Astron. Astrophys. 322, 155–158 (1997)

ASTRONOMY AND ASTROPHYSICS

New ZZ Ceti variables from the Kiso survey*

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Received 4 June 1996 / Accepted 21 November 1996

Abstract. We report the discovery of two new pulsating DA white dwarfs from the Kiso survey of ultraviolet-excess objects. The candidates were selected from their (B-V) and (U-B) color indices. The observations have been performed at the Haute Provence Observatory 1.9m telescope. The new pulsating DA white dwarfs are KUV08368+4026 and KUV11370+4222. KUV08368+4026 shows large amplitude variations and at least two frequencies at 1.62 mHz±0.11 mHz (Period = 618.0 s±44 s) and at 2.02 mHz±0.11 mHz (Period = 494.5 s±28 s). KUV11370+4222 shows a much smaller amplitude and a higher frequency at 3.89 mHz±0.10 mHz (Period = 257.2 s±6.5 s). More observations are needed to confirm additional periods certainly present in these non radial pulsators. The discovery of these two new ZZ Ceti variables increases the number of known pulsating white dwarfs of this type to 26.

Key words: white dwarfs – stars: oscillations – variables – surveys

1. Introduction

Asteroseismology of pulsating white dwarfs offers the opportunity to infer their internal structure and to constrain our current ideas on the still controversial final stages of stellar evolution. However, our knowledge of these late pulsating phases relies on a small sample of known variables. The coolest instability strip, defined by the ZZ Ceti variables or DAV, contains only 24 stars. The two other instability strips for the DBV and PG1159, located at higher effective temperature in the HR diagram, are even less populated. In addition to the work devoted to a better understanding of the physics involved in these non radial pulsators, a continuous search for new variable white dwarfs of the various types is needed. Surveys, either from the ground or from space, have proven to be interesting sources of white dwarf and subdwarf stars, even when their main goal was to search for quasars. One of the most famous examples is the Palomar-Green survey (PG) which almost doubled the number of known white dwarfs and allowed the discovery of some new variable ones (Green, Schmidt, and Liebert 1986). Among the most recent discoveries of new pulsating white dwarfs, the Edinburgh-Cape survey provided two new ZZ Ceti variables: EC23487-2424 (Stobie et al. 1993) and EC14012-1446 (Stobie et al. 1995), increasing appreciably the fraction of the known ZZ Ceti stars in the South hemisphere. The Rosat sky survey has revealed the brightest pulsating PG1159 type star RXJ2117+3412 (Vauclair et al. 1993).

Pursuing our search for new pulsating white dwarfs, we have selected a few candidates from the Kiso survey (Noguchi, Maehara and Kondo 1980; Kondo, Noguchi and Maehara 1984). This survey, whose goal was to detect ultraviolet-excess objects, contains a number of white dwarfs previously not known. In a series of papers, Wegner and collaborators have obtained spectroscopy of about 650 objects from the Kiso survey, allowing their classification and the identification of new white dwarfs (Wegner and McMahan 1985, 1986, 1988; Wegner, McMahan and Boley 1987; Wegner and Swanson 1990a,b; Wegner and Boley 1993). For a sub-sample of spectroscopically identified objects, Wegner et al. (1990) obtained photoelectric photometry from which (B-V) and (U-B) color indices can be derived. We have selected among the DA white dwarfs in this list those with $0.12<(B-V)<0.27$ and $-0.72<(U-B)<-0.48$. These color indices intervals are determined from colors of the known ZZ Cetis, accounting for a generous uncertainty in the photometric measurements. Stobie et al. (1995) have restricted the range of their search to the more severe interval $0.15<(B-V)<0.25$.

We report the discovery of two new variables from this selected sample: KUV08368+4026 and KUV11370+4222.

2. Observations

The observations were performed at the 1.9m telescope of the Haute Provence Observatory. We used the Chevreton's 3-channel photometer equipped with blue-sensitive photomultipliers (Hamamatsu R647-04) in white light. The three channels were measuring simultaneously the variable candidate, a com-

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* Based on observations obtained at the Haute-Provence-Observatory, which is operated by the CNRS.

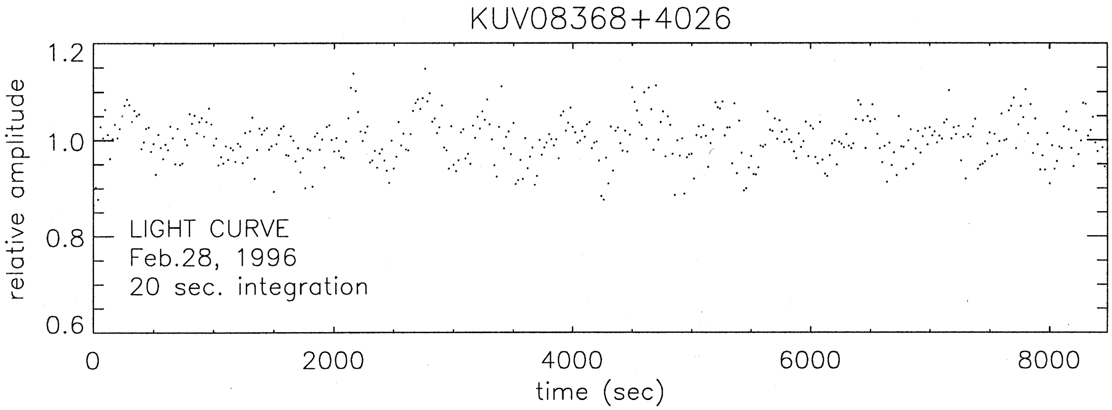

Fig. 1. Normalized light curve of KUV 08368+4026 obtained on February 28, 1996. The data points are averaged every 20 s. The relative amplitude is plotted versus the time in seconds

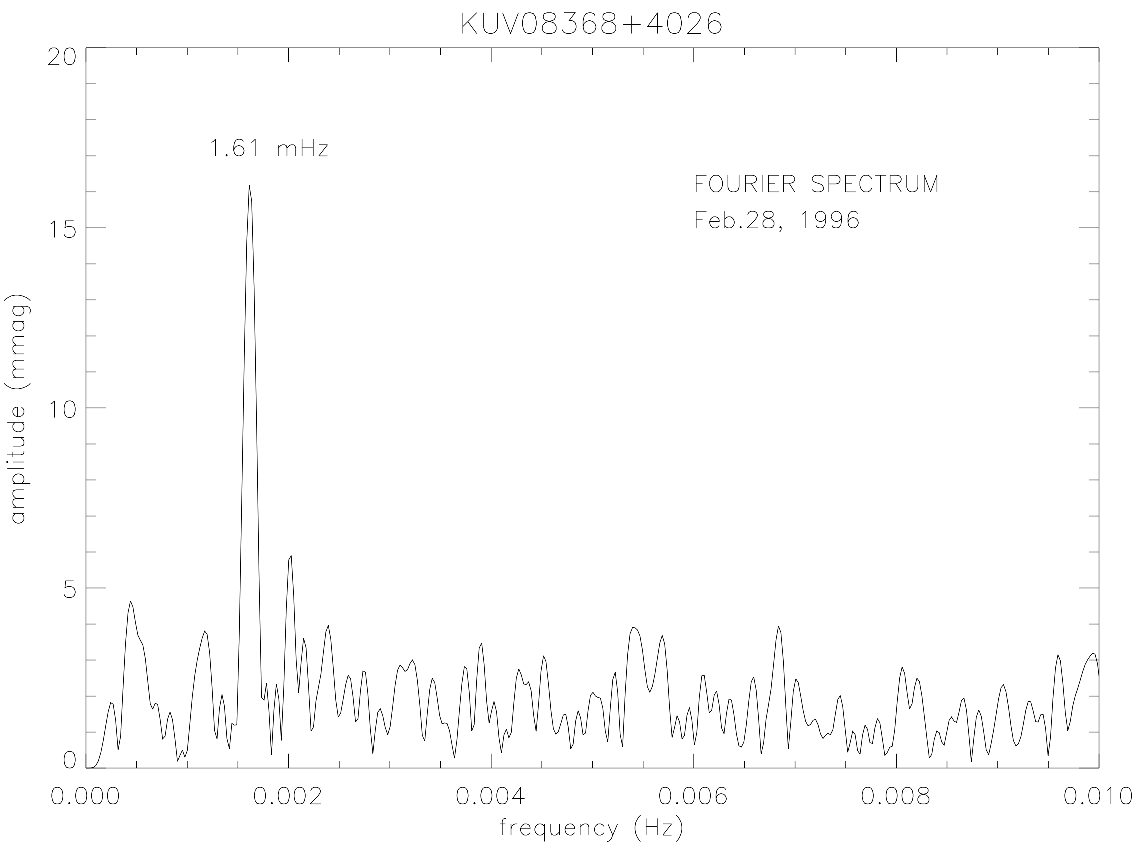

Fig. 2. Fourier spectrum of the KUV 08368+4026 light curve. The amplitude, in millimagnitude is shown as a function of the frequency in the range 0-10 mHz.

parison star and the sky background respectively. We used an integration time of 1s.

KUV08368+4026 is a V=15.55 DA white dwarf (R.A.: 08h36m50.51s; DEC.: +40°25'42.7" (1950)) with color indices (B-V)=+0.22 and (U-B)= -0.59. We obtained a 2.4 hours run on February 28, 1996.

KUV11370+4222 is a one magnitude fainter (V=16.56) DA white dwarf (R.A.: 11h37m02.05s; DEC.:+42°21'57.2" (1950)) with color indices (B-V)=+0.22 and (U-B)=-0.68. A 2.8 hours run was obtained on February 29, 1996. The finding charts for these two white dwarfs are in Kondo, Noguchi and Machara (1984).

3. Data reduction and analysis

The raw data were reduced according to a standard procedure. The sky background is measured at the beginning and at the end of each run on the three channels. These measurements

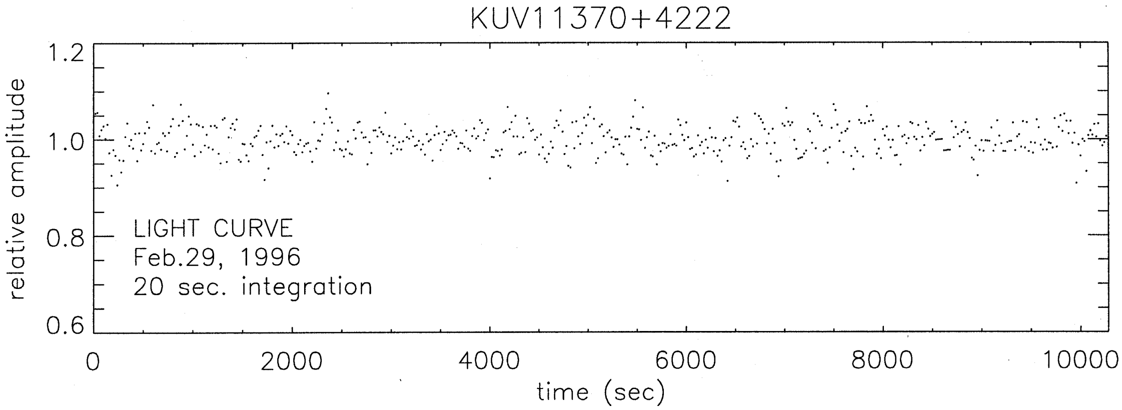

Fig. 3. Normalized light curve of KUV 11370+4222, obtained on February 29, 1996. The data points are averaged every 20 s. The relative amplitude is plotted versus the time in seconds.

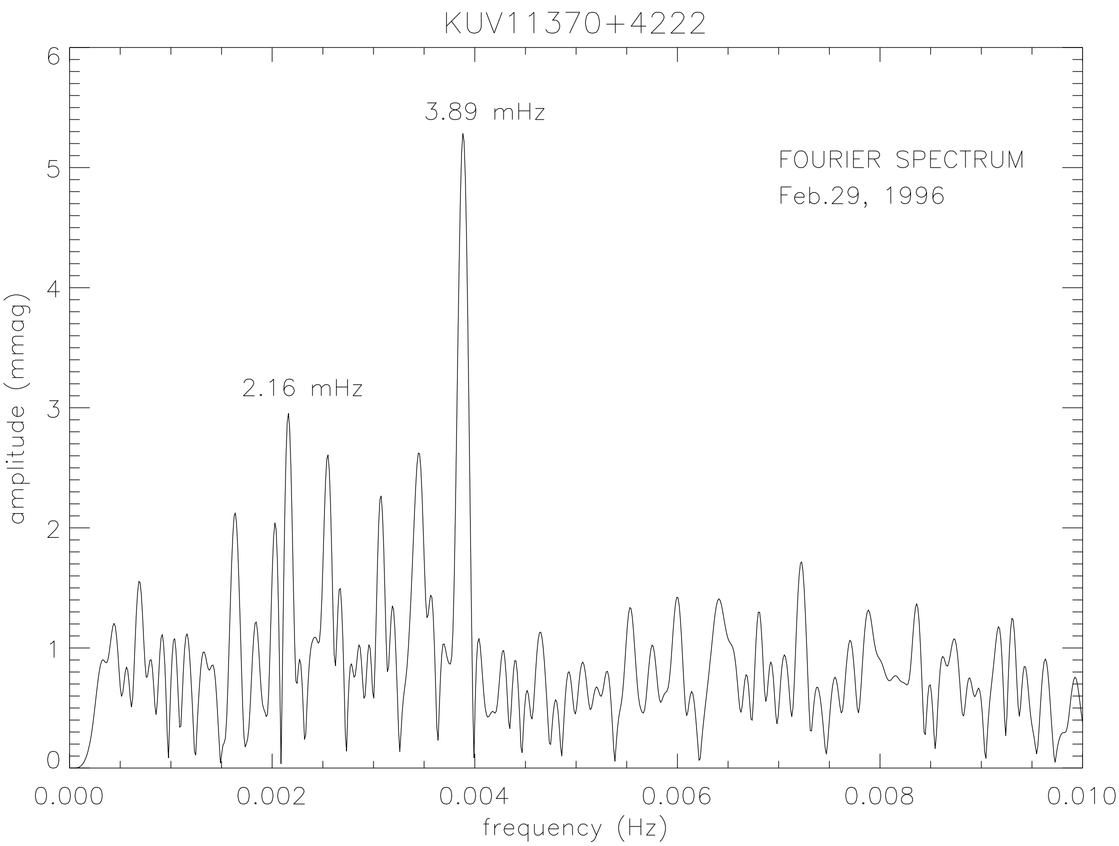

Fig. 4. Fourier spectrum of the KUV 11370+4222 light curve. The amplitude, in millimagnitude, is shown as a function of the frequency in the range 0-10 mHz.

are used to determine the sensitivity ratios between the three channels. The sky background is then subtracted from the counts in the stars channels on a point by point basis. The rapid sky fluctuations are correctly taken into account in this procedure. For the correction of the low frequency variations of the sky transparency during the night, we divide the data by a fourth order polynomial. The data from the candidate star channel are divided by the comparison star channel counts, and are finally divided by the average count number to produce a normalized light curve.

Fig. 1 shows the normalized light curve of KUV08368+4026 with the data points averaged every 20 s. The FFT of this light curve, shown in Fig. 2, has a dominant peak at a frequency of 1.61 mHz$\pm$0.11 mHz (period 618.0 s$\pm$44 s) with an amplitude of 16 mmag. A second peak at a frequency of 2.02 mHz$\pm$0.11 mHz (period 494.5 s$\pm$28 s) of smaller amplitude (5.5 mmag) is marginally detected.

The variations in the normalized light curve of KUV11370+4222, with the data points also averaged every 20 s, have a much smaller amplitude, as seen in Fig. 3. The FFT, shown in Fig. 4, has one dominant peak at a frequency of 3.89 mHz$\pm$0.10 mHz (period 257.2 s$\pm$6.5 s) with an amplitude of 5.3 mmag. Due to the moonlight during the first half of the run, the noise level keeps too high to allow firm detection of more modes in the spectrum. However, our reduction procedure which analyses the whole run in two parts to reduce the noise level, shows that two other peaks may be marginally significant at frequency 2.16 mHz$\pm$0.10 mHz (period 462.9 s$\pm$21.2 s) and 3.41 mHz$\pm$0.10 mHz (period 292.2 s$\pm$8.5 s) with amplitudes of 3.2 mmag and 2.5 mmag respectively. These two peaks are present in the FFT of the two halves of the run.

4. Conclusions

The two new variables are probably multiperiodic. Additional rapid photometry observations are needed to get more informations on the richness of their non radial modes spectrum. The global amplitude-period correlation observed in ZZ Ceti stars, i.e. the amplitude increases with the periods, seems to be verified by the two new variables: KUV08368+4026 has a longer period and a larger amplitude than KUV11370+4222. There is another correlation between the periods (and amplitude) and the effective temperature: cooler ZZ Cetis have longer periods. To check whether the two new variables verify this correlation would require a determination of their effective temperature. The (B-V) color index, usually considered as an effective temperature indicator, is the same for the two stars. They should not have largely different effective temperature even if the (B-V) color index is a rather uncertain temperature indicator. More detailed atmospheric analysis are needed for these two DA white dwarfs.

With the discovery of these two new ZZ Ceti variables, the number of known pulsating white dwarfs of this type increases to 26. When comparing the power spectrum of KUV 08368+4046 with the power spectrum of other ZZ Ceti stars, one finds a striking similarity with G29-38, HL Tau 76 and G255-2. The four of them show large amplitude variations and have common frequencies around 1.6 mHz and 2.0 mHz. That similarity is probably the signature of some fondamental mechanism we still have to decipher.

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