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PHOTOMETRIC VARIABILITY OF THE BINARY HD 1826

S.F. González[1], A. Rolland[2], A. Giménez[3],
P. López de Coca[2], R. Garrido[2], M.A. Hobart[4],
and J.H. Peña[1]

(1) Instituto de Astronomía, UNAM, México.
(2) Instituto de Astrofísica de Andalucía, España.
(3) Depto. de Astrofísica, Universidad Complutense de Madrid.
(4) Universidad Veracruzana, México.

RESUMEN. Se presentan mediciones fotoeléctricas en dos colores de la binaria espectroscópica no resuelta HD 1826 que muestran su variabilidad fotométrica. El período de las variaciones de luz se encuentra en excelente precisión con el período orbital derivado de medidas en la velocidad radial. Una estimación de la amplitud de las variaciones de 0.03 magnitudes fue obtenida independiente del color. El sistema parece ser una variable elipsoidal y los resultados preliminares se discuten en términos del modelo más probable.

ABSTRACT. Photoelectric two-color measurements of the single-lined spectroscopic binary HD 1826 are presented showing its photometric variability. The period of the light variations has been found to be in excellent agreement with the orbital period derived from the radial velocity measurements. An estimation of the amplitude of the variations of 0.03mag has been obtained roughly independent of color. The system appears to be an ellipsoidal variable and the available preliminary results are discussed in light of the most probable binary model.
Key words: PHOTOMETRY -- STARS-BINARY

INTRODUCTION

Ellipsoidal binary stars are non eclipsing close binaries with components distorted by their mutual gravitational interaction. Although physically similiar to the classical eclipsing variables, the ellipsoidal variables show orbital inclinations which are too small to generate eclipses and therefore, their light variations are due to variations in the luminous surface that these distorted stars present to the observer in their different phases.

The star HD 1826 (V = 6.85, A3V) was discovered to be a spectroscopic binary by Tidy (1940). Later, McCrosky and Whitney (1982), when they were looking for photometric variations in twenty nine spectroscopic binaries of short period, detected a suspicious double peak in the light curve of HD 1826 characteristic of ellipsoidal variables. A general study of these types of stars by Morris (1985) considers this star to be a probable candidate with a temptative amplitude of 0.025 mag. Table 1 shows the relevant data for this system which were obtained by Lucy and Sweeney (1971) and by McNamara and Feltz (1977).

OBSERVATIONS

HD 1826 was choosen as a comparison star during a study of the variable Delta Scuti star 28 And independently in observational campaigns

TABLE 1. Relevant data for HD 1826.

Position:	α(1950.0)	$00^h\ 20^m\ 12^s$
	δ "	+29° 10' 39"
Spectroscopy:	P	1.432322 d
	T_o	2429474.6081 J.D.
	f(M)	0.0224 $M_\odot$
	K_1	53.2 Km s^{-1}
Photometry:	V	6.898±0.001
	b-y	0.094±0.001
	m_1	0.231±0.002
	c_1	1.000±0.004
		2.860±0.001

carried out in Spain (1978) and Mexico (1981, 1982). In the observations carried out in Spain a 30 cm telescope was utilized and it was found that HD 1826 showed a larger intrinsic dispersion than the other comparison star (HR 133, V=6.6, AOV), making it a suspicious candidate for variability. In Mexico, a 83 cm telescope was utilized. The same comparison stars were considered with HD 2019 (V=6.8, B9.5) as a check star. In consequence, the variability of HD 1826 was definitely established. In summary this star was observed for 14 nights and 272 photometric points were obtained (HD 1826- HR 133). Table 2 presents the dates, filters (in Johnson's system), observatory and obtained points for each night.

A Fourier analysis of the data was carried out and the results comfirmed the spectroscopic determination of the orbital period of Lucy and Sweeney (1971) (Table 1). The combined light curve of the B and V filters corresponding to the ephemeris listed in table 1 is shown in Figure 1. It can be seen that the two minima of the same depth are followed by two maxima of the same brightness. These observations are fairly well reproduced by the equation

$$\Delta m = m_o + A \cos 2\theta$$

TABLE 2. Nights observed

Night	Date	Filter	Observatory	Points
1	26/27 Oct 1978	B	Sierra Nevada	15
2	27/28 Oct 1978	B	"	20
3	28/29 Oct 1978	B	"	17
4	29/30 Oct 1978	B	"	15
5	5/6 Sep 1981	V	San Pedro Mártir	18
6	6/7 Sep 1981	V	"	22
7	7/8 Sep 1981	V	"	12
8	9/10 Sep 1981	V	"	22
9	9/10 Oct 1982	B	San Pedro Mártir	27
10	10/11 Oct 1982	B	"	23
11	11/12 Oct 1982	B	"	22
12	12/13 Oct 1982	B	"	18
13	13/14 Oct 1982	B	"	22
14	15/16 Oct 1982	B	"	19

where

$A = 0.015 \pm 0.001$ mag

θ = orbital phase

Δm = observed points

$m_o = 0$

The coefficients , A, were found independently of the epoch of the observation and of the adopted filter; besides, an estimation of the order of magnitude suggests a value close to 0.003 mag for the θ and 3θ terms.

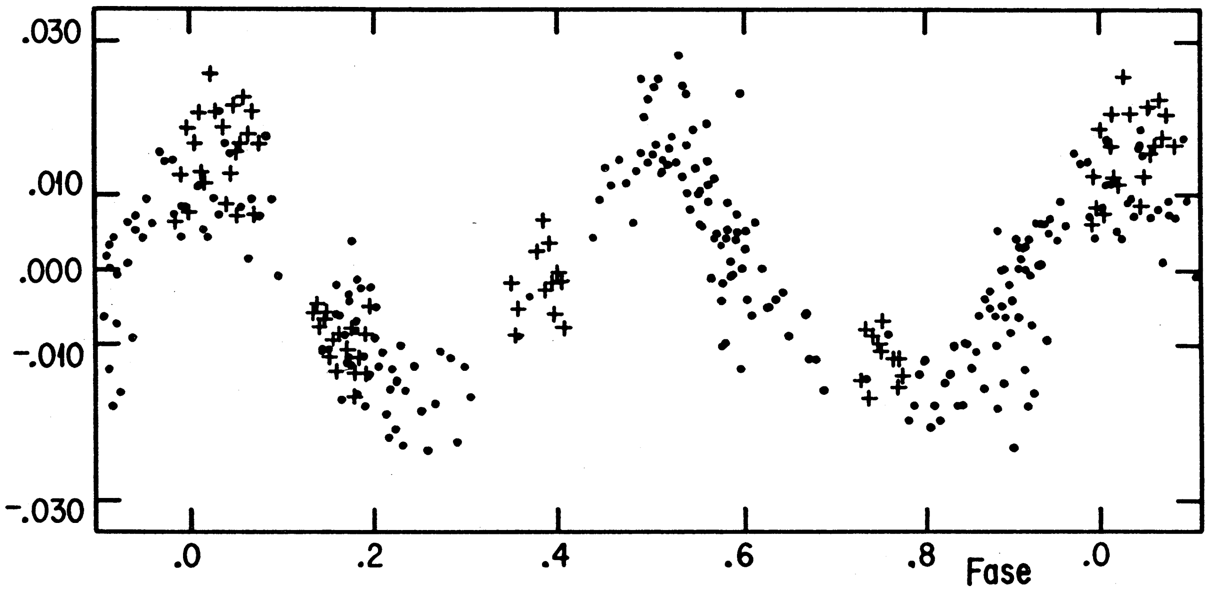

Fig. 1. Phase diagram of HD 1826, normalizing at a zero baseline. The measurements are represented by circles (B) or crosses (V).

DISCUSSION

From the shape of the light curve, the orbital period, the spectral type of the system and the semiamplitude of the variations, it is evident that HD 1826 should be classified as an **ellipsoidal** variable. On the other hand, from the uvby β photometry of McNamara and Feltz (1977), the criteria for A stars of Stromgren (1966) and the revision by Grosbol (1978), it was found that the colors determined for this star fit well with an early A type star in agreement with the spectroscopic classification since the light contribution of the secondary is negligible.

In order to see if the amplitude of the variations and the spectrocopic information is compatible with a normal binary model, the available data was analysed utilizing a procedure described by Morris (1985). A M =2.0 Mo was adopted as suggested by the spectral type and the tabulation of Straizys and Kuriliene (1981). The deduced parameters are listed in Table 3, where it can be seen that all of them are compatible with a normal detached binary system in which the primary component is relatively evolved, but still within the Main Sequence. The massive, remains still in the Main Sequence without evolution; the orbital inclination does not allow for eclipses. Furthermore, utilizing the equations (2) and (3) of Morris (1985) to evaluate the terms cos θ and cos 3θ in the Fourier series, values of the order of 0.003 mag in amplitude are obtained, in perfect agreement with the observational results.

TABLE 3. Parameters of the Binary System (M_1=2.0)

q	M_2	i	r_1	r_R	R_1	$v_1$sin i	log g_1	R_2
0.30	0.60	62.7	0.311	0.485	2.3	71.8	4.02	0.7
0.35	0.70	51.3	0.322	0.472	2.4	66.2	3.98	0.8
0.40	0.80	44.4	0.332	0.460	2.5	61.8	3.94	0.9
0.45	0.90	39.6	0.340	0.449	2.6	58.2	3.91	1.0
0.50	1.00	35.9	0.346	0.440	2.7	55.3	3.89	1.1

M_1 = Mass of the primary star; M_2 = Mass of the secondary star q = M_2/M_1; R_1 = Radius of the primary in solar units; R_2 = Radius of the secondary in solar units; r_1 = Relative radius of the primary star with respect to the radius of the orbit; r_R = Radius of the Roche lobulus for the primary component; i = Orbital inclination; $v_1$sin i = Rotational velocity projected in km s^{-1}.

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P. López de Coca, R. Garrido y A. Rolland: Instituto de Astrofísica de Andalucía, Consejo Superior de Investigaciones Científicas, Apdo. 2144, 18080, Granada, España.
S.F. González Bedolla, M.A. Hobart y J.H. Peña: Instituto de Astronomía, UNAM, Apdo. Postal 70-264, México 04510, D.F., México.
A. Giménez: Departamento de Astrofísica, Universidad Complutense de Madrid, 28040, Madrid, España.