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The Solar Neighborhood X: New Nearby Stars in the Southern Sky and Accurate Photometric Distance Estimates for Red Dwarfs

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ABSTRACT

Photometric ($V_J R_C I_C$) and spectroscopic (6000–9500Å) observations of high proper motion stars discovered during the first phase of the SuperCOSMOS RECONS (SCR) search are used to estimate accurate distances to eight new nearby red dwarfs, including probable 10 pc sample members SCR 1845-6357 (M8.5V at 4.6 pc), the binary SCR 0630-7643AB (M6.0VJ at 7.0 pc), and SCR 1138-7721 (M5.0V at 9.4 pc). Distance estimates are determined using a suite of new photometric color- M_{K_s} relations defined using a robust set of nearby stars with accurate $VRIJHK_s$ photometry and trigonometric parallaxes.

These relations are utilized, with optical and infrared photometry, to estimate distances on a uniform system (generally good to 15%) for two additional samples of red nearby star candidates: several recently discovered members of the solar neighborhood, and known faint stars with proper motions in excess of $1.0''/\text{yr}$ south of $\text{DEC} = -57.5$. Of those without accurate trigonometric parallax measurements, there are five stars in the first sample and three in the second that are likely to be within 10 pc. The two nearest are SO 0253+1652 (M7.0V at 3.7 pc) and DEN 1048-3956 (M8.5V at 4.5 pc). When combined with SCR 1845-6357, these three stars together represent the largest increase in the 5 pc sample in several decades.

Red spectra are presented for the red dwarfs and types are given on the RECONS standard spectral system. Red spectra are also given for two new nearby white dwarfs for which we estimate distances from the photometry of less than 20 pc — WD 0141-675 (LHS 145, 9.3 pc) and SCR 2012-5956 (17.4 pc). WD 0141-675 brings the total number of systems nearer than 10 pc discussed in this paper to 12.

Subject headings: stars: distances — stars: statistics — solar neighborhood

1. Introduction

Large plate digitization efforts such as the Digitized Sky Survey and SuperCOSMOS, as well as sky surveys such as 2MASS and SDSS, have led to a renaissance in the search for faint objects lying undiscovered in the solar neighborhood. In particular, the census of the nearest stars (Henry et al. 1997) is gradually being filled in to the end of the stellar main sequence. Many of the new discoveries are the latest M dwarfs (spectral types M6.0V to M9.5V), some of which are among the nearest few dozen stellar systems. Each of the recent discoveries has been made via high proper motion and/or color surveys, some relying on the classic work of Luyten (Scholz et al. 2001; Reid & Cruz 2002), while others are from entirely original efforts (Delfosse et al. 2001; Lepine et al. 2002; Teegarden et al. 2003; Cruz et al. 2003; this work).

Here we report optical photometry and spectroscopy for nine new nearby star candidates from the first phase of the SuperCOSMOS RECONS (SCR) search (Hambly et al. 2004) that have proper motions in excess of $1.0''/\text{yr}$ or have types of M6.0V or later. One object in particular, SCR 1845-6357, is remarkable, having $V_J = 17.40$, $R_C = 15.00$, $I_C = 12.47$, and spectral type M8.5V. We predict that it lies only 4.6 pc from the Sun, making it the third new stellar system found within 5 pc in the last few years. This jump in the 5 pc census from 44 to 47 systems represents a 7% increase. Two of the three new neighbors are found south of $\text{DEC} = -30$, where searches for nearby stars are less complete than in the north.

We also provide a suite of new, robust, relations using $VRIJHK_s$ photometry to estimate distances for nearby stars. These relations hinge on the M_{K_s} magnitudes of single stars within 10 pc with high quality parallaxes, supplemented with recent results for very red stars, many of which now have reliable parallaxes placing them within 25 pc (e.g. Dahn et al. 2002). When used as an ensemble, these relations allow photometric distance estimates to be more accurate than ever before, generally good to 15%. We give distance estimates for the new SCR discoveries, several red dwarfs advertised to be nearby, and for the sample of known faint stars with $\mu > 1.0''/\text{yr}$ south of $\text{DEC} = -57.5$. We also provide a detailed check of the technique by applying it to the sample of very red dwarfs with parallaxes.

2. Samples

Four samples are included in the current effort. Details are given in Tables 1 and 2. The initial phase of the SCR search provides a large number of new proper motion stars south of $\text{DEC} = -57.5$ that have $R_2 = 10.0$ to 16.5 (R_2 represents the photographic R_{59F} band). Details of the search are given in Hambly et al. (2004). In this paper, we discuss the five SCR stars with $\mu \geq 1.0''/\text{yr}$ and four others with $\mu = 0.4\text{--}1.0''/\text{yr}$ that have spectral types of M6.0V or later. Finder charts are given in Figure 1.

The second sample includes eight red dwarfs with spectral types M6.0V to M8.5V that have

photometric or spectroscopic distance estimates bringing them into the sample of the nearest few hundred stellar systems. Various distance estimates have been made for these stars using many techniques, sometimes yielding highly discordant estimates. Here we provide $VRIJHK_s$ photometry and optical spectroscopy so that they can be compared on uniform photometric and spectroscopic systems.

The third sample includes previously known stars with $\mu \geq 1.0''/\text{yr}$ south of $\text{DEC} = -57.5$, the region investigated in the first phase of the SCR search. The *LHS Catalogue* (Luyten 1979, hereafter LHS) includes a total of 37 stars meeting these criteria, 22 of which are fainter than $m_R = 10$ by Luyten’s estimate. Also meeting these criteria are an additional white dwarf pair found recently by Scholz et al. (2001), and a red dwarf found by Pokorny et al. (2003), bringing the total sample to 25 objects. The SCR search recovered 21 of these — four were missed due to image blending.

The fourth sample includes 31 M dwarfs with spectral types M6.0V to M9.5V within 25 pc that are combined with the RECONS sample of stars within 10 pc to develop high quality color- M_K relations. We refer to these stars as the “supplemental sample”.

3. Observations

3.1. Photometry

The primary sources for red dwarf photometry in the $V_JR_CI_C$ system are the comprehensive efforts reported in Bessell (1990), Bessell (1991), Leggett (1992), Weis (1996), and Dahn et al. (2002). Once those sources were exhausted, additional references were used as listed in Tables 1 and 2, in particular for the reddest M dwarfs.

Optical photometry for the SCR stars and additional objects listed in Table 1 was obtained in the $V_JR_CI_C$ bands using the Cerro Tololo Interamerican Observatory (CTIO) 0.9m telescope during several observing runs from 2000 to 2004 as part of the NOAO Surveys Program and the SMARTS (Small and Moderate Aperture Research Telescope System) Consortium. The 2048×2046 Tektronix CCD camera was used with the Tek #2 VRI filter set. Standard stars from Graham (1982), Bessell (1990), and Landolt (1992) were observed through a range of airmasses each night to place measured fluxes on the $V_JR_CI_C$ system and to calculate extinction corrections.

Data were reduced using IRAF via typical bias subtraction and dome flat fielding, utilizing calibration frames taken at the beginning of each night. In general, a circular aperture $14''$ in diameter was used to determine stellar fluxes in order to match the aperture used by Landolt (1992) for the standard stars. In cases of crowded fields, an appropriate aperture $6\text{--}12''$ in diameter was used to eliminate stray light from close sources, and aperture corrections were applied. Program stars were typically observed on multiple nights, yielding a measure of the internal, night-to-night, errors of $\pm 0.031, 0.021, 0.025$ mag at $V_JR_CI_C$, respectively, for stars with three or more nights of

data (which are usually the faintest targets). From the fits of the standard stars, external errors are estimated to be ± 0.017 , 0.015 , 0.020 mag $V_J R_C I_C$, respectively. From these two error estimates, we adopt a total error of ± 0.03 mag in each band. The final magnitudes are given in Table 1.

Infrared photometry in the JHK_s system has been extracted from 2MASS, and is also given in Tables 1 and 2. The errors are the $x_m sigcom$ errors (where x is j, h, or k), which give a measure of the total photometric uncertainty including global and systematic terms. The errors are almost always less than 0.05 mag, and are typically 0.02–0.03 mag. Notable exceptions are the three white dwarfs SCR 2012-5956 (errors of 0.05, 0.11, null at JHK_s respectively; at $K_s > 15.4$, the star is too faint for a reliable measurement of the magnitude and error), SSPM J2231-7515 (0.04, 0.06, and 0.12 mag), and SSPM J2231-7514 (0.04, 0.06, and 0.08 mag).

3.2. Spectroscopy

There are two large, reliable, bodies of spectroscopic work for M dwarfs that utilize modern CCDs — that of the RECONS group (e.g. Kirkpatrick et al. 1991; Henry et al. 2002) and the Palomar/MSU (PMSU) survey (Reid et al. 1995; Hawley et al. 1996). The PMSU types are based upon comparisons with objects observed by the RECONS group, but employ a restricted range in wavelength coverage, $\sim 6300\text{--}7200\text{\AA}$ (for the CTIO setup, which is the one most relevant for the southern stars discussed here). Spectral types from other authors given in Tables 1 and 2 are often the result of comparison to RECONS spectral types. In one case (Bessell 1991), spectral types are on a different system altogether, but a representative spectral type is better than none.

New spectra were obtained during observing runs in July, October, and December 2003, and March 2004 at the CTIO 1.5m telescope as part of the SMARTS Consortium. The R-C Spectrograph and Loral 1200 X 800 CCD detector were used with grating #32, which provided 8.6\AA resolution and wavelength coverage from $6000\text{--}9500\text{\AA}$. In a few cases, spectra are included from previous CTIO 4.0m runs that utilized the R-C Spectrograph and Loral $3K \times 1K$ CCD detector with grating #181, which provided 5.7\AA resolution and wavelength coverage from $5000\text{--}10000\text{\AA}$. In all cases, data were reduced using IRAF via typical bias subtraction and dome and/or sky flat fielding, using calibration frames taken at the beginning of each night. Fringing at red wavelengths in the 4.0m data was removed by fitting the fringes and subtracting them via a tailored IDL program. Fringing was effectively removed from the 1.5m data in a more straightforward manner using a combination of dome and sky flats.

Spectral types were assigned using the ALLSTAR program as described in Henry et al. (2002), which currently contains a library of ~ 500 K5.0V to M9.0V spectra. RECONS types in Tables 1 and 2 have been assigned using a new finely-tuned set of M6.0V to M9.0V standards, illustrated in Figure 2, thereby placing all stars on a uniform system. In a few cases, spectral types have shifted from those previously published by RECONS and others (given in the notes). These updates are warranted, because the new spectra reported generally have higher resolution and broader

wavelength coverage than previous spectra, and were taken on only two telescopes, thereby reducing instrumental inconsistencies. Spectra of the eight new SCR red dwarfs and seven of the eight new very red solar neighbors are shown in Figures 2–4, ranked from bluest to reddest in each panel.

As predicted by the photometry and the reduced proper motion diagram, the spectrum of SCR 2012-5956 indicates that it is a white dwarf. For comparison, shown in Figure 5 are its spectrum and the similar spectrum of the white dwarf GJ 440. An additional white dwarf, LHS 2621, also has a similar spectrum, and to our knowledge this is the first report that it is a white dwarf. The lack of any obvious spectral features indicates that the type could be DC or DQ (because no strong carbon features typical of DQ white dwarfs are included in the spectral range shown here; the “features” in all three are telluric). Also shown is the spectrum of WD 0141-675 (LHS 145), a new nearby DA white dwarf for which we have determined a parallax within 10 pc (the subject of a future paper), and spectra for two similar DA white dwarfs (note the defining $H\alpha$ absorption features at 6563\AA in each of the DA white dwarfs).

4. Analysis

4.1. Photometric Distances

To estimate distances to red dwarfs in the three target samples, we take advantage of recent photometry and trigonometric parallax determinations, and combine optical $UBVRI$ and near-infrared JHK_s photometry to form an extended baseline over which subtle colors are evident and additional color “leverage” is available. Using all eight filter bands provides 28 possible color- M_{K_s} relations. M_{K_s} has been selected because K_s magnitudes are now available from 2MASS for nearly every red dwarf considered in nearby star studies. These relations can be used in combination to reduce errors in photometric distance estimates caused by photometric outliers in the fits and to overcome photometric errors in one or more filters for the target stars.

The new color- M_{K_s} relations have been developed for red dwarfs with $M_{K_s} \sim 4$ –11, corresponding to spectral types K0.0V to M9.5V. This broad range encompasses eight of the nine SCR stars, all eight of the recent nearby star candidates, and 19 of the 25 stars in the known high proper motion sample (the exceptions are generally white dwarfs). Two samples of stars — stars within 10 pc (the RECONS sample) and the supplemental sample of late-type M dwarfs within 25 pc — have been combined to develop reliable relations. Complete details for the RECONS sample, including all of the photometric values, will be presented in a future 10 pc summary paper in this series. In short, only photometrically single, main sequence stars within 10 pc are used. Subdwarfs, close multiple systems and stars with parallax errors greater than 5 mas (i.e. 5% errors at most, at 10 pc) have been removed. To bolster the red end of the relations, the RECONS sample has been supplemented with the stars listed in Table 2. These stars are nearer than 25 pc, have $M_{K_s} = 9$ to 11 (spectral types M6.0V to M9.5V), have trigonometric parallaxes with errors less than 10 mas, are not subdwarfs, and are not known to be in close multiple systems. There are few objects of

types M7.0V to M9.5V missing from this list that have published trigonometric parallaxes larger than 40 mas.

Trigonometric parallaxes have been collected from the two fundamental parallax references, the Yale Parallax Catalog (van Altena et al. 1995) and Hipparcos (ESA 1997). Additional parallaxes have been determined for many objects with spectral types from M6.0V to M9.5V during the last decade, primarily through the efforts of Tinney et al. (1995), Tinney (1996), and Dahn et al. (2002). Hipparcos parallaxes are available in only a few cases where bright primary stars could be observed, because all of the stars in Table 2 were too faint for Hipparcos. In stellar systems in which the late-type M dwarf is a companion, parallaxes are included for all components in the system, thereby taking advantage of many determinations that may be more accurate than those for the faint component alone. In one case, GJ 644C, Soderhjelm (1999) provides an updated Hipparcos parallax for the primary, GJ 644 ABD, which is actually a close triple. When there is more than one parallax determination, the weighted mean of all available parallaxes for the stellar system has been adopted, as listed in column 4 of Tables 1 and 2, and column 2 of Table 4.

Of the 28 possible color- M_{K_s} relations derivable from $UBVRIJHK_s$, only 12 were deemed useful. Currently, there is insufficient reliable U and B photometry for red dwarfs (particularly past M6.0V), so the 13 relations employing U and B are not used. In addition, the three colors derived from JHK_s alone do not have sufficient baselines to provide reliable distance estimates. Fits to each set of color- M_{K_s} data were made for second through eighth orders. Overall, fifth-order fits proved reliable for all 12 colors used, and higher orders did not improve the fits in any meaningful way.

An exemplary fit, for M_{K_s} vs. $(V - K_s)$, is shown in Figure 6. For each of the 12 relations adopted, the applicable color range, the numbers of stars used from the RECONS and very red samples, the fit coefficients, and the RMS values of the fits are given in Table 3. Equations for the relations have the following format:

$$M_{K_s} = + 0.00959 (V - K_s)^4 - 0.23953 (V - K_s)^3 + 2.05071 (V - K_s)^2 \\ - 5.98231(V - K_s) + 9.77683$$

Of course, trigonometric parallaxes for additional objects (including many of those investigated here) and photometry would allow the improvement of the photometric relation matrix, in particular for the stars with types later than M7.0V. We note that Dahn et al. (2002), who include accurate data for many stars of this type, provide an M_J relation for $2.8 < I - J < 4.2$ (spectral types M6.5V to L8.0V).

The photometric distance estimates for stars in the four samples are given in Table 4, where the number of color- M_{K_s} relations used to generate each mean distance is listed. To determine the reliability of these distance estimates, we have run the complete sample of 140 stars used to generate the fits back through the relations (not all stars have all colors, so 140 exceeds the total number of stars used in each fit, as listed in Table 3). The resulting average error of the suite

of relations technique is 15.3%. The final errors listed for the distance estimates throughout this paper include this 15.3% error (the “external” error from the fits) and the standard deviation of the up to 12 different distance estimates for an individual star (the “internal” error for each star).

For the supplemental sample, which represents the reddest dwarfs focused on in this paper, the differences between the photometric and trigonometric distances shown in Table 4 are remarkably good, with a mean difference of only 9.3%. This is rather better than the 15.3% value obtained when considering the entire range of colors covered by the suite of relations. There are at least two possible causes — either the very red dwarfs are better constrained in M_{K_s} than their earlier type counterparts, or the lack of data for the reddest dwarfs currently provides a poorer measure of the spread in M_{K_s} values. Additional data on the reddest dwarfs (trigonometric parallaxes in particular) should determine which is the true cause.

Illustrated in Figure 7 is a comparison between the two distance determinations for the 31 stars in the supplemental sample. Note that nearly every point is within 1σ of the equal distance line, indicating the strength of the photometric distance technique. Either the photometry or trigonometric parallax (or both) is suspect for the single clear outlier, ESO 207-61, which has an offset of 37.1% between the estimated and true distances. The remaining 30 stars (97%) have distances estimated to better than 30.6% (two times the adopted error for the technique for the full ranges of the relations), and 25 stars (81%) have distance estimates better than 15.3%, thereby indicating that the mean difference is a conservative representation of a 1σ “error” for these stars. As mentioned, we have vetted the sample for known close multiple systems, but additional companions may yet be found to some of the stars included.

For the white dwarfs, we have utilized equation (7) of Salim et al. (2004), which relates M_V and $(V - I)$ for white dwarfs from Bergeron et al. (2001). A trial run of 11 white dwarfs in the RECONS sample with reliable parallaxes and $V_J R_C I_C$ photometry through that single relation yields an average difference between the photometric and trigonometric distances of 13.2%. However, there is significantly more scatter than for results from the red dwarfs’ photometric relation matrix — three of the 11 white dwarf distance estimates are discordant by more than 20%. Because we do not have multiple relations to use to determine an individual error for each white dwarf distance, we conservatively adopt a generic 20% error for each estimate (8 of 11, or 73% of the white dwarfs are within 20%, corresponding roughly to a 1σ “error” for roughly two-thirds of the stars). We plan to create a white dwarf photometric relation matrix and report the results in a future paper in this series.

5. Discussion

Typically, distance estimates are made for the most compelling new nearby star candidates, but comparing one discovery to another is difficult because different methods are used in each publication. The methods used to estimate distances include nearly any permutation involving optical

photometry, infrared photometry, optical spectroscopy, and trigonometric parallaxes. Oftentimes, only a few reference stars are used to establish the distance to a newly discovered star. In addition, as is evident from the need for 25 different references in Table 2, there is a general lack of homogeneity in basic information for the reddest stars.

Here we remedy some of these problems by estimating distances to stars in all three target samples using the suite of relations in a uniform way that allows accurate distance estimates, and perhaps more important, allows the target stars to be compared directly. This effort can overcome some of the differences in photometry and spectroscopy inherent to different observers and their techniques. We highlight results for noteworthy stars here.

5.1. Comments on the SCR Discoveries

SCR 0342-6407 ($\mu = 1.071''/\text{yr}$ @ 141.4°) is the most distant of the five SCR discoveries with $\mu > 1.0''/\text{yr}$ at 38.1 ± 7.8 pc, and has the earliest spectral type, M4.5V.

SCR 0630-7643AB ($\mu = 0.483''/\text{yr}$ @ 356.8°) is a close binary. Images indicate two sources with a constant separation of $1.0''$ over five months and brightness ratio of 0.8 at I . The combined photometry yields a distance estimate of 5.2 ± 0.9 pc. Assuming a brightness difference of 0.25 mag at all wavelengths (no color information is currently available), the distance estimate is 7.0 ± 1.2 pc. By either estimate, the system is almost certainly a new member of the RECONS sample and a promising target for future mass determinations.

SCR 1138-7721 ($\mu = 2.141''/\text{yr}$ @ 286.8°) is a possible new member of the RECONS sample, falling just within the 10 pc horizon at 9.4 ± 1.7 pc.

SCR 1845-6357 ($\mu = 2.558''/\text{yr}$ @ 074.8°) is the third recent discovery of a late M dwarf that is probably within 5 pc, with a distance estimate of 4.6 ± 0.8 pc. At $2.6''/\text{yr}$, it has the highest proper motion of the 120 new SCR stars discovered south of $\text{DEC} = -57.5$ that have $\mu \geq 0.4''/\text{yr}$.

SCR 1848-6855 ($\mu = 1.287''/\text{yr}$ @ 194.4°) appears to be a normal M5.0V star with no obvious subdwarf features. Given its estimated distance of 37.0 ± 9.4 pc and high proper motion, it has a relatively high tangential velocity of 225 km/sec.

SCR 2012-5956 ($\mu = 1.440''/\text{yr}$ @ 165.6°) is a new nearby white dwarf, with an estimated distance of 17.4 pc, using equation (7) of Salim et al. (2004).

5.2. Comments on the Recently Discovered Nearby Late M Dwarfs

SO 0253+1652 has been claimed to be the third nearest star, at a distance of only 2.4 ± 0.5 pc based on a crude trigonometric parallax and 3.6 ± 0.4 pc photometrically using $V = 15.40$, $R = 13.26$, $I = 10.66$ (Teegarden et al. 2003). Our photometry from three nights gives $(V - I) =$

4.24 rather than their $(V - I) = 4.74$, and the relations place it further away, at 3.7 ± 0.6 pc, than their trigonometric distance. This would rank it as the 22nd nearest system, rather than as the third nearest system indicated by the poorly determined trigonometric value.

LP 775-31 and LP 655-48 are M7.0V “twins” reported by McCaughrean et al. (2002) to be 6.2–6.5 pc and 7.9–8.2 pc from the Sun, respectively, using a combination of spectroscopy and infrared photometry, although they reported types of M8.0V and M7.5V. Reid & Cruz (2002) estimated distances of 7.4 ± 1.5 pc and 7.7 ± 1.5 pc. Cruz & Reid (2002) gave types of M6.0V for both and estimated distances of 11.3 ± 1.3 pc and 15.3 ± 2.6 pc. We confirm that they are probable new members of the RECONS sample, and provide distance estimates of 7.3 ± 1.2 pc and 8.2 ± 1.4 pc, respectively.

LHS 2021 is an M7.5V star that had, to our knowledge, no distance estimate until that given here. At 13.8 ± 2.3 pc, it is just beyond the RECONS sample horizon.

LHS 2090 was reported in Scholz et al. (2001) to have spectral type M6.5V and was estimated to be 6.0 ± 1.1 pc distant based on its 2MASS JHK_s photometry and that of a similar star, GJ 1111. Reid & Cruz (2002) report a distance estimate of 5.2 ± 1.0 pc, based upon an $(M_{K_s}, J - K_s)$ relation. We derive a distance of 5.7 ± 0.9 pc.

DEN 1048-3956 was reported in Delfosse et al. (2001) to have spectral type M9.0V and magnitudes $B = 19.0$ and $R = 15.7$ from Schmidt plates, and $I = 12.67$, $J = 9.59$, $K = 8.58$ from the DENIS survey. Gizis (2002) determined a spectral type of M8.0V. Delfosse et al.’s comparison to four M dwarfs with type M9.0V yielded a distance estimate of 4.1 ± 0.6 pc. Preliminary trigonometric parallaxes have been reported by Deacon & Hambly (2001, 5.2 ± 1.0 pc) and Neuhauser et al. (2002, 4.6 ± 0.3 pc), although the latter uses a faint set of reference stars, assumes a proper motion rather than solving for it, and utilizes only three frames. Our photometric distance estimate is 4.5 ± 0.7 pc.

LHS 325a was reported as LHS 325 in Bessell (1991), but it must be in fact LHS 325a, an insertion in the LHS catalog between LHS 325 and 326 because of its RA. We have found it to be rather brighter in VRI than Bessell (1991), who gives $V = 18.67$, $R = 16.60$, $I = 14.36$.

LSR 1826+3014 is an M8.5V object found by Lepine et al. (2002) and noted to be the faintest ($V = 19.36$) red dwarf discovered to have a proper motion larger than $2''/\text{yr}$. Their distance estimate of 13.9 ± 3.5 pc is based on three photometric/spectroscopic estimates. Given the northern declination, we have not observed this object from CTIO. Nonetheless, our distance estimate from published data and 10 relations is 14.5 ± 2.5 pc, which is certainly consistent with theirs.

5.3. Comments on Additional Objects

Among the known high proper motion stars, the true distances to GJ 85 (LHS 150), GJ 181.1 (LHS 199), GJ 1077 (LHS 205), LHS 288, GJ 467AB (LHS 328 and 329), and GJ 808 (LHS 499)

are poorly known, given that their parallaxes have errors larger than 10 mas. Not surprisingly, all but GJ 1077 have photometric distances differing from the trigonometric distances by more than 20%.

WD 0141-675 (LHS 145) is a nearby white dwarf with no trigonometric parallax. We estimate a distance of 9.3 ± 1.9 pc using equation (7) of Salim et al. (2004). This is a probable new member of the RECONS sample and among the 20 nearest known white dwarfs.

GJ 1123 (LHS 263) has a photometric distance estimate of 7.5 ± 1.2 pc, which matches the spectroscopic estimate of 7.6 pc by Henry et al. (2002). It is a likely new member of the RECONS 10 pc sample.

GJ 1128 (LHS 271) has a photometric distance estimate of 6.4 ± 1.0 pc, which matches the spectroscopic estimate of 6.6 pc by Henry et al. (2002). It is a likely new member of the RECONS 10 pc sample.

GJ 1277 (LHS 532) is another probable new member of the RECONS sample, at a distance of 8.9 ± 1.4 pc.

LP 944-20 is an important nearby red dwarf (or brown dwarf) at the end of the M spectral sequence. The first parallax was reported by Tinney (1996), placing it at a distance of slightly less than 5 pc, and making it the most recent addition to the 5 pc sample other than GJ 1061 (Henry et al. 1997). The 22% difference in the photometric and trigonometric distances occurs because there are only three colors available, and all lie near the very limit of each relation.

ESO 207-61 has the poorest match between the photometric and trigonometric parallaxes, which differ by 37%. Ruiz et al. (1991) indicate that the *VRI* photometry is on the Kron-Cousins system, but the observations were made at the CTIO 0.9m (where our observations are made) and likely used the same filter set, as well as similar standards. Nonetheless, the photometry may not be on the Cousins system as we have assumed (and reported in Table 2), thereby causing the discordant distances.

LHS 523 is the final star of the three in the red dwarf supplemental sample having a mismatch between photometric and trigonometric distances greater than 20%, in this case 27%. The 12 distance estimates are the least consistent of all of the stars in the supplemental sample. In particular, distances from colors including the *I* band range from 9.6 to 20.9 pc, indicating a possible problem with the *I* photometry.

6. Conclusions

The 12 new color- M_{K_s} relations given here can be used to estimate distances accurately to stars falling in the color ranges given (generally, K0.0V to M9.5V in spectral type) in any combination. As an ensemble, they provide a powerful means to estimate distances to nearby star candidates on

a uniform system.

We predict that the three most compelling targets, SO 0253+1652, DEN 1048-3956, and SCR 1845-6357 all lie within 5 pc. These three late M dwarfs comprise the largest surge in the nearby star population in several decades.

With $\mu = 2.6''/\text{yr}$, SCR 1845-6357 ranks as the 41st fastest proper motion system known, so it is not surprising that it is probably nearer than 5 pc. Of the 22 other red dwarfs discussed here that have no accurate trigonometric parallaxes, we find that 10 are likely to be closer than 10 pc. In addition, the white dwarf, WD 0141-675, is also probably nearer than 10 pc, bringing the total number of new 10 pc systems discussed here to 12. This sample is currently being observed in the RECONS Cerro Tololo Interamerican Observatory Parallax Investigation (CTIOPI) carried out at the CTIO 0.9m, which should yield parallaxes for these high priority targets in the near future.

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Fig. 1.— Finder charts for the nine SCR stars from the SuperCOSMOS red UK Schmidt images (photographic passband R_{59F}). Each chart is $5'$ on a side, with north up and east to the left, and the epoch of the image is given.

Fig. 2.— Spectra of standard late-type red dwarfs, defining each 0.5 subtype from M6.0V to M9.0V. Important spectral features are labeled at the top. The absorption complex at 9300 \AA and redward is due in part to H_2O in the Earth’s atmosphere.

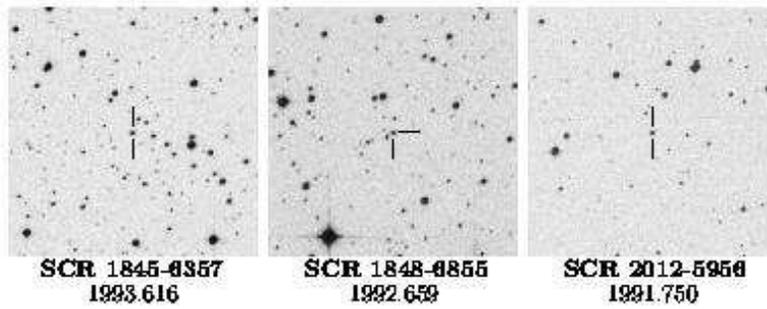
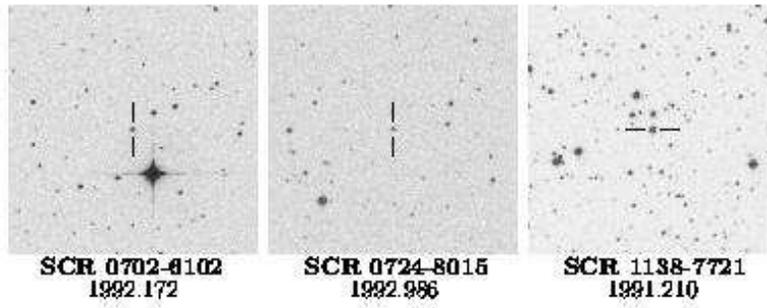
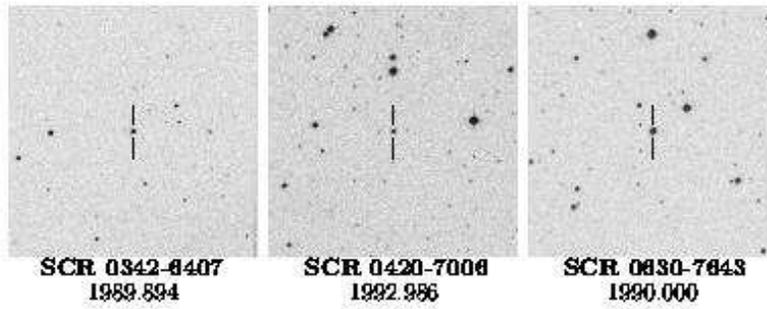
Fig. 3.— Spectra of new SCR discoveries and recently found nearby late M dwarfs with spectral types of M4.5V to M6.0V.

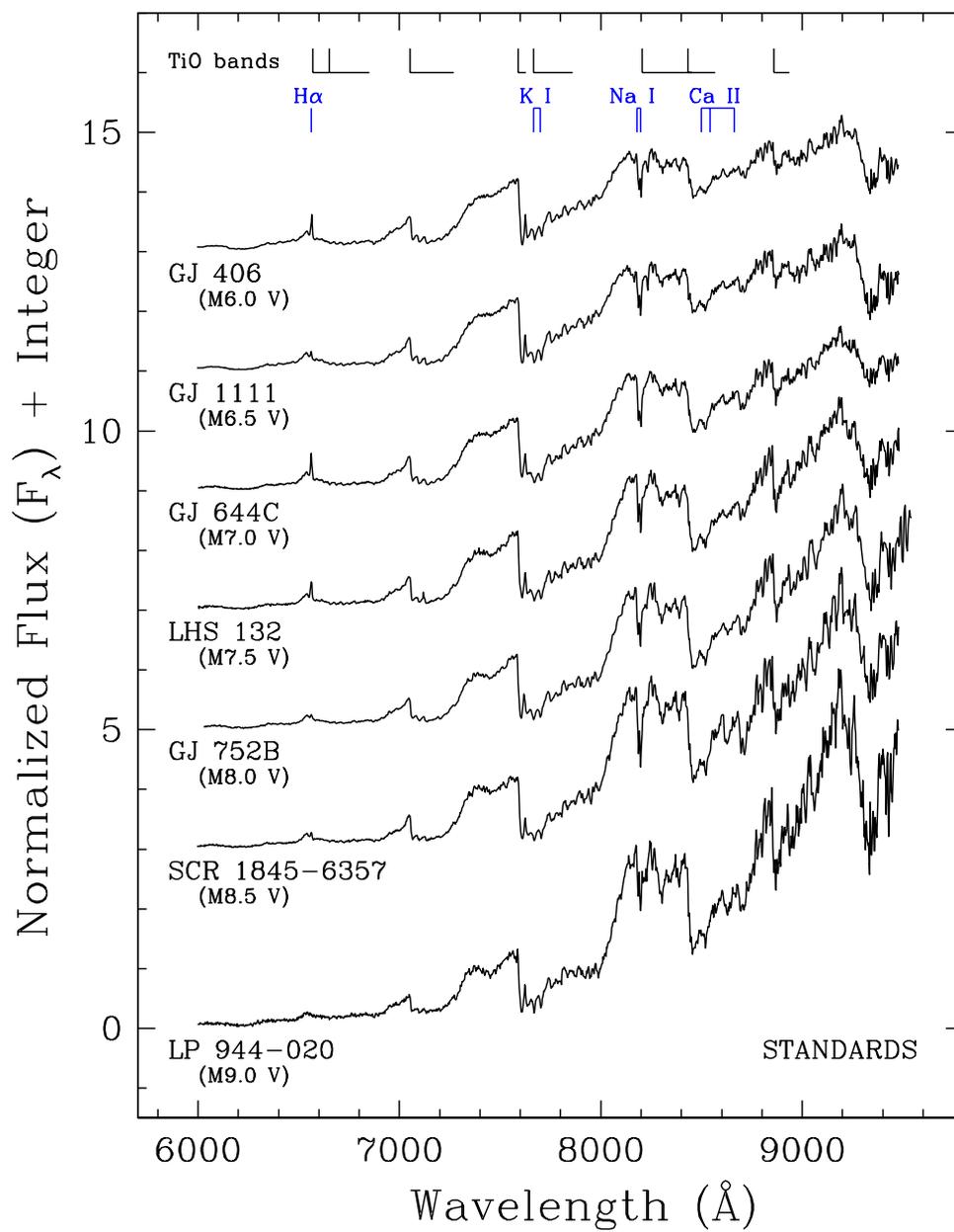
Fig. 4.— Spectra of new SCR discoveries and recently found nearby late M dwarfs with spectral types of M6.5V to M8.5V.

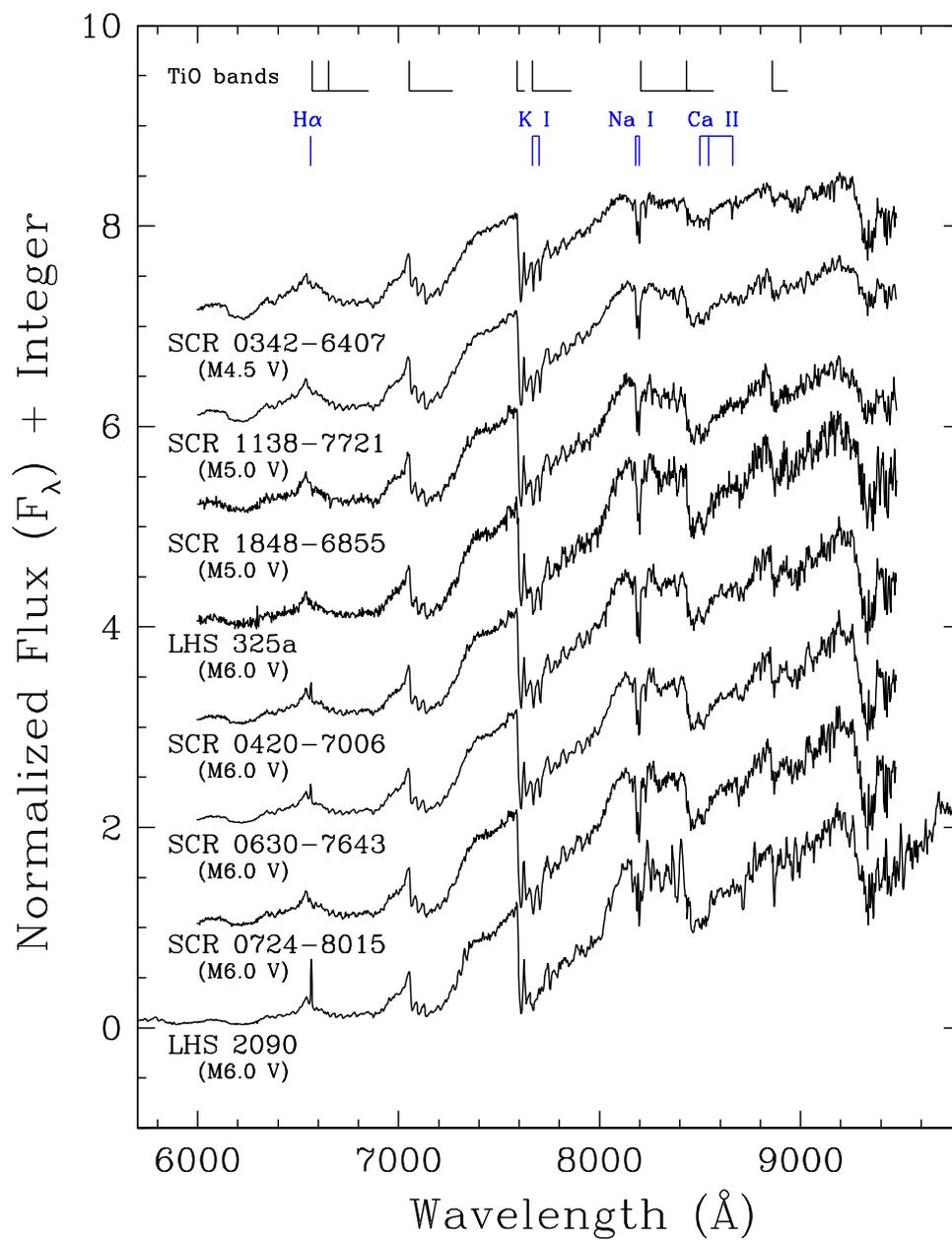
Fig. 5.— Spectra of the nearby white dwarfs LHS 145 (type DA, note the $\text{H}\alpha$ feature at 6563 \AA) and SCR 2012-5956 (type DC or DQ). Also shown for comparison are spectra for white dwarfs of similar types. The DC/DQ types are virtually featureless in this wavelength region — the “features” seen are all telluric.

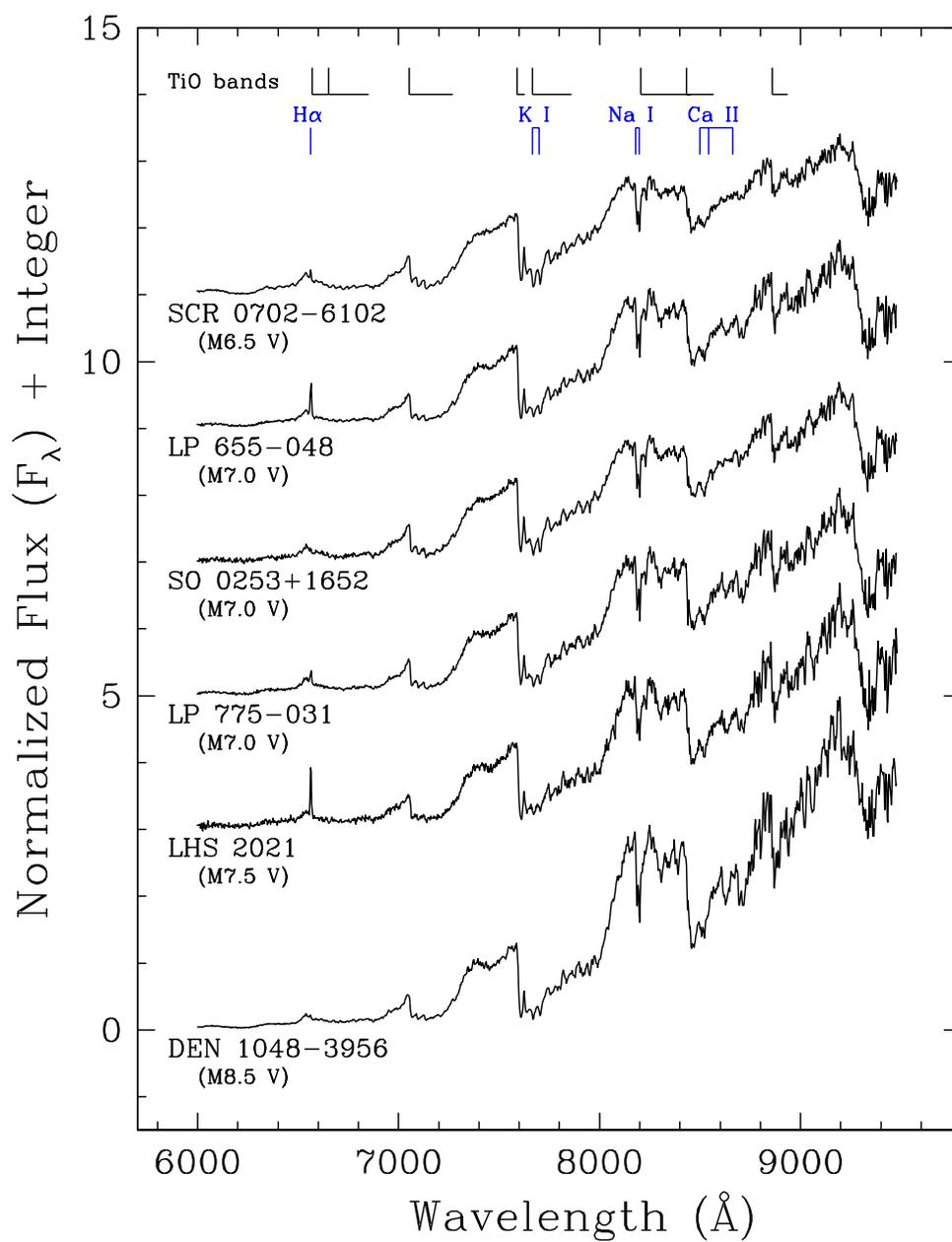
Fig. 6.— Example color- M_{K_s} fit of stars in the RECONS and supplemental samples, illustrating the $(V - K_s)$ relation. Solid points represent RECONS stars within 10 pc. Open points represent stars in the supplemental sample of objects with spectral types of M6.0V and later. Vertical lines indicate the valid limits of the relation at $(V - K_s) = 2.24$ to 9.27 .

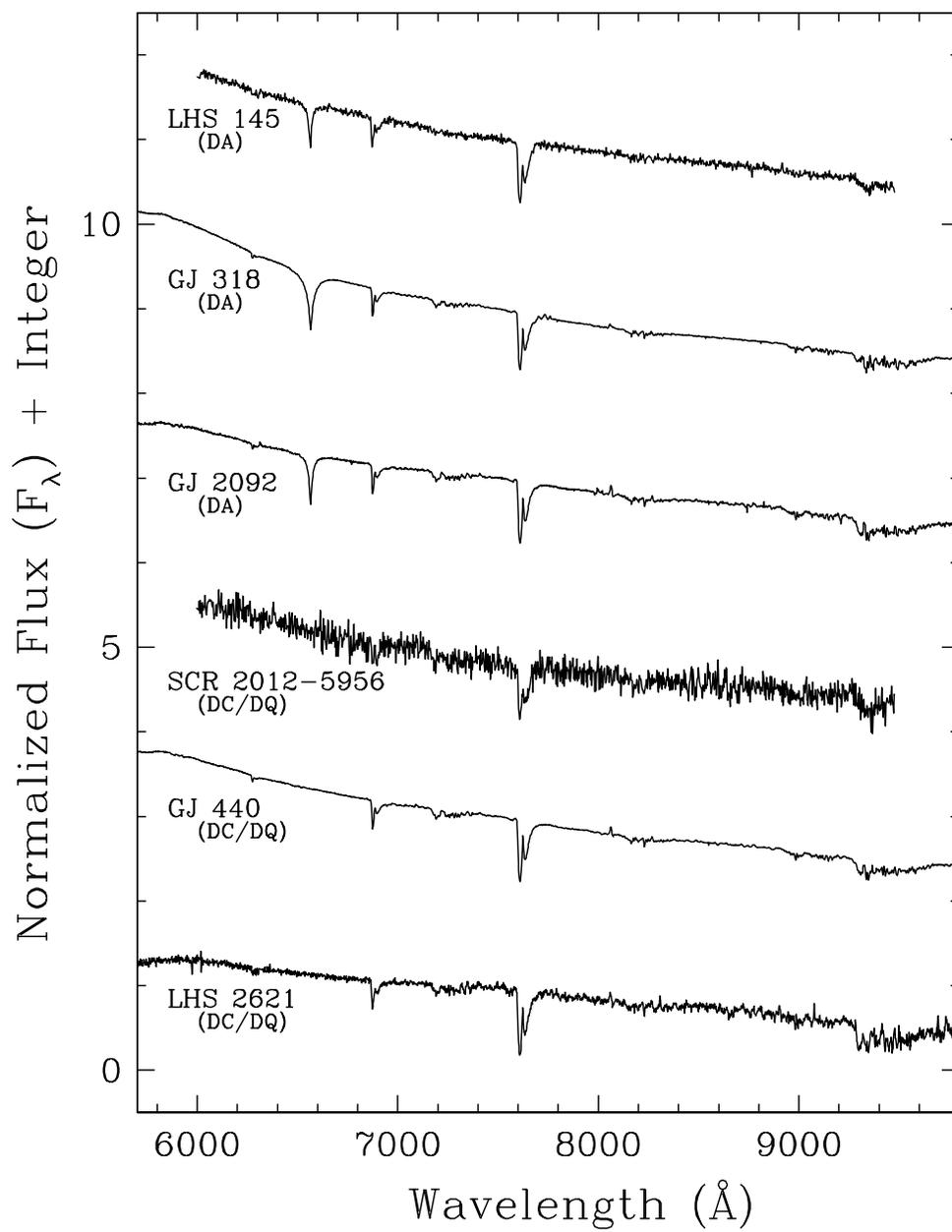
Fig. 7.— Comparison of true trigonometric and derived photometric distances for the 31 late M dwarfs with accurate trigonometric parallaxes listed in Tables 2 and 4. The three labeled stars are discussed in the text.

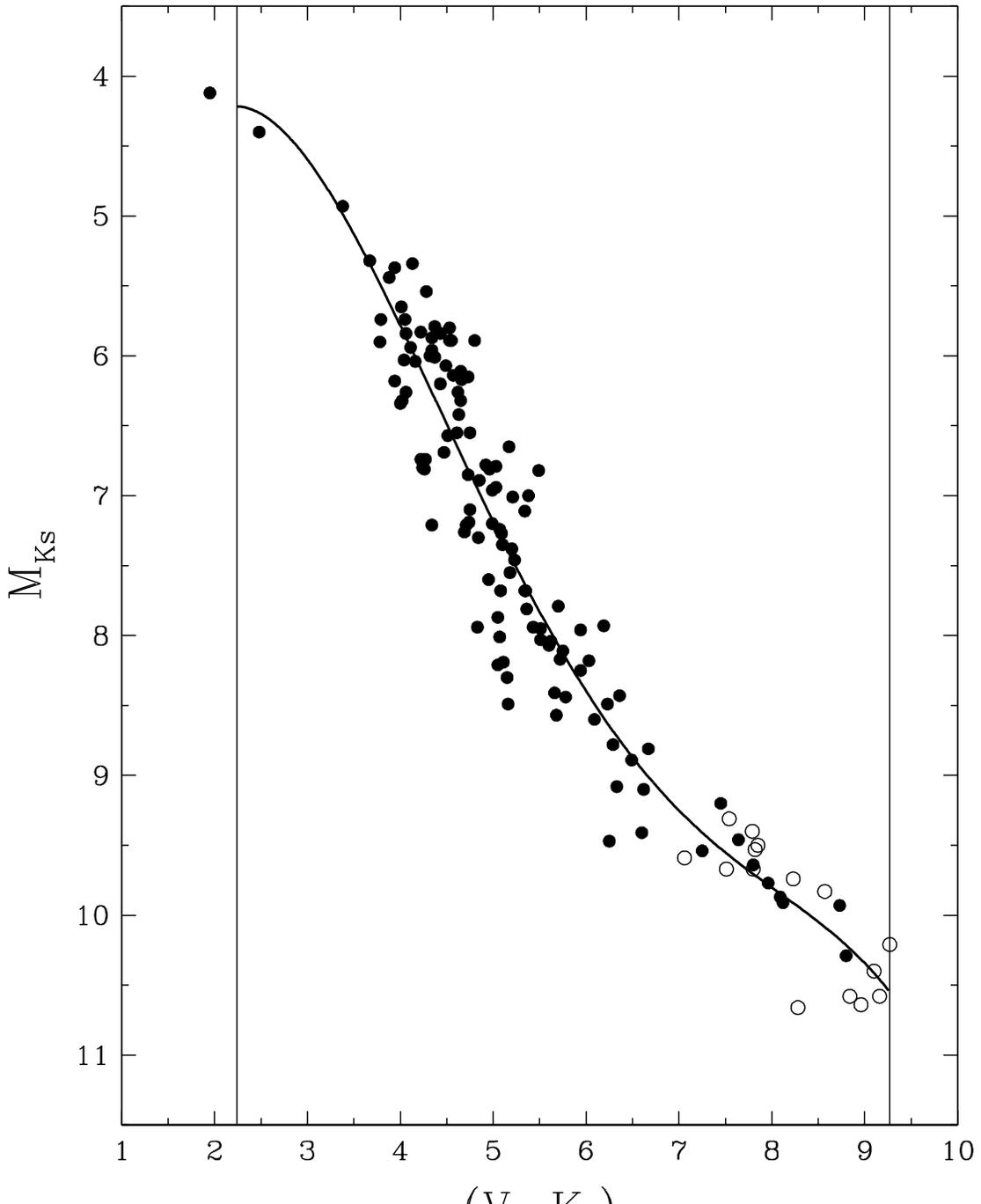












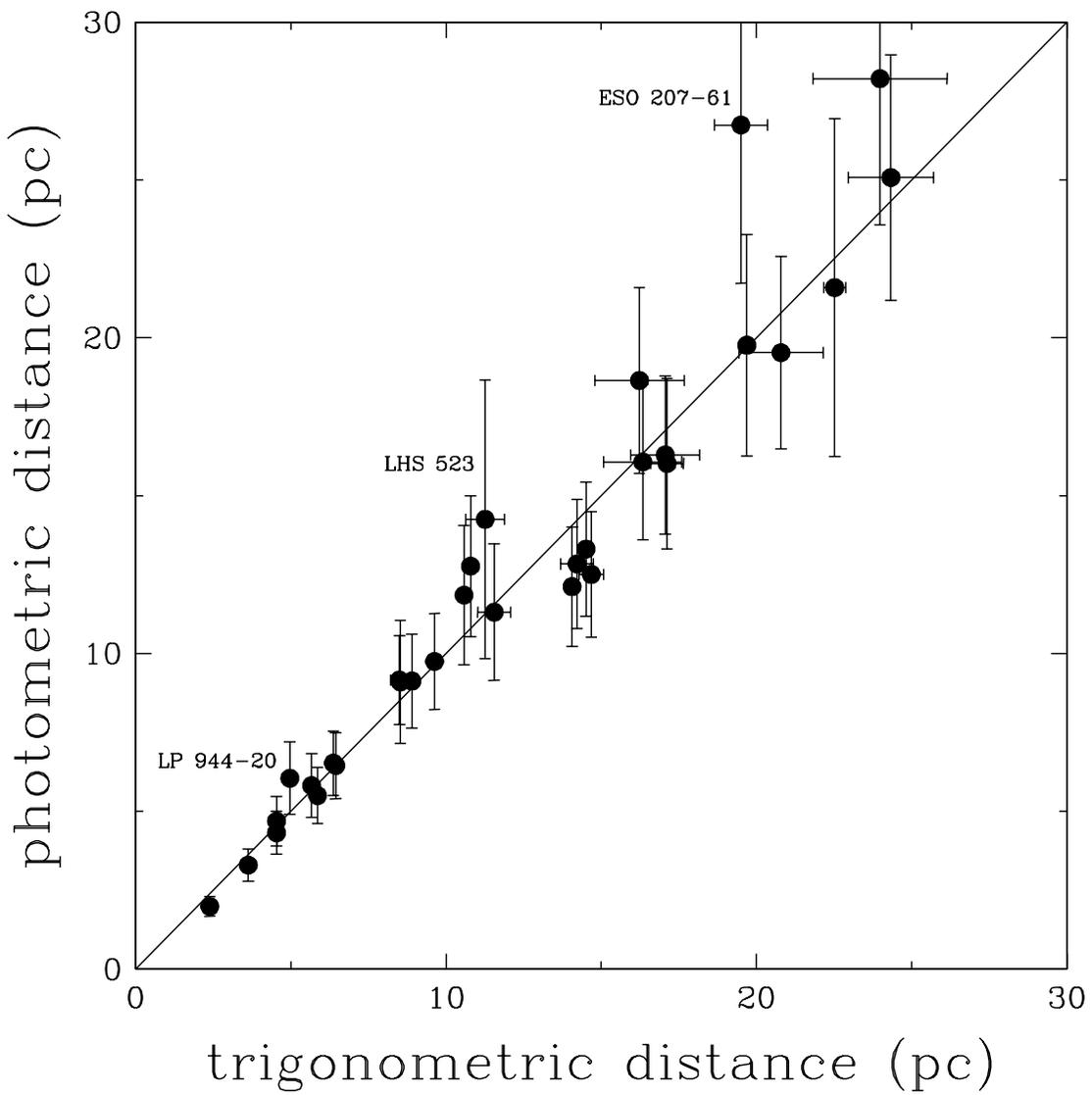


Table 1. Trigonometric parallaxes, VRIJHK_s photometry, and spectral types for SCR stars, recently discovered nearby red dwarfs, and stars with $\mu \geq 1.0''/\text{yr}$ recovered in the SCR search.

Name	LHS	RA (J2000.0)	DEC	Mean π_{trig}	Ref	V _J	R _C	I _C	Ref	J	H	K _s	SpType	Ref	Notes
New SCR Discoveries															
R 0342-6407	...	03 42 57.4	-64 07 56	...	...	15.99	14.62	12.92	1	11.32	10.89	10.58	M4.5V	1	a
R 0420-7006	...	04 20 12.6	-70 05 59	...	...	17.17	15.56	13.49	1	11.19	10.59	10.25	M6.0V	1	
R 0630-7643AB	...	06 30 46.6	-76 43 09	...	...	14.91	13.32	11.24	1	8.89	8.28	7.92	M6.0VJ	1	b
R 0702-6102	...	07 02 50.3	-61 02 48	...	...	16.61	14.75	12.48	1	10.36	9.85	9.52	M6.5V	1	
R 0723-8015	...	07 23 59.7	-80 15 18	...	...	17.41	15.60	13.41	1	11.30	10.82	10.44	M6.0V	1	
R 1138-7721	...	11 38 16.8	-77 21 49	...	...	14.78	13.20	11.25	1	9.40	8.89	8.52	M5.0V	1	a,c
R 1845-6357	...	18 45 05.3	-63 57 48	...	...	17.40	15.00	12.47	1	9.54	8.97	8.51	M8.5V	1	a,d
R 1848-6855	...	18 48 21.0	-68 55 34	...	...	16.87	15.67	13.82	1	11.89	11.40	11.10	M5.0V	1	a
R 2012-5956	...	20 12 31.8	-59 56 52	...	...	15.82	15.39	15.00	1	14.93	15.23	15.41	DC/DQ	1	a,e
Recently Discovered Nearby Late-Type M Dwarfs															
0253+1652	...	02 53 00.9	+16 52 53	...	...	15.20	13.30	10.96	1	8.39	7.88	7.59	M7.0V	1	f
775-31	...	04 35 16.1	-16 06 57	...	...	17.82	15.78	13.36	1	10.41	9.78	9.35	M7.0V	1	g
655-48	...	04 40 23.3	-05 30 08	...	...	17.86	15.95	13.63	1	10.66	9.99	9.55	M7.0V	1	h
S 2021	2021	08 30 32.6	+09 47 16	...	...	19.38	17.22	14.97	1	11.89	11.17	10.76	M7.5V	1	i
S 2090	2090	09 00 23.6	+21 50 05	...	...	16.10	14.09	11.85	1	9.44	8.84	8.44	M6.0V	1	j
N 1048-3956	...	10 48 14.6	-39 56 07	...	...	17.33	14.97	12.46	1	9.54	8.91	8.45	M8.5V	1	k
S 325a	325a	12 23 56.2	-27 57 46	...	...	18.39	16.42	14.20	1	11.98	11.40	11.07	M6.0V	1	l
R 1826+3014	...	18 26 11.0	+30 14 19	...	...	19.36	17.40	14.35	2	11.66	11.18	10.81	M8.5V	2	m
Stars with $\mu \geq 1.0''/\text{yr}$ in Region DEC -57.5 to -90 Fainter than $m_R = 10$															
1022	124	00 49 29.1	-61 02 33	...	...	12.18	11.19	9.93	1	8.63	8.09	7.84	M2.5V	3	
45	128	00 57 19.7	-62 14 44	.05175	.00106	4,5	9.47	8.68	7.98	6	7.08	6.49	6.28	K5.0V	3
D 0141-675	145	01 43 01.0	-67 18 30	...	...	13.83	13.54	13.24	1	12.87	12.66	12.58	DA	1	n
85	150	02 07 23.3	-66 34 12	.06460	.01780	4	11.50	10.49	9.32	6	8.13	7.61	7.36	M1.5V	3
118	160	02 52 22.2	-63 40 48	.08682	.00188	4,5	11.38	10.32	8.99	6	7.67	7.12	6.83	M2.5V	3
181.1	199	04 55 58.0	-61 09 47	.04440	.01080	4	12.05	11.14	10.15	6	9.04	8.51	8.31	K7.0V	3
1077	205	05 17 00.0	-78 17 20	.07750	.01100	4	11.90	10.87	9.49	7	8.07	7.44	7.20	M2.0V	3

Table 1—Continued

Name	LHS	RA (J2000.0)	DEC	Mean π_{trig}	Ref	V_J	R_C	I_C	Ref	J	H	K_s	SpType	Ref	Notes
293	34	07 53 08.2	-67 47 32	.14120 .00840	4	13.60	13.21	12.85	6	12.73	12.48	12.36	DQ9	8	o
1123	263	09 17 05.3	-77 49 23	...	...	13.14	11.80	10.10	1	8.33	7.77	7.45	M4.5V	9	
345	268	09 24 21.0	-80 31 21	.01653 .00098	4,5	10.15	9.80	9.42	6	8.89	8.53	8.46	F-G	10	
1128	271	09 42 46.4	-68 53 06	...	...	12.72	11.35	9.61	1	7.95	7.39	7.04	M4.5V	9	
S 288	288	10 44 21.2	-61 12 36	.22250 .01130	4	13.90	12.31	10.27	1	8.49	8.05	7.73	M5.5V	1	P
422	40	11 16 00.2	-57 32 52	.07954 .00267	4,5	11.64	10.57	9.17	6	7.81	7.30	7.04	M3.5V	3	q
440	43	11 45 42.9	-64 50 30	.21657 .00201	4,5	11.47	11.30	11.15	1	11.19	11.13	11.10	DC/DQ	1	r
467 A	328	12 28 40.0	-71 27 52	.02150 .01910	4	13.65	12.55	11.15	6	9.81	9.30	9.05	M3.0V	1	
467 B	329	12 28 43.1	-71 27 57	.02150 .01910	4	15.75	14.38	12.66	6	10.98	10.50	10.18	M4.5V	1	
551	49	14 29 43.0	-62 40 47	.76876 .00030	4,5,11	11.09	9.42	7.37	1	5.36	4.84	4.38	M5.5V	12	s
S 475	475	19 20 54.3	-82 33 16	...	...	12.68	11.50	10.00	1	8.56	8.00	7.69	M3.0V	3	
1251	493	20 28 03.7	-76 40 16	...	...	13.83	12.67	11.11	1	9.36	8.88	8.60	M4.5V	3	
808	499	20 51 41.6	-79 18 40	.06300 .01170	4	11.83	10.83	9.65	6	8.46	7.91	7.66	M1.5V	3	
H 2115-7541	...	21 15 15.1	-75 41 52	...	...	14.46	13.24	11.66	1	10.14	9.60	9.33	M3.0V	1	t
PM J2231-7515	...	22 30 33.6	-75 15 24	...	...	16.90	16.19	15.56	1	14.86	14.82	14.72	DX14	8	u
PM J2231-7514	...	22 30 40.0	-75 13 55	...	...	16.59	15.95	15.36	1	14.66	14.66	14.44	DX12	8	v
877	531	22 55 45.5	-75 27 31	.11610 .00132	4,5	10.38	9.31	7.95	6	6.62	6.08	5.81	M2.5V	1	w
1277	532	22 56 24.7	-60 03 49	...	...	14.01	12.60	10.81	13	8.98	8.36	8.11	M5.0V	1	x

so in Hambly et al. 2004

binary with separation $1.0''$, J indicates a joint spectrum

found twice in SCR search

possibly variable in spectral type

white dwarf; K_s unreliable

6.5V in Teegarden et al. 2003

8.0V in McCaughrean et al. 2002; M6.0V in Cruz & Reid 2002

7.5V in McCaughrean et al. 2002; M6.0V in Cruz & Reid 2002

error in $V = 0.4$ mag

6.5V in Scholz et al. 2001

9.0V in Delfosse et al. 2001; M8.0V in Gizis 2002; possibly variable in spectral type

6.0V in Bessell 1991 (listed as LHS 325 instead of LHS 325a)

northern target not observed by RECONS from Chile

white dwarf; DA7 in McCook & Sion 2003

white dwarf

missed in SCR search; $VRI = 13.92, 12.33, 10.31$ in Bessell 1991; blended in 2MASS

missed in SCR search

white dwarf; missed in SCR search; DQ6 in McCook & Sion 2003

proxima; missed in SCR search; $VRI = 11.05, 9.43, 7.43$ in Bessell 1990

also SCR 2115-7541

also SCR 2230-7515; white dwarf; $V = 16.87$ in Scholz et al. 2002

also SCR 2230-7513; white dwarf; $V = 16.60$ in Scholz et al. 2002

12.5V in Hawley et al. 1996

4.5V in Hawley et al. 1996

References.— (1) This paper. (2) Lepine et al. 2002. (3) Hawley et al. 1996. (4) van Altena et al. 1995. (5) ESA 1997. (6) Bessell 1990. (7) Leggett 1992. (8) McCook & Sion 2003. (9) Henry et al. 2002. (10) Gliese 1969. (11) Benedict et al. 1999. (12) Henry et al. 1997. (13) Patterson et al. 1998.

Table 2. Trigonometric parallaxes, VRIJHK_s photometry, and spectral types for the supplemental sample of late-type M dwarfs.

Name	LHS	RA (J2000.0)	DEC	Mean π_{trig}	Ref	V _J	R _C	I _C	Ref	J	H	K _s	SpType	Ref	Notes
Late-Type M Dwarfs within 25 Parsecs															
0021-0214	...	00 24 24.6	-01 58 20	.08660 .00400	1	...	17.42	15.16	2	11.99	11.08	10.54	M9.0V	3	a
0050-2722	...	00 52 54.7	-27 06 00	.04171 .00372	4,5	21.50	...	16.82	5,6	13.61	12.98	12.54	M8.0V	7	
GA 0149+2956	...	01 49 09.0	+29 56 12	.04440 .00070	2	21.25	18.94	16.81	2	13.45	12.58	11.98	M9.5V	8	
S 1375	1375	02 16 29.9	+13 35 13	.11770 .00400	4	15.79	...	...	9	9.87	9.31	8.98	M6.0V	3	b
771-21	...	02 48 41.0	-16 51 22	.06160 .00543	5	...	...	15.42	5	12.55	11.87	11.42	M8.0V	10	
412-31	...	03 20 59.7	+18 54 23	.06890 .00060	2	19.21	16.98	14.70	2	11.76	11.07	10.64	M8.0V	11	c
944-20	...	03 39 35.3	-35 25 44	.20140 .00421	5	...	...	14.16	5	10.73	10.02	9.55	M9.0V	3	d
S 1604	1604	03 51 00.0	-00 52 45	.06810 .00180	4	18.02	...	13.80	12	11.30	10.61	10.23	M6.0V	13	e
S 191	191	04 26 19.9	+03 36 36	.05840 .00180	4	18.51	16.24	13.96	14	11.62	11.07	10.69	M6.5V	15	
DO 207-61	...	07 07 53.3	-49 00 50	.05129 .00226	5,16	20.39	18.63	16.23	17	13.23	12.54	12.11	M9.0V:	18	f
283B	234	07 40 19.4	-17 24 46	.11240 .00270	4	16.54	14.68	12.43	19	10.16	9.63	9.29	M6.5V	3	g
1111	248	08 29 49.3	+26 46 34	.27580 .00300	4	14.90	12.90	10.64	19	8.24	7.62	7.26	M6.5V	3	h
S 2026	2026	08 32 30.5	-01 34 39	.05080 .00050	4	18.94	16.69	14.32	14	12.04	11.48	11.14	M6.0V	14	
316.1	2034	08 40 29.7	+18 24 09	.07110 .00100	4	17.59	...	13.45	20	11.05	10.42	10.05	M6.0V	13	i
S 2065	2065	08 53 36.2	-03 29 32	.11730 .00150	4	18.74	16.74	14.54	14	11.21	10.47	9.94	M9.0V	3	j
S 292	292	10 48 12.6	-11 20 10	.22030 .00360	4	15.73	13.67	11.33	14	8.86	8.26	7.93	M7.0V	21	k
S 2314	2314	10 49 03.4	+05 02 23	.04110 .00230	4	19.11	...	14.91	12	12.54	11.97	11.60	M6.0V	13	
406	36	10 56 28.9	+07 00 53	.41910 .00210	4	13.53	11.67	9.50	19	7.09	6.48	6.08	M6.0V	3	l
S 2351	2351	11 06 19.0	+04 28 33	.04810 .00314	5	19.56	17.25	14.91	14	12.33	11.72	11.33	M6.5V	14	
S 2471	2471	11 53 52.7	+06 59 56	.07030 .00260	4	18.11	...	13.66	14	11.26	10.66	10.26	M6.0V	13	m
1222-1222	...	12 24 52.2	-12 38 36	.05860 .00380	5	...	...	15.74	5	12.57	11.82	11.35	M9.0V	11	
S 2924	2924	14 28 43.2	+33 10 39	.09267 .00128	1,4	19.58	...	15.21	20	11.99	11.23	10.74	M9.0V	11	
S 2930	2930	14 30 37.8	+59 43 25	.10380 .00130	4	17.88	...	13.31	20	10.79	10.14	9.79	M6.5V	7	
S 3003	3003	14 56 38.3	-28 09 49	.15705 .00259	4,5	17.05	14.88	12.53	14	9.97	9.32	8.93	M7.0V	3	n
LM 513-46546	...	15 01 08.2	+22 50 02	.09450 .00060	1,2	19.87	17.53	15.16	2	11.87	11.18	10.71	M9.0V	3	o
LM 868-110639	...	15 10 16.8	-02 41 08	.06120 .00470	1	...	...	15.79	1	12.61	11.84	11.35	M9.0V	11	
644C	429	16 55 35.3	-08 23 41	.15497 .00056	4,22,23	16.78	14.60	12.18	19	9.78	9.20	8.82	M7.0V	3	p
GA 1835+3259	...	18 35 37.9	+32 59 53	.17650 .00050	24	18.27	...	13.46	24	10.27	9.62	9.17	M8.5V	24	
752B	474	19 16 57.6	+05 09 02	.17079 .00061	1,4,5,22	17.50	15.10	12.84	14,20	9.91	9.23	8.77	M8.0V	3	q
1245B	3495	19 53 55.2	+44 24 54	.22020 .00100	4	14.01	12.36	10.27	25	8.28	7.73	7.39	M6.0V	15	

Table 2—Continued

Name	LHS	RA (J2000.0)	DEC	Mean π_{trig}	Ref	V_J	R_C	I_C	Ref	J	H	K_s	SpType	Ref	Notes
LHS 523	523	22 28 54.4	−13 25 19	.08880 .00490	4	16.90	14.90	12.56	19	10.77	10.22	9.84	M6.5V	15	^r

^aparallax in van Altena et al. 1995 is superseded by Tinney et al. 1995 value; M9.5V: in Kirkpatrick et al. 1995; M9.5V in Kirkpatrick et al. 2000

^bM5.5V in Reid et al. 1995

^cM9.0V in Gizis et al. 2000; M9.0V in Cruz & Reid 2002

^dM9.0V in Kirkpatrick et al. 2000; M9.5V in McCaughrean et al. 2002; M9.5V in Reid & Cruz 2002

^eM6.0V in Cruz & Reid 2002

^fparallax in van Altena et al. 1995 is superseded by Ianna & Fredrick 1995 value; photometry is quoted as being “Kron-Cousins” but filter set likely matches Cousins; spectral type determined by comparison of printed published spectrum to standards by our group

^gM6.0V in Henry et al. 1994

^hM6.5V in Kirkpatrick et al. 1991

ⁱM6.0V in Bessell 1991

^jM9.0V in Kirkpatrick et al. 1991

^kM6.5V in Henry et al. 1994

^lM6.0V in Kirkpatrick et al. 1991

^mM6.5V in Bessell 1991

ⁿM6.5V in Bessell 1991; M7.0V in Kirkpatrick et al. 1995

^oM8.5V in Kirkpatrick et al. 1995

^pVB 8; several parallaxes for GJ 644ABD and GJ 643, members of the same system, included; M7.0V in Kirkpatrick et al. 1991

^qVB 10; several parallaxes for GJ 752A included; parallax in van Altena et al. 1995 was recalculated without value superseded by Tinney et al. 1995; M8.0V in Kirkpatrick et al. 1991

^rM6.0V in Bessell 1991; M6.5V in Cruz & Reid 2002

References.— (1) Tinney et al. 1995. (2) Dahn et al. 2002. (3) This paper. (4) van Altena et al. 1995. (5) Tinney 1996. (6) Reid & Gilmore 1984. (7) Kirkpatrick et al. 1993. (8) Kirkpatrick et al. 1999. (9) Dahn et al. 1988. (10) Kirkpatrick et al. 1997. (11) Kirkpatrick et al. 1995. (12) Monet et al. 1992. (13) Reid et al. 1995. (14) Bessell 1991. (15) Kirkpatrick et al. 1991. (16) Ianna & Fredrick 1995. (17) Ruiz et al. 1991. (18) Ruiz et al. 1995. (19) Bessell 1990. (20) Leggett 1992. (21) Henry et al. 1994. (22) ESA 1997. (23) Soderhjelm 1999. (24) Reid et al. 2003. (25) Weis 1996.

Table 3. Details for photometric distance relations.

Color	Applicable Range	# RECONS Stars	# Very Red Stars	Coeff #1 $\times (\text{color})^4$	Coeff #2 $\times (\text{color})^3$	Coeff #3 $\times (\text{color})^2$	Coeff #4 $\times (\text{color})$	Coeff #5 (constant)	RMS (mag)
$(V - R)$	0.53 to 2.40	117	8	+ 2.79703	- 17.48617	+ 36.67711	- 25.90589	+ 9.96960	0.40
$(V - I)$	0.88 to 4.81	119	15	+ 0.02853	- 0.49504	+ 2.64479	- 3.51296	+ 5.62135	0.40
$(V - J)$	2.51 to 8.00	115	15	+ 0.02447	- 0.52310	+ 3.91317	- 10.94674	+ 15.31851	0.39
$(V - H)$	3.59 to 8.69	100	15	+ 0.03207	- 0.77797	+ 6.74382	- 23.61879	+ 34.23360	0.42
$(V - K)$	2.24 to 9.27	119	15	+ 0.00959	- 0.23953	+ 2.05071	- 5.98231	+ 9.77683	0.42
$(R - I)$	0.43 to 2.42	117	9	- 1.08390	+ 5.68997	- 9.78999	+ 9.22596	+ 1.54462	0.41
$(R - J)$	1.64 to 5.66	114	9	+ 0.07380	- 1.15011	+ 6.26647	- 12.52051	+ 13.44932	0.41
$(R - H)$	2.68 to 6.36	99	9	+ 0.10427	- 1.91432	+ 12.58352	- 33.56316	+ 36.76955	0.45
$(R - K)$	1.63 to 6.97	117	9	+ 0.01785	- 0.37226	+ 2.59680	- 5.75029	+ 8.19804	0.45
$(I - J)$	0.88 to 3.36	116	19	+ 0.58092	- 4.69507	+ 12.35365	- 9.20851	+ 6.22309	0.45
$(I - H)$	1.67 to 4.23	101	19	+ 0.14094	- 1.31052	+ 3.12906	+ 2.68748	- 2.62035	0.54
$(I - K)$	1.07 to 4.83	120	19	+ 0.19771	- 2.44679	+ 10.18426	- 14.30638	+ 10.38741	0.52

Table 4. Distance estimates from new photometric parallax relations.

Name	Mean π_{trig}	M_{Ks}	# colors	Est Dist (pc)	True Dist (pc)	% Diff	Notes
New SCR Discoveries							
SCR 0342-6407	...	...	12	38.08 ± 7.79	...	...	39.3 ± 11.7 pc in Hambly et al. 2004
SCR 0420-7006	...	...	12	15.41 ± 2.57	...	...
SCR 0630-7643AB	...	...	12	6.95 ± 1.21	...	...	assuming $\Delta mag = 0.25$ in all filters
SCR 0702-6102	...	...	12	10.84 ± 2.06	...	...
SCR 0724-8015	...	...	12	17.16 ± 3.10	...	...
SCR 1138-7721	...	...	12	9.43 ± 1.68	...	...	8.8 ± 1.7 pc in Hambly et al. 2004
SCR 1845-6357	...	...	10	4.63 ± 0.75	...	...	3.5 ± 0.7 pc in Hambly et al. 2004
SCR 1848-6855	...	...	12	37.03 ± 9.43	...	...	34.8 ± 9.8 pc in Hambly et al. 2004
SCR 2012-5956	...	...	1	17.37 ± 3.47	...	...	white dwarf distance estimate
Recently Discovered Nearby Late-Type M Dwarfs							
SO 0253+1652	...	...	12	3.73 ± 0.59	...	...	a
LP 775-31	...	...	12	7.33 ± 1.19	...	...	b
LP 655-48	...	...	12	8.24 ± 1.40	...	...	c
LHS 2021	...	...	12	13.80 ± 2.34	...	...
LHS 2090	...	...	12	5.67 ± 0.88	...	...	d
DEN 1048-3956	...	...	10	4.53 ± 0.73	...	...	e
LHS 325a	...	...	12	20.74 ± 3.43	...	...
LSR 1826+3014	...	...	10	14.48 ± 2.52	...	...	f
Stars with $\mu \geq 1.0''/\text{yr}$ in Region DEC -57.5 to -90 Fainter than $m_R = 10$							
GJ 1022	...	...	12	20.49 ± 3.35	...	...	g
GJ 45	.05175 .00106	4.85	7	19.18 ± 3.11	19.32 ± 0.40	- 0.7	
WD 0141-675	...	...	1	9.27 ± 1.85	...	...	white dwarf distance estimate
GJ 85	.06460 .01780	6.42	12	19.01 ± 3.00	15.48 ± 4.62	+22.8	poor parallax
GJ 118	.08682 .00188	6.52	12	11.57 ± 1.80	11.52 ± 0.25	+ 0.5	
GJ 181.1	.04440 .01080	6.55	9	36.03 ± 5.65	22.52 ± 5.82	+60.0	poor parallax
GJ 1077	.07750 .01100	6.65	12	12.14 ± 2.38	12.90 ± 1.87	- 5.9	poor parallax
GJ 293	.14120 .00840	13.11	1	6.82 ± 1.36	7.08 ± 0.42	...	white dwarf distance estimate
GJ 1123	...	...	12	7.47 ± 1.22	...	...	h
GJ 345	.01653 .00098	4.56	0	...	60.50 ± 3.60	...	too blue for relations
GJ 1128	...	...	12	6.41 ± 1.01	...	...	i
LHS 288	.22250 .01130	9.46	12	6.90 ± 1.74	4.49 ± 0.23	+53.5	poor parallax
GJ 422	.07954 .00267	6.54	12	12.12 ± 1.92	12.57 ± 0.42	- 3.6	
GJ 440	.21657 .00201	12.78	1	4.38 ± 0.88	4.62 ± 0.04	...	white dwarf distance estimate
GJ 467 A	.02150 .01910	5.71	12	30.87 ± 4.98	$46.51 \pm \text{huge}$	-33.6	poor parallax
GJ 467 B	.02150 .01910	6.84	12	28.48 ± 4.79	$46.51 \pm \text{huge}$	-38.8	poor parallax
GJ 551	.76876 .00030	8.81	12	1.17 ± 0.19	1.30 ± 0.01	-10.2	Proxima
LHS 475	...	...	12	13.07 ± 2.03	...	...
GJ 1251	...	...	12	16.05 ± 3.40	...	...

Table 4—Continued

Name	Mean π_{trig}	M_{K_s}	# colors	Est Dist (pc)	True Dist (pc)	% Diff	Notes
GJ 808	.06300 .01170	6.66	12	21.41 ± 7.43	15.87 ± 3.05	+34.9	poor parallax
PJH 2115-7541	...	...	12	24.84 ± 3.84	...	...
SSSPM J2231-7515	...	...	1	14.89 ± 2.98	...	...	white dwarf distance estimate
SSSPM J2231-7514	...	...	1	14.82 ± 2.96	...	...	white dwarf distance estimate
GJ 877	.11610 .00132	6.14	12	7.10 ± 1.10	8.61 ± 0.10	-17.5	
GJ 1277	...	...	12	8.89 ± 1.42	...	...
Late-Type M Dwarfs within 25 Parsecs							
BRI 0021-0214	.08660 .00400	10.23	7	11.31 ± 2.16	11.55 ± 0.53	- 2.1	
RG 0050-2722	.04171 .00372	10.64	7	28.21 ± 4.63	23.98 ± 2.16	+17.7	
2MA 0149+2956	.04440 .00070	10.21	12	21.59 ± 5.35	22.52 ± 0.36	- 4.2	
LHS 1375	.11770 .00400	9.33	3	9.16 ± 1.41	8.50 ± 0.29	+ 7.8	
LP 771-21	.06160 .00543	10.37	3	18.65 ± 2.94	16.23 ± 1.44	+14.9	
LP 412-31	.06890 .00060	9.83	12	13.31 ± 2.13	14.51 ± 0.13	- 8.3	^j
LP 944-20	.20140 .00421	11.07	3	6.05 ± 1.15	4.97 ± 0.10	+21.9	
LHS 1604	.06810 .00180	9.40	7	12.51 ± 1.99	14.68 ± 0.39	-14.8	^k
LHS 191	.05840 .00180	9.53	12	16.02 ± 2.70	17.12 ± 0.53	- 6.5	
ESO 207-61	.05129 .00226	10.66	12	26.74 ± 5.01	19.50 ± 0.86	+37.1	
GJ 283B	.11240 .00270	9.54	12	9.13 ± 1.49	8.90 ± 0.21	+ 2.6	
GJ 1111	.27580 .00300	9.46	12	3.30 ± 0.51	3.63 ± 0.04	- 9.1	
LHS 2026	.05080 .00050	9.67	12	19.77 ± 3.51	19.69 ± 0.19	+ 0.5	
GJ 316.1	.07110 .00100	9.31	7	12.12 ± 1.89	14.06 ± 0.20	-13.9	
LHS 2065	.11730 .00150	10.29	12	9.10 ± 1.95	8.53 ± 0.11	+ 6.7	^l
LHS 292	.22030 .00360	9.64	12	4.32 ± 0.68	4.54 ± 0.07	- 4.9	
LHS 2314	.04110 .00230	9.67	7	25.08 ± 3.89	24.33 ± 1.37	+ 3.1	
GJ 406	.41910 .00210	9.20	12	1.99 ± 0.31	2.39 ± 0.01	-16.5	
LHS 2351	.04810 .00314	9.74	12	19.53 ± 3.05	20.79 ± 1.36	- 6.1	
LHS 2471	.07030 .00260	9.50	7	12.84 ± 2.04	14.22 ± 0.53	- 9.8	
BRI 1222-1222	.05860 .00380	10.19	3	16.29 ± 2.50	17.06 ± 1.11	- 4.6	
LHS 2924	.09267 .00128	10.58	7	12.77 ± 2.23	10.79 ± 0.15	+18.4	
LHS 2930	.10380 .00130	9.87	7	9.75 ± 1.52	9.63 ± 0.12	+ 1.2	
LHS 3003	.15705 .00259	9.91	12	6.53 ± 1.02	6.37 ± 0.11	+ 2.6	^m
TVLM 513-46546	.09450 .00060	10.58	12	11.85 ± 2.21	10.58 ± 0.07	+12.0	
TVLM 868-110639	.06120 .00470	10.28	3	16.07 ± 2.47	16.34 ± 1.26	- 1.6	
GJ 644C	.15497 .00056	9.77	12	6.45 ± 1.05	6.45 ± 0.02	+ 0.0	
2MA 1835+3259	.17650 .00050	10.40	7	5.82 ± 1.01	5.67 ± 0.02	+ 2.7	
GJ 752B	.17079 .00061	9.93	12	5.50 ± 0.89	5.86 ± 0.02	- 6.1	
GJ 1245B	.22020 .00100	9.10	12	4.69 ± 0.79	4.54 ± 0.02	+ 3.4	
LHS 523	.08880 .00490	9.59	12	14.25 ± 4.41	11.26 ± 0.62	+26.5	ⁿ

^a2.4 pc \pm 0.5 pc from astrometry and 3.6 \pm 0.4 pc from photometry in Teegarden et al. 2003

^b6.2–6.5 pc in McCaughrean et al. 2002; 7.4 \pm 1.5 pc in Reid & Cruz 2002; 11.3 \pm 1.3 pc in Cruz & Reid 2002

^c7.9–8.2 pc in McCaughrean et al. 2002; 7.7 \pm 1.5 pc in Reid & Cruz 2002; 15.3 \pm 2.6 pc in Cruz & Reid 2002

^d6.0 \pm 1.1 pc in Scholz et al. 2001; 5.2 \pm 1.0 pc in Reid & Cruz 2002

^e4.1 \pm 0.6 pc in Delfosse et al. 2001

^f13.9 ± 3.5 pc in Lepine et al. 2002

^g7.2 pc and 29.5 pc in Reyle et al. 2002

^h7.6 pc in Henry et al. 2002

ⁱ6.6 pc in Henry et al. 2002

^j11.9 ± 1.9 pc in Cruz & Reid 2002

^k10.9 ± 2.2 pc in Reid & Cruz 2002; 14.7 ± 0.4 pc in Cruz & Reid 2002

^l8.5 ± 1.7 pc in Reid & Cruz 2002

^m6.3 ± 1.3 pc in Reid & Cruz 2002

ⁿ10.9 ± 0.6 pc in Cruz & Reid 2002