PAST AND FUTURE OF Balloon090100001, A KEY STAR IN THE STUDY OF sdB PULSATIONS

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Abstract: We present the state of the art on the extremely interesting sdB object Balloon 090100001 (hereafter BA09). It was previously identified as a V361 Hya member, as it shows short period oscillations due to stellar pulsations, which are theoretically attributed to p-modes. Later, long period variations were also discovered in the light curve of this object. Long period pulsations are typical of the other so far known class of pulsating sdBs: PG 1716 stars and whose modes are identified as g- modes. BA09 thus represents a link between the two pulsating subclasses, and the best candidate for an exhaustive seismological study, as p- and g- modes report information on different depths inside the star.

1 Introduction

The presence of stellar oscillations in some B-type hot subdwarfs (sdBs) allows the use of additional techniques to understand this evolutionary state, in between the Red Giant Branch and White Dwarf phases.

Nowadays two subclasses of pulsating sdBs are distinguished: V361 Hya type (originally EC 14026) and PG 1716 type ones. The former show rapid oscillations, on the order of five minutes, with amplitudes around 10 mmag [1], while the latter, slightly cooler, display flux modulations with longer periods, on the order of one

hour, and amplitudes of ∼1 mmag [2]. The κ mechanism seems to be the responsible of mode excitation in both subclasses, although in V361 Hya the oscillations are identified with p-modes of low degree n and order ℓ, whereas g-modes of high degree and order are excited in PG 1716 objects [3].

However, the limit between V361 Hya and PG 1716 stars are not completely clear, as their respective instability regions in the $T_{\rm eff}$-$\log g$ diagram are very close, even a partial overlap being possible. This fact has recently been confirmed, when at least one long period oscillation mode has been detected in HS 0702+6043 [4], a V361 Hya member until that date. This discovery involves a great deal for its theoretical explanation, as no structural model exhibits excited frequencies in both the p- and g- mode ranges simultaneously.

2 Balloon 090100001: past

Since 1991, when BA09 is identified as an sdB [5], no more references are found about this target until 2004. This year, flux variations with one dominant period at 365 s, and other independent one at 264 s are found [6]. This oscillating behaviour makes BA09 a new member of the V361 Hya class. In Figure 1 the amplitude spectrum found by [6] is displayed.

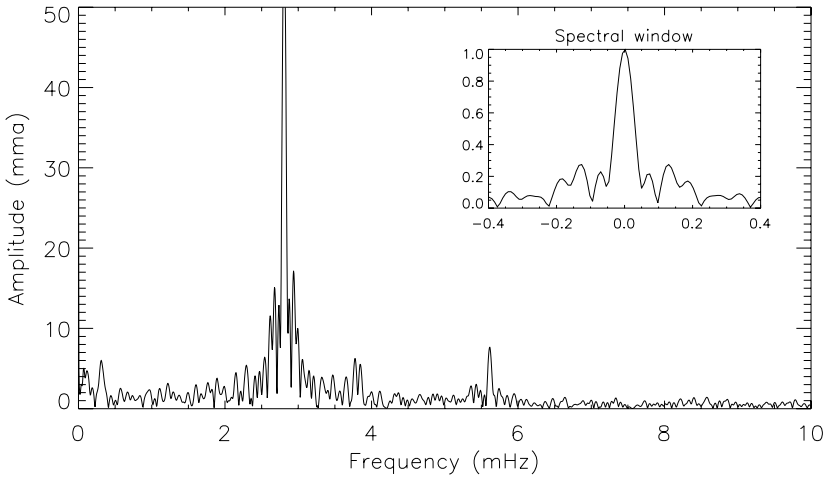

Figure 1: Amplitude spectrum of BA09 obtained when its pulsation nature was discovered [6]. The spectral window of the observations is displayed enclosed.

In a following photometric campaign with higher resolution, the presence of more frequencies in the p-mode range are detected, just as at least three frequencies in the

g-mode region [7]. In Figure 2 the amplitude spectrum found by [7] is shown. Note that the y-axis has been truncated (the main peak has an amplitude ∼50 mma) in order to show the low amplitude features in better detail.

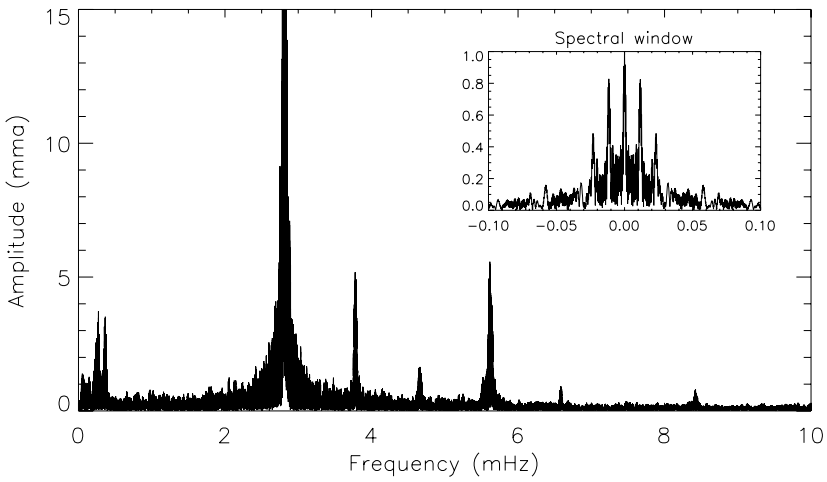

Figure 2: Amplitude spectrum of BA09 obtained when the long period oscillations (< 1 mHz) were discovered [7]. The spectral window of the observations is displayed enclosed.

3 Balloon 090100001: future

The presence of p- and g- modes in the spectrum of the star converts BA09 in the second sdB, together with HS 0207+604, displaying typical pulsations of both pulsating classes simultaneously. Contrary to the latter, with a few excited modes, BA09 presents a rich spectrum in the p-mode region as well as in the g-mode range, which makes it the most attractive object in the sdB field for a seismological study.

With the intention of performing one of the most exhaustive pulsation analysis of an sdB, our group has organized a multi-site photometric campaign, with eight telescopes participating around the Earth. For this purpose a web page has been designed (http://webpages.ull.es/users/raquelor), where all details concerning the campaign are included. The data analysis is under the way, and we hope that a relevant amount of information about the exciting mechanism, the internal structure and the link between the two classes of pulsating objects will be obtained

Acknowledgements: R.O. acknowledges Gobierno de Canarias for its financial support. A.U. acknowledges financial support from the Spanish MEC under research

contract AYA2003-09499. This work has received financial support from the Spanish Plan Nacional del Espacio under project ESP2004-03855-C03-03.

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