PRELIMINARY PHOTOELECTRIC LIGHT CURVE FOR DHK 29 = SAO 70629

Daniel H. Kaiser
Crescent Moon Observatory
2631 Washington Street
Columbus, IN 47201

Jerry B. Gunn
Charles F. Lamb
Jubilee Observatory
606 Skyview Drive
East Peoria, IL 61611

Philip Sullivan
P.O. Box 301
Occidental, CA 95465

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Abstract

The newly discovered eclipsing binary star DHK 29 = SAO 70629 has been observed photoelectrically from October 1992 to October 1993. With the light curve coverage 75% complete, it is apparent that the initial 1.9-day period reported in *IBVS* 3815 is the half-period. Three times of primary minima have been determined. New light elements are given.

1. Introduction

DHK 29 = SAO 70629 = BD +33° 4070 is a ninth-magnitude star of spectral type F8 at RA $20^h\ 51^m\ 09^s$ DEC+33° 55' 45" (1950). It was discovered to be a variable star by Kaiser in September 1992 (Kaiser 1992a) as part of his ongoing photographic patrol. Baldwin subsequently confirmed its eclipsing nature visually (Kaiser and Baldwin 1992). A search of the Harvard photographic patrol plates found 16 minima. These were combined with two Baldwin visual minima in a least squares solution for the light elements:

$$\text{Min.} = \text{HJD } 2448909.558 + 1.9021093\ E \qquad (1)$$

The primary and secondary eclipses could not be distinguished by the photographic and visual data. It was recognized that the period might well be twice this result.

2. Photoelectric Observations

The photoelectric observations of DHK 29 were made at three locations to minimize interruptions due to local weather. The first set was made by Kaiser with his 0.35m telescope and SSP-5 photometer at the Crescent Moon Observatory (Kaiser 1992b). Sullivan made observations from his private observatory, also with a 0.35m telescope and SSP-5 photometer. The Gunn and Lamb observations were made with the Decker/Grebner/VanZandt automated 0.6m telescope and ECF Technology Starlight-1 photometer at the Jubilee Observatory of the Peoria Astronomical Society.

SAO 70626 = HD 199007 was used as comparison star, V = 7.948 B-V = -0.065

(O'Connell 1977), and SAO 70637 as check star. The three stars are well within one degree of one another. We suspect that the check star SAO 70637 is variable on a small scale, 0.02–0.03 V. All of the observers' check star data have larger errors than their DHK 29 data. Also, Kaiser's data set, which has the longest time frame, has errors of just ±0.009 V for DHK 29 outside of eclipse. We therefore have now adopted SAO 70638 = HD 199071 as our new check star.

Kaiser observed DHK 29 with B and V filters on 19 nights between October 1992 and October 1993. All observations were obtained using automatic data acquisition software (Jones 1991a) and reduced to the Johnson UBV system using standard methods with the Kaitchuck and Henden Astronomical Photometry Software (Jones 1991b). Differential extinction corrections were applied to the data, although in all cases they were less than 0.01 magnitude. A total of 251 observations were made. Eclipse depths were determined from these fully transformed data (Table 1).

Table 1. Amplitude of eclipses of DHK29 29 = SAO 70629.

		Min	–	Max	=	Amplitude	s.d.
Primary							
V	=	9.58		8.92		0.66 V	±0.013
B	=	10.15		9.47		0.68 B	±0.007
Secondary							
V	=	9.47		8.92		0.55 V	±0.006
B	=	10.00		9.47		0.53 B	±0.007

Sullivan obtained differential photometric observations of DHK 29 in the B and V passbands on 25 nights between November 1992 and October 1993, for a total of 247 observations. These data were reduced with the Kaitchuck and Henden software and were corrected for extinction but have not yet been transformed to the standard system.

Gunn and Lamb obtained a total of 694 observations in B and V filters on 17 nights between August 1993 and October 1993, using the automated telescope and controlling software developed by Gunn. This total does not include data obviously affected by intermittent clouds. The Gunn/Lamb photometry has not been transformed to the standard system nor has it been corrected for extinction.

Both the Gunn/Lamb and the Sullivan data will be transformed to the standard system at a later date. Observation totals with errors are in Table 2.

Table 2. Observation totals for each observer, with errors.

Observer	Avg. Δ V	s.d.	Total observations
Kaiser	8.92 (V)	±0.009	251
Kaiser	0.55 (B-V)	±0.015	
Sullivan	0.99	±0.024	247
Gunn/Lamb	0.97	±0.016	694
		Total observations for all = 1192	

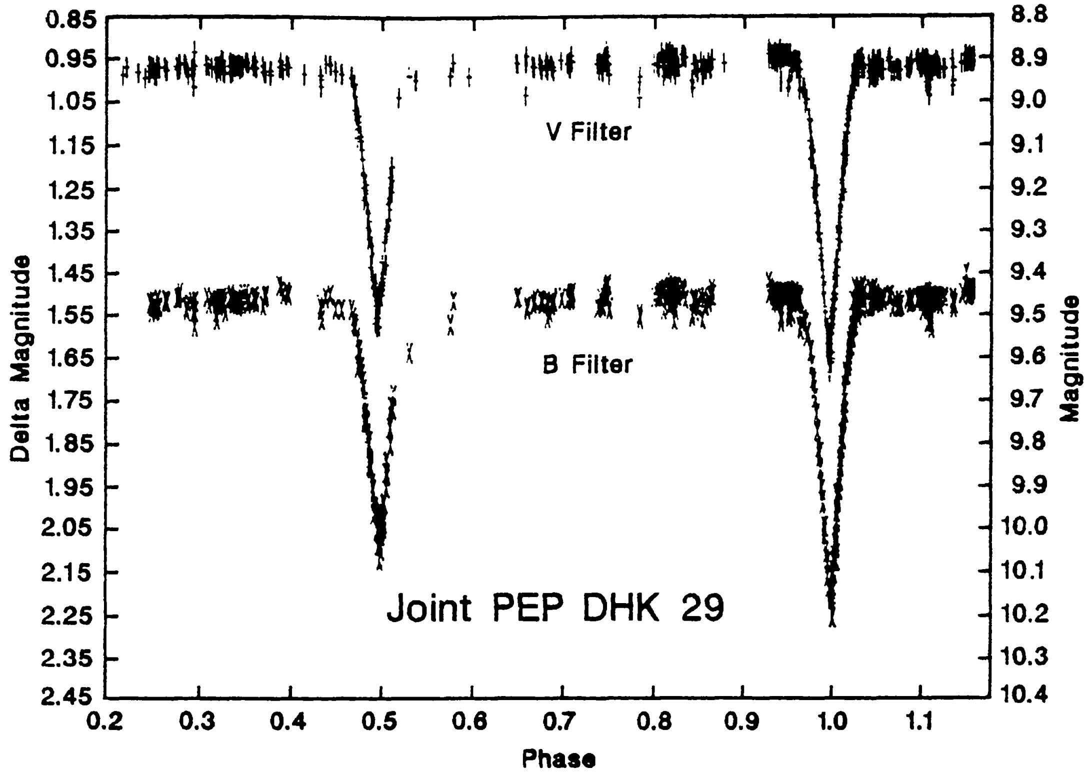

Figure 1. All observations showing total phase coverage, per equation (2). The Sullivan and Gunn/Lamb instrumental differential magnitudes were adjusted to match Kaiser's transformed magnitudes by overlaying them to match at out-of-eclipse phases.

The transformed data and the instrumental magnitude data are not truly comparable: to visualize the light curve, they are artificially overlaid in Figure 1. This was done by adjusting the y axis of the graph until the observations matched at maximum.

The photoelectric data show that the reported period of 1.9 days is in fact the half-period. The primary and secondary eclipses are distinguishable, the primary being 0.66 magnitude in depth and the secondary 0.55 magnitude, both in the V passband, based on the O'Connell magnitude data for the comparison star SAO 70626 (O'Connell 1977). At maximum DHK 29 equals 8.92 V, 0.55 B-V (Table 1).

Three times of primary minima were determined by the Kwee and Van Woerden method (Ghedini 1982, Table 3, below). These times were used along with the 11 primary minima from Kaiser and Baldwin (1992) in a least-squares solution for the light elements. The photoelectric minima were given a weight of 4, while the remaining were assigned a weight of 1 each. The new figures are:

$$\begin{array}{ll} \text{HJD Min I} = 2448909.5641 + 3.8042155\,E & (2) \\ \qquad\qquad\quad \pm\,0.0065 \pm 0.0000023 & \end{array}$$

Table 3. Photoelectric times of minima, HJD Min I.

	HJD	s.d.	Observer
1.	2449198.6866	±0.0011	Kaiser
2.	2449217.7047	±0.0013	Gunn/Lamb
3.	2449255.7451	±0.0007	Sullivan

3. Conclusions

Photoelectric observations spanning one year show this new eclipsing system to be of Algol type, with the primary and secondary eclipses clearly defined. There is an 0.11 V magnitude difference between the primary and secondary eclipses. Also, the B-V changes from 0.57 at primary eclipse to 0.53 at secondary (see Table 1). So, it is reassuring that the color becomes redder at primary minimum when the (hotter) bluer star is eclipsed and becomes bluer at secondary minimum when the (cooler) redder star is eclipsed. This indicates that one star must be somewhat earlier in spectral type than the composite, which is cataloged as F8 (AGK3 1975), and the other star somewhat later. This system may be one of just a handful of known detached late-type main-sequence eclipsing binaries (Popper 1993).

Photoelectric observations are continuing and a light curve solution will be published when phase coverage is complete.

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