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HIGH-SPEED ULTRACAM COLORIMETRY OF THE SUBDWARF B STAR SDSS J171722.08+58055.8

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Abstract. We present high-speed multicolour photometry of the faint subdwarf B star SDSS J171722.08+58055.8 ($m_B = 16.7$mag), which was recently discovered to be pulsating. The data was obtained during 2 consecutive nights in 2004 August using the three-channel photometer ULTRACAM attached to the 4.2m William Herschel Telescope. We confirm the star to be oscillating and we refine the dominant frequency to 6.960mHz. A second new frequency of 7.267mHz is discovered. Both frequencies are significant in all three colours at level $> 5\sigma$ and vary in phase in the three colours. We attempted mode identification for the strongest mode from its amplitude ratios but did not succeed.

Key words: stars: subdwarfs, stars: variables: other, stars: oscillations, stars: individual: SDSS J171722.08+58055.8

1. INTRODUCTION

Of the 33 sdB stars with p-mode oscillations known to date, few have been modelled seismically so far (Charpinet et al., these proceedings). These modelling efforts result in mode identification based on frequency matching from the theoretical predictions, by means of a procedure that gives equal probability to spherical degrees $\ell = 0, 1, 2, 3$. It is therefore clear that a great need for empirical mode identification, i.e., identification obtained independently of the details of the theoretical models, emerges. The easiest way to achieve such empirical identification is from multicolour high-precision photometry (Jeffery et al., these proceedings).

In this poster, we present ULTRACAM multicolour photometry of the sdB star SDSS J171722.08+58055.8 (hereafter abbreviated as SDSS 1717). This is an sdB star of B magnitude 16.7 in which Solheim et al. (2004) discovered oscillations from white-light data gathered with the Nordic Optical Telescope (NOT). The NOT data revealed a frequency of 7.03mHz and a variable amplitude ranging

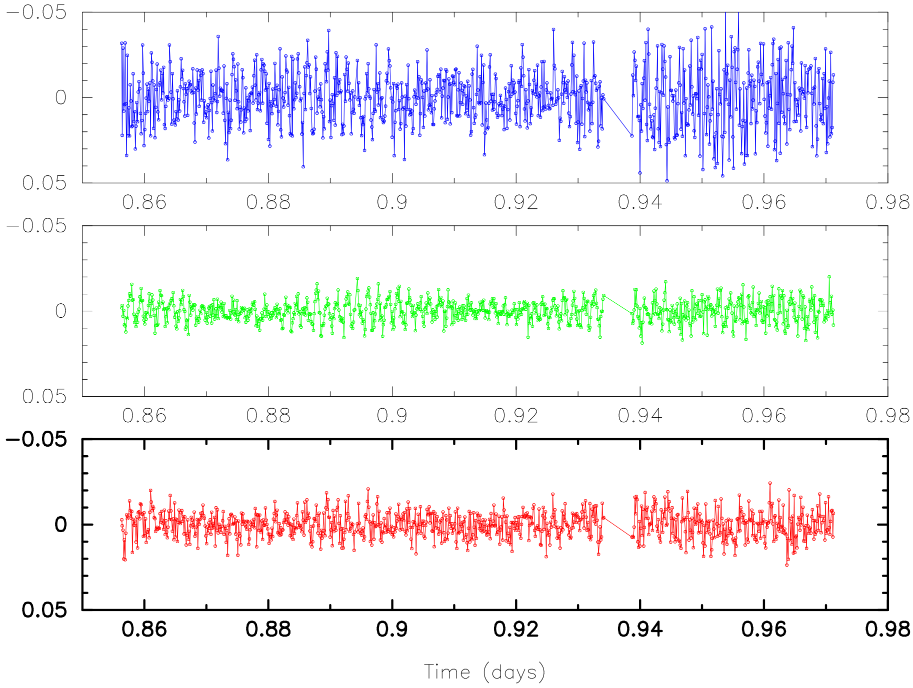

Figure 1: ULTRACAM light curves for SDSS 1717 on 2004 August 24.

from 4.4 to 6.2 mmag, most likely due to multimode beating. Our data confirm this result and prove the multiperiodicity.

2. DATA DESCRIPTION

Jeffery et al. (2005) recently reported on the outcome of a 6n ULTRACAM run with the 4.2m William Herschel Telescope dedicated to the sdB star PG 0014+067 performed in August 2004. The main target was not yet visible during the first 2.5 hours of each of these nights. Two such blocks of 2.5h on two consecutive nights were devoted to SDSS 1717 ($\alpha_{2000} = 17:17:22.0, \delta_{2000} = +58:05:59$) together with several comparison stars. We adopted an integration time of 10s which samples the dominant 140-sec pulsation well.

The reduction of the data frames was performed in the same manner as for PG 0014+067, which was already described in much detail in Jeffery et al. (2005). We hence refer the reader to that paper for information. Different comparison stars were considered to compute the differential magnitudes in the three channels (u', g', r'). The final results of the frequency analysis is independent of the different choices of the comparison stars. The details of the lightcurve computation will be presented elsewhere (Aerts et al., in preparation), but the final result for one night is shown in Fig. 1. A beat pattern is readily seen in the g' lightcurve, pointing towards multiperiodicity as already suspected by Solheim et al. (2004).

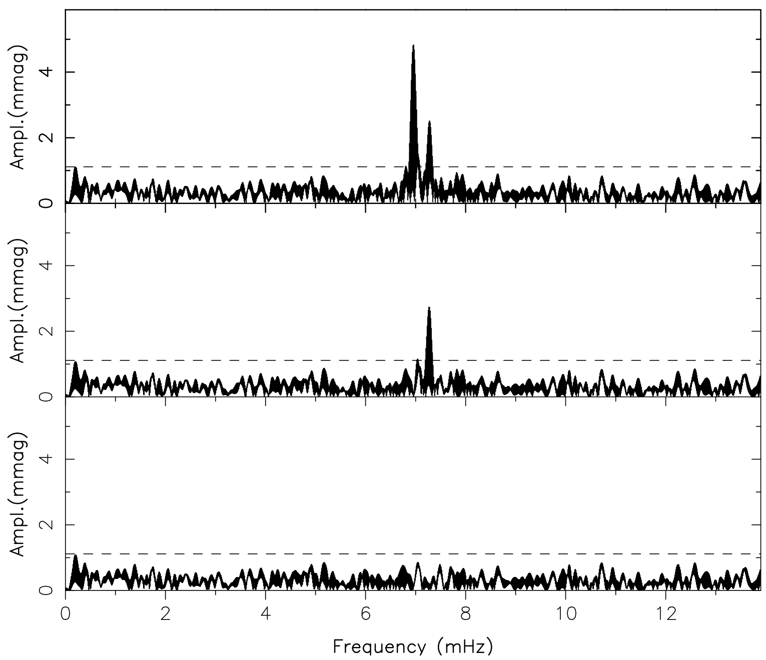

Figure 2: Lomb-Scargle periodograms at subsequent stages of prewhitening for the g' lightcurve. The dashed line indicates the 4σ level after prewhitening with f_1 and f_2 determined within the interval $[17, 23]$mHz.

3. FREQUENCY ANALYSIS

We computed Lomb-Scargle periodograms (Scargle 1982) over the frequency range $[0, 14]$mHz in steps of 0.1μHz for each of the lightcurves and adopted a prewhitening procedure. The results for the g' filter are shown in Fig. 2. We find one dominant frequency of $f_1 = 6.960(2)$mHz with amplitudes of 5.8(8), 5.0(3), and 3.7(4) mmag for respectively u', g', r'. This result is entirely compatible with the one of Solheim et al. (2004). After prewhitening with f_1, we find a second very significant frequency in all three residual lightcurves (middle panel of Fig. 2): $f_2 = 7.267(3)$mHz. This new second frequency has amplitudes 3.8(7), 2.8(3), and 2.0(3) mmag in respectively u', g', r'. The periodograms following the second prewhitening stage reveal no further significant frequencies (see bottom panel in Fig. 2). The dashed lines in Fig. 2 indicate the 4σ level which we adopted as a stop criterion. We conclude to have found two independent oscillation frequencies in SDSS 1717, of which the second one was not known so far. All three lightcurves are in phase with each other for both f_1 and f_2.

4. MODE IDENTIFICATION

We show the amplitude ratios with respect to the g' filter for f_1 and f_2 in Fig. 3. The 1-σ confidence interval is shown only for f_1. The theoretical predictions in the adiabatic approximation are taken from Ramachandran et al. (2004, their Fig.4

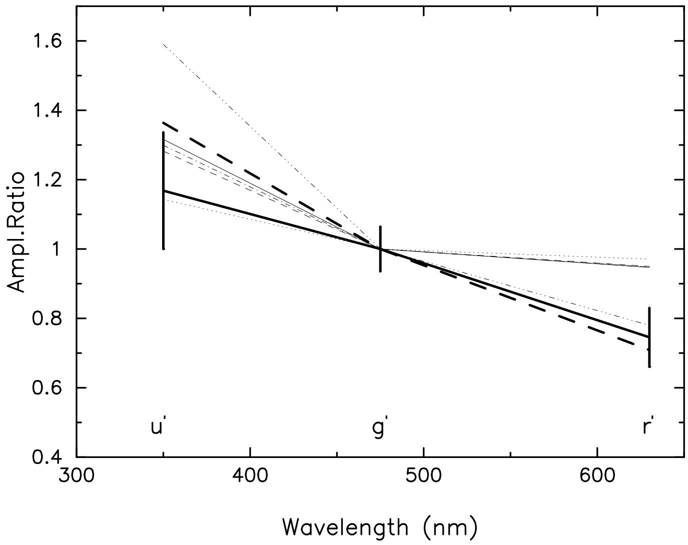

Figure 3: Observed amplitude ratios for f_1 (thick full line) and f_2 (thick dashed line). The 1-σ confidence interval is shown only for f_1. The thin lines are theoretical predictions taken from Ramachandran et al. (2004): dashed-dot-dot-dot: $\ell = 3$, full: $\ell = 0$, dashed-dot: $\ell = 1$, dashed: $\ell = 2$, dotted: $\ell = 4$.

top panel) for the temperature and gravity of SDSS 1717 (Solheim et al. 2004). It is impossible to identify the modes from this plot. For f_1, the ratio u'/g' behaves according to $\ell \neq 3$, while the r'/g' ratio is only compatible with $\ell = 3$. We are currently investigating whether the non-adiabatic approximation (Fontaine, these proceedings) leads to better results. It may also be that unresolved beating affects the observed amplitude ratios and makes them deviate from the theoretical predictions. The error bars for f_2 (not shown) are too large to draw conclusions.

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