PHOTOMETRIC VARIABILITY SURVEY OF M3

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ABSTRACT

We have conducted a three-band (BVI) variability survey of the globular cluster M3. This is the first three-band survey of the cluster using modern image subtraction techniques. Observations were made over nine nights in 1998 on the 1.2 m telescope at the F. L. Whipple Observatory in Arizona. We present photometry for 180 variable stars in the M3 field, 12 of which are newly discovered. New discoveries include six SX Phoenicis–type variables that all lie in the blue straggler region of the color-magnitude diagram, two new first-overtone RR Lyrae variables, a candidate multimode RR Lyrae variable, a detached eclipsing binary, and two unclassified variables. We also provide revised periods for 52 of the 168 previously known variables that we observe.

Key words: binaries: eclipsing — δ Scuti — globular clusters: individual (M3) — stars: variables: other — surveys

Online material: color figures, machine-readable tables

1. INTRODUCTION

The globular cluster M3 (NGC 5272) is one of the most studied clusters in the Galaxy. Since the work of Bailey (1913) and Shapley (1914), there have been numerous surveys for photometric variability in the cluster. In 1973, Sawyer Hogg compiled the most complete catalog of variables in the cluster prior to the modern era. Recently Bakos et al. (2000) compiled a catalog of 274 variable stars in the cluster and published improved identification and astrometry for them. M3 is particularly known for containing the largest number of RR Lyrae variables, with more than 182 such stars (Clement et al. 2001). Many groups have focused on studying the population of RR Lyrae variables. Corwin & Carney (2001) and Clementini et al. (2004) have published a catalog of 222 confirmed or suspected RR Lyrae variables and have provided a detailed analysis of the eight known double-mode RR Lyrae stars (RRds). Other surveys have focused specifically on searches for variability in blue straggler stars (BSSs); notably, Kaluzny et al. (1998) discovered only one SX Phoenicis star out of 25 monitored BSSs. They also discovered a contact binary star near the base of the red giant branch.

In this contribution we present the data from a BVI variability survey of the cluster performed in the spring of 1998. This is the first three-band survey of the cluster using modern image subtraction techniques. New results include the discovery of six new SX Phoenicis variables, two new first-overtone RR Lyrae stars (RR1), a candidate multimode RR Lyrae variable (RR01), a detached eclipsing binary (EB), and two new variables that we do not classify. We also generated light curves using profile photometry, which resulted in generally worse precision and yielded no additional results.

2. OBSERVATIONS AND DATA REDUCTION

The observations were made at the F. L. Whipple Observatory 1.2 m telescope using the 4-Shooter CCD mosaic containing four thinned, back-side–illuminated, AR-coated Loral 2048 × 2048 CCDs. The camera has a pixel scale of 0.333 pixel−1 and a field of view of 11′4 × 11′4 for each chip. We obtained observations on nine nights between the dates of 1998 April 16–20 and May 28–31. These observations consist of 4 × 300 and 67 × 420 s B-band exposures; 14 × 240, 198 × 300, and 13 × 450 s V-band exposures; and 4 × 180 and 72 × 240 s I-band exposures. The sampling cadence was as low as 7 minutes, allowing for the detection of very short period SX Phoenicis variables. The center of M3 at (α, δ) = (13h42m11.2, +28°22′32″) (J2000.0) was positioned in the lower right corner of chip 3. A mosaic of all four chips is shown in Figure 1.

The preliminary CCD reductions were performed using the standard routines in the IRAF CCDPROC package.3 To obtain photometry we used the image subtraction techniques of Alard & Lupton (1998; also Alard 2000) as implemented in the ISIS 2.14 package. To detect variables, we first took the absolute value of all the subtracted images and stacked them to form a single image. We then searched this image for strong point sources, identifying these as variables. We obtained light curves only for sources identified as variable in this way, providing differential photometry in ADUs; to convert to magnitudes, we obtained profile photometry for the stars in our field using the DAOPHOT/ALLSTAR package (Stetson 1987, 1992). As a sanity check, we also generated light curves using profile photometry, which resulted in generally worse precision and yielded no additional

3 IRAF is distributed by the National Optical Astronomy Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under agreement with the National Science Foundation (NSF).

4 ISIS is available from C. Alard’s Web site at http://www2.iap.fr/users/ alard/package.html.
variables. The method that we have just described is the same technique used by Kaluzny et al. (2001); the procedure is discussed in more detail in that paper.

We also generated light curves for BSSs, examining them individually for variability. We identified a handful of low-amplitude (0.04 mag) SX Phoenicis variables in this fashion.

To transform our light curves to standard $BVI$ magnitudes, we observed a total of 128 stars from 22 Landolt (1992) fields so that the transformation for each chip used typically 30 stars from five fields. The air mass of these observations ranged from 1.08 to 1.93. The resulting uncertainty in the zero point of our observations is 0.02 mag. As a consistency check, we calculated the median colors for the turnoff stars independently for each chip. The results shown in Table 1 are consistent with an uncertainty of 0.02 mag.

We obtained astrometry for the variables by first matching to the catalog of Bakos et al. (2000). We used at least 10 preliminary matches on each chip to obtain the transformation between rectangular and equatorial coordinates. The residuals of the matched stars were less than 0\arcsec.1. Using the right ascension and declination from this transformation, we proceeded to match our sources to the Two Micron All Sky Survey (2MASS; Skrutskie et al. 1997) Point Source Catalog, using a matching radius of 0\arcsec.7 for a total of 98 matches. The median residual was 0\arcsec.43. All but three of these matches are RR Lyrae stars. Both of the unclassified newly discovered variables and one of the
newly discovered SX Phoenicis variables matched sources in 2MASS. Figure 2 shows the location of 93 of the matched sources on the 2MASS $J$ versus $J-K$ CMD for M3. The five matched sources not shown in this figure were missing $K$ photometry. The fact that all but a few sources lie clumped near a region of constant $J$ (the horizontal branch) suggests that these matches to RR Lyrae stars are correct, with the scatter likely due to variability of the RR Lyrae stars and blending with nearby sources. In Figure 3 we plot the position on the sky of all RR Lyrae stars in our catalog, together with the positions of those that match 2MASS sources. From this figure it is clear that the nonmatches are due to incompleteness in the 2MASS catalog near the crowded center of the globular cluster.

3. CATALOG OF VARIABLES

Following the above procedures, we identify 180 variable sources, of which 12 are newly identified as variables. The newly identified variables include six new SX Phoenicis stars, two RR1 stars, an RR01 star, one detached EB, and two unclassified variables. We also provide revised periods for 52 of the known variables. The revisions were determined on the basis of visual comparisons between the light curves phased with the published period and the light curves phased with the period calculated using the Schwarzenberg-Czerny (1996) algorithm.

We consider revision of the period to be necessary if the published period is incompatible with the observed light curve given the formal errors from the photometry. We have recovered one of the previously identified SX Phoenicis stars (V237). We note, however, that the coordinates given for this variable appear to have been switched with the coordinates for V238 in the discovery paper by Kaluzny et al. (1998). This error has been propagated through the catalogs of Bakos et al. (2000) and Clement et al. (2001). We also revise the period for this variable. The $V$, $B$, $I$, $B-V$, and $V-I$ light curves for the variable stars are available via anonymous ftp. The full machine-readable version of the catalog is available in the electronic edition of the Journal. We present the last 12 rows (consisting of the newly discovered variables) in Tables 2 and 3; the columns are as follows:

- **ID.**—The ID number of the variable. V1–V285 are taken from Clement et al. (2001). New identifications are denoted by “NV.” The ID number roughly corresponds to discovery order.
- **2MASS Flag.**—Integer denoting whether or not the variable matched a 2MASS source. The flag is 0 for no match and 1 for a match.
- **R.A.**—Right ascension for epoch J2000.0. This value is taken from the 2MASS catalog for sources with a 2MASS match; otherwise it is obtained from the rectangular to equatorial transformation derived using the Bakos et al. (2000) catalog.
- **Decl.**—Declination for epoch J2000.0. This value is taken from the 2MASS catalog for sources with a 2MASS match; otherwise it is obtained from the rectangular to equatorial transformation derived using the Bakos et al. (2000) catalog.
- **$V$-flag.**—Integer denoting the type of $V$-band observations. Values are 1 for observations that could be converted to magnitudes or 2 for observations that were left in differential count units.

### Table 1

**Median Color of M3 Turnoff Stars**

| Chip | $B-V$ | $V-I$ |
|------|-------|-------|
| 1    | 0.450 | 0.592 |
| 2    | 0.456 | 0.580 |
| 3    | 0.450 | 0.561 |
| 4    | 0.473 | 0.590 |

![Fig. 2.](image-url)  
**Fig. 2.** 2MASS $J$ vs. $J-K$ CMD for the globular cluster M3. The circles denote 2MASS sources that match RR Lyrae variables in our catalog, squares denote sources that match unclassified variables in our catalog, and the triangle shows the source that matched an SX Phoenicis variable in our catalog. The fact that the RR Lyrae stars cluster in a single region of the CMD confirms that these matches with 2MASS are real.

![Fig. 3.](image-url)  
**Fig. 3.** Distance from the center of the cluster of RR Lyrae variables that had matches to 2MASS (circles), as well as those that did not (triangles). From this it is clear that nonmatches are the result of incompleteness in the 2MASS catalog in the crowded center of the cluster.

![Table 1](image-url)
TABLE 2

Catalog of M3 Variables: First 13 Columns, Last 12 Rows

| ID   | 2MASS | $\alpha_{J2000.0}$ | $\delta_{J2000.0}$ | $V_{\text{avg}}$ | $B_{\text{avg}}$ | $I_{\text{avg}}$ | $A_V$ | $(V)$ | $A_I$ | $(B)$ | $A_I$ | $(I)$ |
|------|-------|----------------------|---------------------|------------------|------------------|-----------------|------|-------|------|------|------|------|
| NV 286 | 1 | 13 41 51.55 | +28 17 00.6 | 1 | 1 | 0.171 | 17.406 | 0.104 | 17.816 | 0.128 | 16.304 |
| NV 287 | 1 | 13 41 40.0 | +28 20 55.5 | 1 | 1 | 0.060 | 16.964 | 0.107 | 17.747 | 0.064 | 15.935 |
| NV 288 | 0 | 13 42 17.39 | +28 13 35.1 | 1 | 1 | 0.087 | 17.489 | 0.079 | 17.731 | 0.051 | 17.204 |
| NV 289 | 1 | 13 42 12.17 | +28 19 20.9 | 1 | 1 | 0.109 | 17.399 | 0.095 | 17.692 | 0.084 | 17.079 |
| NV 290 | 1 | 13 42 21.30 | +28 23 45.0 | 1 | 0 | 0.060 | 15.670 | 0.107 | 17.747 | 0.064 | 15.935 |
| NV 291 | 0 | 13 42 18.07 | +28 22 39.6 | 1 | 1 | 0.838 | 17.462 | 0.978 | 17.697 | 0.519 | 17.141 |
| NV 292 | 0 | 13 42 11.18 | +28 21 54.0 | 1 | 0 | 0.267 | 15.704 | 0.251 | 15.809 | 0.251 | 15.809 |
| NV 293 | 0 | 13 42 20.59 | +28 28 28.2 | 1 | 0 | 0.093 | 18.024 | 0.107 | 17.747 | 0.064 | 15.935 |
| NV 294 | 0 | 13 42 13.69 | +28 26 30.3 | 1 | 0 | 0.093 | 18.024 | 0.107 | 17.747 | 0.064 | 15.935 |
| NV 295 | 0 | 13 41 58.56 | +28 27 59.4 | 1 | 1 | 0.196 | 18.272 | 0.097 | 17.697 | 0.051 | 17.204 |
| NV 296 | 0 | 13 41 42.98 | +28 24 04.0 | 1 | 1 | 0.087 | 17.813 | 0.079 | 17.731 | 0.051 | 17.204 |
| NV 297 | 0 | 13 41 31.72 | +28 24 10.9 | 1 | 1 | 0.060 | 15.670 | 0.107 | 17.747 | 0.064 | 15.935 |

Notes.—Units of right ascension are hours, minutes, and seconds, and units of declination are degrees, arcminutes, and arcseconds. Full discussion of the column headings is presented in § 3 of the text. Table 2 is published in its entirety in the electronic edition of the Astronomical Journal.

$B_{\text{avg}}$.—Integer denoting the type of $B$-band observations. Values are 0 for no $B$-band detection, 1 for observations that could be converted to magnitudes, or 2 for observations that were left in differential count units.

$I_{\text{avg}}$.—Integer denoting the type of $I$-band observations. Values are 0 for no $I$-band detection, 1 for observations that could be converted to magnitudes, or 2 for observations that were left in differential count units.

$A_V$.—Observed full amplitude in the $V$ band, defined to be the faintest observed magnitude minus the brightest observed magnitude on the cleaned light curve.

$(V)$.—Flux-averaged mean $V$ magnitude of the star. For the EB, this is the out-of-eclipse magnitude determined with the Eclipsing Binary Orbit Program (EBOP; see § 4).

$A_I$.—Observed full amplitude in the $I$ band, defined to be the faintest observed magnitude minus the brightest observed magnitude on the cleaned light curve.

$(B)$.—Flux-averaged mean $B$ magnitude of the star. For the EB, this is the out-of-eclipse magnitude determined with EBOP (see § 4).

Period. —The observed best period of variability in days. This was derived using the ANOVA statistic of Schwarzenberg-Czerny (1996). In cases in which aliasing allowed for a number of acceptable periods, we chose the period corresponding to the peak in the periodogram nearest to the published period, where available.

Published Period. —The published period for the star taken from Clementini et al. (2004), Corwin & Carney (2001), or Clement et al. (2001), in that order of priority.

Period Revision Flag. —Integer denoting whether or not the observed best period should be taken as a revision of the published period. This determination is based on a visual comparison between the light curve phased with the published period and the light curve phased with the observed best period. Values are 1 for a revision and 0 for no revision.

JD of Minimum $V$.—Julian Date (minus 2,450,000) of the first minimum in the $V$ band to occur after the first observation. This field is null for unclassified variables.

Phase of Minimum $B$.—Phase of the minimum in the $B$ band, where zero phase is set to the minimum in the $V$ band.

Phase of Minimum $I$.—Phase of the minimum in the $I$ band, where zero phase is set to the minimum in the $V$ band.

Classification. —Classification of variability. The symbols are as follows:

$RR0$.—Fundamental-mode RR Lyrae star ($RRab$).

$RR1$.—First-overtone RR Lyrae star ($RRe$).

TABLE 3

Catalog of M3 Variables: Last 9 Columns, Last 12 Rows

| ID   | Period | Period$_{\text{pub}}$ | JD$_{\text{min}}$ | $B_{\text{phase}}$ | $I_{\text{phase}}$ | Class | Remarks |
|------|--------|-----------------------|------------------|------------------|------------------|-------|---------|
| NV 286 | ... | ... | 0 | ... | ... | ... | N/A |
| NV 287 | ... | ... | 0 | ... | ... | ... | N/A |
| NV 288 | 0.036600 | ... | 1 | 920.682300 | 0.147541 | 0.874317 | SXP | mp |
| NV 289 | 0.035789 | ... | 1 | 920.703144 | 0.045321 | 0.296544 | SXP | mp |
| NV 290 | 0.240425 | ... | 1 | 920.904200 | ... | ... | RR01 |
| NV 291 | 0.071629 | ... | 1 | 920.770188 | 0.924779 | 0.940555 | SXP |
| NV 292 | 0.296579 | ... | 1 | 920.798310 | 0.887012 | ... | RR1 |
| NV 293 | 0.029462 | ... | 1 | 920.771768 | ... | ... | SXP |
| NV 294 | 0.038827 | ... | 1 | 920.781886 | ... | ... | SXP |
| NV 295 | 0.036081 | ... | 1 | 920.763793 | 0.842549 | 0.853940 | SXP |
| NV 296 | 0.445955 | ... | 1 | 921.127710 | 0.006637 | 0.950825 | EB |
| NV 297 | 0.402037 | ... | 1 | 920.948141 | 0.146715 | 0.748595 | RR1 |

Note.—Full discussion of the column headings is presented in § 3 of the text. Table 3 is published in its entirety in the electronic edition of the Astronomical Journal.
Fig. 4.—The $V, B - V,$ and $V - I$ light curves for six of the 130 previously identified variables for which all three of these measurements were available. Phase = 0 is set to the minimum in $V.$
RR01.—Candidate multimode RR Lyrae star (RRd). Note that the possible presence of multiple periods was determined by eye and was not the result of a systematic search.

SXP.—SX Phoenicis–type variable.

N/A.—Unclassified variable.

EB.—Eclipsing binary.

Remarks.—Here we denote the possible presence of multiple modes ("mp") for SX Phoenicis variables, as well as the presence of the Blazhko effect ("Bl") within the observations.

Figure 4 shows the \( V \), \( B - V \), and \( V - I \) light curves for six of the 130 previously identified variables in the catalog for which these three measurements are available. We display \( V \), \( B - V \), and \( V - I \) light curves, where available, for the two unclassified new variables and the three new RR Lyrae stars in Figure 5 and light curves for the six new SX Phoenicis variables in Figure 6. The \( BVI \) light curves for the EB (NV 297) are shown in Figure 7 together with a model fit.

4. ANALYSIS OF THE ECLIPSING BINARY NV 296

Parameters for the EB NV 296 were determined using EBOP model for detached EBs (Nelson & Davis 1972; Popper & Etzel 1981; see Fig. 7). The first step was to obtain a fit to the \( V \)-band light curve. In doing so we varied the luminosity ratio, the radius of the primary, the inclination of the orbit, and the out-of-eclipse luminosity. We then obtained a second fit by varying the ratio of the radii in place of the radius of the primary. We found empirically that the solution would not converge when the radius of the primary and the ratio of the radii...
Fig. 6.—The $V$, $B-V$, and $V-I$ light curves for the six newly discovered SX Phoenicis–type variables.
Fig. 6.—Continued
were allowed to vary simultaneously. We held the mass ratio fixed at 1.0 and assumed that gravity darkening and the reflection effect were negligible. Because the period is relatively short (0.445955 days), we assumed that the orbits would have circularized, so we held the eccentricity fixed to 0. We note that when we allowed this parameter to vary, the results were consistent with \( e = 0 \). Having obtained a model for the \( V \)-band light curve, we proceeded to fit a model to the \( B \)-band light curve, assuming the same orbital parameters and radii from the \( V \)-band model. We did not analyze the \( I \)-band light curve, since noise and poor phase coverage during the eclipses conspired to prevent us from obtaining an acceptable fit.

Without spectra it is difficult to constrain the spectral types and luminosity classes of the components and hence the limb-darkening coefficients. As a preliminary analysis, we fixed the limb-darkening coefficients for both components to 0.57 in \( V \) and 0.72 in \( B \), which is consistent with an F2 V star in the limb-darkening tables of Claret & Gimenez (1990). We caution that the results from this fit should be treated as preliminary until spectra can be obtained for this variable.

The parameters from the best-fit model are shown in Table 4. To test the effect of the unconstrained mass ratio on the fit, we obtained an independent model, assuming a mass ratio of 0.7. The parameters for this model are also shown in Table 4. We note that the results appear to be consistent; in particular, the position of the components on the CMD is unaffected by the mass ratio. We find that the primary has \( B - V = 0.349 \pm 0.042 \) mag and \( V = 19.331 \pm 0.028 \) mag, while the secondary has \( B - V = 0.395 \pm 0.064 \) mag and \( V = 19.747 \pm 0.042 \) mag. The errors listed here and in Table 4 are propagated from the standard errors produced by the EBOP fits. We caution that for all parameters except the color these errors are likely to be optimistic. In the case of the \( B - V \) colors, the errors listed are calculated assuming \( B \) and \( V \) are uncorrelated, when in reality the two magnitudes will be correlated as a result of the fitting procedure. We note that for three different choices of the limb-darkening coefficients, \( B - V \) changed by less than a percent for both components, whereas the other parameters varied by amounts consistent with the standard errors.

5. COLOR-MAGNITUDE DIAGRAMS

In Figures 8 and 9, we plot the \( B - V \) versus \( V \) and \( V - I \) versus \( V \) CMDs for the cluster. In these figures we use circles to show RR Lyrae variables, squares for SX Phoenicis variables, stars for unclassified variables, and open triangles for the two components of the EB. BSSs that were examined for variability are shown with filled triangles. Note that these stars were selected based on their position in the \( B - V \) CMD. Where available, the locations of these stars in the \( V - I \) CMD are also shown.

The SX Phoenicis variables for which colors could be obtained all lie within the blue straggler region of the CMD as a result of our selection procedure. Although their location on the

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**TABLE 4**

| Parameter           | Value \((q=1.0)\) | Standard Error | Value \((q=0.7)\) | Standard Error |
|---------------------|-------------------|----------------|-------------------|----------------|
| Mass Ratio ........... | 1.0               | 0.0            | 0.7               | 0.0            |
| \( V \) primary ...... | 19.331            | 0.028          | 19.351            | 0.024          |
| \( V \) secondary ... | 19.747            | 0.042          | 19.719            | 0.036          |
| \( B - V \) primary ... | 0.349             | 0.042          | 0.348             | 0.036          |
| \( B - V \) secondary ... | 0.395             | 0.064          | 0.396             | 0.035          |
| \( V \) secondary/B primary ... | 0.65922          | 0.02525        | 0.64884           | 0.02280        |
| \( V \) Jp/Jp ... | 0.63197            | 0.03088        | 0.62028           | 0.02917        |
| \( R_s/R_p \) ... | 0.28594            | 0.00357        | 0.28499           | 0.00360        |
| \( V \) limb darkening ... | 0.57              | 0.00           | 0.57              | 0.00           |
| \( B \) limb darkening ... | 0.72              | 0.00           | 0.72              | 0.00           |
| Inclination (deg) ... | 75.66777          | 0.50846        | 75.86569          | 0.47571        |
| Eccentricity .......... | 0.00              | 0.00           | 0.00              | 0.00           |
| \( V \) scale factor ... | 18.76666          | 0.00214        | 18.76719          | 0.00228        |
| \( B \) scale factor ... | 19.13395          | 0.00230        | 19.13484          | 0.00237        |

**Notes.**—Parameters for which the error listed is identical to zero were held fixed in the fitting process. All other errors are taken from the formal errors given by EBOP. The first two columns display results for a mass ratio of 1.0; the last two display the results for a mass ratio of 0.7. The expressions \( J_2 \) and \( J_3 \) are the surface brightness of the secondary and primary, respectively; \( R_s \) and \( R_p \) are the radii of the secondary and the primary, respectively; and \( a \) is the semimajor axis.
CMD may indicate that these variables are indeed likely members of the cluster, one must be cautious in such claims following the identification with quasars of three variables lying in the blue straggler region of the M3 field CMD (Meusinger et al. 2001).

The components of the EB NV 296 appear to lie near the zero-age main sequence (ZAMS) at a distance of \((m - M)_V = 15.04\) mag (Harris 1996). The photometry for the primary is consistent with an F2 V dwarf, and the secondary is consistent with an F3–4 V dwarf. If the EB is indeed a member of the cluster, then both components (particularly the primary) appear to lie slightly below the cluster main sequence, closer to the ZAMS for the cluster.

The location of the unclassified variables on the CMD is completely uncertain, since we have not observed a full period for either of these stars.

To further study the RR Lyrae population, we plot the horizontal-branch regions of the CMDs in detail in Figures 10 and 11. Here we distinguish between the types of RR Lyrae variables, using filled circles for RR0, open circles for RR1, and stars for RR01 candidates. The evolution from RR0 to RR1 along the horizontal branch is clearly demonstrated in the CMD for M3. We note that some RR Lyrae stars may appear to lie outside of the instability strip as a result of uncertainties in their
colors. We also note that blending near the center of the cluster may cause a few variables to appear artificially bright.

6. DISCUSSION

There has been a great deal of interest in studying the variability of BSSs in globular clusters. A number of globular clusters show a substantial population of variable blue stragglers. Gilliland et al. (1998) found that nine out of 47 monitored BSSs in 47 Tuc showed variability above 0.02 mag. Recently Kaluzny et al. (2004) identified 35 new SX Phoenicis variables in ω Cen. However, despite having a sizable population of BSSs, Kaluzny et al. (1998) found only a single SX Phoenicis star in M3. We confirm the relative underabundance of SX Phoenicis stars in M3, finding only seven variables out of 122 monitored BSSs. We note that with image subtraction we would have been able to detect single-mode, short-period variability in the monitored BSSs with amplitudes greater than 0.02 mag (see, for example, NV 289 in Fig. 4).

EBs are another interesting target for globular cluster variability surveys. Besides the possibility that binaries play an important role in the dynamical evolution of globular clusters (Hut et al. 1992) and the formation of the BSSs (Leonard 1989; Leonard & Fahlman 1991), EBs can also be used as a tool to determine accurate ages and distances to the clusters (Paczynski 1997; see Kaluzny et al. 2004 for a discussion of a systematic program to search for detached EBs in nearby globular clusters). The location of the components of NV 296 on the CMD suggests that the binary may indeed be a member of the cluster. If it is a member, then there must be some mechanism that has allowed the components to avoid evolution into a giant. One hypothesis may be mass transfer onto the primary; however, the fact that the light curve seems well fitted by a detached EB model suggests that mass transfer is not currently occurring at a significant rate. Moreover, the secondary star itself appears to be younger than other F3–F4 V stars in the cluster. It is necessary to obtain spectra for this system before anything more can be said about its membership. If it is a member, then spectra will be useful in determining the masses of the components.

As mentioned in § 1, many of the recent studies of M3 have focused on the RR Lyrae population. Most recently, Cacciari et al. (2005) used data from previous BVI surveys to conduct a detailed analysis of the RR Lyrae population in M3. Other authors have pointed to inconsistencies between existing models for horizontal-branch evolution and the observed population (Catelan 2004; Clementini et al. 2004 discuss the observation of rapid evolution among the double-mode RR Lyrae). Although we do not perform a systematic analysis of the RR Lyrae population, the data that we present should be useful for further investigations of these stars.

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