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PHOTOMETRY OF THE δ SCUTI STAR DG LEO: PRELIMINARY RESULTS

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RESUMEN

Se ha obtenido fotometría fotoeléctrica *uvby* para el sistema estelar triple DG Leo desde dos diferentes observatorios equipados con instrumentación semejante. El análisis preliminar de períodos indica la presencia de al menos 3 frecuencias próximas (10-12 c/d, 3-6 mmag) en la δ Scuti y una variación lenta. Esta variación lenta concuerda muy bien con la mitad del período órbital de la binaria espectroscópica; el nivel de ruido en el espectro de amplitudes es de $3 - 4$ mmag (después del filtrado).

ABSTRACT

New *uvby* photoelectric photometry has been acquired for the triple star DG Leo at two different observatories equipped with analogous instrumentation. A preliminary period analysis indicates the presence of at least 3 close δ Scuti frequencies (10-12 c/d, 3-6 mmag) and a slow variation. This slow variation fits quite well with half the orbital period of the spectroscopic binary; the noise level in the amplitude spectrum is only $3-4$ mmag (after prewhitening).

Key Words: **BINARIES: VISUAL — BINARIES: SPECTROSCOPIC — STARS: VARIABLES: δ SCUTI — TECHNIQUES: PHOTOMETRIC**

1. INTRODUCTION

DG Leo (HR 3889, HIP 48218, Kui 44 AB) is a spectroscopic-visual triple system. It consists of a visual binary system, one component of which is also a short-period spectroscopic binary (with components *Aa* and *Ab*) with an orbital period of 4.15 days (Danziger & Dickens 1967; Fekel & Bopp 1977). The *Aa* and *Ab* components are thought to be two A8IV stars of nearly equal masses (Hoffleit & Jaschek 1982). The visual component *B*, with an angular separation of $0''.17$ and a magnitude difference $\Delta Hp = 0.69$ mag with respect to Aa, b (ESA 1997), has been regularly observed by speckle interferometry (Hartkopf, McAlister & Mason 2001). The existing astrometric data show a high inclination, coupled with a possible orbital period of 100-200 years. Component *B* has been classified as an ultra-short period Cepheid (Eggen 1979) and as a δ Scuti star (Elliot 1974; Fekel & Bopp 1977). Only one periodicity is presently known but more could be present since amplitude and phase changes have been reported previously (Antonello & Mantegaza 1982; Rosvick & Scarfe, 1991 (RS91)). The triple system cannot be resolved photometrically.

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2. OBSERVATIONS

Differential and absolute photometry of DG Leo was performed in the Strömgren photometric system at San Pedro Mártir OAN, México (SPM) and Sierra Nevada Observatory, Spain (SN). The combined data set consists of 1187 epochs and differential magnitudes. Absolute photometric data in the Geneva photometric system were additionally obtained by Dr. P. De Cat with the Mercator telescope at La Palma, Spain, consisting of 90 measurements in all seven filters.

3. PERIOD ANALYSIS

We performed the frequency search step by step: first on each data set and then on the combined data set. For this we used the programme Period98 (Sperl 1998). At this stage we only used the data in the y filter. The results of this frequency analysis are presented in Table 1. The combination of both data sets was useful for (a) the choice of the binarity light curve model and (b) the detection of the multiperiodic character of the oscillations. However the data set time basis is a bit short (T = 12 days) and the theoretical frequency resolution is not better than 0.08 c/d (= 1/T).

The most dominant frequency detected, i.e. about 0.50 c/d, corresponds to a slow variation of the mean intensity level coupled to orbital variations of the short-period pair *Aab*. Since the orbital period

TABLE 1

RESULTS OF THE FREQUENCY ANALYSIS OF DG LEO (COMBINED Y DATA ONLY)

	Freq. c/d	Ampl. mmag	Phase 2π.rad	S/N
F1	0.48	7.0	0.127	14.3
(F2	0.24	0.7	0.509	1.3)
F3	11.98	5.8	0.216	9.7
F4	11.90	5.0	0.304	8.5
F5	12.12	3.3	0.816	5.4

is well known from previous spectroscopic analyses (Fekel & Bopp, 1977; RS91), we have adopted the spectroscopic orbital period in the fit of the model of a light curve for an ellipsoidal binary. The first frequency (F1 in Table 1), equal to $2 * f_{orbital}$ with $P_{orbital} = 4.146747$ days (RS91) is most dominant. It can be associated with ellipticity effects due to the variable cross sections of the system as it rotates around the center of mass. But the second frequency ($f_{orbital}$ – F2 in Table 1) is not relevant at all. It can be associated with the reflection effect due to the heating of the inner cusps with isotropically re-emitted radiation. There will be almost no effect if both temperatures are quite similar.

After prewhitening with the first sinusoid, the residuals are searched for additional frequencies, all three located near to 12 c/d (see Table 1). The fact that two of these are located at exactly 0.08 c/d apart, seems to be a real feature. The S/N ratios are also conclusive. Fig. 1 illustrates the slow variation due to the distortion of both $A-$ stars of the inner binary Aa, b, phased with respect to F1, after prewhitening of the differential data for the close frequency triplet (F3-F5). The continuous ellipsoidal variations can be clearly seen. This is also confirmed by the slow change of the night mean levels in the SNO run, whereas the constant differences of the nightly means in the SPM run could be assigned either to grazing eclipses or to ellipsoidal variations.

4. DISCUSSION

DG Leo is a very interesting asteroseismological target because all three components are potential δ Scuti pulsators and because additional information may come from the multiplicity constraints. We would like to increase the frequency resolution in

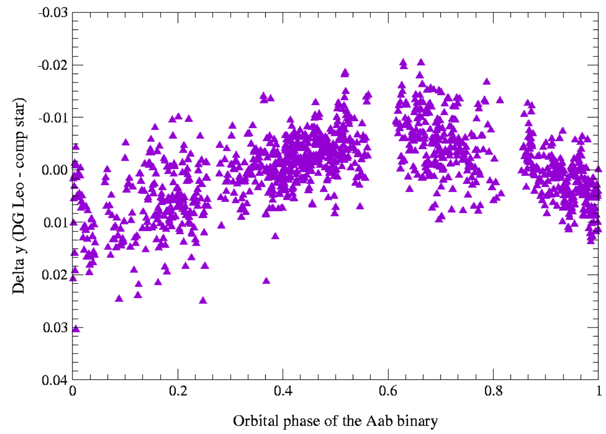

Fig. 1. Residual data of DG Leo phased with twice the orbital frequency.

order to determine whether the triplet is caused by rotationally splitting or not. We have also obtained high resolution spectroscopic data with ELODIE (OHP, France), simultaneously with new photometric data, early in 2003, to continue this study.

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