

Ultracool Neighbors from 2MASS

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Abstract

We present initial results of an all-sky search for cool, low-mass stars and brown dwarfs within 20 pc. We have used the near-infrared photometry provided by the 2-Micron All Sky Survey (2MASS) Second Incremental Data Release to create a target list of 1793 candidates with $6 < J < 17$ and $J-K > 1$. Follow-up observations and existing data have enabled over 85% of the sample to be classified, and spectral types and distances have been derived for over 250 nearby dwarfs. In this poster, we discuss our selection methods and present preliminary results — including 39 newly discovered, bright L dwarfs.

Introduction

- The Galactic Disk contains a great multitude of low-mass stars and brown dwarfs.
- Despite many discoveries from DENIS, 2MASS, and SDSS, there has not been a large-scale, systematic effort to study this new regime.
- In particular, late-M and early-L dwarfs have received relatively little attention while the emphasis has been on pushing detections to lower and lower luminosities and temperatures.
- We have undertaken a project to compile an all-sky, volume-limited sample (20 pc) of nearby objects with spectral types from M8 to L8.
- Candidate nearby dwarfs are found using 2MASS infrared photometry and are followed-up with moderate-resolution, far-red optical spectroscopy. Several methods are used to determine spectral type, absolute magnitude, and distance.

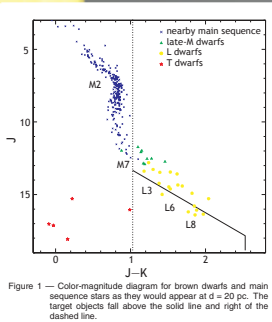


Figure 1 — Color-magnitude diagram for brown dwarfs and main sequence stars as they would appear at $d = 20$ pc. The target objects fall above the solid line and right of the dashed line.

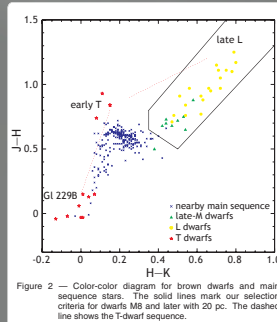


Figure 2 — Color-color diagram for brown dwarfs and main sequence stars. The solid lines mark our selection criteria for dwarfs M8 and later with 20 pc. The dashed line shows the T-dwarf sequence.

The Sample

- We culled 2MASS using several methods to select all of the M and L dwarfs cooler than M8 within 20 pc.
- Confined to 2MASS Second Incremental Release coverage of 47% of the sky.
- Sources are required to have $|b| > 10^\circ$ to avoid Galactic Plane.
- Figure 1 shows our cuts in $(J-K)$ to select L dwarfs and late M-dwarfs within 20 pc.
- Figure 2 shows our cuts in $(J-H)/(H-K)$ to ensure minimal contamination by reddened early-type stars and giants.
- Optical photometry was obtained by cross-referencing bright sources with the Guide Star Catalog enabling a further cut in $J-(R-J)$ to eliminate remaining interlopers.
- Figure 3 shows the distribution on the sky of the candidate nearby dwarfs.

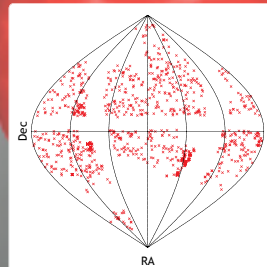


Figure 3 — Distribution of target objects on sky. Our galactic latitude cut as well as the sky coverage of the 2MASS Second Release can be seen.

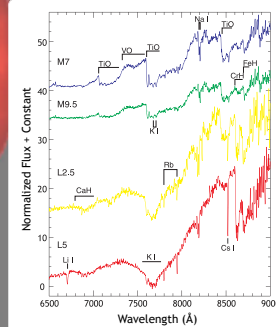


Figure 4 — Spectra of late-type dwarfs with prominent spectral features marked.

Results

- Out of the 347 targets observed, 262 are found to be disk dwarfs.
- Figure 5 shows the spectral type distribution.
- Figure 6 shows the distance distribution of the M8-M9.5 dwarfs.
- Figure 7 shows the distance distribution of the L dwarfs.
- Table 1 lists the closest and the latest objects identified in the sample.
- Based on sky coverage, we estimate ~33% completeness for L0-L3 dwarfs, and therefore expect a total of 45 within 20 pc, or a space density of ~ 0.0013 pc⁻³.

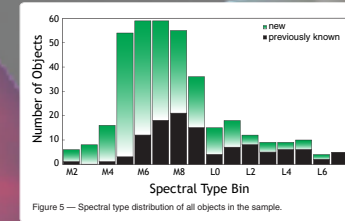


Figure 5 — Spectral type distribution of all objects in the sample.

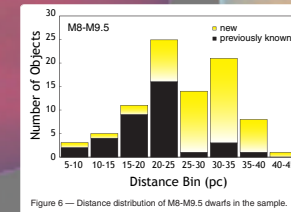


Figure 6 — Distance distribution of M8-M9.5 dwarfs in the sample.

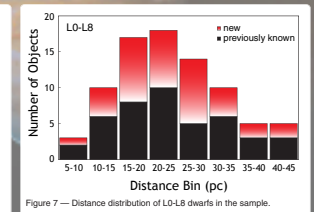


Figure 7 — Distance distribution of L0-L8 dwarfs in the sample.

Observations

- Obtained moderate-resolution ($R \sim 3000$), far-red (6000-10000 Å) follow-up spectroscopy of 347 targets from September 2000 through January 2002 using Kitt Peak and Cerro Tololo 4-m and 2-m class telescopes.
- Figure 4 shows representative spectra of the observed late-type dwarfs with prominent spectral features marked.
- Measured spectral indices defined in Reid, Hawley, & Gizis (1995) (TiO, CaH, CaOH) and Kirkpatrick et al. (1999) (Rb, Cs, TiO, VO, CrH) for all dwarfs.
- Spectral types were determined by comparison with standard spectra and spectral index relations found by Kirkpatrick et al. (1999) and Cruz & Reid (2002).
- Absolute magnitudes were determined using spectral index and spectral type relations found by Kirkpatrick et al. (2000) (M9-M9.5 and L dwarfs) and Cruz & Reid (2002) (M2-M6.5). A linear interpolation of spectral type vs. M_K was used for M7-M8.5 dwarfs.

Identifier	J	J-H	J-K	d (pc)	ST
ZMASS1 0835-0819	13.35	1.20	1.99	9.3	L4.5
ZMASS1 0109-0343	11.70	0.77	1.28	10.4	M9
ZMASS1 0605-0710	13.55	1.18	1.86	10.5	L5
ZMASS1 0144-0716	14.39	1.18	1.90	14.0	L5
ZMASS1 0908-0032	14.56	1.10	1.65	14.6	L6
ZMASS1 1807-5015	12.96	0.81	1.36	15.0	L1.5
ZMASS1 0251-0352	13.08	0.82	1.43	15.5	L1.5
ZMASS1 0223-1803	13.12	0.90	1.49	15.6	L1.5L
ZMASS1 2057-0252	13.12	0.85	1.38	16.0	L1.5
ZMASS1 0439-2353	14.41	1.05	1.61	16.7	L5
ZMASS1 1438-0408	12.92	0.90	1.35	17.4	M9.5
ZMASS1 2104-1037	13.85	0.89	1.49	18.1	L3
ZMASS1 1213-0432	14.67	1.00	1.67	18.5	L5
ZMASS1 1019-2734	12.88	0.64	1.10	18.7	M9
ZMASS1 1723-3344	13.58	0.66	1.11	18.8	L2.5
ZMASS1 0847-1532	13.52	0.89	1.47	18.8	L1.5L
ZMASS1 0445-3048	13.41	0.84	1.43	19.0	L1
ZMASS1 0355-1032	13.09	0.63	1.14	20.3	M9
ZMASS1 0213-0444	13.51	0.74	1.27	20.7	L1
ZMASS1 1017-1308	14.31	0.88	1.44	20.7	L3
ZMASS1 1104-1959	14.46	0.98	1.49	20.8	L4

Table 1 — Coolest and closest objects in the sample.

Future Work

- About 250 potential late-type, nearby objects remain to be observed — most accessible with 4-m class telescopes.
- Measure chromospheric activity and kinematics of sample.
- Compile data on the sub-dwarfs, giants, and carbon stars observed.
- Use complete sample to determine luminosity and mass functions.

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