



Photometric followup investigations on LAMOST survey target Ly And



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HIGHLIGHTS

- We present a low-dispersion spectrum of LY And.
- We got two sets of CCD photometric light curves for LY And for the first time.
- The orbital period of LY And is increasing.
- We obtained a photometric solution for LY And with the Wilson-Devinney program.

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ABSTRACT

We present a low-dispersion spectrum and two sets of CCD photometric light curves of the eclipsing binary LY And for the first time. The spectrum of LY And was classified as G2. We derived an updated ephemeris based on all previously available and our newly acquired minimum light times. Our analyses of LY And light curve minimum times reveals that the differences between calculated and observed minimum times for LY And can be represented by an upward parabolic curve, which means its orbital period is increasing with a rate of $1.88 (\pm 0.13) \times 10^{-7}$ days/year. This increase in orbital period may be interpreted as mass transfer from the primary component to the secondary component, with a rate of $dM_1/dt = -4.54 \times 10^{-8} M_{\odot}/\text{year}$. By analyzing our CCD photometric light curves obtained in 2015, we obtained its photometric solution with the Wilson-Devinney program. This photometric solution also fits very well our light curves obtained in 2014. Our photometric solution shows that LY And is a contact eclipsing binary and its contact factor is $f = (17.8 \pm 1.9)\%$. Furthermore, both our spectroscopic and photometric data show no obvious chromospheric activity of LY And.

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1. Introduction

LAMOST (the Large Sky Area Multi-Object Fiber Spectroscopic Telescope, or Guoshoujing Telescope) is the result of a National Major Scientific Project of the Chinese Academy of Sciences. LAMOST is an innovative and unique telescope, with a special reflecting Schmidt telescope which specializes in conducting spectroscopic surveys. Its circular field of view (FOV) is five degrees in diameter and its effective aperture ranges from 3.6 m to 4.9 m (Wang et al., 1996). It can simultaneously observe the spectra of 4000 objects (Xing et al., 1998). With these capabilities, LAMOST has acquired over four million spectra in the past few years.

Our object LY And (2MASS J02215249 + 3837421, GSC 02831-01925) was first discovered to be a variable star by Kinman et al. (1982) in their survey for RR Lyrae stars. LY And's magnitude varies from 13.8 to 14.65 and its type is EW. LY And has a period of 0.34505 days and initial epoch of 2451576.776 (Otero et al., 2006). There are 65 photographic and 12 CCD light curve minimum times of LY And available from previous observations. Up till now, there has been no published light curves for LY And and no analyses on its period variation.

In this paper, we present a spectrum and two multi-bands light curves for LY And for the first time. We also present our analyses of its orbital period variation, and our photometric solution based on our photometric observations with the SARA 914-mm optical telescope at Kitt Peak National Observatory (KPNO) using the 2003 version of the Wilson-Devinney (WD) program (Wilson and Devinney, 1971; Wilson, 1979; 1990; 1994; Wilson and Van Hamme, 2004, etc.).

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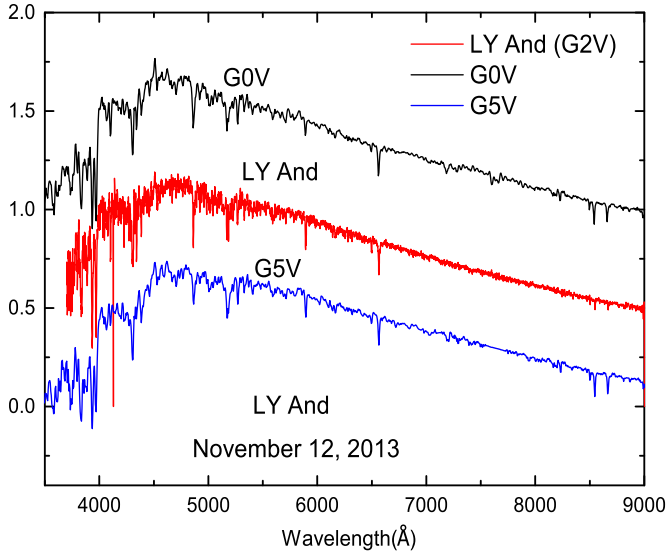
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Table 1

LY And observation log, comparison and check stars.

Observation date	Targets	Name	Coordinates(Ra;Dec 2000)	Mag_J	Mag_H	Mag_K	Source
November 24, 2014	Variable star	LY And	02:21:52.50; + 38:37:42	12.446	12.200	12.129	[1],[2]
November 24, 2014	Comparison star	2MASS J02214446 + 3835224	02:21:44.50; + 38:35:22.8	12.364	12.148	12.128	[1],[2]
November 24, 2014	Check star	2MASS J02220087 + 3840122	02:22:00.91; + 38:40:12.4	13.319	13.091	12.993	[1],[2]
October 23, 2015	Variable star	LY And	02:21:52.50; + 38:37:42	12.446	12.200	12.129	[1],[2]
October 23, 2015	Comparison star	2MASS J02220666 + 3837080	02:22:06.72; + 38:37:08.5	11.037	10.970	10.892	[1],[2]
October 23, 2015	Check star	2MASS J02214374 + 3840582	02:21:43.73; + 38:40:58.5	9.902	9.669	9.595	[1],[2]

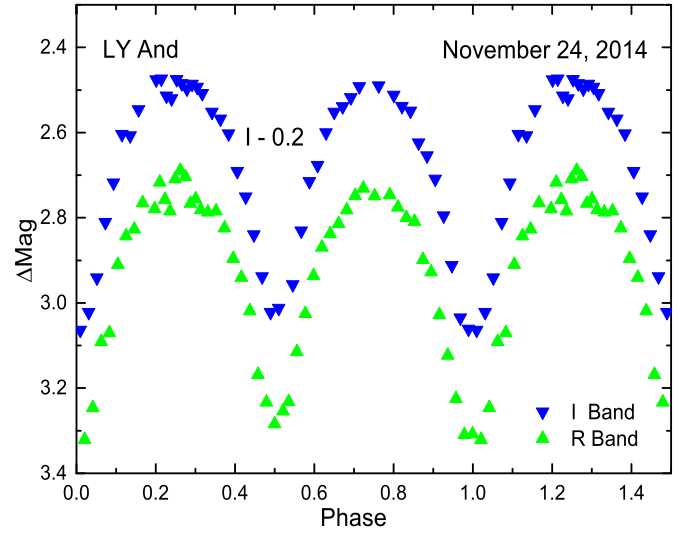
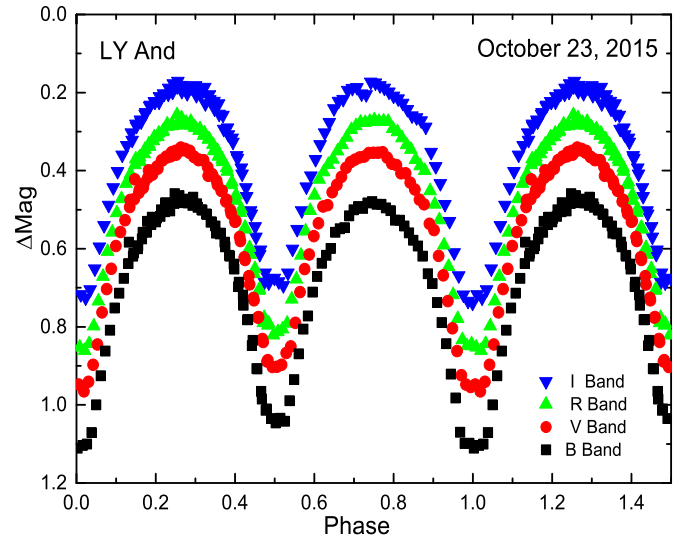
Note. [1]. Cutri et al. (2003); [2]. Morrison et al. (2001).

**Fig. 1.** Middle line: The low-dispersion Spectrum of LY And observed by LAMOST on November 12, 2013. Top and bottom lines are G0V and G5V from the Pickles (1998).

2. Spectroscopic and photometric observations

We obtained three sets of data, including a set of low-dispersion spectroscopic data (Luo et al., 2012) and two sets of CCD photometric data. The spectroscopic observations for LY And were carried out by LAMOST on November 12, 2013. We downloaded the spectroscopic data from the LAMOST website (<http://dr2.lamost.org/>) and found the spectrum of LY And to be G2. New spectrum of LY And from LAMOST, G0V and G5V from Pickles (1998) in Fig. 1. There is no evidence of emission at $H\alpha$, $H\beta$ and $H\gamma$. Therefore, there was no obvious chromospheric activity on LY And.

We obtained our first photometric data set in R and I bands for LY And on November 24, 2014 using the 1-m RCC reflecting telescope at Yunnan Observatory, which was equipped with an Andor DW436 2048 × 2048 CCD camera with a field of view of 7.3' × 7.3'. The exposure times were 300 s for both R and I bands. We chose 2MASS J02214446 + 3835224 and 2MASS J02220087 + 3840122 as the comparison star and check star, respectively. The coordinates and magnitudes in J, H and K of LY And, the comparison star and the check star are listed in Table 1. We reduced these photometric data using the IRAF package in the standard fashion, including image trimming, bias subtraction, flat field division, cosmic-rays removal, and aperture photometry. The results are plotted in Fig. 2. We obtained our second photometric data set in B, V, R and I bands using the SARA 914-mm telescope at Kitt Peak National Observatory on October 23, 2015. This telescope was equipped with a 2048 × 2048 pixels CCD and each pixel after 2 × 2 binning is about 0.86'' (Hashimoto et al., 2016). The exposure

**Fig. 2.** Light curves of LY And for RI bands observed on November 24, 2014, with regular triangles(▲) for R band and inverted triangles(▼) for I band.**Fig. 3.** Light curves of LY And for BVRI bands observed on October 23, 2015, with squares(■) for B band, circles(●) for V band, regular triangles(▲) for R band and inverted triangles(▼) for I band.

times were 120 s in B band and 60 s in V, R and I bands, respectively. Because this telescope had a larger field of view, in analyzing this data set, we chose a different set of comparison and check stars which offered better signal to noise ratio but are slightly further out (see Table 1). The resulting light curves in B, V, R and I bands are plotted in Fig. 3. The second set of photometric data had higher time resolution and better observation conditions, so that the light curves in Fig. 3 are better than that in Fig. 2. These two

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