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Identification of PG 2303+243 pulsation modes

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Abstract. For this study we used total of 40 possibly independent frequencies of pulsation of a cool DA variable star PG 2303+243 observed in 2004 and 2005. Using period spacing diagrams we indentified 10 $l = 1$ and 14 $l = 2$ modes with a mean period spacing of 52.00 s for $l = 1$ modes and 31.85 s for $l = 2$ modes.

1. INTRODUCTION

PG 2303+243 is a cool DA variable (also called ZZ Ceti) star having a rich pulsation spectrum and variable amplitudes. Using photometric observations of PG 2303+243 from 2004 we detected 24 possible independent frequencies within a period interval of 206-2234 s [1]. During 5 consecutive nights in 2005 observations of PG2303+243 were repeated at Molėtai Obs. (Lithuania) and 16 additional possible independent frequencies were detected. For this study we used a total of 40 frequencies (see Fig. 1). 25 of them were identified as $l = 1$ and $l = 2$ modes (Table 1).

2. MODES IDENTIFICATION

The Fourier transform (FT) spectra of PG 2303+243 obtained in 2004 and 2005 are clearly different (Table 1). Although some peaks can be found at about the same frequency, they have different amplitudes. The most stable mode is detected at 1622μHz (616 s). Even though its amplitude from 2004 to 2005 decreased by almost twice, it still was one of the strongest peaks in the FT spectrum.

Pakštienė et al. [1] claimed that the mode at 616 s is a $l = 1$ mode. We compared our results with those obtained by Romero et al. [2]. The latter presented an asteroseismological analysis of 44 bright ZZ Ceti stars based on a new set of fully evolutionary DA white dwarf models characterized by detailed chemical profiles from the centre to the surface [2].

Romero et al. [2] used only four main frequencies of PG 2303+243 with the largest amplitudes to estimate the physical parameters for the star and fixed the harmonic degree to be $l = 1$ for two main modes, 616.4 and 965.3 s, while 863.8 and 394.4 s were allowed to be of degree $l = 1$ or 2.

Our study of period spacings pattern in FT spectrum of PG 2303+243 confirmed $l = 1$ for 616.4 and 965.3 s, and $l = 2$ for 394.4 s, while the mode at 863.8 s was identified as a $l = 1$ mode. Another closely spaced mode at 873.2 s most likely is a $l = 2$ mode. Using 394.4, 616.4 and 965.3 s as datum-periods we estimated l values for most of the modes (see Fig. 1 and Table 1). We were not sure about two modes at 778.5 and 784.5 s. Both modes had high amplitudes, but only one of them could fit our period spacing pattern for $l = 2$. As was written before, these two modes may belong to a multiplet with a central peak at about 778.5 s. We labelled this mode a $l = 2$ mode. If the central peak of the multiplet were at 784.5 s,

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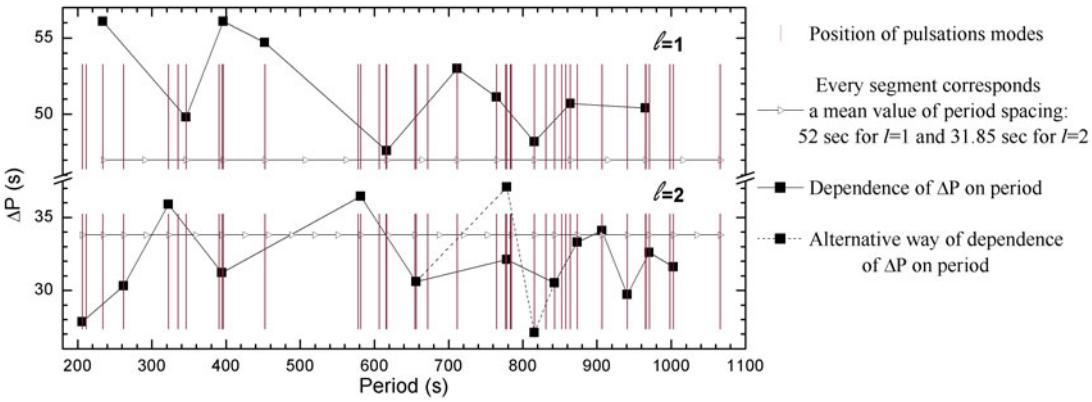

Figure 1. Diagram of "forward" period spacing for PG 2303+243.

Table 1. List of 25 identified modes of PG 2303+243.

P (s)	A (mma)	ΔP (s)	l	k	year	P (s)	A (mma)	ΔP (s)	l	k	year
206.1	2.3	27.8	2	3	2004	778.5	20.9	32.1	2	21	2005
234.1	3.2	56.1	1	1	2004	784.5	14.5	–	(2)	(21)	2005
261.8	2.3	30.3	2	5	2004	815.6	12.4	48.2	1;(2)	12;(22)	2005
322.5	3.1	35.9	2	7	2004	842.7	5.3	30.5	2	23	2005
346.3	3.8	49.8	1	3	2005	863.8	7.4	50.7	1	13	2004
394.4	7.3	31.2	2	9	2004	873.2	3.9	33.3	2	24	2004
396.1	3.7	56.1	1	4	2005	906.5	8.3	34.1	2	25	2005
452.2	2.2	54.7	1	5	2004	940.6	7.5	29.7	2	26	2005
581.7	4.4	36.4	2	15	2005	965.3	19.7	50.4	1	15	2004
616.4	31.3	47.6	1	8	2004	970.3	5.1	32.6	2	27	2005
656.0	2.7	30.6	2	17	2004	1002.9	5.4	31.6	2	28	2005
711.5	2.0	53.0	1	10	2004	1066.1	2.2	–	1;2	17;30	2004
764.5	6.2	51.1	1	11	2005						

it would fit the period spacing pattern of $l = 2$ with no big difference. The mode at 1066.1 s may be both a $l = 1$ or a $l = 2$. The mode at 815.8 s is most likely a $l = 1$ mode, but it may be a $l = 2$ as well, as it is shown in Fig. 1 using dashed line.

The k values for $l = 1$ modes fit very well the values given by Romero et al. [2] with the $k = 1$ mode at 234.1 s, while k values for $l = 2$ may be slightly different. According to Romero et al. [2], the k value for the mode at 206.1 s was set up as equal to 3. As this mode is the first in the list of periods, it may be a $k = 1$ as well (we need to check this with additional analysis).

We couldn't recognise modes of period longer than 1066.1 s because the spaces between them are too big to find unambiguous l values.

3. CONCLUSIONS

As a result of this study we analysed the PG 2303+243 pulsation spectrum and found 10 $l = 1$ and 14 $l = 2$ modes with a mean period spacing of 52.00 s for $l = 1$ modes and 31.85 s for $l = 2$ modes. As Romero et al. [2] used only four main frequencies of PG 2303+243 with the largest amplitudes to

estimate the physical parameters of the star, we suggest to calculate a model of PG 2303+243 using more pulsation modes with known l and k values, determined in this study using observations obtained in 2004 and 2005.

References

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