

## Follow-up observations of the DSCT V350 Peg

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### Abstract

We present all the CCD photometric observations of the  $\delta$  Scuti star V350 Peg performed by us until now. The data have been acquired between 1997 July and 2002 October. A large part has been analysed and presented previously (Vidal 2002a). The new data of 2002 confirm the former conclusion that two frequencies of very similar amplitudes are excited in this star. The entire data set consists of 16191 measurements collected during 48 nights, and may be very helpful to investigate the detailed behaviour of this basically double-mode  $\delta$  Scuti variable if future campaigns are held at a later stage.

### Introduction

V350 Peg (HIP 115563 = HD 220564) was discovered to be a  $\delta$  Scuti variable star by the Hipparcos satellite (ESA 1997). In papers by Vidal et al. (2002a,b) based on observations from 1997 mainly, the star was shown to be a multiperiodic pulsator. Two relatively close frequencies with similar amplitudes, 5.840 and 5.668 c/d, were found. These could not completely explain all the variations. The fact that two equally dominant, close frequencies were found and that non-radial modes are possibly excited made us conclude that this star is a worthwhile target for a multi-site campaign. We started a co-operation from

3 sites on 3 different continents and began to gather new data in 2002. Regrettably, due to various problems, data from only one longitude were secured (2 sites). We present here all the CCD differential data that were used in the previous analysis (Vidal 2002a), as well as the new data obtained during the follow-up campaign.

## The data

The data were collected at Monegrillo Observatory (40cm Newtonian), Esteve Duran Observatory (60cm Cassegrain and 20cm Schmidt-Cassegrain) and Beersel Hills Observatory (40cm Newtonian). Cameras used are a SX Starlight CCD camera with a Sony ICX027BL chip, an Audine camera with a Kodak KAF-0400 CCD chip, and an SBIG ST10 XME camera with Kodak KAF3200ME chip. A V filter according to Bessel's specifications was used. Table 1 lists the telescope and equipment used by each observer and the observer's code. Exposure times ranged from 3 to 30 seconds depending on local conditions. Image cleaning (darkframing and flatfielding) followed by aperture photometry was carried out using a software package called LAIA (Laboratory for Astronomical Image Analysis) for the frames obtained at Monegrillo and Esteve Duran observatories and the Mira AP software (Axiom Research Inc.) for the frames from Beersel Hills Observatory.

The brightness of V350 Peg was measured with respect to HIP 115545 (HD 220538), with SAO 73234 serving as check star. Nightly standard deviations of  $\Delta V$  between check and comparison star ranged between 5 and 13 mmag.

In total we collected 16191 measurements during 48 different nights between 1997 and 2002. The data consist of 7131 differential photometric observations gathered during more than 175 hours on 31 nights for the 1997-98 season, 381 observations obtained during 21 hours on 4 nights in 2001 and 8679 observations gathered during 86 hours on 13 nights for the 2002 season.

Table 2 gives the format in which the data are presented, together with an identification of the comparison stars. The complete dataset (including the data used in Vidal 2002a) is now available under catalogue with reference II/242 (<http://cdsweb.u-strasbg.fr/cgi-bin/qcat?II/242>) from the Vizier Catalogue Service (CDS, Strasbourg).

## Analysis and conclusion

It was necessary to eliminate colour differences between the various data sets in order to combine the data from the multi-site campaign. Since the variable and the check star have similar spectral types (F2 versus F0), the average difference

Table 1: Observer codes

Code	Observer	Observatory	Instrumentation
BHO	Van Cauteren-Lampens	Beersel Hills	40cm Newtonian SBIG ST10 XME
EG1	E. García-Melendo	Esteve Duran	60cm Cassegrain SX Starlight
EG2	E. García-Melendo	Esteve Duran	60cm Cassegrain Audine
EG3	E. García-Melendo	Esteve Duran	C8 Schmidt-Cassegrain Audine
EG4	E. García-Melendo	Esteve Duran	C8 Schmidt-Cassegrain SX Starlight
JVS	J. Vidal-Sáinz	Monegrillo	40cm Newtonian SX Starlight

Table 2: Format of the data file

Bytes	Format	Description
1- 9	F9.4	Heliocentric Julian Date - 2450000
11-16	F6.3	Instrumental $\Delta V$ in the sense variable (V350 Peg) - comparison star (HD 220538)
18-23	F6.3	Instrumental $\Delta V$ in the sense check star (SAO 73234) - comparison star (HD 220538)
25-27	A3	Observer code

between the check and the comparison star for each night was subtracted from the differential data for the variable star. By using a comparison star of similar brightness as the variable we kept the benefit of higher accuracy. The 2002 data were then analysed with the period-search program Period98 (Sperl 1998).

The frequency spectrum is illustrated by Fig. 1. Two frequencies at 5.839 and 5.670 c/d, each with a semi-amplitude of about 25 millimag, are clearly detected. Error bars (half width at half maximum) on the frequencies are on the order of 0.008 c/d. The frequency spectrum after prewhitening, is given in Fig. 2. The residual standard deviation of the data is 19 mmag, a reduction of 40%.

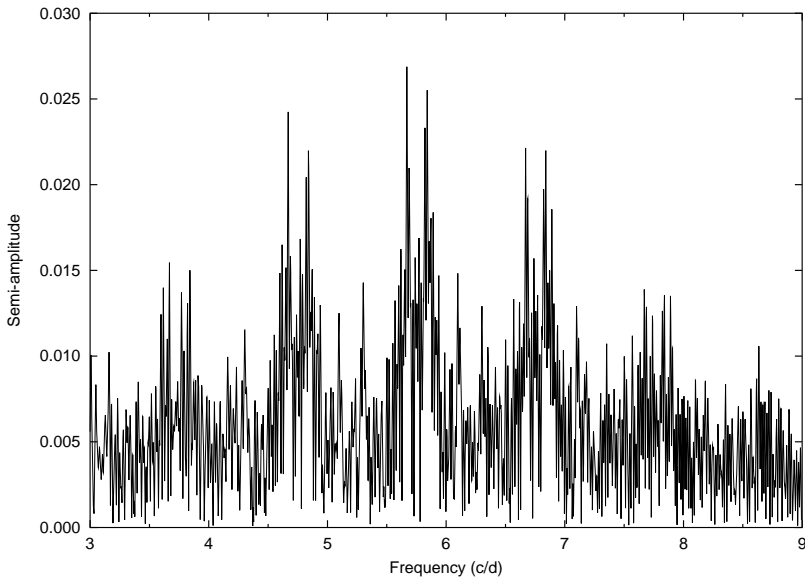


Figure 1: Frequency spectrum of the 2002 data

The frequencies found, perfectly match the previously determined values of 5.840 and 5.668 c/d (Vidal et. al. 2002a,b), meaning that these two frequencies have remained stable since 1997. When the data were combined with the 4 nights of late 2001 (Vidal et. al. 2002a), no change of the frequency values was found. Due to the length of the time elapsed between the observing campaigns of 1997 and 2002, it was impossible to determine unambiguously the exact number of cycles between the two data sets, so that a more accurate period based on all the data can not be given.

Light curves from 2002, with the best two-frequency fit superposed, are

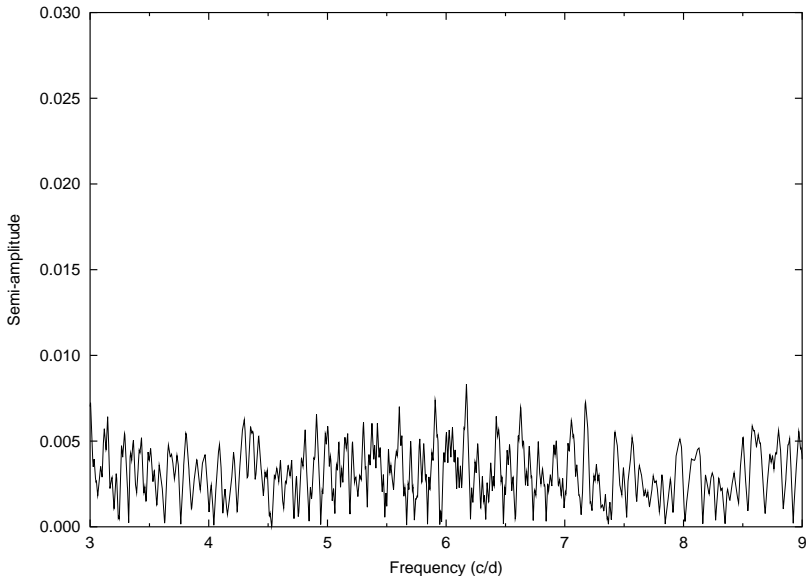


Figure 2: Frequency spectrum after prewhitening the two main frequencies

shown in Fig. 3. There is no other significant frequency detected in the recent data. Deviations between the observations and the model curves based on the two most dominant frequencies may be possibly due to the presence of some hitherto undetected frequency (with semi-amplitude below 12 mmag), as well as to small additional zero point shifts.

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## References

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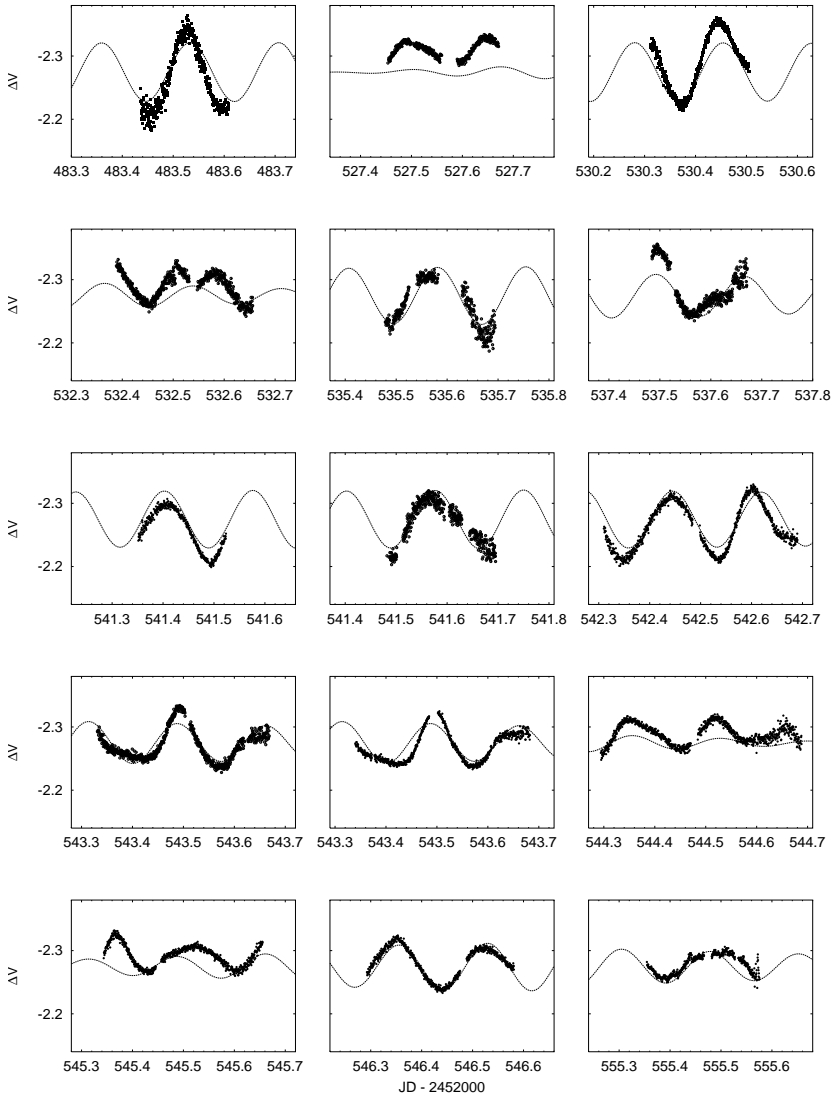


Figure 3:  $V$  light curves of V350 Peg during 2002 with a 2-frequency fit