A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

Nr. 61

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PHOTOELECTRIC OBSERVATIONS OF VARIABLE STARS

Budapest, 1967

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INTRODUCTION

Twenty-eight variable and suspected variable stars were chosen for observation (see Table No. 1) from the "General Catalogue of Variable Stars". An attempt was made to choose stars of questionable classification and also to include some semi-regular and irregular variables which had not been well observed. The stars were also chosen for favorable positions in the sky for the observing period involved.

EQUIPMENT

All observations were made with the Lowell Observatory 21-inch reflector and other photoelectric equipment used for the Solar Variation Program. This equipment includes a photometer with a 1P21, standard B and V filters, a GR 1230 DC amplifier, and a Brown recorder.

OBSERVATIONS

The 1P21 was cooled with dry ice at least two hours prior to the beginning of observations, and dry ice was added each two hours thereafter during the night. Every six or eight weeks the amplifier was calibrated in half and two and a half magnitude steps (Serkowski, 1961). The deflections were recorded on a Brown recorder strip-chart potentiometer in the sequence B, sky B, V, sky V; these were followed by observations of a radioactive source and the dark current.

Many primary and secondary UBV standard stars were observed at various air masses throughout the night (Johnson and Harris, 1954) in order to determine the extinction and color corrections. No observations were made within three days of full moon and no observations were attempted if clouds were suspected.

REDUCTIONS

The reductions were made by means of the formulae and least-squares method described by Serkowski (1961).

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LIGHT CURVES

Drawings showing B, V, and B—V data are given (Figures 1—17) for 17 of the 28 stars observed. Only the most interesting data are shown. The B observations are shown by filled circles, the V observations by the open circles, and the B—V color points below.

DESCRIPTION OF TABLE AND FIGURES

Table No. 1 lists all stars observed. The first four columns list the star names, the type of variable, the period and the spectral types as given in the "General Catalogue of Variable Stars" (second edition). The fifth and sixth columns list the observed B—V values at maximum and minimum light.

Figure 18 is a B—V vs. spectral type diagram for the 28 stars. The long dashed line represents the main-sequence and the small dashed line below the yellow giants according to Johnson and Morgan (1953). Most of the variables plotted appear to lie close to the giant sequence if one assumes that the giant branch crosses the main-sequence at approximately B—V = = +1.6.

Figure 19 is the observed color B—V amplitude vs. the visual V magnitude amplitude. This indicates that a large amplitude in brightness necessitates a large color change for this group of stars.

Figure 20 shows the relation between the log of the period and color at minimum light, after Kron and Svolopoulas (1959) and transformed to the B, V system. The small filled circles to the left indicate 25 galactic cepheid variables observed at minimum light by Eggen, Gascoigne, and Burr (1957) and transformed here to B—V. The open circles to the right show the 12 semi-regular variables observed at minimum light by Smak (1964). The large filled circles to the right are observations from this paper where a period could be found.

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TABLE NO. 1

Name	From "General Catalogue of Variable Stars" Second Edition			Present observations B—V at	
	type	period	spect.	maximum light	minimum light
W BOO	?		M3	1.70	—
Y BOO	cst ?		KO III	1.05	—
RX BOO	SRb	(210±)	M7e—8e	1.76	1.79
RY BOO	cst ?		F6—IV	.44	—
UV BOO	Ia		F5	.41	—
X CNC	SRb	170±	N3($C5_4$)	3.39	3.24
RS CNC	SRc ?	120	M6	1.70	1.66
RT CNC	SRb	90	M5 III	1.56	1.46
V CVN	SRa	191.88	M4e—M6e	1.51	1.60
TU CVN	Ib	(50±)	M6	1.62	1.58
TW COM	Ib		K5	1.51	1.42
VW GEM	Ib		N($C3_9$)	2.44	2.48
BN GEM	Ia ?		08V : pe	—.12	—
BQ GEM	?	(50±)	M4	1.64	1.61
VV LEO	SR	181.5	M7	1.82	1.84
WX LEO	Ib		M5	1.54	1.46
AI LEO	Ib		M5	1.79	1.66
AK LEO	Ib	(60±)	M5	1.49	1.52
SV LYN	SR ?	(70±)	gM5	1.56	1.61
ST UMA	SRb	81	M4 III	1.67	1.63
TV UMA	SRb	50.38	M5 III	1.54	1.52
SW VIR	SRb	150±	M7	1.80	1.76
BG VIR	I ?	(50±)	M5	1.50	1.48
BK VIR	Ib	(150±)	M7	1.62	1.63
CN VIR	Ib	(60±)	M3	1.68	1.63
CO VIR	Ib	(70±)	M5	1.57	1.55
CP VIR	?1		M7	1.55	1.46
CQ VIR	Ib		M3	1.71	1.60

Those periods given in parentheses () above are estimated from the observations here.

NOTES TO TABLE 1.

W BOO: Listed as? Observations here still leave doubt as to variability.

Y BOO: Listed as cst? Observations here indicate it is probably not variable.

RX BOO: Listed as SRb. Light curves appear to confirm this classification. Period $210^d \pm$. See Fig. 1.

RY BOO: Listed as cst? Eighteen observations here indicate it probably is not variable.

UV BOO: Listed as Ia. Sixteen observations here indicate it is probably not variable.

X CNC: Listed as SRb: Light curves appear to confirm this classification. See Fig. 2.

RS CNC: Appears to be as listed (SRc), but with a 160 ($\pm$) day period. See Fig. 3.

RT CNC: Appears to be as listed (SRb), with a period for these observations of 140^d. Note how the B—V changed (bluer) as the star passed through minimum light. See Fig. 4.

V CVN: Listed as SRa with period of 191.88^d. These observations confirm the above. See Fig. 5.

TU CVN: Listed as Ib. Light curve here appears to suggest SRb with period of $50^d \pm$. See Fig. 6.

TW COM: Listed as Ib. Too few observations here.

VW GEM: Too few observations here.

BN GEM: Listed as Ia? Twenty-two observations here indicate it probably not variable.

BQ GEM: Type listed as? The light curves here indicate an SRb type with a period of 50 days ($\pm$). See Fig. 7.

VV LEO: Too few observations here.

WX LEO: Too few observations here.

AI LEO: Listed as Ib, light curves here indicate an SRb type with too few observations to determine a period. See Fig. 8.

AK LEO: Listed as Ib, light curve here suggests it may be SRb with period of $60^d \pm$. See Fig. 9.

SV LYN: Listed as SR? Observations here indicate type SRb with a period of 70 days ($\pm$). See Fig. 10.

ST UMA: Type listed as SRb with a period of 81 days. Observations here confirm the type, but the period appears to be longer ($\sim$90d). See Fig. 11.

TV UMA: Listed as SRb with period of 50.38 days, observations here confirm the type but the average period ($\sim$42d) appears to be shorter. See Fig. 12.

SW VIR: Type listed as SRb with period of 150 days ($\pm$). Too few observations here to confirm. See Fig. 13.

G VIR: Listed as type I? Observations here indicate this star may be type SRb with a period of 50 days($\pm$). See Fig. 14.

BK VIR: Listed as type Ib. Observations here indicate an SRb star with a period of $150^d\pm$. See Fig. 15.

CN VIR: Type listed is Ib. Observations here suggest an SRb star with a period of $60^d\pm$. See Fig. 16.

CO VIR: Listed as type Ib. Too few observations to confirm this classification.

CP VIR: Listed as type ?I. Observations here indicate an SRb type with a period of ~70 days. See Fig. 17.

CQ VIR: Type listed as Ib. Observation here suggest an SRb star with too few observations to determine a period.

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OBSERVATIONS

W BOO

J. D.	Date 1963	B	V
2,438,051	Jan. 21	6.44	4.77
053	23	6.45	4.76
055	25	6.46	4.79
064	Feb. 3	6.49	4.82
067	6	6.44	4.77
082	21	6.45	4.79
096	Mar. 7	6.43	4.73
109	20	6.43	4.74
124	Apr. 4	6.46	4.78
163	May 13	6.43	4.77
186	June 5	6.45	4.79

Y BOO

J. D.	Date 1963	B	V
2,438,055	Jan. 25	8.98	7.95
058	28	8.98	7.95
064	Feb. 3	8.98	7.95
067	6	8.98	7.95
082	21	8.96	7.94
085	24	8.98	7.95
096	Mar. 7	8.97	7.93
109	20	8.98	7.94
124	Apr. 4	8.99	7.95
162	May 12	8.98	7.96
166	16	8.98	7.96

RX BOO

J. D.	Date 1963	B	V
2,438,053	Jan. 23	9.53	7.72
055	25	9.54	7.76
058	28	9.51	7.75
064	Feb. 3	9.55	7.76
067	6	9.50	7.72
082	21	9.40	7.64
096	Mar. 7	9.34	7.57
109	20	9.29	7.53
124	Apr. 4	9.32	7.59
149	29	9.58	7.84
162	May 12	9.74	8.00
166	16	9.79	8.02
171	21	9.83	8.06
174	24	9.86	8.06
179	29	9.89	8.11
186	June 5	9.91	8.12
191	10	9.91	8.11
194	13	9.88	8.12

RY BOO

J.D.	Date 1962		V
2,438,021	Dec. 22	7.56	7.12
029	30	7.56	7.12
	1963		
037	Jan. 7	7.55	7.12
039	9	7.56	7.12
045	15	7.56	7.13
047	17	7.56	7.12
051	21	7.59	7.15
053	23	7.56	7.12
064	Feb. 3	7.60	7.16
067	6	7.56	7.12
082	21	7.56	7.12
085	24	7.56	7.13
096	Mar. 7	7.56	7.12
109	20	7.58	7.15
124	Apr. 4	7.60	7.15
153	May 3	7.56	7.12
162	12	7.58	7.14
166	16	7.56	7.13

UV BOO

J. D.	Date 1963	B	V
2,438,045	Jan. 15	8.55	8.14
047	17	8.55	8.14
051	21	8.55	8.14
053	23	8.55	8.13
055	25	8.54	8.14
058	28	8.55	8.14
064	Feb. 3	8.56	8.15
067	6	8.55	8.13
082	21	8.54	8.12
096	Mar. 7	8.56	8.14
109	20	8.56	8.16
124	Apr. 4	8.58	8.14
149	29	8.55	8.14
162	May 12	8.55	8.14
166	16	8.55	8.14
179	29	8.54	8.11

X CNC

J. D.	Date 1962	B	V
2,437.970	Nov. 1	10.14	6.80
971	2	10.15	6.91
972	3	10.17	6.89
974	5	10.20	6.96
977	8	10.19	6.95
980	11	10.21	6.98
992	23	10.23	6.98
996	27	10.26	7.02
2,438,003	Dec. 4	10.24	7.00
005	6	10.24	6.99
007	8	10.23	7.00
021	22	10.16	6.88
029	30	10.10	6.82
	1963		
039	Jan. 9	10.05	6.55
045	15	9.94	6.42
047	17	9.89	6.44
051	21	9.87	6.42
053	23	9.83	6.37
058	28	9.79	6.35

X CNC (cont)

J. D.	Date 1962	B	V
2,438,064	Feb. 3	9.72	6.30
067	6	9.70	6.28
077	16	9.65	6.26
082	21	9.66	6.27
104	Mar. 15	9.78	6.31
132	Apr. 12	9.80	6.41
145	25	9.77	6.39
153	May 3	9.68	6.39
163	13	9.62	6.34

RS CNC

J. D.	Date 1962	B	V
2,437,970	Nov. 1	7.27	
971	2	7.27	5.67
972	3	7.28	5.66
974	5	7.30	5.67
977	8	7.31	5.67
979	10	7.31	5.70
980	11	7.35	5.71
996	27	7.42	5.78
2,438,003	Dec. 4	7.48	5.86
005	6	7.50	5.85
007	8	7.49	5.85
020	21	7.63	5.99
021	22	7.64	6.00
029	30	7.68	6.04
	1963		
039	Jan. 9	7.71	6.05
045	15	7.68	6.03
047	17	7.60	5.99
051	21	7.57	5.95
053	23	7.53	5.89
055	25	7.48	5.86
064	Feb. 3	7.30	5.68
067	6	7.25	5.64
077	16	7.09	5.47
080	19	7.08	5.44
082	21	7.01	5.40
086	25	6.93	5.30
104	Mar. 15	6.77	5.1

RS CNC (cont.)

J. D.	Date 1963	B	V
2,438,109	Mar. 20	6.76	5.06
132	Apr. 12	7.17	5.50
143	23	7.35	5.68
145	25	7.38	5.70
149	29	7.45	5.74
153	May 3	7.48	5.82
162	12	7.55	5.91
163	13	7.57	5.89
166	16	7.60	5.91
179	29	7.72	6.03

RT CNC

J. D.	Date 1962	B	V
2,437,974	Nov. 5	9.09	7.57
977	8	9.10	7.58
979	10	9.11	
980	11	9.12	7.59
992	23	9.13	7.59
996	27	9.06	7.54
2,438,003	Dec. 4	9.04	7.50
005	6	9.00	7.44
007	8	8.99	7.44
021	22	9.06	7.48
029	30	9.13	7.55
	1963		
039	Jan. 9	9.18	7.61
045	15	9.21	7.70
047	17	9.20	7.72
051	21	9.26	7.78
052	23	9.30	7.80
055	25	9.33	7.83
064	Feb. 3	9.37	7.90
067	6	9.36	7.90
077	16	9.27	7.80
082	21	9.17	7.71
086	25	9.10	7.63
104	Mar. 15	9.11	7.58
132	Apr. 12	8.97	7.41
143	23	8.93	7.36
145	25	8.93	7.36
153	May 3	8.92	7.36
163	13	8.95	7.38
166	16	8.97	7.39

V CVN

J. D.	Date 1962	B	V
2,438,005	Dec. 6	8.86	7.20
021	22	9.05	7.39
029	30	9.26	7.58
	1963		
037	Jan. 7	9.57	7.92
039	9	9.65	8.02
045	15	9.82	8.16
047	17	9.83	8.19
051	21	9.89	8.24
053	23	9.90	8.25
055	25	9.90	8.27
058	28	9.88	8.28
064	Febr. 3	9.81	8.21
067	6	9.79	8.18
082	21	9.81	8.20
124	Apr. 4	8.90	7.41
145	25	8.54	7.03
162	May 12	8.66	7.19
166	16	8.65	7.18
179	29	8.68	7.21
186	June 5	8.79	7.31

TU CVN

J. D.	Date 1962	B	V
2,438,005	Dec. 6	7.33	5.75
020	21	7.33	5.77
029	30	7.25	5.68
	1963		
037	Jan. 7	7.28	5.70
039	9	7.27	5.69
045	15	7.34	5.75
047	17	7.32	5.74
051	21	7.33	5.74
053	23	7.31	5.71
055	25	7.30	5.71
058	28	7.27	5.69
064	Feb. 3	7.27	5.68
067	6	7.26	5.67
082	21	7.37	5.78
096	Mar. 7	7.36	5.75

TU CVN (cont)

J. D.	Date 1963	B	V
2,438,104	Mar. 15	7.17	5.57
109	20	7.17	5.55
124	Apr. 4	7.37	5.78
132	12	7.41	5.83
143	23	7.30	5.73
149	29	7.29	5.70
151	May 1	7.28	5.70
153	3	7.28	5.70
162	12	7.29	5.71
163	13	7.28	5.69
166	16	7.26	5.67
174	24	7.24	5.65
179	29	7.26	5.69
186	June 5	7.34	5.76
194	13	7.32	5.76

TW COM

J. D.	Date 1963	B	V
2,438,051	Jan. 21	11.25	9.77
053	23	11.24	9.82
055	25	11.28	9.82
058	28	11.26	9.78
064	Feb. 3	11.18	9.69
124	Apr. 4	10.95	9.44
143	23	11.33	9.90
162	May 12	11.10	9.64

VW GEM

J. D.	Date 1962	B	V
2,437,979	Nov. 10	11.00	8.52
2,438,007	Dec. 8	10.88	8.42
021	22	10.82	8.39
	1963		
047	Jan. 17	10.74	8.32
053	23	10.72	8.27
064	Feb. 3	10.75	8.33
077	16	10.76	8.35
082	21	10.81	8.39

BN GEM

J. D.	Date 1962	B	V
2,437,970	Nov. 1	6.63	—
971	2	6.64	6.78
972	3	6.63	6.79
974	5	6.64	6.81
977	8	6.63	6.79
992	23	6.62	6.78
995	26	6.64	6.76
996	27	6.64	6.77
2,438,003	Dec. 4	6.62	6.77
005	6	6.62	6.75
007	8	6.63	6.76
021	22	6.64	6.77
	1963		
047	Jan. 17	6.64	6.79
051	21	6.65	6.79
053	23	6.64	6.79
064	Febr. 3	6.64	6.79
077	16	6.63	6.77
082	21	6.63	6.76
104	Mar. 15	6.61	6.76
132	Apr. 12	6.63	6.75
145	25	6.61	6.74
153	May 3	6.64	6.76

BQ GEM

J. D.	Date 1962	B	V
2,437,972	Nov. 3	6.80	
977	8	6.81	5.19
979	10	6.83	5.20
980	11	6.84	5.21
992	23	6.93	
995	26	6.93	5.31
996	27	6.94	5.34
2,438,003	Dec. 4	6.94	5.32
005	6	6.92	5.29
007	8	6.92	5.27
021	22	6.77	5.13
	1963		
047	Jan. 17	6.81	5.19
051	21	6.80	5.15
053	23	6.78	5.14

BQ GEM (cont)

J. D.	Date 1963	B	V
2,438,064	Feb. 3	6.72	5.07
077	16	6.63	4.98
080	19	6.73	5.04
082	21	6.68	5.04
104	Mar. 15	6.93	5.27
132	Apr. 12	6.72	5.05
145	25	6.90	5.23
153	May 3	7.01	5.33

VV LEO

J. D.	Date 1962	B	V
2,438,021	Dec. 22	11.78	10.07
	1963		
047	Jan. 17	11.73	10.00
051	21	11.79	9.97
053	23	11.80	9.98
058	28	11.85	10.01
082	Feb. 21	12.05	10.21

WX LEO

J. D.	Date 1963	B	V
2,438,051	Jan. 21	9.89	8.39
053	23	9.93	8.44
055	25	9.97	8.48
058	28	9.99	8.46
064	Febr. 3	9.96	8.50
067	6	9.95	8.48
124	Apr. 4	9.56	8.05
163	May 13	9.59	8.06
166	16	9.57	8.04
186	June 5	9.48	7.94

AI LEO

J. D.	Date 1963	B	V
2,438,047	Jan. 17	10.23	8.44
051	21	10.26	8.50
053	23	10.29	8.50
055	25	10.32	8.54
058	28	10.36	8.59
082	Feb. 21	10.66	8.93
109	Mar. 20	11.85	9.13
143	Apr. 23	11.09	9.38
162	May. 12	11.11	9.45
163	13	11.13	9.44
166	16	11.13	9.42
174	24	11.02	9.31
179	29	10.88	9.18
194	June 13	10.43	8.69

AK LEO

J. D.	Date 1962	B	V
2,438,003	Dec. 4	10.25	8.72
005	6	10.24	8.68
007	8	10.25	8.68
009	10	10.21	8.71
020	21	10.19	8.70
021	22	10.19	8.66
029	30	10.23	8.75
	1963		
037	Jan. 7	10.26	8.77
039	9	10.26	8.78
045	15	10.28	8.78
047	17	10.28	8.78
051	21	10.33	8.81
053	23	10.35	8.82
055	25	10.36	8.83
058	28	10.38	8.85
064	Feb. 3	10.39	8.87
067	6	10.38	8.89
082	21	10.38	8.88
109	Mar. 20	10.15	8.67
124	Apr. 4	10.53	9.00
132	12	10.25	8.71
143	23	10.29	8.77
145	25	10.27	8.74

AK LEO (cont.)

J. D.	Date 1963	B	V
2,438,149	Apr. 29	10.22	8.69
151	May 1	9.85	8.36
162	12	10.03	8.54
163	13	10.09	8.54
166	16	10.09	8.54
174	24	10.13	8.59
179	29	10.12	8.62
186	June 5	10.06	8.54
194	13	10.01	8.49

SV LYN

J. D.	Date 1962	B	V
2,437,972	Nov. 3	8.40	6.84
977	8	8.42	6.84
979	10	8.42	—
992	23	8.55	6.97
996	27	8.59	7.00
2,438,003	Dec. 4	8.60	7.06
005	6	8.59	7.01
007	8	8.59	—
021	22	8.67	7.09
	1963		
051	Jan. 21	8.51	6.89
053	23	8.51	6.89
058	28	8.42	6.85
064	Feb. 3	8.63	7.03
067	6	8.66	7.07
077	16	8.84	7.24
082	21	8.83	7.26
104	Mar. 15	8.55	6.92
132	Apr. 12	8.50	6.90
145	25	8.65	7.06
153	May 3	8.63	7.03
162	12	8.58	7.00
163	13	8.59	6.96
166	16	8.60	6.94

ST UMA

J. D.	Date 1962	B	V
2,438,003	Dec. 4	8.55	6.92
005	6		6.89
009	10	8.42	6.82
020	21	8.20	6.57
021	22	8.18	6.51
209	30	8.15	6.48
	1963		
037	Jan. 7	8.18	6.50
039	9	8.18	6.53
045	15	8.21	6.57
047	17	8.22	6.59
051	21	8.30	6.65
053	23	8.32	6.67
055	25	8.37	6.74
058	28	8.42	6.77
064	Feb. 3	8.50	6.89
067	6	8.55	6.94
082	21	8.60	6.97
086	25	8.56	6.94
087	26	8.55	6.94
096	Mar. 7	8.44	6.81
104	15	8.34	6.70
109	20	8.28	6.63
123	Apr. 3	8.24	6.58
124	4	8.22	6.56
132	12	8.18	6.54
143	23	8.23	6.59
145	25	8.23	6.58
149	29	8.24	6.59
151	May 1	8.25	6.60
153	3	8.25	6.61
160	10	8.23	6.60
162	12	8.21	6.61
163	13	8.24	6.61
166	16	8.22	6.58
174	24	8.21	6.53
179	29	8.15	6.55
186	June 5	8.22	6.56
194	13	8.19	6.54

TV UMA

J. D.	Date 1962	B	V
2,438,003	Dec. 4	8.66	7.13
005	6	8.61	7.06
009	10	8.54	7.03
020	21	8.70	7.20
021	22	8.71	7.18
029	20	8.81	7.28
	1963		
037	Jan. 7	8.75	7.24
039	9	8.73	7.22
045	15	8.74	7.22
047	17	8.73	7.21
051	21	8.78	7.26
053	23	8.78	7.25
	25	8.79	7.27
058	28	8 79	7.28
064	Feb. 3	8.81	7.29
067	6	8.80	7.29
082	21	8.59	7.04
086	25	8.59	7.04
087	26	8.58	7.03
096	Mar. 7	8.64	7.11
104	15	8.67	7.15
109	20	8.65	7.13
124	Apr. 4	8.41	6.85
132	12	8.49	6.95
143	23	8.64	7.14
145	25	8.66	7.14
149	29	8.70	7.18
151	May 1	8.73	7.22
153	3	8.74	7.24
160	10	8.72	7.22
162	12	8.70	7.19
163	13	8.69	7.16
166	16	8.63	7.11
174	24	8.48	6.93
179	29	8.36	6.83
186	June 5	8.29	6.75
194	13	8.33	6.78

SW VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	8.64	6.90
053	23	8.63	6.88
055	25	8.63	6.89
058	28	8.61	6.88
064	Feb. 3	8.62	6.87
067	6	8.62	6.87
082	21	8.64	6.86
096	Mar. 7	8.59	6.82
109	20	8.61	6.82
124	Apr. 4	8.79	7.02
144	24	8.92	7.17
149	29	8.96	7.19
151	May 1	8.96	7.20
153	3	8.95	7.19
162	12	8.94	7.20
163	13	8.93	7.17
166	16	8.92	7.15
179	29	8.89	7.13
194	June 13	8.90	7.14

BG VIR

J. D.	Date 1963	B	V
2,438,064	Feb. 3	10.58	9.09
082	21	10.68	9.18
085	24	10.67	9.18
096	Mar. 7	10.52	9.01
109	20	10.58	9.04
124	Apr. 4	10.69	9.19
142	22	10.63	9.15
153	May 3	10.57	9.05
162	12	10.44	8.94
166	16	10.50	8.96
171	21	10.60	9.13
174	24	10.67	9.15
179	29	10.64	9.14
186	June 5	10.61	9.11
191	10	10.56	9.04
194	13	10.51	9.02

BK VIR

J. D.	Date 1963	B	V
2,437,047	Jan. 17	9.75	8.12
051	21	9.80	8.15
053	23	9.74	8.10
055	25	9.74	8.14
058	28	9.80	8.18
064	Feb. 3	9.84	8.22
067	6	9.85	8.22
082	21	9.80	8.16
124	Apr. 4	8.92	7.30
132	12	8.89	7.28
143	23	8.90	7.28
149	29	8.96	7.32
151	May 1	8.96	7.34
162	12	9.10	7.51
163	13	9.13	7.50
166	16	9.18	7.55
174	24	9.31	7.65
179	29	9.36	7.74
186	June 5	9.44	7.79
194	13	9.54	7.88

CN VIR

J. D.	Date 1963	B	V
2,438,047	Jan. 17	9.88	8.24
051	21	9.86	8.19
053	23	9.86	8.17
058	28	9.87	8.23
064	Feb. 3	9.98	8.32
067	6	10.02	8.39
082	21	10.13	8.49
124	Apr. 4	10.00	8.38
132	12	10.08	8.49
143	23	10.08	8.47
149	29	10.04	8.42
151	May 1	10.00	8.38
162	12	9.91	8.27
163	13	9.90	8.26
166	16	9.93	8.28
174	24	10.01	8.38
179	29	10.10	8.49
186	June 5	10.24	8.60
194	13	10.25	8.64

CO VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	10.56	9.01
053	23	10.57	9.02
055	25	10.58	9.06
058	28	10.61	9.07
064	Feb. 3	10.68	9.14
067	6	10.73	9.18
082	21	10.85	9.30
124	Apr. 4	10.67	9.13
151	May 1	10.66	9.11
162	12	10.57	9.02
163	13	10.55	9.01
166	16	10.51	8.97
179	29	10.35	8.80
186	June 5	10.33	8.76
194	13	10.40	8.83

CP VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	10.01	8.48
053	23	9.97	8.42
055	25	9.96	8.41
058	28	9.93	8.38
082	Feb. 21	10.18	8.66
096	Mar. 7	10.25	8.69
109	20	10.18	8.62
124	Apr. 4	10.02	8.45
142	22	10.07	8.53
143	23	10.09	8.53
144	24	10.11	8.56
149	29	10.17	8.63
151	May 1	10.22	8.67
153	3	10.23	8.69
162	12	10.37	8.91
163	13	10.38	8.89
166	16	10.37	8.90
179	29	10.31	8.86
180	June 5	10.16	8.63
194	13	10.09	8.52

CQ VIR

J. D.	Date 1963	B	V
2,438,051	Jan. 21	10.76	9.06
053	23	10.74	9.03
055	25	10.75	9.05
064	Feb. 3	10.71	8.99
124	Apr. 4	11.02	9.35
162	May 12	11.24	9.64
166	16	11.25	9.64
174	24	11.22	9.59
179	29	11.23	9.64
186	June 5	11.21	9.57
194	13	11.09	9.51

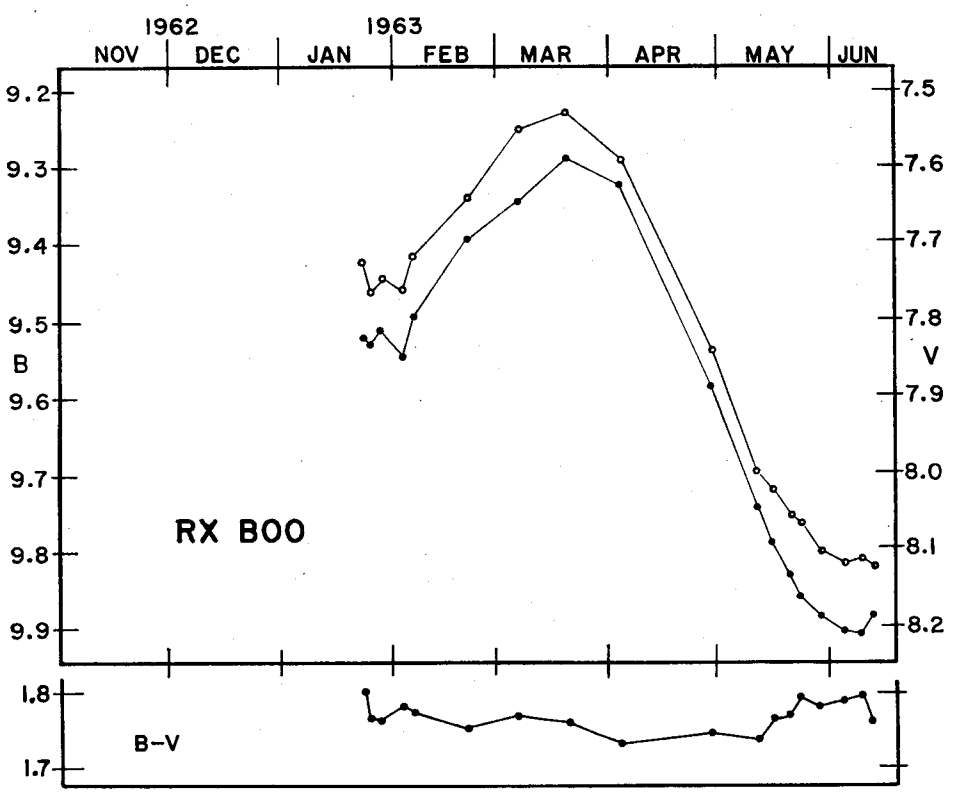


Fig. 1

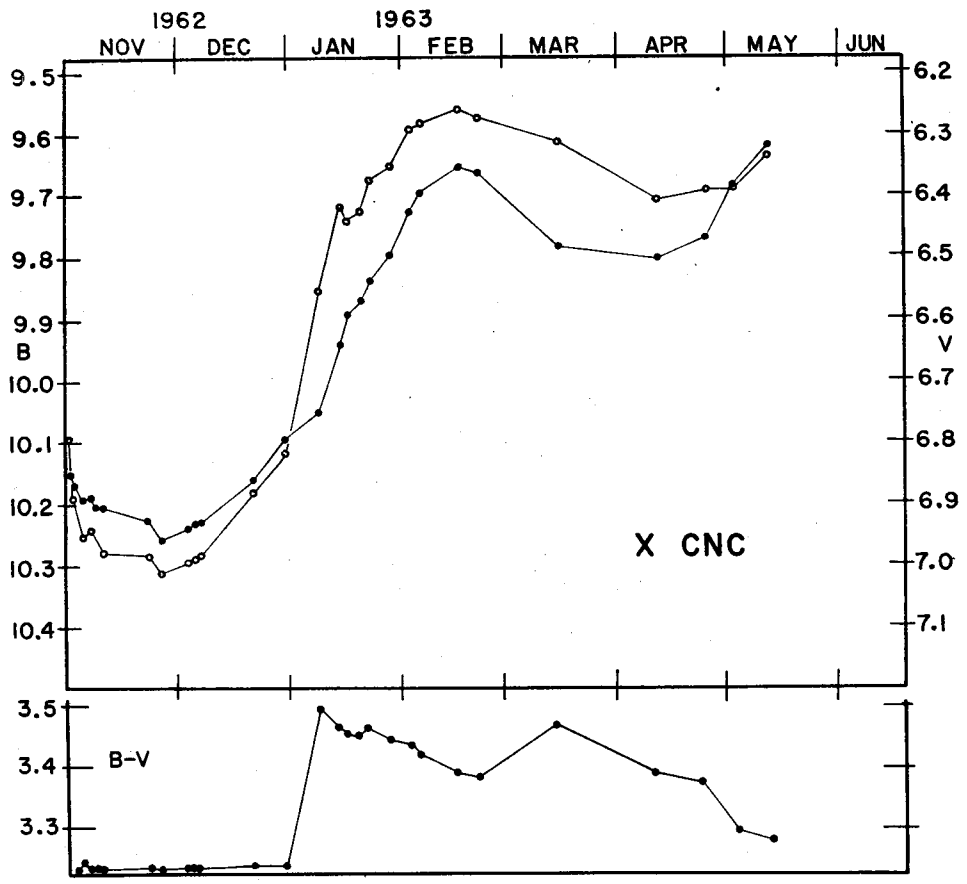

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
9.5
9.6
9.7
9.8
9.9
B
10.0
10.1
10.2
10.3
10.4
6.2
6.3
6.4
6.5
6.6
V
6.7
6.8
6.9
7.0
7.1
X CNC
3.5
3.4
3.3
B-V

Fig. 2

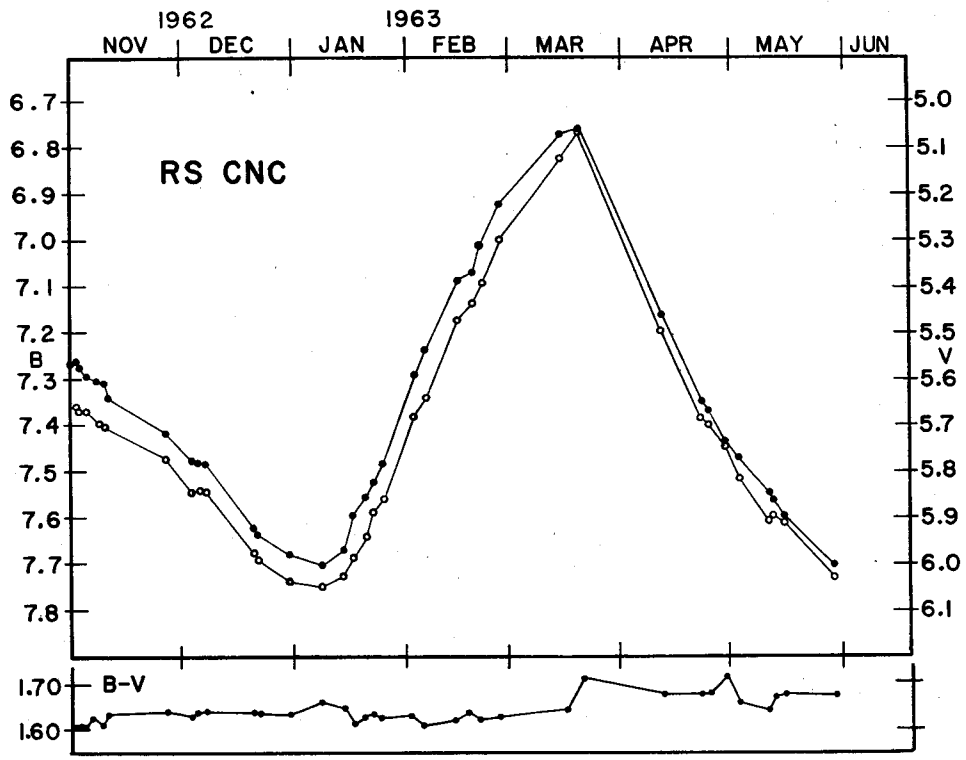

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
RS CNC
B
V
6.7
6.8
6.9
7.0
7.1
7.2
7.3
7.4
7.5
7.6
7.7
7.8
5.0
5.1
5.2
5.3
5.4
5.5
5.6
5.7
5.8
5.9
6.0
6.1
B-V
1.70
1.60

Fig. 3

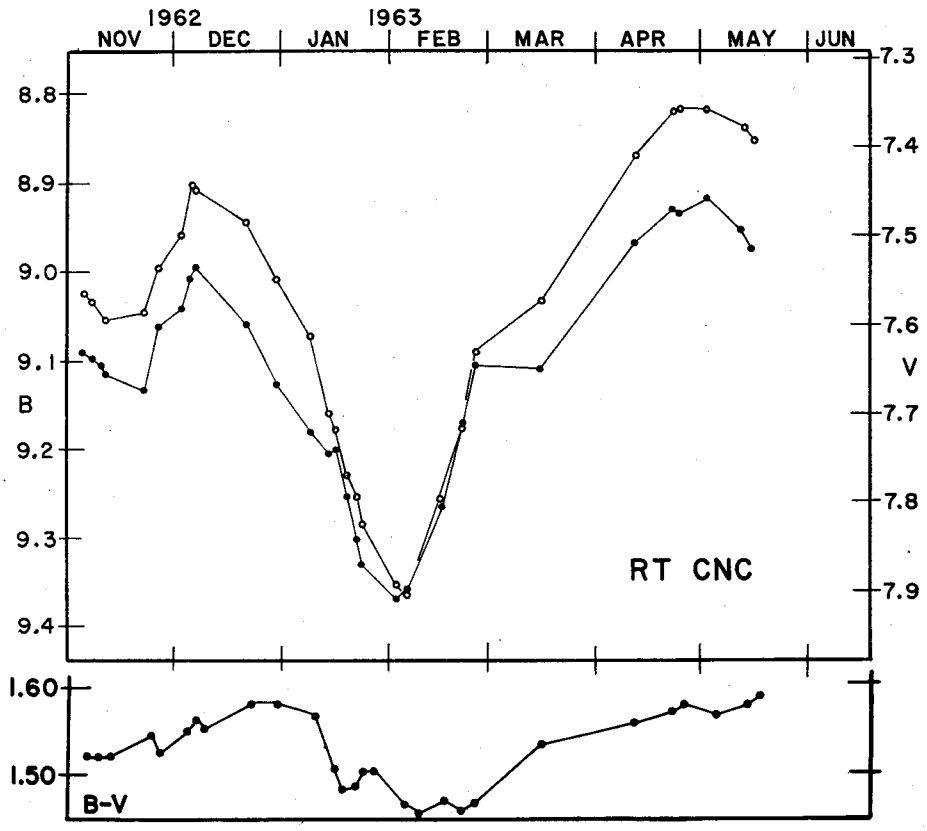

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
8.8
8.9
9.0
9.1
B
9.2
9.3
9.4
7.3
7.4
7.5
7.6
V
7.7
7.8
7.9
RT CNC
1.60
1.50
B-V

Fig. 4

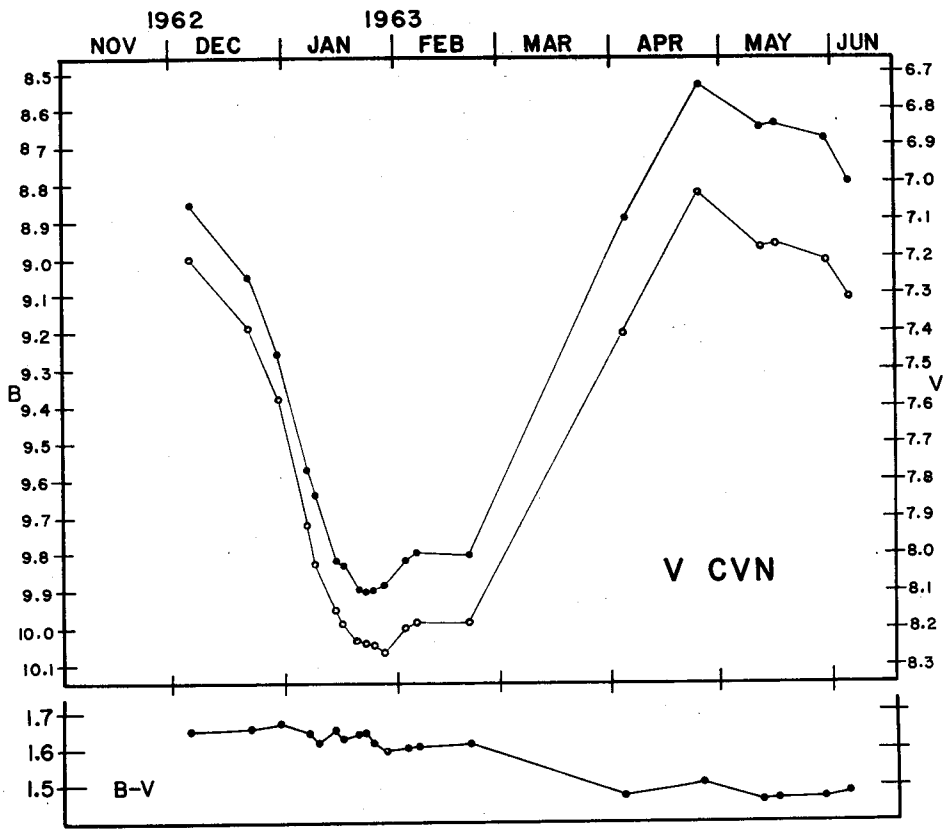


Fig. 5

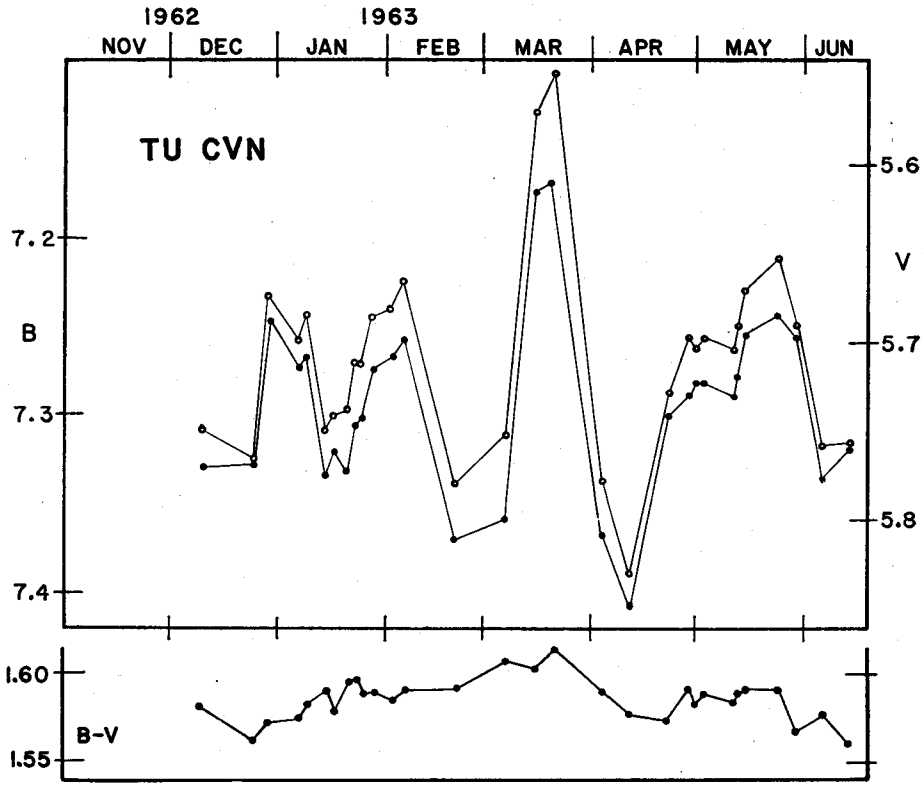
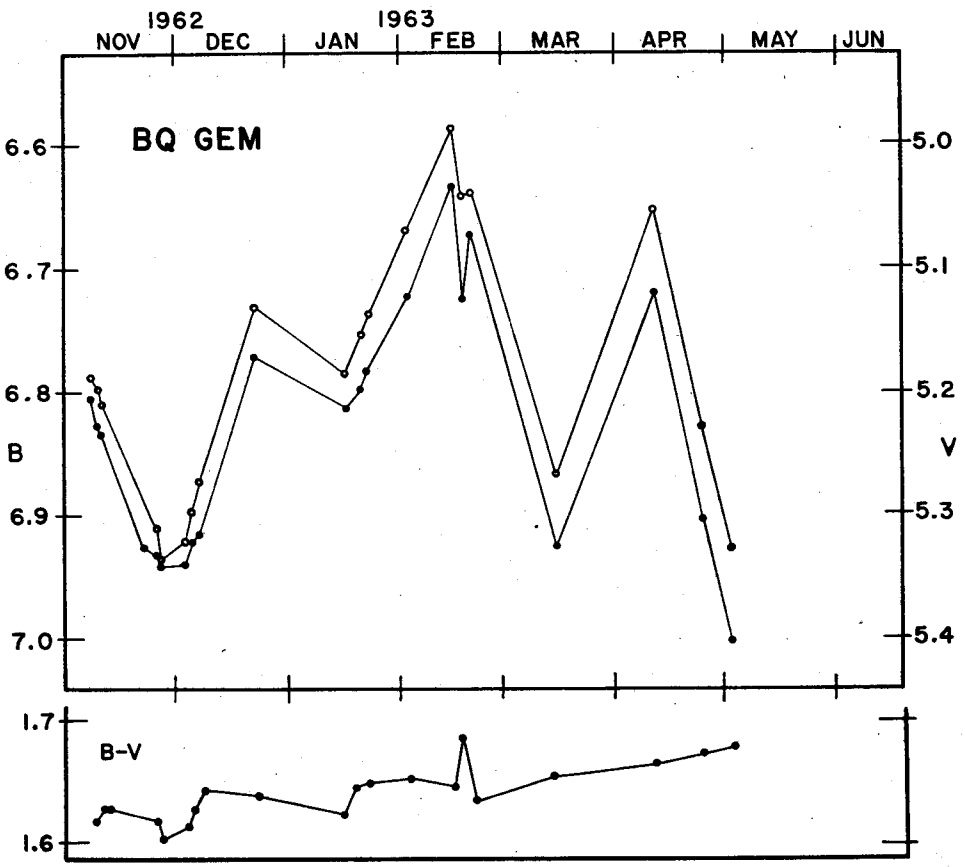

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
TU CVN
7.2
B
7.3
7.4
5.6
V
5.7
5.8
1.60
B-V
1.55

Fig. 6


1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
BQ GEM
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6.7
6.8
B
6.9
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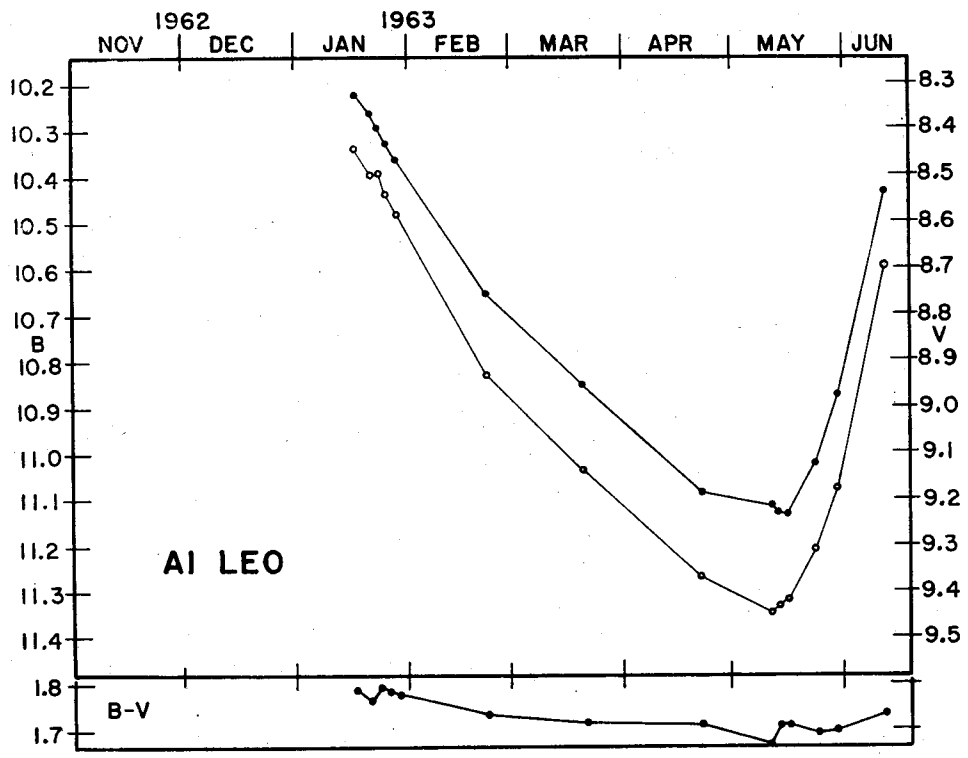
5.0
5.1
5.2
V
5.3
5.4
1.7
B-V
1.6

Fig. 7


1962
1963
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DEC
JAN
FEB
MAR
APR
MAY
JUN
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10.4
10.5
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B
10.8
10.9
11.0
11.1
11.2
11.3
11.4
8.3
8.4
8.5
8.6
8.7
8.8
V
8.9
9.0
9.1
9.2
9.3
9.4
9.5
AI LEO
1.8
1.7
B-V

Fig. 8

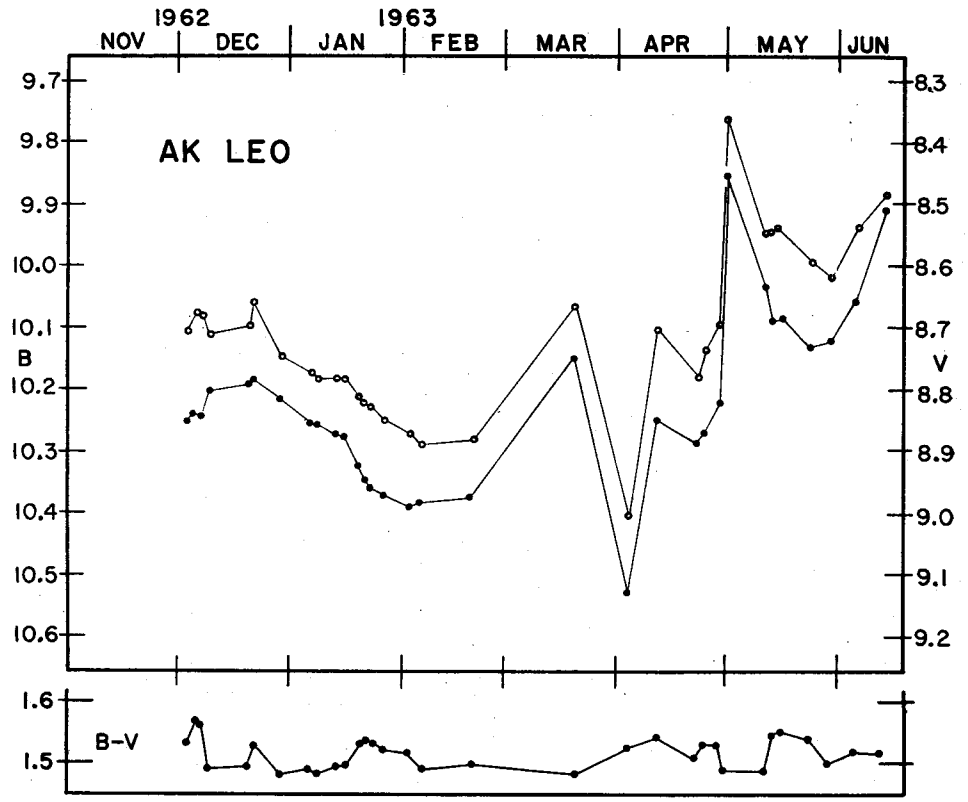

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
AK LEO
B
V
B-V
9.7
9.8
9.9
10.0
10.1
10.2
10.3
10.4
10.5
10.6
8.3
8.4
8.5
8.6
8.7
8.8
8.9
9.0
9.1
9.2
1.6
1.5

Fig. 9

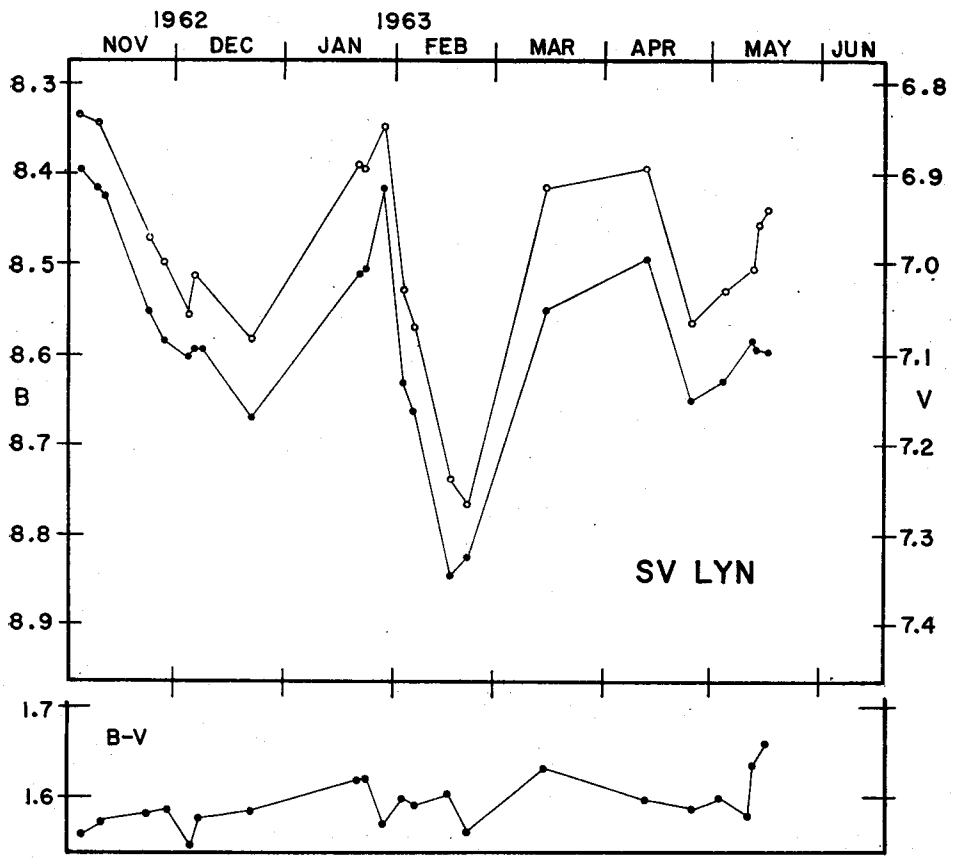

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
8.3
8.4
8.5
8.6
B
8.7
8.8
8.9
6.8
6.9
7.0
7.1
V
7.2
7.3
7.4
SV LYN
1.7
B-V
1.6

Fig. 10

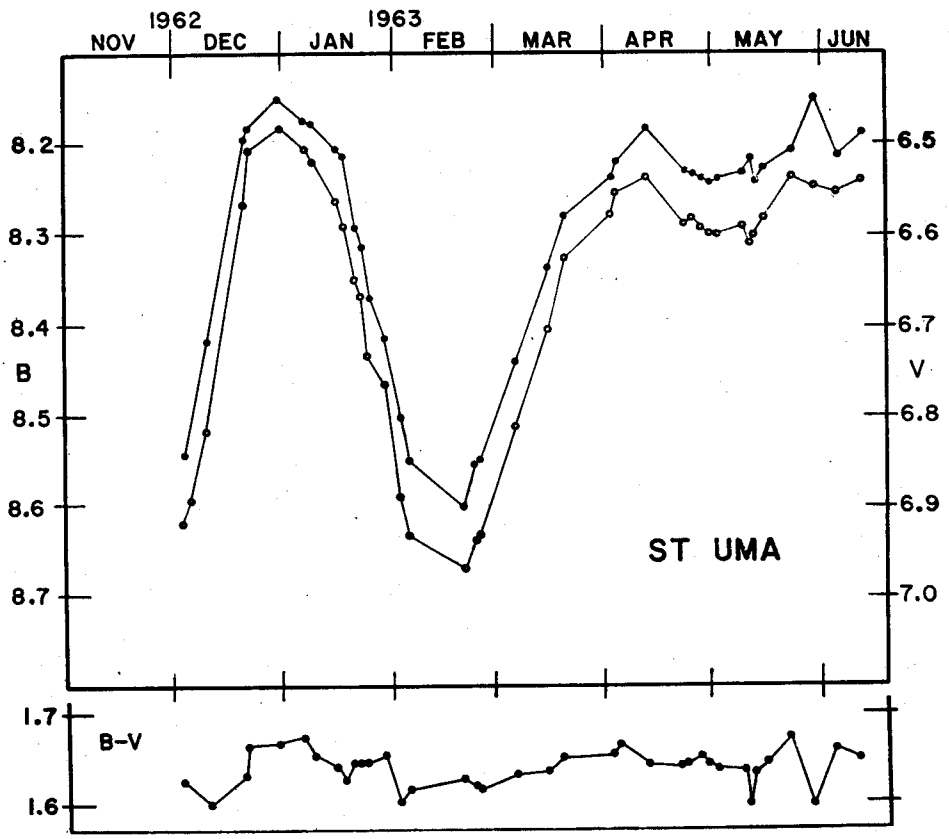

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
8.2
8.3
8.4
B
8.5
8.6
8.7
6.5
6.6
6.7
V
6.8
6.9
7.0
ST UMA
1.7
B-V
1.6

Fig. 11

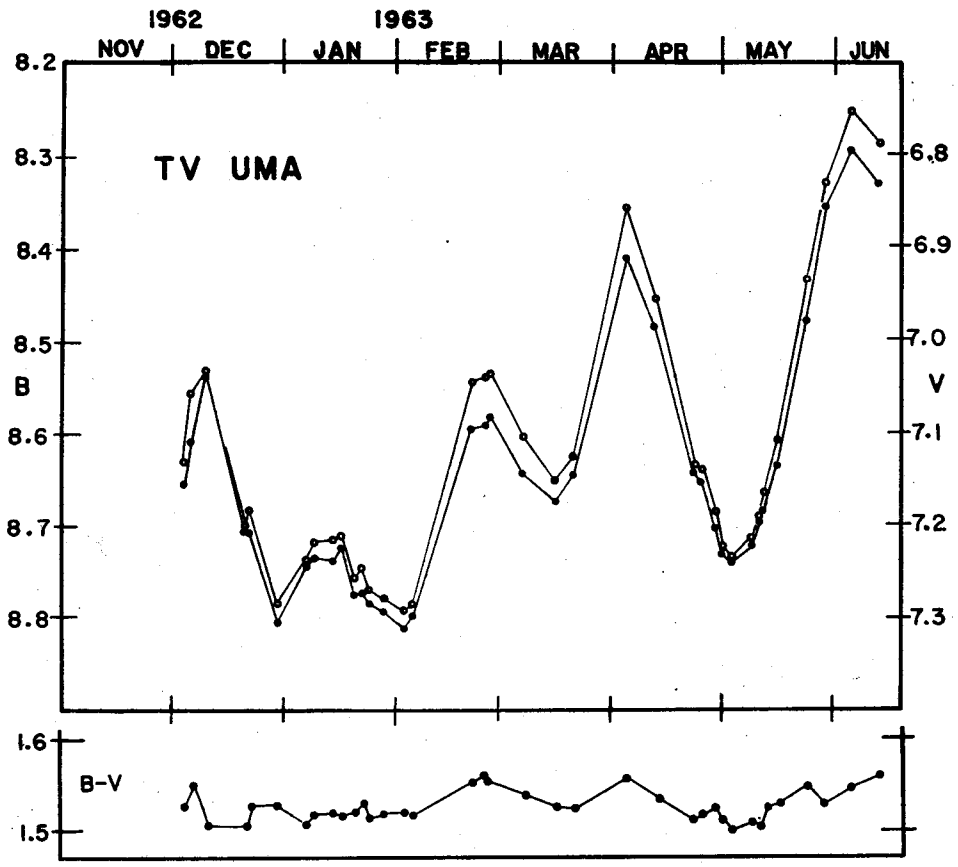
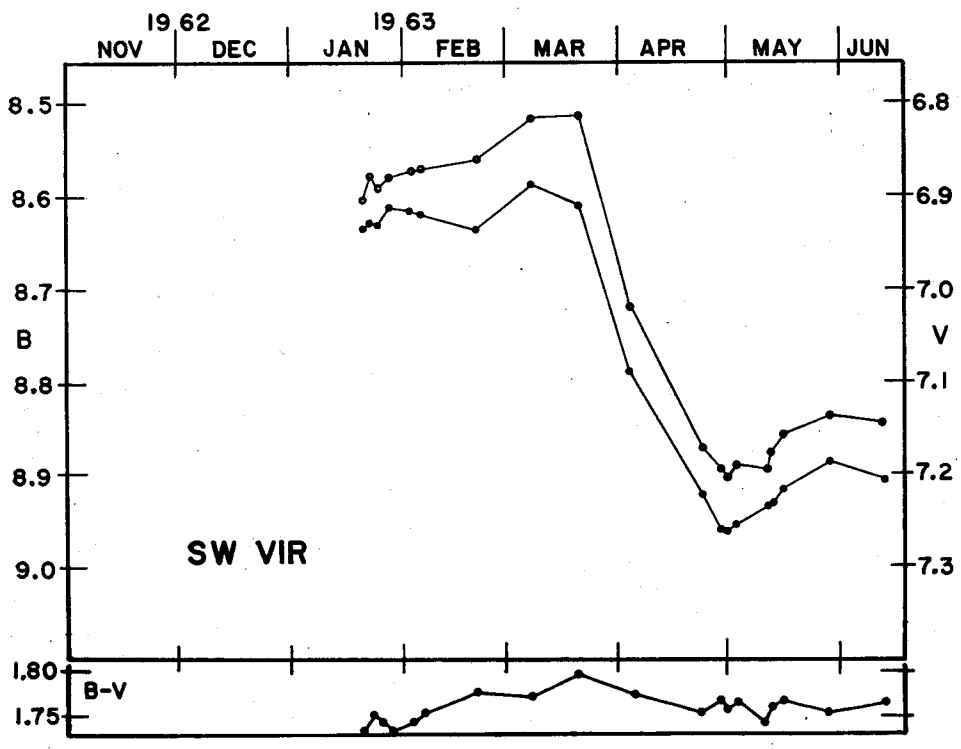

1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
TV UMA
8.2
8.3
8.4
8.5
B
8.6
8.7
8.8
6.8
6.9
7.0
V
7.1
7.2
7.3
1.6
B-V
1.5

Fig. 12


19 62
19 63
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
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8.6
8.7
B
8.8
8.9
9.0
6.8
6.9
7.0
V
7.1
7.2
7.3
SW VIR
1.80
1.75
B-V

Fig. 13

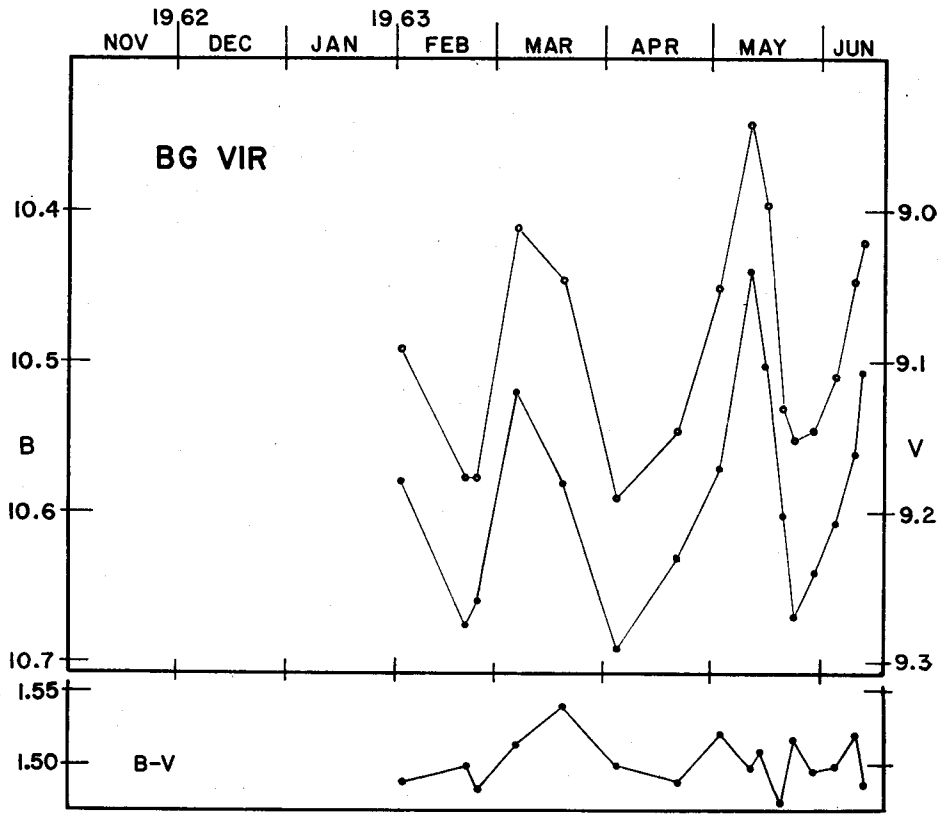
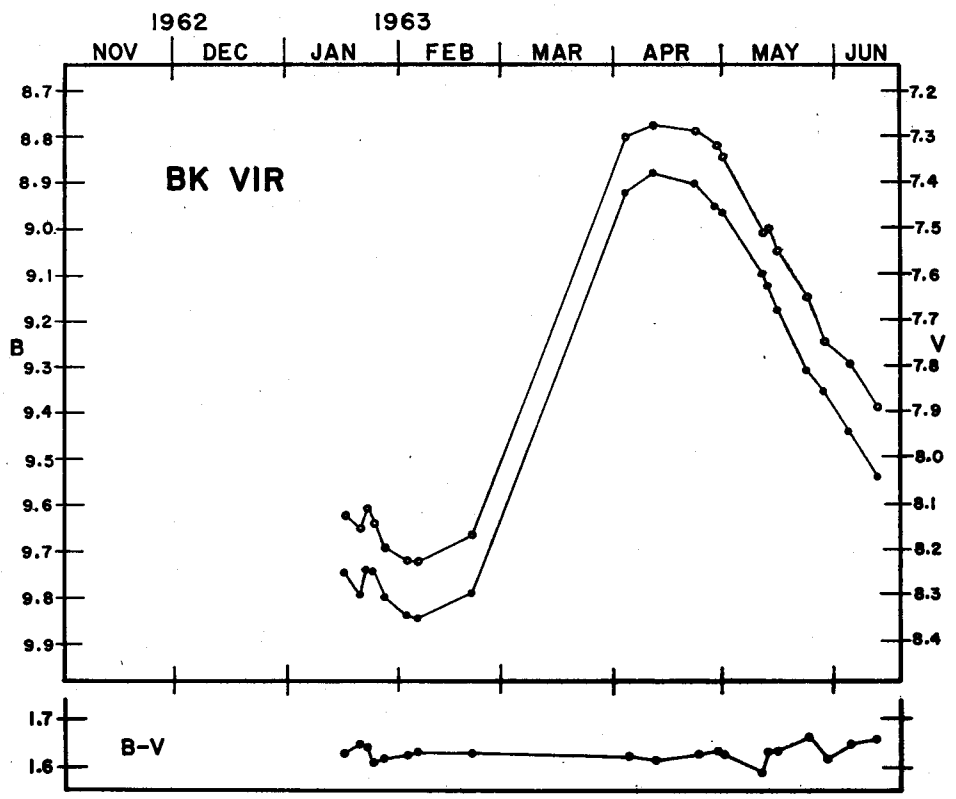

19,62
19,63
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
BG VIR
10.4
10.5
B
10.6
10.7
9.0
9.1
V
9.2
9.3
1.55
1.50
B-V

Fig. 14


1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
BK VIR
B
V
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8.9
9.0
9.1
9.2
9.3
9.4
9.5
9.6
9.7
9.8
9.9
7.2
7.3
7.4
7.5
7.6
7.7
7.8
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8.0
8.1
8.2
8.3
8.4
B-V
1.7
1.6

Fig. 15

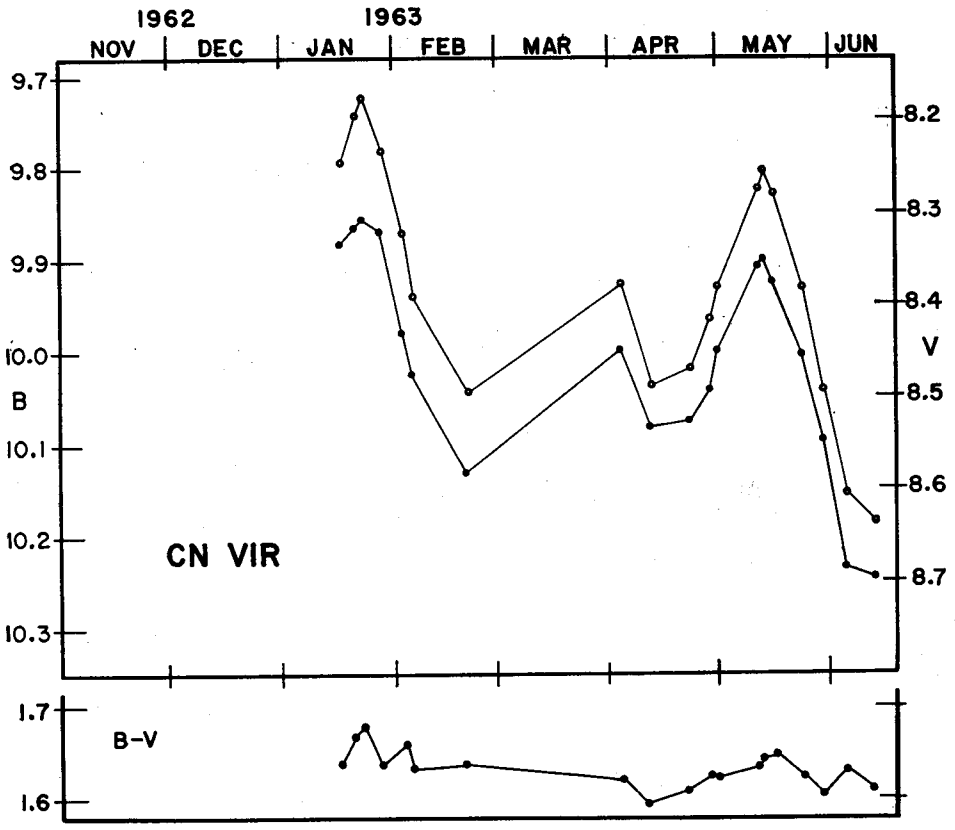
1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
9.7
9.8
9.9
10.0
B
10.1
10.2
10.3
8.2
8.3
8.4
V
8.5
8.6
8.7
CN VIR
1.7
B-V
1.6

Fig. 16

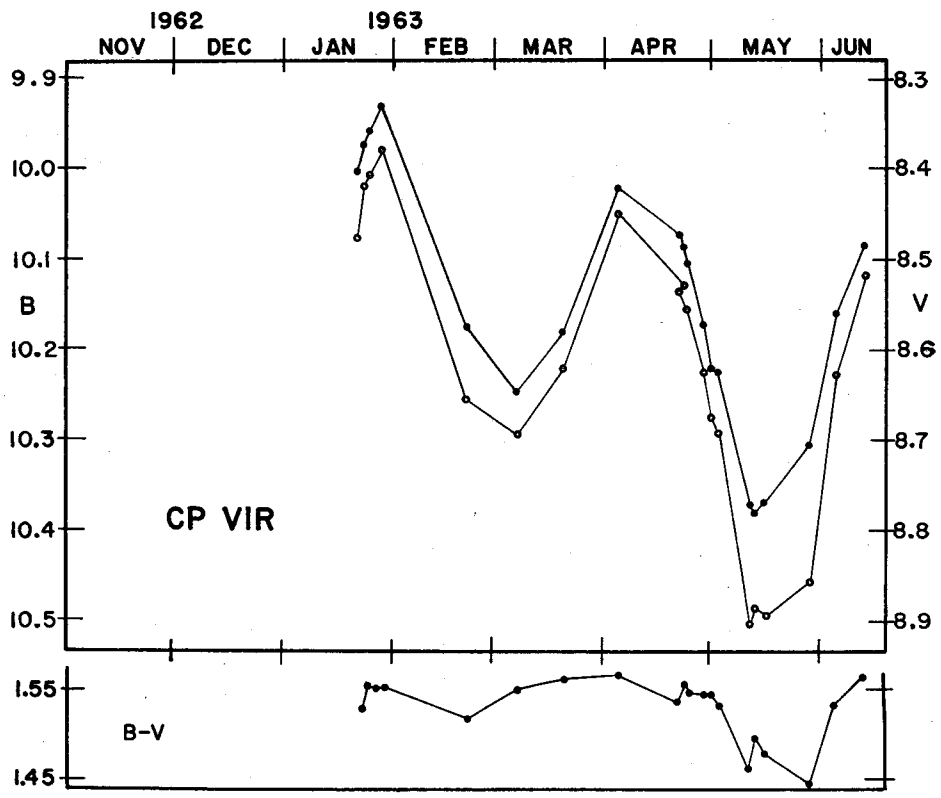
1962
1963
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
9.9
10.0
10.1
B
10.2
10.3
10.4
10.5
8.3
8.4
8.5
V
8.6
8.7
8.8
8.9
CP VIR
1.55
B-V
1.45

Fig. 17

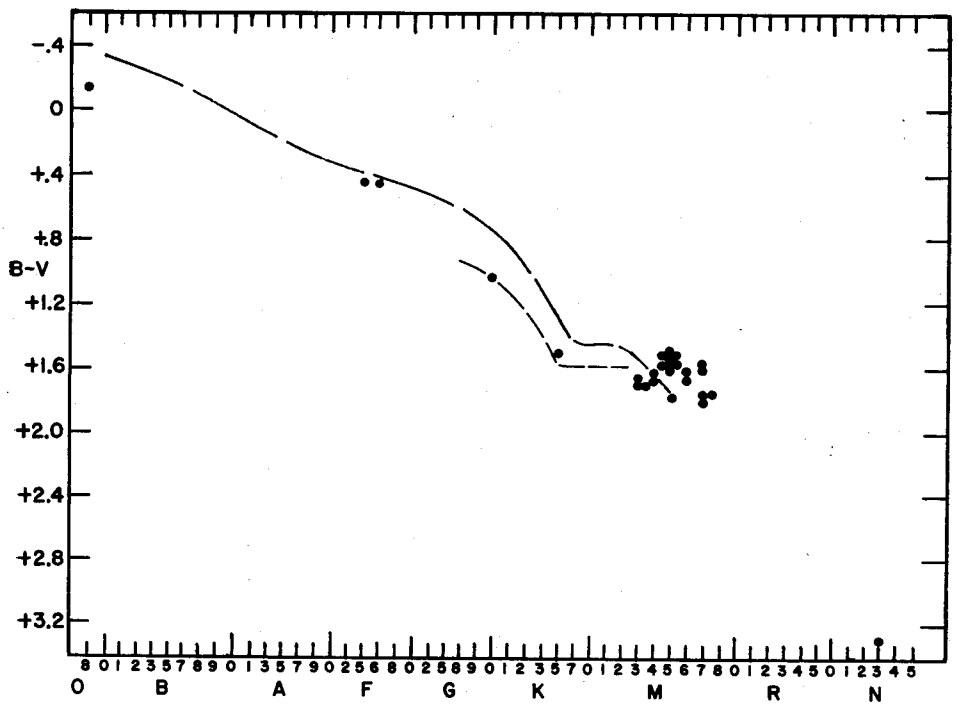

Fig. 18

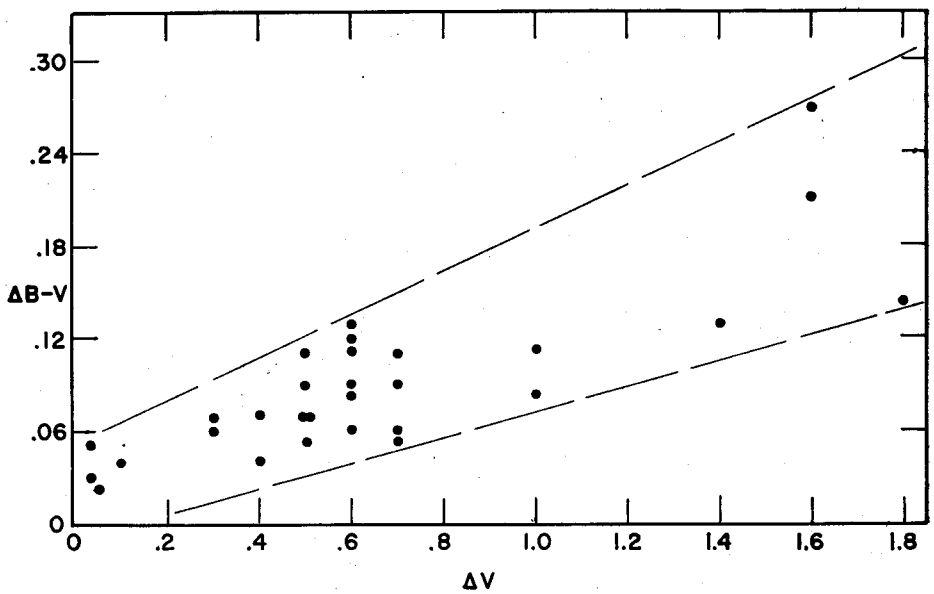

Fig. 19

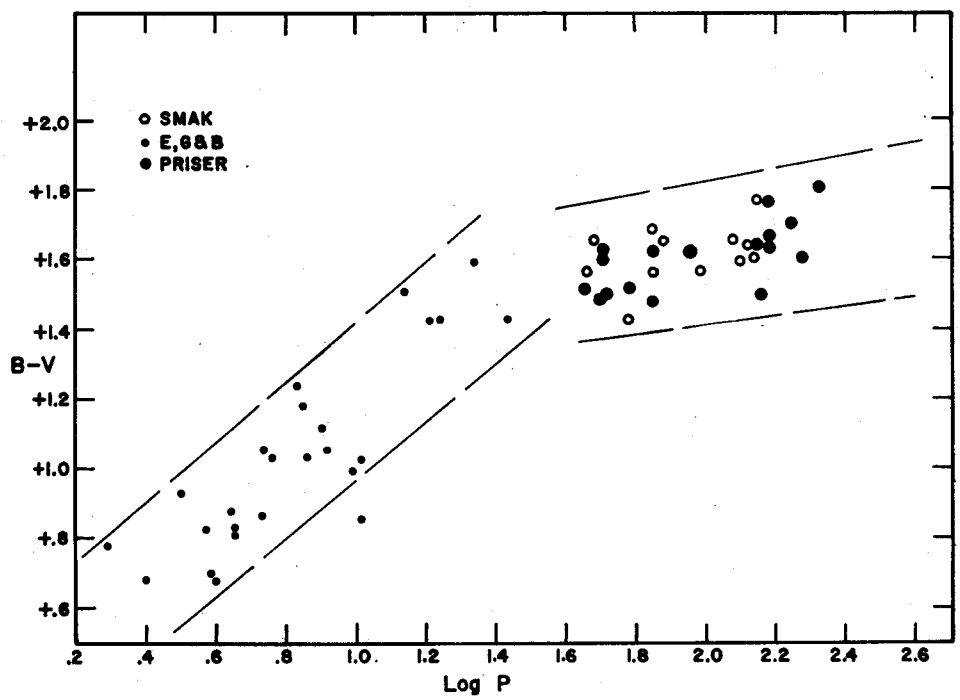

Fig. 20

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