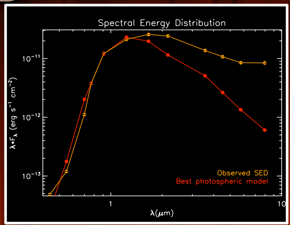
MACBETH: M-dwarf ACcretors Born in an Extremely Turbulent Habitat

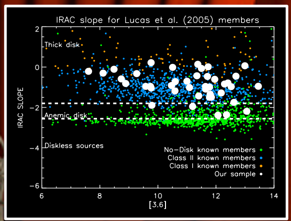
First Act:

Disk characterization

Scene I. Meeting the Orion Molecular Cloud

The curtain opens and the Orion Molecular Cloud (OMC) steps in. This one square degree deep mosaic was obtained by combining ≈80 Spitzer epochs. It shows many star forming regions (SFR) like M42, M43 or the OMC-2/3 where stars are on the first stages of their lifes. The OMC is a very well studied and young (1-3 Myr) star forming region located at 420 pc. It has been observed at several wavelengths and different depths. In this *First Act*, we present the mid-infrared characterization of 42 low-mass members located in the Trapezium region (see red rectangles in the central image) detected by Lucas et al. (2005) using near-IR photometry. In particular, we will study their evolutionary stage and classify their circumstellar disks.



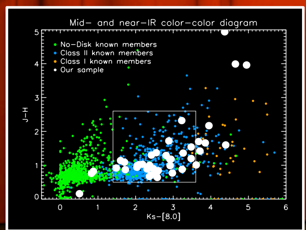


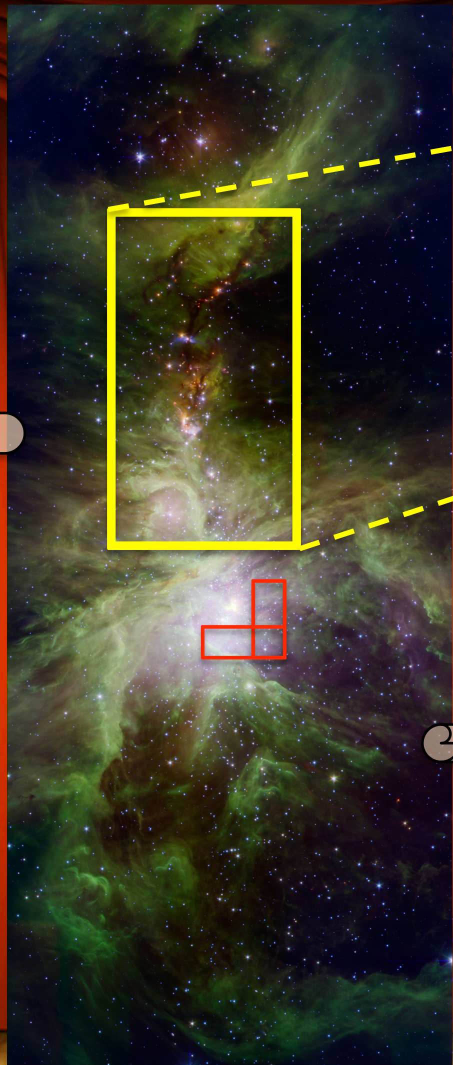
Scene II. Multi-wavelength characterization of disks

We have investigated the lowest mass population of the OMC by first examining the presence of disks in 42 previously known low-mass members (Lucas et al. (2005)) in the Trapezium. We have determined their evolutionary status by studying their accretion disks and spectral energy distribution (SED) using our Spitzer data at IRAC wavelengths. We first checked the SED of our sources from optical to IRAC wavelengths (see figure above). Energy excess with respect to the photospheric emission at mid-IR wavelengths is a clear signal of the existence of dust around the central object (see left image). The structure of the circumstellar disk can be estimated by studying the slope of the SED at IRAC bands. We plot here the results for our 42 objects. The majority of them (37/42) present thick disks and the rest (5/42) are either diskless or have anemic disks.

Scene III. Mid-IR characterization & Conclusions

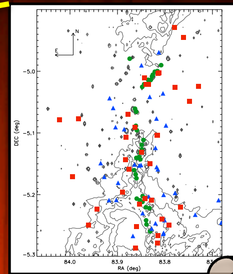
We have followed the Gutermuth et al. (2009) as an additional criteria to determine the evolutionary stage of our sources. Among them, 4/42 objects are Class I YSOs, 33/42 are Class II YSOs and only 5 of them are either diskless sources or with an anemic disk (see Figure). On one hand, the detection of Class I objects and their location in the cloud allow us to test the embryo hypothesis for brown dwarf formation mechanism (but we still need a larger sample to do this). On the other hand, Class II/III YSOs are in the last stages of star formation when isolated planetary mass objects (IPMOs) are expected to form within the disk. The detection of a substellar companion inside the gap of T Cha circumstellar disk by Huelamo et al. (2011) has shown the need for accurate studies of Class II/III objects that can host recently born planets.





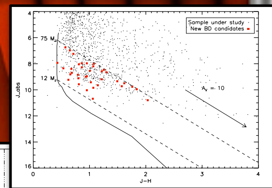
Second Act:

New Low-mass Accretors



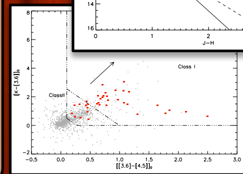
Scene I. Meeting the Orion Molecular Cloud - 2/3

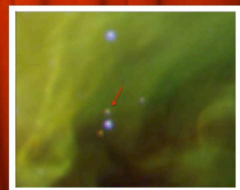
The OMC-2/3 steps in. This region (marked in yellow) is a very young SFR (< 1Myr). Far-Infrared observations pointed out the presence of several sources within the OMC-2/3 concluding that some of them were potential protostars on their formation process (Class 0 objects, green circles). Other mid- and near-Infrared surveys have detected young stellar objects in the first stages of their lifes (Class I/II YSOs, blue triangles). These protostars and YSOs have circumstellar disks accreting matter continously to the central objects and are supposed to be the progenitors of new born planetary systems. For this reason, it is crucial to characterize these environments and understand the conditions that allow their formation. Here, we report the detection of 36 new young brown dwarf candidates in their Class I/II evolutionary stage (red squares).



Scene II. Candidates selection

We have used two deep mosaics in the [3.6] and [4.5] channels of the IRAC instrument onboard Spitzer as well as deep near-IR photometry from the literature to select our candidates. Firstly, we measured the [3.6]-[4.5] and Ks-[4.5] colors to select those sources that present clear excess in these bands probably produced by a circumstellar disk. We have also applied the Gutermuth et al. (2009) criteria to reject extragalactic and background sources and classify the remaining as Class-I/II young stellar objects. We obtained a total sample of 36 sources that fullfilled all these requirements (red squares) and have masses below the hydrogen burning limit (13-75 M_J). In particular, one of our sources has a derived mass (according to its possition in the J vs. J-H diagram) of 13 M_J which means that we have reached the planetary mass limit.

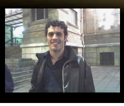




Epilogue

Implications and conclusions

To sum up, we have detected 36 new brown dwarf candidates in the very active region OMC-2/3 (one of them is shown in the [4.5] image). We have applied for time in 8-10m-class telescopes to confirm that they really belong to the cloud. If membership is confirmed, we will study the possible existence of any correspondence between the location of the low-mass members and the millimeter/submillimeter sources. We will study the mass segregation in the OMC-2/3 as a search for hints of the embryo ejection hypothesis as the formation mechanism for the lowest mass population of this cloud (as shown by Reipurth & Clarke (2001)). Moreover, we will be able to construct an improved Initial Mass Function of this very young star forming region.



Come and talk to me (Jorge) if you want to know more.
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