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MEETING THE COOL NEIGHBORS. X. ULTRACOOL DWARFS FROM THE 2MASS ALL-SKY DATA RELEASE

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ABSTRACT

Using data from the 2 Micron All Sky Survey All-Sky Point Source Catalogue, we have extended our census of nearby ultracool dwarfs to cover the full celestial sphere above Galactic latitude of 15°. Starting with an initial catalog of 2,139,484 sources, we have winnowed the sample to 467 candidate late-type M or L dwarfs within 20 pc of the Sun. Fifty-four of those sources already have spectroscopic observations confirming them as late-type dwarfs. We present optical spectroscopy of 376 of the remaining 413 sources, and identify 44 as ultracool dwarfs with spectroscopic distances less than 20 pc. Twenty-five of the 37 sources that lack optical data have near-infrared spectroscopy. Combining the present sample with our previous results and data from the literature, we catalog 94 L dwarf systems within 20 pc. We discuss the distribution of activity, as measured by Hα emission, in this volume-limited sample. We have coupled the present ultracool catalog with data for stars in the northern 8 pc sample and recent (incomplete) statistics for T dwarfs to provide a snapshot of the current 20 pc census as a function of spectral type.

Key words: Galaxy: stellar content – stars: low-mass, brown dwarfs – stars: luminosity function, mass function

Online-only material: machine-readable and VO tables

1. INTRODUCTION

The closing years of the 20th century saw the completion of the first large-scale, deep, near-infrared (NIR) sky surveys, the Deep Near-Infrared Southern Sky Survey (DENIS; Epchtein et al. 1994) and 2 Micron All Sky Survey (2MASS; Skrutskie et al. 2006). Results from those surveys, and from the deep optical imaging of the Sloan Digital Sky Survey (SDSS; York et al. 2000), have revolutionized our understanding of the very low-mass dwarfs that populate the lower reaches of the H-R diagram. Although predated by the identification of the first incontrovertible brown dwarf (Nakajima et al. 1995), the avalanche of discoveries over the past decade (Delfosse et al. 1997; Kirkpatrick et al. 1999, 2000—hereinafter, K99, K00; Fan et al. 2000; Hawley et al. 2002) would not have been possible without the unparalleled sensitivity provided by those surveys. Initial investigations operated in discovery mode, pushing detection to lower and lower temperatures, and extending the spectral classification system to types L (K99; Martín et al. 1999) and T (Geballe et al. 2002; Burgasser et al. 2002, 2006). Analyses of ensemble properties of observational samples, combined with detailed studies of individual objects, have resulted in greater insight into their evolution, atmospheric structure, and composition (Baraffe et al. 1998; Burrows et al. 2001; Marley et al. 2002).

Understanding the statistical properties of brown dwarfs requires that we move beyond discovery mode, and define reliable, unbiased catalogs of late-type dwarfs. As part of the NASA/NSF NStars initiative, we have been undertaking a systematic survey for M and L dwarfs within 20 pc of the Sun. Our initial efforts centered on the 48% of the sky covered by the 2MASS Second Incremental Release (the 2MASS IDR2) and the results from those studies are described in previous papers in this series. We have adopted two main strategies to exploit data from the 2MASS IDR2.

First, we cross-referenced 2MASS data against the NLTT catalogue of proper-motion stars (Luyten 1980), and used the resulting optical-infrared colors to identify early- and mid-type M dwarfs within 20 pc of the Sun. The main results from our M-dwarf surveys are summarized in Papers VIII and XI of this series (Reid et al. 2004, 2007), which present preliminary J-band luminosity functions, $\Phi(M_J)$, for stars within 20 pc of the Sun. That data set includes over 1100 early- and mid-type M dwarfs in ≈1000 systems within 20 pc of the Sun. We are using a variety of techniques to improve the completeness of this sample, including spectroscopic follow-up of additional nearby-star candidates from the recent proper-motion surveys undertaken by Lépine & Shara (2005) and Lépine (2008). At least 450 systems in the current census lack trigonometric parallax data, while at least half of the stars have not been scrutinized for spectroscopic or astrometric binary companions. Given the substantial numbers in this sample, obtaining those ancillary data has a higher priority than extending the M-dwarf survey beyond the bounds of the 2MASS IDR2 database. We refer to these M dwarfs as the 2M2nd sample.

Second, we have used 2MASS photometry to search directly for ultracool dwarfs—spectral types M7 to L8. Paper V (Cruz et al. 2003) and Paper IX (Cruz et al. 2007) summarize the techniques used to define ultracool candidates in the 2MASS IDR2 (the 2MU2 sample), and outline the main results from our analysis of that sample. In total, we identified 637 candidate nearby ultracool dwarfs, and accumulated optical spectroscopy of 480 of those objects. Three hundred and eighty-nine are confirmed

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as spectral-type M7-L6, including 277 new identifications. A future paper in this series will present analysis of near-infrared spectra of the faintest ultracool dwarfs from the 2MU2 sample. Combining these results gives the first volume-complete sample of L dwarfs, and the first derivation of the luminosity function for spectral types M8 to L8.

The 2MU2 20 pc sample includes only 89 ultracool dwarfs, comprising 49 late-M dwarfs and 40 L dwarfs. Those sparse statistics, combined with general interest in the intrinsic properties of these cool, very-low-mass dwarfs, provide strong incentive to expand our survey. With the release of the 2MASS All-Sky Survey, we have the opportunity to double the areal coverage of our investigation. This paper summarizes the results of that process.

We have used the experience gained in compiling the 2MU2 sample to refine the selection criteria and focus our candidate list with higher efficiency on *bonafide* ultracool dwarfs. As in our previous analyses, we use optical spectroscopy as the prime tool for verifying the nature of the candidates, and estimating distances to confirmed ultracool dwarfs. The far-red spectra also allow us to identify lower-mass brown dwarfs, via the presence of lithium absorption, and active objects with appreciable Hα emission.

The present paper is organized as follows: Section 2 describes the revisions made to the selection criteria used to construct the all-sky sample, and summarizes the broad properties of the initial candidate list; Section 3 describes follow-up optical spectroscopy and the spectral classification of candidates; Section 4 discusses the distance distribution and overall properties of the sample, as well as describes some of the more unusual objects in the sample; and Section 5 summarizes our conclusions.

2. THE ALL-SKY ULTRACOOL SAMPLE

The 2MU2 ultracool sample discussed in Papers V and IX is drawn from the 2MASS IDR2, which covers 48% of the sky. Those data were refined for inclusion in the 2MASS All-Sky Point Source catalogue, which forms the basis for our present analysis. As a result, there is significant overlap between the ultracool candidates identified here and the previous 2MU2 sample. For clarity, we treat these two data sets separately, and refer to the new candidates as the 2MUA sample.

2.1. *Defining the 2MUA Sample*

The primary criteria used to define the 2MU2 and 2MUA samples are tied to the NIR photometric properties and Galactic location. Drawing from the experience gained in compiling follow-up observations of the 2MU2 sample, we have modified these selection criteria in certain important respects.

1. We raised the Galactic latitude criterion from $|b| > 10^\circ$ to $|b| > 15^\circ$. Regions near the Galactic Plane suffer from two major problems for our type of survey: high source density, leading to incompleteness and photometric inaccuracies due to image crowding, and extensive reddening due to interstellar dust. To minimize the effects on the 2MU2 sample, we excluded all 2MASS IDR2 tiles that are centered at Galactic latitudes $|b| < 10^\circ$. This had a relatively small impact on areal coverage, since the 2MASS IDR2 release covered predominantly high galactic latitudes. Nonetheless, the 2MU2 ultracool candidates included a significant number of reddened sources. With the higher latitude limit adopted in the present analysis, the majority of those sources are eliminated *a priori*. The $|b| > 15^\circ$ requirement reduces coverage to ~70% of the celestial sphere.
2. We increased the blue $(J - K_S)$ limit at bright magnitudes from $(J - K_S) > 1.00$ to $(J - K_S) \geqslant 1.06$. The 2MU2 candidate list includes several hundred sources with $J > 12$ and $(J - K_S) \leqslant 1.05$ (Figure 4 in Paper V), almost all of which have proven to be M6/M6.5 dwarfs at distances of 30–50 pc. Eliminating the M6 dwarfs comes at a price: with the redder color limit, the 2MUA sample includes few M7 and only a subset of nearby M8 dwarfs. Based on the spectral-type/color distributions derived by Gizis et al. (2000), we expect approximately 50% of M8 dwarfs to meet the current color limits.
3. We considered only sources with magnitudes $J > 9$. Five hundred and eighty-eight of the 2MU2 candidates are brighter than this limit, but only four of these sources proved to be mid- or late-type M dwarfs.

Table 1
Steps to Create the 2MUA Sample

Item	Number
2MASS hits	2,139,482
Automated cuts	
Clouds/crowded	218,204
LMC, SMC, & 47 Tuc	76,617
M31 & M33	945
$J, (J - K)$	1,830,288
$(J - H), (H - K)$	10,462
$R, (R - J)$	1,557
Giants	22
All-sky total	1,387
In 2MU2	369
Interim total	1,018
Source-by-source cuts	
Artifacts	460
Near clouds	26
$\|b\| < -15^\circ$	26
Blue optical/IR colors	31
Near bright stars	8
Total candidates	467

Notes. The initial sample of 2.14 million candidates was selected using two criteria: $(J - K_S) \geqslant 1.06$ and $|b| > 15^\circ$. Subsequently, as described in the text, a series of automated cuts were applied to give the all-sky sample of ultracool candidates. The upper section of this table lists the number of sources rejected based on successive specific criteria (see Paper V for full details), reducing the all-sky sample to 1387 candidates. Three hundred and sixty nine of those candidates are included in the 2MU2 sample, so the 2MUA sample consists of 1018 ultracool-dwarf candidates. Those candidates were checked on an individual basis (see Section 2.1) and the final list reduced to 467 viable ultracool-dwarf candidates.

Other selection criteria outlined in Paper V, based on location in the JHK_S (including the "giant star" criteria defined in Equation (4) of that paper), on location in the $J/(R - J)$ diagrams, and on the 2MASS photometric confusion/solar system flags ($cc_{\rm flg} = 000$, $mp_{\rm flg} = 00$), were retained unaltered.

The upper section of Table 1 (corresponding to Table 1 in Paper V) breaks down the steps used to construct the 2MUA candidate list. As with the 2MU2 sample, the initial catalog of

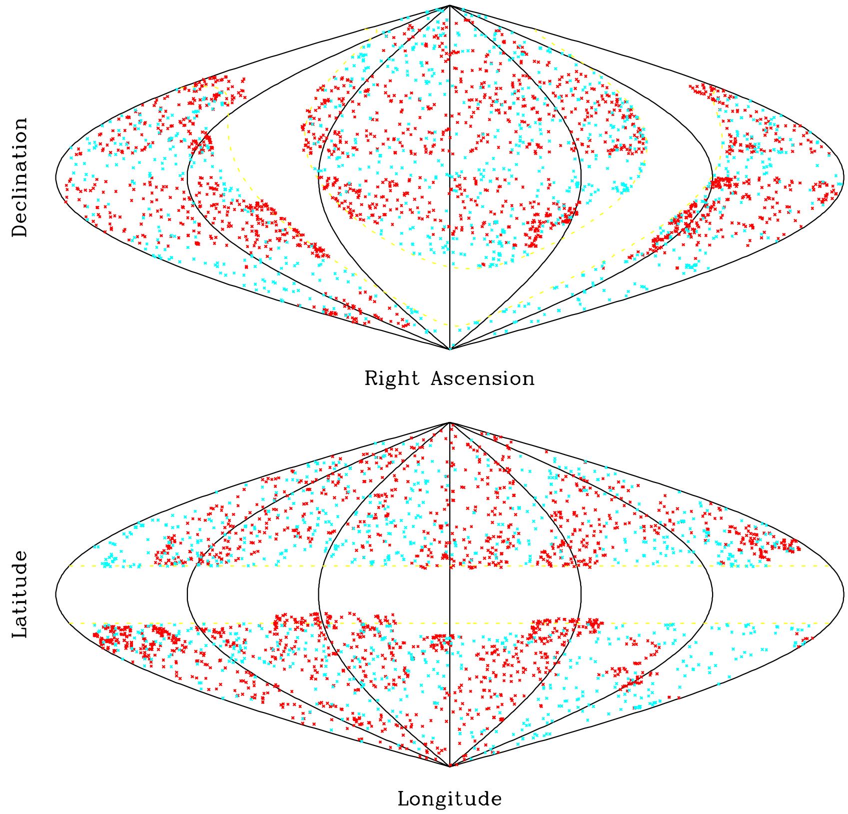

Figure 1. The (α, δ) and (l, b) distributions of ultracool candidates from the 2MU2 (red) and 2MUA (cyan) samples. There are 1672 sources in the former sample, and 1018 in the latter (see Table 1).

2.14 million 2MASS sources with $(J - K_S) \geqslant 1.06$ and latitude $|b| > 15°$ is reduced to manageable proportions, primarily through cuts in the $(J, (J - K_S))$ and $(J - H)/(H - K_S)$ planes, and the elimination of sources in highly-crowded fields near the $|b| = 15°$ cutoff or near known star-forming regions. As discussed in Paper V, rough positions and dimensions for highly-reddened regions were taken from Dame et al. (1987) and Dutra & Bica (2002), and enlarged as necessary where visual inspection revealed high source densities around the edges of the excised regions. Sources eliminated based on this criterion are designated as "clouds/crowded" in Table 1.

The 2MASS All Sky Point Source Catalogue includes the same 48% of the sky covered by the 2MASS IDR2. Our prior analyses, described in Papers V and IX, resulted in the identification of 1672 ultracool candidates within those regions (Paper V, Table 1), and follow-up observations have confirmed 369 to be ultracool dwarfs. Eliminating the 2MU2 sources from the all-sky sample gives a total of 1018 candidate ultracool dwarfs in the 2MUA sample. Figure 1 plots the (α, δ) and (l, b) distributions of the 2MU2 and 2MUA candidates. Combined, the two data sets cover approximately 26,500 deg^2 or $\sim$65% of the sky.

2MASS and Digitized Sky Survey (DSS) images of 1018 ultracool candidates in the 2MUA sample were inspected individually, and the results from those inspections are given in Table 1. Our inspection showed that almost half the sample proved to be artifacts, mainly diffraction spikes and blends with background nebulosity. (The 2MASS catalogue includes a number of flags to identify sources of dubious image quality, and almost all of these sources are indeed flagged as suspect.) A further 26 sources were eliminated since they lie near small star-forming regions ("clouds" in Table 1), and a similar number were disqualified because they lie within 15° of the Galactic equator (the phase I cuts are based on the Galactic latitude of the center of the 2MASS tile, not the positions of the individual objects in each tile). Thirty-one objects have optical/IR colors (based on DSS data) that are obviously inconsistent with ultracool dwarfs, and, finally, eight objects are artifacts associated with bright (H-D catalogue) stars. Removing those sources reduces the candidate list to 467 sources.

2.2. *Known Ultracool Dwarfs*

Over 70 sources in our candidate list have been observed in the course of other surveys for ultracool dwarfs. Fifty-four stars (and brown dwarfs) have extant optical spectroscopy of sufficient signal-to-noise (S/N) and resolution to allow unambiguous classification as late-type dwarfs; in a few cases, we have supplemented the literature data with our own observations. The relevant characteristics of these objects are given in Table 2. Most were identified from follow-up observations of extremely red sources from the 2MASS survey (K00; Gizis et al. 2000; Gizis 2002), the DENIS survey (Martín et al. 1999; Phan-Bao et al. 2001), and the SDSS survey (Fan et al. 2000; Hawley et al. 2002). Twenty-one dwarfs listed in Table 2 have trigonometric or spectroscopic parallaxes that indicate distances within 20 pc of the Sun.

3. SPECTROSCOPY

3.1. *Observations*

We have obtained intermediate-resolution optical spectroscopy of 376 sources from the 2MUA sample. The overwhelming majority of the observations, covering some 355

Table 2
Previously Known Cool Dwarfs Recovered in the 2MUF Sample

2MASS Designation[a]	2MUCD	Other Names	2MASS			Optical	M_J	d (pc)	References[c]
			J	$J-H$	$J-K_S$	Spectral Type[b]			
00043484−4044058	20004	LHS 102B	13.109	1.054	1.713	L5 & L5	. . .	11.5 ± 2.5	1, 2
00154476+3516026	20012	. . .	13.878	0.986	1.614	L2	12.31 ± 0.17	20.6 ± 1.6	3, 4
00210589−4244433	20018	DENIS-P J0021.0-4244/LEHPM 494B	13.521	0.712	1.217	M9.5	11.60 ± 0.13	24.2 ± 1.5	5, 6
00361617+1821104	20029	. . .	12.466	0.878	1.408	L3.5	12.75 ± 0.03[d]	8.76 ± 0.06[d]	3, 4
01075242+0041563	20052	SDSS J010752.33+004156.1	15.824	1.312	2.115	L8	14.86 ± 0.16[d]	15.59 ± 1.10[d]	7–9
01092170+2949255	20055	. . .	12.912	0.754	1.231	M9.5	11.60 ± 0.13	18.23 ± 1.1	10
01300580+1721434	20070	. . .	13.701	0.713	1.125	M8	11.16 ± 0.18	32.3 ± 2.7	10
01353586+1205216	20073	. . .	14.412	0.885	1.494	L1.5	12.15 ± 0.15	28.4 ± 2.1	3
02073557+1355564	20095	SDSS J020735.60+135556.3	15.462	0.988	1.654	L3	12.67 ± 0.20	36.1 ± 3.4	8
02435103−5432194	20128	DENIS-P J0243-5432	14.038	0.716	1.254	M9	11.47 ± 0.14	32.7 ± 2.1	11
02522628+0056223	20132	TVLM 832-10443	13.126	0.684	1.163	M8	10.91 ± 0.03[d]	27.78 ± 0.31[d]	4, 12–14
03454316+2540233	20165	. . .	13.997	0.786	1.325	L0	11.84 ± 0.04	26.95 ± 0.36	4, 15
04172478+1634364	20185	. . .	14.157	0.728	1.259	M8	11.16 ± 0.18	39.8 ± 3.3	16
07075327−4900503	20258	ESO 207-61	13.228	0.690	1.123	M8.5	11.78 ± 0.10[d]	19.48 ± 0.85[d]	17, 18–20
08300825+4828482	20301	SDSS J083008.12+482847.4	15.444	1.101	1.768	L8	14.86 ± 0.11[d]	13.09 ± 0.59[d]	9, 21, 22
08575849+5708514	20320	SDSS J085758.45+570851.4	15.038	1.248	2.076	L7	14.45 ± 0.30	13.1 ± 1.8	8
09492223+0806450	20352	LHS 2195	12.305	0.672	1.099	M8.5[e]	11.32 ± 0.15	15.7 ± 1.1	23
10185879−2909535	20367	. . .	14.213	0.795	1.417	L1	12.00 ± 0.14	27.7 ± 1.9	24
10365305−3441380	20378	. . .	15.622	1.176	1.824	L6	14.02 ± 0.30	20.9 ± 2.9	24
10451718−2607249	20384	. . .	12.791	0.676	1.165	M8	11.16 ± 0.18	21.2 ± 1.7	24
10481463−3956062	20385	DENIS-P J104814.7-395606	9.538	0.633	1.091	M9	11.51 ± 0.02[d]	4.02 ± 0.02[d]	25–29
10484281+0111580	20387	SDSS J104842.81+011158.2	12.924	0.783	1.301	L1	12.00 ± 0.14	15.3 ± 1.0	8
11223624−3916054	20410	. . .	15.705	1.023	1.830	L3	12.67 ± 0.20	40.4 ± 3.8	24
11345493+0022541	20417	SDSS J113454.91+002254.3	12.853	0.677	1.181	M9	11.47 ± 0.14	18.9 ± 1.2	8
11395113−3159214	20419	. . .	12.686	0.690	1.183	(M9)[e]	11.47 ± 0.14	17.5 ± 1.1	24
11485427−2544404	20425	. . .	13.399	0.706	1.230	M8	11.16 ± 0.18	28.1 ± 2.3	24
11553952−3727350	20431	. . .	12.811	0.770	1.349	L2	12.31 ± 0.17	12.6 ± 1.0	24
11593850+0057268	20432	DENIS-P J1159.6+0057	14.084	0.773	1.273	L0	11.73 ± 0.13	29.6 ± 1.8	11
12035812+0015500	20433	SDSS J120358.19+001550.3	14.006	0.950	1.530	L4[e]	13.09 ± 0.22	15.2 ± 1.6	30
12573726−0113360	20460	SDSS J125737.26-011336.1	15.941	1.219	1.818	L4	13.09 ± 0.22	37.1 ± 4.1	8
13240556−3508067	20479	. . .	13.396	0.667	1.090	M6	10.12 ± 0.37	45.3 ± 7.8	24
13262009−2729370	20480	. . .	15.847	1.106	1.995	L5	13.55 ± 0.24	28.7 ± 3.3	24
13285503+2114486	20481	. . .	16.192	1.190	1.927	L5	13.55 ± 0.24[d]	32.26 ± 3.95[d]	4, 15
13290099−4147133	20482	. . .	13.648	0.853	1.375	M9	11.47 ± 0.14	27.3 ± 1.8	24
14122449+1633115	20553	. . .	13.888	0.738	1.367	L0.5	11.86 ± 0.14	25.4 ± 1.6	3

Table 2
(Continued)

2MASS Designation[a]	2MUCD	Other Names	2MASS J	2MASS $J-H$	2MASS $J-K_S$	Optical Spectral Type[b]	M_J	d (pc)	References[c]
14213145+1827407	20562	...	13.231	0.802	1.288	L0	11.73 ± 0.13	20.0 ± 1.2	10
14284323+3310391	20571	LHS 2924	11.990	0.765	1.246	M9	11.80 ± 0.03[d]	10.92 ± 0.11[d]	14, 31–34,
14392836+1929149	20581	...	12.759	0.718	1.213	L1	11.97 ± 0.02[d]	14.37 ± 0.10[d]	4, 15
14413716−0945590	20582	DENIS-P J144137.3-094559	14.020	0.830	1.359	L1 & L1	...	27.69 ± 2.68[d]	11, 35–38
15010818+2250020	20596	TVLM 513-46546	11.866	0.685	1.160	M9	11.74 ± 0.03[d]	10.59 ± 0.07[d]	4, 12
15101685−0241078	20602	TVLM 868-110639	12.614	0.772	1.267	M9	11.55 ± 0.17[d]	16.34 ± 1.25[d]	12, 14, 39
15104761−2818234	20603	...	14.012	0.693	1.227	M9	11.47 ± 0.14	32.3 ± 2.1	24
15104786−2818174	20604	...	12.838	0.728	1.151	M9[e]	11.47 ± 0.14	18.8 ± 1.2	24
16073123−0442091	20660	...	11.896	0.709	1.179	M8	11.16 ± 0.18	14.1 ± 1.2	24
16202614−0416315	20665	Gl 618.1B	15.283	0.934	1.685	L2.5	12.87 ± 0.18[d]	30.33 ± 2.41[d]	40, 41
16325882−0631481	20680	...	12.742	0.697	1.121	M7	10.73 ± 0.25	25.2 ± 2.9	24
17071830+6439331	20700	...	12.539	0.746	1.164	M9	11.47 ± 0.14	16.4 ± 1.1	10
17072343−0558249	20701	...	12.052	0.792	1.341	M9 & L3	...	15.1 ± 1.9	24, 42
18410861+3117279	20791	...	16.158	1.187	1.938	L4pec	13.02 ± 0.20[d]	42.43 ± 3.40[d]	3, 9
19302746−1943493	20818	...	12.339	0.650	1.067	M6.5	10.46 ± 0.31	23.8 ± 3.4	24
20282035+0052265	20866	SDSS J202820.32+005226.5	14.298	0.920	1.505	L3	12.67 ± 0.20	21.1 ± 2.0	8
21272613−4215183	20898	HB 2124-4228	13.321	0.655	1.135	M7.5	10.63 ± 0.47[d]	34.60 ± 7.54[d]	20, 22, 43
22264440−7503425	20946	DENIS-P J222644.3-750342	12.353	0.657	1.107	M8	11.16 ± 0.18	17.4 ± 1.4	44, 45
22443167+2043433	20968	...	16.476	1.477	2.454	L6.5	14.24 ± 0.30	27.9 ± 4.3	4

Notes.

[a] The sexagesimal R.A. and decl. suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.]±ssddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox; the units of R.A. are hours, minutes, and seconds; and units of decl. are degrees, arcminutes, and arcseconds.

[b] Uncertainties on spectral types are ± 0.5 subtypes except where noted by one or two colons, indicating an uncertainty of ±1 and ±2 types, respectively. Spectra displaying low-gravity features are indicated with parentheses.

[c] References listed pertain to spectral data, resolved binaries, and trigonometric parallaxes.

[d] Distance and M_J based on trigonometric parallax.

[e] Spectral type based on new observations.

References. (1) EROS Collaboration et al. 1999; (2) Golimowski et al. 2004; (3) Kirkpatrick et al. 2000; (4) Dahn et al. 2002; (5) Tinney et al. 1998; (6) Basri et al. 2000; (7) Schneider et al. 2002; (8) Hawley et al. 2002; (9) Vrba et al. 2004; (10) Gizis et al. 2000; (11) Martín et al. 1999; (12) Tinney et al. 1993; (13) Kirkpatrick et al. 1997; (14) Tinney et al. 1995; (15) Kirkpatrick et al. 1999; (16) Gizis et al. 1999; (17) Ruiz et al. 1991; (18) Lodieu et al. 2005; (19) Ianna & Fredrick 1995; (20) Tinney 1996; (21) Geballe et al. 2002; (22) Looper et al. 2008; (23) Gizis & Reid 1997; (24) Gizis 2002; (25) Delfosse et al. 2001; (26) Deacon & Hambly 2001; (27) Neuhäuser et al. 2002; (28) Costa et al. 2005; (29) Jao et al. 2005; (30) Fan et al. 2000; (31) Probst & Liebert 1983; (32) Kirkpatrick et al. 1991; (33) Monet et al. 1992; (34) van Altena et al. 1995; (35) Stephens et al. 2001; (36) Bouy et al. 2003; (37) Seifahrt et al. 2005; (38) Costa et al. 2006; (39) Kirkpatrick et al. 1995; (40) Wilson et al. 2001; (41) Perryman & ESA 1997; (42) McElwain & Burgasser 2006; (43) Bessell 1988; (44) Phan-Bao et al. 2003; (45) Crifo et al. 2005.

sources, were obtained in the course of several observing runs between 2003 March and 2004 February. We used the Ritchey-Chrétien (RC) spectrograph on the Kitt Keak National Observatory 2.1 m telescope in 2003 March and October; the MARS spectrograph on the KPNO 4 m telescope in 2003 July and 2004 February; the RC spectrograph on the 1.5 m telescope at Cerro-Tololo Interamerica Observatory in 2003 May and November; and the RC spectrograph on the CTIO 4 m telescope in 2003 April, 2004 August, and 2006 January. In each case, the spectra cover the wavelength range 6300–10000 Å at a resolution of ∼7 Å.

Twenty-one fainter candidates were observed using the Gemini telescopes. The Gemini Multi-Object Spectrometer (GMOS; Hook et al. 2004) was used on Gemini north (GN) and Gemini south (GS) during queue observations taken between 2004 August and 2005 November (Program IDs: GN-2004B-Q-10, GS-2004B-Q-30, GN-2005B-Q-20, GS-2005B-Q-21). The observations were made using the RG610_G0307 filter and R400_G5305 disperser on GN, while the RG610_G0331 filter and R400_G5325 disperser were used on GS. In both cases, the data cover the wavelength range 6000–10000 Å. Two consecutive observations, with the central wavelength offset, were taken of each target to provide a complete wavelength coverage. On both telescopes, the nod and shuffle mode was used with a 0.″75-wide slit to provide good sky subtraction and a resolution of 5.5 Å (4 pixels).

The spectroscopic data acquired from the KPNO and CTIO telescopes were bias-subtracted and flat-fielded using the IRAF CCDRED package, and the spectra extracted, wavelength- and flux-calibrated using standard techniques. The wavelength calibration is based on a single HeNeAr arc, usually taken at the start of the night. Each night we also observed one of the following flux standards: BD+26 2606, BD+17 4708, HD 19445 (from Oke & Gunn 1983); Feige 56, Feige 110, or Hiltner 600 (from Hamuy et al. 1994).

The Gemini GMOS package was used to reduce the data from GN and GS.[9] Nod and shuffle dark frames were subtracted and the data were flat-fielded using the *gsreduce* task and the sky lines were subtracted using *gnsskysub*. Flux calibration was provided through observations of the flux standards G191B2B, LTT 1020 and EG 21 (Massey et al. 1988; Massey & Gronwall 1990; Hamuy et al. 1994). All spectra were extracted using *gsextract* and the flux calibration applied with *calibrate*. As discussed in Cruz et al. (2007), the slope of the spectra from GN-2004B-Q-10 is systematically too steep longward of 8700 Å. None of the spectra have been corrected for telluric absorption.

The 2MASS sources targeted in these observations are listed in Tables 3–6, where the coordinates and near-infrared photometry are from the 2MASS All Sky Point Source Catalogue, and the results deduced from the observations. Table 3 lists data for 44 sources that we identify as ultracool dwarfs likely to lie within 20 pc of the Sun; Table 4 presents data for 228 ultracool dwarfs at larger distances; Table 5 lists 83 spectroscopically confirmed K and M giants; and Table 6 catalogs data for 22 carbon stars. Combining literature data and our own observations, we have optical spectra for 430 of the 467 ultracool candidates. Twenty-eight of the remaining 37 sources have been observed spectroscopically at near-infrared wavelengths, and nine sources have no follow-up observations. Twenty-five of the 28 sources with observations have spectra consistent with ultracool dwarfs lying more than 20 pc from the Sun. Those infrared observations will be discussed in detail in a future paper in this series.

3.2. Spectral Types and Distances

We have applied the methods described in Papers V and IX to determine spectral types, and hence absolute magnitude and distance estimates, for the dwarfs in the 2MUA sample. As discussed in those papers, although molecular band strengths are well correlated with luminosity for early- and mid-type M dwarfs, there are ambiguities for later-type dwarfs. We therefore determine spectral types for the latter dwarfs from the overall spectral energy distribution from 6000 to 10000 Å, using side-by-side comparison with spectral standards. The uncertainties are generally ±0.5 subtypes for well-exposed spectra, rising to $\pm 1 - 2$ subtypes for low S/N data. In cases where we have multiple observations of a particular candidate, we have used the highest S/N spectrum to estimate the spectral type.

Absolute magnitudes of late-type dwarfs (>M6) are derived directly from the spectral types using the calibration given in Paper V. For earlier-type dwarfs, we derive distances using the TiO5, CaH2, and CaOH band strengths and the relations listed in Paper III. In both cases, the calibrations are tied to the 2MASS J passband. The results are collected in Tables 3 and 4. Table 3 presents observations of 44 ultracool dwarfs (spectral types M7 and later) with formal distances less than 20 pc. Table 4 lists data for a further 228 dwarfs that lie beyond our distance limit, including 84 L dwarfs and 132 ultracool M dwarfs. Many late-type M dwarfs and a handful of L dwarfs exhibit Hα emission. Schmidt et al (2007) present a thorough analysis of chromospheric activity in these low-mass dwarfs and also discuss the proper motions and correlations between activity and kinematics. Detailed discussions of individual objects of interest are given in Section 4.

As in our previous spectroscopy of 2MU2 ultracool candidates, a number of late-type dwarfs exhibit anomalously strong VO absorption and/or weaker K I and Na I atomic absorption. This is generally interpreted as evidence for surface gravities that are lower than the typical values for field dwarfs of similar spectral types (Kirkpatrick et al. 2006). Twenty-seven candidate low-gravity dwarfs are identified in Tables 2–4. We have assigned these objects spectral types and, where necessary, spectroscopic parallaxes using conventional criteria; however, if the systems prove to be young, low-gravity dwarfs, it is likely that both spectral types and distances will require revision. Consequently, the spectral types for these objects are listed in parentheses in Tables 2–4. The full characteristics of these candidates' low-gravity dwarfs will be discussed in more detail by K. L. Cruz et al. (2009, in preparation).

Finally, late-type first giant branch and asymptotic giant branch stars can have near-infrared colors that meet our selection criteria, and our follow-up spectroscopic observations have identified a number of such stars. Tables 5 and 6 list data for 83 K and M giants and 22 carbon stars, respectively. A number of carbon-rich dwarfs have been discovered through follow-up observations of 2MASS ultracool candidates (e.g., Lowrance et al. 2003). However, all of the stars listed in Table 6 have classical carbon giant spectra, and none show evidence for significant proper motion. Consequently, it is likely that all are giants rather than nearby dwarfs.

9 Our reduction methods for both traditional and nod and shuffle GMOS data are described in detail at http://www.astro.caltech.edu/∼kelle/gmos/gemini_NSreduction.html.

Table 3
M6–L8 Dwarfs Discovered Within 20 pc

2MASS Designation[a]	2MUCD	Other Name	2MASS J	2MASS $J-H$	2MASS $J-K_S$	Obs. Date (UT)	Telescope	Optical Spectral Type[b]	M_J	d (pc)	References[c]
00413538−5621127	20035	DENIS-P J004135.3-562112	11.964	0.642	1.100	2003 Nov 10	CT 1.5 m	M8	11.16 ± 0.18	14.5 ± 1.2	1, 2
00452143+1634446	20037	. . .	13.059	1.000	1.693	2003 Jul 10	KP 4 m	(L2)	. . .	∼14	3, 22
01025100−3737438	20049	LHS 132	11.130	0.651	1.061	2003 Nov 9	CT 1.5 m	M8	11.16 ± 0.18	12.20 ± 0.41[d]	4, 5, 6
01090150−5100494	20053	SSSPM J0109-5101	12.228	0.690	1.136	2003 Nov 9	CT 1.5 m	M8	11.16 ± 0.18	16.4 ± 1.3	7, 8
		. . .				2004 Aug 9	CT 4 m				
01282664−5545343	20068	. . .	13.775	0.859	1.439	2006 Jan 15	CT 4 m	L2	12.31 ± 0.17	19.6 ± 1.5	9
02150802−3040011	20101	LHS 1367	11.617	0.664	1.075	2003 Nov 8	CT 1.5 m	M8	11.16 ± 0.18	12.4 ± 1.0	5, 10
02284243+1639329	20116	. . .	13.166	0.840	1.348	2003 Jul 9, 2004 Feb 11	KP 4 m	L0:	11.73 ± 0.26	19.4 ± 2.3	3
02572581−3105523	20139	. . .	14.672	1.154	1.796		Keck I	L8	14.77 ± 0.30	9.6 ± 1.3	11
03140344+1603056	20156	. . .	12.526	0.702	1.288	2003 Oct 12	KP 2.1 m	L0	11.73 ± 0.13	14.4 ± 0.9	
		. . .				2004 Feb 11	KP 4 m				
03283463+1129515	20161	LSR J0328+1129	12.463	0.678	1.133	2003 Oct 12	KP 2.1 m	M8	11.16 ± 0.18	18.3 ± 1.5	
03552337+1133437	20171	. . .	14.050	1.520	2.524	2004 Feb 11	KP 4 m	(L5)	. . .	∼13	22
		. . .				2005 Nov 27	GN				
05002100+0330501	20197	. . .	13.669	0.986	1.607	2004 Feb 11	KP 4 m	L4	13.09 ± 0.22	13.0 ± 1.3	
06244595−4521548	20244	. . .	14.480	1.145	1.885	2003 Apr 21	CT 4 m	L5:	13.55 ± 0.47	15.3 ± 3.3	
07140394+3702459	20263	LSPM J0714+3702	11.976	0.724	1.138	2003 Mar 13	KP 2.1 m	M8	11.16 ± 0.18	14.6 ± 1.2	
08040580+6153336	20290	LSPM J0804+6153	12.740	0.811	1.286	2003 Mar 15	KP 2.1 m	M9:	11.47 ± 0.28	18.0 ± 2.3	
08072607+3213101	20292	LP 310- 34	12.168	0.712	1.117	2003 Mar 14, 2003 Oct 12	KP 2.1 m	M8	11.16 ± 0.18	15.9 ± 1.3	3
08303256+0947153	20302	LHS 2021	11.890	0.725	1.134	2003 Mar 13, 2003 Oct 12	KP 2.1 m	M8	11.16 ± 0.18	16.72 ± 1.26[d]	12, 13
		. . .				2004 Feb 10	KP 4 m				
09111297+7401081	20333	. . .	12.921	0.715	1.173	2003 Mar 15	KP 2.1 m	L0	11.73 ± 0.13	17.3 ± 1.1	
		. . .				2004 Feb 10	KP 4 m				
09153413+0422045	20335	. . .	14.548	1.017	1.537	2003 Apr 20, 2006 Jan 15	CT 4 m	L6 & L6	. . .	18.0 ± 4.2	14, 15
		. . .				2004 Feb 11	KP 4 m				
09211410−2104446	20336	SIPS J0921-2104	12.779	0.627	1.089	2003 Mar 13	KP 2.1 m	L1.5	12.15 ± 0.15	11.48 ± 0.34[d]	16
		. . .				2006 Jan 15	CT 4 m				
10224821+5825453	20373	. . .	13.499	0.857	1.339	2003 Mar 13	KP 2.1 m	(L1)[e]	. . .	∼20	17
		. . .				2004 Feb 10, 11, 12	KP 4 m				
10511900+5613086	20388	. . .	13.244	0.821	1.339	2003 Mar 13	KP 2.1 m	L2	12.31 ± 0.17	15.4 ± 1.2	
		. . .				2004 Feb 10	KP 4 m				
10554733+0808427	20391	LSPM J1055+0808	12.550	0.677	1.182	2003 Mar 15	KP 2.1 m	M8	11.16 ± 0.18	19.0 ± 1.6	
12212770+0257198	20444	. . .	13.169	0.759	1.216	2003 Mar 15	KP 2.1 m	L0	11.73 ± 0.13	19.4 ± 1.2	
		. . .				2003 Apr 21, 2006 Jan 15	CT 4 m				
14252798−3650229	20568	DENIS-P J142527.9-365023	13.747	1.172	1.942	2003 Apr 22, 2004 Aug 9, 2006 Jan 14	CT 4 m	L3:	12.67 ± 0.39	16.4 ± 3.0	18

Table 3
(Continued)

2MASS Designation[a]	2MUCD	Other Name	2MASS J	$J-H$	$J-K_S$	Obs. Date (UT)	Telescope	Optical Spectral Type[b]	M_J	d (pc)	References[c]
14482563+1031590	20587	. . .	14.556	1.123	1.873	2003 Apr 20	CT 4 m	L4:	13.09 ± 0.44	19.6 ± 4.0	3
15394189−0520428	20625	DENIS-P J153941.9-052042	13.922	0.862	1.347		Keck I	L3.5	12.88 ± 0.21	16.2 ± 1.6	18, 11
		. . .				2003 Apr 20	CT 4 m				
		. . .				2004 Feb 10	KP 4 m				
15394442+7437273	20626	. . .	12.931	0.723	1.198	2003 Mar 13	KP 2.1 m	M9	11.47 ± 0.14	19.6 ± 1.3	
16154245+0546400	20662	. . .	12.880	0.684	1.139	2003 Apr 21	CT 4 m	M9	11.47 ± 0.14	19.2 ± 1.2	
17054834−0516462	20699	DENIS-P J170548.3-051645	13.309	0.757	1.277	2003 Apr 21	CT 4 m	L0.5	11.86 ± 0.14	19.5 ± 1.2	18
17312974+2721233	20744	LSPM J1731+2721	12.094	0.702	1.180	2003 Apr 22	CT 4 m	L0	11.73 ± 0.13	11.8 ± 0.7	
17351296+2634475	20746	LP 388- 55	11.252	0.661	1.095	2003 Apr 22	CT 4 m	M7: & M8:[f]	. . .	16.4 ± 3.8	19
17534518−6559559	20760	SIPS J1753-6559	14.095	0.987	1.671	2003 Apr 23, 2004 Aug 9	CT 4 m	L4::	13.09 ± 0.89	15.9 ± 6.5	
18451889+3853248	20793	LP 280- 16	12.214	0.753	1.167	2003 Jul 9	KP 4 m	M8	11.16 ± 0.18	16.3 ± 1.3	
19360187−5502322	20823	SIPS J1936-5502	14.486	0.858	1.440	2003 Apr 20, 2004 Aug 9	CT 4 m	L5:	13.55 ± 0.47	15.4 ± 3.3	
20004841−7523070	20845	DENIS-P J200048.3-752306	12.734	0.767	1.223	2003 Apr 23	CT 4 m	(M9)	. . .	∼18	
20360316+1051295	20870	. . .	13.950	0.932	1.503	2003 Jul 9	KP 4 m	L3	12.67 ± 0.20	18.0 ± 1.7	
20450238−6332066	20875	SIPS J2045-6332	12.619	0.811	1.412	2003 Apr 20	CT 4 m	M9	11.47 ± 0.14	17.0 ± 1.1	
21373742+0808463	20909	. . .	14.774	1.168	1.755	2003 Jul 10	KP 4 m	L5:	13.55 ± 0.47	17.5 ± 3.8	
21392676+0220226	20912	. . .	15.264	1.099	1.682	2004 Sep 21	GN	T0:	14.56 ± 0.28[g]	13.8 ± 1.1	
21522609+0937575	20925	. . .	15.190	1.110	1.847	2003 Jul 10	KP 4 m	L6 & L6	. . .	19.9 ± 4.6	14
22521073−1730134	20976	DENIS-P J225210.7-173013	14.313	0.953	1.412	2004 Aug 9	CT 4 m	L6 & T2	. . .	16.9 ± 3.7	18, 20
		. . .				2005 Oct 9	GS				
22551861−5713056	20979	. . .	14.083	0.894	1.504	2004 Aug 9	CT 4 m	L6:& L8	. . .	12.6 ± 2.9	9, 21
23464599+1129094	21011	LSPM J2346+1129	12.798	0.696	1.193	2003 Jul 10	KP 4 m	M9	11.47 ± 0.14	18.5 ± 1.2	

Notes.

[a] The sexagesimal right ascension and declination suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.]±ssddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox.

[b] Uncertainties on spectral types are ±0.5 subtypes except where noted by one or two colons, indicating an uncertainty of ±1 and ±2 types, respectively. Spectra displaying low-gravity features are indicated with parentheses.

[c] References listed pertain to spectral data, resolved binaries, and trigonometric parallaxes.

[d] Distance estimate based on trigonometric parallax.

[e] Displays variable Hα emission as discussed by Schmidt et al. (2007).

[f] M7: and M8: are estimated to be the component spectral types based on our measured combined spectral type of M7.5 and $\Delta I \sim 1$ found by 62.

[g] M_J estimated using 2MASS $(J - K_S)$ color and the spectral-type/M_K relation in 111.

References. (1) Phan-Bao et al. 2001; (2) Phan-Bao & Bessell 2006; (3) Wilson et al. 2003; (4) Reid & Gizis 2005; (5) Reylé et al. 2006; (6) Costa et al. 2005; (7) Lodieu et al. 2002; (8) Lodieu et al. 2005; (9) Kendall et al. 2007; (10) Reylé & Robin 2004; (11) Kirkpatrick et al. 2008; (12) Henry et al. 2004; (13) Costa et al. 2006; (14) Reid et al. 2006b; (15) M. Liu 2008, private communication; (16) Bartlett 2007; (17) Schmidt et al. 2007; (18) Kendall et al. 2004; (19) Law et al. 2006; (20) Reid et al. 2006a; (21) Reid et al. 2008; (22) K. L. Cruz et al. 2009, in preparation.

Table 4
Ultracool Dwarfs at Distances Exceeding 20 pc

2MASS Designation[a]	2MUCD	Other Names	2MASS			Obs. Date (UT)	Telescope	Optical	M_J	d (pc)	Other References[c]
			J	$J-H$	$J-K_S$			Spectral Type[b]			
00054844−2157196	20005	LEHPM 162	13.274	0.657	1.073	2003 Nov 10	CT 1.5 m	M9:	11.47 ± 0.28	23.0 ± 3.0	1, 2, 3
00065794−6436542	20007	...	13.385	0.721	1.216	2003 Nov 09	CT 1.5 m	M9:	11.47 ± 0.28	24.2 ± 3.1	
00085931+2911521	20009	...	13.827	0.700	1.137	2003 Jul 09	KP 4 m	M8.5	11.32 ± 0.15	31.7 ± 2.3	
00165953−4056541	20013	...	15.316	1.110	1.884	2005 Aug 12	GS	L3.5[d]	12.88 ± 0.21	30.7 ± 3.1	4
00184613−6356122	20016	...	15.224	0.995	1.613	2005 Aug 19	GS	L2	12.31 ± 0.17	38.3 ± 3.1	
00285545−1927165	20022	...	14.191	0.860	1.346	2004 Aug 09	CT 4 m	L0:	11.73 ± 0.26	31.1 ± 3.8	
00315477+0649463	20024	LSPM J0031+0649	12.820	0.636	1.102	2003 Oct 12	KP 2.1 m	M7	10.73 ± 0.25	26.1 ± 3.0	
00320509+0219017	20025	...	14.324	0.938	1.522	2003 Jul 09	KP 4 m	L1.5	12.15 ± 0.15	27.2 ± 2.0	5
00325584−4405058	20026	...	14.776	0.919	1.507	2006 Jan 15	CT 4 m	(L0)	...	∼41	
00332386−1521309	20027	...	15.286	1.078	1.876	2005 Oct 10	GS	L3pec	12.67 ± 0.39	33.3 ± 6.1	4

Notes.
[a] The sexagesimal right ascension and declination suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.] ± ddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox.
[b] Uncertainties on spectral types are ±0.5 subtypes except where noted by one or two colons, indicating an uncertainty of ±1 and ±2 types, respectively. Spectra displaying low-gravity features are indicated with parentheses.
[c] References listed pertain to spectral data, resolved binaries, and trigonometric parallaxes.
[d] Sources with lithium absorption.
[e] Distance listed in trigonometric from (114) is very different from our spectrophotometric distance of 30.9 ± 2.2. Even unresolved binarity does not account for large difference, needs more investigation.
[f] Sources with lithium and Hα detections.
[g] Near TW Hydrae Association, but spectrum does not display low-gravity features. We do not have a proper-motion measurement.
[h] Companion to LHS 2722, separation ∼ 2000 AU.
[i] In clump near LDN 391.

References. (1) Reylé & Robin 2004; (2) Lodieu et al. 2005; (3) Kendall et al. 2007; (4) Kirkpatrick et al. 2008; (5) Wilson et al. 2003; (6) Kirkpatrick et al. 2006; (7) Reid et al. 2006b; (8) Bouy et al. 2003; (9) Dobbie et al. 2002; (10) Phan-Bao & Bessell 2006; (11) Delfosse et al. 1999; (12) Kendall et al. 2004; (13) Martín et al. 2004; (14) McLean et al. 2003; (15) Burgasser et al. 2006; (16) Scholz et al. 2002. (17) K. L. Cruz et al. 2009, in preparation.

(This table is available in its entirety in machine-readable and Virtual Observatory (VO) forms in the online journal. A portion is shown here for guidance regarding its form and content.)

Table 5
Spectroscopically Confirmed Giants

2MASS				Date (UT)	Telescope	Giant
Designation[a]	J	$J-H$	$J-K_S$			Spectral Class
00253141+8637440	9.989	0.841	1.306	2003 Oct 09	KP 2.1 m	M pec
00454220+4611578	9.570	0.835	1.266	2003 Oct 09	KP 2.1 m	M8e
02350658−5935521	9.798	0.722	1.156	2003 Nov 07	CT 1.5 m	M7
02544898+1939372	13.823	0.856	1.343	2004 Feb 11	KP 4 m	K5
05030162+6916324	9.271	0.806	1.221	2003 Mar 15	KP 2.1 m	M5
05065349−0617123	11.160	1.245	2.026	2003 Mar 15	KP 2.1 m	K4e
05293582−0629229	11.475	0.994	1.657	2003 Mar 15	KP 2.1 m	K4e
05302872−0928202	10.655	1.871	2.836	2003 Mar 15	KP 2.1 m	M4e
06083605+6407579	10.013	0.789	1.256	2003 Mar 14	KP 2.1 m	M8
07103351-7704039	15.801	1.322	1.973	2005 Jan 08	GS	K4
07262856−8058215	9.075	0.803	1.391	2003 Apr 23	CT 4 m	>M9
08110532+0401382	9.338	0.790	1.271	2003 Mar 14	KP 2.1 m	M8
08423302+0621195	9.582	0.766	1.307	2003 Mar 14	KP 2.1 m	M9
08444317−6851431	9.919	0.861	1.368	2003 Apr 20	CT 4 m	M5
08532732−7003331	9.730	0.869	1.332	2003 Apr 23	CT 4 m	M6
09024587−7017194	9.749	0.826	1.252	2003 Apr 23	CT 4 m	M4
10372421−3503545	9.052	0.794	1.247	2003 May 14	CT 1.5 m	M8
10552346+4910095	10.148	0.949	1.390	2003 Mar 13	KP 2.1 m	M7
11165401−3738062	9.770	0.994	1.505	2003 May 14	CT 1.5 m	M5
12352844−4020003	10.805	0.701	1.155	2003 May 14	CT 1.5 m	M6
12562145−0811144	11.317	0.891	1.323	2003 Mar 13	KP 2.1 m	M7
13155372−4559012	9.591	0.867	1.345	2003 May 14	CT 1.5 m	M8
13205966−4615230	9.015	0.846	1.425	2003 May 17	CT 1.5 m	M9
13430010−7947414	9.170	0.813	1.243	2003 May 17	CT 1.5 m	M6
13464716−4636108	9.136	1.430	2.161	2003 May 14	CT 1.5 m	M7
13483191−4244462	11.240	1.125	1.742	2003 Apr 23	CT 4 m	M4
13514279−4527405	9.008	0.847	1.299	2003 May 14	CT 1.5 m	M8
13573053−3553564	9.208	0.750	1.205	2003 May 14	CT 1.5 m	M6
14325711−4054340	9.227	0.938	1.585	2003 May 14	CT 1.5 m	M9
14483117+4458071	9.607	0.882	1.339	2003 Mar 14	KP 2.1 m	M8
14555725−3858279	9.320	0.880	1.373	2003 May 14	CT 1.5 m	M7
14580255−7850126	9.072	0.808	1.342	2003 May 16	CT 1.5 m	M6
15063359−4021509	9.743	0.778	1.314	2003 May 14	CT 1.5 m	M8
15095265−7555527	9.231	0.846	1.361	2003 May 14	CT 1.5 m	M5
16541965−7002101	9.492	0.921	1.585	2003 May 14	CT 1.5 m	M9
16594990−0543008	10.352	0.865	1.536	2003 Mar 14	KP 2.1 m	M9
17005258−0228357	9.151	0.911	1.489	2003 Mar 14	KP 2.1 m	M9
17091471−0705090	9.501	1.058	1.706	2003 Mar 14	KP 2.1 m	M8
17170581−0804529	9.427	1.005	1.477	2003 Mar 14	KP 2.1 m	M5
17211402−0650483	9.681	0.965	1.457	2003 Mar 14	KP 2.1 m	M3
17240918−6705452	9.138	0.782	1.200	2003 May 14	CT 1.5 m	M5
17254340−0600110	9.136	0.968	1.612	2003 Mar 14	KP 2.1 m	M5
17254957−0529598	9.122	0.977	1.515	2003 Mar 14	KP 2.1 m	M7
17274471−0652133	9.853	1.045	1.554	2003 Mar 14	KP 2.1 m	M3
17304800−0026030	9.241	0.917	1.423	2003 Mar 14	KP 2.1 m	M7
17324109−0441179	9.402	1.013	1.519	2003 Mar 14	KP 2.1 m	M7
17482290+0439383	10.474	0.891	1.394	2003 Mar 14	KP 2.1 m	M6
17531757+0702481	9.765	0.876	1.321	2003 Mar 14	KP 2.1 m	M4
17575002+0648198	9.715	0.933	1.419	2003 Mar 14	KP 2.1 m	M7
17585362−5749440	9.552	0.812	1.290	2003 May 14	CT 1.5 m	M9
18024586−5721115	9.377	0.887	1.334	2003 May 14	CT 1.5 m	M6
18115360+1531399	9.010	0.829	1.248	2003 Mar 14	KP 2.1 m	M8
18193573+1839173	9.433	0.847	1.332	2003 Mar 14	KP 2.1 m	M8 pec
18253733−5100331	9.089	0.797	1.274	2003 May 14	CT 1.5 m	M8 pec
18290436−5104503	9.558	0.863	1.418	2003 May 14	CT 1.5 m	M6
18342367−4427222	9.016	0.789	1.289	2003 May 14	CT 1.5 m	M8
18390419−4803184	10.266	0.807	1.313	2003 May 14	CT 1.5 m	M7
18432457−4619064	9.036	0.760	1.203	2003 May 14	CT 1.5 m	M6
19094930−2626554	9.049	0.798	1.358	2003 May 14	CT 1.5 m	M5
19184869−2231308	9.762	0.830	1.290	2003 May 14	CT 1.5 m	M4
19204458−2034420	10.294	0.851	1.283	2003 May 14	CT 1.5 m	M9
19215465−2904574	11.278	0.777	1.225	2003 Apr 22	CT 4 m	M4
19263642+5852412	10.222	0.850	1.261	2003 Mar 13	KP 2.1 m	M6

Table 5
(Continued)

2MASS				Date (UT)	Telescope	Giant
Designation[a]	J	$J-H$	$J-K_S$			Spectral Class
19374361−2415202	9.472	0.881	1.346	2003 May 14	CT 1.5 m	M8
19401418−3439113	10.801	0.872	1.275	2003 May 14	CT 1.5 m	M5
19433261−6107342	9.311	0.971	1.759	2003 May 14	CT 1.5 m	M8
19522304−1229321	9.332	0.876	1.383	2003 May 16	CT 1.5 m	M9
19540446−0951239	9.446	0.808	1.263	2003 May 16	CT 1.5 m	M9
19551226−5628330	9.297	0.735	1.320	2003 May 16	CT 1.5 m	M7
19552063−0303333	10.059	0.893	1.469	2003 May 16	CT 1.5 m	M9
19552063−0303333	10.059	0.893	1.469	2003 May 16	CT 1.5 m	M9
20035650+0106238	9.009	1.118	1.910	2003 May 14	CT 1.5 m	M9
20153663+0629595	9.147	0.907	1.369	2003 May 14	CT 1.5 m	M7
20155902+6346308	9.349	0.901	1.387	2003 Jul 11	KP 4 m	M8
20272916−3048373	9.020	0.831	1.340	2003 May 16	CT 1.5 m	M8
20284695+0259011	11.449	0.842	1.251	2003 Apr 21	CT 4 m	M4
20394688−1553528	10.098	0.849	1.367	2003 May 17	CT 1.5 m	M8
21015758+0033294	9.553	0.782	1.235	2003 May 14	CT 1.5 m	M6
21092700−7139140	10.811	0.763	1.321	2003 May 16	CT 1.5 m	M4
21262769+2153187	10.058	0.786	1.272	2003 Jul 10	KP 4 m	M5
22323045−4653135	9.777	0.625	1.073	2003 May 14	CT 1.5 m	M6
23040084−6355118	9.444	0.750	1.314	2003 May 16	CT 1.5 m	M8
23570282+3959160	12.296	0.843	1.250	2003 Jul 09	KP 4 m	M7

Note. [a]The sexagesimal right ascension and declination suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.]±ssddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox.

Table 6
Spectroscopically Confirmed Carbon Stars

2MASS			$J-K_S$	Obs. Date (UT)	Telescope
Designation[a]	J	$J-H$			
01405432−7208509	12.205	1.125	1.890	2003 Nov 09	CT 1.5 m
02000890+4137474	10.867	1.318	2.211	2003 Oct 09	KP 2.1 m
03463857+7547165	10.378	1.003	1.541	2003 Oct 09	KP 2.1 m
03595596+0919044	12.757	1.528	2.643	2003 Nov 07	CT 1.5 m
05283374−1651445	9.312	1.011	1.500	2003 Mar 15	KP 2.1 m
07342392+2719115	9.273	1.085	1.734	2003 Mar 13	KP 2.1 m
07522490+0433586	9.233	0.910	1.517	2003 Mar 13	KP 2.1 m
08491096−0721442	10.512	0.988	1.448	2003 Mar 14	KP 2.1 m
13530131+0047140	12.650	1.006	1.567	2003 Mar 14	KP 2.1 m
14023015−4556074	9.322	1.309	2.025	2003 May 16	CT 1.5 m
15224442−1237494	13.080	1.097	1.647	2003 Mar 13	KP 2.1 m
16213627−0853188	9.334	1.002	1.508	2003 Mar 14	KP 2.1 m
17540115+2627121	11.906	1.353	2.371	2003 Apr 21	CT 4 m
19332580+5221281	11.832	1.450	2.485	2003 Jul 09	KP 4 m
19351884+5439535	9.819	1.018	1.569	2003 Mar 13	KP 2.1 m
19393023+7541405	9.426	1.100	1.643	2003 Jul 11	KP 4 m
19514953−3125007	11.429	1.363	2.307	2003 Apr 20	CT 4 m
20005287−3451564	11.148	0.904	1.355	2003 May 16	CT 1.5 m
20481791+1026387	10.059	1.273	2.229	2003 May 14	CT 1.5 m
21271642−3051573	11.100	1.004	1.605	2003 Apr 20	CT 4 m
22435035−5701233	9.539	1.016	1.544	2003 May 14	CT 1.5 m
23083509+4035344	10.445	1.521	2.646	2003 Jul 10	KP 4 m

Note. [a]The sexagesimal R.A. and decl. suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.]±ssddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox.

4. DWARFS OF PARTICULAR INTEREST

4.1. Supplementary Spectral Standards

Spectral classification is a comparative technique, where the overall appearance of a program object is matched against a set of reference calibrators. It is therefore important to have well-defined standard objects. This is particularly the case for ultracool dwarfs, where the spectral type appears to be the empirical parameter that is linked most closely to physical characteristics, such as luminosity and temperature.

Ideally, spectral standards should be bright objects that are accessible to even moderate-aperture telescopes. The primary

Table 7
L Dwarf Spectral Standards

2MASS Designation[a]	Other Names	Spectral Type	2MASS J	μ ($''$ yr^{-1})	PA (°)	CrH-a	Rb-b/TiO-b	Cs-a/VO-b	Color-d	Multiple?	References
				Secondary standards							
2MASS J17312974+2721233	U20744 LSPM J1731+2721	L0	12.094	0.269 ± 0.008	200 ± 2	1.18	0.59	0.71	5.68	N	1–4
2MASS J06023045+3910592	50010 LSR J0602+3910	L1	12.300	0.526 ± 0.006	164.1 ± 0.8	1.25	0.82	0.85	6.79	?	2,5
2MASS J08472872−1532372	10764 ···	L2	13.513	0.274 ± 0.039	146 ± 10	1.48	1.01	0.98	8.52	N	3,4,6
2MASS J15065441+1321060	U11291 ···	L3	13.365	1.093 ± 0.019	271 ± 1	1.75	1.18	1.13	7.80	N	3,7–9
2MASS J05002100+0330501	u20197 ···	L4	13.669	0.362 ± 0.043	182 ± 9	1.95	1.26	1.19	...	N	1,3,4
2MASS J15074769−1627386	U11296 ···	L5	12.830	0.9031 ± 0.0005	190 ± 0.1	2.00	1.46	1.39	13.19	N	4,9–11
2MASS J02550357−4700509	10158 DENIS-P J0255−4700	L8	13.246	1.149 ± 0.002	119.5 ± 0.2	1.29	2.20	1.69	36.62	N	3,9,12–14
				Primary standards from Kirkpatrick et al. (1999)							
2MASS J03454316+2540233	20165 ···	L0	13.997	0.1020 ± 0.0003	249.6 ± 0.2	1.16	0.66	0.78	6.65	N	8,11,15
2MASS J14392836+1929149	20581 ···	L1	12.759	1.2953 ± 0.0002	288.3 ± 0.1	1.37	0.81	0.86	7.33	N	9,11,15,16
2MASS J13054019−2541059	11122 Kelu-1	L2	13.414	0.285 ± 0.001	272.2 ± 0.2	1.54	1.05	1.03	6.70	Y	11,15,17,18
2MASS J11463449+2230527	11010 ···	L3	14.165	0.0960 ± 0.0005	19.5 ± 0.3	1.64	1.16	1.12	7.21	Y	11,15,16,19,20
2MASS J11550087+2307058	50075 ···	L4	15.848	...		1.91	1.32	1.26	9.71	N	15,16
2MASS J12281523−1547342	11073 DENIS-P J1228.2−1547	L5	14.378	0.224 ± 0.001	143.3 ± 0.3	2.20	1.66	1.49	14.41	Y	11,15,19–21
2MASS J08503593+1057156	10770 ···	L6	16.465	0.145 ± 0.002	265.2 ± 0.7	1.79	1.70	1.56	15.55	Y	11,15,16,22
2MASS J02052940−1159296	10096 DENIS-P J0205.4−1159	L7	14.587	0.4378 ± 0.0008	82.8 ± 0.1	1.55	2.19	1.60	22.03	Y	11,15,19–21
2MASS J16322911+1904407	50006 ···	L8	15.867	0.2981 ± 0.0009	100.5 ± 0.2	1.29	2.56	1.63	30.01	N	11,15,16,22

Notes. [a] The sexagesimal right ascension and declination suffix of the full 2MASS All-Sky Data Release designation (2MASS Jhhmmss[.]±ssddmmss[.]s) is listed for each object. The coordinates are given for the J2000.0 equinox; the units of right ascension are hours, minutes, and seconds; and units of declination are degrees, arcminutes, and arcseconds.

References. (1) This paper; (2) Lépine & Shara 2005; (3) Schmidt et al. 2007; (4) Reid et al. 2006a; (5) Salim et al. 2003; (6) Cruz et al. 2003; (7) Gizis et al. 2000; (8) Gizis et al. 2003; (9) Reid et al. 2007; (10) Reid et al. 2000; (11) Dahn et al. 2002; (12) Martín et al. 1999; (13) Deacon et al. 2005; (14) Costa et al. 2005; (15) Kirkpatrick et al. 1999; (16) Reid et al. 2001; (17) Ruiz et al. 1997; (18) Liu & Leggett 2005; (19) Koerner et al. 1999; (20) Martín et al. 2006; (21) Delfosse et al. 1997; (22) Vrba et al. 2004.

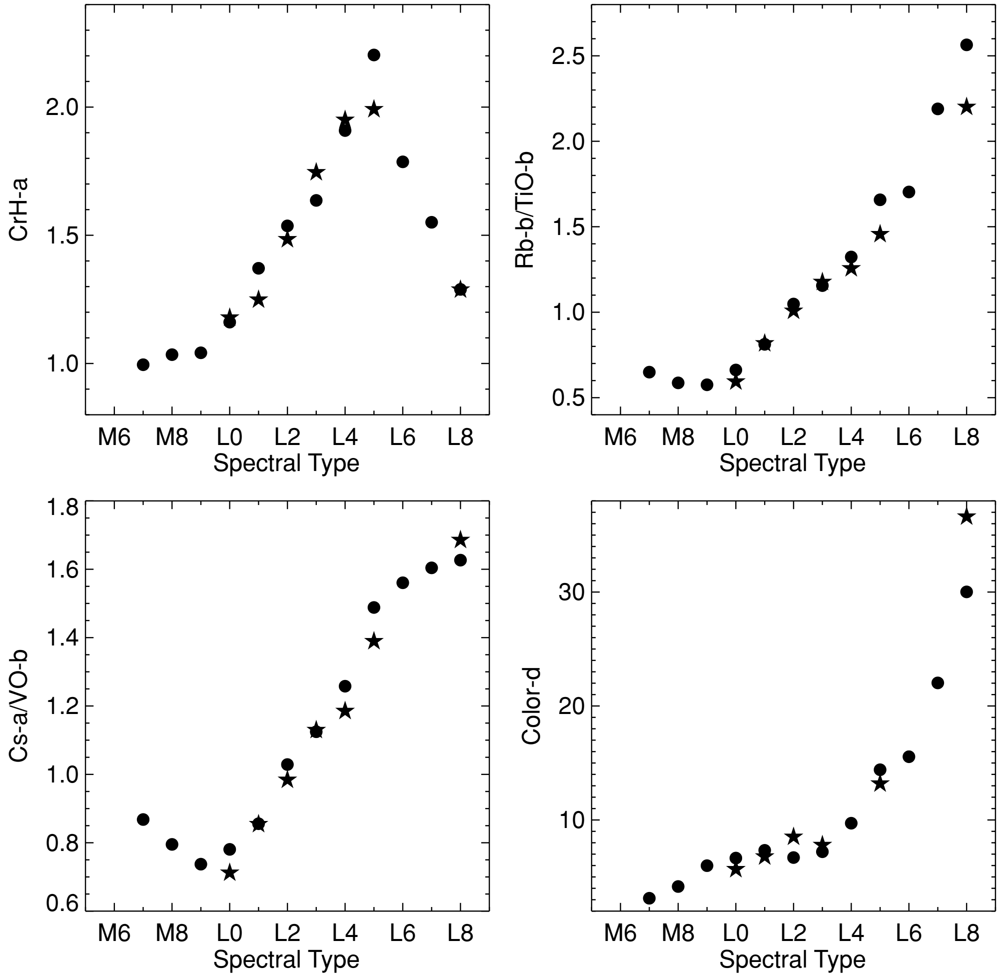

Figure 2. Spectral ratios as a function of spectral type for the supplemental standards listed in Table 7 (stars) and the original L-dwarf standards listed in K99 (circles).

Table 8
L Dwarfs with Lithium Absorption

2MASS J	2MUCD	Spectral Type	EW(Å)	*d* (pc)	M_J	Notes
L dwarfs from this paper						
00165953−4056541	20013	L3.5	5.1	30.7	12.9	Gemini
03231002−4631237	20157	(L0)	3.5	54	11.7	Gemini
03552337+1133437	20171	(L5)	7.0	18.8	12.7	KPNO/Gemini
05012406−0010452	20198	(L4)	9.0	29.0	12.7	KPNO/Gemini
06322402−5010349	20248	L3	7.6	29.5	12.7	Gemini
09054654+5623117	20329	L5	9.8	23.3	13.6	Gemini
19223062+6610194	20812	L1	3.7	32.7	12.0	Gemini
23174712−4838501	20994	L4	12.2	25.8	13.1	Gemini
L dwarfs from Papers V and IX						
0025036+475919	13016	L4:	8.2	32	13.1	Gemini, binary, R
0310140−275645	10170	L5	10.4	28.3	13.6	KPNO/Gemini, IX
0326422−210205	10184	L4	11.9	40.1	13.1	CTIO/Gemini, IX
0421072−630602	10268	(L5)	7.7	31.1	13.1	Gemini, IX
0512063−294954	10372	L4	7.5	30.5	13.1	CTIO/Gemini, V
0652307+471034	10601	L4.5	14.7	11.1	13.3	KPNO/Gemini, IX
1615425+495321	11538	(L4)	12	53	13.1	Gemini, IX

References. V, Cruz et al. 2003, Paper V; IX, Cruz et al. 2007, Paper IX; R, Reid et al. 2006a.

L-dwarf spectral standards are specified by Kirkpatrick et al. in their definition of spectral class L (Table 6 of K99). At that juncture, only ∼25 L dwarfs were known, and, with only a limited parent sample, the later-type standards are relatively faint. Moreover, several of the brightest standards have proven to be close binaries. This is not unexpected, given that this initial set was drawn from a magnitude-limited sample.

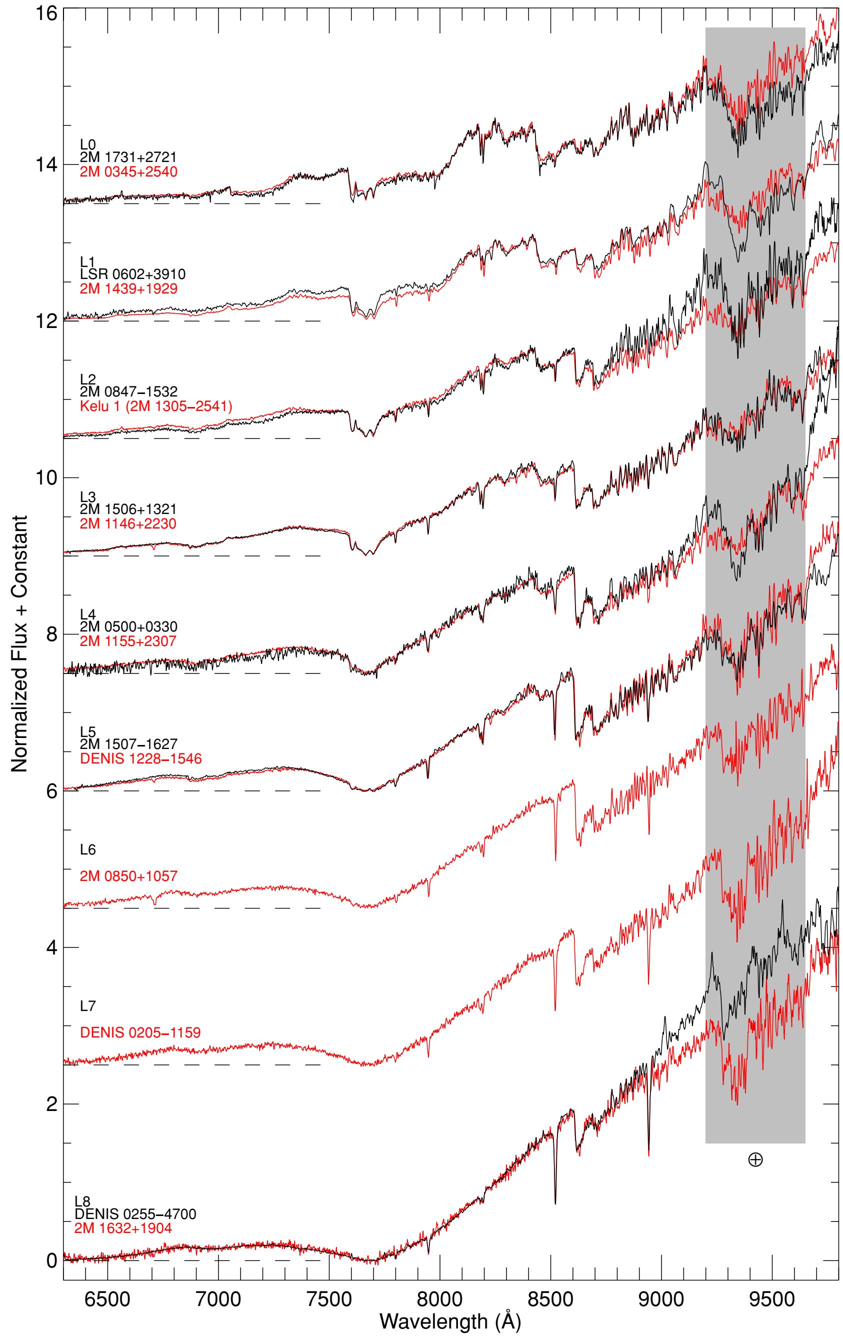

Figure 3. L-dwarf spectral sequence with supplemental standards (black) overplotted on the original standards (red). The new data have not been corrected for telluric absorption, which can significantly affect the spectrum within the shaded region at far-red wavelengths.

Spectroscopic observations have now been obtained for more than 500 L dwarfs, including some that are significantly brighter (in apparent magnitude) than the primary standards in the initial sample. In particular, the present survey, which concentrates on the nearest (and therefore the brightest) L dwarfs, provides an excellent resource for supplementing the reference set of primary standards. All of these observations are cataloged in the online L-dwarf database maintained at http://DwarfArchives.org.

We have selected supplemental spectral standards based on three criteria: apparent brightness, the absence of a known close companion, and spectral morphology. We have not given consideration to the declination of the source (i.e., accessibility from northern and southern ground-based observatories). All bright ($J \lesssim 14$) objects of each subclass that are currently not known to be binary were considered initially. The candidate standards were matched against the original standards through overplotting the spectra, and by comparing the four spectral indices (CrH-a, Rb-b/TiO-b, Cs-a/Vo-b, and color-d) used for spectral typing in K99. Indices for the original standards and new candidates were measured using the same script; our measurements reproduce the values reported in K99 for the original standards. Table 7 catalogs both the original standards and the new objects that best match the original classification scheme, both quantitatively (via spectral indices) and qualitatively (via overplotting). Figure 2 shows how the spectral indices measured for the new standards compare with the primary sequence; and Figure 3 directly compares the far-red optical spectra of the primary and supplementary standards.

We have not been able to identify any completely acceptable L6- or L7-type supplemental standards from the present observational data set. In order to confidently choose a spectral standard, a spectrum of fairly high S/N is required. These late-type L dwarfs are of low luminosity and few objects in our library have spectra of sufficient quality to enable a reliable comparison with the original standard. (Note that we are fortunate that the new L8 standard, with a distance (just) less than 5 pc, is one of the closest brown dwarfs known.) However, we identify 2MASS J15150083+4847416 and 2MASS J09083803+5032088 as potential L6 and L7 standards, respectively. Higher S/N data than our current observations are required before those dwarfs can formally be confirmed as secondary standards

All of the new standards except LSR J0602+3910 have been imaged with NICMOS as part of our search for low-mass companions; none is resolved as a binary (Reid et al. 2006a, 2007). We do not have a spectrum for the new L4 standard 2MASS 0500+0330 that extends far enough into the red for a color-d index to be measured; however, in all other respects, the object meets the criteria that define a spectral standard.

4.2. 2M2139+0220: A Very Early-Type T Dwarf

2MASS J 21392676+0220226 is a faint source ($J = 15.26$) with red near-infrared colors ($(J - H) = 1.10$, $(H - K_S) = 0.58$). The prime aim of the present survey is the identification of late-type M dwarfs and L dwarfs, and these colors are broadly consistent with a mid-type L dwarf at a distance of 25–30 pc. However, the optical spectrum is smooth and largely featureless, with the exception of absorption by Cs I at 8521 and 8963 Å, and H_2O at 9300 Å (Figure 4). Moreover, Burgasser et al. (2006) have obtained low-resolution, near-infrared spectra that indicate the presence of methane absorption. This shows that 2M2139+0220 is a nearby early-type T dwarf, with a spectral type ≈ T1.5. On that basis, we estimate a distance of ∼15 pc. Further near-infrared spectroscopy of this dwarf will be particularly interesting.

4.3. Lithium and Hα Detections

It is now well established that the presence of lithium absorption in ultracool dwarfs indicates that those objects have substellar masses (Rebolo et al. 1992). The critical temperature for lithium burning is $\sim 2 \times 10^6$K, or $\sim 10^6$K cooler than the critical temperature for hydrogen burning. Low-mass dwarfs are fully convective; thus, the presence of detectable lithium in the photosphere indicates that the core temperature has never reached the critical value for hydrogen fusion. Theoretical models (Chabrier & Baraffe 1997) predict that lithium remains undepleted in brown dwarfs with masses below 0.055 $M_\odot$, while lithium is subject to partial depletion in dwarfs with masses in the range $0.055 < \frac{M}{M_\odot} < 0.075$, with the rate of depletion scaling with increasing mass.

We have examined our optical spectra, and identified lithium absorption in eight L dwarfs in the present sample. The measured equivalent widths for those sources are given in Table 8. We also list new observations of a number of L dwarfs from the 2MU2 sample. This represents a very low detection rate for the current sample, which is likely to be explained by the spectral resolution of our observations, coupled with the moderate S/N of our spectra of many late-type L dwarfs. It is notable that all of the lithium dwarfs listed in Table 8 were observed using GMOS on Gemini. Higher resolution and higher-S/N data are likely to reveal Li 6708 Å in a number of other dwarfs in both the present sample and 2MU2 samples.

Turning to the data listed in Table 8, in most cases the lithium lines are moderately strong, with an equivalent width of 3–4 Å. This may indicate that lithium is partly depleted in those systems, suggesting a mass close to 0.065 $M_\odot$. There are, however, a handful of dwarfs with much stronger lithium absorption, such as 2M0310−2756, 2M0652+4710, and 2M2317−4838. We also note that several dwarfs listed in this table have spectral signatures consistent with low surface gravity (the spectral types for those dwarfs are enclosed in parentheses). The presence of lithium clearly adds further weight to the hypothesis that these are young, low-mass brown dwarfs.

Our optical spectra also allow us to probe chromospheric activity through measurements of Hα emission. The overall statistics for activity among ultracool dwarfs are discussed by Schmidt et al. (2007), and we consider the 20 pc L dwarfs in Section 5. Here, we draw attention to two particularly active dwarfs in the present sample: 2M0407+1546 and 2M1022+5825. The latter dwarf, which is discussed by Schmidt et al. (2007), is an L1 dwarf that shows substantial (order of magnitude) variations in the Hα line strength on a timescale of 1–2 days. The L3.5 2M0407+1546 has only one optical observation, with GN, but that observation shows Hα emission with an equivalent width of ∼60 Å. This makes 2M0407+1546 one of the latest-type dwarfs to show substantial chromospheric activity. Further observations may shed light on why this particular dwarf has maintained such a high level of activity at this juncture in its spectral evolution.

5. A 20 pc ULTRACOOL CENSUS

The primary goal of the present program is to compile a census of ultracool dwarfs within 20 pc of the Sun. The combined 2MU2 and 2MUA samples are drawn from ≈65% of the celestial sphere, excluding regions within 15° of the Galactic Plane and high confusion regions, such as the Magellanic Clouds. As outlined in Section 3.2, the follow-up observations described in this paper are not complete: we lack optical observations of 27 of the faintest ultracool candidates. Those sources are most likely to contribute to the lowest luminosity bins in the 20 pc census. The current results are presented with that caveat in mind, and we defer full analysis of $\Phi(M_J)$ to a later paper.

Combining the 2MUA and 2MU2 data sets gives a total of 196 ultracool dwarfs (M7 to T2.5) with formal distances within 20 pc of the Sun. Figure 5 shows the distribution of $(J - K_S)$ colors as a function of spectral type and the near-infrared $(J - H)/(H - K_S)$ two-color diagram for dwarfs with reliable photometry (that is, excluding known close binary systems). For reference, we include data for the T0 dwarf, 2M2139+0220 (Section 4.2).

Focusing on spectral type L, the current 20 pc census includes 76 systems from the 2MU2 and 2MUA samples. Astrometry and photometry of those systems are listed in Table 9, together with data for an additional 18 systems culled from the literature.[10] Most of the additions have been identified from follow-up observations of ultracool candidates from the DENIS survey (e.g., Scholz et al. 2002; Phan-Bao et al. 2008). For consistency,

[10] We include wide, easily-resolved companions of earlier-type main-sequence stars, such as Gl 584C and LHS 102Bab, but not close companions, like LHS 2397aB.

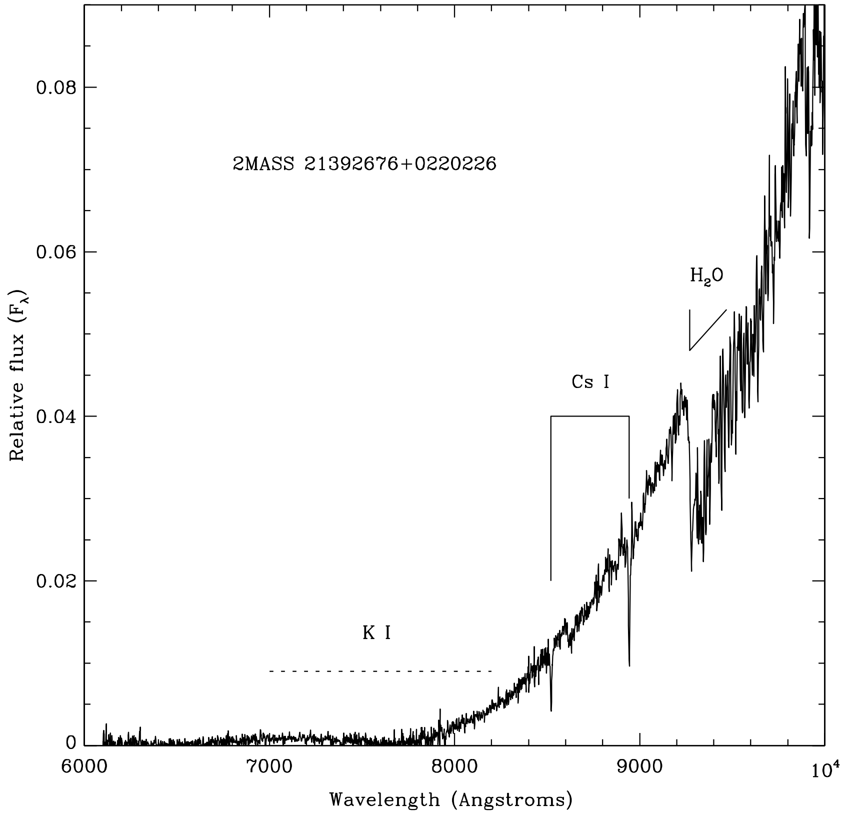

Figure 4. The 2MASS 2139+0220 (2MUCD 20912 in Table 2), a T0 dwarf at an estimated distance of ∼14.5 pc.

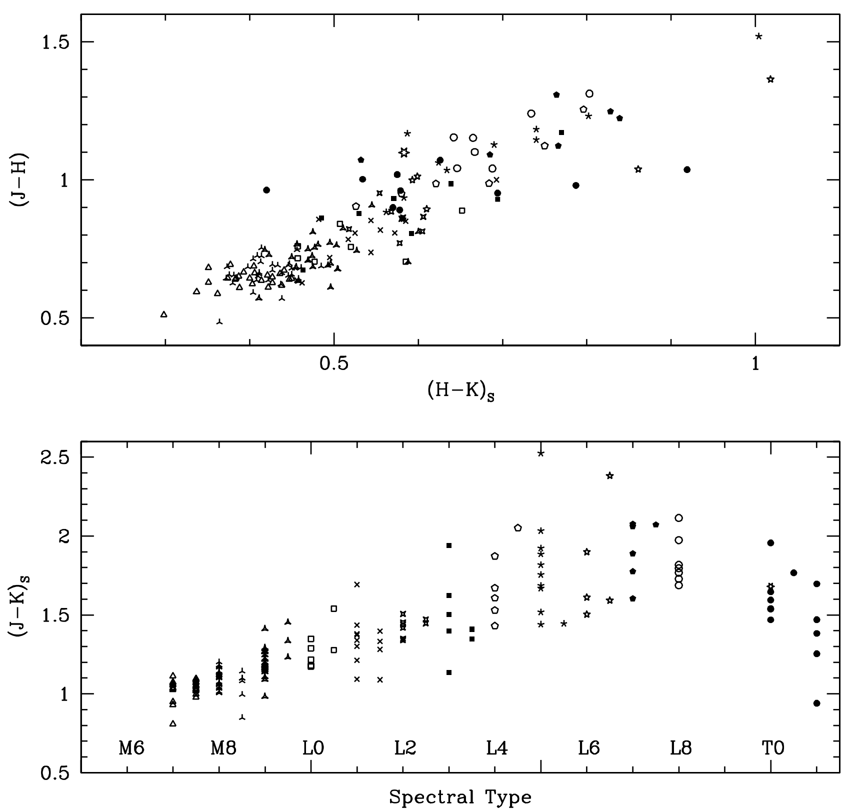

Figure 5. 2MASS near-infrared photometry for the L dwarfs in the 20 pc sample. We include data for nearby late-M and early-T dwarfs to provide context. The lower panel plots the distribution of $(J - K_S)$ color as a function of the spectral type, including data for the T0 dwarf, 2M2139+0220 (Section 4.2). The solid points plot data for early-type T dwarfs from the online T-dwarf database, http://DwarfArchives.org. The upper panel plots the $(J - H)/(H - K_S)$ two-color diagram for the same data set, where the symbols match the coding in the spectral-type diagram (lower panel). The reddest system is 2M0355+1133, with $(J - K_S) = 2.52$ mag. Known binaries are excluded from these diagrams.

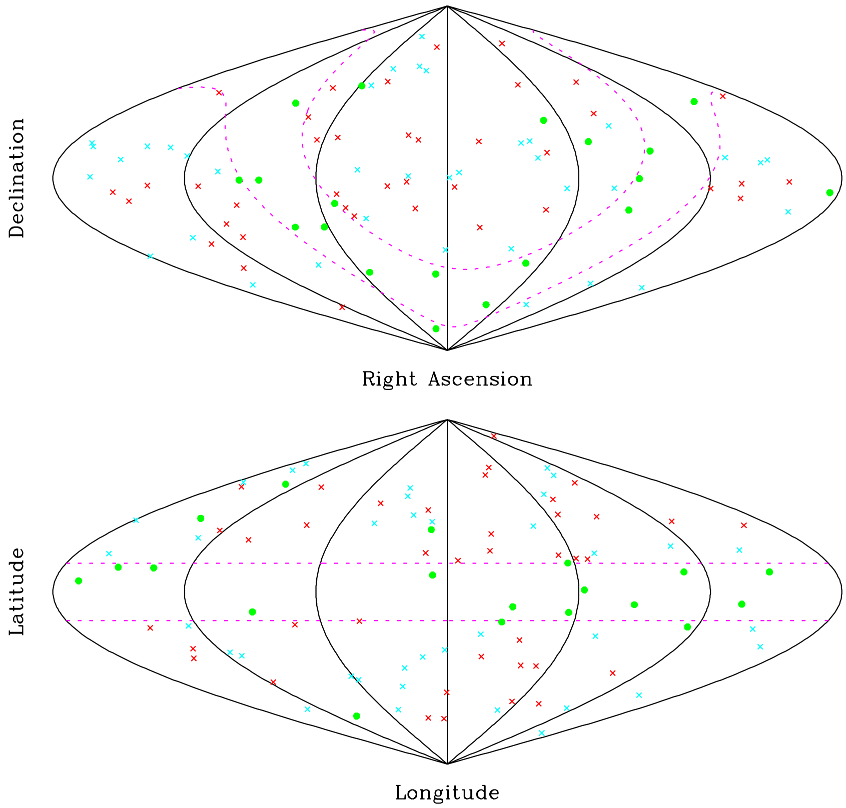

Figure 6. The (α, δ) and (l, b) distributions of the 20 pc L-dwarf sample listed in Table 9. L dwarfs from the 2MU2 (red) and 2MUA (cyan) samples are plotted as crosses; L dwarfs from other data sets are plotted as (green) solid points.

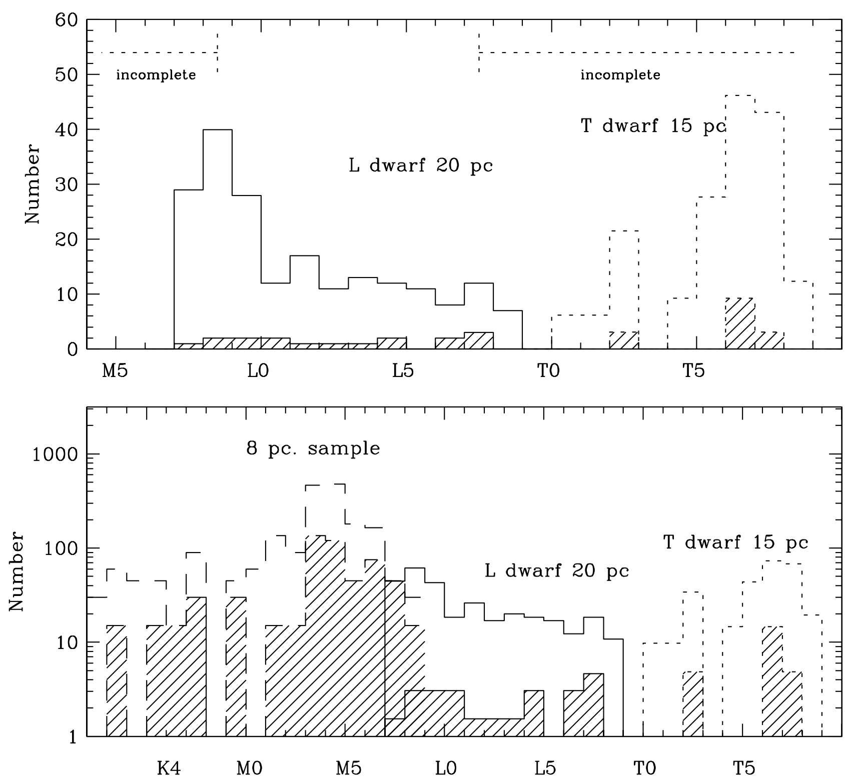

Figure 7. The spectral-type distribution of stars and brown dwarfs cataloged in the local census. The upper panel plots the distribution of ultracool M and L dwarfs from our 2MASS 20 pc sample; as discussed in the text, this sample is known to become incomplete for spectral types earlier than M8 and latter than ~L7. We also show the spectral-type distribution of T dwarfs with distances $d < 15$ pc from the online T-dwarf database, http://DwarfArchives.org, scaling the numbers by a factor of 2 to allow for formal difference of the relative volumes sampled (dotted histogram). The T-dwarf sample is known to be incomplete. In the lower panel, we combine the ultracool distributions with the spectral-type distribution of K and M dwarfs in the northern 8 pc sample (Reid et al. 2004, 2007; dashed histogram). In each case, the hatched histogram shows the contribution from companions in multiple systems.

we have used 2MASS photometry and our spectral-type/M_J relation to estimate distances for the latter objects. This can lead to discrepancies between the distances listed in Table 9 and those given in the original discovery paper; for example, the spectroscopic parallax relation adopted by Phan-Bao et al. (2008) leads to distances that are nearer by ∼5% at L0, ∼10% at L2, and ∼5% at L5.

Table 9 lists data for 107 dwarfs in 94 systems. Two systems require particular comment.

2M0805+4812 was originally classified as an L4 dwarf by Hawley et al. (2002) based on optical spectroscopy. However, Knapp et al. (2004) derived a near-infrared spectral type of L9.5. Burgasser (2007b) has shown that these inconsistencies can be resolved if the system is an unresolved binary, comprising an ∼L4.5 primary and a ∼T5 secondary.

2M1126-5003 was identified by Folkes et al. (2007) in the course of their search for ultracool dwarfs at low Galactic latitude ($|b| \leqslant 15°$). Based on the ∼1.0–1.6 μm spectrum, Folkes et al. (2007) assigned it a near-infrared spectral type of L9 ± 1[11] and estimated a distance of only 7.2 pc. However, subsequent observations by Phan-Bao et al. (2008) and Burgasser et al. (2008) have shown that the optical spectrum is consistent with an L4/L5 dwarf, albeit with enhanced FeH absorption (at 9896 Å). Burgasser et al. comment that the near-infrared spectrum is unusually blue, which they attribute to the presence of clouds of condensates in the L-dwarf atmosphere. We have adopted the spectral type and distance estimate given in the latter paper.

Figure 6 plots the (α, δ) and (l, b) distributions for the 94 L dwarf systems cataloged in Table 9. Fifteen of the 18 systems drawn from the literature lie at low Galactic latitude, and outwith the limits of our ultracool dwarf survey. The remaining three systems, the L/T binary, 2M0805 (Burgasser 2007b) and the two L8 dwarfs 2M1523 (Gl 384C, Kirkpatrick et al. 2000) and 2M1632 (Kirkpatrick et al. 1999), fall within the area covered by the 2MU2 and 2MUA data sets. However, all three dwarfs have $(J - K_S)$ colors that lie blueward of the $(J, (J - K_S))$ selection criteria. As discussed in Paper V, those criteria were chosen to balance sample completeness against a manageable candidate list. Given the overall statistics and the areal coverage of the 2MU2+2MUA samples, it is likely that 25 to 35 L dwarfs within 20 pc of the Sun remain to be discovered in the $|b| < 15°$ Galactic equatorial zone.

Seventy-two of the L-dwarf systems within 20 pc have been observed using high-resolution imaging techniques. Eleven are resolved as close binary systems, corresponding to a binary fraction of $15.3^{+5.1}_{-3.3}$% (Reid et al. 2008). As discussed extensively elsewhere (e.g., Burgasser et al. 2007), almost all ultracool binaries have near-equal mass ratios, and few lie at separations exceeding 15 AU. Data for the companions to the 20 pc L dwarfs (including five T dwarfs) are given in Table 9.

Figure 7 shows the likely spectral-type distribution of dwarfs in the solar neighborhood. The upper panel plots data for the ultracool dwarfs in the current 20 pc census.[12] This is effectively a luminosity function, since we derive absolute magnitudes using the following relation (from Paper V):

$$M_J = -4.410 + 5.04(\mathrm{ST}) - 0.6193(\mathrm{ST})^2 + 0.03453(\mathrm{ST}^3) - 6.892 \times 10^{-4}(\mathrm{ST}^4), \quad (1)$$

where ST = 0 for spectral type L0 ($\Delta\mathrm{ST} \approx 0.55\Delta M_J$). We have identified separately the contribution from known secondary companions. As discussed in Papers V and IX (and Section 2.1 of this paper), the initial $(J, (J - K_S))$ color–magnitude selection criteria lead to the 2MASS ultracool sample becoming incomplete for spectral types earlier than M8 and later than ∼L7.

We have extended the spectral-type census to the T-dwarf regime using the online T-dwarf database, http://DwarfArchives.org, which currently lists data for 122 T dwarfs. Most lack trigonometric parallaxes, so we have used the (M_K, spectral type) relation derived by Burgasser (2007a) to estimate spectroscopic parallaxes. This data set is highly incomplete, even more so than the late-type L dwarfs, and particularly for the neutral-colored, early-type T dwarfs.[13] Nonetheless the data provide a guide to the current status in the field. Figure 7 clearly suggests that, after a broad minimum spanning ∼L5 to ∼T2, there is a rise in number density for later-type T dwarfs. This is in accordance with expectation, since theoretical models predict that the rate of cooling of brown dwarfs slows with decreasing temperature, leading to a pile-up in numbers at later spectral types (Allen et al. 2005; Burgasser et al. 2005).

The lower panel in Figure 7 provides a broader context by expanding the L/T sample to include the expected contribution of K and M dwarfs to the 20 pc census. We have estimated the likely numbers of earlier-type dwarfs using the statistics for the northern 8 pc sample (Reid et al. 2004, 2007), adjusting the numbers to an all-sky 20 pc survey. We have also scaled the observed numbers of L and T dwarfs by a factor of 1.5 to allow for as-yet undiscovered ultracool dwarfs at low Galactic latitudes. The resultant distribution illustrates the dominant contribution made by M dwarfs to the visible stellar populations in the Galactic disk. The expectation is that deep surveys at near- and mid-infrared wavelengths will reveal increasing numbers of cool late-type T dwarfs and even cooler Y dwarfs.

Finally, we note that 87 of the L-dwarf systems listed in Table 9 have optical spectra[14]. Ten systems (12.5%) have detectable Hα emission. The frequency is clearly higher at earlier spectral types, with eight of the active systems having spectral types in the range L0–L2, including six of the 24 L0/L1 systems (25%). The latest-type dwarf that shows evidence of chromospheric activity is 2M0318−3421, an L7 dwarf at a distance of ∼16.5 pc.

6. SUMMARY AND CONCLUSIONS

As part of our continuing survey of the ultracool dwarfs in the immediate solar neighborhood, we have used the 2MASS All-Sky Database to extend coverage to all regions of the sky with Galactic latitudes $|b| > 15°$. We have identified 467 candidate nearby ultracool dwarfs, and this paper presents literature data and our own optical spectroscopic observations of 430 of those candidates. Of this subset, 65 dwarfs have formal distances

[11] We note that there is no type L9 in the optical spectral classification system.

[12] Although spectral types are often quoted at a resolution of 0.5 classes, we have binned the data in unit spectral types since integer types are favored over half-integral types in our classification process (see Paper V, Section 4.1): for example, there are eight sources classed as L3, but only 3 as L3.5; 6 are classed as L6, but only 2 as L6.5; and 24 are classed as M9, but only 4 as M9.5.

[13] We note that examples of spectral type T3 are particularly sparse, with only seven dwarfs classified as T3 or T3.5 in entire DwarfArchives database. This compares with 11 T0s and 13 T1s. The nearest T3 dwarf is 2M1206+2813 at a distance of ∼19 pc.

[14] The three systems that currently lack such data are 2M0155+0950, 2M0830+4828, and 2M1550−442.

Table 9
L Dwarf Systems within 20 pc of the Sun

N	2MASS J	2MUCD	SpT	J	$(J-H)$	$(H-K_S)$	d (pc)	src.	Notes
1[a]	00043484−4044058Ba	20004A	L4.5	13.82	0.95	0.65	9.6	trig	LHS 102Ba, 1, 2
	00043484−4044058Bb	20004B	L4.5	13.90	0.95	0.65	9.6	trig	LHS 102Bb, 1, 2
2[a]	00361617+1821104	20029	L3.5	12.47	0.88	0.53	8.76	trig	3,4
3[a]	00452143+1634446	20037	(L2)	13.06	1.00	0.69	14	sp	9, Hα 14 Å
4[a]	01075242+0041563	20052	L8	15.82	1.31	0.80	15.6	trig	5, 6
5	01282664−5545343	20068	L2	13.78	0.86	0.58	19.6	sp	
6	0144353−071614	10088	L5	14.19	1.19	0.72	13.4	sp	7,8
7[a]	01550354+0950003	20083	L5	14.83	1.06	0.63	17.95	sp	9
8[a]	02052940−1159296A	10096A	L7	15.28	1.02	0.57	19.76	trig	10, 4
	02052940−1159296Ba	10096B	L8	15.4:	1.0:	0.6:	19.76	trig	11
	02052940−1159296Bb	10096C	T0	16.0:	. . .	. . .	19.76	trig	12
9[a]	02132880+4444453	10102	L1.5	13.49	0.74	0.54	18.7	sp	7
10[a]	02284243+1639329	20116	L0	13.17	0.84	0.50	19.4	sp	9
11[a]	02511490−0352459	10151	L3	13.06	0.80	0.59	12.66	trig	7, 13
12[a]	02550357−4700509	10158	L8	13.25	1.05	0.65	4.97	trig	14, 15
13	02572581−3105523	20139	L8	14.67	1.16	0.64	9.6	sp	16
14[a]	03140344+1603056	20156	L0	12.53	0.70	0.58	14.4	sp	9
15[a]	03185403−3421292	10176	L7	15.57	1.22	0.84	16.5	sp	16, Hα 11 Å
16	03400942−6724051	10202	L8:	14.74	1.15	0.67	9.9	sp	17
17[a]	03552337+1133437	20171	(L5)	14.05	1.52	1.00	12.6	sp	9, Li
18[a]	04234858−0414035A	10276A	L6	14.9:	1.0:	. . .	15.17	trig	6, 18
	04234858−0414035B	10276B	T2:	15.5:	0.7:	. . .	15.17	trig	6, 19
19[a]	04390101−2353083	10312	L6.5	14.41	1.00	0.59	10.8	sp	7
20[a]	04455387−3048204	10329	L2	13.39	0.81	0.61	16.6	sp	7
21[a]	05002100+0330501	20197	L4	13.67	0.98	0.62	13.0	sp	9
22[a]	05233822−1403022	10390	L2.5	13.08	0.86	0.58	13.4	sp	7
23[a]	05395200−0059019		L5	14.03	0.93	0.68	13.1	trig	6, 28
24	06023045+3910592		L1	12.30	0.85	0.59	11.5	sp	20
25	06154934−0100415		L2.5	13.75	0.77	0.44	17.9	sp	39
26[a]	06244595−4521548	20244	L5:	14.48	1.15	0.74	15.3	sp	9
27	06521977−2534505		L0	12.76	0.73	0.50	16.1	sp	39
28[a]	06523073+4710348	10601	L5	13.51	1.13	0.69	10.0	sp	7, Li
29[a]	07003664+3157266A	10617A	L3.5	13.23	0.96	0.65	12.2	trig	21, 17
	07003664+3157266B	10617B	L6:	14.40	0.95	0.60	12.2	trig	22
30[a]	07464256+2000321A	10668A	L0.5	12.3:	0.75:	0.5:	12.21	trig	3, 4
	07464256+2000321B	10668B	L2:	12.75:	0.8:	0.5:	12.21	trig	23
31	07511645−2530432		L1.5	13.16	0.67	0.50	15.8	39	
32	08053184+4812330A		L4.5:	14.25	0.63	1.25	14.5	sp	5, 37, 40
	08053184+4812330B		T5:	15.75	-0.26	0.61	14.5	sp	unresolved, 40
33	08230313−4912012		L1.5	13.55	0.91	0.57	18.9	39	
34[a]	08251968+2115521	10721	L7.5	13.79	1.31	0.76	10.66	trig	4, 24
35	08283419−1309198		L2/L1	12.80	0.95	0.55	12.6/14.5	sp	25, 39
36[a]	08300825+4828482	20301	L8	15.44	1.10	0.67	13.1	trig	6, 18
37[a]	08354256−0819237	10742	L5	13.17	1.23	0.80	8.3	sp	7
38[a]	08472872−1532372	10764	L2	13.51	0.89	0.56	17.5	sp	7
39	08575849+5708514	20320	L7	15.04	1.25	0.83	13.1	sp	5
40[a]	08592547−1949268	10789	L7:	15.53	1.09	0.68	16.3	sp	7
41[a]	09083803+5032088	10802	L7	14.55	1.07	0.53	10.5	sp	7
42[a]	09111297+7401081	20333	L0	12.92	0.72	0.45	17.3	sp	9
43[a]	09153413+0422045A	20335A	L6:	15.30	1.02	0.52	18.0	sp	9
	09153413+0422045B	20335B	L6:	15.40	1.00	0.55	18.0	sp	22
44[a]	09211410−2104446	20336	L1.5	12.78	0.62	0.46	11.48	trig	9, 13
45	10101480−0406499	10880	L7	15.51	1.12	0.76	16.2	sp	7
46	10132597−7842551		L3	13.84	1.11	0.70		sp	16
47[a]	10224821+5825453	20373	L1	13.50	0.86	0.48	19.9	sp	9, Hα 20–150 Å
48[a]	10430758+2225236	10926	L8	15.97	1.24	0.74	17.2	sp	17
49[a]	10452400−0149576	10929	L1	13.16	0.81	0.57	16.8	p.	17, 7
50[a]	10484281+0111580	20387	L1	12.92	0.78	0.52	15.3	sp	17
51[a]	10511900+5613086	20388	L2	13.24	0.82	0.52	15.4	sp	9
52[a]	10584787−1548172	10949	L3	14.16	0.94	0.52	17.33	trig	10, 4, Hα 2.4 Å
53[a]	11040127+1959217	10954	L4	14.38	0.90	0.53	18.8	sp	7
54[a]	11083081+6830169	10960	L0.5	13.12	0.89	0.66	18.0	sp	26
55	11263991−5003550		L4.5:	14.00	0.72	0.45	14.5	sp	37, 38, 39
56[a]	11553952−3727350	20431	L2	12.81	0.77	0.58	12.6	sp	27
57[a]	12035812+0015500	20433	L4	14.01	0.95	0.58	15.2	sp	28
58[a]	12130336−0432437	11044	L5	14.68	1.04	0.63	16.7	sp	7

Table 9
(Continued)

N	2MASS J	2MUCD	SpT	J	(J − H)	(H − K_S)	d (pc)	src.	Notes
59[a]	12212770+0257198	20444	L0	12.41	0.76	0.46	19.4	sp	9, Hα 6.7 Å
60[a]	13004255+1912354	11115	L1	12.72	0.64	0.46	13.9	sp	27
61[a]	13054019−2541059A	11122A	L2:	13.90	1.0	0.70	18.66	trig	29, Kelu 1
	13054019-2541059B	11122B	L2:	14.5	1.0	0.7	18.66	trig	30, Hα 1.6 Å
63[a]	14213145+1827407	20562	L0	13.23	0.80	0.49	20.0	sp.	9
64[a]	14252798−3650229	20568	L3:	13.75	1.17	0.78	16.4	sp	31
65[a]	14392836+1929149	20581	L1	12.76	0.72	0.50	14.37	trig	24, 4
66[a]	14482563+1031590	20587	L4:	14.56	1.12	0.75	19.6	sp	9
	14540797−6604476		L3.5	13.06	0.89	0.45	11.5	39	
67[a]	15065441+1321060	11291	L3	13.37	0.99	0.64	14.1	sp	26
68[a]	15074769−1627386	11296	L5	12.83	0.94	0.58	7.30	trig	3, 4
69[a]	15150083+4847416	11314	L6	14.11	1.01	0.60	10.2	7	
70	15200224−4422419A		L1.5	13.55	0.82	0.47	19.0	sp	33,34, 39
	15200224−4422419B		L4.5	14.70	1.00	0.49	19.0	sp	33,34
71	15232263+3014562		L8	16.32	1.32	0.76	17.45	trig	Gl 584C, 35
72[a]	15394189−0520428	20625	L3.5	13.92	0.86	0.49	16.2	sp	31
73[a]	16322911+1904407		L8	15.87	1.25	0.61	15.2	trig	24, 4
74[a]	16580380+7027015	11668	L1	13.29	0.81	0.56	18.55	trig	26, 4
75[a]	17054834−0516462	20699	L0.5	13.31	0.76	0.52	19.5	sp	31
76[a]	17210390+3344160	11694	L3	13.63	0.68	0.46	15.2	sp	7
77[a]	17312974+2721233	20744	L0	12.09	0.70	0.48	11.8	sp	9, Hα 1.5 Å
78	17453466−1640538		L1.5	13.65	0.77	0.48	19.9	sp	39
79	17502484−0016151		L5.5	13.29	0.88	0.56	8.0	sp	33
80[a]	17534518−6559559	20760	L4::	14.10	0.99	0.68	15.9	sp	34, 9
81[a]	18071593+5015316	11756	L1.5	12.93	0.80	0.53	14.6	sp	7, Hα 1.5 Å
82	18212815+1414010		L4.5	13.43	1.04	0.75	10	sp	16
83[a]	19360187−5502322	20823	L5:	14.49	0.86	0.58	15.4	sp	9
84[a]	20025073−0521524	11946	L6	15.32	1.04	0.86	18.2	sp	17
85	20360316+1051295	20870	L3	13.95	0.93	0.57	18.0	sp	9
86[a]	20575409−0252302	12054	L1.5	13.12	0.85	0.55	15.7	sp	7, Hα 9.4 Å
87[a]	21041491−1037369	12059	L2.5	13.84	0.87	0.60	18.7	sp	7
88	21373742+0808463	20909	L5:	14.77	1.17	0.58	17.5	sp	9
89[a]	21481633+4003594		L6.5	14.15	1.37	1.02	9.6	sp	16
90[a]	21522609+0937575A	20925A	L6:	15.95	1.15	0.70	19.9	sp	9
	21522609+0937575B	20925B	L6:	16.00	1.15	0.70	19.9	sp	9
91[a]	22244381−0158521	12128	L4.5	14.07	1.26	0.79	11.49	trig	35, 4, Hα 1.7 Å
92[a]	22521073−1730134A	20976A	L6	14.67	1.05	...	14.3	sp	36
	22521073−1730134B	20976B	T2	15.65	0.45	...	14.3	sp	36
93[a]	22551861−5713056A	20979A	L6	14.3:	1.15	...	14.3	sp	33
	22551861−5713056B	20979B	T0:	15.8:	1.0	...	14.3	sp	33
94[a]	23254530+4251488	13227	L8	15.49	1.04	0.69	14.1	sp	17

Notes. Sources from the 2MU2 sample have 2MUCD five-digit numbers 1xxxx; sources from the 2MUA sample have 2MUCD numbers 2xxxx.
[a] The L dwarf has HST NICMOS observations (Reid et al. 2006a, 2008).
References. (1) EROS Collaboration et al. 1999; (2) Golimowski et al. 2004; (3) Reid et al. 2000; (4) Dahn et al. 2002; (5) Hawley et al. 2002; (6) Vrba et al. 2004; (7) Cruz et al. 2003; (8) Liebert et al. 2003; (9) This paper; (10) Delfosse et al. 1997; (11) Koerner et al. 1999; (12) Bouy et al. 2005; (13) Bartlett 2007; (14) Martín et al. 1999; (15) Costa et al. 2006; (16) Looper et al. 2008; (17) Cruz et al. 2007; (18) Geballe et al. 2002; (19) Burgasser et al. 2005; (20) Salim et al. 2003; (21) Tinney et al. 2003; (22) Reid et al. 2006a; (23) Reid et al. 2001; (24) Kirkpatrick et al. 1999; (25) Scholz et al. 2002; (26) Gizis et al. 2000; (27) Gizis 2002; (28) Fan et al. 2000; (29) Ruiz et al. 1997; (30) Liu & Leggett 2005; (31) Kendall et al. 2004; (32) Burgasser et al. 2007; (33) Kendall et al. 2007; (34) Deacon & Hambly, 2007; (35) Kirkpatrick et al. 2000; (36) Reid et al. 2006b; (37) Folkes et al. 2007; (38) Burgasser et al. 2008; (39) Phan-Bao et al. 2008; (40) Burgasser 2007b.

within 20 pc of the Sun, including 44 that were observed here for the first time. Examining the full data set, we have identified several dwarfs with lithium absorption, indicating masses less than ~0.065 $M_\odot$

We have combined the present data set with our previous surveys of K, M, and L dwarfs, from Papers V, VIII, and IX in this series, and with current census information on nearby T dwarfs from the online database, http://DwarfArchives.org, to provide an estimate of the spectral-type distribution of late-type dwarfs within 20 pc of the Sun. The results show how M dwarfs dominate the local population. The ultracool sample is known to be incomplete for late-L and T dwarfs; nonetheless, the current data show a pronounced minimum from ~L5 to ~T2, with an upturn in the number densities of mid- and late-type T dwarfs. A future paper will present near-infrared spectroscopy of the later-type dwarfs from the present compilation, together with additional sources from the 2MASS All-Sky sample. At that juncture, we will undertake a more quantitative analysis of the ultracool dwarf luminosity function and will consider the implications for the mass function in the substellar regime.

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REFERENCES

Allen, P. R., Koerner, D. W., Reid, I. N., & Trilling, D. E. 2005, ApJ, 625, 385
Baraffe, I., Chabrier, G., Allard, F., & Hauschildt, P. H. 1998, A&A, 337, 403
Bartlett, J. L. 2007, PhD thesis, Univ. of Virginia
Basri, G., Mohanty, S., Allard, F., Hauschildt, P. H., Delfosse, X., Martín, E. L., Forveille, T., & Goldman, B. 2000, ApJ, 538, 363
Bouy, H., Brandner, W., Martín, E. L., Delfosse, X., Allard, F., & Basri, G. 2003, AJ, 126, 1526
Bouy, H., Martín, E. L., Brandner, W., & Bouvier, J. 2005, AJ, 129, 511
Burgasser, A. J. 2007a, ApJ, 659, 655
Burgasser, A. J. 2007b, AJ, 134, 1330
Burgasser, A. J., Geballe, T. R., Leggett, S. K., Kirkpatrick, J. D., & Golimowski, D. A. 2006, ApJ, 637, 1067
Burgasser, A. J., Looper, D. L., Kirkpatrick, J. D., Cruz, K. L., & Swift, B. J. 2008, ApJ, 674, 451
Burgasser, A. J., Reid, I. N., Leggett, S. K., Kirkpatrick, J. D., Liebert, J., & Burrows, A. 2005, ApJ, 634, L177
Burgasser, A. J., Reid, I. N., Siegler, N., Close, L. M., Allen, P., Lowrance, P. J., & Gizis, J. E. 2007, in Planets and Protostars V, ed. B. Reipurth, D. Jewitt, & K. Keil (Tucson: Arizona Univ. Press), 427
Burgasser, A. J., et al. 2002, ApJ, 564, 421
Burrows, A., Hubbard, W. B., Lunine, J. I., & Liebert, J. 2001, Rev. Mod. Phys., 73, 719
Chabrier, G., & Baraffe, I. 1997, A&A, 327, 1039
Costa, E., Méndez, R. A., Jao, W.-C., Henry, T. J., Subasavage, J. P., Brown, M. A., Ianna, P. A., & Bartlett, J. 2005, AJ, 130, 337
Costa, E., Méndez, R. A., Jao, W.-C., Henry, T. J., Subasavage, J. P., & Ianna, P. A. 2006, AJ, 132, 1234
Crifo, F., Phan-Bao, N., Delfosse, X., Forveille, T., Guibert, J., Martín, E. L., & Reylé, C. 2005, A&A, 441, 653
Cruz, K. L., Reid, I. N., Liebert, J., Kirkpatrick, J. D., & Lowrance, P. J. 2003, AJ, 126, 2421 [Paper V]
Cruz, K. L., et al. 2007, AJ, 133, 439 [Paper IX]
Dahn, C. C., et al. 2002, AJ, 124, 1170
Dame, T. M., et al. 1987, ApJ, 322, 706
Deacon, N. R., & Hambly, N. C. 2001, A&A, 380, 148
Deacon, N. R., & Hambly, N. C. 2007, A&A, 468, 163
Deacon, N. R., Hambly, N. C., & Cooke, J. A. 2005, A&A, 435, 363
Delfosse, X., et al. 1997, A&A, 327, L25
Delfosse, X., et al. 2001, A&A, 366, L13
Dobbie, P. D., Kenyon, F., Jameson, R. F., Hodgkin, S. T., Hambly, N. C., & Hawkins, M. R. S. 2002, MNRAS, 329, 543
Dutra, C. M., & Bica, E. 2002, A&A, 383, 631
Epchtein, N., et al. 1994, Ap&SS, 217, 3
EROS Collaboration, et al. 1999, A&A, 351, L5
Fan, X., et al. 2000, AJ, 119, 928
Folkes, S. L., Pinfield, D. J., Kendall, T. R., & Jones, H. R. A. 2007, MNRAS, 378, 901
Geballe, T. R., et al. 2002, ApJ, 564, 466
Gizis, J. E. 2002, ApJ, 575, 484
Gizis, J. E., Monet, D. G., Reid, I. N., Kirkpatrick, J. D., Liebert, J., & Williams, R. J. 2000, AJ, 120, 1085
Gizis, J. E., & Reid, I. N. 1997, PASP, 109, 849
Gizis, J. E., Reid, I. N., Knapp, G. R., Liebert, J., Kirkpatrick, J. D., Koerner, D. W., & Burgasser, A. J. 2003, AJ, 125, 3302
Gizis, J. E., Reid, I. N., & Monet, D. G. 1999, AJ, 118, 997
Golimowski, D. A., et al. 2004, AJ, 128, 1733
Hamuy, M., Suntzeff, N. B., Heathcote, S. R., Walker, A. R., Gigoux, P., & Phillips, M. M. 1994, PASP, 106, 566
Hawkins, M. R. S., & Bessell, M. S. 1988, MNRAS, 234, 177
Hawley, S. L., et al. 2002, AJ, 123, 3409
Henry, T. J., Subasavage, J. P., Brown, M. A., Beaulieu, T. D., Jao, W.-C., & Hambly, N. C. 2004, AJ, 128, 2460
Hook, I. M., Jørgensen, I., Allington-Smith, J. R., Davies, R. L., Metcalfe, N., Murowinski, R. G., & Crampton, D. 2004, PASP, 116, 425
Ianna, P. A., & Fredrick, L. W. 1995, ApJ, 441, L47
Jao, W.-C., Henry, T. J., Subasavage, J. P., Brown, M. A., Ianna, P. A., Bartlett, J. L., Costa, E., & Méndez, R. A. 2005, AJ, 129, 1954
Kendall, T. R., Delfosse, X., Martín, E. L., & Forveille, T. 2004, A&A, 416, L17
Kendall, T. R., Jones, H. R. A., Pinfield, D. J., Pokorny, R. S., Folkes, S., Weights, D., Jenkins, J. S., & Mauron, N. 2007, MNRAS, 374, 445
Kirkpatrick, J. D., Barman, T. S., Burgasser, A. J., McGovern, M. R., McLean, I. S., Tinney, C. G., & Lowrance, P. J. 2006, ApJ, 639, 1120
Kirkpatrick, J. D., Henry, T. J., & Irwin, M. J. 1997, AJ, 113, 1421
Kirkpatrick, J. D., Henry, T. J., & McCarthy, D. W. 1991, ApJS, 77, 417
Kirkpatrick, J. D., Henry, T. J., & Simons, D. A. 1995, AJ, 109, 797
Kirkpatrick, J. D., et al. 1999, ApJ, 519, 802
Kirkpatrick, J. D., et al. 2000, AJ, 120, 447
Kirkpatrick, J. D., et al. 2008, AJ, submitted
Knapp, G. R., et al. 2004, AJ, 127, 3553
Koerner, D. W., Kirkpatrick, J. D., McElwain, M. W., & Bonaventura, N. R. 1999, ApJ, 526, L25
Law, N. M., Hodgkin, S. T., & Mackay, C. D. 2006, MNRAS, 368, 1917
Lépine, S. 2008, AJ, 135, 2177
Lépine, S., & Shara, M. M. 2005, AJ, 129, 1483
Liebert, J., Kirkpatrick, J. D., Cruz, K. L., Reid, I. N., Burgasser, A., Tinney, C. G., & Gizis, J. E. 2003, AJ, 125, 343
Liu, M. C., & Leggett, S. K. 2005, ApJ, 634, 616
Lodieu, N., Scholz, R.-D., & McCaughrean, M. J. 2002, A&A, 389, L20
Lodieu, N., Scholz, R.-D., McCaughrean, M. J., Ibata, R., Irwin, M., & Zinnecker, H. 2005, A&A, 440, 1061
Looper, D. L., et al. 2008, ApJ, submitted
Lowrance, P. J., Kirkpatrick, J. D., Reid, I. N., & Cruz, K. L. 2003, ApJ, 584, L95
Luyten, W. 1980, The New Luyten Two-Tenths Catalogue (NLTT) (Minneapolis, MN: Univ. of Minnesota)
Marley, M. S., Seager, S., Saumon, D., Lodders, K., Ackerman, A. S., Freedman, R. S., & Fan, X. 2002, ApJ, 568, 335
Martín, E. L., Brandner, W., Bouy, H., Basri, G., Davis, J., Deshpande, R., & Montgomery, M. M. 2006, A&A, 456, 253
Martín, E. L., Delfosse, X., Basri, G., Goldman, B., Forveille, T., & Zapatero Osorio, M. R. 1999, AJ, 118, 2466
Martín, E. L., Delfosse, X., & Guieu, S. 2004, ApJ, 127, 449
Massey, P., & Gronwall, C. 1990, ApJ, 358, 344
Massey, P., Strobel, K., Barnes, J. V., & Anderson, E. 1988, ApJ, 328, 315
McElwain, M. W., & Burgasser, A. J. 2006, AJ, 132, 2074
McLean, I. S., McGovern, M. R., Burgasser, A. J., Kirkpatrick, J. D., Prato, L., & Kim, S. S. 2003, ApJ, 596, 561
Monet, D. G., Dahn, C. C., Vrba, F. J., Harris, H. C., Pier, J. R., Luginbuhl, C. B., & Ables, H. D. 1992, AJ, 103, 638
Nakajima, T., Oppenheimer, B. R., Kulkarni, S. R., Golimowski, D. A., Matthews, K., & Durrance, S. T. 1995, Nature, 378, 463

Neuhäuser, R., et al. 2002, Astron. Nachr., 323, 447
Oke, J. B., & Gunn, J. E. 1983, ApJ, 266, 713
Perryman, M. A. C., & ESA 1997, in The *HIPPARCOS* and *TYCHO* catalogues. Astrometric and Photometric Star Catalogues Derived from the ESA *HIPPARCOS* Space Astrometry Mission, ESA SP Ser. Vol. 1200 (Noordwijk, The Netherlands: ESA Publications Division)
Phan-Bao, N., & Bessell, M. S. 2006, A&A, 446, 515
Phan-Bao, N., et al. 2001, A&A, 380, 590
Phan-Bao, N., et al. 2003, A&A, 401, 959
Phan-Bao, N., et al. 2008, MNRAS, 383, 831
Probst, R. G., & Liebert, J. 1983, ApJ, 274, 245
Rebolo, R., Martín, E. L., & Magazzu, A. 1992, ApJ, 389, L83
Reid, I. N., Cruz, K. L., & Allen, P. R. 2007, AJ, 133, 2825 [Paper XI]
Reid, I. N., Cruz, K. L., Burgasser, A. J., & Liu, M. C. 2008, AJ, 135, 580
Reid, I. N., & Gizis, J. E. 1997, AJ, 113, 2246
Reid, I. N., & Gizis, J. E. 2005, PASP, 117, 676
Reid, I. N., Gizis, J. E., Kirkpatrick, J. D., & Koerner, D. W. 2001, AJ, 121, 489
Reid, I. N., Kirkpatrick, J. D., Gizis, J. E., Dahn, C. C., Monet, D. G., Williams, R. J., Liebert, J., & Burgasser, A. J. 2000, AJ, 119, 369
Reid, I. N., Lewitus, E., Allen, P. R., Cruz, K. L., & Burgasser, A. J. 2006a, AJ, 132, 891
Reid, I. N., Lewitus, E., Burgasser, A. J., & Cruz, K. L. 2006b, ApJ, 639, 1114
Reid, I. N., et al. 2004, AJ, 128, 463 [Paper VIII]
Reylé, C., & Robin, A. C. 2004, A&A, 421, 643
Reylé, C., Scholz, R.-D., Schultheis, M., Robin, A. C., & Irwin, M. 2006, MNRAS, 373, 705
Ruiz, M. T., Leggett, S. K., & Allard, F. 1997, ApJ, 491, L107
Ruiz, M. T., Takamiya, M. Y., & Roth, M. 1991, ApJ, 367, L59
Salim, S., Lépine, S., Rich, R. M., & Shara, M. M. 2003, ApJ, 586, L149
Schmidt, S. J., Cruz, K. L., Bongiorno, B. J., Liebert, J., & Reid, I. N. 2007, AJ, 133, 2258
Schneider, D. P., et al. 2002, AJ, 123, 458
Scholz, R.-D., Ibata, R., Irwin, M., Lehmann, I., Salvato, M., & Schweitzer, A. 2002, MNRAS, 329, 109
Seifahrt, A., Guenther, E., & Neuhäuser, R. 2005, A&A, 440, 967
Skrutskie, M. F., et al. 2006, AJ, 131, 1163
Stephens, D. C., Marley, M. S., Noll, K. S., & Chanover, N. 2001, ApJ, 556, L97
Tinney, C. G. 1996, MNRAS, 281, 644
Tinney, C. G., Burgasser, A. J., & Kirkpatrick, J. D. 2003, AJ, 126, 975
Tinney, C. G., Delfosse, X., Forveille, T., & Allard, F. 1998, A&A, 338, 1066
Tinney, C. G., Mould, J. R., & Reid, I. N. 1993, AJ, 105, 1045
Tinney, C. G., Reid, I. N., Gizis, J., & Mould, J. R. 1995, AJ, 110, 3014
van Altena, W. F., Lee, J. T., & Hoffleit, E. D. 1995, The General Catalogue of Trigonometric [stellar] Paralaxes (4th edn.; New Haven, CT: Yale Univ. Obs.)
Vrba, F. J., et al. 2004, AJ, 127, 2948
Wilson, J. C., Kirkpatrick, J. D., Gizis, J. E., Skrutskie, M. F., Monet, D. G., & Houck, J. R. 2001, AJ, 122, 1989
Wilson, J. C., Miller, N. A., Gizis, J. E., Skrutskie, M. F., Houck, J. R., Kirkpatrick, J. D., Burgasser, A. J., & Monet, D. G. 2003, IAU Symp., Vol. 211, Brown Dwarfs, ed. E. Martín (San Francisco, CA: Astronomical Society of the Pacific), 197
York, D. G., et al. 2000, AJ, 120, 1579

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ERRATUM: "MEETING THE COOL NEIGHBORS. X. ULTRACOOL DWARFS FROM THE 2MASS ALL-SKY DATA RELEASE" (2008, AJ, 136, 1290)

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