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IS PRAESEPE KW284 ACTUALLY A DELTA SCUTI STAR?

The δ Scuti stars are nearly a hundred radial and non-radial pulsators located, close to the Main Sequence, at the Cepheid instability strip (Rodríguez et al., 1994), being objects of extreme interest for asteroseismic investigations (Brown and Gilliland 1994).

These variables show short periods (typically shorter than 5 hours and longer than half an hour) and luminosity amplitudes ranging from several tenths of a magnitude to a lowest level which is continuously decreasing from one day to another (frequency peaks with amplitudes of the order of 0.4 mmag have been found in recent campaigns).

In the last few years, extremely good observational results have been obtained on δ Scuti stars, especially on their multi-periodic character, which seems to be more the rule than the exception (Breger, 1994). On the other hand, pure theoretical work is also currently undertaken on the subject (see e.g. Dziembowski, 1994).

A connection between high quality frequency spectra, which are being obtained, and theoretical work, carried out in order to interpret them, is being produced (Goupil et al. 1993, Pérez Hernández et al. 1994).

On the fourth photometry campaign of the STEPHI network, the δ Scuti-like stars BN Cnc (HD73576) and BUC nc (HD73576) were simultaneously monitored during a three-week, three-continental run, in February 1992 (Belmonte et al., 1994). Both stars are members of the Praesepe cluster. The "constant" star HD 73712 (KW284) was chosen as comparison star since, at that moment, no variability about it had been reported.

However, we were really surprised when we realized that KW284 had been discovered as a possible Delta Scuti star by Rolland et al (1991), with observations performed in February 1991, a year before our campaign.

Rolland et al. (1991) obtained observations over two distant nights (five hours on JD 2 448 303 and five hours on JD 2 448 311). The resolution in frequency associated to such a window is very close to the one obtained for one single night of 5 hours (50μHz). We thus have considered that the error bar on the frequency determined by Rolland et al. was of order $\pm 20\mu$Hz.

We have looked for this $80\pm 20\mu$Hz oscillation frequency in our data. In principle, we noticed that some frequency peaks, that we had identified as possible noise signals in previous analyses, were found at the correct frequency and with significant amplitudes (Figure 1).

On the other hand, during the STEPHI IV analysis, we had produced and analysed three different differential light-curves: BU Cnc/HD 73712, BN Cnc/HD 73712 and BU Cnc/BN Cnc. The comparison of these three light curves was used to ascertain which oscillation frequency corresponds to which star.

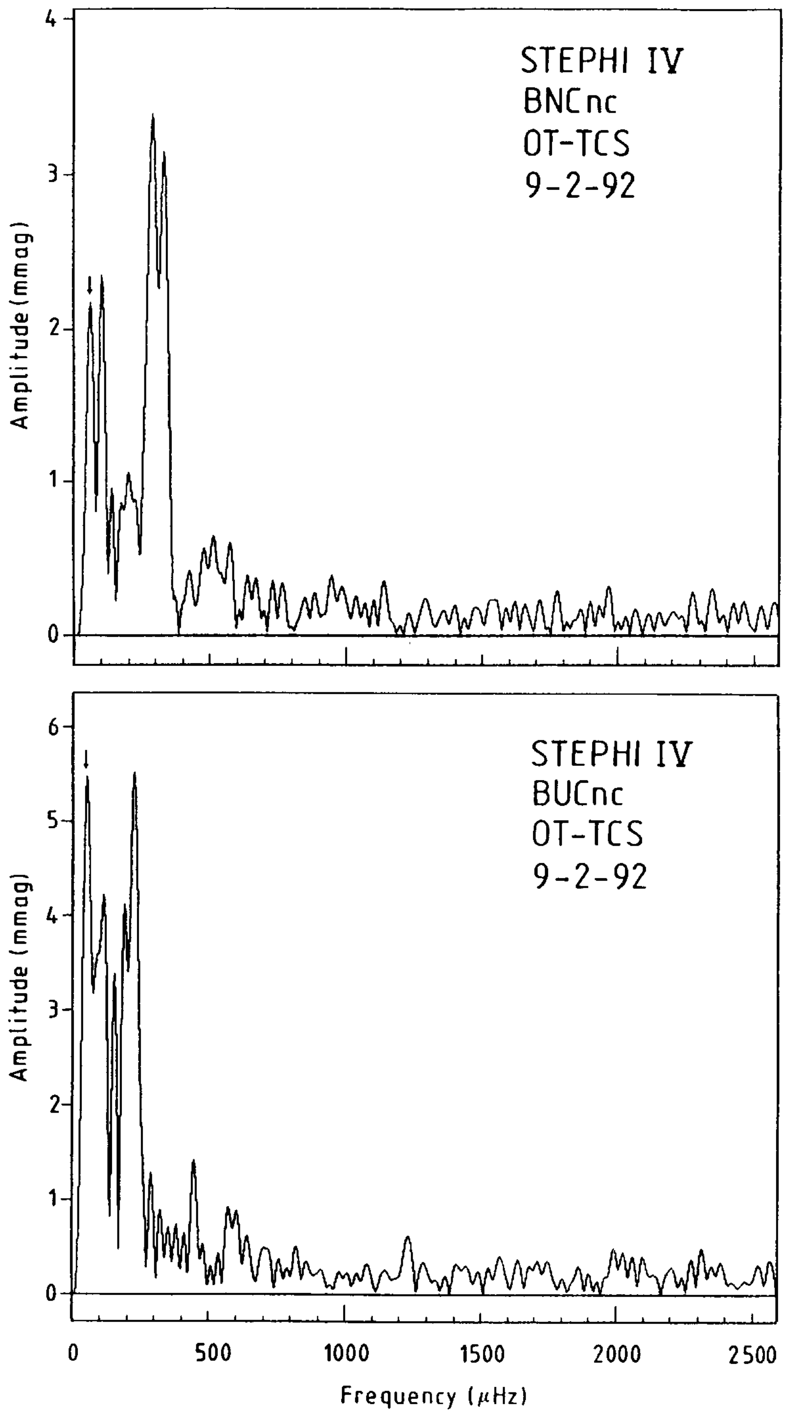

Figure 1: Frequency spectra of the time series BN/Comp. and BU/Comp., for February 9, 1992, at Observatorio del Teide. A common peak, at 70±30 μHz, was initially believed to be caused by noise. However, we now consider that it could be related to an oscillation frequency of the "constant" comparison star KW284.

Besides the results produced in Belmonte et al. (1994), the presence of a peak at 69.5±0.5μHz was noticed in the two light-curves, involving the comparison star HD73712 and not in the third light curve. The detection confidence level was around 20% and, in the absence of further information, this peak was attributed to noise in the comparison light-curve. However, the discovery of a 80±20μHz oscillation frequency in this star obliged to revise this detection.

We will not go into the details of the statistical test used in the analysis of the STEPHI campaigns. This test is derived from the Fisher's test (Fisher 1929, Koen 1990, Michel 1992). The point is that the confidence level attributed, according to this test, depends on the width of the frequency range in which one expects to detect oscillation frequencies. For a given peak, this dependence goes like the power of the frequency range ratio: $CL1 = CL2^{(FR1/FR2)}$, where $CL1$ is the confidence level associated with the frequency range $FR1$, and $CL2$, with the frequency range $FR2$. This simply reflects the fact that the probability to find, in a Fourier spectrum, a noise peak higher than a given amplitude increases with the number of events considered, i.e. with the number of independent frequency samples investigated.

In the STEPHI IV analysis, we were looking for oscillation frequency in the complete range of oscillation frequencies expected for Delta Scuti stars: $\sim$46μHz to $\sim$1500μHz, corresponding to periods from 6 hours to 10 minutes. However, if we now consider the detection, by Rolland et al. (1991), of an oscillation frequency in the range [60μHz, 100μHz] as completely secure (confidence level 100%), and if we investigate this restricted frequency range in the STEPHI data, the confidence level of the peak we see at 69.5μHz becomes: $0.2^{(40/1450)} \geq 95\%$.

We thus conclude that the oscillation frequency detected by Rolland et al. is very probably the 69.5±0.5μHz detected in the STEPHI IV data. The difference in amplitude between the two analyses ($\sim$4 mmag for Rolland et al. and 1.7 mmag and 3.0 mmag, for the two light curves considered in the STEPHI analysis) is not related to an amplitude change of the mode, but rather it can perfectly be attributed to the noise, which we found to be rather high at low frequency. Consequently, KW284 is probably a long period Delta Scuti star, located in the upper part of the Main Sequence –almost evolving to subgiant– where it is crossed by the instability strip.

Further data will be needed to establish its frequency spectrum with high accuracy. Hopefully, further campaigns of STEPHI or the Delta Scuti Network will provide such high quality data in the future.

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