First Photometric Analysis of the Solar-Type Binary, V428 Cep (NSV 395), in the field of NGC 188

Ronald G. Samec

Astronomy Group, Department of Natural Sciences, Emmanuel College, 181 Springs Street, Franklin Springs, GA 30639; ronaldsamec@gmail.com

Jeremy Clark David Malonev

Astronomy Program, Department of Physics and Engineering, Bob Jones University, 1700 Wade Hampton Boulevard, Greenville, SC 29614; clarky1123@gmail.com; david.edward.maloney@gmail.com

Daniel B. Caton

Dark Sky Observatory, Physics and Astronomy Department, Appalachian State University, 525 Rivers Street, Boone, NC 28608-2106; catondb@appstate.edu

Danny R. Faulkner

Director, Johnson Observatory, 1414 Bur Oak Court, Hebron, KY 41048

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Abstract V428 Cep (or NSV 395) is a faint 15th magnitude binary observed in a study of the open cluster NGC 188. However, its distance from the core of the cluster might exclude its membership. Its light curve was classified as a short period EB type eclipsing binary with a period of 0.3079 d and an amplitude of ~0.7 magnitude in all curves. The difference in component temperatures is some $\Delta T = 180$ K and its fill-out is a hefty 35%. A brief, 2.5 year period study yields, as expected, a constant period, which is 0.3076789 d. More monitoring is needed to determine its true orbital evolution. The inclination, 80° is not quite enough to produce total eclipses, so a q-search was performed using the September 17, 2004 version of the Wilson-Devinney program. Our lowest residual solution gives a q = 0.4. A cool spot was modeled on the primary component to take care of the light curve asymmetries. V428 Cep is a K-type W UMa contact binary.

1. Introduction

This paper represents the first precision, four-color, BVRI photometric study of this interesting contact binary which is in the field of the open cluster NGC 188.

2. History and observations

The variable was originally listed as short period variable NSV 395 (S8282) from photographic data (Hoffmeister 1964). It was observed in a study of the very old open cluster (age 5–7 Gyr) NGC 188 (Popov *et al.* 2013). This cluster age is what we might expect for such a W UMa binary. This paper designated it as a β Lyr-type eclipsing binary with a period of 0.3077 day and an Rmagrange of 14.392–15.675 and a secondary minimum of 15.552. They gave the first published ephemeris:

JD Hel MinI =
$$2455632.260 + 0.3077 d \times E.$$
 (1)

Popov et al.'s (2013) CCD light curves are given in Figure 1.

This system was observed as a part of our student/ professional collaborative studies of interacting binaries from data taken from Dark Sky Observatory (DSO) observations. The observations were taken by Dr. Dan Caton, Dr. Ron Samec, and Jeremy Clark. Reduction and analyses were mostly done by Dr. Samec and David Maloney. Our 2013 BVRI light curves were taken with the DSO 0.81-meter reflector at Philips Gap, North Carolina, on 2, 3, and 4 November 2013 with a thermoelectrically cooled (-40°C) 2KX2K Apogee Alta camera.

Individual observations included 128 in B and R, and 132 in V and I. The probable error of a single observation was 2% in B and V, and 1% in R and I. The relatively large errors are assumed due to the faintness of the binary. Figures 2a and 2b show sample observations of R, I, and R–I color curves on the night of 2 November, and of B, V, and B–V color curves on the night of 3 November 2013, respectively.

Our complete observations are given in Table 1, in delta magnitudes, ΔB , ΔV , ΔR_c and ΔI_c , in the sense of variable minus comparison star (V–C), phased with Equation 2.

3. Finding chart

The finding chart, given here for future observers, is shown in Figure 3. The coordinates and magnitudes of the variable star, comparison star, and check star are given in Table 2. The C–K values stayed fairly constant throughout the observing run, varying 1-2%.

4. Period study

Five times of minimum light were calculated, three primary and two secondary eclipses from our present observations:



Figure 1. V428 Cep-NGC 188. R, I CCD light curves were taken by Popov et al. 2013.



Figure 2a. V428 Cep-NGC 188. R (middle), I (bottom) delta magnitudes from sample observations and color curve (top) on 2 November 2013.



Figure 2b. V428 Cep-NGC 188. B (middle), V (bottom) delta magnitudes and color curve (top) on 3 November 2013.

HJD I = 2456598.6746 ± 0.0007
2456599.5990 ± 0.0014
2456600.8292 ±0.0013

HJD II = 2456598.8299 ± 0.0026 2456599.7549 ± 0.00025 .

Six CCD times of minimum light were determined using previous observations of Popov *et al.* 2013. These were included in our determination of an improved linear ephemeris:

HJD MinI =
$$2456599.5990 + 0.30767914 \times E$$
 (2)
 $\pm 0.0010 \pm 0.00000043$

Since this study covers only 2.5 years of observations, at least 10 more years of patrolling are needed to determine if the period is



Figure 3. V428 Cep-NGC 188 finding chart. V428 Cep Variable (V), Comparison (C) and Check (K).

changing. The times of minimum light and the linear residuals are given in Table 3. Figure 4 shows the linear residuals (O–C's) from this calculation.

5. NGC 188

NGC 188 is an old open cluster of age 5–10 Gyr and has quite a few W UMa binaries (for example, six in Zhang *et al.* 2002), which fall in this age range. From his analysis of the precontact W UMa binary, V12, Meibom (2009) gives a cluster distance of $1,770 \pm 75$ pc and a main sequence age of 6.2 ± 0.2 Gyr. The position of V428 Cep on the color magnitude diagram is to the right of the main sequence branch before the turnoff, as expected for this cool-type binary system. We believe that the binary could well be a part of the cluster despite its position in the field (43' from the cluster center). W UMa binaries are noted for having high velocity dispersions, and it may be escaping the cluster (Guinan and Bradstreet 1988). The R, R–I color magnitude diagram is shown in Figure 5.

6. Light curve characteristics

The light curves were phased using Equation (2). These are given in Figures 6a and 6b. A table of light curve characteristics is given in Table 4. The curves are only of fair precision, averaging between 1 and 3%, probably due to the binary's faintness. The amplitude of the light curve varies from 0.76 to 0.65 magnitude in B to I, respectively. The O'Connell effect (the difference in maxima), which is classically an indication of spot activity, is slightly larger than the scatter/ averaging 4%. The difference between the two minima is substantial for a W UMa binary, some 0.1–0.2 magnitude, and is undoubtedly the reason it was designated a β Lyr type EB by Popov *et al.* (2013). However, the light curve characteristics point to a

Table 1. V428 Cep-NGC 188 observations, ΔB , ΔV , ΔR , and ΔI , variable star minus comparison star.

ΔB	HJD	ΔB	HJD	ΔB	HJD	ΔB	HJD	ΔB	HJD
	2455800+		2455800+		2455800+		2455800+		2455800+
5.486	98,5258	5.029	98.7333	5.187	99.4821	5.024	99.6427	5.538	99.7570
5.404	98.5315	4.986	98.7417	5.075	99.4844	4.977	99.6475	5.523	99.7618
5.367	98.5372	4.947	98.7501	5.082	99.4906	5.036	99.6516	5.372	99.7659
5.236	98.548	4.957	98.7602	5.033	99.4929	4.908	99.6565	5.241	99.7701
5.055	98.5584	4.975	98.7686	4.905	99.4951	4.957	99.6606	5.298	99.7750
5.028	98.5658	5.044	98.777	4.913	99.4974	4.861	99.6648	5.292	99.7792
4.983	98.5731	5.055	98.7854	4.915	99.5029	4.900	99.6707	5.083	99.7833
4.928	98.5804	5.156	98.7938	4.884	99.511	4.888	99.6749	5.071	99.7876
4.941	98.5878	5.252	98.8044	4.937	99.5175	4.882	99.679	5.000	99.7917
4.901	98.5968	5.378	98.8128	4.920	99.525	4.855	99.684	4.983	99.7961
4.910	98.6041	5.527	98.8212	4.906	99.5323	4.952	99.6882	5.026	100.//3/
4.922	98.6115	5.524	98.8296	4.945	99.5391	4.946	99.6924	5.011	100./80/
4.996	98.6188	5.440	98.838	5.016	99.5455	4.942	99.6965	5.050	100.7877
5.040	98.6262	5.302	98.8475	4.983	99.5519	5.000	99.7007	5.128	100./948
5.115	98.6362	5.133	98.8559	5.043	99.5604	4.919	99.7048	5.196	100.8026
5.202	98.6436	5.025	98.8644	5.169	99.5702	5.070	99.7097	5.351	100.8097
5.279	98.6509	4.904	98.8/2/	5.3/1	99.581	5.102	99.7139	5.516	100.81/1
5.335	98.6584	5.004	98.8811	5.606	99.5923	5.126	99.718	5.615	100.8241
5.518	98.6657	4.941	98.9113	5./18	99.6043	5.086	99.7227	5.6/3	100.8311
5.564	98.6738	4.999	98.9221	5.540	99.6136	5.182	99.7268	5.600	100.8382
5.539	98.6822	5.019	98.9302	5.390	99.6188	5.290	99.731	5.397	100.8456
5.366	98.6906	5.115	98.941	5.274	99.6226	5.350	99.7352	5.288	100.8534
5.205	98.699	5.263	98.9519	5.319	99.6265	5.281	99.7393	5.100	100.8608
5.099	98.7074	5.655	98.9599	5.201	99.6301	5.494	99.7435	5.018	100.8678
5.001	98.7165	4.989	99.47/6	5.097	99.6339	5.588	99.7487		
5.064	98.7249	5.084	99.4799	5.171	99.6375	5.443	99.7528		
ΔV	HJD	ΔV	HJD	ΔV	HJD	ΔV	HJD	ΔV	HJD
ΔV	HJD 2455800+	ΔV	HJD 2455800+	ΔV	HJD 2455800+	ΔV	HJD 2455800+	ΔV	HJD 2455800+
ΔV 5.227	HJD 2455800+ 98.524	Δ <i>V</i> 4.702	HJD 2455800+ 98.7388	Δ <i>V</i> 4.946	HJD 2455800+ 99.479	Δ <i>V</i> 4.778	<i>HJD</i> 2455800+ 99.650	ΔV 5.137	<i>HJD</i> 2455800+ 99.769
ΔV 5.227 5.173	HJD 2455800+ 98.524 98.530	ΔV 4.702 4.679	HJD 2455800+ 98.7388 98.7472	ΔV 4.946 4.959	<i>HJD</i> 2455800+ 99.479 99.481	ΔV 4.778 4.756	<i>HJD</i> 2455800+ 99.650 99.654	ΔV 5.137 5.122	<i>HJD</i> 2455800+ 99.769 99.773
ΔV 5.227 5.173 5.071	HJD 2455800+ 98.524 98.530 98.535	ΔV 4.702 4.679 4.661	HJD 2455800+ 98.7388 98.7472 98.7556	ΔV 4.946 4.959 4.881	HJD 2455800+ 99.479 99.481 99.484	ΔV 4.778 4.756 4.763	HJD 2455800+ 99.650 99.654 99.659	ΔV 5.137 5.122 5.001	HJD 2455800+ 99.769 99.773 99.778
ΔV 5.227 5.173 5.071 5.009	HJD 2455800+ 98.524 98.530 98.535 98.541	ΔV 4.702 4.679 4.661 4.696	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657	ΔV 4.946 4.959 4.881 4.900	HJD 2455800+ 99.479 99.481 99.484 99.486	ΔV 4.778 4.756 4.763 4.736	HJD 2455800+ 99.650 99.654 99.659 99.663	ΔV 5.137 5.122 5.001 4.951	HJD 2455800+ 99.769 99.773 99.778 99.782
ΔV 5.227 5.173 5.071 5.009 4.841	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553	ΔV 4.702 4.679 4.661 4.696 4.727	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741	$\begin{array}{c} \Delta V \\ 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492	ΔV 4.778 4.756 4.763 4.736 4.744	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668	ΔV 5.137 5.122 5.001 4.951 4.838	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786
ΔV 5.227 5.173 5.071 5.009 4.841 4.790	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563	ΔV 4.702 4.679 4.661 4.696 4.727 4.764	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825	ΔV 4.946 4.959 4.881 4.900 4.790 4.821	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494	ΔV 4.778 4.756 4.763 4.736 4.744 4.721	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673	ΔV 5.137 5.122 5.001 4.951 4.838 4.776	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.563 98.571	ΔV 4.702 4.679 4.661 4.696 4.727 4.764 4.838	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.494 99.497	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794
$\begin{array}{c} \Delta V \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.563 98.571 98.578	ΔV 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.494 99.497 99.499	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799
$\begin{array}{c} \Delta V \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.563 98.571 98.578 98.578 98.585	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.499 99.509	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.746 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759
$\begin{array}{c} \Delta V \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.746 \\ 4.741 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682 99.687 99.687 99.691	$\begin{array}{ c c c c c } & \Delta V \\ \hline & 5.137 \\ & 5.122 \\ & 5.001 \\ & 4.951 \\ & 4.838 \\ & 4.776 \\ & 4.738 \\ & 4.776 \\ & 4.738 \\ & 4.712 \\ & 4.708 \\ & 4.690 \\ \hline \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768
$\begin{array}{c} \Delta V \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.746 \\ 4.741 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768 100.778
$\begin{array}{c} \Delta V \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.674 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.602	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.697 \\ \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.699	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.768 100.778 100.785
$\begin{array}{c} \Delta V \\ \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.609 98.616	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.690 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.699 99.703	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.768 100.778 100.785 100.792
$\begin{array}{c} \Delta V \\ \\ 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \\ 4.760 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.571 98.578 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.972 \\ \hline \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.853	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.509 99.514 99.522 99.530 99.536 99.536 99.543	ΔV 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.695 99.699 99.703 99.708	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 4.906 \\ 4.915 \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768 100.778 100.785 100.792 100.799
$\begin{array}{c} \Delta V \\ \\ 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \\ 4.760 \\ 4.759 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624 98.631	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.864 \\ \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7909 98.7993 98.8099 98.8183 98.8267 98.8183 98.8267 98.8351 98.8435 98.8435 98.853 98.8615	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550	$\begin{array}{c c} \Delta V \\ \hline 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.805 \\ \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.687 99.691 99.695 99.699 99.703 99.708 99.712	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.042 \\ \hline \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768 100.778 100.785 100.785 100.792 100.799
$\begin{array}{c} \Delta V \\ \\ 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \\ 4.760 \\ 4.759 \\ 4.883 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624 98.631 98.641	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7657 98.7741 98.7825 98.7909 98.8099 98.8183 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.853 98.8615 98.8698	$\begin{array}{c} \Delta V \\ 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.833 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.673 99.682 99.687 99.681 99.691 99.695 99.699 99.703 99.708 99.712 99.717	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.758 100.778 100.778 100.785 100.792 100.799 100.807 100.814
$\begin{array}{c} \Delta V \\ \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \\ 4.760 \\ 4.759 \\ 4.883 \\ 4.951 \\ 4.951 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624 98.624 98.631 98.641 98.641 98.649	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.780 \\ \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.853 98.8615 98.8698 98.8782	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.697 4.690 4.701 4.729 4.760 4.927	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.497 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556 99.556	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.673 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.708 99.712 99.717 99.717 99.721	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.337 \\ 5.377 \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821
$\begin{array}{c} \Delta V \\ \\ \hline 5.227 \\ 5.173 \\ 5.071 \\ 5.009 \\ 4.841 \\ 4.790 \\ 4.734 \\ 4.684 \\ 4.677 \\ 4.653 \\ 4.653 \\ 4.653 \\ 4.674 \\ 4.702 \\ 4.760 \\ 4.759 \\ 4.883 \\ 4.951 \\ 5.093 \\ 5.093 \\ 5.093 \end{array}$	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624 98.624 98.631 98.641 98.641 98.649 98.656	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.8615 98.8698 98.8782 98.8866	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.697 4.690 4.701 4.729 4.760 4.927 5.172	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.479\\ 99.481\\ 99.484\\ 99.486\\ 99.492\\ 99.492\\ 99.494\\ 99.497\\ 99.497\\ 99.509\\ 99.514\\ 99.522\\ 99.514\\ 99.522\\ 99.530\\ 99.536\\ 99.536\\ 99.556\\ 99.556\\ 99.556\\ 99.57$	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.924 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.663 99.673 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.708 99.712 99.717 99.712 99.717 99.721 99.725	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.602 98.609 98.616 98.624 98.624 98.631 98.641 98.649 98.656 98.656 98.656 98.656	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.683 \\ 4.675 \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.8435 98.8615 98.8698 98.8782 98.8866 98.8953 90.000	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.556 99.556 99.576 99.576 99.587	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.928 \\ 4.928 \\ 5.202 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682 99.682 99.691 99.695 99.695 99.699 99.703 99.708 99.712 99.717 99.712 99.717 99.725 99.730 99.730	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.355 \\ 5.355 \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.828 100.825
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.260	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.593 98.602 98.602 98.602 98.609 98.616 98.624 98.631 98.641 98.641 98.649 98.656 98.663 98.671 20.672	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.853 98.8615 98.8698 98.8782 98.8866 98.8953 98.9019 90.9060	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.556 99.556 99.565 99.576 99.576 99.587 99.616	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.020 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.695 99.699 99.703 99.708 99.712 99.717 99.712 99.717 99.725 99.730 99.734	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.912 \end{array}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828 100.835 100.843 100.843
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.602 98.602 98.609 98.616 98.624 98.631 98.641 98.641 98.649 98.656 98.663 98.671 98.679	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675 \\ 4.677$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.813 98.8267 98.8351 98.8435 98.8435 98.853 98.8615 98.8698 98.8782 98.8666 98.8953 98.9019 98.9069	ΔV 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.492 99.497 99.497 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556 99.556 99.565 99.576 99.587 99.616 99.621	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.736 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.039 \\ 5.039 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682 99.682 99.682 99.691 99.695 99.699 99.703 99.703 99.708 99.712 99.717 99.712 99.717 99.721 99.725 99.730 99.734 99.738	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.54 \\ 5.043 \\ 5.044 $	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.782\\ 99.786\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.759\\ 100.768\\ 100.778\\ 100.785\\ 100.792\\ 100.792\\ 100.799\\ 100.807\\ 100.814\\ 100.821\\ 100.828\\ 100.835\\ 100.835\\ 100.843\\ 100.850\\ 100.8$
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360 5.206	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.602 98.609 98.616 98.624 98.624 98.631 98.641 98.649 98.656 98.663 98.671 98.679 98.688	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675 \\ 4.677 \\ 4.696 \\ 4.696 \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.853 98.8615 98.8698 98.8782 98.8666 98.8953 98.9019 98.9069 98.9164 20.272	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \\ 4.927 \\ 5.172 \\ 5.364 \\ 5.357 \\ 5.208 \\ 5.124 \\ 5.222 \end{array}$	$\begin{array}{r} HJD\\ 2455800+\\ \hline\\ 99.479\\ 99.481\\ 99.484\\ 99.486\\ 99.492\\ 99.492\\ 99.494\\ 99.497\\ 99.499\\ 99.509\\ 99.514\\ 99.522\\ 99.536\\ 99.536\\ 99.536\\ 99.536\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.576\\ 99.576\\ 99.587\\ 99.616\\ 99.621\\ 99.625\\ \end{array}$	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.020 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5.000 \\ 5.039 \\ 5.000 \\ 5$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.703 99.708 99.712 99.717 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.738	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.894$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.778 100.785 100.792 100.799 100.807 100.814 100.828 100.835 100.835 100.843 100.858 100.858
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360 5.206 5.208	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.602 98.602 98.609 98.616 98.624 98.631 98.624 98.631 98.641 98.656 98.656 98.656 98.663 98.671 98.679 98.688 98.696	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675 \\ 4.677 \\ 4.696 \\ 4.749 \\ 4.749 \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.853 98.8615 98.8698 98.8782 98.8666 98.8953 98.9019 98.9069 98.9164 98.9272 20.0272	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \\ 4.927 \\ 5.172 \\ 5.364 \\ 5.357 \\ 5.208 \\ 5.124 \\ 5.033 \\ 4.032 \end{array}$	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.479\\ 99.481\\ 99.484\\ 99.486\\ 99.492\\ 99.492\\ 99.494\\ 99.497\\ 99.499\\ 99.509\\ 99.514\\ 99.522\\ 99.536\\ 99.536\\ 99.536\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.576\\ 99.587\\ 99.616\\ 99.621\\ 99.625\\ 99.622\\ 99.622\\ \end{array}$	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.864 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.206 \\ 5.257 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.682 99.687 99.691 99.695 99.695 99.703 99.703 99.712 99.717 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.742 99.746	$\begin{array}{c c} \Delta V \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.894 \\ 4.784$	$\begin{array}{r} HJD\\ 2455800+\\ \hline\\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.786\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.759\\ 100.778\\ 100.785\\ 100.778\\ 100.785\\ 100.792\\ 100.792\\ 100.807\\ 100.814\\ 100.821\\ 100.828\\ 100.835\\ 100.835\\ 100.843\\ 100.850\\ 100.858\\ 100.858\\ 100.865\\ 100.$
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360 5.206 5.028 4.902	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.578 98.585 98.593 98.602 98.602 98.602 98.602 98.616 98.624 98.631 98.641 98.649 98.656 98.656 98.663 98.671 98.679 98.688 98.696 98.705	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675 \\ 4.677 \\ 4.696 \\ 4.749 \\ 4.766 \\ 4.749 \\ 4.762 \end{array}$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.8615 98.8698 98.8782 98.8666 98.8953 98.8953 98.9019 98.9069 98.9164 98.9272 98.9353 98.9353	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \\ 4.927 \\ 5.172 \\ 5.364 \\ 5.357 \\ 5.208 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.522 \end{array}$	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.536 99.536 99.536 99.543 99.550 99.556 99.556 99.556 99.576 99.576 99.587 99.616 99.621 99.625 99.622 99.632	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.763 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.924 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.206 \\ 5.275 \\ 5.225 \end{array}$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.682 99.687 99.682 99.687 99.691 99.695 99.695 99.703 99.703 99.708 99.712 99.717 99.721 99.712 99.725 99.730 99.734 99.738 99.742 99.742 99.746 99.751	$\begin{array}{c} \Delta V \\ \\ 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.894 \\ 4.784 \\ 4.752 \end{array}$	$\begin{array}{c} HJD\\ 2455800+\\\\\hline\\99.769\\99.773\\99.778\\99.782\\99.786\\99.790\\99.794\\99.799\\100.759\\100.759\\100.768\\100.778\\100.785\\100.792\\100.799\\100.807\\100.814\\100.821\\100.828\\100.835\\100.835\\100.843\\100.858\\100.858\\100.858\\100.858\\100.865\\100.872\end{array}$
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.653 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360 5.206 5.028 4.902 4.813	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.578 98.585 98.593 98.602 98.602 98.602 98.616 98.624 98.624 98.631 98.641 98.649 98.656 98.663 98.671 98.679 98.688 98.696 98.705 98.713 90.722	$\begin{array}{c c} \Delta V \\ \hline 4.702 \\ 4.679 \\ 4.661 \\ 4.696 \\ 4.727 \\ 4.764 \\ 4.838 \\ 4.912 \\ 5.029 \\ 5.149 \\ 5.300 \\ 5.270 \\ 5.103 \\ 4.972 \\ 4.864 \\ 4.815 \\ 4.780 \\ 4.732 \\ 4.683 \\ 4.675 \\ 4.677 \\ 4.696 \\ 4.749 \\ 4.766 \\ 4.859 \\ 5.270$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8435 98.8435 98.8615 98.8698 98.8782 98.8666 98.8782 98.8666 98.8953 98.8019 98.9019 98.9069 98.9164 98.9272 98.9353 98.9462 20.977	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \\ 4.927 \\ 5.172 \\ 5.364 \\ 5.357 \\ 5.208 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.853 \\ 4.957 \end{array}$	$\begin{array}{r} HJD\\ 2455800+\\ \hline\\ 99.479\\ 99.481\\ 99.484\\ 99.486\\ 99.492\\ 99.494\\ 99.497\\ 99.499\\ 99.509\\ 99.514\\ 99.522\\ 99.536\\ 99.536\\ 99.536\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.576\\ 99.587\\ 99.616\\ 99.621\\ 99.625\\ 99.625\\ 99.632\\ 99.632\\ 99.636\\ 99.636\\ 99.632\\ 99.636\\ 99.656\\ 99.66$	$\begin{array}{c} \Delta V \\ 4.778 \\ 4.756 \\ 4.763 \\ 4.744 \\ 4.721 \\ 4.715 \\ 4.732 \\ 4.740 \\ 4.756 \\ 4.757 \\ 4.764 \\ 4.784 \\ 4.738 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.833 \\ 4.805 \\ 4.924 \\ 4.924 \\ 4.928 \\ 5.000 \\ 5.039 \\ 5.121 \\ 5.206 \\ 5.275 \\ 5.283 \\ 5$	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.682 99.687 99.687 99.691 99.695 99.695 99.703 99.708 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.738 99.742 99.746 99.751 99.756	$\begin{array}{c} \Delta V \\ 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.894 \\ 4.784 \\ 4.752 \end{array}$	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.786\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.768\\ 100.778\\ 100.785\\ 100.792\\ 100.799\\ 100.807\\ 100.814\\ 100.821\\ 100.828\\ 100.835\\ 100.835\\ 100.843\\ 100.850\\ 100.858\\ 100.858\\ 100.858\\ 100.865\\ 100.872\\ \end{array}$
ΔV 5.227 5.173 5.071 5.009 4.841 4.790 4.734 4.684 4.677 4.653 4.653 4.673 4.653 4.673 4.653 4.674 4.702 4.760 4.759 4.883 4.951 5.093 5.247 5.344 5.360 5.206 5.028 4.902 4.813 4.739	HJD 2455800+ 98.524 98.530 98.535 98.541 98.553 98.563 98.571 98.578 98.585 98.593 98.602 98.602 98.602 98.616 98.624 98.624 98.631 98.641 98.649 98.656 98.663 98.671 98.679 98.688 98.679 98.688 98.696 98.705 98.713 98.722	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	HJD 2455800+ 98.7388 98.7472 98.7556 98.7657 98.7741 98.7825 98.7909 98.7993 98.8099 98.8183 98.8267 98.8351 98.8435 98.8435 98.8615 98.8615 98.8698 98.8782 98.8666 98.8782 98.8866 98.8782 98.8866 98.8733 98.9019 98.9069 98.9164 98.9272 98.9353 98.9462 98.957 98.957	$\begin{array}{c c} \Delta V \\ \hline 4.946 \\ 4.959 \\ 4.881 \\ 4.900 \\ 4.790 \\ 4.821 \\ 4.784 \\ 4.785 \\ 4.710 \\ 4.743 \\ 4.677 \\ 4.697 \\ 4.690 \\ 4.701 \\ 4.729 \\ 4.760 \\ 4.927 \\ 5.172 \\ 5.364 \\ 5.357 \\ 5.208 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.853 \\ 4.867 \\ 4.677 \\ 5.77 \\ 5.208 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.853 \\ 4.867 \\ 4.677 \\ 5.77 \\ 5.708 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.853 \\ 4.867 \\ 5.77 \\ 5.77 \\ 5.708 \\ 5.124 \\ 5.033 \\ 4.912 \\ 4.853 \\ 4.867 \\ 4.777 \\ 5.77 \\ 5$	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.479\\ 99.481\\ 99.484\\ 99.486\\ 99.492\\ 99.492\\ 99.494\\ 99.497\\ 99.499\\ 99.509\\ 99.514\\ 99.522\\ 99.536\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.556\\ 99.576\\ 99.587\\ 99.616\\ 99.621\\ 99.625\\ 99.625\\ 99.632\\ 99.632\\ 99.636\\ 99.640\\ 99.64$	ΔV 4.778 4.756 4.763 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 4.928 5.000 5.039 5.121 5.206 5.275 5.283 5.248 5.248	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.691 99.695 99.695 99.703 99.708 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.734 99.738 99.742 99.746 99.751 99.756 99.760	$\begin{array}{c} \Delta V \\ 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \\ 5.043 \\ 4.894 \\ 4.784 \\ 4.752 \end{array}$	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.786\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.768\\ 100.778\\ 100.785\\ 100.785\\ 100.792\\ 100.807\\ 100.814\\ 100.821\\ 100.828\\ 100.835\\ 100.835\\ 100.843\\ 100.850\\ 100.858\\ 100.858\\ 100.858\\ 100.852\\ 100.872\\ \end{array}$

Table continued on next page

Table 1. V428 Cep-NGC 188 observations, ΔB , ΔV , ΔR , and ΔI , variable star minus comparison star, cont.

ΔR	HJD	ΔR	HJD	ΔR	HJD	ΔR	HJD	ΔR	HJD
	2455800+		2455800+		2455800+		2455800+		2455800+
	2100000		2100000		2100000	I	2100000		2100000
4.933	98.523	4.425	98.745	4.544	99.481	4.502	99.644	4.817	99.763
4.918	98.528	4.385	98.754	4.512	99.483	4.453	99.649	4.814	99.767
4.574	98.551	4.414	98.764	4.504	99.485	4.441	99.653	4.738	99.772
4.513	98.562	4.455	98.772	4.477	99.492	4.392	99.658	4.639	99.777
4.475	98.569	4.490	98.781	4.471	99.494	4.418	99.662	4.631	99.781
4.429	98.577	4.562	98.789	4.447	99.496	4.389	99.666	4.614	99.785
4.415	98.584	4.723	98.808	4.467	99.498	4.367	99.672	4.542	99.789
4.406	98.591	4.843	98.816	4.417	99.507	4.379	99.676	4.514	99.793
4.413	98.600	4.979	98.825	4.399	99.513	4.383	99.681	4.518	99.798
4.401	98.608	5.004	98.833	4.409	99.520	4.397	99.686	4.389	100.759
4.438	98.615	4.868	98.842	4.415	99.528	4.396	99.690	4.399	100.767
4.467	98.622	4.765	98.851	4.402	99.535	4.429	99.698	4.449	100.777
4.510	98.630	4.658	98.860	4.442	99.542	4.472	99.702	4.475	100.784
4.550	98.640	4.548	98.868	4.484	99.548	4.502	99.706	4.552	100.791
4.662	98.647	4.517	98.876	4.505	99.555	4.490	99.711	4.622	100.798
4.791	98.654	4.464	98.885	4.580	99.564	4.528	99.715	4.752	100.806
4.935	98.662	4.406	98.892	4.720	99.574	4.585	99.720	4.879	100.813
5.061	98.669	4.394	98.900	4.945	99.585	4.612	99.724	5.055	100.820
5.097	98.677	4.410	98.905	4.950	99.605	4.685	99.728	5.081	100.827
4.985	98.686	4.430	98.915	4.867	99.615	4.738	99.733	5.045	100.834
4.795	98.694	4.440	98.925	4.774	99.620	4.804	99.737	4.820	100.841
4.657	98.703	4.496	98.933	4.688	99.624	4.835	99.741	4.774	100.849
4.578	98.711	4.557	98.944	4.644	99.628	4.951	99.745	4.670	100.856
4.505	98.720	4.697	98.955	4.557	99.632	4.966	99.750	4.560	100.864
4.453	98.729	4.809	98.963	4.561	99.635	4.990	99.754		
4.436	98.737	4.535	99.479	4.520	99.639	4.930	99.759		
ΔI	HJD	ΔI	HJD	ΔI	HJD	ΔI	HJD	ΔI	HJD
ΔI	HJD 2455800+	ΔI	<i>HJD</i> 2455800+	ΔI	HJD 2455800+	ΔI	HJD 2455800+	ΔI	<i>HJD</i> 2455800+
ΔΙ	HJD 2455800+		HJD 2455800+	ΔI	HJD 2455800+		HJD 2455800+		HJD 2455800+
Δ <i>I</i> 4.642	HJD 2455800+ 98.522	Δ <i>I</i> 4.702	HJD 2455800+ 98.739	Δ <i>I</i> 4.946	HJD 2455800+ 99.479	Δ <i>I</i> 4.778	HJD 2455800+ 99.650	Δ <i>I</i> 5.137	<i>HJD</i> 2455800+ 99.769
Δ <i>I</i> 4.642 4.648	HJD 2455800+ 98.522 98.527	Δ <i>I</i> 4.702 4.679	HJD 2455800+ 98.739 98.747	Δ <i>I</i> 4.946 4.959	<i>HJD</i> 2455800+ 99.479 99.481	Δ <i>I</i> 4.778 4.756	<i>HJD</i> 2455800+ 99.650 99.654	Δ <i>I</i> 5.137 5.122	<i>HJD</i> 2455800+ 99.769 99.773
Δ <i>I</i> 4.642 4.648 4.590	HJD 2455800+ 98.522 98.527 98.533	Δ <i>I</i> 4.702 4.679 4.661	HJD 2455800+ 98.739 98.747 98.756	Δ <i>I</i> 4.946 4.959 4.881	<i>HJD</i> 2455800+ 99.479 99.481 99.484	Δ <i>I</i> 4.778 4.756 4.763	HJD 2455800+ 99.650 99.654 99.659	Δ <i>I</i> 5.137 5.122 5.001	<i>HJD</i> 2455800+ 99.769 99.773 99.778
Δ <i>I</i> 4.642 4.648 4.590 4.496	HJD 2455800+ 98.522 98.527 98.533 98.539	Δ <i>I</i> 4.702 4.679 4.661 4.696	HJD 2455800+ 98.739 98.747 98.756 98.766	Δ <i>I</i> 4.946 4.959 4.881 4.900	HJD 2455800+ 99.479 99.481 99.484 99.486	Δ <i>I</i> 4.778 4.756 4.763 4.736	HJD 2455800+ 99.650 99.654 99.659 99.663	Δ <i>I</i> 5.137 5.122 5.001 4.951	HJD 2455800+ 99.769 99.773 99.778 99.782
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550	Δ <i>I</i> 4.702 4.679 4.661 4.696 4.727	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774	Δ <i>I</i> 4.946 4.959 4.881 4.900 4.790	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492	Δ <i>I</i> 4.778 4.756 4.763 4.736 4.744	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561	Δ <i>I</i> 4.702 4.679 4.661 4.696 4.727 4.764	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783	Δ <i>I</i> 4.946 4.959 4.881 4.900 4.790 4.821	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494	Δ <i>I</i> 4.778 4.756 4.763 4.736 4.744 4.721	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243 4.203	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568	Δ <i>I</i> 4.702 4.679 4.661 4.696 4.727 4.764 4.838	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791	Δ <i>I</i> 4.946 4.959 4.881 4.900 4.790 4.821 4.784	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.494	Δ <i>I</i> 4.778 4.756 4.763 4.763 4.736 4.744 4.721 4.715	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575	Δ <i>I</i> 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799	Δ <i>I</i> 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499	Δ <i>I</i> 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.678	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583	Δ <i>I</i> 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810	Δ <i>I</i> 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509	Δ <i>I</i> 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732 4.740	HJD 2455800+ 99.650 99.654 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.142	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818	$\begin{tabular}{ c c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.492 99.494 99.497 99.499 99.509 99.514	Δ <i>I</i> 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756	HJD 2455800+ 99.650 99.654 99.663 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.768
Δ <i>I</i> 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.142 4.143	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522	Δ <i>I</i> 4.778 4.756 4.763 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756 4.757	HJD 2455800+ 99.650 99.654 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.681 99.691 99.695	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713	H.ID 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768 100.778
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.142 4.143 4.136	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530	ΔI 4.778 4.756 4.763 4.736 4.736 4.721 4.715 4.732 4.740 4.756 4.756 4.756 4.756 4.756 4.757 4.764	HJD 2455800+ 99.650 99.654 99.663 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.681 99.691 99.695 99.699	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749	H.ID 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.768 100.778 100.785
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.142 4.143 4.136 4.155	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270 5.103	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536	ΔI 4.778 4.756 4.763 4.736 4.736 4.721 4.715 4.732 4.740 4.756 4.756 4.756 4.756 4.756 4.757 4.764 4.784	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.699 99.703	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826	H.ID 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.142 4.143 4.136 4.155 4.211	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.575 98.583 98.590 98.599 98.606 98.614 98.621	$\begin{tabular}{ c c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.818 98.827 98.835 98.844 98.853	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.543	ΔI 4.778 4.756 4.763 4.736 4.736 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.699 99.703 99.708	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906	H.JD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.163 4.142 4.143 4.136 4.155 4.211 4.234	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.818 98.827 98.835 98.844 98.853 98.862	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550	$\begin{tabular}{ c c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.708 99.712	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906 5.042	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.768 100.778 100.785 100.792 100.799 100.807
ΔI 4,642 4,648 4,590 4,496 4,343 4,243 4,243 4,163 4,163 4,163 4,142 4,143 4,136 4,155 4,211 4,234 4,308	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628 98.638	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556	ΔI 4.778 4.756 4.763 4.763 4.744 4.715 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738 4.805 4.833	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.703 99.708 99.712 99.717	ΔI 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906 5.042 5.177	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814
ΔI 4,642 4,648 4,590 4,496 4,343 4,243 4,243 4,163 4,163 4,163 4,142 4,143 4,136 4,155 4,211 4,234 4,308 4,394	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.590 98.599 98.606 98.614 98.621 98.628 98.638 98.638 98.646	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.818 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.697 4.690 4.701 4.729 4.760 4.927	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.556 99.556	ΔI 4.778 4.756 4.763 4.763 4.744 4.721 4.715 4.732 4.740 4.756 4.756 4.756 4.756 4.756 4.756 4.756 4.756 4.756 4.756 4.757 4.764 4.738 4.805 4.833 4.864	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.687 99.691 99.695 99.699 99.703 99.703 99.708 99.712 99.717 99.721	Δ <i>I</i> 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906 5.042 5.177 5.337	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.778 100.785 100.792 100.792 100.799 100.807 100.814 100.821
ΔI 4,642 4,648 4,590 4,496 4,343 4,243 4,203 4,163 4,163 4,163 4,142 4,143 4,136 4,155 4,211 4,234 4,308 4,394 4,496	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.590 98.599 98.606 98.614 98.621 98.628 98.638 98.638 98.646 98.653	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844 98.853 98.844	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.543 99.550 99.556 99.555 99.576	ΔI 4.778 4.756 4.763 4.763 4.744 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.758 4.805 4.833 4.864 4.924	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.687 99.691 99.695 99.699 99.703 99.703 99.708 99.703 99.712 99.717 99.721 99.725	$\begin{tabular}{ c c c c c c c } \hline \Delta I \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \end{tabular}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.163 4.142 4.143 4.136 4.155 4.211 4.234 4.308 4.394 4.496 4.633	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628 98.614 98.628 98.638 98.638 98.646 98.653 98.661	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.813 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.878 98.879	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556 99.556 99.565 99.576 99.587	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756 4.756 4.756 4.732 4.740 4.756 4.757 4.764 4.738 4.805 4.833 4.864 4.924 4.928	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.673 99.673 99.678 99.682 99.687 99.691 99.695 99.695 99.699 99.703 99.708 99.712 99.717 99.721 99.725 99.730	$\begin{tabular}{ c c c c c c } \hline \Delta I \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \end{tabular}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828 100.835
ΔI 4.642 4.648 4.590 4.496 4.343 4.243 4.203 4.163 4.163 4.163 4.142 4.143 4.136 4.155 4.211 4.234 4.308 4.394 4.496 4.633 4.786	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628 98.638 98.638 98.646 98.653 98.661 98.661	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.870 98.878 98.875 98.887 98.895 98.902	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.550 99.556 99.556 99.576 99.587 99.616	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.732 4.740 4.756 4.756 4.756 4.732 4.740 4.756 4.757 4.764 4.738 4.805 4.833 4.864 4.924 4.928 5.000	HJD 2455800+ 99.650 99.654 99.659 99.663 99.663 99.673 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.695 99.703 99.703 99.708 99.712 99.712 99.717 99.721 99.725 99.730 99.734	$\begin{tabular}{ c c c c c c } \hline \Delta I \\ \hline 5.137 \\ 5.122 \\ 5.001 \\ 4.951 \\ 4.838 \\ 4.776 \\ 4.738 \\ 4.776 \\ 4.738 \\ 4.712 \\ 4.708 \\ 4.690 \\ 4.713 \\ 4.749 \\ 4.826 \\ 4.906 \\ 5.042 \\ 5.177 \\ 5.337 \\ 5.362 \\ 5.355 \\ 5.199 \end{tabular}$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.778 100.792 100.799 100.807 100.814 100.821 100.828 100.835 100.843
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.136 \\ 4.155 \\ 4.211 \\ 4.234 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.590 98.606 98.614 98.621 98.628 98.614 98.628 98.638 98.646 98.653 98.661 98.668 98.676	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.870 98.878 98.879 98.878 98.879 98.879	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.556 99.556 99.565 99.576 99.587 99.616 99.621	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.678 99.682 99.682 99.687 99.691 99.695 99.699 99.703 99.708 99.708 99.712 99.717 99.712 99.717 99.721 99.725 99.730 99.734 99.738	$\begin{tabular}{ c c c c c } \hline & & & & & & & \\ \hline & & & & & & & & \\ \hline & & & &$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828 100.835 100.843 100.850
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.136 \\ 4.155 \\ 4.211 \\ 4.234 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \\ 4.776 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628 98.638 98.638 98.638 98.646 98.653 98.661 98.668 98.676 98.685	$\begin{tabular}{ c c c c c } \hline & & & & & & & & & & & & & & & & & & $	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.844 98.853 98.862 98.870 98.870 98.878 98.879 98.879 98.879 98.870	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208 5.124	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.543 99.556 99.556 99.556 99.556 99.556 99.556 99.556 99.556 99.556 99.556 99.556 99.556	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 4.928 5.000 5.039 5.121	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.687 99.691 99.695 99.699 99.703 99.703 99.712 99.712 99.717 99.721 99.721 99.725 99.730 99.734 99.738 99.742	ΔI 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906 5.042 5.177 5.362 5.355 5.199 5.043 4.894	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.792 100.799 100.807 100.814 100.821 100.828 100.835 100.843 100.850 100.858
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.136 \\ 4.155 \\ 4.211 \\ 4.234 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \\ 4.776 \\ 4.574 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.628 98.638 98.638 98.638 98.646 98.653 98.661 98.668 98.676 98.685 98.693	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270 5.103 4.972 4.864 4.815 4.780 4.732 4.683 4.675 4.677 4.696 4.749	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.878 98.870 98.878 98.879 98.879 98.895 98.902 98.907 98.916 98.927	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208 5.124 5.033	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.556	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.721 4.715 4.721 4.715 4.721 4.715 4.721 4.756 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 5.000 5.039 5.121 5.206	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.691 99.695 99.695 99.699 99.703 99.712 99.712 99.717 99.721 99.721 99.725 99.730 99.734 99.738 99.742 99.746	ΔI 5.137 5.122 5.001 4.951 4.838 4.776 4.738 4.712 4.708 4.690 4.713 4.749 4.826 4.906 5.042 5.177 5.337 5.362 5.355 5.199 5.043 4.894 4.784	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.785 100.778 100.785 100.785 100.799 100.807 100.814 100.821 100.828 100.835 100.835 100.843 100.856
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \\ 4.776 \\ 4.574 \\ 4.418 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.621 98.628 98.638 98.646 98.633 98.646 98.653 98.661 98.668 98.676 98.685 98.693 98.701	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270 5.103 4.972 4.864 4.815 4.780 4.732 4.683 4.675 4.677 4.696 4.749 4.766	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.844 98.853 98.862 98.870 98.878 98.877 98.878 98.877 98.895 98.902 98.907 98.916 98.927 98.935	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208 5.124 5.033 4.912	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.556 99.556 99.556 99.565 99.576 99.576 99.587 99.616 99.621 99.625 99.629 99.632	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.721 4.715 4.721 4.756 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 4.928 5.000 5.039 5.121 5.206 5.275	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.691 99.695 99.699 99.703 99.712 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.742 99.746 99.751	$\begin{tabular}{ c c c c c c } \hline & & & & & & & \\ \hline & & & & & & & & \\ \hline & & & &$	HJD 2455800+ 99.769 99.773 99.778 99.782 99.786 99.790 99.790 99.794 99.799 100.759 100.759 100.768 100.778 100.785 100.785 100.792 100.799 100.807 100.814 100.821 100.828 100.835 100.843 100.855 100.855 100.855 100.855
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.136 \\ 4.155 \\ 4.211 \\ 4.234 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \\ 4.776 \\ 4.574 \\ 4.418 \\ 4.314 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.599 98.606 98.614 98.621 98.621 98.628 98.638 98.646 98.653 98.661 98.668 98.661 98.665 98.661 98.665 98.661 98.665 98.661 98.665 98.661 98.665 98.676 98.685 98.693 98.701 98.710	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270 5.103 4.972 4.864 4.815 4.780 4.732 4.683 4.675 4.677 4.696 4.749 4.766 4.859	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.878 98.870 98.878 98.877 98.895 98.902 98.907 98.916 98.927 98.935 98.946	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208 5.124 5.033 4.912 4.853	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.543 99.556 99.556 99.556 99.556 99.565 99.576 99.576 99.587 99.616 99.621 99.625 99.629 99.632 99.636	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.721 4.715 4.721 4.756 4.740 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 4.928 5.000 5.039 5.121 5.206 5.275 5.283	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.682 99.687 99.682 99.687 99.691 99.695 99.699 99.703 99.712 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.742 99.746 99.751 99.756	$ \Delta I $	$\begin{array}{c} HJD\\ 2455800+\\ \hline\\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.782\\ 99.786\\ 99.790\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.759\\ 100.768\\ 100.778\\ 100.785\\ 100.785\\ 100.785\\ 100.785\\ 100.807\\ 100.807\\ 100.814\\ 100.821\\ 100.828\\ 100.835\\ 100.843\\ 100.855\\ 100.858\\ 100.858\\ 100.858\\ 100.858\\ 100.858\\ 100.865\\ 100.872\\ \end{array}$
$\begin{array}{c} \Delta I \\ \hline 4.642 \\ 4.648 \\ 4.590 \\ 4.496 \\ 4.343 \\ 4.243 \\ 4.203 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.163 \\ 4.142 \\ 4.143 \\ 4.136 \\ 4.155 \\ 4.211 \\ 4.234 \\ 4.308 \\ 4.394 \\ 4.496 \\ 4.633 \\ 4.786 \\ 4.816 \\ 4.776 \\ 4.574 \\ 4.418 \\ 4.314 \\ 4.242 \end{array}$	HJD 2455800+ 98.522 98.527 98.533 98.539 98.550 98.561 98.568 98.575 98.583 98.590 98.590 98.690 98.606 98.614 98.621 98.628 98.638 98.646 98.653 98.661 98.668 98.661 98.668 98.676 98.665 98.663 98.676 98.685 98.693 98.701 98.710 98.710	ΔI 4.702 4.679 4.661 4.696 4.727 4.764 4.838 4.912 5.029 5.149 5.300 5.270 5.103 4.972 4.864 4.815 4.780 4.732 4.683 4.675 4.677 4.696 4.749 4.766 4.859 5.062	HJD 2455800+ 98.739 98.747 98.756 98.766 98.774 98.783 98.791 98.799 98.810 98.818 98.827 98.835 98.844 98.853 98.844 98.853 98.862 98.870 98.870 98.878 98.877 98.895 98.902 98.907 98.916 98.927 98.935 98.946 98.957	ΔI 4.946 4.959 4.881 4.900 4.790 4.821 4.784 4.785 4.710 4.743 4.677 4.697 4.690 4.701 4.729 4.760 4.927 5.172 5.364 5.357 5.208 5.124 5.033 4.912 4.853 4.867	HJD 2455800+ 99.479 99.481 99.484 99.486 99.492 99.494 99.497 99.499 99.509 99.514 99.522 99.530 99.536 99.536 99.556 99.556 99.556 99.556 99.556 99.576 99.587 99.616 99.621 99.625 99.629 99.632 99.636 99.640	ΔI 4.778 4.756 4.763 4.736 4.744 4.721 4.715 4.721 4.715 4.732 4.740 4.756 4.757 4.764 4.784 4.738 4.805 4.833 4.864 4.924 4.928 5.000 5.039 5.121 5.206 5.275 5.283 5.248	HJD 2455800+ 99.650 99.654 99.659 99.663 99.668 99.673 99.673 99.682 99.687 99.691 99.695 99.699 99.703 99.712 99.712 99.717 99.721 99.725 99.730 99.734 99.738 99.742 99.746 99.751 99.756 99.760	$ \Delta I $	$\begin{array}{c} HJD\\ 2455800+\\ \hline \\ 99.769\\ 99.773\\ 99.778\\ 99.782\\ 99.786\\ 99.790\\ 99.790\\ 99.794\\ 99.799\\ 100.759\\ 100.759\\ 100.768\\ 100.778\\ 100.785\\ 100.792\\ 100.785\\ 100.828\\ 100.843\\ 100.828\\ 100.835\\ 100.843\\ 100.850\\ 100.858\\ 100.858\\ 100.858\\ 100.855\\ 100.872\\ \end{array}$

Table 2. Information on the stars used in this study.

Star	Name	R.A. (2000) h m s	Dec. (2000) ° ' "	V	B-V	J–K
V	3UC350-0013921	01 08 12.900	+84 38 06.00	15.51	_	0.581
С	TYC 4619 738	01 07 54.577	+84 33 30.582	10.917	0.535	
K (Check)	TYC 4619 618	01 07 29.1344	$+84\ 40\ 41.871^2$	12.029	0.813	

Table 3. V428 Cep-NGC 188 times of minimum light and linear residuals.

No.	Epoch HJD 2400000+	Cycle	Weight	0–С	Reference
1	55632.2584	-3144.0	1.0	0.0026	Popov <i>et al.</i> 2012
2	55635.3352	-3134.0	1.0	0.0026	Popov et al. 2012
3	55638.2565	-3124.5	0.5	0.0009	Popov et al. 2012
4	55638.2593	-3124.5	0.5	0.0037	Popov et al. 2012
5	55639.3325	-3121.0	1.0	0.0000	Popov et al. 2012
6	55640.2480	-3118.0	1.0	-0.0075	Popov et al. 2012
7	56598.6746	-3.0	1.0	-0.0014	Present Observations
8	56598.8299	-2.5	1.0	0.0001	Present Observations
9	56599.5990	0.0	1.0	0.0000	Present Observations
10	56599.7549	0.5	1.0	0.0020	Present Observations
11	56600.8292	4.0	1.0	-0.0006	Present Observations



Figure 4. V428 Cep-NGC 188. Linear O-C residuals from the period study.



Figure 5. V428 Cep-NGC 188. R, R–I color magnitude diagram of NGC 188 with the turnoff and the position of V428 Cep identified.

contact binary—the B–V color curves dip downward at phase 0.0 and at phase 0.5, which point to each component filling its Roche Lobe. At each quadrature, beginning at phase 0.0, the Δ (B–V) values are 0.31, 0.20, 0.24, and 0.23, respectively. Thus, the curves indicate a contact, classical EW-type binary.

7. Temperature

Table 4 of Popov *et al.* (2013) gives the color indices of the newly discovered variable stars. The V428 Cep spectral type is given as K1. Its period tells us it is of class V. So we have assigned the temperature 5000 K (spectral type, K2V) to the primary component. These results closely match those of 2MASS photometry. Although its faintness is of the right magnitude and its placement is to the right of the main sequence of the CMD (Bettis 1975), its spatial position is rather far from the center of the cluster. It is assumed to be a field star (see section 4). It is of interest that K-type contact binaries, with periods shorter than 0.3 day, and the period of V428 Cep is on the borderline, are important objects for explaining the period cutoff phenomenon (Liu *et al.* 2014).

8. Synthetic light curve solution

The B, V, R, and I curves were pre-modeled with BINARY MAKER 3.0 (Bradstreet and Steelman 2002) and fits were determined in all filter bands. The resulting parameters were then averaged and input into a four-color simultaneous light curve calculation using the Wilson-Devinney Program (WD; Wilson and Devinney 1971; Wilson 1990, 1994; van Hamme and Wilson 1998). The solution was computed in Mode 3 (contact mode). Convective parameters g = 0.32, A = 0.5 were used.

Since eclipses did not appear to be quite total, a q (m_2/m_1) search was performed over the range q = 0.27 to 4.0 (see Figure 7). The sum of square residuals minimized at approximately q = 0.4. Beginning at this value, q was included with the rest of the adjustable parameters to obtain a final solution. The solution is given in Table 5. The normalized curves overlain by our light curve solutions are shown as Figures 8a and 8b. The geometrical (Roche-Lobe) representation of the system is given in Figures 9a, b, c, and d at the light curve quadratures so that the reader may see the placement of the spot and the relative size of the stars as compared to the orbit.

9. Discussion

V428 Cep in the field of NGC 188 is a W UMa binary in a classic contact configuration. Its spectral type, K1V, indicates

Table 4. V428 Cep-NGC 188 light curve characteristics.

Filter	Phase	Magnitude Max. I	Phase	Magnitude Max. II
-	0.25		0.75	
В		4.91 ± 0.04		4.92 ± 0.03
V		4.71 ± 0.03		4.68 ± 0.03
R		4.38 ± 0.01		4.40 ± 0.01
Ι		$4.12 ~\pm~ 0.01$		$4.17~\pm~0.02$
Filter	Phase	Magnitude	Phase	Magnitude
		Min. II		Min. I
	0.50		0.00	
В		5.51 ± 0.05		$5.66~\pm~0.06$
V		5.27 ± 0.02		$5.35~\pm~0.01$
R		$4.96~\pm~0.03$		$5.07~\pm~0.01$
Ι		$4.67 ~\pm~ 0.01$		$4.82~\pm~0.02$
Filter	Min. I –	Max. I –	Phase	Min. I –
	Max. I	Max. II		Min. II
В	0.76	0.10 ± -0.01	0.06	0.16 ± 0.11
V	0.65	$0.04 ~\pm~ 0.02$	0.06	$0.09~\pm~0.03$
R	0.69	0.02 ± -0.02	0.01	$0.11~\pm~0.04$
Ι	0.70	0.04 ± -0.04	0.03	$0.15~\pm~0.03$



Figure 6a. V428 Cep-NGC 188. B (middle), V (bottom) delta magnitude and color magnitudes vs. phase plots in the sense of V–C (top).



Figure 6b. V428 Cep-NGC 188. R (middle), I (bottom) delta magnitude and color magnitudes vs. phase plots in the sense of V–C (top).

Table 5. V428 Cep-NGC 188 light curve solution.

Parameters	Values
$\lambda_{\rm B}, \lambda_{\rm V}, \lambda_{\rm R}, \lambda_{\rm I} ({\rm nm})$	440, 550, 640, 790
$X_{holl 2}, Y_{holl 2}$	0.643, 0. 643, 0.160, 0.160
\mathbf{x}_{1121} , \mathbf{y}_{1121}	0. 647, 0.647, 0. 183, 0. 183
$X_{1R,2R}$, $Y_{1R,2R}$	0. 735, 0.735, 0. 165 0.165
X _{1V2V} , Y _{1V2V}	0.797, 0.797, 0. 108, 0. 108
x _{1B 2B} , y _{1B 2B}	0. 852, 0.852, -0.018, -0.018
g_1, g_2	0.32
A_1, A_2	0.5
Inclination (°)	80.9 ± 0.1
$T_{1}, T_{2}(K)$	$5000, 4822 \pm 6$
$\Omega_1 = \Omega_2$	2.634 ± 0.003
$q(m_2 / m_1)$	0.4228 ± 0.0009
Fill–outs: $F_1 = F_2$	34.5 ± 1.5 %
$L_1 / (L_1 + L_2)_I$	0.710 ± 0.002
$L_1 / (L_1 + L_2)_R$	0715 ± 0.002
$L_1 / (L_1 + L_2)_V$	0.724 ± 0.003
$L_1 / (L_1 + L_2)_B$	0.734 ± 0.005
JD _o (days)	2456599.6001 ± 0.0002
Period (days)	0.30790 ± 0.00007
r_1, r_2 (pole)	$0.445 \pm 0.007, 0.30 \pm 0.01$
r_1, r_2 (side)	$0.48\pm 0.01, 0.32\pm 0.01$
$\mathbf{r}_1, \mathbf{r}_2$ (back)	$0.51 \pm 0.01, 0.37 \pm 0.03$
SPOT Parameters	
Spot 1 On STAR 1	Cool Spot
Colatitude (°)	75.0 ± 2
Longitude (°)	39 ± 1
Spot radius (°)	16.6 ± 0.5
Spot T-factor	0.89 ± 0.01
Sum(res) ²	0.125



Figure 7. V428 Cep-NGC 188. Chart of solution residuals of mass ratios extending from 0.35 to 3 minimizes near 0.4.



Figure 8a. V428 Cep-NGC 188. B (middle), V (bottom) synthetic light curve solutions overlaying the normalized flux curves.



Figure 8b. V428 Cep-NGC 188. R (middle), I (bottom) synthetic light curve solutions overlaying the normalized flux curves.









Figure 9c. V428 Cep-NGC 188. Roche Lobe surfaces from our BVRI simultaneous solution, phase 0.50.

Figure 9d. V428 Cep-NGC 188. Roche Lobe surfaces from our BVRI simultaneous solution, phase 0.75.

a surface temperature of 5000 K for the primary component. The q-search indicates the mass ratio is 0.4, with a light curve amplitude of 0.76–0.65 magnitude in B to I, respectively. The secondary component has a temperature of ~4822 K (K3), which means the secondary is over luminous for its main sequence mass. The fill-out is 35%. The high inclination of 80° results in a near total eclipse with less than 1% of the light due to the secondary component at phase 0.5. It is an A-type

W UMa binary that has not quite reached thermal equilibrium. The primary component was modeled with a moderately sized cool spot region of 16° radius and a mean T-factor of ~0.89 (T~4300K) -- not unusual in solar-type binaries.

10. Conclusion

Our 2.5-year period study yields little information about the orbital evolution of the binary. However, since the system has strong magnetic activity, over time, the system should slowly coalesce due to magnetic braking as it loses angular momentum due to ion winds moving outward on stiff magnetic field lines rotating with the binary (out to the Alfvén radius). If the mass ratio becomes more extreme and the fill-out increases, than we would predict the binary will coalesce, producing a rather fast rotating, single A-type main sequence field star (Guinan and Bradstreet 1988). Radial velocity curves are needed to obtain absolute (not relative) system parameters.

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