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VARIABILITY TYPE OF BD+46°2731

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BD+46°2731 (R.A.=$19^h35^m17\overset{s}{.}87$; DEC.=+46°25′08″.35 [2000.0]) is a relatively bright star with V≈ 9 mags and spectral type F0 and included in many star catalogs. It was also mentioned as an unconfirmed variable star in the "New Catalogue of Suspected Variable Stars" (Kukarkin et al., 1982) with number NSV 12196. The premise for placing the star in the catalog was the study by Seliwanow, Henroteau and Fredette (1923). It was that paper where the photographic magnitudes obtained by Fredette during 27 nights of observation from Aug to Dec 1920 (see Figure 1) were presented. Those observations appeared to confirm the variability with a period of approximately 28.5 days. The authors proposed to classify this star as an ellipsoidal variable.

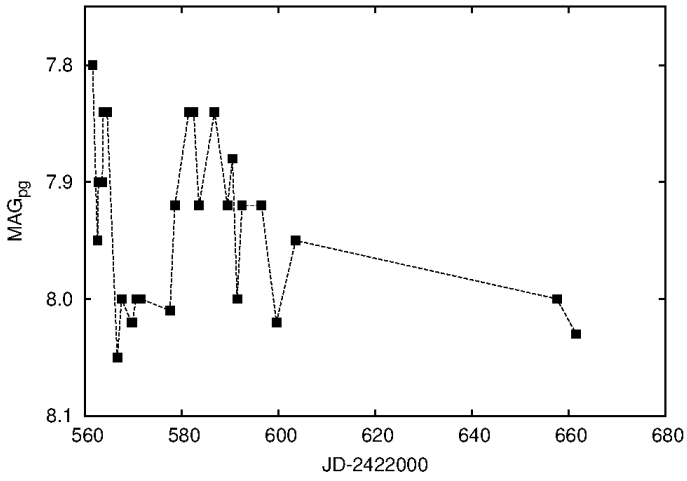

Figure 1. Photographic magnitudes obtained for BD+46°2731 by J.F. Fredette in Aug–Sep 1920.

We observed the field of the open cluster NGC 6811 in the Maidanak Observatory (Uzbekistan) during several nights in 2010 with Taiwan Automated Telescope (TAT, Chou et al., 2010). The TAT uses a 9-cm Maksutov-type telescope with f=25, manufactured by "Questar". The CCD camera is Apogee Alta U6 16-bit 1024 × 1024, the CCD chip is a Kodak KAF-1101E, its scale is 2″.18 per pixel which gives a field of view of $0\overset{\circ}{.}62\times0\overset{\circ}{.}62$. Because the telescope was not originally equipped with standard color filters, observations

were made in integrated light, exposure times were either 280 or 320 sec. The main goal of the observations was a search for new variables as well as asteroseismic analysis of known δ Sct stars. Among all nights of observations we had four nights (Aug 26, 27 and Sep 7, 10) when the star BD+46°2731 was found in the field of view close to the edge of the frames. Basic reduction of the frames was done using standard IRAF† software.

To obtain light curve of the BD+46°2731 we used the method of differential photometry. For this goal we extract photometry of a set of stars across the field of NGC 6811. During the photometric analyses we encountered two main problems: (i) strong coma distortions of the stellar profiles due to a quite wide field of view of the telescope, and (ii) moderate star crowding on the field.

To avoid these problems we performed only aperture photometry with an aperture radius is being approximately equal to FWHM. Having had the instrumental magnitudes we computed the light curve and subtracted low-frequency trends (due to possible effects of differential absorption) by fitting low-order polynomial. Then we used the method of ensemble photometry (Honeycutt, 1992) realized in "Ensemble-0.7" software by Michael Richmond (http://spiff.rit.edu/ensemble). Due to the proximity of BD+46°2731 to the edge of the frames some pixels have poor count statistics for sky background estimation. These pixels were removed from our data analyses. The final light curve contains 225 data points and is shown in Figure 2.

For the power spectral analysis of the light curve the FAMIAS software package (Zima, 2008) was used. The width of the smoothing window for noise level estimation was set to 5 c/d, the Nyquist frequency (approximated by the inverse mean of the time-difference of consecutive measurements by neglecting large gaps) was set to 121.561 c/d and frequency resolution was set to 0.003289 c/d. Only those modes were selected whose amplitudes in power spectra exceeded 4σ. These modes have frequencies of 18.95 c/d, 13.66 c/d, 16.70 c/d and 8.23 c/d. Parameters of the modes are presented in Table 1. The power spectra after subsequent pre-whitening procedures are shown in Figure 3. The observed and fitted light curve is plotted in Figure 4.

Table 1. Mode parameters of BD+46°2731

Mode	P (c/d)	σ(P) (c/d)	A (mmag)	σ(A) (mmag)	S/N
f1	18.9510	0.00137	11.925	0.697	9.30
f2	13.6533	0.00240	6.480	0.690	7.61
f3	16.7796	0.00332	5.097	0.690	6.95
f4	8.2332	0.00323	4.745	0.680	4.91

Considering the amplitudes and periods of oscillations, as well as the spectral type of the star we conclude that BD+46°2731 could be a variable of δ Sct type. Taking into account its brightness it will be a convenient target for a future asteroseismic campaign even with small telescopes. It should be mentioned that BD+46°2731 is located in the Kepler field (KIC 9715035) but unfortunately it was not observed.

†IRAF is distributed by the NOAO, which are operated by the AURA, Inc., under cooperative agreement with the NSF

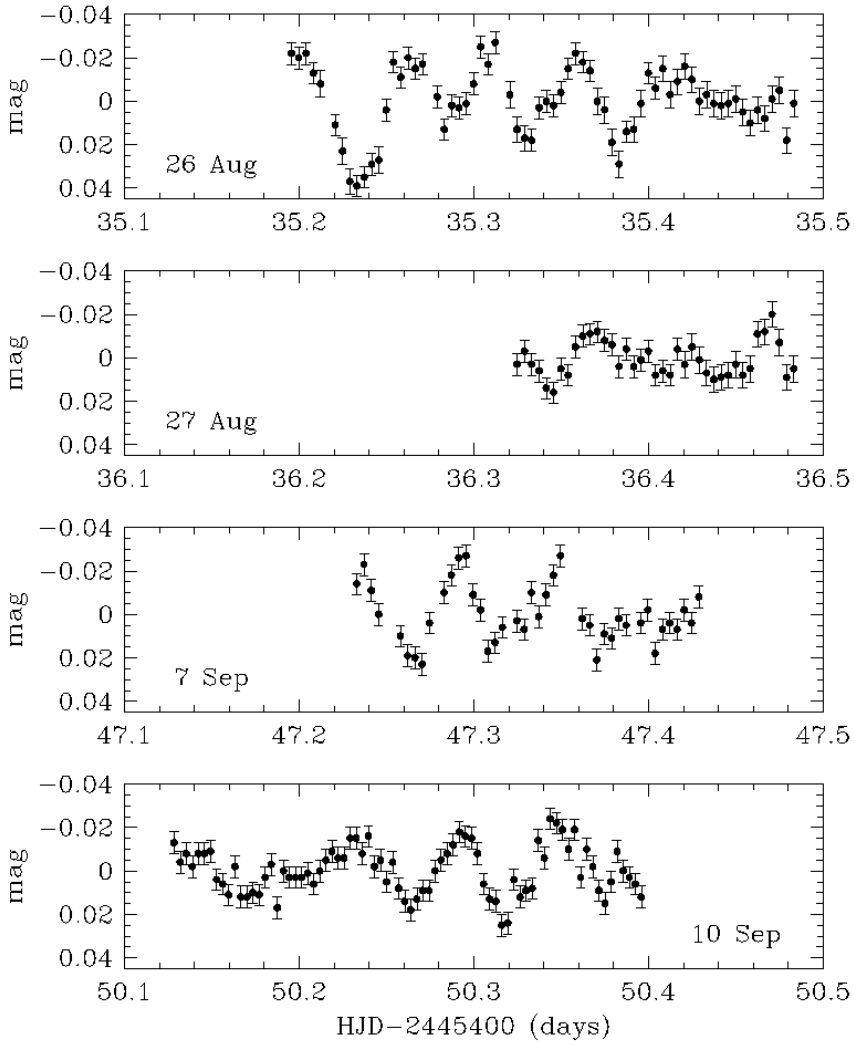

Figure 2. Light curves of the star BD+46°2731 observed in the Maidanak Observatory in 2010.

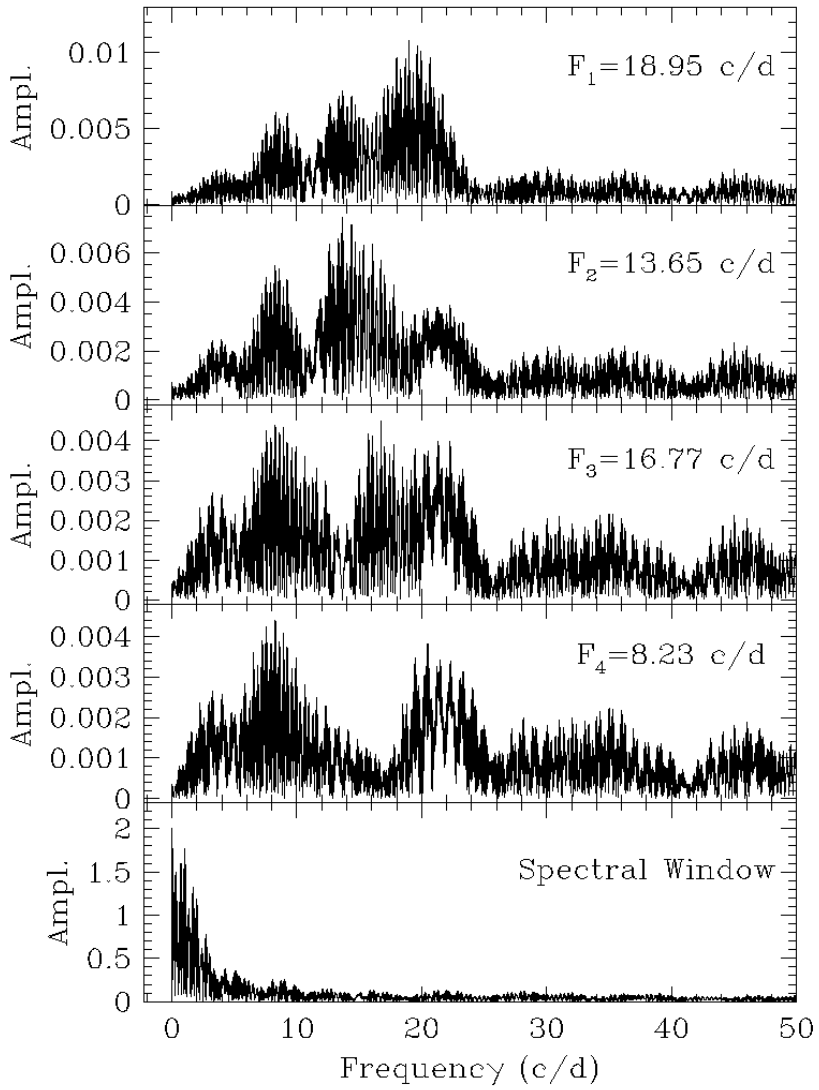

Figure 3. Four panels from the top: amplitude spectra for different identified modes which satisfied the 4σ rejection criteria. The last panel: amplitude spectrum of window function.

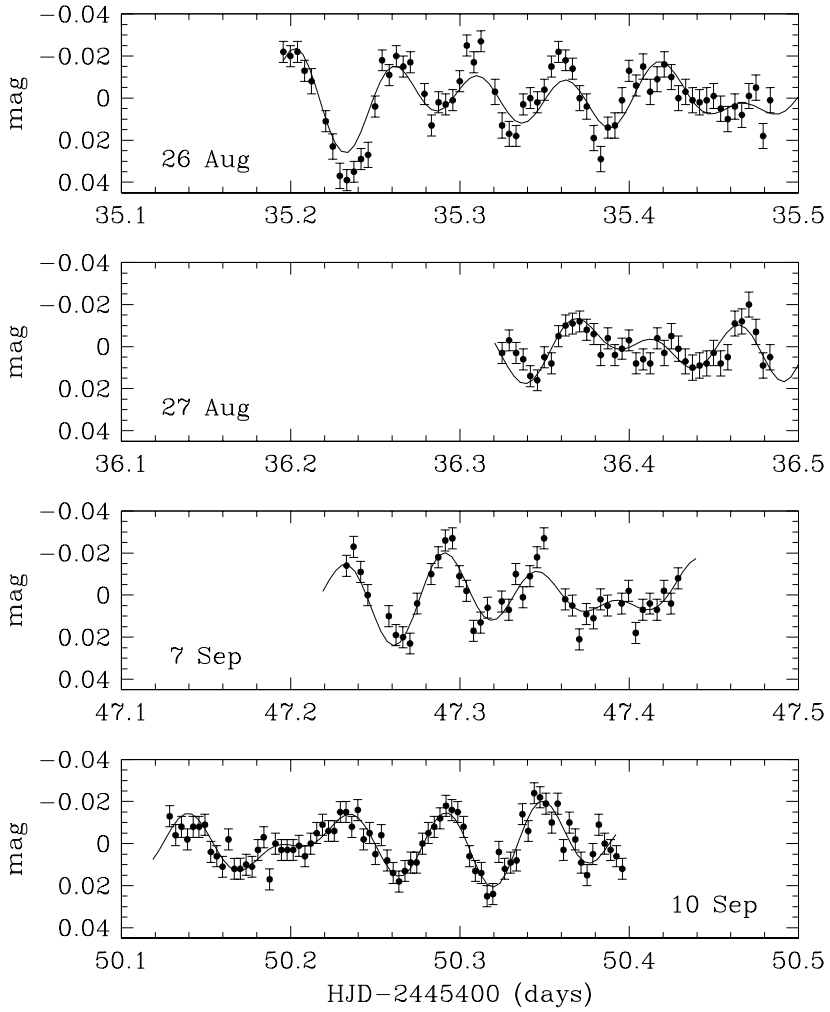

Figure 4. Light curves and fitting results for BD+46°2731.

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References:

Chou, D.-Y., Sun, M.-T., Fernandez, F.J. et al., 2010, *Advances in Astronomy*, **2010**, 13
Honeycutt, R.K., 1992, *PASP*, **104**, 435
Kukarkin, B.V., Kholopov P.N., Artiukhina N.M. et al., 1982, *New Catalogue of Suspected Variable Stars*, Moscow: Nauka Publishing House
Seliwanow, S., Henroteau, F. and Fredette, J.F., 1923, *AN*, **219**, 351
Zima, W., 2008, *Communications in Asteroseismology*, 155, 17