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Sterrewacht Leiden **Leiden Observatory**

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Chapter 1

Review of major events

Review of major events

Chapter 1

There were several important developments at Leiden Observatory during the past year.

Leiden is heavily involved in many of the projects being undertaken by the Nederlands Onderzoekschool voor Astronomie (NOVA), an association of all the university astronomy departments in the Netherlands. The 5-year funding for NOVA awarded in 1998, begun to be translated into definite projects during 1999.

An important component of the NOVA proposal is to develop expertise in optical interferometry, emphasizing faint source science. During 1999 the NOVA - ESO VLTI Expertise Centre (NEVEC) was set up at Leiden Observatory as a joint venture between NOVA and ESO. Three full-time NEVEC staff were recruited during the past year and an additional 4 members of Leiden staff participated in the project.

During 1999, ANTU, the first element of the Very Large Telescope in Chile, was completed by the European Southern Observatory. As elaborated elsewhere in this report Leiden researchers were extremely successful in obtaining observing time on it.

Two endowments to Leiden Observatory from our kind friends and benefactors Dr. Raymond and Mrs Beverly Sackler, came to fruition during the past year. One of these supports a lecture to be held annually by a distinguished astronomer. The first Raymond and Beverly Sackler Lecture was held on 11 February by Professor Charles Townes, in the presence of the Sacklers. Professor Townes spent several days within our midst. An additional endowment was provided by the Sacklers to fund our Laboratory of Astrophysics, constituted by Professor Greenberg in the early seventies and now directed by Professor van Dishoeck. The Raymond and Beverly Sackler Laboratory of Astrophysics at Leiden Observatory was inaugurated on 11 October, by Dr. and Mrs. Sackler.

Another highlight was the visit of our 1999 Oort Professor, Sir Martin Rees, during April and May. Besides delivering the Oort Lecture on 28 April, entitled " Het Heelal van begin tot eind" and giving a series of lectures to our postgraduate students, he organized a workshop on 27 and 28 May.

According to the new regulations of the Leiden University Faculty of Mathematics and Natural Sciences a supervisory board must oversee each of the 9 research institutions within the Faculty. During 1999 such a board was appointed by the Faculty to oversee Leiden Observatory. This "Raad van Toezicht" includes Professor Dr.Ir. A.J. Berkhout, Mr. P. Morley, M.Sc., Professor dr. C.J. Oort, and Drs. P.H. Schoute. It is chaired by Professor Dr. H. van der Laan. The first annual meeting of the Board took place on June 1.

Leiden Observatory enters the new Millennium well placed to exploit the enormous opportunities in astronomical research that will be provided during the next few decades. Our staff members are heavily involved in planning new large facilities such as the Atacama Large Millimeter Array (ALMA), the Next Generation Space Telescope (NGST) and the Low Frequency Radio Array (LOFAR). However, one cloud on the horizon is the difficult financial situation of the University and Faculty and their need to economize.

Prof. dr. George K. Miley
Scientific Director,
Leiden Observatory

Chapter 2

Research highlights

Chapter 2
Research highlights

The research interests of the Leiden Observatory are very broad, ranging from the solar system to very distant galaxies. Below the highlights of results obtained in 1999 are described.

2.1 The solar system

2.1.1 The outer solar system

This year saw the final stages of surveys of the Kuiper Belt conducted by David Jewitt, Chad Trujillo, and Jane Luu at the Canada-France-Hawaii Telescope on Mauna Kea, Hawaii. Highlights include

- The publication of the results of the survey for scattered Kuiper Belt objects (those with semimajor axes $a \sim 100$ AU and high orbital excentricities). The Scattered Kuiper Belt population is found to contain $\sim 10^4$ objects with diameter ≥ 100 km, and contribute a mass of ($\sim 0.1\ M_\oplus$). This is comparable in number and mass to the Kuiper Belt inside 50 AU.
- The detection of water ice in the Centaur 2060 Chiron (believed to be an ex-Kuiper Belt object). Based on this detection, Luu et al. predict that water ice is ubiquitous in objects originating in the Kuiper Belt, although its detectability depends on the fraction of the surface covered by the ice.
- The publication of an accretion model of KBOs that takes into account velocity evolution and fragmentation. The results indicate that the original Kuiper

Belt was ~ 100 times more massive than it is now, containing a mass of order $10\,M_{\oplus}$.

2.1.2 Asteroids

In 1999 the Minor Planet Center in Cambridge, USA has given definitive numbers to 304 asteroids found by C.J. van Houten and I. van Houten-Groeneveld in the 4 surveys of 1960, 1971, 1973, and 1977.
Summary of asteroids found by the van Houtens and definitively numbered in 1999:

year of observation:	1960	1971	1973	1977		
number of asteroids:	123+4	48	66+6	56+1	=	293 field asteroids + 11 trojans

Of these 304 objects, 151 objects have been named by the IAU commission Small Bodies Names Committee. For 114 the van Houtens have proposed the name. In the "Discoverers Ranking List" of the "Dictionary of Minor Planet Names" the van Houtens are now first. The fourth edition of "Dictionary of Minor Planet Names" published 1999 was dedicated to I. van Houten-Groeneveld and Brian Marsden.

2.2 Stars and circumstellar matter

2.2.1 Wolf-Rayet stars

Veen finished his thesis work on variability of Wolf-Rayet (WR) stars. Specifically, he worked on the peculiar object WR 46 (= HD104994, WN3p), which also has been suggested to be a (kind of) cataclysmic variable. He analysed photometric data collected over the last decade, and concluded that there are enigmatic behaviours in the variability.

Based on the evasive period, it could be that the WR star is a multi-frequency non-radial pulsator. However, the combination of photometric double wave and radial velocity single wave resembles ellipsoidal variability. In that case, a low-mass non-compact companion may orbit a distorted WR star, and the variability would be due to either intrinsic variation of the WR wind, or to the orbit truly shrinking on a timescale of years.

2.2.2 S Dor variables

Van Genderen started writing a review paper on S Dor variables (or luminous blue variables) which will include an inventory of these objects in the Galaxy and the Magellanic Clouds. The goal is amongst others to summarize the scientific achievements in the 20th century on S Dor variables, emphasizing on the photometric results of the various types of instabilities and the investigation of the structure of the S Dor area on the HR-diagram. The current list contains 34 confirmed S Dor variables and a number of candidates, with their various physical and photometric parameters.

Sterken, Freyhammer, Arentoft (Brussels) and van Genderen reported and discussed the steady brightening of η Car in 1998 and 1999 and concluded that this is not an eruption, but a so-called "S Dor phase" of the central S Dor star (hided in the nebula).

This is a phase in which the star moves temporarily to the red on the HR-diagram.

2.2.3 Final, or late He-flash objects

Duerbeck, Sterken, Arentoft (Brussels), Benetti (La Palma), Liller (Viña del Mar, Chile), van Genderen, Arts, Kurk, Voskes, van der Meer (all in Leiden) and Janson, Brogt and Dijkstra (all in Groningen) continued to keep V4334 Sgr (Sakurai's Object under photometric surveillance and concluded that dust forming events occur frequently. The analysis of the observations revealed that a complete dust shell has been formed around the object. The energy distributions for the years 1996–1999 show that an ever increasing fraction of the energy is reradiated by this expanding and cooling dust shell. A comparison of time scales of the final He flash objects FG Sge, V605 Aql and V4334 Sgr, shows that the latter is the most rapidly evolving star ever.

2.2.4 Type IIn supernovae: evidence of circumstellar interaction

The most remarkable observational features of Type IIn Supernovae (SN) known up to now are: their optical spectrum which is dominated by intense emission lines and their slow luminosity and spectral evolution: ~ 0.004 mag/day. Further more, some (but not all) are among the most powerful radio supernovae and/or X-ray emitters. And finally, there are some indications that they have IR excess, due to dust formation.

The interaction of the ejecta of a supernova explosion with the dense circumstellar medium (CSM) plays a significant role in the output energy of these Type IIn Supernovae. This interaction produces a radiative shock which becomes more

and more important as the density of the CSM increases, and for densities of the order of $\sim 10^7$ cm^{-3} it is the dominant physical process. Despite being so crucial, direct observations of such dense CSM are rare. This is because when the radiative shock phenomena occurs the radius of the SN remnant is very small, making it very difficult to separate the different contributions to the received flux. This situation has now changed thanks to the high-resolution spectra (better than 10 km s^{-1}) provided by echelle spectrographs. These echelle spectra of Type IIn SN show a very narrow P Cygni line atop the broad emission lines Hα and Hβ. This narrow P Cygni profile originates in the dense and slowly expanding medium into which the SN shock progresses. This points to a massive and slow wind of the progenitor just before its explosion as Supernova.

Two Type IIn SN have been studied by Salamanca and collaborators: SN 1997ab and SN 1997eg. Following the analysis of echelle and long-slit spectra, the conclusion was reached that both supernovae were surrounded by a very dense material (density $\sim$ few $\times 10^5$ cm^{-3}) that is moving at a speed of ~ 100 km s^{-1}. If such material is created by a wind of the progenitor star just prior to the explosion, then the mass loss rate must be of the order of 10^{-2} M$_\odot$ yr^{-1}. This value is much larger than the typical mass loss rate of the winds of O stars.

2.2.5 Young stellar groups and OB associations

De Bruijne, in collaboration with Hoogerwerf and de Zeeuw, continued his work on secular parallaxes for the members of nearby young stellar groups. Secular parallaxes are determined using the "known" space motion of a moving group and the observed proper motions of its members. The relative accuracy of the secular parallaxes is of the same order as that of the proper motions, and can thus be larger than the relative accuracy of individual Hipparcos trigonometric parallaxes.

The secular parallaxes for stars in the nearby Scorpius OB2 association are $\sim$2 times more precise than the Hipparcos trigonometric parallaxes. The enhanced parallax precision significantly narrows the locus of stars in the colour-absolute magnitude diagram, and allows to resolve the parallax distribution, and thus the spatial structure, of the different subgroups. Secular parallaxes for members of the Hyades cluster are $\sim$3 times more precise than the Hipparcos parallaxes. The ACT (the Astrographic and Tycho Reference Catalogue) and TRC (Tycho Reference Catalogue) proper motions of faint candidate members not observed by Hipparcos allow the derivation of high-precision secular parallaxes, which provides the unique opportunity to locate these stars on the Hertzsprung–Russell diagram. The new parallaxes provide the sharpest view of the three-dimensional structure of the Hyades obtained ever. The colour-absolute magnitude diagram shows a very well-defined main sequence, which provides the first unambiguous observational evidence of Böhm–Vitense's prediction that the onset of surface convection in stars

significantly affects their broad-band colours. The precision with which the new parallaxes constrain the location of individual members of the cluster on the theoretical Hertzsprung–Russell diagram is now limited by (systematic) uncertainties related to the transformations from observed colours and absolute magnitudes to effective temperatures and luminosities.

Two new major astrometric catalogues (the TRC and ACT) were used by Hoogerwerf to extend the membership lists of the nearby OB associations as determined by de Zeeuw et al. (1999). These catalogues are complete to $V = 10.5$ mag, three magnitudes fainter than the Hipparcos Catalogue. The study resulted in candidate membership lists for the nearest associations (Sco OB2 and Per OB3) with a field-star contamination less than 50%. These lists thus form an excellent starting point for follow-up observations. Furthermore, Hoogerwerf in collaboration with Blaauw also investigated the quality of the proper motions in the TRC and ACT catalogues. They find that in general the ACT and TRC proper motions are free of systematic errors except for a fraction of the ACT stars. The proper-motion errors of the latter are underestimated by 30–40%.

Hoogerwerf, de Bruijne, and de Zeeuw continued the study of the nearest OB runaway stars, started by den Hollander last year. The orbits of runaways, present in the Hipparcos Catalogue, were traced back in time to determine their parent groups and their runaway ages. This procedure is possible only because of the milli-arcsecond accuracy proper motions of Hipparcos. They confirmed the proposition by Blaauw & Morgan that the runaways AE Aur and μ Col originated from the same physical event. These runaways were created by a dynamical encounter in the Trapezium cluster, $\sim$2.5 Myr ago, which also involved the presently massive, highly eccentric binary ι Ori. Furthermore, retracing the orbit of the runaway ζ Oph and the orbits of some of the local pulsars Hoogerwerf et al. found that PSR J1932+1059 and ζ Oph were once two components of the same binary system in the Upper Scorpius association. The two component became separated when the primary exploded as a supernova and the binary became unbound. These two examples prove that both scenario's for the production of runaway stars, the binary supernova scenario and the dynamical ejection scenario, operate.

2.2.6 ω Centauri

Van Leeuwen (Cambridge), Reijns, Le Poole, Freeman (Canberra) and de Zeeuw concluded the measurements and initial interpretation of very accurate internal proper motions for nearly 8000 members of the globular cluster ω Centauri, derived from 100 plates taken with the Yale-Columbia refractor in the thirties and eighties.

2.2.7 Dust particles in stellar winds

Icke finished his work on the kinetic theory of the Brownian motion of dust particles that are strongly accelerated in stellar winds. When low-mass stars die, they pass through the limbo of the Asymptotic Giant Branch (AGB). In this phase, dust condenses in the stellar atmosphere. The radiation of the dying star accelerates the dust to very high speed, driving the atmosphere out as an AGB-wind. This raises a fascinating problem in kinetic theory: the motion of highly accelerated particles in a surrounding bath of gas atoms. The situation is very far from equilibrium, but surprisingly this allows a very simple treatment of the problem. Instead of the usual Langevin Equation, one obtains a modified form that has an asymptotic solution for the mean terminal velocity of the dust. This velocity depends, surprisingly, on one parameter only: it is inversely proportional to the square root of the dust mass. That means, effectively, that all dust particles have the same kinetic energy. Accordingly, there are two extreme cases: one, small dust grains that move very rapidly, mostly supersonically, through the gas; two, large dust grains that have a small drift velocity. The coupling of this microphysics to macroscopic phenomena (transport, momentum transfer, hydrodynamics) produces new dynamical effects in the stellar atmosphere. In particular, the atmosphere can flip between two states: low and high drift velocity.

2.3 Interstellar matter

2.3.1 The properties of the small-scale structure in the polarized component of the galactic radio background

In their study of the properties of the small-scale structure in the polarized component of the galactic radio background, Haverkorn, Katgert and De Bruyn (ASTRON/Groningen) have concentrated on WSRT observations at five frequencies in the range 341–375 MHz of the so-called “Boomerang” field.

The structure in the polarized component of the galactic radio background is most likely due to Faraday modulation of the radio emission from the galactic halo by the magneto-ionic screen of the relatively nearby Interstellar Medium (at distances of less than about 500 pc or so). It appears that the narrow depolarized “canals” visible in the observations are due to beam depolarization, see Fig. 2.1. This explanation implies that there are very significant and quite abrupt changes in Rotation Measure which must be due to structure in the electron density and/or magnetic field in the ISM. These variations in Rotation Measure can give information on the strength and structure of the galactic magnetic field in the Interstellar

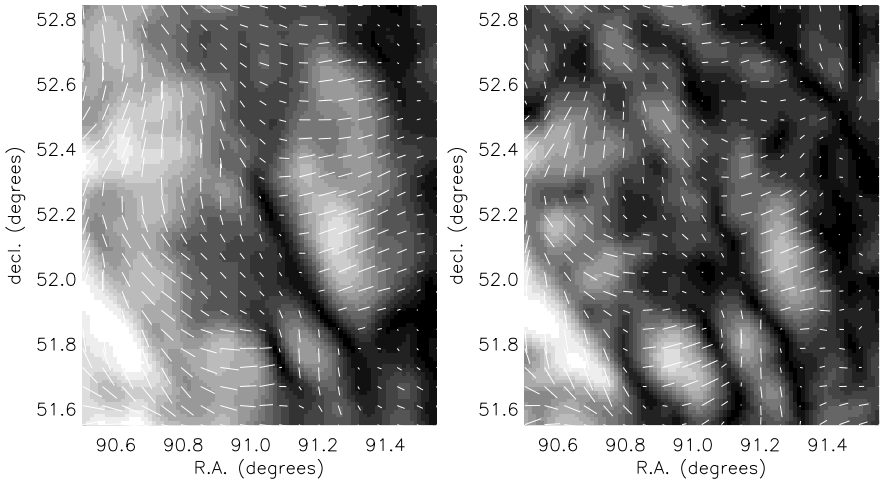

Figure 2.1: Polarized intensity at 349 MHz (left) and 360 MHz (right) in a part of the "Boomerang" field. Polarization angles and intensities are indicated by the vectors, which are sampled at locations $4'$ apart. The change in polarization angle of $\sim 90°$ seen across low-polarization "canals" indicates beam depolarization. This implies the existence of large, quite abrupt changes in Rotation Measure, which must be due to structure in magnetic field and/or electron density.

Medium, especially when the observations are compared to numerical models of the turbulent ISM.

2.4 The Galaxy

2.4.1 The stellar halo

Helmi, together with White, continued her work on the formation of our Galaxy in the context of hierarchical cosmologies. One of the goals of this research was to assess whether a merger origin for the stellar halo would leave observable fossil structure in the phase-space distribution of nearby stars. She performed numerical simulations of the disruption of satellite galaxies in a Galactic potential, and developed an analytic description of the evolution of the debris in phase-space. This

work showed that, after 10 Gyr, stars originating in objects which could contribute substantially to the stellar halo near the Sun, should be spread evenly through a large volume. In any relatively small region stars should be concentrated into a large number of coherent streams in velocity space, each showing an internal velocity dispersion of only a few km s^{-1} .

Even though there have been reports of substructure in the motions of halo stars, such detections have been marginal and difficult to relate to disrupted galaxies. Nevertheless, the modeling results suggested an analysis of the HIPPARCOS measurements of nearby halo stars, would be useful for constructing accurate 3–dimensional velocity distributions. This collaboration with White, de Zeeuw and Zhao, led to the discovery of the first fossil evidence of the hierarchical formation of the Milky Way: two stellar streams which can be traced back to one progenitor galaxy, probably similar to the Fornax or Sagittarius dwarf spheroidals.

Together with White, Helmi studied the Sagittarius dwarf galaxy, a clear example that merging is still on-going in our Galaxy. Using numerical simulations, they obtained simple dynamical models for this system, which match all the present observational constraints. Possible progenitors of Sagittarius could be satellites similar to Local Group dwarf spheroidals, with a core radius of about 0.56 kpc, a central M/L ratio of 2.25 and a total stellar velocity dispersion of about 18 km s^{-1} . Viable models may have a wide range of total luminosities and masses, and both with and without extended dark halos. The data available at present only weakly constrain the total initial extent either of the light or of the mass. Further work on the debris streams of Sagittarius is in progress, with White and Springel, to constrain better its initial total luminosity, and to distinguish between purely stellar or dark-matter dominated progenitors.

Zhao has continued with a project to reconstruct the dynamical history of satellites in the halo of the Milky Way. To map out the extent of the Sagittarius dwarf galaxy, Zhao and Mario Mateo obtained VLT spectroscopic data of the possible southern tail of the Sagittarius dwarf. Zhao and collaborators (Johnston, Spergel, and Hernquist) also extended their simulations of halo streams to include the effect of the time evolution of the potential. They propose to observe halo giants and obtain accurate proper motions and parallax with the GAIA astrometric mission, which could constrain the evolution history of the Galactic potential.

2.4.2 Gravitational lensing

Zhao has continued with the study of gravitational microlensing events towards the Magellanic Clouds. He suggested to obtain radial velocity and reddening of the microlensed source stars observationally. Any difference in the reddening and velocity distributions from the random stars in the LMC could only be explained if the lenses are in the LMC disc. There should not be any systematic differences if the

lenses are in the halo of the Galaxy. In collaboration with Rodrigo Ibata, Mike Irwin, Zhao obtained AAO/2dF data of the microlensed fields, and is proposing to obtain VLT spectroscopic data of previous known microlensing events for comparison.

Zhao and Pronk started to work on a project to find multiple images of stars created by the black hole in the center of the Galaxy. Relating positions, proper motions and magnitudes of pairs of stars near the center might reveal that the light of the two stars actually comes from the same source star, whose light is bent by the black hole. Upon finding such an image-pair it will be possible to set a lower bound on the mass of the central black hole, independent of dynamical determinations.

2.5 Nearby galaxies

2.5.1 Carbon in the N159/N160 complex of the Large Magellanic Cloud

Israel, collaborating with Bolatto, Jackson (both Boston Univ.), Zhang (SAO) and Kim (Univ. of Illinois), mapped the actively star-forming regions N159 and N160 in the LMC in J=1–0 ^{13}CO, J=2–1 and J=4–3 ^{12}CO and in C^o. They found that previously mapped major CO cloud complexes are immersed in a large envelope of extended, low-level emission. This emission is optically thin in ^{12}CO, and relatively bright in both C^o and C$^+$. The distribution of neutral carbon peaks on a quiescent dense cloud in the complex, while in the more evolved northern region N160 C^o is anticorrelated with C$^+$. Over the whole complex, they find that C$^+$ is enhanced with respect to similar complexes in the Milky Way, whereas C^o is similar or reduced in emission. A possible explanation for this difference is relatively rapid ionization of C^o produced by CO photodissociation.

2.5.2 Dynamics of dwarf galaxies

Stil completed his PH.D thesis on dwarf galaxies. He presented neutral hydrogen maps and rotation curves for 29 galaxies observed with the WSRT, one of the largest samples of its kind. The sample was selected to include dwarf galaxies over a wide range of optical luminosities and colours. Most of these galaxies were also imaged in B, V, R, I and Hα with the JKT 1-m telescope.

In his analysis, Stil found that local HI velocity dispersion vary by factors of two on spatial scales not exceeding a few hundred parsec. Velocity dispersion maxima are not correlated with the presence of star formation regions. Likewise, there is no correlation between HI velocity dispersion and column density. In fact, broad HI line profiles are found without any detectable optical counterpart. At least some

of the maxima can be resolved into two distinct velocity components. Stil suggests that type Ia supernova events may be the factor dominating HI velocity dispersions in dwarf galaxies.

The large size of the sample made it possible to statistically analyze their rotation curves. By introducing an "turnover" radius R_{to}, and normalizing the observed curves to this radius, Stil could show that the sample galaxies have identical rotation curve shapes; in fact all galaxies tested, including much larger spiral galaxies, have identical rotation curves out to $R = 2\ R_{to}$. For dwarf galaxies, steep density gradients in the center are excluded, and in all but the most extreme halo-dominated dwarf galaxies does the stellar disk contribute significantly to the total mass distribution.

A most surprising result was that the Tully-Fisher relation which very successfully describes the relation between the luminosity and the rotational velocity of a galaxy, breaks down for dwarf galaxies. Some very faint dwarf galaxies, with absolute magnitudes $M < -14$ mag are fully supported by rotation although the Tully-Fisher relation predicts rotational velocities less than the HI velocity dispersion. For the first time, Stil could describe this effect for a sample of galaxies with direct measurements of the rotation velocity. Further analysis showed that the rotationally supported dwarfs have larger gas-to-star ratios than the pressure-supported dwarfs, that they are dominated by dark matter and that they have a much higher mass-density than the pressure-supported rotators which are dominated by baryonic mass. The rotationally supported dwarfs will continue to disobey the Tully-Fisher relation, or they may evolve towards it but only if evolution in both linewidth and luminosity occurs.

2.5.3 The Local Group dwarf galaxy LGS 3

Miller, Dolphin (NOAO), Hodge (UWash), Lee and Kim (Seoul), have analyzed new, deep Hubble Space Telescope (HST) images of the Local Group dwarf galaxy LGS 3. LGS 3 is intriguing because it has properties of both dwarf spheroidal (dSph) and dwarf irregular (dI) galaxies. Its optical appearance and old, metal-poor stellar population makes it similar to the dSph companions of the Milky Way. Yet, like a dI it has a small amount of HI gas and a hint of a younger stellar population. Therefore, it is commonly considered to be a dSph/dI "transition object." To determine the star formation history in more detail, deep images with HST were taken, which revealed the horizontal branch for the first time. Modeling suggests that the galaxy is closer than previously thought and that the star formation history was dominated by a strong burst about 14 Gyr ago followed by relatively constant star formation since then. Most of the recent star formation is concentrated towards the center of the galaxy.

2.5.4 Dwarf elliptical galaxy snapshot survey

Miller, in collaboration with Ferguson, Stiavelli, and Whitmore (STScI), and Lotz (Johns Hopkins), is currently involved in a HST snapshot survey of dE galaxies in the Fornax and Virgo Clusters to study their globular clusters and nuclei. They have shown that the globular cluster specific frequency (SN) of dEs is in the range 2–6, similar to giant ellipticals, and that SN in nucleated dEs is about twice that for non-nucleated dEs (Miller et al. 1998). The luminosity function (LF) of the GC candidates is consistent with a Gaussian with a peak at $M_V^0 \approx -7.3$ and a width $\sigma_V \approx 1.4$ mag. The LFs of globular cluster systems of giant ellipticals are also Gaussian shaped with a peak at $M_V^0 \approx -7.4$. Also, with a mean color of $\langle V-I \rangle \approx 0.95$, the GCs in dEs are similar to the old and metal-poor ($[\mathrm{Fe/H}] \approx -1.5$) GC populations in nearby giant ellipticals and spirals. Star clusters in dEs tend to be bluer than both the background light of the galaxies and the bright nuclei. If this color difference is due to metallicity, then the GCs are between 0.0 and 0.4 dex more *metal-poor* than the stars in bodies of the galaxies. The nuclei have a range of colors, or metallicities, between that of the GCs and the stellar background light. Alternatively, these color differences may imply age differences between the GCs, nuclei, and stars in the galaxies. However, it appears that GCs in dwarf ellipticals formed at about the same time and with similar efficiencies as the oldest GCs in giant ellipticals and spirals. This supports the idea that there was a common era of early cluster formation. This could be explained if these old GCs were formed preferentially in dwarf galaxy sized fragments that latter merged into larger galaxies.

They are also investigating the nuclear cusp slopes of the dEs and looking for the effects of dynamical friction on the GC populations. The nuclear cusp slopes have exponential shapes rather than steeper $R^{1/4}$ profiles of giant elliptical galaxies and the bulges of some spirals. The dE profiles are similar to a class of spiral galaxies with exponential bulges. Some of the properties of the nuclei in dEs could be explained if they are the result of mergers of GCs that fall to the centers of the galaxies via dynamical friction. The dynamical friction timescales are short enough that the process could be important. If dynamical friction is at work, then there should be a tendency for the second brightest GC to be found near the center of the galaxy. Such a trend is seen, indicating either that other forces are keeping the GC orbits from decaying or that the GCs may be younger than assumed so far.

2.5.5 Dynamical modeling of elliptical galaxies

Cretton, Rix and de Zeeuw modeled the giant elliptical galaxy NGC 2320 with the extended orbit superposition method of Schwarzschild to obtain direct constraints on the orbital distribution. Long-slit spectra along multiple position angles was

used to derive the stellar line–of–sight velocity distribution within one effective radius. In addition, the rotation curve and dispersion profile of an ionized gas disk are measured from the [OIII] emission lines. After correcting for the asymmetric drift, they derived the circular velocity of the gas, which provides an independent constraint on the gravitational potential. Models with radially constant mass-to-light ratio Υ_V and models with dark matter provide comparably good fits to the data and possess similar dynamical structure. Across the full range of Υ_V permitted by the observational constraints, the models are radially anisotropic in the equatorial plane over the radial range of the kinematical data ($1'' < r < 40''$).

Verolme continued the development of dynamical models for early-type galaxies. The aim is to measure the masses of central black holes and the distribution of intrinsic shapes and internal kinematic properties of (mainly) ellipticals. The method used is Schwarzschild's numerical orbit superposition scheme for reproducing the properties of a galaxy. Data on a large variety of scales is used: high-resolution HST spectra as well as large-scale two-dimensional spectra from the new integral-field spectrograph Sauron. Verolme upgraded the existing axisymmetric machinery developed by van der Marel and Cretton for use on Sauron data. The next steps are applications to galaxies with Sauron data, and an extension to triaxiality.

Zhao investigated the role of the fish orbits in non-axisymmetric 3-dimensional galactic nuclei with power-law density profile. His analytical results suggest that fish orbits are not optimal to support triaxiality.

Copin (Lyon), Zhao and de Zeeuw have found an accurate and computationally efficient way to simulate regular orbits in galaxy models, in particular their line of sight velocity distribution. The gain in speed and accuracy comes from making the calculation semi-analytical using the spectral dynamics method.

Yanguas, with de Zeeuw, worked out the approximate integrals of motion in axisymmetric and triaxial perturbed isochrone models, using a method based on Delaunay variables, developed previously by Yanguas and Palacian.

Evans (Oxford), Carollo (Columbia) and de Zeeuw completed their analysis of Jeans solutions in scale-free triaxial potentials. They used the results to show that a moderately flattened triaxial dark halo causes an annual modulation in WIMP detection rates, provided these are the major constituent of the dark halo.

2.5.6 Nearby early galaxies sample survey

With Holland Ford and Frank v.d. Bosch, Jaffe continued his program of HST imaging of a large, unbiased sample of nearby early galaxies. The new snapshot survey contains 65 not previously imaged galaxies. These show a variety of expected and unexpected nuclear structures, and several have been approved by the HST Time Allocation Committee for spectral observations to investigate the dynamics.

2.5.7 Star Clusters in the Antennae galaxies

Whitmore, Zhang, Leitherer, Fall (STScI), Schweizer (OCIW) and Miller completed work on WFPC2 HST observations of young star clusters in the merging galaxies NGC 4038/4039 ("The Antennae"). Pre-refurbishment HST images of NGC 4038/39 showed the cluster candidates to have $R_{\rm eff} > 10$ pc and a power-law luminosity function. Thus, it was argued that these objects would not become GCs and that galaxy mergers would not produce GC systems like seen in ellipticals, calling into question whether ellipticals were produced by mergers. The new data allows measurement of the sizes much more accurately, revealing possible changes in both the effective and tidal radii with age. Old cluster candidates have $\langle R_{\rm eff}\rangle = 3.0 \pm 0.3$ pc while young and intermediate age cluster candidates have $\langle R_{\rm eff}\rangle = 4.6 \pm 0.4$ pc. Further, the tidal radii of the young clusters can be much larger than for the old clusters. Thus, the density distribution of clusters may extend beyond their tidal radii at birth and a few orbits around the galaxy are needed to remove the stars beyond the tidal radius. There is also evidence for flattening of the globular cluster luminosity function. The break occurs at a mass of $\sim 10^5$ $M_\odot$, similar to the peak in the old GC mass function. While this is suggestive that the mass function may not be a single power law, a reconstruction of the mass function by Zhang and Fall (1999) shows that it is still consistent with a single power law with $\phi(M) \propto M^{-2}$.

2.5.8 Molecular hydrogen emission in the ultraluminous merger NGC 6240

Kosters, Van der Werf, Israel and Moorwood (ESO) analyzed the HST/NICMOS data of the ultraluminous merger NGC 6240 (Fig. 2.2). The results confirm the presence of a molecular gas component between the two nuclei of the merging galaxies, as seen in the H_2 $v = 1\rightarrow0$ S(1) line. Combined with kinematic information and near- and mid-infrared spectroscopy of other H_2 lines a molecular gas inflow rate of about 260 $M_\odot\,{\rm yr}^{-1}$ is inferred, a significant fraction of which is towards the central molecular gas component. However, star formation in this component is probably prevented by the large shear in this region.

2.6 Active galaxies and distant galaxies

2.6.1 Nearby radio-loud galaxies

Verdoes Kleijn, de Zeeuw, and Baum (STScI) continued their study of the central regions of a complete sample of 21 nearby radio-loud FR I (Faranoff Riley Type I)

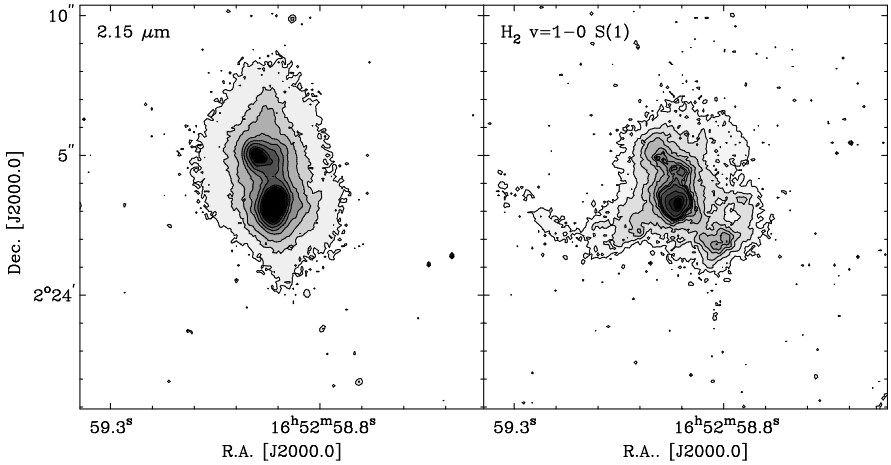

Figure 2.2: HST/NICMOS imaging of the ultraluminous merger NGC 6240 (Van der Werf, Kosters, Moorwood, Israel): 2.15 μm continuum (left panel) and H_2 $v = 1 \rightarrow 0$ S(1) emission (right panel).

early-type galaxies. The galaxies have velocities less than 7000 km s^{-1}. The primary goal is to obtain a better understanding of the formation, working and evolution of FR I nuclei. The HST/WFPC2 observations were completed, providing V, I and in narrow band filters centered on Hα+[NII]. An isophotal analysis was performed, and the dust and emission gas content in the centers of these galaxies was studied. The galaxies contain small nuclear disks and lanes of gas and dust. The next step is a HST/STIS spectroscopic follow-up survey (expected completion January 2001) of the nuclear emission-gas. These observations are primarily aimed at determining black hole mass and constraining the ionization mechanism of the gas.

2.6.2 Giant and double-double radio sources

Schoenmakers (also Utrecht) and Röttgering, together with de Bruyn (ASTRON/ Groningen) and Van der Laan (Utrecht), have proceeded with their investigations of a large sample of Giant Radio Sources (GRSs) selected from the WENSS survey. With a linear size exceeding 1 Mpc ($H_0 = 50$ km s^{-1} Mpc^{-1}) these are the largest radio sources in the Universe associated with Active Galactic Nuclei (AGN) (Figure 2.3 shows an example). Many of the results of these efforts can be found in Schoenmakers' Ph.D. thesis: "A Population Study of Giant Radio Sources" (October 1999, Utrecht University).

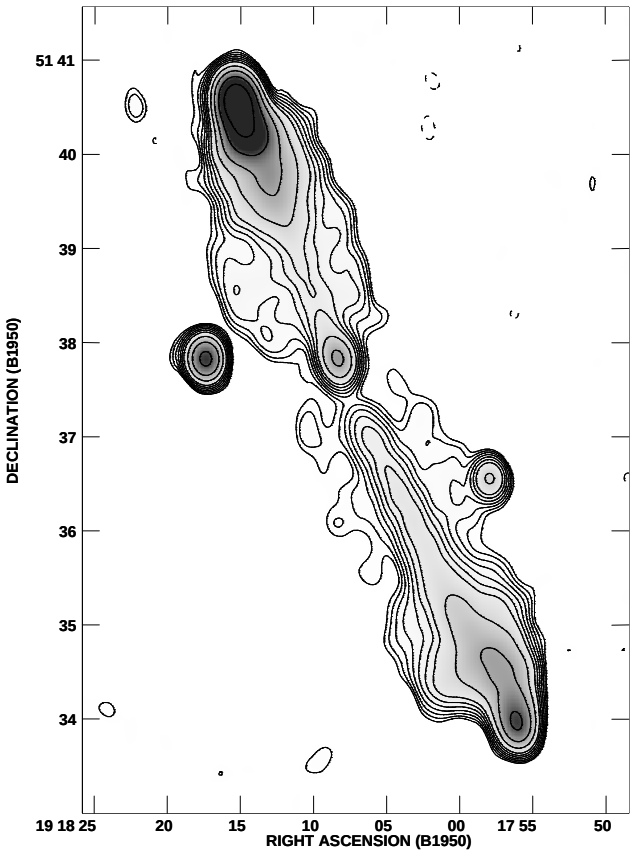

Figure 2.3: Radio map of the giant radio galaxy B 1918+516. This source has a redshift of 0.284 and a projected linear size of 2.3 Mpc ($H_0 = 50$ km s^{-1} Mpc^{-1}). The map is the result of a 12-hr WSRT observation at 1.4 GHz. It beautifully shows the extended radio lobes, the radio core and two jet-like structures emanating from this core. The two unresolved sources alongside the giant are most likely unrelated radio sources.

Apart from a careful study of multi-frequency radio observations of these sources, Schoenmakers' complete sample of low redshift GRSs has been used to provide observational constraint on the evolution of large FRII-type radio sources in the Linear Size – Radio power (P–D) diagram. Theoretical models predict a decline in the radio power as radio sources increase in size. The rate of decrease of radio power is expected to grow for sources larger than 1 Mpc, but this predicted effect could never be properly tested observationally due to the lack of decent samples of such

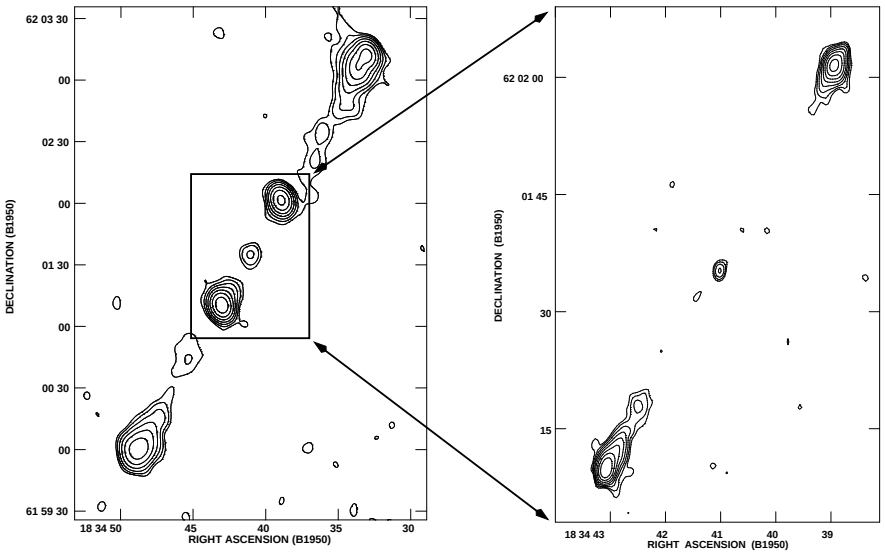

Figure 2.4: Radio contourplots of the DDRG B 1834+620. The plot on the left shows the source as a whole, observed with the VLA in its D-configuration at 8.4 GHz (8 arcsec resolution). The plot on the right shows the inner part only, observed with the VLA in its A-configuration at 1.4 GHz (1 arcsec resolution). It shows that the inner structure is a double-lobed radio source itself.

large sources. With Schoenmakers' sample of GRSs it has been possible to include sources larger than 1 Mpc in size in a fitting procedure to investigate the behaviour of the radio power of such sources. It was found that in order to fit the observed number of sources with linear sizes larger than 100 kpc, steep evolutionary tracks are necessary with a downward bend at a linear size of about 1 Mpc, much like those predicted by the theoretical evolution models.

Schoenmakers et al. have also investigated the optical emission-line properties of their sample of GRSs, and the correlations of these with radio properties. For this purpose they have made extensive use of the 2.5-m INT telescope on La Palma. It was found that the emission-line properties of GRSs are not different from those of smaller sized (but larger than 50 kpc) radio sources. There are no significant correlations between emission-line strengths or ratios and either linear size, radio core power or total radio power in these sources. Furthermore, although a most careful analysis of the emission line luminosities was performed, the measured emission-line ratios did not make clear what the ionization mechanism of the emission-line

gas is. Still, this study has provided a valuable database of emission line properties of a complete sample of Mpc-sized radio sources which can be used for comparison purposes in the future.

Another fascinating group of radio sources is that of the class of Double-double radio galaxies (DDRGs). These are radio sources consisting of a well aligned, co-centered, double-lobed radio sources of different size (see Fig. 2.4 for an example). The favoured explanation for this strange morphology is that of a radio source which underwent an interruption of its central jet-forming activity. In this model, the inner radio lobes are the youngest, and the outer radio lobes are currently fading because they are cut-off from the energy supply of the jet. These sources allow us to investigate several poorly understood issues of radio source evolution, among which the following. First, what happens to radio lobes when the energy supply by the jet is stopped? An investigation of the outer lobes of the DDRGs can clarify this issue since they most likely are in this evolutionary stage. Second, what is the contents of a radio lobe? Is it only jet material, or is there mixing with the surrounding intergalactic medium? In the DDRGs, the inner radio lobes are expanding within the cocoons of the outer radio lobes. Therefore, any information on the (environment of) the inner lobes is highly interesting. Third, how often do such interruptions of the jet occur and how long do they last? Again, the DDRGs are excellent candidates to study this behaviour. Last, is there any relation between DDRGs and the so-called "X-shaped", or winged radio sources? Perhaps the DDRGs are those sources in which a restarted jet has not drastically changed its outflow direction. Clearly, DDRGs are a fascinating group of radio sources that can be used to investigate a variety of topics.

2.6.3 Seyfert and starburst galaxies

Chatzichristou defended her Ph.D. thesis entitled "Imaging and Bidimensional Spectroscopy of Active and Interacting Galaxies" on 15th June and took up a postdoctoral position at NASA, Goddard. Her Ph.D. project used optical imaging and spectroscopic data for several IRAS-defined samples of Seyfert and starburst galaxies to investigate the triggering of nuclear activity and to what extent the differences between different types of active galaxies can be attributed to their orientation, their evolutionary history or their environments. She concluded (i) that there is strong evidence that nuclear activity is linked to galaxy interactions, (ii) that there is an evolutionary sequence linking the IR spectra to the Seyfert type. The fraction of isolated systems declines dramatically from Seyfert 1 to Seyfert 2 and from mid-IR warm to mid-IR cold galaxies. In several cases coupling between the radio jet and ambient gas indicate that hydrodynamic processes (galactic-scale starbursts or AGN-driven outflows) dominate the kinematics in the central 10–20 kpc regions.

2.6.4 VSOP observation of bright GHz peaked spectrum sources

As a part of a programme to study young radio sources Tschager, Schilizzi (JIVE & Leiden), Snellen (IoA Cambridge), Röttgering and Miley were granted observing time within the VLBI Space Observatory Programme (VSOP) at 5 GHz and 1.6 GHz for a sample of 11 and 8 GPS (GHz Peaked Spectrum) sources, respectively. The VSOP observation were combined with ground-based matched-beam images at 15 GHz and 5 GHz, respectively. The observational part is now concluded.

In particular, Tschager et al. continued their work on GPS radio source 2021+614 observed with VSOP. Refining the techniques for measuring tiny amounts of separation increase between individual component they showed that the radio source 2021+614 has an age of 440 ± 80 years.

2.6.5 A new sample of faint compact steep-spectrum radio sources

Compact radio sources with peaked spectra are important to radio source evolution, not only because they are often found at high redshift, but also because they may well represent an early phase in the evolution of more common extended radio sources.

Tschager, Schilizzi (JIVE & Leiden), Snellen (IoA Cambridge), Röttgering and Miley continued their observational work on a sample of faint CSS (Compact Steep Spectrum) radio sources. Their working sample comprises 99 sources. Optical studies of the sample were carried out using the ING telescopes in La Palma. So far, CCD imaging has been carried out to optically identify 30 radio objects and intermediate dispersion spectroscopy gave redshifts for 25 members of the working sample.

2.6.6 Neutral gas: HI associated radio 21 cm absorption

Tschager, Vermeulen (NFRA) and Taylor (NRAO) used the Westerbork telescope to search for HI 21-cm line absorption in the radio spectra of all the 12 compact symmetric objects found in the Caltech-Jodrell Bank surveys. The search for HI absorption is an important tool for investigating the neutral gas contents and provides information about radio source evolution. They detected absorption in 5 objects and are analysing the observations.

2.6.7 Distant radio galaxies

Galaxies associated with powerful radio sources are among the most frequently used cosmological probes, because their enormous radio luminosities enable them

to be easily pinpointed out to large distances. There is strong evidence that distant radio galaxies are amongst the oldest and most massive galaxies in the early Universe and located in dense cluster environments. As such they place important constraints upon the initial epoch of star formation. Further, because their many interacting constituents emit radiation which is both highly luminous and spatially–extended HzRGs provide a unique set of diagnostics for probing stellar populations, neutral and ionized gas, dust and relativistic plasma in the early Universe.

During 1999 a large group worked at Leiden on various aspects of ultra- steep spectrum radio sources, These included Best, Kurk, Miley, Pentericci, Rengelink, Röttgering, Schilizzi, Tschager, van der Werf and Venemans. In addition, De Breuck is working on a joint Leiden-U.Cal Ph.D project and during 1999, he returned from a 3-year stay at the Lawrence Livermore Labs to spend the last year of his thesis research at Leiden. Also, Pentericci completed a Ph.D thesis and took up a postdoctoral position with the Max Planck Institut at Heidelberg. During 1999 an important new tool for studying these objects became available. A Leiden programme to study distant radio galaxies was the first project scheduled for general visitor time on the VLT.

Searches for distant galaxies

De Breuck, Röttgering, Miley together with van Breugel (U.Cal) have combined WENSS (0.36 GHz), and the two VLA surveys FIRST and NVSS (both at 1.4 GHz. They have demonstrated that concentrating on the particularly rare radio sources with spectral indices < -1.3 increases the success rate of finding the most distant ($z > 3$) radio galaxies even further. About 1 % of the WENSS sources have < -1.3. Searches using this sample have revealed several very distant objects including the most distant known galaxy in the southern hemisphere. The power of this technique was confirmed by observations of De Breuck, Röttgering and Miley together with van Breugel, Stern, and Stanford (U.of Cal) and Carilli (NRAO) using the LRIS spectrograph on the Keck telescope. These observations showed that a radio source from the above sample having a spectral index of -1.6 was identified with a galaxy at a redshift of 5.19, making it the most distant radio galaxy known.

In collaboration with Minniti (PUC, Santiago, Chile), De Breuck, Röttgering, Miley and van Breugel observed a $z = 4.11$ radio galaxy with the VLT. The spectrum exhibited an asymmetric Lyα profile, presumably caused by associated HI absorption. The continuum drop across Lyα, as measured by the D_A parameter is lower than in quasars at similar redshifts, suggesting that the color selection of the quasar samples introduces a bias into the D_A statistics.

Probes of massive galaxy formation

On 15th October Pentericci defended her Ph.D thesis entitled "The most distant radio galaxies: probes of massive galaxy formation". This thesis contains a large body of multiwavelength data obtained with the HST, ground-based optical and infrared telescopes, the VLA and ROSAT with which Pentericci and other members of the Leiden group were involved. The thesis demonstrates that the optical continuum emission from distant radio galaxies is highly clumped and that the structures of these objects bear a striking resemblance to that predicted by hierarchical models of massive galaxy formation. Radio depolarization measurements of distant radio galaxies and X-ray data on the $z = 2.2$ object 1138-262 provide strong evidence that distant galaxies are embedded in a hot dense gaseous medium and associated this with forming proto-clusters of galaxies.

CO emission from high redshift radio galaxies

Papadopoulos, Van der Werf and Röttgering, with Omont (IAP), Van Breugel (LLNL), Tilanus (JACH) and Guilloteau (IRAM) obtained the first detections of CO emission in two high-z radio galaxies. These galaxies were also detected with SCUBA in the rest-frame far-infrared. The large far-infrared luminosities and gas masses imply that we are witnessing major starbursts in these galaxies, with conditions more extreme than in local ultraluminous infrared galaxies. In one case, the CO emission is extended over more than 30 kpc and spans a velocity range of more than 1000 km s^{-1}.

Ionized gas: Lyman alpha emission halos

A spectacular property of high-redshift radio galaxies is their association with giant halos of line-emitting ionized gas. The emission-lines are dominated by luminous ($> 10^{44}$ erg/s) Lyman alpha halos which have enormous extents, sometimes exceeding 100 kpc and can act as tracers of kinematics. During 1999, a radio galaxy, 1138-262 with $z = 2.17$, was imaged through a redshifted Lyman alpha narrowband filter using the first of the VLT telescopes, ANTU. These observations revealed that the Lyman alpha halo in 1138-262 is extended by 30" (corresponding to 240 kpc, making it the largest such structure known).

Kurk and Röttgering together with Binette (Intituto de Astronomía UNAM) completed an analysis of the gaseous structure surrounding the radio galaxy 0943-242 at $z = 2.9$, an object whose Lyman alpha profile exhibits a deep absorption trough. They conclude that the absorption takes place in a very low density, low metallicity gas shell around the radio galaxy.

2.6.8 Star forming galaxies at $z \sim 2.2$

Van der Werf, in collaboration with Moorwood and Cuby (ESO) and Oliva (Florence) used the new ISAAC spectrograph at Antu (VLT-UT1) on Paranal to obtain spectroscopic confirmation of a sample of candidate Hα emitting galaxies at $z \sim 2.2$. The candidates were selected based on narrow-band flux excess in the K-band as measured with SOFI at the NTT in an earlier stage of the project. The ISAAC campaign was extremely successful: 6 candidates were spectroscopically confirmed (see Fig. 2.5). These objects form the largest homogeneously selected sample of blank-field spectroscopically confirmed star forming galaxies at $z = 2.2$ known to date. Implied star formation rates are in the range $20-35\ M_\odot\,\mathrm{yr}^{-1}$, i.e., significantly higher than local spiral galaxies.

2.6.9 General lens models

Zhao and Pronk found a general, semi-analytical class of lens models that allows for non-elliptical and non-scale-free potentials. The radial mass distribution can be derived non-parametrically. The lens equations can be reduced to a set of linear equations, greatly simplifying the calculations.

They applied the models to the quadruple lensed system PG1115+080, and found good fits to the image positions and flux-ratios. The mass to light ratio of the lens is predicted to increase radially, suggesting a dark halo reaching up to three times the half-light radius. The models do not uniquely predict the Hubble constant, mainly because H_0 is sensitive to the powerlaw slope, which changes dramatically upon a small adjustment of the model.

2.7 Clusters of galaxies and large scale structure

2.7.1 The distribution and kinematics of various types of galaxies in clusters

With Biviano (Trieste), Thomas and Mazure (Marseille), Katgert has studied in more detail the distribution and kinematics of various types of galaxies in clusters, in an attempt to understand the relations between the various types of galaxies during the formation and evolution of a cluster. This work is based on the ENACS survey that was conducted in the first half of the 1990s, and that has yielded more than 5600 redshifts for galaxies in about 100 clusters. In the literature, information exists for a comparable number of galaxies in other clusters, but since those galaxy

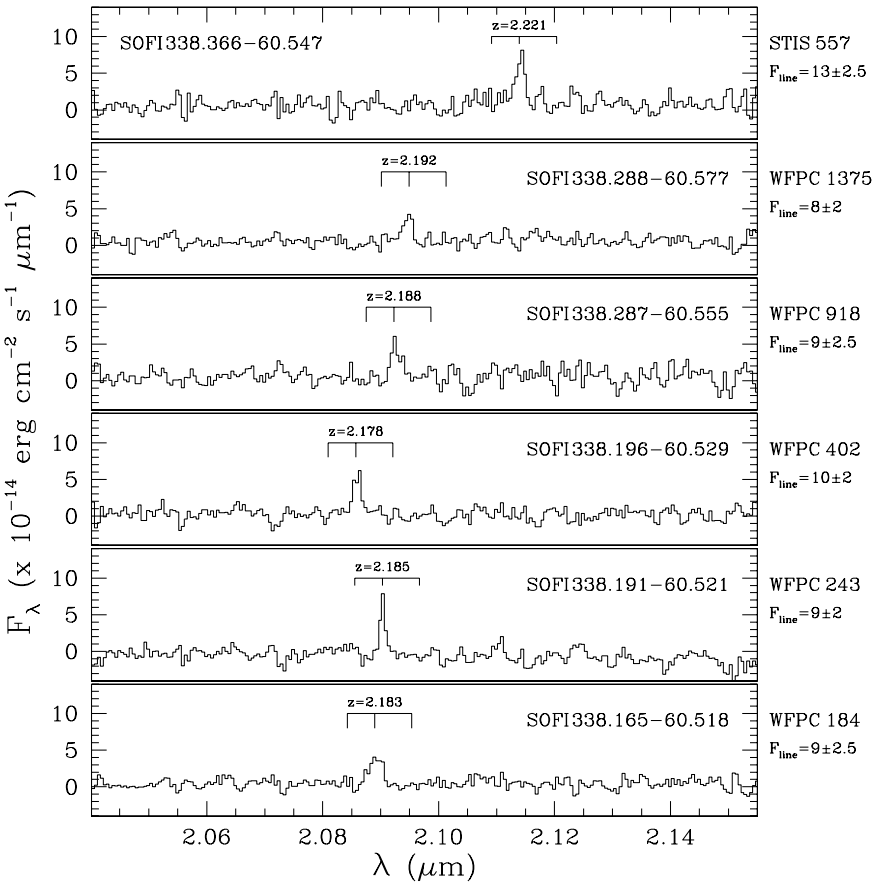

Figure 2.5: Near-infrared spectra of star forming galaxies at $z \sim 2.2$, obtained by Van der Werf, Moorwood, Cuby, and Oliva with ISAAC at Antu on Paranal. The line is in all cases redshifted Hα.

samples have ill-defined properties, those data cannot be used in the present analysis.

For a large fraction of the galaxies in the ENACS clusters, CCD images were obtained, over a extended period, with the Dutch telescope at La Silla. These images allow morphological classification and quantification of the properties of the brightness profiles. The latter is of interest for the study of the Fundamental Planes in about 25 ENACS clusters. With Hartendorp, Thomas is studying the brightness profiles of the early-type galaxies in the ENACS clusters. This information will be

combined with the results of the study of the internal velocity dispersions of these galaxies, carried out by Thomas. These velocity dispersions are derived from the ENACS spectra; since these were observed trough fibres, a long-slit calibration programme was carried out with the 1.5-m telescope at La Silla and the 2.5-m telescope at La Palma.

Using the galaxy types obtained either from CCD imaging (supplemented if necessary with information on the brightness profile) or from the ENACS spectrum (as obtained earlier by de Theije and Katgert from a PCA/ANN analysis), Biviano (Trieste) and Katgert studied the distributions w.r.t. projected distance from the cluster centre and relative velocity from the cluster average for various types of galaxies, and in various cluster samples. In addition to the well-known global segregation between early- and late-type galaxies, several interesting detailed segregations are observed.

There does not seem to be evidence for luminosity segregation, other than that of the very luminous ellipticals. On the other hand, there do seem to be significant differences between the distribution and kinematics of the various galaxy classes in clusters with and without significant dynamical substructure. However, the details of this have to be investigated further. The results of the segregation studies are required for the study of the mass profile and the galaxy orbits, through the Jeans equation of stellar dynamics.

With Van der Wel, Katgert is studying the applicability of the Jeans equation to galaxy clusters. Clusters are not in perfect equilibrium, because the galaxies outside the virialized core are still falling into the potential well of the cluster, while the sphere of influence of the cluster increases with time. However, the bias in the derived mass profile that is the result of neglecting these deviations from equilibrium probably is quite small in practice.

2.7.2 The merger fraction in clusters of galaxies as a function of z

Van Dokkum and Franx, in collaboration with Fabricant, Kelson, and Illingworth (van Dokkum et al 1999) have studied the galaxy population in the rich cluster MS1054–03 at a redshift of 0.83. The cluster has been observed with the Hubble Space Telescope, and a large multicolor mosaic of WFPC images has been obtained. The Keck telescope was used to take 200 spectra of objects in the field. Of these, 80 were cluster galaxies, and combining this with data from literature, they have 81 confirmed cluster members with HST images. These 81 cluster members were classified, and a large fraction turned out to be mergers. A fraction of 17% of the classified galaxies is classified as a merger. These are either on-going mergers, or merger remnants, characterized by irregular outer structure. The high merger fraction indicates that many early-type galaxies in clusters have undergone such an

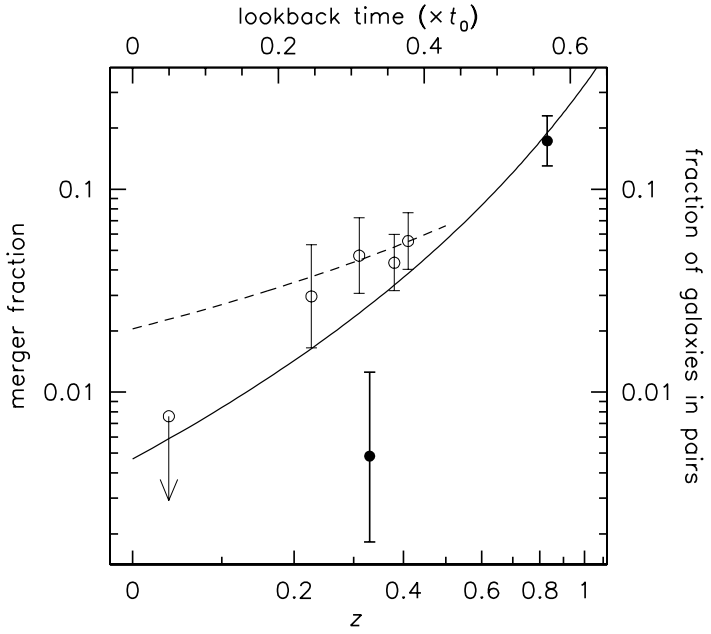

Figure 2.6: The merger fraction in rich clusters as a function of redshift. The solid symbols are the clusters MS1358+62 at $z = 0.33$ and 1054 at $z = 0.83$ from our study. Literature studies of rich clusters are indicated by open symbols. The solid line is a fit to the cluster data. The broken line is a fit to the fraction of field galaxies in close pairs from Patton et al. (1997). The merger fraction evolves rapidly in clusters and in the field, possibly even stronger in clusters.

event since $z = 1$. Even though it is not certain how typical this result is, it indicates that as many as 50% of the ellipticals may have formed through mergers since $z = 1$. Most of the mergers are not very blue, but rather red. This indicates a rather old stellar population, and is consistent with limits on the mean stellar formation redshift of stellar populations in early type galaxies in clusters. The merger fraction in MS1054–03 is higher than in other clusters studied until now. Figure 2.6 shows the merger fraction for clusters studied until now. A steep trend with redshift is indicated by the current results. Clearly, clusters at redshifts higher than 1 will be important to study this issue further.

2.7.3 The Fundamental plane for early type galaxies in a cluster at $z = 0.33$

Franx, in collaboration with Kelson, Illingworth, and van Dokkum has studied the Fundamental Plane relation for the early type galaxies in the cluster MS1358+62 at $z = 0.33$. The 30 early type galaxies follow a very clear relation, with a slope very similar to that found locally, and a similar scatter. The offset of the relation is consistent with earlier results on this clusters based on a much smaller number of galaxies. The fact that the slope is similar to that at low redshift indicates that a simple age effect is unlikely to produce the systematic differences in the mass-to-light ratios across the Fundamental Plane. The sample also contained early-type spirals, for which a relation with a much large scatter was found. Age effects are likely to contribute to the scatter.

2.7.4 Mass determination with weak lensing

Hoekstra, Franx, and Kuijken studied the distribution of mass in MS1054–03 measured from weak lensing. The HST images were analyzed, and a clear weak lensing signal was found. The strength of the lensing signal was calibrated using photometric redshift distributions for the Hubble Deep Fields North and South. The final mass estimate of the cluster agrees well with those obtained from X-ray emission and the measured velocity dispersion.

2.7.5 Thick gravitational lenses

Together with Rijkhorst (Amsterdam), Icke finished a study of the behaviour of thick gravitational lenses. In this work, it is *not* assumed that the lensing mass can be flattened in a single 'lens plane'. Instead, the photons are traced through the whole three-dimensional mass distribution. Rijkhorst showed that the actual ray tracing is not needed for masses below about the current horizon mass; it is sufficiently accurate to compute piecewise linear paths between the scattering planes of the individual point masses that sample the global mass distribution. The work is currently being extended to include variable mass distributions, such as occur when large scale structure forms between redshift of 20 and zero. The intention is to get a quantitative idea of the behaviour of the Rees-Sciama effect, and of the shearing properties in a Voronoi mass distribution.

2.7.6 Radio galaxies as tracers of distant galaxies

Best and Röttgering, together with Longair (Cambridge), have continued their studies of the 28 3CR radio galaxies with redshifts $z \sim 1$ in their Hubble Space Telescope sample. A clustering analysis has revealed a broad span of environmental densities with the mean environment being similar to that of Abell Class 0 to 1 clusters. Together with Eales (Cardiff) and Rawlings (Oxford) they have embarked upon an equivalent imaging and spectroscopic survey of 6C radio galaxies at the same redshifts. The strong evolution of the kinematical and ionisation properties of the emission line gas seen for the 3CR appears to be duplicated in this lower radio power sample.

Best and Röttgering, together with Lehnert (Munich) have used the Molonglo Survey to define a new large sample of the most powerful equatorial radio galaxies, complementary to the northern 3CR sample but visible to large southern telescopes. Observations taken on the ESO 3.6-m telescope have led to all 178 objects being optically identified and spectroscopic redshifts being obtained for all but one of them. This new sample is the target of many follow-up projects using the unique combination of VLT and VLA.

One important project based on this sample is a search for clusters around $z \sim 1.5$ radio galaxies. Time to pursue this project has been allocated on the ESO NTT.

At higher redshifts, Kurk, Röttgering and Miley together with van Breugel (U Cal/ LLNL), Carilli (NRAO/MPI), Ford and Heckman (JHU) McCarthy (Carnegie) and Moorwood (ESO) carried out a search for Lyman alpha excess objects around the $z \sim 2.2$ radio galaxy 1138-262. They imaged a 38 square arcmin field around the target with a narrow-band filter centred on redshifted Lyman alpha using FORS on the ANTU telescope of the VLT. 50 cluster member candidates were detected, having rest equivalent width larger than 20 Å.

2.7.7 Emission line regions in cooling flow galaxies

Jaffe has carried out AAT observations of cooling flow galaxies with the TTF FP-filter and showed extended emission line regions, both filamentary and diffuse around several, but not all, central cluster galaxies.

VLT spectra were taken of the nuclei and of some of the filaments. The nuclear spectra showed strong molecular Hydrogen emission lines. In the outer filaments, at distances up to 60 kpc from the nuclei, strong HII emission was found, at a lower excitation level than in the nuclear spectra. The IR spectra at this distance showed possible molecular emission, which would be unexpected and possibly point to a disrupted spiral galaxy as a source of the gas. This must be confirmed.

2.8 Molecular astrophysics

This year was characterized by the continuing rich harvest of results from ISO, as well as exciting new complementary submillimeter data from the JCMT.

2.8.1 Detection of interstellar H_2D^+

A highlight in 1999 was the first detection of H_2D^+ emission in interstellar space by Stark (MPIfR, Bonn), van der Tak and van Dishoeck. The $J = 1_{10} \rightarrow 1_{11}$ transition at 372 GHz was detected in the envelope of the cold protostellar source NGC 1333 IRAS 4A using the new sensitive dual polarization B3 receiver on the JCMT (see Fig. 2.7). Observations of this line require excellent weather, and the detection greatly benefitted from the flexible scheduling strategy. H_2D^+ is important as a probe of the major molecular ion H_3^+ (which cannot be observed in submillimeter emission), which drives the ion-molecule chemistry and measures the fractional ionization of clouds. In addition, the H_2D^+ abundance is enhanced relative to that of H_3^+ at low temperatures by orders of magnitude with respect to the [D]/[H] elemental abundance ratio. This "fractionation" effect is transferred to many other molecules resulting in high abundances of DCN, DCO^+ and other deuterated species which have long fascinated astrochemists. By combining the analysis, the data can be used to trace the temperature history of interstellar clouds.

The JCMT data have been analyzed using the power law models developed by van der Tak, coupled with a small chemical network containing the main production and destruction processes of H_2D^+. The good agreement between models and observations provides strong support for ion-molecule chemical schemes at low temperatures. NGC 1333 IRAS4A is a deeply-embedded cold protostellar source where much of the CO is frozen-out, leading to enhanced H_2D^+ abundances; future searches for H_2D^+ should focus on such objects.

2.8.2 Tracing the evolution of deeply embedded massive young stars

Van der Tak, in collaboration with van Dishoeck, Evans (Texas) and Blake (Caltech), continued his study of deeply embedded massive young stars. This project aims at linking observational phenomena associated with high-mass star formation, such as luminous infrared sources, ultracompact H II regions, hot molecular cores and masers into an evolutionary scheme. Fourteen sources, selected on infrared and millimeter properties, have been observed with single-dish submillimeter telescopes, millimeter interferometers and a near-infrared echelle spectrograph, complementing existing full ISO-SWS spectra. The first step in the analy-

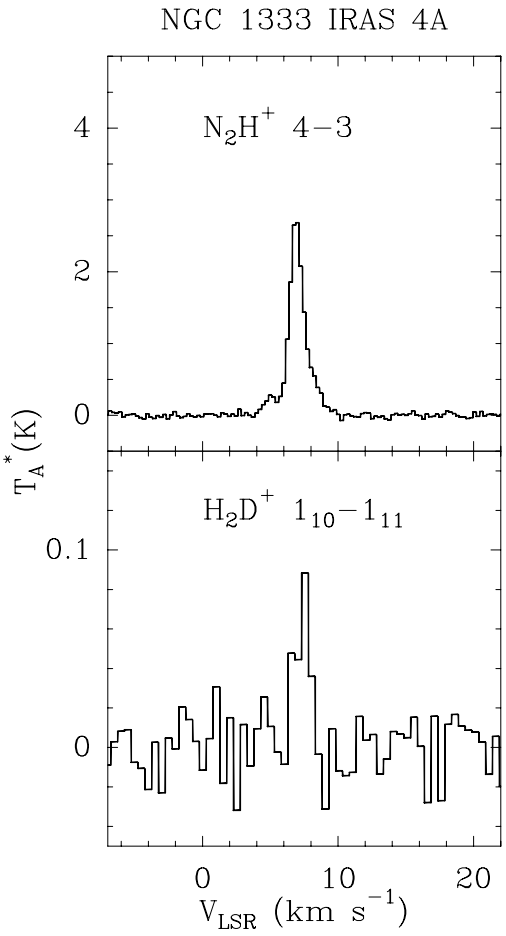

Figure 2.7: First detection of H_2D^+ $1_{10} - 1_{11}$ emission at 372.421 GHz toward the cold protostellar source NGC 1333 IRAS 4A, obtained with the JCMT. The N_2H^+ $4-3$ line at 372.672 GHz is observed simultaneously (from: Stark, van der Tak & van Dishoeck).

sis is the development of models of the physical structure of the envelopes. The temperature structure is obtained by self-consistent continuum radiative transfer, whereas the dust mass is probed by fitting submillimeter photometry. The slope of the density gradient is determined by modeling CS emission at submillimeter wavelengths with a Monte Carlo program written by Hogerheijde (UC Berkeley)

and van der Tak. A first paper applying this analysis to the source GL 2591 appeared in 1999, whereas a second paper describing the results for the full sample is in press. Systematic increases in the gas/solid ratios, abundances of evaporated molecules (see below) and fraction of heated ices (see laboratory section) with increasing temperature are found. Since these diverse phenomena involve a range of temperatures from < 50 K to 1000 K, the enhanced temperatures must be communicated to both the inner and outer parts of the envelopes. This "global heating" plausibly results from the gradual dispersion of the envelopes with time, reducing the ratio of envelope to stellar mass.

2.8.3 Hot CH_3OH: probing ice evaporation

Van der Tak, van Dishoeck and Caselli (Arcetri, Italy) have used the derived temperature and density profiles for massive protostars to determine abundance profiles of several molecules, in particular H_2CO and CH_3OH. These molecules are good test cases of hot core chemistry, since they may form by hydrogenation of CO on grain surfaces in the cold pre-stellar phase, and evaporate into the gas phase when an embedded star heats up the cloud. The results indicate that the methanol is not evenly distributed through the envelope, but that the abundance "jumps" by a factor of ~ 100 when the temperature reaches 90 K, where ice mantles evaporate. This is strong evidence for formation of methanol on grain surfaces.

Other evaporating species besides methanol are H_2O and CO_2 as observed with ISO-SWS (see below), and the abundance ratios of these species may constrain the conditions and time scales of the pre-stellar phase of molecular clouds. If surface chemistry dominates, this phase lasted $< 10^5$ years, during which time the density was high, a few $\times 10^4$ cm^{-3} or more, but the temperature low, < 15 K. Thus, the evaporating ice mantles may provide a unique fossil record of the pre-stellar phase.

2.8.4 Gas-phase molecules toward massive protostars

Van Dishoeck and Lahuis (SRON Groningen) have analyzed observations of the gas-phase C_2H_2 and HCN bands at 13.7 and 14.0 μm obtained with the ISO-SWS toward the same sample of massive protostars as studied by van der Tak et al. in submillimeter emission. These wavelength regions are heavily affected by instrumental fringing and new data reduction techniques had to be developed. Comparison with model spectra allows the excitation temperatures and abundances of molecules to be determined. The excitation temperatures range from <10 K to nearly 1000 K, whereas the abundances increase by more than an order of magnitude with increasing temperature. The observed gas-phase C_2H_2 likely comes from direct evaporation of ices at an abundance consistent with that found in cometary

ices. The enhanced HCN is probably produced by a combination of ice evaporation and high-temperature gas-phase chemistry.

Boonman, in collaboration with van Dishoeck, Wright (UNSW, Australia) and Lahuis (SRON Groningen), analyzed the ro-vibrational absorption bands of gas-phase H_2O and CO_2 at 6 and 15 μm observed with the ISO-SWS toward the same sample of massive protostars. The molecules have been detected toward most sources. Model results show that the H_2O abundances are high and increase with temperature, whereas those of CO_2 are almost constant for $T > 100$ K. Increases in the gas/solid ratios are found with increasing temperature, suggesting that grain-mantle evaporation indeed plays an important role. The corresponding solid-state abundances are up to factors of 10 higher, implying the destruction of gas-phase H_2O and CO_2 after evaporation from the ices.

2.8.5 Water absorption toward Orion

Wright (UNSW), van Dishoeck, Black (Onsala, Sweden), de Graauw (SRON Groningen) and collaborators obtained the first detections of thermal water vapor absorption lines toward Orion IRc2 using the ISO-SWS. Grating spectra covering wavelengths 25–45 μm yield 19 pure rotational lines, originating from levels 200–750 K above ground. Fabry-Pérot spectra of 5 transitions resolve the line profiles, which reveal the H_2O gas kinematics, see Fig. 2.8. The fact that all lines are seen in absorption is in striking contrast with data from the ISO-LWS, where the H_2O lines appear in emission. At least one line displays a P-Cygni profile, which suggests that the water is located in an expanding shell centered on or near IRc2. The expansion velocity is 18 km s^{-1}, in agreement with the value inferred from H_2O maser observations. Because the continuum is intense and likely formed in or near the water-containing gas, the excitation of the observed transitions is dominated by radiative processes. A simple, generalized curve-of-growth method has been developed to analyze the data. Combined with the H_2 column density derived from ISO observations of the pure rotational H_2 lines and assuming a temperature of 200–350 K, the inferred H_2O abundance is $\sim$ (2–5)$\times 10^{-4}$ in the warm shocked gas, similar to that derived from the LWS data, but higher than that found for most other shocked regions.

2.8.6 Detection of H_2 emission from the GG Tau circumbinary disk

Thi, van Dishoeck, van Zadelhoff, Blake (Caltech) and Hogerheijde (UC Berkeley) obtained the first detection of the low-lying pure rotational emission lines of H_2 from circumstellar disks around T Tauri stars, using the ISO-SWS, see Fig. 2.9. These lines provide a direct measure of the total amount of warm molecular gas

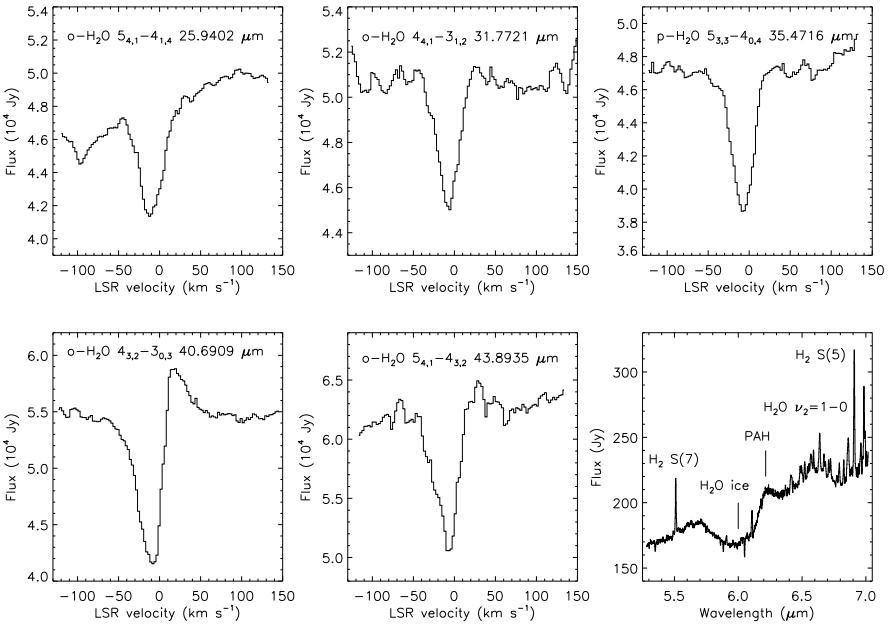

Figure 2.8: ISO-SWS Fabry-Pérot spectra toward Orion IRc2 of a selection of highly-excited H_2O lines. The P-Cygni-type profile seen for some lines indicates that the H_2O is located in an expanding shell with a very high water abundance. The panel in the lower right-hand corner displays the 5.3–7.0 μm grating spectrum of the H_2O ν_2=1–0 vibration-rotation band (from: Wright et al.).

in disks. The J=2→0 S(0) line at 28.218 μm and the J=3 →1 S(1) line at 17.035 μm have been observed toward the double binary system GG Tau. Together with limits on the J=5 →3 S(3) and J=7 →5 S(5) lines, the data suggest the presence of gas at $T_{\rm kin} \approx 110 \pm 10$ K with a mass of $(3.6 \pm 2.0) \times 10^{-3}$ $M_\odot$. This amounts to ~ 3 % of the total gas + dust mass of the circumbinary disk as imaged by millimeter interferometry, but is larger than the estimated mass of the circumstellar disk(s). The origin of this warm gas is still unclear; possibilities include photon and wind-shock heating mechanisms of the circumbinary material, but existing model calculations fall short by a factor of a few. The first results for GG Tau were published in ApJ Letters; the analysis of a larger sample of objects in underway.

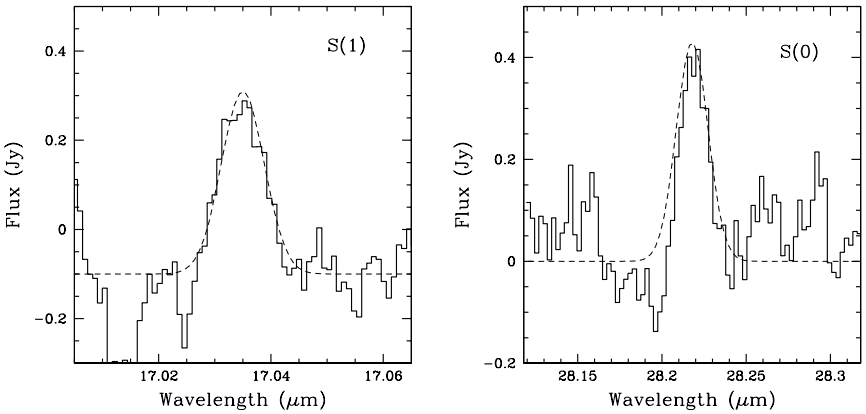

Figure 2.9: Detection of H_2 J=2 $\rightarrow$0 S(0) and S(1) J=3 $\rightarrow$1 emission from the circumbinary disk around GG Tau obtained with the ISO-SWS. The solid lines indicate Gaussian fits to the data with a width fixed at the instrumental resolution (from: Thi et al.).

2.8.7 Submillimeter lines from circumstellar disks

Van Zadelhoff, together with van Dishoeck, Thi and Blake (Caltech), continued their work on observations and modeling of submillimeter emission lines from circumstellar disks. High-excitation lines of various (organic) molecules have been detected with the JCMT, whereas the lower excitation lines have been imaged with OVRO. Radiative transfer calculations of the molecular excitation and emission from circumstellar disks are being developed, using disk models from the literature. Comparison with observations gives insight into both the physical structure of disks as well as their chemical nature.

2.8.8 Two-dimensional axisymmetric PDR models

Van Zadelhoff, in collaboration with van Dishoeck and Hogerheijde (UC Berkeley), continued their work on a code for 2D cylindrically symmetric photon-dominated regions (PDRs). The code will be applied to describe the temperature structure of envelopes around T-Tauri stars.

2.8.9 The diffuse interstellar bands and large molecules

Ehrenfreund and collaborators continued their studies of the diffuse interstellar bands (DIBs), a set of more than 200 lines seen in absorption in diffuse clouds.

The first DIBs were discovered in the 1920's, but their identification has remained a mystery for nearly 80 years. Recent research indicates that most DIB carriers are probably large carbon-bearing molecules which reside ubiquitously in the interstellar gas. O'Tuairisg and Ehrenfreund analysed their spectral survey toward BD +63 1964, a star which shows – to date – the largest number of DIBs in the wavelength range from 3906–6812 Å. Of the 253 measured features, 60 DIBs were until now unrecorded, and the large number of bands allowes valuable statistics on the overall DIB population. Physical modelling of the BD +63 1964 line of sight was performed using other atomic and molecular species and helped to describe the specific environmental conditions.

Sonnentrucker (ESTEC/Strassburg) and Ehrenfreund studied the spatial distribution of the λ6613 Å DIB carrier in the Perseus OB2 association based on high resolution observations toward lines of sight representing different interstellar environments. The velocity of the λ6613 Å DIB carrier was compared with that of Na I, as well as with CO, OH, H I and Ca II measurements from the literature. The behaviour of the λ6613 Å DIB carrier follows the overall expansion motion of the gas in the association, and its total column density is proportional to that of Ca II and H I, making those atoms good tracers of the λ6613 Å DIB carrier. The new results support the assumption that the λ6613 Å DIB arises from a gas phase molecule, possibly singly-ionized.

Ehrenfreund and Krelowski (Poland) compiled a database of the major DIBs at 5780 and 5797 Å as well as the violet lines of CH and CH^+ in the lines of sight toward some 70 stars representing various degrees of the interstellar reddening. The results show that these DIBs probably form in diffuse cloud interiors, in a related regime where CH and H_2 form. The ratio of the two DIBs correlates with the CH abundance, confirming that the λ5797 Å carrier is favoured in enhanced molecular gas regions over the λ5780 Å carrier. The ratio of the two DIBs correlates poorly with the CH^+ abundance.

2.8.10 Organic molecules in the star-forming regions, comets and meteorites

Van Dishoeck, together with Hogerheijde (UC Berkeley) and van der Tak, finished several reviews on the astrochemical evolution of gas and dust in star-forming regions and circumstellar disks, based on recent submillimeter and infrared/ISO observations. Procedures for determining the temperature, density and abundance profiles are outlined and clear diagnostics of the various evolutionary stages are summarized.

Ehrenfreund and Charnley (NASA-Ames, USA) have compiled the current view on the evolution of organic molecules, and their voyage from molecular clouds to

the early Solar System and Earth for the Annual Reviews of Astronomy & Astrophysics 2000. This review recapitulates the inventory and distribution of organic molecules in different environments, and their evolution, survival, transport and transformation from interstellar clouds until their incorporation into Solar System material, such as comets and meteorites.

2.9 Raymond & Beverly Sackler Laboratory

This section summarizes the research carried out in the Raymond & Beverly Sackler Laboratory for Astrophysics. It is closely linked with the Molecular Astrophysics research described in the previous section. A highlight in 1999 was the dedication ceremony of the lab on October 11 1999 by Raymond & Beverly Sackler. It was preceded by a one-day international symposium on "Highlights of Laboratory Astrophysics" attended by about 50 scientists, and followed by a four-day workshop on "Interstellar Ices" in the Lorentz Center, organized by A.G.G.M. Tielens (SRON/University of Groningen).

2.9.1 Ice segregation toward high-mass star-forming regions

Our current view of interstellar ice chemistry has been strongly influenced by recent data from the Infrared Space Observatory (ISO). ISO and ground-based results have shown that the most abundant ices in warm regions close to massive protostars are H_2O, CO_2, and CH_3OH. Ice segregation in those environments reflects the extensive thermal processing of grains over the lifetime of protostars. Ehrenfreund, Kerkhof, Schutte and collaborators presented a systematic set of laboratory infrared spectra of these ice mixtures which have been exposed to thermal processing. It is shown that the infrared bands of CO_2 and CH_3OH are particularly sensitive to the ice composition, temperature and applied ultraviolet irradiation. The laboratory data suggest partial crystallization of interstellar ices in the warm parts of the protostellar envelope. Detailed analysis of the H_2O, CO_2 and CH_3OH bands shows that their profiles can be effectively used to trace the line-of-sight conditions and the origin and evolution of the ice composition in dense clouds. A database containing 325 experiments on the thermal processing of H_2O:CH_3OH:CO_2 ice mixtures in the wavelength range 6000–400 cm^{-1} has been posted on the WWW at `http://www.strw.leidenuniv.nl/~lab`.

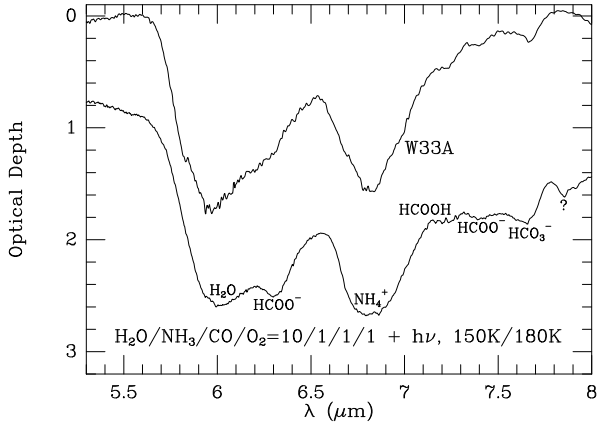

Figure 2.10: Comparison between the ISO-SWS spectrum of the high mass embedded young stellar object W 33A and the UV irradiated ice mixture $H_2O/NH_3/CO/O_2$ = 10/1/1/1 in the 6.8 μm region, suggesting the presence of ammonium bicarbonate. Several features present in the laboratory spectra appear to have corresponding structure in the observations (from: Schutte et al.).

2.9.2 The unidentified 6.8 μm feature: ammonium bicarbonates?

A strong absorption band at 6.8μm has been detected in the spectra of most protostellar sources, the carrier of which has so far remained unidentified. A suggestion in the literature is that it is due to carbonates. To test this hypothesis, Schutte, in collaboration with Moore, Khanna and Hudson (NASA-Goddard, USA), studied the formation of ammonium carbonate ($(NH_4^+)_2CO_3^{2-}$) by irradiation of astrophysical ice analogs containing H_2O, CO_2, NH_3 and O_2. Irradiation was performed with MeV protons at the NASA Goddard lab and with vacuum ultraviolet radiation at the Sackler Laboratory. In both cases a strong infrared feature was produced in samples falling at 6.8 μm. Comparison with literature data indicates the presence of ammonium bicarbonate ($NH_4^+.HCO_3^-$) in the irradiated sample, see Fig. 2.10. While NH_4^+ produces a strong feature at 6.8 μm, the bicarbonate ion only produces minor spectral structure. The 6.8 μm feature of ammonium bicarbonate gives a good match to the observed interstellar 6.8 μm feature. The presence of abundant NH_4^+ may indicate that the protostellar objects have gone through a phase of intense processing of the circumstellar material, in which a large part of the gas was atomized by radiation or shocks.

Novozamsky, in collaboration with Schutte, performed a research project on the deuterium shift of the ν_3 band of OCN^- at 4.62 μm. Measurements indicate that this feature, which is produced by irradiation of NH_3/CO ices, shows a shift in ices

with ND_3, casting some doubt on the original assignment of this band to the OCN^- ion. Since this band is widely observed toward protostars, a correct identification is of considerable interest. Because OCN^- forms a close complex with the NH_4^+ counter-ion inside the ice matrix, a small deuterium shift may actually occur even if the ion itself does not contain hydrogen. Direct measurements of this complex in the Sackler laboratory confirmed the presence of such a shift, thereby strengthening the OCN^- assignment.

2.9.3 Why is the 3.4 μm feature weak in dense clouds?

A band at 3.4 μm due to the CH-stretching mode of organic materials has been detected in diffuse interstellar clouds, but is reduced by at least 60% in strength in dense clouds. A laboratory study on the destruction of this feature was carried out by Muñoz, Schutte, Ruiterkamp and Greenberg, in collaboration with Mennella (Naples, Italy). Simulation experiments using hydrocarbon materials such as laboratory produced Hydrogenated Amorphous Carbon indicate that its reduction could be caused dehydrogenation upon ultraviolet irradiation. The feature may be restored in the diffuse medium by rehydrogenation, while in dense clouds this is not possible since the organics are covered by ices.

2.9.4 Processing of organic residues

Muñoz, Schutte and Greenberg studied the chemical properties of the organic residues created by the irradiation of interstellar ice analogs. The goal of this research is to provide laboratory experimental data related to the ESA-Rosetta mission on the study of organic components in the nucleus of comet Wirtanen. The samples were analyzed by Liquid Chromatography/Mass Spectrometry at the Univ. of Amsterdam and by Gas Chromatography/Mass Spectrometry at the Univ. of Bremen. Components were detected with masses 154, 156, 170 and 182 a.m.u., corresponding to Hexamethylene tetramine (HMT) ($C_6H_{12}N_4$) with different radicals attached to it, most likely Methyl-HMT, Hydroxy-HMT, CH_2OH-HMT and Acetaldehyd-HMT. These results have important implications for the search parameters that are needed to investigate the composition of comets.

2.9.5 Probing surface chemistry: the SURface Reaction Simulation Device

Schutte, in close collaboration with Post of the Huygens mechanical workshop, designed and build a new set-up for the Sackler laboratory called the SURface REac-

tion SImulation DEvice (SURFRESIDE). This set-up is designed to study chemical reaction of cryogenic ice samples like CO, O_2 and H_2CO with atomic beams such as H. The experiment will be able to simulate the basic surface chemistry which is thought to be responsible for most of the molecules found in interstellar ices, such as H_2O, CO_2, and CH_3OH.

2.9.6 Extraterrestrial amino acids in the Orgueil meteorite: a cometary origin?

Ehrenfreund and collaborators at UC San Diego (group of J. Bada) started a project to trace the parent body of meteorites found on Earth. Several carbonaceous meteorites, including the famous Orgueil meteorite, have been analyzed and are known to contain extraterrestrial matter, even presolar material. Ehrenfreund et al. have investigated the amino acid composition in the Orgueil meteorite by hot water extraction and acid hydrolysis. The most abundant amino acid measured in pristine Orgueil samples is β-alanine, followed by glycine. The racemix ratio of D/L alanine in those samples indicates an extraterrestrial origin. The amino acid composition and C-isotopic measurements can be used to trace their extraterrestrial and presolar record. A comparison of the three carbonaceous meteorites Orgueil, Murchison and Murray shows that Orgueil must have originated from a different parent body. Whereas a heated sample of Murchison provides an excellent match to the spectral properties of C and G asteroid spectra, the current inventory of cometary volatiles favors the formation of amino acids like glycine and β-alanine, as seen in the Orgueil meteorite. Ehrenfreund et al. therefore propose a cometary origin for the Orgueil meteorite.

2.10 Instrumentation, surveys and databases

2.10.1 VLTI

An important goal of ESO's VLT programme since its inception has been to combine the radiation from the four constituent 8m telescopes and several smaller auxiliary telescopes into the VLT Interferometer (VLTI), giving a FWHM resolution of a few tens of milliarcsec at 10 micron to 1 milliarcsec in the visible. Dutch participation in the VLTI programme was an important part of the proposal to NWO by the Netherlands Research School in Astronomy (NOVA) in the context of the "diepte strategie" for funding Dutch research schools. There are several components to Dutch participation in the VLTI programme, all of which attempt to exploit the

strengths of Dutch astronomy and to build up the expertise which will optimise scientific use of the facility.

MOU with ESO

To be an official partner in the programme and a member of the VLTI Tripartite Steering Committee with guaranteed observing time, requires a contribution to ESO additional to the normal subscription. On 31 May 1999, a memorandum of understanding was signed by the Director of NOVA and the Director General of ESO guaranteeing additional Dutch contributions to the VLTI project and providing for Dutch membership of the Steering Committee. The additional contribution consisted of two components.

NEVEC: NOVA-ESO expertise centre for VLTI

First, NOVA has committed to fund a new national expertise centre in optical/infrared astronomy as a joint venture with ESO, based at Leiden. The goals of the NOVA-ESO Expertise Centre of VLTI (NEVEC) are:

(i) the development of instrument modelling, data reduction and calibration techniques for VLTI, concentrating on optimizing VLTI for studies of faint objects
(ii) the accumulation of expertise relevant for a second-generation VLTI instrument
(iii) provision of education in VLTI

Besides providing an infrastructure for NEVEC, NOVA has guaranteed funding for a minimum of 18 my of scientists and software engineers to work at NEVEC during the period from 1999 to 2004. At least 10 my will be devoted to carrying out a set of tasks to be defined jointly by NOVA and ESO within the bounds of the available manpower. The relevant work-packages and management structure for NEVEC are being developed in mutual agreement between NOVA and ESO. Selection of NEVEC staff is being carried out in consultation with ESO.

Direct contribution of funds to ESO

During 1999 NOVA contributed DM 200,000 to ESO to fund the VLTI infrastructure and committed to making every effort to ensure further additional funding for VLTI by the Netherlands, with a target of DM 800,000 during the period 2000 to 2004.

Instrument contribution (MIDI)

Currently several Dutch astronomers (Jaffe, Le Poole, Pel, Waters) are member of the definition team for the 10–20 micron VLTI instrument (MIDI), with main partner the Max Planck Institüt fur Astronomie Heidelberg (MPIA). The PI for the Netherlands component of MIDI is Waters. The collaboration with MPIA amounts to a significant share in development of MIDI. Stichting ASTRON is constructing part of the MIDI hardware under contract from NOVA and considerable progress was made in this during 1999. In addition, NEVEC is developing software to analyze fringes from MIDI, an activity for which 3 man-years has been guaranteed to the MIDI project.

Oversight of Dutch VLTI

Dutch participation in VLTI is being guided by a national team which meets twice per year, consisting of de Graauw (SRON, Groningen), Jaffe (Leiden), Le Poole (Leiden), Miley (Leiden - Chair), Noordam (ASTRON, Dwingeloo), Röttgering (Leiden), Pel (Groningen), Schilizzi (JIVE, Dwingeloo) and Waters (Amsterdam). NOVA has appointed Le Poole, Miley and Waters to be members of the new Quadrupartite Steering Committee.

NEVEC: NOVA-ESO expertise centre for VLTI

During the latter half of 1999, the first appointments were made to NEVEC. Three technical astronomers who obtained Ph.Ds in optical interferometry were recruited. Percheron, came to Leiden from a position in US industry. Meisner is an optical engineer who obtained his Ph.D from U. Minnnesota in 1995. The third member of the team, Mennesson, recently obtained his Ph.D under the supervision of Lena and Mariotti. Valuable additional expertise was provided by Cotton (NRAO) an experienced radio interferometerist and one of the chief architects of the astronomical data reduction package AIPS, who spent a sabbatical at Leiden, partially funded by NWO. Additional contributions to the Dutch VLTI effort were provided by several Leiden staff, including Jaffe (60%), Le Poole (70%) and Röttgering (15%). Further staff will be added to NEVEC in 2000.

One of the main occupations of NEVEC in its initial half-year was to define a task package together with ESO. Several tasks were identified for a long-term plan. These included:

(i) an analysis of atmospheric effects on the MIDI and PRIMA
(ii) consideration of optimum parameters and modes for calibration and development of a calibration database
(iii) compilation of a list of potential phase-referencing targets for PRIMA
(iv) fringe detection optimization
(v) definition of FITS format for VLTI

Optical interferometry is of interest to several groups at Delft and the NEVEC participants have several areas where collaborative projects are under consideration. Le Poole and Röttgering are collaborating on research on an investigation on phase shifting for nulling interferometers for ESA's forthcoming Darwin satellite with the Optics Research Group in the Technical Physics Department of the TU Delft led by Braat. The optics group of the space engineering department of TNO/TPD (Hoekstra, Snijders, Braam etc.) is also heavily involved.

Röttgering, in his role as Darwin Science Team member, organized several meetings to explore possible collaborative projects involving the synergy between VLTI and space interferometry, including a workshop to bring together the various groups involved in optical interferometry in the Netherlands under the umbrella of an informal working group, the Dutch Joint Aperture Synthesis Team (DJAST). Besides participants from NEVEC and Leiden Observatory, representatives were present from SRON, Fokker Space, ESA and TU Delft, TNO/TPD, TNO/Fel, SRON and NIVR. A particularly valuable participant at the workshop was Professor Charles Townes, who had the previous day delivered the first Sackler Lecture on near-IR interferometry.

2.10.2 HIPPARCOS and GAIA

ESA is studying a possible follow-up mission to HIPPARCOS, called GAIA, which will deliver parallaxes and proper motions of microarcsecond accuracy for all objects brighter than $V \sim 20$. The Science Advisory Group contains two Leiden staff members: Perryman (chair) and de Zeeuw. Perryman leads the entire effort, and de Zeeuw coordinates the scientific case, together with Gilmore (Cambridge).

Robichon considered the scientific impact of GAIA on the study of open clusters, and showed that the vast majority of the 3000 or so open clusters closer than 5 kpc contain members which GAIA will be able to separate from field stars. In the open clusters closer than 500 pc, the 3-dimensional structure will be seen, and the internal accuracy of the tangential velocities of the members will be smaller than the cluster internal velocity dispersions.

Reuland finished the simulations of expanding OB associations. The results show that the future astrometric satellite GAIA will provide positions, proper motions, parallaxes, and radial velocities accurate enough to determine the expansion rate of the nearby (<1.5 kpc) OB associations. Furthermore, Reuland showed, by retracing the orbits of the association members, that it is possible to reconstruct the initial conditions (both spatial configuration and expansion age) of OB associations at their birth time.

2.10.3 SAURON

De Zeeuw, Bureau, and Miller, Carollo (JHU), Bacon, Copin, and Emsellem (Lyon), Monnet (ESO), Davies and Kuntschner (both Durham), and Peletier (Nottingham) have built a wide-field successor to the TIGER integral-field spectrograph, for use with the 4.2-m William Herschel Telescope on La Palma. The new instrument is called SAURON (Spectroscopic Areal Unit for Research on Optical Nebulae), and records about 1600 spectra simultaneously, with full sky coverage in a field of 33 by 44″, additional coverage of a small "sky" field 2′ away, spatial sampling of 1.0″, and an instrumental dispersion of 75 km/s. It is funded in part by a grant from ASTRON/NWO to de Zeeuw, and was built at the Observatoire de Lyon. Miller and Bureau have joined the SAURON team. The instrument was completed in late 1998, and tested in Lyon. It was delivered to La Palma in early 1999, and first light was obtained on February 1, 1999. Miller developed userfriendly pipeline software for efficient reduction of the data. Two observing runs in the course of the year provided extended kinematic and linestrength maps for 15 galaxies, 6 of which with multiple pointings. A number of these show significant deviations from axisymmetric kinematics, including minor axis rotation, and s-shaped emission-line gas distributions. The galaxies are part of a representative sample of nearby early-type galaxies (ellipticals, lenticulars, and Sa bulges, in clusters and in the field), carefully put together by Bureau. The SAURON observations will be complemented with high spatial resolution observations of the nuclei. Dynamical modeling and analysis of the linestrength maps in terms of age and metallicity of the stellar populations, will provide black hole masses, intrinsic shapes, and internal structure as a function of Hubble type.

2.10.4 SETI

Ollongren presented his second paper in his sequel (Large Size Message Constructon for SETI, initiated in 1998) at the 50th International Astronautical Congress in Amsterdam, during the SETI session. The paper presents a new method for clarifying the contents of messages for ETI. Textual contents of a static nature are pro-

vided with abstract types at a meta level in this way. In collaboration with Douglas Vakoch of the SETI institute, California, these ideas are being worked out in more detail.

Chapter 3

Education, popularization and social events

Chapter 3
Education, popularization and social events

3.1 Educational matters

3.1.1 Organization

After having served as Director of Education since he arrived at the Sterrewacht in 1984, Prof. van Schooneveld reached the age of mandatory retirement in December, 1998, and was succeeded as Director of Education by Prof. Burton on January 1, 1999.

The formal responsibility for awarding the Propedeuse certificate and the Doctoraal degree resides with the "Examencommissie" for Astronomy. During 1999 the committee comprised Prof. Burton (chairman), Dr. Israel, Dr. van der Werf, Prof. de Zeeuw, and Prof. Nienhuis (from the Physics Department). The Director of Education was advised by the Education Committee ("Opleidingscommissie"), consisting of Prof. Franx (chairman), Dr. Israel, Dr. Jaffe, and Drs. Le Poole, all as representatives from the scientific staff; Drs. Boonman, a representative from the Ph.D. students; and, representing each of the undergraduate classes, T. Nieuwenhuizen, C. van Breukelen, M. Kriek, G. van de Ven, and A. van der Meer. The Education Committee for Astronomy occasionally meets jointly with that for Physics, to discuss curriculum issues of mutual concern.

During the last two decades the number of educational duties and the associated administration has grown significantly. Therefore, some of the Education Director's tasks are delegated to other staff members, often members of the Committee for Education. Dr. Lub, as Secretary of the Sterrewacht, ably assisted with many of the educational matters. The undergraduate and graduate students play a particularly important role as hosts and enthusiastic providers of information

during the various Open Days for prospective students which are organized regularly throughout the academic year. The members of the society for astronomy students, "De Leidsch Astronomisch Dispuut 'F. Kaiser"', continued to contribute positively to the social cohesion of the Sterrewacht and to its vigorous public outreach program.

3.1.2 Student counseling

Several years ago the system of "mentor groups" was introduced, whereby each first-year student is assigned to one of three groups, lead by a member of the permanent staff, and assisted by one or two older students. Each mentor group meets once a week during the first semester, and somewhat less frequently during the second, usually for lunch. The mentor groups serve to answer questions from the first-year students about the still-unfamiliar study procedures, and generally to offer support and advice. Each student also has more formal access to a staff member who serves as counselor, following the student's progress and advising on study habits and choice of curriculum. During 1999 Dr. Israel served as faculty advisor for the undergraduates in the first three years of their studies (with Prof. Burton taking over the task for the first-year students during the second semester). Prof. Burton served as the faculty advisor for the undergraduates during the last two years of their studies. The faculty advisors report twice each academic year to the Education Committee.

Despite the efforts and thought which has gone into the matter of student counseling, the attrition rate remains high amongst the first-year students. The number of first-year students enrolling each year has remained quite constant over the past two decades, with this number hovering near 25. (In 1999, 27 students enrolled for the first year; 7 of these were women.) The constancy of this flux of incoming students differentiates Astronomy from the other studies within the Faculty of Mathematics and the Natural Sciences, where the number of incoming students has been dropping, just as it has within the Leiden University as a whole. Despite satisfaction with the total number of students, Astronomy remains concerned by the attrition rate amongst first-year students: typically some 6 or 7 of the first-year students do not continue with their Astronomy studies after their first year, either switching to another field (usually outside of the sciences), or leaving the University altogether. After successful completion of the first-year course leading to the Propedeuse certificate, the attrition rate for Astronomy students is modest.

The mentor system is one of initiatives taken to ameliorate the first-year attrition rate. It seems that some of the entering students choose to study astronomy without fully realizing just how dominated the curriculum is by mathematics and physics: students majoring in astronomy in Leiden have to earn 45% of their credits

in mathematics and 40% in physics during their first year, with but little exposure to astronomy. But some of the first-year students who have chosen for Astronomy evidently do not have a robustly secure aptitude for an essentially quantitative, mathematical study. There being no entrance examination (yet) for entrance to a Dutch university (beyond the requirement of successful completion of the academically-oriented high school), the Astronomy Department publicizes widely the tight correlation between high-school grades in mathematics and physics and the chance of success during the first year of Astronomy study at the University. A graph showing this correlation is printed, for example, in the brochure sent to prospective students, and is given prominence at the various Open Days and other recruiting occasions for prospective students.

3.1.3 The "Bologna Declaration"

Several years ago the Ministers for Education of the various member states of the European Union signed the "Bologna Declaration", which anticipates a more uniform system of degrees and diplomas at European universities, facilitating the exchange of students across national borders. Implementation of the Bologna Declaration would result in an educational system arranged quite like the undergraduate and graduate programs of the universities in Great Britain and the United States. The current Propedeuse certificate would be seen as a "qualifying examination" for two additional years of study after which a Bachelor's degree would be awarded. At the Bachelor's degree level, students from outside of the Netherlands could apply for admission to the graduate school program, which would lead to a Master's degree (replacing the current Doctoraal degree) after two additional years of student. In order to make this program accessible to students from outside The Netherlands, lectures would be given in English. Entrance examinations would apply, including one in the English language. After the Master's Degree, a further qualifying examination would be required before admission to the four-year Ph.D. program. The requirements and consequences of implementing the Bologna Declaration are being studied by a Faculty committee chaired by Prof. Berends, of the Physics Department.

3.1.4 Different options for the 5th year

The undergraduate program in Astronomy reverted to a five-year curriculum, beginning with the enrollment of students entering in September, 1997. The revised curriculum involves three different options for the fifth year, namely a Research

Option, a Communication/Education Option, and a so – called Beta – Management Option, and follows an agreement reached between the association of Dutch universities (the VSNU) and the Ministry of Education & Science.

- The Research Option is the one which most of the Astronomy students will choose. This program involves two research projects, the "Klein Onderzoek" to be carried out during the fourth year, and to represent about a half-year's effort at half-time investment, and the "Groot Onderzoek" to be carried out in the fifth year, amounting to a full-year's half-time investment.
- The Communication/Education Option is intended for students who might wish a career in science journalism, for example, or in a museum, or as a physics teacher in an academically-oriented high school.
- The Beta Management Option is intended for students who wish a broad knowledge of Astronomy supplemented with training in business economics and management skills. This option would prepare graduates for careers in science-related governmental or private organizations.

The differences in the curriculum for the Communication/Education and Beta Management options compared to the curriculum of the Research option are largely confined to the fifth year. The courses specific to options other than the Research one are organized and presented on a central level by the Faculty, not by the staff of the Sterrewacht. The internships which take the place of the "Groot Onderzoek" in the Research Option are intended nevertheless to have an obvious connection with Astronomy.

3.2 Degrees awarded in 1999

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

In 1999 eight students passed the final examination for the Doctoraal (M.Sc.) Degree in Astronomy. They are:

Date	**Name**
February 23	E.K. Verolme
February 23	S.R.R. van der Laan
May 25	E.G. van den Heuvel
August 31	M.A. Reuland
August 31	B.P. Venemans
August 31	T.J. van de Kamp
September 28	R. den Hollander
November 30	T. Voskes

3.2.2 Ph.D. Degrees

In 1999 six graduate students successfully defended their theses in the Senate Room of the Academie on the Rapenburg, and were awarded the Ph.D. degree. They are:

Date	**Name (thesis advisor)**	**Title**
February 17	R.B. Rengelink (Miley/deBruyn)	The Westerbork Northern Sky Survey
June 15	E.T. Chatzichristou (Miley/Jaffe)	Imaging & bidimensional spectroscopy of active and interacting galaxies
September 9	N. Cretton (de Zeeuw/Rix)	Dynamical models of early-type galaxies
September 9	J. Stil (Habing/Israel)	Dwarf galaxies: dynamics and star formation
September 22	C.P. Dullemond (Icke/Turolla)	Radiative transfer in compact circumstellar nebulae
October 28	L. Pentericci (Miley/Röttgering)	The most distant radio galaxies: probes of massive galaxy formation

The Ph.D. theses are also listed in Appendix X.

3.3 Courses and teaching activities

3.3.1 Regular courses taught by the observatory staff

Compulsory courses (verplichte vakken):

Name	Title	Semester
V. Icke	Inleiding Astrofysica	1
A.M. van Genderen	Sterrenkundig Practicum 1	2
H.J. Habing	Elementaire Sterrenkunde	3
H.J. Habing	Spreekbeurt 1	4
F.P. Israel	Sterrenkundig Practicum 2	4
R.S. le Poole	Sterren	5
R.S. le Poole	Spreekbeurt 2	5
C. van Schooneveld	Astronomische Waarneemtechnieken 1 + Ruis	5
E.F. van Dishoeck	Stralingsprocessen	5
H.J.A. Röttgering	Sterrenkundig Practicum 3	6
M. Franx	Sterrenstelsels	6
M. Franx	Spreekbeurt 3	6
E.R. Deul	Introductie Week	7
W.B.Burton/G.K.Miley	Studenten Colloquium	8, 9 and 10

Normal selected courses (regelmatige keuzevakken):

Name	Title	Semester
J. Luu	Solar Systems	7 and 9
J. Lub	Stellar Evolution	7 and 9
P. Katgert	Interstellar Matter	8 and 10
J.G.B.M. Bloemen	High-Energy Astrophysics	8 and 10

Incidental selected courses (incidentele keuzevakken):

Name	Title	Semester
A. Ollongren	Celestial Mechanics	8 and 10
A.M. van Genderen	Variable Stars	7 and 9

3.3.2 Astronomy Kaleidoscope

Freshman students were introduced to current research projects being carried out by Astronomy and Physics personnel in a series of lectures held in January, February, and March. Three lectures in astronomy were given:

Date	Speaker	Title
January 27	P.T. de Zeeuw	SAURON, black holes, and the structure of galaxies
February 10	G.K. Miley	Probing the early Universe with distant radio galaxies
March 3	E.F. van Dishoeck	The nurseries of stars and planets

3.3.3 Leiden-Dwingeloo summer school in astrophysics

During alternate summers a two-week-long program is offered to interested high school students, following an initiative of Dr. W.J. Jaffe. The residential program makes use of the ASTRON facilities in Dwingeloo. The 1999 Leiden-Dwingeloo Summer School in Astrophysics focussed on the theme "When Galaxies Collide". Some 15 students from VWO high schools throughout The Netherlands attended lectures given by W.J. Jaffe and V. Icke, and participated in hands-on workshop sessions. Six graduate students assisted in the school. Financial support came from the Observatory, as well as from Leiden University, the Leids Kerkhoven-Bosscha Fund, and ASTRON.

3.4 Popularization and media contacts

De Bruijne

"De Gould Belt" (Leidse Weer- en Sterrenkundige Kring (LWSK; NVWS), December 14)
"Hipparcos" (Haarlemse Weer- en Sterrenkundige Kring (HWSK; NVWS), December 16)

De Breuck

"Waaslander ontdekt oudste zwarte gat" (Belsele, June 18)

Van Dishoeck

"ISO confirms that the normal matter in the universe is not enough to cause a Big Crunch" (ESA Information Note, March 5)
"First detection of emission by deuterated molecular hydrogen in space" (Science Now, March 10)
"Deuteriumgehalte van heelal bevestigt eeuwige uitdijing" (NRC Handelsblad, April 3)
"Le Big Crunch n'aura pas lieu" (Info Science, May 3)
"Interstellaire chemie: processen onder ultrahoog vacuum" (Nederlandse Vacuum Vereniging, May 28)
"Lofty Observatory Gets Boost" (Science, June 18)
"De Fascinatie" (Academia, July issue, pp. 22–24)
"Astrochemistry" (Stars & Universe, Korea, October issue, pp. 20–23)
"De Kraamkamer van Sterren en Planeten" (Bataafsch Genootschap, Rotterdam, December 6)

Van Dishoeck, Israel

"Europa en VS bouwen nieuwe radiotelescoop" (Telegraaf, June 19)

Schutte, van Dishoeck, Greenberg

"De Kosmos onder handbereik" (Volkskrant, October 9)
"Astrofysici vieren feest" (Mare, October 14)

Ehrenfreund

"Roet zijt gij" (De Volkskrant, February 13)

Haverkorn

"Rimpelingen in de achtergrondstraling" (Haarlem, October 21)
"Rimpelingen in de achtergrondstraling" (Nijmegen, November 9)
"Het begin van het heelal" (Leiden, November 16)

Icke

"Het Heelal in een borrelglas" (Lions Club, Oegstgeest, February 3)
"Geloof en sterrenkunde" (Haarlems Dagblad, March 11)
"Tussen planeten en sterrenstelsels" (JWG, Utrecht, March 13)
"Het heelal in 40 stappen" (Fioretti College, Lisse, April 19)
"Tijd in natuur- en sterrenkunde" (Teleac, May 25)

"Sterrenkundig onderzoek" (Faros Radio, June 1)
"Het einde van de Zon" (Zuiderlicht, VPRO, June 18)
"Kosmologie" (Comenius Leergang, RUG, June 24)
"Weerslag" (Radio West, August 8)
"Zonsverduistering" (NCRV Radio, August 9)
"Zonsverduistering" (TV West, August 9)
"Zonsverduistering" (BNN Radio, August 10)
"Zonsverduistering" (AVRO Radio, August 11)
"Zonsverduistering" (NOVA TV, August 11)
"Sterrenkunde studeren" (El Cid, August 17)
"De kosmische kat" (Broekhin College, Roermond, September 24)
"Alle fysica is astrofysica" (ANW cursus, Amsterdam, November 10)
"Hoe ontstaan sterren?" (Wetenschapsquiz Junior, VPRO-TV, November 15)
"In gesprek met Mulisch" (Wintertuin, Nijmegen, November 16)
"Nieuwe presentatievormen in de popularisatie" (Stichting WeTeN, Utrecht, November 18)
"De lange arm van de Leidse sterrenkunde" (Cleveringa Lezing, Breda, November 26)
"Alle fysica is astrofysica" (Woudschoten Conferentie, December 11)
"De volgende 25 jaar" (Volkskrant magazine, December 12)
"Sterrenkunde in de volgende eeuw" (Wereldomroep, December 14)
"Sterrenkunde in de volgende eeuw" (Radio West, December 24)

Israel

"Mars Polar Lander" (Wereldomroep, January 4)
"Mars" (BNN, March 31)
"Kosmische Rampen" (Haagsche Courant, June 30)
"SETI" (NOS Aktueel, October 29)
"Leoniden" (SBS 6, December 3)
"Leoniden" (Radio Rijnmond, December 6)
"Reizen naar de Sterren" (Nationale Wiskundedag, Noordwijkerhout, February 5)

Kurk

"Het Oerknalmodel" (Delft, April 19)
"Het Oerknalmodel" (Heerlen, October 23)

Luu

"Is Pluto a planet?" (Debate panel, American Natural History Museum, New York, May 24, 1999)
"The Kuiper Belt" (VPRO radio studio, Amsterdam, Nov 26, 1999)

Ollongren

"Communicatie aspecten met buitenaardse intelligentie" (Amsterdamse Weer- en Sterrenkundige Kring, Amsterdam, 17 maart 1999)
"Communicatie met buitenaardse intelligentie" (Vereniging Sterrenkunde Midden Limburg, Roermond, 13 december 1999)

Schutte

"Wij bestuderen ijs in de ruimte" (Intermediair, October 21)

Thomas

"Enkele eigenschappen van melkwegstelsels in clusters" (NVWS, Heerlen, 11 december)

Verolme

"De 24-uurs economie" (Leids Dagblad, July)

Vlemmings

"VLBI: Het Globale Netwerk van Radiotelescopen" (Haarlem, November 18)

De Zeeuw

"Sterren, gas, en donkere materie in de Melkweg halo" (Leidse Weer en Sterrekundig Kring, January 19)

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 contact between undergraduate students and the Observatory. The association is named after the founder of the Old Observatory, Frederik Kaiser. His birthday and dying day are commemorated every five years. The activities are open to all astronomers and astronomy students. The current board, consisting of Roderik Overzier, Glenn van de Ven, Stijn Wuyts and Leonie Snijders, tries to prolongate the success of the previous years. The main activities are studentenlezingen, the sterrewacht-borrels, instruction courses at the Old Observatory and the famous Sterrewachtbarbecue in June.

The association also contributes to the popularization of astronomy by giving tours at the Old Observatory and assisting on "open dagen". Every last Friday of the month a Sterrewacht Borrel is 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, include borrels and lectures by senior students. Each year an exuberant dinner is organized just for members, this year at restaurant "Oudt Leyden". This year the Dispuut organized its biggest event ever: an excursion to the total solar eclipse in France on August 11th. There were 65 participants, mostly students. Current information about the Association, its activities and plans for the future is available on their new website at `http://www.strw.leidenuniv.nl/~kaiser`.

3.5.1 "Studentenlezingen"

Date	**Speaker (affiliation)**	**Title**
February 24	Dr. J.J.M. Sleutels (Perception Cognition Ontology, Faculty of Philosophy, Leiden University)	"Do stars know their mathematics?"
December 7	Prof. Dr. A. Ollongren (LIACS, Leiden University)	"CETI: Communication with Extra Terrestrial Intelligence"

3.5.2 Tours old observatory

For the popularization of astronomy, for which there is a broad interest, the Leidsch Astronomisch Dispuut "F. Kaiser" is happy to organize tours at the Old Observatory, located in the historical center of Leiden. To honor the glorious past of the oldest academic observatory in the world, the association gives tours along the historical telescopes and tells the visitors the stories that come with the building and the instruments on request. It also provides visitors lectures about astronomy. Topics include history of astronomy in Leiden, extra-terrestrial life, the solar system, the universe and distance measurements in astronomy.

Date	**Group**	**Speaker(s)**
January 13	Ashram College	Maurits Hartendorp, Ivo Labbe
January 23	small group	-
February 4	schoolclass	-
February 11	small group	-
February 12	small group	Maurits Hartendorp
February 13	small group	-
February 18	birthday party	Guido Kosters
March 16	small group	-
April 7	Eurometaal	Maurits Hartendorp
April 29	Oranje Nassau College	Maurits Hartendorp, Jasper Arts
June 5	small group	-
August 6	Japanese group	Roderik Overzier
August 27	NATO	Maurits Hartendorp, Guido Kosters, Roderik Overzier
September 28	Scoutinggroup	Maurits Hartendorp
October 9	small group	Roderik Overzier
October 9	birthday party	Roderik Overzier
November 16	schoolclass	Roderik Overzier

3.5.3 "Studententhee"

Occasionally, the "Leidsch Astronomisch Dispuut 'F. Kaiser"' organizes a "studententhee (student's tea)", a more official version of the daily tea break, mainly visited by senior students. Regularly a lecture is held by one of the students, often about their student project. However, this year no lectures have been organized. In order to reestablish the "studententhee" a new coordinator has been appointed: Gerben Dirksen will organize a new series of lectures.

Appendix

I

Observatory staff on December 31,1999

Observatory staff on December 31, 1999

Appendix I

Hoogleraren

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

Bijzondere Hoogleraren

Prof.dr. R.T. Schilizzi (JIVE, voor het J.H. Oort Fonds)
Prof.dr. V. Icke (UL, Beta Plus Foundation, aan de Universiteit van Amsterdam)
Prof.dr. M.A.C. Perryman (ESTEC, voor het Leids Universiteits Fonds)
Prof.dr. R.P.W. Visser (UU, Teyler's Hoogleraar)

Universitaire Hoofddocenten en Docenten

Dr. F. Baas
Dr. A.M. van Genderen
Prof.dr. V. Icke
Dr. F.P. Israel
Dr. W. Jaffe
Dr. P. Katgert
Dr. J. Lub
Dr. J. Luu
Drs. R.S. Le Poole
Dr. H.J.A. Röttgering
Dr. W.A. Schutte
Dr. P.P. van der Werf

Andere leden van de Wetenschappelijke Staf, Postdocs en Gastonderzoekers

Dr. P.N. Best	Postdoc (EU/TMR)
Drs. M.J. Betlem	Gastmedewerker
Dr. J.B.G.M. Bloemen	Gastmedewerker (SRON)
Dr. W.B. Boland	Gastmedewerker (NWO/NOVA)
Dr. M. Bureau	Postdoc (NWO)
Dr. W.B. Cotton	Gastmedewerker (NRAO) (sabbatical)
Dr. P. Ehrenfreund	Postdoctoral Fellow (NOVA)
Dr. D.A.P. Hartmann	Gastmedewerker (Bonn)
Dr. J.K. Katgert-Merkelijn	Gastmedewerker (Astronomy & Astrophysics)
Dr. I. Kamp	Postdoc (EU/Marie Curie) (from 01-02-2000)
Dr. R.S. Klessen	Postdoc (UL)
Dr. J. Meisner	Postdoc (NEVEC/NOVA)
Dr. B. Miller	Postdoc (NWO/ASTRON) (until 31-12-99)
Dr. P.P. Papadopoulos	Postdoc (EU/TMR)
Dr. R. Pereira Ortiz	Postdoc (Brazil)
Dr. I. Percheron	Postdoc (NEVEC/NOVA)
Dr. J. Roland	Gastmedewerker (CNRS, Frankrijk)
Dr. I. Salamanca	Postdoc (EU/Marie Curie)
Dr. P. Sonnentrucker	Gastmedewerker (ESTEC)
Dr. W. Verschueren	Gastmedewerker (Antwerpen, België)
Dr. H.S. Zhao	Postdoc (UL)

Emeriti

Prof.dr. A. Blaauw	Emeritus Hoogleraar
Dr. L.L.E. Braes	Emeritus Docent
Prof.dr. J.M. Greenberg	Emeritus Hoogleraar
Dr. M.S. de Groot	Gastmedewerker
Dr. I. van Houten-Groeneveld	Gastmedewerker
Dr. C.J. van Houten	Gastmedewerker
Prof.dr. H.C. van de Hulst	Emeritus Hoogleraar
Dr. K.K. Kwee	Gastmedewerker
Prof.dr. A. Ollongren	Emeritus Hoogleraar
Prof.Ir. C. van Schooneveld	Emeritus Hoogleraar
Dr. J. Tinbergen	Emeritus Hoofddocent

Doctorandi (AiO, OiO, Beurspromovendi)

Drs. A. Boonman	Onderzoeker in Opleiding
Drs. C. De Breuck	Assistent in Opleiding (EU/TMR, Livermore)
Drs. M.R. Cioni	Assistent in Opleiding
Drs. V. de Heij	Assistent in Opleiding
Drs. J.M.T. van der Heijden	Assistent in Opleiding (helft promotieonderzoek gefinancierd door de Schuurman Schimmel-van Outeren Stichting, from 01-01-00)
Drs. B. Heijligers	Assistent in Opleiding (from 01-01-00)
Drs. A. Helmi	Assistent in Opleiding
Drs. M. Haverkorn	Onderzoeker in Opleiding
Drs. R. Hoogerwerf	Onderzoeker in Opleiding
Drs. J. Kurk	Assistent in Opleiding
Drs. M. Messineo	Assistent in Opleiding (NOVA)
Drs. G. Muñoz Caro	Beurspromovendus (Max Planck)
Drs. M. Reuland	Assistent in Opleiding (UL/Livermore)
Drs. R. Ruiterkamp	Onderzoeker in Opleiding (SRON)
Drs. C. Shen	Assistent in Opleiding (World Lab)
Drs. Y. Simis	Assistent in Opleiding
Drs. F.S.S. van der Tak	Onderzoeker in Opleiding
Drs. W.F.D. Thi	Assistent in Opleiding
Drs. T. Thomas	Assistent in Opleiding
Drs. W. Tschager	Assistent in Opleiding
Drs. M. Tuemmers (Utrecht)	Onderzoeker in Opleiding
Drs. E. Verolme	Assistent in Opleiding
Drs. G. Verdoes-Kleijn	Assistent in Opleiding (UL/STScI)
Drs. W. Vlemmings	Onderzoeker in Opleiding
Drs. A.A. Wielders	Assistent in Opleiding
Drs. G. van Zadelhoff	Assistent in Opleiding
Drs. J. de Bruijne	Gastmedewerker
Drs. F. Favata	Gastmedewerker (ESTEC)
A. Holl	Gastmedewerker (Hongarije)
Drs. S. de Koff	Gastmedewerker
Drs. R. van der Meulen	Gastmedewerker
Drs. P.M. Veen	Gastmedewerker

Technische Staf

A.J. van der Helm	Electronicus (Dwingeloo)

Technische Staf in dienst bij ASTRON (op declaratiebasis)

R.J. Pit	Telescooptechnicus/Electronicus (La Palma)

Computer Staf

Dr. E.R. Deul	Senior Project Medewerker
Dr. D. J. Jansen	Wetenschappelijk Programmeur
M. Feleus	Programmeur (0.5) (until 31-12-99)
Dr. R. Rengelink	Wetenschappelijk Programmeur (NOVA, OmegaCam)
A. Vos	Programmeur

Technisch en Administratief Personeel

K. Weerstra	Adm. ambtenaar (ASTRON)

Secretariële Staf

K. Kol-Groen	Secretaresse
J.G.C. Slegtenhorst	Secretaresse
J.R. Soulsby-Pitts	Secretaresse
M. Zaal	Secretaresse

Astronomy & Astrophysics Office

Prof. H.J. Habing	Editor
Dr. J.K. Katgert-Merkelijn	Assistant Editor
B. Smit	Secretaresse
Drs. M. Wisse-Schouten	Assistente
Drs. J.M.T. van der Heijden	Copy Editor (tot 31-12-99)
A. van der Meer	Assistent

NOVA Office

Prof.dr. P.T. de Zeeuw	Directeur
Dr. W.B. Boland	Adjunct-Directeur (0.5) (NWO/NOVA)
R.T.A. Witmer	Financial Controller (0.2) (UL/FWN)
M. Zaal	Management Assistant

Seniore Studenten

J. Arts	M. van Mil
P. Bhagwandin	J. Novozamsky
R. Bouter	R. Overzier
W. Claus (Gent)	D. Pronk
B. van Dam	W. van Reeven
M. Feleus	(U. Shimron)
M. Hartendorp	M. Smit
R. Heijmans	L. van Starkenburg
O. Janssen	K. Steenbrugge
M. Kamerbeek	G. van de Ven
M. Kloppenburg	A. Verhoef
G. Kosters	S. Veijgen
I. Labbé	A. van der Wel
A. van der Meer	F. Wesseling

Staf Mutaties en Bezoekers in 1999

Naam (Locale Financier):	**start :**	**eind :**
Staf		
Drs. J. de Bruijne (UL)		09-10-99
Dr. C. Dominik (NWO)		31-08-99
Dr. P. Ehrenfreund (Austria)		31-08-99
idem (UL/NOVA)	01-09-99	
M. Feleus (UL)		31-12-99
Drs. J.M.T. van der Heijden (A&A)	01-07-99	31-12-99
idem (UL)	01-01-00	
Drs. B. Heijligers (UL/Fokker)	01-04-99	31-08-99
idem (UL)	01-01-00	
A. de Jong (UL/ASTRON)		30-09-99
Dr. I. Kamp (EU/Marie Curie)	01-02-00	
K. Kol (UL)	01-12-99	
S. van der Laan (A&A)		31-03-99
A. van der Meer (A&A)	06-03-99	
Dr. J. Meisner (UL/NOVA)	01-10-99	
Dr. B. Miller (NWO)		31-12-99
Drs. M. Messineo (UL/NOVA)	01-12-99	
I. Otto (UL)	01-10-99	30-11-99
Drs. L. Pentericci (UL)		30-09-99
Dr. I. Percheron (NEVEC/NOVA)	01-09-99	
Dr. N.R. Robichon (EU)		30-04-99
Dr. R. Rengelink (UL/NOVA)	01-11-99	
Drs. M. Reuland (UL/Livermore)	01-10-99	
Drs. R. Ruiterkamp (SRON)	01-11-99	
T. Schoenmaker (UL/ASTRON)		30-09-99
Dr. J. Tinbergen (UL)		17-12-99
Drs. E. Verolme (UL)	01-04-99	
H.A.Versteege-Hensel (ASTRON)		07-12-99
Drs. M. Wisse (A&A)		31-08-99
idem (A&A)	01-12-99	

Naam (Locale Financier):	**start :**	**eind :**
Bezoekers		
Dr. W.D. Cotton (NWO beurs, NRAO)	01-09-99	
Dr. P.G. van Dokkum (RUG)		31-07-99
Prof. Dr. M. Rees (J.H.Oort Fonds)	28-04-99	29-05-99
Dr. A. Schoenmakers (NWO,Utrecht)		01-11-99
Dr. G. Wuchterl (NWO beurs, Wenen)	01-11-99	
Dr. P. Yanguas (Spanje)	01-03-99	31-08-99

Appendix

II

Committee membership

Committee membership

Appendix II

STERREWACHT COMMISSIES

Sterrewachtdirectie

G.K. Miley (directeur)
J. Lub (secretaris)
H.J. Habing (plaatsvervangend directeur)

Sterrewacht Management Team

G.K. Miley (voorzitter)
W.B. Burton
M. Franx
H.J. Habing (vice voorzitter)
J. Soulsby
J. Lub
F.P. Israel
D. Jansen
N. van Wijngaarden (beheer)

Onderzoekscommissie

E.F. van Dishoeck (voorzitter)
M. Franx
W. Jaffe
W.B. Burton
V. Icke
H.J.A. Röttgering

Opleidingscommissie Sterrenkunde

W.B. Burton (opleidingsdirecteur & eerstejaars studentenbegeleider)
M. Franx (voorzitter)
P.T. de Zeeuw
A. Boonman (vertegenwoordiger AIO/OIO)
F.P. Israel (juniore studentenbegeleider)
W. Jaffe (seniore studentenbegeleider)
T.P.C. Nieuwenhuizen (1e jaars)
C. van Breukelen (2e jaars)
M. Kriek (3e jaars)
G. van de Ven (4e jaars)

Examencommissie Sterrenkunde

W.B. Burton (voorzitter)
F.P. Israel
G. Nienhuis (Natuurkunde)
P.P. van der Werf
P.T. de Zeeuw

Bibliotheekcommissie

W. Jaffe (voorzitter)
A.M. van Genderen
vacature (secretaris)
J. Lub

Computercommissie

P. Katgert (voorzitter)
P.T. de Zeeuw
Y. Simis
P.P. van der Werf
P. Best
F. van der Tak
J. Soulsby
C. Dominik (vacature)

Computer Groep

W. Jaffe (voorzitter)
A. Vos
E. Deul
D. Jansen

Wetenschappelijke Raad Onderzoekinstituut

V. Icke (voorzitter)
F. Baas
E.F. van Dishoeck
A.M. van Genderen
W. Jaffe
J. Luu
M.A.C. Perryman
H.J.A. Röttgering
W. Schutte
P.P. van der Werf
E. Deul
J. Lub (secretaris)
J.B.G.M. Bloemen
M. Franx
H.J. Habing
P. Katgert
G.K. Miley
R.S. Le Poole
R.T. Schilizzi
R.P.W. Visser
P.T. de Zeeuw

Instituutsraad

E. Deul (voorzitter)
F.P. Israel
A. van der Meer
E. Verolme (secretaris)
V. de Heij (secretaris)
W. Jaffe
J. Soulsby

Commissie Publiekscontact

V. Icke (voorzitter)
J. de Bruijne
R. Hoogerwerf
F.P. Israel
M. Haverkorn

Commissie Begeleiding Promovendi

P.P. van der Werf (voorzitter)
M. Franx
W. Boland (NWO)
W.B. Burton

Sociale Commissie

C. Dominik
G. Miley
M. Reuland
J. Soulsby (tot 1-12-99)
R. Klessen (vanaf 1-12-99)
R. Overzier (vanaf 1-12-99)
S. van der Laan
R. Le Poole
Y. Simis (tot 1-12-99)
M. Zaal (vanaf 1-12-99)
J. Luu (vanaf 1-12-99)

UNIVERSITAIRE COMMISSIES

W.B. Burton	Lid, Gemeenschappelijke Opleidings Commissie Natuur- en Sterrenkunde
	Lid, Overlegcommissie Opleidingsdirecteuren Faculteit W & N
E.F. van Dishoeck	Member, Faculty Research Committee (WECO)
	Member, Raad van Toezicht, Leiden Institute of Physics (LION)
M. Franx	Lid, Gemeenschappelijke Opleidings Commissie Natuur- en Sterrenkunde
A.M. van Genderen	Voorzitter Studiegidscommissie, Faculteit W & N
	Lid, Afdelingscommissie
	Lid, Roostercommissie
	Member, Studierichtingscommissie
H.J. Habing	Voorzitter, Kamer Sterrenkunde van de VSNU
V. Icke	Lid, Onderwijs Advies Groep “De Rode Draad”
F.P. Israel	Lid, Gemeenschappelijke Opleidings Commissie Natuur- en Sterrenkunde
W.J. Jaffe	Lid, Faculteit Millennium Coördinatie Commissie
	Lid van het Bestuur van het Centrum voor Wetenschappelijk Computing in Leiden
	Facultaire Bibliotheek Commissie
J. Lub	Secretaris, Kamer Sterrenkunde van de VSNU
	Commissie Publiekscontact van de Afdeling SN

G.K. Miley	Lid, Overlegcommissie Wetenschappelijk Directeuren Faculteit W & N
C. van Schooneveld	Opleidingscommissie Faculteit W & N
W. Schutte	Voorzitter, Veiligheidscommissie Huygens Laboratorium, Oortgebouw en Kamerlingh Onnes Laboratorium
P.P. van der Werf	Organist of the Academy Auditorium
P.T. de Zeeuw	Lid, Steering Committee, Lorentz Center (Internationaal Centrum voor Astronomie, Wiskunde, en Natuurkunde) Lid, Adviescommissie Lorentz Professor, Universiteit Leiden Lid, Adviescommissie Kloosterman Professor, Universiteit Leiden Lid van het Bestuur, Mathematisch Instituut, Universiteit Leiden

Appendix III

Science policy functions

Science policy functions

Appendix III

M. Bureau	Member, LOC of Lorentz Center Workshop on Dynamics of Galaxies
W.B. Burton	Chairman, Editorial Board, Astrophysics and Space Science Library, Kluwer Academic Publishers
	Director, Leids Kerkhoven–Bosscha Foundation
	Director, Jan Hendrik Oort Foundation
	Director, Leids Sterrewacht Foundation
	Chairman of Board, Expertisecentrum for Astronomical Image Processing
	Chairman, Appointment Advisory Committee, Oort Visiting Professorship
	Member, Supervisory Committee, Oort Adjunct Professor
	Member, Board of Curators, Adjunct Professorship in Cosmology, Beta Plus Foundation, University of Amsterdam
	Member, Appointment Advisory Committee, Leiden University Foundation Adjunct Professorship
E.R. Deul	Member, DENIS project team
	Member, EIS project team
	Member, OmegaCam project team

E.F. van Dishoeck	Member, JCMT Board
	Secretary, IAU Working Group on Astrochemistry (until September 1, 1999)
	Chair, IAU Working Group on Astrochemistry (from September 1, 1999)
	Member, Organizing Committee of IAU Commission 34 on Interstellar Matter
	Chair, Working Group 5 on Molecular Data, IAU Commission 14
	Member, SRON Science Board
	Member, ALMA Science Advisory Committee
	Member, NRAO Advisory Committee for the Millimeter Array
	Member, ESA Astronomy Working Group
	Member, ESA–NGST Science Study Team
	Member, NASA–NGST Ad Hoc Science Working Group
	Member, FIRST–HIFI Science Advisory team
	Member, VLT–VISIR Science Advisory team
	Secretary, Scientific Organizing Committee of IAU Symposium 197 “Astrochemistry: from molecular clouds to planetary systems”, Sogwipo, Korea
	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
	Secretary, National Committee for Research on Interstellar Matter (LWG Interstellaire Materie)
	Member, Scientific Organizing Committee 33rd ESLAB Symposium “Star Formation from the Small to the Large Scale”, Noordwijk, The Netherlands
	Member, Scientific Organizing Committee, winter school on “Disks, planetesimals & planets”, Tenerife, Spain

P. Ehrenfreund	Convener: "Laboratory investigations supporting planetary space missions", General Assembly European Geophysical Society, The Hague, The Netherlands
	Member, Working Group: "The role of laboratory experiments in the characterization of cosmic material", ISSI, International Science Institute, Bern, Switzerland
	Member, Working Group: "Composition and evolution of cometary grains in the coma" ISSI, International Science Institute, Bern, Switzerland
	Member, Steering Group: "European Astrobiology Network"
M. Franx	Member, ESO Science and Technology Committee
	Member, STC working group on second generation VLT instruments
	Member, ESO contact committee
	Member, Advanced Camera for Surveys Science Team
	Member, NOVA Fellowship Committee
A.M. van Genderen	Member, Secretary, Dutch Program Committee for the Dutch 90-cm telescope on La Silla, Chile
	Member, Indonesia/Netherlands Astrophysics Collaboration, as part of the Cultural Exchange between the two countries
H.J. Habing	Editor-in-Chief, "Astronomy and Astrophysics"
	Member, Royal Academy of Sciences
	Chairman, Teylers Tweede Genootschap
	Member, Hollandse Maatschappij van Wetenschappen
	Member, Academia Europea
	Member, Academia Astronautica
	Member, Board Space Research Organisation of The Netherlands
	Chairman, Advisory Council about Astronomy to GB-E, NWO
	Chairman, National Committee for Astronomy
	Chairman, Kamer Sterrenkunde
	Chairman, Nederlandse Astronomen Club

	Vice-chairman, Science Team for ESA's Infrared Space Observatory
	Member, Committee for the preparations for the 425th anniversary of Leiden University
	Treasurer, Board of Trustees "Legatum Stolpianum"
	Member, Committee for awarding the Livio Gratton Price (Rome, Italy)
V. Icke	Member, National Committee on Astronomy Education
	Member, Minnaert Committee (NOVA Outreach)
	Member, Netherlands Astronomical Society Education Committee
	Member, "Natuur & Techniek" Editorial Council
	Member, "Ned. Tijdschr. Natuurkunde" Board of Editors
	Member, Board of Directors, National Science Museum "NewMetropolis"
	Member, Jury for Science Films, National Filmfestival
F.P. Israel	Member, Noordwijk Space Expo Foundation (NSE) Exposition Committee
	Chairman, LOFAR Study Committee
W. Jaffe	Member, IAU Commissions 37 and 48
	Member, AIPS++ Technical Advisory Group
P. Katgert	Secretary/Treasurer, Leids Sterrewacht Fonds
	Secretary/Treasurer, Jan Hendrik Oort Fonds
	Secretary/Treasurer, Leids Kerkhoven-Bosscha Fonds
J. Lub	Member, ESO Contact Committee
	Substitute Member, ESO Observing Programs Committee (OPC)
	Director, Leids Sterrewacht Fonds
	Director, Leids Kerkhoven Bosscha Fonds
	Director, Jan Hendrik Oort Fonds

	Member, Dutch Programs Committee for the Dutch 90-cm telescope on La Silla, Chile
	Secretary, Nederlands Comité Astronomie
	Secretary, Kamer Sterrenkunde van de VSNU
J. Luu	Member, Sterrewacht Faculty Search Committee
	Member, ASTRON Telescope Time Allocation Committee
G.K. Miley	Chairman, Space Telescope Users Committee
	Chairman, Netherlands National VLTI Team
	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 of the KNAW
	Leiden PI, EU TMR Programme: European Large Area ISO Survey (ELAIS)
	Leiden PI, EU TMR Programme: Formation and Evolution of Galaxies
	Representative, VLTI Tripartite Steering Committee
	Advisor, ESO Observing Programme Committee Cosmology Panel
	Member, SOC Johannesburg Millennium Conference on the Morphology of Galaxies
A. Ollongren	Member, SETI Committee International Astronautical Academy (from October 2, 1999)
	Member, IAU Commissions 7, 33 and 56
	Member, European Astronomical Society

M. Perryman	Chairman, NOVA Instrument Steering Committee
	Chairman, GAIA Science Advisory Group
	Member, Scientific Committee, IAU Commission 33
H. Röttgering	Deputy coordinator of the European Association for Research in Astronomy (EARA)
	Leiden coordinator of the EU programme "Training and Mobility of Researchers", "The Formation and Evolution of Galaxies"
	Member of the ESO Interferometry Science Advisory Committee (ISAC)
	Member, ESO Imaging Survey Working Group
	Member, Dutch Joint Aperture Synthesis Team (DJAST)
	Member, Netherlands VLTI team
	Member, Mid-Infrared interferometric instrument for VLTI (MIDI) working group
	Member, Science Advisory Group on ESA's InfraRed Space Interferometer DARWIN
	Member, LOFAR Study committee
	Member, panel of LUF Internationaal Studie Fonds (LISF)
	Member, VISIR Science team
	Member, Omegacam Science team
R.T. Schilizzi	Director, Joint Institute for VLBI in Europe
	Member, Editorial Board, Experimental Astronomy
	Co-Chairman, RADIOASTRON International Scientific Council (until October 8, 1999)
	Member, VSOP International Scientific Council
	Member, Netherlands Geodetic Commission
	Chairman, URSI Global VLBI Working Group
	Member, Organising Committees of IAU Divisions X and XI
	Chairman, Scientific Organising Committee, IAU Symposium 205

W. Schutte	Member, Working Group: "The role of laboratory experiments in the characterisation of cosmic material", ISSI, International Science Institute, Bern, Switzerland
P.P. van der Werf	Member, ESO User's Committee
	Member, ASTRON Observing Programme Committee
	Member, EU-TMR Network "Sky surveys with ISO"
	Member, ELAIS (European Large Area ISO Survey) Consortium
	Member, Next Generation Space Telescope IFMOS Study team
	Member, Next Generation Space Telescope Payload Study team
	Member, VISIR Science team
	Member, HIFI Science team
	Member, steering committee ISO data centre Groningen (DIDAC)
	Member, JCMT Technical Advisory Panel
	Project Scientist, NOVA contributions to SINFONI
	Member, NOVA wide-field imaging team
	Member, NOVA ALMA team
	Member, NWO research grant jury
P.T. de Zeeuw	Director, NOVA
	Chair, SOC of Lorentz Center Workshop on *Dynamics of Galaxies*
	Member, SOC of ESO Workshop on *Black Holes in Binaries and Galactic Nuclei*
	Member, SOC of Hawaii Workshop on *Astrophysical Ages and Timescales*
	Member, SOC of Conference on *Stellar Dynamics, from Classic to Modern*
	Member, National Committee Astronomy (NCA)
	Member, Scientific Advisory Board of *New Astronomy*

Member, Science Advisory Group for GAIA, European Space Agency

Member, Commission 28 (Galaxies) of the International Astronomical Union

Member, IFMOS Study Consortium for ESA contributions to NGST

Member, Hubble Space Telescope Second Decade Study

Vice-chair, Joint Steering Committee (UK/NL Collaboration on La Palma) (until August 1, 1999)

Chair, Isaac Newton Group Board (UK/NL Collaboration on La Palma) (after August 1, 1999)

Vice-chair, Space Telescope Science Institute Council

Member, Steering Committee Lorentz Center (Intern. Center for Astron., Math. & Phys.)

Member, SINFONI Science Team

Director, Leids Sterrewacht Fonds

Director, Leids Kerkhoven Bosscha Fonds

Director, Jan Hendrik Oort Fonds

Appendix

IV

Visiting scientists

Sterrewacht Leiden

Visiting scientists

Appendix IV

Name	Dates	Institute
Dr. S. Sirono	Jan 15 – Feb 15	Kobe University, Japan
Prof. B. Burke	Jan 20 – Feb 21	MIT, MA, USA
Dr. B. Guiderdoni	Jan 28 – 29	Institute d'Astrophysique de Paris, France
Dr. J. Kleijna	Jan 29 – Feb 2	Institute of Astronomy, Cambridge, UK
Dr. P. Yanguas-Sayas	Feb 2 – Aug 1	University of Navarra, Pamplona, Spain
Dr. J. Palacian	Feb 1 – Aug 1	University of Navarra, Pamplona, Spain
Prof.dr. Zhang Jian	Feb 1 – Aug 31	Peking University, China
V. Mennella	Mar 9 – 12	Osservatorio di Capodimonte, Italy
Dr. M. Seigar	Mar 24 – 25	University of Ghent, Belgium
Dr. T. Herbst	End of March	MPIA, Heidelberg, Germany
Prof. T. Saito	Apr 2	University of Tokyo, Japan
Dr. H. Hashimoto	Apr 2	University of Tsukuba, Japan
Dr. C.R. Kaiser	Apr 5 – 11	MPI, Garching, Germany
Prof.dr. F.J. Lockman	Apr 2 – 5	NRAO, Green Bank, USA
Dr. D. Graff	Apr 6 – 9	University of Ohio, Athens, OHIO, USA
Dr. M. Bremer	Apr 8 – 14	University of Bristol, UK
Dr. A. Thean	Apr 16 – May 1	Bologna, Italy
Dr. P.M.W. Kalberla	Apr 26 – 28	University of Bonn, Germany
Dr. A. Brown	May 3 – 7	UNAM, Mexico
Dr. B. Cotton	May 18 – 22	NRAO, Green Bank, USA
Dr. R. van der Marel	May 31 – Jun 6	STScI, Baltimore, USA

Dr. S. Sirono	June (1 week)	Kobe University, Japan
Prof. K. Kobayashi	June 2 – 4	Yokohama National University, Japan
Dr. H. de Ruiter	June 15 – 30	Osservatorio Astronomico di Bologna, Bologna, Italy
Dr. P. Parma	June 15 – 30	IRA, Bologna, Italy
G. D. Illingworth	June 18 – 21	University of California, Santa Cruz, USA
Drs. Y. Copin	July 4 – 23	Observatoire de Lyon, France
Dr. E. Emsellem	July 4 – 23	Observatoire de Lyon, France
Dr. H. Kuntschner	July 4 – 13	University of Durham, UK
Prof. J. Allington Smith	July 4 – 13	University of Durham, UK
Prof. R.F. Peletier	July 4 – 23	University of Nottingham, UK
G. D. Illingworth	July 5 – 8	University of California, Santa Cruz, USA
Prof.dr. M. Feast	July 5 – 8	University of Capetown
D. Kelson	July 5 – 18	DTM, Washington, USA
Prof. R. Bacon	July 5 – 9	Observatoire de Lyon, France
Prof. R.L. Davies	July 5 – 7	University of Durham, UK
Prof. G. Monnet	July 5 – 9	ESO, Garching, Germany
Prof. M.C. Carollo	July 8 – 21	Columbia University, Washington D.C., USA
P. Schechter	July 13 – 22	MIT, Cambridge, USA
Dr. M. Tsvetkov	July 21 – 23	Institute of Astronomy, Sofia, Bulgaria
Dr. R. Stark	Aug 2 – 5	MPIfR, Bonn, Germany
A. Thean	Aug 16 – 23	Bologna, Italy
Dr. R. van der Marel	Sept 8 – 11	STScI, Baltimore, USA
Dr. H.W. Rix	Sept 8 – 9	MPIA, Heidelberg, Germany
Dr. C. Wright	Sept 13 – 23	Australian Defence Force Academy, UNSW, Canberra, Australia
Prof. J. Krelowski	Sept 20 – Oct 1	University of Torun, Poland
S. O'Tuarisg	Sep 20 – Oct 2	University of Galway, Ireland
Dr G. L. Granato	Sept 23 – 24	Osservatorio Astronomico di Padova, Italy

Dr. C. Kaiser	Oct 4 – 8	MPA, Munich, Germany
Dr. J. Dennett-Thorpe	Oct 7 – 8	Groningen, The Netherlands
Dr. R. Sackler	Oct 10 – 12	Norwalk, CT, USA
Mrs. B. Sackler	Oct 10 – 12	Norwalk, CT, USA
Dr. P van Dokkum	Oct 15 – Nov 5	Caltech, California, USA
Dr. M.H. Moore	Oct 20	NASA Goddard Space Flight Center, Greenbelt, USA
Prof.dr. F. Kamijo	Nov 12 – 17	Tokyo, Japan
Dr. G. Wuchterl	Nov 1 – Jan 31, 00	University of Vienna, Austria
Dr. M. Sevenster	Nov 8 – 26	Mount Stromlo, Weston Creek, Australia
Dr. U. Lisenfeld	Nov 8 – 13	IRAM, Granada, Spain
A. Biviano	Nov 13 – 19	Osservatorio Astronomico di Trieste, Italy
Drs. Y. Copin	Nov 29 – 30	Observatoire de Lyon, France
Prof. R. Bacon	Nov 29 – 30	Observatoire de Lyon, France
G. Rudnick	Dec 6 – 10	University of Arizona, Tucson, USA
H.W. Rix	Dec 7 – 8	MPA Heidelberg, Germany
A. Moorwood	8 Dec	ESO Garching, Germany

Appendix V

Colloquia and lectures

Colloquia and lectures

Appendix V

This appendix includes the endowed lectures given by distingueshed speakers, the regular colloquia series as well as the programmes of the workshops held in Leiden.

V.1 Endowed lectures

Date	**Speaker (affiliation)**	**Title**
February 11	Prof. C.H. Townes (UC Berkley)	Sackler Lecture: *Stellar Interferometry at Mid-IR Wavelengths*
April 28	Prof. M. Rees (IoA Cambridge)	Oort Lecture: *Cosmic Evolution: understanding the beginning and the end*

V.2 Scientific colloquia

The Leiden Observatory Colloquia are generally held weekly, on Thursday afternoon at 16:00 hours, preceded by an Astronomers' Tea at 15:30 hours. In 1999, the colloquium series was organized by Paul van der Werf.

Date	**Speaker (affiliation)**	**Title**
January 14	L. Gurvits (Joint Institute for VLBI in Europe)	*Cosmological tests with milliarcsecond structures in extragalactic radio sources*
January 21	R. Waters (University of Amsterdam)	*Crystalline silicates in circumstellar shells*

Date	Speaker (affiliation)	Title
January 28	M. Bureau (Leiden Observatory)	*The dark halo of NGC 2915*
February 4	J. Lunine (Steward Observatory)	*The outer solar system: chemical constraints on planet formation*
February 18	N. Thatte (MPE, Garching)	*3D integral field spectroscopy - the next leap forward in astronomy*
February 25	E. Tolstoy (ESO, Garching)	*The cosmological significance of the Local Group*
March 11	I. Parry (Institute of Astronomy, Cambridge)	*COHSI - deep integral field and multi-object spectroscopy on GEMINI-North in the near-infrared*
March 18	K.P. Schröder (Technische Universität, Berlin)	*Tip-AGB stellar evolution and dust-driven superwinds*
March 25	T. Herbst (MPIA, Heidelberg)	*A micropupil-based near- infrared imaging spectrograph and an ongoing search for extremely red objects*
April 15	J. Lockman (NRAO, Charlottesville)	*The Green Bank Radio Telescope: history, status and scientific program*
April 22	T. Hayward (Cornell University)	*Thermal infrared imaging and spectroscopy at Palomar observatory*
May 6	G. Wiedemann (ESO, Garching)	*High resolution infrared spectroscopy: power tool for astronomy*
May 20	H.U. Käufl (ESO, Garching)	*From ISAAC to GOLIATH - infrared instrumentation concepts for 100m class optical telescopes*
June 3	P. Katgert (Leiden Observatory)	*Nearby rich clusters of galaxies: mass profile and galaxy orbits*
June 10	N. Walton (Isaac Newton Group, La Palma)	*The science- instrumentation linkage: new directions at the Isaac Newton Group in the 8m telescope era*
June 17	P. van Dokkum (Leiden Observatory)	*Formation and evolution of elliptical galaxies*

Date	Speaker (affiliation)	Title
July 5	M. Feast (University of Capetown)	*Problems of distance scales and ages after HIPPARCOS*
August 17	W. Gieren (Universidad de Concepción, Chile)	*Cepheids as distance indicators*
September 2	J. Stil (Leiden Observatory)	*Dwarf galaxies: dynamics and star formation*
September 8	N. Cretton (MPIA, Heidelberg)	*Axisymmetric three-integral models for galaxies*
September 16	I. van Bemmel (ESO, Garching)	*ISO observations of double-lobed AGNs*
September 23	R. Turolla (University of Padova)	*Comptonization in hot (and cold!) astrophysical plasmas*
September 30	A. Schoenmakers (Sterrewacht, Leiden)	*A population study of giant radio sources*
October 7	J. Bézecourt (Kapteyn Institute, Groningen)	*Galaxy evolution probed with strong gravitational lensing*
October 14	F. Favata (ESTEC, Noordwijk)	*The size of stellar coronae*
November 10	D. Sanders (University of Hawaii)	*Luminous infrared galaxies, SCUBA sources, and the extragalactic background light*
November 11	P. Goldsmith (Cornell University)	*Initial results from the SWAS satellite: the O_2 abundance and implications for molecular cloud structure*
November 25	G. Wuchterl (University of Vienna)	*From clouds to stars - protostellar collapse and early pre-main-sequence evolution*
December 2	M. van der Klis (University of Amsterdam)	*Probing strong gravity and dense matter in X-ray binaries*
December 9	T. Galama (Caltech, Pasadena)	*Gamma-ray burst afterglows*
December 16	M. Garrett (Joint Institute for VLBI in Europe)	*Radio observations of M82 and the Hubble Deep Field*

V.3 Student colloquia

Date	Speaker	Title
January 18	Sebastiaan van der Laan	*Hydrodynamics in Barred Spirals*
January 25	Ellen Verolme	*Numerical simulations of interacting galaxies*
February 22	Oswin Kerkhof	*Laboratory simulations of thermally and UV processed interstellar ices*
April 26	Guido van den Heuvel	*Numerical Thermodynamics in Gravitating Systems*
June 21	Michiel Reuland	*Recovering the Early Stages of High-Mass Star Formation with Micro-arcsecond Astrometry*
July 19	Tijmen van der Kamp	*Rotational flattening and linearization of soft dust clusters*
July 26	Bram Venemans	*A cluster of galaxies around a high z radio galaxy?*
August 23	Rob den Hollander	*Runaway stars from OB associations*
October 19	Tom Voskes	*The Warped HI Layer of the Outer Galaxy*

V.4 Workshops

V.4.1 TMR Workshop on Hydrodynamical Aspects of Galaxy Formation

This workshop was held at the Lorentz Center from March 8 to 10. It brought together specialists in various aspects of hydrodynamics with graduate students and postdocs who use or plan to use hydrodynamical techniques to address problems related with galaxy formation and evolution. The main idea was to define the most interesting and important scientific questions and to give an overview over the existing numerical schemes and their applicability. The meeting furthermore promoted the exchange of knowledge and experience between scientist working on related fields. Organizing Committee: Ralf Klessen, Yvonne Simis, Jaron Kurk, Vincent Icke, Huub Röttgering.

Invited lectures:

Speaker	**Title**
Vincent Icke	*A Sample Hydrodynamic Code*
Garrelt Mellema	*The Radiation Transfer Problem*
Ewald Mueller	*Hydrodynamics*
Frazer Pearce	*Galaxy Formation and Evolution*
Tomasz Plewa	*Adaptive Mesh Refinement Techniques*
Matthias Steinmetz	*Hydrodynamics in Galaxy Formation*

Contributed talks and posters

Speaker	**Title**
Tom Abel	*The formation of the first stars*
Andrew Benson	*SPH & semi-analytic galaxy formation: Do they agree?*
Klaus Dolag	*SPH simulations of magnetic fields in galaxy clusters*
Sergio Dos-Santos	*Hydrodynamics of the intracluster medium: The temperature profile of X-ray clusters of galaxies*
Ralf Klessen	*From molecular clouds to stars: a series of puzzles*
Cesario Lia	*A parallel Tree-SPH code for galaxy formation*
Tom Theuns	*Cosmological dependencies of the Lyman-alpha forest*

V.4.2 Oort Workshop 1999

Prof.dr. Sir Martin Rees who was at the Leiden Observatory in April and May, as the 1999 Oort Professor, and Prof.dr. G.K. Miley organised an informal workshop at the Observatory, on May 27 and 28, entitled "The epoch of formation of AGNs" The programme for the workshop follows below:

Date	**Speaker (affiliation)**	**Title**
May 27	Rees (Cambridge)	*Introduction*
	De Zeeuw (Leiden)	*Black holes in nearby galaxies*
	Magorrian (Cambridge)	*Demography of MBHs*
	Peacock (Edinburgh)	*Constraints on AGN space density*
	Franx (Leiden)	*Gravitationally lensed high-z hosts*
	Röttgering (Leiden)	*Distant radio galaxies*
	Gurvits (NFRA)	*Milliarcsecond radiostructures in high redshift quasars*
	Frossati (Leiden)	*Gravitational wave detectors: present situation and prospects*
May 28	Abel (Garching)	*Formation of first collapsed objects*
	Coppi (Yale, New Haven, USA)	*High-z star formation*
	Haiman (Batavia, USA)	*Empirical constraints on high-z miniquasars*
	Haehnelt (Garching)	*Formation efficiency of high-z quasars*
	Norman (Baltimore)	*Fuelling, secular evolution and feedback*
	Rees (Cambridge)	*Summary and discussion*

V.4.3 Radiative Transfer in Molecular Lines

From May 17 to 21, a workshop on "Radiative Transfer in Molecular Lines" was held in the Lorentz Center, organised by Dullemond, van der Tak, van Dishoeck, van Zadelhoff and Yates (Univ. of Hertfordshire). The aim was to exchange knowledge and expertise on the numerical, physical and astronomical challenges that researchers in this field are faced with today and will be in the future. Molecular lines are excellent probes of the physical and chemical conditions in interstellar clouds, PDRs, protostellar envelopes, circumstellar shells around AGB stars. However a good and self-consistent interpretation of such lines often relies heavily on the use of sophisticated line radiative transfer programs. The workshop was attended by ∼30 international experts, presenting different aspects of the problem and participating in lively discussions. The workshop also led to the establishment of a set of test problems, against which various codes can be tested.

Date	**Speaker**	**Title**
May 17	G. Rybicki (Harvard)	*Radiative transfer in astrophysics*
	E.F. van Dishoeck (Leiden)	*Astrophysical applications of radiative transfer*
	J. Yates (Hertfordshire)	*Radiative transfer methods currently used by molecular astrophysicists*
	D. Field (Aarhus)	*Radiative transfer for modeling masers*
	A.G.G.M. Tielens (Groningen)	*Radiative transfer needs for the FIRST satellite*
May 18	S. Doty (Denver)	*ALI radiative transfer*
	M. Juvela (Helsinki)	*Monte Carlo radiative transfer calculations with 3-D models of inhomogeneous molecular clouds*
	J. Cernicharo (Madrid)	*Molecular lines as tracers of physical and chemical conditions in interstellar and circumstellar media*
	C. P. Dullemond	*2-D radiative transfer in circumstellar envelopes using accelerated lambda iteration based on short characteristics*
May 19	R. Phillips (Kent)	*2-D axially symmetric radiative transfer modeling*
	M. Hogerheijde (Berkeley)	*A 2D Monte-Carlo code for axisymmetric geometries*

Date	Speaker	Title
May 19	H. Wiesemeyer (Bonn)	*Molecular excitation and line formation in axisymmetric protostellar media*
	J. Rawlings (UCL)	*Using spectral lines to diagnose protostellar infall*
	C. Ceccarelli (Grenoble)	*The inner regions of the envelopes surrounding low-mass protostars: hints on their chemical and physical structure*
	M. Gray (Bristol)	*A new finite element code for molecular line transfer*
May 20	R. Liseau (Stockholm)	*Observations and models of pre-and post-main sequence objects*
	A. Efstathiou (London)	*Radiative transfer models of dusty starburst galaxies*
	A. de Koter (Amsterdam)	*Continuum radiative transfer models for AGB stars*
	S. Wolf (Jena)	*Multidimensional self-consistent continuum radiative transfer: simulations based on the Monte Carlo method*
	V. Ossenkopf (Cologne)	*Approximations to the excitation problem in turbulent media*
May 21	J.H. Black (Onsala)	*Line formation in reactive molecules*
	M.C. van Hemert (Leiden)	*Collisional excitation rates for use in RT models*
	F. van der Tak (Leiden)	*Radiative transfer models of line emission from massive protostars*
	E. Keto (Harvard)	*Matching and modeling, data interpretation*

V.4.4 FIRST-HIFI Workshop

From June 16 to 18, Leiden Observatory hosted a three-day workshop to review the design and development of the heterodyne receivers for the HIFI instrument on FIRST, as well as the science case. This meeting was attended by about 30–50 scientists from about 10 European countries and from the USA.

V.4.5 Symposium on Highlights of Laboratory Astrophysics: Tracing the Nature of Dust from Molecular Clouds to Comets

On October 11, Leiden Observatory hosted a one-day international symposium on "Highlights of Laboratory Astrophysics: Tracing the Nature of Dust from Molecular Clouds to Comets" associated with the dedication ceremony of the Raymond & Beverly Sackler Laboratory for Astrophysics later that same day. The workshop was attended by about 50 people and presented a broad overview of the progress that has been made in the last 25 years in our understanding of the nature, composition and evolution of interstellar dust. The close interaction between (space) observations and laboratory astrophysics was emphasized. The program was as follows:

Date	**Speaker (affiliation)**	**Title**
October 11	J.M. Greenberg (Leiden Observatory)	*From the laboratory to interstellar dust to comets*
	L. d'Hendecourt (IAS Paris)	*From interstellar ices to meteorites: laboratory studies*
	W.A. Schutte (Leiden Observatory)	*Grain surface reactions with SURFRESIDE*
	P. Ehrenfreund (Leiden Observatory)	*Evolution of interstellar and solar system ices: from ISO to Rosetta*
	J. Kissel (MPE Garching, Germany)	*Cosmic dust in our hands*
	L.B.F.M. Waters (University of Amsterdam)	*Observations and analysis of crystalline silicates with ISO*
	Th. Henning (University of Jena, Germany)	*Laboratory Synthesis and Spectroscopy of Nanoparticles*
	A.G.G.M. Tielens (University of Groningen)	*Observations and analysis of PAHs with ISO*
	L.J. Allamandola (NASA-Ames, USA)	*Laboratory Astrophysics: steps toward astrobiology*

This was followed by the dedication ceremony.

October 11	J.M. Greenberg (Leiden Observatory)	*The first 20 years of laboratory astrophysics*
	E.F. van Dishoeck (Leiden Observatory)	*Future scientific directions of the Raymond & Beverly Sackler Laboratory for Astrophysics*
	L.E.H. Vredevoogd (Leiden University)	*Science at Leiden University*
	R.R. Sackler (Sackler Foundation)	*Dedication*

V.4.6 Interferometry Workshop

On February 12, Leiden Observatory hosted a workshop under the auspices of the Dutch Joint Aperture Synthesis Team (DJAST) with the topic "Optical/Infrared Interferometry". The purpose of this meeting was to present all the ongoing activities in this area in the Netherlands. The program was as follows:

Date	**Speaker (affiliation)**	**Title**
February 12	C.H. Townes (UC Berkley)	*Welcome*
	H.J.A. Röttgering (Leiden Observatory)	*The Dutch perspective*
	R. Waters (UA)	*Formation and evolution of stars*
	H. Habing (Leiden Observatory)	*Dynamics of the galaxy*
	G.K. Miley (Leiden Observatory)	*Extragalactic science*
	R.Laurance/M. Fridlund (ESA-ESTEC)	*IRSI (InfraRed Space Interferometer)*
	R. Hoogerwerf (Leiden Observatory)	*GAIA (Global Astrometric Interferometer for Astrophysics)*
	R. Le Poole (Leiden Observatory)	*VLTI (Very Large Telescope Interferometer)*

Date	Speaker (affiliation)	Title
February 12	L. d'Arcio (TUD)	*Prototyping*
	M. van Kerkwijk (UU)	*COAST: a working interferometer*
	H.Hogenhuis (Fokker Space)	*VLTI Delay Lines*
	J.-W.Pel (NFRA Groningen)	*MIDI (MID Infrared instrument for the VLTI*
	P. Roussel (ESA-ESTEC)	*The ESA perspective*
	B. Snijders (TNO/TPD)	*General Strategy*

V.4.7 Visit Prof. C.H. Townes

Prof. C.H. Townes (UC Berkeley) visited February 8–12 to deliver the first Sackler Lecture. The title was "Stellar Interferometry at Mid-infrared Wavelengths". He also gave the Colloquium Ehrenfestii that week, about the development of the laser and the maser. The organization of this visit was Harm Habing, Willem Schutte, Floris van der Tak & Yoke Slegtenhorst.

Appendix VI

Participation in scientific meetings

Participation in scientific meetings

Appendix VI

The attendance of Leiden Observatory staff members at various meetings is indicated here, together with the titles of presentations in italics made at the meetings.

Best

The Hy-redshift Universe (Berkeley, USA; June 21–24)
"The cluster environments of powerful radio galaxies at z=1"

Clustering at high redshifts (Marseille, France; June 29–July 2)
"Clustering around powerful radio galaxies at redshift one"

Formation and Evolution of Galaxies (Asiago, Italy; August 30–September 4)
"Ionisation, shocks, and evolution of the emission line gas of z=1 radio galaxies"

Boonman

Ice Workshop (Groningen, The Netherlands; March 4–5)
"HCN, C_2H_2 and CO_2 toward Orion-IRc2 and Peak 2"

IAU Symposium 197: Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, Korea; August 23–27)
"H_2O and CO_2 spectra toward massive protostars"

ISO meeting (Amsterdam, The Netherlands; December 3)
"H_2O and CO_2 spectra toward massive protostars"

De Breuck

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30–Sept. 4)
"The quest for $z > 5$ radio galaxies"

De Bruijne

Euroconference "Star Clusters and Associations" (Mondello Palermo, Sicily, Italy; May 25–28)
"The low-mass stellar content of Scorpius OB2 as seen by Hipparcos; improved colour-magnitude diagrams based on secular parallaxes"

ESLAB33: Star Formation from the Small to the Large Scale (Noordwijk, The Netherlands; November 2–5)

Bureau

The Epoch of Formation of AGNs (Leiden, The Netherlands; May 27–28)

Dynamics of Galaxies: From the Early Universe to the Present (Paris, France; July 9–13)
"The Vertical Structure of Bars"

Dynamics of Galaxies (Leiden, The Netherlands; July 5–23)
"The Vertical Structure of Bars"

Galactic Disks (Heidelberg, Germany; October 4–6)
"Bars and Boxy Bulges in Edge-On Spiral Galaxies"
"SAURON Observations of E/S0/Sa Galaxies"

Burton

IAU Colloquium 174: Small Galaxy Groups (Turku, Finland; June 14–18)
"The characteristics of compact high–velocity clouds"

The Chemical Evolution of the Milky Way: Stars versus Clusters (Vulcano, Italy; September 20–24)
"The deployment of the compact HVC objects"

Cioni

2nd Austrian ISO Workshop (Vienna, Austria; May 27–29)
"DENIS Colours of RGB and AGB stars in the Magellanic Clouds"

The Changes in Abundances in Asymptotic Giant Branch Stars (Rome, Italy; September 16–18)
"DENIS Colours of Giant Stars in the Magellanic Clouds and the determination of the distance using the tip of the Red Giant Branch"

Cotton

First Winter School on Radio Astronomy Techniques and Applications to Astrophysics (Santa Maria, RS. Brazil; July 5–8)
"Aspects of Data Processing II. Fringe-fitting, Self-calibration and Deconvolution of VLBI data"
"Issues on modern polarization theory"

EVN School 1999 (Dwingeloo, Netherlands; November 4)
"Amplitude calibration and fringe-fitting"

Van Dishoeck

Jaarlijkse bijeenkomst Chemische Wetenschappen sectie Spectroscopie en Theory (Lunteren, The Netherlands; February 8)
"Infrared Spectroscopy in Outer Space" (plenary lecture)

Symposium on "Atomic and Molecular Data for Astronomy for the new Millennium", APS Centennial Meeting (Atlanta, USA; March 22–24)
"Infrared Spectroscopy of Gas-phase and Solid-state Species in Outer Space" (invited lecture)

Nederlandse Astronomen Club bijeenkomst (Utrecht, The Netherlands; April 1)
"Chemie in circumstellaire schijven rond jonge sterren"

Nederlandse Astronomen Conferentie (Elspeet, The Netherlands; May 5)
"The Atacama Large Millimeter Array" (invited talk)
"The Next Generation Space Telescope" (poster)

Star Formation and SOFIA workshop (Santa Cruz, USA; July 13–17)
"Gas-phase and Gas-Grain Chemistry in Star-Forming Regions: From ISO to SOFIA" (invited talk)

IAU Symposium 197 on Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, South Korea; August 23–27)
"Chemistry in the Envelopes around Massive Young Stars" (invited review)

NGST Science & Technology Exposition (Hyannis, USA; September 13–16)
"Mid-Infrared Astronomy with the Next Generation Space telescope" (invited review)

3rd European Workshop on Time-dependent Methods in Gas-Surface Dynamics (Leiden, The Netherlands; September 27–28)
"Gas-surface Processes in Interstellar Space"

Conference on Science with the Atacama Large Millimeter Array (Washington D.C., USA; October 6–8)
"Unravelling the Chemical Structure of Young Stellar Objects with ALMA" (invited talk)

Workshop on Interstellar Ices (Leiden, The Netherlands; October 12–15)
"Chemistry in Circumstellar Disks"

Ehrenfreund

European Geophysical Society (The Hague, The Netherlands; April 19–23)
"Laboratory investigations supporting planetary space missions"

American Astronomical Society (Chicago, USA; May 30–June3)
"The diffuse interstellar bands as evidence for polyatomic molecules in the diffuse interstellar medium"

12th International Conference on the Origin of Life, 9th ISSOL meeting (San Diego, USA; July 11–16)
"Cosmic Dust: From the interstellar medium to comets to Life ?"

IAU Symposium 197 Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, Korea; August 23–27)
"Infrared observations of interstellar ices"

Stromboli Workshop 99: The Bridge between the Big Bang and Biology (Stromboli, Italy; September 13–17)
"The diffuse interstellar bands and organic molecules in space"

The role of laboratory experiments in the characterisation of cosmic material: Critical analysis of past experience and guidelines for future developments (Bern, Switzerland; October 6–8)
"Organics in the interstellar medium and Solar System: open questions?"

Highlights of Laboratory Astrophysics: Tracing the Nature of Dust from Molecular Clouds to Comets (Leiden, The Netherlands; October 11)
"Evolution of interstellar and solar system ices: from ISO to Rosetta"

Inaugural Meeting of the European Exobiology Steering Group (London, United Kingdom; October 25–26)
"Astrobiology in The Netherlands"

3rd ROSETTA Lander Meeting (Ringberg, Germany; November 22–26)
"Organics in the Universe: from dark clouds to the early Earth"

NL Gravity Symposium (Amsterdam, The Netherlands; December 10)
"Evolution of organic matter in space-The International Space Station"

Astronomical Geophysical Union (San Francisco, USA; December 10–14)
"Extraterrestrial amino acids in the Orgueil meteorite: a cometary origin ?"

Franx

VLT Opening Conference (Antofagasta, Chile; March 1–4)
"The evolution of galaxy M/L ratios and morphologies out to z = 0.83"

Galaxies (Venice, Italy; March 17–20)
"The evolution of galaxy M/L ratios and morphologies out to z = 0.83"

NFRA Conference: Perspectives on Radio Astronomy (Amsterdam, The Netherlands; April 7–8)

Gravitational Lensing Network meeting (Toulouse, France; April 21–24)

Clustering of High Redshift (Marseille, France; June 29–July 2)
"A high fraction of mergers in the cluster MS1054-03 at z = 0.83"

Oort workshop (Leiden, The Netherlands; July 5–8)
"What are the masses of high redshift galaxies?"

Gravitational Lensing: Recent Progress and Future Goals (Boston, USA; July 23–30)
"Weak lensing from widefield HST imaging of MS1054-03 at z = 0.83"

Galaxies (Paris, France; July 9–13)
"Passive evolution, or the evolution of the M/L ratio of early-type galaxies"

Formation of Galaxies (London, UK; November 2–5)
"The evolution and merging history of cluster ellipticals from z = 0 to z = 0.83"

Van Genderen

SUA (Working group Stars with Extended Atmospheres) (Amsterdam, The Netherlands; March 20)
"η Carinae - a celestial Chinese lantern - a massive binary?"

SUA (Working group Stars with Extended Atmospheres) (Leiden, The Netherlands; November 27)
"η Carinae, News and Views"

Greenberg

212. W.E. Heraeus Seminar "Chemie im Weltall - Wege zu Bausteinen des Lebens" (Bad Honnef, Germany; January 13–15)
"The chemistry of interstellar dust and comets: a source of prebiotic molecules"

Life Odyssey Symposium (Maastricht, The Netherlands; May 29–June 2)
"Prebiotic molecules in interstellar grains and delivery to the earth"

Galileo, Ulysses, Cassini and Stardust, Dust Science Meeting (Münster, Germany; August 16–19)
"Fluffy comets"

IAU Symposium 197: "Astrochemistry" (Cheju, Korea; August 23–27)
"Nature and evolution of organic refractory material"

Towards a New Millennium in Galaxy Morphology conference (Johannesburg, South Africa; September 11–22)
"Cosmic dust in the 21st century"

ISSI workshop:"The role of laboratory experiments in the characterisation of cosmic material: critical analysis of past experience and guideline for future developments" (Bern, Switzerland; October 6–8)
"Evolution of organics and silicates in the ISM"

Haverkorn

Young European Radio Astronomers Conference (Manchester, United Kingdom; August 14–18)
"Small-scale polarization structure in the diffuse galactic radio background"

Van der Heijden

The Legacy of J.C. Kapteyn (Groningen, The Netherlands; June 9–11)
"The Lost Letters of J.C. Kapteyn"

Helmi

Cosmological Implications of the Local Group (Aspen, US; January 24–30)
"Building up the stellar halo of the Galaxy"

Ringberg workshop on Satellite galaxies (Ringberg, Germany; June 28–July 2)
"Halos formed by disrupted satellites"

The Galactic Halo: from Globular Clusters to Field Stars (Liège, Belgium; July 5–8)
"From satellite galaxies to field stars...What would the stellar halo look like?"

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30–Sept. 4)
"Stellar streams in the Milky Way's halo: Predictions and observations for a Galaxy built hierarchically"

Hoogerwerf

33rd ESLAB Symposium: Star Formation from the Small to the Large Scale (Noordwijk, The Netherlands; November 2–5)

Van Houten & Van Houten-Groeneveld

Treasure-Hunting in Astronomical Plate Archives (Sonneberg Observatory, Germany; March 4–6)

Icke

High-energy cosmology (Dourdan, France; May 17–21)
"Cosmic Nucleosynthesis"

Israel

H_2 in Space (Paris, France; September 27–October 1)
"Extragalactic H_2 and its Variable Relation to CO"

International Astronautical Federation (Amsterdam, The Netherlands; October 5)
"SETI II Session Chair"

Jaffe

Working on the Fringe (Dana Point, USA; May 24–27)
"FITS formats for Optical/IR interferometric data"

Katgert

Clustering at High Redshift (Marseille,France; June 29–July 2)

Klessen

GRAPE User Workshop (Tokyo, Japan; January 28–29)
"Simulations of Dwarf Spheroidal Galaxies without Dark Matter with GRAPE"

Star Formation in Galaxies (Les Diablerets, Switzerland; March 21–27)

Workshop on SPH (Heidelberg, Germany; May 7)
"Simulations of Star Formation with SPH"

Local Group Dwarf Galaxies (Schloß Ringberg, Rottach-Egern, Germany; June 27–July 2)
"Dwarf Spheroidal Galaxies without Dark Matter"

JENAM '99 – Star Formation in the Galaxy (Toulouse, France; September 7–11)
"Star Formation in Turbulent Molecular Clouds"

Star Formation (ESTEC Noordwijk, The Netherlands; November 2–5)
"Local Collapse in Turbulent Molecular Clouds: Implications for Star Formation"

Kurk

EARA workshop on the Intra Cluster Matter (Paris, France; February 5–6)
"Using Powerful Radio Galaxies to probe the ICM at high redshift"

TMR workshop on hydrodynamics of galaxy formation (Leiden, The Netherlands; March 8–10)

IGRAP conference on Clustering at High Redshift (Marseille, France; June 29–July 2)
"Deep Lyman alpha imaging of 1138-262 at z=2.2"

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30–Sept. 4)
"Does Jet Induced Star Formation Exist"?

XI Canary Winterschool on High Redshift Galaxies (Santa Cruz de Tenerife, Spain; November 15–26)
"Deep Lyman alpha imaging of 1138-262 at z=2.2"

Lub

VLT Opening Symposium (Antofagasta, Chile; March 1–4)

The Changes in Abundances in Asymptotic Giant Branch Stars (Monte Porzio, Rome, Italy; September 16–18)

VLT Official Inauguration (Paranal, Chile; March 5)

Luu

Darwin and Astronomy - the Infrared Space Interferometer mission (Stockholm, Sweden; November 17–19)
"Planetology and Dust"

Meisner

Working on the Fringe: An International Conference on Optical and IR Interferometry from Ground and Space (Dana Point, California, US; May 24–27)
Richard Roosen, Jeffrey Meisner, "Use of a Seeing Monitor to Determine the Velocities of Turbulent Atmospheric Layers"

Miley

Inaugural Meeting of ESO VLT (Antafagasta, Chile; January 27– March 9)

Symposium: A new millennium for galaxy morphologies (Johannesburg, South Africa; September 10–17)

Miller

193rd meeting of the American Astronomical Society (Austin, TX, USA; January 5–9)
"Globular Cluster Systems of dE Galaxies"

Imaging the Universe in Three Dimensions (Walnut Creek, CA, USA; March 29–April 1)
"SAURON: Integral-field Spectroscopy of Galaxies"

54th Nederlandse Astronomen Conferentie (Elspeet, The Netherlands; May 6)
"SAURON: Integral-field Spectroscopy of Galaxies"

194th meeting of the American Astronomical Society, special topical session on globular cluster systems (Chicago, IL, USA; May 30–June 3)
"Globular Cluster Systems of Dwarf Ellipticals"

From Dust to Galaxies: a meeting in honour of Paul Hodge (Friday Harbor, WA, USA; September 9–11)
"Stellar Populations in LGS 3"

Massive Stellar Clusters (Strasbourg, France; November 8–10)
"Massive Stellar Clusters in Interacting Galaxies"

Muñoz Caro

European Geophysical Society, XXIV Assembly (Den Haag, The Netherlands; April 19–23)
"UV Photolysis of Hydrocarbons under Simulated Diffuse and Dense Cloud Conditions" (short talk)

Nederlandse Astronomen Conferentie (Elspeet, The Netherlands; May 7–10)
"UV Photolysis of Hydrocarbons under Simulated Diffuse and Dense Cloud Conditions" (poster presentation)

IAU Symposium 197 (Sogwipo, Cheju Island, Korea; August 23–27)
"UV Photolysis of Hydrocarbons under Simulated Diffuse and Dense Cloud Conditions" (poster presentation)

The 1999 Rosetta Lander Science Meeting (Schloß Ringberg, Germany; November 22–26)
"Synthesis of compounds which could be found by COSAC", (invited speaker)

NOVA Herfstschool (Dwingeloo, The Netherlands; November 9–13)
"Evolution of interstellar dust"

Ortiz

2nd Austrian ISO Workshop (Vienna, Austria; May 27–29)
R. Ortiz, E. Copet, S. Ganesh, H.J. Habing, A. Omont, "OH/IR stars in the galactic bulge as seen by ISOGAL"

Papadopoulos

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30–Sept. 4)
"Gas and dust in two high-z radio galaxies"

Canary Islands Winter School: "The high redshift Universe" (Santa Cruz, Tenerife, Spain; November)
"CO lines at high redshift" (poster)

Pentericci

TMR meeting (IAP-Paris, France; February 5–6)
"Clustering around high redshift galaxies"

Robichon

The second "Three-Islands" conference (Mondello, Sicily, Italy; May 25–28)

Röttgering

X-ray surveys and the history of accretion in the Universe (Monte Porzio, Rome, Italy; Feb 8–10)
"Radio Surveys and AGN"

Clusters of Galaxies at High Redshift (Universidad Catolica del Norte, Antofagasta, Chile; March 1–4)
"Clustering around high-z radio galaxies"

NFRA: Perspectives in Radio Astronomy (Amsterdam, The Netherlands; April 7–9)
"The most distant radio galaxies: present and future"

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30–Sept. 4)
"HST observations of distant radio galaxies"

DARWIN and Astronomy, the Infrared Space Interferometer (Stockholm, Sweden; Nov 17–19)
"Astrophysical imaging with Darwin"

IAU Symposium 199, The Universe at Low Radio Frequencies (Pune, India; Nov 30–Dec 4)
The most distant radio galaxies

Salamanca

The Greatest Explosions since the Big Bang: Supernovae and Gamma Ray Burst (Space Telescope Science Institute, USA; May 3–6)
"The evolution of the Type IIn SN 1997ab"
"Type IIn Supernova 1997eg: Another detection of very narrow P Cygni profile"

Schutte

IAU Symposium 197; Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, Korea; August 23–27)
"The SURFace REactions SImulation DEvice (SURFRESIDE): A new tool for studying interstellar solid state chemistry"

The role of laboratory experiments in the characterisation of cosmic material: Critical analysis of past experience and guidelines for future developments (Bern, Switzerland; October 6–8)
"Laboratory Astrophysics: how to address current issues in solid state astrochemistry by laboratory simulation?"

Thermal Emission and Spectroscopy and Analysis of Dust, Disks, and Regoliths (Houston, USA; April 28–30)
Muñoz, "UV photolysis of carbon-based materials under simulated dense and diffuse cloud circumstances"

Highlights of laboratory Astrophysics: Tracing the Nature of Dust from Molecular Clouds to Comets (Leiden, The Netherlands; October 11)
"Grain surface reactions with SURFRESIDE"

Third European Workshop on Time-dependent Methods in Gas Surface Dynamics (Leiden, The Netherlands; September 26–28)
"Surface Chemistry of Interstellar Dust"

Nederlandse Astronomen Conferentie (Elspeet, The Netherlands; May 5–7)
"Laboratory Astrophysics"

Shen

Workshop on the origin and evolution of interstellar ices (Lorentz Center, Leiden, The Netherlands; October 11–15)

Simis

TMR Workshop "Hydrodynamics of Galaxy Formation" (Leiden, The Netherlands; March 8–10)

2nd Austrian ISO workshop: "Atmospheres of M, S and C giants" (Vienna, Austria; May 27–29)
"Dynamical two fluid calculations of dust driven AGB winds"

ESMN summer school on "Radiative Transfer and Radiation Hydrodynamics" (Oslo, Norway; June 1–11)
"Numerical hydrodynamics of dust forming stellar winds"

"Asymmetrical Planetary Nebulae II: From Origins to Microstructures" (Cambridge, MA, USA; August 3–6)
"The effect of grain drift on the structure of (Post–) AGB stars"

"Low Mass Wolf-Rayet stars: origin and evolution" (Amsterdam, The Netherlands; September 2–3)

Van der Tak

Workshop Radiative Transfer in Molecular Lines (Leiden, The Netherlands; May 17–21)
"Radiative transfer models of the line emission from massive protostars"

IAU Symposium 197 Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, Korea; August 23–27)
"The efficiency of CO hydrogenation on grains: CH_3OH and H_2CO observations of massive young stars"

Workshop Origin and Evolution of Interstellar Ices (Leiden, The Netherlands; October 11–15)
"The physical structure of YSO envelopes"

Thi

Radiative Transfer in Molecular Lines (Leiden, The Netherlands; May 17–21)

Origins of Solar Systems (Nenniker, USA; June 13–18)
"H_2 emission in disks around TTauri and Herbig Ae stars "

IAU Symposium 197 Astrochemistry: From Molecular Clouds to planetary Systems (Sogwipo, Korea; August 23–27)
"H_2 emission from disks around pre-main-sequence stars with ISO-SWS"
"Organic molecules in disk(s) around Herbig Ae and T Tauri stars"

Highlights of Laboratory Astrophysics:Tracing the Nature of Dust from Molecular Clouds to Comets & Ice Workshop (Leiden, The Netherlands; October 11–15)

Ateliers PNP/ASPS 1999/2000 "Formation des systèmes stellaires et planetaires" (Paris, France; October 29–31)

Thomas

EARA workshop (Paris, France; February 5–6)
"The Mass Profile of Clusters of Galaxies"

Tschager

NFRA: Perspectives in Radio Astronomy (Amsterdam, The Netherlands; April 7–9)

Nederlandse Astronomen Conferentie 99 (Elspeet, The Netherlands; May 5–7)
"A Population Study of Faint Compact Steep Spectrum Sources"

EVN VLBI School (Dwingeloo, The Netherlands; November 3–5)
"GPS Radio source 2021+614"
Demonstration of AIPS data reduction

TMR-Network Meeting on Galaxy Formation (Asiago, Italy; August 30– Sept. 4)
"GHz Peaked Spectrum radio source 2021+614"

Life Cycles of Radio Galaxies (Baltimore, MD, USA; July 15–17)
"A Population Study of Faint Compact Steep Spectrum Sources"

Verolme

Galactic Disks (Heidelberg, Germany; October 4–6)
"SAURON Observations of E/S0/Sa Galaxies"

Vlemmings

Nederlandse Astronomen Conferentie (Elspeet, The Netherlands; May 5–7)

EVN/VLBI school 1999 (Dwingeloo, The Netherlands; November 2–5)
"VLBI Measurement of the Parallax of U Her"
Demonstration of AIPS data reduction

Van der Werf

Extragalactic astrophysics at millimetre and infrared wavelengths (Cumberland Lodge, Windsor Park, United Kingdom; July 19–22)
"Are damped Lyα absorbers associated with ultraluminous infrared galaxies?"

H_2 in the universe (Paris, France; September 28–October 1)
"H_2 emission as a diagnostic of physical processes in starforming galaxies"

Galaxy evolution in the infrared (Novartis Foundation, London, United Kingdom; November 3–5)
"From 1 to 1000 μm in the field of the cluster A2218"

Van Zadelhoff

IAU 197, Astrochemistry: From Molecular Clouds to Planetary Systems (Sogwipo, Korea; August 23–27)
"A 2D Axisymmetric PDR code: Molecular lines from the envelopes around Protostars"
"Comparison of Radiative Transfer Codes"

Radiative transfer in Molecular lines (Leiden, The Netherlands; May 17–21)

Tracing the Nature of Dust from Molecular Clouds to Comets (Leiden, The Netherlands; October 11–15)

De Zeeuw

Structure and Dynamics of Galaxies (Venice, Italy; March 18–19)
"Integral Field Spectroscopy of Galaxies: First Results with SAURON"

Galactic Disks (Heidelberg, Germany; October 4–6)
"Conference Summary"

Black Holes in Binaries and Galactic Nuclei (Garching, Germany; September 5–8)
"Dynamical Evidence for Massive Black Holes in Galaxy Centers"

Appendix

VII

Observing sessions abroad

Observing sessions abroad

Appendix VII

Best
WHT (La Palma, Spain; March 20–22)

De Bruijne
ESO 1m52 telescope (La Silla, Chile; April 25–30)

Bureau
WHT (La Palma, Spain; February 14–20)
Australia Telescope Compact Array (ATCA) (Narrabri, Australia; April 19)
Swedish-ESO Submillimetre Telescope (SEST) (La Silla, Chile; November 6–9)

Burton
Arecibo Radio Telescope (Arecibo, Puerto Rico; November 8–13)

Ehrenfreund
WHT (La Palma, Spain; July 22–24)
NRAO (Tucson, AZ, USA; November 13–17)

Van Dishoeck
JCMT (Hawaii, USA; November 11–14)

Franx
W.M. Keck Observatory (Hawaii, USA; January 22–26)

Israel
ESO (Chile; May 12–25)

Jaffe
VLT(Paranal, Chile; July 13–14)

Klessen
WFI 2.2m (ESO, La Silla, Chile; September 14–October 2)

Kurk
WHT (La Palma, Spain; May 17–20)

Luu
Canada-France-Hawaii Telescope (Mauna Kea, Hawaii, USA; February 10–14)
Kitt Peak 0.9m (Kitt Peak, AZ, USA; February 15–19)
Canada-France-Hawaii Telescope (Mauna Kea, Hawaii, USA; September 4–7)
WHT (La Palma, Spain; September 29–October 1)
WHT (La Palma, Spain; November 9–10)

Miley
VLT (Antafagasta, Chile; April 8–19)

Miller
WHT (La Palma, Spain; January 24 – February 21)
D90 (La Silla, Chile; March 18–23)
WHT (La Palma, Spain; October 2–16)
NTT (La Silla, Chile; November 13–16)

Papadopoulos
James Clerk Maxwell Telescope (Mauna Kea, Hawaii, USA; July)
Plateau de Bure Interferometer (Grenoble, France; February)

Van der Tak
OVRO (CA, USA; April 1–5)

Röttgering

VLT (Paranal, Chile; April 12–13)
VLT (Paranal, Chile; April 19)
WHT (La Palma, Spain; May 17–19)

Tschager

JKT(La Palma, Spain; January 13–18)
INT(La Palma, Spain; March 8–9)
JKT(La Palma, Spain; April 10–14)

Verolme

WHT (La Palma, Spain; October 10–17)

Van der Werf

ESO New Technology Telescope (La Silla, Chile; April 2–10)
ESO Antu (Paranal, Chile; September 10–26)
James Clerk Maxwell Telescope (Mauna Kea, Hawaii, USA; December 2–14)

De Zeeuw

WHT (La Palma, Spain; February 1–7)
WHT (La Palma, Spain; October 12–14)

Zhao

ESO/NTT (La Silla, Chile; July 14–17)

Appendix

VIII

Working visits abroad

Working visits abroad

Appendix VIII

Best

Cavendish Astrophysics (Cambridge, UK; October 18–22)

Bureau

Instituto Astrofisica de Canarias (IAC) (La Laguna, Spain; February 25–28)
Kapteyn Laboratorium (Groningen, The Netherlands; March 8–9)
Australian National University (ANU) (Canberra, Australia; April 22–25)
Australia Telescope National Facility (ATNF) (Sydney, Australia; April 26–30)
Université de Montréal (Montréal, Canada; June 14–25)
Universitäts Sternwarte Göttingen (Göttingen, Germany; December 1–3)

Burton

Institute d'Astrophysique Spatiale (Orsay, France; December 6–7)

Cioni

IAP (Paris, France; April 12–17, December 6–16)

Cretton

MPIA (Heidelberg, Germany; February–June)

De Breuck

Institute of Geophysics and Planetary Physics, Lawrence Livermore National Laboratory (California, USA; April 12, 1996–May 30)

Van Dishoeck

ESTEC (Noordwijk, The Netherlands; April 15–16)
Space Telescope Science Institute (Baltimore, MD, USA; April 22–23)
Royal Observatory Edinburgh (Edinburgh, Scotland; May 25–26)
European Southern Observatory (Garching, Germany; June 3)
California Institute of Technology (Pasadena, CA, USA; July 16–22)
Seoul National University (Seoul, South Korea; August 19)
Korea National Observatory (Taejeon, South Korea; August 31)
ESTEC (Noordwijk, The Netherlands; September 8–9)
Naples Observatory (Naples, Italy; September 20–23)
Rensselaer Polytechnic Institute (Troy, New York, NY, USA; October 4–5)
European Southern Observatory (Garching, Germany; October 29)
Space Telescope Science Institute (Baltimore, MD, USA; November 3–5)
Keck Headquarters (Waimea, USA; November 16)
Joint Astronomy Center (Hilo, Hawaii, USA; November 17–19)
Space Telescope Science Institute (Baltimore, MD, USA; November 22–23)

Ehrenfreund

NSCORT, Scripps Institute, USCD (San Diego, CA, USA; January 24–March 21)
NASA Ames Research Center (Moffett Field, CA, USA; March 8–10)
University of Hawaii (Honolulu, Hawaii, USA; March 10–13)
NSCORT, Scripps Institute, USCD (San Diego, CA, USA; July 7–10)
NSCORT, Scripps Institute, USCD (San Diego, CA, USA; November 17–21)

Franx

University of Toronto (Toronto, Canada; January 19–21)
Max Planck Institut für Astronomie (Heidelberg, Germany; May 18–19)
Max Planck Institut für Astrophysik (Garching, Germany; August 29–31)
ESO Garching (Garching, Germany; September 1)
Johns Hopkins University (Baltimore, MD, USA; February 25–27)
ESO Garching (Garching, Germany; November 10)
ESO Garching (Garching, Germany; October 24–27)

Greenberg

Stanford University, NASA Ames Laboratory (Stanford, CA, USA; March 8–15)
"Sulden" meeting of the (1) COSIMA ROSETTA project for the study of dust of comet Wirtanen, (2) CIDA stardust project (Glurns, Italy; March 22–25)
World Federation of Scientists Delegation to the Vatican (meeting with H.H. John Paul II) (Rome, Italy; March 25–28)
COSIMA pre EQM review (Garching, Germany; August 4–6)

World Laboratory (Geneva, Switzerland; October 28–31)
"Examinateur" of Herv Cottin for PhD. in chemistry (Paris, France; November 9–11)

Van der Heijden

Helsinki Observatory (Helsinki, Finland; March 17–21)
Cambridge University Library (Cambridge, UK; March 24–27)
Royal Astronomical Society Library (London, UK; March 28–31)
Huntington Library (San Marino, CA, USA; April 7–11)
California Institute of Technology (Pasadena, CA, USA; April 11–15)
Mary Lea Shane Archives of the Lick Observatory (Santa Cruz, CA, USA; April 15–20)
Yerkes Observatory (Williams Bay, WI, USA; April 20–24)
Harvard University Archives (Cambridge, MA, USA; April 24–29)
Library of Congress (Washington, DC, USA; April 29–May 3)
American Institute of Physics (College Park, MD, USA; May 4–8)

Helmi

Institute for Advanced Study (Princeton, NJ, USA; January 20–24)
Astronomy Department, University of Virginia (Charlottesville, VA, USA; February 1–3)
Astronomy Department, University of Córdoba (Córdoba, Argentina; September 27–30)
Max Planck Institut für Astrophysik (Garching, Germany; April 12–24; August 9–21; November 22–December 3)

Jaffe

NRAO (Socorro, USA; February 9–10)
MPIA (Heidelberg, Germany; February 3)
MPIA (Heidelberg, Germany; March 23)
ESO (Garching, Germany; April 30)

Katgert

Osservatorio Astronomico (Trieste, Italy; July 26–August 1)
Lab. d' Astronomie Spatiale (Marseille, France; September 27–October 6)

Klessen

Max-Planck-Institut für Astronomie (Heidelberg, Germany; May 6–17)
Max-Planck-Institut für Astronomie (Heidelberg, Germany; November 15–27)

Kurk

Max Planck Institut für Astrophysik (Garching bei München, Germany; April 19–23)

Lub

Paranal Observatory (Paranal, Chile; March 5)

Miley

Review of TMR Network, Formation and Evolution of Galaxies (Paris, France; February 18–20)
ACS/HST Science Team Meeting, JHU (Baltimore, MD, USA; February 24–27)
ESO OPC Cosmology Panel (Garching, Germany; June 7–8)
Chair, Space Telescope Users Committee (Baltimore, MD, USA; June 9–13)
Meeting on Low Frequency Radio Array (LOFAR), Naval Research Laboratory (Virginia, USA; September 28–30)
ACS/HST Science Team Meeting, JHU (Baltimore, MD, USA; September 30–October 2)
Chair, Space Telescope Users Committee (Baltimore, MD, USA; November 2–8)
ESO OPC Cosmology Panel (Garching, Germany; November 29–December 1)

Miller

University of Wisconsin (Madison, WI, USA; January 11–15)
CRAL (Lyon, France; May 10–11)

Muñoz Caro

University of Amsterdam (Amsterdam, The Netherlands; March 10, June 30)
Max Planck Institute for Aeronomy (Katlenburg-Lindau, Germany; May 18–19)
University of Bremen (Bremen, Germany; May 20, August 31–September 3)

Ortiz

Institut d'Astrophysique de Paris (Paris, France; October 4–5 and November 3–5)

Pentericci

Observatories of the Carnegie Institute (Pasadena, CA, USA; March 9–22)

Rengelink

European Southern Observatory (Garching, Germany; November 8–12)
European Southern Observatory (Garching, Germany; December 13–17)

Röttgering

Service d'Astrophysique, CEA (Saclay, France; February 1–2)
Institute d'Astrophysique (Paris, France; February 18–20)
ESO (München, Gemany; March 22–23)
ESO (München, Gemany; October 13–14)
Institute d'Astrophysique (Paris, France; December 7)

Schutte

NASA Goddard Space Flight Center (Greenbelt, MD, USA; April 6–8)
NASA Ames Research Center (Moffett Field, CA, USA; April 19–22)

Van der Tak

Osservatorio di Arcetri (Florence, Italy; February 1–4)
NASA-Ames (Mountain View, USA; April 6–14)
University California (Berkeley, CA, USA; November 8–12)
Caltech (Pasadena, CA, USA; November 15–16)
University Wisconsin (Madison, WI, USA; November 17)
University Maryland (Maryland, MD, USA; November 18–19)
Smithsonian Astrophysical Observatory (Cambridge, USA; November 22–24)
Max-Planck Institut für Radioastronomie (Bonn, Germany; December 6–9)

Verdoes Kleijn

Space Telescope Science Institute (Baltimore, MD, USA; October 10–31)

Vlemmings

N.R.A.L. (Jodrell Bank, UK; July 15–19)

Van der Werf

ESA Headquarters (Paris, France; January 7–8)
Imperial College of Science, Technology, and Medicine (London, UK; February 4–5)
Daimler-DASA Aerospace (Ottobrunn, Germany; February 22–23)
Max-Planck-Institut für extraterrestrische Physik (Garching, Germany; April 12–13)
Centre d'Etudes Astrophysique (Saclay, France; May 3–7)
Osservatorio Astronomico de Arcetri (Florence, Italy; May 25–30)

De Zeeuw

MPIA (Heidelberg, Germany; January 13–15)
Obs. Roque de los Muchachos (La Palma, Spain; January 31–February 7)
STScI (Baltimore, MD, USA; February 10–14)
JILA (Boulder, CO, USA; February 15–16)

Institute for Advanced Study (Princeton, NJ, USA; February 21–24)
STScI (Baltimore, MD, USA; February 24–28)
ESTEC (Noordwijk, The Netherlands; March 8–10)
STScI (Baltimore, MD, USA; April 11–16)
ESO (Garching, Germany; May 5–24)
Dept. of Physics and Astronomy (Durham, UK; June 2–4)
STScI (Baltimore, MD, USA; June 9–16)
ESO (Garching, Germany; September 6–8)
MPIA (Heidelberg, Germany; October 3–7)
Obs. Roque de los Muchachos (La Palma, Spain; October 12–17)
Observatoire de Genève (Genève, Switzerland; October 21)
STScI (Baltimore, MD, USA; October 25–27)
Astronomy and Astrophysics Center (Chicago, IL, USA; December 6–8)
Astron. Dept., Univ. of Michigan (Ann Arbor, MI, USA; December 9–10)

Zhao

University of Michigan (Ann Arbor, MI, USA; March 20–March 25)

Appendix

IX

Colloquia given outside Leiden

Colloquia given outside Leiden

Appendix IX

Bureau

"The Nature of Boxy/Peanut-Shaped Bulges in Spiral Galaxies"	Instituto Astrofisica de Canarias (IAC), La Laguna, Spain; February 25
"The Nature of Boxy/Peanut-Shaped Bulges in Spiral Galaxies"	Kapteyn Laboratorium, Groningen, The Netherlands; March 8
"SAURON: A New Integral-Field Spectrograph for the WHT"	Australian National University, Canberra, Australia; April 23
"SAURON: A New Integral-Field Spectrograph for the WHT"	Australia Telescope National Facility (ATNF), Sydney, Australia; April 29
"SAURON: A New Integral-Field Spectrograph for the WHT"	Université de Montréal, Montréal, Canada; June 22
"The Dark Matter Halo of NGC2915"	Universitäts Sternwarte Göttingen, Göttingen, Germany; December 2
"SAURON: Integral-Field Spectroscopy of Galaxies"	Universitäts Sternwarte Göttingen, Göttingen, Germany; December 3

Burton

"The compact, isolated high–velocity clouds seen under high resolution"	Arecibo Observatory, Arecibo, Puerto Rico; November 15

Cotton

"The Environment of the CSS Quasar 3C138 and the Development of Extended Radio Sources"	Northwestern Univ, Evanston, Illinois, USA; July 20

Cretton

"Dynamical Models of Early-type Galaxies"	MPIA, Heidelberg, Germany; October

Van Dishoeck

"Detection of the HD J=1→0 112 μm Line and the Deuterium Abundance in the Galaxy"	MPI für Radio Astronomie, Bonn, Germany; January 13
"Molecules between the Stars"	MPI für Kernphysik, Heidelberg, Germany; January 14
"ISO Spectroscopy of Star-forming Regions"	JILA/University of Colorado, Boulder, CO, USA; February 15
"Detection of the HD J=1→0 112 μm Line and the Deuterium Abundance in the Galaxy"	JILA/University of Colorado, Boulder, CO, USA; March 1
"Infrared Spectroscopy from Space: Molecules between the Stars"	Physics Department, Rijksuniversiteit Groningen, The Netherlands; March 18
"ISO Spectroscopy of Star-forming Regions"	Div. of Geology & Planetary Sciences, California Institute of Technology, Pasadena, CA, USA; July 20
"ISO's View on the Interstellar Medium and Star Formation"	Seoul National University, Seoul, Korea; August 20
"ISO's View on the Interstellar Medium and Star Formation"	Johns Hopkins University, Baltimore, MD, USA; November 4
"Chemistry in Stellar and Planetary Nurseries"	Keck Observatories Headquarters, Waimea, USA; November 16

Ehrenfreund

"Interstellar and cometary ices, an ISO View"	UCSD, San Diego, CA, USA; February 11
"Interstellar dust and gas: an ISO View"	University of Hawaii, Honolulu, USA; March 12
"Kosmischer Staub: Vom interstellaren Raum via Kometen zum Ursprung des Lebens"	Univ. of Vienna, Vienna, Austria; June 18

Franx

"Evolution of Early Type Galaxies"	University of Toronto, Canada; January 20
" Evolution of Early Type Galaxies"	Max Planck Institut für Astronomie, Heidelberg, Germany; May 18

Greenberg

"All comets are born equal"	NASA Ames Research Center, Moffett Field, CA, USA; April 14
"From interstellar dust to comets to the origin of life"	Noordwijk, The Netherlands; September 9 (for chemistry students from Groningen)

Helmi

"Building up the stellar halo of the Galaxy"	Astronomy Department, University of Virginia, Charlottesville, VA, USA; February 2
"The formation of the Galactic halo"	University of Córdoba, Córdoba, Argentina; September 28

Icke

"Kunst en wetenschap"	Faculty of Philosophy, Maastricht, The Netherlands; October 22
"Cosmic length scales"	AMC, Amsterdam, The Netherlands; October 28
"Hydrodynamics of dying stars"	FOM, Koningshof, The Netherlands; November 17

Israel

"Centaurus A"	Kapteyn Institute, Groningen, The Netherlands; February 8

Luu

"The New Outer Solar System"	Utrecht University, Utrecht, The Netherlands; March 24
"The New Outer Solar System"	ESTEC, Noordwijk, The Netherlands; March 26
"The Sun's Circumstellar Disk"	Groningen, The Netherlands; March 29
"The Kuiper Belt"	Antwerp, Belgium; April 24
"The New Outer Solar System"	Oxford University, Oxford, UK; May 11
"The New Outer Solar System"	University of Amsterdam, Amsterdam, The Netherlands; May 27

Muñoz Caro

"Analysis of Comet Analogues, Results and Future Plans"	Max Planck Institute for Aeronomy, Katlenburg-Lindau, Germany; May 19
"Products Obtained from the Photolysis of Interstellar Ice Analogs"	Bremen University, Department of Physical Chemistry, September 1

Papadopoulos

"Molecular gas in Seyfert Galaxies"	Kapteyn Instituut, Groningen, The Netherlands; March

"Cold dust and the diffuse ISM"	National Observatory of Athens, Greece; April
"CO J=4-3 and dust emission from two high-z radio galaxies"	Institute of Technology, California, USA;
"CO lines and dust emission in the high-z Universe"	University of Toronto, Canada; November

Pentericci

"Radio galassie di alto redshift e la formazione delle galassie brillanti in ammass"	Osservatorio Astronomico di Roma, Monteporzio, Italy; March 2
"The formation and evolution of brightest cluster galaxies"	MPIA, Heidelberg, Germany; May 7

Perryman

"Stereoscopic Mapping of our Galaxy: the scientific case for GAIA and its technical feasibility"	Seminar, SRON Utrecht, The Netherlands; January 19
"Astronomical Potential of Superconducting Tunnel Junction Detectors"	At the conference "Imaging the Universe in 3 Dimensions", Walnut Creek, California, USA; March 30
"Stereoscopic Mapping of our Galaxy: the scientific case for GAIA and its technical feasibility"	Seminar, Groningen, The Netherlands; April 19
"Extrasolar planets and space astrometry"	Planet Formation and Extra-solar Planets, 24th General Assembly of the European Geophysical Society, The Hague, The Netherlands; April 21
"GAIA"	Seminar, University of Barcelona, Spain; April 22
"A Stereoscopic View of Our Galaxy"	The Royal Astronomical Society George Darwin Lecture, 1988, given at the Royal Astronomical Society, London, UK; May 14

"Modern Astrometry"	at the Symposium on the Legacy of J.C. Kapteyn, Groningen, The Netherlands; June 9–11

Schutte

"Interstellar Ices after ISO"	NASA Goddard Space Flight Center, Greenbelt, MD, USA; April 8
"Interstellar Ices after ISO"	NASA Ames Research Center, Moffett Field, CA, USA; April 22

Van der Tak

"Physical and Chemical Structure of Regions of Massive Star Formation"	Osservatorio di Arcetri, Florence, Italy; February 2
"Physical and Chemical Structure of Regions of Massive Star Formation"	NASA-Ames, Mountain View, USA; April 9
"Physical and Chemical Structure of Regions of Massive Star Formation"	University California, Berkeley, CA, USA; November 8
"Physical and Chemical Structure of Regions of Massive Star Formation"	Caltech, Pasadena, USA; November 16
"Physical and Chemical Structure of Regions of Massive Star Formation"	University Wisconsin, Madison, WI, USA; November 17
"Physical and Chemical Structure of Regions of Massive Star Formation"	University Maryland, Maryland, MD, USA; November 18
"Physical and Chemical Structure of Regions of Massive Star Formation"	Smithsonian Astrophysical Observatory, Cambridge, USA; November 24
"Physical and Chemical Structure of Regions of Massive Star Formation"	Max-Planck Institut für Radioastronomie, Bonn, Germany; December 8

Van der Werf

"Steps towards the cosmic star formation history"	Osservatorio Astronomico de Arcetri, Florence, Italy; May 27

De Zeeuw

"A HIPPARCOS Census of Nearby OB Associations"	JILA, Boulder, CO, USA; February 15
"A HIPPARCOS Census of Nearby OB Associations and a Preview of GAIA"	ASTRON, Dwingeloo, The Netherlands; March 26
"GAIA: A Stereoscopic Census of Stars and Planets in the Galaxy"	ESO, Garching, Germany; May 11
"Integral Field Spectroscopy of Galaxies: First Results with SAURON"	ESO, Garching, Germany; May 18
"SAURON on La Palma"	Presentation to ING Board, Durham, UK; June 3
"Integral Field Spectroscopy of Galaxies: First Results with SAURON"	Kapteyn Laboratorium, Groningen, The Netherlands; November 12
"Integral Field Spectroscopy of Galaxies: First Results with SAURON"	Astronomy and Astrophysics Center, Univ. of Chicago, IL, USA; December 8
"Integral Field Spectroscopy of Galaxies: First Results with SAURON"	Dept. of Astronomy, Univ. of Michigan, Ann Arbor, MI, USA; December 9

Zhao

"Tidal streams and microlensing towards the Magellanic Clouds"	Observatory of Carnegie Institution of Washington, Pasadena, USA; March 20

Appendix X

Scientific publications

Scientific publications

Appendix X

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

K. Altwegg, P. Ehrenfreund, W. Huebner, and J. Geiss, Composition and Origin of Cosmic Materials, Space Science Reviews 90, 1-2, Kluwer Academic Publishers, 1999.

E. T. Chatzichristou, Imaging & bidimensional spectroscopy of active and interacting galaxies, Ph.D. thesis, Leiden University, June 1999.

N. Cretton, Dynamical models of early-type galaxies, Ph.D. thesis, Leiden University, September 1999.

C. P. Dullemond, Radiative transfer in compact circumstellar nebulae, Ph.D. thesis, Leiden University, September 1999.

P. Ehrenfreund and H. Kochan, Laboratory studies and observations on dust, ices and organics in the Solar System, Physics and Chemistry of the Earth, Part C, Solar-Terrestrial and Planetary Science, vol. 24, 1999.

P. Ehrenfreund, C. Krafft, H. Kochan, and V. Pirronello, Earth Moon and Planets, Special Issue, Laboratory Astrophysics and Space Research 80, nos. 1-3, Kluwer Academic Publishers, 1999.

P. Ehrenfreund, C. Krafft, H. Kochan, and V. Pirronello, Laboratory astrophysics and space research, Laboratory astrophysics and space research / editors P. Ehrenfreund ... [et al.]. Dordrecht ; Boston : Kluwer Academic Publishers, 1998. (Astrophysics and space science library ; v. 236) QB461 .L3 1999, 1999.

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X.4 Popular articles

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H. W. Duerbeck and A. M. van Genderen, Sakurai's Object: A rare stellar Cataclysm, Southern Stars **38**, 80–89.

P. Ehrenfreund, Les molecules organiques de l'espace sont-elles les briques de la vie sur la terre?, Le Figaro.

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M. A. C. Perryman, Hipparcos: The Stars in Three Dimensions, Sky & Telescope **97**, 40–50.

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X.5 Multimedia and electronic publishing

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X.6 Awards

R. Klessen was awarded the "Otto Hahn Medal" on June 9th 1999 by the German Max Planck Society for the dissertation "Fragmentation of Molecular Clouds: The Initial Phases of Stellar Clusters".

M. Perryman was awarded the "Akademiepenning" of the Koninklijke Nederlandse Akademie van Wetenschappen (Royal Netherlands Academy of Arts & Sciences)

Appendix XI

Phone-, room numbers and e-mail addresses

Phone-, room numbers and e-mail addresses

Appendix XI

Fax and Phone numbers: only the internal extensions are given. To call from outside the institute the numbers have to be preceeded by (+31 +71) 527.

E-mail: Usernames are given. The complete e-mail addresses with the domain name are `user@strw.LeidenUniv.nl`

Office	**Fax number**	**E-mail address** `user`
Observatory	5819	`strw`
A&A	5803	`aanda`
NOVA	5743	`nova`

Name	**Phone number**	**Room number**	**E-mail address** `user`
D'Arcio	5813	437	`darcio`
Arts	5866	567	`arts`
Bhagwandin	5594	527	`bhagwand`
Blaauw	5811	532	`blauuw`
Bloemen	5891	570	`bloemen`
Boland	5873	464	`boland`
Boonman	5815	504	`boonman`
Bot	5591	508	`bot`

Name	Phone number	Room number	E-mail address user
Bureau	5882	455	bureau
Cioni	5815	504	cioni
Dam, van	5845	436	bdam
De Breuck	5572	528	debreuck
Deul	5827	509a	deul
Dirksen	5597	542	dirksen
Dishoeck, van	5814	505	ewine
Ehrenfreund	5812	507	pascale
Feleus	5805	558	feleus
Franx	5870	553	franx
Fraser	5818	537	fraser
Genderen, van	5863	568	genderen
Greenberg	5804	501	greenber
Habing	5916	525	habing
Habing	5853	539	habing
Hartendorp	5877	562	mhartend
Haverkorn	5831	506	haverkrn
Heij, de	5866	567	deheij
Heijden, van der	5842	534	heijden
Heijligers	5866	567	heyliger
Heijmans	5845	436	heijmans
Houten, C. van	5876	432	houten
Houten-Groeneveld, I. van	5881	435	vhouten
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Jansen	5810	509c	jansen
Janssen	5826	561	olafj
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Kamp	5841	569	kamp
Kanter, de	5801	521	kanter
Katgert	5817	502	katgert
Katgert-Merkelijn	5916	525	merkelijn
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Kurk	5838	571	`kurk`
Kwee	5881	435	`kwee`
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Luu	5846	441	`luu`
Meer, van der	5884	434	`vdmeer`
Meisner	5572	528	`meisner`
Mellema	5738	467	`mellema`
Messineo	5594	527	`messineo`
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Le Poole	5871	541	`lepoole`
Pronk	5825	468	`pronk`
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Roland	5818	537	`roland`
Röttgering	5851	465	`rottgeri`
Ruiterkamp	5594	527	`ruiterka`
Salamanca	5838	571	`salamanc`
Schilizzi	5839	439	`rts`
Schöir-Larsen	5812	507	`fredrik`
Schutte	5801	521	`schutte`
Shen	5804	501	`shen`
Simis	5841	569	`simis`
Slegtenhorst	5832	460	`slegten`
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Sonnentrucker	5865	536	`sonnentr`
Soulsby	5833	458	`soulsby`
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Steenbrugge	5851	465	`steenbr`
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Thi	5809	503	`thi`
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Ven, van de	5836	438	`vdven`
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Wisse	5916	525	`wisse`
Witmer	5873	464	`witmer`
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