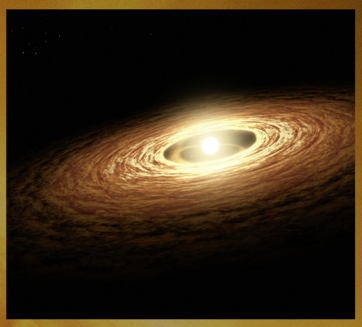
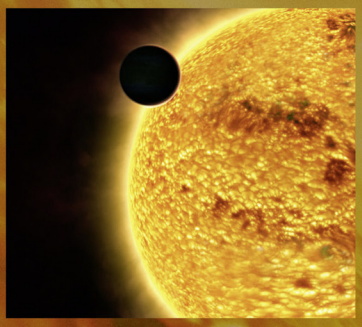
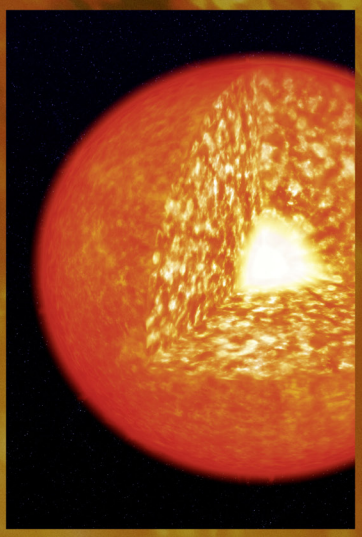
ABSTRACT BOOKLET







ORIGIN AND FATE OF THE SUN

EVOLUTION of SOLAR-MASS STARS

OBSERVED WITH HIGH ANGULAR RESOLUTION

2–5 March, 2010
Garching Germany

The goal of this workshop is to review recent results on solar-mass stars obtained with infrared and millimeter interferometers, and to discuss their importance for our understanding of formation, evolution and fate of stars similar to the Sun.

www.eso.org/sci/meetings/stars2010

Scientific Organizing Committee

Rachel Akeson (Caltech)
Martin Asplund (MPA)
Gerard van Belle (ESO)
Maria-Rosa Cioni (U. Hertfordshire)
Malcolm Fridlund (ESA)
Andrea Richichi (ESO)
Leonardo Testi (ESO)
Christoffel Waelkens (K.U. Leuven)
Markus Wittkowski (ESO, chair)

The Origin and Fate of the Sun: Evolution of Solar-mass Stars Observed with High Angular Resolution

ESO, Garching b. München (Germany), 2-5 March 2010

P R O G R A M

(as at 22-02-2010)

TALKS: **Auditorium**
POSTERS: **Room 231/232**

TUESDAY, 2 March		
9:00-09:30	*Registration (in front of the Auditorium)*	
09:30-09:45	Welcome	T. de Zeeuw
SESSION 1: Young stellar objects (Chair: R. Akeson)		
09:50-10:30	Forming solar-mass stars: an overview of Young Stellar Objects (Overview)	M. Hogerheijde
10:30-11:00	Disk structure and evolution (Invited)	C. Dullemond
11:00-11:30	**Coffee Break**	
11:30-11:50	The Pisa pre-main sequence tracks and isochrones	P.G. Prada-Moroni
11:50-12:10	The dynamical evolution of Sun and solar-like stars: from contraction to MS	S. Turck-Chièze
12:10-14:00	**Lunch Break**	
14:00-14:30	Spatially resolved investigations on YSO disk structure (Invited)	S. Kraus
14:30-14:50	Probing the first stages of planet formation from (sub-)mm interferometry	L. Ricci
14:50-15:10	The potential of VLBA obervations to make a significant and lasting contribution to the study of star formation	R.M. Torres
15:10-15:30	AMBER observations of circumstellar disks around Herbig AeBe stars	F. Massi
15:30-15:50	MIDI's view on circumstellar disks around young, solar-mass stars	T. Ratzka
15:50-16:20	Discussion YSO	R. Akeson
16:20-18:00	**Coffee Break / POSTER Viewing Session** (Rooms 231/232)	
18:00-19:00	**Welcome Reception**	

WEDNESDAY, 3 March		
SESSION 2: Main sequence & Debris disks (Chair: M. Fridlund)		
09:00-09:30	Debris Disks: The Late Stages of Planetary System Formation (Invited)	A. Roberge
09:30-09:50	Hot dust around sun-like stars	E. Di Folco
09:50-10:10	Post-MS evolution of debris discs	A. Bonsor
10:10-10:30	The mass-radius relationship of low and very-low mass stars	B.-O. Demory
10:30-10:50	Zooming in the delta Velorum system using VLTI/AMBER	A. Mérand
10:50-11:20	**Coffee Break**	
11:20-11:50	The detection and characterzation of extrasolar planets (Invited)	D. Pollacco
11:50-12:20	Discussion MS & debris disks	M. Fridlund
12:20-14:00	**Lunch Break**	
SESSION 3: Stellar evolution & atmospheres (Chair: M. Asplund)		
14:00-14:40	Quo vadis stellar evolution (Overview)	F. Herwig
14:40-15:20	Stellar atmospheres (Overview)	B. Gustafsson
15:20-15:40	Stellar surface structure and evolution	K. Strassmeier
15:40-16:00	Fundamental stellar parameters and the fine structure of the Main Sequence	L. Casagrande
16:00-16:30	**Coffee Break**	
16:30-17:00	Atmospheric Dynamics and Winds: A Theorist's View (Invited)	S. Höfner
17:00-17:20	Interpretation of interferometric observations with 3D radiative hydrodynamics simulations of cool stars	A. Chiavassa
17:20-17:40	Interferometric observations of young and evolved stars	F. Cusano
17:40-18:10	Discussion evolution & atmospheres	M. Asplund

THURSDAY, 4 March

SESSION 4a: RGB and AGB stars (Chair: M.-R. Cioni)

09:00-09:40	Centimeter and (Sub)millimeter Wavelength Imaging of the Photospheres and Envelopes of AGB Stars (Invited)	K. Menten
09:40-10:10	Probing the outer atmosphere and mass loss in red giants by IR interferometry (Invited)	K. Ohnaka
10:10-10:30	Local red giants radii and convection prescription	L. Piau
10:30-10:50	Investigating star spots using Doppler imaging and optical interferometry	H. Korhonen
10:50-11:20	**Coffee Break**	
11:20-11:40	Images of Chi Cygni; a pulsation observed by interferometry	S. Lacour
11:40-12:00	Interferometric monitoring of evolved stars	I. Karovicova
12:00-12:20	A possible solution to the problem of mass loss in M-type AGB stars	S. Ramstedt
12:20-14:00	**Lunch Break**	
14:00-14:20	Detached shells of dust and gas around carbon AGB stars	M. Maercker
14:20-14:40	Mining the PTI-archive: uncovering the pulsating photospheres of Miras	M. Hillen
14:40-15:00	C-rich stars: Atmospheric models vs. spectro-interferometric observations	C. Paladini
15:00-15:20	Observing and modeling the dynamic atmosphere of the C-star R Sculptoris at High Angular Resolution	S. Sacuto
15:20-15:50	Discussion RGB/AGB stars	M.-R. Cioni
15:50-16:20	**Coffee Break**	

SESSION 4b: post-AGB stars and PNe (Chair: C. Waelkens)

16:20-17:00	The formation and evolution of a planetary nebula (Overview)	A. Zijlstra
17:00-17:30	Optical Interferometry observations of the latest stages of solar-like stars (Invited)	O. Chesneau
17:30-17:50	Resolving evolved star mass loss	A. Richards
18:30	**Workshop Dinner: Restaurant “Neuwirt” in Garching**	

FRIDAY, 5 March

SESSION 4b: post-AGB stars and PNe (Chair: C. Waelkens) continued

09:00-09:30	Compact discs and their link to binarity in our Galaxy and the LMC (Invited)	H. van Winckel
09:30-09:50	Magnetic fields of AGB and post-AGB stars	W. Vlemmings
09:50-10:10	The magnetic field of the evolved star W43A	E. Amiri
10:10-10:40	Discussion AGB/post-AGB	M.-R. Cioni / C. Waelkens
10:40-11:10	**Coffee Break**	

SESSION 5: Instruments (Chair: G. van Belle)

11:10-11:40	Observational opportunities with the VLTI	A. Richichi
11:40-12:10	Prospects with ALMA for solar mass stars	L. Testi
12:10-13:00	Panel Discussion and Summary	tbd
13:00	End of workshop	

LIST OF POSTER PAPERS

P-1/S-1	Determination of accurate dynamical masses in the pre-main sequence triple system Cru-3 with AMBER	S. Correia
P-2/S-1	Herbig Ae disks in the interferometric era: connecting the mid-IR and sub-mm regions	E. Di Folco
P-3/S-1	Testing stellar models against binary stars: a Bayesian approach. Application to the PISA pre-MS models.	M. Gennaro
P-4/S-1	High-mass star formation and dynamics in Orion BN/KL	C. Goddi
P-5/S-1	Constraining variations of dust properties in circumstellar disks with mm observations	F. Trotta
P-6/S-1	VLT/NACO detection of a proplyd candidate in Trumpler 14	S. Vicente
P-7/S-1	AKARI results on the Taurus Auriga star forming region	S. Zahorecz
P-8/S-2	Search for the best solar twin in the Geneva Copenhagen Survey	J. Datson
P-9/S-2	Reconstruction of the 3D Magnetic Topology of Active Regions using 2D magnetograms	A. Pasqua
P-10/S-3	Lithium-7 depletion in young open clusters: theoretical models vs observations	E. Tognelli
P-11/S-4	Thermohaline instability and rotation-induced mixing in low-mass red giant stars	C. Charbonnel
P-12/S-4	Limits for one-dimensional stellar evolution: C12-proton combustion in post-AGB stars and at very low metallicity	F. Herwig
P-13/S-4	Towards 3D simulations of dust-driven winds of AGB stars	S. Höfner
P-14/S-4	Warm molecular layers in cool giants and equilibrium chemistry	J. Hron
P-15/S-4	Dusty disks around evolved stars	F. Lykou
P-16/S-4	IM Peg: An interferometry target?	S. Marsden
P-17/S-4	Mass loss in Post-AGB stars	A. Ruiz Velasco
P-18/S-4	Cool carbon star TX Piscium observed with AMBER ESO VLTI	I. Spaleniak
P-19/S-4	Structure and shaping processes of the extended atmosphere of AGB stars	M. Wittkowski
P-20/S-4	Coordinated studies of AGB stars with the VLBA and the VLTI	M. Wittkowski
P-21/S-4	What can Interferometry tells us about the AGB Star W Hya?	R. Zhao-Geisler
P-22/S-5	Speckle Interferometry at the Observatorio Astronómico Nacional, Mexico	V. Orlov
P-23/S-5	Problems of the AMBER wavelength calibration	S. Stefl

The Origin and Fate of the Sun:
Evolution of Solar-mass Stars Observed with High Angular Resolution

ESO, Garching b. München (Germany), 2-5 March

ABSTRACT BOOK

(as at 22-Feb-2010)

TALKS

In the order of the Program

Tuesday, 2 March

HOGERHEIJDE, Michiel
Leiden Observatory (NL)

Forming solar-mass stars: an overview of Young Stellar Objects (Overview)

The life story of a star begins already before its formation itself, when the initial conditions of its parental interstellar cloud are set. I will review the properties of the dark molecular clouds from which stars form, follow their contraction and collapse, and present the current observational knowledge of the various stages preceding the star's main-sequence life. I will focus on those aspects that are immediately relevant for the star's main-sequence life, namely how its mass is determined, whether it finds itself part of a multiple system or not, and if it is surrounded by a disk that may lead to a planetary system. While the main emphasis of this review is observational, connections to theoretical work will be made throughout. An outlook to future developments, and especially those involving high-angular resolution observations, will conclude my talk.

DULLEMOND, Cornelis
Max-Planck-Institut für Astronomie, Heidelberg (DE)

Disk structure and evolution (Invited)

In this talk I will give an overview of theoretical modeling efforts of the structure and evolution of protoplanetary disks. I will show what the role of dust continuum radiative transfer is and how this determines not only the disk vertical hydrostatic structure, but also the spectral energy distribution of the disk. I will discuss the complexities of the dust inner rim, as well as emission from quantum-heated grains. In the surface layers of the disk, a rich photochemistry takes place, which, in combination with heating processes such as the photoelectric effect and cooling processes via line radiation, leads to a hot "corona" on top of the disk. This corona is in some places driving an outflow of matter from the disk, a process called "photoevaporation". This process affects the disk evolution and tends to destroy the disk within a few million years. I will discuss to which extent such processes might be an explanation for the so-called "transition disks", disks with large inner holes.

PRADA MORONI, Pier Giorgio
Università di Pisa, Dip. di Fisica "E. Fermi" (IT)

The Pisa pre-main sequence tracks and isochrones - A rich database covering a large range of Z, Y, mass and age values

In recent years, the growing amount of high quality data of pre-main sequence (pre-MS) stars prompted a renewed interest in modelling this evolutionary phase. In my talk I will describe the updated Pisa Stellar Models of pre-MS phase, discussing their main characteristics. Comparison with other pre-MS models available in the literature will be shown, too. The database of the Pisa pre-MS evolution tracks (mass range: M=0.2-7 Msun) and isochrones (age range: 1-100 Myr), includes 13 values of metallicities (from Z=0.0002 to 0.03), 3 values of the initial helium abundance for each Z, 3 values of the mixing-length parameter and 2 values of the initial deuterium abundance for each chemical composition.

TURCK-CHIÈZE, Sylvaine
CEA - IRFU/Service d'Astrophysique (FR)

The dynamical evolution of Sun and solar-like stars: from contraction to main sequence

Rotation and magnetic field are the keys to properly follow young solar-type objects up to main sequence stars. Thanks to the seismic constraints we progress on the understanding of these internal phenomena and more and more the crucial phase appears to be the contraction phase. I shall illustrate by the most recent works done recently (Turck-Chièze, Palacios et al. 2010, Duez et al. 2009) how we progress on the internal dynamical picture and what are the crucial questions to solve. Upon them, the way the star leaves the disc and how the magnetic field evolves needs certainly more attention and measurements.

KRAUS, Stefan
University of Michigan, Dept. of Astronomy (USA)

Spatially resolved investigations on YSO disk structure (Invited)

The circumstellar disks around young stars play a central role in the star formation process and provide the stage for the formation of planetary systems. Over the last decades, most disk properties has been deduced from spatially unresolved observations using, for instance, the spectral energy distribution (SED). This approach has resulted in the development of increasingly sophisticated models describing the disk structure and evolution, although it is known that pure SED model fits can yield highly ambiguous results, requiring complementary constraints from spatially resolved observations.

In this talk, I will present some specific studies in order to illustrate how interferometric observations have contributed to our understanding of the inner structure and composition of young stellar disks and how they allow for solving the model degeneracies which are inherent to spatially unresolved observations. In particular, I will focus on near- and mid-infrared interferometric studies, which can achieve now a milli-arcsecond resolution, providing direct constraints on the AU-scale gas and dust distribution and on the accretion and outflow processes taking place close to the star. Finally, I will discuss some of the fascinating new observational opportunities which will be enabled by the upcoming generation of interferometric facilities, covering the infrared and sub-millimeter wavelength regimes.

RICCI, Luca
ESO-Garching

Probing the first stages of planet formation from (sub-)mm interferometry

An interesting by-product of the process of star formation is the birth of planetary systems. The initial phases of planet formation involve dust grain growth and settling in the circumstellar-protoplanetary disks. These processes can be best studied at millimeter wavelengths where the disk is mostly optically thin and the emission from the dust in the disk midplane can be observed. In this talk, I will present a study on a sample of 43 protoplanetary disks in the Taurus-Auriga and p-Oph star forming regions, whose recent observative data at (sub-)mm wavelengths let us investigate the dust grain properties. In particular for 11 sources in Taurus-Auriga and 22 in p-Oph we obtained new data at ~3mm with the IRAM Plateau de Bure Interferometer and the Australian Telescope Compact Array respectively. Thanks to the information about the disks spatial extension from interferometric observations, we derived from the (sub-)mm spectral energy distribution constraints for the dust opacity law at these wavelengths, using two-layer flared disk models. Adopting a physical model for the dust grain, made of silicates, water ices and carbonaceous materials, we find that the observed spectral energy distributions are typically consistent with the presence in the disk midplane of dust particles that have grown to sizes as large as a few centimeters. I will discuss about the impact of these results to the processes of dust grain growth and dust migration, that are key mechanisms in the early stages of planet formation. I will show preliminary results on the relation between the derived disk characteristics, e.g. disk mass and grain growth, and the properties of the central forming star, like its mass, age and mass accretion rate, in the range 0.5 - 2 MSun in stellar mass.

TORRES, Rosa M.
Argelander-Institut für Astronomie, Univ. Bonn (DE)

The potential of VLBA observations to make a significant and lasting contribution to the study of star formation

Much of what we know about the formation of low-mass stars has been derived from the observation and modeling of a few nearby star-forming regions (Taurus, Ophiuchus, Serpens, etc.). The distance to even these birth places was not known to better than 20 to 30% and, as a consequence, the luminosity of any given star cannot be assessed to better than 50%, and the stellar masses were also poorly determined. This limits the comparison between observations and detailed theoretical models. Multi-epoch observations with Very Long Baseline Interferometers (particularly the VLBA) can be used to trace the parallactic motion of young stars with a precision of about 1% (more than one order of magnitude more accurate that the best existing alternatives). Also the proper motions of young stellar objects can be used to characterize the overall dynamics of star-forming regions and the orbital paths of young multiple systems. In this talk I will show the potential of VLBA observations to make a significant and lasting contribution to the study of star formation, by (1) providing the distance structure and kinematics of Taurus, and (2) providing, for two multiple systems in Taurus, very important constraints for pre-main sequence evolutionary models.

MASSI, Fabrizio
INAF - Osservatorio Astrofisico di Arcetri (IT)

AMBER observations of circumstellar disks around Herbig AeBe stars: evidence for a new family of refractory dust grains around HD163296

The distribution of the circumstellar material surrounding Herbig AeBe stars has been widely debated. In the past decade, the general consensus has been that the observed near infrared excess is due to thermal emission from hot dust located at the sublimation radius. In this talk, I will present a case that suggests that this description can be too simple.

I will show impressive long-baseline spectro-interferometric observations of the Herbig~Ae star HD163296 obtained with the AMBER instrument at VLTI, resulting in the largest UV coverage achieved on a young star today. Model fitting of the SED, K and H-band visibilities and closure phases, proved that models in which the entire emission is due to thermal emission from hot dust in a puffed-up inner rim can not explain the interferometric observations. In fact, an additional component must exist inside the silicate dust sublimation radius and dominates the near-infrared continuum emission. This emission isoptically thin, extends up to 0.1~AU, and supported by the absence of strong molecular lines in the spectral energy distribution, we argue that refractory dust grains such as iron, graphite or corundum -rather than gas- could be responsible for it.

This study stresses out that HAeBe environments can be very complex and could not be explained by a common idea. Deeper understanding in fact requires multi-wavelength observations together with sophisticated models, including for example self-consistent treatment of gas and dust emissions.

RATZKA, Thorsten
Universitäts-Sternwarte München (DE)

MIDI's view on circumstellar disks around young, solar-mass stars

MIDI, the mid-infrared interferometric instrument at the VLTI, offers a new view on young, solar-mass stellar objects. The warm dust around these stars can now be studied with a spatial resolution much higher than that of a single telescope. Consequently, simultaneous fits to the interferometric data and the spectral energy distribution are commonly used to determine the dust distribution in the circumstellar discs. This approach helps to overcome ambiguities left by models based on photometric measurements alone. With the spectrally dispersed interferometric data also the composition of the dust at various distances from the star can be determined. This information on the dust composition restricts the models further and gives insights into the first stages of dust processing and grain growth.

Two prominent sources that have been studied with MIDI are TW Hya with an estimated age of 10 Myr and the much younger multiple system T Tau.

Our observation of TW Hya confirms that its circumstellar disc is best described by an optically thick outer disc with an abrupt transition between 0.5 and 0.8 AU to an optically thin inner part. However, this transition occurs much closer to the star than predicted by models of the spectral energy distribution alone. A closer orbit of a potential planet is thus required. We also conclude from the correlated flux, that most of the crystalline material is located close to the star. This means that the disc is not well mixed at the present epoch.

The study of the triple system T Tau shows that the orbits and discs in this system have complex orientations. The observations confirm the picture of an almost face-on disc around T Tau N. Here we find again that dust processing occurs in the inner parts of the disc. The tight binary T Tau S with a separation of about 0.1 arcsec and located only 0.7 arcsec south of T Tau N is well resolved interferometrically, but not photometrically. The interferometric data reveal an elongated structure for T Tau Sa, interpreted as a compact disc seen nearly edge-on. The orientation of this disc is almost north-south. T Tau Sa might thus be the driving source of the east-west jet. The derived individual spectra of T Tau Sa and Sb confirm a high foreground extinction that might be partly explained by a circumbinary disc.

Besides these two examples many other solar-mass, young stellar objects have been successfully observed with MIDI during the last years. In this talk we try to give a review of the derived results as well as the strategies used for the interpretation of the interferometric data. We will also show the potential of mid-infrared interferometry at the VLTI in the upcoming era of ELTs.

Wednesday, 3 March

ROBERGE, Aki
NASA Goddard Space Flight Center, Greenbelt (USA)

Debris Disks: The Late Stages of Planetary System Formation (Invited)

The basic character of debris disks was established soon after their discovery in the mid -1980's. These circumstellar disks are composed of material (mostly dust) produced by collisions and/or evaporation of extrasolar asteroids and comets. However, fundamental observational questions about debris disks remain unanswered. How much material do debris disks typically contain and how does it evolve with time? What is the composition of their dust and gas? Are planets present or forming in the disks? Answers to these questions will provide insights into the formation of planetary systems and the origins of terrestrial planet atmospheres.

In this talk, I will review the known characteristics of debris disks and explain their place in the planetary system formation process. Progress toward addressing the questions given above will be discussed, with emphasis on recent and upcoming studies of the small but important gas component. Finally, I will outline the implications of debris dust for future efforts to directly image and characterize extrasolar terrestrial planets.

DI FOLCO, Emmanuel
CEA - Service d'Astrophysique (FR)

Hot dust around sun-like stars: a 4-year near-IR interferometric survey

While recent Spitzer surveys have successfully detected tenths of stellar systems harbouring large amounts of cold dust grains, we have demonstrated that near-IR, short baseline interferometry is a unique technique to probe the terrestrial planet regions around nearby sun-like stars. Using VLTI/VINCI and CHARA/FLUOR instruments, we performed a systematic survey of bright main-sequence stars and searched for high-contrast, hot dust emission in nearby exo-zodiacal discs. About 25% of our 40 targets revealed a near-IR excess emission brighter than ~1000 times our zodiacal cloud luminosity. Together with complementary mid-IR photometry, we modelled these systems to constrain the dust distribution in these possible planetary systems. Such detections raise questions about the dynamical processes at play to feed the inner disc and have a deep impact on the detectability of exo-Earths. We will review the recent detections, present the statistics and search for possible correlations with the system properties

BONSOR, Amy
Institute of Astronomy, Cambridge (UK)

Post-main sequence evolution of debris discs

Debris discs are a relatively common phenomena around main sequence stars. Thermal emission from the rocks and dust orbiting the star in the disc can be observed at 24μm and 70μm by Spitzer. These observations are successfully modelled by a steady state model for the collisional evolution of the disc (Wyatt et al 07). Very little, however is known about debris discs around evolved stars. Here, I present an extension of these models that includes the evolution of the star and investigates the fate of the observed population of debris discs. In particular I focus on the changes to the properties of the disc due to stellar evolution and the consequences in terms of observations of discs around evolved stars. In a separate piece of work I consider the dynamical effects of stellar mass loss on a disc, in particular in the context of the observations of hot dust around white dwarfs, for example Farihi et al 09.

DEMORY, Brice-Olivier
Massachusetts Institute of Technology

The mass-radius relationship of low and very-low mass stars

We examine the theoretical mass-radius relations for K and M dwarfs in the light of recent interferometric observations. This approach represents an excellent method to test our understanding of the physics of low and very low-mass stars. The precision of the new interferometric radii now competes with what can be obtained for double-lined eclipsing binaries. Interferometry provides access to much less active stars, as well as to stars with much better measured distances and luminosities, and therefore complements the information obtained from eclipsing systems. The radii of magnetically quiet late-K to M dwarfs match the predictions of stellar evolution models very well, providing direct confirmation that magnetic activity explains the discrepancy that was recently found for magnetically active eclipsing systems. The accuracy achieved on the surveyed sample allows us to discuss on how chemical composition and convection efficiency affect low-mass stars radii.

MÉRAND, Antoine
ESO-Chile

Zooming in the delta Velorum system using VLTI/AMBER

Even close and bright stars can be surprising. Delta Velorum, a second magnitude star, has been discovered to be an eclipsing binary only in 2000. It is also one of the main sequence A type star with the highest infrared excess, which was originally attributed to a large debris disk. Recent studies have shown that the excess is probably due to an interaction between the stellar radiation and the Inter Stellar Medium. Our current interest is to determine the masses of the stars of the delta velorume system with high precision: the 2 components of the eclipsing binary, and a third physical companion, less than one arcsecond away. For this, we combine astrometric measurements of the wide component (VLT/NACO) and interferometric imaging of the eclipsing binary (VLTI/AMBER) to determine the physical orbits. We find evidence that the members of the eclipsing pair are also fast rotators, and we might resolve the gravity deformation of the photospheres with our AMBER data. Such a pair would be an invaluable source of information to study the fast rotation of stars.

POLLACCO, Don
Queen's University Belfast, Mathematics & Physics (UK)

The detection and characterisation of extrasolar planets (Invited)

Since the 1990's the study of extrasolar planets has changed from science fiction to a legitimate area of research. While this has, at least initially, been driven by new instrumental developments, the new discoveries have led to an explosion of theoretical studies of planetary evolution. Here we will look at the major discovery techniques and the main results that have followed. We will also look forward to the first habitable zone terrestrial planets.

HERWIG, Falk
University of Victoria, Dept. of Physics & Astronomy (CA)

Quo vadis stellar evolution (Overview)

I will give an overview of the the current status of stellar evolution of low mass stars, including some persistent unsolved problems as well as progress in several areas. In particular there is a building effort to directly approach the multi-dimensional (or non-spherically symmetric) aspects of stellar evolution. Demand for higher fidelity simulation data of stellar evolution and nucleosynthesis is increasing, including from research involving, e.g., extra-galactic stellar populations, the early Universe, pre-solar grains and time-domain astronomy.

GUSTAFSSON, Bengt
University of Uppsala, Dept. of Physics and Astronomy (SE)

Stellar atmospheres (Overview)

The understanding of the atmosphere of a star with 1 solar mass and solar composition is presented as a function of evolutionary stage. The great extent to which the atmosphere and its emitted radiation reflect non-trivial aspects of the evolution of the star is stressed.

STRASSMEIER, Klaus
Astrophysikalisches Institut Potsdam - AIP (DE)

Stellar Surface Structure and Evolution

Surface magnetic field structures will remove angular momentum if their field lines are predominately open. Recent observations of magnetic surface structures with the ZDI technique suggest their existence but we still lack a coherent observational picture from pre-ZAMS to the RGB phase. I present and outline a new survey of rotation in open clusters.

CASAGRANDE, Luca
Max-Planck-Institut für Astrophysik, Garching (DE)

Fundamental stellar parameters and the fine structure of the Main Sequence

The Infrared Flux Method is one of the most accurate techniques to derive fundamental stellar parameters across most regions of the HR diagram. We review the method and its application to solar and later type stars, highlighting recent advances in precisely setting the zero point of the temperature scale via solar twins and space based spectrophotometry. The comparison with respect to interferometric angular diameters is discussed and the possibility of studying the fine structure of the main sequence in greater detail than before is addressed.

HÖFNER, Susanne
University of Uppsala, Dept. of Physics &Astronomy (SE)

Atmospheric Dynamics and Winds: A Theorist's View (Invited)

As solar-mass stars evolve away from the main sequence and, eventually, turn into cool giant stars, dynamical processes become increasingly important for their structures and observable properties. Convection develops from small-scale photospheric turbulence (affecting high-precision determinations of abundances) to giant convection cells (reaching deeply into the stellar interior and bringing newly-produced elements to the surface), where velocities, spatial and temporal scales may reach levels comparable to stellar pulsations. Shock waves triggered by convection and pulsation strongly affect the structure of the outer atmospheric layers, playing a crucial role for the formation of molecules, dust grains, and outflows. In this talk I will outline how the interplay of dynamical models and spatially resolved observations can help us to solve fundamental questions about stellar/circumstellar chemistry, wind mechanisms and mass loss of evolved stars.

CHIAVASSA, Andrea
Max-Planck-Institut für Astrophysik, Garching (DE)

Interpretation of interferometric observations with three-dimensional radiative hydrodynamics simulations of cool stars

Interferometric observations provide an innovative way of addressing the detailed studies of granulation pattern on late type stars. I will present recent results (Chiavassa et al. 2009, A&A 506, 1351-1365) of three-dimensional radiative hydrodynamics (RHD) simulations of cool stars from solar mass stars to red supergiant stars, which are essential to a proper quantitative analysis of interferometric observations.

I will describe the prospects for the detection and characterization of granulation (i.e., contrast, size) on late type stars and I will demonstrate that the RHD simulations provide an excellent fit to existing interferometric observations (visibility and closure phases at different wavelength from optical to infrared), in contrast to limb darkened disks.

CUSANO, Felice
INAF - Osservatorio Astrofisico Catania (IT)

Interferometric observations of young and evolved stars with AMBER

In this talk I will present recent results on the determination of fundamental physical parameters of young and evolved stars using interferometry. Combining AMBER and spectroscopic data we were able to measure the masses of a young binary system, allowing a first test of the evolutionary tracks of PMS stars. Further AMBER observations performed on 5 giant stars allowed us to determine the physical diameters of these stars with an accuracy of about 2%. The observations were also compared with hydrostatic model atmospheres to have an accurate determination of model parameters. With these AMBER observations an unknown binary system was also found.

Thursday, 4 March

MENTEN, Karl M.
Max-Planck-Institut für Radioastronomie, Bonn (DE)

Centimeter and (Sub)millimeter Wavelength Imaging of the Photospheres and Envelopes of AGB Stars (Invited)

A new generation of vastly more sensitive radio- and submm-wavelength facilities is about to start working: The Expanded Very Large Array (EVLA), e-MERLIN and the Atacama Large Millimeter Array (ALMA). All will allow imaging of the stellar photospheres of nearby AGB stars, their atmospheres and their expanding envelopes on scales of a few to many hundreds of AU. The superb spectroscopic capabilities afforded by the new generation highly advanced correlators will not only allow observations of many tens of km/s wide spectra with adequate (sub-km/s) velocity resolution, but also simultaneous imaging of many molecular species, various isotopologues for each. Imaging of vibrationally excited lines from many species will yield unique chemical information on the hottest gas in and just outside the atmospheres before it depletes into dust grains and partakes in the outflows. ALMA, for which a very large number of different molecules are accessible, will thus allow direct, quantitative studies of nucleosynthesis products and element depletion in the stars' inner and the photochemical processes in their outer envelopes. Highly efficient surveys with the EVLA will lead to the detection of SiO maser emission from thousands of oxygen-rich Mira stars throughout the Milky Way and even the Magellanic Clouds, allowing, e.g., detailed kinematic studies of the Galaxy's bar potential.

OHNAKA, Keiichi
Max-Planck-Institut für Radioastronomie, Bonn (DE)

Probing the outer atmosphere and mass loss in red giants by IR interferometry (Invited)

IR interferometry provides a unique opportunity to spatially resolve the outer atmosphere of red giant stars and derive the physical properties of the region where the wind acceleration is expected to occur. While many observations have been carried out for Mira stars with AMBER and MIDI, studies of the mass loss mechanism of non-Mira stars (semi-regular or irregular variables), which are actually the majority of red giant stars, lag behind those of Mira stars. In this talk, I will present recent results from VLTI about non-Mira (i.e, "normal") M giants as well as those about Mira stars.

PIAU, Laurent
CEA - Service d'Astrophysique (FR)

Local red giants radii and convection prescription

I will confront present stellar evolution calculations and the recent interferometric radii measurements of nearby giant stars (e.g. CHARM2). Selecting the objects with linear radius uncertainty less than 10%, we obtained a sample of 38 stars of spectral types G5 to M0. We then built low mass RGB models with two prescriptions for the surface convection: the usual mixing length theory and the more recent theory of Canuto, Goldman and Mazzitelli (CGM). Models with different masses, metallicity and helium fraction were explored. The purpose is to check how the usual and the interferometric data on the local RGB constrain the present surface convection prescriptions. Given the age constrains on the local Galactic disk, we suggest that the CGM theory more appropriately describes the stars of our sample. We will discuss the other consequences the interferometric radii have on RGB low mass stars evolution. The detailed results of this work (Piau, Kervella & Hauschildt) are to be submitted shortly.

KORHONEN, Heidi
ESO-Garching

Investigating starspots using Doppler imaging and optical interferometry

We present contemporaneous observations obtained at the ESO VLT with the UVES high resolution spectrograph at UT2 and the AMBER three beam combiner of the VLTI. The UVES observations are used to obtain surface temperature maps of two RS CVn binaries, IM Peg and TX Pic. These maps reveal the starspot locations on their surface. The chromospheric activity and surface flows are also investigated from the UVES data. AMBER observations in medium resolution mode aim at detecting a photocentre shift of the CO bands, which are expected to originate in the cooler starspots, with respect to the nearby continuum. Here, we present the observations and the results obtained in this pilot study.

LACOUR, Sylvestre
Observatoire de Paris - LESIA (FR)

Images of Chi Cygni: a pulsation observed by interferometry

We will present infrared interferometric imaging of the S-type Mira star Chi Cygni. The object was observed at four different epochs in 2005-2006 with the IOTA optical interferometer (H band). Images show up to 40% variation in the stellar diameter, as well as significant changes in the limb darkening and stellar inhomogeneities. We also show that combining the angular acceleration of the molecular layer with CO (Delta v=3) radial velocity measurements yields a 5.9(+/-1.5) mas parallax for a 2.1(+1.5/-0.7) solar mass star.

KAROVICOVA, Iva
ESO-Garching

Interferometric monitoring of Evolved Stars

We will present observations of the pulsating atmosphere and the circumstellar environment of a sample of four evolved stars, using the near- and mid-infrared interferometric instruments AMBER and MIDI at the VLTI. Our sample includes 3 Mira variables: RR Aql, GX Mon, S Ori and one supergiant AH Sco. The targets were observed at several epochs, and we have followed them over several cycles to investigate cycle-to-cycle in addition to intra-cycle variations. (with MIDI, RR Aql was observed at 15 epochs between Apr 9, 2004 and Jul 28, 2007 covering 4 pulsation cycles, GX Mon at 9 epochs between 12/03/2006 and 12/01/2008, S Ori at 10 epochs between 21/09/2006 and 12/01/2008, and AH Sco at 11 epochs between 12/04/2004 and 04/07/2007. In addition we obtained a few AMBER epochs). The reduced data were fitted to basic models, such as a simple uniform disk model and Gaussian model as well as to dynamic model atmospheres complemented by radiative transfer model of the dust shell. We used the complete self-excited dynamic model atmosphere series discussed in Ireland et al. (2004a,b) to describe the dust-free stellar atmosphere including the continuum photosphere and overlying molecular layers. For the radiative transfer model of the dust shell we used the Monte Carlo radiative transfer code mcsim mpi (Ohnaka et al. 2006, 2007). Infrared observations allow us to explore the characteristics of the molecular shells and the dust formation zone, and to study the connection between stellar pulsation and the mass loss process, which is an important step for understanding the late stage of stellar evolution and the chemical evolution of galaxies.

RAMSTEDT, Sofia
Argelander-Institut für Astronomie, Univ. Bonn (DE)

A possible solution to the problem of mass loss in M-type AGB stars

Many different aspects of the final evolution of solar-like stars are determined by the mass loss through the stellar wind. A problem with the generally accepted scenario for the mass loss was recently realized: silicate grains, with the optical properties allowing them to form close to the star, are not able to drive the wind due to their insufficient absorption efficiency. A possible solution is given if the grains are larger than previously assumed. With grain size, the scattering efficiency increases and will eventually become sufficiently large (at around 1 micron) to affect the wind dynamics. In an attempt to constrain the grain size close to the star, we have observed the oxygen-rich AGB star RT Vir with the VLTI/MIDI instrument using the auxiliary telescopes and will present our preliminary results.

MAERCKER, Matthias
ESO / Argelander-Institut für Astronomie, Univ. Bonn (DE)

Detached shells of dust and gas around carbon AGB stars

In their final stages of evolution, all stars between 0.8 and 8 Msun will ascend the Asymptotic Giant Branch (AGB). During the AGB phase the star periodically rapidly burns He in a shell surrounding the core, increasing the luminosity to up to 10^8 Lsun. This process is known as the helium-shell flash, or thermal pulse. Changes in the star during a thermal pulse may lead to an increase in mass-loss rate and expansion velocity for a period of a few hundred years, and may cause the creation of shells of dust and gas that are detached from the star. I will present observations of stellar light scattered by the detached gas and dust shells around the carbon stars U Ant, R Scl, and U Cam, using ground-based and Hubble Space Telescope data. The data makes it possible to separate the scattering agents, and reveals the structure in the shells with unprecedented detail. The detached shells carry information on their formation process. Comparing the data of scattered stellar light with high-resolution ALMA maps will provide information on the dust and gas content in the shells, and any dynamical interaction between the dust and gas, revealing important details on the mass-loss mechanism.

HILLEN, Michel
Institute for Astronomy K.U.Leuven (BE)

Mining the PTI-archive: uncovering the pulsating photospheres of Miras

In this contribution I propose to present our study of the relationship between a Mira's pulsating photosphere and its surrounding molecular layer(s) throughout several pulsation cycles, based on spatially resolved data. Our dataset consists of archival narrow-band observations in the near-infrared H and K bands obtained with the Palomar Testbed Interferometer between 1999 and 2006, extended with near-infrared SAAO photometry. The fitted model is an extended version of the geometric star + layer model used by Perrin et al. (2004). Preliminary results for one of the stars in our sample, the O-rich Mira R Boo, show a rather static layer residing at ±0.5R_* above the violently pulsating photosphere. The variation of stellar temperature and diameter follow a sinusoidal trend. Modelling of the other 20 O-rich Miras in our sample will start soon so that a statistical analysis can be performed. This will shed more light on the wind driving mechanism in these stars, currently one of the major unknowns in post-MS evolution of solar-mass stars.

PALADINI, Claudia
Institut für Astronomie, Universität Wien (AT)

C-rich stars: Atmospheric models vs spectro-interferometric observations

Stars with mass range between one and eight solar masses go through the late evolutionary stage called asymptotic giant branch (AGB). The subject of this contribution are a sub-class of AGB stars enriched in carbonaceous molecules, the carbon stars. C-rich stars constitute the primary route for carbon mass-loss into the ISM, therefore studying these objects is particularly relevant for understanding the late stage of stellar evolution and the chemical evolution of galaxies. We combined optical interferometry from PTI and spectroscopy to investigate the main characteristics and global structure of C-rich stars. The observations are compared with a recent large grid of hydrostatic model atmospheres. Optical interferometry is confirmed as a very powerful and complementary tool to constrain the stellar parameters (temperature, radius, etc.) of our sample of stars.

SACUTO, Stéphane
Institut für Astronomie, Universität Wien (AT)

Observing and modeling the dynamic atmosphere of the low mass-loss C-star R Sculptoris at High Angular Resolution

We studied the circumstellar environment of the carbon-rich star R Sculptoris using the near- and mid-infrared high spatial resolution observations from the ESO-VLTI focal instruments VINCI and MIDI.

We first compare the spectro-interferometric measurements of the star at different epochs to detect the dynamic signatures of the circumstellar structures at different spatial and spectral scales. We then interpret these data using a self-consistent dynamic model atmosphere to discuss the dynamic picture deduced from the observations.

Interferometric observations show that the structures located in between the photosphere and the dust condensation zone, corresponding to extended (1.5 to 2 stellar radii) warm molecular layers, are sensitive to the stellar pulsation. We also find that these layers are very reactive to the brightness fluctuation of the star, showing a significant change in a small time interval close to the maximum light. We demonstrate that the presence of extended molecular layers of C2H2 and HCN revealed by the MIDI visibilities is predicted by the dynamic model. The VINCI visibilities are well reproduced meaning that the model structure is suitable in the near-infrared. In the mid-infrared, the model structure is not able to reproduce the MIDI visibilities.

Among the different explanations for the discrepancy between the model and the measurements, the strong non equilibrium process of dust formation is one of the most probable.

ZIJLSTRA, Albert
University of Manchester, School of Physics & Astronomy (UK)

The formation and evolution of a planetary nebula (Overview)

At the tip of the Asymptotic Giant Branch, stars experience a short phase of extreme mass loss, which removes the hydrogen envelope and terminates the stellar evolution. The ejecta are briefly visible as a planetary nebula, ionized by the hot post-AGB star. Important questions, still unanswered, include the mass loss process, the shaping process, the dust evolution and the initial-final mass relation especially for lower mass stars.

CHESNEAU, Olivier
Observatoire de la Côte d'Azur (FR)

Optical Interferometry observations of the latest stages of solar-like stars: mass-loss and development of asymmetries (Invited)

Solar-mass stars end their lives by expelling a significant amount of their mass during a short time. This shell will then shine as the hard radiations from the hot core ionize the medium. Rarely, a late or very late thermal pulse reignites for a short time the nuclear reactions at the surface of this core, leading to the nova-like outburst. At this critical stage, the ejecta are very sensitive to any small perturbation, and the observed complexity of the planetary nebula structures exemplify the complexity of the physical processes 'allowed' to interact with the ejected material. The recent high angular resolution observations have shown that the transition between a globally symmetrical giant and a source surrounded by a spatially complex environment occur relatively early, as soon as the external layers of the stars are not anymore tightly bound to the core of the star. I will present many examples of high angular resolution observations that show the complexity of the late stages circumstellar environments, and how these observations are often closely related to the influence of companions, ranging from stellar to sub-stellar masses. I shall discuss in particular the broad range of circumstances and time scales for which more or less bipolar nebulae together with disks are observed.

RICHARDS, Anita
UK ARC, University of Manchester

Resolving evolved star mass loss

Radio interferometric imaging of water masers around AGB stars, at sub-AU resolution, shows that they form dense clumps. These flow radially away from the star under radiation pressure. Their sizes appear to scale with stellar mass and simple extrapolation suggests a birth size c. 10% of the stellar diameter. Future, coordinated observations with e-MERLIN, ALMA, VLTI and other interferometers will test this hypothesis by tracing mass loss from the stellar surface into the wind, through the various molecules and dust which trace different temperatures and densities. Multi-epoch, multi-wavelength continuum observations will also resolve the star itself, down to different layers depending on the local optical depth. This will reveal the relative importance of convection cells, pulsation and persistent asymmetries in shaping the mass loss.

Friday, 5 March

VAN WINCKEL, Hans
Institute for Astronomy K.U.Leuven (BE)

Compact discs and their link to binarity in our Galaxy and the LMC (Invited)

Arguably one of the most important issues which govern the discussion in the international research on the final evolution of low- and intermediate-mass stars is the impact of binarity on our global understanding of this late stellar evolution. Indeed, a rich zoo of peculiar, evolved objects are born from the interactions between the loosely bound envelop of a (super)giant, and the gravitational pull of a companion. The balance between the equipotential surfaces (Roche Lobes) and the stellar radius are the key ingredients in theoretical channels but, owing to the strong radiation pressure of the AGB-star in a close binary system, the classical Roche potential is no longer valid and the ratio of the radiation pressure force to the gravitational attraction becomes a critical ingredient into the theoretical models. But also mechanisms for single stars have been put forward to explain strong deviations for non-spherical geometry of the envelopes. In this contribution I review some recent progress and focus on the important role of interferometry (optical and radio) in unraveling the final fate of the solar-like stars.

VLEMMINGS, Wouter
Argelander-Institut für Astronomie, Univ. Bonn (DE)

Magnetic fields of AGB and post-AGB stars

This talk will highlight the current efforts in determining the magnetic field strength and structure throughout circumstellar envelopes. Specifically, the role of high resolution maser polarization observations and dust/line polarization in the submm regime will be addressed. While current observations are limited in sample size, strong magnetic field appear ubiquitous at all stages of (post-)AGB evolution. The magnetic field is thus a strong candidate for shaping the stellar outflows on the path to the planetary nebula phase and might even play a role in determining the stellar mass-loss.

AMIRI, Nikta
Leiden Observatory / Joint Institute for VLBI in Europe (JIVE) (NL)

The magnetic field of the evolved star W43A

The majority of the observed planetary nebulae exhibit elliptical or bipolar structures. Theoretical modeling has indicated that magnetically collimated jets may be responsible for the formation of the non-spherical planetary nebulae. We report a measured magnetic field of approximately 100 microG in the OH maser region of the circumstellar envelope around the evolved star W43A. The GBT observations reveal a magnetic field strength BII of ~30 mG changing sign across the H2O masers at the tip of the red-shifted lobe of the bipolar outflow. The GBT observations confirm that the magnetic field collimates the H2O maser jet, while the OH maser observations show that a strong large scale magnetic field is present in the envelope surrounding the W43A central star.

RICHICHI, Andrea
ESO-Garching / INS

Observational opportunities with the VLTI

The Very Large Telescope Interferometer (VLTI) is a powerful facility for stellar astrophysics at the highest possible angular resolution, from the near to the mid infrared. I will provide a general overview of the VLTI and present some of the recent highlights in observations of solar-mass stars. I will then illustrate the second generation VLTI instruments, currently in advanced state of design, and outline their potential for improved observations in the near future.

TESTI, Leonardo
ESO-Garching

Prospects with ALMA for solar mass stars

The evolution of solar mass stars from their formation, through the evolution of the circumstellar disk and planet formation, the final stages of stellar lives and their interaction with the ISM are key scientific themes for ALMA. In this talk I will review what we currently think will be the main areas where ALMA will provide new and key contributions. I will also focus on the opportunities for Early Science with ALMA, which we expect to be offering to the community in early 2011.

POSTER PAPERS

P-1 / S-1

CORREIA, Serge
Astrophysikalisches Institut Potsdam - AIP (DE)

Determination of accurate dynamical masses in the pre-main sequence triple system Cru -3 with AMBER

We report on VLTI/AMBER observations of the low-mass pre-main sequence triple system Cru-3. The system is composed of an optical double-lined spectroscopic pair and a third unseen component. The aim is to derive the astrometric orbits of this system and, by combination with their spectroscopic orbital solutions, to measure the dynamical masses of the individual components with an accuracy of a few percent which will eventually constrain the current pre-main sequence evolutionary models. Moreover, the determination of the relative orientation of inner and outer orbits will place constraints on the physical processes involved at the earliest stages of multiple star formation.

P-2 / S-1

DI FOLCO, Emmanuel
CEA - Service d'Astrophysique (FR)

Herbig Ae disks in the interferometric era: connecting the mid-IR and sub-mm regions

We have used VLTI/MIDI to resolve few famous Herbig Ae disks in order to characterize the morphology of the 2-10 AU region. Radiative transfer modelling allows us to directly determine the flaring angle and the scale height of the disk, taking advantage of the synergy between interferometric and spectro-photometric quantities. In addition, radial variations of the dust properties (growth and crystallization) can also be tested with these techniques. In connection with earlier sub-mm interferometric studies, the disk morphology is quasi-continuously determined on spatial scales ranging from 2 to few 100 AU, and can be compared with theoretical models. We will present our recent MIDI results for proto-typical systems like AB Aurigae, MWC758 and HD97048. These observational studies illustrate the benefit of the complementary IR and sub-mm approaches to characterize the planet forming regions, in the perspective of the opening ALMA era.

P-3 / S-1

GENNARO, Mario
Max-Planck-Institut für Astronomie, Heidelberg (DE)

Testing stellar models against binary stars: a Bayesian approach. Application to the PISA pre-MS models

We developed a Bayesian approach to infer ages, masses and chemical compositions of stars by comparing their observed properties with those predicted by stellar evolutionary models. We tested the reliability of the method using artificial stars with known properties. We then applied our method to a large sample of binaries found in the literature, with dynamical masses estimates and including at least one pre-main-sequence (PMS) star.

Double-lined, eclipsing binaries are the only stars for which masses can be directly measured. With few assumptions also temperatures and luminosities can be estimated, so that this objects can be placed in an HR diagram. In this way they can be directly compared to theoretical models, without the need of additional transformations to the observational plane, which rely on model atmospheres. Among these binaries, detached systems represent the best test-bench for single-star evolutionary models.

We calculated stellar models using the latest version of the PISA-FRANEC evolutionary code, with up-to-date input physics and a fine grid of masses, ages and chemical compositions. Great attention has been devoted to the PMS phase.

With our Bayesian approach, the assumption of coevality for the two components can be dropped and ages can be derived separately for each star, giving hints on the formation scenario of stars of different masses. The agreement between derived and dynamical masses is very good.

P-4 / S-1

GODDI, Ciriaco
ESO-Garching

High-mass star formation and dynamics in Orion BN/KL

The details of how massive stars form are poorly understood. Testing the viability of disk-mediated accretion, known to be at work in solar-like young stars, benefit from direct measurement of the dynamics of gas at small radii, where outflows are launched and collimated. Using high-angular resolution radio observations, for the first time we have mapped gas structures and tracked 3-D motions, 10-1000 AU from a high-mass YSO in Orion BN/KL, the nearest known region with ongoing high-mass star formation. We resolve an edge-on disk about 50 AU across and a wide-angle outflow that collimates at radii beyond 100 AU. We also tracked the proper motions of the radio sources in BN/KL, which give us clues about the dynamical history of the global star forming region.

P-5 / S-1

TROTTA, Francesco
INAF - Osservatorio Astrofisico di Arcetri (IT)

Constraining variations of dust properties in circumstellar disks with mm observations

Grain growth in protoplanetary disks is the first step towards the formation of the rocky cores of planets. Models predict that grain grow, migrate and fragment in the disk and predict varying dust properties as a function of radius and disk age and physical properties. To constrain grain growth and migration in protoplanetary disks, recent and future observations will focus to try detect radial variation of dust properties.

In order to interpret these observation we have modified a two-layer model for circumstellar disks to include the possibility to have a radial variation of the dust properties. In particular, the possibility to modify the grain sizes distribution depending on the location on disk.

We will present the predictions of these models for a range of parameters and discuss the possibility of constraining dust properties with millimeter high angular resolution observations.

P-6 / S-1

VICENTE, Silvia
ESA/ESTEC, RSSD, Noordwijk (NL)

VLT/NACO detection of a proplyd candidate in Trumpler 14

Externally illuminated protoplanetary disks or “proplyds” are a special class of low-mass young stellar objects (YSOs) found embedded within or near a HII region. They are usually identified as comet-shaped photoionized envelopes with bright ionization fronts facing the source of external UV radiation and extended tails pointing away from it which are most visible in hydrogen recombination lines and other ionized species in the optical like [OIII], [SII] and [NII].

In this poster I report the discovery and present the results of a first analysis of the observed morphology of an extended globule that might be a photoevaporating protoplanetary disk/microjet system similar to the bright proplyds found in the Trapezium cluster. The object was discovered in the course of a VLT/NACO JHKsL" survey (PI, S. Vicente) of the core of Trumpler 14, a young cluster in the Carina Nebula (NGC 3372). Archival HST/ACS images in the optical, together with the adaptive optics near-IR images and existing photoevaporating theories, were used to discuss the possible scenarios for the nature, origin and expected lifetime of this object that can be confirmed or rejected by future high-resolution multi-wavelength observations.

P-7 / S-1

ZAHORECZ, Sarolta
Eötvös Loránd University, Dept. of Astronomy, Budapest (HU)

AKARI results on the Taurus Auriga star forming region

We present an analysis of AKARI (Murakami et al. 2007) Far-Infrared Surveyor (FIS, Kawada et al. 2007), Spitzer Space Telescope (SST, Werner et al. 2004) Infrared Array Camera (IRAC; Fazio et al. 2004) and Mid-Infrared Photometer for Spitzer (MIPS; Rieke et al. 2004) data as well as various other photometric data of the Taurus-Auriga region. Our aim was to locate and describe young stellar objects (YSOs), and to test the potential of AKARI FIS data in the classification of YSOs. We studied 32 YSOs, 7 of those had not been observed by the SST. We successfully modeled 21 YSOs with the "SED Fitting Tool" of Robitaille (2007). We approved the previous models in 13 cases. This research is part of the AKARI Mission Program "Star Formation".

P-8 / S-2

DATSON, Juliet
University of Turku, Tuorla Observatory (FI)

Search for the best solar twin in the Geneva Copenhagen Survey

Until today no object was found on which the astronomical community could agree on being the best solar twin. Mostly photometric and spectroscopic candidates do not match. One needs to combine both techniques to find the best solar twin.

In our work we used sun-like stars from the Geneva Copenhagen Survey, constraining absolute magnitude, b-y and the metallicity to values as close as possible to the solar values. Our aim is to find in this sample of 71 stars the object which is spectroscopically closest to the sun. For this we have retrieved FEROS spectra for all of them, which we are now in the process of analysing.

P-9 / S-2

PASQUA, Antonio
University of Manchester (UK)

Reconstruction of the 3D Magnetic Topology of Active Regions using 2D magnetograms

Phenomena of the Solar Activity are caused by topological variation of magnetic field related to Active Regions. The interpretation and the modelling of these phenomena cannot have to do without the knowledge of the tri-dimensional magnetic topology, that spread in the Solar Corona starting from the Photosphere. On the other hand, the measure of magnetic field of the Active Regions is limited at the longitudinal component at photospheric level and from this component with different methods we can extrapolate the tri-dimensional configuration at higher heights. Consolidate numerical methods are based on the tri-dimensional solution of MHD equation and this imply a long time of calculation also for a region of limited extension. If we consider force-free and quasi-static coronal field, an analytical and numerical method recently proposed allow us to reconstruct the magnetic field starting from observations in different times of the longitudinal component, using stereoscopy of rotation, in a shorter time. The purpose of my work is the application to different cases of a numerical code, written in IDL language at the INAF-OATs, that implement the stereoscopic method to verify its functionality and the physical congruity of 3D topology reconstructions.

P-10 / S-3

TOGNELLI, Emanuele
Università di Pisa, Dip. di Fisica "E. Fermi" (IT)

Lithium-7 depletion in young open clusters: theoretical models vs observations

The analysis of surface lithium abundance in open clusters is an indirect method to investigate the time evolution of the extension of the convective envelope; in fact during the pre-main sequence and main sequence evolution of low and intermediate mass stars the temperature at the base of the convective zone is high enough to burn lithium. In this work we re-analysed the well known problem of the disagreement between theoretical predictions and observational data for the surface lithium-7 in clusters of different chemical composition and ages. In our procedure we rely on homogeneous data of observed lithium abundances for cluster of different ages and chemical composition making also use of accurate observational colour-magnitude diagrams; the cluster age is directly derived by means of our theoretical isochrones. We show that it is possible to reproduce the depletion profile of lithium for young clusters (age below 100-200 Myr) adopting a value of alpha in pre-main sequence that results almost independent of both the mass and the chemical composition. Moreover we confirm that the depletion on time scale typical of the MS is incompatible with the hypothesis of standard mixing, that is convection and diffusion, within the theoretical uncertainties.

P-11 / S-4

CHARBONNEL, Corinne
Geneva Observatory (CH) & CNRS

Thermohaline instability and rotation-induced mixing in low-mass red giant stars

Thermohaline mixing has been recently identified as the dominating process that governs the photospheric composition of low-mass bright giant stars (Charbonnel & Zahn 2007a). Here we present the predictions of stellar models computed with the code STAREVOL that take into account this mechanism together with rotational mixing and atomic diffusion.

P-12 / S-4

HERWIG, Falk
University of Victoria, Dept. of Physics & Astronomy (CA)

Limits for one-dimensional stellar evolution: C12-proton combustion in post-AGB stars and at very low metallicity

We present multi-physics investigation of the very late helium shell flash that is believed to have erupted in Sakurai''s object. This real-time evolving post-AGB star shows the observational signatures of a complicated interplay between hydrodynamic convection and nuclear flash burning that defies the assumptions of spherical stellar evolution. We use a combination of 3D hydrodynamic simulations, complete multi-zone nuclear network simulations as well as stellar evolution to investigate the nature of the high-neutron burst nucleosynthesis that derives from observations. Our conclusions are important for stellar evolution and yield prediction of the first generations of stars because the combustion situations investigated here are prevalent in low-Z stellar environments.

P-13 / S-4

HÖFNER, Susanne
University of Uppsala, Dept. of Physics and Astronomy (SE)

Towards 3D simulations of dust-driven winds of AGB stars

Stars on the asymptotic giant branch sustain phases of strong mass loss, a process which has been modelled successfully in terms of dust-driven winds. While detailed 1D radiation hydrodynamics calculations already give insight into characteristic properties like mass loss rates and wind velocities, it would be interesting to see a full 3D structure of these winds. In our earlier investigations we included dust formation and grain growth into 3D "star-in-a-box" simulations. In this contribution we report first results and challenges considering models which take radiation pressure on dust grains into account.

P-14 / S-4

HRON, Josef
Institut für Astronomie, Universität Wien (AT)

Warm molecular layers in cool giants and equilibrium chemistry

The concept of warm molecular layers has been introduced in the late 1990s in order to explain excess absorption/emission features seen in infrared spectra of cool giants and supergiants. The layer properties are usually derived for individual molecular species independently. We discuss the consistency of such an approach with spectroscopic and interferometric observations when equilibrium chemistry is assumed.

P-15 / S-4

LYKOU, Foteini (Claire)
Jodrell Bank Centre for Astrophysics, Univ. Manchester (UK)

Dusty disks around evolved stars

Mass-loss shaping mechanisms during the late stages of evolution of intermediate-mass stars are not well understood. A comparison of structures created by those mechanisms at different evolutionary stages may shed some light into this problem. We have observed such structures using the VLTI, and we have found dusty disks and torii around the cores of evolved stellar objects. Our sample consists of three different stages of late-type evolution objects, namely a post-AGB star (Mz3), a planetary nebula (M2-9) and a very-late-thermal-pulse object (V4334 Sgr). For each of the three cases, we have detected a disk/torus around the central ionizing source in the mid-infrared. The first two objects contain disks composed of silicate dust, while the latter contains a torus of carbonaceous material. The dusty disks are aligned with the minor axis of the bipolar nebulae and their inner rim radii are less than 100AU. We have constrained their intrinsic geometric and physical properties with the use of radiative transfer modelling.

P-16 / S-4

MARSDEN, Stephen
Anglo-Australian Observatory, Sydney

IM Peg: An interferometry target?

Stellar interferometry is now starting to reach resolutions where it becomes feasible to map the surface spot features on giant stars. In this poster I present spot maps from the primary of the RSCVn system IM Pegasi obtained through Doppler imaging. This relatively bright (V ~ 6) early-K giant shows long-lived polar and low-latitude spot features. Active giant stars like IM Peg would make excellent targets for stellar interferometry.

P-17 / S-4

RUIZ VELASCO, Alma
ESO-Garching

Mass loss in Post-AGB stars

We started a project to study post-AGB stars using interferometric observations with VLTI AMBER and MIDI. This observations will provide important information on the mass-loss envelope, which was produced during the super-wind phase at the tip of the AGB and will be used to constrain and further develop our theoretical models of the mass-loss history. This observations are also very important to investigate the break of symmetry between spherically symmetric AGB stars and axisymmetric PNe.

P-18 / S-4

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Cool carbon star TX Piscium observed with AMBER ESO VLTI

Late-type giants are crucial for our understanding of evolution in Sun-like stars, but some of their characteristics are still not very good understood. To supply the theoretical models with sufficient information on the scale of milliarcseconds (mas), only high image resolution techniques can be used, such as optical long baseline interferometry. This study was conducted to determine the angular diameter and possible asymmetries of the cool carbon star TX Psc, by means of fringe visibility and closure phase. For this, data taken with the near-IR instrument of ESO Very Large Telescope Interferometer AMBER, were used. The model of a uniform disc (UD) was applied to the visibility data. The results show a wavelength-dependent diameter and highlight changes with time, possibly related to the star's variability. A characteristic size of about 9.5-10 mas was found. However, also possible asymmetries both from the diameter measurement and from the closure phase were found. These are probably due to the contribution from the circumstellar shell.

P-19 / S-4

WITTKOWSKI, Markus
ESO-Garching

Structure and shaping processes of the extended atmosphere of AGB stars

We present recent studies using the near-infrared instrument AMBER of the VLT Interferometer (VLTI) to investigate the structure and shaping processes of the extended atmosphere of AGB stars. Spectrally resolved near-infrared AMBER observations of the Mira variable S Ori have revealed wavelength-dependent apparent angular sizes. These data were successfully compared to dynamic model atmospheres, which predict wavelength-dependent radii because of geometrically extended molecular layers. Most recently, AMBER closure phase measurements of several AGB stars have also revealed wavelength-dependent deviations from 0/180 deg., indicating asymmetric morphologies. The variation of closure phase with wavelength might indicate a complex non-spherical stratification of the extended atmosphere, and may reveal whether observed asymmetries are located near the photosphere or in the outer molecular layers. Concurrent observations of SiO masers located within the extended molecular layers provide us with additional information on the morphology, conditions, and kinematics of this shell. These observations promise to provide us with new important insights into the shaping processes at work during the AGB phase. With improved imaging capabilities at the VLTI, we expect to extend the successful story of imaging studies of planetary nebulae to the photosphere and extended outer atmosphere of AGB stars.

P-20 / S-4

WITTKOWSKI, Markus
ESO-Garching

Coordinated studies of AGB stars with the VLBA and the VLTI

We present an overview of a program currently underway to study Asymptotic Giant Branch (AGB) stars using polychromatic imaging with the Very Long Baseline Array (VLBA) and the Very Large Telescope Interferometer (VLTI). These two high-resolution instruments allow us to probe the star and its surrounding environment at unprecedented accuracy from centimeter to near-infrared wavelengths. The regions which we are able to study, working outward from the star itself, include: the photosphere (VLTI/AMBER, near-IR), the molecular layer (VLTI/MIDI, mid-IR), the SiO maser shell (VLBA/SiO, 7mm), the dust shell (VLTI/MIDI, mid-IR), and the circumstellar wind region (VLBA/H2O, 1.3cm). Thus far, we have coordinated observations of five Mira variables - S Ori, RR Aql, GX Mon, R Cnc, and X Hya - and one supergiant star, AH Sco. Since these stars are inherently variable, it is important to get concurrent observations over multiple epochs in order to study both intra- and inter-cycle changes in the various regions of the circumstellar envelope. Here, we present in particular results on coordinated VLTI/VLBA observations of S Ori and GX Mon. Additional very recent results from this project are presented by Karovicova et al.

P-21 / S-4

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What can Interferometry tells us about the AGB Star W Hya?

We observed the dusty circumstellar environments of Asymptotic Giant Branch (AGB) stars with MIDI, a MID-Infrared (N-band, around 10 microns) interferometer with a spectral resolution between 30 and 230. In principle, such observations will allow us to fit for the stellar diameter and structure of the dense stellar winds, in particular the location of the dust formation layer and its dependence on pulsation cycle, mass loss rate, and chemistry.

A fit of the reduced data set of W Hya to a basic fully limb darkened model gives in comparison to the near IR an about 1.5 times greater diameter. The change throughout the N-band gives rise to the speculation that this is due to very close dust like amorphous alumina. Nevertheless another possibility could be a close warm molecular layer. Thus far, these data are probably insufficient to study the dependence on pulsation phase or model an asymmetric dust shell but a first inspection revealed some systematic.

P-22 / S-5

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Speckle Interferometry at the Observatorio Astronómico Nacional, Mexico

The Observatorio Astronómico Nacional (OAN) is a facility of the Instituto de Astronomia of University Nacional Autonomo de Mexico, (IA UNAM). There are two astronomical sites where placed four telescopes. One site is located at San Pedro Martir (OAN-SPM), Baja California, Mexico. The second one at Tonantzintla (OAN-T), is located at few km away from the Puebla, Mexico. The 1-m telescope which is found there can be effectively used for speckle interferometric measurements of binary stars with the diffraction Rayleigh resolution ~λ/D. Firstly we used Speckle Interferometric technique at Observatorio Astronómico Nacional (OAN) in 2006. Regular Speckle Interferometric observations at OAN were started in November 2008.

P-23 / S-5

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Problems of the AMBER wavelength calibration

Errors in the wavelength calibration of the high-resolution AMBER observations are derived by cross-correlation with the Phoenix/Gemini Br-gamma spectra obtained for the target quasi-simultaneously monitored with both instruments in 2008-2009. The planned activities to improve the AMBER wavelength calibration are discussed as well.