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REVISED ELEMENTS. IV. R PYXIDIS, RT VELORUM, V MICROSCOPII, WW AQUARII, RT AQUARII, AND RT OCTANTIS

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Abstract

The Mira variables R Pyx, RT Vel, V Mic, WW Aqr, RT Aqr, and RT Oct, considered for the HIPPARCOS observing program, have been studied using the Harvard College Observatory photographic plate collection. Previously published elements have been revised.

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This paper, the fourth in a series of four, examines six Mira variables which have been considered for observation by the HIPPARCOS astrometric satellite. Elements published in the fourth edition of the **General Catalogue of Variable Stars** (Kholopov et al. 1985) (GCVS) were revised in order to assist in scheduling the satellite's observation of these stars. Data were obtained from the Harvard College Observatory plate collection, as there were very few visual observations in the AAVSO data files for these particular stars. Due to time constraints, only data from the Damon plate series (1952 - present) were collected for R Pyx, WW Aqr, and RT Oct. Data acquisition and reduction are described in greater detail in Lysaght (1988; 1989a; 1989b).

Finder charts and photographic sequences obtained with the iris photometer at Harvard College Observatory (Lysaght 1989b) are shown in Figures (1a) - (1f). The stars are listed in Table I with the results of this study and other pertinent information.

1. R Pyxidis

R Pyx was discovered by Holetschek (1890). The GCVS lists the following elements:

$$JD_{(max)} = JD\ 2418606 + 364.7\ E. \quad (1)$$

A date-compensated discrete Fourier transform (DCDFT) period search, provided by the director of the Maria Mitchell Observatory, Dr. E. P. Belserene, was used to revise the period. The revised elements, calculated from 59 observations (December 1971 - May 1988) are:

$$JD_{(max)} = JD\ 2445841 + 363.77\ E. \quad (2)$$

The star was found to be very red (**B-V** ~ 4 magnitudes) when the photographic observations were compared to AAVSO visual data. The mean curve, calculated by a Maria Mitchell Observatory BASIC program, is shown in Figure 2.

2. RT Velorum

RT Vel was discovered by Fleming, and its variability was confirmed by Wells (Pickering 1908). No research has been done for this star since its elements were calculated by Payne (1928).

The period was found by a DCDFT period search, using 404 observations (April 1894 - June 1988) from the B, AM, RB, MF and DSB

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photographic plates at Harvard College Observatory:

$$JD_{(max)} = JD\ 2432983 + 437.1\ E. \quad (3)$$

Figure 3 shows the O-C curve, constructed with C defined by equation (3). The curve was found to be a parabola by least-squares analysis (Maria Mitchell Observatory FORTRAN program), with a confidence level of 100% (Pringle, 1975). The parabola implies new elements as follows:

$$JD_{(max)} = JD\ 2430397 + \underset{\pm 0.58}{433.78}\ E - \underset{\pm 0.02192}{0.26752}\ E^2. \quad (4)$$

Thus, the period changes at a rate of approximately -0.45 day per year. Figure 4 shows the mean curve; phases were calculated taking the third term into account (Lysaght 1989b).

3. V Microscopii

V Mic was discovered by Fleming, and its variability was confirmed by Wells (Pickering 1904). The GCVS reports that it displays OH and water maser emission, and lists the following elements:

$$JD_{(max)} = JD\ 2430044 + 381.15\ E. \quad (5)$$

The period was revised by a DCDFT period search. The elements are as follows:

$$JD_{(max)} = JD\ 2447334 + 382.65\ E. \quad (6)$$

The mean curve, calculated from 184 photographic observations (November 1928 - September 1988) is shown in Figure 5.

4. WW Aquarii

WW Aqr was discovered by Reinmuth (1925). The GCVS reports the following elements:

$$JD_{(max)} = JD\ 2440878 + 241.18\ E. \quad (7)$$

The elements were revised by a DCDFT period search, using 127 observations (September 1968 - December 1988):

$$JD_{(max)} = JD\ 2447380 + 240.68\ E. \quad (8)$$

The mean curve is shown in Figure 6.

5. RT Aquarii

RT Aqr was discovered by Fleming (Pickering 1901). Cannon (1907) found its period to be 241 days. This was later revised by Muller and Hartwig (1920) to 246 days, and Esch (1934) found the period to be 242 days for the years 1920-1927. Kukarkin et al. revised this period to 245 days, and later 246.3 days (1948; 1958). The GCVS reports the following elements:

$$JD_{(max)} = JD\ 2434986 + 246.3\ E. \quad (9)$$

O-C values were calculated, using equation (9) as C, from 217 observations (November 1928 - September 1988) from the Harvard plates, 213 observations (June 1889 - December 1905) published by Fleming (1907), and published dates of maximum by Cannon (1907; 1909) and Esch (1934). Fleming's observations were recalibrated, using revised values for her sequence stars. The O-C curve (Figure 7) was found to be a least-squares parabola, with a confidence level of 100% (Pringle 1975).

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The revised elements are:

$$JD_{(max)} = JD\ 2424331 + 243.37\ E - 0.02009\ E^2. \quad (10)$$
$$\pm 0.14 \qquad \pm 0.00265$$

The third term implies a rate of change in the period of -0.06 day per year. The mean curve is shown in Figure 8; phases were calculated taking the third term into account (Lysaght 1989b).

6. RT Octantis

RT Oct was discovered by Leavitt (Pickering 1916). The GCVS reports the following elements:

$$JD_{(max)} = JD\ 2436063 + 180.16\ E. \quad (11)$$

The revised elements, calculated by the DCDFT period search, are:

$$JD_{(max)} = JD\ 2447021 + 180.26\ E. \quad (12)$$

The mean curve, calculated from 101 observations (May 1970 - August 1988) is shown in Figure 9.

Members are once again encouraged to observe these stars before and during the HIPPARCOS mission in order to obtain better-defined light curves. Anyone wishing to assist the AAVSO in this collaboration may obtain charts from AAVSO Headquarters. The charts have photoelectric (V) sequences provided by Grenon et al. (1989).

I would like to thank Dr. Janet A. Mattei for her guidance; Dr. Martha L. Hazen, curator of the Harvard College Observatory Photographic Plate Collection, for her assistance with the plates; Dr. Emilia P. Belserene of the Maria Mitchell Observatory for kindly providing computer programs; and the staff at AAVSO Headquarters for their support. I gratefully acknowledge NASA grant NAGW-1493 to the AAVSO, which funded this project; and the Fund for Astrophysical Research, which provided the computer facility.

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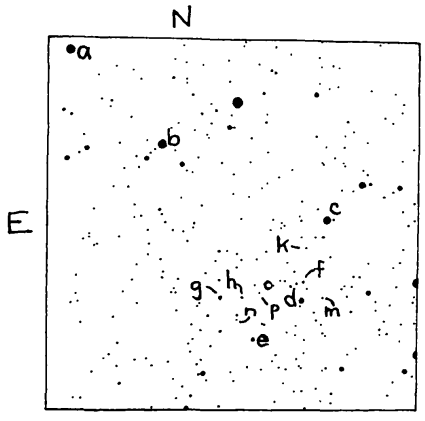
TABLE I

Summary Table for R Pyx, RT Vel, V Mic, WW Aqr, RT Aqr, and RT Oct

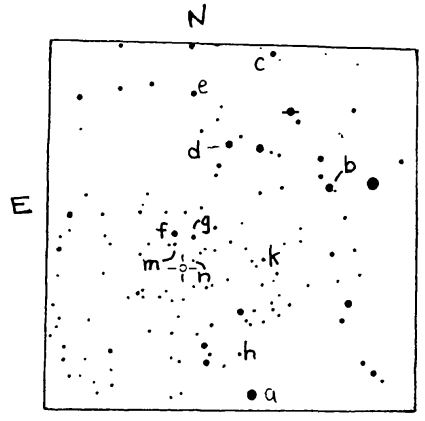
Star	Position (1950) R.A.	Dec.	Type	Spec.	Revised Period	Revised Max.	ptg Min.	No. Obs.	Remarks
R Pyx	$08^h43^m24^s$	$-28^o01'.1$	M	C(R)e	363.77	<9.9>	<14.2>	59	
RT Vel	10 28 06	-46 27	M	M7e	433.78	<12.4>	(15.0	404	1
V Mic	21 20 38	-40 54.9	M	M3e-M6e	382.65	<12.17>	(15.6	184	2
WW Aqr	21 32 21	+02 28.8	M	---	240.68	<12.34>	(14.0	127	
RT Aqr	22 20 28	-22 18.6	M	M5e-M6e	243.37	<10.82>	<12.84>	217	3
RT Oct	22 51 49	-87 18.6	M	Me	180.26	<11.56>	<14.60>	101	

Remarks
1. Period is variable: see equation (4).
2. OH, water maser emission (GCVS).
3. Period is variable: see equation (10).



a = $9^m.0$ pg
b = 9.1
c = 10.0
d = 10.7
e = 11.1
f = 11.7
g = 12.0
h = 12.4
k = 12.7
m = 13.2
n = 13.9
p = 14.1

Figure 1a. R Pyx. From an AAVSO (d) chart. Each side is 45′.



a = $9^m.3$ pg
b = 9.9
c = 10.4
d = 10.7
e = 10.9
f = 11.2
g = 11.8
h = 12.5
k = 12.7
m = 13.3
n = 14.4

Figure 1b. RT Vel. From an AAVSO (d) chart. Each side is 35′.

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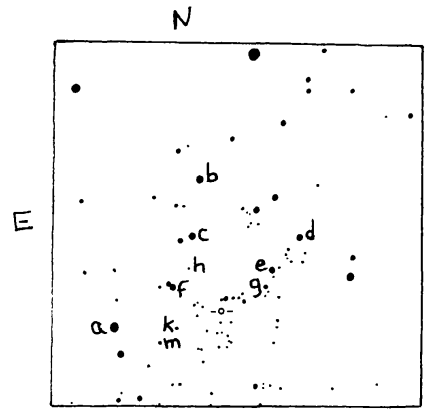

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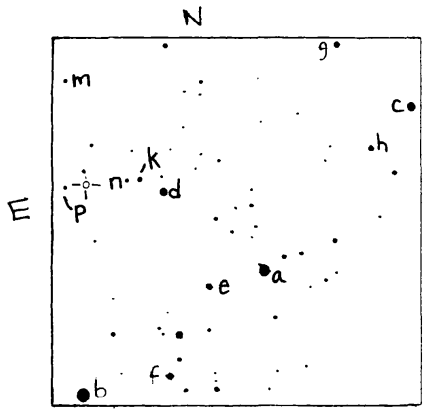
b = 10.5
c = 10.9
d = 11.4
e = 11.7
f = 12.0
g = 12.6
h = 13.5
k = 13.9
m = 14.4

Figure 1c. V Mic. From an AAVSO (d) chart. Each side is 30′.



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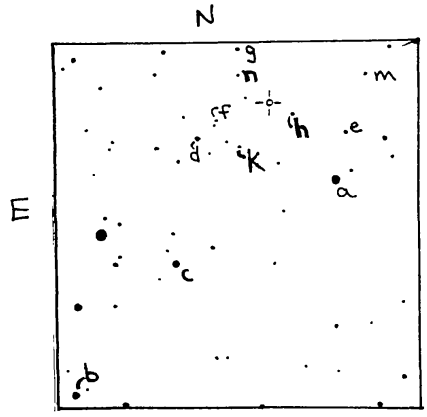
c = 11.5
d = 11.8
e = 12.0
f = 12.4
g = 12.8
h = 13.0
k = 13.2
m = 13.4
n = 13.9
p = 14.0

Figure 1d. WW Aqr. From an AAVSO (e) chart. Each side is 20′.



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c = 11.5
d = 12.2
e = 12.8
f = 13.1
g = 13.5
h = 13.9
k = 14.4
m = 14.8
n = 15.1

Figure 1e. RT Aqr. From an AAVSO (d) chart and Sturch (1989). Each side is 35′.

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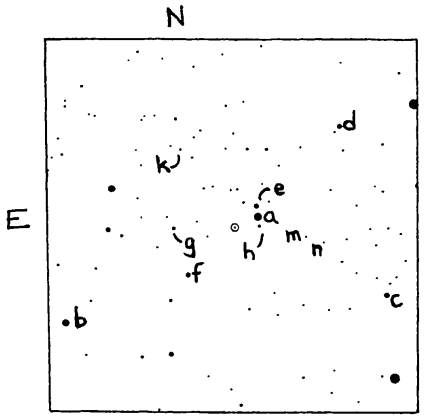

a = 10^{m}.5 pg
b = 11.1
c = 11.3
d = 11.7
e = 12.0
f = 12.1
g = 12.6
h = 13.1
k = 13.3
m = 13.7
n = 14.1

Figure 1f. RT Oct. Chart is from Bateson (1979). Each side is 40′.

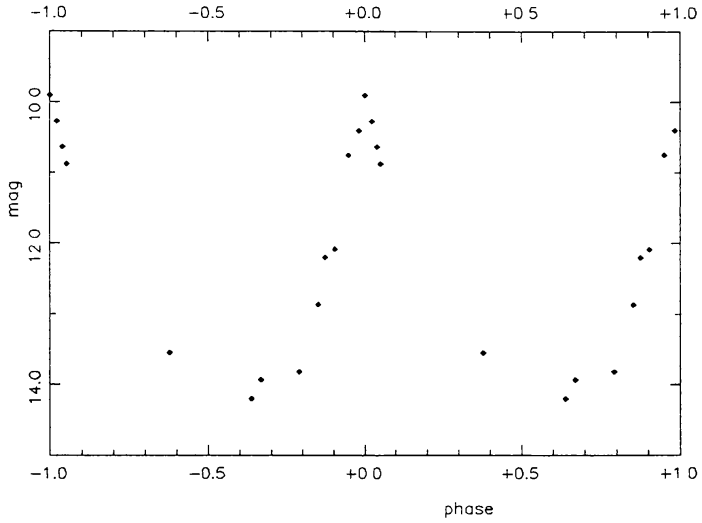

Figure 2. Photographic mean light curve for R Pyx.

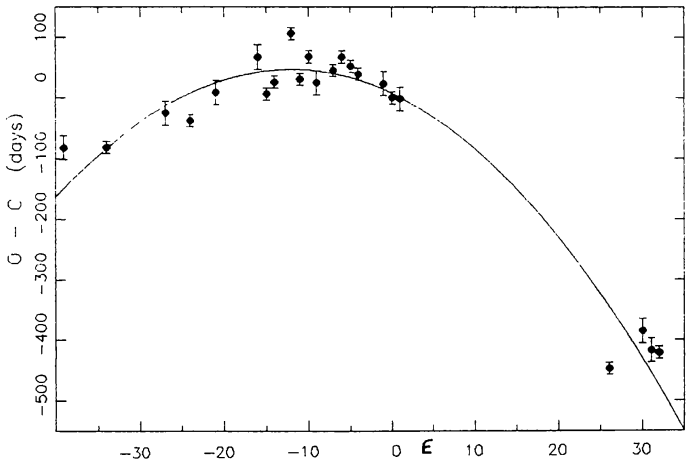

Figure 3. O-C curve for RT Vel.

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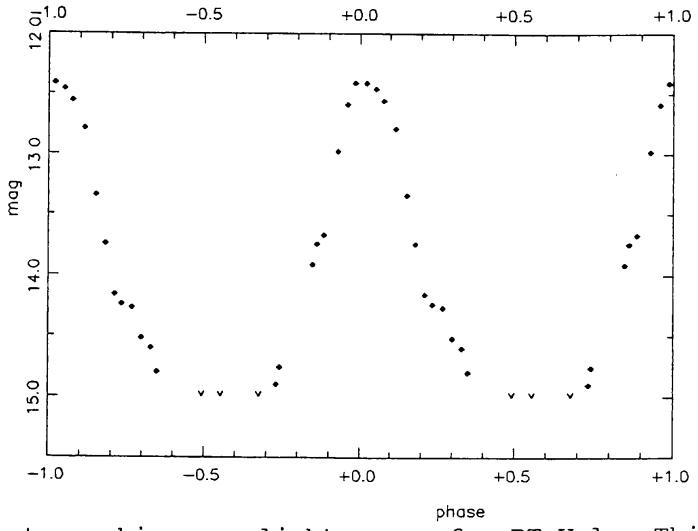

Figure 4. Photographic mean light curve for RT Vel. Third term has been taken into account in calculation of phase (Lysaght 1989b).

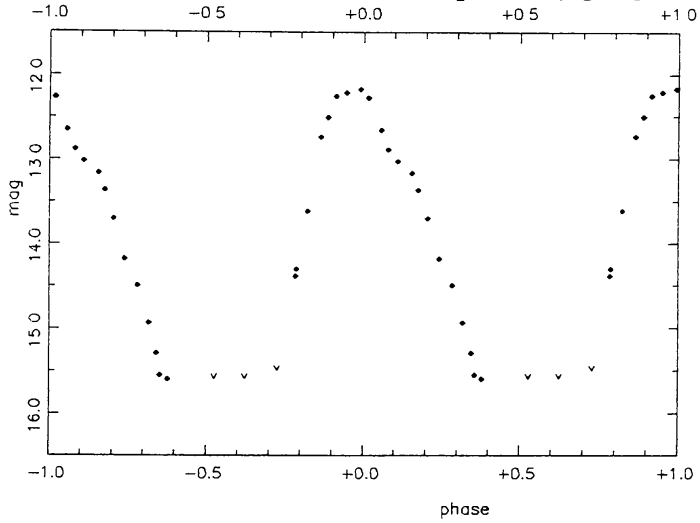

Figure 5. Photographic mean light curve for V Mic.

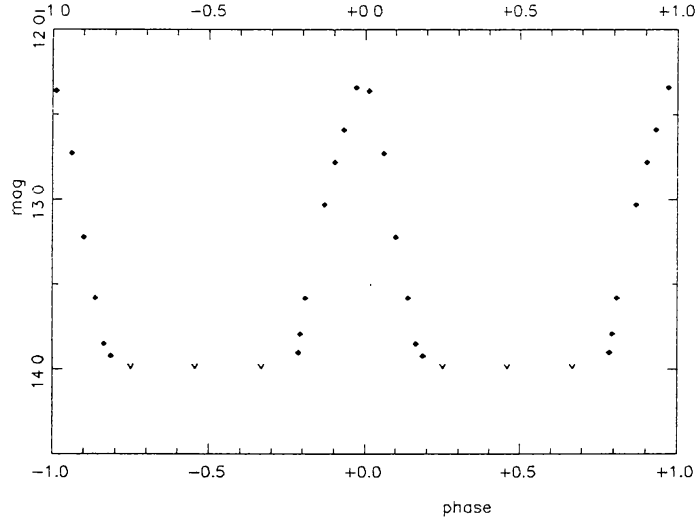

Figure 6. Photographic mean light curve for WW Aqr. "v" means "fainter than".

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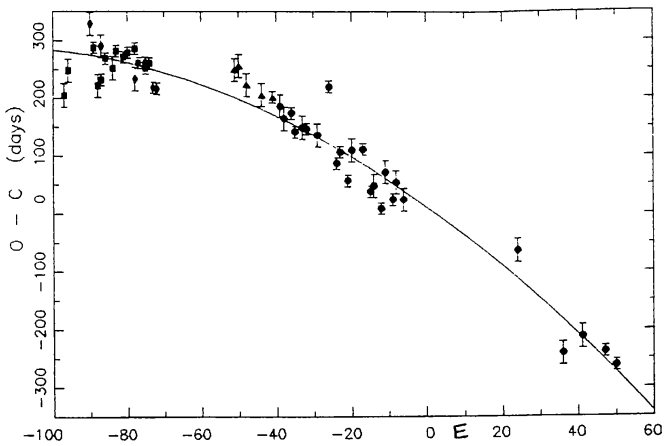

Figure 7. O-C curve for RT Aqr. Circles indicate points calculated from maxima of the Harvard photographic data; squares indicate those calculated from published data from Fleming (1907); diamonds are from maxima observed by Cannon (1907; 1909); and triangles are from maxima observed by Esch (1934).

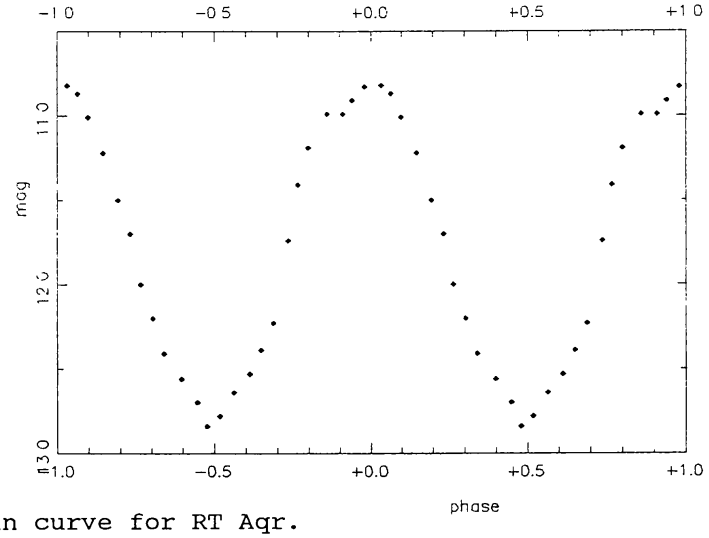

Figure 8. Mean curve for RT Aqr.

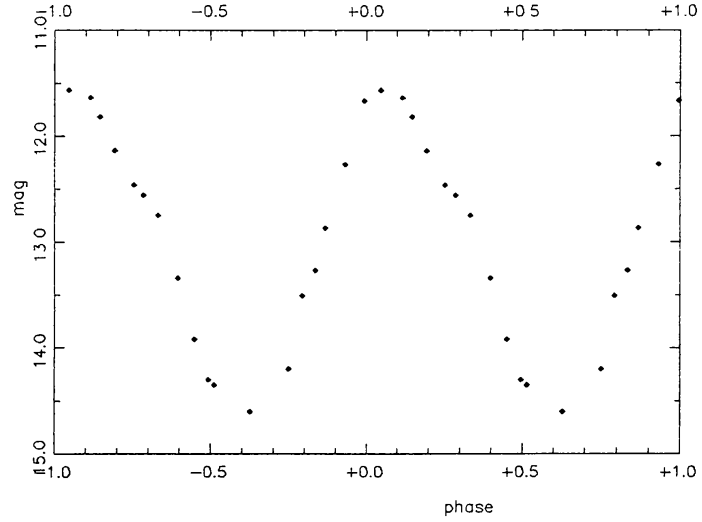

Figure 9. Mean curve for RT Oct.

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