**DISK POPULATION IN THE OUTER GALAXY: THE STAR FORMING REGION NGC1893 .**

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## 1 Introduction

Star formation is a process present in both the inner and outer part of the Galaxy. Molecular clouds and very young stellar associations are also present at large distances from the galactic center, implying that star formation is still occurring in these regions. Conditions in the outer Galaxy should be much less conducive to star formation: the surface and volume densities of atomic and molecular hydrogen are much smaller than in the solar neighborhood or in the inner Galaxy, the interstellar radiation field is weaker, prominent spiral arms are lacking and there are fewer supernovae to act as external triggers for the star formation. Therefore, one of the key questions is whether star formation proceeds in the same way under the very different environmental conditions of the inner and outer regions of the Galaxy.

We present an *IRAC* observation of NGC1893, a young cluster ($\sim$ 3 Myrs), far away form the galactic center with the aim to study star formation in the outer region of the Galaxy and investigate on the disk properties of the cluster stars. This is part of a Large *Chandra* Project, joint with *Spitzer*.

## 2 Observation

NGC1893 was observed with the Infrared Array Camera (*IRAC*; Fazio et al., 2004) on board of the *Spitzer* Space Telescope. All four bands ($3.6$, $4.5$, $5.8$ and $8.0$ $\mu m$) were observed simultaneously, in the High Dynamic Range (HDR) mode with a long integration frame of $26.8$ $s$ and a short one of $1.0$ $s$. We covered the region of the cluster using a 5 rows X 5 columns map with five dithers at each map position. The total area is $\sim 31.2'$ x $26.0'$.

Using the *SSC Mopex* code (Makovoz & Khan, 2005), we combined the images into a single mosaic for each channel and exposure time, averaging together the overlapping frames; in this way we obtained 4 composed images for the long integration frame and 4 for the short one, with an S/N factor higher than the single images.

## 3 Photometry and Catalog

We analyzed each mosaic image with the *DAOPHOT II* procedures (Stetson, 1987), in order to obtain a list of point sources, their positions and their magnitudes. We computed the aperture photometry with a aperture radius of 3 pixels ($3.6$"), and we applied the relative aperture corrections. For the zeropoint fluxes and the aperture corrections values we used values found in the *IRAC Data Handbook*[1].

[1] *http:// ssc.spitzer.caltech.edu/irac/dh/iracdatahandbook3.0.pdf*

Table 1: Detected sources in the NGC1893 region

| Band | Number of sources | Detection limit (mag) |
|---|---|---|
| $3.6\mu m$ | 12176 | 19.03 |
| $4.5\mu m$ | 10316 | 18.34 |
| $5.8\mu m$ | 2932 | 15.88 |
| $8.0\mu m$ | 1705 | 14.92 |
| $K_{2MASS}$ | 2203 | 15.01 |
| 4 IRAC bands | 1028 | – |
| 4 IRAC bands and $K_{2MASS}$ | 771 | – |

Using the *ALLSTAR/ALLFRAME DAOPHOT* procedures we computed also the PSF photometry, calibrating the PSF magnitudes by means of a comparison with the aperture photometry. Since the mosaic image is derived from the combination of dithered frames, for the bright stars the uncertainties related to the PSF magnitudes are larger than the aperture ones, but, on the other hand, the PSF errors are small for faint stars; for this

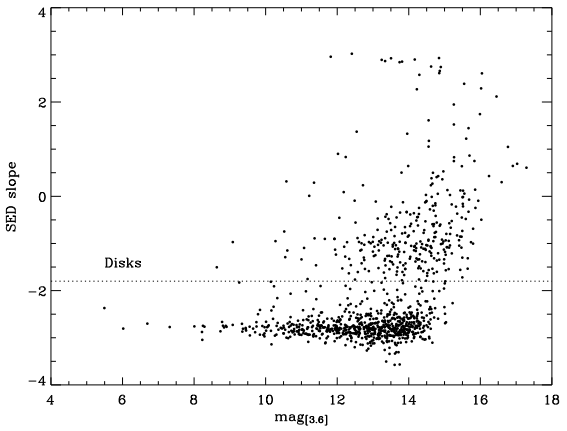


Figure 1: Power-law slopes of the *IRAC* SEDs for stars identified in the NGC1893 region, plotted as a function of the magnitude in the 3.6 $\mu m$ band. Sources whose slopes is $\alpha > -1.8$ correspond to stars with disks.

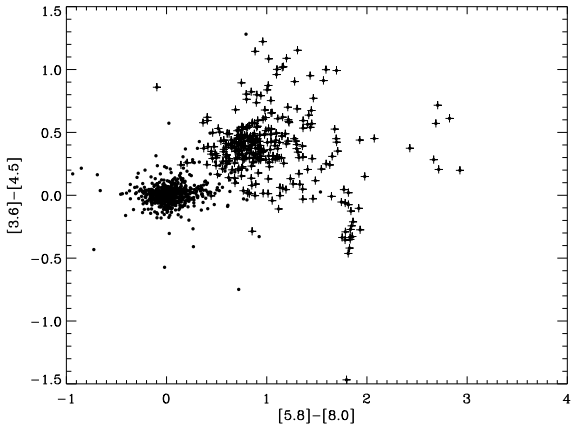


Figure 2: Color-color diagram in the four *IRAC* bands. Dots represent stars with the slope of the power law lower than 1.8, while crosses represent stars with disks. Sources identified with this method are in the right part of the color color diagram.

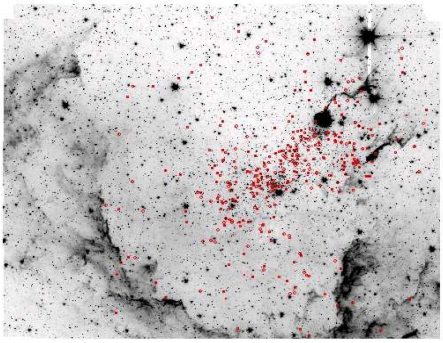

Figure 3: *IRAC* image at $3.6\mu m$. The star with disks, highlighted with red circles, are candidate members of the young clusters NGC1893.

reason we decided to use, for each star the magnitude with the smallest uncertainty.
In order to eliminate false sources, we merged the 4 *IRAC* lists and the 2MASS K band, by cross-identifying sources, using a radius of $0.6$". We included in our catalog only the stars, which magnitudes have an uncertainty less than $0.1$ and that are at least detectable in two different wavelengths. In the Table 1, we report the number of objects in our catalog, specifying the number of sources in each *IRAC* channel and in the 2MASS catalog and the detection limit for each band. At $5.8\ \mu m$ and $8.0\ \mu m$, where the sensitivity is lower than the other two channels, we find fewer sources. Although the number of sources common to the four channels is strongly limited of the sensibility in these two channels, we find 1028 objects, the 25 % of wich were not previously detected by 2MASS.

## 4 Results: Stars with disks

The examination of the infrared Spectral Emission Distribution (SED) provides a robust method for the identification of circumstellar disks. In particular, in the *IRAC* bands the shape of the SED can be approximated with a power law and its slope is a useful parameter to identify disks (Lada, 1987). From a comparison between models and observed SED, Lada et al. (2006) found that in the *IRAC* bands stars with disk have slope $\alpha > -1.8$.
We evaluate the slope of the SED in the $3.6-8.0\mu m$ range, for the stars detected in all the four *IRAC* bands in the NGC1893 regions. In this way, we found 316 objects for which the slope is $\alpha > -1.8$, that are therefore identified as stars with disk. In Fig. 1 we plotted the slope of SED power law for stars versus the magnitude in the $3.6\mu m$.
In Fig. 2 it is plotted the color-color diagram for all the detected stars; we note that the stars selected as sources with disks (crosses) by means of the SED method show large infrared excesses in the higher wavebands channels of *IRAC*. Figure 3 shows the image of the NGC1893 region at $3.6\mu m$ where the stars with disks, candidate members of the cluster, are indicated by red circles.

## 5 Conclusions

We analyzed an *IRAC* observation of NGC1893, a young cluster ($\sim$ 3 Myr), in the outer part of the Galaxy. The analysis of the *IRAC* images permitted us to find in the field of view 1028 sources, 25% of wich were not previously detected by 2MASS. The study of the SED of the detected sources in the region permitted us to identify 316 stars with disks, confirming that star formation is an active process also in the outer Galaxy. Although we are not able to detect all the members of the cluster, the high number of stars with disk indicates that NGC1893 is a quite rich cluster and confirms the very young estimated age. While the infrared observation permitted us to identify very embedded objects, with the *Chandra* X-ray observation we will be able to detect also the young stars without disks, that don't show infrared excesses.

## References

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