Multicolor analysis of superhump activity of WZ Saggitae type variable TCP J23580961+5502508

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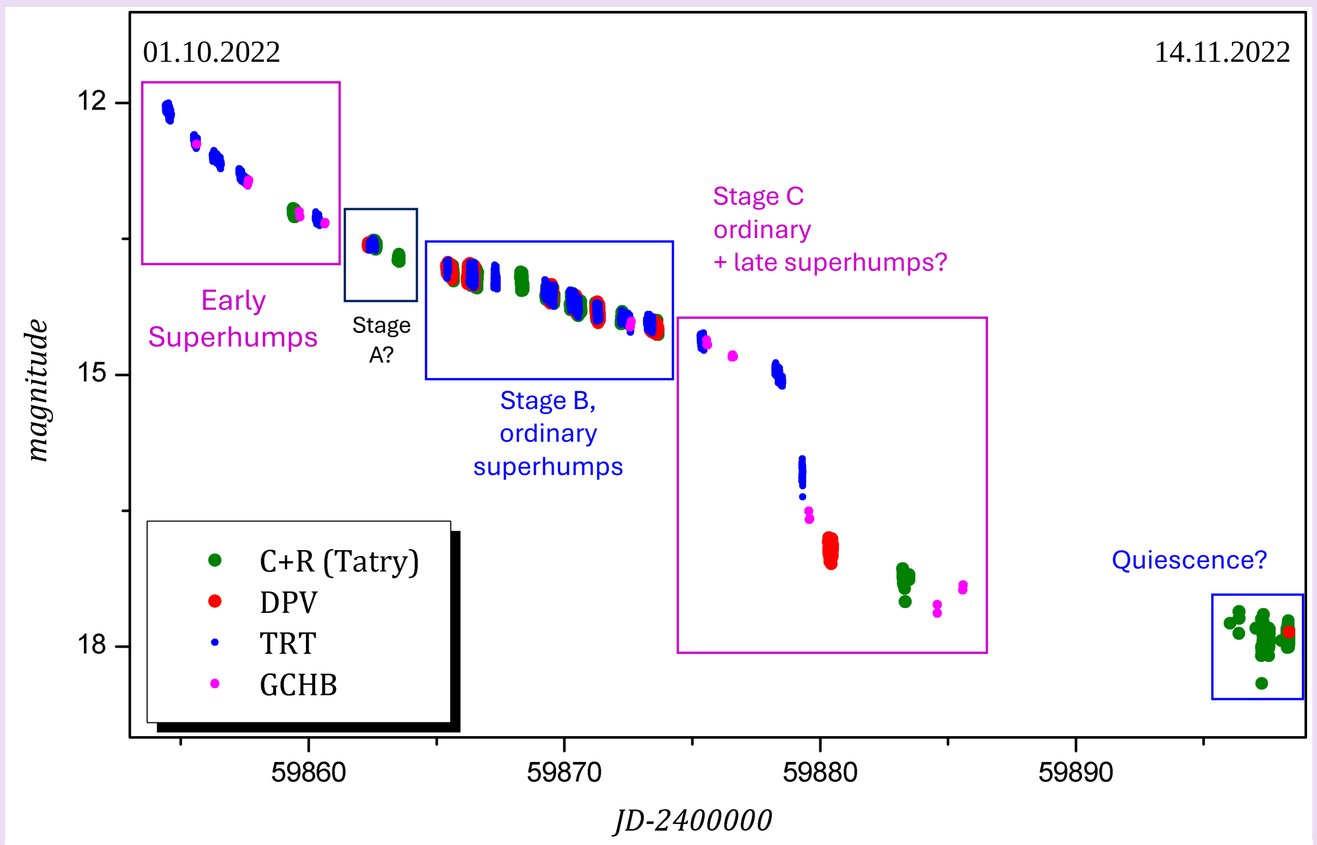
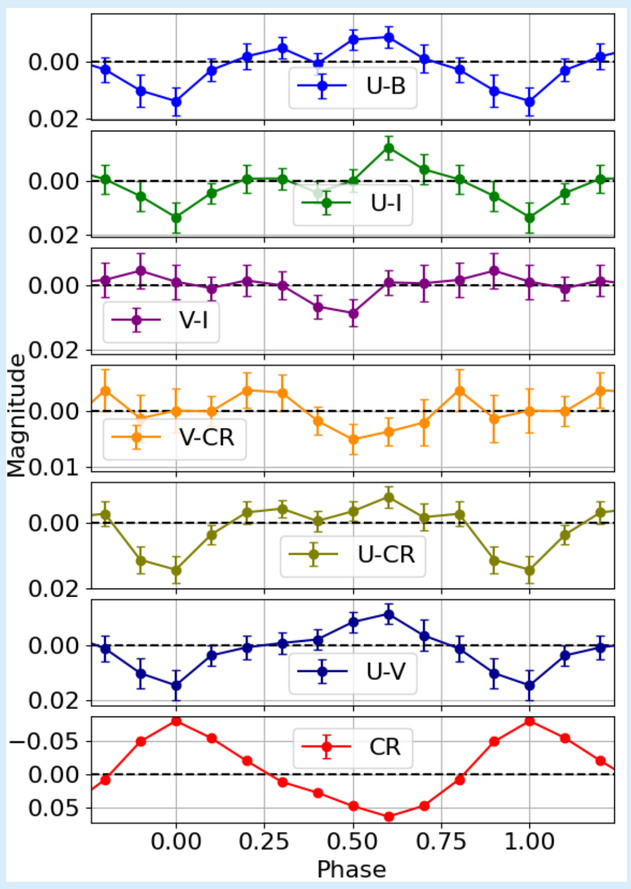
TCP J23580961+5502508 (Gaia22eci) was detected in the outburst in September, 2022. The UBVRI observations were made by using the 60cm telescope of the Astronomical Institute of Slovak Academy of Science. Using our photometric observations and AAVSO CCD-data, we studied superhumps evolutions from the early to late ones due to the precession of the accretion disk. Superhumps cyclicity changes displayed on O-C curves. Phase diagrams in different colors were constructed for selected nights with good coverage of observations and color indices (CI) curves were built by using the mean phase curves at the ordinary superhump stage and for selected "good" nights. The dependences of CI on phase show that during the ordinary superhumps near the superhump maximum, the colour indices U-V, U-I etc. have the largest values (Fig. a-b), i.e., the system is the reddest (according to these CI). Note that the CI curve changes for different nights (Fig. b): at the beginning of this stage the variations are minor, later the amplitude of CI increases, and by the end it decreases again. If we compare similar colour indices for RZ LMi of SU UMa subtype (Shugarov et al. 2018), the U-B values also show a similar course. Before the outburst maximum, these oscillations are not pronounced, further they develop, show the largest amplitude, and disappear at the end. The object SSS J122221.7-311525 showed a similar phase-dependent behaviour of the B-I colour index (Neustroev et al, 2017). Unfortunately, the authors did not make observations in the U band, but the variations of the B-I are small at the beginning of the outburst and in the quiescence, while during the outburst this CI shows the same behaviour as in the present research.



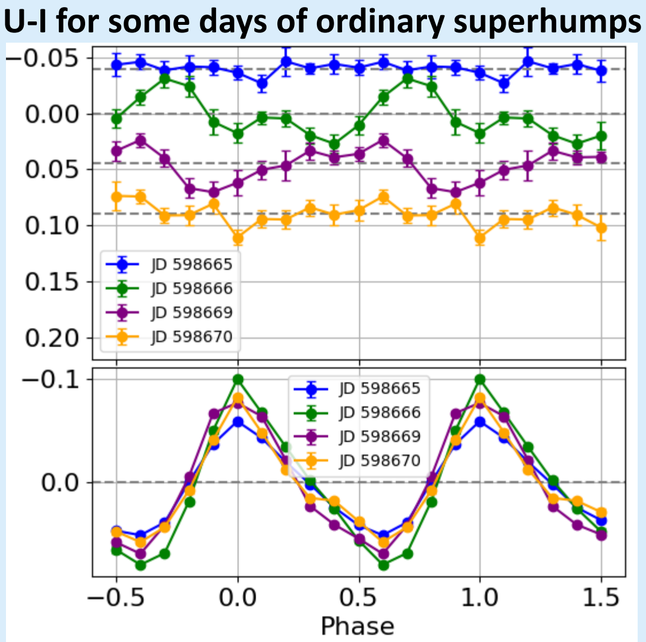
Light curve based on observations made by using the 60cm telescope of the Astronomical Institute of Slovak Academy of Science (Tatry), Kolonica Observatory (DPV=Pavol Dubovsky) and AAVSO observars Tordai, Tamás (TRT), Galdies, Charles (GCHB). All observations were corrected to R passband of Johnson-Cousins system.

Color indices changes:

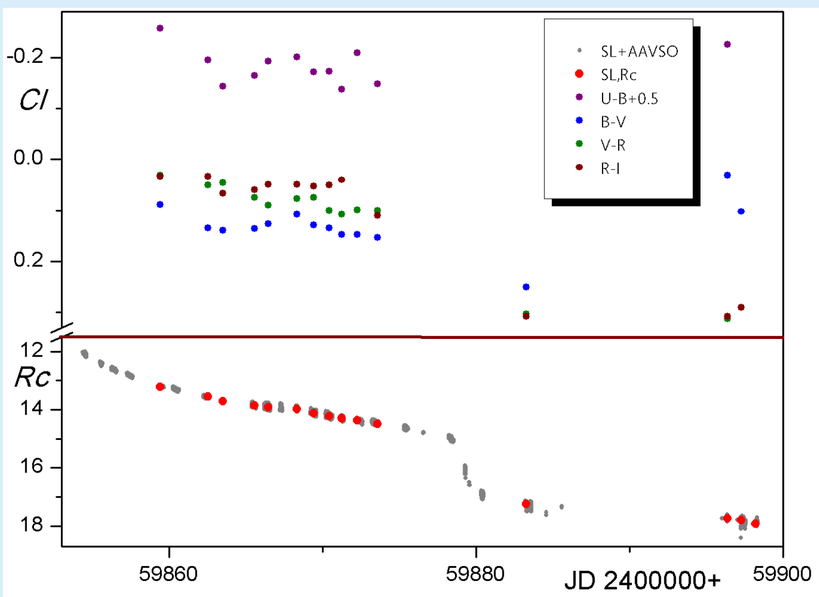
a) Average for ordinary superhumps



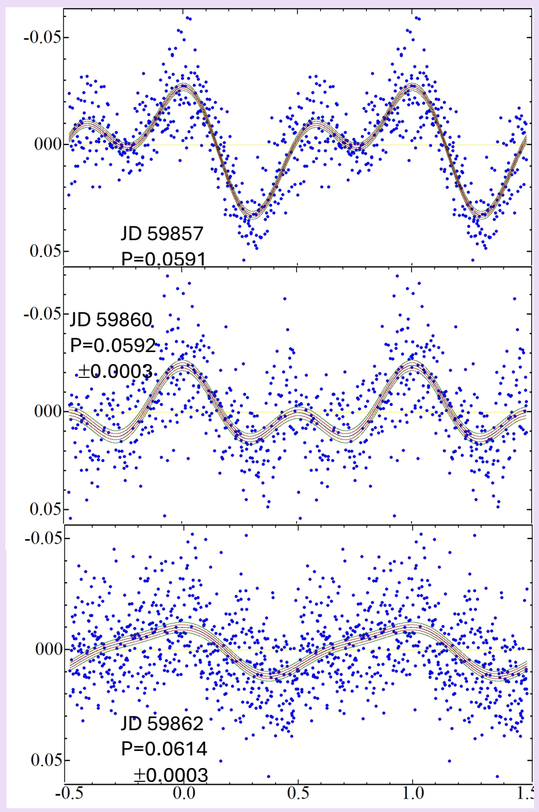
b) U-I for some days of ordinary superhumps



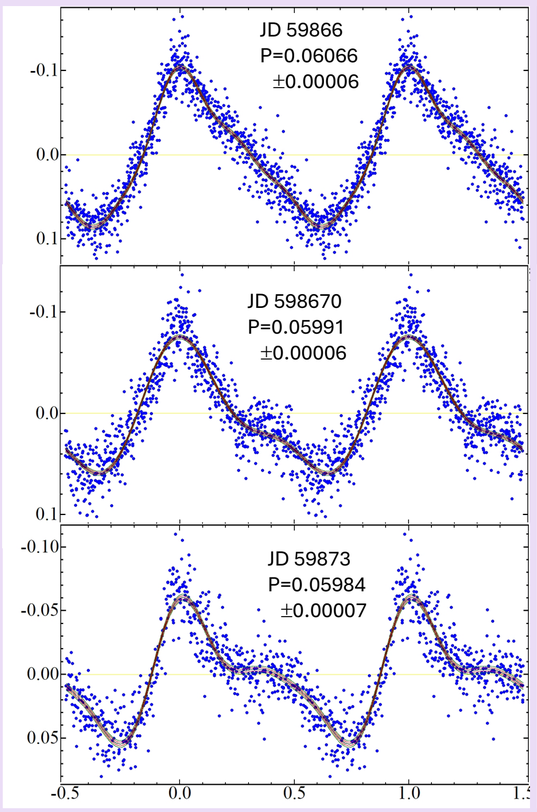
c) Night-average color indices



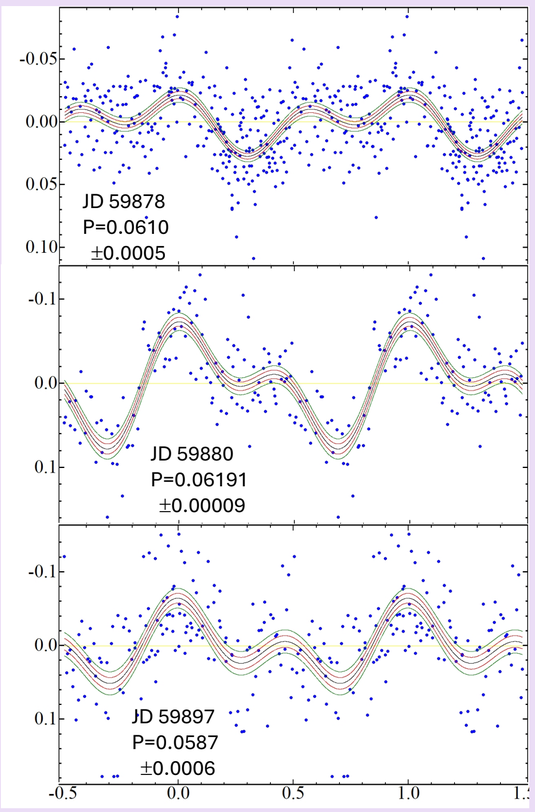
Early superhumps



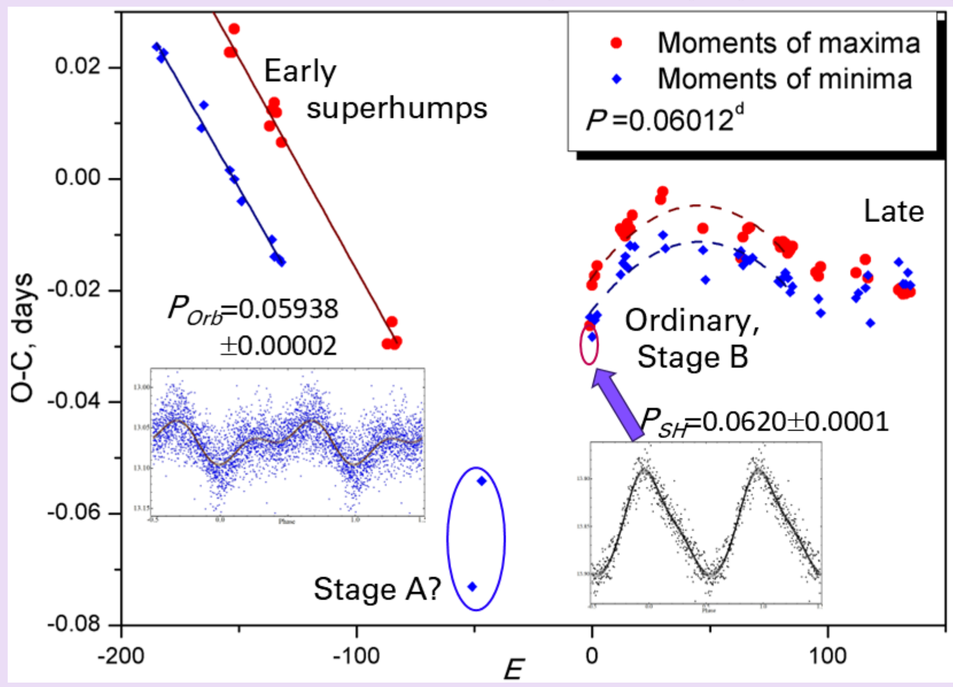
Ordinary superhumps



Late superhumps



O-C curves and superhumps period change parameters:



Period excess value:

$$\varepsilon^* = 1 - \frac{P_{Orb}}{P_{SH}} = 0.042$$

Period change rate (stage B):

$$P_{dot} = \frac{\dot{P}}{P} = -20.0 \cdot 10^{-5}$$

Mass ratio by using ε^* (Kato, Osaki, 2013, Kato, 2022):

$$q \simeq 0.13$$

The night-average CI variations also were studied from the maximum of outburst till quiescence (Fig. c). They show the reddening of the variable during the decline after outburst (because accretion disk is cooling) and they turn back to blue in quiescence due to increase the influence of hot WD and its surrounding.
Knowing the orbital period (0.05937) and the early shuperhump period at the stage B, we estimated some parameters of the binary system (Here we take M_{RD} = 0.078 M_{sun} for cataclysmic variables (Knigge et al., 2011))

Parameter	Value
P_{Orb}, days	0.05938 ±0.00002
$q=M_{RD}\,M_{WD}$	0.13±0.2
M_{WD}, M_{sun}	~0.6
a, a.u	0.0026±0.0002

References
Knigge, C., Baraffe, I., & Patterson, J. 2011, ApJS, 194, 28
Kato, T., Osaki J. 2013, PASJ, 65, 115
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Neustroev et al., 2017, MNRAS 467, 597.

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