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SPECTROSCOPY OF BLUE AND YELLOW LONG-PERIOD VARIABLES IN THE SMALL MAGELLANIC CLOUD

R. E. Mennickent,[1] L. S. Cidale,[2] G. Pietrzyński,[1,3] W. Gieren,[1] and B. Sabogal[1]

RESUMEN

Presentamos espectroscopía de 17 estrellas variables brillantes posibles miembros de la Nube Pequeña de Magallanes. Estas estrellas son variables OGLE cuya periodicidad fotométrica no ha sido explicada. Hemos determinado tipos espectrales y velocidades radiales para estas estrellas. La mayoría resultaron ser objetos con líneas Balmer en emisión, gigantes o supergigantes, de tipos espectrales B−F. Del análisis de las curvas de luz hemos encontrado una nueva binaria interactuante de periodo orbital 184 días, y dos nuevas variables elipsoidales de tipo espectral temprano. El caso de OGLE00445466-7328029 es muy interesante; esta estrella Be, de tipo espectral tardío, muestra un fenómeno de batido causado primariamente por dos frecuencias cercanas, 0.05733 c/d (17.44 d) and 0.06347 c/d (15.76 d). Discutimos especialmente este caso.

ABSTRACT

We present spectroscopy for 17 bright variable stars possible members of the Small Magellanic Cloud. These stars are OGLE variables whose photometric periodicity is poorly understood. We have determined spectral types and radial velocities for the stars of our sample. Most targets turned out to be emission-line objects of spectral type B−F and luminosity class giant or supergiant. From the analysis of the OGLE light curves, we find a new interacting eclipsing binary with a period of 184 days, and two new early-type ellipsoidal variables. The case of OGLE00445466-7328029 is specially interesting; this late-type Be star shows a beating phenomenon primarily caused by two closely spaced frequencies, 0.05733 c/d (17.44 d) and 0.06347 c/d (15.76 d). We discuss this case in particular.

Key Words: **STARS: BINARIES: ECLIPSING — STARS: EARLY-TYPE — STARS: EMISSION-LINE, BE — STARS: VARIABLE**

1. INTRODUCTION

We investigate the nature of some periodic variable stars found in the Small Magellanic Cloud (*SMC*) (Mennickent et al. 2002, hereafter M02). The nature of these variables is still unclear; they are redder than typical Be stars and usually show variable amplitudes. The photometric variability is different from that observed in any known pulsating variable in the color range, like SPBs or α Cyg stars. In order to contribute to understand these objects, we carried out a spectroscopic study.

2. OBSERVATIONS

Spectroscopic observations were conducted at CTIO during October 8-12 2003 (UT). We used the 1.5 m telescope with the Cassegrain Spectrograph and the Loral 1K detector. The first two nights the grating # 26 tilted at 16.2 degree, and a slit width of 2 arcsecond, yielded a spectral range of 3700-5470 Å, a dispersion of 1.3 arcsec/pix and an effective resolution of 2 Å. During the third and fourth nights we used grating # 36, with the same slit width, that yielded a dispersion of 0.77 Å/pix, a 1.9 Å effective spectral resolution and a wavelength range of 5765-6694 Å. Comparison spectra provided wavelength calibration functions with typical *rms* of 0.1 Å for grating # 26 and 0.01 Å for grating # 36. Observations of the standard star LTT 2415 were used to calibrate the spectra in absolute flux units. The *rms* of the sensitivity function was 0.05 mag for grating # 26 and 0.02 mag for grating # 36. Corrections for atmospheric extinction were done for every spectrum using average extinction coefficients available for CTIO. Spectroscopic reductions were carried out in the usual manner, using IRAF packages.

3. RESULTS

Results are given in Table 1. The radial velocities are in general consistent with a *SMC* member-

[1]Departamento de Astronomía, Universidad de Concepción, Casilla 160-C, Concepción, Chile (rmennick, pietrzyn, wgieren, bsabogal@astro-udec.cl).

[2]Facultad de Ciencias Astronómicas y Geofísicas, Univ. Nacional de La Plata, Paseo del Bosque S/N, 1900 CGA, La Plata, Argentina (lydia@fcaglp.fcaglp.unlp.edu.ar).

[3]Warsaw University Observatory, AL. Ujazdowskie 4, 00-478 Warszawa, Poland (pietrzyn@sirius.astrouw.edu.pl).

TABLE 1

The OGLE photometry is given, along with our determinations for spectral type, luminosity class and radial velocity. n is the number of lines averaged for the radial velocity determination. A note about photometric variability is provided: m stands for multiperiodic, t for transient periodicity, $e1$ for the eclipsing binary with orbital period 184 days, $e2$ for ellipsoidal variable and s for single period variable.

OGLE-name	V	$(B-V)$	$(V-I)$	v$\pm\sigma_V$	n	Spectral type	Note
OGLE00433691-7326377	14.18	0.18	0.33	114±31	15	A7-F5e I	m
OGLE00445466-7328029	14.82	0.29	0.58	137±26	7	B7-9 IIIe	m
OGLE00455414-7314043	15.48	0.52	0.71	174±23	7	F0 Ib-II	s
OGLE00463376-7312043	14.06	0.21	0.38	126±15	1	F5 Ie + G5-K0 I	$e1$
OGLE00475014-7313164	15.48	0.27	0.47	139±5	7	B7-8 III	t
OGLE00492141-7258449	14.61	0.32	0.50	191±23	13	A5 II	t
OGLE00502564-7258071	14.01	0.29	0.45	127±15	10	F4 IV	t
OGLE00504344-7327053	13.65	-0.19	0.01	179±26	4	WR	Wolf-Rayet
OGLE00510018-7253039	13.61	-0.03	0.19	172±32	12	B1 II-IIIe	s
OGLE00510759-7326366	15.05	0.02	-0.03	138±18	1		$e2$
OGLE00535922-7235089	14.40	0.12	0.33	54±17	12	A3 III	$e2$
OGLE00552027-7237101	14.88	0.19	0.29	141±16	2	A0 Ibe	m
OGLE00574525-7235321	13.82	-0.15	-0.15	195±37	22	B1 II-III	t
OGLE00581258-7230485	14.90	0.06	0.26	164±24	4	B0 IIIe	Be X-ray
OGLE01000078-7255229	14.44	0.04	0.24	222±32	14	B8-9 IIIe	s
OGLE01045121-7246469	13.42	-0.04	0.13	179±32	16	B1 Ib-IIe	s
OGLE01045299-7159188	14.22	-0.17	-0.07	143±24	15	B2 IIIe	s

ship, but OGLE00502564-7258071, classified F4IV, is a probable member of the Milky Way halo. We observe that the spectral types and luminosities are consistent with B−F giants and supergiants. We have found several emission line objects and some multiperiodic stars in our sample. Fig. 1 shows the example of OGLE00445466-7328029. The beating between two closely spaced frequencies is evident. This star is classified B7−9IIIe. The beating could be explained if the star pulsates with a period of 15.556 days, is member of a binary of orbital period 326 days, and has the pulsational axis inclined regarding the orbital axis. Reed & Brondel (2005) have shown that there is a splitting of the pulsational frequency, proportional to the orbital frequency, in close binary systems with misaligned pulsational-orbital axis. However, we recognize the problem of the origin of the putative pulsation and the axis inclination in this long-period binary. From Table 1 we conclude that the periodic photometric variability of the stars classified "Type-3" by M02 has multiple causes, and that they do not correspond to an homogeneous group of stars. This work was partly supported by grant Fondecyt 1030707.

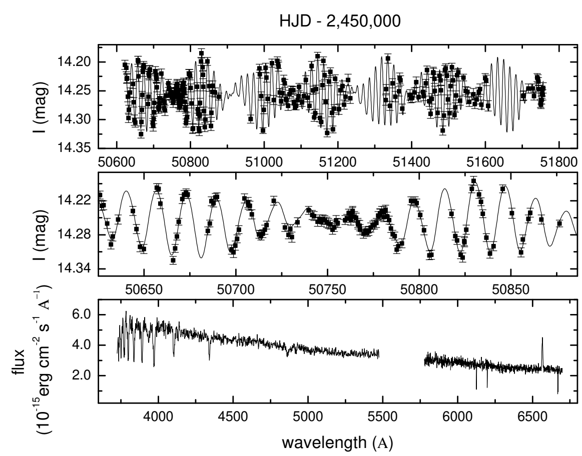

Fig. 1. (a) Light curve for OGLEOGLE00445466-7328029 and the best fitting function (top), detail of the light curve and fit (middle) and spectrum (bottom) of SMC3-2.

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