Research Institute Leiden Observatory

(Onderzoekinstituut Sterrewacht Leiden)

Annual Report 2002

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Front cover:	Circumstellar disk warped by a tenuous stellar wind. (Work by Rijkhorst and Icke, see Section 2.10.2)
Back cover:	Up: VLT Ks image from Brandner et al. (2000, A&A 364, L13) Below: Detection of strong solid CO absorption in the edge-on protoplanetary disk around the solar-mass young star CRBR 2422.8–3423 by Thi et al. (2002, A&A 394, L27) using VLT-ISAAC. This is the first direct evidence for significant freeze-out of CO in the cold layers of a disk: the amount of solid CO is comparable to that of gaseous CO.

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Production Annual Report 2002:
J. Drost, F. P. Israel, J. Lub, R. Meijerink, R. Overzier

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In memoriam
Cees van Houten

1920 – 2002

In memoriam Cornelis Johannes van Houten

With great sadness we received the news that our colleague Cornelis Johannes van Houten had died on August 24, 2002, at the age of 82. Kees had been at Leiden Observatory for more than fifty years, with only a two-year break (January 1954 - March 1956) which he spent as a research assistant at the University of Chicago's Yerkes Observatory.

He was born in The Hague in 1920, and attended the Gymnasium Haganum finishing his secondary education in 1940. During the War, he enrolled at the universities of Leiden and Amsterdam, but understandably made little progress in his studies. In 1946 he recommenced at Leiden and graduated in June 1952. In the meantime, he had already been appointed to the position of scientific assistant. Soon after his graduation, he was encouraged by Jan Oort to start a Ph.D study on the surface brightness of extragalactic systems. Insight would be gained in the evolution of such systems, the distributions of old and young stars, and the way in which these results were influenced by the scattering and absorption properties of interstellar dust. The latter turned out to be negligible, much against the then dominating views. A paper on the rotation curve of the galaxy NGC 3115 by Oort, Minkowski and van Houten, although never published, nevertheless was frequently cited because it received world-wide circulation as a preprint. Kees obtained his Ph.D in June 1961 on a thesis entitled 'Surface Photometry of Extragalactic Nebulae'.

His stay in the USA had a lasting influence on both his personal life and his scientific career. There, he met his wife-to-be, Ingrid Groeneveld, who also was an astronomer. The two of them developed a lifelong fascination for the objects in the asteroid belt between Mars and Jupiter. Their good friend and colleague, Tom Gehrels, remembers that the Yerkes staff had noticed Kees' enamoration of Ingrid. There were, however, two problems. Tom further remembers: 'A Danish astronomer was also vying for Ingrid's hand. He seemed to be winning her over while all of us thought Kees the better candidate. Kees was inexperienced in such matters, he was rather shy and would never have dared to ask her right then and there, before it might be too late. So, Dr. Kuiper arranged for an observing run in Texas by himself, Kees and Ingrid, over Weihnachten. I remember rushing to Dr. Kuiper to volunteer my services as well, but he rebuffed me with a mysterious wink of his eye. A few hours before departure, Dr. Kuiper had some phoney emergency so that he could not go to Texas either. After three weeks they came back… engaged'.

At the time, Kees and Ingrid were collaborating with Gehrels in an investigation into the statistical properties of asteroids, iniated by Gerard Kuiper. This became a life's work for the couple. The basis of the investigation was formed by three extensive photographic surveys (e.g. the Palomar-Leiden survey) on a very large number of plates, aimed at finding thousands of asteroids and determining their orbits. From studies of their statistical and physical properties emerged the existence of distinct ‘families’ of asteroids that contain information on collisional fragmentation over time. At the same time, they tell us about origin of the Solar system. Decades of extremely careful ’blinking’ (the technique used to find fast-moving objects on the plates) were interspersed with a fundamental statistical analysis almost singlehandedly and painstakingly developed by Kees, practically from first principles. Modern surveys still make use of these techniques. The completeness of the identifications and the reliability of the analysis then frequently turn out to be better than those provided by modern electronic methods. The results have been published in a series of papers, the last of which appeared in 1991. The van Houtens have named many of the asteroids discovered by them after Dutch professional and amateur astronomers, whenever accurate orbits had been determined.

In 1981 Kees published a paper on one of his old favourites: a model for the complex light curves and radial velocity curves of close binaries. Already in 1967, he had presented this at the time very revolutionary model in an Observatory colloquium. In his analysis, the primary is greatly flattened by rapid rotation, allowing streams of gas to separate from the two tidal bulges, falling back to the surface a quarter turm away. The primary is surrounded by an accretion disk inside its Roche lobe, whereas the secondary completely fills its Roche lobe. It took more than a year, util 1968, for the presence of accretion disks to be used as explanation for the exotic, highly-energetic phenomena in binary stars. Now, this is no longer a matter of debate. When Kees retired in March 1985, he was honored with a workshop on asteroids featuring speakers from the Netherlands, Tucson and Harvard. He was visibly moved by this, but did not really retire. At the time he said that he had work left for more than three years, but that turned out to be closer to sixteen years! As late as 1999 through 2001, seven more papers appeared, some of them with Kees as the sole author, containing his careful analyses of photometry gathered during observing trips to the former Leiden Southern Station in the Republic of South Africa. The subjects were asteroids, eclipsing binaries, and young hot stars.

More than anybody else he preferred to quietly sit in the library to read newly arrived books and journals from cover to cover. As perennial secretary/treasurer of the Leiden Observatory Fund and the Leiden Kerkhoven-Bosscha Fund he was noted for his perhaps somewhat old-fashioned ways of book-keeping: everything written by hand in long tables, but extremely accurately. Many of us will remember him as the modest and gentle man, who kept in the background during meetings, but always made time available if you came to his room with questions, who was generous with little puns and jokes, and who though it quite normal, even in 2001, to perform his calculations with a slide rule.

A.M. van Genderen

Contents

Chapter 1

Review of major events

Chapter 1

Review of major events

The past year was an eventful one in the life of the Sterrewacht. Two new full professors joined our staff: Koen Kuijken and Andreas Quirrenbach. They strengthen two important areas of Sterrewacht research, galactic astronomy and astronomical instrumentation. Also, Pascale Ehrenfreund became a UHD (associate professor) and was appointed to the adjunct professorship of Astrobiology at the University of Nijmegen. Richard Schilizzi, who has been an Extraordinary Adjunct Professor of Radio Astronomy at Leiden for the last decade became a structural Adjunct Professor. He also resigned his position as Director of the Joint Interferometry VLBI in Europe to become Director of the new international Square Kilometer Array project.

During 2002 involvement by the Sterrewacht in a range of instrumental projects continued to grow. The optical interferometry activities of the last few years began to show results, with the successful commissioning of MIDI at the VLT. Jaffe is the Project Manager for the international MIDI consortium software. A considerable amount of the MIDI software development was carried out by the NOVA ESO VLTI Expertise Centre (NEVEC), for which the Sterrewacht is host. In December Andreas Quirrenabach was awarded one of NWO's new prestigious VICI grants ($\sim$1.5 M Euro). This will support the project that he is leading to develop the VLT phase-referencing interferometry system (PRIMA) and use it for the detection of extrasolar planets.

Sterrewacht staff are involved in several other international facilities for which milestones occurred in 2002. During March the Advanced Camera for Surveys was fitted to the Hubble Space Telescope and the camera is now functioning excellently. Franx and Miley are members of the ACS Science team. Substantial funding was provided by NWO to support Dutch involvement in MIRI, the mid-infrared instrument for the JWST (previously NGST), presently scheduled to be launched by NASA in 2010. The Dutch MIRI consortium is led by van Dishoeck. The Sterrewacht is also involved in planning the development of the Low Frequency Radio Array (Miley, Röttgering) and ALMA (van Dishoeck). During 2002 ALMA funding was secured and an additional 11 M euro funding for LOFAR was provided by NWO and the northern Dutch provinces.

As described elsewhere in this report, the Sterrewacht continues to carry out a broad-based research programme in astronomy and astrophysics and to attract excellent postdoctoral fellows and graduate students. During the year 7 young astronomers obtained a Leiden University Ph.D. A particular noteworthy research highlight was the discovery by Guillermo Muñoz Caro and collaborators published in Nature, that the conditions of interstellar space, when simulated in the laboratory, can produce many of the amino acids that serve as the building blocks of life.

Several ceremonial lectures were given under the auspices of the Sterrewacht during the last year. Professor Jim Gunn delivered the 13th Oort Lecture entitled ”Mapping the Nearby Universe” on 25th April and spent about a month at Leiden interacting with students and staff. During his visit he gave a series of lectures to our postgraduate students and organized a workshop devoted to ”Astronomical Surveys” on 17th - 18th June. Another highlight of 2002 was a visit by Professor Tim Heckman to deliver the 2002 Sackler Lecture on 12th December, entitled ”Spectroscopy of 100 Kilo-Galaxies: Implications for the Evolution of Galaxies and Active Galactic Nuclei”.

I must regretfully report additional sad losses for the Sterrewacht in 2002. Kees van Houten, an international leader in asteroid research passed away on 24th August at the age of 82. His obituary is contained in this report. Further, Arend Meester, the long-time head of the Sterrewacht workshop and Til Kloër our retired receptionist died during the year. All these ex-Sterrewachters left an indelible mark on our institute and will be dearly missed.

George K. Miley

Director of Research,
Leiden Observatory

Chapter 2

Research

Sterrewacht Leiden

Research

Chapter 2

2.1 Solar System

2.1.1 Minor Planets

In 2002, another set of 630 normal and 6 Trojan asteroids which were found by C.J. van Houten and I. van Houten-Groeneveld in their earlier surveys, received a definitive number. A summary is as follows:

Year of Observation	1960	1971	1973	1977
Survey	P-L	T-1	T-2	T-3
	L4	L5	L4	L5
Normal Asteroids Found	251	70	146	163
Trojan Asteroids Found	1	–	3	2

For several asteroids discovered by them, van Houten and van Houten-Groeneveld proposed names which were subsequently accepted by the Committee of Small Bodies Nomenclature (CSBN) of the IAU. Examples are given in the table below.

At the invitation of the van Houtens, the first two names were provided by Schmadel. Asteroid 10647 Meesters was named after a well-known Dutch amateur astronomer and telescope builder from the first half of the 20th century. Nicolaes Witsen was a 17th centurt scholar, mayor of Amsterdam and Board Member of the (Dutch) United East India Company (V.O.C.), the geographers and map-makers Plancius and Blaeu were his contemporaries, while Houtman, Keyser, van Linschoten and Bontekoe were navigators and maritime explorers from the same period, Holland's 'Golden Age'.

Definite Number	Survey Number	Name	Discovery Date	Minor Planet Circular No.
(9819)	2172 T-1	Sangershausen	1971/03/25	47166
(9820)	3064 T-1	Hempel	1971/03/26	47166
(10647)	3074 P-L	Meesters	1960/09/25	47167
(10648)	4089 P-L	Plancius	1960/09/24	46682
(10650)	4110 P-L	Houtman	1960/09/24	47167
(10651)	4522 P-L	Van Linschoten	1960/09/24	47167
(10652)	4599 P-L	Blaeu	1960/09/24	47167
(10653)	6030 P-L	Witsen	1960/09/24	47167
(10654)	6673 P-L	Bontekoe	1960/09/24	47167
(10655)	9535 P-L	Pietkeyser	1960/10/17	47167
(10656)	2213 T-1	Albrecht	1971/03/25	47167
(10657)	2251 T-1	Wanach	1971/03/25	47167
(10665)	3019 T-3	Ortigo	1977/10/16	46682

2.2 Stars

2.2.1 Binaries η Carinae and HD 93205

Van Genderen, Sterken (Brussels, Belgium) and Allen (New Zealand) published multi-colour photometry of the flare-like events occurring during three periastron passages (1987.0, 1992.5, 1998.0) of the binary in η Carinae. These events might be explanained by the creation of a hot spot in an accretion disk caused by the increasing mass flow from the S-Dor primary when the two stars approach periastron. They also developed a method to derive the apparent magnitudes of this light source at maximum and found it to be fainter than the central light source by $1^{\mathrm{m}} - 3^{\mathrm{m}}$. The peculiar spectral energy distribution in the optical and in the near-UV confirms the non-stellar origin of this light source, with a luminosity possibly of the order of $10^5\ L_\odot$. Two new continuum flux-density determinations in the near-UV ($VBLUW$ system) reinforce an impression derived from HST measurements, that the central light source has a very strong radiation peak in the Balmer continuum. This points to a significant contribution by non-stellar light somewhere in the field surrounding the central light source, such as derived from hot shock-fronts or systems of accreted matter or both.

Van Genderen also analyzed $VBLUW$ photometry of a rare type of binary: the O3V+O8V close binary HD 93205. Its binary period is $6^{\mathrm{d}}.08$ and has an apsidal motion with a period of 185 yr. In a comparison of Van Genderen's data-set (1982–1985) with one obtained in 1993 by other workers, the effect of the apsidal motion becomes obvious, in the form of phase shift between the two light curves and a change in shape. A phase-locked light variation in the L passband (containing the higher Balmer lines) was clearly present in the 1982–1985 dataset. It is presumably due to absorption when the O8 star is seen through cooler inter-binary gas, e.g. the bow-shock between the two colliding winds.

2.2.2 OB Associations

For the first time, the stellar population of the Upper Scorpius OB association (a subgroup of the Sco OB2 association) has beem measured directly over the entire stellar mass range from 0.1 $M_\odot$ to 20 $M_\odot$. Brown, Preibisch (Bonn, Germany), Bridges (Epping, Australia), Guenther (Tautenburg, Germany) and Zinnecker (Potsdam, Germany) accomplished this feat by combining the Hipparcos membership census with X-ray and spectroscopic searches for pre-main sequence stars.

The Hertzsprung-Russell diagram of all 364 stars in the sample exhibits a very narrow age distribution of the stars around 5 Myr (see Fig. 2.1) with insignificant dispersion. This implies that both the low and the high mass stars have formed together and that the star formation process occurred over a very short period of time, no more than a few Myr. Brown and collaborators measured the initial mass function of the OB association by estimating individual masses for all stars and correcting the pre-main sequence sample for observational completeness and spatial coverage. This IMF is consistent with recent determinations of the field mass function. A power-law fit of the form $dN/dM \propto M^\alpha$ yielded a slope of $\alpha = -2.6$ above $\sim$ 2 $M_\odot$ and a much shallower slope $\alpha = -0.9$ below $\sim$ 0.6 $M_\odot$. The total stellar mass in the association (including binary components) is 2060 $M_\odot$.

Steenbrugge (SRON-Utrecht), de Bruijne (ESTEC-Noordwijk), Hoogerwerf (CfA-Boston) and de Zeeuw completed the reduction and interpretation of spectra of O-, B-, and A-type stars in and near the Perseus OB2 association, which were obtained at the Observatoire de Haute Provence. They determined the radial velocities of a few dozen target stars relative to a set of observed standard stars with cross-correlation techniques. A careful analysis of the error budget showed random errors of the order of 1–3 km s^{-1}. The radial velocities allowed refinement of the Hipparcos-based membership list of the group, since they separate Per OB2 members cleanly from the local field stars. The measurements also led to the discovery of additional spectroscopic binaries in Per OB2.

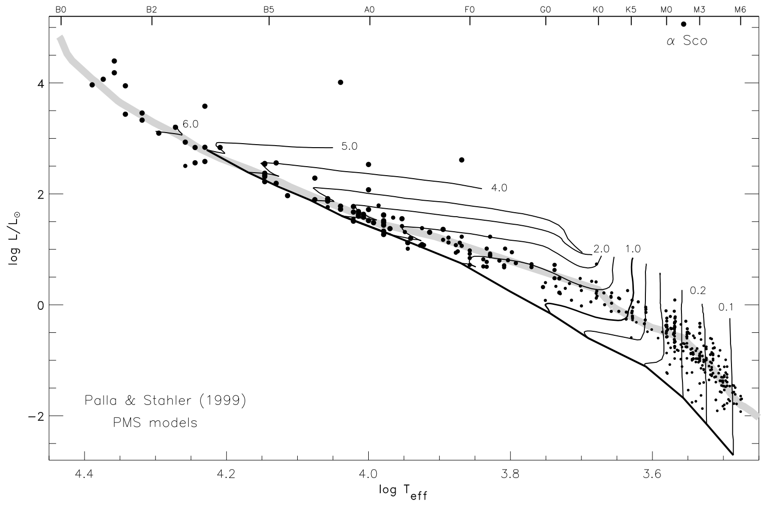


Figure 2.1: HR diagram for the Upper Scorpius OB association members in the Hipparcos sample, the X-ray-selected and spectroscopically selected pre-main-sequence samples. Lines show evolutionary tracks from Palla & Stahler PMS models, some labelled by mass in Solar units. The thick solid line marks the main sequence. In addition, the 5-Myr isochrone is shown as a thick gray line. Apparent deviations from the isochrone can be explained by spectral peculiarities, binarity, observational uncertainties and the distance spread (see Section 2.2.2).

2.2.3 Statistical Equilibrium in Stellar Atmospheres

Kamp and Mashonkina (Kazan, Russia) collaborated with Korotin (Odessa, Ukraine), Przybilla (Munich, Germany) and Shimansky (Kazan, Russia) in an effort to compare different codes to calculate the statistical equilibrium in stellar atmospheres. The comparison of results for neutral and ionized carbon in the Sun and in Vega shows that different line and continuum opacities in the various codes give rise to a final uncertainty in level populations of 20% in the Sun and up to 50% in Vega. The large uncertainty for the latter is due to the importance of overlapping background lines of other elements, which is not accounted for in some codes.

2.2.4 The λ Bootis Phenomenon

The group of λ Bootis stars comprises Population I, late B to early F-type stars with moderate to extreme (up to a factor 100) surface underabundances of most Fe-peak elements and solar abundances of lighter elements (C, N, O, and S). Stimulated by a surprising correlation between stellar and interstellar sodium abundances, Kamp and Paunzen (Vienna, Austria) suggested a new model for the formation of the λ Bootis abundance pattern in stellar atmospheres: the interaction between a star and a diffuse interstellar cloud. With appropriate diffuse cloud densities, sizes and velocities, this model naturally explains (1) the separation of gas and dust near the star, (2) the gas accretion rates required to establish the photospheric abundance pattern and (3) the spectral range of the λ Bootis phenomenon (A-F stars).

With Paunzen, Weiss (both Vienna, Austria) and Wiesemeyer (IRAM, France) Kamp also investigated the properties of λ Bootis stars in the infrared and radio spectral ranges. Some 23% of the λ Bootis stars have an infrared excess and simple modeling shows a similarity to the excess seen in Vega-type stars in terms of dust temperatures and fractional luminosities L_{IR}/L_{*}. Alternatively, the infrared excesses might also be explained by star-cloud interactions, where interstellar dust grains are heated by stellar radiation near the avoidance radius.

2.2.5 OH/IR and AGB stars

Vlemmings concluded his astrometric VLBI project of monitoring proper motion and parallax of Mira variable stars by their main-line OH maser emission. In collaboration with van Habing, van Langevelde, Schillizzi (both ASTRON) and Diamond (NRAO, USA), he observed the compact OH maser spots of the stars U Her, W Hya, S CrB and R Cas for over 2.5 years. Using a VLBI phase-referencing technique, he determined accurate absolute positions and obtained a significant improvement over earlier Hipparcos results in distances and proper motions. He established that in the cases of U Her and W Hya, the more blue-shifted maser spot represents the amplified emission from the star. Observations with the MERLIN array of the water masers around U Her revealed that water masers, which are found closer to the star in an accelerating part of the envelope, can show amplified stellar emission as well. Vlemmings also created a 3-D Monte Carlo code to model the 1612 MHz satellite OH maser line in circumstellar envelopes with little symmetry or with strong density enhancements. This code was used to determine the effect of radio emission from the underlying star on the maser shell and on the creation of an amplified stellar image.

Schöier, Ryde (Austin, USA) and Olofsson (Stockholm, Sweden) investigated the use of rotational CO line emission as a probe of carbon star mass loss. Circumstellar envelope characteristics were probed over a great range of radii by a combination of radio observations and ISO infrared data, supplemented by detailed radiative transfer modelling. However, only three out of nine carbon stars were observed long enough by ISO to yield a detection of far-infrared rotational CO lines.

The model calculations limited long-term mass-loss rate modulations to less than a factor of ~5 over the past thousands of years.

Working with Olofsson, González-Delgado (both Stockholm, Sweden) and Kerschbaum (Vienna, Austria), Schöier determined mass loss rates and gas expansion velocities for a representative sample of 69 M-type irregular and semi-regular variable AGB-stars using a radiative transfer code to model circumstellar CO emission. The distribution of mass loss rates has a median value of 2.0×10^{-7} $M_\odot$ yr^{-1}. They found no significant differences in mass loss characteristics between the two types of objects. The mass loss rates did not show a dependence on the period of the semi-regular objects, nor on stellar temperature. However, a strong relation with gas expansion velocity was noted, in line with predictions for optically thin dust-driven winds.

2.3 Protostars and Circumstellar Disks

2.3.1 Physical and Chemical Structure of Low-Mass Protostars

Jørgensen, Schöier and van Dishoeck, together with Tielens (Groningen, NL), Maret, Caux (Toulouse, France) and Ceccarelli (Grenoble, France) continued their use of the JCMT to conduct a large submillimeter line survey of a sample of low-mass (class 0 and I) protostars. Using the physical structure established last year from dust continuum observations, they determined accurate abundances for various species. This year's efforts focussed on HCO^+, HCN, HNC and CN including isotopes and deuterated species. Clear signatures of evaporation and subsequent gas-phase chemistry were found with increasing temperature, with the CO and HCO^+ abundances closely related. The degree of deuterium fractionation for HCO^+ showed an anti-correlation with that of HCN, providing constraints on the temperature dependence of gas-phase fractionation processes.

Physical models constrained by single-dish data were also used for the interpretation of observations of the protostar NGC1333-IRAS2A, observed with the OVRO and BIMA millimeter interferometers in a collaboration with Hogerheijde (Steward OBS., USA) and Blake (Caltech, USA). The outflow associated with this protostar shows, at high resolution, clear spatial differences between various molecules as a result of shock chemistry. Abundances in the shocked region were derived from CSO and Onsala 20 m data, and revealed strong enhancements of molecules such as CH_3OH, SO, CS and SiO as compared to the abundances found in protostellar envelopes.

2.3.2 Do Low-Mass Protostars Have Hot Cores?

Detailed modeling of multi-transition single-dish data of the 'archetypical' low mass proto-binary star IRAS 16293–2422 by Schöier, Jørgensen, van Dishoeck and Blake (Caltech, USA) has shown that the abundances of some molecules, in particular H_2CO and CH_3OH, are greatly increased in the warm and dense inner regions of its circumstellar envelope. Two competing theories exist for such abundance enhancements: thermal evaporation of ices and liberation of ices in the shocks created by the interaction of the outflow(s) with the inner envelope. To futher investigate this issue, high angular resolution H_2CO OVRO and continuum interferometry observations at 1-mm were carried out (see Fig. 2.2). Modeling of the continuum emission suggested that the binary has cleared away most of the material in the inner envelope, out to the binary separation. The H_2CO emission is dominated by compact dense and hot ($T > 150\,\mathrm{K}$) gas close to the positions of the protostars. The observed velocity structure indicated large-scale rotation roughly perpendicular to the CO outflow. This increase appeared to occur at the radius where ices thermally evaporate off the grains ($\sim 90\,\mathrm{K}$). The line widths and morphology of the observed interferometric emission suggested that little of it was directly associated with the known outflow(s). In contrast, a similar study of the low-mass protostar L1448-mm did show high-resolution H_2CO emission with a velocity pattern consistent with the outflow direction.

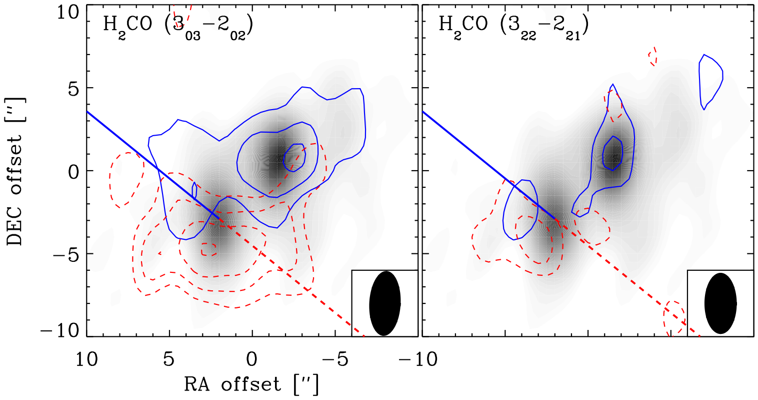


Figure 2.2: OVRO interferometer maps of H_2CO emission (contours) superposed on 1.37 mm continuum emission (greyscale) from the protobinary object IRAS 16293–2422. The H_2CO emission has been separated into a blue (4-7 $\mathrm{km\,s^{-1}}$; solid lines) and a red (1-4 km $\mathrm{s^{-1}}$; dashed lines) part. The velocity pattern is consistent with a rotating disk or envelope, perpendicular to the direction of the large scale CO outflow (Schöier et al., see Section 2.3.2).

2.3.3 A VLT Survey of CO and CH_3OH Ices Around Low-Mass YSO's

Pontoppidan, Thi, and van Dishoeck, in a collaboration with Tielens (SRON, Groningen, NL), Dartois and d'Hendecourt (both IAS, Paris, France), finished their large ESO VLT-ISAAC program to study ices and gas around a large sample of low-mass young stellar objects (YSO's) in nearby star-forming regions at unprecedented S/N ratios and spectral resolution. In total, spectra of about 50 sources have been obtained covering the $3-5$ μm atmospheric windows with resolving powers up to $\lambda/\Delta\lambda \approx 10000$. Pontoppidan and Fraser focussed on the analysis of the 4.67 μm CO ice bands toward 36 sources (see Fig. 2.3). Using a phenomenological decomposition of the band as well as a simple physical model, they showed that the CO ice has the same fundamental structure along all lines of sight: surprisingly, all CO ice bands observed provided excellent model fits requiring only 3 linear parameters. This result has important consequences for the understanding of the formation and structure of interstellar ice mantles. The observations showed evidence for irregularly-shaped grains and for the existence of most interstellar CO ice in a nearly pure form, i.e., contaminated by less than 10-20% other molecular species. Finally, they concluded that linear polarization of the background light may significantly change the shape of the CO ice band profile.
Also as part of this VLT survey, Pontoppidan and Dartois (IAS, Paris, France) have detected abundant solid methanol towards three young, low-mass stars in the Serpens and Chamaeleon star-forming clouds. These were the first detections of solid methanol reported towards such objects. The inferred abundances of 15-25% with respect to water ice are as high as those found towards some high-mass YSO's. This result was of great relevance to the ongoing discussion on the formation mechanism of methanol, and its role in hot-core chemistry, as it invalidated the previous assumption that highly abundant solid methanol would only be found near massive young stars.

2.3.4 Chemical Changes During Star Formation: High-Mass versus Low-Mass YSO's

Van Dishoeck completed a review paper on the chemical changes during star formation, focussing on a comparison between low-mass and high-mass YSO's. In both cases, chemical characteristics are dominated by freeze-out in the cold outer parts of the envelope and evaporation of ices in the warm inner parts. Both sets of objects have a similar power-law envelope structure, and present evidence for abundance jumps in the inner envelope for at least some molecular species by up to three orders of magnitude. On the other hand, potential distinctions include (i) the hot core chemistry, with complex organic molecules so far detected only in high-mass YSO's; (ii) the degree of deuterium fractionation, high levels seen only

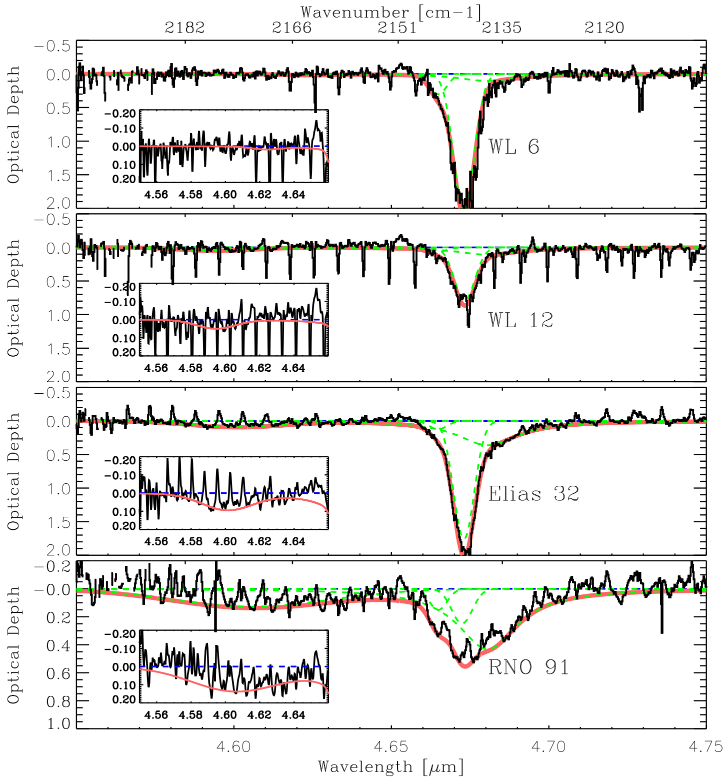


Figure 2.3: Examples of VLT-ISAAC spectra in the vicinity of the CO vibrational band at 4.67 μm towards a sample of low-mass YSO's in Ophiuchus, exhibiting strong absorption by solid CO together with absorption and/or emission by gas-phase CO. All solid CO bands can be decomposed in just three components, marked by light lines, suggesting that the CO ice has the same basic structure for all lines of sight (Pontoppidan et al., see Section 2.3.3).

in low-mass YSO's; (iii) the effects of internal or external UV and X-rays; (iv) the relative importance of shocks versus thermal heating of the envelope; and (v) the importance of geometrical effects.

2.3.5 Gas-Phase CO_2 Towards Massive Protostars: Shock Tracer?

Boonman, van Dishoeck, Lahuis (SRON Groningen, NL), and Doty (Denison Univ., Ohio, USA), analyzed the spectral signature of gas-phase CO_2 around 15 μm towards 14 deeply embedded massive protostars, obtained with the Short Wavelength Spectrometer (SWS) on board the Infrared Space Observatory (ISO) (see Fig. 2.4). Excitation temperature and gas-to-solid ratios increase with the temperature of the warm gas, in agreement with other evolutionary tracers. Detailed radiative transfer models applied to the warmest source, AFGL 2591, showed a jump in the CO_2 abundance at $T \sim 300$ K. The low CO_2 abundances of $\sim 10^{-8}$ found for $T < 300$ K were unexpected because of the high abundance of solid CO_2, which can evaporate at ~ 100 K. Boonman et al. favoured an explanation in which destruction of CO_2 following evaporation by a shock in the past, combined with freeze-out in the coldest part at $T < 100$ K. The high abundance of $\sim 10^{-6}$ for $T > 300$ K might then be due either to X-ray driven chemistry in the inner envelope or to incomplete destruction of evaporated CO_2 for $T > 300$ K.

2.3.6 Constraints on the Abundance Profile of Gas-Phase H_2O in Massive YSO Envelopes

Boonman, van Dishoeck, Doty (Denison Univ., USA), Bergin, Melnick (both CfA, Boston, USA), Wright (ADFA, Australia) and Stark (MPIfR Bonn, Germany) modeled H_2O spectra between 5 and 540 μm toward six deeply embedded massive protostars, obtained with the ISO-SWS and LWS and with the Submillimeter Wave Astronomy Satellite (SWAS). Detailed radiative transfer modeling in combination with different physical and chemical scenarios showed that ice evaporation in the warm inner envelope and freeze-out in the cold outer part are important for most sources and occur at $T \sim 90 - 110$ K. The modeling suggested that the 557 GHz SWAS line included contributions from both the cold and the warm H_2O gas. Shocks did not seem to contribute significantly to the observed emission, as opposed to the case for Orion. Three of the observed and modeled H_2O lines provided good physical and chemical diagnostics, and thus were found to be useful for future observations with the Herschel Space Observatory.

2.3.7 Molecules in Circumstellar Disks: Detection of DCO^+

Van Dishoeck, Thi and van Zadelhoff obtained the first detection of a deuterated molecule in a circumstellar disk (see Fig. 2.5). The DCO^+ $J = 5 - 4$, HCO^+ and $H^{13}CO^+$ $J = 4 - 3$ lines yielded an accurate value for the DCO^+/HCO^+ ratio, 0.035 ± 0.015, for the disk around TW Hya. This value was close to that found in cold pre-stellar cores but somewhat higher than that measured in the envelope around the low-mass protostar IRAS 16293-2422 which has started to heat its surroundings. It was also close to the DCN/HCN ratio obtained for pristine cometary material in

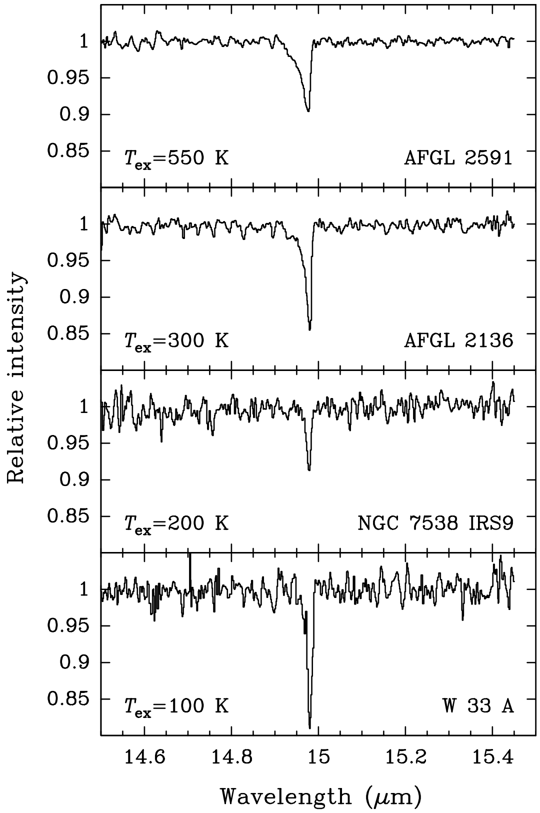


Figure 2.4: ISO-SWS spectra of the CO_2 ν_2 ro-vibrational band towards four deeply embedded massive protostars. Excitation temperatures increase from bottom to top, consistent with other temperature tracers for the envelopes of these sources (Boonman et al., see Section 2.3.5)

the jet of comet Hale-Bopp, allowing the thermal history of protoplanetary material to be traced. The observed DCO^+/HCO^+ ratio was also found to be consistent with the outcome resulting from theoretical disk models which consider gas-phase fractionation processes within realistic 2-D temperature distributions and include the effects of freeze-out onto grains.

Thi, van Zadelhoff and van Dishoeck also finished their searches with the JCMT 15m and IRAM 30m telescopes for gas-phase molecules in the disks around two T Tauri stars and two Herbig Ae stars. Simple molecules such as CO, ^{13}CO, HCO^+, CN, HCN, H_2CO and CS were readily detected, but no CH_3OH was seen. The line ratios

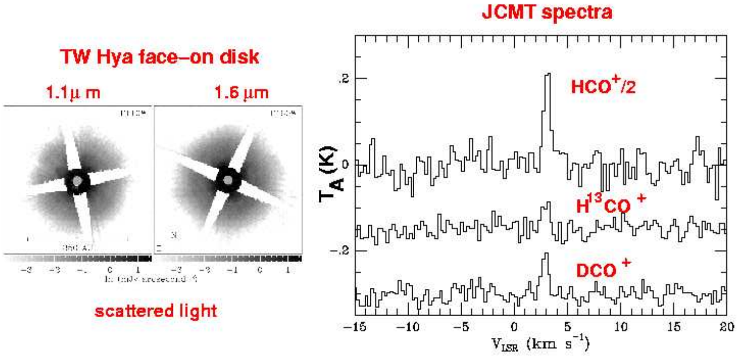


Figure 2.5: Right: JCMT detection of the DCO^+ $J = 5 - 4$ line, together with the HCO^+ $J = 4 - 3$ and $H^{13}CO^+$ $J = 4 - 3$ lines, in the disk around the pre-main sequence star TW Hya. The $H^{13}CO^+$ and DCO^+ spectra have been shifted by -0.15 and -0.3 K, respectively. Left: Near-infrared scattered light image of TW Hya by Weinberger et al. (2002), showing the 200 AU radius face-on disk (van Dishoeck, Thi & van Zadelhoff, see Section 2.3.7).

indicated that the observed emission arose from dense ($10^6 - 10^8$ cm^{-3}) and moderately warm ($T \sim 20-30$ K) regions of the disk atmosphere at intermediate heights between the midplane and the upper layer, in accordance with model predictions for disk chemistries (see below). The abundances of most species were found to be lower than in the envelope around the solar-mass protostar IRAS 16293-2422 due to freeze-out and photodissociation. CN was strongly detected in all disks, and the CN/HCN abundance ratio towards the Herbig Ae stars was even higher than that found in Galactic photon-dominated regions, testifying to the importance of photodissociation.

Aikawa (Univ. of Kobe, Japan), Thi, van Zadelhoff, van Dishoeck and collaborators marginally resolved H_2CO in the disk around the T Tauri star LkCa15 using the Nobeyama Millimeter Array. H_2CO is one of the most complex organic molecules detected in the gas in circumstellar disks. The H_2CO abundance inferred for LkCa15 was higher than that observed in the DM Tau disk and also higher than predicted by theoretical disk chemistry models. Its line profile indicated that it is less centrally peaked than CO.

2.3.8 Abundant CO Ice in an Edge-On Circumstellar Disk

Thi, Pontoppidan, van Dishoeck and collaborators obtained the first direct evidence for significant CO freeze-out in a circumstellar disk. The edge-on object

CRBR 2422.8-3423 was observed in the M band with VLT-ISAAC at a resolving power $R \approx 10\,000$. The spectrum exhibited the deepest solid CO absorption feature ever observed. Absorption by foreground cloud material probably accounts for only a small fraction of the total solid CO column. Gas-phase ro-vibrational CO absorption lines were also detected at mean temperatures of 50 ± 10 K. The average gas-to-solid CO ratio was ~ 1 along the line of sight. For an estimated disk inclination of $20^{\circ} \pm 5^{\circ}$, the solid CO absorption originates mostly in the cold, shielded outer part of the flaring disk.

2.3.9 Structure and Chemistry of (Flaring) Disks

Van Zadelhoff, Aikawa (Kobe, Japan), Hogerheijde (Steward Obs., USA) and van Dishoeck, finished their calculations of the abundances in disks around pre-main sequence stars. they used a full-2D UV continuum radiative transfer code to calculate the dissociation rates of molecular species. The effects of different stellar spectra (cool 4000 K blackbody vs. star with excess UV radiation) were also investigated. Most molecular abundances do not depend significantly on the type of stellar emission, but radicals such as CN and C_2H will be enhanced by more than an order of magnitude in the outer regions for stars with excess UV radiation.

Sammar and Kamp investigated the more tenuous disks around young solar-type stars. The stellar radiation field was reproduced by a Kurucz atmospheric model and a chromosphere model. The latter was determined from IUE observations and by scaling present solar chromospheric observations back to times of higher stellar activity. This “active” chromosphere leads to significant CO photodissociation and C ionisation throughout the disk. Compared with purely atmospheric models, dust temperatures are a factor of two higher because of the additional heating by the chromosphere.

Kamp, van Zadelhoff, van Dishoeck and Stark (MPIfR Bonn, Germany) modeled the line emission from C, C^+ and CO for tenuous disks such as those around β Pictoris and Vega. The abundances of the different species were calculated assuming dissociation by stellar and interstellar UV photons, whereas gas temperatures were computed explicitly taking all the heating and cooling processes into account. A comparison with published and ISO archive observations served to constrain the gas-to-dust mass ratio to $0.5 < \mathrm{M_{gas}/M_{dust}} < 9$ for β Pictoris and $\mathrm{M_{gas}/M_{dust}} < 33$ for Vega. Predictions of line intensities for future facilities such as APEX, Herschel-HIFI and ALMA could also be made.

Jonkheid, Faas, van Zadelhoff and van Dishoeck, performed explicit calculations of flaring-disk gas temperature. A simple model was used to calculate the chemistry and temperature structure in the vertical direction at different radii. The role of gas-dust coupling in the heating-cooling balance was found to be most significant in the denser parts of the disks, where gas temperatures approach those of the dust. In the upper layers, gas temperatures may exceed those of dust significantly In turn, this may affect the vertical structure of the disks.

2.3.10 Testing Molecular Line Radiative Transfer Codes

In response to outside comments, van Zadelhoff and collaborators performed additional tests in their comparison of NLTE one-dimensional line radiative transfer codes. They found the algorithms to agree to within the accuracy of the codes for small optical depths, for simple two-level problems with a constant temperature, no velocity structure and a power-law density. However, for high optical depths and for cases with gradients in velocities, density and temperature, the differences can rise up to 12%. Such differences are well within current day observational errors but they may pose limitations to the high calibration accuracy goals of future facilities.

2.3.11 Sticking of H-atoms to Crystalline Water Ice

Al-Halabi, together with van Dishoeck, Kroes and Kleyn (both UL Chemistry), performed classical trajectory calculations of the sticking of hydrogen atoms to the basal plane face of crystalline ice. The sticking probability was found to decrease with incidence energy (E_i) and surface temperature (T_s). In the trapped state, the adsorbed H-atom is located on top of the ice surface, over the center of the hexagonal ring. The calculations were in good agreement with experimental results of H_2 formation on amorphous ice, but yielded values lower than some previous calculations. The discrepancy was traced to incorrect implementation of the H-H_2O potential in previous work.

2.4 Interstellar Medium

2.4.1 The Peculiar Nebula Simeis 57

The Galactic nebula Simeis 57 (= HS 191 = G 80.3+4.7) is rather prominent on the Palomar Sky Survey images. Israel and Kloppenburg analyzed high-resolution radio-continuum maps of the object obtained together with Dewdney (DRAO, Canada) and Bally (UColorado, USA) at the Westerbork Synthesis Radio Telescope and the Dominion Radio Astrophysical Observatory at frequencies of 609, 1412 and 1420

MHz. The radio continuum emission from the object (corresponding to the moderately strong radio source W 61) closely follows the optical outlines, including the peculiar "*S*" shape, and the long, thin and straight filaments crossing the "*S*" (see Fig.2.8). The radio-continuum spectral-index distribution, and the similarity of the radio morfology to the Hα image of the nebula indicate that its radio emission is wholly thermal and optically thin. The origin of the peculiar structure is still completely unknown. No exciting stars have been identified, even though they should be visible at optical or near-infrared wavelengths. Not only is the source of excitation of the nebula unknown, its distance is also undetermined, although it is probably not very great. The object has a large angular size and a relatively low extinction. Obscuring dust is closely associated with the nebula, but seems to occur mostly in front of it. Extinctions vary from $A_V = 1.0$ mag to $A_V = 2.8$ mag with a mean of about 2 mag. The distributions of this extinction (derived from Hα and radio continuum emission) and the 100 μm far-infrared emission are remarkably similar. Simeis 57 can only have a moderate electron density of typically $n_e = 100$ cm^{-3} and a relatively low mass, not exceeding some tens of solar masses. Peak emission measures are 5000 pc cm^{-6}. Analysis of neutral hydrogen images and molecular line observations are in progress, in a further attempt to unravel the nature of this very remarkable object.

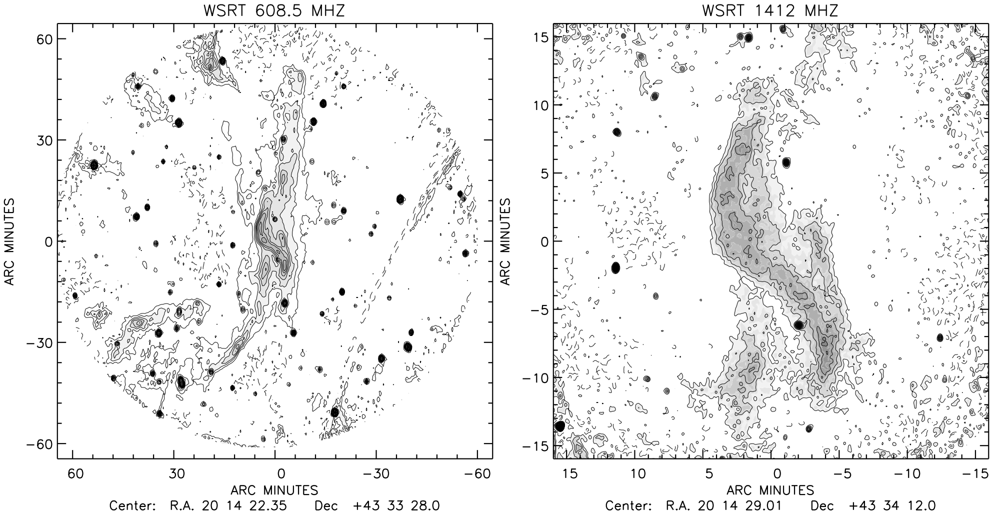


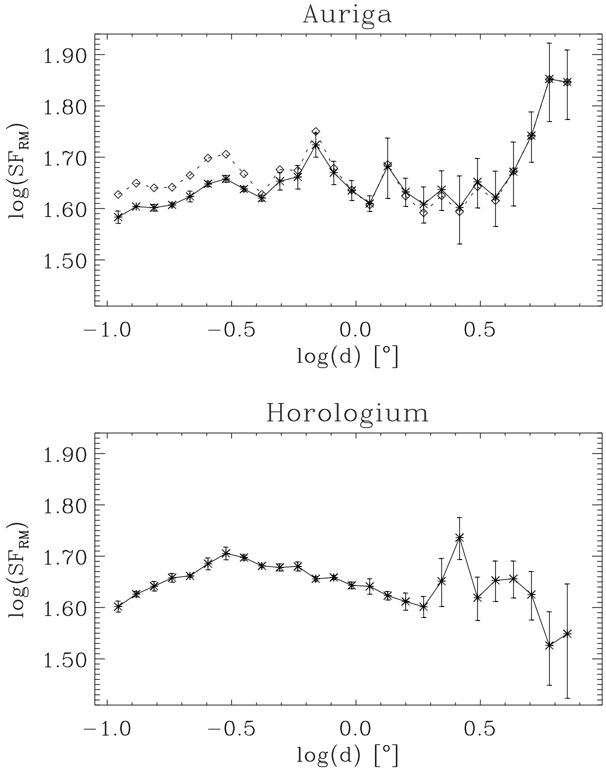
Figure 2.6: WSRT maps of Simeis 57 and its surroundings. Left: 608.5 MHz map showing the '*S*' shaped nebula at center, crossed by long thin filaments. Right; 1412 MHz map showing the nebular in greater detail (see Section 2.4.1).

2.4.2 Interstellar Polarization Screens

Haverkorn finished her extensive multi-frequency polarimetry investigation of the Galactic synchrotron background at frequencies around 350 MHz. This work, which was carried out together with Katgert and de Bruyn (ASTRON Dwingeloo, NL), dealt with the statistical description of ISM properties as represented by the observed distributions of (i). Stokes parameters Q and U, (ii). polarized intensity P and (iii). rotation measure RM, together with (iv). the distribution of Stokes parameter I. Across the observed fields, well-established polarized structures were found, invariably without any accompanying structure in total intentensity. Haverkorn, Katgert and de Bruijn concluded that the polarized intensity structure must be due to Faraday rotation in combination with one or more depolarization mechanisms. Depolarization caused by extended structures inadequately sampled by discrete interferometer spacings could only be a minor effect. In particular, the widespread occurrence of narrow (one-beamwidth) elongated 'canals' in the observed fields suggested significant beam-depolarization due to very steep Rotation Measure gradients.

On larger angular scales, the observed polarized structure must be due to so-called depth-depolarization. This occurs when the Faraday-rotating medium is mixed with a synchrotron-emitting medium, causing contributions from different positions along the line-of-sight to cancel. Haverkorn et al. described such situations with a single-cell-size model of the magneto-ionic interstellar medium, constrained by the observed distributions of Q, U, P and RM. Thus estimating regular and random Galactic magnetic field strengths, Galactic halo background intensities, cell sizes and polarization horizons, they could explain the absence of structure in total intensity by regular, large-scale magnetic fields being perpendicular to the line of sight. Random fields are comparable to the regular field and certainly not much larger as was previously concluded from pulsar data.

They also performed a statistical analysis by means of power spectra and structure functions of the polarized radiation and of the rotation measure RM. In Fig. 2.7, structure functions of RM are plotted for two observed fields in constellations Auriga and Horologium. Together with Heitsch (Univ. of Wisconsin, USA), Haverkorn studied polarized radiation propagation through a numerical magnetohydrodynamical simulation of the warm ionized ISM. Comparison of the resulting polarization with the radio polarimetric observations allowed them to estimate of the importance of beam depolarization in the medium, most notably in the long one-beam wide depolarization canals, ubiquitous in both observations and simulations. She also started a collaboration was started with Reynolds and Madsen (Univ. of Wisconsin, USA) with the goal of combining optical Fabry-Perot intensity measurements of the diffuse Hα emission with the radio-derived Rotation Measure structures. As Hα Emission Measures only depend on electron-density, information on small-scale magnetic field structures in the galactic ISM will be derived.


Auriga

Horologium

Figure 2.7: Solid lines show the RM structure function SF_{RM} as a function of distance d in degrees for the Auriga region (top) and the Horologium region (bottom), using only reliable RM values. The dotted line in the top plot gives SF_{RM} evaluated for the entire grid, including also unreliable RM determinations (see section 2.4.2).

2.5 Galactic Structure

2.5.1 AGB Stars and Milky Way Mass Distribution

Infrared-bright AGB stars are good tracers of Galactic structure and kinematics. They are visible in obscured regions, and their envelopes often harbour masers which reveal stellar line-of-sight velocitis to within a few km s^{-1}. Many AGB stars in the inner Galaxy have been identified with ISOCAM in the course of the ISOGAL programme, a 7/15 μm survey of $\sim$16 $\deg^2$ of selected fields along the Galactic plane, mostly toward the Galactic centre. Messineo, Omont, Schuller and others put the final touches on the ISOGAL point source catalogue, which contains over 100,000 objects and is now in publication. In collaboration with Ortiz and others, Messineo identified $\sim$100 OH maser sources less than one degree from the Galactic Centre with ISOGAL sources. OH/IR stars result in the brighest AGB stars at 15μm. Their luminosities and periods do not follow the relation found for Mira stars.

Messineo, Habing, Sjouwerman (NRAO), Omont (IAP, France) and Menten (MPIfR, Germany), conducted 86-GHz ($v = 1, J = 2 \rightarrow 1$) SiO maser line observations with the IRAM 30-m telescope of a sample of late-type stars in the inner Galaxy in order to measure radial velocities. The stars were selected on the basis of their infrared magnitudes and colours from the ISOGAL and MSX catalogues. SiO maser emission was detected in 271 sources, doubling the number of maser line-of-sight velocities known toward the inner Galaxy. 86-GHz SiO maser emitters are mostly Mira variables, and more numerous than OH/IR stars. Their longitude-velocity diagram clearly revealed a stellar nuclear disk component.

2.6 Structure and Dynamics of Nearby Galaxies

2.6.1 Dynamics of ω Centauri

Verolme, Kouwenhoven and de Zeeuw continued work on dynamical models of the globular cluster ω Centauri. By combining proper motions and radial velocity observations of individual stars (which are binned into apertures), a dynamical estimate of the distance to this cluster can be obtained. The inclusion of proper motion observations required an extension of existing axisymmetric Schwarschild software. Tests showed that it was possible to obtain accurate estimates of the distance, inclination and mass-to-light ratio of the cluster. Application of the extended method to the observations of ω Centauri is nearly completed.

2.6.2 Local Group Dwarf Galaxies

Habing and Cioni (ESO, Germany) started a programme to obtain maps in I, J, and K from Local Group dwarf galaxies and to analyse these data in the same way as they earlier treated the DENIS IJK photometric data of the Magellanic Clouds. They obtained excellent data at the william Herschel Telescope. With Corradi of the

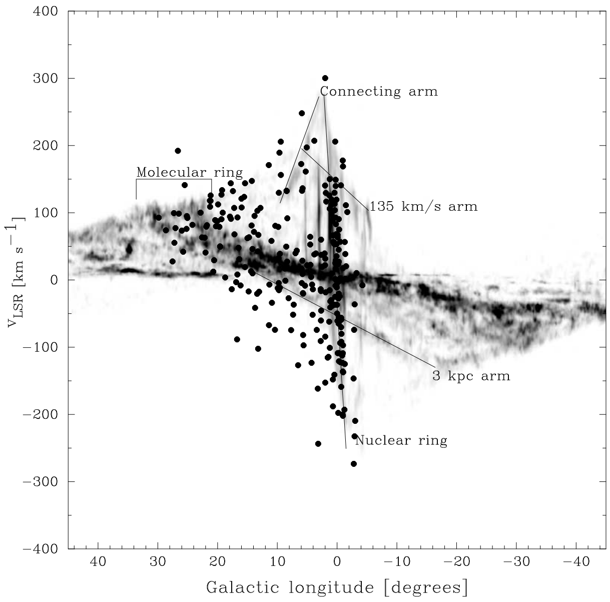


Figure 2.8: Stellar (l, v) diagram overlayed on the grayscale CO (l, v) diagram. The SiO 86 GHz masers are shown as dots (see Section 2.5.1).

Northern Hemisphere Observatory, they started a monitor programme with the INT to find long-period variables among the many AGB seen. Cioni and Habing also found the number ratio of carbon stars M-type AGB stars to be elevated in a ring-like zone around the outer edge of the LMC, strongly suggesting that metal abundances are lower in the ring-zone.

Israel and Baas, in a collaboration with Rudy (Aerospace Corp., USA), Skillman and Woodward (both UMinnesota, USA) analyzed a very extensive set of data on Hubble V, the brightest HII region complex in in the metal-poor Local Group dwarf galaxy NGC 6822. In particular, this database included maps in the first four transitions of ^{12}CO as well as maps of the 158μm transition of C^{+}, the 21-cm line of HI, the Pβ line of HII, and the continuum at 21-cm and 2.2μm wavelengths. Emission associated with the star-forming region Hubble V was was clearly detected in all maps, but the extent of CO emission is very limited and does not exceed the size of the ionized gas (HII) region. At least part of the CO clouds is hot ($T_{\rm kin}$ = 150 K) and part has a high molecular gas density ($n(\mathrm{H}_2) \approx 10^4$ cm^{-3}).

It appeared that the more abundant molecular hydrogen gas extends well beyond the boundaries of the CO emission. An indication for this was provided by the extent of ionized carbon, C+, with column densities more than an order of magnitude higher than those of CO. The total mass of the complex is about 10^6 $M_\odot$ and molecular gas accounts for more than half of it. The complex is excited by luminous stars apparent at near-infrared wavelengths, but reddened or even completely obscured in the visual. The combined mass of the embedded stars may account for about 10% of the total mass, and the mass of ionized gas for 5% of it. Hubble V illustrates that in low-metallicity objects, modest star formation efficiencies may be associated with high CO destruction efficiencies. The analysis of the Hubble V photon-dominated region (PDR) confirmed in an independent manner the high value of the CO-to-H_2 conversion factor X found earlier, characteristic of starforming low-metallicity regions. The second-brightest HII region, Hubble X was also observed. Nothwithstanding its location in a region of relatively strong HI emission, the CO maps surprisingly failed to reveal any significant emission.

2.6.3 Neutral Hydrogen in NGC 1569

Stil and Israel analyzed WSRT observations of very high sensitivity and resolution of HI in the post-starburst dwarf galaxy NGC 1569. For a distance of 2.2 Mpc, they found a total HI mass of 1.3×10^8 $M_\odot$ primarily distributed as a dense and clumpy ridge surrounded by more extended diffuse HI. they also found a few additional, discrete features such as a Western HI Arm and an HI bridge reaching out to a small counterrotating companion cloud. About 10% of the HI mass in NGC 1569 occurs at unusually high velocities. Some of this HI may be associated with the mass outflow evident from Hα measurements, but some of it also appears to be associated with NGC 1569's HI companion and intervening HI bridge. This suggests that infall rather than outflow is the cause of the discrepant velocities. No indication of a large bubble structure was found in position-velocity maps of the high-velocity HI.

The galaxy as a whole rotates with modest overall velocities. However, in the central arcminute (corresponding to radii $R < 0.6$ kpc, i.e over most of the optical galaxy) the HI gas lacks all signs of rotation. Instead, it appears that rotational movements are wholly dominated by turbulent motions resulting from the starburst. This is the same region where Lisenfeld, Israel, Stil and Sievers earlier found the dust population to be highly processed, i.e. to be dominated by small rather than large dust particles (see Annual Report 2001, p. 19). In the outer disk, rotational velocities reach a maximum of 35 ± 6 km s^{-1}, but turbulent motion remains significant. It thus appears that starburst effects are noticeable even in the outer HI disk, although they are no longer dominant. Another remarkable property of NGC 1569 is its very high HI velocity dispersion. Even excluding the more extreme high-velocity HI clouds, its mean velocity dispersion is $\sigma v = 21.3$ km s^{-1} which is more than twice that of other dwarf galaxies. It is conceivable that this very high velocity dispersion is related to the extreme dust processing already referred to.

2.6.4 Nuclear Disks in Early-Type Galaxies

Krajnovic and Jaffe analysed WFPC2 imaging and STIS spectroscopy of nuclear stellar disks in four near-by edge-on E and S0 galaxies, obtained with the Hubble Space Telescope. Since the disks are confined to the nuclei of the galaxies and are seen edge-on, measuring rotation curves and constructing axisymmetric models of the galaxies, made it possible to estimate the masses of black holes in the centers of the galaxies. The multiband imaging and slit-spectra will be used to determine the age and metallicity of the stars in the disk and in the rest of the galaxy.

2.6.5 Dynamical Modeling of Elliptical Galaxies

Verolme continued her development of an implementation of Schwarzschild's orbit superposition method that can reproduce kinematical observations of triaxial galaxies. The method was tested extensively against theoretical models. These tests showed that the scheme worked and closely matched analytical results. The method is currently being applied to the kinematically decoupled core galaxy NGC 4365. In the process, some aspects of the method such as the implementation of a regularization tool may have to be refined. When this is done, this extended Schwarzschild method allows us to better study the many triaxial galaxies that were observed with the integral-field spectrograph SAURON.

Van den Bosch, in collaboration with Cappellari extended the Schwarzschild dynamical modeling method to incorporate the irregular bin shapes generated by the 2D-binning method developed by Cappellari & Copin. The code also introduced improvements designed to make the computation of orbital observables more accurate than in the previous code. The method was applied to the modeling of the integral-field SAURON observation of the elliptical galaxy NGC 4473.

Cappellari studied the properties of the projections of regular stellar orbits in a galaxy onto the plane of the sky and found that observables are dominated by singularities (catastrophes). This shows that integral-field kinematical data are needed to constrain the orbital distribution of galaxies from the observations. It also has implications for the optimal construction of the orbital library that is used in the Schwarzschild dynamical modeling method.

Krajnovic, together with Cappellari and de Zeeuw constructed axisymmetric dynamical models for the SAURON observations of NGC 2974. The best fitting model gives $M/L = 3.5$ and an inclination of 60 degrees. The gas is distributed in a disk structure defined by the potential from the best fitting stellar model. The difference between the streaming velocity and circular velocity is due to the asymmetric drift (given by Jeans equations). The gas model is in a good agreement with the observations outside the central 3 arcsec.

McDermid, assisted by Cappellari and Verolme, completed dynamical modeling of SAURON data of the disky elliptical galaxy NGC 821, using the axisymmetric Schwarzschild method developed here in Leiden. As well as showing excellent agreement with an independent determination of the central black-hole mass, this work attempted, for the first time, to separate in an objective way the structural components of the galaxy via the phase-space distribution of the stellar orbits. The galaxy is found to contain two distinct components: a dynamically hot, spherical component, with little rotation; and a rapidly rotating, dynamically cooler component which accounts for the object's disk-shaped isophotes. This agrees with previous explanations for the structure of disky ellipticals, but allows study of the two components in a fully general way without assuming any particular form for the disk and bulge.

2.6.6 Analytic Methods

Van de Ven, Hunter (Florida State U., USA), Verolme and de Zeeuw have found the general analytical solution of the Jeans equations for triaxial Stäckel models. This set of three highly-symmetric first-order partial differential equations was first derived over 40 years ago by Lynden–Bell, but resisted solution by standard methods. Application of the so-called singular solution method not only allowed an elegant rederivation of the existing two-dimensional solutions, but also yields the general solution in explicit form. Given a density and separable Stäckel potential of a stationary triaxial galaxy, this solution yields the intrinsic mean squared velocities. Together with the streaming motions, which follow from a formalism first proposed by Statler (Ohio University), semi-analytical triaxial dynamical models can be constructed and investigated. Comparison of the projected velocity and velocity dispersion fields with observed maps will provide significant constraints on the intrinsic structure of triaxial galaxies.

Jalali (Inst. Advanced Stud., Iran) and de Zeeuw extended their earlier investigation of the so-called curvature condition for the existence of two-dimensional self-consistent scale-free galaxy models to three-dimensional triaxial models.

2.7 Active Galaxies and Quasars

Wilman, Fabian, Crawford (both Cambridge, UK) and Cutri (IPAC, Pasadena, USA), analysed XMM-Newton observations of two hyperluminous IRAS galaxies with $L(IR) > 10^{13}$ $L_\odot$ and redshifts 0.3 and 0.6 respectively. They sought to make direct hard X-ray detections of the obscured active nuclei which likely power around half of the reprocessed infrared dust emission of these galaxies. Only the lower-z galaxy was detected, with thermal soft X-ray emission from the starburst and reflected hard X-rays from the active nucleus; the presence of the latter component suggests that the active nucleus is not obscured over all solid angles, consistent with its Seyfert 2 optical emission line spectrum. Our sightlines to the active nuclei in both objects are obscured by Compton-thick matter, much of which may be associated with the starbursts which supply the remaining infrared luminosity. In a separate work, a subset of the team also assessed the contribution of such Compton-thick quasars to the hard X-ray background resolved by Chandra and XMM-Newton.

McLure (Edinburgh, UK) and Jarvis showed that the black-hole masses in quasars could be estimated using the full-width at half-maximum of the MgII ultraviolet emission line along with the monochromatic luminosity at 3000Å. The existence of such a UV virial estimator means that black-hole mass estimates are no longer limited to the low-redshift Universe, and the growth of black holes in some of the most massive galaxies in the Universe can now be investigated. They also showed that flat-spectrum radio-loud quasars are consistent with having similar host galaxies, and hence black-hole masses, to galaxies of similar *intrinsic* radio luminosity, in line with orientation based unified schemes.

2.8 Clusters and Cluster Galaxies

2.8.1 Galaxy Clusters

Thomas, Katgert and Biviano (Trieste, Italy) continued their analysis of the ESO Nearby Abell Cluster Survey (ENACS) for evidence on cluster environment influences on galaxies. By combining spectral, morphological and positional information, Thomas concluded that the local clusters contain a fossil record of their formation processes, which have changed the morphological composition of clusters since a redshift of about 0.5, in the sense that that early spirals have transformed into S0 galaxies through impulsive encounters, while the late spirals did not seem to be involved at all. Instead, these appear to fall into the cluster at the present time and their kinematics and spatial distribution suggest that tidal effects largely destroy them in the crossing of the central cluster potential. Biviano and Katgert used the enlarged ENACS dataset to derive an average mass profile of the clusters by applying the Jeans equation of stellar dynamics. They found that the elliptical and S0 galaxies appear to be in equilibrium with a mass profile of the NFW kind. However, the velocity distributions of early- and late type spirals were found to be anisotropic, albeit for different reasons. Whereas the late spirals are mostly on first-approach orbits, the early spirals have probably been around much longer but the process of transformation into S0 galaxies is likely to have caused the anisotropy of their velocity distribution.

2.8.2 Clustering of Faint Red Galaxies

Daddi and Röttgering collaborated with the FIRES consortium to measure the clustering properties of faint $K_{VEGA} < 24$ galaxies using the ultradeep J, H and K near-IR images of the Hubble Deep Field South (HDF-S). They found a relatively large clustering amplitude at a level comparable to the measurements at $K \sim 19$. At the highest redshifts, $2 < z_{phot} < 4$, galaxies selected in the rest frame optical (K-band) appeared to be significantly more clustered than galaxy populations selected in the rest frame UV (i.e. Lyman Break Galaxies, LBGs). Furhtermore, galaxy clustering depends on the $J - K$ color at $2 < z_{phot} < 4$, with the reddest objects having correlation length a factor 3-4 larger that LBGS with similar number densities. This is interpreted as the reddest galaxies with red $2 < z_{phot} < 4$ to be older and more massive galaxies, on average, than LBGs. The overall properties of this strongly clustered population suggest that they are the progenitors, of local massive early-type galaxies, close to their major epochs of formation.

2.8.3 Luminosity Function of Radio Haloes

A significant fraction of galaxy clusters posses radio haloes of megaparsec size. Ensslin (MPI, Münich) and Röttgering have predicted the local and higher redshift radio halo luminosity function on the basis of (i) an observed and a theoretical X-ray cluster luminosity function (XCLF), (ii) the observed radio–X-ray luminosity correlation of galaxy clusters with radio halos and (iii) an assumed fraction of $f_{\mathrm{H}\alpha} \approx \frac{1}{3}$ galaxy clusters to have radio halos as supported by observations. They found 300-700 radio halos with $S_{1.4\mathrm{GHz}} > 1$ mJy, and $10^5 - 10^6$ radio halos with $S_{1.4\mathrm{GHz}} > 1\,\mu$Jy should be visible on the sky. 14% of the $S_{1.4\mathrm{GHz}} > 1$ mJy and 56% of the $S_{1.4\mathrm{GHz}} > 1\,\mu$Jy halos are located at $z > 0.3$. More realistic predictions that take into account a refined estimate of the radio halo fraction as a function of redshift and cluster mass, and a decrease in intrinsic radio halo luminosity with redshift due to increased inverse Compton electron energy losses on the Cosmic Microwave Background (CMB) reduced the radio halo counts from the simple prediction by only 30 % overall. The calculations showed that the new generation of sensitive radio telescopes like LOFAR, ATA, EVLA, SKA and the already operating GMRT should be able to detect large numbers of radio halos and will provide unique information for studies of galaxy cluster merger rates and associated non-thermal processes.

2.8.4 Fundamental Plane (FP) of Strong Lensing Galaxies

Van de Ven, Van Dokkum (Caltech, USA) and Franx have extended the analysis of the Fundamental Plane (FP) of strong lensing galaxies with redshifts up to $z \sim 1$. The FP, a tight relation between structural parameters and the velocity dispersion, is being used as a probe for the evolution of these field early-type galaxies. The mass-to-light ratio (M/L) evolution that follows from the FP, provides a very strong constraint on the epoch of star formation of the galaxies, and hence on their formation history. The resulting mean formation epoch is not significant different from that found for cluster early-type galaxies. However, the scatter in the restframe colors of the lens galaxies, which is correlated with the scatter in M/L, is significant. This led to the conclusion that lens galaxies probably have stellar ages that are 10–15 % younger than those of cluster galaxies, and have a significant age spread.

2.9 High-Redshift Objects and Large-Scale Structure

2.9.1 The Deepest Near-Infrared View of the Universe.

Labbé and Franx made publicly available all reduced observations of the Hubble Deep Field South, the first of two fields in the Faint InfraRed Extragalactic Survey (FIRES) comprising the deepest groudbased near-infrared (NIR) images of the sky, and the deepest K_s-band in any field. These data amount to 100 hours under the best seeing conditions and allow an unprecendent view of the rest-frame optical properties of high redshift galaxies. The results shed new light on how galaxies formed and evolved in the early universe. Unexpectedly, many infrared-selected galaxies have red colors and show little visible star-forming activity, unlike those found in optical surveys. Already, they appear to have formed stars in large quantities, sufficient to account for half the total luminous mass of the universe at that epoch. The galaxies were found to form tight clusters which can be taken as evidence that they formed in the highest-density regions of dark matter. Surprisingly, at least some of the galaxies at high redshift are large and disk-shaped, showing spiral structure similar to that seen in nearby galaxies. The HDF-N seems to be deficient in red or large, disk-like galaxies.

2.9.2 Compact Steep-Spectrum Radio Sources at 74 NHz

Gigahertz-Peaked Spectrum (GPS) sources and Compact Steep-Spectrum (CSS) sources are characterised by a convex radio spectrum. GPS radio sources have spectra which peak at a frequency of about 1 GHz and have sizes of typically 10 to 100 pc. CSS radio sources have spectra which peak around 100 MHz and have sizes of typically a few to a few tens of kpc. Until recently, detailed population studies have been limited to samples of bright GPS sources, bright CSS sources and faint GPS sources To complement these studies Tschager, Schillizi, Snellen (Edinburgh) and Röttgering embarked on a project to investigate a new sample of faint CSS radio sources. This sample was defined using the the WENSS, NVSS and FIRST radio surveys. An important first step was to determine determine the peak frequency and peak flux density of these CSS sources. For this, Tschager carried out VLA observations at 74 Mhz to sample the low part of the radio spectrum. This will allow modelling the growth process of faint peaked-spectrum radio sources at early stages of their life over a wide range of physical size and intrinsic radio luminosity, thereby reproducing the self-similarity characeristics of the growth process.

2.9.3 Distant Starburst Galaxies

Van der Werf, acting as part of the ELAIS team completed and published the analysis of the Infrared Space Observatory (ISO) 7 and 15 μm data of the Hubble Deep Field South. These data form the deepest survey to date at these wavelength, and resulted in the detection 35 faint infrared sources. Eight of these were identified as galactic stars, two were likely active galactic nuclei, and the remaining 22 were characterized as normal spiral or starburst galaxies, at redshifts out to $z = 1.3$. Derived star formation rates has a median value of $\sim\ 40\,M_\odot\,\mathrm{yr}^{-1}$, showing that this survey sampled for the first time the population of luminous (but not ultraluminous) infrared galaxies out to $z\ \sim\ 1.3$. Active follow-up observations using near-infrared spectrscopy at the VLT is underway.

Knudsen and van der Werf made major progress on the SCUBA-Leiden Lens Survey. Knudsen developed, coded and tested a mathematically rigorous source extraction algorithm, tailored specifically to SCUBA data. This algorithm, based on isotropic wavelets and developed in collaboration with Barnard (Cambridge, UK) was extensively characterized on artificial data and found to be robust down to the 3σ level. Application of this method to the SCUBA survey data resulted in a reliable sample of 60 submillimetre galaxies. This formed the largest homogeneous sample available to date and was a major step forward, considering that only 150 to 200 submillimetre galaxies were known to date. A futher crucial step was the completion of deep K-band imaging (6 hours with ISAAC of all fields accessible from the VLT), which resulted in reliable identifications of a significant number of sources.

2.9.4 The FIRES MS1054–03 Field

Förster Schreiber, Franx, Labbé, Rudnick, and van Dokkum also made significant progress on the Faint InfraRed Extragalactic Survey (FIRES) of the field around the cluster MS 1054−03. FIRES is a very deep near-infrared survey carried out at the ESO Very Large Telescope (VLT). The MS 1054−03 field complemented the ultra-deep near-infrared imaging of the first FIRES field, the Hubble Deep Field South (HDF-S), with four times larger area for more robust statistics on source populations down to about 0.75 mag brighter than the faintest HDF-S limits.

The near-infrared data from the VLT ISAAC instrument were fully reduced. A total of 78 h integration time was split equally between the J_s, H, and K_s bands and over four pointings covering $5\ \mathrm{arcmin}^2$. The data were obtained under excellent seeing conditions, and constituted the best combination of area surveyed and depth obtained from the ground to date. Complementary VLT FORS1 optical data in the U, B, and V bands also have been reduced. The ISAAC and FORS1 data, together with existing HST WFPC2 V_{606} and I_{814} optical imaging, were used to generate a K_s-band limited multicolour catalogue and derive photometric redshifts (z_phot).

A substantial population of galaxies was detected at $2 < z_\mathrm{phot} < 4$ with very red near-infrared colours ($J_\mathrm{s} - K_\mathrm{s} > 2.3$). Their rest-frame optical colours are similar to those of nearby normal galaxies with pronounced spectral breaks attributed to the Balmer/4000 Å break, indicative of fairly evolved stellar populations. Most of these galaxies were very faint in the observed optical and would be missed by the standard "U-dropout" criteria used to select high redshift galaxies in optical deep surveys. The detections in the MS 1054−03 field confirmed and complemented with a larger sample the findings for the HDF-S. The first results of the MS 1054−03 spectroscopic follow-up program at the W. M. Keck Telescope demonstrated the efficiency of the $J_\mathrm{s} - K_\mathrm{s} > 2.3$ criterion, with five out of six measured redshifts in the range $2.43 \leq z_\mathrm{spec} \leq 3.52$. This new population has a number density comparable to that of Lyman-break galaxies and might represent the oldest and most massive galaxies yet identified at $z > 2$.

2.9.5 Proto-Clusters at High Redshifts

Powerful high-redshift radio-galaxies (HzRGs) are unique probes of galaxy and cluster formation. They are amongst the oldest and most massive objects in the early

Universe and appear to be galaxies in formation at the centre of a clusters or protocluster. Miley, Venemans, Röttgering, Kurk and collaborators used the ESO-VLT to find and study galaxy proto-clusters in the redshift range $2 < z < 4.1$. They obtained HzRG images with FORS2 in a narrow band centered on the redshifted Lyα line, and in a broad band on the continuum to the red of the line. The carried out spectroscopy of the brightest candidate Lyα emitters to confirm whether the candidates were cluster members and to measure cluster velocity distributions. All six radio galaxies (at $z = 2.2, 2.9, 2.9, 3.1, 3.2, 4.1$ respectively) for which they carried out imaging and spectroscopy to a sufficient depth, show an overdensity of Lyα emitters. The velocity dispersion of the confirmed emitters ranges between 300 and 1000 km s^{-1} and the sizes of the proto-clusters generally exceed the 7'×7' FORS field. The estimated masses are in the range 10^{14}–10^{16} $M_{\odot}$, comparable with the mass of present day rich clusters of galaxies. The proto-cluster at $z = 4.1$ is the most distant structure known (and became the subject of an ESO press release in April, see Fig. 2.9 and 2.10).

Kurk, Röttgering, Pentericci (MP, Heidelberg), Overzier and Miley continued their research of the proto-cluster associated with radio galaxy PKS 1138−262 at $z = 2.16$ beyond the 15 Lyα emitting cluster galaxies with $\Delta z = 0.02$ already known. Further imaging observations in the near-infrared added tens of new Hα emitters to the list of possible proto-cluster members. Spectroscopic observations of nine candidate Hα emitters with the VLT-ISAAC confirmed three of these as Hα emitters at $z \sim 2.16$, and five more as tentative identifications of Hα at $z \sim 2.16$. Pentericii (now at MPIA, Heidelberg) and Kurk found an overdensity of Chandra X-ray point sources in the PKS 1138−262 field as compared with deep X-ray surveys. The most likely explanation is a concentration of AGN associated with the $z = 2.16$ protocluster. Ninety per cent of the sources can be identified in previously obtained optical and infrared images. Six sources are (almost) certainly part of the proto-cluster.

Best (Edinburgh), Röttgering, Miley and Lehnert (MPE, Münich) studied the environments of a complete subsample of 6 of the most powerful radio–loud AGN at redshifts $z \sim 1.6$, using deep RJK imaging obtained at the ESO NTT telescope. They found an excess of galaxies in K–band counts in these fields. These surplus galaxy counts are predominantly associated with red galaxies ($R - K > 4$) of magnitudes $17.5 < K < 20.5$ found within ∼1 Mpc of the AGN host. The magnitudes, colours and locations are consistent with old passive elliptical galaxies in cluster environments at the redshifts of these AGN. Using both an Abell–style classification scheme and investigations of the angular and spatial cross–correlation functions of the galaxies, Best and co-workers found the average environment of the fields around these AGN to be consistent with Abell cluster richness classes 0 and 1.

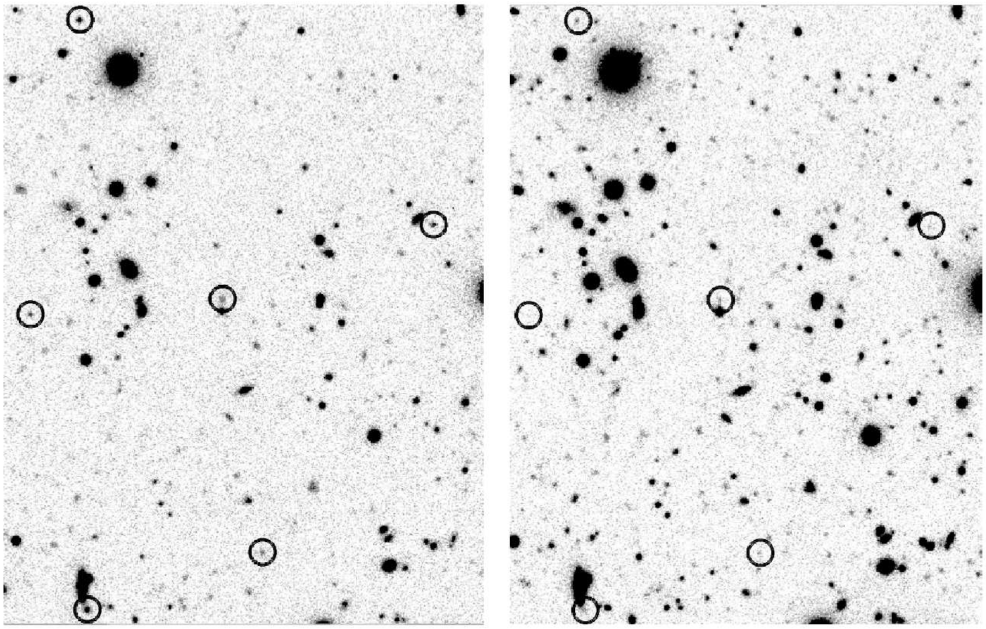


Figure 2.9: Narrowband and broadband image of a field near the radio galaxy TN J1338-1942 at z = 4.1. The narrowband filter used for the image on the left is centered at $\lambda = 6210 \AA$, which corresponds to Lyα at z = 4.1. The image on the right used an R filter, which measures the UV continuum at z = 4.1. The encircled objects all have an excess flux in the narrowband, and were candidates for followup spectroscopy (see Section 2.9.5).

2.9.6 Lyα emission line regions

Reuland, van Breugel (IGPP. Univ. of Cal., USA) and Röttgering analysed deep Keck narrow-band Lyα images of the luminous $z > 3$ radio galaxies 4C 41.17, 4C 60.07, and B2 0902+34. The images show giant, 100-200 kpc scale emission line nebulae with a wealth of structure including extended low surface-brightness emission in the outer regions, radially directed filaments, cone-shaped structures and (indirect) evidence for extended Lyα absorption. They interpreted these features with a general scenario in which nebular gas cools gravitationally in large Cold Dark Matter (CDM) haloes, forming stars and multiple stellar systems. Mergers of these "building" blocks trigger large scale starbursts, forming the stellar bulges of massive radio galaxy hosts,and feeds super-massive black holes which produce the powerful radio jets and lobes. The radio sources, starburst superwinds and AGN radiation then disrupt the accretion process limiting galaxy and black hole growth,

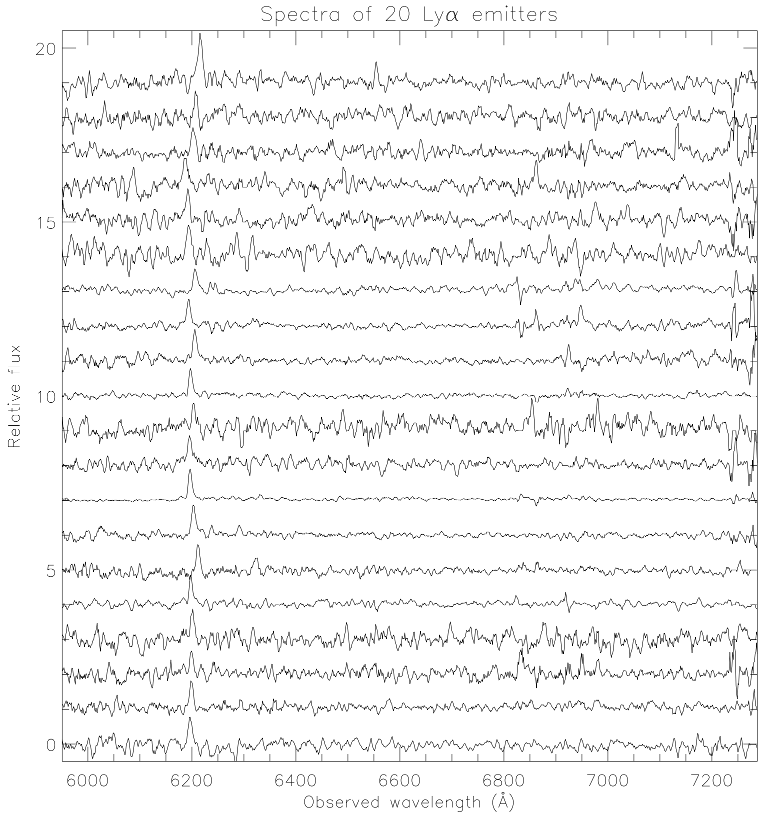


Figure 2.10: Spectra of 20 Lyα emitting galaxies detected around TN J1338-1942 at z = 4.1. All the emission line galaxies show a line near 6200 $\mathring{A}$. Analysis of the spectra confirmed that all the lines are from Lyα at z = 4.100 ± 0.012 (Venemans et al. 2002, see Section 2.9.5).

and imprint the observed filamentary and cone-shaped structures of the Lya nebulae.

Reuland, van Breugel (IGPP, Univ. of Cal.), Röttgering and de Breuck (Paris) have observed the dust continuum emission from a sample of $z > 3$ radio galaxies with the SCUBA bolometer array. They confirmed earlier results that HzRGs are massive starforming systems and that submillimeter detection rates are primarily a strong function of redshift. Perhaps as many as 10% of high-redshift radio galaxy (HzRG; $z > 2$) candidates that are selected by the Ultra Steep radio Spectrum (USS) criterion fail to show optical emission (continuum, lines) in deep Keck exposures. Their parent objects are only detected in the near-IR and are probably heavily obscured, at very high redshift or both. To search for dust signatures and thus constrain the nature and redshifts of these "no-z" radio galaxies, Reuland and co-workers conducted a program of (sub)millimeter observations. One of these objects, WN J0305+3525 was strongly detected at both 0.85 and 1.25 mm. On the basis of its faint K-band magnitude, spectral energy distribution and other evidence the radio galaxy was estimated to be at a redshift $z = 3 \pm 1$. This would make it a radio-loud Hyper Luminous Infrared Galaxy embedded in a very dense, dusty medium.

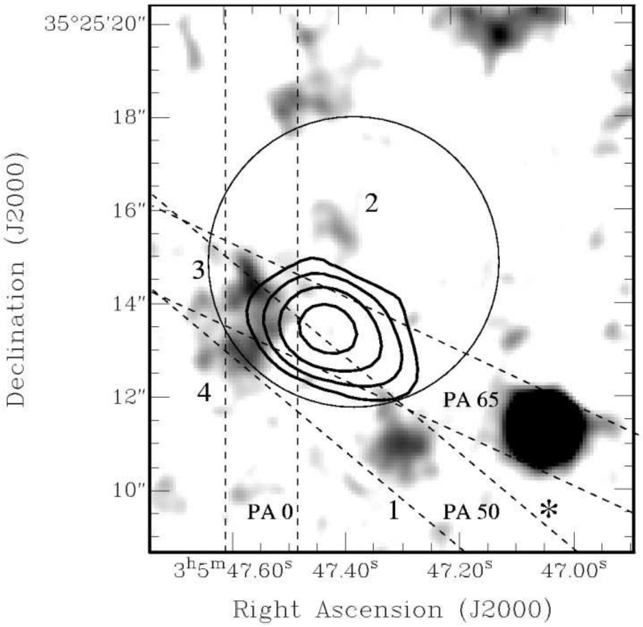


Figure 2.11: Keck/NIRC K-band image with 4.85 GHz VLA radio contours (De Breuck et al. 2000b) overlaid on the HzRG candidate WN J0305+3525. The gray-scale image has been smoothed to a resolution of 0.7", and the contour levels are 0.25, 0.5, 1, and 2 mJy beam^{-1}. Note the multiple components. The bright object to the southwest is a spectroscopically confirmed star. The circle with 3 radius represents the nominal 3 astrometric uncertainty for the centroid of the 850 μm emission, and dashed lines indicate the LRIS slit positions (see Section 2.9.6).

Inskip (Cambridge), Best (Edinburgh), Röttgering and collaborators, carried out a spectroscopic analysis of 3CR and 6C radio galaxies at redshift $z \sim 1$. The results were compared to the properties of radio galaxies at lower redshifts, matched in radio luminosity to the 6C sources studied at $z \sim 1$ enabling the redshift–radio power degeneracy to be broken. Statistical analysis of the kinematic properties of the emission line gas shows that these are strongly correlated independently with both redshift and radio power. The correlation with redshift is the stronger of the two, which suggests that host galaxy composition or environment may play a role in producing the less extreme gas kinematics observed in the emission line regions of low redshift galaxies. For both the ionization and kinematic properties of the galaxies, the independent correlations observed with radio size are stronger than with either radio power or redshift. Radio source age is clearly a determining factor for the kinematics and ionization state of the extended emission line regions.

2.9.7 Structure of High-z Galaxies

Mellema, Kurk, Röttgering and Rijkhorst studied the problem of jet induced star formation in high redshift radio galaxies. Jet induced star formation can explain the observed alignment between the radio jet and optical/UV emission regions. They showed that density enhancements in the circumgalactic medium will be strongly compressed and also fragment. The compression is efficient enough to make these clouds collapse and form stars. Initial two-dimensional simulations of the interaction between the shock bounding a radio lobe and a density condensation were followed up by three-dimensional ones, using the new Flash code. These calculations were performed on TERAS, the Dutch national supercomputer operated by SARA.

Jarvis, Wilman, Röttgering and Binette (UNAM, Mexico) completed their initial study of the low-density gaseous environments of two high-redshift radio galaxies, the results of which implied a huge deposit of metals around young powerful radio galaxies. This was interpreted as evidence for concurrent triggering of the radio source and a massive starburst. Further VLT-UVES observation of other high-redshift radio galaxies have been proposed in Period 71 to investigate this further.

2.10 Models and Theory

2.10.1 Disk-Planet Interaction

Paardekooper and Mellema showed that the ‘metric’ approach used by the Roe-solver method for hydrodynamics, renders it excellently suited to deal with the problem of the flows set up by a massive planet in a gas disk. The Roe-solver deals perfectly with angular momentum conservation (often a problem in this type of calculation), and handles rotating frames of reference without problems. The code was submitted to a wide range of test problems. Simulations of a Jupiter-size planet orbiting in a minimum solar disk, showed a number of interesting differences with previous calculations: a five times slower planet accretion rate, and short periods of outward migration, although the main migration direction remains inward.

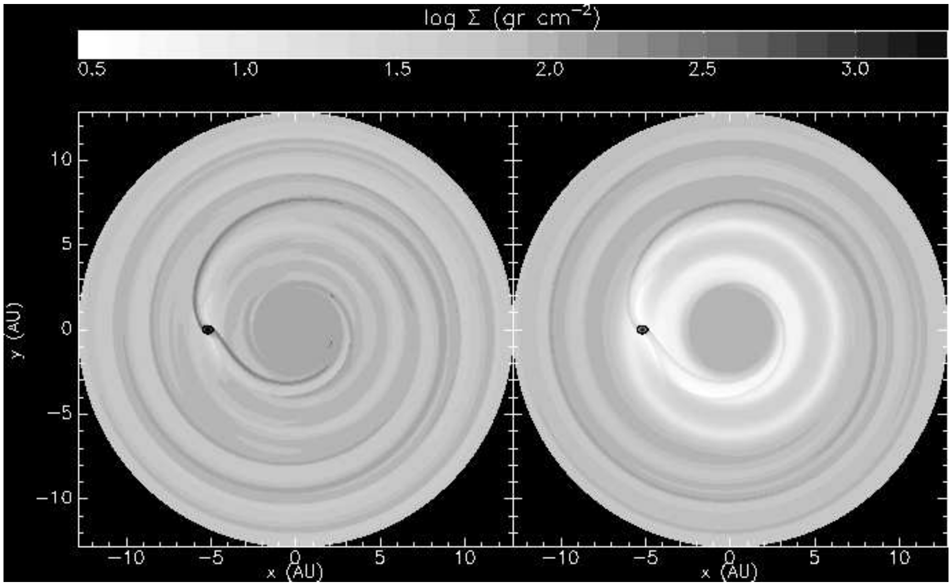


Figure 2.12: Logarithmic plot of the surface density after 5 and 50 orbits of a Jupiter-size planet in a proto-planetary disk (see Section 2.10.1).

2.10.2 Hydrodynamics of Planetary Nebulae

Meijerink, in a collaboration with Mellema and Simis, modelled the evolution of Asymptotic Giant Branch (AGB) mass loss variations during the post-AGB/Planetary phase. The results showed that the observable effects of mass loss variations disappear in a few thousand years after ionization. This is consistent with the fact that only a few planetary nebulae have been found surrounded by 'rings'. The observational characteristics derived are in very good agreement with previous observations of the rings around NGC 6543: the rings are clearly visible in [OIII] images, the Hα and [OIII] emissivities have slightly different radial profiles, and the lines are broadened to about 30 km s^{-1}. In order to make a better comparison between models and observations Mellema, together with Corradi (ING), and Schwarz (CTIO) took deep long slit spectra of the rings in NGC 6543 using the ISIS spectropolarimeter on the WHT. The polarization measurements show approximately 5% of linear polarization in the rings, with the vectors tangent to the rings, indicating scattering from a central source. This is the first time that clear polarization was measured in the ionized gas of a Planetary Nebula (see Fig. 2.13).

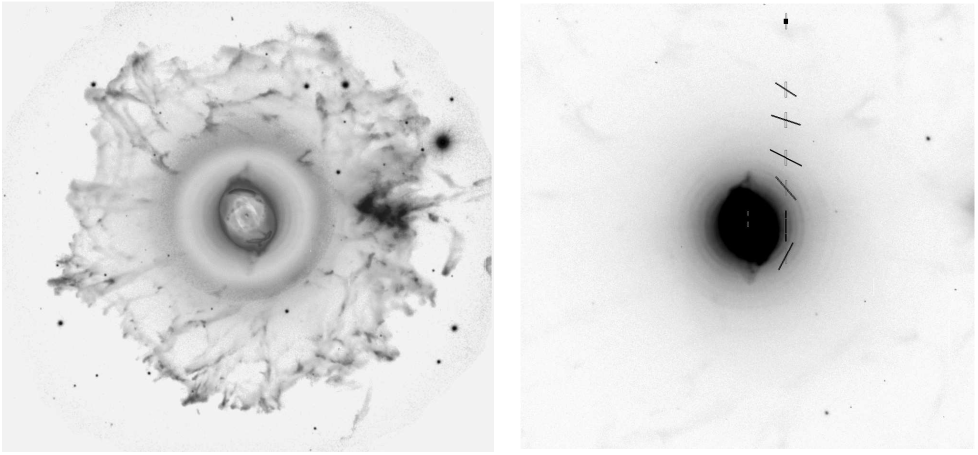


Figure 2.13: Observations of the planetary nebulae NGC 6543, the Cat's Eye. To the left an image taken by Corradi & Gonsalves with the NOT. To the right the central part of this image shwoing the circular rings around the bright core nebula, and the sticks indicating the direction and percentage of linear polarization (see Section 2.10.2).

Mellema and Lundqvist (Stockholm, Sweden), studied the interaction of hydrogen-free, metal-rich winds of stars with Wolf-Rayet type spectra with the surrounding medium. Using numerical hydrodynamic modelling coupled with non-equilibrium cooling and ionization calculations, they showed that ring nebulae around WR stars are *not* expected to be momentum-driven (i.e. being pushed directly by the stellar wind), but rather energy-driven (i.e. being pushed out by hot shocked stellar wind gas in their interiors). They also found that the usual observational estimate for establishing the character of stellar wind bubbles gives misleading results, even under ideal circumstances.

Mellema and Lundqvist (Stockholm) studied the effects of thermal conduction in Planetary Nebulae, focusing on the resulting X-ray spectrum. Chandra and XMM-Newton observations have shown that the spectra of PNe are too soft for what was expected. Thermal conduction is one process which could lower the temperature of the hot gas, although it is expected to be rather ineffecient due to the presence of magnetic fields. Numerical hydrodynamic models confirm that models without thermal conduction indeed produce X-ray spectra which do not match the observations. Thermal conduction of around 1% efficiency is enough to reproduce the observed spectra.

Rijkhorst, Icke and Mellema numerically studied the interaction of a tenuous stellar wind blowing into a warped circumstellar disk. This acts as a mechanism to create point-symmetric (multi-polar) shells such as those observed in many young planetary nebulae (e.g., M1-26, He2-138, He2-47). This problem was first explored using two-dimensional (slab-symmetry) simulations which showed that strikingly point-symmetric structures were indeed obtained. Subsequent three-dimensional simulations (see Fig. 2.14) using the Flash code confirmed the results, and made it possible to view the results from different projection angles. These three-dimesional simulations were run on TERAS, the Dutch national supercomputer operated by SARA.

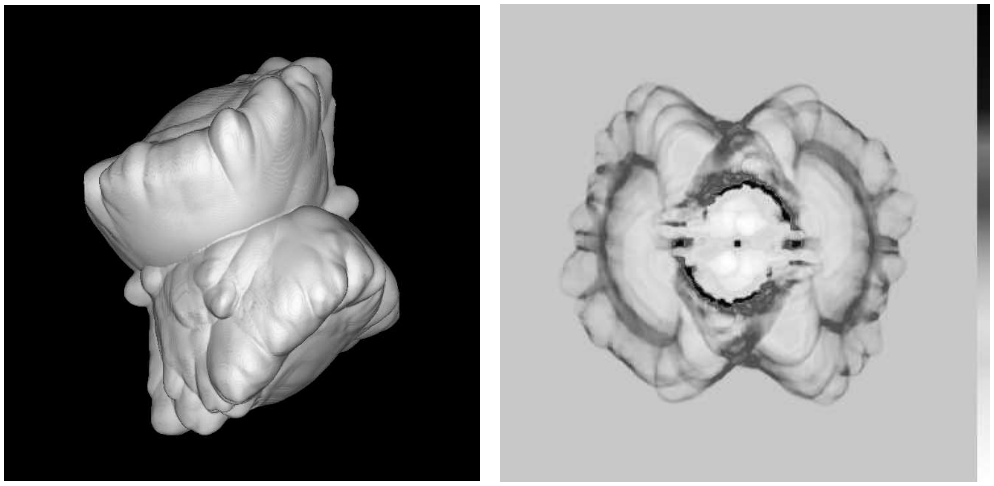


Figure 2.14: Two representations of the results of a 3D simulation of the interaction of a stellar wind with a warped disk, as a model for point-symmetric planetary nebulae (see Section 2.10.2). On the left, an iso-density surface plot, on the right a synthetized (projected) Hα image of the resulting nebula (darker shades correspond to higher intensities).

2.10.3 Hydrodynamics of Stellar Systems

Ritzerveld and Icke studied colliding stellar winds in open star clusters by analytically solving the equations of hydrodynamics assuming an irritational gas-flow.

Hereby, the position of a shockfront could be predicted. Extending the results numerically, Ritzerveld studied the evolution in time of the shock regions in a cluster. This led him to conclude that the shockfront positions were quite stationary, notwithstanding the significant movement of individual members of the cluster.

Pelupessy worked on a N-body/SPH code for simulating entire galaxies. He made several improvements with respect to the previous version of the code. These improvements mostly affect the treatment of thermodynamic processes of the interstellar gas. He included metallicity dependent radiative cooling using calculations done by Mellema, cosmic ray ionization, and a new method for accounting for the feedback of Supernovae, which has been shown to reproduce observed dispersion patterns when applied to simulations of dwarf galaxies.

2.10.4 Numerical Astrophysics Modeling

The use of adaptive mesh refinement (AMR) (see Fig. 2.15) techniques and parallelized computer codes is required to simulate three-dimensional flows. In the context of the AstroHydro3D project, Rijkhorst made an inventory of publicly available AMR packages and investigated the differences in performance of a cell-based (Yguazu), and a block-based AMR code (Flash/Paramesh). These two codes were combined with existing hydro solvers (Roe-solver from Mellema, FCT-solver from Icke) and a radiative cooling routine (from Mellema). It was found that block-based AMR is computationally more effective with respect to parallelization aspects and memory requirements than cell-based AMR. After the first successful two-dimensional tests, the code was subsequently used to simulate two different 3D numerical models.

Pelupessy demonstrated together with van de Weygaert and Schaap (both Kapteyn Inst., Groningen, NL) the superior performance in comparison with conventional SPH of the Delaunay triangulation field estimator for the density estimates in particle hydrodynamic simulations. They are implementing this novel idea in a computer code for gasdynamical calculations.

Ritzerveld worked with Icke and Rijkhorst to develop an N-dimensional method to solve the equations of radiative transfer on unstructured grids. The ultimate aim was to incorporate radiative transfer with the usage of Delaunay-triangulations to simulate galaxies as a whole using SPH-methods. He proved analytically that the method solved the equations in polynomial time, after which he implemented it numerically in order to test it. The resulting method has been proven to numerically solve the transfer equation in all regimes of optical thickness.

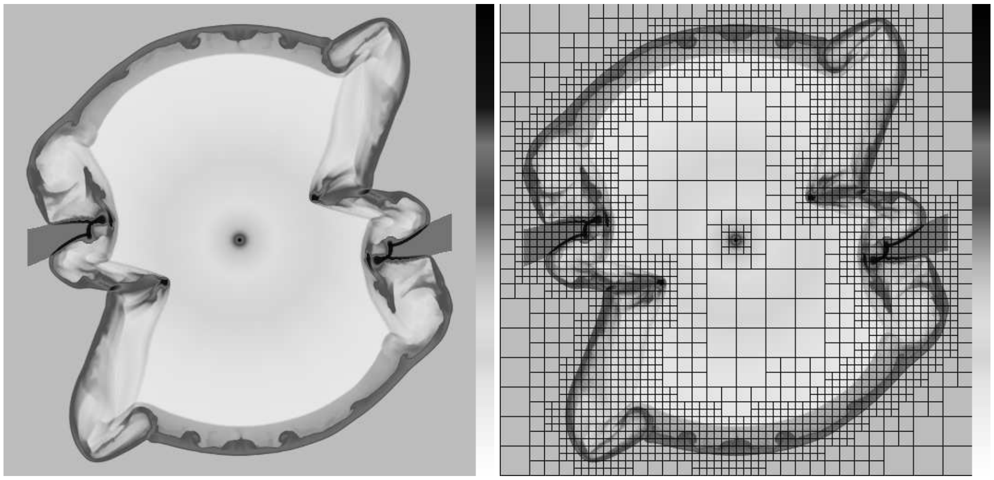


Figure 2.15: Greyscale plot of the logarithm of the density in a 2D simulation of the interaction of a stellar wind with a warped disk. Darker shades correspond to higher densities. On the right the corresponding grid structure is overplotted (see Section 2.10.4).

2.11 Raymond & Beverly Sackler Lab. for Astrophysics

2.11.1 Complex Organic Molecules in Interstellar Ice Analogs

Muñoz Caro and Schutte performed a detailed quantitative infrared analysis of the complex organic refractory material produced by photo- and thermal processing of interstellar ice analogs. They investigated the effects of the most relevant free parameters, such as ice composition, UV dose, photon energy and temperature. For the first time, they could present evidence for the presence of carboxylic acid salts and the formation of hexamethylenetetramine (HMT) at room temperature. The analysis of the products by gas chromatography-mass spectroscopy, in collaboration with Meierhenrich (CNRS, Orleans, France), led to the detection of nitrogen-heterocyclic species, sulfur-bearing molecules and amines. Fig. 2.16 shows the gas chromatogram corresponding to the sample obtained from photolyzed H_2O:CO:NH_3:H_2S = 2:1:1:0.04 ice. Sulfur-polymerization was found to be efficient while other detected species, like pentathian (S_5CH_2), show chemical interaction between the C and the S elements. Some of these species are of prebiotic interest and could be present in comets.

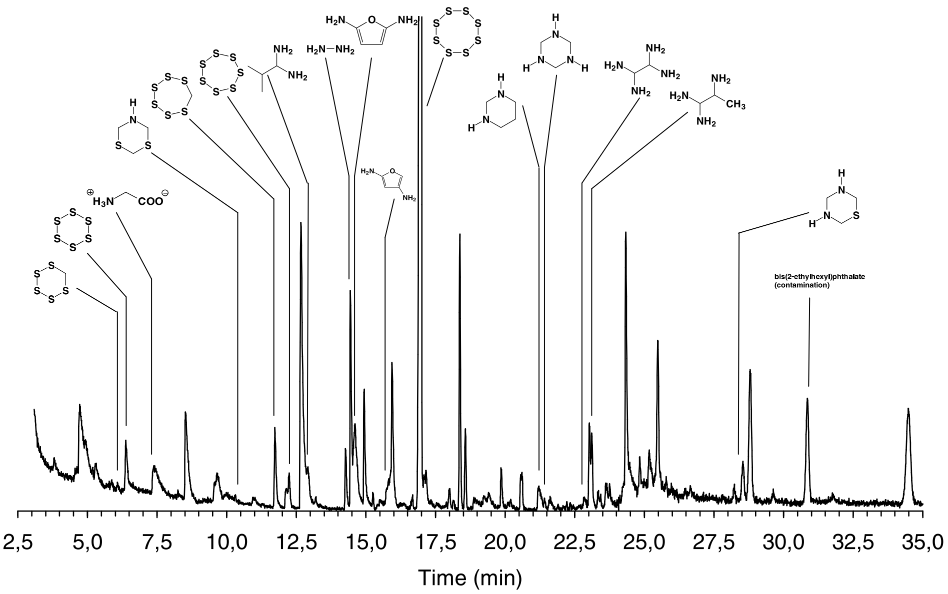


Figure 2.16: Gas chromatogram showing the sulfur- and nitrogen-species generated under simulated interstellar/circumstellar conditions, corresponding to photolyzed H_2O:CO:NH_3:H_2S = 2:1:1:0.04 ice after warm-up to room temperature (see Section 2.11.1).

2.11.2 Upper Limits on Solid NH_3 Abundances

Taban, Schutte and Pontoppidan analysed the near-infrared spectrum of the high-mass, embedded protostar W 33A obtained with the VLT. Their aim was to search for the 2.21 μm overtone feature of solid NH_3 and the 2.27 μm band of solid CH_3OH. The abundance of solid NH_3 has been a hotly debated subject: tentative detections of the 9.1 μm umbrella mode indicated a high abundance of 15 % with respect to H_2O ice, while the weakness of the ammonium hydrate feature gave estimates of less than 5 %. The advent of 8 m class telescopes allowed for the first time meaningful observations of the weak near-IR features of ice components. The absence of the 2.21 μm NH_3 band in the W 33A spectrum gave an upper limit of less than 5 %, derived from comparison with relevant laboratory spectra. The 2.27 μm CH_3OH feature was positively identified and its derived abundance was very similar to values derived earlier from mid-IR features, demonstrating the feasibility of probing ices by near-IR spectroscopy.

2.11.3 Spectroscopy of CO on Astrophysical Surfaces and Ices

Bisschop and Fraser investigated the behavior of CO ices on a number of astrophysical grain analogs, including HAC (hydrogenated amorphous carbon), CsI and zeolites. They found that at high spectral resolution the CO-ice band could be deconvolved into at least two and occasionally three components, in keeping with the recent observational findings by Pontoppidan. CO can be easily trapped in any hydrogen-bonding ice system, but the final desorption temperature of the CO depends intrinsically on the interplay between the crystallization and desorption behavior of the trapping matrix. The behavior of CO on an acidic ice, HCOOH, was studied in detail. In an effort to understand a new solid state feature observed by Pontoppidan et al. at 2175 cm^{-1}, Bisschop and Fraser investigated direct gas-grain interactions on naturally occurring zeolites. CO was observed to chemisorb at 2175 cm^{-1} with the band strength increasing at lower temperatures (see Fig. 2.17).

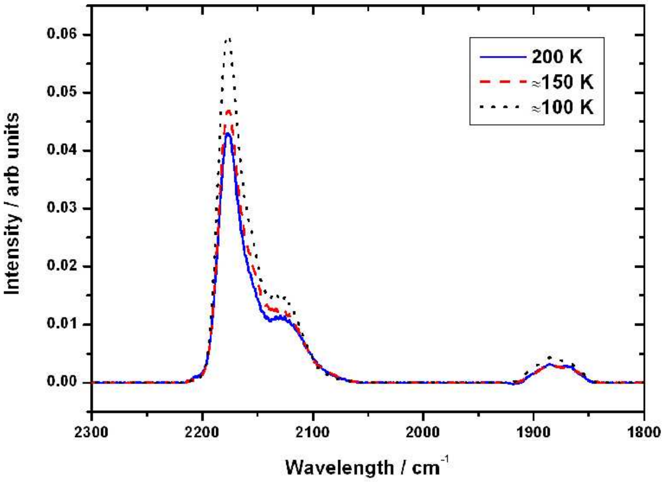


Figure 2.17: Infrared features of CO gas-adsorbate species on a zeolite (i.e., an aluminum-containing silicate) surface, providing a tentative identification of the 2175 cm^{-1} feature observed in spectra toward low-mass YSO's by Pontoppidan et al.(Bisschop & Fraser, see Section 2.11.3).

2.11.4 Formation of OCN^{-} in Interstellar Ices

Van Broekhuizen and Schutte finished their laboratory simulations of the formation of OCN^{-} in interstellar ices. This ion, which can be probed through its vibrational stretching mode at 4.62 μm, has been observed towards a large number of mostly high-mass protostars. Several pathways were investigated involving either UV photolysis or thermal processing of relevant ice mixtures. Photolysis of CO with NH_3 is too inefficient to account for the high observed abundances, but photolysis of CH_3OH with NH_3 showed an unexpectedly high OCN^- production rate. Thermal processing of mixtures involving HNCO can also meet the observational constraints.

2.12 Astrobiology

Botta installed laboratory hardware and implemented procedures as part of the new astrobiology research group for the analysis of carbonaceous meteorites as well as other geophysical samples. With the help of chromatographic techniques he studied exogeneous delivery to Earth-like planets and moons. In December, Botta's experiment ”MILLER” was selected to fly on the 2003 Dutch Taxi-Flight to the International Space Station (ISS). This experiment will study prebiotic chemical pathways in microgravity.

In a collaboration with the NASA AMES Research Center, Ruiterkamp performed spectroscopic studies on large – specially synthesized – polycyclic aromatic hydrocarbons (PAHs). Data from the Infrared Space Observatory (ISO) have provided new insights into the size distribution and the structure of interstellar PAH molecules pointing to a trend towards larger-size PAHs. The mid-infrared spectra of galactic and extragalactic sources have also indicated the presence of five-ring structures and PAH structures with attached side groups. Ruiterkamp measured those large and unusual PAHs for the first time in the laboratory using matrix isolation spectroscopy. These laboratory spectra were used for comparison with astronomical data and for the preparation for the BIOPAN/PHOTON 2002 orbit flight and EXPOSE experiment on the International Space Station ISS. Unfortunately, the Russian Photon rocket with BIOPAN on-board exploded 27 seconds after launch on October 15, utterly destroying Ruiterkamp's experiment.

Ten Kate and Ruiterkamp worked wiyth members of the TOS and SSD departments at ESTEC, to refurbish a Mars simulation chamber for use in investigations of chemical surface and subsurface processes on Mars. A gas-inlet system to fill the chamber with Martian atmosphere analogue, a solar simulator that provides the solar spectrum on Mars, vacuum tight gloves for sample handling in the chamber, a cooling device that will be used for cooling the samples and a feed through system for the liquid nitrogen used for additional cooling have been implemented. After some preliminary testing a new sample holder, which will contain mixtures of Martian soil analogue and organic compounds, has been designed. A sampling system to sample gas from the tank towards a GCMS (gas chromatograph/mass spectrometer), was also developed. First tests were performed on surface samples.

In collaboration with colleagues from the NASA AMES Research Center, Ehrenfreund studied cometary chemistry by using laboratory simulations, observations and modelling. With the Ultraviolet Visual Echelle Spectrograph mounted at the ESO-VLT, Ehrenfreund, Cox, Kaper and a large international consortium have observed at unprecedented spectral resolution the absorption spectrum toward reddened stars in the Magellanic Clouds over the wavelength range of 3500-10500 Å. This range covers the strong transitions associated with neutral and charged large carbon molecules of varying sizes and structures. Ehrenfreund et al. reported the first detection of diffuse interstellar bands (DIBs) at 5780 and 5797 Å in the Small Magellanic Cloud, and the variation of the 6284 Å DIB toward several targets in the Large Magellanic Cloud. The results show that the variation of DIBs in the Magellanic Clouds compared with galactic targets may be governed by a combination of the different chemical processes prevailing in low-metallicity regions and the local environmental conditions. The astrobiology group was selected by the European Space Agency as a Recognized Cooperating Laboratory for Mars Express/Beagle 2 in the category *Exobiology*.

2.13 Instrumentation

2.13.1 NEVEC

The NOVA-ESO VLTI Expertise Centre (NEVEC) is a national expertise centre in optical/infrared interferometry partially funded by NOVA as a joint venture with ESO. For a description of the goals and general activities of NEVEC we refer to the Sterrewacht Leiden Annual Report 2001. Leiden-based personnel included the NOVA-funded NEVEC staff (Project Manager Bakker, De Jong, Meisner and Percheron) as well as several tenured staff of Leiden Observatory (Jaffe, Project Scientist Le Poole, Principal Investigator (until September 2002) Miley, Rttgering, and Principal Investigator Quirrenbach (from September 2002). Additional NEVEC personnel at Leiden include d'Arcio (funded by SRON) and Heiligers, a Ph.D. candidate, and Gori a Ph.D. student funded by TNO/TPD.

VLTI Calibrators

noi Percheron and Richichi (ESO) started a joint project to build a database of VLTI calibrators with self-consistent angular diameters. The team working on this project will be extended to include the French efforts of the VLTI/AMBER (Astronomical Multi BEam Recombiner, a 3-way beam combiner operating at 2 micron) team and possibly those of other optical interferometers in the world.

MIDI

Preliminary Acceptance Europe (PAE) was passed on September 10. The Assembly, Verification, and Integration (AIV) phase of MIDI at Paranal was successfully passed in December. The first fringe event on 15 December 2002 was presented by both ESO and NOVA through a press release to the international press. De Jong contributed mainly to the Near-Real-Time System (NRTS) of MIDI. This subsystem must analyse the incoming data as fast as possible, determine the quality of the data and apply corrections to the delay lines and/or telescope position. Most of the past effort was its integration with other MIDI subsystems and extensive testing to guarantee reliability. Integration involved in particular communication with the top-level software, proper error handling, panels for graphical user interfaces and better conformation to the ESO standards. A large effort was put into effeciency improvements in order to apply corrections as quickly as possible after data reception. During the MIDI Assembly, Integration and Verification phase, de Jong established that NRTS works reliably during normal operations.

Meisner developed the pipeline software development for the MIDI delay-scan mode. He also worked on the detection of planets (and faint companions) using interferometric phase detectability in the presence of random dispersion and worked with the MIDI science team in proposing MIDI observations of three such objects. Bakker continued development of operational procedures for MIDI while Jaffe further developed the Expert Workbench Station and near-real time data quality applications.

GENIE, VINCI

Meisner performed an analysis of the dispersion effects of dry air and water vapour on the performance of an optical interferometer. Based on this analysis an experiment to measure the humidity at several locations in the delay line tunnels of the VLTI has been proposed to ESO. Algorithms to correct interferometric data for dispersion effects were developed and published. Meisner also worked on a large set of VINCI data, giving special attention to scientific results obtainable through coherent integration. He began work on a major project to extract astronomical and instrumental results using the totality of 7000-10000 visibility points measured by VINCI.

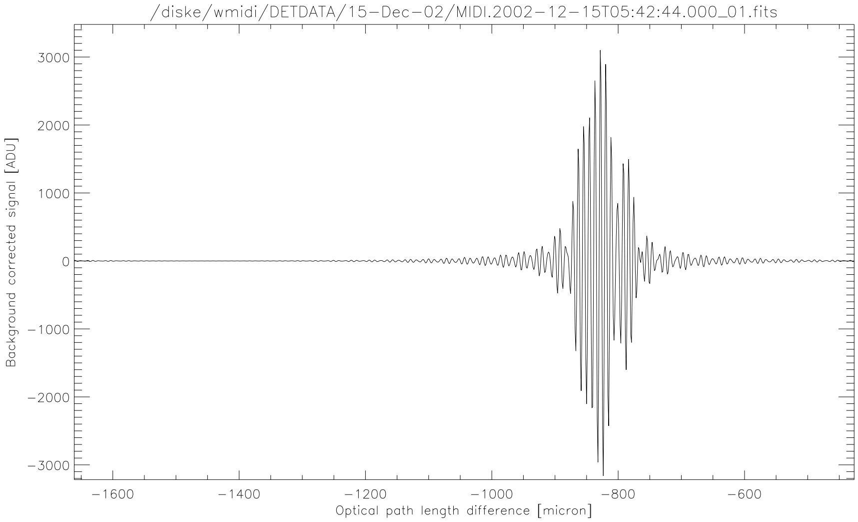


Figure 2.18: MIDI first fringe of Epsilon Carina, obtained on 15 December 2002 with UT1 and UT3. The signal of a filtered fringe is presented at -820μm optical path length between the two interferometer beams. This position corresponds to a net optical-path difference of zero, causing constructive signal interference. Require additional calibrator measurements, this fringe cannot yet be used for scientific purposes. Nevertheless, it marks the beginning of the era of 10μm interferometry in Europe (see Section 2.13.1).

2.13.2 DARWIN

D'Arcio (SRON), Le Poole, Rttgering and Den Herder (SRON) started conceptual studies for the forth-coming IRSI/Darwin satellite, with emphasis on co-hasing and wide-field imaging techniques, in collaboration with the Technical Physics Department of TU Delft, and the optics group of the space-engineering department of TNO/TPD. These activities included investigation on phase-shifting for nulling interferometers, and conceptual studies for SMART3, a precursor mission to Darwin.

2.13.3 SAURON

De Zeeuw, Cappellari, Krajnović, McDermid, van de Ven and Verolme are members of the SAURON team that has built a panoramic integral-field spectrograph for the 4.2m William Herschel Telescope on La Palma, in a collaboration which involves groups in Lyon (Bacon) and Durham (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 90 km/s. SAURON is funded in part by a grant from ASTRON/NWO to de Zeeuw, and was built at the Observatoire de Lyon. First light was obtained on February 1, 1999.

SAURON is used for a multi-year program to measure the kinematics and linestrength distributions for a representative sample of 72 nearby early-type galaxies (ellipticals, lenticulars, and Sa bulges, in clusters and in the field). An observing run in spring 2002 saw the near-completion of the survey, with data in hand for 70 of the 72 objects.

In parallel with the data taking, the team is developing a number of tools that are key to analyse all the resulting maps. In Leiden, Cappellari and Copin developed a method, based on the centroidal Voronoi tessellation, to adaptively bin integral-field spectroscopic data to an optimal signal-to-noise ratio per bin. This is crucial for the proper extraction of kinematical information from the data.

Krajnovic extended and applied the technique of kinemetry, developed earlier by Copin, and building on work in Leiden and Groningen for the analysis of HI maps, to SAURON data. The technique is based on the Fourier expansion of any kinematic map along concentric rings. In this way it is possible to describe the whole map with a modest number of terms. This allows accurate measurement of e.g., kinematic misalignment and of deviations from axisymmetry.

The SAURON observations of the representative sample are being complemented with high spatial resolution observations of the nuclei. OASIS observations for 33 objects were obtained at the CFHT. Dynamical modeling and analysis of the linestrength maps in terms of age and metallicity of the stellar populations, will provide black hole masses, intrinsic shapes, and internal structure as a function of Hubble type. Results of this multi-year project were presented at half-a-dozen conferences, and at institutions around Europe, and in the USA.

2.13.4 SINFONI

SINFONI (SINgle Faint Object Near-infrared Investigation) 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 and will be installed at the VLT in 2004. A laser guide star facility will enable nearly diffraction-limited imaging over the whole sky. A seeing-limited mode is also available. Leiden astronomers strongly involved in SINFONI are Van der Werf, Franx, De Zeeuw and Katgert. Van der Werf is Principal Investigator of the NOVA components of SINFONI. The NOVA contribution consists of a combination of adaptive optics effort (carried out partly by Brown in Leiden) and development of the camera required for enhancing SINFONI with a 2048^2 detector (done at ASTRON). Principal milestone in 2002 of the camera was the succesful Preliminary Design Review in September. The work of Brown simulating the performance of SINFONI with Laser Guide Star is described below.

In the context of the NOVA-SINFONI project Brown upgraded the simulation package that ESO has developed for the simulation of curvature based adaptive optics systems. A sodium laser guide star was implemented in a realistic way. Included are the launch of the laser beam and its propagation to the atmospheric sodium layer; a modelling of the laser beacon in three dimensions; the downward propagation of the laser light through atmospheric turbulence layers at various heights, including the so-called cone effect; and finally, the effect of the extent of the laser beacon along the line of sight at the curvature sensor of the adaptive optics system of SINFONI.

2.13.5 LOFAR

LOFAR, the Low Frequency Array, is a large radio telescope consisting of approximately 100 soccer-field sized antenna stations spread over a region of 400 km in diameter. It will operate at frequencies from $\sim$ 10 to 240 MHz, with a resolution at 240 MHz of better than an arcsecond. Its superb sensitivity will allow for studies of a broad range of astrophysical topics, including reionisation, transient radio sources and cosmic rays, distant galaxies and AGNs. Röttgering, Miley and Johston-Hollitt have been actively involved in a number of aspects related to the construction of LOFAR, including the development of the science case, the conceptual design and management of the project.

2.13.6 SURFRESIDE

Fraser, together with van Broekhuizen, Schutte and de Kuyper (FMD), made significant progress on the construction of SURFRESIDE, the Surface Reaction Simulation Device. SURFRESIDE now reaches pressures of better than 1×10^{-10} Torr as standard. When cooling is applied, this can drop to $5 - 6 \times 10^{-11}$ Torr, well below the original specifications and ideally suited for surface chemistry studies under interstellar conditions. The experiment has now been set-up for experimental use, with the exception of the atomic beam. The FTIR-RAIRS (Reflection Absorption InfraRed Spectroscopy) system has been aligned, a method for calculating ice porosities and thicknesses using non-normal incidence of a He-Ne laser has been finalized, and heating ramps and temperature control has been established.

The experiment has been tested using simple ice systems, specifically to investigate the trapping of molecular species such as CO with no or very small permanent dipole moments within ices that are or are not capable of hydrogen bonding. This will shed light on general gas trapping mechanisms in interstellar ices, allowing determination of sticking probabilities and binding energies between CO and various molecular ices, as well as identification of the temperature range for which CO may be retained above its sublimation temperature and thus be available for further reactions.

First results using temperature programmed desorption to study the desorption kinetics of CO when trapped in CH_3OH show that CO can become trapped in the CH_3OH matrix until the CH_3OH ice itself undergoes a phase change. This behavior is similar to that of the CO–H_2O system studied previously by Fraser and collaborators. The data also indicate that CO can be released from the ice surface at much higher temperatures than was previously assumed, relating to the binding energy between CO and CH_3OH being greater than that between CO and CO. The implications of these findings will be implemented in the models and observational interpretations of the molecular astrophysics group.

2.13.7 CRYOPAD

Van Broekhuizen and Schutte, together with de Kuiper, Benning (both FMD) and van As (LIS) and with advice from Fraser, finalized the design and most of the assembly of the new Cryogenic Photoproduct Analysis Device, CRYOPAD. CRYOPAD is specifically designed to simulate the formation of volatile complex organic molecules from interstellar ice by solid state chemistry in ‘hot cores’ such as found around massive protostars. The processes to be studied include processing by ultraviolet radiation and by heating. Ultra high vacuum conditions of the entire assembly were reached in late 2002, with first experiments ready to start in early 2003. Desorption products and surface reactions will be simultaneously detected by quadrupole mass spectrometry and by FTIR-RAIRS.

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 2002/2003, 32 first year students registered for the new Bachelors programme. Some of these change into other studies in the first year, as the astronomy programme is challenging. The astronomy students are taught astronomy in all of the five years of the programme, but the emphasis in the first two years is on physics and mathematics to lay the foundation for the advanced astronomy courses in the last 3 years.

The progress of the students is monitored by three of our faculty advisers: van der Werf and Israel for the students in the first three years of the programme, and Jaffe for the senior undergraduates. These advisers speak to the students on a regular basis, and can be consulted by the students.

The students in the first year are divided in three groups, and these groups meet regularly with a stafmember, called a "mentor", plus two senior students who act as "student mentors". The mentors for the academic year 2002/2003 were Kuijken, Röttgering, and Schutte. The students can exchange their experiences in these mentor groups. The university requires that each first year student collects a minimum number of credit points. This minimum is set at half of the total credit points for a year. The mentor groups can play an important role in helping the students to achieve this goal.

The Education Committee, consisting of faculty members and students, meets regularly to discuss student progress reports, and to advise the director of Education, prof. Franx. The committee consisted of faculty members Katgert (chair), Israel, Dr. Jaffe, van der Werf, de Zeeuw and student members van Breukelen, Weijmans, van der Berg, van de Voort, Lukkezen. In the year 2002, the committee finalized the new programmes for the Bachelors and Masters degrees. The Bachelors programme gives more flexibility to the students, and has a larger research component. The students will perform two main research projects during their two year Masters programme.

The astronomy curriculum is formally defined by the "Examen commissie" (Committee of Examination). In September 2002, its members were Franx (chair), Israel, Nienhuis (Physics), van der Werf, and de Zeeuw.

3.1.2 Educational Review ("Onderwijs Visitatie")

The astronomy and physics programmes are reviewed every 5 years by an outside committee. This review took place in November of 2001. The report was issued in 2002. We were delighted to notice that the review committee thought very highly of the Astronomy programme in Leiden.

3.2 Degrees awarded in 2002

3.2.1 Ph.D. degrees

A total of 7 graduate students defended their thesis successfully in 2002. They all obtained their Ph.D. degree. They are:

W.-F. Thi	February 13
Title thesis:	*Gas and dust around young low-mass*
Thesis advisor:	Van Dishoeck
T. Thomas	March 6
Title Thesis:	*The influence of cluster environment on galaxies*
Thesis advisor:	De Zeeuw / Copromotor: Katgert (Leiden)
G.A. Verdoes Kleijn	March 6
Title Thesis:	*The Centers of Nearby Radio-Loud Galaxies*
Thesis advisor:	De Zeeuw / Copromotor: Baum (STScI)
V. de Heij	May 1
Title Thesis:	*Compact high-velocity clouds*
Thesis advisor:	Burton / Copromotor: Braun (Astron)
G.-J. van Zadelhoff	May 15
Title Thesis:	*Shaping disks*
Thesis advisor:	Van Dishoeck

W. Vlemmings	November 14
Title Thesis:	*Circumstellar Maser Properties through VLBI Observations*
Thesis advisor:	Habing

M. Haverkorn	December 19
Title Thesis:	*WSRT Polarimetric Imaging of the warm ISM*
Thesis advisors:	Miley & de Bruyn / Copromotor: Katgert (Leiden)

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

The following 10 students obtained their Master's degrees in 2002:

Name	**Date**
Frank Faas	January 29
Martijn Kloppenburg	March 26
Gerben Dirksen	June 25
Lottie van Starkenburg	August 27
Thijs Kouwenhoven	August 27
Arjan Verhoeff	August 27
Sijme-Jan Paardekoper	August 27
Rowin Meijerink	September 24
Maurice van Mil	October 29
Stijn Wuyts	December 17

3.3 Courses and teaching activities

3.3.1 Regular courses taught by Sterrewacht staff in 2002

Compulsory courses

Semester	Course title	Teacher
1	Introduction Astrophysics	P. van der Werf
2	Astronomy Lab 1	R. S. Le Poole
3	Elementary Astronomy	F. P. Israel
4	Presentation 1	F. P. Israel
4	Astronomy Lab 2	M. Franx
5	Stars	R. S. Le Poole
5	Presentation 2	R. S. Le Poole
5	Observational Techniques 1	C. van Schooneveld
5	Radiative Processes	P. Katgert
6	Observational Techniques 2	H. J. A. Röttgering
6	Astronomy Lab 3	W. Schutte
6	Galaxies	J. Lub
6	Presentation 3	J. Lub
7	Introduction Observatory	E. R. Deul
7-10	Student Colloquium	G. K. Miley

Regular advanced courses

Semester	Course title	Teacher
7,9	Cosmology	P. Katgert
7,9	InterStellar Matter	E. F. van Dishoeck
8,10	Stellar Evolution	J. Lub
8,10	Solar System	P. Ehrenfreund

Incidental advanced courses

Semester	Course title	Teacher
7,9	Stellar Dynamics	W. Jaffe
7,9	Radio Astronomy and VLBI	R.T. Schilizzi
8,10	Milky Way	H. J. Habing

Other courses

As in the years before, Israel gave a lecture course on Astronomical Space Research for 4th year students in Aeorspace Enigineering at Delft Technical University (TUD).

Icke and Van Ruitenbeek (Physics) organized an interdisciplinary course The Living Universe (Het Levend Heelal) for first-year students on various topics centered on the question of life in the universe. In addition to members of the Physics, Biology and Chemistry departments, several Sterrewacht staff (Icke, Israel, Röttgering, van Dishoeck) lectured in this series.

3.3.2 Astronomy and Physics Kaleidoscope

Each year, freshman students are introduced to current research projects carried out by astronomers and physicists at Leiden University, in a series of lectures held in the first three months of the year. The 2002 programme included:

Date	Speaker	Title
February 4	M. Perryman	*Changing the expanses of our galaxy*
February 11	Th. Schmidt	*Biofysica met enkele moleculen*
February 18	E. Eliel	*Met de quantum mechanica het lab in: verstrengelde fotonen en quantum informatie*
February 25	P. van Baal	*Het lijmen van quarks*
March 4	J. Frenken	*Atomen ”zien” en ”voelen”*
March 11	G. Nieuwenhuys	*Magneetvelden meten tussen de atomen*
March 18	V. Icke	*Ontploffende sterren: geen Oerknal, maar toch...*

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 enthousiastic 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

Boonman
"De Geschiedenis van de Leidsche Sterrewacht" (Leiden, May 25)
"De Geschiedenis van de Leidsche Sterrewacht" (Haarzuilens, December 17)

Van Broekhuizen
"Natuurkundig Practicum 1" (Leiden University, 2002/2003)
"Computer Comity" (Leiden University, 2002/2003)
"HOORT!" (Leiden University, 2002/2003)
"Proefpersonen" (Intermediair Starters, 14 June 2002)

Van Dishoeck
"Van moleculen tot planeten" (Jubileum meeting NVWS kring, 's Hertogenbosch, May 16)
"Bouwstenen voor leven tussen de sterren" (Kekulé cyclus 'Wetenschap fascineert', Antwerpen, België, April 23)
"Van moleculen tot planeten" (Opening academisch jaar UL, Leiden, September 2)
"Van moleculen tot planeten" (Artis planetarium, Amsterdam, October 1)
"Van moleculen tot planeten" (NVWS kring, Hilversum, November 15)
"Van moleculen tot planeten" (Symposium Astrofysica, TU Delft, December 3)
"Astronomy in Leiden" (Chinese t.v., June 7)
"Scheikunde tussen de sterren" (Vacature, België, July)
"Nederland helpt Hubble opvolgen" (Volkskrant, September 14)

Ehrenfreund
"Astrobiology" (Oude Sterrewacht, October 22)
"Astrobiology" (L.A.D. Kaiser, November 18)
"Astrobiology" (SRON Utrecht Museum, November 24)

Fraser
"Hot Topics in Astrochemistry" (BBC1, Final Frontier, March 22)
"It's life Jim - but not as we know it" (Schools Lecture, The British School in the Hague, Netherlands, July 2 and November 9)
Invited Attendee - "Voice of the Future" A consultation between the House of Commons Science and Technology Select Committee and young scientists (Burlington House, London, February)

Interviewed for July 15th issue of Chemical and Engineering News (American Chemical Society)

Haverkorn

“Magneetvelden in de melkweg” (Enschede, January 9)
“Wat doet een sterrenkundige?” (Den Haag, January 15)
“Rimpelingen in de achtergrondstraling” (Wormerveer, March 29)
“Rimpelingen in de achtergrondstraling” (Deventer, April 11)
“Interview n.a.v. sluiting van het British Flying Saucer Bureau” SBS6 Nieuws, April 24 “Magneetvelden in de melkweg” (Alkmaar, April 27)
“Rimpelingen in de achtergrondstraling” (Putten, May 28)
“Rimpelingen in de achtergrondstraling” (Zwolle, September 20)
“Magneetvelden in de melkweg” (Hoorn, October 5)

Van der Heijden

“Frederik Kaiser en de stichting van de Sterrewacht” (Leiden, Landelijke Sterrenkijkdagen, March 23)
“Geschiedenis van de Leidse Sterrenkunde (lecture in series ’Leidse Geschiedenis’)” (Leiden, Het Leidse Volkshuis, April 24)

Israel

“Asteroid Impacts” (Utrecht, September 15)
“Tenth Planet” (Skepter, November 11)
“Asteroids” (RTL 4 News, June 21)
“Asteroids” (TV West/Rijnmond, November 15)

Jaffe

“Guest High School Lecture: How Big is the Universe” (Almere, April 1)

Kamp

“Van interstellaire moleculen naar planeten” (Zaanstreek, November 21)

Kurk

“Het Oerknalmodel” (Alkmaar, April 26)

Meijerink

“Sterevolutie” (Volkssterrenwacht Coenraad Ter Kuile, Enschede, March 12)

Mellema
"Het ontraadselen van Planetaire Nevels" (Volkssterrenwacht Phoenix, Lochem, November 16)
"Het ontraadselen van Planetaire Nevels" (NVWS Venlo, November 29)
"Het ontraadselen van Planetaire Nevels" (NVWS Heerlen, December 14)

Muñoz Caro
"Formatie van kometen" (Alkmaar, February 8)
"Buitenaards leven" (Radio West, April 4)
"Een sterrenkundige vindt bouwstenen van het leven in nagebootst ruimtestof" (Natuur & Techniek, April 9)
"Koude geboorte van levensbouwstenen" (Mare, April 11)
"Poussières de vie" (Sciences et avenir, May)
"Un físico extremeño recrea las condiciones en que se produjeron los elementos esenciales de la vida" (Hoy, May 12)
"Leven tussen de sterren" (Intermediair, May 30)
"Novas evidências de que a vida veio do espaço" (Ciência Hoje, June 12)
"Demuestran que los elementos de la vida se pueden crear en el espacio" (El Universal, July)

Ollongren
"Communicatie met buitenaardse intelligentie" (Nederlandse Vereniging voor Weer- en Sterrenkunde, Afdeling Venlo, September 27)
"Communicatie met een volledig onbekende" (CREA Studium Generale over Buitenaards Leven, Universiteit van Amsterdam, November 29)
"Lingua Cosmica" (Symposion, Studievereniging Wijsbegeerte, Leiden University, December 19)

Schutte
"Amino zuren in de ruimte en het ontstaan van leven" (Met het oog op morgen, March 28)

Venemans
"Verre groepen van sterrenstelsels" (Apeldoorn, December 12)

3.5 The "Leidsch Astronomisch Dispuut 'F. Kaiser' "

The "Leidsch Astronomisch Dispuut 'F. Kaiser' " is an association founded by five astronomy students on March 1, 1993. Its major goal is to improve the mutual contacts between undergraduate students and Observatory personnel. The association is named after the founder of Leiden Observatory, Frederik Kaiser. The days of his birth and death are commemorated every five years. Kaiser activities are open to all astronomers and astronomy students. The board consisted of Niels ter Haar, Martijn Nuyten, Maaike Damen and Siard van Boven. Like their predecessors, they prolongated the success of previous years. This year's main activities included: student lectures (see below), weekly 'Sterrewacht-borrels', instruction courses allowing students to make use of the telescopes at the Old Observatory (44 students received instructions by Wouter van Reeven), and the traditional Old Observatory barbecue in June ($\sim$ 80 attendants).

'F. Kaiser' also contributes to the popularization of astronomy by providing guided tours for the public at the Old Observatory complex and assisting on open days. Since 1994 tours at the Old Observatory are also given to first and second year undergraduate students in order to familiarize themselves with the rich history of astronomy in Leiden.

3.5.1 "Studentenlezingen"

Speaker	**Title**
Prof.E. van Dishoeck	*The construction of planets*
P. T. de Zeeuw	*The Sauron project*
H.J.H. Röttgering	*The Darwin project*
P. Ehrenfreund / M. Bernstein	*Astrobiology/Our universal chemical ancestors*

3.5.2 Old Observatory tours

In order to promote the popularization of astronomy, for which there is a broad public interest, the "Leidsch Astronomisch Dispuut 'F. Kaiser"' was happy to organize several guided tours of the Old Observatory, located in the historical center of Leiden. To illustrate the glorious past of the oldest academic observatory in the world, 'Kaiser' provides on request tours of the historical telescopes, telling visitors many of the stories that go with the buildings and instruments. 'Kaiser' also provided popular lectures on a variety of astronomical topics, such as: History of Astronomy in Leiden, Lunar eclipses, the Solar System, the Universe and The powers of ten. In 2002, several tours and lectures were given by Martijn Nuyten, Maaike Damen, Siard van Boven, Stijn Wuyts, Rowin Meijerink and Niels ter Haar. Next to numerous smaller groups, highlights included a visit by a junior high school class working on a project about the expanding Universe, and a large group from University visiting the Old Observatory on the occasion of the retirement of L. Vredevoogd (a former member of the university board).

Appendix I

Observatory staff

December 31, 2002

Appendix I

Observatory staff December 31, 2002

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. Kuijken
G.K. Miley
A. Quirrenbach
P.T. de Zeeuw

Full Professors by Special Appointment

P. Ehrenfreund (UL, for Nijmegen University Fund)
M.A.C. Perryman (ESTEC, for Leiden University Fund)
R.T. Schilizzi (JIVE, Faculty W&N)
R.P.W. Visser (UU, Teyler's Professor)

Associate Professors and Assistant Professors

P. Ehrenfreund
F.P. Israel
W. Jaffe
P. Katgert
J. Lub
R.S. le Poole
H.J.A. Röttgering
W.A. Schutte
P.P. van der Werf

Visiting Staff

M.J. Betlem
C. Eiroa (NWO, Madrid)
J. Gunn (J.H. Oort Fund)
P. Papadopoulos (ESTEC)
J. Roland (CNRS)

Emeriti

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

Postdocs and Project Personnel

L. d'Arcio	postdoc (NEVEC/SRON)
J.-C. Augereau	postdoc (EU)
S. Andersson	postdoc (Spinoza) LIC; UL
E. Bakker	postdoc / NEVEC Manager
O. Botta	ESA fellow
A. Brown	postdoc (NOVA/Sinfoni)
M. Cappellari	ESA fellow
N. Förster-Schreiber	postdoc (NWO)
H. Fraser	postdoc (NOVA)
M. Johnson-Hollitt	postdoc (LOFAR/ASTRON)
J. de Jong	S/W postdoc (Sauron/NEVEC)
I. Kamp	postdoc (EU/Marie Curie)
F. Lahuis	postdoc (Spinoza) SRON Groningen
B. McDermid	postdoc (NWO)
J. Meisner	research scientist (NEVEC/NOVA)
G. Mellema	KNAW fellow
I. Percheron	research scientist (NEVEC/NOVA)
R. Rengelink	S/W postdoc (NOVA/Omegacam)
R. Stuik	postdoc (NOVA)
F. Schöier-Larsen	postdoc (UL)
R. Wilman	postdoc (EU/Marie Curie)
T. Webb	postdoc (NOVA)

Ph.D. Students

A. Boonman	3
F. van Broekhuizen	2
J.-M. Gori*	13
J.M.T. van der Heijden	1,5
B. Heijligers	1,6
J. Jörgensen	4
B. Jonkheid	7
I. ten Kate	1
K. Kraiberg-Knudsen	4
D. Krajnović	2
J. Kurk*	1
I. Labbé	4
P. Lacerda	4
R. Meijerink*	1
M. Messineo	2
G. Muñoz Caro	8
R. Overzier	4
S.-J. Paardekoper*	1
I. Pelupessy	4
K. Pontoppidan	2
M. Reuland	1,9
R. Ruiterkamp	2
E. J. Rijkhorst	4
L. van Starkenburg*	2
W. Tschager	1
B. Venemans	2
E. Verolme	1
G. van de Ven	1,2
A. van der Wel	1,2
S. Wuijts*	4
Z. Peeters (visitor)	14

Funding notes:
1. Leiden University; **2.** NOVA program; **3.** NWO direct; **4.** NWO via Leiden University; **5.** 50% funding by Schuurman Schimmel-van Outeren Foundation; **6.** 50% funding by Fokker Space; **7.** funding by Spinoza award; **8.** funding by Max Planck Gesellschaft; **9.** funding in

part by L. Livermore Laboratory; **10.** funded by SRON; **11.** funded by World Lab; **12.** partly funded by Space Tel. Sc. Inst.; **13.** funded by TPD Delft; **14.** funded by Vernieuwingsimpuls Ehrenfreund.
***** denotes employment for only part of the year – see section staff changes

Computer staff

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

R. Rengelink	scientific programmer (NOVA, OmegaCam)
J. de Jong	scientific programmer (NEVEC; Sauron)

Management Assistants

J. Drost
B. de Kanter (voluntary)
K. Kol-Groen
M. Zaal

Astronomy & Astrophysics office

H.J. Habing	editor
J.K. Katgert-Merkelijn	assistant editor
M. Kriek	student assistant
E. Lindhout	editorial asssistant
F. Sammar	student assistant
B. Smit	secretary

NOVA office

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

NFRA/NWO staff

R.J. Pit (La Palma)	as of 01/01/2002 funded by NWO
K . Weerstra	as of 01/11/2002 Voluntary Early Retirement

Senior students

C. Beekman
R. van den Bosch
S. van Boven
C. van Breukelen
B. van Dam
M. Damen
M. van Duijn
R. Ensing
H. Intema
O. Janssen
T. van Kempen
J.-P. Keulen
G. Kosters
M. Kriek
F. Maschietto
K. Menendez Delmestre (Fulbright stipend)
M. Nuijten
J. Ritzerveld
F. Sammar
D. Schnitzeler
M. Smit
L. Snijders
M. Valdes (Florence)
S. Veijgen
A. Weijmans

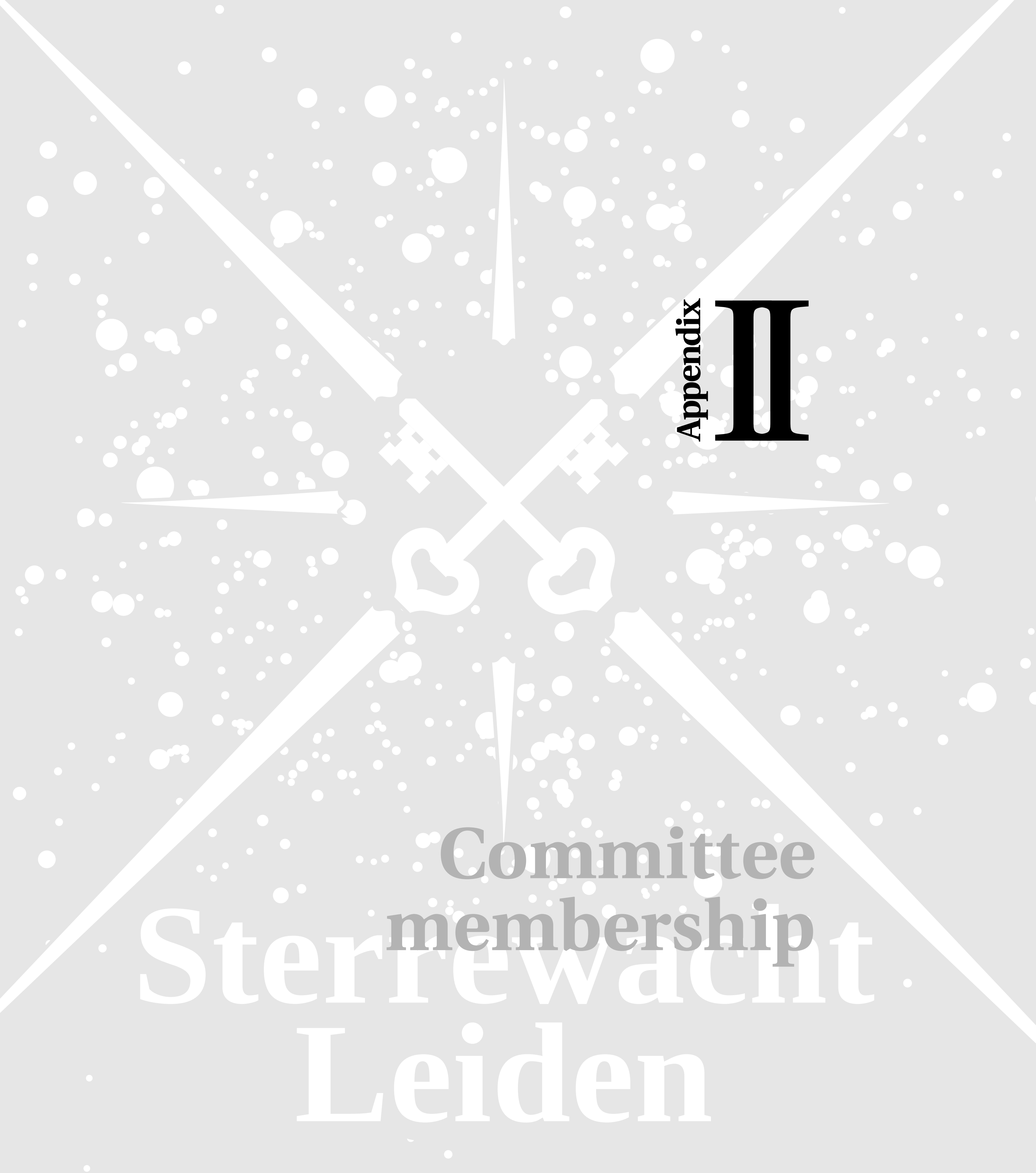
W. Alsindi (Nottingham. Erasmus)
K. Baker (Bristol, EU)
L. Clewley (UCL, EU)

Staff changes and visitors in 2002

Name (Funded by)	**start**	**end**
R.J. Pit (La Palma) (UL)		31-12-01
Drs. F. Lahuis (Groningen) (Spinoza)	01-04-02	
Prof. Dr. J. Gunn (JHOF)	20-04-02	01-06-02
Dr. O. Botta (ESA)	01-05-02	
Prof. Dr. K. Kuijken (UL)	01-06-02	
Dr. S. Mengel (EU/TMR)		01-07-02
Dr. S. Andersson (LIC) (spinoza)	01-07-02	
Prof. Dr. A. Quirrenbach (UL/NOVA)	01-08-02	
Drs. J.-M. Gori (UL/TPD)	01-09-02	
Drs. L. van Starkenburg (UL/NOVA)	01-09-02	
Drs. S.-J. Paardekoper (UL)	01-09-02	
Dr. J.-C. Augereau (EU/TMR)	01-10-02	
Drs. R. Meijerink (UL)	01-10-02	
Dr. T. Webb (NOVA)	13-10-01	
Dr. B. McDermid (UL/NWO)	01-10-02	
Prof. Dr. H.J. Habing (UL)		01-11-02
K. Weerstra (ASTRON)		01-11-02
Dr. M. Johnson-Hollitt (LOFAR/ASTRON)	26-11-02	
Dr. R. Stuik (UL/NOVA)	01-12-02	
Drs. S. Wuijts (NWO)	01-01-03	

Appendix II

Committee membership



Committee membership

Appendix II

II.1 Observatory Commitees

(As of December 31, 2002)

Board of directors
(Directie onderzoekinstituut)
G.K. Miley (director)
J. Lub (secretary)
P.T. de Zeeuw (adjunct director)

Observatory management team
G.K. Miley (chair)
P.T. de Zeeuw (vice-chair)
E. Deul
M. Franx
J. Lub
F.P. Israel
N. van Wijngaarden (administration)
J. Drost (minutes)

Research committee
(Onderzoek-commissie OZ)
E.F. van Dishoeck (chair)
M. Franx
W. Jaffe
I. Kamp
P. Katgert
R.T. Schilizzi
P.P. van der Werf

Astronomy education committee
(Opleidingscommissie OC)
P. Katgert (chair)
G. van de Ven
F. P. Israel
W. Jaffe
K. Kol
P.P. van der Werf
P.T. de Zeeuw

C. van Breukelen
G. van de Ven
A.M. Weijmans
M. van den Berg
F. van de Voort

Astronomy examination committee

(Examen-commissie)

M. Franx (chair)
F.P. Israel
G. Nienhuis (Physics)
P.P. van der Werf
P.T. de Zeeuw

Library committee

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

Computer committee

P.P. van der Werf (chair)
F. van Broekhuizen
A.G.A. Brown
B. Venemans
K. Kol
G. Mellema
P.T. de Zeeuw

Computer group

W. Jaffe (chair)
E. Deul
D. Jansen
A. Vos
T. Bot

Research institute scientific council

(Wetenschappelijke raad onderzoekinstituut)

E. Deul
E.F. van Dishoeck
M. Franx
A.M. van Genderen
H.J. Habing
V. Icke
F.P. Israel (chair)
W. Jaffe
P. Katgert
K. Kuijken
J. Lub
R.S. Le Poole
M.A.C. Perryman
H.J.A. Röttgering
A. Quirrenbach
R.T. Schilizzi
W. Schutte
P.P. van der Werf
P.T. de Zeeuw

Institute council

(Instituutsraad)

E. Deul (chair)
J. Drost
F.P. Israel
W.J. Jaffe
A. van der Wel
S. Wuyts

Public outreach committee

V. Icke (chair)
F.P. Israel
G. van de Ven
P. van der Heijden
I. Pelupessy
A. van de Wel

Graduate student review committee

G. Miley (chair)
J. Lub
W. Boland (NOVA)
K. Kuijken

Social committee

M. Kriek
G. Mellema
M. Zaal
K. Kraiberg-Knödsen
R. S. le Poole

II.2 University Committees

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

Franx
Member, Overlegcommissie Opleidings Directeuren, Faculteit W & N
Member, Gemeenschappelijke Opl. Commissie, Natuur- en Sterrenkunde

Habing
Member, special advisory board of Dean
Member, KNAW subcommission for the recognition of research schools in physics, mathematics and astronomy
Chairman, Chamber for Astronomy, VSNU
Chairman, Nederlandse Astronomen Club

Israel
Member, Gemeenschappelijke Opleidings Commissie, Natuur- en Sterrenkunde

Jaffe
Member, Board Centre for scientific computing in Leiden
Member, Faculty Library Committee

Lub
Member, Public Relations Committee Faculty W & N

Miley
Member, Overlegcommissie Wetenschappelijke Directeuren Faculteit W & N

Ollongren
Member, Committee Higher Education for Elderly People

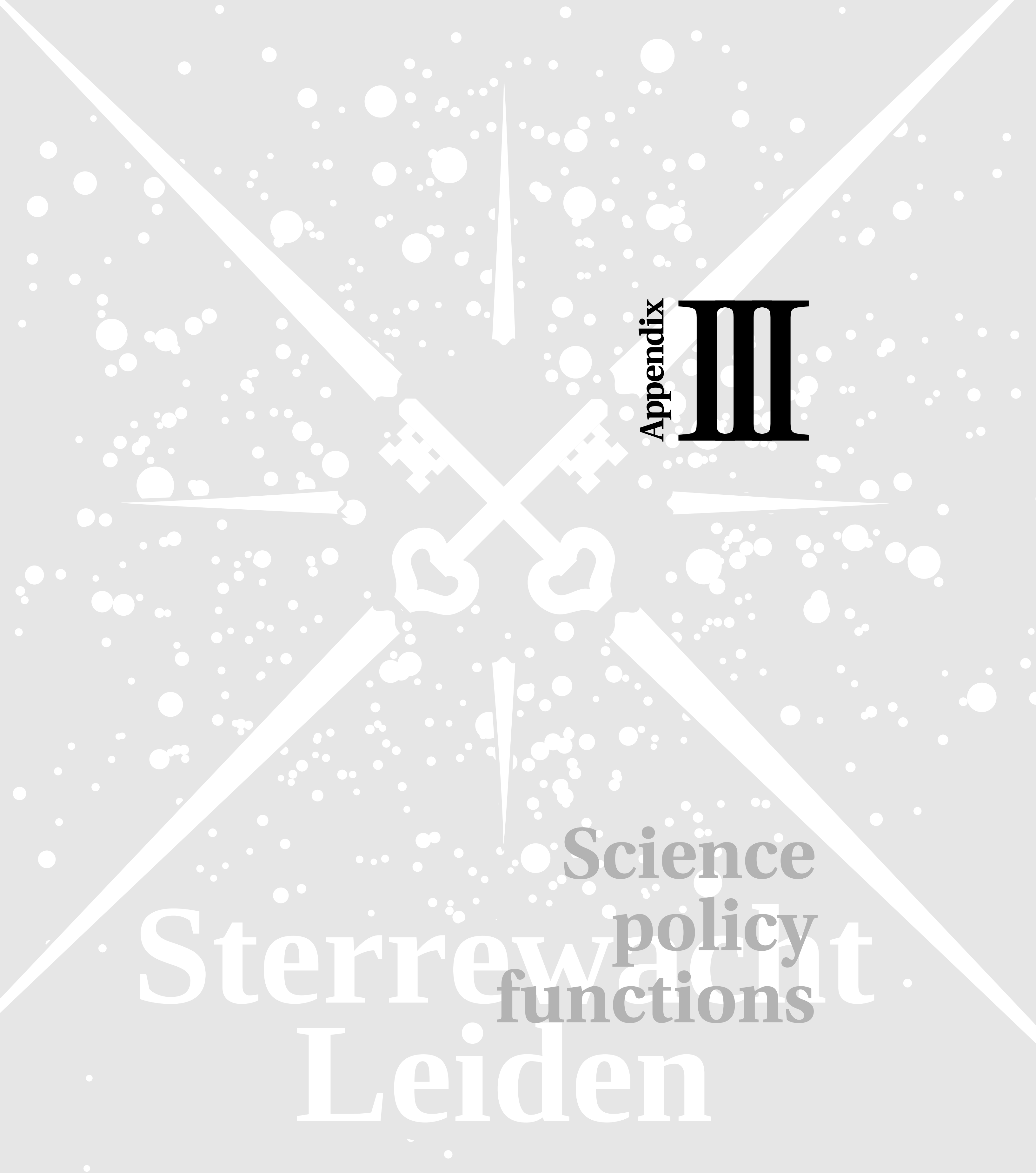
Perryman
Member, Committee NOVA Graduate School in Astronomy

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

Schutte
Chair, Safety Committee Huygens Laboratory, Oortgebouw, and Kamerlingh Onnes Laboratory

Van der Werf
Member, Gemeenschappelijke Opleidings Commissie, Natuur- en Sterrenkunde
Organist, Academy Auditorium

De Zeeuw
Member, Advisory Committee Lorentz Professor, Leiden University
Member of the Board, Department of Mathematics, Leiden University
Member, Advisory Committee Kloosterman Professor, Leiden University
Chair, Advisory Committee Oort Professor, Leiden University



Appendix III

Science policy functions

Science policy functions

Appendix III

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

Van Dishoeck
Member, SRON Board
Member, ESA–NGST Science Study Team
Member, ESO-CRIRES Science Team
Chair, IAU Working Group on Astrochemistry
Member, Organising Committee of IAU Commission 34 on Interstellar Matter
Chair, Working Group 5 on Molecular Data, IAU Commission 14
Member, VLT–VISIR Science team
Member, Scientific Advisory Board of New Astronomy
Member of the Board, J.C. Kapteyn and Pastoor Schmeits Foundations
Coordinator, NOVA network II on "Birth and Death of Stars and Planets"
Member, ALMA Executive Committee
Interim ALMA European Project Scientist
Co-PI, European NGST-MIRI consortium
Member, MPIA-Heidelberg Fachbeirat
Member, Visiting Committee Astronomy Department of Harvard University
Member, FOM-AMO Werkgemeenschapscommissie
Member, VICI beoordelingscommissie CW
Member, Scientific Organising Committee, Waterloo Conference on 'Chemistry as a Diagnostic of Star Formation'
Member, ALMA Science Advisory Committee
Member, Herschel–HIFI Science team

Ehrenfreund
Member, Working Group, ISSI, International Space Science Institute, Bern
Member ESF Working Group Life Science/Exobiology
Member ESSC, European Space Science Committee
Discipline Editor of the European Journal "Planetary and Space Science"
Discipline Editor of the European Journal "International Journal of Astrobiology"
Discipline Editor of the US Journal "Astrobiology"

Franx
Member, ESO Science and Technology Committee
Member, ESO contact committee
Member, Advanced Camera for Surveys Science Team
Member, NOVA Fellowship committee
Member, NOVA Instrument Steering Committee
Member, SINFONI Science Team
Member, ESO-Omegacam science team
Member, MUSE Science Team
Member, NWO astronomy committee
Organizer, FIRES Workshop
Director, Leids Kerkhoven–Bosscha Fondsn
Director, Leids Sterrewacht Fonds
Director, Jan Hendrik Oort Foundation

Fraser
Team Member, ESA ICAPS (Interactions in Cosmic and Atmospheric Particle Systems) Experiment for International Space Station
Team Member, ESA Topical Team on Physico-Chemistry of Ices in Space
Ordinary Committee Member, Astrochemistry Group of the RSC and RAS, U.K.

Van Genderen
Member, Indonesia/Netherlands Astrophysics Collaboration, as part of the Cultural Exchange between the two countries

Habing
Editor-in-Chief, "Astronomy and Astrophysics"
Chair, Scientific Advisory Board to the Board on Exact Sciences, NWO
Chair, Netherlands Committee for Astronomy
Chair,"Kamer Sterrekunde" of the VSNU
Chair, Nederlandse Astronomen Club
Member, Royal Netherlands Academy of Sciences (KNAW)
Member, committee for awarding the Pieter Langerhuizen fund of the Hollandsche Maatschappij der Wetenschappen
Member, search committee Professorial position in the history of the Exact Sciences, Vrije Universiteit, Amsterdam

Icke
Member, National Committee on Astronomy Education
Member, Minnaert Committee (NOVA Outreach)
Member, Netherlands Astronomical Society Education Committee
Member, "Natuur & Techniek" Editorial Council
Member, Board of Directors, National Science Museum NEMO

Israel
Member, IAU Commissions 28, 40 and 51
Member, Editorial Board Euro Physics News, European Physical Society
Member, Noordwijk Space Expo Foundation (NSE) Exposition Committee
Member, HIFI Science Team

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

Kuijken
Dutch representative, ESO Science and Technical Committee
Principal Investigator, OmegaCAM project
Coordinator, NOVA Research Network ”Galaxies: from high redshift to the present”
Member, NOVA Instrumentation Steering Committee
Member, ESO contact commissie

Lub
Director, Leids Sterrewacht Fonds
Director, Leids Kerkhoven–Bosscha Fonds
Director, Jan Hendrik Oort Foundation
Member at Large, ESO Observing Programs Committee
Member, ESO Contact Committee
Secretary, Netherlands Committee for Astronomy
Secretary, Kamer Sterrenkunde van de VSNU

Miley
Chair, Space Telescope Users Committee
Chair, Netherlands LOFAR Steering Committee
Chair, Netherlands National VLTI Team
Principal Investigator, NOVA/VLTI Programme
Member, ESO Visiting Committee
Member, Dutch National Science Team, VISIR
Member, Science Team, Advanced Camera for Surveys on the HST
Member, Board of Stichting ASTRON
Member, Board of NOVA
Member, Board of EARA
Member, Royal Netherlands Academy of Sciences (KNAW)
NOVA Representative, ESO VLTI Implementation Committee
Leiden PI, EU TMR Programme: European Large Area ISO Survey (ELAIS)
Leiden PI, EU TMR Programme: Formation and Evolution of Galaxies

Mellema
Treasurer, Association of Academy-Fellows (VvAO)

Deputy, European Association for Research in Astronomy (EARA)

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

Perryman
Chair, GAIA Science Advisory Group
Member, HIFI Science Tea

Röttgering
Leiden PI, European Research and Training Network "The Physics of the Intergalactic Medium"
Member, Dutch Joint Aperture Synthesis Team (DJAST)
Member, Netherlands VLTI team
Member, Management Team NEVEC
Member, Mid-Infrared interferometric instrument for VLTI (MIDI) Science Team
Member, NASA's Terrestrial Planet Finder Science Team
Member, Science Advisory Group on ESA's InfraRed Space Interferometer DARWIN
Member, LOFAR, Dutch steering group
Member. LOFAR, Science consortium board
Member, VISIR Science team
Member, OmegaCam Science team
Member, XMM Large Scale Structure Consortium
Chair, ASTRON Observing Programme Committee
Member, Board of ASTRON
Member, NWO selection committee for VENI postdocs
Member, JCMT international time allocation committee

Schilizzi
Editor, Experimental Astronomy
Member, RadioAstron International Scientific Council
Chair, URSI Global VLBI Working Group (until August 2002)
Member, Board of the European Consortium for VLBI
Chair, IAU Working Group on Future Large Scale Facilities
Member, SKA International Steering Committee
Vive-President, URSI Commission J (Radio Astronomy) (from August 2002)

Schutte
Member, Working Group: "The role of laboratory experiments in the characterisation of cosmic material", ISSI, International Science Institute, Bern, Switzerland
Chair, IAU Working group on molecular reactions on solid surfaces
Member, NL-PC proposal review board

Van der Werf
Principal Investigator, NOVA-SINFONI
Member, ESO Contact Committee
Member, ESO User's Committee
Team Leader, EC-RT Netw. "Prob. the origin of the extragalactic background" (POE)
Member, EC - RT Network "Promoting 3D spectroscopy in Europe" (Euro3D)
Member, JWST near-IR spectrograph study team
Member, SINFONI Science Team
Member, VISIR Science Team
Co-investigator, HIFI
Member, JCMT Advisory Panel
Member, NOVA Wide-field Imaging Team
Member, NOVA Millimetre Interferometry Team
Member, Preliminary Design Review board, SINFONI-2K camera
Co-investigator, Multi-Unit Spectroscopic Explorer (MUSE)
Member, PPARC Astronomy Advisory Panel
Member, NOVA instrumentation advisory committee

De Zeeuw
Member, Scientific Advisory Board of *New Astronomy*
Member, IAU Commission 28 (Galaxies)
Member, SINFONI Science Team (MPE & ESO)
Member, OPTICON Board
Member, ESO/OPTICON Science Working Group for Extremely Large Telescopes
Member, Leiden University Representative to AURA
Member, AURA Board of Directors
Member, National Committee Astronomy
Member, Steering Committee Lorentz Center
Member, Board of Directors, Leids Kerkhoven Bosscha Fonds
Member, Board of Directors, Leids Sterrewacht Fonds
Member, Board of Directors, Oort Foundation
Member, Scientific Advisory Committee, SRON
Member, ESO Contact Committee
Member, NASA NGST Scientist Selection Panel
Member, Panel Galaxies and Galactic Nuclei, ESO Observing Program Committee
Member, Steering Committee Extremely Large Telescopes
Member, MUSE Executive Board
Member, SOC, Workshop on Galactic Dynamics, JENAM 2002
Chair, Isaac Newton Group Board
Chair, Advisory Committee for Astronomy, NWO
Chair, Interim STScl Visiting Committee
Co-Chair, SOC of Oort Workshop on Astronomical Surveys
Deputy Chair, Space Telescope Institute Council
Director, Netherlands Research School for Astronomy, NOVA

Appendix IV

Visiting scientists

Visiting scientists

Appendix IV

Name	Dates	Institute
B. Rickett	Jan 6 – Jun 30	Univ. of California,San Diego
K. Freeman	Jan 16 – Jan 22	Mt. Stromlo Obs.,Canberra
R. Stark	Jan 21 – Jan 23	Max-Planck Inst., Bonn
A. Helmi	Jan 29 – Feb 1	Max-Planck Inst.,Garching
S. Rodgers	Feb 1 – Mar 31	NASA AMES, Moffett Field
J. Falcon Barroso	Feb 21 – Mar 1	University of Nottingham
N. Sambhus	Mar 1 – Mar 6	Universitaet Basel
M. Hogerheide	Mar 4 – Mar 12	Univ. of Arizona, Tucson
R. van der Marel	Mar 4 – Mar 8	STScI, Baltimore
S. Baum	Mar 5 – Mar 7	STScI, Baltimore
A. Biviano	Mar 5 – Mar 13	Triest University, Italy
K. Bakker	Mar 15 – May 15	Bristol Univ., England
K-V. Tran	Apr 15 – Apr 20	ETH, Zurich
S. Charnley	Apr 17 – Apr 24	NASA AMES, Moffett Field
J. Gunn	Apr 21 – May 3	Princeton University
R. Wyse	May 1 – May 5	Johns Hopkins, Baltimore
G. Rudnick	May 5 – May 10	Max-Planck Inst, Garching
S.D. Doty	May 14 – Jun 17	Denison University, Ohio
C. Dullemond	May 14 – May 16	Max-Planck Inst, Garching
D. Johnstone	Jun 1 – Jul 16	Herzberg Astrop. Victoria
F. van den Bosch	Jun 3 – Jun 6	Max-Planck Inst, Garching
J. Gunn	Jun 5 – Jun 21	Princeton University
D. Martinez-Delgado	Jun 10 – Jun 12	IAC, Tenerife
H.-W. Rix,	July 9 – July 11	MPIA, Heidelberg, Germany
H. Olofsson	Jun 11 – Jun 16	SCFAB,Astronomy,Stockholm
M. Reuland	Jun 13 - Jul 28	L. Livermore Labs.
H. Hoekstra	Jun 19	University of Toronto, Canada
K. Gebhardt	Jun 21 – Jun 26	Univ. of Texas, Austin
J. van Gorkom	Jul 10 – Aug 31	Columbia University,N.Y.
R. McDermid	Jul 22 – Jul 28	Durham University
K. Baker	Jul 23 – Sep 15	Bristol University
C. Knez	Jul 25 – Aug 7	Univ. of Texas, Austin
F. Heitsch	July 30 – Aug 3	MPIA, Heidelberg, Germany

Name	**Dates**	**Institute**
M. Redman	Aug 2 – Aug 7	University College London
E. Emsellem	Aug 5 – Aug 7	Observatoire de Lyon
K. Gebhardt	Aug 18 – Aug 18	Univ. of Texas, Austin
C. Eiroa	Sep 1 – Aug 31	University of Madrid
L. Sjouwerman	Sep 6 – Sep 10	NRAO, Charlottesville
E. Dartois	Sep 20 – Sep 26	IAS, Paris
J. Dever	Sep 23 – Nov 15	University of Nottingham
I. Iliev	Sep 30 – Oct 5	Nat. Astrofisica, Firenze
H. Morrison	Oct 1 – Nov 8	Case Western Reserve Univ
P. Harding	Oct 5	Univ. of Arizona, Tucson
N. van der Bliek	Oct 14 – Oct 18	CTIO, La Serena
T. Statler	Oct 15 – Oct 24	University of Ohio
R. Hudec	Nov 4 – Nov 9	Ondrejov Obs., Czech Rep.
M.R. Cioni	Nov 11 – Nov 15	ESO, Garching
J. Kessler	Nov 12 – Nov 22	CalTech, Pasadena
A. Boogert	Nov 17 – Nov 22	CalTech, Pasadena
M. Bremer	Nov 22 – Nov 26	Bristol Univ., England
G. Blake	Nov 17 – Nov 25	CalTech, Pasadena
M. Bernstein	Nov 18 – Nov 19	NASA AMES, Moffett Field
G. Rudnick	Dec 2 – Dec 7	Max-Planck Inst, Garching
T. Heckman	Dec 8 – Dec 15	Johns Hopkins, Baltimore
K-V. Tran	Dec 9 – Dec 11	ETH, Zurich
J. Cleaves	Dec 9 – Dec 13	UCSD, San Diego
J. Garry	Dec 11 – Dec 12	Open University, UK
B. Balick	Dec 16 – Dec 23	Univ.of Washington,Seatle
P. van Dokkum	Dec 17 – Dec 31	CalTech, Pasadena
Y. Aikawa	Dec 18 – Dec 24	Kobe Univ. Tokyo

Appendix V

Workshops, colloquia and lectures

Workshops, colloquia and lectures

Appendix V

V.1 Workshops and Meetings

Sterrewacht Science Day
On February 1, a Sterrewacht Science Day with staff, postdocs and PhD students giving short presentations of recent results was organized by van Dishoeck on behalf of the Observatory Research Committee. One of the highlights featured our Scientific Director attempting his first laboratory experiments. Otherwise, the programme wasas follows:

Brown	*The Binary Population in OB associations*
Vlemmings	*Magnetic Fields around Late-Type Stars: Circular Polarization of Water Masers*
van Dishoeck	*Infrared Spectroscopy of Protostars*
Fraser	*Through the Keyhole: a Glimpse into the World of Laboratory Astrophysics*
Jarvis	*The Link between Black Hole Mass, Host Galaxy, Radio Power, and Environment for a Complete Sample of Radio Galaxies at z=0.5*
van der Werf	*Rotation Curves of Redshifted Galaxies - z=0.6 to 3.2*
Verolme	*A SAURON Study of M32*
Röttgering	*Clustering of Distant Elliptical Galaxies and Radio Sources*
van Genderen	*The Zoo of Massive Unstable Stars*
Paardekooper	*On the Variability of WR86*
van der Heijden	*Frederik Kaiser (1808-1872) and the Professionalisation of Dutch Astronomy*
Mellema	*Dynamics of [WR]-Panetary Nebulae*
Icke	*Blowing up Non-Planar Disks*
Israel	*The Unusual Submillimeter Emission from NGC 1569*
Labbé	*Ultradeep NIR Observations of the Hubble Deep Field-South*
Tinbergen	*Optical Interferometry and Polarization: How to Avoid Disaster*

The XMM Large-Scale Structure Survey

Taking advantage of the unrivaled sensitivity of the X-ray Multi mirror observatory (XMM-Newton), a European consortium has designed an XMM wide area survey with the aim of tracing the large scale structure (LSS) of the universe out to a redshift of z 1 as traced by clusters and quasars : the XMM-LSS Survey. This makes the XMM-LSS some 1 000 times more sensitive than previous surveys and the only wide area X-ray deep survey for the coming decade. The X-ray survey is coupled with an extensive follow-up programme of radio, optical and IR observations.

Röttgering, Pierre (Paris) and Wilman organised a meeting at the Lorentz Center of the consortium that is carrying out the XMM-LSS survey. This meeting took place Jan 8, 9, and 10. After a short presentation of the XMM status and standard data analysis/delivery, the first results from the XMM survey were discussed. Further items on the agenda included (i) the status of the observing and funding proposals submitted since last meeting, (ii) activities of the Working Groups and of the general organization, (iii) planning of further XMM, optical and radio observation, (iv) collaboration with SIRTF survey SWIRE, and (v) meetings of the various working groups (X-ray analysis, Catalogue, X-opt identifications,).

Programme and list of attendents can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2002/20020108/info.php3?wsid=50`

Science with the Low Frequency Array

The Low Frequency Array (LOFAR) is a radio telescope that will operate at the lowest frequencies that are accessible from earth. It is being developed by ASTRON, based in Dwingeloo (the Netherlands), the Naval Research Laboratory in Washington DC (USA) and MIT's Haystack Observatory (USA). LOFAR's goal is to open a new, high-resolution window on the electromagnetic spectrum from 10-250 MHz (corresponding to wavelengths of 1.5-30 m).

Röttgering, and van Haarlem (ASTRON Dwingeloo) organised a workshop at the Lorentz center that was held Jan 21 - 24 on the definition of the formal user requirements for LOFAR. Discussion focussed on those aspects of the design of the instrument that are of interest to potential users. These included specification and scheduling, operational modes, calibration and data processing, data export, and user interaction with the telescope and processing infrastructure

Programme and list of attendents can be found on the website:
`http://www.lc.leidenuniv.nl/lc/web/2002/20020121/info.php3?wsid=47`

Dutch Astrophysics Days 2

On April 2 and 3, Mellema and Pelupessy once again organised the Dutch Astrophysics Days. This is an annual meeting of Dutch astronomers with a focus on theoretical work. Leiden-based speakers were Kamp, Pelupessy, van de Ven and Verolme. Other speakers included Dessart, Keppens, Macquart, Moortgat, Portegies Zwart, Romano-Diaz, Schaap, and van de Weijgaert. The special guest lecture was delivered by A. van den Berg from Earth Sciences at the University of Utrecht, on *Thermal convection and compositional differentiation in the planetary evolution of Earth and Mars.*

EARA Workshop on the Side-Effects of Star Formation

This workshop took place on May 6 and 7, and was one in an ongoing series organised at each of the institutes participating in EARA on quite general topics, with the aim of fos-

tering better contacts between the EARA institutes, mainly among graduate students and post-doctoral fellows. Relevant research at Leiden Observatory was presented by Boonman *("Molecular Spectroscopy of Young Stars")*, Mellema *("Side-effects of Star Formation")*, and Mengel *("Starburst Galaxies and the IMF")*.
Other speakers from IoA (Cambridge, UK), MPA (Munich, D) and IAP (Paris, F) included Ciardi, Kobayashi, Theuns, de Grijs, Beaulieu, Paumard, Fromang and Noel

GENIE WORKSHOP

On June 3 through 6, a workshop was organized by a team including Bakker and Röttgering on various aspects of the Ground-based European Nulling Interferometry Experiment. GENIE will be built by ESA as technology demonstrator for DARWIN and is meant to become a full facility instrument for ESO's VLTI. The current preliminary design of GENIE concentrates on a two-way beam combiner operating in the near-infrared (K, L, or N band). The science objective of GENIE is to observe a couple of hundred candidate stars for DARWIN in order to measure the zodiacal light and bright orbiting extra-solar planets. The instrument is scheduled for commissioning in 2006. More details can be found at the web-site:
`http://www.strw.leidenuniv.nl/%7Egenie/index.html`

JWST-MIRI Science Team meeting

On June 4, the first meeting of the European science team for the mid-infrared camera and spectrometer (MIRI) on the Next Generation Space Telescope (now called the James Webb Space Telescope), took place in Leiden, organized by van Dishoeck. About 25 scientists gathered to present and discuss science drivers and ideas for mid-infrared observations with this revolutionary instrument, which will become operational around 2011.

Workshop on Radio Glaxies - Past, Present and Future

Radio galaxies: past, present and future.

Jarvis and Rẗtgering organised an international workshop at the Lorentz centre, titled 'Radio galaxies: Past, present and future' (November 11 – 15). During this workshop the major advances that have been made in this field during the in the past 5 years were discussed. Possibly the most notable of these is the strong evidence which suggests that powerful radio galaxies are extremely good probes of large scale structure in the young Universe. There has also been huge developments in the field of black-hole demographics and the physical processes occurring with the central kpc. The results coming from both XMM-Newton and Chandra are also providing new and exciting insights into the AGN itself and the surrounding hot gas.

This workshop was attended by 60 workers in the field. Its proceedings will be published by Elsevier. List of participants and probramme can be found on the www site:
`http://www.lc.leidenuniv.nl/lc/web/2002/20021111/info.php3?wsid=69`

Herschel HIFI Science team meeting

From December 16–18, a meeting of the Herschel-HIFI science team took place in Leiden, organized by van Dishoeck and Kol, in collaboration with SRON. About 100 scientists from many different nationalities gathered for three days to discuss the plans for the HIFI guaranteed time and key programs. In addition, progress from the different working groups on modeling, laboratory measurements and preparatory studies was reported. The full pro-

gram can be found at:
`http://www.sron.nl/~bloemen/hificoresc.html#program`.

ALMA workshop: science related issues

From December 18–20, a three day workshop was organized by van Dishoeck in the Lorentz Center on various scientific issues related to the Atacama Large Millimeter Array, attended by ∼25 scientists. The program on the first day was joint with the Herschel-HIFI meeting. The aim of the workshop was three-fold. First, to stimulate interaction between the ALMA and Herschel-HIFI communities on issues of common interest, in particular calibration, data analysis and modeling. Second, to discuss face-to-face the workplan for the European ALMA science team in 2003, in particular on calibration. Third, to work on ALMA proposals in connection with the EU FP6 Framework announcement of opportunity. For details see:
`http://www.lc.leidenuniv.nl/lc/web/2002/20021218/info.php3?wsid=75` for details.

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 2002 the colloquium series was organized by Huub Röttgering.

Date	**Speaker (affiliation)**	**Title**
Jan 10	Rob Rutten (Utrecht, NL)	*Solar Physics with the Dutch Open telescope*
Jan 17	Yvonne Simis (Potsdam, D)	*Mass Loss Modulation in Dust Forming Stellar Winds*
Jan 24	Bob O'Dell (Nashville, USA)	*Star Formation in the Orion Nebula Cluster*
Jan 31	Bernhard Brandl (Ithaca, USA)	*Massive Young Clusters and Infrared Instrumentation*
Feb 4	Rafael Millan Gabet (Cambridge, USA)	*Long Baseline Optical Interferometry of Young Stellar Objects*
Feb 7	Fabio Favata (Noordwijk, NL)	*The Satellite Eddington*
Feb 14	Maria Rosa Cioni (Garching, D)	*AGB stars and other red giants in the Magellanic Clouds*
Feb 21	Aaron Romanowsky (Groningen NL)	*Exploring and Exploiting Elliptical galaxy Halos*
Feb 28	Maurice van Putten (Boston, USA)	*Gamma-ray Bursts and Gravitational Radiaton from Black Hole-torus Systems*
Mar 4	Roeland van der Marel (Baltimore, USA)	*Structure and Kinematics of the Large Magellanic Cloud*

Date	**Speaker (affiliation)**	**Title**
Mar 21	Jelle Kaastra (Utrecht, NL)	*High Resolution X-ray Spectroscopy of AGN: Mapping the Black Hole Environment*
Mar 28	Michele Cappellari (Leiden, NL)	*The SAURON Project: Integral Field Spectroscopy of Nearby Galaxies*
Apr 11	Barney Rickett (San Diego, USA)	*Probing the Radio Core of a Quasar by Scintillation Mondelling of its Intra-day Variations in Polarization*
Apr 18	Tom Thomas(Leiden, NL)	*The Influence of the Cluster Environment on Galaxies*
Apr 25	Dan Jaffe (Austin, USA)	*High resolution Near-IR Spectroscopy of Young Stellar Objects*
May 2	Rosemary Wyse (Baltimore, USA)	*Long Ago and Far Away: the Stellar IMF at High Redshift*
May 16	Ilse van Bemmel (Groningen, NL)	*An Infrared View of Active Galaxies*
May 30	Annette Ferguson (Groningen, NL)	*The Formation and Evolution of Disk Galaxies: Clues from the Local Universe*
Jun 5	M. Fridlund & A. Glindemann (Garching, D)	*Extra-Solar Planets in the Context of groundbased Interferometry*
Jun 6	Anthony Brown (Leiden, NL)	*From Brown Dwarf to O Star: Unveiling the Stellar Population in OB Associations*
Jun 10	David Martinez-Delgado (Tenerife, Sp)	*Dwarf Galaxies: the Building Blocks of the Milky Way?*
Jun 13	Hans Olofsson (Stockholm, Sw)	*Highly Episodic Mass Loss of AGB-Stars: Results from Radio Interferometry Observations and Images in Scattered Stellar Light*
Jun 20	Simon Portegies Zwart (Amsterdam, NL)	*The life and death of dense star clusters near the Galactic center*
Jun 26	Wing-Fai Thi(London, UK)	*Gas and dust in the circumstellar environment of pre main-sequence stars*
Jul 4	Huib J. Zuidervaart (Leiden, NL)	*Duch astronomy in the 18th century: a neglected and undervalued history*
Jul 11	Hans Walter Rix (Heidelberg, D)	*Tidal Tail Tales from the Sloan Digital Sky Survey*
Sep 5	Martin Harwit (USA)	*The Energy and Chemical Abundance Budgets of the Universe since the End of te Dark Ages*
Sep 12	Freek Beekman (Utrecht, NL)	*Imaging of biological processes using emission tomography: physics and image reconstruction*
Sep 19	Eelco van Kampen (Edinburgh, UK)	*The SCUBA/BLAST survey: constraints on galaxy formation models*
Sep 26	Helen Fraser (Leiden, NL)	*The Cosmic Chemical Cauldron: Deciphering the solid State Chemistry of Star Forming Regions*
Sep 30	Heino Falcke (Bonn, D)	*The power of jets*

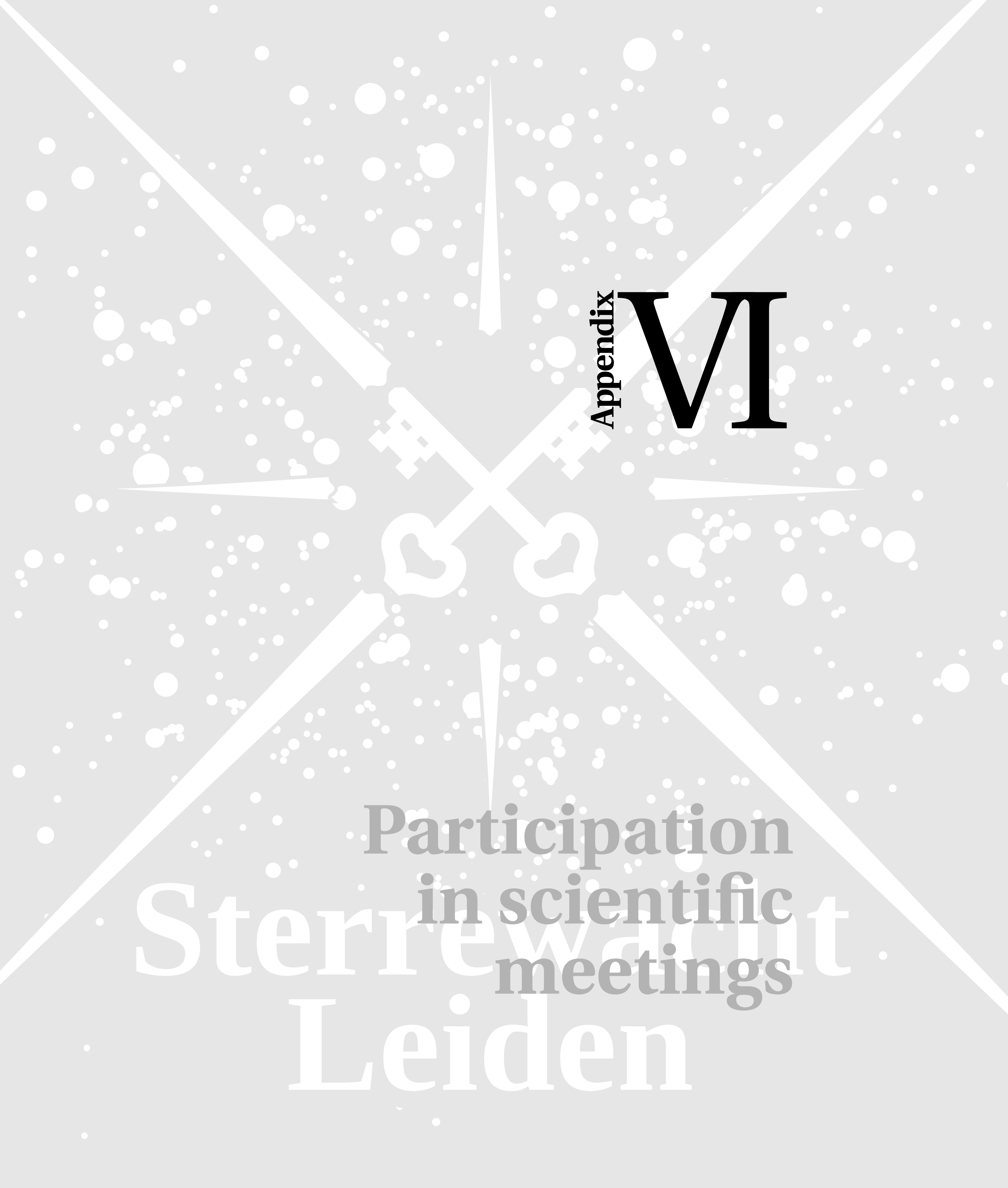
Date	Speaker (affiliation)	Title
Oct 10	Heather Morrison (Cleveland, USA)	*Star Streams in the Milky Way - Fragments of its History*
Oct 17	Alain Jorissen (Bruxelles, B)	*Asymptotic Giant Branch Stars in Binary Systems and their Progeny*
Oct 24	Andrea Ferrara (Arcetri, I)	*The Cosmic Dawn*
Oct 28	Gijs Verdoes Kleijn (Baltimore, USA)	*Nearby Radio Galaxies with HST*
Oct 31	Jeanette Onvlee (De Bilt, NL)	*Weather Outlook for the Coming Days - Past, Present and Future of Numerical Weather Prediction Models*
Nov 7	Avishai Dekel Jerusalem, (Is)	*Feedback to the Rescue of Galaxy Formation in CDM*
Nov 21	Carlos Eiroa (Madrid, S)	*An Observational View on the Variability of Disks around Pre-Main-Sequence Stars*
Nov 28	Harvey Butcher (Dwingeloo, NL)	*Science and Instrument Development at ASTRON*
Dec 18	Ed Churchwell (Wisconsin, USA)	*Hypercompact HII Regions: a New Stage of O-Star Evolution?*

V.3 Student colloquia

Date	Speaker	Title
Mar 18	M. Kloppenburg	*The peculiar nebula Simeis 57*
Jun 19	G. Dirksen	*The dynamics of the outer Jovian satellites*
Jun 21	L. van Starkenburg	*Weak galaxy-galaxy lensing in HDF-N and HDF-S*
Aug 19	T. Kouwenhoven	*Dynamical models of the globular cluster* ω *Cen*
Aug 20	A. Verhoeff	*Galactic binary statistics*
Aug 20	S. Paardekooper	*Planets in Discs*
Sep 18	R. Meijerink	*Variable Mass-Loss Evolution around AGB and Post-AGB stars*
Oct 21	M. van Mil	*Dependence of Galaxy Luminosity Functions on Environment*
Dec 10	S. Wuyts	*Fundamental plane of clusters MS2053–04 (z=0.58) and MS1054–03 (z=0.83)*

V.4 Endowed lectures

Date	Speaker (affiliation)	Title
		Oort Lecture:
December 12	T. Heckman (Baltimore, USA)	Sackler Lecture: *Spectroscopy of 100 Kilo-Galaxies: Implications for the Evolution of Galaxies and Active Galactic Nuclei*



Appendix VI

Participation in scientific meetings

Participation in scientific meetings

Appendix VI

Botta

36th ESLAB Symposium (Noordwijk, The Netherlands; June 3–7)
"Exogenous Material Delivery to Earth-like Planets and Moons"

Asteroids, Comet, Meteors (Berlin, Germany; July 29–August 2)
"The Amino Acid Composition of Carbonaceous Chondrites: Clues to Their Parent Bodies"

2nd European Exo-/Astrobiology Workshop (Graz, Austria; September 16–19)
"Organic Chemistry in Meteorites"

World Space Congress and 34th COSPAR Meeting (Houston, USA; October 10–19)
"Cometary Chemistry: Constraints from Observations and Laboratory"

Van Breukelen

Nederlandse Astronomen Conferentie (Lunteren, The Netherlands; May 22–24)

Van Broekhuizen

Conference on Surface Processes (Les Houches, France; January 14–18)

Workshop on Laboratory Astrophysics (FOM, Rijnhuizen, the Netherlands; March 15)

Chemistry as a Diagnostic for Star Formation (Waterloo, Canada; August 20–23)
" A Hot Core Laboratory"

Brown

GAIA photometry meeting (Copenhagen, Denmark; November 18–22)

GAIA Classification working group meeting (Heidelberg, Germany; December 2–3)

van Dishoeck

Astronomy, Cosmology and Fundamental Physics: ESO-ESA-CERN Symposium (Garching, Germany; March 4–7)
"Formation of planetary systems (invited lecture)"

EU-TMR Astrochemistry Network Meeting (Perugia, Italy; April 4–5)
"Gas and dust in protoplanetary disks (invited lecture)"

US National Academy of Sciences Annual Meeting (Washington, USA; April 27–30)
"Molecules as probes of star- and planet formation (invited lecture)"

Nederlandse Astronomen Conferentie (Lunteren, Netherlands; May 22–24)
"Gas and dust in protoplanetary disks (invited lecture)"

Star Formation Workshop 2002 (Taroko Gorge, Taiwan; June 13–15)
“Chemical evolution during star formation (invited review)”

The Chemically Controlled Cosmos, 16’th UCL Colloquium (Cumberland Lodge, UK; July 15–17)
“Gas and dust in protoplanetary disks (invited lecture)”

XXVIIth General Assembly of the International Union of Radio Science (Maastricht, The Netherlands; August 17–24)
“Overview of millimeter observatories (invited review)”

Chemistry as a Diagnostic of Star Formation (Waterloo, Canada; August 21–23)
“Chemical changes during star formation: high- vs. low-mass YSOs (invited review)”

Chemie & Heelal: KNCV Jaarcongres (Den Haag, The Netherlands; September 19)
“Van moleculen tot planeten (invited lecture)”

Third IRAM Millimeter Interferometry School (Grenoble, France; October 1–5)
“The Atacama Large Millimeter Array: science drivers (invited lecture)”

Science Operations with the Atacama Large Millimeter Array (Garching, Germany; November 8)
“Science operations with ALMA (invited lecture)”

Afscheidssymposium prof. K.R. Libbenga (Leiden, The Netherlands; November 19)
“Op zoek naar de bouwstenen voor leven in het heelal (invited lecture)”

Science with the Herschel-HIFI instrument (Leiden, The Netherlands; December 16–18)
“Observing circumstellar disks with HIFI”
“Radiative transfer modeling for Herschel-HIFI and ALMA”

Ehrenfreund

IAU 186, Cometary Science after hale-Bopp (Tenerife, Canary Islands; January 20–25)
“Physico-chemistry of comets: constraints from the laboratory”

AAAS (Boston, USA; February 14–16)
“The chemistry of ices in interstellar space: constraints from the laboratory”

ICAPS Meeting (Estec, Noordwijk, The Netherlands; April 16)

Astrobiology research in the Netherlands in the framework of the AURORA programme (SRON, Utrecht, The Netherlands; April 18)

European Geophysical Society (Nice, France; April 22–26)
“Laboratory studies in Astrobiology”

STSCI (Baltimore, USA; May 6–9)
“From dark clouds to the early Earth”

Team meeting, ISSI International Space Science Institute (Bern, Switserland; June 3–6)

ESLAB (Noordwijk, The Netherlands; June 6–7)
“Complex organics and prebiotic chemistry in space”

Topical Team Meeting (ESTEC, Noordwijk, The Netherlands; June 10–11)

ESA WORKSHOP: Mars Mission Simulations (Paris, France; June 24–25)

ROSETTA (SWT/ESTEC, Noordwijk, The Netherlands; June 26–27)

ISSOL (Oaxaca, Mexico; June 30–July 5)
"Formation and Evolution of organics in Space"

ESEG (ESA Headquarters, Paris, France; July 16)

Low T physics (Keuruu, Finland; August 3–8)
"Ice chemistry in space"

Goldschmidt Conference (Davos, Switserland; August 18–23)
"Complex organics and prebiotic molecules in space: constraints from the laboratory"

(Vienna, Austria; September 4)
"Innovative Technology/Astrobiology"

ESSC European Space Science Committee (Cologne, Germany, September 9–11)

2nd European Exo/Astrobiology Conference (Graz, Austria; September 16–19)
"Astrophysical and Astrochemical Insights into the origin of life"

EXPOSE meeting (Graz, Austria)

The Living Planet, Carnegie (Washington DC, USA; September 22–26)
"Origin and evolution of organic matter in interstellar clouds"

Mars Society Convention (Rotterdam, The Netherlands; September 27–29)
"Astrobiology and Mars"

COSPAR (Houston, USA; October 10–19)
"From dark clouds to comets"
"Cometary chemistry: constraints from observations and laboratory"
"Simulation of physical and chemical processes in support of space missions"

SRON Board (Utrecht, The Netherlands; November 7)
"Astrobiology in the Netherlands"

Mars Express Meeting (Estec, Noordwijk, The Netherlands; December 5)
"RCL Mars Express: Organics chemistry on Mars"

Topica ()

Förster Schreiber

IAU Symposium No. 212: A Massive Star Odyssey, from Main Sequence to Supernova (Lanzarote, Spain; June 24–28)
"M 82 — Starburst Rosetta Stone"

Structure Evolution and Cosmology: New Synergy between Ground-based Observations, Space Observations and Theory (Santiago, Chile; October 28–31)
"FIRES Survey: the MS 1054–03 Field"

Franx

van Albada workshop (Groningen, NL; march 15)
"Very Deep Infrared Imaging with the VLT"

van Albada workshop (Groningen, NL; march 19)
"Evolution of galaxies from the Fundamental Plane"

Fraser

Surface Photochemistry Workshop (,Les Houches, France, January 2002)

National Astronomy Meeting, Astrochemistry Special Sessions (University of Bristol UK March 2002)

NASA Laboratory Astrophysics Workshop (NASA AMES, USA May 2002)
"Deciphering Chemical Reactions in Icy ISM Regions"
"Laboratory Surface Science: The Key to the Gas-Grain Interaction"

ESA Topical Team Physico-Chemistry of Ices in Space (3rd Meeting ESTEC, Noordwijk, Netherlands, 2002)

ESA Topical Team Physico-Chemistry of Ices in Space (4th Meeting Bologna, Italy, 2002)

COSPAR / WORLD SPACE CONGRESS (Houston, USA October 2002)
"Skating on Thin Ice: Surface Chemistry in the Interstellar Medium' - Solicited Lecture 'Physico-Chemistry of Ices in Space: From Earth to the ISS to the Solar System and Beyond' "

The 3rd Nordic Conference on Laboratory Astrophysics, at the meeting of the Danish Physical Society (Odensee University, Denmark September 2002)
"'CO'ded messages? Just what can we learn about the ISM with Surface"

The Chemically Controlled Cosmos: a Conference in Honour of D.A.Williams (Cumberland Lodge, Windsor, UK, July 2002)
"Skating on Thin Ice: What Laboratory Astrophysics tells us about Interstellar Chemistry"

Haverkorn

Dutch Astrophysics Days (Leiden; Mar 1–2)

Gaseous Matter in Galaxies and Intergalactic Space (Paris, France; June 19–23)
"Parsec-scale structure in galactic disk and halo, from diffuse radio polarization"

Astrophysical Polarized Backgrounds (Bologna, Italy; Oct 9–12)
"Parsec-scale structure in the warm ISM from polarized galactic radio background observations"

Van der Heijden

Sterrewacht Science Day (Leiden, The Netherlands; February 1)
"Frederik Kaiser (1808–1872) and the professionalisation of Dutch astronomy"

The Book of Nature (Groningen, The Netherlands; May 22–25)

Fasenovergangen: De Hollandse School rond 1900 (KNAW Amsterdam, The Netherlands; October 10)

Zeeman, Lorentz & the Electron (Leiden, The Netherlands; October 11)

Israel

Chemical Evolution of Dwarf Galaxies (Ringberg, Tegernsee, Germany; July 29–August 2)
"Molecular Content of Dwarf Galaxies"

Jaffe

Future of High Resolution Work in Holland (Noordwijkerhout, The Netherlands; Jan 10-11)

Jarvis

Coevolution of black hole and galaxies (Pasadena, USA; October 20–25)
"The M_{bh} *-* L_{rad} *relation for flat-spectrum quasars "*

RTN annual meetiong - IGM (Florence, Italy; September 14–18)
"Probing the absorbing haloes around two high-redshift radio galaxies with VLT-UVES"

UK SKA meeting (Oxford, UK; November 7–7)

Radio Galaxies - Past, present and future (Leiden, Netherlands; November 11–15)
"Host galaxy properties of flat-spectrum quasars"

de Jong

SAURON team meeting (Observatoire de Lyon, France; March 13–16)
"Report on the status of the SAURON pipeline reduction software."

Jørgensen

Star Formation Workshop (Taroko Gorge, Taiwan; June 12–17)
"The physical and chemical structure of low-mass protostellar envelopes"

Chemistry as a diagnostic of star formation (Waterloo, Canada; August 21–23)
"Molecular abundances in low-mass protostellar envelopes"

Third IRAM Millimeter Interferometry School (Grenoble, France; September 29–October 5)
"The physical and chemical structure of low-mass protostars"

Kamp

ICM meeting (Amsterdam, The Netherlands; March 27)

Dutch Astrophysics Days (Leiden, The Netherlands; April 3-4)
"Two-fluid disk models for λ *Bootis stars"*

Fred Gillett Symposium (Tucson, US; April 11-14)
"Possible tracers of circumstellar gas in the disk around β *Pictoris"*

Star Formation Workshop (Taipei, Taiwan; June 10-16)
"On the nature of tenuous circumstellar disks"

AG meeting (Berlin, Germany; September 23-28)
"Tenuous disks around young solar-type stars"
"Interaction between a star and a diffuse interstellar cloud"

Ten Kate

Water in the Upper Martian Surface (Potsdam, Germany; April, 17-19, 2002)
"Complex Organics on Mars - Poster"

European Geophysical Society - 27th General Assembly (Nice, France; April, 21-26, 2002)
"Complex Organics on Mars - Poster"
"Ground support programme for future Mars missions - Oral presentation"

ESLAB 36 - Earth-like planets and moons (Noordwijk, the Netherlands; June, 3-8, 2002)
"Complex Organics on Mars - Poster"

ISSOL (Oaxaca, Mexico; June 30- July 5, 2002)
"Complex Organics on Mars - Poster"

2nd European Exo/Astrobiology Conference (Graz, Austria; September, 16-19, 2002)
"Laboratory simulations on complex organics on Mars - Oral presentation"
"Laboratory simulations on complex organics on Mars - Poster"

Exploring Mars surface and its Earth analogues - Workshop and field trip (Sicily / Mount Etna, Italy; September, 21-25, 2002)
"Laboratory simulations on complex organics on Mars - Poster"

Knudsen

Nederlandse Astronomen Conferentie (Lunteren, The Netherlands; May 22–24)
"Deep Submillimeter Continuum Mapping of Lensing Galaxy Clusters"

Kuijken

2002 Oort workshop (Leiden, NL)
"OmegaCAM"

Towards an International Virtual Observatory (Garching, Germany; June 10–14)
"ASTRO-WISE: an astronomical survey system for Europe"

SISCO network kick-off (Durham, UK; October 1–2)
"Surveys with OmegaCAM"

Kurk

Lyα Emission at High Redshift (Cambridge, UK; February 25–26)
"Lyα Emission and Hα emission from PKS 1138−262"

RTN Physics of the intergalactic medium, annual meeting (Gargonza, I; Septeber 14–18)
"A study of the evolutionary state of the cluster 1138−262 at $z = 2.2$ on the basis of Hα, Lyα and X-ray emitters and extremely red objects"

Radio Galaxies: Past, Present and Future (Leiden, NL; November 11–15)
"A study of the evolutionary state of the cluster 1138−262 at $z = 2.2$ on the basis of Hα, Lyα and X-ray emitters and extremely red objects"

Labbé

FIRES Workshop (Leiden, July 8–12)

SPIE (Discoveries and Research Prospects from 6-10m Class Telescopes: August 22–23)
"Talk: Ultra-deep near infrared imaging of HDF-south: restframe optical properties of high redshift galaxies "

Lacerda

JENAM 2002 (Porto, Portugal; September 2–7)
"On the detectability of lightcurves of Kuiper Belt objects"

Asteroids, Comets and Meteors 2002 (Berlin, Germany; July 29–August 2)
"On the detectability of lightcurves of Kuiper Belt objects"

Lub

Nederlandse Astronomen Conferentie (Lunteren, the Netherlands; May 23–24)

New Horizons in Globular Clusters (Padua, Italy: June 24–28)

The Extragalactic Distance Scale (Concepcion, Chile; December 9–11)

Meijerink

Nederlandse Astronomen Conferentie (Lunteren, The Netherlands; May 22–24)

Dutch Astrophysics Days 2 (Leiden, The Netherlands; April 3–4)

NOVA Fall School (Dwingeloo, The Netherlands; October 7-11)
"Molecular Gas in Galactic Nuclei"

Mellema

Adaptive Mesh Hydrodynamics (UNAM, Mexico City, Mexico; February 4–14)

Tracing the Emergence of Structure in the Universe (Groningen, The Netherlands; March 14–15)

Dutch Astrophysics Days 2 (Leiden, The Netherlands; April 3–4)

EARA Workshop Side-effects of star formation (Leiden, The Netherlands; May 6–7)

η **Carinae, reading the legend** (Crystal Mountain WA, USA; July 11–13)
"How to make bipolar nebulae"

Winds, Bubbles, Explosions (Patzcuaro, Michoacan, Mexico; September 9–13)
"Stellar wind bubble: H-deficient stars and X-ray spectra"

Radio Galaxies: past, present and future (Leiden, The Netherlands; November 11–15)
"The fate of clouds in radio lobes"

Kick-off meeting Computational Science (Amsterdam, The Netherlands; November 29)
"Squashing interstellar clouds in 3 dimensions"

MODEST-2 (Amsterdam, The Netherlands; December 16–17)

Messineo

Mass-losing pulsating stars and their circumstellar matter (Sendai, Japan; May 13 – 16)
"Late type stars in the Galactic Bulge and SiO masers"

The central 300 parsecs (Hawaii, USA; November 4 – 8)
"Late type stars in the Galactic Bulge and SiO masers"

Muñoz Caro

EGS, XXVII General Assembly (Nice, France; April 21–26)
"Formation of chiral organic molecules in simulated interstellar conditions"

Ollongren

Workshop on interstellar message construction (Paris; 18 March 2002) "Music in Lingua Cosmica" with D. Vakoch, poster at IAU Symposium 213 BIOASTRONOMY 2002: LIFE AMONG THE STARS, Section SETI, July 8-12 Hamilton Island, Great Barrier Reef, Australia, "Self-interpretation in LINCOS"

Overzier

X-ray astronomy in the new millennium (London, UK; February 20)

The 12th New England regional quasar/AGN meeting (Haystack, USA; May 30)

Tracing the emergence of cosmic structure in the Universe (Groningen, The Netherlands; March 14–15)

The emergence of cosmic structure (College Park, USA; October 7–9)
"The redshift evolution of massive galaxy clustering"

Pelupessy

Dutch Astrophysics Days (Leiden; 3–4 april)
"SPH modelling of galaxies"

Nederlandse Astronomen conferentie (Lunteren; 22–24 mei)

XIV Winterschool of Astrophysics: Dark matter and Dark energy in the Universe (Tenerife, Spain; 18–29 november)
"Simulations of Feedback in Dwarf Galaxies"

Röttgering

Lyman alpha Emission at High Redshift (Cambridge, UK; Feb 25–26)
"Lyman alpha emitters associated with $2 < z < 4.1$ *radio galaxies: Is every powerful radio galaxy with z¿2 associated with a protocluster? "*

Tracing the Emergence of Structure in the Universe (Groningen, March 14-15)
"Large scale structure in the Universe as probed by distant ellipticals, AGN and proto-clusters around 2¡z¡4.1 powerful radio sources. "

Copenhagen Distant Cluster Workshop (Copenhagen, Denmark, May 22-24)
"The most powerful radio galaxies and the detection of proto-clusters up to z=5.2 using Lyman alpha emitting galaxies."

ESO distant cluster survey, project meeting (Paris, France, June 16-17)

ESO distant cluster survey, project meeting (Garching, Germany, Dec 16-17)

Yearly meeting EU network on "Physics of the IGM (Gargonzo, Italy, Sep 16 - 18)

LOFAR, System Requirements Review (NRL, Washington, USA, Oct 21-24)

Texas in Tuscany, XXI Symposium on Relativistic Astrophysics (Venice, Italy, Dec 8-10)
"LOFAR: a new telescope for the early Universe"

Rijkhorst

Adaptive Grid Gasdynamics Workshop (Mexico City, Mexico; February 4-14)

Dutch Astrophysics Days (Leiden, The Netherlands; April 3-4)

Nederlandse Astronomen Conferentie (Lunteren, The Netherlands; May 22-24)
"Adaptive Mesh Refinement for Three-Dimensional Hydrodynamics"

NOVA Fall School (Dwingeloo, The Netherlands; October 7-11)
"3D Hydrodynamics using Adaptive Mesh Refinement"

Computational Science Kick-off Meeting (Amsterdam, The Netherlands; December 29)

"Squashing Interstallar Clouds in 3 Dimensions"

Schöier

Chemistry as a diagnostic of star formation (Waterloo, Canada; August 20–23)
"Does IRAS 16293–2422 contain a hot core? New interferometric results; A database of molecular line data for rotational transitions from selected species of astrophysical interest "

Science Operations with ALMA (Garching, Germany; November 8)
"Radiative transfer tools and molecular data bases for ALMA"

Schutte

Chemistry as a Diagnostic of Star Formation (Waterloo, Canada; August 21–23)
"Stringent upper limits to the solid NH_3 *abundance towards W33A from near-IR spectroscopy with the Very Large Telescope"*

Biannual Conference on Chemistry Chem.02 (Cairo, Egypt, March 4–7)
"Amino Acids from Ultraviolet Irradiation of Interstellar Ice Analogs"

NASA Laboratory Astrophysics Workshop (NASA-Ames Research Center. Moffett Field, USA, May 1–3)
"Formation of Chiral Organic Molecules in Simulated Dense Cloud Environments"

Venemans

Nederlandse Astronomen Conferentie (Lunteren, NL; May 22–24)
"Large Scale Structures around High z Radio Galaxies"

Structure Evolution and Cosmology (Santiago, Chile; October 28–31)
"A protocluster at $z = 4.1$*"*

Radio Galaxies: Past, present and future (Leiden, NL; November 11–15)
"Large Scale Structures around High z Radio Galaxies"

van der Werf

Faint InfraRed Extragalactic Survey workshop (Lorentz Centre, Leiden; July 8–12)

Science with HIFI (SRON, Utrecht; September 25)
"Extragalactic astronomy with HIFI"

HIFI core science (Lorentz Centre, Leiden; December 16–18)
"Starburst galaxies with HIFI"

Wilman

Radio galaxies, past, present and future (Leiden; November 11–15)
"The absorbing haloes around high-redshift radio galaxies: the UVES view (talk)"
"Clustered sub-mJy radio sources in The Bootes Deep Field (poster)"

Meeting of the XMM Large Scale Structure Survey Consortium (Leiden; January 8–10)

van Zadelhoff

Debris disks and the formation of planets: A symposium in memory of Fred Gillett (Tuscon, USA; April 11–13)
"Axi-symmetric models of ultraviolet radiative transfer with applications to circumstellar disk chemistry"
"The gas temperature in circumstellar disks: effects of dust settling"

The 16th UCL Astronomy Colloquium: The chemically controlled cosmos (London, United Kingdom; July 15–18)
"Circumstellar disk chemistry: 2D UV radiative transfer and effects of stellar UV"

Appendix VII

Observing sessions abroad

Observing sessions abroad

Appendix VII

Botta
Stewart Observatory 12 m Telescope (Tucson, USA; November 17–24)

Van Breukelen
JKT (La Palma, Spain; February 13–19; July 4–10)

Van Dishoeck
VLT (Paranal, Chile; May 4–8)

Förster Schreiber
WHT (La Palma, Spain; October 20–23)

Franx
Paranal, Chili, Aug 31-Sept 6
Keck Observatory, Feb 13-18

Israel
SEST (La Silla, Chile; May 6–16)

Jaffe
VLTI (Paranal, Chile; Nov 17-Dec 17)

Jarvis
OVRO (California, USA; Jan 2–8)
JCMT (Hawaii, USA; May 7–14)
WHT (La Palma, Spain; August 9–10; November 30 – December 1)
JKT (La Palma, Spain; August 11–12)

de Jong
VLT (Paranal, Chile; November 13–December 3)

Jørgensen
OVRO (California, US; January 24–30)
JCMT (Hawaii, US; May 3–10; August 25–September 8)

Knudsen
JCMT (Hawaii, USA; January 3–8; April 9–16)

Kuijken
INT (La Palma, Spain; Jul 16–21)
WHT (La Palma, Spain; Oct 8–13)

Kurk
VLT (Paranal, Chile; March 23–25)

Labbé
William Herschel Telescope (La Palma, Spain; October 20–23)

Mellema
WHT (La Palma, Spain; August February 4–5)

Messineo
IRAM 30m (Pico Veleta, Spain; March 24 – April 2)
CTIO 4m-Blanco (La Silla, Chile; 2 July – 6)

Overzier
VLT (Paranal, Chile; March 23–25)

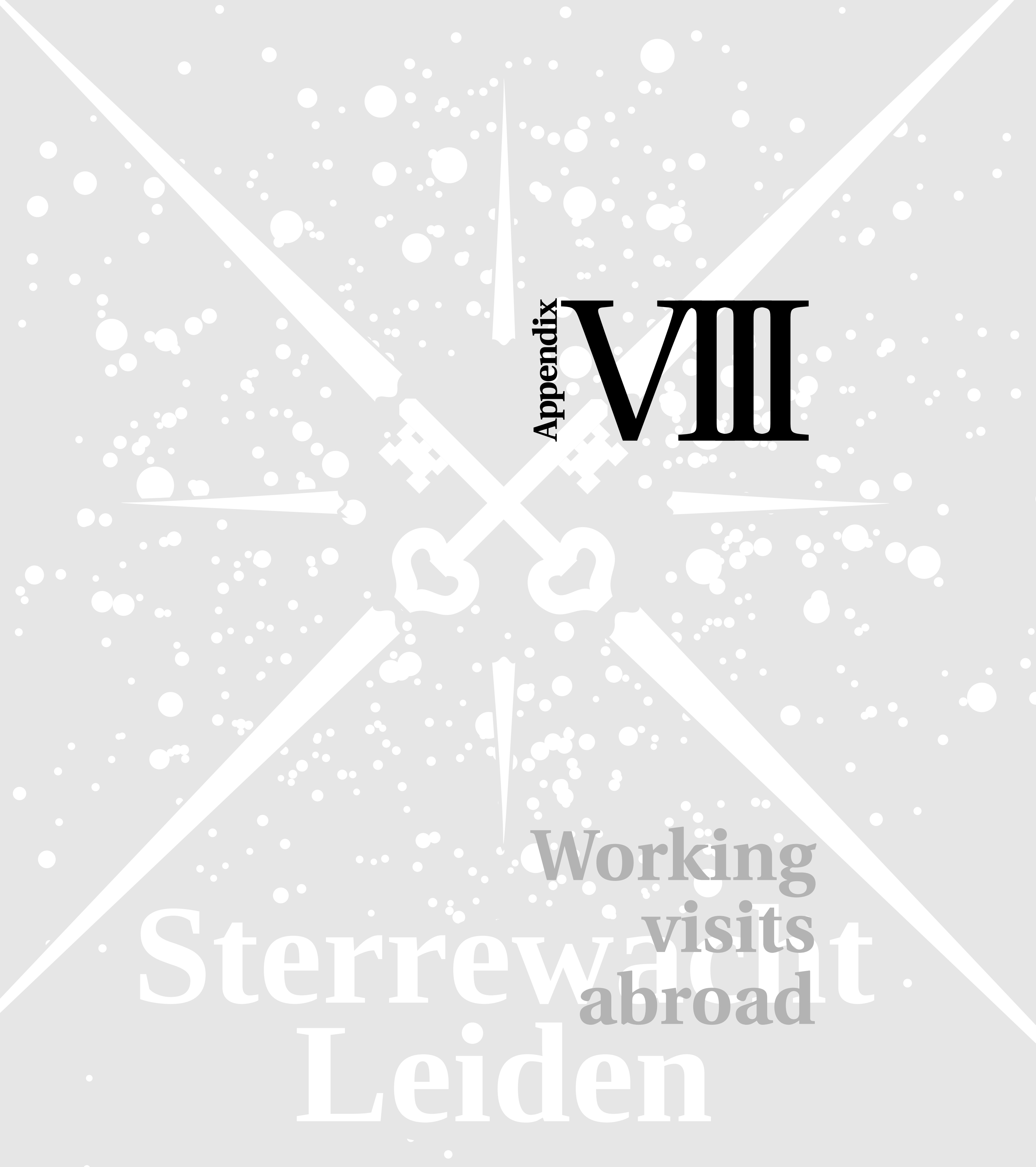
Röttgering
VLT (Paranal, Chile, April 16-22)

Schöier
OSO (Onsala, Sweden; March 8–15)
JCMT (Hawaii, USA; August 25–September 8)

Venemans
Keck (Hawaii, USA; January 14–15)
ESO VLT (Paranal, Chile; March 8–11; April 17–20; September 6–9)

van der Werf
ESO (Paranal, Chile; February 23–26)
JCMT (Mauna Kea, Hawaii, USA; November 18–26)

Wilman
WHT (La Palma, Spain; November 30–December 1)



Appendix VIII

Working visits abroad

Sterrewacht
Leiden

Working visits abroad

Appendix VIII

Brown
MPIfR (Bonn, Germany; January 21–25)
ESO (Garching, Germany; January 28–30)

van Dishoeck
IAS (Paris, France; January 18)
IAP (Paris, France; February 4)
MPIA (Heidelberg, Germany; February 6–7)
ESO (Garching, Germany; February 19)
Saclay (Paris, France; February 20–22)
ESO (Garching, Germany; March 6)
National Astronomical Observatory (Tokyo, Japan; March 18–21)
ROE (Edinburgh, UK; April 9–10)
ESO (Garching, Germany; April 12)
Academy Institute (Venice, Italy; April 18–20)
ESO (Garching, Germany; April 24)
Penn State University (State College, USA; May 1–2)
University of Texas (Austin, USA; May 9–11)
ASIAA & National Tsing Hua Universities (Taipei, Taiwan; June 10–11)
Astrium (Stevenage, UK; September 4)
NRAO (Socorro, USA; September 6–8)
ESTEC (Noordwijk, The Netherlands; September 10–13)
ESO (Garching, Germany; September 16–18)
IRAM (Grenoble, France; October 5)
ESO (Garching, Germany; October 14)
EU headquarters (Brussels, Belgium; October 18)
ESO (Garching, Germany; November 4–8)
ESA Headquarters (Paris, France; November 5)
MPIA (Heidelberg, Germany; November 21–22)
RAL (London, UK; November 25–26)
Center for Astrophysics (Cambridge, USA; December 10–12)

Ehrenfreund
University of Vienna (Vienna, Austria; October 18–22)

Förster Schreiber
Max-Planck-Institut für Astronomie (Heidelberg, Germany; January 29–31)

Franx
Paris Observatory (Paris, France; Januari 22-23)
MPIA (Heidelberg, Germany; Januari 29-Februari 1)
Caltech (Pasadena, USA; Februari 10-13)
Caltech (Pasadena, USA; Februari 18-20)
Hopkins University (Baltimore, USA; June 23-25)
Center for Astrophysics (Cambridge, USA; June 25-27)
UC Santa Cruz (Santa Cruz, USA; June 28-July 2)
Hopkins University (Baltimore, USA; August 28-30)
University of Lyon (Lyon, France; September 18-20)
Hopkins University (Baltimore, USA; November 13-16)
Caltech (Pasadena, USA; November 17-22)

Fraser
University of Nottingham(Nottingham, UK; January 24–27)
University of Nottingham(Nottingham, UK; September 1–5)

Haverkorn
MPIA (Heidelberg, Germany; Jan 26 – 31)
HIA/DAO (Victoria, Canada; Dec 5–9)
DRAO (Penticton, Canada; Dec 9–14)
CfA (Boston, USA; Dec 14–19)

Israel
MPE (Garching, Germany; February 15)
PPS (Lisbon, Portugal; October 18–19)

Jaffe
MPIA (Heidelberg, Germany; Jan 23–25)
MPIA (Heidelberg, Germany; Feb 24–26)
MPIA (Heidelberg, Germany; March 11–13)
MPIA (Heidelberg, Germany; March 24–26)
MPIA (Heidelberg, Germany; April 23–25)
MPIA (Heidelberg, Germany; May 12–15)
MPIA (Heidelberg, Germany; May 23–24)
MPIA (Heidelberg, Germany; August 5–8)
MPIA (Heidelberg, Germany; Sept 4–11)
MPIA (Heidelberg, Germany; Oct 23–25)

Jarvis
IAC (La Laguna, Spain; February 25–28)
Kapteyn Laboratorium (Groningen, The Netherlands; March 8–9)

de Jong
MPIA (Heidelberg, Germany; January 21–25)
MPIA (Heidelberg, Germany; March 3–13)
MPIA (Heidelberg, Germany; April 28–May 17)
MPIA (Heidelberg, Germany; June 12–20)
MPIA (Heidelberg, Germany; August 4–9)
MPIA (Heidelberg, Germany; September 4–11)

Jørgensen
Caltech (Pasadena, California, US; January 31–February 8)

Kamp
Max-Planck-Institut für extraterrestrische Physik (Garching, Germany; July 1-3)
Max-Planck-Institut für Astrophysik (Garching, Germany; July 4-5)
Max-Planck-Institut für extraterrestrische Physik (Garching, Germany; September 10-11)
Institute für Theoretische Phsyik und Astrophysik (Kiel, Germany; September 29-30)

Knudsen
Caltech (Pasadena, USA; January 14–17)
Cavendish (Cambridge, UK; February 25–March 1)

Kuijken
Munich Observatory (Munich, Germany; Jun 5–6) Padua Observatory (Padua, Italy; Oct 17–18) ESO (Garching, Germany; Oct 23–24)

Lub
ESO (Garching, Germany; June 3–7)
ESO (Garching, Germany; November 25–29)

Mellema
Korea National Observatory (Daejon, Korea; January 3–11)
Stockholm Observatory (Stockholm, Sweden; May 22-31)
University of Rochester (Rochester NY, USA; September 16–21)

Messineo
IAP (Paris, France; February 17 – 22)
CTIO (La Serena, Chile; June 28 – July 23)

Muñoz Caro
Bremen University (Bremen, Germany; January 21)

Overzier
Johns Hopkins University (Baltimore, USA; May 15–16)
Harvard/SAO CfA (Cambidge, USA; May 17–31)
Johns Hopkins University (Baltimore, USA; July 21–29)
Johns Hopkins University (Baltimore, USA; September 14 – December 15)

Röttgering
ESO (Garching, Germany, Mar 8)

Venemans
Institute of Geophysics and Planetary Physics (Livermore, USA; January 16–February 18)

Van der Werf
European Southern Observatory (Garching, Germany; March 25–26)
OPTICON OWL working group (Turku, Finland; May 3–4)
Imperial College of Science, Technology and Medicin (London, England; September 19–20)
European Southern Observatory (Garching, Germany; October 2–3)
PPARC Astronomy Advisory Panel (London, England; October 9–10)

Wilman
CEA (Saclay, France; September 17–20)
Naval Research Laboratory (Washington DC, USA; August 26–September 3)
University of Durham (Durham, UK; April 30–May 3)

Appendix IX

Colloquia given outside Leiden

Colloquia given outside Leiden

Appendix IX

Boonman

The Physical and Chemical Structure of Massive Protostars	Universiteit Utrecht, The Netherlands; November 26

Brown

The Binary Population in OB Associations	MPIfR, Bonn, Germany; January 24

van Dishoeck

Gas and Dust in Protoplanetary Disks	Penn State University, State College, USA; May 1
Gas and Dust in Protoplanetary Disks	ASIAA, Taipei, Taiwan; June 10
Infrared Spectroscopy from Space: Gases and Solids during Star Formation	National Tsing Hua University, Taiwan; June 11
The Atacama Large Millimeter Array: Project Status and Science Operations	Kapteyn Institute, Groningen, The Netherlands; September 20
Gas-grain Processes in Protoplanetary Disks around Young Stars	FOM Rijnhuizen, Utrecht, The Netherlands; October 10

Ehrenfreund

Astrobiology-the search for life in the universe	Kapteyn Laboratorium, Groningen, The Netherlands; February 8
Idem	University of Dundee, Dundee, Scotland; March 8
Idem	AMOLF, Amsterdam, The Netherlands; April 15
Idem	Technische Universiteit Eindhoven, Eindhoven, The Netherlands, October 31
Small bodies in the solar system	IAC 2002, Utrecht, The Netherlands: May 1

Fraser

Through the Keyhole: a Glimpse at the World of Laboratory Astrophysics	FOM, Rijnhuizen, The Netherlands; March 2002
Skating on Thin Ice: Surface Chemistry in the Interstellar Medium	University of Liverpool, Liverpool, UK; May 2002

Haverkorn

Turbulent magnetic fields? Parsec-scale structure in the warm ISM, from radio polarization data	Max-Planck-Institut für Astronomie, Heidelberg, Germany; January 29
Multi-frequency polarimetry of the Galactic radio background at wavelengths around 90cm	Dominion Astrophysical Observatory (DAO), Victoria, Canada; December 7
Idem	Dominion Radio Astrophysical Observatory (DRAO), Penticton, Canada; December 12
Idem	Harvard-Smithsonian Center for Astrophysics (CfA), Boston, USA; December 18

Jarvis

On the redshift cut-off of radio galaxies	IfA, Edinburgh, UK; March 22

Jørgensen

The physical structure of low-mass protostellar envelopes	Caltech, Pasadena, California, US; February 5
Idem	Joint Astronomy Centre, Hilo, Hawaii, US; May 3

Kamp

Formation of Jupiter-like planets around young A-stars: still possible!	Kapteyn Institute, Groningen, The Netherlands; May 17
On the nature of tenuous circumstellar disks	Max-Planck-Institut für extraterrestrische Physik, Garching, Germany; July 2
Tenuous disks around young stars: models and observations	Max-Planck-Institut für Astrophysik, Garching, Germany; July 4
Idem	Hamburger Sternwarte, Hamburg, Germany; October 1

Mellema

Planetary Nebulae around H-deficient stars	Korea National Observatory, Daejon, Korea; January 10
Planetary Nebulae around H-deficient stars	Kapteyn Laboratorium, Groningen, The Netherlands; June 28
Clouds in radio lobes	University of Rochester, Rochester NY, USA; September 16
Fate of clouds in radio lobes	Vanderbilt University, Nashville TN, USA; December 5

Overzier

The Cosmological Evolution of (Active) Galaxy Clustering	Harvard/SAO CfA, Cambridge, USA; June 3

Schöier

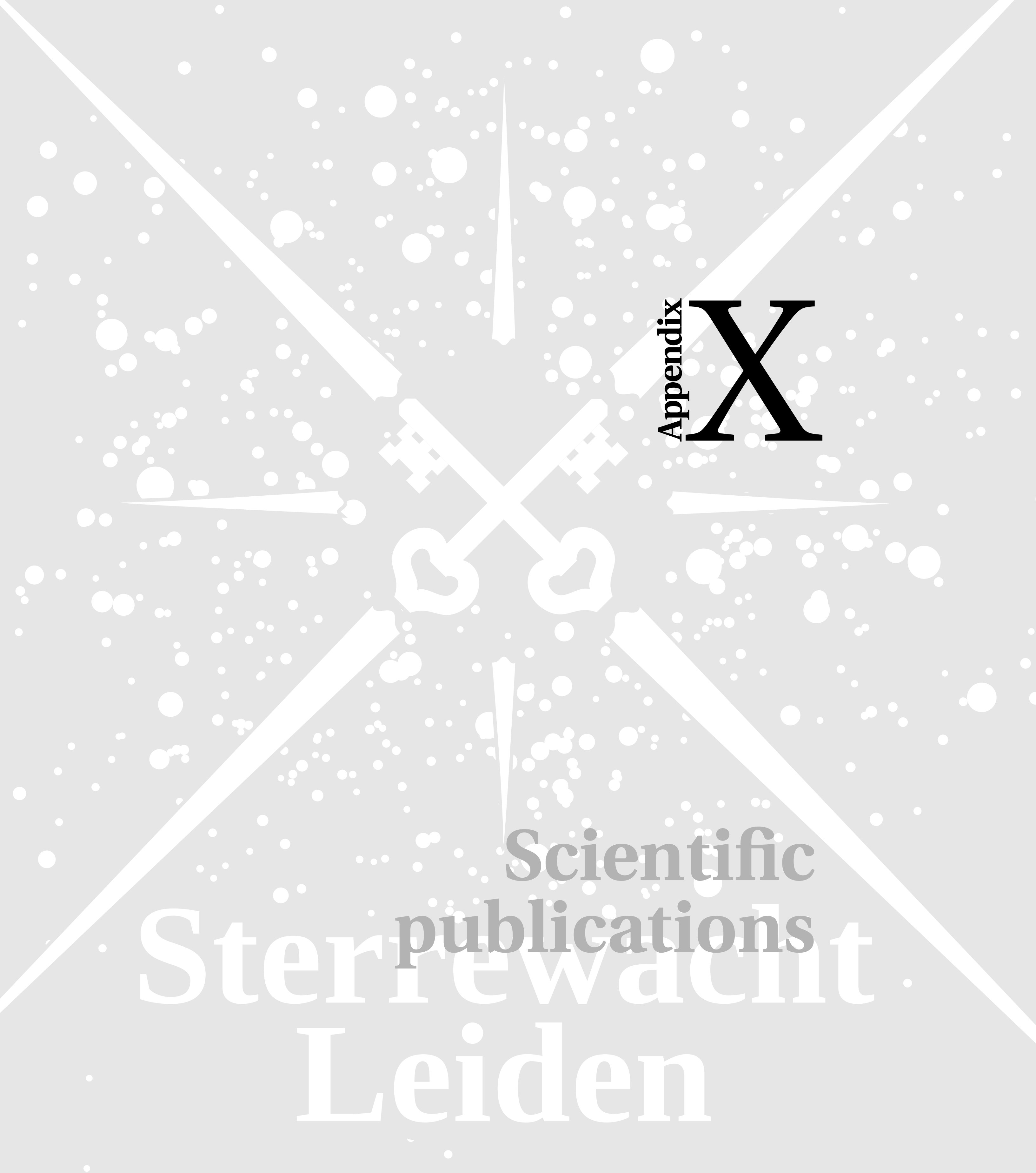
Radiative transfer tools and molecular data bases for ALMA	ESO headquarters, Garching, Germany; November 8

Gerd-Jan van Zadelhoff

The physical and chemical structure of circumstellar disks around young stellar objects	Arcetri, Firenze, Italy; August 27

Appendix X

Scientific publications



Scientific publications

Appendix X

X.1 Ph.D. theses, books and catalogues

V. de Heij, Compact high-velocity clouds, Ph.D. thesis, Leiden University, May 2002.

M. Haverkorn, WSRT Polarimetric imaging of the warm ISM, Ph.D. thesis, Leiden University, December 2002.

W.-F. Thi, Gas and dust around young stars, Ph.D. thesis, Leiden University, February 2002.

T. Thomas, The influence of cluster environment on galaxies, Ph.D. thesis, Leiden University, March 2002.

G. A. Verdoes Kleijn, The centers of nearby radio-loud galaxies, Ph.D. thesis, Leiden University, March 2002.

W. Vlemmings, Circumstellar maser properties through VLBI observations, Ph.D. thesis, Leiden University, November 2002.

G.-J. Zadelhoff, Shaping disks, Ph.D. thesis, Leiden University, May 2002.

X.2 Papers in refereed journals

Y. Aikawa, **G. J. van Zadelhoff**, **E. F. van Dishoeck**, and E. Herbst, Warm molecular layers in protoplanetary disks, *Astron. Astrophys.* **386**, 622–632.

A. Al-Halabi, A. Kleyn, **E. F. van Dishoeck**, and G.J. Kroes, Sticking of H atoms on ices: dependence on incidence angle, J. Phys. Chem. B **106**, 6515–6522.

M. G. Allen, W. B. Sparks, A. Koekemoer, A. R. Martel, C. P. O'Dea, S. A. Baum, M. Chiaberge, F. D. Macchetto, and **G. K. Miley**, Ultraviolet Hubble Space Telescope Snapshot Survey of 3CR Radio Source Counterparts at Low Redshift, *Astrophys. J. Suppl. Ser.* **139**, 411–438.

M. Bellazzini, F. Fusi Pecci, **M. Messineo**, L. Monaco, and R. T. Rood, Deep Hubble Space Telescope WFPC2 Photometry of NGC 288. I. Binary Systems and Blue Stragglers, *Astron. J.* **123**, 1509–1527.

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A. Biviano, **P. Katgert**, **T. Thomas**, and C. Adami, The ESO Nearby Abell Cluster Survey. XI. Segregation of cluster galaxies and subclustering, *Astron. Astrophys.* **387**, 8–25.

A. C. A. Boogert, M. R. Hogerheijde, C. Ceccarelli, A. G. G. M. Tielens, **E. F. van Dishoeck**, G. A. Blake, W. B. Latter, and F. Motte, The Environment and Nature of the Class I Protostar Elias 29: Molecular Gas Observations and the Location of Ices, *Astrophys. J.* **570**, 708–723.

O. Botta, D. P. Glavin, G. Kminek, and J. L. Bada, Relative Amino Acid Concentrations as a Signature for Parent Body Processes of Carbonaceous Chondrites, Origins of Life and Evolution of the Biosphere **32**, 143–163.

Z. Cai, R. Nan, **R. T. Schilizzi**, **G. K. Miley**, M. A. R. Bremer, **B. van Dam**, **H. J. A. Röttgering**, H. Liang, K. C. Chambers, L. I. Gurvits, and H. Y. Zhang, A 327 MHz VLBI study of high redshift radio galaxies 1345+245, 1809+407 and 2349+289, *Astron. Astrophys.* **381**, 401–407.

M. Cappellari, Efficient multi-Gaussian expansion of galaxies, *Monthly Notices Roy. Astr. Soc.* **333**, 400–410.

M. Cappellari, **E. K. Verolme**, R. P. van der Marel, **G. A. Verdoes Kleijn**, G. D. Illingworth, **M. Franx**, C. M. Carollo, and **P. T. de Zeeuw**, The Counterrotating Core and the Black Hole Mass of IC 1459, *Astrophys. J.* **578**, 787–805.

C. L. Carilli, D. E. Harris, L. Pentericci, **H. J. A. Röttgering**, **G. K. Miley**, **J. D. Kurk**, and W. van Breugel, The X-Ray-Radio Alignment in the z=2.2 Radio Galaxy PKS 1138-262, *Astrophys. J.* **567**, 781–789.

C. M. Carollo, M. Stiavelli, M. Seigar, **P. T. de Zeeuw**, and H. Dejonghe, Spiral Galaxies with HST/NICMOS. I. Nuclear Morphologies, Color Maps, and Distinct Nuclei, *Astron. J.* **123**, 159–183.

S. B. Charnley, S. D. Rodgers, H. M. Butner, and **P. Ehrenfreund**, Chemical Processes in Cometary Comae, Earth Moon and Planets **90**, 349–360.

C. S. Crawford, P. Gandhi, A. C. Fabian, **R. J. Wilman**, R. M. Johnstone, A. J. Barger, and L. L. Cowie, Multiwavelength observations of serendipitous Chandra X-ray sources in the field of A2390, *Monthly Notices Roy. Astr. Soc.* **333**, 809–824.

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D. de Mello, T. Wiklind, C. Leitherer, and **K. Pontoppidan**, The Nature of Submm-Detected Galaxies, *A. Space Sci.* **281**, 549–550.

W. H. de Vries, R. Morganti, **H. J. A. Röttgering**, R. Vermeulen, W. van Breugel, R. Rengelink, and **M. J. Jarvis**, Deep Westerbork 1.4 GHz Imaging of the Bootes Field, *Astron. J.* **123**, 1784–1800.

V. de Heij, R. Braun, and **W. B. Burton**, An all-sky study of compact, isolated high-velocity clouds, *Astron. Astrophys.* **392**, 417–451.

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A. C. Fabian, **R. J. Wilman**, and C. S. Crawford, On the detectability of distant Compton-thick obscured quasars, *Monthly Notices Roy. Astr. Soc.* **329**, L18–L22.

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