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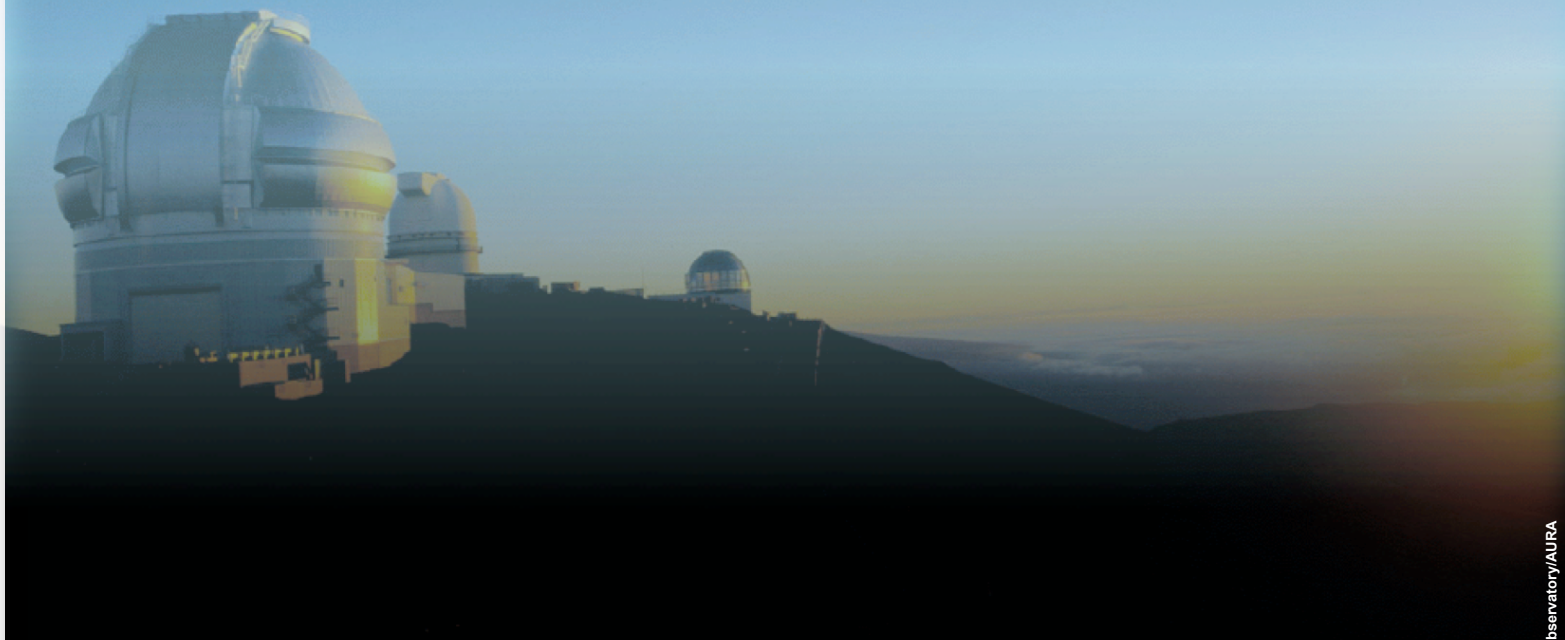
RECIPES FOR MAKING BROWNIES: THEORY VS. OBSERVATIONS

A joint ESA-CONSTELLATION workshop on the formation of brown dwarfs

September 9th - 11th 2009
ESTEC - The Netherlands



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WORKSHOP

Recipes for making brownies: theory vs. observations

Scientific Rationale:

The origin of Brown Dwarfs (BDs) is an important component of the theory of star formation. Recent ground based and satellite observations are revealing an increasing number of BDs; however, their origin remains somewhat mysterious as their mass is 2 orders of magnitude below the average Jeans mass in star-forming clouds. Explaining why they are so common thus requires detailed understanding of the fragmentation processes during star formation, as well as exploring other formation scenarios.
This workshop will focus on recent theoretical and observational progresses in the field of BD formation as well as explore current and future perspectives. Our purpose is to bring together the leading experts working in this field, foster new collaborations and, in particular, promote extended interactions among young PhD/post-doc researchers.

SOC:
L. Spezzi (chair, ESTEC)
B. Merín (ESAC)
D. Stamatellos (University of Cardiff)
V. Konyves (CEA/Saclay,SAp)
C. Alves de Oliveira (LAOG, Grenoble)

LOC:
L. Spezzi (co-chair)
J. Walcher (co-chair)
G. Beccari

Program:

9 September 2009

08:30 - 10:00 Registration + Coffee

10:00 - 10:15 Opening

10:15 - 11:00 I. Bonnell, *BD formation, an introductory review*

Session 1: Observations of BDs

Chairman: E. Mouraux

11:00 - 11:30 K. Luhman, *BD identification and characterisation*
11:30 - 11:45 C. Briceño, *Surveying the substellar component of the Orion dispersed populations*
11:45 - 12:00 V. Geers, *SONYC: Searching for the bottom of the IMF*
12:00 - 12:15 C. Reylè, *Latest news from the Canada-France BD Survey*
12:15 - 12:30 E. Solano E, *Discovery of utracool subdwarfs using VO tools*
12:30 - 13:00 Poster session

13:00 - 14:30 Lunch break

Chairman: M. Meyer

14:30 - 15:00 Ch. Helling, *Theoretical and observational differences between BDs and free-floating planets*
15:00 - 15:15 S. Casewell, *Methane imaging of T dwarfs in the Pleiades*
15:15 - 15:30 K. Haisch, *Methane imaging of BDs and planetary mass objects in ρ-Ophiuchi*
15:30 - 16:00 J. Bouvier, *The sub-stellar IMF*
16:00 - 16:15 C. Alves de Oliveira, *Probing the low-mass end of the IMF in the ρ-Ophiuchi molecular cloud*

16:15 - 16:45 Coffee break

Chairman: P. André

16:45 - 17:00 B. Burningham, *The sub-stellar IMF from the UKIDSS Large Area Survey*
17:00 - 17:15 N. Lodieu, *Is the IMF universal? Latest results from the UKIDSS Galactic Clusters Survey*
17:15 - 17:30 M.R. Meyer, *Distinguishing brownies from fudge: sub-stellar IMF vs. CMRD*
17:30 - 18:00 A.M. Cody, *A search for pulsation in young BDs and low mass stars*

10 September 2009

Chairman: A. Scholz

09:00 - 09:30 V. Joergens, *BD multiplicity and kinematics*
09:30 - 09:45 B. Goldman, *BD binarity using laser-guide adaptive optics systems*
09:45 - 10:00 A. Burgasser, *The BD multiplicity fraction: are most BDs in (tight) multiples?*
10:00 - 10:15 J. Faherty, *Higher order multiplicity amongst widely separated BD companions to stars*

10:15 - 10:45 Coffee break

Chairman: V. Joergens

10:45 - 11:15 R. Jayawardhana, *Accretion disks in the sub-Stellar realm: properties and evolution*
11:15 - 11:30 P. Harvey, *A Spitzer Search For Disks around young planetary mass objects*
11:30 - 11:45 J.L. Monin, *BDs disks sizes as a clue to their formation model*
11:45 - 12:00 L. Valdivielso, *Protoplanetary disks of isolated VLMOs discovered in the IPHAS survey*
12:00 - 12:15 S. Goodwin, *What do disks tell us about BD formation?*
12:15 - 12:45 A. Natta, *Accretion and ejection of matter in BDs*

12:45 - 14:00 Lunch break

Chairman: P. Harvey

14:00 - 14:15 A. Scholz, *Accretion and disks in BDs: the variability perspective*
14:15 - 14:30 S. Mohanty, *Disk accretion in young stars and BDs with multipole magnetic fields*
14:30 - 14:45 T. Huard, *Proto-BD populations inferred from Spitzer and NEWFIRM*
14:45 - 15:00 A. Palau, *Searching for bona fide proto-BDs*

15:00 - 15:30 Coffee break

Session 2: Theory of BD formation

Chairman: A. Whitworth

15:30 - 16:00 P. Padoan, *BD formation from turbulent fragmentation in clouds*
16:00 - 16:30 P. Hennebelle, *Pre-main sequence evolutionary models for BDs and the gravo-turbolent formation scenario*
16:30 - 16:45 S. Glover, *Forming BDs at high redshift and low metallicity*
16:45 - 17:15 M. Bate, *BD formation from early ejection: results from recent SPH simulations*
17:15 - 17:30 S. Boudreault, *Constraint on BD formation via ejection: radial variation of the stellar and sub-stellar mass function of the young open cluster IC 2391*
17:30 - 18:00 L. Testi, *ALMA*

20:00 Social dinner

11 September 2009

Chairman: M. Bate

09:30 - 10:00 A. Whitworth, *BD formation from fragmentation of protostellar discs*
10:00 - 10:15 D. Stamatellos, *The predictions of the disk fragmentation model*
10:15 - 10:45 P. Clark, *BD formation from gas filaments infalling onto stars*

10:45 - 11:15 Coffee break

Chairman: C. Briceño

11:15 - 12:00 Discussion:
- Different predictions from the BD formation models
- What the observers need/can do in order to determine the dominant mode of BD formation
- How can we incorporate/accommodate the observational results into theory
- Better cooperation/interaction between theoreticians and observers
- Creation of guidelines on future strategies to adopt

12:00 - 13:00 Poster session

13:00 - 14:00 Lunch break

Session 3: Future perspectives

Chairman: T. Huard

14:00 - 14:30 M.R. Zapatero Osorio, *Surveys for BDs - IR imaging*
14:30 - 14:45 H. Zinnecker, *VISTA microlensing survey of free-floating BDs towards the Galactic Center*
14:45 - 15:15 M. Fridlund, *CoRoT*
15:15 - 15:45 F. Comerón, *Observing BDs in the ELT era*

15:45 - 16:15 Coffee break

16:15 - 16:45 P. André, *Searching for low-mass prestellar cores with Herschel*
16:45 - 17:30 M. McCaughrean, *Summary talk & Discussion: expectations from Herschel and ALMA*

Abstracts for talk contributions

• **C. Alves de Oliveira,** ***Probing the low-mass end of the IMF in the ρ-Ophiuchi molecular cloud***

Abstract: The characterisation of young stellar populations in star forming regions down to the planetary mass regime is a fundamental step towards the understanding of the physics behind their formation. We present the results of a major observational study of the low mass population of the 1 Myr old ρ-Ophiuchi molecular cloud. Candidate BDs and isolated planetary mass objects have been identified using the deepest near-IR imaging survey of the entire region (WIRCAM/CFHT). A spectroscopic follow-up of these candidates has been conducted using several facilities (TNG, GTC, NTT, ISAAC), allowing for an estimation of their spectral types and masses, and ultimately, to construct the low-mass end of the IMF for this star forming region.

• **P. André,** ***Searching for low-mass prestellar cores with Herschel***

Abstract: The Herschel Space Observatory, which was successfully launched in May 2009, will provide a unique opportunity to improve our global understanding of the early phases of star formation. As prestellar cores and young protostars emit the bulk of their luminosity at ∼80-400 microns, the SPIRE and PACS bolometer cameras on Herschel are ideal for taking a complete census of these objects down to ∼0.01-0.1 $M_\odot$ in nearby (<0.5 kpc) molecular cloud complexes. I will present the objectives of the Herschel survey of the Gould Belt, which is an approved key project led by CEA/Saclay (cf. http://herschel.cea.fr/star-formation/). The project will deliver large samples of dense cores and protostars with well characterised luminosities, temperatures, and masses. An expected immediate outcome will be an accurate prestellar core mass function from the pre-BD to the intermediate-mass regime. This Herschel survey will allow us to determine whether a large fraction of BDs can form from the collapse of ultra-low-mass prestellar cores. It will also probe the genetic link between diffuse, low-density cloud structures in the interstellar medium and compact, self-gravitating dense cores, thereby providing insight into the core formation process.

• **M. Bate,** ***BD formation from early ejection: results from recent SPH simulations***
Abstract: I will present results from recent hydrodynamical, radiation hydrodynamical, and radiation magnetohydrodynamical SPH simulations of the collapse and fragmentation of molecular clouds to form stellar groups and clusters. The main focus of the talk will be on the formation mechanism of BDs and their predicted statistical properties including the IMF, multiplicity and binary properties.

• **I. Bonnell** ***BD formation, an introductory review***
Abstract: There are numerous theories to explain the origin of BDs, from the fragmentation of turbulent molecular clouds, to the photo-erosion of higher-mass pre-stellar cores. I will review the various formation mechanisms of BDs concentrating on the critical physical processes required for each. I will also discuss the predictions and observational signatures that are likely outcomes of each model. This introductory review will aim to initiate a critical discussion of the various theoretical models and the observations needed to differentiate between them.

• **S. Boudreault,** ***Constraint on BD formation via ejection: radial variation of the stellar and sub-stellar mass function of the young open cluster IC 2391***

Abstract: Here we present the results of a program to study the mass function and its radial dependence in one of the nearest open cluster, IC 2391 (age ∼50Myr, distance ∼146pc) in order to put constraints on the different formations mechanism of BDs. The survey consist of 35 34×33 arcmin fields extending to 3 degrees from the center of the cluster, for a total coverage of 10.9 sq. degrees. We conclude that ejection formation scenario is not a significant BD formation mechanism if it results in a higher velocity dispersion of BDs compared to stars. However, if ejection mechanism is the unique BD formation path, then both BDs and stars should have the same velocity dispersion.

• **J. Bouvier,** ***The sub-stellar IMF***

Abstract: Estimates of the sub-stellar IMF have now been derived for a number of young open clusters (30-600 Myr) down to 20-30 Jupiter masses and for various star forming regions (1-5 Myr) down to 5-10 Jupiter masses. We will review recent results regarding the shape of the sub-stellar IMF and its sensitivity (or lackof) to environmental conditions, and discuss its temporal evolution in populated clusters. We will also present new results on the youngest and lowest mass T-dwarfs discovered so far in star forming regions, as well as on new cool T-dwarfs in young open clusters

• **C. Briceño,** ***Surveying the substellar component of the Orion dispersed populations***
Abstract: We present the latest results of our ongoing large-scale, optical photometric and spectroscopic survey of the Orion OB1 association, aimed at detecting very low mass PMS stars and young BDs (M<0.2 $M_\odot$). The survey is based on the combination of multi-epoch photometry obtained with the CCD Mosaic Camera on the 1m Schmidt telescope of the Venezuela National Astronomical Observatory (CVSO Survey), with near-IR data from the 2MASS. The search area spans 240 deg^2 across Orion OB1, with I-band photometry complete to I≈19.5 (0.03 $M_\odot$), and a deeper subsample, complete to I≈20.5 (0.025 $M_\odot$), over 100 deg^2. The photometric survey is being complemented with follow up optical spectroscopy on the Hectospec instrument on the MMT, which so far has provided spectroscopic confirmation of young BDs down to 0.06 $M_\odot$ over 6 deg^2, in selected areas such as Orion OB1a, OB1b and the 25 Ori cluster, with ages ranging from 5 to 10 Myr. In this contribution we discuss the sample of stellar and sub-stellar objects spectroscopically confirmed as members, and those that still remain as photometric candidates. Membership was assigned based on spectral features that are indicators of youth, such as strong Li I absorption (6707Å) and strong Hα (6563Å) emission, or indicators of low surface gravity such as NaI absorption (8195Å). We analyze the spatial distribution, near-IR excesses and fractions of objects with Classical or Weak T Tauri-like characteristics. We explore how these properties behave below and above the sub-stellar limit, during the period from 5 to 10 Myrs.

• **A. Burgasser,** ***The BD multiplicity fraction: are most BDs in (tight) multiples?***
Abstract: Our most robust empirical constraints on the BD multiplicity fraction have come from resolved imaging studies of large samples, suggesting a minimum multiplicity fraction of roughly 10%. Complementary constraints from RV variability and parallax (overluminosity) studies suggest a multiplicity fraction at least twice as large and perhaps five times larger, although statistics are less reliable. We present the results of a fourth approach, the identification of spectral binaries composed of L and T dwarf components. Our method is not limited by angular or spectral resolution constraints, enabling the detection of closely-separated, distant and intrinsically faint pairs, and hence the construction of large statistically significant samples. We have so far uncovered 20 new BD binary candidates by this technique. Using a Monte Carlo method to account for complex selection effects, we find a multiplicity fraction of roughly 30%, suggesting that most BDs may reside in multiples, predominantly closely-separated systems neither accessible to direct imaging nor suitably modeled in current SPH simulations.

• **B. Burningham,** ***The sub-stellar IMF from the UKIDSS Large Area Survey***

Abstract: The sub-1000K T_{eff} distribution of field BDs is extremely sensitive to the underlying form of the sub-stellar IMF, a fundamental observable of the BD formation process. The UKIDSS Large Area Survey (UKIDSS-LAS) is providing unprecedented depth and coverage in four near-infrared bands, YJHK, allowing extension of the current sample of BDs to ever lower temperatures. The UKIDSS Cool Dwarf Science Working Group (CDSWG) is engaged in a major effort to identify the coolest BDs in the field, and obtain a statistically significant sample of very cool T dwarfs. With over 70 UKIDSS-LAS T dwarfs now identified, and follow-up of DR3 and DR4 nearly complete, I will present our latest constraints on the form of the sub-stellar field IMF, measured using the largest sample of T dwarfs yet identified.

• **P. Clark,** ***BD formation from gas filaments infalling onto stars***

Abstract: We review a new model for the formation of BDs, that suggests that BDs and low-mass stars can form via the break-up of infalling gaseous filaments in stellar clusters. As the filaments fall towards the cluster centre, they are compressed by gravitational potential of the system, lowering the local Jeans mass in the filament. When the Jeans mass becomes sufficiently low, and when the associated density is above the limit required for the gas to be stable against tidal shear from the cluster potential, the filament is able to fragment, forming low-mass objects. Further, the tidal shear and high-velocity dispersion present in the cluster preclude any subsequent accretion. Ejections are not required as the BDs enter the cluster with high relative velocities, suggesting that their disk and binary properties should be similar to that of low-mass stars. This mechanism requires the presence of a strong gravitational potential due to the stellar cluster, implying that BD formation should be more frequent in stellar clusters than in distributed populations of young stars.

• **S. Casewell,** ***Methane imaging of T dwarfs in the Pleiades***

Abstract: I will present the results of methane imaging Pleiades T dwarfs, and discuss predictions from recent synthetic spectra and the formation of methane in these low gravity atmospheres. A BD initial reservoir of thermal energy is set by gravitational contraction which is mass dependant, and the cooling rate is set by its age-dependent luminosity. Therefore there is a degeneracy between the mass, age and observable parameters (i.e. luminosity, colour) of a field BD. One cannot distinguish between a young, low mass BD and an old, massive one from spectral type and luminosity alone. Nearby open star clusters are ideal laboratories with which to study BDs as all cluster members have the same, and more importantly a known, age, distance and metallicity. This knowledge breaks the mass/age degeneracy and provides independent information that may be used to influence BD evolutionary models. Recently we conducted a study of the Pleiades (125 Myr) using deep optical (CFH12k) and infrared (WFCAM) images separated by a 5 yr baseline. Using photometry, proper motion and state of the art evolutionary models, we were able to select new cluster members, some of which had a high probability of being T dwarfs (Casewell et al. 2007). These were the first T dwarfs discovered in the Pleiades and have estimated masses of $\sim$10 M_J. Using Gemini and NIRI we have imaged these candidates using methane long and short filters. Methane imaging has been used on field T dwarfs with great success; since the Pleiades objects are very faint (J$\sim$20), which makes spectroscopy impossible, this is a reliable way to identify bona fide T dwarfs. We obtained a negative result for the methane imaging, which is contradictory to the result predicted by the broadband colours. It has been suggested that the lower gravity in these young clusters can affect these colours, particularly the H-K, which is dominated by methane in the T dwarf atmosphere. I therefore will discuss our new results, and how they differ from the methane colour as predicted by synthetic spectra for these objects.

• **A.M. Cody,** ***A search for pulsation in young BDs and low mass stars***

Abstract: Pulsation powered by deuterium burning in BDs and very low mass stars has been put forth (Palla & Baraffe 2005) as a novel probe of the interiors of these objects in the 1-15 Myr age range. Previous observations have hinted at variability on the expected timescales of a few hours, suggesting but not confirming that the phenomenon is at work in young BDs. We have recently carried out a dedicated campaign to search for this putative class of pulsators among known low-mass members of five young star clusters. Our survey achieves sensitivity to periodic oscillations with photometric amplitudes down to several millimagnitudes. We will present the census of variability over timescales ranging from minutes to days and discuss the current prospects for pulsation as a tool in the study of young objects near the sub-stellar boundary. As a byproduct, this work provides new insights into the distribution of stellar rotation periods at young ages via the detection of variability due to cool surface spots.

• **F. Comerón,** ***Observing BDs in the ELT era***

Abstract: With their enormous light-gathering power, the Extremely Large Telescopes (ELTs) currently undergoing detailed study phases are expected to produce quantum leaps in virtually every area of observational astrophysics. BD studies are no exception. In this talk we review some of the topics in which the European ELT (E-ELT), a fully adaptive 42m-diameter telescope, will open new research perspectives in this field, particularly when combined with the GAIA results that should become available around the time when the E-ELT starts operations. We will also show that the E-ELT should be able to open the field of extragalactic BD research by placing within reach BDs in the Magellanic Clouds. Some detailed simulations will be presented to give a preview of what we may expect from the E-ELT performance when applied to the study of BDs.

• **J. Faherty,** ***Higher order multiplicity amongst widely separated BD companions to stars***

Abstract: Kinematics provide important information concerning ages, multiplicity, moving group membership, and evolutionary trends. In order to study 6D positions and velocities of the ultracool dwarf population, we have initiated the BD Kinematics Project (BDKP) which aims to measure and compile precise positions, distances and velocities for all known BDs within 20 pc of the Sun and a select sample of unusually young, old and peculiar sources. To date, proper motions for 427 late-type M,L, and T dwarfs have been measured and combined with published measurements to form a catalog of 841 M7-T8 dwarfs. We have cross-correlated our BDKP catalog against the Hipparcos and LSPM-N catalogs and re-discovered all 42 known wide (>100 AU) stellar companions to ultracool dwarfs (UCDs) as well as four new systems. From these 46 systems, we found a resolved binary frequency for low mass companions to widely separated primaries (i.e. at least a triple system) which is 3-4 times greater than the frequency found for the field UCD population. The ratio of triples to binaries and quadruples to binaries for these wide resolved systems is 7:11 and 1:4, respectively, compared to 8-parsec sample values of 1:4 and 1:26. I will discuss the new wide companion systems that we have discovered as well as the formation requirement for hierarchical, widely separated UCD companion systems.

• **M. Fridlund, *CoRoT***

Abstract: One of the potentially interesting applications of exo-planetary transit searches is to discover and study in detail BDs orbiting solar type primaries. While more than a dozen candidates have been discovered in radial velocity searches (which only provides a minimum mass), only 2 very good candidates have been discovered in transit searches (which ideally provide more exact orbital elements, an exact mass and a radius): XO-3, found by the ground based XO network, and CoRoT-3b (C-3b), found by the CoRoT satellite. They show different sets of properties. XO-3 is measured at $\sim$12 M_J, while C-3b weights in at 21.66 M_J. What is even more interesting is that XO-3 have a very high eccentricity in spite of being in a tight orbit (3.19 d), while the orbit of C-3b is circular (4.25 d). The major discrepancy is, however, the radii of the 2 objects. C-3b is around 1 R_J like the models say it should be. XO-3 is significantly larger than the models indicate. We will discuss the reality of this discrepancy, comparing it to other large mass, short period objects straddling the borderline between planets and brownies.

• **V. Geers, *SONYC: Searching for the bottom of the IMF***

Abstract: The stellar IMF appears to extend well into the "planetary" regime in some star forming regions, but there are few constraints on the frequency, nature and origin of the lowest-mass free-floating objects. The SONYC (Sub-stellar Objects in Nearby Young Clusters) project aims to address these issues through ultra-deep, wide-area optical and infrared imaging surveys of several nearby young clusters with large telescopes, allowing us to identify candidates down to estimated masses of a few times that of Jupiter. Follow-up spectroscopy, and complementary Spitzer photometry, permit confirmation and characterisation of our candidates. Here I will present first results from the SONYC imaging and spectroscopic campaigns, including constraints on the bottom end of the IMF and disk fractions in the very low mass regime.

• **S. Glover,** ***Forming BDs at high redshift and low metallicity***

Abstract: In metal-poor gas, thermal coupling between the gas and the dust occurs only at late times during gravitational collapse, at a point when the gas density is very large. The onset of thermal coupling leads to a rapid drop in the gas temperature. This induces vigorous fragmentation, leading to a very densely packed cluster of low-mass stars, many of which will have masses in the BD regime. We present results from numerical simulations that show this process in operation, and discuss its sensitivity to radiative feedback from the first protostars to form, and its dependence on the nature of high-redshift dust.

• **B. Goldman,** ***BD binarity using laser-guide adaptive optics systems***

Abstract: Binarity of BDs is one of the observational characteristics to confront the formation scenarios with. Formation models sometimes make predictions on the binary fraction as well as separation and mass distribution. In the stellar regime, these parameters change with the primary spectral type, or more specifically, its mass, and – although the observed variations are not fully understood in that mass regime – it is important to see if the trends are extended into the BD mass range, or if a discontinuity or a reverse trend is observed. Finally, it has been proposed that the L/T transition surprising features, such as the widely different atmospheric properties at similar effective temperatures, may be explained by a high fraction of L+T binaries. Possibly even all such objects may be composite BDs. We started a laser-guide adaptive optics high-resolution imaging survey for mid-L to late-T BDs, at the VLT (PARSEC/NACO) and Lick observatories. We imaged 12 targets not previously observed. We resolve no new binaries. We revise the binary fraction among BDs and L/T transition BDs. We confirm the lower BD binary fraction than for M dwarfs, thus extending the trend observed at larger masses. Despite a larger fraction best value, the current statistics do not significantly support the hypothesis of a larger fraction among L/T transition BDs.

• **S. Goodwin,** ***What do disks tell us about BD formation?***

Abstract: It is commonly assumed that the presence and size of disks around BDs are a significant clue to their formation mechanism. In particular, that disks will be present around BDs that form in a star-like way (i.e. in cores), but not around those that form by an ejection-type scenario. I will argue that (a) ejection/liberation scenarios do produce BDs with disks, and (b) star-like formation could well result in BDs without disks. Therefore, with our current state of understanding disks do not tell us anything about the formation mechanism of BDs.

• **K. Haisch,** ***Methane imaging of BDs and planetary mass objects in ρ-Ophiuchi***

Abstract: T dwarfs are the coolest and least massive compact astrophysical objects that we can directly observe outside our Solar System. With masses inferred to lie between ∼10 and 60 times that of Jupiter, these objects represent a class of object linking the properties of observable low mass stars and BDs with those of unobservable extrasolar planets. T dwarf surveys in young star clusters can provide important answers to questions such as "Is there a minimum mass for star formation?" and "How important is dynamical evolution for cluster mass functions?". In recent years, methane imaging has emerged as a powerful tool for identifying T dwarf candidates in very young clusters, where T dwarfs are at their brightest and have not yet been subject to possible dynamical ejection from their clusters. We have recently initiated a methane imaging survey of six young, nearby clusters for T dwarfs. In this contribution, we present our results for the ρ-Ophiuchi cloud.

• **P. Harvey,** ***A Spitzer Search For Disks around young planetary mass objects***

Abstract: We report on a Spitzer IRAC program to obtain very deep mapping of a region in Ophiuchus containing candidate young very low mass objects. Our observations are aimed at detecting disks around objects down to planetary masses in a region already surveyed at higher brightness limits by Allers et al.

• **Ch. Helling,** ***Theoretical and observational differences between BDs and free-floating planets***

Abstract: BDs and planet can have very alike properties. Hence, the differentiation between BDs and (free-floating) planets is a matter of defining an appropriate criterion the fulfilment of which, however, is perturbed by model uncertainties like in the case of mass determination. The only presently applicable method to unambiguously detect a free-floating Earth-mass-like planet is micro-lensing which, however, produces a signal that can not be repeated. The question is if an unambiguous criterion exists at all. A suitable working-hypothesis is therefor that BDs and planets form by different processes. Than, a way to differentiate between BDs and free-floating planets is the study of their atmospheric composition. Ideally, a BD atmosphere would exhibit the element abundances of the molecular cloud it formed from, but a free-floating planet atmosphere would be determined by the element abundances of the protoplanetary disks where it formed in. One of the challenges is now that these atmospheres are cool enough to allow solids and/or liquids to condense from the gas phase, hence, the formation of clouds alters the primordial element abundances inside the atmosphere. I will summarise the complications in differentiating BDs and free-floating planets with respect to observational findings and theoretical approaches including recent developments in sub-stellar atmosphere modelling.

• **P. Hennebelle,** ***Pre-main sequence evolutionary models for BDs and the gravoturbolent formation scenario***

Abstract: In the first part of the talk, I will describe recent results highlighting the role of accretion on young low-mass stars (LMS) and BDs. These calculations provide a plausible explanation for the observed spread of temperatures/luminosities for young low-mass objects and reinforces the suggestion that accretion on nascent (class-O to class-I) LMS/BDs is episodic. This also highlights the significant uncertainties in PMS or young BD tracks, and on the inferred masses and/or ages for given observational properties. In the second part of the talk, I will present a new analytical theory, inspired from the approach used in cosmology to predict the galaxy mass spectrum, which use the statistical properties of the supersonic turbulence inferred from numerical simulations. The theory predicts an IMF which seems to be in good agreement with the observations and also with the results of numerical simulations. Within the same formalism, I will show that the mass spectrum of the molecular clumps can also be predicted and linked to the power-spectrum of the density fluctuations.

• **T. Huard,** ***Proto-BD populations inferred from Spitzer and NEWFIRM***

Abstract: A systematic and sensitive search for proto-BDs has been made possible by the Spitzer Space Telescope. One of the first results from the Cores-to-Disks (c2d) Spitzer Legacy team was the discovery of a Very Low Luminosity Object, or VeLLO, in the isolated core L1014. Its intrinsic luminosity, estimated to be 0.09 $L_{\odot}$, is consistent with it being sub-stellar. Furthermore, its rising spectral energy distribution suggests that it is deeply embedded within the core. This source may represent the first discovery of a proto-BD, although it is unclear whether it will accrete more mass to become a star or if it will remain sub-stellar. Since this discovery, more VeLLOs have been identified based on their spectral energy distributions (SEDs). Because SEDs of VeLLOs resemble those of some background galaxies, without complementary data, it can be difficult to distinguish an embedded population of VeLLOs from galaxies. In several cases where VeLLOs have been studied in detail, their inferred low accretion rates and envelope masses suggest they may not accrete much more material, making them prime proto-BD candidates. We are conducting systematic searches for VeLLOs, especially those that may be proto-BDs, in nearby isolated cores and large molecular clouds observed by the c2d and Gould's Belt Legacy teams. The properties of these sources will be summarised, and limits placed on the population of proto-BDs in these environments. Very deep, ground-based, near-infrared observations from NEWFIRM will be presented for some of these regions, and the benefits of such observations will be discussed.

• **R. Jayawardhana,** ***Accretion disks in the sub-Stellar realm: properties and evolution***

Abstract: It is now well established that young BDs harbour accretion disks –and thus undergo a T Tauri phase– similar to their low-mass stellar counterparts. The supporting evidence includes infrared and millimeter observations of the dust component as well as optical and infrared spectra with signatures of gas accretion and outflow. Recent findings suggest that disks are common even around young planetary mass objects (PMOs). The ubiquity of circum-substellar disks not only hints at a common formation scenario for PMOs, BDs and stars, but also offers a new regime for investigating processes such as episodic accretion, grain growth and disk clearing.

• **V. Joergens,** ***BD multiplicity and kinematics***

Abstract: Multiplicity is a key parameter for formation models of BDs, as it is for stars. Surveys for companions to BDs by direct (AO or HST) imaging and by radial velocity monitoring led to the discovery of many BD binaries and a few higher order multiple systems in the last few years. New sub-stellar binaries are constantly being detected. I will review the current knowledge about BD binaries and their properties (e.g. frequency, separation and mass ratio distribution), for which the surveys cover now for the first time the complete orbital separation range. Furthermore, the kinematics of BDs in young cluster will be presented. It will be discussed how these observations constrain current models for the formation of BDs (e.g. magneto-turbulent fragmentation, ejection, instabilities in massive disks) and which future observational efforts are necessary to further enlighten our understanding of formation processes in the sub-stellar mass regime.

• **N. Lodieu,** ***Is the IMF universal? Latest results from the UKIDSS Galactic Clusters Survey***

Abstract: In this talk, I will focus on the latest results obtained from the UKIRT Infrared Deep Sky Survey (UKIDSS) Galactic Clusters Surveys (GCS) in 4 regions: Pleiades (130 Myr), IC 4665 (27 Myr), Upper Sco (5 Myr), and σ-Orionis (3 Myr). I will briefly describe the selection procedures used in each cluster to identify very low-mass star (M$\leq$0.5 $M_{\odot}$) and BD member candidates. Then, I will compare the mass functions in the 0.5-0.03 $M_{\odot}$ mass range with the field mass function. I will show that these (system) mass functions follow the extrapolation of the field mass functions of Kroupa (2002) & Chabrier (2003) down to 0.03 $M_{\odot}$. However, we seem to observe a difference at lower masses for the youngest clusters, especially in the case of Upper Sco for which spectroscopic follow-up is available. Under the assumption of a universal log-normal IMF for the star formation process, our results indicate that the characteristic mass is lower and the mass-scale (or width) is higher than was found by Kroupa (2002) & Chabrier (2003) using the higher mass and mixed-age field stars.

• **K. Luhman,** ***BD identification and characterisation***

Abstract: I will review the techniques that have been used in searching for BDs in the solar neighbourhood and in young clusters and summarise the progress from these surveys. I will also discuss methods of estimating the physical properties of BDs, particularly at young ages.

• **M.R. Meyer,** ***Distinguishing brownies from fudge: sub-stellar IMF vs. CMRD***

Abstract: Considerable progress has been made over the past decade in characterising the shape of the stellar and sub-stellar IMF in regions of nearby star formation and young open clusters(e.g. Meyer et al. 2000; Luhman et al. 2007; Moraux et al. 2007). However, fundamental questions remain unanswered. Does the ratio of stars to sub-stellar objects vary as a function of initial condition in molecular clouds? Is there an "end" to the IMF set by the opacity-limit for fragmentation? Is the "companion mass ratio distribution" for multiples distinct from the IMF as a function of primary mass and/or orbital separation? I will summarise recent results from our group that offer answers to these questions focusing on studies concerning: i) the sub-stellar IMF down to 30 M_J in nearby star-forming regions (Andersen et al. 2008); and ii) comparing the sub-stellar companion mass ratio distribution to various forms of the IMF as a function of orbital radius.

• **S. Mohanty,** ***Disk accretion in young stars and BDs with multipole magnetic fields***

Abstract: The manner in which young classical T Tauri stars (cTTs) and BDs accrete gas from their surrounding disks and simultaneously drive jets and outflows is central to understanding low-mass star/BD and planet formation, but remains an ill-understood and hotly debated subject. One of the central issues is the stellar field configuration: while analytic theories of magnetospheric accretion assume an idealised stellar dipole, T Tauri/BD fields are observed to be complex multipolar beasts. I present here an analytic generalisation of the popular X-wind theory to include such fields. Independent of the precise field geometry, the generalised model makes a unique prediction about the relationship between various cTTs/BD observables that is supported by recent data, including detailed spectropolarimetric measurements. In this light, I discuss the unique insights offered by recent magnetic field measurements on accreting BDs: while they agree beautifully with the "accretion theory" above, they also pose a large puzzle for "magnetic field generation theory". Resolving this conundrum promises to illuminate our general picture of accretion in fully convective objects, and thereby both the formation/IMF of low-mass stars and BDs as well as the formation of planets in the accretion disks that girdle them.

• **J.L. Monin,** ***BDs disks sizes as a clue to their formation model***

Abstract: We want to check if the disk size vary with the central object mass. We use disk sizes published on the "circumstellar.org" web site, to compare these sizes with the central object spectral type, used as a proxy for its mass. To our surprise, we find that the disk size actually increases when the spectral type gets later, hence when the central object mass decreases. We interpret this result in view of recent theoretical models and discuss the consequences for BD formation models.

• **A. Natta,** ***Accretion and ejection of matter in BDs***

Abstract: I will first discuss some recent results on winds/jets evidence in BDs. Then, I will present some new results on accretion as function of the (sub-)stellar mass in the σ-Orionis region.

• **P. Padoan,** ***BD formation from turbulent fragmentation in clouds***

Abstract: I will briefly review the process of turbulent fragmentation and show how it could explain the formation of stars of mass as low as BDs. Turbulent fragmentation describes star formation by assuming it can be viewed as the result of two almost independent processes, i) the generation of strong density enhancements by the turbulent velocity field through shocks, and ii) the gravitational collapse of the densest peaks set up by the turbulent flow. To move beyond this idealised picture, I will present results from recent numerical simulations of supersonic MHD turbulence including the effect of self-gravity. Collapsing objects of BD mass are found in these simulations and their formation process can be investigated.

• **A. Palau,** ***Searching for bona fide proto-BDs***

Abstract: We present a multi-wavelength study of a peculiar object found in the direction of the Barnard 213 dark cloud in Taurus. The object has Spitzer IRAC colours typical of Class 0/I protostars, and its 3.6 micron magnitude is consistent with a sub-stellar object. We have collected data ranging from near infrared at 1.1 micron up to radio wavelengths at 6 cm, including data from the Calar Alto Observatory, the Caltech Submillimeter Observatory, the IRAM 30m Telescope, the Kitt Peak 12m and Submillimeter telescopes, and the Very Large Array. The source has a bolometric temperature of ∼200 K, whereas the central object seems to have an effective temperature, based on theoretical models, in the range 800-1700 K. The Spitzer photometry and spectral energy distribution allow us to classify it as a Class I source. The object is associated with an extended submillimeter envelope with a dust temperature approximately in the range 15–25 K. If located at the distance of Taurus, the bolometric luminosity would be 0.003 $L_{\odot}$, which would put this object well below the characteristics of other Very Low Luminosity Objects discovered up to date, and thus could be the best proto-BD candidate identified so far.

• **C. Reylè,** ***Latest news from the Canada-France BD Survey***

Abstract: Since the first discoveries of BDs in 1995, several hundreds of BDs have been identified, most of them thanks to large scale surveys. We undertook such a survey, the Canada-France BD Survey (CFBDS), based on deep multi-colour MegaCam optical imaging obtained at the Canada-France-Hawaii Telescope (CFHT). Candidate BDs and quasars are initially identified on the MegaCam optical images as objects which have very red colours (high $i' - z'$ colours). Near-infrared J-band imaging is thus performed to separate high redshift quasars and BDs. Besides pinpointing the few high redshift quasars that bring important clues on the reionization of the Universe, the J-band photometry very effectively rejects any remaining observational artifacts, as well as the more numerous low-mass M-stars scattered into the BD/quasar colour region by large noise excursions. We expect that complete J-band imaging follow-up of all our candidates will yield about 100 T dwarfs and over 400 L or very late-M dwarfs, approximately doubling the number of known BDs. Follow-up spectroscopy of the T dwarfs candidates with the reddest $z - J$ colour was then carried out. Up to now, 41 T dwarfs are spectroscopically confirmed T dwarfs, with spectral type ranging between T0 and T9. Here we present the status of the survey and the latest results drawn from the spectroscopic follow-up, including several very late T dwarfs and T dwarfs-main sequence stars binaries.

• **A. Scholz,** ***Accretion and disks in BDs: the variability perspective***

Abstract: Variability is a defining feature of T Tauri stars. It constitutes a valuable source of information about the dynamics and structure of the disk, and provides important clues on the physics of the accretion process. In our long-term program, we have demonstrated that young BDs show photometric and spectroscopic variations that are entirely consistent with the characteristics known for stars. Based on an extensive set of observations, we have identified and characterised a sample of ∼10 young and strongly variable very low mass objects, covering timescales from minutes to 5 years. The variability is caused either by hot spots or by obscuration with circumstellar material. Colours and amplitudes of the variations allow us to put limits on the physical properties of the accretion flow and the inner disk. The emission line variations seen in the BD 2M1207 are in line with what is expected for magnetospheric accretion. We show that strong changes in the global accretion rate are the exception, not the norm. In this talk, I will present our results, discuss their implications for our understanding of disk accretion in BDs, and point out future directions. Based on results from Scholz & Eisloeffel (2004, 2005), Scholz et al. (2005), Scholz & Jayawardhana (2006), Stelzer et al. (2007), Nguyen et al. (2009), Scholz et al. (2009).

• **E. Solano,** ***Discovery of utracool subdwarfs using VO tools***

Abstract: Being intrinsically faint objects, the detection of ultracool dwarfs and subdwarfs is not straightforward. In fact, very few of them were known until the advent of global surveys at deep optical and near-infrared wavebands like 2MASS, SDSS, DENIS or, more recently, UKIDSS. Although these surveys have demonstrated to be very effective in uncovering hundreds of ultracool objects, the search is far from being completed. The identification of ultracool objects usually requires mining the sky through an appropriate combination of attributes available from different archives (e.g. colours and/or proper motion information), a tedious and time-consuming task if a "classical" methodology is used. Conversely, the navigation across large databases in an efficient and organised way is an approach that perfectly fits the framework of the Virtual Observatory. In this contribution we will describe a number of projects presently carried out in the framework of the Spanish Virtual Observatory with the goal of identifying ultracool dwarfs and subdwarfs.

• **D. Stamatellos,** ***The predictions of the disk fragmentation model***

Abstract: We will present the predictions of the disk fragmentation model and we will compare these predictions with the observed properties of low-mass stars and BDs. In particular, we will show that the model of disk fragmentation can explain the binary properties of low-mass stars, the BD desert, and the existence of free-floating planetary mass objects. We will also discuss predictions of the model that can be tested by future observations and the possibility of observing fragmenting disks with mm interferometers.

• **L. Testi, *ALMA***

Abstract: The Atacama Large Millimeter/submillimeter Array (ALMA) is being constructed in northern Chile and will become the leading millimeter/submillimeter observing for the coming decades. ALMA is currently expected to release the first call for observing proposals towards the end of 2010. With its superb sensitivity, angular resolution and image fidelity ALMA is the perfect instrument to study the formation and early evolution of young BDs. In this talk I will discuss the capabilities and possible impact of ALMA in this field of research.

• **L. Valdivielso, *Protoplanetary disks of isolated VLMOs discovered in the IPHAS survey***

Abstract: In our previous study (Valdivielso et al. 2009), Virtual Observatory tools were used to cross-match the IPHAS catalogue with the 2MASS catalogue. We defined photometric criteria to identify Hα emission sources with near-infrared colours similar to known young very low-mass stars and BDs. Spectral types have been derived for the 33 candidates that have spectroscopically confirmed Hα emission, negligible reddening and spectral class M. Ten have classes in the range M5.5-M7.0 and could thus be very young BDs. Many objects also have weak NaI doublet, an indication of low surface gravity. We will report on a deeper study of the targets. We found that many of them display a clear excess in the Spitzer bandpasses, commonly associated with the presence of circumstellar material. Together with their strong Hα emission, which must be associated to accretion, the mid-infrared excesses confirm the youth of these objects. Also, first results of distance estimations of these objects show that only few of them might belong to nearby star forming regions.

• **A. Whitworth,** ***BD formation from fragmentation of protostellar disks***

Abstract: We present analytic results and numerical simulations demonstrating that BDs can form efficiently from the fragmentation of protostellar accretion disks, and that the BDs formed in this way have multiplicity statistics and other observational properties closely similar to those of observed BDs.

• **M.R. Zapatero Osorio,** ***Surveys for BDs - IR imaging***

Abstract: BDs and massive planetary-mass objects, once elusive, now known to be nearly ubiquitous, are characterised by their low surface temperature and quite red optical-NIR colours. NIR surveys have been unquestionably conclusive for their detection in quantities, have made their study possible in various ways, and have contributed to the understanding of their population number. In this talk, I will review the detection of BDs and planetary-mass objects as companions to stars and as free-floaters in small- and large-scale NIR and IR surveys.

• **H. Zinnecker,** ***VISTA microlensing survey of free-floating BDs towards the Galactic Center***

Abstract: We propose a near-IR microlensing survey of the central 2 degree field of the Galactic Center, in an attempt to estimate the surface density and mass distribution of distant BDs in the Galactic bulge and in the inner disk, acting as lenses of bright stars towards the Galactic Center. We estimate the probability (optical depth) of microlensing events to be 10^{-7} and the typical timescale (full width) of the amplification lightcurve to be about 1 week. The necessary wide-field near-IR technology will become available soon with VISTA at ESO/Paranal.

Abstracts for poster contributions

• **M. Aberasturi & E. Solano,** ***Discovery and characterisation of BDs using Virtual Observatory tools***

Abstract: BDs are intrinsically faint objects so their detection is not straightforward. Building a census of sub-stellar objects implies the discovery of a statistically significant number of them through queries that combine attributes (colours, proper motions, etc) available from different archives (e.g. UKIDSS, SDSS, 2MASS, DENIS, etc). This is an approach that perfectly fits in the framework of the Virtual Observatory. In this poster we describe the methodology and lines of work that, in the field of detection and characterisation of BDs, are being developed by members of the Spanish Virtual Observatory.

• **A.S.M. Burgess,** ***Three New T-Dwarfs in IC 348***

Abstract: The determination of the lower-end of the IMF provides strong constraints on star formation theories. We report here on a search for isolated planetary-mass objects in the 3 Myr-old star-forming region IC 348. Deep, narrowband CH4 off/on images were obtained with CFHT/WIRCAM over 0.11 sq. deg. in the central part of IC 348 to identify young T-dwarfs from their 1.6μm methane absorption bands. We report 3 faint (J$\approx$21 mag) T-dwarf candidates with CH4 on-CH4 off colours >0.4 mag. Extinction was estimated for each candidate and lies in the A_V range 5-12 mag. Comparisons with T-dwarf spectral models, and colour/colour and colour/magnitude diagrams, result in preliminary spectral type estimates between T5 and T6. These objects are not thought to be foreground field dwarfs from a number density argument, and also from their strong extinction, nor background field T-dwarfs which would be expected to be much fainter. With a mass of a few Jupiter masses, the 3 young T-dwarf candidates reported here are potentially the youngest, lowest mass objects detected in a star forming region so far.

• **C.V. Cardoso,** ***Epsilon Indi Ba, Bb: dynamical masses for the nearest BD binary***

Abstract: We present new preliminary astrometric results for the closest known BD binary to Earth, Epsilon Indi Ba, Bb at a distance of 3.6224 pc. The relative orbital motion of the BDs (spectral types T1 and T6) has been monitored since June 2004 with the VLT NACO near-IR adaptive optics system. With data for more than half the orbit now, we obtain an accurate total dynamical system mass (<1%), considerably in excess of earlier determinations based on evolutionary models. We have also been monitoring the absolute astrometric motion of the system since August 2005 against a network of field stars using the VLT FORS2 optical imager with the aim of determining the individual masses. Our current orbit solution predicts periastron passage in early 2010, and shortly thereafter, we should be able to determine the absolute masses to better than 5% in a model independent way.

• **F. Delorme,** ***Field BD luminosity function from the Canada-France BD Survey***

Abstract: The Canada-France BD Survey is a wide field survey for cool BDs conducted with the MegaCam camera on the CFHT telescope. Our objectives are to find ultracool BDs and to constrain the field BD mass function from a large and homogeneous sample of L and T dwarfs. We identify candidates in CFHT/Megacam i' and z' images and follow them up with pointed NIR imaging on several telescopes. Our survey has to date found $\sim$70 T dwarfs candidates and $\sim$300 L or late M dwarf candidates drawn from a larger sample of 1300 candidates with typical ultracool dwarfs $i' - z'$ colours, found in 899 square degrees. We currently have completed the NIR follow-up on a large part of the survey for all candidates from the latest T dwarfs known down to the late L colour range. We determined clean completeness and rejection of false positive rates for each CFBDS field. This allows us to build on a complete and well defined sample of

ultracool dwarfs to investigate the luminosity function of field L and T dwarfs.

• **N. Huélamo,** ***Circumstellar disks around low-mass stars and BDs in Collinder 69***
Abstract: We present our results from Spitzer+VISIR/VLT observations of six low-mass tars and BDs in Collinder 69, the ∼5 Myr central cluster in the λ Orionis star forming region. We have fitted the spectral energy distributions of the objects with radiative transfer models to derive the main properties of the disks. Finally, we have compared these properties with those of Upper Scorpius, a cluster with a similar age but with a different star formation history, and with no massive stars in the neighbourhood.

• **M. Kaplan,** ***The survival of BD/BD binaries in a fractal star clusters***
Abstract: It has been suggested that BDs (BDs) and BD/BD binaries form by fragmentation of massive extended protostellar disks around Sun-like stars (Stamatellos & Whitworth 2009). We present numerical N-body simulations following the long-term dynamical evolution of BDs and BD/BD binaries formed in this way. The initial conditions are systems, each comprising a primary star and four (in general) lower-mass companions formed out of the primary's circumstellar disk. The primaries and the secondaries have log-normal mass functions, which together mimic the observed stellar IMF. The systems (comprising a primary and four secondaries) are distributed in a star cluster with fractal dimension 2; they are randomly orientated relative to one another, and the four low-mass secondaries are initially either all on independent orbits, or two of them are in a close BD/BD binary, or all four are in two close BD/BD binaries. The clusters are followed for 15 Myrs. By means of numerical experiments we evaluate (i) the fraction of BDs which end up in BD/BD binaries, (ii) the statistical properties of these binaries, (iii) whether these binaries remain attached to the primary, and (iv) where the BDs end up relative to the overall cluster, as it relaxes to a non-fractal state.

• **S. Kitsionas,** ***Forming free-floating BDs as a by-product of multiple star formation***
Abstract: The formation of free-floating BD-mass objects is a common outcome in SPH simulations of dynamical star formation (Bate, Bonnell & Bromm 2002a,b, 2003; Kitsionas & Whitworth 2007). These objects get ejected from the protostellar disks they form in at early stages of their formation, i.e. at their first phases of accretion. Therefore, they end up with low masses outside the mass reservoir of their forming site. On average they are ejected at moderate speeds as a result of dynamical interactions (star-star, disk-disk, star-disk, etc.) in their forming environment. We present new as well as previous (Kitsionas & Whitworth 2007) SPH simulations of cloud-cloud collisions in which BDs get ejected in the course of interactions within filaments between their parental protostellar disks. Such interactions lead to the formation of (close) stellar binaries and the ejection of low-mass objects forming in the disks. It is important to understand the statistics (frequency, efficiency etc.) of such formation scenarios in order to be able to assess the number of free-floating BDs in star formation sites and the field. Hans Zinnecker in his contribution bases his calculations on the feasibility of microlensing observations of free-floating BDs towards the Galactic Centre on the binary and disc fragmentation statistics. This poster sets some constraints on such statistics.

• **R. Köhler,** ***Dynamical mass determinations of BD binaries***
Abstract: We present orbit determinations for the BD binaries Epsilon Indi B and Kelu-1. Cardoso et al. have been monitoring the relative positions of Epsilon Indi Ba and Bb for 5 years, which corresponds to almost half its orbital period. This enables us to obtain precise estimates for the orbital parameters. The error of the dynamical mass is only about 1%, where the main contribution comes from the uncertainty of the distance to Epsilon Indi B. Kelu-1 A-B has been monitored by Stumpf et al. for three years, which covers only about 10% of the orbit. Therefore, the estimates for the orbital parameters are less precise. We present the latest results on the two orbits and discuss the methods for the orbit determination and error estimates.

• **R. Kurtev, *BDs with companions***
Abstract: The binarity of ultracool BDs can help to constrain the models of their formation and evolution. Furthermore, no radial velocity (RV) planet has been discovered around a BD yet. Here we present the first results of a RV study with GEMINI/PHOENIX of a couple of BDs that use the telluric absorptions in the near infrared as a natural iodine-like cell that has the potential of delivering RV measurements with accuracy of 300-600 m/s, allowing us to probe the BD companions down to the planet range.

• **B. Lòpez Martì, *Young low-mass objects in the Elephant Trunk***
Abstract: The IC 1396 HII region is one of the best examples of star formation in dark cometary globules, triggered by the winds of the massive O6 star HD 206267 at its center. Here, we present the first results of a survey for very low-mass objects in the IC 1396A globule, also known as the Elephant Trunk Nebula. Our RIz and JHK_S data are combined with the IRAC/Spitzer photometry from Morales-Calderón et al. (2009) to select candidate members of the region. Our objects have magnitudes between 14< I <20, corresponding to masses down to about 40 M_J in the areas of lowest extinction. They are the first sub-stellar candidates identified so far in this region.

• **K. Mi-Ryang, *A search for proto-BD candidates (VeLLOs) in Gould's belt clouds***
Abstract: The Gould's belt survey of the Spitzer Legacy projects has observed in 3.6-160 μm toward nearby star-forming regions. We present the results of searching for the very low luminosity objects (VeLLOs; internal luminosity : $L_{int} < 0.1$ $L_\odot$) using the survey data. The clouds are Auriga, Cepheus, Corona Australis, IC 5146, Lupus V, Musca, and Scorpius, having the properties of low-mass star-forming such as the Taurus cloud. We used the same criteria by Dunham et al. to select VeLLOs among which the most important criterion is a flux density at 70 μm that is directly converted to the internal luminosity. We identify a total of 68 new embedded VeLLO candidates with $L_{int} < 0.1$ $L_\odot$, 15 in Auriga, 14 in Cepheus, 6 in Corona Australis, 26 in IC 5146, 2 in Lupus V, and 5 in Scorpius. We present a fit to the spectral energy distributions and IRAC color-color diagrams and calculate evolutionary properties for each object. We discuss that the evolutionary state of these candidates is either proto-BDs or stars.

• **E. Moraux, *The lower mass function of the young open cluster NGC 2516***
Abstract: From the detection of several tens of BDs using wide-field cameras, we derive a new estimate of the present day mass function (PDMF) of the young (∼150 Myr) open clusters NGC 2516 from 0.2 $M_\odot$ down to 50 Jupiter masses. We compare our result with the PDMF of 2 other young open clusters of similar age (Pleiades and Blanco 1) but different stellar density. The mass function of the three clusters are remarkably similar, suggesting little impact of specific conditions on the mass distribution from 10 $M_\odot$ down to 30 Jupiter masses. Functional forms are provided to allow quantitative comparison with MFs derived in other environments.

• **K. Peña Ramìrez, *Searching for T-type, free-floating super Jupiters in the σ-Orionis cluster***
Abstract: We present a new multi-wavelength photometric study using optical (I, Z), near-infrared (J, H, CH4) and IRAC/Spitzer ([3.6], [4.5]) photometry in an area of 114 square arcmin in the σ Orionis cluster reaching limiting magnitudes (4σ) of J=22 and H=22. We search for faint and red T-type cluster member candidates that comply with the following criteria: J≥19.5, I-J≥3.5, J-H≥0.5, J-[4.5]≥ 1.8, J-[3.6]≥3.2. According to theoretical evolutionary models, they would have estimated masses in the range 2-10 M_J.

• **M. Perger, *A UKIDSS-based search for BDs in young nearby star-forming regions***
Abstract: We searched for MLT type BD-, variable- and transition disk candidates in young nearby star-forming regions with different fractions of sub-stellar to stellar objects possibly related to their stellar densities. They have been selected from the UKIDSS Galactic Cluster

Survey using photometric and proper motion criteria. Recent formation models include that such objects could be located further away from the main clouds where up to date no such searches were applied. We found candidates in IC 348, in yet unexplored small stellar clumps in Orion encountered by the calculation of an extinction map and in the north of Taurus main cloud, where a dearth of BDs is measured. We might therefore contribute to the interesting questions of the BD formation and the form and the universality of the low-mass mass function. The ongoing observations of the candidates shall help to assign spectral type, estimate surface gravity and to derive new number frequencies.

• **M. Reggiani, *Ages and mass accretion rates in the Orion Nebula Cluster***
Abstract: We present a new HR diagram of the Orion Nebula Cluster (ONC), obtained using the broad-band photometry taken for the HST Treasury Program on the ONC and the most recent estimate of the cluster distance. We compare the source distribution in the HR diagram with the theoretical isochrones derived by different groups to estimate the mean cluster age, the age dispersion and the mass distribution. From the inferred masses and radii and a bayesian estimate of the accretion luminosity we derive the mass accretion rate towards each source to search for evidence of trends with the stellar age.

• **B. Riaz, *Silicate evolution in BD disks***
Abstract: We present a compositional analysis of the 10μm silicate spectra for BD disks in the Taurus and Upper Scorpius (UppSco) star-forming regions, using archival Spitzer/IRS observations. A variety in the silicate features is observed, ranging from a narrow profile with a peak at 9.810μm, to nearly flat, low-contrast features. For most objects, we find nearly equal fractions for the large-grain and crystalline mass fractions, indicating both processes to be active in these disks. The median crystalline mass fraction for the Taurus BDs is found to be 20%, a factor of 2 higher than the median reported for the higher mass stars in Taurus. The large-grain mass fractions are found to increase with an increasing strength in the X-ray emission, while the opposite trend is observed for the crystalline mass fractions. A small 5% of the Taurus BDs are still found to be dominated by pristine ISM-like dust, with an amorphous sub-micron grain mass fraction of 87%. For 15% of the objects, we find a negligible large-grain mass fraction, but a >60% small amorphous silicate fraction. These may be the cases where substantial grain growth and dust sedimentation has occurred in the disks, resulting in a high fraction of amorphous sub-micron grains in the disk surface. Among the UppSco BDs, only usd161939 has a S/N high enough to properly model its silicate spectrum. We find a 74% small amorphous grain and a 26% crystalline mass fraction for this object.

• **E. Rigliaco, *Disks and activity around low-mass stars in the σ-Ori star forming region***
Abstract: Circumstellar disks are observed around pre-main sequence objects of masses from few $M_\odot$ to BDs, and the correlation with the accretion properties is crucial to understand the disk evolution. We present here a study of the accretion properties based on the U-band excess emission for a sample of pre-main sequence stars in the intermediate age star forming region σ-Orionis in the mass interval from 0.008 to 0.8 $M_\odot$.

• **G. Scandariato, *JHK photometry of the sub-stellar population in the Orion Great Nebula***
Abstract: We present near-infrared (J-, H-, and Ks- bands) photometry of the Orion Nebula Cluster. A 30'×40' region has been observed with the ISPI camera at the CTIO Blanco 4m telescope, covering the whole area with 11 contiguous fields with 300s typical exposure time. Our final catalog contains 7766 sources. We classify 6630 sources as point-like and 933 sources as diffuse objects. For 203 bright sources, saturated in our shortest 3s exposures, we adopt the photometry taken from the 2MASS catalog. Point-like sources magnitudes, converted in the 2MASS photometric system, are in the range 8< K_S <21. The (H,J-H) and (K_S,H-K_S) color-magnitude (CM) diagrams show that our catalog is sensible to objects with masses down

to 0.002 $M_{\odot}$. We analyse the Luminosity Functions (LFs), the color-color and color magnitude diagrams comparing the results obtained for different projected distances from the cluster center. We find the largest fraction of sources with IR excess compatible with a circumstellar disk in the inner core (projected radius <0.7 pc), whereas at intermediate distances (0.7 to 1.6 pc) the average extinction rises, compatible with a young population still embedded in the OMC1 cloud. Dereddening our photometry using theoretical evolutionary models for a 1 Myr isochrone, we estimate the mass of our point-like sources. We discuss the dependency of the LF and IMF on the distance from theta1 Ori-C, which shows signs of variations in the ratio of stellar-to-substellar populations.

• **M. Sierra,** ***Differences between disked and diskless low-mass populations in Lupus and Cha II***
Abstract: The Spitzer data, with their wavelength coverage, offer an exceptional tool for studying the status and evolution of the inner zones in the disks around young stars (1-30 AU), where planets eventually form. We present an analysis of data from the "Cores to Disks" (c2d) Spitzer Legacy Program, which mapped five nearby star-forming regions from 3 to 70 μm and provides a large and magnitude-limited sample of 800 protoplanetary disks with ages smaller than 10 Myr. In particular this poster presents the analysis of 213 PMS objects in the Lupus and Cha II clouds. In order to understand the dependence of disk dissipation around young low-mass stars, we compare the stellar parameters of disked and diskless star samples in these clouds. This could provide evidences for conditions favourable for early inner disk evolution and possibly efficient planet formation. Finally, these results are relevant for future studies since Herschel will provide very complementary information about the outer disks.

• **L. Testi,** ***A low-resolution near-infrared spectral library of M-, L-, and T-dwarfs***
Abstract: We present complete near-infrared (0.85–2.45 μm), low-resolution (R$\sim$100) spectra of a sample of 54 disk M-, L-, and T-dwarfs with reliable optical or near infrared spectral-type classification from the literature. The observations were obtained with a prism-based optical element, the Amici device, which provides a complete spectrum of the source on the detector. Our observations indicate that low-resolution near-infrared spectroscopy can be used to determine the spectral classification of late-type field dwarfs in a fast but accurate way. We derive a set of near-infrared spectral indices that are useful to the classification of field dwarfs not seriously affected by reddening. Finally, we show that the comparison of Amici spectra with model atmospheres allows us to obtain a reliable estimate of the dwarf effective temperatures.

• **S. Walch,** ***BD formation in Ophiuchus - 3D SPH simulations***
Abstract: Ophiuchus is one of the best observed nearby star forming regions. The properties of harboured prestellar cores as well as the statistics of young stars found within this region are well constrained. Thus, Ophiuchus provides the ideal opportunity to investigate low-mass star and BD formation in simulations, starting from initial conditions which are as closely as possible informed by observations. We perform 3-dimensional simulations of prestellar core collapse with the SPH code SEREN. We include the radiative cooling description of Stamatellos et al.(2007) and sink particles, and start from mildly turbulent, super-critical Bonnor-Ebert spheres. We use a small Monte Carlo sample of turbulent initial conditions for every Ophiuchus core. In this poster, I will present the results on BD formation and statistics from core collapse and disk fragmentation.

• **C. Won Lee,** ***Discovery of A proto-BD candidate in the starless dense core L 328***
Abstract: We report the discovery of a proto-BD candidate in the "starless" dense core L328, using the Spitzer Space Telescope and ground based observations from near-infrared to millimeter wavelengths. The Spitzer 8 μm image indicates that L 328 consists of three subcores of which the smallest one may harbour a source, L328-IRS, while two other subcores remain starless. L328-IRS is a Class 0 protostar according to its bolometric temperature (44 K) and the high fraction ($\sim$72%) of its luminosity emitted at sub-millimeter wavelengths. Its inferred

"internal luminosity" (0.04-0.06 $L_\odot$) using a radiative transfer model under the most plausible assumption of its distance as 200 pc is much fainter than for a typical protostar, and even fainter than other very low luminosity objects studied previously. Low angular resolution observations of CO do not show any clear evidence of a molecular outflow activity. But broad line widths toward L 328, and Spitzer and near-infrared images showing nebulosity possibly tracing an outflow cavity, strongly suggest the existence of outflow activity. Provided that an envelope of at most 0.1 $M_\odot$ is the only mass accretion reservoir for L328-IRS, and the star formation efficiency is close to the canonical value $\sim$30%, and L328-IRS has not yet accreted more than $\sim$0.05 $M_\odot$, at the assumed distance of 200 pc, L328-IRS should be a proto-BD to become a BD in future.

Table 1: **List of Participants**

No.	Name	Contribution	Title	e-mail
1	Aberasturi M.	Poster	Discovery and characterisation of BDs using Virtual Observatory tools	Miriam.Aberasturilaeff.inta.es
2	Alves de Oliveira C.	Talk	Probing the low-mass end of the IMF in the ρ-Ophiuchi molecular cloud	Catarina.Oliveiraobs.ujf-grenoble.fr
3	André P.	Talk	Searching for low-mass prestellar cores with Herschel	pandrecea.fr
4	Bate M.	Talk	BD formation from early ejection: results from recent SPH simulations	mbateastro.ex.ac.uk
5	Bonnell I.	Talk	BD formation, an introductory review	iab1st-andrews.ac.uk
6	Boudreault S.	Talk	Constraint on BD formation via ejection: radial variation of the stellar	boudreampia.de
7	Bouvier J.	Talk	The sub-stellar IMF	Jerome.Bouvierobs.ujfgrenoble.fr
8	Briceno C.	Talk	Surveying the substellar component of the Orion dispersed populations	bricenocida.ve
9	Burgasser A.	Talk	The BD multiplicity fraction: are most BDs in (tight) multiples?	ajbmit.edu
10	Burgess A.S.M.	Poster	Three New T-Dwarfs in IC 348	aburgessobs.ujf-grenoble.fr
11	Burningham B.	Talk	The sub-stellar IMF from the UKIDSS Large Area Survey	b.burninghamherts.ac.uk
12	Clark P.	Talk	BD formation from gas filaments infalling onto stars	pccita.uni-heidelberg.de
13	Cardoso C.V.	Poster	Epsilon Indi Ba, Bb: dynamical masses for the nearest BD binary	catiaastro.ex.ac.uk
14	Casewell S.	Talk	Methane imaging of T dwarfs in the Pleiades	slc25star.le.ac.uk
15	Cody A.M.	Talk	A search for pulsation in young BDs and low mass stars	amcastro.caltech.edu
16	Comerón F.	Talk	Observing BDs in the ELT era	fcomeroneso.org
17	Delorme F.	Poster	Field BD luminosity fonction from the Canada-France BDs Survey	pd10st-andrews.ac.uk
18	Faherty J.	Talk	Higher order multiplicty amongst widely separated BD companions to stars	jfahertyamnh.org
19	Fridlund M.	Talk	CoRoT	mfridlunrssd.esa.int
20	Geers V.	Talk	SONYC: searching for the bottom of the IMF	cgeersastro.utoronto.ca
21	Glover S.	Talk	Forming BDs at high redshift and low metallicity	sgloverita.uni-heidelberg.de
22	Goldman B.	Talk	BD binarity using laser-guide adaptive optics systems	goldmanmpia.de
23	Goodwin S.	Talk	What do disks tell us about BD formation?	s.goodwinsheffield.ac.uk
24	Haisch K.	Talk	Methane imaging of BDs and planetary mass objects in ρ-Ophiuchi	Karl.Haischuvu.edu
25	Harvey P.	Talk	A Spitzer search for disks around young planetary mass objects	pmhastro.as.utexas.edu
26	Helling C.	Talk	Theoretical and observational differences between BDs and free-floating planets	Christiane.Hellingstand.ac.uk
27	Hennebelle P.	Talk	Pre-main sequence evolutionary models for BDs and the gravoturbolent formation scenario	patrick.hennebellelra.ens.fr
28	Huard T.	Talk	Proto-BD populations inferred from Spitzer and NEWFIRM	thuardastro.umd.edu
29	Huélamo N.	Poster	Circumstellar disks around low-mass stars and BDs in Collinder 69	nhuelamolaeff.inta.es
30	Jayawardhana R.	Talk	Accretion disks in the sub-stellar realm: properties and evolution	rayjayastro.utoronto.ca
31	Joergens V.	Talk	BD multiplicity and kinematics	vikimpia.de
32	Kaplan M.	Poster	The survival of BD/BD binaries in a fractal star clusters	Murat.Kaplanastro.cf.ac.uk
33	Kitsionas S.	Poster	Forming free-floating BDs as a by-product of multiple star formation	skitsionasgooglemail.com
34	Köhler R.	Poster	Dynamical mass determinations of BD binaries	rkoehlerlsw.uni-heidelberg.de
35	Kurtev R.	Poster	BDs with companions	radostin.kurtevuv.cl
36	Lodieu N.	Talk	Is the IMF universal? Latest results from the UKIDSS Galactic Clusters Survey	nlodieuiac.es
37	López Martí B.	Poster	Young low-mass objects in the Elephant Trunk	belenlaeff.inta.es
38	Luhman K.	Talk	BD identification and characterisation	kluhmanastro.psu.edu
39	McCaughrean M.	Talk	Summary talk	mjmastro.ex.ac.uk
40	Merín B.	-	-	Bruno.Merinsciops.esa.int
41	Meyer M.R.	Talk	Distinguishing brownies from fudge: sub-stellar IMF vs. CMRD	mmeyerphys.ethz.ch
42	Mi-Ryang K.	Poster	A search for proto-BD candidates (VeLLOs) in Gould's belt clouds	mrkimkasi.re.kr
43	Mohanty S.	Talk	Disk accretion in young stars and BDs with multipole magnetic fields	s.mohantyimperial.ac.uk
44	Monin J.L.	Talk	BDs disks sizes as a clue to their formation model	Jean-Louis.Moninobs.ujf-grenoble.fr
45	Moraux E.	Poster	The lower mass function of the young open cluster NGC2516	estelle.morauxobs.ujf-grenoble.fr
46	Natta A.	Talk	Accretion and ejection of matter in BDs	nattaarcetri.astro.it
47	Padoan P.	Talk	BD formation from turbulent fragmentation in clouds	ppadoanucsd.edu
48	Palau A.	Talk	Searching for bona fide proto-BDs	apalaulaeff.inta.es
49	Peña Ramírez K.	Poster	Searching for T-type, free-floating super Jupiters in the σ-Orionis cluster	karlaiac.es
50	Perger M.	Poster	A UKIDSS-based search for BDs in young nearby star-forming regions	mpergeriac.es
51	Reggiani M.	Poster	Ages and mass accretion rates in the Orion Nebula Cluster	maddalena.reggianigmail.com
52	Reylé C.	Talk	Latest news from the Canada-France BD Survey	celineobs-besancon.fr
53	Riaz B.	Poster	Silicate evolution in BD disks	basmahiac.es
54	Rigliaco E.	Poster	Disks and activity around low-mass stars in the σ-Ori star forming region	erigliacoarcetri.astro.it
55	Scandariato G.	Poster	JHK photometry of the sub-stellar population in the Orion Great Nebula	gasoact.inaf.it
56	Scholz A.	Talk	Accretion and disks in BDs: The variability perspective	as110st-andrews.ac.uk
57	Sierra M.	Poster	Differences between disked and diskless low-mass populations in Lupus and Cha II	Mar.Sierrasciops.esa.int
58	Solano E.	Talk	Discovery of utracool subdwarfs using VO tools	esmlaeff.inta.es
59	Stamatellos D.	Talk	The predictions of the disk fragmentation model	D.Stamatellosastro.cf.ac.uk
60	Testi L.	Talk	ALMA	ltestieso.org
61	Valdivielso L.	Talk	Protoplanetary disks of isolated VLMOs discovered in the IPHAS survey	lvaliac.es
62	Walch S.	Poster	BD formation in Ophiuchus - 3D SPH simulations	stefanie.walchastro.cf.ac.uk
63	Whitworth A.	Talk	BD formation from fragmentation of protostellar discs	a.whitworthastro.cf.ac.uk
64	Won Lee C.	Poster	Discovery of a proto-BD candidate in the starless dense core L328	cwlkasi.re.kr
65	Zapatero M.R.	Talk	Surveys for BDs - IR imaging	mosorioiac.es
66	Zinnecker H.	Talk	VISTA microlensing survey of free-floating BDs towards the Galactic Center	hzinneckeraip.de