COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS
Number 4917

Konkoly Observatory
Budapest
3 July 2000
HU ISSN 0374 – 0676

PHOTOELECTRIC OBSERVATIONS OF THE FLARE STAR YZ CMI IN 1999-2000

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The well-known spotted flare star YZ CMi was extensively observed during the past years and flares have been detected in the optical, radio and X-ray wavebands. YZ CMi is a spotted dM4.5e star at a distance of 5.9 pc (Gershberg et al., 1999). The rotational period, determined from spot light curves, is about 2.77 days (Chugainov, 1974; Pettersen et al., 1983).

Here we report on 7 flares detected on this star during our observing run in 1999–2000.

As a part of a flare star monitoring programme, YZ CMi was observed at the Rozhen National Astronomical Observatory with the 60-cm telescope and the *UBV* photon-counting single-channel photoelectric photometer. The monitoring was carried out in the *U*-band with an integration time of 1 s.

The log of observations is given in Table 1. I_0 is the quiet star intensity minus sky background, and σ/I_0 is the noise. During the total of 9.589 hours 7 flares were recorded and their characteristics are listed in Table 2. The flare magnitudes were computed with respect to the quiescent stellar level I_0 as

$$\Delta m \ [\mathrm{mag}] = 2.5 \log \frac{I_{0+f}}{I_0}. \tag{1}$$

The flare amplitude is:

$$\frac{I_f}{I_0} = \frac{I_{0+f} - I_0}{I_0}. \tag{2}$$

By numerical integration of the flare light curve, the equivalent duration of each flare was calculated from

$$ED = \int_{\mathrm{flare}} I_f(t)\, dt. \tag{3}$$

The flare energies (last column in Table 2) were obtained by the relation

$$\log E_f = \log ED + \log E_q^U, \tag{4}$$

where the quiescent star luminosity of YZ CMi $E_q^U = 4.11 \times 10^{28}$ ergs s^{-1} was determined using: $V = 11.15$, $B - V = 1.61$, $U - B = 0.97$, distance $r = 5.9$ pc (Gershberg et al., 1999), and the luminosity of a star with an absolute magnitude $M = 0$ in the *U*-band $E^U = 3.65 \times 10^{34}$ ergs s^{-1} (Moffett, 1973).

The light curves of the observed flares are plotted in Figures 1-2.

Table 1: Log of U-band flare monitoring of YZ CMi from Rozhen NAO.

Date		Monitoring intervals [UT] [h:m:s–h:m:s]	Effective monitoring time [s]	Noise σ/I_0	Flares
1999	11 Mar	19:01:54–19:12:32, 19:13:25–19:26:46	1441	0.22	no
	13 Mar	18:55:07–19:10:56, 19:11:31–19:27:06, 19:28:03–19:43:41, 19:44:49–19:46:56, 19:47:40–20:06:01, 20:06:52–20:24:25, 20:26:51–20:44:15, 20:50:17–20:09:15.	7293	0.17	2
	14 Mar	18:29:27–18:46:40, 18:50:02–19:08:06, 19:10:10–19:28:10, 19:29:00–19:46:15, 19:49:31–20:07:58, 20:08:42–20:26:11, 20:26:56–20:43:49, 20:46:30–20:03:55, 21:05:31–21:23:30, 21:24:16–21:39:39	10458	0.27	3
	15 Mar	18:26:49–18:44:04, 18:44:54–19:01:59, 19:03:26–19:20:54, 19:21:36–19:38:52, 19:40:21–19:57:42, 19:58:47–20:15:09, 20:06:03–20:33:05	7205	0.17	no
	01 Oct	02:45:16–03:05:10, 03:05:53–03:15:30	1773	0.23	no
2000	09 Mar	17:48:40–17:59:07, 18:00:44–18:16:26, 18:17:20–18:32:50, 18:33:26–18:50:30	3527	0.20	2
	12 Mar	18:09:05–18:24:22, 18:25:07–18:41:11, 18:42:15–18:57:55	2824	0.30	no
		Total time:	$34521^{\rm s} = 09^{\rm h}35^{\rm m}21^{\rm s}$		

Table 2: Characteristics of the U-band flares for YZ CMi.

No.	Date [UT]	Flare max [UT]	$t_{\rm rise}$ [sec]	Duration [m:s]	Noise $\frac{\sigma}{I_0}$	Amlitude $\frac{I_{0+f}-I_0}{I_0}$	Δm [mag]	$\log E_f$ [ergs]
1	13.03.1999	20:13:30	8	1:28	0.18	0.89	0.69	30.06
2	13.03.1999	20:30:06	12	0:59	0.16	1.19	0.85	29.84
3	14.03.1999	18:32:15	2	0:30	0.27	0.86	0.68	29.68
4	14.03.1999	18:52:30	58	2:26	0.26	1.31	0.91	30.14
5	14.03.1999	19:20:41	52	1:57	0.28	2.61	1.39	30.45
6	09.03.2000	17:50:20	2	0:04	0.18	5.34	2.00	29.64
7	09.03.2000	18:11:09	14	0:30	0.21	0.94	0.72	29.52

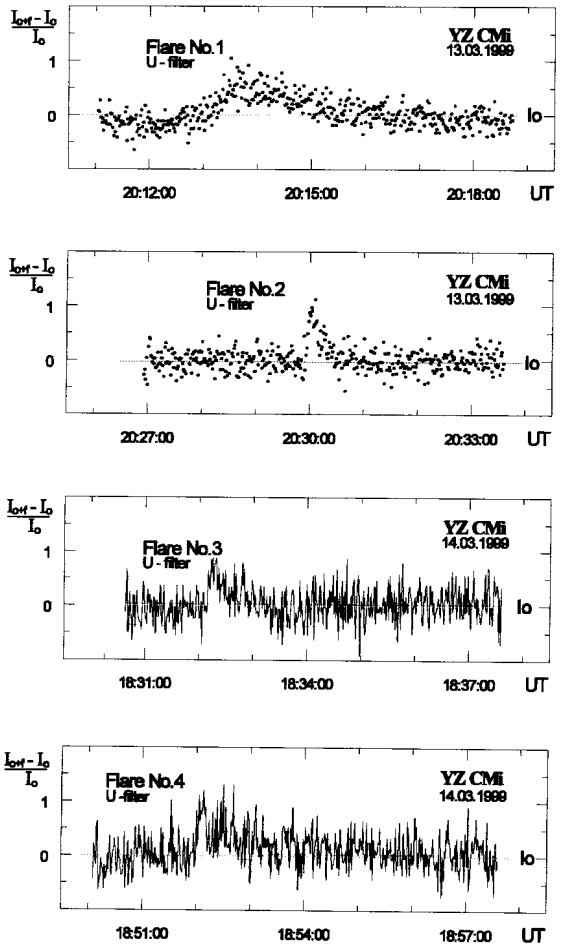

Figure 1. YZ CMi flares No. 1, 2, 3 and 4

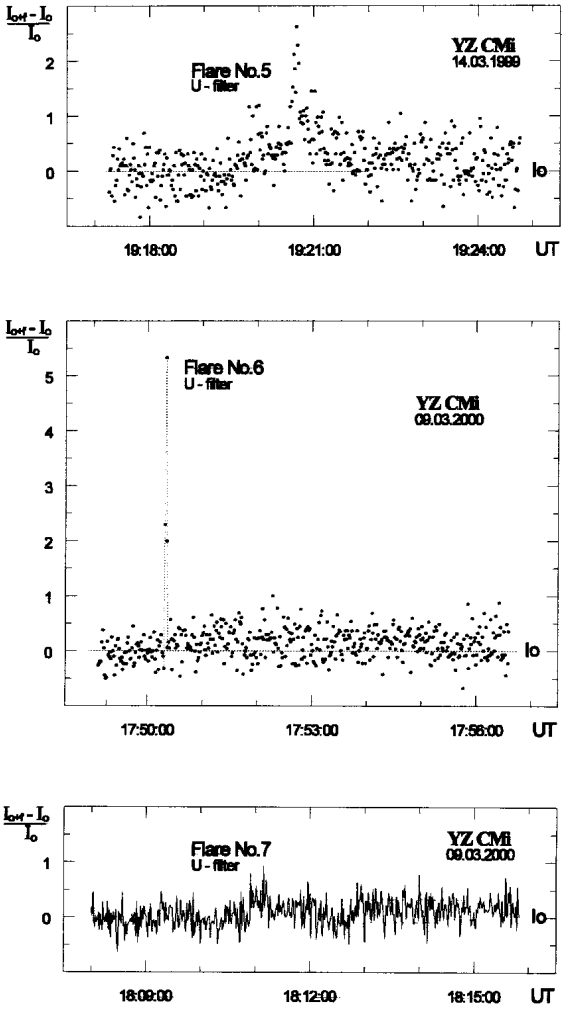

Figure 2. YZ CMi flares No. 5, 6, and 7

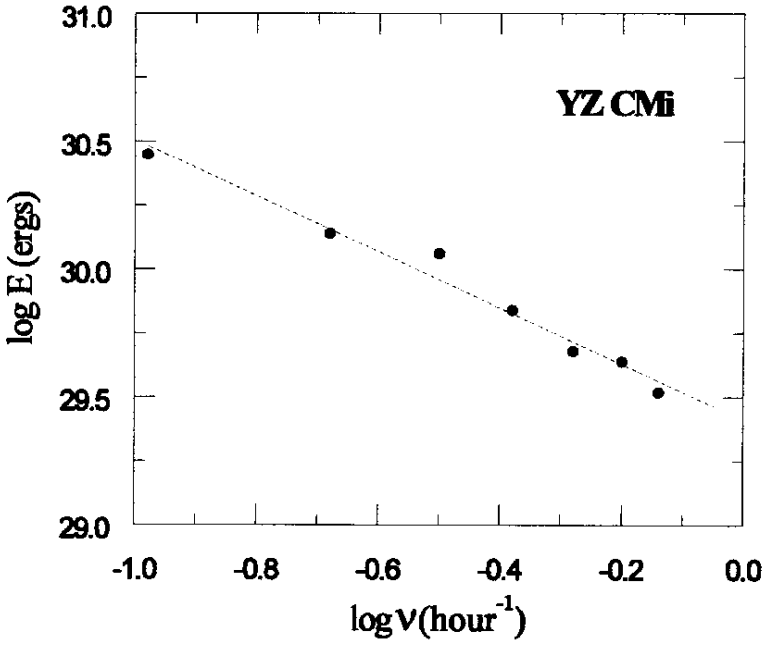

Figure 3. Flare energy $\log E$ vs. cumulative flare frequency $\log \nu$.

- Note the possible *pre-flare dip* for flare No. 7. Pre-flare dips have been heavily disputed in the past because single-channel photometers cannot control the sky during the flare record. If this pre-flare dip is real, it could be due to enhanced opacity by negative hydrogen ions H^- as a result of free-electrons production during the first stage of the flare, when the plasma is heated (Grinin, 1968).
- Another interesting flare is flare No. 6, with a total duration of 4 s and rise-time of 2 s. The flare amplitude is 5.34 ($\Delta m = 2.00$ mag). This is a typical case for *rapid spike flare*.
- Flare No. 5 shows a *pre-flare*.

According to Gershberg and Shakhovskaya (1983), the flare activity is described with the relation

$$\log \nu = a - b \log E, \tag{5}$$

where $\nu = N/T$ is the cumulative flare frequency, E is the flare energy, a and b are constants. Figure 3 shows a plot of the flare energies versus cumulative flare frequency. From our observations we get: $\log \nu = 26.2 - 0.89 \log E$.

Although the flare statistics is rather poor, the comparison with the above relationship shows remarkable agreement. Therefore we find no evidence for changes in the flare activity of YZ CMi.

References:

Chugainov, P.F., 1974, *Izv. KAO*, **52**, 3
Gershberg, R.E., Katsova, M.M., Lovkaya, M.N., Terebizh, A.V., and Shakhovskaya, N.I., 1999, *A&ASS*, **139**, 555
Gershberg, R.E. and Shakhovskaya, N.I., 1983, *ApSS*, **95**, 235
Grinin, V.P., 1968, *Izv. KAO*, **48**, 58
Moffett, T.J., 1973, *Mon. Not. R.A.S.*, **164**, 11
Pettersen, B.R., Kern, G.A., and Evans, D.S., 1983, *A&A*, **123**, 184