Research Institute Leiden Observatory

(Onderzoekinstituut Sterrewacht Leiden)

Annual Report 2004

Sterrewacht Leiden
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Front cover: 30 Doradus in the Large Magellanic Cloud, the closest starburst region, seen with the Spitzer Space Telescope at 3.6 micron (green) and 8 micron (red) wavelength. The wind-blown bubbles in the warm interstellar medium are filled with diffuse, hot X-ray gas (Chandra 0.6 keV in blue). (Bernhard Brandl, see section 2.5.1).

Back cover: Spitzer spectrum of ices in the protoplanetary disc of the system CRBR 2422.8-3423 (Klaus Pontoppidan, see section 2.3.5).

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

Production Annual Report 2004:
J. Lub, H.A. Quirrenbach, L. Snijders, D. Schnitzeler, L. van der Veld

Sterrewacht Leiden

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Sterrewacht Leiden

Review of major events

Chapter 1

The year 2004 saw much activity at the Sterrewacht. Two new staff members were appointed, from a field of over 80 applicants from all over the world. Ignas Snellen from the Royal Observatory in Edinburgh arrived in October to work on active galactic nuclei and searches for extra-solar planets. Joop Schaye from the Institute for Advanced Study, an expert in galaxy formation, accepted the other position, but deferred his arrival to early 2005. Stephan Schlemmer, who arrived in 2003 to lead the Raymond and Beverly Sackler Laboratory for Astrophysics, received an offer which he could not refuse, and left for the University of Köln in October. Harold Linnartz from the Free University of Amsterdam will join us soon to succeed him.

Seven PhD degrees were awarded in 2004, to Maria Messineo, Kirsten Kraiberg Knudsen, Davor Krajnović, Ivo Labbé, Jes Jorgensen, Klaus Pontoppidan, and Richard Ruiterkamp. In addition, seven undergraduates received their MSc degrees. The scientific highlights of the past year are summarized elsewhere in this Annual Report, which has been compiled by Leonie Snijders, Dominic Schnitzeler and Andreas Quirrenbach. Particularly noteworthy was the early work with the Spitzer Space Telescope, which included the first look in stellar nurseries in the Tarantula Nebula by Bernhard Brandl, and the discovery of icy planetary building blocks in a system believed to resemble our own Solar system in its infancy, by an international team led by Klaus Pontoppidan. This was the subject of a major press release of Spitzer, and earned Klaus the privilege to represent the Observatory in the annual Faculty-wide competition for *discoverer of the year*

The research carried out in Leiden continues to be diverse, and includes observations with telescopes on the ground and in orbit, laboratory astrophysics, data analysis and interpretation, and purely theoretical work. Leiden astronomers are involved in the development of instrumentation for the William Herschel Telescope, the Very Large Telescope and the VLT Interferometer, including SINFONI and the second generation instruments MUSE and PRIMA, 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 HIFI for the Herschel Space Observatory, in the MIRI and NIRSPEC instruments for the James Webb Space Telescope, and in Gaia. Observatory staff also continues to serve on high-level international oversight committees for ESO, ESA, ALMA, AURA, and the Hubble Space Telescope.

All of this is possible because of the strong support from the higher levels of the University, our excellent administrative and computer staff, and substantial external funding (provided by NOVA, NWO, and the EU), which now comprises 55% of the Observatory budget. The NWO funding included a number of projects obtained in the Open Competition, a prestigious VIDI grant for Michiel Hogerheijde to build his own research group, and a grant from the NWO-M program for Michael Perryman and Anthony Brown to prepare for ESA's Gaia mission. In the course of 2004 we also received the welcome news that Joop Schaye would receive a large Excellence Grant from the European Union, as the only scientist in Holland and one of 15 in all of Europe, from a field of more than 300 applicants.

The steadily increasing number of researchers at the Sterrewacht has led to significant pressure on office space. During the course of 2004 it became possible to add new offices, a student computer room, and a brand new lecture room on the fourth floor of the Huygens Building to our 'territory'. Earlier in the year, most desks had been replaced to comply with current rules, and the existing offices on the fifth floor of the Huygens Building had received a long-overdue makeover, including a change from the outdated mustard–colored paint to something more pleasing to the eye and spirit. Much archival material was moved elsewhere, and the central area on the fifth floor now hosts a modern optical laboratory, led by Remco Stuik. This work was organized very effectively by Erik Deul and our computer-group. Even so, the pressure on offices remains high, and many offices are shared by three or four persons.

The annual Oort Lecture was presented by Professor Rashid Sunyaev of the Max Planck Institute für Astrophysik, entitled *Clusters of Galaxies as a Tool for Cosmology*. He also led a very interactive workshop on *Observational Consequences of Reionization*. Professor Geoffrey Blake of the California Institute of Technology visited for a week in early December, and presented the 2004 Sackler lecture, entitled *Molecules and the Search for Developing Planetary Systems*. Nearly a dozen other astronomical workshops were held in Leiden, many in the Lorentz Center.

Our alumni organization ('Vereniging van Oud-Sterrewachters') celebrated its second lustrum, with a mini-symposium on the past, present, and future of the Observatory, followed by a buffet dinner. This was a very happy reunion of many former students and staff, and surely something to be repeated.

A major milestone was reached in April, when Professor Adriaan Blaauw, the nestor of Dutch astronomy and a distinguished emeritus of our University, celebrated his 90th birthday with a well-attended party at estate Nienoord near Groningen. It was followed by a National Astronomy Conference in his honor, on Vlieland in late May.

The past year also saw the fiftieth anniversary of the Leids Kerkhoven Bosscha Fonds. The LKBF is vital for the Observatory through its financial support of travel for workshops and research visits abroad. The treasurer, Peter Katgert, is currently completing a book chronicling the remarkable history of the LKBF.

On October 28, Minister Maria van der Hoeven of OC&W awarded the Huygens Prize to Leiden graduate Amina Helmi, now at the Kapteyn Institute in Groningen, for the best Dutch PhD thesis in the space sciences in the period 2000–2003.

Finally, Ewine van Dishoeck was appointed to the Board of Annual Reviews and Astrophysics, as its first non-US member. She will become associate editor in 2005.

Professor C.A. (Lex) Muller passed away on August 8, at age 81. He was a pioneer of radio astronomy, and was recruited to Leiden by Jan Oort shortly after the Second World War. He designed and built receivers for the Kootwijk, Dwingeloo and Westerbork telescopes and was the first director of the Dwingeloo Observatory. The first map of the neutral hydrogen distribution in the Galaxy, by Van de Hulst, Muller and Oort, was a milestone in the history of astronomy. Muller was a professor at the Sterrewacht, and moved to the Technical University of Twente in 1970.

On November 25, we lost Peter de Kler, after a long illness. He was responsible for personnel matters, first under Jan Coremans and later as a member of the P&O department of the Faculty of Mathematics and Natural Sciences. He had a remarkable talent for finding the right balance between the needs of the individual and the interests of the University, which allowed him to mediate and resolve many issues.

The Sterrewacht is a diverse international research institute in our University, where well over one hundred students, promovendi, postdocs, staff and many visitors work together in a cordial atmosphere. Maintaining this atmosphere, despite worrisome world-wide trends towards a less open society, is key to the continued success of our research and education program, and I am committed to do so.

Tim de Zeeuw
Director

Chapter 2

Research

Sterrewacht Leiden

Chapter 2
Research

2.1 Solar System

2.1.1 Minor Planets

Many new asteroids were discovered, numbered or named by I. van Houten, continuing the work by herself and her late husband C.J. van Houten (see Annual Report 2002). In 2004, the Minor Planet Center in Cambridge (USA) gave definitive numbers to 382 objects, including 2 Trojans in L4.

34 names were given to Minor Planets of the van Houten's in 2004. Some of these names are of particular interest: (18235) LyndenBell, (18237) Kenfreeman, (18240) Mould, (18242) Peebles, and (18243) Gunn have been named after Oort professors, who previously did not have an asteroid named after them. (10649) VOC has been named in honor of the Vereenigde Oostindische Compagnie (Dutch East-India Company) founded in 1602, shortly after the discovery of the shipping route to the far East. The complete list of names assigned in 2004 is:

```
(10649) 4098 P-L   VOC                  Mar 2004
(10963) 2088 T-1   van der Brugge       Mar 2004
(10965) 3297 T-1   van Leverink         Mar 2004
(11238) 2044 P-L   Johanmaurits         Mar 2004
(11239) 4141 P-L   Marcgraf             Mar 2004
(11240) 4175 P-L   Piso                 Mar 2004
(11241) 6792 P-L   Eckhout              Mar 2004
(11242) 2144 T-1   Franspost            Mar 2004
(11246) 4250 T-3   Orvillewright        Jan 2004
(11247) 4280 T-3   Wilburwright         Jan 2004
(11248) 4354 T-3   Bleriot              Mar 2004
(11249)%1971 FD    Etna                 Jul 2004
(11753) 2064 P-L   Geoffburbidge        Mar 2004
(11754) 2560 P-L   Herbig               Mar 2004
(11755) 2691 P-L   Paczynski            Mar 2004
```

All objects numbered in 2004 found by the van Houtens

year of observation	1960	1971	1973	1977	Total
survey	P-L	T-1	T-2	T-3	
region	L4	L5	L4	L5	
regular asteroids found	125	19	119	117	380
Trojans found	1	0	1		2

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(11756) 2779 P-L   Geneparker          Mar 2004
(11757) 2799 P-L   Salpeter            Mar 2004
(11758) 4035 P-L   Sargent             Mar 2004
(11759) 4075 P-L   Sunyaev             Mar 2004
(13897)%4216 T-2   Vesuvius            Jul 2004
(17305) 4652 P-L   Caniff              Jan 2004
(18235) 1003 T-2   Lynden-Bell         Jan 2004
(18237) 1182 T-2   Kenfreeman          Jan 2004
(18240) 1317 T-2   Mould               Jan 2004
(18242) 2102 T-2   Peebles             Mar 2004
(18243) 2272 T-2   Gunn                Jan 2004
(19034)%2554 P-L   Santorini           Jul 2004
(23405)%1973 SB1   Nisyros             Jul 2004
(26761)%2033 P-L   Stromboli           Jul 2004
(34919)%4710 P-L   Imelda              MPC  52770
(37452)%4282 P-L   Spirit              MPC  52770
(39382)%2696 P-L   Opportunity         MPC  52770
(73637)*1973 SX1   Guneus              Jul 2004
(85030)*2804 P-L   Admetos             MPC  52771
* means Trojan asteroid,   % means Hilda-object
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2.1.2 Planets

Together with researchers from UC Berkeley (Dunn, de Pater, Wright, & Molnar), Hogerheijde studied millimeter-interferometric observations of the rings around Saturn. These observations were taken with near-maximum ring opening, allowing for the first time resolved observations at these wavelengths. The emission was successfully modeled as arising both from scattered and thermal light from the dust particles in the rings, providing insight into their composition and structure.

2.1.3 Kuiper Belt Objects

The Kuiper Belt is a ring of icy objects with heliocentric orbits in the trans-Neptunian region. These Kuiper Belt objects (KBOs) are most likely remnants of outer solar system planetesimals, left over from the epoch of planet formation. For this reason, Kuiper Belt studies are expected to contribute significantly to our understanding of the formation and evolution of planetary bodies in the outer solar system.

Pedro Lacerda has been studying the shapes and spins of KBOs through analysis of their lightcurves. Kuiper Belt lightcurves are periodic brightness variations caused primarily by the varying reflecting cross-section of the KBOs aspheric shapes as they spin. The period of the lightcurve is the spin period of the KBO, and the lightcurve amplitude has information on how aspheric the KBO is (i.e., how large is ratio of longest to shortest axis, a/b).

The existing database of KBO lightcurves indicates that the mean spin period of these objects is ~ 9.2 hours. For comparison, asteroids in the same size range have a mean spin period of ~ 6.5 hr. Lacerda has addressed the question of the origin of KBO spins, namely if collisions between KBOs, since the epoch of formation, are the cause for the observed rotation rates. For this purpose, a model was constructed to simulate the collisional evolution of KBO spins since the time of their formation, about 4–4.5 Gyr ago. Lacerda found that the spin rates of KBOs with radii larger than about $r = 200$ km, have not been changed by collisions; their spin must be "primordial", acquired during (or close to) the formation epoch. Smaller KBOs have had their spins significantly altered by mutual collisions.

If KBOs grew by *isotropic* accretion of material, angular momentum conservation should significantly slow down their spins, to rates much slower than what is observed. On the other hand, *anisotropic* accretion could explain the observed rotation of the large KBOs. Lacerda considered the possibility of anisotropic accretion, and concluded that an asymmetry of about 10% in the angular momentum contributed by the accreted particles is enough to explain the observations. However, this is only necessary if the accreted particles are very small. If they are at least 1/5 of the size of the growing body, then isotropic accretion can also reproduce the observed spins, because individual impacts can significantly alter the spin rate of the growing object.

2.1.4 Comets

Part of a team of 13 researchers from the Illinois, Berkeley, Maryland, and Caltech, Hogerheijde observed molecular line emission from two comets that approached the Sun in May of 2004, LINEAR (C/2002 T7) and NEAT (C/2001 Q4). Clear detections of emission from HCN and CS molecules using both the Berkeley-Illinois-Maryland and Owens Valley millimeter arrays lead to relative chemical abundances of these ice species which can be interpreted in the framework of evaporation and photochemistry in the expanding coma.

2.2 Stars

2.2.1 Pre-Main-Sequence Stars

In collaboration with the EXPORT consortium, Quirrenbach continued photometric and spectroscopic investigations of the properties of pre-main-sequence and young main-sequence stars. The two Herbig AeBe stars HD 34282 and HD 141569 were found to be metal-deficient; this resolves the puzzle that both stars appeared to lie below the main sequence in the HR diagram. Spectro-astrometric observations confirmed that HK Ori is a binary system consisting of a hot and a cool component; the active component in the system is a T Tau star with UX Ori characteristics.

2.2.2 Dust-Driven Stellar Winds

Woitke has developed the first multi-dimensional models for dust-driven stellar winds. These models reveal a much more complex picture of the dust formation and wind acceleration compared to existing 1D (spherically symmetric) models, with a turbulent dust-formation zone which creates dust clouds rather than dust shells (see Fig. 2.1). Latest IR interferometric observations point to similar wind asymmetries in AGB stars and red supergiants. The model combine multi-dimensional hydrodynamics (FLASH code) with time-dependent chemical modeling (dust formation) and proper continuum radiative transfer (Monte Carlo method).

2.2.3 η Carinae, Supergiants

Van Genderen and Sterken (Brussels, Belgium) compared ground-based broadband photometry of η Carinae (Homunculus and central star) with simultaneously obtained broad- and narrow-band photometry of the isolated central star by the HST made from 1997 to the end of 2003. Many workers believed that large-aperture photometry of the entire Homunculus is a quite unreliable diagnostic tool for unraveling the variability of the central star, quite contrary to what van Genderen and Sterken repeatedly alleged (although, a small smearing-out effect could not be excluded).

Their investigation shows that, apart from the extreme brightening of the central star in 1998 and 1999 (which is probably due to an accidental fast decrease of

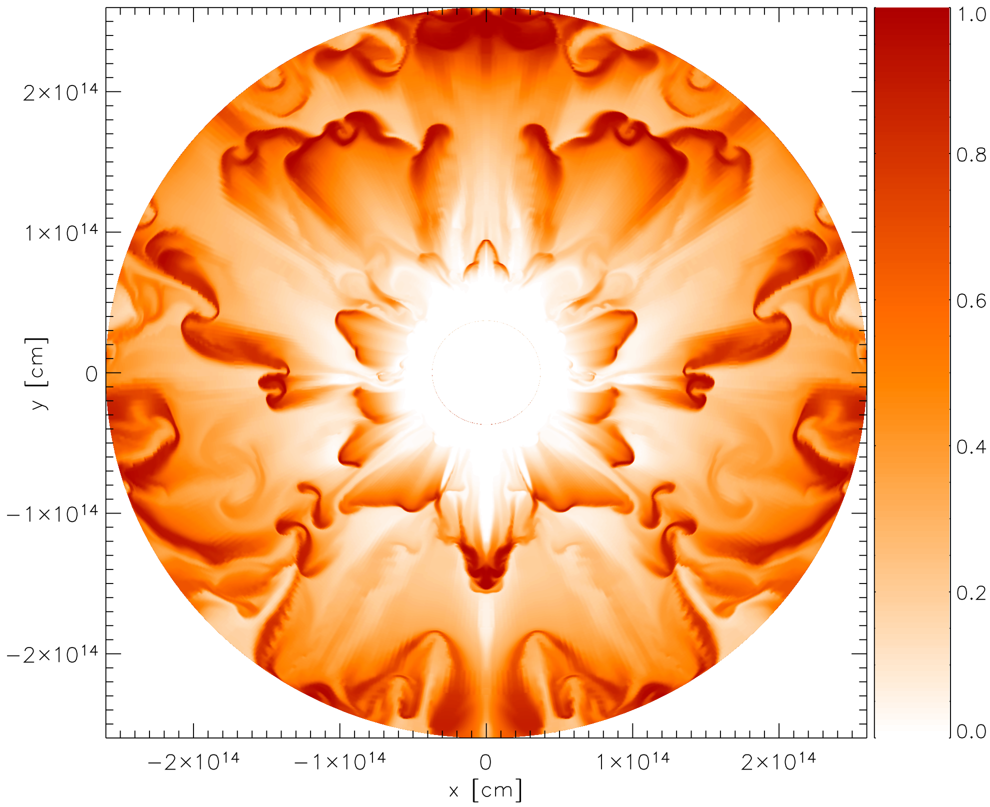

Figure 2.1: Snapshot of the normalized dust-to-gas mass ratio.

extinction in front of this area), the Homunculus (plus central star) and the isolated central star varied in a very similar way.

This discovery was quite surprising. Such behavior excludes the existence of any measurable smearing-out effect including light-time effects in the Homunculus due to reflections. Except, perhaps, for the variable excess-UV radiation originating in the ionized gas clouds lying in the equatorial plane, which according to the HST observations appeared to be modulated by the 5.52 yr binary period. The presumable explanation for the absence of measurable smearing-out effects is that the brightest part of the SE lobe which faces the Earth, other bright parts in the equatorial plane and the NW lobe, and for which light-time effects are negligible anyway, are photometrically dominant as compared to the remainder of the Homunculus.

Van Genderen and Sterken (Brussels, Belgium) finished the analysis and discussion of $VBLUW$ photometry (Walraven system) of five late-type supergiants in the Small Magellanic Cloud.

The results are described in the twentieth paper in the series on the study of the "Light Variations of Massive Stars (α Cygni Variables)" in the Galaxy and the Magellanic Clouds. Only one of the five selected supergiants (AV 369) turned out to be variable with a time scale of about two months and amplitudes of $0^m_{\cdot}1$ to $0^m_{\cdot}5$ from the visual to the UV, respectively.

With the aid of the photometric metal-index diagram $[B-L]/[L-U]$, the metal abundances of these SMC objects were compared with those of SMC Cepheids and supergiants in the Galaxy and the LMC. The results are in agreement with earlier photometric and spectroscopic studies.

2.2.4 Exoplanets

The direct observation of extrasolar planets and their spectra is coming within reach with the new generation of ground-based near-IR interferometers, like the VLTI. The high contrast between star and planet requires an excellent calibration of atmospheric distortions. Proposed techniques are the observation of color-differential or closure phases. While the differential phase is affected by atmospheric dispersion, which might prevent its application to extrasolar planets, the closure phase is immune to atmospheric phase errors and is therefore a promising alternative. Joergens and Quirrenbach modeled the response of the closure phase instrument AMBER at the VLTI to realistic models of known extrasolar planetary systems taking into account their theoretical spectra as well as the geometry of the VLTI. It was shown that the nulls in the closure phase do only depend on the system geometry, but not on the planetary or stellar spectrum. Based on the relation between these nulls and the nulls of the phases on individual baselines, a strategy was developed to determine the geometry of the system as well as to synthesize the planetary spectrum from closure phase observations in a deterministic way without any a priori assumptions.

Hekker, Reffert and Quirrenbach, 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 the 3.6 m telescope on La Silla, Chile. These high resolution spectra are used to measure spectral line bisectors, in order to reveal the mechanism that causes the observed radial velocity variations.

Quirrenbach, in collaboration with a group at St. Andrews led by K. Horne, continued the analysis of monitoring observations in the fields of the open clusters

NGC 6819, NGC 6940, and NGC 7789, which had been designed to be sufficiently sensitive for the detection of planetary transits. A large number of variable stars have been classified, and a few candidates that require further follow-up have been identified.

2.2.5 SETI

A. Ollongren, in collaboration with the research group on Interstellar Message Construction of the SETI Institute at Mountain View, California, continued his work on the development of the new Lingua Cosmica. A restricted enrichment of LINCOS with non-deterministic typing and symbolic computation was achieved. Results were reported at the 8^{th} IAU International Conference on Bioastronomy in Reykjavik and at the 55^{th} International Astronautical Congress in Vancouver.

2.3 Protostars and Circumstellar Disks

2.3.1 Physical and Chemical Structure of Low-Mass Protostars

Jørgensen, van Dishoeck and Schöier (Stockholm) continued to harvest the scientific results of a large JCMT + Onsala 20 m (sub)millimeter survey of the chemical properties of low-mass protostars. An important new result is the possibility to use the freeze-out of specific molecules as "time indicators" for protostellar evolution (see Fig. 2.2). In the outer part of the envelope, the timescales for freeze-out are longer than the lifetimes of the cores, whereas in the inner warm part heated by the protostar ices are evaporated. The heavy depletions are thus limited to an intermediate cold high density zone in the envelope, with the size of this freeze-out zone related to the evolutionary stage. Fits to single-dish observations of molecules such as CO, HCO^+ and H_2CO indicate short timescales of only $\sim 10^5$ years from the time when a dense pre-stellar core has formed until a protostar emerges. This so-called 'drop' abundance structure has been confirmed by OVRO interferometer observations of H_2CO and CO in a few objects.

2.3.2 A Starless Core that isn't

The radiative transfer techniques developed in the course of this work have also been applied to new Spitzer Space Telescope observations of a dark cloud core, L1014, previously thought to be starless. The highly sensitive Spitzer observations revealed a faint mid-infrared source toward its center. Jørgensen, as part of the Spitzer "cores to disks" (c2d) legacy team together with Young, Evans (PI, Texas), Shirley (NRAO, Socorro) and others, developed detailed models constraining the

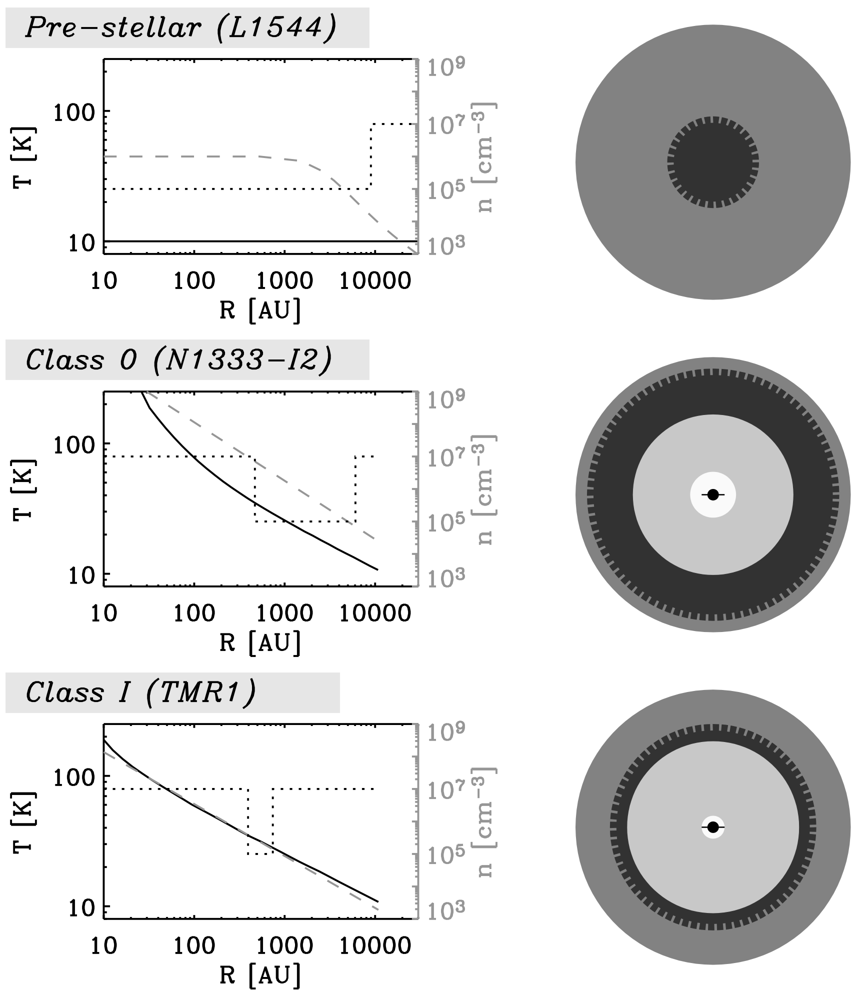

Figure 2.2: Proposed chemical evolutionary sequence for low-mass pre- and protostellar objects. The left column gives the temperature and density as functions of radius for a pre-stellar core, a class 0 and a class I object. The dotted line indicates the derived abundance structure. The right column gives the depletion signature for each class of objects with dark grey indicating the region where the density is too low for depletion, black the zone indicating heavy freeze-out and light grey the inner region where molecules evaporate (from: Jørgensen et al.)

nature of this interesting very low-luminosity source resulting in a publication in the special Spitzer ApJ issue.

2.3.3 OCN^- Survey Toward Embedded Low-Mass YSOs

Pontoppidan, van Dishoeck and Fraser, in collaboration with Dartois and d'Hendecourt (IAS, Paris) and Tielens (RuG/SRON), continued to analyze the data from their ESO VLT-ISAAC programs to observe ices and gases around a large sample of low-mass young stellar objects (YSOs) in nearby star-forming regions. This year, the analysis focussed on the OCN^- ice feature. In a study led by van Broekhuizen, it was shown that the famous XCN band at 4.62 μm consists of at least two components, of which only one can be ascribed to OCN^-. The other component is likely due to CO directly adsorbed on the silicate surface, reported last year by Fraser. The high S/N data allow the OCN^- abundance to be derived for 34 low-mass YSOs with typical values of ≤ 0.85 % with respect to H_2O ice, somewhat lower than those toward high-mass YSOs. Abundances are found to vary by at least a factor of 10–20 and large source-to-source abundance variations are observed within the same star-forming cloud complex on scales down to 400 AU. Comparison with laboratory data indicates that the inferred abundances are quantitatively consistent with a photochemical formation of OCN^-, but the large abundance variations are not easily explained in this scenario unless local radiation sources or special geometries are invoked. Surface chemistry should therefore be considered as an alternative formation mechanism of OCN^-.

2.3.4 Spitzer Spectroscopy of Ices in Low-Mass YSOs

Pontoppidan and van Dishoeck, in collaboration with Boogert and Blake (Caltech) and Lahuis, analyzed the mid-infrared spectra of embedded low-mass young-stellar objects obtained in the context of the Spitzer c2d legacy program. These data are complemented by ground-based VLT-ISAAC and Keck data below 5 μm. A first publication concerns the HH 46 and B5 IRS1 low-mass YSOs. The CO_2 bending mode at 15 μm is a particularly powerful tracer of the ice composition and processing history. Toward these protostars, this band shows little evidence for thermal processing at temperatures above 50 K. Signatures of lower temperature processing are present in the CO and OCN^- bands, however. Comparison of the observed CO_2 profile with laboratory data indicates an intimate mixture with H_2O, but not necessarily with CH_3OH, in contrast to some high-mass protostars. This is consistent with the low CH_3OH abundance derived from the ground-based L-band spectra. The CO_2 abundance with respect to H_2O ice is high, $\sim$35%. Clearly, Spitzer spectra are essential for studying ice evolution in low-mass protostellar environments and for eventually determining the relation between interstellar and solar system ices.

2.3.5 First Detection of Heated Ices in an Edge-on Disk

Pontoppidan and Dullemond (MPIA, Heidelberg), in collaboration with the c2d Spitzer legacy team carried out a detailed study of the edge-on disk CRBR 2422.8-3423 in the Ophiuchus molecular cloud. This object is known for showing deep absorption features due to ices, such as water, CO and CO_2. A two-dimensional Monte Carlo radiative transfer code was used in combination with Spitzer-IRS data and VLT-ISAAC near-infrared imaging to construct a physical model for the disk. While much of the ice observed along the line of sight is located in a foreground molecular core, a significant fraction of the ice is likely present in the outer disk. This is supported by the shape of the 6.85 μm band, attributed to NH_4^+ ice, which shows indications of heating of $\sim$50% of the ice. This is arguably the strongest evidence for the presence of ices in circumstellar disks surrounding young solar-type stars. The results were featured at a NASA press release on November 7, see `http://www.spitzer.caltech.edu/Media/releases/ssc2004-20/release.shtml`.

2.3.6 High-Energy Radiation Probes of Protostellar Envelopes

Together with Stäuber and Benz (ETH, Zürich), van Dishoeck, Doty and Jørgensen 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 YSOs. Because of the high extinction in protostellar regions, ultraviolet radiation and X-rays cannot be detected directly from these objects, but they can selectively enhance molecules due to photodissociation and ionization processes. A JCMT program to search for CN, CO^+ and NO was continued and CO^+ was found in several high-mass sources. Time- and depth-dependent chemical models containing ultraviolet and X-ray chemistry have been developed using the temperature and density structure derived from continuum observations. Most of the effort this year focussed on a detailed implementation of the X-ray chemistry. The main difference with UV radiation is the much greater penetration depth of X-rays, up to at least 1000 AU from the central source. Species like HNC, SO, SH^+ and HCO^+ are exclusively enhanced by X-rays, whereas other molecules are more enhanced by UV. Best fit models for the massive YSO AFGL 2591 indicate an X-ray luminosity of at least 2×10^{31} erg s^{-1} with a hard X-ray spectrum corresponding to $\geq 3 \times 10^7$ K. High-J lines of molecules are best suited to probe these processes. Predictions for future instruments such as Herschel-HIFI and ALMA have been made.

2.3.7 Testing Grain-Surface Astrochemistry

Bisschop, van Dishoeck and Jørgensen performed deep searches for complex molecules using the JCMT in a small sample of low- and high-mass protostars. Molecules that are thought to originate through grain surface chemistry by successive hydrogenation and oxydation 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. Interestingly, initial data show that some molecules like CH_3OCHO are present only in the colder environments, whereas others like CH_2CH_3OH are more abundant in warmer gas.

2.3.8 Spitzer Spectra of T Tauri Stars: Silicates and PAHs

Augereau, Geers and van Dishoeck, in collaboration with Kessler-Silacci, Evans (Texas), Brown and Blake (Caltech), have been involved in the interpretation of the first Spitzer spectra of circumstellar dust disks around young solar-type (T Tauri) stars obtained with Spitzer as part of the c2d Legacy Program. A large fraction of the observed spectra have a flat and boxy 10 μm silicate emission feature and a flat spectrum beyond 20 μm. Only a small fraction of sources have a rising mid-infrared spectrum with a PAH feature at 11.3 μm (Fig. 2.3). Assuming that the relation between the shape of the spectral energy distribution of a disk and its geometry inferred with ISO for Herbig Ae stars also holds for the lower-mass T Tauri stars, this implies that most of the observed T Tauri disks have non-flaring geometries except when PAHs are detected. This proposition is being tested using 2D radiative transfer models in collaboration with Dullemond (Heidelberg). The detailed composition and size of the dust grains responsible for the observed spectral features are inferred by Kessler-Silacci with dust opacity model developed by Augereau. There is clear evidence for grain growth up to a few μm in a large fraction of c2d sources.

Geers has focussed on the reduction and analysis of the $\sim$ 20% of the observed T Tauri sources 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. These detections indicate that PAH molecules receive sufficient UV radiation from the central star to be excited, suggesting an additional source of UV radiation above the stellar photosphere, most likely associated with the accretion process. The correlation with rising mid-infrared spectra suggests that this subsample of T Tauri stars has disks with a flaring geometry. In collaboration with Visser (student VU), Augereau, van Dishoeck and Geers developed a PAH chemistry and infrared emission model which is being coupled with Dullemond's radiative transfer disk models in order to constrain the characteristics (size, charge) of the PAHs observed with Spitzer.

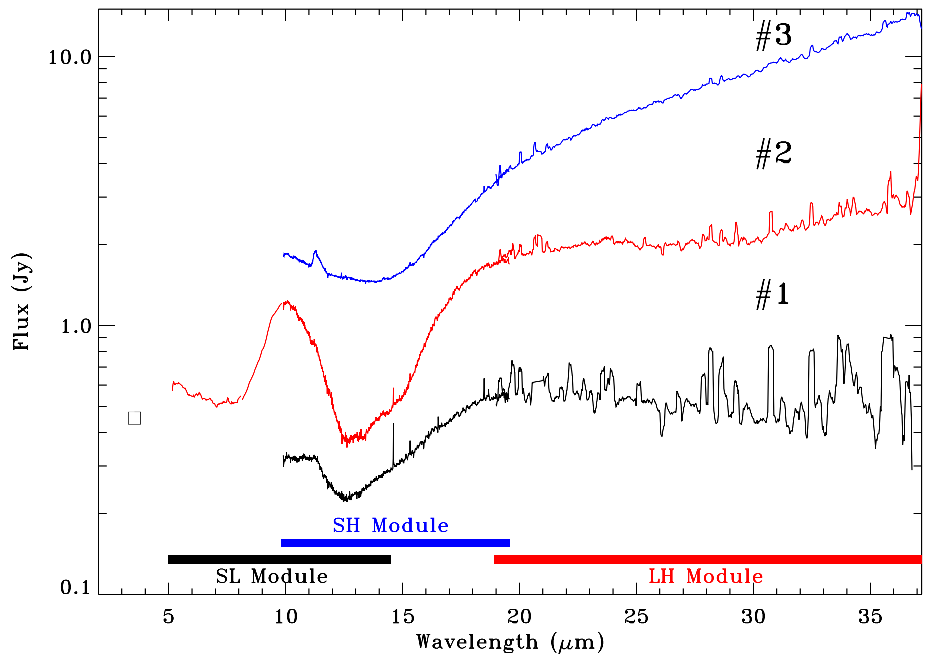

Figure 2.3: Examples of SEDs of T Tauris stars in the c2d legacy program. A large fraction of the objects has flat and boxy 10 μm silicate features indicative of grain growth to sizes of a few μm (type 1). These sources also have flat mid-infrared spectra characteristic of self-shadowed disks. A smaller fraction shows a rising spectrum with PAHs features indicative of a flaring disk heated by UV radiation from the star (type 3) (from: Augereau, Geers et al.)

2.3.9 Shadows of Circumstellar Disks

Pontoppidan, in collaboration with Dullemond (Heidelberg), studied the phenomenon of a small circumstellar disk casting a shadow on a large reflection nebulosity surrounding the central star-disk system. In such a system, a small 50 AU disk may cast a shadow extending over more than 10 000 AU making disk shadows easily observable. It was shown that disk shadows are likely common and may form a variety of different morphologies in reflection nebulae. The shape of a disk shadow can thus be used to obtain unique constraints on the physical structure of disks. A number of disk shadow candidates were identified including EC 82 —

the illuminating source of the Serpens reflection nebula — and Ced 110 IRS 4 in the Chamaeleon star-forming cloud. These objects were modeled using a two-dimensional Monte Carlo radiative transfer code and compared to both VLT-ISAAC near-infrared images as well as mid-infrared spectroscopy from ISAAC, ISO and Spitzer.

2.3.10 Gas and Dust in Planetesimal Disks

Augereau, in collaboration with Thébault (Meudon/Stockholm), addressed the problem of conflicting gas mass estimates in the inner disk of β Pictoris. Specifically, the effect of gas drag on the dynamics of the dust particles was modeled to derive an upper limit on the gas mass in this system. The dust particles are assumed to originate from a colliding annulus of planetesimals peaked around 100 AU from the central star. Various gas densities inferred from independent observing techniques have been tested and their impact on the dust dynamics and on the disk profile in scattered light along the midplane have been studied. It is shown that the observed scattered light profile of the disk cannot be properly reproduced if the hydrogen gas number density at 117 AU exceeds 10^4 cm^{-3}. This corresponds to an upper limit on the total gas mass of about 0.4 Earth masses and to a gas-to-dust mass ratio smaller than 1. This approach therefore provides an independent diagnostic for gas depletion in the β Pictoris system relative to the dust disk. Such an approach could also be used to constrain the gas content of recently identified systems like the edge-on disc around AU Mic.

2.3.11 Gas Temperature of (Flaring) Disks

Jonkheid and van Dishoeck extended their calculations of the gas temperature of the outer regions in flaring circumstellar disks to include a full 2D radiative transfer for the UV radiation (developed by van Zadelhoff) for heating the gas. Previous models assumed that the stellar radiation incident on the disk's surface traveled in the vertical direction. It was found that the 2D radiative transfer leads to a steeper vertical temperature distribution. The effects of dust settling on the temperature structure and on important emission lines were also examined. It was found that relatively high-lying lines, such as the [C II] 158 μm and [O I] 63 and 145 μm lines, are much stronger when the gas temperature is calculated explicitly instead of taken to be equal to the dust temperature.

In collaboration with Augereau and Kamp, Jonkheid started on 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 phase. The dust distribution as imaged by HST and other telescopes shows that the dust is concentrated in two rings, probably shaped by an external object. CO has also been detected by single-dish telescopes and interferometers. Because the dust is optically thin, Jonkheid adopted his code to treat the chemical structure in radial rather than vertical slices. The aim of this study is to constrain the gas temperature and total gas mass in this object.

2.3.12 Testing Temperature Calculations in PDRs

Jonkheid and van Dishoeck have compared the results of the PDR code developed by the Leiden group to those of other institutes in a benchmark testing campaign during a week-long workshop in the Lorentz Center. At the end of the test, the results of various codes were sufficiently close to give renewed confidence in the Leiden PDR code.

2.3.13 Submillimeter Observations of L1489 IRS

Brinch and Hogerheijde investigated recent single-dish submillimeter line observations of the circumstellar material around the young star L1489 IRS. This material is distributed in a disk-like configuration, with a velocity field dominated by Keplerian rotation but with significant inward motions. Brinch and Hogerheijde analyzed the molecular line data to obtain estimates of the temperature and density in the emitting gas, as well as constraints on the chemical abundances. This will lead to an accurate description of this transitionary object between a collapsing cloud core and a circumstellar disk.

2.3.14 Debris Disks

Jourdain de Muizon and Laureijs (ESA-ESTEC) have extended the work of Habing et al. (1999 & 2001) on debris discs around stars observed with ISO (in which they had been long involved). In particular they have exploited the ISOPHOT chopped data at 60 and 90 μm that had been left aside in the first place due to the complexity of a reliable data reduction in this mode. This study leads to the detection of a few new candidate-discs from the original Habing et al. sample. It also adds a 90 μm point on the SEDs (Spectral Energy Distribution) of the infrared excesses which puts constraint on the properties of the disc. The conclusion of Habing et al. that debris discs around A stars are rather young (less than 400 Myr) is confirmed, but it seems that some debris disks around F and G stars could be much older (a few Gyr). A paper is in preparation.

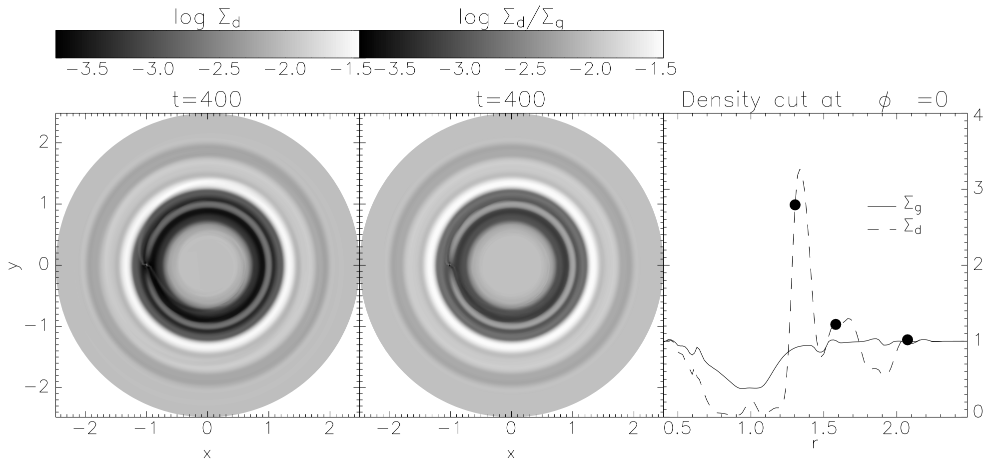

Figure 2.4: Dust flow near a 0.1 Jupiter mass planet after 400 orbits of the planet. Left panel: dust surface density. Middle panel: dust-to-gas ratio. Right panel: radial cut opposite to the planet's position. A gap forms in the dust fluid, not in the gas. Outside the gap, the dust particles are concentrated in resonances (indicated with dots) with the planet.

2.3.15 Modeling of Dusty Gas Disks

Paardekooper & Mellema developed a two-fluid hydrodynamics code to model dusty gas disks in the context of planet-disk interaction. The dust fluid is treated as a pressureless gas, and the interaction terms with the gas are integrated analytically. They showed that particles of approximately 1 mm are moved by the gas into mean motion resonances with a Neptune-class planet. Moreover, the particles are very effectively removed from the orbital radius of the planet while the gas stays in place. The dust gaps in gas disks that are created this way will be observable at mm-wavelengths by ALMA.

2.4 Structure of the Milky Way Galaxy

2.4.1 The Interstellar Medium

Schnitzeler and Katgert analyzed gradients of polarization angle of the galactic radio background in galactic latitude and longitude. In this work they attempt to study gradients of galactic Faraday rotation, and thereby the large-scale properties of the galactic ISM, in particular its magnetic field. The periodic nature of the polarization angle data precludes a direct Fourier decomposition. Instead, gradients are fitted to the data by solving for the most plausible unwrapping of the data, by addition of appropriate multiples of 180°. The analysis confirms their earlier reconstructions of the dependence of polarization angle on galactic latitude. In particular, large-scale polarization angle gradients in Galactic latitude can abruptly change sign on scales of a few degrees.

In the process, Schnitzeler developed a new way of fitting linear gradients to periodic data. Previously, a discrete set of possible slopes and 180° wraps was analyzed for the best fit to the unwrapped data points. In the old method, the fits are restricted to the possible solutions, i.e. to combinations of 180° wraps that provide consistent solutions. The new method covers the entire (continuous) range of possible slopes and offsets. Therefore it is a lot more reliable than the grid-based approach, and for medium-sized data sets it demands much less computing power than would be necessary to get a higher reliability from the old grid-based approach.

Schnitzeler also developed a radiation transport code for the full Stokes vector, to simulate the effects of Faraday rotation and depolarization on polarized emission when it passes through a medium that Faraday rotates and / or emits radiation. For particular situations where the solution can also been obtained analytically, the code appears to give correct results, and it reproduces e.g. depolarization horizons and canals.

2.4.2 Structure and Kinematics of the Inner Galaxy

Messineo and Habing, in collaboration with Menten (MPIfR), Omont (IAP), and Sjouwerman (NRAO), have continued to study stellar populations in the inner Galaxy. A proper correction for interstellar extinction is of primary importance for a photometric study of stellar populations in the inner Galaxy, where extinction can be significant even at infrared wavelengths. This is critical especially in the central Bulge region where interstellar extinction may exceed 30 visual magnitudes and where due to the current uncertainties in the near-infrared extinction law (30%) the uncertainty in the bolometric luminosities of evolved late-type stars is at least 1 magnitude. By analyzing the colors of giants detected by the 2MASS survey toward the inner Galaxy they found that the near-infrared extinction law is well approximated by a power law $A_\lambda \propto \lambda^{(\alpha=-1.9\pm0.1)}$ and that the quite often used value $\alpha = 1.6$ is inconsistent with the colors of the stars in the inner Galaxy.

The extinction is a powerful distance indicator and is used to improve the understanding of the velocity-longitude diagram of maser stars by locating foreground stars. The combined information on extinction and kinematics properties made it possible for the first time to separate maser stars into three groups each at a different distance from the Sun. Habing and Messineo in collaboration with van de Ven, Sevenster, and Kuijken have analyzed the longitude and velocity distribution of over 1000 OH and SiO maser stars. In support of earlier studies they also conclude that the Milky Way Galaxy contains a bar. The inner Lindblad resonance (at 0.8 kpc) and the co-rotation (at 3.3 kpc) each leaves a clear mark in the longitude-velocity diagrams of the maser stars. After reconstruction of the stellar density a clearly outlined bar of stars appear in the inner Milky Way Galaxy.

2.4.3 Internal Dynamics of Globular Clusters

De Zeeuw, van den Bosch, van de Ven and Freeman (Australian National University) finished a paper reporting line-of-sight velocity measurements of 2305 stars in the globular cluster ω Centauri, obtained in the early nineties by Reijns and Seitzer (University of Michigan). Comparison of the measurements for stars in common with two previous studies established the external accuracy of the velocities to be better than 2 km/s.

Van de Ven, van den Bosch and de Zeeuw determined the dynamical distance and intrinsic structure of ω Centauri, building on earlier work together with Verolme. They used an extension of the existing axisymmetric Schwarzschild orbit superposition software to construct realistic flattened and anisotropic dynamical models which simultaneously fit the observed surface brightness, the proper motion measurements by van Leeuwen and Le Poole, and the line-of-sight velocity measurements of individual stars in the cluster. This allows measurement of the distance (which is needed to convert the proper motions to physical units) together with the inclination and the mass-to-light ratio of the cluster. They used a maximum likelihood method to correct the observed velocities for measurement errors, and carried out a careful and consistent data selection. In the process, they invented a method to correct the proper motion data for residual systematic solid body rotation. The resulting best-fit model reveals 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 distance of 4.8 ± 0.3 kpc is consistent with earlier photometric estimates. The best-fit model is nearly isotropic in the inner parts, but increasingly tangential anisotropic outwards, and it contains an inner disk. This phase-space structure, which seems to be influenced by the tidal field of the Milky way and linked to the multiple stellar populations observed in ω Centauri, is expected to provide important constraints on its formation history.

Van den Bosch, de Zeeuw and van de Ven, together with Noyola and Gebhardt (both University of Texas, Austin) used the same modeling method to study the globular cluster M 15 using Gebhardt's ground-based radial velocity measurements and recently published proper motions obtained by the Hubble Space Telescope.

In contrast with ω Centauri, this core-collapsed globular cluster shows a significant radial dependence of the mass-to-light ratio. The study also puts an upper limit on the mass of a possible black hole at the center of this cluster.

2.5 Stars, Gas, and Dust in Nearby Galaxies

2.5.1 Starburst Galaxies

The Spitzer Space Telescope, NASA's fourth Great Observatory, began its nominal science operations in December 2003, making 2004 a year full of exciting new data from the mid-IR wavelength regime. Brandl and his collaborators on the Spitzer-IRS GTO team started a large program on the mid-IR properties of starbursts, based on IRS spectra of about thirty, relatively nearby starburst galaxies. One of them, the prototypical starburst galaxy NGC 7714 was the first one to be analyzed and published. The larger project involves a comparative study of the PAH emission features, silicates and emission lines and their dependencies on each other. While the PAH spectra seem to be remarkably invariant over a whole range of starburst galaxies the strength of the PAH feature varies significantly with its environment from the lowest metallicity dwarf galaxies to the most luminous ULIRGs. The hardness of the radiation field as measured e.g., by the [Ne III] / [Ne II] ratio does not depend on the total luminosity of the starburst, but can vary significantly across the disk of a galaxy; an increase in hardness has been observed and published for NGC 253. The comparably narrow slits of the Spitzer-IRS have also emphasized the importance of spatial resolution for quantitative spectroscopy. In collaboration with Lee Armus (Caltech), Brandl studied the properties of ULIRGs based on a Spitzer-IRS sample of 110 sources between $10^{11.7}\,L_\odot$ and $10^{13.13}\,L_\odot$. First papers have been published but the analysis of the entire sample is still ongoing.

Brandl also leads a collaboration to characterize the most massive HII regions within the Local Group. Even HII regions of about the same age come in a variety of luminosities, dust content, X-ray emission and stellar cluster condensations. The combination of Spitzer imaging with spectroscopy enables a comprehensive study of the conditions of the ISM within those building blocks of more luminous starburst systems are being born. The first observation from that program, 30 Doradus in the LMC, revealed a very complex structure and a linear extent of more than 250 parsecs. It was also featured in a NASA press release (see Fig. 2.5).

2.5.2 Star Formation in Dwarf Irregular Galaxies

Pelupessy studied star formation in dwarf irregular galaxies using advanced computer simulations. He found that periodically bursting star formation natu-

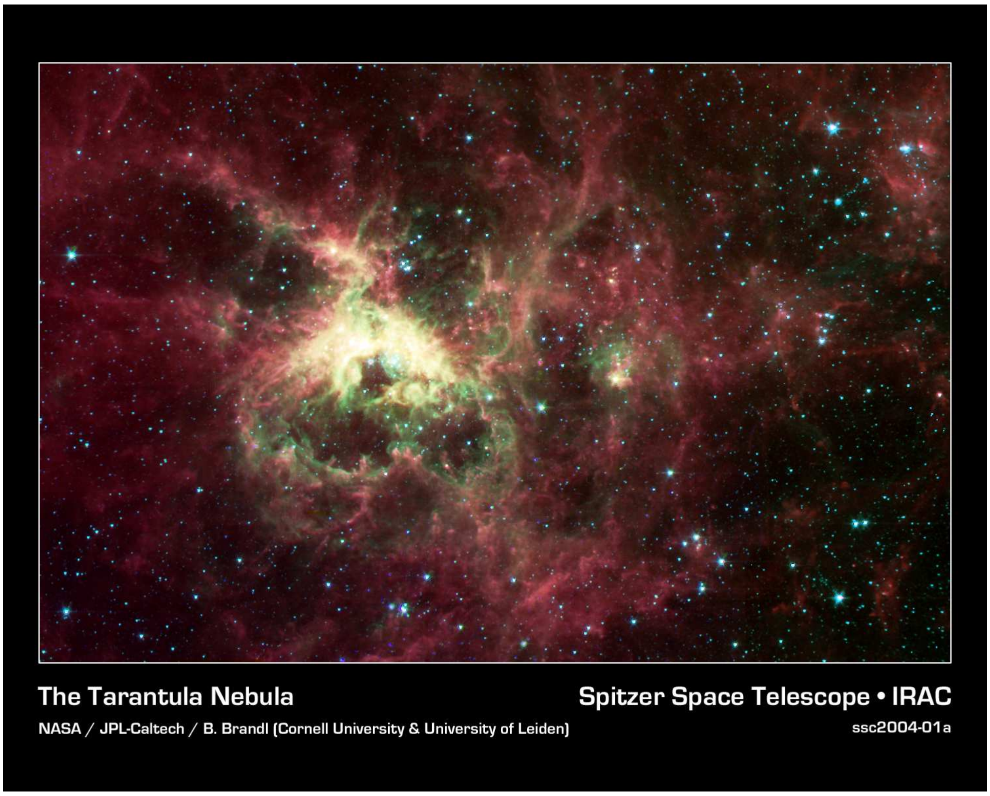

Figure 2.5: Spitzer Space Telescope observations of the Tarantula Nebula. At the heart of the nebula is a compact cluster of stars, known as R136, which contains very massive and young stars. The brightest of these blue supergiant stars are up to 100 times more massive than the Sun, and are at least 100,000 times more luminous. These stars will live fast and die young, at least by astronomical standards, exhausting their nuclear fuel in a few million years. The Spitzer Space Telescope image was obtained with an infrared array camera that is sensitive to invisible infrared light at wavelengths that are about ten times longer than visible light. In this four-color composite, emission at 3.6 microns is depicted in blue, 4.5 microns in green, 5.8 microns in orange, and 8.0 microns in red. The image covers a region that is three-quarters the size of the full moon.

rally results from the effects of supernova feedback and the flat cores of their dark halo distribution. Together with student de Vries he also studied the influence of structural parameters of dwarf galaxies on the star formation behavior. Pelupessy and de Vries showed that the peculiar star formation properties of Blue Compact Dwarfs result from the strong peak in both the dark matter and gas distribution.

Pelupessy extended his model code to follow for the first time the formation and destruction of the primary "fuel" of star formation, the H_2 gas. He applied this to the problem of molecular gas in dwarf galaxies, revealing a sensitive dependence of the H_2 fraction on formation rate and metal content.

2.5.3 Super-Starclusters

Snijders and Van der Werf studied massive star formation in young clusters in the Antennae merger pair (NGC 4038/4039) using JHK spectra obtained with ISAAC at the ESO VLT. The near-infrared spectra contain a wealth of diagnostic features, including hydrogen and helium recombination lines, strong [FeII] lines and H_2 rovibrational lines. Explaining the strength of the hydrogen recombination lines (extinction corrected) requires the presence of about 35000 O-stars within a volume with a half-light radius of 32 pc. The effective temperature derived from the ratio of helium and hydrogen recombination lines is $T_{\rm eff} \approx 38,500$ K, corresponding to a ZAMS spectral type of O7.5.

2.5.4 Molecular Gas in the Central Regions of M 51

Israel, Tilanus (JAC, Hawaii) and the late Baas mapped the central arcminute of the grand design spiral galaxy M 51 in the the J=2–1, J=3–2, J=4–3 lines of CO maps; they also collected measurements of the J=2–1, J=3–2 ^{13}CO and 492 GHz [CI] lines. Position-velocity cuts reveal a compact central feature exhibiting a rapid solid-body rotation, but the maps show that the center of the galaxy is poor in molecular gas, though not entirely devoid of it. Most of the molecular gas resides in the spiral arms. The absence of a circumnuclear disk or torus in M 51 is important: it implies that the presence of rapidly rotating material close to a galaxy nucleus can just as well be due to molecular enhancement of inner spiral arms as to frequently assumed circumnuclear disks.

The observed line intensities require modeling with a multi-component molecular gas. In the center, a dense component with $n({\rm H_2}) \approx 10^3\,{\rm cm^{-3}}$ and $T_{\rm kin} \approx 100$ K is accompanied by either a *less dense* component with $n({\rm H_2}) \approx 10^2\,{\rm cm^{-3}}$ at the same temperature, or a *more dense* component with $n({\rm H_2}) \approx 3 \times 10^3\,{\rm cm^{-3}}$ at a much lower temperature of $T_{kin} \approx 20$ K. Only a small fraction of all carbon is in CO. Total carbon column densities are about 7 times the CO column density. At least in the center of M 51, most of the carbon appears to be in the form of C^+. The observed line ratios are consistent with standard PDR models.

Emission from the CO peak in the northwestern arm likewise originates in (at least) two different gas components. One is modestly dense ($n(H_2) \approx 10^3\,\mathrm{cm}^{-3}$) and the other is relatively tenuous ($n(H_2) \approx 10^2\,\mathrm{cm}^{-3}$) but more widespread. Both must be at elevated temperatures $T_{\mathrm{kin}} = 100\ldots150\,\mathrm{K}$.

The center of M 51 has a face-on gas mass density of $40\pm20\,\mathrm{M}_\odot\,\mathrm{pc}^{-2}$, and a well-established CO-to-H_2 conversion factor $X = 0.50\pm0.25\times10^{20}\,\mathrm{cm}^{-2}/\,\mathrm{K\,km\,s}^{-1}$, i.e. a factor of four to five lower than commonly assumed standard Galactic values, but in line with similar determinations in other galaxy centers.

2.5.5 Molecular Gas in Compact Galaxies

Israel presented new observations of eleven compact (dwarf) galaxies in the CO $J = 2-1$ and $J = 3-2$ transitions, and constructed from these observations and literature data accurate line ratios in matched beams, allowing the modeling of physical parameters. Matching a single gas component to observed line ratios tended to produce physically unrealistic results, and was often not possible at all. He obtained much better results by modeling two distinct gas components.

Radiative transfer (LVG) modeling showed that in most observed galaxies, the molecular gas is warm ($T_{\mathrm{k}} = 50\ldots150$ K) and at least partially dense ($n(H_2) \geq 3000\,\mathrm{cm}^{-3}$). Most of the gas-phase carbon in these galaxies is in atomic form; only a small fraction ($\sim 5\%$) is in carbon monoxide. Beam-averaged CO column densities are low (of the order of $10^{16}\,\mathrm{cm}^{-2}$). However, molecular hydrogen column densities are high (of the order of $10^{22}\,\mathrm{cm}^{-2}$) confirming large CO-to-H_2 conversion factors (typically $X = 10^{21}\ldots10^{22}\,\mathrm{cm}^{-2}/\,\mathrm{K\,km\,s}^{-1}$) found for low-metallicity environments by other methods.

From CO spectroscopy, three different types of molecular environment may be distinguished in compact galaxies. Type I (high rotational and isotopic ratios) corresponds to hot and dense molecular clouds dominated by star-forming regions. Type II has lower ratios, similar to the mean found for infrared-luminous galaxies in general, and corresponds to environments engaged in, but not dominated by, star-forming activity. Type III, characterized by low CO (2–1)/(1–0) ratios, corresponds to mostly inactive environments of relatively low density.

2.5.6 Dense Irradiated Gas in Galaxy Nuclei

Meijerink and Spaans (Kapteyn Institute, Groningen) developed, in close collaboration with Israel, codes to describe both far-ultraviolet (PDR) and X-ray dominated regions (XDR) with the ultimate aim to explore in some detail the physical environment defined by the central regions in galaxies. They included a large variety of thermal and chemical processes pertaining to irradiated gas. In particular, they included a careful treatment of PAH and H_2 formation, destruction and excitation. For each code, they calculated four depth-dependent models at different densities and radiation fields, chosen to mimic conditions in starburst and active galactic nuclei. They made a detailed comparison between PDR and XDR physics for total gas column densities between $\sim 10^{20}$ and $\sim 10^{25}\,\mathrm{cm}^{-2}$ by calculating cumulative line intensities for a number of selected fine-structure lines such as [CII], [OI], [CI], [SiII], [FeII], and also cumulative column densities and column density ratios for a number of common molecular species such as CO, H_2, HCO^+, HCN, and HNC. By comparing the results for PDRs and XDRs they found that, up to $N_{\mathrm{H}} = 10^{22}\,\mathrm{cm}^{-2}$, column density ratios in XDRs are effectively constant, unlike those in PDRs. In PDRs, for example, the fraction of carbon locked up in car bon monoxide, i.e. the CO/C ratio, changes over four orders of magnitude starting at the cloud edge and going to a column of $N_{\mathrm{H}} = 10^{22}\,\mathrm{cm}^{-2}$. At low column H_2 densities, both the carbon monoxide fraction (CO/C ratio) and the carbon monoxide abundance (CO/H_2 ratio) are lower in XDRs than in PDRs. They start to rise only at high column densities $N_{\mathrm{H}} > 10^{23}\,\mathrm{cm}^{-2}$. At most column densities $N_{\mathrm{H}} > 3 \times 10^{21}\,\mathrm{cm}^{-2}$, HNC/HCN ratios are lower in XDRs too, but they show a more moderate increase at higher N_{H}.

2.6 Elliptical Galaxies

2.6.1 Nearby Radio Galaxies

Verdoes–Kleijn and de Zeeuw completed their study of the properties of central dust in nearby quiescent and active early-type galaxies. They showed that radio galaxies contain a higher fraction of regular dust "ellipses" compared to quiescent galaxies which contain more often irregular dust distributions. The morphology, size and orientation of dust ellipses and lanes in quiescent early-types and active early-types with kpc-scale radio jets is very similar. Dust ellipses are aligned with the major axis of the galaxy, dust lanes do not show a preferred alignment except for large (>kpc) dust lanes which are aligned with the minor axis of the galaxy. As projected on the sky, jets do not show a preferred orientation relative to the galaxy major axis (and hence dust ellipses), but jets are preferentially perpendicular to dust lanes. Dust ellipses are consistent with being nearly circular thin disks viewed at random viewing angles. The lanes are likely warped dust structures, which may be in the process of settling down to become regular disks or are being perturbed by a non-gravitational force.

2.6.2 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 4.2 m William Herschel Telescope on La Palma, in a collaboration which involves groups in Lyon (Bacon) and Oxford (Davies). SAURON (Spectroscopic Areal Unit for Research on Optical Nebulae) records 1577 spectra simultaneously, with full sky coverage in a field of 33 by 44″, additional coverage of a small "sky" field $1.9'$ away, spatial sampling of $0.94'' \times 0.94''$, and an instrumental dispersion of 105 km/s. SAURON was funded in part by a grant from NWO to de Zeeuw, and was built at Observatoire de Lyon. First light was obtained on February 1, 1999.

SAURON was used to measure the kinematics and line strength 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. In parallel with the data taking, the team developed a number of tools that are key to analyze all the resulting maps.

De Jong completed software which automatically organizes and consistently reduces the SAURON survey data. Information of the intermediate reduction steps is maintained in a database which can be viewed by a web-based user interface. The astronomer can alter parameters to optimize the reduction, after which the pipeline only repeats the affected steps.

Falcón–Barroso, together with Sarzi (Oxford), Cappellari, McDermid, and Krajnović implemented a new emission line-fitting method to separate the stellar absorption lines from the gas emission lines in SAURON spectra. This provides accurate maps of the stellar and gas kinematics, and allows cleaning of the spectra from emission, so that reliable absorption line-strength indices can be measured. This procedure was applied to the entire SAURON representative sample of 48 elliptical and lenticular galaxies. In general, the gas maps display regular motions with smooth variations in angular momentum. In the majority of the galaxies, the gas kinematics is decoupled from the stellar counterpart, and less than half displays signatures of recent acquisition of gaseous material. The presence of dust features is always accompanied by gas emission while the converse is not always true. Finally, a considerable range of values for the [OIII]/Hβ ratio was found both across the whole sample and within single galaxies. Application of the same approach to the SAURON data for 24 representative Sa bulges has commenced.

Krajnović continued work on the technique of kinemetry, which is a method to describe and quantify the features of kinematic maps such as provided by SAURON and OASIS. It is based on Fourier analysis, analogous to the method used to describe HI velocity fields. He showed that expansion along optimally chosen ellipses rather than the circles used earlier produces a much simpler and therefore superior description of the observed maps.

Damen imaged SAURON galaxies with the 1.3 m telescope of the MDM Observatory, at Kitt Peak in Arizona. Together with Falcón-Barroso she reduced the complete data set for all the galaxies in the representative survey, and combined the wide-field groundbased images with high-resolution images of the nuclei taken with the Hubble Space Telescope.

Shapiro (now at University of California, Berkeley) and McDermid completed the reduction of the SAURON follow-up survey obtained with the OASIS integral-field spectrograph during its period at the CFHT, Hawaii. This resulted in high-resolution kinematic maps of the nuclei of two dozen E/S0 galaxies, and the discovery of additional examples of galaxies with kinematically decoupled cores. McDermid and van Boven investigated the possible deconvolution of these data using broad- band images obtained with the Hubble Space Telescope.

2.6.3 Dynamical Models

Cappellari, together with van den Bosch, Damen, Falcon–Barroso, Krajnović, McDermid, van de Ven and de Zeeuw, investigated the well-known correlation between the dynamical mass-to-light ratio of galaxies and the corresponding velocity dispersion σ of the stars. He constructed dynamical models for a sample of 25 elliptical and lenticular galaxies with SAURON integral-field stellar kinematics up to about one effective radius, well-calibrated I-band HST/WFPC2 photometry and accurate surface brightness fluctuations (SBF) distances, chosen to be consistent with axisymmetry. This is the largest sample of galaxies for which accurate and general dynamical models have been constructed to date. He found a tight correlation, of the form $(M/L) \propto \sigma_e^{\beta}$, between the M/L measured from the dynamical models and the luminosity-weighted second moment of the line-of-sight velocity σ_e within the half-light radius. The observed intrinsic rms scatter in M/L for this sample is negligible relative to the (small) measurement errors in the SBF distances. The comparison of the observed accurate correlation with the similar one derived using simple virial estimates of M/L and with estimates of the M/L of the stellar population, showed that (i) the “tilt” of the Fundamental Plane of early-type galaxies is almost exclusively due to a real M/L variation, while orbital and photometric non-homology has a negligible effect on it; (ii) galaxies are likely not to be dark-matter dominated within R_e; (iii) the virial mass, which is generally used in high-redshift studies, is a good estimator of the galaxy mass.

Krajnović together with Cappellari, McDermid, Emsellem (Lyon) and de Zeeuw, in an effort to understand the formation and evolution of galaxies, completed the case study of the nearby elliptical galaxy NGC 2974 observed with SAURON. This galaxy has large quantities of gas, both neutral and ionized, which shows regular motion in a disk, except in the very center which reveals a weak non-axisymmetric perturbation. The existence of the gas disk can be used to compare the dynamical models of the stellar and gaseous components. The stellar component was modeled using the axisymmetric Schwarzschild method. The motion of the gas clouds was described by means of the asymmetric drift correction to the circular motion. Both approaches give consistent results and describe the observed kinematics of the galaxy well. This study was also used for a more general test of the ability of the Schwarzschild method to recover the M/L and the orbital distribution of simulated input galaxy models with axisymmetric shapes. The results showed that the Schwarzschild method can indeed be used in realistic conditions, with noise in the data, and with finite spatial resolution and field coverage, to recover the intrinsic orbital distribution of galaxies.

The reliability of the black hole mass determination was one of the main topics of a Lorentz Center meeting on *The Nuclei of Galaxies*, which brought the Nuker team and another US group working on this problem to Leiden. Considerable progress occurred in reaching a common view of the character of this problem, which led to a strong impression that the groups were finding valid solutions to the problem. The groups agreed on two specific test problems which would be done by each team and compared in the future. This project is led by McDermid.

One of the major goals of the dynamical modeling effort is to recover the large-scale intrinsic orbital distribution of a statistically selected sample of nearby galaxies. Given that the orbital structure of an axisymmetric galaxy can only be uncovered (if the potential is known) with the full integral-field coverage of the kinematics, this effort will provide the first unbiased view of the internal dynamics of nearby galaxies. Cappellari, assisted by the other local SAURON team members, started to analyze the orbital distribution derived from the Schwarzschild modeling of the sample of 25 early-type galaxies described previously, and found that a revision may be needed of the conventional interpretation of the $(V/\sigma) - \epsilon$ diagram, which relates the observed flattening of early-type galaxies to their amount of rotation. The models reveal that the non-rotating elliptical galaxies are generally quite round and not far from isotropic inside R_e. The anisotropy of the flatter ellipticals is either due to the presence of disk-like components, which tend to be radially anisotropic (heated?), or due to counter-rotating stellar components, which produce tangential anisotropy, or in some cases to strong triaxiality and the presence of barred components.

Van den Bosch and van de Ven, in consultation with de Zeeuw, further developed the Schwarzschild orbit superposition software for triaxial galaxies. It enables the construction of realistic triaxial dynamical models, which fit the observed surface brightness as well as two-dimensional kinematical measurements of elliptical galaxies. The existing code is based on the fully operational code for axisymmetric geometry. An earlier version was thoroughly overhauled, and now includes the orbit "dithering" developed by Maschietto and Cappellari amongst numerous other improvements. Currently the method is being tested against analytical models. An initial application to SAURON observations of NGC4365 shows that the method is able to reproduce the kinematically decoupled core and other observational features within the errors. After the method is fully implemented, it will allow a detailed study of many of the elliptical galaxies in the SAURON sample that show significant signatures of non-axisymmetry, and will provide accurate mass-to-light ratios, central black hole masses, and internal orbital structures of these galaxies.

2.6.4 Analytic methods

Van de Ven continued work on theoretical triaxial galaxy models with a gravitational potential of separable Stäckel form. For these models the continuity equation and the three Jeans equations have been solved analytically. The resulting first and second velocity moments can be used to construct velocity and velocity dispersion fields. By fitting two-dimensional kinematic observations of elliptical galaxies, with integral-field spectrographs such as SAURON, their intrinsic structure and orientation can be constrained. Moreover, the latter reduction of parameter space in combination with the computationally expensive but also more general Schwarzschild software, allows the construction of detailed realistic dynamical models of elliptical galaxies.

Van de Ven also investigated so-called Abel models, which are a special case of galaxy models with a Stäckel potential. For these models the density and higher velocity moments can be written as single integrals of Abel form and can be evaluated efficiently. They have enough freedom to be able to incorporate many of the observed triaxial features of elliptical galaxies. The Abels models are important to test the triaxial Schwarzschild software, as well as the above implementation of the triaxial Jeans models.

Weijmans and de Zeeuw continued their analysis of the joint probability distributions of ellipticity and misalignment of axisymmetric and triaxial galaxies. New analytical expressions were found, and checked using Monte Carlo simulations. Weijmans used these probability distributions in a Maximum Likelihood method to find the best fitting intrinsic misalignment for a sample of galaxies, given their ellipticity and observed misalignment. In this way she confirmed results found earlier by Verdoes-Kleijn (ESO) for a sample of radio galaxies with misaligned jets and dust disks. For the 48 early-type galaxies in the SAURON survey, the analysis demonstrates that the observed division in “fast” and “slow” rotators is inconsistent with one population of rotating objects seen at random viewing angles. In this case the number of slow rotators would be significantly smaller than observed.

2.6.5 IC 2531

Smit finished his MSc project on gas kinematics in the edge-on galaxy IC 2531. From HI and Hα spectroscopic data several kinematic features were identified as indications of a bar. In combination with K-band photometry the distribution of the dark halo was analyzed and it was possible to rule out a steep density cusp in favor of a constant density core.

2.7 Active Galaxies and Quasars

2.7.1 Centaurus A

Cappellari and Häring (MPIA Heidelberg) worked on the determination of the mass of the supermassive black hole in the elliptical galaxy Centaurus A (NGC 5128), using adaptive-optics assisted 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 object for studying the connection between supermassive black holes and mergers.

2.7.2 Mid-infrared Interferometry of AGNs with VLTI-MIDI

Jaffe's work on NGC 1068 led to a Nature paper and a presentation at IAU Symposium 222. In the meantime two other AGNs, Cen A and Circinus have been detected and are being analyzed in conjunction with Conrad Tristram and Klaus Meisenheimer at MPIA-Heidelberg.

Röttgering, Meisenheimer (Heidelberg), Jaffe, Sol (Meudon) organized a workshop at the Lorentz center to discuss the implications of the the first mid-infrared *interferometric* spectral observations of the nearby active galaxy, NGC 1068, at a resolution of ~ 30 mas. These observations proved the existence of a compact dust structure only a few parsec across, around an unresolved hot core, possibly the accretion disk; models invoking much larger dust distributions are excluded. The spectra indicate dust of distinctly different composition from that common in our Galaxy. Also at the 10 m Keck telescope interferometric observations have been obtained. In addition, a number of other techniques have come to bear interesting results. These include adaptive optics measurements and X-ray and radio measurements.

The workshop brought together the team that is carrying out the interferometric observations. Furthermore, the workshop was attended by astronomers that are in the process of detailed modeling the observed phenomenon and astronomers that are carrying out observations of AGN with other techniques. The final programme contained a number of elements, including:

- An overview of the recent results of multi-wavelength observations of nearby AGN;
- A detailed discussion of the VLTI data obtained together with a comparison of the various reduction methods;
- A first confrontation of the various models with the data obtained last year.

2.8 Clusters and Cluster Galaxies

2.8.1 Nearby Galaxy Clusters

Biviano (Trieste) and Katgert published their work on the orbits of the different types of galaxies in an ensemble of 59 nearby ($z < 0.1$), rich clusters from the ENACS sample. They confirmed that the orbits of the early-type galaxies (all but the brightest ellipticals and the S0 galaxies) are consistent with being isotropic. The orbits of the early spirals show an apparent tangential anisotropy near about half the virial radius, which is possibly connected to the process by which the early spirals are thought to be transformed into S0 galaxies. Finally, the late spirals have orbits which, beyond about half the virial radius, are clearly radially elongated. The kinematics of the late spirals thus brings them close to the center of their parent clusters, where they apparently get disrupted through tidal forces due the global cluster potential. Unlike the other galaxies, the late spirals get destroyed because their internal potential is quite shallow.

Biviano and Katgert have also tried to determine the kinematics of the (galaxies in) substructures. The procedure that was developed for the analysis of the other galaxies indicates that the (galaxies in) substructures are on strongly tangential orbits. Although this conclusion is not completely implausible, Biviano and Katgert have started a study of the way in which the procedure by which the substructure galaxies were selected may have influenced this result. Therefore they reconsidered the properties of substructures in these rich ENACS clusters, i.e. their kinematics, distribution and composition.

Katgert has made a comparison between the observed properties of the rich clusters and of the galaxies in them, and the properties ascribed to clusters and their constituent galaxies in numerical simulations. His purpose is to learn from the differences between models and observations in what respects the models must be improved.

2.8.2 Cooling Flows

Together with Bremer and Baker (Bristol Univ.) Jaffe has shown that molecular gas is present over wide areas of cooling flow. In fact, where ionized Hydrogen is seen, molecular hydrogen is also always found. Detailed kinetic matching of the two phases has been found. An MNRAS article is in preparation. Further Sinfoni and Spitzer observations are planned.

2.8.3 Abell 1689

Weijmans used the photometric fitting routine GALFIT to measure magnitudes and effective radii of galaxies in the cluster Abell 1689, using HST/ACS images. She derived the Kormendy relation for this cluster. This work was partly carried out at Oxford University, as part of the Gemini/HST galaxy cluster project.

2.8.4 Fundamental Planes of Galaxy Clusters

Wuyts, van Dokkum (Yale, New Haven), Kelson (Carnegie, Pasadena), Franx and Illingworth (UC, Santa Cruz) completed a detailed Fundamental Plane (FP) study of two high redshift clusters: MS 2053–04 at $z = 0.58$ and MS 1054–03 at $z = 0.83$. The residuals from the FP of MS 2053–04 are correlated with residuals from the $H\beta - \sigma$ relation, suggesting that stellar populations are playing a role in shaping the FP. The measured evolution in mass-to-light (M/L) ratio is influenced by selection effects, as galaxies with lower M/L in the Johnson B-band enter a magnitude-limited sample more easily. Selecting high mass early-type galaxies to avoid this bias, the M/L ratio is found to evolve as $\log M/L_B \sim -0.47z$. The formation redshift $z_{\rm form} \sim 2.95$ is similar to earlier results based on smaller samples.

2.8.5 The Red-Sequence Cluster Survey

Webb carried out a large observational program to study galaxy and galaxy cluster evolution. The survey consists of sub-millimeter, near-infrared, and radio imaging of galaxy clusters in the Red-Sequence Cluster Survey with the goal of studying star formation and Active Galactic Nuclei in clusters at redshift ~ 1. The year 2004 saw 80% completion of the sub-millimeter observations and a significant part of the radio and near-infrared imaging was acquired. The first paper presenting the surveys results was submitted.

2.9 Distant Objects and Large-Scale Structure

2.9.1 Galaxies at Intermediate Redshift

van der Wel and Franx studied the Fundamental Plane of early-type field galaxies at $z = 1$, based on observations with the VLT and the HST. The difference between the mass-to-light ratios of those distant galaxies and local early-type galaxies, inferred from the Fundamental Plane, implies that massive field early-type were formed at high redshift ($z \geq 2$), which is comparable to the formation redshift of equally massive cluster galaxies. Galaxy formation models predict, however, that there is a large age difference between galaxies in low and high density environments, a prediction falsified by this study. It was found that the age of an early-type galaxy instead correlates with galaxy mass, high mass galaxies being older than low mass galaxies.

Holden (UCSC), van der Wel and Franx studied the Fundamental Plane of the CL1252 cluster at $z = 1.24$. They find, similar to earlier work but using higher quality data, that massive cluster galaxies have formed at $z \geq 2$. The most massive galaxies are found to be the oldest, some of the less massive galaxies show evidence of more recent star formation activity.

2.9.2 High-Redshift Galaxies

De Zeeuw, Bacon (CRAL, Lyon) and Davies (University of Oxford) contributed to a study by Wilman, Gerssen, Bower and Morris (all University of Durham, UK) of a a star-forming galaxy at a redshift of 3.09 with SAURON. Its spatially extended Lyα emission appears to be absorbed by a foreground HI screen covering the entire galaxy, with a lateral extent of at least 100 kpc and remarkable velocity coherence. This was plausibly ejected from the galaxy during a starburst event several 10^8 year earlier and has subsequently swept up gas from the surrounding intergalactic medium and cooled. This is one of the clearest demonstrations yet of the galaxy-wide impact of high-redshift superwinds.

2.9.3 Dusty Starburst Galaxies at High Redshift

The work of Knudsen and Van der Werf on distant sub-millimeter galaxies was completed with the construction of the cumulative $850\,\mu$m source counts shown in Fig. 2.6. Source counts at $850\,\mu$m in the 1 mJy regime are of interest because the integrated background at $850\,\mu$m is dominated by sources at this flux density level. However, probing the 1 mJy sources directly is prohibited by confusion. Knudsen and Van der Werf circumvented this problem by using gravitationally lensing cluster fields, which magnify the source plane, hence alleviating the confusion problem. This project resulted in the first substantial source count at flux density levels fainter than 2 mJy (the blank-field confusion limit of the James Clerk Maxwell Telescope at $850\,\mu$m), reaching levels as faint as 0.1 mJy. These source counts confirm that 50% of the $850\,\mu$m background is produced by sources with flux densities between 0.5 and 2 mJy. A key result is the first indication of a flattening of source counts at lower flux levels, which is necessary in order to not overproduce the in-

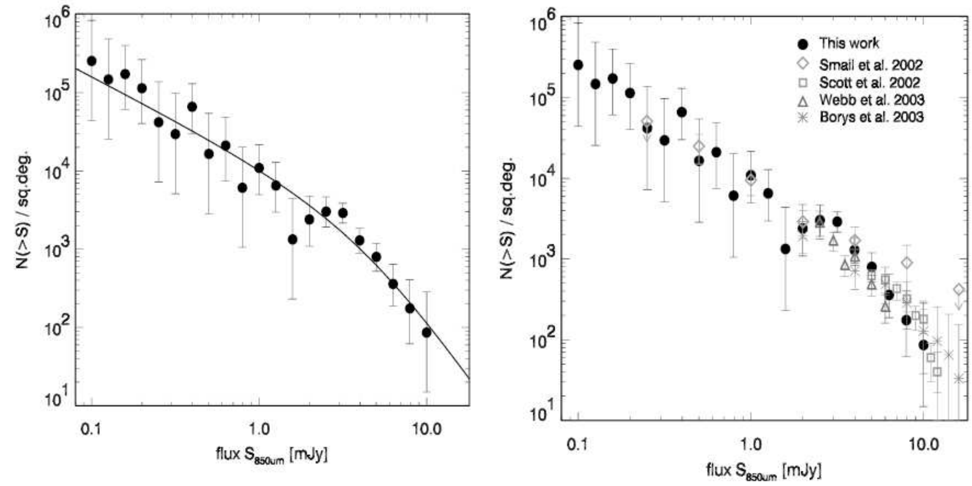

Figure 2.6: Cumulative source counts from the Leiden-SCUBA Lens Survey. A flattening of the counts towards the faint end is evident.

tegrated $850\,\mu$m background, and is here detected for the first time. Knudsen described these results in her Ph.D. thesis, which she defended in 2004.

An further result is the detection in the survey by Knudsen and Van der Werf of a triple-image lensed ultraluminous infrared galaxy (ULIRG), which is gravitationally lensed by the foreground cluster A2218 into three discrete images, as shown in Fig. 2.7. Subsequent follow-up investigations using deep optical and near-infrared (near-IR) images identify a faint counterpart to each of the three images, with similar red colors and Hubble Space Telescope morphologies.

By exploiting a detailed mass model for the cluster lens we estimate that the combined images of this galaxy are magnified by a factor of ~ 45, implying that this galaxy would have unlensed magnitudes $Ks = 22.9$ and $I = 26.1$, and an unlensed $850\,\mu$m flux density of only 0.8 mJy. Moreover, the highly constrained lens model predicted the redshift of the source to be $z = 2.6 \pm 0.4$. This estimate was confirmed using deep optical and near-IR Keck spectroscopy, measuring a redshift of $z = 2.516$ (see Fig. 2.8). This object is the faintest sub-mm selected galaxy so far identified with a precise redshift. Interestingly, there are two other highly amplified galaxies at almost identical redshifts in this field (although neither is a strong sub-mm emitter). The three galaxies lie within a $\sim$100 kpc region on the background sky, suggesting this sub-mm galaxy is located in a dense high-redshift group.

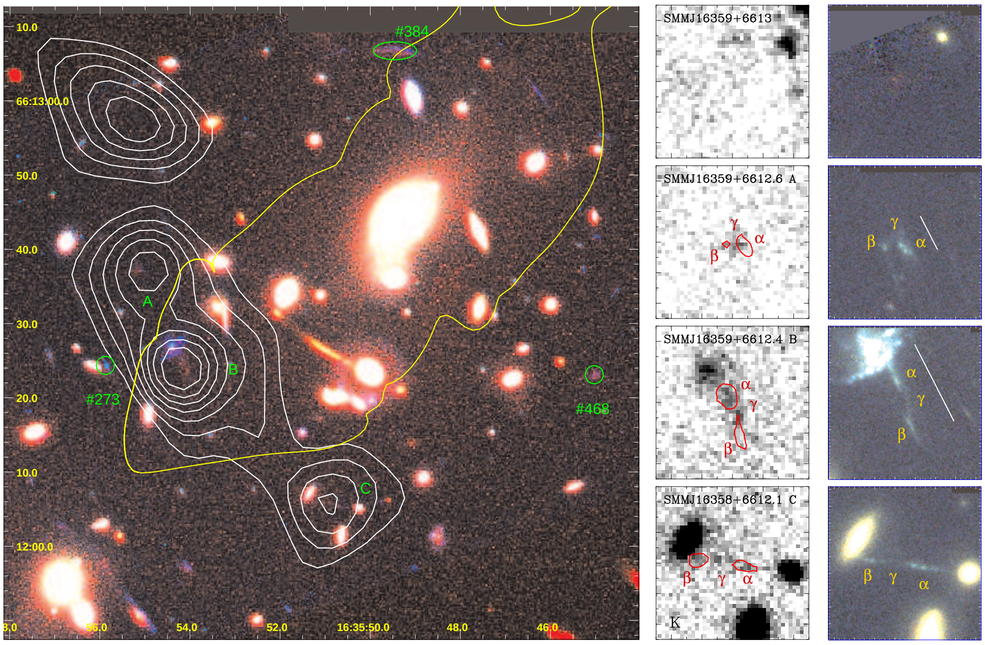

Figure 2.7: This montage shows on the left-hand side a true-color image of the core of A2218 composed from the HST F450W (blue), HST F814W (green) and WHT/INGRID Ks (red) images. The 850 μm sub-mm image from SCUBA is overlayed as white contours. The three images of the multiply imaged sub-mm galaxy are annotated as A, B and C. The yellow line shows the critical line at $z = 2.515$. The right-hand side shows $10'' \times 10''$ images of the INGRID Ks-band (left column) and HST true-color image from F450W/F606W/F814W (right column) of the four sub-mm sources in the core of A2218. The contours on the Ks frames show the morphologies of the galaxy in the F814W passband at the resolution of the Ks-band frame. Note how each of the southern sub-mm sources, comprises a near-IR source which is bracketed by two features in the F814W image. The morphological and photometric similarity of these three objects suggests that they are all images of the same background source.

2.9.4 Dynamics of high-redshift galaxies

Van Starkenburg and Van der Werf studied the challenges in measuring Tully-Fisher relations at high redshift using emission line galaxies. They found that the most difficult part is obtaining unambiguous velocity measurements. In contrast, extinction, inclination and star formation can be corrected for. Accurate treatment

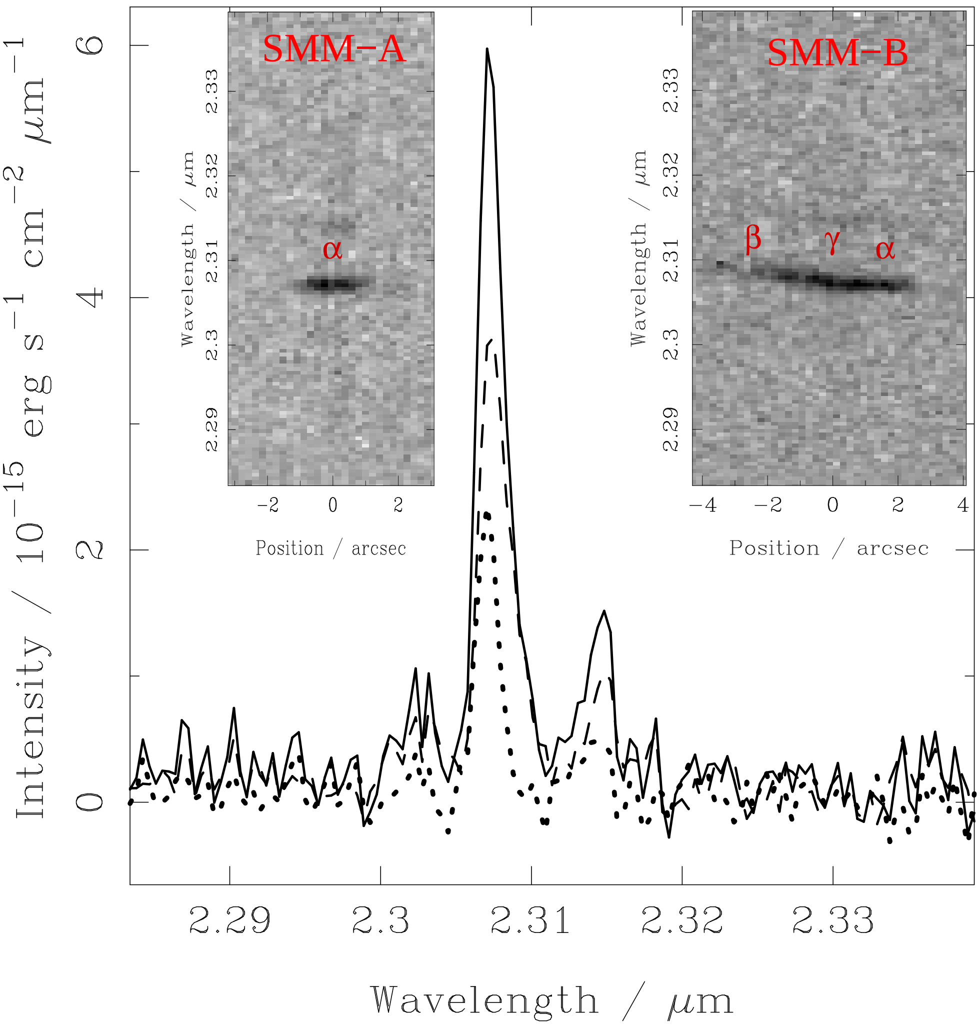

Figure 2.8: Keck/NIRSPEC K-band spectra of the three images of the triple-image sub-mm source behind A2218. The implied redshift is $z = 2.516$. The insets show the extent along the slit of the Hα emission of two of the images.

of all selection effects is of crucial importance to distinguish luminosity evolution from sample peculiarities.

2.9.5 Detailed Studies of Starburst Galaxies

An investigation of star-burst galaxies at low and high redshift was carried out. Webb obtained spatially resolved spectroscopy of two sub-mm selected galaxy mergers at low redshift with VIMOS on the VLT which will allow a study of the spatial distribution of star formation in these interesting systems. At high redshift, deep sub-mm imaging of two redshift 6.5 Lyα emitters was acquired. No detection of the Lyman-alpha emitters was made, implying they do not contain large quantities of dust and their optically estimated star-formation rates are not severely underestimated due to extinction.

2.9.6 Distant Red Galaxies

Wuyts, Franx and van Dokkum (Yale, New Haven) studied the redshift distribution and spectral type of 22 spectroscopically confirmed Distant Red Galaxies (DRGs), selected by the simple color criterion $J - K > 2.3$. The redshift distribution peaks at $z \sim 2.6$, in good agreement with the photometric redshifts. With only 3 red galaxies below $z = 2$, the criterion is very efficient in selecting high redshift galaxies. All but one of the redshift identifications were based on emission features (Lyα and possible other emission lines). The fraction of DRGs hosting an AGN is estimated to be less than 4% based on the presence of CIV in emission. Consequently, the contribution of AGN emission to the broad-band fluxes used in SED modeling of DRGs is small.

2.9.7 Properties of Galaxies at High Redshift

Franx continued his studies of the newly discovered population of red galaxies at redshifts higher than 2. In collaboration with Förster-Schreiber and the FIRES team, he studied the stellar populations and spectral energy distributions of these red galaxies (named DRGs for Distant Red Galaxies). The galaxies have generally old ages (around 1 Gyr) and high extinction. They are red because they are old and dusty. Some are best fit by population models with little if any star formation. The constitute the most massive galaxies at high redshift, and their average star formation rates are high (more than 100 $M_\odot$ / year).

Franx obtained near infrared spectroscopy of these galaxies in collaboration with van Dokkum and the FIRES group. Several galaxies were detected in Hα, and the emission line widths indicate high masses. For the first time, a correlation was found between line width and restframe V band flux, indicating the possible presence of a Tully-Fisher relation at $z > 2$.

The star formation rates of the DRGs were also derived from deep X-ray imaging of one of the fields. Franx, in collaboration with Rubin, van Dokkum and others showed that the average X-ray flux from the DRGs is consistent with star formation rates estimated from SED fitting, and has an average above 100 $M_\odot$ / year.

The sizes of galaxies at $z = 2 \ldots 3.5$ were studied by Franx, Trujillo, and the FIRES collaboration. They found that the sizes are smaller, given the luminosity of the galaxies; but that the sizes remain fairly constant as a function of mass. This is inconsistent with most of the models of galaxy formation.

Franx, in collaboration with Bouwens, Illingworth, and others studied the population of galaxies at $z = 7 \ldots 8$ using the very deep UDF imaging supplemented with their very deep NICMOS imaging. Five candidate galaxies were found, which is significantly less than expected $(10 \ldots 14)$. Obviously, more fields need to be studied, but the results imply a further evolution of the luminosity function with increasing redshift, in the sense that the density goes down at high luminosity.

2.9.8 Radio-Selected Distant Protoclusters

The large Leiden-led program on the search for and study of radio-selected distant protoclusters yielded several interesting results in 2004 (Miley, Venemans, Overzier, and collaborators). VLT observations showed that the most luminous radio galaxies are excellent tracers of distant protoclusters. A highlight of the followup was the discovery of a probable Lyman break population in the protocluster 1338$-$19 at redshift $z \sim 4.1$, discovered previously by Venemans et al., based on an overdensity in Lyman alpha emission galaxies. This was published as a Letter to Nature.

Based on the success of our ESO Large VLT Program on radio-selected protoclusters, a large multi-year project was defined to study the evolution of the most distant protoclusters and their constituent galaxies. The PROtoCluster Evolution Systematic Study (PROCESS) is an international project that will focus on a unique sample of $z > 2$ galaxy overdensities. Studies of the spectral energy distributions and structures of 4 key targets in PROCESS (z = 4.1, 3.1. 2.3 and 1.2) with carefully selected filters will be used to disentangle the history of star formation from that of structure assembly in several different populations of (proto-)cluster galaxies. During 2004 PROCESS was awarded a large amount of time on forefront facilities (HST 120 orbits, Spitzer ~ 56 hours, VLT > 5 nights, Keck ~ 6 nights, SUBARU 4 nights). The relevant observations commenced in 2004 and will proceed throughout 2005.

2.9.9 Low-Frequency Radio Observations

At the WSRT radio telescope the new Low-Frequency Front End system that operates at 115 to 180 MHz was commissioned. This test system is a step towards tackling the various problems related to sensitive observations at low radio frequencies. Important results from this system so far are that radio frequency interference does not affect the final quality of the images, and that the proposed way of reducing the data, taking into account differential ionospheric effects, can be applied successfully albeit with a significant computational effort.

van Weeren, van Hoven and Röttgering used the LFFEs to observe two fields (A2256 and Bootes) optimized for studying ultra-steep radio sources ($\alpha < -1$) with the aim of (i) constraining the luminosity function of diffuse cluster emission out to substantially higher redshifts than hitherto, (ii) search for low-luminosity diffuse supercluster emission close to a cluster rich in such objects, (iii) identify luminous radio sources at $z > 4$ and (iv) test reduction methods being developed for LOFAR. Within the NRAO reduction package AIPS, a procedure has been developed for the LFFE reductions that not only implements the standard self-calibration and imaging cycles, but also properly removes the influence of strong sources (Cygnus A, etc) far from the field center, taking account of the ionospheric variation in the directions of each of these strong sources. This process has been named "Peeling", and is yielding good results (see Fig. 2.9).

2.9.10 High-Redshift Radio Galaxies

Distant luminous radio galaxies are the IR-brightest and presumably most massive galaxies at $z > 2$. They are likely galaxies at the centers of forming clusters. Miley, Röttgering, Venemans, Kurk and collaborators conducted a large program on the Very Large Telescope to find overdensities of Lyman α emitters around $z > 2$ radio galaxies. They used the FORS2 instrument to image the radio galaxy fields in a narrow band centered on the wavelength of the Lyα emission of the radio galaxy and in a broadband to measure the UV continuum redward of the Lyman α line. In these images objects were located which had an excess in the narrow-band image. Subsequently, they carried out spectroscopy of the brightest of these Lyman α emitting candidates to confirm whether the galaxies have a redshift similar to the radio galaxy. All seven radio galaxies (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 Lyman α emitters. The galaxy overdensities are 5 – 15 and the velocity dispersions are 300 – 1000 km s^{-1}. The structure sizes are $>$ 3 Mpc, exceeding the $7' \times 7'$ FORS field, and the masses are estimated to be $> 10^{14} - 10^{15}$ M$_\odot$, comparable to the mass of present day rich clusters of galaxies.

Wilman (Durham), Jarvis (Oxford), Röttgering and Binette (UNAM, Mexico) presented VLT-UVES echelle spectra of the Lyα emission and absorption in five ra-

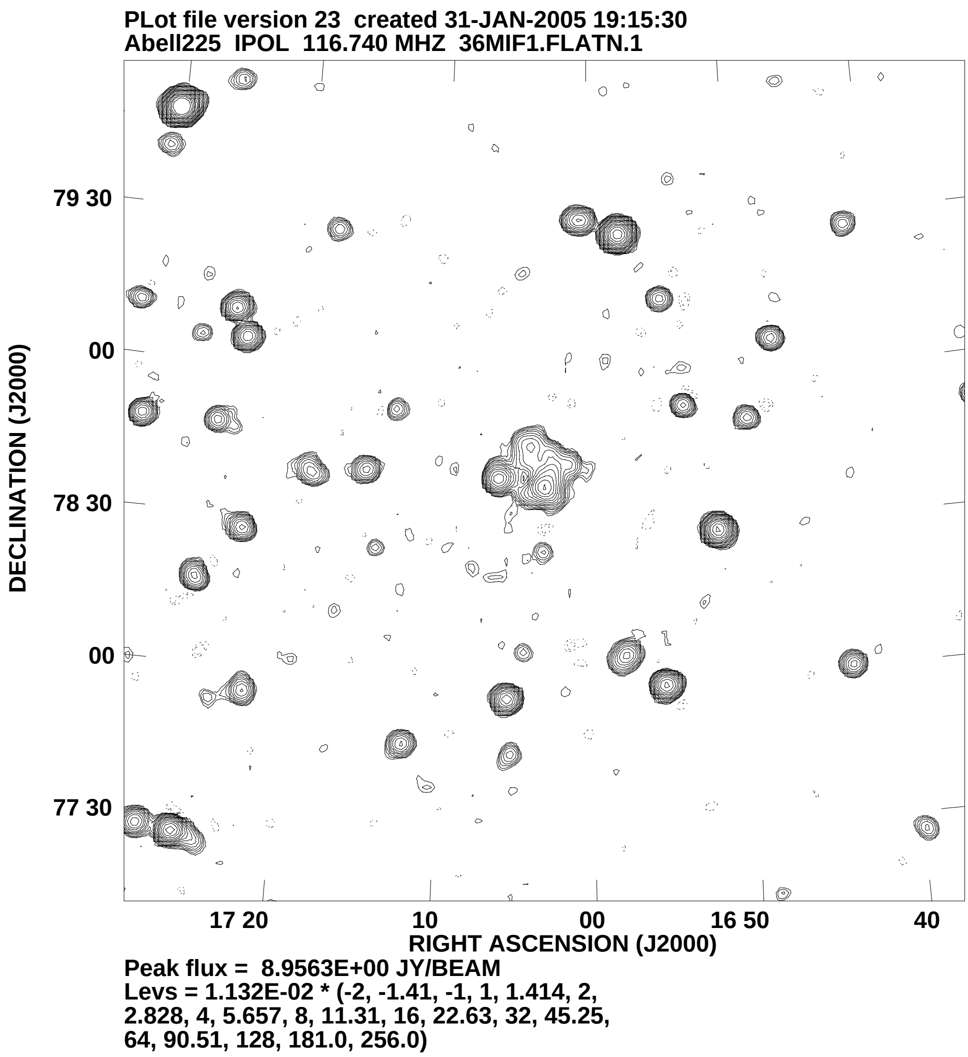

Figure 2.9: A contour presentation of the central part of the A2256 field as observed with WSRT radio telescope using the new Low Frequency Front Ends (120 - 180 MHz). Note that the resolution is only 170 arcsec, a factor 9 less than the proposed GMRT observations will provide.

dio galaxies at redshifts $z = 2.55 \ldots 4.1$. Two groups of HI absorbers are identified: strong absorbers with $N_{HI} = 10^{18} \ldots 10^{20}\,cm^{-2}$ and weaker systems with $N_{HI} = 10^{13} \ldots 10^{15}\,cm^{-2}$. There is none at intermediate N_{HI}. The strong absorbers are suggested to be a byproduct of massive galaxy formation or could instead represent material cooling behind the expanding bow shock of the radio jet. It is argued that the weaker absorbers are part of the Lyα forest, as their rate of incidence is within a factor of 2-4 of that in the intergalactic medium at large. Such column densities are consistent with models of a multiphase proto-intracluster medium at $z > 2$.

Solórzano-Iñarrea (Edinburgh, UK), Best (Edinburgh, UK), Röttgering and Cimatti (Arcetri, Italy) carried out deep spectropolarimetric observations using ESO's Very Large Telescope on two powerful radio galaxies, 0850−206 ($z = 1.3373$) and 1303+091 ($z = 1.4093$). Both their total flux spectra and polarized flux spectra reveal the 2200-Å dust feature, and comparison with dust scattering models suggests that the composition of the dust in these galaxies is similar to that of Galactic dust. In 0850−206, scattered quasar radiation dominates the UV continuum emission, with the nebular continuum accounting for no more than 22 per cent and no requirement for any additional emission component such as emission from young stars. In contrast, in 1303+091, unpolarized radiation could be a major constituent of the UV continuum emission, with starlight accounting for up to 50 per cent and the nebular continuum accounting for 11 per cent.

Cohen (NRL, Washington) Röttgering and Jarvis (Oxford) finished a deep survey with the new 74 MHz system at the VLA radio telescope. High-resolution VLA follow-up observations of the sources with the steepest radio spectrum were carried out and show that these excellent candidates for high-redshift radio galaxies. Subsequent near-infrared K-band imaging using the UKIRT telescope confirmed that a number of highest-redshift ($z > 5$) radio galaxies should be contained in this sample.

2.9.11 Photo-Ionization in the Early Universe

Mellema developed a new algorithm to calculate the transfer of ionizing radiation. This method allows the process to be followed with much larger time steps than before, which makes it ideal to be combined with hydrodynamics and N-body simulations. The method was extensively tested against analytical solutions for the growth of HII regions in various environments.

With this new method the effects of photo-ionization in the early universe are studied, following the growth of (cosmological) HII regions around the first galaxies, as well as zooming in on small dark matter halos and studying their evaporation in these HII regions. This is work done in collaboration with Ilian Iliev (CITA) and Paul Shapiro (U Texas, Austin).

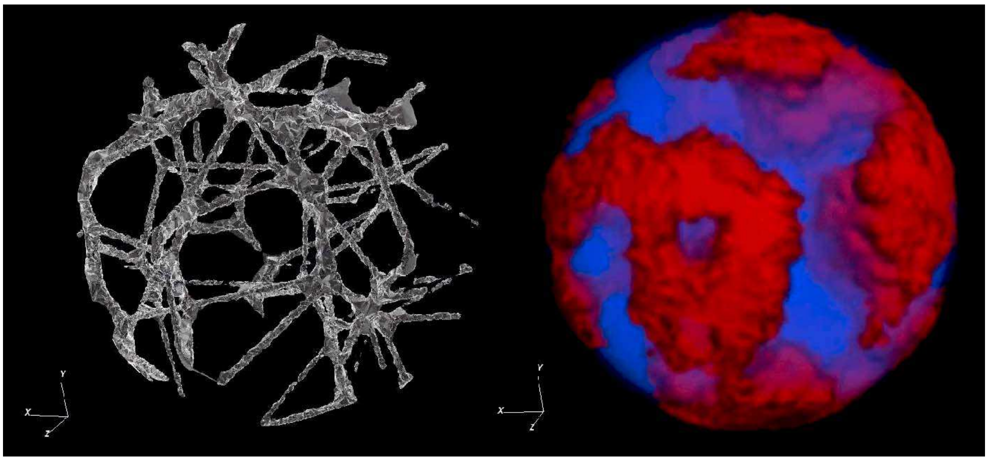

Figure 2.10: Left: Visualization of the filamentary distribution of first stars, which represent the large scale structure of the Universe. Right: Volume rendering of the Universe, when it is halfway through the EOR. The blue (transparent) regions have already been ionized, whilst the red (opaque) regions are still neutral.

2.9.12 The Epoch of Reionization

Ritzerveld and Icke used their new, radically different, radiative transfer method to do simulations on the reionization of the large scale structure of the Universe, during the Epoch of Reionization (EOR).

When the first sources of light form, the density distribution through which the photons propagate has become highly inhomogeneous, just as the distribution of first stars itself.

Thus, numerical modeling of this epoch is of high complexity, given that the geometry of the medium and the source function are inhomogeneous.

Thus far, this has posed a great difficulty for the cosmological radiative transfer community, because most available methods scale with the number of sources, and simulating an inhomogeneous source function would be an enormous computational task. Our radiative transfer method, SimpleX, does not scale with the number of sources, and, as such, was ideal to do unprecedented EOR simulations on a simple desktop computer. Results of these simulations are shown in Fig. 2.10.

2.9.13 Weak Lensing

Kuijken took part in the “Shear Testing Programme” (STEP), which is a large blind experiment in which various gravitational lensing shear pipelines are compared on an extensive set of simulated data. It appears that current techniques are at the level where shears can be believed to the level of a few percent. Kuijken's contribution was a pipeline based entirely on the "shapelets" formalism, en efficient image compression technique developed by Refregier et al. The formalism will be incorporated into the OmegaCAM data flow system.

2.10 Raymond & Beverly Sackler Laboratory for Astrophysics

2.10.1 LIRTRAP

LIRTRAP consists of a low-temperature 22-pole ion trap designed to determine rate coefficients for gas phase ion-molecule reactions under interstellar conditions and to measure infrared spectra of astrophysically interesting ions. In winter 2004, a successful measurement campaign was conducted using the free electron laser FELIX at FOM Rijnhuizen. Schlemmer and Asvany applied the method of laser induced reactions (LIR) to obtain (far-)infrared spectra of the ions $C_2H_2^+$ and CH_5^+. In both cases, important vibrational features have been detected for the first time and two publications are being finalized.

$C_2H_2^+$ is also of interest to theoretical chemists, due to the fact that it is the only tetra-atomic molecule exhibiting the Renner-Teller effect in the ground state. There has been much confusion in the literature about the bending vibrations of $C_2H_2^+$. With the LIR method, the infrared active cis-bending vibration could be detected for the first time with spectroscopic accuracy, and is found to be located at 710 cm^{-1}. The magnitude of the Renner-Teller-splitting has been determined through simulations in collaboration with Giesen (Köln).

Similarly, CH_5^+ is interesting because it is the prototype of a floppy molecule with very extended absorption features as shown in Fig. 2.11. A collaboration with Marx (Bochum) helped to decipher the spectral fingerprints of CH_5^+. CH_5^+ is considered to consist of a CH_3 tripod, to which a H_2 moiety is attached, with the intense feature at 3000 cm^{-1} due to the C-H-stretching motion involving H atoms from the tripod, and the weaker wings extending down to 2500 cm^{-1} to stretching involving the H_2 moiety. The broad feature at 1200 cm^{-1} is due to H-C-H-bending.

In preparation of future LIR-experiments, LIRTRAP has been improved in various aspects. A new temperature control system based on silicon diode temperature sensors has been installed. This system enables to measure the temperature of an ion-molecule reaction down to 10 K with improved accuracy. Furthermore, a new gas-inlet system using exclusively ultra-high vacuum components has been manufactured and installed with help of Bennning (FMD). Hugo joined the LIRTRAP

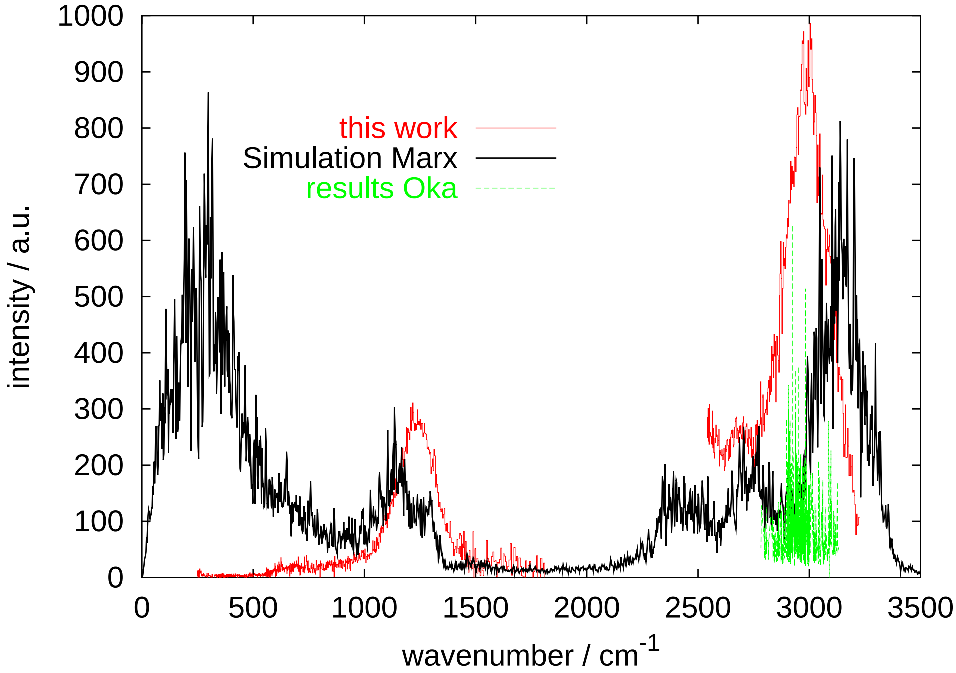

Figure 2.11: Spectrum of CH_5^+ obtained with LIRTRAP using the free-electron laser FELIX at FOM Rijnhuizen by Asvany & Schlemmer. The measured absorption features (red/grey) are compared to a theoretical spectrum obtained from ab initio molecular dynamics calculations by Marx (black) and high-resolution spectra measured previously in the C-H-stretching region by Oka (Chicago).

project as an AIO in fall 2004 on a project to study the H_3^+ deuteration reactions. Initial simulations of this important system have been performed.

2.10.2 SURFRESIDE

Bisschop, Schlemmer and Fraser continued installation and testing of the atomic line delivered last year by Oxford Scientific for SURFRESIDE, the Surface Reaction Simulation Device. The atomic line is designed to provide a low flux of atoms and radicals to examine solid state atom-molecule reactions at low temperatures and pressures to study grain surface reactions. Significant adaptations were made to the original experiment to accommodate the discharge source and its peripheries, and basic operation of the beam source was achieved, although not at the level expected from the specifications. Further tests are ongoing. In parallel, Fuchs, Fraser and Schlemmer investigated a second hydrogen-only source, which will be added to SURFRESIDE in 2005.

2.10.3 CRYOPAD

Van Broekhuizen, Schlemmer and Fraser, together with de Kuiper, Benning (both FMD), finished construction of the CRYOgenic Photo-product Analysis Device, CRYOPAD, designed to study solid-state processes under hot-core conditions. Together with Öberg (visiting student Caltech) and Bisschop, they have studied CO-N_2 ices using Temperature Programmed Desorption (TPD) and Reflection Absorption Infrared Spectroscopy (RAIRS) with a view to understanding the differential gas-phase chemistry of CO and N_2 observed in dense pre-stellar cores: generally in regions where CO is depleted, N_2H^+ (as tracer of N_2) is prevalent, primarily because the key mechanisms for destroying this ion all involve CO. To reproduce the observed abundances and chemistry of these cores, astrochemical models assume that CO and N_2 have significantly different binding energies on interstellar ice, with the ratio between the two binding energies typically taken to be $\sim$0.65. The CRYOPAD results, published in an ApJ Letter, clearly show that N_2 does desorb prior to CO in pure ice samples, but that the ratio between the binding energies is only 0.9–1, depending whether pure, mixed or layered samples are studied. Between 50 and 100% of the initial N_2 in the ice can actually remain trapped on the surface, mixed with the CO molecules, until the CO itself desorbs. Thus, the new results make it more difficult to explain the observed anti-correlation between CO and N_2H^+ in cold pre-stellar cores.

2.10.4 Spectroscopy of CO-CO_2 Ices

Groot (student LIC), together with van Broekhuizen, Fraser and Schlemmer, used the high-vacuum set-up to study the spectroscopic characteristics of CO and CO_2 in mixed and layered ice configurations. In addition, the thermal desorption of CO was studied for both ice systems. These experiments are triggered by VLT/Keck infrared spectra of solid CO at 4.67 μm and Spitzer data of solid CO_2 at 15 μm, which show indications of CO-CO_2 mixtures in space. This study also served as a preparation for upcoming research to be performed on CRYOPAD. There are two possible scenarios for CO and CO_2 ice to co-exist: either CO condenses from the gas phase prior, or subsequent to, CO_2 surface chemical formation, or CO and CO_2 are produced from chemical reactions induced in the ice mantle by irradiative processes. The experiments show that both the spectroscopy and the thermal behavior of CO and CO_2 in mixed and layered ices are significantly different.

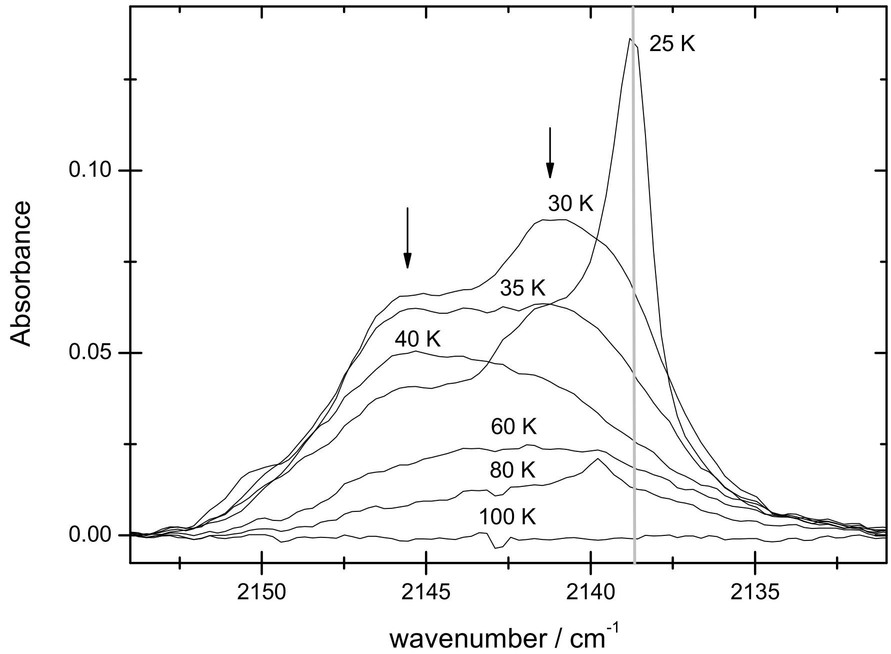

Figure 2.12: The thermal evolution of the CO-stretching vibration at 4.6 μm in a 10/1 CO_2/CO layered ice system, from 25–100 K. The grey vertical line marks the peak center position of the main feature of pure CO ice. The two arrows indicate the two shoulders that evolve as the temperature increases. These shoulders may explain the blue wing seen in astronomical solid CO spectra (van Broekhuizen et al.).

2.10.5 The Mystery of the Missing 2152 cm^{-1} CO band

Fraser, together with Collings, Dever and McCoustra (Nottingham) used laboratory data on the CO-H_2O ice system to explain why a 2152 cm^{-1} band is never observed in astronomical spectra of CO-ice. The 2152 cm^{-1} band has been proven by theoretical and laboratory studies to be related to CO molecules bound at dangling OH sites at the surface of an amorphous or crystalline H_2O ice surface. The fact such bands are missing in space is a key clue to astrochemistry and the location of CO in interstellar ices, as well as the structure of interstellar ice. Careful analysis of laboratory data shows that the water ice must still be porous and amorphous, but that prior to the freeze-out of CO the dangling bond sites must be already occupied – by some molecule which forms stronger hydrogen bonds than CO. Such species could be CO_2, NH_2 or CH_3OH.

2.10.6 Adsorption on Cl- and Br-Containing Species on H_2O Ice

Fraser, together with Greca, Backus, Bonn and Kleyn (all LIC) and Pradeep (Indian Institute of Technology) studied the effects of adsorbing $CHBr_3$ and $CHCl_3$ onto crystalline and amorphous H_2O ice. Temperature programmed desorption (TPD) studies of the ice-adsorbate systems show that the binding sites for the two molecules are similar on the same ice phases, although their mobilities differ significantly. $CHCl_3$ was found to be more tightly bound to the crystalline ice than the amorphous ice surface, but was immobile on both surfaces even up to its desorption temperature of 140 K. Conversely $CHBr_3$ was mobile on both the crystalline and amorphous ice surfaces, and counter to intuition (as it is the larger molecule) typically traversed the ice layer and preferentially bound directly to the substrate, from which it later desorbed. Such mobility was even observed at temperatures as low as 85 K. The anomalous reactivity of Br-containing species in ice-chemistry in the atmosphere may well be related to such diffusion effects.

2.10.7 Molecular Dynamics Simulations of H_2O Ice Photodissociation

Andersson, in discussions with Kroes (LIC) and van Dishoeck, finished the development of a set of programs to calculate the photodissociation dynamics of a water molecule in an ice layer at 10 K using classical molecular dynamics. As a first application, crystalline ice has been studied. Photodissociation in the first bilayer leads mainly to H atoms desorbing (65%), while in the third bilayer trapping of H and OH dominates. The H atoms move on average 11 Å in the ice before becoming trapped, while the OH radicals move typically 2 Å. Thus, in interstellar space these radicals will be available for further reactions in the ice with other species. The results will be published in Chem. Phys. Lett. The next step is to do a similar study for amorphous ice.

2.11 Instrumentation

2.11.1 Optical / Infrared Interferometry

NEVEC and OPTICON

The NOVA-ESO VLTI Expertise Center (NEVEC) is a national center partially funded by NOVA as a joint venture with ESO. It provides support for users of ESO's VLTI, and fulfils some specific tasks related to the technical development and calibration of the VLTI facility. Within the framework of NEVEC, Albrecht calibrated and installed a set of humidity sensors for the VLTI. These sensors will help the PRIMA instrument meet its requirements for the astrometric planet search program. The sensors will allow monitoring of atmospheric dispersion effects for the MIDI and GENIE instruments.

Quirrenbach and Bakker coordinated the European Interferometry Network, which is supported by the 6^{th} Framework Program of the European Union through OPTICON. The Interferometry Network sponsors an international exchange program, which is now called the Fizeau program. The Network organizes workshops aimed at bringing together instrument specialists and astronomers interested in using interferometry for their research; it has also embarked on defining a scientific strategy and technological roadmap for a large next-generation interferometric facility.

MIDI

The MIDI instrument, which was constructed by a consortium led by MPIA Heidelberg with a large contribution from Leiden, is now operating routinely at Cerro Paranal. The instrument team was still involved in several commissioning runs, and has provided support for improvements of the operational software.

Jeroen de Jong developed for MIDI several observation templates to use new instrument modes and to improve the acquisition of the sources (mosaic acquisition). Observation templates specify how users should prepare their observations with the Phase 2 Proposal Preparation tool (P2PP). MIDI now supports all major instrument modes for general users.

In addition Jaffe participated in a number of MIDI projects with other members of the MIDI team. Most importantly these included reducing and interpreting data on the protoplanetary disks in Herbig Be stars and in supermassive stars like η Car.

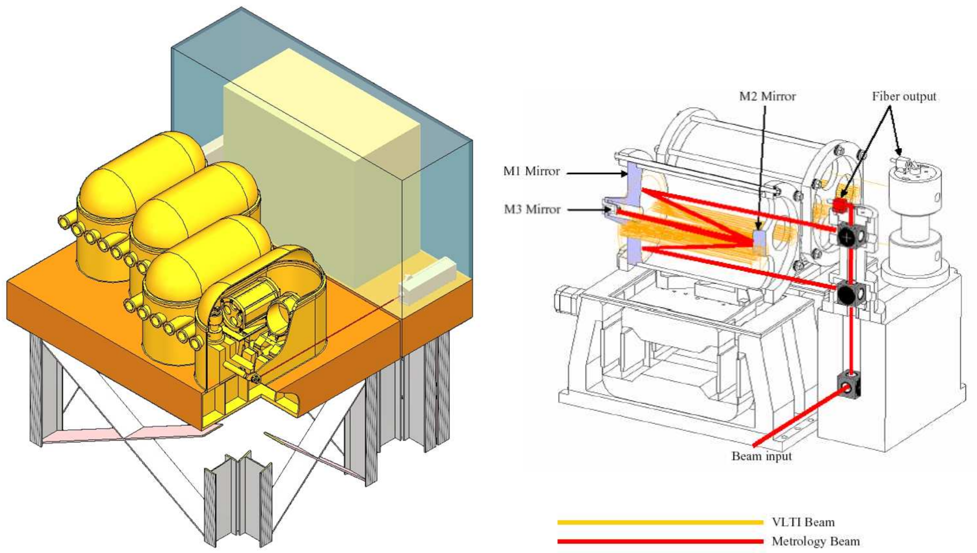

Figure 2.13: Preliminary design of the Differential Delay Lines for PRIMA at the VLTI.

PRIMA

The PRIMA (Phase-Referenced Imaging and Microarcsecond Astrometry) facility will implement dual-beam interferometry at the European Southern Observatory's Very Large Telescope Interferometer. The purpose of PRIMA is threefold:

1. Provide on-axis and off-axis (within the isoplanatic angle) fringe tracking for all VLTI instruments;

2. Conduct precise differential astrometry between stars separated by a few tens of arcseconds;

3. Perform phase-referenced imaging of faint sources with off-axis fringe tracking.

The PRIMA hardware consists of four major sub-systems:

1. Star separator systems (sometimes also called "Dual star modules") that accept the light from two stars within a $2'$ field and transfer it to the two input ports of the long-stroke delay lines;

2. Differential delay lines (DDLs) that compensate the delay difference of up to a few cm between the two stars;

3. Dedicated fringe detection units for the two stars;

4. An end-to-end metrology system that will monitor the internal differential delay with high precision.

The first, third, and fourth items from this list are being produced by various suppliers under contracts with ESO. A consortium consisting of Observatoire de Genéve, MPIA Heidelberg, and Leiden Observatory / NOVA is producing the differential delay lines, with support from several additional institutions, including ASTRON. The Consortium also works together with ESO on the analysis of the astrometric error budget and on the development of the observing strategy, and will deliver software tools required to reduce astrometric data. The scientific goal of the consortium is the use of PRIMA for measurements of the masses and orbital inclinations of extrasolar planets.

The Consortium will deliver two pairs of differential delay lines, as required for the operation of a single-baseline dual-star interferometer. The overall design of the mechanical part of the DDL is shown in Fig. 2.13. A monolithic cat's eye structure is mounted on top of translation stages that can move the cat's eye mirrors in the longitudinal direction over a distance of 70 mm. Parallel beam sliders with blade spring hinges ensure that a very high accuracy in the lateral directions is maintained. A two-actuator system is chosen; one to provide a long stroke, requiring a very accurate translation mechanism, and one actuator for the high frequency response over small displacements. The whole system is mounted in a vacuum system to have the differential OPD independent of environmental changes in refraction properties of the air. Each pair of delay lines will have a separate vacuum vessel ($l \times w \times h = 1000\,\mathrm{mm} \times 480\,\mathrm{mm} \times 500\,\mathrm{mm}$). A metrology system, based on a He-Ne laser (632 nm), measures the position of the translation stage via the same cat's eye, but along different paths to avoid interfering signals. The resolution of the metrology system is 1 nm. A local control electronics system is responsible for the control of the DDL; it also provides the interface between the DDL and the PRIMA control system.

The Leiden PRIMA team (Quirrenbach, Jaffe, Bakker, de Jong, Köhler, le Poole, Mathar, Reffert, Tubbs) has started to design the PRIMA Astrometry Data Reduction Software. This design includes a Data Analysis Facility, which is a new concept for ESO instruments, as it must allow for the analysis of the entire astrometric data set in order to support the identification of all error sources. As a first step a PRIMA astrometric simulator has been produced. Intensive efforts have been devoted to an analysis of the PRIMA error budget, and to the definition of the observing and instrument calibration strategy. A preliminary target list has been compiled, and first observations have been conducted at La Silla to characterize possible astrometric reference stars.

UVES-I

In the framework of studies for second-generation VLTI instruments, Albrecht and Quirrenbach developed a concept for interferometric spectroscopy, based on the idea of linking the VLTI with fibers to the UVES spectrograph. This "UVES-I" concept is based on the realization that once the fringes have been stabilized with a fringe tracking unit (such as the PRIMA FSU), only a small piece of hardware is needed to combine the beams and to feed the four fringe quadratures into optical fibers. By taking advantage of the investment that has already been made into UVES, one could thus provide a completely new observational capability, which would support a science case that covers the detailed study of Cepheid pulsations, studies of the atmospheres of late-type stars, generalized Doppler imaging, and many other applications to stellar astrophysics.

As a first step to demonstrate the feasibility of UVES-I, Albrecht set up a prototype interferometric beam combiner in the new optical laboratory, obtaining first fringes in December.

GENIE

Quirrenbach and Reffert participated in a design study for GENIE, a proposed nulling instrument for the VLTI, which would demonstrate some crucial technologies needed for ESA's Darwin mission. The study was led by Astrium Germany; the tasks of the Leiden interferometry group were mainly in the areas of the instrument calibration strategy and the selection of suitable astronomical calibrators.

ELSA

Looking further into the future, Quirrenbach developed a strawman concept for a next-generation optical interferometer, dubbed ELSA (Extremely Large Synthesis Array). With 27 ten-meter telescopes and baseline lengths up to 10 km, ELSA would provide completely new insight into many astrophysics phenomena. It could be used to obtain resolved images of nearby brown dwarfs which would reveal weather phenomena in their atmospheres, to give detailed pictures of stellar surfaces, interacting binaries, and circumstellar material, to study general-relativistic effects on the orbits of stars near the center of our Galaxy, to obtain "movies" of expanding supernovae, to image the broad-line regions of active galaxies, and to measure the geometry of the fireballs producing the afterglow of gamma-ray bursts.

Observations of faint objects will be possible by using an external reference star (within the isoplanatic angle) to co-phase the array. Telescopes with large diameters are essential to provide good sky coverage in this observing mode. The use of optical fibers for beam transport and delay compensation is highly desirable, as this eliminates the need for an expensive beam train with meter-sized optical elements, and a very large vacuum system. The most challenging aspect of fiber-coupled interferometry is dispersion in the fibers, which has to be eliminated or compensated precisely. Advances in telescope technology and fiber optics expected for the next decade may bring the cost of a facility similar to the ELSA concept into a range that would be affordable as an international project.

2.11.2 First Light of SINFONI

In July 2004, first light was obtained with SINFONI on the ESO Very Large Telescope. SINFONI (Spectrograph for INtegral Field Observations in the Near-Infrared) is a collaboration between the European Southern Observatory (ESO), the Max-Planck-Institut für Extraterrestrische Physik (MPE) and the Nederlandse Onderzoekschool Voor Astronomie (NOVA). SINFONI combines a cryogenic near-infrared (J,H and K-bands) integral field (image slicer) spectrograph ($R \sim 3000$) with an adaptive optics unit. A laser guide star facility will enable nearly diffraction-limited imaging over the whole sky. A seeing-limited mode is also available. Principal Investigator of the NOVA components for SINFONI is Van der Werf.

The SINFONI project obtained a major success with the first light of SINFONI on July 9 on VLT UT4 (Yepun). This was followed by an extremely smooth commissioning run, which was so successful that it was decided to offer SINFONI for proposals by the community at large as of April 2005. This success was the reward for several years of hard work by the entire SINFONI team (which in Leiden includes Van der Werf, Brown, De Zeeuw, Franx, Katgert, Bakker, and Van Starkenburg). A sample data set from the commissioning run is shown in Fig. 2.14.

2.11.3 Adaptive Optics Instrumentation Development

McDermid and the OASIS-NAOMI instrument team at the William Herschel Telescope (WHT), La Palma, completed science verification of the OASIS optical integral-field spectrograph, working in combination with the NAOMI adaptive optics (AO) system. Results included a factor of two improvement on natural seeing as far blue as the V and R band, giving an effective point spread function (PSF) FWHM width of 0.25 and 0.2 arcseconds respectively, while guiding on a 10^{th} magnitude stellar source.

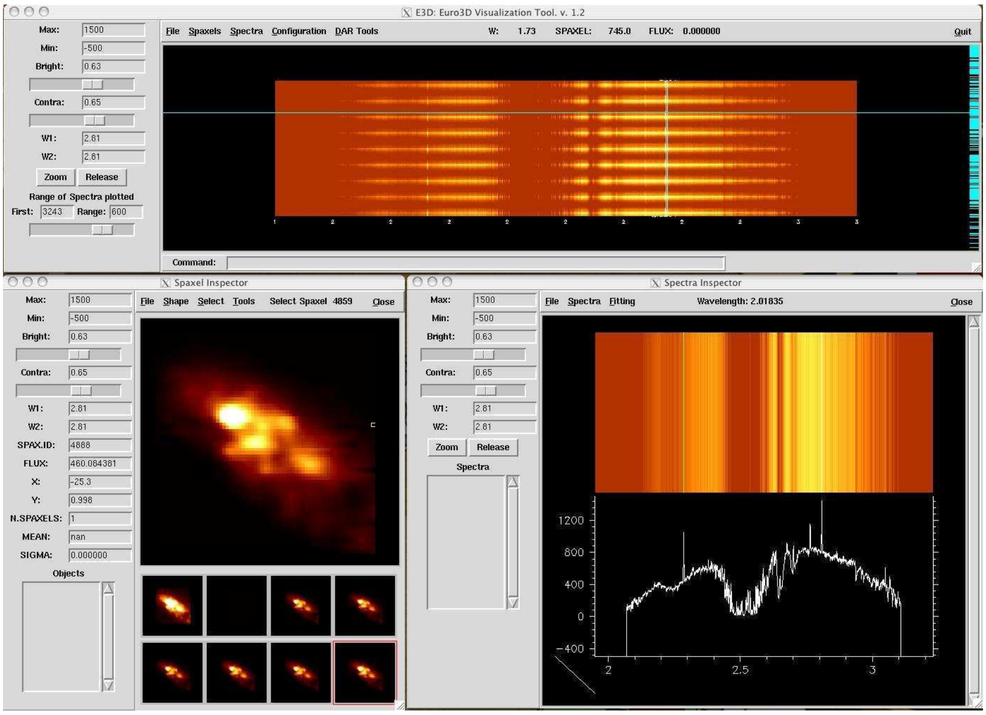

Figure 2.14: Screenshot of the SINFONI data of the starburst galaxy NGC 253 (one of the Science Verification projects) loaded in the Euro3D analysis tool.

After a rigorous remodeling of the central area of the fifth floor of the Huygens building, a new High Resolution Astronomy Laboratory has been established here (Stuik, Brandl, Quirrenbach). "First light" on the first experiment was achieved by Stuik on the 20^{th} of October. The laboratory consists of a large working area, a temperature controlled clean experimental area and a closed-off area for delicate mounting of equipment. The instrumentation group now has three optical benches for experiments in the area of, among others, Adaptive Optics (AO), Interferometry and IR spectroscopy. General lab equipment and arrived by the end of the year and both an Interferometry and Adaptive Optics setup are being built by Albrecht and Stuik, respectively.

The instrumentation group is still involved in three AO instrumentation projects. MUSE, a 2^{nd} generation instrument for the VLT featuring an AO assisted Integral Field Spectrograph (IFS), successfully passed the Study Phase Review and now continues into the Design Phase. Stuik, Flicker, Brandl and Quirrenbach contributed to the Adaptive Optics system design and simulations and will remain active in the AO and the interfaces between the Adaptive Optics module and the IFS. In anticipation of the likely installation of an adaptive secondary mirror at one of the VLT telescopes, the pupil relay has been removed from the baseline configuration of the MUSE AO system. Work on this new AO concept (called GALACSI), and on a test facility for the adaptive secondary (called ASSIST), was conducted by the Leiden AO group in close consultation with ESO.

Stuik and Flicker were also active in the design and performance studies of the AO system of another 2nd generation VLT instrument, CHEOPS. CHEOPS is a planet finder, aimed at the direct detection of Jupiter-like planets around nearby stars. In our concept, this is achieved by an AO assisted coronograph, fitted with both a polarimeter and IFS, Both are used in differential imaging mode to optimally enhance the Signal-to-Noise ratio. Two competing consortia have delivered their Concept Study to ESO in December 2004 and ESO is expected to make a choice between the two concepts early 2005.

The third AO instrument project is GLAS, the Ground-Layer Adaptive Optics System for the WHT. This largely NWO funded, project aims at increasing the sky coverage of the current NAOMI AO system to almost 100Rayleigh guide star system. Stuik was working on simulations of the sky coverage and general instrument concept. The documentation of the study phase of GLAS was submitted to a review board in December, with the Review meeting in January 2005.

As external project scientist, McDermid assisted in submitting the preliminary design review for the GLAS Rayleigh laser adaptive optics system at the WHT. This project will install a laser guide star system at the WHT by mid-2006, to be used in conjunction with a modified NAOMI AO system, and will increase sky coverage for obtaining a full AO-corrected PSF from a few percent to over ninety percent.

2.11.4 OmegaCAM

The wide-field imager for the VST, OmegaCAM (built by a consortium of German, Italian and Dutch institutes as well as ESO, and for which Kuijken is PI) was delivered to ESO Garching at the end of 2004, ready for integration with the detector system built at ESO. It should enter service on Paranal around the end of 2005.

In preparation for start of operations, a large survey (the Kilo-Degree Survey, KIDS) has been planned. One of its main aims will be to study the distribution of dark halos around galaxies through the gravitational lensing effect.

2.11.5 Radio Projects

ALMA

The Atacama Large Millimeter Array (ALMA) is a collaboration between Europe and North America (with participation by Japan), to build an interferometer consisting of up to sixty-four 12 m antennas located at the Chajnantor site at 5000 m altitude in Chile. Each antenna will be equipped with cryogenic heterodyne receivers covering the 30–950 GHz (0.3–7 mm) frequency range. With baselines up to 14 km, ALMA will have unprecedented spatial resolution at (sub)millimeter wavelengths down to 10 milli-arcsec at the highest frequencies. The combination of ALMA's large collecting area, the quantum-limited sensitivities of the receivers and the excellent site guarantee major steps forward compared with existing facilities.

Van Dishoeck has a significant role in the planning of ALMA as chair/ member of the European and worldwide ALMA Scientific Advisory Committees, and the European ALMA Board. As (former) European Project Scientist, she was responsible for developing the ALMA Design Reference Science Plan (see `http://www.strw.leidenuniv.nl/~alma`). Hogerheijde is a member of the ALMA Science IPT.

On the technical side, a Dutch consortium consisting of NOVA, RuG, SRON and TU Delft, are developing the 600–720 GHz receivers for the highest frequency band, Band 9, of the baseline ALMA project. The group is led by Jackson (SRON/RuG) with van Dishoeck and de Graauw members of the steering committee. In 2004, significant progress was made in the design of the Band 9 cartridge, the production of prototypes of critical components, and the development of test equipment. The mixers developed for ALMA by Baryshev (SRON/RuG) are also used in the CHAMP+ heterodyne array receiver (Boland, PI; Hogerheijde, NL project scientist) for use on the APEX telescope in a joint project with MPIfR (Bonn).

Hogerheijde and van Dishoeck developed plans for a Dutch node of the ALMA Regional Support Center. In response to a call for statements of interests by ESO, a document was prepared by a working group consisting of representatives of NOVA, ASTRON, JIVE, JCMT, and SRON, led by Hogerheijde. Three areas for focus of the Dutch activities were identified: high-frequency projects (especially as related to Band 9), high dynamic-range and wide-field imaging, and access to science analysis tools.

LOFAR

LOFAR is a new low frequency array that is currently being built in the Netherlands and expected to be operational in 2008. With 50 stations spread over an area of 100 km in diameter, its resolution and sensitivity will be unprecedented in the frequency range 10-200 MHz.

During 2004, the LOFAR project has been progressing at a significant pace. LOFAR's organizational structure has been set up, significant technical work has been carried out, detailed work on overall planning and budgets have been performed, and significant progress can be reported in several critical areas, including those related to understanding the radio frequency interference and calibration. ASTRON is leading the technical work and Röttgering and Miley are involved in defining the scientific capabilities of the instrument.

The design of LOFAR has been driven by four fundamental astrophysical applications that fit excellently with the expertise and scientific interests of the four participating Dutch university astronomy groups. These drivers are:

- The Epoch of Reionization (EOR);
- Extragalactic Surveys and their exploitation to study the formation and evolution of clusters, galaxies and black holes (SURVEYS);
- Transient Sources and their association with high energy objects such as gamma ray bursts (TRANSIENTS);
- Cosmic Ray showers and their exploitation to study the origin of ultra-high energy cosmic rays (CR).

An extensive plan for project "the Development & Commissioning of LOFAR for Astronomy (DCLA)" was developed (PI Röttgering). This project consists of the development of essential capabilities to each of the 4 key projects in astronomy to be carried out and commissioning tasks to optimize LOFAR for these fundamental astronomical applications.

An important highlighted was the production of a beautiful all sky map with data from the LOFAR initial test station, located in de municipality Borgen-Odoorn. Salter, Paardekooper and Röttgering have been taking data with this facility to obtain deep low frequency radio maps with the aim of characterizing the antenna beams and obtaining a spectral index map of the galaxy.

2.11.6 Space Projects

ISO Infrared Astronomical Spectroscopic Database (IASD)

Jourdain de Muizon, with support from the ISO team (Vilspa, Spain) and from Castets (Bordeaux, France), is working on the constitution of a database of all published ISO spectroscopic results. The output product is basically a big table in which each ISO observed and published spectral line or feature is described in a line of the table giving most of its possible observation and spectroscopic parameters. It will eventually be either a side product of the ISO Archive or included in it, in any case available on Internet and also connected to Simbad. Given that Spitzer does not have any spectroscopic instrument which resolution can compete with ISO-SWS and ISO-LWS, she aims at having IASD ready in time to help preparing observations with Herschel. The database currently contains about 3000 line entries.

Preparation for Herschel / HIFI

In the framework of a workshop at the Lorentz Center (March 22–24) Hogerheijde and van der Tak (MPIfR, Bonn) investigated the computational problem of the excitation of the water molecule using their Accelerated Monte Carlo technique. The excitation of water is closely coupled to the dust thermal radiation field, but also reaches large optical depths and populations inversions easily. These factors complicate accurate line-strength predictions, which are required to interpret future observations with the HIFI spectrograph on the Herschel Space Observatory (launch 2007). Key factors to reach reliable results are strict convergence control and accurate implementation of the velocity field of the emitting gas.

GAIA Technical Preparation

Together with the photometry working group Brown worked on the optimization of the broad and medium band photometric systems for the Gaia mission. The proposed photometric systems were evaluated for their performance with respect to the astrophysical parameterization of stars (determining $T_{\rm eff}$, $\log g$, A_V, [Fe/H], and [α/Fe]). This was done by calculating for each photometric system a figure of merit which is based on the expected parameterization errors which are calculated from a noise model of the instrument and the gradients of the filter fluxes with respect to changes in the stellar parameters. Brown wrote the corresponding software which was integrated into the Gaia photometry simulator at the University of Barcelona. The figure of merit was calculated for a set of stellar types (spanning the entire Hertzsprung-Russell diagram) thought to be the most important for addressing the Gaia science case. The photometric system for Gaia was subsequently optimized by varying the width and position of the photometric bands and evaluating the impact on the performance with respect to astrophysical parameterization.

In addition to characterizing the parameterization performance of a photometric system it is also important to understand the global degeneracies. This refers to the problem of distinguishing (for example) reddened hot stars from unreddened cool stars. Brown studied this problem for the proposed photometric systems by employing self-organizing maps as a means for identifying the natural clusterings of stellar types in the space of measured filter fluxes. The results showed that in terms of the global degeneracies the proposed photometric systems were very similar.

The result of these efforts was a recommendation for a baseline photometric system for the Gaia mission consisting of 5 broad bands and 14 bands of intermediate width. The locations of the filter bands for both photometric systems are shown in Fig. 2.15. This recommendation was adopted by the Gaia science team in December 2004.

Detection of Satellite Remnants in the Galactic Halo with Gaia

Brown, Velázquez (Ensenada) and Aguilar (Ensenada) studied the problem of identifying remnants of satellite galaxies in the halo of the Milky Way galaxy with Gaia data. The remnants have to be extracted from a very large data set (of order 10^9 stars) in the presence of observational errors and against a background population of Galactic stars. This issue was addressed through numerical simulations.

A Monte Carlo simulation of the Gaia catalogue was generated with a realistic number of entries. The model of the Galaxy includes separate light distributions and kinematics for the bulge, disk and stellar halo components. For practical reasons the region within Galactic coordinates: $-90° \leq \ell \leq 90°$ and $-5° \leq b \leq 5°$ was excluded. Nevertheless, the synthetic catalogue contains 3.5×10^8 stars. Tree code 10^6–body simulations were performed of satellite dwarf galaxies in orbit around a rigid mass model of the Galaxy. The simulations were followed for 10^{10} years. The resulting shrinking satellite cores and tidal tails were then added to the Monte Carlo simulation of the Gaia catalogue. Care was taken to include the complication that the luminosity function of the satellite is probed at various depths as a function of position along the tidal tails.

The feasibility was explored of detecting tidal streams in the halo using the energy vs. angular momentum plane. As illustrated in Fig. 2.16 a straightforward search in this plane will be very challenging. The combination of the background population and the observational errors will make it difficult to detect tidal streams as discrete structures in the E-L_z plane. In addition the propagation of observational errors leads to apparent caustic structures in the integrals of motion space that may be mistaken for physical entities. Any practical search strategy will have to use a combination of pre-selection of high-quality data and complementary searches using the photometric data that will be provided by Gaia.

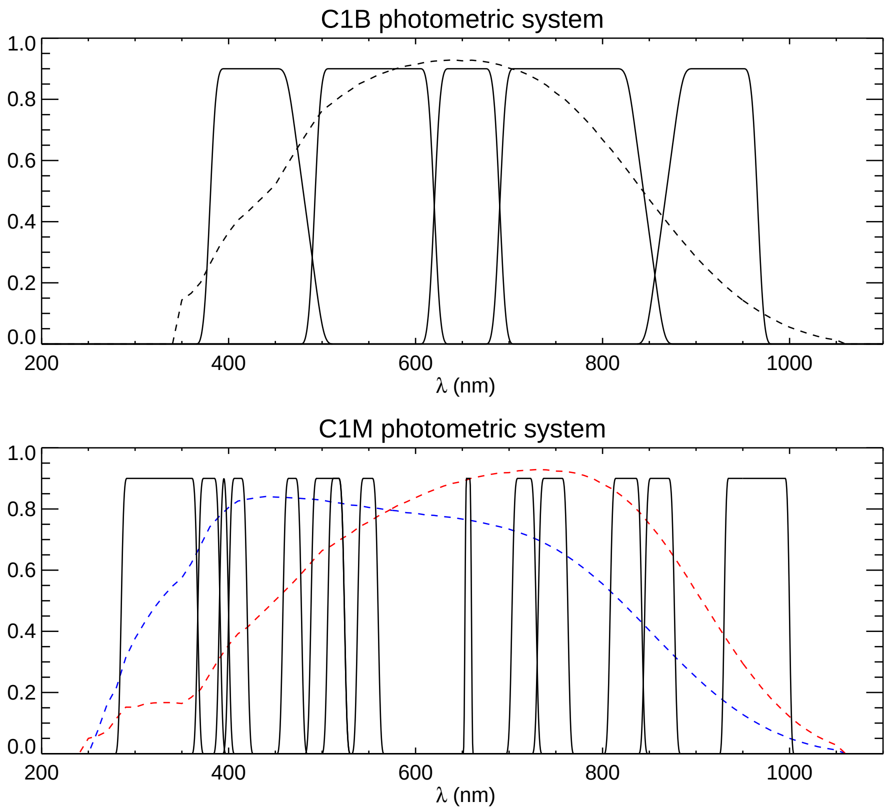

Figure 2.15: The baseline photometric systems for the Gaia mission. The top panel shows the transmission curves for the broad band systems and the bottom panel shows the same for the medium band system. The dashed lines are the CCD quantum efficiency curves, where for the medium band system blue and red-enhanced CCDs are used.

GAIA Conference

De Zeeuw summarized the conference *The Three-Dimensional Universe with GAIA*, which was attended by over 250 astronomers working on, and preparing for, the GAIA space mission. It will be launched in 2011 or 2012, and will provide a stereoscopic census of the Milky Way with mind-boggling astrometric accuracy. The resulting paper briefly summarizes the science goals, and considers GAIA's unique contributions to astrophysics in the period 2015–2020.

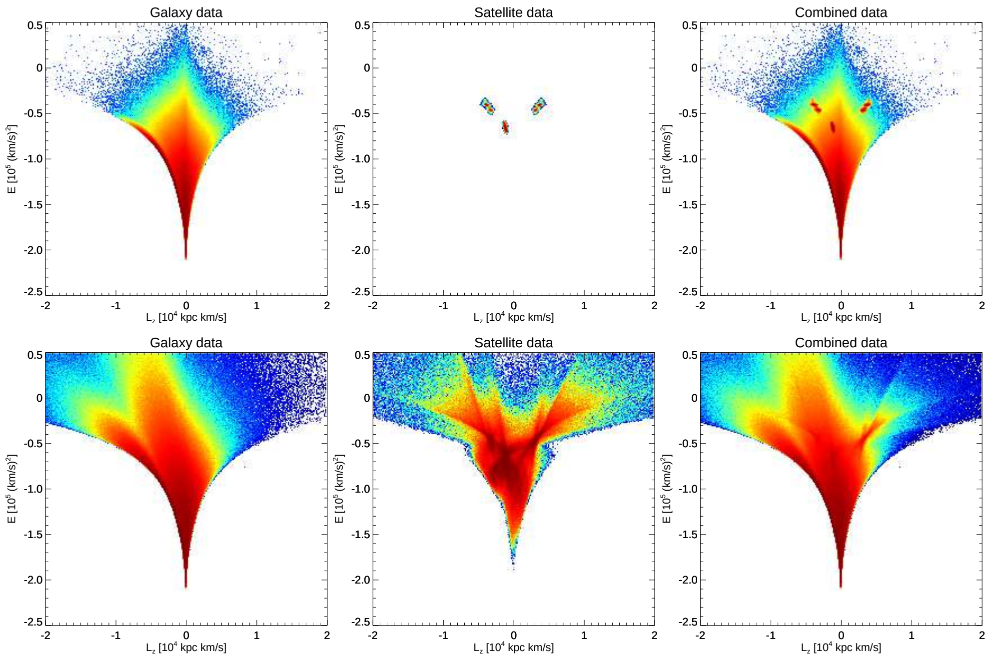

Figure 2.16: E-L_z space as obtained from the synthetic Gaia catalogue, including the Monte Carlo model of the Milky Way and three disrupted N-body satellites. The upper panels show the error-free E-L_z diagrams (from left to right: Galaxy stars only, satellite stars only, and Galaxy and satellite stars combined, respectively). The bottom panels show E-L_z space after the expected Gaia observational errors have been added.

JWST-MIRI

The Mid-Infrared Instrument (MIRI) is a combined imager / integral field spectrometer covering 5–28 μm on board the ~6m James Webb Space Telescope (JWST), the successor of HST to be launched around 2013. MIRI is designed and built by a joint US/European consortium, led by the UK. The Netherlands, led by NOVA (PI: van Dishoeck, deputy-PI: Brandl) with ASTRON and TPD as subcontractors, is responsible for the camera and dispersion optics of the spectrometer. With its unprecedented sensitivity and spatial resolution, MIRI will provide a huge discovery space and will have tremendous power for studying the mid-infrared sky. Scientific oversight is through the joint NASA-ESA MIRI Science Team, of which van Dishoeck is a member.

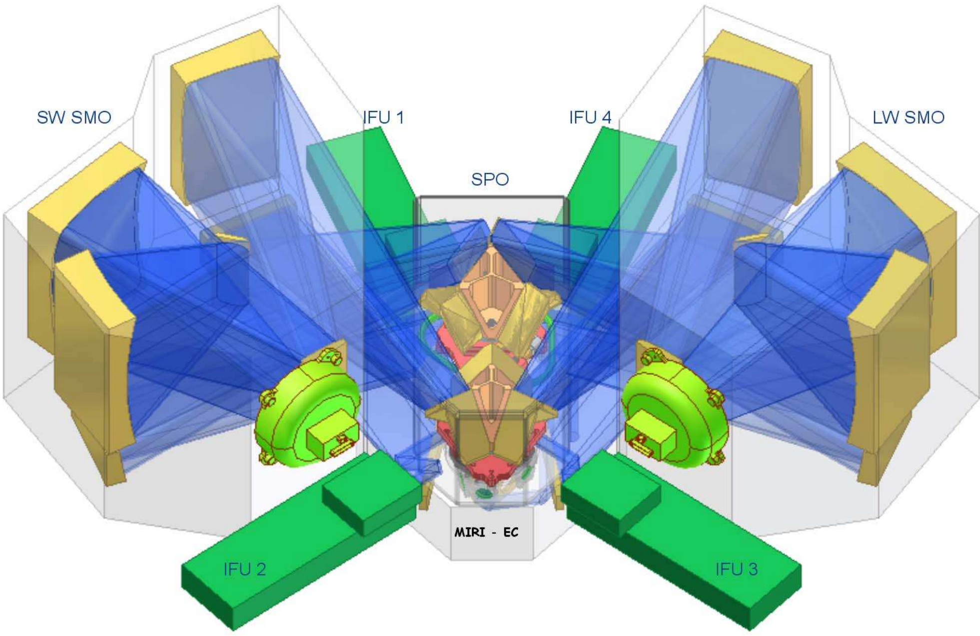

Figure 2.17: Overview of the MIRI spectrometer.

The spectrometer can obtain simultaneous spectral and spatial data on a few arcsec region by using four integral field units constructed of image slicers, with spectral resolving powers $R \approx 2000 - 3700$ (see Fig. 2.17). The optical design, developed at TPD with significant input from Pel (RuG) and ASTRON, has been frozen. The (opto-)mechanical design work is led by Kroes (ASTRON) and the concept study has been completed, with detailed design ongoing. The Structural-Thermal Model was designed, built, tested and delivered to RAL. Other activities include design and engineering models of the mirrors and grating wheel assembly, and procurement of the gratings (see Fig. 2.18). The MIRI Optical bench Assembly passed its Systems Requirements Preliminary Design Reviews in 2004.

Planning for integration, testing and calibration on the ground and in-orbit has started within the European Consortium. Brandl is involved in the MIRI calibration working group, led by Meixner (StScI), and is composing the strategy with stellar calibrators based on experience from ISO-SWS and Spitzer-IRS. The Dutch team has stressed the general need for a well characterized relative spectral response function before launch, and first steps have been made to incorporate such measurements in the Flight Model test plan at RAL.

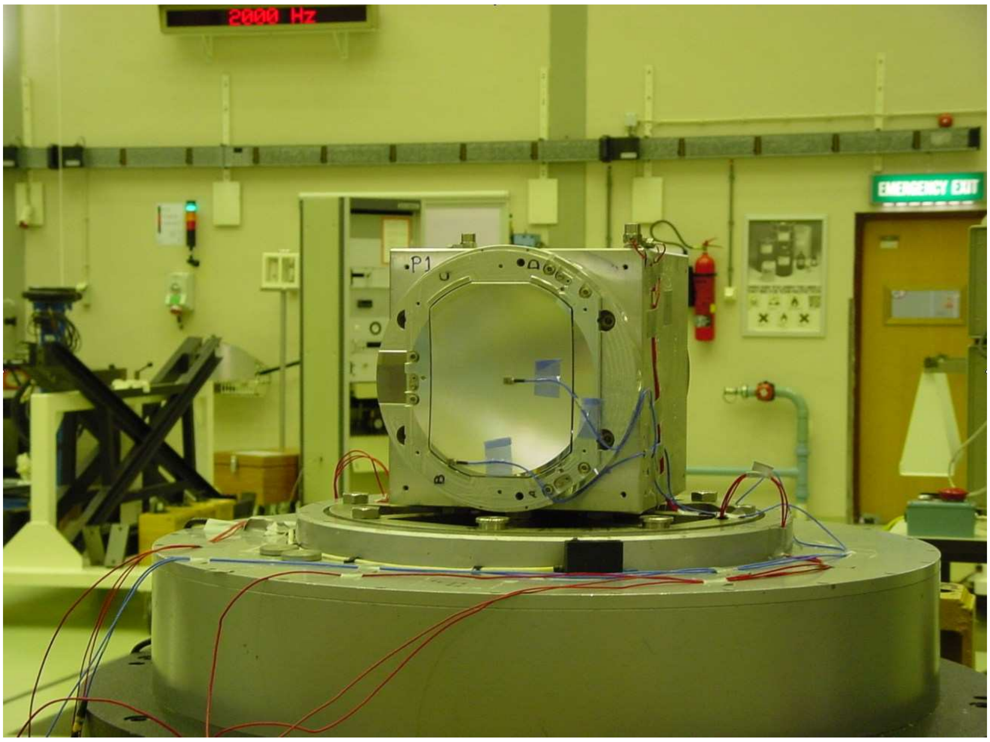

Figure 2.18: Vibration test of the MIRI engineering qualification mirror at ESTEC.

Darwin and the Detection of Terrestrial Exoplanets

As members of ESA's Terrestrial Exoplanets Science Advisory Team (TE-SAT), Röttgering and Quirrenbach worked on various aspects of the planned Darwin mission, which will search for and characterize Earth-like planets outside the Solar System. For this purpose, ESA is pursuing the development of a mid-infrared interferometer. The two main arguments in favor of the infrared interferometer are the slight superiority of the mid-infrared for planet characterization (including the available biomarkers), and the larger number of stars that can be surveyed (because the inner working angle is not limited by the size of a telescope that must be fitted into available fairings).

To achieve the required angular resolution in the mid-infrared, Darwin requires an interferometer with baselines of at least $50 \ldots 100$ m to separate the planets from their host stars. It appears that mounting each telescope and the beam combiner on a separate spacecraft will be much easier than building a single large structure, and therefore a “free-flyer” approach has been adopted. With this architecture, it will also be possible to conduct a “general astrophysics” program of interferometric imaging in the mid-infrared.

Quirrenbach organized a workshop on “Coronographic Methods for the Detection of Terrestrial Planets” in the Lorentz Center, which brought together scientists from the US and Europe to discuss the technology development for space-based coronographic telescopes. This is NASA’s preferred option for the first mission aimed at the characterization of terrestrial planets. Particular attention was paid at the workshop to areas that could be of special interest for collaborations between European and American institutions and scientists. The status and prospects of all important technological areas were summarized in a 100-page report, which was drafted during the workshop and subsequently edited by Quirrenbach into a coherent document.

Chapter 3

Education, popularization and social events

Education, popularization and social events

Chapter 3

3.1 Educational matters

3.1.1 Organization

The education of students is a top priority of the Leiden Observatory. Fortunately, we can welcome a high number of new students every year. In the academic year 2004/2005, 25 freshman students registered for the new Bachelors program. In their first year, some of these change over to other studies, as the astronomy program is challenging. In each of the five years of the program, students are presented with astronomy courses. However, in the first two years the emphasis lies on physics and mathematics as a foundation for the more advanced astronomy courses in the last three years.

Astronomy student performance is monitored by three members of our faculty: Van der Werf and Kuijken for the students in the first three years of the program, and Le Poole for the senior undergraduates. These advisers have regular contacts with the students and can be consulted at any time.

Moreover, for the duration of their first year, students are assigned to any of the three groups which meet at regular intervals with a staff member acting as a mentor, assisted by two senior students acting as "student mentors". The university requires each freshman to collect a minimum number of credit points. The mentor groups play an important role in helping the students to achieve this goal. In the academic year 2004/2005, mentors were Hogerheijde, Israel and Lub.

The "Opleidingscommissie" (Education Committee) consists of both faculty members and students. It meets regularly to discuss student performance reports, and to advise the director of Education, Franx. In 2004, the committee consisted of faculty members Katgert (chair), Le Poole, Kuijken, Van der Werf, Van de Ven and student members Van der Berg, Van de Voort and Lukkezen.

The astronomy curriculum is formally defined by the "Examen commissie" (Committee of Examination). In 2004, its members were Franx (chair), Groenen (Physics), Israel, Kuijken and Van der Werf.

3.2 Degrees awarded in 2004

3.2.1 Ph.D. degrees

A total of 7 graduate students defended their PhD thesis successfully in 2004 and were awarded their Ph.D. degree. They are:

M. Messineo	June 30
Title thesis:	*Late type giants in the inner galaxy*
Thesis advisor:	Habing
K.K. Knudsen	October 6
Title Thesis:	*Deep submillimetre observations of faint dusty galaxies*
Thesis advisor:	Franx / Copromotor: Van der Werf
D. Krajnovic	October 12
Title Thesis:	*On the nature of early-type galaxies*
Thesis advisor:	De Zeeuw / Copromotor: Jaffe
I.F.L. Labbé	October 13
Title Thesis:	*Deep infrared studies of massive high redshift galaxies*
Thesis advisor:	Franx
J.K. Jørgensen	October 14
Title thesis:	*Tracing the physical and chemical evolution of low-mass protostars*
Thesis advisor:	Van Dishoeck
K.M. Pontoppidan	October 14
Title thesis:	*Fire and ice: Infrared spectroscopy as a probe of ice and gas in star forming regions*
Thesis advisor:	Van Dishoeck
R.Ruiterkamp	October 28
Title thesis:	*Aromatic Molecules in Space: Laboratory Studies and Applications to Astrochemistry*
Thesis advisor:	Ehrenfreund

3.2.2 Master's degrees ("doctoraal diploma's")

The following 7 students obtained their Master's degrees in 2004:

Name	Date	Present
Sander von Benda-Beckmann	January 27	Ph.D. Astrophysikalisches Institut Potsdam
Remco van den Bosch	February 24	Ph.D. Leiden Observatory
Jean-Paul Keulen	February 24	Science journalist Kijk
Tim van Kempen	June 29	Ph.D. Leiden Observatory
Caroline van Breukelen	August 31	Ph.D. Oxford Astrophysics
Huib Intema	December 14	Ph.D. Leiden Observatory
Anne-Marie Weijmans	December 14	Ph.D. Leiden Observatory

3.3 Courses and teaching activities

3.3.1 Courses taught by Sterrewacht staff in 2004

Elementary courses

Semester	Course title	Teacher
1	Introduction Astrophysics	K.H. Kuijken
2	Astronomy Lab 1	P. Katgert
3	Stars	R.S. Le Poole
4	Astronomy Lab 2	M. Franx
4	Modern astronomical research	K.H. Kuijken
4	Presentation 1	F.P. Israel
5	Presentation 2	R.S. Le Poole
5	Observational Techniques	H.A. Quirrenbach
5	Radiative Processes	M.R. Hogerheijde
6	Bachelor research project	P.P. van der Werf & W.J. Jaffe
6	Galaxies	J. Lub
6	Introduction bachelor research	E.R. Deul
6	Observational Techniques 2	H.J.A. Röttgering
6	Presentation 3	J. Lub
6	Introduction Observatory	E.R. Deul
7-10	Student Colloquium	G. K. Miley

Advanced courses

Semester	Course title	Teacher
7,9	Active galactic nuclei	H.J.A. Röttgering
7,9	Laboratory astrophysics	S. Schlemmer
7,9	Radio astronomy	R.T. Schilizzi
8,10	Interstellar matter	E.F. van Dishoeck
8,10	History of Sciences	R.P.W. Visser
8,10	Stellar Evolution	P.T. de Zeeuw

Other courses

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

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

The astronomy departmant 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, in 2004 eleven and in 2004/5 thirty-three students participated.

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

Planets and Exoplanets - Dr. P.P. van der Werf
Observing in Astronomy - Dr. H. Röttgering
Gas and Radiation - Prof. dr. V. Icke
Galaxies and Active Galactic Nuclei - Prof. dr. M. Franx
Astronomy Lab (Parallax, moons of Saturn) - Drs. J. Ritzerveld & Drs. D. Schnitzeler
What makes the Sun shine? Stars and their Evolution - Dr. J. Lub
Cosmology - Dr. P. Katgert
Visit to the radio telescopes in Westerbork and Dwingeloo

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

3.4 Popularization and media contacts

3.4.1 Organization

Astronomy has a strong appeal to the general public, and is well represented in the media. Our staff, PhD 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" (Weer- en Sterrenkundige Vereniging Triangulum; Sept 16)

Brandl
"Stormy Cloud of Star Birth Glows in New Spitzer Image"(NASA press rel.; Jan 13)
"Gigantische haardroogers in de Tarantulanevel"(Leidsch Dagblad; Jan 28)
"The Infrared Universe seen by NASA's Spitzer Space Observatory" (Weer- en Sterrenkundige Vereniging Triangulum; Dec 16)

Van Dishoeck
"Chemie onder extreme condities in de ruimte"(Studenten symposium scheikunde, Nijmegen, Mar 17)
"Van moleculen tot planeten"(NVON lezing, Leiden, Mar 26)
Idem (26 november lezing, Loosdrecht, Nov 26)
"Sterren in de Sterrenkunde"(Universum, Jongerenwerkgroep voor Sterrenkunde)
"64 eyes are better than one"(Astronomy Now, 2004 Yearbook)
"Waar blijven de vrouwen?"(NRC, Sept 1)

Hogerheijde
Interview for Noorderlicht (VPRO radio; Oct 5)

Icke
Sirius lecture (Museum Sterrenwacht Sonnenborgh, Utrecht; Jan 9)
"Structuur van het Heelal" (Comenius Lecture, Groningen; Jan 16)
Radio Interview (Jet van Boxtel, VPRO Radio, Hilversum; Feb 2)
Radio Interview (Casa Luna, NCRV Radio, Hilversum; Feb 9)
Radio Interview (Paul Witteman, VARA, Hilversum; Feb 16)
"Sterren en Melkweg" (Weekendschool, Amsterdam-West; Feb 22)
"Feynman" (Bert Bakker, KRO Radio, Hilversum; Feb 23)
"Toekomst van het Heelal" (ASV Prometheus, Leiden; Feb 25)
Presentatie Boekman (KNAW, Amsterdam; Mar 10)
VSNU Cafe (Den Haag; Mar 18)
"Ruimteonderzoek" (Weekendschool, Amsterdam-West; Mar 21)
"Huygens in de o.v.t.t." (Dijksterhuislezing, Univ. Bibliotheek, Leiden; Apr 28)
"Observed and theoretical images in astronomy"(ImaGO, Utrecht; Apr 29)
Interview Weekendschool (May 3)
"Het AstroHydro 3D Project" (Bessensap, NWO, Amsterdam; May 18)
"Waarom is het 's nachts donker?" (PION-lezing, Leiden; June 3)
Venus overgang (Korenbeursbrug, Leiden; June 8)
Uitreiking boek Van den Broek & Schulp (Naturalis, Leiden; June 8)
Universiteitsdag (University of Amsterdam; June 12)
Opening Technika 10, DreamGirlzzz (Space Expo, Noordwijk; June 13)
"Schaduw" (Interview Nanda Janssen voor Kunsttijdschrift Mr. Motley; Aug 11)
"Hoe groot is het heelal?" Melanchton College, Roterdam; Sept 16)
Technika 10 vrijwilligersdag (Utrecht; Sept 24)
"Zwarte Gaten" (Interview Ernst van Eijk, Natuurwetenschap & Sept 29)
"Huygens" (Sylvia Brouwer, Voorburgse Courant; September 30)
Desmet Live (Amsterdam; Sept 30)
"Probeer het eens zonder" (Gastcollege Wetenschap & Samenleving, Leiden; Oct 1)
Interview over Cassini-Huygens (Voorburgse Courant; Oc 11)
"De Eekhoornformule" (Signeren bij Kooyker met Rudy Kousbroek, Leiden; Oct 20)
Interview RTV West (Oct 21)
"Gebruik je hersens" (Wetenschapsdag landelijke universiteiten, Leiden; Oct 24)
"Huygens als grootste wetenschapper" (De Balie, Amsterdam; Oct 25)
"De dood van de Zon" (Artis, Amsterdam; Nov 2)
"Gas en straling, van vuurwerk tot ijs" (Philippus Lansbergen, Middelburg; Nov 12)
"Heimweeproject" (Teylers Genootschap, Haarlem; Nov 18)
"Cijferringh" (Bartjens, Zwolle; Nov 19)
Discussie Kenniseconomie (Loevestein; Nov 22)
"Wetenschapsfilosofie" (University of Amsterdam, Contact; Nov 23)
"Vuurwerk en ijs" (Cleveringa Lezing, Nijmegen; Nov 26)
"Images of Science" (Rathenau Instituut; Dec 7)

"Het Heelal voorspeld"(HOVO, Erasmus Universiteit Rotterdam; Dec 16)

Israel
Interview Hoe?Zo!(Teleac Radio, Feb 26)
"Buitenaards Leven"(Moderator UvA Study Program, Mar 16)
"De Tiende Planeet"(Interview VPRO Radio 1, Mar 21)
"De Leidse Sterrewacht"(Rechtbank Rotterdam, Leiden, Apr 2)
"De Leidse Sterrewacht"(KU Nijmegen/Thijm Genootschap, Leiden, Apr 17)
"Astronaut als Idool"(Interview Hoe?Zo! Teleac Radio, Apr 20)
"Terra Incognita in het Zonnestelsel"(Dispuut Prometheus, Leiden, May 12)
"Mens en Ster"(Rotary Club, Leiden, June 14)
"Hoezoe 2 x 12 uur?"(Interview Hoe?Zo! Teleac Radio, Apr 20)

De Jong
"MIDI - Een Midden-Infrarood Instrument voor de VLTI" (KNVWS Delft; Jan 20)
Idem (KNVWS Utrecht; Mar 16)
Idem (Volkssterrenwacht Copernicus; Sept 16)
Idem (KNVWS Venlo; Nov 26)

Katgert
"Clusters van melkwegstelsels" (VWO Zoetermeer; Jan 8)
Idem (VWO Rotterdam; Apr 7)
"WMAP" (Weer- en Sterrenkundige Vereniging Triangulum Apeldoorn; Apr 15)
Idem (Eindhovense Weer- en Sterrenkundige kring; Nov 11)

Kuijken
"Gravitatielenzen" (NVON Symposium; Mar 27)

Mellema
"Planeten: Vinden, Vormen, Vullen" (Vereniging Triangulum, Apeldoorn; Feb 19)
Idem (Stichting J.C. van der Meulen, Hoorn; Apr 6)
Idem (KNVWS 't Gooi, Hilversum; Oct 15)
Idem (Vereniging voor Weer- en Sterrenkunde Thales, Zwolle; Oct 28)
Idem (KNVWS 's Gravenhage en omstreken; Nov 19)
"Radiosterrenkunde en het eerste licht in het heelal" (Rotary, Dwingeloo; Nov 9)

Miley
"LOFAR" (Leids Natuurkundig Gezelschap; Nov 18)

Ollongren
"Communicatie met buitenaardse intelligentie" (KNVWS Amersfoort, Feb 11)

Pontoppidan
"Spitzer spectroscopy of ices in the edge-on disk CRBR 2422.8-3423"
(Spitzer press conference; Nov 9)

Quirrenbach
"Does Life Exist Elsewhere in the Universe?" (Faculty club, Leiden; May 11)
"Gibt es Leben anderswo im Weltall?" (Studienstiftung des Deutschen Volkes, St.Johann, Italy; Aug 30)
Interview (NRC Handelsblad; Dec 14)

Ritzerveld
Lecture for science journalists (Bessensap, NWO, Amsterdam; May 18)

Röttgering
"Het ontstaan van melkwegstelsels, quasars en de speurtocht naar leven in het heelal" (Lion-club Bleiswijk, Oct 18)

Snijders
"Op reis door het zonnestelsel" (IMC Weekendschool, Amsterdam; Mar)
"Machten van tien" (IMC Weekendschool, Amsterdam; Mar)
"(Ge)Varen door de ruimte" (IMC Weekendschool, Amsterdam; Mar)

Woitke
Group presentation (Bessensap, NWO, Amsterdam; May 18)

De Zeeuw
"Structure and Formation of Galaxies, as revealed by SAURON" (Jongeren Werkgroep NVWS, Utrecht, Jan 10)
"De Sterrewacht 2004–2014" (VO-S/Sterrewacht Reunie, Leiden, May 15)
"Uitdijende OB associaties, wegren sterren en pulsars" (KNVWS Symposium, Leiden, Sept 25)

3.5 The “Leidsch Astronomisch Dispuut ‘F. Kaiser’ ”

The student association L.A.D. ’F. Kaiser’ is named after the founder of the Leiden Observatory, Professor Frederik Kaiser. In 2004, the board consisted of Laura Helmsing (praeses), Eveline Helder, Demerese Salter and Patrick Herfst.

The L.A.D.’s major goal is to improve the social contacts between undergraduate students and the Observatory personnel. Several lectures were organized for freshmen by Schlemmer and Kuijken. A soccer tournament open for students of the ’Leidsche Flesch’ and employees of the Observatory was organized early April. With about ten teams participating, the tournament was a success and was won by a team from the physics department. This year’s Barbecue was organized in combination with the ’Sterrewachtdag’. With over 50 people, a beautiful sunny evening and good wine, the barbecue was a success.

The L.A.D. contributes to the popularization of astronomy by providing guided tours for the public at the Old Observatory, located in the historival center of Leiden. The tours are always preceded by a lecture, explaining the basics of astronomy to the general audience. This year, over 30 tours were given to people interested in astronomy. On short notice, a small symposium for the Mars society was also organized.

3.6 Vereniging van Oud-Sterrewachters (VO-S)

The “Vereniging van Oud-Sterrewachters”, abbreviated “VO-S”, is the official association of Sterrewacht (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 in the autumn of 2004 in which, among others, details of MiniGRAIL were explained by Arlette de Waard (http://www.minigrail.nl/). Arlette’s presentation was followed by a visit to the impressive MiniGRAIL experimental facility. In addition, the VO-S and Sterrewacht jointly organised a Sterrewacht reunion in 2004 attended by more than 100 people, representing many decades of Sterrewacht staff and students. Participants enjoyed presentations covering the past, present, and future of the Sterrewacht by Harm Habing, Frank Israel and Tim de Zeeuw as well as guided tours of the Oort building. Ample time had been reserved in the programme to catch up with former colleagues and friends and to re-live memorable moments of the past. The day culminated in a Sterrewacht-family dinner buffet during which many more nostalgic memories surfaced. An impression of the reunion, together with all relevant information on how to enroll as a member, can be found on http://www.vo-s.nl/.

Appendix I

Observatory staff December 31, 2004

Sterrewacht Leiden

Observatory staff December 31, 2004

Appendix I

The Sterrewacht website

`http://www.strw.LeidenUniv.nl/org/people_byname.php`

provides names, e-mail adresses, room numbers and telephone extensions of all personnel currently at the institute. 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
K.H. 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 (International Square Kilometre Array Project, Faculty W&N, UL(0.0))
R.P.W. Visser (UU(0.5)/UL(0.5), Teyler's Professor)

Associate Professors and Assistant Professors

B.R. Brandl
M. Hogerheijde
F.P. Israel
W.J. Jaffe
P. Katgert
J.Lub
R.S. le Poole
H.J.A. Röttgering
J. Schaye (01/03/05)
S. Schlemmer (0.0)
I.A.G. Snellen
P.P. van der Werf

Visiting Staff

M.J. Betlem
P. Ehrenfreund (LIC)
C. Helling
G. Mellema (ASTRON)
J. Meisner (ESO)
P. Papadopoulos (ETH)
J.A. Stuwe
R. Sunyaev (J.H. Oort Fund)
M. Jourdain de Muizon (Observatoire de Paris, Meudon)

Management Assistants and Secretaries

J.C. Drost
K. Groen
B. de Kanter (voluntary)
R. Kerpershoek (stagiair)
B.A. Smit
L. van der Veld

Computer staff

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

NOVA office

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

Emeriti

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

Ph.D. Students

S.H. Albrecht	1,10	R.A. Overzier	3
P.M. Lopes Beirao *	1	S.-J. Paardekoper	1
S.E. Bisschop	1,2	F.I. Pelupessy *	3
C. Brinch *	5	M.A. Reuland *	1,7
R.C.E. van den Bosch *	3	N.G.H. Ritzerveld	3
F.A. van Broekhuizen	2	E.J. Rijkhorst	3
V.C. Geers	4	L. van Starkenburg	2
P.M.B.J.C. Gori	8,11	D.H.F.M. Schnitzeler	3
S. Hekker	11,1	L. Snijders	1
E. Hugo *	9	M.H.Soto Vicencio*	1
B.J. Jonkheid	4	K. Steenbrugge (SRON Utrecht)	9
I.L. ten Kate	1	C. Tasse	1
T.A. van Kempen *	3,4	E.N. Taylor *	3
M.T. Kriek	3	P.M. van de Ven	1,2
P. Lacerda *	3	B.P. Venemans	2
F. Lahuis (SRON Groningen)	4	A. van der Wel	1,2
R. Meijerink	1	S.E.R. Wuijts	3
E. Micelotta *	5		

Funding notes:
1. Leiden University; **2.** NOVA program; **3.** NWO via Leiden University; **4.** funding by Spinoza award; **5.** funding by EU EARA MC network; **6.** funded by SRON; **7.** funding in part by L. Livermore Laboratory; **8.** funded by TPD Delft; **. 9.** funded by DFG; **10.** funded by NOVA2 OPTICON; **11.** funded by VICI Quirrenbach.
***** denotes employment for only part of the year – see section staff changes

Senior students

M.E. Ameling	G.M. Kosters
S.C. van Boven	F. Maschietto
M.C. Damen	J.H.M. Nuijten
S.C.A. van Dongen	J.-P. Paardekoper
M.L. van Duin	E.T. van Scherpenzeel
R.S.A. Ensing	D.M. Smit
S.J. Franssen	P. Verburg
C.A. ter Haar	S.R.G. Veijgen
E.A. Helder	F. van de Voort
P. Herfst	N. de Vries
M.B. van Hoven	J. M. van Vugt
H.T. Intema	E.B.M. de Wachter
O. Janssen	A. Weijmans
G. Chaparro Molan (MSc student)	D.M. Salter (MSc student)

Postdocs and Project Personnel

S.J.S. Andersson	Spinoza, LIC	J.K. Katgert-Merkelijn	UP (posting UB)
O.I.L. Asvany	NWO, Spinoza	R.D.. Koehler	NOVA, Prima
J.-C. Augereau	EU	F. Lahuis	NWO, Spinoza (SRON)
E.J. Bakker	NEVEC Manager	R.J. Mathar	NWO, VICI
A.G.A. Brown	NOVA,GAIA	R. McDermid	NWO
M. Cappellari	NWO, VENI	K.M. Pontoppidan	NWO, Spinoza
J. Falcon Barroso	EU	S. Reffert-Frink	NWO, VICI
R. Flicker	NWO, VICI	R. Stuik	NOVA2 OPTICON
H.J. Fraser	NWO, Spinoza	R.N. Tubbs	EU Marie Curie
G.W. Fuchs	NOVA, Sackler	R.J. Vink	NOVA2 MUSE
V. Joergens	EU Marie Curi	T.M.A. Webb	NOVA
J.A. de Jong	S/W NOVA, NEVEC	A.W. Zirm	NWO

Staff changes and visitors in 2004

Name (Funded by)	start	end
S.H. Albrecht (UL)		31-03-04
S.H. Albrecht (NOVA2 OPTICON)	01-04-04	
O.I.L. Asvany (NWO, Spinoza)		30-06-04
O.I.L. Asvany (NWO)	01-07-04	
P. Beirao (UL)		
S.E. Bisschop (UL, NOVA)		31-10-04
S.E. Bisschop (UL)	01-11-04	
R.C.E. van den Bosch (NWO)	01-04-04	
C. Brinch (EU EARA)	01-10-04	
M.P.E.J. Driessen (UL)		01-11-04
R. Flicker (NWO, VICI)	01-04-04	

Staff changes and visitors in 2004 - *continued*

Name (Funded by)	start	end
H.J. Fraser — (NWO, Spinoza)		31-12-04
G.W. Fuchs (UL, NOVA/Sackler)	01-11-04	
J.M.T. van der Heijden (UL)		01-03-04
B.M.R. Heijligers (UL)		15-10-04
S. Hekker (NWO, VICI)		31-03-04
S. Hekker (UL)	01-04-04	
E. Hugo (UL, DFG)	01-10-04	
V. Joergens (NWO, VICI)	01-11-03	31-03-04
V. Joergens (EU, Marie Curie)	01-04-04	
J.K. Joergensen (UL, NOVA)		15-09-04
M. Johnson - Hollitt (NWO, LOFAR)		01-07-04
I. Kamp (UL, NOVA)		01-03-04
J.A. Katgert - Merkelijn (UL, UB)	01-11-04	
J.A. Katgert - Merkelijn (UL, AandA)		31-12-04
T.A. van Kempen (UL, NWO)	01-10-04	
R.D. Kerpershoek (UL, stagiair)	01-09-04	
R. Koehler (NOVA MIDI)	01-01-05	
D. Krajnović (UL, NOVA)		09-10-04
K. Kraiberg Knudsen (NWO)		11-09-04
I.F.L. Labbé (NWO)		15-10-04
P. Lacerda (NWO)		01-12-04
R.J. Mathar (NWO, VICI)	01-06-04	
M. Messineo UL, NOVA)		08-01-04
B.A. Merin Martin (Spanje)	01-11-04	
J.A. Meisner (NWO, VICI)		31-08-04
E. Micelotta (EU EARA)	01-11-04	
F.I. Pelupessy (UL,NWO)		31-12-04
K.M. Pontoppidan (UL, NOVA)		31-10-04
K.M. Pontoppidan (NWO, Spinoza)	01-11-04	
M.A. Reuland (UL, High z)		01-07-04
R. Rengelink (NOVA, Omegacam)		01-04-04
R. Ruiterkamp (UL, SRON)		01-10-04
S. Schlemmer (UL, NOVA/Sackler)	30-09-04	
M.H.Soto Vicencio (UL)	01-09-04	
I.A.G. Snellen (UL, KNAW)	01-09-04	
R. Stuik (NOVA MUSE/Cheops)		31-03-04
R. Stuik (NOVA2 OPTICON)	01-04-04	
R. Sunyaev (J.H. Oort Fund)	15-04-04	31-05-04
E.N. Taylor (NWO)	01-08-04	
R.N. Tubbs (NOVA/NEVEC)		31-03-04
R.N. Tubbs (EU, Marie Curie)	01-04-04	
R.J. Vink (NOVA2, MUSE)	01-01-05	
B.P. Venemans (UL, NOVA)		31-13-04

Appendix II

Committee membership

Committee membership

Appendix II

II.1 Observatory Commitees

(As of December 31, 2004)

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

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

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

Astronomy education committee
(Opleidingscommissie OC)
P.Katgert (chair)
J.C. Drost (minutes)
K.H. Kuijken
R.S. Le Poole
P.M. van de Ven
P.P. van der Werf

M. van den Berg
J.H.J. Lukkezen
F. van de Voort

Astronomy examination committee
(Examen-commissie)
M. Franx (chair)
E.J.J. Groenen (Physics)
F.P. Israel
K.H. Kuijken
P.P. van der Werf

Computer committee
P.P. van der Werf (chair)
B.R. Brandl
F.A. van Broekhuizen
A.G.A. Brown
M. Cappellari
G. Mellema
B.P. Venemans
K. Groen

Computer group
W.J. Jaffe (head)
E.R. Deul
D.J. Jansen
T. Bot
A. Vos

Research institute scientific council
(Wetenschappelijke raad onderzoekinstituut)
F.P. Israel (chair)
B.R. Brandl
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
G.K. Miley
J. Lub
R.S. Le Poole
M.A.C. Perryman
H.J.A. Röttgering
H.A. Quirrenbach
R.T. Schilizzi
S. Schlemmer
R.P.W. Visser
P.P. van der Werf

Institute council
(Instituutsraad)
E. Deul (chair)
J. Drost
F.P. Israel
W.J. Jaffe
A. van der Wel
J.H.M. Nuijten

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

Public outreach committee

V. Icke
F.P. Israel
M.T. Kriek
F.I. Pelupessy
P.M. van de Ven
A. van der Wel

Library committee

W.J. Jaffe (chair)
J. Lub
A.M. van Genderen
F.P. Israel

Social committee

A.G.A. Brown
T.A. van Kempen
K. Groen
M.T. Kriek
R.S. Le Poole
I.A.G. Snellen

II.2 University Committees

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

Franx
Member, Committee of Education Directors, Faculty of Sciences
Director, Leids Kerkhoven–Bosscha Foundation
Director, Leids Sterrewacht Foundation
Director, Jan Hendrik Oort Foundation

Habing
Member, special advisory board of Dean

Israel
Member, Education Committee Physics and Astronomy
Member, Department Council of the Faculty of Sciences(Faculteitsraad)

Katgert
Member, Education Committee Physics and Astronomy

Kuijken
Member, Faculty Research Committee (WECO)
Chair, Astronomy Programme Board, Lorentz Center
Member of the Board, International Center

Lub
Member, Public Relations Committee Faculty of Sciences
Member, Department Student Recruitment Committee
Director, Leids Sterrewacht Fonds
Director, Leids Kerkhoven–Bosscha Fonds
Director, Jan Hendrik Oort Foundation

Ollongren
Member, Committee University Level Courses for Seniors

Röttgering
Chair, Panel of LUF Internationaal Studie Fonds (LISF)

Schlemmer
Member, Mayo Greenberg Scholarship Prize Committee

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

Van der Werf
Member, Astronomy and Physics Joint Education Committee
Organist of the Academy Auditorium

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

Appendix III

Science policy functions

Sterrewacht Leiden

Science policy functions

Appendix III

Augereau
Member, VLT/PLANET FINDER Science Team
Member, VLTI/APreS-MIDI Science Team

Bakker
Member, Dutch Joint Aperture Synthesis Team (DJAST)
Member. NOVA-ESO VLTI Expertise Centre (NEVEC) Management Team

Brandl
Deputy Co-PI for NL, European JWST-MIRI consortium
Co-Investigator, Spitzer-IRS
Co-Investigator, PHARO camera (Palomar 200″)
Co-Investigator, WIRC camera (Palomar 200″)
Co-Investigator, Optical laboratory at the Sterrewacht
Member, MUSE science team
NL representative, OPTICON Key technologies working group

Brown
Member, IAU Commission 37
Member, NOVA-SINFONI management team
Member, Gaia photometry, Classification and Simulation Working Groups
Member, Gaia Data Access and Analysis System Steering Committee

Van Dishoeck
Member, SRON Board
Member, MPIA-Heidelberg Fachbeirat
Member, Visiting Committee Astronomy Department of Harvard University
Member, European ALMA Board
Member, ALMA Science Advisory Committee
Chair, ALMA European Science Advisory Committee
Co-PI for NL, European JWST-MIRI consortium
Member, StScI Director Search Committee AURA
Member, Onsala Director Search Committee
Member, ESO-CRIRES Science Team
Member, Herschel–HIFI Science team
Member, VLT–VISIR Science team

Chair, IAU Working Group on Astrochemistry
Chair, Scientific Organising Committee, IAU Symposium 231
Member, Scientific Organising Committee, 'Protostars & Planets V'
Coordinator, NOVA network II on "Birth and Death of Stars and Planets"
Member, Editorial Board Annual Reviews of Astronomy & Astrophysics
Foreign Associate, US National Academy of Sciences
Member, Royal Netherlands Academy of Sciences (KNAW)

Franx
Member, Advanced Camera for Surveys Science Team
Member, Nova Board
Member, Sinfoni Science Team
Member, ESO-Omegacam Science Team
Member, MUSE Science Team
Member, NWO Astronomy Proposal Evaluation Committee
Member, JWST-NIRSPEC Science Team
Organizer, FIRES Science Meeting in Lorentz Center

Fraser
Team Member, ESA ICAPS Experiment for International Space Station
Team Leader, ESA Topical Team on Physico-Chemistry of Ices in Space
Ordinary Committee Member, Astrochemistry Group of the RSC and RAS, UK

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

Hogerheijde
Member, Ad-hoc Panel for Review of JCMT-SMA Linked Interferometry
Member, ALMA Science Integrated Product Team
Member, Netherlands Programme Committee

Icke
Member, National Committee on Astronomy Education
Member, Minnaert Committee (NOVA Outreach)
Member, Netherlands Astronomical Society Education Committee
Member, Editorial Council "Natuur & Techniek"
Member, Board of Directors, National Science Museum NEMO
Member, Advisory Council, "Technika10"
Member, Board of Editors, Nederlands Tijdschrift voor Natuurkunde
Member, Advisory Committee, Computational Science (NWO)
Representative for the Netherlands, ESO Observing Programme Committee
Member, Advisory Council, Faculty of Creative and Performing Arts

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

Jaffe
Member, FITS standards committee
Co-Project Scientist, NEVEC

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

Kuijken
NL Representative, Science and Technical Committee, ESO
Member, Instrument Steering Committee, NOVA
Principal Investigator, OmegaCAM project
Co-Investigator, Planetary Nebulae Spectrograph Project
Local Coordinator, EU-FP5 RTN network SISCO
Board Member, EARA
Foreign Member, Faculty Search Committee, Astronomy Group, Gent
Chair, LOC and SOC, Oort Workshop 2004, Leiden
Member, ESO Contact Commissie
Member, ESO Working Group on Optimizing Scientific Return from VLT

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

Mellema
Treasurer, Association of Academy-Fellows (VvAO)

Miley
Chair, National Radio Astronomy Observatory Visiting Committee
Member, Max Planck Institut fur Radioastronomie Fachbeirat
Chair, LOFAR Research Management Committee
Member, Board of Stichting ASTRON
Chairman, International ”Universe Awareness” for Young Children Steering Committee
Member, Royal Netherlands Academy of Arts and Sciences (KNAW)

Ollongren
Member, Permanent SETI Study Group
International Astronautical Academy (IAA)
Member, IAU Commissions 7, 33 and 51
Founding member, European Astronomical Society

Perryman
Chair, GAIA Science Advisory Group

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

Reffert
Member, PRIMA Science Team

Röttgering
Member, Dutch Joint Aperture Synthesis Team (DJAST)
Member. NOVA-ESO VLTI Expertise Centre (NEVEC) Management Team
PI, European Research and Training Network "The Physics of the Intergalactic Medium"
Member, Mid-Infrared interferometric instrument for VLTI (MIDI) Science Team
Member, VLTI Science Demonstration Team (SDT)
Member, NASA's Terrestrial Planet Finder Science Working group (TPF-SW)
Member, ESA's Terrestrial Exo-planet Science Advisory Team (Te-SAT)
Chair, LOFAR's Astronomy Research Committee
Principle Investigator, Development and commissioning of LOFAR for Astronomy (DCLA)
Member, Development and commissioning of LOFAR for Astronomy managament team
Member, Omegacam Science team
Member, XMM Large Scale Structure Consortium
Chair, ASTRON Observing Programme Committee
Chair, NWO selection committee for VENI postdocs
Chair, JCMT international time allocation committee

Schilizzi
Editor, Experimental Astronomy
Member, IAU Working Group on Future Large Scale Facilities
Member-at-large RadioNet Board
Vice-President, URSI Commission J on Radio Astronomy
Member Scientific Advisory Committee, SRON
Member, KNAW Netherlands Geodetic Commission
Member, LOFAR Astronomy Research Committee

Snellen
Panel member, ESO OPC, Cosmology
Member, LOFAR Survey Team
Member, Science Team, High Resolution Near-InfraRed Spectrograph for Gemini-S

Van der Werf
Principal Investigator, NOVA-SINFONI
Team Leader, EC - RT Network "Probing the origin of the extragalactic background" (POE)
Member, EC - RT Network "Promoting 3D spectroscopy in Europe" (Euro3D)
Member, MIRI Science team
Member, NOVA wide-field imaging science team
Member, NOVA millimetre interferometry team
Member, SINFONI Science team
Member, VISIR Science team
Co-investigator, HIFI
Member, Extragalactic Herschel Open Time consortium (ExtraHOT)
Member, JCMT Board
Member, JCMT Survey Steering Group
Co-investigator, Multi-Unit Spectroscopic Explorer (MUSE)
Member, Scientific Organizing Committee "Starbursts - from 30 Doradus to Lyman Break Galaxies"

De Zeeuw
Member, Scientific Advisory Board of " New Astronomy"
Member, Publications Committee, Astronomical Society of the Pacific
Member, SOC, The Three-Dimensional Universe with GAIA
Member, MUSE Executive Board
Member, SINFONI Science Team (MPE&ESO)
Member, OPTICON Board
Member, Science Working Group for Extremely Large Telescopes
Member, National Committee Astronomy
Member, Scientific Advisory Committee, SRON
Chair, Advisory Committee for Astronomy, NWO
Member, ESO Council
Member, ESO-Spain In-kind Working Group
Member, ESO Scientific Strategy Working Group

Member, ESO Contact Committee
Leiden University Member Representative to AURA
Chair, Space Telescope Institute Council
Member, Interim STScI Visiting Committee
Member, AURA Board of Directors
Director, Netherlands Research School for Astronomy, NOVA

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

Appendix IV

Visiting scientists

Sterrewacht Leiden

Visiting scientists

Appendix IV

Name	**Dates**	**Institute**
Geoffrey Blake	Dec 5 – 11	Caltech, Pasadena, USA
Helen Jane Buttery	Nov 11 ('03) – May 1	Cambridge University, UK
Maria Rosa Cioni	Oct 2 – 17	ESO, Garching, Germany
Aaron Cohen	Aug 30 – Sept 3	Naval Research Laboratory, Washington, USA
Jerome Courtin	Jan 21 – Aug 1	École Normale Supérieure de Lyon, France
Roger Davies	Oct 11 – 12	Oxford University, UK
Pieter Daniel Deroo	Apr 26 – 30	Instituut voor Sterrenkunde, Leuven, Belgium
Steve Doty	June 17 – 23 & July 7 – 24	Denison University, USA
Anshu Dubey	Aug 16 – 19	Argonne National Laboratory, Chicago, USA
Sheila Everett	Aug 2 – 19	Denison University, USA
Natascha Förster Schreiber	July 1 – 6	MPE, Garching, Germany
Nadine Haering	Apr 26 – May 23	MPIA, Heidelberg, Germany
Christiane Helling	Mar 4 – Nov 5	Zentrum für Astronomie & Astrophysik, TU Berlin, Germany
Doug Johnstone	Apr 20 – June 30	Herzberg IoA, Victoria, Canada
Krzysztof Kaminski	Oct 10 – Nov 5	Warsaw University of Technology, Poland
Karin Oberg	June 14 – Sept 7	Caltech, Pasadena, USA
Ryan Quadri	Sept 13 – 24	Yale Univ, New Haven, USA
Douglas Richstone	July 21 – 30	University of Michigan, USA
Marc Sarzi	Oct 11 – 12	Oxford University, UK
Joop Schaye	Aug 25 – Oct 9	Princeton University, USA
Frederik Larsen Schoier	May 22 – June 12	IoA Zürich, Switzerland
Kristen Shapiro	Apr – July	Williams College, Massachusetts, USA
	Dec 17 - 22	
Arend Sluis	Feb 5	Rutgers University, New Jersey, USA

Name	Dates	Institute
Ian Smail	Oct 6 – 7	Durham University, UK
Mario Humberto Soto	Mar 4 – 14	Universidad Católica, Chile
Pascal Stäber	June 17 – 22	Caltech, Pasadena, USA
Massimo Stiavelli	Oct 21 – 22	STScI, Baltimore, USA
Rashid Sunyaev	Apr 20 – 30	MPA, München, Germany
Roeland van der Marel	Sept 2 – 12	STScI, Baltimore, USA
Peter van Dokkum	Sept 20 – 24	Yale Univ, New Haven, USA
Huib Jan van Langevelde	Jan 13 – 14	Joint Institute for VLBI in Europe, Dwingeloo, NL

Appendix V

Workshops, colloquia and lectures

Sterrewacht Leiden

Workshops, colloquia and lectures

Appendix V

V.1 Workshops and Meetings

The structure and composition of Active Galactic Nuclei: Optical interferometry and adaptive optics of NGC 1068
Jan 12 – 14 Röttgering and Jaffe organized a workshop to bring together teams that observed the nearby AGN NGC 1068 at various wavelengths (MID-infrared Interferometer (MIDI) coupled to ESO's VLTI, 10m Keck telescope interferometric observations and a number of others) and astronomers that are in the process of detailed modeling the observed phenomenon. The aims of the workshop were to get an overview of the recent results of multiwavelength observations of nearby AGN, to have a detailed discussion of the VLTI data obtained together with a comparison of the various reduction methods and to have a first confrontation of the various models with the data obtained last year.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040112/info.php3?wsid=111`

Coronographic Methods for the Detection of Terrestrial Planets
The goals of this workshop held from Feb 2 – 6 on the detection of terrestrial planets using coronographs were to inform European scientists about status of coronograph studies in the US, to identify European scientists who are working or would like to work on coronographs, to identify European companies with specialized knowledge that may be useful and to identify opportunities for US-European collaboration.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040202/info.php3?wsid=112`

Radiative Transfer Modeling of Water
This workshop, organized from March 22 – 24 by Hogerheijde, brought together experts in the field of radiative transfer modeling and astrophysical spectroscopy of water, both from within and outisde the HIFI consortium. The overall aim of the workshop was to better understand the excitation and line-formation mechanisms of water in astrophycisal environments, which will be essential to fully exploit the planned HIFI observations.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040322/info.php3?wsid=118`

Benchmarking of PDR models
From April 5 – 8, van Dishoeck co-organized a workshop in the Lorentz Center on "Benchmarking of PDR Models". About 25 scientists gathered to compare the results of a number of well-defined test problems. Substantial progress was made in understanding the differences between various codes.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040405/description.php3?wsid=105`

Cores to Disks Spitzer-IRS meeting
From April 19 – 22, van Dishoeck organized a meeting in Leiden of the spectroscopy part of the 'Cores to Disks' Spitzer legacy team. About 15 scientists gathered to discuss recent Spitzer data and associated modeling tools.

The CMB and first objects in the end of dark ages:
Observational signatures of reionization
This is the title of the 2004 Oort workshop, organized from April 24 – 26 by Kuijken. The epoch of reionization is a hot topic in astronomy, driven by results of the first WMAP observations, measurements of the Gunn-Peterson absorption and very high-z quasars in the Sloan Digital Sky Survey. The participants, amongst whom this year's Oort lecturer Rashid Sunyaev, discussed the first sources and their observable characterisctics.

Near- and mid-IR studies of galaxies in or near the Local Group
Cioni and Habing organized a workshop on the near- and mid-IR studies of galaxies in or near the Local Group from May 3 – 7.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040503/info.php3?wsid=120`

Magnetic Fields in Galaxies
The purpose of this workshop,organized by Katgert July 5–8, was to develop a better understanding of magnetic fields in galaxies: to define what we think is well-established, and to define how to move forward. In particular, the workshop aims to bring together and compare observations, numerical simulations and analytical theory on galactic magnetic fields. Subjects covered were magnetic fields in external galaxies and the Milky Way, models of the (warm) turbulent ISM and the origin and evolution of galactic magnetic fields.
Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040705/info.php3?wsid=124`

The Nuclei of Galaxies
From July 26 – 30 Richstone (Ann Arbor, USA), Cappellari and De Zeeuw organized a workshop with the aim to to bring together the main groups who study massive black holes in (normal) galactic nuclei, and their relations with the host galaxy properties. Results of the different teams were compared in detail, including the inner workings of the independent modeling software. Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040726/info.php3?wsid=123`

FIRES: The Study of Near-IR Selected High Redshift Galaxies

From Sept 13–17 Franx organized the FIRES workshop.The FIRE Survey is a deep NIR survey of two fields of the sky, supplemented with optical imaging, both from groundbased telescopes and HST. The goal was to improve our understanding of the high redshift universe, and to measure the evolution and formation of galaxies. During the weeklong meeting, we discussed results from the survey, and related programs. Furthermore, new observing sessions and the work for the coming year were planned.

Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20040913/info.php3?wsid=135`

Conceptual Design Review PRIMA Astrometry Operations and Software

The European Southern Observatory (ESO) is currently acquiring the hardware for PRIMA, a facility that will enable astrometric observations with the VLTI. The PRIMA facility holds the promise to carry out an exciting program on the astrophysics of extra-solar planets through precise astrometry, which is a very complementary technique to the radial-velocity method. A consortium has formed that build the required hardware and develops the required software, to turn the PRIMA astrometry facility in a successful science instrument which delivers astrometric information at unprecedented accuracy. This three day workshop (Sept 28–Oct 1) organized by Bakker focused on a Conceptual Design Review of the consortium activities related to the PRIMA astrometric operations and software.

Additional information can be found on the website:
`http://www.eso.org/projects/vlti/instru/prima/index_prima.html`

VLTI / MIDI School for Data Reduction, Analysis and Science

Bakker, Jaffe, Quirrenbach and Tubbs organized the VLTI / MIDI School from Oct 11 – 15 with the objective to enhance the scientific productivity of the VLTI/MIDI instrument. MID-Interferometer (MIDI) is the first facility instrument for ESO Very Large Telescope Interferometer (VLTI) which was successfully commissioned in 2002. The workshop provided the knowledge, insights, and tools to write an observing proposal. Additionally the software tools to reduce and analyse MIDI data were addressed.

Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20041011/info.php3?wsid=134`

Herschel Space Observatory Calibration Workshop: Models and observations of astronomical calibration sources

The Herschel Space Observatory is the fourth cornerstone mission in the ESA science "Horizon 2000" plan. It will carry a 3.5 meter passively cooled telescope, and will perform imaging photometry and spectrometry in the far-infrared and submillimetre part of the spectrum, covering approximately the 60-670 micrometres range. From Dec 1–3 experts gathered to provide an overview of the state of the art of models, observations and laboratory spectroscopic studies associated with Herschel calibration sources, and to facilitate the discussion.

Programme and list of attendants can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2004/20041201/info.php3?wsid=126`

V.2 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 2004 the colloquium series was organized by Bernhard Brandl.

Date	Speaker (affiliation)	Title
Jan 8	Kees Dullemond (Münich, DE)	*The Structure of Protoplanetary Disks: Models and Observational Tests*
Jan 15	Ralph Wijers (Amsterdam, NL)	*The Energy and Origin of Gamma-ray Bursts*
Jan 22	Torsten Boeker (Noordwijk, NL)	*The Nature of Nuclear Star Clusters in Spiral Galaxies*
Jan 29	Jean-Charles Augereau (Leiden,NL)	*Dynamics of Planetesimals in Extrasolar Planetary Disks*
Feb 2	Stephan Schlemmer (Leiden, NL)	*On the Importance of Gas Phase Chemistry in Star Forming Regions*
Feb 12	Sandy Faber (Santa Cruz, USA)	*Recent Results from the DEEP Survey*
Feb 19	Neil Nagar (Groningen, NL)	*Accretion in Nearby "Normal" Galaxies*
Feb 26	Alex Szalay (Baltimore,USA)	*The Sloan Digital Sky Survey: Mapping the Cosmic Large Scale Galaxy Distribution*
Mar 11	Bob Fosbury (Garching, DE)	*HII Regions at High Redshift*
Mar 18	Zoltan Haiman (New York, USA)	*Reionization History of the Universe*
Mar 25	Paul Schechter (Massachusetts, USA)	*Flux Ratio Anomalies in Lensed Quasars: Micro-lensing or Milli-?*
Apr 1	Peter Barthel (Groningen, NL)	*To be or not to be active*
Apr 8	Imke de Pater (Berkeley, USA)	*Volcanism on Io and Titan's Atmosphere+Surface, as observed with the Keck AO System*
Apr 15	Peter Kooiman (CPB, Den Haag, NL)	*Models and Scenario's in Applied Economic Policy Analysis (CPB)*
Apr 22	Neal Evans (Texas, USA)	*The Formation of Low Mass Stars: Overview and Recent from the Spitzer Space Telescope*
Apr 29	Arthur Wolf (San Diego, USA)	*CII Absorption in Damped Lyman Alpha Systems: A New Window on the Star Formation History of Galaxies*
May 6	Jay Frogel (NASA HQ, USA)	*The Spitzer Space Observatory: An Overview and Early Science Results*
May 13	Peter Woitke (Leiden, NL)	*Modeling the Mass-loss Mechanism of AGB Stars*

Date	Speaker (affiliation)	Title
May 27	Ed Salpeter (New York,USA)	*Fallacies in Astronomy and Medicine and the Use of Meta-analysis*
Jun 3	Joeri van Leeuwen (Utrecht, NL)	*Drifting Subpulses and the Pulsar Emission Mechaninism*
Jun 10	Moshe Elitzur (Lexington, USA)	*IR emission from AGN-support for unified schemes*
Jun 17	Richard Schilizzi (Leiden, NL)	*The Square Kilometre Array: Its Science and Technology*
Jun 18	John Wilson (Virginia, USA)	*Astronomical Instrumentation at the University of Virginia*
Jun 24	Reynier Peletier (Groningen, NL)	*The Formation of Galactic Bulges*
Jul 1	Jim Houck (New York, USA)	*First Results from SIRTF*
Sept 2	Roeland van der Marel (STScI, USA)	*Intermediate-Mass Black Holes: Formation Mechanism and Observational Constraints*
Sept 7	Klaus Pontoppidan (Leiden, NL)	*Ices in Low-Mass Starforming Regions*
Sept 16	Henrik Spoon (New York, USA)	*Probing the dusty nuclei of ULIRGs with Spitzer IRS*
Sept 23	Davor Krajnovic (Leiden, NL)	*Structure and Dynamics of Early-type Galaxies*
Sept 27	Kirsten Kraiberg Knudsen (Leiden, NL)	*Deep Submillimetre Observations of Faint Dusty Galaxies*
Sept 30	Nick Seymour (Paris, F)	*The Nature of Faint Sub-mJy Radio Population*
Oct 7	Eva Grebel (Basel, CH)	*The Violent Local Group - A History of Accretion and Survival*
Oct 11	Luis Ho (Pasadena, USA)	*Massive Black Holes and their Accretion Disks in nearby galaxies*
Oct 21	Massimo Stiavelli (Baltimore, USA)	*The Hubble Ultra-Deep Field*
Oct 26	Ivo Labbé (Leiden, NL)	*Deep Infrared Studies of Massive High-Redshift Galaxies*
Nov 4	Joe Silk (Oxford, UK)	*Dark Matter and Galaxy Formation*
Nov 11	Ken Freeman (Weston Creek, AU)	*Galactic Disks*
Nov 18	Johan Bleeker (SRON, NL)	*The Hot Universe: Science with XMM-Newton and beyond*
Nov 25	Katrien Steenbrugge (SRON, NL)	*Ionization structure of the warm wind in the AGN NGC 5548: discrete or continuous?*
Dec 2	Ted Bergin (Michigan, USA)	*The Chemical and Physical Nature of a Cold Dark Cloud: Setting the Initial Conditions of Star Formations*

V.3 Student colloquia

Date	Speaker	Title
Jan 14	Sander von Benda-Beckmann	*Collimating relativistic MHD jets from black hole accretion disks*
Feb 16	Remco van den Bosch	*A proper motion study using the HST/WFPC2*
Jun 2	Sirach Franssen	*M32 as progenitor for M31 Halo Structure?*
Jun 23	Tim van Kempen	*Multi-frequent radiative transfer with SimpleX*
Aug 19	Caroline van Breukelen	*Searching for Ly-alpha emitters with Integral Field Spectroscopy*
Nov 23	Huib Intema	*Lyman Break Galaxies around radio galaxy TN J1338-1942: A search for large scale structure at $z = 4$*

V.4 Endowed lectures

Date	Speaker (affiliation)	Title
Apr 29	Rashid Sunyaev (MPIA, Garching, DE)	**Oort lecture: Clusters of Galaxies as a tool for Cosmology**
Dec 9	Geoffrey Blake (Caltech, Pasadena, USA)	**Sackler lecture: Molecules and the Search for Developing Planetary Systems**
Nov 4	Joe Silk (Oxford, UK)	**Blaauw lecture: Dark Matter and Galaxy Formation**
Nov 11	Ken Freeman (Weston Creek, AU)	**Blaauw Lecture: Galactic Disks**

Appendix VI

Participation in scientific meetings

Sterrewacht Leiden

Participation in scientific meetings

Appendix VI

Albrecht

Astronomical Telescopes and Instrumentation 2004 (Glasgow, UK; June 21 – 25)
"Calibration of temperature and relative humidity sensors for use on the VLT-Interferometer"
Summer school Alpbach (Alpbach, Austria; July 27 –A ugust 5)
"A satellite mission concept for detecting Gamma Ray Bursts from the first generation of stars"
NOVA fall school (Dwingeloo; October 3 – 7)
"Interferometric High-Resolution Spectroscopy"

Andersson

Bijeenkomst van de CW-studiegroep Spectrosopie en Theorie (Lunteren; January 26 – 27)
"The Performance of Density Functionals for Calculating Barrier Heights of Chemical Reactions Relevant to Astrophysics"
Molec XV on Dynamics of Molecular Systems (Nunspeet; September 5 – 10)
"Performance of Novel Density Functionals for Calculating Barrier Heights of Chemical Reactions"

Asvany

High Resolution Molecular Spectroscopy (Prague, Czech Republic; September 8 – 12)
"Laser Induced Reactions: Spectroscopy of $C_2H_2^+$ and CH_5^+"
Fall meeting NNV AMO division (Lunteren, The Netherlands; November 11 – 12)
"Laser Induced Reactions: Spectroscopy of $C_2H_2^+$ and CH_5^+"

Augereau

FGLA Spring meeting (Leiden, The Netherlands; April 16 – 16)
"On the Dynamics of Planet-Formation in Disks"
"Cores to Disks" Spitzer Legacy IRS team meeting (Leiden, The Netherlands; April 19 – 23)
"Silicate features"
Dusty 2004: A Prelude to Herschel and ALMA (Paris, France; October 27 – 29)
"Spitzer spectroscopy of circumstellar dust disks"
"Young debris disks: grain size distribution and residual gas"
"Cores to Disks" Spitzer Legacy team meeting (Pasadena, USA; August 5 – 13)
"Modeling of PAH infrared emission"
"Disk modeling tools"
"Cores to Disks" Spitzer Legacy team meeting (Pasadena, USA; November 6 – 7)
"Chemistry and infrared emission of circumstellar PAHs"

The Spitzer Space Telescope: New views of the Cosmos (Pasadena, USA; November 9 – 12)
“Spitzer IRS Observations of ”Protoplanetary” Disks”

PLANETS Network School and Mid-term Review (Fréjus, France; Nov 29 – Dec 3)
“Infrared Spectroscopy of Protoplanetary Disks and Modeling of Debris Disks”

Bisschop

Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
“CO as a Gas Adsorbate under Interstellar Conditions”

NOVA fall school 2004 (Dwingeloo, The Netherlands; October 4 – 8)
“Testing Grain chemistry”

Molecular Physics and Plasma Physics School (Eindhoven, The Netherlands; Nov 3 – 5)
“Desorption of CO and N_2 Ices under Interstellar Conditions”

Van den Bosch

Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)

SAURON **Team Meeting** (Aussios, France; June 14 – 18)

Galactic Nuclei (Leiden, The Netherlands; July 26 – 31)

NOVA Herfstschool (Dwingeloo, The Netherlands; October 4 – 8)
“Dynamics of Triaxial Elliptical Galaxies”

EARA 2004 (Munchen, Germany; December 2 – 3)
“Studying Galaxy Nuclei using Integral Field Spectroscopy”

Brandl

AAS Meeting (Atlanta, USA; January, 4 – 9)
“First extragalactic results from the Spitzer Infrared Spectrograph”

IMF@50: The Initial Mass Function 50 years later (Abbazia di Spineto, Italy; May 16 – 20)
“The Starburst IMF – An Impossible Measurement?”

Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May, 26 – 28)
“Extragalactic Star Formation – as seen by the Spitzer Space Telescope”

SPIE (Glasgow, UK; June 21 – 25)
“Miscellaneous”

Massive Stars in Interacting Binaries (Montreal, Canada; August, 16 – 21)
“On the Origin of the most massive stars around R136”

Starbursts: From 30 Doradus to Lyman Break Galaxies (Cambridge, UK; September 6 – 10)
“30 Doradus - a Template for ”Real Starbursts”?”

The Spitzer Space Telescope: New views of the Cosmos (Pasadena, USA; November 8 – 12)
“The Properties of Starbursts in the Local Universe”

Brinch

PLANETS Network School and Mid-term Review (Fréjus, France; Nov 28 – Dec 3)

IDA Sub-millimeter Astrophysics Workshop (Copenhagen, Denmark; Dec 20 – 21)

Brown

Gaia Photometric working group meeting (Torino, Italy; January 21)
"Some considerations on the figure of merit and the testing grid for PS optimisation"
Lorentz workshop on Near- and Mid-IR studies of Local Group galaxies (Leiden; May 3 – 7)
"Gaia - Taking the Galactic Census"
Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May 26 – 28)
"OB Associations"
SINFONI science day (Leiden, Netherlands; June 10)
"SINFONI Adaptive Optics Performance Predictions"
SPIE (Glasgow, UK; June 21 – 25)
"Poster: Simulations of Adaptive Optics with a Laser Guide Star for SINFONI"
Gaia photometric working group meeting (Copenhagen, Denmark; June 28 – 29)
"Thoughts on characterising global degeneracies in photometric system"
Gaia simulation and calibration working groups meeting (Torino, Italy; July 8 – 9)
Three Dimensional Universe with Gaia (Paris, France; October 4 – 7)
"Gaia photometric data analysis"
"Poster: From Detailed Galaxy Simulations to a Realistic End-of-Mission Gaia Catalogue"
Gaia photometric and classification working groups meeting (Athens, Greece; Nov 25 – 26)
"Gaia PS Global degeneracies: Results from self-organising maps"
Gaia GDAAS Steering Committee & Science Team meeting (Barcelona, Spain; Dec 14 – 17)

Cappellari

SINFONI meeting (Leiden, The Netherlands; June 10)
"Galaxy nuclei and black holes with SINFONI"
SAURON **meeting** (Aussois, France; June 14 – 18)
"SAURON dynamical modeling"
5th international LISA symposium (Noordwijk, The Netherlands; July 13 – 15)
"Nuclear orbital distribution as fossil record of black hole formation from integral-field spectroscopy"
35th COSPAR scientific assembly (Paris, France; July 18 – 25)
"Formation and evolution of galaxies"
The Nuclei of Galaxies (Leiden, The Netherlands; July 26 – 30)
"Dynamical modeling"

Van Dishoeck

Symposium in Honor of Johan Bleeker (Amsterdam; January 23)
Deutsche Physikalische Gesellschaft Spring Meeting (Munich, Germany; March 25)
"From molecules to planets: the importance of molecular processes in space (invited lecture)"
Radiative Transfer Modeling of Water (Leiden, Netherlands; March 22 – 24)
"HIFI key program: water in star-forming regions"
Benchmarking of PDR models (Leiden, Netherlands; March 22 – 24)

"Discussion leader and conference summary"
Modeling the Structure, Chemistry and Appearance of Protoplanetary Disks (Ringberg, Germany; April 13 – 17)
"Chemistry in disks (invited review)"
Exploring the Cosmic Frontier (Berlin, Germany; May 18 – 21)
"Formation and evolution of complex organic molecules in star-forming regions (invited talk)"
Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May 26 – 28)
"Chemistry as a tracer of protostellar evolution (invited talk)"
Second TPF/Darwin Int. Conf. on Debris Disks (San Diego, USA; July 26 – 29)
"Chemistry of protoplanetary disks (invited review)"
Spitzer 'Cores to Disks' Legacy Team meeting (Pasadena, USA; August 8 – 13)
"IRS observations of the edge-on disk CRBR2422.8-3422"
Chemistry of Protoplanetary Disks (Heidelberg, Germany; October 11 – 13)
"Comparison between models and observations of outer discs (invited talk)"
Dusty 2004: A Prelude to Herschel and ALMA (Paris, France; Oct 27 – 29)
"A submillimeter survey of low-mass protostars (invited talk)"
The Spitzer Space Telescope: New Views of the COSMOS (Pasadena, USA; November 9 – 12)
"Gas and dust in protostellar and protoplanetary regions (invited review)"
PLANETS Network School and Mid-term Review (Nice, France; Nov 29 – Dec 2)
"Spitzer-IRS observations of gas and dust in protoplanetary disks"
Herschel preparatory science workshop (Leiden, The Netherlands; December 15 – 17)
"Models of H_2O and other species in star-forming regions"

Falcón-Barroso
Secular Evolution of Disk Galaxies (Ringberg Castle, Tegernsee, Germany; May 17 – 21)
"Mapping the Stellar Kinematics of Nearby Galaxies"
SAURON **Team Meeting** (Aussois, France; June 14 – 18)
"Disentangling gas and stars in the SAURON *survey"*
The Nuclei of Galaxies (Leiden, The Netherlands; July 26 – 30)
Environment of Galaxies: From Kiloparsecs to Megaparsecs (Crete, Greece; August 9 – 13)
"Kinematic Misalignments in Nearby Galaxies"

Franx
Planets To Cosmology: Essential Science In Hubble's Final Years (Baltimore, USA; May 3–7)
"Evolution of Morphologies and Sizes"
The Quest for a Concordance Cosmology and Beyond (Cambridge, UK; June 6 – 8)
"Distant Red Galaxies at $z > 2$"
The role of mergers and feedback in Galaxy Formation (Ringberg, Germany; Nov 1 – 4)
"Distant Red Galaxies at $z > 2$"

Geers
Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May 26 – 28)
"VLT-ISAAC, TIMMI2 & SPITZER spectroscopy of circumstellar disks"
2nd TPF-Darwin Conference (San Diego, USA; July 26 – 29)
"VLT-ISAAC, TIMMI2 & SPITZER spectroscopy of circumstellar disks"
Spitzer Space Telescope: New Views of the Cosmos (Pasadena, USA; November 9 – 12)
"Spitzer IRS Observations of "Protoplanetary" Disks"

Van Genderen
Light-time Effects in Astrophysics: Causes and Cures of the $O - C$ diagram (Brussels, Belgium; July 19 – 22)
"On light-time effects in the Homunculus of η Carinae"

Hekker
SPIE (Glasgow, UK; June 21 – 25)
"Preparing the PRIMA Astrometric Planet Search: Selecting Suitable Target and Reference Stars"
The First NEON Archive Observing School (Garching, Germany; July 14 – 24)
XVI Canary Islands Winterschool "Extrasolar Planets" (Tenerife, Spain; Nov 22 – Dec 3)
"Searching for Planets around K Giants"

Hogerheijde
Radiative Transfer Modeling of Water (Leiden, NL; March 22 – 24)
"Summary of Splinter Sessions Benchmarking and Outline of Future Work"
European Workshop on Astrophysical Molecules (Zwolle, NL; February 18 – 19)
"Chemical Evolution of Protostars"
Modeling of the Structure, Chemistry, and Appearance of Protoplanetary Disks (Ringberg, April 13 – 17)
"Modeling Molecular Lines from Protoplanetary Disks"
Nederlandse Astronomen Conferentie 2004 (Vlieland, May 26 – 28)
"The Snake Pit: Jet/Cloud Interaction in the Serpens Star-forming Region"
ALMA community day (Garching, Germany; September 24)
"Spitzer Legacy Programs on Star and Planet Formation"
Dusty04 (Paris, France; October 27 – 29)
"Benchmark problems for water radiative transfer"
PLANETS Network School and Mid-term Review (Fréjus, France; Nov 28 – Dec 2)
"Observations of Protoplanetary Disks and Exoplanetesimals"
Herschel Preparatory Science Meeting (Leiden, NL; December 14 – 17)
"The H_2O Radiative Transfer Workshop"

Icke
Dutch Astrophysics Days (University of Nijmegen; April 1-2)
AstroHydro3D Dag (Groningen; April 16)

Israel
European Workshop on Astronomical Molecules (Zwolle, NL, February 18 – 20)
"CO, ^{13}CO and [CI] in Galaxy Centers"

IAU 222 (Gramado, Brasil; Feb 29 – Mar 5)
"Dense Molecular Gas in Spiral Galaxy Centers"

The Central Parsec of Galaxies (Heidelberg, Germany, October 6 – 9)
"Dust and Gas Conditions: Center versus Disk"

The Dusty and Molecular Universe (Paris, France, October 27 – 30)

Jaffe
IAU 222 (Gramado, Brazil; March 01 – 07)
"MIDI observations of NGC 1068"

SPIE General Assembly (Glascow, Scotland; June 22 – 25)
"Coherent estimation of Visibilities"

De Jong
SPIE (Glasgow, UK; June 21 – 25)
"Preliminary Software Architecture for the PRIMA Astrometric Data Analysis Facility"

Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May 26 – 28)
"GANDALF – A generic system for interactive pipeline data reduction"

Jonkheid
Benchmarking of PDR models (Leiden, the Netherlands; April 5 – 8)

Modeling the structure, chemistry and appearance of protoplanetary disks (Tegernsee, Germany; April 13 – 17)
"The gas temperature in the 1+1-D model"

Chemistry of protoplanetary disks (Heidelberg, Germany; October 11 – 13)
"The thermal balance and gas-phase chemistry in disks (with applications to HD141569)"

PLANETS Network School and Mid-term Review (Fréjus, France; Nov 29 – Dec 3)

Joergens
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
"Formation and early evolution of brown dwarfs in the Cha I star forming cloud"

SPIE (Glasgow, UK; June 21 – 25)
"Modeling of closure phase measurements with AMBER/VLTI - Towards characterization of exoplanetary atmospheres"

Cool Stars, Stellar Systems and the Sun (Hamburg, Germany; July 5 – 9)
"Towards characterization of exoplanetary atmospheres with the VLT Interferometer"

Annual Meeting of the Astronomische Gesellschaft (Prague, Czech Republic; Sept 20 – 25)
"Origins of brown dwarfs"
"Towards characterization of exoplanetary spectra with the VLT Interferometer"

VLTI/MIDI School for Data Reduction, Analysis and Science (Leiden, NL; October 11 – 15)

XVI Canary Islands Winterschool "Extrasolar Planets" (Tenerife, Spain; Nov 22 – Dec 3)
"Towards characterization of exoplanetary atmospheres with the VLT Interferometer"

Jørgensen
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
"Tracing the Physical and Chemical Evolution of Low-Mass Protostars"
Interstellar and Circumstellar Meeting (Amsterdam, The Netherlands; June 14)
"Tracing the Physical and Chemical Evolution of Low-Mass Protostars"
Star and Planet Formation Internal Symposium (Cambridge, US; Sept 13 – 15)
"Tracing the Physical and Chemical Evolution of Low-Mass Protostars"

Ten Kate
European Geosciences Union, 1st General Assembly (Nice, France; April 25 – 30)
"Amino Acids under simulated Mars conditions"
"MARS-X: an atonomous X-ray diffraction & fluorescence instrument for use on Mars"
International Mars Conference (Ischia, Italy; September, 19 – 26)
"Amino acids under simulated Mars conditions"

Katgert
Magnetic Fields in Galaxies (Leiden, The Netherlands; July 5 – 8)
"The polarized Galactic radio background"

Knudsen
203rd Meeting of the American Astronomical Society (Atlanta, USA; January 5 – 8)
"A new deep SCUBA survey of gravitationally lensing clusters"

Krajnović
SAURON **team meeting** (Aussois, France; June 14 – 18)
The Nuclei of Galaxies (Leiden, The Netherlands; July 26 – 30)

Kriek
Jerusalem Winter School on the origin of Galaxies (Israel; Dec 29 ('03) - Jan 8)
FIRES workshop (Leiden; September 13–17)

Kuijken
OmegaCAM meeting (Naples, Italy; Jan 14 – 15)
SISCO Meeting (Heidelberg, Germany; Mar 8 – 9)
"Status of OmegaCAM"
OmegaCAM Prelim. Acceptance Europe (Garching, Germany; Apr 1 – 2 & June 16–18)
IAU 225 (Lausanne, Switzerland; July 18 – 24)
"Accurate Shear Measurements from Shapelets"
COSMO'04 (Toronto, Canada; Sept 17 – 21)
"Weak lensing surveys with OmegaCAM"

Mathar
VLTI PAOS Progress Meeting (Leiden, The Netherlands; Sept 29 – Oct 1)
"PRIMA Astrometric Observations: Dispersion Correction"

McDermid
SPIE (Glasgow, UK; June 21 – 26)
"Adaptive Optics Assisted Integral FIeld Spectroscopy with OASIS and NAOMI"

Meijerink
European Workshop 2004 on Astronomical Molecules (Zwolle; February 17 – 20)
IAU 222 (Gramado, Brazil; March 1 – 5)
"Diagnostics of Dense Irradiated Gas around Galaxy Nuclei"
Dutch Astrophysics Days IV (Nijmegen, The Netherlands; April 1 – 2)
"Diagnostics of Dense Irradiated Gas around Galaxy Nuclei"
Benchmarking of PDR-models (Leiden, The Netherlands; April 5 – 8)

Meisner
SPIE (Glasgow, UK; June 21 – 26)
"Coherent integration of complex fringe visibility employing dispersion tracking"

Mellema
Dutch Astrophysics Days IV (Nijmegen, The Netherlands, April 1 – 2)
"Measuring the distances to planetary nebulae"
Numerics of disk-planet interaction (Stockholm, Sweden, May 6 – 7)
"Planets in Disks, a new method"
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands, May 26 – 28)
"Planets in Dusty Gas Disks"
PLANETS Network School and Mid-term Review (Fréjus, France, Nov 29 – Dec 2)
"Planets in Dusty Gas Disks"

Miley
Workshop on new radio facility in Australia (Oahu, USA; March 20 – 22)
Penetrating Bars throgh Masks of Cosmic Dust (Bakubung, South Africa; June 7 – 11)
"Distant $z \geq 2$ Protoclusters and their Galaxies"
ACS Science Team Annual Meeting (Aspen, USA; September 27 – 30)
"The ACS Distant Radio Galaxy GTO Program"

Overzier
XXI Jerusalem Winter School in Theoretical Physics (Jerusalem, Israel; Dec 29 – Jan 8)
"HST/ACS observations of a protocluster at $z = 4.1$."
Annual Meeting of the RTN Network "Physics of the IGM" (Oegstgeest; Sep 12 – 16)
"X-ray observations of the ISM of $z > 2$ radio galaxies."
ACS Science Team Meeting (Aspen, USA; Sep 26 – Oct 9)
"Observations of protoclusters at $z = 4.1$ and $z = 5.2$."

Paardekooper

Dutch Astrophysics Days IV (Nijmegen; April 1–2)

Numerics of disk-planet interaction (Stockholm, Sweden; May 6 – 7)
"Performance of the Roe solver on the comparison problem"

Nederlandse Astronomen Conferentie 2004 (Vlieland; May 26 – 28)
"Planets in Disks: Gas and Dust Dynamics"

PLANETS Network School and Mid-term Review (Fréjus, France; Nov 29 – Dec 2)
"Planets opening dust gaps in gas disks"

Pelupessy

XXIV Moriond Astrophysics Meeting (La Thuile, Italy; march 21 – 28)
"Periodically bursting star formation in dwarf irregulars"

Dutch Astrophysics Days IV (Nijmegen, Netherlands; april 1 – 2)
"Dwarf irregular galaxies"

Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands; May 26 – 28)
"Star formation and molecular gas in dwarf galaxies"

Pontoppidan

Nederlandse Astronomen Conferentie 2004 (Vlieland, Netherlands, May 26 – 28)
"Observations of the chemistry, structure and distribution of interstellar ice"

National Astronomy Meeting of the RAS (Milton Keynes, UK, March 29 – April 2)
"Mid-Infrared Spectroscopy as a Probe of Chemistry in Molecular Clouds"

The Spitzer Space Telescope: New Views of the Cosmos (Pasadena, USA; November 9 – 12)
"Mapping of Ices on Sub-arcminute Scales with Ground-based and Spitzer Spectroscopy"

PLANETS Network School and Mid-term Review (Fréjus, France; December 1 – 3)
"Review of infrared observations of circumstellar disks"

Quirrenbach

AAS Annual Meeting (Atlanta, USA; Jan 4–6)

Astronomical Polarimetry: Current Status and Future Directions (Kona, USA; Mar 15–19)
"Polarization in Optical / Infrared Interferometry"
"Spectropolarimetry of CH_4 *Bands of Solar System Planets"*

Astrobiology Science Conference (NASA AMES, USA; Mar 28–31)

Exploring the Cosmic Frontier: Astrophysical Instruments for the 21st Century (Berlin, Germany; May 17–21)
"Prospects for an Extremely Large Synthesis Array"

AAS Annual Meeting (Denver, USA; May 31–Jun 3)
"The HST/STIS Coronagraphic Survey of Pre-Main Sequence Stars"

Astronomical Telescopes and Instrumentation (Glasgow, UK; Jun 20–25)
"CHEOPS/ZIMPOL: a VLT Instrument Study for the Polarimetric Search of Scattered Light from Extrasolar Planets"
"The Science Case of the CHEOPS Planet Finder for VLT"
"The Second-Generation VLT Instrument MUSE: Science Drivers and Instrument Design"

"Instruments for a European Extremely Large Telescope: the Challenges of Designing Instruments for 30- to 100-m Telescopes"
"Generalized Sky Coverage for Adaptive Optics and Interferometry"
"Interferometric High-Resolution Spectroscopy"
"The PRIMA Astrometric Planet Search Project"
"Modeling of Closure Phase Measurements with AMBER/VLTI: Toward Characterization of Exoplanetary Atmospheres"
"Preparing the PRIMA Astrometric Planet Search: Selecting Suitable Target and Reference Stars"
"PRIMA Astrometry Operations and Software"
"Design Considerations for an Extremely Large Synthesis Array"

Bioastronomy 2004: Habitable Worlds (Reykjavik, Iceland; Jul 12–16)

Second Terrestrial Planet Finder/Darwin International Conference: Dust Disks and the Formation, Evolution and Detection of Habitable Planets (San Diego, USA; Jul 25–29)
"Astrometry Operations and Software for VLTI/PRIMA"
"Towards High-precision Astrometry: Differential Delay Lines for PRIMA at VLTI"
"The Challenge of Astrometric Planet Searches: How to Select Proper Target Stars"

Science Case for Next Generation Optical/Infrared Interferometric Facilities (Liège, Belgium; Aug 23–26)
"Extremely Large Synthesis Array"

JENAM '04: The Many Scales in the Universe (Granada, Spain; Sep 17–18)
"Planet Detection with Interferometry and Large Telescopes"

Reffert

SPIE (Glasgow, UK;June 21 – 25)
"Preparing the PRIMA Astrometric Planet Search: Selecting Suitable Target and Reference Stars"

Astrometry in the Age of the Next Generation of Large Telescopes (Flagstaff, USA; Oct 18 – 20)
"Choosing Suitable Target, Reference and Calibration Stars for PRIMA"

Reuland

Emission line halos: recent observations and modeling (Leiden, The Netherlands; June 20)
"Emission Line Nebulae Around High-z Radio Galaxies: Evidence for Feedback in Galaxy Formation"

RTN: Physics of the intergalactic medium (Leiden, The Netherlands; September 12 – 16)
"Emission Line Nebulae Around High-z Radio Galaxies: Evidence for Feedback in Massive Galaxy Formation"

NOVA fall school (Dwingeloo, The Netherlands; October 6 – 10)
"High Redshift Radio Galaxies: Probes of Massive Galaxy Formation"

Rijkhorst
FLASH/AMR workshop (Durham, UK, June 14-18)
"Simulating Planetary Nebulae: A Radiation Transport Module for Flash"

IGM network meeting (Leiden, Netherlands, September 13-16)

BlueGene/L Workshop (Groningen, Netherlands, December 7-8)

Ritzerveld
Dutch Astrophysics Days IV (Nijmegen, The Netherlands; April 01 – 04)

Oort Workshop: CMB and first objects at the end of the dark ages (Leiden, The Netherlands; April 26 – 28)

Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
"Poster"

Galaxy-Intergalactic Medium Interactions Conference (Santa Barbara, US; October 25 – 29)

Röttgering
The structure and composition of Active Galactic Nuclei: Optical interferometry and adaptive optics of NGC 1068 (Leiden, The Netherlands; Jan 12 – 14)
"NGC 1068: An introduction"

TPF Science working group (Pasadena, USA; Feb 24 – 25)

The Science Potential of a 10-30m UV/VIS Space Telescope (Baltimore, USA; Feb 26 – 27)
"The Clustering of Galaxies in the Early Universe"

XMM-LSS consortium meeting (Saclay, Paris, France; March 1 – 3)

ESA's Terrestrial Exo-planet Science Advisory Team (Estec, Noordwijk; Mar 17 – 18)

TPF General Astrophysics Meeting (Princeton, USA, Apr 14 – 15)
"Darwin, a brief status report"
"Darwin/TPF – I and extragalactic astrophysics"

VLTI Science Demonstration Team meeting (ESO, Garching, Germany; June 17 – 18)

SPIE (Glasgow, UK; June 20 – 22)
"Observing NGC 1068 with the VLT interferometer"

ESA's Cosmic Vision 2015 – 2025 Workshop (Paris, France; Sept 15 – 16)

TPF Science working group (Washington; USA; Oct 11 – 14)

Midi science team meeting (Heidelberg, Germany; Nov 28 – 29)

ESA's Terrestrial Exo-planet Science Advisory Team (Heidelberg, Germany; Dec 9 – 10)
"Imaging with Darwin"

Schilizzi
Astronomy in the 21st Century (Berlin, Germany; May 19 – 21)
"The Square Kilometre Array"

SPIE (Glasgow, UK; June 21 – 24)
"Science with the SKA"

Schnitzeler
Ninth Synthesis Imaging Summer school (Socorro, United States; June 14 – 23)
Leiden workshop on magnetic fields in galaxies (Leiden, The Netherlands; July 5 – 8)
"Magnetic field information from the single-frequency WENSS survey"
Diffuse matter in the Galaxy (Arecibo, Puerto Rico; August 29 – September 2)
"Poster: A WENSS perspective of the Galactic ISM"

Snellen
RAS Meeting (London, UK; November 12)
"Probing the atmospheres of exoplanets using the Rossiter effect"

Snijders
Nederlandse Astronomen Conferentie 2004 (Vlieland; May 26 – 28)
"Poster: Obscured star formation in The Antennae"
SINFONI Science Day (Leiden; June 01)
Starbursts: From 30 Doradus to Lyman Break Galaxies (Cambridge, UK; September 6 – 10)

Van Starkenburg
Starbursts: From 30 Doradus to Lyman Break Galaxies (Cambridge, UK; September 6 – 10)
"Poster: The $z \sim 1.5$ *Tully-Fisher relation"*

Stuik
Polarimetry 2004 (Hawaii, USA; March 14-19)
"Instrumental Polarization in CHEOPS: Exoplanet Detection and Characterization"
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26-28)
"CHEOPS - Direct exoplanet detection from the ground"
SPIE (Glasgow, UK; June 20-25)
"Characterization of Deformable Mirrors for High-Order Adaptive Optics Systems"
"Generalized Sky Coverage for Adaptive Optics and Interferometry"
Michelson Summer School 2004 (Pasadena, USA; July 19-24)
Second Darwin/TPF International Conference (San Diego, USA; July 26-29)

Tasse
Oort Workshop - CMB and first Objects at the end of the Dark ages. (Leiden, The Netherlands; April 26 – 28)

Tubbs
SPIE (Glasgow, UK; June 21 – 25)
"Differential phase delay observations with VLTI-MIDI at N-band"
"Seeing timescales for large-aperture optical/infrared interferometers from simulations"
MIDI Science Group (Heidelberg, Germany; November 29 – 30)
"Accuracy of MIDI differential phase measurements and their use for detecting faint companions"

Van de Ven
Dutch Astrophysics Day (Nijmegen, The Netherlands; April 1 – 2)
"Dynamical models of stellar systems"
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May26 – 28)
"The dynamical distance and intrinsic structure of the globular cluster ω Centauri"
SAURON **Team meeting** (Aussois, France; June 13 – 19)
International Workshop on The Nuclei of Galaxies (Leiden, The Netherlands; July 26 – 30)
"Recovery of the Distribution Function & Triaxial Modelling"

Venemans
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
The Quest for a Concordance Cosmology and Beyond (Cambridge, UK; July 5 – 9)
Annual Meeting of the RTN Network "Physics of the IGM" (Oegstgeest; Sep 12 – 16)
"High redshift protoclusters and their galaxies"

Webb
IAU Colloquium No 195, The Outskirts of Galaxy Clusters (Torino, Italy; March 12 – 16)
"A Submm Survey of High-Redshift Galaxy Clusters: A Submm Butcher-Oemler Effect?"
ALMA Science Workshop (Maryland, USA; May 14 – 15)
CASCA 2004 (Winnipeg, Canada; June 13 – 16)
"A Submm Survey of High-Redshift Galaxy Clusters: A Submm Butcher-Oemler Effect?"
Toward Large Submm Dishes: Science Drivers and Technical Challenges (Edinburgh, UK; October 20 – 22)

Weijmans
SAURON **team meeting** (Aussois, France; June 14 – 18)

Van der Wel
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Nederlands; May 26 – 28)
"The Fundamental Plane at Redshift One"
Massive Galaxies over Cosmic Time (Baltimore, USA; September 27 – 29)
"The Fundamental Plane at Redshift One"

Van der Werf
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May 26 – 28)
"Starburst galaxies at low and high redshift"
Starbursts - from 30 Doradus to Lyman Break Galaxies (Cambridge, UK; September 6 – 10)
"Dissecting starburst galaxies with infrared observations"

Woitke
Dutch Astriophysics Days (Nijmegen, The Netherlands, January 1 – 2)

Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands: May 26 – 28)
"Are dust shells around AGB stars Rayleigh-Taylor unstable?"

Cool Stars, Stellar Systems and the Sun 13 (Hamburg, Germany, Juli 5 – 9)
"2D dynamical models for dust-driven winds of AGB stars"

The Dusty and Molecular Universe. A prelude to HERSCHEL and ALMA (Paris, France, October 27 – 29)
"2D Models for the Winds of AGB Stars"

BlueGene workshop (Groningen, The Netherlands, December 7 – 8)

Wuyts
Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May26 – 28)

The Quest for a Concordance Cosmology and Beyond (Cambridge, England; July 5 – 9)

FIRES: The Study of Near-IR Selected High Redshift Galaxies (Leiden, The Netherlands; September 13 – 17)
"Optical spectroscopy of J-K selected galaxies"

De Zeeuw
STScI May Symposium: Planets to Cosmology (Baltimore, USA, May 3 – 6)
"Invited review: Galaxy Centers"

Nederlandse Astronomen Conferentie 2004 (Vlieland, The Netherlands; May26 – 28)

SAURON **Team meeting** (Aussois, France; June 13 – 19)

Workshop: Galactic Nuclei (Lorentz Center, Leiden, July 26 – 30)
"Concluding talk: The SAURON *project"*

Conference: The Three-dimensional Universe with Gaia (Meudon, France, October 4 – 7)
"Conference Summary: Gaia and Astrophysics in 2015 – 2020"

Appendix VII

Observing sessions abroad

Observing sessions abroad

Appendix VII

Van Dishoeck
JCMT (Hawaii, USA; August 15 – 19)

Bisschop
JCMT (Hawaii, USA; August 15 – 21)

Falcón-Barroso
Calar Alto, 3.5m Telescope (Almeria, Spain; November 6 – 8)

Franx
Keck Observatory (Hawaii, USA; February 9 – 10)
Gemini-South (Cerro Pachon, Chile; March 2 – 5)

Hekker
TNG (La Palma, Spain; January 9, March 28 & May 9)
Lick Observatory (Mount Hamilton, USA; June 11 – 16, August 13 – 17 & September 16 – 22)
TNG (La Palma, Spain; September 27 & October 28)
Lick Observatory (Mount Hamilton, USA; November 9 – 15)
TNG (La Palma, Spain; December 23)

Israel
ESO (La Silla, Chile; February 24 – March 5 & March 13 – 19)

Jaffe
ESO (Paranal, Chile; May 28 – June 5 & August 2 – 10)

Joergens
ESO (Paranal, Chile; March)

De Jong
ESO (Paranal, Chile; Jan 25 – Feb 11 & August 3 – 8)

Kuijken
WHT (La Palma, Spain; Apr 11 – 17)

Kriek
Gemini-North (Hawaii, USA; March 4 – 6)
ESO (Paranal, Chile; April 25 – 27)

Gemini-South (Cerro Pachon, Chile; September 1 – 5)

McDermid
WHT (La Palma, Spain; January 20 – 28, June/July 28 – 5 & December 10 – 20)

Meijerink
JCMT (Hawaii, USA; January 1 – 5)

Quirrenbach
ESO (La Silla, Chile; Jan 17-20)
Lick (Mt. Hamilton, CA, USA; Aug 13–18)
ESO (Paranal, Chile; Nov 9)

Reffert
TNG (La Palma, Spain; January 9)
ESO (La Silla, Chile; January 18 – 19 & March 22 – 23)
Lick Observatory (Mount Hamilton, CA, USA, June 11 – 17 & July 18 – 24)
Lick Observatory (Mount Hamilton, CA, USA, October 7 – 14 & December 13 – 19)

Röttgering
GMRT (Pune, India; April 21 -26)
ING (La Palma, Spain, May 13-18)
ESO (Paranal, Chile; Oct 29 - Nov 2)

Stuik
WHT (La Palma, Spain, September 24-27)

Stuwe
ESO (Chile, April 23 – 24 & April 28 – May 1)
ESA OGS(Tenerife, May 16 – 30 & November 21 – 27)

Tasse
GMRT (Pune, India; August 1 – 5)

Venemans
INT (La Palma, Spain; May 8 – 14)

Webb
JCMT (Hawaii, USA; April 18 – 24)
CFHT (Hawaii, USA; May 25-28)
Magellan Telescope (Las Campanas Observatory, Chile; October 25 – 27)
JCMT (Mauna Kea, Hawaii; December 4 – 17)

Van der Werf
ESO (Paranal, Chile; April 21 – 30)

Appendix VIII

Working visits abroad

Sterrewacht Leiden

Working visits abroad

Appendix VIII

Augereau
OCA (Nice, France; February 25 – 29)
IAP (Paris, France; March 19 – 24)
LAOG (Grenoble, France; Apr 23 – May 10, June 28 – July 9, Aug 30 – Sept 6 & Dec 7 – 10)

Brandl
Cornell University (Ithaca, USA; July 10 – 16)

Brown
Universitat de Barcelona (Barcelona, Spain; February 2 – 4)

Cappellari
Astronomy department (Padova, Italy; September 27 – 30)

Van Dishoeck
CSL (Liège, Belgium; February 5)
ESO (Garching, Germany; March 16 & 25, September 23 – 24, October 19 & November 22)
Cavendish Laboratory (Cambridge, UK; May 10 – 11)
Caltech (Pasadena, USA; August 8 – 13 & November 8)
ESA (Paris, France; September 16)
NRAO (Charlottesville, USA; September 27 – 28)
MPIA (Heidelberg, Germany; October 11 – 12 & November 15 – 16)
JPL (Pasadena, USA; November 12)

Falcón-Barroso
Astrophysikalisches Institut Potsdam (Potsdam, Germany; February 26 – 27 & April 28 – 30)
Centre de Recherche Astronomique de Lyon (Lyon, France; October 19 – 22)

Franx
Yale University (New Haven, USA; February 4-7)
Harvard Smithsonian Center for Astrophysics (Cambridge, USA; May 3, 4 & 6)
ESO (Garching, Germany; September 1 – 2)
Aspen Institute for Physics (Aspen, USA; September 26 – October 2)
MPIA (Heidelberg, Germany; November 5)
Harvard Smithsonian Center for Astrophysics (Cambridge, USA; December 6)
Yale University (New Haven, USA; December 7 – 11)
University of California (Santa Cruz, USA; December 12 – 16)

Hekker
MPIA (Heidelberg, Germany; March 8)

Israel
HIFI Science Team Meeting (Bordeaux, France; February 15 – 18)
EPN Editorial Board Meeting (Birmingham, UK, October 23)

Jaffe
MPIA (Heidelberg, Germany; January 14 – 16, April 18 – 21 & November 28 – 30)
Geneva Observatory (Geneva, Switzerland; Feb 12 – 13)
Bristol University (Bristol, England; Nov 01 – 07)

De Jong
ESO (Garching bei München, Germany; January 22 – 23 & October 18 – 22)

Joergens
MPIA (Heidelberg, Germany; January 15 – 16)

Katgert
Osservatorio Astronomico (Trieste, Italy; Sept 13 – 22)

Knudsen
CfA (Cambridge, USA; January 13)
UMass (Amherst, USA; January 15)
STScI (Baltimore, USA; January 30)

Kriek
Yale University (New Haven, USA; July 1 – August 30)

Kuijken
Columbia University (New York, USA; Jun 28 – 29)
MPE (Garching, Germany; Sep 02)
Bonn Astrophysics (Bonn, Germany; Nov 10)

McDermid
Observatoire de Lyon (Lyon, France; March 8 – 12)
Observatoire de Lyon (Lyon, France; October 6 – 8)
IASF (Milan, Italy; November 23 – 26)
ING (La Palma, Spain; December 16 – 18)

Meisner
ESO (Garching, Germany; August 23 – 28)

Mellema
CITA (Toronto, Canada; 31 May - 12 June)
Stockholm Observatory(Stockholm, Sweden, December 19-23)

Miley
ESO (Vitacura, Chile; January 10 – 29)
ESO (Garching, Germany; February 10 – 10)
JHU (Baltimore, USA; March 30 – April 5, October 1 – 4 & December 14 – 15
EU Schoolnet (Brussels, Belgium; April 10, April 20 – 21, June & July)
Universidad Cattolica (Santiago, Chile; December 6 – 10)
NRAO (Santiago, Chile; December 13 – 13)

Overzier
Johns Hopkins University (Baltimore, USA; Jan 14 – July 10 & Sept 15 – Dec 20)

Paardekooper
IAP (Paris, France; June 7 – 8)

Pontoppidan
ESO (Garching, Germany; Jan 15 – 17)
Caltech (Pasadena, USA; November 12 – 15)
Herzberg Institute for Astrophysics (Victoria, Canada; November 15 – 17)

Quirrenbach
University (Nice, France; January 7 – 8)
ESA (Paris, France; January 15 – 16, May 13 – 14, September 15 – 16 & December 8 – 10)
ESO (Santiago, Chile; January 20 – 30)
University (Geneva, Switzerland; February 11 – 14)
ESO (Garching, Germany; March 1, May 17, May 25 – 26, June 18, November 23 – 24 & December 15 – 16)
UCSD (San Diego, CA, USA; March 11 – 13)
OPTICON (Gent, Belgium; April 1 – 2)
MPIA (Heidelberg, Germany; April 19, June 15 & November 29 – 30)
University (Hamburg, Germany; April 26)
OPTICON (Heidelberg, Germany; Sep 24)
Astrium (Friedrichshafen, Germany; Oct 6)
Nexus (Berlin, Germany; October 22 – 24)
Caltech (Pasadena, USA; October 27 – 29)

Reffert
MPIA (Heidelberg, Germany; March 8)
IPAC (Pasadena, USA; April 5)

Reuland
Research School of Astronomy & Astrophysics ANU (Canberra, Australia; May 11 – June 9)

Rijkhorst
ASC Flash Center (Chicago, USA; March 28-May 14)

Röttgering
CEA (Saclay, France; Dec 16-17)

Schnitzeler
CfA (Cambridge, USA; June 23 – 26)

Snellen
ESO (Garching, Germany; November 23 – 24)
MPE (Garching, Germany; November 25 – 26)
Insitute for Astronomy (Edinburgh, UK; December 14 – 15)

Stuik
ING (Santa Cruz de La Palma, Spain, September 28 – 29)
ESO (Garching, Germany, January 11 – 16, February 26 – 27 & December 15 – 16)
MPIA (Heidelberg, Germany, January 25 – 30 & September 12 – 15)
ETHZ (Zurich, Switzerland, March 9)
LAOG (Grenoble, France, September 15 – 18)

Tasse
NRL (Washington, USA; January 19 – 23 & December 13 – 17)

Tubbs
ESO (Garching, Germany; February 24 – April 24)

Venemans
Carnegie Observatories (Pasadena, USA; November 29 – 30)
California Institute of Technology (Pasadena, USA; December 1)
University of California Berkeley (Berkeley, USA; December 2 – 6)
University of California Santa Cruz (Santa Cruz, USA; December 7)
Harvard-Smithsonian Center for Astrophysics (Cambridge, USA; December 9 – 10)
Johns Hopkins University Center for Astrophysical Sciences (Baltimore, USA; Dec 13 – 15)

Webb
Istituto di Astrofisica Spaziale e Fisica Cosmica (Milan, Italy; November 8 – 11)

Van der Ven
Berkeley University (Berkeley USA; November 29 – 30)
CITA (Toronto, Canada; December 2 – 4)
CfA (Cambridge, USA; December 6)
Princeton (Princeton, USA; December 7 – 8)
STScI (Baltimore, USA; December 9 – 10)

Van der Wel
Yale University (New Haven, USA; October 4 – 30)

Van der Werf
Observatoire de Bordeaux (Bordeaux, France; February 15 – 18)
Observatoire de Paris (Meudon, France; March 18 – 19)
Max-Planck-Institut für extraterretrische Physik (Garching, Germany; April 7 – 8)
University of Saskatoon (Saskatoon, Canada; April 15 – 17)
Royal Observatory (Edinburgh, UK; September 2 – 3)
University of Sussex (Brighton, UK; September 21 – 23)
Observatoire de Lyon (Lyon, France; October 21 – 22)
Joint Astronomy Centre (Hilo, Hawaii, USA; November 7 – 9)

Woitke
Zentrum fuer Astronomie und Astrophysik Berlin, Germany; June 7 – 12

Wuyts
Yale University (New Haven, USA; January 20 – March 21)

De Zeeuw
Space Telescope Science Institute (Baltimore, USA; February 9 – 10 & March 11 – 12)
University of California (Los Angeles, USA; February 18 – 19)
Global Science Forum (Washington DC, USA; April 5 – 6)
European Southern Observatory (Garching, Germany; Apr 22, June 6 – 8, Aug 26 & Dec 7 – 8)
AURA (Annapolis, USA; April 28 – May 1)
Space Telescope Science Institute (Baltimore, USA; May 2 – 6 & November 22 – 24)
Gran Telescopio de Canarias (La Palma, Spain; May 31 – June 2)
Observatoire de Lyon (Lyon, France; June 19)
ESA Headquarters (Paris, France; June 28 – 29)
AURA (Chicago, USA; June 28 – 29)
Carnegie Observatories (Pasadena, USA; September 13 – 14)
Dipartimento de Astronomia (Padova, Italy; September 21 – 22)
Ministry of Foreign Affairs (Roma, Italy; September 30 – October 1)
Observatoire de Paris (Meudon & Paris, France; October 4 – 7)
Astron. Dept. Univ. of Texas (Austin, USA; October 31 – November 6)
Penn State University (State College, USA; November 26)

Appendix IX

Colloquia given outside Leiden

Colloquia given outside Leiden

Appendix IX

Andersson

The Current Status of the Use of Approximate Density Functionals for Chemical Kinetics	University of Latvia, Riga, Latvia; June 22

Brandl

Massive star formation as seen by Spitzer	MPIA, Heidelberg, Germany; March 1
Starburst Studies with the Spitzer Space Telescope	Kapteyn Institute, Groningen; Dec 13

Brown

GAIA - Taking the Galactic Census: Current Status and Activities	Anton Pannekoek, Amsterdam; March 26

Van Dishoeck

ALMA: science drivers and recent developments	Princeton University Observatory, USA; February 9
Evolution of Gas and Dust in Star-Forming Regions	Institute for Advanced Study, Princeton, USA; February 10
Evolution of Ices in Star-Forming Regions	ESO, Garching, Germany; November 22

Franx

A new population of red, distant galaxies	ETH, Zurich, November 16

Hogerheijde

Molecular Views of Planet-forming Disks	Sterrenkundig Instituut Utrecht; Dec 15

Icke

The elegant Universe	Paleis op de Dam, Amsterdam; March 17
Hoe filosofisch is mijn sterrenkunde?	Dept. of Philosophy, Groningen; May 12
Fermi, Pasta, Ulam, BANG!	Leiden University
Hydrodynamica van het Heelal	Delft Aerodynamics, TU Delft; June 9
Radiation Hydrodynamics	Kern Versneller Instituut, Groningen Univ.
De kosmologische constante	Nederlandse Vereniging voor Wetenschaps Filosofie, Utrecht; November 27
Oscillating Giant Stars	University of Groningen; November 29

Israel

Schiettent Aarde	TB, TU Delft; May 13
Von protoplanetaren Scheiben zu Planeten	Astrophysical Inst., Jena, Germany; June 13

Knudsen

A new deep SCUBA survey of gravitationally lensing clusters	CfA, Cambridge, USA; January 13
Idem	UMass, Amherst, USA; January 15
Idem	STScI, Baltimore, USA; January 30

McDermid

The Structure of Early-Type Galaxies with SAURON	ASTRON, Dwingeloo; November 5

Mellema

Cool gas in radio galaxies	CITA, Toronto, Canada; June 3
Photo-evaporating Flows	Stockholm Observatory, Sweden; Dec 21

Messineo

SiO maser stars in the inner Galaxy	MPIfR, Bonn, Germany; August 06

Miley

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

Overzier

HST/ACS observations of galaxies in protoclusters	Johns Hopkins University, Baltimore, USA; Oct 26

Paardekooper

Planets opening dust gaps in gas disks	IAP, Paris, France; June 7

Pontoppidan

Mid-infrared spectroscopy as a probe of chemistry in molecular clouds	ESO, Garching, Germany; January 16
The astrophysics of interstellar ice	HIA, Victoria, Canada; November 16

Quirrenbach

Stellar Interferometry: a Look at the Milliarcsecond Universe	MPIA, Heidelberg, Germany; January 12
Science with Optical / Infrared Interferometry	ESO, Santiago, Chile; January 28
Extrasolar Planets with the VLTI	University, Liège, Belgium; Feb 20
Stellar Interferometry: The Milliarcsecond Universe	University, Bochum, Germany; May 24
Stellar Interferometry: a Look at the Milliarcsecond Universe	University, Sao Paulo, Brazil; November 4

Reffert

Upper Mass Limits for Known Radial Velocity Planets from Hipparcos Intermediate Astrometric Data	Cerro Calan, Santiago, Chile; January 21

Reuland

Gas, Dust and Star formation in Distant Radio Galaxies	RSAA, ANU, Canberra, Australia; June 7

Rijkhorst

Multipolar Planetary Nebulae with Flash: A Radiation Transport Algorithm for AMR Methods	ASC Flash Center, Chicago, USA; April 5

Ritzerveld

Triangulating Radiation: Radiative Transfer on Unstructured Grids	Kapteyn Institute, Groningen, The Netherlands; February 2
Triangulating Radiation: A New Approach to Radiative Transfer	University of Utrecht, The Netherlands; December 8

Röttgering

The evolution of clustering of galaxies and AGN and the quest for proto-clusters	Department of Physics, University of Durham, UK; Mar 10

Schilizzi

The Square Kilometre Array	NRAO, Socorro, USA; April 7
Idem	NRAO, Charlottesville, USA; April 13
The SKA and its scientific potential	MPIfR, Bonn; April 30
Ground-based radio interferometry	TU Delft, The Netherlands; June 9
The SKA and its scientific potential	Cavendish, Cambridge, UK; June 15
Idem	ASTRON & JIVE, Dwingeloo; July 2
Idem	Auckland University of Technology, NZ; Dec 14

Schnitzeler

A WENSS view of the Galactic ISM	CfA, Cambridge, United States; June 25

Snellen

Extra-solar Planet Transits	Cavendish, Cambridge, UK, November 16

Stuik

MUSE and CHEOPS: Future AO assisted instrumentation on the VLT	ASTRON, Dwingeloo, The Netherlands, May 7

Van de Ven

The dynamical distance and intrinsic structure of the globular cluster ω Centauri	Berkeley University, Berkeley, USA; November 29
Idem	CITA, Toronto, Canada; December 2
Idem	CfA, Cambridge, USA; December 6
Idem	Princeton, USA; December 8
Idem	STScI, Baltimore, USA; December 10

Venemans

Protoclusters associated with distant radio galaxies	Carnegie Observatories, Pasadena, USA; November 29
Idem	Caltech, Pasadena, USA; November 30
Idem	University of California Santa Cruz, USA; December 7
Idem	Harvard-Smithsonian Center for Astrophysics, Cambridge, USA; December 9
A study of distant Ly-alpha emitters in overdense regions	Johns Hopkins University Center for Astrophysical Sciences, Baltimore, USA; Dec 14

Webb

Uncovering the Hidden Phases of Galaxy Formation	University of Calgary, Canada; Sept 15
Idem	McGill University, Montreal, Canada; March 18

Woitke

Multi-dimensional Wind Models for Carbon Stars	TU Berlin, Germany; June 9
Multi-dimensional Models for Dust-driven AGB Star Winds	Groningen University; October 11
Idem	Amsterdam University, November 5

De Zeeuw

NOVA Strategy	National Strategy Discussion, Amersfoort; September 20
SAURON & The Fossil Record of Galaxy Formation	Dipartimento de Astronomia, Padova, Italy; September 28

Appendix X

Scientific publications

Sterrewacht Leiden

Scientific publications

Appendix X

X.1 Ph.D. theses and books

J.K. Jørgensen, Tracing the physical and chemical evolution of low-mass protostars, Ph.D. thesis, Leiden University, October 2004.

K. Kraiberg Knudsen, Deep submillimetre observations of faint dusty galaxies, Ph.D. thesis, Leiden University, October 2004.

D. Krajnović , On the nature of early-type galaxies, Ph.D. thesis, Leiden University, October 2004.

I. Labbé, Deep infrared studies of massive high redshift galaxies, Ph.D. thesis, Leiden University, October 2004.

M. Messineo, Late type giants in the Inner Galaxy, Ph.D. thesis, Leiden University, June 2004.

K.M. Pontoppidan, Fire and ice, Ph.D. thesis, Leiden University, October 2004.

R. Ruiterkamp, Aromatic moleculus in space, Ph.D. thesis, Leiden University, October 2004.

X.2 Papers in refereed journals

A. Al-Halabi, **E.F. van Dishoeck**, and G.J. Kroes, Sticking of CO to crystalline and amorphous ice surfaces, *Journal of Chemical Physics* **120 (7)**, 3358–3367.

A. Al-Halabi, **H. J. Fraser**, G. J. Kroes, and **E. F. van Dishoeck**, Adsorption of CO on amorphous water-ice surfaces, *Astron. Astrophys.* **422**, 777–791.

S. Andersson and M. Gruning, Performance of density functionals for calculating barrier heights of chemical reactions relevant to astrophysics, *Journal of phys. chem. A* **108 (37)**, 7621–7636.

L. Armus, V. Charmandaris, H. W. W. Spoon, J. R. Houck, B. T. Soifer, **B. R. Brandl**, P. N. Appleton, H. I. Teplitz, S. J. U. Higdon, D. W. Weedman, D. Devost, P. W. Morris, K. I. Uchida, J. van Cleve, D. J. Barry, G. C. Sloan, C. J. Grillmair, M. J. Burgdorf, S. B. Fajardo-Acosta, J. G. Ingalls, J. Higdon, L. Hao, J. Bernard-Salas, T. Herter, J. Troeltzsch, B. Unruh, and M. Winghart, Observations of Ultraluminous Infrared Galaxies with the

Infrared Spectrograph (IRS) on the Spitzer Space Telescope: Early Results on Markarian 1014, Markarian 463, and UGC 5101, *Astrophys. J. Suppl. Ser.* **154**, 178–183.

O. Asvany, S. Schlemmer, and D. Gerlich, Deuteration of CHn+ (n=3-5) in collisions with HD measured in a low-temperature ion trap, *Astrophys. J.* **617 (1)**, 685–692.

J. C. Augereau and J. C. B. Papaloizou, Structuring the HD 141569A circumstellar dust disk. Impact of eccentric bound stellar companions, *Astron. Astrophys.* **414**, 1153–1164.

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