PROPER MOTION L BROWN DWARFS IN THE PLEIADES CLUSTER

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ABSTRACT:

We performed an optical and near-IR search for substellar objects in the Pleiades open cluster using images in the RI- and J-bands obtained with the CFHT and the 3.5 m CAHA Telescopes, respectively. We identified L-type low-mass brown dwarfs candidates and we confirmed several as Pleiades proper motion members using follow-up WHT and 3.5m CAHA near-IR images.

OBSERVATIONS AND DATA ANALYSIS

Optical R- and I-bands survey images from the Pleiades open cluster were obtained with the CFHT/UH8K (Hawaii Obs.) during December 1996 (Bouvier et al. 1998). The total area covered amounts to 2.5 square degrees. The data reduction, the photometry and a study of the low-mass and substellar population are described in Béjar (PhD Thesis 2000), with similar results as in Bouvier et al. (1998). The survey is complete down to Rc=23.5, Ic=22.5, with limiting magnitudes of R~25.0 and I~23.5.

Near-infrared J-band images of several 29' X 29' CFHT fields were obtained with the 3.6m Telescope/OMEGA-Prime (Calar Alto Obs.) during October 1998. The area covered amounts to 1.8 square degrees. The images were sky-substracted, flat-divided, aligned and analyzed for aperture and psf photometry with scripts and routines in the IRAF environment. The calibration was made using values from 2MASS with errors less than 0.1 mag. Completness and limiting magnitudes were Jc~19.0 and J~19.5, respectively.

Because lower-mass brown dwarfs in the Pleiades open cluster should be fainter and redder, we used as reference the detected J-band sources and searched for their optical counterparts. We studied 7.5 CFHT fields and found several candidates with I>21 and I-J>3.3. Follow-up Ks imaging with the 1.5m TCS/CAIN (Teide Obs.) during December 2004 allowed us to confirm that 6 out of 7 candidates belong to the expected near-infrared photometric sequence of the cluster. We obtained higher-resolution H- and K-band images for the 6 previous candidates, for another candidate and for Teide 1 (Rebolo et al. 1995), with WHT/LIRIS (La Palma Obs.) and the 3.6m Telescope/Omega2000 (Calar Alto Obs.) during January-March 2005. Comparing the pixel positions of the objects in the first epoch I-band images with those in the HK-bands images, we determined their proper motions and found only one or two contaminants. We could confirm as proper motion members two IZ-bands photometric candidates from Moraux et al. (2003) as well as Teide 1, which was observed with both telescopes.

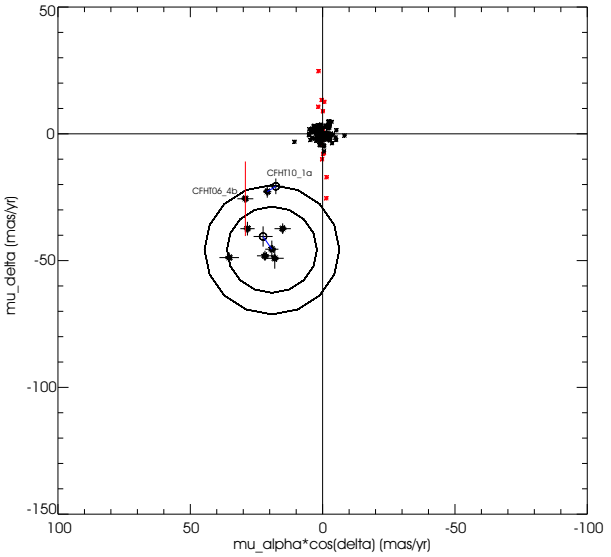

Figure 1:

Vector point diagram of our L low-mass brown dwarf candidates (dots) and the reference objects (stars) used for the astrometric measurements. The circles are centered on the cluster peculiar motion, mu_alpha*cos(delta) = 19.15 +- 0.23 mas/yr, mu_delta= -45.72+-0.18 mas/yr (Robinchon et al. 1999), and have radii of 2 and 3 times the standard deviation (8.5 mas/yr) of the proper motion sample from Moraux et al. (2001). Doble-check observations for the brown dwarf Teide 1 and also CFHT10_1a are represented by the very small circles. CFHT06_4b has a large DEC error bar due to the large dispersion of the reference objects (due to a vertical smearing in the I-band image). This object and CFHT10_1a are possibly contaminants because of their high deviation to the cluster peculiar motion.

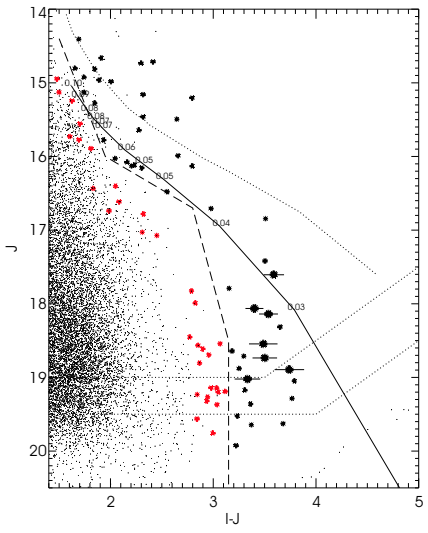

Figure 2:
J,I-J diagram for the candidates found in the 7.5 CFHT fields. These candidates have colors R-I>1.9 and 1.5<I-J<4, and some of them have Li or proper motion confirmation (Martin et al. 2000; Moraux et al. 2001). We defined as most probable candidates (black dots) those to right side of the (dashed line) frontier, and as less probable those to the left. The frontier was fixed at 2 x sigma_(I,J) to the left from the sequence of the Li and proper motion candidates of the Pleiades cluster with the bluest I-J colors. The Dusty isochrone (solid line) from Chabrier et al. (2000) for the Pleaides with an age 120 Myr and a distance of 133.8 pc (Percival, Salaris & Groenewegen 2005) provides a good fit for J <~18, while the Nextgen isochrone (dotted line) from Baraffe et al. (1998) provides a good fit for J less than 16-16.5. Masses for the first isochrone are given in units of solar mass. Our faintest L brown dwarf candidates appear bluer than the Dusty model, which takes into account the dust in the brown dwarf atmospheres.

Brown dwarf candidates with proper motion measurements represented in Fig. 1. The objects with the name appended by * and ** correspond to PLIZ 28 and PLIZ 35 from Moraux et al. (2003).

Name	R-I	I+-s_I	J+-s_J	I-J	H+-s_H	Ks+-s_Ks	J-Ks
CFHT10_1a	1.867	20.923+-0.071	17.419+-0.055	3.504	16.736+-0.025	16.202+-0.063	1.217
CFHT13_3b*	2.368	21.196+-0.073	17.606+-0.067	3.590	16.741+-0.056	16.075+-0.066	1.531
CFHT08_1b**	2.554	21.465+-0.055	18.064+-0.068	3.401	17.325+-0.045	16.560+-0.070	1.504
CFHT10_3b	2.344	21.677+-0.077	18.139+-0.050	3.538	17.049+-0.072	16.386+-0.073	1.753
CFHT06_4b	2.129	22.032+-0.101	18.545+-0.095	3.487	17.470+-0.055	16.650+-0.056	1.895
CFHT08_3b	2.636	22.355+-0.081	19.022+-0.095	3.333	17.890+-0.051	17.004+-0.082	2.018
CFHT11_2b	2.298	22.635+-0.113	18.894+-0.089	3.741	-	17.156+-0.087	1.738

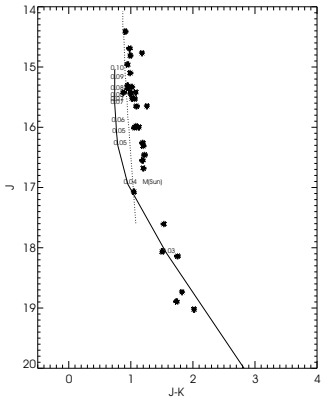

Figure 3:
J,J-K diagram for all the confirmed Pleiades low-mass stars and brown dwarfs with Li or consistent proper motion. We show only our most probable proper motion candidates. The Dusty and Nextgen isochrones (the same models as in Fig. 1.) give relatively good color predictions for J>17 and J<17, respectively.

Conclusion

Comparing deep optical and near-IR images of the Pleiades open cluster obtained with the CFHT and the 3.5 m Calar Telescope, respectively, and covering an area of ~1.8 square degrees, we identified new L-type low-mass brown dwarfs candidates. With follow-up near-infrared HKs-bands photometry using WHT and the 3.5m Calar Telescope, we confirmed 5 candidates and also reconfirmed Teide 1 as Pleiades proper motion members. Some have masses as low as 25 M_Jupiter. 2 other objects observed for proper motion are possibly contaminants. Further observations in the near-infrared are needed to investigate the spectra of these objects and the proper motion of all the other L brown dwarf candidates.

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