

OBSERVATION OF A VARIABLE, ZZ CETI
WHITE DWARF: GD154

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The ZZ Ceti stars form a class of variable white dwarfs: the hydrogen dominated atmosphere ones, which do pulsate in an instability strip in the effective temperature range 13000K–11500K. We know 22 such ZZ Ceti white dwarfs. Their variations are caused by nonradial g-mode pulsations with periods are in the range 100–1000 seconds.

A subsample of the ZZ Ceti stars shows amplitude variations on time scales of the order of one month. These variations could be driven by non-linear phenomena.

One of these potentially non-linear pulsators, GD154, is on the red edge of the ZZ Ceti instability strip. It was first observed on May 1977 (Robinson et al. 1978). They obtained a power spectrum dominated by one mode

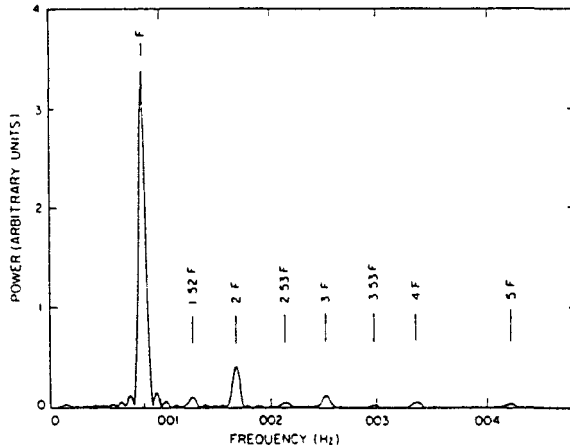


Fig. 1. The power spectrum of the light curve of GD154 on the night of 1977 May 17 (UT). The peak labeled F is the fundamental frequency of the light curve.

(frequency F), its harmonics (nF) and “half integer modes” $((2n + 1)F/2)$ (Fig. 1). Such a spectrum could be characteristic of resonant mode coupling or of a system on the way to chaos. Accordingly, a Whole Earth Telescope campaign (Nather et al. 1990) was organized on May 1991 to study GD154. The goal was to look for the $((2n + 1)F/2)$ modes and amplitude variations.

Eight telescopes at different longitudes worked together to collect continuous data (Fig. 2). The coverage was about 50% from May 13 to 25 (Fig. 3). The resolution was about 10^{-6} Hz (1/12 days).

The Fourier Transform of GD154 light curve was computed (Fig. 4). A comparison of this new power spectrum with the previous one and shows that:

- there were no “half integer modes” during the W. E. T. campaign
- the light curve is dominated by 3 frequencies: f_1 (0.842 mHz), f_2 (0.918mHz) and f_3 (2.484mHz).
- most of the other peaks are linear combinations or harmonics of those frequencies: $2f_1$ (1.683mHz), $f_1 + f_2$ (1.761mHz), $2f_2$ (1.837mHz), $f_3 + f_1$ (3.326mHz), $f_3 + 2 \cdot f_1$ (4.169mHz).

Follow up observations were obtained from June 6 to June 12 from two telescopes (in Arizona and Canaries). Fig. 5 shows the Fourier Transform of these data. The same frequencies f_1 , f_2 and f_3 and their linear combinations and harmonics are still the only features. The main difference with the previous spectrum is the amplitude of the f_2 mode: it is now three times the previous value.

During the W. E. T. campaign and the subsequent follow up observations, the “half integer modes” were not detected. Nonlinear phenomena could

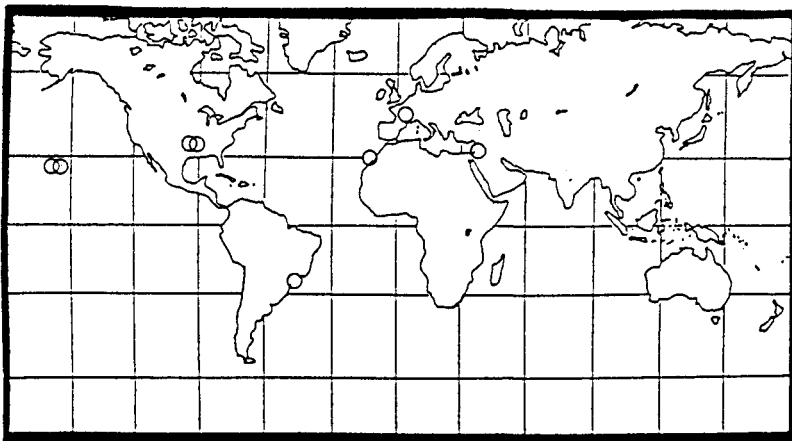


Fig. 2. During the W.E.T. campaign, eight telescopes were observing all around the world: Mauna Kea (C. F. H. and 24 inch), Texas (Mc Donald), Brazil (Itajuba), Canaries (La Palma), France (O. H. P.) and Israel (Wise).

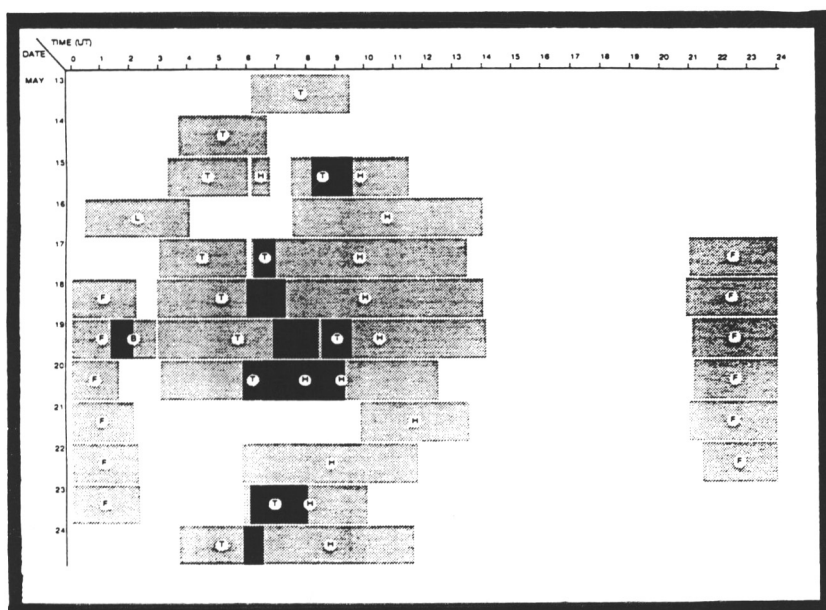


Fig. 3. W.E.T. coverage of GD154. On the vertical axis we plotted the days (13–24) and on the horizontal axis the U.T. Light grey corresponds to one telescope observing, dark grey to two telescopes and black to three. The letters indicate the sites: H for Hawaii, T for Texas, B for Brazil, L for La Palma and F for France.

however take place in GD154: mode coupling could explain the observed amplitude variations and linear combinations of frequencies. The data are studied in more details to look for such a coupling.

References

- Nather, R. E., Winget, D. E., Clemens, J. C., Hansen, C. J., and Hine, B. P.: 1990, *Astrophysical Journal* **361**, 309

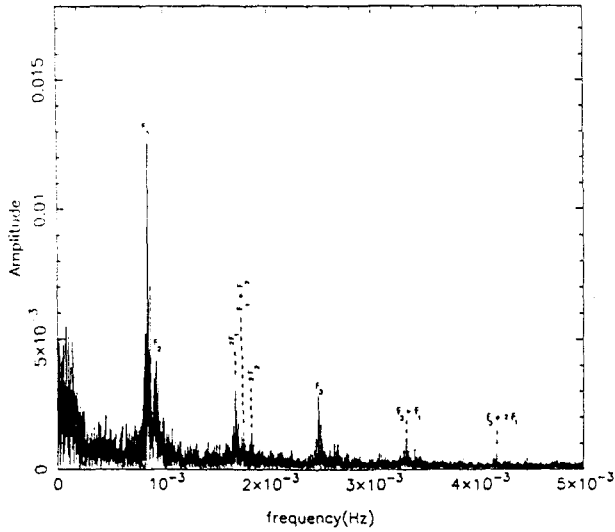


Fig. 4. Power spectrum of GD154 light curve from May 13 to May 24.

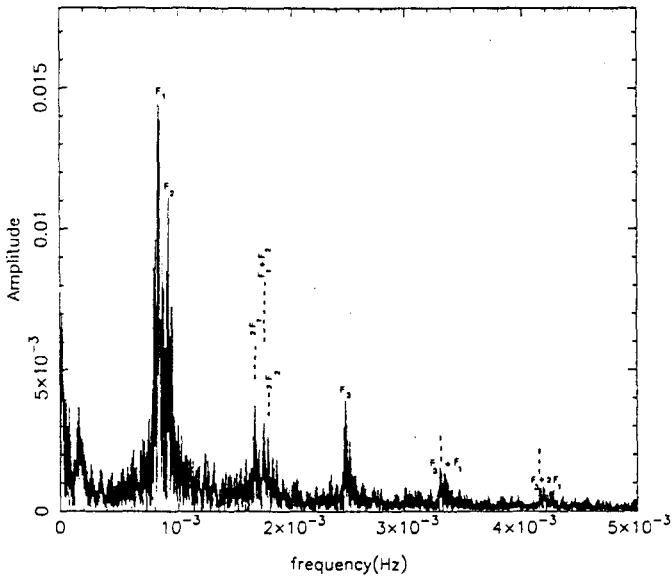


Fig. 5. Power spectrum of GD154 light curve from June 16 to June 12.

Robinson, E. L., Stover, R. J., Nather, R. E., and McGraw, J. T.: 1978, *Astrophysical Journal* 220, 614.