The Lambda Orionis Star Forming Region: the Spitzer Perspective

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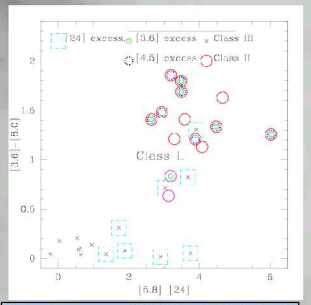
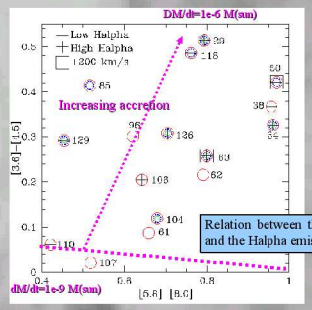
ABSTRACT

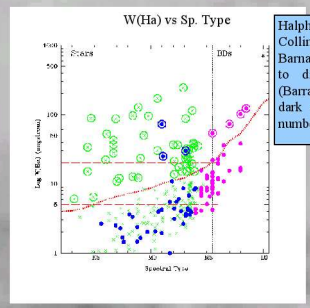
The Head of Orion is a complex star forming region which includes a young open cluster (Collinder 69, about 5 Myr), two dark clouds (Barnard 30 and Barnard 35, with younger populations) and another younger areas (LDN 1588 and LDN1603). We have observed about one square degree in each of these regions in order to study the stellar and substellar population. These data have been complemented with optical and near infrared photometry and spectroscopy. Among the properties we are analyzing are the Initial Mass Function for each association, circumstellar disks and their properties (including the disk fraction). We are also trying to explain all these properties in the context of the differences in the local environment and the evolution.



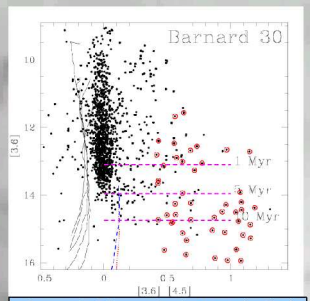
Color-color diagram (CCD) showing Spitzer IRAC and MIPS data for the Collinder 69 open cluster, about 5 Myr. The big, dashed squares correspond to stars with excesses at 24 microns. They have been classified as Class III objects, based on an IRAC CCD. They do **not** show any evidence of accretion. Therefore, it seems that a handful of low mass stars in this cluster have transition disks, in a stage in between accretion and protoplanetary disks.



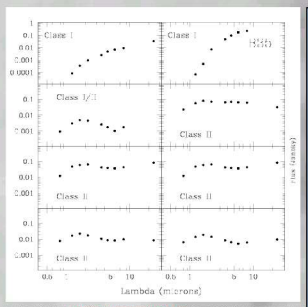
Relation between the Spitzer/IRAC excesses and the Halpha emission for C69 members



Halpha equivalent width versus the spectral type for Collinder 69 members (blue and magenta) and Barnard 30and 35 (green). The red lines correspond to different criteria to discriminate accretors (Barradoy Navascués & Martin 2003). Clearly, the dark clouds, much younger, have a much larger number of Classical TTauri stars.

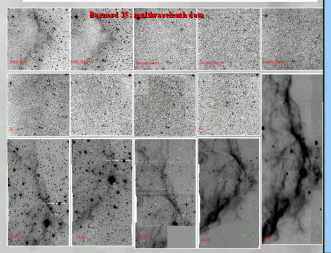


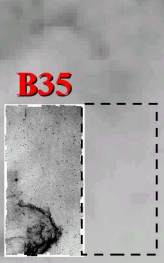
Color-magnitud diagram showing IRAC data for the Barnard 30 dark cloud, about 3 Myr. The big, red circles correspond to members classified as ClassI objects based on IRAC data. The sample suggests that the association contains a significant population of embedded brown dwarfs

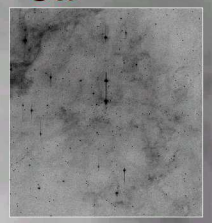


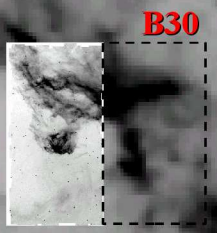
a) Spectral Energy Distribution for several members of the B35 cloud (3 Myr). The members were selected using Spitzer/IRAC data, and additional photometry (24 microns, near IR and optical) was collected with Spitzer/MIPS, WHT/Ingrid and CAHA/BUSCA. We have identified few examples of Class I objects.

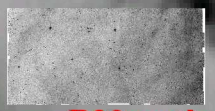
b) A collection of optical, near-IR and Spitzer images. The data, still under analysis, will help to reveal the complete population of the SFR, from very massive stars down to the substellar domain. The dataset will be used, among other analyses, to build SEDs for each member, identify Class I, II and III members, derive effective temperatures, bolometric luminosities and locate the members in an HR diagram. Therefore, we will be able to derive an accurate age for the association. The same process will be applied to the other associations within the Lambda Orionis Star Forming Region.

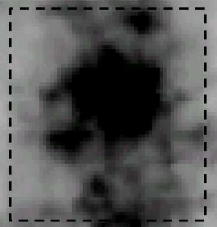




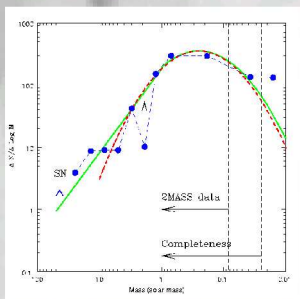




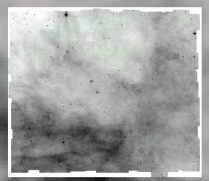


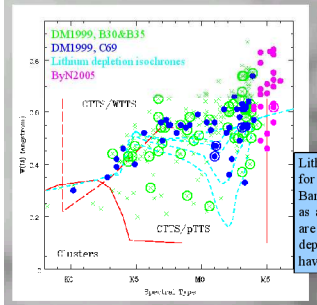


On top, Spitzer images of the selected areas in the LOri SFR, taken at 8micron). At the bottom, an IRAS image taken at 100 micron. The dashed rectangles correspond to additional data.

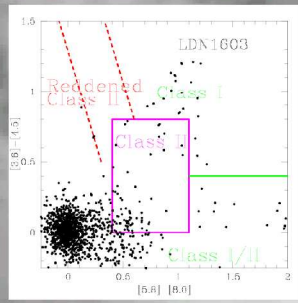


Initial Mass Funtion of Collinder 69, covering the mass range 50-0.020 Msun. This IMF is compatible with the existence of a massive star, the progenitor of the SN postulated by Dolan & Mathiew (2002)

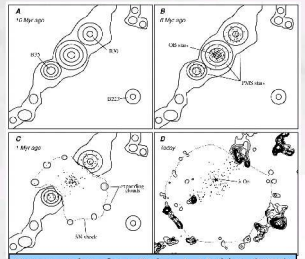




Lithium equivalent width versus the spectral type for members of Collinder 69 (blue and magenta) and Barnard 30 and 35 (green). Accretors (using Halpha as a proxy), where some veiling might be present, are indicated with a large empty circle. Several Li depletion isochrones from Baraffe et al. (1998) have been included as dashed, cyan lines.



Color-color diagram showing IRAC data for the LDN1603 dark cloud, about 1 Myr or even younger. Most of the detected objects are Class III stars, probably foreground stars, much older and neared. Note the large number of Class I candidates compared with Class II, which suggests that we are dealing with a very young association. So far, we do not have spectroscopy of candidate members belonging to LDN1603 or 1588 dark clouds, although we are planning a low- and medium-resolution, near-IR campaign for this Fall. The goal is to establish the spectral types, identify features sensitive to gravity (youth) such as alkali, and measure emission lines due to accretion, such as Br(gamma) or Pa(beta)



Cartoon, taken from Dolan & Mathieu (2002), showing the possible evolution of the Lambda Orionis Star Forming Region. If this hypothesis is correct, the star formation in the external dark clouds (LDN1588 and 1603), was induced by a SN which took place few million years ago in the central region fo the Orion´s Head, in Collinder 69.