ON THE VARIABILITY OF 27 CYGNI

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Abstract

We report on the analysis of three seasons of photoelectric photometry of 27 Cygni (K0IV) and one season of radial velocities. The star shows marginal (but probably real) variability in both light and velocity, on a time scale of weeks. Further study of the star does not seem to be warranted, but it should not be used as a comparison star for differential photometry of other variable stars.

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1. Introduction

27 Cygni (HR 7689, HD 191026, K0IV, **V** = 5.36) was found to be slightly variable in brightness by Percy et al. (1986). It was being used as a "red standard" check star in a long-term **UBV** photometric campaign on Be stars. It appeared on a list of 40 stars suspected of variability on the basis of their chromospheric activity (Fekel and Hall 1985). The observed range in **V** was up to 0.05 magnitude, and the characteristic time scale was 50 to 60 days. One possible explanation for the variability was the rotation of a spotted star. This hypothesis would imply that the period should be reasonably constant from one season to the next, although there might be small fluctuations if the spots migrated and the star rotated differentially. We have therefore examined 1985, 1986, and 1987 **B** and **V** observations, made at the University of Toronto as described by Percy et al. (1986), for variability and periodicity.

2. Photometric Observations

Table I lists the average **B** and **V** magnitudes and their standard deviations (σ) per observation for 27 Cygni (the program star), 36 Cygni (the blue check star in the same group of Be stars as 27 Cygni), and HR 7123 (a "red standard" check star, similar to 27 Cygni in color, in another group of Be stars). These last two stars should serve as adequate controls for 27 Cygni.

The average σ for the control stars is about 0.008 magnitude, which is the typical precision of the observations of other non-variable stars observed with the same telescope. The larger σ for 27 Cygni indicates that it was indeed variable, at least in 1985 and 1987.

We have computed the power spectra of the **V** observations which were obtained in each season, using Scargle's (1982) method. The results are shown in Figure 1. Only the 45.45 day peak in the 1985

power spectrum is significant at the P = 0.99 level. However, it is interesting that each power spectrum shows a peak at about 45 days. (A second peak at about 12 days is of considerably lower significance, and has therefore not been shown in the figure.) The power spectrum of the combined observations is very complex, due to aliasing. The highest peak is at 42.28 days, and there are (probably) alias peaks at 47.73 and 38.02 days. If 27 Cygni has a strict period, then it is probably about 42 days. The variability, if it is real, is irregular as well as small.

3. Radial Velocity Observations

We also obtained 12 radial velocities of 27 Cygni in 1986. The purpose was to determine whether the star might be an RS CVn binary, or might show velocity variations related to the light variations in some other way. The velocities were obtained with the 1.88m reflector at the David Dunlap Observatory. The observation and reduction procedures were as outlined by Percy and Evans (1980): spectra were taken at a reciprocal dispersion of 8 Å/mm on IIa0 plates, and lines were measured from 4000 to 4600 Å. The velocities are within 1 km/sec of the IAU system (Kamper 1985, private communication).

The unweighted mean of the velocities is -32.73 $\pm$ 1.01 km/sec. There is a tendency for the velocities to be less negative in the second half of the season than in the first (mean -33.42 $\pm$ 0.57 km/sec before HJD 2446700 and -31.92 $\pm$ 0.37 km/sec after), and this difference is significant at the P = 0.99 confidence level. The power spectrum of the velocities shows that this difference could be due to a variation with a time scale of about 200 days, or with a shorter period of either 40.8 or about 10 days. It is interesting that the 40.8 day period is close to the most significant one found in the photometry.

R. J. Davis and D. W. Latham (private communication) have kindly provided us with the one velocity measurement of 27 Cygni obtained in their radial velocity program; it was made with the 1.5m telescope on Mt. Hopkins, Arizona. The velocity (-32.85 km/sec on HJD 2444775.95779) is close to the mean of our velocities. We were not able to ascertain whether 27 Cygni has been observed with CORAVEL (Baranne et al. 1979).

We are not aware of any v sin i measurement for 27 Cygni which would enable us to estimate its rotation period.

We emphasize that the light and velocity variations which we have found are both marginal, and it would require many more precise observations to establish firmly the existence, nature, and properties of these variations. It is not clear to us that such effort is warranted. In the meantime, 27 Cygni should be regarded as a probable small-amplitude variable with a possible period of 42 days, perhaps due to rotation. It should not be used as a comparison star for differential photometry of other variable stars.

4. Acknowledgements

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TABLE I

Average Magnitudes and Standard Deviations

		27 Cyg		36 Cyg		HR 7123	
		<Δm>	σ	<Δm>	σ	<Δm>	σ
1985	**V**	5.378	0.013	5.577	0.006	5.505	0.007
1985	**B**	6.229	0.017	5.623	0.008	6.333	0.008
1986	**V**	5.370	0.008	5.575	0.008	5.510	0.009
1986	**B**	6.220	0.011	5.627	0.007	6.335	0.009
1987	**V**	5.383	0.013	5.577	0.013:	5.505	0.009
1987	**B**	6.251	0.018	5.635	0.010	6.349	0.012

TABLE II

Radial Velocities of 27 Cygni

Plate	HJD	Velocity km/sec	PE km/sec	N
49717	2446621.802	-33.03	0.14	33
49732	46645.600	-33.54	0.12	32
49740	46653.784	-34.88	0.23	33
49759	46660.653	-33.45	0.17	34
49769	46662.666	-33.81	0.15	33
49792	46672.655	-32.91	0.14	33
49812	46713.532	-31.88	0.15	33
49817	46719.600	-31.65	0.16	34
49821	46724.490	-31.58	0.16	33
49844	46745.491	-32.51	0.15	33
49848	46752.462	-31.57	0.35	34
49849	46760.501	-31.97	0.16	33

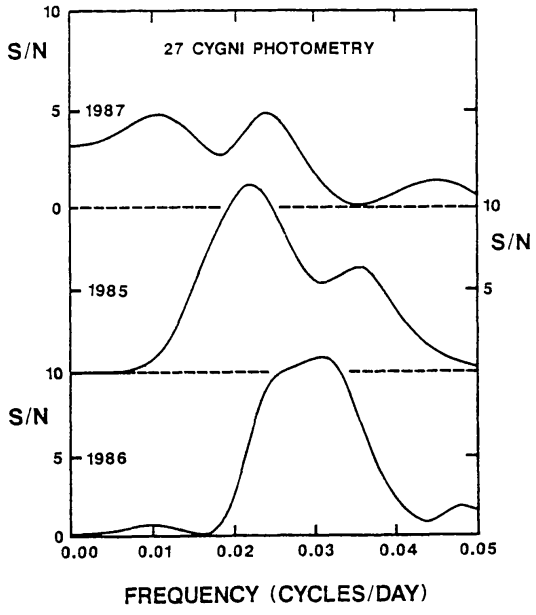

Figure 1. Power spectra of each of three seasons of photometry of 27 Cygni, using Scargle's (1982) algorithm. Top: 1987; middle: 1985; bottom: 1986.