



FOR OPTICAL FLICKERING IN SYMBIOTIC STAR MWC 560

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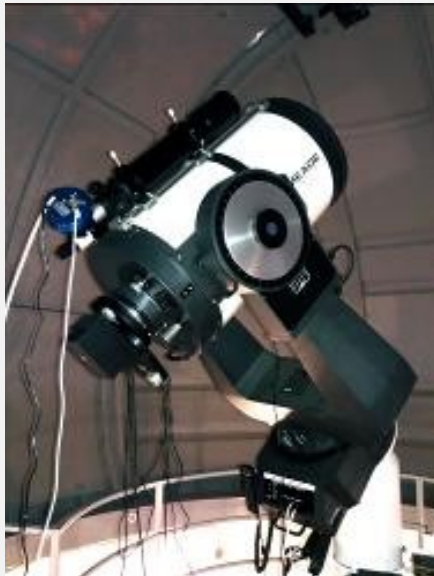


WHAT DO WE KNOW SO FAR ABOUT SYMBIOTIC STAR MWC 560 (V694 MON)

- Symbiotic binary consisting of a mid-M non Mira giant and an white dwarf [Lucy et al. 2020]
- Spectra showed mass ejection with velocities around 6000 km/s [Tomov et al. 1990].
- Optical flickering in all colors observed between 1984 and 2018 with a small exception in 2016.
- Flickering disappeared completely in October 2018 [Goranskij et al. 2018].
- V694 Mon never returned in state of rest but entered a state of continuous brightness increase modulated by different periodicities of 331 and 1860 days and possible 9570 days [Munari et al. 2016].
- In all spectral observations from 2016 until 2020 an Increasing brightness has been noticed that can suggest an expanding common shell of the system [Kazuko et al. 2021]. The formation of such a shell and partial or complete destruction of the accretion disk was also suggested by [Kondratyeva et al. 2021].
- A study of the brightness variability of MWC560, but in a short period of time- two months, was presented by [Munari 2021]. They report a peak of the brightness at 2021 October 27.

OBSERVATIONS

2m telescope with mounted ESPERO Echelle spectrograph



40 cm Schmidt-Cassegrain telescope with CCD



Journal of observations of MWC 560 with the 40-cm telescope of the Shumen Astronomical Observatory.

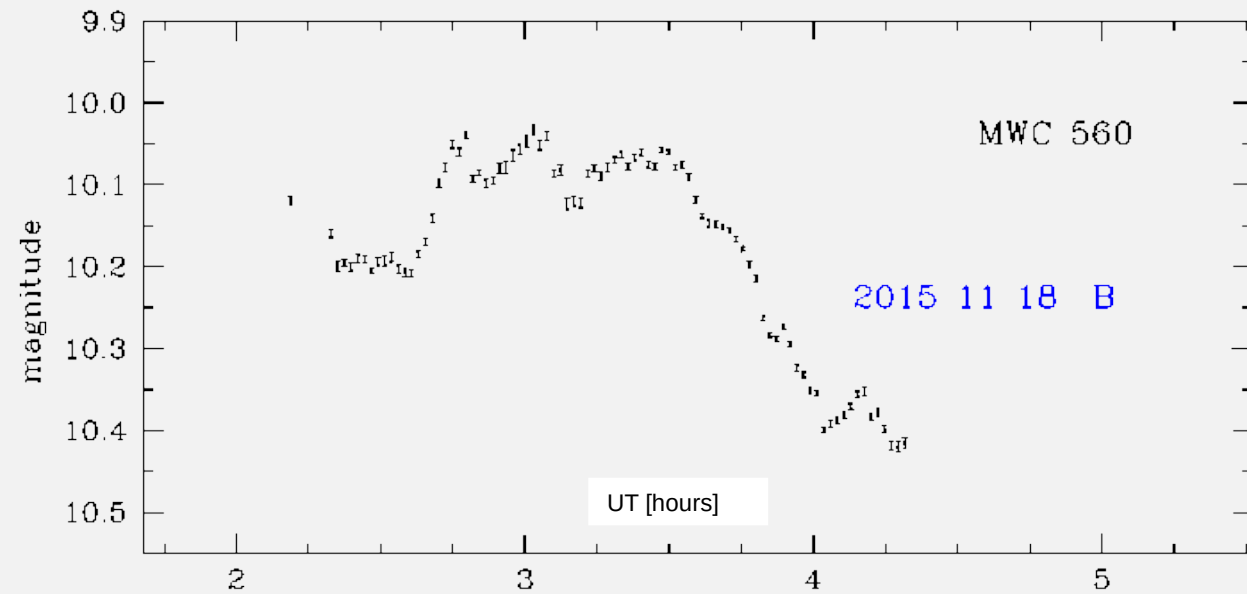
Date	band	UT start – UT end hh:mm – hh:mm	N _{pts}	average [mag]	σ [mag]	amplitude [mag]
28 November 2020	g'	0:12 – 3:32	263	9.096	0.006	< 0.04
	r'		264	8.490	0.007	
22 February 2021	g'	19:16 – 21:45	363	9.149	0.014	< 0.07
	r'		361	8.54	0.015	< 0.08
25 April 2021	g'	18:30 – 20:01	116	9.072	0.015	< 0.05
	r'		116	8.524	0.011	< 0.06
20 October 2021	g'	0:30 – 2:28	216	8.771	0.011	< 0.05
	r'		214	8.26	0.013	< 0.06
08 February 2022	g'	18:56 – 22:30	307	8.798	0.017	< 0.09
	r'		229	8.351	0.016	< 0.09
10 February 2022	g'	20:10 - 22:44	191	8.786	0.009	< 0.042
	r'	20:13 – 22:23	154	8.337	0.008	< 0.042
11 February 2022	g'	20:30 – 23:10	257	8.801	0.014	< 0.05
	r'		256	8.302	0.035	< 0.11

PHOTOMETRICAL STANDARDS USED FOR DIFFERENTIAL PHOTOMETRY

Label	Star ID	RA(2000)	Dec(2000)	g'	r'
C1	TYC 5396-491-1	07 26 00.69	-07 45 34.98	10.644	10.820
C2	TYC 5396-684-1	07 25 27.96	-07 44 41.84	9.013	7.913
C3	TYC 5396-916-1	07 25 43.28	-07 42 04.60	11.771	10.985
C4	TYC 5396-1090-1	07 25 58.36	-07 44 12.00	11.602	10.146
Chk	TYC 5396-1467-1	07 26 16.05	-07 50 10.14	10.315	9.360

We performed differential photometry using 4 standard stars. Their magnitudes above were taken from the catalogue APASS DR9 [Henden et al. 2015]. We transformed the data using equations from article [Kjurkchieva et al. 2020].

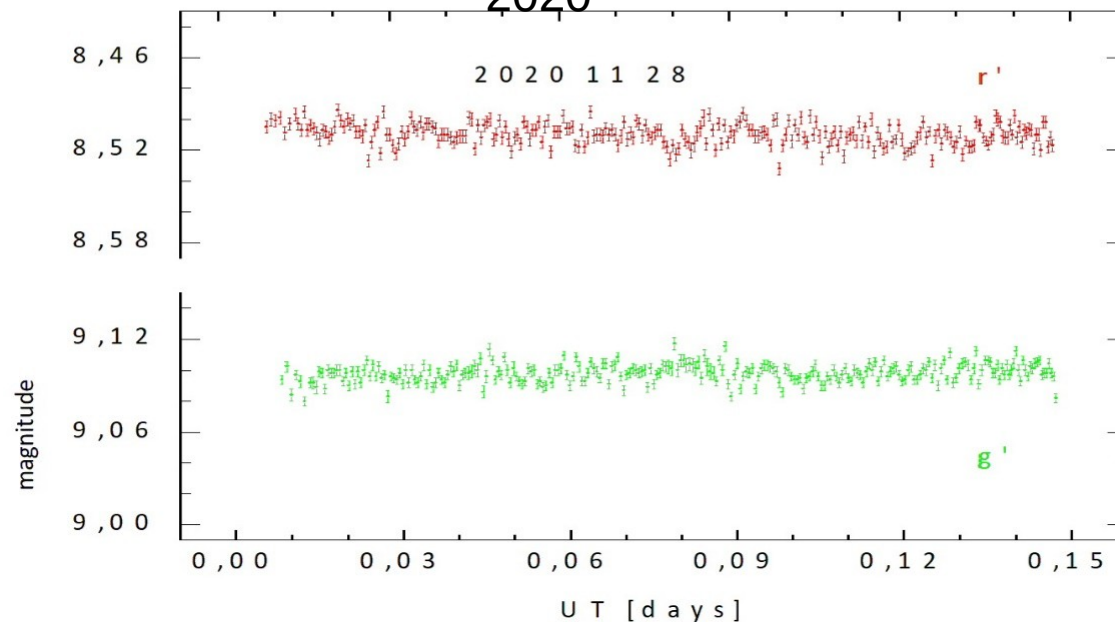
Rozhen 2015



On November 28, 2020, for a 3.5 hours long observation run, we obtained 263 points in Sloan-g' and r' bands. During our run, no variability with amplitude larger than 0.04 mag is visible. The mean magnitudes are $g' = 9.096 \pm 0.006$, $r' = 8.490 \pm 0.007$. Our first observations indicate that the optical flickering is still missing [Zamanov et al. 2020].

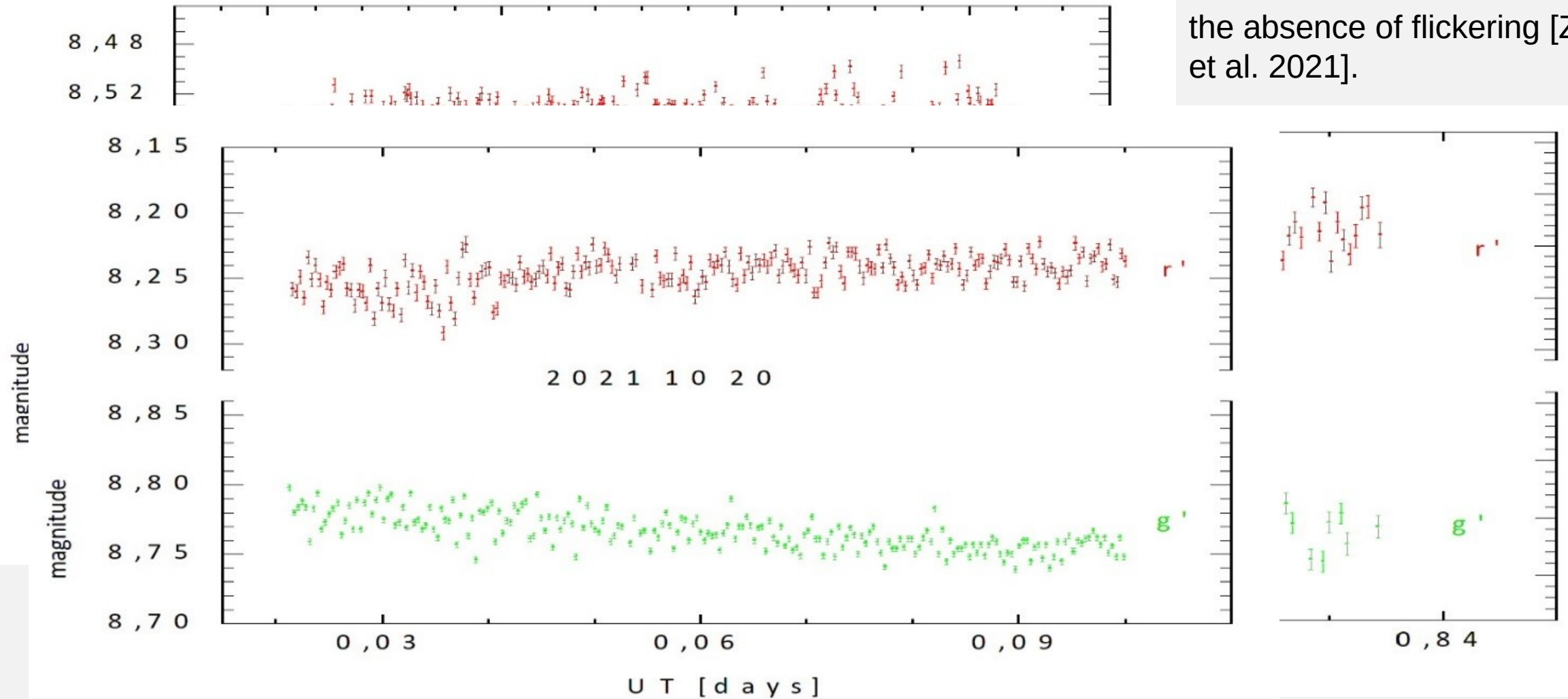
On November 18, 2015 visibly distinguishable flickering with amplitude 0.4 mag. This CCD photometry of MWC 560 was performed with the 50/70 cm Schmidt telescope at the Rozhen National Astronomical Observatory.

Shumen 2020

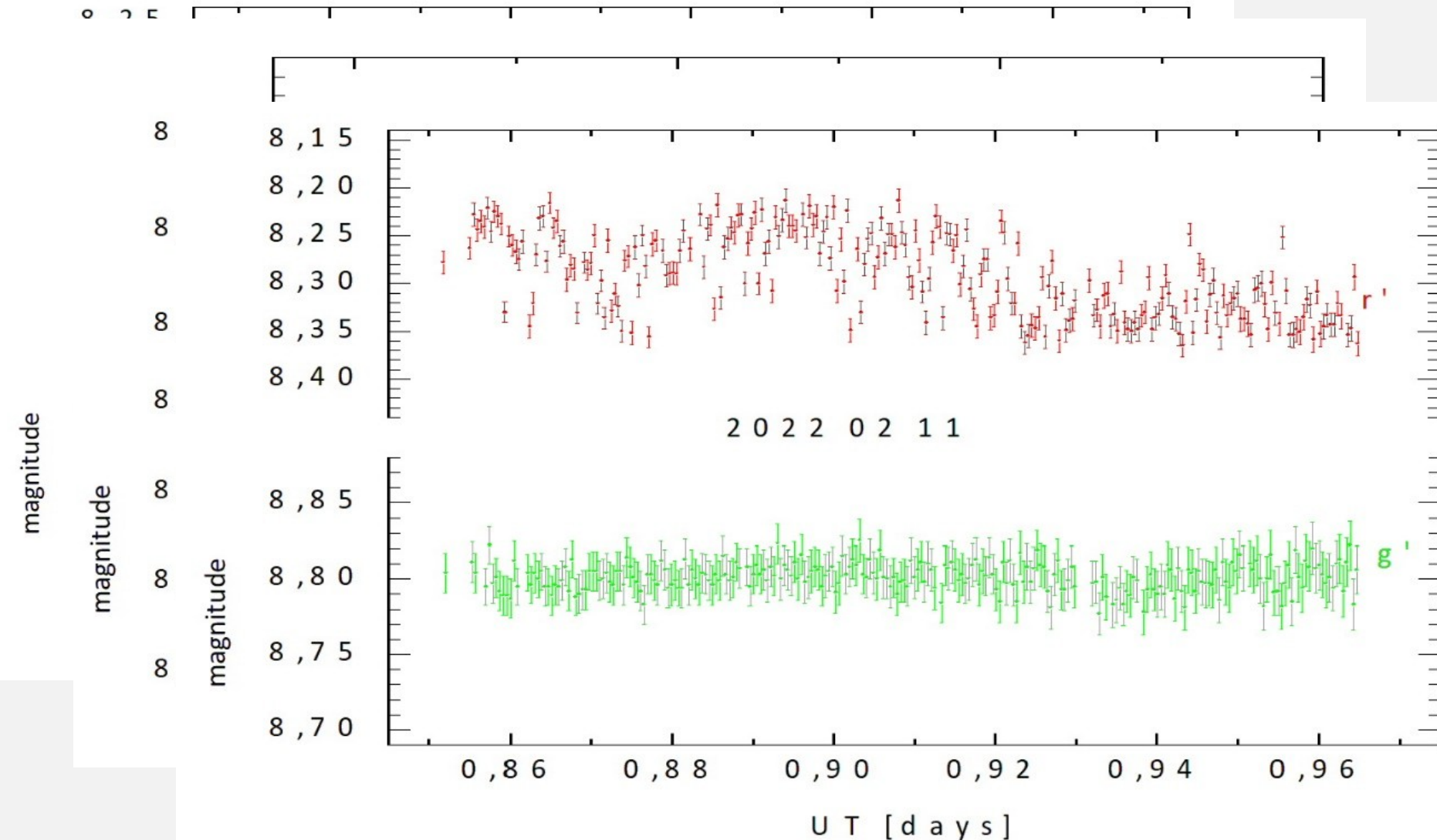


2021 OBSERVATIONS

These observations also confirm the absence of flickering [Zamanov et al. 2021].

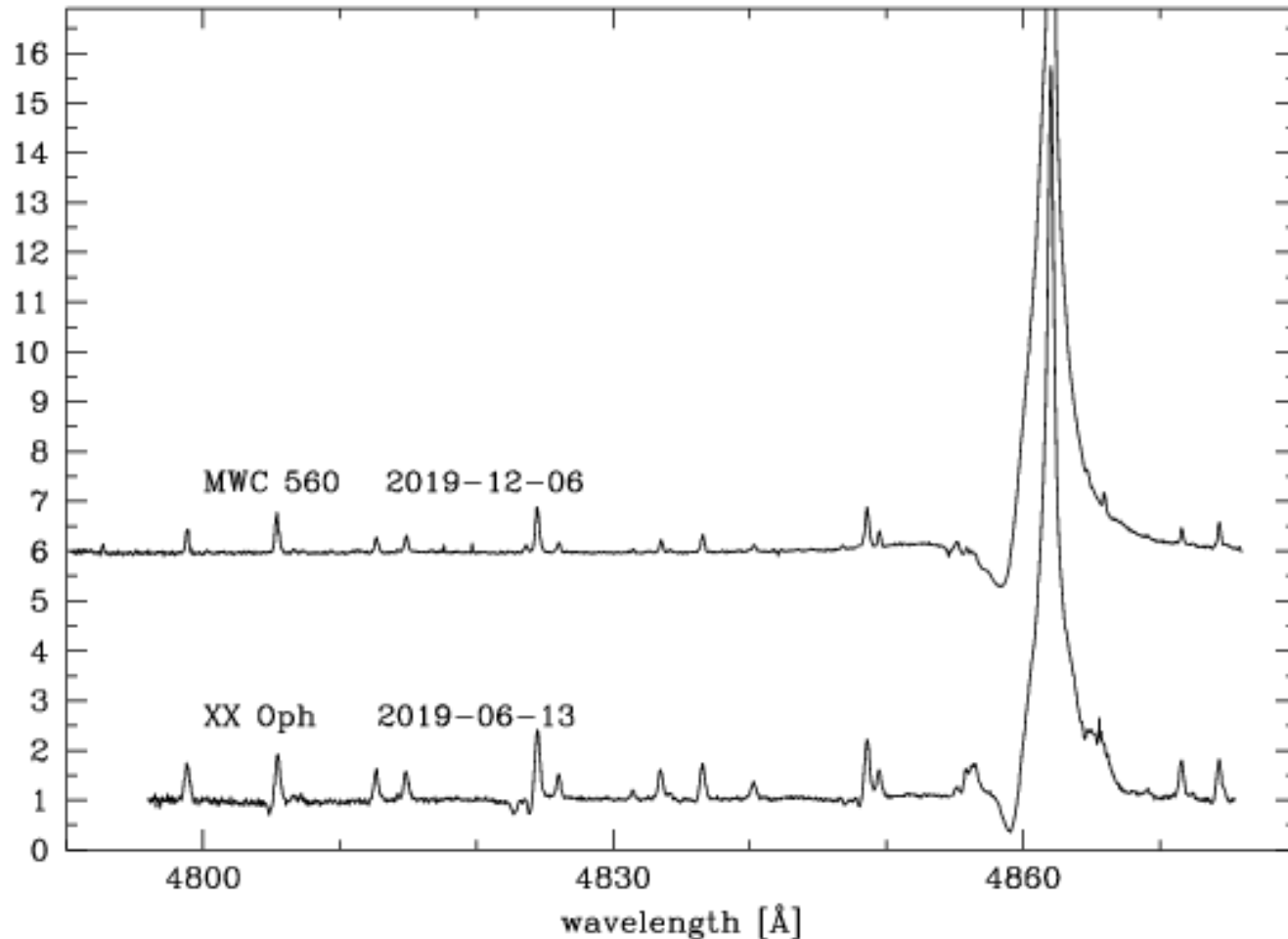


2022 OBSERVATIONS



In 2022 we have observed the star 3 times so far and we see absence of noticeable flickering and relatively high and constant brightness. This shows a continuous high state during 2022 in agreement with the findings of [Kondratyeva et al. 2021] for the period of 2018-2021.

COMPARING THE SPECTRA OF XX OPH AND MWC560



Almost identical spectra of the two systems. At the time when this spectrum of MWC 560 is obtained, the flickering was missing and it was probably in stage of formation of a common envelope due to the transit of the system to a dynamical mode of accretion with an increased rate [Goranskij et al. 2018].

XX Oph is one of the two stars listed as “Iron Stars” [Bopp, B. W., & Howell, S. B. 1989] due to the appearance of metal emission lines in its optical spectrum. There are no clear evidences about the components of XX Oph [Howell et al. 2009].

CONCLUSION

- Our observations show high brightness of the system with a peak at October 2021 in agreement with presented by [Munari 2021].
- Observations from February 2022 show high and constant brightness as well as absence of flickering. The increased brightness and lack of flickering is most likely caused by a wide common shell of the system which is hiding the accretion disk of the compact object. The spectra gathered by [Goranskij et al. 2021], in November 2021 also show fast changes which is in agreement with the idea for the common shell.
- From the similarities of the spectra of XX Oph and MWC 560 we can assume the first has the same components like the latter- a red giant and a white dwarf which are also surrounded by a common envelope. This similarity can be interpreted vice versa- in this stage of the evolution of MWC560, it is mimicking behavior of an “iron star”.

ACKNOWLEDGEMENT

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THANK YOU FOR THE ATTENTION!