

OBSERVING PLANETARY SYSTEMS

Program and Abstract Book

An ESO Workshop

Santiago de Chile, March 5-8, 2007

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Scientific Organizing Committee

Christophe Dumas (co-Chair), ESO
Michael Sterzik (co-Chair), ESO
Isabelle Baraffe, ENS Lyon, France
Antonella Barucci, Observatoire Paris-Meudon, France
Hermann Boehnhardt, MPI for Solar System Research Katlenburg-Lindau, Germany
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Wolfgang Gieren, Universidad de Concepción, Chile
Anne-Marie Lagrange, CNRS, France
Dante Minniti, Universidad Católica de Chile, Chile
Andreas Quirrenbach, ZAH, Landessternwarte Heidelberg-Knigstuhl, Germany
Stéphane Udry, Observatoire de Genève, Switzerland
Benjamin Zuckerman, University of California in Los Angeles, USA

Local Organizing Committee

Christophe Dumas (co-Chair)
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Stéphane Brilliant
Gaël Chauvin
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Markus Hartung
Valentin D. Ivanov
Emmannüel Jehin
Daniel Kubas
Claudio Melo
Dominique Naef
Oliver Schuetz
Martin Vannier
María Eugenia Gómez (logistic)

Contact Address

European Southern Observatory
Alonso de Cordova 3107
Vitacura, Casilla 19001
Santiago 19, CHILE
Phone: (+56 2) 463 3000
Fax: (+56 2) 463 3001
URL: <http://www.sc.eso.org/santiago/science/OPSWorkshop/>
E-mail: ops_ws07@eso.org

PROGRAM

March the 4th, Sunday

18:00 - 21:00 Registration and Welcome cocktail

March 5th, Monday

08:00 - 09:00 Registration

Session 1: From Disks to Planets

Chairs: Pierre-Olivier Lagage & Hans Ulrich Kaeuff

09:00 - 09:15 Welcome (F. Mirabel)

09:15 - 10:00 F. Ménard "Observations and Models of Circumstellar Disks" (Invited Review)

10:00 - 10:20 O. Absil "Exozodiacal Disks with IR Interferometry"

10:20 - 10:40 D. Barrado y Navascués "Transition Disks in Lambda Orionis"

Coffee Break

11:10 - 11:30 A. Hales "Protoplanetary Disks around A-stars"

11:30 - 11:50 O. Mousis "Formation Conditions of Planetesimals"

Lunch

13:30 - 14:15 C. Telesco "Observing Planetesimal Collisions in Disks" (Invited Review)

14:15 - 14:35 A. Lecavelier "The Beta Pic Disk and its Comets"

14:35 - 14:55 C. Snodgrass "Properties of Short Period Cometary Nuclei"

Coffee Break

15:30 - 16:15 A. Morbidelli "Dynamical Processes in the Early Solar System" (Invited Review)

16:15 - 16:35 C. Fuentes "The Edge of the Kuiper Belt"

Session 2: Search for Planets

Chairs: Stéphane Udry & Rita Schultz

16:35 - 17:20 O. Hainaut "Finding the Big Outer Solar System Bodies" (Invited Review)

17:20 - 17:35 G. Tancredi "Who are the dwarfs in the Solar System?"

17:35 - 18:00 Discussion Day 1 /
Poster PopUps

March the 6th, Tuesday

08:00 - 09:00 Registration

Session 1 (continued): From Disks to Planets

Chairs: Pierre-Olivier Lagage & Hans Ulrich Kaeuff

09:00 - 09:20 A. Wootten "ALMA's View of Planetary Systems"

09:20 - 09:40 E. Pantin "Flaring Disk around HD97048"

Session 2 (continued): Search for Planets

Chairs: Stéphane Udry & Rita Schultz

09:40 - 10:25 D. Queloz "Status and Prospect of RV Surveys" (Invited Review)

Coffee Break

11:00 - 11:20 J. Setiawan "Planets around Nearby, Young Stars"

11:20 - 11:40 A. Sozzetti "Planets around Metal-Poor Dwarfs"

11:40 - 12:00 X. Bonfils "Planets around M-dwarfs"

12:00 - 12:20 A. Quirrenbach "Planets around Giants"

Lunch

14:00 - 14:20 B. Enoch/D. Wilson "SuperWASP"

14:20 - 14:40 G. Piotto "Transits in Super-Metal-Rich Clusters"

14:40 - 15:00 S. Vauclair "Astroseismology of Host Stars"

15:00 - 15:20 C. Melo/C. Torres "Search for Young Associations"

Coffee Break

16:00 - 16:45 D. Mouillet "Direct Detections of Exoplanets: Planetfinder" (Invited Review)

16:45 - 17:05 G. Chauvin "Companions of Exoplanet Host Stars"

17:05 - 18:00 Discussion Day 2 /
Poster PopUps

20:00 Buses leave from ESO

20:30 Conference dinner

≈23:00 Buses are back to ESO

March the 7th, Wednesday

08:00 - 09:00 Registration

Session 2 (continued): Search for Planets

Chairs: Stéphane Udry & Rita Schultz

09:00 - 09:20 H. Zinnecker "Substellar Companions of WD"
09:20 - 09:40 S. Mohanty "Planets around BDs"
09:40 - 10:00 A. Seifahrt "Astrometric and photometric monitoring
of the GQ Lup companion"
10:00 - 10:20 E. Mamajek "Mid-IR Imaging of Cool Companions"

Coffee Break

10:50 - 11:10 S. Metchev "BD Companions to Young Solar Analogs"
11:10 - 11:30 G. Montagnier "BD Desert with NACO-SDF"
11:30 - 11:50 M. Schoeller/M. Vannier "Planets with the VLTI"

Session 3: Planet Chemistry

Chairs: Andreas Quirrenbach & Olivier Mousis

11:50 - 12:35 I. Kamp "Astrochemistry: From Disks to
Protoplanets" (Invited Review)

Lunch

14:00 - 14:45 M. Mumma "Comets as Messengers" (Invited Review)
14:45 - 15:05 R. Schulz "Comet Composition and Chemistry:
Promise of ROSETTA"
15:05 - 15:25 E. Jehin "What do Carbon and Nitrogen Isotope
Abundance Ratios tell us on comets origin?"
15:25 - 15:45 C. Dumas "What are Dwarf Planets made of?"

Coffee Break

16:15 - 17:00 D. Charbonneau "Probing Atmospheres of Exoplanets"
(Invited Review)
17:00 - 17:20 G. Tinetti "Transmission Spectra of Hot Jupiters"
17:20 - 17:40 G. Hébrard "Evaporation of Hot Jupiters"
17:40 - 18:00 Discussion Day 3 /
Poster PopUp

March the 8th, Thursday

08:00 - 09:00 Registration

Session 4: Towards Other Earths

Chairs: Wolfgang Gieren & Hermann Boehnhardt

09:00 - 09:45 L. Kaltenegger "Biomarkers of Other Earths" (Invited Review)
09:45 - 10:05 G. Villanueva "IR Signatures of Biomarkers"
10:05 - 10:25 H. Boehnhardt "Comets and Life"

Coffee Break

11:00 - 11:20 M. Hartung "Titan"
11:20 - 11:40 E. Palle "Atmospheric Signatures of Earthlike Planets"
11:40 - 12:00 M. Sterzik "Chiral Signatures in the Earthshine"

Lunch

13:30 - 14:15 M. Fridlund "Transits from COROT and the Darwin
Mission" (Invited Review)
14:15 - 14:35 D. Minniti "mmag Photometry of Transits"
14:35 - 14:55 J.P. Beaulieu "Microlensing"
14:55 - 15:15 D. Kubas/A. Cassan "Planet frequencies from Microlensing"

Coffee Break

15:45 - 16:30 P. Lawson "NASA's Roadmap to Other Earths"
(Invited Review)
16:30 - 16:50 G. Tinetti "Super-Earth Explorer"
16:50 - 17:30 Poster PopUps /
Concluding remarks

17:30 Good-Bye Cocktail

March the 9th, Friday

6:00 - 22:00 Full Day Excursion to the VLT/Paranal Observatory

ABSTRACTS OF TALK

Observation and models of proto-planetary disks
– Invited Review –

Ménard, François (Laboratoire d'Astrophysique de Grenoble, France)

TBA

Exozodiacal discs with infrared interferometry: first results and perspectives

Absil, Olivier (Laboratoire d'Astrophysique de Grenoble, France)

The detection of the warm inner part of debris discs—the extrasolar counterparts of the zodiacal cloud—is of prime importance to characterise the global architecture of planetary systems. Because of the high contrast and small angular separation between the star and the exozodiacal light, high-precision infrared interferometry is the best-suited tool to carry out such observations. In this paper, we review the first detection of an exozodiacal disc by this method recently reported around Vega by Absil et al. (2006), and discuss the currently on-going observing efforts in this domain. We show how interferometric data can give access to the composition and the dynamics (including LHB-like events) of extrasolar planetary systems, and thereby put useful constraints on the presence of small bodies and/or giant planets. This statement is illustrated with new data obtained on various bright Vega-type stars, including Vega itself. Finally, we show how the new generation of interferometric instruments will change our view of debris discs: with their increased sensitivity and imaging capabilities, they will constrain the morphology of bright exozodiacal discs and push the detection limit towards meaningful density levels in the context of future life-finding missions such as Darwin/TPF.

Transition disks in Lambda Orionis low mass members

Barrado y Navascués, David (LAEFF-INTA, Spain)

We present multi-wavelength optical and infrared photometry of 170 previously known low mass stars and brown dwarfs of the 5 Myr Collinder 69 cluster (λ Orionis). The near infrared photometry allows us to identify stars with IR excesses, and we find that the Class II population is very large, around 25% for stars and 40% for brown dwarfs, despite the fact that the $H\alpha$ equivalent width is low for a significant fraction of them. In addition, there are a number of substellar objects, classified as Class III, that have optically thin disks. The Class II members are distributed in an inhomogenous way, lying preferently in a filament running toward the south-east. The IR excesses for the Collinder 69 members range from pure Class II (flat or nearly flat spectra longward of 1 micron), to transition disks with no near-IR excess but excesses beginning within the IRAC wavelength range, to two stars with excess only detected at 24 micron. Collinder 69 thus appears to be at an age where it provides a natural laboratory for the study of primordial disks and their dissipation.

Galactic searches for protoplanetary disks around A-type stars

Hales, Antonio (NRAO, USA)

I will present results from a search for dusty early A-type stars in the northern galactic plane. Photometric data from the IPHAS H α survey is first used to select a sample of galactic A-type stars. This sample is then correlated with data from the Spitzer Space Telescope in order to search for 8 microns and 24 microns excesses associated with warm dust orbiting the stars. The improved photometric sensitivities of these new galactic surveys allow the list of known galactic 'Vega-like' sources to be extended to unexplored optical magnitude ranges (13.5; r ; 18.5 mags). Only 1% of a sample of 3062 A-type stars with available optical to mid-infrared spectral energy distributions showed detectable excesses at 8 microns. Searching over 1860 stars observed at 24 microns yielded similar statistical results. Only 10 stars have both 8 and 24 micron excesses. These results support the idea that warm dust located relatively close to the stars are rare in main sequence systems.

Formation conditions of planetesimals in disks and implications for the composition of exoplanets

Mousis, Olivier (Observatoire de Besançon, France)

We examine the formation conditions of icy planetesimals produced in protoplanetary disks. Assuming that these solids are made from hydrates, clathrate hydrates and pure condensates from a homogeneous gas-phase, we show that their composition does not depend on the thermodynamic conditions adopted for the disk. Instead, we find that it is rather influenced by the variation of the C/O ratio in the gas phase. We then discuss the implications of these calculations for the composition of cool planets. We also give an estimate of the abundance of volatiles that could be measured in the atmospheres of Jupiter-like planets.

Observing Planetesimal Collisions in Disks

– Invited Review –

Telesco, Charles (University of Florida, USA)

The formation of a planet requires the steady accumulation of progressively larger particles and bodies, and so collisions must play a key role in the evolution of planetary systems. It is also clear that, as the average size of the bodies grows, individual collisions become rarer while at the same time becoming much more dramatic observationally. The heavily cratered lunar surface testifies to numerous planetesimal collisions during the heavy bombardment episode late in our solar systems formation. However, the birth of the Moon itself, thought to have resulted from the collision of a Mars-sized body with the proto-Earth, must have been a truly spectacular event. Would the occurrence of such a catastrophic collision in another planetary system be observable directly? If so, we could begin to make a more concrete connection between planet-building collisional processes in our own and other planetary systems, thereby shedding additional light on this important early phase of planetary system evolution. In my presentation, I will review observational evidence suggesting that we may indeed be seeing the immediate aftermath of exosolar planetesimal collisions that in some cases are catastrophic. These observations include detection of spectroscopic signatures and multi-wavelength imaging of circumstellar disk asymmetries.

The Beta Pictoris disk and its families of extrasolar comets

Lecavelier, Alain (Institut d'Astrophysique de Paris, France)

The gaseous component of the debris disk surrounding Beta Pictoris has been subject of detailed observations. The characteristics of the CO detected with HST and the search for H₂ with FUSE demonstrated that the evaporation of frozen bodies like comets must produce the CO seen in the disk. Extensive observations of spectral variability of Beta Pictoris are now interpreted by extrasolar comets evaporating in the vicinity of the central star in this young planetary system. We will present the result of a large survey of these extrasolar comets carried out with HARPS. For the first time, these observations allowed us to discriminate two different dynamical families of comets. One family could be the result of a recent break-up of one or two comets, while the dynamical characteristics of the other family is consistent with a mean motion resonance with a massive planet as proposed by Beust & Morbidelli. In short, we are witnessing an intense cometary activity which is likely similar to the one which took place four billion years ago in our own Solar system.

Internal and surface properties of cometary nuclei

Snodgrass, Colin (ESO)

Colin Snodgrass (ESO, Chile), Alan Fitzsimmons, Stephen Lowry (Queen's University Belfast, UK)

We present results from our observations of short period cometary nuclei, taken with the NTT (La Silla) and the INT (La Palma). We have performed time-series observations of a number of nuclei, and use these to constrain their rotation periods, elongations, sizes and bulk densities. We also measure surface colours of nuclei through multi-filter photometry. The results from our combined database on Jupiter Family Comets are given, and these general population properties are compared with those for other populations, in particular Kuiper Belt Objects. We find evidence of a flat spin-rate distribution, a low cut-off in bulk density, and colours that differ from, but can be linked with, those of the KBOs.

Dynamical Processes in the Early Solar System

– Invited Review –

Morbidelli, Alessandro (Observatoire de Nice, France)

We review our understanding of the dynamical processes that led to the formation of the Solar System as we know it now, and compare the main stages of Solar System evolution to those of known extra-solar systems, enlightening differences and/or similarities.

We begin by discussing the stellar environment in which the Solar System formed. The discovery of the first object (i.e. Sedna) at the inner boundary of the Inner Oort Cloud allows us to estimate the statistical frequency of stellar encounters and to deduce that Solar System formed in an environment of about 200-300 stars within 0.2 parsecs.

Then we discuss the crucial issue of why our Solar System does not have a hot Jupiter planet. We argue that the most plausible reason can be found in the mass hierarchy of our giant planets. We will present new hydro-dynamical calculations showing several possible resonant configurations of our 4 giant planets that are stable and avoid migration towards the Sun. Some of these configurations remain stable even after the disappearance of the gas disk.

Next, we discuss the clearing of the inner part of the disk (i.e. interior to the orbit of Jupiter) due to the formation of the terrestrial planets. The rapid decay of the number of planetesimals compares quite well with the rapid drop of mid-infrared emission of debris disks in the first 10-30 My.

Finally we will focus on the Late Heavy Bombardment. The evidence for a late cataclysmic bombardment episode on the terrestrial planets teaches us two things. First, planets can become temporarily unstable, more or less late in time, which might be linked with the origin of the large eccentricities of extra-solar planets. Second, our planetary system was probably surrounded by a massive disk of planetesimals, sharing some similarities with those of Fomalhaut and AU Mic, until the time of the LHB. The dust produced by this distant disk during its massive phase was comparable to that required to explain the brightness in the far-infrared of some debris disks around main sequence solar stars. The interaction between our giant planets and the disk could have led to the acquisition of their current orbit, starting from one of the resonant, non-migrating configurations achieved during the evolution in the gas disk. We will discuss different possible outcomes, depending on disk mass and radial extent, that might explain observed extra-solar disks.

Characterizing the Kuiper Belt

Fuentes, César (Harvard University, USA)

The dynamical processes that took place during the history of the solar system have shaped the statistical properties of the Kuiper belt. In particular measuring the radial distribution of the Kuiper belt and its edge has been recognized by several authors as being particularly important.

We present the advance on the search for Kuiper Belt objects in a couple of dozens Subaru fields. Our latest results on the cumulative radial distribution of these objects, with a 25th magnitude limit are shown. We use the subtraction method, that has been used extensively in similar pencil-beam searches. The observations were taken in each field in groups of a few, and visited twice a night over 2 nights. We combined the consecutive, relatively short exposures (1 min) and search for moving objects. We finally link detections between visits to the same field.

This is part of a longer project aimed at determining the edge of the Kuiper Belt using wide-field ground based images. We also have deeper fields that should extend the measured distribution to farther, smaller objects. Results for the first of those fields are shown. We have automated a large part of the process and this has allowed us to deal with such large datasets.

Finding the Big Outer Solar System Bodies

– Invited Review –

Hainaut, Olivier (ESO)

With more than 1200 objects known, we have now a large sample of minor bodies in the outer Solar System to work on. They are now distributed among several fairly well defined dynamical classes, and we even have some convincing scenarii explaining the connections between these classes and within a broader picture of the formation of the Solar System. Physical studies also start to produce basic taxonomic classification, that will hopefully evolve into a physical classification. Nevertheless, in many cases, the abundance of objects permits us only to pinpoint where our ignorance lies. For instance, it is absolutely not clear why the Kuiper belt is truncated (or appears to be), what its thickness is, nor what are the various processes that shaped the size distribution(s) of the objects. The recent discoveries of some very large objects has cast some light on the big end of the distribution, while the faint end still lies in darkness. Additionally, these large objects (which also are among the brightest) are invaluable, as they tend themselves to detailed physical studies, and set constraints on many models of the smaller bodies.

This presentation will include a short description of the various methods used to find minor bodies in the outer Solar System, and a review of major surveys that characterized the currently known population, together with other projects and methods that might change the field in the coming years. While extra-Solar Transneptunian Objects are still beyond the horizon, the knowledge of our Kuiper Belt should increase dramatically, and we might have some other belts to compare with.

Who are the dwarfs in the Solar System?

Tancredi, Gonzalo (Departamento de Astronomia, Facultad de Ciencias, UDLAR, Uruguay)

The International Astronomical Union recently adopted in its XXVI General Assembly a definition of planets in the Solar System. Changing 76 years of tradition, our Solar System has 8 planets and an increasing number of a new category of bodies named dwarf planets. According to the resolution: a "dwarf planet" is a celestial body that has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape and has not cleared the neighbourhood around its orbit. In a footnote, the resolution says: An IAU process will be established to assign borderline objects into either a dwarf planet and other categories.

In order to contribute to the establishment of this classification procedure, we analyze the problem of the minimum mass required to become a dwarf planet, either from the theoretical and the observational perspective. We propose a classification criteria based on the available information on the shape and size of TNOs, principally the direct or indirect estimates of the diameter and the estimates of the shapes from the lightcurves. We compile the available observational data on TNOs, and we present a list of more than a dozen icy dwarf planets.

ALMA's View of Planetary Systems

Wooten, Al (NRAO, USA)

The Atacama Large Millimeter Array will provide an excellent instrument for direct and indirect detection of extrasolar giant planets and imaging of extrasolar planetary systems at all evolutionary stages. It will excel at subarcsecond imaging of protostellar, protoplanetary and debris disks; gaps and warps in these images will trace the evolution of material within them, including planets. Direct detection of very young, hot protoJupiters can be achieved out to the nearest star-forming regions. Although massive giant planets such as Jupiter itself can be detected only to a few parsecs, objects such as G1229B might be detected to about 5-10pc. Indirect detection through reflex motions of stars will also be possible.

A flaring disk around HD 97048

Pantin, Eric (SAP CE Saclay, France)

Circumstellar disks (CS) are ubiquitous around stars with intermediate ages around a few millions years. They are the natural outcome of the star formation process because of the angular momentum conservation during the collapse of the initial molecular core. As the system evolves, the gas phase dissipates and properties of the dust dramatically change from small interstellar grains to eventually coagulate into constitutive building blocks (planetesimals) of planetary systems. Dust grains sizes are modified by dust settling in CS disks also as chemical composition, going from amorphous to crystalline phase probably because of annealing processes. Herbig Ae stars represent a particularly interesting laboratory for studying disks evolution and planet formation. They are the more massive (2-10 solar masses) analogues of T Tauri stars. They are the progenitors of the debris disks around A stars (like Beta Pictoris) and were comprehensively studied by the infrared spectrometer (ISO-SWS) on board of the ISO telescope.

Although large progress have been made in modelling the disks structure using radiative transfer models (Chiang & Goldreich, 1997, Natta et al., 2001, Dullemond & Dominik, 2001), the structure of these disks is not uniquely constrained by their source energy distribution (SED) which is in most of the cases, the only observational constraint available up to now. Spatially resolved observations are then essential to bring strong constraints on the disk geometry.

The VISIR instrument is the recently installed mid-infrared imager and spectrometer instrument, attached to the telescope Melipal at VLT observatory (Paranal, Chile). Using this instrument, we have conducted a key program of observations dedicated to the study of such HAe disks, using high angular observations (0.3 arcsec at 10 microns) in imaging and spectrometry. Thanks to these observations, we could spatially resolve a significant fraction of these disks and replace the results in the framework of group I and II disks as defined by Meus, 2001. A spectacular flaring disk was found around HD 97048, detected up to angular distances of more than 3 arcsec (about 500 AU). Its nicely resolved image allows for the first time to constraint directly the disk geometry. Results of the modeling of this disk such as inclination, disk mass, surface density, flaring index; will be presented.

Status and Prospect of Radial Velocity Searches

– Invited Review –

Queloz, Didier (Observatoire de Genève, Switzerland)

I'll review the current status on extra-solar planets researches. The current limitation of radial-velocity surveys shall be in particular discussed in view of the upcoming next generation of precis radial-velocity spectrographs. The transiting planets are a important new subject of researches in extra-solar planet science. I'll shall review the major advancements made thanks to the special geometry of these systems and I shall discuss some ongoing efforts. I'll finish with a short overlook of some futures developments ongoing at ESO.

Planets around nearby young stars

Setiawan, Johnny (Max-Planck-Institut für Astronomie, Germany)

I will present the results of planet searches around nearby young stars with the radial velocity technique by using FEROS at 2.2 m MPG/ESO telescope. During our observations from 2003 until 2006 we found evidence for planetary companions around young (30 - 300 Myrs) stars. The radial velocity variation of the planet host stars have periodicities of several hundred of days which are significantly longer than the stellar rotational periods. The positive detections have been confirmed by the lack of correlation between the bisector velocity spans and radial velocities.

A Keck Hires Doppler Search for Planets Orbiting Metal-Poor Dwarfs

Sozzetti, Alessandro (Harvard-Smithsonian Center for Astrophysics, USA)

We present an analysis of four years of high-precision Doppler measurements with Keck HIRES, searching for giant planets within 1 AU of a well-defined sample of field metal-poor dwarfs in the solar neighborhood. We report on variability, periodicity, and long-term radial-velocity trends for each star. We place upper limits on the companion mass as a function of orbital period and eccentricity. We examine the implications of our results for the observed orbital elements and mass distributions of extrasolar planets. Finally, we place meaningful constraints on the frequency of close-in giant planets around metal-deficient ($[Fe/H] < -0.5$) dwarfs, thereby helping to distinguish between proposed scenarios of gas giant planet formation.

Planets around M dwarfs

Bonfils, Xavier (Lisbon Observatory, Portugal)

While over 200 planets have been found to orbit F, G and K stars, only six have been found around M dwarfs. In spite of their small number, the planets identified around very-low-mass stars exhibit some interesting statistical properties. In particular, they include no hot-Jupiter and very few Jupiter-mass planets at any period. A different frequency of Jupiter-mass planets between sun-like stars and M dwarfs may point toward a stellar mass dependency in planet formation processes. Our recent work on M-dwarf metallicity suggests however that they might have lower abundances of heavy elements than earlier-type stars. Given the well established overabundance of planets around metal-rich stars, one needs to verify whether metallicity alone can explain the statistical properties of M-dwarf planets. I will present the emerging properties of planets around M dwarfs, and briefly discuss how they mesh up with planet formation theories.

Planets around Giant Stars

Quirrenbach, Andreas (Landessternwarte Heidelberg, Germany)

We are conducting a radial-velocity survey of 179 K giants with the Hamilton Echelle Spectrograph at Lick Observatory. Giant stars are interesting targets for planet searches, as they are typically more massive than G-type main sequence stars; one can thus probe the incidence of planets as a function of the host star mass. On the other hand, the atmospheres of K giants are less stable, which makes it more difficult to distinguish the signature of low-mass companions from atmospheric phenomena. I will present a few examples of bona fide planet detections, and draw some preliminary statistical conclusions from our survey.

Transiting Exoplanets with SuperWASP

Enoch, Becky (with D. Wilson) (Open University, UK)

During 2004, SuperWASP-North (La Palma) observed 6.7 million stars of $V=8-15$ for up to 5 months with the aim of identifying new bright transiting extra-solar planets. In the first year of operation, with five 10cm telescopes, several terabytes of data were collected. Hence, an automated but thorough approach to data reduction and transit detection was required. From 2006, a full complement of 16 cameras (at SuperWASP-North and SuperWASP-South (SAAO)) is in use, tripling the data flow. We will discuss the adapted BLS transit-detection algorithm and the filtering procedure we have developed to highlight genuine transiting exoplanets and reject both data artefacts and astrophysical false positives as far as possible. We will also outline the photometric and spectroscopic follow up procedure for the high priority candidates passing this filtering stage, and provide details of the latest results. Further details of the first 2 planets to emerge from the survey, WASP-1b and WASP-2b will be discussed following data from recent observations.

Comments: This talk to be given jointly with SuperWASP member David Wilson of Keele University.

Search for extrasolar planet transits in super metal rich open cluster: NGC 6791 and NGC 6253

Piotto, Giampaolo (Universita' di Padova, Italy)

We present the results of an extended multi-site observing campaign for the search for extra-solar planetary transits in two super metal-rich, old open clusters: NGC6791 and NGC 6253. The purpose of our investigation is to infer the frequency of planets in open cluster environment, and to compare it with that of field stars.

In the case of NGC6791, using the data from four telescopes (CFHT 3.6m, NOT 2.5m, San Pedro Martir 2.2m, and Loiano 1.5m) spanning about 15 nights in two observing seasons (July 2001 for the NOT, and July 2002 for the other, multisite campaign), we achieved millimag photometric precision in more than 3300 cluster stars. Our photometric sequences are fully adequate to detect "hot jupiters", i.e. planets with periods of a few days, transit duration of the order of a few hours, and radii of the order of one jovian radius.

The main result of the investigation is that no significant planetary transits were identified. This null result contrast with the number of transits we expected from our observing campaign.

In fact, a set of detailed simulations show that with reasonable assumptions on planet radii, cluster metallicity, planet frequencies, and for our photometric accuracy and total number of monitored stars, the expected number of detectable transiting planets with at least one transit inside our observing window is 3 ± 1 .

Our simulations also show that the probability to obtain a null result by chance is from 3% to 10%, depending on the adopted metallicity for NGC 6791.

We will discuss the implication of our results, and we will present a possible new observing campaign which could definitively solve the problem of the presence or absence of hot jupiters in NGC 6791.

The analysis of NGC 6253, observed with a 10 day long multisite campaign at ESO using WFI@2.2 and at the AAT, is in progress, and will be presented at the conference.

Asteroseismology of exoplanet-host stars

Vauclair, Sylvie (Observatoire Midi-Pyrénées, Toulouse, France)

Studying the internal structure of exoplanet-host stars compared to that of similar stars without detected planets is particularly important for the understanding of planetary formation and evolution. The observed overmetallicity of stars around which planets have been detected (which means that they have migrated from their initial location) may be a hint in that respect. Asteroseismic studies represent an excellent tool to determine the internal structure of exoplanet-host stars. It also leads to constraints on their external parameters (gravity, effective temperature, metallicity) more precise than obtained from spectroscopy. The determination of the mass and age of the star is also better constrained. After a general discussion on this subject, I will present the special cases of three different stars: μ Arae, observed with the HARPS spectrograph in June 2004 for asteroseismology, which also lead to the detection of a low-mass planet, ι Horologii, which we have precisely modelised and observed with HARPS in November 2006, and HD 52265, one of the main targets of the COROT mission, an exoplanet-host star which will be observed with the COROT satellite during five consecutive months.

Recent papers :

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Search for Associations Containing Young stars (SACY)

Melo, Claudio (with C. Torres) (ESO)

In a recent paper Torres et al (2006) presented the results of a high-resolution optical spectroscopic survey aimed to search for nearby young associations and young stars among optical counterparts of ROSAT All-Sky Survey X-ray sources in the Southern Hemisphere, the SACY survey. In this talk, we describe the SACY survey, its sample and the associations found so far. Future applications for the SACY sample are discussed.

Extrasolar Giant Planets direct detection: current capabilities and developments

– Invited Review –

Mouillet, David (Observatoire Midi-Pyrénées, France)

High contrast imaging techniques enable to separate the flux of an exoplanet from the star halo. This approach is very complementary to other approaches: its own and distinct detection biases open the detection window to new classes of planetary systems and the resulting signal provides complementary astrophysical information on the detected planets, up to, ultimately, the physical and chemical characterization of planetary atmosphere.

The performance of high contrast imaging techniques have impressively improved in the recent years. Current capabilities have made possible the first direct detections of planetary mass companions and motivated large scale observing programs. The current development of next generation instruments will offer the capability to detect EGP around hundreds of targets, around 2010. Such comprehensive studies will complement our knowledge of planetary system statistical properties; they will in particular strongly improve our understanding of the formation and evolution of planetary objects, their relation to disks and the comparison to Brown Dwarfs companions. They will also provide direct information for the characterization of the EGP's physical properties.

Finally, the current developments can also be analyzed in the perspective of future projects, both on the astrophysical and instrumental points of view.

Searching and characterizing long-period companions to exoplanet host stars

Chauvin, Gaël (ESO)

The radial velocity technique is without contest nowadays the most successful method to detect and characterize the properties of exo-planetary systems and brown dwarfs companions. However, this method is intrinsically limited to the close circumstellar environment (<4 AU). To understand the way planetary systems form and evolve, it is then clearly interesting to use complementary techniques such as direct imaging to further complete our view. Since 2003, we have conducted a deep coronagraphic imaging survey of exoplanet host stars, using PUEO-KIR at CFHT, and NACO at VLT. I will describe in this presentation our sample, our observing strategy and the main results of this observing campaign. It includes the discovery of new close stellar and white dwarf companions, their spectral and dynamical characterization and the study of their impact on the formation and the evolution of the inner planetary systems.

An imaging Search for giant planets around white dwarfs

Zinnecker, Hans (Astrophysical Institute Potsdam, Germany)

We have conducted imaging observations of white dwarfs both with HST/NICMOS and VLT/NACO/SINFONI, as well as with IRAC/Spitzer. The scientific rationale and the (non)-detection results will be reported.

The Formation of Planets Around Brown Dwarfs

Mohanty, Subhanjoy (Harvard University, USA)

I discuss the properties of two substellar systems, with a view to understanding the viability of planet formation around brown dwarfs. For the first, 2M1207AB, I present our recent spectroscopic results from VLT NACO, which indicate that (a) the system probably formed like a stellar binary, not a true planetary system, but (b) that nevertheless stellar binary formation mechanisms carried into the substellar regime can form planetary mass companions to brown dwarfs, and (c) that such companions can even possess disks of their own, perhaps capable of forming moons and asteroids. For the second, sigma Ori 12, I present our recent Spitzer spectroscopy, which reveals the presence of a large inner hole in the disk, much bigger than the dust destruction radius, similar to two other substellar disks with inner gaps discovered in the last year. In analogy with similar stellar disks, I argue that such holes are best explained by clearing due to ongoing planetesimal formation. Together, the data indicate that the formation of planetary mass companions may indeed be viable around brown dwarfs, and that such companions can form via a variety of physical processes.

Astrometric and photometric monitoring of the GQ Lup companion

Seifahrt, Andreas (AIU Jena, Germany)

We are monitoring the young star GQ Lup and its sub-stellar companion since a few years with several imaging and spectroscopic observations per year. In this paper, we will present preliminary results on the orbital motion, orbital inclination, and photometric variability of the companion. The mass estimate for the companion from both fitting observed spectra to atmospheric models and formation models implies that it is either a massive planet or a low-mass brown dwarf.

Recent Results from the MMTAO+Clio Survey for Substellar Companions to Nearby Stars

Mamajek, Eric (Harvard-Smithsonian Center for Astrophysics, USA)

The theoretical spectral energy distributions of cool substellar objects (brown dwarfs and extrasolar giant planets) predict that these objects will shine more brightly in the thermal infrared than at shorter near-IR wavelengths at ages of >30 Myr. Nearby stars tend to be older than this limit and a 3-5 micron high contrast search capability enables one to probe physical separations comparable to the giant planets in our own solar system. Here I will summarize recent efforts to use the new Clio 3-5 micron imager, in conjunction with the 6.5-m MMT adaptive optics deformable secondary mirror (MMTAO), to image nearby stellar samples for brown dwarf and extrasolar giant planet populations. Recently, a short observation with Clio was able to place the strongest upper limits yet on the mass of the hypothesized dust-perturbing companion to Vega (<7 Mjup; Hinz et al. 2006, astro-ph/0606129). I will present preliminary results from three surveys of nearby stellar samples, including the nearest A-type stars (Mamajek et al.), the nearest, youngest solar-type stars (Heizman et al.), and the M-type stars within 6 pc (Apai et al.).

Brown-Dwarf Companions to Young Solar Analogs: Frequency and Properties

Metchev, Stanimir (University of California, Los Angeles, USA)

Direct imaging of sub-stellar companions to stars offers a unique glimpse into the properties of wide, low mass ratio systems, and an opportunity to image and characterize extrasolar giant planets. While a number of direct-imaging searches have met with limited success over the past decade, the state of adaptive optics technology on large telescopes is only now sufficiently mature to allow the discovery of a significant population of stellar/sub-stellar binaries. We present updated results on wide sub-stellar companions to stars from a survey of 101 young solar analogs with high-order AO systems on 5-10m telescopes. Because of its large sample size and enhanced sensitivity, the survey offers a more accurate estimate of the frequency of stellar/sub-stellar binaries than has been possible to date. Thus, we find that wide low mass stellar and sub-stellar companions are derived from the same initial mass function as their isolated counterparts. We also discuss evidence for a surface gravity dependence of the effective temperature near the L/T transition, based on the discovery of an L7.5 companion to a 130-400 Myr-old star in our sample. The empirical characterization of the photospheres of similar young ultra-cool dwarfs will be important for future direct-imaging studies of extra-solar giant planets.

Characterization of the brown dwarf desert around solar neighborhood G&K dwarfs using NACO-SDI

Montagnier, Guillaume (LAOG, France / Geneva Observatory, Switzerland)

We have been conducting a systematic search for brown dwarfs around solar neighborhood G&K dwarfs, using NACO in its Simultaneous Differential Imaging mode. We took advantage of the CORALIE planet search radial velocity survey, to select a subsample of 36 G&K dwarfs out of 1600 inside 50 parsecs. These 36 stars display radial velocity drifts compatible with a substellar companions in the separation range accessible to NACO+SDI, and that are not known as long period spectroscopic or visual binaries. We found 16 obvious stellar companions (mostly late M type dwarfs). At this stage of the data processing, we do not directly detect the companions on the remaining 20 stars, pointing that these companions are either massive planets or low mass brown dwarfs. We will present here the results of our program and new constraints on the brown dwarf desert in the separation range from 1 to 100 AU.

Planet detection with the VLTI

Schoeller, Markus & M. Vannier (ESO)

Optical long baseline interferometry provides the spatial resolution and astrometric accuracy needed to detect extrasolar planets. With baselines of up to 200m, four movable 1.8m Auxiliary Telescopes and large apertures on the four 8m Unit Telescopes, the Very Large Telescope Interferometer will play a leading role in ground based searches for exoplanets. We will review the current status of the facility, discuss the various modes which could lead to planet detections, and show results from the first attempts to detect planetary signals.

Astrochemistry: from Disks to Protoplanets

– Invited Review –

Kamp, Inga (STScI, USA)

We know many details of the chemical composition and history of our own Solar System from meteorites, comets and interplanetary dust. In addition, we have a decent understanding of the gas-phase chemistry in young protoplanetary disks and their mineralogy. I will review the current state of our knowledge and focus on how these two separate fields fit together and may provide new insights into the overall process of planetary system formation.

Comets as Messengers from the Early Solar System
– Invited Review –

Mumma, Michael (NASA Goddard Space Flight Center, USA)

TBA

Comet composition and chemistry: what can we expect from Rosetta?

Schulz, Rita (ESA, The Netherlands)

The composition of a comet nucleus cannot be directly determined by remote sensing observations, but is usually inferred from coma observations, assuming certain conditions in the near-nucleus environment. The development of cometary activity is undoubtedly related to most complex, yet unknown, physico-chemical processes in the surface layer of the nucleus and the inner coma. Hence, it is presently not possible to unambiguously extract the true composition of a comet nucleus from its coma composition. Key information on these processes is expected from the Rosetta mission to comet 67P/Churyumov-Gerasimenko. Rosetta will monitor the evolution of the nucleus surface and the coma composition as a function of increasing and decreasing solar flux input along the comets pre- and postperihelion orbit. Different instrumentations will be used in parallel, from multi-wavelength spectrometry to in-situ measurements of coma and nucleus composition and physical properties. This provides the opportunity to cross-correlate the values obtained by the different measurement techniques on board, and in addition link the inner coma chemistry uncovered by the space mission to the abundance of coma species observed from Earth or Earth orbit. Thus, the Rosetta target comet can serve as a reference for interpretation and modelling of the physical and chemical processes relevant for the formation of a cometary coma. If this knowledge is properly transferred to other comets, it will provide new means to distinguish whether differences between comets, observed in their comae, reflect differences of their nuclei or are related to different environmental conditions of the comets at the time of observation. This in turn has important implications to the question of how and where comets were formed in the early solar system.

What do Carbon and Nitrogen Isotope Abundance Ratios tell us on comets origin?

Jehin, Emmanuel (ESO)

Did comets form during the same events that gave birth to the Sun and planets?

Are they more primitive bodies that record pre-solar history ?

Isotopic ratios are one of the most important clues to understand the chemical and physical processing of the solar system material since its formation. Their measurements in comets are then excellently suited to probe the link between comets and the origin of the solar system. We will review the measurements of the stable isotopes of the light elements and focus on the Carbon and Nitrogen isotopic ratios that we have measured from the CN (0,0) violet band in many cometary comas since C/Hale-Bopp, ten years ago. The prospects for future measurements from space missions and ground-base observatories will be presented.

What are Dwarf Planets made of?

Dumas, Christophe (ESO) & F. Merlin, A. Barucci, C. deBergh, A. Guilbert, A. Doressoundiram (Obs. Paris-Meudon), O. Hainaut (ESO)

Spectral modeling methods applied to the reflectance spectra of outer solar system bodies such as Trans-Neptunian Objects, is a powerful tool to establish an inventory of the icy compounds covering their surfaces, as well as to characterize their physical properties (abundance, temperature, mixing-ratio, phase) and the processes (bombardments, irradiation, cryo-volcanism) they have undergone since their accretion in the proto-planetary nebula. We'll present an overview of the latest observational and spectral modeling results concerning the surface composition of the largest TNOs, including the analysis of recent SINFONI spectroscopic data obtained at VLT Observatory for the TNOs 2003 UB313 (Eris) and 2003 EL61.

Probing the Atmospheres of Transiting Planets

– Invited Review –

Charbonneau, David (Harvard-Smithsonian Center for Astrophysics, USA)

Transiting exoplanets afford the opportunity to study their atmospheres without the need to spatially separate the light from the planet from that of the star. By carefully examining the modulation of the combined light from the planet and star during key phases of the known orbit, astronomers have taken a first glimpse into the chemistry, structure, and dynamics of the atmospheres of hot Jupiters. Current rapid progress is driven by the Spitzer Space Telescope, which has yielded broadband photometry and, most recently, spectra of these puzzling worlds. I will review the results obtained during the past year, and look ahead to how these very same techniques might permit a study of the atmospheres of terrestrial planets in the habitable zones of low-mass stars.

Theoretical and observed transmission spectra of Hot Jupiters

Tinetti, Giovanna (Institut d'Astrophysique de Paris, France)

Among the hot Jupiters that transit their parent stars known to date, the two best candidates to be observed with transmission spectroscopy in the mid-infrared (MIR) are HD 189733 b and HD 209458 b, due to their combined characteristics of planetary density, orbital parameters and parent star distance and brightness. Here we present simulations of transmission spectra of these two planets during their primary eclipse in the MIR, and sensitivity studies of the spectra to the changes of atmospheric thermal properties, molecular abundances and C/O ratios. Our model predicts that the dominant species absorbing in the MIR on hot Jupiters are water vapor and carbon monoxide, and their relative abundances are determined by the C/O ratio. Since the temperature profile plays a secondary role in the transmission spectra of hot Jupiters compared to molecular abundances, primary eclipse observations in the MIR of those objects can give an insight on EGP atmospheric chemistry. We discuss our theoretical results in light of the recent observations we made with the Spitzer Space telescope.

Evaporation of hot Jupiters: HST observations and models

Hébrard, Guillaume (Institut d'Astrophysique de Paris, France)

Spectroscopic observations performed during a planetary transit can reveal spectral features in absorption on the continuum background of the parent star, allowing thus direct studies of exoplanets atmospheres. We performed such observations with the Hubble Space Telescope, that allowed evaporation of hot Jupiters to be constrained. I will present the observations and corresponding models.

First, we reported the discovery of escaping hydrogen in the extended atmosphere of HD 209458 b. Subsequent observations confirmed the escape and even more, they allowed the detection of oxygen and carbon, showing that the escape mechanism is not a pure Jeans' escape but an hydrodynamical blow-off. New observations are now available in order to put additional constraints.

To interpret the observations, we developed models that allow physical parameters to be derived for exoplanets, including temperatures, densities, escaping rates or life times. The results nicely fit the observational estimates of the escape rate from HD 209458 b. Moreover, they may explain the lack of low-mass planets with short orbital distances. As those planets might efficiently evaporate, we infer the existence of a new kind of planets, made of the residual core of former hot Jupiters.

Detectable Biomarkers set in context

– Invited Review –

Kaltenegger, Lisa (Harvard Smithsonian Center for Astrophysics, USA)

In a famous paper, Sagan analyzed a spectrum of the Earth taken by the Galileo probe, searching for signatures of life. They concluded that the large amount of O₂ and the simultaneous presence of CH₄ traces are suggestive of biology. In this talk we discuss the biomarkers at different wavelengths and focus on what makes a habitable planet, using Earth as our example and discuss surface, clouds and biosignature evolution over geological time. How do we pick our targets? We look at biomarkers on planets around different stars, and set the measurements in context with physical characteristics of a planet. The search for signs of life implies that we need to gather as much information as possible in order to understand how the observed atmosphere works physically and chemically. We investigate how to detect habitability in extrasolar planets and how different instrument designs influence what you can observe. We live in an exciting time where comparative planetology and the search for life on exoplanets is becoming a reality. This talk shows the stepping stones to make it a reality.

The IR signature of biomarkers in planetary bodies

Villanueva, Geronimo (NASA, Goddard Space Flight Center, USA)

The recent claims by three teams of the existence of methane (CH₄) in Mars implied the possibility of life beyond Earth. This concept was strengthened with the recent discovery of extremophiles, terrestrial microorganisms capable of existing under conditions that most living things cannot tolerate. However, a more robust determination of habitability and the presence of life will require gathering a synergistic combination of information from several fields and spanning many wavelengths. Conducting searches for biomarkers at infrared wavelengths is particularly convenient owing specifically to rovibrational C-H stretching modes in hydrocarbons, which fall in the range $\approx 3.2 - 3.6 \mu\text{m}$. More generally, in the 2-5 μm spectral region, many molecules of possible biological and geothermal origin have strong signatures, for example H₂O, HDO, CO₂, CH₄, C₂H₆, H₂CO, CH₃OH, C₂H₂, C₂H₄, SO₂, OCS, N₂O, NH₃, HCN and CH₃Cl.

We have investigated, both theoretically and by means of high-resolution spectroscopic observations, this rich spectral region in comets, planets, and protoplanetary disks. Increasingly sensitive studies of cometary and planetary atmospheres have become possible thanks to recent (and ongoing) technological developments in infrared instrumentation. Specifically, the cross-dispersed infrared echelle spectrometer at Keck II (NIRSPEC) has proven to be a particularly excellent tool because of its high resolving power and broad spectral coverage. In this talk, we will present synthetic spectra and observations of comet 73P/Schwassmann-Wachmann 3 (in May 2006) and Mars (in January 2006), using NIRSPEC.

Taking both bodies to be proxies for different stages of our Solar System evolution (comet: pristine, Mars: evolved), we will compare their observed chemical signatures and will discuss how they relate to the different stages of solar system evolution (and, by extension, of potential extra-solar planetary system formation and evolution).

Comets and Life Science today and in 7 years from now

Boehnhardt, Hermann (SOC) (MPI for Solar System Research Katlenburg-Lindau, Germany), Fred Goesmann (MPI for Solar System Research, Katlenburg-Lindau), GianPaolo Tozzi (INAF Arcetri Observatory, Florence), Stefano Bagnulo (ESO Santiago de Chile), Ludmilla Kolokolova (Univ. Maryland, College Park)

Comets may have played a role in the creation and evolution of life on Earth through catastrophic impacts that have caused local and global extinction of life forms, through the provision of water to the surface thus contributing to the formation of oceans on Earth, and through the potential delivery of biologically relevant material for the creation of life. The latter is the most interesting, however also most uncertain scenario. There are observational indications for the presence of organic compounds in comets, both in the form of frozen ices and in the dust phase (CHON material), that allow to speculate about the relevance of comets for life on Earth. However, more direct measurements address the chirality of cometary material through remote sensing and in-situ experiments: circular polarization of cometary dust in comet 73P/Schwassmann-Wachmann 3 and chirality of nucleus material at the surface of comet 67P/Churyumov-Gerasimenko. The former was measured in June/July 2006 using FORS1 at the ESO VLT; the latter will be measured by the COSAC instrument on-board the PHILAE lander of ESA's ROSETTA mission. The presentation explains the current knowledge and available results and addresses the expectations for the forthcoming decade.

VLT observations of Titan in the Cassini/Huygens era

Hartung, Markus (ESO)

Even if Titan is a "only" a moon (the second largest after Ganymede), it appears to be the most terrestrial object in our solar system: Its size, the dense nitrogen atmosphere and a methane-based meteorological cycle as well as the similarities to the supposed conditions of prebiotic Earth caused Titan to be the focus of one of the most ambitious space missions. January 2005, the Huygens probe landed successfully on Titan's surface, marking the furthestmost pilotless landing ever achieved so far. The carrier spacecraft Cassini is still orbiting Saturn, and in total 45 Titan flybys have been scheduled until nominal mission end in 2008. I will summarize results of the ESA coordinated ground-based observing campaign to complement the Huygens landing, and then focus in more detail to adaptive-optics supported observations with the VLT. Of particular interest are synergies arising on the study of surface composition and atmosphere, combining ground and space mission data.

Rotational period, and inferring the presence of clouds, from photometric observations of exoplanets

Palle, Enric (Big Bear Solar Observatory-NJIT / Instituto de Astrofísica de Canarias), & E. Ford, S. Seager, M. Vazquez, P. Montanes-Rodriguez

Future observations will aim to determine the surface and atmospheric properties of extrasolar planets similar to the Earth. Here, we have modeled changes in the apparent brightness of the Earth (as a function of its phase angle, and in the direction of the observer's) due to the rotation and orbital motion of the Earth, as well as to the temporal variability of clouds and ice (on daily and seasonal timescales). We apply reflectance models that have been previously validated with observations of the Earthshine that illuminates the dark side of the Moon. We use real cloud data from satellite observations to characterize the hourly, diurnal, and seasonal variability that we might observed in earth-like extrasolar planets. We find that measuring the rotation period of the Earth is non-trivial, even for high signal-to-noise observations, largely due to the temporal variability of cloud cover on timescales comparable to the rotation period. If the rotation period can be measured, then deviations from a periodic signal can be used to infer the presence of tracers (relatively short-living structures) in its atmosphere (i.e., clouds). This could provide a useful technique for recognizing exoplanets that have weather (i.e., cloud cover changing on a diurnal timescale). Such variability is likely to be related to the atmospheric temperature and pressure being near a phase transition. Thus, such observations would support the possibility of liquid water on an extrasolar planet

Search for Chiral Signatures in the Earthshine

Sterzik, Michael (ESO)

We search for circular polarization in the spectrum of the earthshine as induced by chiral molecules of living material on the surface of the Earth at the VLT. Biotic material with its helical molecular structure is known to produce circular polarization of reflected light up to levels of a few percent, thus in the range of detectability of FORS1. Organic material on Earth is abundant, but its detectability using astronomical remote sensing techniques, e.g. through the Vegetation Red Edge, is difficult, and not undisputed. Our experiment is a benchmark required for future attempts to detect biotic material on other astronomical objects.

Transits from COROT and the Darwin mission

– Invited Review –

Fridlund, Malcolm (ESA, The Netherlands)

The recent launch and deployment of the COROT space craft promises the start of systematic and dedicated research into exoplanets being carried out from space. In this review a timeline will be presented that will demonstrate the different elements that take us from COROT until eventually missions like Darwin that will directly study the physical conditions of terrestrial exoplanets will be launched. The relation to ground based programs like ALMA and various ELT options will also be discussed.

While it is too early to report results from the COROT mission, details of its capabilities, and expected results will be presented.

Millimagnitude photometry of extrasolar planetary transits

Minniti, Dante (Pontificia Universidad Católica, Chile)

I will report on the latest results of our programmes to monitor extrasolar planetary transits. We include planets confirmed by radial velocities as well as promising candidates. The observations are carried out at 8m -class telescopes located in Chile, allowing us to obtain very precise transit lightcurves. For the known planets, we measure accurate orbital periods and planetary radii. For the new candidates, we discuss the different possibilities (blends, false positives, planets), choosing the best candidates for radial velocity follow-up.

Searching for Earth mass planet via Microlensing

Beaulieu, Jean-Philippe (Institut d'Astrophysique de Paris, France)

Core accretion models are today the best alternative to explain the formation of planetary systems: accretion of planetesimals lead to the formation of cores, which then start to accrete gas from the primitive nebula (Laughlin G., et al., 2004 ApJ 612, L73). This scenario predicts in the case of M stars a preferred formation of low mass planets (Earth - Neptune) in a few million years and at distances between 1 and 10 AU. More massive planets (Jupiter) formation is hampered by a longer formation time (10 Myr) during which the gas evaporates and is no longer available to be accreted. This is precisely around this type of stars and at these distances from the star that the microlensing technique has its maximum sensitivity. It presents a sounding advantage over competitive techniques (radial velocities or transits) as being the only method sensitive in this range of distances and low masses.

The objective of the PLANET collaboration is the discovery of low mass planets (1 - 15 Earth masses) within 1 - 5 AU of the most common stars in our Galaxy, the M stars, in order to measure their frequency. To achieve this goal, we use the gravitational microlensing effect by following the light curve of stars at 8 different telescopes belonging to the PLANET/RoboNET collaborations (32 scientists). After only two detections of Jupiter-size companions around M stars, we have detected in 2005 a planet of 5.5 Earth masses only at 2.8 AU of its M star (Beaulieu et al. 2006, Nature), which is the first member of a new family of cold telluric planets. This detection confirms the power of this new method and, given our detection efficiency, it suggests that these new planets may be quite common around M stars. I will discuss the next generation of planet hunting programs from existing ground base projects, very aggressive ground based operation, Antarctica based operation, to space projects. The detection space is ranging from frozen SuperEarth/Earth to Earth in habitable zone.

Constraints on the frequency of planets around M- and K-dwarfs from
Microlensing observations

Kubas, Daniel (with A. Cassan) (ESO)

Current groundbased microlensing searches probe distant (at several kpc) cool planetary companions (from 1-10 AU) preferentially around M- and K-dwarf hosts down to one Earth mass. We present two main key achievements of the PLANET (Probing Lensing Aomalies NETwork) collaboration: On one hand, the detection of a cool 5.5 Earth mass planet in a 2.6 AU orbit and its implications for planet formation theories. On the other hand, while now 4 robust detection have been made, the absence of planetary signatures in the microlensing data archives prevails. Using 10 years of collected data we derive constraints on the Galactic abundance of M- and K-dwarf planets.

NASA's Roadmap
– Invited Review –

Lawson, Peter (JPL-Caltech, USA)

NASA's long-term program of space-based missions to detect and characterized exoplanets is the Navigator Program. It comprises a suite of interrelated missions to discover and characterize planetary systems and Earth-like planets around nearby stars. The missions are designed to build on each other's success, each providing an essential step forward toward the goal of discovering habitable planets and life. The missions in the Navigator Program and their relation to each other are described in this talk. Moreover, the Program is described in the wider context of international efforts in the broadening field of exoplanet research. Science priorities and research opportunities related to the Navigator Program are also described.

The Super-Earth Explorer

Tinetti, Giovanna (Institut d'Astrophysique de Paris, France)

The Super-Earth Explorer is a space mission to be submitted to ESA for a launch in 2017. Its objective is to characterize exoplanets previously found by radial velocity (or astrometry) by direct imaging of their reflected light in the visible. We present the main characteristics of the spacecraft and some of its detailed scientific objectives.

ABSTRACTS OF POSTERS

S1-01: Exploring the Kozai Mechanism in the Solar System

Pais, Pablo (Departamento de Astronomía, Facultad de Ciencias, UDLAR, Uruguay)

Kozai Mechanism is a secular evolution that experiences the minor bodies of the Solar System of any orbital semiaxis. Assuming a plane and circular planetary system we numerically calculated the possible trajectories in the space of orbital elements (inclination, perihelic argument) of the particle located in different regions from the Solar System. These trajectories are contours of the mean hamiltonian of the particle. They appear some islands of stability in high eccentricities and inclinations that are explored integrating fictitious particles numerically. These maps formed by contours drastically change when imposing some resonant condition, question that we discussed in this work.

S1-02: The Meudon Multicolor Survey (2MS) of Centaurs and TNOs: from visible to infrared colors

Doressoundiram, Alain (Observatoire de Paris, France)

We present the latest results of the Meudon Multicolor survey (2MS). This survey aimed at characterizing the colors properties and trends of Centaurs and Trans-Neptunian Objects. We report IJHK photometry of objects obtained with CFHT-IR at the Canada-France-Hawaii 3.8-m Telescope (CFHT, Hawaii) and with INGRID at the William Hershel 4.2-m Telescope (WHT, La Palma). Combined with our previous visible colors, we have obtained quasi simultaneous visible-near-infrared colors for 38 objects. This large sample allows an extended characterization of the colors properties of these primitive objects from the B ($0.4 \mu\text{m}$) to the K ($2.2 \mu\text{m}$) regime. Together with all the other infrared color published, we performed a detailed statistical analysis in order to search for significant trends. The most relevant conclusion about visible and near-IR color-color correlations is that, basically, JHK bands alone do not evidence correlations, neither between them nor with BVRIJ bands. Only Centaurs show an anti-correlation between visible colors and H-K. Colors within each dynamical family compare very similarly. All the results will be presented and discussed.

S1-03: VLT photometry of the faint Uranian Irregulars: Constraints on planetary formation

Parisi, M. Gabriela (Universidad de Chile, Chile)

Very recently, rich systems of irregular satellites of the giant planets have been discovered. Their physical and dynamical properties provide a window on processes operating in the young Solar System. In particular for Uranus they may witness the mechanism leading to the peculiar tilt of its rotation axis. The large spin obliquity of Uranus (98 degrees) is usually attributed to a great tangential collision (GC) with another protoplanet at the end of its formation (e.g. Parisi & Brunini 1997, Planet. Space Sci 45, 181). Irregulars should have probably existed at the moment of the GC. The GC perturbs the motion of Uranus and allows orbits of irregulars to change their semimajor axis and eccentricity. The orbits excited by this perturbation should be consistent with the present orbital configuration of the Uranian irregulars. We set theoretical constraints on this scenario from the knowledge of the physical and dynamical properties of these satellites, which also allows us to set constraints on their capture mechanism (Brunini et al. 2002, Icarus 159, 166; Parisi et al. 2006, submitted to Icarus; Maris et al. 2001, AJ 121, 2800; Maris et al. 2006, submitted to A&A). In order to test our theory, we carried out an observing programme of the Uranian irregulars at ESO using FORS2 at VLT-UT1. Through the satellites colors and light curves we looked for their shape and time dependence of their colors and put constraints on their origin as a family, their formation (capture) mechanism, and on the GC as the cause of Uranus' obliquity.

S1-04: Dust Processing in Young Circumstellar Disks

Parisi, M. Gabriela (Universidad de Chile, Chile)

We address the problem of crystallization, melting and evaporation of dust particles in disks around YSOs. This problem has attracted much interest in recent years since it is one important feature which gives considerable insight into evolutionary processes in such disks that is accessible to observations with the new generation of large telescopes. Shock waves seems to be the mechanism able to explain the formation of crystalline silicates found in chondrites, long-period comets, and disks around YSOs (Jones et al. 2000, Protostars and Planets IV, 927; Scott and Krot 2004, ApJ in press). We propose a new energy source of gas dynamics shocks based on gravitational perturbations excited by a companion object, i.e., a giant planet or a companion star. We carry out a parameterization of the wave dynamics and of the dust heating in the shock front that predicts the melting and/or evaporation of silicates in bound orbital ranges determined by the companion orbital semiaxis. We obtain that the gravitational perturbations of the companion would generate shock waves able to process dust particles at $\approx 1-8$ AU depending on the central star and disk physical parameters as well as on the companion parameters (Sterzik and Parisi 2006 submitted to A&A). We speculate that the presence and abundance of crystalline and amorphous silicate grains in young binary systems (young brown dwarfs, T-Tauri stars, and Herbig AeBe stars) are determined by this process. Current infrared observations are just approaching the necessary precision to test this hypothesis.

S1-05: Crystalline Quartz in Protoplanetary Disks

Forrest, William (University of Rochester, USA)

Mid-infrared spectra of a handful of Class II Young Stellar Objects taken using the Infrared Spectrograph (IRS) on board the Spitzer Space Telescope show very prominent narrow emission features indicating silica (crystalline silicon dioxide). Silica is not believed to be a major constituent of the interstellar medium; therefore, any silica present in the circumstellar disks of Class II YSOs must be largely the result of processing of primitive dust material in the protoplanetary disks surrounding these stars. We model the silica features in our spectra using the opacities of various polymorphs of silica and amorphous versions thereof computed from earth-based laboratory measurements. This modeling suggests that the polymorphs of silica that form at high temperatures and low pressures are the dominant forms of silica in some Class II YSO disks. In turn, this constrains the locations within the disk and the physical processes involved in the thermal processing of dust grains.

This work is based on observations made with the Spitzer Space Telescope, which is operated by the Jet Propulsion Laboratory, California Institute of Technology under NASA contract 1407. Support for this work was provided by NASA through contract number 1257184 issued by JPL/Caltech, JPL contract 960803 to Cornell University, and Cornell subcontracts 31419-5714 to the University of Rochester.

S1-06: VISIR/VLT observations of proplyds in Orion

Huelamo, Nuria (LAEFF-INTA, Spain)

In this poster we present mid-IR imaging and spectroscopy of several proplyds in Orion. The high spatial resolution and sensitivity of VISIR/VLT has allowed to resolve dusty structures around several proplyds. The spectra of the objects do not show the silicate emission feature at 9.8 microns but a strong PAH emission at 11.3 microns. This result is in agreement with the suggested anticorrelation (Shuping et al. 2006) between the strength of the silicate emission and the distance to Theta Ori 1 C, the ionizing source in the Trapezium.

S1-07: A Mid-IR Imaging Study of Physical Processes in Debris Disks

Moerchen, Margaret (University of Florida, USA)

Circumstellar disks experience episodes of heightened collisional activity long after planets are expected to have formed. The Late Heavy Bombardment, which occurred ≈ 700 Myr after the formation of the planets, represents just such a period of heightened activity in our solar system. We have initiated a mid-infrared observational program to explore the role played by these dust-producing events in debris disks. The disks in our sample are associated with stars that are much older than the expected lifetimes for primordial dust loss, so the observed dust must be resupplied through collisions of planetesimals or by cometary ejecta. While many debris disks have been photometrically detected, very few have been imaged to determine the actual distribution of dust in the disk.

We give a progress report on our ongoing mid-infrared observational study of debris disks candidates that we are imaging with T-ReCS at Gemini South and Michelle at Gemini North. Our high angular resolution ($\approx 0.5''$) images of the thermally emitting dust in these disks constrain the location of the replenished dust. Our current sample of 20 disks includes that associated with the star Zeta Lep. We have resolved Zeta Lep's disk for the first time and shown it to be the size of our asteroid belt and therefore possibly the archetype for a new class of debris disk. We also present and discuss our images of another disk recently discovered and resolved by others at shorter wavelengths and that bears many intriguing similarities to the Beta Pic disk. Through modeling the disk morphologies, we may be able to set limits on the dominant physical processes responsible for the observed dust distribution.

S1-08: AKARI and the detection and analysis of debris disks

Marshall, Jonathan (Open University, UK)

Circumstellar dust disks are an important diagnostic of planet formation and evolution. Spitzer results constrain the incidence of debris disks around mature stars to $13 \pm 3\%$. Debris disk incidence is found to correlate with spectral type up to K0 and age up to 0.5 Gyr. No correlation is seen between disk incidence and stellar metallicity, in contrast to exoplanet detection. The wider sample of stars available through AKARI will enable a more rigorous study of this effect.

AKARI will survey the entire sky in six spectral bands from 6-180 microns. This coverage, combined with pointed observations, allows observers opportunities to make serendipitous discoveries creating a more complete picture of debris disk evolution in the solar neighbourhood. This research will aid the planning and execution of missions e.g. Darwin and TPF.

S1-09: Disks in solar-type stars with and without Doppler-detected planets

García, Luciano (Observatorio Astronómico de Córdoba, Argentina)

Observations in 24 and 70 microns obtained by instrument MIPS (Multiband Imaging for Photometer Spitzer) have allowed to detect disk structures analogue to the Kuiper Belt in the Solar System in about 10 nearby-solar-type stars that harbor at least one extrasolar planet, detected by means of high precision radial velocity measurements. MIPS has also found Kuiper-Belt-like rings in another group of about 30 G-type stars not known to be associated with planets of the type detected by the Doppler technique, previously mentioned. In this contribution we present initial results of a statistical confrontation of the properties of the disks in both groups of stars. We try to identify the physical conditions that trigger or inhibit the process of planetary formation in each case.

S2-01: NICI: Gemini's first planet finder instrument

Rodgers, Bernadette (Gemini Observatory)

We expect to be in the early stages of commissioning the Gemini Near-Infrared Coronagraphic Imager (NICI) at the time of this meeting. This instrument feeds light via a dedicated Adaptive Optics wavefront sensor onto two detectors for simultaneous differential imaging. It is designed specifically for finding faint companions very close to bright stars- i.e., for planet finding. If invited to attend, I will present an overview of the instrument and a timely update of the status of commissioning.

S2-02: SPHERE: a 2nd generation VLT instrument optimized for exoplanet direct detections

Beuzit, Jean-Luc. (Laboratoire d'Astrophysique de Grenoble (LAOG), France)

Direct detection and spectral characterization of extra-solar planets is one of the most exciting but also one of the most challenging areas in modern astronomy. For its second generation instrumentation on the VLT, ESO has supported two phase A studies for a so-called "Planet Finder" dedicated instrument. Based on the results of these two studies, a unique instrument, SPHERE, is now considered for first light in 2010, including a powerful extreme adaptive optics system (SAXO), various coronagraphs, an infrared differential imaging camera (IRDIS), an infrared integral field spectrograph (IFS) and a visible differential polarimeter (ZIMPOL). The expected performance of the proposed instrument makes possible to investigate the presence of extrasolar giant planets around hundreds of stars. This instrument will also provide new insights in the properties and evolution of the stellar environments in general, including the properties of brown dwarf companions, young disks or debris disks.

S2-03: Photometric and Spectroscopic Studies of Young Brown Dwarfs and Planetary Mass Objects

Oasa, Yumiko (Kobe University, Japan)

We will present the results of our observational studies of very low-mass young stellar objects (YSOs) including brown dwarfs and planetary mass objects in the nearby star-forming regions.

We have performed deep near-infrared surveys that are sensitive enough to provide a census of the stellar population embedded in the clouds down to objects below the deuterium-burning limit (Oasa et al. 2006).

Based on the color-color diagrams, we discriminate YSO candidates with near-infrared excesses from reddened field stars. Combining the reddening-corrected luminosity of the YSO candidates with the theoretical evolutionary models, it is likely that there exists a substantial substellar population, including many potential isolated planetary mass objects.

In addition, the near-infrared spectroscopic observations of the relatively bright substellar YSO candidates have been carried out with the SUBARU telescope. Spectroscopy offers a means for more accurate assessment of cluster membership and more precise measurement of the mass. In order to estimate mass more precisely, we have measured the strength of water and constructed the reddening-independent water absorption index which is an indicator of temperature. Together the luminosity with the water index, we confirm that some YSO candidates have cool temperatures consistent with young brown dwarfs.

S2-04: Search for planetary mass companion to massive stars

Bouy, Herve (UC Berkeley, USA)

We present the result of a recent search for planetary mass companions around 15 B stars using adaptive optics. Our observations were sensitive to planets with masses as low as $0.006 M_{\odot}$ at $0.6''$ of the primary.

S2-05: A Young Brown Dwarf Companion to DH Tauri

Itoh, Yoichi (Kobe University, Japan)

We present the detection of a young brown dwarf companion DH Tau B associated with the classical T-Tauri star DH Tau. Near-infrared coronagraphic observations with CIAO on the Subaru Telescope have revealed DH Tau B with $H = 15$ mag located at 2.3 (330 AU) away from the primary DH Tau A. Comparing its position with a Hubble Space Telescope archive image, we confirmed that DH Tau A and B share the common proper motion, suggesting that they are physically associated with each other. The near-infrared color of DH Tau B is consistent with those of young stellar objects. The near-infrared spectra of DH Tau B show deep water absorption bands, a strong KI absorption line, and a moderate NaI absorption line. We derived its effective temperature and surface gravity of 2700 – 2800 K and 4.0 – 4.5 , respectively, by comparing the observed spectra with synthesized spectra of low-mass objects. The location of DH Tau B on the HR diagram gives its mass of 30 – 50 Jupiter mass.

S2-06: On the rotation period of GQ Lup A

Schmidt, Tobias (AIU - Jena, Germany)

Recently, Neuhäuser et al. (2005) discovered a sub-stellar companion around the classical T Tauri star GQ Lup by direct detection, orbiting at a distance of ≈ 100 AU. Further planet candidates at closer distances are searched for by the radial velocity technique. Unfortunately, classical T-Tauri stars can exhibit strong spot activity. This can mimic radial velocity signals of an orbiting planet.

We have monitored GQ Lup A photometrically in two epochs, took archival data into account and could thus determine a periodicity of the brightness variations. By comparing the photometric amplitude in different wavelength bands we were able to ascribe the variations to surface activity of the star and could therefore determine the rotational period of 8.45 ± 0.2 days.

Assuming luminosity, temperature and the newly found period for this K7V star, the equatorial rotational velocity is about 15.2 km s^{-1} . With the $v \sin i = 6.8 \pm 0.4 \text{ km s}^{-1}$ from Guenther et al. (2005) this implies an inclination of GQ Lup A of about 27 ± 5 degrees and thus an almost pole-on view onto the star. This result may very likely also be the inclination of the disk around GQ Lup A, and possibly also the inclination of its companion.

S2-07: SINFONI Integral field spectroscopy of GQ Lup

Seifahrt, Andreas (AIU Jena, Germany)

We present new mid-resolution ($R=2000-4000$) near infrared (JHK) spectra of the substellar companion to GQ Lup, taken with the integral-field spectrograph SINFONI at the VLT. The GQ Lup companion is a low-mass proper-motion companion to the $1(\pm 1)$ Myr old T-Tauri star GQ Lup A and is supposedly of planetary mass according to recent theoretical models. We compare the measured spectra with the newest generation of synthetic PHOENIX spectra and derive new limits on T_{eff} and $\log g$, which in turn allows a more precise mass determination of the GQ Lup companion.

S2-08: Planets and brown dwarfs around A-F type stars

Desort, Morgan (Laboratoire d'Astrophysique de Grenoble (LAOG), France)

The search for extrasolar planets and brown dwarfs (BDs) making use of radial velocity (RV) techniques currently focuses on solar or later type stars. Nevertheless, we have developed a new RV measurements method that allows to detect very low mass companions around early type stars. Thanks to this powerful method, we are performing a survey dedicated to the search for extrasolar planets and brown dwarfs around a volume-limited sample of A-F type stars. This search will allow to extend the planet and BD formation processes study around stars earlier than F7, which is fundamental in the global understanding of these mechanisms.

We demonstrate here our ability to detect planets and BDs around such A-F type stars, as well as our most recent discoveries on this topic.

S2-09: 3 New Exoplanets Detected with HARPS

Naef, Dominique (ESO-Chile)

In this poster, we present our radial-velocity data of three Solar-type stars: HD100777, HD190647, HD221287. These measurements were obtained with the *High Accuracy Radial-velocity Planet Searcher* (HARPS) mounted on the 3.6-m Telescope at ESO-LaSilla Observatory (Chile). The radial-velocity data of these stars exhibit low-amplitude variations induced by planetary companions with minimum masses of $m_2 \sin i = 1.16, 1.90$ and $3.09 M_{\text{Jup}}$, respectively. The orbital periods of these planets range from a bit more than one to a bit less than 3 years. The three orbits have moderate eccentricities

S2-10: Substellar companionship among nearby white dwarfs

Radiszcz, Matias (Universidad de Chile, Chile)

Our research consists of a near-IR astrometric and spectroscopic study in which we search for substellar objects orbiting nearby white dwarfs (WDs). Our purpose is to test specific predictions of the common envelope evolutionary phase, as well as to provide constraints to planetary system evolution in advanced stages of its parent star.

Observations in near-IR allow us to reach the detection limit of giant planets by taking advantage of the diminished brightness contrast between the primary & secondary objects. First epoch observation in near-IR imaging on a carefully selected sample of WDs within 20 pc of the Sun has produced a list of several extra-solar and brown dwarfs candidates to these nearby WDs. 2nd observation epoch will allow the confirmation (through common proper motion) of sub-stellar objects down to $\approx 5 M_{\text{Jup}}$ among post-main sequence stars. In addition, high S/N near-IR spectroscopic observations were obtained for WDs in this sample, with the goal to detect spectroscopic signatures of unresolved substellar objects orbiting a WD. Preliminary results of this project will be shown.

S2-11: Orbital fits on extrasolar planets systems

Giuppone, Cristian Andrés (Observatorio Astronómico de Córdoba, Argentina)

Most of the extrasolar planets actually known are detected from the periodic variations of the radial velocity of the central star. The orbital elements and mass parameters are obtained from a non-linear least squares fit. Although the fitting process it seems to be simple, in practice there are many difficulties like the short time span of observations, large number of parameters, the possibility of various local minimums, non Gaussian distribution of errors, etc.

We show the preliminary results from our orbital fittings in HD 73526, HD 83943, HD 128311 and 55 Cnc, most of them with 2/1 mean motion resonances. The orbital fits were made combining genetic algorithms and simulated annealing. The uncertain were estimated with a resampling and Montecarlo Markov Chains which allows us to detect correlations between orbital parameters and non-Gaussian errors.

The results obtained were compared whit other authors and with numerical simulations including planetary migrations.

S2-12: Stellar activity's limitation for planet detection by radial velocity method

Marmier, Maxime (Geneva Observatory, Switzerland)

The southern sky extrasolar planet search programme CORALIE has today more than eight years of activity. The number of planets detections and measurements as well as the time baseline of the survey makes now possible a global statistical approach of the data. As a first step in this analysis, stellar spectra from the 1650 sources of the sample were re-reduced to compute the bisector velocity curve of the cross-correlation function. This indicator allow to detect the radial velocity variations due to stellar radial velocity jitter. By this way it's possible to better understand the limitation for planet detection induced by stellar activity.

S2-13: Multiplicity of exoplanet host stars

Mugrauer, Markus (AIU Jena, Germany)

We will present new results of our ongoing multiplicity study of exoplanet host stars carried out in the infrared, using several telescopes and detectors on the northern and southern hemisphere, among those SofI at ESO-NTT and SDI/NACO at ESO-VLT. We will report on our observations of newly found planet hosting stellar systems; e.g. some new binary systems composed of an exoplanet host star and a low-mass stellar companion, as well as one new planet hosting triple star system. Furthermore, we show the spectroscopic confirmation of a new white dwarf companion of an exoplanet host star and our infrared imaging data of the first directly detected brown dwarf companion of an exoplanet host star, observed with SofI. Finally, we will discuss the properties of exoplanets in stellar systems and compare their properties (orbital elements, minimum-masses, angular momenta) with the Properties of planets orbiting around single stars. Differences between the properties of planets revolving around a component of a stellar system and those of planets which are in orbit around an isolated single star might probably point out that the stellar multiplicity alters either the formation or the evolution process of planets.

S2-14: The Direction of the Orbital Motion in Exoplanets

Kotiranta, Samuli (University of Turku, Finland)

Over 200 exoplanets are known. None of the present detection methods measure the sense of the orbital direction. Based on the planetary orbits in our solar system it seems quite natural to assume that all these planets orbit the central star in the same direction as the star rotates. In theory it is possible that some planets could orbit in highly inclined orbits and even in an opposite directions. We will discuss various methods that could be used to detect the direction of the orbital motion in respect to the rotation of the central star.

S2-15: Extrasolar planet taxonomy: a new statistical approach

Ortolani, Sergio (Universita di Padova, Italy)

In this paper we present the guidelines for the development of an extrasolar planet taxonomy. The discovery of an increasing number of extrasolar planets showing a vast variety of the "planetary parameters", like keplerian orbital elements and also "environmental parameters", like stellar masses, spectral types, etc., prompts the development of a planetary taxonomy. In this work via principal component analysis followed by hierarchical clustering analysis, we report the definition of five robust groups of planets. We discuss the physical relevance of such analysis, which may provide a valid support for disentangling the role of the several physical parameters involved in the planetary formation processes and subsequent evolution. For some clusters, we find statistically significant trends such that, for instance, between the metallicity and the orbital parameters of planets. We also comment on the diversity of extrasolar systems with respect to our own Solar System -by including Jupiter- in this scenario.

S2-16: Observing our own minor planets while looking for Exo-Planets

Parley, Neil (Open University, UK)

The SuperWASP project is an ultra-wide angle search for extra solar planetary transits. However, it can also serendipitously detect solar system objects, such as asteroids. Each SuperWASP instrument consists of up to eight cameras, combined with high-quality peltier-cooled CCDs, which photometrically survey large numbers of stars in the magnitude range 7–15. Each camera covers a 7.8 degree field of view. This large field of view both produces advantages and disadvantages for minor planet observations. Slow moving asteroids stay within a single SuperWASP field for several weeks, and may be seen in many fields, providing the opportunity for long-term light curve and phase curve observations. However, the slow movement of an asteroid across the stellar background in a SuperWASP field, combined with the large (13.7 arcsec) pixels means that there must be a constant awareness of blending. In addition, issues relating to cross field calibration must be overcome to produce standard results for asteroids that travel through several fields. These issues are discussed and some results from the 2004 SuperWASP dataset are shown.

S3-01: Photometric and spectroscopic observations of the asteroid (132524) 2002 JF56

Barrera, Luis (Universidad Metropolitana de Ciencias de la Educación, Chile)

The asteroid (132524) 2002 JF56 was the fly-by target of the New Horizons mission on June 13, 2006. In order to allow a good planning of the fly-by, ground based observations of the asteroid were performed on May 2006 at ESO VLT. The analysis of the observations is used for cross-calibration and comparison with the data from the mission spacecraft.

A set of R filter broadband images and reflectance spectra were taken with FORS2 of the ESO VLT for a total of three nights (May 25, 30 & 31, 2006). Each observational cycle spans a time interval of about one hour per night. The observations were performed about two weeks before the fly-by, when the asteroid was at a heliocentric distance of 2.5 AU. Results. The reflectance spectra of 2002 JF56 resemble those of S-type asteroids. From the magnitude of the asteroid, an effective diameter of (2.17 ± 0.01) km is estimated and a lower limit for the axis-ratio of (1.19 ± 0.02) is determined.

S3-02: Mineralogy of 21 Lutetia, target of ROSETTA mission

Birlan, Mirel (Institut de Mécanique Céleste et des Calculs des Éphémérides, France)

Rosetta mission will flyby the asteroid 21 Lutetia in July 2010. An intensive observational campaign was organised in order to improve the knowledge of its mineralogical and physical characteristics. Several observational campaigns were performed between 2003 and 2006 in the 0.8-3.8 μm spectral interval. The spectroscopic observations were carried out in remote mode from CODAM (Meudon, France) by using the NASA's 3 meter aperture telescope IRTF, located at Mauna Kea-Hawaii.

Spectroscopic results were correlated with the asteroid surface by means of physical ephemerides. The 0.8-2.5 μm spectra revealed no major absorption features. The near-equatorial aspect of 21 Lutetia during the 2006 observational campaign allow to conclude to a clear variation between spectra, and their correlation with the rotational period and the geometric aspect. The shallow 3 μm band, presented in the spectrum on 21 Lutetia, privilege a mineralogy where aqueous alteration could be interpreted in terms of minerals favourable to redox reactions.

A chi-square test for the available 0.8-2.5 μm spectra of obtained since 2003 was performed by means of a chosen sample of meteorites. In all cases, chondrite composition of meteorites yielded the best fit. These results are interpreted as a consistency with the primitive composition of 21 Lutetia.

S3-03: A Search for Water on HD 209458 b by Transit Spectroscopy

Rojo, Patricio (Universidad de Chile, Chile)

An attempt to detect water in the atmosphere of the extrasolar planet HD 209458 b using transit spectroscopy will be presented. A radiative transfer model designed and built specifically for this project predicts, given a planetary temperature/pressure/composition profile, the dependence in wavelength of the stellar spectrum modulation due to a transiting planet. A total of 352 spectra around 1.8 microns were obtained on four nights (three in transit) of observations using ISAAC at the Very Large Telescope.

Correlating the modeled modulation with the infrared spectra yields a non-detection of water in the atmosphere of HD 209458 b. However, a quantitative model of an improved observing strategy for future observations of this kind is presented as well as several original data-reduction techniques that were developed during this work.

S3-04: The Infrared Spectroscopic Perspective: Extrapolating from
CRIRES

Kaeufl, Hans Ulrich (ESO-Garching)

Planets are objects better observed in the infrared. Using CRIRES as "role-model" of a high-resolution infrared spectrograph various issues in the context of detection and characterization of brown dwarfs and extra-solar planets or even comets will be reviewed.

The stability limits of CRIRES "as-is" will be reported. The potential of anticipated upgrades such as an image slicer will be discussed.

While CRIRES at the 8m telescope will at best provide for orienting measurements, a dedicated instrument at an ELT could have an impact thanks to the quantum leap in sensitivity.

S4-01: Millimagnitude optical transit photometry for planetary
candidate OGLE-TR-171

Díaz, Rodrigo (Instituto de Astronomía y Física del Espacio (IAFE), Argentina)

We present high-quality optical (V) observations of a transit of planetary candidate OGLE-TR-171. The observations were performed with VIMOS at the European Southern Observatory (ESO) Very Large Telescope (VLT). Our photometry is about 10 times more precise and 100 times more frequent than the OGLE photometry, and that is achieved accumulating more photons faster, using a large telescope.

This allowed to measure the eclipse amplitude with a precision of about 0.001 mag. We also obtained an accurate transit duration and determined the time of mean transit. These parameters were used to obtain a precise estimate of the transit geometry (impact parameter and orbital inclination angle) and the planetary radius.

Our observations can be complemented with previous ones done in other bands, like OGLE I band, to obtain further information about the transiting companion.

S4-02: Milli-magnitude IR transit detection: OGLE-TR-113

Ramírez, Sebastián (Pontificia Universidad Católica, Chile)

On April and March of 2005, we developed a monitoring campaign for a serie of OGLE stars, candidates to present transits due to extrasolar planets. The observations were obtained with the infrared camera SOFI@NTT, through the Ks filter (center at 2162 nm and width of 275 nm), acquiring more than 3 hours of observations for over 10 OGLE stars.

We present the results for OGLE-TR-113 and the IR transit curve for this candidate. With the information derived from the IR observations, we calculated a size for the dimmer companion, obtaining a planetary size. This result allows us to confirm OGLE-TR-113b as a "Hot Jupiter".

S4-03: Millimagnitude Photometry for Transiting Extrasolar Planetary Candidates: The Puzzle of the Extremely Red OGLE-TR-82 Primary Solved

Hoyer, Sergio (Universidad de Chile, Chile)

We present precise new V , I, and K-band photometry for the planetary transit candidate star OGLE-TR-82. Good seeing V -band images acquired at the VLT allows us to measure $V = 20.6$ in spite of the presence of a brighter neighbour about $1''$ away. This faint magnitude answers the question why it has not been possible to measure radial velocities for this object. One transit of this star is well defined in the light curves in the I-band obtained at GEMINI-South. The measurement of the transit allows to verify that this is not a false positive, to confirm the transit amplitude measured by OGLE, and to improve the ephemeris. The near-infrared photometry obtained at the ESO NTT yields $K = 12.2 \pm 0.1$, and $V-K = 8.4 \pm 0.1$, implying that this is a nearby M7V star, or a very reddened distant M-type red giant. Due to the extreme nature of this object, we have not yet been able to measure velocities for this star, but consider two different possible transit configurations. Based on the new data, the nearby M7V dwarf hypothesis yields a radius for the companion of $R_p = 0.3 \pm 0.1 R_J$, i.e. the size of Neptune. The reddened giant hypothesis suggests a normal low mass main-sequence star for the companion. However, both scenarios are inconsistent with the transit length measured here, suggesting a more complicated system. Near-IR spectroscopy finally shows that OGLE-TR-82 is a distant, reddened giant of spectral type M0III. Therefore, we discard the planetary nature of the companion, which is most likely a late M dwarf star. As a case study, this new kind of system that can mimick a planetary transit is a lesson to learn for future transit surveys.

S4-04: Study of OGLE Candidates using their Color-Magnitude Diagrams

Escobar, Maria Eliana (Pontificia Universidad Católica, Chile)

We present V and Ks photometry of four OGLE stars that are candidates to present transits due to extrasolar planets. This is part of a monitoring campaign for a series of OGLE stars. The visual images were taken with the FORS1 instrument at Paranal observatory in March 2006, and the infrared images were taken using SOFI instrument on NTT at La Silla Observatory in April 2005. In order to characterize the OGLE stars we construct the color-magnitude diagrams of the field where the star candidates are located. This will allow us to understand more about the nature of these stars and the conditions in which the planets candidates are exposed, and complement this work with the characterization of the transit itself.

S4-05: Search For Transiting Exoplanets Around Proxima Centauri

Blank, David (James Cook University, Australia)

We have conducted a search for transiting exoplanets around the star nearest to our Sun, Proxima Centauri. We have observed for about 110 hours spread over several months. I will discuss the results of our search.

S4-06: Search for exo-planet transits in the lightcurves of active solar-type giants

Gondoin, Philippe (ESA, The Netherlands)

Yellow giants with masses included between 1.8 and 3.5 solar masses develop thick outer convection zones as they rapidly traverse the G spectral type zone of the H-R diagram. Their increasing convection zone depth combined with fast rotation trigger dynamo processes that generate solar-like magnetic phenomena including large starspots. I investigated the possibility of detecting extra-solar planet transits in the photometric lightcurves of these stars in spite of their high level of magnetic activity. Simulation of planetary transits were conducted using the Corot instrument response and taking into account rotational modulation effects by stellar active regions. I describe the main properties of the exo-planets that could be detected.

S4-07: Follow up observations for transiting extrasolar planets and low-mass stars

Fernández, José (Smithsonian Astrophysical Observatory (SAO), USA)

We present new high-quality light curves for the transiting planet XO-1b and TrES 2 obtained in the SDSS z band using KeplerCam on the 1.2-m telescope at the Whipple Observatory on Mount Hopkins, Arizona. The z band was chosen to minimize the effects of limb darkening. We use the observations to update the radius and orbital inclination of the planets. We also present mass and radius determinations for some M dwarfs eclipsing F and G stars originally identified by the Vulcan, TrES, and HAT wide-angle surveys. These have light curves which are almost indistinguishable from transiting giant planets. In those cases where the rotation of the primary star has been synchronized with the orbital period we can use the observed broadening of the spectral lines to derive the radius and mass of the host star, and therefore the mass and radius of the unseen M dwarf.

S4-08: Transit light curves of three extra-solar planets observed with S-CAM

Schulz, Rita (ESA, The Netherlands)

The transits of three extra-solar planets were monitored at the ESA Optical Ground Station with the S-CAM3, an ultra fast photon counting camera consisting of an array of superconducting tunnel junction detectors, working at a temperature of 300 mK. Its sensitive detectors measure the photon arrival times to microseconds and determine its color while essentially being noise free, only limited by sky background photons. The camera therefore provides high speed low resolution spectra (spectral resolution: 35nm at 500 nm) between 320 nm and 800 nm. In August 2006 we observed the transits of HD 209458, HD 189733 and TrES-1 and a secondary transit of HD 189733. Full transit light curves could be obtained in all cases with a time resolution of 3 seconds. The first results of the analysis of the ingress and egress phases of these light curves will be presented.

S4-09: The Monitor Project: Transits in NGC 2362 - An End to End Systematic Search For Eclipsing Systems

Miller, Adam (Institute of Astronomy, UK)

We have completed a high cadence photometric monitoring survey of the young, open cluster NGC 2362. Observations were made with the Mosaic II imager on the 4m Blanco telescope at CTIO during 16 nights from February 2005 to January 2006.

The youth (5 Myr) and richness (600 cluster members down to $M=0.04M_{\odot}$) of NGC 2362 make it ideal for a monitoring campaign. The detection of a planet around a young star would provide important constraints for planetary formation mechanisms, migration timescales and dynamical evolution, and their relation to disk lifetimes and clearing timescales (Bodenheimer & Lin 2002).

One of the major sources of variability in our lightcurves is the rotation of spots on the surface of the star, which contaminate any occultation search results. We detect rotational modulation in a significant fraction, 40%, of the observed cluster members, which we remove from the lightcurves. We then perform a search for transits (Aigrain & Irwin 2004) and identify 12 eclipsing candidates, a few of which could be caused by planetary companions. We present the candidate eclipsing systems and discuss plans for further photometric and spectroscopic follow-up. Finally, we discuss continuing work to compare our results with predictions from the simulations of Aigrain et al. (2006).

S4-10: A quick solution for the light curves of extra-solar planetary transits

Gimenez, Alvaro (ESA, The Netherlands)

Large surveys, both using ground or space-based facilities, are providing an increasing number of candidate transiting extrasolar planets. A quick solution of the light curve is found to be very useful to discard false candidates as well as to provide good initial elements for a detailed analysis of the data. The obtention of a fully analytical solution of the light curve of extra-solar planetary transits has allowed for the derivation of simple expressions to estimate the best elements for the radii of the star and the planet as well as the inclination of the orbit. The method is presented together with its application to all up-to-now known cases of transiting extra-solar planets. Further examples will be given showing the application of the algorithms to the COROT search for transits.

S4-11: Properties of low mass planets detected by microlensing

Donatowicz, Jadwiga (Technical University Vienna, Austria)

4 planets have been detected so far with the microlensing technique. We will show that follow up observations by the second generation of VLTI instrumentation will allow us to directly detect the lens and greatly improve our knowledge of the systems : By detecting the lens star, we will obtain accurate determination of the mass of the planet, and its orbital separation. We will use OGLE-2005-BLG-390Lb ($\simeq 5.5$ Earth mass orbiting a red dwarf at $\simeq 2.8$ AU) as an illustration.

S4-12: ESPRI: Exoplanet Search with PRIMA

Launhardt, Ralf (Max-Planck-Institut für Astronomie, Germany)

PRIMA, the instrument for Phase Referenced Imaging and Micro-arcsecond Astrometry at the VLTI, is currently being developed at ESO. PRIMA will implement the dual-feed capability at the VLTI for both UTs and ATs to enable simultaneous interferometric observations of two objects that are separated by up to 2 arcmin, without requiring a large continuous field of view. PRIMA will be composed of four major sub-systems: Star Separators, Differential Delay Lines (DDLs), a laser metrology system, and Fringe Sensor Units (FSU). The system is designed to perform narrow-angle astrometry in K-band with two FSUs and, with one FSU in combination with AMBER or MIDI, phase-referenced aperture synthesis imaging.

In order to speed up the full implementation of the 10 mu arcsec astrometric capability of the VLTI and to carry out a large astrometric planet search program, a consortium lead by the Observatoire de Genève (Switzerland), the Max Planck Institute for Astronomy, and the Landessternwarte Heidelberg (Germany) agreed with ESO to build the Differential Delay Lines and to develop all necessary operation tools and data reduction software needed for the full implementation of the precise astrometric capability at VLTI.

In return of its effort, the consortium has been awarded GTO time to carry out a large and systematic astrometric planet search program (with ATs in K-band). This poster gives an overview on the project and describes ongoing hardware and software developments as well as outlines the anticipated astrometric planet search program.

LIST OF PARTICIPANTS AND AUTHORS INDEX

Name	E-mail	Page
Absil, Olivier	olivier.absil@obs.ujf-grenoble.fr	11
Aliste, Rommy	rlasiste@uc.cl	-
Barrado y Navascués, David	barrado@laeff.inta.es	12
Barrera, Luis	lbarrera@umce.cl	88
Beaulieu, Jean-Philippe	beaulieu@iap.fr	58
Birlan, Mirel	Mirel.Birlan@imcce.fr	89
Blank, David	david.blank@jcu.edu.au	96
Boehnhardt, Hermann	boehnhardt@mps.mpg.de	52
Bonfils, Xavier	xavier.bonfils@oal.ul.pt	27
Botti, Ismael	ibotti@das.uchile.cl	-
Bouy, Herve	hbouy@astro.berkeley.edu	75
Brilliant, Stéphane	sbrillan@eso.org	-
Casassus, Simon	simon@das.uchile.cl	-
Cassan, Arnaud	cassan@ari.uni-heidelberg.de	59
Charbonneau, David	dcharbon@cfa.harvard.edu	47
Chauvin, Gaël	gchauvin@eso.org	34
Cisternas, Mauricio	mecister@puc.cl	-
Contreras, Carlos	cecontrep@gmail.com	-
Dall, Thomas	tdall@gemini.edu	-
Desort, Morgan	mdesort@obs.ujf-grenoble.fr	79
Díaz, Rodrigo	rodrigo@iafe.uba.ar	92
Donatowicz, Jadwiga	jadzia@shakti.zid.tuwien.ac.at	102
Doressoundiram, Alain	Alain.Doressoundiram@obspm.fr	64
Dumas, Christophe	cdumas@eso.org	46
Enoch, Becky	r.enoch@open.ac.uk	29
Escobar, Maria Eliana	mescobar@astro.puc.cl	95
Ferlet, Roger	ferlet@iap.fr	-
Fernández, José	jfernand@cfa.harvard.edu	98
Forrest, William	forrest@pas.rochester.edu	67
Fridlund, Malcolm	Malcolm.Fridlund@esa.int	56
Fuentes, Cesar	cfuentes@cfa.harvard.edu	19
García, Luciano	lucianog@oac.uncor.edu	71
Gieren, Wolfgang	wgieren@astro-udec.cl	-
Gimenez, Alvaro	agimenez@rissd.esa.int	101
Giuppone, Cristian Andrés	cristian@oac.uncor.edu	82
Gondoin, Philippe	pgondoin@rissd.esa.int	97
Hainaut, Olivier	ohainaut@eso.org	20
Hales, Antonio	ahales@nrao.edu	13
Hartung, Markus	mhartung@eso.org	53
Hebrard, Guillaume	hebrard@iap.fr	49
Herrera, Cinthya	cherrera@puc.cl	-
Hoyer, Sergio	shoyer@das.uchile.cl	94
Huelamo, Nuria	nhuelamo@oal.ul.pt	68
Itoh, Yoichi	yitoh@kobe-u.ac.jp	76
Ivanov, Valentin	vivanov@eso.org	-
Jehin, Emmanuel	ejehin@eso.org	45
Kaeuff, Hans Ulrich	hukauff@eso.org	91
Kaltenegger, Lisa	lkaltene@cfa.harvard.edu	50
Kamp, Inga	kamp@stsci.edu	42
Kotiranta, Samuli	jankot@utu.fi	85
Kubas, Daniel	dkubas@eso.org	59
Lagage, Pierre-Olivier	pierre-olivier.lagage@cea.fr	-
Lagrange, Anne Marie	anne-marie.lagrange@obs.ujf-grenoble.fr	-
Lawson, Peter	Peter.R.Lawson@Jpl.nasa.gov	60

Name	E-mail	Page
Lecavelier, Alain	lecaveli@iap.fr	16
Lindgren, Harri	hkl1307@googlemail.com	-
Lira, Elias	eslira@uc.cl	-
Lo Curto, Gaspare	glocurto@eso.org	-
Mamajek, Eric	emamajek@cfa.harvard.edu	38
Melo, Claudio	cmelo@eso.org	32
Ménard, François	menard@obs.ujf-grenoble.fr	10
Metchev, Stanimir	metchev@astro.UCLA.EDU	39
Miller, Adam	amiller@ast.cam.ac.uk	100
Minniti, Dante	dante@astro.puc.cl	57
Moerchen, Margaret	margaret@astro.ufl.edu	69
Mohanty, Subhanjoy	smohanty@cfa.harvard.edu	36
Montagnier, Guillaume	Guillaume.Montagnier@obs.ujf-grenoble.fr	40
Morbidelli, Alessandro	morby@oca.eu	18
Mouillet, David	david.mouillet@ast.obs-mip.fr	33
Mousis, Olivier	olivier@obs-besancon.fr	14
Mugrauer, Markus	markus@astro.uni-jena.de	84
Mumma, Michael	Michael.J.Mumma@nasa.gov	43
Naef, Dominique	dnaef@eso.org	80
Nowajewsky, Priscilla	pnowajew@das.uchile.cl	-
Núñez, Carolina	cnunez@uc.cl	-
Oasa, Yumiko	yummy@kobe-u.ac.jp	74
Ordenes D., David	radioboy.2@gmail.com	-
Ortolani, Sergio	sergio.ortolani@unipd.it	86
Pais, Pablo	pol@fisica.edu.uy	63
Palle, Enric	epb@bso.njit.edu	54
Pantin, Eric	epantin@cea.fr	23
Parisi, M. Gabriela	gparisi@das.uchile.cl	65, 66
Parley, Neil	n.r.parley@open.ac.uk	87
Piotto, Giampaolo	giampaolo.piotto@unipd.it	30
Queloz, Didier	Didier.Queloz@obs.unige.ch	24
Quirrenbach, Andreas	A.Quirrenbach@lsw.uni-heidelberg.de	28
Radiszcz, Matias	mradis@das.uchile.cl	81
Ramírez, Sebastián	sramirez@astro.puc.cl	93
Rodgers, Bernadette	brodgers@gemini.edu	72
Rojo, Patricio	pato@das.uchile.cl	90
Schmidt, Tobias	tobi@astro.uni-jena.de	77
Schoeller, Markus	mschoell@eso.org	41
Schuetz, Oliver	oschuetz@eso.org	-
Schulz, Rita	rschulz@rssd.esa.int	44, 99
Seifahrt, Andreas	aseifahr@eso.org	37,78
Setiawan, Johnny	setiawan@mpia.de	25
Siebenmorgen, Ralf	rsiebenm@eso.org	-
Silva, Víctor	-	-
Smith, Verne	vsmith@noao.edu	-
Snodgrass, Colin	csnodgra@eso.org	17
Sozzetti, Alessandro	asozzetti@cfa.harvard.edu	26
Squires, Gordon	squires@ipac.caltech.edu	-
Sterzik, Michael	msterzik@eso.org	55
Tancredi, Gonzalo	gonzalo@fisica.edu.uy	21
Telesco, Charles	telesco@astro.ufl.edu	15
Tinetti, Giovanna	tinetti@iap.fr	48, 61
Toledo, Ignacio	itoledoc@astro.puc.cl	-
Torres, Carlos Alberto O.	beto@lna.br	32
Tsvetanov, Zlatan	zlatan.tsvetanov@nasa.gov	-
Udry, Stéphane	Stephane.Udry@obs.unige.ch	-

Name	E-mail	Page
Vannier, Martin	mvannier@eso.org	41
Vauclair, Sylvie	sylvie.vauclair@ast.obs-mip.fr	31
Vega, Cristian	cnvega@gmail.com	-
Villanueva, Geronimo	villanueva@ssedmail.gsfc.nasa.gov	51
Wilson, David	dw@astro.keele.ac.uk	29
Wootten, Al	awootten@nrao.edu	22
Zapata, Tatiana	taz.cheer@gmail.com	-
Zinnecker, Hans	hzinnecker@aip.de	35