

Spectroscopic distances of 28 nearby star candidates[★] (Research Note)

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ABSTRACT

Aims. Twenty eight hitherto neglected candidates for the Catalogue of Nearby Stars (CNS) were investigated to verify their classification and to improve their distance estimates. All targets had at least a preliminary status of being nearby dwarf stars based on their large proper motions and relatively faint magnitudes. Better photometric and/or spectroscopic distances were required for selecting stars for further trigonometric parallax measurements.

Methods. Low-resolution spectra were obtained with NASPEC at the Tautenburg 2 m telescope and with CAFOS at the Calar Alto 2.2 m telescope. The spectral types of M-type stars were determined by direct comparison of the target's spectra with those of comparison stars of known spectral types observed with the same instrument. The classification of earlier types was performed based on comparison with published spectral libraries.

Results. For most of the target stars reliable spectral types could be determined and in combination with 2MASS photometry new improved distance estimates became available. The majority were classified as M dwarfs including 11 stars within 25 pc. The fainter component of LDS 1365, previously thought to form a nearby common proper motion pair, is according to our results an unrelated high-velocity background star. For several other nearby common proper motion pairs our distance estimates of the fainter components are in good agreement with Hipparcos distances of the brighter components. The three stars in our sample that were previously thought to be white dwarfs (GJ 2091, GJ 2094, GJ 2098) turned out to be more distant high-velocity F- to K-type (sub)dwarfs. For the star with the largest tangential velocity (GJ 2091; $v_{\text{tan}} > 500 \text{ km s}^{-1}$) we have additional evidence for its probable Galactic halo membership from a measured large radial velocity of $266 \pm 25 \text{ km s}^{-1}$ and from its *UBV* photometry indicating a low metallicity.

Key words. Galaxy: solar neighborhood – Galaxy: kinematics and dynamics

1. Introduction

In our efforts to complete our knowledge on nearby stars, another sample of nearby star candidates was observed at Tautenburg observatory between February 2006 and February 2007. Without exception the candidate list contains high proper motion stars that as far as we know, have not yet been observed spectroscopically. Spectra for these stars were desired not only to complete the CNS (Catalogue of Nearby Stars) data sets but also to obtain first or improved distance estimates.

Most of the candidates were in the CNS database that has been managed by one of us (H.J.) for many years. For example, the three white dwarf candidates originating from Eggen (1968) were already published in the GJ supplement (Gliese & Jahreiß 1979). No information about the physical properties of these objects could be found in the literature since then.

Furthermore, some faint components of wide common proper motion binaries were included in the observing list. Often the distance information for such stars is taken from the brighter

component. Yet, it is desirable to obtain independent distance information for the fainter component.

The remaining late type dwarfs, all of which were selected from LHS, were included in the CNS database only after publication of the preliminary version of the Third Catalogue of Nearby Stars (pCNS3; Gliese & Jahreiß 1991). They were mostly borderline cases near or just beyond the present search limit of 25 pc for the CNS sample.

2. Observations and reduction

Optical spectroscopic data were collected with the Nasmyth Focal Reducer Spectrograph (NASPEC) at the 2 m telescope of the Thüringer Landessternwarte (TLS) Tautenburg. The V 200 grism was used, which yields a dispersion of 3.4 \AA per pixel, or 12 \AA FWHM for a slit width of 1 arcsec. The wavelength coverage was from about 4000 \AA to 8500 \AA . For one star (GJ 2091), the Tautenburg spectrum, taken under poor weather conditions, did not have a sufficiently high signal-to-noise ratio for a proper classification. Therefore, we applied for director's discretionary time with the 2.2 m telescope at Calar Alto. The Calar Alto focal reducer and faint object spectrograph CAFOS was used with the B 200 grism giving a wavelength coverage from about 3500 \AA to 7000 \AA and a dispersion

[★] Based on observations with the 2 m telescope of the Thüringer Landessternwarte Tautenburg and with the 2.2 m telescope of the German-Spanish Astronomical Center, Calar Alto, jointly operated by the Max-Planck-Institut für Astronomie Heidelberg and the Instituto de Astrofísica de Andalucía (CSIC).

Table 1. Nearby candidates with new proper motions and previously known spectral characteristics and parallaxes.

cns	RA		J2000.0		Dec		Epoch	μ "/yr	Θ °	SpT	mag	π		s.e.	Source*	Other
	h	m	s	°	'	"						mas	mas			
GJ 1167B	13	09	41.96	+29	01	56.9	2000.277	0.292	234.9	m	17.6 P					LDS 1365B
GJ 2091	12	04	56.32	+04	19	56.0	2000.137	0.199	221.9	WD?	15.03	83.	27.	a		G 13-6
GJ 2094	12	37	52.87	+37	30	31.5	1999.247	0.140	208.2	WD?	15.62	60.	20.	a		GD 266
GJ 2098	13	08	28.67	+40	27	10.7	1999.274	0.263	242.2	WD?	14.00	160.	52.	a		G 164-46
NN 817	09	53	33.53	+50	45	03.8	1999.860	0.530	272.0	m	12.02	39.8	3.3	h		LHS 2205
NN 953	11	22	36.29	+35	46	19.0	1998.189	0.185	7.3	m	14.62	41.3	9.3	p		LP 264-44
NN 991	11	47	52.45	+17	42	39.9	1998.025	0.217	130.2	m	14.73	41.2	9.1	p		LP 433-54
NN 1047A	12	21	27.05	+30	38	35.7	2000.263	0.331	216.9	m	15.31:	81.7	31.3	p		G 148-47
NN 1047B	12	21	26.73	+30	38	37.6	2000.263	0.331	216.9	m	15.4:	81.7	31.3	p		G 148-48
NN 1073	12	38	36.21	+05	21	38.5	2000.184	0.542	266.8	k-m	15.2:	38.4	10.8	p		LHS 2593
NN 1083	12	43	47.59	+00	03	20.4	1999.063	0.691	224.8	m	14.67	33.0	7.6	p		LHS 2616
NN 1169	13	39	15.27	+15	40	59.5	1998.077	0.980	142.3	m	14.16:	34.4	5.0	t		LHS 2774
NN 1246A	14	28	21.52	+05	19	01.4	2000.263	0.376	260.6	g-k	12.54	70.4	51.5	p		G 65-54
NN 1246B	14	28	17.58	+05	18	45.9	2000.263	0.378	259.3	g-k	13.13	70.4	51.5	p		G 65-53
NN 1342B	15	35	25.67	+60	05	07.7	1999.348	0.231	132.9	m	13.46	52.4	.7	h		LP 99-392
NN 1356	15	49	36.74	+00	17	48.9	2000.326	0.599	216.9	m	13.20	35.9	10.5	p		LHS 3123
NN 1361A	15	50	18.62	+34	37	11.5	1998.255	0.195	222.6	m	13.04:	37.1	8.3	p		LP 274-11
NN 1361B	15	50	18.55	+34	37	15.9	1998.255	0.195	222.6	m	16.5:	37.1	8.3	p		LP 274-10
NN 1538B	18	00	45.44	+29	33	56.7	1999.260	0.222	321.2	k	14.5 P	34.6	.7	h		LP 333-29
nn 40	08	12	26.57	+43	09	29.0	1998.852	0.558	165.2	k-m	14.26	38.3	8.7	p		LHS 1988
nn 44	09	08	50.79	+54	07	18.3	1999.948	0.553	221.4	m	15.04	42.3	9.1	p		LHS 2109
nn 51	11	00	35.69	+37	28	50.8	1998.271	0.724	251.8	k-m	15.36	42.9	9.1	p		LHS 2340
nn 76	13	32	00.07	+66	36	00.5	1999.263	0.567	300.5	m	14.05	40.6	9.4	p		LHS 2748
nn 77	14	07	48.03	+57	11	45.3	1999.123	0.693	285.4	m	14.20	47.1	10.5	p		LHS 2864
nn 78	14	16	42.11	+36	00	50.8	2000.186	0.542	146.1	k-m	12.59	33.9	9.2	p		LHS 2886
nn 79	14	20	39.46	+46	02	34.2	1998.395	0.645	253.6	m	15.10	45.4	9.6	p		LHS 2897
nn 87	15	03	35.01	+84	38	26.7	1999.296	0.578	221.0	m	14.15	33.7	7.6	p		LHS 3017
nn 90	16	34	13.72	+54	23	39.8	1999.356	0.569	337.5	k	11.86	33.9	9.1	p		LHS 3214

* a: WD by Eggen (1968), p: photometric parallax, h: Hipparcos (ESA 1997) parallax, and t: ground-based trigonometric parallax.

of 4.7 Å per pixel. All spectra were reduced with standard routines from the ESO MIDAS data reduction package. For details of the data reduction we refer to our previous paper (Scholz et al. (2005)).

The list of nearby star candidates observed in Tautenburg during four runs between February 2006 and February 2007 is presented in Table 1, with an internal CNS designation in Col. 1, the 2MASS right ascension and declination for equinox J2000.0 in Cols. 2 and 3, respectively, and the epoch of the 2MASS observation in Col. 4. The annual proper motion and its direction is given in Cols. 5 and 6. These proper motions were all new determinations making use of the available new digitized sky surveys like DSS and 2MASS. All our objects are at northern declinations, therefore epoch differences of up to 50 years or more became available with the USNO A2 positions from the first Palomar Observatory Sky Survey (POSS-I) leading to proper motion errors well below 10 mas/yr. In Col. 7 the previously known information about spectral characteristics is given, i.e. mostly spectral classes from Luyten's proper motion surveys. In Col. 8 visual or photographic (followed by a P) magnitudes are listed. In Cols. 9 and 10 the previously known parallax and its standard error are given, and in Col. 11 the source code for this parallax. An additional identifier given in the last column should allow easier access to the Simbad database for further information.

Additional spectra of nine stars with known spectral types from M0 to M6.5 (see Fig. 1) were taken to allow a direct comparison of our target spectra. Unfortunately, we could not make use of the spectrum taken for the M2 dwarf G138. Therefore a comparison spectrum for M2 dwarfs could not be performed. For the M dwarf stars the spectral type was then estimated by

comparing the spectra in question directly with the sequence of comparison spectra. All spectra were thus normalized at 7500 Å. Figure 1 shows as an example the spectrum of GJ 1167B compared to the spectra of eight comparison stars. Visual inspection allows a rather accurate determination of the spectral type. However, the calibration of the spectra below 5000 Å and above 8000 Å is less certain.

In addition to the visual estimate an automatic classification method was applied. The difference between the spectrum of the object and each comparison spectrum was calculated and the variance was used as a measure of agreement. The best fit spectral type was then obtained by searching for the minimum of the variance as a function of spectral type using a quadratic regression. Generally, the automatic method provided results in good agreement with the visual classification. Nevertheless, we preferred the results of the latter method.

3. Object classification and distance estimates

In Table 2 the finally adopted spectral types are given in Col. 2. For all the M dwarfs, these spectral types were obtained by visual inspection, comparing the target spectra with the sequence of comparison spectra. Column 3 lists spectral types obtained by the automatic method described in Sect. 2. The adopted spectral types in Col. 2 are followed by the letter "e" if an H α emission line was detected. It is interesting that all emission line M dwarfs were also identified as X-ray sources according to the VizieR Catalogue Service (<http://vizier.u-strasbg.fr/>). The 2MASS magnitude *J* in Col. 4 was used to compute the spectroscopic parallaxes listed in Col. 5 with the recently

in the Kron-Mayall system. Transforming this value to the Kron-Cousins system according to Leggett (1992) yields only a minor change to $V - I = 3.39$. Fleming (1998) published an independent distance estimate of 11.2 pc from his slightly different VI photometry (in the Kron-Cousins system) $V = 14.709, V - I = 3.465$ without being aware that it is a close pair. The latter was recently discussed by Reid et al. (2004), who obtained a revised distance estimate for the system of ~ 12.5 pc.

Averaging our independent spectroscopic distance estimates for the two components we obtain a mean distance of 17 pc for the system. This is close to the corrected value of 15.8 pc from the original estimate of Fleming (1998) assuming a system of almost equal brightness components, which is supported by several observations.

4.6. G 65-54/53 = NN 1246AB

This common proper motion pair separated by 61 arcsec had up to now only UBV -photometry available with $B - V > 1.50$ for both components. Because a value of $B - V \geq 1.30$ does not allow a reasonable distance estimate, this pair was excluded from the pCNS3. Now with the new spectral types and 2MASS photometry a distance of 17.5 pc is proposed.

4.7. LP 99-392 = NN 1342B

LP 99-392 is the fainter common proper motion companion (separation $43''$) to HD 139477. Here we had the curious case that a VRI -photometric parallax of 55 mas was available for the fainter component, whereas for the brighter component only the HD-type K5 was known. Therefore the pair was not included in the pCNS3 although already then it was present in the list of nearby candidates.

Only in 1997 did Hipparcos determine a distance of 19 pc for HD 139477, and almost simultaneously an MK spectral type of K3 V was published for it (Loth & Bidelman 1998). The combination of photometric and spectroscopic parallaxes yields a distance of 18 pc for LP 99-392, and also its proper motion of $\mu = 0.231''/\text{yr}$ in $132^\circ 9$ is in good agreement with the Hipparcos value $\mu = 0.2370''/\text{yr}$ in $133^\circ 4$ for HD 139477. In other words the physical connection of this common proper motion pair is now well established.

4.8. LP 333-29 = NN 1538B

Already the newly determined proper motion $\mu = 0.222''/\text{yr}$ in $321^\circ 8$ for LP 333-29 allowed little doubt about the physical relation with the G2 V primary HD 164595 about $88''$ away having a Hipparcos proper motion of $\mu = 0.2224''/\text{yr}$ in $321^\circ 2$. Now our spectral type of M2.0 provides a direct distance estimate for LP 333-29 as 27.2 pc, which is in almost perfect agreement with the Hipparcos parallax of 34.57 mas for the primary, and the metallicity $[\text{Fe}/\text{H}] = -0.07$ determined for the primary in Bonfils et al. (2005) applies also to the M2 dwarf LP 333-39.

4.9. LHS 1988 = nn 44

VRI photometry consistently provides a parallax of 42 mas. $V - K_s$ and the new spectral type M4.0 yield slightly smaller parallax values of 38 mas, and 37 mas, respectively.

5. Conclusions

With the spectroscopic distances determined in this paper, we were able to solve several doubtful distance estimates for nearby star candidates. Among these Eggen's white dwarf candidates contained in the GJ-supplement are all far away F-K dwarf stars. From their extremely high tangential velocities we suspect them to be subdwarfs. With this classification they would still have large velocities typical of Galactic halo stars. Our measured radial velocity for the star with the highest tangential velocity, GJ 2091, confirms this assumption.

All other stars in our sample were classified as M dwarfs. According to our new distance estimates all but one of these 25 stars lie within 40 pc, including 11 objects falling within the 25 pc horizon of the CNS.

We could show that Luyten's common proper motion pair LDS 1365 consists of two M dwarf stars with similar proper motions but completely different distances and space velocities.

Our spectroscopy in combination with 2MASS colours provided the first reliable distance estimate for the common proper motion pair G 65-54/53, which is probably within 20 pc.

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