Mon. Not. R. Astron. Soc. **378,** L24–L28 (2007) doi:10.1111/j.1745-3933.2007.00312.x

L and T dwarfs in the Hyades and Ursa Major moving groups

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Accepted 2007 March 9. Received 2007 March 5; in original form 2006 September 14

ABSTRACT

We have used the moving cluster method to identify three L dwarfs and one T dwarf in the Ursa Major/Sirius moving group (age 400 Myr). Five L dwarfs and two T dwarfs are found to belong to the Hyades moving group (age 625 Myr). These L and T dwarfs define 400- and 625-Myr empirical isochrones, assuming that they have the same age. Moving group membership does not guarantee coevality.

Key words: stars: kinematics – stars: low-mass, brown dwarfs – open clusters and associations: individual: Ursa Major – open clusters and associations: individual: Hyades – galaxies: star clusters.

1 INTRODUCTION

Apart from a brief phase of lithium burning, brown dwarfs cool continuously. Thus any meaningful comparison with theory requires a knowledge of the age of the brown dwarf. For this reason much effort has been devoted to finding brown dwarfs in clusters whose age is known. The three closest clusters are the Hyades ($d = 46$ pc), Coma ($d = 90$ pc) and the Pleiades ($d = 130$ pc). The Hyades and Coma are old clusters with ages of 625 Myr (Perryman et al. 1998) and 500 Myr (Odenkirchen, Soubiran & Colin 1998) respectively, and were not thought to have any brown dwarfs. More recently, Moraux et al. (2003) have found two brown dwarfs in the Hyades and Casewell, Jameson & Dobbie (2005) have found 13 brown dwarf candidates in the Coma cluster. The Pleiades (age 125 Myr) has some 50 known brown dwarfs (Jameson et al. 2002), with some more recently discovered by Moraux et al. (2003). Thus the nearest cluster with a significant number of known brown dwarfs is the Pleiades at a distance of 130 pc. This distance, together with the intrinsic faintness of brown dwarfs, naturally makes it difficult to study cluster brown dwarfs. By contrast, field brown dwarfs are close (∼10–40 pc) and easier to study but usually have unknown ages. However, some field star ages have been measured [see for example Kirkpatrick et al. (2001) or Burgasser, Burrows & Kirkpatrick (2006)]. Field brown dwarfs are found by surveys such as 2MASS (Skrutskie et al. 1997), DENIS (Epchtein et al. 2002) and the SDSS (York et al. 2003). A compilation of the known L and T dwarfs can be found in the L and T Dwarf Archive (Kirkpatrick 2003).

One possible way of finding the ages of field brown dwarfs would be to see if they are members of a moving group. A moving group is a group of stars with the same velocity, magnitude and direction, and the same age [see Zuckermann & Song (2004) for a recent review]. One of the closest moving groups is the Ursa Major/Sirius moving group (hereafter UMSMG). The core of the moving group, possibly a bound cluster, is in the direction of Ursa Major. Indeed, the stars of the 'Plough' (except α UMa) are all members, as also is Sirius (see Fig. 1). Thus the Sun is actually inside the UMSMG. Group members can be found all around the sky, and may be very close: for example, Sirius is only 2.65 pc from the Sun. The age of the UMSMG has been determined as 300 Myr by Soderblom & Mayor (1993). More recently, Castellani et al. (2002) found 400 Myr while King et al. (2003) found 500 ± 100 Myr for the group age. We will adopt an age of 400 ± 100 Myr.

Since moving group stars have a common velocity, they appear to be moving towards the same place in the sky; this is called the 'convergent point'. The UMSMG convergent point is located at $\alpha_{2000} = 20^{\rm h}18\overset{\rm m}{.}83$, $\delta_{2000} = -34^\circ25\overset{\prime}{.}8$ (Madsen, Dravens & Lindegren 2002). Thus if a field brown dwarf has a proper motion directed towards the UMSMG convergent point, it is a potential member of the UMSMG. This, coupled with two distance tests (see below), allows us to identify members with considerable confidence.

The Hyades is discussed in a thorough paper by Perryman et al. (1998). The cluster lies at a distance of $d = 46$ pc, and has an extent in the sky of approximately 20°; Madsen et al. (2002) give the position of the cluster centroid as $\alpha_{2000} = 4^{\rm h}26^{\rm m}$, $\delta_{2000} = +16^\circ54'$. The Hyades is known to be deficient in low-mass members (Gizis, Reid & Monet 1999). These have probably evaporated from the cluster. Indeed, Chereul, Creze & Bienayme (1998) have identified escaped Hyads and these may be thought of as part of the Hyades Moving Group (HMG). The convergent point of the Hyades is located at $\alpha_{2000} = 6^{\rm h}29\overset{\rm m}{.}48$, $\delta_{2000} = -6^\circ53\overset{\prime}{.}4$, and their total space velocity is 46 km s^{-1} (Madsen et al. 2002). The most recent and generally quoted Hyades age is 625 ± 50 Myr by Perryman et al. (1998), and we will adopt this age.

2 IDENTIFYING GROUP MEMBERS

For the 70 members of the L and T Dwarf Archive (Kirkpatrick 2003) (available at http://www.dwarfarchives.org) with a measured proper motion, we first calculate the angular distance, D, of the

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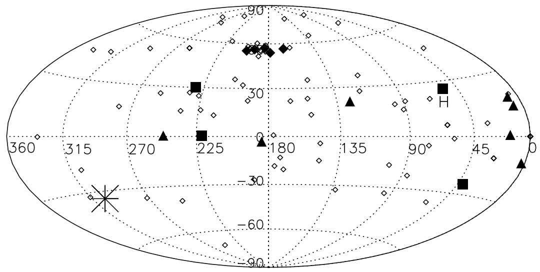

Figure 1. The location of the 77 UMSMG cluster members identified by Madsen et al. (2002) (open circles). The brightest members of the cluster, which along with another star make up the asterism of the 'Plough' (β, γ, δ, ϵ and ζ UMa), are shown as filled diamonds. The four new UMSMG members are shown as filled squares, and the location of the convergent point is indicated by the asterisk. Also shown on the map are the locations of the seven new HMG members (filled triangles), and the location of the Hyades cluster ('H'). The coordinates are equatorial.

dwarf from the UMSMG or HMG convergent point, where D is given by

$$\cos D = \sin\delta \sin\delta_{\rm cp} + \cos\delta \cos\delta_{cp} \cos DA. \tag{1}$$

Here δ and $\delta_{\rm cp}$ are the dwarf declination and convergent point declination, and DA is the difference of their respective right ascensions.

Next we find the direction, θ, from north of the convergent point, where

$$\cos\theta = \frac{\sin\delta_{\rm cp} - \sin\delta\cos D}{\cos\delta\sin D}. \tag{2}$$

A group member should have a proper motion direction equal to θ. However, there is some velocity dispersion amongst group members, otherwise all group members would appear to be very close together, as if in a bound cluster. For the UMSMG the velocity v is 17.98 km s^{-1} and $\sigma_v = 2.82$ km s^{-1} (Madsen et al. 2002). We adopt the same σ_v for the Hyades' recent escapers, even though this value is considerably less than the $\sqrt{3.6^2 + 3.2^2 + 5.2^2} = 7.09$ kms^{-1} given by Chereul, Creze & Bienayme (1999). Thus we impose the same membership conditions for both the UMSMG and the HMG.

We find that members have a proper motion direction within $\sim 13^\circ$ of θ. This corresponds to $1.5\sigma_v$, or 87 per cent completeness, which seems reasonable. This constraint is our first criterion for membership, and the random chance of passing this first test is clearly $4 \times 2 \times 13/360 = 0.28$. The extra factor of 4 is because proper motion directions are not randomly orientated (see Section 7).

It may readily be shown (Carroll & Ostlie 1996) that for a moving group the distance $d_{\rm mc}$ (in parsecs) of any member is given by

$$d_{\rm mc} = \frac{v \sin D}{4.74\mu}, \tag{3}$$

where μ is the proper motion in arcsec per year. If the star is not a moving group member then the above formula does not apply. Our second test is to compare this moving cluster distance with the distance measured by parallax, $d_{\rm p}$. Once again, 1.5 times the velocity dispersion leading to a 28 per cent error compared with the parallax distance seems to cover all the members that we find. As in the first test, we estimate the random chance of a star passing this test. Using the 70 dwarfs with parallaxes, minus the four dwarfs that we ultimately identify as UMSMG members (as discussed in the next section), we calculate $d_{\rm mc}/d_{\rm p}$, and find that nine dwarfs have $0.72 < d_{\rm mc}/d_{\rm p} < 1.28$, i.e. within $1.5\sigma_v$, or 28 per cent. If nine out of 66 dwarfs pass this test by chance, the probability is $9/66 = 0.14$. A similar test for the HMG yields $14/63 = 0.22$. We adopt this higher probability for both the UMSMG and the HMG to avoid over-estimating the significance of the test outcomes.

Finally we calculate the absolute magnitude at any wavelength using the parallax, and our last test is to place the objects in a colour–absolute magnitude diagram. This third check requires that the object lies in a 'correct' or sensible position in the colour–magnitude diagram. By that we mean that there is some evident sequence. We do not require that the objects fit the theoretical isochrones [see point (v) under Section 6].

The entire L dwarf sequence for the 70 field stars is approximately 3.5 mag wide, a factor of 25 in intensity. Allowing for binaries, an isochrone can vary in intensity at any colour by a factor of 2. This gives $2/25 = 0.08$ as the random chance of passing the third test.

Thus the total probability of passing all three independent tests by chance is $0.28 \times 0.22 \times 0.08 = 0.50$ per cent, suggesting that passing all three tests gives 99.50 per cent confidence of membership.

The Dwarf Archive has some 459 entries but unfortunately only 70 of these have measured proper motions. Those with proper motions also have accurate parallaxes.

3 L AND T DWARFS IN THE UMSMG

Of the 70 objects in the archives with proper motions, we find four to be members of the UMSMG. Three are L dwarfs and there is one T dwarf. Table 1 lists their spectral type, magnitude and distance as determined from the moving cluster and parallax methods. Also in Table 1 we give $\Delta\theta$, the difference between the convergent point direction and measured proper motion direction. As mentioned above, due to velocity dispersion and errors in the moving group we do not expect $\Delta\,\theta$ to be zero or $d_{\rm mc}/d_{\rm p} = 1$. Velocity dispersion dominates over measurement errors. As can be seen from Table 1, $\Delta\theta$ varies from $1\overset{\circ}{.}6$ to $13\overset{\circ}{.}5$ and $d_{\rm mc}/d_{\rm p}$ differs from unity by 1–18 per cent. With these two parameters the group members effectively pick themselves. Thus if $\Delta\theta$ is allowed to increase above 13° to (say) 25°, no candidates have $d_{\rm mc}/d_{\rm p}$ close to unity.

However, in the interests of scientific integrity, we point out that a fifth star, 2M 1228–15, passed the first two tests and apparently passed the third. However 2M 1228–15 is a known near-equal-mass binary (Brandner et al. 2004). Thus its two components lie $\sim$0.75 mag below their combined magnitude and do not fit the UMSMG sequence, hence failing the third test. This does not fit very well with our estimate of $\sim$3 per cent chance of passing the first two tests by random chance.

4 L AND T DWARFS IN THE HMG

For the HMG we find that five L dwarfs and two T dwarfs pass all three tests. Again relaxing the constraints on $\Delta\theta$ and $d_{\rm mc}/d_{\rm p}$ would find no further members. However, 2M 0205–11 (also known as DENIS-P J020529.0–115925) was found to be a binary by Koerner et al. (1999) who measured K-band flux ratios of 1.00 ± 0.26 and 0.99 ± 0.08. More recently, Bouy et al. (2005) claim that it is a triple system with I magnitudes of 17.30, 18.38 and 18.80, and spectral types of L5.5, L8 and T0. These parameters suggest that the primary would have more than half of the K flux and so should not be moved down 0.75 mag in the colour–magnitude diagram. We mark 2M 0205–11 with a downward-pointing arrow in Figs 3 and 4 (later) and regard its membership of the HMG as uncertain.

Fig. 2 shows the location of the HMG in the Galactic radial direction (x-axis) and perpendicular to the plane (y-axis). The Sun is at (0, 0). The cluster is obvious and most of the moving group

Table 1. Summary of the four brown dwarf members of the UMSMG and seven brown dwarf members of the HMG identified in this work. Infrared spectral types and magnitudes are listed, along with distances obtained from parallax measurements (d_p) and the moving cluster method (d_mc), and the difference between predicted and observed proper motion directions ($\Delta\theta$).

2MASS ID	IR spectral type	m_J	m_H	m_K	d_p (pc)	d_mc (pc)	$\Delta\theta$ (°)
UMSMG							
2M J02431371–2453298	T6	15.381 ± 0.050	15.137 ± 0.109	15.216 ± 0.168	10.7 ± 0.4	10.6 ± 0.5	1.64
2M J03454316+2540233	L1 ± 1	13.997 ± 0.027	13.211 ± 0.030	12.672 ± 0.024	27.0 ± 0.4	31.7 ± 1.2	5.62
2M J14460061+0024519	L6	15.894 ± 0.082	14.514 ± 0.035	13.935 ± 0.053	22.0 ± 1.5	19.7 ± 1.5	13.54
2M J15232263+3014562*	L8	16.056 ± 0.099	14.928 ± 0.081	14.348 ± 0.067	18.6 ± 0.4	17.1 ± 1.1	11.70
HMG							
2M J16241436+0029158	T6	15.494 ± 0.054	15.524 ± 0.100	15.518 ± 0.000	11.0 ± 0.1	13.9 ± 0.2	14.95
2M J0036159+182110	L4 ± 1	12.466 ± 0.027	11.588 ± 0.029	11.058 ± 0.021	8.8 ± 0.1	10.8 ± 0.1	1.48
2M J00325937+1410371	L8	16.830 ± 0.169	15.648 ± 0.142	14.946 ± 0.109	33.2 ± 6.9	35.4 ± 1.2	0.98
2M J0205293–115930	L5.5 ± 2	14.587 ± 0.030	13.568 ± 0.037	12.998 ± 0.030	19.8 ± 0.6	20.8 ± 0.2	5.21
2M J01075242+0041563	L5.5	15.824 ± 0.058	14.512 ± 0.039	13.709 ± 0.044	15.6 ± 1.2	15.2 ± 0.3	1.10
2M J1217110–031113	T7.5	15.860 ± 0.061	15.748 ± 0.119	15.887 ± 0.000	11.0 ± 0.3	9.2 ± 0.1	2.86
2M J0825196+211552	L6	15.100 ± 0.034	13.792 ± 0.032	13.028 ± 0.026	10.7 ± 0.1	8.7 ± 0.1	6.38

*Also known as Gl 584C.

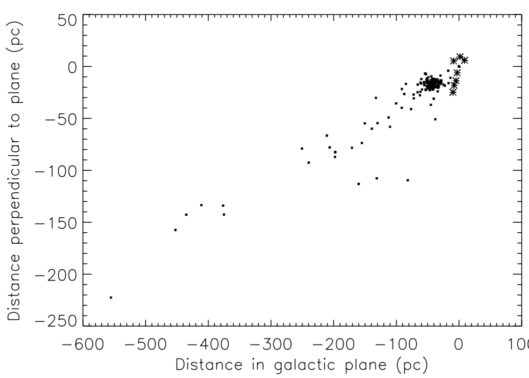

Figure 2. Location of the HMG members (points) and seven group members identified in this work (asterisks). Distances are in parsecs from the Sun, in the radial sense (i.e. the component of distance parallel to the plane of the Galaxy, indicated in the *x*-axis), and perpendicular to the plane (*y*-axis). The newly identified members appear to follow the general distribution of the cluster; this agreement is also observed in the *x*–*y* and *y*–*z* planes.

members form a stream in approximately the Galactic anticentre direction, but with a few in front of the cluster. The seven dwarf members are shown as asterisks. The uncertain binary member, 2M 0205–11, has the most negative distance perpendicular to the plane, and is thus at the extreme end of the group. This might be considered as further evidence of its non-membership. The stream towards the Galactic Centre looks very similar to, but shorter than, that away from the Galactic Centre. The reason for the short length of the forward stream is no doubt because most surveys for Hyads have been conducted in the general direction of the Hyades.

5 NOTES ON INDIVIDUAL STARS

2M 0243–24. Burgasser et al. (2006) listed the effective temperature of this star as $1040 \leqslant T_\mathrm{eff} \leqslant 1100$ K, with $\log g$ in the range 4.8–5.1 and an age of between 0.4 and 1.7 Gyr. This age range just fits to our adopted age for the UMSMG.

2M 1523 + 30. Also known as Gl 584C, this star, which we include as a member of the UMSMG, was considered extensively by Kirkpatrick et al. (2001) who estimated its age to be between 1.0 and 2.5 Gyr. This age is the average of several methods which have a total range of 0.3–2.5 Gyr, and thus encompasses the UMSMG age of 400 Myr.

2M 1624 + 00. Burgasser et al. (2006) listed the effective temperature of this star as $980 \leqslant T_\mathrm{eff} \leqslant 1040$ K, with $\log g$ in the range 5.3–5.4 and an age of between 4.3 and 5.8 Gyr. This age is in clear conflict with the HMG age of 625 Myr. The method used by Burgasser et al. (2006) was to find g and T_eff from spectral indices, and compare these values with the model of Burrows et al. (1997) which yields masses and ages directly. They also used measured luminosities to obtain masses and radii and then the models again to find the ages. This alternative method gives an age of 0.6 to 10 Gyr, just consistent with the Hyades age.

2M 0036+18. Berger et al. (2005) presented a study of the magnetic properties and summarized current research on this object, citing $T_\mathrm{eff} = 1923^{+193}_{-153}$ K (Vrba et al. 2004), $\log g \approx 5.4$ (Schweitzer et al. 2001), and an inferred age of at least 1 Gyr from the work of Burrows et al. (2001).

2M 0205–11. This object is a known binary (Koerner et al. 1999); Bouy et al. (2003) assumed an age ‘greater than 0.5 Gyr’ but in later work, Bouy et al. (2005) presented evidence to suggest that 2M 0205–11 is possibly a triple system and they assumed an age of between 1 and 10 Gyr.

2M 1217–03. Burgasser et al. (2003) suggested the possibility of a faint companion to this object in *Hubble* WFPC-2 data. However, the putative companion is close to the detection limits of the image.

6 DISCUSSION

Fig. 3 plots the $J - K$, M_K colour–magnitude diagram for both the UMSMG and the HMG members. Also shown are the 60 other L and T dwarfs from the archive with known parallaxes (2M 1228–15 A and B are plotted). These show a rather scattered distribution which is to be expected since they presumably have a range of ages. In addition, we have plotted the 500-Myr DUSTY model of Chabrier et al. (2000) and the same age COND models (Baraffe et al. 2003). We draw the following conclusions.

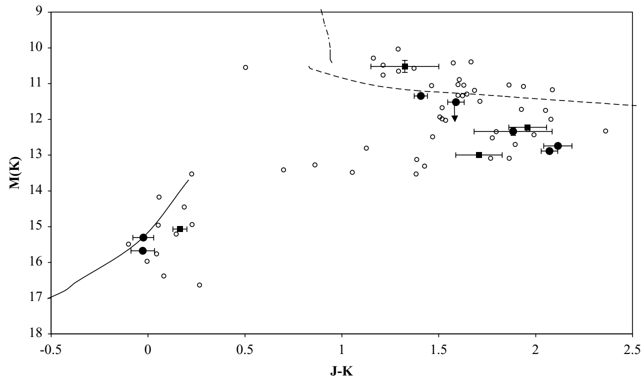

Figure 3. M_K versus $J-K$ diagram for stars in the L and T dwarf list, with parallaxes. 0.5-Gyr isochrones are plotted (explicit 0.4-Gyr data were not available for condensed and dusty models). Solid line: COND model; dashed line: DUSTY model; dot–dashed line: NEXTGEN model. Filled squares indicate the four UMSMG stars, and circles indicate the seven HMG stars, identified as group members in this work. Open circles are field dwarfs not identified with a moving group.

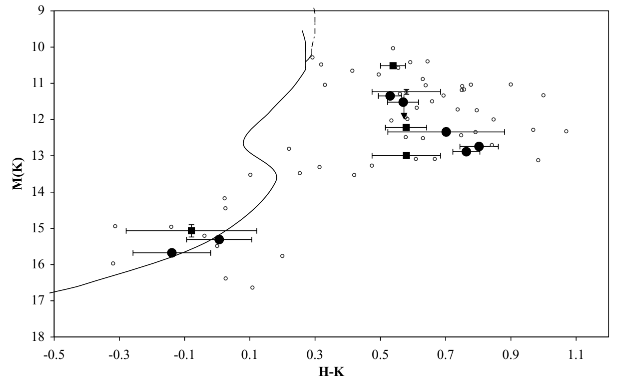

Figure 4. M_K versus $H-K$ diagram for stars in the L and T dwarf list with parallaxes. 0.5-Gyr isochrones are plotted (explicit 0.4-Gyr data were not available for the condensed model). Solid line: COND model; dot–dashed line: NEXTGEN model. The DUSTY model does not give H magnitudes and is therefore not shown. Filled squares indicate the four stars identified in this work as members of the UMSMG; filled circles represent the seven HMG members. Open circles are other field dwarfs.

(i) The five HMG L dwarfs sit on a very tight sequence. This suggests that coeval L dwarfs, unlike field L dwarfs, form a well-defined sequence. We presume that the scattered nature of the field L dwarfs is therefore caused by their variety of ages or gravities, and possibly also metallicities.

(ii) Two of the UMSMG L dwarfs, if joined by a straight line, sit on a sequence that is nearly parallel to and about 0.4 mag above the HMG sequence. This is as expected since the UMSMG is younger than the HMG. Any L dwarf sequence must have a turning point beyond which $J-K$ is decreasing towards the T dwarfs. The HMG sequence reaches $(J-K)_{2MASS} \sim 2.0$, close to the maximum $(J-K)_{MKO} \sim 2.0$ (Leggett et al. 2000), and must therefore be close to or have reached this turning point. The UMSMG L8 dwarf 2M 1523+30 must be on the blueward arm of the L dwarf sequence. The HMG L6 dwarf 2M 0825+21 might also just be on the blueward arm of the sequence.

(iii) None of the L dwarfs except the uncertain 2M 0205–11 and discarded 2M 1228−15 appears to be a low-mass-ratio binary, otherwise they would sit high on the sequence. The only possible exception might be 2M 1523+30 which is alone on the blueward sequence; however, given its locus on the lower envelope of the field stars we think it is unlikely to be a binary. A possible reason for the lack of near-equal-mass binaries is that these are of course more massive entities and therefore less likely to have been ejected from their parent clusters.

(iv) The three T dwarfs appear to form a short sequence that corresponds to an approximate 500-Myr isochrone. At its red end this lies below the COND model (Baraffe et al. 2003).

We have found 11 out of 70 field dwarfs to be members of the UMSMG and HMG. This is a high percentage, nearly 16 per cent. This of course implies that if we had proper motions and parallaxes for all 459 dwarfs in the Dwarf Archive, we would have found $459 \times 11/70 = 72$ members (26 UMSMG and 46 HMG). For the Hyades this would certainly increase the mass function (see Gizis et al. 1999), but not ridiculously so given that the Hyades cluster is known to be deficient in low-mass stars and brown dwarfs.

That a significant percentage of field dwarfs belong to local moving groups may be due to very old (age > 1 Gyr) dwarfs being very cool, faint and therefore difficult to detect and thus under-represented in the dwarf archive.

(v) It can be seen that the DUSTY 500-Myr isochrone is not a good fit to either the UMSMG (age 400 Myr) or the HMG (age 625 Myr). This is perhaps not surprising given the theoretical difficulties of modelling dusty atmospheres. Burrows, Sudarsky & Hubeny (2006) do not give theoretical isochrones. The COND model for T dwarfs fits the HMG at $J-K \simeq 0$ very well, but is not so good for the somewhat redder UMSMG T dwarf.

(vi) Fig. 4 shows the $H-K$, M_K colour–magnitude diagram. Again both moving groups have a well-defined sequence in the L regime, but the UMSMG is almost vertical, whereas the HMG covers 0.3 in $H-K$ colour. Of course, 0.3 is not a great range in colour and it is already well known (e.g. Leggett et al. 2000) that the field L dwarfs have a small range in $H-K$ colour. Given that both moving groups have a similar age and therefore similar gravities, the most likely explanation for the difference is metallicity. The Hyades has Fe/H = +0.13 relative to the Sun, while the UMSMG has –0.08 (King & Schuler 2005). Burrows et al. (2006) have theoretical models of L and T dwarfs and do indeed predict that L dwarfs will be redder in $J-K$ with increased metallicity. Unfortunately they do not consider the $H-K$ dependence on metallicity.

7 COEVALITY

So far we have implied that the membership of a moving group guarantees objects have the same age. This is not necessarily true. Moving groups may arise from a dispersing cluster or from a star formation event in a particular region of a molecular cloud; in either case, the members of the group will be coeval. Alternatively, a moving group may be the consequence of a dynamical process where, for example, the Galactic bar drives some resonance to produce a group of stars with a common velocity. In this case the stars will not be coeval (see, for example, Dehnen 1998). The Pleiades moving group, sometimes called the local group, and other groups have stars of differing ages (Chereul et al. 1998, 1999). Also, the core stars of the UMSMG clearly fit a good sequence in the Hertzsprung–Russell diagram and are coeval (King et al. 2003), but Sirius, which on dynamical grounds is a good member, probably does not have the correct age (Liebert et al. 2005).

Resonance-driven stars tend to favour particular *V* (Galactic azimuthal direction) velocities. These favoured velocities coincide with both the UMSMG and HMG *V* velocities [see, for example, Dehnen (1998) or Skuljan, Hearnshaw & Cottrell (1999)]. Thus there is a greater than random chance that stars will have proper motions pointing to the convergent point of these groups. This effect is rather difficult to quantify over the whole sky, so we have added an estimated factor of 4 in Section 2 for calculating the chance of a proper motion being directed towards the UMSMG or HMG convergent point. However, if an object has the UMSMG or HMG velocity by virtue of a dynamical resonance rather than from being a genuine member of the group, its moving group distance (see Section 2) will not be the same as its parallax distance and it will fail our second test. Perhaps fortuitously, all our objects pass the second test.

Of course our third test, that the dwarfs fit a 'sensible' sequence, should select coeval objects. However, we do not know exactly where this sequence is and the sceptic might argue that we have simply got the wrong sequence. Indeed, with 2M 1228–15 the first two tests produced an object that did not fit the UMSMG sequence (see above). On the positive side the five HMG L dwarfs do seem to form a very good sequence, and the two HMG T dwarfs have very similar absolute *K* magnitudes. The results for the UMSMG are not so compelling, but two L dwarfs lie on a line parallel and above the Hyades sequence as expected for a younger group.

The results described in this paper should perhaps be treated with some caution. Nevertheless, the kinematic data exist and should be used. As more proper motion and parallax data become available, these and other sequences may become better established.

Summarizing, we can say that some moving group members are undoubtedly coeval, but membership of a moving group based on the criteria described in this paper does not guarantee coevality.

8 CONCLUSIONS

We find one T dwarf and three L dwarfs that belong to the UMSMG, whose age is 400 Myr. We find a further two T dwarfs and five L dwarfs, one rather dubious, that are members of the HMG. These stars provide preliminary empirical isochrones for these ages.

We plan to extend this technique to other moving groups. Only 70 of the 459 archived dwarfs have the proper motions and parallaxes needed to identify them with moving groups. We believe that many more L and T dwarfs could be identified with moving groups if more proper motions and parallaxes were available. This would allow them to be assigned an age, although it should be remembered that moving group ages can never be totally secure.

ACKNOWLEDGMENTS

This research has benefited from the M, L and T dwarf compendium housed at DwarfArchives.org and maintained by Chris Gelino, Davy Kirkpatrick and Adam Burgasser. The research makes use of data products from the Two Micron All Sky Survey, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation. We are grateful to the referee, M. Bessel, for his helpful comments which improved this paper.

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