

BRIGHTNESS VARIABILITY AT DIFFERENT TIME-SCALES OF THREE BINARY STAR SYSTEMS

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Introduction

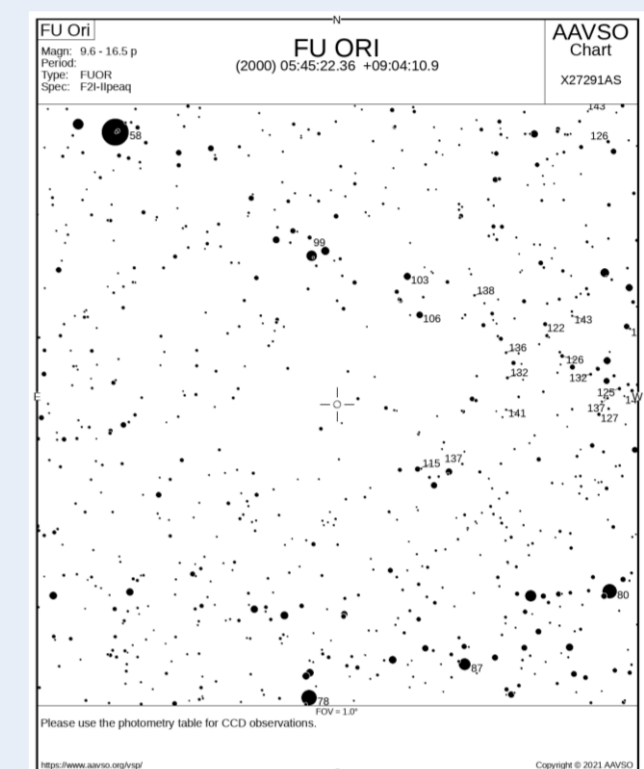
- We present a periodic and quasi-periodic variability in brightness of three binary stars: MV Lyr (Lyrae), ER Del (Delphinus) and FU Ori (Orion).
- Brightness variations are usually associated with fluctuations in light curves that appeared in numerous variable stars, with amplitude of a few 0.1 to 5 and more magnitudes on different time-scales, from seconds to days.
- In depends on these characteristics, the brightness variations could be delimited as flickerings, flares, bursts, outbursts.
- The flickering and flares are known as small-scale amplitude events, of 0.01 to 1 mag (Warner (1995) and Babtista & Bortoletto (2004)). The higher amplitude fluctuations of the bursts and outbursts: >2 magnitudes (Warner 1995, Bisikalo et al. 2003).
- The study of various types of brightness variation is important. The results give an information needed for further calculation of luminosity, stellar masses, radii and temperatures.
- On the base of the observational data, we calculate the color indices during the nights of the three objects high states. Using the B-V index, the color temperatures are calculated.

Objects' details

MV Lyr
Binary system;
 VY Scl subclass of Nova-likes stars (NLs);
 $T_{wd} \approx 50000K$
 $P_{orb} \approx 3.19h$
 $q = 0.4$ (Skillman et al. 1995)
 $t_{sc} \approx q_{po} \approx 10s$ min

ER Del
Binary system;
 Symbiotic binary; Z And type;
 Giant cool companion - S5.5/2.5 (Ake 1979)
 $T_{eff} \approx 3470 - 3500 K$ (Boffin et al. 2014)
 $P_{orb} \approx 2089$ days

FU Ori
Binary system; variable YSO;
 $M_1 = 1.02M_{\odot}$
 $M_2 = 0.5M_{\odot}$ (Hartmann & Kenyon 1996)
 $M_{disc} \approx 10-20 M_{\odot}$ (Liu et al. 2018)
 $R_{disc} \approx 10s$ AU



Results

1. Observational data and light curves of MV Lyr, ER Del and FU Ori.

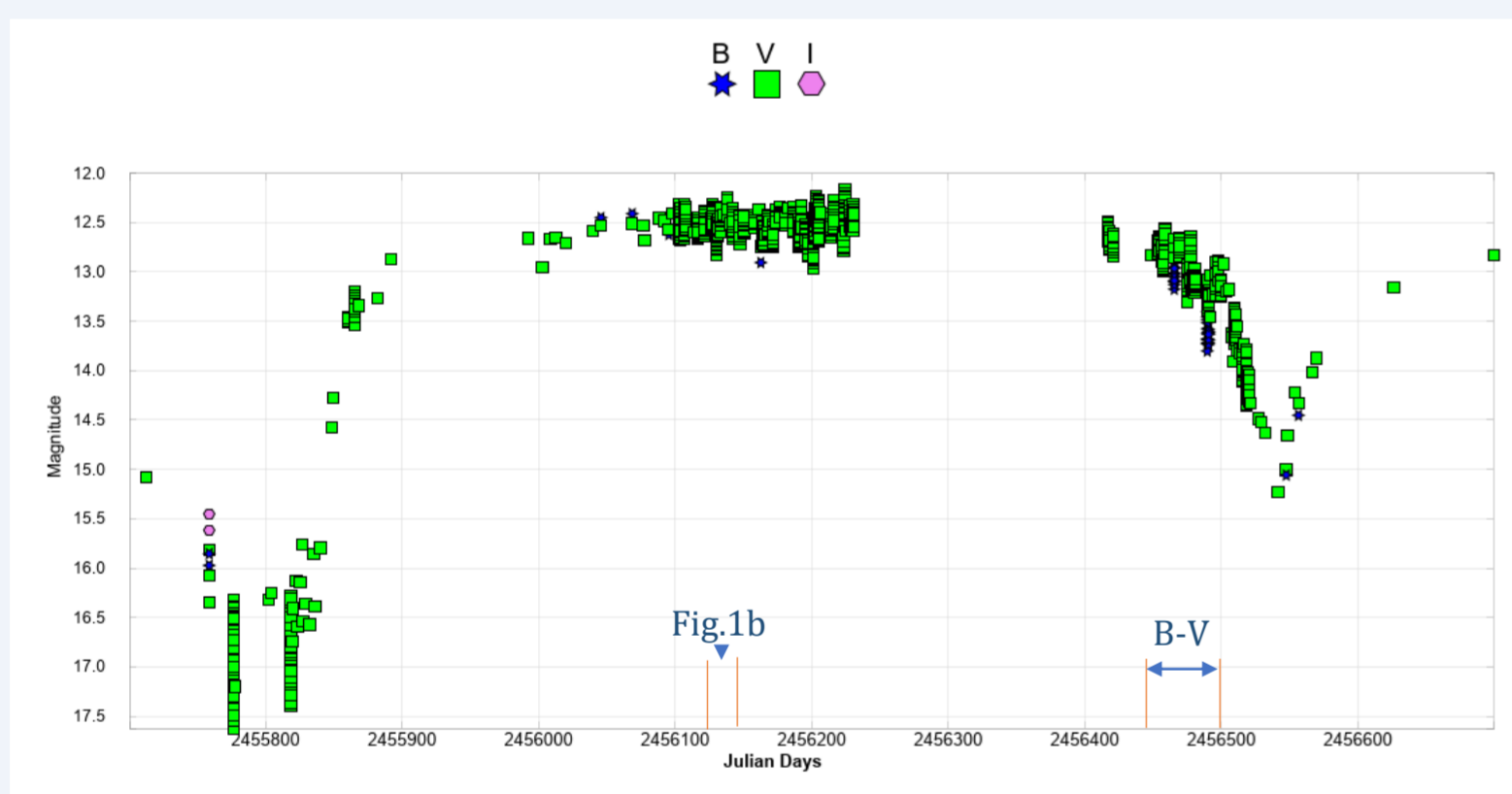


Fig. 1a. Light curve of MV Lyr in B and V bands: Observational period: 2011/03/29 - 2012/11/18. (AAVSO data, Observers' Codes WGR, PVEA, LMJ.)

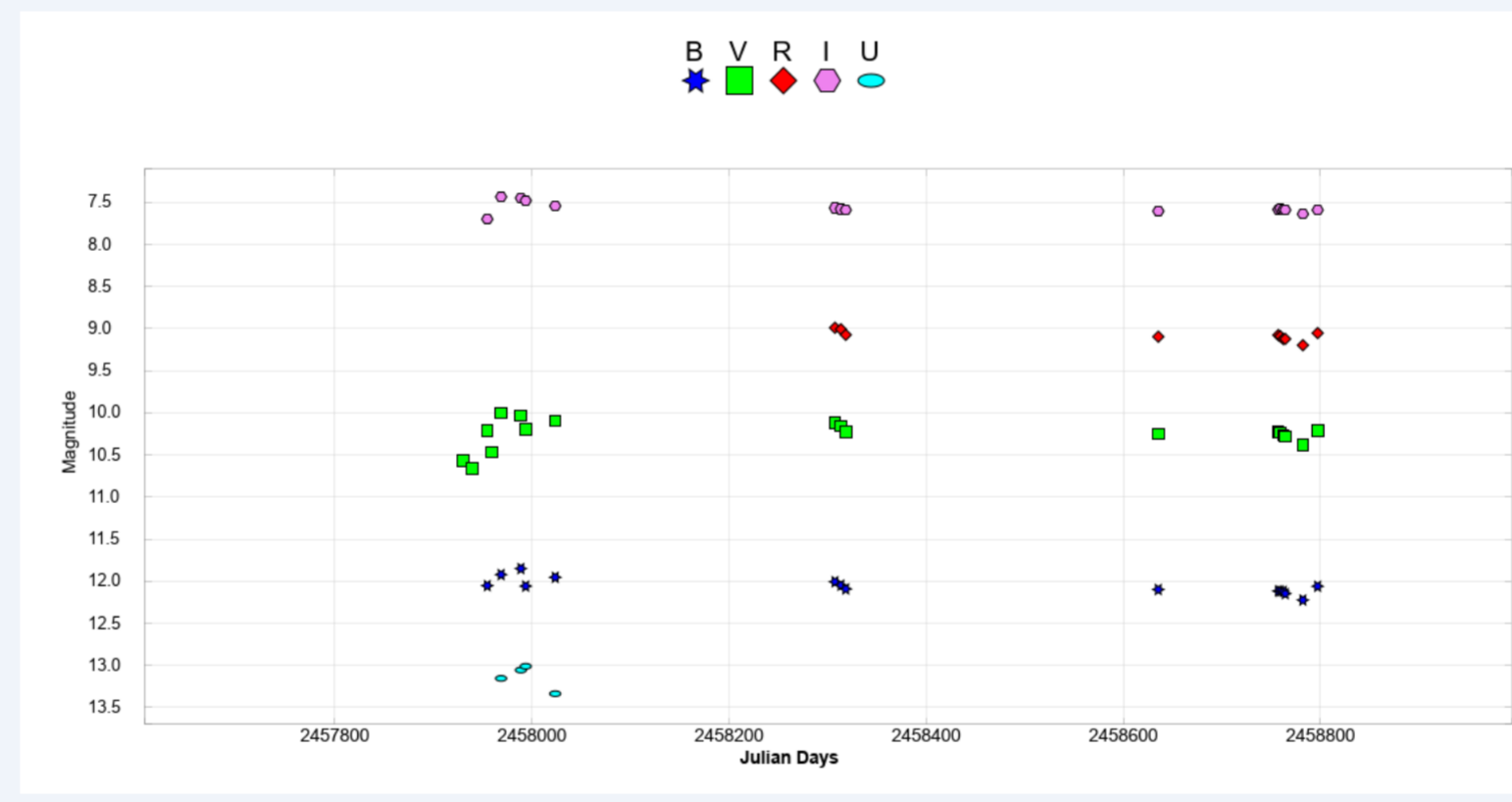


Fig. 2. Light curve of ER Del in UBVR bands. Three months variability: JD 2457920 - 2458040. The entire observational period: 2016/07/30 to 2020/05/30. (AAVSO data, Observer's Code GCO, SRIC, AAUA.)

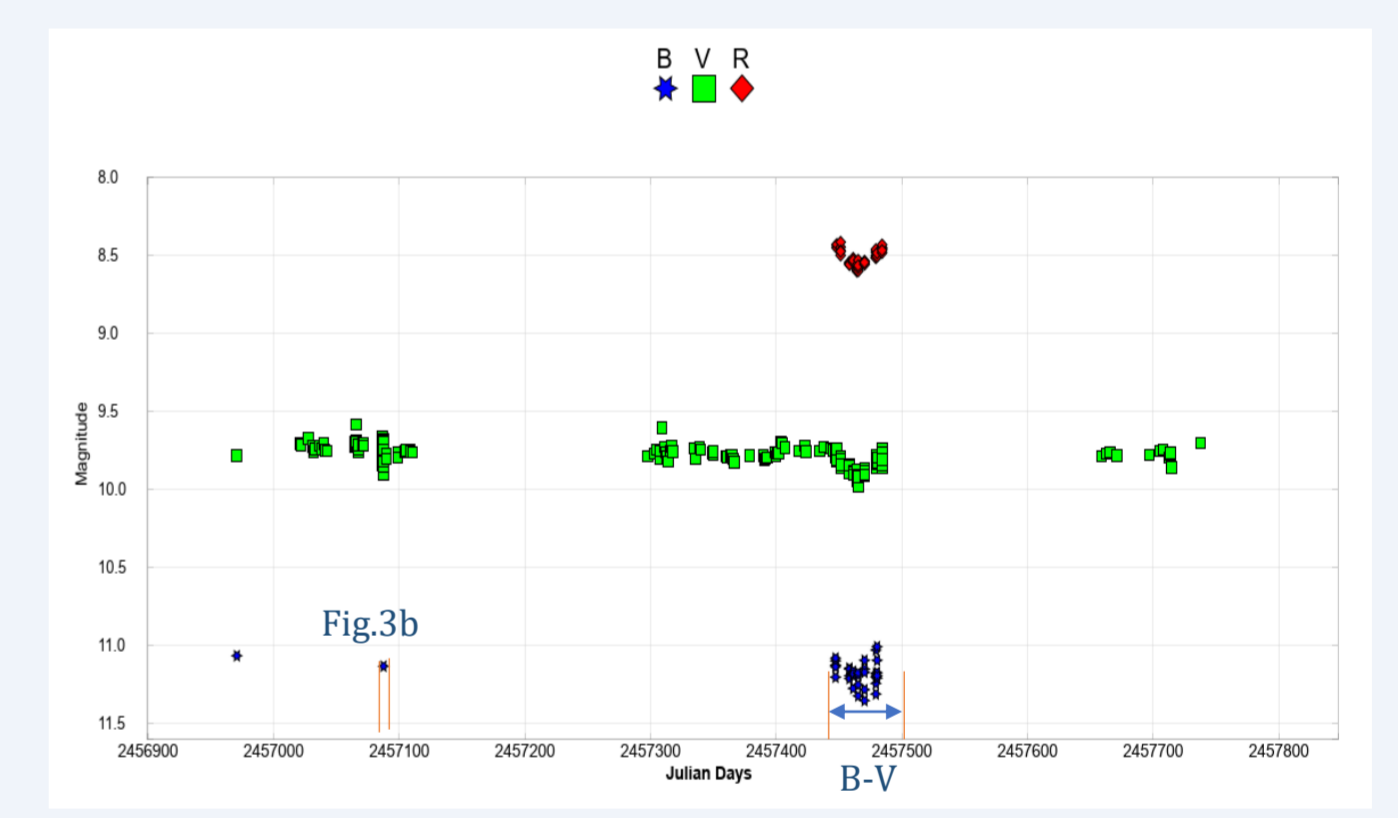


Fig. 3a. Light curve of FU Ori. Variations in BVR bands. Observational period: 2014/07/11 to 2017/04/06. (AAVSO data, Observer's Codes DKS, DUBF, HBB, SAH)

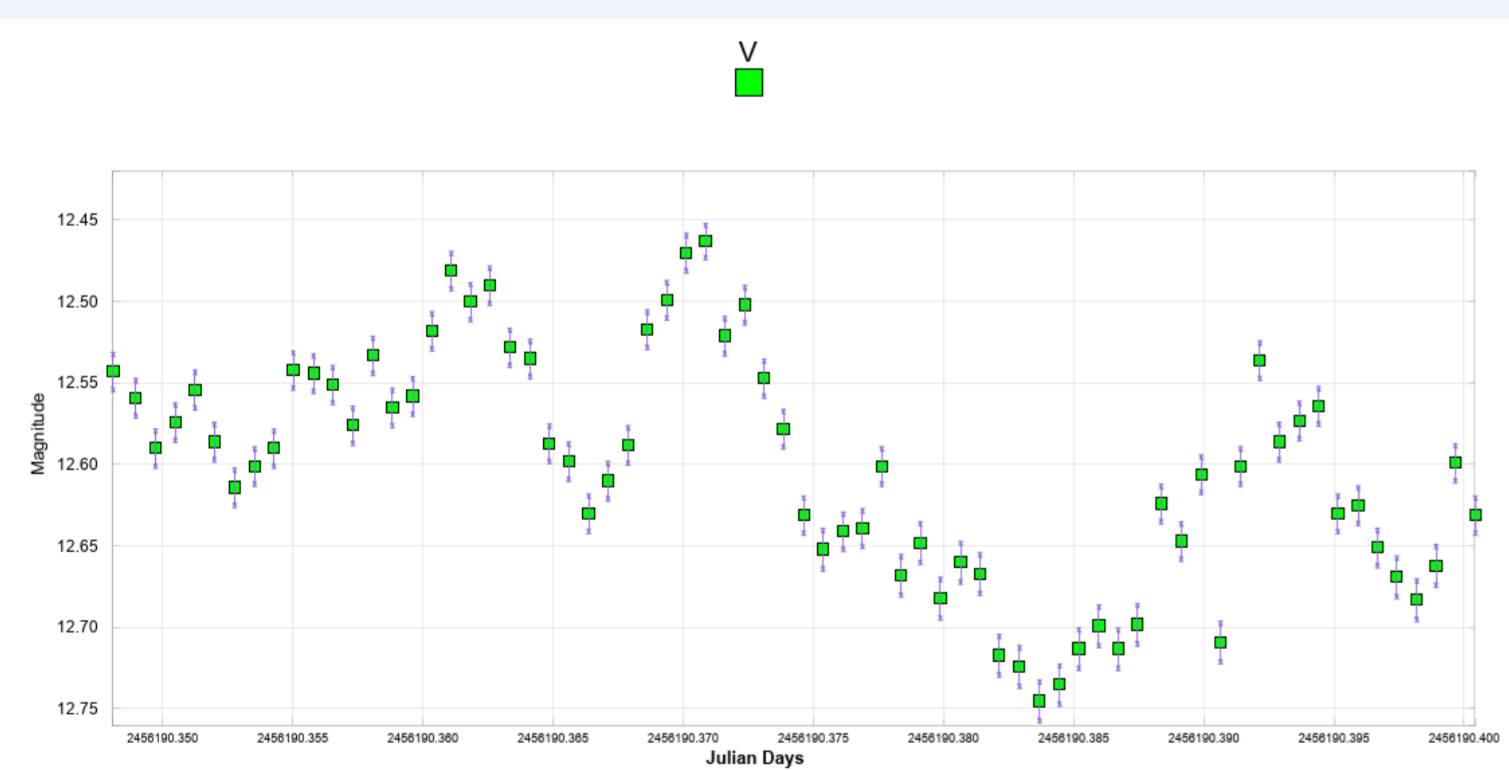


Fig 1b. Light curve of MV Lyr. The figure shows a close up view of the figure 1a, the brightness variability in one night, in V band. Observational period: UTC 2012/09/19 20:21:16 - 2012/09/19 21:36:37 (AAVSO data, Observer's Code ATE.).

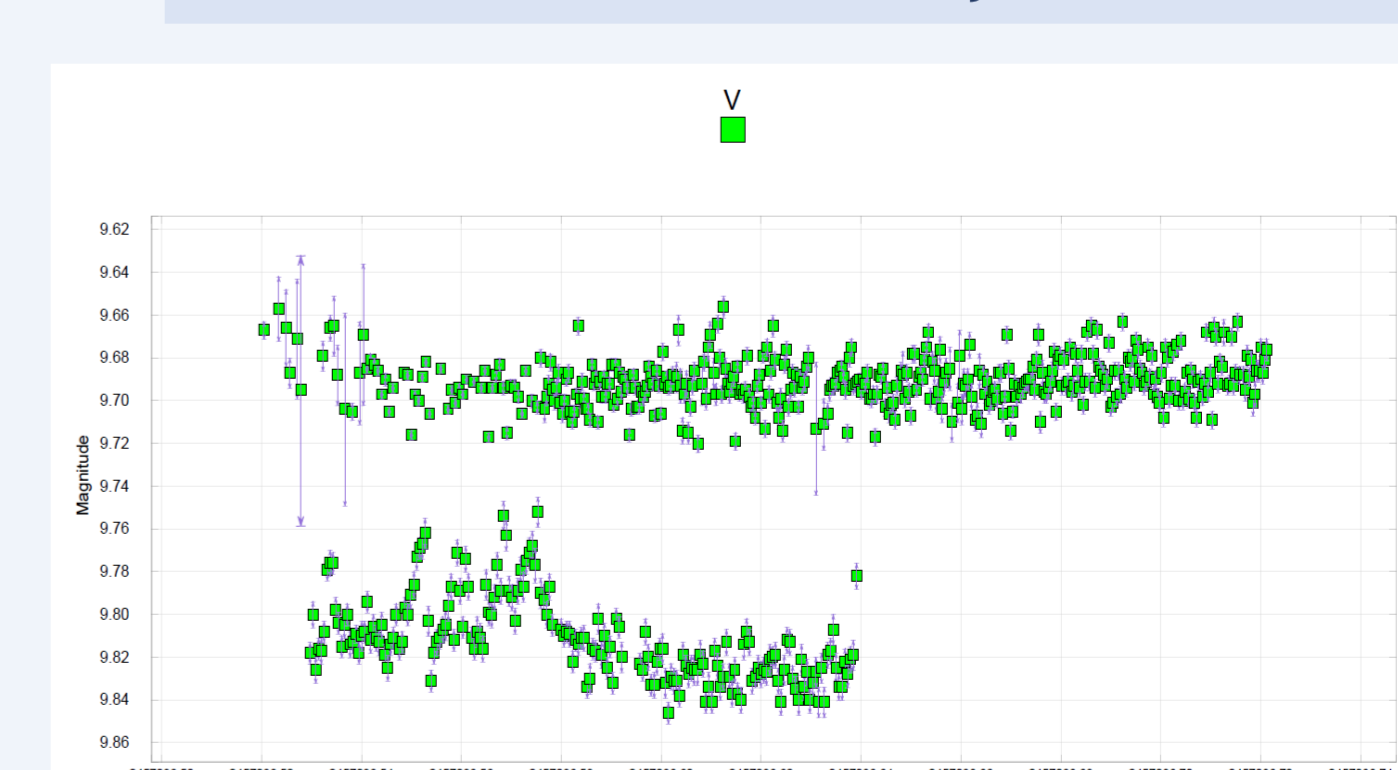


Fig. 3b. Light curve of FU Ori. A close up view of the variations in V bands. Observational time during the night: 2015/03/05 00:28 - 2015/03/05 05:45 UTC. (AAVSO data, Observer's Codes DKS, DUBF, HBB, SAH)

Color index (B-V) and the temperature Tcol

Parameter Object	B-V (min) [mag]	B-V (max) [mag]	Tcol (min) [K]	Tcol (max) [K]
MV Lyr	0.41 ± 0.005	0.32 ± 0.005	$6827K \pm 0.0006$	$7337 K \pm 0.0005$
ER Del	1.56 ± 0.12	1.92 ± 0.1	$3254 K \pm 0.002$	$3705 K \pm 0.0009$
FU Ori	1.37 ± 0.07	1.21 ± 0.07	$4000 K \pm 0.0006$	$4289 K \pm 0.0006$

Concluding remarks

The results show, the color in the selected observational intervals of MV Lyr and ER Del is rather red and the corresponding objects' temperatures are not very high. We compare the properties of the brightness variability events for the three objects. We conclude that it partially depends on the physical nature of the each of the objects, due to their different types of stars.

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