TABLE 1

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Observer	Location and telescope aperture in [cm]	U		B		V		R		I	
		m	n	m	n	m	n	m	n	m	n
.....	APT Mt. Hopkins; [40] Tucson, USA	4	62	4	60	4	59	4	64	4	63
Barksdale	Barksdale Obs.; [35] Winter Park, USA	...	...	...	...	6	63	6	59	5	54
Bertoglio	Cuneo Obs.; [20] Torino, Italy	...	...	...	...	2	10	...	...	2	10
Cortesi	Spec.Sol.Ticinese;[50] Locarno, Switzerland	...	...	11	30	11	30	11	30	11	30
Cutispoto	ESO; [50] La Silla, Chile	13	13	13	13	13	13	13	13	13	13
Engelbrektson Ganis	Pace Univ. Obs.; [28] Pleasantville, USA	...	...	...	...	9	63	...	...	...	...
Gómez, Casas Gallart,Jariod	Grup d'Estudis Astr.; [20, 30, 41] Barcelona, Spain	...	...	...	...	7	10	2	2	1	1
Ito	Kakuda Joshi Obs.; [15] Kakuda, Japan	...	...	2	31	2	39	...	...	...	...
Melillo	Valley Stream Obs.;[20] Valley Stream, USA	...	...	...	...	2	2	...	...	2	2
Ohshima	Tamashima Obs.; [20] Kurashiki, Japan	12	500	12	500	12	500	...	...	...	...
Poole McLaughlin	Grant Obs.; [25] Pittsburgh, USA	...	...	...	...	1	5	1	5	1	5
Powell, Nix	East Tenn. St. U.;[20] Johnson City, USA	...	...	...	...	3	13	3	13	3	13
Soder	Einstein Ap. Obs.; [20] Sidney, USA	...	...	...	...	1	3	1	3	1	3
Wasson	Sunset Hills Obs.; [35] Hacienda Heights, USA	...	...	...	...	2	8	...	...	...	...

m is the number of nights on which HD 26337 was observed.

n is the total number of individual measurements received by the authors and are not necessarily average values.

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Figure Captions

Fig. 1 - Differential V light curve (EI Eri minus 37 Eri) produced by the reduction scheme described in the text. The magnitudes and their error bars come from Table 3.

Fig. 2 - Differential V light curve (EI Eri minus 37 Eri). Contains the uncorrected data of the APT (○), Barksdale (△), Cutispoto (□), and Grup D'Estudis Astronomics (◇).

PHOTOELECTRIC PHOTOMETRY OF THE RS CVn BINARY EI ERIDANI = HD 26337

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1. Introduction

EI Eri (= HD 26337) is a 7.1 mag SB1 star which, according to Bidelman and MacConnell (1973), contains a G5 IV component with CaII H and K emission. Based on this and other analysis, Fekel *et al.* (1982) classified this system as an RS CVn binary, for which the photometric variability is caused by the existence of starspots in the stellar photosphere. Hall *et al.* (1987) found a photometric amplitude ranging from 0.07 to 0.20 mag over six years with an average photometric period of 1.945±0.005 days. The photometric period is in close agreement with the orbital period of 1.9472 days obtained by Fekel *et al.* (1986), suggesting that the system is in synchronous rotation.

As part of an ongoing project to produce simultaneous spot model solutions of EI Eri using both photometric data and the Doppler imaging technique, Strassmeier (1987ab) requested that interested observers at all geographic longitudes obtain *VRI* photometric observations. The result was observations from 14 different observatories in six different countries. Table I lists the various observatories participating in the project, where m indicates the number of nights on which EI Eri was observed and n indicates the total number of individual measurements.

In this paper we present *UBVRI* photometry obtained at 12 different observatories during the time interval 16 Dec 1987 to 20 Jan 1988, and $UBV(RI)_{KC}$ photometry obtained by Cutispoto at ESO in LaSilla, Chile, and by the Vanderbilt 0.4 m Automatic Photoelectric Telescope (APT) atop Mount Hopkins near Tucson, Arizona. Throughout this paper our analysis adopts 1.945 days as the photometric period of the system.

2. Observations

The individual photometric magnitudes have been sent to the IAU Commission 27 Archive for Unpublished Observations of Variable Stars (Breger 1986), where they are available as file No. 157. Throughout this paper the symbol Δ means difference in the sense variable minus comparison.

All of the *UBVRI* measurements were made differentially with 37 Eri (= HD 26409) used as a comparison star. All observatories except Specola Solare Ticinese presented differential magnitudes. Specola Solare Ticinese presented the data in magnitudes rather than differentials. In order to include these data with the differential values, the corresponding average magnitudes of 37 Eri (U = 7.05, B = 6.38, V = 5.44, R = 4.70, I = 4.30) were subtracted from each datum of Specola Solare Ticinese. The average U, B, and V magnitudes for 37 Eri are from Nicolet (1978), while the R and I magnitudes were determined by Cortesi on nights of good photometric quality using the standard stars HR 875, 77 θ^1 Tau, and 78 θ^2 Tau. The internal error for each night used to determine R and I for 37 Eri was ±0.02 mag. Thus, all *UBVRI* photometry has been archived as differential magnitudes, and it has been corrected for extinction and transformed to the *UBVRI* system of Johnson. Those observatories submitting data in bandpasses which required the assumption of color indices for reduction were reduced with the average differential color indices of $\Delta(B\text{-}V)$ = -0.34 mag, $\Delta(V\text{-}R)$ = -0.09 mag, and $\Delta(V\text{-}I)$ = -0.12 mag. In sum, 12 observatories obtained differential *UBVRI* photometry on 32 different nights between JD 2447116 and JD 2447180.

Abstract: Differential $UBV(RI)_{KC}$ and $UBVRI$ photometry of the RS CVn binary EI Eridani obtained during December 1987 and January 1988 at fourteen different observatories is presented. A combined visual bandpass light curve, corrected for systematic errors of different observatories, utilizes the photometric period of 1.945 days to produce useful results. Analysis shows the visual light curve to have twin maxima, separated by about 0.4 phase, and a full amplitude of approximately 0.06 mag for the period of observation, a smaller amplitude than reported in the past. The decrease in amplitude may be due to a decrease or homogenization of spot coverage. To fit the asymmetrical light curve, a starspot model would have to employ at least two spotted regions separated in longitude.

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$UBV(RI)_{KC}$ data were obtained by the Vanderbilt 0.4m APT at Mount Hopkins and by Cutispoto at ESO in LaSilla, Chile. APT measurements were obtained differentially with 37 Eri used as a comparison star. The filter-photomultiplier tube combination used by the APT is such that the photometry could be transformed to the UBV system of Johnson by means of the usual transformation procedures. The R and I bandpasses were not transformed but are thought to match the $(RI)_{KC}$ system of Kron and Cousins closely.

ESO measurements used HD 25852 as a comparison star, and were presented as $UBV(RI)_{KC}$ magnitudes rather than differentials. In order to use the ESO photometry in the resulting differential V light curve, the V magnitude of 37 Eri stated above was subtracted from each datum. However, the ESO data are archived as $UBV(RI)_{KC}$ magnitudes and not differential magnitudes. Together, ESO and the APT observed EI Eri on 17 different nights between JD 2447129 and JD 2447162.

3. The V Light Curve

The data, when initially plotted against phase, exhibited large scatter and apparent systematic errors which were different from observatory to observatory. In order to reduce the effects of the systematic errors on the resulting ΔV light curve, systematic corrections were applied. The steps involved in determining these corrections for the visual data were:

1) Average the observations of each observatory within Julian date bins of width 0.007 days.

2) As a first approximation, consider the light curve to be of the form

mag.

To check the reliability of our reduction method, a second plot of ΔV versus phase is presented (Figure 2) containing only the *uncorrected* observations of the APT, Barksdale, Cutispoto, and Grup D'Estudis Astronomics. These data have been averaged in Julian date bins of width 0.007. An "eyeball" fit places the full amplitude of Figure 2 at $\sim$0.06 mag. Comparison of Figures 1 and 2 shows that both reduction methods produce light curves of comparable amplitude and somewhat similar shape. Any difference between light curves is more likely due to the small amplitude of the light variation and the large scatter in the observations than due to the method of analysis.

4. Discussion

By invoking the starspot model to explain the light variation of EI Eri, it is apparent that spot coverage during the period of observation was either less pronounced than in the past, as reported by Fekel *et al.*(1982) and Hall *et al.*(1987), or spread more homogeneously over the photosphere. Careful inspection of both light curves shows two light maxima, one near phase 0.3, the other near phase 0.7. The appearance of two maxima at such phase angles is indicative of at least two spotted regions displaced in longitude on the stellar photosphere. Further study of EI Eri could show a continued decline in the photometric amplitude of this variable star or it could show an increase. Frankly, we understand too little about the evolution of starspots on this or any chromospherically active star to predict which will happen.

Acknowledgements

$$l = A_\circ + A_1\cos\theta + A_2\cos2\theta,$$

where zero phase is at the deepest minimum, and solve for the coefficients by means of least squares.

3) For each observatory, determine the shift (in magnitudes) which will make the average of the residuals from the curve be zero.

4) Assign each observatory a weight given by $1/\sigma^2$, where σ is the rms residual from the curve (after the shift has been applied).

5) Divide the light curve into phase bins of width 0.02 phase, and calculate a weighted average of all observers in each phase bin.

6) Assign a relative error to each phase bin by the equation

$$\text{error} = [1/\Sigma\sigma^2]^{-1/2}.$$

Table II lists the shifts and weights which apply to each observatory, while Table III contains the corrected photometric data. Phases were computed using the ephemeris

$$\text{JD(hel.)} = 2\ 446\ 074.871 + 1.945\text{E},$$

where the initial epoch corresponds to a time of conjunction (Strassmeier *et al.* 1988). Figure 1 is a plot of the corrected differential *V* magnitudes versus phase; the error bars were calculated by the method described in step 6. The APT data are not included in the light curve of Figure 1. An "eyeball" fit to the light curve in Figure 1 places the full amplitude of the photometric variation in *V* during the period of observation at ~0.06

TABLE 2

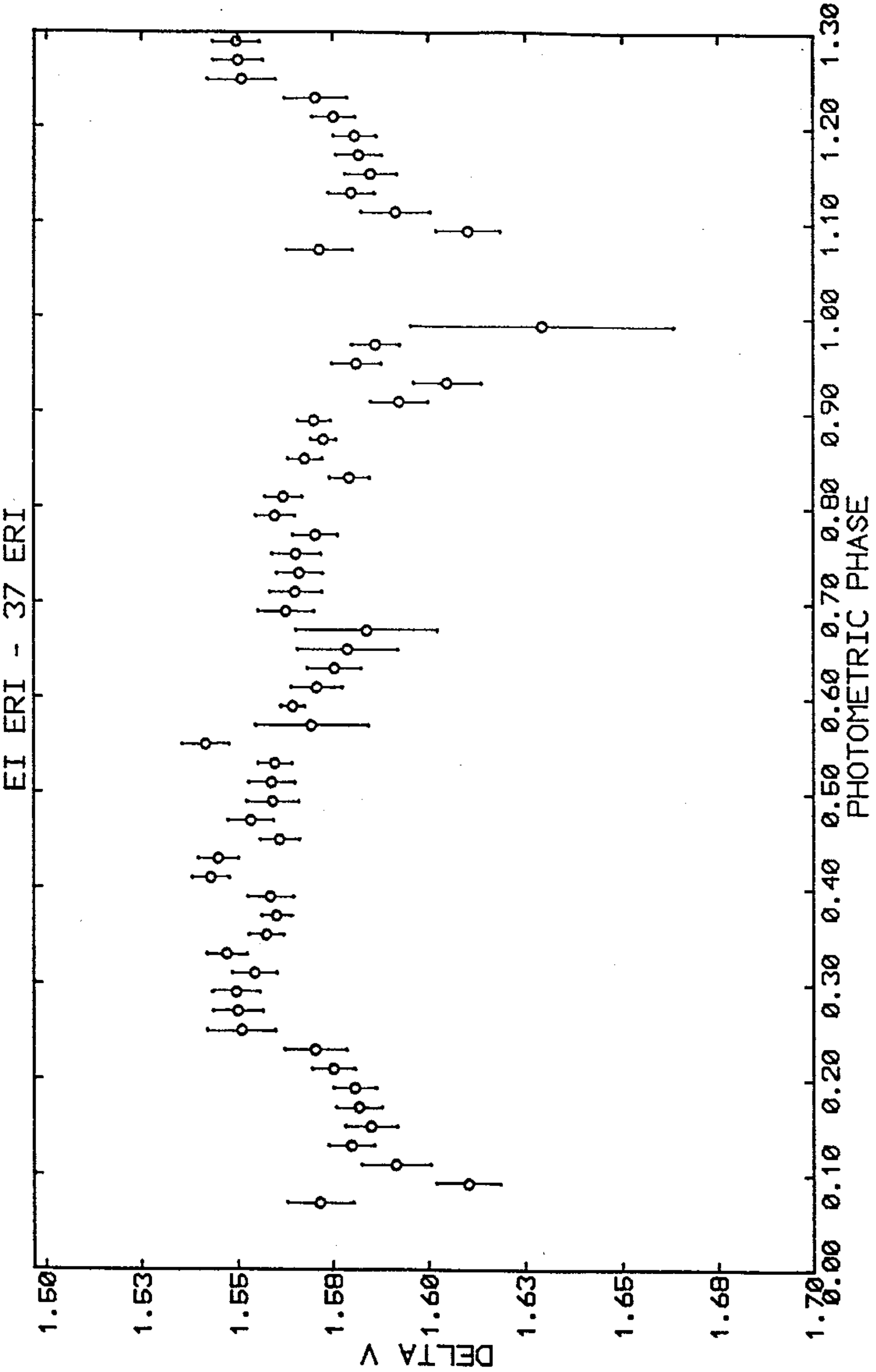
CORRECTIONS APPLIED TO DATA

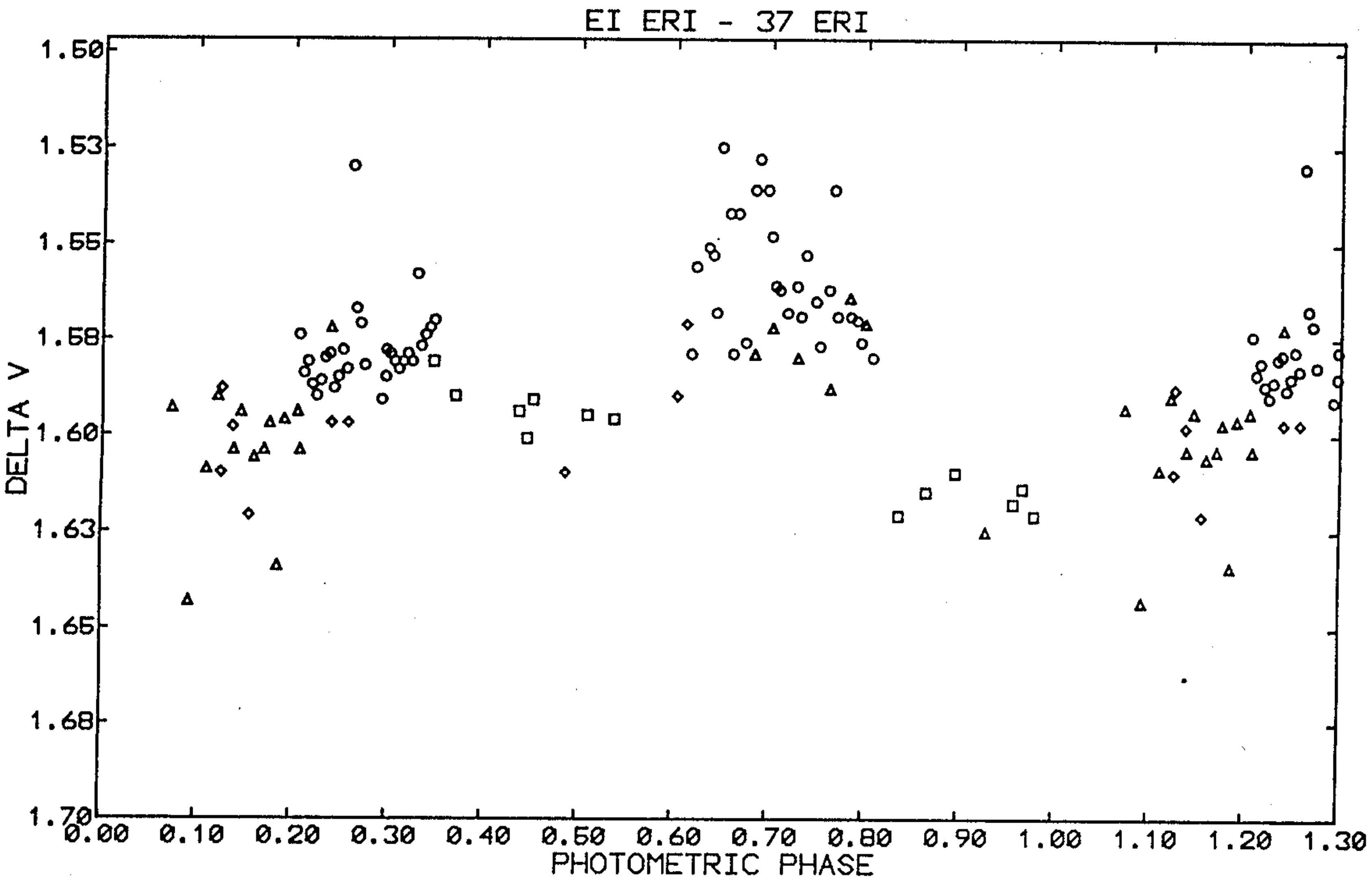
Observer	Shift	Weight
Barksdale	-0.0178	4057
Bertoglio	+0.0140	875
Cortesi	-0.0205	870
Cutispoto	-0.0312	12913
Engelbrektson Ganis	+0.0480	2954
Gómez, Casas Gallart,Jariod	-0.0141	1708
Ito	+0.0207	5827
Melillo	-0.0109	1303
Ohshima	-0.0055	1975
Poole McLaughlin	-0.0145	528
Powell, Nix	+0.0018	1811
Soder	+0.0025	30779
Wasson	+0.0171	707

TABLE 3

CORRECTED DIFFERENTIAL V DATA

Average Phase	Average ΔV Magnitude	Error	Average Phase	Average ΔV Magnitude	Error
0.0700	1.5717	0.0085	0.5500	1.5417	0.0061
0.0900	1.6104	0.0082	0.5700	1.5696	0.0148
0.1100	1.5915	0.0090	0.5900	1.5647	0.0031
0.1300	1.5799	0.0059	0.6100	1.5710	0.0067
0.1500	1.5850	0.0067	0.6300	1.5756	0.0070
0.1700	1.5819	0.0059	0.6500	1.5790	0.0130
0.1900	1.5808	0.0055	0.6700	1.5840	0.0184
0.2100	1.5753	0.0055	0.6900	1.5629	0.0075
0.2300	1.5706	0.0080	0.7100	1.5654	0.0068
0.2500	1.5511	0.0090	0.7300	1.5665	0.0060
0.2700	1.5501	0.0065	0.7500	1.5656	0.0064
0.2900	1.5497	0.0062	0.7700	1.5707	0.0059
0.3100	1.5546	0.0059	0.7900	1.5600	0.0052
0.3300	1.5472	0.0052	0.8100	1.5623	0.0049
0.3500	1.5577	0.0047	0.8300	1.5795	0.0051
0.3700	1.5604	0.0039	0.8500	1.5679	0.0045
0.3900	1.5588	0.0061	0.8700	1.5728	0.0032
0.4100	1.5430	0.0049	0.8900	1.5703	0.0043
0.4300	1.5450	0.0053	0.9100	1.5925	0.0075
0.4500	1.5613	0.0052	0.9300	1.6050	0.0087
0.4700	1.5535	0.0060	0.9500	1.5813	0.0064
0.4900	1.5594	0.0070	0.9700	1.5863	0.0062
0.5100	1.5591	0.0061	0.9900	1.6295	0.0339
0.5300	1.5600	0.0045			


EI ERI - 37 ERI
DELTA V
1.50
1.53
1.55
1.58
1.60
1.63
1.65
1.68
1.70
PHOTOMETRIC PHASE
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30


EI ERI - 37 ERI
DELTA V
1.50
1.53
1.55
1.58
1.60
1.63
1.65
1.68
1.70
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
PHOTOMETRIC PHASE