COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 5540

Konkoly Observatory
Budapest
24 June 2004
HU ISSN 0374 – 0676

ABNORMAL COLOUR VARIATIONS OF THE CLASSICAL T TAURI STAR: SU Aur

PUGACH, A. F.

Main Astronomical Observatory of NASU, Golosiiv, Kiev-127, 03680; e-mail: pugach@mao.kiev.ua

SU Aur is an Orion-type (Classical T Tauri) variable star of relatively later spectral type F5-G2 CIIIe. A histogram of V-magnitudes shows that the most time the star is bright. Sometimes the star brightness fades, amplitude of the Algol eclipse-like fadings reaching up to 1.5-2.0 of magnitude. The photometric properties of the star are properly described in a recent paper by DeWarf et al. (2003). The brightness fadings of Orion-type variables are most likely caused by circumstellar dust clouds orbiting or emerging near the star. While an Orion-type star is fading, the colour index $B-V$ increases and the star becomes "redder". The positive interrelation between the V-magnitude and colour index $B-V$ is a typical characteristic of the stars with Algol-like minima (except for deep minima where so-called "zodiacal light" (Grinin, 1988) appears). As for SU Aur, such a dependence found from our observations (Pugach, 1996), is shown in Fig.1.

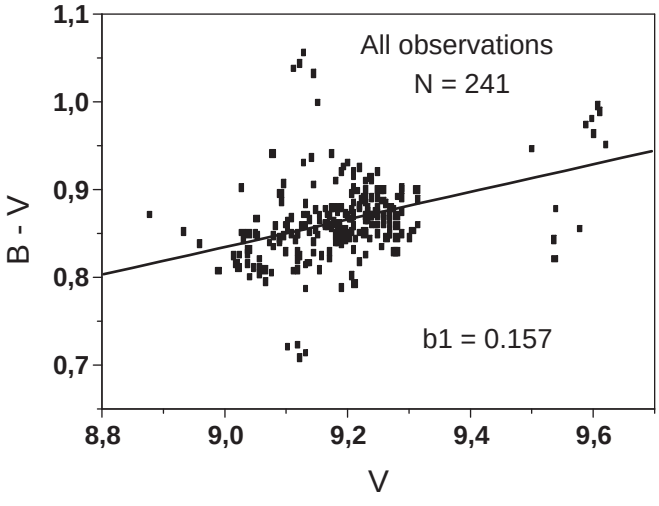

Figure 1. All observations of SU Aur obtained by the author during 1974 - 1985

An analysis of our observations of the star allowed us to identify a new type of photometric variability for SU Aur. Rapid, small amplitude brightness variations at maximum light are observed accompanied by a reverse $V-(B-V)$ relation. During this process

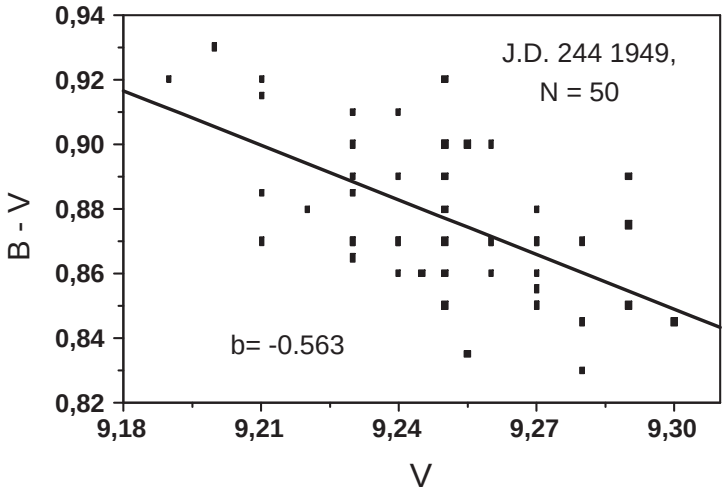

Figure 2. Abnormal $V-(B-V)$ relation for SU Aur. Observations were made at interval J.D. 244 1949.462 - ...1949.577

the colour index $B-V$ increases as the star becomes fainter. Our observations on J.D. 2441949, shown in Fig.2, support this contention. We refer to this effect as the "colour abnormality".

For this colour abnormality the coefficient b in the linear equation:

$$(B-V) = a + bV$$

always shows negative values. For all but one night of our observations when the number (n) of individual observations n≥5, the coefficients b shown in Table are negative.

J.D. 244 0000+	b	N	Δ m
...1949	-0.563±0.110	50	0.11
...1953	0.062±0.789	8	0.03
...1958	-0.620±0.724	6	0.02
...4152	-0.884±0.552	5	0.07
...4280	-0.162±0.109	30	0.09
...4281	-1.346±0.549	7	0.05
...5028	-0.311±0.688	6	0.033
...5033	-0.117±1.926	5	0.021

Photoelectric observations of SU Aur secured by others show similar behaviour. In Fig. 3, the results from the analysis of recent photometry of DeWarf et al. (2003) observations are shown. Although these observations were performed in the Strömgren photometric system, they may well be compared with our UBVR measurements as the effective wavelengths of photometric bands v and y of the Strömgren system are close to bands V and B of the $UBVR$ system. Statistical analysis of the data (DeWarf et al., 2003) reveals that the coefficient b is predominantly negative and has positive values only in 7 cases of 89 nights of observations analyzed, and in 3 cases it was close to zero.

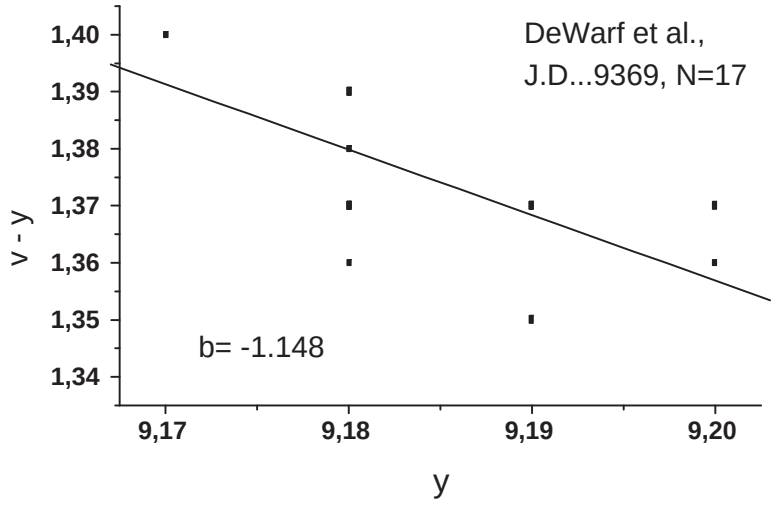

Figure 3. Abnormal colour relation found from the analysis of *uvby* observations of De Warf et al., 2003.

The abnormal colour variations considered are also evident from Zaitseva's (1968) observations (Fig. 4) and from the observations of Herbst et al. (1982) (Fig. 5).

SU Aur is the second related T Tauri variable star showing these abnormal colour variations. Identical abnormal colour variability was previously detected for the T Tau star BO Cep, when it was found to show similar photometric behaviour (Pugach, 2003). The analysis of the BO Cep photometry shows that the unknown agent causing the colour abnormality acts primarily in the photometric V-band. The behaviour of SU Aur is also consistent with this conclusion. Analysis of the SU Aur $UBVR$ observations (Herbst et al. 1982) shows that the colour index $V - R$ varies inversely as $B - V$ (Fig. 5). It's possible only if the abnormal colour variations originate from the changing the V-value solely. Thus, two similar stars BO Cep and SU Aur (considering their spectral and variability types) demonstrate the newly found colour variation abnormality. There is no obvious way to account for it neither by temperature variations nor by changes of the dust extinction. In addition, it is of special interest that the colour abnormality appears to result from changing the brightness of the star in the V band.

Reasons for such colour behaviour of SU Aur are now unknown. The simplest suggestion is that the colour abnormality reflects a process of mineral dust formation and subsequent dissipation.

Acknowledgements: I wish to thank Dr. DeWarf for his kind permission to use his unpublished observational material.

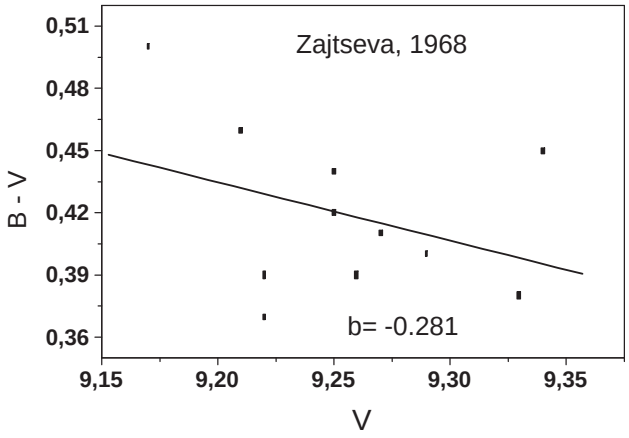

Figure 4. Abnormal colour relation from Zaitseva's observations (1968).

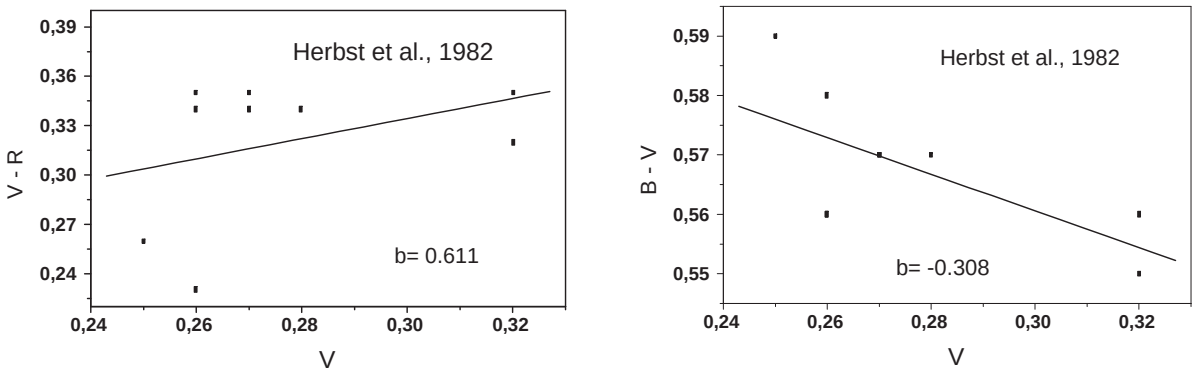

Figure 5. Data of Herbst et al. show that colour indexes $B-V$ and $V-R$ vary with opposite signs. It points out that radiation responsible for abnormal colour variability originates in the V band.

References:

DeWarf L.E., Sepinski J.F., Guinan E.F. et al., 2003, *ApJ*, **590**, 357
Grinin V.P., 1988, *Pisma v Astron. Zh.*, **14**, 65
Herbst W., Holtzman J.A., Phelps B.E., 1982, *AJ* **87**, 1710
Pugach A.F., 1996, *Peremennye Zvyozdy*, **23**, 391
Pugach A.F. 2003, *Kinematika i Fizika Nebesnyh Tel*, **19**, 235
Zaitseva G.V. 1968, *Peremennye Zvyozdy*, **16**, 435