# Cepheid Calibrations of Modern Type Ia Supernovae: Implications for the Hubble Constant[1]

Adam G. Riess[2,3], Lucas Macri[4], Weidong Li[5], Hubert Lampeitl[3,8], Stefano Casertano[3], Henry C. Ferguson[3], Alexei V. Filippenko[5], Saurabh W. Jha[6], , Ryan Chornock[5], Lincoln Greenhill[7], Max Mutchler[3], Mohan Ganeshalingham[5]

## ABSTRACT

This is the first of two papers reporting measurements from a program to determine the Hubble constant to ∼5% precision from a refurbished distance ladder. We present new observations of 110 Cepheid variables in the host galaxies of two recent Type Ia supernovae (SNe Ia), NGC 1309 and NGC 3021, using the Advanced Camera for Surveys on the *Hubble Space Telescope (HST)*. We also present new observations of the hosts previously observed with *HST* whose SNe Ia provide the most precise luminosity calibrations: SN 1994ae in NGC 3370, SN 1998aq in NGC 3982, SN 1990N in NGC 4639, and SN 1981B in NGC 4536, as well as the maser host, NGC 4258. Increasing the interval between observations enabled the discovery of new, longer-period Cepheids, including 57 with $P > 60$ days, which extend these period-luminosity ($P$-$L$ ) relations. We present 93 measurements of the metallicity parameter, 12 + log[O/H], measured from H II regions in the vicinity of the Cepheids and show these are consistent with solar metallicity. We find the slope of the seven dereddened $P$-$L$ relations to be consistent with that of the Large Magellanic Cloud Cepheids and with parallax measurements of Galactic Cepheids, and we address the implications for the Hubble constant. We also present multi-band light curves of SN 2002fk (in NGC 1309) and SN 1995al (in NGC 3021) which may be used to calibrate their luminosities. In the second paper we present observations of the Cepheids in the $H$ band obtained with the Near Infrared Camera and Multi-Object Spectrometer on *HST*, further mitigating systematic errors

[1]Based on observations with the NASA/ESA *Hubble Space Telescope*, obtained at the Space Telescope Science Institute, which is operated by AURA, Inc., under NASA contract NAS 5-26555.

[2]Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218.

[3]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218; ariess@stsci.edu .

[4]George P. and Cynthia W. Mitchell Institute for Fundamental Physics and Astronomy, Department of Physics, Texas A&M University, 4242 TAMU, College Station, TX 77843-4242.

[5]Department of Astronomy, University of California, Berkeley, CA 94720-3411.

[6]Department of Physics and Astronomy, Rutgers University, 136 Frelinghuysen Road, Piscataway, NJ 08854.

[7]Smithsonian Astrophysical Observatory, Cambridge, MA

[8] Institute of Cosmology and Gravitation, University of Portsmouth, Portsmouth, PO1 3FX, UK

along the distance ladder resulting from dust and chemical variations. The quality and homogeneity of these SN and Cepheid data provide the basis for a more precise determination of the Hubble constant.

*Subject headings:* galaxies: distances and redshifts — cosmology: observations — cosmology: distance scale — supernovae: general

## 1. Introduction

The most accurate method to measure the Hubble constant, $H_0$, in the low-redshift Universe has been to meld the Type Ia supernova (SN Ia) and Cepheid distance scales through *Hubble Space Telescope (HST)* observations of Cepheid variables in SN Ia host galaxies within $\sim$ 20 Mpc. Having extremely high and moderately uniform luminosities, SNe Ia are the most precise distance indicators known for sampling the present expansion rate of the Universe. Methods which use the relationship between SN Ia light-curve shape and luminosity (Phillips 1993; Hamuy et al. 1995, 1996; Riess et al. 1995, 1996a, 1998; Perlmutter et al. 1997; Saha et al. 2001) and supernova color to constrain absorption by dust (Riess et al. 1996b; Phillips et al. 1999; Guy et al. 2005; Wang et al. 2009) yield distances with *relative* precision approaching 5% *if applied to modern photometry.* The $\sim$100 high-quality, modern SN Ia light curves currently published in the redshift range $0.01 < z < 0.1$ establish the *relative* expansion rate to an unprecedented uncertainty of <1% (i.e., internal statistical error; Jha, Riess, Kirshner 2005). Yet because SNe Ia are a secondary distance indicator, the measurement of the *true* expansion rate is seriously limited by the few opportunities to calibrate their peak luminosity.

The SN Ia *HST* Calibration Program (Saha et al. 2001; Sandage et al. 2006) and the *HST* Key Project (Freedman et al. 2001) calibrated $H_0$ via Cepheids and SNe Ia using Wide Field and Planetary Camera 2 (WFPC2). These measurements resolved decades of extreme uncertainty about the scale and age of the Universe. However, despite a great amount of careful work, the final estimates of $H_0$ by the two teams differ by 20% and the overall uncertainty in each estimate has proved difficult to reduce to 10% or less. The bulk of this can be traced to systematic uncertainties among the many steps on the path to determining the luminosity of SNe Ia and to the known inaccuracy of the SN Ia calibration sample.

The use of the LMC as the anchor in the Key Project distance ladder presents specific challenges which result in several sources of systematic uncertainty if used for calibrating SNe Ia with Cepheids. The LMC distance is known to only 5% to 10% and its Cepheids, all observed from the ground, are of shorter mean period ($< P > \approx 5$ d) and lower metallicity than those found in the spiral galaxies that host SNe Ia beyond the Local Group. These mismatches propagate unwanted uncertainties to the measurement of the Hubble constant from the use of imperfectly known relations between Cepheid luminosity, metallicity, and period. The use of distance estimates to Galactic Cepheids as anchors by the HST Calibration Program also presents stiff challenges as discussed in §5.

Additional systematic uncertainties in both teams‘ measurements of $H_0$ result from the photometric idiosyncracies of the WFPC2 camera and the unreliability of those nearby SNe Ia which were *photographically* observed, highly reddened, atypical, or discovered after maximum brightness. Only three SNe Ia (SNe 1990N, 1981B, and 1998aq) were free from these aforementioned shortcomings, making ideal SNe a minority of the set used for calibrating $H_0$ with WFPC2 (see Table 1). The use of many unreliable calibrators was necessitated by the limited reach of WFPC2, defining a volume within which Nature provides a suitable SN Ia only once every decade.

The installation of the Advanced Camera for Surveys (ACS; Ford et al. 2003) on board *HST* provided an important improvement in the optical imaging capabilities of the observatory. In regards to the distance ladder, the improved resolution and sensitivity of ACS extended the reach of *HST* Cepheid observations to about 35 Mpc, tripling the enclosed volume and the available number of potential calibrators of SNe Ia since the WFPC2 era. In Cycle 11 we (Riess et al. 2005) used ACS to measure Cepheid variables in the host of an ideal calibrator, SN 1994ae, situated in this extended volume. Two more opportunities to augment the very small, modern sample of calibrated SNe Ia are presented by SN 1995al in NGC 3021 and SN 2002fk in NGC 1309. These SNe Ia were discovered well before their maxima and were observed with the same $UBVRI$ passbands and equipment we employed to measure the SNe Ia that help define the Hubble flow. These SNe Ia present two of the most complete photometric records ever of any SNe Ia (see §4). Calibration of $H_0$ from SN 1995al and SN 2002fk would add only the fifth and sixth reliable SN Ia to Table 1 and, more importantly, only the second and third to use the more reliable and advantageous photometric system of ACS.

By replacing previous anchors of the distance scale with the “maser galaxy” NGC 4258 we can also wring additional precision for the Hubble constant. First, the distance to the masers has been measured geometrically to unprecedented precision for an extragalactic source (Herrnstein et al. 1999, Humphreys et al. 2005, 2008,2009). NGC 4258 also has the largest extragalactic set of long-period Cepheids observed with HST (Macri et al. 2006) Furthermore, we could bypass uncertainties in the determination of the photometric system zeropoints from the ground and space, and in the functional form of the period-luminosity ($P$-$L$ ) relation, because we would only need to determine the relative magnitude offset between each galaxy's set of Cepheids. To maximize this advantage we may also reobserve the hosts of nearby SNe Ia already observed with WFPC2 to place their Cepheids on the same photometric system and to find additional Cepheids whose periods would have been greater than the length of the WFPC2 campaigns. Lastly, the metallicity of the spiral hosts of Cepheid-calibratable SNe Ia is much more similar to that of NGC 4258 than to that of the LMC, reducing the overall dependence of $H_0$ on metallicity corrections. Ultimately, the improved precision in $H_0$ gained from a reduction in rungs on the distance ladder using NGC 4258 will be limited by the number of SN Ia hosts calibrated by ACS (due to the intrinsic scatter of SN Ia magnitudes).

In §2 we present the observations of (a) Cepheids in the new SN hosts, (b) new, longer period Cepheids in the previously observed hosts, and (c) measurements of the metallicities in the vicinity

of the Cepheids. The light curves of the SNe Ia are presented in §3. In §4 we describe the value of these data for the distance scale, a task undertaken in a companion paper (Riess et al. 2009).

Table 1: SN Ia Light Curves with *HST* Cepheid Calibration

| SN Ia | Modern photometry?[e] | Low reddening?[a] | Observed before max? | Normal | Ideal? |
|---|---|---|---|---|---|
| 1895B[b] | No | Unknown | No | Unknown | |
| 1937C[b] | No | Yes | Yes | Yes | |
| 1960F[b] | No | No | Yes | ? | |
| 1972E[b] | Yes | Yes | No | Yes | |
| 1974G | No | No | Yes | ? | |
| 1981B[b] | Yes | Yes | Yes | Yes | √ |
| 1989B[b] | Yes | No | Yes | Yes | |
| 1990N[b] | Yes | Yes | Yes | Yes | √ |
| 1991T[b] | Yes | Yes? | Yes | No | |
| 1994ae[c] | Yes | Yes | Yes | Yes | √ |
| 1995al[d] | Yes | Yes | Yes | Yes | √ |
| 1998aq[c] | Yes | Yes | Yes | Yes | √ |
| 1998bu | Yes | No | Yes | Yes | |
| 1999by | Yes | Yes | Yes | No | |
| 2002fk[d] | Yes | Yes | Yes | Yes | √ |

[a] $A_V < 0.5$ mag.
[b] Calibrated by the Sandage/Tammann/Saha collaboration.
[c] Calibration presented by Riess et al. (2005).
[d] Calibration first presented in this paper.
[e] CCD or photoelectric, not photographic.

## 2. Cepheid Observations

The average of a small sample may be significantly impacted by a moderate systematic error among one of its members. Therefore, *it is essential that each SN Ia in the calibration sample have a reliable photometric record which is accurate and comparable to those of the SNe Ia used to measure the Hubble flow.* To define a reliable calibration sample we use the criteria for inclusion of a SN Ia given by Riess et al. (2005): (a) modern data (i.e., photoelectric or CCD), (b) observed before maximum brightness, (c) low reddening, and (d) spectroscopically typical. In addition, their hosts must be suitable targets for observations by *HST* of their Cepheids, which requires a relatively face-on, late-type host within $\sim 35$ Mpc.

The recent SN 1995al in NGC 3021 and SN 2002fk in NGC 1309 provide two valuable additions to the small calibration set (shown in Table 2). The SN data are described in §4, but both are ideal candidates by the previous criteria and their magnitudes indicate distances of 30–35 Mpc. The host galaxies are moderately sized ($1.5' \times 1.5'$ and $2.0' \times 2.2'$, respectively), face-on Sbc galaxies,

Table 2: Optical Observations of SN Ia Calibration Sample

| Host | SN Ia | Initial campaign | Reobservation |
|---|---|---|---|
| NGC 4536 | SN 1981B | WFPC2 | WFPC2 |
| NGC 4639 | SN 1990N | WFPC2 | ACS |
| NGC 3982 | SN 1998aq | WFPC2 | ACS |
| NGC 3370 | SN 1994ae | ACS | ACS |
| NGC 3021 | SN 1995al | ACS | ACS |
| NGC 1309 | SN 2002fk | ACS | ACS |

each fitting well within the ACS WFC field of view as shown in Figures 1 and 2.

In Cycle 14 (2005–2006, GO-10497) we observed NGC 1309 and NGC 3021 for 12 epochs of 4800 s each with ACS WFC $F555W$ using a power-law spacing of intervals designed to reduce period aliasing up to the full monitoring duration of 52 d. We also observed each host at 5 epochs with $F814W$ for 4800 s each. The telescope position and orientation were fixed for each host and a four-position dither (noninteger shift of 4.5 pixels in each detector coordinate) was performed to better sample the point-spread function (PSF) in the median image.

In Cycle 15 (2006–2007, GO-10802) we reobserved NGC 1309 and NGC 3021, as well as the other four hosts in the calibration sample of Table 2 at two epochs using ACS and $F555W$ (each $F555W$ observation was separated by $\sim$ 10 d) to constrain the phase of the Cepheid light curves for subsequent infrared (IR) observations with the Near Infrared Camera and Multi-Object Spectrometer (NICMOS; Riess et al. 2009) and to aid in the identification of Cepheids with $P > 60$ d which were beyond the interval of the initial, contiguous campaigns.[1] Logs of the exposures for NGC 3021 and NGC 1309 are given in Tables 3 and 4, respectively.

### 2.1. ACS Photometry

For the four hosts with extensive ACS measurements NGC 1309, NGC 3021, NGC 3370 and NGC 4258, the data from programs GO-9810 (P.I. Greenhill), GO-9351 (P.I. Riess), GO-10497 (P.I. Riess), and GO-10802 (P.I. Riess) were retrieved from the *HST* archive. While ACS data for NGC 3370 (Riess et al. 2005) and NGC 4258 (Macri et al. 2006) were previously analyzed to identify Cepheids, the acquisition of the two new epochs of ACS imaging in program GO-10802, better calibration data, and the need for a homogeneous reduction process for the comparison of Cepheid magnitudes necessitated new data reductions undertaken here.

The data retrieval from the Space Telescope Science Institute (STScI) MAST archive made

[1]The Cycle 15 observations of NGC 4536 were obtained with WFPC2 due to the failure of ACS in February, 2007.

Table 3. Log of Observations for NGC 3021

| Epoch # | MJD at mid exposure* V | I |
|---|---|---|
| 01 | 3686.0407 | 3686.1735 |
| 02 | 3686.1066 | 3686.2398 |
| 03 | 3696.4242 | ... |
| 04 | 3696.5566 | ... |
| 05 | 3704.6240 | 3704.7597 |
| 06 | 3704.6929 | 3704.8261 |
| 07 | 3708.7942 | ... |
| 08 | 3708.8564 | ... |
| 09 | 3712.7275 | ... |
| 10 | 3712.7894 | ... |
| 11 | 3715.7923 | ... |
| 12 | 3715.8559 | ... |
| 13 | 3716.7919 | 3716.9227 |
| 14 | 3716.8555 | 3717.0197 |
| 15 | 3718.8569 | ... |
| 16 | 3718.9211 | ... |
| 17 | 3721.9208 | ... |
| 18 | 3722.0161 | ... |
| 19 | 3725.7835 | 3725.9159 |
| 20 | 3725.8488 | 3726.0127 |
| 21 | 3730.5123 | ... |
| 22 | 3730.5778 | ... |
| 23 | 3737.5724 | 3737.7050 |
| 24 | 3737.6380 | 3737.7712 |
| 25 | 4058.9217 | ... |
| 26 | 4066.7134 | ... |

∗: JD-2450000.0

Table 4. Log of Observations for NGC 1309

| Epoch # | MJD at mid exposure* V | I |
|---|---|---|
| 01 | 3588.6856 | 3588.8192 |
| 02 | 3588.7523 | 3588.8856 |
| 03 | 3599.9153 | ... |
| 04 | 3599.9797 | ... |
| 05 | 3606.7768 | 3606.9082 |
| 06 | 3606.8411 | 3606.9744 |
| 07 | 3609.9078 | ... |
| 08 | 3609.9723 | ... |
| 09 | 3615.5304 | ... |
| 10 | 3615.6030 | ... |
| 11 | 3616.9033 | ... |
| 12 | 3617.0008 | ... |
| 13 | 3618.5021 | 3618.6347 |
| 14 | 3618.5676 | 3618.7009 |
| 15 | 3620.9007 | ... |
| 16 | 3620.9992 | ... |
| 17 | 3623.9338 | ... |
| 18 | 3624.0679 | ... |
| 19 | 3629.7599 | 3629.9226 |
| 20 | 3629.8252 | 3630.0626 |
| 21 | 3633.3574 | ... |
| 22 | 3633.4228 | ... |
| 23 | 3640.4216 | 3640.5530 |
| 24 | 3640.4859 | 3640.6192 |
| 25 | 4015.3368 | ... |
| 26 | 4032.5923 | ... |

∗: JD-2450000.0

use of the most up-to-date calibration as applied by the software suite *calacs* in "pyraf." Epoch-by-epoch photometry for all stellar sources identified in a master, composite image was measured for the images obtained in $F555W$ and $F814W$ using the DAOPHOT[2] set of routines following the procedures given by Stetson (1994), Stetson et al. (1998), Riess et al. (2005), and Macri et al. (2006). Magnitudes from PSF fitting were initially measured to include the charge within $0.5''$ radius apertures. These natural-system magnitudes for each candidate Cepheid at each observed epoch are given in Tables 5 and 6, evaluated as 2.5 $\log(e/\mathrm{s})$ − CTE + 25.0, where $e/\mathrm{s}$ is the measured flux (electrons per second) and CTE (charge transfer efficiency) is the magnitude loss given by Chiaberge et al. (2009) for a star as a function of observation date, pixel position, brightness, and background. The median uncertainty for an individual Cepheid magnitude in an epoch was 0.09 mag.

We selected Cepheids following the methodology outlined by Macri et al. (2006). Initially, Cepheid candidates were identified from the time-sampled data by selecting all stellar sources with a modified Welch/Stetson variability index $J_S$ (Stetson 1996) in excess of 0.75 and that were detected in at least 12 of the 14 epochs of $F555W$ data. These candidates were then subjected to a "minimum string-length analysis," which identified as likely periods those that minimized the sum of magnitude variations for observations at similar trial phases (Stetson et al. 1998). Robust least-squares fits were then performed in the two bands, comparing the single-epoch magnitudes to template Cepheid light curves from Stetson et al. (1998), where six parameters representing (1) period, (2) $V$-band amplitude, (3) $I$-band amplitude, (4) epoch of zero phase, (5) mean magnitude in $V$, and (6) mean magnitude in $I$ were free, but the shape of the light curve was a unique function of the assumed period. Finally, one of us (L.M.M.) applied experienced judgement in a visual comparison of the data to the best-fit Cepheid model, rejecting unconvincing candidates (approximately 10%). The criteria used to settle on the final set were (a) how well the light-curve sampling was distributed in phase, (b) the appearance of the characteristic rapid rise and slow fall of the light curve, and (c) the proximity of the amplitudes and colors to the expected range. This same partially subjective process was compared to a purely numerical selection by Riess et al. (2005) for the Cepheids in NGC 3370, resulting in small differences in Cepheid-list membership, and less than 0.04 mag difference in the intercept of the $P$-$L$ relation. When the optimum fit had been achieved, the fitted light curves were converted to flux units and numerically integrated over a cycle to achieve flux-weighted mean apparent brightnesses in each bandpass; these were then converted back to magnitude units.

The photometric zeropoints (the magnitudes resulting in 1 electron $\mathrm{s}^{-1}$ in an infinite aperture) for our ACS magnitudes were obtained using the Vegamag system (i.e., Vega ≡ 0 mag in all passbands). The official STScI ACS zeropoints were revised from those given by Sirianni et al.

[2]Past comparisons of photometry with the popular PSF fitting tools DoPHOT, DAOPHOT (Stetson 1987), and HSTphot by Gibson et al. (2000), Leonard et al. (2003), and Saha et al. (2001) show that the mean difference in *HST* photometry obtained with these packages is not significant.

(2005), and as of the beginning of 2009 have values of $F555W = 25.744$ and $F814W = 25.536$ for data obtained before 2006 July 4 when ACS operated at $-77$ C, and $F555W = 25.727$ and $F814W = 25.520$ after that date when ACS operated at $-81$ C. These are based on an empirical measurement of the system throughput at all wavelengths using the known spectral energy distribution of five white dwarfs. This approach is similar to that of Holtzman et al. (1995) for WFPC2.[3] The PSF magnitudes in Tables 5 and 6 were extended from the $0.5''$ radius aperture to infinity using the aperture corrections given by Sirianni et al. (2005) of 0.092 and 0.087 mag in $F555W$ and $F814W$, respectively. The natural-system magnitudes were converted to the Johnson system (for ease of comparison to non-*HST* Cepheid data) using the formulae in Sirianni et al. (2005). Thus, the natural-system magnitudes in Tables 5 and 6 with zeropoint 25.0 are converted to the Johnson system using the transformations

$$V = F555W + 0.744 - 0.092 - 0.054(V - I), \tag{1}$$

$$I = F814W + 0.536 - 0.087 - 0.002(V - I). \tag{2}$$

This transformation is performed during the simultaneous fitting of the $V$ and $I$ light-curve templates to interpolate the $V - I$ color at epochs when only $F555W$ was measured.

[3]The Key Project zeropoint is based on matching *HST* photometry of globular clusters (including 47 Tuc) to ground-based data obtained by Stetson (2000) on 22 nights from 12 distinct observing runs. Riess et al. (2005) found that the ACS photometric zeropoints of Sirianni et al. (2005), $F555W = 25.704$ mag and $F814W = 25.492$ mag, and those based on the Stetson (2000) system are quite consistent, with a mean difference of 0.015 mag in $V$ and 0.026 mag in $I$ for 250 calibrating stars in 47 Tuc.

Table 5. Cepheid photometry in NGC 3021[a]

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| | **31556$P$ = 11.18 d** | | **30672$P$ = 13.93 d** | | **08621$P$ = 15.38 d** | | **08102$P$ = 18.71 d** | |
| 1 | 26.841(189) | 26.382(185)* | 27.381(323) | 26.677(182) | 26.195(166) | 25.881(145) | 26.313(174) | 25.904(148) |
| 2 | 26.822(218) | 26.807(199) | 27.218(199) | 26.799(206) | 26.390(115) | 25.942(135) | 26.398(108) | 26.110(122) |
| 3 | 27.399(285) | ... | 26.600(165) | ... | 27.078(237) | ... | ... | ... |
| 4 | 26.981(188) | ... | 26.750(152) | ... | 26.742(190) | ... | 26.845(168) | ... |
| 5 | 26.576(137) | 26.543(274) | 27.297(236) | 26.820(181) | 26.614(183) | 25.719(136) | 26.625(171) | 26.056(203) |
| 6 | 26.708(207) | 27.024(332)* | 27.298(282) | 26.854(185) | 26.592(178) | 26.011(124) | 26.144(149) | 26.189(117) |
| 7 | 27.227(371) | ... | 26.593(132) | ... | 27.004(190) | ... | 26.213(248) | ... |
| 8 | 27.754(361) | ... | 26.632(074) | ... | 26.870(228) | ... | 26.543(184) | ... |
| 9 | 26.831(220) | ... | 27.134(337) | ... | 26.881(266) | ... | 27.108(361) | ... |
| 10 | 26.401(119) | ... | 27.175(176) | ... | 26.714(157) | ... | 27.116(242) | ... |
| 11 | 26.619(172) | ... | 27.871(309) | ... | 26.337(133) | ... | 27.021(294) | ... |
| 12 | 26.514(113) | ... | 27.663(252) | ... | 26.203(108) | ... | 27.012(191) | ... |
| 13 | 26.851(261) | 26.678(282) | 27.238(220) | 27.041(300) | 26.481(199) | 25.949(179) | 27.131(287) | 26.539(215) |
| 14 | 26.783(271) | 26.592(270) | 27.649(389) | 26.889(161) | 26.034(133) | 25.944(134) | 27.180(312) | 26.485(290) |
| 15 | 26.966(276) | ... | 26.737(144) | ... | 26.380(145) | ... | 27.416(372) | ... |
| 16 | ... | ... | 26.678(104) | ... | 26.640(163) | ... | 27.321(252) | ... |
| 17 | 26.872(220) | ... | 26.223(133) | ... | 26.731(223) | ... | 26.673(161) | ... |
| 18 | 27.396(250) | ... | 26.355(105) | ... | 26.448(172) | ... | 25.993(095) | ... |
| 19 | 26.103(110) | 26.292(133) | 26.843(148) | 26.567(115) | 27.327(363) | 26.289(214) | 26.601(175) | 26.076(136) |
| 20 | 26.139(150) | 26.315(193) | 26.730(212) | 26.409(129) | 26.561(189) | 26.598(220)* | 26.767(147) | 26.062(144) |
| 21 | 26.662(278) | ... | 26.788(193) | ... | 26.205(184) | ... | 26.570(205) | ... |
| 22 | ... | ... | 27.353(237) | ... | 26.366(166) | ... | 26.996(179) | ... |
| 23 | 26.470(138) | 26.324(186) | 26.411(151) | 26.429(133) | 27.314(338) | 26.223(205) | 27.215(172) | 26.770(261) |
| 24 | 26.582(121) | 26.386(160) | 27.000(180) | 26.286(140) | 27.209(365) | 26.153(165) | 27.468(228) | 26.447(236) |
| 25 | 26.798(252) | ... | 26.930(269) | ... | 26.720(342) | ... | 26.181(249) | ... |
| 26 | 27.510(391) | ... | 27.090(345) | ... | 26.601(256) | ... | 26.950(325) | ... |
| | **20774$P$ = 20.39 d** | | **10786$P$ = 21.16 d** | | **47390$P$ = 21.84 d** | | **33607$P$ = 23.14 d** | |
| 1 | 26.427(141) | 25.821(183) | 26.590(179) | 25.882(125) | 26.292(189) | 25.915(151) | 26.733(116) | 26.360(152) |
| 2 | 26.349(157) | 25.704(100) | 26.658(188) | 25.678(117) | 26.178(118) | 25.662(134) | 27.329(359) | 26.750(181)* |
| 3 | 26.099(123) | ... | 26.737(145) | ... | 26.676(128) | ... | 26.743(208) | ... |
| 4 | 26.322(132) | ... | 27.291(294) | ... | 26.577(164) | ... | 26.391(143) | ... |
| 5 | 26.850(214) | 26.140(181) | 26.392(106) | 26.056(185) | 26.711(171) | 25.925(166) | 27.066(173) | 26.446(181) |
| 6 | 26.533(167) | 26.034(194) | 26.569(152) | 25.866(172) | 27.073(250) | 26.096(165) | 27.059(250) | 26.477(156) |
| 7 | 25.777(114) | ... | 26.686(176) | ... | 26.273(131) | ... | 27.111(193) | ... |
| 8 | 25.770(116) | ... | 26.819(186) | ... | 26.139(097) | ... | 27.160(225) | ... |
| 9 | 25.958(130) | ... | 27.281(294) | ... | 26.267(112) | ... | 26.431(181) | ... |
| 10 | 25.989(150) | ... | 26.880(175) | ... | 26.378(177) | ... | 26.517(160) | ... |
| 11 | 26.131(127) | ... | 27.315(326) | ... | 26.749(189) | ... | 26.520(094) | ... |
| 12 | 26.113(190) | ... | 27.177(317) | ... | 26.573(189) | ... | 26.246(114) | ... |
| 13 | 25.931(091) | 25.698(123) | 27.244(332) | 26.259(175) | 26.639(219) | 26.128(224) | 26.308(145) | 25.972(098) |
| 14 | 26.214(125) | 25.588(100) | 27.034(204) | 26.031(166) | 26.563(150) | 26.037(167) | 26.422(200) | 25.953(107) |
| 15 | 26.212(139) | ... | 26.738(167) | ... | 26.480(210) | ... | 26.870(206) | ... |
| 16 | 26.223(170) | ... | 26.653(134) | ... | 27.133(243) | ... | 26.643(112) | ... |
| 17 | 26.207(232) | ... | 26.241(107) | ... | 27.147(338) | ... | 26.762(161) | ... |
| 18 | 26.871(276) | ... | 26.069(144) | ... | 26.606(223) | ... | 26.720(148) | ... |

Table 5—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 19 | 26.463(168) | 25.909(175) | 26.574(183) | 25.818(095) | 27.102(338) | 26.246(173) | 26.966(202) | 26.371(094) |
| 20 | 26.531(170) | 26.327(162) | 26.254(105) | 25.541(144) | 26.792(194) | 26.245(299) | 26.708(105) | 26.221(103) |
| 21 | 25.676(088) | ... | 27.097(219) | ... | 26.112(130) | ... | 27.313(182) | ... |
| 22 | 25.692(127) | ... | 26.621(144) | ... | 26.321(178) | ... | 27.070(207) | ... |
| 23 | 25.955(121) | 25.559(109) | 27.115(256) | 26.016(166) | 26.478(133) | 25.823(157) | 26.267(095) | 25.910(089) |
| 24 | 26.157(166) | 25.921(116) | 26.833(330) | 26.269(227) | 26.426(142) | 25.660(232) | 26.090(108) | 25.920(096) |
| 25 | 25.806(128) | ... | 26.275(182) | ... | 25.896(128) | ... | 26.572(314) | ... |
| 26 | 26.451(229) | ... | 26.785(379) | ... | 26.498(185) | ... | ... | ... |
| | **32375$P$ = 24.02 d** | | **08636$P$ = 24.36 d** | | **32380$P$ = 25.18 d** | | **32088$P$ = 25.78 d** | |
| 1 | 26.158(059) | 25.689(121) | 26.586(139) | 25.825(164) | 26.736(212) | 25.861(091) | 27.179(229) | 26.010(119) |
| 2 | 26.311(168) | 25.773(144) | 26.710(201) | 25.804(162) | 26.686(113) | 25.809(120) | 27.158(276) | 26.065(138) |
| 3 | 27.245(174) | ... | 25.977(111) | ... | 25.841(061) | ... | 26.308(097) | ... |
| 4 | 26.929(174) | ... | 26.144(114) | ... | 25.846(064) | ... | 25.956(148) | ... |
| 5 | 26.938(299) | 25.984(108) | 26.343(140) | 25.830(137) | 26.476(179) | 25.885(084) | 26.656(136) | 25.591(111) |
| 6 | 26.507(171) | 26.207(106) | 26.398(156) | 25.857(116) | 26.634(226) | 26.384(145)* | 26.651(172) | 25.673(127) |
| 7 | 26.061(102) | ... | 26.709(234) | ... | 26.341(145) | ... | 27.113(190) | ... |
| 8 | 26.065(123) | ... | 26.581(171) | ... | 26.555(242) | ... | 26.761(173) | ... |
| 9 | 26.324(122) | ... | 26.574(172) | ... | 26.623(197) | ... | 27.390(317) | ... |
| 10 | 26.708(116) | ... | 26.786(228) | ... | 26.686(128) | ... | 26.499(229) | ... |
| 11 | 26.587(112) | ... | 25.942(139) | ... | 26.052(098) | ... | 27.373(255) | ... |
| 12 | 26.760(231) | ... | 26.154(119) | ... | 26.021(111) | ... | ... | ... |
| 13 | 26.485(133) | 26.069(099) | 25.850(093) | 25.425(131) | 25.635(105) | 25.296(118) | 27.096(277) | 26.285(163)* |
| 14 | 26.246(135) | 26.084(125) | 25.973(154) | 25.469(074) | 25.586(085) | 25.220(079) | 26.831(230) | 25.895(073) |
| 15 | 26.955(138) | ... | 25.715(094) | ... | 25.571(129) | ... | 25.873(142) | ... |
| 16 | 26.846(194) | ... | 25.752(138) | ... | 25.556(066) | ... | 26.026(139) | ... |
| 17 | 27.359(348) | ... | 25.994(138) | ... | 25.852(134) | ... | 26.389(106) | ... |
| 18 | 27.578(345) | ... | 26.043(124) | ... | 25.932(076) | ... | 26.137(105) | ... |
| 19 | 27.362(196) | 26.397(166) | 26.222(219) | 25.653(138) | 26.029(103) | 25.473(112) | 26.445(158) | 25.795(106) |
| 20 | 26.973(217) | 26.608(205) | 26.130(144) | 25.484(133) | 26.131(100) | 25.621(095) | 26.627(173) | 25.549(106) |
| 21 | 26.477(114) | ... | 26.472(160) | ... | 26.344(111) | ... | 26.714(145) | ... |
| 22 | 26.460(166) | ... | 26.543(231) | ... | 26.414(095) | ... | 26.638(217) | ... |
| 23 | 26.720(141) | 25.934(086) | 26.610(152) | 26.039(184) | 26.600(155) | 26.099(183) | 27.154(259) | 26.008(099) |
| 24 | 26.704(245) | 25.695(081) | 26.474(236) | 26.254(275)* | 26.602(126) | 25.881(091) | 26.978(230) | 26.052(167) |
| 25 | ... | ... | 25.636(159) | ... | 26.438(197) | ... | 26.282(252) | ... |
| 26 | 26.412(296) | ... | 26.186(208) | ... | 26.443(306) | ... | 26.751(342) | ... |
| | **26946$P$ = 26.84 d** | | **09028$P$ = 31.90 d** | | **23149$P$ = 32.53 d** | | **30428$P$ = 32.61 d** | |
| 1 | 26.398(158) | 25.499(065) | 25.256(079) | 24.965(066) | 25.527(084) | 25.135(094) | 26.108(083) | 25.482(082) |
| 2 | 26.790(230) | 25.743(117) | 25.248(069) | 24.888(079) | 25.723(092) | 24.873(068) | 26.015(076) | 25.315(072) |
| 3 | 26.221(105) | ... | 25.877(108) | ... | 26.344(102) | ... | 26.537(103) | ... |
| 4 | 26.366(157) | ... | 25.804(066) | ... | 26.111(128) | ... | 26.664(142) | ... |
| 5 | 25.885(090) | 25.253(078) | 25.989(130) | 25.498(082) | 26.753(106) | 25.747(116) | 25.395(064) | 25.179(073) |
| 6 | 26.078(136) | 25.649(109) | 25.927(086) | 25.476(109) | 26.604(166) | 25.414(113) | 25.478(051) | 25.212(055) |
| 7 | 26.128(123) | ... | 26.280(147) | ... | 26.317(174) | ... | 25.755(086) | ... |
| 8 | 26.153(170) | ... | 26.158(098) | ... | 26.236(195) | ... | 25.733(087) | ... |
| 9 | 26.442(180) | ... | ... | ... | 25.537(046) | ... | 25.860(073) | ... |
| 10 | 26.476(162) | ... | 26.083(092) | ... | 25.439(091) | ... | 25.541(133) | ... |

Table 5—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 11 | 26.654(141) | ... | 25.209(060) | ... | 25.577(069) | ... | 25.981(100) | ... |
| 12 | 26.691(155) | ... | 25.189(062) | ... | 25.559(090) | ... | 25.998(132) | ... |
| 13 | 26.780(152) | 25.564(080) | 25.165(081) | 24.910(065) | 25.777(068) | 25.083(066) | 26.022(093) | 25.386(070) |
| 14 | 26.551(125) | 25.827(132) | 25.192(051) | 25.022(091) | 25.749(093) | 25.053(068) | 26.165(095) | 25.529(070) |
| 15 | 26.461(162) | ... | 25.118(077) | ... | 25.721(090) | ... | 26.118(084) | ... |
| 16 | 26.567(187) | ... | 25.329(071) | ... | 25.750(128) | ... | 26.174(135) | ... |
| 17 | 26.740(112) | ... | 25.440(080) | ... | 25.822(083) | ... | 26.409(096) | ... |
| 18 | 26.923(256) | ... | 25.569(058) | ... | 25.788(076) | ... | 26.255(131) | ... |
| 19 | 25.674(058) | 25.394(065) | 25.677(081) | 25.025(081) | 26.138(098) | 25.182(072) | 26.229(090) | 25.477(086) |
| 20 | 25.750(082) | 25.394(066) | 25.657(068) | 25.044(081) | 25.915(127) | 25.177(112) | 26.559(141) | 25.637(099) |
| 21 | 25.685(078) | ... | 25.910(086) | ... | 26.306(128) | ... | 26.802(149) | ... |
| 22 | 25.984(116) | ... | 25.879(116) | ... | 26.106(190) | ... | 26.788(260) | ... |
| 23 | 26.461(096) | 25.617(106) | 26.022(182) | 25.469(094) | 27.130(245)* | 26.004(168) | 25.443(064) | 25.194(100) |
| 24 | 26.382(132) | 25.787(099) | 26.075(138) | 25.278(092) | 26.518(177) | 25.742(143) | 25.447(088) | 25.162(052) |
| 25 | 26.243(112) | ... | 26.254(197) | ... | 26.225(221) | ... | 26.428(194) | ... |
| 26 | 27.061(252) | ... | 25.183(106) | ... | 26.262(266) | ... | 25.610(139) | ... |
| | **26126$P$ = 34.88 d** | | **12135$P$ = 36.50 d** | | **31803$P$ = 37.28 d** | | **45787$P$ = 37.31 d** | |
| 1 | 25.761(154) | 25.336(104) | 26.200(122) | 25.161(130) | 26.296(122) | 25.437(061) | 25.081(106) | 24.810(154) |
| 2 | 25.691(115) | 25.309(092) | 26.341(134) | 25.482(149) | 26.297(110) | 25.434(069) | 25.285(128) | 24.707(134) |
| 3 | 25.989(201) | ... | 25.886(112) | ... | 26.590(122) | ... | 25.353(167) | ... |
| 4 | 26.065(207) | ... | 25.793(088) | ... | 26.673(190) | ... | 25.273(126) | ... |
| 5 | 25.445(108) | 25.081(084) | 26.098(139) | 25.228(094) | 26.932(185) | ... | 25.629(208) | 24.931(132) |
| 6 | 25.569(085) | 25.214(087) | 26.498(143) | 25.179(083) | 26.780(110) | 26.026(102) | 25.566(161) | 24.991(186) |
| 7 | 25.422(075) | ... | 26.326(136) | ... | 26.861(179) | ... | 25.495(234) | ... |
| 8 | 25.509(129) | ... | 26.628(225) | ... | 26.738(138) | ... | 25.470(141) | ... |
| 9 | 25.595(110) | ... | 26.278(141) | ... | 26.511(212) | ... | 25.455(150) | ... |
| 10 | 25.629(120) | ... | 26.263(121) | ... | 26.213(130) | ... | 25.736(214) | ... |
| 11 | 25.620(129) | ... | 26.470(228) | ... | 25.868(100) | ... | 25.659(229) | ... |
| 12 | 25.830(123) | ... | 26.601(197) | ... | 25.904(079) | ... | 25.663(149) | ... |
| 13 | 25.861(139) | 24.988(124) | 26.387(124) | 25.591(100) | 25.931(125) | 25.476(096) | 25.235(171) | 24.963(157) |
| 14 | 25.607(090) | 24.983(153) | 26.570(152) | 25.843(134) | 25.923(096) | 25.393(061) | 25.703(227) | 24.945(167) |
| 15 | 25.757(163) | ... | 26.915(346) | ... | 26.049(121) | ... | 25.310(152) | ... |
| 16 | 25.874(189) | ... | 26.702(228) | ... | 26.400(180) | ... | 25.539(154) | ... |
| 17 | 25.907(181) | ... | 26.396(192) | ... | 26.144(080) | ... | 24.961(154) | ... |
| 18 | 26.040(138) | ... | 26.387(197) | ... | 26.222(118) | ... | 25.115(105) | ... |
| 19 | 25.967(190) | 25.567(116) | 25.917(124) | 25.030(115) | 26.257(096) | 25.467(105) | 25.314(151) | 24.927(177) |
| 20 | 25.896(197) | 25.510(095) | 25.743(104) | 25.173(087) | 26.409(121) | 25.520(067) | 25.198(135) | 24.767(125) |
| 21 | 26.023(204) | ... | 25.935(102) | ... | 26.768(126) | ... | 25.281(138) | ... |
| 22 | 26.216(201) | ... | 25.915(135) | ... | 26.410(095) | ... | 25.296(158) | ... |
| 23 | 25.314(116) | 25.081(111) | 25.924(116) | 25.053(086) | 26.909(181) | 26.158(097) | 25.449(163) | 24.811(152) |
| 24 | 25.346(090) | 25.269(107) | 26.118(111) | 25.149(072) | 26.646(106) | 25.536(143) | 25.605(216) | 24.887(122) |
| 25 | 25.508(124) | ... | 25.817(145) | ... | 26.206(202) | ... | 25.008(167) | ... |
| 26 | 25.908(244) | ... | 26.130(227) | ... | 26.502(215) | ... | 25.433(249) | ... |
| | **26545$P$ = 39.57 d** | | **09402$P$ = 39.78 d** | | **25375$P$ = 39.96 d** | | **09611$P$ = 40.49 d** | |
| 1 | 26.064(106) | 25.247(087) | 26.664(143) | 25.594(131) | 25.225(085) | 24.974(081) | 25.934(110) | 25.450(104) |
| 2 | 26.176(115) | 25.553(105) | 26.603(198) | 25.502(184) | 25.219(072) | 24.918(074) | 25.941(160) | 25.516(138) |

Table 5—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 3 | 25.305(085) | ... | 26.449(154) | ... | 25.696(084) | ... | 25.614(110) | ... |
| 4 | 25.436(086) | ... | 26.343(252) | ... | 25.699(151) | ... | 25.866(120) | ... |
| 5 | 25.569(088) | 24.824(057) | 25.775(087) | 25.006(070) | 25.718(080) | 25.552(113) | 25.258(076) | 24.963(061) |
| 6 | 25.820(090) | 25.026(091) | 25.875(125) | 25.063(105) | 25.915(098) | 25.438(175) | 25.631(100) | 24.901(109) |
| 7 | 25.949(137) | ... | 25.979(134) | ... | 26.176(153) | ... | 25.485(101) | ... |
| 8 | 25.908(086) | ... | 26.105(210) | ... | 26.167(146) | ... | 25.451(106) | ... |
| 9 | 25.803(124) | ... | 26.234(112) | ... | 26.202(137) | ... | 25.627(089) | ... |
| 10 | 26.113(105) | ... | 26.259(190) | ... | 26.364(207) | ... | 25.532(141) | ... |
| 11 | 26.097(078) | ... | 26.352(115) | ... | 26.101(139) | ... | 25.563(129) | ... |
| 12 | 26.033(135) | ... | 26.272(178) | ... | 26.238(153) | ... | 25.685(133) | ... |
| 13 | 25.925(090) | 25.102(054) | 26.509(189) | 25.244(090) | 26.684(139) | 26.098(179) | 25.685(105) | 25.352(119) |
| 14 | 26.227(169) | 25.408(105) | 26.389(215) | 25.261(086) | 26.342(109) | 26.034(207) | 25.792(104) | 25.096(079) |
| 15 | 25.971(103) | ... | 26.824(287) | ... | 25.766(147) | ... | 25.819(115) | ... |
| 16 | 26.292(130) | ... | 26.527(269) | ... | 25.774(103) | ... | 26.166(180) | ... |
| 17 | 25.896(133) | ... | 26.517(147) | ... | 25.150(050) | ... | 25.950(127) | ... |
| 18 | 26.402(109) | ... | 26.614(206) | ... | 25.294(091) | ... | 25.945(133) | ... |
| 19 | 26.247(089) | 25.216(074) | 26.872(226) | 25.350(104) | 25.283(050) | 25.037(088) | 25.818(091) | 25.481(080) |
| 20 | 26.266(158) | 25.476(102) | 26.482(278) | 25.397(147) | 25.281(074) | 25.093(087) | 25.999(151) | 25.645(107) |
| 21 | 25.317(054) | ... | 26.678(184) | ... | 25.514(068) | ... | 25.958(133) | ... |
| 22 | 25.283(061) | ... | 27.014(343) | ... | 25.388(078) | ... | 25.984(164) | ... |
| 23 | 25.292(061) | 24.746(049) | 26.722(285) | 25.589(138) | 25.726(079) | 25.283(107) | 25.668(128) | 25.144(094) |
| 24 | 25.382(072) | 24.846(058) | 26.371(296) | 25.325(105) | 25.651(078) | 25.179(074) | 25.691(111) | 25.190(151) |
| 25 | 25.650(120) | ... | 25.611(146) | ... | 25.918(124) | ... | 25.801(227) | ... |
| 26 | 25.858(129) | ... | 25.772(156) | ... | 26.000(136) | ... | 25.145(167) | ... |
| | **20415$P$ = 51.51 d** | | **12778$P$ = 63.19 d** | | **19817$P$ = 68.61 d** | | **07098$P$ = 82.66 d** | |
| 1 | 25.740(101) | 25.076(112) | 24.888(109) | 24.425(057) | 25.719(075) | 24.711(061) | 25.202(082) | 24.700(084) |
| 2 | 25.633(146) | 24.819(078) | 24.928(110) | 24.532(058) | 25.605(059) | 24.715(056) | 25.498(055) | 24.723(062) |
| 3 | 25.970(146) | ... | 24.954(090) | ... | 25.802(081) | ... | 25.668(137) | ... |
| 4 | 26.064(102) | ... | 25.018(090) | ... | 25.863(056) | ... | 25.746(080) | ... |
| 5 | 25.942(099) | 25.094(095) | 25.133(105) | 24.845(079) | 25.876(085) | 24.982(086) | 25.429(085) | 25.004(074) |
| 6 | 26.398(127) | 25.098(078) | 25.132(137) | 24.732(060) | 25.937(087) | 24.861(046) | 25.493(108) | 25.107(091) |
| 7 | 26.146(116) | ... | 25.150(114) | ... | 25.885(135) | ... | 25.176(377) | ... |
| 8 | 26.242(120) | ... | 25.201(094) | ... | 25.929(070) | ... | 25.119(062) | ... |
| 9 | 26.149(198) | ... | 25.297(147) | ... | 26.135(074) | ... | 25.113(047) | ... |
| 10 | 26.101(179) | ... | 25.198(114) | ... | 25.996(078) | ... | 24.992(056) | ... |
| 11 | 26.712(183) | ... | 25.118(158) | ... | 26.319(087) | ... | 25.010(077) | ... |
| 12 | 26.563(211) | ... | 25.185(129) | ... | 26.109(140) | ... | 25.013(051) | ... |
| 13 | 26.556(144) | 25.228(077) | 25.131(116) | 24.883(071) | 26.305(131) | 25.230(074) | 25.087(096) | 24.623(071) |
| 14 | 26.429(142) | 25.293(079) | 25.317(124) | 24.863(086) | 26.070(109) | 25.084(042) | 25.230(088) | 24.515(087) |
| 15 | 26.254(188) | ... | 25.165(105) | ... | 26.089(098) | ... | 25.000(144) | ... |
| 16 | 26.181(084) | ... | 25.253(118) | ... | 25.973(082) | ... | 25.037(093) | ... |
| 17 | 25.962(129) | ... | 25.215(075) | ... | 25.946(088) | ... | 25.031(063) | ... |
| 18 | 25.757(130) | ... | 25.252(105) | ... | 25.869(082) | ... | 25.155(074) | ... |
| 19 | 25.593(102) | 25.216(071)* | 24.920(103) | 24.506(097) | 25.777(113) | 24.898(063) | 25.175(062) | 24.616(086) |
| 20 | 25.535(068) | 24.757(081) | 25.080(088) | 24.698(068) | 25.611(077) | 24.864(049) | 24.800(062) | 24.497(066) |
| 21 | 25.865(094) | ... | 24.786(093) | ... | 25.551(054) | ... | 25.408(179) | ... |

Table 5—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 22 | 25.402(109) | ... | 24.717(092) | ... | 25.407(082) | ... | 25.076(067) | ... |
| 23 | 25.887(085) | 25.119(081) | 24.719(064) | 24.552(069) | 25.421(080) | 24.652(041) | 25.329(067) | 24.754(075) |
| 24 | 25.812(086) | 24.791(050) | 24.834(097) | 24.479(061) | 25.403(062) | 24.599(044) | 25.339(077) | 24.633(040) |
| 25 | 26.002(132) | ... | 24.923(138) | ... | 25.903(138) | ... | 25.139(102) | ... |
| 26 | 26.139(283) | ... | 24.888(141) | ... | 25.867(117) | ... | 25.002(120) | ... |
| | **09558$P$ = 88.19 d** | | **12013$P$ = 90.73 d** | | **10203$P$ = 95.91 d** | | | |
| 1 | 26.736(277) | 25.005(092) | 25.268(161) | 24.460(073) | 25.184(099) | 24.440(076) | | |
| 2 | 26.487(194) | 25.118(089) | 25.246(152) | 24.444(096) | 25.192(069) | 24.435(072) | | |
| 3 | 26.526(264) | ... | 25.350(127) | ... | 25.077(071) | ... | | |
| 4 | 27.003(317) | ... | 25.336(156) | ... | 25.007(058) | ... | | |
| 5 | ... | 25.258(123) | 25.176(080) | 24.477(074) | 25.089(089) | 24.475(083) | | |
| 6 | 26.893(281) | 25.319(085) | 25.358(130) | 24.624(111) | 25.231(080) | 24.543(118) | | |
| 7 | 26.688(281) | ... | 25.139(116) | ... | 25.063(072) | ... | | |
| 8 | 26.439(196) | ... | 25.022(106) | ... | 25.163(088) | ... | | |
| 9 | 26.263(161) | ... | 24.851(109) | ... | 25.113(091) | ... | | |
| 10 | 26.276(152) | ... | 24.980(120) | ... | 25.243(094) | ... | | |
| 11 | 26.072(116) | ... | 24.848(078) | ... | 25.268(105) | ... | | |
| 12 | 26.095(181) | ... | 24.982(120) | ... | 25.200(061) | ... | | |
| 13 | 26.107(147) | 24.836(091) | 24.874(123) | 24.209(056) | 25.344(099) | 24.501(078) | | |
| 14 | 26.050(170) | 24.846(090) | 24.997(089) | 24.327(081) | 25.266(100) | 24.437(086) | | |
| 15 | 25.918(127) | ... | 25.024(107) | ... | 25.377(093) | ... | | |
| 16 | 25.999(120) | ... | 24.960(145) | ... | 25.302(065) | ... | | |
| 17 | 26.253(208) | ... | 24.835(070) | ... | 25.610(117)* | ... | | |
| 18 | 25.991(143) | ... | 25.004(094) | ... | 25.357(043) | ... | | |
| 19 | 26.135(149) | 24.915(063) | 24.980(119) | 24.351(096) | 25.348(058) | 24.509(100) | | |
| 20 | 25.876(105) | 24.756(065) | 25.044(110) | 24.247(082) | 25.318(082) | 24.485(055) | | |
| 21 | 25.983(188) | ... | 25.069(118) | ... | 25.293(065) | ... | | |
| 22 | 25.922(149) | ... | 24.994(115) | ... | 25.367(078) | ... | | |
| 23 | 25.989(180) | 24.821(058) | 25.060(123) | 24.405(097) | 25.162(083) | 24.571(097) | | |
| 24 | 26.032(167) | 24.878(080) | 25.089(094) | 24.390(098) | 25.253(081) | 24.418(065) | | |
| 25 | 26.416(219) | ... | 25.384(182) | ... | 25.407(158)* | ... | | |
| 26 | 26.369(199) | ... | 25.199(195) | ... | 25.152(096) | ... | | |

* Data point rejected in light curve fit

[a] $1\sigma$ uncertainties (units of 0.001 mag) are given in parentheses.

Table 6. Cepheid photometry in NGC 1309 [a]

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| | **21599$P$ = 20.93 d** | | **09778$P$ = 21.98 d** | | **08610$P$ = 23.23 d** | | **06631$P$ = 24.82 d** | |
| 1 | 27.127(234) | 26.249(129) | 27.137(249) | 27.083(303)* | 27.039(291) | 26.456(166) | 25.882(101) | 25.646(127) |
| 2 | 26.627(221) | 26.238(114) | 27.535(393) | 26.796(228) | 26.965(368) | 26.012(148)* | 25.574(167) | 25.750(085) |
| 3 | 26.833(225) | ... | 26.316(252) | ... | 26.751(269) | ... | 26.543(262) | ... |
| 4 | 27.354(217) | ... | 26.378(245) | ... | 25.896(130) | ... | 26.628(223) | ... |
| 5 | 27.289(283) | 26.931(180)* | ... | 26.242(181) | 26.792(209) | 26.160(105) | 26.636(135) | 26.135(154) |
| 6 | ... | 26.529(128) | 26.999(280) | 26.442(153) | 26.709(249) | 25.796(142)* | ... | 26.241(139) |
| 7 | 27.012(101) | ... | 26.937(181) | ... | 26.954(277) | ... | 26.483(107) | ... |
| 8 | 27.005(209) | ... | 27.278(334) | ... | 26.677(214) | ... | 26.730(248) | ... |
| 9 | 26.414(086) | ... | 26.900(233) | ... | 27.256(255) | ... | 25.924(130) | ... |
| 10 | 26.304(127) | ... | 27.180(266) | ... | 27.265(332) | ... | 26.061(151) | ... |
| 11 | 26.426(098) | ... | 26.348(174) | ... | 27.385(364) | ... | 26.103(095) | ... |
| 12 | 26.359(089) | ... | 26.308(097) | ... | 27.153(228) | ... | 26.501(174) | ... |
| 13 | 26.743(109) | 26.483(131) | 26.306(132) | 26.080(155) | 27.174(294) | 26.681(220)* | 26.186(149) | 25.706(134) |
| 14 | 26.778(129) | 26.126(074) | 26.535(124) | 26.041(099) | 27.111(266) | 26.333(152) | 26.188(132) | 25.754(089) |
| 15 | 26.759(200) | ... | 26.301(122) | ... | 26.446(099) | ... | 26.242(135) | ... |
| 16 | 26.910(122) | ... | 26.573(108) | ... | 26.742(212) | ... | 26.320(149) | ... |
| 17 | 27.266(252) | ... | 26.806(207) | ... | 26.351(146) | ... | 26.469(126) | ... |
| 18 | 27.273(150) | ... | ... | ... | 26.194(099) | ... | 26.640(218) | ... |
| 19 | 27.630(254) | 26.684(180) | 27.228(297) | 26.922(331) | 26.584(151) | 25.946(101) | 26.945(216) | 26.357(153) |
| 20 | 27.341(292) | 26.751(183) | 27.361(275) | 26.912(205) | 26.441(137) | 26.113(147) | 26.888(188) | 26.171(197) |
| 21 | 26.394(088) | ... | 27.622(356) | ... | 26.915(151) | ... | 26.318(149) | ... |
| 22 | 26.489(109) | ... | 27.123(273) | ... | ... | ... | 26.713(174) | ... |
| 23 | 26.674(172) | 26.192(187) | 26.603(201) | 26.079(149) | 27.276(280) | 26.306(162) | 26.030(107) | 25.791(114) |
| 24 | 26.521(100) | 26.256(135) | 26.210(148) | 26.306(104) | 27.118(374) | 26.364(181) | 26.182(153) | 25.755(083) |
| 25 | 26.723(213) | ... | 26.557(280) | ... | ... | ... | 26.353(215) | ... |
| 26 | 26.163(132) | ... | 26.956(209) | ... | 27.080(346) | ... | 26.341(161) | ... |
| | **06737$P$ = 25.46 d** | | **34523$P$ = 25.52 d** | | **44606$P$ = 25.84 d** | | **48719$P$ = 26.71 d** | |
| 1 | 27.050(175) | 26.533(152) | 26.914(221) | 26.315(135) | 26.729(170) | 26.484(175) | 26.634(166) | 25.954(126) |
| 2 | 26.777(152) | 26.638(175) | ... | 26.662(367)* | 26.344(177) | 26.601(177) | 26.261(177) | 25.903(110) |
| 3 | 26.711(184) | ... | 26.367(200) | ... | 26.447(178) | ... | 26.186(191) | ... |
| 4 | 26.129(117) | ... | 26.188(159) | ... | 26.613(169) | ... | 26.553(235) | ... |
| 5 | 26.306(094) | 25.957(078) | 26.076(095) | 25.989(084) | 27.009(178) | 26.784(248) | 26.890(180) | 25.998(109) |
| 6 | 26.758(247) | 26.093(080) | 26.306(159) | 25.782(138) | 26.653(130) | 26.418(130) | 27.562(394)* | 26.167(137) |
| 7 | 27.053(155) | ... | 26.678(170) | ... | 27.134(162) | ... | 27.216(247) | ... |
| 8 | 26.661(092) | ... | 26.657(219) | ... | 26.464(146) | ... | 26.767(342) | ... |
| 9 | 27.102(199) | ... | 27.084(212) | ... | 27.065(219) | ... | 26.166(144) | ... |
| 10 | 27.320(196) | ... | 26.833(327) | ... | 27.159(191) | ... | 26.299(138) | ... |
| 11 | 27.498(212) | ... | 26.707(165) | ... | 26.486(154) | ... | 25.961(219) | ... |
| 12 | 27.512(246) | ... | 27.487(297) | ... | 26.619(112) | ... | 25.798(161) | ... |
| 13 | 27.047(209) | 26.379(090) | 27.209(310) | 26.152(145) | 25.837(059) | 25.961(162) | 26.128(116) | 25.815(101) |
| 14 | 26.951(154) | 26.372(117) | 26.963(316) | 26.182(154) | 25.846(070) | 25.989(126) | 26.267(148) | 25.760(092) |
| 15 | 27.351(221) | ... | 26.668(180) | ... | 26.083(071) | ... | 26.352(162) | ... |
| 16 | 27.072(176) | ... | 26.632(302) | ... | 25.816(090) | ... | 26.074(144) | ... |
| 17 | 26.830(129) | ... | 26.674(174) | ... | 26.319(086) | ... | 26.350(132) | ... |
| 18 | 27.190(196) | ... | 26.635(230) | ... | 26.197(096) | ... | 26.371(155) | ... |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 19 | 26.451(086) | 25.861(081) | 26.403(181) | 25.941(140) | 26.569(106) | 26.500(160) | 26.575(273) | 25.853(137) |
| 20 | 26.535(106) | 26.038(078) | 26.369(261) | 25.779(091) | 26.338(140) | 26.347(164) | 26.571(172) | 25.909(113) |
| 21 | 26.404(076) | ... | 26.390(124) | ... | 26.752(104) | ... | 26.839(183) | ... |
| 22 | 26.560(137) | ... | 26.270(194) | ... | 26.748(184) | ... | 26.705(173) | ... |
| 23 | 26.944(163) | 26.216(155) | 27.144(215) | 26.127(158) | 26.849(172) | 26.055(150) | 26.853(262) | 26.246(233) |
| 24 | 27.307(228) | 26.360(086) | 26.747(325) | 25.992(219) | 26.966(233) | 27.248(267)* | 27.049(288) | 25.951(115) |
| 25 | 26.516(161) | ... | ... | ... | 26.610(242) | ... | 26.503(211) | ... |
| 26 | 26.496(179) | ... | 26.609(213) | ... | 25.731(087) | ... | 26.743(225) | ... |
| | **55736$P$ = 27.18 d** | | **54039$P$ = 27.65 d** | | **41542$P$ = 27.72 d** | | **12340$P$ = 27.84 d** | |
| 1 | 26.689(145) | 26.246(132) | 26.191(116) | 25.624(105) | 26.548(237) | 25.788(147) | 26.047(147) | 25.748(173) |
| 2 | 27.067(180) | 26.409(154)* | 26.049(132) | 25.529(076) | 26.091(135) | 25.803(119) | 25.888(131) | 25.770(130) |
| 3 | 27.122(175) | ... | 26.922(295) | ... | 26.939(351) | ... | 26.033(241) | ... |
| 4 | 27.235(185) | ... | 26.517(117) | ... | ... | ... | 26.458(331) | ... |
| 5 | 26.473(084) | 25.924(084) | 27.491(373) | 26.316(130) | 25.941(136) | 25.528(110) | 26.378(216) | 26.374(282) |
| 6 | 26.366(202) | 26.011(111) | 27.547(248) | 26.316(108) | 25.939(090) | 25.785(104) | 26.838(308) | 26.203(263) |
| 7 | 26.533(079) | ... | 26.747(164) | ... | 26.179(160) | ... | 27.044(306) | ... |
| 8 | 26.545(095) | ... | 26.550(103) | ... | 26.121(179) | ... | 26.638(256) | ... |
| 9 | 26.900(159) | ... | 26.116(078) | ... | 26.538(201) | ... | 25.923(155) | ... |
| 10 | 26.979(136) | ... | 26.091(086) | ... | 26.423(143) | ... | 25.993(125) | ... |
| 11 | 26.874(114) | ... | 26.347(290) | ... | 26.634(165) | ... | 25.940(138) | ... |
| 12 | 26.612(106) | ... | 26.294(085) | ... | 26.487(250) | ... | 25.821(085) | ... |
| 13 | 26.964(185) | 26.314(066) | 26.423(119) | 25.870(076) | 26.419(142) | 25.880(172) | 25.928(124) | 25.762(138) |
| 14 | 27.174(195) | 26.039(123) | 26.064(098) | 25.713(086) | 26.715(173) | 25.877(173) | 26.068(152) | 25.815(124) |
| 15 | 27.059(220) | ... | 26.547(137) | ... | 26.733(272) | ... | 26.168(156) | ... |
| 16 | 26.957(121) | ... | 26.153(094) | ... | 26.645(155) | ... | 25.989(145) | ... |
| 17 | 27.111(185) | ... | 26.365(100) | ... | 27.139(331) | ... | 26.411(234) | ... |
| 18 | 27.159(172) | ... | 26.336(106) | ... | 26.585(220) | ... | 26.335(201) | ... |
| 19 | 27.179(172) | 26.792(090)* | 27.407(238) | 26.149(110) | 26.789(227) | 25.941(130) | 26.318(183) | 26.792(090)* |
| 20 | 27.205(147) | 26.418(097) | 26.690(119) | 26.134(118) | 26.695(252) | 26.188(168) | 26.502(214) | 26.430(247) |
| 21 | 26.453(081) | ... | 26.696(181) | ... | 26.208(115) | ... | 26.971(328) | ... |
| 22 | 26.375(126) | ... | 26.966(171) | ... | 26.108(149) | ... | 26.804(283) | ... |
| 23 | 26.548(097) | 26.079(095) | 26.273(106) | 25.782(088) | 26.319(158) | 25.533(200) | ... | 26.539(326) |
| 24 | 26.799(263) | 25.985(089) | 26.271(117) | 25.926(067) | 26.322(144) | 25.704(102) | 26.725(202) | 26.564(304) |
| 25 | 26.310(105) | ... | 26.988(311) | ... | 27.123(356) | ... | 26.213(258) | ... |
| 26 | 26.974(213) | ... | 26.342(157) | ... | 26.423(209) | ... | 26.174(250) | ... |
| | **52644$P$ = 29.17 d** | | **02343$P$ = 29.62 d** | | **23076$P$ = 30.67 d** | | **85974$P$ = 30.86 d** | |
| 1 | 27.333(193)* | 26.185(092) | 27.333(193)* | 26.785(171) | 27.518(360) | 26.180(090) | 26.158(120) | 25.702(162) |
| 2 | 26.851(157) | 26.098(125) | 27.113(292) | 26.628(179) | 26.752(274) | 26.269(310) | 25.871(125) | 25.687(108) |
| 3 | 26.047(134) | ... | 26.565(220) | ... | 26.253(134) | ... | 26.407(165) | ... |
| 4 | 25.825(058) | ... | 25.997(178) | ... | 26.238(137) | ... | 26.730(301) | ... |
| 5 | 26.255(078) | 25.902(065) | 26.932(194) | 26.091(084) | 26.653(145) | 25.879(067) | 26.624(138) | 27.053(273)* |
| 6 | 26.481(112) | 25.698(132) | 26.753(146) | 25.794(127) | 26.609(344) | 26.006(190) | 26.820(236) | 26.240(120) |
| 7 | 26.419(089) | ... | 26.794(147) | ... | 26.623(190) | ... | 26.674(174) | ... |
| 8 | 26.502(104) | ... | 26.640(167) | ... | 26.575(270) | ... | 26.656(235) | ... |
| 9 | 26.628(143) | ... | 26.750(145) | ... | ... | ... | 25.754(090) | ... |
| 10 | 26.644(112) | ... | 26.927(167) | ... | 27.382(317) | ... | 25.706(165) | ... |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 11 | 26.613(200) | ... | 27.129(220) | ... | 27.059(264) | ... | 25.451(111) | ... |
| 12 | 26.505(122) | ... | 27.214(230) | ... | 27.152(307) | ... | 25.748(139) | ... |
| 13 | 26.905(135) | 26.089(093) | 27.233(207) | 27.036(193)* | 27.034(215) | 26.180(124) | 26.127(148) | 25.871(142) |
| 14 | 26.718(104) | 26.235(079) | 26.855(219) | 26.652(156) | 26.644(172) | 26.213(151) | 26.027(167) | 25.348(137)* |
| 15 | 26.890(108) | ... | 26.632(132) | ... | 27.513(391) | ... | 26.157(086) | ... |
| 16 | 26.718(105) | ... | 26.396(090) | ... | 26.574(152) | ... | 25.870(140) | ... |
| 17 | 26.066(066) | ... | 25.804(101) | ... | 27.069(214) | ... | 26.250(200) | ... |
| 18 | 25.900(060) | ... | 25.758(066) | ... | 26.768(282) | ... | 26.482(133) | ... |
| 19 | 25.836(078) | 25.502(060) | 26.295(126) | 25.899(089) | 26.269(116) | 26.568(172)* | 26.690(167) | 26.098(144) |
| 20 | 25.844(073) | 25.561(043) | 26.367(150) | 25.849(090) | 26.303(120) | 25.717(124) | 26.622(195) | 26.066(107) |
| 21 | 26.150(071) | ... | 26.408(110) | ... | 26.554(156) | ... | 26.754(164) | ... |
| 22 | 26.309(126) | ... | 26.359(100) | ... | 26.155(125) | ... | 26.314(175) | ... |
| 23 | 26.477(103) | 25.824(075) | 26.512(149) | 26.119(104) | 26.712(395) | 26.462(228)* | 26.523(196) | 26.038(208) |
| 24 | 26.416(135) | 25.787(086) | 26.876(234) | 25.958(137) | 26.494(223) | 26.072(165) | 26.555(202) | 26.346(176) |
| 25 | 26.385(126) | ... | 26.220(134) | ... | 27.448(335) | ... | 25.804(208) | ... |
| 26 | 26.033(154) | ... | 26.945(236) | ... | 26.271(121) | ... | ... | ... |
| | **07224$P$ = 30.91 d** | | **07255$P$ = 31.16 d** | | **50024$P$ = 31.69 d** | | **59151$P$ = 32.62 d** | |
| 1 | 26.148(115) | 25.785(092) | 26.495(215) | 26.092(139) | 27.409(329) | 26.107(099) | 26.200(190) | 25.599(076) |
| 2 | 26.274(111) | 25.972(086) | 26.488(176) | 25.918(175) | 26.909(175) | 25.988(144) | 26.298(149) | 25.681(104) |
| 3 | 26.828(205) | ... | 26.765(241) | ... | 26.759(212) | ... | 26.156(187) | ... |
| 4 | 27.385(302) | ... | 27.086(324) | ... | 26.637(190) | ... | 26.382(188) | ... |
| 5 | 26.965(242) | 26.370(113) | 26.257(152) | 25.978(094) | 26.299(061) | 25.681(110) | 25.839(088) | 25.582(088) |
| 6 | 27.813(288) | 26.274(112) | 26.475(108) | 25.968(096) | 26.236(094) | 25.737(143) | 25.620(188) | 25.311(083)* |
| 7 | 26.913(183) | ... | 26.192(118) | ... | 26.542(120) | ... | 25.738(095) | ... |
| 8 | 27.146(173) | ... | 26.081(108) | ... | 26.610(198) | ... | 25.672(128) | ... |
| 9 | 26.331(089) | ... | 26.355(114) | ... | 26.714(163) | ... | 25.686(144) | ... |
| 10 | 26.318(107) | ... | 26.485(114) | ... | 26.797(163) | ... | 25.664(130) | ... |
| 11 | 26.156(090) | ... | 26.519(163) | ... | 27.039(191) | ... | 26.192(107) | ... |
| 12 | 26.117(112) | ... | 26.539(164) | ... | 26.876(176) | ... | 25.999(113) | ... |
| 13 | 26.174(109) | 25.857(079) | 27.035(250) | 25.989(108) | 26.881(182) | 25.909(115) | 26.329(119) | 25.690(096) |
| 14 | 26.111(061) | 25.834(081) | 26.572(164) | 26.004(100) | 26.623(151) | 25.813(134) | 25.942(130) | 25.513(072) |
| 15 | 26.379(140) | ... | 26.776(232) | ... | 26.612(113) | ... | 26.128(122) | ... |
| 16 | 26.352(105) | ... | 26.894(223) | ... | 27.380(257) | ... | 25.984(113) | ... |
| 17 | 26.295(149) | ... | 26.896(267) | ... | 27.172(190) | ... | 26.456(091) | ... |
| 18 | 26.556(109) | ... | 26.872(308) | ... | 27.802(386)* | ... | 26.225(100) | ... |
| 19 | 26.771(121) | 26.049(081) | 27.067(250) | 26.444(145) | 27.206(178) | 25.980(107) | 26.628(170) | 25.933(084) |
| 20 | 27.610(236) | 26.329(105) | 27.325(287) | 26.260(117) | 27.521(280) | 26.259(140) | 26.659(131) | 26.057(108) |
| 21 | 27.378(238) | ... | 27.004(254) | ... | 26.657(142) | ... | 26.471(132) | ... |
| 22 | 27.412(195) | ... | 26.682(302) | ... | 26.704(151) | ... | 26.845(239) | ... |
| 23 | 27.500(266) | 26.324(131) | 26.157(126) | 25.823(139) | 26.112(138) | 25.513(114) | 25.853(076) | 25.697(069) |
| 24 | 27.820(314) | 26.469(133) | 26.294(110) | 25.791(137) | 26.418(119) | 25.497(111) | 25.824(100) | 25.598(138) |
| 25 | 26.842(274) | ... | 26.170(142) | ... | 26.266(130) | ... | 26.233(141) | ... |
| 26 | 26.820(276) | ... | ... | ... | 26.846(223) | ... | 25.643(083) | ... |
| | **60583$P$ = 32.95 d** | | **04322$P$ = 33.26 d** | | **30349$P$ = 33.51 d** | | **03108$P$ = 33.71 d** | |
| 1 | 26.639(189) | 25.974(111) | 26.847(211) | 26.037(101) | 26.621(250) | 26.222(213) | 26.758(134) | 26.192(103) |
| 2 | 26.968(248) | ... | 26.521(105) | 25.904(116) | 26.775(273) | 26.057(185) | 26.859(168) | 26.205(114) |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 3 | 26.627(345) | ... | 25.701(079) | ... | 25.930(159) | ... | 26.172(118) | ... |
| 4 | 26.083(123) | ... | 25.812(072) | ... | 26.238(186) | ... | 25.922(086) | ... |
| 5 | 27.005(349) | 25.806(113) | 26.185(109) | 25.619(084) | 26.423(197) | 25.861(159) | 26.863(166) | 25.804(096) |
| 6 | 27.470(385) | 25.616(109) | 26.002(094) | 25.582(098) | 26.436(176) | 25.982(178) | 26.455(094) | 25.617(061) |
| 7 | 26.979(212) | ... | 26.199(119) | ... | 26.651(214) | ... | 26.398(134) | ... |
| 8 | ... | ... | 25.836(104) | ... | 26.587(210) | ... | 26.538(166) | ... |
| 9 | 27.276(231) | ... | 26.246(090) | ... | 26.714(216) | ... | 27.005(204) | ... |
| 10 | 26.781(192) | ... | 26.211(122) | ... | 26.301(144) | ... | 26.649(130) | ... |
| 11 | 26.853(201) | ... | 26.443(104) | ... | 26.824(228) | ... | 26.498(150) | ... |
| 12 | 27.482(352) | ... | 26.544(120) | ... | 26.909(210) | ... | 26.857(157) | ... |
| 13 | 26.599(166) | 26.250(174) | 26.541(186) | 26.021(097) | 26.751(226) | 26.133(179) | 26.981(140) | 26.006(130) |
| 14 | 27.271(351) | 26.082(182) | 26.520(131) | 25.847(084) | ... | 26.352(172) | 26.667(145) | 25.748(125) |
| 15 | 27.160(235) | ... | 26.703(151) | ... | 26.640(278) | ... | 26.737(153) | ... |
| 16 | 26.786(283) | ... | 26.339(147) | ... | ... | ... | 26.701(177) | ... |
| 17 | 25.903(101) | ... | 26.980(206) | ... | 26.700(183) | ... | 26.574(161) | ... |
| 18 | 25.807(092) | ... | 26.786(103) | ... | 27.232(389) | ... | 26.521(091) | ... |
| 19 | 26.021(110) | 25.405(116) | 26.443(113) | 25.961(104) | 25.780(142) | 25.574(128) | 26.092(103) | 25.557(082) |
| 20 | 26.219(143) | 25.578(144) | 26.600(200) | 25.973(115) | 26.203(142) | 25.976(157)* | 25.986(138) | 25.711(091) |
| 21 | 26.321(133) | ... | 25.672(086) | ... | 25.965(184) | ... | 25.983(074) | ... |
| 22 | 26.075(126) | ... | 25.607(047) | ... | 26.316(149) | ... | 26.247(089) | ... |
| 23 | 26.744(213) | 25.710(078) | 25.776(083) | 25.321(079)* | 26.765(218) | 26.044(124) | 26.758(195) | 25.889(143) |
| 24 | 26.256(148) | 25.747(125) | 25.852(090) | 25.503(084) | 26.143(169) | 26.350(260)* | 26.513(132) | 25.744(090) |
| 25 | 27.017(381) | ... | 26.398(134) | ... | 26.643(231) | ... | 26.457(153) | ... |
| 26 | 26.596(205) | ... | 25.660(103) | ... | 25.818(127) | ... | 25.848(091) | ... |
| | **09099$P$ = 33.74 d** | | **30771$P$ = 33.75 d** | | **14063$P$ = 34.08 d** | | **59846$P$ = 35.12 d** | |
| 1 | 26.140(148) | 25.794(139) | 27.290(194) | 26.421(175) | 25.971(119) | 25.323(165) | 26.360(152) | 25.806(144) |
| 2 | 26.406(250) | 25.960(175) | 27.206(221) | 26.252(132) | 25.928(168) | 25.762(155) | 26.508(183) | 25.643(125) |
| 3 | 26.725(395) | ... | 26.370(245) | ... | 25.800(188) | ... | ... | ... |
| 4 | ... | ... | 26.284(115) | ... | 25.941(111) | ... | 26.695(306) | ... |
| 5 | 26.786(243) | 26.506(266)* | 26.717(188) | 26.112(170) | 26.288(164) | 25.856(173) | 25.869(178) | 25.598(108) |
| 6 | 26.422(231) | 26.064(172) | 26.517(141) | 25.844(143) | 26.321(369) | 25.753(112) | 26.046(154) | 25.516(102) |
| 7 | 26.854(200) | ... | 27.031(199) | ... | 27.037(261) | ... | 25.862(116) | ... |
| 8 | 26.618(186) | ... | 26.925(176) | ... | 26.270(166) | ... | 25.711(083) | ... |
| 9 | 26.405(237) | ... | 26.942(223) | ... | 26.486(212) | ... | 26.076(108) | ... |
| 10 | 26.236(163) | ... | 26.407(169) | ... | 26.781(293) | ... | 26.080(147) | ... |
| 11 | 26.070(139) | ... | 27.308(236) | ... | 26.488(214) | ... | 26.170(142) | ... |
| 12 | 25.955(133) | ... | 26.980(197) | ... | 26.734(240) | ... | 26.278(200) | ... |
| 13 | 25.957(105) | 25.761(138) | ... | 26.524(162) | 26.525(271) | 25.891(114) | 26.403(164) | 25.661(124) |
| 14 | 26.352(199) | 25.741(140) | 27.347(166) | 26.216(159) | 26.943(302) | 26.126(210) | 25.873(116) | 25.740(133) |
| 15 | 26.189(126) | ... | 26.970(307) | ... | 26.012(145) | ... | 26.241(115) | ... |
| 16 | 25.921(161) | ... | 26.681(225) | ... | 26.198(167) | ... | 26.025(099) | ... |
| 17 | 26.408(159) | ... | ... | ... | 25.610(128) | ... | 26.597(223) | ... |
| 18 | 26.214(206) | ... | 27.438(218) | ... | 25.676(090) | ... | 26.414(182) | ... |
| 19 | 26.198(184) | 25.901(173) | 26.161(067) | 26.011(134) | 25.911(132) | 25.377(076) | 26.871(261) | 25.855(155) |
| 20 | 26.169(151) | 26.164(195) | 26.301(106) | 25.785(115) | 25.761(092) | 25.404(093) | 26.500(185) | 25.910(160) |
| 21 | 26.793(280) | ... | 26.174(079) | ... | 25.930(159) | ... | 26.784(232) | ... |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 22 | 26.594(238) | ... | 26.465(121) | ... | 26.005(143) | ... | 26.740(225) | ... |
| 23 | 26.694(247) | 25.973(161) | 26.408(088) | 26.009(119) | 25.990(150) | 25.593(150) | 25.982(112) | 25.374(110) |
| 24 | 27.180(376) | 26.504(196)* | 26.819(210) | 25.847(091) | 26.119(176) | 25.472(088) | 25.913(167) | 25.305(093) |
| 25 | ... | ... | 26.950(231) | ... | 26.300(188) | ... | 26.241(231) | ... |
| 26 | 26.347(225) | ... | 26.603(231) | ... | 25.749(139) | ... | 25.762(194) | ... |
| | **31655$P$ = 35.83 d** | | **07868$P$ = 36.17 d** | | **69637$P$ = 37.23 d** | | **41024$P$ = 38.63 d** | |
| 1 | 25.836(092) | 25.331(080) | 27.187(303) | 26.410(114) | 25.915(184) | 25.298(120) | 26.011(126) | 25.619(095) |
| 2 | 25.658(075) | 25.056(093)* | 26.607(154) | 26.188(146) | 25.321(079) | 25.378(091) | 26.147(123) | 25.703(122) |
| 3 | 26.120(134) | ... | 26.249(138) | ... | 25.488(146) | ... | 26.524(210) | ... |
| 4 | 26.074(099) | ... | 26.181(105) | ... | 25.932(232) | ... | 26.986(399) | ... |
| 5 | 26.237(078) | 25.677(092) | 26.375(116) | 25.894(148) | 26.158(186) | 25.294(100) | 26.605(168) | 26.271(199) |
| 6 | 26.404(147) | 25.681(073) | 26.438(133) | 25.918(106) | 26.430(172) | 25.360(158) | 27.239(276) | 26.285(204) |
| 7 | 26.187(088) | ... | 26.978(175) | ... | 26.273(177) | ... | ... | ... |
| 8 | 26.039(109) | ... | 26.508(147) | ... | 26.057(200) | ... | 26.282(172) | ... |
| 9 | 25.781(071) | ... | 26.724(126) | ... | 26.469(370) | ... | 25.998(157) | ... |
| 10 | 25.988(095) | ... | 26.707(162) | ... | 26.538(274) | ... | 26.115(154) | ... |
| 11 | 25.766(094) | ... | 27.319(160) | ... | 26.138(154) | ... | 25.795(121) | ... |
| 12 | 25.844(067) | ... | 26.880(138) | ... | 26.058(169) | ... | 25.909(115) | ... |
| 13 | 25.873(086) | 25.438(052) | 27.027(178) | 26.179(122) | 26.450(250) | 25.646(128) | 25.923(108) | 25.788(185) |
| 14 | 25.941(135) | 25.482(091) | 26.856(118) | 26.033(121) | 26.110(152) | 25.726(164) | 25.894(129) | 25.708(139) |
| 15 | 25.698(086) | ... | 26.984(134) | ... | 26.785(338) | ... | 26.001(156) | ... |
| 16 | 25.696(060) | ... | 26.913(176) | ... | 26.144(113) | ... | 25.997(120) | ... |
| 17 | 25.867(083) | ... | 27.042(167) | ... | 26.390(181) | ... | 25.860(086) | ... |
| 18 | 25.780(106) | ... | 27.062(205) | ... | 26.098(196) | ... | 26.229(165) | ... |
| 19 | 25.898(116) | 25.323(084) | 26.861(194) | 26.208(102) | 25.765(097) | 25.281(126) | 26.015(156) | 25.867(149) |
| 20 | 25.945(051) | 25.565(064) | 26.683(159) | 26.083(096) | 25.748(128) | 25.230(096) | 26.246(149) | 26.186(181) |
| 21 | 25.944(112) | ... | 26.254(106) | ... | 25.842(098) | ... | 26.748(272) | ... |
| 22 | 26.044(086) | ... | 26.189(114) | ... | 25.645(164) | ... | 26.770(257) | ... |
| 23 | 26.088(148) | 25.540(071) | 26.788(130) | 25.852(073) | 25.990(187) | 25.241(135) | 26.789(257) | 26.456(215) |
| 24 | 26.224(117) | 25.632(101) | 26.257(111) | 25.758(101) | 25.958(184) | 25.375(115) | 26.860(281) | 26.736(286)* |
| 25 | 25.695(092) | ... | 26.995(316) | ... | ... | ... | 26.226(176) | ... |
| 26 | 26.475(235) | ... | 26.022(152) | ... | 25.885(174) | ... | ... | ... |
| | **34163$P$ = 39.34 d** | | **07989$P$ = 39.42 d** | | **44069$P$ = 39.90 d** | | **27980$P$ = 39.92 d** | |
| 1 | 26.427(188) | 25.711(108) | 26.517(139) | 25.983(166) | 26.566(196) | 26.075(132) | 26.737(129) | 25.678(087) |
| 2 | 26.267(168) | 25.606(091) | 26.413(197) | 25.795(108) | 26.243(125) | 25.854(245) | 26.322(221) | 25.614(175) |
| 3 | 26.671(215) | ... | 27.221(364) | ... | 26.015(138) | ... | 26.666(152) | ... |
| 4 | 26.471(206) | ... | 27.133(267) | ... | 26.066(139) | ... | 27.836(375) | ... |
| 5 | 25.812(113) | 25.343(080) | ... | 26.162(113) | 26.507(143) | 25.823(106) | 26.172(134) | 25.584(086) |
| 6 | 25.508(096) | 25.278(089) | ... | 26.337(091) | 26.156(290) | 25.752(117) | 26.707(234) | 25.644(136) |
| 7 | 25.847(082) | ... | 27.187(203) | ... | 26.657(150) | ... | 25.966(103) | ... |
| 8 | 25.686(110) | ... | 27.314(271) | ... | 26.105(133) | ... | 25.595(079) | ... |
| 9 | 25.920(141) | ... | 27.009(283) | ... | 26.540(215) | ... | 26.027(090) | ... |
| 10 | 25.951(117) | ... | 26.981(149) | ... | 26.654(225) | ... | 26.053(094) | ... |
| 11 | 25.958(128) | ... | 26.542(169) | ... | 26.743(265) | ... | 26.157(071) | ... |
| 12 | 26.268(189) | ... | 26.579(139) | ... | 27.028(315) | ... | 26.143(140) | ... |
| 13 | 26.260(159) | 25.546(145) | 26.540(135) | 25.657(086) | 26.910(295) | 26.668(172)* | 26.180(104) | 25.530(076) |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 14 | 25.998(166) | 25.300(085) | 26.642(136) | 25.816(090) | 26.535(219) | 26.081(123) | 26.342(179) | 25.395(112) |
| 15 | 25.971(098) | ... | 26.399(097) | ... | 26.767(185) | ... | 26.425(127) | ... |
| 16 | 25.897(117) | ... | 26.856(204) | ... | 26.318(151) | ... | 26.448(109) | ... |
| 17 | 26.620(234) | ... | 26.366(152) | ... | 26.939(278) | ... | 26.782(131) | ... |
| 18 | 26.068(182) | ... | 26.482(130) | ... | 26.376(200) | ... | 26.320(141) | ... |
| 19 | 26.277(116) | 25.749(104) | 26.481(125) | 25.992(103) | 26.262(125) | 25.743(079) | 26.518(177) | 25.638(071) |
| 20 | 26.201(187) | 25.739(098) | 26.814(237) | 25.933(086) | 26.018(106) | 25.417(182)* | 26.752(153) | 25.648(105) |
| 21 | 26.655(191) | ... | 26.635(167) | ... | 25.870(076) | ... | 27.060(216) | ... |
| 22 | 26.194(123) | ... | 26.815(130) | ... | 25.689(068) | ... | 26.706(154) | ... |
| 23 | 25.904(188) | 25.535(131) | 27.008(200) | 26.150(160) | 25.912(115) | 25.774(112) | 27.373(305) | 25.919(106) |
| 24 | 26.195(113) | 25.672(119) | 26.896(194) | 26.321(095) | 25.822(121) | 25.478(067) | 27.434(380) | 25.924(140) |
| 25 | 26.055(328) | ... | 26.283(113) | ... | 26.431(191) | ... | 26.145(131) | ... |
| 26 | 26.383(207) | ... | 27.072(286) | ... | 25.789(115) | ... | 26.670(232) | ... |
| | **52975$P$ = 40.52 d** | | **07994$P$ = 40.69 d** | | **01166$P$ = 41.11 d** | | **76534$P$ = 41.86 d** | |
| 1 | 26.361(109) | 25.699(148) | 26.870(249) | 25.585(117) | 26.677(130) | 25.601(101) | 26.319(262) | 25.836(166) |
| 2 | 26.341(128) | 25.875(100) | 26.592(152) | 25.653(113) | 26.602(095) | 25.543(084) | 26.052(272) | 25.215(143)* |
| 3 | 26.759(175) | ... | ... | ... | 27.001(237) | ... | 26.463(286) | ... |
| 4 | 26.900(200) | ... | 27.268(394) | ... | 26.626(096) | ... | ... | ... |
| 5 | 27.122(141) | 26.400(149) | 26.028(084) | 25.651(073) | 26.994(186) | 25.969(090) | 26.159(249) | 25.821(169) |
| 6 | 26.980(218) | 26.393(105) | 26.303(099) | 25.670(095) | 27.684(295) | 26.019(099) | 26.477(387) | 26.154(216)* |
| 7 | 27.459(301) | ... | 25.764(093) | ... | 27.149(189) | ... | 25.816(257) | ... |
| 8 | 27.305(243) | ... | 25.927(069) | ... | 27.316(175) | ... | 26.066(210) | ... |
| 9 | 26.879(165) | ... | 25.870(113) | ... | 27.332(266) | ... | 25.773(136) | ... |
| 10 | ... | ... | 25.927(109) | ... | 27.035(150) | ... | 25.641(185) | ... |
| 11 | 26.990(155) | ... | 25.895(116) | ... | 27.197(139) | ... | 25.917(228) | ... |
| 12 | 26.630(146) | ... | 25.954(089) | ... | 27.069(142) | ... | 25.890(244) | ... |
| 13 | 26.433(121) | 25.832(112) | 26.032(076) | 25.376(076) | 26.936(126) | 25.959(090) | 25.876(149) | 25.457(123) |
| 14 | 26.245(126) | 25.654(091) | 26.130(107) | 25.445(092) | 26.834(133) | 25.945(115) | 25.561(161) | 25.266(116) |
| 15 | 26.268(097) | ... | 26.295(118) | ... | 26.542(100) | ... | 25.748(183) | ... |
| 16 | 26.163(080) | ... | 25.941(066) | ... | 26.617(129) | ... | 25.506(118) | ... |
| 17 | 26.387(142) | ... | 26.380(154) | ... | 26.269(088) | ... | 25.901(143) | ... |
| 18 | 26.213(072) | ... | 25.990(125) | ... | 26.309(067) | ... | 26.003(211) | ... |
| 19 | 26.516(133) | 25.856(111) | 26.392(160) | 25.671(083) | 26.470(112) | 25.758(066) | 26.126(204) | 25.470(115) |
| 20 | 26.879(129) | 26.107(088) | 26.344(092) | 25.466(106) | 26.574(085) | 25.701(084) | 26.145(199) | 25.587(142) |
| 21 | 26.522(147) | ... | 26.545(133) | ... | 26.560(095) | ... | 26.143(196) | ... |
| 22 | 26.599(132) | ... | 26.523(118) | ... | 26.535(119) | ... | 26.213(182) | ... |
| 23 | 26.572(171) | 26.530(197) | 26.703(217) | 25.994(125) | 26.815(178) | 25.777(108) | 26.363(341) | 25.337(131)* |
| 24 | 26.817(143) | 26.403(125) | 26.861(155) | 26.107(095) | 26.629(112) | 25.852(081) | 26.854(365) | 25.692(221) |
| 25 | 27.328(310) | ... | 25.928(092) | ... | 26.649(189) | ... | 26.232(378) | ... |
| 26 | ... | ... | ... | ... | 26.437(220) | ... | 25.550(222) | ... |
| | **22918$P$ = 42.03 d** | | **02032$P$ = 42.54 d** | | **48747$P$ = 42.68 d** | | **67393$P$ = 42.74 d** | |
| 1 | 26.146(115) | 25.443(072) | 25.570(099) | 25.066(088) | 27.048(334) | 25.967(140) | 26.453(277) | 25.409(168) |
| 2 | 26.155(137) | 25.448(082) | 25.495(091) | 25.043(071) | 26.934(187) | 25.792(128) | 26.365(266) | 25.330(158) |
| 3 | 26.523(181) | ... | 26.016(205) | ... | 27.115(223) | ... | 25.575(119) | ... |
| 4 | 27.023(367) | ... | 25.968(106) | ... | ... | ... | 25.409(145) | ... |
| 5 | 25.503(062) | 25.185(092) | 26.236(127) | 25.303(074) | 26.153(090) | 25.862(107) | 25.614(105) | 25.076(143) |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 6 | 25.883(172) | 25.343(071) | 26.096(139) | 25.408(061) | 26.397(091) | 25.761(095) | 25.573(130) | 25.151(128) |
| 7 | 25.629(070) | ... | 25.850(105) | ... | 26.420(120) | ... | 25.939(126) | ... |
| 8 | 25.631(103) | ... | 26.104(077) | ... | 25.898(113) | ... | 26.076(228) | ... |
| 9 | 26.290(198) | ... | 26.304(139) | ... | 26.714(137) | ... | 26.373(247) | ... |
| 10 | 25.770(088) | ... | 26.356(124) | ... | 26.118(210) | ... | 25.943(176) | ... |
| 11 | 25.792(126) | ... | 26.455(110) | ... | 26.532(173) | ... | 26.079(133) | ... |
| 12 | 26.015(118) | ... | 26.707(123) | ... | 26.269(111) | ... | 26.222(216) | ... |
| 13 | 25.769(101) | 25.140(089) | 26.752(137) | 25.561(071) | 26.431(108) | 25.730(123) | 25.458(174)* | 25.394(150) |
| 14 | 25.890(081) | 25.381(078) | 26.609(109) | 25.632(062) | 26.265(081) | 25.708(059) | 25.959(144) | 25.242(140) |
| 15 | 25.836(109) | ... | 26.269(122) | ... | 26.464(122) | ... | 26.173(199) | ... |
| 16 | 25.885(121) | ... | 26.436(097) | ... | 26.218(114) | ... | 26.114(199) | ... |
| 17 | 25.963(092) | ... | 25.714(101) | ... | 26.720(258) | ... | 25.952(157) | ... |
| 18 | 26.295(125) | ... | 25.535(103) | ... | 26.712(105) | ... | 26.206(182) | ... |
| 19 | 26.411(179) | 25.545(091) | 25.889(197) | 25.194(049) | 26.967(328) | 25.932(089) | 26.333(349) | 25.436(199) |
| 20 | 26.303(149) | 25.601(089) | 25.351(080) | 25.084(072) | 26.927(179) | 26.056(086) | 26.342(187) | 25.459(145) |
| 21 | 26.512(162) | ... | 25.592(100) | ... | 27.328(296) | ... | 26.208(213) | ... |
| 22 | 26.484(142) | ... | 25.552(037) | ... | ... | ... | 26.246(210) | ... |
| 23 | 27.061(336) | 25.905(130) | 25.705(118) | 25.199(076) | 27.107(319) | 26.573(206) | 25.565(144) | 25.047(129) |
| 24 | 26.656(257) | 25.721(090) | 25.677(068) | 25.191(074) | 27.345(297) | 26.397(153) | 25.458(130) | 25.171(127) |
| 25 | 26.600(288) | ... | 25.529(067) | ... | 26.790(197) | ... | 26.322(256) | ... |
| 26 | 25.744(075) | ... | 26.274(124) | ... | 26.474(195) | ... | 25.796(187) | ... |
| | **58298$P$ = 43.53 d** | | **07331$P$ = 44.59 d** | | **02979$P$ = 44.91 d** | | **01732$P$ = 45.00 d** | |
| 1 | 26.495(216) | 25.602(107) | 25.252(102) | 25.228(127) | 25.705(085) | 25.003(066) | 25.371(112) | 25.001(075) |
| 2 | 26.333(099) | 25.690(157) | 25.528(090) | 25.331(113) | 25.733(108) | 25.112(063) | 25.228(079) | 24.767(099) |
| 3 | 25.928(149) | ... | 25.886(196) | ... | 26.120(204) | ... | 25.843(109) | ... |
| 4 | 26.039(062) | ... | 25.648(130) | ... | 25.834(131) | ... | 25.648(080) | ... |
| 5 | 25.703(165) | 25.288(146) | 25.603(181) | 25.236(106) | 26.245(129) | 25.527(095) | 25.828(087) | 25.168(068) |
| 6 | 25.758(083) | 25.244(102) | 25.993(147) | 25.225(162) | 26.460(311) | 25.441(055) | 25.775(138) | 25.125(091) |
| 7 | 25.775(105) | ... | 25.681(119) | ... | 26.230(091) | ... | 25.764(072) | ... |
| 8 | 25.859(079) | ... | 25.965(150) | ... | 26.169(095) | ... | 25.711(118) | ... |
| 9 | 25.923(096) | ... | 26.622(320)* | ... | 26.259(106) | ... | 25.885(084) | ... |
| 10 | 25.844(099) | ... | 26.008(147) | ... | 26.319(126) | ... | 25.744(082) | ... |
| 11 | 26.091(124) | ... | 25.782(127) | ... | 26.430(122) | ... | 25.863(073) | ... |
| 12 | 25.943(070) | ... | 26.526(218)* | ... | 26.388(182) | ... | 25.947(078) | ... |
| 13 | 25.990(100) | 25.311(056) | 25.945(092) | 25.532(126) | 26.356(112) | 25.593(087) | 25.918(076) | 25.281(047) |
| 14 | 25.931(072) | 25.341(085) | 26.207(136) | 25.961(126)* | 26.283(080) | 25.559(055) | 25.748(124) | 25.131(083) |
| 15 | 26.078(094) | ... | 26.205(135) | ... | 25.976(089) | ... | 25.844(048) | ... |
| 16 | 26.374(110) | ... | 26.099(146) | ... | 26.095(081) | ... | 25.708(070) | ... |
| 17 | 26.107(153) | ... | 26.116(100) | ... | 25.581(097) | ... | 25.780(075) | ... |
| 18 | 26.184(085) | ... | 26.210(120) | ... | 25.519(081) | ... | 25.824(106) | ... |
| 19 | 26.492(110) | 25.653(056) | 25.406(188) | 25.554(116) | 25.444(064) | 25.015(033) | 25.546(064) | 25.092(046) |
| 20 | 26.535(121) | 25.622(090) | 25.766(093) | 25.494(082) | 25.538(093) | 25.084(058) | 25.345(091) | 24.890(104) |
| 21 | 26.445(124) | ... | 25.255(097) | ... | 25.618(056) | ... | 25.371(053) | ... |
| 22 | 26.664(111) | ... | 25.513(083) | ... | 25.506(043) | ... | 25.356(095) | ... |
| 23 | 26.607(233) | 25.871(130) | 26.630(202)* | 25.297(139) | 25.678(058) | 25.090(048) | 25.527(064) | 24.931(057) |
| 24 | 26.561(158) | 25.965(117) | 25.562(071) | 25.330(132) | 25.684(079) | 25.206(073) | 25.383(073) | 24.844(071) |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 25 | 26.278(229) | ... | 26.021(162) | ... | 26.378(130) | ... | 25.720(103) | ... |
| 26 | 26.465(221) | ... | 25.577(091) | ... | 25.318(087) | ... | 25.576(088) | ... |
| | **19368$P$ = 45.25 d** | | **49584$P$ = 45.67 d** | | **16143$P$ = 46.74 d** | | **15346$P$ = 46.85 d** | |
| 1 | 26.320(180) | 25.378(127) | 26.172(218) | 25.415(119) | 25.992(141) | 25.301(115) | 26.400(184) | 25.581(123) |
| 2 | 26.381(130) | 25.631(094) | 26.067(132) | 25.571(094) | 25.915(077) | 25.171(066)* | 26.489(178) | 25.412(092) |
| 3 | 26.163(168) | ... | 26.400(205) | ... | 26.132(136) | ... | 25.694(163) | ... |
| 4 | 26.807(207)* | ... | 26.484(170) | ... | 26.346(119) | ... | 25.865(127) | ... |
| 5 | 25.693(131) | 25.269(110) | 26.577(211) | 25.822(154) | 26.322(116) | 25.434(086) | 25.731(132) | 25.148(102)* |
| 6 | 26.067(120) | 25.364(086) | 26.667(187) | 25.882(141) | 26.314(149) | 25.549(083) | 26.281(206)* | 25.382(090) |
| 7 | 25.731(088) | ... | 26.447(153) | ... | 26.530(202) | ... | 25.743(086) | ... |
| 8 | 25.818(091) | ... | 26.336(159) | ... | 26.519(124) | ... | 25.680(073) | ... |
| 9 | 25.674(083) | ... | 26.717(262) | ... | 26.700(211) | ... | 25.891(163) | ... |
| 10 | 25.720(078) | ... | 26.444(131) | ... | 26.607(120) | ... | 26.002(102) | ... |
| 11 | 25.598(110) | ... | 26.546(167) | ... | 26.597(195) | ... | 25.887(111) | ... |
| 12 | 25.841(120) | ... | 26.833(170) | ... | 26.334(170) | ... | 26.094(135) | ... |
| 13 | 25.568(081) | 25.135(107) | 26.201(127) | 25.801(112) | 26.746(199) | 25.310(071)* | 25.860(149) | 25.237(088)* |
| 14 | 25.665(060) | 25.216(102) | 26.349(172) | 25.803(105) | 26.767(179) | 25.731(089) | 26.012(106) | 25.508(072) |
| 15 | 25.432(095) | ... | 25.956(092) | ... | 26.681(166) | ... | 25.793(157) | ... |
| 16 | 25.788(085) | ... | 26.183(105) | ... | 26.870(179) | ... | 26.149(126) | ... |
| 17 | 25.679(112) | ... | 25.833(114) | ... | 26.584(164) | ... | 26.084(133) | ... |
| 18 | 25.942(086) | ... | 25.895(083) | ... | 26.927(134) | ... | 26.166(156) | ... |
| 19 | 25.885(147) | 25.202(109) | 25.790(098) | 25.298(091) | 26.831(171) | 25.640(119) | 26.335(133) | 25.654(100) |
| 20 | 26.093(114) | 25.181(102) | 25.968(080) | 25.474(080) | 26.717(195) | 25.904(095) | 26.400(171) | 25.672(094) |
| 21 | 26.054(101) | ... | 26.086(113) | ... | 26.314(116) | ... | 26.476(134) | ... |
| 22 | 26.132(096) | ... | 26.045(083) | ... | 26.788(247) | ... | 26.806(212) | ... |
| 23 | 26.338(147) | 25.461(126) | 26.186(104) | 25.362(067) | 26.137(100) | 25.110(122)* | 25.973(111) | 25.501(100) |
| 24 | 26.469(146) | 25.556(130) | 26.455(166) | 25.331(120) | 26.084(086) | 25.368(054) | 25.985(072) | 25.500(106) |
| 25 | 25.936(141) | ... | ... | ... | 25.991(174) | ... | 26.026(108) | ... |
| 26 | 25.829(139) | ... | 25.998(093) | ... | 26.985(215) | ... | 25.835(143) | ... |
| | **54502$P$ = 47.14 d** | | **59642$P$ = 47.39 d** | | **52566$P$ = 47.42 d** | | **52170$P$ = 47.99 d** | |
| 1 | 26.998(240) | 26.000(097) | 25.399(081) | 25.305(105) | 26.028(126) | 25.623(070) | 26.131(092) | 25.338(070) |
| 2 | 26.922(207) | 25.971(114) | 25.705(091) | 25.256(113) | 26.036(110) | 25.547(094) | 26.197(073) | 25.301(062) |
| 3 | 26.101(130) | ... | 25.988(174) | ... | 26.350(182) | ... | 26.371(172) | ... |
| 4 | 26.207(125) | ... | 26.080(175) | ... | 26.619(233) | ... | 26.512(148) | ... |
| 5 | 25.912(076) | 25.334(061) | 25.805(101) | 25.434(148) | 26.161(108) | 25.996(105) | 26.737(269) | 25.642(073) |
| 6 | 25.775(125) | 25.392(097) | 26.188(201) | 25.606(116) | 26.291(129) | 25.822(086) | 26.533(112) | 25.571(086) |
| 7 | 26.200(101) | ... | 25.999(103) | ... | 25.892(090) | ... | 26.710(145) | ... |
| 8 | 25.772(160) | ... | 25.888(106) | ... | 25.936(090) | ... | 26.765(137) | ... |
| 9 | 26.152(096) | ... | 26.283(147) | ... | 25.569(080) | ... | 27.124(250) | ... |
| 10 | 26.629(161) | ... | 25.818(105) | ... | 25.547(068) | ... | 26.935(156) | ... |
| 11 | 26.263(097) | ... | 26.128(154) | ... | 25.839(099) | ... | 26.908(200) | ... |
| 12 | 26.271(112) | ... | 26.250(214) | ... | 25.741(111) | ... | 26.859(115) | ... |
| 13 | 26.157(073) | 25.595(078) | 26.145(108) | 25.865(137) | 25.835(084) | 25.425(054) | 26.653(118) | 25.680(110) |
| 14 | 26.509(248) | 25.492(085) | 26.260(174) | 26.076(142)* | 25.604(104) | 25.438(071) | 26.558(112) | 25.682(062) |
| 15 | 26.456(120) | ... | 26.398(197) | ... | 25.829(093) | ... | 26.478(098) | ... |
| 16 | 26.446(146) | ... | 26.206(140) | ... | 25.859(114) | ... | 26.199(072) | ... |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 17 | 26.483(100) | ... | 26.188(152) | ... | 25.897(117) | ... | 26.094(121) | ... |
| 18 | 26.319(145) | ... | 25.931(113) | ... | 25.765(113) | ... | 26.017(108) | ... |
| 19 | 26.698(199) | 25.701(068) | 25.445(111) | 25.205(081) | 26.132(126) | 25.534(065) | 26.058(098) | 25.344(071) |
| 20 | 27.248(340) | 25.894(095) | 25.500(103) | 25.367(076) | 25.806(084) | 25.500(070) | 26.037(075) | 25.057(111)* |
| 21 | 27.133(156) | ... | 25.502(094) | ... | 26.116(098) | ... | 25.843(076) | ... |
| 22 | 27.249(316) | ... | 25.380(079) | ... | 26.104(132) | ... | 26.054(055) | ... |
| 23 | 26.910(236) | 25.937(115) | 25.815(136) | 25.309(147) | 26.345(140) | 25.864(091) | 25.967(172) | 25.378(119) |
| 24 | 27.028(200) | 26.146(164) | 25.426(140) | 25.346(099) | 26.190(116) | 25.903(113) | 26.112(090) | 25.340(082) |
| 25 | 26.944(209) | ... | 25.553(083) | ... | 26.307(150) | ... | 26.030(126) | ... |
| 26 | 25.956(087) | ... | 25.812(142) | ... | 26.431(171) | ... | 26.373(141) | ... |
| | **04882$P$ = 48.92 d** | | **68817$P$ = 49.93 d** | | **15318$P$ = 51.46 d** | | **71911$P$ = 51.99 d** | |
| 1 | 26.580(212) | 25.925(137) | 25.861(155) | 25.719(170)* | 25.737(075) | 25.333(078) | 25.290(117) | 24.699(107)* |
| 2 | 27.448(367)* | 26.166(111)* | 25.851(155) | 25.428(111) | 25.662(069) | 25.081(062) | 25.049(099)* | 24.873(113) |
| 3 | 25.940(140) | ... | 25.592(160) | ... | 25.592(105) | ... | 25.493(107) | ... |
| 4 | 25.927(078) | ... | 25.794(189) | ... | 25.599(073) | ... | 25.385(097) | ... |
| 5 | 25.943(108) | 25.452(077) | 25.993(106) | 25.779(135) | 25.972(118) | 25.331(085) | 25.399(092) | 24.834(105) |
| 6 | ... | 25.470(069) | 26.078(197) | 25.611(101) | 25.911(069) | 25.167(061) | 25.742(139) | 25.010(094) |
| 7 | 25.960(112) | ... | 26.120(115) | ... | 25.955(077) | ... | 25.466(074) | ... |
| 8 | 26.544(250) | ... | 25.926(104) | ... | 25.824(142) | ... | 25.789(133) | ... |
| 9 | 26.204(118) | ... | 25.388(166)* | ... | 26.144(065) | ... | 25.707(141) | ... |
| 10 | 26.321(127) | ... | 25.711(125)* | ... | 26.177(101) | ... | 25.625(104) | ... |
| 11 | 26.473(118) | ... | 26.220(175) | ... | 26.206(101) | ... | 25.840(097) | ... |
| 12 | 26.611(127) | ... | 26.421(232) | ... | 26.026(078) | ... | 25.783(114) | ... |
| 13 | 26.198(164) | 25.582(092) | 26.505(202) | 25.682(155) | 26.150(082) | 25.535(091) | 25.771(109) | 24.973(104) |
| 14 | 26.423(114) | 25.645(060) | 26.540(204) | 25.784(153) | 26.158(086) | 25.191(064)* | 25.668(118) | 25.074(098) |
| 15 | 26.315(137) | ... | 26.461(141) | ... | 26.166(072) | ... | 25.766(074) | ... |
| 16 | 26.514(120) | ... | 26.080(144) | ... | 26.282(090) | ... | 25.845(125) | ... |
| 17 | 26.362(149) | ... | 26.412(194) | ... | 26.497(128) | ... | 25.642(102) | ... |
| 18 | 26.208(161) | ... | 26.332(146) | ... | 26.401(101) | ... | 25.720(111) | ... |
| 19 | ... | 25.849(101) | 26.039(136) | 25.635(127) | 26.710(125) | 25.791(101) | 25.912(164) | 25.240(088) |
| 20 | 26.844(121) | 25.925(077) | 26.056(089) | 25.600(163) | 26.545(147) | 25.833(091) | 25.841(088) | 25.149(120) |
| 21 | 26.697(126) | ... | 25.690(121) | ... | 26.387(089) | ... | 25.725(134) | ... |
| 22 | 26.836(135) | ... | 25.872(115) | ... | 26.459(167) | ... | 25.699(094) | ... |
| 23 | 25.813(079) | 25.494(070) | 25.586(178) | 25.369(116) | 25.544(064) | 25.217(077) | 25.402(108) | 24.945(105) |
| 24 | 25.905(076) | 25.457(076) | 25.544(069) | 25.476(110) | 25.627(063) | 25.107(066) | 25.421(070) | 24.896(091) |
| 25 | 26.599(138) | ... | 26.136(189) | ... | 25.626(087) | ... | 25.419(097) | ... |
| 26 | 25.838(091) | ... | 25.766(160) | ... | 26.045(153) | ... | 25.734(125) | ... |
| | **28132$P$ = 52.24 d** | | **06581$P$ = 58.98 d** | | **25965$P$ = 59.02 d** | | **06542$P$ = 59.13 d** | |
| 1 | 26.453(175) | 25.354(126) | 27.137(286) | 26.085(188) | 25.895(182) | 25.408(125) | 26.177(110) | 25.233(064) |
| 2 | 26.540(213) | 25.731(077)* | 26.164(199) | 25.765(118) | 25.791(131) | 25.450(095) | 26.138(097) | 25.211(048) |
| 3 | 26.758(212) | ... | 26.246(205) | ... | 25.785(214) | ... | 26.141(174) | ... |
| 4 | 26.505(250) | ... | 25.630(115) | ... | 25.925(162) | ... | 26.171(115) | ... |
| 5 | 26.330(121) | 25.325(068) | 26.116(122) | 25.582(155) | 26.189(235) | 25.680(128) | 26.181(084) | 25.589(113)* |
| 6 | 26.480(162) | 25.443(112) | 25.822(292) | 25.019(064)* | 26.201(167) | 25.851(148) | 26.444(151) | 25.492(122) |
| 7 | 26.211(118) | ... | 25.800(075) | ... | 26.378(192) | ... | 26.233(080) | ... |
| 8 | 25.737(110) | ... | 25.875(056) | ... | 26.465(245) | ... | 26.257(113) | ... |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 9 | 25.935(123) | ... | 25.636(130) | ... | 26.295(207) | ... | 25.709(102) | ... |
| 10 | 25.858(096) | ... | 25.933(090) | ... | 26.360(259) | ... | 25.960(063) | ... |
| 11 | 25.988(089) | ... | 26.387(189) | ... | 26.437(226) | ... | 25.965(066) | ... |
| 12 | 25.891(105) | ... | 25.971(106) | ... | 26.486(288) | ... | 25.959(070) | ... |
| 13 | 25.964(078) | 25.325(068) | 26.467(141) | 25.645(140) | 26.179(204) | 25.632(128) | 25.852(074) | 25.193(049) |
| 14 | 25.985(082) | 25.243(078) | 26.128(135) | 25.303(101) | 25.737(182) | 25.785(143) | 25.743(090) | 25.207(070) |
| 15 | 26.037(115) | ... | 26.371(217) | ... | 25.906(132) | ... | 25.766(057) | ... |
| 16 | 25.969(109) | ... | 25.857(133) | ... | 26.057(156) | ... | 25.651(076) | ... |
| 17 | 26.005(109) | ... | 26.665(168) | ... | 25.772(117) | ... | 25.627(102) | ... |
| 18 | 25.973(098) | ... | 26.159(075) | ... | 25.598(081) | ... | 25.704(054) | ... |
| 19 | 26.047(163) | 25.330(070) | 26.185(138) | 25.716(154) | 25.800(134) | 25.397(109) | 25.709(062) | 25.078(048) |
| 20 | 26.181(120) | 25.433(093) | 26.515(130) | 25.468(080) | 25.728(172) | 25.233(107) | 25.724(084) | 25.087(062) |
| 21 | 26.453(108) | ... | 26.669(237) | ... | 25.717(120) | ... | 25.706(104) | ... |
| 22 | 26.046(103) | ... | 26.544(094) | ... | 25.752(140) | ... | 25.759(082) | ... |
| 23 | 26.194(106) | 25.481(120) | 26.892(208) | 25.620(115) | 25.710(099) | 25.386(112) | 25.939(049) | 25.103(058) |
| 24 | 26.294(175) | 25.465(114) | 26.857(179) | 26.036(109) | 25.936(193) | 25.262(171) | 25.993(081) | 25.046(066) |
| 25 | 26.817(279) | ... | 25.652(076) | ... | 26.052(185) | ... | 26.222(110) | ... |
| 26 | 25.874(165) | ... | 26.229(132) | ... | 26.017(212) | ... | 25.790(103) | ... |
| | **53187$P$ = 59.75 d** | | **69494$P$ = 60.18 d** | | **02647$P$ = 60.68 d** | | **17049$P$ = 61.25 d** | |
| 1 | 25.912(111) | 25.775(091) | 25.823(113) | 25.576(073) | 25.553(061) | 24.792(082) | 25.438(085) | 24.751(062) |
| 2 | 25.989(117) | 25.536(074) | 25.975(098) | 25.473(064) | 25.834(084) | 24.975(076) | 25.272(089) | 24.742(098) |
| 3 | 26.133(162) | ... | 25.927(182) | ... | 25.814(169) | ... | 25.050(128)* | ... |
| 4 | 26.101(157) | ... | 26.413(192) | ... | 25.819(117) | ... | 25.582(128) | ... |
| 5 | 25.996(106) | 25.696(096) | 26.471(190) | 25.465(111) | 25.916(102) | 25.170(099) | 25.438(109) | 24.956(074) |
| 6 | 26.249(170) | 25.688(095) | 26.784(190) | 25.677(100) | 26.774(308)* | 25.434(054)* | 25.716(127) | 24.879(098) |
| 7 | 26.418(184) | ... | 26.550(132) | ... | 26.089(077) | ... | 25.618(100) | ... |
| 8 | 26.476(184) | ... | 26.415(123) | ... | 26.559(143) | ... | 25.639(123) | ... |
| 9 | 26.450(157) | ... | 26.434(156) | ... | 26.145(108) | ... | 25.635(112) | ... |
| 10 | 26.367(116) | ... | 26.502(190) | ... | 26.316(128) | ... | 25.554(102) | ... |
| 11 | 26.922(191)* | ... | 26.752(211) | ... | 26.208(149) | ... | 25.554(103) | ... |
| 12 | 26.589(213) | ... | 26.706(298) | ... | 26.056(126) | ... | 26.028(122) | ... |
| 13 | 26.512(160) | 26.112(131) | 26.666(204) | 25.806(116) | 25.980(106) | 25.228(075) | 25.599(079) | 25.128(108) |
| 14 | 25.780(287)* | 26.026(173) | 26.611(168) | 25.836(102) | 26.361(119) | 25.386(083) | 25.777(148) | 25.048(097) |
| 15 | 26.282(162) | ... | 26.809(206) | ... | 25.781(087) | ... | 25.900(109) | ... |
| 16 | 26.171(123) | ... | 26.845(128) | ... | 25.722(098) | ... | 25.900(101) | ... |
| 17 | 26.506(100) | ... | 26.632(160) | ... | 25.338(094) | ... | 26.122(133) | ... |
| 18 | 26.403(142) | ... | 26.931(280) | ... | 25.590(061) | ... | 25.698(124) | ... |
| 19 | 26.113(095) | 25.645(105) | 27.291(293) | 25.911(095) | 25.136(056) | 24.737(066) | 26.231(193) | 25.173(122) |
| 20 | 25.995(093) | 25.621(103) | 26.944(247) | 26.047(135) | 25.198(085) | 25.012(087) | 25.796(179) | 25.318(125) |
| 21 | 25.765(115) | ... | 26.909(242) | ... | 25.328(064) | ... | 25.910(093) | ... |
| 22 | 25.926(079) | ... | 27.478(292) | ... | 25.204(075) | ... | 25.886(119) | ... |
| 23 | 26.056(108) | 25.633(090) | 26.772(230) | 25.728(111) | 25.408(079) | 24.736(081) | 25.974(109) | 24.966(112) |
| 24 | 25.961(093) | 25.879(120)* | 26.451(138) | 25.880(113) | 25.390(084) | 24.795(058) | 26.099(201) | 25.235(169) |
| 25 | 26.143(117) | ... | 26.124(173) | ... | 25.704(075) | ... | 25.498(111) | ... |
| 26 | 26.303(147) | ... | ... | ... | 26.006(126) | ... | 25.493(137) | ... |
| | **19918$P$ = 64.95 d** | | **64757$P$ = 65.03 d** | | **13102$P$ = 66.34 d** | | **45088$P$ = 71.41 d** | |

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.588(088) | 24.915(089) | 25.949(090) | 25.135(066) | 25.510(091) | 24.923(056) | ... | 26.346(209)* |
| 2 | 25.454(079) | 24.804(083) | 25.928(082) | 25.186(101) | 25.434(072) | 24.984(080) | 26.697(279) | 25.847(198) |
| 3 | 25.702(087) | ... | 26.102(159) | ... | 25.462(068) | ... | 26.578(228) | ... |
| 4 | 25.718(089) | ... | 25.900(108) | ... | 25.451(083) | ... | 26.465(254) | ... |
| 5 | 26.008(107) | 25.189(079) | 26.077(123) | 25.179(070) | 25.688(080) | 24.984(083) | 26.729(229) | 26.144(177) |
| 6 | 26.184(184) | 25.146(083) | 26.051(190) | 25.295(123) | 25.574(154) | 24.984(087) | 26.500(153) | 26.052(166) |
| 7 | 25.956(099) | ... | 26.171(077) | ... | 25.819(103) | ... | 27.028(292) | ... |
| 8 | 25.978(092) | ... | 26.335(117) | ... | 25.528(128) | ... | 26.517(350) | ... |
| 9 | 25.969(111) | ... | 26.208(107) | ... | 25.886(122) | ... | 26.773(316) | ... |
| 10 | 25.987(102) | ... | 26.358(162) | ... | 25.891(113) | ... | 26.099(129) | ... |
| 11 | 25.845(124) | ... | 26.291(104) | ... | 25.951(075) | ... | 26.336(164) | ... |
| 12 | 25.858(109) | ... | 26.090(100) | ... | 25.943(124) | ... | 26.313(192) | ... |
| 13 | 25.781(083) | 25.188(112) | 26.019(148) | 25.252(062) | 26.062(115) | 25.129(068) | 26.228(233) | 25.791(136) |
| 14 | 25.771(113) | 25.222(091) | 26.233(133) | 25.270(079) | 25.979(093) | 25.136(107) | 26.112(160) | 25.900(189) |
| 15 | 25.558(062) | ... | 26.433(223) | ... | 25.976(079) | ... | 25.988(126) | ... |
| 16 | 25.532(068) | ... | 26.392(122) | ... | 25.842(057) | ... | 25.747(229) | ... |
| 17 | 25.424(078) | ... | 26.259(146) | ... | 26.220(122) | ... | 25.913(128) | ... |
| 18 | 25.274(078) | ... | 26.537(166) | ... | 26.023(089) | ... | 25.615(082) | ... |
| 19 | 25.394(073) | 24.592(143)* | 26.785(235) | 25.386(078) | 26.237(133) | 25.418(073) | 25.518(074) | 25.189(108) |
| 20 | 25.341(053) | 24.927(086) | 26.385(098) | 25.383(090) | 26.363(090) | 25.433(097) | 25.519(079) | 25.078(079) |
| 21 | 25.443(069) | ... | 26.661(151) | ... | 26.281(083) | ... | 25.571(083) | ... |
| 22 | 25.436(058) | ... | 26.633(131) | ... | 26.379(078) | ... | 25.652(103) | ... |
| 23 | 25.426(104) | 24.836(092) | 26.343(176) | 25.408(054) | 25.701(083) | 25.093(100) | 25.736(110) | 25.081(077) |
| 24 | 25.486(087) | 24.853(084) | 26.561(162) | 25.441(085) | 25.698(074) | 24.987(072) | 25.622(138) | 24.964(068) |
| 25 | 25.315(081) | ... | 26.582(242) | ... | 25.847(140) | ... | 26.580(257) | ... |
| 26 | 25.418(112) | ... | 26.351(182) | ... | 26.247(176) | ... | 26.794(238) | ... |
| | **03836$P$ = 73.28 d** | | **07702$P$ = 73.76 d** | | **49485$P$ = 74.19 d** | | **23616$P$ = 82.14 d** | |
| 1 | 26.006(143) | 25.194(122) | 25.521(109) | 24.995(062) | 25.159(077) | 24.761(072)* | 26.527(101) | 25.424(089) |
| 2 | 25.780(084) | 24.973(066) | 25.539(066) | 24.969(068) | 25.115(101) | 25.081(059) | 26.198(083) | 25.535(093) |
| 3 | 26.203(158) | ... | 25.923(147) | ... | 25.381(107) | ... | 25.818(129) | ... |
| 4 | 26.003(076) | ... | 25.775(080) | ... | 25.347(161) | ... | 25.839(115) | ... |
| 5 | 26.504(108) | 25.511(093) | 25.838(100) | 25.095(057) | 25.369(080) | 24.656(054)* | 25.462(068) | 25.050(070) |
| 6 | 26.088(169) | 25.212(066) | 26.338(201) | 24.954(077) | 25.648(163) | 25.131(082) | 26.051(167) | 25.065(056) |
| 7 | 26.023(090) | ... | 25.893(081) | ... | 25.523(080) | ... | 25.921(062) | ... |
| 8 | 26.097(153) | ... | 25.936(086) | ... | 25.365(065) | ... | 25.622(057) | ... |
| 9 | 25.629(104) | ... | 25.975(088) | ... | 25.449(073) | ... | 25.412(064) | ... |
| 10 | 25.778(064) | ... | 26.107(085) | ... | 25.481(131) | ... | 25.289(088) | ... |
| 11 | 25.914(073) | ... | 26.213(137) | ... | 25.661(105) | ... | 25.387(063) | ... |
| 12 | 25.744(086) | ... | 26.024(090) | ... | 26.019(126) | ... | 25.696(046) | ... |
| 13 | 25.934(097) | 25.171(091) | 26.114(091) | 25.150(071) | 25.579(068) | 24.957(072)* | 25.360(073) | 24.833(076) |
| 14 | 25.675(066) | 25.023(062) | 25.974(070) | 25.208(087) | 25.777(124) | 25.174(092) | 25.584(068) | 25.082(045) |
| 15 | 25.715(087) | ... | 26.194(101) | ... | 25.624(075) | ... | 25.431(094) | ... |
| 16 | 25.472(092) | ... | 26.101(133) | ... | 25.639(145) | ... | 25.488(058) | ... |
| 17 | 25.605(087) | ... | 26.255(129) | ... | 25.471(054) | ... | 25.554(077) | ... |
| 18 | 25.402(075) | ... | 26.384(075) | ... | 25.869(096) | ... | 25.646(036) | ... |
| 19 | 25.511(098) | 24.930(085) | 26.523(183) | 25.694(106) | 25.871(076) | 25.020(063)* | 25.676(111) | 24.833(075) |

However we note that our determination of $H_0$ in Riess et al. (2009) is insensitive to the value of the optical zeropoints and aperture corrections since we will make use of *the difference* in the photometry of Cepheids in NGC 4258 and the SN hosts.

The impact of blending and crowding on Cepheid magnitudes in optical *HST* data has been addressed through Monte Carlo "artificial star" experiments. Ferrarese et al. (2000) have shown that the impact of crowding on the measured magnitudes is largely eliminated by application of the previously described selection criteria, whose effect is to reject Cepheids that are significantly contaminated by a close companion. The presence of significant contamination will alter the shape parameters of the Cepheid light curves, reducing the amplitude of variation and flattening the "sawtooth" near minimum light (by contributing a greater fraction to the total flux when the Cepheid is faint). Alternatively, a partial blend will result in a poor PSF fit and a large reported uncertainty, rendering the apparent variability less significant, and also causing a Cepheid candidate to fail one or more of the previous criteria. Ferrarese et al. (2000) found that for multi-epoch data, the net crowding bias on the distance modulus is only $\sim$1%. Riess et al. (2005) similarly found that candidates in "crowded" environments (defined here as having an additional source within at least $0.1''$ which contributes at least $\sim$10% of the peak flux of the variable candidate) usually failed one or more of the previously discussed selection criteria.

The *net* effect of even modest crowding and blending on the distance scale is further reduced by the use NGC 4258 (instead of the LMC or the Galaxy) as an anchor of the distance scale. As shown in Riess et al. (2009), the effect of crowding is reduced to the *difference* in crowding between the SN hosts and NGC 4258, which is negligible as determined from artificial-star tests.

### 2.2. Cepheids in NGC 3021, NGC 1309, and NGC 3370

Here we present the first identification of Cepheids in NGC 1309 and NGC 3021. Each host yielded a sufficient number of Cepheids to provide a mean distance precision which is greater than the SN it hosts.

For NGC 1309 we identified 79 Cepheids, all with $P > 20$ d, providing one of the largest sets of extragalactic Cepheids observed by *HST*. NGC 3021, a third the size of NGC 1309, not surprisingly yielded fewer Cepheids, a total of 31 with 27 at $P > 20$ d. Their light curves are shown in Figures 3 and 4, and the parameters of the Cepheids are given in Tables 7 and 8. The $P$-$L$ relations in $V$ and $I$ are shown in Figures 5 and 6.

Cepheid samples in a magnitude-limited survey may suffer selection bias at the short-period end due to the loss of Cepheids faint for their period (e.g., Ferrarese et al. 2006, Leonard et al. 2003). Such Cepheids may fall below the detection limit or their light curves may be dominated by blending, reducing the significance of their variability. Riess et al. (2005) found this bias to apply for those Cepheids with $P < 20$ d for NGC 3370. This limit applies to NGC 3021 which has similar Cepheid magnitudes at a given period as NGC 3370. As seen in Figure 6, the few Cepheids found

Table 6—Continued

| # | F555W | F814W | F555W | F814W | F555W | F814W | F555W | F814W |
|---|---|---|---|---|---|---|---|---|
| 20 | 25.543(078) | 24.876(065) | 26.491(085) | 25.574(085) | 26.095(257) | 25.557(125) | 25.602(055) | 24.981(046) |
| 21 | 25.571(101) | ... | 26.470(122) | ... | 25.810(155) | ... | 25.646(138) | ... |
| 22 | 25.491(076) | ... | 26.485(100) | ... | 26.062(107) | ... | 25.827(056) | ... |
| 23 | 25.553(086) | 24.847(100) | 26.125(124) | 25.331(107) | 25.678(093) | 25.075(068)* | 26.100(104) | 25.137(105) |
| 24 | 25.706(119) | 25.114(089) | 26.098(080) | 25.438(070) | 25.662(098) | 25.485(124) | 25.910(052) | 25.096(087) |
| 25 | 25.856(102) | ... | 25.527(075) | ... | 25.527(134) | ... | 25.881(122) | ... |
| 26 | 25.720(078) | ... | 25.770(106) | ... | 25.206(087) | ... | 25.851(127) | ... |
| | **19777$P$ = 82.39 d** | | **65015$P$ = 89.04 d** | | **04908$P$ = 97.90 d** | | | |
| 1 | 25.481(131) | 24.927(089) | 26.073(154) | 25.109(127) | 25.906(107) | 25.072(087) | | |
| 2 | 25.819(132) | 25.129(077) | 26.073(168) | 25.202(102) | 25.829(089) | 25.004(057) | | |
| 3 | 25.579(120) | ... | 25.928(163) | ... | 25.911(229) | ... | | |
| 4 | 25.907(103) | ... | 25.985(180) | ... | 25.872(108) | ... | | |
| 5 | 25.992(132) | 25.115(110) | 26.405(145) | 25.417(123) | 25.930(102) | 24.917(090) | | |
| 6 | 26.193(190) | 25.195(098) | 26.263(160) | 25.247(130) | 26.011(146) | 24.911(062) | | |
| 7 | 26.044(133) | ... | 26.390(158) | ... | 25.761(091) | ... | | |
| 8 | 25.703(124) | ... | 26.113(120) | ... | 25.502(068) | ... | | |
| 9 | 25.887(174) | ... | 26.478(218) | ... | 25.402(101) | ... | | |
| 10 | 25.906(139) | ... | 26.609(198) | ... | 25.400(071) | ... | | |
| 11 | 25.788(108) | ... | 26.684(290) | ... | 25.558(079) | ... | | |
| 12 | 26.122(114) | ... | ... | ... | 25.493(077) | ... | | |
| 13 | 25.939(175) | 25.176(105) | 26.194(242) | 25.843(167)* | 25.498(059) | 24.723(079) | | |
| 14 | 25.663(119) | 25.185(081) | 26.465(170) | 25.497(171) | 25.423(081) | 24.791(062) | | |
| 15 | 25.714(133) | ... | ... | ... | 25.393(062) | ... | | |
| 16 | 25.574(075) | ... | 26.515(195) | ... | 25.390(076) | ... | | |
| 17 | 25.503(127) | ... | 26.209(142) | ... | 25.465(080) | ... | | |
| 18 | 25.726(113) | ... | 25.980(130) | ... | 25.435(052) | ... | | |
| 19 | 25.525(111) | 24.754(079) | 25.897(099) | 25.255(142) | 25.254(072) | 24.612(056) | | |
| 20 | 25.470(086) | 24.950(071) | 25.814(168) | 25.018(087) | 25.378(071) | 24.729(067) | | |
| 21 | 25.324(076) | ... | 25.975(163) | ... | 25.338(076) | ... | | |
| 22 | 25.443(071) | ... | 25.810(096) | ... | 25.364(054) | ... | | |
| 23 | 25.401(119) | 24.731(077) | 25.741(137) | 25.022(162) | 25.446(077) | 24.522(074)* | | |
| 24 | 25.300(084) | 24.996(069) | 25.753(109) | 25.040(122) | 25.374(072) | 24.710(067) | | |
| 25 | 25.869(165) | ... | 25.799(190) | ... | 25.160(097) | ... | | |
| 26 | 25.793(142) | ... | 26.162(177) | ... | 25.454(066) | ... | | |

* Data point rejected in light curve fit

[a] $1\sigma$ uncertainties (units of 0.001 mag) are given in parentheses.

with $P < 20$ d tend to be brighter than expected, though no such bias appears for the Wesenheit reddening-free magnitudes (defined in §3; see Madore 1982 and Figure 8). For NGC 1309, whose Cepheids indicate a greater distance than NGC 3370 or NGC 3021, the periods with apparent bias rises to $P < 38$ d (see Fig. 5). Again, the Wesenheit magnitudes do not show this bias at shorter periods (see Figure 8). In both cases this would imply that the Cepheids with periods shorter than the bias limit suffer a modest amount of blending from bluer sources which is largely removed by the color correction. While the Wesenheit magnitudes appear useful at lower periods, it is safer to restrict the use of Cepheids to those with periods greater than the range where their selection appears biased in the individual passbands.

Our additional imaging of NGC 3370 in Cycle 15 allowed us to identify new Cepheids with periods in excess of the original 60 day campaign as well as a few more at shorter periods. For NGC 3370, we have detected 127 Cepheids of which 110 have $P > 20$ d, nearly double the sample found by Riess et al. (2005) and reducing the mean wesenheit magnitudes by 0.035 mag. These are shown in Figure 7 and their parameters are given in Table 9 (where $L_V$ is the $V$-band variability index).

Table 7. Cepheid Candidates in NGC 3021

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 31556 | 147.72782 | 33.55528 | 11.17 | 27.418(0.243) | 27.052(0.072) | 0.600 | 0.322 | 0.804 | 54071.48 |
| 30672 | 147.72778 | 33.54702 | 13.92 | 27.489(0.224) | 26.996(0.137) | 0.618 | 0.429 | 1.187 | 54082.60 |
| 8621. | 147.74838 | 33.55002 | 15.37 | 27.225(0.209) | 26.479(0.111) | 0.470 | 0.206 | 0.908 | 54083.98 |
| 8102. | 147.74935 | 33.55170 | 18.71 | 27.391(0.251) | 26.760(0.121) | 0.536 | 0.270 | 0.991 | 54077.91 |
| 20774 | 147.73750 | 33.55041 | 20.38 | 26.770(0.144) | 26.179(0.174) | 0.447 | 0.268 | 1.313 | 54077.16 |
| 10786 | 147.74693 | 33.55663 | 21.16 | 27.242(0.176) | 26.349(0.152) | 0.465 | 0.243 | 1.256 | 54081.52 |
| 47390 | 147.73410 | 33.55873 | 21.84 | 27.186(0.165) | 26.373(0.151) | 0.455 | 0.212 | 1.300 | 54080.90 |
| 33607 | 147.72083 | 33.55514 | 23.13 | 27.328(0.160) | 26.626(0.050) | 0.450 | 0.268 | 1.532 | 54084.59 |
| 32375 | 147.72586 | 33.55581 | 24.01 | 27.280(0.210) | 26.461(0.148) | 0.552 | 0.301 | 1.530 | 54092.85 |
| 8636. | 147.74871 | 33.55237 | 24.36 | 26.848(0.085) | 26.116(0.102) | 0.451 | 0.288 | 1.588 | 54083.61 |
| 32380 | 147.72645 | 33.56000 | 25.18 | 26.769(0.095) | 26.040(0.134) | 0.560 | 0.346 | 2.752 | 54096.04 |
| 32088 | 147.72678 | 33.55614 | 25.77 | 27.199(0.228) | 26.220(0.103) | 0.552 | 0.245 | 1.733 | 54080.94 |
| 26946 | 147.73211 | 33.54878 | 26.84 | 26.816(0.152) | 25.974(0.149) | 0.587 | 0.170 | 2.380 | 54102.95 |
| 9028. | 147.74791 | 33.55032 | 31.89 | 26.356(0.095) | 25.642(0.071) | 0.516 | 0.277 | 3.677 | 54099.86 |
| 23149 | 147.73688 | 33.55930 | 32.53 | 26.633(0.108) | 25.713(0.157) | 0.555 | 0.367 | 2.523 | 54104.49 |
| 30428 | 147.72812 | 33.54750 | 32.60 | 26.636(0.123) | 25.849(0.088) | 0.576 | 0.244 | 3.384 | 54097.22 |
| 26126 | 147.73336 | 33.55230 | 34.87 | 26.319(0.111) | 25.721(0.150) | 0.328 | 0.176 | 1.092 | 54086.75 |
| 12135 | 147.74553 | 33.55600 | 36.50 | 26.743(0.146) | 25.721(0.127) | 0.426 | 0.303 | 1.492 | 54092.92 |
| 31803 | 147.72789 | 33.55893 | 37.27 | 27.039(0.114) | 26.152(0.156) | 0.486 | 0.353 | 1.601 | 54088.95 |
| 45787 | 147.73632 | 33.55657 | 37.31 | 26.023(0.122) | 25.330(0.059) | 0.282 | 0.125 | 0.709 | 54095.88 |
| 26545 | 147.73249 | 33.54885 | 39.57 | 26.327(0.139) | 25.461(0.140) | 0.590 | 0.323 | 3.045 | 54089.38 |
| 9402. | 147.74757 | 33.55109 | 39.78 | 26.885(0.162) | 25.729(0.104) | 0.623 | 0.317 | 1.558 | 54100.07 |
| 25375 | 147.73388 | 33.55151 | 39.95 | 26.359(0.150) | 25.850(0.118) | 0.614 | 0.560 | 3.372 | 54083.58 |
| 9611. | 147.74740 | 33.55142 | 40.49 | 26.295(0.117) | 25.663(0.101) | 0.400 | 0.396 | 0.963 | 54106.75 |
| 20415 | 147.73892 | 33.55806 | 51.51 | 26.551(0.163) | 25.467(0.124) | 0.476 | 0.220 | 1.712 | 54088.40 |
| 12778 | 147.74489 | 33.55619 | 63.19 | 25.613(0.070) | 25.097(0.095) | 0.278 | 0.198 | 1.265 | 54113.26 |
| 19817 | 147.73982 | 33.56093 | 68.61 | 26.322(0.089) | 25.253(0.057) | 0.370 | 0.259 | 2.211 | 54146.16 |
| 7098. | 147.75116 | 33.55414 | 82.66 | 25.913(0.129) | 25.182(0.138) | 0.344 | 0.186 | 1.127 | 54131.46 |
| 9558. | 147.74734 | 33.55075 | 88.18 | 26.884(0.152) | 25.435(0.085) | 0.435 | 0.262 | 0.932 | 54164.64 |
| 12013 | 147.74545 | 33.55484 | 90.73 | 25.735(0.065) | 24.819(0.094) | 0.237 | 0.119 | 0.757 | 54172.44 |
| 10203 | 147.74683 | 33.55170 | 95.91 | 25.756(0.063) | 24.909(0.049) | 0.170 | 0.020 | 0.908 | 54135.11 |

Table 8. Cepheid Candidates in NGC 1309

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 21599 | 50.52930 | -15.41687 | 20.93 | 27.434(0.201) | 26.744(0.187) | 0.555 | 0.162 | 1.631 | 54053.33 |
| 9778. | 50.53294 | -15.38609 | 21.98 | 27.453(0.199) | 26.869(0.194) | 0.513 | 0.279 | 1.159 | 54057.75 |
| 8610. | 50.53423 | -15.39811 | 23.22 | 27.310(0.182) | 26.615(0.091) | 0.541 | 0.219 | 1.031 | 54064.55 |
| 6631. | 50.53610 | -15.41348 | 24.81 | 26.988(0.150) | 26.405(0.070) | 0.498 | 0.267 | 1.304 | 54060.05 |
| 6737. | 50.53598 | -15.41296 | 25.45 | 27.336(0.217) | 26.628(0.152) | 0.541 | 0.279 | 1.291 | 54060.20 |
| 34523 | 50.52358 | -15.40722 | 25.52 | 27.211(0.198) | 26.476(0.110) | 0.521 | 0.210 | 1.266 | 54061.51 |
| 44606 | 50.51955 | -15.40855 | 25.84 | 27.082(0.228) | 26.699(0.228) | 0.563 | 0.242 | 2.614 | 54059.06 |
| 48719 | 50.51726 | -15.40686 | 26.70 | 27.142(0.167) | 26.370(0.098) | 0.516 | 0.142 | 1.036 | 54045.30 |
| 55736 | 50.50417 | -15.38446 | 27.18 | 27.440(0.125) | 26.670(0.101) | 0.419 | 0.300 | 1.534 | 54069.83 |
| 54039 | 50.50975 | -15.38449 | 27.64 | 27.223(0.235) | 26.415(0.069) | 0.545 | 0.353 | 1.301 | 54057.11 |
| 41542 | 50.52035 | -15.39916 | 27.71 | 27.075(0.141) | 26.293(0.103) | 0.463 | 0.222 | 1.187 | 54051.06 |
| 12340 | 50.53212 | -15.39489 | 27.84 | 26.987(0.165) | 26.575(0.137) | 0.445 | 0.378 | 1.169 | 54063.03 |
| 52644 | 50.51172 | -15.37853 | 29.17 | 26.875(0.136) | 26.244(0.098) | 0.574 | 0.338 | 2.819 | 54064.19 |
| 2343. | 50.54025 | -15.40458 | 29.61 | 27.084(0.182) | 26.489(0.221) | 0.602 | 0.402 | 1.923 | 54068.76 |
| 23076 | 50.52816 | -15.40843 | 30.66 | 27.288(0.261) | 26.467(0.104) | 0.496 | 0.239 | 1.192 | 54061.02 |
| 85974 | 50.51896 | -15.40298 | 30.86 | 26.900(0.155) | 26.396(0.104) | 0.521 | 0.301 | 1.776 | 54047.85 |
| 7224. | 50.53585 | -15.41538 | 30.90 | 27.390(0.257) | 26.555(0.092) | 0.683 | 0.268 | 2.330 | 54050.49 |
| 7255. | 50.53427 | -15.38705 | 31.15 | 27.265(0.159) | 26.531(0.064) | 0.452 | 0.265 | 1.162 | 54045.49 |
| 50024 | 50.51566 | -15.39516 | 31.69 | 27.299(0.214) | 26.290(0.124) | 0.512 | 0.302 | 1.724 | 54048.75 |
| 59151 | 50.53574 | -15.41413 | 32.61 | 26.772(0.174) | 26.180(0.082) | 0.445 | 0.241 | 1.602 | 54065.95 |
| 60583 | 50.53360 | -15.39877 | 32.95 | 27.064(0.296) | 26.136(0.094) | 0.684 | 0.423 | 1.746 | 54054.39 |
| 4322. | 50.53615 | -15.38579 | 33.25 | 26.793(0.132) | 26.208(0.068) | 0.612 | 0.327 | 2.840 | 54067.55 |
| 30349 | 50.52525 | -15.40856 | 33.51 | 27.043(0.212) | 26.430(0.136) | 0.528 | 0.236 | 0.899 | 54066.02 |
| 3108. | 50.53807 | -15.38939 | 33.71 | 26.989(0.180) | 26.245(0.149) | 0.472 | 0.238 | 1.974 | 54067.12 |
| 9099. | 50.53391 | -15.39736 | 33.74 | 27.050(0.186) | 26.379(0.116) | 0.458 | 0.135 | 0.698 | 54057.49 |
| 30771 | 50.52352 | -15.38006 | 33.74 | 27.297(0.228) | 26.524(0.124) | 0.530 | 0.266 | 1.816 | 54069.89 |
| 14063 | 50.53191 | -15.40485 | 34.07 | 26.754(0.188) | 26.033(0.151) | 0.519 | 0.334 | 1.382 | 54068.80 |
| 59846 | 50.53441 | -15.40029 | 35.12 | 26.831(0.157) | 26.052(0.173) | 0.475 | 0.144 | 1.036 | 54065.28 |
| 31655 | 50.52487 | -15.41096 | 35.82 | 26.606(0.123) | 25.976(0.077) | 0.297 | 0.132 | 1.204 | 54049.49 |
| 7868. | 50.53405 | -15.38828 | 36.17 | 27.244(0.184) | 26.456(0.080) | 0.472 | 0.270 | 1.354 | 54069.11 |
| 69637 | 50.52730 | -15.39672 | 37.23 | 26.591(0.260) | 25.841(0.085) | 0.532 | 0.175 | 1.073 | 54074.11 |
| 41024 | 50.52078 | -15.40182 | 38.62 | 26.958(0.216) | 26.440(0.171) | 0.525 | 0.352 | 1.006 | 54043.19 |
| 34163 | 50.52292 | -15.39251 | 39.34 | 26.687(0.183) | 25.985(0.090) | 0.423 | 0.282 | 1.016 | 54079.33 |
| 7989. | 50.53524 | -15.41099 | 39.42 | 27.391(0.166) | 26.482(0.149) | 0.410 | 0.304 | 0.784 | 54055.14 |
| 44069 | 50.51958 | -15.40478 | 39.90 | 26.868(0.213) | 26.258(0.117) | 0.487 | 0.367 | 1.629 | 54072.88 |
| 27980 | 50.52622 | -15.41000 | 39.92 | 27.127(0.253) | 26.059(0.043) | 0.815 | 0.238 | 1.739 | 54050.36 |
| 52975 | 50.51305 | -15.41224 | 40.52 | 27.301(0.155) | 26.533(0.217) | 0.510 | 0.355 | 1.691 | 54067.73 |
| 7994. | 50.53392 | -15.38694 | 40.69 | 26.936(0.169) | 26.038(0.078) | 0.602 | 0.371 | 1.340 | 54059.04 |
| 1166. | 50.54164 | -15.39645 | 41.11 | 27.386(0.175) | 26.279(0.062) | 0.514 | 0.270 | 1.478 | 54076.96 |
| 76534 | 50.52410 | -15.40276 | 41.86 | 26.645(0.162) | 26.005(0.132) | 0.490 | 0.315 | 0.853 | 54073.82 |
| 22918 | 50.52824 | -15.40865 | 42.03 | 26.707(0.193) | 25.889(0.096) | 0.595 | 0.262 | 1.397 | 54071.01 |
| 2032. | 50.54017 | -15.39411 | 42.53 | 26.497(0.183) | 25.768(0.056) | 0.624 | 0.246 | 2.908 | 54053.85 |
| 48747 | 50.51610 | -15.38609 | 42.68 | 27.234(0.182) | 26.373(0.111) | 0.566 | 0.356 | 1.002 | 54079.41 |
| 67393 | 50.52880 | -15.39772 | 42.74 | 26.533(0.131) | 25.685(0.061) | 0.443 | 0.162 | 1.433 | 54068.90 |
| 58298 | 50.53507 | -15.38553 | 43.52 | 26.694(0.111) | 25.922(0.095) | 0.521 | 0.341 | 1.704 | 54083.59 |

Table 8—Continued

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 7331. | 50.53498 | -15.40072 | 44.58 | 26.382(0.145) | 25.850(0.092) | 0.377 | 0.195 | 1.042 | 54080.80 |
| 2979. | 50.53940 | -15.40977 | 44.90 | 26.467(0.123) | 25.737(0.073) | 0.503 | 0.320 | 3.097 | 54076.82 |
| 1732. | 50.54059 | -15.39462 | 45.00 | 26.252(0.094) | 25.525(0.096) | 0.261 | 0.170 | 1.854 | 54082.39 |
| 19368 | 50.52978 | -15.40833 | 45.25 | 26.566(0.158) | 25.759(0.117) | 0.442 | 0.238 | 1.308 | 54065.50 |
| 49584 | 50.51619 | -15.39832 | 45.67 | 26.838(0.143) | 26.046(0.107) | 0.409 | 0.322 | 1.434 | 54082.05 |
| 16143 | 50.53022 | -15.39054 | 46.74 | 27.014(0.173) | 26.015(0.090) | 0.476 | 0.296 | 1.459 | 54058.63 |
| 15346 | 50.53148 | -15.40689 | 46.85 | 26.746(0.147) | 25.925(0.081) | 0.409 | 0.091 | 0.722 | 54068.16 |
| 54502 | 50.50920 | -15.39192 | 47.13 | 26.996(0.205) | 26.100(0.080) | 0.666 | 0.332 | 1.593 | 54075.84 |
| 59642 | 50.53436 | -15.39644 | 47.39 | 26.428(0.155) | 25.925(0.071) | 0.379 | 0.311 | 1.889 | 54059.19 |
| 52566 | 50.51322 | -15.40390 | 47.41 | 26.641(0.105) | 26.095(0.092) | 0.425 | 0.331 | 1.436 | 54088.98 |
| 52170 | 50.51350 | -15.39881 | 47.99 | 26.915(0.134) | 25.940(0.024) | 0.520 | 0.235 | 2.161 | 54058.99 |
| 4882. | 50.53701 | -15.41209 | 48.91 | 26.808(0.158) | 26.046(0.087) | 0.576 | 0.246 | 1.970 | 54084.46 |
| 68817 | 50.52830 | -15.40526 | 49.93 | 26.578(0.160) | 26.036(0.081) | 0.406 | 0.190 | 1.546 | 54086.75 |
| 15318 | 50.53038 | -15.38675 | 51.46 | 26.562(0.088) | 25.781(0.124) | 0.615 | 0.354 | 2.909 | 54055.96 |
| 71911 | 50.52661 | -15.40578 | 51.99 | 26.207(0.098) | 25.447(0.057) | 0.287 | 0.169 | 1.137 | 54059.51 |
| 28132 | 50.52604 | -15.40768 | 52.24 | 26.820(0.129) | 25.815(0.068) | 0.405 | 0.073 | 0.883 | 54084.04 |
| 6581. | 50.53598 | -15.41154 | 58.98 | 26.810(0.262) | 26.005(0.177) | 0.637 | 0.254 | 1.363 | 54073.09 |
| 25965 | 50.52610 | -15.39321 | 59.02 | 26.562(0.148) | 25.964(0.071) | 0.371 | 0.265 | 0.757 | 54100.04 |
| 6542. | 50.53606 | -15.41233 | 59.12 | 26.575(0.093) | 25.663(0.020) | 0.311 | 0.220 | 1.889 | 54096.28 |
| 53187 | 50.51202 | -15.39909 | 59.75 | 26.757(0.119) | 26.179(0.098) | 0.300 | 0.191 | 1.006 | 54113.61 |
| 69494 | 50.52808 | -15.40923 | 60.17 | 27.077(0.173) | 26.150(0.087) | 0.619 | 0.250 | 1.337 | 54069.54 |
| 2647. | 50.53992 | -15.40867 | 60.67 | 26.278(0.127) | 25.452(0.097) | 0.553 | 0.305 | 3.064 | 54115.54 |
| 17049 | 50.53025 | -15.39867 | 61.24 | 26.272(0.154) | 25.415(0.137) | 0.363 | 0.189 | 0.959 | 54082.07 |
| 19918 | 50.52958 | -15.40892 | 64.94 | 26.241(0.086) | 25.425(0.093) | 0.351 | 0.189 | 2.152 | 54082.93 |
| 64757 | 50.53107 | -15.40794 | 65.03 | 26.796(0.138) | 25.710(0.041) | 0.345 | 0.156 | 0.934 | 54107.87 |
| 13102 | 50.53150 | -15.38948 | 66.34 | 26.331(0.115) | 25.506(0.076) | 0.539 | 0.243 | 2.231 | 54113.61 |
| 45088 | 50.51857 | -15.39463 | 71.40 | 26.699(0.197) | 25.912(0.156) | 0.662 | 0.607 | 2.057 | 54128.10 |
| 3836. | 50.53789 | -15.40643 | 73.27 | 26.390(0.128) | 25.504(0.120) | 0.401 | 0.195 | 1.401 | 54066.32 |
| 7702. | 50.53554 | -15.41410 | 73.76 | 26.473(0.110) | 25.596(0.089) | 0.615 | 0.342 | 1.718 | 54094.45 |
| 49485 | 50.51648 | -15.40236 | 74.19 | 26.071(0.155) | 25.670(0.045) | 0.451 | 0.267 | 1.158 | 54099.77 |
| 23616 | 50.52841 | -15.41752 | 82.13 | 26.481(0.178) | 25.579(0.091) | 0.450 | 0.242 | 1.307 | 54107.33 |
| 19777 | 50.52881 | -15.39393 | 82.38 | 26.246(0.135) | 25.437(0.105) | 0.325 | 0.193 | 1.002 | 54128.08 |
| 65015 | 50.53048 | -15.40066 | 89.03 | 26.625(0.137) | 25.576(0.087) | 0.343 | 0.238 | 1.220 | 54084.36 |
| 4908. | 50.53644 | -15.40175 | 97.89 | 26.201(0.098) | 25.247(0.069) | 0.309 | 0.210 | 1.559 | 54115.33 |

Table 9. Cepheid Candidates in NGC 3370

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 88045 | 161.77365 | 17.27522 | 14.45 | 27.620(0.262) | 26.950(0.179) | 0.526 | 0.228 | 1.523 | 54087.72 |
| 35527 | 161.76834 | 17.26353 | 15.09 | 27.634(0.188) | 26.544(0.134) | 0.450 | 0.493 | 1.255 | 54074.51 |
| 8849. | 161.75805 | 17.27787 | 15.39 | 27.414(0.215) | 26.445(0.074) | 0.615 | 0.318 | 1.662 | 54085.07 |
| 52153 | 161.78670 | 17.27016 | 15.77 | 27.495(0.188) | 26.804(0.142) | 0.557 | 0.293 | 1.502 | 54088.84 |
| 2204. | 161.75537 | 17.28996 | 16.22 | 27.626(0.135) | 26.723(0.118) | 0.479 | 0.273 | 1.749 | 54071.32 |
| 24497 | 161.76928 | 17.28204 | 16.78 | 27.609(0.256) | 26.737(0.175) | 0.556 | 0.438 | 1.757 | 54084.18 |
| 4668. | 161.75797 | 17.28751 | 17.26 | 27.494(0.251) | 26.660(0.110) | 0.563 | 0.277 | 1.310 | 54081.86 |
| 78990 | 161.76383 | 17.26409 | 17.37 | 27.381(0.182) | 26.474(0.217) | 0.498 | 0.297 | 1.892 | 54077.47 |
| 2638. | 161.75400 | 17.28417 | 17.46 | 27.290(0.179) | 26.530(0.042) | 0.586 | 0.459 | 2.549 | 54081.90 |
| 37156 | 161.76811 | 17.26012 | 17.84 | 27.603(0.138) | 26.792(0.165) | 0.551 | 0.313 | 2.003 | 54086.86 |
| 9842. | 161.75587 | 17.26928 | 18.39 | 27.747(0.321) | 27.056(0.180) | 0.593 | 0.224 | 1.623 | 54075.80 |
| 11908 | 161.76236 | 17.28264 | 18.76 | 27.238(0.173) | 26.209(0.150) | 0.400 | 0.126 | 1.463 | 54088.84 |
| 8367. | 161.75989 | 17.28410 | 18.88 | 27.693(0.250) | 26.772(0.249) | 0.607 | 0.282 | 1.741 | 54078.46 |
| 44450 | 161.77260 | 17.25851 | 19.10 | 27.693(0.248) | 26.843(0.130) | 0.556 | 0.350 | 1.411 | 54078.88 |
| 5394. | 161.75420 | 17.27504 | 19.21 | 27.432(0.181) | 26.475(0.168) | 0.544 | 0.272 | 2.211 | 54080.20 |
| 21444 | 161.76766 | 17.28206 | 19.64 | 27.452(0.222) | 26.525(0.114) | 0.477 | 0.271 | 1.670 | 54090.17 |
| 52086 | 161.78246 | 17.25879 | 19.91 | 27.201(0.122) | 26.347(0.053) | 0.500 | 0.418 | 2.413 | 54089.91 |
| 45559 | 161.78086 | 17.27835 | 20.21 | 27.272(0.172) | 26.524(0.119) | 0.567 | 0.414 | 2.188 | 54076.41 |
| 45280 | 161.77907 | 17.27414 | 20.27 | 27.603(0.215) | 26.766(0.225) | 0.570 | 0.259 | 0.854 | 54077.95 |
| 51454 | 161.78510 | 17.26936 | 20.51 | 27.328(0.166) | 26.400(0.062) | 0.434 | 0.176 | 1.151 | 54083.93 |
| 50670 | 161.77931 | 17.25660 | 20.52 | 27.237(0.131) | 26.399(0.140) | 0.479 | 0.241 | 2.157 | 54079.69 |
| 26546 | 161.76597 | 17.26987 | 21.57 | 27.028(0.206) | 26.160(0.054) | 0.472 | 0.068 | 1.625 | 54080.85 |
| 11992 | 161.75778 | 17.26972 | 21.78 | 27.509(0.192) | 26.547(0.082) | 0.587 | 0.319 | 1.590 | 54093.66 |
| 10540 | 161.76365 | 17.28919 | 21.79 | 27.442(0.243) | 26.607(0.153) | 0.578 | 0.245 | 1.771 | 54092.36 |
| 51357 | 161.78000 | 17.25566 | 23.43 | 27.198(0.144) | 26.349(0.088) | 0.517 | 0.349 | 2.023 | 54092.68 |
| 871.0 | 161.75495 | 17.29607 | 23.66 | 27.329(0.165) | 26.322(0.130) | 0.543 | 0.281 | 2.276 | 54091.36 |
| 8807. | 161.75882 | 17.28007 | 23.72 | 27.484(0.158) | 26.425(0.129) | 0.524 | 0.175 | 1.537 | 54085.34 |
| 47494 | 161.77627 | 17.25957 | 24.43 | 27.215(0.195) | 25.988(0.101) | 0.532 | 0.217 | 2.100 | 54073.89 |
| 23575 | 161.76105 | 17.26054 | 24.46 | 27.310(0.123) | 26.353(0.108) | 0.448 | 0.273 | 1.512 | 54099.40 |
| 47059 | 161.77441 | 17.25595 | 24.49 | 27.332(0.190) | 26.402(0.090) | 0.589 | 0.436 | 1.913 | 54098.58 |
| 53228 | 161.78689 | 17.25998 | 24.73 | 27.490(0.198) | 26.634(0.141) | 0.487 | 0.289 | 1.719 | 54085.77 |
| 61720 | 161.75875 | 17.28389 | 25.43 | 26.630(0.137) | 25.724(0.114) | 0.429 | 0.236 | 1.991 | 54082.44 |
| 21354 | 161.76299 | 17.26917 | 25.59 | 27.131(0.220) | 26.459(0.105) | 0.380 | 0.271 | 1.186 | 54097.74 |
| 23818 | 161.76845 | 17.28078 | 26.33 | 27.098(0.230) | 26.043(0.109) | 0.486 | 0.230 | 1.355 | 54095.29 |
| 22838 | 161.76132 | 17.26232 | 26.38 | 27.246(0.157) | 26.248(0.193) | 0.476 | 0.256 | 1.916 | 54085.26 |
| 81239 | 161.77044 | 17.27853 | 26.42 | 27.013(0.192) | 26.342(0.134) | 0.551 | 0.430 | 1.258 | 54082.13 |
| 39583 | 161.77518 | 17.27540 | 26.87 | 26.958(0.213) | 26.006(0.185) | 0.552 | 0.157 | 1.950 | 54086.41 |
| 18872 | 161.76209 | 17.27022 | 27.02 | 27.024(0.160) | 26.347(0.118) | 0.583 | 0.480 | 2.014 | 54076.36 |
| 22029 | 161.76515 | 17.27416 | 27.32 | 26.772(0.221) | 25.836(0.149) | 0.422 | 0.036 | 1.325 | 54084.89 |
| 48470 | 161.78219 | 17.27266 | 27.35 | 27.344(0.201) | 26.261(0.193) | 0.518 | 0.259 | 1.982 | 54079.93 |
| 5744. | 161.75647 | 17.28052 | 27.74 | 27.299(0.131) | 26.232(0.106) | 0.755 | 0.352 | 2.625 | 54090.86 |
| 51334 | 161.78015 | 17.25611 | 28.79 | 27.496(0.266) | 26.509(0.088) | 0.669 | 0.476 | 2.088 | 54100.09 |
| 49159 | 161.77565 | 17.25210 | 29.07 | 26.890(0.183) | 26.049(0.116) | 0.512 | 0.366 | 2.097 | 54107.61 |
| 4531. | 161.75831 | 17.28893 | 29.23 | 27.124(0.162) | 26.124(0.128) | 0.581 | 0.276 | 1.516 | 54092.40 |
| 62219 | 161.75791 | 17.28025 | 29.43 | 27.323(0.242) | 26.218(0.172) | 0.785 | 0.434 | 2.143 | 54088.70 |

Table 9—Continued

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 46992 | 161.77485 | 17.25741 | 29.60 | 27.119(0.218) | 26.168(0.075) | 0.627 | 0.278 | 2.739 | 54101.12 |
| 4032. | 161.76154 | 17.29942 | 29.78 | 26.756(0.114) | 25.898(0.118) | 0.547 | 0.249 | 3.155 | 54095.81 |
| 51430 | 161.78069 | 17.25719 | 30.43 | 27.408(0.207) | 26.352(0.126) | 0.518 | 0.244 | 1.715 | 54101.23 |
| 27556 | 161.77156 | 17.28401 | 30.69 | 27.202(0.140) | 26.227(0.126) | 0.421 | 0.230 | 1.872 | 54094.43 |
| 19943 | 161.76245 | 17.26963 | 30.80 | 26.582(0.088) | 25.845(0.084) | 0.343 | 0.206 | 1.649 | 54083.47 |
| 35299 | 161.77125 | 17.27173 | 31.20 | 26.483(0.162) | 25.569(0.109) | 0.371 | 0.218 | 0.759 | 54100.86 |
| 13380 | 161.76194 | 17.27869 | 31.74 | 26.477(0.126) | 25.603(0.102) | 0.261 | 0.162 | 0.810 | 54080.07 |
| 13249 | 161.76203 | 17.27921 | 31.78 | 27.010(0.195) | 26.180(0.141) | 0.440 | 0.274 | 1.494 | 54102.53 |
| 32684 | 161.77068 | 17.27447 | 32.04 | 26.620(0.138) | 25.511(0.113) | 0.460 | 0.272 | 1.661 | 54104.72 |
| 15081 | 161.76554 | 17.28584 | 32.56 | 27.510(0.166) | 26.281(0.076) | 0.423 | 0.343 | 1.419 | 54086.09 |
| 4710. | 161.75647 | 17.28320 | 32.62 | 27.231(0.150) | 26.150(0.108) | 0.470 | 0.207 | 1.513 | 54108.24 |
| 18200 | 161.76118 | 17.26863 | 32.87 | 27.001(0.150) | 25.894(0.104) | 0.463 | 0.305 | 2.597 | 54090.74 |
| 26416 | 161.76487 | 17.26700 | 33.40 | 27.044(0.178) | 25.851(0.084) | 0.495 | 0.182 | 1.799 | 54097.26 |
| 52428 | 161.78414 | 17.26088 | 33.48 | 26.998(0.131) | 25.962(0.128) | 0.483 | 0.214 | 2.033 | 54098.93 |
| 31439 | 161.77252 | 17.28137 | 33.49 | 26.970(0.170) | 25.953(0.104) | 0.428 | 0.139 | 1.968 | 54092.83 |
| 17886 | 161.76336 | 17.27517 | 33.56 | 26.800(0.203) | 25.557(0.043) | 0.688 | 0.289 | 2.100 | 54101.75 |
| 49211 | 161.78007 | 17.26419 | 33.57 | 27.125(0.175) | 26.169(0.110) | 0.484 | 0.259 | 1.834 | 54104.43 |
| 52279 | 161.78547 | 17.26580 | 33.69 | 27.022(0.167) | 25.987(0.131) | 0.445 | 0.359 | 2.101 | 54094.93 |
| 33812 | 161.77245 | 17.27762 | 34.07 | 26.916(0.138) | 26.034(0.111) | 0.488 | 0.380 | 1.673 | 54105.37 |
| 4345. | 161.75620 | 17.28353 | 34.07 | 27.348(0.144) | 26.141(0.116) | 0.739 | 0.360 | 2.373 | 54089.34 |
| 17595 | 161.76259 | 17.27355 | 34.22 | 27.176(0.229) | 26.021(0.152) | 0.741 | 0.375 | 2.019 | 54095.37 |
| 1320. | 161.75212 | 17.28576 | 34.58 | 27.551(0.156) | 26.487(0.097) | 0.414 | 0.196 | 1.104 | 54084.23 |
| 17969 | 161.76144 | 17.26969 | 34.71 | 26.941(0.206) | 25.778(0.161) | 0.673 | 0.328 | 2.096 | 54108.94 |
| 10677 | 161.76072 | 17.28069 | 35.24 | 27.152(0.175) | 26.027(0.077) | 0.645 | 0.381 | 2.083 | 54090.46 |
| 40369 | 161.77544 | 17.27471 | 35.41 | 27.592(0.225) | 26.062(0.069) | 0.581 | 0.208 | 1.189 | 54098.72 |
| 19618 | 161.76333 | 17.27244 | 35.66 | 26.758(0.222) | 25.544(0.184) | 0.509 | 0.209 | 1.731 | 54109.86 |
| 22097 | 161.76764 | 17.28103 | 36.02 | 26.679(0.119) | 25.681(0.133) | 0.480 | 0.246 | 1.666 | 54093.05 |
| 50582 | 161.78077 | 17.26097 | 36.69 | 26.958(0.167) | 25.899(0.062) | 0.489 | 0.343 | 1.736 | 54105.54 |
| 59919 | 161.75710 | 17.28387 | 36.99 | 26.703(0.165) | 25.819(0.162) | 0.506 | 0.377 | 2.357 | 54108.29 |
| 45614 | 161.77520 | 17.26245 | 37.02 | 26.788(0.144) | 25.958(0.103) | 0.526 | 0.171 | 2.055 | 54090.95 |
| 21445 | 161.76923 | 17.28640 | 37.10 | 27.064(0.150) | 25.975(0.077) | 0.618 | 0.284 | 1.887 | 54090.02 |
| 16214 | 161.75886 | 17.26535 | 37.21 | 27.394(0.171) | 26.191(0.127) | 0.513 | 0.189 | 1.208 | 54110.28 |
| 30965 | 161.77252 | 17.28201 | 37.28 | 26.549(0.097) | 25.594(0.105) | 0.606 | 0.322 | 3.412 | 54094.59 |
| 20306 | 161.76295 | 17.27049 | 37.28 | 26.834(0.131) | 26.072(0.106) | 0.257 | 0.214 | 0.871 | 54082.04 |
| 21506 | 161.76844 | 17.28412 | 38.54 | 26.163(0.098) | 25.409(0.067) | 0.480 | 0.339 | 2.652 | 54103.44 |
| 31251 | 161.77276 | 17.28228 | 39.30 | 26.314(0.094) | 25.373(0.071) | 0.337 | 0.179 | 2.062 | 54118.69 |
| 47492 | 161.77587 | 17.25844 | 39.41 | 27.278(0.185) | 26.133(0.059) | 0.396 | 0.157 | 1.264 | 54084.59 |
| 7613. | 161.75941 | 17.28456 | 39.50 | 27.209(0.196) | 26.166(0.167) | 0.442 | 0.239 | 1.149 | 54120.64 |
| 18990 | 161.76910 | 17.28952 | 40.01 | 26.664(0.136) | 25.855(0.037) | 0.522 | 0.325 | 3.251 | 54097.25 |
| 13355 | 161.76178 | 17.27834 | 41.09 | 26.420(0.123) | 25.492(0.126) | 0.412 | 0.168 | 1.564 | 54116.06 |
| 20732 | 161.76774 | 17.28324 | 41.55 | 26.881(0.124) | 25.715(0.042) | 0.389 | 0.169 | 1.612 | 54099.06 |
| 29982 | 161.76730 | 17.26882 | 42.75 | 26.440(0.149) | 25.523(0.055) | 0.386 | 0.250 | 1.278 | 54107.93 |
| 9431. | 161.76075 | 17.28388 | 43.10 | 26.126(0.109) | 25.287(0.044) | 0.447 | 0.310 | 2.588 | 54087.71 |
| 6440. | 161.75761 | 17.28213 | 43.94 | 26.483(0.135) | 25.311(0.065) | 0.632 | 0.248 | 3.243 | 54087.45 |
| 85483 | 161.77245 | 17.27666 | 44.57 | 26.444(0.136) | 25.310(0.107) | 0.362 | 0.116 | 1.106 | 54088.24 |

### 2.3. Long-Period Cepheids

The initial *HST* imaging campaigns of the SN hosts were too brief to reliably identify Cepheids with $P > 60$ d as their duration was shorter than a full pulsation cycle. While long-period Cepheids are rarer than their older cousins, their greater brightness and contrast makes them easier to detect and they are very valuable for extending the range of Cepheids as distance indicators. At $P > 100$ d, the $P$-$L$ relations flatten (e.g., Freedman et al. 1992) and such Cepheids require the use of different relations as discussed by Bird et al. (2009). While we have as yet no Cepheids with $P > 100$ days in our sample, in the future such objects could be useful for extending the range to which SNe Ia may be calibrated.

For the three SN hosts exclusively observed with ACS (NGC 3370, 1309, and 3021), we have identified a total of 39 and 18 Cepheids with periods greater than 60 and 75 d, respectively. For NGC 4258 we identified additional Cepheids using the new epochs beyond those analyzed by Macri et al. (2006), 149 in all including 68 with $P > 20$ d, 6 with $P > 60$ d, and 3 with $P > 75$ d. The optical Cepheid data for NGC 4258 are given by Macri et al. (2009). In Table 10 we indicate the number of Cepheids with long periods found in the previously discussed hosts.

The new epochs of imaging of the three hosts initially observed with WFPC2 (NGC 3982, NGC 4536, and NGC 4639) also enabled the discovery of new Cepheids at $P > 60$ d not previously identified. However, the fractional coverage of these hosts is less, limited by the smaller field of WFPC2. To look for such objects we retrieved the WFPC2 data which originated from programs GO-5427, GO-5981, and GO-8100 (SN Ia *HST* Calibration Program, P.I. Sandage) to combine with the Cycle 15 data from our SHOES (Supernovae and $H_0$ for the Equation of State) program. These data were processed in the same manner as the ACS data described in the previous section while making use of the latest WFPC2 CTE corrections. The search for Cepheids in these hosts netted a dozen Cepheids with $P > 60$ d to augment those previously detected in the original analyses of Saha et al. (1996, 1997, 2001), Gibson et al. (2000) and Stetson & Gibson (2001) .[4] Additional imaging might reveal so-called "ultra long-period Cepheids" ($P > 100$ d; e.g., Bird et al. 2009) of future value.

### 2.4. Cepheid Homogeneity

The reliable use of Cepheids along the distance ladder relies on their homogeneity. To test this we constructed composite light curves in the well-sampled $V$ band, as shown in Figure 9. We limited inclusion to long period Cepheids, i.e., those with $P > 10$ d, resulting in averages of 20 to 40 d in the hosts. We find that these mean light curves in each galaxy to be quite homogeneous. Table 11 gives the mean half-amplitude for the SN hosts, each of which is measured to 1% to 2%

[4]We rediscovered ∼90% the Cepheids presented in the previous analyses. For these Cepheids we found a negligible difference (0.3 d) in their mean period, with a dispersion about the difference of 1.3 d.

Table 9—Continued

| id | $\alpha$ (J2000) | $\delta$ (J2000) | period (days) | $< V >$ (mag) | $< I >$ (mag) | $\mathrm{Amp}_V$ (mag) | $\mathrm{Amp}_I$ (mag) | $L_V$ | $t_0$ (2400000+) |
|---|---|---|---|---|---|---|---|---|---|
| 25870 | 161.76779 | 17.27589 | 44.81 | 26.379(0.155) | 25.410(0.139) | 0.523 | 0.336 | 1.405 | 54099.75 |
| 37212 | 161.77170 | 17.26998 | 44.87 | 26.705(0.175) | 25.701(0.141) | 0.529 | 0.225 | 2.175 | 54121.50 |
| 28504 | 161.76514 | 17.26491 | 44.97 | 26.387(0.101) | 25.564(0.073) | 0.378 | 0.287 | 1.768 | 54109.23 |
| 9014. | 161.75980 | 17.28234 | 45.10 | 27.106(0.190) | 25.985(0.160) | 0.563 | 0.234 | 2.191 | 54101.07 |
| 40168 | 161.77694 | 17.27923 | 45.40 | 26.626(0.095) | 25.606(0.076) | 0.552 | 0.288 | 2.503 | 54122.22 |
| 5439. | 161.75713 | 17.28309 | 45.82 | 26.409(0.124) | 25.424(0.052) | 0.576 | 0.258 | 2.602 | 54089.11 |
| 46830 | 161.77864 | 17.26849 | 45.88 | 27.114(0.232) | 26.032(0.132) | 0.602 | 0.355 | 1.969 | 54104.19 |
| 34313 | 161.77155 | 17.27429 | 47.19 | 26.634(0.204) | 25.659(0.049) | 0.451 | 0.204 | 2.193 | 54099.56 |
| 20949 | 161.77120 | 17.29254 | 47.37 | 26.415(0.120) | 25.453(0.074) | 0.431 | 0.216 | 2.543 | 54098.79 |
| 2074. | 161.75695 | 17.29511 | 49.85 | 26.699(0.143) | 25.738(0.079) | 0.480 | 0.244 | 2.455 | 54129.77 |
| 46035 | 161.78023 | 17.27523 | 50.13 | 26.580(0.110) | 25.497(0.106) | 0.636 | 0.286 | 3.021 | 54112.43 |
| 28129 | 161.76619 | 17.26830 | 50.57 | 26.245(0.122) | 25.118(0.092) | 0.465 | 0.233 | 2.670 | 54127.73 |
| 5361. | 161.75695 | 17.28274 | 50.60 | 25.948(0.115) | 25.052(0.086) | 0.394 | 0.255 | 1.797 | 54115.05 |
| 28534 | 161.77050 | 17.27974 | 51.15 | 26.929(0.146) | 25.944(0.062) | 0.462 | 0.333 | 1.986 | 54095.76 |
| 48903 | 161.77827 | 17.26024 | 51.69 | 26.717(0.161) | 25.620(0.139) | 0.668 | 0.323 | 2.414 | 54136.82 |
| 15864 | 161.76420 | 17.28080 | 52.41 | 26.144(0.067) | 25.109(0.042) | 0.357 | 0.243 | 1.478 | 54109.82 |
| 4367. | 161.75525 | 17.28084 | 52.72 | 26.941(0.148) | 25.723(0.064) | 0.312 | 0.181 | 1.130 | 54088.61 |
| 13303 | 161.76500 | 17.28732 | 52.74 | 26.716(0.122) | 25.561(0.043) | 0.539 | 0.245 | 2.246 | 52817.50 |
| 1528. | 161.75194 | 17.28407 | 60.68 | 25.982(0.076) | 25.156(0.043) | 0.350 | 0.217 | 2.805 | 54113.52 |
| 5501. | 161.75677 | 17.28193 | 62.71 | 26.093(0.053) | 24.833(0.025) | 0.176 | 0.050 | 0.853 | 54142.71 |
| 6706. | 161.75874 | 17.28466 | 64.79 | 26.238(0.096) | 25.267(0.072) | 0.559 | 0.224 | 2.216 | 54148.62 |
| 7014. | 161.75977 | 17.28685 | 66.71 | 25.781(0.104) | 24.700(0.070) | 0.320 | 0.198 | 2.104 | 54126.33 |
| 33669 | 161.76845 | 17.26671 | 67.23 | 26.670(0.154) | 25.282(0.126) | 0.408 | 0.184 | 1.565 | 54115.81 |
| 9063. | 161.75862 | 17.27891 | 68.90 | 25.687(0.045) | 24.875(0.038) | 0.201 | 0.136 | 1.571 | 54135.47 |
| 22612 | 161.76869 | 17.28313 | 69.35 | 25.746(0.069) | 24.703(0.073) | 0.391 | 0.212 | 2.692 | 54095.88 |
| 29662 | 161.76544 | 17.26415 | 71.53 | 26.272(0.119) | 25.366(0.110) | 0.484 | 0.259 | 1.869 | 54152.55 |
| 22718 | 161.76805 | 17.28118 | 73.36 | 25.673(0.108) | 24.763(0.042) | 0.430 | 0.207 | 1.547 | 54112.11 |
| 1454. | 161.75252 | 17.28609 | 79.26 | 26.521(0.092) | 25.188(0.094) | 0.674 | 0.374 | 2.578 | 54159.30 |
| 33346 | 161.76861 | 17.26770 | 80.85 | 26.002(0.121) | 25.105(0.064) | 0.407 | 0.216 | 0.979 | 54171.59 |
| 33195 | 161.77345 | 17.28137 | 81.04 | 25.895(0.072) | 24.884(0.048) | 0.281 | 0.164 | 1.654 | 54177.57 |
| 4471. | 161.75697 | 17.28539 | 83.28 | 27.010(0.093) | 25.584(0.095) | 0.351 | 0.213 | 1.314 | 54158.04 |
| 22098 | 161.76770 | 17.28115 | 86.33 | 25.892(0.116) | 24.822(0.129) | 0.247 | 0.112 | 1.918 | 54146.68 |
| 3205. | 161.75284 | 17.27851 | 88.25 | 26.112(0.120) | 25.097(0.083) | 0.356 | 0.186 | 1.005 | 54172.21 |
| 31067 | 161.76816 | 17.26970 | 88.54 | 25.667(0.100) | 24.516(0.046) | 0.330 | 0.131 | 1.147 | 54130.16 |
| 48741 | 161.77799 | 17.26004 | 96.49 | 25.522(0.051) | 24.561(0.028) | 0.248 | 0.146 | 2.139 | 54131.89 |
| 8038. | 161.76096 | 17.28786 | 96.82 | 26.286(0.101) | 25.194(0.080) | 0.336 | 0.182 | 2.181 | 54135.30 |
| 17501 | 161.76206 | 17.27215 | 98.72 | 26.034(0.131) | 24.952(0.051) | 0.295 | 0.208 | 2.189 | 54158.29 |

Table 10: Long-Period Cepheids

| Host | SN Ia | $P > 60$ d | $P > 75$ d |
|---|---|---|---|
| NGC 4536 | SN 1981B | 5 | 4 |
| NGC 4639 | SN 1990N | 2 | 1 |
| NGC 3982 | SN 1998aq | 5 | 3 |
| NGC 3370 | SN 1994ae | 19 | 10 |
| NGC 3021 | SN 1995al | 6 | 4 |
| NGC 1309 | SN 2002fk | 14 | 4 |
| NGC 4258 | ——— | 6 | 3 |

precision and is consistent with the sample average of 0.48, including that of the inner field of NGC 4258. The exception may be the outer field of NGC 4258 whose mean is 13% lower than the sample mean, though this difference is not significant due to the small number of long-period Cepheids in this field. *Individual* half-amplitudes for the Cepheids range from 0.15 to 0.80 mag.

There are pertinent reasons why the *mean* shape or amplitude of the light curve might vary from galaxy to galaxy. A difference in blending would alter the apparent amplitudes, reducing them in the presence of greater blending. Chemical composition may also affect Cepheid amplitudes. Paczyński & Pindor (2000) found that the mean amplitude of Cepheids in the Galaxy is 7% greater than in the LMC, and the mean amplitude of Cepheids in the Small Magellanic Cloud is 25% smaller than in the LMC; they suggested that a natural explanation for the difference is their relative metal content. This difference would be in the same direction as the low metallicity of the outer region of NGC 4258, though more data would be required to see if this is a significant difference. Pulsation models also indicate a dependence between amplitude and chemical composition (Bono et al. 1999; Marconi et al. 2005). Finally, Cepheid amplitudes also vary with temperature or color, resulting in the amplitude-color relations (e.g., Kanbur & Ngeow 2006).

The 2% limit on the difference in the mean of the half amplitude for NGC 4258 (inner field) and the SN hosts constrains the *differential blending* between NGC 4258 and the SN hosts to $< 5\%$ of the mean Cepheid flux. The uniformity of the observed amplitudes is also consistent with the finding in §3 that the metallicities near the Cepheids are homogeneous.

In Figure 10 we show the composite light curves of all Cepheids with $P > 60$ d. These have lower mean amplitudes, as expected, but the characteristic sawtooth shape clearly demonstrates their authenticity.

## 3. Cepheid Metallicities and Pulsation Relations

Past work (Kochanek 1997; Kennicutt et al. 1998; Sakai et al. 2004; Macri et al. 2006) has demonstrated a significant dependence between the apparent magnitudes of Cepheids at a fixed

Table 11: $V$-Band Half-Amplitudes

| Host | Mean $V$ ($\sigma$) | $\sigma$ from sample mean | No. $P > 10$ d |
|---|---|---|---|
| NGC 3370 | 0.486(0.011) | 0.56 | 130 |
| NGC 1309 | 0.474(0.013) | −0.48 | 86 |
| NGC 3021 | 0.464(0.020) | −0.78 | 33 |
| NGC 4536 | 0.467(0.024) | −0.54 | 34 |
| NGC 3982 | 0.490(0.019) | 0.56 | 37 |
| NGC 4639 | 0.483(0.017) | 0.14 | 30 |
| NGC 4258i | 0.472(0.011) | −0.72 | 144 |
| NGC 4258o | 0.418(0.045) | −1.39 | 7 |

period and the metallicity in the environment of the Cepheid. This dependence and its uncertainty propagates as one of the largest sources of systematic error in the Hubble constant measured via the LMC, ∼4% (Freedman et al. 2001). The SHOES program was designed to mitigate the sensitivity of the Hubble constant measurement to metallicity by 1) utilizing Cepheids in a narrow range of the metallicity parameter [O/H], and by 2) measuring Cepheids in the near-infrared where the metallicity dependence is diminished (Alibert et al. 1999; Persson et al. 2004; Marconi et al. 2005; Gieren et al. 2008).

Nevertheless, to account for even a modest metallicity dependence and its uncertainty, we measured the [O/H] abundance from 93 H II regions in the vicinity of the Cepheids in all of the galaxies in Table 2 using slit masks with the Low Resolution Imaging Spectrometer on the Keck I telescope (Oke et al. 1995). Our analysis methods are described in §2.5 of Riess et al. (2005) and follow the calibration from Zaritsky et al. (1994), for which $[\mathrm{O/H}]_{\mathrm{solar}} = 7.9 \times 10^{-4}$ and the solar abundance is 12 + log[O/H] = 8.9. The result is the measurement of a gradient in 12 + log[O/H] for each galaxy across the deprojected radii occupied by the Cepheids (Table 12), as shown in Figure 11. The intercepts and gradients were used to estimate the metallicity at the deprojected radius of each individual Cepheid.

Table 12: Metallicity (12 + log[O/H]) of SHOES Hosts

| Host | at $r = 30''$ | change per $10''$ | avg. at Cepheid positions | dispersion |
|---|---|---|---|---|
| NGC1309 | 9.013 | −0.098 | 8.90 | 0.19 |
| NGC3021 | 9.018 | −0.224 | 8.94 | 0.25 |
| NGC4536 | 9.104 | −0.025 | 8.79 | 0.12 |
| NGC4639 | 9.130 | −0.086 | 8.96 | 0.14 |
| NGC4258[a] | 9.015 | −0.006 | 8.94 | 0.05 |
| NGC3370 | 9.030 | −0.090 | 8.82 | 0.19 |
| NGC3982 | 8.998 | −0.152 | 8.74 | 0.25 |

[a]For inner field of Macri et al. (2006); outer field average = 8.72, dispersion = 0.03.

The mean value of 12 + log[O/H] at the positions of the Cepheids in the SN hosts is quite similar to that in the *inner field* of NGC 4258, with a difference that is less than the dispersion of the means of the SN hosts. This statement is independent of the normalization of the metallicity scale as it depends on the difference in metallicity. Thus, a correction to the distance scale is unwarranted when comparing these Cepheids.[5] The exception is the outer field of NGC 4258 whose values are determined to be 8.72 ± 0.03.

Interestingly, the metallicities of the Cepheids in the SN hosts and the inner field of NGC 4258 are very similar to the solar neighborhood value of 8.9 and the value of 8.81 measured for 68 Galactic Cepheids (Andrievsky et al. 2002, 2004). Thus, in principle, Galactic Cepheids could provide a suitable calibration of the luminosities of our Cepheid sample in the SN hosts independent of NGC 4258. In practice, the calibration of Galactic Cepheid luminosities is compromised by the precision and accuracy of their distance estimates, their large extinction, and the inhomogeneity of their photometry.

Sandage & Tammann (2008) contend that the *slope* of the Cepheid $P$-$L$ relation is sensitive to chemical composition and that solar-metallicity Cepheids used in the distance scale should be calibrated with Galactic Cepheids. This conclusion could have important consequences for the determination of the distance scale via the LMC. Tammann et al. (2003) used a mixture of Baade-Becker-Wesselink and cluster-based distance estimates to Galactic Cepheids to calibrate the $V$-band and $I$-band $P$-$L$ relations which should then be applicable to the solar-metallicity Cepheids in SN Ia hosts. Corrections for the extinction of Cepheids in SN hosts are subsequently made by the use of two colors and a Galactic reddening law (Saha et al. 2006). This is equivalent to the use of a "Wesenheit reddening-free" mean magnitude, $m_w$, defined by Madore (1982) as

$$m_w = m_V - R(m_V - m_I) = a_w \log P + b_w, \tag{3}$$

where $R \equiv A_V/(A_V - A_I)$, and $a_w$ and $b_w$ are the slope and intercept of this $P - w$ relation, respectively.

The Tammann et al. (2003) Cepheid analysis provides a slope for the $P-w$ relation in equation (3) of $-3.75 \pm 0.09$ mag, which is used by Saha et al. (2006) to determine distances to the SN Ia hosts. This slope is the steepest estimate of the Galactic relation to date (Tammann et al. 2003) and is much steeper than the LMC $P-w$ slope of $-3.2$ to $-3.3$ mag (Udalski et al. 1999). Because the mean period for Cepheids seen in SN hosts, $< P >= 30 - 35$ days, is longer than that in the LMC, $< P >= 5$ days, this steeper slope results in the bulk of the 15% increase in the Sandage et al. (2006) determination of the distance scale from that of Freedman et al. (2001).

[5]However, even using the Sakai et al. (2004) zeropoint relation of $\delta(m - M)\delta[\mathrm{O/H}] = -0.24 \pm 0.05$ and these Cepheids to calibrate the distance scale would result in a modest 1% correction to the Hubble constant with a systematic error of 0.2%, a substantially reduced sensitivity from past use of LMC Cepheids and their values of 12 + log[O/H] = 8.5.

As seen in Table 12, the measurements here provide the largest sample of Cepheids to date with solar metallicity (mean 12 + log[O/H] = 8.9), long periods (Kanbur & Ngeow 2004, beyond the break in the LMC relation at $P = 10$ d), and uniform measurements. Here we use them to measure the slope of the $P - w$ relation, whose value is vital to measurements of the Hubble constant.

For the Cepheids in each host we fit equation (3) to determine the slope and zeropoint. We used an iterative clipping of $\pm 3\sigma$ from the mean to remove outliers and limited the fit to Cepheids with $10 < P < 100$ d to avoid the possibility of a break at $P = 10$ d and a change of slope at $P > 100$ days (Bird, Stanek, and Prieto 2009). In the SN hosts we also limited the Cepheids to $20 < P$ d to mitigate selection as discussed in §2.2. We did not include the outer field of NGC 4258 because it has too few Cepheids (7 with $P > 10$ d, 2 with $P > 20$ d) to yield a reliable result. The values and uncertainties of the slopes based on the 445 Cepheids are given in Table 13, and the results are plotted versus the host metallicity in Figure 12. The mean slope for all Cepheids was $-2.98 \pm 0.07$ mag. Changing the lower period cutoff to $P > 10$ d for the Cepheids in the SN hosts gives a mean of $-3.00 \pm 0.07$ mag. Setting the lower period cutoff for each galaxy individually based on the completeness boundaries like those shown in Figures 6 to 8 yields a mean slope of $-2.98 \pm 0.08$ mag. Overall, we found the mean slope to be insensitive to the period range, with a moderately shallower slope at the longest periods as expected (Bird et al. 2009). This finding is consistent with the analysis by (Madore & Freedman 2009) who show that a color tilt in the monochromatic $P - L$ slope due to metallicity is diminished in the $P - w$ due to dereddening.

We find no evidence that the slope is steeper than the LMC slope, as ours is consistent with the LMC though $1\sigma$ to $2\sigma$ *shallower*. The mean slope is significantly lower and inconsistent with the results from Tammann et al. (2003). (Even the poorly determined mean slope of the 3 hosts observed with WFPC2 yield -3.26 $\pm$0.22 which is $> 2\ \sigma$ shallower than the Tammann et al. slope). We discuss likely origins of this difference in §5.

Table 13: Cepheid $P - w$ slopes

| Host | slope (mag) | $\sigma$ |
|---|---|---|
| NGC 3370 | −2.94 | 0.14 |
| NGC 1309 | −2.82 | 0.21 |
| NGC 3021 | −2.60 | 0.24 |
| NGC 3982 | −3.15 | 0.42 |
| NGC 4639 | −3.07 | 0.55 |
| NGC 4536 | −3.38 | 0.30 |
| NGC 4258i | −3.05 | 0.10 |

## 4. Light Curves of SN 1995al and SN 2002fk

Use of the Cepheid data in the previous sections and the flux-calibrated light curves of the new SNe presented in this section provide the means to determine their luminosity.

Both SN 1995al (NGC 3021) and SN 2002fk (NGC 1309) were spectroscopically normal SNe Ia (Wei et al. 1995; Ayani & Yamaoka 2002).

SN 2002fk was extensively monitored by the 0.76 m Katzman Automatic Imaging Telescope (KAIT; Li et al. 2000; Filippenko et al. 2001) commencing 13 d before $B$-band maximum. The SN photometry was measured with the benefit of galaxy subtraction and PSF fitting relative to stars in the field of the SN. These field stars were later calibrated on five photometric nights with KAIT and the Nickel 1 m telescope at the Lick Observatory using Landolt (1992) standards.

The mean magnitudes of the field stars are given in Table 14 and their positions are shown in Figure 13. The light curves of the SN are shown in Figure 14 compared to their model fits using the MLCS2k2 (Jha et al. 2007) algorithm. The fits are consistent with those obtained for well-observed SNe Ia and are sufficient to constrain the relative distance modulus to a precision of 0.068 mag or 0.105 mag, with the intrinsic contribution of 0.08 mag (Jha et al. 2007) added in quadrature.

For SN 1995al, photometric monitoring was conducted starting 5 d before $B$-band maximum with the FLWO 1.2 m telescope equipped with a thick, front-illuminated Loral CCD ("Andycam") and a set of Johnson $UBV$ and Kron-Cousins $RI$ filters. The observations were initially presented by Riess et al. (1999) as a member of a set of 22 SNe Ia and we direct the reader there for additional details. The photometry presented by Riess et al. lacked the benefit of galaxy template subtraction and multiple zeropoint calibrations. These steps can improve the precision of SN Ia photometry and a reanalysis is warranted for including this SN in the small calibration set. We have now undertaken the galaxy subtraction and obtained zeropoint calibrations on 5 independent nights using the Landolt (1992) standard stars for the fundamental calibration.

The mean magnitudes of the field stars are given in Table 15 and their positions are shown in Figure 13. The photometric differences with the version from Riess et al. (1999) are a few hundredths of a magnitude in all bands except $I$, which differed in the mean by 0.1 mag. The light curves of the SNe are shown in Figure 14 compared to their model fits using the MLCS2k2 (Jha et al. 2007) algorithm.

Photometry of the two SNe is given in Tables 16 and 17 and their photometric parameters in Table 18.

It is important to insure that the photometry of the other 4 SNe Ia in Table 2 is also reliable. For SN 1990N, Lira et al. (1999) undertook a comprehensive recalibration of SN 1990N. SN 1994ae was recalibrated using galaxy subtraction in Riess et al. (2005) which also contained the calibration of SN 1998aq using the same techniques.

We have also verified the photometric calibration of SN 1981B presented by Buta & Turner

Table 14. Comparison Stars for SN 2002fk

| Star | $U$ | N | $B$ | N | $V$ | N | $R$ | N | $I$ | N |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | —- | 0 | 16.255(0.007) | 5 | 15.748(0.013) | 5 | 15.441(0.006) | 3 | 15.034(0.010) | 3 |
| 2 | —- | 0 | 16.415(0.006) | 5 | 15.784(0.012) | 3 | 15.405(0.015) | 3 | 15.002(0.002) | 2 |
| 3 | —- | 0 | 16.331(0.009) | 5 | 15.787(0.007) | 5 | 15.444(0.012) | 4 | 15.047(0.015) | 4 |
| 4 | —- | 0 | 17.513(0.010) | 3 | 16.954(0.012) | 5 | 16.611(0.014) | 2 | 16.176(0.009) | 2 |

Table 15. Comparison Stars for SN 1995al

| Star | $U$ | N | $B$ | N | $V$ | N | $R$ | N | $I$ | N |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 15.078(0.019) | 3 | 14.619(0.004) | 4 | 13.795(0.004) | 4 | 13.307(0.004) | 3 | 12.836(0.008) | 3 |
| 1 | 19.027(0.079) | 2 | 18.050(0.051) | 2 | 16.865(0.007) | 2 | 16.067(0.002) | 2 | 15.350(0.011) | 2 |
| 2 | 13.633(0.021) | 2 | 13.686(0.009) | 2 | 13.246(0.015) | 2 | 12.977(0.013) | 2 | 12.692(0.004) | 2 |
| 3 | 14.586(0.025) | 3 | 14.628(0.006) | 3 | 14.132(0.008) | 3 | 13.842(0.008) | 3 | 13.551(0.009) | 3 |
| 4 | 15.390(0.018) | 3 | 14.870(0.002) | 4 | 14.050(0.006) | 4 | 13.620(0.005) | 3 | 13.244(0.006) | 3 |
| 5 | 16.536(0.012) | 3 | 16.744(0.002) | 4 | 16.322(0.007) | 4 | 16.042(0.009) | 4 | 15.737(0.012) | 4 |
| 6 | 18.499(0.007) | 2 | 17.451(0.013) | 4 | 16.425(0.005) | 4 | 15.822(0.012) | 4 | 15.326(0.014) | 4 |
| 7 | 16.894(0.027) | 2 | 16.667(0.004) | 4 | 15.990(0.004) | 4 | 15.609(0.008) | 4 | 15.250(0.010) | 4 |
| 8 | 17.893(0.012) | 3 | 17.538(0.006) | 4 | 16.757(0.006) | 4 | 16.295(0.009) | 4 | 15.881(0.017) | 4 |
| 9 | 17.558(0.019) | 2 | 16.878(0.009) | 4 | 15.967(0.011) | 4 | 15.429(0.011) | 4 | 14.928(0.015) | 4 |
| 10 | 99.999(9.999) | 0 | 17.371(0.015) | 4 | 15.879(0.003) | 4 | 14.820(0.005) | 3 | 13.629(0.016) | 3 |
| 11 | 15.432(0.021) | 3 | 15.291(0.009) | 4 | 14.654(0.006) | 4 | 14.296(0.005) | 4 | 13.951(0.009) | 4 |
| 12 | 17.086(0.006) | 3 | 16.860(0.012) | 4 | 16.132(0.015) | 4 | 15.693(0.013) | 4 | 15.318(0.008) | 4 |

Table 16. Photometry of SN 2002fk

| JD-2.4e6 | $B$ | $V$ | $R$ | $I$ |
|---|---|---|---|---|
| 52535.99 | 15.061(0.010) | 15.152(0.032) | 15.090(0.049) | 14.879(0.025) |
| 52537.00 | 14.667(0.011) | 14.760(0.010) | 14.721(0.038) | 14.518(0.020) |
| 52537.97 | 14.347(0.010) | 14.450(0.012) | 14.396(0.033) | 14.238(0.011) |
| 52541.99 | 13.600(0.010) | 13.714(0.011) | 13.693(0.042) | 13.603(0.015) |
| 52544.00 | 13.472(0.010) | 13.592(0.028) | 13.529(0.016) | 13.557(0.020) |
| 52544.96 | 13.386(0.010) | 13.508(0.020) | 13.462(0.010) | 13.510(0.011) |
| 52548.99 | 13.327(0.010) | 13.366(0.011) | 13.382(0.011) | 13.573(0.010) |
| 52549.98 | 13.311(0.010) | 13.363(0.010) | 13.380(0.010) | 13.589(0.011) |
| 52550.95 | 13.349(0.011) | 13.400(0.010) | 13.380(0.010) | 13.654(0.012) |
| 52551.97 | 13.383(0.011) | 13.424(0.010) | 13.397(0.013) | 13.691(0.010) |
| 52553.95 | 13.519(0.011) | 13.468(0.011) | 13.481(0.013) | 13.784(0.012) |
| 52555.94 | 13.658(0.010) | 13.549(0.010) | 13.647(0.036) | 13.953(0.010) |
| 52559.95 | 13.973(0.013) | 13.766(0.010) | 13.941(0.035) | 14.199(0.012) |
| 52562.89 | 14.298(0.011) | 13.957(0.010) | 14.111(0.033) | 14.292(0.010) |
| 52565.90 | 14.669(0.010) | 14.127(0.013) | 14.187(0.049) | 14.296(0.034) |
| 52570.95 | —- | 14.372(0.025) | 14.191(0.030) | 14.179(0.039) |
| 52574.87 | 15.549(0.013) | 14.569(0.022) | 14.269(0.040) | 14.023(0.011) |
| 52576.89 | 15.757(0.042) | 14.684(0.011) | 14.378(0.038) | 14.044(0.010) |
| 52579.90 | 15.977(0.048) | 14.859(0.016) | 14.488(0.010) | 14.121(0.011) |
| 52582.87 | 16.109(0.031) | 15.055(0.026) | 14.690(0.010) | 14.293(0.010) |
| 52588.93 | 16.363(0.038) | 15.367(0.025) | 15.024(0.034) | —- |
| 52594.84 | 16.513(0.018) | 15.538(0.021) | 15.263(0.017) | 15.003(0.028) |
| 52604.83 | 16.650(0.017) | 15.819(0.012) | 15.635(0.011) | 15.490(0.026) |
| 52607.80 | 16.751(0.027) | 15.884(0.014) | 15.705(0.049) | 15.600(0.018) |
| 52610.85 | 16.812(0.034) | 15.996(0.019) | 15.826(0.024) | 15.755(0.026) |
| 52613.81 | 16.799(0.017) | 16.037(0.020) | 15.955(0.014) | 15.917(0.032) |
| 52616.79 | 16.873(0.038) | 16.161(0.027) | 16.011(0.033) | 16.097(0.060) |
| 52619.77 | 16.889(0.020) | 16.223(0.037) | 16.147(0.053) | 16.090(0.035) |
| 52631.79 | 17.153(0.028) | 16.547(0.026) | 16.584(0.063) | 16.595(0.069) |
| 52644.73 | 17.323(0.048) | 16.830(0.018) | 16.977(0.020) | 17.103(0.074) |
| 52657.72 | 17.301(0.084) | 17.148(0.036) | 17.309(0.050) | 17.792(0.135) |
| 52673.63 | 17.723(0.101) | 17.551(0.035) | 17.903(0.050) | 18.125(0.139) |

(1983). For the Buta & Turner stars A, B, and C, we found respective differences in the $B$-band of 0.02, -0.01, and 0.02 mag (an average of 0.01 mag), where a positive difference indicates our photometry is brighter. For the $V$ band we found differences of 0.01, 0.00, and 0.00 mag, respectively.

## 5. Discussion

In a companion paper (Riess et al. 2009), we present IR measurements from NICMOS on *HST* of the Cepheids analyzed here. Although the new, optical photometry of SNe Ia and Cepheids presented here already addresses some of the largest sources of systematic error in the determination of the Hubble constant, the *remaining* errors are further reduced from observations of these Cepheids at longer wavelengths.

One of the biggest of these remaining uncertainties results from the corrections applied for Cepheid reddening. Systematic errors in the apparent color excess arise from differences in the photometric system used to measure Cepheid colors in the SN hosts and the anchor galaxy or from intrinsic differences in color resulting from those in metallicity. Errors in the optical color excess are further amplified by use of a $V-I$ reddening ratio, $R = \frac{A_V}{E_{V-I}} \approx 2.5$. Another source of error arises from differences in the value of $R$ from host to host or sight line to sight line for which Galactic variations in $R$ are $\sim 0.2$ (Valencic, Clayton and Gordon 2004). Reobserving the Cepheids with a single instrument (to negate photometric system differences) and at redder wavelengths (reducing the scale of $R$ and its variations) would mitigate these uncertainties. We therefore defer our full analysis of the Hubble constant resulting from the data presented here to Riess et al. (2009), where we present the long-wavelength observations from NICMOS.

However, we note here that the two new SNe Ia, SN 1995al and SN 2002fk, and the Cepheids in their hosts yield estimates of the SN Ia luminosity (corrected to the fiducial of the luminosity-light curve shape relation) which are quite consistent with the other SNe in Table 2. Due to the relationship between luminosity and light curve shape, the value of the fiducial luminosity depends on which light curve shape within a family of light curves is chosen to be the fiducial . Based on the maser distance to NGC 4258 and its Cepheids, Riess et al. (2009) find for the MLCS2k2 light curve family (Jha, Riess, Kirshner 2005) the fiducial, dereddened absolute magnitude, $M_V^0$ (defined at the time of $B$ max) of SN 1995al and SN 2002fk is $-18.99 \pm 0.14$ and $-19.16 \pm 0.12$ mag, respectively, in good agreement with the average of $-19.05 \pm 0.07$ mag for the mean of the previous four (also from Riess et al. 2009). Thus the average for all 6 is $M_V^0 = -19.06 \pm 0.05$.

From our analysis it appears that the slopes for $P$-$L$ and $P-w$ derived by Tammann et al. (2003) from Galactic Cepheids are inaccurate. Even limiting the analysis of the Tammann et al. Cepheids to the 27 with $P > 10$ d, in order to remove more rapid ones not represented in our sample, we find a slope of $-4.37 \pm 0.18$. The Galactic Cepheids have the *same metallicity* as those presented here yet the Tammann et al. slope is $7\sigma$ greater than the mean of $-2.98 \pm 0.07$ for the 7

Table 17. Photometry of SN 1995al

| JD-2.4e6 | $U$ | $B$ | $V$ | $R$ | $I$ |
|---|---|---|---|---|---|
| 50024.990 | —- | 13.45(0.02) | 13.43(0.02) | 13.32(0.06) | 13.64(0.02) |
| 50026.030 | 13.01(0.02) | 13.40(0.02) | —- | 13.32(0.02) | 13.61(0.02) |
| 50030.010 | 13.23(0.04) | 13.28(0.02) | 13.25(0.04) | 13.24(0.02) | 13.66(0.02) |
| 50032.000 | 13.35(0.02) | 13.32(0.02) | 13.28(0.02) | 13.24(0.02) | 13.70(0.02) |
| 50035.020 | 13.48(0.04) | 13.53(0.02) | 13.33(0.02) | 13.34(0.02) | 13.82(0.02) |
| 50037.020 | —- | 13.69(0.02) | 13.43(0.02) | 13.32(0.10) | 13.87(0.02) |
| 50038.020 | 13.60(0.04) | 13.70(0.02) | 13.43(0.02) | 13.48(0.02) | 13.96(0.02) |
| 50040.000 | —- | 13.85(0.02) | 13.55(0.02) | 13.62(0.02) | 13.99(0.02) |
| 50042.000 | 14.16(0.06) | 14.08(0.02) | 13.71(0.02) | 13.82(0.03) | 14.20(0.07) |
| 50047.980 | —- | 14.55(0.02) | 13.82(0.02) | 13.81(0.02) | 13.94(0.03) |
| 50051.020 | 15.18(0.03) | 15.00(0.02) | 14.01(0.03) | 13.88(0.03) | 13.89(0.04) |
| 50067.000 | 16.38(0.04) | 16.06(0.02) | 14.88(0.02) | 14.50(0.02) | 14.22(0.02) |
| 50070.860 | —- | 16.19(0.02) | 15.07(0.02) | 14.74(0.02) | 14.47(0.02) |
| 50078.950 | —- | 16.38(0.06) | 15.35(0.02) | 14.99(0.06) | 14.90(0.02) |
| 50086.980 | —- | 16.54(0.04) | 15.55(0.03) | 15.32(0.06) | 15.25(0.05) |
| 50088.900 | —- | 16.51(0.06) | 15.58(0.03) | 15.33(0.05) | 15.25(0.05) |
| 50103.820 | —- | 16.76(0.08) | 16.02(0.04) | 15.86(0.03) | 15.91(0.05) |
| 50136.900 | —- | 17.31(0.12) | 16.86(0.08) | 16.90(0.12) | 17.21(0.17) |
| 50161.730 | —- | 17.81(0.21) | 17.53(0.16) | 17.85(0.21) | 17.83(0.45) |

Table 18. Table 18: SN Observables[a]

| SN | $U_{\max}$ (mag) | $B_{\max}$ (mag) | $V_{\max}$ (mag) | $R_{\max}$ (mag) | $I_{\max}$ (mag) | $\Delta m_{15}(B)$ |
|---|---|---|---|---|---|---|
| SN 2002fk | —— | 13.32(0.02) | 13.38(0.02) | 13.39(0.03) | 13.50(0.04) | 1.08(0.03) |
| SN 1995al | 13.01(0.05) | 13.31(0.02) | 13.27(0.02) | 13.23(0.02) | 13.62(0.03) | 1.00(0.05) |

[a]The uncertainty is given in parentheses.

hosts in Table 13. While one might invoke an unusual helium abundance as a possible explanation for the conflict with a single host (e.g., for NGC 4258 when Macri et al. 2006 showed the same discrepancy), this would be unlikely to explain why each of the 7 hosts in Table 13 are inconsistent with the Tammann et al. slope for $P > 10$ d Cepheids.

We note that it is far more difficult to reliably measure the $P - w$ (or $P$-$L$ ) slope of Galactic Cepheids (from our vantage point within the Galaxy) than for extragalactic Cepheids. While Cepheids in an external host can be treated as coincident in distance, the estimate of the Galactic Cepheid slope suffers from the need for many individual, accurate distances. The cluster-based distances used for the longest period Galactic Cepheids are not very reliable as they frequently utilize tenuous stellar associations rather than cluster membership. In addition, past distance estimates to Galactic Cepheids using the Baade-Becker-Wesselink method did not consider a period dependence of the projection factor which may be significant (Gieren et al. 2005; Fouqué et al. 2007) and could lead to an inaccurate slope.

Geometric distance measurements via parallax are the "gold standard" for estimating distances. They are much more robust than the previous methods. The direct parallaxes of 10 Galactic Cepheids were measured by Benedict et al. (2007) using the Fine Guidance Sensor on *HST*. These 10 Cepheids alone or combined with Hipparcos parallaxes yield a $P - w$ slope of $-3.29 \pm 0.15$ (van Leeuwen et al. 2007), consistent with the SN hosts ($-2.98 \pm 0.07$) and the LMC ($-3.2$ to $-3.3$).

The mean extinction of the Tammann et al Galactic Cepheids is high, with a mean of 1.8 visual magnitudes, and is even higher for the longest period Cepheids. A possible error in the assumed value of the reddening parameter (e.g., $\sigma_R \approx 0.5$) for these Cepheids would bias the pulsation relations by 0.3 mag if each had the same extinction. Thus, without more precise knowledge of this ratio of optical absorption to reddening, it does not seem possible to use the Galactic Cepheids with high extinction to determine $H_0$ to better than $\sim 15\%$. Because younger and higher mass Cepheids have more than the average extinction, the *slope* of the inferred Galactic $P$-$L$ can also be biased by an error in $R$. The mean of the Benedict et al Cepheids is a more modest 0.36 visual magnitudes which also adds to their reliability.

The Galactic measurement at the long-period end also suffers from limited statistics. The Tammann et al. (2003) sample has a mean period of 12 d with only 7 Cepheids at $P > 30$ d and only 1 at $P > 50$ d. In our SN hosts, over 200 Cepheids (more than half of the sample) have $P > 30$ d. A Galactic sample of just 7 Cepheids at this range and with the aforementioned concerns would appear insufficient, even if their luminosities were accurate, to support a very precise measurement of the Hubble constant. However, the product of the 0.5 mag steeper slope from that of the Benedict et al sample or the SN host sample and difference in the mean period between the Galactic and SN host samples of $\Delta logP = 0.4 - 0.5$ causes a decrease in $H_0$ of 10%-12% in Sandage et al.

Comparing results for the sum of the standardized peak magnitudes of nearby SNe Ia and the

Hubble diagram intercept, $m^0_{v,i}+5a_v$, a quantity which is invariant to the method of standardization, the difference of the weighted mean for the four (out of six) SNe Ia (SN 1981B, SN 1990N, SN 1994ae, and SN 1998aq) that are in common with Sandage et al. (2006) is $0.02 \pm 0.04$ mag, showing excellent agreement. Sandage et al. (2006) also use SNe Ia data obtained from the photographic era (SN 1937C, 1960F, and 1974G) which R05 do not. There are clear reasons for not using the photographic data: they are not measured in the same way as for the Hubble-flow set, they have been shown to be unreliable, and they disagree with modern data (Riess et al. 2005). Even within the Sandage et al. analysis, the the absolute magnitude inferred from the photographic subset ($-19.68 \pm 0.10$) differs from the modern set ($-19.42 \pm 0.05$) by $2.6\sigma$, making the average brighter by 0.05 mag and decreasing $H_0$ by 2.5%.

Little of the difference in $H_0$ results from the determination of the absolute distance scale. Sandage et al. (2006) use an LMC distance modulus $\mu_0 = 18.54$ mag as one route to their value. The implied LMC distance based on NGC 4258 and Galactic Cepheids (Macri et al. 2006; Benedict et al. 2007) is $\mu_0 \sim 18.42$ mag, and Freedman et al. (2001) and Riess et al. (2005)adopted $mu_0 \equiv 18.50$ mag.

## 6. Summary and Conclusions

(1) Using ACS we have observed a total of 237 Cepheids (216 with $P > 20$ d) in three recent SN Ia hosts: NGC 1309 (SN 2002fk), NGC 3021 (SN 1995al), and NGC 3370 (SN 1994ae). We also present the multi-band light curves of SN 1995al and SN 2002fk.

(2) We reobserved the hosts of 6 reliable SNe Ia and the "maser galaxy" NGC 4258 in *HST* Cycle 15 (following the initial contiguous cycle of *HST* discovery observations) to identify longer period Cepheids. We found 57 with $60 < P < 100$ d and 29 with $75 < P < 100$ d which can aid in extending Cepheid measurements to greater distances.

(3) We have measured the metallicity parameter, 12 + log[O/H], in H II regions to infer the metallicity of the Cepheid sample. We find the values for the Cepheids in the SN hosts and the inner region of NGC 4258 to be very homogeneous, all consistent with the solar value of 8.9.

(4) Based on 445 Cepheids across 7 hosts of solar metallicity we find the mean slope of the $P - w$ relation using $V$-band and $I$-band measurements, the most commonly used for distance-scale work, to be $-2.98 \pm 0.07$. The 7 individual slopes are all consistent with the mean. The observed slope is fairly consistent with the slope of LMC Cepheids and consistent with the slope from Galactic Cepheid parallax distances. It is inconsistent with the slope of Galactic Cepheid distances from Tammann et al. (2003) using Baade-Becker-Wesselink and cluster distances. Using the slope derived here increases the value of $H_0$ from that measured by Sandage et al. (2006) and Tammann et al. (2008) by $\sim 15\%$ and constitutes the bulk of the difference in $H_0$ with Freedman et al. (2001) and Riess et al. (2005). A companion paper (Riess et al. 2009) provides the addition of $H$-band measurements of the Cepheids in the 7 hosts and takes advantage of the

full reduction in systematic errors afforded by our refurbished distance ladder to provide a new determination of $H_0$.

We are grateful to Peter Stetson for making his DAOPHOT/ALLFRAME software available. Financial support for this work was provided by NASA through programs GO-9352, GO-9728, GO-10189, GO-10339, GO-10497 and GO-10802 from the Space Telescope Science Institute, which is operated by AURA, Inc., under NASA contract NAS 5-26555. A.V.F.'s supernova group at U.C. Berkeley is also supported by NSF grant AST–0607485 and by the TABASGO Foundation. KAIT was constructed and supported by donations from Sun Microsystems, Inc., the Hewlett-Packard Company, AutoScope Corporation, Lick Observatory, the US National Science Foundation (NSF), the University of California, the Sylvia & Jim Katzman Foundation, and the TABASGO Foundation. Some of the data presented herein were obtained with the W. M. Keck Observatory, which is operated as a scientific partnership among the California Institute of Technology, the University of California, and NASA; the observatory was made possible by the generous financial support of the W. M. Keck Foundation. We wish to extend special thanks to those of Hawaiian ancestry on whose sacred mountain we are privileged to be guests.

**Figure Captions**

Figure 1: Image of a $2' \times 2'$ region of the field of NGC 1309 from ACS WFC $F555W$. North is up and east to the left. The locations of the Cepheids identified are indicated by circles.

Figure 2: Same as Figure 1 but for NGC 3021.

Figure 3: $F555W$ and $F814W$ light curves of Cepheids in NGC 3021. For each of the Cepheid candidates listed by identification number in Table 8, the photometry is fit to the period-specific light-curve template.

Figure 4: Same as Figure 3 for NGC 1309 (see Table 7).

Figure 5: $V$-band, $I$-band, and Wesenheit dereddened $[V - 2.45(V - I)]$ $P$-$L$ relations for Cepheids identified in NGC 1309. The $P$-$L$ relation shown is from the LMC and is only fit to the filled symbols (see Figure 12 for a slope fit to the individual relations). An approximate instability-strip width of 0.35 mag is also given for comparison. Open symbols indicate short-period Cepheids in the period range which appears to suffer an incompleteness bias (preferentially bright or significantly blended with a blue source).

Figure 6: Same as Figure 5 but for NGC 3021.

Figure 7: Same as Figure 5 but for NGC 3370.

Figure 8: Dereddened distance modulus from the $P - w$ relation as a function of the period cutoff. Although there is some evidence of an incompleteness bias at the short-period end of the $V$-band and $I$-band $P$-$L$ relations, there is no significant change in the dereddened distance modulus with period cutoff.

Figure 9: Composite $V$-band Cepheid light curves. For the Cepheids with $P > 10$ d in each host, the fitted mean magnitude was subtracted from the observations which were then plotted as a function of their phase, as inferred from the fitted period. As seen and shown in Table 11, for each host the mean half-amplitude is consistent with 0.48 mag. This consistency indicates a lack of significant variation in blending from host to host and also provides a more direct probe of metallicity which can cause amplitude differences in the mean.

Figure 10: Composite $V$-band Cepheid light curves of the longer period Cepheids, $P > 60$ d, whose discovery was enabled by reobservations of each host *HST* cycles subsequent to the discovery cycle. Although Cepheids at $P > 60$ d have reduced amplitudes, they exhibit the characteristic sawtooth light curve of a classical Cepheid and serve to extend the use of the $P$-$L$ to greater distances.

Figure 11: Radial gradients of the oxygen-to-hydrogen ratios [O/H] of H II regions in the Cepheid hosts. Following the method of Zaritsky et al. (1994), emission-line intensity ratios of [O II] $\lambda\lambda$3726, 3729, [O III] $\lambda\lambda$4959, 5007, and H$\beta$ were used to derive values of 12 + log[O/H] for H II regions. The fitted linear gradient was used to determine the value of the metallicity correction

at the individual radii of the observed Cepheids. The variance in the data is dominated by spatial variations, not measurement errors.

Figure 12: The measured slopes of the dereddened (Wesenheit) $P - w$ relations as a function of the mean metallicity parameter. The 7 hosts in Table 2 (including the inner region of NGC 4258) have solar-like metallicities and slopes which are mutually consistent with their mean of $-2.98 \pm 0.07$. This mean is consistent with the slope inferred from parallax distances to Galactic Cepheids (Leeuwen et al. 2007) indicated by the X, in good agreement with the LMC slope (square) and inconsistent with the Galactic slope (diamond) inferred from non-geometric distance measures (Tammann et al. 2003).

Figure 13: Ground-based comparison stars in the field of NGC 1309 (SN 2002fk; *left*) and NGC 3021 (SN 1995al; *right*) used to calibrate the light curves of the respective SNe Ia.

Figure 14: MLCS2k2 fits to the multi-band data for SN 1995al and SN 2002fk.

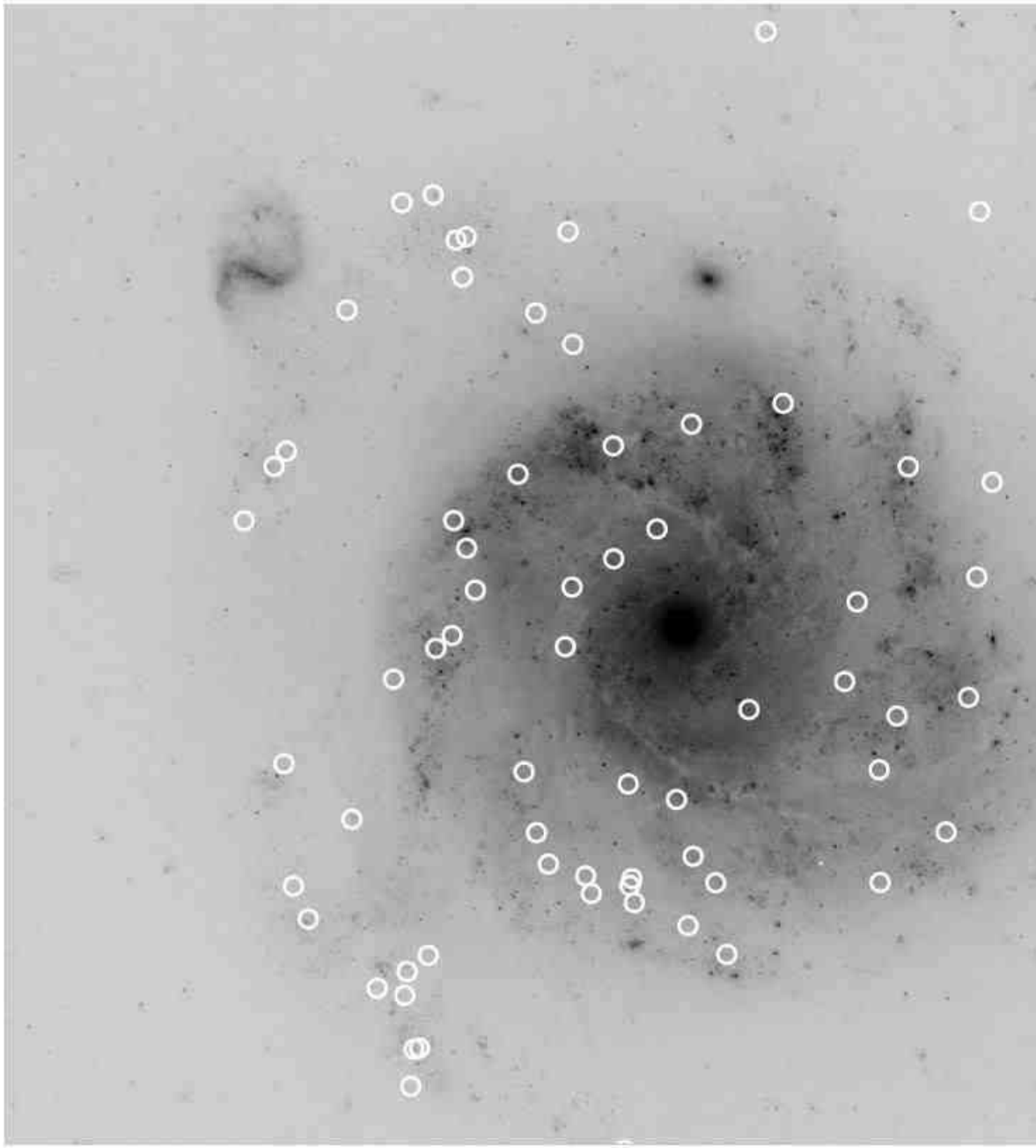


Fig. 1.—

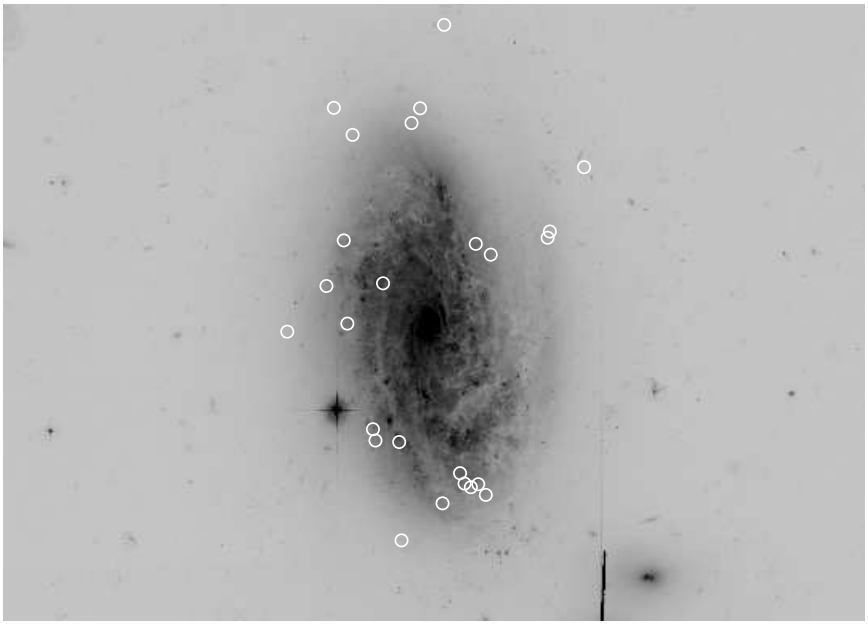


Fig. 2.—

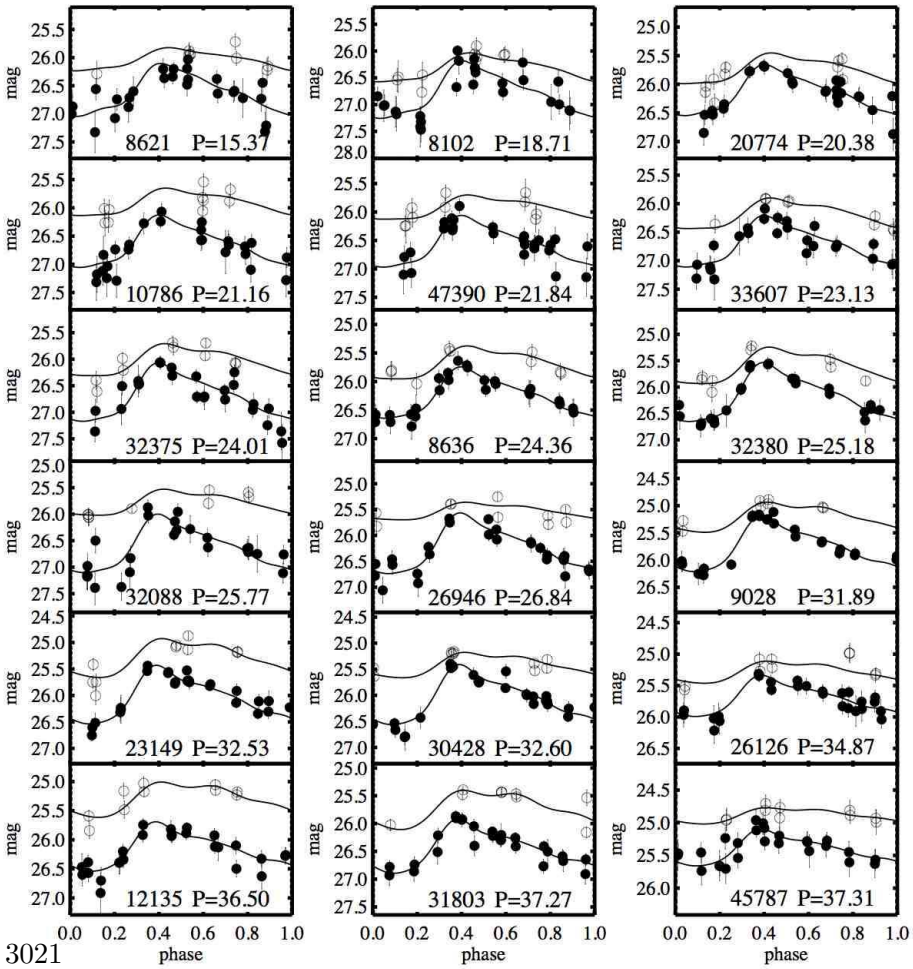



Fig. 3.— Page 1 of 2 3021

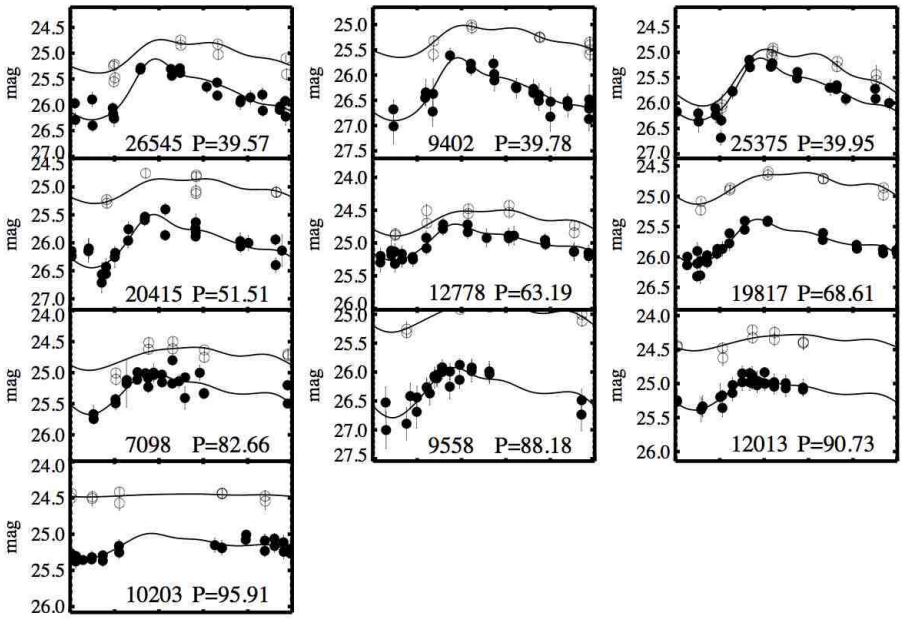



Fig. 3.— Page 2 of 2 3021

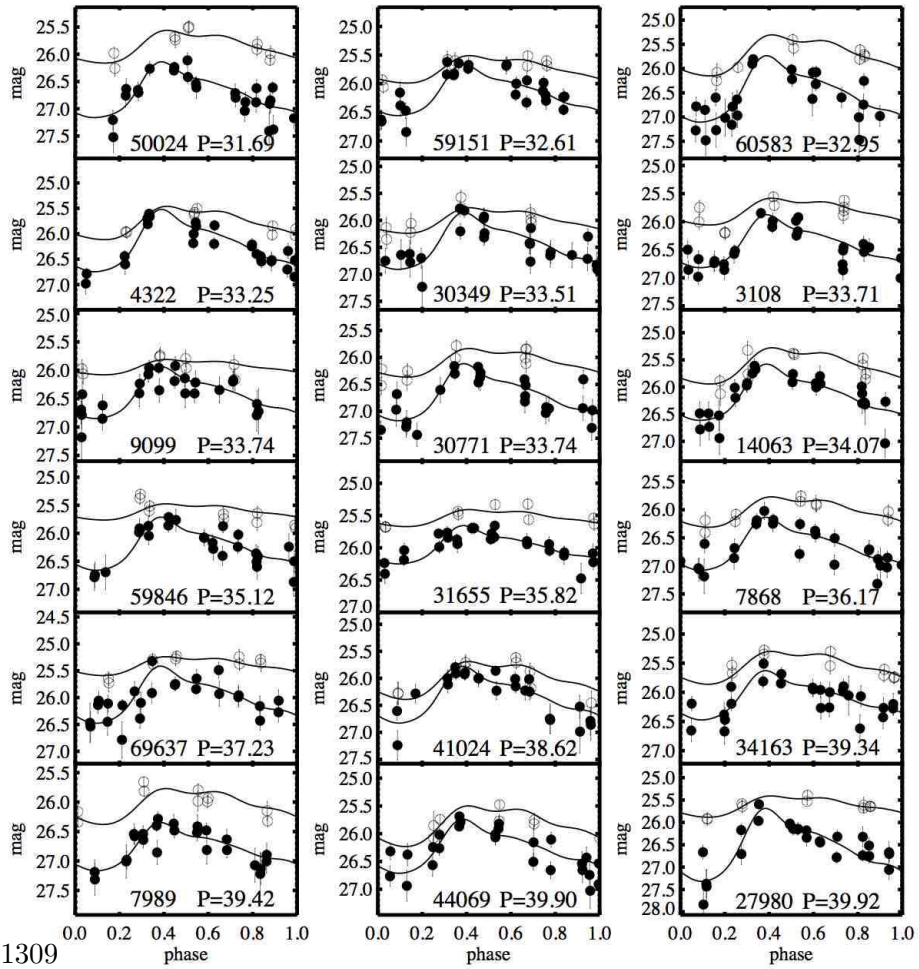



Fig. 4.— Page 1 of 5 1309

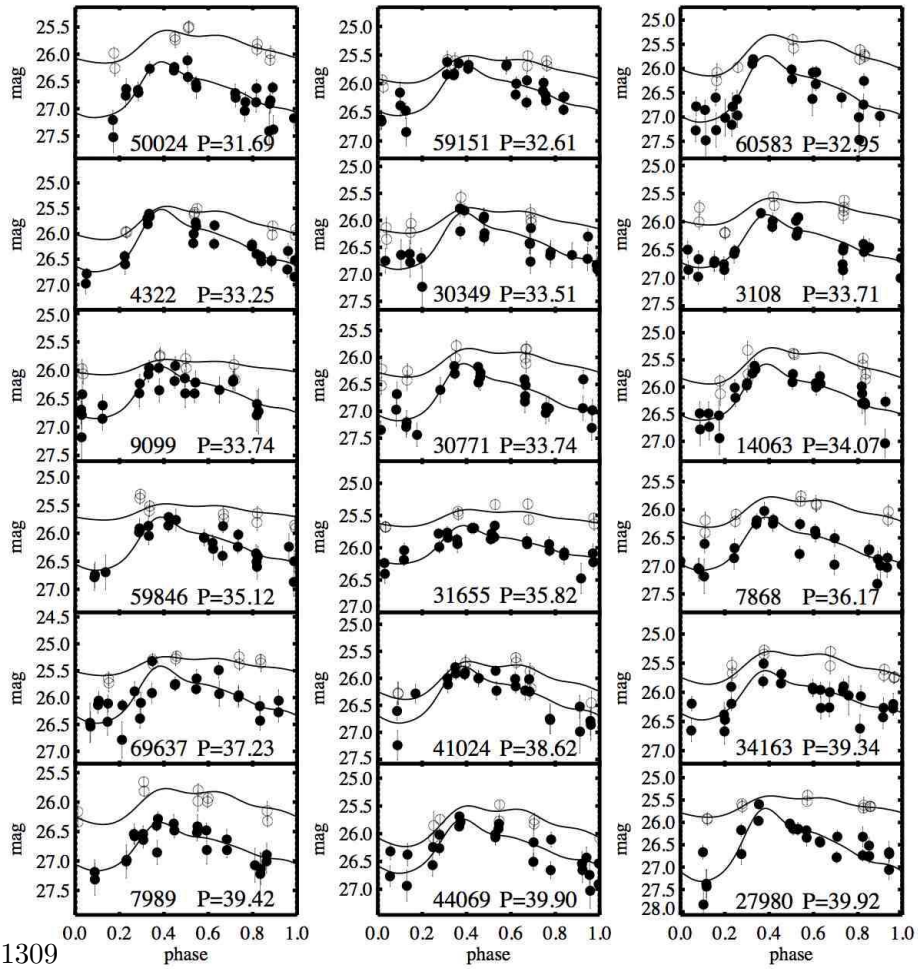



Fig. 4.— Page 2 of 5 1309

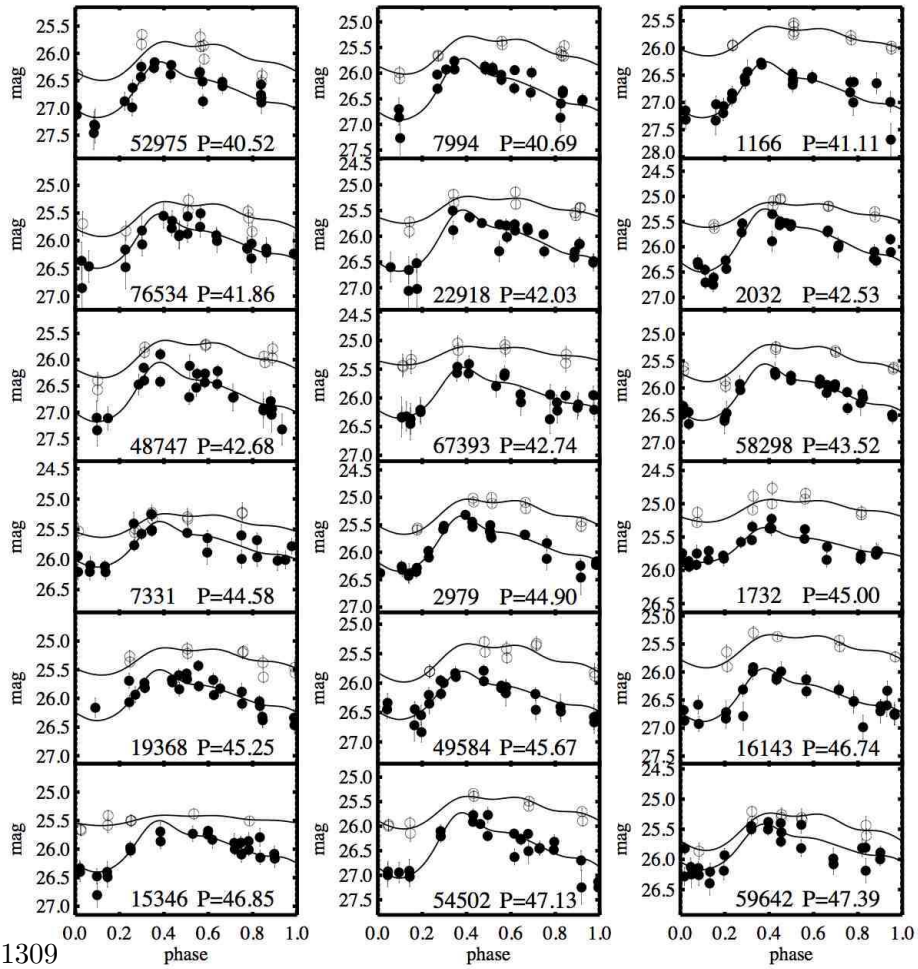



Fig. 4.— Page 3 of 5 1309

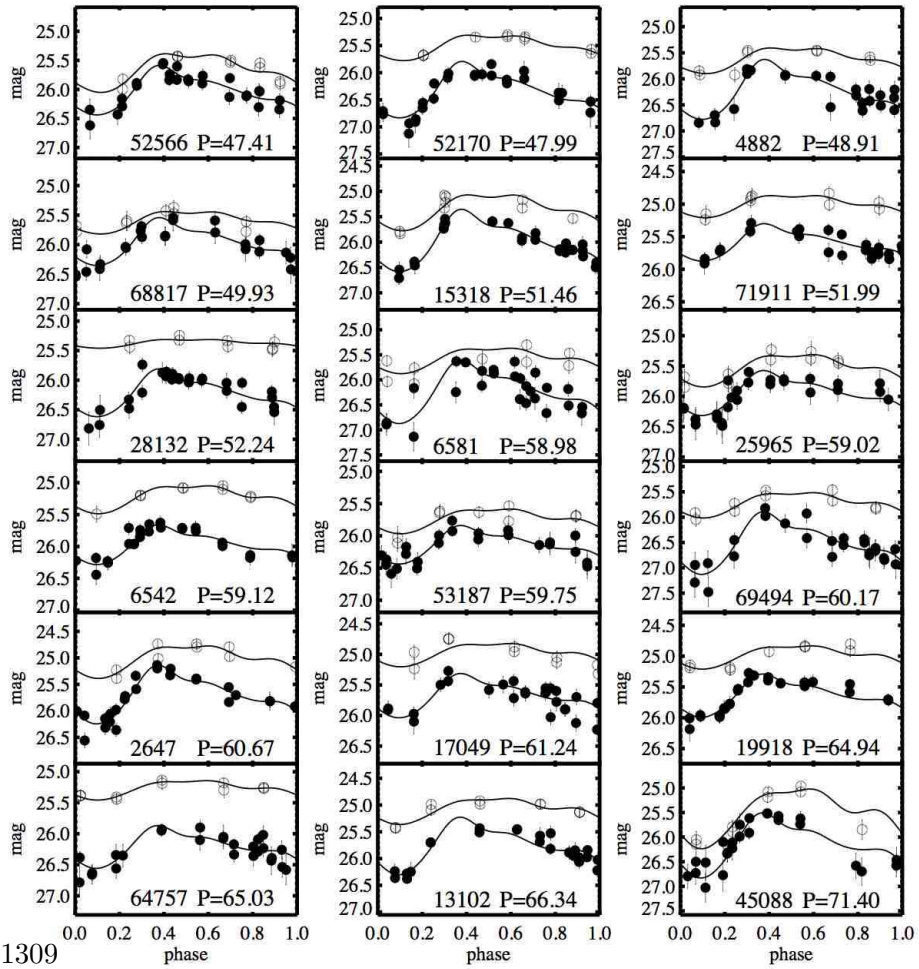



Fig. 4.— Page 4 of 5 1309

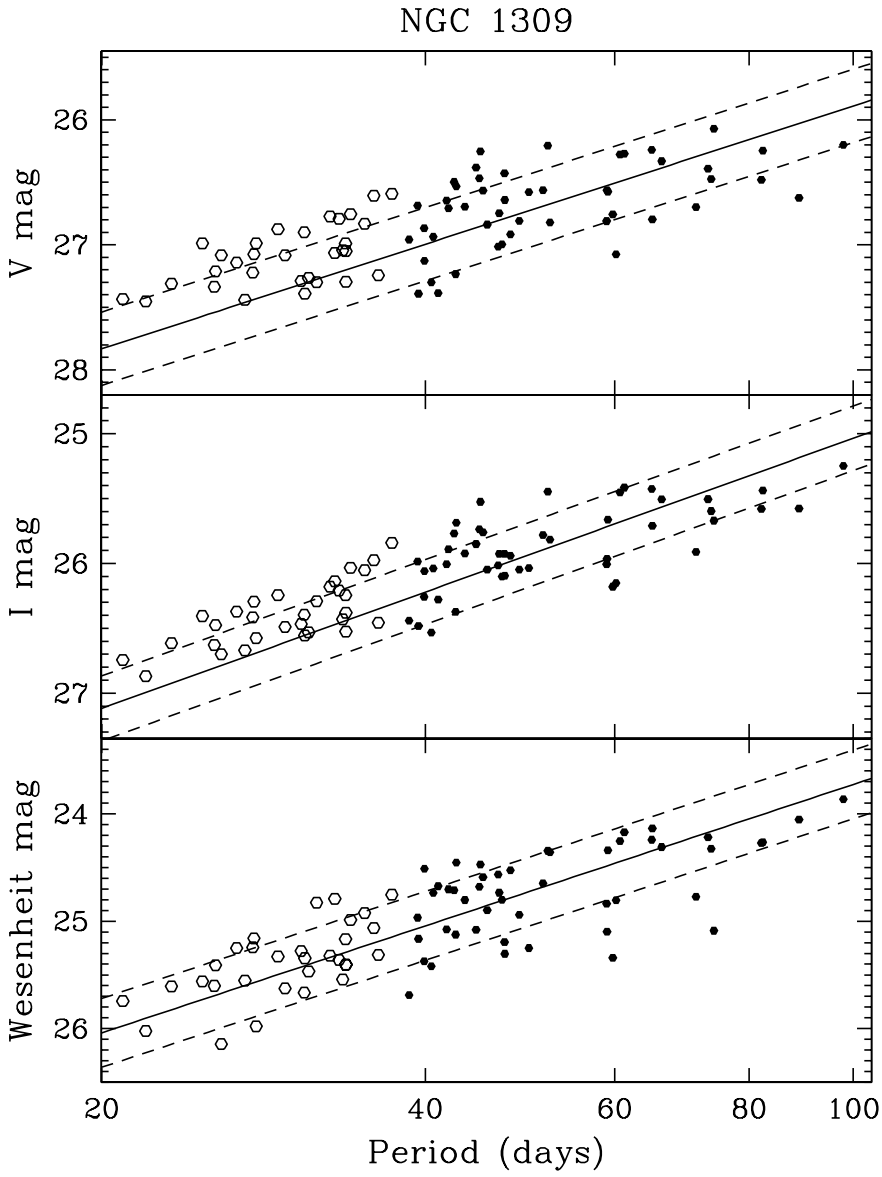

NGC 1309
V mag
I mag
Wesenheit mag
Period (days)
26
27
28
25
26
27
24
25
26
20
40
60
80
100

Fig. 5.—

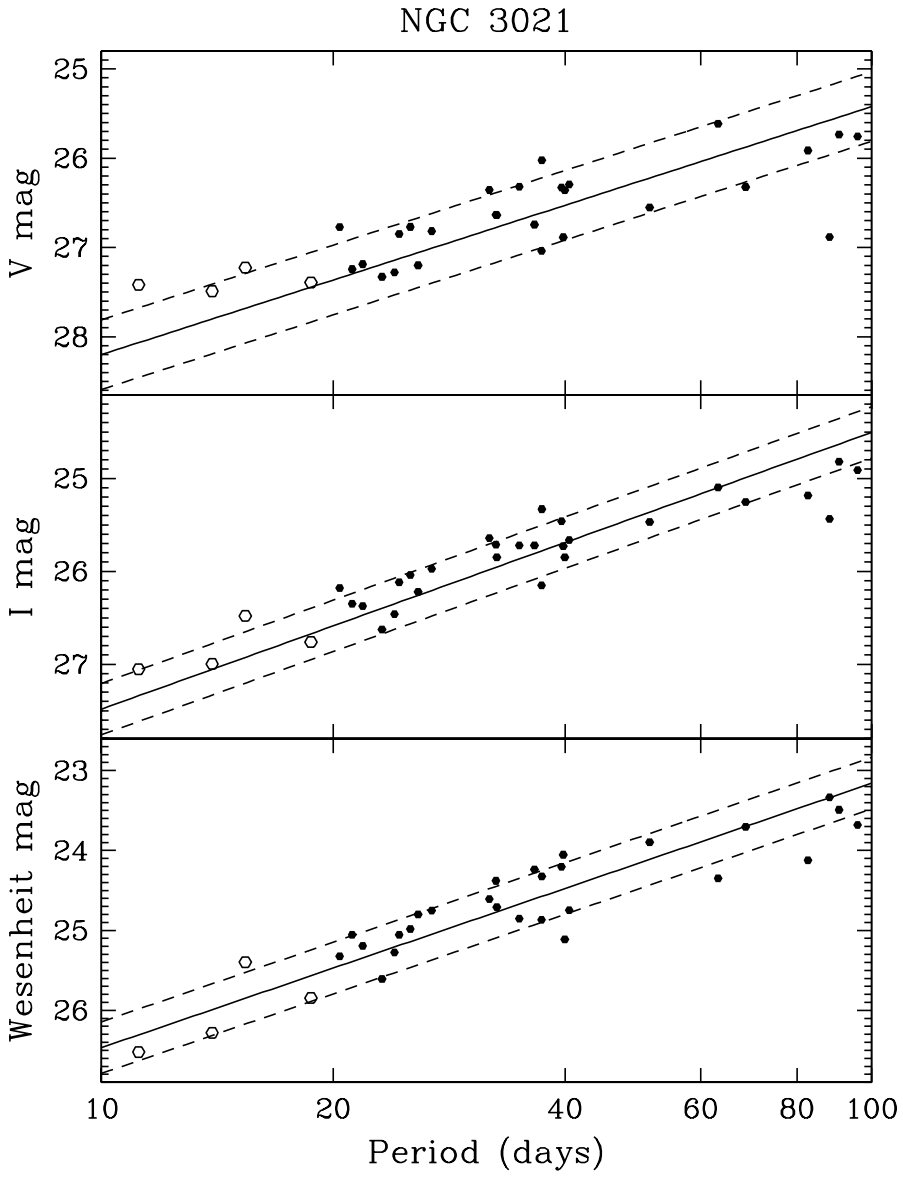

NGC 3021
V mag
I mag
Wesenheit mag
Period (days)
25
26
27
28
23
24
10
20
40
60
80
100

Fig. 6.—

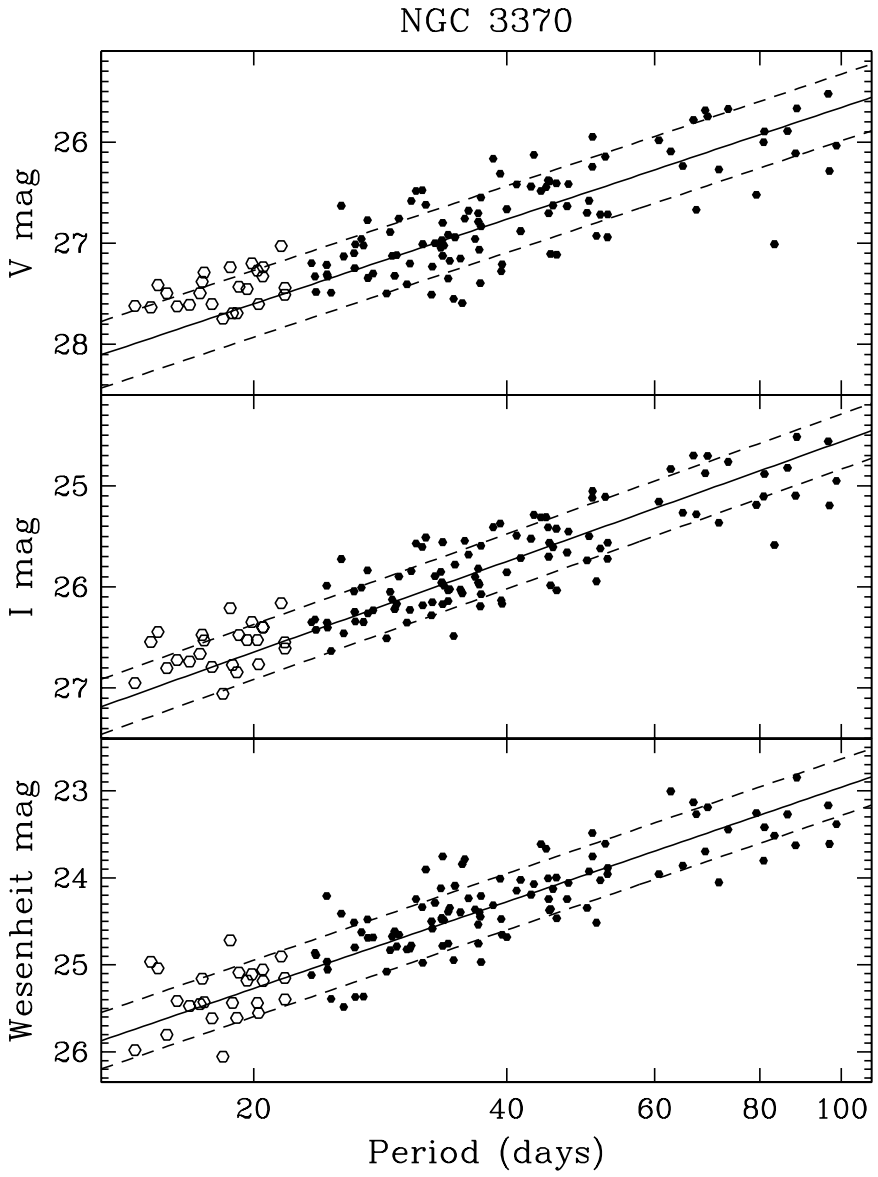

NGC 3370
V mag
I mag
Wesenheit mag
Period (days)
26
27
28
25
26
27
23
24
25
26
20
40
60
80
100

Fig. 7.—

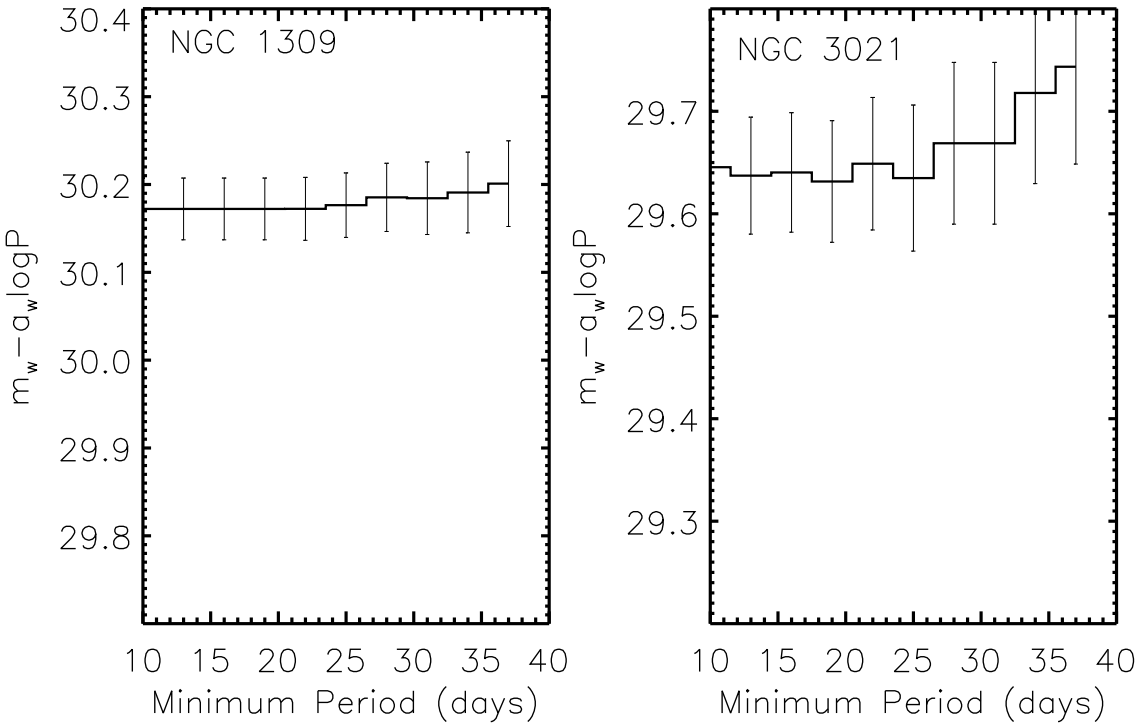

NGC 1309
NGC 3021
$m_w - a_w \log P$
Minimum Period (days)
30.4
30.3
30.2
30.1
30.0
29.9
29.8
29.7
29.6
29.5
29.4
29.3
10 15 20 25 30 35 40

Fig. 8.—

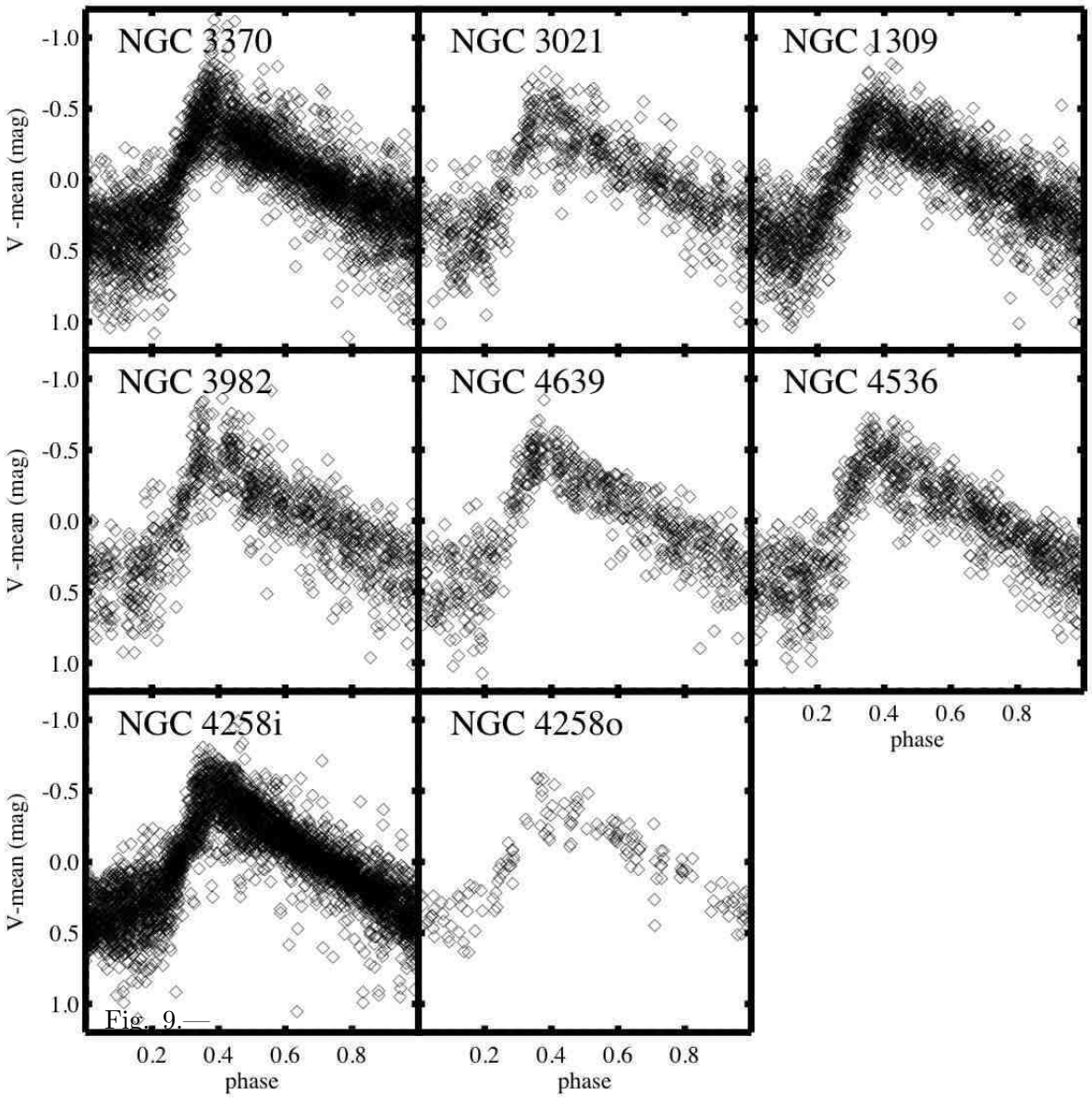

NGC 3370
NGC 3021
NGC 1309
NGC 3982
NGC 4639
NGC 4536
NGC 4258i
NGC 4258o
V -mean (mag)
V-mean (mag)
-1.0
-0.5
0.0
0.5
1.0
0.2
0.4
0.6
0.8
phase

Fig. 9.—

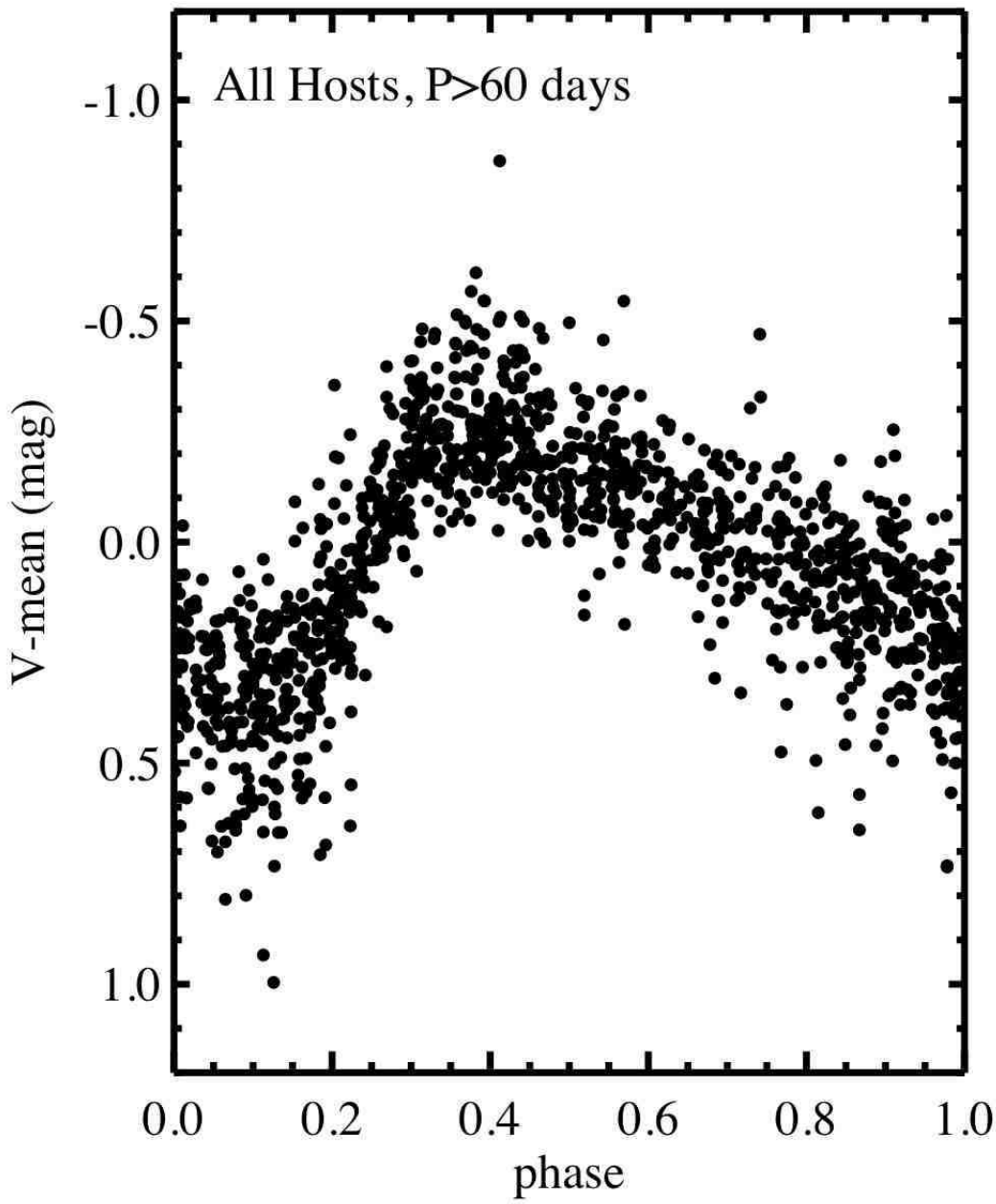

All Hosts, P>60 days
-1.0
-0.5
0.0
0.5
1.0
V-mean (mag)
0.0
0.2
0.4
0.6
0.8
1.0
phase

Fig. 10.—

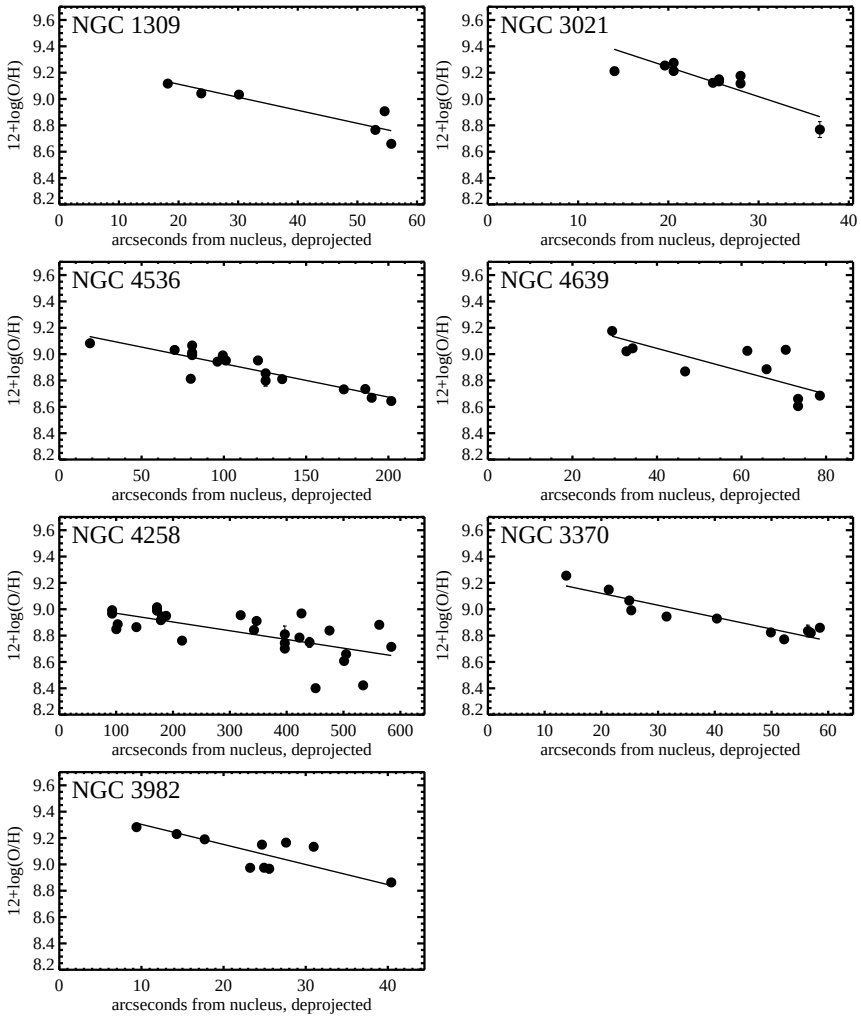

NGC 1309
NGC 3021
NGC 4536
NGC 4639
NGC 4258
NGC 3370
NGC 3982
12+log(O/H)
arcseconds from nucleus, deprojected

Fig. 11.—

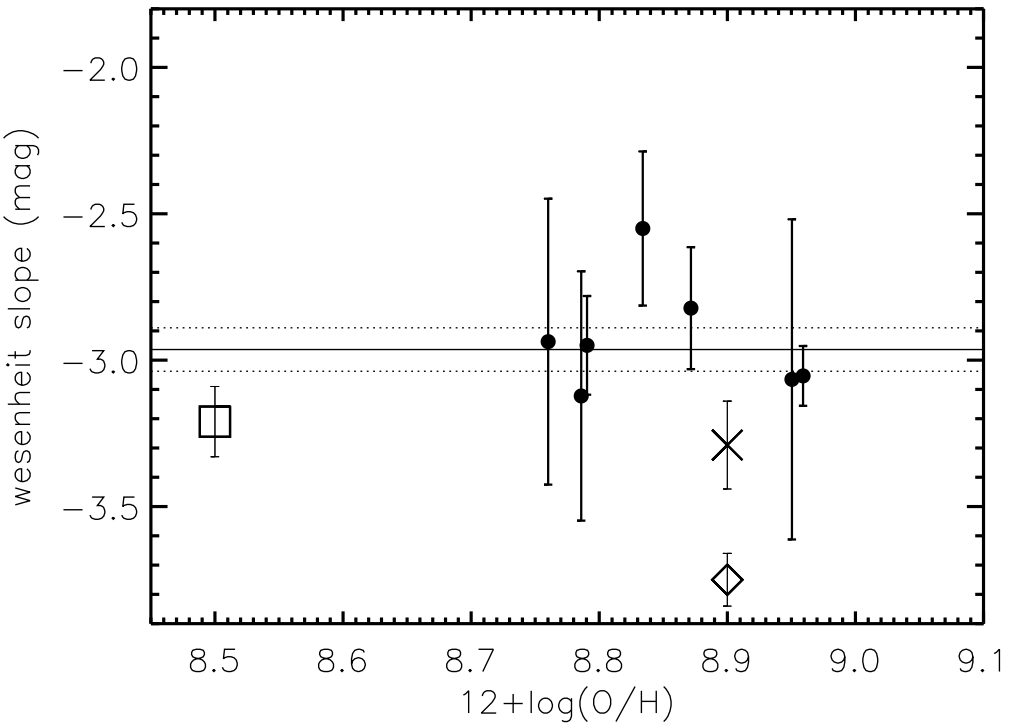



Fig. 12.—

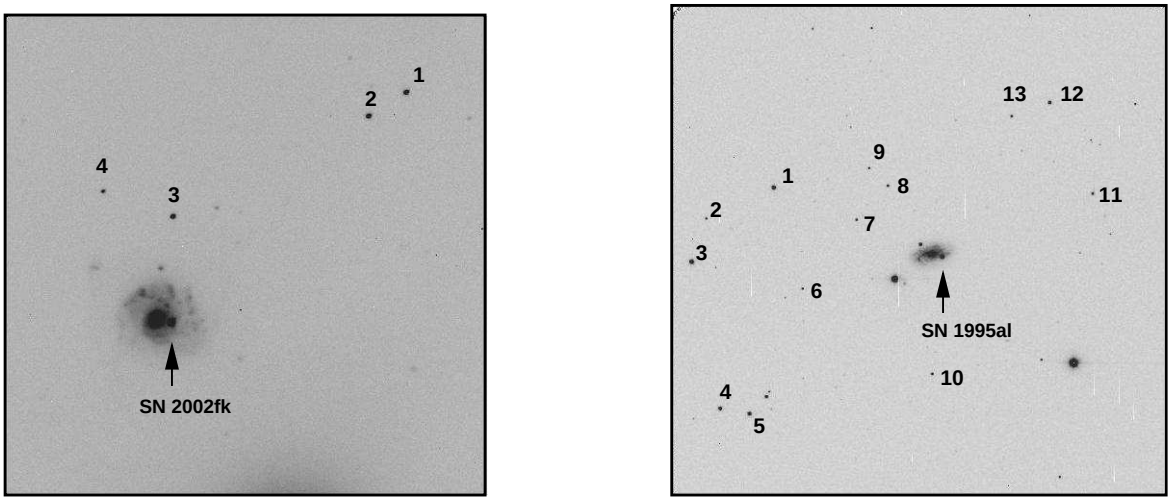



Fig. 13.— Comparison Star Finders for SNe

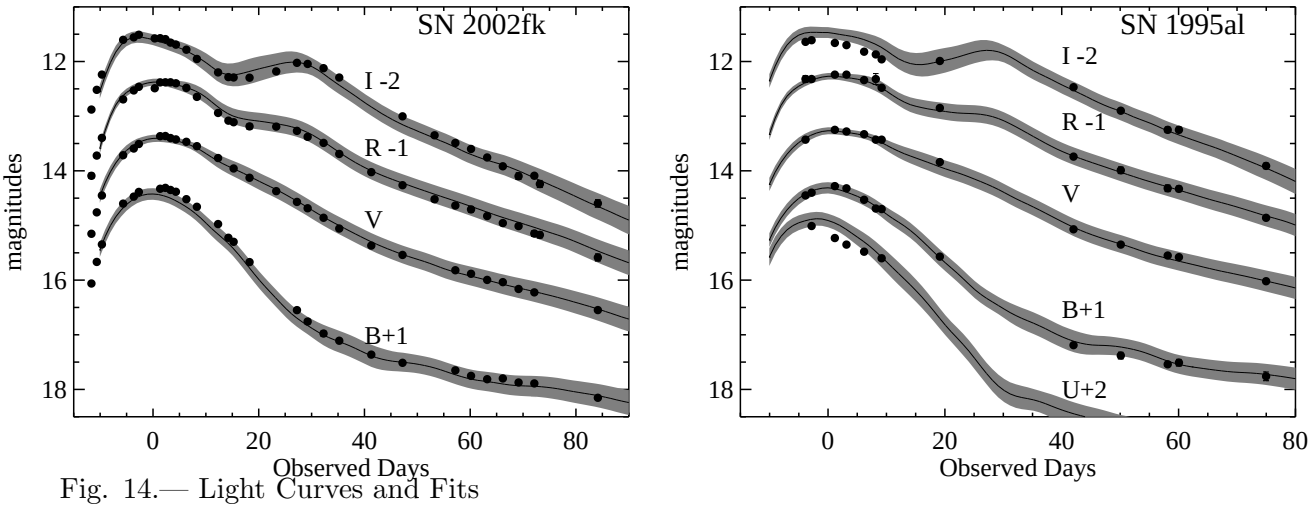



Fig. 14.— Light Curves and Fits

## REFERENCES

Alibert, Y., Baraffe, I., Hauschildt, P., & Allard, F. 1999, A&A, 344, 551

Andrievsky, S. M., Kovtyukh, V. V., Luck, R. E., Lépine, J. R. D., Maciel, W. J., & Beletsky, Y. V. 2002, A&A, 392, 491

Andrievsky, S. M., Luck, R. E., Martin, P., & Lépine, J. R. D. 2004, A&A, 413, 159

Ayani, K., & Yamaoka, H. 2002, IAU Circ. No. 7976

Benedict, G. F., et al. 2007, AJ, 133, 1810

Bird, J. C., Stanek, K. Z., & Prieto, J. L. 2009, ApJ, in press (arXiv:0807.4933)

Bono, G., Caputo, F., Castellani, V., & Marconi, M. 1999, ApJ, 512, 711

Buta, R. J., & Turner, A. 1983, PASP, 95, 72

Chiaberge, M., et al. 2009, HST ACS Instrument Science Report

Ferrarese, L., Silbermann, N. A., Mould, J. R., Stetson, P. B., Saha, A., Freedman, W. L., & Kennicutt, R. C., Jr. 2000, PASP, 112, 177

Filippenko, A. V., Li, W. D., Treffers, R. R., & Modjaz, M. 2001, in Small Telescope Astronomy on Global Scales, ed. W. P. Chen, C. Lemme, & B. Paczyński (San Francisco: ASP), 121

Ford, H. C., et al. 2003, Proc. SPIE, 4854, 81

Fouqué, P., et al. 2007, A&A, 476, 73

Freedman, W. L., Madore, B. F., Hawley, S. L., Horowitz, I. K., Mould, J., Navarrete, M., & Sallmen, S. 1992, ApJ, 396, 80

Freedman, W. L., et al. 2001, ApJ, 553, 47

Gibson, B. K., et al. 2000, ApJ, 529, 723

Gieren, W., et al. 2005, ApJ, 627, 224

Gieren, W., et al. 2008, ApJ, 683, 611

Guy, J., Astier, P., Nobili, S., Regnault, N., & Pain, R. 2005, A&A, 443, 781

Hamuy, M., Phillips, M. M., Maza, J., Suntzeff, N. B., Schommer, R. A., & Aviles, R. 1995, AJ, 109, 1

Hamuy, M., Phillips, M. M., Suntzeff, N. B., Schommer, R. A., Maza, J., Smith, R. C., Lira, P., & Aviles, R. 1996, AJ, 112, 2438

Holtzman, J. A., Burrows, C. J., Casertano, S., Hester, J. J., Trauger, J. T., Watson, A. M., & Worthey, G. 1995, PASP, 107, 1065

Jha, S., Riess, A. G., & Kirshner, R. P. 2007, ApJ, 659, 122

Jha, S., et al. 2006, AJ, 131, 527

Kanbur, S. M., & Ngeow, C.-C. 2004, MNRAS, 350, 962

Kanbur, S. M., & Ngeow, C.-C. 2006, MNRAS, 369, 705

Kennicutt, R. C., et al. 1998, ApJ, 498, 181

Kochanek, C. S. 1997, ApJ, 491, 13

Landolt, A. U. 1992, AJ, 104, 340

Leonard, D. C., et al. 2003, ApJ, 594, 247

Li, W. D., et al. 2000, in Cosmic Explosions, ed. S. S. Holt & W. W. Zhang (New York: AIP), 103

Macri, L. M., Stetson, P. B., Bothun, G. D., Freedman, W. L., Garnavich, P. M., Jha, S., Madore, B. F., & Richmond, M. W. 2001, ApJ, 559, 243

Macri, L. M., Stanek, K. Z., Bersier, D., Greenhill, L. J., & Reid, M. J. 2006, ApJ, 652, 1133

Macri, L. M., et al. 2009, submitted

Madore, B. F. 1982, ApJ, 253, 575

Madore, B. F. & Freedman, W. L., 2009, ApJin press

Marconi, M., Musella, I., & Fiorentino, G. 2005, ApJ, 632, 590

Oke, J. B., et al. 1995, PASP, 107, 375

Paczyński, B., & Pindor, B. 2000, ApJ, 533, L103

Perlmutter, S., et al. 1997, ApJ, 483, 565

Persson, S. E., Madore, B. F., Krzemiński, W., Freedman, W. L., Roth, M., & Murphy, D. C. 2004, AJ, 128, 2239

Phillips, M. M., Lira, P., Suntzeff, N. B., Schommer, R. A., Hamuy, M., & Maza, J. 1999, AJ, 118, 1766

Phillips, M. M. 1993, ApJ, 413, L105

Riess, A. G., Press, W. H., & Kirshner, R. P. 1995, ApJ, 438, L17

Riess, A. G., Press, W. H., & Kirshner, R. P. 1996, ApJ, 473, 88

Riess, A. G., Press, W. H., & Kirshner, R. P. 1996, ApJ, 473, 588

Riess, A. G., et al. 1998, AJ, 116, 1009

Riess, A. G., et al. 1999, AJ, 117, 707

Riess, A. G., et al. 2005, ApJ, 627, 579

Riess, A. G., et al. 2009, submitted

Saha, A., Sandage, A., Labhardt, L., Tammann, G. A., Macchetto, F. D., & Panagia, N. 1997, ApJ, 486, 1

Saha, A., et al. 1996, ApJ, 466, 55

Saha, A., et al. 2001, ApJ, 562, 314

Saha, A., et al. 2006, ApJS, 165, 108

Sakai, S., et al. 2004, ApJ, 608, 42

Sandage, A., & Tammann, G. A. 2008, ApJ, 686, 779

Sandage, A., et al. 2006, ApJ, 653, 843

Sirianni, M., et al. 2003, ApJS, 148, 175

Stetson, P. B. 1987, PASP, 99, 191

Stetson, P. B. 1994, PASP, 106, 250

Stetson, P. B. 1996, PASP, 108, 851

Stetson, P. B. 2000, PASP, 112, 925

Stetson, P. B., & Gibson, B. K. 2001, MNRAS, 328, L1

Stetson, P. B., et al. 1998, ApJ, 508, 491

Tammann, G. A., Sandage, A., & Reindl, B. 2008, ApJ, 679, 52

Tammann, G. A., Sandage, A., & Reindl, B. 2003, A&A, 404, 423

Udalski, A., et al. 1999, Acta Astronomica, 49, 223

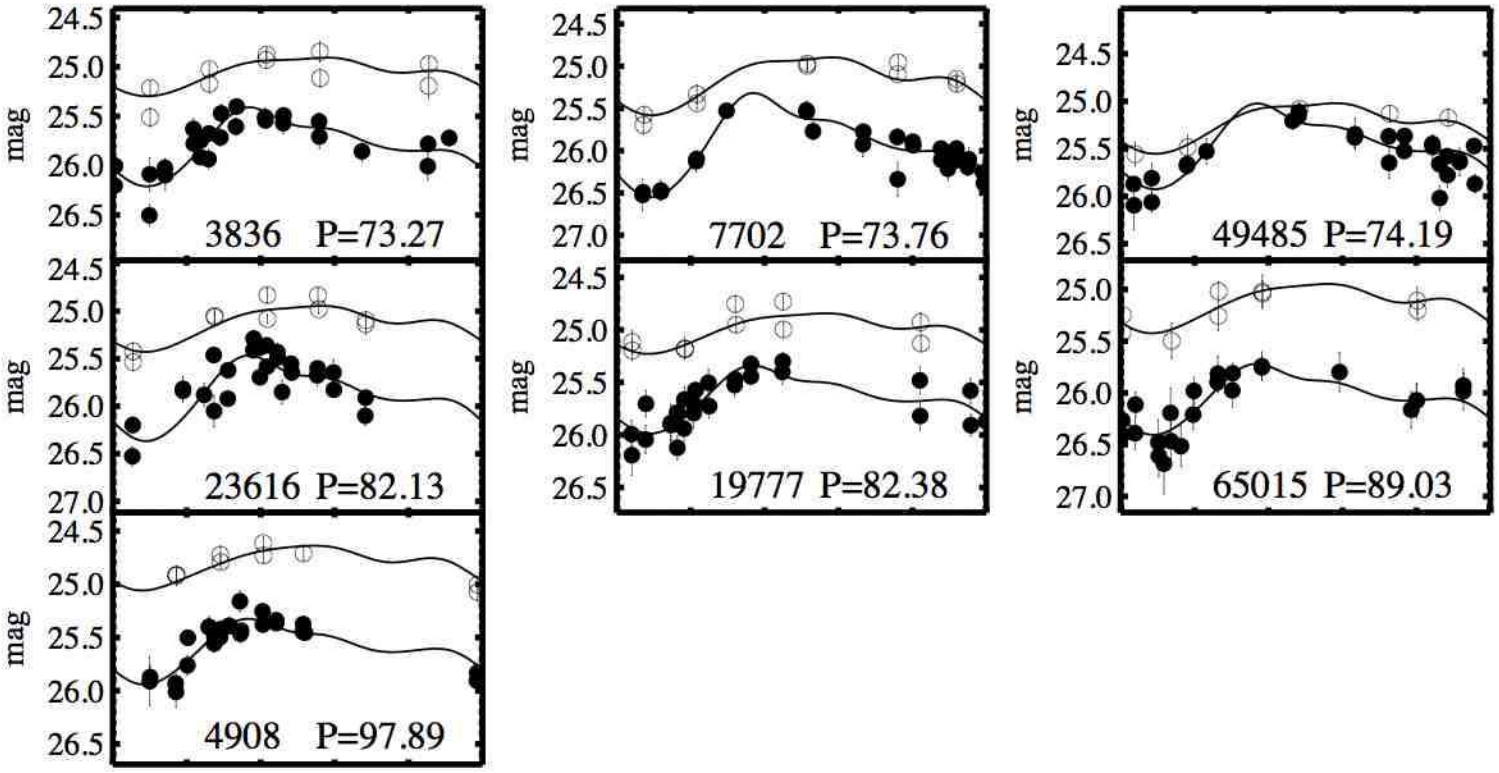
van Leeuwen, F., Feast, M. W., Whitelock, P. A., & Laney, C. D. 2007, MNRAS, 379, 723

Valencic, Clayton, & Gordon, 2004, ApJ, 616, 912

Wang, X., et al. 2009, ApJ, submitted (arXiv:0811.1205)

Wei, J.-Y., et al. IAU Circ. No. 6256

Zaritsky, D., Kennicutt, R. C., & Huchra, J. P. 1994, ApJ, 420, 87


mag
3836 P=73.27
23616 P=82.13
4908 P=97.89
7702 P=73.76
19777 P=82.38
49485 P=74.19
65015 P=89.03