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The Journal of the American Association of Variable Star Observers

An Interview With Dorrit Hoffleit

Kristine Larsen with Dorrit Hoffleit

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- The Changing Nature of the Dwarf Nova BV Centauri
- Period Changes in δ Scuti Stars: ρ Puppis
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4) not more than 2,500–3,000 words in length (10–12 pages double-spaced).

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Photographs and halftone images will be considered for publication if they directly illustrate the text.

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1) provided separate from the main body of the text;
2) numbered sequentially and referred to by Arabic number in the text, e.g., Table 1.

References:
1) References should relate directly to the text.
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3) In the case of three or more joint authors, the text reference should be written as follows: (Smith *et al.* 1976).
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   Brown, J., and Green, E. B. 1974, *Astrophys. J.*, **200**, 765.
   Thomas, K. 1982, *Phys. Report*, **33**, 96.
5) Abbreviations used in references should be based on recent issues of the Journal or the listing provided at the beginning of *Astronomy and Astrophysics Abstracts* (Springer-Verlag).

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1) Equations should be written on a separate line and given a sequential Arabic number in parentheses near the right-hand margin. Equations should be referred to in the text as, e.g., equation (1).
2) Magnitude will be assumed to be visual unless otherwise specified.
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A Message From the Incoming Editor

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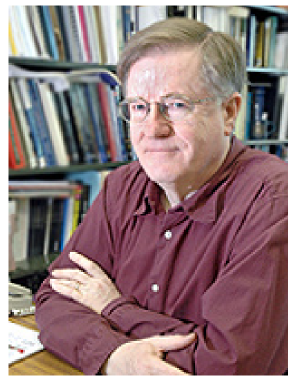
Dr. John R. Percy

In 1975 (*JAAVSO* **4**, 1), Professor Charles (Chuck) Whitney outlined two principal challenges that he faced as the newly-appointed Editor of this journal: to encourage contributions from both amateurs and professionals, and to convey the continued importance of amateurs' work. Looking at issues of the journal, over the years, it's clear that Chuck has more than met these challenges. *JAAVSO* is a vibrant, accessible source of interesting, useful publications by amateurs, professionals—and students. They illustrate the ever-growing partnerships between these three parts of "the astronomical community" that is the hallmark of the AAVSO. Chuck has also been part of an AAVSO Headquarters staff team that has, together with the Council, continued to raise the Association's profile and effectiveness: it is one of the world's best-known and most-respected "citizen science" organizations. Chuck has served for a remarkable thirty-four years. On behalf of all AAVSO members, observers, and friends, I offer our heartfelt thanks for his service, and best wishes for a well-deserved second retirement.

Speaking of which, by way of introduction: I have just "retired" after forty-one years as a faculty member in Astronomy and Astrophysics, and in Science Education at the University of Toronto. But I continue to be active: I am thoroughly immersed in several International Year of Astronomy projects; I am enjoying giving lectures and courses for later-life learners; I continue to supervise variable star projects by enthusiastic undergraduate and senior high school students (their results are frequently published in this Journal). And my new appointment as Editor enables me to continue to serve an organization which is dear to my heart. But if I were to serve for thirty-four years, I would retire (or die) at the age of 101!

So please continue to contribute to *JAAVSO*. We welcome contributions on any aspect of variable-star science, techniques, education, history, and related topics. A few years ago, the AAVSO organized a workshop (http://www.aavso.org/aavso/meetings/spring06wkshp.shtml) to encourage you to do so, and to provide useful advice on how to prepare your manuscript. Manuscripts are received first by Production Editor Michael Saladyga. He forwards them to me, to double-check that they are appropriate for the journal, and to ask for suggestions about possible referees. The manuscript is sent to a referee (or two, if necessary); the referee's comments and suggestions are then sent to the author. Mike and I, and the referee if necessary, look at the revised manuscript; the AAVSO Headquarters scientific editorial staff—Associate Editor Elizabeth O. Waagen and Assistant Editor Matthew Templeton—will then look at it also. Indeed, I took on the editorship cheerfully, knowing that Mike, Elizabeth, and Matt did most of the work, and did it with judgement, efficiency, and good cheer! Our goal is to enable you to publish a paper of high standard, that you will be proud of, and that I and your other fellow readers will learn from and enjoy.

Good observing, and good writing!

Period Changes in δ Scuti Stars: ρ Puppis

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Abstract Using new and published photometric observations of ρ Pup spanning sixty-two years, a period of pulsation of 0.14088143(3) day was determined. Unfortunately the value for the period of ρ Pup listed in the GCVS appears to be inconsistent with the value determined from this extensive body of data. The epoch given by Struve *et al.* (1956) at HJD 2435560.756 was chosen from existing epochs as it displays the maximum light near the middle of the magnitude-phase plot. Additionally, it was determined that any period change for ρ Pup is within $\pm 8 \times 10^{-9}$ yr $^{-1}$, although a period change arising from evolution of this star would be expected to be positive in the sense of the period lengthening.

1. Introduction

δ Scuti variables are pulsating stars lying in the lower part of the Cepheid instability strip, near the main sequence. This class of variable star is believed to comprise pre-main-sequence, main-sequence, and post-main sequence stars of mainly Population I but also including some of Population II. Templeton (2005) and Breger and Pamyatnykh (1998) have discussed period changes in δ Scuti stars in the context of stellar evolution and its underlying astrophysics. In principle, measuring such changes provides an observational test of stellar evolutionary theory, however, a number of problems have arisen:

- Period changes reported for some δ Scuti stars greatly exceed rates derived from theoretical models of stellar evolution.

- There are nearly equal numbers of negative and positive rates of period change reported, whereas current theoretical understanding predicts that the periods for radial modes increase during most of the post-main sequence stage of evolution of δ Scuti variables. Positive changes (i.e. increasing periods) should then predominate owing to a greater number of δ Scuti variables being post-main sequence stars.

- Sudden changes or “jumps” in period have been reported or inferred.

- Effects of binarity may not be readily detected or, where detected, not well determined.

Theoretical studies of stellar evolution suggest that rates of period (P) changes, (1/P)dP/dt, increase from 10^{-10} yr^{-1} for stars on the main sequence to 10^{-7} yr^{-1} for evolved δ Scuti stars. While higher rates are indicated for pre-main sequence stars, these form only a very small subset of the known δ Scuti stars. Breger and Pamyatnykh (1998) discuss the apparent discrepancy between observed period changes and those calculated to arise from stellar evolution, suggesting that other, undetermined, mechanisms may be at work. Templeton (2005) notes, however, that explanations such as observational uncertainties and analysis artifacts cannot be ruled out.

Ongoing observations of δ Scuti stars are thus needed to improve the determination of their periods of pulsation and accurately ascertain both the magnitude and sign of any period changes. ρ Pup provides an ideal candidate for such studies because:

- It has a single period of pulsation.
- For a δ Scuti star it has a relatively large amplitude ($\Delta V > 0.1$ magnitude).
- There is strong evidence that it exhibits only radial pulsation, as its radial velocity curve follows a sinusoid predicted from simple radial pulsation theory (Campos and Smith 1980).
- As one of the first five of this class of variable to be identified and measured (Baglin *et al.* 1973), there are photometric observations extending back over sixty years to 1946 and radial velocity measurements over 110 years to 1897. This provides a long baseline for accurate determination of its period.

There are, however, drawbacks to the ongoing monitoring of the light variations of this star:

- It is a third magnitude star and hence best suited to measurement through a small-aperture telescope but, being a δ Scuti star, photoelectric techniques are required for accurate measurement of its light variations.
- It is best observed from southern latitudes where there are, unfortunately, fewer observers available to monitor such stars.

Furthermore, analysis of the light variations is hampered by the incongruities between the various epochs and periods reported—particularly between the current listing in the *General Catalogue of Variable Stars* (GCVS4; Samus *et al.* 2004) and earlier sources.

Using new photometric measurements of ρ Pup taken in 2008, previously unpublished photometric measurements by one of the authors from 1983, and the following published photometric measurements:

- Hipparcos collected between 1990 and 1993,
- Tycho collected between 1990 and 1993,
- Cape Observatory reported in 1953,
- Eggen reported in 1956,
- Ponsen reported in 1963 (includes measurements with Walraven),
- Doss reported in 1969,
- Bessell reported in 1969, and
- Dravins *et al.* reported in 1977,

a comprehensive analysis was undertaken to establish a suitable epoch, determine a best estimate of period, and look for evidence of a period change.

2. Published data

The variations in brightness of ρ Pup came to notice when they were reported by Eggen (1956), who noted that its light variations had been independently discovered at the Cape Observatory in South Africa (Cape 1953). While Eggen's measurements were in the photoelectric Johnson *V* band, the earlier Cape Observatory measurements were made in the photographic m_{pg} band. From his data Eggen determined the period to be approximately 0.141 day. Using radial velocity measurements Struve *et al.* (1956) derived a period of 0.1409 day, setting as an epoch the time of *maximum* velocity at HJD 2435560.756. Later Buscombe (1957) analyzed all radial velocity measurements available to him and claimed that a period of 0.14088143 day fitted the data with an uncertainty of 10^{-8} day.

Ponsen (1963) undertook an extensive analysis of ρ Pup which included new "blue-filter" photometric measurements, five-color photometry taken in the Walraven system, the earlier photoelectric measurements by Eggen (1956), magnitudes determined photographically (Cape 1953), and the various radial velocity measurements made between 1897 and 1956. Using the radial velocity data alone, he derived a period of 0.14088141(6) day and an epoch of HJD 2435561.672(6) which corresponded to an instance of *minimum* radial velocity. Ponsen also noted that the period he had determined from radial velocity measurements was practically identical to that used by Cousins to compute the phases for the Cape data (0.1408814 day). The value determined by Buscombe (1957) also agreed with both of these to within Ponsen's standard error of $\pm 6 \times 10^{-8}$ day.

Bessell (1969) undertook spectrophotometric measurements of ρ Pup at wavelengths between 339 and 1,040 nm. The data are presented in his Table 1 with magnitudes as a function of phase for each wavelength. Phases were calculated using the epoch given by Struve *et al.* (1956) and the period as determined by Buscombe (1957). The epochs of Buscombe and Ponsen thus differ by only 6½ cycles but, more importantly, in the sense that one relates to the maximum of the radial velocity curve and the other to its minimum.

The current values for the epoch (HJD 2444995.905) and period (0.1408809 day) of ρ Pup given in the GCVS4 (Samus *et al.* 2004) are attributed to a paper by Fracassini *et al.* (1983). They are, however, not consistent with earlier values, for example, values that were derived by Ponsen (1963) and Buscombe (1957). Fracassini *et al.* (1983) evaluated their epoch and period for ρ Pup from a least-squares solution for the epochs given by Ponsen (1963), and later observations of maxima by Trodahl and Sullivan (1977) and Dravins *et al.* (1977). Trodahl and Sullivan (1977) note in their paper that the observing conditions were unfavorable at the time of measurement of ρ Pup, that it was only observed from the Carter Observatory *"where rapidly changing weather patterns can lead to systematic errors in the measured color indices,"* and that a different comparison star was used for measurements on the second night. Additionally, their published paper includes the data only as a course-grain plot of magnitude versus time, where the time was measured relative to local midnight. Heliocentric corrections are thus not applied and no epoch is listed. Consequently, Trodahl and Sullivan's data could not be included in our analysis.

Dravins *et al.* (1977) give a plot of Strömgren *v*- and *y*-band magnitudes and *b–y* color index as a function of HJD. In a following table they list the epochs for the *v*, *b*, and *y* bands along with other quantities for ρ Pup, but it should be noted that the epochs listed relate to the *maximum numerical* values of the quantities tabulated, which in the case of the *v*- and *y*-band measurements correspond to *minimum* brightness. Also, they report differences in the epochs of the maxima observed in the *v*, *b*, and *y* bands but these differences amount to a little more than two minutes. Such a difference may then be viewed in the context of the description of their observing procedure where they note that the *"integration time for each filter was ≈ 10s and the interval between successive sets of* ρ *Pup observations ≈ 6m."* Dravins *et al.* (1977) also mention photometric observations by Doss (1969). This work, published as a *Kodaikanal Observatory Bulletin*, was not referenced in any of the other papers used in our analysis of ρ Pup. Although the paper is somewhat obscure, a scanned copy was eventually located via an Internet search. Some significant discrepancies in the paper were noted, such as an incorrect value given for Ponsen's published epoch for his photometric measurements (which the author apparently uses in their calculations), the mixing of the epoch from Ponsen's photometric measurements with the period he gives for the radial velocity measurements, and no mention of the comparison star to which the values of Δm listed in his Table 1 are relative. Noting the two comparison stars used, we inferred from the size of values of Δm listed that they represent differences in magnitude between 11 Pup (HR 3102) and ρ Pup, hence a suitable dataset of Johnson *B* or *V* magnitude versus HJD could be reconstructed.

While Fracassini *et al.* (1983) include computed maxima for the fluxes they measured from UV high-resolution spectra of ρ Pup they note that these maxima "*must be considered with great caution owing to the interval of time between the exposures (≈30m–40m), too long in comparison with the pulsation period of the star, and the poor number of point[s].*" Thus, the maxima they evaluated have not been included in the current analysis.

Hipparcos H_p and Tycho V_T magnitudes (as a function of heliocentric Julian Date) for ρ Pup were downloaded from the Hipparcos and Tycho catalogues (ESA 1997). Access to these catalogues was through the VIZIER database (Ochsenbein *et al.* 2000). The Hipparcos data downloaded span the time interval from 7 January 1990 to 25 February 1993, and the Tycho data from 7 January 1990 to 24 February 1993.

3. Unpublished data

Photometry of ρ Pup had previously been undertaken by one of the authors (Moon) on 19 April, 11 May, and 18–20 May 1983, but remained unpublished. The resulting measured *V* magnitudes, forty-seven in all, were calculated using the same comparison star as used by Eggen (1956), i.e., ξ Pup. For this analysis data reduction was undertaken afresh with corrections applied for atmospheric extinction (evaluated for each night from the comparison star). The magnitudes obtained were then transformed to the Johnson *V* band using the transformation coefficient determined in June 1983. Twenty-eight further measurements of ρ Pup were made on 15 February 2008 by one of the authors (Moon). For these data, HR 3102 was used as the comparison star and HR 3131 as the check star, the comparison and check stars being, respectively, about 0.3 magnitude redder and bluer in *B–V* than ρ Pup. Average *V* magnitudes for these two datasets (separated by almost twenty-four years) differed by 0.02. This may be accounted for by uncertainties arising from multiplying the rather large transformation coefficient (0.10) used for the 1983 data with a color difference between ξ Pup and ρ Pup of *B–V*=0.82. As the analysis undertaken focused on times of maxima, and the data were to be combined with data from other sources that were in other photometric bands, no adjustment was made to the 1983 magnitudes to bring the average of the two sets of data into agreement. The seventy-five new measurements are presented as two distinct datasets in Table 1.

The photometric data on ρ Pup used in this analysis thus represent a comprehensive, and perhaps exhaustive, dataset comprising approximately 1,800 measurements and spanning more than sixty years.

4. Analysis

The ρ Pup photometric data assembled by the authors are a heterogeneous dataset as they comprise measurements made with different photometric systems. As the analysis focused on selecting a suitable epoch and then evaluating an accurate period through determining the times of maxima of the light curve, the various measurements of magnitude were left in their original systems rather than attempting to apply corrections to bring their average values and ranges of light variation into alignment. This also facilitated the display of the results through a natural separation of the different datasets on the plot of magnitude as a function of phase. The particulars of the photometric bands for the datasets used in the analysis are given in Table 2.

4.1. Choice of epoch

For pulsating stars the time of maximum light coincides only approximately with that of minimum radial velocity; in the case of δ Scuti stars the minimum velocity lags approximately 1/10 of a period behind maximum light. Also there are small variations in color which are in phase with the variations in light (Percy 2007). The choice of epoch is thus somewhat problematic, as an epoch conveniently chosen to display radial velocity variations may not be the best for displaying the light variations. The earliest published photoelectric measurements with an accompanying epoch are those by Eggen (1956) spanning one week in March 1956. Ponsen (1963) noted that Eggen's data were discordant with all the other data available to him (the difference amounting to 40 minutes) but remarked that it was not clear how this should be explained. Using the adjustment of –40 minutes applied by Ponsen, Eggen's data were found to then be in agreement with all other data analyzed here. While the epoch used by Struve *et al.* (1957) is only about one day earlier than that of Ponsen, it corresponds to a maximum in radial velocity, hence, for photometric measurements, maximum light occurs near the middle of the phase plot. This epoch was also used by Bessell (1969) for his analysis. It was thus chosen as the most suitable existing epoch for analysis of the assembled photometric datasets.

4.2. Determination of the period

Values for the period of ρ Pup given by Buscombe (1957) and Cousins (see Ponsen 1963) are in agreement with that of Ponsen (1963) to within his standard error. Ponsen's period was thus chosen as the starting point for our analysis. The resulting plot of magnitude as a function of phase for the various datasets is displayed in Figure 1. Here an error of ± 0.05 magnitude is adopted for Cape Observatory photographic magnitudes (Budding and Demircan 2007). Errors are not plotted for the photoelectric measurements as they are within ± 0.01 magnitude.

There is good agreement in times of maxima for these datasets (spanning sixty-two years) to within the precision to which the maxima can be readily determined. Maximum light occurs at a Phase of about 0.4 relative to the time of maximum radial velocity. This is consistent with the expected lag of approximately 1/10 of a period between the maximum of the light variations and the minimum of the radial velocity.

Polynomial fits were made to the nine photoelectric datasets to estimate the phases of the maxima. (The Cape photographic measurements with their large errors, and the maximum and minimum observed by Dravin *et al.*, where the maximum was estimated from the epoch given for minimum light measured in the *y* band, were not used.) The phase of the predicted maxima for each dataset was then plotted as a function of its average cycle number. The resulting plot did not display any trend that could be interpreted as a period change. Incremental changes to the period, within the range of the error given by Ponsen, changed the slope of a straight line fitted (via linear regression) to the predicted maximum phase versus average cycle number for the nine photoelectric datasets. The point where the slope changed from positive to negative (and was closest to zero when using increments of 1×10^{-8}) corresponded to a period of 0.14088143 day.

The plot of resulting phase of maximum brightness versus cycle number is shown in Figure 2. For this best estimate of period the scatter in the calculated phases was ± 0.03 of a period corresponding to six minutes, which is on the order of the typical resolution in time (and arises from the time between consecutive measurements of a star when undertaking differential photometry). This gives an estimate of 3×10^{-8} day for the uncertainty in the period determined above. Changing the period by a quantity larger than Ponsen's standard error led to the datasets being no longer aligned.

4.3. Upper limit to evolutionary period changes for ρ Pup

Between the start of Eggen's measurements and those taken in 2008 by Moon, 18,959 days had elapsed (corresponding to 134,574 cycles). The magnitude of the error in the period as determined above would then correspond to a difference of 0.004 day (approximately six minutes) over this 52-year interval. Using the equation given by Breger and Pamyatnykh (1998) such an error puts an upper limit on the magnitude of the period change of 8×10^{-9} yr^{-1}, a value consistent with the range calculated from stellar evolutionary theory.

5. Conclusions

The singly-periodic pulsation of ρ Pup appears to be stable over the more than sixty years for which photometric data exist. Using a comprehensive dataset, comprising approximately 1,800 photoelectric measurements and spanning fifty-two years, the period was determined to be 0.14088143(3) day.

From the estimated error in the period it was calculated that any change in the period of pulsation of ρ Pup is within ± 8 × 10^{-9} yr^{-1}, although a measured change would be expected to be positive in the sense of the period lengthening. Such an upper limit to the observed rate of period change appears consistent with current theory.

The epoch of Struve *et al.* at HJD 2435560.756, which is based on a maximum in the radial velocity variations, appears to be the best choice of existing epochs for displaying photometric observations as it gives a maximum near the middle of the phase plot. The maximum brightness in the Johnson *V* band at HJD 2454512.0387 is well defined and may provide a more recent epoch for future measurements of this star. While ρ Pup remains a suitable candidate for searching for period changes arising from stellar evolution, the time taken to cycle between consecutive measurements now limits the precision with which times of maxima, and subsequently changes in period, can be determined. Techniques that reduce the cycle time between measurements should be developed.

It is recommended that HR 3102 and HR 3131 be used as comparison and check stars rather than ξ Pup for any future photometric measurements as their *B–V* indices straddle that of ρ Pup, being about 0.3 magnitude redder and bluer, respectively. Neither star is listed as variable in the GCVS4.

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Table 1a. Measurements of ρ Pup taken in 1983.

HJD	*V*	*HJD*	*V*	*HJD*	*V*
2445444.009	2.838	2445472.984	2.792	2445474.965	2.794
2445444.011	2.837	2445472.986	2.800	2445474.967	2.803
2445444.012	2.836	2445473.932	2.738	2445474.968	2.798
2445444.013	2.835	2445473.934	2.732	2445474.971	2.798
2445444.015	2.834	2445473.935	2.734	2445474.972	2.801
2445466.008	2.795	2445473.938	2.734	2445474.974	2.800
2445466.012	2.791	2445473.939	2.728	2445474.977	2.810
2445466.016	2.784	2445473.943	2.734	2445474.978	2.812
2445472.967	2.759	2445473.944	2.731	2445474.979	2.809
2445472.973	2.760	2445473.945	2.732	2445474.990	2.808
2445472.973	2.772	2445473.947	2.738	2445474.992	2.813
2445472.975	2.776	2445473.960	2.762	2445474.993	2.813
2445472.976	2.772	2445473.961	2.762	2445474.995	2.816
2445472.979	2.782	2445473.963	2.769	2445474.996	2.815
2445472.980	2.785	2445474.963	2.791	2445474.997	2.816
2445472.982	2.793	2445474.964	2.795		

Table 1b. Measurements of ρ Pup taken in 2008.

HJD	*V*	*HJD*	*V*	*HJD*	*V*
2454511.969	2.858	2454512.026	2.765	2454512.071	2.811
2454511.977	2.855	2454512.032	2.762	2454512.076	2.807
2454511.982	2.847	2454512.036	2.759	2454512.084	2.827
2454511.989	2.839	2454512.042	2.761	2454512.088	2.831
2454511.996	2.823	2454512.045	2.760	2454512.094	2.834
2454512.002	2.823	2454512.048	2.757	2454512.098	2.838
2454512.007	2.815	2454512.055	2.776	2454512.103	2.850
2454512.014	2.797	2454512.058	2.783	2454512.107	2.858
2454512.019	2.787	2454512.064	2.794		
2454512.023	2.781	2454512.068	2.802		

Table 2. Particulars of photometric bands of datasets used in analysis.

Photometric Band	*Effective Wavelength (nm)*	*FWHM (nm)*	*References*
Cape Photographic (m_{pg})	425	?	Allen (1973)
Johnson *V*	550	89	Allen (1973)
Johnson *B*	440	98	Allen (1973)
Ponsen “blue” filter	> 425	?	Ponsen (1963)
Walraven *V*	544	71	Mermilliod *et al.* (1997)
Bessell (1/λ = 1.8)	560	5	Bessell (1969)
Strömgren *y*	547	23	Mermilliod *et al.* (1997)
Hipparcos H_p	480	230	Bessell (2000)
Tycho V_T	510	105	Bessell (2000)

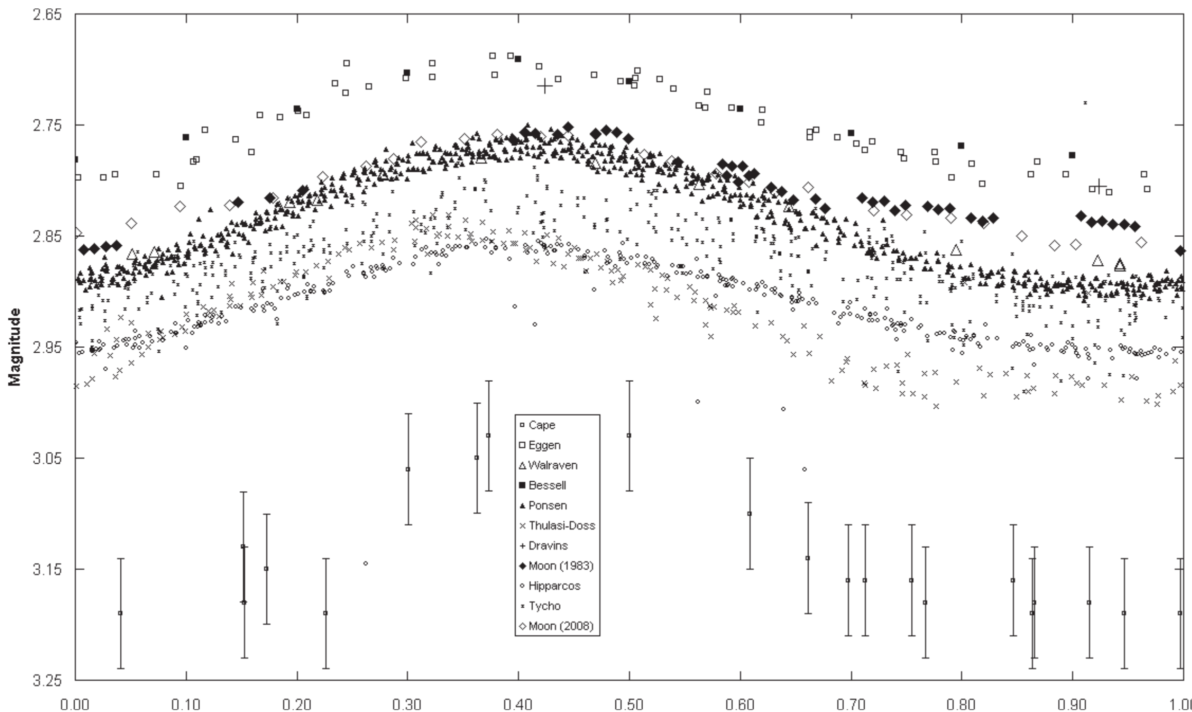

Figure 1. Measured magnitudes of ρ Pup as function of phase using an epoch of HJD 2435560.756 and a period of 0.14088141 day. Eggen's data have been corrected by –40 minutes as determined by Ponsen (1963). The typical error for a photoelectric measurement is ± 0.01 magnitude. For the photographic measurements a typical error is ± 0.05 magnitude as shown for the Cape data.

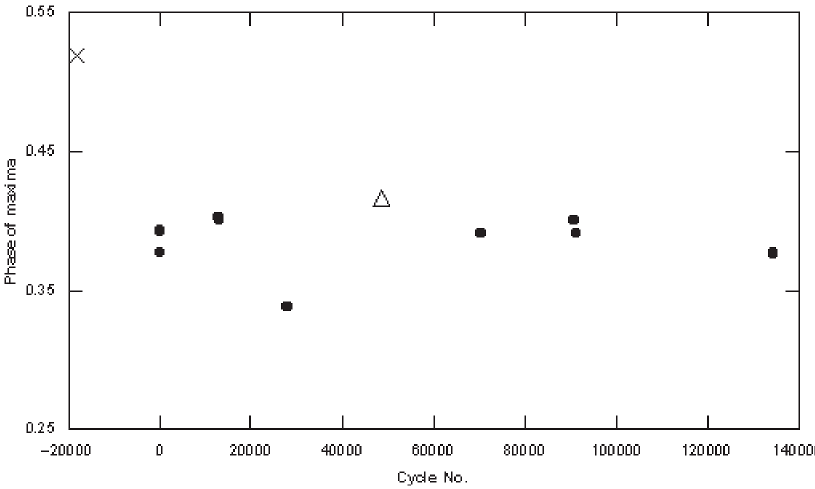

Figure 2. Phase of predicted maximum brightness as a function of average cycle number for nine photoelectric datasets (using an epoch of HJD 2435560.756 and a period of 0.14088143 day). For completeness the phases for the photographic Cape data (cross) and the maximum given by Dravins *et al.* (triangle) are included although they were not used in the analysis.

Identifying Previously Uncatalogued Mira Variable Stars in the Optical Gravitational Lensing Experiment (OGLE) Database

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Abstract Candidate variable stars in the publicly available data of the Optical Gravitational Lensing Experiment (OGLE) project were identified by data mining the galactic disk photometry database for entries that matched the following criteria: mean *i*-magnitude between 8 and 14 and standard deviation of *i*-magnitude between 0.5 and 1.0. Ten previously uncatalogued Mira variable stars have been identified, with only stars not listed in the International Variable Star Index (VSX) at the time of submission being included.

1. Introduction

The second phase of the Optical Gravitational Lensing Experiment (Udalski *et al.* 1997) was conducted from the Las Campanas Observatory in Chile using a 1.3-meter telescope operating at an effective focal ratio of *f* / 9.2. This gave an image scale of 0.417 arcsec/pixel. All observations were made in driftscan mode with the majority of observations made using an *i*-band filter with a passband near to Cousins *I*.

The pulsating long period red variable stars forming the subject of this survey are asymptotic giant branch (AGB) stars of spectral types K and M. They fall into one of three categories: Mira (M), semiregular (SR), and slow irregular (L) variables. Both the M and SR category variable stars obey a period-luminosity relationship and so can be used as indicators of distance and as targets for studies of galactic kinematics. A discussion of the importance of these variable stars was written by Wożniak *et al.* (2004).

Mira variable stars have periods between 80 and 1,000 days and light amplitudes between magnitudes 2.5 and 11 in the *V*-band, although infrared amplitudes are far less than this. Results from Lockwood and Wing (1971) and Reid and Goldston (2002) suggest that $\Delta V = \Delta\ i\ (5 \pm 1)$. This is important in the current study where the measurements contributing to the light curve and to the reported amplitudes are all in the infrared.

The 1,000-day duration of phase 2 of the OGLE project means that, though it was easy to conclude that a star was variable, it was sometimes difficult to determine either the period or the full amplitude of variation of the star.

2. Object selection

The primary aim of this experiment was to devise a system for rapidly identifying previously uncatalogued Mira type variable stars, but it was not the intention at this stage to publish details of every uncatalogued Mira variable in the database. For this reason results for just ten stars are presented and there is no significance to the fact that they are all in Norma rather than Carina, Centaurus, or Scorpius.

The OGLE database contained over 10^{10} measurements of more than 40 million objects in the OGLE-II fields, so it was important to use a range of selection criteria that would facilitate the identification without also including large numbers of stars without any reliable photometry, or stars where the amplitude was too small for the stars to be classified as Mira type variables.

For this reason candidates were identified by data mining the galactic disk photometry database (Szymański 2005) for entries that matched the following criteria: mean *i*-magnitude between 8 and 14 and standard deviation of *i*-magnitude between 0.5 and 1.0. Only 166 stars matched both criteria.

Subsequent trials showed that only five stars had a standard deviation greater than 1.0. Of these, two had no photometry and three were already present in the International Variable Star Index (VSX; Watson *et al.* 2007). Reducing the lower cutoff for the standard deviation rapidly increased the number of candidate variable stars requiring study while simultaneously reducing the percentage of stars that could be classified as Mira type variables. However there is no doubt that more Mira type variables can be identified by studying fainter stars and stars with a lower standard deviation in the *i*-magnitude results.

3. Data

Identification and classification of these long period variable stars required time-resolved photometry and examination of the resultant light curve.

The OGLE photometry was examined using the SQL interface available from the OGLE website (http://ogledb.astrouw.edu.pl/~ogle/photdb/phot_query.html). Identifying candidate variable stars was a five-stage process:

- Option "Select OGLE target:"—select Galactic Disk
- Option "Select parameters database:"—select PSF photometry
- From range of parameters—select and use "Mean *I*-magnitude" with values 8 to 14
- From range of parameters—select and use "Standard deviation of *I*-magnitude" with values 0.5 to 1.0
- Select "Sexag. RA/Dec output"

A total of 166 candidate variable stars were identified using this technique. It was then possible to examine the light curve for each star by clicking on the relevant StarID in the table of results generated via the sql interface.

4. Periods and amplitudes

The intention was to determine the period, amplitude, type, and epoch of the new discoveries using the software package PERANSO (Vanmunster 2007), but there were some difficulties partly due to the *General Catalogue of Variable Stars* (GCVS; Kholopov *et al.* 1985) classification scheme for these red long period variable stars being based only on the amplitude and regularity of the visual-band variation.

Although the period and shape of the light curves obtained is typical of long period variable stars, the observed amplitude is less in the infrared band used by OGLE than it would have been in the more frequently used Johnson *V*-band. This is because infrared magnitudes are not subject to the effect of absorption by titanium oxide (TiO) that contribute significantly to the observed variation in *V*-band magnitudes.

Also, the time span of the survey, plus the seasonal nature of the observations, means that only partial coverage of a small number of cycles was obtained. This meant that in some cases neither the maxima nor minima magnitudes were reported, and so it was not always possible to determine either the full amplitude of variation or the epoch of maximum light (Greaves 2008).

In addition, many of the candidate variable stars showed substantial variation in both the shape of the light curve and in the peak magnitude reached in consecutive cycles. This was reflected in the phase plots.

5. Reliability and completeness

In the case of this survey, every entry was subject to a clerical and then to an astronomical check. The clerical check was used to ensure that the associated data files were complete and free from error, and the astronomical check was to ensure that the star was "clearly variable" based on the OGLE data and that at the time that VSX was checked—December 2008 to January 2009—that the variability of each new entry had not previously been reported.

6. Data access and light curves

All data, including phase plots, relating to the new discoveries discussed in this paper can be downloaded from http://www.martin-nicholson.info/ogle.xls.

Figures 1 through 10 illustrate the light curves of the ten Mira variable stars discovered during the course of this project, and Table 1 presents the key features of these stars. In all cases a provisional classification of M seems justified, although the previously mentioned caveats should not be ignored.

7. Summary

Ten previously uncatalogued Mira variable stars in the constellation of Norma have been identified using the publicly available data of the Optical Gravitational Lensing Experiment (OGLE) project.

8. Acknowledgements

This publication makes use of data products from *The Two Micron All Sky Survey* (Skrutskie *et al.* 2006), which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

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Table 1. Details of ten previously uncatalogued Mira variable stars.

Name	R. A. (2000) h m s	Dec. (2000) ° ' "	Max	Min	P(d)	Epoch
NOR_SC1 135123	16 13 12.80	–54 21 44.1	11.7	14.2	398	2451015
NOR_SC1 194064	16 13 22.75	–54 25 05.5	12.3	15.0	463	2450919
NOR_SC3 43905	16 15 21.26	–53 46 46.8	12.9	14.5	273	2451256
NOR_SC3 71397	16 15 53.58	–54 21 24.9	12.0	14.6	338	2451685
NOR_SC3 100580	16 15 51.86	–53 59 31.7	11.8	>14.2	331	2451597
NOR_SC4 48534	16 16 46.75	–53 41 10.4	<12.0	>14.2	359	
NOR_SC4 121227	16 17 13.57	–53 38 02.6	11.0	14.4	301	2451229
NOR_SC4 129604	16 17 06.95	–53 32 08.4	11.8	14.8	377	2451632
NOR_SC4 189185	16 17 39.19	–53 33 36.4	11.8	13.9	288	2450859
NOR_SC7 113114	16 26 06.43	–52 05 31.8	11.9	14.5	284	2450902

Notes NOR_SC1 135123 may be identical to NSV 7525, which is nominally 0.54 arc minute away.

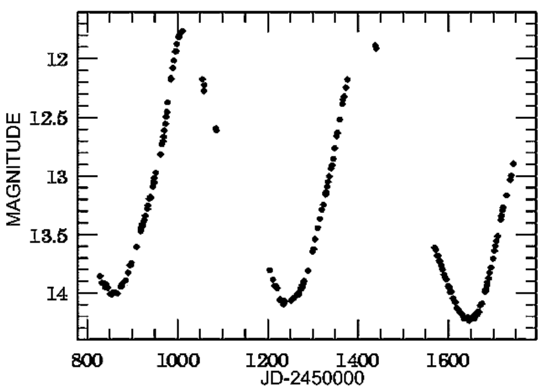

Figure 1. Light curve of NOR_SC1 135123, 2MASS J16131280-5421434.

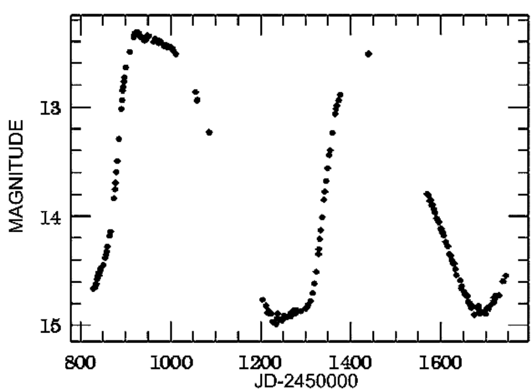

Figure 2. Light curve of NOR_SC1 194064, 2MASS J16132274-5425047.

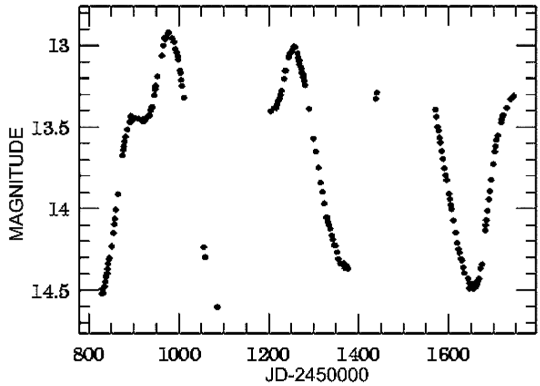

Figure 3. Light curve of NOR_SC3 43905, 2MASS J 16152132-5346459.

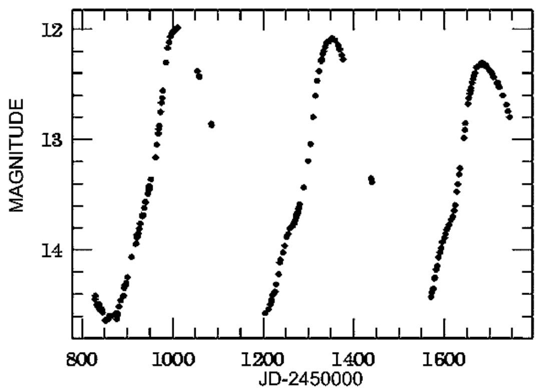

Figure 4. Light curve of NOR_SC3 71397, 2MASS J 16155358-5421244.

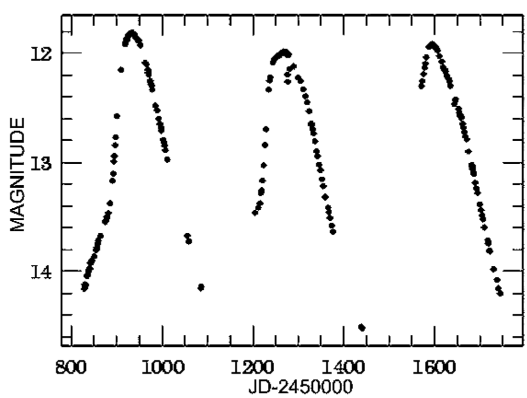

Figure 5. Light curve of NOR_SC3 100580, 2MASS J16155191-5359310.

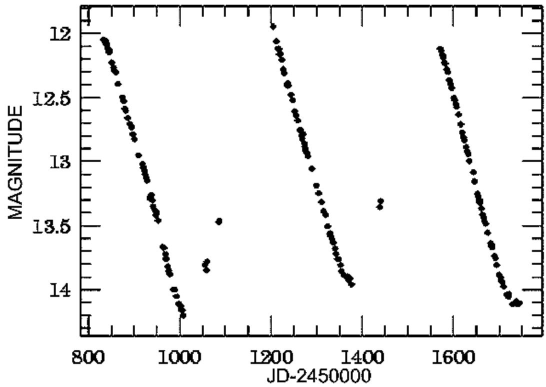

Figure 6. Light curve of NOR_SC4 48534, 2MASS J 16164682-5341095.

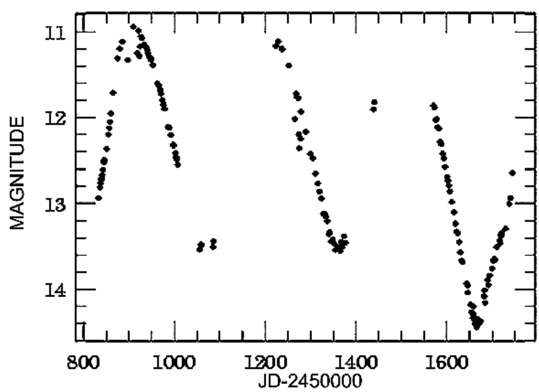

Figure 7. Light curve of NOR_SC4 121227, 2MASS J 16171367-5338016.

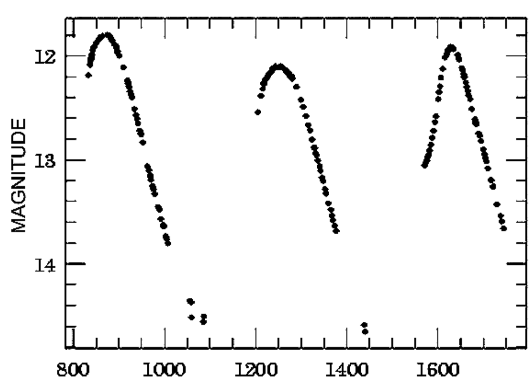

Figure 8. Light curve of NOR_SC4 129604, 2MASS J 16170706-5332073.

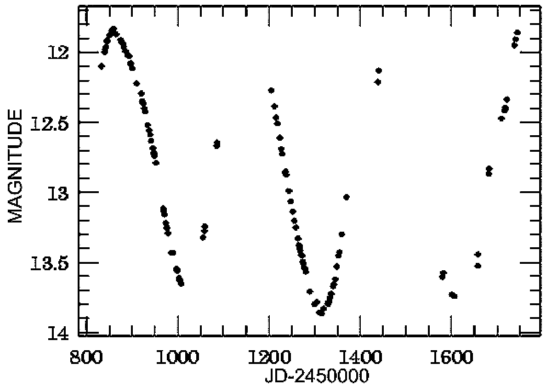

Figure 9. Light curve of NOR_SC4 189185, 2MASS J 16173928-5333355.

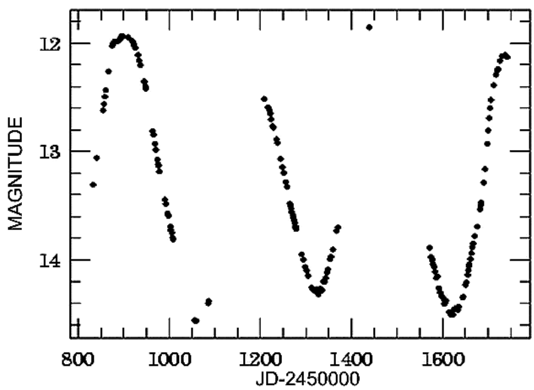

Figure 10. Light curve of NOR_SC7 113114, 2MASS J 16260650-5205316.

The Changing Nature of the Dwarf Nova BV Centauri

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Abstract A 54-year light curve of the dwarf nova BV Cen is presented. Interpretation of the curve raises possibilities including a slow decrease in mass transfer with a larger recent drop, evidence for a magnetic cycle, and a strengthened case for an unobserved nova eruption some time in the past.

1. Introduction

BV Centauri is a well observed dwarf nova listed in the *General Catalogue of Variable Stars* (GCVS; Kukarkin *et al.* 1971) as UGSS type, with a quiescent visual range of 12.8–13.3 mag, and an outburst period of 149.4 days (Kukarkin *et al.* 1971). Warner (1995) lists the orbital period as 0.61day and a secondary spectrum of G5-8V. Frank Bateson of the Variable Star Section of the Royal Astronomical Society of New Zealand (VSS RASNZ) put the object on their observing program in 1954, instigating decades of observation. Later, other observations went to the AAVSO. The recent merging of the two databases has made this information very easily accessible. For this work, the *All Sky Automatic Survey* (ASAS; Pojmański 2002) observations of BV Cen have also been added. In total, there is almost perfect coverage from 1954 until recent years, when an annual break occurs. One of us (AP) has observed the object for several years, including the last two outbursts.

2. Observations

The complete observations have been plotted using PERANSO software (Vanmunster 2005), and the resulting light curve is presented in Figure 1. No distinction is necessary between the AAVSO, RASNZ, and ASAS data sets because the visual and electronic observation sets both have excellent coverage, and no magnitude correction is required. Next, the number of days between outburst peaks was measured and plotted in Figure 2. The triangles are the maxima of the major outbursts, and the squares represent peaks that only went to 12.0 magnitude. The determination of the 12th magnitude peaks is rather subjective, as there is no clear distinction between the quiescent noise and (real) flickering, and the smaller maxima. However, note that many of these minor peaks are as clearly defined in the data as the full outbursts.

3. Discussion

Although a real statistical analysis is outside the present scope, there is much to be gleaned from these two figures. Figure 1 shows clearly that the outburst behavior of the object has changed in recent years. Obviously, the GCVS 149.4-day average is no longer safe to apply. In fact, Figure 2 shows that the average time between outbursts has been increasing gradually over time, possibly from the beginning of the data.

Concerning the minor peaks (Figure 2, squares), while there do appear to be some interesting features worthy of attention (e.g., possible clustering and an apparent cessation since December 2001), no further analysis is done here. Only the full outbursts are discussed below.

The major peaks (triangles) in Figure 2 imply much. The increasing period between outbursts is possibly indicative of decreasing mass transfer from the secondary star, resulting in slower build up in the disc before outburst (Warner 2008). Menzies *et al.* (1986) put forward the idea that BV Cen had an unobserved classical nova eruption a century or more ago, and this current behavior is to be expected if that is indeed the case. It is not impossible such an outburst was missed. While there were fine observers in the south during the 19th century, not the least being John Tebbutt (1834–1916) in Australia, the fact remains there were fewer observers than in the northern hemisphere.

Concerning the dramatic recent increase in period between outburst peaks, Warner (2008) suggests that some critical point has been passed in the reduction of mass transfer, or that some as yet unknown characteristic has changed in the disc. Coincident with this major change in behavior, the quiescent magnitude dropped by 0.5 magnitude or so, and has been slowly rising since. In passing we note that the visual comparison sequence has remained unchanged through almost the entire 54-year period, only being revised in 2007–2008 (Morel 2008).

The shape of the outbursts are worthy of note. As noted by Menzies *et al.* (1986), BV Cen has a slow rise to a peak and a slow fall similar to the old classical nova and now dwarf nova GK Per ($p \approx 1000$ days). A more typical dwarf nova eruption has a faster rise, a plateau of some sort, and a faster decline. Compare the light curves of BV Cen and GK Per with the dwarf nova prototypes U Gem and SS Cyg in Figure 3. Although the outburst shape of BV Cen does show variations (Bateson 1974), and sometimes even a brief standstill (as can GK Per), no outburst of BV Cen examined in these data shows a plateau. With the increase in period found here combined with shape of the outbursts, BV Cen now resembles GK Per significantly more than the U Gem or SS Cyg prototypes.

A possible solar-like magnetic cycle might be discernable in Figure 2. The ~8 year oscillations of increasing amplitude visible in the later two thirds of the figure may be interpreted as a magnetic cycle in the G5-8V secondary star.

Such a process, located at the base of the convective layer, could cyclically increase the radius of the secondary, thus similarly increasing the mass transfer through the L1 point (Warner 1995, 2008).

4. Conclusion

The changing nature of the light curve of BV Cen warrants further study, whatever the cause. What is the meaning of the smaller outbursts and their apparent cessation? What is their relationship to the full outbursts? Are the above interpretations of Figure 2 correct? Has there indeed been some critical point reached in the reduction of mass transfer, and why?

The most recent outburst, that of September 2008, was observed by only two people (known so far at least; one of us (AP) and Rod Stubbings of Australia, both visual observers) plus the ASAS. Three observers is an absolute minimum to be sure of catching an outburst. It is hoped that more observers will participate in the long term study of BV Cen.

5. Acknowledgements

I acknowledge gratefully all the observers of the AAVSO and VSS RASNZ, and in particular Albert Jones, who is almost entirely responsible for the early years of observations. Dr. Brian Warner has provided invaluable assistance and insight.

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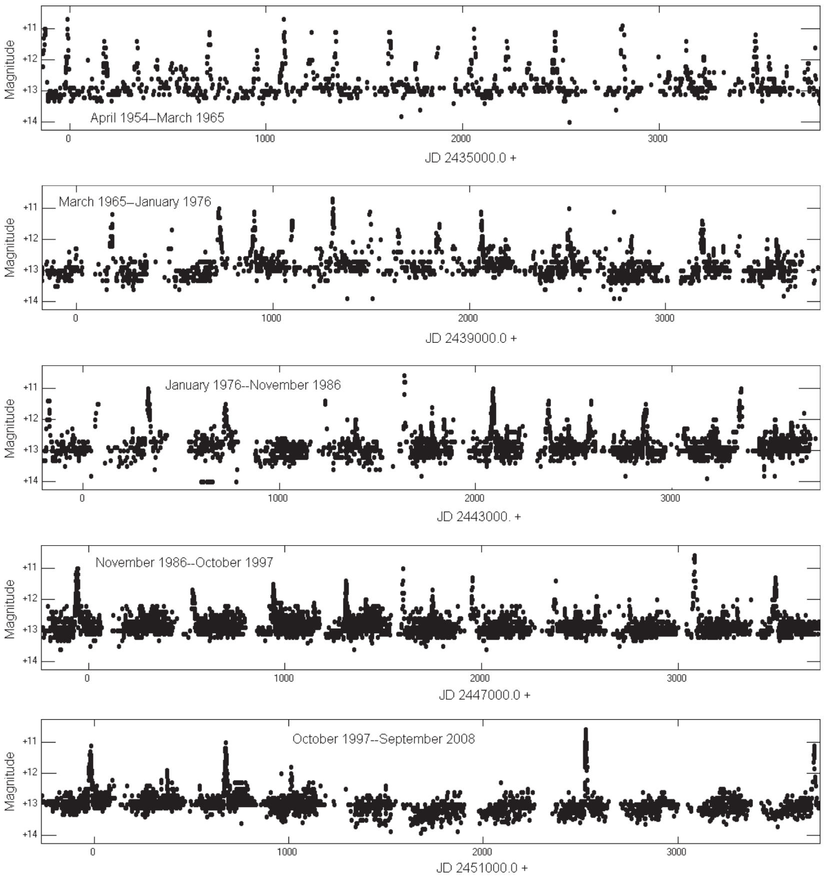

Figure 1. The Light curve of BV Cen using the observations of the RASNZ, AAVSO, and ASAS. No distinction is made between visual and *V* data.

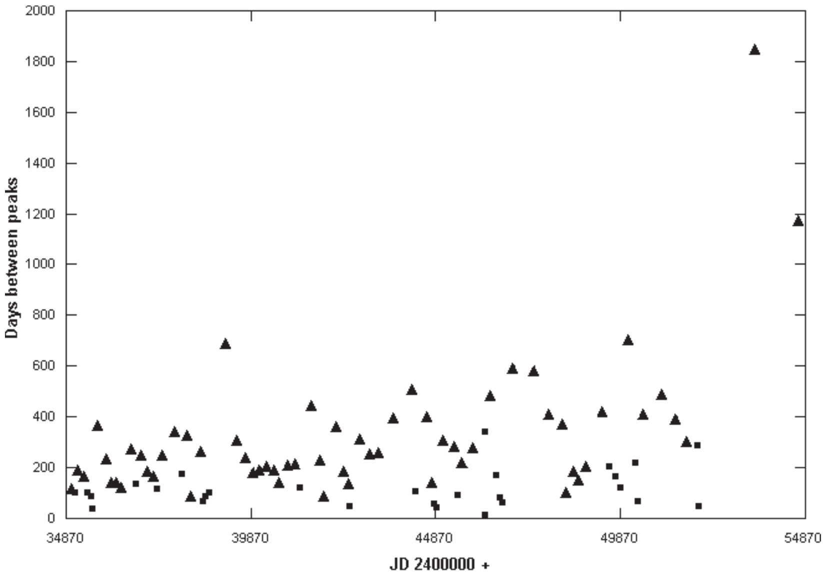

Figure 2. The number of days between outburst peaks of BV Cen. Triangles are normal outbursts; squares are outbursts that go only to 12.0 magnitude.

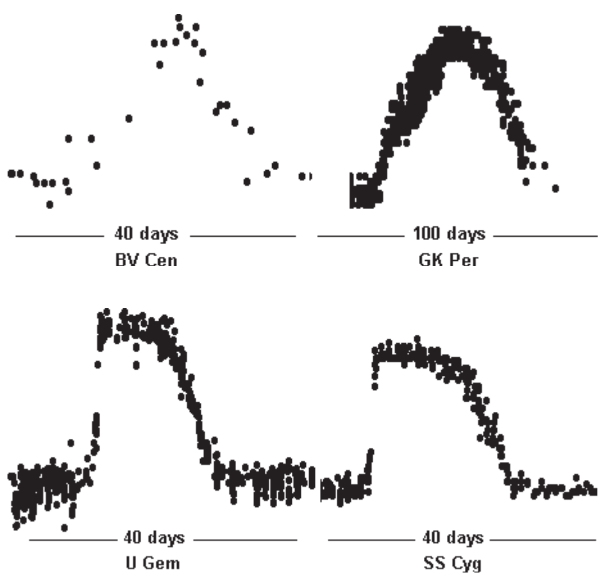

Figure 3. Examples of outbursts from the light curves of BV Cen, GK Per, U Gem, and SS Cyg. The BV Cen excerpt is the last outburst shown in Figure 1, and the GK Per, U Gem, and SS Cyg data are extracted from the AAVSO International Database.

Two-Color Photometry of the Double-Mode RR Lyrae Star NSVS 5222076

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Abstract Observations of double-mode RR Lyrae stars are especially useful to modelers because their two independent pulsation periods allow a unique determination of the star's mass. Only recently identified as an RRd field star, NSVS 5222076 is bright and well-placed for Northern Hemisphere observers. Photometry time-series data were acquired in both the *V* and *I* bands. The *V* data, when combined with those of Oaster, Smith, and Kinemuchi (2006), allowed the periods to be determined more precisely as $P_0 = 0.49405$ day and $P_1 = 0.36690$ day. The amplitude ratio, A_0/A_1, was found to be about 1.4. Time variation of *V–I* color was also determined.

1. Introduction

The *Northern Sky Variability Survey* (NSVS; Wożniak *et al.* 2004) contains unfiltered photometry data, taken over a one-year baseline, for approximately fourteen million objects in the magnitude range $8.0 \leq m_V \leq 15.5$. From that database, Oaster (2005) discovered the nature of NSVS 5222076 as a double-mode RR Lyrae (RRd) star. Oaster, Smith, and Kinemuchi (2006, cited as OSK hereafter) followed up on her discovery by making 1,570 *V*-band observations of the star on sixteen nights over a 108-day baseline. From analysis of their data, they confirmed the star's double-mode nature, and determined its fundamental and first-overtone pulsation periods to be 0.4940 ± 0.0001 day and 0.3669 ± 0.0002 day, respectively.

NSVS 5222076 (=GSC 03059-00636) is a 13th magnitude field star located in Bootes (R.A. $15^h 46^m 26^s$; Dec. +44° 18' 47" (J2000.0)), conveniently located for Northern Hemisphere observers. For most RRd stars, the amplitude of the first-overtone mode pulsation is greater than the amplitude of the fundamental-mode pulsation. However, NSVS 5222076 is unusual among RRd stars in that its fundamental mode is dominant. Indeed, OSK measured the amplitude ratio for the fundamental and first-overtone modes, A_0/A_1, to be approximately 2. They pointed out that this unusually high amplitude ratio makes NSVS 5222076 a rarity, even among those RRd stars that have relatively strong fundamental-mode pulsation.

Observations of RRd stars and their cousins, the double-mode ("beat") Cepheids, are especially useful to modelers because their two independent pulsation periods allow a unique determination of the star's mass (Clementini *et al.* 2004; Cox 1980).

2. Objectives

The objectives for the work reported herein were as follows:

a. Observe NSVS 5222076 in the *V*-band over a sufficiently long baseline to allow the shape of its light curve to be ascertained and its pulsation periods to be determined.

b. By combining these data with the *V*-band photometric data of OSK, expand the time baseline of observations, thereby permitting more precise determination of the pulsation periods and their ratio, P_1/P_0.

c. Contiguously with the above *V*-band observations, observe the star in the *I*-band. A light curve for NSVS 5222076 in the *I*-band has not previously been reported in the literature, so this would be a scientifically new result.

d. Determine the ratio of amplitudes, A_0/A_1, of the deconvolved fundamental and first-overtone modes for both wavelength bands.

e. From the contiguous *V*-band and *I*-band observations, determine the variation of *V–I* color as a function of time. This would also be a scientifically new result for NSVS 5222076.

3. Equipment and methods

The telescope used for this study was a Meade 40-cm (16-in) Schmidt-Cassegrain, permanently mounted at the author's Toby Point Observatory on the south coast of Rhode Island. On fourteen nights, between JD 2454631 and 2454720, continuous, alternating *V*-band and *I*-band exposures were made, starting shortly after twilight and ending when the star disappeared behind the observatory's roof. A total of 1,109 *V*-band and 1,051 *I*-band images were made, using a Santa Barbara Instrument Group (SBIG) ST-8XME CCD camera, with its pixels binned 2 × 2 to increase sensitivity. The filters used were Johnson-*V* and Cousins-*I* from Custom Scientific.

Differential photometry of NSVS 5222076 was performed with AIP4WIN version 1.4 (Berry and Burnell 2000). GSC 03059-00534 was used as the comparison star, where $V = 14.035$, $I = 13.385$, and $V–I = 0.650$. GSC-03060-00055 was used as the check star, for which $V = 13.576$, $I = 12.810$, and $V–I = 0.766$. Henden (2008) performed the photometric calibration of the star field in April 2008, using the robotic telescope at Sonoita Research Observatory near Sonoita, AZ. This calibration is available at ftp://ftp.aavso.org/public/calib/g3059.dat.

Period analysis was performed with the Deeming discrete Fourier transform (DFT) algorithm as provided in PERANSO version 2.20 (Vanmunster 2005).

4. Photometric uncertainty

The photometric uncertainty for both the 1,109 *V*-band and 1,051 *I*-band images was ±0.025 magnitude. While this uncertainty level was entirely adequate for period analysis with PERANSO, it proved to be too high for a precise determination of *V–I* color. To improve the signal-to-noise ratio, it became necessary to digitally stack images, and then redo the photometry. This approach resulted in 235 stacked *V*-band images, 231 stacked *I*-band images, and a photometric uncertainty of ±0.009 magnitude, or better.

5. Results

Figure 1 shows the phase curve resulting from differential photometry of the stacked *V*-band images from the present study, combined with the 1,570 points from Michigan State's *V*-band photometry (OSK 2006). While the agreement of the two datasets is gratifying, the chief advantage of combining them is that it expands the time baseline of observations (from 89 and 108 days, respectively) to 1,306 days, thereby permitting more precise determination of the pulsation periods. By use of the Deeming DFT algorithm, the fundamental and first-overtone periods were, respectively, determined to be $P_0 = 0.49405 \pm 0.00007$ day and $P_1 = 0.36690 \pm 0.00003$ day. The period ratio, P_1/P_0 is, therefore, 0.7426 ± 0.0001, in good agreement with the 0.743 value found by OSK. Note in the figure the presence of a bump prior to the rise to maximum. In RRab stars, such bumps are usually attributed to shock wave phenomena. OSK suggest that the interplay of the two pulsation modes modulates the amplitude of the bump.

Figures 2 and 3 show *V*-band phase curves from the present study for the deconvolved pulsation modes of NSVS 5222076. Figure 2 is plotted for the fundamental period of 0.49405 day, while Figure 3 is plotted for the first-overtone period of 0.36690 day. The different symbols for the data points represent the fourteen different observation nights. From these curves, the amplitude ratio, A_0/A_1, for the fundamental and first-overtone modes is estimated to be about 1.4, a value significantly less than the OSK estimate of "approximately 2." A gain in strength of the first-overtone mode relative to the fundamental mode would suggest rapid blueward evolution of the star on the horizontal branch (Clementini *et al.* 2004) over the three-year interval between the OSK observations and those of the present study. Further observations are needed to verify this result, which may perhaps indicate that NSVS 5222076 is in the process of changing its dominant pulsation mode from fundamental to first-overtone.

Figures 4 and 5 show phase curves for the deconvolved pulsation modes in the *I*-band. An *I*-band light curve for NSVS 5222076 has not previously been reported. The amplitudes of the *I*-band curves are about 60% those of their counterparts in the *V*-band. Hence, the amplitude ratio, A_0/A_1, for the fundamental and first-overtone modes is again found to be about 1.4.

Figure 6 is a graph of the time-variation of *V–I* color, determined from contiguous *V*-band and *I*-band observations. The values of *V–I* in Figure 6 vary over the range from +0.52 at the red end to +0.25 at the blue end. It would be of interest to assign values of effective temperature, T_{eff}, to those limits. However, further consideration reveals a number of difficulties in doing so. First, there is the issue of estimating the reddening. If we estimate a mean visual magnitude of 12.85 from Figure 1, and accept an absolute visual magnitude value of +0.71 for RR Lyrae stars in the galactic halo (Layden *et al.* 1996), we can calculate a distance for NSVS 5222076 of 2,680 parsecs, assuming no extinction. However, we know that even though it is out of the galactic plane, there must be extinction and reddening for a star at that apparent distance, i.e., it is both closer and bluer than it appears. The second difficulty in assigning values of effective temperature to Figure 6 is that T_{eff} is a function of metallicity, among other things, and the metallicity of NSVS 5222076, a Population-II star, has not been determined. So, it is clear that assigning values of T_{eff} to Figure 6 would be complicated, and that attempting to do so would likely be more misleading than informative. However, the amplitude of *V–I* color variation measured relative to the mean, $\Delta(V\text{–}I) = 0.14$, is less dependent on the factors mentioned above, so is likely to be reliable.

6. Acknowledgements

The author gratefully acknowledges AAVSO Director, Arne Henden, for helpful discussions of the work as it progressed, and for providing his Sonoita Research Observatory photometric calibration of the star field. The author also expresses his appreciation to an unknown referee for constructive suggestions that have enhanced the scientific content of this paper.

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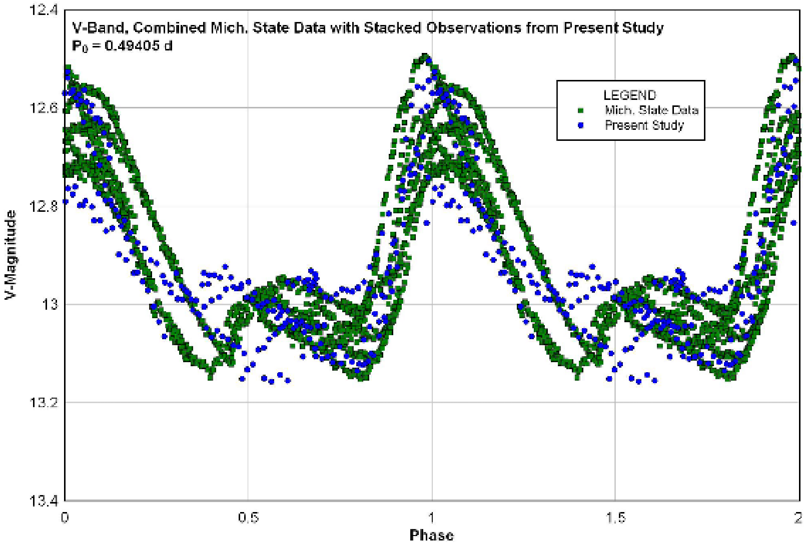

Figure 1. Phase curve for the Michigan State Univ. data of OSK, plus *V*-band photometry of 235 stacked images of NSVS 5222076.

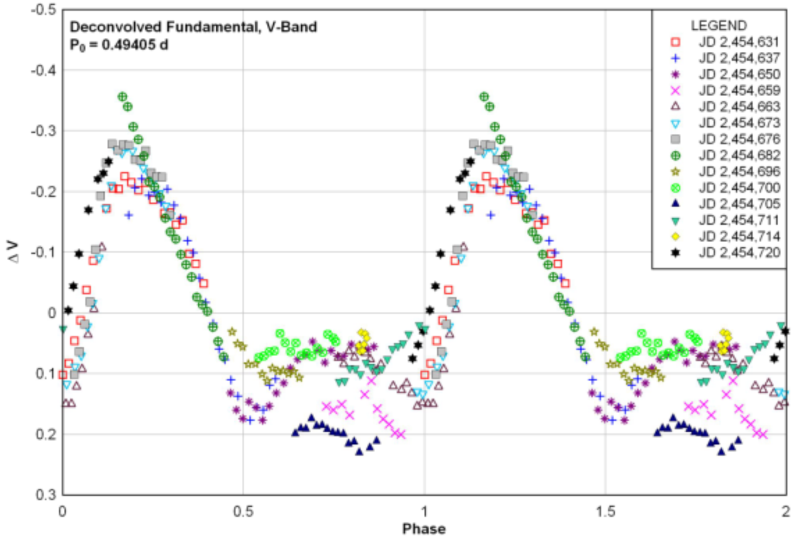

Figure 2. Deconvolved fundamental of NSVS 5222076. Phase curve for *V*-band photometry of 235 stacked images.

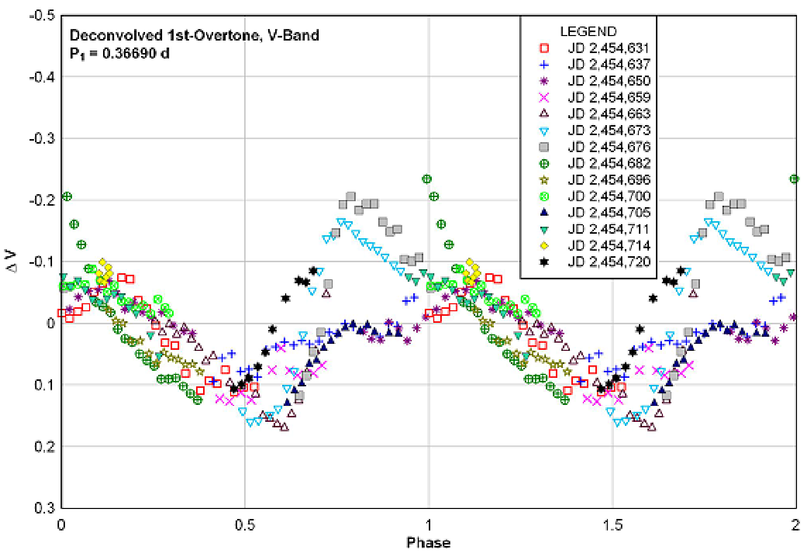

Figure 3. Deconvolved first-overtone of NSVS 5222076. Phase curve for *V*-band photometry of 235 stacked images.

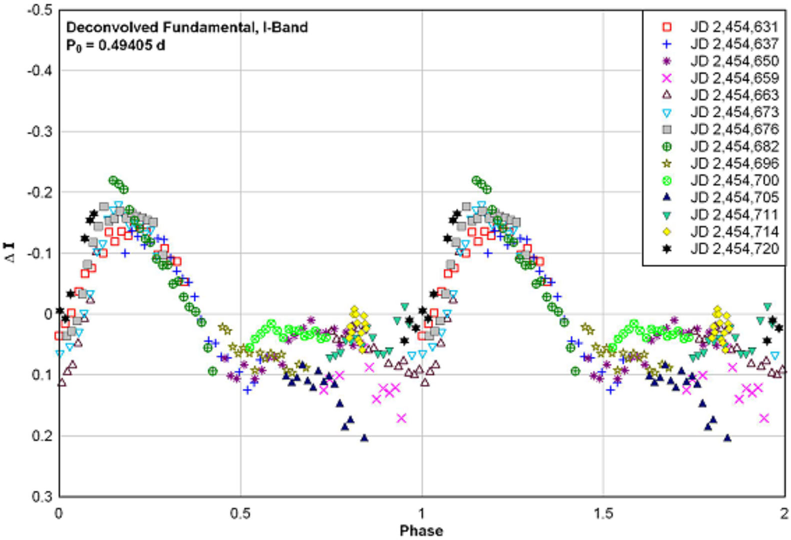

Figure 4. Deconvolved fundamental of NSVS 5222076. Phase curve for *I*-band photometry of 231 stacked images.

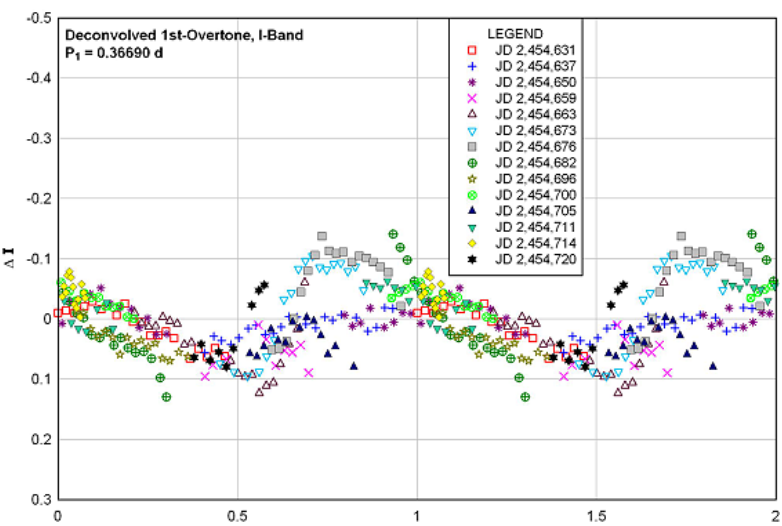

Figure 5. Deconvolved first-overtone of NSVS 5222076. Phase curve for *I*-band photometry of 231 stacked images.

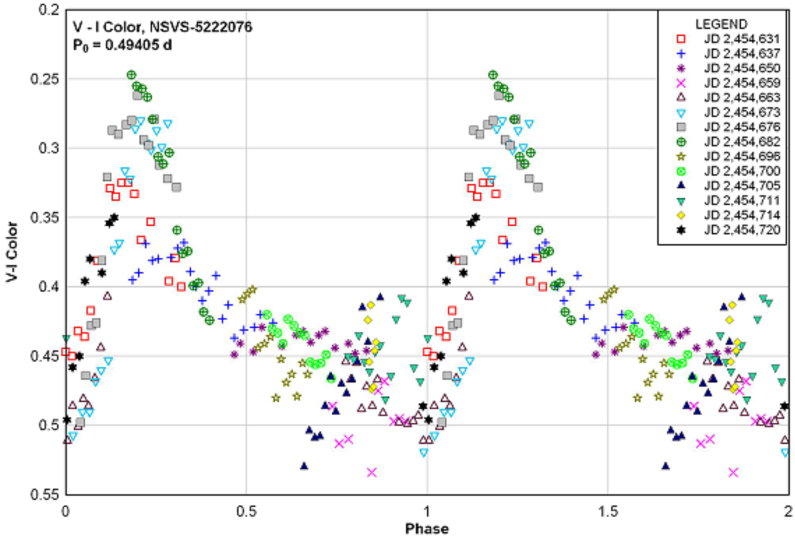

Figure 6. Phase curve for the *V–I* color of NSVS 5222076.

Consecutive Eclipses of Z Chamaeleontis in Outburst

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Abstract Observations of two consecutive eclipses of the dwarf nova Z Chamaeleontis are presented. The results obtained confirm that neither the linear, quadratic, nor sinusoidal ephemeris presented in the astronomical literature appear to model accurately the observed period changes.

1. Introduction

Z Chamaeleontis is a dwarf nova of the SU Ursae Majoris subtype. This type of variable star consists of a close binary pair made up of white dwarf primary star with a surrounding accretion disk and a K-M dwarf or sub-giant secondary star that has filled its inner Roche lobe. Matter transfer takes place through the inner Lagrangian point of the secondary star to this accretion disk. The "hot spot" is where the material reaches the disk and it is the interactions within this disk that give rise to the observed outbursts. In the specific case of Z Cha, the white dwarf, the accretion disk, and the hot spot are eclipsed every 107 minutes by the red dwarf secondary star (Wood *et al.* 1986).

2. Observations

Z Cha was observed with a 0.25-meter telescope and a SBIG ST-10XM CCD camera situated at the Riverland Dingo Observatory in Moorook, South Australia. The *f*/6 focal ratio gave a scale of 0.93 arc second per pixel and a field of view of 34 × 22.9 arc minutes. An exposure time of 30 seconds was used with a *V*-band filter. The signal-to-noise ratio at minimum light was 150. Subsequent image processing was carried out using the software package MAXIM DL version 3.22 (Diffraction Limited 2004). Information about the comparison and check stars can be found in Table 1.

3. Light curves

Z Cha was in outburst when the two observing runs took place. Figure 1 shows the *V* magnitude versus time for the first observing run on the night of February 18, 2008. Figure 2 shows the *V* magnitude versus time for the second run on the same night. In both cases the time of minimum light was calculated using the software package PERANSO (Vanmunster 2007) and the results are presented in Table 2.

As the bright spot rotates into view it results in a "hump" in the light curve prior to the onset of the eclipse. The rapid flickering, characteristic of dwarf novae, can best be seen in the second light curve after the end of the eclipse.

4. Results and analysis

At different times the ephemeris for Z Cha has been represented by a linear (Kreiner 2004), quadratic (Cook and Warner 1981), and a sinusoidal (Baptista *et al.* 2002) equation. The O–C results using the different equations from the three sources are presented in Table 3.

Baptista *et al.* present compelling evidence for the rejection of the quadratic ephemeris and that a linear plus sinusoidal ephemeris is preferable to a purely linear one. However, the analysis contains the caveat that the observed variation is "not sinusoidal or, most probably, is not strictly periodic."

The results obtained in 2008 support these contentions. The O–C value for the quadratic ephemeris, at over 24 minutes, is far outside any possible error in the timings taken. At under five minutes the O–C value for the sinusoidal ephemeris is the smallest of the three but is still outside the range of experimental error.

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Table 1. Z Cha comparison and check stars.

Designation	*R.A. (2000)*	*Dec. (2000)*	*V mag. (AAVSO)**
Comp GSC 9394–1549	08^h 09^m 06.8^s	–76° 32’ 14.8”	12.59
Check GSC 9394–2743	08^h 09^m 13.9^s	–76° 33’ 38.3”	12.78

**The V magnitudes were obtained from the AAVSO chart for Z Chamaeleontis.*

Table 2. Z Cha time of minimum light.

Run number	*Minimum light (JD)*	*Error (JD) ±*	*Minimum light (HJD)*
1	2454515.128110	0.000169	2454515.128112
2	2454515.202871	0.000126	2454515.202875

Table 3. Z Cha O–C values for the two imaging runs.

Source	*Equation type*	*O–C run #1*	*O–C run #2*	*Cycle number*
Kreiner	Linear	–0.00426 day	–0.00400 day	27048 and 27049
Cook	Quadratic	–0.01724 day	–0.01698 day	191283 and 191284
Baptista	Sinusoidal	–0.00333 day	–0.00307 day	191283 and 191284

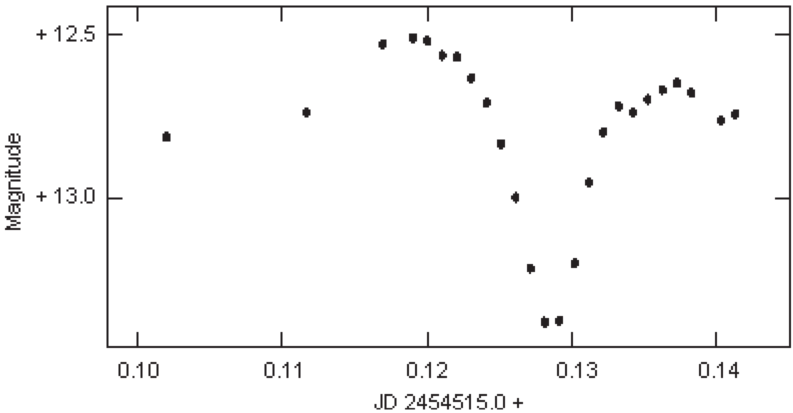

Figure 1. *V* magnitude versus time for the first observing run of Z Cha.

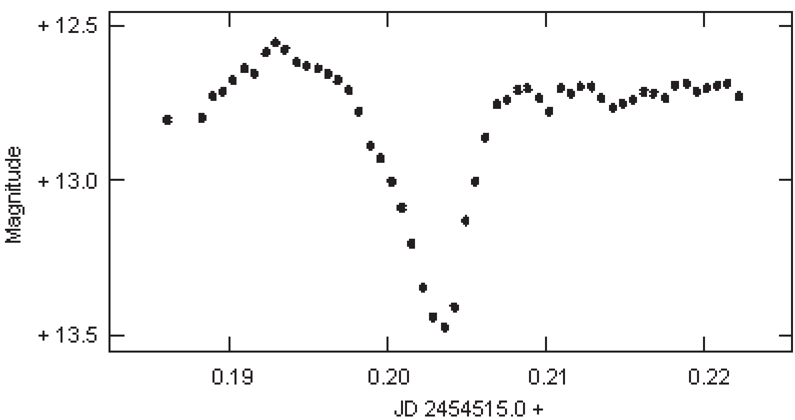

Figure 2. *V* magnitude versus time for the second observing run of Z Cha.

Eclipses of OY Carinae in Outburst

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Abstract Observations of two eclipses of the dwarf nova OY Carinae are presented. The results obtained confirm that neither of the linear ephemerides presented in the astronomical literature appear to model accurately the observed results. Quadratic and sinusoidal alternatives are assessed and both appear to offer closer, but not perfect, predictive tools.

1. Introduction

OY Carinae is a dwarf nova of the SU Ursae Majoris subtype. This type of variable star consists of a close binary pair with a Roche lobe-filling secondary star transferring matter in a well-defined stream through the inner Lagrangian point of the secondary star to an accretion disk around a white dwarf primary star. The "hot spot" is where the material reaches this disk and it is the interactions within this disk that give rise to the observed outbursts. In the specific case of OY Car, the white dwarf and the hot spot are eclipsed by the secondary star every 91 minutes (Greenhill *et al.* 2006).

2. Observations

OY Car was observed with a 0.25-meter telescope and a SBIG ST-10XM CCD camera situated at the Riverland Dingo Observatory in Moorook, South Australia. The *f*/6 focal ratio gave a scale of 0.93 arc seconds per pixel and a field of view of 34 × 22.9 arc minutes. Multiple 30-second unfiltered exposures were made throughout both observing runs. Subsequent image processing was carried out using the software package MAXIM DL version 3.22 (Diffraction Limited 2004). Information about the comparison and check stars can be found in Table 1.

3. Light curves

Figure 1 shows the light curve for the first observing run on March 21, 2008. Figure 2 shows the light curve for the second run on March 27, 2008. In both cases the time of minimum light was calculated using the software package PERANSO (Vanmunster 2007) and the results are presented in Table 2.

As the bright spot rotates into view it results in a "hump" in the light curve prior to the onset of the eclipse. This can best be seen in the second light curve. It should be noted that although the pre- and post-eclipse magnitudes differ by 0.1 on March 21 there is no such difference on March 28.

The rapid flickering, characteristic of dwarf novae, can best be seen in the second light curve after the end of the eclipse.

4. Results and analysis

At various times the ephemeris for OY Car has been represented by two different linear equations (Wood *et al.* 1989; Samus *et al.* 2008), a quadratic equation (Greenhill *et al.* 2006), and a sinusoidal equation (Greenhill *et al.* 2006). Details of the four equations and the O–C results obtained using these four different equations from the three sources are presented in Table 3.

Greenhill *et al.* present strong evidence for rejecting a linear ephemeris and the results obtained in 2008 support this. The O–C value for both the linear equations, at between 2.9 and 3.5 minutes, is outside any possible error in the timings taken.

Both the quadratic (O–C between 20 and 60 seconds) and the sinusoidal ephemeris (O–C between 4 and 36 seconds) remain viable options although the analysis by Greenhill *et al.*(2006) contains the caveat that both alternative models still have, "highly significant systematic deviations with time-scales of years."

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Table 1. Comparison and check stars.

Designation	R.A. (2000)	Dec. (2000)	Assumed mag
Comp GSC 9214-0727	$10^h\ 05^m\ 48.9^s$	–70° 17’ 11.0”	12.50
Check GSC 9214-0973	$10^h\ 05^m\ 38.2^s$	–70° 16’ 47.6”	n/a

The assumed magnitude used for the preparation of the light curve in PERANSO *(Vanmunster 2007) is not crucial for the estimation of the time of minimum light. However, it is important to note that although OY Carinae had faded significantly in the six days between the two observing runs, "changes in the eclipse light curve do not contribute to the observed changes in orbital period" (Greenhill et al. 2006).*

Table 2. Time of minimum light.

Run # Date	Minimum Light (JD)	Error (JD) ±	Minimum Light (HJD)	Minimum Light (HJED)
1. 03 21 2008	2454547.178290	0.000108	2454547.180031	2454547.180785
2. 03 27 2008	2454553.175111	0.000089	2454553.176977	2454553.177731

Table 3. O–C values for the two imaging runs.

Source	Equation Type	O–C run #1 (days)	O–C run #2 (days)	Cycle number
Wood	Linear Equation[1]	–0.002167	–0.001709	167197 and 167292
GCVS	Linear Equation[2]	–0.002457	–0.001999	167197 and 167292
Greenhill	Quadratic Equation[3]	+0.000229	+0.000691	167197 and 167292
Greenhill	Sinusoidal Equation[4]	–0.000044	+0.000414	167197 and 167292

For equations (1), (3), and (4) below, the O–C values were calculated using the time of minimum light expressed in HJED. For equation (2), the O–C value was calculated using the time of minimum light expressed in HJD.

[1] $HJED = (2{,}443{,}993.553839 \pm 9) + (0.0631209239 \pm 5)\ E$

[2] $HJD = 2{,}443{,}993.553241 + 0.0631209247\ E$

[3] $HJED = 2{,}443{,}993.553813 + 0.0631209343E - (1.47 \times 10^{-13})\ E^2$

[4] $HJED = 2{,}443{,}993.55406 + 0.0631209126E + (5.3 \times 10^{-4}) \sin(2\pi\ (E - 1.7 \times 10^{-4})/2 \times 10^5)$

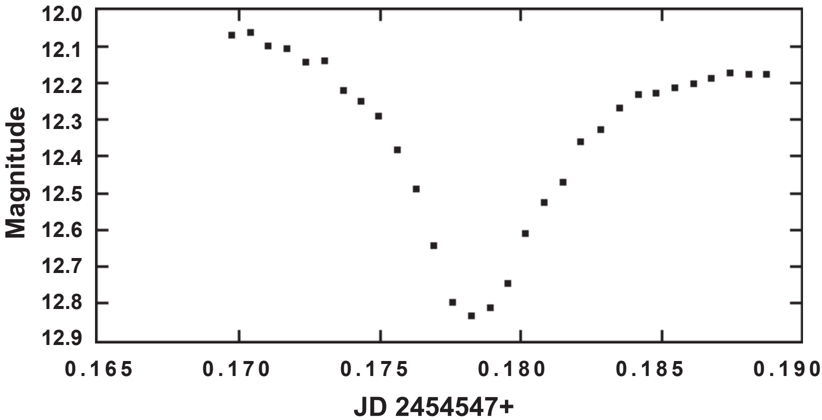

Figure 1. OY Car plot of magnitude versus time for the first observing run, March 21, 2008 (clear filter but using *V*-band comparison star magnitudes).

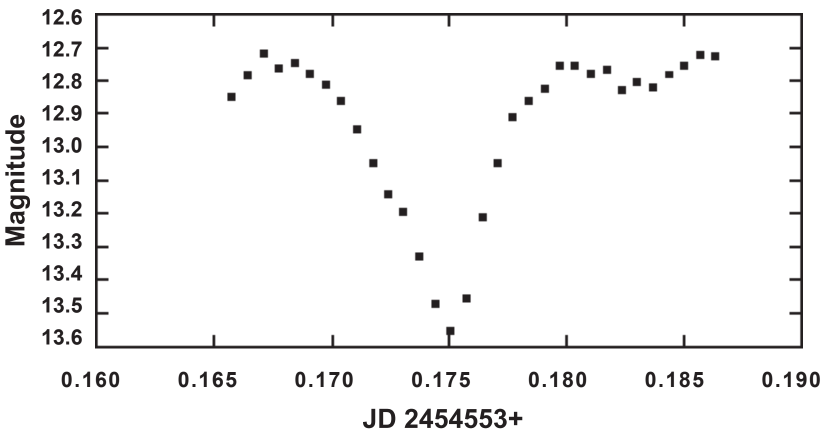

Figure 2. OY Car plot of magnitude versus time for the second observing run, March 27, 2008 (clear filter but using *V*-band comparison star magnitudes).

Recent Minima of 154 Eclipsing Binary Stars

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Abstract This paper continues the publication of times of minima for eclipsing binary stars from observations reported to the AAVSO Eclipsing Binary Committee. Times of minima from observations made from September 2008 through February 2009 are presented.

1. Recent Observations

The accompanying list contains times of minima calculated from recent CCD observations made by participants in the AAVSO's eclipsing binary program. This list will be web-archived and made available through the AAVSO ftp site at ftp://ftp.aavso.org/public/datasets/jsamoj371.txt. This list, along with eclipsing binary data from earlier AAVSO publications, is also included in the Lichtenknecker database administrated by the Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV) at http://www.bav-astro.de/LkDB/index.php?lang=en. These observations were reduced by the observers or the writer using the method of Kwee and Van Worden (1956). The standard error is included when available.

The linear elements in the *General Catalogue of Variable Stars* (GCVS; Kholopov *et al.* 1985) were used to compute the O–C values for most stars. For a few exceptions where the GCVS elements are missing or are in significant error, light elements from another source are used: CD Cam (Baldwin and Samolyk 2007), CW Cas (Samolyk 1992a), DV Cep (Frank and Lichtenknecker 1987), Z Dra (Danielkiewicz-Krośniak and Kurpińska-Winiarska 1996), DF Hya (Samolyk 1992b), DK Hya (Samolyk 1990), GU Ori (Samolyk 1985). O–C values listed in this paper can be directly compared with values published in recent numbers of the AAVSO *Observed Minima Timingsof Eclipsing Binaries* series.

The number of observations used for determination of each time of minimum is given under *N* in the table when available.

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Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program.

Star	*HJD(min) 2400000+*	*Cycle*	*O–C*	*N*	*Type*	*Observer**	*Standard Error*
RT And	54813.5504	21738	–0.0084	62	CCD	SAH	0.0001
TW And	54781.7489	3823	–0.0265	79	CCD	SAH	0.0005
UU And	54750.6325	8814	0.0796	77	CCD	SAH	0.0004
UU And	54814.5454	8857	0.0817		CCD	MZK	0.0002
WZ And	54729.8375	19920	0.0481	90	CCD	MZK	0.0003
XZ And	54799.7876	22709	0.1700	113	CCD	SAH	0.0001
XZ And	54863.5797	22756	0.1700	56	CCD	SAH	0.0002
AD And	54816.5361	16035.5	–0.0583	85	CCD	SAH	0.0003
BD And	54744.5451	42735	0.0153	76	CCD	MZK	0.0001
BX And	54781.5507	29917	–0.0476	88	CCD	SAH	0.0002
CX Aqr	54771.6421	32947	0.0098	108	CCD	SAH	0.0001
CZ Aqr	54792.5648	13238	–0.0417	89	CCD	SAH	0.0001
XZ Aql	54751.5339	6006	0.1518	70	CCD	SAH	0.0004
OO Aql	54708.3580	31759	0.0405	112	CCD	CLZ	0.0003
OO Aql	54727.6159	31797	0.0404	100	CCD	SAH	0.0001
OO Aql	54730.4054	31802.5	0.0426	150	CCD	CLZ	0.0005
V346 Aql	54725.6320	11576	–0.0101	181	CCD	MZK	0.0001
RX Ari	54769.6778	15900	0.0547	135	CCD	SAH	0.0002
RX Ari	54870.5838	15998	0.0574	95	CCD	SAH	0.0004
RY Aur	54873.5910	6085	0.0238	79	CCD	SAH	0.0002
TT Aur	54877.8088	25238	–0.0135	105	CCD	SAH	0.0004
ZZ Aur	54831.1930	48779	0.0160	232	CCD	VJA	0.0001
AP Aur	54797.7709	21698	1.2193	80	CCD	SAH	0.0003
AP Aur	54877.7728	21838.5	1.2328	70	CCD	SAH	0.0003
CL Aur	54799.7670	17545	0.1298	118	CCD	SAH	0.0001
CL Aur	54885.6298	17614	0.1315	102	CCD	SAH	0.0002
EP Aur	54781.7934	48176	0.0100	39	CCD	MZK	0.0002
EP Aur	54871.6304	48328	0.0138	124	CCD	SAH	0.0004
HP Aur	54834.6609	8489	0.0521	69	CCD	PRX	0.0001
IM Aur	51919.487	9143	–0.087	15	CCD	CK	
IM Aur	54834.4074	11480	–0.0972	55	CCD	CLZ	0.0007
TU Boo	54871.8062	67241.5	–0.1287	61	CCD	MZK	0.0001
TY Boo	54861.8474	64264.5	0.0840	85	CCD	MZK	0.0001
TZ Boo	54869.8947	51275	0.0713	116	CCD	MZK	0.0001
VW Boo	54610.3791	68464.5	–0.1574	53	CCD	SFV	0.0002
ZZ Boo	42928.7171	874	0.0136	27	PEP	RNN	0.0004
AR Boo	54680.3421	43239.5	0.0879	42	CCD	SFV	0.0002
Y Cam	54799.7163	3581	0.3478	89	CCD	SAH	0.0002

Table continued on following pages

Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program, cont.

Star	*HJD(min) 2400000+*	*Cycle*	*O–C*	*N*	*Type*	*Observer**	*Standard Error*
SV Cam	54728.8783	20460	0.0519	59	CCD	SAH	0.0002
AL Cam	54768.7508	21348	–0.0326	108	CCD	SAH	0.0001
AL Cam	54792.6607	21366	–0.0327	77	CCD	SAH	0.0001
CD Cam	54771.7476	2629	0.0088	160	CCD	SAH	0.0008
RT CMa	54857.5493	21822	–0.6903	52	CCD	SAH	0.0006
SX CMa	54825.8552	16457	0.0350	78	CCD	SAH	0.0002
SX CMa	54856.7154	16476	0.0343	91	CCD	PRX	0.0002
SX CMa	54887.5772	16495	0.0352	91	CCD	SAH	0.0003
TU CMa	54830.8129	24697	–0.0100	62	CCD	SAH	0.0003
TZ CMa	54792.8487	14475	–0.2032	60	CCD	SAH	0.0005
TZ CMa	54863.6215	14512	–0.1539	104	CCD	SAH	0.0003
UU CMa	54832.7741	4724	–0.1093	54	CCD	SAH	0.0003
XZ CMi	54797.9252	21343	–0.0077	75	CCD	SAH	0.0003
XZ CMi	54825.7101	21391	–0.0056	74	CCD	SAH	0.0003
XZ CMi	54847.7035	21429	–0.0070	65	CCD	PRX	0.0002
XZ CMi	54877.8008	21481	–0.0078	84	CCD	SAH	0.0002
YY CMi	54884.6265	24553	0.0138	139	CCD	MZK	0.0002
AK CMi	54866.6630	20790	–0.0180	81	CCD	PRX	0.0001
RZ Cas	54771.5503	9681	0.0578	105	CCD	SAH	0.0001
TV Cas	54792.8430	5622	–0.0229	52	CCD	SAH	0.0004
TW Cas	54797.5889	8954	–0.0115	98	CCD	SAH	0.0001
TW Cas	54847.5802	8989	–0.0115	88	CCD	SAH	0.0003
AB Cas	54845.5652	8875	0.0975	104	CCD	SAH	0.0001
CW Cas	54799.6310	41295	–0.0470	93	CCD	SAH	0.0002
CW Cas	54857.6634	41477	–0.0479	67	CCD	PRX	0.0002
CW Cas	54863.5621	41495.5	–0.0482	65	CCD	SAH	0.0002
IR Cas	54769.5552	18225	0.0098	48	CCD	SAH	0.0001
IR Cas	54792.6983	18259	0.0096	90	CCD	SAH	0.0001
IS Cas	54717.7115	14087	0.0633	81	CCD	MZK	0.0002
IS Cas	54730.6024	14094	0.0636	77	CCD	SAH	0.0002
IS Cas	54870.5575	14170	0.0638	65	CCD	SAH	0.0001
MM Cas	54759.6066	16710	0.0899	98	CCD	MZK	0.0002
OR Cas	54792.6862	8495	–0.0228	97	CCD	HES	0.0001
PV Cas	54873.5514	8367	–0.0343	92	CCD	SAH	0.0002
V364 Cas	54721.8363	13213	–0.0192	72	CCD	MZK	0.0004
U Cep	54770.7405	4103	0.1635	108	CCD	SAH	0.0001
SU Cep	54829.5755	31622	0.0049	91	CCD	SNE	0.0001
WZ Cep	54768.5646	64027.5	–0.0856	97	CCD	SAH	0.0002

Table continued on following pages

Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program, cont.

Star	HJD(min) 2400000+	Cycle	O–C	N	Type	Observer*	Standard Error
WZ Cep	54797.5770	64097	–0.0858	56	CCD	GHS	0.0002
WZ Cep	54832.6406	64181	–0.0877	71	CCD	PRX	0.0003
XX Cep	54752.3838	4241	–0.0205	247	CCD	VJA	0.0002
ZZ Cep	54743.7742	12520	–0.0128	111	CCD	HES	0.0001
DK Cep	54717.5835	21429	0.0323	87	CCD	MZK	0.0001
DL Cep	54751.5979	12760	0.0523	86	CCD	SAH	0.0002
DV Cep	54799.5665	6916	–0.0042	103	CCD	SAH	0.0002
SS Cet	54751.7028	4136	0.0091	79	CCD	SAH	0.0002
TW Cet	54822.6223	39290.5	–0.0253	71	CCD	SAH	0.0001
TX Cet	54788.6614	15801	0.0103	90	CCD	SAH	0.0002
RZ Com	54887.8522	59232	0.0426	74	CCD	MZK	0.0001
SS Com	54880.8609	72379.5	0.6796	90	CCD	MZK	0.0001
CC Com	54814.8773	69244.5	–0.0168	65	CCD	MZK	0.0001
RW CrB	54572.4305	19026	–0.0030	79	CCD	SFV	0.0002
W Crv	54828.9260	39118.5	0.0201	86	CCD	SAH	0.0003
W Crv	54832.9987	39129	0.0179	65	CCD	SAH	0.0003
WW Cyg	54720.6768	4323	0.0754	91	CCD	MZK	0.0001
ZZ Cyg	54708.6559	15444	–0.0534	92	CCD	DSV	0.0001
ZZ Cyg	54730.6589	15479	–0.0520	47	CCD	GHS	0.0001
AE Cyg	54797.5803	10536	–0.0048	108	CCD	SAH	0.0002
CG Cyg	54652.7220	24127	0.0610	68	CCD	GHS	0.0002
CG Cyg	54681.7568	24173	0.0633	46	CCD	GHS	0.0001
CG Cyg	54688.6983	24184	0.0623	59	CCD	GHS	0.0002
DK Cyg	54799.5505	35692	0.0796	45	CCD	GHS	0.0004
V387 Cyg	54799.5635	41858	0.0184	75	CCD	SNE	0.0002
V456 Cyg	54680.6446	10962	0.0427	33	CCD	GHS	0.0001
V477 Cyg	54736.6167	4494	–0.0230	112	CCD	HES	0.0001
V477 Cyg	54736.6204	4494	–0.0193	79	CCD	SRIC	0.0001
V704 Cyg	54750.6663	29457	0.0296	68	CCD	SAH	0.0003
V704 Cyg	54792.5357	12134	–0.0041	75	CCD	SAH	0.0005
W Del	54728.6459	2372	0.0272	166	CCD	SAH	0.0002
TY Del	54751.6537	9900	0.0525	98	CCD	SAH	0.0002
YY Del	54718.7006	14827	0.0106	82	CCD	SRIC	0.0002
YY Del	54722.6681	14832	0.0126	47	CCD	SRIC	0.0002
FZ Del	54726.6822	29880	–0.0393	118	CCD	SAH	0.0001
FZ Del	54737.6496	29894	–0.0369	34	CCD	SRIC	0.0002
Z Dra	54797.6524	3649	–0.0315	81	CCD	SAH	0.0002
RZ Dra	54799.5511	19282	0.0470	81	CCD	SAH	0.0001

Table continued on following pages

Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program, cont.

Star	*HJD(min) 2400000+*	*Cycle*	*O–C*	*N*	*Type*	*Observer**	*Standard Error*
TW Dra	54799.5388	3799	0.0320	99	CCD	SAH	0.0002
BH Dra	54797.5785	8132	–0.0038	111	CCD	SAH	0.0004
UZ Eri	52638.5288	24066.5	–0.1079	33	CCD	DKS	0.0001
UZ Eri	54791.2725	28901	–0.0675	67	CCD	SFV	0.0002
YY Eri	54750.7972	40962	0.1298	51	CCD	SAH	0.0002
YY Eri	54792.7520	41092.5	0.1296	97	CCD	SAH	0.0001
YY Eri	54799.8260	41114.5	0.1308	52	CCD	SNE	0.0002
YY Eri	54860.5886	41303.5	0.1310	22	CCD	MZK	0.0003
SX Gem	54792.8190	26163	–0.0540	90	CCD	SAH	0.0001
WW Gem	54873.5570	23339	0.0291	76	CCD	SAH	0.0003
AL Gem	54870.6061	20517	0.0674	73	CCD	SAH	0.0003
RX Her	54751.5948	12134	–0.0007	72	CCD	SAH	0.0004
LT Her	53589.6659	11839	–0.1117	55	CCD	HES	0.0006
LT Her	54235.7502	12435	–0.1187	77	CCD	BIZ	0.0005
LT Her	54261.7725	12459	–0.1135	135	CCD	HES	0.0003
LT Her	54596.7338	12768	–0.1224	68	CCD	BIZ	0.0008
WY Hya	54825.9757	19909	0.0268	66	CCD	SAH	0.0005
WY Hya	54864.6408	19963	0.0275	65	CCD	PRX	0.0001
AV Hya	54797.9008	26521	–0.0910	71	CCD	SAH	0.0002
DF Hya	54799.8083	36333.5	–0.0131	72	CCD	SAH	0.0001
DF Hya	54873.6989	36557	–0.0128	84	CCD	PRX	0.0002
DF Hya	54885.6009	36593	–0.0126	110	CCD	SAH	0.0001
DI Hya	54832.8983	38455	–0.0288	49	CCD	SAH	0.0003
DI Hya	54882.6914	38536	–0.0275	78	CCD	PRX	0.0002
DK Hya	54824.9364	22956	0.0068	91	CCD	SAH	0.0001
DK Hya	54890.6987	23082	0.0071	76	CCD	PRX	0.0002
SW Lac	54771.7918	29610	–0.1017	64	CCD	SAH	0.0001
VX Lac	54721.6017	8807	0.0653	82	CCD	MZK	0.0001
VX Lac	54749.5389	8833	0.0656	86	CCD	MZK	0.0001
VX Lac	54750.6142	8834	0.0664	69	CCD	SAH	0.0003
AR Lac	54797.7215	6658	–0.083	125	CCD	SAH	0.0003
AW Lac	54771.6389	24629	0.1692	95	CCD	SAH	0.0007
CO Lac	54829.5959	17699	–0.0074	102	CCD	SAH	0.0001
Y Leo	54861.7438	5590	–0.0174	83	CCD	MZK	0.0001
UV Leo	54800.8696	27263	0.0319	68	CCD	MZK	0.0002
T LMi	54867.6256	3136	–0.1018	68	CCD	MZK	0.0001
Z Lep	54829.8085	27579	–0.1685	112	CCD	SAH	0.0001
Z Lep	54851.6700	27601	–0.1687	75	CCD	PRX	0.0001

Table continued on following pages

Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program, cont.

Star	*HJD(min) 2400000+*	*Cycle*	*O–C*	*N*	*Type*	*Observer**	*Standard Error*
RR Lep	54856.5888	26741	–0.0333	79	CCD	SAH	0.0004
VZ Lib	54667.3522	27574	0.0088	260	CCD	SFV	0.0001
RY Lyn	54797.7953	8300	–0.0481	76	CCD	SAH	0.0003
RU Mon	54823.8676	3649	–0.0762	137	CCD	SAH	0.0001
RU Mon	54877.6385	3664	–0.0765	87	CCD	SAH	0.0002
RW Mon	54885.6774	11125	–0.0678	125	CCD	SAH	0.0001
AT Mon	54863.6405	13926	0.0080	114	CCD	SAH	0.0002
BB Mon	54873.6120	38477	–0.0025	98	CCD	GHS	0.0004
EP Mon	54797.7889	19083	0.0340	104	CCD	SAH	0.0002
V508 Oph	54721.3643	27955.5	–0.0151	200	CCD	SFV	0.0001
EQ Ori	54830.6369	13397	–0.0317	131	CCD	SAH	0.0001
ER Ori	54791.4352	31093.5	0.0727	138	CCD	SFV	0.0001
ER Ori	54797.7888	31108.5	0.0753	81	CCD	SAH	0.0002
ER Ori	54838.6463	31205	0.0749	62	CCD	PRX	0.0001
ER Ori	54853.6728	31240.5	0.0707	108	CCD	WEY	0.0003
ER Ori	54860.6634	31257	0.0752	59	CCD	MZK	0.0001
ER Ori	54870.6142	31280.5	0.0762	67	CCD	SAH	0.0001
ET Ori	54877.6181	29648	–0.0036	90	CCD	SAH	0.0003
FZ Ori	54877.6333	27134	–0.0614	84	CCD	SAH	0.0007
GU Ori	54877.5967	25086.5	–0.0452	103	CCD	SAH	0.0003
U Peg	54727.7945	48605	–0.1256	97	CCD	SAH	0.0002
U Peg	54731.3571	48614.5	–0.1234	200	CCD	VJA	0.0002
UX Peg	54728.6242	9260	–0.0082	53	CCD	MZK	0.0001
BB Peg	54728.6903	30330	–0.0018	90	CCD	MZK	0.0001
BG Peg	54825.5955	4760	–1.8697	62	CCD	SAH	0.0003
BX Peg	54721.7261	37538	–0.0870	50	CCD	MZK	0.0003
DI Peg	54799.5955	13491	–0.0129	73	CCD	MZK	0.0001
GP Peg	54751.5670	13851	–0.0445	80	CCD	SAH	0.0003
Z Per	54812.6581	2995	–0.2252	128	CCD	SAH	0.0001
RT Per	54856.6066	25289	0.0636	79	CCD	SAH	0.0001
RV Per	54799.6234	6462	–0.0003	133	CCD	SAH	0.0001
XZ Per	54863.6886	9861	–0.0529	73	CCD	SAH	0.0002
XZ Per	54863.6887	9861	–0.0528	82	CCD	PRX	0.0001
IK Per	52260.6900	36778	–0.1091	42	CCD	DKS	0.0010
IK Per	54828.2199	40576	–0.1674	188	CCD	VJA	0.0003
IU Per	54751.6226	10665	0.0139	113	CCD	HES	0.0003
Beta Per	54799.7764	3194	0.0930	136	CCD	SAH	0.0002
AE Phe	54824.5998	30608.5	–0.0985	72	CCD	SAH	0.0004

Table continued on following page

Table 1. Recent times of minima of stars in the AAVSO eclipsing binary program, cont.

Star	HJD(min) 2400000+	Cycle	O–C	N	Type	Observer*	Standard Error
RV Psc	54726.8671	54776	–0.0486	104	CCD	SAH	0.0003
UZ Pup	54824.7481	12846.5	–0.0061	107	CCD	SAH	0.0002
UZ Pup	54863.6977	12895.5	–0.0042	64	CCD	SAH	0.0005
UZ Pup	54885.5542	12923	–0.0061	68	CCD	SAH	0.0001
AV Pup	54877.7380	42599	0.1262	64	CCD	SAH	0.0004
AZ Pup	54542.0260	30472.5	0.2075	111	CCD	SFV	0.0002
RZ Tau	54843.5721	41299	0.0557	83	CCD	SAH	0.0001
TY Tau	54800.7499	31195	0.2501	70	CCD	MZK	0.0001
TY Tau	54814.7559	31208	0.2505	87	CCD	MZK	0.0002
TY Tau	54868.6241	31258	0.2509	61	CCD	MZK	0.0002
CT Tau	54797.9444	14087	–0.0530	110	CCD	SAH	0.0005
CT Tau	54888.6342	14223	–0.0522	111	CCD	SAH	0.0003
EQ Tau	54781.7109	42679	–0.0259	33	CCD	MZK	0.0001
EQ Tau	54797.7538	42726	–0.0264	70	CCD	SAH	0.0001
EQ Tau	54830.3538	42821.5	–0.0251	62	CCD	VJA	0.0001
RV Tri	54742.6488	11556	–0.0290	65	CCD	MZK	0.0001
RV Tri	54868.5102	11723	–0.0299	58	CCD	MZK	0.0001
W UMa	54770.8880	26991	–0.0600	75	CCD	SAH	0.0001
TY UMa	54871.6988	43264.5	0.2670	49	CCD	MZK	0.0002
UX UMa	54797.9128	88295	0.0017	79	CCD	SAH	0.0001
XZ UMa	54797.9078	7060	–0.0974	62	CCD	SAH	0.0001
RU UMi	54769.8704	25096	–0.0135	74	CCD	SAH	0.0001
AG Vir	54620.3855	14297	–0.0069	75	CCD	SFV	0.0004
AW Vir	54829.9762	27704.5	0.0227	73	CCD	SAH	0.0002
AX Vir	54571.3490	38434	0.0130	112	CCD	SFV	0.0002
AY Vul	54730.6508	4993	–0.0731	33	CCD	SAH	0.0006
AY Vul	54771.6593	5010	–0.0762	107	CCD	SAH	0.0002
BS Vul	54770.5500	24159	–0.0227	86	CCD	SAH	0.0001
BU Vul	54797.5358	37371	0.0154	74	CCD	SAH	0.0001

**Observers: BIZ, J. Bialozynski; CK, S. Cook; CLZ, L. Corp; DKS, S. Dvorak; DSV, S. Diesso; GHS, H. Gerner; HES, C. Hesseltine; MZK, K. Menzies; PRX, R. Poklar; RNN, T. Renner; SAH, G. Samolyk; SFV, F. Salvaggio; SNE, N. Simmons; SRIC, R. Sabo; VJA, J. Virtanen; WEY, E. Wiley*

An Interview With Dorrit Hoffleit

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Abstract An interview with Dr. E. Dorrit Hoffleit, Senior Research Astronomer, Retired, Yale University, conducted by Dr. Kirstine Larsen on October 7, 1994, is presented.

1. Introduction

This interview was conducted in Dorrit's office at Yale University on October 7, 1994. This is a verbatim transcription with the exception of minor editing.

2. The interview

Kristine Larsen *(l)* with Dorrit Hoffleit in 1998

[I've always heard you referred to as Dorrit, but come to find out your real first name is Ellen.]

Well, my father named me Ellen, my mother named me Dorrit, and the woman in the house always has her way. Which is better, because there are very many more Ellen's than Dorrit's around. On the other hand, a great many people think that that name is male and so I get a lot of mail over the years addressed to me as Mister. So when I made a mistake in a publication of the AAVSO recently, you know about that [concerning the name of amateur astronomer Alika Herring], well I finally got even. And there are so many names like Evelyn, Marion, and so on which can be either, and then of course if you don't know the nationality of a person, then [a name] spelled "Jean" can be a man or a woman—a man if you're in France and a woman if you're over here. And then when you're dealing with all nationalities you can't say that certain names are really male or female, because they get transliterated and transcribed [and] they could be either, and I assume that most names that end in an "a" are women. Well, you can have fun when you've made the mistake and then I say in my case I finally got even.

[Tell me about your family—do you have any siblings?]

Oh yes, I have a brother [Herbert]. He's gone now. He was the important person in the family. He was very, very bright; he was kind of a genius as a child. He got his Ph.D. from Harvard at age twenty-one. Classics, and that was a subject in which I was very poor because learning new languages requires a good memory and I always had a bad memory. I didn't mind the mathematics because there you don't memorize anything, you just think it through, but when it comes to a foreign language you don't think through, you have to know. One of my grade school classes I had the same teacher that my brother had had a few years previously, and my mother and I were walking down the street one day [and] we bumped into my teacher. Mother and the teacher started talking about various things and the teacher says "Dorrit isn't as bright as her brother, is she?", whereupon my mother says "What can you expect, she's only a girl." I was deeply hurt, but years later my mother told me when I told her how I was hurt by that (it was true of course, but you know, to say that to the teacher), [she] said "well I really didn't mean you, I meant her." Well, I didn't see much of my father. I think I was his favorite child, though. He left home when I was nine years old and so I saw almost nothing of him after that. Yes, he [brother] was about ten years older than I, and I just worshipped and adored him. Nobody had a brother like my brother.

[Did he help you with your school work?]

No, he graduated from Harvard the same year that I was supposed to graduate from high school in Cambridge, but Harvard commencement was a few weeks before high school was out so I came into my Latin class in the morning and my teacher stopped me as I was entering her class and she said she had just read in the morning Herald that somebody with my name graduated magna cum laude in Classics from Harvard—"was that by chance any relative of yours?" I said "Oh yes, that's MY brother," big emphasis on the "my." "Humpf, I should think he would have helped you with your Latin."

[Sounds like your teachers weren't very helpful.]

No, no, hardly anybody was really helpful to me. My mother supported me a whole lot but she had good European ideas on the difference between girls' and a boy's education, and she thought music and fine arts and things like that, and fancy work, needlework, were the things for girls, whereas I wasn't very good at any of those. I was pretty good at drawing, but not in music. It didn't occur to her that her husband was partially hard of hearing and that some of her offspring might inherit that branch of the family, whereas she had been brought up in the conservatory, singing and piano. She'd left home because she had a stepmother and they didn't get along very well together, so she saw an ad about girls going into nursing and when she went into nursing her father seemed (he was a college professor), he seemed mad. He didn't bring up his daughter to wash the behinds of old women (that's the idea of what nursing was) and so he disinherited her. And so she married a cousin of the stepmother.

The only thing they had in common was that neither of them was happy in Germany.

He was already over here; that was the attraction, to come to America. It was called "land of boundless opportunities," but the real translation is possibilities, not opportunities, and in their case it worked in the reverse. So any way, my mother's goals were accomplished. My brother became a professor, like her father, while I wasn't exactly good college material because I was poor in Latin, and you know in those days you couldn't get into Radcliffe without Latin. But anyway she had some confidence in me when I got the opportunity to go to Radcliffe so that her brilliant son wouldn't be ashamed of his dumb sister. Opportunities come in various kinds of ways. And so it ended up my being, well, salary-wise of course my brother was always ahead of me because he was a man, but otherwise it's the case of the fairy tale about the tortoise and the hare: he got along real fast and conked out, and I trudged along and learned how to work and so on, and here I still am, and here you are interviewing me. He never had that kind of interview; of course he got into *Who's Who*, but no special articles on him. Just the obituary, you know, which doesn't count for much. Obituaries, you have to remember what's good about a person, and don't mention anything else. You can think of so many minuses and only a few plusses (which you write down). So I don't want to write obituaries. I wouldn't mind writing about people I really admire very much, and there's lots and lots of people like that, because most people are brighter than I am. Reason I am where I am is that I learned how to work, whereas my brother learned things so easily that he just hated writing anything—that was work. He preferred to keep on learning, whereas I can't remember anything so I have to write it down.

[But in the process you're making lots of important discoveries.]

Well, I'm finding a lot of nice things. No, but I think they're getting a bit away from that [memorizing] in the public schools now, but when I grew up [in] my school career, memory was the thing for getting grades. Of course as you get older and older you forget more and more things. I find myself doing some research and then I'm half way through it and I discover I've already done it a long time ago. That's annoying because I think of all the time I wasted. On the other hand, here's an independent check. Always look for the blessing in disguise when you do something wrong.

[So how did you become interested in astronomy?]

Well, I guess "fell into it" is about the word for it. When we were children we always sat in the backyard (this was Pennsylvania), to watch shooting stars in August, and they were fascinating and beautiful. So I took my first course in astronomy at Radcliffe when I was a sophomore, then I had to wait to my senior year to get the second course because they wouldn't give the course unless there were at least four students, and that was almost a fiasco course because in order to have the four students in my senior year we had to accept a young lady who was a major in English and she said she wanted a second course in astronomy because she just loved the way Harlan Stetson read Alfred Norris poetry to the class. Well, then there were us two mathematicians. I was a senior and the other one was a junior, and [the] fourth essential person was a graduate student in Physics. So you can imagine the poor professor'd have a little problem in what to do with us. So first semester he turned us loose on the transit instrument, which was lots of fun. I think I got a B in the course because when I finished the assignment I used the transit instrument to see just how long it would take for the Pole Star to cross the transit wire—you know it doesn't move very fast. And so I learned a good bit about seeing instead: [it] took forever for that star to cross the transit wires but what was most amazing is it didn't move across these lines but it jumped back and forth — bad seeing, you see. Well, you know I was a dunce to do that, for the purpose of the experiment was you used only the stars near the equator that moved away fast and the times of crossing really meant something. If you made an error it was because your thumb was a little slow pushing the button, but, with the Pole Star, you'd hold it, let go when it moved and then got back on, that was real good fun. But I don't think my professor appreciated the educational value of that experiment. I think I got a lot more out of the Pole Star than I did out of what the thing was intended for. So you see, independence wasn't appreciated even then.

[It appears to be a main theme in your life—independence.]

That was what was nice [about] working with [Harlow] Shapley [at Harvard College Observatory]—he suggested a lot of projects but he didn't force them upon you unless it was a case of he needed something in a hurry, like a lecture or something was coming up. In general he thought up any project, he'd suggest it to you, but he'd suggest enough and you'd have enough ideas of your own, so it was up to you whether you followed the most recent suggestion or not. So I was effectively very, very independent, especially after I got my degree [Ph.D.]. But when I came to Yale, boy, that was a revelation. The director, he had very old-fashioned European ideas, which were prevalent all over everywhere in the years before that, but at Harvard the discrimination against women was salary-wise. That was literally all, except you know people like Cecilia Payne were horribly annoyed they couldn't be professors, but that didn't bother me. I wasn't planning to be a professor, and anyway the research was the fun. And when I came here to Yale, shortly after I came here, Mr. [Dirk] Brouwer came into my office and asked me to do something, and I basically told him I'd already done it, and I thought he'd be happy to know something was accomplished, and he traipsed out the door and said, "Such independence." Boy, you aren't supposed to be independent, whereas that's what the meaning of Ph.D. is, to be independent. And then I helped Miss [Ida] Barney finish her last catalogues and she asked me to write the introduction because she really—she wasn't like me—she really wanted to retire, but she did want to finish her last job. So she asked me to write the introduction, and put a big red X through the paragraph I had about double stars in the catalogue. Double stars are a bane to astrometry people: sometimes what you do for the proper motion is you take an old catalogue which you generally compile visually and compare with a modern photographic catalogue, and there are things called color indices, which you've heard about. What happens is a visual observer's eyes would be more sensitive to red stars, and the photographic plate the blue, so the visual observer, if there were two stars, double stars, would measure the red component. On the photographic [plate that] one would be very faint (all the red would be very faint on the blue-sensitive plates) and [so you would] measure the blue one and get a nice high proper motion which was equivalent to the separation of the two stars divided by the time interval between the two observations. Well, so I put down the problems of the double stars—she crossed that out—and she said, "Dr. [Frank] Schlesinger didn't put that in the catalogue so why should you?" Well, I thought, gee whiz, that's what you called progress. If your predecessor hasn't done it you don't do it either. So, it was pretty trying here, but here at Yale I was a woman and a woman does what she's told and these influences said, "don't do your own thinking, just follow what's been done before," and that makes me, coming from a free place like Harvard under Shapley, that was really trying. Of course now that I'm retired it's just as nice here as it was at Harvard under Shapley. I do what I please; of course, people ask me to do everything and I'm terribly overworked because I don't know how to say "no" to anybody, because what they ask me to, well you know, you're flattered to think you know something, and also some of the things are fascinating. And so you try to do everything everybody wants you to do, and you try to do all the things that you were planning to do in your retirement and sometimes it gets kind of tiring—you get very tired. Just when you're planning to do some more work you just can't hold your head up anymore.

[So you said you were a math student at Radcliffe?]

Well, you see with just two courses offered in astronomy throughout college you couldn't major in, concentrate in astronomy, with only two courses when it took eight [courses].

[So you still have free access to the Harvard plate collection?]

They let me use them. Well, it sounded very depressing a few weeks ago. Somebody called me up and said that the current director was planning to get rid of the plate collection because you know the Harvard-Smithsonian is within that, [and] the Smithsonian decided they'd like to have that building and to convert the plate stacks into their office buildings. Word got to me and several other places about that but evidently Martha Hazen has talked them out of it. But the director says, "hardly anyone uses these plates, might as well get rid of them." The most priceless collection in the whole world! Lots of observatories have collections for certain parts of the sky and some have pretty good collections for the northern part of the sky, but this is the only institution that has full coverage from north pole to south pole. And then to say because very few people are using it it's useless. Yes, that's why I left Harvard, because [Donald] Menzel was throwing out the plates.

[Did you have any female role models or mentors at college?]

Not really, no. No, I wasn't going after people and precedence, I was just going after the subject matter. I was pretty much of a recluse as a child and most of my youth so the books and the science were the important things, more so than the people. And then as for astronomy, except what I got from my brother and my mother, I had no education in any kind of astronomy until I got into college formally, whereas when my niece's little boy was in kindergarten, he wrote me a letter he addressed to me as "Dear Aunt Dorrit" spelled ANT Dorrit (always think of that when you hear that "Hooked on Phonics" business), well, anyway he wrote me all about Jupiter that he had learned in kindergarten, so his kindergarten was as advanced as my second year in college. I like that. Some schools do and did for many many years ago [have astronomy] but I unfortunately wasn't in any such one; of course if I'd been where science was a specialty rather than languages and so on I would have done a whole lot better. Because I did all right in math and science and I did very poorly in everything else. I did all right, too, in fine arts courses. I thought many years ago that what I wanted to go into was fine arts, but what I found out as time went on, well, I wasn't quite as good in drawing as I should have been to go into that, even though I was better than most people, but I wasn't good and then just, going through the museums and everything you need to know more, you have to be a little more expert in history and religion than I was. I was brought up without any religion except my mother was very religious but we didn't go to church or anything, we just had the books. You make up your own mind about things but that isn't the way you learn enough to go on how Raphael and others portrayed things. Fine arts isn't just looking at the picture and seeing how good it is [but] knowing the story behind the picture. So anyway, I fell into the right place. When I got my first job at Harvard, that was, well that was really falling into the right place.

[So that was the big catalyst?]

Oh that was, that was it.

[How did you get that first job?]

Well, one of my classmates had gotten a job in the Radcliffe employment office and she of course knew all of the recent graduates who were looking for jobs, and when a job turned up at the Harvard Observatory she suggested I go try for it. This happened around Christmas-time, so during Christmas recess I went. I didn't get a job when I graduated; these were hard times, too. I was taking graduate courses, one in astronomy and three in math, and when she called me up and said there was this opening I went up and tried the job out during Christmas recess and got the appointment for as soon as exams would be over. And so, before I really knew that I had clinched the job but while I was trying it out, I got a job offer from another college that paid a little more than twice as much as Harlow Shapley was paying us women, and I had no qualms about saying to them, “no thanks, I found a job I like.” Now, since I came from a home where Papa was unemployed and the mother had sold her cottage in Pennsylvania in order to give her two children a college education, it’s kind of a risky thing to do, to take the lowest paying job because you like it, but that was an opportunity and my mother had no objections to that at all because that’s exactly the way she felt. The other job was just being a statistician for somebody, where this was discovering things.

[You thought an M.A. was the highest degree you were qualified for?]

I was never bright in math and science, I was a B student. I wasn’t an A student, and for a Ph.D. I thought you really had to be an A student, and so anyway of course Dr. [Bart] Bok thought it was terrible that I didn’t just say yes right away when Shapley asked me about that. The two of us were sitting there together, but I had to tell him that I didn’t think I could do better because after all I immediately made up my mind, yes, that was great but they’d better know that I might flunk out, because after all a C in the graduate school is flunking out, and chances were pretty good that I’d get some C’s. So anyway that was a great day—I’ll never forget that day. I had finished my M.A. and then I got a ruptured appendix (fortunately after I finished the M.A.), and then I just went back evenings in the observatory and did what I pleased, the way I’m doing here now—daytimes now because we don’t go out at night. In those days it was all right to go home at 2 a.m. by yourself and walk a mile and a half but nowadays you can’t cross the street after dark. So anyway, I like meteors, and I had taken one course in meteors and then I decided that since I was working on light curves of variable stars why not light curves of shooting stars? So I wrote a paper and I put it up on Shapley’s desk and he called me up into his office and he looked real glum and he says, “What’s this?”, because I was being paid to do variable star work, and I said, “Oh, that’s what I came back evenings to do.” Well, he took that and he sent it out to be refereed and it got some pretty good reports and that’s the reason that he and Bok decided that I ought to go on, because after all, I’d proved what a Ph.D. stands for—independent work.

[Did that paper become your thesis?]

Oh no, he told me when I was ready for a thesis I could do it in anything I pleased. I was working on meteors and variable stars and absolute magnitudes from spectra, and I chose the spectra as part of the thesis.

[Did your thesis get published?]

In parts, not as a whole, but several sections of it, The first part of it was published a couple of years before I got my degree in the Harvard Tricentenary volume [co-authored with Peter M. Millman, published in Volume 105 of the *HCO Annals* as *Tercentenary Papers*], and others in, I think one got published in the *Proceedings of the National Academy*, and *Philosophical Transactions*—the American Philosophical Proceedings.

[You've worked on every branch of astronomy?]

Oh, I've spread myself so thin that I can't go deep on anything. Well, you see, Shapley encouraged versatility and of course that was one of the big attractions of the job. That plate collection, boy, there's so much to be discovered still on those plates. Well, one example of the disaster—when they destroyed a third of the collection (that's what Menzel did)—is that shortly after I got here to Yale the very first quasars got discovered. Harlan Smith, who was a Harvard Ph.D. who was here then, and I went back to Harvard to raid the plate collection to find out whether quasars varied or not, and to think that two people who had defected from Harvard and were at the rival institution Yale go raid the Harvard plate collection which was absolutely devoid of people at the time, and were the first to discover a quasar that varied. We had a graduate student here who had been a student at Harvard, I guess he was a Harvard undergraduate; he told me years later that Menzel was planning to destroy more of the plate collection when this quasar came along and that deterred him from destroying more. Well, what some people don't realize is that the only thing that counts is their own interest.

[Tell me about your work at the Aberdeen Proving Ground.]

Well, there was a Major down in Aberdeen Proving Ground at the time who was a Harvard employee, graduated, Ph.D. from Cambridge University in England, and he kept calling me up to say that they needed somebody of my abilities down there and he finally talked me into it. I felt that being of German descent I had better do some war work. So anyway after I'd agreed to go down there then he informed me that I could not have a professional rating because I was a woman, that the colonel who was in charge of the ballistics laboratories would not approve of having a woman with a professional rating, but I'd get the same salary to begin with as the boys were getting. So the young man who just graduated from Harvard gets a P2 rating, which is the same salary as the SP8 subprofessional 8 that I was getting, and within six months he was eligible for promotion but I was already getting the highest salary for a SP rating—that, of course, was not revealed to me as I was coming down. But the war would be over and I wasn't going to stay there anyway, so what. This Harvard professor, he assured me that I'd be doing the same work as though I were a professional so it was just on the payroll and the things that wouldn't show up. But then, after I'd been there about a year, the inspector general of the Baltimore district (where Aberdeen is) discovered there was a woman Ph.D. with the subprofessional rating, and he came around on a day when the colonel was down at Washington instead of in Aberdeen, and he wanted to find out all about the story about why I was on a subprofessional [rating]. I told him, you know that, I was told that women couldn't have listings, the war'd be over anyway. Well, that happened to be flaunting civil service regulations, so when the inspector general [came] he deprived me of my lunch that day because he came in at lunch time and he wanted me to write all this out for him before he'd have to leave by two o'clock.

So when the colonel came back the next day and heard about what happened he sent the chairman of the section that I was [in]—the department I was working in—a major, you know a major in the reserve, and you know what happens in the military: if your rank is less that somebody else's rank then you say "yes, sir, yes, sir" that's all you say. So anyway the colonel told the major to tell me that there was no room for professional women in the RL [research laboratories], that I'd have my choice: either I could transfer to the Pentagon, or he, the poor major, was to make sure that I did nothing but subprofessional work because if I didn't do anything but subprofessional [work] then it would be all right to keep me on subprofessional [rating]. So I told the poor quaking major that he (since the colonel wouldn't talk to me himself), he the major could go back and tell the colonel, "Thanks, I don't accept either alternative—that isn't what I came down here for." Poor quaking major! Well, somebody in the headquarters in the Proving Ground told me not to worry about this, that there was nothing the colonel could do about it. So a little bit later the section chief of the department I was working in, who was a captain in the Army, he was being transferred out as all good captains are, and the major comes to me and says, "There are only two people who are qualified to take over the section head: you're one and Dr. [Fritz] John is the other, but since the colonel will not allow a woman to be a section head, will you work under Dr. John?" "Major," I said, "Since you put it that way, I guess."

[Were you trying to give the Major a hard time?]

I was not going to be pushed around! And so anyway he then fixed things up nicely, that I was to be taken out of that section and I had twenty girls working under me, mostly blacks, and I could pick any four of them that I wanted and I'd be an independent section. You know, not a section head, just an independent section. Well, other departments found me useful and would shoo all their stuff in to me to reduce their observations for them and all that sort of thing, which was fun, but I got kind of tired of having somebody from another department come over and ask me to do something and we had to go through three channels — from the other department through the major down to me, back through the major and back there. So one day, when I was kind of fed up with this thing, well, we always had weekly meetings with the staff people, and the major had a bulletin board which said directives received, computations started, computations so far complete, and so on, and finally finished. Then he comes around and asks me what I'd been doing the past week and I said, "Well, these records, photographic records received, measurements complete." He said, "Look at that production board—where does all that fit in?" "Well," I said, "It doesn't, but I thought that you, since you're my superior, you'd want to know what I'd been doing." Well, that wasn't satisfactory, so after the next load of film that I reduced I stayed late because I noticed that the head of the other department that was shooing this to me was staying late. I showed Dr. [Thomas] Johnson what I had done, and he was very affable and gracious and he smiled and so on, and I saw favorable reactions, which I wasn't used to. I said, "Dr. Johnson, couldn't I work straight for you instead of going through all these back and forth channels?" He looked real pleased and says, "Well, I'll ask the colonel." And the colonel said, "I don't know why you shouldn't have her." So he transferred [me].

Well, then the senior staff had a meeting one day and the boys who were at it told me in great glee what was happening there because I wasn't there of course. And what happened was that a problem came up, something that needs to be done, and somebody said I was a good person to do this and so the colonel turns to the major and says, "Well, you ask her to do it," and [the major] says, "She isn't working for me anymore."

"What, where is she?" "She's working for Dr. Johnson." "Why is she working for Dr. Johnson?" "I suppose because she likes him."

Anyway, Dr. Johnson was highly respected; he was a Yale Ph.D. in Physics, a cosmic ray man, and very brilliant, but always gracious about taking care of people working under him so that they'd do the best work for him. Since Dr. Johnson and the colonel were good friends, why, that put me in a better light and to end this long, long story about all my tales of woe, I won a war against my ancestors in Germany and against the colonel who behaved more like a Prussian general than an American. And after the war was over all these priceless men were all going back to colleges so the colonel stops me where everyone could see how gracious he was to me to tell me if I'd stay at Aberdeen after the war, I'd have any ranking I pleased. So for anybody who was passing by to hear I said, "Thanks very much, that wouldn't be very fair to the men."

Then a security officer stopped me one day, and he says, "If you're going back to that place, that Harvard, to work under THAT person," (he meant Shapley), "you would be considered a security risk and you wouldn't be allowed back on the Proving Ground." So when the colonel suggested that I apply for a consultantship after I had left, well I didn't want that. But here Shapley's name was at stake. I wouldn't be allowed back if I worked under Shapley, which I was going back to do, so I filled out the applications for consultantships. I waited a long time—I though, gosh, maybe they're right—but after about two months the appointment came through and I marched myself back for my first tour of duty down there. And the colonel tells me he had a long list of people he'd recommended for consultantships, but my appointment came through first. So three cheers, Shapley exonerated! And after that he got transferred out—of course military people never stay forever. But I got Christmas cards from him until a few years before his death. So that was really winning a war. That story about my Ph.D. and about winning the war with the colonel are the two best things in my life. But anyway winning the war with the colonel was really good.

[You were on a split contract, Maria Mitchell Observatory for six months/ six months at Yale? And you were with the Maria Mitchell Observatory for twenty-two years?]

Yes, the reason that was half-time was financial conditions down there.

[You've said that you had over one hundred girls in the Maria Mitchell program over the years, that over twenty-five have since gotten Ph.D.s. Are there a few you are most proud of?]

Well, I'm proud of a good many of them. You may or may not know some of these names. Janet Mattei you'd know, of course. She's really a prize person, she's one of mine. Oh, as a matter of fact it was Nantucket fog that got her her job at the AAVSO. I'll tell you that story. The year that she was one of my girls down on the island I had to go to an astrometric conference in Virginia at the beginning of the week, whereas I'd invited the AAVSO to come down at the end of the week. AAVSO starts [its annual meeting on] Friday evening with a lecture and goes through Saturday and Sunday morning. So anyway, I went to my Virginia meetings and I got back to Boston on Thursday—plenty of time to get back to the island. But the plane, the Boston-Nantucket, got delayed, and got delayed some more, and got delayed some more, and finally it got cancelled and I had to stay at a hotel overnight. And the next morning it got delayed and it got delayed and it got delayed and the storm got worse and worse (you know, downpour as well as fog). And so I called up Janet on the island and told her to take charge of the meeting until such time as I get there. Well, I finally arrive by a boat that was going across the channel like this [up and down hand motion], and I arrived on the island just as the sky was clearing at the last moment and got to the banquet site just as the banquet was breaking up, and these astronomers all wanted to go to the observatory to use the telescope. Well, my girl Janet had done such a marvelous thing running the meeting for me that, when Margaret Mayall was looking for an assistant at a time when Janet was looking for a job, I got the two of them together again and Margaret of course grabbed Janet because she had been so good at running the AAVSO meeting. And then when Margaret was ready to retire there were a half a dozen people who wanted her job, and [Janet] was unanimously elected to the job all because of the Nantucket fog. If it hadn't been for the fog, she couldn't have made such a marvelous impression. I think that's a great success story.

Well, other girls—I can't name them all—but you probably know Andrea Dupree. She was one of the earliest girls I had there. She was only sixteen when I had her, and she was a charming little girl at that time. She asked me one day, did I think she would be—she was a sophomore at the time—she asked me if I through she'd become good graduate school material. By a foregone conclusion—she was so bright. Then, do you know Nancy Houk, who's reclassifying the *Henry Draper Catalogue*—she was one of my girls. And then there's Nancy Evans in Toronto, who's on the faculty there, who's doing a good job, and Marcia Riecke in Tucson, who's doing extremely good modern work in infrared astronomy. And Karen Meech is in Hawaii, a comet expert. That's a really good name to remember, because after all Maria [Mitchell] became famous because of a comet, and now Karen is a comet expert. She's writing marvelous things on comet theory and so on. There's a sampling. You know when you get old it's so marvelous to see these young people that you've known before they really were astronomers when they were still undergraduates and then see how well [they've turned out]. They've done things that I wouldn't ever be capable of doing—such theoretical, difficult theoretical work and so on. And Janet's administrative abilities are just fantastic. So you know it makes your old age real nice to look around and see what's happened to some of these girls.

[When did you officially retire from Yale?]

Well, I reached the retirement age in 1975, but since I got a joint NSF grant with Bill Van Altena (since I was retirement age I couldn't apply for any NSF funds on my own—that's contrary to university rules), so anyway Bill Van Altena was going to compile a catalogue of trigonometric parallaxes and I was going to get on a new catalogue of the *Bright Star Catalogue*, a new edition, so we wrote a joint proposal on that. And so for the next few years, I was officially employed half-time. As a retired person I couldn't be employed more than half-time. That doesn't mean I worked that few hours, but that I was half-time pay for a few years after that. 1975 is the official retirement date, because after that you're sort of a part-time employee. That lasted I guess three years—the grant was for three years.

[What's your official position now?]

Senior Research Astronomer, Retired, since it's only the professors who get the title Emeritus. The rest of us are just plain retired. I'm Emeritus from Nantucket. Well you see on Nantucket I had tenure, but at Yale, starting out as a research associate; associates depend on outside funding and so you don't get tenure, and I claim that it's much more prestigious to have stuck it out for thirty years on government grants than on tenure.

[You've always been a research astronomer, but you were a lecturer at Wellesley for one year]

For one year, yes, and I did some part-time teaching here, too. Of course, having the half-time appointment here which ran from October through April, to the first of May, I was not here when courses started and I wasn't here when courses finished. But we used to have beginning graduate student general courses in astronomy, sampling of research in the various fields. So I took part in those for quite a number of years, but the course was then in charge of somebody who was a professor and I was second fiddle. But that was o.k. First few years I did that I liked that because I could teach them all about things I learned at Harvard—spectra and meteors and variable stars. Things are different here now than they were in Brouwer's day. Under Brouwer celestial mechanics was THE thing, and astrometry was next highest [in] importance. But other fields were pretty much neglected. [Rupert] Wildt was here, and he was employed primarily to build up astrophysics, but he had the reputation of finding that his students weren't good enough for his valuable time. So when Brouwer died, then Mr. Wildt was complaining that Brouwer did not build up astrophysics, whereas that was what he was supposed to do. But anyway, things here at Yale now are very much the way there were under Shapley at Harvard, whereas right now at Harvard, it's just the Smithsonian is so big that students are better off here than they are Harvard now. Because here you've got almost a one-to-one ratio of the number of graduate students and the number of faculty so that students can take up almost any branch of astronomy that interests them, whereas under Brouwer that was not so easy. Wildt did have graduate students in astrophysics but a relatively small number compared with celestial mechanics.

[How long have you been involved with the AAVSO?]

Oh, well the AAVSO was a significant part of Harvard. It was founded by [Edward C.] Pickering and the person who was called the Recorder—Mr. [Leon] Campbell was a Harvard employee—because all of these observations by amateurs were funneled unto Harvard at the time. *[Ed. note: It was amateur astronomer William Tyler Olcott who founded the AAVSO. The operations of Harvard and the AAVSO were intertwined for so long that Pickering/Campbell-as-founders became a widespread misconception during Dorrit's time there.]* And so anyway since the AAVSO headquarters were at Harvard Observatory, I naturally got involved. The second paper which I was involved in publishing was—I'd been working on variable stars in Centaurus, and Mr. Campbell had lots of observations, visual observations, of a bright long period variable [RV Cen] that had a larger color index than any other star that was known at the time, something like four-magnitude color index. And so when he found out that I was working on plates of the same region we got together and I measured up all the plates for the photographic light curve, and he compiled the visual light curve and we got a good color curve for that star. My first paper was on variable stars in my region of Centaurus, my second was as co-author with Campbell on the AAVSO paper [both papers were published in 1930].

[You were president of the AAVSO for one year?]

Two years. Well, the bylaws say one can be president for only two consecutive terms. Occasionally somebody will then become president a second time some years later. And I don't want to become president now, because after all when you get into my years you'd better not be responsible for too many things that involve lots of people.

[Well, you're very much involved with the AAVSO anyway, so you don't need a title.]

Oh yes, I get them to work for me and they get me to work for them. That's my favorite organization. I think it's the friendliest organization that I'm aware of, at least in astronomy.

[How would you like to be most remembered?]

Well, I think that I'll be mostly forgotten, that's natural, but I hope they'll still be using *The History of Astronomy at Yale*.

[You're very proud of that.]

Well, I like that, but everything else I've done—with research everything else is just a stepping stone for the future generation. Either things die out or they improve so much that, well, the *Bright Star Catalogue* is a good illustration. Schlesinger got out the first one, first two editions with help, and I got out the third and fourth editions, but when the third edition came out I was sole author for it. It was catalogued down in the university under Schlesinger. So maybe the fifth one, if it ever comes out, may still be listed in my name, but after that (if any) they'll be some other names and so on. Nowadays when people talk about the *Bright Star Catalogue* they no longer think of Schlesinger, they think of me. Well, I'm gonna die too just the same way he did. But the history of the institution, I don't think anybody's gonna rewrite that very soon. They should, however, bring it up to date, and a long time ago my friend Bill Van Altena said that he thinks he'll write the sequel—some day. Now he'd got quite a few years before he retires—that's what I tell everybody, that writing the history of your institution is a very enjoyable thing to do for your retirement project. Because I didn't have time to do it before I was retired and, also, most of the time before I was retired I had to do what I was told. I must say though that when Pierre Demarque first came here he heard that I was hoping to do that as a retirement project. He said, "Why don't you do it now?" Well, I had to finish these government grants first. So even though he was agreeable to my doing what I pleased you have responsibilities when you have a grant.

[So what do you do outside of astronomy?]

Eat and sleep. Well, there are so many aspects—you just drew up all the things I'm interested in. Well, every one of them is a hobby from the other.

[You already said you weren't very good at drawing or needlework.]

Well I like all of those things, but I'm no good at them and these other things [in astronomy] I think some of them I can do better than other people or at least other people wouldn't do them. No, I'm a moron. It's true I own some versatility in my own field, but I know next to nothing about any other field.

[It doesn't mean you're a moron.]

It does if you don't try to go after those other things.

[Do you consider yourself to be a feminist?]

Not really. I do all this looking up things about women. I enjoy doing that, and of course I started the program in Nantucket for women astronomers for several reasons. One reason, practical reason, was that I was offered an attic room with four beds in it and I wasn't going to make that co-educational. And the other thing was it was obvious that women had more difficulty getting jobs than men did and so between those two factors it was natural to set up the program primarily for girls. The reason that it finally became co-educational was because we depended very highly on the government or other outside support and the rules became more firm that one couldn't discriminate against anybody, and I had a high reputation for discriminating against men down there. Well, just before women got admitted to just about everything at Yale, one of the Dean's departments sent out a circular letter to faculty to ask what they were doing for the furtherance of women, so I sent them a small brochure that I had made out which I sent to all the girls' colleges about summer openings on Nantucket, and I sent that in as a reply to what anybody at Yale was doing for women. And I got a telephone call from the secretary of the person who had sent this out and said, "We can't post that circular that you sent us because that's discriminating against men." And I said, "that's all right by me—that isn't what I sent [it] to you for." The most fortunate thing about my life is that I've got a sense of humor, otherwise I'd be dead. Well, when you get old enough you know that no matter how bad a struggle you're going through, you're gonna laugh at it eventually. Because the harder your life has been, the funnier it is when you talk about it. I'm somewhat concerned about these extremely bright youngsters who get A+ in everything and are well-to-do so they don't have to do anything for their living. I just wonder what's going to happen with them when they do run into a problem because in their formative years they aren't learning how to cope with anything, simply because they're too bright.

[Can I ask you to talk about Miss Maury?]

Oh yes, Miss [Antonia] Maury. You said you were writing her up too. I knew Miss [Annie] Cannon and Miss Maury, and Miss [Henrietta] Leavitt was gone already. She was one that I would have loved to know.

[It seems as though you were more impressed with Miss Maury than Miss Cannon.]

She was more of an intellectual than [Cannon]. Miss Cannon was so extremely successful because what she did required a great deal of knowledge but she wasn't original the way Miss Maury was. She did what Pickering expected of women; she did exactly what she was told and she did it very, very well, better than anybody else. Whereas Miss Maury discovered that there were things in the spectra that Pickering was evidently unaware of and unwilling to admit. Well, I think in the Harvard Observatory history [by Jones and Boyd], they definitely state there that Pickering had said, I've always quoted too, that when Hertzsprung wrote to point out how important this c-characteristic in the spectra was, Pickering wrote back and said that the spectrograms that Miss Maury was using where not of good enough quality to show what she had [claimed]. But Hertzsprung proved this was important and yet Pickering said, in other words, it wasn't that he couldn't see them, [it was] that he was miffed that she was the one that discovered something. And it's rather sad too, because all the other women that worked under Pickering—from what I heard from Miss Maury and also from Miss [Margaret] Harwood—practically all adored Pickering, but they all obeyed his orders. They didn't do their own thinking. And as Schlesinger said, and Pickering agreed, that the advantage of women was that a man would easily tire of something that required repetitive thinking, like getting out the *Henry Draper Catalogue*. Pickering set up the original system but to get ten volumes out, he couldn't have done it. I guess he wouldn't have been capable of sticking with it. Whereas he was capable of holding the stick over the others to do it. Well, all the women who worked under Pickering did what he wanted them to do; Miss Maury was supposed to do exactly what Miss Cannon was doing—just adopt his system and apply it, whereas she sat down and thought it out on her own, and came up with something. Well, her system was far more clumsy [and] has all those Roman numerals, going up to twenty-two of them or something like that. When the MK system was started, they adopted the same clumsy Roman numerals for the sequence. On the other hand, they don't go up to two digits. And it's far easier to remember the difference between an A and B than between II and III.

[Many textbooks give Cannon credit but don't mention Maury or Williamina Fleming.]

No, Mrs. Fleming was, well, they originally called the system the Pickering-Fleming system and then dropped the Fleming. I think Mrs. Fleming probably was more influential in setting up the system than Miss Cannon would have been. Miss Cannon did improve the system here and there, improving it in detail but not finding new characteristics.

[Should the textbooks mention all three because they all made contributions?]

I don't object to having the textbooks simply mention Miss Cannon and nowadays of course you should stress the MK system, but you should mention that Miss Maury was a very significant forerunner of that classification system and that Morgan himself agrees completely, because he certainly respected her to no end. He dedicated at least one maybe more papers to her, because he was really, really impressed with her work and he didn't understand why she wasn't more successful at Harvard. So when I wrote the article about Miss Maury for the Radcliffe Biographical books I sent him a copy of that paper and he wrote a very touching letter back to me saying—really emotional about it—that he had always wondered why she didn't get full credit and so on at Harvard because she pointed the way for his better work.

[You've mentioned elsewhere that part of the reason why Maury wasn't given more credit was because her aunt, Mrs. Draper, wasn't too fond of her.]

Miss Maury was—well, Mrs. Draper, from one of these pictures, you can see was a very elegantly dressed lady, whereas Miss Maury [was not]. You read some of the things about that. Well, I don't know whether you've heard this story or not, possibly you have, because I wrote a note, unpublished, about a Christmas party at the Shapley's. The Shapley's always had parties for the staff as they kept us all happy. Miss Maury came to this party (this was about the first or second year I was there), and she had on a dark green velvet dress. The velvet had little rosebuds, not embroidered in but woven into this dress. Absolutely gorgeous. That was an heirloom dress. Well, Miss Maury was evidently short on wardrobes, and so from that day on—everybody complimented her on the dress—so she wore it to the office, day in and day out. And I was sitting in the room where people came in to get their mail and I wasn't facing the [door] but you know you see things out of the corner of your eye. It seemed as though something was flashing, and I looked around to see what it was. It was Miss Maury and her green velvet dress. It split, for there around the back, [the] whole seat split, so what I'd seen was this flash of white slip where the dress [split]. She was completely oblivious, and of course I was very [much] younger then and she was quite old so I wouldn't dare say anything. In those days some people still wore those old fashioned worsted stockings, you know, the heavy stockings. Well, generally her heels were always showing through. Then some youngster that lived in the Hastings [on Hudson] talked about her, how she was so badly dressed, grease on her dress or something like that, completely oblivious. They thought she was awful, but then when you started talking with her—and this happens to everybody—you start talking with Miss Maury and you forgot about how she looked or anything. She could talk about every subject imaginable. Unlike me, she was not a moron—she could talk on everything.

When I was in the hospital one time (she didn't know I was in the hospital but she knew I was out sick), she and another member of the staff came to see me, and my mother was then there at the time. My mother lived in California at the time but she had come back East because I was sick. And these two ladies, one of whom was a chatterbox with hardly any brains and Miss Maury, who was very thoughtful in her talking, well, my mother had just been back from Italy and she had a Piranesi etching she'd left on top of the piano [that] she was going to take back to California eventually. Miss Maury comes in, perfect stranger to my mother, she looks at that and gives Mother a complete half-hour lecture on Piranesi.

[Was your mother impressed?]

Extremely—that's how I know about it. And that's the way [Maury] was with almost any subject matter that came up. It didn't have to be astronomy, she was just a cultured lady in everything except personal appearance. Yes, I'm very fond of her. You know you wouldn't jest about her or laugh about it if you didn't love her.

[In the introduction Pickering wrote to Maury's catalogue, it seems he wanted to distance himself from her work, compared to Cannon. It was obvious who his favorites were.]

But you know, Miss Maury, it was 1948, was given the Annie J. Cannon award. I thought that was sad, because here was her arch-rival. She wouldn't have looked upon [Cannon] as a rival, but that's exactly what she was. Here an extremely original brilliant person being honored by her chief rival who had achieved fame only by doing the same thing over and over and over again. Of course we all loved Miss Cannon. You couldn't help that—she was a charming person, so gracious and always interested in people. But such a contrast.

[How true is the story about how Mrs. Fleming got hired?]

I got the story largely through, orally through Margaret Harwood, so it makes a good story, and I think it's true enough. It may have been embellished somewhat, because I think Margaret had a tendency to accentuate matters.

[KL note: That's exactly how it ended—we were running against time constraints and I just got in as many last minute queries about HCO gossip as I could.]

NOTES