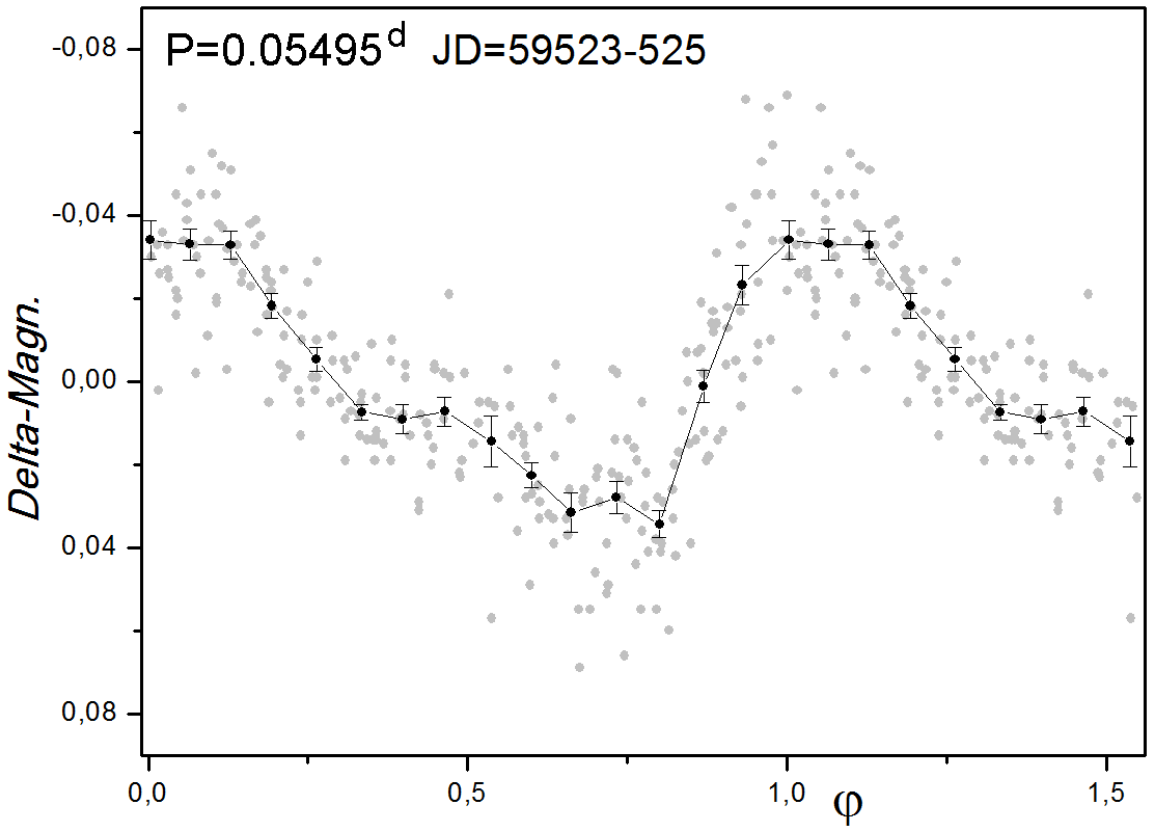
Phase light curves of superhumps

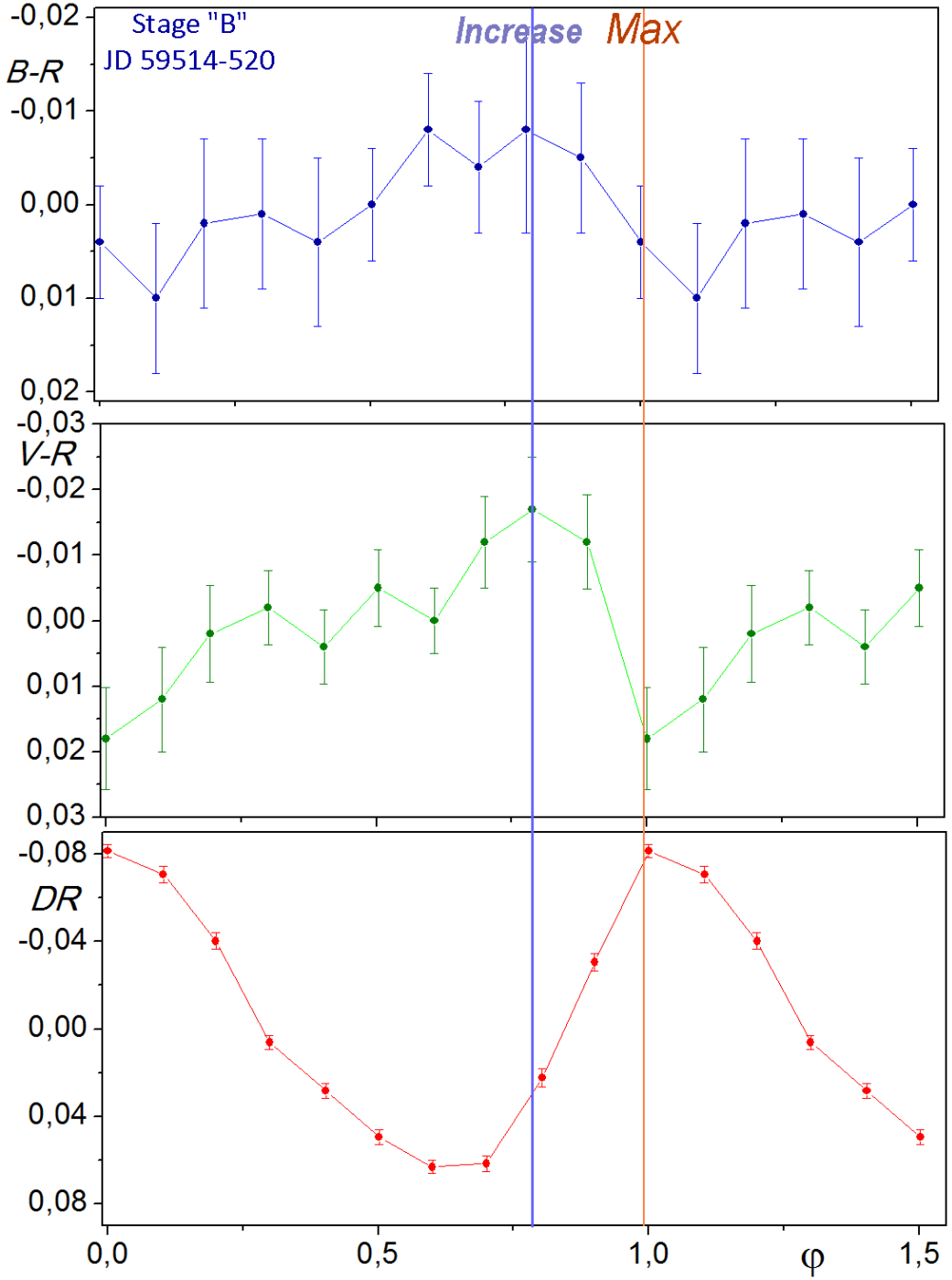
(B+V+R magnitudes after the detrending)

Stage B



Stage B



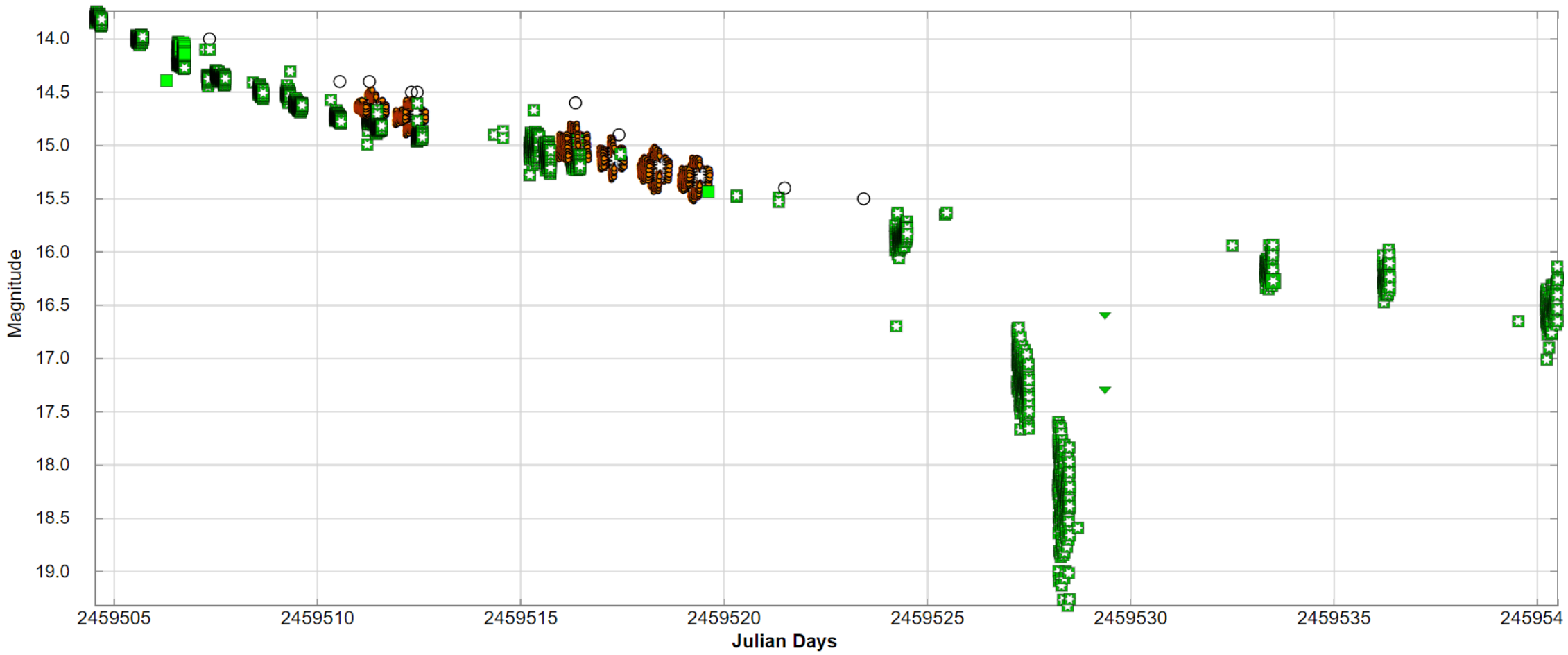


Color indices

It can be seen that near the maximum brightness of the superhump (orange line) the color indices are close to the maximum, i.e. the variable at this time is the reddest.

During the rising of brightness to the superhump (blue line), the variable is the bluest. This behavior of color indices is often observed in stars like WZ Sge and SU UMa types.

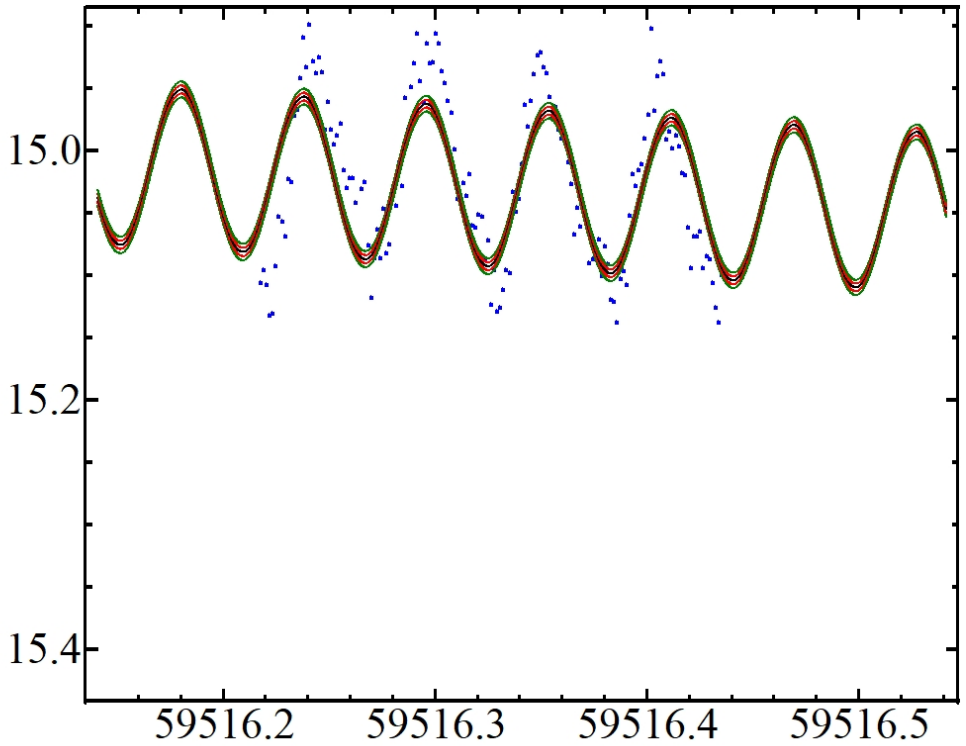
AAVSO observations

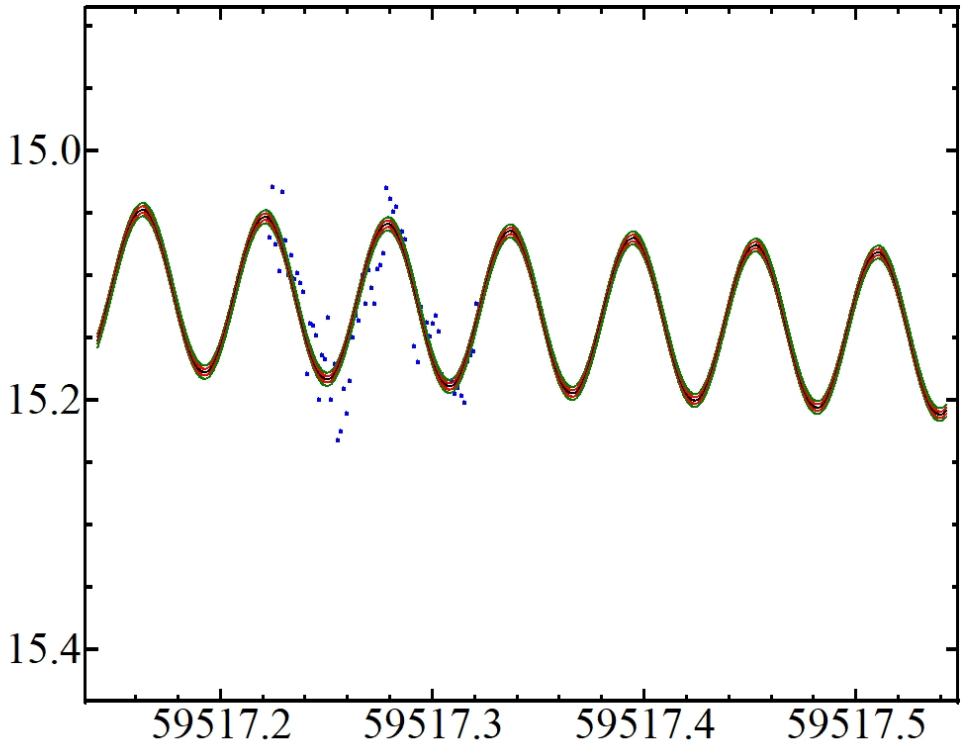


☐	BOZ (6) : Vis	☑	Bago, Balazs	HU	MCSE		☐	HMB (1252) : CV	☑	Hambsch, Franz-Josef	BE	VVS
☐	MUY (10) : CV	☑	Muyllaert, Eddy	BE	VVS		☐	PYG (20) : CV,V,Vis	☑	Poyner, Gary	GB	BAA-VSS
☐	RFDA (133) : V	☑	Romanov, Filipp	RU	AAVSO		☑	TRT (1088) : CV	☑	Tordai, Tamás	HU	MCSE
☐	TUB (1) : V	☑	Tuboly, Vince	HU	MCSE		☐	VMT (2290) : CV	☑	Vanmunster, Tonny	BE	VVS
☐	WKL (8) : CV,Vis	☑	Wenzel, Klaus	DE	BAV							

AAVSO (Tordai Tamas) - superhumps

Polynomial trend n=1, trigonometrical polynomial n=1 p=0.05464^{d}.





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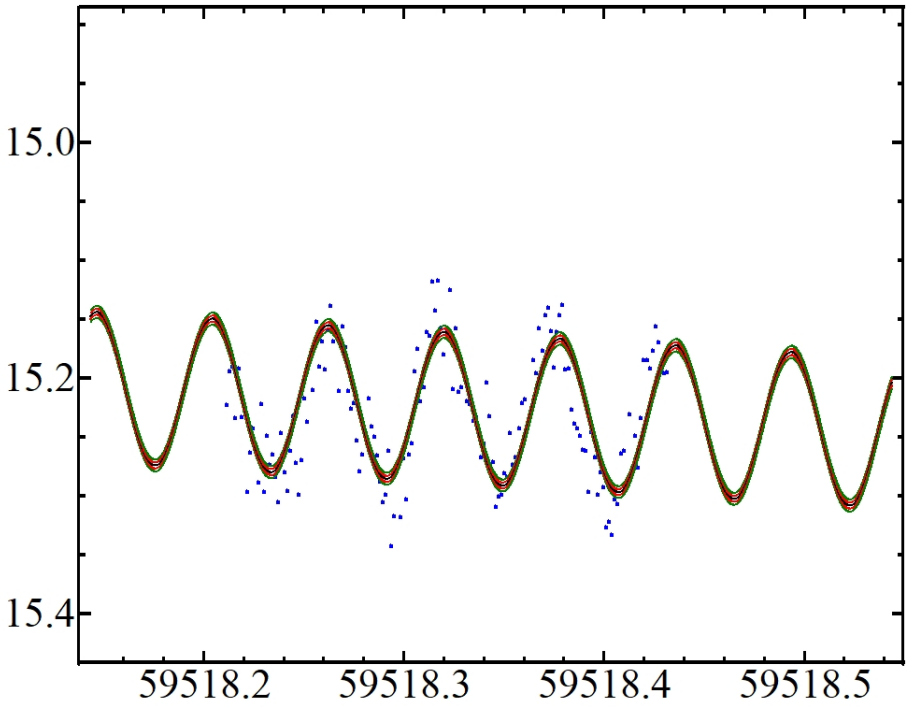
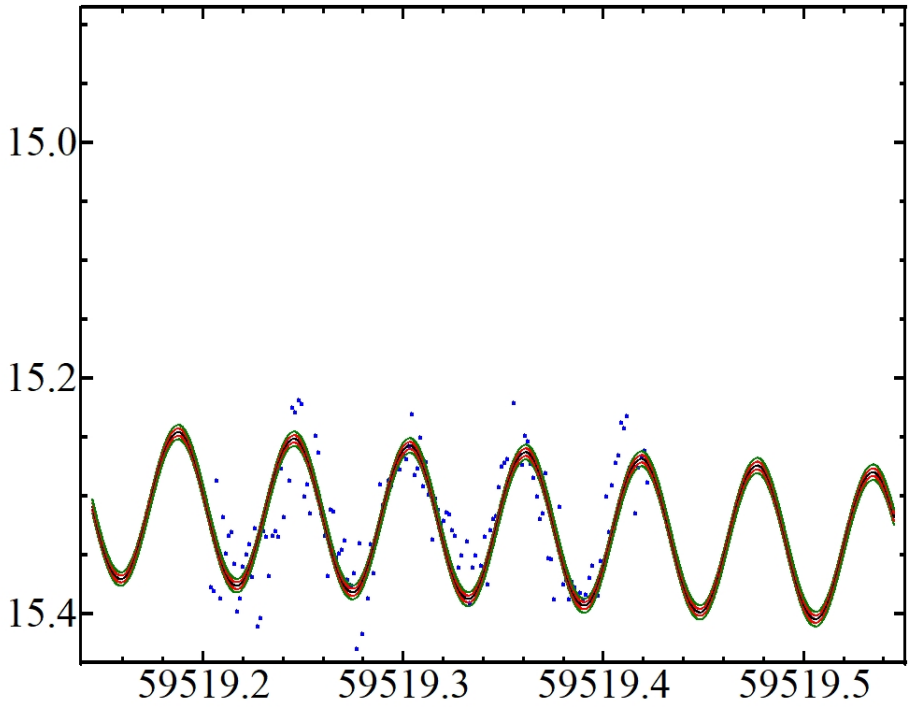
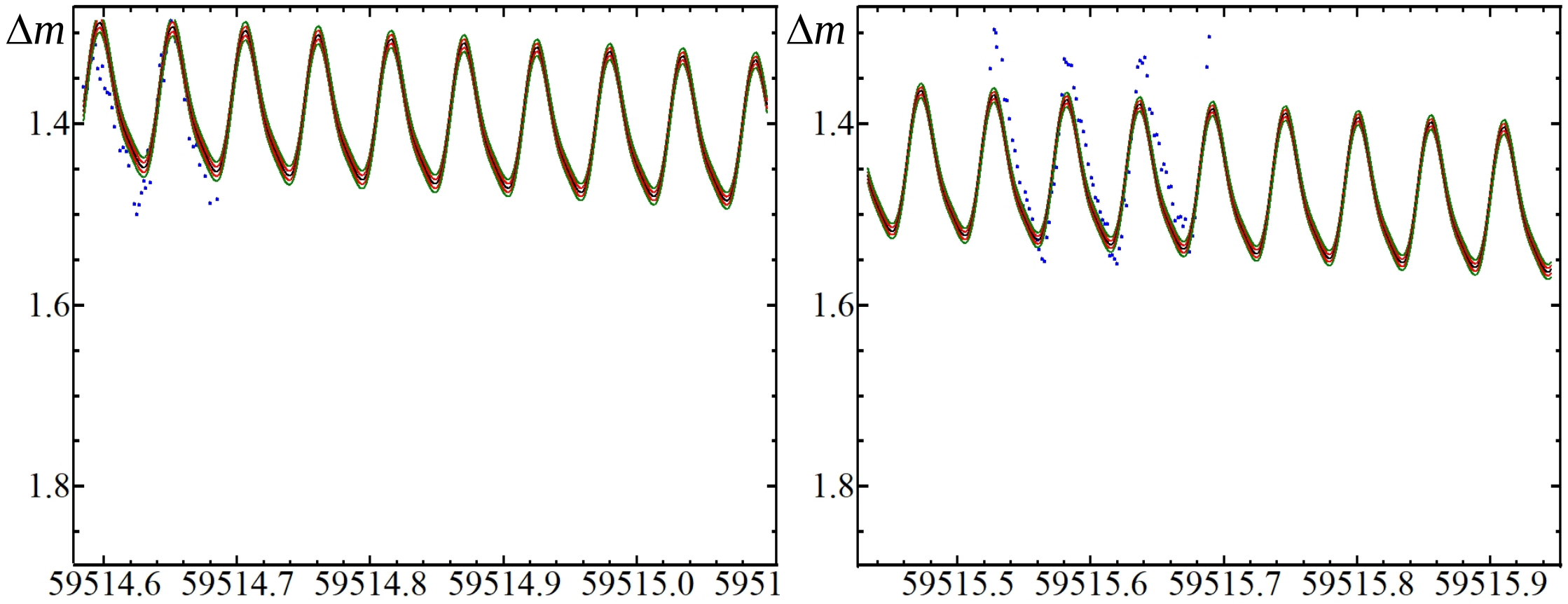




Our observations, R+C (corrected to R)

Polynomial trend n=2, trigonometrical polynomial n=2, p=0.05474^{d}.



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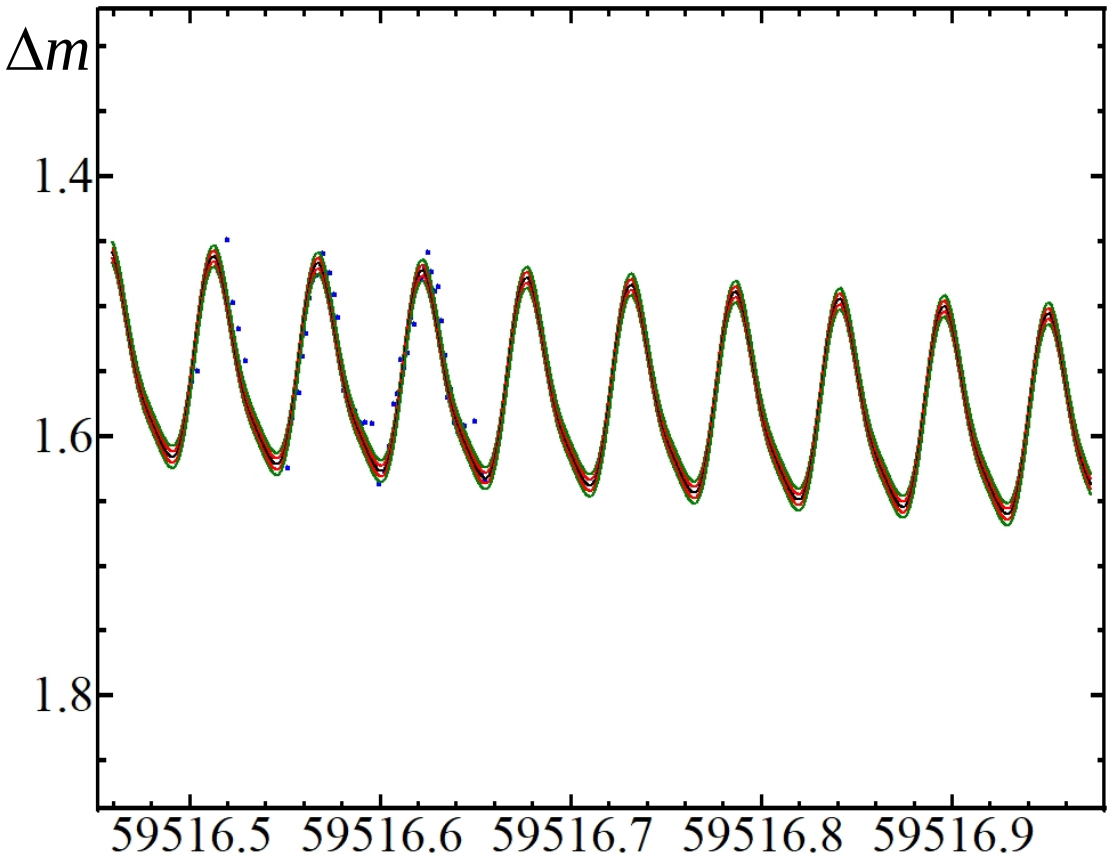

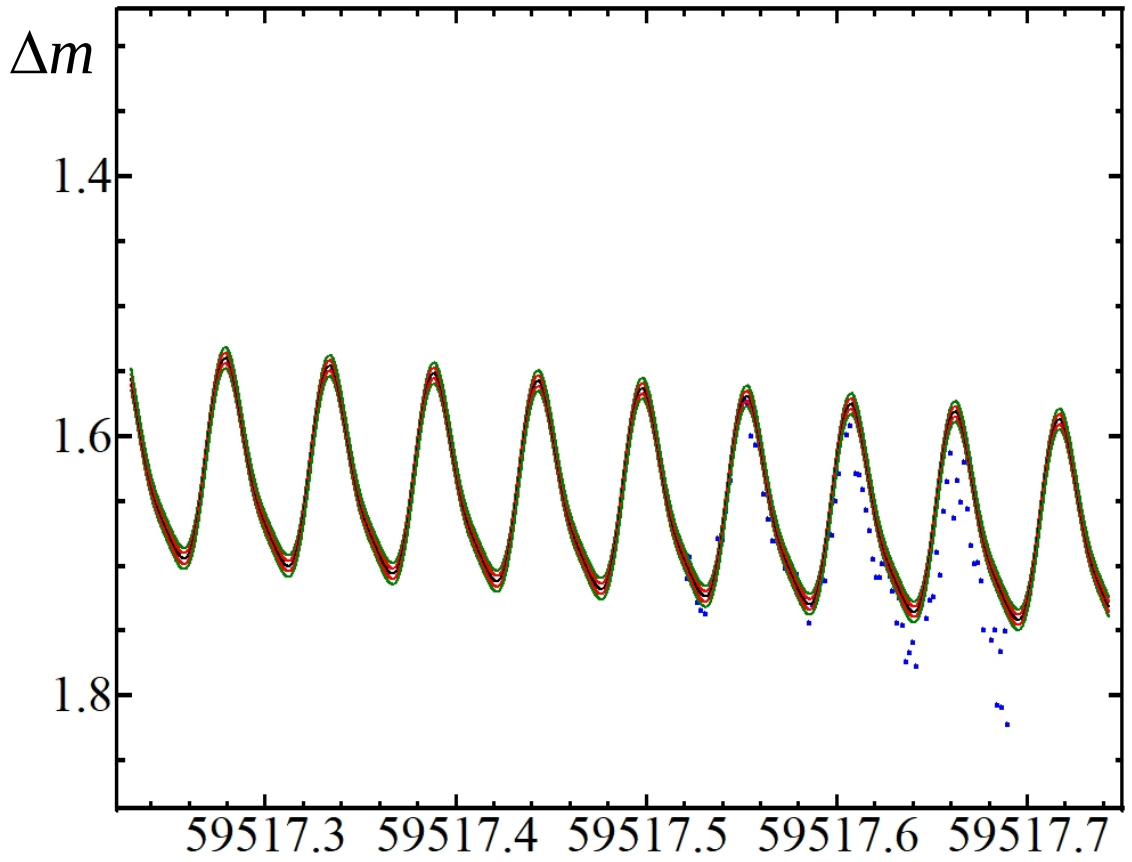

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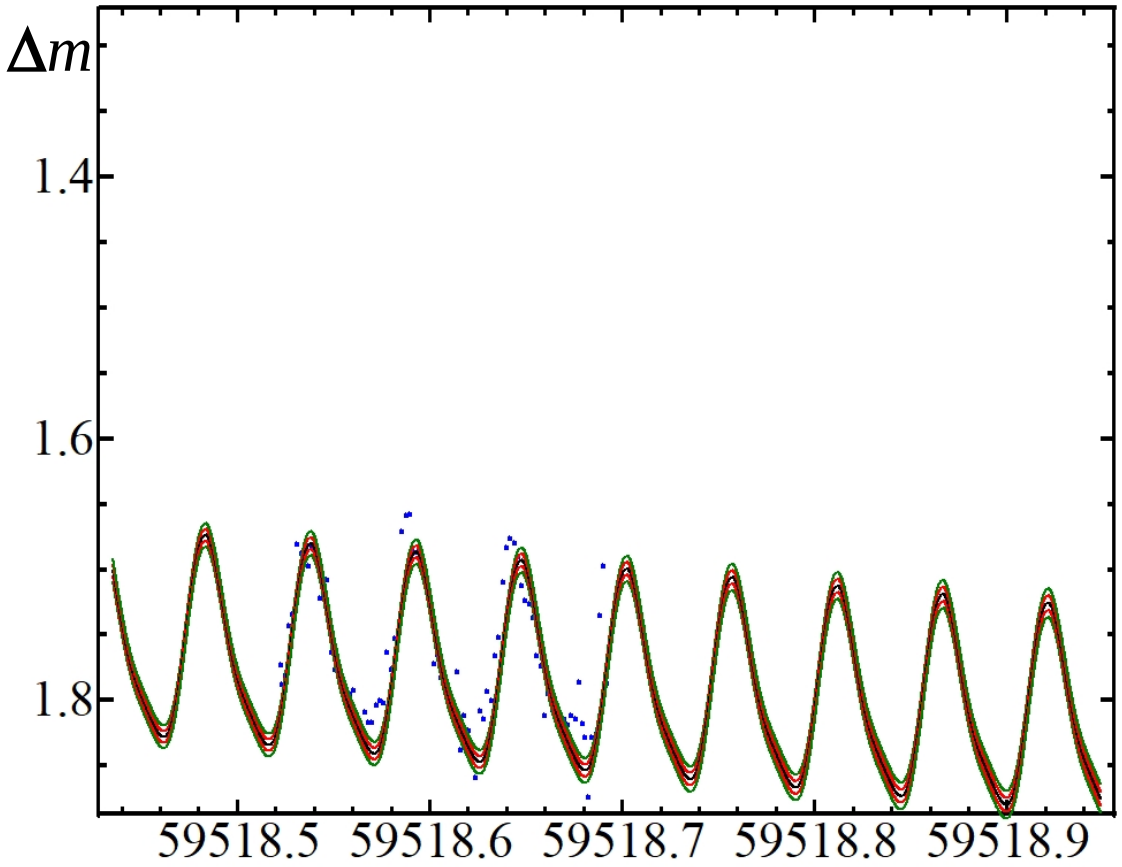
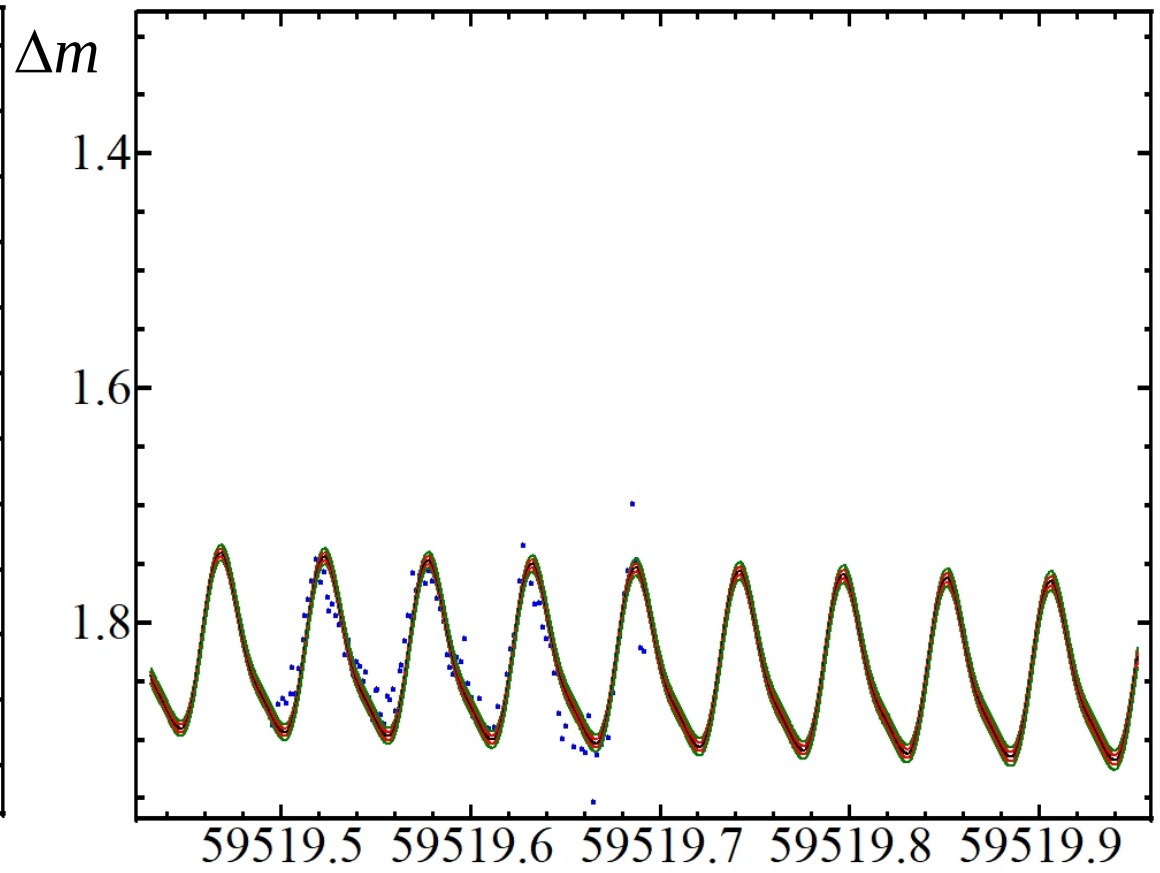
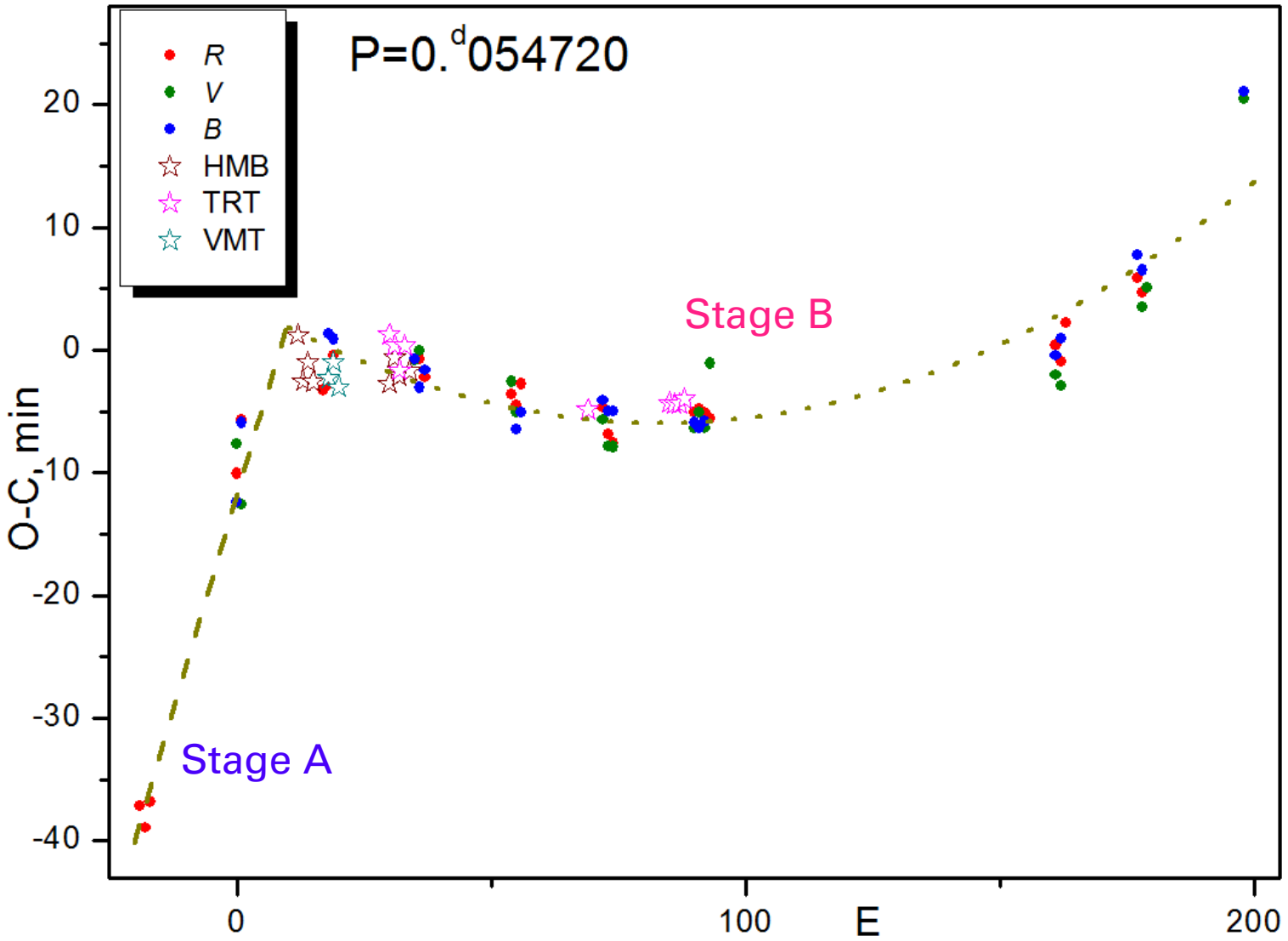




O-C of superhumps (AAVSO + our photometry)



Period excess values:

$$\varepsilon = \frac{P_{SH}}{P_{Orb}} - 1 \simeq \frac{P_{SH(A)}}{P_{EarlySH}} - 1 = 0.033$$

$$\varepsilon^* = 1 - \frac{P_{Orb}}{P_{SH}} = 0.032$$

Period change rate (stage B):

$$\frac{\dot{P}}{P} = 3.5 \cdot 10^{-5}$$

Mass ratio by using ε^* (Kato, Osaki, 2013):

$$q \simeq 0.09$$

Conclusion

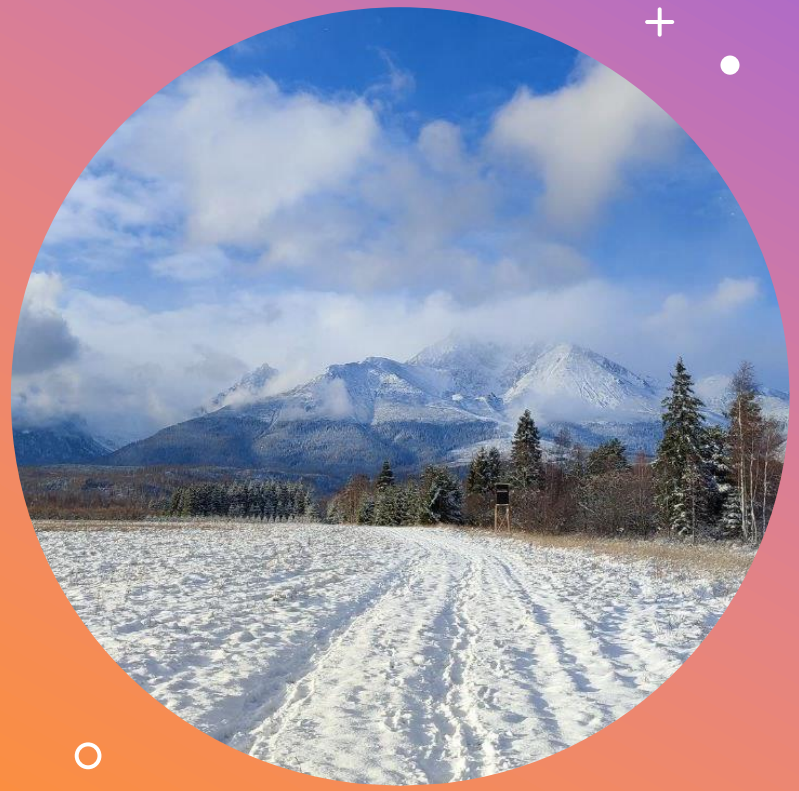
Variable XM78HT belongs to WZ Sge type, since:

- ✓ Amplitude of **superoutburst** is highter than 5 magnitudes;
- ✓ The **superhumps** with period of about 0.05472^d were detected and **their period changes and color indices changes** are typical for WZ Sge type;
- ✓ Right away after the superoutburst the **early superhumps** occurred with the period close to ½ superhumps' one;
- ✓ **Period excess** value is about $\varepsilon=0.033$;
- ✓ **The deep darkening** (more than 2.5 magnitude) was detected during the slow brightness decrease after superoutburst.

Al of these properties are typical for WZ Sge type dwarf novae.

Acknowelegements

- To organisers of KOLOS conferences and VARIABLE astrocamps,
  who have made my way back to the science easier
- To coleagues who help me to come to Slovakia with the support of SAIA scolarship program:
  Dr S.Parimucha, Dr S.Shugarov
- To SAIA for financial support of this research



Thank you for attention

Tatranska Lomnica, 2021