AN IPHAS-BASED SEARCH FOR ACCRETING VERY LOW-MASS OBJECTS USING VO TOOLS

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ABSTRACT

We prove that accreting very low-mass (VLM) stars and brown dwarfs (BDs) can be identified in IPHAS, an Hα emission survey of the northern Milky Way. Full exploitation of the IPHAS database and a future extension of it in the southern hemisphere will be useful in identifying VLM accreting objects near to and far from well-known star-forming regions. We have used Virtual Observatory (VO) tools to cross-match the IPHAS catalogue with the 2MASS catalogue. We defined photometric criteria to identify Hα emission sources with near-infrared colours similar to those of known young VLM stars and BDs. 4000 candidates were identified that met our criteria over an area of 1600 square degrees.

Key words: Virtual Observatory, very low mass stars.

1. INTRODUCTION

Since the first unambiguous discovery of BDs (Rebolo et al., 1995; Nakajima et al., 1995) this field has progressed rapidly. Considerable observational effort has been devoted to identifying BDs in known nearby star-forming regions (SFRs) and young open clusters. Due to mass accretion processes, many young low-mass stars and BDs show stronger Hα emission than expected from chromospheric activity. Studying the Hα equivalent width and the spectral type using low-resolution spectra can determine whether or not a star is accreting (Barrado y Navascués & Martín, 2003). The INT Photometric Hα survey of the Northern Galactic Plane (IPHAS) is a valuable source for discovering young VLM stars and BDs using Hα emission. So far, the overwhelming majority of the surveys for young VLM objects are concentrated in the known SFRs and nearby young clusters. The IPHAS survey offers a complementary approach because it allows us to use Hα as a primary selection criterion and provides a wide area coverage around or outside the well-known SFRs and clusters.

2. SAMPLE SELECTION

The VO offers the possibility of efficiently cross correlating large multi-wavelength databases. We have used Aladin to look for new VLM objects via cross-correlation of the IPHAS catalogue with 2MASS. The photometric data available in these catalogues provides magnitudes in Hα , r', i', J, H and K for the selected objects. Our candidates met the following criteria: a) IPHAS-2MASS coincidence in coordinates within $1''$; b) The IPHAS sources should be classified as stellar or probably stellar in the r', i' and Hα bands and have colours in the range $1.1 <$ r'-Hα < 3.0; and magnitudes i' < 18.5; c) The 2MASS sources should have colours in the range $0.7 <$ J-H < 1.3; and $0.4 <$ H-K < 1.1.

3. OBSERVATIONS AND SPECTRAL ANALYSIS

We have carried out three campaigns of follow-up low-resolution spectroscopic observation of our targets. Altogether, spectra for 113 candidates have been obtained, which represent only 3% of our total sample. We found that 42 of our 113 targets have strong Hα emission. For the sample selection we used a preliminary version of the IPHAS catalogue available to us in July 2006. Due to the improvement of the Hα zero point calibration on the IPHAS catalogue, only 48 of them fit the selection criteria according to the new photometry. Thus, we have 48 observed candidates that really fit the criteria, and 40 of these show Hα emission which is an 83% success rate.

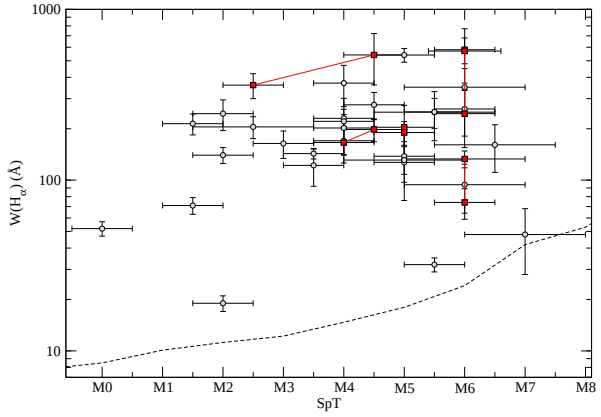

Figure 1. Hα equivalent width vs adopted spectral type. The dashed line separates chromospheric activity and disc accretion. Our objects are above the dashed line and are hence probably undergoing mass accretion.

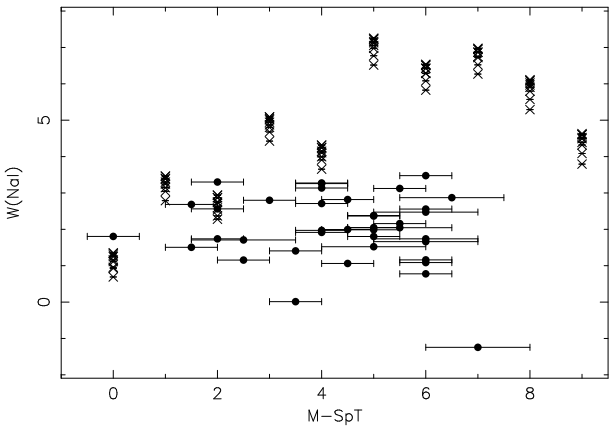

Figure 2. Dependence of W(Na I) on residual fringing and spectral type. Filled circles: IPHAS objects; crosses: measurements with different fringing residuals for the M objects used as reference to classify the IPHAS objects.

4. RESULTS

Spectral types have been derived for the 33 candidates that have spectroscopically confirmed Hα emission, negligible reddening and spectral class M. We have also measured Hα emission and investigated the NaI doublet (818.3 nm, 819.5 nm) in these 33 objects.

In order to discern whether the observed Hα emission is probably due to chromospheric activity or to disc accretion, we plot our Hα equivalent widths versus the adopted spectral type and compare these with the empirical upper limit boundary of chromospheric activity derived by Barrado y Navascués & Martín (2003) (Fig. 1). Twenty-three objects have spectral class M4 or later, of which ten have classes in the range M5.5-M7.0 and could thus be very young brown dwarfs.

The NaI subordinate doublet at 818.3 nm and 819.5 nm is a good gravity indicator for late-M spectral types (Kirkpatrick et al., 1991). This doublet decreases with surface gravity. We found that many objects have a weak NaI doublet, an indication of low surface gravity (Fig. 2). We conclude that in all of our objects classified as M3-4 the NaI doublet is weaker in our Hα emission objects than in field dwarfs of similar spectral class and much weaker for objects later than M4. This is consistent with our previous conclusion that most of our objects are very young and actively accreting. The half-life for disc accretion in VLM objects has been estimated at less than 5Myr by Mohanty et al. (2005). Thus, the results suggest that the half-life of our sample is less than 5Myr.

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