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FLARES IN THE ACTIVE GIANT V390 Aur

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V390 Aur = HD33798, an approximately 7th magnitude G8III star was found to flare on January 1, 1998 and February 22, 1998. Fekel & Marschall (1991) classified the star as a chromospherically active single giant. They pointed out to the moderately strong Ca II K & H emission cores and periodic photometric variability for it. No flare events were reported for this star up to now.

We carried out observations of this star with the 60-cm telescope at Belogradchik Observatory and a single-channel photoelectric photometer attached. The equipment is described in Antov & Konstantinova-Antova (1995). UBV measurements and U-filter patrol monitoring with an integration time of 1 sec were done. The standard deviation of random noise fluctuations σ was in the interval $0^m_.01$–$0^m_.02$. The differential photometry method was applied with HD34533A as a comparison star. The data processing with the program package APR (Kirov et al. 1991) was done.

Short-lived flares were detected during $23^h58^m55^s$ total effective monitoring time obtained in the period December 30, 1997–March 3, 1999. More than 9 such events are observed during 2 nights. The longest event duration is 11 sec and the shortest one is 1 sec. The largest detected amplitude is $0^m_.29$. Data for the flares are presented in Figures 1 and 2 and in Table 1. The inspection of the UBV light curves obtained by us (Fig. 3) shows that the appearance of flares independent from the brightness of the star in these bands.

Van Biesbroeck (1974) reported about a $3^m_.3$ fainter secondary star located at 0.4 arcsec away of V390 Aur. The Hipparcos mission confirmed his measurement. The components cannot be separated in the photometer diaphragm, that is why they are observed together with our equipment. But taking in mind the event durations, the shape of their light curves and the secondary star magnitude, we came to the conclusion that it is more likely these events to happen on the primary star, V390 Aur, in spite of the possibility such ones to occur on the secondary star could not be ruled out completely. If we assume that flares with such resulting amplitudes are produced by the secondary star, then their real amplitudes should be $\geq 1^m_.5$. Flares with U-amplitude of approximately $1^m_.5$ and a duration of the order of 10 sec were detected on active red dwarf stars. However, a set of events having similar characteristics occurs very rarely. We have not observed such ones during our long practice as flare star observers.

If we consider the detected flares as a manifestation of the giant chromospheric activity their properties should be explained, in particular, by analysing the general differences

Table 1: Data for the observed events.

Date	Event No.	Δm_U	σ	U.T. beginning	Duration [sec]
January 1, 1998	1	$0\overset{m}{.}12$	$0\overset{m}{.}015$	$20^h47^m33^s$	11
	2	$0\overset{m}{.}18$	$0\overset{m}{.}015$	$20^h47^m57^s$	1
	3	$0\overset{m}{.}17$	$0\overset{m}{.}015$	$20^h48^m12^s$	9
	4	$0\overset{m}{.}14$	$0\overset{m}{.}015$	$20^h48^m53^s$	9
	5	$0\overset{m}{.}13$	$0\overset{m}{.}015$	$20^h52^m08^s$	3
	6	$0\overset{m}{.}06$	$0\overset{m}{.}015$	$20^h52^m45^s$	11
February 22, 1998	1	$0\overset{m}{.}29$	$0\overset{m}{.}02$	$21^h24^m05^s$	6
	2	$0\overset{m}{.}18$	$0\overset{m}{.}02$	$21^h24^m10^s$	2
	3	$0\overset{m}{.}12$	$0\overset{m}{.}02$	$21^h24^m12^s$	4

between the giant atmosphere and those ones of the active dwarf stars. The giant atmosphere is less dense with a smaller gravity. This fact implies smaller density and larger sizes of the active areas in giant stars. The Hα behaviour of V390 Aur, reported by Strassmeier et al. (1990) and our high-resolution (0.2 Å) Hα observations, obtained during 6 nights in the period August 26, 1996–February 18, 1998 with the 2-m RCC telescope and CCD camera mounted on the Coude spectrograph at the Rozhen Observatory are in agreement with the above mentioned speculations. Hα is a normal absorption feature and is not collisional dominated as it is in the active dwarf stars (Cram & Mullan 1985, Houdebine & Stempels 1997). Let us recall that Fekel & Marschall (1991) reported moderately strong Ca II K & H emission cores for V390 Aur.

Following the solar paradigm we must point out that the early analyses of the hard X-ray emission (Van Beek et al. 1974, De Jager et al. 1976) revealed that the impulsive phase of a solar flare consists of a number of events with a duration of few seconds, the so-called elementary flare bursts. Evidence for quasiquantization of energy release in solar flares is presented in Kaufman et al. (1980). The rapid variations detected in the millimeter-wave radio flux are interpreted as an effect of superposition of individual "sub-bursts" having duration of order of 0.05 s. Based on these observational results, Dermendjiev (1989) proposed a magnetohydrodynamic model for the elementary solar flare bursts. The main assumption in the model is the current cord formation in vortex rings, where accelerated to high energies electrons may provide a burst-like event.

Katsova et al. (1997) considered the impulsive stellar flares as a set of elementary bursts too. However, one basic assumption of the gas-dynamic model (Katsova & Livshits, 1991) is that a low-temperature condensation formed in the chromosphere during the flare process should emit in the optical continuum. The minimum duration of a flare depends on the characteristic gas-dynamic time (a ratio of the length of the scale heights to the sound speed) in these layers and in the case of the giant star V390 Aur optical spikes with a duration shorter than 100 sec could not be easily explained by the theory.

A possible explanation of the observed events could be given within the framework of influence of fluxes of accelerated particles onto more dense chromospheric and upper photospheric layers. These particles should propagate from one foot point to another and give rise of the optical continuum in one or several low-lying loops.

The unusual spike structure of the V390 Aur flares needs a further investigation and is a challenge to the theory. In future, high-speed simultaneous patrol observations are also required to refine our knowledge on the characteristics of the flares in this star.

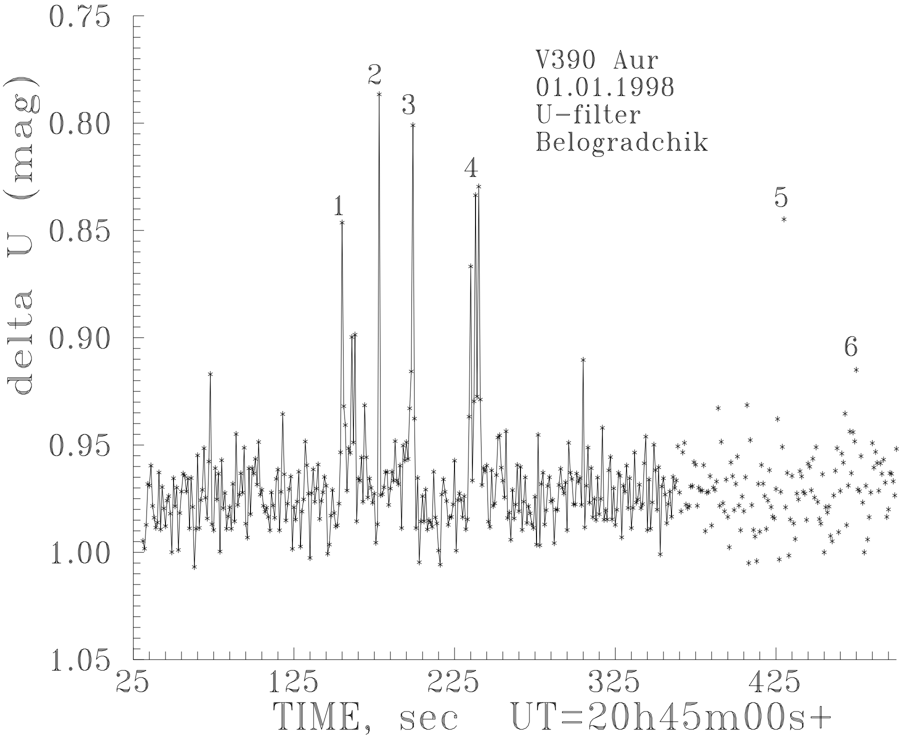

Figure 1. Flares detected on January 1, 1998. The events specified in Table 1 are labeled by numbers.

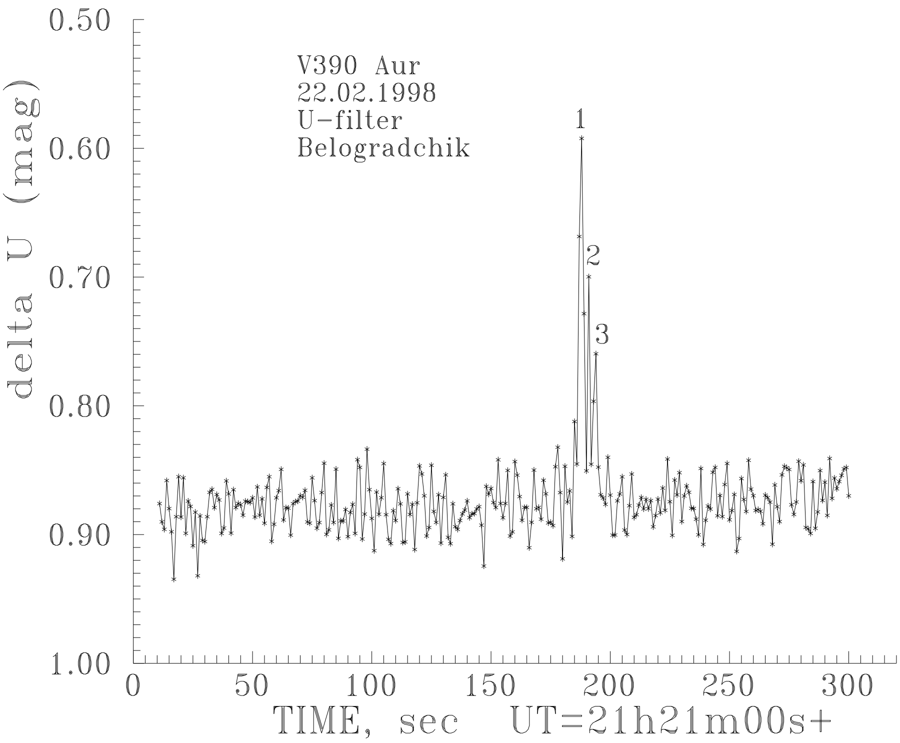

Figure 2. The flare detected on February 22, 1998. The elementary events are labeled by numbers.

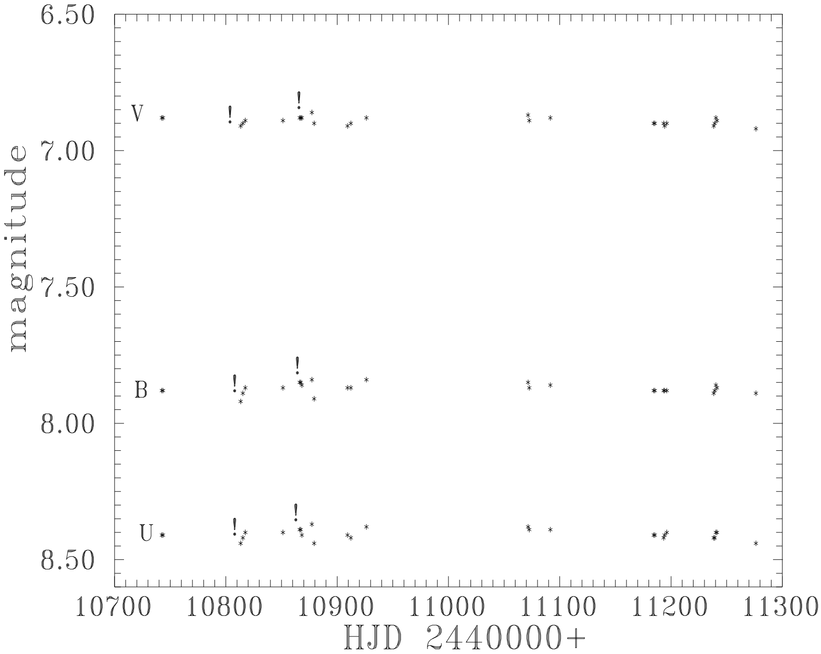

Figure 3. V390 Aur UBV light curves. The moments of the detected flares are denoted by exclamation marks.

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