UPDATE ON EPSILON AURIGAE (May 1984)

A PAPER PRESENTED AT THE 1984 I.A.P.P.P. SYMPOSIUM IN BIG BEAR

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I. INTRODUCTION

During the 1982 I.A.P.P.P. Big Bear Symposium I presented a paper on epsilon Aurigae (Hopkins 1983). That was at the start of the 1982-1984 eclipse. This paper is presented near the end of egress as an update on what has happened during the eclipse.

Epsilon Aurigae is an eclipsing binary star system that has baffled astronomers for over a century. The German amateur astronomer Fritsch (1821) first noted the variability in 1821. The eclipse has been observed every 27 years since. Ludendorff (1904) determined that the eclipse had a period of 27.1 years, lasted about two years, and was flat bottomed. The primary star is a massive FO-F2 super-giant 250 times larger than our sun and 50,000 times brighter. The system is located 1900 light years (Van de Kamp 1978) away. During the eclipse the visual magnitude decreases by 0.8. Because of the long period and the length of the eclipse, the implied size of the eclipsing body is gigantic. Another part of the mystery is that the occulting body does not appear to radiate because, during the eclipse, the spectrum of the primary does not change even though the eclipse appears to be total. Many models have been proposed for the occulting body but none has completely fit the observed data. Recent polarimetry data obtained by Kemp (1984) point to the strong possibility of a proto-planetary system. Nobody, however, is placing any bets until all the data are in.

II. THE CAMPAIGN

F. B. Wood organized and coordinated the campaign to study epsilon Aurigae during the 1955-1957 eclipse. He also suggested a campaign for the 1982-1984 eclipse. Then R. E. Stencel (NASA), D. S. Hall (Dyer Observatory), and R. M. Genet (Fairborn Observatory) initiated procedures for organizing the present campaign. A campaign newsletter was started to provide rapid distribution of information and observational data during the eclipse. Stencel published the first two campaign newsletters. Since then the Hopkins Phoenix Observatory has been publishing the newsletter and coordinating the photoelectric photometry data. Stencel has been providing editorial comment and coordinating the spectroscopy data. J. C. Kemp (University of Oregon) has been providing the polarimetry reports. As of March 1984, ten newsletters have been published.

The present campaign has over 80 members with 17 active photoelectric observers. These observers are located all over the world and have provided over 1200 UBV data points from before the eclipse until the present. In addition, several observers have provided I, R, J, H, K, L, M, N, and Q data. This campaign is an excellent example of advanced amateurs working with professionals to contribute to an important astronomical project.

TABLE I

Basic Parameters for the Epsilon Aurigae Eclipse

PRIMARY	SECONDARY
BS 1605	
Mv 3.0 - 3.8	?
SPEC F0 - F2	I ?
DIA 250 X SUN	DIA 2800 X SUN ?
MASS 15 SUNS	MASS 10 - 20 SUNS
DISTANCE 1900 L.Y.	
PERIOD 27.1 YEARS	
DURATION 2 YEARS	

III. THE 1982-1984 PHOTOELECTRIC PHOTOMETRY DATA

Several interesting variations can be seen in the UBV light curves of epsilon Aurigae. Table I shows a summary of the basic physical parameters which describe epsilon Aurigae. Table II is a sample of the UBV data base used in the campaign newsletter. Figure 1 shows a composite plot of all V-band photoelectric data submitted to the campaign (as of the date indicated on the plot). There is considerable scattering of the data points. Data from the Tjorn Island Astronomical Observatory in Sweden and the Hopkins Phoenix Observatory in Arizona were combined to form the plots of UBV data shown in Figures 2, 3, and 4. These data were selected because they represent nearly complete

TABLE II

Composite Data, Reported as of 13 May 1983, for the 1982-1984 Eclipse of Epsilon Aurigae

UT	DATE	2440000 + HJD	VISUAL V	N	SD	BLUE B	N	SD	ULTRA VIOLET U	N	SD	NOTES/ OBSERVER	
18	SEPT 80	4501.	3.09	1	----	-----	-	----	-----	-	----	RES IUE	*
4	AUG 81	4821.	3.12	1	----	-----	-	----	-----	-	----	RES IUE	*
29	AUG 81	4846.	3.11	1	----	-----	-	----	-----	-	----	RES IUE	*
	JAN 82												
23	FEB 82	5024.66	3.040	-	.005	-----	-	----	-----	-	----	KK SJC	*
3	MAR 82	5032.70	3.005	-	.009	-----	-	----	-----	-	----	KK SJC	*
9	MAR 82	5048.71	2.932	1	----	-----	-	----	-----	-	----	ECO ML	
22	MAR 82	5051.62	2.937	1	----	-----	-	----	-----	-	----	ECO ML	
23	MAR 82	5052.62	2.938	1	----	-----	-	----	-----	-	----	ECO ML	
25	MAR 82	5054.38	2.920	1	.030	-----	-	----	-----	-	----	RM MO	
28	MAR 82	5057.23	3.025	2	.016	3.508	2	.008	-----	-	----	IED AUO	
4	APR 82	5064.	3.07	1	----	-----	-	----	-----	-	----	RES IUE	*
8	APR 82	5068.29	3.000	1	----	3.529	1	----	-----	-	----	IED AUO	
13	APR 82	5073.	3.15	1	----	-----	-	----	-----	-	----	RES IUE	*
19	APR 82	5079.	3.13	1	----	-----	-	----	-----	-	----	RES IUE	*
25	APR 82	5085.	3.10	1	----	-----	-	----	-----	-	----	RES IUE	*
27	APR 82	5087.46	3.030	2	.040	-----	-	----	-----	-	----	RM MO	
30	APR 82	5091.61	3.120	1	----	-----	-	----	-----	-	----	P/E GCO	
5	MAY 82	5095.43	3.124	4	.020	3.590	4	.030	3.710	4	.040	RM MO	
8	MAY 82	5099.60	3.160	1	----	-----	-	----	-----	-	----	P/E GCO	
9	MAY 82	5100.60	3.110	1	----	-----	-	----	-----	-	----	P/E GCO	
10	MAY 82	5100.42	3.103	3	.030	-----	-	----	-----	-	----	RM MO	
10	MAY 82	5101.58	3.080	1	----	-----	-	----	-----	-	----	P/E GCO	
	JUNE 82												
21	JULY 82	5172.47	3.098	9	----	3.649	3	.005	-----	-	----	SII TAO	
24	JULY 82	5175.	3.26	1	----	-----	-	----	-----	-	----	RES IUE	*
26	JULY 82	5177.50	3.127	6	.003	3.658	3	.014	-----	-	----	SII TAO	
29	JULY 82	5181.50	3.126	4	.009	3.702	3	.012	-----	-	----	SII TAO	
31	JULY 82	5182.49	3.111	4	.005	3.663	3	.008	3.890	3	.005	SII TAO	*
2	AUG 82	5184.48	3.115	3	.007	3.654	3	.017	3.827	3	.014	SII TAO	*
4	AUG 82	5186.50	3.119	3	.009	3.679	3	.011	3.828	3	.011	SII TAO	*
13	AUG 82	5195.61	3.224	3	.015	3.921	3	.020	-----	-	----	RM MO	
14	AUG 82	5196.	3.24	1	----	-----	-	----	-----	-	----	RES IUE	*
24	AUG 82	5206.	3.29	1	----	-----	-	----	-----	-	----	RES IUE	*
28	AUG 82	5210.46	3.180	3	.006	3.737	3	.003	3.891	3	.012	SII TAO	*
28	AUG 82	5210.57	3.168	4	.015	3.849	4	.015	4.001	4	.025	RM MO	
2	SEPT 82	5215.63	3.217	5	.015	3.879	5	.015	4.006	5	.020	RM MO	
4	SEPT 82	5217.48	3.236	3	.007	3.768	3	.009	3.981	3	.009	SII TAO	*
7	SEPT 82	5220.	3.41	1	----	-----	-	----	-----	-	----	RES IUE	*
11	SEPT 82	5224.48	3.305	3	.007	3.884	3	.009	4.059	3	.007	SII TAO	*
16	SEPT 82	5229.41	3.386	3	.015	3.958	3	.009	4.140	3	.012	SII TAO	*
18	SEPT 82	5231.99	3.425	3	.031	3.954	3	.007	4.141	3	.004	JLH HPO	
21	SEPT 82	5234.	3.56	1	----	-----	-	----	-----	-	----	RES IUE	*
21	SEPT 82	5234.98	3.430	3	.005	3.968	3	.003	4.174	3	.005	JLH HPO	
23	SEPT 82	5236.	3.57	1	----	-----	-	----	-----	-	----	RES IUE	*
23	SEPT 82	5236.40	3.442	3	.006	3.973	3	.033	4.163	3	.009	SII TAO	*
23	SEPT 82	5236.98	3.433	3	.005	3.978	3	.003	4.167	3	.008	JLH HPO	
24	SEPT 82	5237.97	3.439	3	.011	3.982	3	.001	4.171	3	.004	JLH HPO	
25	SEPT 82	5238.98	3.446	3	.002	3.977	3	.003	4.174	3	.010	JLH HPO	
26	SEPT 82	5239.--	3.517	1	----	4.098	1	----	4.304	1	----	O/Y JAP	
26	SEPT 82	5239.15	3.529	1	----	4.067	1	----	4.452	1	----	JAPOA	
27	SEPT 82	5240.83	3.350	1	----	-----	-	----	-----	-	----	P/E GCO	
28	SEPT 82	5241.--	3.487	1	----	-----	-	----	-----	-	----	O/Y JAP	

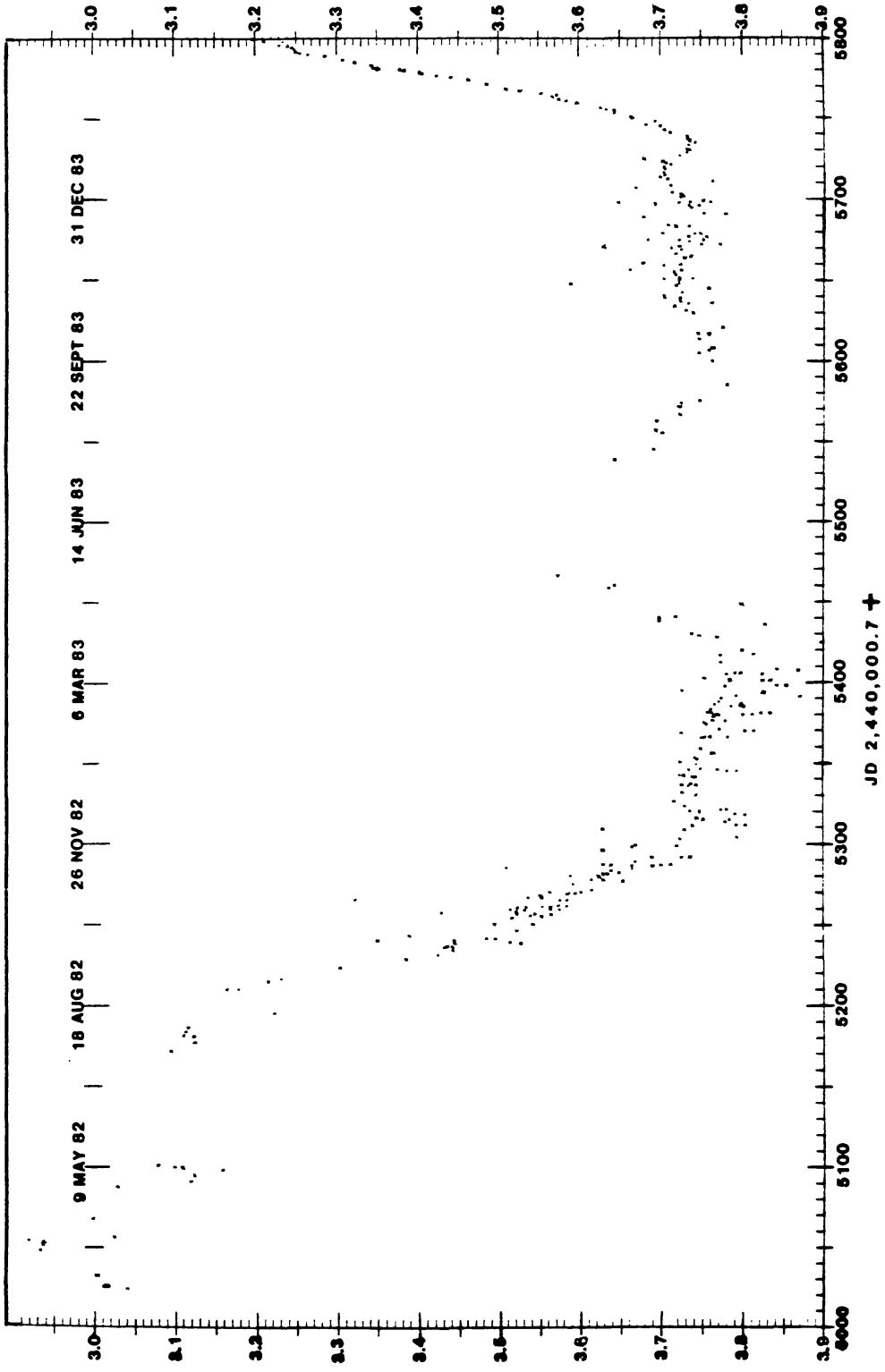

Figure 1. The 1982-1984 eclipse of epsilon Aurigae. The ordinate in V magnitude. The points represent the composite data as of March 1984.

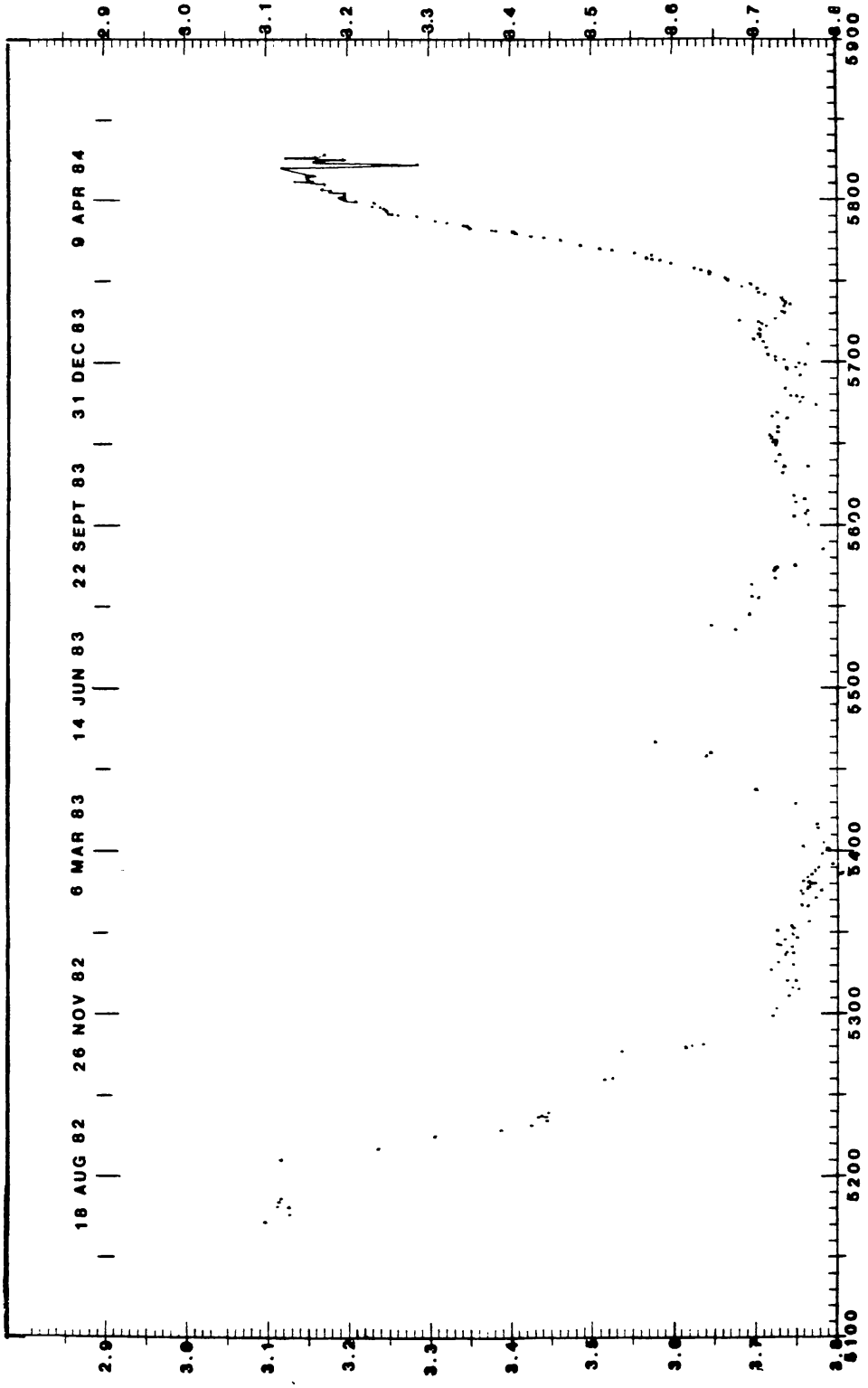

Figure 2. The same as figure 1 except the points represent data from the Tjorn Island Astronomical Observatory and the Hopkins Phoenix Observatory.

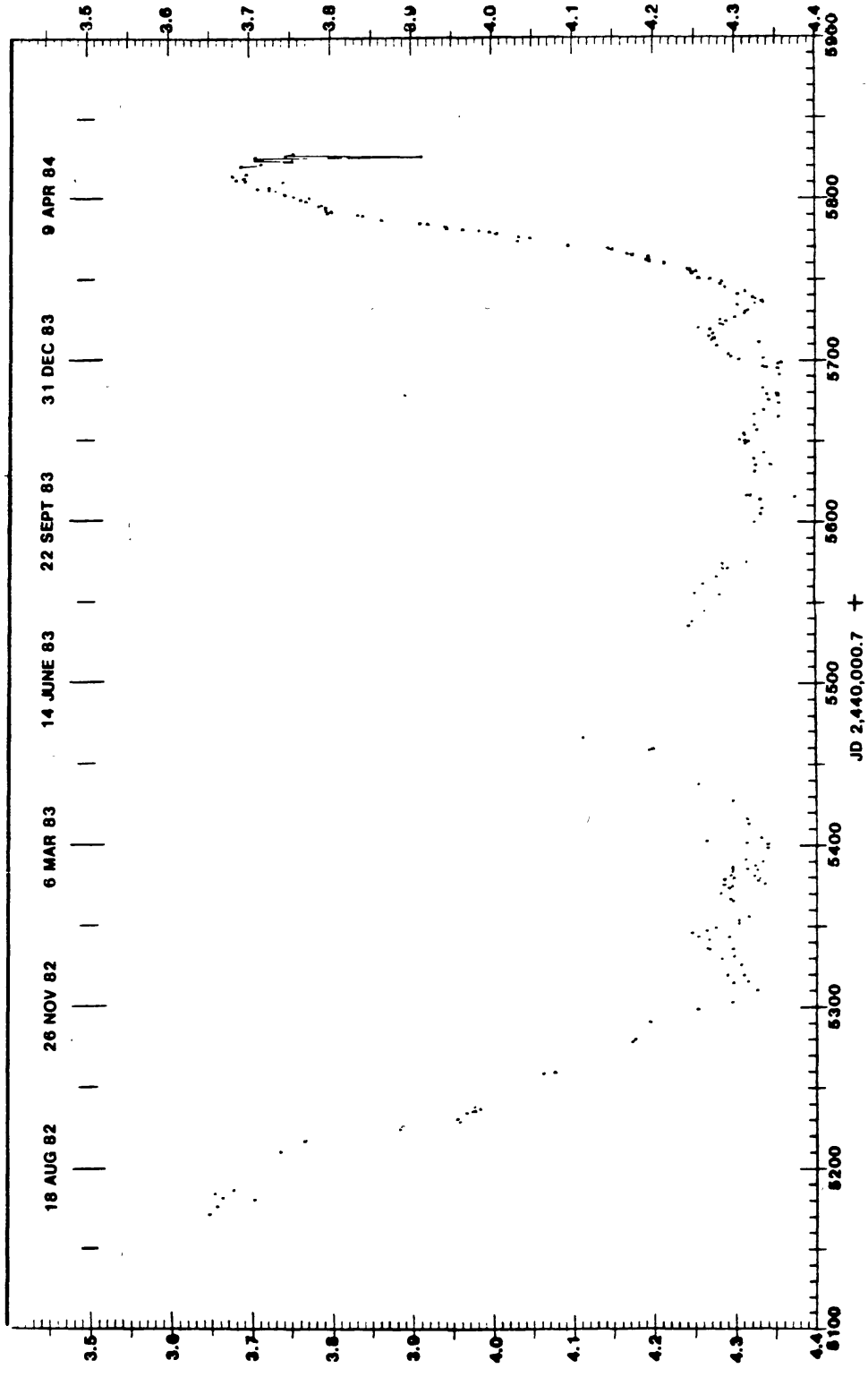

Figure 3. The same as figure 2 except the ordinate is B magnitude.

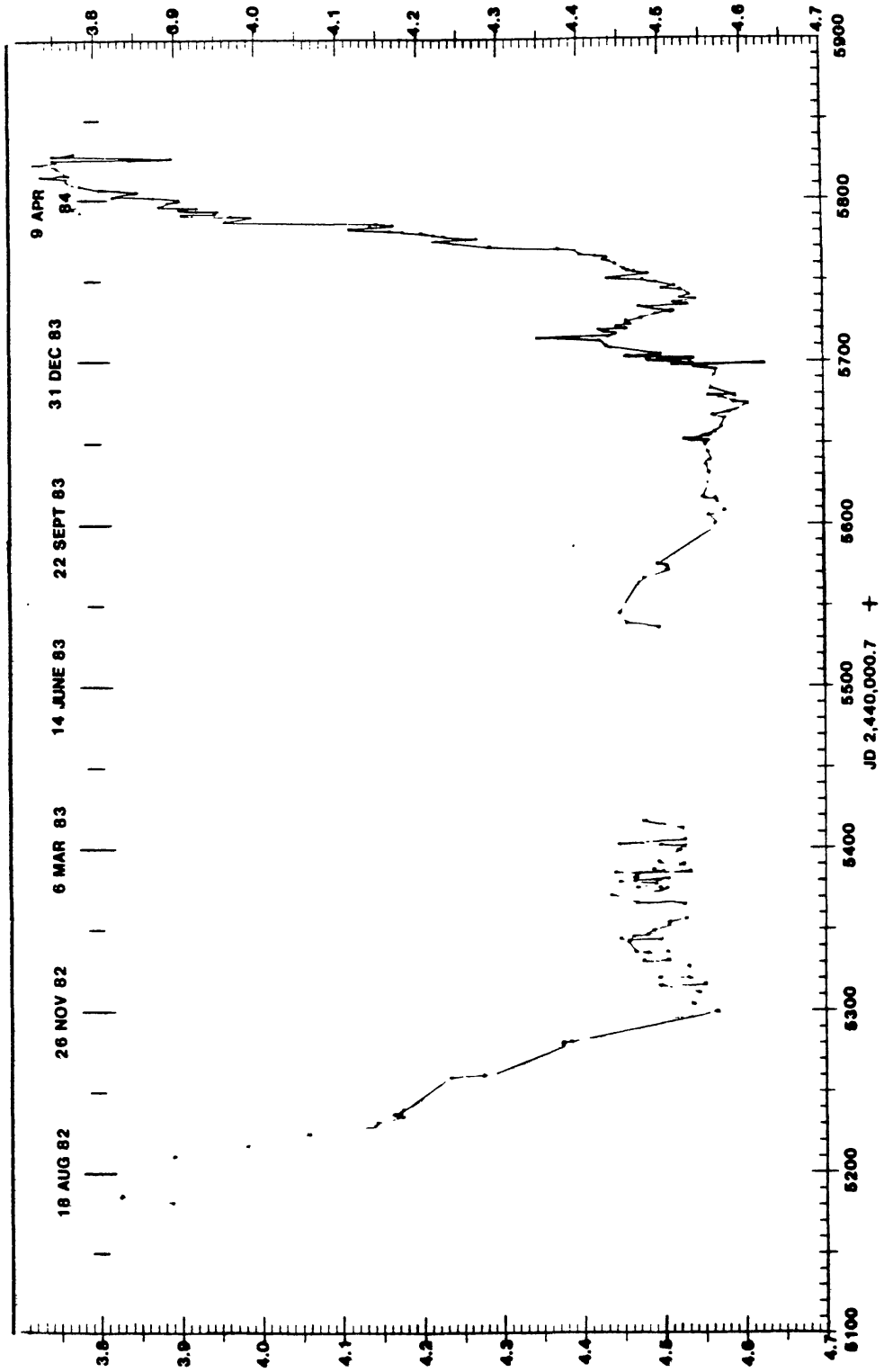

Figure 4. The same as figure 3 except the ordinate is U magnitude.

coverage of the eclipse and are in close agreement with each other.

Cepheid-like pulsations of the F supergiant primary star, with a period of 105 to 120 days, have been observed (Guinan 1982). This pulsation complicates the light curve analysis.

Variations of 0.06 magnitude (using a 3940 Angstrom narrow-band filter) with periods on the order of minutes have been reported (Xuefu and Xioyu 1984). These variations may be due to flare activity or possible variable transparency in the extended atmosphere of the secondary.

As can be seen in the UBV plots, there seems to be a mid-eclipse brightening of over 0.2 magnitude. A similar brightening was seen in the previous eclipse. A suggestion has been presented that we may be seeing a lens effect due to the great mass of the secondary. More work is needed to determine if there is indeed a possibility.

About 40 days prior to egress a brightening in all three bands (UBV) can be seen. The U band shows a brightening of nearly 0.15 magnitude, the B band 0.07 magnitude, and the V band 0.04 magnitude. This brightening has been observed by numerous observers. So far no theories have been presented but it may be due to a brightening of the F supergiant primary or an increase in the transparency of the secondary's atmosphere. More data and analysis are needed.

Variations in the U band, up to 0.05 magnitude in amplitude and about three days in period, have been noticed in data obtained at the Hopkins Phoenix Observatory. Comparison with other data and further analysis are needed to ascertain if this is a real variation.

IV. CONCLUSION

Although the present eclipse has nearly ended, continued observations of epsilon Aurigae are needed. The nature of the Cepheid-like variations, as well as the short-term variations, must be investigated. Data on epsilon Aurigae are needed for at least another year and possibly even several more years to help unravel its light curve morphology. The campaign will continue into 1985 and beyond to provide a focal point for reports on data, papers, and developments.

A workshop on epsilon Aurigae will follow the January 1985 meeting of the American Astronomical Society in Tucson, Arizona. Details of the meeting will be published in a future issue of the campaign newsletter or can be obtained by writing to me. Proceedings of the workshop will be published shortly thereafter.

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