STABILITY OF PULSATIONAL AMPLITUDE FOR CEPHEIDS OF PERIOD = 6 ± 1^d

M.A. Abdel-Sabour
National Research Institute of Astronomy and Geophysics
Helwan, Cairo, Egypt *Sabour2000@hotmail.com*

ABSTRACT. Fourier decomposition of light curves used to obtain rigorous estimates of the pulsational amplitudes. A limit sample of Cepheids of period = 6 ± 1^d ,was chosen to demonstrate the capabilities of this technique. The pulsational amplitude shows significant increase and decrease for some stars.

Key words: Cepheids, Evolution

1. Introduction

The study of Cepheids and pulsating stars in general has a very important field in astronomy, also regular pulsation of Cepheids variables makes these stars to be ideal targets for studying subtle secular phenomena due to stellar evolution. A goodbye to Polaris as a Cepheids was announced (Fernie et al. 1993) predicting that Polaris will stop pulsating in 1995. About a hundred years ago it was spotted having a pulsational amplitude of dv 0.12 magnitude, which by now has declined to 0.01 magnitude. Kamper and Fernie (1998) discussed a serious error in their earlier paper, which predicted decline in amplitude of Polaris in 1995. They corrected this error and no longer predict cessation of pulsation in 1995. Not so longer ago Fernie (1990) suggested that another Cepheid Y Oph, shows that the amplitude of this Cepheid varies periodically on a time scale of about 1400 days (Burki et. al. 1986). Platis and Mandushev (1993), studied the stability of the pulsational amplitude for a sample of three s-Cepheids, SU Cas, SZ Tau and V1726 Cyg, using the Fourier decomposition of light curves. The pulsational amplitude shows no decisive change as a function of time in any of three Cepheids. Sandage and Tammann (1971), have argued that for a restricted period range 0.4 $<$ log p $<$ 0.86 Cepheids have their largest amplitudes at the blue (hot) edge of the instability strip. Yakimova et al. (1975), have examined more extensive but less accurate photographic data and concluded that irrespective of period range, amplitude is largest on the red edge of instability strip. In the opposite direction Butler (1976), found no strong evidence for any amplitude mapping. Evans et al. (2002), studied the amplitude of Polaris, they found that, the evidence from amplitude, period change and Fourier diagnostic all agree with overtone pulsation for Polaris. Polaris has an increasing period, which can be interpreted in evolutionary terms as the stars moving toward cooler temperatures. This is this original reason why the decrease in amplitude was thought to series from evolution out of the instability strip. But they found that Polaris is near the blue edge of the strip, which means that the period change as an evolutionary affect would mean that Polaris is moving into the instability strip (i.e. Polaris should increasing in pulsational amplitude). A number of studies, (e.g. Szabados, 1977) have been devoted to the Cepheid period stability; however, with a few exceptions stated above, the pulsational amplitude was scrutinized for possible trends and secular evolution. Turner and et al.(2005) studed the pulsation amplitude of Polaris underwent a marked change. Prior to 1963 the V amplitude was in excess of about 0.1 mag, possibly decreasing at a rate of 0.019 mag century. Following the hiatus of 1963-1966, the pulsation amplitude underwent a sharp decline and now appears to be erratic on a cycle-to-cycle basis, always smaller than 0.05 mag. Here we present an analysis of the pulsational amplitude stability, utilizing the Fourier fits of light curves parameters for Cepheids of period between 6 ± 1^d, which have a long history of observations. This was carried out by analysis of their light curves obtained over a long period (depending on the observational record available) to investigate if the light curves obtained for each star are stable or showing temporal variations in light curve parameters.

2. Data and Technique of Reduction

In collecting our data, we bear in mind that the data should cover the minimum and maximum parts of the light curves to enable reliable amplitude estimation using the Fourier decomposition technique, which has a widely use in light curve analysis of pulsating stars (Simon 1988). This technique can provide quantative parameters to define the shape of light curves and it is for this reason a powerful tool classification purpose. It's worthy to mentioned that we applied our investi-

Table 1: Mathematical results of the liner fit for the total Fourier amplitude in visual mag.

Name	A	$B \times 10^{-7}$	$\log dP/dt$	Expected δV
AP Sgr	-4.16±3.71	10.85±0.15	-0.70	increase
AX Cir	0.89±0.81	-2.21±0.003	-0.44	increase
BG Vel	1.09±0.52	-3.58±2.137	-0.26	increase
CV Mon	0.08±2.27	0.99±9.290	-0.74	increase
FM Aql	0.71±0.82	4.25±3.360	-1.14	increase
S Tra	0.84±1.16	-2.02±4.75	-0.61	increase
ST Vel	1.77±2.37	-6.07±9.60	-0.61	increase
U Aql	-5.37±1.95	23.46±7.97	-0.81	increase
U Sgr	2.12±0.98	-7.29±4.01	-0.47	increase
V419 Cen	1.18±1.33	-4.17±5.46	-0.43	increase
V Cen	3.32±3.08	-10.2±10.26	-0.34	increase
RS Cas	-0.30±0.72	2.68±2.95	-1.23	increase
T Cru	-1.61±0.93	7.48±3.76	0.76	increase
V386 Cyg	-3.17±0.84	14.26±3.96	-1.08	increase
V378 Cen	-0.22±0.15	1.67±1.44	-0.22	increase
X Lac	-2.67±1.64	10.18±6.7	0.10	increase
V733 Aql	-2.33±3.16	10.034±10.29	-1.00	increase
Y Sgr	3.89±2.26	-10.45±6.22	-0.89	increase
AP Pup	3.76±1.67	-10.41±0.68	-0.64	decrease
AY Sgr	2.70±3.85	-9.46±0.157	-2.49	decrease
CR Ser	-2.76±9.13	10.26±30.73	-0.54	decrease
AT Pup	1.85±1.41	-5.84±0.057	-0.99	decrease
R Cru	1.63±1.6	-5.22±6.58	-1.09	decrease
BP Cir	3.15±1.47	-10.22±6.003	0.05	decrease
V737 Cen	-8.34±4.32	30.48±10.76	0.40	decrease
VW Cas	-0.66±1.77	3.99±7.24	-1.93	decrease
GH Car	0.79±0.60	-2.6±2.46	-0.53	decrease
V1162 Aql	8.13±4.37	-30.22±10.78	0.33	decrease
WW Pup	-1.14±8.13	6.44±3.32	-0.26	decrease
XX Vel	2.21±2.51	-7.42±10.02	-1.28	decrease
XX Sgr	-7.17±1.81	30.09±7.39	-0.66	decrease

gation on V band only. we did not use B, I or U bands, since the infrared technique is relatively new and the investigated stars had no long term observations in this band, also the U band was not used due to the faintness of the studied stars in that band, While B band is very important in our study, because the amplitude is greater in B band than in V band, but unfortunately we haven't sufficient observations in that band. Following Antonello et al. (1990), we applied the Fourier decomposition technique to the light curves in V-bandpass. It is based upon Fourier decomposition of the light curves by series:

$$V(t) = V_o + \sum A_z \cos[2\pi f_z(t - T_o) + \Phi_z] \quad (1)$$

Where A_z is a semi-amplitude of light variation, Φ is the phase shift, T_o and f are the adopted epoch of light maximum and frequancy. The program package Mufran (Kollath, 1990), which is a user friendly software for period analysis was used to determine the numerical parameters describing the light curves of the studied stars

3. Result and Conclution

The final results of the total Fouries harmonic amplitude of all studied stars in visual and photographic bands are represented in Table 1 The mathematical form of the long term behavior for the light curves of the studied stars were calculated in visual and photographic bands. The results can be summarized into two categiries: First: Included those stars that show significant secular increase in total harmonic Fourier amplitude. This result, were confirmed by Turner and et al. (2006), where they studied the rate of period change for the same sample of stars and found that the evolution of these stars is toward the cool side in the instability strip of H-R diagram, i.e the crossing numbers of the stars in the instability strip are first and third crossing Second: Some stars show significant secular decrease in total harmonic Fourier amplitude. From Turner at al. (2006) this result can be confirmed, where the evolutionary trend of these stars is toward the hot side of the H-R diagram, i.e the crossing number of the stars in the instability strip are second and forth crossing. There are miss-understand in results of two stars, AP Pup and AY Sgr, which show significant secular decrease in their total harmonic Fourier amplitude, while from Turner et al. (2005) studied their O-C diagrams and found that their period increase (positive change) and their crossing number is odd, which means that the amplitude must change in increasing manner, but unfortunately we found that the trend of amplitude variation is in decreasing manner. Our interpretation for this result is that, the available observations for these stars may not be sufficient to give complete information about the behavior of amplitude stability with time. Last column of table 1, shows the results of the behavior of each star (increase or decrease).

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