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THE PRE-MAIN SEQUENCE POPULATION OF NGC 6530 IN M8

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RESUMEN

Presentamos los resultados de una investigación de probables miembros débiles del cúmulo abierto muy joven NGC 6530 en M8, basados en espectroscopía de resolución intermedia obtenida con el telescopio Magallanes I de 6.5 m del Observatorio Las Campanas. El análisis de los espectros condujo al descubrimiento de 39 nuevas estrellas de pre-secuencia principal en la región. De acuerdo a los tipos espectrales, y a la presencia de líneas de emisión y de línea de absorción de litio, identificamos 30 estrellas T-Tauri clásicas, 7 estrellas T-Tauri débiles y dos objetos Herbig Ae/Be. Utilizando magnitudes infrarrojas de 2MASS y de nuestro trabajo previo, y las huellas evolutivas de Palla & Stahler (1999), estimamos las masas y edades de estas estrellas. Encontramos que casi todas las estrellas de nuestra muestra son más jóvenes que 3×10^6 años y abarcan un intervalo de masas de entre 0.8 y 2.0 $M_\odot$.

ABSTRACT

We report the results of an investigation of faint probable members of the very young open cluster NGC 6530 in M8, based on intermediate resolution spectroscopy obtained with the 6.5 m Magellan I telescope at Las Campanas Observatory. The analysis of the spectra lead us to discover 39 new pre-main sequence stars in the region. According to the spectral types, the presence of emission lines and lithium absorption line, we identify 30 classical T Tauri stars, 7 weak T Tauri stars and two Herbig Ae/Be objects. Using infrared magnitudes from 2MASS and from our previous work and the evolutionary tracks from Palla & Stahler (1999), we estimate the masses and ages of these stars. We find that almost all of our sample stars are younger than 3×10^6 years and span a range of masses between 0.8 and 2.0 $M_\odot$.

Key Words: **H II REGIONS — STARS: PRE-MAIN SEQUENCE**

1. INTRODUCTION

NGC 6530 is located in the M8 H II region, at a distance of 1.25 Kpc (Prisinzano et al. 2005, Arias et al. 2006). Its previoulsy known stellar population shows evidence of either recent or on-going star forming processes. The cluster has been claimed to contain three different stellar generations (Lightfoot et al. 1984). Consequently it can provide an example of the sequential star formation mechanism (Lada et al. 1976).

Several optical studies have been devoted to this region since the first one by Walker (1957). It is interesting to note that two of the most recent photometric analysis arrive to different conclusions regarding the star forming history of NGC 6530: while van den Ancker et al. (1997) conclude that the star forming process in this cluster began a few ten million years ago and that massive star formation has already stopped, Sung et al. (2000) find evidence of current star formation and estimate a cluster age of 1.5 Myr.

A very recent study of a small field in the core of M8 (Hourglass Nebula) revealed the presence of a hundred near-IR-excess sources identifiable of young stellar objects (YSOs), such as Class I "protostars", T Tauri stars and Herbig Ae/Be objects, along with the detection of the first Herbig-Haro objects in the region (Arias et al. 2006).

We present here preliminary results of a spectroscopic investigation of PMS candidate cluster members that show that NGC 6530 is definitely an active star forming region with a rich population of YSOs.

2. OBSERVATIONS

Targets were selected from the lists of PMS candidates with Hα emission in the photometric work by Sung et al. (2000), as well as from their near-infrared colours and morphological appearance in *HST* images (Arias et al. 2006).

The observations were obtained using the Boller & Chivens spectrograph at the 6.5 m Magellan I telescope (Baade), during the nights of July 29 and 30, 2003. The dispersion is 1.6 Å px^{-1} over a wavelenght range of 3865-6995 Å. Typical S/N ratios are 50-200.

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3. RESULTS

3.1. *Spectral Classification*

We have determined the spectral types of the observed stars by comparison with the spectrophotometric standards of Pickles' (1998) spectrum library, although the resolution of our observations is quite higher than the corresponding to this data base. We find that our objects are late-type stars with spectral types between G0 and K7, showing superimposed a variety of both forbidden and permitted emission lines. The presence of strong or moderate Hα emission along with the Li I 6708Å absorption line establish the definitive PMS nature of these objects.

According to the equivalent width of the Hα emission line, the most common criterion used to distinguish between classical and weak T Tauri (CTT and WTT) stars, 30 of our objects are identified as CTT stars and only 7 are classified as WTT stars, which was to be expected since most of the targets were selected due to their colours indicative of strong Hα emission. Finally, the two objects in the sample are identified as Herbig Ae/Be stars.

3.2. *Hertzsprung-Russell diagram*

We estimated effective temperatures (T_{eff}) and bolometric luminosities (L_{bol}) of our objects in order to place them in the Hertzsprung-Russell (HR) diagram. T_{eff} for each star comes directly from its spectral type according to Kenyon & Hartmann (1995). L_{bol} is determined from the near-infrared photometric data. We used J magnitudes, either from 2MASS or from Arias et al. (2006), because they are the least affected by contamination from circumstellar excess emission. Thus, L_{bol} can be calculated from the following expresions:

$$\log(L_{bol}/L_{\odot}) = 1.89 - 0.4M_{bol}$$
$$M_{bol} = J - A_J - DM + BC_J$$
$$A_J = 2.65 \times E_{IS}(J - H)$$

where $DM = 10.5$ is the distance modulus, BC_J is the J-band bolometric corrections (Hartigan et al. 1994) and A_J is the extinction reddening law (Rieke & Lebofsky 1985), being $E_{IS}(J - H)$ the colour excess due to the difference of interstellar extinction in the J and H bands.

The location of the new PMS stars in the HR diagram is shown in Figure 1. Evolutionary tracks and isochrones from Palla & Stahler (1999) are also indicated in the figure. According to these models, almost all of the objects in the sample appear to be younger than ~ 3 Myr and span a range of masses between 0.8 and 2.0 $M_{\odot}$.

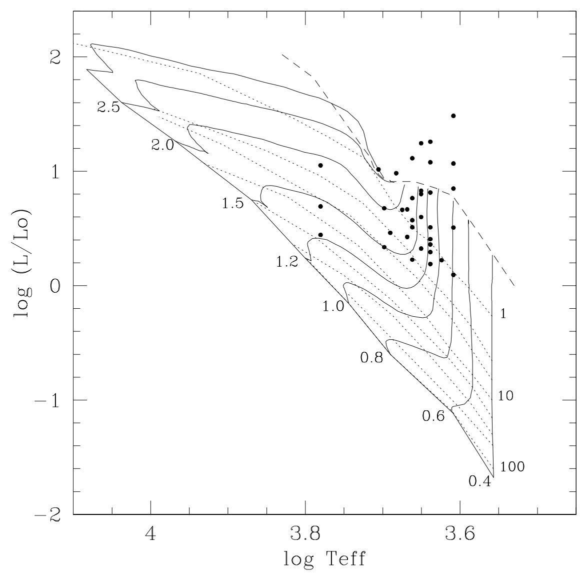

Fig. 1. Location of the observed stars in the HR diagram, assuming a distance modulus of 10.5. Dotted lines represent isochrones of 1, 3, 5, 10, 20, 30, 50 and 100 Myrs and solid lines indicate evolutionary tracks for masses between 0.4 and 2.5 $M_{\odot}$ (Palla & Stahler 1999).

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