SPECTROSCOPIC SURVEY OF CIRCUMSTELLAR DISKS IN ORION

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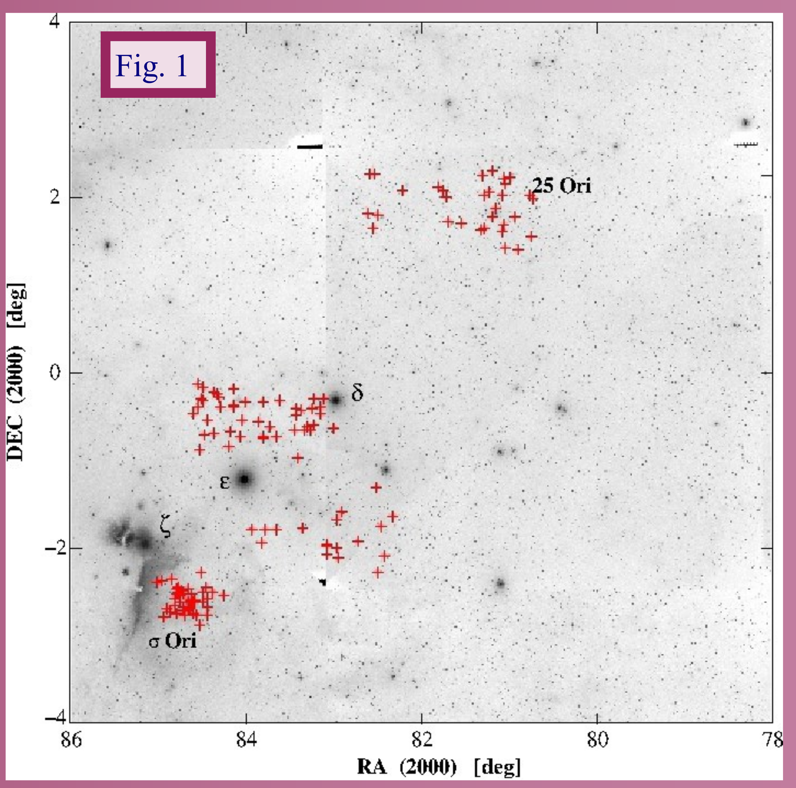
ABSTRACT

As a second stage of a project focused on characterizing candidate stars bearing a circumstellar disk in Orion, we present a spectroscopic follow-up of a set of about 170 bright stars. The present set of stars was selected by their optical (UBVRI) and infrared photometric behavior in different color-color and color-magnitude diagrams. Observations were carried out at the Observatorio Astronómico Nacional located at the San Pedro Mártir, B.C. and at the Observatorio Guillermo Haro in Cananea, Sonora, México. Low resolution spectra were obtained for all candidates in the sample. Using the SPTCLASS code, we have obtained spectral types and equivalent widths of the Li I λ6707 Å and Hα lines for each one of the stars. This project is a cornerstone of a large scale survey of young stars aimed to obtain stellar parameters in a homogeneous way using spectroscopic data.

INTRODUCTION

Young stellar clusters and associations are fundamental laboratories for studying stellar formation as well as circumstellar disk formation and evolution. Since spectral type is one of the fundamental parameters for characterizing individual stars, we have initiated a collaboration project aimed to obtain the spectral types. To date we have obtained low resolution spectra for a sample of ~170 candidate stars in Orion. With this sample we expect to get more or less complete spectroscopic survey of candidate stars with V< 16. The Orion OB1 association is one of the most important star forming regions both because of its variety of stellar ages in their different subgroups and its location in the close neighborhood of our solar system. Since 1964, Blaauw identified four main subgroups, Ori OB1a, 1b, 1c, and 1d. In this work we study a sample of stars located in the area of Ori OB 1a and 1b, which are regions of old (~8 to 10 Myr) and intermediate age (~3 to 5 Myr) stellar populations (Briceño et al. 2005). Two stellar subgroups are of particular interest in these regions: the σ Ori cluster and the 25 Orionis group since it has been suggested that the latter may be the kinematical evolved counterpart of the younger σ Ori group (Briceño et al. 2007). Stars analyzed in the present work are located in these two regions and in Ori OB1b in the surroundings of the belt stars, see Fig. 1.



OBSERVATIONS

Low resolution, long slit-spectra were obtained with the Boller & Chivens spectrograph mounted on the 2.1m telescope at the San Pedro Martir Observatory (OAN-SPM) during two observing runs: 2011 Oct 28 to 30 and 2012 Oct 18 to 21.

A Marconi CCD (13.5 μm/pix) with 2k x 2k pixel array was used a detector. We have used a 400 lines/mm dispersion grating along with a 2" slit width, giving a spectral resolution of 5.4 Å (FWHM). Spectra reduction was carried out following standard procedures in XVISTA. We have obtained three spectra for each star and combined them to get a median individual spectrum.

A second set of low resolution long-slit spectra was obtained with the Boller & Chivens spectrograph mounted on the 2.1m telescope at the Observatorio Astrofisico Guillermo Haro (Cananea, Mexico), during the nights 1-4 December 2012. A SITe CCD with 1k x 1k pixels of 24 μm was used as a detector. We have used a 150 lines/mm dispersion grating and a slit width of 2", giving a spectral resolution (FWHM) of about 10 Å. Observing strategy and spectra reduction were the same described above.

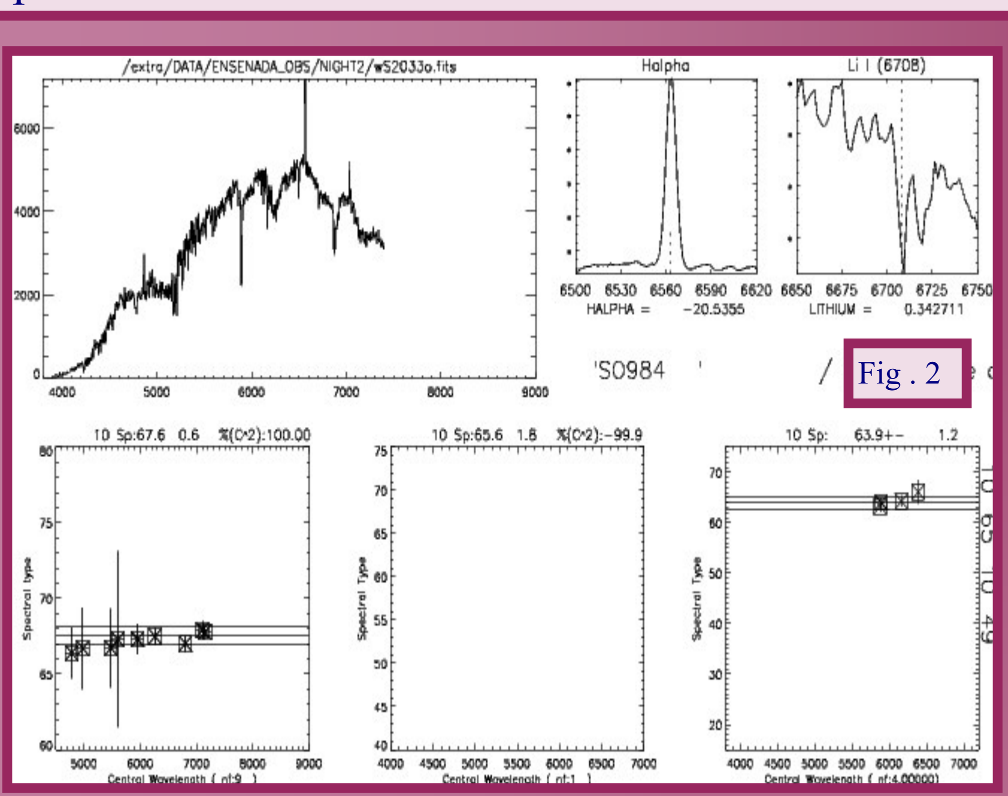


Fig. 2. Typical SPTCLASS output file corresponding to one star in our sample, S0984, located in the σ Ori cluster. We can inspect the stellar spectrum (top-left panel) with a zoom in Hα (top-mid panel) and Li I 6707 Å (top-right panel). Bottom panels show the different fit results from each part of the code: Late-type (left), G-type (middle) and HAeBe (right).

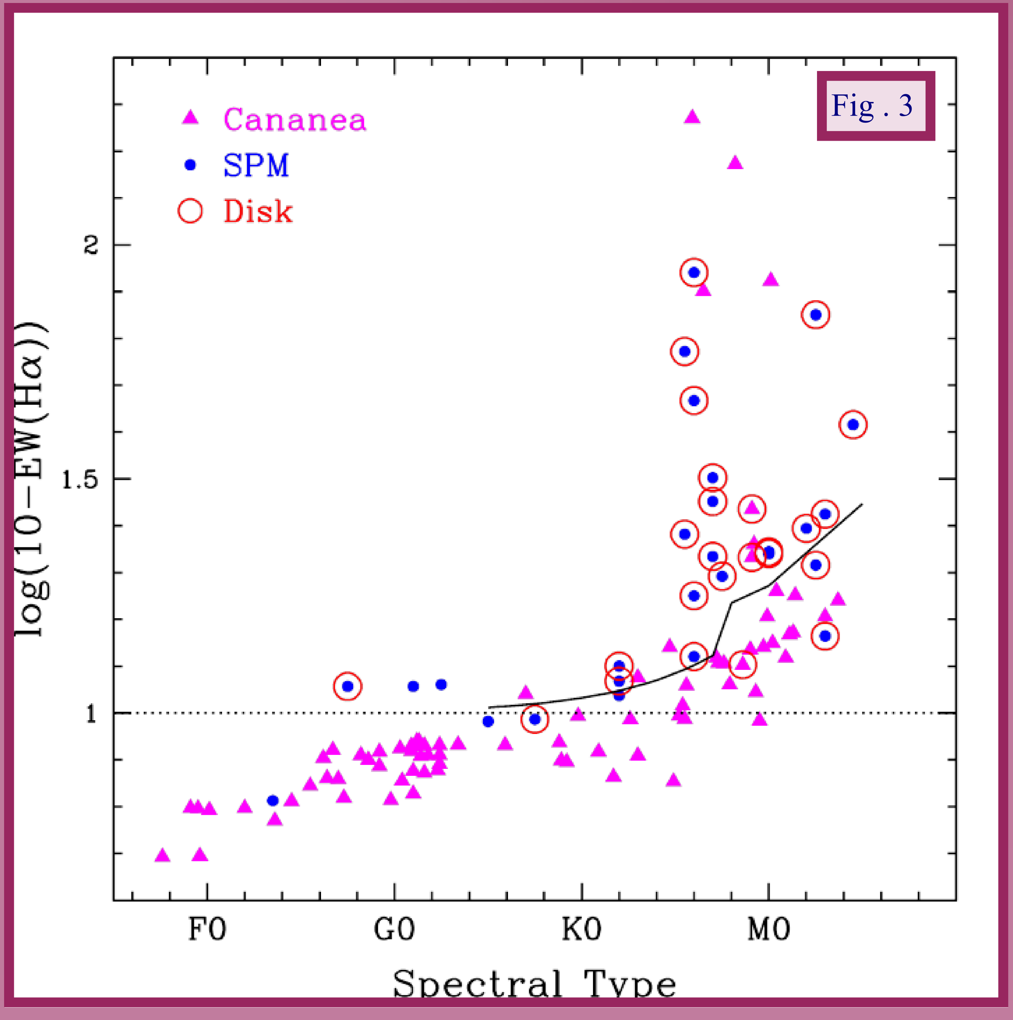


Fig. 3. Relation between the EWHa and the spectral type. In order to plot our data in a logarithmic scale, EWs have been shifted by ten units. Solid line delimits the area for Classical and Weak-line T Tauri stars based on the Hα emission (Barrado y Navascués 2003). Blue dots correspond to stars with San Pedro Mártir spectra and magenta triangles to the GH Observatory in Cananea, Sonora, México.

PRELIMINARY RESULTS

In order to assign spectral types to a sample of stars in a semi-automatic way we have used the code SPTCLASS (Hernández 2005). The main code includes three spectral classification schemes: the first one is optimized to classify stars in the mass range of TTS (K5 or later; late-type), the second one is optimized to classify stars in the mass range of IMTTS (F late to K early; G-type), and the third one is optimized to classify stars in the mass range of HAeBe (F5 or earlier). The code generates an output file which contains the individual results from different spectral indices, and a closer view around the lines Hα and Li I 6707Å. The code has an interactive module where you can select the best result from the three schemes and you can easily analyze the input spectra. Spectral type O1 corresponds to 11, B1 to 21, A1 to 31, etc.

In Fig. 2 we show a typical SPTCLASS output file corresponding to one of our sample stars, namely S0984. This star shows Hα in emission and Li I 6707 Å in absorption indicating that it is a young star. In this case, both late-type and HAeBe fits assign a K spectral type. The large error in the HAeBe fit is not reliable, so we assigned a K7.0 (± 0.5) type to S0984. In a similar way, we have assigned a spectral type to all our sample stars.

With this information, we are in the process of analyzing the relation between the equivalent width of the Hα (EWHa) line and the spectral type as an accretion indicator, see Fig. 3. We use the criterion described by Barrado y Navascués (2003) to discriminate between an accreting star, with an optically thick full disk (CTTS), from a non-accreting star (WTTS). We can see that almost all σ Ori stars in our sample are located in the area of the CTTS with active disks. These stars are surrounded by a large red circle. However, there is a group of stars located in the WTTS region with optically thick disks that appear to be in a passive stage. A deeper analysis of the σ Ori cluster is presented in a poster by J. Hernández.

A similar analysis is being carried out for other clusters and groups of young stars as part of our collaboration project.

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