

Photoelectric Observations of Zeta Aurigae During the 1963-1964 Eclipse

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U, B, V, photometry of 12 nights for the 1963-1964 eclipse of Zeta Aurigae is presented. The colors and magnitudes of the star have been determined. At minimum it appears somewhat fainter than the eclipse in 1956. The observations confirm the chromospheric extinction effect but reveal no noticeable variations during totality.

SIMULTANEOUS photoelectric and spectrophotometric observations of Zeta Aurigae during the 1963-1964 eclipse were carried out at the George R. Agassiz Station of Harvard College Observatory as part of the IAU coordinated program. This report summarizes the results of photoelectric photometry.

Photoelectric observations in three colors were obtained on 12 nights with a photometer of conventional design attached to the 24-in. Clark reflector. An unrefrigerated 1P21 photomultiplier was used with the following filters: yellow, Corning 3384; blue, Corning 5030 plus Schott GG-13; ultraviolet, Corning 9863. The red leak of the ultraviolet filter was measured with a filter combination consisting of Corning 3384 plus Corning 9863.

The primary comparison star used was 2 Aurigae. It was found to be constant by frequent checks with the secondary comparison Lambda Aurigae which is also a *U, B, V* standard. Both were used as extinction stars for determination of color dependence of extinction coefficients. The observations were corrected for differential extinction and the difference in color between the variable and the comparison was taken into account. They were tied into the *U, B, V* system on two nights through observations of seven standard stars (Table I) published by Johnson and Harris (1954) and by Johnson and Morgan (1953). The tie-in gave the magnitude and colors of 2 Aurigae as

$$V = 4.803 \pm 0.011 \text{ p.e.,}$$

$$B - V = +1.423 \pm 0.010 \text{ p.e.,}$$

$$U - B = +1.582 \pm 0.013 \text{ p.e.,}$$

and indicated that

$$\Delta V = \Delta y + 0.0 \Delta(B - V),$$

$$\Delta(B - V) = 1.080 \Delta(b - y),$$

$$\Delta(U - B) = 0.970 \Delta(u - b),$$

where small letters refer to instrumental magnitude and colors reduced to no atmosphere.

Table II lists the differential magnitude and colors of Zeta Aurigae in the sense of Zeta minus 2 Aurigae. The columns are self-explanatory. Each entry is an individual measure based on two deflections in each

color; the internal probable error of a single observation is ± 0.007 in ΔV , ± 0.010 in $\Delta(B - V)$ and ± 0.012 in $\Delta(U - B)$ in magnitude scale. For three nights the values are given only to the second decimal place because of the use of poorly determined extinction coefficients.

The light and color curves of Zeta Aurigae are shown in Fig. 1. The blue and ultraviolet observations have been derived from the yellow magnitude and color indices and also plotted for comparison. Each point represents a nightly mean of the observations given in Table II except during the egress, where more points are plotted. The left-hand coordinate lists the differential values and the right-hand coordinate gives magnitudes and colors in the *U, B, V* system. Arrows at the top indicate the contact times predicted with an extrapolated value of the duration of totality (Gyldenkerne 1963). To find the magnitudes and colors at minimum, average values of six nights within totality are taken. For those at maximum, mean values of the February and March observations are used because the number of points just before and after the eclipse is inadequate. These values together with the derived *B* and *U* magnitudes and depths of eclipse are given in Table III.

Although the points immediately before and after the eclipse are few, they confirm the chromospheric extinction effect that the eclipse begins earlier and lasts longer at shorter wavelengths, a fact reported by many previous observers. In addition, if we compare the two points just before the eclipse with those at maximum, we find that the beginning of ingress seems to occur earlier than predicted even in visual light.

TABLE I. Magnitudes and color indices of *U, B, V* standards.

Star	Spectral type	<i>V</i>	<i>B - V</i>	<i>U - B</i>	Remarks
γ Ori	B2 III	1 ^m 64	-0 ^m 23	-0 ^m 87	
π^4 Ori	B2 III	3.69	-0.17	-0.81	
η Aur	B3 V	3.17	-0.18	-0.67	Variable?
π^3 Ori	F6 V	3.19	+0.45	-0.01	
λ Aur	G0 V	4.71	+0.67	+0.10	Secondary comparison
δ Tau	K0 III	3.73	+0.98	+0.84	
ϵ Tau	K0 III	3.54	+1.02	+0.88	

TABLE II. Photoelectric observations of ζ Aurigae.

Date (UT)	ΔV	$\Delta(B-V)$	$\Delta(U-B)$
1963 Dec. 1	.359	-1 ^m .041	-0 ^m .146
	.368	1.035	0.146
	.390	-1.030	-0.177
Dec. 2	.122	-1.021	-0.122
	.126	1.021	0.122
	.209	1.038	0.126
	.222	-1.040	-0.130
Dec. 5	.103	-0.863	+0.208
	.130	0.875	0.205
	.135	0.878	0.206
	.210	0.886	0.210
	.215	0.886	0.203
	.233	0.895	0.209
	.242	0.893	0.213
	.289	0.884	0.203
	.302	-0.869	+0.210
Dec. 15	.231	-0.884	+0.227
	.235	0.892	0.230
	.250	-0.891	+0.228
Dec. 16	.238	-0.889	+0.222
	.257	-0.887	+0.223
Dec. 20	.116	-0.890	+0.217
	.271	-0.887	+0.228
Dec. 21	.206	-0.88	+0.24
	.211	-0.88	+0.24
1964 Jan. 8	.257	-0.88	+0.21
	.263	0.87	0.21
	.282	0.90	0.22
	.287	-0.90	+0.22
1964 Jan. 11	.016	-0.913	+0.123
	.021	0.911	0.120
	.048	0.919	0.089
	.124	0.949	0.081
	.128	0.949	0.085
	.136	0.956	0.086
	.152	0.952	0.065
	.207	0.959	0.051
	.210	0.959	0.051
	.234	0.970	0.054
	.293	0.980	0.015
	.332	-0.985	+0.005
Jan. 12	.010	-1.030	-0.143
	.015	1.030	0.132
	.058	1.023	0.135
	.105	1.029	0.136
	.140	1.036	0.134
	.144	1.036	0.135
	.259	1.035	0.139
	.300	-1.035	-0.140
Feb. 15	.162	-1.034	-0.166
	.231	-1.047	-0.163
Mar. 21	.068	-1.05	-0.16
	.083	-1.05	-0.17

However, this is not very certain because of the lack of observations before the eclipse.

The present series of observations agrees very well with the U , B , V photometry of Zeta Aurigae during the 1955–1956 eclipse (Grant and Abt 1959; Popper

TABLE III. Magnitudes and color indices of Zeta Aurigae and of comparison stars.

Star	Spectral type	V	$B-V$	$U-B$	B	U
ζ Aur (max)	K4 II + B7 V	3 ^m 76	+1 ^m 26	+0 ^m 42	5 ^m 02	5 ^m 44
ζ Aur (min)	K4 II	3.91	+1.65	+1.81	5.56	7.37
Depth of eclipse		0.15	0.39	1.39	0.54	1.93
2 Aur (primary comparison)	K3 III	4.80	+1.42	+1.58		
λ Aur (secondary comparison)	G0 V	4.71	+0.67	+0.10		

1961), except that during totality the star appeared somewhat fainter in blue and visual light.

The present observations do not reveal noticeable variations at total phase, particularly in yellow light. The constancy of the ΔV magnitude during totality may be accidental because of insufficient observation. On the other hand, the ultraviolet observations obtained on 8 January are a little higher than the average

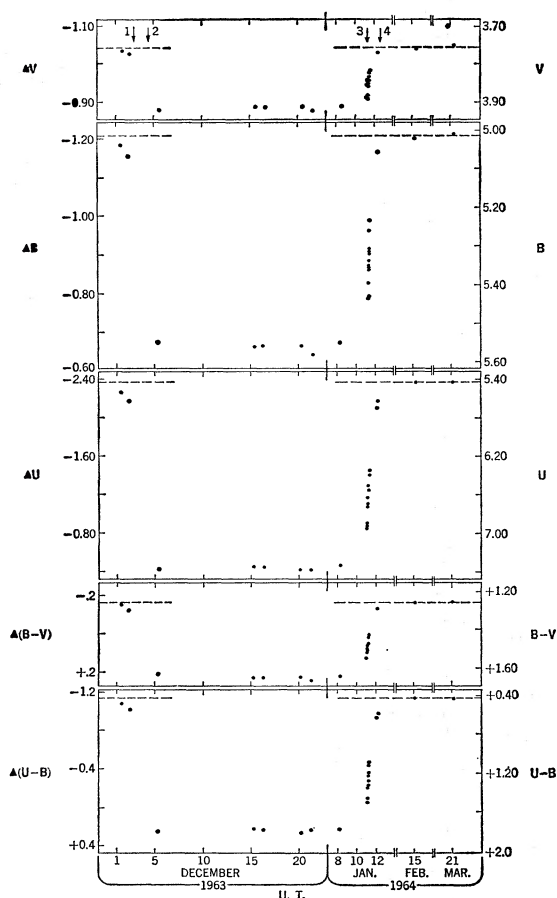


FIG. 1. The light and color curves of Zeta Aurigae during the 1963-1964 primary minimum. The dashed lines represent the magnitudes and colors outside eclipse. Arrows at the top indicate the predicted times of contacts.

and somewhat beyond the range of observational uncertainty.

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