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OSIRIS DEEP IMAGING OF CYGNUS OB2: THE STELLAR POPULATION OF THE CYGNUS X CENTRAL ENGINE

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RESUMEN

Cyg OB2 es el cúmulo joven y masivo más cercano al Sol, con una zona activa de formación estelar también masiva. Tiene cientos de miembros, y es el mejor blanco para estudiar en la Vía Láctea el proceso de la retroalimentación en la formación estelar. Cyg OB2 ha sido observado con GTC/OSIRIS y Chandra/ACIS-I para estudiar su población estelar. Los primeros resultados se presentan aquí.

ABSTRACT

The young massive cluster Cyg OB2 is the closest massive star forming region to the Sun, with hundreds of OB members, and then the best target in the Milky Way to study the feedback of massive stars on the star formation process. To study in detail the stellar population of such a unique target, Cyg OB2 has been observed with GTC/OSIRIS and Chandra/ACIS-I. We present the OSIRIS observations, the catalog and the preliminary scientific results.

Key Words: catalogs — stars: formation — stars: pre-main sequence

1. CYGNUS OB2

In several regions of our Galaxy it has been observed that the energetic radiation emitted by OB stars can have dramatic effects on the surrounding parental cloud and the nearby low-mass Pre-Main Sequence (PMS) stars.

The study of these processes is always hampered by the typically large distances of massive clusters from the Sun. The exception to this is the young massive cluster Cyg OB2, which has a distance of 1450 pc (Hanson 2003). The cluster hosts hundreds, maybe thousands, of OB stars (Comerón et al. 2002), with some of the most massive stars known in our Galaxy, and a significant population of low-mass PMS stars with an age ranging from 3 Myr to 5 Myr (Wright et al. 2010). Given these properties, Cyg OB2 is the best target in the Milky Way to study star formation in the presence of copious OB stars.

Cyg OB2 has recently been observed with Chandra/ACIS-I[4] and GTC/OSIRIS. Together with other existing infrared catalogs of this region, these data allow us to study how the star formation has proceeded in Cyg OB2.

2. THE OBSERVATIONS AND THE MULTIBAND CATALOG

The OSIRIS observations are arranged in a 5×5 mosaic, covering approximately an area $40' \times 40'$ wide. Each field has been observed in three bands (r', i', z') with an integration time of 80 sec for each image (see Figure 1), allowing us to reach a deep limit of $r' = 25^m$ (0.2 $M_\odot$ at the distance of Cyg OB2). The final OSIRIS catalog consists of 79136 sources.

We combined the OSIRIS catalog with existing infrared data of the whole field and the Chandra data of the two fields shown in Figure 1 (Wright & Drake 2009), to select the PMS stars associated with Cyg OB2, both with and without a disk.

3. PRELIMINARY RESULTS FROM THE ANALYSIS OF THE OSIRIS DATA

3.1. *The optical diagrams and the extinction in the direction of Cyg OB2*

Figure 2 shows the $r' - i'$ vs. $i' - z'$ diagram for the OSIRIS sources in the catalog. The optical+X-ray sources mark a well defined cluster locus, that has an extinction between $A_V = 6^m$ and $A_V = 11^m$. The number of observed foreground objects and the decrease of source density in the diagram between

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[4]The 1.08 Msec Chandra Cyg OB2 Legacy Survey, P.I. J. Drake, `www.cygob2.org`.

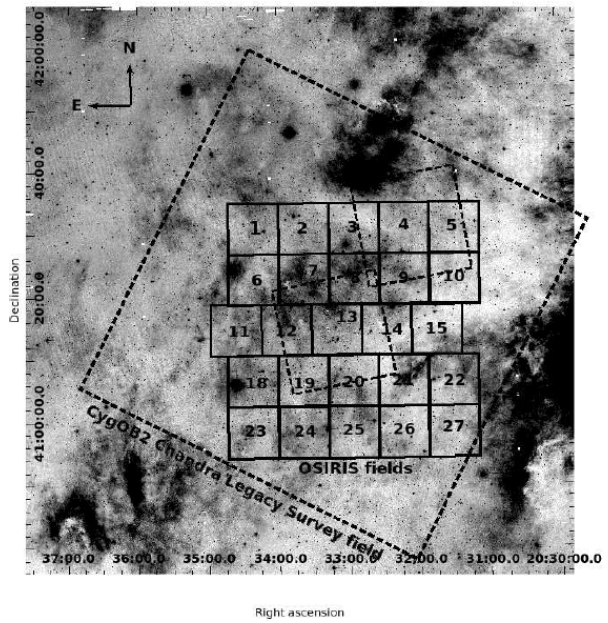

Fig. 1. IPHAS Hα image of a $1.47^\circ \times 1.47^\circ$ of CygOB2. The numbered black boxes are the OSIRIS fields. The large inclined dashed box contains the area observed in the Chandra Cygnus OB2 Legacy Survey. The small inclined boxes are the existing Chandra pointings on this region.

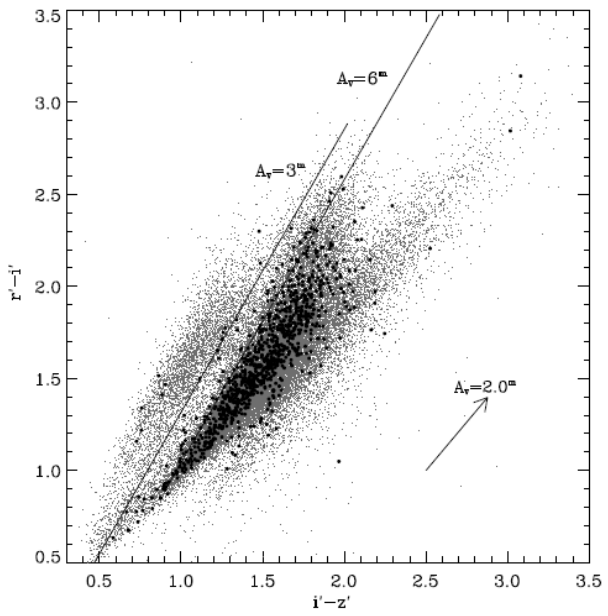

Fig. 2. $r' - i'$ vs. $i' - z'$ diagram for the optical sources in the OSIRIS FoV (gray points). The black dots are the optical sources with X-ray counterpart. The black lines are the 3.5 Myr isochrone (Siess et al. 2000), drawn for two different values of extinction.

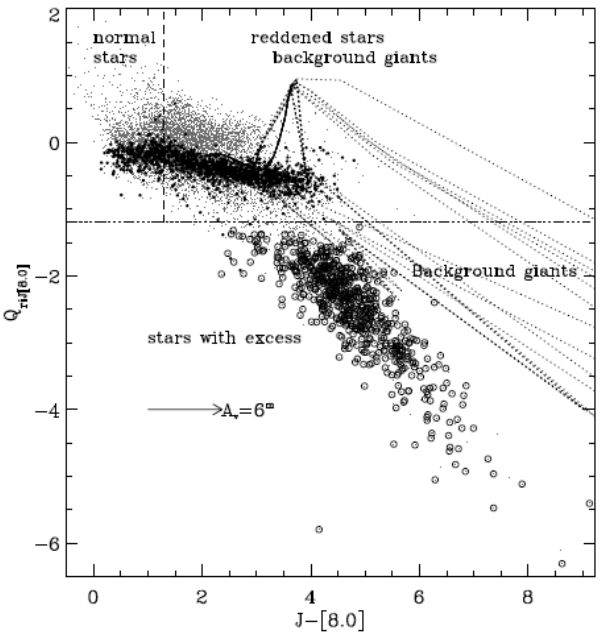

Fig. 3. Diagram of $Q_{riJ[8.0]}$ vs. $J - [8.0]$ for the stars in the OSIRIS FOV (grey dots). The black dots mark those stars with known photospheric IRAC colors. The large circle are the stars with excesses in [8.0] selected using this index. The dashed lines are the colors predicted by the giant models from the PADOVA database (`http://stev.oapd.inaf.it/cgi-bin/cmd`).

$A_V = 2^m$ and $A_V = 6^m$ has been reproduced using the TRILEGAL stellar population model (Girardi et al. 2005), simulating the presence of a dense nebulosity at a distance from the Sun ranging from 1120 ± 20 pc to 1470 ± 30 pc, depending on the adopted Initial Mass Function (IMF). We also derived an extinction map of the region showing an increase of the extinction from North Southward, with a maximum coincident with the cluster center. The cluster locus is also well-defined in the color-magnitude diagrams. This will allow us to make reliable estimate of ages and masses of cluster members, which is necessary to study the triggering of star formation by OB stars and their effect, if any, on the cluster IMF.

3.2. *Selection of stars with disks*

To obtain a robust list of candidate stars with disks, we adopted several selection criteria. These were mostly based on infrared diagrams, though the addition of optical photometry allows the definition of several reddening-free Q color indices which permit direct comparison of optical colors (representative of photospheric emission) with infrared colors

(see Damiani et al. 2006 for a detailed description of these color indices and how they can be used to select stars with disks). Figure3 shows the indices $Q_{riJ[8.0]}$ used to select the stars with excesses in [8.0], where the loci of stars with disks, reddened photospheres and background giants are well separated.

The total number of selected stars with disk is 2663, with 265 selected only with the Q indices. This latter sample of sources is dominated by stars with low mass disks and stars with almost edge-on disks observed in optical scattered light, that are inconspicuous in infrared diagrams (Guarcello et al. 2010).

4. CONCLUSIONS

We present the GTC/OSIRIS survey of the young massive cluster Cyg OB2. The surveyed area is $40' \times 40'$ wide and a total of 79136 sources have been detected down to $r' = 25^m$. We combined the optical data with existing infrared and X-ray data of the region in order to study the extinction affecting the cluster members and to select those with circumstellar disks. This combined catalog, together with the X-ray data from the Chandra Cyg OB2 Legacy Survey, will allow an analysis with unprecedented detail of how massive stars affect the star formation process and the evolution of protoplanetary disks evolution.

REFERENCES

Comerón, F., et al. 2002, A&A, 389, 874
Damiani, F., et al. 2006, A&A, 459, 477
Girardi, L., et al. 2005, A&A, 436,895
Guarcello, M., et al. 2010, A&A, 521, 18
Hanson, M. M. 2003, ApJ, 597, 957
Siess, L., et al. 2000, A&A, 358, 593
Wright, N. J., & Drake, J. J. 2009, ApJS, 184, 84
Wright, N. J., et al. 2010, ApJ, 713, 871