Characterization of high proper motion sources from NIR surveys.

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After the appearance of 2MASS and DENIS, several near infrared (NIR) large area surveys have scanned the sky going deeper and/or with a better spatial resolution. Hundreds of new low mass objects and high proper motion stars and brown dwarfs have been discovered thanks to these surveys, and further characterization is required.

We have used multi-epoch data to obtain precise proper motion measurements and parallaxes for nearby sources found near the galactic bulge and inner disk. In addition we are obtaining spectral classes for selected sources (brown dwarfs and/or stars with MIR excess) and applying spectral energy distribution fitting, using multi-wavelength photometry for newly identified high proper motion sources from VVV and WISE surveys. Here we show first results and perspectives of this project.

The VVV survey, a unique tool

The Vista Variables in the Vía Láctea (VVV) survey is an ESO public survey being carried at the 4.2m VISTA telescope at Paranal (Minniti et al. 2010, Saito et al. 2011), Chile. VVV survey observes over 560°^{2} towards the Galactic bulge and inner southern disk (Figure 1) at 5 near infrared bands Z,Y,J,H,Ks (Figure 2) with a spatial resolution of 0.34''/pix. The VVV variability campaign consist of 100 observations in the Ks band spanned over 7 years, individual observations reach as deep as Ks ~ 17-18 mag. (depending on crowding).

Taking advantage of deep high resolution images in the NIR that VVV survey offer, we are currently doing a color blind search of High Proper Motion (HPM) objects in all the VVV area. (Gromadzki et al. 2013, Beamin et al. 2014a, Kurtev et al. in prep.)

The multi-epoch nature of the VVV survey allows us to calculate parallaxes of the candidates,

This search had lead to the discovery of a nearby brown dwarf at 17.5 pc (Beamin et al. 2013) and hundreds of new bright high proper motion sources and companions to previously known high proper motion stars (Ivanov et al. 2013, Kurtev et al. in prep.). The parallax of this first unusually blue brown dwarf is shown in Fig 1.

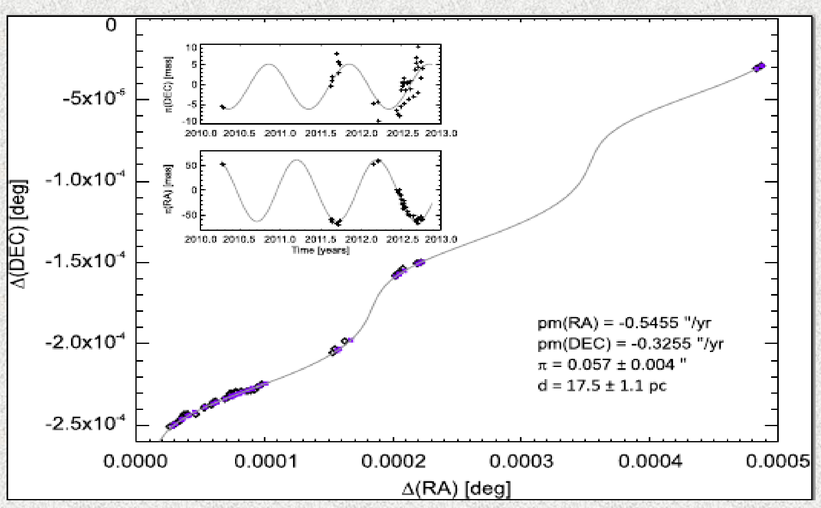

Fig. 1 Parallax and proper motion of VVV BD001 we estimated a distance of 17.5 pc
and a total proper motion of 635 mas/yr

Follow up of High proper motion sources from WISE all sky survey

WISE mid IR mission had revolutionized the study of the coldest stars and brown dwarfs This all sky survey mission has delivered hundreds of new ultra cool dwarfs (Kirkpatrick et al. 2011), and also had unveiled the coldest brown dwarfs which had been classified in a new spectral class of brown dwarf, the Y class (Cushing 2011).

The coldest brown dwarf known

After the successful searches based on color cuts, early this year, Luhman 2014 published the discovery of the coldest brown dwarf known to date based on the high proper motion and the extreme red W1-W2 color. Located only 2.2 pc away from the Sun is the fourth closest system.

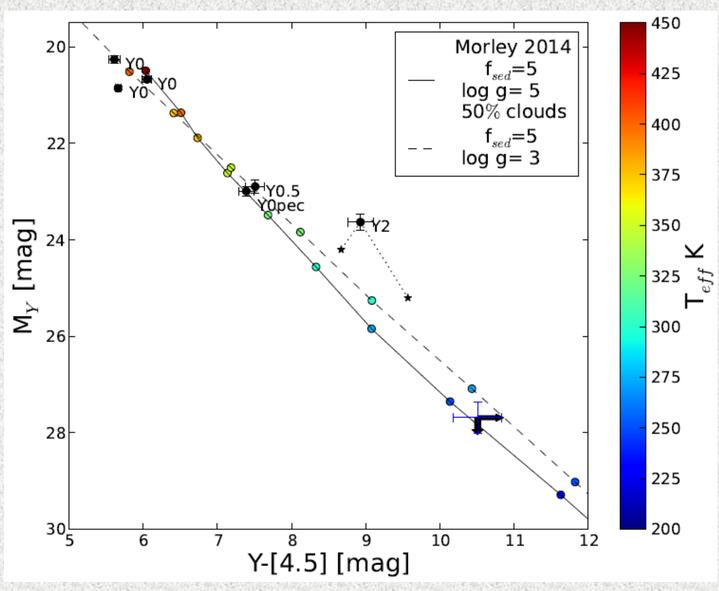

Fig. 2 Color magnitude diagram for Y dwarfs.
WISE 0855-0714 is shown in the lower right part of the figure between the two models the arrows size correspond to the 3-σ uncertainties

With no detection of this object in the near IR, we attempted to detect it using the Y band filter in the HAWK-I instrument at VLT.

We were able to set an upper limit of Y>24.4 mag. Making this object the reddest/coldest brown dwarf. (Beamin et al 2014b)

Comparing all the photometry available and upper limits against state of the art models of brown dwarfs, the maximum temperature allowed correspond to 250 K. A color magnitude diagram with all the Y dwarfs with Y band filter detection against color Y-[4.5] (the 4.5 micron channel in Spitzer) is shown in Fig. 2. The color-bar show the temperature, and the solid and dashed lines curves show two atmosphere models including partial cloud coverage and different surface gravities.

We can see as well in this diagram how these 2 colors provide a nice one-one relation for color and temperature, making it ideal for future studies of Y dwarfs (Leggett et al. 2013)

Spectroscopy of new HPM sources

Several catalogues of high proper motion sources have been published in the recent years. Two of them in particular were pubilshed this year based on WISE multi-epoch data (Luhman and Shepard 2014, and Kirkpatrick et al. 2014). We created a reduced proper motion diagram based on these objects (See Fig. 3) in order to identify interesting objects, such as nearby stars and extremely cool brown dwarfs or probable L/T transition objects.

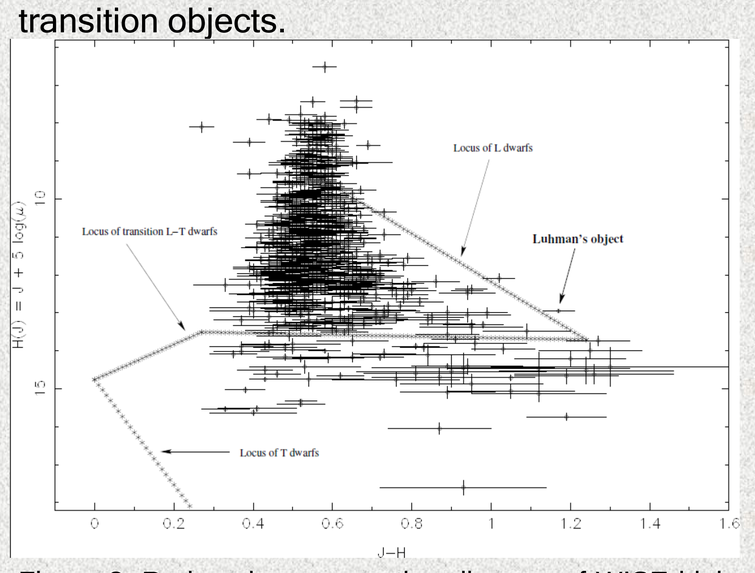

Figure 3. Reduced proper motion diagram of WISE high proper motion sources in Luhman & Shepard 2014.

We search for previous detections at different wavelengths and analyzed their spectral energy distribution using VOSA tool* (Bayo et al. 2008). In Fig. 4 there is an example of the fit for 2 sources.

After this process we obtain a more robust target list for spectroscopic follow up. We have obtained optical spectra for a sample of ~25 common proper motion objects and some near IR spectra for isolated brown dwarf candidates. We are currently analyzing these objects, and applying for more time to observe some of the faintest and lowest temperature candidates we found in these catalogues

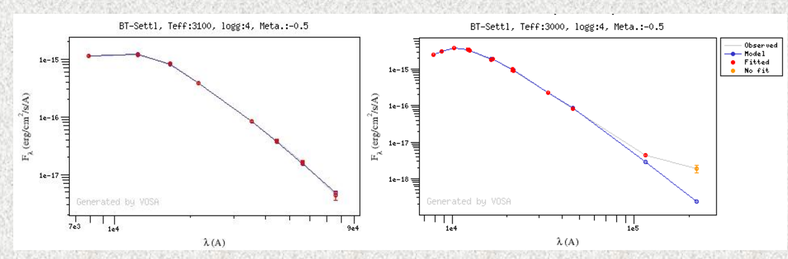

Figure 4. Spectral energy distribution and best fitting model for 2 objects in the Luhman and Sheppard 2014 catalogue

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* VOSA is available at http://svo2.cab.inta-csic.es/theory/vosa4/index.php

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