FORMATION and EARLY EVOLUTION of VERY LOW MASS STARS and BROWN DWARFS

11–14 October 2011
Garching, Germany

SOC

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ABSTRACT BOOK

TALKS

Very Low Mass Stars and Brown Dwarfs

ESO, Garching b. München (Germany), 11-14 October 2011

ABSTRACT BOOK

TALKS

In the order of the Program

(as at 4-Oct-2011)

Very Low Mass Stars and Brown Dwarfs

ESO, Garching b. München (Germany), 11 – 14 October 2011

P R O G R A M

(as at 4-Oct-2011)

TUESDAY, 11 October		
Session 1: Structure of molecular clouds: Formation and properties of cores		
09:30	P. Myers	Cloud structure and star formation (invited)
10:10	P. André	From the filamentary structure of molecular clouds to the formation and properties of prestellar cores (invited)
10:50	**Coffee Break**	
11:05	A. Hacar	Dense core formation by fragmentation of velocity-coherent filaments in L1517
11:25	E. Bressert	The spatial distribution of prestellar cores and YSOs in the solar neighbourhood
11:45	K. Tomida	Exposed Long-lifetime First core: Star formation in very low-mass molecular cloud cores
12:05	W. Fischer	Adding HOPS to the Hunter's Brew: Insights from Herschel on Star Formation in Orion
12:25	**Lunch Break**	
Session 2: From cores to stellar systems: fragmentation, properties and multiplicity of protostars		
14:00	M. Bate	From prestellar cores to stellar systems: fragmentation, properties and multiplicity of protostars – Theory (invited)
14:40	A. Boss	Collapse and Fragmentation of Magnetic Molecular Cloud Cores with an AMR Code
15:00	S. Basu	Brown Dwarfs from Disk Fragmentation and Ejection
15:20	D. Stamatellos	The formation of low-mass stars and brown dwarfs by disc fragmentation
15:40	**Coffee Break**	
16:00	B. Commerçon	Early stages of low mass star formation
16:20	P. Teixeira	Jeans fragmentation within the OMC1 filaments: clues to how the core mass function is assembled
16:40	M. Dunham	The Low End of the Protostellar Luminosity Distribution: Very Low Mass Star Formation, Proto-Brown Dwarfs, First Hydrostatic Cores, and Episodic Mass Accretion
17:00	T. Huard	The Nature and Fate of VeLLOs
17:20	**Posters and Bier and Brezeln at ESO**	

WEDNESDAY, 12 October		
9:00	G. Duchene	From prestellar cores to stellar systems: fragmentation, properties and multiplicity of protostars – Observations (invited)
9:40	P. Almeida	Finding proto-spectroscopic binaries: Precise multi-epoch radial velocities of 7 protostars in Ophiuchus
10:00	A. Kraus	Multiple Star Formation to the Bottom of the IMF
10:20	R. Parker	Dynamical evolution of very low mass binaries in open clusters
10:40	**Coffee Break**	
Session 3: Revealing and understanding the low mass end of the stellar IMF		
11:00	G. Chabrier	The initial mass function in the low-mass regime - Connection with low-mass star and brown dwarf formation (invited)
11:40	N. Deacon	A solar neighbourhood proper motion survey with PS1+2MASS
12:00	B. Reipurth	The Brown Dwarf Ejection Model 10 Years Later
12:20	**Lunch Break**	
14:00	K. Luhman	Revealing and understanding the low mass end of the stellar IMF (invited)
14:40	P. Dawson	Brown Dwarfs in Upper Scorpius: new results from 3 surveys
15:00	N. Lodieu	Testing the fragmentation limit in the Upper Sco association
15:20	C. Alves de Oliveira	Probing the substellar IMF in nearby star-forming regions: a WIRCam/CFHT survey
15:40	**Coffee Break**	
16:00	K. Muzic	Substellar Objects in Nearby Young Clusters (SONYC): Towards an Unbiased Census
16:20	K. Peña Ramirez	The complete low-mass mass function of the young star cluster sigma Orionis
16:40	A. Bayo	Spectroscopy of Very Low Mass Stars and Brown Dwarfs in the Lambda Orionis Star Forming Region
17:00	J. Downes	The very low mass star and brown dwarf population of the 25 Orionis group
19:30	**Conference Dinner**	

THURSDAY, 13 October		
Session 4: The circum(sub)stellar environment: disks, outflow and accretion processes		
9:00	A. Natta	Disks, Accretion and Outflows (invited)
9:40	L. Hartmann	The circum(sub)stellar environment: disks, outflow and accretion processes (invited)
10:20	G. de Marchi	Low-mass star formation in the Local Group
10:40	**Coffee Break**	
11:00	S. Mohanty	Disk Masses around Low Mass Stars & Brown Dwarfs: A Bayesian Analysis
11:20	L. Testi	Disk evolution and the initial steps towards planet formation
11:40	D. Jaffe	What Controls the Properties of Disks Around Young Brown Dwarfs?
12:00	M. Gully-Santiago	Observations of grain properties and accretion in the circum(sub)stellar disk environment
12:20	**Lunch Break**	
14:00	B. Riaz	The radial distribution of dust species in young brown dwarf disks
14:20	T. Preibisch	Lifetimes of disks around low-mass stars in extreme environments
14:40	A. Scholz	T Tauri stars vs. young brown dwarfs: similarities and differences
15:00	J.M. Alcalá	An X-Shooter survey of nearby star forming regions: low and sub-stellar mass objects
15:20	**Coffee Break**	
15:40	C. Manara	The HST Treasury Program on the Orion Nebula Cluster: Mass Accretion Rates Estimates
16:00	V. Joergens	Outflows, accretion and binaries among ChaI brown dwarfs / VLMS
16:20	M. R. Zapatero Osorio	Near-infrared linear polarization of ultracool dwarfs
16:40	**Posters and Bier and Brezeln at ESO**	

FRIDAY, 14 October		
Session 5: Early evolution of very low mass stars and brown dwarfs		
9:00	I. Baraffe	Early Evolution of Very Low Mass Stars and Brown Dwarfs (invited)
9:40	L.Spezzi	Early evolution of low mass stars and brown dwarfs: an observational overview (invited)
10:20	S. Offner	The Role of Episodic Accretion in Low-Mass Star Formation
10:40	S. Antoniucci	POISSON project: an optical/IR spectral survey of Young Stellar Objects from different star-forming regions
11:00	**Coffee Break**	
11:20	J. Patience	Infrared spectroscopy across the brown dwarf/planet boundary
11:40	G. Wuchterl	Transit Tests of Formation Theory
12:00	T. Dupuy	Testing Formation with Brown Dwarfs in the Solar Neighborhood
12:20	W. Brandner	Binarity of brown dwarfs
12:40	J. Bochanski	FIRE Spectroscopy of the ultra-cool brown dwarf, UGPS J072227.51-054031.2
13:00	**Closing Remarks**	
End of the meeting		

Tuesday, 11 October

ABSTRACT

Phil Myers
Harvard-Smithsonian Center for Astrophysics, Cambridge (US)

Cloud structure and star formation (Invited)

The dense gas in star-forming regions of molecular clouds can be described as a network of clumps, filaments and cores. This structure is reproduced fairly well by numerical simulations involving a combination of supersonic colliding flows, turbulent fragmentation, magnetic fields, and gravity. The genetic relation between such cloud structure and star formation is unclear. Protostars appear to be born in cores, and clusters appear to be born in clumps. But debate continues on how closely core masses generate star masses, especially for massive stars. More generally, what is the relative importance for star formation of initial conditions of structure, compared to gravitational dynamics and stellar feedback during cluster evolution? Recent efforts to match initial structure to the IMF seem useful for isolated cores in filaments but less so in the densest parts of clusters. There, a more dynamic model of core-clump accretion may give a better description of protostar masses and luminosities.

ABSTRACT

Philippe André
CEA Saclay, Service d'Astrophysique (AIM) (FR)

From the filamentary structure of molecular clouds to the formation and properties of prestellar cores (Invited)

The seeds or direct progenitors of stars within molecular clouds are believed to be gravitationally-bound, starless cloud fragments known as prestellar cores. Improving our understanding of the formation and evolution of prestellar cores is crucial to gain insight into the origin of stars of all masses, including very low mass stars and brown dwarfs.

I will review observational progress in this area, with a particular emphasis on recent results obtained with the Herschel Space Observatory. Altogether, the Herschel results favor a scenario in which interstellar filaments and prestellar cores represent two fundamental steps in the star formation process: First, large-scale magneto-hydrodynamic turbulence generates a complex web of filaments in the ISM; second, the densest filaments grow and fragment into prestellar cores (and ultimately protostars) via gravitational instability.

ABSTRACT

Alvaro Hacar
Observatorio Astronomico Nacional, Madrid (ES)

Dense core formation by fragmentation of velocity-coherent filaments in L1517

As recently stressed by the latest Herschel results (e.g. André et al. 2010), filaments play a key role in the star formation process promoting the formation of dense cores within molecular clouds. To investigate the connection between cores and filaments we have systematically studied the L1517 cloud, a representative star-forming region within the Taurus-Auriga molecular complex. Our results show that the gas found along this region is highly organized forming 4 filaments that have typical lengths of 0.5 pc. The analysis of their internal gas kinematics shows that all these filaments are extremely quiescent showing subsonic internal motions and exhibiting a coherent velocity structure over their whole length. Moreover, two of these filaments shows large-scale velocity oscillations likely related to the core-forming flows. These results suggest that core formation ocurrs in two steps. First, the subsonic, velocity-coherent filaments condense out of the more turbulent ambient cloud. Then, the cores fragmented quasi-statically and inheriting the kinematics of the filaments. (Hacar & Tafalla, 2011, accepted by A&A, arXiv:1107.0971)

ABSTRACT

Eli Bressert
ESO-Garching / University of Exeter

The spatial distribution of prestellar cores and YSOs in the solar neighbourhood

We present the results of two recent studies regarding the clustering properties of prestellar cores & low-mass young stellar objects (YSO) in the solar neighbourhood. First, we discuss the global YSO surface densities in star forming regions based on a comprehensive collection of Spitzer Space Telescope surveys, which encompasses nearly all star formation within 500 pc. We show that the distribution of YSO surface densities is a smooth distribution, being adequately described by a lognormal function from a few to 10^3 YSOs/pc^2, with a peak at ~22 YSOs/pc^2 & a dispersion of ~0.85. We do not find evidence for multiple discrete modes of star-formation (e.g. clustered & distributed) & that not all stars form in clusters.

The spatial distribution of YSOs has been questioned whether their positions are a result of being dynamically dispersed from small groups/clusterings or are the YSOs tracing the primordial structure from which they formed, the molecular gas filaments. With Herschel's Gould Belt Survey we show that the YSO distribution is spatially correlated to the prestellar cores in several nearby star forming regions. This correlation shows that the YSOs are indeed tracing the filamentary gas. Additionally, we discuss the relationship between the prestellar cores & their surrounding environment gas densities (e.g. A_V threshold for star formation), which could lead to a better understanding on how low-mass star formation is initiated.

ABSTRACT

Kengo Tomida
The Graduate University for Advanced Studies (NAOJ), Tokyo (JP)

Exposed Long-lifetime First core: Star formation in very low-mass molecular cloud cores

A first adiabatic core is a transient object formed in the early phase of star formation. Despite its short lifetime, first cores are of great importance to understand star formation because they are the sites of interesting phenomena such as disk fragmentation and driving molecular outflows. Observations of first cores are believed to be difficult because of their short lifetime and low luminosity. But recently some candidates are reported (Chen et al. 2010, Enoch et al. 2010, Kawabe et al. in prep.) and will be possibly confirmed with ALMA.

On the basis of 3D nested-grid radiation hydrodynamic simulations, we propose a novel theoretical model of first cores, the Exposed Long-lifetime First core (ELF). In the very low-mass molecular core, the first core evolves slowly and lives longer than 10,000 years because the accretion rate is considerably low. The evolution of ELFs is different from that of ordinary first cores because radiation cooling has a significant effect there. We also carry out a radiation-transfer calculation of dust-continuum emission from ELFs to predict their observational properties. ELFs have slightly fainter but similar spectral energy distributions to ordinary first cores in radio wavelengths, therefore they can be observed. Although the probabilities that such low-mass cores become gravitationally unstable and start to collapse are low, we still can expect that a considerable number of ELFs can be formed because there are many low-mass molecular cloud cores in star-forming regions that could be progenitors of ELFs.

ABSTRACT

Will Fischer
The University of Toledo, OH (US)

Adding HOPS to the Hunter's Brew: Insights from Herschel on Star Formation in Orion

The Herschel Orion Protostar Survey (HOPS) is a survey of 286 Spitzer-identified protostars designed to increase our understanding of low-mass protostellar evolution and its dependence on environment. We combine HST imaging at 1.6 and 2.05 um, Spitzer and Herschel imaging and spectroscopy from 3.6 to 160 um, and APEX/LABOCA imaging at 850 um. Our goal is to trace the evolution of protostars and their envelopes from the earliest stages detectable in the IR to the late stages, where only a tenuous envelope remains. We present a unique method of optimized grid-based SED fitting to accurately estimate the bolometric luminosities, bolometric temperatures, and envelope densities of the sources. We compare these results to models of protostellar evolution to constrain how luminosity and envelope density evolve with time. With our sensitivity to detect sources down to a luminosity of 0.15 L_sun, we highlight the properties of the lowest-luminosity objects in our sample and discuss whether they may be the progenitors of VLM stars and BDs. We also discuss a sample of about 75 newly discovered Herschel sources; these sources are too cold to have been identified by Spitzer and therefore may represent a very early stage of protostellar evolution.

ABSTRACT

Matthew Bate
University of Exeter (UK)

From prestellar cores to stellar systems: fragmentation, properties and multiplicity of protostars - Theory (Invited)

I will present results from numerical simulations of the gravitational collapse and fragmentation of molecular clouds to form stellar groups and clusters. I will concentrate on the formation mechanisms and properties of very-low-mass stars and brown dwarfs, and how the properties compare with those of observed systems.

ABSTRACT

Alan Boss
Carnegie Institution, Washington (US)

Collapse and Fragmentation of Magnetic Molecular Cloud Cores with an AMR Code

Magnetic fields are important contributers to the dynamics of collapsing molecular cloud cores, and can have a major effect on whether collapse results in a single protostar or fragmentation into a binary or multiple protostar system. New models are presented of the collapse of magnetic cloud cores using the adaptive mesh refinement (AMR) code "enzo" (Collins et al. 2010). The code was used to calculate the ideal magnetohydrodynamics (MHD) of initially spherical, uniform density clouds with m=2 density perturbations, i.e., the Boss & Bodenheimer (1979) standard isothermal test case for 3D hydrodynamics codes. After first verifying that enzo reproduces the binary fragmentation expected for the non-magnetic test case, a large set of models with varied initial magnetic field strengths Bo, field directions, and density perturbation amplitudes A2, was run on the xenia cluster at DTM. For initial magnetic fields perpendicular to the cloud's rotation axis and A2=0.5, clouds with Bo=0.3 mG (milliGauss) collapsed and fragmented into two fragments with multiple spiral arms, with Bo=0.6 or 0.8 mG formed single protostars with spiral arms, while with Bo=1.0 mG or higher did not collapse. For initial magnetic fields parallel to the rotation axis and A2=0.5, clouds with Bo=1.6 mG or lower fragmented to form binary or higher order multiple systems, accompanied by multiple spiral arms, while clouds with Bo=1.8 mG or higher did not collapse significantly. For the parallel field and A2=0.1, clouds with Bo=0.8 mG or less fragmented, with Bo= 1.0 or 1.2 mG formed single protostars, while those with Bo=1.4 mG or higher did not collapse. These first results for the standard 3D test problem illustrate the importance of both magnetic field direction and field strength for determining the outcome of dynamic protostellar collapse. Future models will consider the MHD collapse of more realistic, centrally-condensed, spheroidal molecular cloud cores.

ABSTRACT

Shantanu Basu
University of Western Ontario (CA)

Brown Dwarfs from Disk Fragmentation and Ejection

We present a calculation of protostellar disk formation and evolution in which gaseous clumps are ejected from the disk during the early embedded stage of evolution. This is a universal process related to the phenomenon of ejection in multiple systems of point masses, however it occurs in our model entirely due to the interaction of diffuse gaseous clumps. We conclude that clump ejection and formation of isolated low mass stellar and substellar objects is a common occurrence, with important implications for understanding the initial mass function, brown dwarf desert, and the formation of stars in all environments and epochs.

ABSTRACT

Dimitris Stamatellos
Cardiff University (UK)

The formation of low-mass stars and brown dwarfs by disc fragmentation

The formation of low-mass stars and brown dwarfs by disc fragmentation can address critical observational constrains such as the low-mass end of the IMF, the brown dwarf desert and the binary properties of low-mass objects. I will briefly present the predictions of the disc fragmentation model and discuss whether this mechanism can actually function in nature, considering the role of radiative feedback from the host protostar in heating and stabilising the disc, possibly suppressing fragmentation. Finally, I will present simulated observations of fragmenting discs and discuss the possibility of observing such discs using current and future facilities (e.g. ALMA).

ABSTRACT

Benoît Commerçon
MPI for Astronomy, Heidelberg (DE)

Early stages of low mass star formation

I will present radiation-magneto-hydrodynamics calculations of low mass dense core collapse, focusing on the first collapse and first Larson core formation. The influence of magnetic field and initial mass on the fragmentation properties will be investigated. Last, I will show synthetics observations of spectral energy distribution and derive usual observational quantities such as bolometric temperature and luminosity. Synthetics SEDs will for instance help to state whether VeLLos can be first core candidates or not.

ABSTRACT

Paula Stella Teixeira
Universität Wien, Institut für Astronomie (AT)

Jeans fragmentation within the OMC1 filaments: clues to how the core mass function is assembled

We report Submillimeter Array (SMA) 1.3vmm observations of the the OMC1 northern filaments that were previously identified from SCUBA JCMT 850 micron continuum and VLA ammonia observations. We find 16 compact sources along an extent of 3' within the filaments. The sources range in mass from 0.8 to 2.8 MSun and 3 of them are driving highly collimated CO molecular outflows. The millimeter emission may be arising from the circumstellar disk and inner part of the envelope; these compact sources are therefore in the Class 0/I evolutionary phase. We find tentative indications of a mass gradient along the filaments: the more massive sources are located in the southern end whereas the least massive protostars are in the northern end. Finally, the spatial analysis of the protostars shows that these are separated by a quasi-equidistant length of 30' (0.06pc), consistent with the Jeans length (for a temperature of 17K and a mean density of 1.9x105cm-3), i.e., thermal fragmentation. SMA observations of OMC2-3 have similarly revealed fragmentation scales consistent with the Jeans length. The star formation within these filaments may therefore be similar to that of the Spokes cluster in NGC2264, although observed at a much earlier phase. Comparison of these different regions has allowed us to explore the role of Jeans fragmentation in the origin of the core mass function.

ABSTRACT

Michael Dunham
Yale University (US)

The Low End of the Protostellar Luminosity Distribution: Very Low Mass Star Formation, Proto-Brown Dwarfs, First Hydrostatic Cores, and Episodic Mass Accretion

A long-standing problem in low-mass star formation is the luminosity problem, whereby protostars are underluminous compared to the accretion luminosity expected from theoretical collapse calculations. I will present observational and modeling results aimed at constraining the embedded phase mass accretion process and revealing how mass accretes from the dense core, through the circumstellar disk, and onto the protostar. I will present the protostellar luminosity function assembled from recent Spitzer Space Telescope surveys of nearby star-forming regions, focusing on a set of very low luminosity objects (VeLLOs) that may represent the earliest stages of brown dwarf and very low mass star formation. I will also present very recent discoveries of several sources undetected in the Spitzer surveys that either represent first hydrostatic cores or the lowest luminosity (and possibly lowest mass) protostars currently known to exist. I will discuss the known properties of these sources and our current understanding of where they fit in the overall scheme of low-mass star formation. Finally, I will compare the observed protostellar luminosity function to evolutionary models and discuss the viability of episodic mass accretion as a solution to the luminosity problem.

ABSTRACT

Tracy Huard
University of Maryland (US)

The Nature and Fate of VeLLOs

Since a new class of embedded sources, referred to as Very Low Luminosity Objects (VeLLOs), was discovered using Spitzer Space Telescope observations, the number of known VeLLOs has been slowly growing. Still, their nature remains unclear: they may be progenitors of typical low-mass stars or of brown dwarfs. The few VeLLOs with millimeter observations suggest that they sustain outflows with a wide range of energetics, suggesting VeLLOs may represent an inhomogeneous group. For example, the large-scale outflow driven by a VeLLO in core IRAM 04191+1522 is three orders of magnitude stronger than the weak, compact outflow driven by the prototypical VeLLO L1014-IRS, despite these sources having comparable luminosities. Interferometric millimeter observations of a greater number of VeLLOs may help to resolve the ambiguity concerning their nature. We have obtained CO(2-1) CARMA observations toward eight known VeLLOs and candidates to study their outflows, which may be indicative of accretion history. In addition, we obtained 1.3-mm continuum CARMA observations to detect their inner envelopes, which is indicative of the mass reservoir for future accretion. These outflow and continuum properties give insight into which VeLLOs are likely protostars and which are likely proto-brown dwarfs. Finally, these VeLLOs will be placed in context of their larger-scale environments using column density maps constructed from deep WFC3 infrared observations from the Hubble Space Telescope.

Wednesday, 12 October

ABSTRACT

Gaspard Duchene
UC Berkeley (US)

From prestellar cores to stellar systems: fragmentation, properties and multiplicity of protostars - Observations (Invited)

Multiplicity is ubiquitous to the process of (sub)stellar formation. Differences in the frequency and properties of multiple systems as a function of mass, most notably a much lower frequency and a deficit of wide systems among very low-mass stars and brown dwarfs, provide insight on the physics of star formation. It is widely believed that most prestellar cores fragment prior to or during their collapse to form multiple systems that subsequently evolve dynamically to produce the observed multiplicity properties of pre-main sequence and field stars. For instance, dynamical ejection of low-mass "seeds'' before the end of the main accretion phase has been proposed as one possible formation mechanism for very low-mass stars and brown dwarfs. In this talk, I will present an overview of our observational knowledge of core fragmentation and of the multiplicity properties of protostars and pre-main sequence stars, and briefly discuss how this informs us on the origin of the lowest mass objects in the Galaxy.

ABSTRACT

Pedro Viana Almeida
Centro de Astrofisica da Universidade do Porto (PT)

Finding proto-spectroscopic binaries: Precise multi-epoch radial velocities of 7 protostars in ρ Ophiuchus

Stars in the solar neighborhood are mostly found in multiple systems. While the existence of stellar companions at visual distances can be easily explained as a normal outcome of the star formation process itself, it is still unclear how spectroscopic companions are actually formed. If they are a by-product of the initial fragmentation of molecular clouds, or resultant from dynamical evolution within pristine multiple systems is still an open question in star formation. To uncover a young spectroscopic binary would be therefore an invaluable clue for understanding the mechanisms and the time scales involved in their formation. Aiming at finding such young spectroscopic companions, we present a near-IR high resolution (R ~ 60000) multi-epoch radial velocity survey of 7 young stellar objects in the star forming region ρ Ophiuchus. The radial velocities of each source were derived using a two-dimensional cross-correlation function designed to deliver the radial velocity of the target relative to the zero-point established by the earth's atmosphere. Over 14 spectral lines in the CO Δν = (0-2) bandhead window were used in the cross-correlation against LTE atmospheric models to compute the final results. We found that the spectra of the protostars in our sample agree reasonably well with predicted stellar photospheric profiles indicating that the radial velocities uncovered are of stellar nature. Three of the targets analyzed give us hints that the first proto-spectroscopic binaries might have been found. If confirmed, it will bring an important piece into the (binary) star formation puzzle, namely, that multiplicity at sub-AU scale starts (or not) at birth. Our preliminary binary fraction of ~71% (when merging our results with those of previous studies) is also in line with the notion that multiplicity is very high at young ages and therefore it might be a product of star formation.

ABSTRACT

Adam Kraus
Institute for Astronomy, Univ. of Hawaii (US)

Multiple Star Formation to the Bottom of the IMF

The frequency and properties of multiple star systems offer powerful tests of star formation models. Multiplicity surveys over the past decade have shown that binary properties vary with mass, but the functional forms and the interplay between frequency and semimajor axis remain largely unconstrained. We will present the results of a large-scale survey of multiplicity to the bottom of the IMF in nearby star-forming regions, encompassing 78 VLMS/BD members of Taurus and Upper Scorpius observed with Keck laser guide star adaptive optics. Our survey confirms the overall trend observed in the field for lower-mass binary systems to be less frequent and more compact, including a null detection for any substellar binary systems with separations wider than 7 AU and for any planetary-mass analogs to 2M1207b. Combined with a Bayesian re-analysis of existing surveys, our results demonstrate that the binary frequency and binary separations decline smoothly between masses of 1 Msun and 0.02 Msun. We also show that the mass ratio distribution becomes progressively more concentrated at q=1 for declining masses, though a small number of VLM binary systems do appear to have unusually wide separations and low mass ratios. We will discuss the implications of these results in the context of a single formation process for stars of all masses, from solar analogs to the lowest-mass brown dwarfs.

ABSTRACT

Richard Parker
ETH Zurich, Institute for Astronomy (CH)

Dynamical evolution of very low mass binaries in open clusters

The binary fraction and separation distribution of Very Low Mass (VLM) stars and Brown Dwarfs appear to be very different to those for M-dwarfs with masses > 0.2 Msun. Can the apparent differences be the result of a different formation process for VLM objects, or can they be explained through dynamical evolution in dense clusters? I will present the results of N-body simulations in which I compare the results of dynamical evolution on different VLM binary populations. I find that dynamical evolution does not affect the majority of VLM binaries, suggesting a different formation mechanism from higher mass binaries, or significant observational incompleteness.

ABSTRACT

Gilles Chabrier
ENS Lyon (FR)

**The initial mass function in the low-mass regime.
Connection with low-mass star and brown dwarf formation (Invited)**

I will first examine the present status of the determination of the initial mass function down to the brown dwarf regime, both in the field and in young clusters. In the second part of the talk, I will consider various theoretical scenarios of star and brown dwarf formation and examine the possibility for these scenarios to adequately reproduce the IMF over the entire explored mass range.

ABSTRACT

Niall Deacon
MPI for Astronomy, Heidelberg (DE)

A solar neighbourhood proper motion survey with PS1+2MASS

The local population of brown dwarfs provides an snapshot of the integrated substellar formation history over a range of formation environments. The Pan-STARRS 1 telescope is currently producing the largest, multiepoch, multicolour, CCD based survey ever done. Its combination of high quality photometry, excellent red optical sensitivity and multiple epochs make it a valuable tool for probing our nearby cool neighbours. Here we outline the results of an extensive survey of the Pan-STARRS 1 sky for bright, previously unknown T dwarfs. Our work combines g,r,i,z,y data from the Pan-STARRS 1 3Pi survey with J, H and K_s data from 2MASS. The addition of PS1 data allows us to mine the widely exploited 2MASS database more deeply than others have before. Using proper motion and photometric selection we are especially sensitive to early/mid T dwarfs which are routinely excluded from near/mid-infrared only studies due to restrictive colour selection. This work provides the basis for studies using multiple Pan-STARRS 1 epochs which will lead to a complete and unbiased field substellar luminosity function yielding important constraints on the Initial Mass Function independent of estimations from clusters and star forming regions.

ABSTRACT

Bo Reipurth
Institute for Astronomy, Univ. of Hawaii (US)

The Brown Dwarf Ejection Model 10 Years Later

There are three principal ways in which a brown dwarf can be formed: 1) the initial supply of gas may be limited, 2) the stellar embryo may be ejected in dynamical interactions with other components, and 3) the initial supply of gas may be destroyed by UV radiation from a nearby massive star. All three modes are likely to operate, but their effectiveness may vary from one region to another or with time. We review the physical principles of the ejection model, compare to new observations, and present extensive N-body simulations of unstable triple systems in dense cloud cores. Observational consequences are discussed.

ABSTRACT

Kevin Luhman
Penn State University (US)

Revealing and understanding the low mass end of the stellar IMF (Invited)

I will review the latest measurements of the IMF of low-mass stars and brown dwarfs in the nearest star-forming regions and the constraints that they provide for theories of the origin of IMF. In particular, I will examine whether there is evidence for significant variations in the IMFs of these regions and I will describe the current constraints on the minimum mass of the IMF.

ABSTRACT

Paul Dawson
Dublin Institute for Advanced Studies (IE)

Brown Dwarfs in Upper Scorpius: new results from 3 surveys

Results from a combination of 3 infra-red surveys in Upper Scorpius have increased the numbers of known brown dwarfs to a point where statistical comparison with other clusters is becoming possible. The same surveys are also yielding information on the lifetimes of circumsubstellar disks. The proposed talk will focus on the meaning of these results for the low mass end of the IMF in Upper Scorpius and the evolution of brown dwarf disks. The Upper Scorpius star forming region is the nearest OB association and represents our best chance of constraining the impact of massive stars on the formation and early evolution of very low mass objects. The Galactic Cluster Survey component of UKIDSS is enabling a census of brown dwarfs in ten large open star clusters and star forming regions. Data from the all sky surveys 2MASS and (most recently) WISE can now be combined with GCS data from Upper Scorpius. The proposed talk will show how this combination is extending the census of brown dwarfs in Upper Scorpius allowing a reliable star to brown dwarf ratio (3.8) be calculated. The talk will also discuss how WISE data is used to derive a new disk fraction (0.2) for brown dwarfs in Upper Scorpius.

Based on Dawson, Scholz & Ray (MNRAS, submitted), Scholz et al. (2007).

ABSTRACT

Nicolas Lodieu
Instituto de Astrofísica de Canarias (ES)

Testing the fragmentation limit in the Upper Sco association

We present the results of a deep YJ+methane photometric survey of a 0.95 square degree area in the central region of the Upper Sco association complemented by optical data. We have selected five potential T-type objects belonging to Upper Sco on the basis of their colours and identified a sample of 8 member candidates bridging the gap between known cluster M-types and our new T-type candidates. These candidates were selected based on their positions in various colour-magnitude diagrams and they follow the sequence of known Upper Sco members identified in the UKIDSS Galactic Clusters Survey (GCS). We present optical and near-infrared spectra obtained with the VLT X-Shooter spectrograph for five L-type candidates, none of them being confirmed as a young brown dwarf. We discuss the lack of detection of new candidate members as well as the issue of the fragmentation limit that we may have approached in USco.

ABSTRACT

Catarina Alves de Oliveira
IPAG, Observatoire de Grenoble (FR)

Probing the substellar IMF in nearby star-forming regions: a WIRCam/CFHT survey

I will present the latest results of the WIRCam/CFHT survey aimed at uncovering the low mass population in several nearby star-forming regions. Candidate brown dwarfs have been identified using the deep near-IR imaging survey complemented with archival data. A spectroscopic follow-up has been conducted using several facilities (TNG, GTC, NTT, VLT, Gemini) to ascertain the spectral types and masses of the candidates. In the first clusters studied, IC 348 and Rho Ophiuchus, we discover new members down to the L dwarf spectral type regime, the least massive known objects in both regions. We do not find evidence for a significant variation or truncation of the low-mass end of the IMF down a few Jupiter masses.

ABSTRACT

Koraljka Muzic
University of Toronto (CA)

Substellar Objects in Nearby Young Clusters (SONYC): Towards an Unbiased Census

The origins and characteristics of the lowest mass free-floating objects constitute a major question in the study of star formation. SONYC, "Substellar Objects in Nearby Young Clusters", is an ongoing project to provide a census of the substellar population in nearby star forming regions. The survey uses extremely deep wide-field optical and near-infrared imaging at 4- to 8-m telescopes, combined with Spitzer photometry. In our extensive follow-up campaigns, we have obtained more than 500 spectra in NGC1333, rho Ophiuchi, and Chamaeleon-I, using MOIRCS and FMOS at the Subaru Telescope, VIMOS and SINFONI at the VLT, and GNIRS at Gemini-N. We report discoveries of ~30 spectroscopically confirmed very-low-mass objects, including one with the mass of about 6 MJup, placing it among the lowest mass free-floating objects identified thus far. Our findings have doubled the number of confirmed brown dwarfs in NGC 1333, and comprise about one fifth of the entire substellar population in rho-Oph. Here we present the results and the status of SONYC. We investigate the benefits and biases of the currently used observing strategies, address the completeness of the current brown dwarf census in young clusters, and the implications of our findings for the initial mass function and star formation theory.

ABSTRACT

Karla Peña Ramírez
Instituto de Astrofísica de Canarias (ES)

The complete low-mass mass function of the young star cluster sigma Orionis.

For the first time, we present the low-mass function of the entire young star cluster Sigma Orionis (3 Myr, 352 pc, no internal extinction) from 0.25 Msol through the brown dwarf regime down to 2-3 Mjup in the planetary-mass domain. We have used VISTA Orion data (ZYJHKs) in the magnitude interval J= 13 - 21 (completeness at J = 21.0 mag, Z = 22.6 mag, and 10 Mjup), which combined with Spitzer/IRAC (3.6 and 4.5 micron) and optical images (I-band) from our archives has allowed us to identify over 200 cluster low-mass member candidates in an area of 0.79 deg^2, i.e., uncovering most of the cluster area. All of these objects have colors compatible with spectral types M, L, and T, i.e., Teff = 3000-1000 K. By considering the Mayrit catalog, we have "extended" our mass function from 0.25 Msol up to the high-mass stars (O-type) of the cluster. This combined mass function may become a reference in the field.

ABSTRACT

Amelia Bayo
ESO-Chile

Spectroscopy of Very Low Mass Stars and Brown Dwarfs in the Lambda Orionis Star Forming Region. Enlarging the census down to the planetary mass domain in Collinder 69

Whilst there is a generally accepted evolutionary scheme for the formation of low--mass stars, the analogous processes when moving down in mass to the brown dwarfs regime are not yet well understood. I will present the most complete and unbiased spectroscopically confirmed census of the population of Collinder 69, the central cluster of the Lambda Orionis Star Forming Region, as a first step to address the question on how brown dwarfs and planetary mass objects are form. With this census, we have assembled of one of the most complete Initial Mass Functions from 0.016 to 20 M_sun. And we have studied the implications of the spatial distribution of the confirmed members in the proposed mechanisms of brown dwarfs formation.

ABSTRACT

Juan Jose Downes
Centro de Investigaciones de Astronomía, Merida (VE)

The very low mass star and brown dwarf population of the 25 Orionis group

In this contribution we present the latest results of an ongoing large-scale, optical photometric and spectroscopic survey of very low mass stars and brown dwarfs down to 0.02 Mo in the dispersed, off-cloud populations of the Orion OB1 star forming region, focused on the 7 Myr old 25 Orionis group. The complete survey is based on the combination of multi-epoch optical photometry in R and I bands obtained with the Quest-I camera at the Venezuela National Astronomical Observatory, with near-IR data from the VISTA and 2MASS surveys, spanning a total area of ~200 deg2. The photometric survey is being complemented with follow-up optical spectroscopy on the Hectospec instrument on the 6.5m MMT, which so far has provided spectroscopic confirmation of young VLMS and BD down to ~0.05 Mo. The properties of VLMS and BD spectroscopically confirmed as members of the 25 Orionis group and those that still remain as photometric candidates will be discussed, focused on the initial mass function, the mass dependence of the spatial distribution, the near infrared excesses and the fraction of objects with Classical or Weak T Tauri-like characteristics.

Thursday, 13 October

ABSTRACT

Antonella Natta
Osservatorio di Arcetri (IT)

Disks, Accretion and Outflows (Invited)

In this talk, I will review recent results on disk properties, accretion and mass ejection in brow dwarfs and very low mass objects.

ABSTRACT

Lee Hartmann
University of Michigan (US)

The circum(sub)stellar environment: disks, outflow and accretion processes (Invited)

I will attempt to review what we have found out observationally and what we may understand theoretically (a much smaller subset of the previous item) about mass and angular momentum transport in pre-main sequence circumstellar disks, taking a broad perspective but with a focus on very low-mass objects. As we have only imperfect or indirect measures of the basic physical properties that we wish to know, I will discuss attempts to combine observational properties, with an emphasis on assuming initial conditions in disks appropriate for forming stars.

ABSTRACT

Guido De Marchi
ESA/RSSD, Noordwijk (NL)

Low-mass star formation in the Local Group

We have undertaken a systematic study of pre-main-sequence (PMS) stars spanning a wide range of masses (0.5 - 4 Msolar), metallicities (0.1 - 1 Zsolar) and ages (0.5 - 30 Myr). We have used the HST to identify and characterise a large sample of PMS objects in three star forming regions in the local group, namely NGC 3603 in the Milky Way, 30 Doradus in the Large Magellanic Cloud and NGC 346 in the Small Magellanic Cloud. Thanks to a novel method that we have developed to combine broad-band (V,I) photometry with narrow-band Halpha imaging, we have determined the physical parameters (temperature, luminosity, age, mass and mass accretion rate) of more than 2000 bona-fide PMS stars still undergoing active mass accretion. This is presently the largest and most homogeneous sample of PMS objects with known physical properties. I will present the main results of this research, including the fact that mass accretion rate appears to scale with the first power of the stellar mass, with the square root of the age, and approximately with the inverse of metallicity. These results are bound to have important implications for, and constraints on our understanding of the star formation process.

ABSTRACT

Subhanjoy Mohanty
Imperial College London (UK)

Disk Masses around Low Mass Stars & Brown Dwarfs: A Bayesian Analysis

We present new very deep observations of disk masses, combined with previous surveys, and discuss the implications of the whole sample in the crucial context of using Bayesian analysis to make optimal use of upper limits in surveys. Specifically: We present SCUBA-2 850um observations of 7 very low mass stars (VLMS) and brown dwarfs (BDs). 3 are located in Taurus and 4 in the TW Hydrae Association (TWA), and all are actively accreting classical T Tauri (cTT) analogs. The sample increases the number of VLMS/BD accretors surveyed in the sub-mm/mm by 50%, and includes all such objects known in the TWA. We detect 2 of the 3 Taurus disks, but none of the TWA ones. For standard disk grains, our 3-sigma detection limits correspond to a disk dust mass of ~1.3 M_Earth in Taurus and a mere ~0.2 M_Earth in the TWA. We combine our Taurus data with other sub-mm/mm disk surveys in Taurus and rho Ophiuchus to examine the trend in disk mass (Md) with stellar mass (M*) during the cTT phase. Assuming a disk gas-to-dust ratio of 100:1, we find the following:

(1) There is an upper mass limit to these disks at Md/M* ~ 0.1, possibly suggesting a cutoff imposed by prior gravitational instabilities.

(2) The upper envelope of Md/M* for M* >~ 0.5 Msun declines roughly as $M^{*-1.5}$. This cannot be due to changes in disk temperature (it would imply cooler disks around hotter stars), but is consistent with a depletion of detectable dust in these stars via grain growth to sizes >>1 mm by ~1 Myr.

(3) A Bayesian analysis reveals that cTT disks among VLMS/BDs, solar-type stars and intermediate-mass stars all follow similar lognormal distributions (within 1-sigma of each other), with a mean log[Md/M*] ~ -2.4. This agrees with previous suggestions that Md ~ 0.01M* throughout the stellar/substellar domain.

(4) If the TWA VLMS/BD accretors conform to the same trend, then their non-detections imply grain growth to sizes >>1 mm by 10 Myr around such low mass objects. This is consistent with the SED of our one firmly detected BD disk in Taurus, which indicates grain sizes >1 mm even by ~1 Myr.

(5) The disk masses we infer can support the eventual coalescence of such grains into terrestrial mass planets via core accretion around VLMS; however, they suggest such planets may be relatively rare around BDs.

ABSTRACT

Leonardo Testi
ESO-Garching

Disk evolution and the initial steps towards planet formation

Planet formation is expected to occur in circumstellar disks during the first few Myrs of the stellar pre main sequence evolution. In the core accretion paradigm of planet formation, the solid component of the disks (the dust) grows and coagulate to form planetesimals and rocky cores of planets. We have been conducting extensive surveys and detailed studies of individual objects at millimetre wavelengths of the dust emission from circumstellar disks in the Taurus, Ophiuchus and Orion star forming regions with the aim of relating the grain growth signatures with environment and young stellar object properties. We find a remarkably low dispersion of properties and we discuss our findings in the context of evolutionary models of dust populations in disks. Our results suggest that grain growth occurs early in the life of disks and, contrary to simple model expectations, remain in the outer disks for relatively long time (few Myrs). We will discuss possible models that can solve the discrepancies with observations and observational tests in disks around sub-stellar young stellar objects that will provide critical constraints on the model assumptions.

ABSTRACT

Daniel Jaffe
University of Texas at Austin (US)

What Controls the Properties of Disks Around Young Brown Dwarfs?

There is a secular decrease in disk frequency as one examines 1-10 million year old populations of low mass stars. At the same time, there are examples of the simultaneous presence of classical TTauri disks, of transition disks, and of weak TTauri stars with no detectable disks in regions with apparent ages throughout this range. One way to understand the factors that control disk properties and evolution is to study the variation in behavior with central object mass. We have developed a sample of spectroscopically confirmed brown dwarfs in a low extinction portion of the Ophiuchus molecular cloud that are analogs of CTTs, transition disk sources, and WTTs but have 10-30 times lower mass than the TTauri stars. We use optical, near-IR and mid-IR spectroscopy of the sample to investigate the relation between photospheric and disk properties. With the broad mass range from our brown dwarf sample to existing TTauri star samples, we can learn what factors other than chronological age affect the disk properties in young systems.

ABSTRACT

Michael Gully-Santiago
University of Texas at Austin (US)

Observations of grain properties and accretion in the circum(sub)stellar disk environment

With the goal of characterizing the circum(sub)stellar disk environment, we present photometry and spectroscopy from 0.8 to 24 um on a sample of 18 brown dwarfs and very low mass stars in nearby young star forming regions. Our observations shed light on the accretion and disk properties as a function of central object mass down to near planetary masses. We highlight results from Spitzer IRS mid-IR spectroscopy of the shape and strength of the 10 um silicate feature, which probe grain growth and dust settling in the disks. The accretion properties are consistent with the reported trend in mass accretion rate with central object mass.

ABSTRACT

Basmah Riaz
University of Hertfordshire (UK)

The radial distribution of dust species in young brown dwarf disks

We present a study of the radial distribution of dust species in young circum(sub) stellar disks. Our work is based on a compositional analysis of the 10 and 20mu silicate emission features for a large sample of brown dwarf disks in the Taurus-Auriga star-forming region. A fundamental finding of our work is the almost constant crystallinity observed regardless of the disk radius being probed. Brown dwarfs exhibit stronger signs of dust processing in the cold component of the disk compared to the higher mass T Tauri stars in Taurus, which can be explained if the 20mu feature probes lower disk scale heights in brown dwarfs than T Tauri disks. We find no correlation between the presence of a large inner hole and low crystallinity in the disk. There are a few interesting `outlier' cases among the brown dwarfs that show strong 10mu emission but no emission is observed in the cold component of the disk, or vice versa. Such outliers suggest that dust processing mechanisms may not proceed simultaneously in the inner and outer regions of the disk. We also present new Chandra X-ray observations for Taurus brown dwarfs. Combining with previously published X-ray data, we find the inner disk crystalline mass fraction to be anti-correlated with X-ray strength in circum(sub)stellar disks. No such correlation is observed for the T Tauri disks.

ABSTRACT

Thomas Preibisch
Universitäts-Sternwarte München (DE)

Lifetimes of disks around low-mass stars in extreme environments

In rich clusters, low-mass stars form in close proximity to massive stars that profoundly influence their environment by their strong ionizing radiation, their powerful stellar winds, and, finally, supernova explosions. How strongly this affects the evolution of protoplanetary disk around young low-mass stars is not well known, since most observations have focused on rather nearby low- and intermediate-mass star forming regions, where massive star feedback is absent or weak. The Great Nebula in Carina is the best galactic analog of giant extragalactic HII and starburst regions and a superb location for such a study. We used HAWK-I at the ESO VLT to survey the central 0.36 square-degree area of the Carina Nebula deep enough to detect the full low-mass stellar population and brown dwarfs down to 0.035 Msun through extinctions of AV=10 mag. Our analysis of the ages, masses, and disk properties of the low-mass stars inferred from the HAWK-I data shows that the near-infrared excess fractions in the young clusters in the Carina Nebula are considerably lower than typical for clusters of similar age in nearby, quiescent star forming regions. This suggests that the very high level of massive star feedback accelerates the dispersal of circumstellar disks. We discuss our results in the context of recent observations of other massive star forming regions and theoretical models for disk dispersal.

ABSTRACT

Aleks Scholz
Dublin Institute for Advanced Studies (IE)

T Tauri stars vs. young brown dwarfs: similarities and differences

Young brown dwarfs are ideal targets to test how the formation and early evolution of stars as well as the conditions for planet formation change with object mass. In this talk I will give a comprehensive overview about the properties of young substellar sources in comparison with solar-mass T Tauri stars, based on multi-wavelength observations. In many ways brown dwarfs are scaled-down versions of young stellar objects. For example, disks are observed for brown dwarfs down to planetary masses, and the disk masses appear to scale with object mass. The accretion is non-axisymmetric, presumably structured by the magnetic field. There is evidence for long-term changes of the accretion flow, including strong outbursts, as in more massive stars. On the other hand, young brown dwarfs rotate significantly faster and have lower accretion and outflow rates than T Tauri stars. There are also indications that the disk structure and lifetime are functions of object mass. I will show how we can use these observational results to put constraints on theories for star and planet formation.

Based on Scholz & Eisloeffel (2004, 2005), Scholz, Jayawardhana, Brandeker (2005), Scholz, Jayawardhana, Wood (2006), Scholz et al. (2007), Stelzer, Scholz, Jayawardhana (2007), Scholz & Jayawardhana (2007, 2008), Scholz et al. (2009, 2010, 2011)

ABSTRACT

Juan Manuel Alcalá
INAF-Osservatorio Astronomico di Capodimonte (IT)

An X-Shooter survey of nearby star forming regions: low and sub-stellar mass objects.

Results of an X-Shooter@VLT survey of the nearby star-forming regions in Lupus, sigma Ori and TW Hya are presented. This survey allows a detailed characterization of the Young Stellar and sub-stellar Objects (YSOs), and provides a database of accretion diagnostics from the Br-gamma and Pa-beta lines in the near-IR to the Balmer jump in the UV (detected even in some brown dwarfs), including the full optical band with the Balmer series and He 5876 and the Ca IRT. A major topic of this project is studying empirical relations between each of these accretion diagnostics and the mass accretion rate. Eventually, this enables the investigation of the scatter in the mass accretion rate vs. mass diagram, and to constrain formation and early evolutionary scenarios of low-mass YSOs and BDs. Several of our targets drive outflows that are traced by forbidden lines. The ratio between outflow and accretion rate is an important ingredient of jet launching models, and can be constrained here for very low-mass objects. In short, the enormous wavelength range of X-Shooter yields the opportunity for a comprehensive study of accretion and outflows through simultaneous observations of all diagnostics, eliminating variability-induced uncertainties.

ABSTRACT

Carlo Felice Manara
ESO-Garching / STScI

The HST Treasury Program on the Orion Nebula Cluster: Mass Accretion Rates Estimates

The HST Treasury Program on the Orion Nebula Cluster (Cycle 13, GO 10246, P.I. M. Robberto) provided us with the most complete and detailed picture of one of the most interesting nearby stellar nursery. We have analyzed the extensive of this program to derive the mass accretion rates of ~300 nearly coeval (~1Myr) T Tauri stars. The size of the sample allows for the most robust statistical study to date of the final phases of the stellar mass build-up and inner disk evolution. I will report on the observed trends of Lacc and mass accretion rates vs. the main stellar parameters (mass, age, luminosity, rotation...) and compare our findings with current models.

ABSTRACT

Viki Joergens
MPI for Astronomy / ITA Univ. Heidelberg (DE)

Outflows, accretion and binaries among ChaI brown dwarfs / VLMS

Based on high-resolution VLT spectra outflows, accretion, and close binaries were detected for brown dwarfs and very low-mass stars in the Cha I cloud. Spectro-astrometry of forbidden line emission allowed us to confirm the outflow of a brown dwarf and newly discover the outflow of a VLMS. The results are discussed together with disk and accretion properties and models of the objects. Precise radial velocity (RV) monitoring led to the detection of several very low-mass spectroscopic binaries. Among them are a possible brown dwarf spectroscopic triple, a VLM binary for which upper mass limits are derived based on NACO observations, as well as the very low-mass binary ChaHa8 which is comprised of at least one brown dwarf and for which the RV orbit based on 10 years of RV monitoring was solved. Furthermore, the BD/VLM binary properties of the whole Cha I sample are discussed in comparison with results of other RV and direct imaging surveys for BD/VLM binaries.

ABSTRACT

Maria Rosa Zapatero Osorio
CAB (INTA-CSIC), Madrid (ES)

Near-infrared linear polarization of ultracool dwarfs

We have obtained J-band polarimetric photometry and Spitzer and WISE mid-infrared photometry of eight ultracool dwarfs with spectral types between M7 and early-T. All the targets are known to be young (< 300 Myr) or photometrically variable. The mid-infrared data have allowed us to confirm the peculiar red colors of five sources in the sample. We can impose rather modest upper limits of 0.9% and 1.8% on the linear polarization degree for seven targets with a confidence of 99%. Only one source, 2MASS J02411151-0326587 (L0), appears to be strongly polarized (P ~ 3%) in the J-band with a significance level of P/sigma_P ~ 10. The likely origin of its linearly polarized light and rather red infrared colors may reside in a surrounding disk with an asymmetric distribution of grains. Given its proximity, this object becomes an excellent target for the direct detection of the disk.

Friday, 14 October

ABSTRACT

Isabelle Baraffe
University of Exeter (UK)

Early Evolution of Very Low Mass Stars and Brown Dwarfs (Invited)

I will discuss the early evolution of low mass objects and will analyse the main uncertainties in current evolutionary models, including the effects of rotation, magnetic field and early accretion history on young object's structure. Special attention will be paid to the well known spread in HRD observed in star formation regions and young clusters for objects of a few Myr old and to light element depletion, used as an age indicator and a criterion for cluster membership for low mass stars.

ABSTRACT

Loredana Spezzi
European Space Agency (ESA-ESTEC) (NL)

Early evolution of low mass stars and brown dwarfs: an observational overview (Invited)

The importance of unveiling the physical processes governing the early phases of low-mass star and brown dwarf evolution stems from their direct relevance to fundamental questions of stellar and planetary origins and properties. Observations of stellar birth sites at infrared and millimeter wavelengths from space and the ground have resulted in considerable progress in this area of research. In this contribution I will review the empirical basis for our current understanding of the early phases of low-mass stars and brown dwarfs evolution, with an emphasis on the latest results from the Herschel space telescope.

ABSTRACT

Stella Offner
Harvard-Smithsonian CfA, Cambridge (US)

The Role of Episodic Accretion in Low-Mass Star Formation

A number of young stars, like FU Orionis, have been observed to experience short abrupt changes in their luminosity of an order of magnitude or more. These changes are commonly attributed to episodic fluctuations in the accretion rate onto the star. However, the characteristics, frequency and importance of these bursts in the star formation process are poorly constrained. Recently, episodic accretion has been proposed as the origin of the stellar age spread in low-mass stars inferred in young clusters (Baraffe et al. 2009). Episodic accretion has also been suggested as a solution for the protostellar "luminosity problem," wherein protostars are observed to be dimmer than predicted by star formation models (e.g., Kenyon et al. 1990, Evans et al. 2009, Dunham et al. 2010). In this talk, I will give an overview of each of these issues and evaluate whether episodic accretion could provide a solution. In particular, I will present new work exploring the origin of stellar age spreads and show that variation in the initial radius and choice of model have a much larger effect on early stellar evolution than accretion (Hosokawa, Offner & Krumholz 2011). I will also discuss theoretical predictions for the protostellar luminosity function (PLF), which can be used to constrain the protostellar accretion history (Offner & McKee 2011). These PLF models suggest that an accretion time (i.e., Class 0 and Class I lifetime) of 0.3 +/- 0.1 Myr taken together with some accretion that occurs in episodic bursts can resolve the classical "luminosity problem."

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[5] Hosokawa, T., Offner, S. S. R. & Krumholz, M. R. 2011, ApJ, in press.
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ABSTRACT

Simone Antoniucci
INAF - Osservatorio Astronomico di Roma (IT)

POISSON project: an optical/IR spectral survey of Young Stellar Objects from different star-forming regions

The POISSON project (Protostellar Optical-Infrared Spectral Survey On NTT), is a collection of low resolution spectra (0.6-2.5 um) of Spitzer-selected Class I/II Young Stellar Objects in six different star-forming regions (ChaI-II, L1641, Vel, Ser, Lup, R CrA). The main goal of this project is the study of the accretion and ejection properties of the sources and their relationship with the evolutionary stage and cloud properties. In particular, we have derived the accretion luminosity (Lacc) of the sources from different optical/NIR emission lines commonly employed as tracers (namely [OI], H_alpha, CaII, Pa_Beta, Br_Gamma), making use of the relevant empirical relationships present in the literature, which connect the line luminosity to Lacc. We will discuss here the reliability and limitations of the different accretion tracers/relationships, the evolution of the mass accretion rate and its dependence on the source properties and local environment. In addition, we will provide constraints on size, temperature and density of the IR HI line emission region from the analysis of the line ratios.

ABSTRACT

Jenny Patience
University of Exeter (UK)

Infrared spectroscopy across the brown dwarf/planet boundary

With a uniform data set of nine objects estimated to have very low brown dwarf/planetary masses of ~5-20 Mjup and young ages ranging from ~2-50 Myr, we have developed an empirical grid of J,H,K spectra. Most of the targets are substellar companions, and companion objects are especially valuable for comparison with atmosphere and evolutionary models, since they present rare cases in which the age is accurately known. The sample covers three age bins, with three members of star-forming regions 2-3 Myr old, three members of the ~8 Myr TW Hydra Association, and two members of ~30 Myr Tucana-Horologium Association and one young field object. All objects are expected to have low surface gravity. For all members of the sample, there are archive infrared J,H,K spectra from the VLT integral field spectrograph SINFONI, forming an empirical grid of the atmospheres of substellar objects covering the critical early phases of their evolution. The data are compared with theoretical grids of four different atmospheric models to explore the effects of different physical processes included in the models and the effects of low surface gravity. For one target, the SINFONI spectra represent a second epoch, and the combined data show no variations in the shape of the continuum over time. For another target, the J-band portion of the spectrum is very difficult to explain with current models.

ABSTRACT

Günther Wuchterl
Thüringer Landessternwarte, CoRoT / DLR (DE)

Transit Tests of Formation Theory

Radiation-fluid-dynamical models of the formation of stars, brown dwarfs and planets are confronted to constraints on masses and radii obtained for recent discoveries of the CoRoT-mission including CoRoT-2b,-3b,-15b and CoRoT-18b. We further show how a new statistical theory of planet formation can be used to physically distinguish between planets and brown dwarfs in a probabilistic mass-radius diagram. Finally we use the latter approach to identify under which formation-conditions radius anomalies may occur.

ABSTRACT

Trent Dupuy
CfA/SAO, Cambridge (US)

Testing Formation with Brown Dwarfs in the Solar Neighborhood

I will present results from our program to test models using precise dynamical masses for ultracool binaries, based on IR parallaxes from CFHT, near-IR spectroscopy, and Keck laser guide star AO astrometry for a sample of over 30 objects since 2005. In just the last 3 years, we have more than tripled the number of late-M, L, and T dwarf binaries with dynamical masses. In addition to strong tests of substellar model cooling tracks and atmospheres, we have employed our large sample of binary orbits to carry out a novel test of the earliest evolutionary stages by using the distribution of orbital eccentricities to distinguish between competing models of brown dwarf formation. Finally, our sample of directly measured masses has also revealed that the solar neighborhood contains some surprisingly young and low-mass brown dwarfs that bridge the populations studied in star-forming regions and older field brown dwarfs.

ABSTRACT

Wolfgang Brandner
MPI for Astronomy, Heidelberg (DE)

Binarity of brown dwarfs

We give an update on our long-term monitoring programme of binary brown dwarfs at high-angular resolution using ground-based adaptive optics and the Hubble Space Telescope. New astrometric and spectroscopic data provide better constraints on orbital parameters, and hence improved dynamical mass estimates for brown dwarfs in binary systems. The data include the first decade of monitoring of the orbital motion of the prototypical brown dwarf binary Kelu 1. The results seem to support previously reported findings that current evolutionary and atmospheric models might underestimate the mass of very-low-mass stars and brown dwarfs.

ABSTRACT

John Bochanski
Pennsylvania State University

FIRE Spectroscopy of the ultra-cool brown dwarf, UGPS J072227.51−054031.2: Kinematics, Rotation and Atmospheric Parameters

We present R = 6000 near–infrared spectroscopy of the nearby T9 dwarf, UGPS J072227.51−054031.2, obtained during the commissioning of the Folded–Port Infrared Echellette Spectrograph on the Baade Magellan telescope at Las Campanas Observatory. The spectrum is marked by significant absorption from H2O, CH4 and H2. We also identify NH3 absorption features by comparing the spectrum to recently published line lists. The spectrum is fit with BT-Settl models, indicating Teff ∼ 500 − 600 K and log g ∼ 4.3 − 5.0. This corresponds to a mass of ∼ 10−30 MJup and an age of 1−5 Gyr, however there are large discrepancies between the model and observed spectral energy distribution. The radial and rotational velocities of the object are measured as 46.9 ± 2.5 and 40 ± 10 km s−1, respectively, reflecting a thin disk Galactic orbit and fast rotation similar to other T dwarfs, suggesting a young, possibly planetary-mass brown dwarf.