The Impact of Large-Scale Surveys on Pulsating Star Research
ASP Conference Series, Vol. 203, 2000
L. Szabados & D. W. Kurtz, eds.

The Fourier Decomposition of the Light Curves of High Amplitude δ Sct Stars

Ennio Poretti

Osservatorio Astronomico di Brera, Via E. Bianchi 46, I-23807 Merate, Italy

Abstract. A significant improvement of the relationships between observed and physical properties of high amplitude δ Scuti stars (HADS), SX Phe stars, and RRc stars can be obtained by the systematic application of Fourier decomposition to their light curves.

Pulsation theory explains several properties of pulsating stars. However, many problems are not yet solved. In this context, new techniques of data analysis, such as the Fourier decomposition, allow us to compare theory with observations. Fourier decomposition was first applied by Simon & Lee (1981) to the light curves of classical Cepheids, then to the light curves of RRab type stars (Simon & Teays 1982; Petersen 1984). From our side, we investigated the light curves of Cepheids with P<8 d, and we obtained a full description of the s-Cepheids' light Curves (Poretti 1994 and references therein), suggesting their first overtone nature and the presence of a resonance near P$\sim$3 d; moreover, these results were confirmed, and their importance stressed, by the photometric studies on the Magellanic Cloud Cepheids (EROS and MACHO projects).

More recently, we supplied a full and synthetic description of the light curves of double-mode Cepheids (Pardo & Poretti 1997; Poretti & Pardo 1997) by means of the generalized phase differences. We showed as the values of these parameters are strongly order-dependent and they are confined in well defined loci in the Fourier parameter space. As a direct consequence, the physics of the stellar models should now consider more precise constraints, since we quantitatively determined the importance of the cross-coupling terms (particularly important for the nonlinear approach), and we detected the signature of resonance effects in the regular progressions of some Fourier parameters.

As a natural extension of this work toward the lower part of the instability strip, Antonello et al. (1986) and Poretti, Antonello, & LeBorgne (1990) applied Fourier decomposition to the light curves of large amplitude (>0.20 mag), short period (P<0.35 d) δ Sct stars, generally considered to be very stable single-mode pulsators. Corroborated by the excellent results obtained on the Cepheid light curves, we suggest reanalysis of the available large data bases to investigate better some unclear observational facts:

1. The progression of the phase differences ϕ_{21} is well defined, but a change in the slope is observed at P=0.12 d (Poretti 1999); is this feature a resonance effect, similar to that observed in the ϕ_{21} progression of the Cepheids?

2. The discovery of new double-mode pulsators in HADS stars could help in the study of the dependence of the F/1O ratio on physical parameters,

https://doi.org/10.1017/S0252921100057201 Published online by Cambridge University Press

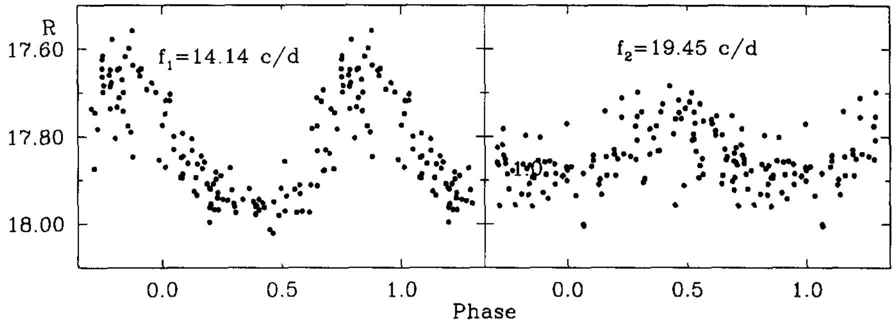

Figure 1. The star V142 in the OGLE field BW2 is a new double-mode pulsator. The light curves of the two periods are shown.

such as the metallicity. Double-mode pulsators are probably hidden in the large data bases; we already found one, the star V142 in the BW2 field of the OGLE survey (see Fig. 1).

3. Poretti & Antonello (1988) discovered some stars showing a descending branch of the light curve steeper than the ascending one (V1719 Cyg variables). The implications for stellar models were stressed by Antonello, Poretti, & Stellingwerf (1988) and by Guzik (1992), but the physical conditions necessary to generate such a light curve are not yet well established (helium diffusion? resonances?). The peculiarity seems to be connected with a double-mode pulsation (Musazzi et al. 1998), and other candidates in the period range 0.19–0.27 d need to be investigated.

References

Antonello, E., Broglia, P., Conconi, P., & Mantegazza, L. 1986, A&A, 169, 122

Antonello, E., Poretti, E., & Stellingwerf, R. 1988, in Multimode Stellar Pulsations, ed. G. Kovács, L. Szabados, & B. Szeidl (Budapest: Konkoly Observatory & Kultura), 27

Guzik, J. A. 1992, Delta Scuti Star Newsletter, No. 5, 8

Musazzi, F., Poretti, E., Covino, S., & Arellano Ferro, A. 1998, PASP, 110, 1156

Pardo, I. & Poretti, E. 1997, A&A, 324, 133

Petersen, J. O. 1984, A&A, 139, 496

Poretti, E. 1994, A&A, 285, 524

Poretti, E. 1999, in Variable Stars as Important Astrophysical Tools, NATO ASI, ed. C. Ibanoglu (Dordrecht: Kluwer), in press

Poretti, E. & Antonello, E. 1988, A&A, 199, 191

Poretti, E., Antonello, E., & LeBorgne, J. F. 1990, A&A, 228, 350

Poretti, E. & Pardo, I. 1997, A&A, 324, 121

Simon, N. R. & Lee, A. S. 1981, ApJ, 248, 291

Simon, N. R. & Teays, T. 1982, ApJ, 265, 586

https://doi.org/10.1017/S0252921100057201 Published online by Cambridge University Press