BROWN DWARF PROJECTS AT THE SPANISH VO

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ABSTRACT

This paper elaborates on a talk presented at the workshop "Astronomical Spectroscopy and the Virtual Observatory" sponsored by the EuroVO Data Centre Alliance[1]. We present several projects that are being carried out in the framework of the Spanish Virtual Observatory Thematic Network, an initiative that aims to coordinate the VO activities of the Spanish astronomical community. First, we are working towards making the IAC catalogue of ultracool dwarfs compliant with VO standards. Second, we are developing projects of searching for brown dwarfs by cross correlations of large databases (DENIS, IPHAS, SDSS, 2MASS). We explain the motivation and work method, and show initial results from these programs.

Key words: Virtual Observatory.

1. INTRODUCTION

Brown dwarfs (BD), substellar mass objects that do not stabilise on the Hydrogen-burning main sequence, cool and fade continuously with time as they shrink to increasingly degenerate configurations. They start as relatively warm objects, spectral class M, and evolve to cooler temperatures, characterised spectroscopically as spectral classes L and T. All dwarfs with spectral type later than M6 are generally known as ultracool dwarfs, and they may be very low-mass stars or brown dwarfs. It is agreed that objects later than mid-L class are most likely brown dwarfs. For a general overview of brown and ultracool dwarfs we refer to the proceedings book of IAU Symposium 211: Brown Dwarfs.

At the IAC we have compiled a catalogue of dwarfs with spectral types M, L and T (IAC-UDC for brevity). It was presented in Martín, Cabrera & Cenizo (2005) and it is available at http://www.iac.es/galeria/ege/catalogo-espectral/ The first section of this paper deals with our efforts to make this catalogue compliant with Virtual Observatory (VO) standards.

2. MAKING THE IAC ULTRACOOL DWARF CATALOGUE COMPLIANT WITH VO STANDARDS

The IAC-UDC contains photometric data and spectra (1D) for more than 850 objects. The information is archived in an XML file and displayed all at once in a single table. The objects are ordered by right ascension but the user has no other way to sort them or interact with the catalogue in any way. The XML file is not the best solution that can be considered for such a number of registers. Moreover, one is already handling rather big files and including new registers is uncomfortable.

In order to make the IAC-UDC available to a wider community and to implement searching tools we have started working towards making it compliant with VO standards. The general idea is to store the data in tables and develop tools that enable the user to access the data interactively. The user should be able to search the catalogue according to key parameters, such as, for example, object coordinates, magnitude, spectral class, or wavelength range of the available spectra.

The first step is to convert the current database of the IAC-UDC to MySQL. This application will handle the data storage, the interaction between the remote user and the database will be through a web interface written in PHP. It is critical to make a good design of the MySQL database. Our concept is to have 4 separate data tables; namely, one with object names and coordinates, another one with data such as photometric magnitudes, radial velocities and spectra, a third one with the spectra and finally a table with the references to the sources of the data.

[1]http://cds.u-strasbg.fr/twikiDCA/bin/view/EuroVODCA/WebHome/

The second step will be to write the search tools. We expect these programs to perform searches following the "Simple Cone Search" protocol and to return a compliant VOTable (as described in the "VOTable Format Definition"). At the time of writing this paper we are still working on the first step.

3. SEARCHING FOR BROWN DWARFS BY USING VO TOOLS

VO tools allow us to search efficiently for peculiar objects by performing cross-correlation of large databases. Wide surveys at optical and infrared wavelengths have been particularly effective in uncovering hundreds of ultracool dwarfs. Recent examples include nearby late-M and L dwarfs selected from DENIS (Crifo et al. 2005; Kendall et al. 2004), and field L and T dwarfs found using SDSS (Chiu et al. 2006).

Now that these surveys are available to the general public it becomes possible to make searches that combine two or more surveys. We have started searching for candidate high proper-motion dwarfs by cross-correlating DENIS and 2MASS point source catalogues. Many candidates were selected, but follow-up observations of the most promising ones have not confirmed them. It is likely that artifacts are contaminating the search. We have also started a search by cross-correlation of SDSS and 2MASS. Several promising candidates await follow-up observations.

We have joined the IPHAS collaboration (Drew et al. 2005) with the main goal of searching for very young brown dwarfs. Using VO tools we have cross-correlated the IPHAS point source catalogue with 2MASS. We have selected candidate Hα emission objects with red near-infrared colours. In our search we have applied the following criteria: (a) r-Ha$\geq$1.1 to select Hα emission candidates, (b) I-J colour $\geq$2.8 to select red objects, (c) J-H colour $\leq$1.6 to reject heavily reddened objects, (d) H-K colour $\geq$0.4 to select objects with cool photosphere and/or near-infrared excess, (e) low-reddening in the line of sight estimated from visual inspection of IRAS images. We have selected 400 BD candidates and with I-band magnitudes $\leq$18.0. Young BDs with distances closer than about 250 pc are expected to meet these criteria. An example of selected sources in the right ascension range 0 to 75 degrees (Galactic anticenter) is shown in Figure 1.

Follow-up spectroscopic observations at the 4.2-m William Herschel Telescope in La Palma (as part of the International Time Program), and the 2.5-m Nordic Optical Telescope have been carried out in August and October 2006. We have identified dozens of M-type Hα emitters, some of them cool enough to be considered brown dwarf candidates. We show one example in Figure 2. We estimate as spectral type of M4.5. Strong Hα emission is seen, and we measure an equivalent width of 130 Å. According to the criteria defined by Barrado y Navascués & Martín (2003), this object is likely a very low-mass star with an accretion disk.

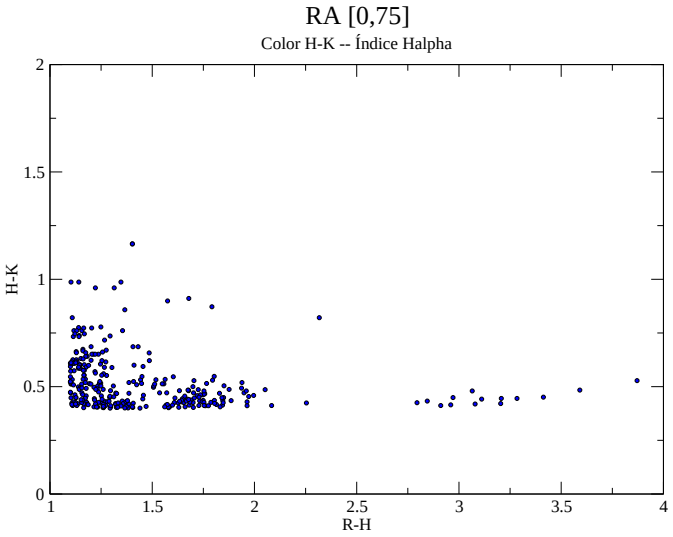

Figure 1. Sources selected by cross-correlation of IPHAS with 2MASS in the right ascension range from 0 to 75 degrees. R-H is the colour obtained by comparing broad-band R-band photometry with narrow-band Hα photometry.

So far all the surveys for very young brown dwarfs concentrate on the known star-formation regions, such as, for example, the Taurus-Auriga star-forming region which is the prototypical low-density diffuse cloud. The correlation of IPHAS and 2MASS with VO tools allows us for the first time to select young BD candidates over a large area, far from known star-forming regions. The presence of such very young and very low-mass objects far from known star-forming regions may be of high interest for understanding the formation of very low-mass stars and brown dwarfs.

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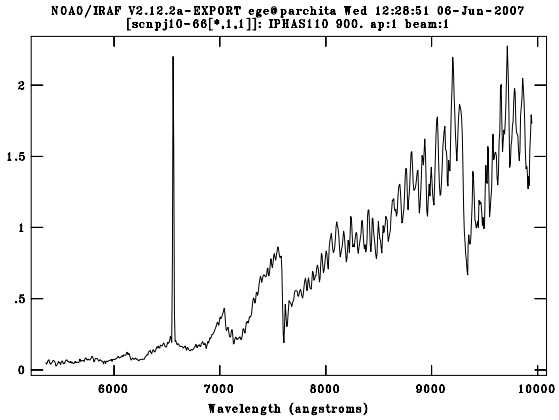

Figure 2. Spectrum of an IPHAS-SVO brown dwarf candidate obtained with NOT/ALFOSC in October 2006.

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