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# BROWN DWARFS IN THE HYADES CLUSTER

Bouvier, J. et al.[1]

**Abstract.** We present the results of a search for brown dwarfs (BDs) and very low-mass (VLM) stars in the 625 Myr-old, metal-rich ([Fe/H]=0.14) Hyades cluster. We performed a deep (I∼23, z∼22.5) photometric survey over 16 deg$^2$ around the cluster center. We report the discovery of the first 2 BDs in the Hyades cluster, with a spectral type T1 and T2, respectively. Their optical and near-IR photometry, as well as their proper motion, are consistent with them being cluster members. According to models, their mass is about 50 Jupiter masses at an age of 625 Myr. We also report the discovery of 3 new very low-mass stellar members and confirm the membership of 15 others.

## 1 The CFHT survey of the Hyades cluster

The Hyades is one of the richest open clusters and the closest to the Sun. Perryman et al. (2008) derived its main structural and kinematical properties based on Hipparcos measurements : a distance of 46.3±0.27 pc, an age of 625±50 Myr, and a metallicity [Fe/H] of 0.14±0.05. The large proper motion of the cluster ($\mu \simeq$100 mas yr$^{-1}$) can be easily measured from imaging surveys over a timeframe of only a few years, which helps in assessing cluster's membership.

Wide-field optical images were obtained in the I and z bands with the CFHT 12K camera, a mosaic of 12 CCD arrays with a pixel size of 0.21" which provides a FOV of 42′×28′. The survey consists of 53 mosaic fields covering a total of 16 square degrees. The survey is at least 90% complete down to I∼23.0 and z∼22.5, a limit which varies only slightly with seeing conditions (0.6-0.8 arcsec).

## 2 Hyades brown dwarfs

PSF photometry was performed on the I and z-band images with a modified version of SExtractor (Bertin & Arnouts 1996). The (I, I-z) color magnitude diagram (CMD) is shown in Figure 1. A total of 125 Hyades candidate members were selected in this CMD from their location relative to model isochrones. Follow up K-band imaging was obtained for 108 candidate members using the 1k×1k CFHT WIRCAM camera. The (I, I-K) CMD for these candidate members is shown in Figure 1. In addition, proper motion was computed from pairs of optical and infrared images obtained 2 or 3 years apart. The proper motion vector diagram of 107 optically selected Hyades candidate members is shown in Figure 1.

Based on photometry and astrometry, we eventually identified 20 candidates which consistently qualify as probable Hyades members. Of these, 15 were already listed as possible or probable Hyades members in the Prosser & Stauffer's Open Cluster Database. The remaining 5 probable members we report here are new. They include 3 very low-mass stars (∼0.14 M$_\odot$) and 2 objects well within the substellar regime.

Our survey thus identifies the first 2 Hyades BD candidates (CFHT-Hy-20, 21), with an estimated mass of about 50 Jupiter masses, and a very low-mass star (CFHT-Hy-19) close to the stellar/substellar limit (75 jupiter masses). We obtained low resolution infrared spectra for these 3 objects using TNG/NICS (Fig. 1). Fitting the observed spectra with those of template field dwarfs observed with the same instrument, we derive a spectral type of M8, T2 and T1 for CFHT-Hy-19, 20 and 21, respectively.

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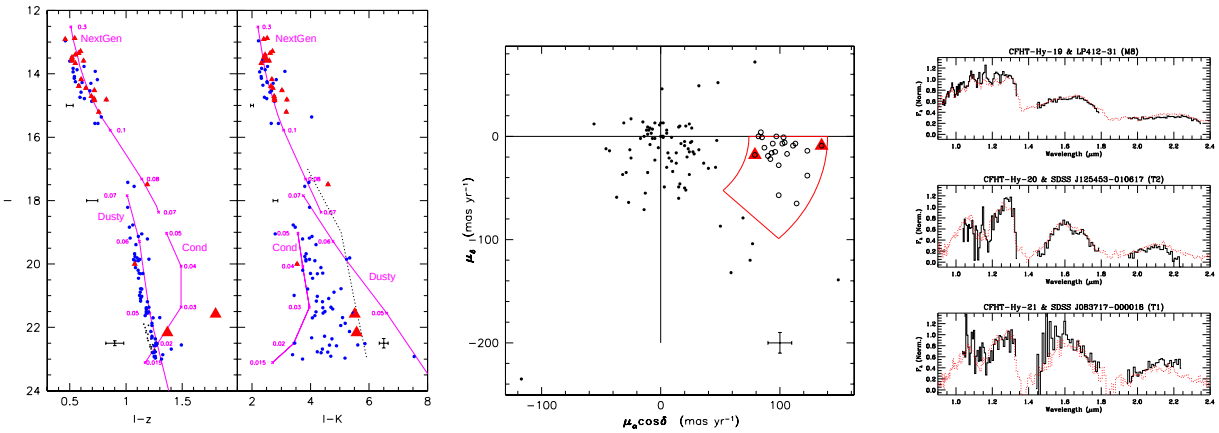


**Fig. 1. Left**: (I, I-z) and (I, I-K) CMDs of optically selected candidated followed up with CFHT IR in the K-band. Small dots : 17 optically selected candidates without follow up IR photometry. Large dots : optically selected candidates whose proper motion is inconsistent with Hyades membership (cf. central panel). Triangles : candidates whose proper motion is consistent with Hyades membership. The stellar/substellar boundary occurs at I≃17.8 mag. The 2 most promising substellar cluster candidates are shown by large triangles. NextGen (0.07-0.3 $M_\odot$), Dusty (0.04-0.07 $M_\odot$) and Cond (0.015-0.05 $M_\odot$) 600 Myr isochrones are shown and labelled with mass (Baraffe et al. 1998; Chabrier et al. 2000). In the (I, I-K) CMD, the dotted line indicates the locus of M8-T5 field dwarfs. The rms photometric error is shown as bars. **Center**: Proper motion vector diagram for 107 optically selected candidates followed up in the K-band (see text). The expected proper motion for Hyades members is shown by the (red) box. Within these boundaries, 23 optically selected candidates (empty circles) are found to share the proper motion of the cluster, including 2 BDs (large triangles). Typical rms errors on the ppm measurements are shown by a cross. **Right**: Near-infrared Amici low resolution spectra of CFHT-Hy-19, 20 and 21 (solid lines from top to bottom). In each panel we also show the closest matching field dwarf spectrum (dotted line) from the low resolution Amici spectral library (Testi et al. 2001).

## 3 Conclusion

Our survey is complete in the mass range from less than 50 Jupiter masses up to 0.20 $M_\odot$. In this mass range, we identified 18 very low-mass stars, down to the stellar-substellar limit, as well as 2 brown dwarfs with a spectral type T1 and T2. These are the first T-dwarfs identified in the Hyades cluster at an age of 625 Myr[1], and also the only known instances of metal-rich ([Fe/H]=0.14) methane dwarfs. Additional spectroscopy of these lowest mass Hyades members is scheduled on Gemini in the fall of 2008. A full account of these results is given in Bouvier et al. (2008).

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[1]Since then, Hogan et al. (2008) reported the discovery of 12 L-dwarfs in the cluster.