PG 1707+427: The DOV Star with the Simplest Fourier Transform

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PG 1707+427 was identified in the Palomar-Green survey (Green Schmidt and Liebert, 1986) as an object with a significant ultraviolet excess. Observations by Bond and Grauer in 1982 showed it to be a pulsating variable (Bond, Grauer, Green and Liebert, 1984). Fourier transforms of the discovery time-series photometric runs revealed power in PG 1707+427's light curves in two bands with periods near 450-s and 333-s. The longer period peak was observed to have a variable amplitude while the other one appeared relatively constant in strength. Wesemael, Green and Liebert (1985) placed PG 1707+427 in the spectroscopic class of PG 1159-035 (DOV) pulsating variables.

McGraw, Starrfield, Liebert and Green (1979) found that PG 1159-035 pulsates. It is the prototype of the DOV class of variable stars. These authors and others (Winget, Hansen and Van Horn, 1983) suggested that the internal structural evolution of such a star can be measured through careful observation of its pulsational periods. Winget, Kepler, Robinson, Nather and O'Donoghue (1985) have been able to measure an evolutionary rate of period change for PG 1159-035.

In 1987 the authors began to gather time-series photometric data on PG 1707+427 to determine if any stable periods suitable for the measurement of dP/dt exist in its power spectrum. The 1.3-m telescope at Kitt Peak National Observatory and Steward Observatory's 1.5-m telescope on Mt. Bigelow and 1.5-m telescope on Mt. Lemmon were used. The two-star photometer of the University of Arkansas at Little Rock was used for all of the observations. An Apple II microcomputer

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recorded the 1987 data. It was replaced in 1988 by an IBM PC clone type computer with an interface board designed by Chris Clemens (1988). PG 1707+427 and a nearby comparison star were observed simultaneously with two separate photomultipliers. No filters were used with the blue-sensitive (3200-6500 A) bialkali photocathodes to increase the count rates. The effective wavelength of the photomultiplier-tube-atmosphere combination is slightly bluer than Johnson B with a peak response occuring between 3700 and 4000 A. To date more than 114 hours of observations on 30 nights have been recorded. The purpose of this paper is to report on the preliminary results of this effort.

A 3.1-h run on 23 May 1987 coupled with a 6.4-h time-series data set obtained on the following night revealed several important facts concerning PG 1707+427. The Fourier transform (Deeming, 1975) calculated from each night's data contained only two peaks with periods near 448-s and 335-s. The amplitude of the shorter period component was approximately the same on both nights while that of the longer period one was significantly different for these two data sets. When the transform of both nights data combined was calculated the main (448-s) peak appeared to be unresolved. However CLEAN (Roberts, Lehar and Dreher 1987) found this peak to have a 447.107-s and a 449.026-s component whose beat period is 1.2 days. Future observations showed a remarkable similarity between this calculation and what is actually happening in PG 1707+427's light curves.

Thirty time-series data sets were obtained for PG 1707+427 in May, June and October of 1987 and May and June of 1988. The Fourier transforms of every one of the individual nights show only two peaks near 448-s and 335-s. The amplitude of the 448-s period peak varies by more than a factor of three while that of the shorter period one is similar from night-to-night. For example, semi-amplitudes of the 448-s peak on 9 May and 11 May of 1988 were 29.2 and 9.2 millimagnitudes respectively.

The amplitude of the 448-s period peak was calculated for each of the nineteen nights obtained in May and June of 1988. For those data sets longer than 6-hr in duration, transforms of both the first and second half of the data set were also calculated. A total of 29 Fourier transform amplitudes for the 448-s peak were fitted to a sine wave using a least squares technique. The beat period so obtained is 1.30218-d. The same sine wave fits both the May and June 1988 data.

For the May 1988 data set, simple inspection of the multi-night transform and CLEAN show the main peak to have a 447.163-s and a 448.942-s component whose beat period is 1.306-d.

The light curves have been analyzed individually and in blocks of nights by using a non-linear least squares fit to a sine wave. The two components constituting the main peak in the power spectrum have been found to have phase coherence for over one year. These components have periods of 447.163854-s and 448.947344-s. It appears that it will be possible to have a sufficient time base to measure dP/dt for this star in the near future.

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