Research Institute Leiden Observatory

(Onderzoekinstituut Sterrewacht Leiden)

Annual Report 2005

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Front cover: The central few arcminutes of deep Spitzer Space Telescope IRAC imaging of the Hubble Deep Field South. This is a false colour image made by combining the IRAC 4.6 μm (red) and 3.5 μm (green) images with the deepest ground based (VLT) K band image ever taken (blue). The circles show the position of Distant Red Galaxies at $z \gtrsim 2$, 30 % of which appear not to be forming stars, even at this relatively early point in the Universe's history.

Back cover: A laboratory simulation of an interstellar cloud. In this supersonic planar plasma expansion transient species of astrophysical interest are formed and tunable infrared spectroscopy is used to derive molecular fingerprint spectra (Harold Linnartz; see section 2.10.6).

An electronic version of this annual report is available on the web at
`http://www.strw.leidenuniv.nl/research/annrep.php`

Production Annual Report 2005:
M. Franx, J. Lub, E.N. Taylor, S. Wuyts

Sterrewacht Leiden

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Sterrewacht
Leiden

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Review of major events

Chapter 1

The year 2005 was another exciting one for the Sterrewacht. Two new staff members were appointed: Yuri Levin from the Canadian Institute for Theoretical Astrophysics and Harold Linnartz from the Free University of Amsterdam. Yuri Levin is an expert on the properties of neutron stars, gravitational waves, pulsar timing and the Galactic Center. He has a part-time appointment in theoretical physics, and I am very pleased with this further strengthening of the links between the Observatory and LION. Harold Linnartz leads the Raymond and Beverly Sackler Laboratory for Astrophysics, and brought a number of exciting new experiments which necessitated an expansion and upgrade of the laboratory space on the fifth floor of the Huygens Laboratory. Furthermore, Joop Schaye, who was appointed in 2004, took up his faculty position in early Spring, Frank Israel was promoted to full professor, and former Leiden graduate Huib–Jan van Langevelde from JIVE in Dwingeloo joined the Observatory as adjunct associate professor. And Dirk van Delft, at the time the editor-in-chief of the science segment of one of the main national newspapers (NRC), joined the Observatory on a part-time associate professor appointment to strengthen the faculty-wide effort on the history of science.

Ten Ph.D. degrees were awarded in 2005, to Katrien Steenbrugge, Dirk van Delft, Pedro Lacerda, Michiel Reuland, Inti Pelupessy, Fleur van Broekhuizen, Bram Venemans, Arjen van der Wel, Glenn van de Ven, and Erik Jan Rijkhorst. In addition, nine undergraduates received a Bachelor degree, and another five were awarded M.Sc. degrees. The scientific highlights of the past year are summarized elsewhere in this Annual Report, which was compiled by Marijn Franx, Jan Lub, Edward Taylor, and Stijn Wuyts. Particularly noteworthy was the work with the Spitzer Space Telescope by Ivo Labbé who studied high redshift galaxies and discovered a population of galaxies which appeared to have stopped forming stars (see front cover). Fred Lahuis and colleagues used Spitzer to find organic gases around young stars. The ingredients—gaseous precursors to DNA and proteins—were detected in the disk's terrestrial planet zone, a region where rocky planets such as the Earth are thought to be born. And in November ESO awarded over 400(!) nights of telescope time to the KIDS project, led from Leiden, which will use OmegaCAM and VISTA to map a large part of the sky in order to study dark matter and dark energy through gravitational lensing and other techniques.

The year 2005 also saw the completion of a research project which had its beginnings in the nineteen thirties, when Leiden student W. Chr. Martin took hundreds of photographic plates of the globular cluster ω Centauri with the Yale–Columbia refractor in South Africa. Former Oort Professor Ken Freeman organized a second run of plates in the late seventies, after the telescope had moved to Mount Stromlo Observatory in Australia. Rudolf Le Poole measured the star positions with the Leiden ASTROSCAN in the eighties, and started the derivation of the proper motions. Renate Reijns pushed this further in the nineties, and also obtained many radial velocitities at Cerro Tololo. Floor van Leeuwen, at the Institute of Astronomy (Cambridge, UK) completed the proper motion measurements. The final step required the construction of a detailed dynamical model that fits all the kinematic measurements. This was initiated by Ellen Verolme, and completed by Remco van den Bosch and Glenn van de Ven in 2005. Glenn's *cum laude* Ph.D. thesis contains the full analysis of the measurements, and a model which provides a very accurate geometric distance to the cluster, and reveals an internal structure which shows clear signs of the repeated passage of ω Centauri through the Galactic Plane. Based on this work, Glenn was the Observatory nominee for the Faculty-wide 'Discoverer of the Year' competition.

The research carried out in Leiden includes observations with ground– and space–based telescopes, laboratory astrophysics, data analysis and interpretation, and purely theoretical work with emphasis on two of the three main research areas in the national NOVA program, namely the formation, structure and evolution of galaxies and the formation of stars and planets. Leiden astronomers are involved in the development of instrumentation for the William Herschel Telescope, the Very Large Telescope and the VLT Interferometer, including the second generation instrument MUSE, and lead the development of OmegaCAM for the VLT Survey Telescope. There is also strong involvement in the commissioning of LOFAR for astronomy, in the construction of CHAMP$^+$ and the ALMA Band 9 receivers, in the eSMA on Mauna Kea, in HIFI for the Herschel Space Observatory, in the MIRI and NIRSPEC instruments for the James Webb Space Telescope, and in the Gaia satellite. Observatory staff also serve on high-level international oversight and advisory committees for ESO, ESA, ALMA, NRAO, AURA, and the Hubble Space Telescope. All of this is possible because of the continued strong support from the University, our excellent administrative and computer staff, and substantial external funding (through NOVA, NWO, and the EU), which comprises nearly 60% of the Observatory budget. The NWO funding included a number of projects obtained in the Open Competition, and a grant from the NWO-M program for a national team led by Huub Röttgering to prepare high-level analysis software for LOFAR.

Her Excellency Maria van der Hoeven (Minister for Education, Culture and Science), Piet van der Kruit (Groningen, President of ESO Council), Ewine van Dishoeck, and Tim de Zeeuw in front of the APEX antenna, more than 5000m above sea level, at Chajnantor, Chile. (Image credit: ESO; http://www.eso.org/outreach/press-rel/pr-2005/pr-14-05.html)

The education of undergraduate students is a key priority for the Observatory. The year 2005 marked the completion of the introduction of the Bachelor–Master system. The early participation of bachelor students in research projects at the Observatory is a significant step forward. The new system also encourages foreign students to enter Leiden University as Master students, and their numbers are now increasing quickly. In 2005, four foreign Master students were registered at the Observatory, with more arriving in 2006. The Observatory offers the Oort Scholarship to excellent foreign master students, and has been quite effective in securing additional scholarships through national funding agencies. In May, Frank Israel took over the position of Director of Education, which had been held by Marijn Franx since 2000. Marijn enjoyed a well-deserved mini-sabbatical at Harvard over the summer.

One of the high points in the year was the visit in May by her excellency Maria van der Hoeven, the Minister for Education, Culture and Sciences, to the ESO Very Large Telescope at Paranal and the ALMA project near San Pedro de Atacama. Piet van der Kruit (Groningen), Ewine van Dishoeck and myself had the honor to accompany her, together with highly-ranked officials from the Ministry. It was a

A very happy Ingrid van Houten–Groeneveld in front of her collection of photographic plates in their new home at the Astronomiches Rechen-Institut in Heidelberg, Germany.

unique opportunity to see the tremendous accomplishments of ESO, and the contributions which the Netherlands has been able to make, in particular through the NOVA program.

The annual Oort Lecture was presented by Professor Anneila Sargent from Caltech, USA, and was titled 'New Waves – Probing our Origins with Arrays of Telescopes'. Together with Ewine van Dishoeck she also organized a two-day workshop in the Lorentz Center on 'Protoplanetary Disk Evolution'. Professor John Peacock from Edinburgh visited for a week in early November, and presented the 2005 Sackler lecture, entitled 'The Outlook for Large-scale Structure in Cosmology'. Nearly a dozen other astronomical workshops were held in Leiden, many in the Lorentz Center.

The photographic plate collection of Ingrid van Houten-Groeneveld and her late husband Cees van Houten was moved from Leiden Observatory to the Astronomisches Rechen-Institut in Heidelberg (above). This legendary collection was built up over many decades, and allowed the Van Houtens to discover thousands of asteroids. The Astronomisches Rechen-Institut will provide superior access to the plates in the future, and is able to maintain their quality in a stabilized environment.

November 2005 saw the unexpected loss of Willem Wamsteker (1942-2005) in Madrid. Willem studied astronomy in Leiden and received his Ph.D. here in 1975 with Henk van de Hulst as advisor. He worked in Tucson, at ESO La Silla and at ESA Vilspa where he was involved with IUE and, after his retirement, with the World Space Observatory project.

The Sterrewacht is an increasingly diverse research institute in our University, where about 120 students, promovendi, postdocs, staff and visitors work together in a cordial and informal atmosphere. Our research and education program is part of an extensive network of international collaborations, in a field that enjoys much public interest and support, and where technological developments allow many new discoveries. Maintaining the present high level of achievement is one of the key goals for the future.

Tim de Zeeuw

Director

Chapter 2

Research

Sterrewacht Leiden

Chapter 2

Research

The research activities at Leiden Observatory span a very wide range, from small bodies in the Solar System to reionisation of the Universe and cosmology on the largest scales. This section aims to provide an overview of active areas of research, and a summary of the principal results obtained in 2005. To get a sense of the sheer volume of work produced by Observatory researchers, the reader is recommended to Appendix X, which gives a complete list of material published in 2005.

2.1 Solar System

2.1.1 Minor Planets

Many new asteroids were identified, numbered, or named by I. van Houten-Groeneveld, continuing the work by herself and her late husband, C.J. van Houten. Definitive numbers were given to 333 of these objects by the Minor Planet Center (Cambridge, USA) in 2005. Six names were given to minor planets discovered by the Van Houtens in 2005. Of particular interest are: (18238) Frankshu, (18241) Genzel, (18244) Anneila, which have been named after Oort professors.

2.1.2 Planets

Hogerheijde continued his collaboration with De Pater (UC Berkeley, USA) in using millimeter interferometers to study Solar System objects. The main results for 2005 included the detection with the BIMA array of HCN J=1–0 toward the comets LINEAR (C/2002 T7) and NEAT (C/2001 Q4) that passed through the inner Solar System in May 2004. A simple yet reliable method to derive HCN column densities was developed, which yields HCN production rates relative to water comparable to comets such as Hyakutake en Hale-Bopp.

Using the BIMA and OVRO interferometer together, 3.0 and 1.3 mm continuum detections of Saturn's rings were obtained. At the time of the observations, Saturn's rings were near their maximum ring opening angle ($|B| \sim 26°$), allowing mapping of Saturn and ring emission separately. Saturn showed clear latitudinal structure corresponding to gas upwelling on the Southern hemisphere and sinking on the Northern one. The rings were brighter at 1.3 mm than at 3.0 mm, as expected from the increase in ring particles' thermal emission at shorter wavelengths. Detailed model calculations suggested that the particles in the B ring do not scatter isotropically at these wavelengths, but preferentially in the forward/backward direction.

2.2 Exoplanets

Albrecht, Hekker, Quirrenbach, and Reffert, in collaboration with Fischer (SFSU, USA), Marcy (UCB, USA), and Butler (Carnegie Washington, USA) obtained a large number of radial velocity observations at Lick Observatory for a sample of about 400 K giants. Some of these stars have been identified as good candidates for harboring extrasolar planets, and are followed up with high resolution spectroscopy at the TNG (Roque de los Muchachos Observatory) and CES on the 3.6m telescope on La Silla, Chile. These high resolution spectra are used to measure the shapes of spectral lines, in order to reveal the mechanism that causes the observed radial velocity variations.

Reffert and Quirrenbach analysed the Hipparcos Intermediate Astrometric Data for two stars known to harbor substellar companions and identified the astrometric signatures of the companions in the Hipparcos data. The masses derived for the two companions showed that they were both brown dwarfs (before, only lower mass limits existed for these companions, leaving their exact nature unclear). This adds two more objects to the very sparsely populated 'Brown Dwarf Desert'.

Snellen continued his work on the detection and characterisation of transiting extrasolar planets, in particular on attempts to detect the secondary eclipse of HD209458b. This would result in a direct measurement of thermal emission from this extra-solar planet. K-band photometry using the United Kingdom Infrared Telescope resulted in a photometric precision of $\sim$1 milli-magnitude, but no firm detection of the eclipse could be claimed. It was shown however, that the relative photometry between the target and the reference stars over several weeks is consistent down to the $<$0.1 % level, very interesting in the light of future near-infrared surveys planned to search for transiting planets around M and L dwarfs.

2.3 Protostars and Circumstellar Disks

2.3.1 Protoplanetary Disks Around Low-Mass Stars

Hogerheijde started an extensive study into the formation, structure, and evolution of protoplanetary disks surrounding newly formed low-mass stars. With support from a VIDI grant from NWO and the EARA scheme from the EU, Brinch and Panić joined the Observatory as Ph.D. students to work on this project. Observations from submillimeter telescopes such as JCMT and APEX, and interferometers such as the SMA, have been obtained that reveal the structure of the disks. Using hydrodynamical simulations of collapsing cloud cores with angular momentum conservation, the observations are being interpreted in an evolutionary framework.

2.3.2 Numerical Simulations of Planets and Protoplanetary Disks

Paardekooper and Mellema finished the first three-dimensional radiation-hydrodynamical simulations of the interaction of low-mass planets with protoplanetary disks. This project was selected by NWO as a Dutch Computational Challenge Project, which gave them a huge amount of time on the Dutch National Supercomputer to run these large simulations. The first major result concerns planet migration: in isothermal disks migration was always directed inward, which made it difficult for planets not to fall into the central star, but when the energy balance (including radiation) is correctly taken into account the direction of migration depends on the cooling efficiency of the disk. Only in regions of low density, where cooling is very efficient, migration is directed inward. When the density is higher ($\sim 10^{-10}$ g cm^{-3}), as is the case in the inner regions of circumstellar disks, migration is directed outward. This saves low-mass planets from falling onto the central star.

Van Boven and Paardekooper looked at the interaction of a massive planet with a circumstellar disk that is depleted in gas (i.e. in a late stage of evolution). Because the gas-to-dust ratio is close to 1 in these disks the motion of the gas is affected by the dust. They showed that this leads to deeper and wider gaps in the gas as well as in the dust. This has implications for observations of these transitional disks. Furthermore, they studied the signature of eccentric planets in these disks, and they showed that the structures seen in the inner part of the disk in HD 141569 can easily be explained by a Neptune-mass planet on an eccentric orbit ($e = 0.1$).

2.3.3 Protostellar Holes

Jørgensen (Boston, USA), Lahuis and Van Dishoeck, in collaboration with the Spitzer 'Cores to Disks' (c2d) legacy team, obtained the first mid-infrared spectrum of a deeply embedded Class 0 object, IRAS 16293 –2422, with the Spitzer InfraRed Spectrometer (IRS). A detailed radiative transfer model reproducing the full spectral energy distribution (SED) requires a large inner cavity of radius 600 AU in the envelope to avoid quenching the emission from the central sources. This is consistent with a previous suggestion based on high angular resolution millimeter interferometric data. The cavity size is comparable to the centrifugal radius of the envelope and therefore appears to be a natural consequence of the rotation of the protostellar core, which has also caused the fragmentation leading to the central protostellar binary. The proposed cavity will have consequences for the interpretation of molecular line data, especially of complex species probing high temperatures in the inner regions.

2.3.4 High-Resolution Imaging of Low-Mass Protostars

A new window on the innermost warm and dense parts of protostellar envelopes and disks is opened up by the Submillimeter Array. Interferometry at 345 GHz at $< 2''$ resolution of the Class 0 source NGC 1333 IRAS 2A by Jørgensen, Van Dishoeck and co-workers has revealed complex organics such as CH_3OCH_3 and CH_3OCHO on scales of < 200 AU. The continuum data show a compact but resolved component, presumably a disk with 200–300 AU diameter, providing accurate constraints on disk properties in the earliest phase. Some of the compact molecular emission could originate from this disk.

Van Kempen, Van Dishoeck and Hogerheijde, in collaboration with Guesten and Schilke (Bonn, Germany), have used the newly commissioned Atacama Pathfinder Experiment telescope during science verification to observe high excitation CO $J = 4 - 3$ and 7–6 lines in the envelope of the IRAS 12496-7650 YSO (Young Stellar Object). The 7–6 line is much stronger than expected based on an envelope model, but does not show the high velocity wing seen prominently in 4–3. Combined with lower$-J$ and isotopic CO lines, these data put constraints on the temperature and kinematics of the outflow gas on small scales.

2.3.5 A Substellar Young Stellar Object in L1014

L1014 attracted attention in 2004 as the first ‘starless’ core in which Spitzer, as part of the c2d legacy program, revealed a young protostar with 0.09 $L_\odot$ undetected by previous infrared studies. Since the discovery, a huge effort has been made to further investigate this source, which is the prototype of a new class named Very Low Luminosity Objects (or VeLLOs). Crapsi, together with Bourke (CfA, USA) and collaborators, has participated in follow-up studies of the molecular content of the surrounding core, a search for disk and outflow signatures at high resolution, and near-infrared observations aimed at revealing the density structure of the core.

The L1014 core is found to be neither particularly dense nor massive compared with other truly starless cores, and its chemical properties are only moderately enhanced. This suggests that the path to star formation may not be unique. The CO outflow imaged with the SMA is the smallest ever seen. Comparison with evolutionary tracks indicates that L1014-IRS may have a substellar mass.

2.3.6 High-Energy Radiation Rrobes of Protostellar Envelopes

Together with Stäuber and Benz (ETH Zürich, Switzerland), Van Dishoeck, Doty (Denison, USA) and Jørgensen (CfA, USA) continued their observational and modeling program to search for molecular probes of high-energy ultraviolet radiation and/or X-rays in the inner envelopes of deeply-embedded Young Stellar Objects (YSOs). Because of the high extinction, ultraviolet radiation and X-rays cannot be detected directly, but they can selectively enhance molecules due to photodissociation and ionisation processes. In 2005, the X-ray models were used to investigate the water abundance in low-mass YSO envelopes. Water is found to be destroyed by X-rays on relatively short timescales ($< 10^4$ yr) for realistic X-ray fluxes. The average water abundance in Class I sources with $L_X > 10^{27}$ erg s^{-1} is less than 10^{-6}.

Van Kempen, Van Dishoeck and Hogerheijde have started an extensive radiative transfer study of the rotational emission lines of H_2O and $H_2^{18}O$ from solar-mass protostellar envelopes for a range of model abundances, including those with X-ray chemistry. The model predictions form an essential input for planning Herschel-HIFI observations. Water is a key molecule in star-forming regions, both as a physical probe and a cooling agent. Its chemistry responds strongly to temperature and density changes.

Jørgensen, Johnstone (HIA, Canada), Doty, and Van Dishoeck studied the effects of an enhanced external interstellar radiation field on the observables of protostellar cores in Orion. The increased gas temperature in the outer envelope due to the enhanced UV is needed to explain the ^{13}CO line data. Typical dust temperatures are higher than the CO desorption temperature, but analysis of the $C^{17}O$ data indicates significant freeze-out. One possible explanation for this apparent discrepancy is that the radiation field has changed through the evolution of the cores.

2.3.7 Testing Grain-Surface Astrochemistry

Bisschop, Van Dishoeck, and Jørgensen finished their JCMT program of deep searches for complex molecules in a small sample of low- and high-mass protostars. Molecules that are thought to originate through grain surface chemistry by successive hydrogenation and oxidation of CO were targeted. The aim is to derive abundances and abundance ratios for these species and compare them with grain-surface and gas-phase chemical models. The results show that some molecules, such as C_2H_5OH and CH_3CN, are only present in warm gas, pointing to the hot core nature of these molecules. Other molecules such as CH_2CO and CH_3CCH have been found to have low rotational temperatures and are thus present only in colder gas. The abundances of many of the hot core species correlate with each other, indicating that they are chemically related.

2.3.8 Ice Spectroscopy

Spitzer's IRS has the sensitivity to obtain mid-infrared spectra of stars that lie behind dense molecular clouds. Together with Knez (Austin, USA), Van Dishoeck, Pontoppidan, Lahuis and the c2d team obtained complete 5-20 μm spectra of three stars behind the Serpens and Taurus clouds, providing the first complete inventory of solid-state material before star formation begins. Remarkably, the spectra show strong 6.0 and 6.8 μm features as well as strong CO_2 ice bands. Thus, the production of the carrier of the 6.8 μm band does not require energetic input of a nearby source. Models of star formation should begin with dust models already coated with a fairly complex mixture of ices.

Thi (Amsterdam), Van Dishoeck, and collaborators finished an analysis of the VLT-ISAAC spectra of a set of intermediate mass YSOs in Vela. One source, LLN 17, shows an extremely broad CO ice feature accompanied by strong OCN^- and CH_3OH ice, whereas its lower mass companion at a few thousand AU distance has a narrow CO ice profile. This provides direct evidence for local thermal processing of the ice close to the protostar.

2.3.9 Hot Organic Chemistry in the Inner Disk

Lahuis, Van Dishoeck, Pontoppidan, and Hogerheijde, together with the c2d team, detected surprisingly strong absorption due to the gaseous molecules C_2H_2, HCN and CO_2 toward the low-mass YSO IRS 46 in Ophiuchus using Spitzer-IRS see (see Figure 2.1). Only 1 out of 100 sources in the c2d survey shows these features. Analysis of the data combined with Keck and JCMT spectra shows temperatures of at least 350 K and abundances up to 10^{-5} with respect to H_2, orders of magnitude higher than in the surrounding cloud. The most plausible origin of this hot gas rich in organic molecules is in the inner (< 6 AU radius) region of the disk, either the disk itself or a disk wind. Thus, these data provide a first look at chemistry in the planet-forming zones of disks.

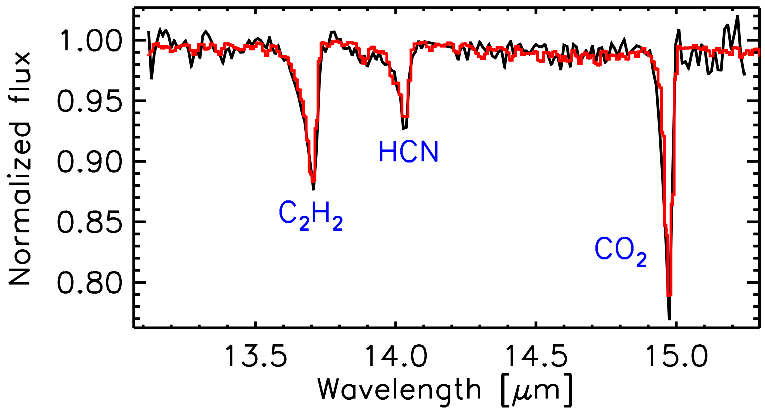

Figure 2.1: Blowup of the IRS46 normalised Spitzer-IRS spectrum covering the C_2H_2, HCN and CO_2 rovibrational absorption bands. Included in gray is a best-fit synthetic spectrum (from: Lahuis et al.).

2.3.10 Grain Growth in Disks Around T Tauri Stars

Augereau, Geers, Lahuis, and Van Dishoeck, in collaboration with Kessler-Silacci (Austin, USA) and the c2d team, finished a survey of the initial set of Spitzer-IRS spectra of circumstellar dust disks around T Tauri stars. The observed 10 and 20 μm silicate feature strengths/shapes are consistent with source-to-source variations in grain size. A large fraction of the features are weak and flat, indicating fast grain growth from 0.1–1.0 μm in radius. In addition, approximately half of the T Tauri star spectra show crystalline silicate features near 28 and 33 μm indicating significant processing compared to interstellar grains. The 10 μm feature strength versus shape trend is not correlated with age or Hα equivalent width, suggesting that some amount of turbulent mixing and regeneration of small grains is occurring. The trend is related to spectral type, however, with M stars showing significantly flatter 10 μm features (larger grain sizes) than A/B stars. The connection between spectral type and grain size is interpreted in terms of the variation in the silicate emission radius as a function of stellar luminosity.

Pontoppidan and collaborators have obtained a deep mid-infrared spectrum with Spitzer-IRS of the edge-on disk “The Flying Saucer” (2MASS J16281370-2431391). The shape of the spectrum shows that the emission from the object is dominated by photons scattered on the disk surface out to wavelengths of 20 μm. Radiative transfer modeling shows that this requires grains that have grown to at least 5 μm in size. The presence of large grains in the upper layers puts significant constraints on models of grain growth and dust mixing in planet-forming disks.

Lommen, Jørgensen, Van Langevelde, and Van Dishoeck, together with collaborators in Australia and the USA, have used the Australia Telescope Compact Array (ATCA) to observe 14 of the c2d T Tauri sources in Chamaeleon and Lupus at mm wavelengths. Nine sources were detected at 3 mm, giving disk masses comparable to the minimum solar mass of 0.01 $M_\odot$. Combined with 1 mm fluxes from the literature, the submm spectral slope was found to be shallower than that of interstellar medium grains, confirming the conclusion from the infrared data that the grains have grown to μm, and even mm, size.

2.3.11 PAHs in Circumstellar Disks

Geers, Augereau, and Van Dishoeck, in collaboration with the c2d team, have analysed Spitzer spectra of a handful of T Tauri stars which show PAH emission. Considerable care was taken to prove that the emission arises from the source itself and not from the general surrounding cloud. The detections indicate that an additional source of UV radiation besides that expected from a ZAMS star is needed to excite the PAH molecules. Options include UV from the shock associated with magnetospheric accretion and chromospheric activity. The absence of PAH features in the majority of T Tauri star spectra may be related to disk structure and PAH abundance, in addition to the amount of UV radiation.

Visser, in collaboration with Augereau, Van Dishoeck, and Geers, developed a PAH chemistry and infrared emission model. This has subsequently been coupled with Dullemond's radiative transfer disk models in order to constrain the characteristics (abundance, size, charge, hydrogenation state) of the PAHs observed with Spitzer and ISO.

2.3.12 VV Ser: a Mid-Infrared Shadow Disk

Pontoppidan and Dullemond (Heidelberg, Germany) continued their 3D Monte Carlo radiative transfer modeling of disks. One particularly interesting case is formed by the UX Orionis star VV Ser. This young star is surrounded by an extended (over 4′) mid-infrared nebulosity interpreted as being due to PAHs and very small grains that have been transiently heated by stellar UV photons. Additionally, the nebulosity is intersected by a dark wedge-shaped band indicative of a shadow cast by a much smaller, inclined disk. The Spitzer and complementary data, including near-infrared interferometric visibilities, were modeled successfully by adapting the Monte Carlo code to treat transiently heated grains. The relative abundance of PAH molecules is constrained to 3 ± 1% of the total dust mass. The relatively high in-

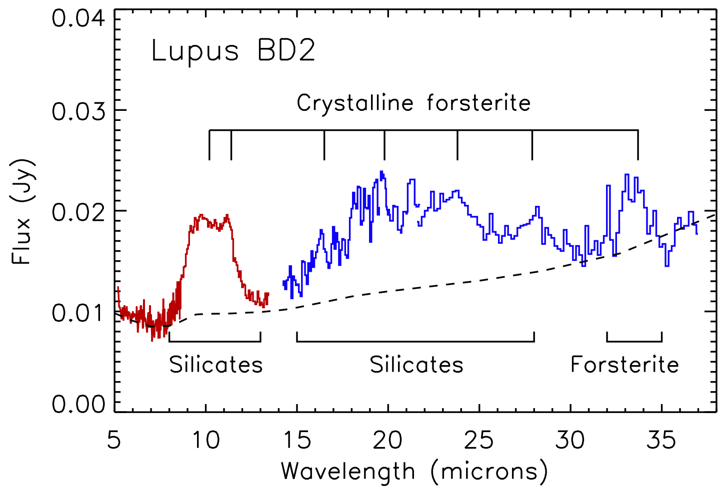

Figure 2.2: Spitzer-IRS spectrum of a newly discovered candidate brown dwarf in Lupus. This object shows an unusually high silicate feature/continuum ratio at 10 and 20 μm together with strong crystalline silicate features, indicative of significant processing (From: Merín et al.).

clination of the system is consistent with the interpretation of UX Orionis variability as being due to dust clumps in Keplerian orbits in the innermost part of the disk.

2.3.13 Disks Around Brown Dwarfs

Merín, Augereau, and Van Dishoeck, in collaboration with the c2d team, have discovered several new brown dwarf candidates with disks in the Lupus star-forming region as part of the Spitzer c2d program. Spectroscopic followup with the IRS shows that one of the objects, Lupus BD2, has spectacular silicate emission bands at 10 and 20 μm as well as several features from crystalline silicates, in particular forsterite (see Figure 2.2). The analysis of the SED suggests a passive disk with (small) dust grains and a mass fraction of crystalline material of 30%, which is among the highest found to date.

2.3.14 Discovery of a Gas-Rich Disk in Lupus

An important question in disk evolution is the gas content. Van Kempen, Van Dishoeck, Brinch, and Hogerheijde performed a JCMT CO J=3-2 survey of 21

T Tauri stars (each part of the c2d survey) with disks in Lupus. One new large gas-rich disk was found, IM Lup, which will be an excellent target for future SMA and ALMA studies. For all other targets, the single-dish data are dominated by extended cloud emission, pointing to the need for interferometry in the Southern sky.

2.3.15 The Gas Distribution in the HD 141569 Transitional Disk

In collaboration with Augereau and Kamp, Jonkheid and Van Dishoeck constructed chemical models of the circumstellar disk around the Herbig Ae star HD 141569. The disk around this object is in an interesting transitional state between the optically thick gas-rich phase and the optically thin debris stage. The dust distribution is concentrated in two rings, probably shaped by an external object, and has a large inner hole. CO has also been detected by single-dish telescopes and interferometers. The best fitting model has a total gas mass of about 80 $M_\oplus$, with some gas present in the inner hole of the dust disk.

2.3.16 The Origin of the Dust Structure in the AU Mic Disk

Augereau, in collaboration with Beust (Grenoble, France), continued his study of the dust distribution in debris disks. AU Mic is the first M-type star for which a debris disk has been spatially resolved in scattered light. In contrast with the β Pictoris system, radiation pressure is not important for AU Mic because of the low luminosity of the central star. Nevertheless, the edge-on disk shows a very similar brightness profile to that of β Pic. It was shown that if the star possesses a stellar wind with a mass loss rate of a few 10^{-12} $M_\odot$ per year, then the dynamics of the grains are very similar to that of the grains in the β Pic system.

2.3.17 A Database for Analysis of Sub-mm Line Observations

Schöier (Stockholm, Sweden), Van der Tak (Bonn, Germany), Black (Chalmers, Sweden), and Van Dishoeck summarised available atomic and molecular data for transitions of astrophysically interesting species, including energy levels, Einstein$-A$ coefficients and collisional rate coefficients. The latter were extrapolated to higher temperatures, up to 1000 K. The data are essential input for non-LTE radiative transfer programs and are made publically available over the internet. This database should form an important tool for analysing data from current and future submillimeter telescopes, in particular APEX, Herschel and ALMA.

2.3.18 Fragmentation of circumstellar disks

Together with Matzner, Levin completed an analytical study of fragmentation of circumstellar disks around low-mass stars. They showed that the fragmentation is suppressed by irradation of the disk by the reprocessed accretion luminosity and by the self-luminosity of the disk. Thus, they argued that formation of planets and brown dwarfs from fragmentation of the circumstellar disks is unlikely. This finding may help explain the 'brown dwarf desert' around low-mass stars.

2.4 Star Formation

2.4.1 Formation of Brown Dwarfs

Joergens studied the formation of brown dwarfs. There is no widely accepted model for the formation of brown dwarfs. As with stars, the multiplicity properties of brown dwarfs (frequency, separation, and mass ratio distributions) are intimately tied to their formation. For example, embryo ejection scenarios predict few binaries in only close orbits, while isolated fragmentation scenarios allow for an abundance of binaries over a wide range of separations. In recent years, numerous low-mass and brown dwarf binaries were detected by direct AO imaging. However, these surveys cannot resolve the inner $\sim$1 to 10 AU (depending on distance) around the objects. Spectroscopic monitoring for radial velocity variations provides a means of identifying the closest companions, which is essential for assessing whether the formation mechanism of companions in substellar multiple systems changes with separation. Joergens carried out a survey for close low-mass binaries in the Chamaeleon I star-forming region with the high-resolution UVES spectrograph at the VLT. Among a subsample of ten low-mass objects (M <0.12 $M_{\odot}$, M5–M8), none show signs of companions down to the masses of giant planets for separations of $a < 0.1$ AU. For Cha Hα 8 (M6.5), data recorded across a longer period of time do indicate the existence of a spectroscopic companion of planetary or brown dwarf mass with an orbital period of several months to a few years. Furthermore, a substellar companion candidate was found around the low-mass star CHXR74 (0.17 $M_{\odot}$). The first results of this survey indicate a binary fraction consistent with that of stellar binaries in the same separation range. This indicates that the finding of a smaller binary fraction for brown dwarfs than for stars by the direct imaging surveys cannot be explained by a shift to smaller separations with smaller primary mass, but that instead the overall binary fraction is smaller in the substellar than in the stellar regime – a finding which can be explained by a common formation of brown dwarf and stellar binaries and random pairing from the same mass function.

Some models for the formation of brown dwarfs via embryo ejection predict that brown dwarfs are born with higher velocity dispersions than stars. Joergens measured precise radial velocities of low-mass stars and brown dwarfs in Chamaeleon I from UVES spectra and detected that they are slightly less dispersed (0.9$\pm$0.3 km/s) but still consistent with those of stars (1.3$\pm$0.3 km/s). The absence of a significant mass dependence of the velocities is consistent with a common origin of brown dwarfs and stars. It is also consistent with some models of the ejection scenario, however, the observed global radial velocity dispersion (brown dwarfs and stars) for Chamaeleon I members is smaller than predicted by any model of the ejection scenario.

2.4.2 Complex W49A

Brandl, Van Duin, and Bos investigated the Galactic star forming complex W49A. W49A is arguably the most massive Galactic starburst complex with large amounts of associated molecular gas and numerous massive stars at different evolutionary states. The observations revealed that substructures that were previously believed to be separate, in fact are closely related, forming one big star formation complex. Based on Spitzer-IRAC images about 50 infrared sources could be identified and characterised using their near- and mid-infrared broadband flux densities. Only the sources with the steepest infrared spectra have radio counterparts. The colors of the IR sources show similarities with those of Class I sources and Class II methanol masers in other Galactic massive star forming regions. These investigations were followed by Spitzer-IRS spectroscopy of a subset of heavily embedded sources to model the mass/age of the central stellar sources and their geometry.

2.4.3 OB Associations

As part of Kouwenhoven's (Amsterdam) Ph.D. project on the primordial binary population in young star clusters, he, Brown, and Kaper (Amsterdam) reduced and analysed the data from their NAOS/CONICA adaptive optics observations of candidate companions to A stars in the Sco OB2 association. They had previously discovered these companions in an AO survey carried out with the ADONIS instrument. JHK_S images were made of 22 A stars in the Sco OB2 association. They detected 62 stellar components in the range $0.1''$–$11''$ (13–1430 AU) of which 18 are physical companions and 44 are background stars. Three of the 18 companions were previously unknown. The companion masses are in the range 0.03–1.19 $M_{\odot}$. Combining these results with the ADONIS data suggests that there is a lack of brown dwarf companions in the separation range 130–520 AU for A and late B-type stars in Sco OB2.

2.5 Stars and Circumstellar Matter

2.5.1 Pre-Main Sequence (PMS) Stars

Up to now, precise temperature constraints for PMS stars are only available from PMS eclipsing double-lined spectroscopic binaries. Joergens together with Ammler and Neuhäuser (Jena, Germany) showed how the assumption of coeval formation of the components of young eclipsing double-lined spectroscopic binaries can be used to constrain their effective temperatures independently of any assumption on the luminosity class. The new method was applied to two eclipsing binaries from the literature. It was found that none of the tested evolutionary models gives coeval solutions simultaneously in mass, radius and effective temperature for these systems.

The x-ray ROSAT All-Sky-Survey detected many young objects outside any known star-forming region. In order to improve the knowledge about their formation, which is yet unclear, Joergens together with Broeg, Ammler, Neuhäuser (Jena, Germany), Fernández (Heidelberg, Germany), Husar (BAV, German amateur astronomy society) and Hearty (Pasadena, USA) measured the rotational properties of 31 low-mass PMS stars (T Tauri stars) situated partly outside any known cloud (south of Taurus-Auriga) and partly in star forming clouds (MBM12 and Taurus-Auriga). The determined rotational periods range between 0.6 and 7 days. A statistical analysis showed that the rotational period distribution of the off-cloud weak-line T Tauri stars is not significantly different from that of the in-cloud weak-line T Tauri stars.

2.5.2 η Carinae, Wolf-Rayet stars

Van Genderen in collaboration with Sterken (Brussels, Belgium), started an analysis of ground-based optical and NIR photometry (35 yr) and space-based (Hubble Space Telescope) narrow-band photometry and narrow-band spectrograms of η Carinae, the most massive and luminous binary ($P = 5.52$ yr) in our neighbourhood. Both stars are embedded in a dense dust and gas nebula, the Homunculus. The character of the peculiar optical and NIR photometric features in the light curves during the periastron passages, of the slow secular brightening of the Homunculus, of the fast brightening episodes after the 1997.9 and 2003.5 periastron passages, and of the two types of UV-continuum light oscillations are investigated. The purpose is to get more insight in their causes.

Veijgen analysed Stroemgren $uvby$ and Bessell UBV CCD photometry of the WC-type Wolf-Rayet star WR 103. The star appears to be variable on a time scale of days and weeks, but the variations are not periodic, and they are likely not due to instabilities of the stellar continuum. The occurrence of prominent emission lines in some photometric pass bands, such like CIII and CIV in the spectrum, offers a possibility to establish which one is the source of the light variations.

2.5.3 Red Giants

Hekker, in collaboration with Aerts and De Ridder (Leuven, Belgium) analysed 3 pulsating red giants in order to obtain their pulsation modes. Additionally, different methods to measure spectral line shapes were compared.

2.5.4 Binaries in Orion

Köhler and Quirrenbach completed the analysis of a high-spatial-resolution survey for binary stars in the periphery of the Orion Nebula Cluster. They used adaptive optics systems at the 3.6 m telescope on La Silla and the Keck telescope on Hawaii to observe 228 stars, and detected 13 new binaries. The multiplicity of stars with masses $> 2\,M_\odot$ is found to be significantly larger than that of low-mass stars. The companion star frequency of low-mass stars is less than half that of solar-type main-sequence stars, and more than four times lower than in the Taurus-Auriga and Scorpius-Centaurus star-forming regions. However, the most important result is that the binary frequency of low-mass stars in the periphery of the cluster is about the same as in the cluster core. This is in contrast to the prediction of the theory that the low binary frequency in the cluster is caused by the disruption of binaries due to dynamical interactions. If this theory is correct, the binary frequency in the periphery should be higher than in the core. There are two ways out of this dilemma: Either the initial binary frequency in the Orion Nebula Cluster was lower than in Taurus-Auriga, or the Orion Nebula Cluster was originally much denser and dynamically more active.

2.5.5 Methanol Masers in High Mass Stars

Van Langevelde with Bartkiewicz and Szymczak (Torun) continued their research on methanol masers associated with high mass star formation. They observed sources from the Torun blind survey with VLBI using the EVN at 5cm. The data proved to be of excellent allowing high fidelity imaging and astrometry. One of the sources, called G23.657-0.127, shows a beautiful ring structure, reminiscent of the circumstellar SiO masers around evolved stars. Such a ring has not been observed in methanol masers before and it offers a unique perspective for the interpretation. Most importantly, in this case there can be no doubt where the central source is located. The distance to this source is unknown but can be estimated from the Galactic rotation, yielding a physical size of the ring of 1000 to 2000 AU. There is no clear velocity structure around the ring, which one would expect if this was resulting from a circumstellar disk seen face-on. Instead an interpretation is preferred where the ring delineates some sort of shock front running into the molecular material around the forming star .

2.5.6 Numerical Simulations

Woitke continued his research on the dust-driven winds of AGB stars. The 2D hydrodynamical models with time-dependent treatment of dust formation have been extended to include Monte Carlo continuum radiative transfer, which allows for a profound investigation of the time-dependent behaviour of dust-driven outflows, their stability and possible deviations from spherical symmetry. The new 2D models reveal a rather turbulent nature of dust-driven winds, undiscovered by previous 1D models.

Detailed radiative transfer calculations were carried out which predict photometric brightnesses (e.g. lightcurves), spectra, images and visibilities. The first prototype visibilities for carbon stars were presented.

The latest work considered the formation of dirty O-rich dust, being composed of Al2O3, SiO2, Mg2SiO4, TiO2 and solid iron. The latter is found to be crucial for the radiation pressure and to regulate the dust temperature.

2.6 Structure of the Milky Way

Levin and collaborators investigated the dynamics of an Intermediate-Mass Black Hole (IMBH) in the Galactic Center. They modeled numerically a scenario in which the young stars near SgrA* were delivered by an inspiralling IMBH, and computed the distribution of the expected stellar orbits. While the simulations reproduced some features of the observed stellar distribution (e.g., the thin stellar disk, high eccentricity of some stars, etc.), other features of the observed stellar orbits remain unexplained within this model. Levin derived the velocity distributions of the stars ejected by the inspiralling IMBH, and has computed the time history of the ejections. The ejected stars may be seen as high-velocity stars flying through the Galaxy. Levin demonstrated how the future proper-motion surveys of high-velocity stars (by PAN-STARRS or Gaia) may be able to confirm the presence of the IMBH inspiral in the past 10 Myr and to constrain its dynamical history.

2.6.1 Internal Dynamics of Globular Clusters

Van de Ven, Van den Bosch, and De Zeeuw determined the distance and the orbital structure of the Milky Way globular cluster ω Centauri. They used an extension of existing axisymmetric Schwarzschild software to construct realistic flattened and anisotropic dynamical models that fit the observed surface brightness of ω Centauri, as well as proper motion and line-of-sight velocity measurements of individual stars in the cluster. There is no dynamical evidence for a significant radial dependence of the mass-to-light ratio, in harmony with the relatively long relaxation time of the cluster. The best-fit model is close to isotropic near the center, but becomes increasingly tangentially anisotropic in the outer region, which displays significant mean rotation. This phase-space structure is caused by the effects of the tidal field of the Milky Way. The cluster contains a separate disk-like component in the center, contributing about 4% to the total mass. This structure seems to be linked to the multiple stellar populations observed in ω Cen.

Van den Bosch, De Zeeuw, and Van de Ven, together with Noyola and Gebhardt (both Austin, USA) constructed orbit-based axisymmetric dynamical models for the globular cluster M15 which fit groundbased line-of-sight velocities and Hubble Space Telescope line-of-sight velocities and proper motions. This provided the variation of the mass-to-light ratio (M/L) as a function of radius in the cluster, as well as the distance and inclination of the cluster. The inferred mass in the central 0.05 parsec is $3400 M_\odot$, implying a central density of at least $7.4 \times 10^6\ M_\odot$ pc^{-3}. The central mass concentration could be an intermediate mass black hole or it could be large number of compact objects, or it could be a combination. The central 4 arcsec of M15 appears to contain a rapidly spinning core.

2.6.2 Galactic Magnetic Field

Schnitzeler and Katgert continued their analysis of the WENSS polarisation data of a large (1000 sq. degrees) part of the second Galactic quadrant. Extended structures cannot be picked up by an interferometer since the central hole in the (u,v) plane is not covered by the observations. To supply information about such structures they included the single-dish Brouw & Spoelstra dataset. They estimate that the combined dataset is not sensitive to structure on scales between 2°and 5°.

The WENSS data contains only a single frequency, which previously had led them to determine gradients in polarisation angle from this dataset and interpret these gradients as gradients in rotation measure (RM). Where the single-dish data indicated that large-scale structure is not missing from the interferometer observations they were able to compare gradients in polarisation angle in WENSS including the single-dish data to RM gradients from the single-dish data. Using a Kolmogorov-Smirnov test they showed that both sets of gradients are similar, and concluded that the smaller RM in the single-dish data must be due to beam depolarisation.

The single-dish RMs were scaled up to correct for beam effects, and from these the average line-of-sight component of the magnetic field was derived. By combining information on the different components of the magnetic field that were determined by other groups the complete three-dimensional magnetic field vector was reconstructed. This reconstruction shows that the (average) magnetic field component perpendicular to the Galactic plane can be reasonably determined, and is within a factor of 4 as strong as the line-of-sight component. This in turn means that the magnetic field vector is highly aligned with Galactic longitude: the large-scale magnetic field in this part of the sky is on average azimuthally oriented.

2.7 Nearby Galaxies

2.7.1 The SAURON Project

De Zeeuw, Van den Bosch, Cappellari, Damen, Falcón-Barroso, Krajnović, McDermid, Van de Ven, and Weijmans are members or associates of the SAURON team that has built a panoramic integral-field spectrograph for the 4.2m William Herschel Telescope on La Palma, in a collaboration which involves groups in Lyon (Bacon) and Oxford (Davies). SAURON was used to measure the kinematics and linestrength distributions for a representative sample of 72 nearby early-type galaxies (ellipticals, lenticulars, and Sa bulges, in clusters and in the field). The entire survey was completed in 2003, and since then several follow-up projects were carried out on specific targets. In parallel with the data taking, the team developed a number of tools that are key to analyse all the resulting maps. In 2005 the team completed a number of papers, some of which are highlighted below.

Cappellari led the analysis of the orbital distribution of 24 E/S0 galaxies which are consistent with being axisymmetric and found that (i) the slow-rotators tend to have a nearly isotropic velocity dispersion tensor, (ii) the fast-rotators are consistent with axisymmetry and span a large range of anisotropies. These results are at variance with the classic interpretation of the so-called $(V/\sigma, \varepsilon)$ diagram, where the bright non-rotating galaxies are anisotropic and the faint fast-rotating ones are nearly isotropic.

Falcón-Barroso led the study of the stellar and gas kinematics of the 24 Sa galaxies in the SAURON sample. The stellar kinematics reveal a significant fraction of kinematically decoupled components (12/24), many of them displaying central velocity dispersion minima. They are mostly aligned and co-rotating with the main body of the galaxies, and are usually associated with dust disks and rings detected in unsharp-masked images. The kinematics of the ionised gas is consistent with circular rotation in a disk co-rotating with respect to the stars, and suggests that the gas has an internal origin. The star formation rates in the sample are comparable to those in normal disk galaxies. The OIII/Hβ ratio is usually very low, indicative of current star formation, and shows various morphologies (ring-like structures, alignments with dust lanes or amorphous shapes). Low gas velocity dispersion values appear to be linked to regions of intense star formation activity.

McDermid led a follow-up survey of elliptical and lenticular galaxies from the SAURON sample, using the OASIS integral-field spectrograph to obtain high spatial resolution spectroscopic maps of these galaxy centers. 28 objects of the 48 galaxy sample were observed at the CFHT (Hawaii), and fully analysed. This revealed that many galaxies with globally young stellar populations also show distinct central regions of young stars, and that these are often associated with counter-rotating components, something which was not resolved with the SAURON observations.

Helder, together with Van de Ven, started an analysis of the line-of-sight velocity fields of the barred spiral galaxies NGC 5448 and NGC 4596, using the SAURON data of these galaxies. She determined the bar pattern speed, the strength of the bar with respect to the rest of the galaxy and the damping term, which indicates the dissipation of the gas.

2.7.2 Supermassive Black Holes

Häring-Neumayer (Heidelberg, Germany) and Cappellari continued to work on the determination of the mass of the supermassive BH in the elliptical galaxy Centaurus A, using adaptive-optics assisted (AO) measurements of the gas kinematics taken with NAOS/CONICA on the Very Large Telescope. This galaxy is the nearest massive elliptical galaxy and the nearest merger, so it is an ideal place to study the connection between BHs and mergers.

Shapiro (Berkeley, USA), Cappellari, De Zeeuw, McDermid, and Van den Bosch completed a pilot study on the recovery of the orbital distribution in galaxy nuclei, based on SAURON and OASIS integral-field stellar kinematics. The orbital distribution can be robustly recovered and appears to be remarkably isotropic, contrary to the predictions from N-body simulations. The availability of high resolution HST/STIS kinematics of the nuclear gas disk in this galaxy allowed one of the first comparisons to be made between the stellar and gaseous determinations of black hole masses. The two determinations are mutually consistent.

2.7.3 Dark Matter

Weijmans, Cappellari and McDermid obtained integral-field data of the E1 galaxy NGC 3379 with SAURON on the WHT (La Palma, Spain). The spectrograph was pointed at 3 and 4 half-light radii. Stellar kinematics extracted at these radii are needed to constrain the mass distribution, and to establish the presence of a dark matter halo around this elliptical galaxy. Weijmans reduced the data, but due to the bad weather conditions during the observations not enough signal had been collected to provide reliable kinematics. Preliminary results indicate the presence of dark matter in NGC 3379, contrary to results obtained with, e.g., planetary nebulae for this galaxy. Re-observations of NGC 3379 are scheduled for spring 2006.

Weijmans, Krajnović (Oxford), Morganti and Oosterloo (both ASTRON) extracted a rotation curve from VLA observations of the E4 galaxy NGC 2974. Combination with SAURON integral-field data produced an accurate mass model for NGC 2974, containing a stellar contribution, a dark halo and a small gas disk.

Van de Ven, Falcón–Barroso, Cappellari, McDermid, and De Zeeuw obtained two-dimensional stellar kinematics of the lens galaxy in the Einstein Cross with the integral-field spectrograph GMOS. They built axisymmetric stellar dynamical models that fit the observed kinematic maps, and constructed a gravitational lens model that accurately fits the positions and relative fluxes of the four quasar images. The stellar velocity dispersion measurements are in agreement with predictions from their and previous lens models. The best-fit dynamical model implies an Einstein mass that is consistent with that from the lens model. The shapes of the mass distribution inferred from the surface brightness and from the lens model are very similar, but improved kinematic data is needed before firm conclusions on the total mass distribution can be drawn.

2.7.4 Dynamical Models and Analytic Methods

Van den Bosch, Van de Ven, Cappellari and De Zeeuw continued development of the Schwarzschild orbit superposition software for triaxial galaxies. This is a flexible and efficient approach to construct models of triaxial galaxies with a cusp and a central black hole. The models are constrained by measurements of the full line-of-sight velocity distribution (wherever available) and the observed surface brightness distribution. It can deal with surface brightness distributions that show position angle twists and ellipticity variations.

Van de Ven, De Zeeuw, and Van den Bosch investigated a special set of galaxy models with a phase-space distribution function that depends on linear combinations of the three exact integrals of motion for a separable potential. These Abel models are the axisymmetric and triaxial generalisations of the well-known spherical Osipkov-Merritt models. The line-of-sight velocity distribution of Abel models can be calculated efficiently and the models capture much of the rich internal dynamics of early-type galaxies. They used these models to mimic the two-dimensional kinematic observations that are obtained with integral-field spectrographs such as SAURON, and fitted these with axisymmetric and triaxial dynamical models constructed with the numerical implementation of Schwarzschild's orbit-superposition method. Schwarzschild's method is able to accurately recover the internal dynamics and three-integral distribution function of early-type galaxies.

2.7.5 Superstarclusters

Snijders and Van der Werf took a major step forward in the study of massive young superstarclusters in nearby starburst galaxies by obtaining high spatial resolution mid-infrared (10 and $20\,\mu$m) imaging and spectroscopy with the new VISIR instrument at the ESO VLT. Comparison with Spitzer spectra (through a larger slit) reveals very interesting differences: the VISIR data reveal higher excitation, indicating that the VISIR spectra zoom in on the youngest regions. Interestingly, the equivalent width of PAH emission at $11.3\,\mu$m is much lower in the VISIR spectra. These results show that VISIR begins to resolve the individual ionised and molecular gas complexes that make up the starburst.

2.7.6 Spitzer Observations of LMC SNR N157B

Micelotta, Brandl, and Israel carried out a study of the supernova remnant N157B in the Large Magellanic Cloud, using near- and mid-infrared observations with Spitzer. The images showed a complex infrared morphology offset from the optical, radio and X-ray structures of the remnant. Spectroscopy revealed the presence of different components; in addition to those from the dust itself, PAH emission is seen, and various ionic emission lines occur, notably high-excitation emission lines from [Ne III] at 15.6 μm, allowing characterisation of the ambient radiation field.

2.7.7 Central Regions of NGC 1068 Dominated by X-Rays

Meijerink, Israel, and Spaans (RUG) developed codes to describe both far-ultraviolet (PDR) and X-ray dominated region (XDR) with the ultimate aim to explore the physical environment characteristic of the central regions (typically the inner kiloparsec) in galaxies. They calculated depth-dependent models for different volume densities and a range of radiation fields to mimic the conditions in starbursts and active galactic nuclei. They now have applied their models to the molecular gas in the circumnuclear disk in NGC 1068. In this AGN, the observed HCN(1-0)/CO(1-0) intensity ratio is in the range of 0.4-0.7, which is much higher than ratios seen in Galactic PDRs. In fact, PDR models predict ratios falling well short of the values observed in NGC 1068. Such high ratios are, however, well-reproduced by XDR models with volume densities $n = 10^6$ cm^{-3} together with X-ray fluxes of $F_X = 160$ ergs cm^{-2} s^{-1} impinging on column densities $N_{\rm H} > 10^{23.5}$ cm^{-2}.

2.7.8 The Spiral Structure of M 51 at 850 μm

Meijerink, Tilanus (Hilo, Hawaii), Israel, and Van der Werf further analysed the 850 μm emission from dust in M 51, observed with SCUBA at the JCMT. They concentrated on the emission from the spiral arms, and compared this with HI and CO data from the literature to obtain a fairly comprehensive view of gas and dust in the arms; in particular they studied the mass of dust mass, the gas-to-dust ratio and the CO-to-H_2 conversion factor X in M 51. In the center of M 51, they found a gas-to-dust ratio of 60, increasing with radius. In this center, the CO-to-H^2 conversion factor is typically ten times lower than in the Solar Neighbourhood, $X = 0.2 \times 10^{20}$ cm^{-2} / (K km s^{-1}), again increasing outwards to $X = 1.3 \times 10^{20}$ cm^{-2} / (K km s^{-1}) at a distance of 170 arcsec (8 kpc) from the center.

2.7.9 Mid-Infrared Spectroscopy of Starburst Galaxies

Brandl and collaborators from the IRS team at Cornell University studied the spectral properties of a large sample of starburst galaxies. The spectra show a great variety of features ranging from fine structure lines and molecular hydrogen lines, to a rich display of dust features such as silicates and polycyclic aromatic hydrocarbons (PAHs), which are commonly regarded as good tracers of massive star formation. The starbursts cover a wide range of silicate absorption, ranging from essentially no absorption to heavily obscured systems. PAHs and dust appear to be uniformly mixed on large scales. The continuum slope longward of 15μm can be used to discriminate well between starburst and AGN powered sources. On the global scales of luminous starbursts there is no systematic dependency of the PAH equivalent width on the hardness of the radiation field (as given by the [Ne III]/[Ne II] ratio) between individual starburst galaxies. However, Beirão and Brandl also studied the spectral variations across the central region of the low-metallicity starburst galaxy NGC 5253 and found a clear anti-correlation of the PAH emission with the strength of the radiation field. This is suggestive of the photo-destruction of the PAH molecules in extreme environments.

2.7.10 Star Clusters in the Antennae

Brandl and collaborators at the University of Florida and Cornell University studied the near-infrared properties of about two hundred star clusters in the Antennae galaxies with the Palomar wide-field camera WIRC. The correlation between the near-IR and optical and radio fluxes suggest that the infrared bright clusters are younger than 10 Myrs and show no good correlation between their infrared colors and 6 cm radio properties. The clusters cover a wide range in infrared colors due to extinction *and* evolution. The average extinction is about $A_V \sim 2$ mag while the reddest clusters may be reddened by up to 10 magnitudes.

2.7.11 MIDI Observations of AGN

Jaffe and Raban continued work on mid-infrared interferometric observations of AGNs with the VLTI instrument MIDI. They analysed a large dataset obtained on NGC 1068 to provide an essentially "complete" map of the object within the capabilities of the VLTI at the higher spectral resolution provided by the GRISM mode.

In parallel, the MIDI GTO group has steadily obtained MIDI data on two nearby AGNs: the Circinus galaxy and Centaurus A. The lead on these objects is being taken by Meisenheimer and his students at MPIA Heidelberg, Germnay, but Jaffe and Raban at Leiden are heavily involved in both the technical details of the reduction and the interpretation. Interestingly, the structures of the central regions of the three AGNs so far studied seem quite different. NGC 1068 shows a thick disk with a substantial *hot* central throat region; Circinus seems to be a thin disk with little short wavelength thermal radiation; NGC 5128 is essentially a point source, even at sub-parsec resolution and can be entirely explained as synchrotron emission from the radio/X-ray jet.

Additionally, Jaffe has been supporting other MIDI observers with reduction and interpretation of their data; this led to three refereed publications in 2005.

2.7.12 Cooling Flows

With Malcolm Bremer (Bristol, UK) Jaffe continued studies of the "cooler" gas phases of cooling flow galaxies with deep VLT spectra (ISAAC and FOS) and with Spitzer midIR spectra. These show that the molecular gas, with temperatures of 300–2000 K is a significant energetic component of the gas phase; its luminosity is comparable to that of the ionised gas at ~ 10000 K. It is very difficult to keep this gas warm because of its rapid cooling rate. The spectra seem to indicate that it is being heated by extreme UV photons at energies of 30–90 eV. If these photons arise from stars, these must be much hotter than standard OB stars. The IR spectra in fact resemble those of molecular clouds near Planetary Nebulae.

2.7.13 Microlensing in the Andromeda Nebula

Kuijken and De Jong (Groningen), together with Crotts, Cseresnes (New York, USA), Sackett (Mt. Stromlo, Australia), and Widrow (Kingston, Canada) completed their analysis of the four year monitoring campaign of the Andromeda galaxy (M31), using the Isaac Newton Telescope on La Palma. The main aim of the study was to determine the microlensing rate of stars in Andromeda, and thereby measure the fraction of the dark halo around M31 that consists of massive condensed objects (MACHO's). From observations taken on 200 nights, they found 14 microlensing events, but analysis shows that this number is consistent with the expectations from the known stellar populations of M31. An upper limit of 20% can be set on the MACHO fraction of M31's halo, with most likely value zero. These results comprised the Ph.D. thesis of De Jong.

In a follow-up study, they obtained Hubble Space Telescope images of a large part of M31, and were able to identify three of the source stars in the INT microlensing events. The measurement of the unlensed brightness of the stars allows a more accurate mass estimate for the lens to be obtained: in all cases the masses are consistent with ordinary stars, confirming the earlier conclusions.

2.7.14 Weak Lensing Techniques

Kuijken continued his development of algorithms for weak gravitational lensing, based on the shapelets formalism. The aim is to develop a higher-order correction for the main instrumental effect, blurring by the atmosphere and telescope optics, that affects weak lensing surveys. As part of the international 'STEP' project (Shear Testing Programme) he participated in a series of blind tests in which end-to-end weak lensing pipelines were on run on simulated realistic sky images. Additional developments should further improve the (by now percent-level) accuracy of the analysis pipeline.

2.7.15 The KIDS Survey

In 2005 the Kilo-degree survey (KIDS) on the VLT Survey Telescope (VST) was approved by ESO. This survey (PI Kuijken) will cover a total of 1500 square degrees of sky in four optical bands, and will be matched with a near-infrared survey on the same area. The main scientific goal of the survey is to study the dark halo properties of galaxies via their gravitational lensing, and to study the equation of state of the dark energy by studying the evolution of large-scale structure and of the strength of gravitational lensing with redshift.

KIDS will cover the same area of sky in which the 2dF Galaxy Redshift Survey was done. The 200,000 redshifts that are available in the KIDS area map out the foreground structure in detail, and this can be used to measure accurate lensing masses, halo sizes and shapes for well-selected samples of galaxies, for galaxy groups and even for larger structures. In addition, the survey will form an excellent hunting ground for high-redshift quasars, very faint brown dwarfs, galaxy clusters, galactic white dwarfs, etc. Compared to the Sloan Digital Sky Survey (SDSS), KIDS will cover about one-sixth the area, but to a depth that is about 2 magnitudes deeper, and with images that are twice as sharp. It targets nine times the area of the CFHT Legacy Survey, about 1 magnitude less deep.

The survey will take 3–4 years to complete, and will use the OmegaCAM wide-field camera that a NOVA-led team (PI Kuijken; major contributions from Universities of Groningen, Munchen, Gottingen, Padua and Naples as well as ESO) completed in 2005. The heart of the camera is a 300-million pixel CCD array, and will image a square degree field of view in one single exposure with fine (0.2 arcsec) resolution. It will enter service on the VST as soon as the telescope is completed and erected on Paranal.

2.8 High Redshift Galaxies

2.8.1 Distant Red Galaxies

Labbé, Franx, and collaborators studied Distant Red Galaxies (DRGs) with IRAC. The IRAC photometry is critical for a good understanding of the nature of these galaxies. It turns out that 30% of the DRGs are old ($>$ 1Gyr), and have stopped star formation, and the others are younger, are forming stars, and dusty. Larger samples are now needed to get statistically meaningful results.

Knudsen, Van der Werf, Franx, and collaborators studied DRGs with SCUBA, the camera on the JCMT. When the signal of the galaxies is co-added, a clear detection results. When interpreted as caused by star formation, the average star formation rate is 127 $\pm$ 34 $M_{\odot}$ per year, which is high. The average age of these galaxies would be 2 Gyr. This type of galaxies can contribute significantly to the sub-mm background.

Van der Wel, Franx, and collaborators studied the evolution of field early-type galaxies to $z = 1$ and beyond. They found that the evolution of massive field galaxies is slow, and consistent with high formation redshifts: $\Delta \log M/L_B = -(1.20 \pm 0.18)z$. Lower mass galaxies appear to evolve faster, but this is at least partly caused by selection effects. Lower mass galaxies with lower M/L are more likely to ented the sample than galaxies with higher M/L.

Bouwens, Franx, and collaborators studied very high redshift galaxies in the Hubble Ultra Deep Field. By selecting J dropout galaxies, they found three possible $z = 10$ candidates. They could not rule out that these candidates are "interlopers" at lower redshift, so they consider this an upper limit. Even so, this number is much lower than expected if the luminosity function at $z = 10$ is the same as that at $z = 3$. Hence evolution in the luminosity function from $z = 3$ to $z = 10$ is strong. The density at $z = 10$ is possibly even lower than the density at $z = 6$.

2.8.2 Protoclusters of Galaxies

The large Leiden-led program on the search for and study of radio-selected distant protoclusters yielded several interesting results (Miley, Röttgering, Venemans, Overzier, and collaborators).

Venemans' Ph.D. thesis containing the results of a Large Programme carried out with the VLT was completed in 2005. This showed that the most luminous radio galaxies are excellent tracers of distant protoclusters. All seven radio galaxies investigated (at z = 2.2, 2.9, 2.9, 3.1, 3.2, 4.1 and 5.2) studied to sufficient depth are surrounded by an overdensity of Lyα emitters. The galaxy overdensities are 5 - 15 and the velocity dispersions are 300–1000 km/s. The structure sizes are $>$ 3 Mpc, and the masses are estimated to be $>$ 10^{14}–10^{15} $M_{\odot}$, comparable to the mass of present day rich clusters of galaxies.

A large multi-year project was commenced to study the evolution of the most distant protoclusters and their constituent galaxies. The PROtoCluster Evolution Systematic Study (PROCESS) is investigating the spectral energy distributions and morphologies of galaxies in four key targets (z = 4.1, 3.1. 2.3 and 1.2). Carefully selected filters are being used to disentangle the history of star formation from that of structure assembly in protocluster galaxies. SEDs are being measured over rest wavelengths from $\sim$1200 Å to $\sim$20,000Å. The results for several galaxy populations in the protoclusters detected using different detection techniques (Lyα, Hα, [OIII], Ly break, 4000Å break). PROCESS has been allocated a large amount of time on heavily oversubscribed facilities (HST – 100 orbits, Spitzer – 56 hours, VLT – 7 nights, Keck – 6 nights, SUBARU 4 nights).

2.8.3 Formation of Massive Galaxies

Distant luminous radio galaxies are among the brightest known galaxies in the early Universe and the likely progenitors of dominant cluster galaxies. For these reasons, high-redshift radio galaxies (HzRGs) are unique laboratories for studying massive galaxy formation. Miley led a project within the HST/ACS GTO Team to use HzRGs as probes of massive galaxy formation. A highlight was the acquisition of deep images of the rest-frame UV continuum emission of the radio galaxy MRC 1138-262 at z = 2.2. These images reach $>$ 2 magnitudes fainter and provide spectacular evidence that tens of satellite galaxies were merging into a massive galaxy, 11 Gyr ago.

With the aim of studying the progenitors of nearby clusters, Venemans, Röttgering, and Miley presented observations of the field of the powerful radio galaxy MRC 0316–257 at $z = 3.13$. Using narrow- and broad-band imaging and spectroscopy obtained with the VLT, 31 Lyα emitters with redshifts similar to that of the radio galaxy were discovered. Where the signal-to-noise was large enough, the Lyα profiles were found to be asymmetric, with apparent absorption troughs blueward of the profile peaks, indicative of absorption along the line of sight of an HI mass of at least $2 \times 10^2 - 5 \times 10^4$ M$_\odot$. The properties of the Lyα galaxies (faint, blue and small) are consistent with young star forming galaxies which are still nearly dust free. The volume density of Lyα emitting galaxies in the field around MRC 0316–257 is a factor of about three larger compared with the density of field Lyα emitters at that redshift. The size of the structure is larger than 3×3 Mpc^2. Its mass is estimated to be $>$ 3–6 $\times 10^{14}$ M$_\odot$ indicating it could be the progenitor of a cluster of galaxies similar to e.g. the Virgo cluster.

Overzier, Röttgering, and Miley in collaboration with Pentericci (Rome, Italy), Carilli (Tuscon, USA), and Harris (Cambridge, USA) used the Chandra X-ray satellite to study five radio galaxies in the redshift range $2.0 < z < 2.6$. For four of the five galaxies unresolved X-ray components coincident with the radio nuclei were detected. From spectral analysis and comparison to the empirical radio to X-ray luminosity correlation for AGN, the cores seem to be underluminous in the X-rays indicating that obscuring material ($N_{\rm HI} \sim 10^{22}$ cm^{-2}) may be surrounding the nuclei. Furthermore, X-ray emission coincident with the radio hotspots or lobes is detected in four of the five targets. This extended emission can be explained by the Inverse-Compton (IC) scattering of photons that make up the cosmic microwave background (CMB). By co-adding the five fields a deep, 100 ksec exposure was created to search for diffuse X-ray emission from thermal cluster gas. No diffuse emission was detected, thereby ruling out a virialised structure of cluster-size scale associated with $z \sim 2$ radio galaxies.

Powerful radio galaxies often display enhanced optical/UV emission regions, elongated and aligned with the radio jet axis. On the basis of HST and UKIRT IR imaging of a sample of 6C radio galaxies, Inskip (Cambridge, UK), Best (Edinburgh, UK), Longair (Cambridge, UK) and Röttgering have investigated the effects of radio power and redshift on the alignment effect, together with other radio galaxy properties. The host galaxies are well described as de Vaucouleurs ellipticals, with typical scale sizes of $\sim$ 10 kpc. This is comparable to the host galaxies of low$-z$ radio sources of similar powers, and also to the more powerful 3CR sources at the same redshift. The 6C alignment effect is remarkably similar to that seen around more powerful 3CR sources at the same redshift in terms of extent and degree of alignment with the radio source axis, although it is generally less luminous. Furthermore, it is considerably stronger than that seen around lower redshift galaxies of similar radio powers. This all indicates that for the alignment effect the Cosmic epoch is just as important a factor as radio power.

2.8.4 Evolution of Morphology-Density Relation

Nuyten, Simard (Victoria, Canada), Gwyn (Victoria, Canada), and Röttgering studied the relationships between galaxy properties such as total luminosity morphology, color and environment as a function of redshift. They used a magnitude-limited sample of 65,624 galaxies in the redshift range $0 < z < 1.3$ taken from one of the 1 deg $\times$ 1 deg Canada–France–Hawaii Telescope Legacy Survey Deep Fields. They found that the fraction of "bulge-dominated" to "disk-dominated" galaxies is constant with redshift in the field. However, for overdense environments this fraction is larger and increases towards lower redshifts, higher densities and higher luminosities. Rest-frame color-magnitude diagrams show that the color distribution is bimodal out to a redshift limit of $z \sim 1$ with a prominent red-sequence of galaxies at $0.2 < z < 0.4$ and a large blue-peak dominance at $0.8 < z < 1$. For all environments, this fraction of red galaxies increases towards lower redshifts and higher luminosities. The red fraction within cluster-like regions changes 60% faster with redshift as compared to the field for galaxies with $M_{g'} < -19.5$. These results are in qualitative agreement with hierarchical formation models.

2.8.5 Faint Submillimeter Galaxies

A key result from the Ph.D. thesis of Knudsen (2004, now Heidelberg, Germany) was the discovery of a triply-lensed submillimetre galaxy at $z = 2.516$, behind the cluster A2218. This galaxy is lensed by a factor of about 45, and would be too faint to detect without lensing. However, its properties are of interest since with its low intrinsic flux it is characteristic of the galaxies that make up the bulk of the submillimetre background. Radio observations with the WSRT and the VLA were carried out by Garrett (JIVE) in collaboration with Van der Werf and Knudsen. All three images were detected, with an implied star formation rate of about $500\,M_\odot\,yr^{-1}$, and no evolution in the infrared-radio relation out to $z = 2.5$. The object was also observed in the CO(3$-$2) and CO(7$-$6) lines with the IRAM Plateau de Bure interferometer by Kneib (Marseille, France), in collaboration with Van der Werf and Knudsen. The velocity profile of the CO(3-2) line displays a double-peak profile which is well fit by two Gaussians with FWHM of 220 $km\,s^{-1}$ and separated by 280 $km\,s^{-1}$. The implied dynamical mass is $\sim 1.5 \times 10^{10}\,M_\odot$ and an H_2 gas mass of $4.5 \times 10^9\,M_\odot$. This system is much less luminous and massive than other high-redshift submillimetre galaxies studied to date, but it bears a close resemblance to similarly luminous, dusty starburst resulting from lower-mass mergers in the local Universe.

2.8.6 The SCUBA-2 Cosmology Legacy Survey

Recognising the enormous potential of SCUBA-2, the successor of the SCUBA $850\,\mu$m camera at the JCMT, the JCMT Board has approved the concept of large-scale community-wide legacy surveys with the JCMT in the period from 2007. The most highly rated of these was the SCUBA-2 Cosmology Legacy Survey, with four Principal Investigators: Van der Werf (Leiden), Smail (Durham), Dunlop (Edinburgh) and Halpern (Vancouver). This survey, to be carried out from 2007 to

2009 will revolutionise submillimetre cosmology by mapping 15 square degrees to the confusion limit at $850\,\mu$m and 0.5 square degrees to the confusion limit at $450\,\mu$m. The time allocation was 1220 hours, including 490 hours of the best quality weather. It is clear that a project of this magnitude could never have been achieved through the normal time allocation process.

2.8.7 Dynamics of High Redshift Galaxies

Van Starkenburg and Van der Werf continued their study of the kinematics of high redshift galaxies using rest-frame optical emission lines. They finished their analysis of a sample of $z \sim 1.5$ galaxies. A ~ 2 mag offset from the local B band Tully-Fisher relation was found, with considerably uncertainties due to ambiguities in velocity measurements and sample selection effects.

They also did their first observations with SINFONI (the new near-infrared integral field spectrograph of the VLT) and obtained a new sample for the study of the kinematics of high redshift galaxies. Targets were $z \sim 0.8$ galaxies selected to be very suited for kinematical studies. Much effort was invested in the accurate reconstruction of SINFONI's field of view.

2.9 Theory and Numerical Simulations of Galaxy Formation

2.9.1 Simulating the Formation and Evolution of Galaxies and the Intergalactic Medium

Dalla Vecchia, Schaye, and Wiersma, working together with Springel (MPA), Theuns (Durham), and Tornatore (SISSA), created various new modules for smoothed particle hydrodynamics simulations and implemented them into the code Gadget II. A module for star formation characterises the unresolved, multiphase interstellar medium by a threshold density and its effective equation of state, and is able to produce any Schmidt law for any polytropic equation of state. The detailed, timed release of 10 elements by supernovae of types Ia and II, as well as by AGB stars, is modeled by a chemodynamics module. A module for radiative cooling computes the cooling rates on an element-by-element basis and takes photoionisation by the UV background into account.

2.9.2 Modeling 21cm Emission from the Epoch of Reionisation

Pawlik, Schaye, and Röttgering developed software to create and analyse 21cm emission maps from smoothed particle hydrodynamics simulations of the epoch of reionisation.

2.9.3 The Importance of Local Sources of Radiation for Quasar Absorption Line Systems

Schaye developed an analytic model for high column density quasar absorption line systems. Assuming that they arise in the halos of galaxies, the model can be used to predict the distribution of impact parameters, luminosities and flux from the central sources. He showed that local radiation, which is usually ignored, likely dominates over the ionising background radiation for systems rarer than Lyman limit systems. For damped Lyα systems, the local radiation field has actually been measured and is in excellent agreement with the model. He also showed that consistency between observations of the UV background, the UV luminosity density from galaxies, and the number density of Lyman limit systems requires escape fractions of order 10 %.

2.9.4 The Spatial Distribution of Metals in the Intergalactic Medium

Schaye, together with Pieri (Laval, Canada) and Aguirre (Santa Cruz, USA), studied the spatial distribution of heavy elements in the intergalactic medium at redshift $z \sim 3$. They carried out a detailed analysis of a high-quality Keck/HIRES absorption spectrum of the quasar Q1422+231 and found that within 600 km/s from strong C IV absorbers, which are thought to arise in the halos of galaxies, the abundance of carbon and oxygen is significantly higher than for gas of the same density (i.e., with the same level of HI absorption) but in a random location. However, if the analysis was restricted to the two thirds of the spectrum that are at least 600 km/s away from any C IV line strong enough to detect ambiguously, the metal-line absorption was only slightly less strong than for the entire spectrum. This suggests that while the metallicity is enhanced in regions close to galaxies, the enrichment is likely to be much more widespread than their immediate surroundings.

2.9.5 Confronting Cosmological Simulations with Observations of Intergalactic Metals

With Aguirre (Santa Cruz) and others, Schaye compared H I, C IV and C III absorption in a set of six high-quality $z \sim 3-4$ quasar absorption spectra to that in spectra drawn from two different state-of-the-art cosmological simulations that include galactic outflows from $z \lesssim 6$ galaxies. They found that compared with observations, the simulated metals resided in gas that was too hot, had too low density, and that the metals were distributed too inhomogeneously. They concluded that an additional (perhaps higher-z) contribution to the enrichment of the intergalactic medium may be required.

2.9.6 Simulations of Magnetic Fields in Large-Scale Filaments

Together with Brüggen (Bremen, Germany) and others, Dalla Vecchia carried out adaptive mesh refinement simulations of magnetic fields in large-scale filaments. The simulation was used to probe the growth of magnetic fields in filaments by passively evolving the fields in them. The results show that within the cluster seed fields are amplified by a factor of 7000 between redshift 50 and today. Within filaments the amplification is 10-300 (up to ~ 3 nG), and the fields are aligned with the filament.

2.9.7 Simulations of Sound Waves in the Intracluster Medium

Dalla Vecchia, Mazzota (Rome, Italy), Rasia (Padova, Italy), Bower, Theuns, and Frenk (Durham, UK) worked on simulations of the propagation of sound waves generated by AGN bubbles. Preliminary simulations show that measurements of the distance between observed sound waves can give a good estimate of the duty cycle of AGN.

2.9.8 AGN Heating in Galaxy Halos

Dalla Vecchia, together with Bower, Theuns and Frenk (Durham), worked on simulations of the heating of the gaseous halos of massive galaxies by AGN bubbles. Preliminary runs indicate that there exists a mass limit above which AGN heating quenches the cooling flow. This form of feedback may determine the high luminosity cut-off of the galaxy luminosity function.

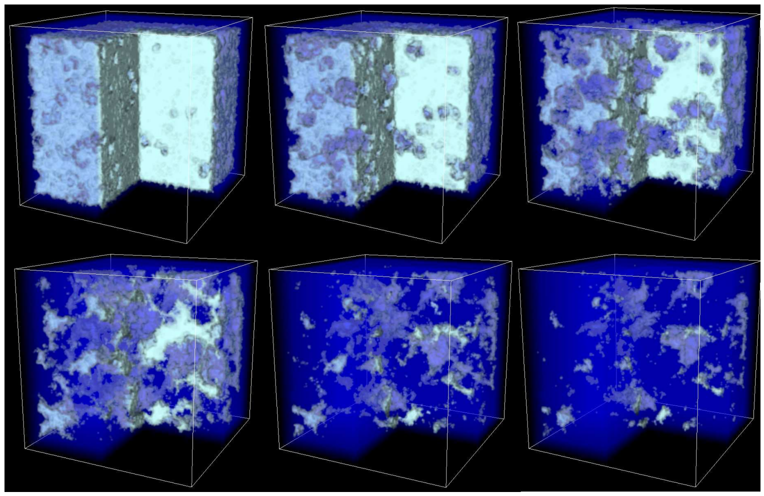

Figure 2.3: Volume rendering of six time-slices of a reionisation simulation of an inhomogeneous matter and source distribution within a 100Mpc box. White (opaque) is the neutral hydrogen and blue (transparent) are the ionised regions. A quarter of the boxes has been cut out, to help make the internal structure of the box more clearly visible.

2.9.9 Epoch of Reionisation

Ritzerveld used his new radiative transfer method, SimpleX, to do simulations of the Epoch of Reionisation (EOR). Up until then, simulations were restricted to relatively small boxes (<10Mpc), because the ionising photon consumption is dominated by the small scale structure, which one therefore needs to resolve. It is well-known, however, that one needs much larger boxes to suppress cosmic variance, to resolve the long frequency modes of the density spectrum, and to resolve the ionisation bubbles, which are expected to have a size of the order of tens of Mpc. Because the number of sources scales with the simulation volume, larger simulation boxes were out of reach, because of computational restrictions.

SimpleX does not scale with the number of sources, by which it was possible to do reionisation simulations within boxes up to a size of 100 Mpc. An example of the output is given in Figure 2.3. Because an adaptive point process is used, it is possible to cover a large box, without losing resolution for the small scale structure.

2.9.10 Cosmological Radiative Transfer Code Comparison

Ritzerveld was invited to participate in a worldwide comparison project, in which the nine important cosmological radiative transfer codes, including his SimpleX code, were to run four standard cosmological testcases. The tests were defined in a first meeting in Toronto in May, and the comparison project was closed in a final meeting in Leiden in December. The codes compared fairly well, although the complexity and performance of each code differed tremendously.

2.9.11 Diffuse Radiation

Ritzerveld showed analytically that the standard derivations considering ionisation fronts bounding an HII region, and the resultant Strömgren spheres, are not correct so long as they involve the so-called 'On-The-Spot' (OTS) approximation. In this old bookkeeping trick, one ignores the locally produced diffuse ionising recombination radiation by recognising that the mean free path for such photons is very small, and, as such, they are absorbed almost immediately. Ritzerveld showed that this a faulty argument, because diffuse photons are on equal footing with the source photons and can therefore not be singled out. When one relaxes the OTS approximation, and also tracks the diffusion radiation, one can show that the often ignored diffuse radiation actually dominates within HII regions, and causes the ionisation fronts to slow down, and the morphology of shadows to change drastically. Ritzerveld worked this out analytically for several relevant density distributions.

2.9.12 Transport Theory

Ritzerveld and Icke showed that their SimpleX method for radiative transfer can be used more generally to solve the general Master Equation used in many different branches of science, from sociology to chemistry, and from traffic control to astrophysics. More specifically, they showed it can be used to efficiently solve the equations used in transport theory, such as the well known Boltzmann equation. Ritzerveld and Icke showed that the use of a random point process as a basis for the graph, or lattice, on which the transport takes place, solves the years-old dilemma within the Lattice Gas Automata and the Lattice Boltzmann community, in that it does provide a suitable lattice in 3D, whereas using regular lattices, as had been the case, rules out a useable lattice in 3D. Moreover, the resulting lattice can be shown to be Poincaré invariant (needed to obtain Naviér Stokes-like equations in the limit), a property a regular lattice lacks.

2.9.13 Particle Sampling Theory

Maschietto, Ritzerveld, and Icke studied the mathematical properties of point distributions used within numerical methods such as N-body (gravity) codes, SPH (hydrodynamics), DTFE (field estimators) and SimpleX (radiative transfer) to sample a continuous field. They worked out a point distribution equivalent of the Nyquist frequency, well known from sampling theory. For this they used Fourier analysis, and spherical harmonics decomposition in multi-dimensional space to derive the spectral properties of the continuous field. This they combined with the available analytical properties of random point processes. From the result, one can quantitatively derive the minimum number of points, or the number of experiments if the maximum number of points available is not large enough, one needs to sample, or resolve, the smallest scale structure of the continuous field. As an example, they analysed the spectrum of the density field of a protoplanetary disk, simulated by RODEO (Paardekooper & Mellema), and they found that the number of points needed to accurately sample that distribution was much larger than the resolution used by SPH methods for similar simulations.

2.9.14 Random Graph Theory

Maschietto, Ritzerveld, and Icke studied the properties of graphs, or unstructured grids, based on random point processes. These random point processes are or can be used in numerical methods such as SPH or SimpleX. They obtained analytic expressions for the expectation values of random walks on such graphs, which can be shown to be isomorphic to the solutions of the equations of transport theory. The results can be used in a wider context, because the Poincaré invariance of such random graphs, makes them useful also in Lattice QCD calculations, or as simple elementary building blocks for Feynman diagrams.

2.10 Raymond & Beverly Sackler Laboratory for Astrophysics

The research in the Raymond & Beverly Sackler Laboratory for Astrophysics is aimed at the construction of state-of-the-art experiments in which inter- and circumstellar processes are simulated under laboratory controlled conditions. The results are interpreted in unambiguous physical-chemical models, provide molecular data as input to astrochemical models and support or guide the analysis of new observational spectra. The research comprises both solid state experiments — CRYOPAD, SURFRESIDE, HV-SETUP and CESSS — and gas phase experiments —

LIRTRAP, SPIRAS and LEXUS. Several of these experiments are performed in close collaboration with theoretical groups.

In 2005, Linnartz was appointed at Leiden Observatory as the new head of the laboratory. With this appointment a number of infrastructural changes have taken place: the Sackler laboratory has become larger and the laboratory infrastructure has been adapted to present standards.

2.10.1 CRYOPAD – CRYOgenic Photo-product Analysis Device

The construction of CRYOPAD by Van Broekhuizen, Schlemmer (Cologne), Fraser (Strathclyde, UK), Fuchs, and Benning was completed in 2005. CRYOPAD routinely achieves ultra-high vacuum (UHV) conditions (5×10^{-11} mbar) and ices are grown with mono-layer precision at 14 K. Sensitive detection techniques such as TPD (temperature programmed desorption) and RAIRS (reflection absorption infrared spectroscopy) are used to study both spectroscopic and thermal properties of pure, layered and mixed ices upon warm-up or irradiation, to simulate the processes in hot cores around protostars.

Systematic studies were performed on CO-N_2 and CO-O_2 ices with a view to understand the differential gas-phase chemistry of CO and N_2H^+ observed in dense pre-stellar cores and to explain the low abundances of oxygen in interstellar clouds by possible freeze-out on interstellar grains. Specifically, Bisschop, Fraser, and Van Dishoeck modeled the TPD experiments of pure, mixed and layered CO and N_2 ices taken by Öberg and Schlemmer. The aim of the model was to derive kinetics and parameters on desorption, mixing and segregation of CO-N_2 ice system for use under astrophysical conditions. The models imply that the N_2 binding energy is much closer to that of CO than previously assumed in astrochemical models. In layered ices N_2 desorption occurs in two temperature steps whereas for mixed ices it occurs in a single step.

Acharyya (Greenberg Fellow), Fuchs, Linnartz, Fraser and Van Dishoeck found that in all CO-O_2 ice systems, O_2 desorbs at somewhat higher temperatures than CO. Thus, O_2 can be “hidden” on grains in space up to higher temperatures than CO. The O_2-CO interactions are much weaker than those for N_2-CO. It was also shown that both O_2 and CO likely undergo phase changes from amorphous to crystalline ices prior to desorption. As a follow-up project, Fuchs, Acharyya, and Linnartz studied the RAIRS behaviour of pure CO in its amorphous and crystalline forms. RAIR spectroscopy is more difficult to interpret than transmission spectroscopy but has the advantage that it is more sensitive and has greater diagnostic capability for the precise ice structure.

Van Broekhuizen, Schlemmer, and Fraser started a program on systematic studies of the photodesorption of CO in pure CO-ices, which is a potentially important process in protoplanetary disks. The ultraviolet lamp has been calibrated to derive quantitative results. Initial data indicate that the direct photodesorption probability is low; follow-up experiments are carried out by Öberg, Fuchs, and Linnartz.

2.10.2 SURFRESIDE – SURFace REaction SImulation Device

Construction of SURFRESIDE was taken over by Fuchs, Bisschop, Linnartz, de Kuiper (FMD), Benning (FMD) and, Verdoes (FMD) from Fraser and Schlemmer. The goal of this setup is to study atom-molecule reactions on surfaces under simulated interstellar conditions. As in CRYOPAD, interstellar ice analogues are grown with mono-layer precision under UHV conditions and monitored using TPD and RAIRS. In 2005 much effort was put in instrumental improvements. In close collaboration with Disselhorst (ED) a low-flux microwave driven atomic beam source from Oxford Scientific was successfully redesigned and now has an unprecedented cracking capacity of H_2, O_2 and N_2 in continuous mode operation. In parallel, a second H- and D-atom source was tested by Fuchs at the manufacturer and purchased. This new source is a well characterised thermal cracking source with high dissociation rates and a broad spectrum of available atom fluxes. In collaboration with the FMD, work is in progress to design efficient cooling stages and to implement both cracking devices in a redesigned SURFRESIDE.

2.10.3 HV-SETUP – High Vacuum Setup

The HV-setup was used by Öberg and Bisschop for a number of temperature dependent experiments on interstellar ices using Fourier Transform Infrared transmission spectroscopy. New Spitzer spectra obtained by the c2d Legacy team indicate the need for a detailed study of the H_2O-CO_2 system. In particular, the laboratory data show that the intensity ratios of different water bands change by more than a factor two in mixed ices with CO_2. This resolves discrepancies in derived abundances from the H_2O bending and stretching modes in interstellar clouds.

Van Broekhuizen, together with Groot, Fraser, Schlemmer, and Van Dishoeck, finished the analysis of CO and CO_2 spectra in mixed and layered ice configurations and showed that they exhibit very different spectral characteristics, which depend critically on thermal annealing. CO only affects the CO_2 bending mode spectra in mixed ices below 50 K, where it exhibits a single asymmetric band profile in intimate mixtures. In all other ice morphologies the CO_2 bending mode shows a double peaked profile, similar to that observed for pure solid CO_2. Conversely, CO_2 induces a blue-shift in the peak-position of the CO stretching vibration. The results are applied to the interpretation of VLT-ISAAC spectra of solid CO and Spitzer spectra of solid CO_2 to constrain the CO_2 formation scenarios.

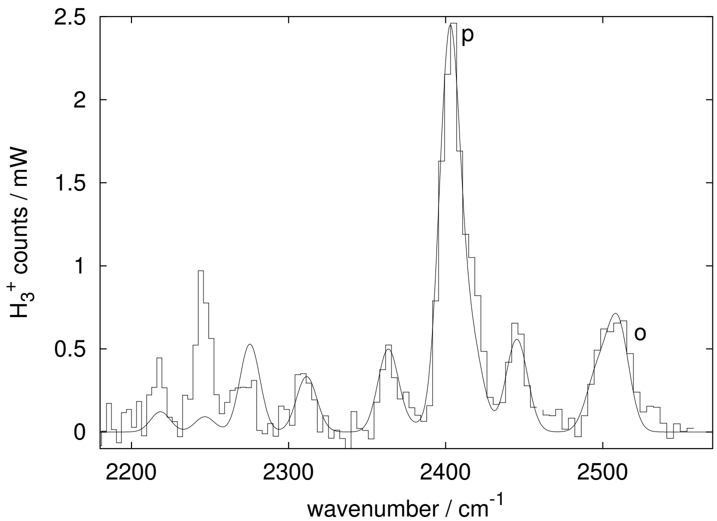

Figure 2.4: LIR spectrum of H_2D^+ in collisions with n-H_2. The simulation (dotted line) represents contributions from the ν_2 and ν_3 vibrational modes. Transitions of the lowest ortho (o) and para (p) state used for the analysis are marked.

2.10.4 CESSS – Cavity Enhanced Solid State Spectrometer

CESSS is in the phase of construction by Bouwman and Linnartz. It combines the expertise available from the HV-SETUP with an optical detection scheme that became recently available from gas phase spectroscopy: Incoherent BroadBand Cavity Enhanced Absorption Spectroscopy. Spectroscopy of interstellar ices has so far been mainly limited to infrared (i.e., vibrational) studies. Here the aim is to extend the techniques into optical (i.e., electronic) spectroscopy of interstellar ices. The technique is sensitive, fast and covers large frequency regimes in a short time, i.e. is ideally suited to study *in situ* and online reaction products following UV bombardment of interstellar ice analogues.

2.10.5 LIRTRAP – Laser Induced Reactions TRAPping device

LIRTRAP is a low-temperature ion trapping machine used by Asvany, Hugo, and Schlemmer to measure infrared spectra of astrophysically interesting ions as well as ion-molecule rate coefficients. In early 2005, a successful measurement campaign employing this setup was conducted at the free electron laser FELIX at FOM

Rijnhuizen. The method of Laser Induced Reactions (LIR) was used to obtain infrared spectra of CH_5^+ as well as of its deuterated versions. Furthermore, H_2D^+, one of the key molecular ions to promote deuteration in cold clouds, was probed by excitation of the ν_2 and ν_3 ro-vibrational bands and subsequent reaction with n/p-H_2 (see Figure 2.4). The latter experiments have been continued at the University of Düsseldorf in the group of Schiller with the aim to work with high resolution laser systems. As a spectroscopic result, a number of new lines in the ν_1 band have been detected. In addition, the populations of the lowest para- and ortho-states of H_2D^+ have been probed, and the experimental results show a more efficient relaxation when this ion is stored in p-H_2 (rather than n-H_2). Hugo has started to develop a model for the H_2D^+ populations to interpret the experiments and extrapolate to interstellar conditions. With the help of the FMD the ion trap was improved to reach lower temperatures, down to 14 K.

2.10.6 SPIRAS – Supersonic Plasma InfraRed Absorption Spectrometer

Many gas phase species observed in space are open shell species, particularly molecular radicals and ions. SPIRAS, constructed and operated by Verbraak and Linnartz, offers the unique possibility to study such species at high resolution (< 0.001 cm^{-1}) in the frequency region of 1000–3000 cm^{-1} by combining sensitive tuneable diode laser spectroscopy and special supersonic planar plasma expansions under mass spectrometric controlled conditions. The setup was moved from the Laser Centre Vrije Universiteit to Leiden and is meanwhile fully operational. The setup is used to characterise fundamental properties in ion-neutral interactions by studying strongly bound ionic complexes some of which (e.g. $(CO)_2^+$) might be of astrophysical relevance. As a prototype for a charge transfer complex the infrared spectrum of the $[Ar\text{-}N_2]^+$ has been studied in close collaboration with the theoretical chemistry group of Bickelhaupt (VU). Currently work is in progress to extend applications towards high resolution infrared spectroscopy of highly unsaturated linear carbon chain radicals of astrophysical interest, e.g. the linear CCCCCCH chain. For this a new plasma source (see Figure 2.5) is constructed.

2.10.7 LEXUS – Laser EXcitation setup for Unstable Species

LEXUS is a recently constructed setup by Linnartz which was moved from Amsterdam to Leiden. It is capable of detecting optical spectra of very small gas amounts without a serious loss in sensitivity by applying time gated fluorescence spectroscopy. Plasma discharge techniques was developed in which low rotational excitation is coupled with high vibrational temperatures. The setup is particularly

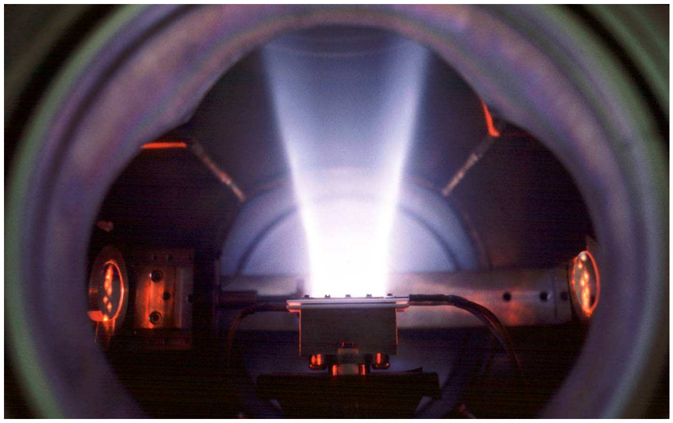

Figure 2.5: A planar plasma jet in full operation: a mixture of C_2H_2 in He is discharged. Exotic species, such as the astrophysically relevant C_6H, are formed in the adiabatic expansion by recombination collisions. Typical rotational temperatures are 10 K.

suited to study gases that come in small supply; isotopes (e.g. deuterated species) and species that are toxic in large amounts, e.g. PAHs.

2.10.8 Molecular Dynamics Simulations of H_2O Ice Photodissociation

In support of the CRYOPAD experiments, Andersson, Kroes (LIC), and Van Dishoeck studied the photodissociation dynamics of a water molecule in an amorphous and crystalline ice layer at 10 K using classical molecular dynamics. The final outcome is found to strongly depend on the original position of the photodissociated molecule. For molecules in the first (bi)layer, desorption of H atoms dominates. Deeper into the ice, H atom desorption becomes less important and trapping and recombination of H and OH dominate. The distribution of distances traveled by H atoms in the ice peaks at 6 Å with a tail going to 60 Å. The mobility of OH radicals is low within the ice with distances of $\sim$ 2 Å, except at the surface where OH can move over more than 80 Å. Only minor differences are found between amorphous and crystalline ice. Simulated absorption spectra of crystalline ice, amorphous ice, and liquid water are found to be in very good agreement with experiments. Desorption of H_2O has a low probability (less than 0.5% yield per absorbed photon) for both types of ice, a prediction which will be tested by future CRYOPAD experiments.

2.11 Instrumentation

2.11.1 MIDIR

Brandl, Stuik, and Hallibert, together with an international team involving the Max-Planck Institut für Astronomie (Heidelberg, Germany), ASTRON (Dwingeloo), and the European Southern Observatory (Garching, Germany) investigated possible concepts for a mid-infrared instrument for a future 100m OWL telescope. An instrument, consisting of a combined imager and spectrograph for the $3.5 - 20\mu$m range was discussed and submitted to ESO under the acronym T-OWL. Although the telescope concept was significantly changed from a 100m to a $30 - 60$m telescope in late 2005, the conceptual work (now also including the UK-ATC in Edinburgh) on such an instrument continued under the name MIDIR.

Van Eijck and Brandl investigated the possibilities of a novel concept for a simple mid-IR camera for spectral surveys. Instead of *spatial* chopping by moving the field of view to accurately subtract the thermal background, the technical needs for *spectral* chopping by periodic, rapid filter adjustments in the pupil plane were investigated. This work required a test setup in the optical lab to compare and test possible schemes.

2.11.2 GLAS

The largely NWO-funded Rayleigh laser guide star system for the WHT, GLAS (McDermid, Stuik), progressed on schedule through final design review, and remains on target to be commissioned on-sky in the summer of 2006. This system will increase the available sky coverage for adaptive-optics corrected observations to almost 100 %. The main uses of GLAS will be for near-diffraction limited infrared imaging using the INGRID imager, and high-spatial resolution integral field spectroscopy using the optical spectrograph, OASIS.

2.11.3 HORATIO

A first Adaptive Optics setup was designed and build in the Leiden Observatory Optical/IR lab, as part of the Bachelor Research projects by Roduner and Buurman and further enhanced by McHugh, a summer student from the National University of Ireland, Galway. Further improvements were made by Van Hal (wavefront sensing) and Westmaas (phase screens).

2.11.4 MUSE

MUSE, the Multi Unit Spectroscopic Explorer is second generation instrument for the VLT featuring Wide-Field, Adaptive Optics Assisted Integral Field Spectroscopy. After its positive review and subsequent approval by ESO in 2004, MUSE entered its Preliminary Design Phase with a Kick-off meeting in January 2005. The MUSE consortium currently consists of seven institutes and is led by the Observatory of Lyon. NOVA, by way of Leiden Observatory, is mainly involved in the Adaptive Optics system and the science team of MUSE. The MUSE AO system, GALACSI, is an integral element of the VLT Adaptive Optics Facility (AOF) and in this context Hallibert, Stuik, and Vink have made a preliminary opto-mechanical design of the test bench, called ASSIST, for GALACSI and other elements of the VLT AOF. After a rigorous review process, the VLT AOF was approved in December 2005 by ESO Council, clearing the way for a simplified solution for the MUSE AO system. Stuik was also actively involved in defining the interface between GALACSI and the MUSE spectrograph.

2.11.5 PRIMA

Mathar and Quirrenbach continued their work on PRIMA (Phase-Referenced Imaging and Microarcsecond Astrometry), which is scheduled to become part of the VLTI (Very Large Telescope Interferometer) operated by the European Southern Observatory (ESO). The contribution by the Leiden Observatory was an analysis of the Error Budget of the astrometric mode that uses two of the 1.8 m Auxiliary Telescopes (AT's), development of calibration strategies with focus on higher order differential setups of the instrument based on the principle of building averages to reduce instrumental asymmetries, plus first steps in the development of the Data Reduction Software (DRS). The Preliminary Design Review of the hardware of the Differential Delay Lines (DDL's) and the DRS was passed in May.

A scalar equation connects the angle τ on the sky, the baseline b, the difference ΔD between the optical path differences of the two stars, and the difference ξ between the projected baseline angle and star orientation angle (see also Figure 2.6):

$$\tau = \frac{\Delta D}{b \cos \xi}.$$

Monitoring the mean and the amplitude of ΔD as a sinusoidal function of time with a 24 hrs period might also allow to split the angle τ into polar and equatorial vector components in the geocentric coordinates of the Earth.

Resolving the angle to an accuracy aimed at 10 μarcsec is equivalent to measuring the difference between the two interferometric delays over baselines of 100 m at a precision of 5 nm, and requires knowledge of this baseline to approximately 40

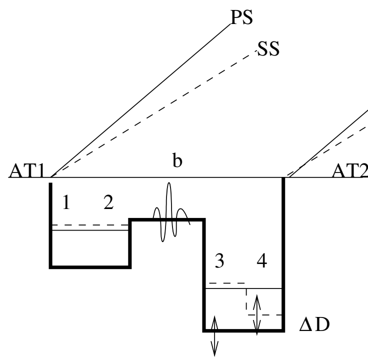

Figure 2.6: The interferometric principle of measuring the star separation τ with PRIMA: the two telescopes AT1 and AT2, a baseline length b apart, receive light from the two off-axis stars, the primary star (PS) and the secondary star (SS), separated by τ. Adjustment of one of the two Main Delay Lines and one of the four Differential Delay Lines (arrows) within the coherence length creates K band fringes on two detectors in the VLTI laboratory.

μm. Some characteristic challenges to achieve this goal are worked out in the Error Budget: (i) The star light of both stars defining two off-axis beams on both telescopes is transferred via sets of 11 mirrors in each telescope to a "star separator" that divides the field-of view. Up to this point one needs symmetry of both telescope optics to approximately 200 nm to avoid parasitic optical path differences on the characteristic length scale of 5 nm. (ii) The fringe tracker software will be challenged by fluctuating photometric signals, as the coupling coefficients of the wave fronts to some intermediate optical fibers within the fringe sensor (detector) units will be rather sensitive to atmospheric speckles—the Auxiliary Telescopes are not equipped with adaptive optics beyond a 10 Hz tip-tilt correction. (iii) Horisontal temperature gradients between the two star's beams in the delay line system will accumulate some tens of nanometers of optical path length difference by moving the beams through slightly different indices of refraction. The statistics of the humidity sensors installed in 2004 now covers four seasons and defines the typical time scales of temperature and density fluctuations of beam ducts and delay line air that are to be interpreted as changes in the longitudinal index of refraction. (iv) The sphericity of the atmosphere above the telescopes equivalent to the Earth curvature induces lensing effects well known under the keyword "wet delay maps" to Radio Interferometry. The points of entry of the two 1.8 m beams into the atmosphere define a baseline vector there which is neither parallel to nor as long as the equivalent geometric baseline vector between the two apertures on the ground. (v)

The use of PRIMA as an astrometric instrument is ultimately tied to the interpretation of measured raw fringe phases. Turning them into path differences relies on good knowledge of the effective wave length of the spectrum seen by the detector, which is a superposition of star spectra, atmospheric and mirror absorptions, fiber coupling and detector efficiencies.

Albeit these studies took the form of opto-engineering consulting to the European Southern Observatory, with no science involved, they are the prerequisites to design calibration and operation strategies of the instrument, and eventually distill this knowledge into the, both generic and rigid, software framework envisaged by the data flow pipeline of the ESO Data Management Division. Lobbying for the use of Object Oriented programming languages and the use of a Database Management System in this framework turned out to be largely unsuccessful. On the positive side, the need to provide the offline Data Reduction Software with some fundamental raw data, most importantly the detector quadrant readouts with what are called the ABCD phases in two-beam phase-shifting interferometry, was acknowledged by the ESO Instrument Division.

2.11.6 GAIA

Marrese and Brown worked on an end-to-end simulation of the photometric data analysis chain by simulating in detail the photometric measurements that will be obtained by Gaia. The results are fed into the overall data simulation efforts for the Gaia mission and are used to support the optimisation of the instrument design and the development of the photometric data processing algorithms.

To facilitate the organisation of the data processing for Gaia the science team issued a request for letters of intent regarding the involvement of institutes throughout Europe in the data processing for Gaia. Brown coordinated the Dutch response.

Within the Gaia project a Data Analysis Coordination Committee (DACC) was set up which is tasked with defining and putting into place the Gaia Data Processing and Analysis Consortium (DPAC). The DPAC is expected to start operating in mid-2006 and will conceive, implement and operate the Gaia data processing system. Brown is a member of the DACC. The main tasks of the DACC are to design a workable structure for the data processing and to match the community interests (as expressed by the Letters of Intent) to the required tasks. The planning of the Gaia data processing task has been subdivided according to a number major tasks (such as astrometric and photometric processing) and delegated to so-called coordination units. The photometric coordination unit is led by Van Leeuwen (Cambridge), and Brown and Jordi (Barcelona) are deputy managers. Together they worked out a detailed plan for the photometric data analysis task and have matched the community interests to the photometric data analysis work-packages.

2.11.7 MIDI

In early 2005, Tubbs studied the sensitivity of the MIDI instrument on the VLTI to the detection of faint stellar companions. The results were presented at the *Power of Optical/IR Interferometry* in Garching. Simulations of the performance of optical interferometers with adaptive optics correction were also published by Tubbs.

2.11.8 ISO Infrared Astronomical Spectroscopic Database (IASD)

Jourdain de Muizon, with support from the ISO team (Vilspa, Spain) and from Castets (Bordeaux, France), worked on a database of all published ISO spectroscopic results. The final product is essentially a table in which each published, ISO–observed spectral line or feature is given in a line of the table with most of its possible observation and spectroscopic parameters. IASD has been used as the reference implementation Atomic and Molecular Spectroscopic Line database for the proposal of two protocols for the IVOA (International Virtual Observatory Alliance) at the ADASS meeting in October 2005. The aim is to implement IASD in the Virtual Observatory when it is operational. In the meantime IASD is made available as a beta-version in VizieR. Given that Spitzer has no spectroscopic instrument whose resolution can compete with ISO-SWS & -LWS, it is expected to have most of IASD ready in time to help preparing observations with Herschel. The database currently contains about 4000 line entries.

2.12 History of Science

Van Delft finished his doctoral thesis, which presents a biography of Heike Kamerlingh Onnes, the low-temperature physicist at Leiden University. Together with J.D. Van der Waals, H.A. Lorentz, P. Zeeman, J.H. Van 't Hoff, and W. Einthoven, Onnes represents the so-called 'Second Golden Age', the heyday of Dutch physics in the period around 1900. The central question in this book is how Kamerlingh Onnes was able to succeed so brilliantly in developing his cryogenics laboratory - undoubtedly an exceptional feat in terms of its scale and its almost industrial approach in the Netherlands of the last quarter of the nineteenth century. A related question is what determined his success - his abilities as a scientist, his organisational talent, or his personality? This portrayal of Kamerlingh Onnes, the man and the scientist, gives ample attention to the social and scientific environment in which he operated.

Heike Kamerlingh Onnes (1853-1926) was the oldest son of a Groningen manufacturer of bricks and roofing tiles. In 1882 he was appointed Professor of Experimental Physics in Leiden. In his inaugural lecture on 11 November, he coined the aphorism 'through measurement to knowledge'. In Leiden Kamerlingh Onnes embarked on a programme to meticulously verify the molecular theories of his compatriot Joahannes Diederik Van der Waals. Onnes' approach rested on two foundation stones: accuracy and cold. Accuracy because both the equation of state and the law of corresponding states had only an approximate validity, and identifying deviations in those laws would lead to advances in physics. Cold because the best way to test Van der Waals' theories was to start with research on simple substances (and mixtures), and this required low temperatures. Substances like oxygen, hydrogen and nitrogen have critical temperatures far below the freezing point for water, so there was no option but to set up a cryogenics laboratory. This undertaking absorbed almost all Onnes' energy during the initial period of his professorship.

In 1892 the Leiden cascade produced the first drops of liquid oxygen, in 1906 the hydrogen liquefier was completed and on 10 July 1908 Onnes was the first to achieve the liquefaction of helium, making Leiden 'the coldest place on earth'. The crowning glory was the discovery in 1911 of superconductivity. Two years later Kamerlingh Onnes was awarded the Nobel Prize for Physics for his work with liquid helium.

Chapter 3

Education, popularization and social events

Education, popularization and social events

Chapter 3

3.1 Education

3.1.1 Organisation

Education and training of students is a major priority of Leiden Observatory. In 2005, 18 freshmen started their studies in astronomy, and 21 students started their second bachelor year. In total, including Bachelors, Masters, and doctoral students, there were 115 students registered at the Observatory. In additional, several students from the applied physics and aerospace departments of Delft Technical University attended courses in the Leiden astronomy curriculum as part of the requirements for a minor in astronomy.

From May 1, Israel took over from Franx as Director of Education. At the same time, Snellen was appointed as Van der Werf's successor as freshman-student adviser, and coordinator for the various activities directed at secondary school students, including the Pre-University program and LAPP-Top courses, open days, and guest lectures. Kuijken assumed the remaining duties of Van der Werf and became study adviser for the Bachelor course beyond the first year. Le Poole remained study advisor at the Masters level. Administrative support was provided by Drost and Gerstel. The education website (`http://www.strw.leidenuniv.nl/education`) was completely redesigned and updated. This site provides a great deal of up-to-date information, including the formal curriculum descriptions ('OERs'), as well as archival material, in a user-friendly format.

In addition to regular counseling by the student advisor, freshman students are assigned to small groups meeting at regular intervals with a mentor group consisting of a staff member (Snellen and Hogerheijde) and two senior students. Since the minimum number of credits required by the University for further study was raised this year from 30 to 40 EC (out of 60 EC), the Observatory, together with the physics department, also began an experiment in providing students, on a voluntary but regular basis, with senior students acting as tutors.

Although most of the initial courses deal with physics and mathematics, the Observatory provides astronomy courses right from the beginning. As part of the 'Introduction to astrophysics' course students were taken on December 9 to the Artis Planetarium in Amsterdam for a lesson in coordinate systems, time, and constellations in the sky. As part of the second-year training in practical astronomy, honours students were offered the opportunity to take their own observations at the Isaac-Newton-Telescope on La Palma, Canary Islands. Other courses were introduced to familiarise students with research in astronomy. These included an interactive course on modern astronomical research in the second year, and a major bachelor research project in the third year.

Registration for the newly introduced degree of Master of Science in astronomy is taking off. In 2005, the number of excellent applications from outside the Netherlands doubled to eight. A new element in the master curriculum is the 'compact' lecture course (3 EC) meant to either deepen or broaden insights gained in regular courses (6 EC).

The astronomy curriculum is monitored by the 'Opleidingscommissie' (Education committee), which advises the Director of Education on all relevant matters. Katgert resigned as chair by the summer, and was replaced by Van der Werf. The quality of curriculum and exams is guarded by the 'Examencommissie' (Exam committee) where Israel took the chair from Franx. Admission to the master-curriculum for students without a BSc in astronomy from a Netherlands university requires a recommendation by the 'Toelatingscommissie' (Admissions committee). Details of all committees can be found in Appendix II.

3.2 Degrees Awarded in 2005

3.2.1 Ph.D. degrees

A total of ten graduate students successfully defended their Ph.D. theses in 2005 and were duly awarded their Ph.D. degree. They are:

K.C. Steenbrugge	February 2
Title thesis:	*High resolution X-ray spectral diagnostics of active galactic nuclei*
Thesis advisor:	Schillizzi

D. van Delft	February 10
Title thesis:	*Heike Kamerlingh Onnes, een biografie*
Thesis advisor:	Visser
P.C. Lacerda	February 17
Title thesis:	*The shapes and spins of Kuiper Belt objects*
Thesis advisor:	Habing
M.A. Reuland	February 24
Title thesis:	*Gas, dust and star formation in distant radio galaxies*
Thesis advisor:	Miley
F.I. Pelupessy	March 16
Title thesis:	*Numerical studies of the interstellar medium on galactic scales*
Thesis advisor:	Icke
B.P. Venemans	April 27
Title thesis:	*Protoclusters associated with distant radio galaxies*
Thesis advisor:	Miley
F.A. van Broekhuizen	June 29
Title thesis:	*A laboratory route to interstellar ice*
Thesis advisor:	Van Dishoeck
A. van der Wel	September 29
Title thesis:	*Setting the scale: photometric and dynamical properties of high-redshift early-type galaxies*
Thesis advisor:	Franx
P.M. van de Ven*	December 1
Title thesis:	*Dynamical structure and evolution of stellar systems*
Thesis advisor:	De Zeeuw
E.J. Rijkhorst	December 6
Title thesis:	*Numerical nebulae*
Thesis advisor:	Icke

* denotes *Cum Laude*.

3.2.2 Master's Degrees (Doctoraal diploma's)

The following five students were awarded Master's/Doctoral degrees in 2005:

Name	Date	Present Position
Maaike Damen	Aug 30	Ph.D. candidate, Leiden Observatory
Martijn Nuijten	Aug 30	Accenture Technology Solutions
Nathan de Vries	Aug 30	Ph.D. candidate, Leiden Observatory
Joke van Vugt	Aug 30	Production manager, Phillip Morris Holland
Siard van Boven	Nov 29	Management trainee, Rabo-Bank Utrecht

3.2.3 Bachelor's Degrees

A total of nine students were awarded their (newly introduced) Bachelor's degree in 2005:

Name	Date
Mark den Brok	August 26
Laura Helmsing	August 26
Ernst de Mooij	August 26
Eveline van Scherpenzeel	August 26
Edo van Uitert	August 26
Freeke van der Voort	August 26
Arsham Farzinnia	November 29
Uri Shimron	November 29
Martijn van Riet	November 29

3.3 Courses and Teaching

3.3.1 Courses Taught by Observatory Staff (Curriculum 2005–06)

Elementary Courses

Semester	Course title	Teacher
1	Introduction to astrophysics	K.H. Kuijken
2	Astronomy lab 1	P.P. van der Werf
3	Stars	J. Lub
3	Modern astronomical research	B. Brandl
4	Astronomy lab 2	I. Snellen
4	Galaxies and cosmology	M. Franx
5	Observational techniques 1	H.A. Quirrenbach
5	Radiative processes	M.R. Hogerheijde
5-6	Bachelor research project	W.J. Jaffe
6	Introducing the observatory	E.R. Deul
7-10	Student colloquium	J. Lub

Advanced Courses

Semester	Course title	Teacher
7,9	Stellar evolution	P.T. de Zeeuw
7,9	Observational techniques 2	R.S. Le Poole
7,9	Large scale structure and galaxy formation	J. Schaye
8,10	Active galactic nuclei	H.J.A. Röttgering
8,10	Radio astronomy and techniques	R.T. Schilizzi
8,10	Interstellar matter	E.F. van Dishoeck
8,10	History of astronomy	(interacademial lecture course)

Pre-University Program

The Pre-University College is a new pilot program initiated by Leiden University to introduce talented fifth and sixth grade high-school students to university studies. It includes courses in several disciplines within the university, including astronomy. During 2005, nine students participated in the astronomy program given by Miley and Snellen. The course concentrated on radio astronomy and on the new LOFAR radio telescope presently being built in the north of the Netherlands. The course consisted of three half-day sessions with lectures and practical work and a whole day excursion to the Westerbork radio telescope and the Research and Development Department of the ASTRON Foundation at Dwingeloo. Subsequently, the students prepared and delivered a presentation on LOFAR.

LAPP-Top, the Leiden Advanced Pre-University Program for Top Students, is aimed at enthusiastic and ambitious high-school students from the fifth and sixth 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 six to eight meetings from January to May, following the program of their own choice.

The astronomy department has participated in the LAPP-Top program since it started in 2001. In that pilot year five students participated, in 2002/3 there were six, 11 in 2003/4, 33 in 2004/5, and now 17 beginning in 2005.

The astronomy LAPP-Top program was developed by Van der Werf from 2002 onward. In eight sessions the following subjects are treated:

Planets and exoplanets	(P. van der Werf)
Observing in astronomy	(H. Röttgering)
Gas and radiation	(V. Icke)
Galaxies and active galactic nuclei	(M. Franx)
Astronomy lab (parallax, moons of Saturn)	(R. van den Bosch, M. van Duin, D. Schnitzeler)
What makes the Sun shine? Stars and their evolution	(J. Lub)
Cosmology	(P. Katgert)
Visit to the radio telescopes in Westerbork and Dwingeloo	

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

Other Courses

Israel gave his annual lecture course 'Astronomy' at Delft Technical University, for about 50 students in the departments of aerospace and applied physics.

Icke and Van Ruitenbeek (Physics) organised an interdisciplinary course 'The Living Universe' for first-year students, concerning life in the universe. Several Observatory staff (Van Dishoeck, Icke, Israel) lectured in this series.

3.4 Popularisation and Media Contacts

3.4.1 Organisation

Astronomy has a strong appeal to the general public, and is well represented in the media. Our staff, Ph.D. students, and undergraduate students spend considerable time and effort to explain the exciting results of astronomy to the general public, in the form of lectures, press releases and newspaper articles, courses, public days at the old observatory, and television and radio programmes. These efforts are very successful every year, and help to make young high school students enthusiastic about science in general, and astronomy in particular. They play a very important role in maintaining the student inflow, and in keeping Leiden Observatory known throughout the country.

3.4.2 Public Lectures and Media Interviews

Bisschop
'Astrochemie: Van Waarnemingen tot Experimenten' (Oct 4)

Brandl
'Weltraumgebundene Infrarot Astronomie' (the Amateur Astronomer Society in Nordenham, Germany; Apr 14)

Van den Bosch
'Krachten in de Sterrenkunde' (KNWVS Almere; Oct 25)

Van Dishoeck
'From molecules to planets' (Helen Sawyer-Hogg public lecture; University of Toronto, Toronto, Canada; Jan 20)
'Chemie onder extreme condities in de ruimte' (Studenten symposium scheikunde Nijmegen; Mar 17)
'From molecules to planets' (Chemerda public lecture; Penn State University, State College, USA; Nov 1)
'De eerste stap in de wetenschap' (Academie Nieuws, 83, pp. 18-20)

Geers
'Ster- en planeetvorming. Nieuwe resultaten met Spitzer Space Telescope' (Weer- en Sterrenkunde Vereniging Galileo, Heerlen; Nov 12)

Hekker
'Op reis door het zonnestelsel' (IMC Weekendschool, Amsterdam; Mar 6)
'Machten van tien' (IMC Weekendschool, Amsterdam; Mar 13)
'(Ge)Varen in de ruimte' (IMC Weekendschool, Amsterdam; Apr 3)
'Snelheidsvariaties in Kreuzen: planeten of pulsaties?' (Eindhovense Weer en Sterrenkunde Vereniging; Oct 20)
'Idem' (Leidse Weer en Sterrenkunde vereniging; Oct 25)

Van Houten-Groeneveld
'Kleine Planeten' (Werkgroep "NEO's en Planetoiden" of the 'Nederlandse Vereniging van Weer en Sterrenkunde', Leiden; 26 Feb)

Icke
'Alle kunde is sterrenkunde' (Comenius; Jan 13)
'Christiaan Huygens en de relativiteitstheorie' (Studium Generale, Universiteit Maastricht; Jan 13)
'De gloed van de Oerknal' (JWG Leiden; Jan 15)
'Helden van de wetenschap' (NEMO; Jan 20)
'Gas en Straling' (LAPP-Top Programma; Feb 2)
'Einsteins Origami' (Gastcollege Rietveld Academie, Arti Amsterdam; Feb 16)
'De toekomst van het heelal' (Comenius; Feb 17)
'Sterren in de Kunst' (Willem II College, Tilburg; Mar 3)
'Wat doet een sterrenkundige' (Weekendschool, Amsterdam; Mar 6)
'Reizen in de ruimte' (Weekendschool, Amsterdam; Apr 3)
'Alle kunde is sterrenkunde' (Ouderdag De Leidsche Flesch; Apr 16)
'Christiaan Huygens' (Vlaamse Radio, Brussels, Belgium; May 12)
'Wonderlijke alledaagse quanta' (Lezing World Year of Physics; June 16)
'Relativiteitstheorie' (HOVO, Leiden; Sep 1)
'Practical Pandemonium' (Sterrewacht Science Day; Sep 8)
'Toekomst in het Groot' (Publiekslezing Universiteit van Amsterdam; Sep 13)
'Het principe van Huygens' (Symposium Passages, Leeuwarden; Sep 15)
'Interview over Krachten met Theodor Holman' (747 AM; Oct 28)
'Gloed van de oerknal' (Kaleidoscoop, Leiden; Nov 1)
'Hoe exact is het dagelijks leven?' (Exactdag 5 van Nijgh, Nijkerk; Nov 15)
'Een zerk in het zwerk' (Onthulling ramen Pieterskerk, Leiden; Dec 7)

Israel
'Planeet Saturnus' (UL Lipsius; Jan 1)
'Interview – Hoe? Zo!' (Teleac Radio; Feb 21)
'Huygens, Saturnus en Titan' (Lustrum Dispuut Huygens; Mar 12)
'Wij zijn van sterrenstof' (Raad van State; Mar 22)

'Wij zijn van sterrenstof' (VROM, Space Expo; Sep 1)
'The Sky is the Limit' (Leidsche Flesch, Leiden; Nov 11)
'Korstmossen in de Ruimte' (Moderator Minisymposium Space Expo; Dec 14)

Jaffe
'How big is the universe?' (Mar 23)
'How big is the universe?' (Nov 25)

Katgert
'Het Uitdijend Heelal, wie wat en hoe?' (VWO Breda; Jan 20)
'Idem' (VWO Hardenberg; Jan 27)
'Idem' (VWO Hilversum; Mar 2)
'De eerste 3 minuten' (Triangulum Apeldoorn; Apr 14)
'Idem' (NVWS Zwolle; Sep 29)
'WMAP' (NVWS Oostzaan; Oct 27)
'Kosmologie: de film van het Heelal' (NVWS Scheveningen; Dec 12)

Kuijken
'Oratie' (Leiden Academiegebouw; Jan 14)
'Een heelal vol donkere materie en donkere energie' (Leidsche Flesch Symposium; Mar 23)
'A journey through Time and Space' (General Assembly of EUROPUR, Prague, Czech; June 9)

Lahuis
'Partial Ingredients for DNA and Protein Found Around Star' (NASA Press Release; Dec 20)
'Astronomen ontdekken acetyleen en blauwzuur bij jonge ster' (Leiden Observatory Press Release; Dec 21)
'Ruimteonderzoekers vinden bouwstenen voor leven bij andere ster' (SRON/NOVA Press Release; Dec 21)
'Interview "Radio 1 nieuws"' (Radio; Dec 21)
'Interview "Radio-TV Noord"' (Radio & TV; Dec 21)
'Interview "Met het oog op morgen"' (Radio; Dec 23)

McDermid
'Radio Interview' (Business Nieuws Radio, Marc Wesseling; Feb 21)

Miley
'LOFAR' (Leids Natuurkundig Gezelschap; Nov 18)
'LOFAR' (Avro Network Television; Oct 23)

Pontoppidan
'Life in the Universe?' (Faculty of Theology, Aarhus University, Denmark; Feb 6)

Ritzerveld
'The Universe on a Hard Disk' (Public Lecture KNVWS Arnhem; Feb 2)
'Idem' (Public Lecture Kaiser, Leiden; May 26)
'Idem' (Public Lecture KNVWS Zwolle; Nov 17)
'Information Theory and Cryptography' (Invited Lecture, Levend Heelal Lecture Series, Leiden; May 30)

Röttgering
'Van de Big Bang tot het leven in het heelal' (Artis planetarium, Amsterdam; Oct 4)

Snellen
'Planeten buiten ons zonnestelsel' (Dec 14)

Snijders
'Reis door het zonnestelsel' (Kaiser public lecture; Mar 3)
'Idem' (lecture IMC weekendschool; Mar 6)
'Machten van tien' (lecture IMC weekendschool; Mar 13)

Taylor
'The edge of the observed universe' (Oude Sterrewacht, Leiden; Apr 28)

Weijmans
'Reis door het heelal' (Kinderlezing L.A.D. Kaiser; Mar 31)
'Donkere Materie' (KNVWS Amersfoort; Nov 23)
'Idem' (KNVWS 't Gooi; Dec 16)

Quirrenbach
'Lecture Series in Adaptive Optics' (National Astrophysics and Space Science Programme, Cape Town, South Africe, Nov 7–11)

Van der Wel
'Elliptische Sterrenstelsels Vroeger en Nu' (LWSK; Sep 13)

Wuyts
'Tot de Grenzen van het Heelal' (Public Lecture; Nov 1)

De Zeeuw
'Remarks by the Club Guest' (RAS Club Dinner, London; Mar 11)
'De Leidse Sterrewacht' (Visit Raad van State to Old Observatory, Leiden; Apr 22)
'Uitdijende OB associaties, wegren sterren en pulsars' (JVS/VVS Weekend, Nieuwpoort, Belgium; Oct 15)

3.5 The Leidsch Astronomisch Dispuut 'F. Kaiser'

The student association L.A.D. 'F. Kaiser' is named after the founder of Leiden's Old Observatory, Professor Frederik Kaiser. The board for 2005-2006 consists of Sander de Kievit (president), Demerese Salter (vice-president), Susanne Brown (secretary) and Patrick Herfst (treasurer). The 2004-2005 board consisted of Laura Helmsing, Eveline Helder, Demerese Salter and Patrick Herfst.

The L.A.D.'s main goal is to improve social contacts between (under)graduate students and Observatory personnel. In 2005, this was accomplished by organising several 'borrels' (drinks and snacks) in the Kaiser Lounge: one to celebrate the New Year, one to welcome the new freshmen to our faculty, and one to celebrate the constitution of Kaiser's new board. A football tournament was also organised in May. This tournament was open to all students of the 'Leidsche Flesch' and to employees of the Observatory. With ten teams participating, it was a very successful and enjoyable afternoon. A large barbecue, too, was organised in early July. It took place at the Old Observatory in the centre of Leiden, and with around 60 people attending. This too was a success, even despite less than ideal weather.

Another main goal of the L.A.D. is to popularise astronomy among the general public. To this end, tours of the historical Old Observatory are given upon request. A small financial contribution is asked for these tours. The tours usually consist of an astronomical lecture, explaining some basics of astronomy and lasting for 30 to 45 minutes, followed by a tour of some of the telescopes at the Observatory. Weather permitting, the tour groups are given the chance to view through the telescopes. The year 2005 was a very busy one for Kaiser with respect to these tours, and it looks like 2006 will be just as busy. Kaiser tends to receive several requests a week, and it's a rare occasion when a week passes without Kaiser giving a tour!

The year 2005 also saw the first series of public lectures organised by Kaiser. These lectures, given at the Old Observatory, were open to the general public at no charge. They were held by Ph.D. students. Five lectures were given in total, in the months of April through June. After the lectures, the audiences had the opportunity to tour the telescopes. The first two lectures aimed especially at youger audiences, from eight-year-olds upwards. All public lectures were well visited. The public lecture series will be continued in 2006.

A main event for the general public was organised by the L.A.D. on Friday January 14th, the day the Huygens-probe landed safely on Titan. Kaiser organised a celebratory evening, which began with two lectures, held in the Lipsius building; one focusing on Saturn and Titan, and one focusing on the history of Huygens and Cassini. A DVD by ESA/ESTEC about the mission was also shown. These lectures were attended by about 100 people. Afterwards, there was the opportunity to view Saturn and Titan through the '10 duims' and Zundermann telescopes at the Old Observatory. A small exhibition about the mission was set up in the central hall of the Observatory building. The telescopes stayed open all evening, and were visited by about 500 people. Possibly a record!

All tours and lectures organised by the L.A.D. 'F. Kaiser' are held by student volunteers from the Leiden Observatory. We would like to thank all of them for their commitment.

3.6 Vereniging van Oud-Sterrewachters

The "Vereniging van Oud-Sterrewachters" (VO-S) is the official association of Sterrewacht/Observatory (ex-)affiliates. It has been in existence for some 10 years now and has seen another active year. As usual, the 130 members were offered a variety of activities. These included a social drink prior to the Oort Lecture, and an annual meeting. This year the annual meeting was held in Dwingeloo, and attended by nearly 50 people, particularly from the north of the Netherlands.

Appendix I

Observatory staff December 31, 2005

Observatory staff December 31, 2005

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
M. Franx
V. Icke
F.P. Israel
K. Kuijken
G.K. Miley (KNAW)
H.A. Quirrenbach
P.T. de Zeeuw

Full Professors by Special Appointment

M.A.Th.M. de Graauw	(SRON Groningen, for J.H.Oort Fund)
M.A.C. Perryman	(ESTEC, for Leiden University Fund)
R.T. Schilizzi	(JIVE, Faculty W&N)
R.P.W. Visser	(UU(0.5)/UL(0.5), Teyler's Professor)

Associate Professors and Assistant Professors

B.R. Brandl
D. van Delft (0.2) *
M. Hogerheijde
W.J. Jaffe
P. Katgert
H.J. van Langevelde (0.0) **
Y. Levin
H. Linnartz
J. Lub
R.S. Le Poole
H.J.A. Röttgering
J. Schaye
S. Schlemmer (0.0) ***
I.A.G. Snellen (KNAW)
P.P. van der Werf

NOVA office

P.T. de Zeeuw	director
W.H.W.M. Boland	adjunct director (UL/FWN)
T. Brouwer	financial controller (0.2) (UL/FWN)
K. Groen	management assistant

Management Assistants and Secretaries

J.C. Drost
K. Groen
B. de Kanter (voluntary)
E. Lindhout
L. van der Veld

Computer staff

E.R. Deul	manager, computer group
D. J. Jansen	scientific programmer
T. Bot	programmer
A. Vos	programmer

Visiting Staff

M.J. Betlem
P. Ehrenfreund (LIC)
C. Helling
M. Jourdain de Muizon
G. Mellema (ASTRON)
A. Sargent (J.H. Oort foundation)
M. Spaans (RUG)
R. Stark (NWO)
J.A. Stuwe

Emeriti

A. Blaauw (also: Groningen)
W.B. Burton
A.M. van Genderen
H.J. Habing
I. van Houten-Groeneveld
K.K. Kwee
K.R. Libbenga
A. Ollongren
C. van Schooneveld
J. Tinbergen

* Science Editor NRC Handelsblad; ** Staff, JIVE, Dwingeloo; *** Professor, Universtät Köln.

Postdocs and Project Personnel

O.I.L. Asvany	NWO	R. McDermid	NOVA, Glass
A.G.A. Brown	NOVA,GAIA	B. Merín Martin	Spanje/Spinoza
M. Cappellari	NWO, VENI	C.J. Ödman (0.5)	KNAW
A. Crapsi	EU/NWO VIDI	N.M. Ramanujam	NOVA, LOFAR
C. Dalla Vecchia	EU-EXT	S. Reffert-Frink	NWO, VICI
J. Falćon Barroso	EU	J.P. Reunanen	NOVA Sinfoni
G. Fuchs	NOVA, Sackler	R. Stuik	NOVA OPTICON
P. Hallibert	NOVA Muse	K.H. Tran	NOVA
V. Joergens	EU Marie Curie	R.J. Vink	NOVA Muse
R. Köhler	NWO, VICI	T.M.A. Webb	NWO, VENI
P. Marrese	NWO, GAIA	P. Woitke (0.8)	UL
R.J. Mathar	NWO, VICI		

Ph.D. Students

S. Albrecht	1,9	S.-J. Paardekoper	1
P. Beirão	1	O. Panić *	3
S. Bisschop	1,2	A.H. Pawlik *	5
R. van den Bosch	3	F. Petrignani *	7
C. Brinch	5	D. Raban *	3
M. Damen *	1,2	J. Ritzerveld	3
V. Geers	4	D.H.F.M. Schnitzeler	3
S. Hekker	1,10	D.M. Smit *	3
H. Intema *	6	L. Snijders	1
B. Jonkheid	4	M.H. Soto Vicencio	1
I. ten Kate	1,3	L. van Starkenburg (0.8)	1,2
T. van Kempen	3,4	E.N. Taylor	3
M. Kriek	3	H.E. Verbraak *	8
F. Lahuis (SRON Groningen)	4	R. Visser *	4
D.J.P. Lommen *	2	N. de Vries *	1
R. Meijerink	1	A. Weijmans *	3
E. Micelotta	5	R. Wiersma *	11
K.I. Öberg *	5	S.E.R. Wuyts	3
R. Overzier	3		

Funding notes:
1. funded by Leiden University; **2.** funding through NOVA program; **3.** funded by NWO, via Leiden University; **4.** funding from Spinoza award; **5.** funding from EU EARA MC network; **6.** funding from KNAW; **7.** external funding source; **8.** employed by FOM; **9.** funded by NOVA2 OPTICON; **10.** funded from VICI Quirrenbach; **11.** funded from EU Excellence grant.

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

Senior students

N.J.C.P. Baars
M. van den Berg
R. Berkhout
C.C. Bonnett
A. Bos
M.P. den Brok
S.Y. Brown
E.E. Caris alias Reynders
B. Clauwens
B. van Dam
S. van Dongen
M. van Duin
D. van Eijck
A. Farzinnia
S. Fransen
N. ter Haar
G. van Hal
E. Helder
P. Herfst
B. Holl
M. van Hoven
S. de Kievit
A.C. Kockx
G. Kosters
A.L. Kroonenberg
F. Maschietto
E.J.W. de Mooij
J.B.R. Oonk
S. Ophof
F.J. Roduner
E.T. van Scherpenzeel
W.P. Spaan
S. Toonen
E. van Uitert
S. Veijgen
P. Verburg
F. van de Voort
E. de Wachter
S.H. Welles
A.N.M. Westmaas

G. Chaparro Molano (MSc student)
A.-M. Madigan (MSc student)
O. Rakic (MSc student)
D.M. Salter (MSc student)

A.J.C.P. Hagenaars (BSc)
T.D.J. Kindt (BSc)
S.V. Nefs (BSc)
M. van Riet (BSc)
I.R. Rosenbrand (BSc)
W.C. Schrier (BSc)
J.A.P. Severijnen (BSc)
D. Szomoru (BSc)
C.H.M. de Valk (BSc)
A.W. de Vries (BSc)
M. Zwetsloot (BSc)

Note:
BSc students listed are only those doing a research project.

Staff changes in 2005

Name (Funded by)	start	end
S.J.S. Andersson (UL, NWO)	01-04-05	01-10-05
J. Augereau (EU)		01-01-05
E.J. Bakker (UL,NOVA)		01-10-05
F. van Broekhuizen (UL, NOVA)		01-03-05
F. van Broekhuizen (NWO, Spinoza)	01-03-05	01-06-05
A.G.A. Brown (UL,NOVA)		01-03-05
A.G.A. Brown (NWO, UL)	01-03-05	
A. Crapsi (EU)	01-09-05	
C. Dalla Vecchia (EU, EXT)	22-06-05	
M. Damen (UL, NOVA)	15-09-05	
D. van Delft (UL) (0.2)	01-08-05	
R. McDermid (UL, NWO)		01-10-05
R. McDermid (NWO, Lapalma)	01-10-05	
J. Falcón Barroso (EU)		01-07-05
J. Falcón Barroso (UL, NOVA)	01-07-05	
R. Flicker (NWO, VICI)		01-03-05
G. Fuchs (UL, NOVA/Sackler)		01-09-05
G. Fuchs (UL, NOVA/Lab)	01-09-05	
P.M. Gori (UL, VICI)		01-04-05
P.A.J. Hallibert (UL, NOVA)	01-04-05	
E. Hugo (UL, DFG)		01-07-05
H. Intema (UL, KNAW)	01-02-05	
J. de Jong (UL, NOVA)		01-03-05
I.L. ten Kate (UL)		01-11-05
I.L. ten Kate (NWO, vern. impuls)	01-11-05	
R. Kerpershoek (UL, stagiair)		01-02-05
R. Köhler (NOVA MIDI)	01-01-05	31-12-05
F. Lahuis (NWO, Spinoza)		01-05-05
F. Lahuis (NWO, Spinoza)	01-08-05	
Y. Levin (UL)	01-08-05	
H. Linnartz (UL)	01-09-05	
E. Lindhout (UL)	01-03-05	
D.J.P. Lommen (UL,NOVA)	15-04-05	
P. Marrese (UL, NWO)	01-02-05	
K. Öberg (EU, EARA)	01-09-05	
C. Ödman (UL, KNAW) (0.5)	15-09-05	
O. Panić (NWO, VIDI)	01-09-05	
A. Pawlik (EU, EARA)	01-05-05	
K. Pontoppidan (NWO, Spinoza)		01-09-05

Staff changes in 2005 (continued)

Name (Funded by)	start	end
D. Raban (UL,NWO)	01-03-05	
M. Ramanujam (UL,NOVA)	15-05-05	
J.P. Reunanen (UL,NOVA)	01-06-05	
R. Rengelink (NOVA, Omegacam)		01-04-05
E.J. Rijkhorst (UL, NWO)		01-11-05
R. Ruiterkamp (NWO, Vern, Impuls)		01-03-05
J. Schaye (UL)	01-03-05	01-06-05
J. Schaye (EU,EXT)	01-06-05	
B.A. Smit (UL)		01-08-05
D.M. Smit (UL,NWO)	01-09-05	
K.H. Tran (UL, NOVA)	01-12-05	
R.N. Tubbs (EU, Marie Curie)		16-06-05
P. van de Ven (UL)		31-12-05
A. Venemans (KNAW)	01-07-05	01-11-05
R.J. Vink (UL, NOVA)	01-01-05	
R. Visser (NWO, Spinoza)	01-09-05	
N. de Vries (UL)	01-09-05	
T.M.A. Webb (UL,NOVA)		01-04-05
T.M.A. Webb (NWO, VENI)	01-04-05	
A. van der Wel (UL)		01-11-05
A. Weijmans (UL, NWO)	01-02-05	
R. Wiersma (EU, EXT)	01-07-05	
P. Woitke (UL, NWO)		01-12-05
P. Woitke (UL)	01-12-05	
A.W. Zirm (UL, NWO)		15-03-05
A.W. Zirm (UL, KNAW)	15-03-05	01-10-05

Appendix II

Committee membership

Sterrewacht Leiden

Committee membership

Appendix II

II.1 Observatory Committees

(As on December 31, 2005)

Directorate
(Directie onderzoekinstituut)
P.T. de Zeeuw (director of research)
F.P. Israel (director of education)
J.Lub (institute manager)

Observatory management team
(Management team Sterrewacht)
P.T. de Zeeuw (chair)
J.C. Drost
E.R. Deul
F.P. Israel
K.H. Kuijken
K. Groen (minutes)
J. Lub

Oversight Council
(Raad van toezicht)
H. van der Laan (chair)
B. Baud
J.A.M. Bleeker
C.J. Oort
W. van Saarloos

Research committee
(Onderzoek-commissie OZ)
K.H. Kuijken (chair)
A.G.A. Brown
M.R. Hogerheijde
W.J. Jaffe
P. Katgert
R.T. Schilizzi
T.M.A. Webb
P.P. van der Werf

Research institute scientific council
(Wetenschappelijke raad onderzoekinstituut)

F.P. Israel (chair)
B.R. Brandl
D. van Delft
E.R. Deul
E.F. van Dishoeck
M. Franx
M.A.Th.M. de Graauw
M.R. Hogerheijde
V. Icke
W.J. Jaffe
P. Katgert
K.H. Kuijken
Y. Levin
H. Linnartz
J. Lub
G.K. Miley
R.S. Le Poole
M.A.C. Perryman
H.J.A. Röttgering
H.A. Quirrenbach
J. Schaye
R.T. Schilizzi
I.A.G. Snellen
R.P.W. Visser
P.P. van der Werf

Institute council
(Instituutsraad)

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

Astronomy education committee
(Opleidingscommissie OC)

P.P. van der Werf (chair)
J.C. Drost
M. Damen
V. Icke
J. Schaye

S. van den Berg
A. Hagenaars
H. Intema
R. Leijssen
R. Oonk
S. Toonen

Oort scholarship committee

M. Franx (chair)
F.P. Israel
R.S. Le Poole

Mayo Greenberg prize committee

G. Miley (chair)
E.F. van Dishoeck
H. Linnartz
J. Lub

Astronomy admissions committee
(Adviescommissie toelating Sterrekunde)

R.S. Le Poole (chair)
M. Franx
F.P. Israel

Astronomy examination committee
(Examen-commissie)

F.P. Israel (chair)
M. Franx
E.J.J. Groenen (Physics)
K.H. Kuijken
P.P. van der Werf

Graduate student review committee
(Commissie studievoortgang promovendi)

E.F. van Dishoeck (chair)
W.H.W.M. Boland (NWO)
B.R. Brandl
H.J.A. Röttgering
R.Stark (NOVA)

Computer committee

P.P. van der Werf (chair)
S. Bisschop
B.R. Brandl
A.G.A. Brown
M. Cappellari
K. Groen
S.-J. Paardekooper

Website design committee

J. Schaye (chair)
E. Deul
S. de Kievit
M. den Brok

Library committee

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

Public outreach committee

F.P. Israel (chair)
V. Icke
T. van Kempen
M.T. Kriek
S. Hekker

Social committee

T.A. van Kempen (chair)
A.G.A. Brown
E. Caris alias Reynders
K. Groen
I.A.G. Snellen

II.2 Membership of University Committees

Van Dishoeck
Member, Faculty Research Committee (WECO)
Member, Lorentz Center Astronomy Board
Member, Raad van Toezicht, Leiden Institute of Physics (LION)

Franx
Member, Committee of Education Directors, School of Sciences
Member, Board of Directors, Leids Sterrewacht Fonds
Member, Board of Directors, Jan Hendrik Oort Foundation

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

Katgert
Secretary/Treasurer, Leids Sterrewacht Fonds

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

Kuijken
Member, Board International Centre
Member, Faculty Research Committee (WECO)

Linnartz
Member, FMD/ELD user committee

Snellen
Member, Leiden International Student Fund Committee

Van der Werf
Member, Joint Physics & Astronomy Education Committee (Opleidingscommissie)
Member, ICT Overleg Faculteit W&N
Organist of the Academy Auditorium

De Zeeuw
Member, Advisory Committee, Lorentz Professor
Member, Advisory Committee, Kloosterman Professor
Member, Board of Directors, Leids Sterrewacht Fonds
Member, Board of Directors, Jan Hendrik Oort Foundation
Member, Steering Committee Lorentz Center

Appendix III

Science policy functions

Sterrewacht Leiden

Science policy functions

Appendix III

Brandl
Co-PI, T-OWL/MIDIR (ELT mid-IR instrument concept study)
Deputy Co-PI for NL, European JWST-MIRI consortium
Co-Investigator, Optical laboratory at the Sterrewacht
Co-Investigator, PHARO camera (Palomar 200″)
Co-Investigator, Spitzer-IRS
Co-Investigator, WIRC camera (Palomar 200″)
Member, Dutch observing program committee (NL-PC)
Member, MUSE science team
NL representative, OPTICON Key technologies working group

Brown
Member, IAU Commission 37
Member, Gaia Data Access and Analysis System Steering Committee
Member, Gaia Data Analysis Coordination Committee
Member, Gaia photometry, Classification and Simulation Working Groups

Van Dishoeck
Co-PI, European JWST-MIRI consortium
Associate Editor, Annual Reviews of Astronomy & Astrophysics
Coordinator, Herschel-HIFI Key Program
Coordinator, NOVA network II ('Birth and Death of Stars and Planets')
Coordinator, EU-PLANET network school and meeting
Coordinator, Oort 2005 professorship and Oort workshop
Coordinator, Spitzer 'Cores to Disks' Legacy team meeting
Chair, ALMA European Science Advisory Committee
Chair, IAU Working Group on Astrochemistry
Chair, Scientific Organising Committee, IAUS 231 ('Astrochemistry across the Universe')
Member, ALMA Science Advisory Committee
Member, ESO-CRIRES Science Team
Member, European ALMA Board
Member, Herschel–HIFI Science team

Member, MPIA-Heidelberg Fachbeirat
Member, Royal Netherlands Academy of Sciences (KNAW)
Member, Scientific Organising Committee, 'Protostars & Planets V'
Member, SMA Visiting Committee
Member, SRON Board
Member, STScI Director Search Committee, AURA
Member, Visiting Committee, Astronomy Department of Harvard University
Member, VLT–VISIR Science team

Franx
Chair, Netherlands Program Committee
Member, Board of Directors, Leids Kerkhoven–Bosscha Foundation
Member, Advanced Camera for Surveys Science Team
Member, ESO-OmegaCAM science team
Member, JWST-NIRSPEC science team
Member, MUSE science team
Member, NOVA Board
Member, Sinfoni Science Team

Habing
Chair, Nederlandse Astronomen Club
Member, Royal Netherlands Academy of Sciences (KNAW; retired)
Member, KNAW Subcommittee, Natural Sciences ECOS

Hogerheijde
Project scientist for CHAMP+/Netherlands
Member, ALMA Regional Center Coordinating Committee
Member, ALMA Science Integrated Project Team
Member, Board of Directors, Leids Kerkhoven-Bosscha Fonds
Member, ESO OPC panel (Interstellar Medium & Solar System)
Member, ESA ASTRO-F Time Allocation Committee
Member, Netherlands Program Committee

Van Houten-Groeneveld
Member,IAU Commission 20

Icke
Member, Board of Directors, National Science Museum NEMO
Member, Board of Editors, Nederlands Tijdschrift voor Natuurkunde
Member, Advisory Committee, Computational Science (NWO)
Member, Advisory Council, "Technika10"
Member, Advisory Council, Winkler Prins Encyclopedie
Member, Editorial Council "Natuur & Techniek"
Member, Minnaert Committee (NOVA Outreach)
Member, National Committee on Astronomy Education
Member, Netherlands Astronomical Society Education Committee

Member of the Jury, Nationale Wetenschapsprijs
Member of the Jury, Techniek Tournooi

Israel
Member, Editorial Board Europhysics News
Member, IAU Comissions 28, 40, and 51
Member, NL Selection Jury International Space Camp
Member, NWO Selection Committee for VENI Postdocs
Member, Science Team Herschel-HIFI
Member, Science Team JWST-MIRI
Member, Science Team APEX-Champ+

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

Kuijken
Principal Investigator, OmegaCAM
Principal Investigator, KIDS survey
Co-Investigator, Planetary Nebulae Spectrograph project
NL Representative, ESO Science and Technical Committee
External Reviewer, Belgian Science Policy Office (BELSPO)
Local coordinator, EU-RTN Network SISCO
Member, Board EARA
Member, Board EU-RTD Network Astro-WISE
Member, ASTRON Board
Member, Astronomy Programme Board, Lorentz Centre
Member, ESO-KMOS Instrument Science Team
Member, FWO-Vlaanderen Project selection committee
Member, Kapteyn Fonds Board
Member, NOVA Instrument Steering Committee
Member, NWO Advisory Committee Astronomy
Member, Pastoor Schmeidts Fonds Board

Le Poole
Project Scientist, NOVA-ESO VLTI Expertise Centre (NEVEC)
Advisor, Delft Testbed Interferometer (DTI), TNO
Advisor, Knowledge Center for Aperture Synthesis (KAS), TNO
Member, Review Board SCUBA II
Member, Review Board VLTI 'recovery'
Member, Dutch Joint Aperture Synthesis Team (DJAST)

Lub
Secretary, Netherlands Committee for Astronomy
Secretary, Kamer Sterrenkunde van de VSNU
Member, ESO Contact Committee

Merín
Member, Dutch group of MIRI European Consortium (NWO)
Member, European MIRI Test Team (NWO/CSIC)
Member, Spanish Research Project (PNAYA/CSIC)

Miley
Chair, LOFAR Research Management Committee
Chair, National Radio Astronomy Observatory Visiting Committee
Chair, International Universe Awareness Steering Committee
Member, Board of ASTRON Foundation until November
Member, Board of Governors of the LOFAR Foundation
Member, Max Planck Institut fur Radioastronomie Fachbeirat
Member, Royal Netherlands Academy of Sciences (KNAW)

Quirrenbach
Principal Investigator, Netherlands-ESO VLTI Expertise Center (NEVEC)
Principal Investigator, PRIMA DDL/AOS Project
Coordinator, OPTICON Interferometry Network
Data Scientist, NASA Space Interferometry Mission
Member, ASTRON Contactraad
Member, ESA Astronomy Working Group
Member, ESO OPC Panel, Stars
Member, ESA Terrestrial Exoplanets Science Advisory Team
Member, ESO VLT Interferometer Implementation Committee
Member, IAU Working Group on Extrasolar Planets
Member, IAU Working Group on Interferometry
Member, NOVA Instrument Steering Committee
Member, NWO Adviescommissie Astronomie
Member, SRON, Wetenschappenlijke Raad

Reffert
Member, PRIMA Science Team

Röttgering
Principle Investigator, Development and commissioning of LOFAR for Astronomy (DCLA)
Chair, ASTRON Observing Programme Committee
Chair, LOFAR's Astronomy Research Committee
Chair, JCMT international time allocation committee
Observer, ASTRON board
Member, DCLA management team
Member, Dutch Joint Aperture Synthesis Team (DJAST)

Member, ESA's Terrestrial Exo-Planet Science Advisory Team (Te-SAT)
Member, LOFAR Research Management Committee (RMC)
Member, Mid-Infrared interferometric instrument for VLTI (MIDI) Science Team
Member, NASA's Terrestrial Planet Finder Science Working group (TPF-SW)
Member, OmegaCAM Science team
Member, Space science and astronomy review panel of the Academy of Finland
Member, XMM Large Scale Structure Consortium

Schaye
Principal Investigator, Marie Curie Excellence Team
Principal Investigator, OWLS collaboration
Core member, Virgo Consortium for Cosmological Supercomputer Simulations
Member, LOFAR epoch of reionization science team
Member, MUSE science team

Snellen
Member, GENIUS Gemini High resolution Infrared Spectrograph science team
Member, LOFAR DCLA Management Team
Member, ZIMPOL collaboration

Weijmans
Member, National Education Committee Astronomy (LOCNOC)

Van der Werf
Principal investigator, NOVA components of SINFONI
Principal Investigator, SCUBA-2 Cosmology Legacy Survey
Co-investigator, HIFI
Team member, EU RT Network "Euro3D"
Member, ESI (European SPICA Instrument) team
Member, ELT mid-infrared instrument study science team
Member, European JWST-MIRI Science Team
Member, Extragalactic Herschel Open Time (ExtraHOT) consortium
Member, JCMT Board
Member, JCMT Survey Steering Group
Member, JCMT Oversight Committee
Member, NWO VIDI grant allocation panel

Van de Ven
Member, National Education Committee Astronomy (LOCNOC)

De Zeeuw
Director, Netherlands Research School for Astronomy, NOVA
Chair, ESO Scientific Strategy Working Group
Chair, ESO Contact Committee
Chair, Science Vision Working Group, EU–ASTRONET
Chair, Space Telescope Science Institute Council

Leiden University Member Representative to AURA
Member, AURA Board of Directors
Member, Board of Directors, Leids Kerkhoven Bosscha Fonds
Member, OPTICON Board
Member, ESA Space Science Advisory Committee
Member, ESO Council
Member, ESO-Spain In-kind Working Group
Member, External Evaluation Committee, ESA Research and Scientific Support
Member, National Committee Astronomy
Member, MUSE Executive Board
Member, Publications Committee, Astronomical Society of the Pacific
Member, Scientific Advisory Board of *New Astronomy*
Member, SINFONI Science Team
Member, SOC, Adaptive-Optics-Assisted Integral-Field Spectroscopy

Zirm
Deputy, European Association for Research in Astronomy (EARA)

Appendix IV

Visiting scientists

Sterrewacht Leiden

Visiting scientists

Appendix IV

B. Matthews	Jan 17 – Jan 27	Herzberg Institute of Astrophysics, Canada
D.-H. Lee	Jan 25 – Jan 29	Korea Astronomy and Space Science Institute, Korea
W.D. Geppert	Jan 26 – Jan 28	Stockholm University, Sweden
J. Gerssen	Jan 26 – Jan 28	Stockholm University, Sweden
E.E. Bayet	Feb 1 – May 31	L'Observatoire de Paris, France
M. Dopita	Feb 21 – Feb 26	The Australian National University, Australia
S. Toft	Feb 21 – Feb 25	Yale University, USA
M.T. Huynh	Mar 1 – Mar 9	Mt. Stromlo Observatory, Australia
P. Papadapoulos	Mar 15 – Mar 20	ETH Zürich, Switzerland
A.H. Pawlik	Apr 12 – Apr 15	Universität Potsdam, Germany
M. Gerin	Apr 19	L'Observatoire de Paris, France
A. Sargent	Apr 21 – Apr 31	California Institute of Technology, USA
H.V.J. Linnartz	Jun 1 – Aug 31	Vrije Universiteit Amsterdam, Netherlands
I. Pelupessy	Jun 1 – Aug 26	Carnegie-Mellon University, USA
I. de Pater	Jun 4 – Jun 28	University of California, Berkeley, USA
E.E. Rigby	Jun 6 – Jun 17	Institute for Astronomy, Edinburgh, UK
L. Blitz	Jun 8 – Jun 10	University of California Berkeley, USA
A. Poncelet	Jun 13 – Aug 15	L'Observatoire de Paris-Meudon, France
I.M. van Bemmel	Jun 14 – Nov 21	Space Telescope Science Institute, USA
T. Wong	Jun 30 – Jul 1	Australia Telescope National Facility, Australia

Name	Dates	Institute
D. Vir Lal	Jul 1 – Sep 30	National Centre for Radio Astrophysics, India
W. Sargent	Jul 2 – Jul 29	California Institute of Technology, USA
J. de Jong	Jul 4 – Jul 8	ESO Garching, Germany
M. Valdés	Jul 4 – Dec 15	SISS/ISAS, Italy
A. Sargent	Jul 5 – Jul 29	California Institute of Technology, USA
C. Booth	Jul 11 – Jul 15	Durham University, UK
M. Schöller	Jul 11 – Jul 22	ESO Paranal, Chile
T. Theuns	Jul 11 – Jul 14	Durham University, UK
V.S. Springel	Jul 13	MPA Garching, Germany
K. Shapiro	Jul 21 – Jul 29	University of California, Berkeley, USA
L. Tornatore	Jul 26	MPA Garching, Germany
A.S. Cohen	Aug 7 – Aug 31	Naval Research Laboratory, USA
A. Forestell	Aug 8 – Aug 28	University of Texas at Austin, USA
C. Hopman	Aug 9 – Aug 10	Weizmann Institute of Science, Israel
N. Murray	Aug 27 – Aug 30	Canadian Institute for Theoretical Astrophysics, Canada
P. Lacerda	Aug 29 – Sep 4	GUAC, Departamento de Matématica, Portugal
H. Hoekstra	Aug 30 – Sep 2	University of Victoria, Canada
J. Kurk	Sep 5 – Sep 6	MPIA Heidelberg, Germany
M. Haverkorn	Sep 6 – Sep 8	University of California Berkeley, USA
M. Bureau	Sep 12 – Sep 16	Oxford University, UK
L.A. Aguilar	Sep 14 – Sep 20	Instituto de Astronomia, UNAM, Mexico
R. Hoogerwerf	Sep 19 – Sep 23	Harvard-Smithsonian Center for Astrophysics, USA
J. de Bruijne	Sep 19 – Sep 23	RSSD ESTEC, Netherlands
T. Slanger	Sep 23	Molecular Physics Laboratory, USA
T. Theuns	Sep 25 – Oct 1	Durham University, UK
J. de Jong	Oct 4 – Oct 14	ESO Garching, Germany
G. Novak	Oct 17 – Oct 30	University of California Santa Cruz, USA
D. Krajnovic	Oct 19 – Oct 22	Oxford University, UK
W. Vlemmings	Oct 19 – Oct 22	Jodrell Bank Observatory, UK
J. Huang	Oct 24 – Oct 28	Harvard-Smithsonian Center for Astrophysics, USA
R. Quadri	Oct 24 – Nov 5	Yale University, USA
K. Kaminski	Oct 24 – Oct 28	Poznan Astronomical Observatory, Poland
J. Peacock	Oct 30 – Nov 4	Institute for Astronomy, Edinburgh, UK
E. Rovilos	Nov 6 – Nov 12	Jodrell Bank Observatory, UK
A. Omar	Nov 7 – Nov 11	Raman Research Institute, India
I. Labbé	Nov 8	Carnegie Observatories, USA
H. Fraser	Nov 18 – Nov 21	Strathclyde University, UK
S. Richling	Nov 18 – Nov 25	Institut d'Astrophysique de Paris, France
S. Andersson	Nov 22 – Nov 24	University of Göteborg, Sweden
K. Knudsen	Nov 28 – Dec 2	MPIA Heidelberg, Germany
W. Vlemmings	Nov 28 – Dec 1	Jodrell Bank Observatory, UK
N. Förster -Schreiber	Nov 28 – Nov 30	MPA Garching, Germany
T. Plewa	Dec 4 – Dec 10	University of Chicago, USA

Appendix V

Workshops, lectures, and colloquia in Leiden

Workshops, lectures, and colloquia in Leiden

Appendix V

V.1 Workshops and Meetings

Legacy Surveys with the James Clerk Maxwell Telescope
`http://www.lc.leidenuniv.nl/lc/web/2005/147/info.php3?wsid=147`

On January 24–26, Van der Werf and Ivison (UKATC), co-organised a meeting on "Legacy Surveys with the James Clerk Maxwell Telecope." The James Clerk Maxwell Telescope will in the coming years be equipped with new state-of-the-art instrumentation, dramatically increasing its observing speed and survey power. Legacy Survey proposals have been prepared, in order to maximally exploit the capabilities of the new instrumentation and to provide a lasting scientific heritage. The programs proposed include cosmological surveys, nearby extragalactic surveys in continuum and lines, surveys of the Galactic plane and of high and low-mass star forming regions, as well as spectral surveys. The workshop produced a coherent and balanced set of Legacy Survey programs.

Ground Layer Adaptive Optics
`http://www.lc.leidenuniv.nl/lc/web/2005/159/info.php3?wsid=159`

From April 26–28, Quirrenbach, Stuik, and Flicker (Keck Observatory) organized a workshop on "Ground Layer Adaptive Optics". 34 international experts and graduate students in the field of Adaptive Optics (AO) gathered to discuss the benefits and challenges of implementing Ground Layer Adaptive Optics (GLAO) into the future generation of AO systems. In several sessions and discussions the different elements of a GLAO system, ranging from modeling to experiments and verification, were discussed. An improved appreciation of the various GLAO methods was gained and the workshop succeeded in defining a better strategy to promote GLAO in current and future generations of telescopes.

Oort 2005 Workshop: Protoplanetary Disk Evolution

http://www.lorentzcenter.nl/lc/web/2005/165/info.php3?wsid=165

On July 7-8, Van Dishoeck organized the Oort workshop on "Protoplanetary disk evolution" in honor of the 2005 Oort professor Anneila Sargent. About 30 experts gathered to discuss various new observational and theoretical results in this rapidly developing field.

SAURON Team Meeting

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

From July 11–14, the SAURON team met at Kasteel Oud Poelgeest. There were about 20 participants from six countries (and ten nationalities). With all the data from the representative survey of nearby early-type galaxies reduced, this meeting saw the completion of the first interpretational paper on the correlation of M/L with galaxy mass. Other topics discussed included the nature of young kinematically decoupled nuclei, of large-scale embedded stellar disks with enhanced metal-linestrengths, and of a kinematic classification of early-type galaxies which should replace the traditional labeling of E and S0 galaxies. Over a dozen team papers were planned and discussed; eight of these have appeared by mid 2006, with four more submitted to the journals. The meeting coincided with a Nature press release on the discovery with SAURON of a galaxy wide superwind at redshift three.

Cores to Disks Spitzer Legacy Team Meeting

http://www.lorentzcenter.nl/lc/web/2005/153/info.php3?wsid=153

From July 11–29, Van Dishoeck and Evans (University of Texas) co-organized a meeting in the Lorentz Center on "Star and planet formation with the Spitzer Space Telescope". About 50 members from the 'Cores to Disks' Spitzer Legacy team gathered to discuss data reduction, source identification and analysis of the Spitzer imaging and spectroscopy data of nearby star-forming regions.

Extragalactic Herschel Open Time (ExtraHOT) Meeting

http://www.lc.leidenuniv.nl/lc/web/2005/175/info.php3?wsid=175
http://astronomy.sussex.ac.uk/∼sjo/extrahot/

On October 20–21, Van der Werf and Eales (Cardiff University) co-organized a meeting on "Extragalactic Herschel Open Time (ExtraHOT)". The ExtraHOT consortium was established at the Herschel Space Observatory Extragalactic Open Time Discussion Meeting in Sussex in September 2004. The workshop brought a wide variety of theoretical expertise to the optimising of observing plans. It also aimed to ensure that the required preparatory data is in place.

The Study of Near-IR Selected High Redshift Galaxies

http://www.lc.leidenuniv.nl/lc/web/2005/178/info.php3?wsid=178

On October 31–November 4, Franx organised a workshop on "The Study of Near-IR Selected High Redshift Galaxies". This workshop brought together astronomers working on different aspects of high redshift galaxies. The common theme was the study of high redshift galaxies in the rest-frame optical and near-infrared. The goal was to improve our understanding of the high redshift universe, and to measure the evolution and formation of galaxies. Specifically, participants of the FIRES and MUSYC collaborations, and IRAC-GTO team came together to discuss results from the ongoing surveys and related programs, and to make plans for the future.

AstroWise Workshop

http://www.lc.leidenuniv.nl/lc/web/2005/180/info.php3?wsid=180

On November 14–18, Deul and Valentijn (Groningen) co-organized the "AstroWise" workshop. This training workshop introduced potential observers to the complex astronomical data reduction process associated with images produced by the large imaging camera OmegaCAM. The workshop also allowed the developers of the AstroWise Software Environment to discuss together the continued software development and the managerial workload of all project leaders.

PLANET School and Meeting

http://www.strw.leidenuniv.nl/cms/web/2005/20051114/info.php3?wsid=3

From November 14–18, Van Dishoeck, Augereau, Geers, and Mellema (ASTRON), organized the PLANET school on "Spitzer's view of Star and Planet Formation", consisting of a series of lectures and invited talks on recent results from the Spitzer Space Telescope, as well as the regular EU-PLANET network meeting. About 60 participants, mostly Ph.D. students and postdocs, gathered at Kasteel Oud Poelgeest in Oegstgeest to discuss new Spitzer results on disk evolution, especially from the 'Cores to Disks' and the 'Formation and Evolution of Planetary Systems' Legacy programs, covering ages from $<$1 Myr to 1 Gyr. The network meeting featured hydrodynamical simulations of disk evolution and planet-disk interactions.

Spitzer's View on Mass-Losing AGB Stars

http://www.lc.leidenuniv.nl/lc/web/2005/168/info.php3?wsid=168

On November 28–December 2, Habing, Blommaert (KU Leuven), and Wood (ANU) co-organized a workshop on "Spitzer's view on mass-losing AGB stars". About 16 Spitzer satellite programs from the Guaranteed Time or the first cycle of Open Time, investigate AGB stars or related objects in different environments like the Magellanic Clouds and our Galaxy. With several months before the deadline for the next cycle of Spitzer observing time, this workshop brought together representatives from the different teams, to discuss current results, finalise papers within teams, collaborate between teams, and plan future observations.

Optimising Tools for Science with HIFI

http://www.lc.leidenuniv.nl/lc/web/2005/187/info.php3?wsid=187

On December 5–8, De Graauw, Caux (CESR/CNRS), Helmich (Groningen), Ossenkopf (Köln), R. Shipman (Groningen), and P. Roelfsema (Groningen) co-organized a workshop "Optimising Tools for science with HIFI" in the Lorentz Center. The goals of this workshop were *a*) to bring together the teams that develop HIFI operations, the HIFI Instrument Control Center (ICC) and the Herschel-HIFI guaranteed time key programs, and *b*) to make an inventory of the need and availability of scientific analysis tools to maximize the science output, and to prepare an implementation plan. The participants were: HIFI-(co-)PIs, lead co-Is and Herschel mission scientists, Key Program PIs and their data processing and calibration experts, HIFI ICC Calibration scientists and Instrument scientists and other experts of the HIFI subsystems and system, members of the Herschel Science Center and external ICC-WP leaders.

Cosmological Radiative Transfer Comparison Project

http://www.lc.leidenuniv.nl/lc/web/2005/188/info.php3?wsid=188
http://www.mpa-garching.mpg.de/tsu3

On December 12–14, Ritzerveld, Mellema (ASTRON), and Iliev (CITA) co-organized a workshop on the "Cosmological Radiative Transfer Comparison Project". In recent years, considerable progress has been made in the design of numerical methods to deal with the influence of radiation on structure formation. Radiative transfer is, however, a complicated process, and we are still only beginning to include it realistically in the simulations of structure formation. This workshop aimed to bring together people working in the field of numerical methods of studying the transfer of ionizing radiation in a cosmological context.

V.2 Endowed Lectures

Date	Speaker (affiliation)	Title
Apr 28	Anneila Sargent (Caltech,USA)	*New waves - Probing our origins with arrays of telescopes* (Oort lecture)
Nov 4	John Peacock (Edinburgh, UK)	*The outlook for large-scale structure in cosmology* (Sackler Lecturer)

V.3 Scientific Colloquia

The Leiden Observatory Colloquia are generally held weekly on Thursday afternoons at 16:00 hours, preceded by an Astronomers' Tea at 15:50 hours. In 2005 the colloquium series was organized by Bernhard Brandl.

Date	Speaker (affiliation)	Title
Jan 3	Jes Jorgensen (Leiden, Netherlands)	*Tracing the physical and chemical evolution of low-mass protostars*
Jan 13	Mike Garrett (JIVE, Netherlands)	*21st century VLBI*
Jan 20	Guinevere Kauffman (MPA, Germany)	*Lessons about galaxy formation from 200,000 Sloan Digital Sky Survey spectra*
Jan 26	Wolf-Dietrich Geppert (Stockholm, Sweden)	*Ions behaving badly: Unexpected reactions with electrons relevant for astronomy*
Jan 27	Pedro Lacerda (Leiden, Netherlands)	*Shapes and spins of Kuiper belt objects*
Feb 3	Perry Gerakines (Alabama, USA)	*Laboratory studies of interstellar and planetary ice analogs and the properties of ices in astrophysical environments*
Feb 9	Maurice van Putten (MIT, USA)	*Endpoints of massive stars: singlets, doublets? Triplets!*
Feb 14	Yuri Levin (CITA, Canada)	*Young stars near SgrA**
Feb 23	Michael Dopita (ANU, Australia)	*Modelling starburst galaxies*
Mar 3	Minh Huynh (Mt Stromlo, Australia)	*Cosmic star formation history and radio sources in the Hubble Deep Field South*
Mar 10	Roger Blandford (Stanford, USA)	*Accretion and its consequences*
Mar 17	Michiel Reuland (Leiden, Netherlands)	*Gas, dust, and star formation in distant radio galaxies*
Mar 24	Lex Kaper (Amsterdam, Netherlands)	*Massive Stars and their compact remnants in HMXBs*
Mar 31	Gerard van der Steenhoven (RUG, Netherlands)	*Neutrino telescopes and the development of astroparticle physics in the Netherlands*

Date	Speaker (affiliation)	Title
Apr 7	Norbert Langer (Utrecht, Netherlands)	*The gamma-ray burst progenitor puzzle*
Apr 14	Bram Venemans (Leiden, Netherlands)	*Protoclusters associated with distant radio galaxies*
Apr 4	Inti Pelupessy (Leiden, Netherlands)	*Forecasting star formation*
Apr 21	Anthony Brown (Leiden, Netherlands)	*GAIA - Taking the galactic census: Current status and activities*
May 4	Rob Visser (Leiden/Utrecht, Netherlands)	*Science and the public: the problem of scientific illiteracy*
May 12	Christiane Helling (ESTEC, Netherlands)	*Simulations of substellar atmospheres: More than an extra-terrestrial weather forecast?*
May 26	Fleur van Broekhuizen (Leiden, Netherlands)	*A laboratory route to interstellar ice*
Jun 2	Roberto Gilmozzi (ESO, Germany)	*Science and technology of the ESO OWL 100m telescope*
Jun 9	Leo Blitz (Berkeley, USA)	*GMCs and star formation in galaxies*
Jun 16	Mark Dickinson (NOAO, USA)	*Deep Spitzer observations of the distant universe from the Great Observatories Origins Deep Survey*
Jun 23	Alan Dressler (Carnegie, USA)	*Environmental influences on galaxy evolution and the building of galaxy clusters*
Jun 30	Phil Nicholson (Cornell, USA)	*Near-infrared observations of Saturn's rings and satellites with Cassini*
Sep 1	Arjen van der Wel (Leiden, Netherlands)	*Setting the scale - Dynamical and photometric properties of high-redshift early-type galaxies*
Sep 15	Ed van den Heuvel (Amsterdam, Netherlands)	*Double neutron stars: Evidence for different neutron star formation mechnisms?*
Sep 22	Viki Joergens (Leiden, Netherlands)	*On the formation of brown dwarfs based on observations in ChaI*
Oct 6	Deidre Hunter (Lowell, USA)	*Double exponential disks and implications for star formation thresholds*
Oct 13	Henny Lamers (Utrecht, Netherlands)	*Formation and destruction of star clusters in galaxies*
Oct 20	Alberto Franceschini (Padova, Italy)	*Evolutionary paths for galaxies and AGNs: New insights by the Spitzer Space Telescope*
Oct 27	Malcolm Walter (Macquarie, Australia)	*The oldest evidence of the life on Earth and the search for life on Mars*

Date	Speaker (affiliation)	Title
Nov 7	Erik-Jan Rijkhorst (Leiden, Netherlands)	*Numerical nebulae*
Nov 10	Glenn van de Ven (Leiden, Netherlands)	*Dynamical structure and evolution of stellar systems*
Nov 17	Simon White (MPIA, Germany)	*The millennium simulation - our Universe in a box?*
Nov 24	Andreas Eckart (Köln, Germany)	*The variability of Sagittaruis A**
Nov 30	Peter Wood (Mt Stromlo, Australia)	*Variable red giant stars*
Dec 8	Tomasz Plewa (Chicago, USA)	*Detonating failed deflagrations of pype Ia supernovae*
Dec 15	Paul Murdin (IoA, UK)	*The Paris Meridian in fiction, art, adventure and science*

V.4 Student Colloquia

Date	Speaker	Title
Jun 9	Joke van Vugt	*Basic angle control for GAIA: Student internship at Alenia Space, Turin*
Jun 23	Martijn Nuyten	*The CFHT legacy survey: The morphology-density relation of galaxies out to* $z \sim 1$
Jul 27	Nathan de Vries	*Watching dwarf galaxies evolve*
Aug 18	Maaike Damen	*Structural properties of early-type galaxies: linking photometry and kinematics*
Sep 2	Jochem Haverhoek	*Ultrahigh energy cosmic ray extensive air shower simulations using CORSIKA*
Nov 24	Siard van Boven	*Planets in transitional disks*

Appendix VI

Participation in scientific meetings

Sterrewacht Leiden

Participation in scientific meetings

Appendix VI

Andersson

Bijeenkomst van de CW-Studiegroep Spectrosopie en Theorie (Lunteren, Netherlands; Feb 7–8)
"Photodissociation of a water molecule in ice: A molecular dynamics study"

IAU Symposium 231: Astrochemistry: Recent Successes and Current Challenges (Pacific Grove, USA; Aug 29–Sep 2)
"Photodissociation of a water molecule in ice: A molecular dynamics study"

Albrecht

The power of optical/IR interferometry: recent scientific results and 2nd generation VLTI instrumentation (Garching, Germany; Apr 4–8)
"UVES-I - High Resolution Spectroscopy with the VLTI"

JENAM 2005 (Liege, Belgium; Jul 4–7)

Asvany

FGLA Symposium (Pillnitz, Germany; Jun 5–9)
"IR spectroscopy and reaction dynamics of $C_2H_2^+$, CH_5^+, *and* H_2D^+*"*

60th Symposium on Molecular Spectroscopy (Columbus, USA; Jun 20–24)
"FIR spectroscopy of bare CH_5^+ *using Laser Induced Reactions"*

FGLA Symposium (Köln, Germany; Nov 25)
"Laser Induced Reactions with FELIX and other IR sources"

Beirão

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)

NOVA Fall School (Dwingeloo, Netherlands; Oct 3–7)
"Mid-Infrared Properties of Starburst Galaxies"

Spitzer 2005 Conference (Pasadena, USA; Nov 14–16)
"Spitzer Mapping of Starburst Galaxy NGC 5253"

Van den Bosch

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)

5th Marseille International Cosmology Conference: "The Fabulous Destiny of Galaxies: Bridging Past and Present" (Marseille, France; Jun 20–24)

SAURON team meeting (Leiden; Jul 10–15)
"Progess of the triaxial modeling"

Galactic Nuclei (Leiden; Jul 24–28)
"Triaxial Orbit-based Models Of Elliptical Galaxies"

MODEST-6 (Evanston, USA; Aug 29–31)
"The dynamical M/L-profile and distance of the globular cluster M15"

Bisschop

IAU Symposium 231: Astrochemistry – Recent successes and current challeges (Asilomar, USA; Aug 28–Sep 2)
"The behavior of N_2 and O_2 in pure, mixed or layered CO ices"
"Testing grain-surface chemistry in hot core regions"

Protostars and Planets V (Waikoloa Village, USA; Oct 24–28)
"Testing grain-surface chemistry in hot core regions"

Brandl

IAUS 227: Massive Star Birth: A Crossroads of Astrophysics (Acireale, Italy; May 16–20)
"Massive Clusters as seen by Spitzer"

Great Observatories Workshop on Star Formation (Cambridge, USA; Jul 13–15)
"Spitzer & Chandra views of massive HII regions"

Presentation of all OWL Instrument Studies (Garching, Germany; Sep 27)
"The Science Case for the T-OWL imager/spectrograph"

IAU Symposium 227: Massive Star Birth (Acireale, Italy; May 16–20)
"Massive Clusters as seen by Spitzer"

Great Observatories Workshop on Star Formation (Cambridge, USA; Jul 13–15)
"Spitzer & Chandra views of massive HII regions"

Spitzer IR Diagnostics of Galaxy Evolution (Pasadena, USA; Nov 14–16)
"The mid-IR Properties of Starburst Galaxies from IRS Spectroscopy"

Presentation of all OWL Instrument Studies (Garching, Germany; Sep 27)
"The Science Case for the T-OWL imager/spectrograph"

Spitzer IR Diagnostics of Galaxy Evolution (Pasadena, USA; Nov 14–16)
"The mid-IR Properties of Starburst Galaxies from IRS Spectroscopy"

Brinch

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"From Collapsing Cloud to Protoplanetary disk"

IAU Symposium 231 (Asilomar, USA; Aug 29–Sep 2)
"From Collapsing Cloud to Protoplanetary disk"

Protostars and Planets V (Waikoloa, USA; Oct 24–28)
"From Collapsing Cloud to Protoplanetary disk"
PLANET Network meeting (Leiden, Netherlands; Nov 14–18)
"A 2D Radiative Transfer Model Of The L1489IRS Protoplanetary Disk"

Brown
Gaia Simulation Working Group meeting (Leiden, Netherlands; Jan 27–28)
Gaia Photometry and Radial Velocity data processing meeting (Cambridge, UK; Feb 7–8)
"Gaia Photometric Data Analysis Overview"
Gaia Joint RVS/Photometry/Classification WG workshop (Barcelona, Spain; Apr 27–29)
"Gaia Photometric Data Analysis Overview"
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Detection of satellite remnants in the Galactic Halo with Gaia"
Modelling the Galaxy: An ESF Exploratory Workshop (Oxford, UK; Sep 6–9)
"Parallax Surveys"

Cappellari
The Origin of the Hubble Sequence (Vulcano, Italy; Jun 6–10)
"Revisiting the $(V/\sigma, \varepsilon)$ *anisotropy diagram"*
Mass Profiles and Shapes of Cosmological Structures (Paris, France; Jul 4–9)
"Dark matter in the central regions of early-type galaxies"
SAURON team meeting (Leiden, Netherlands; Jul 11–14)
"Dynamics of early-type galaxies"
Nearly normal galaxies in a Λ**CDM universe** (Santa Cruz, California; Aug 8–12)
"The $(V/\sigma, \varepsilon)$ *diagram from integral-field stellar kinematics"*
Gas in early-type galaxies (Dwingeloo, Netherlands; Sep 26)
"The Black Hole in the Nucleus of NGC 3379 from gas and stellar kinematics"

Crapsi
PLANET Network Meeting (Leiden, Netherlands; Nov 14–18)
"Observing the temperature drop in the high-density nucleus of L1544."

Damen
Spitzer Science Center 2005 Conference: Infrared Diagnostics of Galaxy Evolution (Pasadena, USA; Nov 14–16)

Dalla Vecchia
Open Question in Cosmology: the First Billion Years (Munich, Germany; Aug 22–26)
RTN annual meeting (Kloster Seeon, Germany; Aug 28–Sep 1)
"Quenching cooling flows with AGN bubbles"
Virgo meeting (Durham, UK; Nov 7–8)
EARA workshop (Paris, France; Dec 1–2)
"AMR simulations of AGN bubbles"

Van Delft

Who Needs Scientific Instruments? (Museum Boerhaave, Leiden; Oct 20–22)
"The Blue Boys: the School of Instrument Makers in the Leiden Physics Laboratory of Heike Kamerlingh Onnes"

Einstein und Europa (Düsseldorf, Germany; Dec 12)
"Moderator of two panel discussions"

Van Dishoeck

JWST-MIRI EC Science Team meeting (Zürich, Switzerland; Jan 5–6)

From Disks to Planets (Pasadena, USA; Mar 5–9)
"Gas dispersal in protoplanetary disks"

Fysica 2005 (Delft, Netherlands; Apr 8)
"Ijzige processen in de ruimte"

Theoretical Chemistry symposium (Leiden, Netherlands; Jun 2)
"Astrochemical puzzles: past and future"

Protoplanetary Disk Evolution (Leiden, Netherlands; Jul 7–8)

Star- and Planet Formation with Spitzer (Leiden, Netherlands; Jul 11–29)
"Spectroscopic results from the Spitzer c2d legacy program "

Herschel-HIFI Water in Star-Forming Regions (Berkeley, USA; Aug 26–27)
"Water observations of low-mass protostars"

Astrochemistry across the Universe: IAU Symposium 231 (Asilomar, USA; Aug 28–Sep 2)
"Panel Discussion"

ISM/CSM semi-annual science meeting (Leiden, Netherlands; Sep 13)
"What is NOVA network 2? The Spitzer c2d program"

Science Requirements for a Far-Infrared Mission (Leiden, Netherlands; Oct 17–19)
"Protoplanetary disks: gas"

Protostars & Planets V (Waikoloa, USA; Oct 23–28)
"Chemistry of protoplanetary disks"

EU-PLANET school and meeting (Leiden, Netherlands; Nov 14–18)
"Disks and envelopes in the embedded phase"

Optimising Tools for Science with HIFI (Leiden, Netherlands; Dec 5–8)
"HIFI key program on 'water in star-forming regions'"

The Molecular Universe (Leiden, Netherlands; Dec 7–9)

Pacifichem Laboratory Astrophysics symposium (Honolulu, USA; Dec 17–20)
"Spectroscopy and processing of interstellar ice analogs "

Falcón Barroso

MIRI Integral-Field Unit meeting (Instituut voor Sterrenkunde, Leuven, Belgium; Feb 7–8)
"Integral-Field Unit software tools: XSauron and Euro3D packages"

Adaptive Optics-Assited Integral-Filed Spectroscopy (La Palma, Canary Islands, Spain; May 9–11)
"Morphology and kinematics of the ionized gas in early-type galaxies"

Island Universes: Structure & Evolution of Disk Galaxies (Terschelling, Netherlands; Jul 3–8)
"On the relation between stars and gas of Sa galaxies in the SAURON survey"
Science Perspectives for 3D Spectroscopy (ESO, Garching, Germany; Oct 10–14)
"Morphology and kinematics of the stars and ionised-gas in Sa galaxies"

Franx
FIRES/MUSYC/IRAC workshop (Cambridge, USA; Jun 2–3)
"Perspective for the future"
Nearly Normal Galaxies 2 (Santa Cruz, USA; Aug 6–11)
"Scaling relations at $z = 1$*"*
The Early Universe (Garching, Germany; Aug 22–25)
The study of Near-IR selected high redshift galaxies (Leiden, Netherlands; Oct 31–Nov 11)
"Summary and conclusions"
Infrared Diagnostics of Galaxy Evolution (Pasadena, USA; Nov 12–18)
"What have we learned from Spitzer on galaxies at $z \geq 1$*?"*

Fuchs
NNV, 30th Fall meeting (Lunteren, Netherlands; Nov 10–11)
"Laboratory Studies of Interstellar Ice Analogs - Layered and Mixed $\mathrm{CO} - \mathrm{O_2}$ *Ices"*
IAU Symposium No.231 "Astrochemistry throughout the universe: Recent Successes and Current Challanges" (Asilomar, USA; Aug 29–Sep 2)
"Trans-Ethyl Methyl Ether, the Struggle for the Detection of a Complex Molecule in Hot Cores"

Geers
Oort Workshop Protoplanetary Disk Evolution (Leiden, Netherlands; Jul 7–8)
Spitzer 'Cores to Disks' Legacy Team workshop: "Star and Planet formation with the Spitzer Space Telescope" (Leiden, Netherlands; Jul 11–29)
"PAHs in T Tauri disks. New results from Serpens follow-up observations"
Workshop on Solid State Astrochemistry of Star Forming Regions (Leiden, Netherlands; Apr 13–17)
IAU Symposium 231: Astrochemistry (Asilomar, USA; Aug 29–Sep 2)
"PAHs in Circumstellar Disks Around T Tauri Stars"
8th ICM meeting (Leiden, Netherlands; Sep 13)
Protostars & Planets V (Waikoloa USA; Oct 24–28)
"PAHs in Circumstellar Disks Around T Tauri Stars"
PLANET network school+meeting (Leiden, Netherlands; Nov 14–18)
"PAHs in Circumstellar Disks Around T Tauri Stars"
Molecular Universe meeting (Leiden, Netherlands; Dec 8)

Hallibert
Center for Adaptive Optics Summer School (Santa Cruz, USA; Aug 6–12)
Workshop on Ground Layer AO (Leiden, Netherlands; Apr 26–29)

Hekker
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Radial velocity variations in K giants: Planets or Pulsations?"
JENAM (Liege, Belgium; Jul 4–7)
"Radial velocity variations in K giants: Planets or Pulsations?"

Hogerheijde
Submillimeter Astronomy in the Ear of the SMA (Cambridge, USA; Jun 14–17)
"A Molecular Inventory of the L1489 Protoplanetary Disk"
IAU231 (Monterey, USA; Aug 29–Sep 2)
"Into the Snake Pit: How Star Formation Affects the Chemistry of the Serpens Molecular Cloud"

Icke
Dutch Astrophysics Days (Dwingeloo, Netherlands; Mar 17–18)
"Exotic Voronoi Tessellations"
Quanta (Cambridge, UK; Apr 6–9)
"On the Small Scale Structure of Space-Time"
Graduate School in Theoretical Physics (Texel, Netherlands; Sep 18–22)
"Precision Cosmology"

Intema
SISCO Winter School 2005 (Obergurgl, Austria; Feb 12–19)
European Radio Interferometry School (Manchester, UK; Sep 5–9)
LOFAR survey team meeting (Leiden, Netherlands; Sep 27)
"WSRT and GMRT observations of Abell 2256 and Boötes field"
NOVA Fall School (Dwingeloo, Netherlands; Oct 3–7)
"Formation and evolution of galaxies and galaxy clusters"
JIVE ParselTongue Workshop (Dwingeloo, Netherlands; Oct 13)

Israel
Legacy Surveys with the James Clerk Maxwell Telescope (Leiden, Netherlands; Jan 24–26)
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
Science Requirements for a Far-InfraRed Mission (FIRM) (Leiden, Netherlands; Oct 17–19)
Extragalactic and Galactic ISM Modelling in an ALMA Perspective (Gothenburg/Onsala, Sweden; Oct 19–22)
"discussion session leader"
Extragalactic Herschel Open Time (ExtraHOT) meeting (Leiden, Netherlands; Oct 20–21)

Jaffe
The Power of Optical/IR Interferometry (Garching, Germany; Apr 4–8)

Joergens

The Power of Optical/IR Interferometry: Recent Scientific Results and 2nd Generation VLTI Instrumentation (Garching, Germany; Apr 4–8)

Multiple Stars across the H-R Diagram (Garching, Germany; Jul 12–15)
"Spectroscopic companions to very young brown dwarfs"

Protostars and Planets V (Waikoloa Village, Hawaii; Oct 24–28)
"The Formation of Brown Dwarfs: Observations"
"Close companions to young brown dwarfs"

PPV Brown Dwarf Workshop (Waikoloa Village, Hawaii; Oct 29)

PLANET Network Meeting (Leiden, Netherlands; Nov 14–18)

Jonkheid

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Modeling the gas chemistry in protoplanetary disks"

IAUS 231 Astrochemistry - Recent Successes and Current Challenges (Pacific Grove, USA; Aug 28–Sep 2)
"Chemistry and thermal balance in a transitional disk: the gas around HD141569A"

PLANET Network Meeting (Leiden, Netherlands; Nov 14–18)
"Modeling the chemistry and gas mass of the HD 141569 transitional disk."

Ten Kate

European Geophysical Union, Second General Assembly (Vienna, Austria; Apr 25–29)
"Glycine and D-alanine in Mars-like Conditions"

Pacifichem 2005 (Honolulu, USA; Dec 15–20)
"Mars simulations in support of planetary exploration"

Van Kempen

IAU symposium (Asilomar, USA; Aug 29–Sep 2)
"Simulating water in circumstellar envelopes for Herschel"

Protostars and Planets V (Waikoloa, USA; Oct 24–28)
"Simulating water in circumstellar envelopes for Herschel"

IRAM Fall School 2005 (Pradollano, Spain; Sep 30–Oct 7)

Planet Network Meeting 2005 (Leiden, Netherlands; Nov 14– Nov 17)

Köhler

The power of optical/IR interferometry: recent scientific results and 2nd generation VLTI instrumentation (Garching, Germany; Apr 4–8)
"MIA + EWS, The Software for MIDI Data-Reduction"

79th Annual Scientific Meeting of the Astronomische Gesellschaft (Cologne, Germany; Sep 26–30)
"MIA + EWS, The Software for MIDI Data-Reduction"

Protostars and Planets V (Waikoloa, USA; Oct 24–28)
"Binaries in the Orion Nebula Cluster"

Kriek

The Fabulous Destiny of Galaxies: Bridging Past and Present (Marseille, France; Jun 20–24)
"Spectral confirmation of evolved stellar populations in galaxies at $z \sim 2.3$"

FIRES/MUSYC/IRAC workshop (Cambridge USA; Jun 2–3)

Nearly Normal Galaxies in a ΛCDM Universe (Santa Cruz USA; Aug 8–12)
"NIR spectroscopy of Nearly Normal $z \sim 2.5$ Galaxies"

The study of Near-IR selected high redshift galaxies (Leiden, Netherlands; Oct 31–Nov 4)

Kuijken

SISCO Network Winter School "Surveying the Universe" (Obergurgl, Austria; Feb 12–19)
"Surveys with OmegaCAM"

ESO User Committee (Garching, Germany; Apr 12)
"The OmegaCAM Guaranteed Time Programme"

ESO Science and Technical Committee (Garching, Germany; Apr 14–15)

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Surveys with OmegaCAM"

ESO Public Surveys Meeting (Garching, Germany; Jun 22–24)

Planetary Nebulae as astronomical tools (Gdansk, Poland; Jun 28–Jul 2)
"A Review of Dark Matter"

The Shear Testing Project (STEP) (Pasadena, USA; Jul 25–28)
"Shears from Shapelets"

SISCO network meeting (Edinburgh, UK; Sep 15–16)

ESO Science and Technical Committee (Garching, Germany; Oct 17–18)

Astro-WISE (Leiden, Netherlands; Nov 14–18)
"Shears from Shapelets"

ESO Science and Technical Committee (Garching, Germany; Nov 22)

Lahuis

IAU 231: Astrochemistry-Recent Successes and Current Challenges (Asilomar, USA; Aug 28–Sep 2)
"Hot organic chemistry in the inner part of protoplanetary disks"

Van Langevelde

SKA software workshop (Dwingeloo, Netherlands; Jun 22–24)

European Radio Interferometry School (Manchester, UK; Sep 4–7)

IAU 227 "Massive Star Birth: A Crossroads of Astrophysics" (Acireale, Catania, Italy; May 16–20)

ADASS XV (El Escorial, Spain; Oct 3–5)

Levin

KITP "Black Hole Paradoxes" Meeting (Santa Barbara)

Astronomical Society of Ireland (Ireland)

Linnartz

CW meeting 'Spectroscopy and theory' - 2005 (Lunteren, Netherlands; Feb 7–8)
"New laboratory data of a molecular band at 4429 Å"
"Mass spectrometric and laser spectroscopic characterization of a supersonic planar plasma expansion"

Frontiers in low temperature plasma diagnostics meeting (Les Houches, France; Apr 17–21)
"High resolution spectroscopy through planar plasma expansions; an effective tool for the study of molecular transients of interstellar interest"

Interstellar reactions; from gas phase to solis (Pillnitz, Germany; Jun 5–9)
"Supersonic plasmas and molecular laboratory astrophysics"

TDLS (Tunable diode laser spectroscopy) meeting 2005 (Florence, Italy; Jul 11–15)
"A combined spectroscopic and theoretical study of the charge transfer complex $[\mathrm{Ar}\text{-}\mathrm{N}_2]^+$*"*

NNV-FOM annual meeting (Lunteren, Netherlands; Nov 10–11)
"The $\mathrm{A}^2\mathrm{B}_2 - \mathrm{X}^2\mathrm{A}_1$ *electronic transition of* $^{15}\mathrm{NO}_2$*: a rovibronic survey covering 14300-18000* cm^{-1}*"*
"Cavity ring down spectroscopy of molecular transients of astrophysical interest"

Lommen

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)

Submillimeter Astronomy in the era of the SMA (Cambridge, USA; Jun 13–16)

Oort Workshop (Leiden, Netherlands; Jul 7–8)

c2d Team Meeting (Leiden, Netherlands; Jul 11–29)

ISM/CSM meeting (Leiden, Netherlands; Sep 13)

European Radio Interferometry School (Manchester, UK; Sep 5–9)

NOVA Fall School (Dwingeloo, Netherlands; Oct 3–7)
"Studying the first steps of planet formation"

Protostars and Planets V (Waikoloa, USA; Oct 24–28)
"Investigating grain growth in disks around southern T-Tauri stars at long wavelengths"

PLANET Network School and Meeting (Leiden, Netherlands; Nov 14–18)

Lub

Stellar Pulsation and Evolution (Monte Porzio Catone, Italy; Jun 19–24)

A life with Stars (E.P.J. van den Heuvel Symposium) (Amsterdam, Netherlands; Aug 22–26)

Marrese

Gaia Photometry and RV Data Processing Workshop (Cambridge, UK; Feb 7–8)

Joint Gaia RVS/Photometry/Classification WG workshop (Barcelona, Spain; Apr 27–29)

Close Binaries in the 21st Century (Syros, Greece; Jun 27–30)

Gaia 10th RVS Workshop (Cambridge, UK; Sep 15–16)

Gaia 7th Simulation Working Group Meeting (Paris, France; Nov 2–4)

McDermid

UK National Astronomy Meeting (Birmingham, UK; Apr 5–9)
"Future science prospects for GLAS and OASIS"

AO Assisted Integral-Field Spectroscopy Workshop (Santa Cruz de La Palma, Spain; May 10–12)
"Nearby Early-Type Galaxy Nuclei with OASIS"

Euro3D Workshop (Garching, Germany; Oct 7–11)
"High Spatial Resolution IFU Observations of Early-Type Galaxy Nuclei"

SAURON Team Meeting (Leiden, Netherlands; Jul 10–15)
"OASIS integral-field spectroscopy of elliptical and lenticular galaxy centres"

Gas in Early-Type Gaalxies (Dwingeloo, Netherlands; Sep 26)
"Ionized gas properties of early-type galaxies observed with SAURON"

Meijerink

Dutch Astrophysics Days (Dwingeloo, Netherlands; Mar 17–18)
"Molecules in Extreme Environments"

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Far-Ultraviolet and X-ray Dominated Regions"

IAU Symposium: Astrochemistry - Recent Successes and Current Challenges (Monterey, USA; Aug 29–Sep 2)
"The X-ray Dominated Region in NGC 1068"

Workshop: Galactic and Extragalactic ISM Modelling in an ALMA Perspective (Onsala, Sweden; Oct 13–15)
"X-ray illumination: XDRs versus PDRs"

Merín

Spanish Red de Planetas (Madrid, Spain; Feb 3–4)

ESLAB (ESTEC, Nethelands; Apr 19–21)
"A new VO tool for studying developing planetary systems"

Oort Symposium on Star and Planet Formation (Leiden, Netherlands; Jul 7–8)

"Cores 2 Disks" Spitzer Legacy Team (Leiden, Netherlands; Jul 11–29)

IAU Symposium 231: Astrochemistry (Asilomar, USA; Aug 29–Sep 2)
"Spitzer spectroscopy of newly discovered clusters of star formation in Serpens"
"Astrochemistry with the JWST-MIRI"

Dutch ISM-CSM (Leiden, Netherlands; Sep 13)
"Spitzer studies of disk evolution in Serpens"

Protostars & Planets V (Hawaii, USA; Oct 24–28)
"Spitzer spectroscopy of newly discovered clusters of star formation in Serpens"
"Protostars and Planets with the JWST-MIRI"

PLANETS Network School (Leiden, Netherlands; Nov 14–18)
"Disk evolution in Serpens"

Micelotta
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)

NOVA Herfstschool 2005 (Dwingeloo, Netherlands; Oct 3–7)

The Spitzer Science Conference 2005: Infrared Diagnostics of Galaxy Evolution (Pasadena, USA; Nov 14–16)
"Spitzer Imaging and Spectroscopy of the Supernova Remnant N157B"

Miley
First Universe Awareness Workshop (ESO, Garching, Germany; May 27–28)
"Universe Awareness, an international inspirational programme for disadvantaged children"

IAU Symposium 230, Populations of High Energy Sources in Galaxies (Dublin, Ireland; Aug 16–21)

Workshop on Astronomy on the Moon (EADS Bremen; Sep 15–16)

ACS Science Team Annual Meeting (Aspen, USA; Sep 18–23)
"Progress of the ACS GTO distant radio galaxy programme"

Astronomy Science Group of Ireland (Dublin, Ireland; Oct 6–7)
"Universe Awareness, an international inspirational programme for Disadvantaged Children"

XXVIIIth URSI General Assembly (Delhi, India; Oct 19–30)

Grote Reber Memorial Conference (Hobart, Australia; Dec 1–10)
"LOFAR, A new low-frequency array"

Öberg
PLANET Network school and meeting on star and planet formation with Spitzer (Leiden, Netherlands; Nov 14–18)

Molecular Universe meeting (Leiden, Netherlands; Dec 13–14)

Overzier
ACS Sceince Team Meeting (Aspen, USA; Sep 19–23)
"Evolution of clusters and protoclusters"

Workshop on high redshift radio galaxies (Granada, Spain; Apr 18–20)
"HST/ACS observations of protoclusters"

Paardekooper
Dutch Astrophysics Days V (Dwingeloo, Netherlands; Mar 17–18)
"Planets in Disks: a fly through"

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–21)
"3D Planet-Disk Interaction"

Annual meeting RTN Network "The Origin of Planetary Systems" (Leiden, Netherlands; Nov 14–18)
"Radiation-Hydrodynamical models of planet-disk interaction"

Panić

Molecular Astrophysics (Les Houches, France; Sep 26–30)
"Dynamical and chemical evolution of prestellar cores"

Netherlands Research School for Astronomy (Dwingeloo, Netherlands; Oct 3–7)
"Observational Studies of Circumstellar Disks"

Planet Network Meeting (Leiden, Netherlands; Nov 14–18)

Molecular Universe Workshop (Leiden, Netherlands; Dec 7–9)

Pawlik

EARA Workshop Galaxy Formation (Paris, France; Dec 1–2)
"LOFAR and the Epoch of Reionization"

1st European Radio Interferometry School (Manchester, UK; Sep 2–9)

IGM Network Meeting (Seeon, Germany; Aug 28–1)
"LOFAR as a Cosmological Probe"

Open Questions in Cosmology (Munich, Germany; Aug 22–26)

Reionizing the Universe (Groningen, Netherlands; Jun 27–1)

Pontoppidan

Astro-chemistry from Laboratory to Telescope (Cardiff, UK; Jan 6–7)
"The physics and chemistry of interstellar ices: new results from Spitzer"

IAU 231 symposium on Astrochemistry (Asilomar, USA; Aug 29–Sep 2)
"The spatial distribution of ices in star-forming regions"

Quirrenbach

Habitable Planets Workshop (Bern, Switzerland; Feb 14–16)

Disks to Planets (Pasadena, USA; Mar 7–10)

The power of optical/IR interferometry: recent scientific results and 2nd generation VLTI instrumentation (Garching, Germany; Apr 4–8)
"Beyond the VLTI"
"UVES-I: Interferometric High Resolution Spectroscopy"

Adaptive Optics-Assisted Integral Field Spectroscopy (La Palma, Spain; May 9–11)
"OSIRIS: Adaptive Optics-Assisted Integral Field Spectroscopy at Keck"

ISSOL (Beijing, China; Jun 17–26)

JENAM 2005 (Liege, Belgium; Jul 4–7)
"Arrays With a Wide Field of View"

Michelson Summer School (Pasadena, USA; Jul 28–30)
"PRIMA: Astrometry with the VLTI"

Direct Planet Detection (Nice, France; Oct 3–7)

Three Dimensional Spectroscopy (Garching, Germany; Oct 10–14)
"OSIRIS: A New Intergral Field Spectrograph at Keck Observatory"

Protostars and Planets V (Waikoloa, USA; Oct 24–28)
"Astrometry: Prospects for Detection and Characterisation"

ELT Science Conference (Cape Town, South Africa; Nov 14–18)
"Direct Imaging of Exoplanets: Science and Techniques"
Interferometry/Astroseismology Workshop (Porto, Portugal; Nov 30–Dec 3)
"Present and Future Capabilities in Interferometry"

Raban
MIDI Science team meeting (Nice, France; Apr 12–13)
Interferometry summer school (Manchester, UK; Sep 4–11)
NOVA fall school (Dwingeloo, Netherlands; Oct 3–7)

Ritzerveld
Computational Science Days (Leiden, Netherlands; Jan 12–01)
"Reionizing the Large Scale Structure"
Dutch Astrophysics Days 5 (Dwingeloo, Netherlands; Mar 17–18)
"Simplicial Lattice Boltzmann Solvers"
Workshop on Cosmological Radiative Transfer Code Comparison (Toronto, Canada; May 9–15)
"SimpleX: Radiative Transfer on Unstructured Grids"
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"Reionizing the Large Scale Structure"
Reionizing the Universe (Groningen, Netherlands; Jun 27–Jul 1)
"Reionizing the Large Scale Structure"
From Strings to Cosmic Web (Groningen, Netherlands; Nov 11–Dec 2)
Workshop on Cosmological Radiative Transfer Code Comparison (Leiden, Netherlands; Dec 12–14)
"SimpleX: Transport on Simple Graphs"

Röttgering
Netherlands/UK LOFAR meeting (Southampton, UK; Feb 1–2)
"Surveys with LOFAR"
TPF Science working group (Pasadena, USA; Mar 8–11)
IAU Colloquium 199: Probing galaxies through quasar absorption lines (Shanghai, China; Mar 13–19)
"LOFAR and reionisation: a progress report"
MIDI science team meeting (Nice, France; Apr 15)
High Redshift Radio Galaxies (Granada, Spain; Apr 17–21)
"Conference summary"
Reionizing the Universe: The Epoch of Reionization and the Physics of the IGM (Groningen, Jun 27–Jul 1)
TPF Science working group meeting (New York, USA; Sept 13–16)
Netherlands/DE LOFAR meeting (Köln, Germany; Sept 8)
"Surveys with LOFAR"

LOFAR Splinter Meeting, Annual Meeting of the Astronomische (Köln, Germany; Sept. 26–30)
"150 MHz observations with the Westerbork and GMRT radio telescopes of Abell 2256 and the Bootes field: Ultra-steep spectrum radio sources as probes of cluster and galaxy evolution"
Workshop on Measuring the Diffuse Intergalactic Medium (Kanagawa, Japan; Oct 8–13)
"Low-frequency observations of diffuse radio emission combined with high spectral resolution X-ray and optical surveys: a powerful tool for studying the Warm Hot Intergalactic Medium "
ESA's Terrestrial Exo-planet Science Advisory Team (Granada, Spain; Nov 23–26)
"Imaging with Darwin"

Schaye
Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
IAU Symp. 228: From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution (Paris, France; May 23–27)
"Abundances in the Intergalactic Medium"
Open Questions in Cosmology: the First Billion Years (Garching, Germany; Aug 22–26)
"Controversies in the enrichment history of the intergalactic medium"
Annual Meeting of the EU RTN Network "The Physics of the Intergalactic Medium" (Chiemsee, Germany; Aug 28–Sep 1)
Mass, Light, and Chemistry (Minneapolis, USA; Oct 6–9)
"Metals in the Intergalactic Medium"
Virgo Collaboration Meeting (Durham, UK; Nov 7–8)
"The OWLS project"
IAU Symp. 232: The Scientific Requirements for Extremely Large Telescopes (Cape Town, South Africa; Nov 14–18)
"Metals in the Intergalactic Medium"

Schnitzeler
Polarization 2005 (Paris, France; Sep 12–15)

Smit
AstroWISE Workshop (Leiden, Netherlands; Nov 14–18)

Snellen
OmegaTranS Science Meeting (Napels, Italy; Sep 23–24)
"Transiting planets: lessons learned from the OGLE-III survey"
CoRoT week (Noordwijk, Netherlands; Dec 5–9)

Snijders
Island Universes (Terschelling, Netherlands; Jul 3–8)
"Island Universes Colliding"
RAS specialist discussion meeting: Star-Forming Galaxies in the Local Universe (London, UK; Dec 9)

Soto

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)

Island Universes (Terschelling, Netherlands; Jul 3–8)
"3-d Dymamics of the Galactic Bulge"

NOVA fall school 2005 (Dwingeloo, Netherlands; Oct 3–7)
"Stars kinematic in the galactic center"

Van Starkenburg

Nederlandse Astronomen Conferentie 2005 (Blankenberge, Belgium; May 18–20)
"The $z \sim 1.5$ Tully-Fisher relation"

Island Universes (Terschelling, Netherlands; Jul 4–8)

The study of Near-IR selected high redshift galaxies (Leiden, Netherlands; Oct 31–Nov 4)
"The high redshift Tully-Fisher relation"

Stuik

Workshop on Adaptive Optics Assisted Integral Field Spectroscopy (Santa Cruz de La Palma, Spain; May 8–12)
"GALACSI - The ground-layer AO system for MUSE"

Workshop on Instrumentation for ELTs (Rottach-Egern, Germany; Jul 25–30)

Taylor

Surveying the Universe: SISCO Winter School 2005 (Obergurgl, Austria; Feb 12–19)
"On star formation and the (non)-existence of dark galaxies"
"Measuring galaxy evolution since z = 1 using ACS imaging from GOODS"

FIRES/MUSYC/IRAC workshop (Cambridge USA; Jun 2–3)

The Fabulous Destiny of Galaxies: Bridging Past and Present (Marseille, France; Jun 20–24)
"On star formation and the non-existence of dark galaxies"

Nearly Normal Galaxies in a ΛCDM Universe (Santa Cruz USA; Aug 8–12)
"Why are there no galaxies without stars?"

The study of Near-IR selected high redshift galaxies (Leiden, Netherlands; Oct 31–Nov 4)

GEMS/STAGES Collaboration Workshop (Heidelberg, Germany; November 7–11)

Tubbs

The power of optical interferometry (Garching, Germany; Apr 4–8)
"Searching for faint companions with MIDI differential phase measurements"

Venemans

Granada Workshop on High Redshift Radio Galaxies (Granada, Spain; Apr 18–20)
"Protoclusters associated with distant radio galaxies"

Verbraak
Meeting of the section ”CW-studiegroep Spectroscopie en Theorie” (Lunteren, Netherlands; Feb 7–8)
“High resolution infrared spectroscopy of cluster ions”

International Conference on Tunable Diode Laser Spectroscopy (Florence, Italy; Jul 11–15)
“A remotely controlable optical multi-pass system.”
“Tunable diode laser spectroscopy of the $[\mathrm{Ar}-\mathrm{N_2}]^+$*-complex: new experimental/theoretical results”*

Fall meeting of the section ”Atomic Molecular and Optical Physics” (Lunteren, Netherlands; Nov 10–11)
“Tunable diode laser spectroscopy of the $[\mathrm{Ar}-\mathrm{N_2}]^+$*-complex: new experimental/theoretical results”*

NOVA Fall School 2005 (Dwingeloo, Netherlands; Oct 3–7)
“Chemistry and IR Emission from PAHs in Protoplanetary Disks”

PLANET School and Network Meeting (Leiden, Netherlands; Nov 14–18)

The Molecular Universe (Leiden, Netherlands; Dec 7–9)

De Vries
NOVA Fall School (Dwingeloo, Netherlands; Oct 3–7)
“Baby-AGN”

Webb
Legacy Surveys with the James Clerk Maxwell Telescope (Leiden, Netherlands; Jan 24–26)

Canadian Astronomical Society General Meeting (Montréal, Canada; May 15–17)
“Extragalactic Science with SCUBA”

Science Requirements for a Far-Infrared Mission (FIRM) (Leiden, Netherlands; Oct 17–19)

Extragalactic Herschel Open Time (ExtraHOT) meeting (Leiden, Netherlands; Oct 20–21)

The study of Near-IR selected high redshift galaxies (Leiden, Netherlands; Oct 31–Nov 4)
“Star formation at high redshift: Sptizer observations of the HDFS”

Weijmans
Summer School Alpbach 2005 (Alpbach, Austria; Jul 19–28)

Van der Wel
ACS Science Team Meething (Aspen, USA; Sep 19–23)
“Optical and Near-IR Properties of Early-Type Galaxies at z=1”

Van der Werf
Extreme starbursts, near and far (Lijiang, China; Aug 15–19)
“Extreme superstarclusters”

Wiersma

Open Questions in Cosmology (Garching, Germany; Aug 22–26)

RTN Meeting (Seon, Germany; Aug 29–Sep 1)
"OWLs"

EARA Workshop (Paris, France; Dec 1–2)
"Cooling in Cosmological Simulations"

Woitke

Dutch Astrophysics Days (Dwingeloo, Netherlands; Mar 2005)
"Radiation Hydrodynamics with Monte Carlo Radiative Transfer - Mission Impossible?"

The Power of Optical/IR Interferometry (Garching, Germany; Apr 4–8)
"The Choatic Winds of AGB stars: Observation Meets Theory"

Dutch ISM/CSM meeting (Leiden, Netherlands; Sep 2005)
"2D Models for Dust-driven AGB Star Winds"

Spitzer's View on AGB-Stars (Leiden, Netherlands; Nov 28–Dec 2)
"Oxygen-rich Dust Formation - A Theoretical Perspective"

Wuyts

The Fabulous Destiny of Galaxies: Bridging Past and Present (Marseille, France; Jun 20–24)
"Optical Spectroscopy of Distant Red Galaxies"

The Dark and the Luminous Sides of the Formation of Structure (Novigrad, Croatia; Sep 5–17)

The Study of Near-IR Selected High Redshift Galaxies (Leiden, Netherlands; Oct 31–Nov 4)
"IRAC observations of the Hubble Deep Field South"

de Zeeuw

RAS meeting: Current Problems in Relativistic Astrophysics (London, UK, Mar 11)
"Black Holes in Galactic Nuclei"

Island Universes: Structure and Evolution of Disk Galaxies (Terschelling, Netherlands, Jul 3–8)
"Conference Summary: Island Universes"

SAURON Team meeting (Oud Poelgeest, Netherlands, Jul 11–15)

RAS meeting: Science From La Palma (London, UK, Oct 14)
"Science with SAURON"

Appendix VII

Observing sessions abroad

Sterrewacht Leiden

Observing sessions abroad

Appendix VII

Albrecht
Lick Observatory (Mount Hamilton, USA; Aug 24–31)
Lick Observatory (Mount Hamilton, USA; Nov 21–30)

Van den Bosch
Isaac Newton telescope (La Palma, Spain; Apr 20-27)

Bisschop
James Clerk Maxwell Telescope (Mauna Kea, USA; Feb 20–27)

Cappellari
William Herschel Telescope (La Palma, Spain; Mar 4–15)
ESO Very Large Telescope (Paranal, Chile; Apr 1–8)

Crapsi
James Clerk Maxwell Telescope (Mauna Kea, USA; Aug 24–Sep 2)

Franx
William Herschel Telescope (La Palma, Spain; Jan 25, 27)
William Herschel Telescope (La Palma, Spain; Mar 26–29)
ESO-Very Large Telescope (Paranal, Chile; Dec 10–13)

Geers
ESO-Very Large Telescope-Antu Telescope (Paranal, Chile; Mar 9–15)

Hekker
Lick Observatory (Mount Hamilton, USA; Jan 24–31)
Lick Observatory (Mount Hamilton, USA; Feb 20–Mar 2)
Telescopio Nazionale Galileo (La Palma, Spain; Mar 20)
Lick Observatory (Mount Hamilton, USA; Jul 25–Aug 4)
Telescopio Nazionale Galileo (La Palma, Spain; Aug 23)

Hogerheijde
ESO-Very Large Telescope (Paranal, Chile; Jun 29–Jul 4)

Intema
Giant Metre-wave Radio Telescope (Khodad, India; Jun 3–7)

Israel
James Clerk Maxwell Telescope (Hawaii, USA; Mar 23–30)

Jaffe
ESO-Very Large Telescope Interferometer (Paranal, Chile; Feb 23–Mar 3)
ESO-Very Large Telescope Interferometer (Paranal, Chile; Nov 11–16)

Joergens
ESO-Very Large Telescope (Paranal, Chile; Mar 20–21)

Van Kempen
James Clerk Maxwell Telescope (Mauna Kea, USA; Apr 21–28)

Kriek
William Herschel Telescope (La Palma, Spain; Jan 25–27)
William Herschel Telescope (La Palma, Spain; Mar 26–29)
Gemini South (Pachon, Chile; May 15–19)
ESO-Very Large Telescope (Paranal, Chile; Dec 10–13)
Keck Observatory (Hawaii, USA; Dec 24–26)

Kuijken
William Herschel Telescope (La Palma, Spain; Mar 31–Apr 6)

Van Langevelde
James Clerk Maxwell Telescope (Manua Kea, USA; Oct 26-4)

Lommen
Submillimeter Array (Mauna Kea, USA; Jun 27–Jul 2)
Australia Telescope Compact Array (Narrabri, Australia; Aug 8–29)

McDermid
William Herschel Telescope (La Palma, Spain; Mar 6–10)
William Herschel Telescope (La Palma, Spain; Dec 2–5)

Merín
Calar Alto Observatory (Almeria, Spain; Apr 4–7)

Le Poole
Isaac Newton Telescope (La Palma, Spain; Apr 20–27)

Pontoppidan
ESO-Very Large Telescope (Paranal, Chile; Jun 6–13)

Quirrenbach
Keck Observatory (Hawaii, USA; Feb 22–23)
Keck Observatory (Hawaii, USA; Mar 27–29)
ESO-Very Large Telescope (Paranal, Chile; May 21–29)

Reffert
Telescopio Nazionale Galileo (La Palma, Spain; Jan 23)
Telescopio Nazionale Galileo (La Palma, Spain; Jul 21)
ESO (La Silla, Chile; Feb 13–14)
Lick Observatory (San Jose, USA; Mar 11–17)
Lick Observatory (San Jose, USA; Apr 28–May 5)
Lick Observatory (San Jose, USA; Oct 5–11)

Röttgering
Isaac Newton Telescope (La Palma, Spain; May 4–8)

Snellen
United Kingdom Infra-Red Telecope (Hawaii, USA; Jan 20–23)
Isaac Newton Telescope (La Palma, Spain; Apr 22–27)

Snijders
James Clerk Maxwell Telescope (Hawaii, USA; Jan 21–28)
ESO-Very Large Telescope (Paranal, Chile; Apr 17–20)
ESO-Very Large Telescope (Paranal, Chile; Jun 14–15)
ESO-Very Large Telescope (Paranal, Chile; Oct 8)

Van Starkenburg
ESO-Very Large Telescope (Paranal, Chile; Aug 26–28)

Weijmans
William Herschel Telescope (La Palma, Spain; Mar 7–10)
MDM McGraw-Hill Telescope (Tucson, USA; Nov 2–6)

Appendix VIII

Working visits abroad

Sterrewacht Leiden

Working visits abroad

Appendix VIII

Beirão
Cornell University (Ithaca, USA; Apr 18–May 5)

Bisschop
Harvard-Smitsonian Center for Astrophysics (Boston, USA; Feb 14–16)
California Institute of Technology (Pasadena, USA; Mar 3–4)

Brandl
ETH Zürich (Zürich, Switzerland; Jan 5–7)
Ecole Normale (Lyon, France; Jan 17–19)
University of Leuven (Leuven, Belgium; Feb 7–8)
Astrophysikalisches Institut (Potsdam, Germany; Apr 2–4)
Univerity of Stockholm (Stockholm, Sweden; May 6–8)
Cornell University (Ithaca, USA; Jun 12–20)
Paul Scherrer Institut (Villigen, Switzerland; Sep 19–21)
European Southern Observatory (Garching, Germany; Oct 2–3)
UK Astronomy Technology Centre (Edinburgh, UK; Dec 12–14)

Brinch
L'Institut d'Astrophysique de Paris (Paris, France; Feb 22–23)
L'Institut d'Astrophysique de Paris (Paris, France; Mar 14–Apr 10)

Cappellari
University of California, Berkeley (Berkeley, California; Aug 1–7)
MPI (Heidelberg, Germany; Feb 1–3)

Damen
Carnegie Observatories (Pasadena, USA; Nov 13–Dec 3)

Dalla Vecchia
MPA (Garching, Germany; Jul 31–Aug 5)
Institute for Computational Cosmology (Durham, UK; Oct 24–29)
Institute for Computational Cosmology (Durham, UK; Nov 9–13)

Deul
Rijksuniversiteit Groningen (Groningen, Netherlands; Jan 1, 18, 25; Feb 10, 22; Mar 8, 15; Apr 5, 12, 26; May 17, 31; Jun 14; Jul 5, 26; Sept 9; Oct 11)

Van Dishoeck
University of Toronto (Toronto, Canada; Jan 16–21)
European Southern Observatory (Garching, Germany; Feb 4)
European Space Agency (Paris, France; Feb 10–11)
Humboldt stiftung (Bonn, Germany; Feb 21)
European Southern Observatory (Garching, Germany; Feb 23–25)
Association of Universities for Research in Astronomy (Washinton, USA; Mar 2–4)
European Southern Observatory (Garching, Germany; Mar 24)
Center for Astrophysics (Cambridge, USA; Apr 11–14)
Annual Reviews of Astronomy and Astrophysics (Palo Alto, USA; Apr 30)
European Southern Observatory (Santiago, Paranal, Chajnantor, Chile; May 12-15)
University of Leuven (Leuven, Belgium; May 23)
Stockholm University (Stockholm, Sweden; Jun 7)
Academy (Helsinki, Finland; Jun 8)
NASA-Ames Research Center (Mountain View, USA; Aug 25)
European Southern Observatory (Garching, Germany; Sep 14–15)
Paul Scherrer Institute (Zürich, Switzerland; Sep 19–20)
University of Chile (Santiago, Chile; Sep 30)
European Southern Observatory (Garching, Germany; Oct 20)
Institute for Advanced Study (Princeton, USA; Oct 29)
Penn State University (State College, USA; Oct 30–Nov 2)
UK Astronomy Technology Centre (Edinburgh, UK; Dec 12–13)
Joint Astronomy Centre (Hilo, USA; Dec 15)
Institute for Astronomy (Honolulu, USA; Dec 16)

Falcón Barroso
Instituto de Astrofísica de Canarias (La Laguna, Tenerife, Spain; May 1 – 12)

Franx
Florence Observatory (Florence, Italy; Feb 8,9)
European Southern Observatory (Garching, Germany; Apr 13)
Harvard Smithsonian Center for Astrophysics (Cambridge, USA; May 7–Jun 14)
Exeter University (Exeter, UK; Jun 15–17)
Harvard Smithsonian Center for Astrophysics (Cambridge, USA; Jun 25–Jul 9)
Aspen Institute for Physics (Aspen, USA; Sep 18–Sep 21)
Space Telescope Science Institute (Baltimore, USA; Sep 22–23)
Astrium (Ottobrun, Germany; Oct 5,6)
Yale University (New Haven, USA; Oct 9–14)

Fuchs
I. Physikalische Institut, (Cologne, Germany; Febuary 18–23, Mar 22, Dec 12 & 14)
Forschungszentrum Jülich (Jülich, Germany; Feb 17 and May 11)
University College London (London, UK; Mar 18)
MPIA (Heidelberg, Germany; Dec 5–8)
MPIfR (Bonn, Germany; Dec 9)
Ruhr University (Bochum, Germany; Dec 13)

Hallibert
REOSC (St Pierre du Perray, France; Jul 18)
European Southern Observatory (Garching, Germany; Sep 28-30)
Observatoire de Lyon (St Genis-Laval, France; Oct 25-28)
MPI Astronomy (Heidelberg, Germany; Apr 17-19)

Hekker
Sterrenkundig Instituut, KU Leuven (Leuven, Belgium; Oct 1–Dec 31)

Hogerheijde
University of California (Berkeley, USA; Aug 25–27)

Israel
Astronomy Dept, UCLA (Los Angeles, USA; Apr 1)
NASA-Jet Propulsion Laboratory (Pasadena, USA; Apr 4)
Aerospace Corporation (Los Angeles, USA; Apr 5)

Jaffe
L'Observatoire de Genève (Geneva, Switzerland; Feb 17–18)
MPIA (Heidelberg, Germany; Jan 20–21)
European Southern Observatory (Garching, Germany; Jun 27–28)
MPIA (Heidelberg, Germany; Sep 11–13)
L'Observatoire de Genève (Geneva, Switzerland; Sep 19–20)

Joergens
Dr. Remeis Sternwarte Bamberg / University of Erlangen (Bamberg / Erlangen, Germany; May 30)
Astrophysikalisches Institut und Universitäts-Sternwarte Jena (Jena, Germany; May 31–Jun 2)
MPE (Garching, Germany; Nov 21–Dec 9)

Jourdain de Muizon
Observatoire de Paris-Meudon (Paris, France; May 30–31)

Katgert
Osservatorio Astronomico (Trieste, Italy; Sep 8–16)

Köhler
L'Observatoire de Genève (Geneva, Switzerland; Feb 17–18)
European Southern Observatory (Garching, Germany; Apr 27–29)
European Southern Observatory (Garching, Germany; Jun 27–28)
MPIA (Heidelberg, Germany; Sep 12–13)
MPIA (Heidelberg, Germany; Dec 19–20)

Kriek
Yale University (New Haven, USA; Apr 17–May 31)

Levin
Australia Telescope National Facility (Sydney, Australia)

Linnartz
Technische Universität Berlin (Berlin, Germany; Nov 13–14)

Lommen
Harvard-Smithsonian Center for Astrophysics (Cambridge, USA; Jun 17–24)
California Institute of Technology (Pasadena, USA; Nov 8–11)

Marrese
Barcelona University (Barcelona, Spain; Mar 7–11)
INAF, Bologna Astronomical Observatory (Bologna, Italy; Apr 8)

Mathar
European Southern Observatory (Garching, Germany; Jun 27–Jun 27)

McDermid
Observatoire de Lyon (Lyon, France; Jan 11–12)
Goettingen (Goettingen, Germany; Jul 7–8)

Merín
Maryland Astronomy Department (Adelphi, USA; Jan)

Miley
EU Schoolnet (Brussels, Belgium; Jan 20–Jan 20)
National Radio Astronomy Observatory (Socorro, USA; Mar 6–Mar 7)
National Radio Astronomy Observatory (Charlottesville, USA; Mar 28–Mar 29)
National Radio Astronomy Observatory (Green Bank, USA; Mar 30–Apr 1)
Johns Hopkins University (Baltimore, USA; Apr 3–Apr 5)
National Radio Astronomy Observatory (Charlottesville, USA; Apr 13–Apr 15)
EU Schoolnet (Brussels, Belgium; Apr 22–Apr 23)
National Radio Astronomy Observatory (San Francisco, USA; Jun 14–Jun 20)
UNESCO (Paris, France; Oct 5–Oct 6)

Ödman
UNESCO (Paris, France; Oct 4–7)

Overzier
Johns Hopkins University (Baltimore, USA; Apr 1–14)
Johns Hopkins University (Baltimore, USA; Sep 1–Oct 4)
Royal Observatory (Edinburgh, UK; Aug 25–31)

Le Poole
Institute of Astronomy (Cambridge, UK; May 9–12)
European Southern Observatory (Santiago, Chile; Dec 14–23)

Pontoppidan
MPIA (Heidelberg, Germany; Feb 13–18)

Quirrenbach
European Space Agency (Paris, France; Jan 11–14)
MPIA (Heidelberg, Germany; Feb 7)
L'Observatoire de Genève (Geneva, Switzerland; Feb 18)
European Southern Observatory (Garching, Germany; Feb 28–Mar 1)
US Naval Observatory (Washington, USA; Mar 10–17)
L'Observatoire de Genève (Geneva, Switzerland; Mar 18)
L'Observatoire de la Côte d'Azur (Nice, France; Apr 15–17)
European Southern Observatory (Garching, Germany; Jun 27–29)
Academy of Science (Prague, Czech Republic; Sept 8–10)
MPIA (Heidelberg, Germany; Sep 12–13)
L'Observatoire de Genève (Geneva, Switzerland; Sep 19–20)
European Space Agency (Paris, France; Sep 22–23)
European Southern Observatory (Garching, Germany; Sep 29–30)
European Southern Observatory (Garching, Germany; Nov 1–2)
Astronomy Department (Cape Town, South Africa, Nov 6–20)
European Southern Observatory (Garching, Germany; Nov 22)
Instituto de Astrofisica de Andalucia (Grenada; Spain; Nov 23)
MPIA (Heidelberg, Germany; Dec 18–20)

Reffert
MPIA (Heidelberg, Germany; Jan 19–22)
European Southern Observatory (Garching, Germany; Jun 26–28)
Geneva Observatory (Geneva, Switzerland; Sep 19–20)
MPIA (Heidelberg, Germany; Dec 19–20)

Röttgering
Academy, (Helsinki, Finland; Sep 5–6)

Snellen
Cavendish Astrophysics (Cambridge, UK; May 30)
SISSA (Trieste, Italy; Oct 12–13)

Stuik
European Southern Observatory (Garching, Germany; Apr 11, Aug 8–11)
Observatore de Lyon (Lyon, France; Jan 16–17, Feb 15, Oct 25–28)
Isaac Newton Group (Santa Cruz de La Palma, Spain; Jan 27–28)
Sagem (Paris, France; Jul 19)
Osservatorio Astrofisico di Arcetri (Florence, Italy; Jul 7–8)

Taylor
Space Telescope Science Institute (Baltimore, USA, May 6–10)
Harvard-Smithsonian Center for Astrophysics (Cambridge, USA; May 10–Jun 4)

Vink
Center for Adaptive Optics (Santa Cruz, USA; Aug 7–12)
CRA Lyon (Lyon, France; Feb 13–14)

Webb
ETH Zürich (Zürich, Switzerland; Jun 13-17)
Harvard-Smithsonian Center for Astrophysics (Cambridge, USA; Sep 2-9)

Wiersma
European Southern Observatory (Garching, Germany; Aug 27)

Van der Werf
Eidgenössische Technische Hochschule (Zürich, Switzerland; Jan 6)
University of Wales (Cardiff, UK; May 18–22)
University of Wales (Cardiff, UK; Jun 14–17)
University of Manchester (Manchester, UK; Oct 13–14)
Joint Astronomy Center (Hilo, USA; Nov 12–18)

Woitke
Friedrich-Schiller-Universität (Jena, Germany; Jun 21–24)

De Zeeuw
Observatoire de Lyon (Lyon, France; Jan 18–20)
European Space Agency (Paris, France; Jan 21)
European Southern Observatory (Garching, Germany; Jan 31)
Space Telescope Science Institute (Baltimore, USA; Feb 7–8)
European Space Agency (Paris, France; Feb 10–11)
Cerro Tololo Interamerican Observatory & Gemini South (La Serena, Chile; Feb 21–22)
Paranal Observatory (Paranel, Chile; Feb 24–25)

Atacama Large Millimeter Array (San Pedro de Atacama, Chile; Feb 26)
European Southern Observatory (Garching, Germany; Mar 1–2)
Institute of Astronomy (Cambridge, UK; Mar 10)
Association of Universities for Research in Astronomy (Chicago, USA; Apr 3–4)
Institute for Astronomy (Honolulu, USA; Apr 5–6)
International Gemini Observatory (Hilo, USA; Apr 7–10)
NOAO, Steward Observatory & AURA (Tucson, USA; Apr 11–16)
European Southern Observatory (Garching, Germany; Apr 21)
Ministry of Science (Madrid, Spain; Apr 27)
European Space Agency (Paris, France; May 1–2)
European Southern Observatory (Garching, Germany; May 3–4)
European Southern Observatory Vitacura & Joint Astronomy Office (Santiago, Chile; May 11–12)
Paranal Observatory (Paranal, Chile; May 13–14)
Atacama Large Millimeter Array & APEX (San Pedro de Atacama, Chile; May 14–15)
Observatoire de Paris (Paris, France; May 31)
Ministry of Research and Education (Helsinki, Finland; Jun 5–7)
Space Telescope Science Institute (Baltimore, USA; Jun 8–10)
European Southern Observatory (Garching, Germany; Sep 5–7)
European Space Agency (Paris, France; Sep 9)
Space Telescope Science Institute (Baltimore, USA; Sep 11–13)
European Southern Observatory (Garching, Germany; Sep 16)
BELSPO (Brussels, Belgium; Sep 29–30)
European Space Agency (Paris, France; Oct 12–13)
Dipartimento de Astronomia (Bologna, Italy; Oct 23–26)
Institute for Advanced Study (Princeton, USA; Oct 29)
Space Telescope Science Institute (Baltimore, USA; Oct 31–Nov 3)
European Southern Observatory (Garching, Germany; Dec 7–8)
Astron. Dept. Univ. of Texas (Austin, USA; Dec 12–16)
European Southern Observatory (Garching, Germany; Dec 21)

Appendix IX

Colloquia given outside Leiden

Sterrewacht Leiden

Colloquia given outside Leiden

Appendix IX

Andersson

Photodissociation of a water molecule in ice: A molecular dynamics study	Aarhus University, Aarhus, Denmark; Apr 26

Brandl

Massive star formation as seen by Spitzer	Astronomical Institute Anton Pannekoek, Amsterdam, Netherlands; Apr 1

Brinch

Radiative transfer models of protoplanetary disks	IAP, Paris, France; Apr 7

Cappellari

Dynamics of Nearby Galaxies and the Origin of the Fundamental Plane	MPI, Heidelberg, Germany; Feb 2
Idem	Universidad de Chile, Santiago, Chile; Apr 7
Idem	MPA, Garching, Germany; Apr 22
Idem	Astronomy Department, Berkeley, California; Aug 3
Revisiting the (V/σ, ϵ) diagram of early-type galaxies	Astronomy Department, Padova, Italy; Dec 7

Van Dishoeck

Gas and Ice in Protoplanetary Disks	University of Toronto, Toronto, Canada; Feb 18
Idem	McMaster University, Toronto, Canada; Feb 19
The Physical and Chemical Structure of Low-Mass Protostellar Envelopes: from JCMT to Herschel and ALMA	University of Toronto, Toronto, Canada; Feb 18
Spitzer's View of Star- and Planet-Forming Regions	MPIfR, Bonn, Germany; Feb 21
Spitzer Observations of Gas and Dust in Star- and Planet-forming Regions: Ice Cold and Steaming Hot	Cecilia Payne-Gaposhkin Lecture, Harvard University, Cambridge, USA; Apr 14
Idem	NASA-Ames Research Center, Mountain View, USA; Aug 25
Idem	University of Chile, Santiago, Chile; Sep 30
Idem	Penn State University, State College, USA; Oct 31
Idem	Institute for Astronomy, Honolulu, USA; Dec 16
ALMA: science drivers and project overview	OSF, San Pedro de Atacama, Chile; May 14
Chemistry around Low-mass Protostars	Penn State University, State College, USA; Nov 1

Fuchs

Laboratory studies of O_2 in pure, mixed and layered CO ices and a comparison with the N_2-CO ice system	MPIA, Heidelberg, Germany; Dec 7
Idem	I. Physikalische Institut, Cologne, Germany; Dec 12
Idem	Ruhr University, Bochum, Germany; Dec 13

Hekker

Pulsations in K giants?	Sterrenkundig Instituut KU Leuven, Leuven, Belgium; Dec 16

Hogerheijde

Planet-forming Disks: Recent Results from (Sub) Millimeter Interferometers and the Spitzer Space Telescope	MPIfR, Bonn, Germany; Jan 14
Idem	ASTRON/JIVE, Dwingeloo, Netherlands; Feb 11
Idem	Astronomisch Instituut Anton Pannekoek, Amsterdam, Netherlands; Apr 22

Icke

Computation and the Critical Cycle	Computing Centre RUG, Groningen, Netherlands; Apr 26
Astrophysical Applications of Radiation Hydrodynamics	FOM Rijnhuizen, Jutphaas, Netherlands; May 26
Gravity, Particles, and the Cosmological Constant	NIKHEF, Amsterdam, Netherlands; Jun 24
Causaliteit en vensterglas	Fac. Filosofie, Amsterdam, Netherlands; Nov 11
The SimpleX Algorithm for radiation Hydrodynamics	TUE Natuurkunde, Eindhoven, Netherlands; Nov 24

Jaffe

VLTI observations of AGN	Univ. National de Chile, Santiago, Chile; Nov 15

Joergens

On the Origins of Brown Dwarfs	Dr. Remeis Sternwarte Bamberg / University of Erlangen, Erlangen, Germany; May 30
Idem	Astrophysikalisches Institut und Universitäts-Sternwarte Jena, Jena, Germany; Jun 1
On the Formation of Brown Dwarfs based on Observations in ChaI	Universitätssternwarte München, München, Germany; Nov 30

Ten Kate

Laboratory simulations on organics on Mars	Dept of Microbiology, TU Delft, Delft, Netherlands; Oct 11

Katgert

The Magnetic Field of the Galaxy	Osservatorio Astronomico, Trieste, Italy; Sep 14

Linnartz

Planar plasma expansions as a tool for high resolution spectroscopy of unstable species	Institut für Physikalische Chemie, Würzburg,Germany; Jan 28

Miley

Radio Galaxies: Probes of the Most Distant Protoclusters	ESO, Vitacura, Chile; Jan 21

Röttgering

The new low-frequency radio telescope LOFAR	IAP, Paris, France; Sept 23
Idem	National Astronomical Observatory of Japan, Mitika, Japan; Oct 12
Idem	Royal Observatory Edinburgh, Edinburgh; Dec 2

Schaye

Metal Enrichment of the Intergalactic Medium	Joint ICTP-SISSA, Trieste, Italy; May 24
Metals in the intergalactic medium	ETH, Zurich, Switzerland; Jun 6
The Chemical Enrichment of the Intergalactic Medium	Astronomical Institute Anton Pannekoek, Amsterdam, Netherlands; Oct 21
Idem	Sterrenkundig Instituut, Utrecht, Netherlands; Nov 2

Snellen

Transiting extrasolar planets	ASTRON-JIVE, Dwingeloo, Netherlands; Jun 17

Van der Wel

Setting the Scale - Dynamical and Photometric Properties of High-Redshift Early-Type Galaxies	Kapteyn Institute, Groningen, Netherlands; Sep 12

Woitke

Multi-dimensional Models for Dust-driven AGB Star Winds	Dwingeloo, Netherlands; Jan 7
Modelling Dust Formation	Friedrich-Schiller-Universität,Jena, Germany; Jun 23

Wuyts

Optical Spectroscopy of Red Galaxies at $z > 2$	Carnegie Observatories, Pasadena, USA; Feb 8

Van de Ven

Dynamical structure and evolution of stellar systems	Kapteyn Instituut, Groningen, Netherlands; Dec 13

De Zeeuw

SAURON & The Fossil Record of Galaxy Formation	Institute of Astronomy, Cambridge, UK; Mar 10
Idem	Institute for Astronomy, Honolulu, USA; Apr 6
Idem	International Gemini Observatory, Hilo, USA; Apr 7
Idem	National Optical Astronomy Observatories, Tucson, USA; Apr 12
Idem	European Southern Observatory, MPE & MPA, Garching, Germany; Apr 21
Idem	Dipartimento de Astronomia, Bologna, Italy; Oct 25

Appendix X

Scientific publications

Sterrewacht Leiden

Scientific publications

Appendix X

X.1 Ph.D. Theses and Books

P. B. Lacerda, The shapes and spins of Kuiper Belt objects, Ph.D. thesis, Leiden University, February 2005.

F. I. Pelupessy, Numerical studies of the interstellar medium on galactic scales, Ph.D. thesis, Leiden University, March 2005.

M. A. Reuland, Gas, dust, and star formation in distant radio galaxies, Ph.D. thesis, Leiden University, February 2005.

E. J. Rijkhorst, Numerical nebulae, Ph.D. thesis, Leiden University, December 2005.

K. C. Steenbrugge, High-resolution X-Ray spectral diagnostics of Active Galactic Nuclei, Ph.D. thesis, Leiden University, February 2005.

F. A. van Broekhuizen, A laboratory route to interstellar ice, Ph.D. thesis, Leiden University, June 2005.

D. van Delft, Heike Kamerlingh Onnes, een biografie, Ph.D. thesis, Leiden University, February 2005.

A. van der Wel, Setting the scale: photometric and dynamical properties of high-redshift early-type galaxies, Ph.D. thesis, Leiden University, September 2005.

G. van de Ven, Dynamical structure and evolution of stellar systems, Ph.D. thesis, Leiden University, December 2005.

B. P. Venemans, Protoclusters associated with distant radio galaxies, Ph.D. thesis, Leiden University, April 2005.

X.2 Articles in Refereed Journals

W. H. Allen, **A. M. van Genderen**, and C. Sterken, The 2003.5 Post-Periastron Brightening of eta Carinae, Informational Bulletin on Variable Stars **5601**, 1.

M. Ammler, **V. Joergens**, and R. Neuhäuser, What are the temperatures of T Tauri stars?. Constraints from coeval formation of young eclipsing binaries, *Astron. Astrophys.* **440**, 1127–1132.

D. R. Ardila, S. H. Lubow, D. A. Golimowski, J. E. Krist, M. Clampin, H. C. Ford, G. F. Hartig, G. D. Illingworth, F. Bartko, N. Benítez, J. P. Blakeslee, R. J. Bouwens, L. D. Bradley, T. J. Broadhurst, R. A. Brown, C. J. Burrows, E. S. Cheng, N. J. G. Cross, P. D. Feldman, **M. Franx**, T. Goto, C. Gronwall, B. Holden, N. Homeier, L. Infante, R. A. Kimble, M. P. Lesser, A. R. Martel, F. Menanteau, G. R. Meurer, **G. K. Miley**, M. Postman, M. Sirianni, W. B. Sparks, H. D. Tran, Z. I. Tsvetanov, R. L. White, W. Zheng, and **A. Zirm**, A Dynamical Simulation of the Debris Disk around HD 141569A, *Astrophys. J.* **627**, 986–1000.

A. Bartkiewicz, M. Szymczak, and **H. J. van Langevelde**, Ring shaped 6.7 GHz methanol maser emission around a young high-mass star, *Astron. Astrophys.* **442**, L61–L64.

A. D. Bolatto, **F. P. Israel**, and C. L. Martin, High Excitation Molecular Gas in the Magellanic Clouds, *Astrophys. J.* **633**, 210–217.

R. J. Bouwens, G. D. Illingworth, R. I. Thompson, and **M. Franx**, Constraints on $z \sim 10$ Galaxies from the Deepest Hubble Space Telescope NICMOS Fields, *Astrophys. J. Lett.* **624**, L5–L8.

D. M. Bramich, K. Horne, I. A. Bond, R. A. Street, A. C. Cameron, B. Hood, J. Cooke, D. James, T. A. Lister, D. Mitchell, K. Pearson, A. Penny, **A. Quirrenbach**, N. Safizadeh, and Y. Tsapras, A survey for planetary transits in the field of NGC 7789, *Monthly Notices Roy. Astr. Soc.* **359**, 1096–1116.

B. R. Brandl, D. M. Clark, S. S. Eikenberry, J. C. Wilson, C. P. Henderson, D. J. Barry, J. R. Houck, J. C. Carson, and T. L. Hayward, Deep Near-Infrared Imaging and Photometry of the Antennae Galaxies with WIRC, *Astrophys. J.* **635**, 280–289.

T. Broadhurst, N. Benítez, D. Coe, K. Sharon, K. Zekser, R. White, H. Ford, R. Bouwens, J. Blakeslee, M. Clampin, N. Cross, **M. Franx**, B. Frye, G. Hartig, G. Illingworth, L. Infante, F. Menanteau, G. Meurer, M. Postman, D. R. Ardila, F. Bartko, R. A. Brown, C. J. Burrows, E. S. Cheng, P. D. Feldman, D. A. Golimowski, T. Goto, C. Gronwall, D. Herranz, B. Holden, N. Homeier, J. E. Krist, M. P. Lesser, A. R. Martel, **G. K. Miley**, P. Rosati, M. Sirianni, W. B. Sparks, S. Steindling, H. D. Tran, Z. I. Tsvetanov, and W. Zheng, Strong-Lensing Analysis of A1689 from Deep Advanced Camera Images, *Astrophys. J.* **621**, 53–88.

A. G. A. Brown, H. M. Velázquez, and L. A. Aguilar, Detection of satellite remnants in the Galactic Halo with Gaia- I. The effect of the Galactic background, observational errors and sampling, *Monthly Notices Roy. Astr. Soc.* **359**, 1287–1305.

M. Brüggen, M. Ruszkowski, A. Simionescu, M. Hoeft, and **C. Dalla Vecchia**, Simulations of Magnetic Fields in Filaments, *Astrophys. J. Lett.* **631**, L21–L24.

M. Brusa, A. Comastri, E. Daddi, L. Pozzetti, G. Zamorani, C. Vignali, A. Cimatti, F. Fiore, M. Mignoli, P. Ciliegi, and **H. J. A. Röttgering**, XMM-Newton observations of Extremely Red Objects and the link with luminous, X-ray obscured quasars, *Astron. Astrophys.* **432**, 69–81.

M. Cappellari, and **R. M. McDermid**, The nuclear orbital distribution in galaxies as a fossil record of black hole formation from integral-field spectroscopy, Classical and Quantum Gravity **22**, 347–+.

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