Research Institute Leiden Observatory

(Onderzoekinstituut Sterrewacht Leiden)

Annual Report 2009

Sterrewacht Leiden
Faculty of Mathematics and Natural Sciences
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Cover:
Logarithmic rendering of the gas flow in the equatorial plane of a massive binary star in which both stars are losing mass. The orbital eccentricity is 0.8, the mass ratio is 0.25, the time is about one tenth of a period before periastron passage. The red colour shows the gas density, green: pressure, blue: absolute value of the velocity.

An electronic version of this annual report is available on the web at http://www.strw.leidenuniv.nl/research/annualreport.php?node=23

Production Annual Report 2009:
A. van der Tang, E. Gerstel, F.P. Israel, A. van Genderen, J. Lub, E. van Uitert, E. Deul.

Sterrewacht Leiden

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Sterrewacht Leiden

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Chapter 1

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Review of major events

Chapter 1

Foreword

2009 was a busy year at the Sterrewacht. The institute's permanent staff saw some important changes, with the arrival of Xander Tielens at the beginning of the year, Simon Portegies Zwart in the spring, and Matt Kenworthy at the end of the year, and the appointment of Rychard Bouwens (who will arrive during 2010). Xander moved to Leiden from NASA-AMES, and takes up a chair in interstellar medium physics and chemistry, and will further strengthen our astrochemisty research. He won an important grant from the European Research Council with which he will build up a significant group.

Simon Portegies Zwart moved here from Amsterdam, and is our new professor of numerical astrophysics. His work centers on gravitational dynamics of star clusters and galaxies, and involves using dedicated specialized hardware such as GRAPE boards and Graphical Processing Units. He obtained a VICI grant for his research, and leads a large NOVA project on computational astrophysics, AMUSE. A third new professor is Huub Rottgering, who was promoted from his senior lecturer position.

Matt Kenworthy joined us from Steward Observatory in Arizona, and specializes in astronomical instrumentation, especially adaptive optics, for exoplanet research. He takes up a position as lecturer. Rychard Bouwens, from the University of California at Santa Cruz, an expert on high-redshift galaxy studies with Hubble Space Telescope in particular, accepted an offer of a lectureship with us and will start in 2010.

A small symposium was held for Peter Katgert in September. Peter retired after some 40 years on the faculty at the Sterrewacht, and handed over his careful stewardship of the Leids Sterrewacht, Leids Kerkhoven Bosscha, and Oort foundations as secretary-treasurer to Michiel Hogerheijde.

The support staff underwent many changes as well.

Jan Lub stepped down as institute manager after many years, but will still be around to provide his successor, Evelijn Gerstel, with the benefit of his memory and experience. Evelijn moved to the Sterrewacht from the physics department, where she had been coordinator of the education activities. The Sterrewacht's education coordinator, Petra Oosthoek, moved to the Computer Science department. Finally Kirsten Groen, who has been a member of our secretariat for the last 10 years and has ably assisted me and my predecessor as management assistant, decided to move full-time to the NOVA office as financial controller, and her work was taken over by Jeanne Drost. In spite of all the changes, the handovers were smooth and somehow everything continued to run the way it should, in large part due to the dedication of all concerned. My thanks!

The most significant events of the year included the launch of Herschel, the successful refurbishment of Hubble, the first images from VISTA and the first maps from LOFAR: we have major plans for all these facilities and first results have already been obtained. These highlights underscore that we owe much of our scientific reach to the facilities we have access to, and have a role in developing, in collaboration with organizations and institutes such as ESA, ASTRON, ESO, SRON and our sister institutes in NOVA. Continued involvement in developing the facilities of the future will ensure that we keep on creating such scientific opportunities.

2009 was the International Year of Astronomy, and under this extra spotlight a number of prominent activities took place. Ewine van Dishoeck was the lecturer at the university's dies natalis on February 9, speaking on "New Worlds". The 20th Oort lecturer was Bruce Draine from Princeton, and Jerry Nelson (Santa Cruz) delivered the Sackler lecture in the fall. The old observatory building's renovation was started, with the first of the domes hoisted off the building by minister Plasterk of education, culture and science on April 6. Everything seems to be on track for the old observatory's reopening in 2011.

11 graduate students successfully defended their thesis and obtained their PhD, a near-record: but with around 50 PhD students at the observatory now, we will have to get used to this rate! Our graduates continue to do well on the international job market, with the Hubble Fellowship for Karin Oberg, and the Jansky Fellowship for Huib Intema, as most impressive examples.

Finally, a sad piece of news that reached us during the year was the passing of Maarten Floor (1917-2008): he worked at the Sterrewacht as a 'calculator' from 1955 until his retirement in 1980. I imagine he would have been quite amazed at the calculations we now take for granted.

As I write this introduction, preparations for a research assessment in the spring of 2010 are in full swing. We are working hard to ensure that the Sterrewacht (as well as the rest of NOVA) will come through this process with flying colours, and given the many results and achievements described in this annual report there certainly are plenty of reasons to be optimistic!

Koen Kuijken

Chapter 2

Research

Sterrewacht Leiden

Research

Chapter 2

History and heritage

The Sterrewacht acts as host to the history group of the Leiden University Department of Mathematics and Science.

Van Delft (director Museum Boerhaave), holding a part-time appointment as professor extraordinary in the history of science, focused his research on the Leiden cryogenic laboratory, the international temperature scale and the International Institute of Refrigeration.

Van Lunteren, also holding a part-time appointment as professor extraordinary, conducted studies on 19th- and 20th-century Leiden scientists which resulted in three papers: one on the astronomer Kaiser as a Dutch pioneer of the new genre of popular science, one on the cultural roots of the views of the physicist Fokker on causality and time symmetry, and finally a study, together with Hollestelle, of the Austrian-Dutch physicist Ehrenfest.

Elbers is studying the rise of radio astronomy in the Netherlands in the post-war years. Her research is predominantly based on primary sources in the Oort-archives and in those of the Observatory itself. It focuses on the interplay of the personal and as well as the more general factors that may serve to account for the successful launch of this new research field. She presented preliminary results at the meeting of the History of Science Society in Phoenix and constructed a general framework for her PhD-project. She also located several other relevant archival collections.

Weiss studied the archives of the Teyler's Museum in Haarlem in order to reconstruct the changes in both the public and research functions of this institution. He unearthed previously unknown documents concerning the Teyler's Museum 19th- century collection policy. He also systematically compiled the accounts by visitors of their experiences at Teyler's Museum from the early decades of the museum's history. Finally, he initiated and organised a national conference on the public usage of 19th century Dutch collections which will be held in 2010.

Baneke completed his inventory of the paper collections of Frederik Kaiser and Willem de Sitter, being the two major constituents of the Leiden Observatory Archives. These archives were transferred to Leiden University Library for preservation and digitalization. He also completed a research project on the history of Dutch astronomy in 1880-1940, analyzing changes in the scientific culture, the introduction of new educational programs at Dutch astronomical institutes, and the remarkable renaissance of Leiden Observatory in the 1920's.

2.1. Solar System

2.1.1 Asteroids

After sixty years of minor planet (planetoiden in Dutch) research I. van Houten-Groeneveld and her late husband C.J. van Houten, the former is still actively continuing her work. The new names of minor planets and the lists of new definitive numbered minor planets of the van Houten sample are published in the Minor Planet Circulars (MPC), which come out monthly at full Moon.

The van Houten Palomar-Leiden survey plates are now at Heidelberg Sternwarte (Germany) in the custody of L. Schmadel (Astronomisches Rechen-Institut). All short-exposure plates of P-L-survey and all Selected Area plates have now been measured: 36 187 individual positions of 4 906 different objects.

The P-L-Survey contains the following numbers of objects: 2124 found, 242 found by other observers, as well as 2540 new ones found by Schmadel of which 1817 are numbered, and 723 are provisionally named. By using overlays of all 2008 known minor planets and extrapolating back to the P-L-plate epoch of 1960, Schmadel found the positions of significantly more objects than the van Houtens originally found. This means 52% pre-discovery-objects were found!

In 2008 and 2009, 2093 van Houten survey minor planets were definitely numbered, five of them being Trojans. In the same year, 40 received names following proposals communicated by Van Houten-Groeneveld. Eleven names of Dutch origin should be mentioned:

(Number)	Name	Discovery date	Name MPC
(12151)	Oranje Nassau = 1220 T-1	1971 03 25	61764
(12618)	Cellarius = 6217 P-L	1960 09 24	61764
(10662)	Peterwisse = 3201 T-2	1973 09 30	63639
(12169)	Munsterman = 2031 T-3	1977 10 16	64312
(12170)	Vanvollenhoven = 2372 T-3	1977 10 16	64563
(12156)	Ubels	1973 09 29	65121
(12173)	Lansbergen	1977 10 16	65121
(11433)	Gemmafrisius	1977 10 16	65710
(12625)	Koopman	1960 10 17	65710
(12626)	Timmerman	1971 03 25	65710
(12157)	Können = 1070 T-2	1973 09 29	67759
In addition to:			
(12619)	Anubelshunu = 6242 P-L	1960 09 24	67759
(12620)	Simagian = 6335 P-L	1960 09 24	71764
(12621)	Alsufi = 6585 P-L	1960 09 24	61764
(12622)	Doppelmayr – 6614 P-L	1960 09 24	61764
(10972)	Merbold – 6614 P-L	1973 09 29	62928
(10973)	Thomasreiter = 1210 T-2	1973 09 29	62929
(173117)	Promachus = 1973 SA1 (Trojan)	1973 09 24	62932
(12608)	Aesop = 2091 P-L	1960 09 24	63640
(12609)	Apollodoros = 2155 P-L	1960 09 24	63640
(12616)	Lochner = 4874 = P-L	1960 09 26	63640
(12617)	AngelusSilesius = 5568 P-L	1960 10 17	63640
(12165)	Ringleb = 3289 T-2	1973 09 03	64311
(12166)	Oliverherrmann = 3372 T-2	1973 09 25	64311
(12167)	Olivermüller = 4306 T-2	1973 09 29	64311
(12168)	Polko = 5141 = T-2	1973 09 25	64311
(136557)	Neleus = 5214 T-2 (Trojan)	1973 09 25	64565
(171465)	Evamaria = 6847 P-L	1960 09 24	64565
(173108)	Ingola = 6240 P-L	1960 09 24	64565
(189004)	Capys = 3184 T-3 (Trojan)	1977 10 16	64565
(12623)	Tawaddud	1960 10 17	65710
(12624)	Mariacunitia	1960 10 17	65710
(12627)	Maryedwards	1971 03 25	65711
(12628)	Ackworthorr	1971 03 25	65711

(12615)	Mendelsdeleon	1960 09 24	66242
(19872)	Chendonghua	1960 09 24	67217
(19873)	Chentao	1960 09 24	67217
(19874)	Liudongyan	1960 09 24	67217
(19875)	Guedes	1960 09 24	67218
(12158)	Tape – 1101 T-2	1973 09 29	67759

2.2. Exoplanets

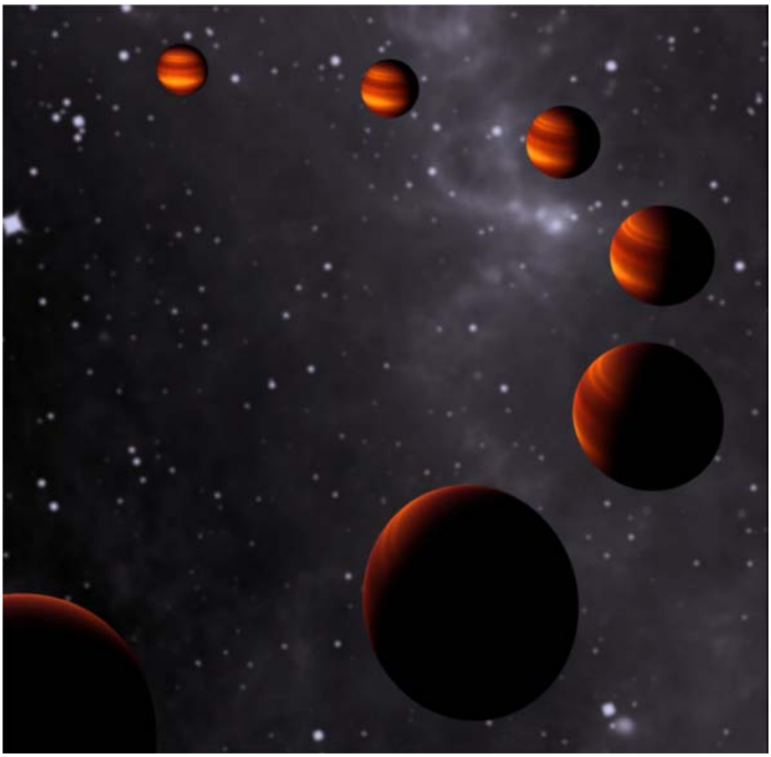


Figure 1: Artist impression of the changing phases of extrasolar planet CoRoT-1b, as detected by Snellen, de Mooij, and Albrecht. The phase variation is just as we see it for the interior planets in our own solar system.

2.2.1 Eclipsing Exoplanets

Snellen and collaborators worked on the detection and characterization of transiting extrasolar planets. Most of the more than 200 known extrasolar planets have been found using the radial velocity technique. Although their orbits are well known, not much is being learned about the planets themselves. This is very different when the orientation of a planet is such that it transits its host star, regularly blocking off a fraction of the star light. For these planets, the mass, radius, and average density can be determined, and their atmospheres probed through secondary eclipse photometry and transmission spectroscopy. De Mooij and Snellen presented the first ground-based K-band detection of the secondary eclipse of an extrasolar planet. Together with Albrecht they published in Nature the optical phase curve of an extrasolar planet using CoRoT data.

2.2.2 Metal-dependent Planet Formation

Exoplanets are preferentially observed around metal-rich stars. Rich in elements heavier than hydrogen and helium. Johansen, Youdin (CITA, Canada), and Mac Low (American Museum of Natural History) found a physical explanation for this phenomenon. They performed 3-D computer simulations of the initial stages of planet formation, varying the heavy element abundance of their disk models. Planets form in protoplanetary discs around young stars as dust particles collide and grow to ever larger structures, but this process becomes inefficient on scales of a few centimeters. Pebbles of such size have very poor sticking properties. However, hydrodynamical simulations show that pebbles moving through gas will spontaneously form dense clumps and that these clumps can contract under their own weight into mini-planets (called planetesimals) of several hundreds of kilometers in diameter. Johansen and collaborators found that the process of clumping depends strongly on the mass loading of pebbles in the gas, i.e. on the heavy element abundance. Below solar metallicity they observed no clumping and no planet formation, whereas slightly above solar metallicity planet formation has become very efficient. Their findings, summarized in a press release titled “Dirty stars make good planetary hosts”, were picked up by several news media, including SPACE.com, Astronomy Now, and ABC news.

2.3 Protostars and Circumstellar Disks

2.3.1 Predicting the Water in Protoplanetary Disks

Brinch completed the LIME code. This is a 3-D molecular excitation and radiation transfer code that has been under development for several years. LIME models radiation transfer on unstructured, random Delaunay-triangulated grids, and it produces high-resolution predictons of the spectral emission distribution. LIME is designed to be used to model Young Stellar Objects (YSO's) and their environments with the specific aim of becoming a robust modeling tool for use with ALMA observations. Toward the end of 2009, LIME was used for the first time to predict water line emission from the hot surface of a protoplanetary disk (Fig. 2) in very high resolution. This predictions will be verified by HIFI observations with the Herschel Space Observatory in the near future.

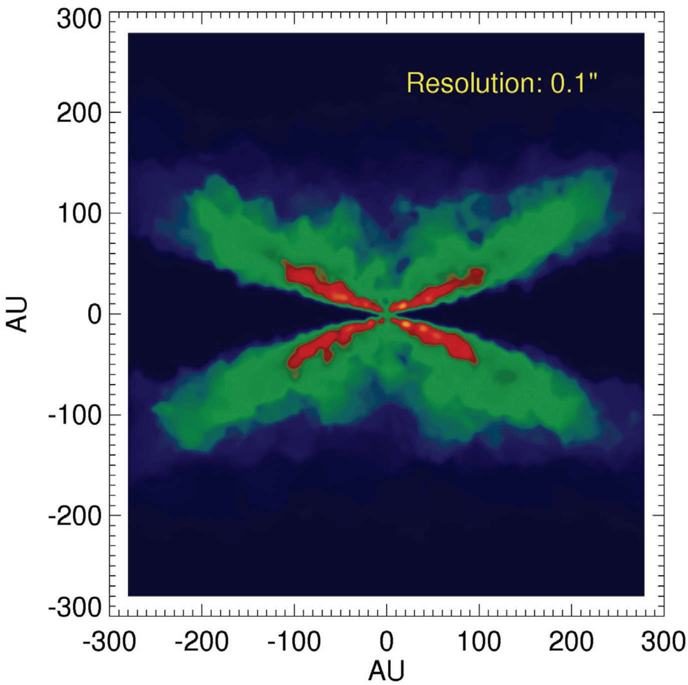


Figure 2: Model prediction of water line emission from the hot surface layers of a protoplanetary disk. The cold mid-plane of the disk is emission free because the water is frozen out as ice.

2.3.2 The Molecular Content of Protoplanetary Disks

Panič completed her PhD thesis under supervision of Hogerheijde, describing high-angular-resolution observations of protoplanetary disks. She focused on the molecular content of these disks, the total amount of material and its kinematics. Panič and Hogerheijde studied two samples of objects: T Tauri stars (roughly comparable to the young Sun) and Herbig Ae stars (their slightly more massive counterparts). It turned out that the latter class is most amenable to investigation through the emission of CO and its isotopes, because these stars are brighter: they heat the disks to higher temperatures in excess of 20 K. This precludes the freeze-out of CO onto dust grains, prevalent in T Tauri disks. In a more detailed study of the disk around the star HD100546, Panič et al. found that there is a significant amount of warm (typically 100 K) gas, betrayed by APEX/CHAMP+ CO J=6-5 measurements. This gas is probably heated by the stellar ultraviolet radiation. At the same time, this radiation must be sufficiently 'soft' to avoid dissociation of CO into C and O, as emission from the carbon atom is wholly absent in the same data. Interestingly, the shape of the spectral line indicates that the disk is not uniformly heated, but rather that one side 20--40 K warmer than the other side. It is possible that the inner disk is warped, and casts a shadow on the outer disk.

2.3.3 Ice Survey of Low-Mass Protostellar Envelopes

Bottinelli, Öberg, Boogert (IPAC, Pasadena, USA), Pontoppidan (Caltech, Pasadena, USA), van Dishoeck, Lahuis and the 'Cores to Disks' (c2d) IRS team completed their Spitzer + ground-based 3-38 micron spectral survey of 41 low-luminosity young stellar objects (YSOs) down to proto-brown dwarfs. Their fourth paper addressed the solid NH_3 and CH_3OH abundances, both of which are key ingredients for making prebiotic molecules in ices. Identification of these molecules is complicated by the blending of their main features at 9.0 and 9.7 micron with the strong silicate absorption band (see Figure below), and different methods had to be developed to extract them. The resulting NH_3 abundances were between 2 and 15%, whereas those for CH_3OH had a broader range from <1% to nearly 30% with respect to H_2O ice. Comparison with laboratorium results by Bouwman, Beckwith and Linnartz showed that NH_3, like CH_4, is formed largely by hydrogenation of atomic N on grains, whereas CH_3OH appears to form mostly through hydrogenation of CO in a nearly pure CO ice environment. Quantitative simulations of the latter process were carried out by Cuppen and collaborators using the latest Leiden laboratory data.

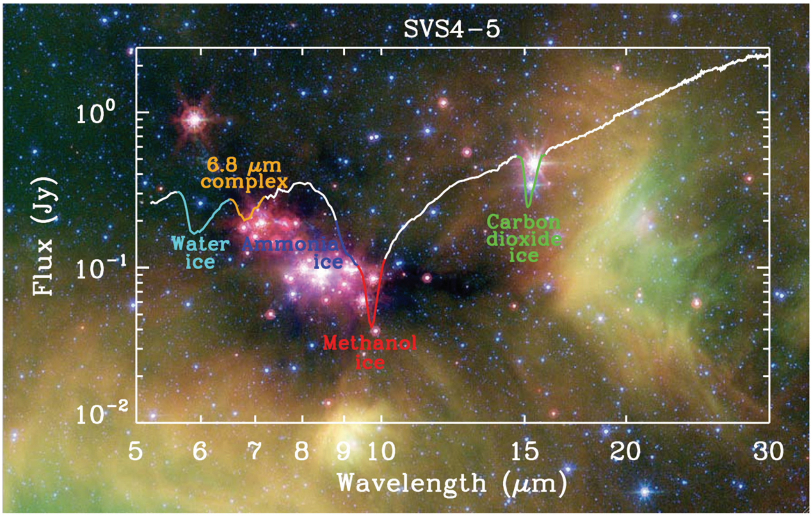


Figure 3. Spitzer infrared spectrum toward the deeply embedded solar mass protostar Serpens SVS 4-9, showing CH_3OH and NH_3 ice absorptions at 9.7 and 9.0 micron superposed on the silicate feature. The background image is the Spitzer c2d 3.6, 8.0 and 24 micron color image of the Serpens core.

2.3.4 Origin and Evolution of Complex Organic Molecules in Space

Complex organic molecules are ubiquitous in space. Herbst (Ohio State, USA) and Van Dishoeck reviewed the topic for Annual Reviews in Astronomy and Astrophysics. There is now strong evidence that the rich variety of volatile complex molecules seen in the millimeter spectra of young stellar objects are primarily formed in the ice mantles on interstellar grains. This chemistry appears ubiquitous throughout the Milky Way, with remarkably similar abundances on large scales. Öberg, Bottinelli and van Dishoeck developed an indirect method for testing this hypothesis through two organic molecules - CH_3OH and HNCO - that can be observed both in the gas and in the ice. They found a tentative correlation between the ice and gas abundances with a measured gas-to-ice ratio of 10-4, which agrees well with predictions for the photo-desorption mechanism measured in the laboratory by Öberg and collaborators. This provided a proof of concept that non-thermal desorption products in cold clouds can serve as a signature of the (complex) ice composition.

2.3.5 Chemical Evolution from Cloud to Disk

Visser, van Dishoeck, Doty (Denison Univ., Ohio, USA), and Dullemond (MPIA Heidelberg, Germany) developed a semi-analytical 2-D model to describe how material changes physically and chemically as it is transported from a collapsing cloud to a protoplanetary disk. Thus far, only 1-D models were used but they could not properly describe the incorporation of material into disks. The model computed infall trajectories from any point in the cloud and tracked the radial and vertical motion of material in the viscously evolving disk. It included a full time-dependent radiative transfer treatment of the dust temperature, which controls much of the chemistry. As a first application, the freeze-out and evaporation of CO and H_2O ice were studied, as well as the potential for forming complex organic molecules in ices. A fraction of the ices in comets are indeed expected to be pristine molecular cloud material. Material that ends up in the planet- and comet-forming zones of the disk (~5-30 AU from the star) is predicted to spend enough time in a warm zone during the collapse to form first-generation complex organic species on the grains.

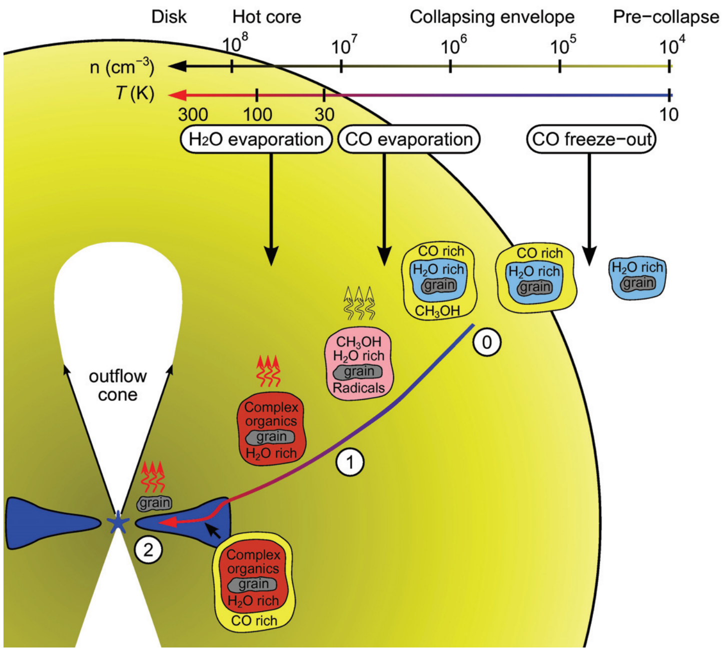


Figure 4. The evolution of material from the prestellar core stage through the collapsing envelope into a protoplanetary disk. The formation of zeroth- and first-generation organic molecules in the ices is indicated occurs at 0 and 1, and second-generation molecules in the hot-core region at 2. Once material enters the disk, it will rapidly move to the cold midplane where additional freeze-out and grain surface chemistry occur. All ices evaporate inside the (species-dependent) sublimation radius ('snow line')

2.3.6 Sun-bathing around Low-Mass Protostars

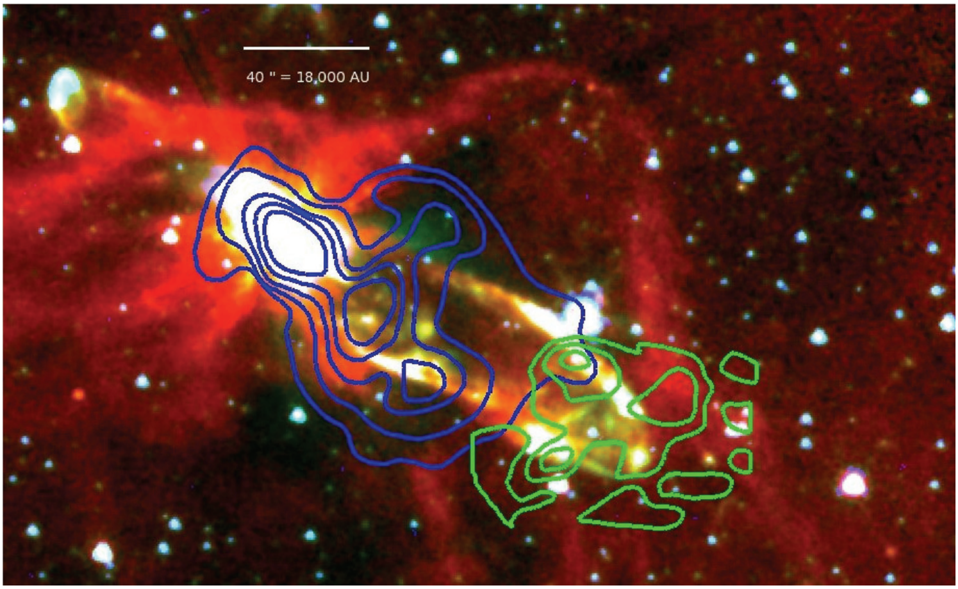


Figure 5.Spitzer three color (3.6 (blue), 4.5 (green) and 8 micron (red)) image with the contours of integrated CO J=6-5 emission (blue/dark) observed with APEX-CHAMP+ overlaid. The [C I] 2-1 emission (green/light) is detected weakly on source but peaks further down at the tip of the outflow where the UV photons produced in the fast bow shock are hard enough to dissociate CO. Analysis of the line profiles shows that the emission consists both of accelerated swept-up gas along the outflow as well as quiescent, photon-heated gas surrounding the outflow cavity walls.

Van Kempen, van Dishoeck, Hogerheijde, Kristensen, Yildiz, Guesten (MPIfR, Bonn, Germany) and collaborators used the new CHAMP+ camera on APEX to image CO J=6-5, 7-6 lines, as well as lines from isotopologues and [C I] 809 GHz, in a dozen low-mass protostellar sources on scales of several arcmin to probe the origin of warm gas in their surroundings. Such studies have only become possible thanks to the development of heterodyne arrays at high frequency combined with an excellent site. Surprisingly strong quiescent extended emission from narrow high-J ^{12}CO 6-5 and 7-6 lines is seen toward all protostars, suggesting that heating by UV photons along the outflow cavity dominates the emission. The UV photons are generally not energetic enough to dissociate CO since the [C I] 2-1 emission, also probed by our data, is weak except at the bow shock at the tip of the outflow. Shock-heated warm gas characterized by broad CO line profiles is seen only toward the more massive Class 0 outflows. This shocked gas is also revealed through Spitzer maps of the pure rotational lines of H_2 in the NGC 1333 region in a complementary study led by Maret (Grenoble, France) and involving Kristensen.

In collaboration with Bruderer, Benz (both ETH, Zürich, Switzerland) and Doty (Denison Univ., Ohio, USA), multidimensional chemical models have been developed which can tackle the physical and chemical structure of irridiated outflow walls. The initial application has been to high-mass YSOs, but such models are now being constructed for low-mass YSOs together with Visser for interpretation of Herschel data.

2.3.7 Mid-infrared Spectral Variability Atlas of Young Stellar Objects

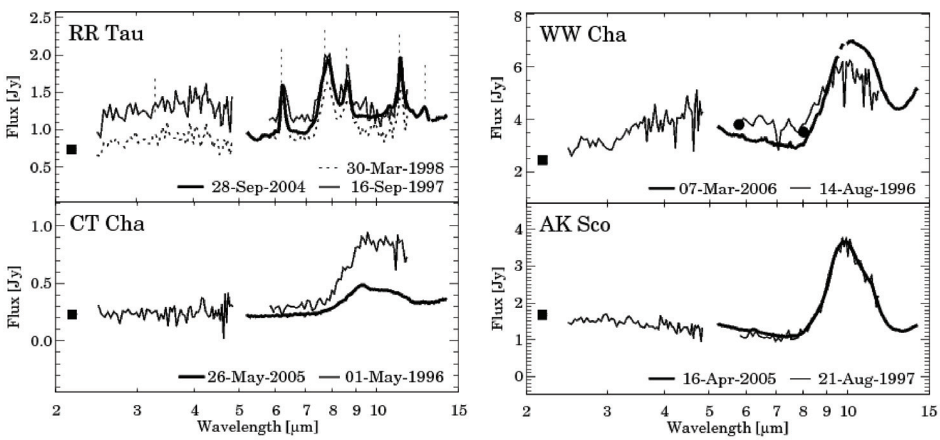


Figure 6. Mid-infrared observations of pre-main sequence stars. Thin lines: ISO/ISOPHOT-S, thick lines: Spitzer/IRS, dots: Spitzer/IRAC, squares: 2MASS. RR Tau shows wavelength-independent flux changes; CT Cha displays a variable 10 micron silicate feature but mostly constant continuum; WW Cha shows anti-correlation between flux changes below and above 8 micron; while AK Sco exhibit no mid-infrared variability.

Kóspál, Abrahám, Kun, Moór (Konkoly Obs., Hungary), Henning, Leinert (MPIA Heidelberg, Germany), and Acosta-Pulido (IAC Tenerife, Spain), compiled a mid-infrared spectral atlas containing observations of 68 low- and intermediate-mass young stellar objects. The atlas contains 2.5-11.6 micron low-resolution spectra obtained with the ISOPHOT-S instrument on-board the Infrared Space Observatory, as well as 5.2-14.5 micron low-resolution spectra obtained with the IRS instrument on-board the Spitzer Space Telescope between 2004 and 2007. The observations were retrieved from the archives and were post-processed interactively by self-developed routines. Kóspál, and Collaborators analyzed the mid-infrared variability on both yearly and decadal timescales. They identified 38 candidate variable sources and characterized the wavelength-dependence and possible physical mechanisms of the flux changes.

2.3.8 Characterization of Embedded YSOs and Disks

Van Kempen, van Dishoeck and collaborators developed a method to characterize the truly embedded stellar population in Ophiuchus. They used the extent and strength of a high density tracer, HCO^+ J=4-3 observed with JCMT HARP-B, combined with two column density tracers, $C^{18}O$J=3-2 and the SCUBA dust continuum. Of the 40 candidate sources, only 17 turned out to be bona-fide embedded YSOs. Accurate classification is essential to determine reliable lifetimes of the various evolutionary phases. Jörgensen (Bonn, Germany), van Dishoeck, Visser, Lommen and collaborators used the Smithsonian Millimeter Array to characterize young disks in the embedded stage of star formation through a survey of 20 sources. The interferometer data allow the disk and envelope emission to be disentangled. They found the envelope mass to sharply decrease from the Class 0 to the Class I stage, whereas the disk mass showed no evolution between these stages. In addition, four Class I sources exhibited signs of Keplerian disk rotation in HCO^+ J=3-2 data. The inferred stellar masses indicate that the stars contain 70-98% of the total mass in the star-disk-envelope system, confirming that most of the material has already accreted onto the central star at this stage. Comparison with evolutionary models showed that these tended to overestimate disk relative to stellar masses. Thus, material accreted from the large scale envelope has to be processed more rapidly onto the central star by some mechanism.

2.3.9 First Results from WISH

Van Dishoeck, Kristensen, van Kempen (CfA, Boston, USA), Herczeg (MPE, Munich, Germany) and collaborators obtained the first data from the 'Water in Star-Forming Regions with Herschel' key program. PACS spectra and maps were obtained for three science demonstration sources. The water molecule is a particularly sensitive probe of where a young star dumps energy into its surroundings. Figure 7 shows the water emission map along the outflow lobes of the deeply embedded protostar L 1157 in a study led by Nisini (INAF, Rome, Italy). The water emission shows up most strongly in "hot spots" due to strong shocks symmetrically displaced from the young star. Toward another young sun-like star, HH 46, PACS has imaged a strong line of atomic oxygen. This line is one of the most direct probes of the rate at which the young star loses mass. Interestingly, the line detected by PACS shows not only the low velocity gas swept up by the jet, but also very fast moving gas that is part of the jet itself. This will allow a direct determination of the energy involved in both processes.

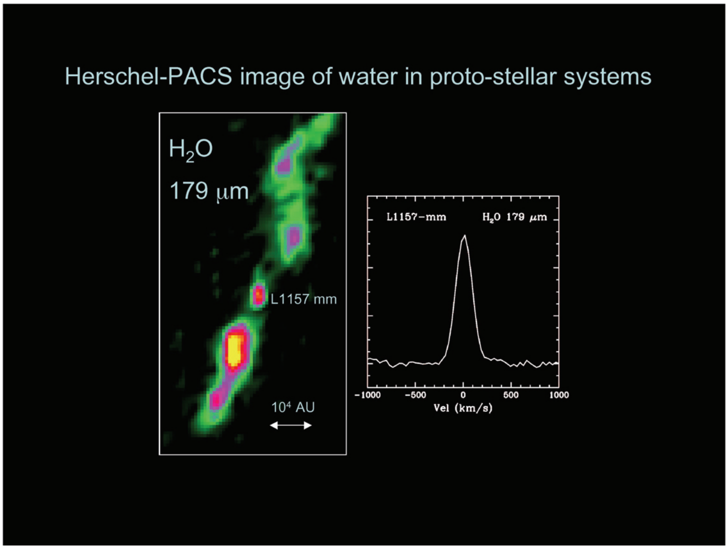


Figure 7. PACS image of water 179 micron emission toward the young solar analog L 1157, lighting up the two-sided outflow of gas.

2.3.10 Spitzer c2d Census of Cold Disks with Large Inner Dust Holes

Understanding how disks evolve and dissipate is essential to studies of planet formation. Merin (HSC Madrid, Spain), van Dishoeck, Brown (MPE, Munich, Germany) and collaborators used the Spitzer c2d survey to identify 35 candidate transitional disks for which IRS spectra were obtained in a Spitzer program. Of these, 15 turn out to be 'cold' disks lacking mid-infrared excess, whereas a large fraction of the remaining 20 are disks in which the grains have grown and settled to the mid-plane. These statistics give a frequency of cold disks of 4-8% of the YSO population, indicating that transitional disks represent a short-lived phase in disk evolution. Hole sizes are generally smaller (a few AU) than for previously discovered cold disks and reflect a distribution more consistent with exoplanet radii. Reliable criteria for identifying disks with inner holes from

Spitzer photometry have been determined, which can be applied to larger samples.

2.3.11 CO Isotope-Selective Photodissociation Revisited

Photodissociation by UV light is an important destruction mechanism for CO in many astrophysical environments. Visser, van Dishoeck and Black (Chalmers Univ., Göteborg, Sweden) revisited this process using recent spectroscopic data which allowed determination of depth-dependent and isotope-selective photodissociation rates with higher accuracies. Theirs is the first such model to include the rare isotopologues $C^{17}O$ and $^{13}C^{17}O$. The results have been applied to diffuse and translucent clouds, photon-dominated regions, and circumstellar disks. Increasing the excitation temperature reduces the isotopic selectivity by as much as a factor of three, whereas grain growth can enhance it by an order of magnitude. The photodissociation rates of $C^{17}O$ and $C^{18}O$ show almost exactly the same depth dependence so ^{17}O and ^{18}O are equally fractionated with respect to ^{16}O.This supports the recent hypothesis that CO photodissociation in the solar nebula is responsible for the anomalous ^{17}O and ^{18}O abundances in meteorites. Using the unprecedented quality of ESO-VLT-CRIRES data, high precision measurements of $C^{17}O$, $C^{18}O$ and $C^{16}O$ abundances have been made by Smith (UCLA, USA) and collaborators (including van Dishoeck) of one disk and one protostellar envelope as part of a VLT large program led by van Dishoeck. The derived oxygen abundance ratios for the VV CrA disk show a significant mass-independent deficit of $C^{17}O$ and $C^{18}O$ relative to $C^{16}O$ compared to ISM baseline abundances, consistent with the isotope selective process in the upper layers of the disk. The Reipurth 50 envelope shows no clear differences, as expected.

2.3.12 Crystalline Silicates in Disks

As part of the c2d legacy program, Olofsson, Augereau (Grenoble, France), van Dishoeck and the c2d team analyzed Spitzer-IRS spectra of ~100 T Tauri stars to quantify their crystallinity fraction. More than 3/4 of the objects show at least one crystalline silicate feature that can be essentially attributed to Mg-rich silicates. The Fe-rich crystalline silicates are largely absent in the c2d sources. The strength and detection frequency of the crystalline features seen at long wavelengths (probing scales less than 10 AU) correlate with each other, but not with those at 10 micron (probing even smaller scales less than 1 AU). This leads to a crystal paradox: the crystalline silicate features are detected 3.5 times more frequently in the colder outer disk (~55% vs. ~15%) than in the much warmer inner disk regions where the material supposedly crystallized. Thus, the need for an efficient outward radial transport mechanism in disks around T Tauri stars is suggested.

2.3.13 An Unbiased Disk Sample in Serpens

The Spitzer c2d survey has revealed a new population of YSOs in a previously unexplored region of the Serpens molecular cloud. Compared with other low-mass star-forming clouds, Serpens has a much higher star formation rate per unit volume. Thus, it is an excellent laboratory to test disk properties in a clustered environment. Oliveira, Pontoppidan, van Dishoeck, Merin and collaborators have carried out a flux-limited IRS spectroscopic survey of some 100 disks down to the young brown dwarf limit. In addition, complementary optical spectroscopy, millimeter emission and X-ray surveys have been done. The majority of the disks show silicate emission, 8% have 30/13 micron flux ratios consistent with cold disks with inner holes and 4% of the disks show PAH emission. Comparison with models indicates that dust grains in the surface layers have sizes of at least a few micron. No significant difference is found in the distribution of silicate feature shapes and strengths between Serpens and other well-studied large samples of disks such as that of Taurus. The remarkably similar distribution in samples with different median ages imply that the dust population in the disk surface results from an equilibrium between dust growth and destructive collisional processes that is maintained over a few million years, irrespective of environment.

2.3.14 Pebbles in Disks

Grains in disks around young stars are thought to grow from interstellar submicron sizes to planetesimals, up to kilometres in size, over the course of several Myr. The largest grains that can be detected have sizes of pebbles, and can be best observed at centimeter wavelengths. However, other emission mechanisms can contribute, most notably free-free emission from stellar winds and chromospheric activity. Lommen, Wright (ADFA, Australia), Maddison (Swinburne Univ., Melbourne, Australia) and collaborators used the Australia Telescope Compact Array to determine the mechanisms of centimeter emission for several T Tauri stars through monitoring over several years. Some disks have confirmed grain growth up to at least millimeter sizes, whereas one source shows variable emission at the longest wavelengths indicative of non-thermal emission. A larger sample has subsequently been surveyed with ATCA and SMA to search for correlations between the submillimeter spectral slope, characteristic of grain growth across the disk midplane, and the 10 micron feature, indicative of growth in the surface layers in the inner disk.

2.4 Star Formation

2.4.1 Zonal Flows in Accretion Disks

Young stars and supermassive black holes are fed by accreting gas from an orbiting disc, an accretion disk. Accretion is facilitated by the turbulent mass of the gas. A path to make accretion disks turbulent is through the so-called magnetorotational instability, which renders any Keplerian flow with an appropriately strenghted magnetic field unstable. Accretion disk turbulence is often studied in a corotating reference frame representing a small region in the disk. However, such an approach neglects potentially important dynamics at scales larger than the simulation box. Johansen, Youdin (CITA, Canada), Klahr (MPIA, Heidelberg, Germany) developed a new numerical method that allows the study of MHD turbulence in very large simulation domains. They found that the turbulence has significant structure at large scales. The most striking feature of their simulations was large scale "zonal flows", i.e. regions of faster or slower rotation similar to the banded cloud structure on the giant planet Jupiter. Such zonal flows can have important effects on planet formation, since pebbles and rocks are trapped between regions of slower and faster rotation.

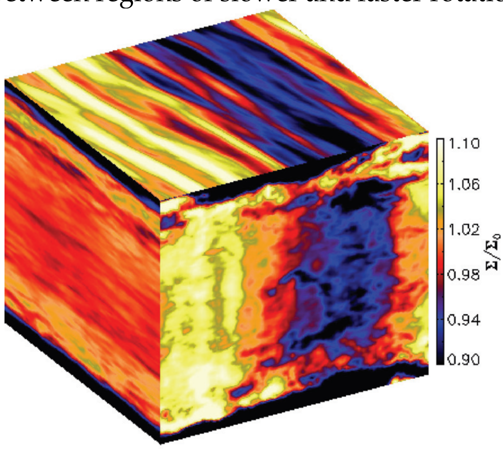


Figure 8. Zonal flows.

2.4.2 The Spitzer c2d Legacy: Statistics

The Spitzer c2d legacy team, led by Evans (Univ. Texas, USA), and including van Dishoeck, van Kempen and Merin, performed a statistical analysis of the more than 1000 YSOs found in the five star-forming clouds mapped by c2d.

Current star-formation efficiencies are found to range from 3% to 6%, overall from 15% to 30%. The star-formation surface density is more than an order of magnitude larger than would be predicted from the Kennicutt relation used in extragalactic studies, reflecting the fact that those relations apply to larger scales where more diffuse matter is included in the gas surface density. The derived lifetime for the embedded Class I phase is 0.44 Myr, considerably longer than some estimates. Similarly, the lifetime for the Class 0 SED class, 0.1 Myr, with the notable exception of the Ophiuchus cloud, is longer than early estimates. The great majority (90%) of young stars lie within loose clusters with at least 35 members and a stellar density of 1 M_sun pc-3. The data confirm and aggravate the "luminosity problem" for protostars. At a given T_{bol}, the values for L_{bol} are less than predicted by standard infall models and scatter over several orders of magnitude. These results strongly suggest that accretion is time variable, with prolonged periods of very low accretion.

2.4.3 Mapping Molecular Gas in Stellar Nurseries

Hogerheijde, together with a large team of researchers from the UK and Canada, is executing a Legacy Survey on the James Clerk Maxwell Telescope (JCMT) using the HARP receiver array. This 'spectral-line camera' has revolutionized the capabilities of the JCMT to map out the distribution of molecular gas in the Universe. Hogerheijde is one of the coordinators of the Gould Belt Survey, aimed at mapping all nearby star-forming regions in emission of CO and its isotopes ^{13}CO and $C^{18}O$. Papers describing the first results of this survey were completed in 2009, presenting maps of the star forming clouds in Serpens, Taurus, and Orion. These clouds showed a remarkable variety of morphologies and kinematics, illustrating the diversity of star-forming environments in the Solar vicinity. This ranges from isolated, mostly quiescent condensations in Taurus, to the much more energetic regions of Serpens and Orion which are criss-crossed by protostellar jets and show indication of large-scale cloud collisions.

2.4.4 High Mass Star Formation

Torstensson and Van Langevelde continued their studies of methanol masers associated with high mass star formation. Collaborating with van der Tak (SRON, Groningen) and Vlemmings (Bonn Univ., Germany), they obtained interesting results on the nearest high-mass star-forming region Cep A, which is studied as the archetypical source in the sample. Analysis of HARP data taken with the JCMT allowed the derivation of the rotation temperature and column density of the thermal methanol gas. The methanol is clearly associated with the central source in this famous HII region and the derived temperature peaks at the location of the maser. Excitation models show that radiative excitation is limited to the very central region.

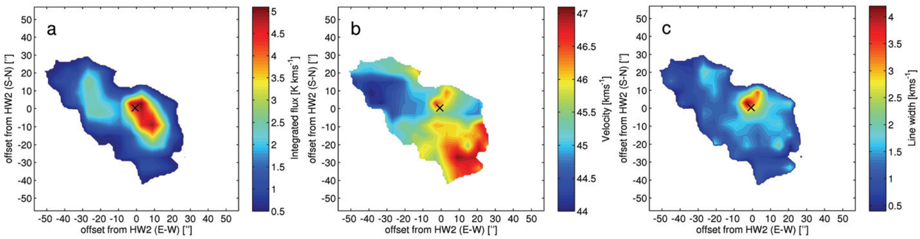


Figure 9. Thermal methanol in Cep A, from left to right the integrated flux, the velocity field and the line width of the methanol (7 1 7 -- 6 1 6) E-type transition is shown. This is the strongest unblended line in the JCMT HARP spectra.

The direction of the outflow is roughly consistent with the orientation of the methanol masers on the much smaller scale observed with the European VLBI Network. The methanol masers straddling the waist of Cep A probably outline a large ring structure perpendicular to the outflow axis of the central source. Remarkably, the velocity field does not show a rotation signature but seems to be dominated by a small radial motion. Thus, the ring may outline an accretion shock, where in-falling gas hits the accretion disk.

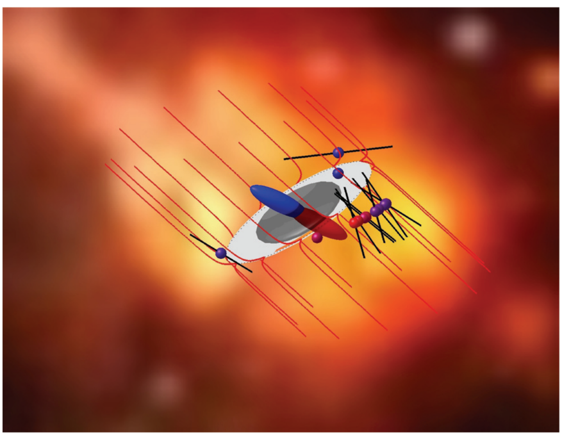


Figure 10. The magnetic field configuration around the young massive star Cepheus A HW2 and the location of the methanol regions from which the 3-D structure was inferred. The figure shows a magnetic field almost perfectly perpendicular to the disk through which matter is transported onto the star.

Vlemmings observed the same Cep A methanol masers with MERLIN to obtain measurements of the magnetic field direction. Although the interpretation of maser polarization can be quite complex, the measurements reveal a structured large scale magnetic field perpendicular to the accretion disk in this high-mass YSO. Field structure and strength reveal that magnetic fields can be the dominant force in regulating the formation of high mass stars. This is an important clue that the formation mechanism of high mass stars may resemble that of less massive stars.

2.5 Stars and Interstellar Matter

2.5.1 Searching for the Siblings of the Sun

Bean (Leiden and Missouri State University), Portegies Zwart and Brown used data from the Hipparcos Catalogue to conduct a preliminary search for stars that were born in the same cluster as the Sun: the Sun's Siblings. They ran simple simulations of a cluster dissolving during the Sun's lifetime as it orbits in the potential of the Galaxy. The stars lost from the cluster in the simulation end up along the cluster's orbit and their characteristics (space distribution and kinematics) should identify candidate siblings of the Sun in the Hipparcos Catalogue. Bean and coworkers made a further selection among the candidates by looking for stars that photometrically appear to have the same age as the sun and then examined these by looking up accurate age and metallicity estimates in the Geneva-Copenhagen Survey catalogue. Somewhat as expected, no actual siblings of the Sun were found but the study forms a good basis for future searches with larger astrometric and photometric surveys such as will be provided by the Gaia mission.

2.5.2 An Arc of Gas and Dust around the Young Star DoAr21

Hogerheijde, Panič, Merin, and Schouten obtained detailed images of the circumstellar dust around the young star DoAr21. It had been suggested that this star is surrounded by a disk, which has already cleared-out its inner region -- a telltale sign of disk evolution and possible planet formation. However, the VLT-SINFONI and VLT-VISIR images obtained by Hogerheijde et al. showed a very different picture: instead of a disk, the molecular hydrogen and the warm dust form an arc on just one side, at roughly 70-200 AU from the star. The most likely explanation is that DoAr21 is not surrounded by a cleared-out disk, but instead that it just happens to travel past a dense cloud condensation in the Rho Ophiuchi cloud. DoAr21 is known to be bright in X-rays, and this radiation should heat the surface of the condensation to hundreds if not thousands of K, sufficient to explain the observed emission. The observations illustrated the power of VISIR and SINFONI to probe the environment of young stars.

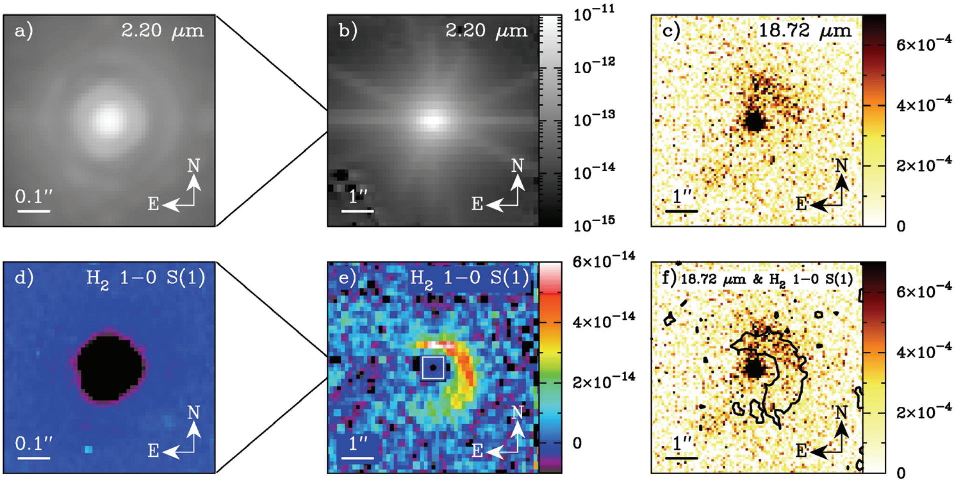


Figure 11. Different views of the circumstellar environment of DoAr21: a) image of the star at 2.1 micron obtained with SINFONI using Adaptive Optics, clearly showing the diffraction pattern of the telescope. b) same, zoomed out to a 8 arcsecond field of view. c) image of the field at 19 micron showing the stellar photosphere and the emission of the arc of warm dust 1 arcsecond NW of the star. d) image of the inner field around DoAr21 at the wavelength of the H_2 line emission, with the stellar emission subtracted, showing the absence of any circumstellar material in these scales. e) same, zoomed out to a 8 arcsecond field of view, clearly showing the arc of glowing H_2 to the NW of the star. f) comparison of the locations of the warm dust and glowing H_2 gas.

2.5.3 The Misaligned DI Herculis System

Albrecht led a study using the Rossiter-McLaughlin effect which reveals the spin-orbital alignment in two binary star systems, a technique also used for transiting extrasolar planets. In a Nature publication, they revealed that in one of these systems, DI Herc, the orbital plane and spin-axis are strongly misaligned. This unexpected result solved the 20-year old mystery of the slow apsidal motion of this binary star system.

2.5.4 Evolved Stars: Planetary Nebula Progenitors?

Amiri, van Langevelde, and Vlemmings (Bonn Univ., Germany) studied the role of magnetic fields in shaping the circumstellar envelope of evolved stars that are Planetary Nebula (PNe) progenitors. MERLIN observations of the OH maser region in the so-called water fountain source W43A revealed circular polarization. Amiri and coworkers interpreted this as caused by the Zeeman effect and found the strength to be consistent with previous determinations of the magnetic field in the jet-like water maser emission [see Figure].

Using Effelsberg 100 m telescope, the same team discovered another 22 GHz water maser in the supposedly dead OH/IR star, IRAS18455+0448 for which the sudden disappearance of the OH 1612 MHz line had been reported previously. Such a dying OH/IR star should not possess a water maser. An interesting possibility is that the new masing spots originate further out in the circumstellar envelope, making this the youngest proto-PNe ever detected.

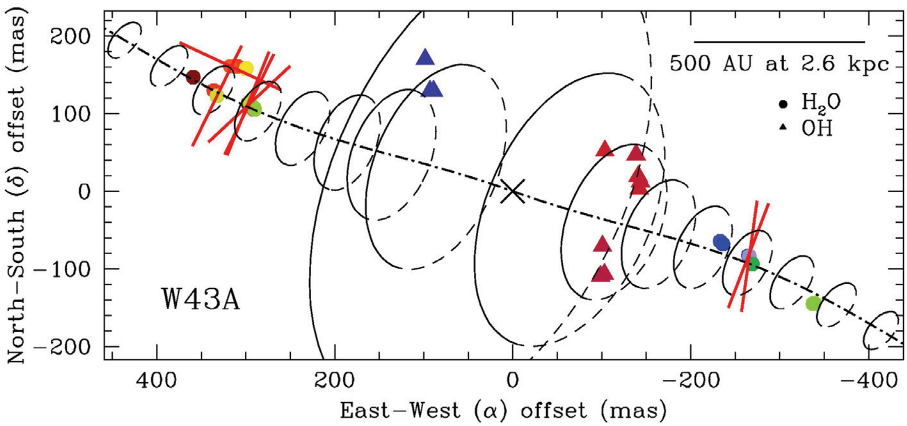


Figure 12. Spatial distribution of OH and H_2O maser features in W43A. The offset positions are with respect to the reference feature. H_2O features are indicated by filled circles and OH components are shown as triangles. Red and blue show the redshifted and blueshifted features.

2.6 Structure of the Milky Way

2.6.1 The Galactic Magnetic Field

Nota and Katgert studied the large-scale magnetic field in the Galactic plane in the fourth Galactic quadrant. They used published rotation measures of pulsars and extragalactic sources. They made a special effort to identify those objects for which the distribution of free electrons between observer and source is probably far from uniform. Structure in the distribution of free electrons biases the estimate of the strength of the magnetic field from rotation measures, especially if the field reverses direction somewhere along the line of sight or has structure on small scales.

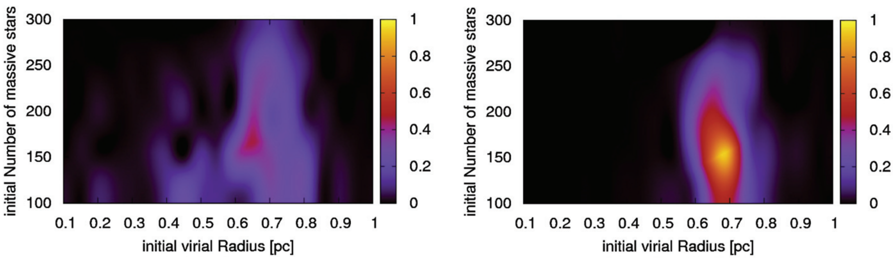
The strength of the large-scale field was estimated by comparing the acceptable data to model predictions. It appears that the large-scale field most likely follows the spiral arms. For a large range of assumed arm properties (such as pitch angle and arm-width), the large-scale field shows two robust reversals; from Norma arm (counter-clockwise) to Norma-Crux interarm region (clockwise), and from Norma-Crux interarm region to Crux arm (CCW). The field strengths are typically a few µGauss. At the same time, Nota and Katgert found evidence for a small-scale field that is a factor of two to three stronger than the large-scale field.

2.6.2 Bulge Dynamics: Studing the Closest Galactic Bar

Soto, Kuijken, and Rich (UCLA, USA) constructed a model of the stellar kinematics towards the bar in the Milky Way bulge. They based the model on new measurements of proper motions and radial velocities from HST and the ESO-VLT, respectively. The VLT observations used an integral field unit to take spectra of very crowded star fields in the bulge, from which stellar spectra were then extracted using the precise position information measured on the HST images. Repeat HST images separated by 3-5 years allowed accurate proper motions (equivalent to 30km/s accuracy at the distance of the bulge) to be measured. A separate analysis of a data set of K giants revealed a significant vertex deviation in the metal-rich stars which is a clear signature of bar-like kinematics. In their master thesis project, Zeballos and Astraatmadja derived proper motions from HST data in three new fields, at galactic longitudes between 5 and 10 degrees.

2.6.3. Mass Function of the Arches Cluster

The Arches cluster is one of only a handful of young and massive starburst clusters in the Milky Way. Located at the Galactic center, this cluster is a unique object for studying star formation and early cluster dynamics. Harfst and Portegies Zwart constructed an N-body counterpart of the Arches cluster by systematically comparing a large number of simulation results with observations. The observational data were provided by Stolte (Cologne University, Germany). The results showed that the flattened mass function observed today is the result of the dynamical evolution of the cluster combined with a selection effect. The Arches cluster is consistent with a standard Salpeter initial mass function and not, as was considered in earlier studies, an counter-example to the universality of the initial mass function.



a) *(b)*

Figure 13. Quality of fit to observation for varying model parameters, a value of unity indicating the best fit. The two panels show results from models using a Salpeter and a flat initial mass function (panel a) and b), respectively).

2.6.4 The Central Supermassive Black Hole

Levin, PhD students and international collaborators continued to work on issues related to the supermassive black hole in the Galactic Center, and to gravitational-wave detection.

Madigan, Levin, and Hopman identified a new secular instability in eccentric stellar disks around supermassive black holes. They showed that a combination of coherent torques and retrograde precession of the stellar orbits amplifies deviations of individual orbital eccentricities from the average, and thus drives all eccentricities away from their initial value. This physical process is relevant for the Galactic center, where massive stars are likely to form in eccentric disks around the SgrA* black hole. They showed that the dynamical evolution of such a disk results in several of its stars acquiring high ($e > 0.99$) orbital eccentricities.

Binary stars on such highly eccentric orbits would get tidally disrupted by the SgrA* black hole, possibly producing both the S-stars, a cluster of young stars on random orbits near the black hole, and hyper-velocity stars in the Galactic halo.

Levin, working with Genzel's group at MPE (Munich, Germany) has also obtained new results on the geometry of the Galactic-Center stellar disks. This work has shown that the clockwise disc is strongly warped and the counterclockwise disc is dissolving.

2.7 Nearby Galaxies

2.7.1 Magellanic Clouds

To understand the impact of low metallicities on giant molecular cloud (MC) structure, Israel as part of an international team working on Spitzer Space Observatory data compared far-infrared dust and millimeter CO emission, and dynamics in the star-forming complex N83 in the Small Magellanic Cloud wing. Dust emission probes the total gas column independent of molecular line emission and traces shielding from photo-dissociating radiation. They resolved the relative structures of H_2, dust, and CO within this a giant molecular cloud complex, one of the first times such a measurement has been made in a low-metallicity galaxy. The results indicated that the CO is photo-dissociated while H2 self-shields in the outer parts of low-metallicity GMCs, implying that dust/self shielding is the primary factor determining the distribution of CO emission. The CO-to-H_2 conversion factor averaged over the whole cloud is very high, 20 to 55 times the local Galactic value. This factor also varies across the complex, with the lowest values near the CO peaks. The bright CO emission is occurs along line-of-sight with high extinction. A simple model in which CO occurs in a smaller sphere nested inside a larger cloud roughly relates the H2 masses measured from CO kinematics and dust.

2.7.2 Star-Burst Modelling

Martinez Galarza, Groves, and Brandl developed a method to compare physical models of star-burst spectral energy distributions with actual mid-infrared spectra from the Spitzer Space Telescope. They accomplished their star-burst modeling by implementing a reproducible least-square fitting method and comparing the model spectra to the spatially averaged IRS spectral map of 30 Doradus, which is a very well-studied giant HII region complex in the Large Magellanic Cloud. This approach can accurately constrain the relevant physical parameters of the star formation activity in 30 Doradus in a comprehensive manner, including the mass of the central cluster, the contribution of UCHII regions, and the contribution of PDR material to the total luminosity and compactness.

2.7.3 Molecular Gas in Late-Type Spiral Galaxies

Israel completed studies of molecular gas in the centers of the nearby star-burst galaxies NGC 278, NGC 660, NGC 3628, NGC 4631, and NGC 4666. The bright CO emission required modeling with at least two distinct gas components, although the physical condition differ from galaxy to galaxy. Relatively tenuous (less than a 1000 per cc) and warm (~125 K) gas occurs in all galaxies and is mixed with cooler (~20 K) and denser (~6000 per cc) gas. Molecular gas masses within radii of 0.6 to 1.5 kpc are about 100 million solar masses, i.e. no more than a few per cent of the dynamical mass in the same region. In all galaxy centers there is less H2 than CO intensities would suggest.

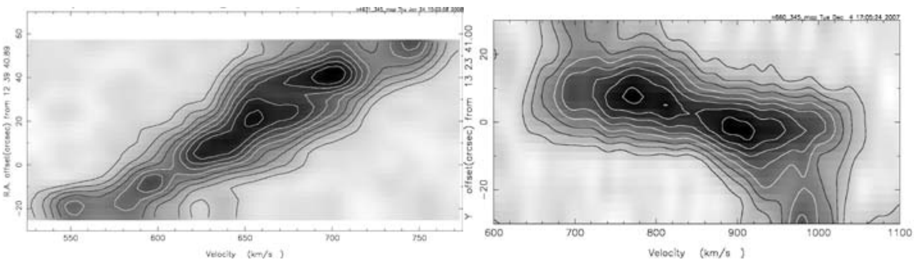


Figure 14. Major-axis-velocity diagrams of the merger/starburst NGC 660 (right) and the starburst galaxy NGC4631 (left). NGC660 exhibits strong circumnuclear CO, whereas the edge-on NGC4631 only shows a number of giant molecular cloud complexes distributed throughout the disk.

As co-coordinator of the JCMT Nearby Galaxies Legacy Survey (NGLS) , Israel and NGLS team members published a CO(3-2) study of four spiral galaxies in the Virgo cluster ((NGC 4254, NGC4321, NGC 4569, and NGC 4579). The first three have total molecular gas masses of about one billion solar masses and gas depletion times of about 1.5 Gyr. NGC 4254 appears to have a smaller gas depletion time (i.e. larger star formation rate) than the other, perhaps because it is on its first passage through the Virgo Cluster. The interaction of NGC 4569 with the interacted medium appears to be directly affecting the dense star-forming portion of the interstellar medium. NGC 4579, has weak CO(3-2) emission although it is bright in the mid-infrared. Much of the central luminosity in this galaxy may be due to the presence of a central AN.

The NGLS data of NGC 2403 were combined with Spitzer Space Telescope infrared maps at wavelengths between 3 and 160 microns and VELA HI data. In this very nearby Sabled galaxy, the dust surface density is a function of the total hydrogen gas surface density and galactocentric radius. The gas-to-dust ratio from ~100 in the nucleus to ~400 at 5.5 kpc radius. Its slope follows that of the oxygen abundance, suggesting that metallicity strongly affects the gas-to-dust ratio within this galaxy. The CO(3-2) radial profile has an exponential scale length identical to that of the (stellar continuum-subtracted) 8 micron PAH emission. However, CO J=(3-2) and PAH 8 micron surface brightnesses are uncorrelated on sub-kilo-parsec scales.

2.7.4 Infrared Study of the Antennae Galaxies (NGC 4038/39)

Brandl, Groves, van der Werf, Snijders, and Den Brok have studied the famous Antennae galaxies NGC4038/39 with the Infrared Spectrograph on the Spitzer Space Telescope. The spatially resolved spectra allowed a detailed study of the luminosities, dust content, and emission properties of the super star-clusters in the so-called overlap region. Molecular hydrogen was found to be rather confined to the nucleus of NGC 4039, where shocks appear to be the dominant excitation mechanism, and the southern part of the overlap region, where it traces the most recent star-burst activity. The overall properties of the warm molecular gas appear to be in good agreement with the findings in other star-burst galaxies, which is in contrast to previously reported findings from ISO.

2.7.5 Atlas of High-Resolution Mid-Infrared Starburst Spectra

Together with collaborators at Cornell and Caltech, Brandl produced an atlas of Spitzer/IRS high-resolution (R ~ 600) 10-37 micron spectra for 24 well-known star-burst galaxies. The spectra are dominated by fine-structure lines (including the high excitation [Ne V] line), molecular hydrogen lines, and emission bands of polycyclic aromatic hydrocarbons (PAHs). The spectra also revealed weak hydrocarbon features at 10.6, 13.5, 14.2 µm, and a previously unreported emission feature at 10.75 µm. An unidentified absorption feature at 13.7 ?m is detected in many of the starbursts. From the mid-IR fine-structure lines and the atomic hydrogen (H 7-6) line, the metallicities for 14 objects were derived. The spectra of all starburst galaxies were combined to create a high signal-to-noise ratio template, which was subsequently made available to the community.

2.7.6 The SuperMassive Black Hole in Centaurus A

In one of the first Guaranteed Time observing runs with SINFONI on the VLT, Van der Werf, De Zeeuw, Cappellari, Reunanen, Davies (MPE, Munich, Germany), Neumayer, and Rix (MPIA, Heidelberg, Germany) observed the

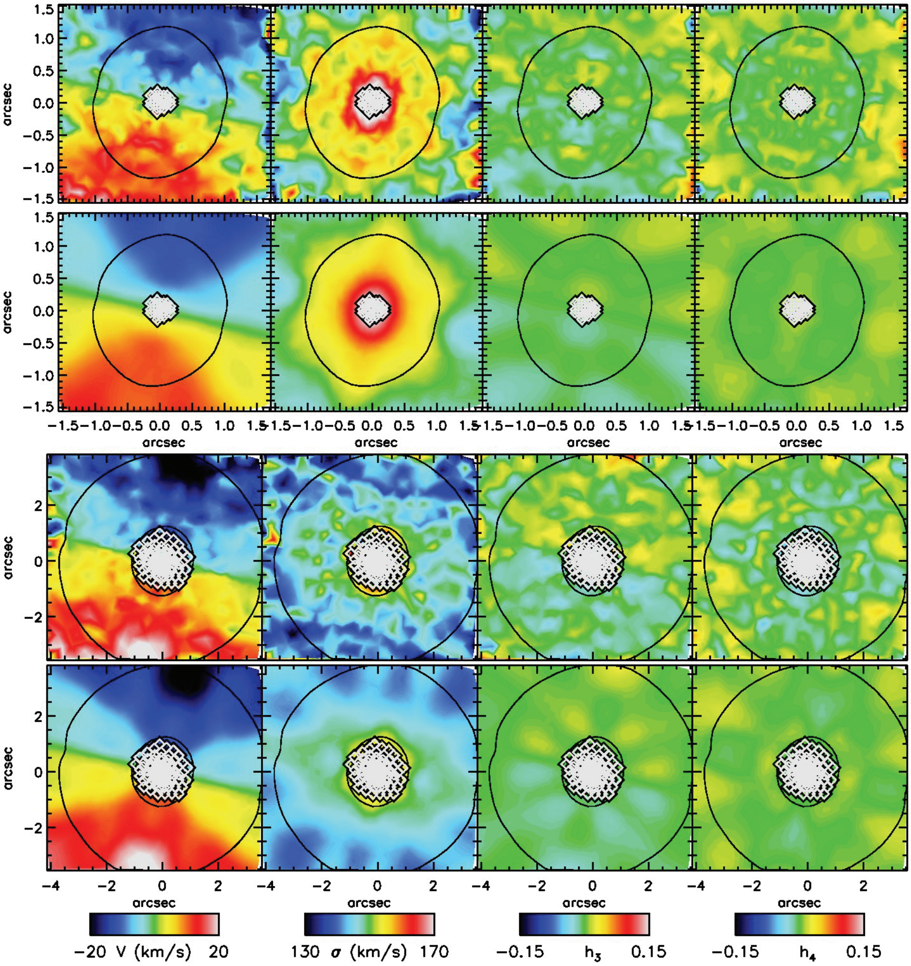


Figure 15. Data-model comparison for the best-fitting three-integral model of CO-band stellar kinematics in the nucleus of Cen A. Top two panels: the top row shows the bisymmetrized and linearly interpolated 0.1 arcsec pixel SINFONI data. The second row shows the best-fitting dynamical model predictions. The central bins excluded from the fit are shown with white diamonds. Bottom two panels: same as in the top two panels, for the 0.25 arcsec pixel SINFONI kinematics. For each quantity, the colour scale is the same in the two instrumental configurations.

optically obscured nucleus of the nearest radio galaxy Centaurus A. A nearby star allowed adaptive optics corrections resulting in data with a K-band resolution of 0.12 arcsec. The CO bandheads at 2.3 micron in this data set were used to determine the central black hole mass from stellar kinematics. Due to the very high signal-to-noise ratios, the shape of the stellar line-of-sight velocity distribution was reliably extracted. Remarkably, the stars were found to counter-rotate with respect to the gas. Using axisymmetric three-integral models (see Figure), the team found the black hole mass to be 55+/-30 million solar masses, in agreement with the earlier determination from the gas kinematics. The result provided one of the cleanest gas versus stars comparisons of M_{BH} determination; it also brought Cen A into agreement with the general M_{BH} - sigma relation.

2.7.7 Using PN.S to Study Elliptical Galaxy Outskirts

The PN.S team (including Kuijken, Douglas, Arnaboldi, Capaccioli, Coccato, Freeman, Gerhard, Merrifield, Napolitano, Noordermeer, Romanowsky) is in the process of carrying out a study of elliptical galaxy halos. The PN.S is a purpose-built narrow-band, two-arm slitless counter-dispersing spectrograph that finds, and measures velocities of planetary nebulae (PNe) in external galaxies from a single observation. The ongoing survey typically yields 100-200 PNe per galaxy, mostly beyond two effective radii from the center where motions are dominated by the dark matter halo potential. The team has now obtained good data sets for a dozen galaxies. Interestingly, a significant number of galaxies exhibit a sharply declining velocity dispersion profile.

2.7.8 Nuclear Phenomena in Active Galaxies

De Vries, Snellen, Schilizzi, and Röttgering studied very young radio galaxies in the expectation of shedding new light on the question why certain galaxies become active and how the central activity influences the surrounding galaxy. They showed that the expansion velocities of young radio sources depend on their radio luminosity. Their analysis also indicated that the mortality rate of radio-loud AGN is high during the earliest phase of their evolution.

Holt also continued working on radio galaxies at optical wavelengths, in collaboration with Tadhunter (Sheffield, UK) and Morganti (Astron), among others. They presented their results on the dominant ionization mechanisms in the fast nuclear outflows in compact (young) radio galaxies.

Finally, Spoon (Cornell) and Holt reported the discovery of strongly blueshifted mid-infrared neon emission lines in a sample of ULIRGs highlighting the presence of outflows in these sources.

Jaffe, Oonk, and Hatch used the Hubble Space Telescope ACS to obtain evidence for large-spread Far-Ultraviolet emission from cooling flow clusters. The source of this emission is unknown; it may be young stars (unusual for elliptical galaxies) or indirect emission from cosmic rays.

2.7.9 Nearby Clusters of Galaxies

Katgert and Biviano (Trieste, Italy) calibrated the effects of projection (from 6-d phase space to 2+1-d observation space) on the detection of kinematical and dynamical substructure in the clusters of the ESO Nearby Abell Cluster Survey. They used numerical simulations of clusters, in which all 6 phase-space coordinates are available, so that the real kinematical and dynamical substructure could be detected. These simulations were also projected into 2+1-d pseudo-observations. Special attention was given to the question of a meaningful cross-correlation between the properties of the substructure observed in 6-d and in the 2+1-d projection.

2.8 Distant and High-Redshift Galaxies

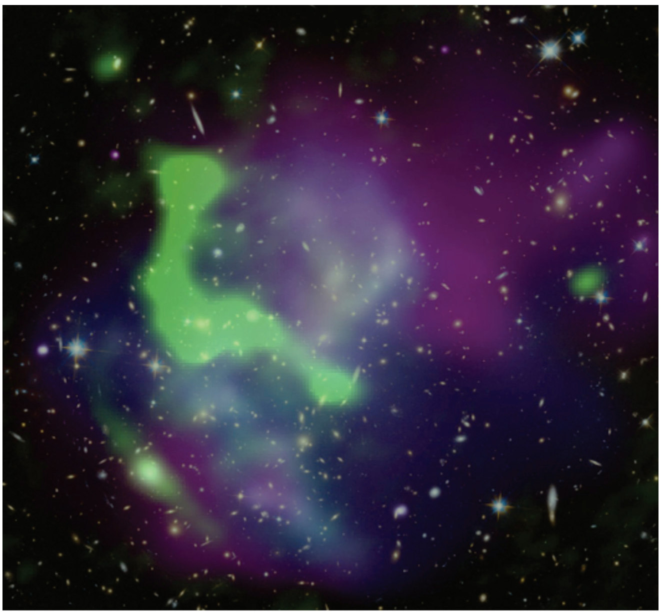


Figure 16. GMRT radio (green), Chandra X-ray (blue/magenta) and HST (whitish/red) observations of the merging cluster MACS J0717.5+3745 ($z=0.5$). The main central radio emitting region is located at the interface between merging clusters. The temperature of the X-ray gas in this interface region is relatively high, indicating that shocks in the X-ray gas accelerate the radio emitting particles.

2.8.1 Radio Cluster Haloes

Diffuse radio emission in clusters, often classified as radio "relics" or "haloes", trace regions with shocks and turbulence resulting from cluster merger events. Van Weeren, Röttgering, Brüggen (Bremen, Germany), and Cohen (NRL, Washington, USA) have carried out low-frequency radio observations at 610 MHz with the Giant Meterwave Radio Telescope (GMRT) of diffuse ultra-steep-spectrum sources and constructed the first sample of such sources associated with clusters. They showed that smaller relics have steeper spectra and larger relics are predominantly located in cluster outskirts while smaller relics arecloser to cluster centers. They suspect that this is the consequence of larger shock waves occurring mainly in lower-density regions and having larger Mach numbers.

Combining radio and Chandra X-ray observations of the merging cluster MACS J0717.5+3745 (z=0.5), Van Weeren, Röttgering, Brüggen, and Cohen (NRL, Washington, USA) discovered the most powerful radio halo known. The coincidence of steep-spectrum radio emission with high temperature X-ray gas (see Fig. 1) constituted strong evidence that the radio emitting particles are accelerated in a merger-related shock wave.

2.8.2 Radio Structure of Abell 2256

Abell 2256 is a massive cluster at a redshift of 0.0581. It is presently merging with a smaller sub-structure. At radio wavelengths, the cluster reveals a very complex morphology showing a bright peripheral radio relic, a radio halo, several complex relatively compact filamentary sources and "head-tail" sources. Van Weeren, Intema, Oonk, Röttgering and Clarke (Washington, USA) complemented deep 325 MHz GMRT radio continuum observations with WSRT 115-165 MHz observations and optical WHT imaging (See Figure previous page). They discovered three diffuse elongated radio sources about 1 Mpc from the clustercenter with extents of 170, 140 and 240 kpc, respectively. Their extremely steep radio spectra suggests them to be the result of adiabatic compression of fossil radio plasma caused by merger shocks. They concluded, from the timescales related to AGN activity, synchrotron losses, and the presence of shocks, that most massive clusters should possess similar sources. An exciting possibility is that such sources will determine the general appearance of clusters in the low-frequency, high-\ resolution radio maps produced by LOFAR or LWA.

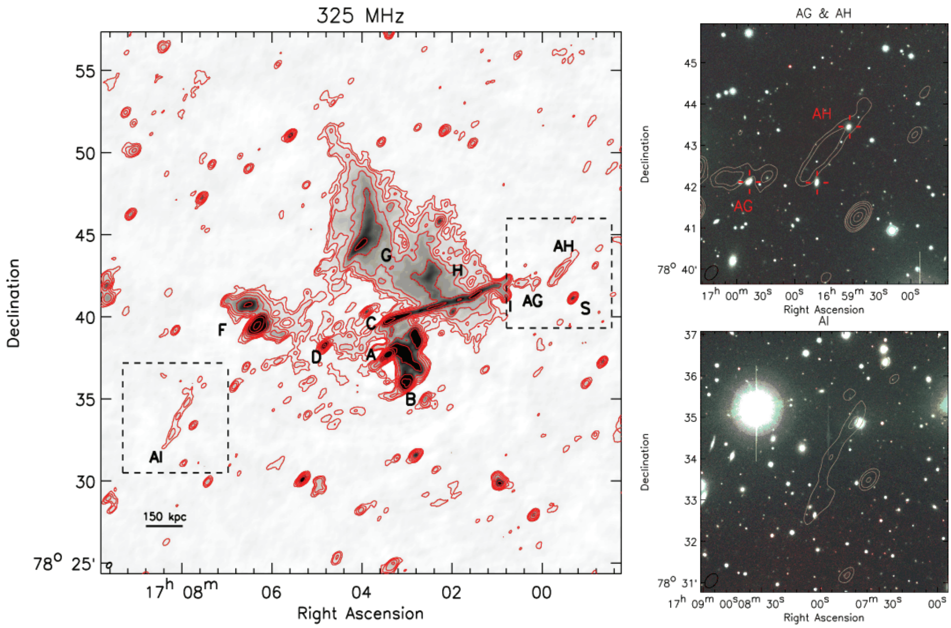


Figure 17. Left: 325 MHz GMRT radio map of the cluster A2256. Right: optical images around the diffuse steep spectrum radio sources AG+AH(top right) and AI (bottom rightl) composed out of V (blue), R (green), and I (red) band images.

2.8.3 Metallicities of Galaxies around Redshift of One

Brinchmann participated in two efforts to determine metallicities in galaxies at redshifts between 0.5 and 1.3 from the Vimos Very Deep Survey. The effort led by Lamareille (Toulouse, France) focused on the evolution of the mass-metallicity relation with redshift using the same techniques as had previously been applied to the Sloan Digital Sky Survey (SDSS). They found a modest evolution in the relation out to z~0.7 and possibly some evidence for a change in shape. The second effort, led by Pérez-Montero (Toulouse, France), focused on calibrating a new metallicity indicator for use at redshifts out to z~1.3. This was used to extend the study of the mass-metallicity relation to higher redshift, and an evolution relative to the present-day Universe was found but no statistically significant evolution was found between z~0.7 and z~1.

2.8.4 SDSS Galaxy Statistics

Brinchmann, mainly in collaboration with Christy Tremonti (U. Wisconsin, USA), carried out a re-analysis of all SDSS DR7 spectra and derived physical parameters for all galaxies in the SDSS DR7, about 1 million. This dataset has been provided on-line at http://www.mpa-garching.mpg.de/SDSS/DR7 and is a reference dataset for galaxy properties in the SDSS. Brinchmann also participated in an effort to study the effect of lopsidedness on the properties of galaxies in the SDSS. The effort was led by Reichard (Johns Hopkins, Baltimore, USA). They showed that lopsidedness in galaxies correlates with residuals in the mass-metallicity relation and that powerful AGN tend to be hosted by lopsided galaxies but that this is an incidental correlation. The physical correlation appears to be that the delivery of cold gas to the central regions of galaxies, triggering star formation and black hole growth, is aided by the process that produce lopsidedness.

2.8.5 Blue-to-Red Ratio in Massive Clusters

Hoekstra, Willis, Urquhart (both Univ. of Victoria, Canada) and Pierre (CEA, France) studied the fraction of blue galaxies (relative to galaxies on the red sequence) for a combined sample of massive clusters (from the Canadian Cluster Comparison Project led by Hoekstra) and low mass systems discovered by the XMM-LSS survey. The results, although not fully conclusive, suggest that environment may play an important role in setting the blue fractions of galaxy clusters.

2.8.6 Galaxy Proto-Cluster Structure in the Early Universe

Miley, Hatch, Röttgering, Masschietto, Kuiper, and collaborators have been using high-redshift radio galaxies (HzRGs) to probe galaxy and cluster formation in the early Universe. The very massive luminous high-z radio galaxies are the likely progenitors of cDs and Brightest Cluster Galaxies (BCGs). Leiden studies focussed on (i) population and kinematic study of radio-selected protoclusters from $2<z<4$, (ii) studies of merging, AGN feedback and galaxy downsizing in the massive cD progenitor hosts and (iii) preparation for a search for $z>6$ HzRGs with LOFAR (potential probes of the Epoch of Reionization).

To unravel the history of protoclusters, it is essential to study galaxies of different ages, masses and dust content. Lyman-alpha excess galaxies and Lyman break-galaxies are dominated by young dust-free stellar populations, while Balmer-break galaxies are dominated by older stars. The Leiden group has shown that Lyman-alpha is a powerful tracer of the young star-bursting population in $z>2$ protoclusters. They were allocated an ESO large project with the tunable OSIRIS camera on the new Grantecan Telescope to make a Lyman-alpha kinematic study of 19 HzRGs at $2<z<3.5$. Highlights of these studies are the population studies of Maschietto and collaborators and Kuiper on the protocluster MRC0316-257 at z=3.1, and Overzier and colleagues on protoclusters at z>4.

Maschietto et al selected 13 candidate [OIII] emitters in a 1 Mpc2 region around the z=3.1 radio galaxy, and followed up by spectroscopic observations. Three [OIII] emitters have velocities within a few hundred km/s of each other, but blue-shifted by about 2100 km/s from both the radio galaxy and the protocluster Lyman-alpha emitters previously detected by Venemans et al. These results indicate that the radio-selected protocluster is forming at the centre of a larger superstructure with a size of 60 co-moving Mpc.

Kuiper and colleagues took this a step further and analyzed in detail four distinct populations within this z>3.1 protocluster: the young stellar populations pinpointed by Lyman alpha emitters and Balmer break candidates and the older populations observed as [OIII] emitters and Balmer break candidates. They found a radial spatial segregation within the protocluster. The galaxies with the highest masses and star formation rates are located losest to the radio galaxy. Thus, the protocluster environment already influences galaxy evolution at z~3.

2.8.7 The Spiderweb Galaxy

Miley and his collaborators have shown that HzRGs have many of the properties expected from progenitor cD galaxies - clumpy optical morphologies, spectra indicative of extreme star formation and large stellar masses. The best studied example is the spectacular Spiderweb Galaxy at z=2.2, with a mass of about 10^{12} solar masses, among the largest known. The galaxy is surrounded by a giant (200 kpc) Lyman-alpha halo and embedded in dense hot ionized gas with an ordered magnetic field. It is associated with a 3 Mpc-sized structure of galaxies, of derived mass in excess of 2×10^{14} solar masses, a presumed antecedent of a local rich cluster. HST studies by Hatch et al revealed information about merging, downsizing, AGN feedback and intergalactic star formation. For the Spiderweb Galaxy comparison of the UV luminosity (young stars) with the IR luminosity (old stars) implied that most of the mass had already assembled by z~2.2, consistent with downsizing scenarios. Intriguingly, Hatch and colleagues showed that downsizing may also be occurring within the Spiderweb itself. Although the less massive satellite galaxies contain only 30% of the total mass, they are responsible for about 75% of the star formation.

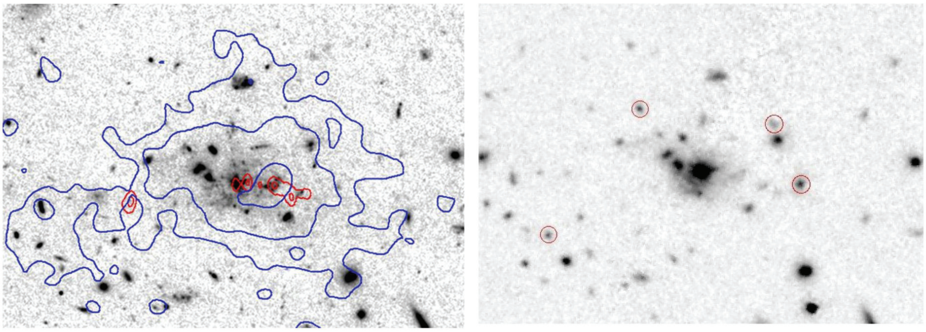


Figure 18. Left. Deep HST/ACS image of the Spiderweb Galaxy at the center of the MRC 1138-262 protocluster at z = 2.2, with VLT Lyman alpha contours (blue) delineating the gaseous nebula and the VLA 8GHz radio contours (red) superimposed on the composite ACS image. The gaseous nebula is extended by ~200 kpc and comparable in size with the largest cD galaxies in the local Universe.
Right. A H-band HST/NICMOS image at ~500A rest-frame. Red circles indicate red galaxies with little UV continuum. Note differences between the ACS image (young population) and the NICMOS image (old population). Spectral comparisons and IFU spectroscopy are being used to disentangle the history of star formation and structure assembly.

Hatch and collaborators also found that about 40% of the UV light from the Spiderweb is in a diffuse intergalactic component, probably produced by intergalactic star formation at rates of 60 solar masses per year. This discovery posed several questions. How ubiquitous is the extended light and what role does it play in massive galaxy evolution? Are extended stars produced by gas that has been stripped from the satellite galaxies?

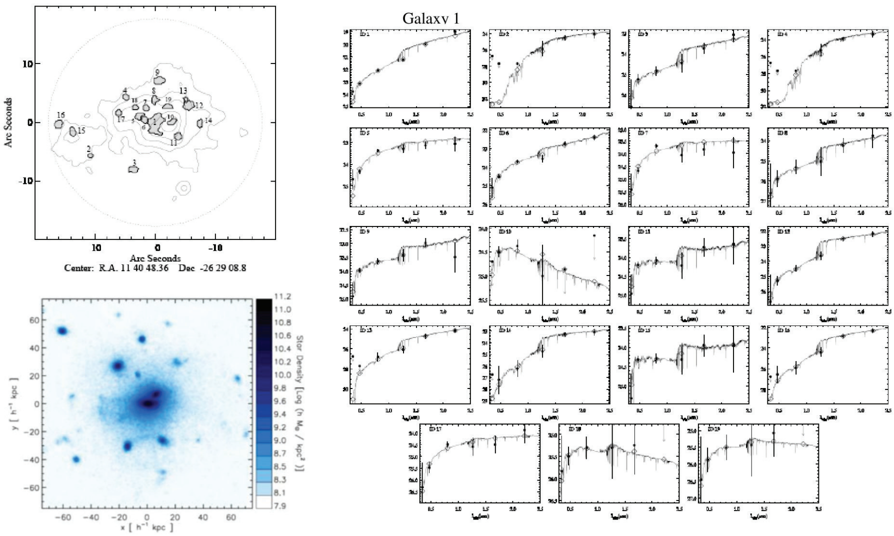


Figure 19. On the right are the spectral energy distributions of galaxies within the Spiderweb Galaxy according to the decomposition shown at the top lefl. The first SED is that of the central massive radio galaxy (Galaxy 1) and the other SEDs are those of 18 satellite galaxies. The derived mass of the Spiderweb is ~10^{M}, of which 70% is in the central object, whereas 75% of the star formation appears to occur in the less massive satellite galaxies. These data are presently being complemented by IFU spectroscopy. Bottom left is a simulation of the centre of the Spiderweb protocluster by Saro et al. for comparison.

2.8.8 Faint Submillimeter Galaxies

Van der Werf, Knudsen (MPIfR, Bonn, Germany) and Kneib (LAS, Marseilles, France) studied the molecular (CO) properties of intrinsically faint Submillimeter Galaxies, gravitationally lensed by the massive cluster A2218. With the Plateau de Bure Interferometer they detected CO J=2-1 and J=4-3 emission from two SMGs at redshifts z=1.034 and z=3.187. They used the measurements to estimate molecular gas masses and star formation efficiencies, the results being consistent with the local L(FIR)-L(CO) relation. One of the objects had the lowest far-infrared luminosity of all SMGs with a known redshift and is one of the few high-redshift LIRGs whose properties can be estimated prior to ALMA.

2.8.9 Massive starburst galaxies at redshift 2

Van der Werf also collaborated with a team led by Huang (CfA, Boston, USA) in a study of infrared colour-selected galaxies. The selection criteria efficiently isolated massive star-forming galaxies at a redshift of approximately 2. The fractional luminosity in Polycyclic Aromatic Hydrocarbon (PAH) features for the new sample is the highest ever seen, about three times higher than in local starbursts. HST images show that most objects have very extended morphologies in the rest-frame ultraviolet band. The resulting sample constitutes the first starburst-dominated ULIRG sample at high redshift with total infrared luminosity measured directly from FIR and millimeter photometry, and as such gives us the first accurate view of broadband spectral energy distributions for starburst galaxies at extremely high luminosity and at all wavelengths.

2.8.10 Lyman-BreakGalaxies at $3<z<5$

Hildebrandt and coworkers selected the largest samples of high-redshift ($3<z<5$) galaxies to date, using Lyman-break imaging data from the Canada-France-Hawaii-Telescope Legacy Survey. They measured the clustering of the ~80 000 star-forming galaxies to unprecedented accuracy which yielded estimates of the masses of the dark matter halos hosting those Lyman-break galaxies (LBGs). They used the same sample to establish a new observational technique of using weak gravitational lensing to study cosmology. They succeeded in detecting the cosmic magnification effect in the LBGs, the first time this was done with normal galaxies. This effect introduces characteristic angular cross-correlations between galaxies at low and at high redshift due to weak lensing by the foreground galaxies. Hildebrandt and coworkers showed that the signal scales with magnitude and redshift as expected from lensing theory (see Fig. 1).

2.8.11 Distant Galaxies and the Red Sequence

Damen, Franx, and collaborators found that the specific star formation rates of massive galaxies out to $z=3$ increases rapidly with redshift (roughly like $(1+z)^5$). The increase is similar for all masses, but galaxies with higher masses have lower average specific star formation rates. The observed high specific star formation rates lie well above the levels that can be reproduced by the current models for galaxy formation that generally predict specific star formation rates on the order of 1/t(hubble).

Williams, Quadri, Franx, and collaborators used the Ultra Deep Near-IR Survey and found that galaxies with little star formation can be identified in a red sequence out to $z=2$ by combining the near-IR photometry with optical and 3-5 micron photometry from the Spitzer Space Telescope. In the rest-frame U-V, V-J color-color diagram, the star-forming galaxies lie in an area different from the “quiescent galaxies”. This new diagnostic is confirmed by using the mid-IR emission at 24 micron, which shows strong emission from star-forming galaxies and none from the quiescent galaxies.

Holden (UC Santa Cruz, USA), Franx, and collaborators showed that early-type galaxies in high-z clusters have the same ellipticity distribution as early-type galaxies in clusters at low-z. This suggests strongly that the average bulge-to-disk ratio is rather similar, and does not evolve. It also indicates that earlier efforts in trying to distinguish ellipticals and S0s are not effective. Taylor, Franx, and collaborators showed that red galaxies can be identified out to a redshift of two. Although photometric errors hamper the definition of red sequence galaxies at z=2, it is likely that a significant fraction of massive galaxies were ''red" at that redshift.

2.8.12. Evolving Galaxies in the Distant Universe

Kriek (Princeton Univ., USA), Franx, and collaborators obtained a very deep spectrum of a compact, massive galaxy at z=2.1. The spectrum shows clear absorption lines, indicating a 2 Gyr old galaxy. The galaxy must have formed at significantly higher redshift. In addition, the galaxy had weak liner-like emission lines, indicating the presence of an AGN. Van Dokkum (Yale Univ. USA), Kriek, and Franx measured the velocity dispersion to be 510 +- 100 km/s. The error on this measurement is large but the galaxy clearly is truely massive, and lies far from the local mass-size or velocity dispersion – size relation.

Kriek, Franx, and collaborators presented high resolution imaging of z=2.3 galaxies with previously obtained rest-frame optical spectroscopy. There is a clear separation of galaxies into star-forming, large systems and compact quiescent systems showing that the equivalent of the Hubble Sequence is present at that redshift. Brammer (Yale Univ., USA), Franx, and collaborators used a new, medium band near-IR survey to derive very accurate photometric redshifts and rest-frame colors. The survey shows a distinct red sequence for the galaxies without star formation. These galaxies can be selected based on their spectral energy distributions, or based on the absence of mid-IR emission as measured by the Spitzer Space Telescope.

Bouwens (Univ of Santa Cruz, USA), Franx, and collaborators analyzed the properties of high redshift galaxies and found that high-z galaxies become bluer at higher redshift (from z=3 to z=7), and at lower intrinsic magnitude. The highest redshift galaxies are extremely blue, and hard to model. Muzzin (Yale Univ., USA), Franx, and collaborators found consistently high masses, independent of model assumptions used, for the very compact galaxies at z=2.3.

Hence it is very hard to explain their small sizes by postulating that their masses are overestimated by a large factor.

Marchesini (Yale Univ., USA), Franx, and collaborators studied the evolution of the stellar mass function from z=3.5 to low-z. They specifically studied the uncertainties due to random and systematic effects, including the effect of metallicity, extinction law, stellar population synthesis model, and initial mass function. They show that these uncertainties dominate all other uncertainties.

2.8.13 The LABOCA ECDFS Submillimeter Survey (LESS)

Van der Werf participated in a new large-area submillimeter survey that was carried out with the LABOCA 870 micron bolometer camera at the APEX telescope, by a team led by Smail (Durham, UK), Weiss (MPIfR, Bonn, Germany) and Walter (MPIA, Heidelberg, Germany). The LABOCA ECDFS Submillimetre Survey (LESS) covers the full 30' x 30' field size of the Extended Chandra Deep Field South and is thus the largest contiguous deep submillimeter survey undertaken to date. In total 126 SMGs were detected with a significance level above 3.7 sigma. The field is sufficiently large that it can be shown that the shape of the source counts is not uniform across the field. Instead, it steepens in regions with low SMG density. This survey also allowed an investigation of the clustering of SMGs in the ECDFS by means of a two-point correlation function, providing evidence for strong clustering on angular scales <1' with a significance of 3.4 sigma. Another result from this survey was the discovery of the most distant SMG known today with a spectroscopic redshift (z=4.76).

2.8.14 Weak Lensing in the COSMOS Field

Schrabback, Hoekstra, Kuijken, Hildebrandt, Semboloni, and Velander completed a comprehensive analysis of the large-scale mass distribution in the HST map of the COSMOS field, together with collaborators in the EU-funded DUEL network. A key development was the inclusion of accurate photometric redshifts for large numbers of galaxies, allowing a measurement of the evolution of the growth of large-scale structure and a 3-D tomographic lensing analysis. For the first time, they could show that the weak shear of distant galaxies scales with redshift as expected in the standard LambdaCDM model. This established the combination of weak lensing and photometric redshifts as a cosmological probe. The results of the 1.6-square degree survey confirmed the accelerated expansion of the universe, and demonstrated the potential of all-sky space-based weak lensing and photometric redshift surveys for precise measurements of the properties of the dark energy.

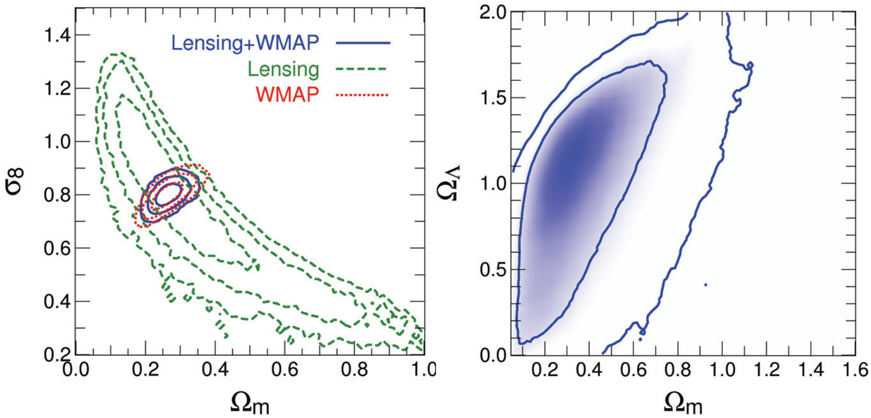


Figure 20. Constraints on cosmological parameters from our three-dimensional analysis of weak gravitational lensing distortions in the Hubble Space Telescope COSMOS Survey. The ontours indicate the 68%, 95% (and 99.7%) confidence regions. Left: Constraints on the matter density Omega$_m$ and amplitude of matter fluctuations sigma$_8$ for a standard, spatially flat Lambda-CDM cosmology. The COSMOS lensing constraints are nearly rthogonal and hence complementary to WMAP5 results from the cosmic microwave background. Right: Constraints on the density of matter Omega$_m$ and vacuum nergy Omega$_{Lambda}$ for a Lambda-CDM cosmology with curvature from COSMOS. From these constraints we compute a 96% probability for cosmic acceleration, providing further support for the presence of dark (or vacuum) energy.

2.8.15 Magnification Mapping of the Large-Scale Structure

From the 4 square-degree CFHTLS-deep survey, Hildebrandt and collaborators (including members of the Leiden lensing group led by Kuijken and Hoekstra) compiled a large sample of high redshift Lyman-break galaxies. They convincingly demonstrated that these sources are correlated with foreground galaxies, due to the magnifying action of gravitational lensing. Though the effect is statistically less powerful than weak shear measurements, it can be applied to distant unresolved galaxies and therefore provides a complementary way of measuring the matter distribution from gravitational lensing, particularly for sources at high redshift. The study also served as an excellent qualification of photometric redshifts, which are a crucial component of any future projects to probe the cosmological model using gravitational lensing.

2.8.16 Radio Haloes as Tracers of Cosmological Structure

Radio haloes provide one of the most important pieces of evidence for non-thermal components in large scale structure. Statistics of their properties can be used to discriminate among various models for their origin. Cassano, Brunetti (Bologna, Italy), Röttgering, and Brüggen (Bremen, Germany) carried out Monte Carlo simulations to model the formation and evolution of radio haloes in a cosmological framework. First, they computed the fraction of galaxy clusters that show radio halos and derived the luminosity function of radio halos. Then, they established differential and integrated number count distributions of radio haloes at low radio frequencies with the goal of exploring the potential of the upcoming LOFAR surveys. By restricting themselves to clusters at redshifts z<0.6, they found that the planned LOFAR all sky survey at 120 MHz may detect about 350 giant radio haloes.

2.9. Simulations, models, theory

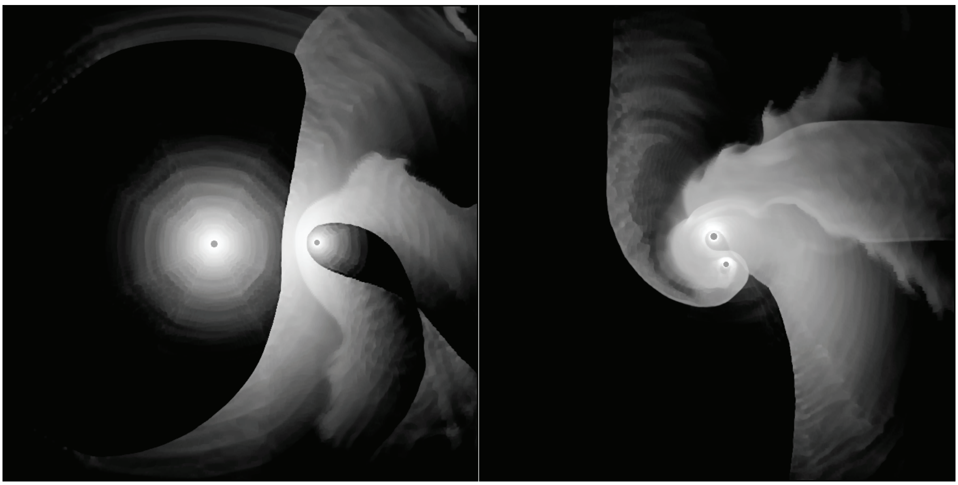


Figure 21. Logarithmic rendering of the gas density in a simulated massive binary star in which both components are losing mass. The orbital eccentricity is 0.8, the mass ratio 1/4. Left: gas density at apastron. Right: gas density just after periastron. Due to the high eccentricity, the double-discontinuity layer beteen the stars is pierced by both stars on their closest approach, producing a very intricate entanglement of intersecting shocks.

2.9.1 Double-Winds in Eta Carinae

Icke continued his exploration of the hydrodynamic behaviour of double-wind massive binaries, in preparation for his NWO project on the extreme binary star Eta Carinae. This system is one of the most complex and fascinating objects in our Galaxy: a supermassive interacting binary at the centre of a bipolar nebula expanding at about 500 km/s. The investigation aims at finding the mechanisms behind Eta Car's appearance and behaviour. Icke has already extensively explored the general types of flow pattern expected.

2.9.2. Pulsar Timing and Gravitational waves

Van Haasteren and Levin continued their work on Pulsar Timing Array (PTA) data analysis. They developed, together with McDonald and Lu (CITA, Toronto, Canada), a Bayesian analysis method to detect the stochastic gravitational-wave background, thought to be emitted by an ensemble of supermassive black-hole binaries in galactic centers. Application of the analysis method to data of the European Pulsar Timing Array has led to the determination of a gravitational-wave background upper limit. van Haasteren and Levin also showed that the general relativistic effect of gravitational wave memory can be used to detect physical mergers of supermassive black holes in distant galactic nuclei.

2.9.3 AMUSE: Astrophysics Multipurpose Software Environment

The core development team of AMUSE (Van Elteren, Pelupessy, Marosvolgyi and de Vries) released the first version of the AMUSE package for computational astrophysics. The initial release consisted of the basic framework and initial implementations of codes in the gravitational dynamics and stellar evolution domains. Later releases will also include support for hydrodynamics and radiative transport.

MUSE is a software framework for combining existing computational tools for different astrophysical domains into a single multiphysics, multiscale application and facilitates the coupling of existing codes written in different languages by providing inter-language tools and by specifying an interface between each module and the framework. This approach allows scientists to use combinations of codes to solve highly-coupled problems without the need to write new codes for other domains or significantly alter their existing codes. MUSE currently incorporates the domains of stellar dynamics, stellar evolution and stellar hydrodynamics for studying generalized stellar systems. MUSE treats multi-scale and multi-physics systems in which the time- and size-scales are well separated. The current MUSE code base is publicly available as open source at http://muse.li.

2.9.4 N-body simulations on Graphical Processing Units

Pelupessy has examined star formation and the evolution of the molecular gas phase using computer simulations. He developed a novel method to include the multiscale physics inherent in these processes into galaxy-scaled simulations. This new method reproduces fundamental relations between star formation, gas surface densities and observed molecular gas fractions.

Gravitational direct N-body simulations can be performed using the commercial NVIDIA GeForce 8800GTX Graphics Processing Unit (GPU). The force evaluation of the N-body problem is implemented in CUDA using the GPU to speed-up the calculations. Portegies Zwart and collaborators tested the implantation on three different N-body codes, two direct N-body integration codes, using the 4th order predictor-corrector Hermite integrator with block time-steps, and one Barnes-Hut treecode, which uses a 2nd order leapfrog integration scheme. The integration of the equations of motions for all codes was implemented in C on the host computer.

For simulations involving more than 512 particles the GPU outperforms the special purpose GRAPE-6Af, if some softening in the force calculation is accepted. Without softening and for very small integration time steps the GRAPE still outperforms the GPU. Portegies Zwart and co-workers concluded that modern GPUs offer an attractive alternative to GRAPE-6Af special purpose hardware.

2.9.5 Shock-Processing of PAHs

Micelotta, Tielens, and Jones (IAS, Paris, France) have studied the processing of large Polycyclic Aromatic Hydrocarbon (PAH) molecules in interstellar shocks and in the hot gas associated with supernova remnants. Their analysis used a detailed model of the physical interaction of energetic electrons and ions with large molecules and established PAH molecule destruction timescales of 100 million years in the interstellar medium. The widespread association of PAH emission with hot, X-ray emitting gas reveals the importance of neutral material entrainment by explosions and fast stellar winds. PAHs act thus as colorful dye markers for such phenomena.

Tielens collaborated with Boersma (RU Groningen), Allamandola, Bauschlicher (both NASA Ames Research Center, CA, USA), and Peeters (UNO) in a study of the emission characteristics of large PAH molecules at far-infrared wavelengths, using the NASA Ames data base of PAH infrared spectra. The results showed that the so-called drum head modes of PAHs are very characteristic of molecular size rather than molecular structure. Observations with the PACS instrument on board the Herschel Space Observatory are expected to provide key information on the population of large PAH molecules in space.

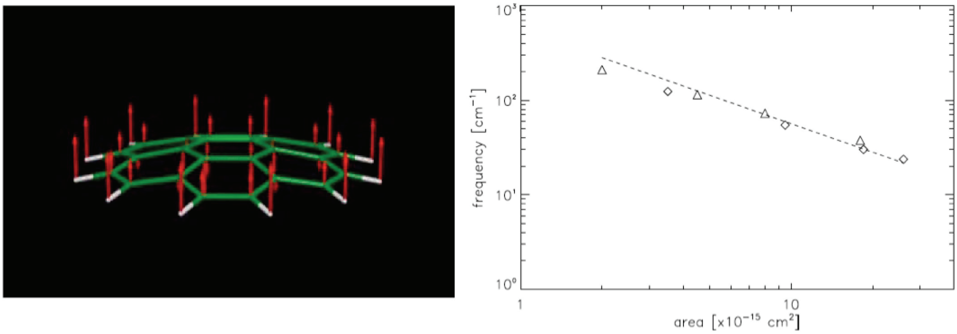


Figure 22. Left: A schematic illustrating the lowest frequency mode of the coronene molecule (C_24H_12). In this drumhead mode, all atoms are in a concerted motion. Right: The frequency of the drumhead mode as a function of the PAH area. Triangles and diamonds mark species of the pyrene-like and coronene-like families, respectively. Molecular sizes are in the range (16 to 130 C-atoms) that is thought to dominate the interstellar PAH family. The dashed line indicates the frequencies expected for an unclamped drum with a rigidity characteristic of PAHs.

2.9.6. Diagnosing the Excitation of Extragalactic Ionized Gas.

Groves created a new emission line tool for diagnosing the excitation mechanism of ionized gas in galaxies. His code, named ITERA (IDL Tool for Emission-line Ratio Analysis) enables users to compare observed emission line ratios with existing libraries of photoionization and shock models, involving supernova, AGN and starforming regions. ITERA was put publicly on-line at http://www.brentgroves.net/itera.html. In addition, his on-going work with Jonsson (CfA, Harvard, USA), included the implementation of his star formation region SEDs in a pre-existing 3-D radiative transfer code (SUNRISE). The code can be applied to hydrodynamical simulations of galaxies creating full UV-to-IR spectra of both quiescent and merging galaxies viewed at any inclination, on either global or kiloparsec scales.

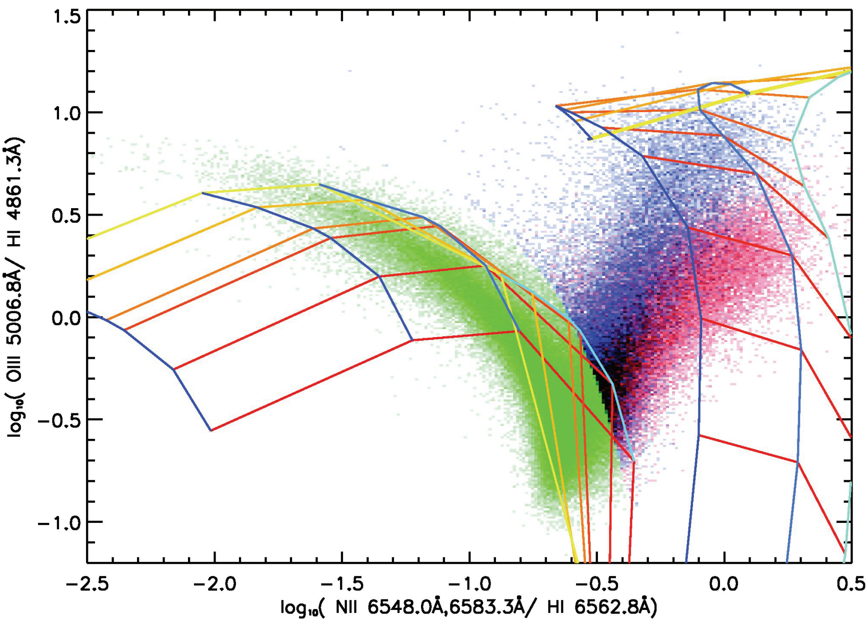


Figure 23 Emission-line diagnostic diagram form ITERA, showing Starburst (left grid) and AGN (right grid) models overlaying the distribution of emission-line galaxies from SDSS.

2.9.7. SIMPLEX and Cosmic reionization

Paardekooper developed a transport scheme for the SimpleX radiative transfer method that ensures correct photon transport in the low optical depth regime. This new transport scheme shows the results of standard test problems to correspond much better with the analytical solution (if available) and the results of other, more conventional radiative transfer methods. At the same time, the advantages of SimpleX remain, such as the high computational speed and the independence on the number of sources thereof. Paardekooper then used SimpleX to study the escape fractions of ionizing photons from high-redshift dwarf galaxies, which is an important parameter in models of cosmic reionisation. By post-processing dwarf galaxy models with realistic supernova and stellar wind feedback and star formation, Paardekooper and Pelupessy showed that high-z dwarf galaxies played an important role in early stages of cosmic reionisation.

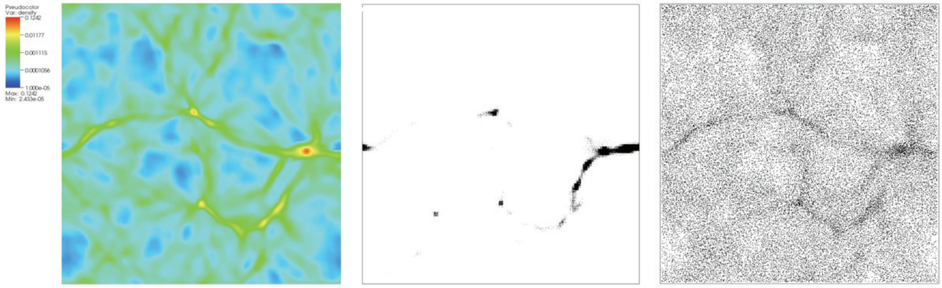


Figure 24. Translation from a density field to a representative point set of 1 10^5 points. Left panel: cut through a cosmological density field; colours indicate number density on a logarithmic scale. Middle panel: Using a sampling function that results in a linear scaling of the point-to-point distance with the mean free path of the photons. Right panel: Using our improved sampling function that incorporates information about the grid in order to get a point set optimized for SimpleX.

Kruip devised a method to translate density/opacity fields from hydrodynamical simulation to an unstructured Delaunay grid optimized for the SimpleX radiative transfer method. Such a scheme paves the way to the coupling of SimpleX to hydrocodes. He also implemented multi-frequency support in SimpleX and substantially extended the physics module of the method.

2.9.8. Photo-ionization and Cooling Rates of Astrophysical Plasmas

Wiersma, Schaye, and Smith (Univ. Colorado, USA) investigated the effects of photo-ionization of heavy elements by the meta-galactic ionizing background and those of variations in relative abundances on the cooling rates of optically thin gas in ionization equilibrium. They found that photo-ionization by the background radiation strongly reduces the net cooling rates at gas densities and temperatures typical of the shock-heated intergalactic medium and of proto-galaxies. They concluded that both photo-ionization by the ionizing background and heavy elements need to be taken into account in order for cooling rates to be correct within an order of magnitude, and that more accurate rates require departures of the relative abundances from solar to be taken into account.

2.9.9. Keeping the Universe Ionised

Pawlik, Schaye, and Van Scherpenzeel conducted a suite of cosmological simulations to calculate the clumping factor of the IGM at redshifts z >>= 6. The critical star formation rate density required to keep the intergalactic hydrogen ionised depends crucially on the average rate of recombinations in the intergalactic medium (IGM), which is proportional to this clumping factor. They found that photo-ionization heating by the ultraviolet background strongly reduced the clumping factor as the increased pressure support smoothed out small-scale density fluctuations, making it easier to keep the universe ionised. They also found that the observed population of star-forming galaxies at z ~ 6 is sufficient to keep the IGM ionized if it was reheated at redshifts earlier than z = 9 and the fraction of ionizing photons escaping star-forming regions to ionise the IGM exceeds 0.2.

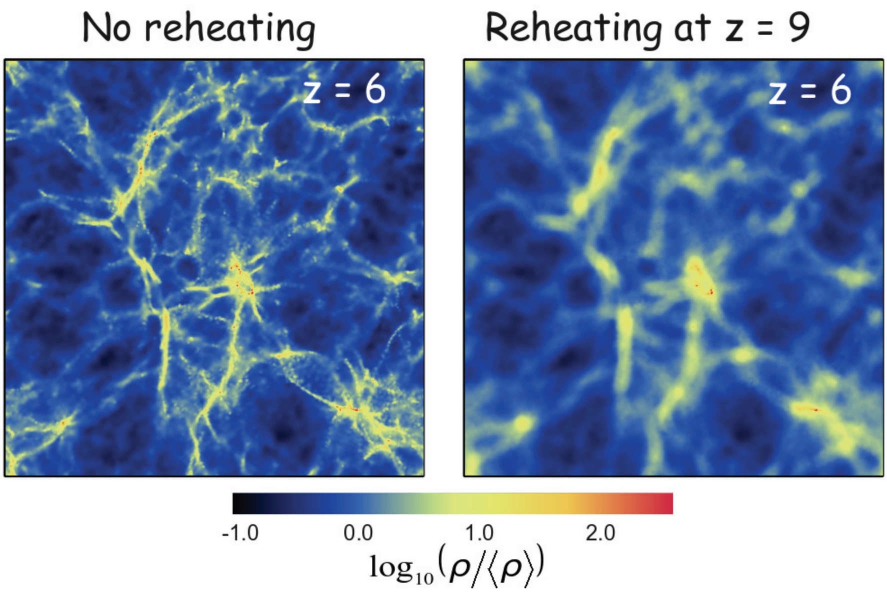


Figure 25. The effect of photo-heating on the gas density distribution of the intergalactic medium at redshift z=6. The figure shows the gas density contrast in a slice of comoving 3.125 Mpc/h on a side through a hydrodynamical simulation at redshift z = 6. The simulation on the left did not include reionization, while for the one shown on the right the ionizing background radiation was turned on at z = 9. The reheating associated with reionization strongly suppresses the clumpiness of the intergalactic medium. The associated reduction of the recombination rate strongly reduces the star formation rate required to keep the universe ionized.

Pawlik and Schaye investigated the interplay between photo-heating associated with cosmic reionization and kinetic feedback from core-collapse supernovae in a set of cosmological simulations. They showed that photo-heating and supernova feedback mutually amplify each other's ability to suppress the high-redshift cosmic star formation rate.

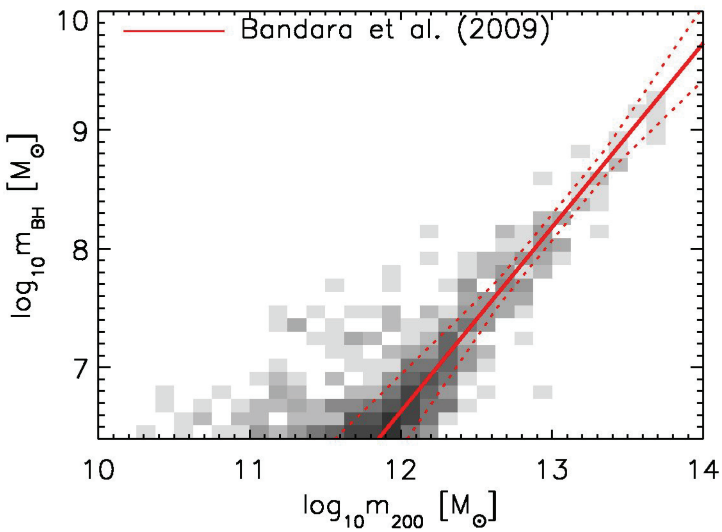


Figure 26. The relation between black hole mass and dark matter halo mass. The grey pixels show the simulation predictions. The solid, red line withj a slope of 1.55 marks the observational determination of the M_{BH} vs M_{Halo} relation. The dotted, red lines show the observational 1-sigma errors. The slope and its scatter suggest that halo binding energy rather than halo mass determines black hole masses.

2.9.10 SuperMassive Black Holes and Feedback from AGNs

Booth and Schaye presented a method that self-consistently tracks the growth of supermassive black holes (BHs) and the feedback from active galactic nuclei (AGN) in cosmological, hydrodynamical simulations. Because cosmological simulations at present lack both the resolution and the physics to model the multiphase interstellar medium, they tend to strongly underestimate the Bondi-Hoyle accretion rate. To allow low-mass BHs to grow, it is therefore necessary to increase the predicted Bondi-Hoyle rates in star-forming gas by large factors. Booth and Schaye found that the freedom introduced by the need to increase the predicted accretion rates by hand, is the most significant source of uncertainty in the model. Their simulations demonstrated that supermassive BHs are able to regulate their growth by releasing a fixed amount of energy for a given halo mass, independent of the assumed efficiency of AGN feedback, which sets the normalization of the BH scaling relations. They further showed that, regardless of whether BH seeds are initially placed above or below the BH scaling relations, they grow on to the same scaling relations. Finally, they demonstrated that AGN feedback efficiently suppresses star formation in high-mass galaxies.

2.9.11 Formation of High-Redshift SuperMassive Black Holes

Schleicher, Spaans and Glover examined the chemical conditions for black hole formation in massive primordial galaxies at $z>10$. They focussed on the effects of Lyman-alpha trapping and photo-dissociating radiation from nearby galaxies. They found that the combination of these effects can keep the primordial gas at temperatures larger than 5000 K during the collapse, which may give rise to large accretion rates on the central clump. However, as the temperature slightly decreases with density, fragmentation cannot be totally suppressed. The formation of a central clump may thus be accompanied by a nuclear starburst.

2.9.12 Chemical Enrichment in Cosmological Simulations

Wiersma, Schaye, Theuns (Durham, UK), Dalla Vecchia, and Tornatore (Trieste, Italy) presented an implementation of stellar evolution and chemical feedback for smoothed particle hydrodynamics simulations. They considered the timed release of individual elements by both massive (Type II supernovae and stellar winds) and intermediate-mass stars (Type Ia supernovae and asymptotic giant branch stars). A comparison of nucleosynthetic yields taken from the literature indicated that relative abundance ratios may be reliable only to factors of two, even for fixed initial mass functions. Abundances relative to iron were found to be even less certain as Type Ia supernova rates are poorly known. Wiersma et al. investigated, using several large simulations, the evolution of the distribution of heavy elements and found them to be in reasonably good agreement with observational constraints. In the local universe, most of the metals are locked up in stars. The gaseous metals are distributed over a very wide range of densities and temperatures. The shock-heated warm-hot intergalactic medium has a relatively high metallicity of 0.1 solar that evolves only weakly. It is therefore an important reservoir of metals. Any census aiming to account for most of the metal mass will have to take a wide variety of objects and structures into account.

2.9.13 How to Study X-Ray Dominated Regions with ALMA

Schleicher, Spaans and Klessen looked into the possibilities of detecting the central X-ray-dominated regions (XDRs) of high-redshift quasars with ALMA. They showed that the expected sensitivity and angular resolution of ALMA should be sufficient to detect and at least marginally resolve such XDRs. The XDRs can be distinguished from starbursts on the same spatial scales by using the CO line transition ladder. Schleicher and colleagues estimated the expected CO line fluxes, as well as various fine-structure lines, illustrating their dependence on X-ray luminosity, cloud column density and gas volume density. They compared their models to observations of local and high-redshift objects such as NGC 1068, APM 08279 and SDSS J114816.64+525150.3. They found that both a cold low-density component and a warm high-density component were required to explain the observed line fluxes of the latter.

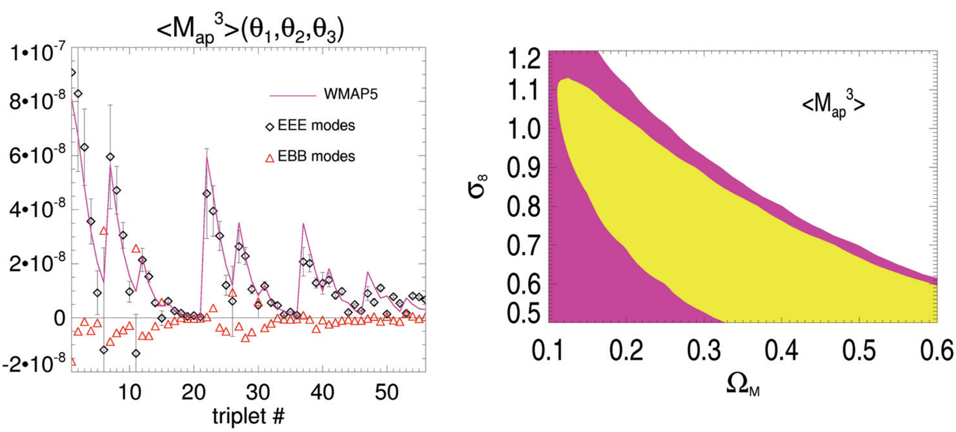


Figure 27. Left: The third-order moment of the aperture mass statistics in the COSMOS galaxy catalogue. The black squares show the amplitude of the cosmic shear signal whereas the red triangles show the amplitude of the non-gravitational shear component, which should be zero. The pink solid line shows the amplitude of the third-order aperture mass statistics for a WMAP5 best-fit cosmology. The agreement between the WMAP5 best-fit model and the measured signal is remarkable. Right: Likelihood analysis performed using the third-order moment of the aperture mass statistics. The yellow (pink) region indicates the 68% (95%) confidence region of the value for the matter parameter, Om and the amplitude of the power spectrum of matter fluctuations, s8

2.9.14 Cosmic Shear

Semboloni, Sanaz Vafaei, and Van Waerbeke (both UBC, Vancouver, Canada) have been working on the potential of three-point cosmic shear statistics measurements. These are a powerful tool to investigate the evolution of the power spectrum of matter fluctuations on strongly non-linear regime and they can provide competitive constraints on cosmological parameters. Semboloni has recently completed the first three-point cosmic shear analysis using data from a galaxy catalogue produced by Schrabback, who was able to estimate highly accurate galaxy shapes in COSMOS images.

2.10 Instruments and facilities

2.10.1 The Low-Frequency Array (LOFAR)

LOFAR is a next-generation radio telescope that will observe in the frequency range of 10 to 240 MHz, presently being built by a Dutch consortium led by ASTRON. At the end of the year, hardware of 20 stations had been placed in the fields and connected to the central processor. Rollout of the LOFAR international stations also made excellent progress with the Effelsberg station coming fully on-line and the Tautenburg and Unterweilenbach stations only awaiting HBA tiles. In parallel with the station rollout, deployment of the first phase of LOFAR dedicated processing hardware was completed. This provided 10 TFLOPS of processing power and 2 PB of storage space. A first version of the LOFAR imaging pipeline was installed on the new hardware and started to be used to support commissioning activities.

The Leiden LOFAR survey team (Röttgering, Miley, Snellen, Mohan, Birzan, Rafferty, van der Tol, Intema, van Weeren, and van Bemmel) concentrated on (i) testing and commissioning of LOFAR data, (ii) building software for the source extraction and characterization and for simulation of the LOFAR sky and (iii) ionospheric calibration. Birzan, Rafferty and van Weeren were deeply involved in taking and reducing first LOFAR data and testing the BSS reduction pipeline (Figure below). While Birzan concentrated on reducing VLA data with BBS as a test of the software system, Rafferty worked on comparing the various methods to deal with Radio Frequency Interference. Mohan worked on his source extraction pipeline. The methods are now sufficiently robust that they deliver science quality source lists. Intema and Van der Tol designed and tested a method to take out ionospheric disturbances from low-frequency radio data on the basis of a 2-D ionospheric model. Extensive testing on VLA 74 MHz data showed improvements of up to a factor of 2 in dynamic range over classical methods.

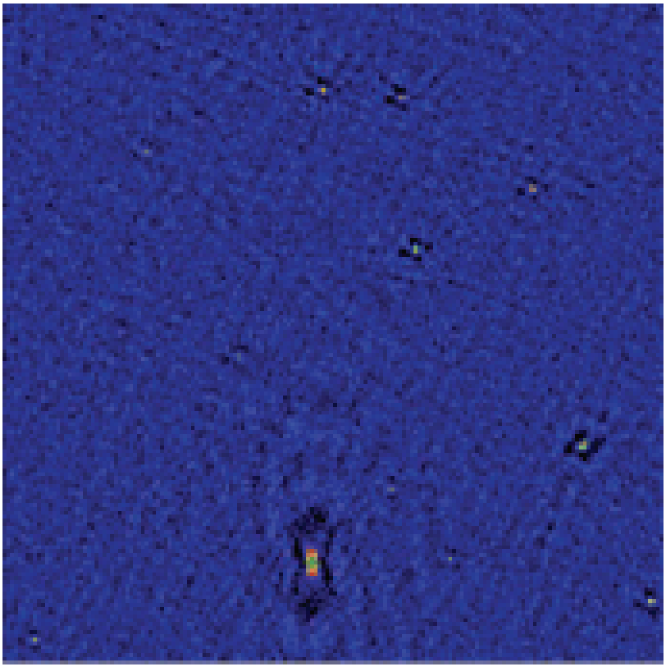


Figure 28. Part of an image of the field of 3C196 obtained with five stations. The observations were made with a 24 MHz bandwidth spread over a 30-75 MHz frequency range. The full field of view is ~ 6 x 3 degrees of which only 20% is shown here.

In collaboration with the MeqTree team at ASTRON, Van Bemmel has developed the SimCa module to simulate the impact of ionospheric turbulence and waves on LOFAR observations. Under average ionospheric conditions, coherence is lost below 15 MHz. This implies that observing at low frequencies is only possible under excellent ionospheric conditions. Van Bemmel also tested the LOFAR pipeline software (BBS) in simulations. This uncovered some interesting and not yet understood behaviour in the package, demonstrating the power of using simulated data for software testing.

Cohen (NRL, Washington, USA) and Röttgering used data from the nearly complete 74 MHz VLS Survey of the entire sky visible to the VLA telescope in Socorro, New Mexico to study the the impact of the ionosphere on low-frequency radio observations. They obtained a detailed characterisation of the dependence of the median differential refraction on source pair separation, elevation, and time of day.

They found large, but geometrically predictable at elevation effects that can be removed analytically with a 'thin-shell"'model of the ionosphere. They also noted significantly greater ionospheric spatial variations during the day than at night. The diurnal variations appeared to affect the larger angular scales to a greater degree indicating that they are caused by disturbances on relatively large scales (hundreds, rather than tens of kilometres).

2.10.2 ALLEGRO: the ALMA Regional Center Node in the Netherlands

The year 2009 has been pivotal in the construction of ALMA, the Atacama Large Millimeter / Submillimeter Array. In Chile, aantenna assembly progressed steadily, and the first three antennae arrived at the Llano de Chajnantor. All receiver bands have seen first light on the sky, and three-element interferometry was established by the end of the year. At Leiden Observatory, the ALMA Regional Center node (Allegro, ALMA Local Expertise Group) led by Hogerheijde took further shape with a grant for long-term funding from NWO, and the hiring of Brinch as Allegro postdoc. In addition to contributions to testing of the ALMA software, Allegro has focused on the use of the expanded-SMA as a testbed for submillimeter interferometry and the use of the CHAMP+ receiver on APEX for exploring the submillimeter sky. CO line measurements of a sample of AGB stars have been performed with this instrument, and analysed to form a calibration set for ALMA.

2.10.3 The expanded Submillimeter Array (eSMA)

The eSMA combines the dishes of the SMA, JCMT and CSO on the summit of Mauna Kea (Hawaii, USA) into a single facility, providing enhanced sensitivity and spatial resolution owing to the increased collecting area at the longest baselines. Until ALMA early science observing (2011), the eSMA will be the facility capable of the highest angular resolution observations at 345 GHz. In 2009, development of the eSMA progressed toward making it a working interferometer, involving Tilanus (JCMT), van Langevelde, Hogerheijde, and Van Dishoeck, together with colleagues from SMA and CSO. Successful science demonstration observations were obtained, followed by numerous tests of the receivers and correlator to fully characterize the interferometer and its sensitivities. The science demonstration observations included imaging of the protostellar binary IRAS 16293-2422, resolving its component A into multiple sources of emission of continuum and warm methanol. In contrast, its component B, while clearly resolved by these high angular resolution data, remains a single source, and exhibits remarkable absorption of the same methanol lines.

2.10.4 VLTI: MIDI and Matisse

Jaffe continued his work on midInfrared interferometric observations of AGNs with the VLTI instrument MIDI in collaboration with Raban and Röttgering, as well as colleagues at MPIA Heidelberg and Bonn (Germany), and NRAO (USA). Their most important result was a demonstration of the extreme irregularity of the dust structures around the nearby Seyfert galaxy NGC~1068. These irregularities are indirect but strong proof of the clumpy nature of the dust.

Jaffe is also the Dutch PI for the instrument MATISSE, which has been accepted as a second generation VLTI instrument by ESO. The ESO council and the team agreed on the GTO allocation to the consortium upon completion. The Cold Optical Bench for MATISSE will be built in Dwingeloo. Jaffe is on the Science Team and the Instrument team with special responsibility for real-time data processing and polarization characterisation. MATISSE should be at Paranal, Chile in 2014.

Figure 29. AM1 under test at AMOS, the manufacturer of AM1. Shown is AM1 after its spherical lapping. In its final shape, AM1 will be an 1.7-meter aspherical mirror with a standard aluminum coating.

2.10.5 VLT: MUSE and ASSIST

MUSE, the Multi Unit Spectroscopic Explorer is a second generation instrument for the VLT, featuring Wide-Field, Adaptive Optics Assisted Integral Field Spectroscopy. MUSE passed its final design review and is currently being manufactured by a number of European companies. Integration will to start in mid-2010. The MUSE consortium consists of 7 institutes and is lead by the Observatory of Lyon. NOVA, by way of Stuik at Leiden Observatory, is mainly involved in the interface between MUSE and its Adaptive Optics system (GALACSI), the preparations for scientific operation of MUSE--like the

Exposure Time Calculator (ETC) and Operation, Calibration of MUSE and the MUSE observation templates efforts led by Serre--and the MUSE science team.

ASSIST--the Adaptive Secondary Setup and Instrument STimulator is the test system for the VLT Adaptive Optics Facility (AOF) and will allow for verification of the operation of the various hardware and software systems for the AOF without the need for--sometimes long--on-sky testing. ASSIST, as currently being developed by Deep, Stuik and Wiegers has passed its Final Design Review and is currently being manufactured. The main optical components were well under way at the end of 2009 and the mechanical components will be ordered in early 2010, in time for the integration of the main components by the end of 2010.

2.10.6 KiDS: Studying Dark Matter with Light Rays

Kuijken continued his role as P.I. of the KiDS project, a large collaboration of nine European institutes that will map 1500 square degrees of sky in good seeing conditions with OmegaCAM on the VST in Paranal, in order to find gravitational lenses. Weak gravitational lensing can be used to study the mass distribution around galaxies and on larger scales. Unfortunately the telescope construction has been long delayed, with start of operations considered likely only in 2010 at the time of writing. Over 2009, preparations for KiDS continued in the form of algorithm development for multi-colour photometry and for weak lensing measurement. Members of the KiDS team were also involved in the analysis of the Canada-France-Hawaii Telescope Legacy Survey (CFHTLS), currently the most powerful data set for weak lensing measurements. It comprises 170 square degrees of sky imaged in five bands. The CFHTLS analysis made it possible to identify and address various systematic effects that plague the measurements.

2.10.7 E-ELT-METIS

Brandl, Stuik, Molster, Kendrew, van Dishoeck and van der Werf worked on the conceptual study of METIS - the Mid-Infrared E-ELT Imager and Spectrograph. With a mirror diameter of 42 meter, the European Extremely Large Telescope (E-ELT) project aims to provide European astronomers with the largest optical-infrared telescope in the World. METIS is a combined imager and spectrometer, working in the thermal/mid-infrared wavelength range from 3 to 14 microns. The design has been derived in collaboration with the instrumentation group at NOVA ASTRON, and partners at MPIA (Germany), CEA Saclay (France), KU Leuven (Belgium) and ATC (UK). The work was performed for ESO as a phase-

A study for an early E-ELT instrument. The figure below shows an artist conception of METIS on the E-ELT instrument platform.

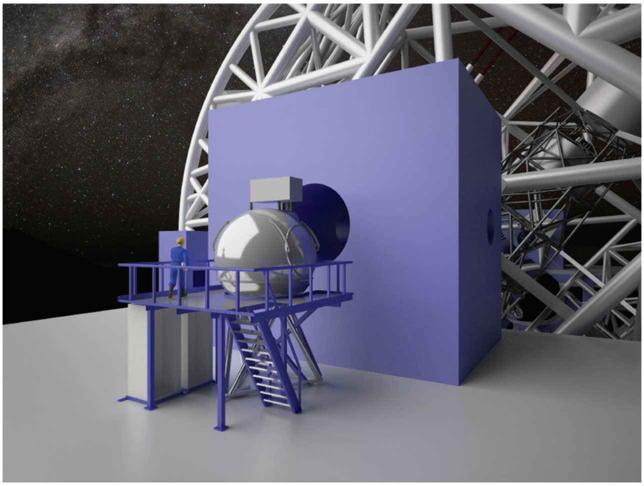


Figure 30. Artist impression of METIS on te ELT.

2.10.8 GAIA

The Leiden Gaia group, led by Brown, is involved in the preparations for the data processing for ESA's Gaia mission. Scheduled for launch in 2011, Gaia aims at providing a stereoscopic census of the Milky Way galaxy by measuring highly accurate astrometry (positions, parallaxes and proper motions), photometry and radial velocities for one billion stars and other objects down to 20th magnitude.

In the past year, Brown, Busso, and Marrese continued their work on the development of the data processing software for the photometric instrument of Gaia in collaboration with groups in Rome, Teramo, Cambridge, and Barcelona. The photometric data for Gaia will be collected through low dispersion spectrophotometry with prisms and the group in Leiden is responsible for developing the algorithms that extract the spectra from the raw data. A first version of the processing algorithms developed in Leiden, Rome, and Teramo were successfully integrated into the pipeline running in Cambridge and a test of the algorithms on a 30 million star data set was run without significant problems. Busso and Marrese completed a number of upgrades, related in particular to the crowded field treatment, to the data processing algorithms. Brown implemented a simplified version of some of the algorithms developed in

Leiden in the initial data treatment pipeline. The latter is the data processing system that first receives the raw telemetry from Gaia and carries out important pre-processing steps for which photometric information is needed.

Prod'homme addressed a major concern for the Gaia mission, the effect of radiation damage to the CCDs (due to Solar wind and cosmic ray protons) by conducting theoretical and empirical modeling of radiation damage effects. These would lead to an increased level of charge transfer inefficiency causeing a loss of signal as well as a distortion of the image. The latter will produce systematic errors in the astrometry if not carefully controlled. Prod'homme uded the CTI modelling tool CEMGA (CTI Effects Model for Gaia), developed by himself, to analyze laboratory test data from EADS-Astrium in order to probe the detailed physics of CTI. In addition, he used CEMGA to determine whether the Cramer-Rao limit on the precision of the estimated location for stellar images can still be reached in the presence of CTI. De Valk also used CEMGA, to study the effect of CTI on the weak-lensing survey planned for the proposed EUCLID space mission. The results were not conclusive but do indicate a need to carefully consider this issue for EUCLID. Ter Haar studied the variance in the CTI effects caused by the different orientations of the Gaia CCDs with respect to the same field on the sky over the course of the mission. The results confirmed the idea that the details of the so-called illumination history of the CCDs play an important role in the systematic errors induced in the Gaia measurements. Finally, Prod'homme also completed a first validation study of an approximate but fast analytical model of CTI effects. This kind of model will be needed in the Gaia data processing for which the detailed Monte Carlo model developed by Prod'homme is too slow.

Risquez has been developing detailed simulations of Gaia's attitude, incorporating all of the relevant physical effects, in collaboration with van Leeuwen (Cambridge, UK) and Keil (Bremen, Germany. In order for Gaia to reach its astrometric accuracy goals, the highest quality for the attitude knowledge of the spacecraft is needed. It is thus important to incorporate a complete physical understanding of the dynamics of a continuously rotating space platform into the attitude modelling for Gaia. Risquez completed the development of several modules that simulate specific physical effects in the spacecraft attitude. These include: micro-meteoroid impacts, thermal infra-red emission from the satellite surface, and noise due to the micro-propulsion system. In addition, he implemented a model of Gaia's star-tracker and the on-board estimator of stellar image velocities in the focal plane (which serve as input to the on-board attitude control system).

2.10.9 JWST-MIRI Testing

The mid-IR Instrument (MIRI) for the James Webb Space Telescope approaches Flight Model (FM) Testing, preparing for a 2014 launch. As part of their contribution to the MIRI Test Team, Martinez Galarza, Kendrew and Brandl have analyzed a first set of data obtained using the Verification Model and developed a method to measure the wavelength characterization of the instrument's medium resolution IFU spectrometer (MRS) and low resolution slit spectrometer (LRS). Comparison with optical models has shown that the actual resolving power satisfies the requirements. Further analysis of FM data will allow a full wavelength range characterization and a study of the unresolved line profiles prior to delivery to NASA in early 2011.

2.11 Astrochemistry

2.11.1 Interstellar molecules formed on grains

Cuppen studied the formation of methanol (CH_3OH) and its precursor formaldehyde (H_2CO) in dense cold cores. Many important molecules do not form efficiently in the gas phase in the cold, dilute interstellar medium. Instead, they require dust surfaces for their formation, but the detailed processes are still unclear. Laboratory experiments provide ways to study these, but the results are not always straightforward to interpret and the experiments themselves are performed under conditions that still differ much from interstellar conditions. Monte Carlo has been used successfully to disentangle the various mechanisms and to extrapolate results to interstellar conditions, for instance in the case of H_2, H_2O and CH_3OH.

Cuppen conducted Monte Carlo simulations under a variety of conditions and showed that both CH_3OH and H_2CO indeed form efficiently in cold dense insterstallar cloud cores and in the cold outer envelopes of young stellar objects. She discovered that dust grain mantles have a layered structure with CH_3OH on top, whereas molecular species such as CO and H_2CO exist mainly in the lower layers of ice mantles where they are not available for later hydrogenation. Her findings differ from many gas-grain models which do not take into account the layering of the ice. She found her model results to agree reasonably well with observed solid H_2CO/CH_3OH and CO/CH_3OH abundance ratios in the outer envelopes of young stellar objects agree, and she concluded that the large range in observed CH_3OH/H_2O abundance ratios may represent a range in evolutionary stages.

2.11.2 Simulations of Ice Photo-Dissociation

Arasa, Andersson, Cuppen, Kroes and van Dishoeck used classical molecular dynamics simulations at different ice temperatures to clarify the photo-desorption of water molecules in amorphous ice H photo-desorption provides the most important channel in the uppermost ice layers, with probabilities a hundred to a thousand times higher than those of OH and H_2O photo-desorption. It does not show a dependence on ice temperature. Arasa and collaborators also compared the estimated total $OH+H_2O$ photo-desorption probability per incident photon to the experimental yields measured by Oberg. The experimental yields exceeded the theoretical probabilities by factors of 3-6. Nevertheless, Arasa and coworkers concluded that, given the experimental uncertainties and the theoretical approximations, the simulations agreed reasonably well with the experimental results which are also typical for those used in modelling astrophysical environments.

2.12 Raymond and Beverly Sackler Laboratory for Astrophysics

Figure 31. The Sackler Laboratory

2.12.1 Laboratory Experiments

Conditions in space are extreme and not in favour of an efficient chemistry: temperatures are low, radiation fields are intense and particle densities are exceedingly low. Nevertheless, more than 150 different molecular species have been identified in star-forming regions. These comprise both simple and complex species as well as both stable and transient molecules and result from exotic chemical evolution. Today, astrochemists explain the chemical complexity in space as the cumulative outcome of gas, grain and gas-grain interactions. Gas-phase models explain the observed abundances of the smaller as well as many of the larger radical species. These models, however, fail to explain the presence of stable and complex, partially organic species in space, such as acetonitrile, a precursor molecule for the simplest amino acid glycine. It is now generally accepted that such species form on icy dust grains, small solid particles that are an important ingredient of the material found between the stars. These dust particles play an essential role because they provide opacity (blocking regions of the galaxy from UV radiation). They are also the basic material that form icy planetesimals and ultimately planets and they provide catalytic sites for molecule formation. Thermal and ultraviolet processing as well as atom bombardment of icy dust grains trigger a fascinating solid state astrochemistry. Understanding the cycle of matter in galaxies, the origin of stars and planetary systems and the complex (organic) chemistry that is found in molecular clouds and proto-planetary disks is intimately linked to the study of the role icy solids have in space. A quantitative characterization of this role is only possible through detailed laboratory studies and this is the research topic of the work performed at the Sackler Laboratory for Astrophysics. The focus of the past year has been 'Molecular Complexity in Space'.

2.12.2 UV Photo-Processing of Interstellar and Circumstellar Ice Analogues

In September, Öberg defended her thesis 'Complex Processes in Simple Ices' describing UV-induced processes in ices under astronomical conditions: the photo-desorption and photo-dissociation as well as the photo-chemistry of ices (H_2O, CO_2 and CH_3OH) upon UV irradiation. Her detailed analysis showed UV-processed methanol ice to provide the basic elements for complex molecule formation, as observed around young stellar objects. Öberg's work at the setup CRYOPAD was continued by Fayolle who will focus on photo-induced processes upon resonant ice excitation.

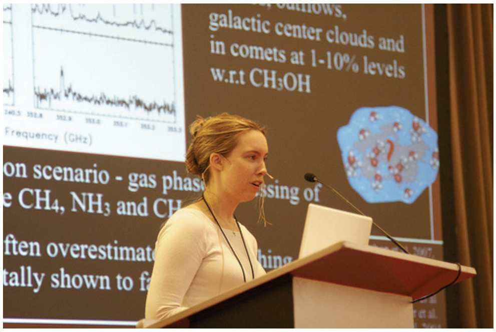


Figure 33. Karin Öberg addresses her favourite topic.

The team around the setup CESSS (Bouwman, Allamandola and Cuppen) has been able to study the photophysical and photochemical behaviour upon UV irradiation of polycyclic aromatic hydrocarbons included in an astronomical water ice analogue. In situ and real time optical data provided insight in the role PAHs play in the solid state and in addition provided an alternative route to search for PAHs in space.

2.12.3 Atom Bombardment of Interstellar and Circumstellar Ice Analogues

The team around the SURFRESIDE setup (Ioppolo, Romanzin, Cuppen) focused on water and methanol formation by hydrogenation reactions of oxygen/ozone and carbon monoxide ice, respectively. They derived temperature-dependent and flux-dependent reaction rates that elucidated the role of solid state reaction schemes in the formation of water and methanol in space and extended the results to astrochemical models. In parallel, they constructed a next generation setup constructed which will allow them to study the simultaneous processing of ices by H- and O/N-atoms.

Isokoski constructed a new ultrasensitive setup, MATRI2CES, with which to test the influence of simultaneous UV irradiation and atom bombardment of an interstellar/circumstellar ice analogue. The setup combines laser desorption and time-of-flight detection and is expected to visualize chemical pathways towards molecular complexity in much more detail than possible with the regular UHV RAIRS and TPD techniques.

2.12.4 Molecular finger prints

Bottinelli, Bouwman and Beckwith made detailed ice spectroscopic measurements on NH_3 and CH_3OH containing ices in order to identify molecular signatures in recent Spitzer data. They found an unambiguous presence in space of ammonia in the solid state. This was an important result, as nitrogen-containing species are required in formation routes towards biologically relevant species.

Wehres was able to measure vibronically excited C_2 spectra on the LEXUS setup and to compare these to emission features observed in the nebula known as the Red Rectangle. Her laboratory data proved the presence of C_2 in the outflows of this proto-planetary nebula and also offered an analytical tool to describe chemical processes as a function of the separation from the central star.

Finally, Guss has started to construct a new infrared laser detection scheme for molecular transients in space on the setup SPIRAS. A cavity-enhanced detection scheme, in combination with a planar plasma expansion, is used to search for molecular fingerprints of transient species as may be detected by e.g. the HIFI experiment on the Herschel Space Observatory

Chapter 3

Education, popularization and social events

Education, popularization and social events

Chapter 3

3.1. Education

Education and training of students is a major priority of Leiden Observatory. In 2009, 46 freshmen started their studies in astronomy. Of this number, 10 (22%) are women, and 19 (41%) is pursuing a combined astronomy/physics or astronomy/mathematics degree.

The Observatory registered a total number of 92 bachelor students at the end of the year, including 42 (46%) aiming for a combined astronomy/physics degree. A quarter of all BSc students is female. There were 36 MSc students, including 14 (39%) women and 12 (33%) foreign nationalities. In addition, there were still two old-style doctoral students. Several students from the applied physics department of Delft Technical University took courses of the Leiden astronomy curriculum as part of the requirements for a minor in astronomy.

Twenty students passed their propedeutical exam, of which fully half completed the requirements in the nominal one year. There were 10 BSc exams, and 7 MSc exams. In addition, 4 students obtained the old-style degree of doctorandus.

At the beginning of the year, three staff members were acting part-time as study advisers. However, Hogerheijde stepped down as freshman-student adviser in summer. His tasks were taken over by Linnartz, who already was the study adviser for the remainder of the Bachelor program. Portegies Zwart took over from Röttgering as master-program study adviser. At the end of the year, the number of student advisers was thus reduced from three to two. In November, Oosthoek left as education coordinator leaving a gap in the daily running of tasks.

In addition to regular counseling by the student adviser, incoming students were assigned to small groups meeting at regular intervals with a staff mentor (Hoekstra, Icke, and Levin) and a senior student mentor. Student tutoring was done by senior astronomy and physics students. In the tutor program, physics and astronomy freshman students are provided, on a voluntary but regular basis, with coaching by senior students.

As part of the introductory astronomy course, students were taken to the Artis Planetarium in Amsterdam for a lesson in coordinate systems, time and constellations in the sky (Hoekstra). As part of the second-year training in practical astronomy, 12 honors students were offered the opportunity to take part in a specially arranged observing trip to the Isaac-Newton-Telescope on La Palma, Canary Islands (Van der Werf, de Mooij, van Haasteren).

The parallel course Analysis 3NA, provided by the mathematics department at the specific request of both astronomy and physics, was very succesful. In this course, (astro)physical applications of the mathematical tools are covered more extensively than in the regular course which emphasizes mathemetical rigour. Unlike the regular course Analysis 3, this parallel course does not prepare for Analysis 4.

The astronomy curriculum is monitored by the 'Opleidingscommissie' (education committee), which advises the Director of Education on all relevant matters, and which was chaired by Van der Werf. Other members are Icke, Schaye, Franx, and Damen, as well as De Valk, Van den Broek, Straatman, Langelaan and Pijloo for the student body. In the fall, the composition changed: Van der Werf, Icke and Damen were replaced by Röttgering, Van Dishoeck and Van Uitert respectively, and student representatives became Bremer, Pijloo, Segers, and Vreeker. Under the authority of the Opleidingscomissie, the lecture course monitoring system (SRS) was continued. In this system, students provide feedback to lecturers during and after the course.

The quality of curriculum and exams is guarded by the Exam Committee (Examencommissie) chaired by Lub, with Israel, Aarts (physics), Hogerheijde and Röttgering as members.

Admission to the master-curriculum for students without a BSc in astronomy from a Netherlands university requires a recommendation by the 'Toelatingscommissie' (admissions committee) chaired by Schaye and having Israel and Linnartz as members.

3.2. Degrees awarded in 2009

3.2.1. Ph.D. degrees

A total of 11 graduate students successfully defended their Ph.D. theses in 2009 and were duly awarded their Ph. D. degree: They are:

Name: Dave Lommen
Titel thesis: The first steps of planet formation
Promotor: E.F. van Dishoeck
Co-promotor H.J. van Langevelde, C.M. Wright

Name: Huib Intema
Titel thesis: A sharp view on the low-frequency radio sky
Promotor: H. Röttgering
Co-promotor G.K. Miley

Name: Anne-Marie Weijmans
Titel thesis: The Structure of Dark and Luminous Matter in Early-Type Galaxies
Promotor: P.T. de Zeeuw

Name: Karin Öberg
Titel thesis: Complex Processes in Simple Ices
Promotor: E.F. van Dishoeck, H.V.J. Linnartz

Name: Andreas Pawlik
Titel thesis: Simulating Cosmic Reionisation
Promotor: H. Röttgering
Co-promotor: J. Schaye

Name: Ruud Visser
Titel thesis: Chemical Evolution from Cores to Disks
Promotor: E.F. van Dishoeck

Name: Olja Panic
Titel thesis: High angular resolution studies of protoplanetary discs
Promotor: E.F. van Dishoeck
Co-promotor: M.R. Hogerheijde

Name: Elisabetta Micelotta
Titel thesis: PAH Processing in Space
Promotor: F.P. Israel
Co-promotor: A.G.G.M. Tielens

Name: David Raban
Titel thesis: Infrared Interferometric Observations of Dust in the Nuclei of Active Galaxies
Promotor: H. Röttgering, W.Jaffe

Name: Nathan de Vries
Titel thesis: The Evolution of Radio-Loud Active Galactic Nuclei
Promotor: R.T. Schilizzi
Co-promotor: I.A.G. Snellen, H. Röttgering

Name: Edward Taylor
Titel thesis: Ten Billion Years of Massive Galaxies
Promotor: M. Franx

3.2.2. Master's degrees (Doctoraal diploma's)

The following 11 students were awarded Master's/Doctoral degrees in 2009:

Name	Date	Present Position
Wouter Spaan	Mar 24	Physics Teacher (VWO)
Bas Nefs	Mar 24	Ph.D. Leiden Observatory
Maarten van den Berg	Aug 25	
Niels ter Haar	Aug 25	Physics Teacher (VWO)
Marco van der Sluis	Aug 25	Interim manager
Sander de Kievit	Aug 25	Finance Concurrence
Remco van der Burg	Aug 25	Ph.D. Leiden Observatory
Ali Rahmati	Aug 25	Ph.D. Leiden Observatory
Daniel Szomoru	Aug 25	Ph.D. Leiden Observatory
Jesse van de Sande	Oct 27	Ph.D. Leiden Observatory
Charlotte de Valk	Dec 15	-

3.2.3. Bachelor's degrees

A total of 10 students obtained their Bachelor's degree:

Name	
Arthur Bakker	David Huijser
Tjarda Boekholt	Marinus Israel
Nadieh Bremer	Gilles Otten
Willem de Pous	Piet Vandevelde
Ricardo Herbonnet	Nienke van der Marel

3.3. Academic Courses and Pre-University Programs

3.3.1. Courses taught by Observatory curriculum staff 2009 - 2010

Elementary courses:

Semester	Course title	Teacher
1	Introduction astrophysics	F.P. Israel
2	Astronomy lab 1	H. Hoekstra
3	Stars	A.C.A. Brown
3	Modern astronomical research	H.V.J. Linnartz
4	Astronomy lab 2	P. van der Werf
4	Stellar systems and cosmology	H.J.A. Röttgering
5	Observational techniques 1	B. Brandl
5	Radiative processes	V. Icke
5-6	Bachelor research project	I. Snellen
6	Introduction observatory	E.R. Deul

Advanced Courses (Keuzevakken; semesters 7, 8, 9, 10):

Stellar structure and evolution	J. Lub
Galaxies: structure, dynamics, evolution	M. Franx
Interstellar matter	M. Hogerheijde
Galaxy formation	J. Schaye
Interferometry	W. Jaffe
Radio Astronomy	M. Garrett
Databases and data mining	J. Brinchmann
Astrophysical accretion	Y. Levin

3.3.2. Pre-University Programs

LAPP-Top, the Leiden Advanced Pre-University Program for Top Students, is aimed at enthusiastic and ambitious high-school students from the 5th and 6th grade. Candidates are selected on the basis of their high-school grades and their enthusiasm to participate. Students that are selected will then take part in 6 to 8 meetings from January till May, following the program of their own choice.

The Sterrewacht has been participating in the LAPP-TOP program since its start in 2001. In that pilot year five students participated, in 2002/3 six, in 2003/4 eleven, in 2004/5 thirty-three, in 2005/6 seventeen, in 2006/7 twenty seven, in 2007/8 sixteen and in 2008/9 twenty.

The astronomy LAPP-TOP program was developed by Van der Werf from 2002 onward. From 2005-2008 the project was coordinated by Snellen. Since 2008 it is coordinated by Franx. In eight sessions the following subjects were treated:

Extrasolar planets – I. Snellen
The Milky Way and other galaxies – J. Schaye
Practicum: distances in the Universe
Gas and Radiation - V. Icke
Quasars, black holes and active galactic nuclei – H. Röttgering
Practicum: The black hole in the center of our Milky Way
Cosmology - P. Katgert
Excursion to the radio telescopes in Westerbork and Dwingeloo

After successfully completing the program participants have been awarded with a certificate from the University of Leiden. High-school students are allowed to use this project as part of their final exams.

3.3.3. Contact.Vwo

Contact.Vwo has been in existence for three years. Buisman and van der Hoorn (physics teachers in secondary schools) both work one day a week for the Physics and Astronomy Departments in order to intensify the contacts between secondary schools and the university.
Van der Hoorn organizes twice yearly a production and mailing of posters and organizes three times an informative meeting for physics teachers, starting at 6

p.m. and featuring a lecture on modern developments in physics or astrophysics, an informal dinner with extensive networking between teachers and university workers, and after-dinner subjects dealing with the change from secondary school to university study).
Buisman is concerned with school classes (programs for whole-day visits as well as individual help (assisting pupils with practical work, answering questions by mail etc.). He also has organized a training session for the module Measuring in Star Systems (Meten aan Melkwegstelsels) which is part of the school curriculum track Nature, Life and Technology (Natuur, Leven en Technologie). Contact.Vwo answers ad hoc requests for assistance by school pupils or teachers. Buisman also has an appointment for one day a week as local coordinator of the HiSPARC project, but although related, this is not a part of the activities of Contact.Vwo.

Activities at Leiden University in 2009
For teachers:
February 12, 2009: Theme: Astrophysics: the use of Planck's Law.
April 8, 2009: Meeting teachers of the Modern Physics project
May 18, 2009: Theme: Cosmology in the era of Planck and the LHC
October 29, 2009: Measuring in star systems
November 2, 2009. Theme: Elementary particles

For School classes:
January 23, 2009; school: De Populier, Den Haag; Measuring in Star Systems
May 27, 2009, school: Hermann Wesselink, Amstelveen; Laboratory day
June 12, 2009, school: Bonaventura, Leiden; Laboratory day
July 01, 2009, school: VCL, Den Haag; profielwerkstukken
November 13, 2009, school: VCL, Den Haag; Measuring in Star Systems

Five teams of pupils have been supported by Contact.Vwo working on a practical assignment (profielwerkstuk) about astronomy.

Further information
http://www.physics.leidenuniv.nl/edu/contactpuntvwo/index.asp

3.4. Popularization and Media Contacts

3.4.1. Public Lectures and Media Interviews

Baneke
Salon Boerhaave: Hoe Nederland een astronomische grootmacht werd (Leiden, Sep 30)

van Bemmel
Infraroodsterrenkunde (KNVWS, Delft, Netherlands; Jan 20)
Het hoe en wat van LOFAR en SKA (KNVWS, Almere,Netherlands; Feb 3)
Idem (Volkssterrenwacht Copernicus, Haarlem, Netherlands; Mar 19)
Idem (Astronomische vereniging Wega (KNVWS, Tilburg, Netherlands; Apr 7)

Brown
'Gaia - Een stereoscopische kaart van de Melkweg' (KNVWS, Roermond; Mar 3)
Idem (Eindhoven; Mar 19)
Idem (Den Bosch; Dec 16)

van der Burg
'Ja/Nee quiz' (Old Observatory, Leiden; Jan 7)
'Sterren & Exoplaneten' (Groene Hart Lyceum; Alphen a/d Rijn, Jan 15)
'Machten van 10' (Old Observatory, Leiden; Jan 15)
'Sterrenstelsels & het Heelal' (Groene Hart Lyceum, Alphen a/d Rijn; Jan 22)
'Het leven van een Astronoom' (Visser 't Hoofd Lyceum, Leiden; Feb 5)
'Extrasolaire Planeten' (Lionsclub Rijnwoude, Hazerswoude Dorp; Apr 7)
'De Maan, Ja/Nee quiz' (Leonardoschool, Gouda; Dec 11)

van Delft
'De collectie is de ruggengraat van het museum' (Interview, Universiteit Leiden Nieuwsbrief; Jan 16)
'Blingbling, sleutelwaarde en het miskende instrument' (inaugural lecture special professor Material Cultures of the Sciences; Jan 16)
'Koude en kunst' (A.S.V. Prometheus; Mar 4)
'Einstein's vulpen' (ScienceFlash; Mar 6)
'Het nut van een biografisch portaal' (symposium Het Biografisch Portaal Nederland; Mar 27) *'De veiling van een Van Leeuwenhoek microscoop'* (Interview, Radio Wereldomroep; Mar 27)
'Heike Kamerlingh Onnes en de Tweede Gouden Eeuw' (Genootschap Oud-Rijnsburg; Apr 22)

'De evolutie van musea voor de geschiedenis van (bèta)wetenschap' (Leidse Historische Kring; Apr 24)
'Heike Kamerlingh Onnes en de Tweede Gouden Eeuw' (Museum Boerhaave; May 9)
'Met Einstein op de fiets' (bike tour; May 10)
'Over conservatoren, wetenschap en waarde' (symposium Natuurhistorisch Museum Maastricht; May 15)
'Heike Kamerlingh Onnes en de Tweede Gouden Eeuw' (Keerpunten in de geschiedenis van de natuurwetenschappen; 25 mei)
'Van Adam tot DNA' (exhibition opening speech; June 5)
'Museum Boerhaave and the History of Science' (Woudschoten III; June 26)
'Koude drukte. Het Leidse cryogeen laboratorium en de internationale temperatuurschaal 1927' (Woudschoten III; June 27)
'Museum Boerhaave and the digital world' (Science Museum London; July 9)
'400 jaar telescoop Galilei' (radio interview Met het oog op morgen Aug 24)
'400 jaar telescoop Galilei' (RTL tv-journaal; Aug 25)
'Kosmos' (book presentation Harm Habing; Sep 1)
'The Quest for Absolute Zero. A Human Story about Rivalry & Cold' (Artefacts, Science Museum London; Sep 21)
'Dat mag in de krant! Over wetenschap en de pers' (Fysica & Samenleving; Oct 6)
'Sleutelstukken en storytelling in Museum Boerhaave' (master science communication; Oct 9)
'Reis naar het ultieme onbekende: een zwart gat' (Scheltemacomplex; Oct 18)
'Einsteins liefde voor Leiden' (P.J. Bloklezing; Oct 22)
'To live and die in an Iron Lung' (radio interview Met het oog op morgen; Oct 31)
'Cool Reception. Leiden's Quest for Cold and the International Temperature Scale 1927' (HSS Annual Meeting Phoenix; Nov 21)
'Museum Boerhaave en het nut van wetenschap in een vitrine' (Fysica & Samenleving; Nov 24)
'Heike Kamerlingh Onnes, James Dewar en de strijd om vloeibaar helium' (Cleveringa lecture London; Nov 26)
'Zwaartekracht en NewtonMania' (radio interview Met het oog op morgen; Dec 15)
'NewtonMania and gravity' (exhibition opening speech; Dec 16)
'Museum Boerhaave en de Tweede Gouden Eeuw' (Natuurwetenschappen voor niet-beta's; Dec 18)
'Wat gebeurt er bij het absolute nulpunt?' (MuseumjeugdUniversiteit; Dec 20)

van Dishoeck
'De 10 beste vrouwen in de wetenschap' (Interview, Vrij Nederland; 17 jan)
'NL activiteiten IYA2009' (Opening IYA NL, Utrecht; Jan 21)
Interview (Kijk; feb)
'Vaklui (V): vrouwen met een mannencarrière '(ESTA, nr. 3-2009, p. 32-36)
'Nieuwe werelden' (Dies oratie, Universiteit nieuwsbrief, Leiden; 3 feb)
Idem (Universiteit Leiden; 9 feb)
'Van moleculen tot planeten' (METIS, Alkmaar; Feb 27)
'Astrochemie: op zoek naar de bouwstenen voor leven in de ruimte' (Paradiso, Amsterdam; Mar 1)
'Van moleculen tot planeten' (IYA2009 cyclus, Leuven, Belgium; Mar 3)
'Ontstaan planeten en sterrenstelsels onderzocht in nieuwe onderzoekscentrum' (Universiteit nieuwsbrief, Leiden; Mar 24)
Idem (Leidsch Dagblad, Leiden, Mar 25)
'Nachtmijmeringen over de sterrenkunde '(Radio 1, Casa Luna, Apr 2)
'Geboorte van sterren' (NEMO, Masterdam; Apr 4)
'Future millimeter and infrared telescopes: a supersharp view of stellar and planetary nurseries '(Fysica symposium, Groningen; Apr 24)
'Serving the planet: scheikunde tussen de sterren' (Hoftoren lezing, Den Haag, p.13; June 3)
'Kraamkamer van sterren' (NRC Wetenschap, p.13; June 27)
'Natuur- en Scheikunde tussen de sterren' (inauguratie VU; Sep 19)
'Auf der spur einer zweiten Erde '(Münchner Mercur, P. 17; Sep 16)
'Leidse leermeesters' (Leidraad; Oct)
'Water in de wolken zoeken' (Quest, p. 105; Oct)
Idem (Experiment.nl, p. 169; Oct)
Interview (Eureka; Nov)
'Mijn begin' (Volkskrant; Dec 24)

van Genderen
'Over de Zon, de Maan, de kometen en de sterren' (De Nuts Basisschool, Voorschoten; June 8)

Haas
'Stervorming: clusters of losse sterren?' (KNVWS) (2x)
'De vorming van sterrenstelsels; van waarneming tot simulatie' (KNVWS) (3x)
'Alternatieve zwaartekrachttheorieen' (JWG summer camp; Aug)
'Radiosterren of rare sterrenstelsels?' (JWG, Utrecht, Netherlands; Feb)
'Het ontstaan van de wereld' (Islamic high school, Amsterdam, Netherland;, Jan)
'Deep-sky objecten' (beginners course of JWG, Amersfoort, Netherlands; Jan)

Hoekstra
'Wat doet een sterrenkundige?' (Weekendschool, Den Haag; Mar 22)
'De duistere kant van het heelal '(International year of astronomy event, NEMO, Amsterdam; Apr 5)

Hopman
'Laboratory Evidence for Solid State Astrochemical Processes' (Hotel Oud Poelgeest , Oegstgeest; 10 Oct)

Israel
'40 Jaar Apollo Maanlanding' (TOP, Delft; June 18)
'Terug naar de Maan' (Interview op Radio 1; June 19)
'De vreemde exoplaneet' WASP 18b (BNR Nieuwsradio; Aug 28)
'Schietschijf Aarde' (Leidsche Flesch; Oct 30)
'Is de Zon dood?' (NCRV radio; Nov 26)

Johansen
'Dirty stars make good solar system hosts' (Press release for paper 'Particle clumping and planetesimal formation depend strongly on metallicity')

Katgert
'Het Uitdijend Heelal' (VWO Zwijndrecht; Jan 14)
'Terugkijken naar de Oerknal' (VWO Hilversum; May 12)
'Het Uitdijend Heelal' (VWO Voorburg; Apr 16)
Idem (VWO Haarlem; June 9)
'Het Signalement van het Heelal' (HOVO Leiden; Jan 29, Feb 5, Feb 12, Feb 19, Feb 26, Mar 5, Mar 12, Mar 19, Mar 26, Apr 2)

Kóspál
Participated at a TV shooting for a documentary programme about women in science for the Hungarian TV channel "Duna TV" (Budapest; June 22)

Kuijken
'Kosmologie, donkere materie, donkere energie en het ontstaan van Melkwegstelsels' (Public lecture, Volkssterrewacht Armand Pien, Gent, Belgium; Oct 24)
'Gravitational lensing: studying the dark energy with light rays' (Invited lecture, NNV, Lunteren, Netherlands; Nov 6)
'Missie Maan' (Basisschoolproject + les, Montessorischool Oegstgeest; Dec 8 en 11)

van Langevelde
'Introducing JIVE, VLBI, e-VLBI ' (SURFNet pres event, Dwingeloo; Apr 3)
'The European VLBI Network' (IYA round the world webcast Dwingeloo; Apr 3)
'Een telescoop groter dan Europa' (NL IYA event NEMO, Amsterdam; Apr 5)
'Introducing JIVE, VLBI, e-VLBI' (International ambassadors visiting Drenthe; May 15)

Linnartz
'*Het heelal, van toen tot nu*' (for 'Vrouwen van nu', Loenen a/d Vecht; Oct 15)
'*De hemel boven Vreeland*' (Vreelandbode (monthly))

van Lunteren
'Albert Einstein: leven en werk' (Visit Scholengemeenschap Het Noordik, Leiden; Mar 3)
'Nederland, de meter, en het Internationale Bureau voor Maten en Gewichten '
(Jaarvergadering Kadaster, Utrecht; Mar 18)
'Galilei en de kerk '
(Grotius College, Delft; Apr 17)
'Galilei en de Sterrenboodschapper '
(Ouderdag Leidsche Fles, Leiden; Apr 18)
'De elementen: een geschiedenis van de bouwstenen van de wereld'
PION (Leiden; May 29)
'De sterrenkundige ontdekkingen van Galilei '
(Sonnenborgh, Culturele Zondag, Utrecht; Sep 13)
'Grootste natuurkundige aller tijden Galileo Galilei'
(Museum Boerhaave, Leiden; Oct 21)
'Miskende Genieën'
(symposium 'vergeten wetenschap', Leidse Biologen Club; Nov 9)
'Galilei en de ontdekking van de hemel'
(Cleveringa-lecture, Brussel; Nov 19)
'Spanning en sensatie: elektriciteit in de achttiende eeuw'
(Teylers Museum, Haarlem; Dec 20)
'De glimlach van de Cheshire kat' (Oratie)

Martinez Galarza
'Astronomia en la Proxima Decada con el Telescopio Espacial James Webb' (Bogota; Nov 17)
Idem (Videoconference, Cali; Nov 13)

Ödman
'Stars at your Fingertips' (Workshop, Grahamstown, South Africa; Mar 25 – 31)
'Space Journey: from SciFest to the Universe' (Science show, Grahamstown, South Africa; Mar 25)
'Workshop: Stars at your Fingertips' (Workshop, Cairo, Egypt; May 12)
'UNAWE – Perspectives' (Public lecture, Dunsink Observatory, Dublin; Ireland; Sep 15)
'Exhibition opening: Our place in the Universe' (Birr Castle, Ireland; Sep 18)

Portegies Zwart
Nationale wetenschapsquiz (VPRO publieke omroep; 24-12)
Noorderlicht Nieuws (VPRP publieke omroep)
Publiekslezing (Amsterdam, Artis, Planetarium)
Noorderlicht Nieuws (VPRO publieke omroep)

Röttgering
'De LOFAR radio telescoop' (Katholieke Scholengemeenschap, Hoofddorp; 14 oct)

Snellen
'*De ontdekking van nieuwe werelden'* (Guest lecture, Montaigne Lyceum, Den Haag; Feb 18)
Idem (St. Michaelcollege Zaandam; Mar 12)
Idem (Gymnasium Hilversum, Hilversum; Apr 7)
'Op zoek naar exoplaneten' (Science center NEMO, Amsterdam; Apr 5)
'Op zoek naar tweeling Aarde' (KNVWS Afdeling 't Gooi, Utrecht; Sep 26)
Idem (Wetenschapsdag, Leiden; Oct 18)
'Leven in het heelal' (ESERO onderwijsconferentie, Hilversum; Nov 4)
'The search for twin-Earth' (University College Utrecht, Utrecht; Nov 11)
'Detectie van extrasolaire planeten'(VVTP symposium "Science of Fiction", Delft; Nov 24)
'Op zoek naar tweeling Aarde' (Cleveringalezing Rome, Italy; Nov 27)
Press release: 'Warme gloed exoplaneet vanaf de grond gemeten' (Press release; Jan 15)
'Astronomen ontwaren schijngestalten van een exoplaneet' (Press release; May 27
'Bizar tollende dubbelster verklaart 30 jaar oud raadsel' (Press release; Sep 16)

Tielens
'Ecology van de Melkweg'(Presentation, Leuven, Belgium; June 2)

Visser
'Protosterren: Van Bewolkt tot Zonnig' (Public lecture, Overveen; Feb 19*Idem* (Papendrecht; Oct 30)

van de Voort
'The Universe in the computer' (Presentation, Leiden; Oct 27)
Weekendschool (Den Haag; Mar 22, Mar 29, Apr 5)
Board LWSK (from December 1)
Publiekscommissie (Outreach committee) Sterrewacht; full year)

3.4.3 Tours at the Old Observatory

None took place as the building was closed for restoration purposes.

3.5. Universe Awareness Program

Universe Awareness:
Ödman and Miley continued their work on the Universe Awareness programme.

Universe Awareness (UNAWE) is an international programme instigated by Miley to expose underprivileged young children aged from 4 to 10 years to the inspirational aspects of astronomy. By raising awareness about the scale and beauty of the Universe, UNAWE attempts to broaden the mind and awaken curiosity in science, at a formative age when the value system of children is developing. A goal of UNAWE is to stimulate their development into curious, tolerant and internationally minded adults.
Since its initiation by Miley in 2004, UNAWE has grown from a concept to a thriving network of more than 200 UNAWE volunteers and experts active in more than 35 partner countries worldwide. Some important achievements of UNAWE during 2009 were:
(i) The addition of several new partner countries to the programme
(ii) The organization of many international UNAWE events for young children
(iii) The implementation of UNAWE as a global cornerstone programme of the UN-designated International Year of Astronomy in 2009
(iv) Development of a range of international UNAWE materials and activities, instigation of a sustained development of new materials
(v) Lobbying for acquisition of EU funding

3.6. IAU Strategic Plan: Astronomy for the Developing World

As the responsible IAU Vice President, George Miley led the development of a new strategy to use astronomy for international development and education. This was formalized as the IAU decadal strategic plan, "Astronomy for the Developing World – Building from IYA 2009". The plan was written and edited by Miley and endorsed overwhelmingly at the IAU General Assembly at Rio de Janeiro in August. It shows that astronomy can make a unique contribution to building the technological, scientific and cultural capacities of developing countries.
The plan lays out an ambitious plan to exploit astronomy for such ends during 2010 – 2020, with contributions at every level (primary, secondary and tertiary education, research infrastructure and public outreach).

Elements of the strategy include:
1. An integrated strategic phased approach
2. Increase regional involvement
3. Building on the momentum generated by the IYA by continuing IYA cornerstone projects, exploiting the IYA network of 148 countries and the alliance between professional and non-professional astronomer,
4. Enlarging the number of active volunteers
5. Initiating several new activities, including semi-popular lectures in developing countries and long-term institute twinning between developed astronomy organizations and departments in developing countries
6. Advancing the UN Millennium Goals
7. Exploit new tools and opportunities, including mobile planetaria and internet educational telescope networks and
8. Creating small global "Office for Astronomy Development" and regional nodes throughout the world.

Following on from the highly successful International Year of Astronomy 2009, the new plan is a pioneering international venture seeks to exploit scientists and pure research for the benefit of global development.

3.7. The Leidsch Astronomisch Dispuut 'F. Kaiser'

With only one significant activity, this might well be the simplest annual report of L.A.D. F. Kaiser in years. In early february 2009 the Old Observatory closed its doors for a well deserved renovation, but this left Kaiser without its star attraction. This meant no observing nights and tours for some time to come.

Despite this, the board organised the annual soccer tournament. This tournament was a huge success and a week later it was still easy to tell who had participated and who hadn't. Unfortunately the Kaiser team lost, but not without an heroic battle, making two board members limp for a few weeks. The winner was the Sterrewacht team "The Smokers", who ironically didn't have to catch their breath afterwards.

In the course of the year, two board members got a PhD position in Leiden, which made it harder to find time to organise events. Therefore in 2010 we will be looking for new board members to take over the torch and entertain us with new exciting activities.

3.8 Vereniging van Oud-Sterrewachters

The 'Vereniging van Oud-Sterrewachters' (VO-S; http://www.vo-s.nl/) is the official association of Sterrewacht/Observatory (ex-)affiliates.

It has been in existence for over 15 years now and has seen another active year. As usual, the 150 members were offered a variety of activities. The activities included a social drink prior to the Oort Lecture and an annual meeting. This year, the annual meeting was held in Leiden and involved, among others, a visit of Museum Naturalis. The meeting was attended by 30 members. VO-S members also received a newsletters with Sterrewacht news and were offered an electronic member dictionary.

Appendix I

Observatory staff December 31, 2009

Observatory staff December 31, 2009

Appendix I

Names, e-mail addresses, room numbers, and telephone numbers of all current personnel can be found on the Sterrewacht website:

http://www.strw.leidenuniv.nl/people

Telephone extensions should always be preceded by (071) 527 … (from inside The Netherlands) or by +31-71-527 … (from abroad)

Full Professors:

E.F. van Dishoeck	G.K. Miley (0.0)
M. Franx	S. Portegies Zwart
V. Icke	H.J.A. Röttgering
F.P. Israel	A.G.G.M. Tielens
K. Kuijken (Director)	P.T. de Zeeuw (0.0)

Full Professors by Special Appointments:

D. van Delft*	(Museum Boerhaave, Stichting tot beheer Museum Boerhaave)
M. Garrett**	(ASTRON, Sterrewacht, Faculty W&N)
H.V.J. Linnartz	(Stichting Fysica, Vrije Universiteit Amsterdam)
F. van Lunteren	(UL (0.5)/VU (0.3), Teijler's Hoogleraar
H.A. Quirrenbach	(Landessternwarte Heidelberg, Faculty W&N)

* Director Boerhaave Museum
** Director ASTRON

Associate Professors and Assistant Professors / Tenured Staff:

R. Bouwens (0.0)
B.R. Brandl
J. Brinchmann
A. Brown
M. Haverkorn (0.0) *
H. Hoekstra
M. Hogerheijde
W.J. Jaffe
P. Katgert (0.0)
M. Kenworthy
H.J. van Langevelde (0.0)**
Y. Levin (0.8)
H.V.J. Linnartz
J. Lub
R.S. Le Poole (0.0)
J. Schaye
I.A.G. Snellen
R. Stuik (NOVA Muse)
P.P. van der Werf

Visiting Scientists:

J.K. Katgert-Merkelijn
R. Mathar
E.M. Penteado (Greenberg fellow)
M. Spaans (RUG)
R. Stark (NWO)
J.A. Stüwe

Emeriti:

A. Blaauw
W.B. Burton
A.M. van Genderen
H.J. Habing
I. van Houten-Groeneveld
K. Kwee
A. Ollongren
C. Van Schooneveld
J. Tinbergen

* Staff, ASTRON Dwingeloo
** Director, JIVE, Dwingeloo

Postdocs and Project Personnel:

C. Arasa Cid	NWO TOP CW	L. Kristensen	UL
D. Baneke	Gratama-St.	E. Loenen	NOVA/NW1
I. van Bemmel	UL, EU SKADS	M.A. Marosvolgyi	NOVA AMUSE
L. Birzan	NWO LOFAR	J. Meisner	EU OPTICON
C. Booth	NWO, EU-EXT	R. Meijerink	NWO TAMASIS
C. Brinch	NWO ALLEGRO	F. Molster	NWO (NOVA) detachering
G. Busso	UL/NOVA-GAIA	C.J. Ödman	UNAWE
H. Cuppen	NWO, VENI	B.D. Oppenheimer	NOVA/NW1
A. Deep	UL/NOVA	F.I. Pelupessy	NOVA AMUSE
A. van Elteren	NOVA AMUSE	R. Quadri	UL/NOVA
E. Gaburov	NWO VIDI	D.A. Rafferty	NWO LOFAR
C.H.J.M. Groothuis	NOVA O/IR (in Dwingeloo)	N.M. Ramanujam	NOVA, LOFAR
B. Groves	UL/NOVA	D. Rizquez-Oneca	EU-ELSA
M.A. Gurkan	NWO VENI	D. Schleicher	ESO, ALMA
J. Guss	SRON/UL	T. Schrabback	NWO
S. Harfst	NWO STARE	E. Sembolini	NWO VIDI
H. Hildebrandt	EU	D. Serre	UL/NOVA-MUSE
J. Holt	NWO	S. van der Tol	NWO LOFAR
A. Johansen	NWO VIDI	R. Visser	NWO SPINOZA
S. Kendrew	UL/NOVA	C.E. Vlahakis	NWO
A. Kospal	NWO-VIDI	N. de Vries	NOVA AMUSE

Ph.D. Students:

N. Amiri	12	R. Oonk	1
J. Bast	3	J.-P. Paardekooper	2
P. Beirao	10	F. Petrignani	16
J. Bedorf *	3	T. Prod'homme	5
J. Bouwman	8	A. Rahmati	2
R.F.J. van den Burg *	3	O. Rakic	3
Y. Cavecchi	1,2	S. Rieder	3
M. Damen	1,2	M. SadatShirazi	1
A. Elbers *	9	D. Salter	1
E. Fayolle *	2	J. van de Sande	2
D. Groen *	3	D.M. Smit	10
M. Haas	1	M.H. Soto Vicencio	10
R. van Haasteren	3	D. Szomoru	15
M. van Hoven	1	K. Torstensson	12
M. Iacobelli *	11,1	F. van de Voort	3
S. Ioppolo	2	E. van Uitert	1
K.M. Isokoski	2,1	M. Velander	5
C. Kruip	2	S. Verdolini	1
E. Kuiper	3	L. Vermaas	2
A.M. Madigan	3	K.-S. Wang	2
J.R. Martinez Galarza	2	R. van Weeren	1,6
F. Maschietto	3	N. Wehres	13
E. de Mooij	1	M. Weiss	14
M. Mosleh	5	R. Wiersma	10
B. Nefs *	3	U. Yildiz	1
I. Oliveira	1,4		

Funding notes:
1. funded by Leiden University; 2. Funded by NOVA program; 3. funded by NWO, via Leiden University; 4. funded by Spinoza award; 5. funded by EU; 6. funded by KNAW; 7. funded by SRON; 8. employed by FOM; 9. funded by 'Campagne voor Leiden'; 10. Guest finalizing thesis; 11. funded by ASTRON; 12. funded by JIVE – EU ESTRELA netwerk; 13, funded by Groningen – EU Molecular Universe Network; 14. funded by Teyler's Foundation; 15. Funded by A-ERC grant Franx.16. Externally funded

* denotes employment for only part of the year - see section staff changes.

Management Support and Secretaries:

J.C. Drost	Management assistant
E. Gerstel	Institute manager
A. van der Tang	Secretary
L. van der Veld	Secretary
P. Oosthoek /Vacancy	Programme coordinator BSc and MSc

Computer staff:

E.R. Deul	Manager computer group
D. J. Jansen	Scientific programmer
T. Bot	Programmer
A. Vos	Programmer

NOVA office:

E. van Dishoeck	Science director
W.H.W.M. Boland	Managing director
K. Groen	Financial controller
J.T. Quist	Management Assistent (0.5)
F. Molster	Project Manager (ESFRI, NWO)

Msc Students:

A.S. Abdullah
A.H. Bakker
T.C.N. Boekholt
N.A. Bremer
S. van den Broek
J. Figuera
M.P. van Daalen
J.D. Delgado Diaz
D.S. Harsono
R.T.L. Herbonnet
J. Hu
D.S. Huijser
M.P.H. Israël
R.M.J. Janssen
T.D.J. Kindt
M.J. van der Laan
M.T.A. Lambrechts
M. Lameé
N. van der Marel
T.R. Meshkat
A.N.G. Mortier
G.P.P.L. Otten
W.M. de Pous
W.C. Schrier
S. Shah
A. Shulevski
R. Smit
C.M.S. Straatman
C.H.M. de Valk
F.N. Vuijsje
S.T. Zeegers
C.H. Schönau (doctoral student)

Senior Bsc Students:

K.A.J.B. Beemster
Y.O. van Boheemen
S. Crezee
I.C. Icke
M.J. Luitjens
G.P.P.L. Otten
S.T. Zeegers

Staff changes in 2009:

Name (funded by)	start	end
R. Alexander (NWO)		30-11-2009
S. Anderson (NWO - TOPCW)		1-5-2009
C. Arasa Cid (NWO - TOPCW)	15-4-2009	
J. Bedorf (NWO)	1-5-2009	
F.L. Birzan (NWO LOFAR, NOVA)	1-8-2009	
C. Brinch (NWO, ALLEGRO)	1-9-2009	
Y. Cavecchi (NOVA)	1-1-2009	
H.M. Cuppen (NWO VENI)		30-9-2009
H.M. Cuppen (SPINOZA/NOVA)	1-10-2009	
C. Dalla Vecchia (EU-EXT)		31-5-2009
M.C. Damen (UL, NOVA)		31-12-2009
N. de Vries (UL)		31-10-2009
N. de Vries (NOVA)	1-12-2009	
A. Elbers (Campagne voor Leiden)	15-2-2009	
E. Gerstel (UL)	26-10-2009	
E.C. Fayolle (NOVA)		
D.J. Groen (NWO)	1-5-2009	
M.A. Gürkan (NWO, VENI)	1-8-2009	
J.S. Guss (UL)	1-9-2009	
N. Hatch (UL, KNAW)		30-9-2009
S. Harfst (NWO)	1-6-2009	
C.J.H.M. Groothuis (NOVA)	1-3-2009	
C. Hopman (NWO, VENI)		31-8-2009
M. Iacobelli (NWO, ASTRON)	15-11-2009	
H. Intema (NOVA, KNAW)		31-7-2009
L. Jolissaint de Sepibus (NWO/NOVA)		31-10-2009
S.A.S. Kendrew (UL/NOVA)		31-1-2009
S.A.S. Kendrew (NOVA/METIS)	1-2-2009	
M. Kenworthy (UL)	1-1-2010	
A.F. Loenen (NOVA)	1-12-2009	
D.J.P. Lommen (NOVA)		14-6-2009
P. Lopes Beirao (UL)		20-2-2009
M.A. Marosvolgyi (NOVA)	1-10-2009	
P. Marrese (UL/NOVA-GAIA)		31-12-2009
H. Masso-Gonzalez (NWO-Rubicon)		14-5-2009
R. Meijerink (NWO)	1-1-2010	
E. Micelotta (UL, EU)		14-5-2009

Name (funded by)	start	end
K.I. Oberg (EU)		31-8-2009
S.V. Nefs (NWO)	1-4-2009	
C.J. Ödman (UNAWE, UL)		31-12-2009
C.J. Ödman (UNAWE, ASTRON)	1-1-2010	
A. Omar (NWO)		30-9-2009
P. Oosthoek (UL)		26-11-2009
B.D. Oppenheimer (NOVA)	1-8-2009	
M. Pandey (NWO, LOFAR)		21-10-2009
O. Panic (NWO, EU)		14-8-2009
A.H. Pawlik (EU)		30-4-2009
A.H. Pawlik (UL)	1-5-2009	30-9-2009
F.I. Pelupessy (NOVA)	1-5-2009	
S. Portegies Zwart (UL)	1-5-2009	
D.A.Rafferty (NWO)	1-8-2009	
A. Rahmati (NOVA)	1-9-2009	
J.T. Quist (NOVA)	15-9-2009	
D. Raban (NWO)		28-2-2009
S. Rieder (NWO)	15-5-2009	
M. Sadatshirazi (UL)	1-3-2009	
E. Semboloni (NWO)	1-10-2009	
D.M. Smit (NWO)		31-8-2009
I.A.G. Snellen (KNAW)		30-9-2009
I.A.G. Snellen (UL)	1-10-2009	
M.H. Soto Vicencio		31-3-2009
D. Szomoru (EU)	1-9-2009	
E.N. Taylor (NWO)		31-8-2009
A.G.G.M. Tielens (UL)	1-1-2009	
K.J.E. Torstensson (JIVE-EU ESTRELA netwerk)		31-8-2009
K.J.E. Torstensson (NWO ASTRON)	1-9-2009	
O. Usov (UL, KVI)		30-4-2009
R.F.J. van de Burg (NWO)	15-9-2009	
J. van de Sande (NOVA)	1-11-2009	
S. van der Tol (NWO LOFAR)	1-5-2009	
A.K. van Elteren (NOVA)	1-5-2009	
S. Verdolini (UL)	1-9-2009	
R. Visser (Spinoza award, PhD position)		31-10-2009
R. Visser (Spinoza award, postdoc position)	1-11-2009	
K-S. Wang (NOVA)	15-9-2009	
A. Weijmans (NWO)		31-7-2009
R. Wiersma (ASTRON)		30-9-2009
R. Williams (NWO)		31-8-2009

Appendix II

Committee membership

Committee membership

Appendix II

II.1. Observatory Committees

(As on December 31, 2009)

Directorate
(Directie onderzoekinstituut)
K. Kuijken (director of research)
F.P. Israel (director of education)
E. Gerstel (institute manager)

Observatory management team
(Management Team Sterrewacht)
K.H. Kuijken (chair)
E.R. Deul
J. Drost (minutes)
E. Gerstel
F.P. Israel
J. Lub (advisor)

Oversight council
(Raad van Toezicht)
J.A.M. Bleeker (chair)
B. Baud
J.F. van Duyne
W. van Saarloos
C. Waelkens

Research committee
(Onderzoek-commissie OZ)
M. Franx (chair)
H. Cuppen
A.G.A. Brown
W. Jaffe
Y. Levin
P.P. van der Werf

Research institute scientific council

(Wetenschappelijke raad onderzoekinstituut)

W. Boland	H.J. van Langevelde
B. Brandl	R.S. Le Poole
A.G.A. Brown	Y. Levin
D. van Delft	H.V.J. Linnartz
E.R. Deul	J. Lub
E.F. van Dishoeck	F. van Lunteren
M. Franx	G.K. Miley
M. Garrett	S. Portegies Zwart
T. de Graauw	A. Quirrenbach
H. Habing	H.J.A. Röttgering
H. Hoekstra	
M. Hogerheijde	J. Schaye
V. Icke	I. Snellen
F.P. Israel	R. Stuik
W.J. Jaffe (chair)	A.G.G.M. Tielens
P. Katgert	P.P. van der Werf
K.H. Kuijken	P.T. de Zeeuw

Institute council

(Instituutsraad)

E. Deul (chair)	W.J. Jaffe
J. Drost	M. Smit
F.P. Israel	

Astronomy education committee

(Opleidingscommissie OC)

E. van Uitert	vacancy (minutes)
M. Franx	N.A. Bremer
E. van Dishoeck	T. Pijloo
J. Schaye	M.C. Segers
H. Röttgering	A. Vreeker

Astronomy board of examiners

(Examencommissie)

J. Lub (chair)	I. Snellen
J. Aarts (Physics)	P.P. van der Werf
F.P. Israel	

Oort scholarship committee
F.P. Israel
J. Schaye
S. Portegies Zwart

Mayo Greenberg prize committee
G. Miley (chair)
H. Linnartz
E.F. van Dishoeck
J. Lub
P. Katgert

PhD admission advisory committee
H. Hoekstra
J. Schaye (chair)

MSc admission advisory committee
J. Schaye (chair)
H.V.J. Linnartz
F.P. Israel

Graduate student review committee (2009 Cttee)
(Commissie studievoortgang promovendi)
M. Franx (chair)
H. Linnartz
W. Boland
J. Schaye

Colloquia commitee
J. Brinchmann
H. Hoekstra

Computer committee
A.G.A. Brown (chair)
A. Johansen
B. Brandl
M. Smit

Library committee
W.J. Jaffe (chair)
J. Lub
F.P. Israel

Public outreach committee
F.P. Israel (chair)
J. van de Sande
V. Icke
F. van der Voort
R. van der Burg

Social committee

M. Smit (chair)
J. Bast
J. Drost
D. Groen
I.A.G. Snellen

II.2. Membership of University Committees (non-Observatory)

(As on December 31, 2009)

Deul
Member Begeleidings Commissie ICT projecten
Chair Facultair Overleg ICT
Member Facultair Beleids Commissie ICT

van Dishoeck
Chair, Faculty Research Committee (WECO)
Member, Raad van Toezicht, Leiden Institute of Physics (LION)

Franx
Member, Faculty Research Committee (WECO)
Director, Leids Kerkhoven-Bosscha Foundation
Director, Leids Sterrewacht Foundation
Director, Jan Hendrik Oort Foundation

Hoekstra
Member CFHT Science Advisory Committee until 12/2008

Hogerheijde
Member, Board of Directors, Leids Kerkhoven-Bosscha Fonds
Member, Board of Directors, Leids Sterrewacht Fonds
Member, Board of Directors, Jan Hendrik Oort Foundation

Icke
Member, Advisory Council, Faculty of Creative and Performing Arts
Member, Belvédère Committee

Israel
Member, board FWN Graduate School

Kuijken
Chairman, board of directors Leids Sterrewacht Fonds
Chairman, board of directors Oort Fonds
Member, board of directors Leidsch Kerkhoven-Bosscha Fonds

Linnartz
Member, FMD/ELD user committee
Member, laboratory user group 'FWN nieuwbouw' (from november)
Member, Selection Committee, J. Mayo Greenberg Scholarship Prize
Chairman, SLA Exchange Foundation

Van Lunteren
Scientifc Board Scaliger Institute
Historical Committee of Leiden University
Studium Generale Committee Leiden University
Writer-in-residence Committee

Miley
Chairman, Selection Committee, J. Mayo Greenberg Scholarship Prize

Röttgering
Member, Curatorium of the professorship at Leiden University
'Experimental Astroparticle physics'

Schaye
Member, education advisory committee new buildings

Snellen
Member, LUF International Study Fund (LISF) committee

Van der Werf
Member Faculty Council
Organist of the Academy Auditorium

Appendix III

Science policy functions

Sterrewacht Leiden

Science policy functions

Appendix III

Brandl
Principal Investigator, E-ELT/METIS instrument phase-A study
Deputy co-PI, European JWST-MIRI consortium
Instrument Scientist, JWST-MIRI Spectrometer
Member, NOVA Instrument Steering Committee (ISC)
Editor, Conference proceedings on "400 Years of Astronomical Telescopes"
Member, ELT Design Study WP5000 (science preparations)
Member, Herschel Open Time Key Program (KINGFISH)

Brinchmann
Member, ESA Astronomy Working Group (AWG)
Member, ESO FP7 coordinating action on Wide-field imaging with the E-ELT
Member, OPTIMOS-DIORAMAS Science Team
Member of management committee, Antarctic Research, a European Network for Astrophysics (ARENA)
Member, WFOS-MOBIE Science Team
Member, DFG review committee for Priority Program "Galaxy Evolution"

Brown
Member, Organizing Committee IAU Commission 8
Member, IAU Commission 37
Member, Gaia Science Team
Member, EU Marie-Curie RTN European Leadership in Space Astrometry (ELSA)
Member, AERES visiting committee to GEPI department of the Observatoire de Paris

van Delft
Member commissie wetenschapsgeschiedenis KNAW
Member jury Annual Prize ´Wetenschap en maatschappij
Member Interdisciplinary Program Board Lorentz Center / NIAS
Member organisatie KunstWetenschapSalon
Member adviesraad tijdschrift NWT (Natuur, Wetenschap en Techniek)
Member Raad van Advies Jaarboek KennisSamenleving
Member begeleidingscommissie Digitaal Wetenschapshistorisch Centrum, Huygens Instituut
Member comité van aanbeveling Science Café Leiden
Member board Nederlands Natuur- en Geneeskundig Congres
Member Maatschappij der Nederlandse Letterkunde
Member (director) Hollandsche Maatschappij der Wetenschappen

van Dishoeck
Scientific Director, Netherlands Research School for Astronomy (NOVA)
Associate Editor, Annual Reviews of Astronomy & Astrophysics
Member, ALMA Board
Member, SRON Board
Member, MPIA-Heidelberg Fachbeirat
Member, Spitzer Time Allocation Committee GO4
Member, Herschel-HIFI Science team
Member, ASTRONET Science Vision Panel-C
Member, VICI committee EW
Co-PI, European JWST-MIRI consortium
Chair, IAU Working Group on Astrochemistry
Member, IAU Commission 14, working group on 'molecular data'
Coordinator, Herschel-HIFI WISH Key Program
Member, National Committee on Astronomy (NCA)
Member, Search committee SRON director
Vice-president, IAU Commission 14
Co-chair, Scientific Organising Committee, From circumstellar disks to planetary systems, Garching

Franx
Chair, Nova network 1 science team
Member, MUSE science team
Member, JWST-NIRSPEC science team
Member, JWST Science Working Group
Member, ACS science team
Chair, ESO-ELT Science Working Group
Member, ESO-ELT Science and Engineering Core Working Group

Member, NL-PC Allocation Committee

Hoekstra
Member, Eilandtelescopen Time Allocation Committee
Member, Science Advisory Commitee, Isaac Newton telescopes Group

Hogerheijde
Member, ALMA Science Advisory Committee
Member, ALMA European Science Advisory Committee
Member, ALMA Science Integrated Project Team
Member, ALMA European Regional Center Coordinating Committee
Member, IRAM Programme Committee
Project Scientist for CHAMP+/Netherlands
Co-coordinator, JCMT Gould Belt legacy Survey
Member, Board of Directors Leids Kerkhoven-Bosscha Fonds
Member, Board of Directors Leids Sterrewacht Fonds
Member, Board of Directors Jan Hendrik Oort Fonds
Member, SOC workshop From Disks to Planets

Icke
Member, National Committee on Astronomy Education
Member, Minnaert Committee (NOVA Outreach)
Member, Netherlands Astronomical Society Education Committee
Member, Editorial Council Natuur & Techniek
Member, Advisory Council, Technika 10
Member, Board of Directors, Nederlands Tijdschrift voor Natuurkunde
Member, Jury 'Rubicon' (NWO)
Member, Jury, Annual Prize 'Wetenschap en Maatschappij'

Israel
Member, NWO Selection Committee for Free Competition Awards
Member, IAU Comissions 28, 40 and 51
Member, Science Team Herschel-HIFI
Member, Science Team JWST-MIRI
Member, Science Team APEX-Champ+
Member, Editorial Board Europhysics News
Coordinator-NL SCUBA2 Legacy Survey Nearby Galaxies

Jaffe
Director, NEVEC
Member, IAU Commission 40, 28
Member FITS Working Group

Member ESO User's Committee
Vice-Chairman European Interferometry Initiative

Katgert
Secretary/Treasurer, Leids Kerkhoven-Bosscha Fonds
Secretary/Treasurer, Leids Sterrewacht Fonds
Secretary/Treasurer, Jan Hendrik Oort Fonds

Kuijken
Advisor to National Delegate, ESO Council
Chair, ESO contact committee
Member, board of directors Kapteyn fonds
Member, board NOVA
Key researcher, NOVA Dieptestrategie
Member, ESO KMOS Instrument Science Team
Principal Investigator, ESO KiDS Survey
Principal Investigator, OmegaCAM project
Co-investigator, ESO VIKING Public Survey
Co-investigator, Planetary Nebulae Spectrograph project
Deputy coordinator, DUEL EU-FP6 Network
Local coordinator, EVALSO EU-FP7 programme
Member, board EARA
Member, board MICADO E-ELT instrument design study
External member, FWO-Flanders astronomy & physics programme committee
Member, DFG visiting committee, IMPRESS astronomy research school Heidelberg
Member, structuurcommissie Astrofysica, Universiteit Utrecht
Member, ERC Starting grants jury
Member, National commission for astronomy (NCA)
Member, board Physics society 'Diligentia', The Hague

van Langevelde
Member consortium board European VLBI Network
Member RadioNet Board and Executive Board
Coordinator EXPReS (Expres Production Real-time e-VLBI System), board and management team
PI, RadioNet reserach activity ALBiUS (Advanced Long Baseline Interoperable User Software)
Member board ESTRELA (Early Stage Training Site for European Long-wavelength Radio Astronomy)
Member board SKADS (SKA Design Studies)
Member board PrepSKA (Prepatory SKA studies)

Member European SKA Consortium
NOVA Instrumentation Steering Committee
Dutch URSI committee
Member board of directors Leids Kerkhoven Bosscha Fonds
Member board of directors Leids Sterrewacht Fonds
Member board of directors Jan Hendrik Oort Fonds
NWO I-science program committee
SKA klankbordgroep NL
Allegro steering committee

Linnartz
'SPIN' chair for Molecular Laboratory Astrophysics, LCVU
Editor CAMOP (Comments on Atomic, Molecular and Optical Physics)
Workgroup leader, FOM group FOM-L-027
Workgroup leader, FP7 ITN 'LASSIE' (Laboratory Astrochemical Surface Science In Europe)
Member, NWO-EW/CW 'DAN' (Dutch Astrochemistry Network)
Member, NWO-EW 'Vrije Competitie' allocation committee
Member, NASA Laboratory Astrophysics Panel
Member, NWO-CW 'Spectroscopy and Theory'
Member, NWO-FOM 'COMOP'' (Condensed Matter and Optical Physics)
Member, HRSMC research school
Chairman, 8th Workshop on Cavity Enhanced Spectroscopy
Member, International Scientific committee IPS (Infrard Plasma Spectroscopy)

Lub
Secretary, Netherlands Committee for Astronomy
Member, Board Astronomy & Astrophysics

van Lunteren
Education and Research Board Huizinga Institute

Miley
Vice President, International Astronomical Union (Education and Development)
Chair, International Universe Awareness Steering Committee
Chair, LOFAR Research Management Committee
Chairman, LOFAR Survey Science Group, Highest Redshift Objects
Member Executive Committee International Astronomical Union
Member, LOFAR Astronomy Research Committee

Member, Board of Governors of the LOFAR Foundation
Member, Max Planck Institut fur Radioastronomie Fachbeirat
Member, Core Team, LOFAR Surveys Key Project
Member, ESF Latsis Prize Committee

Portegies Zwart
Netherlands representative, ESF ASTROSIM
European ambassador, Meta Institute for Computational Astrophysics
member, Rhine Network: Inter European N-body community

Röttgering
Member, ESO OPC
Member, ASTRON Science Advisory Committee
Co-I, Near Infrared Spectrograph for Euclid, ESA's Dark Energy Mission
Member, Science team MID-infrared Interferometric instrument for VLTI (MIDI)
Member, XMM Large Scale Structure Survey Consortium
PI, DCLA (Development and Commissioning of LOFAR for Astronomy)
& project for the scientific preparation of science with
&LOFAR at 4 partaking Netherlands universities
Member, LOFAR Technical Working Group
Member, LOFAR Astronomy Development (LAD) board
Member, LOFAR Astronomy Research Committee (ARC)
Member, Selection panel NWO's Rubicon program.
Member, Spitzer warm legacy survey project SERVS

Schaye
Member of the steering committee, Virgo Consortium for cosmological supercomputer simulations
Co-Investigator, MUSE (Multi Unit Spectroscopic Explorer)
Member, MUSE science team
Member, LOFAR Epoch of Reionization science team
Member, ISTOS science team (Imaging Spectroscopic Telescope for Origins Surveys)
Member, Xenia science team (A probe of cosmic chemical evolution)
NL-representative, Euro-VO Data Center Alliance, Theoretical astrophysics expert group
Chair, Organizing Committee, LC workshop "The chemical enrichment of the intergalactic medium"
Member, Scientific Organizing Committee, "Cosmological reionization", Allahabad, India

Member, NWO Rubicon committee
PI, Marie Curie Excellence Team
PI, OWLS collaboration

Snellen
Member, Astron (WSRT/LOFAR) Programme Committee
Board member, Nederlandse Astronomen Club

Stuik
Associate member of the OPTICON Key Technologies Network
Member of the FP7 Network "Wide field imaging at the E-ELT: from GLAO to diffraction limit"

Tielens
Member management committee, COST Action CM0805 The chemical cosmos: understanding chemistry in astronomical environments

van der Werf
Member, James Clerk Maxwell Telescope Board
Principal Investigator, SCUBA-2 Cosmology Legacy Survey
Principal Investigator, Herschel Comprehensive ULIRG Emission Survey
Co-investigator, HIFI
Co-investigator, MIRI
Member, SAFARI Science team
Member, METIS Science Team
Member and co-chair of Galaxies Panel, ESO Observing Programmes Committee
Member, STFC Herschel Oversight Committee
Member, Scientific Organizing Committee of 3 international conferences
Member, TAMASIS Network

Appendix IV

Visiting scientists

Sterrewacht Leiden

Visiting scientists

Appendix IV

Name	Dates	Institute
K. Holhjem	Jan 20-23	AIfA Bonn, Germany
C. Tadhunter	Jan 26	University of Sheffield, UK
A. Duffy	Feb 23-27	University of Manchester, UK
L. Koopmans	Feb 24	University of Groningen, Netherlands
O. Vaquero	Feb 24	University of Groningen, Netherlands
J. Hartlap	Mar 2-3	AIfA Bonn, Germany
K. Holhjem	Mar 23-26	AIfA Bonn, Groningen
L. Allamandola	Apr 1-June 1	NASA AMES, USA
O. Vaquero	Apr 6	University of Groningen, Netherlands
A. Pal	Apr 15-22	Konkoly Observatory, Budapest, Hungary
J. Szulagyi	Apr 15-22	Konkoly Observatory, Budapest, Hungary
H. Zhao	May-Nov	University of St.Andrews, Scotland
E. Tenenbaum	May 1-31	Steward Observatory, University of Arizona
C. Bildfell	May 1-30	University of Victoria, Canada
C. Ferrari	May 5-8	Observatoire de la Côte d'Azur, Nice, France
C. Coti	May 5-19	Institute for advanced computer science, Paris, France
A. Stolte	May 8-9	Bonn University, Germany
T. Ishiyama	May 10-24	Tokyo University, Japan
A. Babul	May 18-19	University of Victoria, Canada
J.H. Fillion	May 18-19	SOLEIL, UPMC, Paris, France
M. Gieles	May 18-19	ESO, Chili

Name	Dates	Institute
B. Oppenheimer	May 19-June 6	University of Arizona, USA
M. Chun	May 21	University of Hawaii, USA
D. Maschiettie	June 1-july 3	Padua, Italy
S. McMillan	June 1-6	Drexel University, Philadelphia, USA
R. Keil	June 4-7	ZARM, Bremen, Germany
K. Holhjem	June 8-12	AIfA Bonn, Germany
K. Nitadori	June 15-22	University of Tokyo, Japan
L. Sales	June 17	University of Groningen, Netherlands
R. Crain	June 22-26	Swinburne University, Australia
P. Abraham	Juni 29- July 5	Konkoly Observatory, Budapest, Hungary
O. Mangete	July 25-30	Drexel University, Philadelphia, USA
A. Duffy	Aug 4-7	University of Manchester, UK
K. Holhjem	Aug 6-14	AIfA Bonn, Germany
M. Schirmer	Aug 6-14	AIfA Bonn, Germany
P. Brochado	Aug 10-20	Centro de Astrofísica da Universidade do Porto, Portugal
R. Keil	Aug 23-28	ZARM, Bremen, Germany
A. Biviano	Sep 13-19	Osservatorio Astronomico, Trieste, Italy
P. Melchior	Sep 14-15	University of Heidelberg, Germany
O. Pols	Sep 21-Oct 2	University of Utrecht, Netherlands
J. Nelson	Sep 26- Oct 4	UCSC, USA
V. Springel	Sep 30	MPA, Germany
R. Azzollini	Oct 5-6	Consejo Superior de Investigaciones Cientificas, Spain
A. Glauser	Oct 5-6	UK Astronomy Technology Centre, Scotland
A. Hernan	Oct 5-6	Consejo Superior de Investigaciones Cientificas, Spain
B. Devecci	Oct 11-15	
G. de Marchi	Nov 2-3	ESO, Noordwijk, Netherlands
E. Calzavarini	Nov 6	ENS, Lyon, France
I. Cherchneff	Nov 9-11	University of Basel, Switzerland
C. Qi	Nov 9-13	Harvard Smithsonian Center for Astrophysics, USA
C. Dalla Vecchia	Nov 2-6	MPE, Germany
M. Kato	Nov 8-22	Tokyo Institute of Technology, Japan
E. Dwek	Nov 9-12	Nasa, Goddard, USA
M. Gladders	Nov 18-20	University of Chicago, US

Name	Dates	Institute
C. Kemper	Nov 30-Dec 1	University of Manchester, UK
M. Gieles	Dec 3-4	ESO, Chili
A. Duffy	Dec 4-12	University of Western Australia, USA

Appendix V

Workshops, lectures, and colloquia in Leiden

Workshops, lectures and colloquia in Leiden

Appendix V

V.1. Workshops

Most of the workshops were held in the Lorentz Center, an international center which coordinates and hosts workshops in the sciences. In 2009 the Leiden astronomers contributed to the following workshops there:

February 2 - 6
Deep IR studies of the distant universe
P. van Dokkum, M. Franx

March 16 - 20
From Disks to Planets: Learning from Starlight, 2009 EARA workshop
D. Salter, I. Oliveira, M. Hogerheijde, E.F. van Dishoeck

April 6 - 9
Interactions in the Dark: physics of Dark Energy-Dark Matter interactions
H.S. Zhao, H. Hoekstra, B. Famaey, B. Foster

May 18 - 20
Varying Fundamental Constants
C. Martins, J. Brinchmann

May 25 - 29
The Chemical Enrichment of the Intergalactic Medium
J. Schaye, S. Borgani, J.X. Prochaska, J.M. Shull, C.C. Steidel

July 13 - 17
Distribution of Mass in the Milky Way Galaxy
A. Klypin, H. Zhao, J. Binney, L. Blitz, A.G.A. Brown

November 2 - 6
Cavity enhanced spectroscopy – Recent developments and new challenges
H.V.J. Linnartz, W. Ubachs, A. Ruth

November 23 - 27
Powerful Radio Galaxies: Triggering and Feedback
C. Tadhunter, R. Morganti, P. Best, J. Holt, N. Nesvadba, M. Hardcastle

November 30 - December 4
Astronomy 2009 - Astronomy and the New Media in the International Year of Astronomy
A. Allan, C. Odman, S. Kendrew, R. Simpson, S. Lowe, C. Lintott

Additional meetings:

October 9 – 10
Stockholm Astrobiology school visit
On October 8-10, about 15 members of the Stockholm Astrobiology school visited Leiden Observatory. They participated in the NOVA network 2 meeting in Leiden on October 8 and joint scientific talks and discussions with members of the astrochemistry and laboratory astrophysics groups were held on October 9-10.

November 23 – 27
WISH team meeting
On November 23-27, about 35 members of the `Water in Star-forming regions with Herschel' met in Leiden to discuss the initial Herschel PACS science demonstration phase data, as well as progress on complementary data and modeling efforts. More information can be found on www.strw.leidenuniv.nl/WISH

V.2. Endowed Lectures

Date	Speaker	Title
Apr 21	Bruce Draine	Cosmic Dust – Mother Nature's Galactic Beauty Powder
Oct 1	Jerry Nelson	Segmented Mirror Telescopes and the TMT (Thirty Meter Telescope)

V.3. Scientific Colloquia

Date	Speaker (affiliation)	Title
Jan 29	Leon Koopmans (Kapteyn)	*Strong Gravitational Lens Modeling: The Structure & Evolution of Early-type Galaxies to z=1 and beyond*
Feb 4	Christoph Pfrommer (CITA)	*Deciphering an enigma - Non-thermal emission from galaxy clusters*
Feb 5	David Raban (Leiden Observatory)	*Mid-IR interferometric studies of nearby AGN (PhD student colloquium)*
Feb 12	Matt Lehnert (Observatoir de Paris, GEPI)	*Direct Observations of (some of) the Physical Drivers of Galaxy Evolution*
Feb 19	Susanne Aalto (Onsala)	*Molecular gas and chemistry in dusty nuclei*
Feb 23	Ivo Labbé (OCIW)	*The formation histories of massive galaxies*
Feb 24	Carsten Dominik (University of Amsterdam)	*Dust in protoplanetary disks: Tales of optical depth*
Feb 25	Matthew Kenworthy	*Direct Imaging of Exoplanets: Promises and Challenges*
Mar 4	Rychard Bouwens (Lick Observatories)	*Early Galaxy formation: Studying the build up and evolution of galaxies during the first 2 Gyr of the Universe*
Mar 5	Joeri van Leeuwen (Astron)	*Radio pulsar surveys and the evolution of neutron-star binaries*
Mar 10	Joe Tufts (Las Cumbres Observatory)	*A biased approach to efficient ELT instrumentation*
Mar 12	Dave Lommen (Leiden Observatory)	*The first steps of planet formation - Studying grain growth with millimetre interferometers (PhD colloquium)*
Mar 13	Michael McElwain (Princeton)	*Exoplanetary Science: Instrumentation, Observations, and Expectations*
Mar 16	Lucas Labadie (MPIA Heidelberg)	*Exoplanetary Systems: Instrumentation, Technology and Observations*
Mar 19	Georges Meynet (Geneva Observatory)	*Evolution of Massive Stars along the Cosmic History*
Mar 20	Frans Snik (Utrecht)	*Polarized views of the Universe*

Date	Speaker (affiliation)	Title
Mar 26	Chris Pritchett (University of Victoria)	*The Supernova Legacy Survey - Cosmology and Constraints on the Nature of Type Ia Supernovae*
Apr 2	Thomas Henning (MPIA Heidelberg)	*The Formation of Massive Stars*
Apr 8	Carolina Ödman (Leiden Observatory)	*Universe Awareness*
Apr 22	Margaret Meixner (STScI)	*Spitzer Survey of the Large Magellanic Cloud, Surveying the Agents of a Galaxy's Evolution (SAGE)*
May 7	Matthias Bartelmann (Institut für Theoretische Astrophysik, Heidelberg)	*Do we understand gravitational arcs?*
May 19	Alan McConnachie (Herzberg Institute for Astrpphysics)	*The Pan-Andromeda Archaeological Survey: unraveling galaxy formation in the near-field*
May 28	Crystal Martin (UCSB)	*Galactic Winds*
June 4	Karin Öberg (Leiden Observatory)	*Complex processes in simple ices - Gas-grain interactions during star formation (PhD colloquium)*
June 11	Andreas Pawlik (Leiden Observatory)	*Simulating cosmic reionization (PhD colloquium)*
June 18	Olja Panić (Leiden Observatory)	*The gas and dust spatial distribution in disks around low-mass stars*
June 25	Simon Portegies Zwart (Leiden Observatory)	*Simonfest*
Aug 6	Steve Kahn (Stanford)	*The Large Synoptic Survey Telescope*
Aug 27	Anne-Marie Weijmans (Leiden Observatory)	*Dark matter in early-type galaxies: mapping dark haloes with integral-field spectrography*
Sep 4	Elisabetta Micelotta (Leiden Observatory)	*PAH Processing in Space*
Sep 10	Richard Bower (Durham)	*The flipside of galaxy formation*
Sep 17	Ray Jayawardhana (University of Toronto)	*Exploring Young Brown Dwarfs: disks, companions and the bottom of the IMF*
Sep 21	Ruud Visser (Leiden Observatory)	*Chemical Evolution from Cores to Disks*
Oct 1	Jerry Nelson (UCSC)	*Segmented Mirror Telescopes and the TMT (thirty Meter Telescope) [2009 Sackler Lecture]*

Date	Speaker (affiliation)	Title
Oct 8	Jason Hessels (ASTRON/UvA)	*Exploring the World of Pulsars and Fast Radio Transients with LOFAR*
Oct 9	Pedro Beirao (Leiden Observatory)	*ISM Conditions in Starburst Galaxies (PhD colloquium)*
Oct 15	Jörg Hörandel (Radboud University Nijmegen)	*Exploring the highest-energy particles in the Universe with the Pierre Auger Observatory*
Oct 20	Cecilia Ceccarelli (Laboratoire d'Astrophysique de Grenoble)	*Molecular complexity and star formation*
Oct 22	Steve Balbus (Laboratoire de Radioastronomie)	*Differential Rotation and Convection in the sun*
Oct 29	Nathan de Vries (Leiden Observatory)	*The evolution of radio-loud Active Galactic Nuclei (PhD colloquium)*
Nov 11	Ian McCarthy (Kavli Institute for Cosmology, Cambridge University	*Thermal histories of galaxies and groups in cosmological hydrodynamic simulations*
Nov 11	Eli Dwek (NASA, Goddard Space Flight Center)	*Five Years in the Mid-Infrared Evolution of the SN 1987A Supernova Remnant*
Nov 12	Anatoly Spitkovsky (Princeton)	*Physics and Astrophysics of Collisionless Shocks*
Nov 19	Mike Gladders (Chicago)	*Strong Lensing by Optically-Selected Galaxy Clusters*
Nov 26	Matthew Bate (Exeter University)	*Numerical simulations of star cluster formation*
Dec 3	S. George Djorgovski (Caltech)	*Exploring the Time Domain With Synoptic Sky Surveys*
Dec 11	Edward Taylor (Leiden Observatory)	*10 Billion Years of Massive Galaxies*
Dec 14	Mark Krumholz (UCSC)	*Turbulence, Feedback, and Slow Star Formation*
Dec 17	Leo Blitz (UC Berkeley)	*Counterintuitive Star Formation*

V.4. Student Colloquia

Date	Speaker	Title
Feb 16	Wouter Spaan	*SOS: simulated observations of cluster simulations*
Feb 23	Bas Nefs	*A LABOCA continuum view on dusty envelopes in southern starforming regions*
June 2	Niels ter Haar	*Systematic study of radiation effects on Gaia astrometric measurements*
June 8	Sander de Kievit	*Starts around Recoiled Super Massive Black Holes*
June 15	Daniel Szomoru	*Biases in cosmic shear surveys*
June 22	Marco van der Sluis	*Analysis of the WFCAM Transit Survey: The search for planetary transits around M dwarfs*
June 29	Remco van der Burg	*The UV galaxy luminosity function at z=3-5*
July 6	Maarten van den Berg	*3D Weak Lensing with Galaxy Cluster MS0451*
July 13	Jesse van de Sande	*Sizes and colour gradients of High Redshift Galazies in GOODS CDFS*
July 20	Alireza Rahmati	*Evolution of Dusty Galaxies*
Nov 2	Charlotte de Valk	*The effects of CCD radiation damage on the EUCLID weak-lensing survey*

Appendix VI

Participation in scientific meetings

Sterrewacht Leiden

Participation in scientific meetings

Appendix VI

Alexander
EARA Workshop "From disks to planets: learning from starlight" (Leiden, Netherlands; Mar 16-20)
Talk: 'Can [NeII] emission-line profiles probe photoevaporative disc winds?'
The dynamics of discs and planets (Cambridge, UK; Aug 17-21)
Poster: 'Planet migration in evolving gas discs'
Angular Momentum Transport and Energy Release in Accretion Discs (Cambridge, UK; Sep 7-8)
Invited talk: 'Giant planet migration, disc evolution, and the origin of transitional discs'
Dynamics of Outer Planetary Systems (Edinburgh, UK; Nov 9-11)
Invited review talk: 'Outer disc evolution'

Amiri
ESTRELA workshop (Bologna, Italy; Jan)
Scientific Writing workshop (Blankenberge, Belgium; May)
ESTRELA workshop (Gothenberg, Sweden; May)
Maser Workshop (Bonn, Germany; Nov 11-12)

Arasa
42nd IUPAC Conference (Glasgow, Scotland; Aug 1-7)
'Molecular dynamics simulations of ice photochemistry at different Temperatures'
GORDON Conference (Dynamics At Surfaces),Proctor Academy (Andover, USA; Aug 9-14)
'Molecular dynamics simulations of ice photochemistry at different Temperatures'

Baneke
Landelijke Werkgroep Wetenschapsgeschiedenis (Woudschoten, Netherlands; June 26-27)
Hoe word ik astronoom? Veranderingen in de professionele identiteit, IUHPS / ICHST (Budapest, Hungary; July 28-Aug 2)
'Look South, Go West. The astronomical community, 1870-1940'
History of Science Society Annual Meeting (Phoenix, USA; Nov 19-22)
'Educating Astronomers: the astronomical community 1880-1940'

Bast
Vatican Observatory Super Science Summer School 2009 Astronomy: A Common Ground for Sharing Humanity's Concerns (Sassone, Italy, June; 21-26)
'Exploring terrestrial planet-forming regions in protoplanetary disks with high resolution spectroscopy'
42nd IUPAC congress Analysis & Detection Astrochemistry (Glasgow, UK; Aug 2-5)
'Exploring the chemical and physical structure of terrestrial planet-forming zones in protoplanetary disks with CO line profiles'
CRIRES + CO meeting (Amsterdam, Netherlands; Aug 31)
'Single-peaked CO emission line profiles from the inner regions of disks'

Van Bemmel
SKADS DS2 team meeting (Valletta, Malta; Jan 6-8)
'SimCa for LOFAR: ionospheric impact on imaging'

Booth
The Monster's Fiery Breath (Madison, WI, USA; Jun 1-6)
'AGN modelling in a cosmological context'
Virgo Consortium Meeting (Garching, Germany; Jan 28-29)
'Understanding AGN models'

Bouwman
International Symposium on Molecular Spectroscopy (Columbus OH, USA; June 22-26)
'Shining light on PAHs in interstellar ices'
NAC - Dutch Astronomy Conference (Kerkrade, Netherlands; May 13 – May 15)
'Shining light on PAHs in interstellar ices'

Brandl
AO4ELT (Paris, France, June; 22-26)
'Extreme Adaptive Optics in the mid-IR: The METIS AO system'
SFR@50 (Spineto, Italy; July 5-10)
'Starburst Activity on Small Scales'

Brinch
Data Needs for ALMA (Cologne, Germany; Oct 5-7)
ARTIST meeting (Bonn, Germany; Nov 9-11)
'Introducing LIME'

Brinchmann
Deep IR studies of the distant universe (Leiden, Netherlands; Feb 2-6)
'Estimating gas masses in galaxies. Can we move past the Kennicutt-Schmidt law?'
ESO Spectroscopic Survey Workshop (Garching, Germany; Mar 9-10)
An astronomical Observatory at Concordia (Dome C, Antarctica) for the next decade (Frascati, Italy; May 11-15)
Imaging at the E-ELT - a one day workshop (Garching, Germany; May 29)
'Deep Extra-Galactic Imaging'
IAU General Assembly, S262: Stellar Populations: Planning for the Next Decade (Rio de Janeiro, Brazil; Aug 3-7)
'Challenges in Stellar Population Studies'
UK E-ELT Science Workshop II. Stellar Populations with the European ELT(Cambridge, UK; Sep 17-18)
'Challenges in Stellar Population Studies'
Assembly, Gas Content and Star Formation History of Galaxies (Charlottesville, USA; Sep 21-24)
'Moving past the Kennicutt-Schmidt law?'
Observing the Dark Universe with Euclid (Noordwijk, Netherlands; Nov 17-18)

Brown
ELSA CCD modelling workshop (Leiden, Netherlands; Jan 19-21)
Talk: 'Dealing with Gaia CCD radiation damage effects: overview of activities'
ELSA Mid-Term Review and follow-up meeting (Brussels, Belgium; Feb 2-4)
Gaia Science Team meeting (Noordwijk, Netherlands; Feb 26-27)
Gaia radiation calibration working group meeting (Noordwijk, Netherlands; mar 6)
GREAT kick-off meeting (Cambridge, UK; Mar 26-27)
Talk: 'ELSA - European Leadership in Space Astrometry'
Gaia Coordination Units 2 and 3 meeting (Torino, Italy; Apr 20-23)
Nederlandse Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)

Gaia Science Team meeting (Noordwijk, Netherlands; May 19-20)
Satellite dynamics: Simulation challenges and requirements (Bremen, Germany; June 18-19)
Gaia calibration workshop (Leiden, Netherlands; June 25-26)
Talk: 'Gaia System Calibration Plan Workshop – Introduction'
Gaia radiation calibration working group meeting (Noordwijk, Netherlands; July 7)
Talk: 'CDM-02 validation and parameter estimation - progress report'
GREAT Gaia spectroscopic follow-up meeting (Cambridge, UK; July 8-9)
Talk:' Gaia - need for follow-up spectroscopy'
Distribution of Mass in the Milky Way Galaxy (Leiden, Netherlands; July 13-17)
The Milky Way and the Local Group - Now and in the Gaia Era (Heidelberg, Germany; Aug 31 - Sep 4)
Invited talk: 'The scientific impact of Gaia'
Gaia Science Team meeting (Noordwijk, Netherlands; Sep 17-18)
ELSA School on the Techniques of Gaia (Heidelberg, Germany; Sep 28 - Oct 2)
AMUSE workshop (Leiden, Netherlands; Oct 5-7)
Gaia calibration working group meeting (Noordwijk, Netherlands; Oct 6)
Talk: 'DPAC inputs to the Gaia Calibration Plan'
Gaia DPAC Radiation Task Force meeting (Cambridge, UK; Oct 26-27)
Gaia Coordination Unit 8 meeting (Nice, France; Nov 18)
Talk: 'Status of hardware issues and data processing for BP/RP'
GREAT plenary meeting (Nice, France; Nov 19-20)
Gaia Coordination Unit 5 meeting (Barcelona, Spain; Dec 1-4)

van der Burg
Nationale Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)
'The UV Luminosity Function at z=3-5'
Galaxies and Cosmology meeting (Groningen, Netherlands; Aug 24)
Observing the Dark Universe with Euclid (Noordwijk, Netherlands; Nov 17-18)

Busso
GAIA CU5 Plenary Meeting (Bologna, Italy; Mar 17-20)
GAIA CU5 Plenary Meeting (Barcelona, Spain; Dec 1-4)
IAU XXII General Assembly, JD5 "Modelling the Milky Way in the Era of Gaia" (Rio de Janeiro, Brazil)
'Gaia Photometric Data Processing in Crowded Fields'

Cuppen
Annual FOM meeting (Veldhoven, Netherlands; Jan 20-21)
Annual CW Theoretical Chemistry and Spectroscopy meeting (Lunteren, Netherlands; Jan 26-27)
'H2 formation on graphitic surfaces'
Heterogeneous Chemical Processes in the Astronomical Environment (London, UK; June 16)
'Surface processes on interstellar grains: linking laboratory data with models'
Nordic-NASA Summerschool on Water, Ice and the Origin of Life in the Universe (Iceland; June 29-July 10)
Contribution 1: 'Depletion of molecules in the pre-collapse phase of star-forming regions'
Contribution 2:'Chemistry on icy grain surfaces'
Contribution 3: 'Introduction into Monte-Carlo studies on ice surface chemistry'
42nd International Union of Pure and Applied Chemistry congress "Chemistry Solutions"(Glasgow, UK; Aug 2-7)
Contribution 1: 'H2 formation on graphitic surfaces'
Contribution 2: 'Surface processes on interstellar grains: linking laboratory data with models'
European Conference on Surface Science 26 (Parma, Italy; Aug 30- Sep 4)
'Surface processes on interstellar grains: linking laboratory data with models'

Deep
NAC 2009 ,Rolduc (Kerkrade, Netherlands; May 13-15)
ASSIST: the test set-up for VLT adaptive optics facility AO4ELT (Paris, France; June 22 -26)
'Use of AO PSF Models for the Study of Resolved Stellar Population'

Van Delft
Het biografisch portaal (Amsterdam, Netherlands; Mar 27)
'Het nut van een biografisch portaal'
Symposium Natural History Museum Maastricht (Maastricht, Netherlands; May 15)
'Over conservatoren, wetenschap en waarde'
Dutch Science, World Science (Woudschoten, Netherlands; June 26-27)
'Museum Boerhaave and the History of Science'; Koude drukte'
'Het Leidse cryogeen laboratorium en de internationale temperatuurschaal 1927'
The relations of science and technology as portrayed in Museums (London, UK; Sep 20-22)
'The Quest for Absolute Zero. A Human Story about Rivalry & Cold'
HSS Annual Meeting 2009 (Phoenix, USA; Nov 19-22)

'Cool Reception. Leiden's Quest for Cold and the International Temperature Scale 1927'

van Dishoeck
Submillimeter astrophysics and technology (Pasadena, USA; Feb 23-25)
Invited: 'Sun-bathing around low-mass protostars: APEX-CHAMP+ observations of high-J CO'
From Disks to planets: learning from starlight (Leiden, Netherlands; Mar 17-20)
Invited: 'Disks and their evolution: future prospects'
ALMA and ELTs: a deeper, finer view of the Universe (Garching, Germany; Mar 24-27)
Invited review: 'Star- and planet formation in our Galaxy: ALMA-ELT synergies'
StScI symposium: The search for life in the Universe (Baltimore, USA; May 4-7)
Invited review: 'Complex organic molecules in star- and planet-forming regions'
High angular resolution observations at millimeter wavelengths (Taipei, Taiwan; June 6-10)
Invited review: 'Water and organic molecules in disks: ALMA and IR synergy'
Science with JWST-MIRI (Chicago, USA; June 15-16)
'MIRI observations of protostars'
Astrochemistry: 42nd IUPAC congress (Glasgow, UK; Aug 2-5)
Invited review: 'Chemistry during star- and planet formation'
To the edge of the Universe: 30 yr IRAM (Grenoble, France; Sep 28-30)
Invited review: 'Astrochemistry'
Spitzer and VLT observations of protostars and protoplanetary disks (Garching, Germany; Oct 30 - Nov 2)
'Introductory overview'
From circumstellar disks to planetary systems (Garching, Germany; Nov 3-6)
Invited review: 'Chemistry of protoplanetary disks'
Herschel science demonstration phase results (Madrid, Spain; Dec 17-18)
'First results from the WISH key program'

Elbers
Annual Meeting History of Science Society (Phoenix (AZ), USA; Nov 19-22)
'Radio astronomy in the Netherlands: a peculiar history'

Fayolle
NAC 2009 (Kerkrade, Netherlands; May 13-15)
Poster: 'Ice Segregation around Protostars'
42nd International Union of Pure and Applied Chemistry Congress (Glasgow, UK ; Aug 2-7)

Poster: 'Thermal Dynamics of Ice Mixtures'
NOVA Fall School, Dwingeloo, Netherlands; Oct 5 - 9
'Ices in Star Forming Regions'

Groves
Galaxy Metabolism: Galaxy Evolution near and far (Sydney, Australia; 22-26 June 2009)
Invited Talk: 'The UV-IR SEDs of Galaxies'
Powerful Radio Galaxies: Triggering and Feedback, Lorentz Center (Leiden, Netherlands; 23-27 Nov)
Talk: 'Distinguishing Diagnostics; Emission Line Ratios as analysis tools'

Haas
IAU General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
'Galactic consequences of clustered star formation'
Nederlandse Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)
'Physical Properties of Simulated Galaxies'
Virgo Meeting (Garching, Germany; Jan 28-29)

Harfst
NAC 2009 (Kerkrade, Netherlands; May 13-15)
'Reconstructing Arches'

Hildebrandt
Meeting of the DUEL Network (Heidelberg, Germany; Jan 14-16)
'DUEL Node Overview Leiden'
NAC 2009 (Kerkrade, Netherlands; May 13-15)
DUEL Mid-Term Review (Edinburgh, UK; July 8-9)
Meeting of the CFHTLS Collaboration (Edinburgh, UK; Oct 1-3)
'Cosmic Magnification - A New Window to Cosmology'

Hoekstra
Dutch Astroparticle-physics meeting (Leiden, Netherlands; Mar 20)
'Weak lensing by large scale structure'
Lorentz Workshop "Interactions in the dark"(Leiden, Netherlands; Apr 6-9)
'Weak gravitational lensing'
JENAM (Hertfortshire, UK; Apr 20-23)
'Weak lensing by large scale structure: results from the CFHTLS'
'Weak lensing studies of galaxy clusters'
Nederlandse Astronomen Club AGM (Kerkrade, Netherlands; May 13-15)
'Weak lensing by large scale structure'
Galaxy masses (Kingston, Canada; June 15-19)

'Weak lensing studies of galaxy halos'
Lensing school (Paris, France, Aug 26-29)
'Lectures on shape measurement methods'
NOVA herfstschool (Dwingeloo, Netherlands; Oct 6-9)
'Lecture series on gravitational lensing'

Hogerheijde
From Disks to Planets (Leiden, Netherlands; Mar 16-20)
ALMA and the ELTs (Garching, Germany; Mar 24-27)
Nederlandse Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)
'An arc of gas and dust around the young star DoAr21'
Submillimeter Astronomy at High Angular Resolution (Taipei, Taiwan; June 8-12)
'Gas and dust in protoplanetary disks: recent results from SMA, CARMA, and PdBI'
Data Needs for ALMA (Cologne, Germany; Oct 5-7)
'Self–consistent radiative transfer models of low–mass protostars in the ALMA era'
From Circumstellar Disks to Planetary Systems (Garching, Germany; Nov 3-6)
Poster: 'An arc of gas and dust around the young star DoAr 21'

Holt
Deep IR studies of the distant universe (Leiden, Netherlands; Feb 2-6)
'UltraVISTA survey: progress report AGN-induced outflows in young radio sources'
UK National Astronomy Meeting (Hatfield, UK; Apr 20-23)
'AGN-induced feedback in young radio galaxies'
Powerful Radio Galaxies: Triggering and Feedback (Leiden, Netherlands; Nov 23-27)
'Member of the SOC'

Ioppolo
CW Theoretical Chemistry and Spectroscopy meeting (Lunteren, Netherlands; Jan 26-27)
Poster: 'Laboratory Evidence for Efficient Water Formation in Interstellar Ices'
Nordic-NASA Summer School: Water, Ice and the Origin of Life (Reykjavik, Iceland; June 29-July 13)
Poster: 'Water Formation in the Interstellar Medium'
42nd IUPAC World Chemistry Congress (Glasgow, UK; Aug 2-7)
Poster: 'Water Formation in the Interstellar Medium'

Isokoski
CW Theoretical Chemistry and Spectroscopy meeting (Lunteren, Netherlands; Jan 26-27)

Poster: 'Double-Insertion of Xe into Water: HXeOXeH '
Nordic-NASA Summer School: Water, Ice and the Origin of Life (Reykjavik, Iceland; June 29-July 13)
NOVA Fall School 2009 (Dwingeloo, Netherlands; Oct 5-9)

Israel
3rd Arena Conference: An astronomical observatory at Concordia (Dome C, Antarctica) for the next decade (Frascati , Italy; May 11-15)
`Dense star forming gas and dust in the Magellanic Clouds'
The Many Faces of Centaurus A (Sydney, Australia; Jun 28 - Jul 3)
`Emission and absorption of circumnuclear molecular gas in Centaurus A'

Jaffe
Interferometry of AGNs (Heidelberg, Germany; Mar 29-30)
MIDI Science Team Meeting(Heidelberg, Germany; Apr 21-23)
MIDI Science Team Meeting(Heidelberg, Germany; Nov 09-10)

Johansen
Turbulence-Assisted Planetary Growth (Uppsala, Sweden; Feb 25-27)
'Why do planets rotate?'
Planet Formation and Evolution: The Solar System and Extrasolar Planets (Tübingen, Germany; Mar 02-06)
'Formation and growth of planets in turbulent protoplanetary discs'
From Disks to Planets: Learning from Starlight (Leiden, Netherlands; Mar 16-20)
'Why do planets rotate?'
The Astrophysics of the Magnetorotational Instability and Related Processes (Ringberg, Germany; Apr 14-18)
'The role of the MRI for planetesimal formation'
Workshop on the Magneto-Rotational Instability in Protoplanetary Disks (Kobe, Japan; June 02-03)
'Planetesimal formation in turbulent protoplanetary discs'
Origins Of Solar Systems (Mt Holyoke, Massachusetts, USA; July 05-10)
'Formation and growth of planets in turbulent protoplanetary discs'
The Dynamics of Discs and Planets (Cambridge, United Kingdom; Aug 17-21)
'The crucial role of metallicity for planetesimal formation'
Pencil Code User Meeting 2009 (Heidelberg, Germany; Aug 24-28)
'Pencil Code on a Blue Gene/P'
Angular momentum transport and energy release in accretion discs (Cambridge, United Kingdom; Sep 07-08)
'Computer simulations of the Parker instability in strongly magnetised

Keplerian discs'
ISM/CSM Meeting (Leiden, Netherlands; Oct 08)
'On the metallicity dependence of planet formation'

Kendrew
MIRI European Consortium meeting (Leuven, Belgium; Jan 21-23)
MIRI European Consortium meeting (Leicester, UK; Apr 28-30)
METIS progress meeting (Edinburgh, UK; May 19)
IAU General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
'High-resolution infrared spectroscopy at high and low altitudes'
MIRI European Consortium meeting (Copenhagen, Denmark; Sep 8-9)
DotAstronomy workshop(organizing committee) (Leiden, Netherlands; Nov 30- Dec 4)

Kóspál
Planet Formation and Evolution: The Solar System and Extrasolar Planets (Tübingen, Germany; Mar 2 – 6)
Contributed talk: 'On the relationship of planets and debris disks'
From Disks to Planets: Learning from Starlight (2009 EARA workshop) (Leiden, Netherlands; Mar 16 – 20)
Contributed talk: 'On the relationship of planets and debris disks'
From circumstellar disks to planetary systems (Garching, Germany; Nov 3 – 6)
Poster: 'Infrared variability as disk diagnostics'

Kristensen
Herschel data processing spectroscopy workshop (Madrid, Spain; Mar 24-26)
42nd IUPAC Congress (Glasgow, Scotland; Aug 2-4)
Talk: 'Mapping CH3OH emission in young stellar objects'
Herschel data reduction and first results workshop (Madrid, Spain, Dec 14-18)

Kruip
Subdivide and Tile(Leiden, Netherlands; Nov 16-21)
'Systematic effects in transport over Delaunay structures'

Kuijken
ESO Committee of Council (Garching, Germany; Mar 2-3)
ESO Spectroscopic Surveys Workshop (Garching, Germany; Mar 9-10)
'Extragalactic imaging surveys with VST and VISTA'
EUCLID Stakeholders' meeting, ESTeC (Noordwijk, Netherlands; Mar 20)

'Dutch contributions to EUCLID'
ESO Council (Vienna, Austria; June 3-4)
OmegaCAM/VST interface meeting, ESO (Garching, Germany; June 16-17)
Workshop on Astronomical Instrumentation, TU (Delft, Netherlands; July 8
'Instrument research in Astronomy'
Workshop on using OmegaCAM/VST Guaranteed Time Observations (Naples, Italy; July 20-21)
'OmegaCAM Guaranteed Time plans; the KiDS survey'
ESO Committee of Council (San Pedro de Atacama, Chile; Oct 5-7)
Planetary Nebulae Spectrograph Team meeting (Malta; Oct 20)
EUCLID Conference, ESTeC (Noordwijk, Netherlands; Nov 17-18)
'Groundbased imaging for the EUCLID mission'
MICADO phase A final review meeting, ESO (Garching, Germany; Nov 30-Dec 1)
ESO Council (Garching, Germany; Dec 9-10)

Kuiper
Deep IR studies of the distant universe (Leiden, Netherlands; Feb 2 - 6
Talk: 'Galaxy Populations in a protocluster at z=3.13'
Galaxy Clusters in the Early Universe (Pucon, Chile; Nov 9 – 12)
Talk: 'Growing up in the city: Galaxy populations in a z~3 protocluster'

van Langevelde
Start International Year of Astronomy (Paris, France; Jan 15-16)
'Introducing the e-VLBI demo'
Int. SKA Forum (Cape Town, South Africa; Feb 23-28)
Science and Technology of Long Baseline Real-time Interferometry: The 8th International e-VLBI Workshop (Madrid, Spain; June 21-26)
"The future of e-VLBI" dot-Astronomy 2009 (Leiden, the Netherlands; Nov 30-4)
'e-VLBI: a telescope larger than Europe'

Linnartz
CW 'Spectroscopy and Theory' meeting (Lunteren, Netherlands; January)
DPG Meeting, Special symposium 'High resolution spectroscopy' (Hamburg, Germany; Mar 2-6)
ISM/CSM meetings (Amsterdam, Netherlands; June 5)
Clustertreffen Heraeus Stiftung (Freiburg, Germany; Oct 4-7)
ISM/CSM meeting (Leiden, Netherlands; Oct 8)
8th Workshop on cavity enhanced spectroscopy (Leiden, Netherlands; Nov 2-6)

Lub
Opening Ceremony International Year of Astronomy 2009 (Unesco, Paris , France; Jan 15-16)
Stellar Pulsation, Challenges for Theory and Observation (Santa Fe NM, USA; May 31 - June 5)
IAU General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
Nederlandse Astronomenconferentie (NAC) (Rolduc; Netherlands; May 13 – 15)

Van Lunteren
Meeting of the Dutch Mass Spectrometry Society (NVMS) and the Belgium Society for Mass Spectrometry (BSMS), Rolduc (Kerkrade, Netherlands; Mar 25-26)
'Instruments and the early-modern rise of experimental science'
KNAW symposium 'Alexander von Humboldt in Holland (1800-1900)' (Amsterdam, Netherlands, Apr 3)
'Buys Ballot as a Humboldtian scientist'
History of Science Society Annual Meeting (Phoenix, USA, Nov 19-22)
'Frederik Kaiser, popular astronomy, and the decline of natural theology'

Madigan
Physics of Galactic Nuclei (Ringberg, Germany; June 15-19)
'A new secular instability in eccentric stellar disks around supermassive black holes, with application to the Galactic Center'
ASGI Meeting (Galway, Ireland; Oct 8-9)
'A New Instability in Eccentric Stellar Disks around Supermassive Black Holes'
Galactic Center Workshop 2009 (Shanghai, China; Oct 19-23)
'A New Instability in the Eccentric Stellar Disk Around SgrA'*
Stars and Singularities (Rehovot, Israel; Dec 8-14)
'Resonant relaxation and the angular momentum distribution of stars around MBHs'

Marrese
GAIA CU5 Plenary Meeting(Bologna, Italy; Mar 17-20)
GAIA CU5 Plenary Meeting (Barcelona, Spain; Dec 1-4)

Martinez-Galarza
MIRI Data analysis workshop (Leuven, Belgium; Jan 19-23)
'Wavelength characterisation of the MIRI Medium Resolution Spectrmoeter'
MIRI Data analysis workshop (Madrid, Spain; June 1-5)
XXVII IAU General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
'Characterizing Star Formation in 30 Doradus via Mid-IR Starburst Modelling Astronomy Education and Research in Colombia'

MIRI EC Meeting (Copenhagen, Denmark; Sep 8-10)
MIRI Test team meeting (Ghent, Belgium; Dec 2-4)
'Wavelength characterisation of the MIRI Medium Resolution Spectrmoeter'

Miley
International Year of Astronomy Opening Ceremony (UNESCO) (Paris, France; Jan 15 - 16)
IAU Symposium 260 - Astronomy and Culture (UNESCO) (Paris, France; Jan 15 - 16)
'The IAU Strategic Plan: Astronomy for the Developing World'
VTB-Pro Symposium
'The Universe Awareness Programme for very young children'
LOFAR Survey Science Team (ROE) (Edinburgh, Scotland; June 17 - 19)
'The LOFAR High-redshift programme'
IAU General Assembly (Rio de Janeiro, Brazil; Aug 2 - 15)
The IAU Strategic Plan (Science City, Tunis; June 22)
The IAU Strategic Plan (IAU Special Session 2; Aug 5)
The IAU Strategic Plan (IAU Special Session 4; Aug 7)
Influence of Society on Astronomical Discovery (IAU Special Session 5; Aug 14)
International UNAWE Workshop (Aug 9)
EU-South African Collaboration in astronomy (Brussels, Belgium; Sep 24)
The IAU Strategic Plan
ESO Conference on distant cluster (Pucon, Chile; Nov 9 - 12)
'Probing distant protoclusters with radio sources'
Deciphering the Universe through Spectroscopy (Potsdam, Germany; Sep 21-25)
'Cosmogrid: Simulating the Universe across the Globe'

De Mooij
2009 Sagan Exoplanet Summer Workshop: Exoplanetary Atmospheres (Pasadena CA, USA; July 20-24)

Nefs
NOVA Fall School (Westerbork, Netherlands; Oct 5-9)
'Hot planets and cool stars-the hunt for M dwarf planets'
RoPacS meeting (La Laguna Tenerife, Spain; Nov 17-19)
'Hot planets and cool stars-Leiden analysis and follow-up'

Öberg
Advancing Chemical Understanding through Astronomical Observations (Green Bank, West Virginia, U.S.A.; May 26-29)

'Complex processes in simple ices Ð the role of UV light'

Ödman
IAU Symposium 260 (Paris, France; Jan 19 – 13)
'Universe Awareness: Inspiring young children around the world'
2nd International Meeting of Astronomy and Astronautics (Campos de Goytacazes, Brazil; Apr 17 – 20)
'The Universe Awareness Programme'
JENAM - European week of Astronomy and Space Science (Hatfield, UK; Apr 20 – 23)
'Making Universe Awareness Happen'
Building the Scientific Mind (co-organiser) (Cairo, Egypt; May 10 – 14)
'Universe Awareness: A programme about children'
'Building the scientific mind in practice: Analysis of the 'Stars at your Fingertips' workshop'
IAU General Assembly (Rio de Janeiro,Brazil; Aug 3 – 14)
'Universe Awareness: an update (SpS2)'
'Universe Awareness: Innovations in Astronomy Education (SpS4)'
4th International UNAWE Multidisciplinary Workshop (organisor) (Rio de Janeiro, Brazil; Aug 9 – 10)
South Africa - EU International Year of Astronomy event (co-organisor) (Brussels, Belgium; Sep 24)
Astronomy 2009, Lorentz Center (co-organisor) (Leiden, Netherlands; Nov 30 - Dec 4
'Boinc 101, introduction to a citizen science platform'

Oliveira
From Disks to Planets (Leiden, Netherlands; Mar 16 – 20)
'Serpens as a laboratory for star and planet formation'
NAC (Rodulc, Netherlands; May 13 – 15)
'Evolution of Young Stars and their Disks in Serpens'
ASTROCAM Summer School (El Escorial, Spain; Jun 29 - Jul 3)
'Serpens as a laboratory for star and planet formation'
General Assembly of the IAU - Special Session 7 (Rio, Brasil; Aug 11 – 14)
'Evolution of Young Stars and their Disks in Serpens'
From Circumstellar Disks to Planetary Systems (Garching, Germany; Nov 3 – 6)
'Evolution of Young Stars and their Disks in Serpens'

Oonk
IAU General Assembly XXVII - JD2 Diffuse Light in Galaxy Clusters (Rio de Janeiro, Brasil; Aug 3-14)

'Extended Ionized and Molecular Gas Emission in Galaxy Clusters'
IAU General Assembly XXVII - JD8 Hot Interstellar matter in Elliptical Galaxies (Rio de Janeiro, Brasil; Aug 3-14)
'Extended Ionized and Molecular Gas surrounding Brightest Cluster Galaxies'
IAU General Assembly XXVII - S267 Evolution of Galaxies and Central Black
Holes: Feeding and Feedback (Rio de Janeiro, Brasil; Aug 3-14)
'Ionized and Molecular Gas in and around Brightest Cluster Galaxies'

Paardekooper
The Cosmic Evolution of Helium and Hydrogen (Ringberg, Germany, Mar 24-27)
'*SimpleX: Radiative Transfer on an Unstructured, Dynamic Grid*'

Panič
From Disks to Planets: Learning from Starlight (Leiden, Netherlands; Mar 16-20)
'Do gas and dust in discs have their story straight?'
Scientific Writing for Young Astronomers (Blankenberge, Belgium; May 18-20)
ISM/CSM meeting (Amsterdam, Netherlands; June 5)

Pelupessy
Workshop on Galaxy formation (Sesto, Italy; July 13-17)
Molecular gas and Star Formation in Galaxy Simulations: emergent empirical rela$AMUSE kickoff meeting and workshop (Leiden, Netherlands; Oct 5-7)
'Science with AMUSE'

Portegies Zwart
MODEST-9b (Tokyo, Japan, Sep 5-10)
KNAW FOS (Beijing, China, Nov 7-10)

Prod'homme
CCD modelling workshop at Dutch Space (Leiden, Netherlands; Jan 19-21)
Talk: 'CTI Modelling at the CCD Pixel Level'
ELSA Mid-Term Review (Brussels, Belgium; Feb 2-3)
Talk: 'Radiation Damage on Gaia CCDs - Modelling to Mitigate the Threat'
4th Gaia Radiation Task Force (Cambridge, UK; Apr 6-7)
Talk: 'RC2 Charge Injection Profile Analysis'
Talk: 'CDM02 Validation'
1st EIROforum School on Instrumentation (CERN, Switzerland; May 11-15)

Poster: 'Radiation Damage on Gaia CCDs, Modelling to Mitigate the Threat'
IAU General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
Poster: 'Radiation Damage on Gaia CCDs, Modelling to Mitigate the Threat'
Poster: 'ELSA - a Research Training Network for Gaia'
The Milky Way and the Local Group - Now and in the Gaia Era (Heidelberg, Germany; Aug 31 - Sep 4)
Talk: 'Radiation Damage on Gaia CCDs - Modelling to Mitigate the Threat'
ELSA school on the techniques of Gaia (Heidelberg, Germany; Sep 28 - Oct 2)
Talk: 'Euclid'
5th Gaia Radiation Task Force (Cambridge, UK; Oct 26-27)
Talk: 'Testing CDM02 on Radiation Campaigns 2 data'

Rakic
The Chemical Enrichment of the Intergalactic Medium (Leiden, Netherlands; May 25-29)
'Observations of the IGM near star-forming galaxies at z ~ 2.3'
Harvesting the Desert: The Universe Between Redshift 1 and 3 (Marseille, France; June 29 - July 3)
'Observations of the IGM near star-forming galaxies at z ~ 2.3'

Rieder
MODEST-9c (Tokyo, Japan; Sep 7-14)
CosmoGrid
SIREN09 (Enschede, Netherlands; Nov 5-5)
MPWide: a light-weight communication library
SC09 (Portland OR, USA; Nov 14-20)
MPWide: a light-weight communication library

Risquez
CCD modelling workshop at Dutch Space (Leiden, Netherlands; January 19-21)
Talk: 'CCD experience from the Optical Monitoring Camera of Integral'
CU2 Metting Cycle 7 Kick-Off (Turin, Italy; April 21-24)
Talk:' Modelling Physical Effects in Gaia Attitude'
Workshop Simulation Challenges and Requirements (Bremen, Germany; June 18-19)
Talk: 'Gaia Attitude Model'
International Astronomical Union, General Assembly (Rio de Janeiro, Brazil; Aug 3-14)
Poster: 'ELSA - a Research Training Network for Gaia'
Poster: 'Gaia Attitude Model'

Congress The Milky Way and the Local Group - Now and in the Gaia Era (Heidelberg, Germany; Aug 31 - Sep 4)
Talk: 'Gaia Attitude Model'
ELSA School on the Techniques of Gaia (Heidelberg, Germany; Sep28 - Oct 2)
Talk: 'Gaia Attitude Model'

Röttgering
SKADS consortium meeting (Malta; Jan 9-10)
'SKA en ionospheric calibration'
Swedish LOFAR meeting(Stockholm, Sweden; Jan 15)
'LOFAR key programme on extra-galactic surveys'
Deep IR studies of the distant Universe (Leiden, Netherlands; Feb 2- 6)
'Two distinct accretion processes in radio galaxies'
Multi-field and multi-beam science with the SKA (Mar 16-17)
'Ionospheric calibration'
Meeting LOFAR key programme "Cosmic Magnetism" (Cambridge, USA; Mar 25-26)
'Progress report on LOFAR key programme on extra-galactic surveys'
Meeting LOFAR survey team (Edinburgh, UK; June 16-19)
The Space Infrared Telescope for Cosmology & Astrophysics: Revealing the Origins of Planets and Galaxies (Oxford, UK; July 6-8)
'SPICA and the upcoming revolution in radio astronomy'
Euclid team meeting (Bologna, Italy; Sep 20)
Evolution of galaxies from mass selected samples (Nov 9-13)
'Feedback, a few recent results'
Powerful Radio Galaxies: Triggering and Feedback (Leiden, Netherlands; Nov 23-27)
'Two distinct accretion processes in AGN: evolution up to z~1 and prospects for LOFAR'
Reionization@Ringberg: The Cosmic Evolution of Helium and Hydrogen (Ringberg Castle, Germany; Mar 24-27)
Invited review: 'Metals as a probe of helium reionisation'
The Chemical Enrichment of the Intergalactic Medium (Leiden, Netherlands; May 25-29)
MUSE science team meeting (Lyon, France; June 3-5)
Virgo collaboration meeting (Durham, U.K.; June 9-10)
Harvesting the desert: The universe between redshift 1 and 3 (Marseille, France; June 30 - July 2)
Invited review: 'Metals in the IGM as a star formation tracer'
SFR@50: Filling the Cosmos with Stars (Spineto, Italy; July 6-10)

Invited: 'Star formation laws and their role in models of the formation and evolution of galaxies'
IAU General Assembly XXVII - Joint Discussion #12 (Rio de Janeiro, Brazil; Aug 10-11)
Invited: 'Feedback from High Redshift Star Formation'
Hunting for the Dark: The Hidden Side of Galaxy Formation (Malta; Oct 19-23)
'Insights into the formation of galaxies from the OverWhelmingly Large Simulations project'
Virgo collaboration meeting (Durham, U.K.; Nov 30 - Dec 1)
'The OverWhelmingly Large Simulations project'
ELIXIR network meeting (Oxford, UK; Dec 10)
Invited: 'Feedback and self-regulation in galaxy formation'

Schleicher
Annual Fall Meeting of the German Astronomical Society "Deciphering the Universe through Spectroscopy" (Potsdam, Germany; Sep 21-25)
'Probing the center of high-redshift quasars with ALMA'
Kick-off workshop "The Formation of the First Stars" (Heidelberg, Germany; Oct 6)
'Primordial magnetic fields: Influence on reionization and the first stars'

Schrabback
AG Annual Fall Meeting - Splinter: Recent advances in cosmology, AIP (Potsdam, Germany; Sep 22-25)
3D Cosmological Weak Lensing with COSMOS CFHTLS weak lensing systematics workshop, ROE (Edinburgh, UK; Oct 1-3)
'Summary CFHTLS PCA PSF modelling'
Observing the Dark Universe with Euclid, ESTEC (Noordwijk, Netherlands; Nov 17-18)

Semboloni
CFHTLS workshop (Edinburgh, UK; Oct 1-3)
'Three-point shear statistics with the CFHTLS'

Serre
Galaxies at redshift >3 with MUSE (Toulouse, France; Mar 18-19)
'The MUSE Exposure Time Calculator'
Preparing the way to space borne Fresnel Imagers (Nice, France; Sep 23-25)
'The Fresnel Imager: Learning from ground-based generation I prototype'
'The Fresnel Imager: Instrument Numerical Model'

Snellen
Pathways towards habitable planets (Barcelona, Spain; Sept 14-18)
'Secondary eclipses in the PLATO era'
JENAM (Hatfield, UK; Apr 20-23)
'Ground-based observations of hot_jupiter atmospheres'
ROPACS meeting (Hatfield, UK; Apr 23)
'Transiting extrasolar planets at Leiden Observatory'
Dutch Exoplanet Meeting, UvA (Amsterdam, Netherlands; June 25)
'The changing phases of extrasolar planet CoRoT-1b'
Verwevenheid van onderzoek en onderwijs (Leiden, Netherlands; Sep 23)
'Undergraduate research in de sterrenkunde'
ROPACS, IAC (Tenerife, Spain; Nov 17-18)

Stuik
XXVII General Assembly of the International Astronomical Union (Rio de Janeiro, Brazil; Aug 3-14)
'Extreme Adpative Optics in the mid-IR: the METIS AO system'
Adaptive Optics for ELTs (Paris, France; June 22-26)
'Extreme Adaptive Optics in the mid-IR: the METIS AO system'
Nederlands Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)
'Adaptive Optics in Antarctica'

Tielens
JENAM, University of Hertfordshire (UK, Apr 21-23)
Keynote address: The cosmic journey of dust.
Life in the Universe, STScI (Baltimore, May 4-8)
Herschel Science Demonstration Phase Initial Results Workshop,The promise of HIFI.

Torstensson
4th ESTRELA Workshop (Bologna, Italy; Jan 19-22)
'JCMT observations of methanol in Cepheus A'
2nd Scientific Writing for Young Astronomers (Blankenberge, Belgium; May 18-20)
5th ESTRELA Workshop (Gothenburg, Sweden; May 27-29)
'Distribution and excitation of thermal methanol in Cepheus A'
Dutch ISM/CSM Meeting (Amsterdam, Netherlands; June 5)
'Distribution and excitation of thermal methanol in Cepheus A'
Masers: the ultimate astrophysical tools (Bonn, Germany; Nov 11-12)
'Methanol masers in Cepheus A'

van Uitert
DUEL winter meeting (Heidelberg Germany; Jan 13-16)

Unveiling the Mass: Extracting and Interpreting Galaxy Masses (Kingston, Canada; June 14-20)
Poster: Weak lensing in the RCS2 survey
DUEL summer school (Paris, France; Aug 23-28)

Visser
Computational Astrochemistry (London, UK; Jan 6-7)
'Chemical History of Ices in Protoplanetary Disks: Chemistry in a Dynamical Model'
Nederlandse Astronomen Conferentie (Rolduc, Netherlands; May 13-15)
'A New CO Photodissociation Model Applied to Circumstellar Disks'
From Circumstellar Disks to Planetary Systems (Garching, Germany; Nov 3-6)
'Chemical Evolution from Cores to Disks'

Vlahakis
SFR@50: filling the Cosmos with Stars (Spineto, Italy; July 6-10)
'A HARP-B CO(J=3-2) map of M51: Investigating star formation processes on 600pc scales'
VII Reunion Anual de la sociedad Chilena de Astronomia (SOCHIAS) (Santiago, Chile; Jan 14-16)
'The Sombrero galaxy's dust ring'

Van de Voort
Virgo meeting (Munich, Germany; Jan 28-29)
Nederlandse Astronomen Conferentie (Kerkrade, Netherlands; May 13-15)
'How hot and cold accretion determine the cosmic star formation rate'
The Lyman alpha universe (Paris, France; July 6-10)
'Lighting up structure formation with Lyman-alpha'
Prospects in theoretical physics: computational astrophysics (summer school) (Princeton, NJ, USA; July 13-24)
Virgo meeting (Durham, UK; Nov 30-Dec 1)
'The growth of haloes and galaxies'

Van Weeren
IAU XXVII GENERAL ASSEMBLY (Rio de Janeiro, Brazil; Aug 3-14)
'The diffuse radio emission and magnetic field in the galaxy cluster ZwCl 2341.1+0000'

Weiss
Tweede Promovendicongres Wetenschapsgeschiedenis (Kerkrade, Netherlands; Jan 22-23)
'Geschiedenis van Teylers Museum in de 19de Eeuw'

Instruction, Amusement and Spectacle (Exeter, UK, Apr 16-18
Third Bi-Annual Dutch Conference in the History of Science (Woudschoten, Netherlands, June 26-27)
'A Writer of Popular Science as Curator ? T.C. Winkler at Teylers Museum'
Das Neue Museum im Internationalen Kontext: Museale Spezialisierung und Nationalisierung ab 1830 (Berlin, Germany, Oct 22-24)

Van der Werf
Vatican Observatory Summer School (Sassone, Italy; June 22-24)
'Inside the music of the spheres'
Joint European/Japanese Workshop on the SPICA Mission (Oxford, UK; July 6-8)
'Cooling lines as probes of the formation and buildup of galaxies and black holes'
General Assembly of the International Astronomical Union (Rio de Janeiro, Brazil; Aug 7-14)
'Probing the warm and dense molecular gas in (U)LIRGs'
Herschel Science Demonstration Program Workshop (Madrid, Spain; Dec 17-18)
'First results from the Herschel Comprehensive ULIRG Emission Survey'

Yildiz
2009 EARA Workshop; "From Disks to Planets: Learning from Starlight" (Leiden, Netherlands; Mar 16-20)
64th Nederlandse Astronomie Conferentie (Kerkrade, Netherlands; May 13-15)
Poster: 'The shocking truth about star formation as revealed by warm CO CHAMP+ Mapping'
5th IRAM 30m Summer School, Paving the way: From Millimeter to Far-Infrared Astronomy (Sierra Nevada, Spain; Sep 4-11)
Project & Talk: 'Trifid Nebula, High-Mass Star Forming Region'
WISH Team Meeting (Leiden, Netherlands ; Nov 23-27)
Talk: 'Low-Mass Star Formation as revealed by warm CO CHAMP+mapping'

Appendix VII

Observing sessions abroad

Observing sessions abroad

Appendix VII

Amiri
Effelsberg Telscope (Bonn, Germany; Nov 13)
JCMT (Mauna Kea, Hawaii, USA; Nov 25-29)

Van Dishoeck
VLT-CRIRES (Paranal, Chile; Jan 1-3)

Fayolle
JCMT (Hawaii, USA; June 30 - July 4)

Hildebrandt
ING WHT Telescope (La Palma, Spain; Oct 9-14)

Isokoski
James Clerk Maxwell Telescope (JCMT) (Mauna Kea, Hawaii, US, Aug 02-08)

Kóspál
Telescopio Carlos Sanchez, Teide Observatory (Tenerife, Canary Islands, Spain; Sep 16 – 25)

Kristensen
APEX (San Pedro, Chile; June 16-18)
IRAM-30m (Granada, Spain; July 15-18)

Kuijken
William Herschel Telescope (La Palma, Spain; Mar 27-30)

De Mooij
INT (La Palma, Spain; May 6-11)
WHT (La Palma, Spain; July 3, 5 and 8)
INT (La Palma, Spain; July 9-11)
WHT (La Palma, Spain; Sep 5)
VLT (Paranal, Chile, Oct 9)
UKIRT (Hawaii, USA, Dec 15-18)

Nefs
Isaac Newton Telescope (Roque de Los Muchachos, La Palma; July 7-12)
William Herschel Telescope (Roque de Los Muchachos, La Palma; Aug 8)
William Herschel Telescope (Roque de Los Muchachos, La Palma; Oct 2)
Isaac Newton Telescope (Roque de Los Muchachos, La Palma; Dec 24-Jan 3)

Öberg
IRAM 30m telescope (Pico Veleta, Spain; Feb 27 - Mar 3)

Rakic
Keck Observatory (Waimea, HI, USA; Mar 24-26)
Palomar Observatory (CA, USA; Apr 3-5)
Keck Observatory (Waimea, HI, USA; Nov 13-14)

Röttgering
WHT (La Palma, Spain; Apr 14-18)

Schaye
Keck Observatory (Mauna Kea, Hawaii, USA; Nov 13-14)

Schrabback
Isaac Newton Group of Telescopes 4.2m William Herschel Telescope (La Palma, Spain; Oct 16-20)

Snellen
ESO VLT (Paranal, Chile; Aug 6-7)

van Weeren
4.2m William Herschel Telescope (La Palma, Spain; Apr 15-19)
Giant Metrewave Radio Telescope (Pune, India; May 12-20)
2.5m Isaac Newton Telescope (La Palma, Spain; Oct 1-8)
Giant Metrewave Radio Telescope (Pune, India; Nov 9-27)

Van der Werf
Isaac Newton Telescope (La Palma, Spain; May 6-11)
ESO VLT (Paranal, Chile; July 7-14)

Yildiz
IRAM 30m Telescope (Sierra Nevada, Spain; June 5-9)
James Clerk Maxwell Telescope (Mauna Kea, Hawaii; Feb 9-13)

Appendix VIII

Working visits abroad

Working visits abroad

Appendix VIII

Alexander
Isaac Newton Institute for Mathematical Sciences (Cambridge, UK; Aug 16-Sep 12)

Amiri
Bonn University (Germany; Mar)
University of Michigan (USA; Aug-Nov)

Baneke
National Air and Space Museum (Washington DC, USA; Oct 26-30)

Bast
MPE, Garching (Germany; Jan 22 -Aug 29)

Van Bemmel
Oxford University Astrophysics Department (Oxford, UK; mar 23-27)

Booth
ICC (Durham; Oct 7-25)

Bouwman
NASA Ames (Moffett Field CA, USA; Sep 18 – Nov 14)

Brandl
Katholieke Universiteit Leuven (Belgium; Jan 21-23)
ESO (Garching, Germany; Jan 26-27)
Katholieke Universiteit Leuven (Belgium; Feb 3-5)

ESO (Garching, Germany; Feb 9-10)
Department of Astronomy, University of Leicester (UK; Apr 28-30
ATC (Edinburgh, UK; May 18-20)
ESO (Garching, Germany; May 25-28)
MPIA (Heidelberg, Germany; June 30 - July 2)
Department of Astronomy (Copenhagen, Denmark; Sep 8-10)
ASTRID (Madrid, Spain; Sep 22-24)
ESO (Garching, Germany; Dec 16-18)

Brinchmann
CAUP (Porto, Portugal; Jan 1-13)
CAUP (Porto, Portugal; Mar 31 - Apr 14)
LAM (Marseille, France; Nov 9-10)
IAP (Paris, France; Nov 30)
CAUP (Porto, Portugal; Dec 7-18)

Busso
Institute of Astronomy (Cambridge, UK; Jan 20-23)

Brown
Observatoire de Paris (Paris, France; Apr 6-7)

Cuppen
University of Iceland (Reykjavik, Iceland; June 21-29)
University College Londen (Londen, United Kingdom; 15 Sep)

Deep
ESO (Garching, Germany; Mar 23-26)
AMOS (Leige, Belgium; Mar 31)
ESO (Garching, Germany; June 07 -10)
ESO (Garching, Germany; June 29 - July 03)
ESO (Garching, Germany; Aug 25 -28)
Winlight Optics (Marseille, France; Sep 28 -29)
ESO (Garching, Germany; Oct 12 -16)
ESO (Garching, Germany; Nov 29 - Dec 1)
ESO (Garching, Germany; Dec 7 – 11)

van Dishoeck
MPI für Extraterrestrische Physik (Garching, Germany; Jan 6-14)
Sterrenkundig instituut (Leuven, Belgium; Jan 22-23)
MPI für Extraterrestrische Physik (Garching, Germany; Feb 14-18)
ALMA (Santiago/San Pedro, Chile; Mar 7-15)

Royal Observatory Edinburgh (Edinburgh, UK; Apr 8-9)
MPI für Extraterrestrische Physik (Garching, Germany; Apr 25-27)
University of Leicester (Leicester, UK; Apr 28-29)
Princeton University (Princeton, USA; May 4-15)
Annual Reviews (Palo Alto, USA; May 16)
MPI für Extraterrestrische Physik (Garching, Germany; May 21-26)
University of Illinois (Urbana, USA; June 17)
California Institute of Technology (Pasadena, USA; June 18-19)
MPI für Extraterrestrische Physik (Garching, Germany; July 8-31)
MPI für Extraterrestrische Physik (Garching, Germany; Aug 16-30)
Danish Space Science Institute (Copenhagen, Denmark; Sep 8-9)
University of Cologne (Cologne, Germany; Sep 18)
MPI für Extraterrestrische Physik (Garching, Germany; Oct 16-19)
ALMA (San Pedro, Chile; Nov 9-14)
MPI für Extraterrestrische Physik (Garching, Germany; Dec 9-14)

Fayolle
Laboratoire de physique moléculaire pour l'atmosphère et l'astrophysique (LPMAA) (Paris, France; Oct 19)
Laboratoire de physique moléculaire pour l'atmosphère et l'astrophysique (LPMAA) (Paris, France; Nov 3)

Groves
IAP (Paris, France; 8 -24 Jan)
University of Crete (Heraklion, Greece; 13-27 July)
University of Hertfordshire (Hatfield, UK; 8-9 Oct)

Harfst
ZAA (Berlin, Germany; Aug 3-14)

Hildebrandt
AIfA (Bonn, Germany; Jan 11-12)
UBC (Vancouver, Canada; May 16-June 4)
AIfA (Bonn, Germany; June 17-19)

Hoekstra
Institute for the Physics & Mathematics of the Universe (Tokyo, Japan; Jan 4-13)
Canadian Institute for Advanced Research AGM (Mt Tremblant, Canada; Mar 5-7)
University of Edinburgh (UK; Oct 1-3)
University of Chicago (USA; Oct 22-24)

UC Berkeley, Berkeley (US; Nov 23-25)
University of Victoria (Victoria, Canada; Nov 26-Dec 4)

Jaffe
ESO User's Committee (Garching, Germany; Apr 27-28)
MATISSE PDR Planning(Nice, France; June 02-03)
MIDI Large AGN Project Planning(Bonn, Germany; Oct 16)
ESO VLTI baseline strategy meeting (Garching, Germany; Oct 19)
MATISSE PDR (Garching, Germany; Nov 16-19)

Johansen
Center for Planetary Science (Kobe, Japan; May 25-June 18)
Isaac Newton Institute for Mathematical Sciences (Cambridge, UK; Oct 8-26)

Katgert
Osservatorio Astronomico (Trieste, Italy; May 20 -29)

Kendrew
Max Planck Institute for Extraterrestrial Physics (Garching, Germany; Jan 28-30))
University of Texas at Austin (Austin, USA; Feb 23- Mar 13)
University of Texas at Austin (Austin, USA; 21 Sep-16 Oct)
CEA Saclay (Paris, France; Nov 20-23)

Kospal
Eotvos Lorand University (Budapest, Hungary; Jan 18 – 21)
IRAM Headquarters (Grenoble, France; May 13 – 16)
Konkoly Observatory (Budapest, Hungary; Jun 21 – 28)

Kuiper
Institut d'Astrophysique Spatiale (Orsay, France; Feb 24 – 28)

Kristensen
Observatoire de Paris (Paris, France; Jan 12-16)
SRON (Groningen, Netherlands; Jan 20-23)
Observatoire de Paris (Paris, France; May 4)

Linnartz
CAMOP editorial meeting (London, UK; Apr 16)
NASA Laboratory Astrophysics meeting (Washington, USA; June 19th)

Madigan
Columbia University (New York, USA; July 6-10)

Miley
Discussions with EC DG Research about UNAWE (Mar 18)
IAU Executive Committee (IAP, Paris, France; Apr 7 - 8)
Collaborative research, Johns Hopkins University (Baltimore, USA; Apr 9 - 11)
AURA Representatives meeting (Tucson, USA; Apr 23 - 24)
Visit to UNAWE Tunisia (Tunis, Tunisia; June 21 -24)
Collaborative research, Johns Hopkins University (Baltimore, USA; July 30 – Aug 1)
IAU General Assembly (Rio de Janeiro, Brazil; Aug 2 - 15)
The IAU Strategic Plan, South African Embassy (Brussels, Belgium; Aug 24)
Collaborative research, Johns Hopkins University (Baltimore, USA; Nov 15 - 16)
Collaborative research, Johns Hopkins University (Baltimore, USA; Dec 9 - 13)

Nefs
Cambridge University (Cambridge, UK; June 30)

Ödman
Observatoire de Meudon (Paris, France; Feb 5 – 8)

Oliveira
ESO (Garching, Germany; Feb 1 – 28)
ESAC (Madrid, Spain; July 6 – 10)
MPE (Garching, Germany; Oct 27 - Nov 2)
LAOG (Grenoble, France; Dec 7 – 11)

Portegies Zwart
CfCA (Tokyo, Japan; Sept 10-14)
KITP (Beijing, China; Nov 10-14)

Prod'Homme
Lund Observatory (Lund, Sweden; Mar 9-20)
Institute of Astronomy (Cambridge; UK; Mar 23 - Apr 9)
Observatoire de Paris-Meudon (Meudon, France; June 28 - July 5)

Rakic
Caltech (Pasadena, CA, USA; Mar 22 - Apr 8)
Caltech (Pasadena, CA, USA; Nov 8 – 25)

Rieder
Vanderbilt University (Nashville TN, USA; Dec 12-19)

Risquez
Lund Observatory (Lund, Sweden; Mar 9-20)
Institute of Astronomy (Cambridge, UK; Apr 14-18)
ZARM (Bremen, Germany; Nov 23-27)

Röttgering
ESO (Garching, Germany; May 25-29)
ESO (Garching, Germany; Nov 16-20)
Oxford (UK; July 1 - Sept 1)

Schaye
MPA (Garching, Germany; July 17)
Lyon Observatory (Lyon, France; Sep 15)

Schleicher
ITA (Heidelberg, Germany; Oct 5-23)
MPIfR (Bonn, Germany; Oct 29-30)
ITA (Heidelberg, Germany; Nov 26 - Dec 4)

Schrabback
AIfA, Bonn (Germany; Feb 11 -13)
AIfA, Bonn (Germany; July 31)

Serre
ESO (Garching, Germany; Mar 11-13)
CRAL (Lyon, France; July 6-8)
OCA (Nice, France; July 20-24)
CRAL (Lyon, France; Sep 14-15)
Porquerolles Island (France; Oct 5-9)
ESO (Garching, Germany; Nov 4-6)
LATT (Toulouse, France; Nov 18-20)
LATT (Toulouse, France; Dec 14-15)

Snellen
Institute of Astronomy (Cambridge, UK ; June 30)

Stuik
KU Leuven (Leuven, Belgium; Feb 4)

ESO (Garching, Germany; Mar 11-12)
AMOS (Liege, Belgium; Mar 31)
UK ATC, (Edinburgh, UK; May 19-20)
ESO (Garching, Germany; May 16)
ESO (Garching, Germany; June 30)
Arcetri Observatory (Florence, Italy; July 28)
Winlight (Aix-en-Provence, France; Sept 29)
ESO (Garching, Germany; Dec 17-18)

Tielens
NASA ARC (California, USA; Jan 31-Feb 7)
CEA (Paris, France; Mar 1–4)
LAOG (Grenoble, France; Mar 30-Apr 3)
Onsala Space Observatory, Chalmers University (Sweden; Apr 7-9)
COST Office Brussel, Kick off meeting CM0805 (Brussel, Belgium; Apr 17)
STScI (Baltimore, Md, USA; Apr 29-May 21)
CESR (Toulouse, France; May 25-27)
CEA & IAS (Paris, France; June 28-July 1)
STScI (Baltimore, Md, USA; July 11-July 17)
NASA ARC (California, USA; July 18-Aug 30)
CEA (Paris, France; Sep 7-11)
University of Cologne (Cologne, Germany; Sep 17-18)
Osservatorio astrofysica di Catania (Italy; Oct 13-16)
NASA ARC (California, USA; Oct 19-Nov 6)
Katholieke Universiteit Leuven (Belgium; Dec 7)
MPIfR (Bonn, Germany; Dec 14)

Vermaas
ESO Garching (Germany; Apr 20-May 1)

Visser
Denison University (Granville, OH, USA; Jan 8-25)
Ohio State University (Columbus, OH, USA; Jan 26-27)
University of Michigan (Ann Arbor, MI, USA; Jan 29-30)
MPE (Garching, Germany; Mar 23-27)
ETH (Zurich, Switzerland; May 25-30)
MPE (Garching, Germany; July 13-17)
MPIA (Heidelberg, Germany; Nov 16-17)
Bonn University (Bonn, Germany; Nov 18-20)

Vlahakis
ESO Santiago (Santiago, Chile; Jan 5 - Feb 2)

Osservatorio Astrofisico di Arcetri (Florence, Italy; Mar 10-13)
ESO Garching (Munich, Germany; Mar 24-27)
ESO Garching (Munich, Germany; May 11-13)
Observatorio Astronomico Nacional (Madrid, Spain; Oct 26-30)

Van de Voort
CRAL (Lyon, France; Nov 1-2)

van der Werf
Leicester University (Leicester, UK; Apr 28-29)
European Southern Observatory (Garching, Germany; May 24-29)
Cavendish Laboratory (Cambridge, UK; June 1-3)
Royal Observatory (Edinburgh, UK; June 8-10)
Copenhagen University Observatory (Copenhagen, Denmark; Sep 8-9)
European Southern Observatory (Garching, Germany; Nov 15-20)
Joint Astronomy Center (Hilo, Hawaii, USA; Dec 6-12)
ESAC (Madrid, Spain; Dec 17-18)

Appendix IX

Colloquia given outside Leiden

Colloquia given outside Leiden

Appendix IX

Alexander
The evolution and dispersal of protoplanetary discs
Instituut Anton Pannekoek, Universiteit Amsterdam, Amsterdam, Netherlands; Jan 15
The evolution and dispersal of protoplanetary discs
Yale Centre for Astronomy & Astrophysics, Yale University, New Haven, Connecticut, USA; Feb17
Protoplanetary disc evolution and the formation of planets
University College London, London, UK; Oct 19

Amiri
The magnetic field of the evolved star W43A
MPIfR, Bonn, Germany; Nov 13
Idem
Joint Astronomy Center, Hilo, Hawaii, USA; Nov 24

Booth
What Physics Shapes the Galaxy Population?
ICC, Durham, UK; Oct 11
Understanding Galaxy Formation Simulations
Physics, Leicester, UK; Jul 8
Idem
IOA, Cambridge, UK; June 11

Bouwman
Experimental Techniques in Laboratory Astrophysics
NASA Ames, Moffett Field CA, United States; Nov 6
Idem
UC Berkeley, Berkeley CA, United States; Nov 13

Brandl
Infrared Views of Starburst Clusters
Radboud University, Nijmegen, Netherlands; Mar 24
Idem
Astronomical Institute "Anton Pannekoek", Amsterdam, Netherlands; Apr 7
Idem
Astronomical Institute, ETH, Zürich, Switzerland; June 11

Brinchmann
Emission lines in the SDSS from the extreme to the mundane
Kapteyn, Groningen, Netherlands; Mar 2
Wolf-Rayet stars in the local Universe, from stellar models to GRBs
Radboud University, Nijmegen, Netherlands; 16 June

Brown
Gaia - Taking the Galactic Census
Department of Astrophysics, Radboud University, Nijmegen, Netherlands; Dec 8

Cuppen
Surface processes on interstellar grains: linking laboratory data with models and observations
University of Manchester, Manchester, UK; 16 Sep
Idem
University of Nottingham, Nottingham, UK; 18 Sep
Idem
University of Leeds, Leeds, UK; 17 Sep
Modelling surface processes on interstellar grains: linking laboratory data and astronomical observations
Radboud University Nijmegen, Nijmegen, Netherlands; 12 Oct
Idem
Eindhoven University of Technology, Eindhoven, Netherlands; 15 Oct
Idem
FOM Institute Rijnhuizen, Nieuwegein, Netherlands; 19 Nov

Deep
ASSIST : the test set-up for VLT adaptive optics facility
IUCAA, Pune, India; Jan 6
Idem
TIFR, Mumbai, India; Jan 9

van Dishoeck
Star formation in our Galaxy: new insights from Spitzer
MPE, Garching, Germany; Mar 5
From molecules to planets: SACIRR colloquium
University of Edinburgh, UK; Apr 8
Chemistry in evolving protoplanetary disks
Royal Observatory Edinburgh, UK; Apr 9
Evolving protoplanetary disks
Princeton University, USA; May 5
Astrochemistry lectures: 1. Basic molecular processes; 2. Chemistry in star-forming regions; 3. Chemistry in circumstellar disks
Princeton University, USA; May 6-14
Chemistry in protostellar and protoplanetary regions
University of Illinois, USA; June 17
Gas in protostellar and protoplanetary regions: a VLT-CRIRES evolutionary study
University of Amsterdam, Netherlands; Aug 31
ALMA: a supersharp view on galaxy-, star- and planet-forming regions
Groningen, Netherlands; Oct 12

Groves
Controlling Parameters of the Starburst SED
University of Crete, Heraklion, Greece; 14 Apr

Haas
Nature and Nurture in Galaxy Formation Simulations
Steward Observatory, Tucson, USA; Nov 13
Idem
University of California, San Diego, USA; Nov 17
Idem
University of California, Irvine, USA; Nov 18
Idem
Harvard-Smithsonian Center for Astrophysics, Institute for Theory and Computation, Cambridge, USA; Nov 24
Idem
American Museum for Natural Histroy, New York, USA; Dec 1
Idem
STScI, Baltimore, USA; Dec 4
Idem
Stockholm Observatory, Stockholm, Sweden; Oct 13
Idem
Department of Mathematical Physics and Astronomy, Ghent University, Belgium; Oct 2

Harfst
Numerical Simulations of Stellar Dynamical Problems
ZAA, Berlin, Germany; Aug 7

Hildebrandt
Cosmic Magnification
UC Santa Barbara, USA; Dec 11
Idem
UC Berkeley, USA; Dec 14
Idem
Stanford University, USA; Dec 15

Hoekstra
Weak lensing by large scale structure
IPMU, Tokyo, Japan; Jan 7
Idem
Groningen University, Groningen, Netherlands; Jan 19
Idem
Radboud University, Nijmegen, Netherlands; May 19
Idem
Cambridge University, Cambridge, UK; Oct 29
Idem
UC Berkeley, Berkeley, USA; Nov 24
Measuring masses: from galaxy cluster down to galaxies
University of Edinburgh, UK; Sep 30

Hogerheijde
The molecular content of planet-forming disks
Kapteyn Institute Groningen, Netherlands; Mar 9
Idem
Astronomy Department, ETH Zürich, Switzerland; Oct 29

Israel
Centaurus A
ASTRON, Dwingeloo, Netherlands; Feb 5

Johansen
MHD simulations of accretion discs
Katholieke Universiteit Leuven, Belgium; Feb 03
Formation (and growth) of planetesimals in turbulent protoplanetary discs
Universität Zürich, Switzerland; Apr 22

Computer simulations of accretion discs: Planet formation and large scale magnetic fields
AIP Potsdam, Germany; Oct 16
Planetesimal formation in turbulent protoplanetary discs
Astronomical Institute Anton Pannekoek, Amsterdam, Netherlands; Nov 27

Kuijken
Lecture series on weak lensing and photometric redshifts
Institute for Mathematical Physics, Astrophysics, Tehran, Iran; Apr 22-28
KiDS: studying dark energy end dark matter with light rays
Naples University, Italy; May 26

Madigan
Resonant Relaxation near Massive Black Holes
Columbia University, New York, USA; July 9

Miley
Probing the Early Universe with Radio Galaxies
INAF Trieste, Italy; May 21

De Mooij
Optical and Near-Infrared day-side emission from exoplanets
IAC, La Laguna, Spain; July 7

Ödman
About Universe Awareness
Dublin Institute for Advanced Studies, Dublin, Ireland; Sep 15

Portegies Zwart
AMUSE
CfCA, Tokyo, Japan; Sep 10-14

Prod'homme
CTI Modelling at the CCD Pixel Level
Dutch Space, Leiden, Netherlands; Jan 20
Radiation Damage on Gaia CCDs - Modelling to Mitigate the Threat
Université Libre de Bruxelles; Feb 2
Idem
Heidelberg University, Heidelberg, Germany; Sep 1
RC2 Charge Injection Profile Analysis
Institute of Astronomy, Cambridge, UK; Apr 6

CDM02 Validation
Institute of Astronomy, Cambridge, UK; Apr 6
Euclid
Heidelberg, Germany; Sep 28
Testing CDM02 on Radiation Campaigns 2 data
Institute of Astronomy, Cambridge, UK; Oct 26

Röttgering
LOFAR: Opening up a new window on the Universe
Krakow, Poland; Feb 6
Idem
Sheffield, UK; Apr 1

Schaye
Insights into the formation of galaxies from the OverWhelmingly Large Simulations project
University of Hawaii, Honolulu, Hawaii, USA; Nov 18

Schleicher
Primordial magnetic fields: Influence on reionization and the first stars
MPIfR, Bonn, Germany; Oct 30

Schrabback
Studying the Dark Side of the Universe with Weak Gravitational Lensing
IKTP, Dresden, Germany; Feb 12

Stuik
Een brilletje voor je telescoop - Adaptive Optics
Faculteit der Natuurwetenschappen, Wiskunde en Informatica Universiteit van Amsterdam, Amsterdam, Netherlands; May 27

Tielens
Interstellar PAHs and star formation
Onsala Space Observatory, Chalmers University; Apr 8
idem
STScI, Baltimore, Md, USA; May 13
idem
Osservatorio astrofysica di Catania; Oct 15
idem
Radboud University, Nijmegen, Netherlands; Sep 29
First results from Herschel
STScI, Baltimore, Md, USA; July 16

Herschel and SOFIA
NASA ARC, USA; Aug 26

Visser
The Chemical History of Molecules in Circumstellar Disks
ETH, Zürich, Switzerland; May 29
Chemical Evolution from Cores to Disks
MPIA, Heidelberg, Germany; Nov 16
Chemical Evolution from Cores to Disks
Bonn University, Bonn, Germany; Nov 19

Vlahakis
A new class of submm galaxy? Properties of very low-z sources from the CUDSS survey
ESO Santiago, Santiago, Chile; Jan 26

Van Weeren
Diffuse radio emission from galaxy clusters
NCRA, Pune, India; Nov 26

Appendix X

Scientific publications

Scientific publications

Appendix X

X.1. Ph.D. Theses and Books

B. R. Brandl; **R. Stuik**; **J. Katgert-Merkelijn** ; 400 Years Of Astronomical Telescopes: A Review Of History, Science And Technology; ISBN: 9048122325; 2009

H. T. Intema, A Sharp View of the Low-Frequency Radio Sky; Ph.D. thesis Leiden; 2009

D. Lommen, The first Steps of Planet Formation: Studying Grain Growth with Millimetre Interferometers; Ph.D. thesis Leiden; 2009

E. Micelotta, PAH Processing in Space; Ph.D. thesis Leiden; 2009

K. Öberg, Complex Processes in Simple Ices:Laboratoty and Observational Studies of Gas-Grain Interactions during Star Formation; Ph.D. thesis Leiden; 2009

O. Panic, High Angular Resolution Studies of Proto Planetary Disks; Ph.D. thesis Leiden; 2009

A. H. Pawlik , Simulating Cosmic Reionisation; Ph.D. thesis Leiden; 2009

D. Raban, Infrared Interferometric Observations in the Nuclei of Active Galaxies; Ph.D. thesis Leiden; 2009

E. N. Taylor, Ten Billion Years of Massive Galaxies; Ph.D. thesis Leiden; 2009

R. Visser, Chemical Evolution from Cores to Disks; Ph.D. thesis Leiden; 2009

N. de Vries, The Evolution of Radio-Loud Active Galactic Nuclei; Ph.D. thesis Leiden; 2009

A. Weijmans, The Structure of Dark and Luminous Matter in Early-Type Galaxies; Ph.D. thesis Leiden; 2009

X.2. Publications in refereed journals

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