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TYC 5353-1137-1: AN ENIGMATIC DOUBLY PERIODIC VARIABLE OF SEMIREGULAR AMPLITUDE

ROSALES, J. A., MENNICKENT, R. E.

Astronomy Department, University of Concepción, Concepción, Chile
e-mail: jrosales@astro-udec.cl; rmennick@astro-udec.cl

To date the Doubly Periodic Variables (DPVs) discovered by Mennickent et al. (2003) in the Large Magellanic Cloud (LMC) and the Small Magellanic Cloud (SMC) have been interpreted as semi-detached interacting binary stars with a B-type component surrounded by an optically thick disk. These stars seem to experience regular cycles of mass loss (Mennickent et al. 2008) and are characterized by orbital photometric variability on time scales of 2 to 100 days. These systems show a long period which is on average 33 times longer than the orbital period (Mennickent et al., 2016; Mennickent, 2017; Poleski et al., 2010). Currently, the DPVs found are Algol-type eclipsing (DPV/E) and ellipsoidal (DPV/ELL) system.

Therefore, we have performed a new search for DPVs of short period in the ASAS[1] catalog (Pojmanski, 1997), focusing on those stars with orbital periods between 2 to 3 days which also show variations in their brightness. From a total of 244 objects, we have found another candidate DPV, one whose mean brightness is gradually decreasing. By fitting a 3rd order polynomial to the mean magnitude (red line in Fig. 1.) and then moving it to zero for a second analysis, a gradual decrease over 2500 days was revealed. During the last 1000 days of this decrease, a 42% increase in the variation between the minimum and maximum values of the magnitude was observed (Fig. 1). We determined the orbital period by using the PDM (phase dispersion minimization) IRAF[2] software (Stellingwerf, 1978) and estimated the errors for the orbital period and the long cycle by visual inspection of the light curves phased with trial periods near the minimum of the periodogram given by the PDM. The two main frequencies of the system were disentangled using the code written by Zbigniew Kołaczkowski and described by Mennickent et al. (2012). This code was specially designed to adjust the orbital signal with a Fourier series and disentangle both frequencies using the fundamental frequencies and harmonics we supplied. The code removed this signal from the original time series thus allowing long periodicity to appear in a residual light curve, and we obtained both isolated light curves without additional frequencies, as shown in Figs. 2 and 3. We presented the search results and ephemeris in Table 1 and Fig. 1 (left) both of which illustrate the gradual brightness decrease in the ASAS photometry. In the right panel of this figure we show the photometric variation, ΔV shifted to average zero and, finally, the disentangled light curves in Figs. 2 and 3.

[1] `http://www.astrouw.edu.pl/asas/`
[2] IRAF is distributed by the National Optical Astronomy Observatories, which are operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.

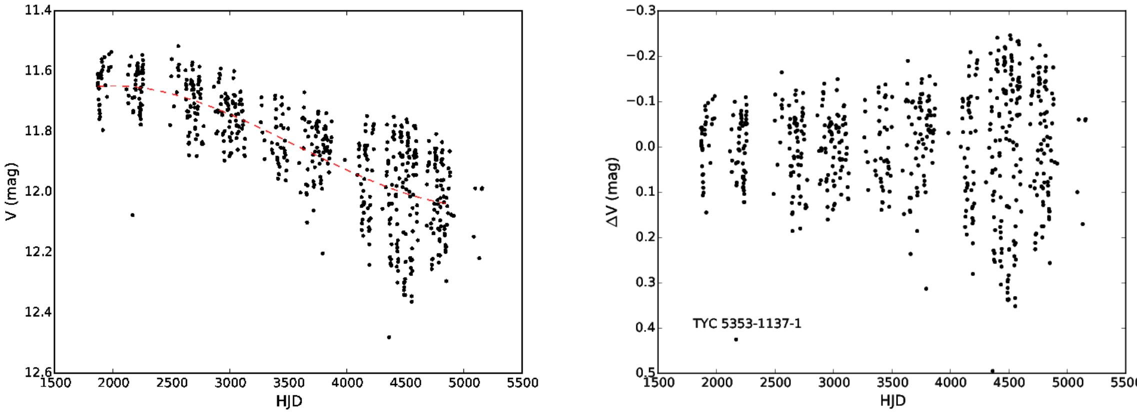

Figure 1. (Left) The ASAS photometry reveals a gradual decrease in the brightness of DPV TYC 5353-1137-1 over 2500 days, followed by an increase of 42% in the amplitude of the photometric variation over the last 1000 days (right). The red line corresponds to a 3rd-order polynomial representing the mean magnitude.

ASAS-ID	Other ID	RA (2000)	DEC (2000)	P_o (days)	P_l (days)	$T_0(\min_o)$ -2450000	$T_0(\max_l)$ -2450000	V (ASAS) (mag)
060418-1009.4	TYC 5353-1137-1	06:04:18.0	-10:09:24.0	2.028(1)	60.455(6)	4491.602390	4404.77653	11.56

Table 1: Parameters of the newly confirmed DPV TYC 5353-1137-1 and its orbital (P_o) and long periods (P_l). Epochs for both the minimum brightness of the orbital light curve and the maximum brightness of the long-cycle light curve are given.

This enigmatic DPV presents a variable amplitude in the light curve when it is phased using the orbital period at three different photometric datasets (Fig. 2.). The changes in the orbital light curve could be related to changes in disc size/temperature and spot temperature/position as proposed by Garcés et al. (2018) for the DPV OGLE-LMC-DPV-097. Afterwards we disentangled the light curve using the long period and phased it. For that, we used the same time intervals as those used for the orbital period as a way to analyze possible variations in the amplitude of this enigmatic phenomenon in the DPVs, and we apparently observed an effect of switch off-on of the long-cycle in the dataset of HJD between 2500 and 4000 (Fig. 3), this is observed for the first time in these kind of systems. Therefore, we consider TYC 5353-1137-1 to be an optimal target for further photometric monitoring and spectroscopic studies, due to that it will help us to test the mechanism based on cycles of the magnetic dynamo in the donor proposed by Schleicher & Mennickent (2017), the cause of mass loss in some Algol stars and the evolutionary process of the DPVs.

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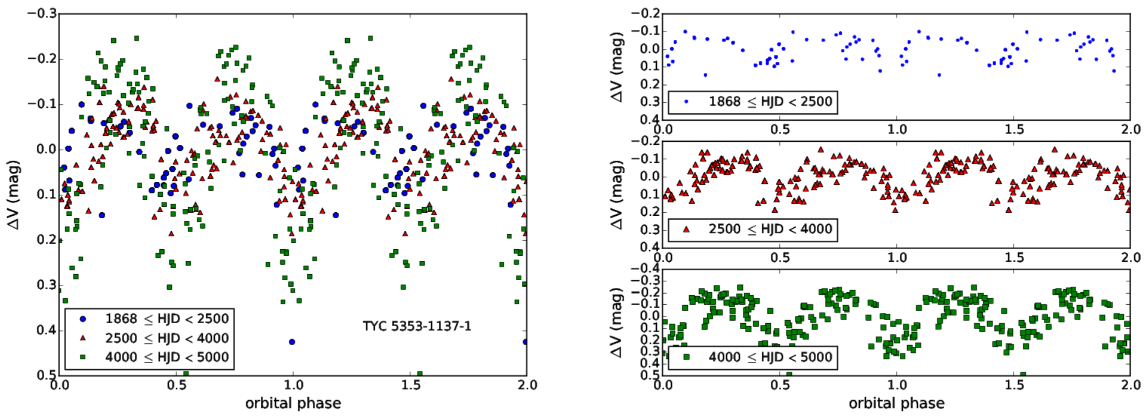

Figure 2. Disentangled ASAS V-band light curve of the new confirmed Doubly Periodic Variable. The orbital phase has been separated in the three datasets (HJD–2450000.0), representing the variation of the amplitude.

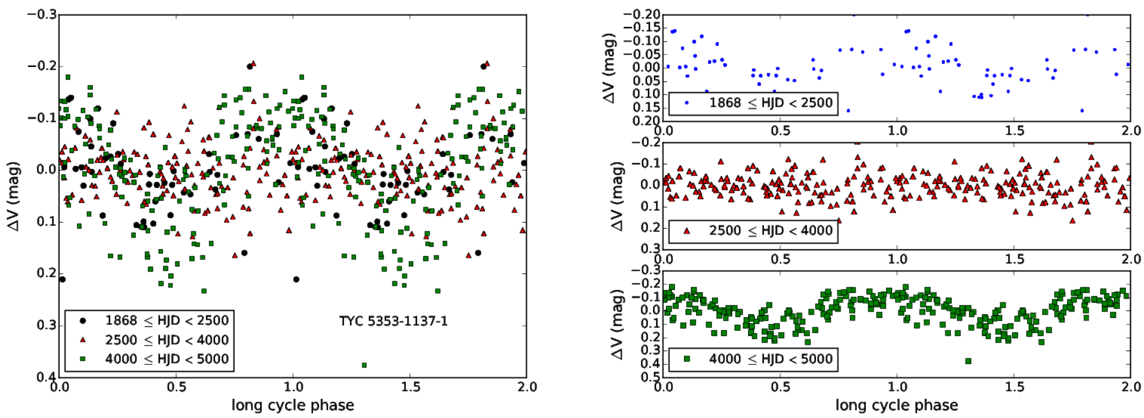

Figure 3. The long cycle phase has been disentangled and separated into three datasets (HJD–2450000.0). The first dataset shows less amplitude in the light curve of the long cycle (blue), during the second epoch an effect of switch off occurs (red), and the third dataset shows a remarkable increase in the amplitude of variability (green). Note the different y-axis scales in the panels.

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