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Study of variability and periodicity in white dwarf stars

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Abstract. We studied the photometric variability in white dwarfs, through the use of the Period04 program, in the periodicity search. A new ZZ Ceti was found with three pulsation periods. In magnetic white dwarves, due to their scale of variation being unknown and the lack of photometric data, no significant period was found.

Resumo. Nós estudamos a variabilidade fotométrica em anãs brancas, a través do uso do programa Period04, na busca por periodicidade. Foi achado uma nova ZZ Ceti com três períodos de pulsação. Nas anãs brancas magnéticas, devido a sua escala de variação ser desconhecida e a falta de dados fotométricos, não foi encontrado nenhum período significativo.

Keywords. white dwarfs – stars: variables: ZZ Ceti

1. Introduction

White dwarf stars are the final evolutionary state of stars with mass lower than ∼ 10 solar masses, corresponding to at least 95% of all stars in the Milky Way. The most common class of white dwarf is the one with hydrogen atmosphere. Those stars have photometric variability due to stellar pulsation when they cool to an effective temperature of ∼ 12000 K. In these case, they are called ZZ Ceti stars. About 4% of single white dwarfs have a magnetic fields (Kepler et al. 2013). The variability can be as a result of atmospheric spots, caused by the change of energy transport in the stellar atmosphere by the magnetic field.

2. Methodology

We present the firsts results using Period04 (Lenz et al. 2005) which calculates the Fourier transform (FT) from the light curve of each star, decomposing a function of time (a signal) into the frequencies that make it up, what will show the variability of each object and, if possible, determine the rotational period.

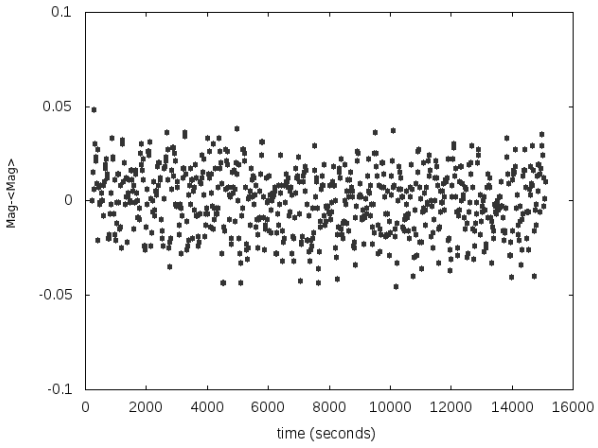

Figure 1. The light curve of the star ZZ Ceti J082804.63+094956.66, observed with SOAR telescope over 4 hours. The *x*-axis indicates time and the y-axis gives the measured magnitude minus the average magnitude <Mag>.

3. Results

3.1. J082804.63+094956.66

The light curve of the star observed with the telescope SOAR, displayed in figure 1, presents three main peaks in its Fourier transform, as well the pre-whitening process, displayed in figure 2, where the dashed line is 3 times the average value <*A*> of the amplitude of the peaks. The main peak gave us a period P_1 = (286.1 ± 0.2) s, the second peak P_2 = (196.39 ± 0.08) s and the third peak P_3 = (255.4 ± 0.3) s. That star is a new ZZ Ceti with effective temperature T_{eff} = (11560 ± 70)K and mass M = (0.73 ± 0.02)$M_\odot$.

3.2. J064532.74+280330.5

The same method used before was apply to a magnetic white dwarf. The light curve of this star, available in Mikulski Archive for Space Telescopes (MAST) from Kepler spacial mission, is shown in figure 3 and its FT in figure 4. However, in this case, we used the significance threshold as 5 times the average value <*A*> of the amplitude, because of the Kepler Satellite's rocket, when it is turned on to center the object again, causing a non-real variation in the light curve. None of the peaks correspond to a periodic variability.

4. Conclusion

A new star ZZ Ceti has been discovered with three pulsating periods. For magnetic white dwarfs, it was not possible to find pulsation variability, due to their scale of variation, that can vary from seconds to years, and of not having photometric data. We will apply the technique presented to other variable white dwarf stars observed with SOAR telescope and Observatório do Pico dos Dias (LNA) during the years 2016 and 2017, in order to determine their periodicities.

References

Kepler, S. O. et al. 2013, MNRAS, 429, 2934
Lenz P., Breger M. 2005, CoAst, 146, 53

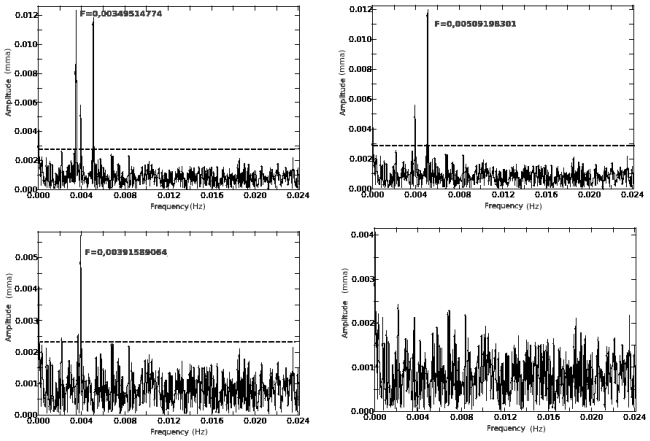

Figure 2. FT of the light curve of the star ZZ Ceti J082804.63+094956.66 with the three peaks, in decreasing amplitude order P_1 = (286.1 ± 0.2), P_2 = (196.39 ± 0.08) and P_3 = (255.4 ± 0.3) s, is shown in the top left image, as well the pre-whitening process in the others three images. The dashed line is the 3<A> significance threshold.

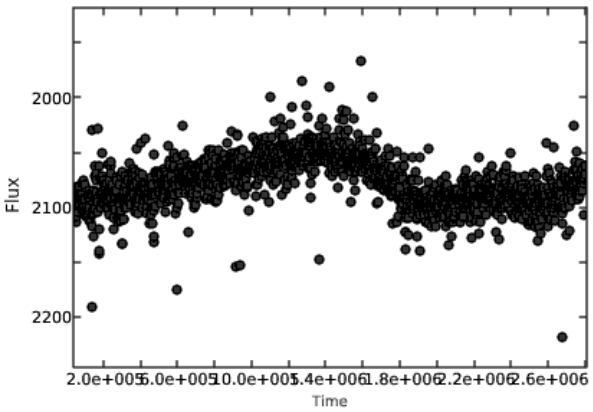

Figure 3. Light curve of magnetic white dwarf J064532.74+280330.5 available in Mikulski Archive for Space Telescopes (MAST) from Kepler spacial mission. The x-axis is time in seconds and the y-axis is the relative flux.

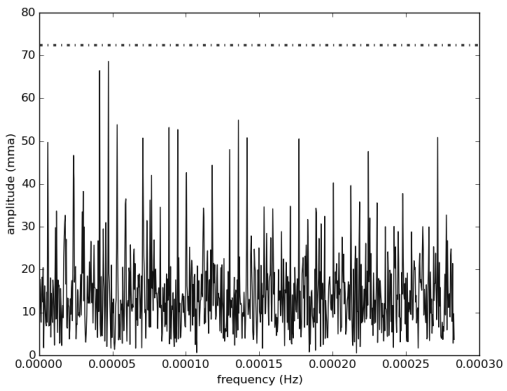

Figure 4. FT of magnetic white dwarf J064532.74+280330.5 The dashed line is the 5<A> significance threshold of the data.