COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS

Number 2263

Konkoly Observatory
Budapest
1983 January 10

HU ISSN 0374-0676

A PRELIMINARY EPHEMERIS FOR THE NEWLY-DISCOVERED ECLIPSING BINARY HD 174403 (A POSSIBLE COMPANION TO THE CEPHEID BB Sgr?)

Gieren (1981) recently reported the detection of an eclipse for the 7th magnitude spectroscopic binary HD 174403 (Wilson and Joy 1950, Lloyd Evans and Stobie 1971), which is located at $\alpha(1950) = 18^h\ 48^m\ 09^s$, $\delta(1950) = -20°\ 21'\ 36''$. This star is the closest object of comparable brightness to the $6^d.6$ classical Cepheid BB Sgr (1½ arcmin distant), and has frequently been used as a comparison star for this variable, despite being of earlier spectral type (B6). In fact, it has been suggested that HD 174403 might be a physical companion to BB Sgr, despite some evidence to the contrary (Stephenson 1960, Lloyd Evans and Stobie 1971). Consequently, a full orbital and eclipse solution for this system would be very useful both for establishing its distance and for investigating its relationship to the Cepheid in more detail. We recently obtained new photometry for HD 174403 as part of a program involving the study of BB Sgr as a coronal member of the open cluster Cr 394, and independently detected an eclipse for this system. Our purpose here is to present a preliminary ephemeris for HD 174403 derived from the available data, and to draw the attention of other observers to the pressing need for more extensive photometric and spectroscopic observations of this eclipsing/spectroscopic binary system.

The photometric data used in this analysis consist of the various observations of the system (all but one at maximum light) that are alluded to by Pel (1976) and Gieren (1981), who used this object as a comparison star for BB Sgr, a single observation at maximum published by Fernie (1969), and new observations presented in Table I. Only V magnitudes are listed here. The average values for the colours of the star outside of eclipse are as follows:

V = 7.51, B-V = 0.16, U-B = -0.26, V-R = 0.11, V-I = 0.23.

These values differ slightly from those given by Gieren (1981).

Other observations of this star are reported in the literature, but lack any record of the date of observation. The useable data sample the star brightness on 70 different nights, on only two of which was the object observed to be in eclipse. Our eclipse observation of HJD 2444738.7824 found the star $0^m.36$ fainter than maximum, while the star was $0^m.23$ fainter than maximum for

Table I

Photoelectric Observations of HD 174403

HJD 2440000+	V	n	Observer	Telescope
4489.549	7.54:	3	Fernie	David Dunlap 0.5-m
4686.872	7.52	1	Pedreros	Las Campanas 0.6-m
4687.856	7.50	1	Pedreros	Las Campanas 0.6-m
4688.832	7.53	1	Pedreros	Las Campanas 0.6-m
4689.842	7.49	2	Pedreros	Las Campanas 0.6-m
4690.817	7.51	1	Pedreros	Las Campanas 0.6-m
4723.867	7.50	2	Turner	Las Campanas 0.6-m
4724.823	7.50	1	Turner	Las Campanas 0.6-m
4728.842	7.51	1	Turner	Las Campanas 0.6-m
4729.834	7.51	1	Turner	Las Campanas 0.6-m
4730.854	7.51	1	Turner	Las Campanas 0.6-m
4738.7824	7.87*	1	Turner	Las Campanas 0.6-m
4739.873	7.51	1	Turner	Las Campanas 0.6-m
4850.682	7.53:	1	Turner	Kitt Peak #4 0.4-m
4852.688	7.50	1	Turner	Kitt Peak #2 0.9-m
4854.649	7.51	1	Turner	Kitt Peak #2 0.9-m
4855.642	7.52	1	Turner	Kitt Peak #2 0.9-m
4857.645	7.52	2	Turner	Kitt Peak #2 0.9-m
5105.839	7.51	2	Pedreros	Las Campanas 0.6-m
5107.856	7.49	2	Pedreros	Las Campanas 0.6-m
5108.829	7.51	2	Pedreros	Las Campanas 0.6-m
5110.861	7.50	2	Pedreros	Las Campanas 0.6-m
5112.900	7.51	2	Pedreros	Las Campanas 0.6-m
5114.842	7.50	1	Pedreros	Las Campanas 0.6-m

* - Star in eclipse.

Gieren's eclipse observation. Our observation must correspond more closely to the brightness at mid-eclipse than that of Gieren, although by how much is still uncertain. The period of variability is presumably some fraction of $299^{d}.2846$, which is the difference in dates between the two eclipse observations.

A unique solution for the period of HD 174403 would not be possible were it not for the availability of radial velocity observations for this star. Lloyd Evans and Stobie (1971) have published 4 values for the radial velocity of HD 174403 derived from plates obtained on 4 nights in 1969-70, and we can quote an additional measure of -2.8 (± 2.2) km s^{-1} (based on 8 lines) from a 12 Å mm^{-1} plate of HD 174403 obtained in May 1980 (HJD 2444375.855) with the Cassegrain spectrograph on the David Dunlap Observatory 1.9-m telescope. The velocity measures suggest a period of about 60 days for the system, but we tested for the true period using all reasonable integral fractions of $299^{d}.2846$. Only for P = $59^{d}.86$ are the radial velocity observations consistent with the phase of primary eclipse occurring when the primary is on the far side of its orbit. A detailed orbital solution is not possible with so few observations, but a reasonable guess at the radial velocity curve for HD 174403 based upon

the 5 measures is presented in Figure 1. Estimates for the orbital elements of the system, as derived from this curve, are as follows:

V_o = -8.3 km s^{-1} e = 0.31 a sin i = 0.08 A.U.

K = 15.3 km s^{-1} ω = -23°.98 $f(M_1,M_2)$ = 0.019

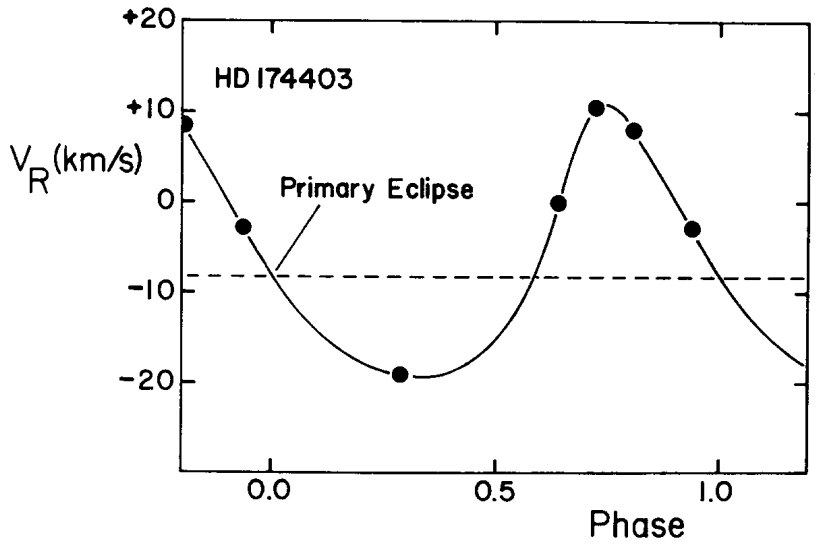

Figure 1

A preliminary ephemeris for the times of primary eclipse in HD 174403 is:

HJD (V_{min}) = 2444738.7824 + 59.8569 E .

A search through the available photometry confirms that none of the other observations, other than the two already mentioned, were made at the times of primary eclipse. A secondary eclipse is expected near phase 0.585 according to the radial velocity data, and an observation by Pel (1976) on HJD 2440823.317 coincides with this exactly. However, Pel did not note any significant change in brightness for HD 174403 on this date, so the depth of secondary minimum is presumably not more than 0.01 or 0.02 in V.

It is possible to make some predictions about the components of HD 174403 by using the radial velocity data, the photometric data, information on the spectral type (B6 IV) of the primary, and the knowledge that i ≈ 90°. On this basis, we estimate the masses of the two components of HD 174403 to be about

6 $M_\odot$ and 1 $M_\odot$, respectively. The luminosity of the primary inferred from its spectral type (and from an unpublished Hβ observation by J.D. Fernie) is $M_V \simeq -1.5$, and the probable value of ΔV between the two stars in the system is perhaps 6^m. The lack of detectable secondary eclipses in the system would seem to confirm this last estimate.

From the photometric data we find a reddening for HD 174403 of $E_{B-V} = 0.30$, and a distance of 415 pc ($V_o - M_V = 8.09$). In contrast, the cluster Cr 394, of which BB Sgr is probably a member, has a reddening of $E_{B-V} = 0.33 \pm 0.01$ m.e. for member stars near HD 174403 (and BB Sgr), and a distance of 646 pc ($V_o - M_V = 9.05$). The radial velocity of BB Sgr (Gieren 1982) is about 11 km s^{-1} more positive than that of HD 174403, so one might conclude from the evidence that the two are not physically related. Nevertheless, there are enough uncertainties in some of these quantities that the question cannot be considered as fully resolved. Gieren (1982), for example, has suggested that BB Sgr may itself be a spectroscopic binary, in which case a comparison of radial velocities for it and HD 174403 (particularly in the absence of velocity measures for Cr 394 members) may not be entirely meaningful. The luminosity of HD 174403 is also not well-determined from the spectroscopic data, and the star does fit extremely well onto the top end of the main-sequence in the cluster H-R diagram, as do cluster stars which photometrically appear to be of spectral type B6 IV. Thus, until an eclipse solution for HD 174403 becomes available, it seems best to postpone further discussion of its possible relationship to the Cepheid BB Sgr.

DAVID G. TURNER
Department of Physics and Astronomy
Laurentian University
Sudbury, Ontario, P3E 2C6, Canada

MARIO PEDREROS
Department of Astronomy
University of Toronto
Toronto, Ontario, M5S 1A7, Canada

References:

Fernie, J.D. 1969, J. Roy. Astron. Soc. Canada 63, 133.

Gieren, W. 1981, Astrophys. J. Suppl. 47, 315.

Gieren, W. 1982, Astrophys. J. Suppl. 49, 1.

Lloyd Evans, T., and Stobie, R.S. 1971, Observatory 91, 160.

Pel, J.W. 1976, Astron. Astrophys. Suppl. 24, 413.

Stephenson, C.B. 1960, Astron. J. 65, 60.

Wilson, R.E., and Joy, A.H. 1950, Astrophys. J. 111, 221.