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THE CLASSICAL CEPHEID PROGRAM
JD 2442000 - 2443000

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Abstract

AAVSO observations of the long period Cepheid variables RW Cas, VX Per, SZ Cas, RW Cam, SV Per, AN Aur, SY Aur, SV Mon, T Mon, ST Pup, ζ Gem, RU Cam, SS CMa, X Pup, AQ Pup, RS Pup, W Vir, AL Vir, RX Lib, Y Oph, RU Sct, Z Sct, SZ Aql, TT Aql, SV Vul, SZ Cyg, X Cyg, TX Cyg, Z Lac, and RY Cas have been compiled for the interval JD 2442000 - 2443000 (November 13, 1973 - August 9, 1976), and are presented as mean light curves, with accompanying comments. Also presented is a list of contributing observers and their observational totals.

* * * * *

This paper contains a compilation of data on 30 long period Cepheids in the AAVSO Cepheid observing program for the interval JD 2442000 - 2443000. Comments for this interval are included for selected Cepheids.

For information on the aims of the AAVSO Classical Cepheid Program, and for continuity of the data base, it is suggested that reference be made to Cragg (1972, 1975).

The elements for all the stars in this report are those given in the General Catalogue of Variable Stars (GCVS) (Kukarkin et al. 1969). Data for all of the stars except X Cyg have been reduced to daily means, phased plus and minus one period either side of maximum. Note that mean curves generally reduce the actually observed range of a star several tenths of a magnitude.

The amount of effort expended on some of the stars merits more than the casual summary given in this report. It is hoped that a more exhaustive analysis on these will be forthcoming. It is disappointing that NO photoelectric photometric data were available for any program stars during the included interval.

Table I is a summary of the observed data for the program stars. Those program stars not listed did not have enough observations accumulated to determine any of the table components to any reasonable degree of certainty. Table II is a list of observers and the number of observations each contributed.

In the body of the paper, information in the heading for each star includes the Harvard designation, star name, period in days, and type of Cepheid.

Mean light curves of the stars described below for the interval JD 2442000 - 2443000 appear in Figure 1.

INDIVIDUAL STARS

0130+57 RW Cas ($14^{d}.8$) $C\delta$

The 474 estimates were submitted for this star. The sudden rise just prior to maximum is reminiscent of the PEP curve of TT Aql of

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Landis (Cragg 1975). The resulting O-C is $+4\frac{1}{2}^d$ and the observed M-m is 6^d = 0.41P (.32P in GCVS). The mean (v) range is between magnitude 8.8 and 9.8.

0200+57 VX Per ($10^d.9$) Cδ

The light curve of 36 estimates is little more than a scatter diagram resembling a CW curve, whose maximum would generate an O-C of -3^d, and an M-m of $\sim 5^d$ = .46P (.47P in GCVS).

0219+59 SZ Cas ($13^d.6$) CW

The lack of scatter in the data to produce a good curve with such small amplitude is surprising indeed. There is some evidence of the shoulder on the descending branch. However, the minimum is unusually flat for a CW star. The observed (v) range of magnitude 9.15 - 9.5 is much smaller than what is considered a good program star, but if this kind of effort is put forth by the observers it is hard not to include it. The O-C (primary max) is $\sim +1\frac{1}{2}^d$, while the observed M-m (primary max to the preceeding min) is $\sim 5^d$ = 0.37P (.42P in GCVS).

0346+58 RW Cam ($16^d.4$) Cδ

Little reliable information can be derived from only 15 estimates, but if one grossly overinterprets the data, an O-C of essentially zero and an observed M-m of 6^d = 0.37P (.32P in GCVS), and a range between 8.1 and 9.0 magnitudes are obtained.

0442+42 SV Per ($11^d.1$) Cδ

The 42 estimates yield a fairly good curve with an O-C of $\sim\frac{1}{2}^d$ and an M-m of 4^d = 0.36P (.39P in GCVS). A rather clear pre-max at $-3\frac{1}{2}^d$ is indicated, which seems confirmed on the plus side, but such conclusions are usually premature with small data samples.

0452+40 AN Aur ($10^d.3$) Cep

The light curve of daily means of 31 estimates yields a mean (v) range between magnitudes 9.5 - 10.5, an O-C of $\sim -2^d$, and an M-m of $\sim 5^d$ = .49P (.46P in GCVS).

0454+39 RX Aur ($11^d.6$) Cδ

Insufficient data for meaningful commentary.

0505+42 SY Aur ($10^d.1$) Cδ

A rather symmetrical curve is generated by the 40 estimates submitted yields a mean (v) range between magnitudes 8.6 and 9.3, O-C of zero, and M-m of 5^d = 0.5P (.46P in GCVS).

0616+06 SV Mon ($15^d.2$) Cδ

The 147 estimates submitted yield a curve whose maximum indicates an O-C of $+1\frac{1}{2}^d$. Although reported as essentially zero in the previous reports (Cragg 1972, 1975), if the $-\frac{1}{2}^d$ point on the 1000-2000 interval data (Cragg 1975) were high, one could say the O-C was $\sim +\frac{1}{2}^d$. This value would be more in line with the current data set. A (v) range between magnitudes 8.0 and 8.9 is obtained from the mean curve, and the observed M-m is 6^d = 0.39P (.35P in GCVS).

0619+07 T Mon ($27^d.0$) Cδ

This excellent binocular cepheid continued as the second most popular star on the program, receiving 931 estimates. The mean curve is in substantial agreement with the last one (Cragg 1975) except that the minimum seems better defined. If minimum is taken as the lowest point, M-m = 10^d = 0.37P; if the mid-point between that and the start of the sudden rise, M-m = $7\frac{1}{2}^d$ = 0.28P (.29P in GCVS). The observed O-C is $+1\frac{1}{2}^d$.

0645-37 ST Pup ($18^d.9$) CW

The light curve of the daily means of 75 estimates results in a very poor curve. Evidence is that the period has changed or is changing sufficiently to create the scatter. Although very preliminary, minima are indicated at $-12\frac{1}{2}^d$, and $+6\frac{1}{2}^d$, while two maxima are indicated at $-6\frac{1}{2}^d$ and $-\frac{1}{2}^d$. The last O-C[2] of $\sim -3\frac{1}{2}^d$ to primary maximum to $-6\frac{1}{2}^d$ on this data set seems indicative of a real shift,

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indicating a shortening of the period by the order of $0^d.003$. M-m seems on the order of 5^d = 0.26P (.13P in GCVS).

0658+20 ζ Gem ($10^d.1$) Cδ

The 467 estimates submitted yield a light curve remarkably similar to the last report (Cragg 1975). Although the range is small, ζ Gem's being a naked eye object with good sequence makes it a good star to observe in the program. The data yield an O-C of essentially zero ($-\frac{1}{2}^d$), an M-m of 5^d = 0.50P (.50P in GCVS), and a mean range in (v) between magnitudes 3.6 and 4.1.

0710+69 RU Cam ($22^d.1$) CW

The estimates result in a very scattered mean light curve between magnitudes 8.6 and 8.8. Needs PEP data.

0722-25 SS CMa ($12^d.4$) Cδ

A good cepheid, on the VY CMa chart, which has been added to the program. Thirteen estimates by Cragg indicate (via an individual plot, not a mean plot) a range in (v) between magnitudes 10.3 and 11.4, an O-C of ∼-2.0, and an M-m of $\sim 5^d$ = 0.40P (.37P in GCVS).

0728-20a X Pup ($26^d.0$) Cδ

This excellent star for the program has still not received the attention it deserves. The very sharp rise in report 2 (Cragg 1975) is confirmed this time with an observed M-m of $\sim 4^d$ = 0.17P (.27P in GCVS) as is the O-C of $\sim +1^d$.

0743-25 AD Pup ($13^d.6$) Cδ

Not observed sufficiently to merit comment. A "b" chart now exists for AD Pup, containing a naked eye star, a UG star (BV Pup), and a Z Cam star (BX Pup).

0754-28 AQ Pup ($29^d.9$) Cδ

An excellent star observed only by C. P. Mahnkey. A plot of his data shows a (v) range between magnitudes 8.1 and 9.4, O-C of $\frac{1}{2}+3^d$, and an M-m of $\sim 4-5^d$ = 0.15P (.15P in GCVS). AQ Pup is one of the fastest rising stars in the program.

0809-34 RS Pup ($41^d.4$) Cδ

A plot of the daily means of the 76 estimates shows considerable scatter, but the maximum and minimum are reasonably well defined. They yield an O-C of almost zero and an M-m of $\sim 12^d$ = 0.29P (.24P in GCVS). The visual mean range in (v) is between magnitudes 6.0 and 8.0. Better coverage on RS Pup is strongly recommended as it has the second longest period of the cepheids in the program.

1320-02 W Vir ($17^d.3$) CW

The mean curve from 113 estimates is very similar to the last report (Cragg 1975). This data set yields an O-C from primary maximum of $+8^d$, an M-m of $\sim 7\frac{1}{2}^d$ = 0.43P (.47P in GCVS), and a visual mean range between magnitudes 9.5 and 10.5.

1405-12b AL Vir ($10^d.3$) CW

The 123 estimates yield a mean curve with a smaller magnitude than the last report (Cragg 1975). The mean curve indicates an O-C of essentially zero ($-\frac{1}{2}^d$), M-m of $\sim 4-5^d$ = 0.4 - 0.5P (.42P in GCVS), and a range of variation between magnitudes 9.1 and 9.6. The mean curve does not look like the characteristic W Vir curve.

1536-20b RX Lib ($24^d.9$) CW

Due to the special effort of R. Annal, a reasonable mean curve is available. It does indicate a definite W Vir characteristic with an M-m (primary maximum) of 7^d = 0.28P (.39P in GCVS), an O-C from primary to $\sim 6\frac{1}{2}^d$, and a (v) range between magnitudes 11.5 and 13.0. RX Lib is an excellent example of the class W Vir and should be perused more ardently than it is. See "d" chart for 1536-20a U Lib.

1747-06 Y Oph ($17^d.1$) Cep

Because of the effort by E. Oravec, a mean curve is possible for

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this star of small range. An O-C of about $+2\frac{1}{2}^d$, an M-m of $8^d = 0.47P$ (.40P in GCVS), and a range between magnitudes 5.9 and 6.6 are obtained.

1758-22 AV Sgr ($15^d\!.4$) Cδ

Insufficient data for a meaningful commentary.

1836-04a RU Sct ($19^d\!.7$) Cδ

A reasonably good mean curve is produced using the 51 estimates. A slightly larger range than in Cragg 1972 is found in this curve but that is expected, since this curve is a simple daily mean compared to a 4-day running mean last time (Cragg 1975). An O-C of $\sim+6^d$, an M-m of $\sim 8^d = 0.41P$ (.38P in GCVS), and a mean range of variation between magnitudes 8.9 and 9.9 are indicated.

1873-05 Z Sct ($12^d\!.9$) Cδ

The 180 estimates yield a mean light curve similar to the previous report (Cragg 1975). The resultant O-C of $+\frac{1}{2}^d = 0.43P$ (.39P in GCVS) and a (v) range of variation between magnitudes 9.2 and 10.0 are obtained.

1859+01 SZ Aql ($17^d\!.1$) Cδ

The difference between this mean curve and that published previously (Cragg 1975) is the much sharper rise. Some of this difference can be explained by the last curve's being a 3-day running mean and the current curve's being daily means. An O-C of $+1\frac{1}{2}^d$, an M-m of $5^d = 0.29P$ (.33P in GCVS), and a mean range of variation between magnitudes 8.4 and 9.6 are obtained from this data set.

1903+01 TT Aql ($13^d\!.8$) Cδ

The resulting mean curve from the 386 estimates is almost a carbon copy of the visual curve determined in the last report (Cragg 1975). The very sharp rise indicated by the PEP data continues to be unconfirmed by the visual data. The averaging technique used in the reduction of the visual data can smooth such a sudden rise considerably, but hardly to the extent indicated in the last report. The current data set indicates an O-C of $+\frac{1}{2}^d$, an M-m of $5\frac{1}{2}^d = 0.40P$ (.34P in GCVS), and a mean range of variation between magnitudes 7.0 and 7.8.

1947+27 SV Vul ($45^d\!.0$) Cδ

The mean curve resulting from 776 estimates shows an O-C of zero, an M-m of $\sim 12^d = 0.27P$ (.19P in GCVS), and a mean range of variation between magnitudes 6.9 and 8.0. Slight irregularities about 7 days past maximum on the mean curve are conceivably a residual of whatever caused the second peak in the first report (Cragg 1972).

2008-14 TW Cap ($28^d\!.6$) CW

Insufficient data for a meaningful commentary.

2029+46 SZ Cyg ($15^d\!.1$) Cδ

Although SZ Cyg is distant from a sequence, the 125 estimates considered define a fair mean cure from which an O-C of $\sim+1^d$, an M-m of $6^d = 0.40P$ (.38P in GCVS), and a mean range of variation between magnitudes 9.0 and 9.8 can be derived. The previous report (Cragg 1975) indicated a significantly larger range (1.4 magnitude in (v)) but was based largely on one observer's data. The inherent k-factor differences work normally towards lessening the mean range.

2039+35 X Cyg ($16^d\!.4$) Cδ

X Cyg is by far the most popular star in the program, having received nearly 2000 estimates! Such coverage deserves much more attention than the casual treatment here. A subsequent more exhaustive analysis of those stars well-observed is planned. A half-day mean curve was derived which shows the premaximum centered on $-3\frac{1}{2}^d$ and $+13^d$ even better than before. The statistical information derived is O-C = zero, M-m = $6^d = 0.37P$ (.35 in GCVS), and a mean (v) range of variation between magnitudes 6.0 and 7.0.

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2042+44b BZ Cyg ($10^d.1$) Cδ

Insufficient data for a meaningful commentary.

2056+42 TX Cyg ($14^d.7$) Cδ

The light curve derived from 25 estimates received from S. O'Connor indicates an O-C of ∿+1^d, an M-m of ∿7^d = 0.48P (.32 in *GCVS*), and a mean range of variation between magnitudes 9.2 and 10.4.

2236+56 Z Lac ($10^d.9$) Cδ

The 60 estimates combined into a mean curve yield an O-C of zero, an M-m of 5^d = 0.46P (.40P in *GCVS*), and a (v) range of variation between magnitudes 8.0 and 9.2).

2347+58 RY Cas ($12^d.1$) Cδ

The 130 estimates considered for this star yield a fairly good mean curve with an O-C of ∿+$1\frac{1}{2}^d$, an M-m of ∿5^d = 0.41P (.38P in *GCVS*), and a mean range of variation between 9.3 and 10.2.

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TABLE I

Summary of Observational Data

Design.	Star	O-C 1	O-C 2	O-C 3	Mean Date (3)	Number of Estimates	Observed M-m in (P) 1	Observed M-m in (P) 2	Observed M-m in (P) 3	Observed M-m in (P) GCVS	P (days)
0130+57	RW Cas	-	-	+4½	2442500	474	-	-	0.41	0.32	14.5
0200+57	VX Per	-	-	-3	2442500	36	-	-	0.46	0.47	10.9
0219+57	SZ Cas	+5	+2	+1½	2442500	276	-	∼0.5	0.37	0.42	13.6
0346+58	RW Cam	-	-	0	2442400	15	-	-	0.37	0.32	16.4
0442+42	SV Per	-	-	∼+½	2442400	42	-	-	0.36	0.39	11.1
0452+40	AN Aur	-	-	-2	2442400	31	-	-	0.49	0.46	10.3
0505+42	SY Aur	-	-	0	2442400	40	-	-	0.5	0.46	10.1
0616+06	SV Mon	0	0	+½	2442350	147	0.5	0.33	0.39	0.35	15.2
0619+07	T Mon	+2½	+1	+1½	2442500	931	-	0.33	0.28	0.29	27.0
0645-37	ST Pup	-	-3½	-6½	2442400	75	-	0.29	0.26	0.13	18.9
0658+20	ζ Gem	1	0	-½	2442500	467	0.44	0.55	0.50	0.5	10.2
0710+69	RU Cam	-	∼-10	-	2442500	337	-	0.23	-	-	22.1
0722-25	SS CMa	-	-	-2	2442600	13	-	-	0.40	0.37	12.4
0728-20a	X Pup	-	0	+1	2442400	105	-	0.18	0.17	0.27	26.0
0754-28	AQ Pup	-	-	+3	2442470	14	-	-	0.15	0.15	29.9
0809-34	RS Pup	-	0	0	2442350	76	-	0.26	0.29	0.24	41.4
1320-02	W Vir	+6½	+7	+8	2442500	113	-	0.40	0.43	0.47	17.3
1405-12b	AL Vir	0	0	0	2442500	123	-	0.5	0.45	0.42	10.3
1536-20b	RX Lib	-	-	6½	2442600	65	-	-	0.28	0.39	24.9
1747-06	Y Oph	-	+1	+2½	2442500	131	-	-	0.47	0.40	17.1
1836-04a	RU Sct	+5	+5	+6	2442400	51	-	0.3	0.41	0.38	19.7
1837-05	Z Sct	-5½	0	+½	2442500	180	0.3	0.39	0.43	0.39	12.9
1859+01	SZ Aql	+½	+3	+1½	2442500	239	0.3	0.41	0.29	0.33	17.1
1903+01	TT Aql	-2½	0	+½	2442500	386	0.3	0.36	0.40	0.34	13.9
1947+27	SV Vul	(-3 / +5)	-1	0	2442500	776	?	0.20	0.27	0.19	45.0
2029+46	SZ Cyg	-	0	+1	2442350	125	-	0.33	0.40	0.38	15.1
2039+35	X Cyg	0	0	0	2442500	1999	0.4	0.40	0.37	0.35	16.4
2056+42	TX Cyg	-	-	+1	2442250	25	-	-	0.48	0.32	14.7
2236+50	Z Lac	-	-	0	2442350	60	-	-	0.46	0.40	10.9
2347+58	RY Cas	-	-	+1½	2442500	130	-	-	0.41	0.38	12.1

'ES: 1. Columns 1, 2, and 3, under "O-C" and "Observed M-m" refer to Reports 1 (Cragg 1972), 2 (Cragg 1975), and 3 (this publication), respectively.

2. The mean date would be JD 2442500 for a star observed equally throughout the 1000-day interval. Those which were covered for only part of the time or for which the data were grossly asymmetrically distributed will have a mean date reflecting this problem.

3. 0346+58 RW Cam, 0442+42 SV Per, 0452+40 AN Aur, and 0505+42 SY Aur were observed for an 80-day interval only, around the indicated date.

4. 0754-28 AQ Pup was observed for 30 days only, centered on the given date.

5. The O-C for Z Sct in Report 1 (Cragg 1972) is almost certainly in error, as a preliminary run prior to that time had an O-C of essentially zero.

6. The dual O-C for SV Vul in Report 1 (Cragg 1972) reflects the double maximum in that Report.

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TABLE II

Contributing Observers and Observation Totals

AD	R. M. Adams	2
ANJ	J. Andette	4
ANN	R. J. Annal	151
ARI	R. B. Ariail	79
BM	M. E. Baldwin	320
BAU	J. Bauer	13
BBA	B. B. Beaman	1
BET	C. D. Bertwell	34
BLU	B. Blundell	1
BOH	D. Böhme	46
BOI	B. Bois	22
BRJ	J. E. Bortle	90
BLP	P. Brlas	1
BRT	T. Brown	6
BUW	R. Buhrow	1
CHP	D. P. Christensen	4
CST	G. J. Christensen	138
COL	P. L. Collins	1
CR	T. A. Cragg	295
DEA	R. DeMartino	2
FD	C. B. Ford	3
FT	G. L. Fortier	2
GER	R. Geszler	4
GLF	F. R. Glenn	49
GLW	W. H. Glenn	47
GOP	P. N. Goodwin	49
GAS	E. R. Grasshoff	33
GRW	D. W. E. Green	3
GRI	J. W. Griese III	1
HK	E. A. Halbach	10
HMR	R. Ham	220
HRR	P. Harrington	15
HAY	E. R. Hayden	27
HZL	L. Hazel	12
HGA	A. Hedge	2
HEV	Z. Hevesi	1
HE	F. L. Hiett	63
HOP	U. Hopp	411
HOU	D. Hough	7
HR	C. Hurless	4
JOG	G. E. Johnson	2
JRD	D. Jordahl	8
KLY	G. W. Kelley, Jr.	23
KIM	M. Kiehl	239
KLK	K. Klebert	1
KRS	R. S. Kolman	4
KIS	G. Krisch	1
LOT	H. Louth	6
LX	W. M. Lowder	317
LKS	R. Lukas	21
MDD	P. J. Madden	241
MAN	C. P. Mahnkey	583
MYR	E. H. Mayer	22
MCB	R. McCallum	41
MCT	A. McCright	1
MCI	B. J. McInnerny	1
MEN	P. T. Menoher	11
MRO	P. D. Morrison	38
MRD	J. Muirden	15
MUR	P. A. Murn	5
MYE	K. J. Myers	8
OCN	S. D. O'Connor	375
OME	S. O'Meara	1
OV	E. G. Oravec	794
PFF	G. Pfeiffer	102
PRO	D. J. Prososki	3
RSS	S. T. Roess	1
ROJ	J. M. Roney	8
SNL	J. G. Sandell	188
SCC	J. D. Scarl	2
SMJ	J. F. Scholl	14
SCE	C. E. Scovil	104
SHS	S. B. Sharpe	80
SKL	K. Simmons	2
SLB	B. F. Small	105
SJ	J. R. Smith	4
STL	M. B. Smith	6
STU	W. E. Staruk, Jr.	3
STI	P. C. Steffey	7
STQ	N. Stoikidis	33
STO	P. M. Stone	1
SUR	U. Surawski	364
SVN	P. L. Sventek	22
SWO	A. Swoboda	1
SZN	P. Szente	1
SZC	B. Szentmartoni	35
TLA	M. D. Taylor	3
THM	J. V. Thomas	5
TMR	R. Thomas	2
THS	R. S. Thompson	23
TFN	F. N. Traynor	1
TRR	D. Trommer	13
TYS	R. L. Tyson	65
VIS	G. Visocki	5
WSW	W. S. Walker	1
WER	R. J. Weber	612
WEL	D. L. Welch	16
WLM	T. R. Williams	13
WJA	J. A. Wilson	15
WSN	T. W. Wilson	733
WNB	B. Wingate	19
WOO	M. Woolbright	1
ZAF	J. Zaffi	1

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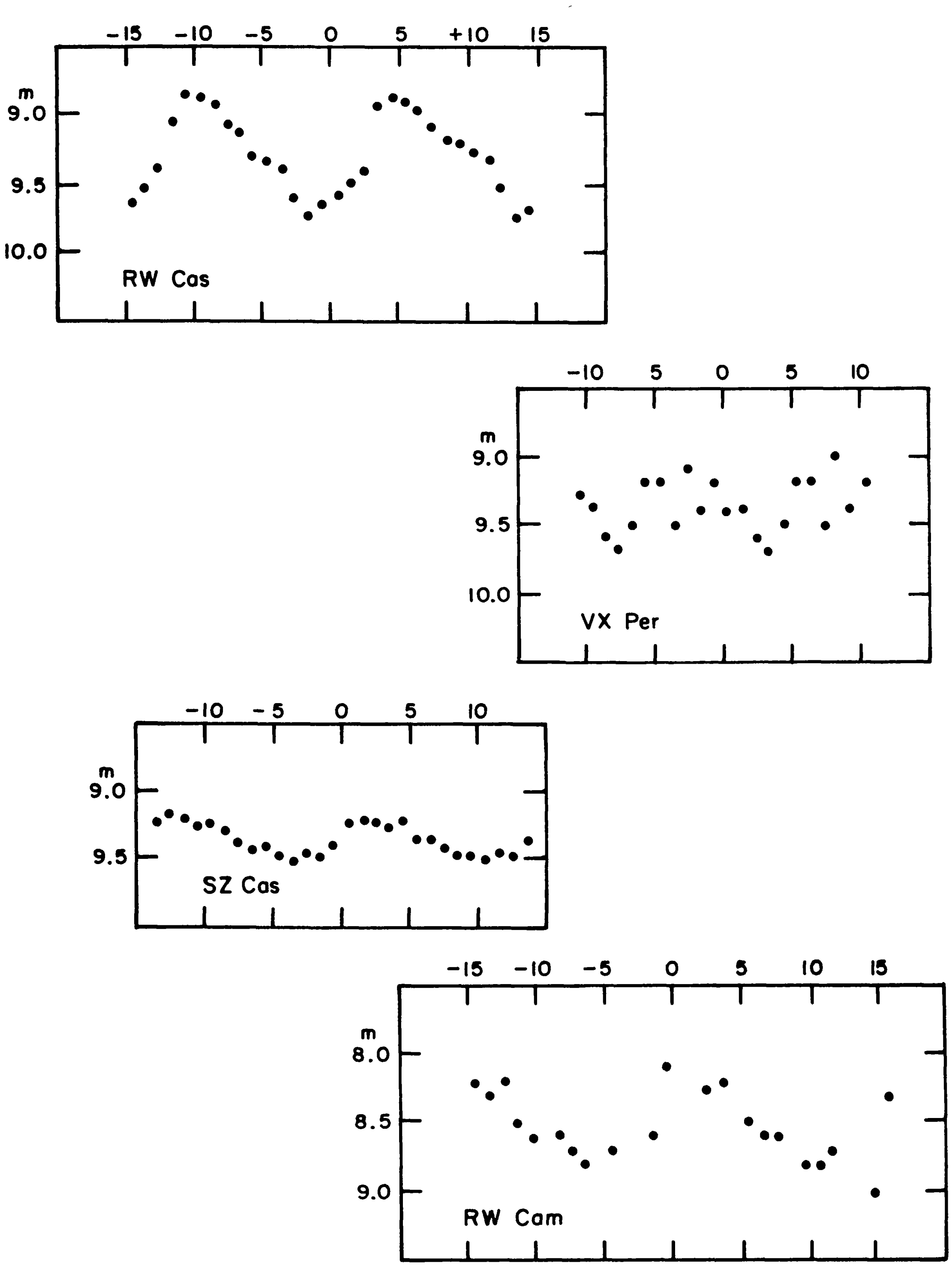

Figure 1. Mean light curves of the long period Cepheids RW Cas, VX Per, SZ Cas, RW Cam, SV Per, AN Aur, SY Aur, SV Mon, T Mon, ST Pup, ζ Gem, RU Cam, SS CMa, X Pup, AQ Pup, RS Pup, W Vir, AL Vir, RX Lib, Y Oph, RU Sct, Z Sct, SZ Aql, TT Aql, SV Vul, SZ Cyg, X Cyg, TX Cyg, Z Lac, and RY Cas. Curves are phased plus and minus one period either side of maximum and cover the interval JD 2442000 - 2443000.

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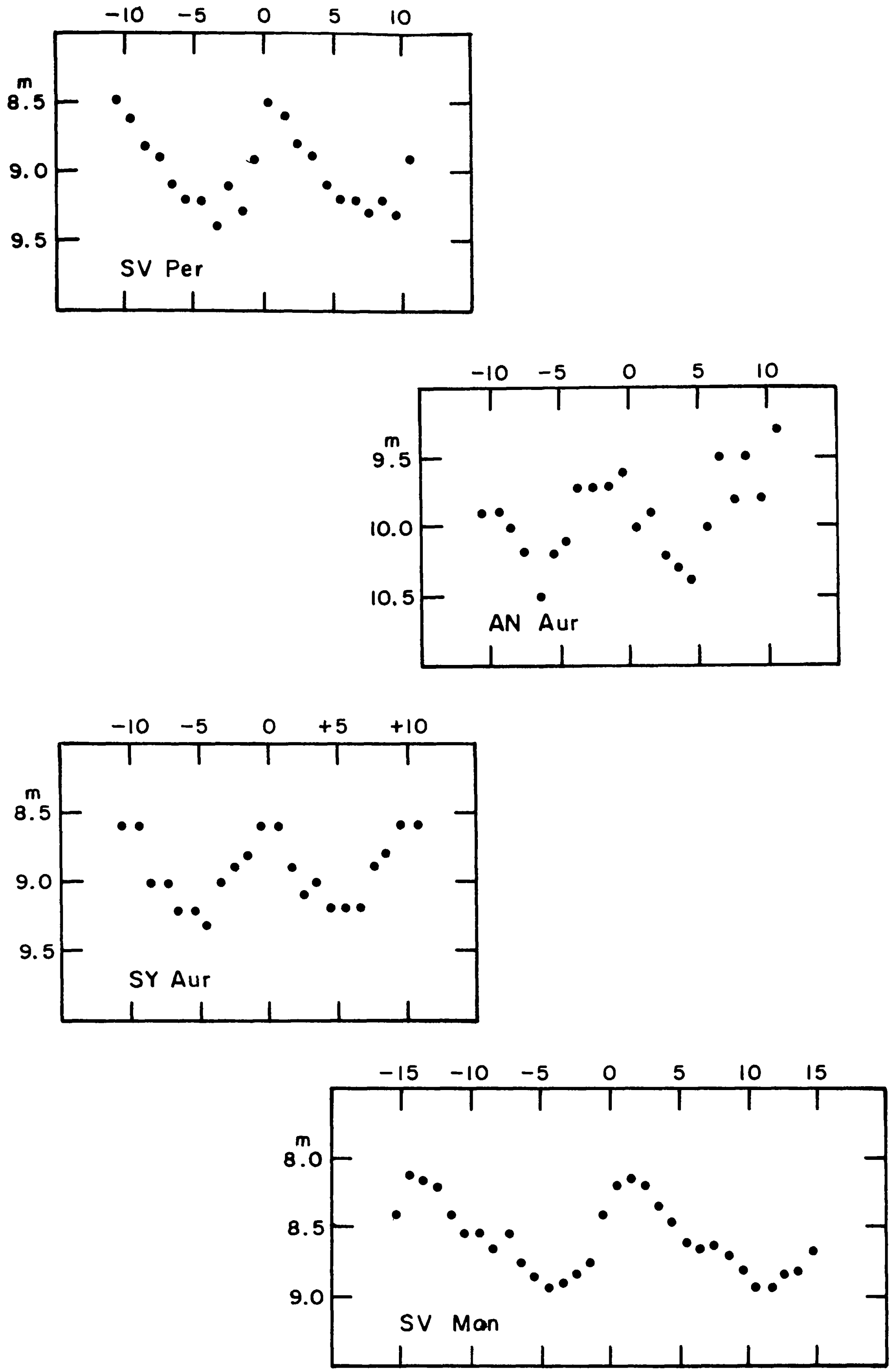

Figure 1 (cont'd).

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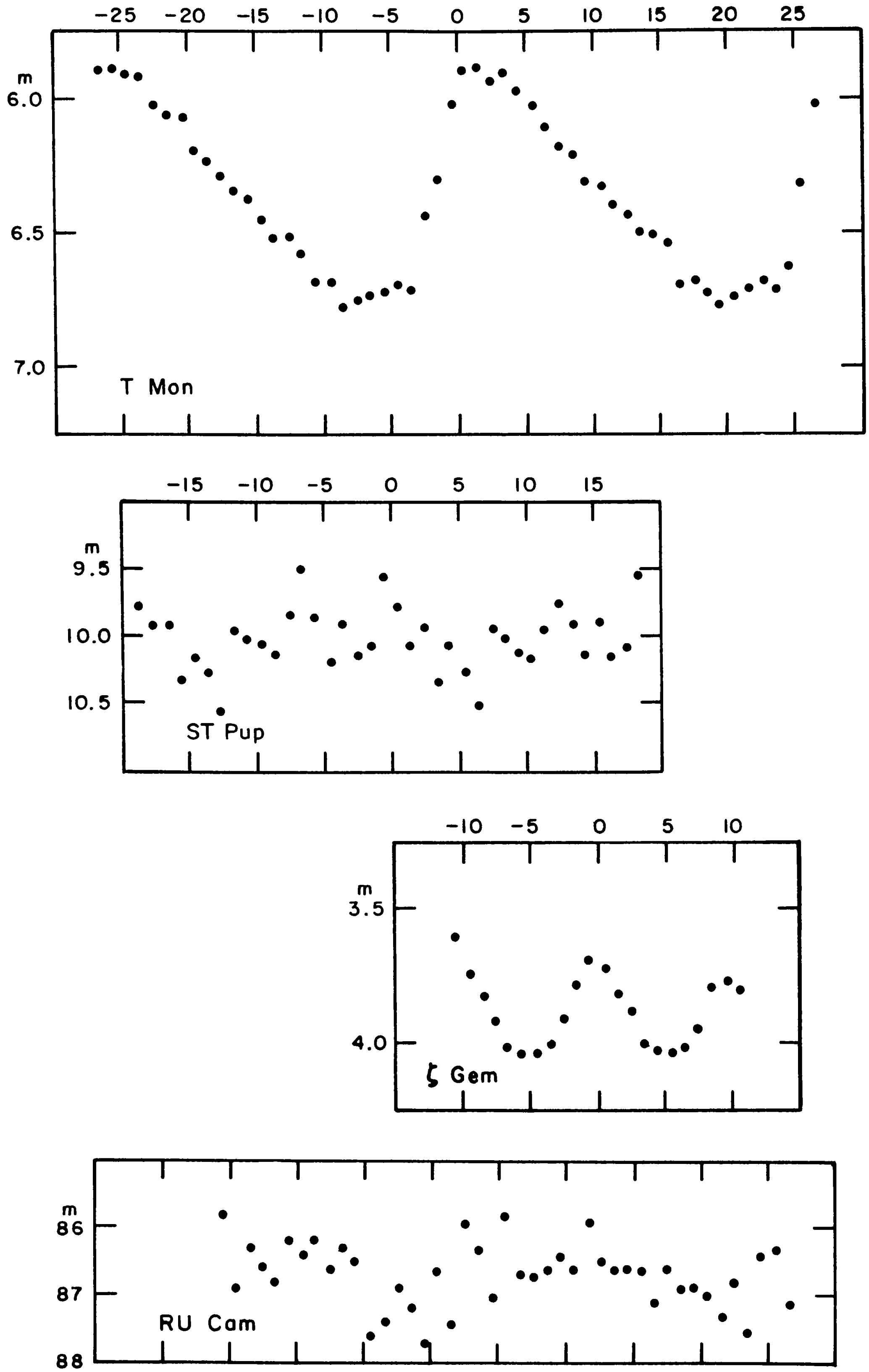

Figure 1 (cont'd).

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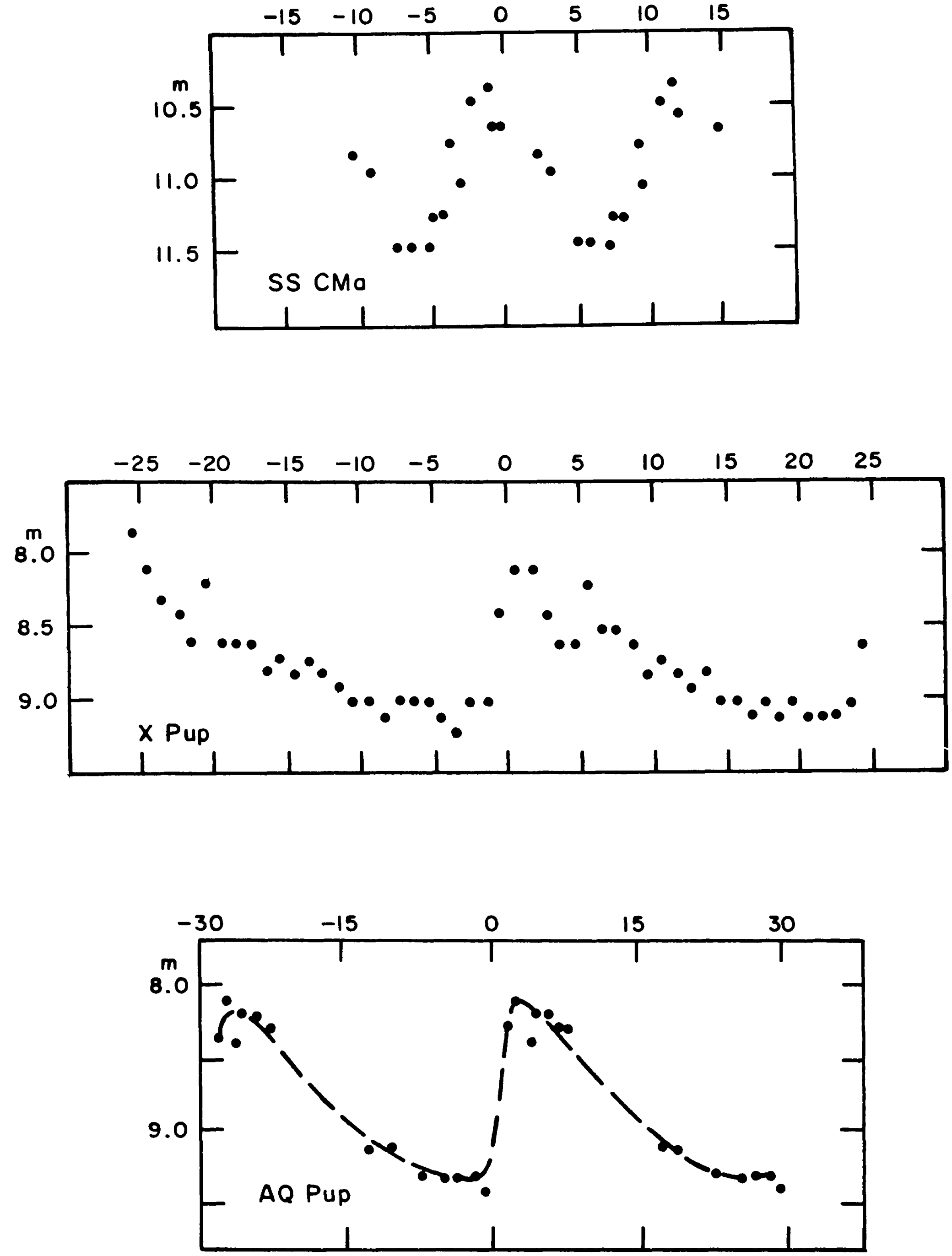

Figure 1 (cont'd).

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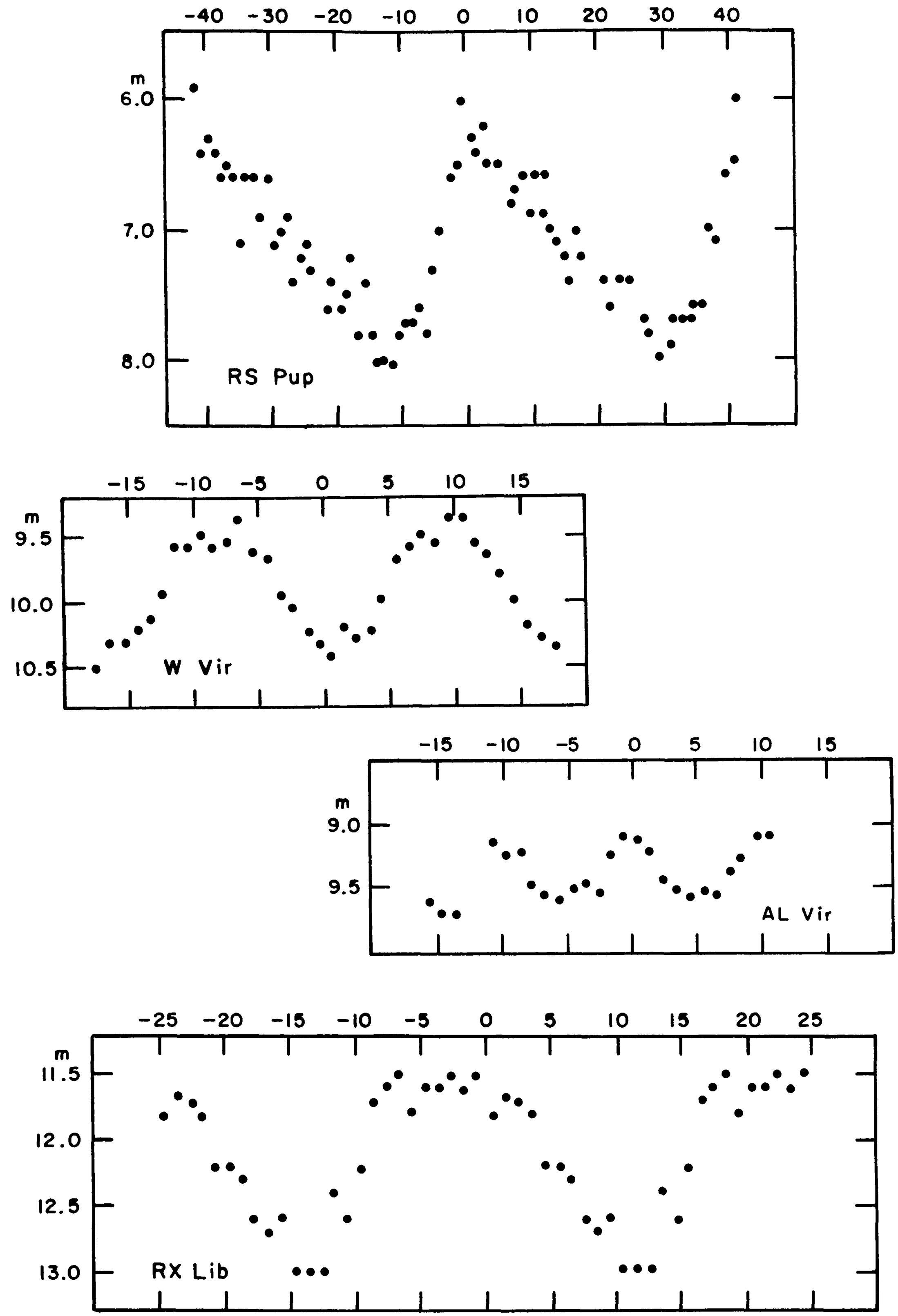

Figure 1 (cont'd).

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1983JAVSO..12...20C

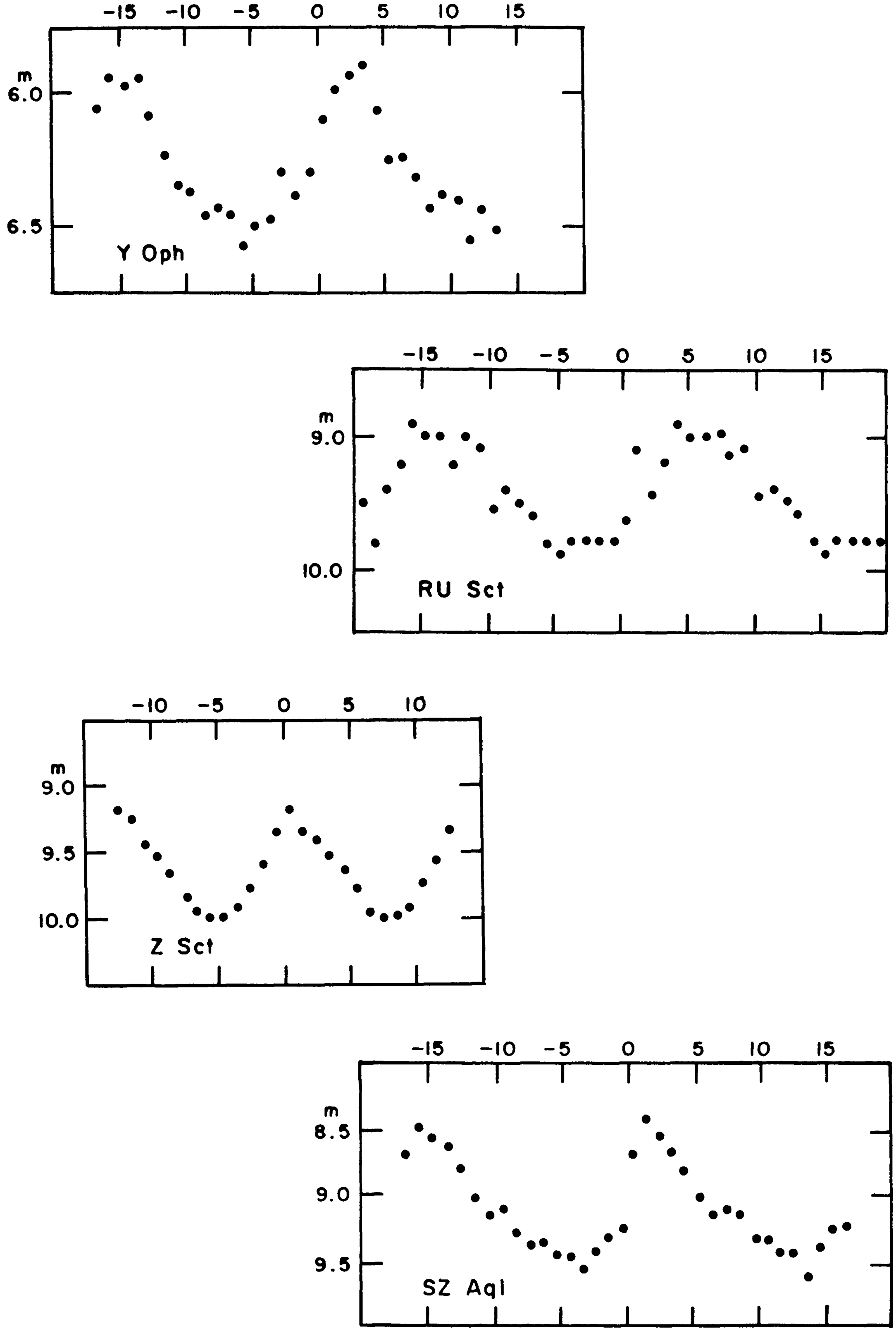

Figure 1 (cont'd).

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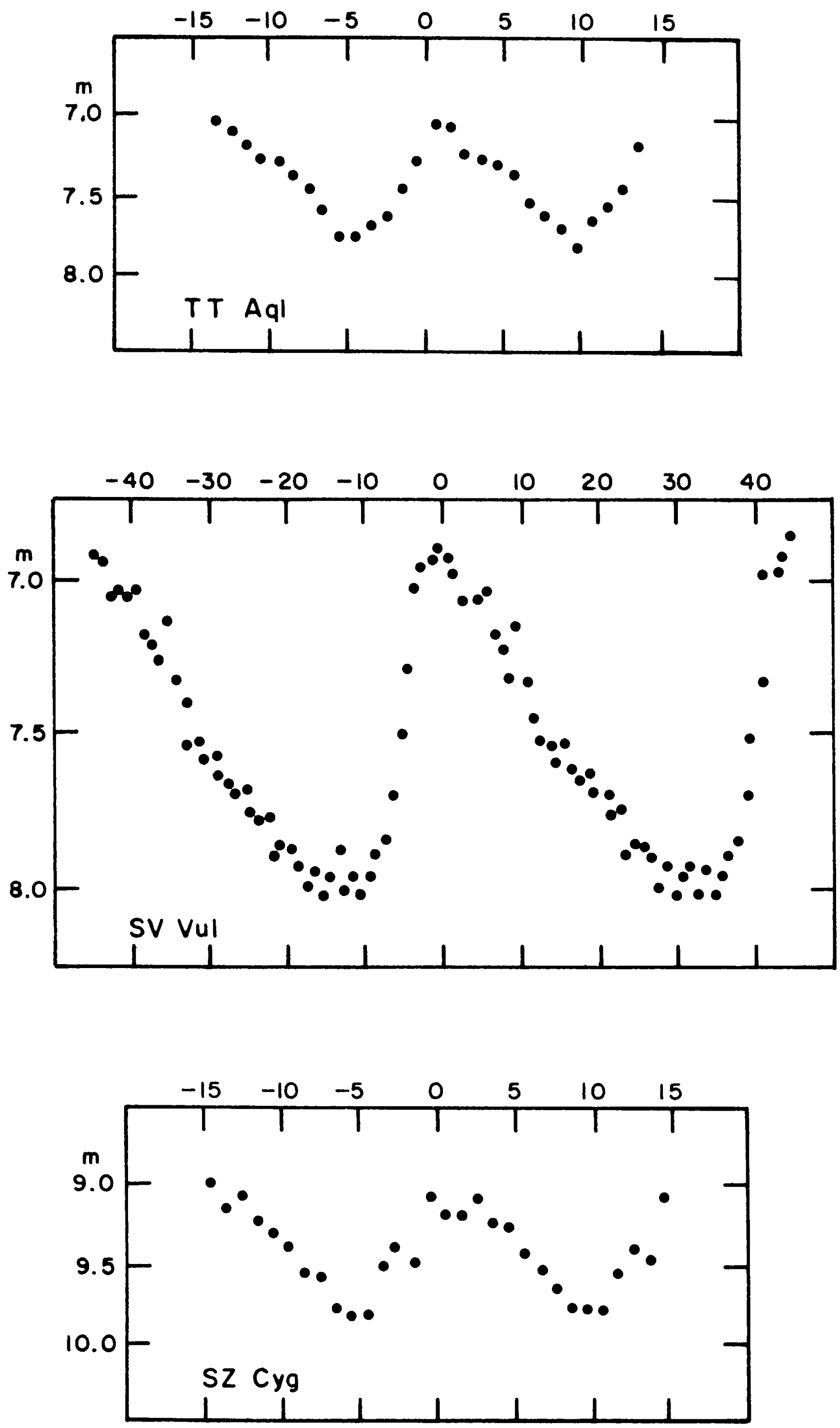

Figure 1 (cont'd).

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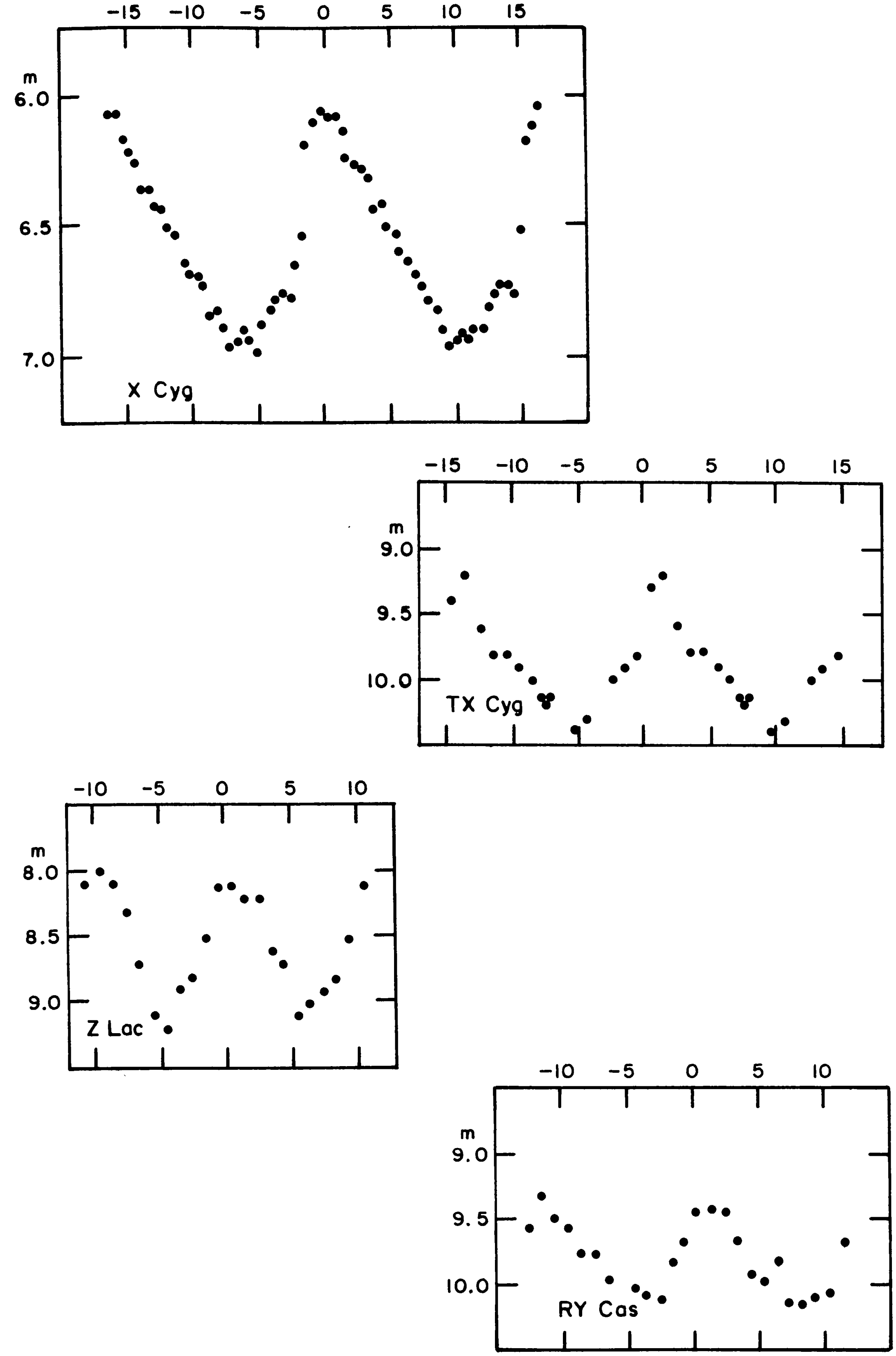

Figure 1 (cont'd).

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