The substellar content of the Orion Nebula Cluster

H. Drass[1], R. Chini[1,2], D. Nürnberger[1], A. Bayo[3], M.Hackstein[1], M. Morales-Calderón[4], V. Hoffmeister[1], M. Haas[1]

(1) Astronomisches Institut, Bochum, Germany (2) Instituto de Astronomía, Universidad Católica del Norte, Antofagasta, Chile
(3) European Southern Observatory, Santiago, Chile (4) Centro de Astrobiología, Madrid, Spain

Motivation

The **Trapezium Cluster** is a **nearby, very young and active region of star formation** with a wide range of stellar masses. Often observed but until now **an extensive wide field and deep infrared study is missing** to address the following issues:

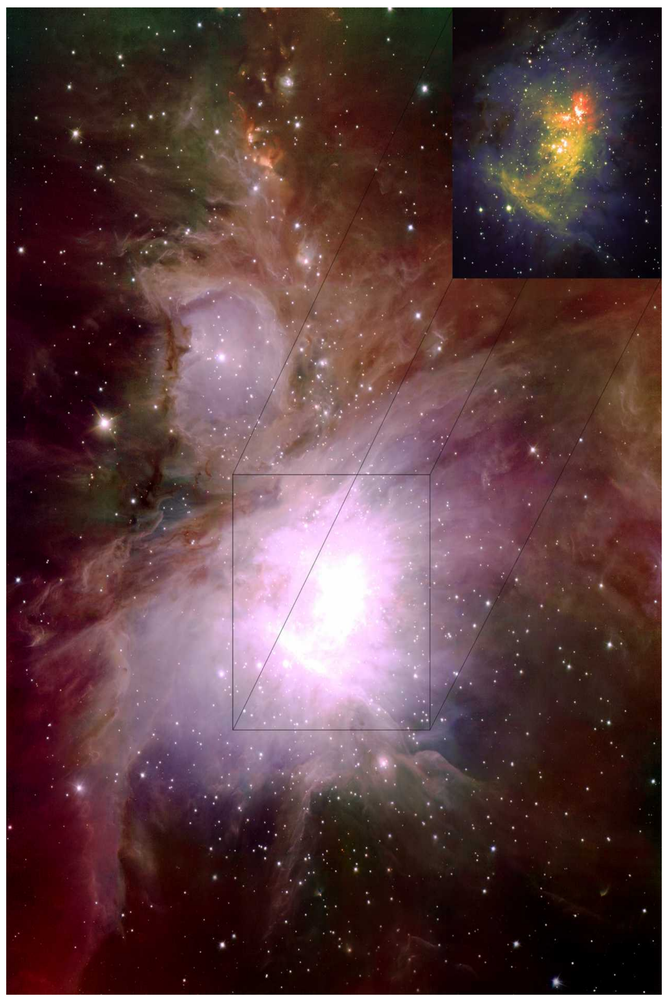
What is the **detailed shape of the initial mass function** from $38 M_\odot$ to substellar masses?

Has this region undergone **triggered star formation**?

Which were first? Low-mass or high-mass stars?

What is the **size of the circumstellar disk population** as given by **IR excesses**?

How do these aspects change with **cluster radius**?



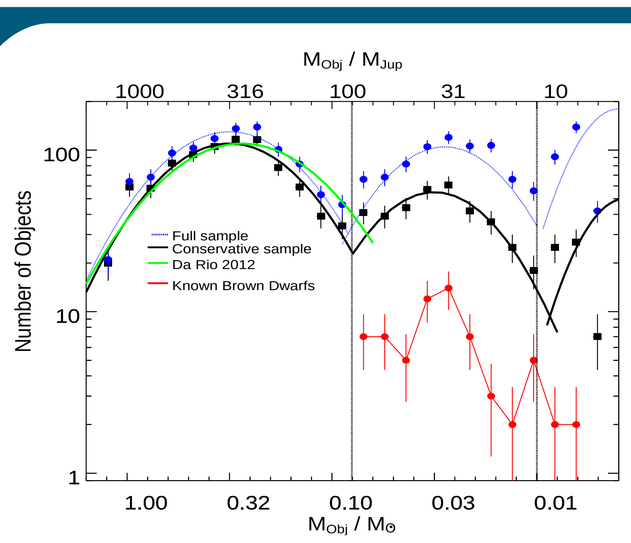
Observations: 2 nights JHK, 12 field-mosaic; total FoV 23`x 30`

Number of sources:

N_J = 5600 4.6 ≤ J ≤ 22.4 mag

N_H = 6094 4.5 ≤ H ≤ 21.4 mag

N_K = 5765 4.4 ≤ K ≤ 20.3 mag



Results:

Initial mass function:

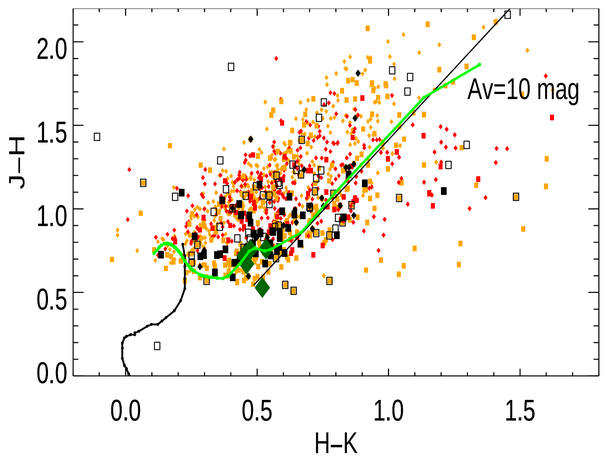
Shows a pronounced second peak at Brown Dwarf masses and a third raise at the planetary mass regime. Results for the full sample indicate the same amount of stars and Brown Dwarf candidates (BDCs). The number of Planetary Mass Object candidates (PMOCs) are even higher. In the full sample we find:

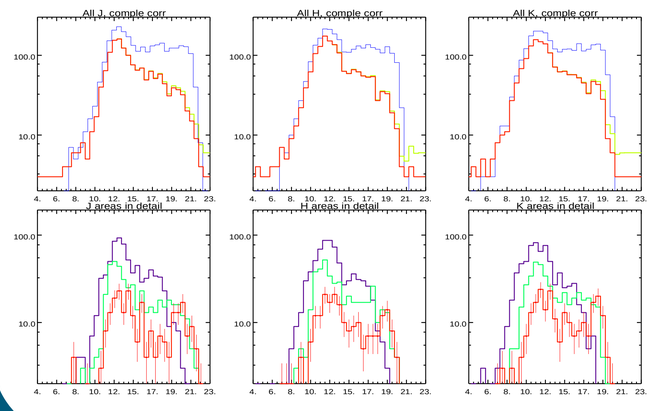
652 BDCs ($0.012 M_\odot < M < 0.08 M_\odot$)

352 PMOCs ($M < 0.012 M_\odot$)

Candiates with disks from the NIR:

BDs (orange) and PMOs (red) populate the complete CCD. Black symbols denote the colors of known BDs in Orion. Green diamonds represent spectroscopically confirmed BDs with disks in Collinder 69 from Bayo et al. (2011, 2012) with photometry from Barrado (2007). 104 BDs and 70 PMOs from the full sample, located to the right of the isochrone, have NIR excess and are therefore considered as candidates with circum–substellar disks.





ONC Member Luminosity Function:

Upper row: Accumulated LF for each filter (conser. / full sample: red/blue) with completeness correction (green)

Lower row: radial dependence for the conser. sample shown for areas with radii of 240” (purple), 480” (green), and 720” (red).

Most relevant feature is a turn over at $K \sim 15$ mag. Specially pronounced in the outer cluster region.

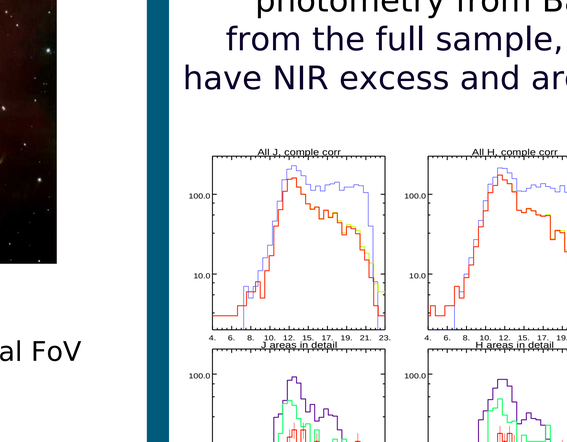
Membership:

Comparison between total could extinction and foreground extinction for each source.

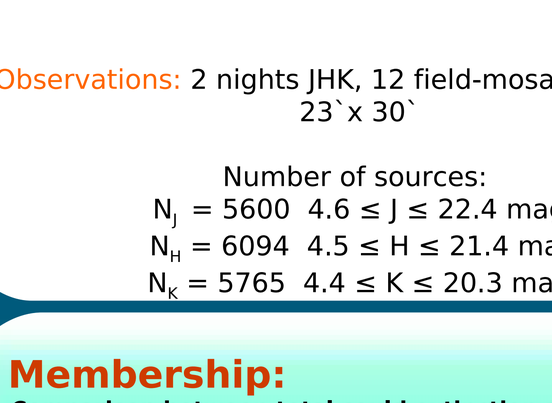
Individual foreground extinction (shift back to (J-H)=0.5) and masses from CMD (3Myr Isochrone from Allard (2011)):

Selection tests:
- Blue sources = located left of the Isochrone = foreground objects
- Round black dots are known Brown Dwarfs in Orion from Slesinck (2004), Riddick (2007) and Weights (2009)

Selection criterion is in good agreement with both testing samples.



CO measurements (Shimajiri et al, 2011) calibrated with extinction map from Scandariato et al. (2011):

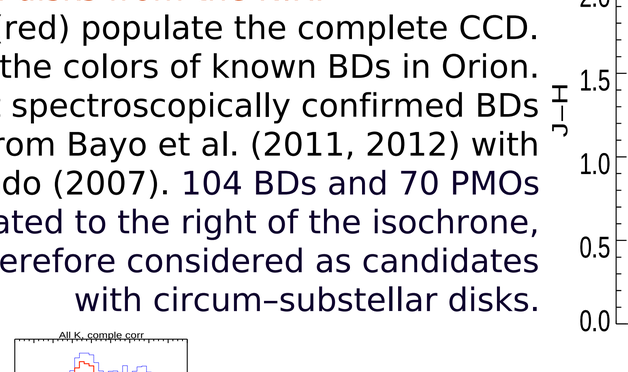


Two sample derived:

- Conservative sample under the orange line

- Full sample under the green line

Mass segregation:



Assuming the full sample the observed mass segregation is in good agreement with Anderson et al. (2011), while the results for Collinder 69 from Bayo et al. show a different trend.

This shows the BDC and PMOC fraction in the ONC is up to a factor 3 higher in the outskirts of the cluster.

Future Work:

- Investigation of the substellar SEDs.
- Up to now no correction for line of sight alignment of disks and disk frequency.
  How many more candidates can be expected?
  -> Model comparison!
- Extensive follow-up spectroscopy of BDC and PMO has been proposed.
- Analysis of extended sources: A first inspection indicates a large number of extended objects. Therefore many new, at least partly resolved circumstellar disks are expected.

Questions and suggestions? Please contact me!

Directly here or at hdrass@astro.rub.de