Research Institute Leiden Observatory

(Onderzoekinstituut Sterrewacht Leiden)

Annual Report 2001

Sterrewacht Leiden
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Front cover: False-color composite image of HST Deep Field South combining the deepest-ever ISAAC VLT near-infrared observations with an HST WFPC2 image. The images were smoothed to a seeing of FWHM$\approx 0\farcs46$, using WFPC2 I_{814} as blue, ISAAC J_s as green and ISAAC K_s as red. Some of the faint high-redshift sources are *large* in the observed NIR and resemble local spiral galaxies. Other galaxies, visible as red sources, are extremely faint in the optical and would be missed by traditional selection criteria. Work by Franx and Labbé, see Chapter 2 of this report.

Back cover: False-colours displaying the density structure of a cloud after the passage of a strong shock. Work by Mellema, see Chapter 2 of this report.

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Production Annual Report 2001:
F. P. Israel, J. Lub, J. Drost, I. Labbé, R. Meijerink, R. Overzier, M. Zaal

Sterrewacht Leiden

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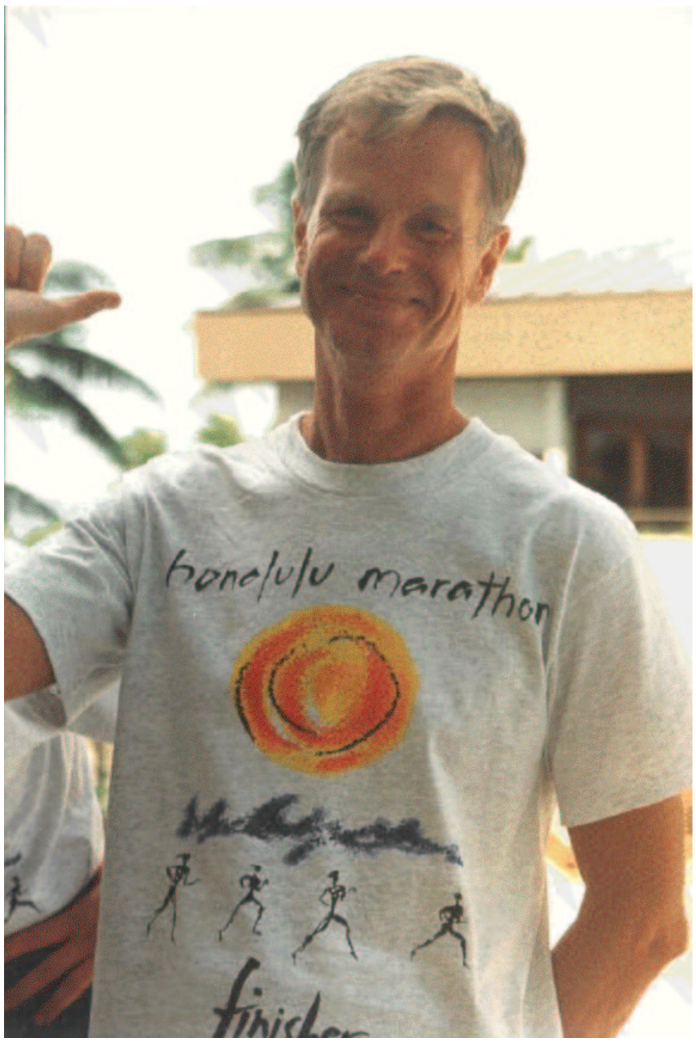
Sterrewacht Leiden

In memoriam
Ferdinand Baas



1944 – 2001

Ferdinand Baas

Ferdinand (Fred) Baas died in his house in Hilo (Hawaii) on April 4, 2001. He was only 56 years old, and suffered from a melanoma cancer that had been discovered just four months earlier. For many of us it was hard to accept that, of all people, Fred with his iron constitution was no longer with us. He was an experienced long-distance runner, and only half a year before his death he had succesfully taken part in the 'Iron Man' triathlon considered murderous by virtually all of us.

After a number of jobs, among others one as a sailor for the Holland-America Line, Fred started his study of physics in Leiden at the age of 22. In 1976 he succesfully defended his Ph.D. thesis 'Optical Studies on Transport Phenomena in Gases'. His supervisor was J. J. M. Beenakker and Fred obtained his degree cum laude. Even before he finished his thesis work, he already received the C. J. Kok Award for his experimental work on double refraction in gases. He then worked for a year with Nobel Laureate C.H. Townes in Berkeley, California before he returned to Leiden and joined the Leiden Working Group for Laboratory Astrophysics newly founded by Mayo Greenberg.

From 1990 onwards, Fred Baas was employed as Associate Professor (UHD) by the Dutch Science Foundation (NWO) and the Leiden Observatory. To support Dutch astronomy, he was stationed in Hawaii at the British-Canadian-Dutch James Clerk Maxwell (JCMT). At the JCMT, Fred not only helped, if not instructed, Dutch astronomers plan and conduct their investigations on molecular gas clouds in interstellar space, but he also proved again his worth as an experimental physicist, for instance, by succesfully conducting a painstaking investigation into the nature and causes of telescope deformation under changing temperature conditions.

However, this description of his life is completely inadequate as it fails to do him justice by not mentioning his personal character. Fred was truly exceptional among the rest of us by always taking a positive view and never speaking ill of others. He had a strong sense of duty, and went to great lengths to help other people. He literally thought nothing of giving away his 'frequent flyer air miles' to allow people with lesser incomes to visit their family on the mainland. The hospitality of the Baas family in Hawaii was proverbial. Countless visitors from Holland were warmly received in his house, while Fred and his wife Margje also took in several lonely young friends of their daughters, who –again literally – became like adopted children. At the same time, Fred had an independent and critical mind, which sadly not always endeared him to the British-dominated and civil-service oriented organisation that he was part of.

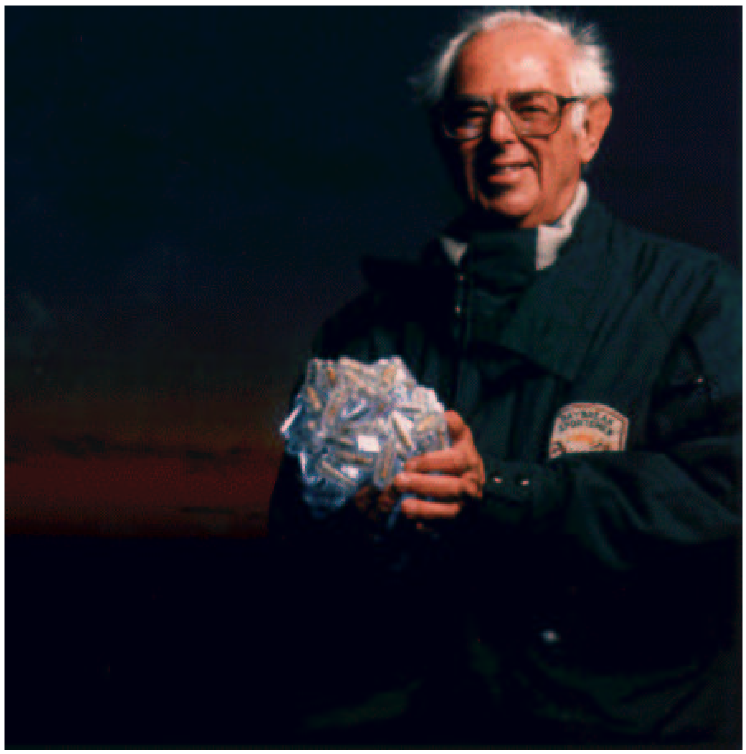
Fred took a great interest in education. Frequently, he came back to Leiden for a few months to conduct a lecture course. In Hawaii, he lectured at the local University of Hawaii college, in his own time and without reimbursement. The pleasure of explaining physics to students he considered sufficient reward.

Yet he enjoyed life. With his family or alone, in a jeep, on a motorbike or in a sports car he would traverse the Big Island. Many of us were introduced by him to the fascinations of scuba diving. Just for fun, he would run ten miles and back, but with equal pleasure he would enjoy the sunset with a 'mai tai' cocktail in his hand.

It is a privilige to have known Fred Baas. Greater is the sense of loss.

Frank P. Israel

In memoriam
J. Mayo Greenberg



1922 – 2001

J. Mayo Greenberg

On 29 November the death occurred at his home in Leiden of J. Mayo Greenberg, emeritus professor of laboratory astrophysics at Leiden University and pioneer in the fields of astrochemistry and astrobiology. He was 79.

Mayo Greenberg was born on January 14th 1922 in Baltimore Maryland. At school he exhibited extraordinary mathematical talents. He decided to study physics and became an undergraduate at the Johns Hopkins University when he was only 15. Just over 2 years later he entered graduate school. His university research career was interrupted by the Second World War, when he was recruited to analyse the problems of air flow that caused the experimental P-38 dive bomber to crash repeatedly. He returned to Johns Hopkins and in 1948 obtained a PhD based on the theory of how radiation is scattered by matter.

His first postdoctoral position was at the University of Delaware. He soon left to work at the University of Maryland and in 1952 he became an Assistant Professor at Rensselaer Polytechnic Institute in Troy New York where he rapidly rose to the rank of full professor. He then moved to the State University of New York at Albany in 1970, where he was department chair until taking up a position in Leiden in 1975. During these years, Greenberg's interests broadened from theoretical to experimental studies. He began measuring the scattering properties of small particles. During this period he was developing a keen interest in astronomy. He realized that studying the processes by which light is scattered is essential for understanding how light from stars in large regions of the Milky Way is reddened and blocked.

Scattering of radiation by dust and gas in interstellar space was a major interest of the famous Dutch astronomer Henk van de Hulst. In 1961 Greenberg decided to spend a sabbatical year at Leiden to learn more about astronomy from Van de Hulst and Jan Oort. Greenberg returned to Leiden Observatory for a year as Visiting Professor in 1968. When Van de Hulst persuaded the university to instigate a chair of laboratory astrophysics, Mayo Greenberg was the obvious choice to fill it. Van de Hulst persuaded Greenberg to move permanently to Leiden in 1975 where he subsequently made his home.

Greenberg's laboratory was a pioneering venture. The idea was to use conventional laboratory techniques to simulate the extreme conditions of space and for the first time to apply experimental techniques as a complement to observations and theory for studying the dusty universe. By carrying out experiments under controlled conditions he could study questions such as the composition and evolution of the icy mantles that surround interstellar dust grains. The Astrophysics Laboratory was set up as an autonomous ”working group” in a joint venture between the physics and astronomy departments. As such it was shielded from much of the bureaucratic inefficiencies of the then university administration. Mayo Greenberg thrived within this structure. He was an entrepreneur who, until the time of his death continually raised large amounts of funding for postdocs, Ph.D. candidates and equipment from diverse international sources, some of which were completely unknown to anybody else in the department.

For the last quarter century, the laboratory that Greenberg created has produced a constant stream of fundamental research papers, and cultivated a series of brilliant students who have gone on to be scientific leaders themselves. Although the Leiden laboratory was the first such facility, there are now several comparable laboratories throughout the world, some of which are led by ex-students or staff of the Leiden lab.

Greenberg's retirement in 1992 coincided with severe economic cutbacks within the Faculty of Mathematics and Natural Sciences and a decision was made by the board of the then combined physics and astronomy department to close the laboratory. Mayo Greenberg fought tirelessly along with Ewine van Dishoeck to keep the lab open, but for several years its survival hung by a thread. In 1998, after a visit to Leiden Observatory, the distinguished American philanthropists Raymond and Beverly Sackler provided funding that assured the future of the lab. The Sacklers decided to be benefactors of the lab after a persuasive discussion with Mayo Greenberg and an excellent dinner at the Greenbergs.

During the sixties and seventies Greenberg became increasingly interested in the life-cycle of interstellar dust grains and in particular in the complicated chemical processes that occur when they are exposed to the intense optical and ultraviolet radiation from the stars. He became convinced that the processes involved could produce complicated molecules (organic refractory material) and might even lead to the pre-biotic building blocks of life. The question of whether life reached the Earth by means of dust in comets is one that fascinated Mayo Greenberg for the last three decades. Mayo's work in this field was the precursor of two new interdisciplinary fields of science, astrochemistry and astrobiology that have since developed into large disciplines in their own right. Throughout most of his career Greenberg concentrated on understanding interstellar dust in the Milky Way. In recent years it became evident that dust plays a crucial role not only in the birth and death of stars in our own galaxy, but also in the formation of galaxies. Dust has been detected in the most distant galaxies in the early Universe. On learning of this discovery, about 2 years before his death, Greenberg excitedly started modeling the primeval dust in these galaxies. Greenberg's work provides an important foundation for future studies of dust in the early Universe.

From 1989 until 1997, Mayo Greenberg was also Director of the NATO International School of Space Chemistry held every few years in the town of Erice, Sicily. Many young scientists benefited greatly from this 2-week intensive course, which featured many internationally renowned scientists.

Nobody who talked with Mayo could avoid being affected by his infectious enthusiasm for his work. This contributed to his ability to convey the excitement of his work both to students and to the general public and persisted throughout his courageous fight against pancreatic cancer. Until a few weeks before his death, he could be seen at the Sterrewacht, playing ping pong with his students and promovendi in between lively scientific discussions. Of the more than 300 publications of which he was co-author, about 50 were produced during the last 5 years. I know of nobody else with the exception of Jan Oort that has kept scientifically so young as they grew physically older.

He regarded science popularization as an important duty and loved it. He appeared numerous times in popular science programs on television and radio and in many newspaper interviews. His last interview in The Haagsche Courant, which appeared barely a month and half before his death clearly illustrated his ability to bridge the gap, seemingly without effort, between scientist and non-scientist. It speaks to the passion he brought to his research on interstellar chemistry and the origin of life that at the time of his interview, he was already plagued by the effects of his illness.

The other important aspect of Mayo Greenberg was his family life. He married Naomi Slovin in 1947 and for the last 54 years Mayo and Naomi formed a couple that complemented each other in most respects. Naomi's support was crucial in facilitating Mayo's achievements and the Greenberg's hospitality is legendary. Together with their four children the Greenbergs are a close family with wide interests and a deep love of classical music.

Mayo Greenberg would have been 80 in January 2002. Only two months before his death, a symposium was held at Leiden Observatory to celebrate his 80th birthday, which friends and colleagues from several continents attended. He was an active participant, making many perceptive and stimulating remarks. Mayo was a dear colleague and friend, who all of us at the Sterrewacht greatly miss.

George K. Miley

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Chapter 1

Review of major events

Review of major events

Chapter 1

The Leiden Faculty of Mathematics and Natural Sciences is still undergoing a painful reorganization in which severe cutbacks are being made in the larger departments of the Faculty. As part of the planning for this reorganization, the Sterrewacht produced an updated strategic plan in October 2001. The plan is built on the following three key research areas (i) formation and late stages of stars; (ii) formation and late stages of galaxies and (iii) astronomical instrumentation. The plan, accepted by the Board of the Faculty foresees the number of tenured scientific staff at the Sterrewacht remaining at 17.

As outlined elsewhere in this report, the Sterrewacht continues to pursue a broad range of research topics within the above-mentioned key areas. An essential ingredient of the lively research atmosphere at the Sterrewacht has long been our graduate students (promovendi) and postdoctoral fellows. The contribution of the NOVA funding to Dutch astronomy is now very apparent at Leiden, with the appointment in 2001 of several excellent new graduate students and postdocs to the staff in 2001.

During 2001, several members of the staff were involved in the development of astronomical instruments. Their activities included work on various ESO projects (VLTI, SINFONI and OMEGACAM) and the Sackler Laboratory. On the longer term, the Sterrewacht is involved in the planning of major facilities such as ALMA (Van Dishoeck) and LOFAR (Miley, Röttgering). In the course of this year considerable progress was made in securing funding for these facilities and in securing their technical realization. Furthermore, a team led by Van Dishoeck and including many Leiden staff members proposed involvement in a consortium to build a mid-infrared instrument for the NGST.

Several important events took place in 2001. The Descartes-Huygens Prize was awarded to Tim de Zeeuw on 11 December, in recognition of his exemplary contributions to the advancement of Dutch-French collaboration in science. Pascale Ehrenfreund, a member of our academic staff, was successful in winning personal NWO funding of about 400 kEuro to pursue her research in astrobiology. Her funding was allocated as part of an NWO scheme designed to stimulate innovative new research directions. Earlier, Ehrenfreund had already been honoured on 17 May with the Pastoor Smeits prize.

Several ceremonial lectures were given under the auspices of the Sterrewacht during the last year. Professor Jim Peebles delivered the 12th Oort Lecture entitled *"Discovering the Expansion of the Universe"* on 26 April. He 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 on *"Galaxy Formation"*. Another highlight of 2001 was a visit by Professor Geoff Marcy to deliver the 2001 Sackler Lecture on 4 December on *"Planets and the Prospects for Life in the Universe"*. On 22 May Vincent Icke delivered his inaugural lecture as a Leiden professor entitled *Onzicbtbare Wetenschap* and on 30 November, Harry van der Laan, the Chairman of the Supervisory Board of the Sterrewacht, gave a lecture to mark his 65th birthday entitled *"Scholars, Concepts and Discoveries – a 3 × 3 Silhouette"* This lecture was preceded by a two-day symposium and concluded by the award to Professor van der Laan of one of the most prestigious Royal Awards: 'Commandeur in de Order van de Nederlandse Leeuw'.

The year 2001 also brought sadness to the Sterrewacht. On 4 April our colleague Fred Baas died of cancer at the age of 56. Fred had been seconded from Leiden to the Joint Centre of Astronomy in Hawaii for several years, where he served the international astronomical community and the users of the JCMT loyally and with great expertise. Half a year later we were saddened to hear that Heleen Kluyver, one-time associate of the Sterrewacht and widow of Drs. Pels and Van Herk had died on November 15. A final shock occurred a forthnight later, when Mayo Greenberg passed away on 29 November, just 2 months before his 80th birthday. Only a few months before Mayo's death, on 17th September, the Sterrewacht had organized a symposium in honour of his birthday. The symposium, entitled *"From Interstellar Dust to Comets: A Journey through Space and Time"* was attended by colleagues and friends from many parts of the world.

During 2001, other changes occurred in our senior scientific staff. Butler Burton and Aernout van Genderen retired. Jane Luu left to take up a position in the USA. Pascale Ehrenfreund became a UHD (Associate Professor). Our support staff also underwent modifications. Jeanne Drost joined the Sterrewacht as a Management Assistant while Yoke Slegtenhorst and Janet Soulsby left us after many years of faithful service.

George K. Miley

Director of Research,
Leiden Observatory

Chapter 2

Research

Sterrewacht Leiden

Research

Chapter 2

The research interests of the Leiden Observatory are very broad, ranging from the solar system to very distant galaxies. This chapter gives an overview of results obtained in 2001.

2.1 History of Astronomy

Van der Heijden, working on a Ph.D. thesis on the subject of “Frederik Kaiser (1808–1872) and the modernisation of Dutch astronomy” concentrated on the process of professionalisation of astronomy in The Netherlands in the second half of the 19th century. Kaiser was the first professor appointed in charge of astronomy *exclusively* in The Netherlands and director of Leiden observatory from 1837 until his death in 1872. He was instrumental in the establishment of the new, state-of-the art observatory building in 1860.

Van der Heijden started work on one of the main aspects of Kaiser’s influence on the development of Dutch astronomy: his popular works. He became widely known for his spellbinding popular lectures and his many articles in popular magazines. His aim was to disclose the practice of science to the public, to eliminate superstition, and – eventually – to emphasize the greatness and beauty of Creation (a form of moral education). His writings usually were accompanied by complaints about the poor state of astronomy in The Netherlands, good for winning public support for the science of astronomy. Kaiser’s most appreciated work was ”De Sterrenhemel” (1844–1845), an overview of astronomical theory and practice for the layman. It appeared in two volumes, four editions; parts of it were translated into German, Danish and French.

At times, Kaiser was explicit on the way science should be brought to the public. He even wrote a treatise on how to popularize science, especially astronomy: *”Het wezen en de eischen van de populaire voordragt der natuurkundige wetenschappen,* *en meer bepaaldelijk van die der sterrekunde".* This – among other things – makes him a unique figure in the Dutch scientific world of the 19th century.

2.2 Solar System

2.2.1 Minor Planets

In 2001, Van Houten-Groeneveld and Van Houten proposed names for 59 minor planets discovered by them in 1960, 1971, 1973 and 1977. Out of these 59, 36 were Main-Belt objects and 23 were Trojans. In addition to the well-known writer of popular astronomy books Wanders (10428), Dutch astronomers thus honored by having a minor planet named after them included Van Woerden (10429), Schmidt (Martschmidt = 10430), Pottasch (10431), Schwarz (Ullischwarz = 10432), Ponsen (10433), Tinbergen (10434), Van Albada (Tjeerd = 10435), Pel (Janwillempel = 10436) and Van der Kruit (10437). Althoux six of the nine astronomers named were associated with Groningen University, all but Van Albada were once employed at the Leidse Sterrewacht.

2.3 Stars

2.3.1 B[e] stars/S Dor variables

Van Genderen and Sterken (Brussels) conducted a multi-colour photometric (V, B, L, U, W system) study of three B[e] supergiants: R 66 = HDE 268835 and R 126 = HD 37974 in the LMC and S 18 in the SMC. Their data-set represented the largest body of multi-colour photometric data of B[e] supergiants to date. In spite of the general view that most of these objects are not variable, Van Genderen and Sterken could show that all three – arbitrarily selected – objects are subject to two (R 66 and R 126) respectively three (S 18) types of light oscillations. Most of these are probably pulsational oscillations. They discussed the issue of the evolutionary connection between B[e] stars and S Dor variables: both types of objects share the same characteristics due to their spectroscopic similarity and their non-spherical winds, to which were now added a number of photometric instabilities. The study by Van Genderen and Sterken further supports the suspicion that a strong B[e]–S Dor variable connection exists. Both groups seem to emerge gradually into each other.

2.3.2 Binaries

Paardekooper, Veen, Van Genderen and Van der Hucht (SRON-Utrecht) investigated the nature of the Wolf-Rayet star WR 86, a known visual binary. Their large photometric and spectroscopic data-sets allowed them to solve the puzzle of the photometric variability of WR 86. The companion turned out to be a β Cephei star, a pulsating star of early B-type, while the Wolf-Rayet primary appeared to be relatively quiet. With the aid of stellar models they were able to shed further light on the evolutionary status of WR 86.

2.3.3 Chemical composition of A stars

Kamp, together with Hempel (Hamburg, Germany) and Holweger (Kiel, Germany) analysed the chemical composition of a sample of both dusty and dust-free A stars. Due to the shallow convection zones of A stars, accretion of circumstellar material should modify the chemical composition of the photospheres of these stars. Nevertheless, a detailed abundance analysis failed to show any chemical composition differences between dusty and dust-free A stars. This was taken to imply that either accretion rates are too low to contaminate a significant fraction of the stellar photospheres, or that inner disk clearance prevents accretion onto the stellar surfaces.

2.3.4 The λ Bootis phenomenon

Kamp carried out a systematic study of the properties of λ Bootis stars in the post-Hipparcos era, in collaboration with Paunzen (Wien, Austria), Iliev and Barzova (Smolyan, Bulgaria). They found a strikingly tight correlation between the stellar and interstellar sodium abundances, and also obtained evidence that the λ Bootis stars form a homogeneous group of population I objects. The still unknown mechanism behind the λ Bootis phenomenon acts continously from late B to early F-type stars from the Zero Age Main Sequence to the Terminal Age Main Sequence.

Kamp and Simis also explored the parameter space (density and dust grain size) for gas/dust separation in one-dimensional two-fluid hydrodynamic disk models. The models span the whole range between full coupling of gas and dust to complete decoupling. They determined that the disks around metal-poor λ Bootis stars fall into the regime where gas and dust are fully decoupled. The metal-poor gas accretes back onto the stellar surface, which may explain the metal depletion seen in the surface layers of these stars.

2.4 Embedded Stars and Circumstellar Matter

2.4.1 Wolf-Rayet stars and planetary nebulae

Mellema studied the effects of hydrogen-deficient stellar winds emanating from [WC] stars. These are central stars of planetary nebulae which have hydrogen-free atmospheres, the gas consisting of roughly equal amounts of helium and carbon. Because a metal such as carbon has many more possible transitions than hydrogen, it has substantially higher cooling rates for its atoms and ions. Using the new *DORIC* radiation module, Mellema investigated differences between the evolution of wind-blown bubbles emanating from normal hydrogen-rich central stars of planetary nebulae, and from [WC] stars. He found that the initial momentum-driven phase lasts about twice as long for the [WC] stars, leading to more perturbed nebular shells, as is indeed observed.

2.4.2 Rings around the Cat's Eye

Mellema and Hyung (Korea Astronomy Observatory) used archival *HST* WFPC2 images of the planetary nebula NGC 6543 (the "Cat's Eye") to show that the inner halo surrounding this nebula has a higher electron temperature than is expected from mere photo-ionization. This inner halo is also the region which shows the ring-like features associated with mass loss variations during the previous AGB phase. Using a numerical radiation-hydrodynamic model, Mellema and Hyung were able to show that these higher electron temperature can be understood by the existence of velocity variations within the halo gas. The required amplitudes of these variations are similar to the velocity variations found in the models constructed by Simis for mass loss during the AGB phase

2.4.3 Properties of circumstellar envelopes around AGB stars

Schöier and Olofsson (Stockholm, Sweden) performed extensive modelling of circumstellar CO radio line emission from a large sample of optically bright carbon stars. Using a detailed radiative transfer analysis, combined with an energy balance equation for the gas, they determined the properties of the circumstellar envelopes were determined. The derived mass loss rates and expansion velocities are correlated with the pulsational period and stellar luminosity, putting constraints on the mass loss rate mechanism. The observed trends supported the common sense that these winds are driven by radiation pressure on dust grains.

Schöier and Ryde (Austin, Texas) investigated the circumstellar environment of *o* Ceti (Mira) using CO observations at near-IR, far-IR and (sub)millimetre wavelengths. Their detailed modelling indicated that the gas close to the star $\sim 100\,R_*$ could be in a condition allowing light to pass through, either by being clumpy or by being distributed in radial structures which further out would develope into more smooth or shell-like structures.

2.4.4 Chemical survey of low-mass protostars

Jørgensen, Schöier and Van Dishoeck, together with Tielens (Groningen), Ceccarelli (Bordeaux, France) and Maret (CESR, Paris) initiated a large JCMT-survey for submillimeter emission lines from a sample of low-mass protostellar (class 0 and class I) sources. They established the physical structure of the envelopes around these deeply embedded objects by radiative transfer modelling of SCUBA dust continuum observations. They did not find a significant difference in the power-law structure for class 0 and I sources. The resulting temperature and density distributions formed the starting point for modelling the chemical properties of the envelopes. The first molecule investigated was CO, which they found to be heavily depleted in the class 0 objects. Surprisingly, however, the J=2–1 and 3–2 lines of $C^{18}O$ and $C^{17}O$ do not require a jump in the CO abundance at 20 K, but instead suggest evaporation at a higher temperature.

2.4.5 Does IRAS 16293-2422 have a hot core?

Schöier, Jørgensen and Van Dishoeck, completed their reanalysis of the JCMT and CSO single-dish data of the IRAS 16293-2422 class 0 protostar. Using the temperature and density profile derived from SCUBA submillimeter continuum data, they made quantitative estimates of various molecular abundances and possible changes with radius. The excitation analysis revealed that the emission from some molecular species is well reproduced by the assumption of a constant fractional abundance throughout the envelope. However, a number of notable exceptions such as H_2CO, CH_3OH, SO, SO_2 and OCS show a drastic increase in their abundances in the warm and dense inner region. This occurs at the radius where ices are expected to thermally evaporate off the grains, consistent with a hot core. However, the ices may also be liberated due to grain-grain collisions in turbulent shear zones where the outflow interacts with the envelope. Further high-resolution observations with OVRO are being pursued to address this issue. The accurate molecular abundances presented for this low-mass protostar may well serve as a reference for comparison with other objects, in particular circumstellar disks and comets.

2.4.6 Abundant SO_2 in massive protostars

Boonman, Van Dishoeck, Keane and Tielens (Groningen) have detected, for the first time, the ν_2 ro-vibrational band of gaseous SO_2 around 7.3 μm in absorption towards a sample of deeply embedded massive protostars using the Short Wavelength Spectrometer (SWS) on board the Infrared Space Observatory (ISO) (see Fig. 2.1). They derived excitation temperatures T_{ex} ~200–700 K, indicating an origin in the warm gas of the inner envelope close to the protostar. The SO_2 abundances are high ($\sim 10^{-7}$) and very similar for the different sources which suggests that the formation of SO_2 has saturated. Unfortunately, the low spectral resolution of the data ($\lambda/\Delta\lambda \sim$1500) makes it difficult to rule out an origin in shocks. Therefore, Braakman (student Amsterdam), Boonman, Van Dishoeck and Van der Tak (MPIfR, Bonn) have analyzed submillimeter spectra of sulfur-bearing species towards the same sources. Linewidths are only a few km s^{-1} and the abundance ratios SO/SO_2, SO/CS do not agree with those predicted by shock models. Thus, shocks do not appear to play a dominant role in these sources, in contrast to what is seen in Orion-KL.

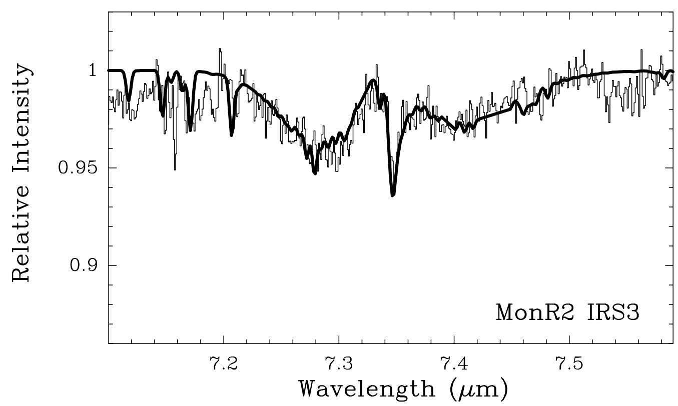

Figure 2.1: Detection of the SO_2 ν_2 ro-vibrational band toward the deeply embedded massive protostar MonR2 IRS3 with the ISO-SWS with the best-fit model overlaid (Keane, Boonman, Tielens & van Dishoeck, A&A, 2001).

2.4.7 CO_2 absorption and emission toward Orion-KL

Boonman, Van Dishoeck and Lahuis (SRON-Groningen) have analyzed spectra obtained with the ISO Short Wavelength Spectrograph (SWS) in the 13–15 μm range towards Orion-IRc2 and the shocked positions Orion Peak 1 and Peak 2. They detected in absorption the ro-vibrational bands of CO_2, HCN, and C_2H_2 towards IRc2, with a probable origin in the plateau gas. The same bands were detected in emission towards Peak 2. Towards Peak 1 they found only CO_2 inn emission. The CO_2 toward these positions probably also arises in the plateau gas, but the HCN and C_2H_2 emission appears to originate in cooler gas.

2.4.8 VLT-ISAAC survey of ices and gas around low- and intermediate mass YSO's

Pontoppidan, Van Dishoeck, Thi and Dartois (IAS, Paris), collaborating with Schutte, Tielens (Groningen) and d'Hendecourt (IAS, Paris), obtained as part of a larger program $3 - 5$ μm spectra with a resolution of up to $R = 10,000$ of low-mass, young stellar objects with the infrared spectrometer ISAAC on the VLT-ANTU. The goal of the project is to search for broad absorption features from ices (CO, H_2O, OCN^-,etc.) and for CO gas through its ro-vibrational transitions around 4.7 μm. The targeted objects are mostly protostars of low and intermediate mass, intended to be complimentary to high-mass YSO's studied with the ISO-SWS. Most class I sources have strong absorption of ices in the L- and M-band spectra, with gas-phase CO present in many cases. Surprisingly, the embedded source GSS 30 IRS1 in the Ophiuchus core shows a large number of bright ro-vibrational lines from ^{12}CO and ^{13}CO *in emission* (see Fig. 2.2). Pontoppidan and Schöier analyzed these lines and found that the emission must originate in a reservoir with $10 - 100$ $M_\odot$ of thermalized gas at a well-determined single temperature of ~ 515 K. Although not conclusive, their evidence suggests that the gas is associated with an accretion shock in the disk rather than an outflow.

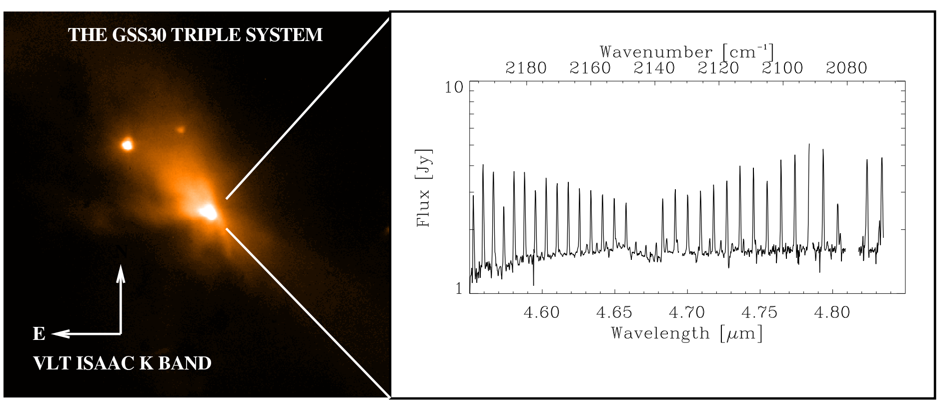

Figure 2.2: Strong gas-phase CO emission lines found toward the embedded YSO GSS30 with the VLT-ISAAC by Pontoppidan et al.

Within the context of the large VLT-ISAAC program, Thi and collaborators obtained 3–5 μm spectra of a set of intermediate mass YSOs in the southern hemisphere Vela molecular cloud. They detected, for the first time, absorption features from solid in these objects, and found strong variations in the CO gas/CO ice abundance ratio. These may be related to the thermal structure and evolution of the objects. Solid methanol was found towards one source, IRAS 08448-4343, which also showed a strong feature attributed to OCN^-. Detailed comparison with laboratory spectra of porous and non-porous ices is being carried out to investigate the structure of the ices.

2.4.9 Gas disks around young stars

Thi, Van Dishoeck and Van Zadelhoff, in collaboration with Blake and Sargent (Caltech, Pasadena), Mannings (JPL, Pasadena), Horn, Becklin (both UCLA, los Angeles), Natta (Firenze, Italy) and Van den Ancker (CfA, Harvard) continued their search for H_2 in disks surrounding 1–10 Myr old T Tauri and Herbig Ae stars using data collected by the ISO-SWS. They detected significant amounts of warm (T$\sim$100 K) H_2 in several disks, unexplained by current disk models. Also using ^{13}CO and ^{12}CO J=3–2 data gathered with the JCMT, they calculated total gas masses which turned out to be lower than those inferred from the dust by more than an order of magnitude – at least under the assumption of a standard gas-to-dust ratio of 100. When the disk starts to dissipate after 10 Myrs, it becomes warmer and H_2 may probe the entire gas mass. The gas-to-dust mass ratio for objects older than 10 Myrs is indeed close to the typical value of 100. This suggests that in disks, the gas does not disappear as rapidly as previously thought. This is important, as it considerably lengthens the time available for the fomation of giant planets.

Kamp, Van Zadelhoff and Van Dishoeck calculated the line emission from C, C^+ and CO for debris disks around the young stars β Pictoris and Vega. They determined the abunances of the different species from dissociation by stellar and interstellar UV photons and self-consistently calculated the gas temperature using the detailed heating and cooling balance. They recognized that the inclusion of collisions with H_2, H and electrons was needed to properly describe the level populations of these species. Predictions for future facilities (APEX, Herschel, ALMA) are being made.

2.4.10 Water masers around late-type stars

Vlemmings, Diamond (Jodrell Bank, UK) and Van Langevelde (ASTRON Dwingeloo) concluded their analysis of the first detections of circularly polarized circumstellar water masers in a sample of late-type stars. They determined magnetic field strengths using both LTE and non-LTE models for the 22GHz water maser transition including all hyperfine components. They found the fields in the water maser region of supergiant stars (S Per, VY CMA and NML Cyg) to be of the order of ≈ 250 mG, while the fields around the Mira variable star U Her were $\approx$ 1 G. Vlemmings also continued his VLBI monitoring of the position of the stellar image amplified by the 1667 MHz circumstellar OH maser of the Mira variable star U Her.

2.5 Interstellar Medium

Haverkorn, Katgert and De Bruyn (ASTRON Dwingeloo) pursued their multifrequency polarimetry study of the Galactic synchrotron background in the 350 MHz frequency range. They analyzed the observations of two fields, located at intermediate to high galactic latitudes in the second galactic quadrant. These fields had sizes of about $8^o \times 8^o$ and an instrumental resolution of $4'$. A map of polarized intensity at 349 MHz in one of these fields is shown in Fig. 2.3. A third field observed by them was reduced, but not yet fully analyzed. All three fields, however, showed abundant small-scale structure both in polarized intensity and in polarization angle *without any measurable small-scale structure in total intensity*. The structure in polarized intensity must thus be wholly due to Faraday rotation combined with depolarization mechanisms. As the observations were made in 5 to 8 frequency bands, rotation measures can be determined reliably, yielding information on the electron-density-weighted magnetic field in the warm interstellar gas.

Haverkorn, Katgert and Heitsch (Boulder, Colorado) constructed power-spectra, in order to further quantify polarized intensity and rotation measure structures on scales between an arcminute and several degrees. These observational power-spectra are now being compared to power-spectra predicted from MHD simulations of the warm ISM in an attempt to constrain the parameters in those simulations from the observations.

2.6 Galactic Structure

2.6.1 SiO maser emission from AGB stars in the inner Galaxy

Messineo, Habing, Menten (MPIfR Bonn, BRD), Omont (IAP, Paris) and Sjouwerman (NRAO, Socorro) selected sources from the ISOGAL and MSX catalogues of infrared stars to search for 86 GHz SiO ($v = 1$) maser emission from AGB stars in the inner Galaxy. Their observations with the IRAM 30 m telescope near Granada (Spain) yielded a high detection rate (61 %), which demonstrated that the number of stellar line-of-sight velocities can be enlarged sufficiently to bring the ultimate goal of the project within reach. This is a description of the stellar kinematics in the inner Galaxy from which a well-constrained dynamical model of the triaxial mass distribution (the “bar”) will be derived.

2.6.2 Tidal Streams in the Galaxy

Brown, Velázquez and Aguilar (both UNAM Ensenada, Mexico) further investigated the possibilities of using GAIA astrometric and radial velocity data for detecting

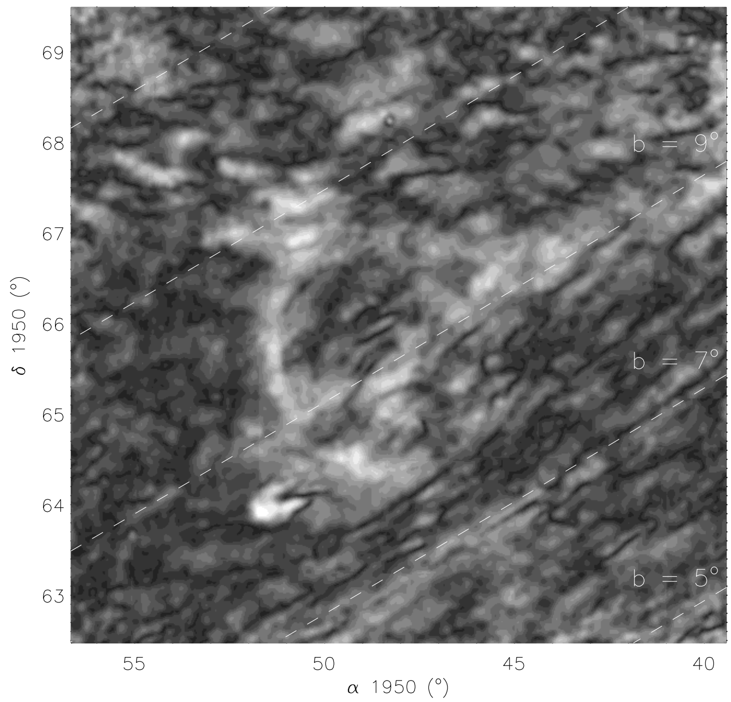

Figure 2.3: Polarized intensity at 349 MHz for a field centered on $(\alpha, \delta) = (48^{o}, 66^{o})$ at $4'$ resolution. Overplotted are lines of constant Galactic latitude. The ring structure is also visible in polarization angle, but no structure is present in total intensity. Note the depolarization canals in the south west, running along Galactic latitude.

debris from tidally disrupted dwarf galaxy satellites in the halo of our Galaxy. The principle aim of their study was to find out how well such tidal streams can be identified in the GAIA catalogue in which the vast majority of stars will belong to the Galaxy rather than to a stream. To this end, they carried out detailed N-body simulations of satellite galaxies being disrupted in the Mily Way potential. Galactic stars were simulated using a Monte Carlo model of the Galaxy, including both the positions and kinematics of the stars. This model was converted into simulated GAIA data, taking into account the details of the astrometric and radial velocity errors as a function of apparent magnitude, colour and sky position of the stars. After excluding the strip of sky located between $\ell = \pm 90°$ and $b = \pm 5°$ where extinction impedes tidal debris studies, Brown and coworkers were able to construct a simulated GAIA catalogue containing an entry for every star expected in a survey out to $V = 20$ (i.e. 3.2×10^8 stars!). They have now combined their simulated Galactic and satellite data in a consistent manner, and have started to concentrate on actual methods of identifying the tidal streams in the data base.

2.6.3 An all-sky catalog of Compact High-Velocity Clouds

De Heij, Braun (ASTRON-Dwingeloo) and Burton continued their investigations of the class of compact, isolated, high–velocity H I clouds (CHVCs) which are sharply bounded in angular extent with no kinematic or spatial connection to other H I features down to a limiting column density of 1.5×10^{18} cm^{-2}. They developed an automated search algorithm and applied it to the Leiden/Dwingeloo Survey north of $\delta = -28°$ and, together with Putman (Colorado) and others from the HIPASS team, to the Parkes HIPASS data south of $\delta = 0^o$, thus producing an all–sky catalog numbering 246 CHVCs. They argued that these objects are more likely to represent a single phenomenon in a similar evolutionary state than would a sample which included any of the major HVC complexes. Five principal observables were identified for the CHVC population: (1) the spatial deployment of the objects on the sky, (2) the kinematic distribution, (3) the number distribution of observed H I column densities, (4) the number distribution of angular sizes, and (5) the number distribution of line widths. The spatial and kinematic deployments of the ensemble of CHVCs contain various clues regarding their characteristic distance. These clues are not compatible with a location of the ensemble within the Galaxy proper. The deployments resemble in several regards those of the Local Group galaxies.

2.6.4 CHVC's: Local Group or Milky Way halo objects?

De Heij, Braun and Burton specified a model testing the hypothesis that the CHVCs are a Local Group population. The agreement of the model with the data was judged by extracting the observables from simulations, in a manner consistent with the sensitivities of the observations and explicitly taking account of Galactic obscuration. They showed that models in which the CHVCs are the H I counterparts of dark–matter halos evolving in the Local Group potential provide a good match to the observables, if account is taken of tidal and ram–pressure disruption, the consequences of obscuration due to Galactic H I and of differing sensitivities and selection effects pertaining to the surveys. Although the models predict a substantial clustering of CHVCs near M31 and the Local Group barycenter, the sensitivity of the Leiden Dwingeloo Survey data is not high enough to have detected most of these objects. Specific predictions were made which will be confronted when more sensitive data are available. The currently available sensitivity of the combined LDS and HIPASS material is insufficient to discriminate between a model in which the CHVCs are distributed throughout the Local Group and one in which the objects are scattered throughout an extended Galactic halo, at characteristic distances of order 100 kpc.

Braun (ASTRON Dwingeloo) and Burton also considered the status of H I CHVC searches in nearby galaxy groups, and in the far reaches of the Local Group. They concluded that even the most sensitive large–area surveys are still too limited in sensitivity to sample more than the extreme upper–mass end of the implied CHVC mass distribution. They concluded, however, that detection limits an order of magnitude deeper will soon be available thus enabling either direct study of the CHVC objects beyond and throughout the Local Group, or definitively rule out their existence.

Braun (ASTRON Dwingeloo), Burton, Chengalur (Pune, India), and De Heij studied a representative sample of CHVCs with high angular resolution (sub-arcmin) using the WSRT and with high $N_{\rm HI}$ sensitivity ($< 10^{17}$ cm^{-2}) using the Arecibo telescope. The picture that emerged was that of a nested morphology of CNM cores shielded by WNM cocoons, surrounded by a Warm Ionized Medium halo, and stable in the presence of an ionizing radiation field of the sort expected in the Local Group environment. The cores, at characteristic temperatures of about 100 K, contribute typically about 40% of the H I flux, while covering about 15% of the surface of the CHVC. The WNM temperatures were measured to be about 8000 K. These observations lead to indirect constraints on the distances, in the range of several hundred kpc.

2.7 Structure and Dynamics of Galaxies

2.7.1 Dynamics of ω Centauri

Kouwenhoven started, in collaboration with Verolme and de Zeeuw, with the construction of an axisymmetric three-integral dynamical model for ω Centauri (NGC 5139), by adapting software developed for the modeling on integrated light measurements of elliptical galaxies. He has finished a self-consistent model that reproduces the observed radial velocity measurements. Extension of the machinery to include the proper motion data is in progress. The aim is to obtain accurate values for the distance, the inclination and the mass-to-light ratio of this globular cluster.

2.7.2 CO maps of GMC 37 in the Large Magellanic Cloud

The eighth paper containing results of the ESO-SEST Key Programme on CO in the Magellanic clouds, conducted by a consortium of observers led by Israel and Johansson (Onsala, Sweden), was accepted for publication. This installment dealt with a giant molecular cloud complex (no. 37 in the list by Cohen and co-workers) at the western edge of the LMC, west of 30 Doradus. This particular complex turned out to consist of two molecular cloud groups, the major one of which is associated with Henize HII regions N72 and N167, the minor one associated with N169. Indidiviual clouds were found to have dimensions of 20 – 40 pc, and CO luminosities covering the large range of 700 – 50000 K km/s pc^2. Peak CO line opacities were found to be much lower than those generally derived for Galactic CO clouds. A comparison with the low-resultion, large area maps made by Cohen and coworkers showed that there is little diffuse CO emission outside the discrete cloud groups.

2.7.3 A Large Population of Very Small Grains in NGC 1569

Israel and Stil obtain excellent SCUBA images of the bright and compact post-starburst dwarf galaxy NGC1569 at 450 and 850 μm. In a collaboration with Lisenfeld and Sievers (IRAM, Granada), they combined their results with those obtained at 1.2 mm with the IRAM 30 m and with published data at 12, 25, 60 and 100 μm (see Fig. 2.4).

They fitted the dust grain population model of Désert and collaborators to the resulting midinfrared-to-millimeter spectrum of the galaxy. They found that the contribution of polyaromatic hydrocarbons (PAH's) to the emission from NGC 1569 is wholly negligible. Interestingly, attempts to fit a population consisting predominantly of large-grains, i.e. following traditional lines of interpretation, only produced physically implausible results. Succesful fits required not only a combination of large dust particles and very small grains, both exposed to a strong radiation field, but also a considerable enhancement of the number of very small grains relative to that of large grains. In their interpretation, this unusual dust population is the consequence of stronger-than-normal destruction of large grains caused by shocks in the very turbulent interstellar medium of NGC 1569 (see Fig. 2.5)..

They also found that the distributions of both the dust and the molecular gas reach a *maximum* very close to the peak of radio continuum emission, at a *minimum* in the HI gas distribution. By comparing the HI, CO and dust emission distributions, and assuming that in a small galaxy such as NGC 1569 the gas-to-dust mass ratio is the same everywhere, they arrived at an estimated ratio of molecular hydrogen column density to integrated CO intensity – the so-calles X factor – of about 25 – 30 times the local Galactic value. The actual gas-to-dust ratio was found to be in the range of 1500 – 3000, which is about an order of magnitude higher than in the Solar Neighbourhood.

2.7.4 Superstarclusters in the merger NGC4038-4039

In collaboration with a team of the Max-Planck-Institut für extraterrestrische Physik in Garching (BRD) consisting of Lehnert, Thatte, Tacconi-Garman and Genzel, Men-

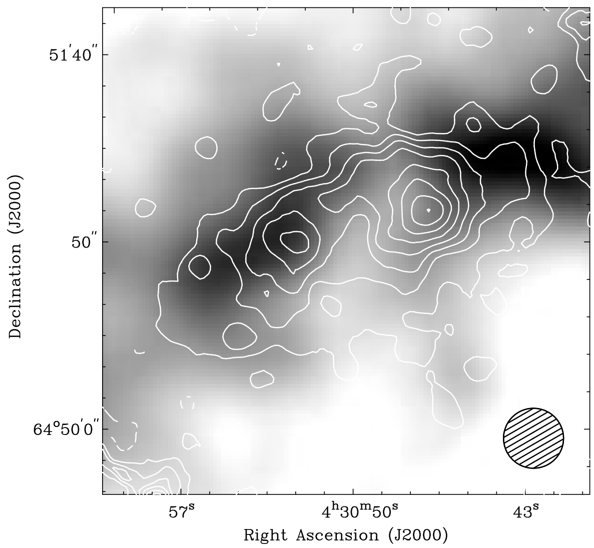

Figure 2.4: Distribution of dust, represented by 850μm intensity contours measured with SCUBA, follows the distribtion of neutral hydrogen gas, represented by HI column density gray scales, in an overall sense, but not in detail. Contours are linear in steps of 8 mJy/beam, and grayscales range linearly from 1×10^{21} to 7×10^{21} cm^{-2} (from Lisenfeld, Israel, Stil and Sievers, A&A, 2002).

gel made use of K-band spectroscopy and broad-band colours to study a sample of four infrared-luminous super-starclusters as well as the two nuclei in the galaxy merger NGC 4038-4039 (the "Antennae"). She found that the clusters suffer from heavy extinction. They are all young although their ages show significant spread from 4 to 13 Myr. The starbursts in the nuclei are much older, typically 65 Myr. The cluster masses are of the order of $10^6\ M_\odot$, which is comparable to the mass of a Galactic globular cluster.

Mengel, Lehnert, Thatte and Genzel (MPE Garching, BRD) also continued their near-infrared investigation of star formation in nearby interacting galaxies. One of their main results is that some of the star clusters formed in mergers have the masses, sizes, concentrations and IMFs to survive for tens of Gyrs and to evolve into globular clusters, in agreement with the hierarchical merger scenario. However, the IMF seems to vary between different clusters, and some may host too few low mass stars to survive for more than a Gyr.

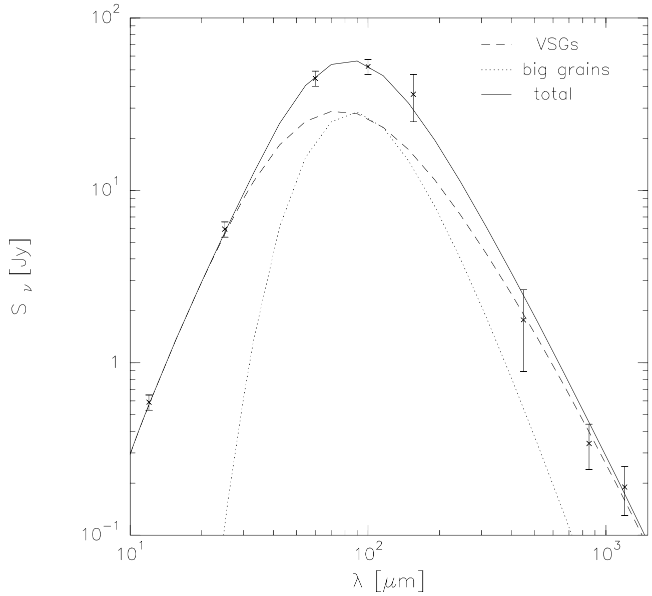

Figure 2.5: The mid-infrared to millemeter spectrum of NGC 1569 compared to the dust model by Desert and coworkers, assuming a radiation field 60 times that of the Solar Neighbourhood, no PAH's and an increase of Very Small Grain with respect to Big Grains by a factor of seven over local Solar Neighbourhood values. (from Lisenfeld et al., A&A, 2002).

2.7.5 Hidden starbursts and Arp 220

Van der Werf analyzed the obscured starburst in the ultraluminous infrared galaxy Arp 220. It is often argued that the peculiar properties of the starburst in Arp 220 are solely due to foreground extinction. Using new Brγ spectroscopy, Van der Werf showed that this conclusion is not tenable. Instead, the starburst takes place in compact and ultracompact HII regions, where most of the Lyman continuum radiation is absorbed by dust, not by hydrogen. As a result, all the usual starburst tracers (recombination lines, fine-structure lines, free-free emission) are not extincted, but *quenched*. A quantitative analysis supports this conclusion. This calls for caution in interpreting starburst galaxy data without a proper inclusion of Lyman continuum absorption by dust, especially for the more extreme cases such as the ultraluminous infrared galaxies.

Jansen, Franx, and Fabricant analysed a set of integrated spectra of nearby galaxies to study the applicability of the [OII] 3727 Å emission line as a tracer of star formation. They found that the ratio of [OII]/Hα fluxes vary by a factor of 7 as a function of magnitude. The variation is caused by changes in metallicity and absorption by dust. The work implies that the [OII] line is a very uncertain indicator of star formation, and shows that Hβ is more accurate.

2.7.6 Neutral Atomic Carbon in Centers of Galaxies

Israel and Baas, using the JCMT on Mauna Kea at a frequency of 492 GHz, completed a massive survey of the emission from the centers of 15 spiral galaxies in the $^3P_1 - ^3P_0$ fine-structure transition of neutral carbon. Their sample covered the full range from quiescent to starburst to active galaxy centers. They compared the intensities of neutral carbon to those of the J=2-1 ^{13}CO and J=4-3 ^{12}CO transitions and found that most galaxy centers emit more strongly in [CI] than in ^{13}CO, which is just the opposite from the situation in Galactic molecular cloud regions. They also found that [CI] intensities are only little lower than J=4-3 ^{12}CO intensities, again rather different from the situation in Galactic sources. The ratio of [CI] to ^{13}CO intensity increases with the central [CI] luminosity of a galaxy; it is lowest for quiescent and mild starburst centers, and highest for strong starburst centers and active nuclei. This ratio thus appears to be an unexpectedly sensititive diagnostic tool for determining the nature of galaxy centers (see Fig. 2.6).

Israel and Baas could show that most observed galaxy centers have neutral carbon abundances close to, or exceeding, carbon monoxide abundances, rather independent from the assumed model gas parameters. Model calculations also suggested that the emission from neutral carbon and carbon monoxide originated in a warm and dense gas rather than a hot and tenuous, or a cold and very dense gas. A final comparison of the [CI] survey data with [CII] line and far-infrared continuum data from the literature confirmed that a significant fraction of the observed emission must have originated in a medium-density gas ($n = 10^3 - 10^4$ cm^{-3}) subjected to radiation fields of various strengths.

2.7.7 Dynamical modeling and central black hole masses

Cappellari, Verolme, Verdoes Kleijn, Franx and De Zeeuw completed the construction of dynamical models for the stellar and gas kinematics of the elliptical galaxy NGC1459, as obtained from an HST/STIS spectrum and ground-based long-slit spectra. They estimated the mass in the counter-rotating stellar disk, and found that the mass of the supermassive black hole (BH) at the center of this galaxy, as derived from gaseous measurements, is an *order of magnitude lower* than the BH mass obtained by modeling the groundbased and HST stellar kinematics. This is one of the first case in which a BH mass was determined independently with observations of both stellar and gas kinematics. The BH mass discrepancy indicates the urgent need for further work before the correlation and the scatter between the BH mass and other galaxy global parameters can be interpreted reliably.

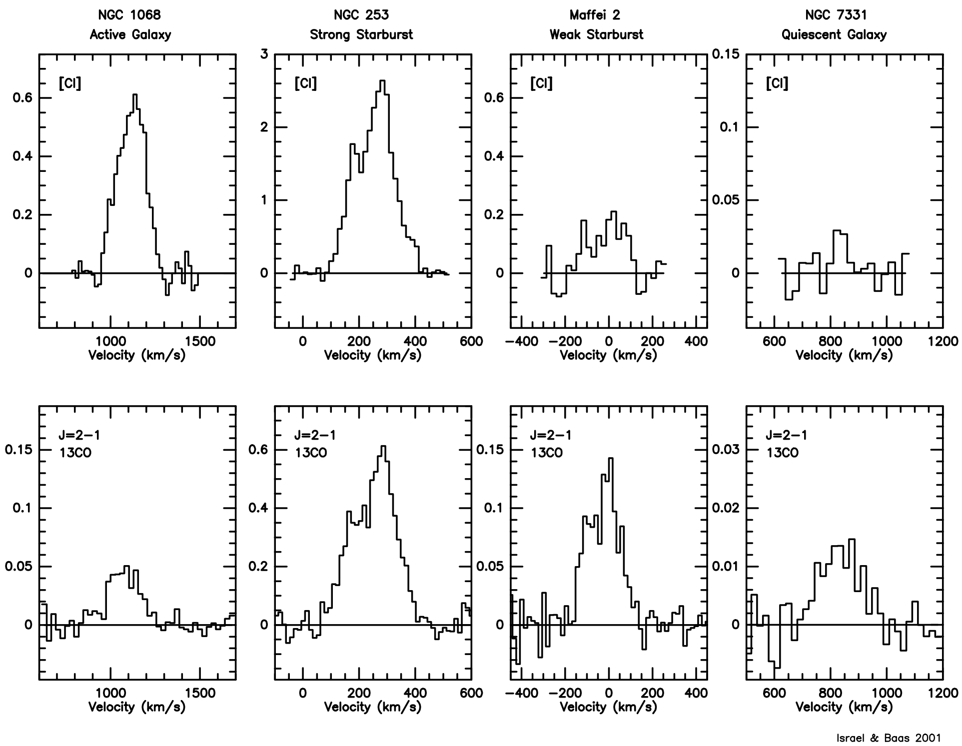

Figure 2.6: Comparison of $^3P_3P_0$ neutral carbon (top row) and ^{13}CO (bottom row) emission from centers of galaxies. Central emission profiles obtainbed with the JCMT, are shown for various classes of galaxies, with nuclear activity decreasing towards the right. Note that [CI] intensities increase significantly with respect to ^{13}CO intensities with increasing nuclear activity.

Verdoes Kleijn, De Zeeuw, Noel-Storr, Carollo, Van Gorkom (all three Columbia University New York), Baum and Van der Marel (STScI Baltimore) continued their analysis of an HST/STIS spectroscopic follow-up survey of the nuclear emission-gas for a complete sample of UGC FR I radio galaxies. These observations were primarily aimed at determining central black hole masses and constraining the ionization mechanism of the gas. Verdoes Kleijn and collaborators determined an upper-limit to the central black hole (BH) mass for one case, NGC 4335. The inferred mass upper-limit falls below the BH mass central velocity dispersion relation. This suggests that either the relation is not as tight as previously thought or the commonly used gas dynamical models are not adequate for a reliable BH mass determination.

2.7.8 Dynamical modeling of elliptical galaxies

Cappellari developed an efficient and robust algorithm for the Multi-Gaussian Expansion (MGE) fit of galaxy images, which provides an accurate description of the observed light distribution. These MGE models are used to compute the density distribution and gravitational potential of the galaxies, required for dynamical modeling.

Verolme and De Zeeuw completed their work on the use of Schwarzschild's orbit superposition method for building two-integral dynamical models for early-type galaxies. A number of properties of these systems can be calculated by analytic means, so that the numerical method is very efficient. Tests on theoretical models demonstrated the reliability of Schwarzschild's method. Verolme, Cappellari and de Zeeuw together with van der Marel (STScI) and the SAURON team used Schwarzschild's method to construct three-integral dynamical models of the nearby elliptical M32 (see Fig. 2.7). It is the first study in which two-dimensional kinematics obtained with the integral-field spectrograph SAURON, are used to constrain numerical models. By combining the SAURON data with observations from HST, it is possible to measure not only the mass-to-light ratio and the central black hole mass of M32, but also, for the first time, the inclination, and hence the intrinsic shape. Applications to other galaxies are in progress, as is an extension of the Schwarzschild software to triaxial models.

Van de Ven, Hunter (Florida State), Evans (Oxford, UK), Verolme and De Zeeuw found an analytical solution of the Jeans equations for triaxial Stäckel models. The basic equations form a set of three highly-symmetric first-order partial differential equations in three variables. They were derived over 40 years ago by Lynden–Bell, and while solutions were known for two-dimensional limiting cases, the general case had resisted solution by standard methods. Application of the so-called singular solution superposition method not only allowed an elegant rederivation of the two-dimensional solutions, but, remarkably, provided the general solution in explicit form. Given a density and Stäckel potential of a stationary triaxial galaxy, this solution yields the intrinsic mean squared velocities. Comparison with observed velocity and velocity dispersion maps will provide significant constraints on the intrinsic structure of triaxial galaxies.

Jalali (Institute for Advanced Studies, Iran) and De Zeeuw continued their investigation of the so-called curvature condition for the existence of self-consistent scale-free galaxy models, originally developed by Zhao for elongated disks. They completed the re-analysis of these disks, and derived a number of new potential-density pairs. An extension to three-dimensional triaxial models is in progress.

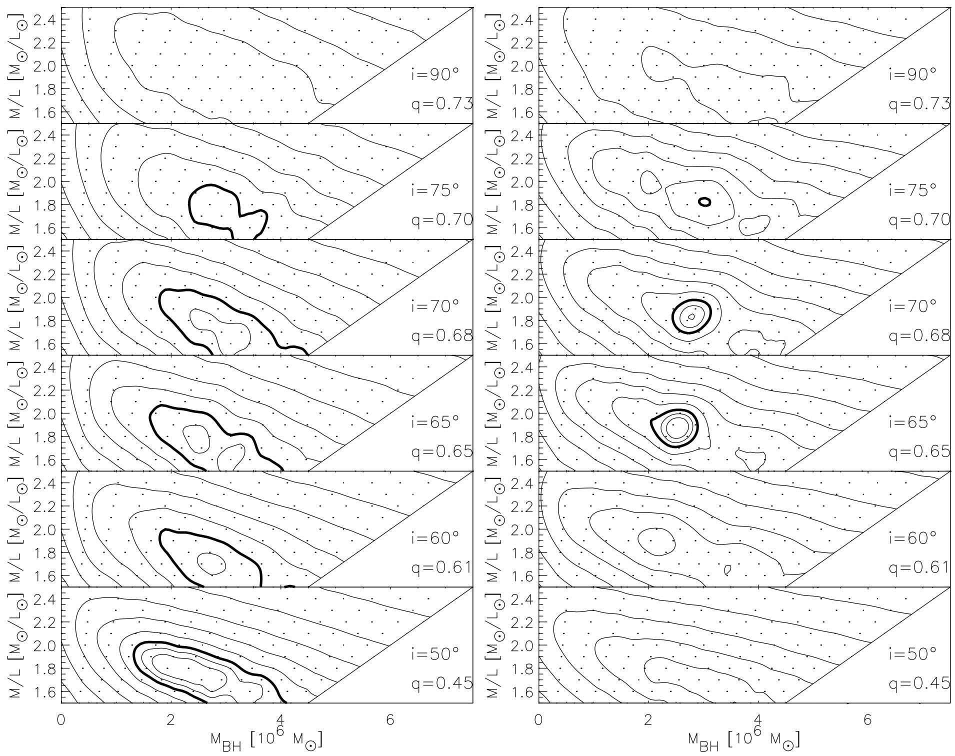

Figure 2.7: The crucial quality of two-dimensional spectroscopic observations for the determination of the intrinsic properties and dark matter content of early-type galaxies is illustrated by model results displaying the goodness-of-fit parameter $\Delta\chi^2$ as a function of the central black hole mass $M_\bullet$ and stellar mass-to-light ratio M/L for three-integral axisymmetric Schwarzschild models of the nearby elliptical M32. Different panels correspond to different inclinations, $i = 90°$ corresponding to edge-on viewing. Panels on the left show models that are constrained by HST `STIS` data and observations in four 'pseudo-slits', extracted from the `SAURON` data along the major and minor axis and at 45° and 135° from the major axis. Thick contours indicate formal 3σ levels. Panels on the right show models constrained by *all* `SAURON` and `STIS` measurements. Clearly, the use of the full two-dimensional data set on the right has resulted in a much narrower 3σ region than the use of the limited data set on the left, indicating that the best-fitting model parameters are constrained much more tightly. The allowed range of parameters is quite small en the orientation of M32 with respect to the line-of-sight is well-constrained at $i = 70°$.

2.7.9 Properties of early-type galaxies

Van Dokkum, Franx, and collaborators measured the evolution of the Mass-to-Light ratio (M/L) for early-type galaxies in the field. They found that the M/L ratio of these field galaxies evolves similar to that of early-type galaxies in clusters: out to $z = 0.55$ $\Delta lnM/L_B = (-1.35 \pm 0.35)z$. The Fundamental Plane of the galaxies is well defined. They found a statistically insignificant, but intriguing, difference between cluster galaxies and field galaxies: at $z = 0.43$, field early-type galaxies are younger than their cluster counterparts by 21 ± 13 %. These results are inconsistent with predictions from semi-analytical models, which predict very large differences between field early-type galaxies and cluster early-type galaxies.

Kelson (Carnegie, Washington D.C), Franx, and collaborators also measured the evolution of linestrenghts of early-type galaxies in clusters out to $z = 0.83$. They found slow evolution in the average absorption line strength of Hδ and Hγ. The evolution is consistent with high formation redshifts for early-type galaxies in clusters. Ignoring the effects of morphological evolution, the results imply a formation redshift higher than 2.5. The evolution of the mass-to-light ratio is consistent with the evolution of the linestrengths.

Krajnović and Jaffe investigated a sample of early-type galaxies which were surveyed with the VLA at 3.6 cm to a sensitivity of 100 μJy. They constructed a Radio Luminosity Function (RLF) of these galaxies to $\sim 10^{19}$ W Hz^{-1} and found that $\sim 50\%$ of these galaxies have AGNs at this level. The space density of these AGNs equals that of starburst galaxies at this luminosity. Several dust-free galaxies have low-luminosity radio cores, and their RLF is not significantly less than that of the dusty galaxies.

2.8 Active galaxies and quasars

2.8.1 The origin of AGN core emissions

Verdoes Kleijn, Baum and O'Dea (both STScI Baltimore) completed a study of the origin and beaming of AGN core emissions in a sample of UGC FR I radio galaxies and in a comparison sample of Low-Ionization Narrow Emission-Line Region (LINER) galaxies. The AGN radio and optical continuum and line core emission in both classes of galaxies display similar correlations and are possibly produced by jets in both cases.

2.8.2 Towards interferometric observations of nearby Active Galactic Nuclei

The standard model for Active Galactic Nuclei (AGNs) assumes that the central engine (a hot accretion disk around a massive black hole) is encapsulated by a dusty torus. Heijligers, Röttgering and Meisenheimer (Heidelberg) worked on a programme aimed at observing centers of nearby AGN with MIDI, the 10μm interferometric instrument to be used with the VLT Interferometer. Such observations could provide direct observational evidence for the existence of these tori and could distinguish between models predicting tori with sizes different by up to a factor of 20. A prerequisite is the determination of good positions and fluxes at 10μm of the MIDI target list. Heijligers and coworkers used TIMMI2 at the 3.6-m ESO telescope and showed that the majority of the targets are good MIDI targets, having bright and unresolved nuclei on scales of $\sim 0.''5$.

2.9 Clusters and cluster galaxies

2.9.1 Galaxy group masses from weak lensing

Hoekstra (CITA Toronto, Canada), Franx, Kuijken and the CNOC2 collaboration used weak lensing to measure the mass distribution of galaxy groups. With the William Herschel Telesope on La Palma (Spain) they imaged fields for which CNOC2 had obtained redshifts out to $z = 0.55$. By adding together the signal of all the groups in the fields, they found a clear signal. This is the first weak lensing measurement of galaxy group mass. The strength of the signal is well fit by a singular isothermal sphere with an Einstein radius of 0.72 ± 0.29 arcsec, corresponding to a velocity dispersion of 274±54 km/s. The average M/L ratio of 254±110 h M/L_{solar} implies an average matter density of 0.19±0.10. This is the first weak lensing measurement of the masses of groups (see Fig. 2.8).

2.9.2 Evolution of early-type galaxies

Van Dokkum and Franx analyzed the evolution of early-type galaxies in clusters and the field. It is usually assumed that the evolution of these galaxies is very simple, but on the other hand evidence has accumulated which shows that these galaxies were transformed from later types quite recently. Such morphological transformations have a strong effect on the interpretation of the data on distant galaxies, as the set of early-type galaxies at high redshift is a special subset of all progenitors of early-type galaxies at low redshift: they are preferentially the older ones. As a result the apparent evolution of early-type galaxies is artificially slow. Van Dokkum and Franx showed that the small scatter in the Fundamental Plane, and color magnitude relation at low redshift puts a strong constraint on the bias that is caused by this morphological evolution, and as a result the corrections on the previous estimates of the formation redshifts are not very large. The best-fit mean formation redshift of early-type galaxies in clusters is 2 ± 0.3 for models with $\Omega_M = 0.3$ and $\Omega_\Lambda = 0.7$.

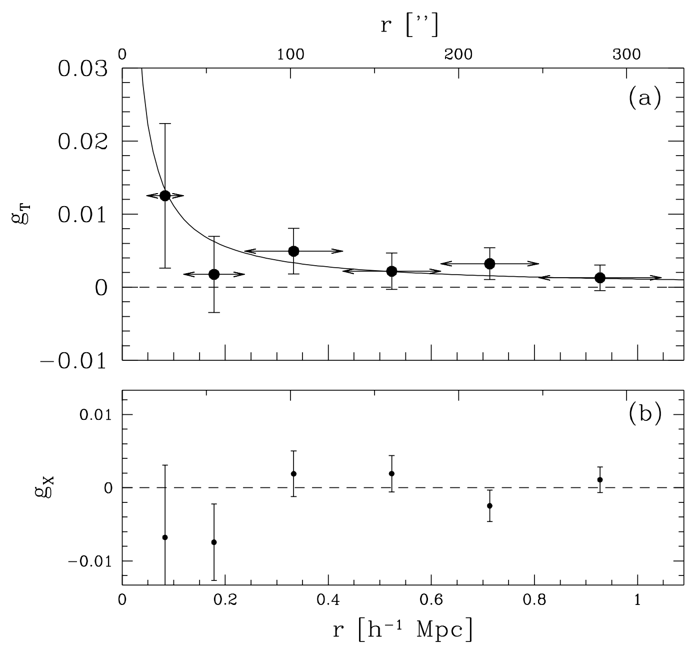

Figure 2.8: The weak lensing signal from groups, measured by Hoekstra, Franx, Kuijken et al. The top panel shows the average signal measured from 50 groups. The drawn curves is the best fitting isothermal model, with a velocity dispersion of 274 ± 54 km s^{-1}. The bottom curve shows the signal after all the sources have been rotated by 45 degrees. It should be zero.

Van de Ven extended the analysis of the Fundamental Plane (FP) of lensing galaxies with redshifts up to $z \sim 1$. In this project, together with Van Dokkum and Franx, the FP, a tight relation between structural parameters and the velocity dispersion, is being used as a probe of 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 preliminary results show that the field galaxies have a larger spread in the stellar population ages than the cluster galaxies. Some of them follow the young-age prediction from the hierarchical models, but about half of the lens galaxies have the same old stellar population as cluster galaxies.

2.9.3 Warm H_2 in central cluster galaxy cooling flows

Wilman, Edge (Durham, UK), Fabian, Crawford, Allen and Johnstone (all Cambridge, UK) completed the analysis of H- and K-band UKIRT spectra of a large sample of optically line-luminous central cluster galaxies. The majority exhibit rovibrational H_2 emission at the level of one to ten per cent of the Hα flux, together with H recombination and [FeII] lines. This represents a three-fold increase in the number of central cluster galaxies with H_2 detections. They proposed a scenario for the origin and excitation of this warm, dense H_2, invoking a symbiosis of strong shocks and hot stellar UV continua.

2.9.4 Effects of cluster environment on galaxies

Thomas, Katgert, Hartendorp and Biviano (Trieste, Italy) continued their analysis of the extent in which galaxies are influenced by the cluster environments measured in the ESO Nearby Abell Cluster Survey (ENACS), To this end, they combined the ENACS spectroscopy with the results of a long-term imaging programme on the Dutch telescope at La Silla. The latter has provided morphological types for close to 2300 galaxies, while for 1200 of these the photometric data allowed a reliable decomposition of the brightness profile (with multi-Gaussian expansions) into a bulge and a disk component.

They compared morphological types derived from the CCD-imaging with the galaxy types estimated previously from the ENACS spectra (through a PCA/ANN analysis) by De Theije and Katgert. This allowed a recalibration of the galaxy types derived from the spectrum alone, which yields a sample of more than 3000 galaxies with consistently derived galaxy types, either from imaging or spectrum alone, or from a combination of the two. These classifications were shown to be fully consistent with, and of the same quality as, the best classifications from the literature. For each of the morphological galaxy classes, the average spectrum was derived, separately for galaxies with and without emission lines in the spectrum. It appeared that the average difference between the continua of the spectra of galaxies with and without emission lines does not depend on galaxy type, at least to first order.

Where possible, they studied the morphology-radius and morphology-density relations. The classes of early and late spirals could be (and were) distinguished, unlike previous studies. They could also distinguish other classes such as the brightest ($M_R < -22$) ellipticals, the other ellipticals, and the S0 galaxies. The brightest ellipticals are very centrally concentrated (and also have a very small velocity dispersion). The radial distributions of the other ellipticals, the S0 galaxies and the early spirals appears to be indistinguishable, while the late spirals avoid the central region and have a much wider distribution than any of the other classes.

They studied the dependence of morphological mix on density using two estimates of projected density: one based on the projected distance to the 10-th nearest neighbour and another on the distance of the nearest neighbour. With respect to the first measure of projected density, only late spirals (and the brightest ellipticals) stand out, with the other three classes indistinguishable. The reason for that turns out to be the strong correlation between the density based on the 10th nearest neighbour and projected radius. However, if the density based on the nearest neighbour was used, the ellipticals, S0 galaxies and early spirals appeared ordered in decreasing local density (on average), and the differences between them were significant at more than 95%. This can be put in other words: whereas the segregation of late spirals and brightest ellipticals is driven by global conditions, that of the other three classes appears to be driven by local conditions. The average local density around S0 galaxies is higher than that around early spirals. This is supporting evidence for current models of the transformation of spirals into S0 galaxies. However, the analysis of the bulge- and disk luminosities of S0 galaxies and early and late spirals makes it very unlikely that the late spirals are also involved in the transformation process.

2.10 High-redshift objects and large-scale structure

2.10.1 FIRES: MS1054-03 Field

Förster Schreiber, Labbé and Franx made significant progress on the Faint InfraRed Extragalactic Survey (FIRES) of the field around the distant cluster MS1054-03. FIRES is an ultradeep near-infrared survey of two selected fields, including the Hubble Deep Field South in addition to the MS1054-03 field. Over the year, the observations of the MS1054-03 field have been completed. These amount to a total of 78 hours integration with ISAAC at the Very Large Telescope (VLT), split equally between the J_s, H, and K_s bands and over four pointings for a $5\ \mathrm{arcmin}^2$ mosaic, providing the best combination of field area and depth achieved so far at near-infrared wavelengths from the ground. The data reduction is nearing completion; first results show an excellent quality with $0.45''$ resolution. Together with ground-based and existing space-based optical imaging (from the VLT/FORS1 and HST/WFPC2 instruments), fundamental issues of galaxy evolution can be addressed. Analysis of the data set is underway, and the reduced data and source catalogues will be made public as soon as possible.

2.10.2 Ultradeep ISAAC near-IR observations of Hubble Deep Field South

Rudnick, Franx, Labbé, analysed infrared VLT imaging of the Hubble Deep Field South, deriving photometric redshifts as well as the luminosities in the redshifted optical U, B and V bands. They found an excess of bright galaxies with $L_B > 5 \times 10^{10} h^{-2} L_{solar,B}$: local B-band luminosity functions predict 0.1 galaxies in the redshift range $2 \leq z \leq 3.5$, but they found 9. Luminosity evolution in the B-band by a factor of 2.4-3.2 can explain the discrepancy. Confirmation of the photometric redshifts is, however, desirable to verify these results (see Fig. 2.9).

Labbé and Franx fully reduced and analyzed the ultradeep near-infrared imaging of the Hubble Deep Field South: the first of two fields in the Faint InfraRed Extragalactic Survey (FIRES) imaged with ISAAC on the VLT. The data were collected in about 100 hours under the best seeing conditions; they constitute the deepest ground-based infrared observations to date, and form the deepest K_s-band in any field (see front cover). The depth of the current survey allowed determination of the spectral energy distributions of high-redshift galaxies with unprecendented accuracy, essential to a proper understanding of their stellar populations. Labbé and Franx constructed a K_s-limited multicolor catalog, selecting high-z galaxies from their rest-frame optical light. They found a wide variety of morphologies: some galaxies are large in the rest-frame optical, where the rest-frame optical light is more concentrated compared to the rest-frame UV light, as in nearby normal spirals. They also found a new population of optically faint galaxies at redshifts $2 < z_{phot} < 4$ with very red near-infrared colors ($J_s - K_s > 2.3$), that would be missed completely by the standard U-dropout criteria. These galaxies are generally compact and many show pronounced breaks in the observed near-infrared, identified as the Balmer/4000 Å break. They may contribute substantially to the total stellar mass density at redshifts $z \sim 3$. Overall, the results demonstrated the necessity of extending optical observations to near-infrared wavelengths for a more complete census of the early universe.

2.10.3 Shock-cloud interaction and jet-induced star-formation

Mellema, Kurk and Röttgering conducted a numerical study of jet-induced star-formation. This scenario is commonly invoked to explain the alignment effect in high redshift radio galaxies. Using two-dimensional numerical hydrodynamic modeling, Mellema and coworkers studied the evolution of clouds subjected to the passage of a radio jet cocoon. Most of the simulations done for this project were run on TERAS, the SGI Origen 3800 machine operated by SARA on behalf of the organisation for National Computer Facilities (ONF). They found that the clouds get shocked but cool very efficiently. By consequence, they collapse into an ensem-

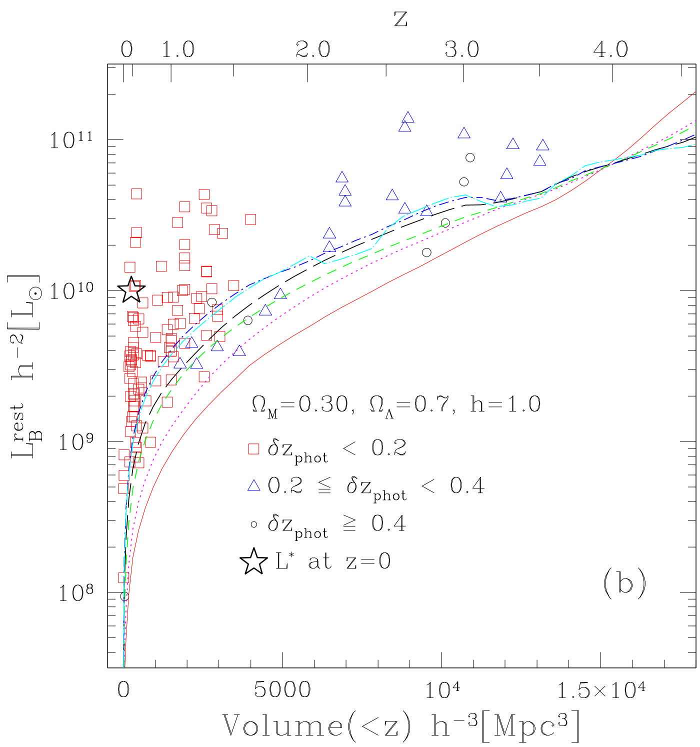

Figure 2.9: The restframe B luminosities of galaxies in the Hubble Deep Field South as measured by Rudnick, Franx and collaborators. The excess of very luminous galaxies at $2 \leq z \leq 3.5$ is clearly visible. The excess is consistent with luminosity evolution of a factor of 2.4-3.2. The x-axis shows the enclosed volume of the field as a function of redshift. If galaxies do not evolve, they should have a random distribution as a function of volume. The curves show the lower limits in luminosity due to the magnitude limit of the data. The different curves apply to different spectral types.

ble of small dense clouds, most of which are Jeans-unstable. The models therefore showed that the jet-induced star-formation scenario indeed may apply, although the fragmentation process produces a series of small clouds instead of a single collapsing (see Fig. 2.10).

2.10.4 High-redshift radio galaxy evolution

Jarvis and collaborators in the UK and USA obtained the first *complete* sample of low-frequency selected (151 MHz) radio sources with the aim of finding high-

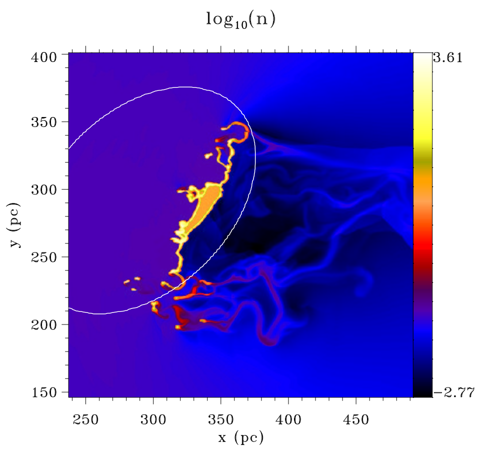

Figure 2.10: The boxes show two phases of the evolution of a cloud which has been run over by the cocoon of a radio jet. The white contour indicates the shape and position of the original cloud, before it was run over from the left by the cocoon. The colours represent the density at times 0.8 and 1.1 Myears. The maps show how the cloud is compressed over a 1000 times and fragments.

redshift radio galaxies (HzRGs). They found further evidence that these high z radio sources are surrounded by a shell of low-density ionised gas which is near the radio galaxy, but not appear to reside in clouds mixed with the emission-line regions. They found also more compelling evidence that HzRGs occur in massive galaxies at the bright end of the elliptical galaxy luminosity function. Using the K-z relation for radio galaxies along with galaxy population synthesis models, Jarvis and coworkers dit *not* find evidence for significant merger events in which the mass of these galaxies had increased. They interpreted this as further proof that radio galaxies have formed at very high redshift ($z > 5$) and have undergone simple passive evolution ever since.

They also probed the space density evolution of radio-loud active galaxies, with particular attention to the time preceding the 'quasar epoch' at $z \sim 2.5$. Limited statistics prevented a definite conclusion on the question of the 'redshift cut-off', but the most likely scenario was found to be that of a constant co-moving space density of radio sources beyond $z \sim 2.5$, at least for low-frequency selected sources. The slight difference in the high-redshift space density between radio sources selected at here at low frequencies, and those selected at high frequencies, which are dominated by relativistic beaming, can be resolved by the argument that the latter reside at a lower luminosity on the underlying low-frequency radio luminosity function.

2.10.5 Powerful radio sources as tracers of distant proto-clusters

Luminous high redshift radio galaxies (HzRGs) are excellent signposts marking rich galaxy clusters. Within thre framework of an ESO Large Programme, Miley, Venemans, Röttgering, Kurk and collaborators have been using the VLT to find and study galaxy proto-clusters in the redshift range $2 < z < 4.1$. First, they used narrow-band imaging with the FORSW2 imaging spectrograph to select galaxies emitting in Lyα around 10 preselected HzRG targets. They then exploited deep multi-object spectroscopy with FORS2 to (i) confirm cluster candidates and measure their velocity dispersions (a key cosmic parameter), (ii) investigate galaxy overdensity as a function of z, (iii) study the properties of cluster members (star formation rates, sizes, rotation curves), and (iv) study the ionization and kinematics of the giant gas haloes that surround HzRGs and that may play an important role in the formation of central cluster galaxies. All four radio galaxies for which sufficient imaging and spectroscopy has been obtained thus far (at $z =$ 2.2, 2.9, 3.1, 4.1) have substantial galaxy overdensities with spectroscopically confirmed companions, velocity dispersions between 300 and 1000 km/s, cluster sizes that generally exceed the $7' \times 7'$ FORS field and masses $> 10^{14}$ $M_\odot$. The most impressive case was that of the luminous radio galaxy TN J1338–1942 at $z = 4.1$ where they found 20 Lyα emitters within a projected distance of 1.3 Mpc and within 600 km s^{-1}, i.e. corresponding to an over-density by a factor of about 15. The structure has a projected size of at least 2.7 Mpc $\times$ 1.8 Mpc and a velocity dispersion of 325 km s^{-1}, which makes it the most distant structure known. The statistics of bright radio sources and those of concentrations in the Lyman break galaxy population suggest that each of those concentrations harbours an active or passive luminous radio source.

The powerful radio galaxy PKS 1138$-$262 at $z = 2.156$ is located in one of the densest environments known at $z > 2$ and has been suspected to be a massive galaxy in the center of a newly-forming cluster. Kurk, Röttgering, Miley, and Pentericci (Heidelberg) have studied the galaxies in this "cluster". Employing infrared narrow-band imaging, they discovered 60 candidate Hα emitting galaxies that have nominal rest-frame equivalent widths > 25 Å close to the radio galaxy in velocity and position. They also found an additional 37 objects with very red colours ($I - K > 3$). The space densities of both Hα emitters and extremely red objects (EROs) increases towards the radio galaxy, indicating a physical association. In contrast, the spatial distribution of candidate Lyα emitters is quite uniform over the field. The properties of the Lyα emitters are consistent with a population of very young, relatively dust-free, galaxies falling into a potential well centered at the radio galaxy, while the properties of the Hα emitters imply an older, dustier population of galaxies that has become more settled. Kurk and coworkers concluded that PKS 1138$-$262 is located at a spatial density peak which will evolve into a cluster of galaxies with a mass of the order of 10^{15}. They noted that the existence of a structure with such a mass at $z \sim 2.2$ is inconsistent with a cosmology having $\Omega_M = 1$.

2.10.6 Imaging Lyα emission line gas at $z > 3$

Reuland, Röttgering, Miley and Van Breugel (LLNL, UC) obtained extremely deep narrow–band images centered at the Lyα emission line of three $z > 3$ radio galaxies (see Fig. 2.11). The Lyα emitting gas extends over a region of more than 100 kpc. While most of the bright, central emission is due to ionization by starburst and radio jets, the cone–shaped, filamentary features resemble those of nearby active galactic nuclei (AGN; Seyferts, radio galaxies) and ultraluminous infrared galaxies (ULIRGs) indicating that they may exhibit huge starburst superwinds. The spherically symmetric, low surface-brightness emission extends to very large (> 100 kpc) radii. This may be primordial gas that is still falling towards the central object.

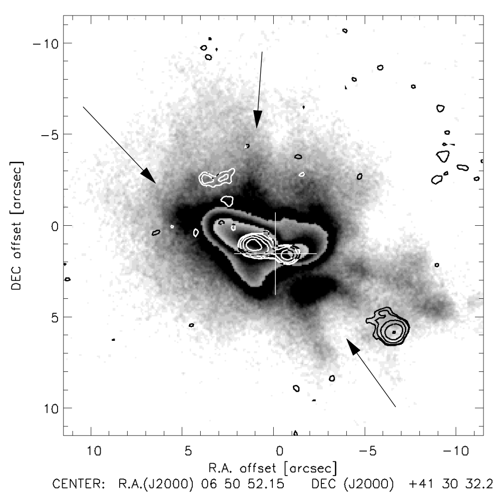

Figure 2.11: Grayscale Lyα image of the powerful radio galaxy 4C41.17 at $z = 3.8$ with a contour representation of the 4.9 GHz VLA radio map overlaid. The grayscale has been color-cycled to show the details of the high and low surface brightness simultaneously. The radio core is identified with a cross, and the contour levels are 0.07, 0.11, 0.4, 1.6 and 6.4 mJy beam^{-1}. The arrows indicate "plumes" of enhanced emission on both sides of the Northern Lobe and a separate emission line cloud with filaments extending to the SSW and SW.

2.10.7 Self-similar growths of young radio sources

Objects with a GHz-Peaked Spectrum (GPS) or a Compact Steep-Spectrum (CSS) are considered to be young radio sources. GPS-sources are characterized by a simple convex radio spectrum peaking at a frequency of about 1 GHz and are typically 100 pc in size. CSS-sources have peaks in their spectra at lower frequencies and have projected linear sizes of < 15 kpc. The ratio between the overall angular size and the angular size of the dominant radio components producing the peaked spectrum is constant throughout different samples of GPS and CSS sources, suggesting that peaked spectrum sources evolve in a self-similar way. Determination that the self-similar evolution theory applies to all classes of peaked spectrum sources is essental to construct and test models of the evolution of young radio sources. Tschager, Schilizzi, Röttgering and Miley have obtained a sample of faint peaked sources from the WENSS, NVSS and FIRST radio surveys to fill in the unexplored segment of the peak flux density–peak frequency plane. They determined spectral turnovers for 49 objects of this sample by conducting low-frequency radio observations with the new 74 MHz system at the VLA.

2.10.8 A catalogue of galaxies near bright stars: preparing for VLT-adaptive optics and VLT-interferometry

Röttgering, Van Breukelen, Jarvis, Overzier, Le Poole and collaborators have compiled a catalogue of those NVSS/FIRST radio sources that have near-infrared counterparts with $K < 15$ in the 2-micron all-sky survey (2MASS), and are also near bright ($K < 10$) stars. A second catalogue of radio-quiet and resolved extragalactic objects allows direct comparison of normal galaxies with those harbouring radio activity of any sort.

2.10.9 The Westerbork Bootes Deep Survey

De Vries (LLNL, UC), Röttgering, Morganti (ASTRON) and collaborators have carried out deep (16×12 hr) Westerbork Synthesis Radio Telescope (WSRT) observations of the approximately seven square-degrees Bootes Deep Field (see Fig. 2.12). The survey consisted of 42 discrete pointings, with enough overlap to ensure a uniform sensitivity across the entire field and a limiting sensitivity of 28 μJy (1σ rms). It resulted in a catalog containing 3172 distinct sources. This work was part of an optical/near-infrared imaging and spectroscopy survey effort conducted with the NOAO telescopes.

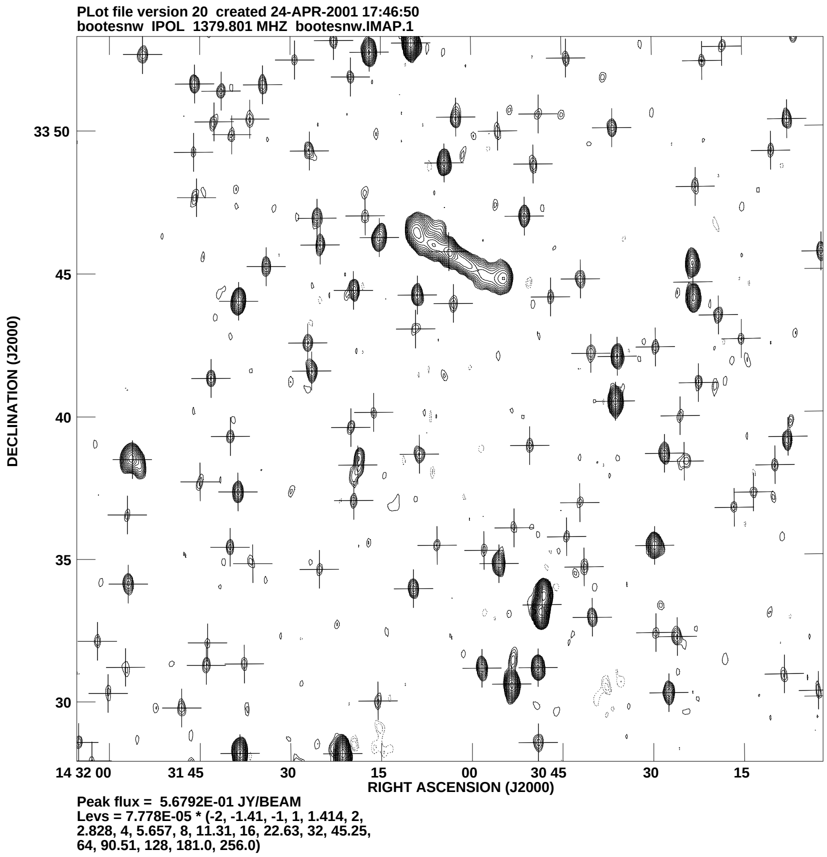

Figure 2.12: A contour presentation of 1/36 of the Laμb survey. The contours are at levels 78 μJy $\times$ (-2,-1.4,-1,1,1.4,2,2.8,4,5.7,8,11.3,23,32,45,64,90,128,181,256). The crosses indicate positions of sources with a signal to noise ratio larger than five.

2.10.10 Clustering of radio sources

Overzier, Röttgering, Rengelink and Wilman studied the clustering of radio sources observed in the 1.4 GHz NVSS and FIRST radio surveys. They found that the angular correlation function at small angular scales is dominated by classical double radio sources. They explained this by a simple model taking into account the physical size distribution of FRII radio galaxies changing as a function of redshift. They also found a trend of increasing angular clustering amplitude with increasing flux density, and interpreted this with a scenario in which powerful radio galaxies probe significantly more massive spatial structures than the less powerful radio galaxies at $z \sim 1$.

Wilman, Röttgering, Overzier and Jarvis measured the angular two-point correlation function of radio sources in the Bootes Deep Field discussed above. They found a constant clustering amplitude down to the survey limit of 0.2 mJy, matching smoothly onto results from the NVSS at higher flux-densities, and consistent with the correlation length of the AGN being independent of radio power over this flux range.

2.10.11 Absorbing HI haloes around high-redshift radio galaxies

Wilman, Jarvis and Röttgering used the UVES echelle spectrograph on the ESO-VLT to probe the HI absorption in the spatially-extended Lyman α emission around two radio galaxies at redshifts 2 to 3. Despite an order of magnitude increase in resolution over previous spectra, the absorbers exhibited little additional structure. This finding supported the model advanced by Binette and coworkers in which the absorbing gas consists of a shell of low density, low metallicity material, situated well beyond the emission line gas.

2.10.12 CO in a gravitationally lensed quasar at redshift 3.91

Papadopoulos, Ivison (UCL London, UK), Carilli (NRAO Virginia) and Lewis (AAT, Australia) used the Very Large Array in New Mexico to detect CO $J = 1 \rightarrow 0$ and $2 \rightarrow 1$ emision from the gravitationally lensed quasar APM08279+5255 at redshift z=3.91. With these low-J lines they found an amount of molecular gas *about a factor of 10 higher* than previously suggested by observation of high-J CO lines. This important result, which was published in Nature and accompanied by a press release, indicated that the reservoirs of molecular gas at high redshift may be much larger than previously thought.

2.10.13 Dusty starburst galaxies at high redshift

Knudsen completed the data acquisition phase of her Ph.D. project with Van der Werf on the SCUBA-Leiden Lens Survey (SCULLS). Her work is now moving towards development of a mathematically rigorous algorithm for source extraction. Pending this, a less sophisticated source extraction method produced about 30 submillimetre galaxies, which was a major step forward in this field. A futher crucial step was provided by her deep K-band imaging (6 hours with ISAAC) of all fields accessible from the VLT, which resulted in reliable identifications of a large number of sources. This is another breakthrough in this field. The majority of the SCUBA sources were identified with extremely red objects *only* detected in the K-band. These results demonstrate that only by employment of near-IR spectroscopy the required redshifts may be obtained. This will be extremely challenging even with a 8m-class telescope.

2.11 Models and theory

2.11.1 BGK method

During a visit to the Max Planck Institute for astronomy (MPIA) in Heidelberg, Mellema worked with Slyz on comparing two different numerical hydrodynamics methods: the Roe solver (Mellema) and the BGK method (Slyz). The first is a so-called Riemann solver, the second solves the Boltzmann equation by using the BGK approximation for the collisional term. Mellema ans Slyz concluded that the BGK solver did not perform substantially better than the Roe solver, and would need some more work before it could be considered as a replacement for it.

2.11.2 3D hydrodynamics code including ionization

Mellema started a collaboration with Lim (UCL London, UK) to develop a three-dimensional numerical hydrodynamics code on an adaptive mesh, which includes the transfer of ionizing radiation. The code is also parallelized to run on a shared-memory machine (such as the Dutch national supercomputer TERAS). This allows running simulations of 512^3. As a first test problem they considered the photo-evaporation of two clouds, one partly shadowed by the other. They found that a complicated interaction between the two clouds results, causing the survival time of the shielded cloud to be is approximately 50% longer. Existing examples of such shielding can be found in the Helix Nebula (NGC 7293) and in the Proplyds in the Orion nebula.

2.11.3 Improved DORIC 3

In a collaboration with Lundqvist (Stockholm, Sweden), Mellema worked on an improved version of the radiation physics module for hydrodynamic simulations *DORIC*. This latest version was completely reprogrammed in Fortran 90. It includes all ionic species of H, He, C, N, O, and Ne, a time-dependent ionization calculation taking into account electron collisions, charge exchange with H, radiative and di-electronic recombination. Also included are non-equilibrium cooling rates for all ions. As all atoms and ions have the same status, this version can deal with arbitrary abundances.

2.11.4 Cosmic-ray induced desorption in dense clouds

Shen, Greenberg and Schutte continued their modeling of the non-thermal desorption of ices. It is well known that heavy molecules exist in the gas-phase of cold dense clouds notwithstanding the fact that they should freeze onto the grain surfaces in times much shorter than the lifetime of such regions. The desorption mechanisms that keep them in the gas-phase are poorly understood. In this work, desorption due to cosmic-rays was considered, including effects of ultraviolet radiation induced by cosmic-rays, the production of free radicals, heating of grains by cosmic rays and desorption due to radical reactions and cosmic-ray heating in dense clouds. Shen et al. developed a model starting from cosmic-ray spectra and compared its results to existing observations of cold dark clouds which show increasing depletion with depth into the cloud.

2.11.5 Chemical and physical models of circumstellar disks

Van Zadelhoff, Van Dishoeck, Aikawa (Kobe, Japan) and Herbst (Ohio State, USA) finished their calculations of the abundances in disks around pre-main sequence stars and the comparison with JCMT observations of various molecular transitions. Most of the emission was found to originate from a warm intermediate layer where the temperatures are high enough to prevent freeze-out onto grains and where ultraviolet photons induce an active chemistry. In the cold mid-plane, most molecules are depleted onto the grains, whereas in the upper surface layers the rapid UV photodissociation results in low molecular abundances. In an expansion of this work, they developed models including a full 2D continuum radiative transfer in order to calculate the dissociation rates of molecular species at different positions in the disk more accurately. They also investigated the effects of different stellar spectra. Most abundances do not depend significantly on the spectral shape of the stellar radiation field. However, the radical species are enhanced by more than an order of magnitude near stars with excess UV radiation.

Faas, Van Zadelhoff and Van Dishoeck computed gas temperatures in massive circumstellar disks around pre-main sequence stars, taking into account the effects of dust settling. They solved the gas and dust temperatures independently for a series of vertical slabs as a function of radius, taking into account various line cooling and heating mechanisms due to the stellar and interstellar ultraviolet fluxes. The gas and dust were found to decouple near the surface of the disk in the inner region and throughout most of the disk at larger radii. If dust settling is taken into account the size of the hot surface layer grows accordingly.

2.11.6 Vertical structure of disks

Van Zadelhoff and Dullemond (MPI Garching, BRD) developed models of the vertical structure of T Tauri and Herbig Ae/Be disks. In contrast to earlier work, their models employed full frequency- and angle-dependent radiative transfer instead of the usual moment equations. This improvement was found to have a strong influence on the resulting vertical structure of the disk, with differences in temperature as large as a factor of two. The differences only mildly affected the spectral energy distributions of these sources, but the line emission from CO and its main isotopomers was found to be sensitive to the differences in temperature structure.

2.11.7 Testing molecular line radiative transfer codes

Van Zadelhoff and collaborators finished their comparison of rotational line radiative transfer codes in one dimension. For the comparison, a spherical model of a collapsing cloud with a power-law density distribution and line optical depths up to $\tau \sim 100$ was used. HCO^+ was used as a test species to ensure NLTE level populations under these conditions. The results agree with a standard deviation of a few % for the J=1 population and up to 12 % for the J=4 population in the high optical depth case; for lower optical depths, agreement is much better.

2.11.8 Models of circumstellar molecular radio line emission

Schöier and Olofsson (Stockholm, Sweden) finished their survey for circumstellar CO radio line emission from a large sample of optically bright carbon AGB stars. The CO lines were modelled using a detailed radiative transfer analysis, combined with an energy balance equation for the gas. Basic parameters of the circumstellar envelopes, such as the stellar mass loss rate, the gas expansion velocity and the kinetic temperature structure of the gas were derived.

2.12 Raymond & Beverly Sackler Lab. for Astrophysics

2.12.1 Amino acids from ultraviolet irradiation of interstellar ice analogues

Muñoz-Caro, Schutte and Meierhenrich (CNRS, Orléans) have succeeded in producing amino acids in the laboratory under simulated interstellar conditions. Amino acids are the essential molecular components of living organisms on Earth, but proposed mechanisms for their spontaneous generation have been unable to account for their presence in Earth's early history. The alternative of an extraterrestrial origin for organic compounds has been hotly debated although several amino acids have been found in meteorites. Muñoz-Caro and coworkers subjected an interstellar ice analogue consisting of H_2O, CO, CO_2, CH_3OH and NH_3 ice kept at $T \approx 12$ K to hard UV-irradiation at high vacuum pressures (see Fig. 2.13). By gas chromatography-mass spectrometry, they subsequently identified 16 different amino acids in the room-temperature residue of this ice analogue. The chiral amino acids showed enantiomeric separation. Pyrroles and furanes were also found. The products were confirmed by ^{13}C-labelling of the ice. Some of the amino acids produced in these experiments have also been found in carbonaceous chondrites.

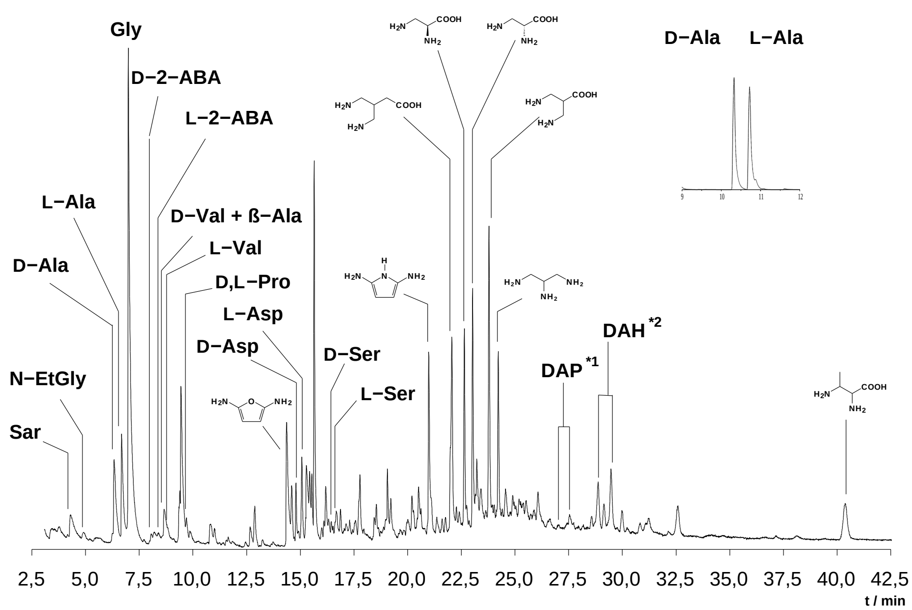

Figure 2.13: Gas chromatogram showing the amino acids and other compounds generated under simulated interstellar conditions by Muñoz-Caro et al.

2.12.2 Trace molecular species in interstellar ices

Schutte, Keane and Tielens (RuG/SRON) investigated the origin of the weak absorption bands at 6.3, 7.2 and 7.4 μm in the spectrum of the embedded high mass young stellar object W 33A. Laboratory experiments showed that HCOOH gives a good fit to the observed 7.2 μm feature, while the 6.3 and 7.4 μm bands are well matched by the corresponding molecular ion, $HCOO^-$. The existence of HCOOH ice was previously suggested by Schutte in order to explain observed spectral features at 5.8 μm. It is the heaviest molecule that has been observed directly in interstellar ices. The presence of $HCOO^-$ moreover confirms that acid-base reactions are an essential factor in interstellar ice chemistry.

2.12.3 Origin of OCN^- in interstellar ices

Van Broekhuizen and Schutte simulated the formation of OCN^- in interstellar ices in the laboratory. This ion, probed through its vibrational stretching mode at 4.62 μm, has been observed towards a large number of high and low mass protostars Several pathways for its formation were investigated: UV photolysis of ice samples containing either CO and NH_3 or CH_3OH and NH_3, photolysis of HNCO and NH_3, or radiationless formation by warm-up of ices containing HNCO and NH_3. Van Broekhuizen and schutte concluded that the photolysis of CO with NH_3 is too inefficient to account for the high observed OCN^- abundance in sources such as W 33A. However, processing of HNCO and NH_3 or CH_3OH and NH_3 both meet the observational constraints.

2.12.4 Formation of solid CO_2

Fraser, Ruiterkamp and Tielens (RuG) continued their attempts to identify chemical reactions that may lead to CO_2 production under interstellar conditions. Ruiterkamp focused on reactions that may occur in regions dominated by UV photon-induced chemistry. Under these conditions, the reaction between H_2O and CO is now known to progress via a diffusion-limited reaction between CO and OH radicals. Fraser focused on photon-dominated reactions in the absence of H_2O, and also looked at the direct reaction between CO and O atoms. Tielens constructed models of both systems in order to reproduce the laboratory findings.

2.12.5 Thermal desorption of ices

Fraser, McCoustra, Collings (both Nottingham, UK) and Williams (UCL, UK) continued to work on laboratory experiments to study the physical properties of ices under interstellar conditions. They focused on the desorption of simple ices from interstellar grain mimics. In particular, the desorption conditions for amorphous and crystalline H_2O ices, and complex binary systems of H_2O and CO were elucidated.

2.13 Astrobiology

Ehrenfreund received a VENI ('Impulse for Renewal') grant in order to establish the first research group of Astrobiology in The Netherlands, consisting of herself, Ruiterkamp, Ten Kate and Peeters. The group developed close collaborations with other groups in the Netherlands (at TU Delft and at Leiden) and abroad. Leiden astrobiologists participate in several research programs in support of future space missions.

In preparation for the BIOPAN/PHOTON 2002 orbit flight and EXPOSE experiment on the International Space Station ISS, Ruiterkamp has measured for the first time the spectroscopic properties of polycyclic aromatic hydrocarbons (PAHs) with sizes up to 600 amu, including 5-ring species and PAHs containing heteroatoms. The spectra of the neutral species and the associated cations and anions measured in this work have been compared to astrophysical spectra of Diffuse Interstellar Bands (DIBs). Ruiterkamp also finalized the sample carrier design for the BIOPAN/PHOTON 2002 orbit flight.

Ten Kate and Ruiterkamp, together with the TOS and SSD departments at ESTEC, have refurbished a Mars simulation chamber for the experiment "Complex organic on Mars" in support of the EMF (Exobiology Multi-User Facility), designed for future Mars missions. This ground-support experiment investigates the behaviour of organics, embedded in Martian soil analogs, exposed to simulated Martian atmospheres, UV radiation, oxidizing agents and effects of thermal cycling in order to study the stability and evolution of organic molecules on the Martian surface. Subsequently this experiment studies also the implications for extinct and extant life on Mars and is highly relevant to the preparation and interpretation of Mars Express Exobiology data from Beagle 2.

Ehrenfreund has investigated the photostability of amino-acids under simulated space conditions with collaborators at NASA AMES Research center and from meteoritic samples, together with colleagues at Scripps/UCSD San Diego. Her results indicated that the amino acid composition of certain meteorites can be used to distinguish between their parent bodies. Amino acids are not very photostable which may explain their absence in interstellar clouds. Furthermore the results indicate that the amino acids, which have arrived on Earth via meteorites, are likely formed within the protected environment of meteorites during the aqueous alteration process on the parent body. Peeters has investigated the photostability of nucleobases (such as adenine) under simulated space conditions which seem to be much more stable than amino acids. In collaboration with colleagues from NASA AMES research center Ehrenfreund and Ruiterkamp have studied via observations and modelling the interstellar and cometary chemistry of large organic molecules.

2.14 Instrumentation

2.14.1 NEVEC

General matters

The NOVA-ESO VLTI Expertise Centre (NEVEC) for the Very Large Telescope Interferometer (VLTI) at Leiden is a national expertise centre in optical/infrared interferometry partially funded by NOVA as a joint venture with ESO.The goals of NEVEC are:

- The development of instrument modelling, data reduction and calibration techniques for VLTI, concentrating on optimizing VLTI for studies of faint objects
- The accumulation of expertise relevant for a second-generation VLTI instrument
- Provision of education in VLTI.

As well as carrying out a set of tasks that are mutually defined between NEVEC and ESO, NEVEC is heavily involved in the development of software for the Mid-Infrared Instrument (MIDI). The year 2001 was an exiting year, both for the progress of VLTI in general and the development of MIDI.

Involved with NEVEC at Leiden are the NOVA-funded NEVEC staff, Bakker (Project Manager), De Jong, Meisner, Percheron, as well as several tenured Leiden staff, Jaffe, Le Poole (Project Scientist), Miley (Principal Investigator) and Röttgering. Additional NEVEC personnel include d'Arcio (funded by SRON) and Heiligers, a Ph.D. student. During 2001, guests and temporary staff working within NEVEC also included Cotton (NRAO) and Hartmann.

NEVEC maintained close contacts with the other Dutch university departments of astronomy, but also worked closely with the NWO foundations ASTRON and SRON, with the Optica Group at Delft Technical University (TUD) as well as and semi-government organizations and private industry in order to develop infrared and optical astronomy in The Netherlands

In February, the Dutch VLTI team met in Leiden to discuss strategies for NL interferometry. A successful workshop *Imaging with the VLTI* was organised in by Bakker in close collaboration with TNO/TPD bringing together all those in the Netherlands involved in optical interferometry.

VINCI

The first interferometric instrument for the VLTI, the two-way beam combiner operating at a wavelength of 2μm, VLTI Interferometer Commissioning Instrument (VINCI), was commissioned by ESO. The first fringes on a celestial object were acquired with VINCI on March 17 with the siderostats at Paranal and on October 29 with the VLT unit telescopes. NEVEC made significant contributions to these accomplishments. Percheron, Jaffe and Cotton participated in the VIMCI commissioning at Paranal, while Meisner and Le Poole analysed data at their home office at Leiden. New measurements with VINCI gave an angular size for Alpha Hydrae of 9.29$\pm$0.17 milli-arcseconds (with a 16 meter baseline on the siderostats), and for Achernar an angular size of 1.92$\pm$0.05 milli-arcseconds (with a 102 meter baseline on the unit telescopes ANTU and MELIPAL).

MIDI software development

MIDI, the two-way beam combiner operating at a wavelength of 10μm, is the first scientific instrument planned for the Very Large Telescope Interferometer and due to be commissioned in 2003. Jaffe is Project Manager for the MIDI software development. Development of the *Near Real Time System* developed by De Jong and Jaffe resulted in the detection of the first fringes from MIDI in the laboratory at Heidelberg on October 30. The Final Design Review for MIDI software was passed on April 9 and 10. The development of software to facilitate the operating procedures (Bakker and Jaffe) progressed substantially and should be completed during 2002.

Defining Calibrators for VLTI

Percheron and Richichi (ESO) started a program to measure and build a self-consistent database of VLTI calibrators. Any interferometer suffers from a loss of contrast in the instrument. The instrumental 'transfer function' can only be measured if a set of calibrators of known angular size is available. As only interferometers can measure these diameters, only a few stars exist with angular diameters known sufficiently well to have them serve as VLTI calibrators. Some additional information is available from lunar occultations and speckle interferometry. NEVEC and ESO started a joint project to compile a database of calibrators with self-consistent angular diameters. The team to work on this project will be extended to include the results of the efforts of the French VLTI/AMBER (Astronomical Multi BEam Recombiner, a three-way beam combiner operating at a wavelewngth of 2μm) team

Preparation and Calibrators for PRIMA

The Phase Referenced Imaging and Micro-arcsecond Astrometry (PRIMA) is a phase-referencing instrument planned to be developed for VLT during the next few years. By studying objects close to bright reference stars, PRIMA will extend interferometry to faint targets and make possible a broad range of new fundamental astrophysics based on high-resolution astrometry and imaging. To optimally exploit PRIMA, preparatory surveys for suitable reference objects and scientific targets are essential. Röttgering and Le Poole therefore initiated a project to search for faint science objects close to bright reference sources to be used as targets for PRIMA.

2.14.2 Advanced Camera for Surveys

Franx and Miley, continued as members of the Science Teams of the Advanced Camera for Surveys, intended to be fitted to the Hubble Space Telescope in 2002. They both participated in planning the dedicated program for observations of galaxy clusters, to be carried out in the guaranteed observing time allocated to the Science Team. Miley is leading the program to study the regions surrounding high-redshift radio galaxies, that has been provisionally allocated 55 orbits with the ACS.

2.14.3 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 intended for VLT installation in 2004. A laser guide-star facility will enable nearly diffraction-limited imaging over the whole sky. Leiden astronomers involved in SINFONI are Van der Werf, Franx, De Zeeuw and Katgert. Van der Werf is Principal Investigator of the NOVA components of SINFONI: a combination of adaptive optics effort and development of the camera required for enhancing SINFONI with a 2048^2 detector. Brown joined the Leiden team in 2001, to work on simulations of SINFONI performance with a laser guide star. His work has concentrated on addressing the effect of an extended reference source as guide star.

2.14.4 NGST near-IR spectrograph

Van der Werf and De Zeeuw are involved in a study for a near-IR multi-object spectrograph (MOS) for the Next Generation Space Telescope (NGST). This ESA-initiated studiy with Le Fèvre (Marseille) as Principal Investigator includes a number of European top institutes in the field of astronomical instrumentation. The work is concentrating on MEMS-based concept, but other architectures are also considered in a parallel ESA-initiated study by the same team.

2.14.5 LOFAR

Several members of the Leiden staff are involved heavily in the LOFAR project. LOFAR (the Low Frequency Array) is a radio array consisting of about 50 elements located over an area spanning 300 km and intended to operate from ~ 10 MHz (ionospheric cut-off) to ~ 230 MHz.

The facility, planned for completion during 2006–2007 will open up this relatively unexplored region of the spectrum. Scientific drivers are broad and include (i) studying the epoch of reionization (ii) using low frequency radio sources to constrain galaxy and cluster formation and evolution (iii) searching for variable sources such as gamma ray bursters, pulsars and extrasolar "Jupiters" (iv) studying cosmic rays within the galaxy and (v) monitoring solar weather.

The project, initiated in the Netherlands by Miley is now an international joint venture between the Netherlands and the USA estimated to cost about $70M$. The official partners are the Stichting ASTRON (Dwingeloo), MIT and NRL (the Naval Research Laboratories).

During 2002 LOFAR development within the Netherlands was supported by advance funding from the 3 northern Dutch provinces and optimism grew that the construction of LOFAR will be funded under the auspices of the development of infrastructure within the Netherlands. A national LOFAR Steering Committee (NLSC) was set up to oversee the LOFAR project within the Netherlands. Leiden members of the NLSC are Miley (Chair) and Röttgering.

Israel, Miley and Röttgering were responsible for developing different aspects of the Dutch Science Case for LOFAR. On the international front Miley supported Butcher (Dwingeloo) at meetings of the LOFAR International Steering Committee and Röttgering became a member of the Board of the Science Consortium, with responsibility for leading the extragalacic surveys.

2.14.6 Darwin Interferometric space mission

ESA's Darwin mission to be launched in 2014 will be an interferometric mission that will operate both as a conventional Michelson interferometer carrying out high-resolution astrophysical observations as well as a nulling interferometer for the detection/characterization of earth-like exoplanets. d'Arcio, Röttgering, den Herder and LePoole worked on a number of issues related to the Darwin imaging mode. First, overall system aspects were addressed including expected sensitivity, and baseline reconfiguration needs. Subsequently, a conceptual design was developed relating to cophasing of the DARWIN interferometer. This is based on a phase-referencing architecture allowing for the simultaneous observation of the science object, and an off-axis reference target for stabilization purposes. The reference and science beams are wavelength-multiplexed and propagate along a common path through the interferometer. Finally a preliminary concept is developed for a dedicated, wide-field imaging beam combine based on homothetic mapping. Requirements, expected performance, technology development needs, and current activities in this area are discussed and presented to ESA.

2.14.7 SURFRESIDE

Fraser and Van Broekhuizen, supported by De Kuyper (Huygens Laboratory mechanical workshop), Schutte and Van Dishoeck, completed the re-design and construction of SURFRESIDE, a new ultra high vacuum (UHV) experiment that is being used to study surface chemistry under interstellar conditions.Pressures closely mimicking those of the densest molecular clouds and circumstellar disks are now routinely achieved with base operating pressures of the system 1000 - 10,000 times better than in obtainable the previous experiments (see Fig. 2.14).

2.14.8 Physico-chemistry of ices in space

Fraser and Ehrenfreund obtained an ESA grant to initiate an ESA Topical Team to study physical and chemical aspects of ices in space. In collaboration with a number of colleagues from around Europe, the topical team started to investigate how ice studies in microgravity (using parabolic flights, the International Space Station (ISS) and Drop Tower Experiments) can be used to enhance our understanding of cometary, interstellar and atmospheric ices.

As part this team, Fraser worked on the development of a new experiment to fly on the ISS in 2005. The ICAPS experiment (Interactions of Cosmic and Atmospheric Particle Systems) is designed to study physical parameters of particle systems under long duration microgravity conditions. The experiment addresses problems in particle aggregation, icing of dust and light scattering effects.

2.14.9 CRYOPAD

Van Broekhuizen and Schutte, advised by Fraser and Van Dishoeck, completed the first stage of the design of the CRYOgenic Photoproduct Analysis Device, CRYOPAD, in close collaboration with De Kuyper (Huygens Laboratiry mechanical workshop) and Van As (Leidsche Instrumentmakers school). CRYOPAD is designed to study the role of solid-state processes in hot core chemistry. It is conceived as an UHV

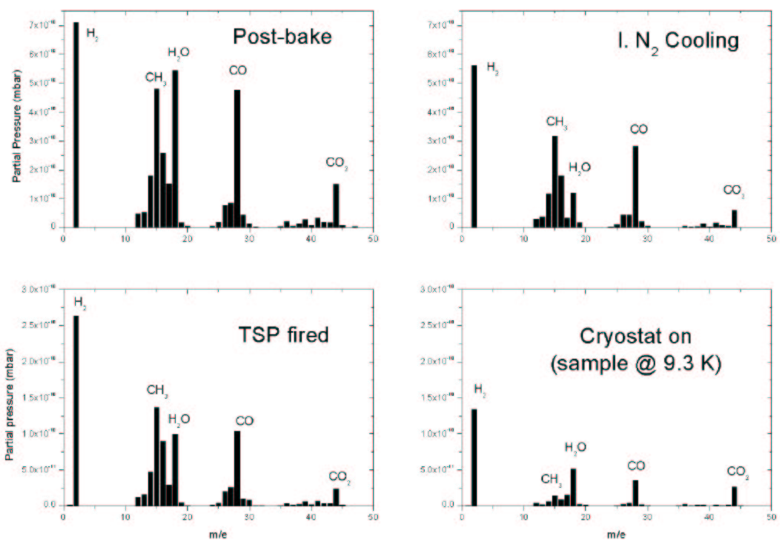

Figure 2.14: Top left: high vacuum conditions, comparable to those in all previous ice experiments in the Sackler laboratory. Top right, the vacuum conditions under ultra high vacuum conditions. Notice that the vacuum is now dominated by H_2 and not H_2O molecules. Bottom left: the vacuum after sublimation pumping. Bottom right: system is cooled to 10 K, mimicking closest the interstellar conditions.

system to analyze in detail volatile complex organics created from interstellar ice analogs by energetic processing (e.g., UV-photon irradiation or charged particles). In discussion with Kleyn (Chemistry, Leiden) and Heeren (AMOLF) it was decided that the product analysis will be performed by in situ Mass Spectrometry and Infrared Spectrometry. The experience gained with SURFRESIDE proved of great value for the design of CRYOPAD . Difficulties with SURFRESIDE have however postponed the construction of CRYOPAD and led to significant changes of CRYOPAD's original design.

2.15 SETI

Ollongren continued his work on the development of a new Lingua Cosmica for communciation with extraterrestrial intelligence based on constructive logic and typing, in collaboration with Vakoch (SETI Institute).

Chapter 3

Education, popularization and social events

Education, popularization and social events

Chapter 3

3.1 Educational matters

3.1.1 Organization

Student education is a top priority of the Leiden Observatory. Fortunately, we can welcome a high number of new students every year. For the academic year 2001/2002, 29 freshman students registered. Astronomy and astrophysics are essential parts of the curriculum from the very beginning and are taught in each of the five years of the programme. However, in the first two years the emphasis is on physics and mathematics in order to provide a thorough foundation for the advanced astronomy courses given in the last three years. This renders the astronomy programme quite challenging, so that each year a significant number of students that started in astronomy in the course of the first year changes to another study.

Student progress monitored by three staff members: Van der Werf advises junior students who started after 1998, and Israel does the same for junior students who started before 1999. Senior undergraduate students are monitored and avised by Jaffe. These advisers speak with the students on a regular basis and can be consulted at all times.

In order to accomodate the smooth entry of first-year students into academic life, they are divided in groups of about ten, and these groups meet regularly with a staffmember, functioning as "mentor". Mentors for the academic year 2001/2002 were Röttgering, Van Genderen, and Schutte. In these mentor groups, students discuss their experiences, ask questions, get to learn to know one-another etc. Leiden University requires that each first-year student collects a minimum number of credit points before the beginning of the next academic year. This minimum is set at half of the total credit points set for a year. The mentor groups play an important role in helping the students to achieve this goal.

The Education Committee consists of members of the faculty as well as students. It meets regularly to discuss student progress reports and to advise the director of Education (Franx) on all matters relevant to education. The committee consisted of Katgert (chair), Israel, Jaffe, Van der Werf, De Zeeuw, and the student members Kriek, Van Breukelen, Weijmans, Van den Berg and Schnau. In 2001, the committee discussed the new curriculum which will be started coincident with the introduction of the Bachelors/Masters system at Leiden University in September 2002. The three-year programme required for the Bachelor of Science in Astronomy degree was established. The new programme gives more flexibility to the students and provides early preparation for the research project which they must carry out at the end of the third year.

The astronomy curriculum is formally defined by the "Examen Commissie" (or Committee of Examination). In September 2001, its members were Franx (chair), Israel, Nienhuis (Physics), Van der Werf and De Zeeuw.

3.1.2 Educational Review ("Onderwijs Visitatie")

Every 5 years, an outside committee reviews the astronomy and physics education and teaching programmes. Such a review was organized in 2001 by the 'Vereniging van Samenwerkende Nederlandse Universiteiten' (VSNU) and took place in November of that year. The review committee was chaired by J. Sengers (Inst. Phys. Sc. and Techn., Univ. Maryland, U.S.A.) and furthermore consisted of J. van Gorkom (Dept. Astron., Columbia Univ. NYC, U.S.A.), H. van Houten (Philips Research Lab., Eindhoven), K. Heyde (Inst. Nucl. Wet., Rijksuniv. Gent, B), D. Pfannkuche (I. Inst. f. Theor. Phys., Univ. Hamburg, BRD) and E. George (student KU Nijmegen).

In preparation for the visit of the review committee, a detailed description of the Leiden educational programme was prepared. Lub and Israel were members of the committee which was responsible for this important task. During their two-day visit in November, the review committee spoke with all persons and committees who deal with educational matters, including students, teachers, and deans of the school of science. The review committee will report in 2002 to the VSNU, the organization of Dutch Universities.

3.2 Degrees awarded in 2001

3.2.1 Ph.D. degrees

Two graduate students obtained Ph.D. after a success thesis defence:

M.R. Cioni	September 20
Title thesis:	*AGB stars and other red giants in the Magellanic Clouds*
Thesis advisor:	Habing / Copromotor: C. Loup (Paris, F.)

Y. Simis	October 10
Title Thesis:	*Mass loss modulation in dust forming stellar winds*
Thesis advisor:	Icke

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

The following eight students obtained their Master's degrees in 2001:

Name	**Date**
Maurits Hartendorp	January 30
Johanna Novozamsky	February 7
Ronald Heijmans	April 24
Jasper Arts	June 26
Arjen van der Wel	August 28
Glenn van de Ven	September 25
Wouter van Reeven	October 30
Roderik Overzier	November 27

3.3 Courses and teaching activities

3.3.1 Regular courses taught by Sterrewacht staff in 2001

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	H. J. Habing
4	Astronomy Lab 2	F. P. Israel
5	Stars	A. M. van Genderen
5	Presentation 2	A. M. van Genderen
5	Observational Techniques 1	C. van Schooneveld
5	Radiative Processes	V. Icke
6	Observational Techniques 2	P. van der Werf
6	Astronomy Lab 3	H. J. A. Röttgering
6	Galaxies	M. Franx
6	Presentation 3	M. Franx
7	Introduction Observatory	E. R. Deul
7-10	Student Colloquium	G. K. Miley

Regular advanced courses

Semester	Course title	Teacher
7,9	Active Galaxies	P. T. de Zeeuw
8,10	Stellar Evolution	J. Lub
8,10	Solar System	J. Luu

Incidental advanced courses

Semester	Course title	Teacher
7,9	Communication with ETI	A. Ollongren
8,10	Star Formation	E. F. van Dishoeck

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, Ollongren, 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 2001 programme included:

Date	Speaker	Title
January 18	M. Perryman	*Be a 21st Century Exploer: Be the First to Chart the Expanses of our Galaxy*
January 25	RINO	*Presentaties voor een Breder Publiek*
February 8	C.A. Swenne	*Een Natuurkundige in de Neurocardiologie*
February 15	R. Bruinsma	*Statistische Mechanica van Proteïnen*
March 1	F.P. Israel	*Het Gewelddadig Heelal*
March 8	V. Icke	*Kosmische Hydrodynamica*
March 15	G. Frossati	*Toepassingen van Ultralage Temperaturen*

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. Sterrewacht staff, Ph.D. students and undergraduate students, often spend considerable time and effort to explain the exciting results of astronomy to the general public, in the form of lectures, courses, press releases and newspaper articles, by organizing public days at the old observatory complex and a summer school, and by assisting in television and radio programmes. Although individual initiatives abound, the more regular activities are usually organized by the Public Outreach Committee chaired by Icke and 'manned' in 2001 by Israel, De Hey, Haverkorn, Van der Heijde and Vlemmings. The last four also took turns answering the variety of questions put by the public to the Observatory by mail, e-mail or telephone. All these efforts are quite successful every year, and also help to make young high school students enthousiastic about science in general and astronomy in particular. They play an important role in maintaining the student inflow and also serve to keep the name of Sterrewacht Leiden well-known throughout the country.

The fifth Leiden-Dwingeloo Summerschool in Astrophysics was once again organized by Jaffe. It was held from July 22 to August 3 at the site of the ASTRON radiosterrenwacht in Dwingeloo. In 2001, The subject was planets in the Solar System, and planets around other stars (exo-planets). The course lasted two weeks and was taught by Leiden staff members Mellema and Luu, assisted by Lacerda, Meijerink, Snijders and Vlemmings. It was enthousiastically attended by 13 fifth-year VWO students with exceptionally high marks for the sciences.

Israel was part of the committee which organized the Dutch participation in the Europe-wide contest *Life in the Universe* which was initiated by the European organizations ESA, ESO and CERN. In this contest, high-school students all over the continent competed in conducting studies, preparing presentations and (electronic) exhibits on the subject.

Finally, H.J. Habing, R.W. Visser and W. Gerritsen formulated a the leading question for a prize contest on the history of how, when and why astrology disappeared from the West-European research programmes. The contest is organized by the two scientific societies belonging to the Teyler foundation in Haarlem.

3.4.2 Public Lectures and Media Interviews

Boonman

"Toxic compound in space signals starbirth" (ESA press release, October 10)

Van Dishoeck

"Bouwstenen voor Leven: Moleculen tussen de Sterren" (Haagsche vestiging UL, Den Haag, January 31)
"Bouwstenen voor Leven tussen de Sterren" (Ouderdagen UL, Leiden, February 15)
"De Kraamkamers van Sterren en Planeten" (Studiever. Natuur- en Sterrenkunde UvA, Amsterdam, March 7)
"Oorsprong van Sterren, Planeten en Leven" (NVWS jubileum symposium, Ede, September 22)
"Bouwstenen voor Leven tussen de Sterren" (Studium Generale UL, Leiden, October 4)
"Van Molecuul tot Planeet" (Rotterdams Natuurkundig gezelschap, November 19)
"Van Molecuul tot Planeet" (Symposium Planeetvorming A-Eskwadraat UU, Utrecht, November 21)
"Descifrar la Química del Universo" (El Pais, Madrid, January 3)
"De kosmos kookt op zijn gemak" (Volkskrant, January 6)
"Enorme hoeveelheid waterstof rond jonge sterren ontdekt" (NRC, January 13)
"IJsjes in de ruimte" (Haagsche courant, January 27)
"Spinoza 2000" (NWO/Spinoza uitreiking, Den Haag, January 31)
"Radio interview" (Radio West, January 31)
"Wetenschappers moeten zelf om aandacht vragen" (Leidsch Dagblad, January 31)
"Ik zou wel als science officer op de Enterprise willen werken" (Intermediair, February 1)
"Van Dishoeck neemt Spinozapremie in ontvangst" (Mare, February 1)
"De kraamkamers van ons melkwegstelsel" (Het Parool, February 3)
"Radio interview" (KRO, February 21, 28)
"Radio interview" (BBC World, February)
"Interview" (Eindhovens Dagblad, February)
"Profiel" (Natuur & Techniek, March issue)
"Het enige meisje tussen de bètajongens" (Opzij, April, p. 38-40)
"Leidse astronome verkozen als lid US National Academy of Sciences" (Sterrewacht persbericht, May 3)
"Roebroeks en Van Dishoeck Akademielid" (Mare, May 23)

Franx

"Het heelal" (Oude Sterrewacht Leiden, 20 november)

Habing

"gastlessen" (Almere, January 12)
"gastlessen" (Stedeljk Gymnasium Leiden, January 29)
"gastlessen" (Lorentz College Arnhem, April 10)

"gastlessen" (Apeldoorn, April 23)

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" (JWG Sterrenkunde Leiden, September 28)
"Het maatschappelijk belang van de sterrenkunde" (Rotary Club Kijkduin, November 13)

Israel

"Rondleiding NSE" (LF, Noordwijk, February 7)
"Landing op Planetoïde EROS" (RTL4 News, February 12)
"SETI" (Radio 5 VPRO, February 13)
"Weer op Andere Planeten" (RTL5 5 in 't Land, April 17)
"Naamgeving Planetoïden" (Radio 2 AVRO, July 17)
"Leven in het heelal" (Ruimtevaart Dispuut Delft, March 1)
"Exoplanets" (Bussiness News Radio, March 31)
"Rondleiding NSE" (Strw, Noordwijk, October 27)

Jaffe

"Gastles" (Prisma Graaf Engelbrecht VWO Breda, November 23)
"Gastles" (Gynasium Haganum Den Haag, March 22)

Katgert

"Kosmologie en sterstructuur: twee mooie theoriën" (Symposium Leidsche Flesch, January 31)
"Supernovae en het Uitdijend Heelal" (L.A.D. 'F. Kaiser', Leiden, February 2)
"Het uitdijend Heelal" (Cursus Kosmologie HOVO, Leiden, February 13)
"Het uitdijend Heelal" (Cursus Kosmologie HOVO, Leiden, February 20)
"Ons beeld van de Oerknal" (Cursus Kosmologie HOVO, Leiden, March 6)

"Op zoek naar de eerste objecten" (Cursus Kosmologie HOVO, Leiden, March 20)
"De eigenschappen van ons Heelal" (Cursus Kosmologie HOVO, Leiden, March 27)

Lub

"Remembering Jan van Paradijs" (Amsterdam, June 7)

Garrelt Mellema

"Jota15: De Dood van de Zon" (TELEAC/NOT, April 15)

Ollongren

"Logic terms from CETI in the painting "Gaia/Voyager" by C. Bangs from New York" (Exposition in New York in 2001; see Zenit juli/augustus 2001)
"Communicatie met buitenaards leven: een logische 'steen van Rosette"' (Dispuut De Vijf II, Leiden, March 9)
"Communicatie met buitenaardse intelligentie" (NVWS, Afdeling Delft, December 18)

Pontoppidan

"Astrogenesis" (International Astronomical Youth Camp 2001, August 15)

Röttgering

"Ontstaan van Melkwegstelsels, Quasars en de Speurtocht naar Leven in het Heelal" (Lion's Club Hoofddorp, October 25)

Schutte

"Hoe vind je groene mannetjes en vrouwtjes ?" (Edith Stein College, Den Haag, February 12)
"Astrochemie" (Wereldomroep, August 23)

Verdoes Kleijn

"Cosmology and Religion" (Theologisch Dispuut FFF Leiden, June 12)
"Nationale Wetenschapsdag" (Leiden, October 7)

Vlemmings

"VLBI: Het Globale Netwerk van Radiotelescopen" (Hilversum, February 28)
"VLBI: Het Globale Netwerk van Radiotelescopen" (Leiden, April 26)
"VLBI: Het Globale Netwerk van Radiotelescopen" (Woerden, May 8)

De Zeeuw
"Vorming van Sterrenstelsels" (C.J. Kok Prize Lecture for Amina Helmi, Leiden, October 11)
"Staff Address" (Isaac Newton Group of Telescopes, La Palma, Canary Islands, October 19)
"Integral Field Spectroscopy of Galaxies: The SAURON Project" (Koninklijk Natuurkundig Genootschap, Groningen, November 20)

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

The "Leidsch Astronomisch Dispuut 'F. Kaiser' " is an association founded by five astronomy students on March, 1st, 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 Stijn Wuyts, Rowin Meijerink, Dominic Schnitzeler, Maaike Damen, Siard van Boven and Maarten van Hoven. Like their predecssors, they prolongated the success of previous years. The main activities were are student lectures, organized drinks ('Sterrewacht-borrels'), instruction courses at the Old Observatory and the famous Sterrewacht barbecue in June.

The association also contributed to the popularization of astronomy by providing guided tours at the Old Observatory complex and assisting on open days. Every last Friday of the month a Sterrewacht Borrel was organized, for students and staff to meet informally. Since 1994 tours at the Old Observatory are given for first and second year undergraduate students in order to make them aware of the rich history of astronomy in Leiden. Other activities for this group of students to make them feel at home at the Observatory, included borrels and lectures by senior students.

3.5.1 "Studentenlezingen"

Date	Speaker	Title
February 5	P. Katgert	*Supernovae and the expanding universe*
April 25	R. Marsden	*Solar physics*
November 7	AIO's and students	*Astronomy research at the Sterrewacht*

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, Extra-Terrestrial Life, the Solar System, the Universe and Distance Measurements in Astronomy. In 2001, tours and lectures were given by Stijn Wuyts, Rowin Meijerink, Dominic Schnitzeler, Maaike Damen, Siard van Boven, Maarten van Hoven, Glenn van de Ven, Roderik Overzier, Wouter van Reeven and Martijn Nuyten.

Date	**Group**
January 24	birthday party
January 26	scoutinggroup
February 2,3,4	Landelijke Sterrenkijkdagen
February 16	small group
February 24	Leidse juniorenkamer
March 6	Lions Club Leiden
May 8	small group
May 16	Biology Student Association
August 29	small group
August 31	small group
September 21	birthday party
October 12	Minerva Jaarclub Orion
November 15	Hydron

Appendix I

Observatory staff December 31, 2001

Sterrewacht Leiden

Observatory staff December 31, 2001

Appendix I

The Sterrewacht website

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

provides names, e-mail adresses, room numbers and telephone extensions of all personnel currently at the institute. Telephone extensions should always be preceded by (071) 527 .... (from inside The Netherlands) or by ++31-71-527 .... (from abroad).

Full Professors

W.B. Burton
E.F. van Dishoeck
M. Franx
H.J. Habing
V. Icke
G.K. Miley
P.T. de Zeeuw

Full Professors by Special Appointment

R.T. Schilizzi (JIVE, for J.H. Oort Fund)
M.A.C. Perryman (ESTEC, for Leiden University Fund)
R.P.W. Visser (UU, Teyler's Professor)

Associate Professors and Assistant Professors

F. Baas (deceased 05/04)
P. Ehrenfreund
A.M. van Genderen
F.P. Israel
W. Jaffe
P. Katgert
J. Lub
J.X. Luu (till 30/10)
R. S. Le Poole
H.J.A. Röttgering
W.A. Schutte
P.P. van der Werf

Visiting Staff

M.J. Betlem
Y. Copin (Sauron/Lyon)
W. Cotton (NWO, NRAO)
J. Roland (CNRS)
P.J.E. Peebles (J.H. Oort Fund)

Emeriti

A. Blaauw
L.L.E. Braes
I. van Houten-Groeneveld
C.J. van Houten
K.K. Kwee
A. Ollongren
C. van Schooneveld
J. Tinbergen

Postdocs and Project Personnel

L. d'Arcio	postdoc (NEVEC/SRON)
E. Bakker	postdoc / NEVEC Manager
A. Brown	postdoc (NOVA/Sinfoni) from 01/04
M. Bureau	postdoc (NWO) until 30/09
M. Cappellari	ESA fellow
N. Förster-Schreiber	postdoc (NWO)
H. Fraser	postdoc (NOVA)
M. Jarvis	postdoc (EU/TMR)
J. de Jong	S/W postdoc (Sauron/NEVEC)
I. Kamp	postdoc (EU/Marie Curie)
J. Meisner	research scientist (NEVEC/NOVA)
G. Mellema	KNAW fellow
S. Mengel	postdoc (EU/TMR)
P.P. Papadopoulos	postdoc (EU/TMR) until 28/01
I. Percheron	research scientist (NEVEC/NOVA)
R. Rengelink	S/W postdoc (NOVA/Omegacam)
F. Schöier-Larsen	postdoc (UL)
R. Wilman	postdoc (EU/Marie Curie) from 01/04

Ph.D. Students

A. Boonman	3	R. Overzier*	4
F. van Broekhuizen	2	I. Pelupessy	4
M.R. Cioni*	1	M. Reuland	1,9
V. de Heij*	1	E.J. Rijkhorst*	4
J.M.T. van der Heijden	1,5	K. Pontoppidan	2
B. Heijligers	1,6	R. Ruiterkamp	10
M. Haverkorn	3	C. Shen	11
J. Jørgensen	4	W.F.D. Thi*	1
B. Jonkheid*	7	T. Thomas	1
I. ten Kate	1	W. Tschager	1
K. Kraiberg-Knudsen	4	B. Venemans	2
D. Krajnović	2	E. Verolme	1
J. Kurk	1	G. van de Ven*	1,2
I. Labbé	4	G. Verdoes-Kleijn*	1,12
P. Lacerda	4	W. Vlemmings	3
M. Messineo	2	A. van der Wel*	1,2
G. Muñoz Caro*	8	G. van Zadelhoff	1

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

Staff funded by NFRA

R.J. Pit	Telescope and electronics technician at La Palma (1.0) (UL)
K. Weerstra	administrative officer

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)
D.A.P. Hartmann	scientific programmer (NEVEC; contract)
J. de Jong	scientific programmer (NEVEC; 0.5)

Management Assistants

J. Drost	J.R. Soulsby-Pitts (LUMS)
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
A. Verpoorte	editorial assistant until 28/02

NOVA office

P.T. de Zeeuw	director
W.B. Boland	adjunct director (0.5) (NWO/NOVA)
R.T.A. Witmer	financial controller (0.2) (UL/FWN)
M. Zaal	management assistant

Senior students

B. van Dam	M. van Mil
G. Dirksen	S.-J. Paardekoper
F. Faas	F. Sammar
O. Janssen	D. Schnitzeler
M. Kloppenburg	M. Smit
G. Kosters	L. van Starkenburg
T. Kouwenhoven	A. Verhoeff
R. Meijerink	S. Veijgen

Staff changes and visitors in 2001

Name (Funded by)	start	end
Dr. E. Bakker (NEVEC/NOVA)	01-01-01	
Dr. S. Mengel (EU/TMR)	01-01-01	
Dr. P.P. Papadopoulos (EU/TMR)		28-01-01
Dr. A. Verpoorte (AandA)		28-02-01
Dr. M. Cappellari (ESA)	01-03-01	
Dr. R. Wilman (EU Marie Curie)	01-04-01	
Dr. A. Brown (UL/NOVA)	01-04-01	
Dr. Y. Copin (EU Marie Curie)	01-04-01	31-08-01
Drs. G. Muñoz Caro (UL)	01-05-01	
Drs. M.R. Cioni (UL)		15-05-01
Drs. W.F.D. Thi (UL)		31-07-01
Drs. A. van der Wel (UL/NOVA)	01-09-01	
Drs. G. van de Ven (UL/NOVA)	01-10-01	
Dr. M. Bureau (NWO)		30-09-01
Drs. V. de Heij (UL)		30-09-01
Drs. E. J. Rijkhorst (NWO)	01-10-01	
Dr. J.X. Luu (UL)		30-10-01
Drs. B. Jonkheid (SPINOZA)	01-11-01	
Drs. G. Verdoes-Kleijn (UL)		31-12-01
Prof. Dr. W.B. Burton (UL)		31-12-01
Drs. R. Overzier (NWO)	01-01-02	

Appendix II

Committee membership

Committee membership

Appendix II

II.1 Observatory Commitees

(As of December 31, 2001)

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

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)
A. Boonman
F. P. Israel
W. Jaffe
K. Kol
P.P. van der Werf
P.T. de Zeeuw

C. van Breukelen
B. Clauwens
M. Kriek
T.P.C. Nieuwenhuizen
G. van de Ven
A.M. Weymans

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
M. Messineo

Computer committee
P.P. van der Werf (chair)
F. van Broekhuizen
A.G.A. Brown
M. Jarvis
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
W. Jaffe
P. Katgert
J. Lub
R.S. Le Poole
M.A.C. Perryman
H.J.A. Röttgering
R.T. Schilizzi
W. Schutte
R.P.W. Visser
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)
M. Haverkorn
V. de Heij
P. van der Heijden
F.P. Israel
W. Vlemmings

Graduate student review committee

H.J. Habing (chair)
P. Katgert
W. Boland (NWO)
P.P. van der Werf

Social committee

G. Dirksen
M. Haverkorn
G. Mellema
R. Overzier
R.S Le Poole
M. Zaal

II.2 University Committees

Burton

Member, Overlegcommissie Opleidings Directeuren, Faculteit W & N (until 01/09)
Member, Gemeenschappelijke Opl. Commissie, Natuur- en Sterrenkunde (until 01/09)

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 (after 01/09)
Member, Gemeenschappelijke Opl. Commissie, Natuur- en Sterrenkunde (after 01/09)

Van Genderen

Chair, study guide committee
Member, rostercommittee

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
Member, Faculty Advisory Council (Faculteitsraad) W & N

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
Member, Faculty Committee on Development of New Academic Tenure System

Appendix III

Science policy functions

Sterrewacht Leiden

Science policy functions

Appendix III

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

Burton
Scientific Editor, The Astrophysical Journal
Chair, Editorial Board, Astrophys. and Sp. Sc. Lib., Kluwer Acad. Publishers
Adjunct Scientist, National Radio Astronomy Observatory

Van Dishoeck
Member, SRON Board
Chair, ALMA Science Advisory Committee
Member, ESA Astronomy Working Group
Member, ESA–NGST Science Study Team
Member, NASA–NGST Interim Science Working Groups
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, FIRST–HIFI Science team
Member, VLT–VISIR Science team
Member, U.K. Royal Society of Chemistry, Astrophysical Chemistry Committee
Member, Scientific Advisory Board of New Astronomy
Member of the Board, J.C. Kapteyn and Pastoor Schmeits Foundations
Member, Scientific Org. Comm., ESO workshop on 'The Origins of Stars and Planets'
Coordinator, NOVA network II on "Birth and Death of Stars and Planets"

Ehrenfreund
Chair, Working Group, ISSI, International Space Science Institute, Bern
Vice President & Dutch Representative, European Exo/Astrobiology Network EANA
Member, ESA Exploration scientific Experts Group ESEG
Member, Science Board SRON
Team Coordinator, SETI Strategic Planning Group LITU: Extraterrestrial Organic Chemistry
Team Leader, ESA Topical team on Physico-Chemistry of Ices in Space
Member, IAU Working Group on Astrochemistry
Discipline Editor, Planetary and Space Science

Editorial Board, Astrobiology, Mary Ann Liebert Inc, Publisher
Editorial Board, International Journal of Astrobiology, Cambridge Press, Publisher

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
Organizer, FIRES Workshop
Director, Leids Kerkhoven–Bosscha Fondsn
Director, Leids Sterrewacht Fonds
Director, Jan Hendrik Oort Foundation

Fraser
President, Young Professionals Committee, Institute of Physics, U.K.
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.
Member, Membership and Qualifications Board, Institute of Physics, U.K.

Van Genderen
Secretary, Dutch Program Committee Dutch Telescope on La Silla, Chile
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 and 51
Member, Editorial Board Euro Physics News, European Physical Society
Member, Noordwijk Space Expo Foundation (NSE) Exposition Committee

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

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
Member, Board of the Association of Academy Fellows (VvAO)

Ollongren
Member, SETI Committee International Astronautical Academy (until 2/10)
Member, Permanent SETI Study Group International Astronautical Academy (after 2/10)

Member, IAU Commissions 7, 33 and 56
Founding Member, European Astronomical Society

Perryman
Chair, GAIA Science Advisory Group
Member, Council European Astronomical Society

Röttgering
Deputy coordinator, European Association for Research in Astronomy (EARA)
Leiden coordinator, EU programme "Training and Mobility of esearchers", "The Formation and Evolution of Galaxies"
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
Member, ASTRON Observing Programme Committee

Schilizzi
Editor, Experimental Astronomy
Member, RadioAstron International Scientific Council
Chair, URSI Global VLBI Working Group
Member, VSOP International Scientific Council
Member, Board of the European Consortium for VLBI
Chair, IAU Working Group on Future Large Scale Facilities
Member, SKA International Steering Committee

Schutte
Member, Working Group: "The role of laboratory experiments in the characterisation of cosmic material", ISSI, International Science Institute, Bern, Switzerland

Van der Werf
Principal Investigator, NOVA-SINFONI
Member, ESO User's Committee
Member, ESO Contact Committee
Member, EC - TMR Network "Sky surveys with ISO"
Member, European Large Area ISO Survey (ELAIS) team
Team Leader, EC-RT Netw. "Prob. the origin of the extragalactic background" (POE)

Member, NGSTp near-IR Spectrograph Study Team
Member, SINFONI Science Team
Member, VISIR Science Tteam
Co-investigator, HIFI
Member, Steering Committee ISO Data Centre Groningen (DIDAC)
Member, JCMT Advisory Panel
Member, NOVA Wide-field Imaging Team
Member, NOVA Millimetre Interferometry Team
Member, Final Design Review board, SINFONI spectrograph
Member, Multi-Unit Spectroscopy Explorer (MUSE) Consortium
Member, PPARC Astronomy Advisory Panel

De Zeeuw
Member, Scientific Advisory Board of *New Astronomy*
Member, IAU Commission 28 (Galaxies)
Member, IFMOS Study Consortium for ESA contributions to NGST
Member, SINFONI Science Team (MPE & ESO)
Member, OPTICON Board
Member, ESO/OPTICON Science Working Group for Extremely Large Telescopes
Member, Apointment Committee Astrophysikalisches Institut Potsdam
Member, Task Force for the Experimental Astrophysics Chair at ETH Zürich
Chair, Isaac Newton Group Board
Vice Chair, Space Telescope Institute Council
Member, Leiden University Representative to AURA
Member, AURA Board of Directors
External Member, NOAO Recompetition Proposal Team
Member, SOC of Hawaii Workshop on *Astrophysical Ages and Timescales*,Hilo
Member, SOC of Les Houches Workshop on *GAIA*
Member, SOC of Conference in Honor of Ken Freeman's 60th birthday
Member, SOC of Conference on ω Centauri
Member, SOC of Workshop on *Next-Generation Wide-Field Multi-Object Spectroscopy*
Member, National Committee Astronomy
Member, Steering Committee Lorentz Center
Director, Leids Kerkhoven Bosscha Fonds
Director, Leids Sterrewacht Fonds
Director, Oort Foundation
Member, Scientific Advisory Committee, SRON
Chair, Advisory Committee for Astronomy, NWO
Member, ESO Contact Committee
Director, Netherlands Research School for Astronomy, NOVA

Appendix IV

Visiting scientists

Visiting scientists

Appendix IV

Name	Dates	Institute
W. Cotton	Jan 1 – Jul 1	NRAO, USA
S. Pluzhnyk	Jan 4	MPIfR, Bonn, Germany
R. Ivison	Jan 29 – Feb 5	University College London, UK
N.R. Mohan	Feb 2 – Mar 16	Raman Res. Inst., Bangalore, India
G. Rudnick	Feb 7 – Feb 11	MPIfA Heidelberg, Germany
G. Illingworth	Feb 7 – Feb 11	UC Santa Cruz, USA
P. Rosati	Feb 8 – Feb 10	ESO, Garching, Germany
M. Postman	Feb 8 – Feb 10	STScI, Baltimore, USA
H. Ford	Feb 8 – Feb 10	Johns Hopkins Univ., Baltimore, USA
H.-U. Käufl	Mar 14 – Mar 15	ESO, Garching, Germany
J. Peebles	Apr 22 – May 24	Princeton University, USA
C. Wright	May 1 – May 12	UCN, Australia
D. Johnstone	May 1 – Jun 30	University of Toronto, Canada
P. van Dokkum	May 7 – May 11	Caltech, Pasadena, USA
A. Lim	May middle	University College London, UK
S. Doty	May 17 – Jun 15	Metropolitan State Coll., Denver, USA
V. Barhard	Jun 8 – Aug 12	Cambridge University, UK
A. Cohen	Jun 10 – Jul 10	Naval Research Lab, Washington, USA
C. Wilson	Jun 14 – Jun 19	McMaster University, Canada
T. Webb	Jun 15	University of Toronto, Canada
W.D. Geppert	Jun 17 – Jun 19	Astr. Inst. Potsdam, Germany
E. Mamajek	Jun 23 – Jun 30	University of Arizona, USA
P. Lundqvist	Jun 24 – Jun 30	Stockholm Observatory, Sweden
P. Lundqvist	Jun 24 – Jul 1	Stockholm Observatory, Sweden
K-V. Tran	Jun 25 – Jul 2	UC Santa Cruz, USA
Y. Aikawa	Jun 28 – Jul 31	Kobe University, Japan
G. Rudnick	Jul 4 – Jul 18	MPIfA, Heidelberg, Germany
J. Noel-Storr	Jul 9 – Jul 22	Columbia University, USA
J. Falkesgaard	Jul 9 – Jul 11	N. Bohr Inst., Copenhagen, Denmark
N.S. van der Bliek	Jul 23 – Jul 28	CTIO, La Serena, Chile
R.P van der Marel	Jul 25 – Jul 29	StScI, Baltimore, USA
F. Heitsch	Jul 30 – Aug 3	MPIfA, Heidelberg, Germany
R. Mathar	Aug 3	MPIfA, Heidelberg, Germany
R. McLure	Aug 6 – Aug 9	University of Oxford, UK
S. Coggins	Aug 6 – Aug 11	University of Nottingham, UK

Name	Dates	Institute
V. Barnard	Aug 6 – Aug 10	Cambridge University, England
S. Charnley	Aug 14 – Aug 23	NASA Ames Center, USA
A. Lim	Aug middle	University College London, UK
K. Gebhardt	Aug 16 – Aug 18	University of Texas, USA
L. Dunne	Sep 3 – Sep 7	University of Wales, Cardiff, UK
M. Reuland	Sep 3 – Sep 28	Lawrence Livermore Lab., USA
R. Ivison	Sep 4 – Sep 8	University of Edinburgh, UK
P. A. Whitelock	Sep 16 – Sep 23	South Afr. Astron. Obs. Cape Town
A. Biviano	Sep 17 – Sep 26	Osservatorio Astr. di Trieste, Italy
G. Rudnick	Sep 18 – Sep 22	MPfA, Garching, Germany
J. Blommaert	Sep 21 –	VILSPA, Madrid, Spain
O. Botta	Sep 24 – Sep 27	University of Chicago, USA
L. Blitz	Sep 27 – Sep 29	Univ. of California, Berkeley, USA
N.S. van der Bliek	Sep 29 – Oct 2	CTIO, La Serena, Chile
K-V. Tran	Oct 1 – Oct 6	University of California, USA
G. Blake	Oct 15 – Oct 24	Caltech, Pasadena, USA
M. Jourdain de Muizon	Oct 16	Paris Observatory, France
H. Olofsson	Oct 19 – Oct 26	Stockholm University, Sweden
M. Hempel	Nov 19 – Nov 23	Sternwarte Hamburg, Germany

Appendix V

Workshops, colloquia and lectures

Workshops, colloquia and lectures

Appendix V

V.1 Workshops and Meetings

Dutch Astrophysics Days

On March 1 and 2, Icke and Mellema organized the first Dutch Astrophysics Days, intended to bring together Dutch astronomers with a preference for theoretical astrophysics. The number of participants was approximately 27 from all institutes in The Netherlands. Of these, 12 gave presentations. D. Frenkel (AMOLF) was the guest speaker on theoretical work outside the field of astronophysics.

March 1		
Dominik	(Amsterdam)	*Modeling Young Circumstellar Disks*
Van Zadelhoff	(Leiden)	*Radiative Transport and Chemistry in Circumstellar Disks*
Larsen	(Leiden)	*Radiative Transport in Circumstellar Environments*
Hoyng	(SRON-U)	*Application of the Theory of Stochastic Processes to Mean Field Dynamos for Sun and Earth*
Frenkel	(AMOLF)	*The Astrophysics of Milk - from Colloids to the Cosmos*
March 2		
Simis	(Leiden)	*Mass Loss Variability on the AGB*
Spaans	(Groningen)	*The Polytropic Equation of State of Interstellar Gas Clouds*
Mellema	(Leiden)	*Compression of Gas Clouds in the Bow Shocks of Jets*
Van de Weygaert	(Groningen)	*The Structure of the Local Universe and the Coldness of the Cosmic Flow*
Verolme	(Leiden)	*Anisotropic Axisymmetric Galaxies with a Cusp and a Central Black Hole*
De Zeeuw	(Leiden)	*Black Holes in Galactic Nuclei*
Icke	(Leiden)	*The Unreasonable Effectiveness of Regular Hydro Grids*

Oort Workshop 2001

On May 9, 10 and 11 the Oort Meeting on Galaxy Formation was held at the Lorentz Center. Organizer was the 2001 Oort Professor J. Peebles, assisted by D. Hogg (New York), M. Fukugita (Tokyo) and M. Franx (Leiden). The purpose of the meeting was to consider what is securely known and established about galaxy formation and evolution from observational and theoretical points of view, and how research might advance our understanding. Attendance included 30 researchers from abroad, and ten from The Netherlands. As the workshop focused on discussion, only brief presentations were given to set the stage for the hour-long discussions that followed. Sessions were devoted to: *Evidence in galaxy luminosity, color, morphology, and mass functions at high redshift and low for departures from pure local (closed box) evolution*, introduced by Hogg, Franx and Ellis; *Star formation histories inferred from distant and local star populations and interstellar and intergalactic gas*, introduced by Kennicutt, Madau, Wyse and Charlot; *Galaxy formation histories of the present morphological types, ellipticals to irregulars, and whatever else is present at higher redshifts*, introduced by Silk, Wolfe, Steidel and Lilly; *Clustering and the environmental dependence of galaxy formation and evolution*, introduced by Efstathiou, Colless and Cowie; *Critical tests of structure formation models, including CDM and its variants*, introduced by Fukugita, Frenk, Ostriker and Kauffmann; and finally *How have the discussions at this meeting changed or reenforced our ideas on how the galaxies formed*, summarized by Peebles and White. A scientific report of the meeting was submitted to *Nature*. More details are listed on the Lorentz Center website: *http://www.lc.leidenuniv.nl/lc/web/2001/20010509/info.php3?wsid=24*

Symposium Honoring of Harry van der Laan

On the occasion of the 65th birthday of Harry van der Laan, director of Leiden Observatory for thirteen years, a symposium entitled *Astronomy, Leadership, Society* was held on November 29 and 30. Highlight of the symposium was the farewell lecture by Van der Laan himself: *Scholars, Concepts, Discoveries: a 3 × 3 Silhouette*. The first day of the symposium was devoted to 'Current Astronomical Research', with addresses by several colleagues, especially from places that Harry has been closely involved with, such as Leiden, Cambridge and Dwingeloo. Speakers included Miley, Braun, De Bruyn, Swarup, Graham Smith, Valentijn, Katgert, Kellermann, Windhorst, Barthel and Rees. On the second day, Van der Laan's policy and managerial interests were addressed in a session devoted to 'Other Challenges in Astronomy, Science and Society', with speakers such as Elzinga, Casse, Schillizzi, De Zeeuw, Tarenghi, Melnick, De Kort, Rotmans, Robillard and Westbroek. More details, including Harry's biography, can be found at the website:
http://www.strw.leidenuniv.nl/vdlaan/vdlaan.html

Workshop on Dynamics of Galaxies

From July 2 to July 13, De Zeeuw, Davies and Bacon organized a two-week meeting of the SAURON team, which is carrying out a systematic survey of the kinematics and linestrengths of 72 nearby early-type galaxies. The meeting was attended by nearly twenty participants from The Netherlands, France, Germany, UK, Spain and Chile. More details can be found at the website:
http://www.lc.leidenuniv.nl/lc/web/2001/20010702/info.php3?wsid=23

Faint Infrared Extragalactic Survey Meeting

Franx organized a FIRES meeting from July 9 to July 13, in which the evolution of galaxies and deep-infrared imaging stood central. Details:
http://www.lc.leidenuniv.nl/lc/web/2001/20010709/info.php3?wsid=25

NEVEC-TNO Workshop

On October 11, Bakker (NOVA-NEVEC) and Braam (TNO) organised a workshop on *Imaging with the VLTI* under the umbrella of the Dutch Joint Aperture Synthesis Team (DJAST). The workshop was aimed at educating personnel of institutes and industries in The Netherlands on the subject of optical interferometry and was attended by about 50 scientists and engineers. Program, list of attendants and proceedings can be found at the website:
http://www.strw.leidenuniv.nl/˜nevec/activities/documents/workshop_2001/

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 15:30 hours. In 2001 the colloquium series was organized by Jane Luu and Huub Röttgering.

Date	Speaker (affiliation)	Title
Jan 18	H. van Winckel (Leuven, B)	*Post-AGB Evlution*
Jan 25	F. Verbunt (Utrecht, NL)	*The Earth-Moon system*
Feb 8	A. Lancon (Strasbourg, F)	*The Spectrum of NGC 7714: Star Formation in an Interacting Starburst Galaxy*
Feb 22	A. Slyz (Heidelberg, D)	*Numerical Hydrodynamics from Gas-Kinetic Theory*
Mar 8	M. de Jong (Amsterdam, NL)	*Antares: a Cosmic Neutrino Telescope*
Mar 15	J. Tinbergen (Dwingeloo, NL)	*Optical versus Radio Aperture Synthesis: Principles and Implementation*
Mar 22	W. Baan (Dwingeloo, NL)	*Molecular characterititistics of luminous IR galaxies*
Mar 30	O. Lahav (Cambridge, UK)	*Galaxy Properties and Cosmological Parameters from the 2dF Galaxy Redshift Survey*
Apr 12	R. Gilmozzi (Garching, D)	*Science and Technology of a 100m Telescope: ESO's OWL (OverWhelmingLarge telescope) Concept*
Apr 19	R. Mushotzky (Greenbelt, USA)	*The X-ray Universe - Recent Results from XMM and Chandra*

Date	Speaker (affiliation)	Title
May 24	P. Papadopoulos (Leiden, NL)	*H_2 in Galaxies: How Much is There?*
May 31	D. S. Gunawan (Groningen, NL)	*Colliding Winds in Wolf-Rayet Binaries*
Sep 10	R. Swaters (Groningen, NL)	*The Central Mass Distribution of Dwarf and LSB Galaxies*
Sep 13	T. Oka (Chicago, USA)	*H_3^+ in the Diffuse and Interstellar Medium: Observations and Enigma*
Oct 4	M. van Kerkwijk (Utrecht, NL)	*The Isolated Neutron Star RX J1856.5-3754 and its Peculiar Hα Nebula*
Oct 11	D. Schönberner (Potsdam, D)	*Planetary Nebulae with Double Shell and Haloes: Insight from Hydrodynamical Simulations*
Oct 16	R.C. Kennicutt (Tucson, USA)	*The SIRTF Nearby Galaxies Survey*
Oct 18	Y. Wu (Toronto, CND)	*Tidal Evolution in Close-in Exoplanets*
Oct 25	H.J.G.L.M Lamers (Utrecht, NL)	*The Discovery of Massive Stars in the Bulge of M51 and the Implications for Star Formation in the Early Universe*
Nov 1	A. Ferguson (Groningen, NL)	*The Formation and Evolution of Disk Galaxies: Clues from the Local Universe*
Nov 8	J.R. Bond (Toronto, CND)	*The Parameters of Cosmic Structure Formation from recent CMB Data*
Nov 15	M. Jarvis (Leiden, NL)	*Radio Galaxies - Do They really Matter?*
Nov 22	I. Kamp (Leiden, NL)	*Formation of Jupiter-like Planets around Young A-stars: Still Possible*
Dec 6	G. Marcy (Berkeley, USA)	*The Revolution in Extra-Solar Planets*
Dec 12	P. Madau (Santa Cruz, USA)	*The End of the Dark Ages and the Reionization of the Universe*

V.3 Student colloquia

Date	Speaker	Title
Jan 22	M. Hartendorp	*The Morphological Properties Of Early Type Galaxies*
Feb 1	J. Novozamsky	*The Deuterium Shift in the 2161 cm^{-1} (= 4.63 micron) OCN^- Band*
Apr 2	R. Heijmans	*Long Period Variables with Carbon Rich Outflows*
Jun 18	J. Arts	*The Cosmic Evolution of Faint Radio Sources*
Jul 5	A. van der Wel	*Simulating the High Redshift Universe*
Sep 4	G. van de Ven	*Kinematics of Triaxial Galaxies: Solving the Jeans Equations*
Oct 22	W. van Reeven	*VLA Radio Continuum Observations of a New Sample of High Redshift Radio Galaxies*
Nov 5	R. Overzier	*Clustering of Radio Sources in the NRAO VLA Sky Survey*
Dec 11	F. Faas	*Gastemperature in Circumstellar disks: Effects of Dust-settling*

V.4 Endowed lectures

Date	Speaker (affiliation)	Title
April 26	J. Peebles (Princeton, USA)	Oort Lecture: *Het Uitdijend Heelal ontdekt*
December 4	G. Marcy (Berkeley, USA)	Sackler Lecture: *Planets and the Prospects for Life in the Universe*

Appendix VI

Participation in scientific meetings

Sterrewacht Leiden

Participation in scientific meetings

Appendix VI

Attendance of Leiden Observatory staff members at various conferences and meetings is listed here; titles of presentations at these meetings are given in *italics*.

Bakker

Science Drivers for Future VLT/VLTI Instrum. (Munich, Germany; June 11–15)
"NEVEC: the NOVA ESO VLTI Expertise Centre"
"The Pre-PRIMA Survey Project: Turning the Problem Around"

Sc. Case for Extr. Large Ground-Based Tel. (Leiden, The Netherlands; May 15–25)

Nederlands ICT-Kenniscongres (The Hague, The Netherlands, September 6–7)

Boonman

Young Astroph. Meeting 2001: Expanding Your Universe (London, UK; March 5)
"Gas-Phase H_2O and CO_2 towards Massive Protostars"

The Origins of Stars and Planets (Munich, Germany; April 24–27)
"High-Resolution Spectra toward Massive Protostars"

SRON Science Days (Dalfsen, The Netherlands; June 13–14)
"ISO-SWS Spectroscopy of Massive Young Stars"

Massive Starbirth Workshop (Boulder, USA; August 6–8)
"Probing the Birth of Hot Cores through Mid-Infrared and Submillimeter Spectroscopy"

Van Broekhuizen

EYU 2001 (London, UK; March 5)

Tulip School on Spectroscopy (Noordwijkerhout, The Netherlands; May 1-4)

Astrobiology Meeting (Amsterdam, The Netherlands; May 15–16)

NOVA School (Dwingeloo, The Netherlands; October 8–12)
"CRYOPAD"

Ann. Conf. on Astrobiol., Astrochem. and Phys. 2001 (Birmingham, UK; July 30 – August 8)
"CRYOPAD a New Instrument for the Experimental Study of Hot-Core Chemistry (poster)"

Brown

GAIA, a European Space Project (Les Houches, France; May 14–18)
"Preparing for the GAIA Mission"

Meeting on Scientific Preparations for GAIA (Noordwijk, The Netherlands; June 27–28)

GAIA RVS Group Workshop (Meudon, France; October 1–2)
"Construction of a Database of Real Spectra"

The Gould Belt and Other Large Star-Forming Complexes (Garching, Germany; October 24–26)
"On the Origin of the Dispersed Population of Young Stars in Gould's Belt"

GAIA Photometry Working Group: Progress Meeting (Barcelona, Spain; November 28–30)
"Observed Spectra for GAIA"

Burton

HI Surveys of the Milky Way (Green Bank, USA; May 21–24)
"The Life and Times of the Dwingeloo Telescope"

Cappellari

Galaxies: The Third Dimension (Cozumel, Mexico; December 3–7)
"Adaptive Spatial Binning of 2D Spectra and Images"

SAURON Meeting (Leiden, The Netherlands; July 2–6)
"Photometry of the SAURON Sample"

Van Dishoeck

Annual Meeting of NNV (Lunteren, The Netherlands; February 14)
"From Molecules to Planets (Invited Lecture)"

Spectroscopy in the 21'st Century (Hayama, Japan; March 18–22)
"Infrared Spectroscopy of Interstellar Gas and Dust: from ISO to NGST (Invited Lecture)"

National Astronomy Meeting Japan (Tokyo, Japan; March 26)
"From Molecules to Planets: prospects for ALMA (Invited Lecture)"

The Origins of Stars and Planets (Garching, Germany; April 24–27)
"Star- and Planet-Formation with ALMA (Invited Lecture)"
"Gas and Ices in Star-Forming Regions: First Results from VLT-ISAAC"

American Astrotomical Society Meeting (Pasadena, USA; June 1-4)
"From Molecular Cores to Protoplanetary Disks: a SIRTF Legacy Program"

The Dynamics, Structure and History of Galaxies (Dunk Island, Australia; July 29 – August 2)
"From Molecules to Planets (Invited Lecture)"

Herschel Preparatory Science Meeting (Leiden, The Netherlands; October 22–24)
"Overview of Molecular Line Modeling Methods"

Ehrenfreund

Vienna Planetarium (Vienna, Austria; January 8)
"Astrobiologie"

ESA Topical Team Selection (Noordwijk, The Netherlands, February 5–6)
"Physico-Chemistry of Ices in Space"

European Geophysical Society (Nice, France; March 26–31)
"Laboratory Studies and Observations of Organics in Space"

ESEG Workshop (Noordwijk, The Netherlands, April 2–3)

American Chemical Society (San Diego, USA; April 3–5)
"Amino Acids in Space Environment"

Astrobiology Workshop (Washington DC, USA; April 12)
"Formation and Evolution of Complex Organics in Space"

Dutch Microgravity/Astrobiology Meeting (Amsterdam, The Netherlands, April 15–16)
"Astrobiology in The Netherlands"

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; April 17)
"Pastoor-Schmeits-Prize Address"

First European Exo/Astrobiology Workshop (Rome, Italy; May 21–24)
"From Astrochemistry to Astrobiology"

SETI Strategic Meeting LITU (San Jose, USA; May 31 – June 4)
"Complex Chemistry in Space"

Kuiper Belt Meeting (Paris, France; June 5–8)
"From the Interstellar Medium to KBOs and Comets"
"Thermal and Radiation Processing of Ices and Organics: Laboratory Spectroscopy"

Topical Team Meeting (Noordwijk, The Netherlands; June 12–13)
"Physico-Chemistry of Ices in Space"

RSC - Astrochemistry of Life (Birmingham, England; August 1–2)
"Formation and Evolution of Organics (in particular Amino Acids) in Space"

SETI Strategic Meeting LITU (San Jose, USA; September 7–10)

ISSI Workshop: Prebiotic Matter in Space (Bern, Switzerland; October 14–18)
"The Interstellar Medium: Solid State"

Herschel Workshop (Leiden, The Netherlands; October 22–24)

Life in the Universe, CERN (Geneva, Switzerland; November 7–11)
"Expert Contribution"

Topical Team Meeting (Paris, France; December 10–11)
"Physico-Chemistry of Ices in Space"

Förster Schreiber

Dwarf Galaxies and their Environment (Bad Honnef, Germany; January 23–27)
"Nature and Evolution of Starburst Activity — Clues from the Near- and Mid-Infrared"

A New Era in Cosmology (Durham, United Kingdom; September 11–15)
"FIRES: First Results of the MS1054-03 Field"

Franx

New Era In Cosmology (Durham, USA; September 10–14)
"Very Deep Infrared Imaging with the VLT"

Formation and Evolution of Ell. Galaxies (Ringberg, Germany; November 26-30)
"First Results from the FIRE Survey"

The Mass of Galaxies at High and Low Redshift (Venice, Italy; October 24–26)
"The Future of Mass Measurements"

Fraser

AVS 2001 (San Francisco, USA, October)
"Physico-Chemical Properties of CO-containing ices"

Gordon Research Conference (Proctor Academy, USA, Augus)
"Surface Reactions between H_2O and CO in the Interstellar Medium"

Astrochemistry of Life, RSC Annual Conference 2001 (Birmingham, U.K. August)
"Surface Reactions in the ISM: Implications for the Origins of Life"
"A New Apparatus to Study Surface Chemistry in Hot-Core Regions"

International Conference on Surface Science (London, UK, April)
"Laboratory Studies of the Chemistry of Ices on Model Interstellar Dust Particles"

ICAPS Phase A Study Meeting (The Netherlands, June)
"Physico-chemistry of Ices in Space"

Dutch Microgravity/Astrobiology Meeting (Amsterdam, The Netherlands, April 15–16)
"Ice in Microgravity Conditions"

Van Genderen

Stars with Extended Atmospheres: Meeting in Honour of the 80th Birthday Prof. C. de Jager (Utrecht, The Netherlands; May 3)
"Cyclicities in the Brightness of P Cygni"

Greenberg

Liquids in Space (Bad Honnef, Germany, January 29–31)
"Ice versus water in comets and asteroids"

The Physical Properties of Potential Earth Impactors (Erice, Italy, June 17–25)
"The comet nucleus: a basic interstellar dust aggregate"

Habing

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May, 16–19)

IAU Symposium on Planetary Nebulae (Canberra, Australia; November 18–27)

Haverkorn

Dutch Astrophysics Days (Leiden, The Netherlands; March 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; October 9–12)
"Parsec-Scale Structure in the Warm ISM from Polarized Galactic Radio Background Observations"

Van der Heijden

55e Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May 10–12, 2000)
"Frederik Kaiser (1808–1872) and the Modernisation of Dutch Astronomy"

The Changing Image of the Sciences (Amsterdam, The Netherlands; June 15–16, 2000)

Colloquium of the Working Group for the History of Astronomy the Annual Scientific Meeting of the Astronomische Gesellschaft (Bremen and Lilienthal, Germany; September 18–21, 2000)
"Frederik Kaiser (1808–1872) and the Modernisation of Dutch Astronomy"

De maatschappelijke taak van wetenschapsstudies (Utrecht, The Netherlands; November 24. 2000)

Fifth Biennial History of Astronomy Workshop (Notre Dame, USA; July 5–8)
"Frederik Kaiser (1808–1872) and the Modernisation of Dutch Astronomy"

De Kon. Akad. en de Tweede Gouden Eeuw (Amsterdam, The Netherlands; September 19)

De Rol van de Maatschappij tijdens het Proces van Losmaking tussen Wetenschap en Samenleving (1840–1880) (Haarlem, The Netherlands; November 2)

Jarvis

QSO Hosts and their Environments (Granada, Spain; January 10–12)
"The Radio Galaxy K-z Relation to $z \approx 4.5$"

Escape of Energy/Metals from Galaxies/AGN and its Effect on the IGM/ICM (Durham, UK; June 1–2)
"Lyman$-\alpha$ Emission around High-Redshift Radio Galaxies"

The Mass of Galaxies from Low to High Redshift (Venice, Italy; October 24–26)
"The Mass of Radio Galaxies from Low to High Redshift"

Jørgensen

Young Astroph. Meeting: Expanding Your Universe 2001 (London, UK; March 5)

Formation of Stars and Planets: The VLT view (Garching, Germany; April 24–27)

The Ann. Meeting of the Danish Phys. Soc. (Nyborg, Denmark; May 31–June 1)
"Tracing the Evolution of Low-Mass Protostars"

Kamp

Dutch Astrophysics Days (Leiden, The Netherlands, March 1–2)

ICM meeting (Amsterdam, The Netherlands; April 10)
"Disk Models for Young A Stars"

Joint European and Nat. Astr. Meeting (Munich, Germany; September 10–15)
"Gas/Dust Separation in Circumstellar Disks"

ICM meeting (Leiden, The Netherlands; November 8)

DFG Abschlußkolloquium (Bad Honnef, Germany; November 12–13)
"Gas and Dust Disks around Young A Stars"

Katgert

Workshop on Galaxy Clusters (Sesto Pusteria, Italy; July 2–7)
"Segregation of Cluster Galaxies and Cluster Substructure"

Knudsen

RTN: Damped Lyα Absorbers (Garching, Germany; January 26–27)
"Dust in Damped Lyα Absorbers"

Krajnović

The Central Kiloparsec of Starbursts and AGNs (La Palma, Spain; May 7–11)
"Ionized Gas in Spheroids: The SAURON Survey"

The Formation and Evolution of Giant Elliptical Galaxies (Tegernsee, Germany; November 26–30)

Kurk

Dutch Astrophysics Days (Leiden, The Netherlands; March 1–2)

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May 16–18)
"Lyman-Alpha Emitters around High Redshift Radio Galaxies"

RTN Meeting: Feedback in Galaxies (Durham, UK; June 1–2)
"Chaotic Kinematics of Gas in a z=2.2 Radio Galaxy"

Tracing Cosmic Evolution with Galaxy Clusters (Sesto, Italy; July 3–6)
"Large Scale Structure Associated with High Redshift Radio Galaxies"

RTN Annual Meeting (Eibsee, Germany: October 7–11)
"Lyman-Alpha Emitters, High Redshift Radio Galaxies and Large Scale Structure"

Labbé

FIRES Workshop (Leiden, The Netherlands; September 11–15)

Conference: A new Era in Cosmology (Durham, UK; September 11–15)
"Ultradeep Near-Infrared ISAAC Observations of the Hubble Deep Field South (poster)"

ESO/USM Workshop on The Mass of Galaxies at Low and High Redshift (Venice, Italy; October 24–26)
"Ultradeep Near-Infrared ISAAC Observations of the Hubble Deep Field South; Selecting High-Redshift Galaxies in the Rest-Frame Optical"

Lacerda

Statistical Challenges in Modern Astronomy III (Pittsburgh, USA; July 18–21)

Physical Properties of Kuiper Belt Objects (Meudon, France; June 5–8)

Lub

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May 16–18)

A Memorial to Jan van Paradijs (Amsterdam, The Netherlands; June 6–8)
"Remembering Jan van Paradijs"

ω **Centauri: A Window into Astrophysics** (Cambridge, UK; August 13–16)
"The Reddening of ω *Centauri"*

Mellema

RTN Workshop on Computational Investigations of the Intergalactic Medium (Garching, Germany; April 9–10)
"Squashing Clouds into Stars"

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May 16–18)
"Squashing Clouds into Stars"

Conference on Computational Physics 2001 (Aachen, Germany; September 5–8)
"Maartje: Three-Dimensional Astrophysical Gas Dynamcis with Radiative Transfer"

RTN The Physics of the IGM Annual Meeting (Eibsee, Germany; October 6–11)
"Survival of Intergalactic Clouds in Jet Cocoons"

IAU Symposium 209: Planetary Nebulae, Their Evolution and Role in the Universe (Canberra, Australia; November 19–23)
"Dynamcis of [WR] Planetary Nebulae"

Dutch Supercomputer User Meeting (Amsterdam, The Netherlands; December 13)
"Astrophysical Flows from Small to Large Scales"

Mengel

Extragalactic Star Clusters (Pucon, Chile; March 12–16)
"IFS and IR Observations of Star Clusters in the Antennae"

Probing the Origin of the Extragalactic Background Radiation (London, UK; September 25–26)
"Star Clusters in Mergers - What Do They Have to Do with the CIB?"

The Evolution of Galaxies - II. Basic Building Blocks (Réunion, France; October 16–21)
"Star Formation in NGC 4038/4039 as seen in the NIR"

Messineo

Cosmic Masers, IAU Symposium 206 (Mangaratiba, Brazil; March 5–10)
"Late-Type Stars in the Galactic Bulge and SiO Masers"

ISM Meeting (Amsterdam, The Netherlands; April 10)
"Late-Type Stars in the Galactic Bulge and SiO Masers"

The Spheroidal Components of Galaxies (Garching, Germany; December 6–7)
"86 GHz SiO Maser Survey in Late-Type Stars in the Inner Galaxy"

Miley

Nature of Quasars (Granada, Spain; January 10–17)

Science with the Low-Frequency Array (West Ford, USA, October 16–19)

Ollongren

Workshop on Interstellar Message Construction (Toulouse, France; September 30 – October 2)
"On Induction in CETI"
"On formalisation in CETI"

52th International Astronautical Congress (Toulouse, France; October 1–5)
"An Experiment in CETI"

Pontoppidan

Star Formation: The VLT View (Garching, Germany; April 21–27)

Röttgering

XXM Large Scale Structure Survey Consortium Meeting (Milan, Italy; March 6–7)
"Radio Observations of the XMM-LSS fields"

MIDI Science Meeting (Heidelberg, Germany; March 26–27)

Microgravity/Astrobiology Workshop (Amsterdam, The Netherlands; May 15–16)
"Characterzing Earthlike Planets Orbiting Nearby Stars and Darwin, ESA's Infrared Space Interferometer Mission"

Darwin Science Advisory Group Meeting (Noordwijk, The Netherlands; May 17)
"Astrophysical Imaging with Darwin"

First Stars and the Reionization of the Universe (Firenze, Italy, June 29–30)
"The Low-Frequency Radio Telescope LOFAR"

The Physics of the Intergalactic Medium (Eibsee, Germany, October 6–9)
"High Redshift Radio Galaxies and their Environments"

LOFAR workshop (Westford, USA, October 15–19)
"LOFAR and the Star-Bursting Universe"

Symp. Nederlandse Vereniging voor Ruimtevaart (Utrecht, The Netherlands; November 2)
"The Infrared Space Interferometer Darwin"

ESO Distant Cluster Survey Meeting (Munich, Germany, December 2–4)

Terrestrial Planet Finder Final Architecture Meeting (San Diego, USA, December 10–16)

NEVEC-TNO workshop on Imaging with the VLTI (Leiden, The Netherlands; October 11)
"Extragalactic Science with the VLTI"

The Science Case for Extremely Large Telescopes (Leiden, The Netherlands; May 14–25)
"Astrophysical Imaging with DARWIN"

Schilizzi

DG-IST (Brussels, Belgium, January 17)
"eEVN"

Global Grid Forum 1 (Amsterdam, The Netherlands; March 6–7)
"eEVN"

NOVA Instrumentation Day (Utrecht, The Netherlands; March 13)
"Future Developments in VLBI"

GRID workshop (Brussels, Belgium; March 23)

Annual Meeting of the Trans-European Research Networks Association (Antalya, Turkey, May 14–18)
"Research Networks and Astronomy"

Joint European and National Astronomical Meeting (Munich, Germany, September 10 -11)
"RadioNET, the Infrastructure Cooperation Network in Radio Astronomy"

5th Hellenic Astronomical Conference (Crete, Greece, September 20–25)
"High-Angular Resolution Radioastronomy"

LOFAR Workshop (West Ford, USA, October 13–17)

Dwingeloo-Bonn Neighbourhood Meeting (Dwingeloo, TheNetherlands; October 30)

SRT Workshop (Cagliari, Italy, November 6–10)
"VLBI and the Sardinia Radio Telescope"

H. van der Laan Symposium (Leiden, The Netherlands; November 29)
"The Early Days of VLBI in Europe"

SKA High-Resolution Workshop (Bonn, Germany; December 10–11)
"Workshop Summary"

Schutte

Physical Properties of Kuiper Belt Objects (Paris, France; June 5–8)

Interstellar Silicate Workshop (Leiden, The Netherlands; April 17–20)

From Interstellar Dust to Comets: A Journey through Space and Time – A Symposium in Honour of the 80th Birthday of J. Mayo Greenberg (Leiden; September 17)
"The Photochemistry of Interstellar Ices"

Venemans

Tracing Cosmic Evolution With Galaxy Clusters (Sesto Pusteria, Italy; July 3–6)

Verolme

Nederlandse Astronomen Conferentie (Dalfsen, The Netherlands; May 16–18)
"Dynamics of Early-Type Galaxies: The SAURON project"

SAURON Team Meeting (Leiden, The Netherlands; July 2–14)
"Axisymmetric Three-Integral Schwarzschild Models (of M32)"

NOVA Herfstschool (Dwingeloo, The Netherlands; October 8–12)
"Dynamical models of Early-Type Galaxies"

Giant Elliptical Galaxies (Tegernsee, Germany; November 26–30)
"Dynamics of Early-Type Galaxies"

Vlemmings

IAU Symposium 206, Cosmic Masers: From Protostars to Black Holes (Angra dos Reis, Brazil; March 5–10)
"Circular Polarization of Circumstellar Water Masers"

Monitoring of AGB stars (Nice, France; May 10)

Van der Werf

2nd Hellenic Cosmology Workshop (Athens, Greece; April 19–20)
"Probing the Evolution of Galaxies using Redshifted Hα Emission"

Science with Extremely Large Telescopes (Lorentz Centre, Leiden; May 14–25)
"Starburst Galaxies"

Scientific Drivers for ESO Future VLT/VLTI Instrumentation (Garching, Germany; June 11–13)

Faint InfraRed Extragalactic Survey Workshop (Leiden, The Netherlands; July 9–13)

Science with HIFI (Leiden, The Netherlands; October 16–19)
"Extragalactic Astronomy with HIFI"

Wilman

National Astronomy Meeting (Cambridge, UK; April 2–6)
"The Environments of ULIRGs"

Physics of the Intergalactic Medium (Eibsee, Germany; October 6–12)
"Exciting H_2 in Cooling Flows"

De Zeeuw

AURA Annual Meeting (Tucson, USA, April 24)
"Future Large UVOIR Space Telescope (Discussion Group Report)"

Workshop in Honor of Paul Murdin (La Palma, Spain, October 10)
"The SAURON Project (invited talk)"

Conference in Honor of Ken Freeman (Dunk Island, Australia, July 31)
"Into the Future with GAIA (Invited Talk)"

Ringberg Conference (Germany, November 26)
"The SAURON Project (Invited review)"

Appendix VII

Observing sessions abroad

Sterrewacht Leiden

Observing sessions abroad

Appendix VII

Brown
ESO 3.6m ADONIS (La Silla, Chile; June 5–9)

Burton
Arecibo Radio Telescope (Arecibo, Puerto Rico; August 16–28)

van Dishoeck
ESO VLT (Paranal, Chile; January 6–12)

Ehrenfreund
ESO VLT (Paranal,Chile; September 24–27)

Förster Schreiber
WHT (La Palma, Spain; October 31–November 2)

Israel
JCMT (Hawaii, USA, January 13–27)

Jarvis
ESO NTT (La Silla, Chile; October 6–10)
INT (La Palma, Spain; December 20–24)

Jørgensen
OVRO (California, USA; January 6–13)
JCMT (Hawaii, USA; May 3–14)
JCMT (Hawaii, USA; August 20–29)

Knudsen
JCMT (Hawaii, USA; May 1–13)

Krajnović
WHT (La Palma, Spain; March 14–26)

Kurk
ESO VLT (Paranal, Chile; March 24–27)

Labbé
WHT (La Palma, Spain; November 1–4)

Lacerda
Dutch 0.9m (La Silla, Chile; January 15–February 3)
WHT (La Palma, Spain; February 8–15)
INT (La Palma, Spain; February 26–March 7)
ESO 2.2m (La Silla, Chile; April 5–15)
WHT (La Palma, Spain; September 11–18)
ESO 2.2m (La Silla, Chile; September 25–October 11)
Danish 1.54m (La Silla, Chile; September 25–October 11)
INT (La Palma, Spain; November 22–27)

Mengel
ESO VLT (Paranal, Chile; April 12–16)
ESO VLT (Paranal, Chile; December 5–8)

Messineo
IRAM 30m (Bonn, Germany; May 22 – 28)
ESO 3.6m (La Silla, Chile; June 30 – July 01)

Meijerink
Dutch 90cm (La Silla, Chile; October 12–November 16)

Miley
ESO VLT (Paranal, Chile; May 15–23)
ESO VLT (Paranal, Chile; September 18–25)

Pontoppidan
ESO VLT (Paranal, Chile; November 11–16)

Röttgering
JCMT (Hawaii, USA, February 21–27)

Schöier
OVRO (Owens Valley, USA; January 6–13)
SEST (La Silla, Chile; April 20–24)

Van der Werf
JCMT (Hawaii; January 25–30)

Wilman
ESO VLT (Paranal Observatory, Chile; 8–9 December)

Appendix VIII

Working visits abroad

Sterrewacht Leiden

Working visits abroad

Appendix VIII

Bakker
MPIfA (Heidelberg, Germany; January 28–30)
MPIfA (Heidelberg, Germany; March 26–28)
ESO (Garching, Germany; May 21)
ESO (Garching, Germany; July 12)
MPIfA (Heidelberg, Germany; August 13–17)
MRAO (Cambridge, UK; September 19–21)
MPIfA (Heidelberg, Germany; November 4–6)
MPIfA (Heidelberg, Germany; November 14–16)

Boonman
Denison University (Granville OH, USA; August 9–23)
University of Texas (Austin TX, USA; August 23– Sept 9)
Harvard-Smithsonian Center for Astrophysics (Cambridge MA, USA; Sept 9–21)

Brown
ESO (Garching, Germany; April 2 – August 31)
IA-UNAM (Ensenada, Mexico; July 7 – August 05)
ESO (Garching, Germany; September 21 – October 01)
ESO (Garching, Germany; October 7–14)
ESO (Garching, Germany; November 8–18)
ESO (Garching, Germany; December 13–18)

Van Dishoeck
University of Chile (Santiago, Chile; January 15)
Space Telescope Science Institute (Baltimore, USA; January 24–25)
Tokyo University (Tokyo, Japan; March 22)
ISAS (Tokyo, Japan; March 23)
Nobeyama Radio Observatory (Nobeyama, Japan; March 24–25)
Steward Observatory, University of Arizona (Tucson, USA; April 19–21)
ESA Headquarters (Paris, France; April 26–27)
CfA/Harvard University (Cambridge, USA; May 30–June 1)
European Southern Observatory (Garching, Germany; June 11–12)
University of Jena (Jena, Germany; June 29–30)
NASA Headquarters (Washington, USA; August 21–22)
University of Chile (Santiago, Chile; September 11–13)

ESA Headquarters (Paris, France; September 20–21)
NSF Headquarters (Washington, USA; October 29–31)
Cornell University (Ithaca, USA; November 1–2)
Rensselaer Polytechnic Institute (Troy, USA; November 5–6)
UMIST (Manchester, UK; November 12–13)
University of Nottingham (Nottingham, UK; November 13–14)
University College London (London, UK; November 15)
King's College (London, UK; November 16)

Ehrenfreund
Centro Astrobiologica (Madrid, Spain; February 24–27)
Univ. Innsbrück (Innsbrück, Austria; March 1)
Univ. Vienna (Vienna, Austria; February 28-March 10)
ESEG Working Group, ESA Headquarters (Paris, France; March 21)
Scripps, USCD (San Diego, USA; April 6–8)
NASA AMES Research Center (Moffett Field, USA; April 9–10)
Univ. Washington (Seattle, USA; April 11)
Univ. Vienna (Vienna, Austria; May 3–8)
ESEG Working Group, ESA Headquarters (Paris, France; May 11)
Univ. Vienna (Vienna, Austria; May 25–28)
Univ. Vienna (Vienna, Austria; June 16–30)
ESEG Working Group, ESA Headquarters (Paris, France; July 10)
NASA AMES Research Center (Moffett Field, USA; September 3–7)

Förster Schreiber
Universitäts-Sternwarte Göttingen (Göttingen, Germany; April 17–20)
Osservatorio Astrofisico di Arcetri (Firenze, Italy; May 27–June 8)

Franx
University of Lyon (Lyon, France; February 1–3)
University of Durham (Durham, UK; April 3–4)
Johns Hopkins University (Baltimore, USA; March 5–8)
Caltech (Pasadena, USA; March 8–13)
Center for Astrophysics (Cambridge, USA; July 23–27)
University of Arizona (Tucson, October 30–November 3)
Caltech (Pasadena, USA; November 10–16)

Fraser
University of Nottingham (Nottingham, UK, March 6–11)
University of Nottingham (Nottingham, UK, April 22–26)
University of Nottingham,(Nottingham, UK, July 27 - Aug 3)
University of Toronto, (Toronto, Canada, August 18–23)
University of Nottingham, (Nottingham, UK, September 29 - Oct 4)
ESA Parabolic Flight Campaign (Bordeaux, France, October 15–16)
University of Nottingham, (Nottingham, UK, November 3–7)

Kayser Threde (Munich, Germany, November 16–18)
Society of Chemical industry (London, UK, November 27)
ESA Headquarters (Paris, France, December 10–11)

Habing
IAP (Paris, France; February 2)
South African Astronomical Observatory (Cape Town, South Africa; February 9–24)
Astronomy Department (Bologna, Italy; May, 4–5)

Haverkorn
MPIfA (Heidelberg, Germany; January 26 – 31)
HIA/DAO (Victoria, Canada; December 5–9)
DRAO (Penticton, Canada; December 9–14)
Center for Astrophysics (Boston, USA; December 14–19)

Israel
Board Meeting EPN (Paris, France, October 6)

Jaffe
MPIfA (Heidelberg, Germany; January 28–30)
MPIfA (Heidelberg, Germany; March 27–28)
European Southern Observatory (Garching, Germany; April 8–11)
MPIfA (Heidelberg, Germany; May 6–9)
ESO–Paranal, VINCI commissioning (Chile; May 29–June 17)
IAP (Paris, France; July 8–11)
Observatoire de Haute Provence (France; August 29–September 1)
MPIfA (Heidelberg, Germany; October 1–2)
MPIfA (Heidelberg, Germany; November 15–17)
MPIfA (Heidelberg, Germany; December 11–13)

Jarvis
Oxford University (Oxford, UK; December 7–14)

Jørgensen
Caltech (Pasadena, California, USA; January 14–18)
Steward Observatory (Tucson, Arizona, USA; September 1–8)

Kamp
Institute for Astronomy (Wien, Austria; March 23–30)
Inst. for Theoretical Physics and Astrophysics (Kiel, Germany; December 14–18)

Katgert
Osservatorio Astronomico (Trieste, Italy; Mar 7–14)

Knudsen
Cavendish Laboratory (Cambridge, UK; July 22–28)

Lub
ESO (Garching, Germany; May 27 – June 1)
ESO (Garching, Germany; November 25–30)

Mellema
UCL (London, UK; February 12–17)
MPIfA (Heidelberg, Germany; May 27 – June 1)

Mengel
MPE (Garching, Germany; February 5–9)
MPE (Garching, Germany; August 21–24)
MPE (Garching, Germany; November 26–30)

Messineo
IAP (Paris, France; February 12 – 16

Miley
Johns Hopkins University (Baltimore, USA; March 3–8)
Space Telescope Science Institute (Baltimore, USA; March 21–26)
Space Telescope Science Institute (Baltimore, USA; April 16–24)
Opticon Board (Münich,Germany; September 10-11)
European Southern Observatory (Munich, Germany; Septemer 28)
Space Telescope Science Institute (Baltimore, USA; October 22–27)

Pontoppidan
Caltech (Pasadena, California; March 12–21)
Caltech (Pasadena, California; September 17–28)

Röttgering
Royal Observatory (Edinburgh, UK, January 9–12)
PPARC Headquarters (Swindon, UK, June 11–12)
Royal Observatory (Edinburgh UK, November 21–23)

Schöier
Caltech (Pasadena, USA; January 14–18)

Verdoes Kleijn
Space Telescope Science Institute (Baltimore MD, USA; February 19 – March 1)

Verolme
University of Durham (Durham, UK; April 16–24)

Van der Werf
European Southern Observatory (Garching, Germany; April 3–4)
European Southern Observatory (Garching, Germany; April 23–24)
Oxford University (Oxford, UK; June 7–8)
European Southern Observatory (Garching, Germany; October 11–12)
PPARC (London, UK; October 25)

De Zeeuw
Ecole Normale Superieure (Lyon, France; February 2)
Space Telescope Science Institute (Baltimore, MD, USA; February 20–21)
Observatory Roque de los Muchachos (La Palma, Spain; March 14–19)
Dept. of Physics and Astronomy (Durham, UK; April 3–6)
Dept. of Physics and Astronomy (St. Andrews, UK; April 9–10)
Steward Observatory (Tucson, AZ, USA; April 18–27)
ETH (Zürich, Switzerland; April 30)
Instituto Astrofysica de Canarias (Tenerife, Spain; May 7–8)
British National Space Centre (London, UK; May 23)
Space Telescope Science Institute (Baltimore, MD, USA; June 12–17)
PPARC/Medical Research Council (London, UK; September 6–7)
Instituto Astrofysica de Canarias (Tenerife, Spain; October 17–18)
Observatory Roque de los Muchachos (La Palma, Spain; October 18–22)
Instituto Astrofysica de Canarias (Tenerife, Spain; October 23)
Space Telescope Science Institute (Baltimore, MD, USA; November 5–8)
University of Texas (Austin, TX, USA; December 4–9)

Appendix IX

Colloquia given outside Leiden

Colloquia given outside Leiden

Appendix IX

Boonman

"Molecular Spectroscopy of Massive Young Stars"	Univ. of Texas, Austin, USA; August 31
Idem	Center for Astrophysics, Cambridge, USA; September 12

Brown

"The Binary Population in OB Associations"	ESO, Santiago, Chile; May 31

Burton

"The Nature of the High-Velocity Hydrogen Clouds"	College of William & Mary, Williamsburg, Virginia, USA; October 5
"Recent Results on Compact High-Velocity Clouds"	Boston University, Boston, Massachusetts, USA; October 22
"Simulations of the Distribution of High-Velocity Clouds"	NRAO, Charlottesville, Virginia, USA; December 5

Cappellari

"The SAURON Project: Dynamical Modeling Tools"	Padova University, Padua, Italy; December 21

Van Dishoeck

"ISO's View on Star- and Planet Formation"	University of Chile, Santiago, Chile; January 16
"Van Molecuul tot Planeet"	Spinoza Ceremony, The Hague, The Netherlands; January 30
"Mid-Infrared Science with the NGST"	University of Utrecht, Utrecht, The Netherlands; March 13
"From Molecules to Planets"	Deptartment of Physics and Astronomy, Amsterdam, The Netherlands; March 15
"ISO's View on Star- and Planet Formation"	ISAS, Tokyo, Japan; March 23
"From Molecules to Planets: the Realm of Astrochemistry" *(Marc Aaronson Memorial Lecture)*	Steward Observatory, Tucson, USA; April 20
"Molecules on a Space Odyssey" *(Sackler lecture)*	Harvard University, Cambridge, USA; May 31
"Cosmochemistry: Prospects for ALMA"	University of Chile, Santiago, Chile; September 13

"Chemistry during Star- and Planet Formation" (Bourke Prize Lecture)	UMIST, Manchester, UK; November 12
"Chemistry between the Stars" (Bourke prize lecture)	Dept. of Chemistry, Nottingham, UK; November 14
"The Chemical Building Blocks of Planets: Gases, Ices and Silicates in Disks around Young Stars"	Dept. of Chemistry King's College, London, UK; November 16
"Infrared Spectroscopy from Space"	AMOLF, Amsterdam, The Netherlands; November 26
"Searching for the Building Blocks of Planets"	KNAW, Amsterdam, The Netherlands; November 26
"Gas and Dust in Protoplanetary Disks"	Steward Observatory, Tucson, USA; April 19
Idem	ASTRON/JIVE, Dwingeloo, The Netherlands; May 11
Idem	Astronomy Department, Jena, Germany; June 29
Idem	Cornell University, Ithaca, USA; November 1
Idem	UMIST, Manchester, UK; November 13
Idem	Kapteyn Institute, Groningen, The Netherlands; December 10

Ehrenfreund

"Staub und Moleküle in der Galaxis"	Univ. Innsbrück, Innsbrück, Austria; March 1
"Complex Organic Molecules in the Interstellar Medium and Comets"	Univ. Washington, Seattle, USA; April 11
"Astrobiology - the Search for Life in the Universe"	Univ. Nijmegen, The Netherlands, October 9
"Ices and organics: A Voyage from Dark Clouds to the Early Earth"	Univ. Amsterdam, The Netherlands; November 20

Förster Schreiber

"Star Formation Histories of Starburst Galaxies — The Infrared Perspective"	Universitäts-Sternwarte Göttingen, Göttingen, Germany; April 19
"Nature and Evolution of Starburst Galaxies — The Infrared Perspective"	Osservatorio Astrofisico di Arcetri, Firenze, Italy; June 6
Idem	ING, La Palma, Spain; November 6

Fraser

"Skating on Thin Ice Surface Chemistry in the ISM"	University of Toronto, Canada; September 8
"The CO + O reaction under Interstellar Conditions"	FOM Rijnhuizen, The Netherlands; December 18

Habing

"The Distribution of AGB Stars in our Galaxy"	Carls University, Prague, Czech Republic: December 11
"Invited talk"	Ondrejov Observatory, Ondrejov, Czech Republic, December 13

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, Victoria, Canada; December 7
Idem	Dominion Radio Astrophysical Observatory, Penticton, Canada; December 12
Idem	Center for Astrophysics, Boston, USA; December 18

Jaffe

"Very Large Telescope Interferometry and ESO"	ESTEC, Noordwijk, The Netherlands; September 21

Jarvis

"On the Redshift Cut-Off for Radio sources"	ASTRON, Dwingeloo, The Netherlands; April 27
"The Radio Galaxy K-z Relation to z=4.5"	Institute of Astronomy, Cambridge, UK; Dec 11

Kamp

"Zirkumstellare Scheiben: Frühphasen der Planetenentstehung"	Institute for Astronomy, Wien, Austria; March 26

Katgert

"Recent Evidence for an Acceleration of the Expansion of the Universe"	NIKHEF, Amsterdam, the Netherlands; November 11

Mellema

"Cometary Knots in the Helix Nebula"	Sterrenkundig Instituut, Utrecht, The Netherlands; January 10
Idem	Sterrenkundig Instituut Anton Pannekoek, Amsterdam, The Netherlands; September 13

Miley

"Probing the Early Universe with Radio Galaxies"	Kapteyn Institute, Groningen, The Netherlands; September 28

Röttgering

"The Most Distant Radio Galaxies: Probing the Formation of Massive Galaxies and Clusters"	Royal Observatory, Edinburgh, UK; January 10

Verdoes Kleijn

"The Nuclei of Nearby Radio Galaxies with HST"	University of Texas, Austin, USA; November 12
Idem	University of Colorado, Boulder, USA; November 14
Idem	University of Arizona/NOAO, Tucson , USA; November 16
Idem	CalTech, Pasadena, USA; November 19
Idem	UC Berkeley, Berkeley, USA; November 21
Idem	ESO, Munich, Germany; December 3

Van der Werf

"Probing the Cosmic Star Formation History Longwards of 1 micron"	Joint Astronomy Center, Hilo, USA; January 23

De Zeeuw

"Integral Field Spectroscopy of Galaxies: Status of the SAURON Project"	ING, Santa Cruz, La Palma; March 16
"Integral Field Spectroscopy of Galaxies: The SAURON Project"	Steward Observatory, Tucson, USA ; April 26
Idem	University of Texas, Austin, USA; December 6

Appendix X

Scientific publications

Sterrewacht Leiden

Scientific publications

Appendix X

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

M.-R. Cioni, AGB stars and other red giants in the Magellanic Clouds, Ph.D. thesis, Leiden University, September 2001.

M.-R. Cioni, J.-B. Marquette, C. Loup, M. Azzopardi, **H. J. Habing**, T. Lasserre, and E. Lesquoy, Variability and spectra of LMC giants (Cioni+ 2001), VizieR Online Data Catalog **337**, 70945+.

P. Ehrenfreund, O. Angerer, and B. Battrick, (eds), First European Workshop on Exo/Astrobiology, ESA-SP 496, 2001.

C. J. van Houten, Walraven photometry of OB stars (van Houten, 2001), VizieR Online Data Catalog **336**, 90527+.

J. K. Katgert, Westerbork Second Deep Survey (Katgert 1974), VizieR Online Data Catalog **303**, 50393+.

R. T. Schilizzi (ed.), Galaxies and their Constituents at the Highest Angular Resolutions, vol. 205, 2001.

A. P. Schoenmakers, A. G. de Bruyn, **H. J. A. Röttgering**, and H. van der Laan, Positions of giant radio galaxies (Schoenmakers+ 2001), VizieR Online Data Catalog **337**, 40861+.

Y. Simis, Mass loss modulation in dust forming stellar winds, Ph.D. thesis, Leiden University, October 2001.

S. A. Stanford, D. Stern, W. van Breugel, and **C. De Breuck**, The FIRST sample of ultraluminous IR galaxies (Stanford+, 2000), VizieR Online Data Catalog **213**, 10185+.

R. A. Windhorst, G. M. van Heerde, and **P. Katgert**, 1412 MHz catalogue of Westerbork survey. I. (Windhorst+, 1984), VizieR Online Data Catalog **405**, 80001+.

X.2 Papers in refereed journals

S. J. Adelman, T. P. Snow, E. L. Wood, I. I. Evans, C. Sneden, **P. Ehrenfreund**, and B. H. Foing, An elemental abundance analysis of the mercury manganese star HD 29647, *Monthly Notices Roy. Astr. Soc.* **328**, 1144–1150.

C. Alard, J. A. D. L. Blommaert, C. Cesarsky, N. Epchtein, M. Felli, P. Fouque, S. Ganesh, R. Genzel, G. Gilmore, I. S. Glass, **H. Habing**, A. Omont, M. Perault, S. Price, A. Robin, M. Schultheis, G. Simon, J. T. van Loon, C. Alcock, R. A. Allsman, D. R. Alves, T. S. Axelrod, A. C. Becker, D. P. Bennett, K. H. Cook, A. J. Drake, K. C. Freeman, M. Geha, K. Griest, M. J. Lehner, S. L. Marshall, D. Minniti, C. Nelson, B. A. Peterson, P. Popowski, M. R. Pratt, P. J. Quinn, W. Sutherland, A. B. Tomaney, T. Vandehei, and D. L. Welch, Mass-losing Semiregular Variable Stars in Baade's Windows, *Astrophys. J.* **552**, 289–308.

A. Ankay, L. Kaper, **J. H. J. de Bruijne**, J. Dewi, **R. Hoogerwerf**, and G. J. Savonije, The origin of the runaway high-mass X-ray binary HD 153919/4U1700-37, *Astron. Astrophys.* **370**, 170–175.

R. Bacon, **Y. Copin**, G. Monnet, B. W. Miller, J. R. Allington-Smith, **M. Bureau**, C. Marcella Carollo, R. L. Davies, E. Emsellem, H. Kuntschner, R. F. Peletier, **E. K. Verolme**, and **P. Tim de Zeeuw**, The SAURON project - I. The panoramic integral-field spectrograph, *Monthly Notices Roy. Astr. Soc.* **326**, 23–35.

A. M. S. Boonman, R. Stark, **F. F. S. van der Tak**, **E. F. van Dishoeck**, P. B. van der Wal, F. Schäfer, G. de Lange, and W. M. Laauwen, Highly Abundant HCN in the Inner Hot Envelope of GL 2591: Probing the Birth of a Hot Core?, *Astrophys. J. Lett.* **553**, L63–L67.

R. Braun and **W. B. Burton**, Status of H I searches for CHVCs beyond the Local Group, *Astron. Astrophys.* **375**, 219–226.

B. Bucciarelli, J. García Yus, R. Casalegno, M. Postman, B. M. Lasker, C. Sturch, M. G. Lattanzi, B. J. McLean, E. Costa, A. Falasca, **R. Le Poole**, G. Massone, M. Potter, A. Rosenberg, T. Borgman, J. Doggett, J. Morrison, A. Pizzuti, E. Pompei, D. Rehner, L. Siciliano, and D. Wolfe, An all-sky set of (B)-V-R photometric calibrators for Schmidt surveys. GSPC2.1: First release, *Astron. Astrophys.* **368**, 335–346.

W. B. Burton, R. Braun, and J. N. Chengalur, Arecibo imaging of compact high-velocity clouds, *Astron. Astrophys.* **369**, 616–642.

W. B. Burton, R. Braun, and J. N. Chengalur, Arecibo imaging of compact high-velocity clouds, *Astron. Astrophys.* **375**, 227+.

M. Cappellari, Nuclear Mass Concentrations in Galaxies, *Publ. Astron. Soc. Pacific* **113**, 769–769.

C. M. Carollo, M. Stiavelli, **P. T. de Zeeuw**, M. Seigar, and H. Dejonghe, Hubble Space Telescope Optical-Near-Infrared Colors of Nearby $R^{1/4}$ and Exponential Bulges, *Astrophys. J.* **546**, 216–222.

S. B. Charnley, **P. Ehrenfreund**, and Y.-J. Kuan, Spectroscopic diagnostics of organic chemistry in the protostellar environment, Spectrochimica Acta **57**, 685–704.

S. B. Charnley, S. D. Rodgers, and **P. Ehrenfreund**, Gas-grain chemical models of star-forming molecular clouds as constrained by ISO and SWAS observations, *Astron. Astrophys.* **378**, 1024–1036.

E. T. Chatzichristou, Multicolor Optical Imaging of Infrared-Warm Seyfert Galaxies. III. Surface Photometry: Light Profile Decomposition, *Astrophys. J.* **556**, 653–675.

E. T. Chatzichristou, Multicolor Optical Imaging of Infrared-Warm Seyfert Galaxies. IV. Surface Photometry: Color Distributions, *Astrophys. J.* **556**, 676–693.

E. I. Chiang, M. K. Joung, M. J. Creech-Eakman, C. Qi, J. E. Kessler, G. A. Blake, and **E. F. van Dishoeck**, Spectral Energy Distributions of Passive T Tauri and Herbig Ae Disks: Grain Mineralogy, Parameter Dependences, and Comparison with Infrared Space Observatory LWS Observations, *Astrophys. J.* **547**, 1077–1089.

D. Chochol, **C. J. van Houten**, T. Pribulla, and J. Grygar, Analysis of multicolour light curves of the eclipsing binaries AQ Tuc and AY Vel, Contributions of the Astronomical Observatory Skalnate Pleso **31**, 5–12.

M.-R. L. Cioni, J.-B. Marquette, C. Loup, M. Azzopardi, **H. J. Habing**, T. Lasserre, and E. Lesquoy, Variability and spectral classification of LMC giants: Results from DENIS and EROS, *Astron. Astrophys.* **377**, 945–954.

C. S. Crawford, A. C. Fabian, P. Gandhi, **R. J. Wilman**, and R. M. Johnstone, Infrared observations of serendipitous hard Chandra X-ray sources, *Monthly Notices Roy. Astr. Soc.* **324**, 427–442.

E. Daddi, T. Broadhurst, G. Zamorani, A. Cimatti, **H. Röttgering**, and A. Renzini, The spatial clustering of distant, z ˜ 1, early-type galaxies, *Astron. Astrophys.* **376**, 825–836.

R. L. Davies, H. Kuntschner, E. Emsellem, R. Bacon, **M. Bureau**, C. M. Carollo, **Y. Copin**, B. W. Miller, G. Monnet, R. F. Peletier, **E. K. Verolme**, and **P. T. de Zeeuw**, Galaxy Mapping with the SAURON Integral-Field Spectrograph: The Star Formation History of NGC 4365, *Astrophys. J. Lett.* **548**, L33–L36.

C. De Breuck, W. van Breugel, **H. Röttgering**, D. Stern, **G. Miley**, W. de Vries, S. A. Stanford, **J. Kurk**, and **R. Overzier**, Spectroscopy of Ultra-steep-Spectrum Radio Sources, *Astron. J.* **121**, 1241–1265.

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