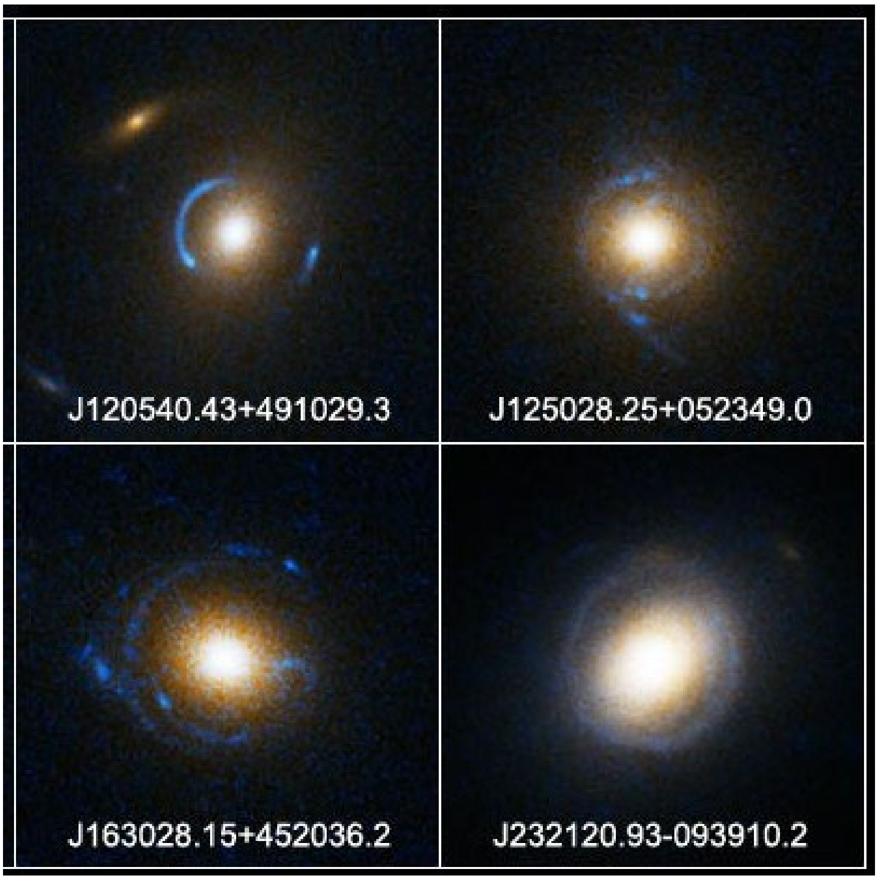
KAPTEYN ASTRONOMICAL INSTITUTE
2005



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KAPTEYN ASTRONOMICAL INSTITUTE

University of Groningen

ANNUAL REPORT

2005

Groningen, July 2006

Cover:
Images of eight strong gravitational lens systems taken by the Hubble Space Telescope's Advanced Camera for Surveys. They are part of an ongoing survey, called the Sloan Lens ACS (or SLACS) Survey, of about 150 galaxies. So far, the survey has netted 40-50 new gravitational lenses, adding significantly to the 100 or so previously known lenses.

Credit: NASA, ESA, and the SLACS Survey team: A. Bolton (Harvard/Smithsonian), S. Burles (MIT), L.V.E. Koopmans (Kapteyn), T. Treu (UCSB), and L. Moustakas (JPL/Caltech).

CONTENTS

1. FOREWORD

This annual report is in the usual handy format. The staff of the Kapteyn Astronomical Institute is responsible for the educational program in astronomy at Groningen University and for the astronomical research, including development of instrumentation and software. The Institute has a close collaboration with the Groningen laboratory of the Netherlands Foundation for Space Research (SRON). Also, it is part of the Netherlands Research School for Astronomy (NOVA), which has been awarded extra funding in the "bonus-incentives scheme" (known as the "dieptestrategie") for top research schools in the Netherlands.

General

The most memorable aspects of 2005 were the large number of scientific meetings organised by staff from the Institute and the handover of the Directorship from Piet van der Kruit to Thijs van der Hulst. This happened a few months sooner than planned because of urgent surgery Piet had to undergo. He recovered very fast and has been back to work for more than half a year at the writing of this foreword. Effectively Thijs van der Hulst took over the directorship of the institute late September, while the official appointment was per 1 January 2006. At the same time the responsibility for the astronomy education was transferred from Thijs van der Hulst to Peter Barthel, who officially is deputy director per 1 January 2006.
The conferences covered a broad range of topics. The first one took place in Groningen end of June and was entitled “Reionizing the Universe: the Epoch of Reionisation and the Physics of the IGM”. Five staff members played an important role in organising this conference: Saleem Zaroubi, Rien van de Weygaert, Leon Koopmans, Ger de Bruyn and Marc Verheijen. Scientifically it was a great success and focused the attention of colleagues around the world on the EoR experiment with LOFAR that is being prepared at the Institute.
This conference was immediately followed by “Island Universes: structure and evolution of disk galaxies”, a conference honouring the Kapteyn Professorship that was awarded to Piet van der Kruit in 2004. This conference was held on beautiful Terschelling and was equally exciting and successful. Also here the help of many staff members was instrumental to its success: Peter Kamphuis, Isabel Pérez Martín, Eline Tolstoy (Chair), Thijs van der Hulst, and Piet van der Kruit. And for both conferences a lot of work was done behind the scenes by Greta de Vries, Hennie Zondervan, Jackie Zwegers and Hans Terlouw.
Another “local” conference was “From Strings to Cosmic Web” organised by the Kapteyn Institute and the Center for Theoretical Physics (Rien van de Weygaert and Eric Bergshoeff). This joint conference joined cosmologists and string theorists in discussing the origin and structure of the early universe.
Other conferences involving Kapteyn staff members but organised at the Lorentz Centre in Leiden were: “QSO Hosts: Evolution and Environment”, 22–26 August 2005 (Peter Barthel); “Outer edges of disk galaxies: A truncated perspective”, 4–7 October 2005 (Isabel Pérez Martin, Reynier Peletier, Michael

Pohlen) and “The Molecular Universe ”, 7–9 December 2005 (Xander Tielens and Frank Helmich).
Simon White was appointed the Blaauw visiting professor for 2005. He visited the Institute several times for a few weeks spread throughout the year. Simon delivered the Blaauw lecture on "Out of the Big Bang: the origin and evolution of structure in our Universe" on 10 October 2005.

On 21 October 2005 the permanent staff of the Institute held its annual retreat at the Piloersemaborg in Den Ham, discussing for a full day all aspects of the future of the Institute. This concerned both the educational program and the scientific activities at the Institute. Regarding the latter: with all positions at staff level filled and all projects the Institute is involved in in full swing (NOVA instrumentation initiatives for the VLT, VST and ALMA, OmegaCen, AstroWise, CHAMP+, LOFAR, etc.) and the number of people working in the Zernike Building has become quite substantial. The Institute and SRON-Groningen together must house some 180 people (including undergraduate and graduate students), not counting the necessary laboratory space. During 2005 more space was secured on the first and second floor on a temporary basis. The discussions at the retrea focused on the future with the possibility of a third period of five-year funding for NOVA at the horizon. There was consensus that for optical instrumentation the Netherlands should focus on a few projects and that members of the Institute should get involved. Follow-up discussions have started in the meantime.

Education

While the Bachelor/Master system has slowly stabilized, discussion has started about the introduction of a major/minor system. Under this regime a student would get a bachelor in Natural Science and Technology and major in astronomy. Other majors within this bachelor are mathematics, physics and chemistry. A series of meetings with different groups has led to a definition of a common first semester with six courses. The inroductory astronomy is cast in a course Quantum and Cosmos which combines elementary quantum mechanics and introductory astronomy. The new program will start in September 2006.
The new curriculum for Instrumentation and Informatics in Physics, Astronomy and Space Research has started. There were a few students who took the first courses. The curriculum is supported by the Kapteyn Institute, the Kernfysisch Versneller Instituut (KVI), Technical Physics, ASTRON and SRON. The hope is that it will attract many students in the future. The program will be advertised internationally. The total number of students at the end of 2004 was 41, of which five master students from abroad. Eight students received a masters degree. The staff of the Kapteyn Institute taught 19 courses. Leon Koopmans took over the student advisor role from Marco Spaans and Saleem Zaroubi is now in charge of distributing and monitoring the undergraduate research projects.
As part of the outreach activities Nigel Douglas organised an “Observing Contest” for high-school students. In February 2005 the four students with winning “proposals” went to La Palma to observe their objects at the 2.5 Isaac Newton Telescope. Master students Jacob van Bethlehem and Else

Starkenburg helped Nigel and the four students to carry out their observing program.
In 2005 for the first time a Masterclass for 5-VWO students was organised by the Kapteyn Institute on 16–18 February. The program consisted of attending lectures, do practical work, visits to ASTRON (WSRT and LOFAR), and "swinging" Groningen. 24 very enthousiastic students participated and the Masterclass was considered a great success. We had great support for this from Greta de Vries, Marco Spaans, Peter Barthel and Dennis Bodewits.

NOVA

The Netherlands Research School for Astronomy (NOVA) consists of the astronomical research institutes of the Universities of Amsterdam, Groningen, Leiden and Utrecht and the astronomy department at the Radboud University of Nijmegen. It has been awarded extra funding in the "bonus-incentives scheme" (in Dutch "dieptestrategie") for top research schools in the Netherlands in 1998. In 2004 this program was evaluated and the Minister decided to continue all the six research schools that are receiving such funding. In 2004 the final plans for Phase 2 been defined and adapted to the funding provided. In 2005 astronomers in the Netherlands have begun to discuss how to proceed with the NOVA program after its termination at the end of 2008. The original idea after two national meetings with presentations an plenary discussions was to write a new strategic plan for Dutch astronomy. This has evolved into a much more concise midterm review of the current strategic plan which runs until 2010 with a forward outlook until 2015. This midterm update will be completed mid-2006.

Research

The main part of this Annual Report concerns a description of the research carried out at the Kapteyn Astronomical Institute. As can be seen from the appendices the work at the Institute resulted in 2005 in (co-)authorship of 104 published papers in refereed journals, 77 contributions to printed conference proceedings and 2 Ph.D. theses. In this year staff members gave 23 invited reviews and contributions at international meetings and 37 colloquia at other institutes. The number of foreign researchers visiting Groningen was 55.
NOVA supports so-called NOVA colloquium speakers. These are senior scientists from abroad who are invited to visit the Netherlands and give colloquia at some or all of the NOVA participating institutes. In 2005 these were Simon White (Max-Planck Institute for Astrophysics, Garching, Germany), Roger Blandford (Stanford, USA), Volker Bromm (University of Texas, USA), Guinevere Kauffmann (M.P.I. for Astrophysics, Garching, Germany), Roberto Gilmozzi (ESO, Munich, Germany), Mark Dickinson (NOAO, USA), Alan Dressler (Carnegie Institution of Washington, USA), Francis Halzen (Univ. of Wisconsin, USA).
In 2005 astronomy got special attention from the Ministry of Education and Science. In April minister Maria van der Hoeven came to Groningen to dedicate the IBM Blue Gene computer (one of the fastest computers in the world at that time) for the LOFAR project. She revealed the new name of the LOFAR central processor: STELLA. At this occasion she personally handed Harvey Butcher, director of ASTRON and professor at the Kapteyn Institute a royal medal

"Officier in de Orde van de Nederlandse Leeuw". One month later the minister visited the ESO facilities in Chile (the VLT at Paranal and the ALMA site Chajnantor) in May. Piet van der Kruit was present as president of the ESO Council and Chair of the ALMA Board.

Staff

There were several changes at the Institute. Wim Brouw formally started work related to LOFAR in January 2005. He received a special professorship in "radio synthesis techniques and signal processing". Reynier Peletier was appointed adjunct-hoogleraar in March 2005. This is within the new tenure-track system. In December 2005 Edwin Valentijn and Wolfgang Wild were appointed "bijzonder hoogleraar". Tom Oosterloo and Raffaella Morganti from ASTRON received a zero-appointment as UHD at the Institute. In 2005 two postdocs left the Institute (Nicola Napolitano and Andrew Cole), while six new appointments were made (Lodovico Coccato, Michael Pohlen, John McFarland, Gijs Verdoes Kleijn, Sarod Yatawatta and Spyros Basilakos).
Jelte de Jong and Benne Holwerda defended their thesis and obtained their Ph.D. in 2005. Electronic versions (in pdf format) of these theses are available via the Web-site of the Institute. During 2005 eleven new Ph.D. students started in Groningen: Matteo Barnabe, Christiaan Boersma, Erwin Platen, Rajat Mani Thomas, Julianna Sansa, Seungyoup Chi, Roberto Pizzo, Attila Popping, Paul Kemper, Edo Loenen, and Mattias Arrigona) The total number of Ph.D. students at the end of 2005 was 32.
Finally the Institute had a memorable retirement. In May Renzo Sancisi formally retired from his part-time appointment at the Institute. We are very pleased that Renzo will continue to be at the Institute several times a year.

Many staff members have contributed to this Annual Report, but I am particular-ly grateful to Gineke Alberts and Jackie Zwegers-Morris for their work on its preparation, and to Piet van der Kruit for editing the science section.

Groningen, July 2006

Thijs (J.M.) van der Hulst
Director

2. EDUCATION

Astronomy Students

Per 31 December 2004, 30 advanced students were registered with Astronomy as their principal subject. There were 6 advanced ‘Physics and Astronomy’ students registered with Astronomy as their principal subject; The table below lists the number of students in the past 12 years:

Year:	number of students per 31 December
1994	43
1995	50
1996	50
1997	52
1998	49
1999	59
2000	62
2001	56
2002	52
2003	39
2004	37
2005	46

The number of students is declining slightly the last couple of years. The fact that in the year 2000 Physics and Astronomy were joined to form “Physics and astronomy” is probably the cause of this; Astronomy was less visible to the students during those few years. In total there were 10 women among the 36 advanced Astronomy and ‘Physics and Astronomy’ students with Astronomy as their principal subject.
The analysis of students in year and achievement (as of 31–12–2005) is as follows:

next exam:	number of students:		per year:	
propedeuse	21	of which	14	1st year’s
			3	2nd
			2	3rd
			1	4th
			0	5th
			1	6th + more
bachelor	16	of which	10	2nd year’s
			4	3rd
			1	4th
			0	5th
			2	6th + more

next exam:	number of students:		per year:	
doctoraal	6	of which	6	6^{th} + more
master	2	of which	2	1^{st} year's

The table below (in 2 parts) gives some statistics (as of 31-12-2005) concerning the progress of students since 1985:

Year									
85	86	87	88	89	90	91	92	93	94
No 1^{st} year (31 Dec)									
14	6	5	13	7	10	13	9	9	10
Influx after the propedeuse									
12	1	0	1	3	4	2	2	0	4
No. of females									
4	0	0	0	0	3	1	1	1	5
Gained propedeuse									
8	5	3	10	6	8	11	7	6	8
Propedeuse in 12 months									
5	0	0	5	0	1	3	3	1	3
Doctorandus degree									
6	3	3	8	3	5	6	5	5	5
Ph.D. Study									
3	1	1	5	2	3	4	5	1	5
Stopped/switched									
9	5	3	5	4	8	11	6	6	5

Year										
95	96	97	98	99	00	01	02	03	04	05
No 1st year (31 Dec)										
18	14	14	10	22	16	16	11	8	15	14
Influx after the propedeuse										
4	0	1	1	0	1	0	0	0	0	0
No. of females										
1	2	1	1	6	3	3	2	3	3	3
Gained propedeuse										
15	7	8	7	11	3	3	1	4	3	-
Propedeuse in 12 months										
8	3	4	4	9	3	3	0	1	8	-
Bachelor degree										
-	-	-	-	-	-	1	-	-	-	-
Doctorandus degree										
8	4	5	2	7	-	-	-	-	-	-
Ph.D. Study										
5	3	1	2	5	-	-	-	-	-	-
Stopped/switched										
13	9	8	4	13	12	14	9	2	2	-

- Based on a period of 19 years (from 1985 through 2003), 55% of the students obtain their propedeuse, and 29% do so within the first year of their study. Although few students get their propedeuse within the first year, many students complete their propedeuse during the second year, whilst following the second year courses at the same time.
- 61% of the total number of students during the years from 1985 to 2003 terminated their studies without obtaining a doctorandus or bachelor degree. The majority left during the first year, indicating that the difficulty factor and the workload of the astronomy study is often underestimated by beginning students. There is also a small number of students who decide to switch to physics after the first year. This number is more or less compensated by the number of 2nd and 3rd year students who switch from physics to astronomy.
- A fairly high percentage of the doctorandi continue with a Ph.D.-study: 58% during the years 1985–2000.

Examinations

The following examinations were taken in 2005:

Propedeuse:	J.E. van den Berg, O.A. van de Berg, E.G.P. Bos, J.T. Buist, E. Busekool, W. Docters, M. Dries, B. de Greef, W.J.A. Jager, S.P.C. Peters, J.B. Ruwen and P.C. van der Wijk
Bachelor:	C. Hadziioannou
Master/ Doctoraal:	C. Boersma, A.F. Loenen, F.F.H. Lugt, E. Platen, P. Polko, A. Popping and D. Seekles

Study supervision and information

The organisation, the innovation of the curriculum, the registration of progress achieved, study supervision and study information are taken care of by P.D. Barthel (director of education from December 2005) and J.M. van der Hulst (director of education until December 2005), G. de Vries (coordinator), L.V.E. Koopmans (student counsellor) and Ms. M.G. Alberts (department secretariat).
The education coordinating staff is also responsible for supplying information to prospective students during the University Open Days, the introduction of first year students, providing job information at secondary schools, organising the Science Week, etcetera.
There is a mentor system for first year students. During the first term, the new students hold regular meetings together under the leadership of two third-year students. In this way, problems can be quickly detected and effective communication with the coordinator can be established. Individual discussions between students and the coordinator take place regularly.
Meetings of the Education Committee were held twice per term during 2005.

Lectures

In 2005 the following lectures were given:

1st semester (2nd quarter) and 2nd semester courses 2004/2005:	
The Evolving Universe	P.D. Barthel, M.A.W. Verheijen
Introductory Astronomy 1B	J.M. van der Hulst
Astrophysics A	L.V.E. Koopmans
Formation and evolution of galaxies	S.C. Trager
Galaxies	A. Helmi
Interstellar Medium	A.G.G.M. Tielens
Modern research	E. Tolstoy
Large Scale Structure of the Universe	M.A.M. van de Weygaert
Observing Techniques in Astronomy I	N.G. Douglas, R.F. Peletier
Astrophysics B	M.C. Spaans
Space Mission Analysis and Design	P.R. Wesselius
Computer course Astronomy	M.G.R. Vogelaar
1st semester courses 2005/2006:	
Introductory Astronomy 1A	P.D. Barthel
Statistical methods	R.F. Shipman
Stellar Atmospheres	A.G.G.M. Tielens
Astrophysics B	S. Zaroubi
Introductory Astronomy 1B	J.M. van der Hulst
Signal Processing in Astronomy	R.F. Peletier
Observing Techniques	N. Douglas
Cosmology	M.A.M. van de Weygaert
Galaxies	A. Helmi

In Utrecht, interuniversity lectures were given during the first months of 2005 on the theme “History of Astronomy”.

Outreach

Kapteyn Institute staff members are spending an increasing amount of their time on education (mostly secondary schools) and outreach. A very successful Astronomy Masterclass for advanced secondary school students was organized by staff member Spaans together with education coordinator De Vries. This class consisted of three days lectures, practical work, and site visits (WSRT, Dwingeloo, LOFAR), during the school spring break (end of February). The Masterclass will become an annual happening, given its success. Barthel continues to be the Rector of the Groningen University Academy for Secondary School Students; as such he is involved in the planning of lectures and other activities for these students.

Innovation

Substantial time was devoted to the set-up of the new Flexible Bachelor system of the Faculty. This new system will offer a major (120 European Credits) and two minors (60 EC each), and will become effective Sept.1, 2006. Staff member Spaans took the responsibility to design a new introductory astronomy course, Quantum and Cosmos, which will be taken by all (100+) first-year students Physics, Mathematics, Chemistry, and Astronomy. Spaans is member of a Working Group designing the first semester of this Flexible Bachelor system. He an Education Director Barthel in addition were members of the working group defining the end terms of the new system. Barthel was member of an ad-hoc committee assessing the connection between the university and secondary education. The results of that assessment are being used in optimizing the university education. Barthel is furthermore member of the national committee NiNa, Nieuwe Natuurkunde, redesigning the national Physics Curriculum (HAVO/VWO).

Special Events

The Kapteyn Institute (Douglas, Barthel), with support from the NOVA Information Centre (NIC), the Radboud and Amsterdam universities, and the Isaac Newton Group of telescopes on La Palma, organised a major outreach program. All VWO school groups (that is, all high school students with science in their curricula) were invited to participate in a competition with, as prize, two nights observing at the 2.5m Isaac Newton telescope on La Palma. Kapteyn students E. Starkenburg, J. van Bethlehem, and C. Boersma were members of the organising committee.
The winners Max Verhagen (Roosendaal), Eveline Dam (Bergen), Caroline Straatman (Leiderdorp) en Suyan Zhang (Hoogezand) were chosen on the basis of an observing proposal. The observing team (Douglas, Starkenburg, van Bethlehem the four winners, and a reporter from the VPRO) departed for La Palma on February 22. Ascent to the observatory was delayed by extra-ordinarily bad weather, but observations were finally possible before the weather again worsened, causing cancelled flights and a delay of one day before the team could return to the Netherlands. Subsequently the school students were invited to Groningen in order to analyse their data and prepare presentations for their school groups.
The initiative was in every respect successful, but most notably for the exposure obtained in the media, which included a radio segment (VPRO) and considerable coverage in national (Volkskrant, Natuur Wetenschap en Techniek) and local press.

2005 being the World Year of Physics, the Kapteyn Institute was heavily involved in several WYP05 events. Staff and students presented lectures and experiments during a weekend in downtown Groningen (in shops and department stores) and during another weekend in science center NEMO in Amsterdam. In addition, a scale model of the solar system was displayed in the city of Groningen during the summer months. On scale 1 : 2.5 billion, the sun was a sphere of diameter 55 cm – it was displayed at a bakery in the heart of the city. The planets were all aligned towards the south, and displayed in shops with informative descriptions. Outermost planet Pluto, measuring half a millimetre, could be found 2700m from the sun, in the hall of a hospital. The scale model was formally opened by staff member Barthel, together with an elementary school group, in the presence of the president of the university and a local TV and radio crew.

Staff member Peletier and colleagues wrote a successful proposal to conduct an Outreach project around the 2006 solar eclipse. Preparations are ongoing to travel to Turkey together with a group of Dutch secondary school students in March 2006, and to invite a similar group from Turkey to Groningen.

3. RESEARCH

3.1 Circumstellar Matter, Interstellar Medium and Star Formation

PAHs as carriers of diffuse interstellar bands

Spaans and Cox (Amsterdam) have continued their investigation of the properties and nature of the carrier(s) of diffuse interstellar bands (DIBs), which have so far resisted unambiguous identification. Polycyclic aromatic hydrocarbons (PAHs) are believed to be a good candidate for the carrier molecule(s). In this light, the Large and Small Magellan Clouds have been modelled and the charge state fractions of different PAHs calculated as a function of depth for various densities, electron abundances, temperatures and strengths of the impinging UV radiation field.
The smaller metallicity of the LMC (0.25 Solar) and SMC (0.1 Solar) impacts the charge balance of the PAH molecules. It is found, for a cationic carrier molecule, that DIB strengths in the LMC and SMC can be comparable to Milky Way values, despite the lower ambient metallicity. This is a result of the suppressed PAH+ recombination rate and the different shape of the UV extinction curve in the LMC and SMC.

Science with Herschel-HIFI

Helmich participates in two of the guaranteed time Key Programmes of Herschel-HIFI: One on spectral surveys of star-forming regions the other on water in star-forming regions. Within these international projects the Groningen focus is on regions of high-mass star formation. In order to be able to interpret the coming HIFI-data ground-based observations are a necessity. Data-taking started in 2005 with the JCMT heterodyne receivers and will continue in the framework of the JCMT legacy surveys. The spectral survey of IRAS16293-2422 was finished (see Figure 1), and these data provide the low-mass equivalent of the HIFI high-mass sources. Also needed is laboratory data which is acquired in the Groningen-led (Tielens) European Union FP6 Marie Curie Research Training Network: "The Molecular Universe".

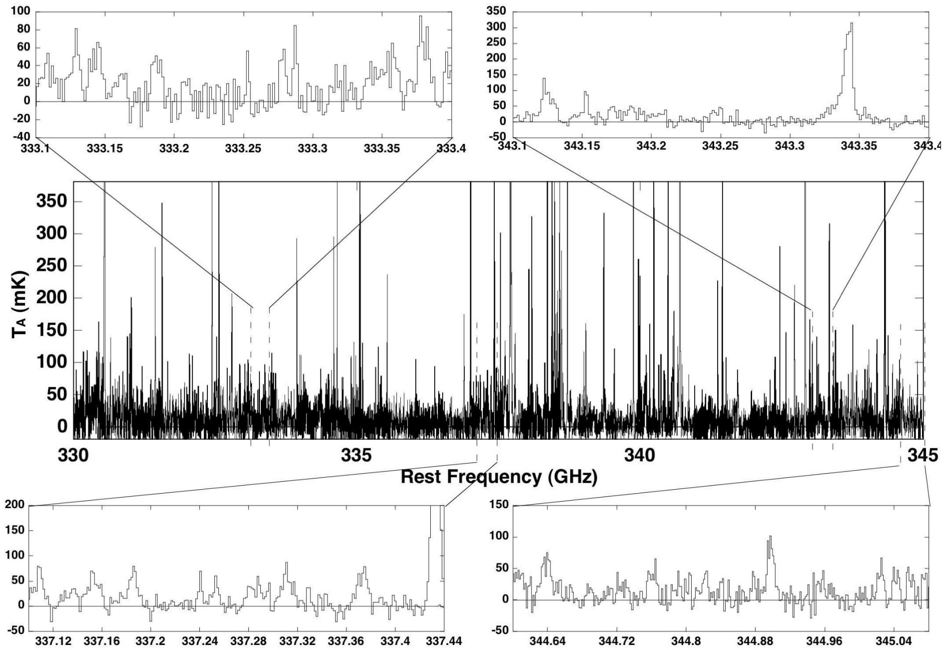

Figure 1: IRAS16293-2422

The excitation of water in the S140 PDR

Spaans and Poelman have considered the excitation of water in the photon-dominated region (PDR) S140. With the use of a two- and three-dimensional escape probability method the level populations of ortho- and para-water up to 350 K (i.e., the first 8 levels), as well as line intensities for various transitions, were computed. Density, temperature and abundance distributions inside the cloud were computed with the use of a self-consistent physi-chemical PDR model in order to reproduce the observed line intensities with SWAS. Predictions have been made for the HIFI instrument on Herschel.

Models for interpreting waterline observations

Poelman has continued his PhD project under the supervision of Spaans, Tielens, and Helmich. It involves creating a state-of-the-art computer model (3D radiative transfer code) to reanalyze and interpret existing observations of H_2O in different environments, and to make predictions for the line intensities of submillimeter lines to be observed with the HIFI instrument on board of the Herschel Space Observatory.

The investigation of the water excitation in the S140 Photon Dominated Region (PDR) has been continued. They predict the emission from the warm (>100 K) and dense (>10^6 cm^{-3}) embedded young stellar sources arising from the PDR. They conclude that water emission in S140 requires a combination of a pure PDR and an embedded source in order to match the observations. Because of its good angular resolution, HIFI will be able to distinguish between a dense star forming region or a more diffuse gas component and test this hypothesis. It is therefore important for future observing programs to consider both cases in their predictions of the emission characteristics of water in these environments. Line profiles of the $1_{10} \rightarrow 1_{01}$ transition of ortho-H_2O are calculated. They find that when a moderate (few km s^{-1}) outflow or infall velocity field is adopted, line profiles are found in agreement with observations.

Planet formation around low and intermediate mass stars

Boersma has started his PhD research February 2005 this year under supervision of Tielens and Waters (Amsterdam). The research concerns the study of dusty disks, the site of ongoing planet formation, around low and intermediate mass protostars; Herbig Ae/Be. The focus of the research is on the characteristics of emission features due to Polycyclic Aromatic Hydrocarbons (PAHs); large molecules of many fused aromatic rings. Spectra obtained with the mid-infrared slit spectrograph (IRS) on board NASA's Spitzer space telescope, together with data obtained with the recently commissioned VISIR and MIDI instruments at the VLT, are analyzed to address questions concerning dust evolution and processing. The answers to questions like e.g. “What is the composition of the emitting PAH family?” and “Where in the protoplanetary disk does PAH processing take place?” are important for a good understanding of the star forming process in general. This is a project in close collaboration with Bouwman (MPIA, Heidelberg and specially Verhoeff (Amsterdam) who focus on the details involving dust comprised by silicates.

Formation of planets around T-Tauri stars

Together with Spaans and Tielens, Ormel continued to work on dust coagulation in protoplanetary disks. In the collisional agglomeration paradigm, dust particles stick together, eventually forming the km-sized planetesimals. This growth is modelled in coagulation models. However, it was soon realised that these models lack physical foundation. At the largest scales, the sticking assumption is questionable, whereas at the smallest scales, the evolution of the internal structure is not accounted for.
They have focused on the latter and used the microphysical collision of Dominik and Tielens (1997) to incorporate the internal structure into coagulation models. They used the porosity parameter as a representation of the internal structure. Collisions are then divided into three regimes: fractal growth (increase in porosity), compaction (decrease in porosity) and fragmentation.
Next, a Monte Carlo code was written to take the porosity as a variable into coagulation models. One of the strength of the Monte Carlo method is that it is very flexible, easily allowing for further expansion. They then calculated the collisional evolution of dust in the gaseous nebula until the point dust particles settle towards the midplane (rain-out). Besides the porosity, the model allows to

vary other physically significant parameters like the turbulent strength (α) and the position within the nebula.
One result is given in Figure 2. Here the porous evolution is shown for four models, one where porosity is unaccounted for (denoted by the 'C' of compact) and three porous. The porous models differ in their turbulent strength. It can be seen that the porosity evolution is very different between the models, resulting also in very different properties of the particles that rain-out to the midplane (crosses).

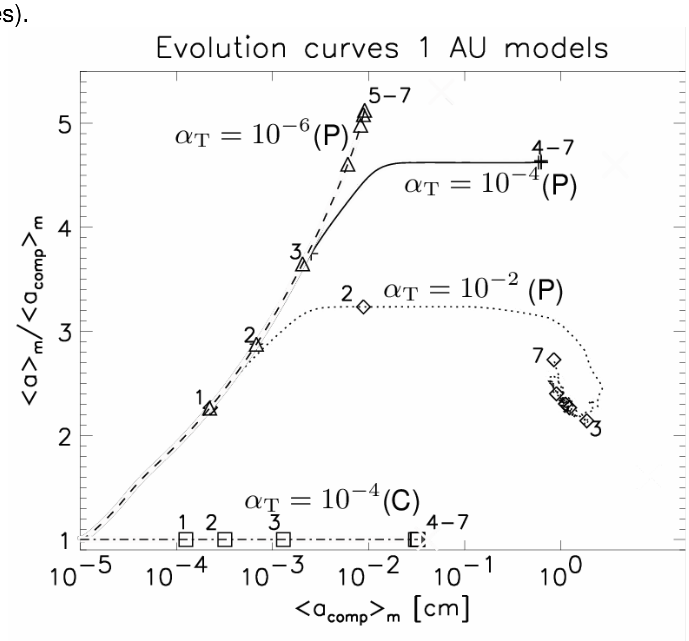

Figure 2: Porosity evolution of agglomerates. Shown are the mean, mass-weighted, compact size of the distribution (x-axis) vs. the enhancement of this quantity due to porosity effects (y-axis) for various values of the turbulent strength parameter, α, (labelled). The ticks denote logarithmic time in years (i.e., t = 10^i yr) and the crosses indicate the particles that rain-out to the midplane (which are the most massive). The regimes of fractal growth (rising curves) and compaction (horizontal/declining curves) can clearly be discerned.

Identification of a Near-Infrared Dark Cloud (N-IRDC) catalogue

Frieswijk successfully finished the identification of a Near-Infrared Dark Cloud (N-IRDC) catalogue from the Outer Galaxy extinction maps. These maps are created with a near-IR colour excess method using the 2 icron All Sky Survey (2MASS) Point Source Catalogue (PSC) and they reveal the extinction in the complete Outer Galactic Plane at a 1.5 by 1.5 arcmin resolution. Part of the results were presented at the PPV meeting in Hawaii, US.

In addition they successfully observed a pilot sample of Outer Galaxy N-IRDCs in several molecular lines using the IRAM, JCMT and Effelsberg 100m telescope. These observations show the filamentary structures of the complexes and verify the expectation that indeed very dense, massive and cold molecular cores are identified.

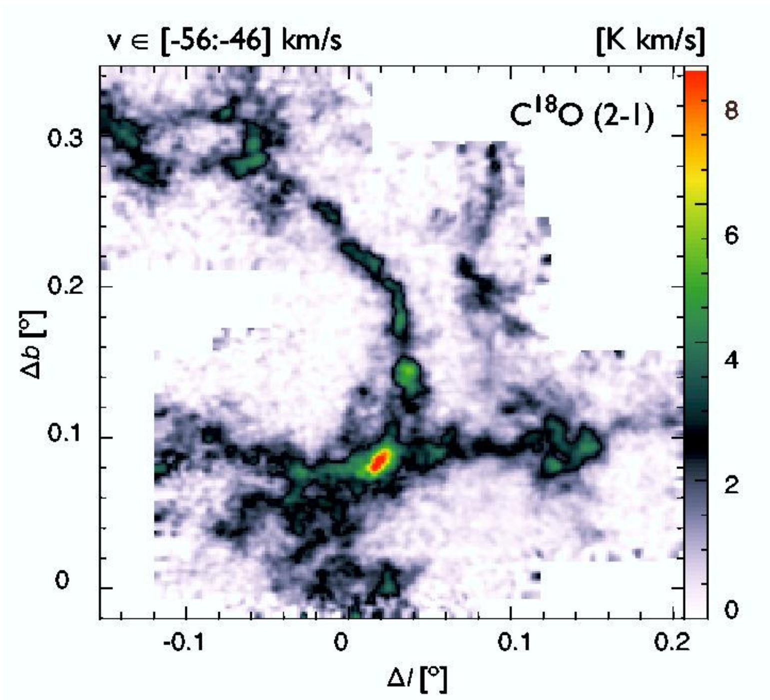

Figure 3: A map of the emission of carbon monoxide ($C^{(18)}O$) from an Outer Galaxy Near-Infrared Dark Cloud located in the Galactic Plane at a distance of 5.4 kpc. The image was taken using the HERA receiver array at the IRAM 30-m telescope at Pico Veleta and reveals a network of massive filaments of typical transverse width 1 pc.

3.2 Structure and Dynamics of Galaxies

Structure in the Milky Way halo

Li started to analyse the substructure properties in the GAnew Milky Way-sized dark matter simulation carried out by Stoehr (IAP). The clustering of subhalos at the accretion epoch has been found indicating group infall at the accretion epoch. The anisotropic disk-like structure defined by 11 MW satellites is also easily produced by selecting 11 subhalos according to the density distribution of MW satellites. This result suggests the current anisotropic distribution of MW satellites has more to do with the dynamical processes which drive the current MW density distribution than other (astro-)physical processes. Finally, the possible link between substructures and the Compact High Velocity Clouds is also explored. Though the selected substructures follow similar trends as the CHVCs in the radial velocity-galactic longitude plot, the details of the two sets do not trace each other very well. Li and White (MPA, Garching) have implemented the "Timing Argument" and the Millennium Run galaxy catalogues provided by De Lucia (MPA) to estimate the mass of the Local Group. The scaling factor between the timing argument mass and the true mass of Local Group-like pairs of galaxies is determined and applied to estimate the LG mass with an interquartile error range to be $\sim 4.6_{-0.7}^{+1.6} \times 10^{12}$ $M_\odot$.

Helmi has led the search for signatures of past accretion events in the Milky Way in the recently published catalogue by Nordström *et al.* (2004), containing accurate spatial and kinematic information as well as metallicities for 13240 nearby stars. To optimize this quest, she has devised a new technique: stars with a common progenitor are expected to show distinct correlations between their orbital parameters; in particular, between the apocentre A and pericentre P, as well as their z-angular momentum (Lz). In the APL-space, such stars are expected to cluster around regions of roughly constant eccentricity. Indeed, the APL space for the Nordström catalogue exhibits a statistically significant excess of stars on orbits of common (moderate) eccentricity, analogous to the pattern expected for merger debris. Besides being dynamically peculiar, the 274 stars in these substructures have very distinct metallicity and age distributions, providing further evidence of their extra-Galactic provenance (see Figure 4). The identification of substantial amounts of debris in the Galactic disk whose origin can be traced back to more than one satellite galaxy, provides direct evidence of the hierarchical formation of the Milky Way.

Radial Velocity Experiment (RAVE)

Helmi is a partner of the RAVE (Radial Velocity Experiment, PI: Steinmetz at Potsdam): an ambitious program to conduct an all-sky survey to measure the radial velocities, metallicities and abundance ratios of 1 million stars using 6dF multi-object spectrograph on the 1.2-m UK Schmidt Telescope of the AAO, over the period 2003–2010. The survey will represent a giant leap forward in our understanding of our own Milky Way galaxy, providing a vast stellar kinematic database an order of magnitude larger than any other survey proposed for this coming decade. The RAVE started in the Spring of 2003 and so far has delivered 80,000 spectra in the Ca-triplet region (8410–8790?) for southern hemisphere stars in the magnitude range $9 < I < 12$ at a resolution of R = 8000-10000. The radial velocities measured in this survey are accurate to a few kilometres per second. The first scientific highlights include the determination of the local escape velocity (led by Smith and Helmi, both at RuG, Ruchti and Wyse at Johns Hopkins), the measurement of the local mass density (led by Bienaymee in Strasbourg), and the use of the diffuse interstellar band at 8620 A as a reddening tracer (led by Munari at Padova).

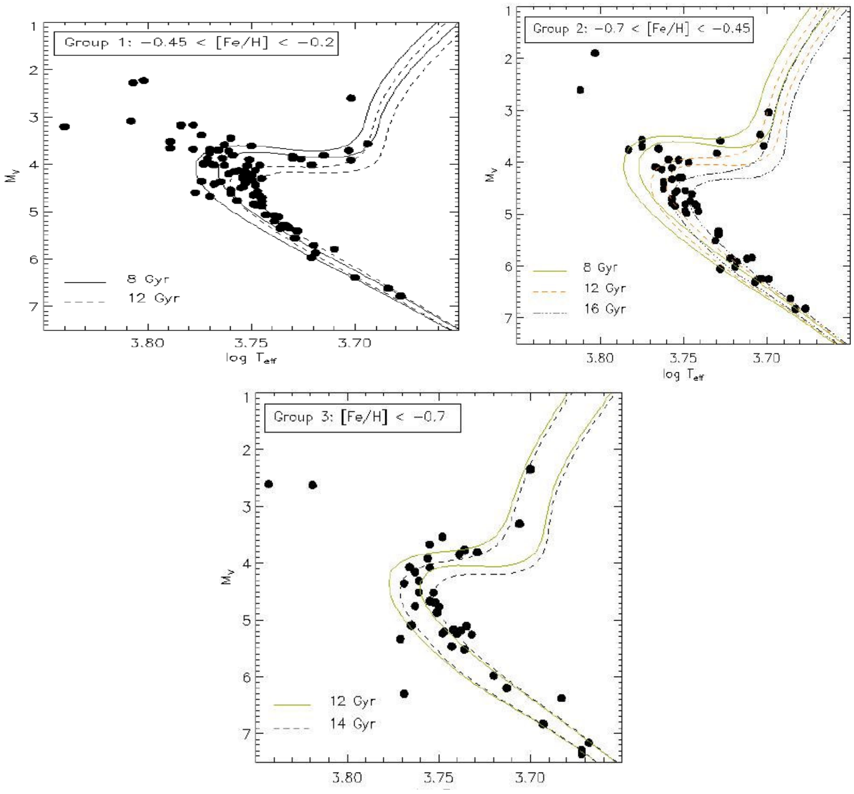

Figure 4: Hertzsprung-Russel diagram of the stars associated to the over-densities found in the APL-space. It is possible to identify three coherent Groups (first, middle and last panels) among these stars on the basis of their metallicity. The well-defined HR diagrams bare a striking resemblance to those of present-day dwarf satellites of the Milky Way, with the provision that they correspond to stars distributed all across the sky! These are in all likelihood the remains of satellites disrupted more than 8 Gyr ago.

Smith spent most of his time this year working on a project to constrain the local escape velocity of the Galaxy using the RAVE survey. However, this is not yet submitted. Apart from this he had a first author paper published on gravitational microlensing, in which they performed Monte Carlo simulations to produce a simulated catalogue of microlensing events. This was done in order to investigate various properties related to 'parallax' microlensing events, i.e. those events that show perturbations due to the Earth's motion around the Sun. This work was carried out in collaboration with a number of researchers from the IoA in Cambridge and also the University of Manchester. Both of these institutes (as well as our own Kapteyn Institute) are part of the ANGLES networks, which is a Marie Curie Research Training Network supported by the European Community.

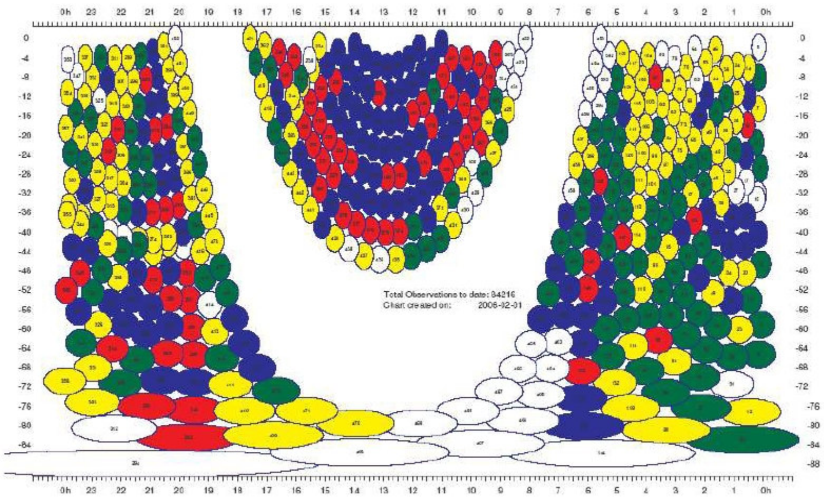

Figure 5: Status of RAVE observations as of December 1st 2005. The colour coding corresponds to the number of times a field has been visited (including re-observations for calibration purpose). Yellow corresponds to one observation, green to two, blue to three and red to four observations. So far ~80,000 spectra have been obtained.

Nearby Dwarf Galaxies

Tolstoy, Cole and collaborators study the properties of large numbers of individual stars in Local Group Dwarf Galaxies. This concerns both high resolution spectroscopy using facilities such as FLAMES and UVES on the VLT and high resolution imaging using the HST ACS. The imaging provides multi-color photometry of the stars and enables identifying individual stellar populations groups using HR diagrams, while the spectroscopy provides detailed information about the stellar types and more importantly, the elemental abundances of the stars. The latter enable a study of the metallicity of the stars on connection with their kinematic characteristics. In the Sculptor, Fornax and Sextans dwarf spheriodal galaxies there appears to be a segregation between the metal rich and the metal poor stars, the latter being more centrally concentrated.
Tolstoy is leading an ESO Large Program entitled “Dwarf galaxies: remnants of galaxy formation and corner stones for understanding galaxy evolution”. This program also involved Helmi and RuG PhD students Battaglia and Letarte and a large number of colleagues around the world who called themselves the Dwarf Abundances and Radial velocities Team (DART). Their main idea is to use spectroscopic and photometric data of stars in the Local Group dwarf galaxies to trace back the star formation history of these systems and

understand galaxy formation from this end rather than looking back in time by going to more and more distant objects. This program found evidence for two distinct ancient stellar components in the Sculptor dwarf spheriodal galaxy. Both components are >10 Gyr old. They used the ESO Wide Field Imager together with the VLT/FLAMES spectrograph to study the properties of the resolved stellar population of Sculptor out to and beyond the tidal radius. They found that the two components are discernible in the spatial distribution of horizontal branch stars and in the [Fe/H] and velocity distributions for their large sample of spectroscopic measurements. They can be generally described as a "metal-poor" component ([Fe/H] ≤ –1.7) and a "metal rich" component ([Fe/H] ≥ –1.7). The metal-poor stars are more spatially extended than the metal-rich stars, and they also appear to be kinematically distinct. These results provide insight into the formation processes of small systems in the early universe. Even this simplest of galaxies appears to have had a surprisingly complex early evolution (Fig 3). Similar results were obtained for the Fornax and Sextans dwarf galaxies which form a large part of the PhD thesis of Battaglia.
Part of this large program also includes high resolution spectroscopy of large samples of individual stars in nearby dwarf galaxies. This is the PhD project of Letarte and in close collaboration with Hill (Observatoire de Paris). Previous spectroscopic samples in dwarf galaxies have been 3-5 stars per galaxy, with FLAMES this is dramatically increased to nearly 100 stars in each of 4 different nearby galaxies (Sculptor, Fornax, Sextans and Carina). This proved unambiguously that stars in dwarf galaxies and all components of the Milky Way have significantly different abundance patterns which mean that the Milky Way can not be built up of building blocks which are like the dwarf galaxies we see around the Milky Way today.
Cole, Tolstoy and collaborators obtained HST/ACS imaging data to look at the Leo A dwarf irregular galaxy, which is an extremely low metallicity (~3% solar) star-forming dwarf galaxy in the Local Group. It is the best nearby candidate to be a redshift zero analogue to the major building blocks of the Milky Way. These new data provide the first opportunity to measure the complete star-formation history of a potential "living fossil" analogue to the building blocks of the Milky Way using color-magnitude diagram analysis. The data show a clear old (but not ancient) main sequence turnoff which proves that the majority of stars in Leo A were formed in the last few Gyr, although it also contains ancient stars (as evidenced by the faint blue horizontal branch sequence of stars in the color-magnitude diagram. It is not clear why this galaxy formed most of its stars relatively recently.

The structure of galactic disks

Pohlen continued working on the structure of galactic disks by studying their radial surface brightness distributions. In collaboration with Beckman (IAC, Tenerife), Erwin (IAC, Tenerife/MPA, Garching), and Trujillo (MPIA, Heidelberg/ Nottingham) they updated and extended Freeman's original disk classification (Type I/II) by studying two independent samples of face-on galaxies: one of about 70 early-type, barred galaxies using deep CCD imaging, and another of about 90 late-type galaxies using data from the SDSS survey.
The key result is that galactic disks come in three main types (see Figure 6). The well known, purely exponential disk (Type I) and two types of profiles which

are better described as a broken exponential: one with a break followed by a downbending, steeper outer region (Type II), and another with a break followed by an upbending, shallower outer region (Type III). The origin of this trichotomy is not yet fully understood but must be intimately linked to the mechanisms involved in the growing and shaping of the galaxies. The Type II class comprises for example galaxies where the break is probably related to a star-formation threshold (classical truncations) and galaxies where the break seems to be closely related to the outer Lindblad resonance of the bar (OLR breaks). Trujillo and Pohlen showed that the breaks in the surface brightness distribution can be used to constrain galaxy evolution, by applying the radial position of the truncation as a direct estimator for the size of the stellar disk. Using a complete sample of galaxies at intermediate redshifts in comparison with the local sample, they could infer a moderate (~25%) inside-out growth of the disk galaxies since z ~ 1.

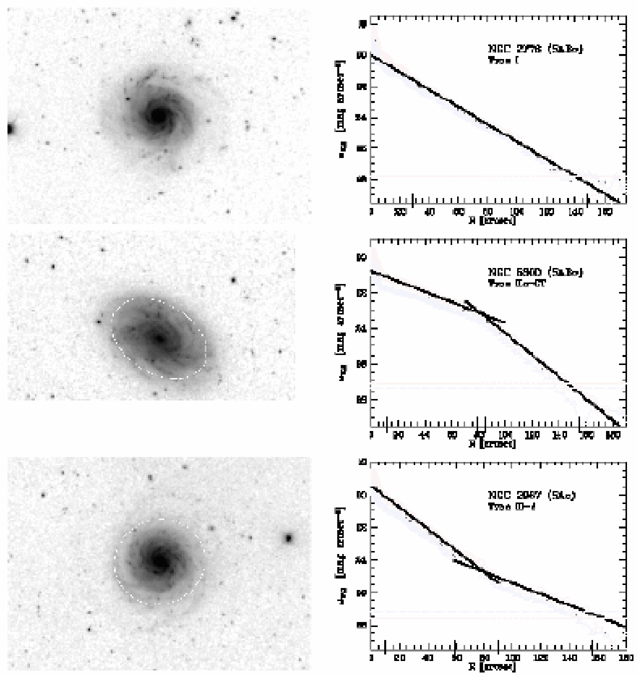

Figure 6: Prototypical examples for each class of profiles: Type I, Type II, and Type III (top to bottom). (Left panels): r'-band images with the break radius marked with an ellipse. The ellipse for the first Type I galaxy corresponds to the noise limit at ~140". (Right panels): Azimuthally averaged, radial SDSS surface brightness profiles in the g' (triangles) and r' (circles) band overlayed by r' band exponential fits to the individual regions: single disk or inner and outer disk.

Microlensing in the Andromeda galaxy

The nature and distribution of dark matter in galaxies is still an unsolved mystery in astronomy. The microlensing results towards the Magellanic Clouds indicate that at most 20 percent of the Galactic dark matter can be in compact objects. The Andromeda galaxy (M31), being the nearest large spiral galaxy to the Milky Way, provides a way of studying another dark matter halo, independent of our own Milky Way halo. Because of the high inclination of M31 a microlensing halo will induce a clear signal in the spatial distribution of the microlensing events.

In 2005 de Jong completed his thesis on a microlensing survey towards M31, as part of the MEGA (Microlensing Exploration of the Galaxy and Andromeda) collaboration. Using a data set obtained at the Isaac Newton Telescope on La Palma, 14 candidate microlensing events were detected. A thorough analysis, including detailed theoretical modelling of the expected microlensing rate, showed that the observed candidate events can be explained by lensing due to the known stellar populations in M31. The results are therefore consistent with a 0% contribution of compact objects to the dark halo mass of M31 and provide an upper limit of 30% to this mass fraction.

The MEGA collaboration involves J.T.A. de Jong, K.H. Kuijken (Leiden), A.P.S. Crotts, R.R. Uglesich, P. Cseresnjes (Columbia University), P.D. Sackett (Mt. Stromlo), W.J. Sutherland (IoA, Cambridge), E.A. Baltz (Stanford), G. Gyuk (Chicago), L.M. Widrow (Queens) (the MEGA collaboration).

The Fornax dwarf galaxy

In 2005, Letarte submitted a paper on his work about the Globular Clusters (GCs) of the Fornax Dwarf Galaxy. The highlight of this paper are the following. Cluster 1 is the most metal poor GC known, with [Fe/H] = -2.5, slightly lower than the M15, M92 or M68. Cluster 3 show an over-abundance in Europium, similar to what have been previously observed in the Galactic GC M15. The GCs in Fornax are a global match to their Galactic counterpart, including some deep-mixing pattern found in two stars. The initial condition at the epoch of formation of the GCs was the same in Fornax as they were in the Milky Way, presumably pre-enriched by the same processes, with identical nucleosynthesis patterns.

In 2005 Letarte continued to work on the complex VLT/FLAMES data set of high resolution observations of 107 field stars in the centre of the Fornax Dwarf Spheroidal. A technique was developed to analyse such a data set, including the use of some new stellar atmosphere models that were published in 2005 (MARCS). Progress have been made so that the results are almost ready to publish. This work was done in collaboration with V. Hill (Observatoire de Paris-Meudon) and Tolstoy. Preliminary results were presented as a poster in two conferences where Letarte attended in 2005. The first conference was the IAU Symposium No. 228, 2005 "From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution" in Paris. The second one was entitled "Mass and Mystery in the Local Group", in Cambridge, UK.

In 2005 Battaglia, in collaboration with the DART team, focused on the study of the resolved stellar population of the Fornax dSph out to and beyond its tidal radius, using photometry from ESO/2.2m Wide Field Imager and spectroscopy

from VLT/FLAMES. They have obtained accurate velocities and metallicities from spectra in the CaII triplet region for 562 Red Giant Branch (RGB) stars, probable velocity members of the Fornax dSph.
They have found evidence for the presence of at least three distinct stellar components: a young population (few 100 Myr old) concentrated in the centre of the galaxy, visible as a Main Sequence in the Colour-Magnitude Diagram; an intermediate age population (2–8 Gyr old); and an ancient population (>10 Gyr), which are distinguishable from each other kinematically, from the metallicity distribution and in the spatial distribution of stars found in the Colour-Magnitude Diagram. From their spectroscopic analysis they find that the “metal rich” stars ([Fe/H] > –1.3) show a less extended and more concentrated spatial distribution, and display a colder kinematics than the “metal poor” stars ([Fe/H < –1.3). There is tentative evidence that the ancient stellar population in the centre of Fornax does not exhibit equilibrium kinematics. This could be a sign of a relatively recent accretion of external material, such as the merger of another galaxy or other means of gas accretion at some point in the fairly recent past, consistent with other recent evidence of substructure (Coleman *et al.* 2004, 2005)

Local group dwarf galaxies

The work of Ripamonti in 2005 can be divided into two main fields, local group dwarf galaxies and the primordial universe. The effort about nearby dwarf galaxies is yet unfinished; however, Ripamonti has been building a numerical code (based on the public N-body code Gadget) for simulating in great detail the dynamical and chemical evolution of dwarf galaxies. This is related to the DART project, as they would like to provide numerical models explaining the basic observations of DART. This part of his work was done in collaboration with Tolstoy, Helmi and Abel (Stanford/ KIPAC).
Ripamonti’s work about the primordial universe focused mainly on the effects of the often neglected HD molecule on the standard model of structure formation, and on writing the review "The Formation of Primordial Luminous Objects" [astro-ph/0507130; unfortunately, due to editorial problems, the real publication is not available yet]; this was done in collaboration with Abel.

The SAURON project

Peletier and Ganda and are members of the SAURON team that has built a panoramic integral-field spectrograph for the 4.2 m William Herschel telescope on La Palma, in a collaboration which involves groups in Leiden (de Zeeuw), Lyon (Bacon) and Oxford (Davies). SAURON (Spectroscopic Areal Unit for Research on Optical Nebulae) records 1577 spectra simultaneously, with full sky coverage in a field of 33'' by 44'', additional coverage of a small “sky” field 1.9' away, spatial sampling of 0.94” by 0.94”, and an instrumental dispersion of 105 km/s.
SAURON was used to measure the kinematics and line strength distributions for a representative sample of 72 nearby early-type galaxies (ellipticals, lenticulars, and Sa bulges, in clusters and in the field). The entire survey was completed in 2003. In parallel with the data taking, the team developed a number of tools that are key to analyze all the resulting maps and the project is

coming to full fruition. The team has built an elaborate software pipeline to reduce and analyze the data which produce full 2D maps of velocity from both stellar absorption lines and ionised gas emission lines, of velocity dispersion and of line ratios. In general, the gas maps display regular motions with smooth variations in angular momentum. In the majority of the galaxies, the gas kinematics is decoupled from the stellar counterpart, and less than half displays signatures of recent acquisition of gaseous material. The presence of dust features is always accompanied by gas emission while the converse is not always true. Also, a considerable range of values for the [OIII]/Hβ ratio was found both across the whole sample and within single galaxies. Absorption line maps in 4 strong absorption lines have been derived for the elliptical and S0 galaxies of the sample. The metal line strength maps generally show negative gradients with increasing radius, consistent with the morphology of the continuum light. For 40% of the galaxies, however, the ones displaying significant rotation, they find that the Mg b isoindex contour maps are flatter than the continuum isophotes. This implies that these fast-rotation components feature a higher metallicity and/or an increased Mg/Fe ratio as compared to the galaxies as a whole. These results appear in 4 papers appearing in 2006. In 2005 2 SAURON-papers in refereed papers were published:

Alard (Hertfordshire), Peletier and Knapen (Hertfordshire) show observations of the central area of the barred spiral galaxy M100 (NGC 4321). M100 contains a nuclear ring of star formation, fuelled by gas channelled inward by the galaxy's bar. They find that the Hβ emission is strongest in the ring, along two curved bar dust lanes and at the ends of the bar. The gas velocity dispersion is notably smaller than elsewhere in the field both in the ring and along the leading edge of the dust lanes. Low gas dispersion is correlated spatially with the Hβ emission. They thus see stars being formed from cold (low-dispersion) gas that is being channelled inward along the dust lanes under the influence of a large bar and accumulated into a ring near the location of the inner Lindblad resonances. This lends further strong support to the interpretation of nuclear rings in barred galaxies as resonance phenomena **(**Figure 7**).**

Fathi (Rochester), van de Ven (Leiden), Peletier et al. (2005) analyse SAURON kinematic maps of the inner kpc of the barred Sa NGC 5448. The observed morphology and kinematics of the emission-line gas is patchy and perturbed, indicating clear departures from circular motion. The kinematics of the stars is more regular, and display a small inner disc-like system embedded in a large-scale rotating structure. Using a harmonic decomposition formalism on the [OIII] gas velocity field they show that the main kinematic features of the observed data are consistent with an analytically constructed simple bar model. The study illustrates how the harmonic decomposition formalism can be used as a powerful tool to quantify non-circular motions in observed gas velocity fields.

Neutral hydrogen in Sauron early-type galaxies

Morganti, de Zeeuw (Leiden), Oosterloo, McDermid (Leiden), Krajnovic (Oxford), Cappellari (Leiden), Weijmans (Leiden) have used the WSRT to carry out deep observations of the neutral hydrogen in a sample of 12 elliptical and lenticular galaxies selected from a representative nearby sample already studied at optical wavelengths with the integral-field spectrograph Sauron.

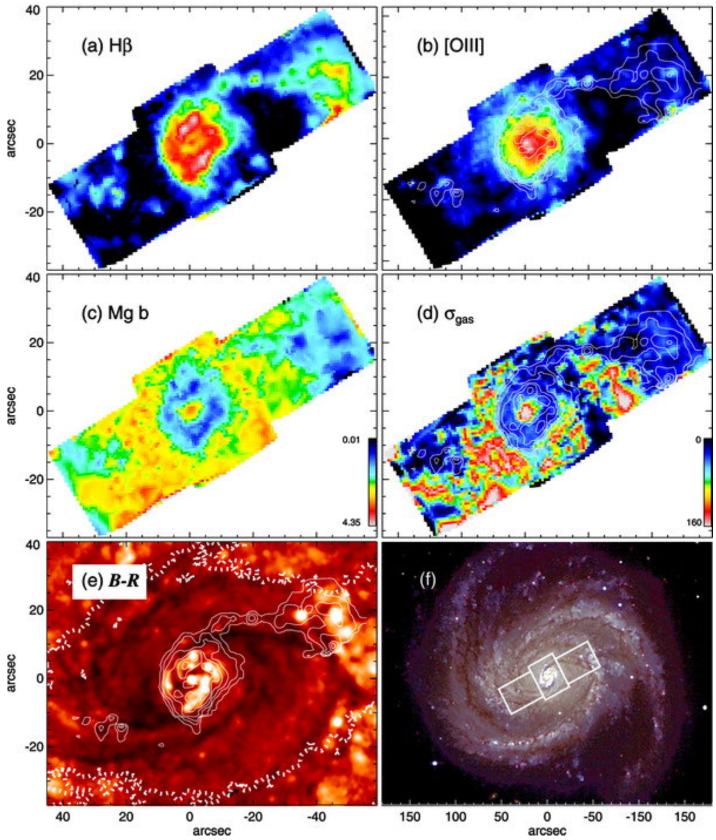

Figure 7: SAURON maps of the central region of M100 (from Allard et al. 2005). (a) HI emission-line intensity. (b) [OIII] emission-line intensity; overlaid are HI emission-line contours at relative levels 0, 0.05, 0.1, 0.2, 0.5, 1, 2, and 3. (c) Mg b absorption-line strength. (d) Gas velocity dispersion (in units of kilometres per second); HI emission-line contours are the same as in (b). (e) B-R image, in which darker shades indicate redder colours, and the location of the bar is indicated by a Ks-band contour (thick dashed line). (f) Real-colour optical image of M100 with approximate locations of the SAURON pointings.

They detect HI in or near 70% of the galaxies. This detection rate is much higher than in previous, shallower surveys, and is similar to that for the ionised gas. The observed total HI masses range between a few times 10^6 $M_\odot$ to just over 10^9 $M_\odot$. The HI morphologies include regular disks as well as offset HI clouds and tails. Galaxies with HI disks tend to also have strong emission from ionised gas. In these cases, the neutral hydrogen and the ionised gas appear to be part of the same structure (see figure for the case of NGC 4278). The kinematical axis of the stellar component is however nearly always misaligned with respect to that of the gas. There is no clear trend between the presence of HI and the age of the stellar population or the dynamical characteristics of the galaxies: HI detections are found uniformly spread through fast- and slow rotating galaxies. Therefore, if these two type of galaxies represent the relics of the different formation paths, this does not appear in the presence and distribution of the HI. They have started to extend the sample for which deep HI observations are available using the VLA. New deep VLA observations of NGC 2974 will be used to further constrain, using the kinematics of the HI in the outer gas disk, the dynamical models for the inner regions that have been constructed using Sauron data.

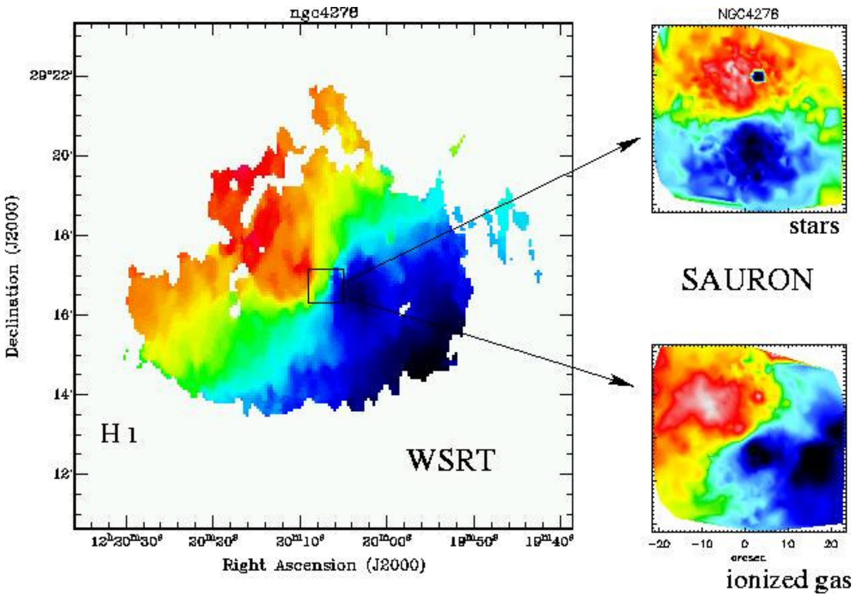

Figure 8: Velocity fields of the HI, ionised gas and stars of the galaxy NGC 4278.

Kinematics and populations in late-type spiral galaxies

Ganda is working on a PhD project dedicated to the study of late-type spiral galaxies (Sb-Sd), supervised by Peletier. These objects have not been studied in detail yet, since they are difficult to observe due to their low surface brightness, and since their analysis is complicated by the presence of big amounts of dust and substructures such as (nuclear) bars, spiral arms, circum-nuclear rings. In the last ten years imaging surveys based on HST data have been dedicated to this kind of objects, but no systematic studies of their spectroscopic properties have been carried out.

Ganda's PhD project's aim is to shed light on the kinematics and stellar populations of late-type spirals, and on their interconnection. In collaboration with the SAURON team (mainly de Zeeuw, Falcon Barroso, Cappellari and

McDermid from Leiden and Emsellem from Lyon) they have obtained SAURON integral-field spectroscopy for a sample of 18 late-type spiral galaxies. The data consist of optical spectra on a 33” x 41" field-of view, covering the nuclear regions, in the range 4800–5300 angstrom, including both emission and absorption features and allowing us to study the inner kinematics of both stars and gas, and the stellar populations as well. The data were fully reduced and calibrated, and the two-dimensional kinematics was extracted, following methods developed within the SAURON team. A clear result is that these are low-dispersion objects, hosting in their centres cold regions – in some times even colder than the surroundings. Both the stellar and gaseos kinematical maps appear often complicated, suggesting the presence of inner components, as hinted by the wealth of structures seen in imaging. This led to a data-paper presenting the maps, which was accepted for publication in the Monthly Notices. To be able to better constrain the stellar populations, one needs spectra on a larger wavelength range than available with SAURON, including more absorption features. In January 2005 they observed a subsample of our 18 objects with the long-slit spectrograph ISIS. The data were reduced and their analysis was started during my three-months visit to the IAC in Tenerife, in collaboration with A. Vazdekis.

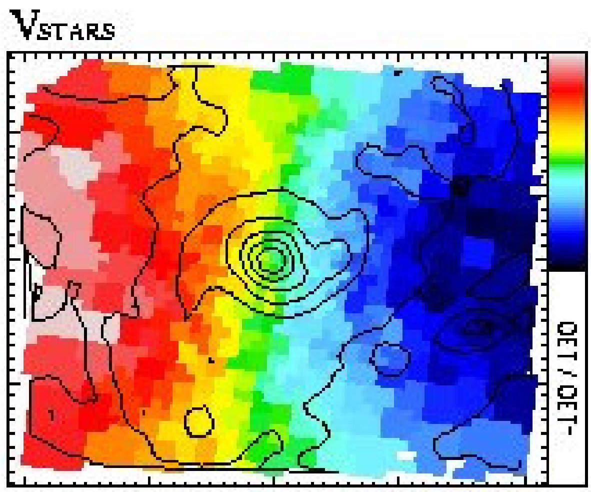

Figure 9: Stellar velocity map for NGC2964, out of Ganda's sample of late-type spirals observed with SAURON.

The Disk Mass project

Verheijen continues his research project with Bershady and Westfall (UW, Madison), Swaters (UMD, College Park) and Andersen (NRC-HIA, Victoria), aiming at measuring the vertical stellar velocity dispersions of stars in the disks of 40 nearly face-on spiral galaxies using two custom-built fiber-based Integral Field Units. From this kinematic information, the mass surface densities and mass-to-light ratios of the stellar disks can be derived and the disk-halo degeneracy in the decomposition of galaxy rotation curves can be broken. Phase A of the survey is complete and H-alpha velocity fields of some 120 nearly face-on galaxies have been obtained and are currently being analyzed. Phase-B observations are halfway through completion and stellar velocity dispersions have been measured in some 25 galaxies. Optical, near-IR and HI imaging of the Phase-B sample is in progress. Initial results indicate that local mass surface density follows local surface brightness regardless of the disk central surface brightness of the galaxy, with high surface brightness galaxies being close to a maximum disk situation and low surface brightness galaxies being significantly sub-maximum. Dependencies on global properties like total mass, colour, morphology, gas content, disk scale length etc. are being explored.

Spiral disks opacity from numbers of distant galaxies

In 2005 the PhD project of Holwerda (supervised by Allen (STScI, Baltimore) and van der Kruit) was concluded successfully with the publication of the thesis titled "The opacity of spiral galaxy disks". In addition, the first two papers, accepted in 2004 appeared in AJ and a second set of three papers was accepted and published in A&A. Per August 19, Holwerda started a position at the Space Telescope Science Institute, continuing the thesis work on two successful cycle-14 HST archival proposals and starting on several new projects.
The thesis project focused on the automation and application of the “Synthetic Field Method" of Gonzalez *et al.* (1998) on the optimal set of HST/WFPC2 images of 29 spirals. The first paper focused on the method, the second reported the radial extinction profiles and their implication. The third paper explored the relation between surface brightness and disk opacity. In the fourth the relation between disk opacity and atomic hydrogen density was discussed. The final paper discussed the practical limits of the method based on this project. One chapter of the thesis discusses the overall temperature of the dust responsible for the disks' opacity. The relation between cloud cover and disk opacity can also be better explored with this technique. These topics will be discussed in forthcoming papers.
Future applications are the large HST campaigns on M101 and M51, briefly discussed in the thesis. These datasets will be analyzed with the financial support of the two cycle-14 HST archival proposals that were approved.

A search for the lowest mass galaxies

Kovač has continued her thesis project (with van der Hulst and Oosterloo) on the studies of low-mass galaxies. Given that small galaxies may be dominated by gas instead of stars, they are undertaking a blind HI survey of the nearby Canis Venatici groups of galaxies with the aim to obtain a sample of small galaxies with selection based on HI. They have been granted with about 60 × 12 hrs to conduct this project using the Westerbork Synthesis Radio Telescope (WSRT). During 2001, 2002 and 2004 they surveyed an area of 86 square degrees in total, with a sensitivity that allows to detect objects with an HI mass of 10^6 $M_\odot$ out to 5 Mpc and 10^7 $M_\odot$ out to 15 Mpc. Their survey is a factor 10

deeper than previous work and gives the first sample covering HI masses down to 10^6 $M_\odot$. All the data, 1372 radio-cubes, have been calibrated and completely searched for objects. 70 objects were found, 21 of them for the first time in HI. All new HI detections fall in the lower part of the mass-histogram, confirming the ability to detect galaxies with small HI masses. All but one of the detections have optical counterparts on the DSS. The small HI mass systems all are optically all small and have low surface brightness. The calculated HI MF is flat in the faint end regime ($\alpha \sim -1.15$), different from the steep rise predicted by CDM models.
The smallest HI detected galaxies are of particular interest. Therefore 21 objects were selected with the smallest HI masses for broad-band *B* and *R* imaging using the Wide Field Camera on the Isaac Newton Telescope at La Palma. For the same sample of galaxies WSRT follows up HI observations with higher velocity resolution were obtained.

Gas dynamics of NGC1530

Pérez together with A. Zurita (Granada University, Spain) have carried out modelling of the gas dynamics of the barred galaxy NGC1530. This galaxy shows a complicated morphology and velocity field (see Figure 10). The modelling has been done using hydrodynamical simulations to reproduce the velocity fields obtained using Fabry-Pérot interferometry in H_α (Zurita et al. 2004). They have been able to reproduce the main features of the velocity field and the gas distribution using the K-band together with the R-band images to derive the mass distribution. Population synthesis models have been used to derived the conversion from light to mass using the broad band colours of the galaxy. The best fit is given using a fast bar with corotation radius at around 1.4 the bar semi-major axis. The paper in which these results will be published is in preparation.

Dark matter in the inner parts of barred galaxies: the data

Pérez, together with Márquez (Instituto de Astrofisica de Andalucia, Spain), Freeman (Mt. Stromlo Observatory) and Fux (Geneva Observatory) have published a study presenting surface photometry (B,V,I,J,H,K) and H_α rotation curves of 27 isolated spiral galaxies. The azimuthally averaged radial surface brightness profiles and the integrated magnitudes obtained from ellipse fitting are given for each of the sample galaxies. The ellipse fitting technique applied to the light distribution also allowed them to obtain the size of the bar, and the inclination and position angle of the outer isophotes that allow the galaxy de-projection. Using these profiles, 1-D disk-bulge decomposition was performed to obtain the disk scale-length and the bulge effective radius for the different bands. Through the fitting of a parametric function to the observed rotation curve, the maximum rotational velocity and the corresponding radius was obtained. The correlation between the bulge and disk parameters is in agreement with previous studies. No correlation between the bulge effective radius and its surface brightness is found, possibly due to the small range of bulge magnitudes covered. They find a smaller scatter in the structural relations when compared to non-isolated samples in agreement with previous work.

Finally, a correlation between the disk scale-length and the bar size is observed, possibly reflecting the rapid growth of a bar.

Figure 10: Combined B,V,I image of NGC1530 taken at the NOT telescope, la Palma).

'Outer edges of disk galaxies: a truncated perspective'

The Kapteyn Institute together with Granada University organised a workshop in October 2005 at the Lorentz Center, Leiden about the outskirts of spiral galaxies. The workshop was really successful and brought together experts from over the world to discuss the main issues in the field. The summary of the discussions is given below:

The discussions were centered on the origin of the distribution of matter in the outer parts of disk galaxies. There were five discussion sessions. In the first three sessions, on the radial distribution of disks, there was unanimity on the fact that the gas in the outer parts is not primordial. There was a large discussion on the observational effects that produce the different shapes of the stellar radial profiles with no general agreement on why, for example, the edge-on systems do not show certain radial profiles that seem to appear in face-on galaxies. After the workshop, everyone did agree that truncations, or break radii, are not always related to morphological features such as bars, spiral arms, etc. Another problem brought up in the discussion was why M33 shows a radial break while the radial profile of the otherwise so similar galaxy NGC300 extends up to 10 scale-lengths. This problem leads to a discussion on the definition of the end of the disks. The agreement after the discussion was that we need to obtain kinematic observations in the outer parts, although that is observationally challenging. The different tracers can help us to understand the origin and evolution of the profiles. Second, there was a wide discussion on the origin of dust and metals. Pollution, accretion and in-situ chemical evolution might equally play a role in this. There was agreement that understanding the dust in the outer parts will help us to understand the origin of the breaks in the radial profiles. It became clear that the intergalactic UV background cannot be the only ingredient to produce the break in the galaxy radial distribution. It must; however, certainly play a role. Third, the session on the vertical distribution put into the picture the merging and internal processes in the disk as shapers of the outer disk. And finally, when discussing the role played by the interactions, it was obvious that one has to be careful, again, when defining a disk, since the accreted matter has different properties than that of the outer disk and there is evidence that there are no breaks in the radial profile when there are signatures of debris in the outskirts of galaxies. In summary, this field is becoming very active and multi-wavelength studies are necessary to understand the distribution of matter in the outer parts of disk galaxies. After the success of this meeting, it was proposed to have a second workshop to report on the state of the field in two or more years time. The workshop was sponsored by NOVA, NWO and the Lorentz Center.

IC 4200, a result of a major merger

In 2005 Serra has completed his work on the galaxy IC 4200 in collaboration with Trager, van der Hulst, Oosterloo and Morganti. This resulted in a paper accepted for publication on A&A and that will be published in 2006 (astro-ph/0602621). The paper focuses on the analysis of the HI and stellar prooperties of the galaxy in order to derive the formation history of the galaxy. In particular, by studying the morphology and kinematics of its large (60 kpc) and massive (8.5 billion solar masses) HI disk, the age of the stellar populations and the optical morphology, they were able to conclude that IC 4200 formed via a major merger between 1 and 3 Gyr ago.

PN Spectrograph project

2005 was a tremendous year for the Planetary Nebula Spectrograph project, an instrument-based study of the dynamics of early-type galaxies led by Douglas. Firstly, the NWO post-doc Lodovico Coccato (Padua) started work (April 1) and immediately began processing the backlog of data that had been collected hitherto. Later in the year, Edo Noordermeer of the Kapteyn Institute joined the team also, as a post-doc in Nottingham. Secondly, the construction of the Hα camera, carried out by RSAA (Mt Stromlo) in Australia, was started, and by the end of the year nearly completed. Thirdly, they came closer to completing the core-program observations of intermediate-luminosity ellipticals thanks to a 10-night joint UK/NL run at the WHT (1–10 April). The data reduction pipeline was completed and the object catalogue on the first of the core-program objects was compiled. In addition, an ESO proposal was accepted for long slit spectro-

scopy of some of the objects with FORS to obtain steller kinematics to assist in modelling the PN.S data.
Finally, the data reduction for the survey of the galaxy M31 (The "Andromeda galaxy") was completed for which observations had commenced in 2002. This project was a collaboration between the PN.S team (largely the work of the Nottingham PhD student Merrett) and a consortium led by Halliday and Carter of the Liverpool John Moores University (also in the UK). The joint goal was to look for kinematic structure in M31, such as streams, for evidence of satellite mergers and other kinematic events, and to test earlier claims of such structures. The LJMU team contributed accurate measurements of the positions and radial velocities of 723 planetary nebulae. The PN.S contributed a catalogue of 3300 radial velocities with slightly lower accuracy. These data sets have still to be fully exploited, but initial results show the value of such a comprehensive survey. For example, the data fill in gaps in phase space on the basis of which the existence of And~VIII, a putative object projected onto the disk of M31, had been claimed.

Besides working on the PNS Spectrograph project, Coccato continued the projects started in his PhD thesis. The principal points can be summarized as:
1) Measurements of the supermassive black hole mass in NGC 4435. This disk galaxy hosts a SMBH with a very low mass, if compared to the predictions of the M-sigma and the M-L scaling relations relations of galaxies. This poses new question marks on the existing relations between SMBH and physical properties of the hosting galaxies and/or the reliability of the gaseous kinematics as a good tracer for the SMBH mass determination. A paper has been accepted (astro-ph/0511696).
2) Study of the Circular-Velocity vs. Central-Velocity-Dispersion (V-sigma) relation. We compared the V-sigma relation of a sample of ellipticals and disk high surface brightness galaxies and low surface brightness galaxies. Apparently the LSB galaxies follow a different V-sigma relation, arguing against the relevance of baryon collapse in the radial density profile of the dark matter halos of LSB galaxies. A paper has been published (Pizzella *et al.* 2005, ApJ, 631, L785).
3) The study of inner polar disks and minor axis velocity gradients in spiral galaxies. Coccato *et al.* 2005, A&A, 440, 107. The bidimensional follow up is still in progress.

Extra-planar gas in disk galaxies

Barnabé, in collaboration with Ciotti (Bologna), Fraternali (Oxford) and Sancisi, continued his work on hydrostatic models for the rotation of extra-planar gas in disk galaxies. Constructing fluid stationary models based on baroclinic solutions, they were able to reproduce the observed negative vertical gradient of the rotation velocity of the extra-planar gas in spiral galaxies. This method was successfully applied to the lagging gaseous halo of NGC 891.

The study of gaseous halos

Oosterloo, Fraternali (Oxford) and Sancisi have continued their study of the HI structure and kinematics of the edge-on galaxy NGC 891 based on 21 cm line observations with the Westerbork Synthesis Radio Telescope. They have constructed 3-D models of disk and halo and derived the vertical gradient of the rotational velocity (decreasing with distance from the plane). They have also analyzed the cloudy and filamentary structure of the HI in the halo. A paper is in preparation.

Gas accretion in galaxies

Sancisi, Oosterloo and Van der Hulst have reviewed and discussed the evidence from HI observations on the gas infall in galaxies. They have drawn attention, in particular, to the large number of minor mergers and have attempted to estimate the rate of gas accretion in galaxies. A paper is in preparation.

High-velocity HI in spiral galaxies

Boomsma has nearly finished his thesis project (with Van der Hulst, Oosterloo (Dwingeloo), Sancisi and Fraternali (Bologna)) on the vertical structure and kinematics of HI gas in spiral galaxies. In particular two galaxies have been studied in detail, NGC 6946 and NGC 253. Last year he has used to analyse the results about the high-velocity HI in NGC 6946.
The thesis concentrates on deep HI observations in the nearby face-on spiral galaxy NGC 6946. In this galaxy large complexes of kinematically anomalous HI have been detected as well as a large number of HI holes. Most of the anomalous HI seems to be located in the halo and rotates more slowly than the HI in the disk of NGC 6946. In addition, vertical flows of HI have been detected in the direction of star forming regions. The HI halo, the massive star formation in the disk and the HI holes seem intimately linked. Furthermore, a plume of HI is seen at the edge of the disk which can be interpreted as the aftermath of an accreted HI cloud or small companion. The high-velocity HI complexes in NGC 6946 may be analogous to the High-Velocity Clouds in the Milky Way.

Rotation curves and mass distribution in early-type disk galaxies

Noordermeer completed his PhD thesis research on the rotation curves and mass distribution in early-type disk galaxies, under supervision of van der Hulst, Sancisi and van Albada. From a combination of Westerbork HI observations and optical spectroscopic data, rotation curves were derived for 19 S0 and Sa galaxies. Most of these systems were found to have declining rotation curves, with the outermost velocity typically 10-20% lower than the maximum. More massive systems have typically more strongly declining rotation curves.
The peculiar shape of the rotation curves was found to have important consequences for the location of these galaxies on the Tully-Fisher relation. In

the traditional formulation of the Tully-Fisher relation (using the maximum rotation velocity), the early-type disks with rotation velocities larger than 200 km/s lie systematically to the right of the relation defined by less massive and later-type systems, causing a characteristic 'kink' in the relation. However, this offset disappears almost entirely when, instead, the lower velocity in the outer regions is used as kinematic parameter. This result strengthens the view that the Tully-Fisher relation fundamentally links the mass of dark matter haloes with the total bayonic mass embedded in them.
The rotation curves were also decomposed into contributions from stellar bulges and disks, gas and dark matter. Strong indications were found that the stellar bulges are 'maximal' and dominate the gravitational potentials in the inner regions. Unfortunately, the contribution of the stellar disks is poorly constrained, hampering an unambiguous determination of the dark matter content. By considering the maximum and minimum disk mass-to-light ratios consistent with the observed rotation curves, lower and upper limits on the dark matter content were determined respectively.

Ultra Luminous Infra Red Galaxies

Loenen has started his PhD research in September 2005 under the supervision of Baan (ASTRON, Dwingeloo) and Spaans. The scientific aim is to study the cores of Ultra Luminous Infra Red Galaxies (ULIRGS). This requires both observations and simulations of the dust and molecular gas in ULIRG cores. The observations and models provide constraints on the energy sources that power active galaxy cores: massive star formation or active galactic nuclei. The research has focused so far on the IR emission of dust surrounding a region of active star formation. In order to study the evolution of these dust enshrouded star formation regions, a model has been created, using available stellar evolution and radiative transfer codes. The model has been calibrated using IRAS data. Also, a database containing observations of molecular emission lines (e.g. HCN, HNC, CO, HCO+) emanating from (U)LIRGS has been made. These data provide input for detailed theoretical modelling. This part of the project is done in collaboration with Henkel (MPIfR, Bonn) and Meijerink (Leiden).

Shell galaxies

In 2005, Sikkema *et al.* submitted a paper about globular clusters in six shell galaxies, observed in V and I by ACS on board of the HST. Shell galaxies are a class of elliptical galaxies which are thought to be remnants of a recent minor or major merger. The colors of the globular clusters and shells might tell us something about whether any stars were formed during the merger. They found that the globular cluster properties of two galaxies (NGC 2865 and NGC 7626) shows indications for recent GC formation. This is inferred from the quite blue NGC 2865, while NGC 7626 shows much brighter GCs compared to other elliptical galaxies.
A second paper about the colors of the shells and dust content is in the making.It was found that V-I colors have the same or redder colors than the underlying galaxy light. This is probably best explained by dust being present

in the shell regions. Sikkema's previous findings of large-scale red rings (0.05 mag higher in V-I than their surroundings) in the V-I color maps of NGC 474 and NGC 3923 had to be withdrawn. Comparison with ground based VLT FORS2 data do not show these rings. Since the rings are already visible in the raw HST data, it is concluded that the rings are likely caused by reflections in the optical system of HST.
It was also found that visible dust is probably more prevalent in shell galaxies. Visible dust is normally seen in about half of all elliptical galaxies, while dust is seen in all six shell galaxies belonging to the HST_ACS sample. It is concluded that merger events probably encourage dust prevalence.

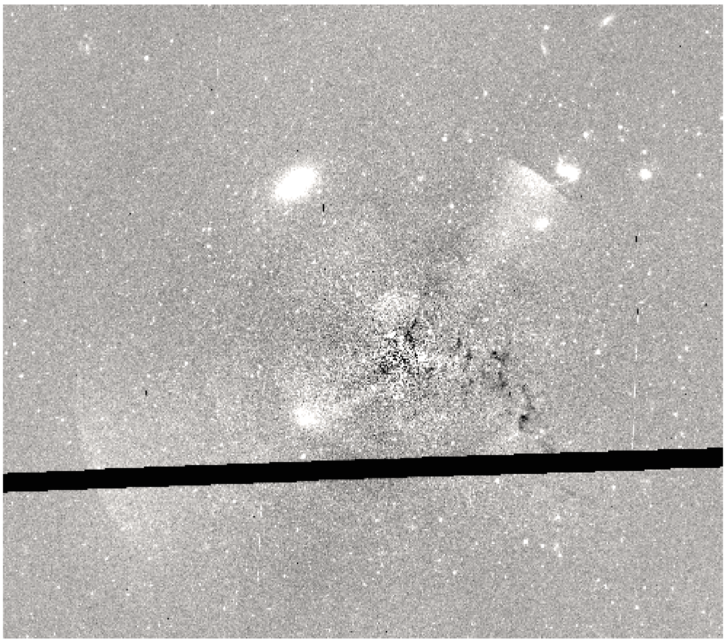

Figure 11: Galaxy subtracted inner region of NGC 7626. Globular clusters, dust and two bright shells are visible.

Ellipticals in the Virgo Cluster

Yamada, Arimoto (both Tokyo), Vazdekis (IAC) and Peletier have determined spectroscopic ages of elliptical galaxies in the Virgo Cluster using spectra of very high signal-to-noise ratio (S/N > 100 Å^{-1}). They observed eight galaxies with the Subaru Telescope and have combined this sample with six galaxies previously observed with the WHT. To determine their ages, they have used a new method based on the $H\gamma_{\sigma}$ age indicator, which is virtually independent of the effects of metallicity. Apart from ages, abundances of various elements were determined. A paper has been published in MNRAS in 2006.

From Nov. 2004 to May 2005 E. Kutdemir (PhD student from Ankara, Turkey) visited the Kapteyn Institute. She worked with Peletier on defining new absorption line indices to be used for stellar population synthesis. To do this, she used the spectra from the new stellar library MILES, which were recently prepared by P. Sánchez-Blázquez while visiting Peletier in 2004.
From July 15 – Oct. 15 C. Carretero (IAC) visited the Kapteyn Institute on a EU Marie Curie visitor grant for PhD students through NOVA. During these three months he worked with Peletier on continuing the work of Kutdemir to define a new system of absorption line indices in the blue, to be used to measure ages and metallicities of galaxies at high redshift. A set of 10 indices were defined which either depend only on metallicity or only on age.

The Cluster project

With an approved Large Programme at the Westerbork observatory, Verheijen has consolidated his research program to image the cold HI in and around two galaxy clusters at z ~ 0.2 in collaboration with van Gorkom (Columbia University/RUG), Szomoru (JIVE, Dwingeloo), Dwarakanath (RRI, Bangalore), Poggianti (Padova) and Schiminovich (Columbia University). Abell 963 is a massive Butcher-Oemler cluster at z = 0.206 with a large blue fraction of 19% while Abell 2192 at z = 0.188 is a more diffuse and less massive cluster. The large field-of-view of the WSRT and the broad bandwidth of the new back-end allows a study of the clusters proper as well as the large scale structure in which these clusters are embedded, with a total surveyed volume of 7×10^4 Mpc^{-3}. Pilot observations taken in 2005 have revealed 41 detections of HI emission, 21 in A963 and 20 in A2192. The HI detected galaxies in A963 are mainly located to the NE of the cluster core, with the bulk of the HI-rich galaxies at slightly larger redshifts. Apparently, a significant group of galaxies is about to fall into this massive cluster, possibly related to the large fraction of blue galaxies in its core. In the case of A2192, the HI-rich galaxies are more uniformly distributed in the observed field. Additional HI data to be collected in the coming years are expected to reveal about 200 HI-rich galaxies in and around these clusters. This will allow the study of the amount of cold gas of the blue galaxies in the cluster cores and the surrounding field in relation to their global and local environments and the evolutionary state of their stellar populations.

HI studies of Virgo Cluster Galaxies

Oosterloo (ASTRON/RuG) and van Gorkom have discovered a very large plume of HI near the centre of the Virgo Cluster. This cloud is 110 × 25 kpc in size and contains 3.4×10^8 solar masses of HI. The morphology and kinematics of this cloud strongly suggest that it consists of HI removed from the galaxy NGC 4388 by ram-pressure stripping. Instead of being the result of an interaction of the ISM of NGC 4388 with the hot cluster halo centred on M87, it is more likely to be due to stripping by the hot gas of the M86 group. The large extent of the plume suggests that gas stripped from cluster galaxies can remain neutral for at least 10^8 yr. Locally, the column density is well above 10^{20} cm^{-2}, suggesting that the intra-cluster HII regions known to exist in Virgo may have formed from gas stripped from cluster galaxies. The existence of the HI plume suggests that stripping of infalling spirals contributes to the enrichment of the ICM.

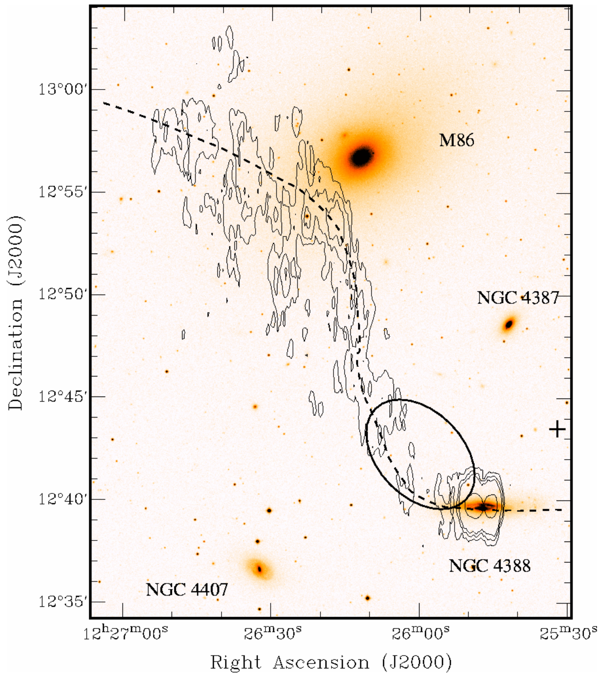

Figure 12: The HI tail of more than 100 kpc long detected in the Virgo cluster (blue) superposed onto an optical image. The spiral galaxy just below the centre of this image is the spiral galaxy NGC 4388, while the bright elliptical galaxies are M86 (left) and M84 (right). The tail most likely consists of gas stripped from NGC 4388 by the hot gaseous halo of M86.

Properties of galaxies

Obrić started a revised PhD project in August 2005, with new supervisors, J. Dalcanton (Washington) and Ž. Ivezić (Washington). A new collaboration was initiated with A. West (University of California, Berkeley). van der Hulst stayed on as her promotor at the Kapteyn Institute. The new project has a general basis in the paper Obrić et al. "Panchromatic Properties of 99,000 Galaxies Detected by SDSS, and (some by) ROSAT, GALEX, 2MASS, IRAS, GB6, FIRST, NVSS, and WENSS Surveys" (submitted to MNRAS), and focuses on possible explanations of mass/rotational velocity bimodality of galaxies and its origins, using SDSS, HI and 2MASS data. She has finished coding scripts for the automatic data processing and created optical-NIR false-color images of a sample of edge-on galaxies which are used in one of the ongoing projects for her thesis.

Stellar populations of galaxies near and far

Trager continued his study of the stellar populations of early-type (elliptical and lenticular) galaxies. By exploiting very-high-signal-to-noise spectra of early-type galaxies in the Coma Cluster, he found that while hot, evolved stars are present in all of these galaxies, all of these galaxies also require at least small amount of recent (last few billion years) star formation to explain their strong absorption lines. This indicates that early-type galaxies in clusters are not old, dead objects that formed all of their stars at very early times, but rather experience a more violent history, with star formation continuing into the recent past. These results were published as Trager *et al.* (2005), in collaboration with Worthey (Washington State), Faber (U. of California Observatories/Lick Observatory), and Dressler (The Observatories of the Carnegie Institution of Washington).

The IMF in starburst environments

Spaans, in collaboration with Klessen (Heidelberg) and Jappsen (Potsdam) have investigated the initial mass function (IMF) in interstellar environments that are exposed to intense radiation and exhibit large densities. Such extreme environments include the nuclei of starburst galaxies and the center of our Milky Way.
It is found that the equation of state in such environments is very stiff and causes interstellar gas to heat up under compression. This prevents gas clouds to fragment significantly. Detailed hydrodynamical simulations of gravo-turbulent fragmentation then lead to the result that the IMF in starburst nuclei deviates from the typical Salpeter shape and exhibits a deficit of stars below 5 Solar masses. Such a top-heavy IMF is likely to persist for only a brief time and is likely to be induced by the energy output (feedback) of an active galactic nucleus.

3.3 Quasars and Active Galaxies

Low redshift QSOs

Low redshift QSOs are being investigated by Barthel and co-workers, targeting the symbiosis of accretion driven energy production and host galaxy star formation. Radio and optical imaging is being combined with molecular gas spectroscopy: an extensive census of molecular gas in nearby QSO Hosts with the 30m IRAM telescope will be carried out. Analysis of the radio and far-infared properties indicates that the host galaxies of QSOs cannot be quiescent galaxies, but must be in the process of the formation of stars. Together with Sanders (Honolulu) Barthel organised a successful workshop on the topic of QSO Host Galaxies, in the Lorentz center (Leiden, August).

Star-formation and nuclear activity in more distant galaxies is being investigated together with Garrett (JIVE, Dwingeloo) and PhD student Chi. Target of research are HDF galaxies, and ultra-sensitive VLBI is being employed.

Radio properties of LINER galaxies

Barthel is collaborating with Ho (Carnegie Observatories) and Filho (Porto) in a study of the radio properties of LINER galaxies, objects displaying a mild form of nuclear activity. High resolution radio observations (VLA, MERLIN, VLBA, and EVN) are being employed to assess accretion driven energy production in galaxies, which is likely to be widespread. A paper describing the radio luminosity function of galaxies down to very low radio flux densities was completed. The radio data are being supplemented with X-ray as well as optical data. A collaborative effort with Groningen staff member Peletier and the SAURON group led by De Zeeuw (Leiden) in this respect is also being continued.

Extremely high redshift QSOs

The search for extremely high redshift QSOs, being conducted in a collaborative effort with Neeser (Munich) and Maza (Santiago), is continuing. Analysis of VLT spectroscopy of two dozen candidate faint ultra-distant QSOs is underway.

Far-IR properties of AGN

Barthel and co-workers are continuing their study of the far-IR properties of AGN. IRAS and ISO data will be supplemented with data to be obtained with the Japanese Akari mission: Barthel is taking part in a British-Groningen consortium collaborating with the Japanese Space Agency JAXA. A PhD student will be appointed shortly: he will work with these Akari data as well as with data from the new VISIR infrared instrument on ESO's VLT.
Studies of the host galaxies of compact powerful radio sources, constraining evolutionary models for these objects, are being continued, in collaboration with De Vries (Livermore), O'Dea (STScI), Hunstead (Sydney), and graduate student Labiano (Baltimore/Groningen). Labiano will defend this PhD thesis in early 2006.
Barthel is spending an increasing amount of his time on the Herschel Mission, ESA's far-IR and submm space telescope, as one of the Mission Scientists in the Herschel Science Team. This 3.5m telescope, with planned launch in 2008, will open up the Universe in the 200–600 micron domain.

Very low polarization in Abell 2256

Brentjens and de Bruyn obtained WSRT observations of Abell 2256 at 350 MHz, that show hardly any polarization, even after RM-synthesis. This suggests that there is severe internal Faraday rotation inside the relics in the cluster periphery. They can use this observation to estimate the thickness of the relic along the line of sight.

Stars, gas and dust in the host galaxies of compact extragalactic radio sources

Recent studies have identified the GHz Peaked Spectrum (GPS) and Compact Steep Spectrum Sources (CSS) radio sources as the most likely candidates for the progenitors of large scale powerful radio sources. According to these studies, GPS evolve into CSS and these into FR I or FR II. However, for this evolutionary sequence to work, GPS and CSS sources must undergo changes along their evolution. Interaction between the radio source and the host galaxy may be responsible for these changes. The thesis of Labiano (finished in 2005) focuses on the study of this interaction and how it affects the evolution of the host galaxy and the radio source.

Fast neutral outflows in powerful radio galaxies: a major source of feedback in massive galaxies

Morganti, Oosterloo, Emonts and Tadhunter (Sheffield) have, profiting from the improved capabilities of the upgraded Westerbork Synthesis Radio Telescope, discovered fast (~1000 km/s), massive outflows of neutral gas in a number of radio-loud AGN. These outflows are observed as 21-cm HI absorption against the strong radio continuum. The neutral outflows occur, at least in those cases where the location could be determined, at kpc distance from the nucleus. They are most likely driven by the interactions between the expanding radio jets and the gaseous medium enshrouding the central regions. The estimated mass outflow rates are up to ~50 M_{sun}/yr, comparable (although at the lower end of the distribution) to the outflow rates found for starburst-driven superwinds in Ultra Luminous IR Galaxies (ULIRG). This suggests that massive, jet-driven outflows of neutral gas in radio-loud AGN can have as large an impact on the evolution of the host galaxies as the outflows associated with starbursts. A radio-loud phase of the AGN is likely a relatively common, albeit short, phase in the life of many (or even all) massive ellipticals. Jet-driven neutral outflows may represent one of the main feedback mechanisms controlling the evolution of these galaxies.

Origin and Evolution of Radio Galaxies

Emonts continued his PhD work on the origin and evolution of radio galaxies observed with HI observations and optical spectroscopy under supervision of Morganti and van der Hulst. In collaboration with Tadhunter, Oosterloo and Holt (Sheffield) they published a detailed study of the ionized gas in radio galaxy 3C 293. The disturbed kinematics and ionization-state of the gas show clear indications of jet-driven outflows (up to 1000 km/s) in the central region of this nearby powerful radio galaxy. This outflow resembles a similar outflow found in HI (Morganti *et al.* 2003, ApJ, 593, L69). Detailed analysis of this outflow shows that, despite the high energies involved in the jet-ISM interaction, most of the

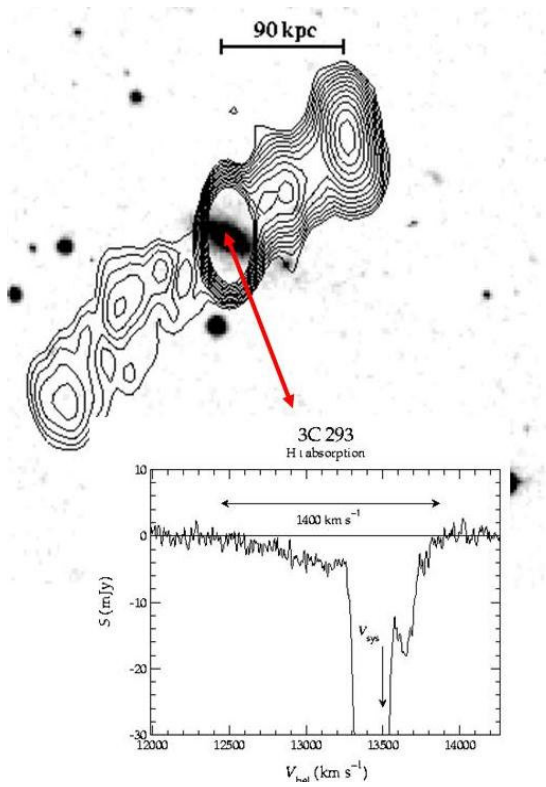

Figure 13: The radio galaxy 3C293 observed with the WSRT: (top) radio continuum (contours) superimposed to an optical image, (bottom) the HI profile observed against the central region. The newly discovered broad (1400 km/s), blueshifted wing is clearly visible.

outflowing gas is in its neutral state.

Emonts, Morganti and van der Hulst, in collaboration with Tadhunter, Oosterloo, Wills (Sheffield) and van Moorsel (Socorro), also continued their work on the origin of radio galaxies. They completed HI observations of a complete sample of 22 nearby radio galaxies (compact and FR-I) in order to trace and date long-lived merger structures. In 25% of the sample sources HI is detected in emission around the host galaxy. In most of these cases the HI is fairly settled in large disks, up to 190 kpc in size. The regular kinematics imply that the HI structures are several Gyr old. It is striking that the most massive HI disks (of about 10^{10} solar masses) are only found around compact radio sources, while the more extended FR-I-type radio sources do not show these large amounts of HI. With the modeling of optical long-slit spectra the stellar populations have been examined in these HI-rich radio galaxies. Some of the radio galaxies contain a post-starburst stellar population, which age is in agreement with the age of the HI disks. These systems are the likely result of a major merger event. Given the relatively young ages of the radio sources, the current phase of radio-AGN activity occurred very late in the lifetime of the merger. However, there are also HI-rich radio galaxies that contain only an old stellar population. A major merger origin is therefore not obvious for all the HI-rich radio galaxies.

Radio galaxy MRC 2104

Villar-Martin (IAA), Sanchez (Calar Alto), de Breuck (ESO), Peletier *et al.* present a kinematic and morphological study of the giant Lyα nebula associated with the radio galaxy MRC 2104-242 ($z = 2.49$) based on integral field spectroscopic VIMOS data from the VLT, and a photometric study of the host (proto?) galaxy based on Spitzer Space Telescope data. The galaxy appears to be embedded in a giant (>~120 kpc) gas reservoir that surrounds it completely. The kinematic properties of the nebula suggest that it is a rotating structure, which would imply a lower limit to the dynamical mass of $\sim 3 \times 10^{11}$ $M_\odot$. An alternate scenario is that the gas is infalling. Such a process would be able to initiate and sustain significant central starburst activity, although it is likely to contribute with less than 10% of the total stellar mass. A paper has been published in MNRAS in 2006.

XDRs in Active Galactic Nuclei

X-ray dominated regions (XDRs) are regions in the ISM where the hard radiation field of an accreting black hole completely determines the temperature and chemical composition of interstellar gas. As such, XDRs are direct manifestations of the energy balance of interstellar gas and their study allows one to determine how the ISM survives the accretion of gas by a central black hole. X-ray photons from nearby sources heat through photo-ionization and dissociate the gas by UV emission from collisions of H and H_2 with secondary electrons.
Fine-structure lines of [OI] and [CII] as well as molecular emission of, e.g., CO and H_2O provide cooling. Spaans and Meijerink (Leiden) have continued their investigation of XDRs and have developed a set of models that allow the modelling of the HCN and HNC line emission of active galaxies. It turns out that an HNC/HCN emission line ratio of larger than unity (for $J = 1,2,3,4$ as the rotational upper state) is an excellent indicator for the presence of an embedded active galactic nucleus.

3.4 High-Redshift Galaxies and Large Scale Structure

Weak gravitational lensing

Christen has continued his PhD project focused on weak gravitational lensing studies using different point spread function (PSF) correction techniques. These techniques are based on the KSB method (Kaiser Squires & Broadhurst,

1995) and shapelets decomposition (Refregier, 2003) of objects image. He has extracted from 50 VLT FORS I reduced data a significant galaxy-galaxy lensing signal and has described from these results an averaged characteristic lens galaxy using standard singular isothermal sphere (SIS) and NFW (Navarro, Frenk & White, 1995) models. The results are in accordance with these ones found in the litterature. The particularity of this conclusion is that, PSF correction performed with shapelets, produced similar results with less noise. The theory predicted this behavour and has been confirmed by this work.
Christen has developed a new technique to measure the charge transfer efficiency (CTE). It is based on the change in variance with CCD rows and columns in simple flat-field images and uses the fact that imperfect charge transfer during readout has a smooth effect on the final image. He has also adjusted the standard photon transfer curve technique to 2 time delay integration (TDI) images to measure rapidly with a high level of confidence the conversion factor. These studies plus the work performed during the first part of his PhD on OmegaCAM CCDs testing have been rewared during the scientific detector workshop for astronomy 2005 (SDW, Taormina, 2005). He has received the award of Young Achiever 2005.

Determining the internal mass structure of early-type galaxies

Koopmans is continuing his work on determining the internal mass structure of early-type galaxies to z=1, using joint constraints from strong gravitational lensing and stellar dynamics, and strong lensing in general, in collaboration with his PhD students (Berciano-Alba, Barnabe and Vegetti) and colleagues in the US and Europe. He is also involved in the EoR Key Project of LOFAR in collaboration with a PhD student (Labropoulos) and colleagues at the Kapteyn Institute and ASTRON (Dwingeloo).

Combining gravitational lensing and stellar dynamics

Barnabé has started his thesis research under the supervision of Koopmans. The aim of the project is to constrain the stellar and dark matter mass distribution and the evolution of early-type galaxies beyond the local universe (up to a redshift $z \approx 1$), through the combination of gravitational lensing and stellar kinematics.
To this end, they have been working on the development and implementation of the modeling code needed to carry on the joint and fully self-consistent analysis of lensing (from HST) and 2D kinematic (from Keck/VLT) data sets. The lensed image reconstruction is based on the non-parametric lens method developed in Koopmans (2005), while the dynamical modeling makes use of the two-integral Schwarzschild method techniques developed in Verolme & de Zeeuw (2002), which were further extended and sped up by several orders of magnitude through a new Monte-Carlo approach. The relative probability for different mass models parameters is evaluated through a Bayesian analysis.

Strong gravitational lensing effect in the radio domain

Berciano-Alba started as PhD student on december 1th 2005 granted by the ANGLES network (Astrophysics Network for Galaxy Lensing Studies). Under the supervision of Garrett (JIVE) and Koopmans, she is studying the strong gravitational lensing effect in the radio domain from two different points of view: as a phenomenon itself, invesigating the problem of the flux-ratio anomalies, and as a tool to study the sub-mm starburst population at high redshift (taking the advantage of the high magnification provided by clusters of galaxies).

Kinematic Imaging of the cosmic HI web

Popping started his PhD project on August 1, 2005 under the supervision of Braun (ASTRON) with van der Hulst as promotor. Numerical simulations and QSO absorption lines predict a filamentary distribution of HI gas with low column densities. These filaments form a Cosmic Web, of which the galaxies are the brightest parts. This phenomenon is at all redshifts, so can be observed at low redshift if sensitivity is high enough. Two complimentary initiatives should lay the groundwork for a comprehensive study of the Cosmic Web phenomenon and provide strong constraints on cosmological models of galaxy evolution. The first one is a complete reprocessing and analysis of the recently published HI Parkes All-Sky Survey (HIPASS). The second initiative involves a novel and extremely sensitive method for detection of faint HI emission features which employs the WSRT to simulate a filled aperture of 300×25 m by observing at low declinations.

The Epoch of Reionisation

The Epoch of Reionization (EoR) is a term used to describe the period during which the gas in the Universe went from being almost completely neutral to a state in which it became almost completely ionised. This watershed event – which has occurred when the Universe was a few hundred million years old (about a twentieth of its current age) and the first radiating objects formed – is intimately linked to many fundamental questions in cosmology and structure formation and evolution. Without a clear understanding of the EoR, we will not fully apprehend how the Universe evolved from its primordial condition to form the astrophysical object we routinely observe today.
Despite its pivotal role, the EoR is one of the least understood epochs in the Universe's evolution. A large amount of theoretical effort, guided by very limited observational evidence, is currently dedicated to understanding the physical processes that trigger this epoch, govern its evolution, and what ramifications it had on subsequent structure formation. In the near future, the LOFAR telescope, which has the EoR as one of its key projects, is set to measure the neutral gas fraction in the Universe as a function of redshift and angular position through the hydrogen hyperfine spin-flip 21 cm line. The 21 cm line is, probably, the only observable tracers of the gas during the EoR. It allows detailed mapping the EoR as it progresses in time and space.
Currently, Zaroubi's (together with de Bruyn and Koopmans) main objective is to develop the necessary data-analysis and theoretical tools to, initially, prepare

the ground and, subsequently, fully exploit the LOFAR-EoR data set, expected to be available within 2-3 years. The synergy between three independent areas of expertise: theory, observation and data analysis, will facilitate addressing the fundamental EoR related questions.
Zaroubi and J. Silk (Oxford) have proposed use of the thickness of the ionisation front as a discriminant between alternative modes of reionization in the early universe, by stars or by miniquasars.

Simulation of 21-CM EoR Signals

Thomas has started his PhD thesis under the supervision of Zaroubi. He is part of the LOFAR-EoR theory group assigned the task of generating simulated LOFAR data with realistic 21-cm signals from the EoR, foregrounds, instrumental response, noise, etc. Currently, they have made progress in their efforts to generate the ionization signal produced by (mini-)quasars ($10^{(40\text{-}46)}$ ergs/sec), during and in between their active periods. A one-dimensional radiative traport code has been developed and tested and currently they are writing a paper summarizing our finddings with regard to teh influence of the (mini-)quasars on the ionization and heating of the inetrgalactic medium.
The next step in the plan is to produce semi-analytical models for the influence of these objects on the ionization of the IGM. The semi-analytical models for miniquasars and and POP-III and POP-II stars (for example following Sugiyama, Zaroubi and Silk 2002) will be implemented on N-body simulations in order to produce 21 cm sightlines with realistic emmission/absorption by the IGM. This would form the approximate 21-cm signature they are looking for various reionization scenarios.

Matter power spectrum at small scales: Estimation from the Lyman-alpha forest

Zaroubi, A. Nusser (Technion, Haifa), M. Viel, M., Haehnelt and T.-S. Kim (IoA Cambrirge) have measured the matter power spectrum on small scales from 33 Lyman-alpha spectra spanning the redshift range of 1.5–3.5. The optical depth for Lyman-alpha absorption of the intergalactic medium, obtained from the flux using the inversion method of Nusser & Haehnelt, is converted to density by using a simple power law relation. The authors find that a CDM power spectrum amplitude is $0.78 < \sigma_8 < 0.98$ (with 3σ confidence level) consistent with previous measurements. The authors also argue that the data support a non-adiabatic temperature evolution at certain stages, consistent with full helium reionization at about $z = 3$.

On the density and velocity correlation functions

Zaroubi and E. Branchini (Roma) have introduced a simple linear equation relating the line-of-sight peculiar-velocity and density contrast correlation functions. Estimation of the cosmological density parameter with this equation from the Point Source Catalogue Redshift (PSC) survey and the SEcat catalogue of peculiar velocities is consistent with $\Omega = 0.3$. The applicability of the method to future data set is discussed.

The 2dF Galaxy Redshift Survey: Wiener reconstruction of the cosmic web

Zaroubi, P. Erdogdu (Cambridge), O. Lahav (UC London) and the 2dF collaboration, have reconstructed the underlying density field of the Two-degree Field Galaxy Redshift Survey (2dFGRS) for the redshift range $0.035 < z < 0.200$ using the Wiener filtering method. They identify all major superclusters and voids in the survey. In particul ar, they find two large superclusters and two large local voids.

Redshift estimation of clusters by wavelet decomposition of their Sunyaev-Zel'dovich morphology

Zaroubi, B. Schaefer and C. Pfrommer have proposed a method for estimating redshifts of galaxy clusters based solely on resolved Sunyaev-Zel'dovich (SZ) images. Given a high-resolution SZ cluster image (with a FWHM of ~1arcmin), the method indirectly measures its structure-related parameters (amplitude, size, etc.) by fitting a model function to the higher-order wavelet moments of the cluster's SZ morphology. This type of estimation is expected to be very valuable once SZ cluster surveys start collecting data (of the order of 10000 clusters) for which individual spectroscopic follow-ups are prohibitively telescope-time consuming.

The VESUVIO project

Using the Astrowise System, Sikkema also largely finalised the reduction of a four square degree area observed in V, R, I with the WFI@2.2m at La Silla. These observations cover several clusters and empty regions near z = 0.1. The goal will be to study galaxy evolution in different environments and is part of the VESUVIO (Vst Exploration of SUperclusters, Voids and Intermediate Objects.) project. An automated version of an ellipse fitting tool has been developed to study the detailed morphology of the thousands galaxies observed in the observed fields.

The Cosmic web and its void outlinings

Platen started his Phd in March 2005, under the supervision of van de Weygaert and Sheth (UPenn, Philadelphia). The project focusses on the role of voids in the evolution of the cosmic web. It follows up on and extends the study by Sheth and van de Weygaert (2004) on the hierarchical evolution of the void population in the cosmic matter distribution within the context of theories of gravitational instability.

Watershed Identification of voids

The first stage of the project concerned a study of the evolution of the void population in large N-body simulations of cosmic structure formation. Platen developed an algorithm to identify voids within the mass distribution along the lines of the watershed algorithm. The underlying density distribution is the one inferred on the basis of the DTFE method of Schaap and van de Weygaert. It was found that the population of small collapsing voids should mainly be identified with that of anisotropically sheared voids near the transition regions between voids and the surrounding medium-density filaments and walls. Even though the absolute sizes differ, the inferred void size distribution resembles the peaked void size distribution implied by the work of Sheth and van de Weygaert. The distribution indeed includes a small void cutoff.

Alpha shape analysis of the cosmic web

Together with Eldering, Kruithof, Vegter, and van de Weygaert, Platen has been working on the translation and implementation of *alpha-shape* analysis of the cosmic matter distribution. Alpha-shape theory has been developed through the work of Edelsbrunner and collaborators and forms the basis for an extensive theory and toolbox towards describing the geometric and topological properties of a spatial point distribution. Alpha-shapes represent the surfaces of natural subsamples of the Delaunay tessellation of a point set defined by means of a tetrahedron circumradius selection factor α. These fundamental constructs from the field of computational geometry has been shown to be of great use in various scientific fields, e.g. in the identification of protein folding. With this complex we can build a filtration on the delaunay triangulation that is sensative to the underlying cosmology. With an appropriate measure on this complex we are then able to characterize the geometrical and topological characteristics of surfaces defined by the given point distribution. The measures we use are the *Minkowski functionals*, and a set of topological measures which are known as *betti-numbers*. Our preliminary study of the *alpha-complex* and *betti-numbers* of a set of Voronoi clustering models was meant to select those parameters that turned out to be most sensitive while attempting to connect them to visually discernable and recognizable patterns. At the moment the results are reported in a publication, Vegter *et al.* 2006.

Peak patch void evolution description

Platen and van de Weygaert are working on a semi-analytic evolution model of the void distribution. We do this in the framework of the Peak-Patch formalism of Bond & Myers (1996a,b,c). The peak patch formalism represents a natural formalism to incorporate the anisotropic collapse of matter concentrations in the cosmic matter distribution. While it has been shown that the anisotropic collapse of overdensities leads to significantly different collapse times and histories with respect to equivalent spherical configurations (e.g Sheth and Tormen 1999), the expectation is this to be more extreme for voids. The forces in their interior remain dominated to a large extent by the external force field, whose anisotropic nature implies an strongly anisotropic evolution. This model provides us with the crucial connection between the analytical models and the results of N-body simulations. The spherical collapse model plus binary inclusion has been implemented, which reproduced the correct results as compared to the original paper. The elliptical model with voids, and a general inclusion-exclusion algorithm has to be implemented, but is straigthforward generalization of the existing algorithm. The mock catalogues produced by this method are of immediate use, they represent an easily computable and natural way of connecting the voids observed in the galaxy redshift surveys with those seen in large N-body simulations of structure formation. Figure 14 shows a slice through one of such a halo mock catalogue, as generated from the program. The displacement vectors, and the final size and position of the haloes in Eularian space is plotted.

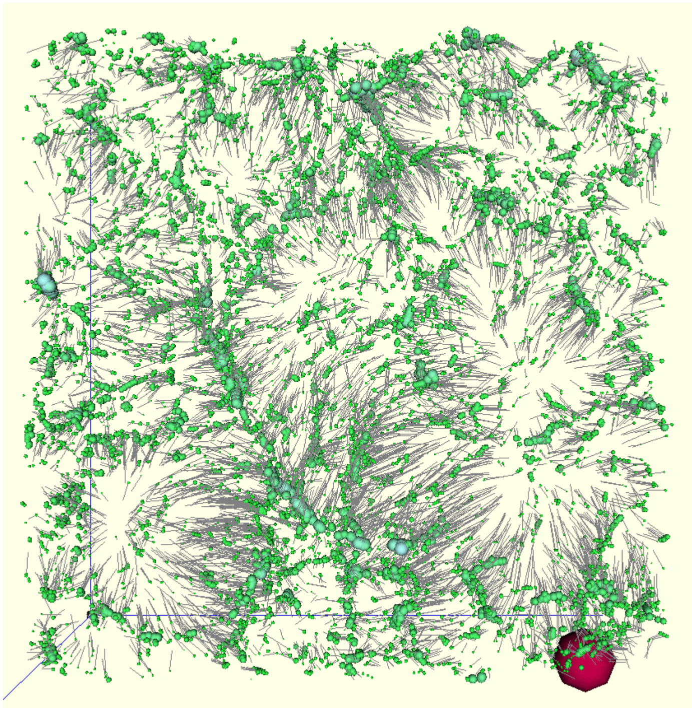

Figure 14: Structure in simulation to study formation of voids. For explanation see text.

The morphological characterization of the cosmic web

During the last year Aragon Calvo worked on the morphological characterization of the cosmic web using a set of filters decribed in a paper to be submitted soon. The analysis was applied to N-Body simulations as well as real galaxy catalogues (SDSS) with excellent results. This morphological analysis allows the separation of the cosmic web into its components (Clusters, Filaments, Walls and Voids) providing with a powerful tool for the study of the properties and dynamics of the Large Scale Structure. During the summer of 2005 he participated in the summer school "Panchromatic view of the Universe" in Puebla, Mexico. After that he visited JHU, Baltimore in order to continue with a collaboration with A. Szalay. In January 2006 he was invited to visit Durham in order to give a talk on his work. Also on March he gave a talk at the Jiwsaw workshop in Leiden. He was invited to participate on the "Cosmic Voids" workshop in Aspen celebrated in June 2006, the feedback from these presentations was very positive. Currently he is writting his thesis in order to defend before the end of the year.

Large-scale structure

Scientific work of van de Weygaert concentrated on the
– (with E. Platen:) Study of the evolving hierarchy of voids in gravitational instability scenarios. Part of the research project focusses on the analysis of large N-body simulations of cosmic structure formation, and seeks to identify the nature of collapsing voids. Their anisotropic collapse is formalized within a low-density version of the analytical peak-patch model of Bond & Myers, the void-patch model (in collaboration with B. Jones, Groningen and R. Sheth, Philadelphia)
– HI (WSRT) and UV (GALEX) study of a sample of void galaxies, selected from the SDSS galaxy redshift survey by means of the MMF technique (see later) such that they are very near the interior of voids. Target is to relate the condition of gas layers in supposedly pristine circumstances with star formation activity, in order to see whether void galaxies are indeed significantly different from "field" galaxies in filaments. Void galaxies form a major testing ground for galaxy formation implied by cosmic structure formation scenarios. Project in collaboration with Aragon, Platen, Kovac, van der Hulst, van Gorkom, J. Peebles, M. Vogeley and Sheth.
– A radio and optical study of galaxy spin alignments in and near the Perseus and Coma Supercluster (with Aragon & van der Hulst), in conjunction with a study of galaxy alignments in the cosmic web traced by SDSS (with Aragon, Szalay and van der Hulst). The MMF method (see above) is used to trace out the galaxies and filaments, their spin direction is correlated with the surrounding matter distribution.
– (with Aragon): N-body study of spin alignments in N-body simulations. it is part of a study of the dynamics and kinematics of the cosmic foam, allowed through the identification of filaments by means of the MMF. Results turn out to be significantly more pronounced than in conventional analysis.
– the development of the Delaunay Tessellation Field Estimator (DTFE) technique (with W. Schaap, Platen, Aragon and Jones) and the related higher order Natural Neighbour Field Estimator, using the as yet unreleased 3-D codes from the CGAL library (with G. Vegter, N. Kruithof, B. Eldering, E. Platen).
– the application of DTFE to pattern recognition in the 2dF and SDSS galaxy distribution, as well as in large N-body simulations of structure formation (with W. Schaap).
– the application of DTFE for the analysis of cosmic density and velocity fields in reconstructions of the Local Cosmic Neighbourhood, sampled by the PSCz catalogue (with Romano-Diaz & Schaap).
– the application of DTFE towards the identification of superclusters in te PSCz catalogue. Preliminary results show a significant different outcome in comparison to straightforward analysis on the basis of (radial) Gaussian smoothing. Collaboration with Romano-Diaz, Plionis & Basilakos.

– the application of DTFE to the analysis of density and velocity fields in large (GIF) N-body simulations, in order to find the characteristics of the cosmic web (with Schaap and Aragon-Calvo).
– (with Platen:) The development of a new void detection algorithm, based on the socalled *watershed formalism* from the field of computer visualisation. The input sample of N-body particles or galaxies is first translated into a density field by means of the DTFE method, subsequently this is used as input for the watershed analysis.
– (with G. Vegter, Platen and N. Kruithof): the description of the morphology of the cosmic foam by means of Alpha Shapes, a subset of the Delaunay tessellation of a point set parameterized by a radius α. After construction of the alpha shapes, the Betti numbers, a parameter series specifying the topology of the spatial point distribution is computed as a function of the parameter α. The alpha shape codes are part of the CGAL computation geometry library which we have started to apply to cosmic matter distribution.
– an investigation of the pattern recognition abilities of Delaunay and Voronoi tessellations and DTFE/NNFE (with Jones) and their relation to wavelet and other multiscale geometric methods (with V. Martinez, D. Donoho, J.L. Starck).
– (with Aragon:) Development of filament detection algorithm using the second order derivative of density field at a hierarchy of embedded scales, using the DTFE density field. The MMF (Multiscale Morphology Filter) has been applied and tested on Voronoi cluster models, and has demonstrated its ability in identifying clusters, filaments and sheets within a point distribution.
– (with S. Shandarin, Platen, Aragon and Jones) Implementation of DTFE density field method in a SURFGEN analysis code for determining the topological properties, c.q. Minkowski functionals, of a cosmic density field.
– Higher order clustering analysis of Voronoi kinematic clustering models.
– Using Voronoi kinematic clustering models as testbeds for a MCMC reconstruction technique of the cosmic web (with J. Moeller, V. Martinez, E. Vedel-Jensen, O. Skare). Parameterized models of point distributions around a Voronoi skeleton are used as prior in an MCMC analysis seeking to determine the most likely Voronoi tessellation from a sampled point distribution. The first models assumed uniform walls and/or edges, in the meantime more sophisticated descriptions are being tested.
– Investigation of infall and virialization of clusters in a set of dark energy dominated CDM models. Attempt to relate the pattern of infall and velocity flow (turnaround region vs. virialized region) in around clusters. With Araya, Jones, Aragon, Basilakos.
– Project started on the biasing properties of HIPASS galaxies. Attempt to relate bias to spatial distribution of galaxies in filaments and walls (with Aragon, Kovac, Basilakos, van der Hulst andJones).
– writing a review/summer school lecture notes on the use of Voronoi/DTFE techniques in astrophysics, for the summerschool on Astronomical Data Analysis held at UIMP, Valencia, September 2004.
– writing a review on clusters and the cosmic web, with J.R. Bond (CITA), for the GH2005 summer school lecture notes.

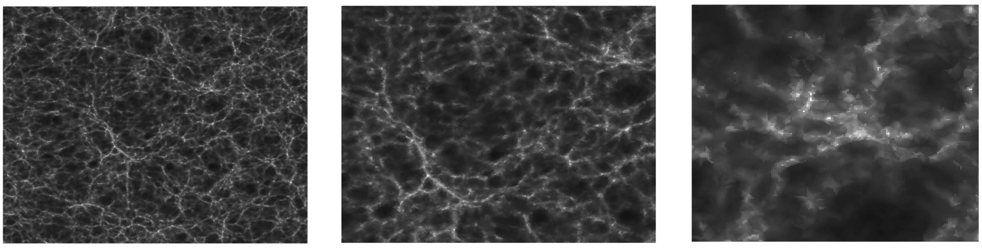

Figure 15: The Cosmic Web in a box: GIF N-body simulation of structure formation in a \LambdaCDM cosmology. Three consecutive zoom-ins onto a central slice through the simulation box. Courtesy: Willem Schaap.

Study of diffuse radio emission from clusters of galaxies

Pizzo started his PhD at the Kapteyn Institute on the first of July 2005. Since then he concetrated on learning the radioastronomical software Miriad. He started reducing the data set of Coma cluster, that is the first cluster of galaxies he will work on. His research project involves the study of diffuse radio emission from clusters of galaxies by means of the analysis of the polarized emission, its rotation measure distribution and the inferred magnetic field, that can tell us more about gasflows and shocks associated with the Large Scale Structure of the universe. The radio data have been obtained so far with the WSRT at low frequency (115–170 and 310–380 Mhz) and starting from 2007 the observations will be carried out with LOFAR in both its high (120–220 Mhz) and low frequency (30–80 Mhz) bands. So far Pizzo produced the total intensity maps of the eight filed of Coma at 139 Mhz.

Ultra-luminous infrared galaxies

In Taylor (Edinburgh) *et al.* (2005), Héraudeau and his collaborators reports on a search for the optical counterparts of 175 µm selected sources from the FIRBACK survey in the ELAIS N2 field. Applying a likelihood ratio technique to optical catalogues from the Isaac Newton Telescope (INT-WFS), they found optical identifications for 33 out of 55 FIRBACK sources. They have investigated the nature of this population through a comparison of their observed spectral energy distributions (SEDs) with predictions from radiative transfer models which simulate the emission from both cirrus and starburst components. They find the far-infrared sources to be 80 percent starburst galaxies with their starburst component at a high optical depth. The resulting SEDs were used to estimate far-infrared luminosities, star formation rates (SFRs), dust temperatures and dust masses. The N2 FIRBACK population is found to consist of four suspected ultraluminous infrared galaxies (ULIRGs) with $L_{FIR} \sim 10^{12}$ L and $SFR_{FIR} > 100$ M yr^{-1}, a number of luminous infrared galaxies (LIRGs) with moderate star formation rates and $L_{FIR} \sim 10^{11}$ L and a population of low-redshift quiescently star-forming galaxies. They also discuss the implications of these results for current evolutionary models.

Hercules cluster

Throughout 2005 Schneider has been working on the reduction of Hercules supercluster data from observations performed in 2004 with the 8K-widefield camera on the MDM 2.4 m telescope at Kitt Peak. 3.5 square degrees were observed in Harris B, Harris R and Gunn Z and about 1 square degree in Harris I during additional observations performed in January 2005 by Kamphuis. Reduction of this data is being performed by the Astro-Wise system, a reduction-pipeline designed for OmegaCam-observations and still under development.
Results from this data will be completed with results from other existing multi-wavelength surveys on the Hercules supercluster, like from 2MASS, Subaru and VLA and with planned observations like from XMM-Newton. Very important in the project will then be the connection between the cluster distribution and the overall matter distribution in the cosmic foam through the application of constrained random field codes.

Radial profile of stellar disks in galaxies at z ~ 1 from the UDF and the GOODS fields

Following the finding that a number of stellar disks at redshift ≈1 show radial profiles best fit by a double exponential (Pérez, 2004), Pérez and collaborators have carried out a campaign to derive the radial profiles of a sample of galaxies from the Ultra Deep Field (UDF). Of the 19 UDF galaxies, six show double exponential profiles. The results are compatible with the previous study and there is no clear evidence for disk evolution. However, they do not detect any galaxy with a break radius larger than 2.5 scale-lengths, unlike the local galaxies where breaks are found up to around 4 scale-lengths. The colours of the truncated galaxies seem to be bluer than those of 'untruncated' galaxies, suggesting a younger population. The ratio between the inner and the outer scale-length is 2.0±0.5 in agreement with the results from the previous sample from GOODS data.

3.5 Computing at the Kapteyn Astronomical Institute

Hardware

In 2005 the main focus of the computer group was again on the installation of reliable hardware and software for server machines. We purchased a new file server and a new web server and installed both with Linux RedHat Enterprise 4. The migration from old to new file server was prepared very carefully (lunch talk April 25) and went very smoothly (June 22). The new file server is faster, is a faster network connection and serves now only files from home directories and a single software partition.
A new web server was also necessary. The old server was the last server that did not operate from within the safe zone (firewall). A reverse proxy server was needed to enable traffic to and from the new web server now located in our

intranet. The migration was on Wednesday December 21 and went unnoticed by users.
Big storage servers seem to be the new trend in software for Astronomy. Data sources like the WSRT produce huge amounts of data which cannot be processed anymore on a standard desktop. A new storage server (Hercules01) with 4 Tb disk space was bought in January and was completely filled up before the end of the year. We ordered an extra 4 Tb disk space for expansion. With a new 48-port 1 Gb switch, one can read from- and write to Hercules from a desktop as fast as with a local disk.
In 2005 the maximum capacity of the central power supply in the Zernike building was exceeded twice causing power failures both times. After discussing our need for extra power in our server room in the near future, 'gebouwbeheer' decided to upgrade the supply. And finally this year our three oldest printers were replaced by new printers and new network connections were realized for rooms on the third floor with a new switch.

Software

After the installation of a number of new printers, we decided to reorganize the print system. A lot of the existing printer queues were removed and replaced by one queue per printer. We wrote a new printer tutorial for users and explained the new system and its options in a software lunch meeting. We advertised the use of so called printer instances to replace specialized queues for colors and transparencies. Also we explained users how important it is to print no more than the quota listed in our printer contract (much higher price per print). The new printer howto has been accessed almost 2000 times (more than all mail howto's together) in a period less than four months. In the first week of October, Vogelaar and Terlouw participated in an OPTICON (Optical Infrared Coordination Network for Astronomy) network meeting and attended the ADASS XV conference in San Lorenzo de El Escorial in Spain. In the first week of November we presented our impressions in a lunch talk under the title *Developments in Astronomical Data Analysis Software*. The discussion focused on OPTICON's requirements for a new interactive data analysis environment, against other options like existing systems based on Python. On the ADASS (Astronomical Data Analysis Software & Systems) conference, we contributed to the discussion about Linux in Astronomy with a talk about how to maintain a software environment for astronomy using RedHat Enterprise Linux.
The operating system of our desktops was migrated from RedHat Enterprise version 3 to version 4. This was an uncomplicated and straightforward operation. On behalf of the computer group, Trager organized a questionnaire in which he expressed the need for users to understand the constraints under which we run IDL. This software is very expensive and we cannot buy more licenses. Therefore we have to invest in alternatives. The computer group installed several alternatives like the GDL (GNU Data Language) and many scientific Python modules.
The software distribution model, based on RedHat's proxy server, works very well. With the current system it was possible to intensify the efforts to distribute more astronomical software. Two members of the computer group attended the LinuxWorld Expo in Utrecht on November 10. With representatives of Novell and SUSE-Linux, we discussed the option to replace RedHat's software

distribution system with a Novell/SUSE solution. We concluded that they offer an alternative but it is not (yet) as advanced as the RedHat version. The Expo also showed that Linux nowadays is considered as a serious alternative for enterprises.

Organization

There are several new options for creating backups. User data is divided into home directories (500 Mb per user), mail boxes and public_html files which have a backup every night on disk and a nightly mirror of local data disks on a local mirror disk. The tape robot is not longer available for backups. We also automated the backup of files for system management. New users are now provided with the '*new users guide'* which is a compilation of computer starter guides, tutorials and howto's. It includes also the '*Info book for newcomers'* which is maintained by the secretariat.

We finally got access to the authentication database of the University. Now we can change passwords of people with a RuG account. Land was invited to tell our user community about 'Spam, viruses and users'. He demonstrated how easy it is to manipulate the 'from' field in a mail and talked about the dangers of viruses and spyware. Still people cannot resist the urge to open attachments with suspicious content.

In an attempt to introduce a bug tracking system for out helpdesk, the application Mantis was introduced. Using Mantis is not as easy as sending a mail. Probably that is the reason that most users still use mail for reporting bugs.

May 27, van der Hulst and Vogelaar had the opportunity to discuss a document (that we wrote to describe our local ICT activities) with representatives of the 'stuurgroep Universitaire ICT Reorganisatie'. In that document we argued that the upcoming centralization of ICT support and development (ICTC or 'Rekencentrum nieuwe stijl') would not be beneficial to our institute. The main reason for this is the large amount of non-standard ICT activities that could not be centralized. It was acknowledged that it was better to keep front- and back office activities at the Kapteyn Institute but also that for some activities we should intensify the corporation with the RC and other departments.

In a Monday lunch (Oct 31) the computer group informed users about the current budget for computing and showed that it will not be easy to economize while the demand for new machines is growing.

Our web pages on the webplatform are visited 97000 times (the hits for our intranet pages are not included here). The conclusion is that these pages are visited frequently so we should keep our information on the webplatform as up-to-date as possible. On the computing home page we assembled logos related to the Kapteyn Institute and we hope that this will prevent further growth of the number of variations on these logos.

In the past year we couldn't discover any hacker or cracker activity and can conclude that the firewall contributed to a safer computer environment.

Education

We had a couple of student trainees. A high school student (Frank den Broeder) enhanced our outreach pages and a computer science student

(Romke Dam) did some research in the field of hardware accelerated image display using OpenGL. A physics student (Maarten Lankhorst) contributed valuable example code to our Python modules documentation.
The setup of the annual computer course was changed to create more space for teaching Python and Python modules. These Python basics make students more productive and less dependent on software like IDL.
On January 21st we had a meeting with the director of the Apollo Project Beldhuis. Apollo is a corporation between universities in the area of education and ICT. As a follow up of a previous project (‘*practical use of MathML in the Nestor environment*’) we wanted to examine the usability of Scalable Vector Graphics (SVG) for education.
AIO Boersma was invited to program some examples in SVG illustrating, for example, elementary statistical methods. Regrettably not all the participating teachers were prepared to invest in this new technology so we agreed to postpone the implementation.
The ‘onderwijsdatabase’ was extended and should be the central entry point for all course related information. Our digital learning environment is based on the information in this database. Both efforts to use ICT to support education were almost completely ignored by teachers, but some of the basic ideas were considered very interesting by the developers of the faculty version of the ‘Onderwijscatalogus’. For this catalogue (OWCII) an automatic upload was prepared. In November this year the faculty decided to switch to an existing catalog (Ocasys) which was already in use by some other faculties. Now we are developing a new interface to be able to transfer data from Ocasys to our local catalog.
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3.6 Instrumentation

Mid-infrared instruments for large telescopes

One year after the successful commissioning of VISIR on the VLT J.W. Pel ended his PI-ship for the VISIR spectrometer. In the last phase of the project (up to final acceptance) this PI-task will be taken over by R.F. Peletier. Pel's instrumental activities now concentrate on two other mid-infrared spectrometers for large telescopes. The first of these is MIRI, the mid-IR spectrometer for the James Webb Space Telescope, for which the optical group at ASTRON is building the Spectrometer Main Optics module. The Dutch contribution is part of the NOVA instrumentation programme and is lead by E. van Dishoeck (PI) and R. Jager (PM). Although the JWST launch date is still several years ahead, MIRI is already close to the Critical Design Review (early 2006); the verification model should then be ready within a year. The second project concerns a feasibility study of mid-IR instrumentation for the next generation of 'Extremely Large Telescopes'. The ASTRON team collaborates in this study with groups in Leiden (Sterrewacht), Heidelberg (MPIfA), Edinburgh (ATC) and Garching (ESO). A first study of a mid-IR imager/spectrometer ("TOWL") for ESO's 100-m OWL telescope design was completed and delivered to ESO in 2005. The next step, partially funded by the EC and by NOVA, will focus on a more detailed study of a similar instrument for a more modest ELT with primary mirror in the 25-50 m range.

OmegaCAM/ OmegaCEN

The OmegaCAM instrument was completed, and crated in the end of 2004 in Garching, where it is now awaiting shipping to Paranal. Documentation is being finalized. The OmegaCEN/NOVA team has delivered an extensive Instrument Characterization report and created first versions of many calibration files in the OmegaCAM/AstroWise system. The performance of the camera, as monitored by a its calibration unit, is very promising and allows photometric analysis at sub 1% level.
OmegaCEN launched the AstroWise web portal (www.astro-wise.org/portal) of the noval information system at the occasion of a AstroWise workshop held at the Lorentz center in November 2005 in Leiden. The portal bundles several GRID-compute and data storage services, next to manuals, how_to's, views on the database and code base. The workshop was attended by about 40 scientists and scientific programmers from institutes who have some relation to the various OmegaCAM surveys (Groningen, Nijmegen, Leiden, Munich, Bonn, Bochum, Paris, Napoli).
While waiting for the VST to be ready, OmegaCEN will keep on working with data from the WFI@2.2m , the La Palma INT and the MDM telescope. The data is used for various PhD projects and qualifications of the OmegaCAM software.
The KIDS project (400 nights of VST/OmegaCAM public time for a 1500-square degree survey for cosmology- co-PI Valentijn) was approved by the ESO OPC in November. This makes KIDS the largest project that will be carried out on the VST. Data processing will be done with the Astro-Wise system developed at OmegaCEN.

LOFAR calibration

Yatawatta's work is focused on calibration of LOFAR which is essential for the Epoch of Reionization project. He has worked with the LOFAR calibration software group at ASTRON, Dwingeloo in developing software for this. He has also worked with a team of astronomers/engineers in the reduction of the data produced from the WSRT/WHAT combination. WHAT is an antenna array made of dipoles similar to the high band antennas to be used in LOFAR. Figure 17 shows a typical gain variation of WHAT compared to a WSRT antenna. This experiment serves as a precursor to actual LOFAR calibration.

Efficient data transport mechanisms for e-VLBI

Sansa started her PhD research on March 1st, 2005. During 2005 she defined the research problem and drew a research plan. She also embarked on a literature survey to get familiar with related studies. Towards the end of the year (October-November 2005), she carried out some experiments/tests on the network links used for e-VLBI between the central correlator in Dwingeloo, the Netherlands and the e-VLBI station in Jodrell Bank, Manchester, UK. From these tests she has written a paper in collaboration with van der Hulst and A.

Szomoru (Joint Institute for VLBI in Europe, the Netherlands), which she has submitted for a conference due to take place in August 2006.

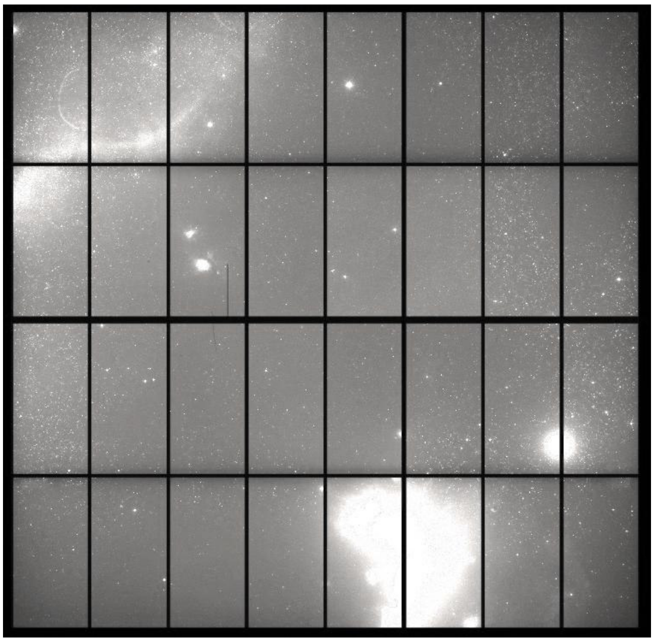

Figure 16: OmegaCAM first laboratory image in colour.

ALMA Band 9

The ALMA project is a collaboration between Europe, North America, and Japan to build an aperture synthesis telescope consisting of at least 50 12-m antennas located at 5000 m altitude in Chile. In its full configuration, ALMA will observe in 10 frequency bands between 30 and 950 GHz, with a maximum baseline of up to 10 km, which will provide astronomers with unprecedented spatial resolution at millimeter and sub-millimeter wavelengths.
Within the Netherlands, a collaboration of NOVA (as PI), the Kapteyn Institute, SRON, and TU Delft is developing heterodyne receivers for the ALMA project covering the 600-720 GHz atmospheric window, under contract to the European Southern Observatory (ESO). As the highest frequency band in the baseline project, these so-called ALMA Band-9 cartridges will provide the observatory’s highest spatial resolution and probe higher temperature scales to complement observations at lower-frequency bands in the baseline project (around 100, 250, and 350 GHz).
The ALMA Band-9 cartridge is a compact unit containing the core of a 600-720 GHz receiver that can be easily inserted into and removed from the ALMA cryostat. It combines high-sensitivity, broadband SIS mixers as its eyes; a high-

power, electronically-tunable local oscillator that drives the mixers at their operating frequency; and low-noise intermediate frequency amplifiers that

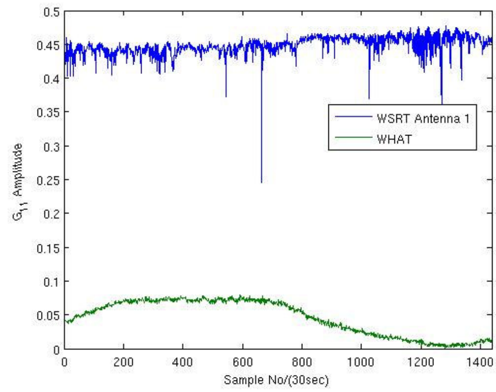

Figure 17.

amplify the mixers' weak outputs before they leave the cryostat. These components are built into a rigid opto-mechanical structure that includes a compact optical assembly that combines the astronomical and local oscillator signals and focuses them into the two SIS mixers.

The first (prototype) ALMA Band-9 cartridge was assembled in early 2005 (see **Error! Not a valid bookmark self-reference.**). Cartridge testing started in April of 2005, with the goal of verifying the cartridge design, including the performance of and interfaces with critical components produced by international partners in the ALMA project. The experience gained with the assembly and testing of this prototype was used to optimize the cartridge design before starting the manufacture of the next seven units in the second half of 2005. Elsewhere in the project, a major milestone was completed in 2005, with each of NSF and ESO placing orders for 25 12-m antennas that will together make up the baseline ALMA array.

CHAMP+

CHAMP+ is a 14-element SIS heterodyne array receiver for the 600–720 GHz (same as ALMA Band 9) and 790-950 GHz (same as ALMA Band 10, large overlap with HIFI band 3) atmospheric windows to be exploited on APEX at the Chajnantor site in Chile. The project is a collaboration between the Netherlands and MPIfR. In the Netherlands the NOVA-ALMA group and TU Delft have extended their collaboration to also build the mixer receivers for CHAMP+, the upgraded CHAMP receiver of MPIfR, using the experience and technology developed for the ALMA Band-9 and HIFI band 3 receivers. This NWO funded project (653 k€), for which NOVA holds formal responsibility, provides astronomers in the Netherlands 42 guaranteed observing nights on APEX spread over six years in access to the open competition time available through ESO. The formal contract between NOVA and MPIfR on CHAMP+ was signed in April 2003. During the reporting period the design of both CHAMP+ mixers was completed for both frequency bands. In addition effort was spent on

improving the sensitivity of the 600-720 GHz receiver through optimizing the design of the SIS junction and the choice for junction materials. Noise temperatures as low as 100K double side band at 690 GHz are achieved. At the end of 2004 all hardware components for the low band sub-array were manufactured through commercial outsourcing and integration of the first mixer began. The low band mixer array was delivered to MPIfR in August 2005.
Assembly of the high band array block has commenced in 2005. Unfortunately the SIS batches produced for HIFI didn't provide enough good SIS junctions for the CHAMP+ high band. Hence a new batch design was made to get a SIS junction better optimized for the CHAMP+ frequency band dictated by the transparency of the Earth atmosphere. Good quality devices for the mixer were received in the end of 2005. The best mixer noise temperature is 250 K at 850 GHz. The high band mixer array with 5 mixers was delivered to MPIfR to facilitate receiver tests. The rest of the mixers will be delivered in the beginning of 2006 – in time for the year 2006 observing season at APEX in Chile.

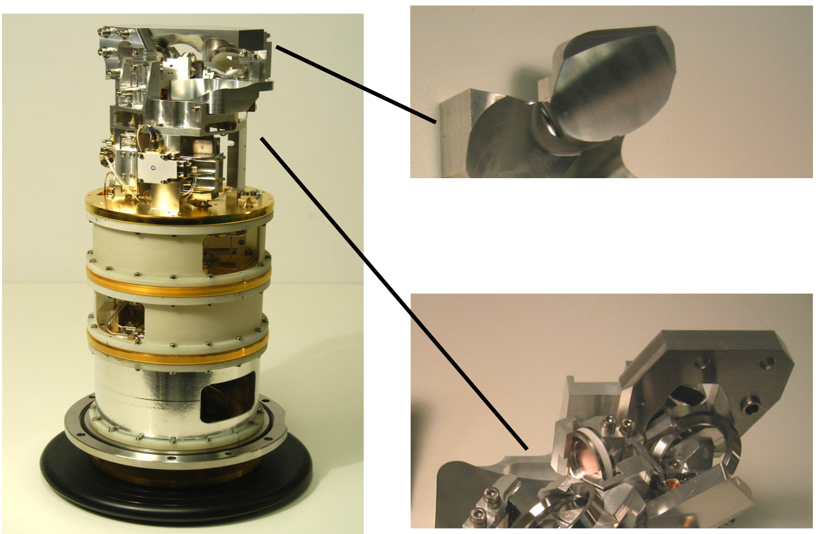

Figure 18: (left) The cryogenic portion of the first ALMA Band 9 cartridge; (right) The two halves of the 4K optics assembly of the first cartridge

APPENDIX I : PUBLICATIONS 2005

I.1 Papers in scientific journals, books

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I.3 Dissertations

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de Jong, Jelte Teun Anne, **Microlensing in Andremeda. A search for Baryonic Dark Matter,** *Dissertation Faculty Mathematic and Natural Sciences, University of Groningen (23–09–2005),* Promotores: Prof. dr. K.H. Kuijken, Prof. dr. P.D. Sackett, Prof. dr. A.P.S. Crotts, beoordelingscommissie: Prof. dr. P.D. Barthel, Prof. dr. J.M. van der Hulst, Prof. dr. R.H. Sanders, 191pgs., 2005.

I.4 Popular articles

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APPENDIX II : Participation in scientific meetings

205th Meeting of the American Astronomical Society (San Diego, USA; 8–15 Jan. ‘05):
A.A. Cole (poster: “Paleochemistry of Local Group Dwarf irregular galaxies”).

Winterschool “Surveying the Universe: Spectroscopic and Imaging Surveys for Cosmology” (Obergurgl, Austria; 12–19 Feb. ’05):
P Héraudeau (“Results from ELIAIS/SI observations with WFI”),
K.H. Kuijken (inv. contr.: “Science with OmegaCam Kids”),
G. Sikkema (poster: “Analysis of HST observations of 6 shell galaxies” – G. Sikkema, R.F. Peletier and E.A. Valentijn),
E.A. Valentijn (inv. contr.: “Virtual survey system: the I-Universe”).

“Dynamics of Galaxies: Baryons and Dark Matter” Conference (Las Vegas, USA; 10–12 March ’05):
I. Pérez Martín (“Gas flow and dark matter in the inner parts of Barred Galaxies”).

IAU Colloquium 198 “Near-Field Cosmology with Dwarf Elliptical Galaxies” (Les Diablerets, Switzerland; 14–18 March ’05):
K. Kovaç (poster: “The faint end of the HI mass function”),
E. Tolstoy (inv. contr. “Chemical compositon of local dsph galaxies”).

Dutch Astrophysics Days 2005 (Dwingeloo, the Netherlands; 17–18 March):
E. Ripamonti (talk: “Chemical evolution of dwarf galaxies: an approach through numerical simulations”),
R. van de Weijgaert (talk: “Analysing cosmic structure formation by DTFE”),
S. Zaroubi (talk: “LOFAR as a probe of reionization sources”).

ANGLES Workshop on Gravitation Lensing (Crete, Greece; 3–8 April ’05):
M. Barnabè: (talk: “Gravitational lensing and stellar dynamics of E/SO galaxies to z~1”),
A. Berciano Alba: (talk: “Gravitational lensing and the problem of faint galaxies”),
M.C. Smith (talk: “Parallax microlensing”).

Workshop “High Redshift Radio Galaxies” (Granada, Spain; 17–22 April ‘05):
B. Emonts (“Origin of radio galaxies investigated with HI observations and optics”),
R. Morganti (inv. review: “Neutral hydrogen in radio galaxies: results from nearby, imporance for far away”).

Workshop "Adaptive optics: assisted integral field spectroscopy" (La Palma, Tenerife, Spain; 9–11 May '05):
R.F. Peletier (inv. contr.: "Uncovering the origin of activity in galaxies").

Vesuvio Workshop (Catania, Sicily; 11–13 May '05):
R. van de Weijgaert (talk: "Cosmic foam analysis and reconstruction").

IAU Symposium 227 "Massive star birth: A crossroads of astrophysics" (Acireale, Italy; 16–20 May '05):
W.F. Frieswijk (poster: "Infra dark clouds in the outer galaxy – Identification of outer galaxy molecular cloud cores" – Frieswijk, W.F., Teyssier, D., Hily-Blant, P. and Shipman, R.F.).

Nederlandse Astronomen Conferentie (Blankenberge, Belgium; 18–20 May '05):
P.D. Barthel (talk: "The exciting prospects of Herschel"),
A. Berciano Alba (talk: "The highly magnified radio counterpart of the sub-mm starburst emission in the cluster-lens MSO451.6–0305"),
K.H. Kuijken (talk: "KIDS: a gravitational lensing survey with OmegaCAM").

IAU Symposium 228 "From Lithium to Uranium: Elemental Tracers of Early Cosmic Evolution" (Paris, France; 23–27 May '05):
B. Letarte (poster: "Fornax RGB field stars seen through VLT/FLAMES").

Workshop "Luminous and dark matter in galaxies and clusters of galaxies" (Bologna, Italy; 28 May–1 June '05):
M. Barnabè ("Constraining mass distribution of E/SO galaxies through gravitational lensing and stellar dynamics"),
A. Berciano Alba ("The highly magnified radio counterpart of the sub-mm starburst emission in the cluster-lens MSO451.6–0305"),
*L.V.E. Koopman (*inv. contr.: "The structure of E/SO galaxes to z=1"),
M.A.W. Verheijen (inv. contr. "The disk mass project: weighing galaxy disks with IFU spectroscopy").

Conference "Computational Cosmology" (Trieste, Italy; 31 May–4 June):
E. Ripamonti (poster: "The importance of HD cooling in primordial star formation").

Conference "The Origin of the Hubble Sequence" (Vulcano Island, Italy; 6–12 June '05):
A. Helmi (inv. contr.: "Structure and substructure of the Milky Way")
M. Pohlen (inv. contr.: "Outer disks of late-type galaxies: probing galaxy evolution").

Conference "The Fabulous Destiny of Galaxies: bridging Past and Present" (Laboratoire d'Astrophysique, Marseille, France; 20–24 June '05):
P. Héraudeau (poster: "An optical and near-infrared survey of the ELIAIS/S2 field. Data reduction with AstroWise" – P. Héraudeau and E. A. Valentijn),
P. Serra (poster: "HI disk and stellar populations in IC4200").

SKA Workshop (Dwingeloo, the Netherlands; 23 June '05):
A.G. de Bruyn (talk: "low frequency imaging with the WSRT")

EURO-VO Workshop (ESO, Garching, Germany; 27–30 June '05):
E.A. Valentijn (inv. contr.: "AstroWise: A Virtual Survey System").

French Astronomical Society Annual Meeting (Strasbourg, France; 27 June – 1 July '05):
P. Héraudeau ("An optical survey of the ELAIS/S2 field, data reduction with Astro-WISE").

Summer School "A Pan-chromatic view on cluster of galaxies and the LSS" (INAOE, Puebla, Mexico; 27 June – 8 July '05):
J.H. van Gorkom (inv. contr.: "Influence of environment on galaxy evolution"),
S.R. Schneider (poster: "Getting on the outskirts of the Hercules supercluster"),
R. van de Weijgaert (inv. contr.: "Patterns across the Universe: clusters and the cosmic web").

Conference "Reionizing the Universe: The Epoch of Reionization and the Physics of the IGM" (Groningen, the Netherlands; 27 June – 1 July '05):
A.G. de Bruyn (inv. review: "The foregrounds of the EoR 21cm signals"),
E. Ripamonti (talk: " An exploration of the effects of HD cooling on primordial star formation"),
S. Zaroubi (Chair).

Conference "Planetary nebulae as astronomical tools" (Gdansk, Poland; 28 June – 2 July '05):
N.G. Douglas (poster: "Measuring the transverse motions of PNE with VLBI").

Conference "Island Universes: the Structure and Evolution of Disk Galaxies", held to honour Prof. P.C. van der Kruit with his appointment on a new chair, the Jacobus C. Kapteyn Professorship in Astronomy (Terschelling, the Netherlands; 3–8 July '05):
P. Kamphuis (poster: "A study of extra-planar HI gas: NGC 7814 and UGC 1281"),
Y.-S. Li (poster: "Infall of substructures onto a Milky Way-like dark halo"),
I. Pérez Martín ("The radial profile of stellar disks in galaxies at z=1"),
M. Pohlen ("The outers disks of galaxies: to be or not to be truncated?"),
M.A.W. Verheijen ("The disk mass project").

21st IAPConference "Mass Profiles and Shapes of Cosmological Structure" (Paris, France; 4–9 July '05):
L.V.E. Koopmans (inv. contr.: "Massive ellipticals: joint constraints from lensing"),
R.H. Sanders (inv. contr.: "Cosmology and MOND").

Workshop "Stellar population: a Rosetta Stone for galaxy formation" (Ringberg, Germany; 4–8 July '05):
R.F. Peletier (inv. contr.: "Ages of disks"),

S.C. Trager (inv. contr.: “Early-type galaxies in the Coma Cluster: evidence for recent star formation”).

Conference “Mass and mystery in the Local Group” (Cambridge, UK; 17–22 July ‘05):
G. Battaglia (“The radial velocity dispersion profile of the Galactic halo”),
B. Letarte (poster: “Field star abundances in the Fornax sSph galaxy with VLT/FLAMES”),
Y.-S. Li (poster: “Infall of substructures onto a Milky Way-like dark halo”),
M.C. Smith (“Constraining the local escape speed with RAVE”),
E. Tolstoy (inv. review: “Metallicities for dwarf galaxies in the Local Group”),
A. Villalobos Cofre (poster: “Formation of thick disks”).

Conference “Nearly Normal Galaxies in a ΛCDM Universe” (Santa Cruz, USA; 6–12 Aug. ’05):
K. Kovaç (poster: “A search for the lowest mass galaxies: properties of the HI selected galaxies” and “A search for the lowest mass galaxies: the faint end of the HIMF”),
S.C. Trager (Session leader: “Galactic Spheroids”).

Conference “Open Questions in Cosmology: the First Billion Years” (Garching, Germany; 21–31 Aug. ’05):
E. Ripamonti (talk:”The role of HD cooling in the formation of the first luminous objects”),
S. Zaroubi (talk: “LOFAR as a probe of the sources of cosmological reionization”).

Aspen Summer Working Group 2005, “Galaxies, Clusters and Voids” (Aspen, Colorado, USA; 26 Aug.– 11 Sept. ’05):
R. van de Weygaert (inv. contr. “A hierarchy of voids”).

Conference “The Origin and Evolution of Cosmic Magnetism” (Bologna, Italy; 29 Aug.– 2 Sept. ’05):
M.A. Brentjens (“Rotation Measure Symnthesis on clusters of galaxies”),
A.G. de Bruyn (“Polarization and RM structure at high galactic latitude”).

Workshop “Modelling the Galaxy in the age of GAIA” (Oxford, UK; 5–10 Sept.):
M.C. Smith (“Galactic microlensing with OGLE-III survey”)

“Gas in early-type galaxies” (ASTRON, Dwingeloo; 26 Sept. ’05):
L. Coccato (talk: “NGC 4435: a bulge dominated galaxy with an unforeseen low mass central black hole”),
B. Emonts (talk: “Gas, stars and the central engine in radio galaxies”),

Bonn-Dwingeloo Neighbourhood Symposium (Bonn, Germany; 22 Sept.):
A. Berciano Alba (talk: “The highly magnified radio counterpart of the sub-mm starburst emission in the cluster-lens MSO451.6-0305”).

Summerschool on Molecular Astrophysics (Les Houches, France; 26–30 Sept '05):
C. Boersma ("Molecules in regions of star formation")
W. Frieswijk ("Massive star formation and infrared dark clouds")
D. Poelman (poster "Excitation of water in the S140 PDR")
M.C. Spaans (invited talk: "Principles of radiative transfer")

3rd Aegean Summer School "The invisible Universe; dark matter and dark energy" (Karfas, Island of Chios, Greece; 26 Sept. – 1 Oct. '05):
R.H. Sanders (inv. contr:. "Modified gravity without dark matter")

Astronomische Gesellschaft Splinter Meeting (Köln, Germany; 28 Sept.):
A.G. de Bruyn (talk: "Polarization and RM structure in the galactic halo and the Perseus cluster").

Conference "Stochastic geometry and its applications" (Bern, Switzerland; 3–7 Oct. '05):
R. van de Weijgaert (invited talk: "The Voronoi Universe").

Workshop "Outer edges of disk galaxies: a truncated perspective" (Lorentz Center, Leiden; 4–7 Oct. '05):
J.M. van der Hulst (talk: "The HI edges of galaxies"),
P. Kamphuis (poster: A study of HI extra-planar gas: NGC 7814 and UGC 1281"),
I. Pérez Martín (talk: "Stellar disk truncation of galaxies to z=1: implications"),
M. Pohlen (talk: "Do we really see disks growing inside-out?; poster: "The structure of galactic disks"),
R.F. Peletier (talk: "The inner regions of late-type spiral galaxies"),
P. Serra (poster: "The very late-stage merger IC 4200: pre-elliptical or pre-spiral?"),
H. van Woerden (talk: The high-velocity clouds: Where? What? Whence?).

Workshop " Detection of the Warm Hot Intergalactic Medium" (Tokyo, Japan; 10–12 Oct. '05):
R. van de Weijgaert (invited talk: "The Cosmic Web: clusters, constraints and analysis").

YERAC Conference (Cagliari, Italy; 10–17 Oct. '05):
P. Serra (talk: "Evolution of gas-rich early-type galaxies").

Conference "Protostars and Planets V" (Hawaii; USA; 24–28 Oct. '05):
C. Boersma (poster: "Dust and PAHs around young stars"),
W. Frieswijk (poster: "(Near) infrared dark clouds in the outer galaxy?"),
C. Ormel (poster "Dust coagulation in protoplanetary disks and their internal structure"),
D. Poelman (poster "Excitation of water in the S140 PDR").

Symposium “Wij zijn van sterrenstof gemaakt” NSA symposium ter ere van Prof.dr. E.P.J. van den Heuvel (Amsterdam, Netherlands; 27 Oct ’05):
R. van de Weijgaert (talk: “Chronicle of the Big Bang: a cosmic history of 13.7 Gyr”).

URSI General Assembly, Session J3 (Delhi, India; 31 Oct. ’05):
A.G. de Bruyn (talk: “Low frequency polarization”).

SKA 2005 (Pune, India; 29 Oct.–4 Nov. ’05):
A.G. de Bruyn (talk: “Review of Groningen EoR conference”),
J.M. van der Hulst (talk: “HI aspects of galaxy evolution with the SKA”).

IAU Symposium 232 “Scientific Requirements for Extremely Large Telescopes” (Cape Town, South Africa; 14–18 Nov. ’05):
E. Tolstoy (talk: “Studying resolved stellar populations with ELTs”).

AstroWise Workshop (Lorentz Centre, Leiden; 14–18 Nov. ’05):
K.H.. Kuijken (“KIDS”),
S.R. Schneider (talk: “Reducing MDM data with AstroWise”),
G. Sikkema (talk: “Running AstroWise on WFI@2.2m data”),
E.A. Valentijn (“Tutorial” and “VESUVIO”).

APPENDIX III : Visits to institutes abroad

III.1 Work visits

M.A. Aragón Calvo
Johns Hopkins University (Baltimore, USA); 23 May–23 June

P. Araya Melo
Pontificia Universidad Catolica (Santiago, Chile); 19 Dec.–10 Jan.

P.D. Barthel
Herschel/SPIRE Consortium Meeting (Los Angeles, USA); 16–23 July

S. Basilakos
University of Athens (Greece); 15–30 Oct ., 15–30 Nov.
Mexico, 7–19 November

G. Battaglia
University of Cambridge (UK) ; 6–12 March
Observatoire de Paris (France); 19--23 May

A. Berciano Alba
University of Manchester (UK) ; 4–11 Sept.
Austrian Academy of Sciences (Graz, Austria) ; November

C. Boersma
M.P.I. für Astronomie (Heidelberg, Germany): 24–28 April
JAC (Hilo, Hawaii, USA); 17–24 Oct.

W.N. Brouw
Beijing and Guiyang (China); 14–25 March

S. Chi
University of Manchester (UK); 4–11 Sept.

L. Coccato
University of Padua (Italy); 24–25 May, 1–2 September.

N.G. Douglas
University of Durham (UK); 24–30 April

B.J.C. Emonts
Mt. Stromlo Observatory, Canberra (Australia): 26–29 Jan.
ATNF, Epping-Sydney (Australia); 30 Jan.–7 Feb.

Jodrell Bank Observatory (UK); 28–30 June
Sheffield University (UK); 30 June–14 July

W. Frieswijk
Dept. of Molecular and Infrared Astrophysics, Madrid (Spain); 16 –18 Feb.

K. Ganda
Cassis (France) ; 26–30 Jan.
I.A.C. (La Laguna, Spain); Sept.–Dec.

J.S. Heiner
Univ. of Hertfordshire (UK); 13–14 Sept.

A. Helmi
Observatoire de Paris (France); 20--21 May
La Plata Observatory (Argentine); 24 June–15 Sept. ,13 Sept.–16 Nov

E.M. Helmich
E.S.O. (Garching, Germany); 10–15 April, 23–28 June, 4–9 Sept
Osservatorio Astronomico di Capodimonte (Naples, Italy); 25–30 July

P. Héraudeau
Edinburgh (UK); 14–16 Sept.
Heidelberg (Germany); 22 July

B.W. Holwerda
Space Telescope Science Inst. (Baltimore, USA); 6–22 Jan., 26 Feb.–6 March
LAM (Marseille, France); 17–19 Feb.

J.M. van der Hulst
MSSSO & ATNF (Australia); 26 Jan.–4 Feb.
Osservatorio Astronomico (Bologna, Italy); 10–16 April
La Palma (Canary Islands, Spain); 8–12 May
Jülich, Germany; 15–16 Dec.

P. Kemper
Jülich, Germany; 15–16 Dec.

L.V.E. Koopmans
Jülich, Germany; 15–16 Dec.

P.C. van der Kruit
ALMA Review Meeting (Garching, Germany); 12–13 Jan.
ESO (Garching, Germany); 1–2 March, 23–24 March, 7–8 Sept., 14–16 Sept.
CalTech (Pasadena, USA); 14–19 March
Ministery of Science (Madrid, Spain); 27–28 April
Space Telescope Science Inst. (Baltimore, USA); 14–19 March
ESO (Santiago, Paranal, Chajnantor, Chile); 11–17 May, 24–27 Aug.
Ministery of Science (Helsinki, Finland); 6–9 June

E. Kutdemir
Cassis (France); 26–30 Jan.

A. Labiano Ortega
Univ. of Rochester and Space Telescope Science Inst. (Baltimore, USA); 28 May – 27 June

Y.-S. Li
M.P.I. für Astrophysik (Garching, Germany); 10 April–28 May

J. McFarland
OmegaCAM (Garching, Germany); 23 June–2 July, 4–9 Sept

N. Mohamed Ahmed
M.P.I für Extragalactic Studies(Munich, Germany); 19 Sept. – 19 Dec.

M. Obriç
Univ. of Washington (Seattle, USA) ; 16 Aug–11 Oct., 25 Oct.–22 Jan. '06

T. Oosterloo
ALMA Meeting (Garching, Germany); 6–8 Jan., 8–10 June
VILSPA (Madrid, Spain); 25–26 Jan.

J.W. Pel
Saclay (France); 13–15 Feb.
ZEISS (Oberkochen, Germany); 17–18 May
Stockholm, Zweden; 5–8 June
MIRI Meeting (Zurich, Switzerland); 19–21 Sept.

R.F. Peletier
Heidelberg, Germany: 22--27 July
Naples, Italy; 23–26 Oct.

I. Pérez Martín
Marseille France; 26–29 Jan.
Univ. of Granada (Spain); 30 Jan. –10 Feb., 27 July – 8 Aug.

R. Pizzo
University of Manchester (UK); 4–11 Sept.

M. Pohlen
EU RTN Meeting (Madrid, Spain); 12–16 June

E. Ripamonte
SISSA/ISAS (Trieste, Italy); 19 June – 1 July
Kavli Inst. for Particle Astrophysics and Cosmology, Stanford University (California, USA); 4–21 Sept.

R.H. Sanders
Vienna (Austria); 22–30 Oct.

Bremen (Germany); 23 Nov.

G. Sikkema
SISCO Winter School (Obergurgl, Austria);12–19 Feb.
Osservatorio Astronomico di Capodimonte (Naples, Italy); 24–26 Oct.

M.C. Spaans
Astrophysikalisches Inst. (Potsdam, Germany); 5–8 April
Osservatorio di Arcetri (Firenze, Italy); 21–25 Nov.

M.C. Smith
Coonabarabran (Australia); 28--31 July
ANU, Mt. Stromlo Observatory (Canberra, Australia); 31 July – 17 Aug.
Swinburne University, Melbourne (Australia); 17–21 July
Jodrell Bank, Manchester (UK); 31 Oct. – 11 Nov.

E. Tolstoy
Chile; 3–23 Jan.
Institute of Astronomy (Cambridge, UK); 5–12 March
Observatoire de Paris (Meudon, France); 19-22 May

S.C. Trager
Universidad Complutense (Madrid, Spain); 19–23 April
Carnegie Observatories (Pasadena, USA); 15–18 August
M.P.I. für Astronomie (Heidelberg, Germany); 16–25 Sept. 8–11 Nov.

E.A. Valentijn
ESO (Munich, Germany); 9–16 April, 27–28 June, 5–9 Sept.
Heidelberg, Germany; 21–22 July
Edinburgh, UK; 14–16 Sept.
IAP, Paris (France); 25–27 Oct.
Rome, Italy,: Nov.
Jülich, Germany, 15–16 Dec.

R. Vermeij
ESO (Garching, Germany); 10–15 April

A. Villalobos Cofré
Case Western University (Cleveland, USA); 4 Aug. – 31 Oct.

M.A.M. van de Weijgaert
National Observatory (Athens, Greece); 23 April – 7 May, 15–26 Oct.
Aalborg, Denmark: 13–17 Aug.
Univ. of Nevada (Las Vegas, USA); 3–7 Sept.
Princeton University (USA); 9–10 Sept.
Columbia University (New York, USA); 11–17 Sept.

III.2 Observing trips

M.A. Aragón Calvo
Isaac Newton Telescope (La Palma, Spain); 4–9 April

C. Boersma
JCMT (Mauna Kea, Hawaii, USA); 11–17 Oct.

L. Coccato
William Herschel Telescope (La Palma, Spain) 6–13 April
ING Telescope (La Palma, Spain); 29 Dec. – 5 Jan. '06

N.G. Douglas
WINT (NOVA outreach program with prize winners to La Palma): 21–28 Feb.
EMMI-MOS, ESO (Chile); 8–12 April
PN.s, William Herschel Telescope (La Palma, Spain); 12–18 Apr.

B. Emonts
ATCA, Narrabri (Australia); 18--23 Jan.

W. Frieswijk
100m Telescope (Effelsberg, Germany); 29 Jan. – 2 Feb.
IRAM (Granada, Spain); 9–15 Feb.
JCMT (Mauna Kea, Hawaii, USA); 4–17 July

K. Ganda
William Herschel Telescope (La Palma, Spain); 8–9 Jan., 2–5 Dec.
NOT (La Palma, Spain); 16–20 Dec.

J.M. van der Hulst
Australia Telescope Compact Array (Narrabri, Australia); 17–26 Jan.

P. Kamphuis
MDM Observatory (Tucson, USA); 11–22 Jan.

K. Kovaç
Isaac Newton Telescope (La Palma, Spain); 30 March – 4 April

E. Noordermeer
PN.s on William Herschel Telescope (La Palma, Spain); 4–8 April

T. Oosterloo
Isaac Newton Telescope (La Palma, Spain); 30 March – 4 April

R.F. Peletier
VISIR gto, Paranal, Chile: 19–27 Jan.
William Herschel Telescope (La Palma, Spain); 20–23 Dec.

I. Perez Martin
William Herschel Telescope (La Palma, Spain); 24–28 Sept.

M. Pohlen
UKIRT (Mauna Kea, Hawaii, USA); 15–20 Aug.
NOT (La Palma, Spain); 16–20 Dec.

P. Serra
ESO/NTT (La Silla, Chile); 29 Jan. – 10 Feb.
William Herschel Telescope (La Palma, Spain); 24–28 Sept.

G. Sikkema
MPG/ESO (La Silla, Chile); 1–14 Oct.

M.A.W. Verheijen
Calar Alto (Granada, Spain); 3–10 May, 1–6 Nov.

U. Yildiz
William Herschel Telescope (La Palma, Spain); 20–23 Dec.

APPENDIX IV : Colloquia, popular lectures

IV.1 Colloquia given outside Groningen

P.D. Barthel – “*To be or not to be active*”: Boston, USA (Oct.).
“Hooggespannen verwachtingen van de Herschel Ruimtetelescoop van ESA”: KNG, Groningen, the Netherlands (18 Oct.).

A.G. de Bruyn – “*The Perseus Cluster*”: Osservatorio Astronomico, Bologna, Italy (7 April),
“*LOFAR, a revolutionary new radio telescope*”: IRA-Bologna, Italy (8 April).

N.G. Douglas – “*Galaxy research with the PN Spectrograph*”: Radboud University, Nijmegen (22 June).

B. Emonts – “*Origin of radio galaxies investigated with HI observations and optical spectroscopy*”: Mt. Stromlo Observatory (28 Jan.), ATNF, Epping-Sydney, Australia (3 Feb.), Jodrell Bank Observatory, UK (29 June).

K. Ganda – “*Late-type spiral galaxies: two-dimensional kinematics of stars and gas*”. Museo de la Ciencia y el Cosmos, La Laguna, Spain (15 Nov.).

P. Heraudeau – “*An optical and near-infrared survey of ELASIS-S2*”: Edinburgh, UK (Sept.),
“*The ELAIS survey*”: Strasbourg, France (Dec.).

J.T.A. de Jong – “*Probing Baryonic dark matter in M31*” : KVI, Groningen, the Netherlands (22 April).
“*Probing MACHOs in M31*”: Universitäts Sternwarte München, Germany (11 Oct.), Universität Göttingen, Germany (10 Nov.).

L.V.E. Koopmans – “*Dark and luminous matter in early-type galaxies from gravitational lensing and stellar dynamics*”: ASTRON, Dwingeloo (15 April).

K. Kovaç – “*A search for the lowest mass galaxies: the HI view*” : University of Washington, Seattle (6 Dec.), University of California, Berkeley (9 Dec.), Johns Hopkins University (12 Dec.) Columbia University, New York, USA (13 Dec.).

B. Letarte – “*Abondances d’étoiles individuelles dans la galaxies naine sphéroïdale Fornax*”: Université de Montréal, Canada (12 Dec.).

R. Morganti – "*The importance of gas in gas-poor galaxies"* : Bologna Observatory, Italy (27 Oct.).

M. Obrić – "*Panchromatic properties of SDSS galaxies*": University of Zagreb, Croatia (14 March).

T. Oosterloo – "*AGN interaction with the HI environment*": Bologna Observatory, Italy (12 Feb.).
"P*eeling for dummies*" : Jodrell Bank, UK (3 March).
"*HI Halo of NGC 891*" : Bad Honnef, Germany (17 Nov.).

R. Pizzo – "*Diffuse radio emission from clusters of galaxies"* :
NOVA School, Dwingeloo, the Netherlands (5 Oct.), Young LOFAR scientist meeting, Dwingeloo (3 Nov.).

M. Pohlen – "*Outer edges of disk galaxies*": Bad Honnef, Germany (17 Nov.).

E. Ripamonti – "*Chemical evolution of dwarf galaxies: an approach through numerical simulations*" : ASTRON, Dwingeloo, the Netherlands (17 March).

M.C. Smith – "*Constraining the local escape speed with RAVE*": Coonabarabran, Australia (July).
"*Galactic microlensing with OGLE*" : Swinburne University, Melbourne, Australia (August).

M.C. Spaans – "*The equation of state of interstellar clouds*" : Potsdam, Germany (8 April).
"*Molecules under extreme conditions*" : Amsterdam (13 Sept.),
"*Models of interstellar clouds*": Onsala, Sweden (Oct.),
"*The IMF of interstellar clouds*" : Firenze, Italy (22 Nov.).

E. Tolstoy – "*De geschiedenis van sterrenformatie in het heelal: de rol van dwergsterrenstelsels":* KNG, Groningen, the Netherlands (19 April).

S.C. Trager – *"Are old, red galaxies dead? The stellar content of early-type galaxies"* : Radboud University, Nijmegen, the Netherlands (30 March), Universidad Complutense Madrid, Spain (21 April), University of Virginia/NRAO Charlottesville, USA (24 August).
"Are old, red galaxies dead? The stellar population of early-type galaxies": ASTRON/JIVE, Dwingeloo, the Netherlands (27 Oct.).

M.A.W. Verheijen – *"The disk mass project"*: Heidelberg, Germany (28 April).

R. van de Weijgaert – *"A hierarchy of voids: Much ado about Nothing"*: National Observatory, Athens, Greece (5 May), University of Nevada Las Vegas, USA (5 Sept.), Columbia University, New York, USA (14 Sept.), Academy of Athens, Greece (18 Oct.).
"*Analyzing the Cosmic Foam: the Delaunay Tessellation Field estimator*": National Observatory, Athens, Greece (5 May).

"*The Voronoi Universe: cosmic structure formation and the cosmic foam*" University of Aalborg, Denmark (15 Aug.),
"*The Cosmic Web: Clusters, constraints and analysis*": National Observatory, Athens, Greece (24 Oct.).

P. Wesselius – "*THz toepassing in gasdetectie*": ASTRON, Dwingeloo (20 May).

S. Zaroubi – "*LOFAR as a probe of the sources of cosmological reionization*": University College London, UK (July).
"*The Lyman-alpha forest as a cosmological probe*": Bologna, Italy (Nov.).

IV.2 Popular lectures

P.D. Barthel – ***"****Herschel: nieuw Gronings onderzoek in de ruimte****"*** World Year of Physics, City of Groningen (2, 3, 4 June).

A. Blaauw – "Nearby Objects, past and future" ("Aardscheerders"). Probus Society, Haren (14 December)

M. Brentjens – *"LOFAR: een nieuwe radiotelescoop"* World Year of Physics, City of Groningen (2 June).

A.G. de Bruyn – *"LOFAR and the Epoch of Reionization"* Koninklijke Maatschappij voor Natuurkunde, Diligentia, Den Haag (4 April).
"LOFAR and de ultieme zoektocht naar HI in het heelal" KNVWS, Alkmaar (12 Dec.).

N.G. Douglas – "*Het onderzoeken van sterrenstelsels met de Planetary Nebula Spectrograph"* KNVWS, Groningen (27 May).

W. Frieswijk – "*Interstellaire materie en sterformatie"* KNVWS, Zwolle (21 April).

F.P. Helmich – "*Ruimteonderzoek in Groningen"* Faculteit Bedrijfskunde, Rijksuniversiteit Groningen (1 June).

J.M. van der Hulst – *"LOFAR: een nieuwe radiotelescoop"* World Year of Physics, City of Groningen (3, 4 June).

D. Poelman – *"Water in het Heelal"* KNVWS, Groningen (14 Oct.).

G. Sikkema – *"Globular clusters"* KNVWS, Assen (16 Sept.).

M.C. Spaans – *"Het leven van een astronoom"* Masterclass Sterrenkunde, Groningen (Feb.), Piter Jellekes College, Leeuwarden (3 Nov.)

R. van de Weijgaert – *"Dark Lords of the Universe"* KNVWS, Zaandam

(27 Jan.).
"Van primordiale ruis tot kosmisch schuim" KNVWS, Eindhoven (24 March).
"Extrasolar Planets" Interview in rubriek "Hoe?Zo!", Radio Teleac (27 Apr.).

P. Wesselius – *"Exoplaneten"* Volkssterrenwacht Busslo, Lochem (21 Jan.), KNVWS, Den Bosch (16 Feb.)
"Space Debris" SRON Groningen (17 May), SRON Utrecht (9 June),
"Ruimtepuin" KNVWS Groningen (16 Dec.)
"Ruimteonderzoek" Openbare Bibliotheken te Westerbork (15 Sept.), Roden (22 Sept.), Smilde (29 Sept.).

H. van Woerden – *"Eet de Melkweg? Of ademt hij?"* KNVWS Zuid-Limburg, Heerlen (15 Jan.).
"Hoe meet je afstanden van sterren?" Interview in rubriek "Hoe?Zo!", Radio Teleac (17 March).
"Zestig jaar Nederlandse Sterrenkunde" KNVWS Het Gooi, Hilversum (15 April) and KNVW Nijmegen (19 April).
"Op reis door het Heelal" Vereniging Gepensioneerden KPMG, Paterswolde (13 Oct.).
"Het Melkwegstelsel" KNVWS-Jongeren Werkgroep voor Sterrenkunde, Hilversum (16 Dec.)

APPENDIX V : Colloquia in Groningen

January 21
Marina Rejkuba (ESO, Garching, Germany): *Stellar populations in galactic spheroids*

January 24
Katrien Steenbrugge (SRON, Utrecht): *The X-ray view of the wind in the AGN NGC 5548*

January 31
Mike Garrett (Jive-Dwingeloo*): 21st Century VLBI & The faintest Radio Sources (near & far)*

February 7
Kirsten Kraiberg (MPIA, Heidelberg, Germany): *Deep submillimetre studies of distant, faint dusty galaxies*

February 14
Marcus Brüggen (International Univ. Bremen, Germany): *AGN feedback in clusters of galaxies*

February 21 **(2005 Blaauw Professor)**
Simon White (Max-Planck Institute for Astrophysics, Garching, Germany): *Simulating the large-scale galaxy distribution*

February 28
Pedro Ferreira (Oxford, UK): *The initial conditions of the Universe*

March 7 **(NOVA Colloquium)**
Roger Blandford (Stanford, USA): *Accretion and its Consequences*

March 14 **(NOVA Colloquium**)
Volker Bromm (University of Texas, USA): *The first luminous objects in the Universe*

March 21
Alain Blanchard (Toulouse, France): *Do we need dark energy?*

March 31 (**NOVA Colloquium)**
Guinevere Kauffmann (M.P.I. for Astrophysics, Garching, Germany): *Lessons on galaxy formation from 200,000 SDSS Galaxies*

April 4
Mark Walker (University of Sydney & Kapteyn Institute):
Interstellar Holography

April 11
Ralf Dettmar (University of Bochum, Germany): *Looking deep at dim galaxies*

April 18
Conny Aerts (Nijmegen/Leuven, Belgium*): Astroseismology: from dream to reality*

April 25
Rene Laureijs (ESA/ESTEC, Noordwijk): *Unexpected properties of dust at far-infrared and submillimetre wavelengths*

April 29
Linda Sparke (University of Wisconsin, Madison, USA): *Bars in bars and rings round stars*

May 9
Benne Holwerda (Kapteyn Institute and STSCI, Baltimore, USA): *The opacity of spiral galaxy disks*

May 23
Adi Nusser (Technion, Haifa, Israel): *The large scale structure of the high redshift Universe*

May 30
Shobita Satyapal (George Mason University, USA*): Low ionization nuclear emission line regions: The "Missing Link" in the AGN Population*

June 3 (**NOVA Colloquium)**
Roberto Gilmozzi (ESO, Germany*): Science and technology of the ESO OWL 100m telescope*

June 14 **(NOVA Colloquium)**
Mark Dickinson (NOAO, USA): *Deep Spitzer Observations of the Distant Universe from the Great Observatories Origins Deep Survey*

June 20 (**NOVA Colloquium)**
Alan Dressler (Carnegie Institution of Washington, USA): *Environmental influences on galaxy evolution and the building of galaxy clusters*

July 11
P.A. Patsis (Research Center for Astronomy, Academy of Athens, Greece):
On the nature of inner rings in bar/s

July 25
Sergei Shandarin (Dept. Physics, Univ. Kansas Lawrence, USA): *Morphological analysis of the Large Scale Structure of the Universe*

August 29
Henk Hoekstra (University of Victoria, Canada): *Virial masses: from galaxy clusters to galaxies*

September 12
Arjen van der Wel (Leiden University): *Setting the Scale - Dynamical and Photometric Properties of High-Redshift Early-Type Galaxies*

September 19
Luis Aguilar (UNAM, Mexico): *Identification of satellite remnants in the galactic halo with Gaia*

September 26
Richard Schilizzi (Leiden & The International SKA Project Office, Dwingeloo): *Square Kilometre Array - next generation radio telescope for the world*

October 3
Dennis Zaritsky (Tucson, Arizona, USA): *New Results on Intracluster Light*

October 20
Takao Nakagawa (Inst. of Space and Astronautical Science, Japan): *ASTRO-F, the next-generation infrared surveyor*

October 24 **(NOVA Colloquium)**
Francis Halzen (Univ. of Wisconsin, USA): *Neutrino Astronomy at the South Pole: From AMANDA to IceCube*

November 7
Nick Walton (Cambridge University, UK): *Science from the Virtual Observatory in Europe*

November 14
Bodo Ziegler (Göttingen, Germany): *Down-sizing in galaxy scaling relations*

November 21
Max Pettini (Cambridge University, UK): *Chemical elements at high and low Redshift*

November 28
Francis Bernardeau (Saclay, France*): From one to multi-field inflation*

December 5
Tom Theuns (Durham, UK): *Galaxies in the Intergalactic Medium*

December 12
Glenn van de Ven (Leiden Observatory): *Dynamical structure and evolution of stellar systems*

December 19 Jelte de Jong (MPI for Astronomy, Heidelberg): *Probing MACHOs in M31*

APPENDIX VI : Guests in Groningen

E. Allard	Unversity of Hertfordshire, UK
R.J. Allen	Space Telescope Science Institute, Baltimore, USA
M. Balcells	Instituto de Astrofísica de Canarias
S. Basilakos	NOA, Athens, Greece
F. Bernardeau	CEA, Saclay, France
M. Bershady	University of Wisconsin, Madison, USA
A. Blanchard	Observatory Midi-Pyrenees, Toulouse, France
R. Blandford	KIPAC, Stanford, USA
A. Bolton	MIT, USA
D. Bond	CITA, Toronto, Canada
C. del Burgo	Dublin Institute for Advanced Studies, Eire
S. Bush	University of Cambridge, UK
D. Carter	Liverpool John Moores University, UK
C.-W. Chen	National Central University, Taiwan
L. Coccato	University of Padua, Italy
A. Crotts	Columbia University, New York, USA
M. Dickinson	NOAO, Tucson, USA
A. Dressler	Carnegie Observatories, USA
C. Fassnacht	Uiversity of California, Davis, USA
K. Fathi	RIT, Rochester, USA
F.A. Gomez	University of La Plata, Argentine
R. Gonzalez	UNAM, Mexico
A. Grocholski	University of Florida, USA
V. Hill	Observatoire de Paris, France
H. Hoekstra	University of Victoria, Canada
J.T.A. de Jong	M.P.I. für Astronomie, Heidelberg, Germany
R. de Jong	Space Telescope Science Institute, Baltimore, USA
N. Kanekar	NRAO, Socorro, USA
S. Kassin	Lick Observatory, USA
G. Kauffmann	M.P.I. für Astrophysik, Garching, Germany
E. Kutdemir	University of Göttingen, Germany
L. MacArthur	University of Britisch Colombia, Canada
J.-P. Macquart	NRAO, Socorro, USA
M. Mapelli	SISSA, Trieste, Italy
D. Mehlert	M.P.I. für Astronomie, Heidelberg, Germany
R. Meijerink	Leiden Observatory, the Netherlands
H. Morrison	Case Western University, USA
T. Nakagawa	ISAS, Japan
A. Omar	ARIES, Nainital, India
P. Patsis	Research Centre for Astronomy, Athens, Greece
I. Pelupessy	Leiden Observatory, the Netherlands
M. Pettini	University of Cambridge, UK
L. Sparke	University of Wisconsin, Madison, USA

N. Nagar	Universidad de Conception, Chile
P. Sanchez Blasquez	Swinburne University, Australia
S. Shandarin	University of Kansas, USA
J. Silk	University of Oxford, UK
H. Spoon	Cornell University, USA
N. Sugiyama	Nat. Astronomical Obs., Tokyo, Japan
S. Suyu	CalTech, Pasadena, USA
P. Teuben	University of Maryland, College Park, USA
T. Tren	Univ. of California, Santa Barbara, USA
M. Walker	University of Sydney, Australia
N. Walton	University of Cambridge, UK
S.D.M. White	M.P.I. für Astrophysik, Garching, Germany

APPENDIX VII : Memberships, etc.

T.S. van Albada:	Lid, Koninklijke Ned. Akademie van Wetenschappen
P.D. Barthel:	Member, ESA FIRST/Herschel Science Team (Mission Scientist) Member, EC Network POE (Probing Origin of Extragalactic Background) Chairman, National and NOVA Astronomy Education Committee Chairman, NAC High School Astronomy Education Working Group Chairman, Lorentz International Center Astronomy Board (Leiden) Member, Minnaert Committee for Public Outreach in Dutch Astronomy Member/co-founder IKSG Consortium (ASTRO-F Mission) Member LOFAR Survey Consortium
A. Blaauw:	Lid, Koninklijke Ned. Akademie van Wetenschappen Foreign Honorary Member, American Academy of Arts and Sciences Member, Royal Society of Sciences, Uppsala Foreign member, Koninklijke Academie voor Wetenschappen, Letteren en Schone Kunsten van België Foreign member, Royal Danish Academy of Sciences and Letters Associate, Royal Astronomical Society Complimentary Member, Astronomical Society of the Pacific Honorary Member, American Astronomical Society Lid, Hollandsche Maatschappij der Wetenschappen Member, Academia Europaea
W. Brouw:	Secretary, International SKA Steering Committee Chair, LOFAR DCLA Review Panel Member, Chinese Academy of Sciences Advisory Committee for FAST telescope

	Lid, NWO STARE beoordelingscommissie Vice-chair, SKA Site Evaluation Working Group Member, LOFAR Calibration Task Force
A.G. de Bruyn:	Lid, Bestuur Leids Kerkhoven-Bosscha Fonds Lid, Bestuur Jan Hendrik Oort fonds Lid, Bestuur Leids Sterrewacht Fonds Member, NoEMI study group, ASTRON/NWO-STW
G. Comello:	Ere-lid Koninklijke Nederlandse Vereniging voor Weer- en Sterrenkunde
N.G. Douglas:	Member, IAU Commission 9 (Instrumentation & Techniques) PI, Planetary Nebula Spectrograph
Th. de Graauw:	PI, HIFI Project Member, coordinating group for submm. research Member, IAU Commission 44 Editor, Journal of Experimental Astronomy Member, NOVA Instrument Steering Committee
A. Helmi	Member, NWO, Beoordelingscomissie Astronomie (BCA) Member SOC "From Lithium to Uranium : Elemental Tracers of Early Cosmic Evolution", IAU Sympoisum
F.P. Helmich:	Member, JCMT Survey Steering group Member HIFI Steering Committee Co-Investigator, Herschel-HIFI Member, Herschel Calibration Steering group
J.M. van der Hulst:	Chair, ING Board Chair, ASTRON Board Member, Selection Committee Rosalynd Franklin Fellows Member, IAU Commission 28 (Galaxies), 34 (Interstellar Matter) and 40 (Radio Astronomy) Member, Dutch National Committee for Astronomy Member NWO/EW Advies Commissie Astronomie Member NOVA Board Coordinator Network-1 of NOVA
L.V.E. Koopmans	Member, Astronomy Research Committee (ARC) of

LOFAR
Member, Steering committee of the EU-RTN Network "Astrophysics Network for Galaxy LEnsing Studies" (ANGLES)

P.C. van der Kruit:

Chairman of the Board, Netherlands Research School for Astronomy (NOVA)
Chairman, Netherlands Committee for Astronomy (NCA)
Vice-Chairman of the Board, Atacama Large Millimeter Array (ALMA)
President of Council, European Southern Observatory (ESO)
Co-chair, Search committee for the Key Personnel in the Joint ALMA Office
Member, European ALMA Board
Co-chair of the ALMA Japan Negotiating Team
Member, Hubble Space Telescope Time Assigning Committee for cycle 13 and chairman of the panel “Extragalactic II"
Chairman, ESO Negotiating Team for the accession of Spain
Member, ESO Contact Commissie (KNAW)
Chairman of the Board, Stichting Groninger Universiteits Fonds (GUF; Foundation Groningen University Fund)
Chairman, Koninklijk Natuurkundig Genootschap (Royal Physical Sciences Society), Groningen
Member, Board of Directors, Leids Sterrewacht Fonds
Member, Board of Directors, Jan Hendrik Oort Fonds
Chairman, Board of Directors, Leids Kerkhoven-Bosscha Fonds
Chairman, Jacobus C. Kapteyn Fund
Chairman, Foundation Pastoor Schmeits Prijs
Member, IAU Commission 28 (Galaxies), 33 (Structure and Dynamics of the Galactic System) and 40 (Radio Astronomy)

J.W. Pel:

Lid ESO Contact Commissie Kon. Nederlandse Akademie van Wetenschappen
Member IAU Commission 25 (Stellar Photometry and Polarimetry)

R.F. Peletier:	Member ESO OPC panel Member, NWO-VENI grant committee
S.R. Pottasch:	Member, Academia Europae
P.R. Roelfsema:	Member, IAU Commission 34 (Interstellar Matter) and 40 (Radio Astronomy) Member, ESA FIRST Ground segment Advisory Group Member, ESA FIRST Ground Segment Engineering Group Member, Herschel Ground Segment review board
R. Sancisi:	Member, Time Allocation Committee, HST
A.G.G.M. Tielens:	Project scientist, HIFI project
E. Tolstoy:	Member, ESO Telescope Time Allocation committee Member, NOVA Instrument Steering Committee Member, Directors Advisory Committee, Isaac Newton Group Subaru Time Allocation Commitee Referee
S.C. Trager	Member, NFRA Program Committee
E.A. Valentijn:	Member, IAU Working Group on Sky Surveys Member, IAU commission 28 on Galaxies Co-Investigator, OmegaCAM project Coordinator, ASTRO-WISE consortium Co-Investigator, Lofar Bsik Consortium OmegaCEN Member, Data Center Alliance Board (DCA) Co-PI, KIDS project (A 1700 Sq Deg OmegaCAM Survey) Co-PI, Vesuvio project (OmegaCAM survey of nearby superclusters) Co-Investigator, VST-16 project (photo-z with OmegaCAM)
P.R. Wesselius:	Member, IAU Division VI, Commission 44 Coordinator Integrated Receiver INTAS proposal Lid, Stuurgroep North Stars
R. van de Weijgaert:	Board member, Assessor, Nederlandse Astronomen Club Member CAN (Consortium for Astroparticle Physics

in the Netherlands)
Member, CWI project "Markov sequential point processes for image analysis and statistical physics"
Member, Nationale Contact Raad, ASTRON

H. van Woerden: Ere-Voorzitter Koninklijke Nederlandse Vereniging voor Weer- en Sterrenkunde
Erelid, Werkgroep Meteoren KNVWS
Lid, Commissie Dr. J. Van der Bilt-prijs KNVWS
Lid, Redactie Maandblad Zenit
Lid, Commissie van Aanbeveling, Volkssterrenwacht Mercurius, Dordrecht
Lid, Commissie van Aanbeveling, Volkssterrenwacht Halley, Heesch
Member, IAU, Commissions 28, 33, 34, 40 and 41
Member, Organizing committee, working group on Historical Radio Telescopes, IAU Commissions 41 and 40

H. Zondervan: Uitvoerend secretaris, Kapteyn Fonds
Uitvoerend secretaris, Stichting Pastoor Schmeits voor Sterrenkunde

APPENDIX VIII : Personnel (Dec. 31, 2005)

(d) = personnel employed by a third party contract
(n) = personnel employed by NWO
(u) = personnel employed by University of Groningen

Full Professors (Hoogleraren)
P.D. Barthel (u)
W.N. Brouw (d) (ASTRON)
A.G. de Bruyn (0.3) (u)
J.M. van der Hulst (u)
P.C. van der Kruit (u)
J.W. Pel (u)
R. Sancisi (0.3) (u) (until 5/05)
R.H. Sanders (u)
A.G.G.M. Tielens (u)
E.A. Valentijn (u) (NOVA) (from 12/05)

Adjunct Professors
R.F. Peletier (NOVA) (from 3/05)
M.A.M. van de Weijgaert (u)

Tenure Track
A. Helmi (NOVA)
L.V.E. Koopmans (u)
M.C. Spaans (u)
E. Tolstoy (u)
S.C. Trager (u)
M.A.W. Verheijen (u)
S. Zaroubi (u)

Research Staff
J. Adema (NOVA)
A. Baryshev (NOVA)
K. Begeman (u)
N.G. Douglas (u)
R. Hesper (NOVA)
P. Mena Mena (NOVA)

Zero Appointments
H.R. Butcher (ASTRON, full prof.)
J.H. van Gorkom (Columbia Univ., full prof.)
M.W.M. de Graauw (SRON, assoc. prof.)
F.P. Helmich (SRON, assist. prof.)
B. Jones (assoc. prof.)
K.H. Kuijken (Leiden, full prof.)
R. Morganti (ASTRON, UHD)
T.A. Oosterloo (ASTRON, UHD)
P.R. Roelfsema (SRON, assist. prof.)
R. Shipman (SRON, assist. prof.)
P.R. Wesselius (SRON, assoc. prof.)
W. Wild (SRON, assoc. prof.)

Emeriti
T.S. van Albada
A. Blaauw
S.R. Pottasch
R. Sancisi (from 5/05)
H. van Woerden

Research Associates (postdocs)
S. Basilakos (u) (from 10/05)
L. Coccato (n) (from 04/05)
M. Pohlen (u) (from 2/05)
E. Ripamonti (u)

A.A. Cole (u) (until 08/05)
Ph. Heraudeau (u)
J. McFarland (u) (from 05/05)
I. Pérez-Martín (u)
M.C Smith (u)
G.A. Verdoes Kleijn (u) (from 09/05)
S. Yatawatta (NOVA)(from 07/05)

Guest staff members

R. Bottema
G. Mellema
M. Mendez
N.R. Napolitano (until 07/05)
W.E. Schaap
M. Walker (until 12/05)

Ph.D students

M. Angel Aragon Calvo (u)
P. Araya Mayo (d)
M. Arrigoni (u) (from 12/05)
M. Barnabe (n) (from 2/05)
G. Battaglia (u)
A. Berciano Alba (n)
C. Boersma (u) (from 2/05)
R. Boomsma (u)
M. Brentjens (n)
S. Chi (u) (from 06/05)
F. Christen (u)
B. Emonts (u)
W. Frieswijk (u)
K. Ganda (u)
J. Heiner (d)
B.W. Holwerda (d) (until 07/05)
W. Jellema (u)
J.T.A. de Jong (u) (until 09/05)
P. Kamphuis (u)
P. Kemper (d) (from 08/05)
K. Kovacs (u)
A. Labiano-Ortega (u)
B. Letarte (u)
Y.S. Li (u)
E. Loenen (u) (from 09/05)
R. Mani Thomas (d) (from 04/05)
N. Mohammed (d)
E. Noordermeer (u)
M. Obric (n)
C. Ormel (u)
R. Pizzo (NOVA) (from 07/05)
E. Platen (u) (from 03/05)
A. Popping (u) (from 08/05)
J. Sansa (u) (from 09/05)
S.R. Schneider (NOVA)
P. Serra (u)
G. Sikkema (u)
A. Villalobos (u)

General Co-ordinator

G. de Vries (u)

Computing staff

E.M. Helmich (d) (ASTRO-Wise)
J.P. Terlouw (u)
E. Tiesinga (u)
M. Tempelaar (d)
R. Vermeij (d) (ASTRO-Wise)
W.J. Vriend (d) (ASTRO-Wise)
M.G.R. Vogelaar (u)
W. Zwitser (u)

Technical personnel

J. Barkhof (u) (NOVA)
D.R. Boxhoorn (u) (NOVA)
G. Comello (u) (0.2)
G.J. Gerlofsma (u) (NOVA)

Library

H. Koster (u) (0.5)

Secretariat

M.G. Alberts (u) (0.7)
G. Comello (u)(0.8)
H. Zondervan-Kimsma (u) (0.6)
J. Zwegers-Morris (u) (0.7)

APPENDIX IX : Organisation of the Kapteyn Astronomical Institute

Director of Research
P.C. van der Kruit

Director of Education
J.M. van der Hulst

General co-ordinator
G. de Vries

Management Team
P.C. van der Kruit (chair)
J.M. van der Hulst
G. de Vries
H. Zondervan-Kimsma

Raad van Advies (Advisory council)
W. Frieswijk (PhD student)
J.M. van der Hulst
P.C. van der Kruit (chair)
S.P.C. Peters (student) (from 04/05)
E. Starkenburg (student) (until 04/05)
M.A.W. Verheijen
M.G.R. Vogelaar (computer group)
G. de Vries
M.A.M. van de Weijgaert
W. Wild (SRON)
H. Zondervan-Kimsma (secretariat)

Education Committee
M.G. Alberts (secretary)
P.D. Barthel (chair) (from 09/05)
W. Frieswijk (advisor)
J.M. van der Hulst (advisor)
L.V.E. Koopmans
M.C. Spaans
A.G.G.M. Tielens (chair) (until 04/05)
E. Tolstoy
M.G.R. Vogelaar (advisor)
G. de Vries (advisor)

student members
J.S. van Bethlehem (until 09/05)
E. Busekool (from 09/05)
W. Oosterheert
S. P.C. Peters (from 09/05)
B. Scholten
E. Starkenburg (until 03/05)

Education Committee (Raad van Advies)
M.G. Alberts (secretary)
P.D. Barthel (chair) (from 09/05)
J.M. van der Hulst (chair) (until 09/05)
S. P.C. Peters
M.C. Spaans
A.G.G.M. Tielens (until 04/05)
G. de Vries

Groningen members of the National Astronomy Education Committee
P.D. Barthel (chair)
E. Starkenburg

Study advisor
L.V.E. Koopmans (from 09/05)

Study co-ordinator
G. de Vries

M.C. Spaans (until 09/05)

Library Committee

W. Jellema
P.D. Barthel
N.G. Douglas
H. Koster
J.W. Pel
R. van de Weijgaert

PhD-supervisor committee

J.-W. Pel
R.H. Sanders
M.C. Spaans
S.C. Trager
G. de Vries

Members of committees of the Faculty of Mathematics and Natural Sciences

Faculty Council
R.F. Peletier
T. Starkenburg (student)

Communication
R.F. Peletier

Finance Committee
R.F. Peletier

Education and Research
T. Starkenburg

Library Committee
P.D Barthel

Personnel and Organization
T. Starkenburg

Board of Natural Sciences and Technology

P.D. Barthel (Astronomy)

Dutch Graduate School for Astronomy (NOVA)

NOVA is a federation of research institutes from the universities of Leiden (Sterrewacht, Leiden), Amsterdam and Utrecht (together forming the Center for High Energy Astrophysics CHEAF), Groningen (Kapteyn Astronomical Institute) and the Department of Astronomy and Nuclear Physics of the Vrije Universiteit Amsterdam.

Board

P.C. van der Kruit (chair)
E.P.J. van den Heuvel (vice-chair)
M. Franx
J. Kuijpers
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M. van der Klis
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P.D. Barthel
R. Gathier
R. Rutten
K. Wakker (observer)
H.R. Butcher (observer)

Office

P.T. de Zeeuw (director)
W. Boland (deputy director)
R.T.A. Witmer (financial control)
K. Groen (secretary)

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R. Ekers (Australia Telescope)
K. Freeman (Mt. Stromlo, Australia)
M. Rees (Cambridge, UK)
F. Shu (Tsing Hua and Berkeley)
R. Sunyaev (Max Planck, Munich)

APPENDIX X : Telephone numbers and electronic mail addresses

Tel.	Name	user@astro.rug.nl
050–3634089	Albada, Prof. dr. T.S. van	T.S.van.Albada
4079	Alberts, Mevr. M.G.	M.G.Alberts
4083	Aragon Calvo, Drs. M.A.	M.A.Aragon
4060	Araya Melo, Drs. P.	P.Araya
4085	Arrigoni, M.	M.Arrigoni
4091	Aykutalp, Mevr. A.	A.Aykutalp
4276	Barnabe, M.Sc. M.	M.Barnabe
4064	Barthel, Prof. dr. P.D.	P.D.Barthel
4081	Battaglia, Mevr. Drs. G.	G.Battaglia
2454	Begeman, Dr. K.	K.Begeman
3505	Berciano Alba, Mevr. M.Sc A	A.Berciano
4089	Bernardi, Dr. G.	G.Bernardi
4091	Bethlehem, J.S. van	J.S.van.Bethlehem
4084	Blaauw, Prof. dr. A.	A.Blaauw
4087	Boersma, Drs. C.	C.Boersma
4080	Boomsma, R. Drs.	R.Boomsma
4091	Bos, N.	N.Bos
4087	Bottema, Dr. R.	R.Bottema
4061	Bout, J.	J.Bout
2454	Boxhoorn, Drs. D.R.	D.R.Boxhoorn
8326	Brentjens, Drs. M.A.	M.A.Brentjens
4067	Brouw, Prof. dr. W.N.	W.N. Brouw
4057	Bruyn, Prof. Dr. A.G. de	A.G.de.Bruyn
4078	Buddelmeijer, H.	H.Buddelmeijer
3505	Chi, M.Sc S.	S.Chi
4098	Christen, Drs. F.	F.Christen
3487	Coccato, Dr. L.	L.Coccato
4059	Comello, G.	G.Comello
4036	Czoske, Dr. O.	O.Czoske
4088	Douglas, Dr. N.G.	N.G.Douglas
4083	Frieswijk, Drs. W.F.	W.F.Frieswyk
8322	Ganda, Mevr. Drs. K.	K.Ganda
8689	Gomez, F.A.	F.A.Gomez
4056	Gorkom, Prof. dr. J.H. van	J.H.van.Gorkom
4045	Helmi, Mevr. Dr. A.	A.Helmi

Tel.	Name	user@astro.rug.nl
4061	Helmich, E.M.	E.M.Helmich
4036	Heraudeau, Dr. Ph.	P.Heraudeau
4061	Hidding, J..	J.Hidding
4054	Hulst, Prof. Dr. J.M. van der	J.M.van.der.Hulst
4276	Jelic, V.	V.Jelic
4070	Jones, Dr. B.	B.Jones
8322	Kamphuis, P. Drs.	P.Kamphuis
4063	Kemper, Drs. P.	P.Kemper
6519	Koopmans. Dr. L.V.E.	L.V.E.Koopmans
4085	Kovac, Drs. K.	K.Kovac
4062	Kruit, Prof. Dr. P.C. van der	P.C.van.der.Kruit
4070	Kuijken, Dr. K.H.	K.H.Kuijken
4078	Laan, Mevr. T.P.R.	T.P.R.van.der.Laan
4060	Labropoulos, P.	P.Labropoulos
4061	Land, D.D.	D.D.Land
4083	Letarte, Drs. B.	B.Letarte
4053	Li, Mevr. M.Sc. Y.S.	ysleigh
4078	Loenen, Drs. A.F.	A.F.Loenen
8326	McFarland, Dr. J.	J.McFarland
4080	Mellema, Dr. G.	G.Mellema
4089	Mevius, Mevr. Dr. M.	M.Mevius
4060	Mohamed, N.M.A.	N.M.Mohamed
4080	Morganti, Mevr. Dr. R.	R.Morganti
4063	Obric, Mevr. Drs. M.	M.Obric
4080	Oosterloo, Dr. T.A.	T.A.Oosterloo
4085	Ormel, Drs. C.W.	C.W.Ormel
3487	Pandey, Dr. V.	V.N.Pandey
4082	Pel, Dr. J.W.	J.W.Pel
6647	Peletier, Dr. R.F.	R.F.Peletier
4036	Pérez Martin, Mevr. Dr. I.	I.PerezMartin
8689	Pérez-Beaupuits, J.P.	J.P.Perez-Beaupuits
8324	Pizzo, M.Sc. R.	R. Pizzo
4087	Platen, E.	E.Platen
4063	Poelman, Drs. D.	D.Poelman
4095	Pohlen, Dr. M.	M.Pohlen
4078	Polko, Drs. P.	P.Polko
4081	Popping, Drs. P.	A.Popping
4097	Pottasch, Prof. Dr. S.R.	S.R.Pottasch
4091	Praagman, Mevr. A.	A.Praagman
4090	Ripamonti, Dr. E.	E.Ripamonti
4078	Romanini, Mevr. M.	M.Romanini
4057	Sancisi, Prof. Dr. R.	R.Sancisi
4065	Sanders, Prof. Dr. R.H.	R.H.Sanders
3505	Sansa, Mevr. Drs. J.	J.Sansa

Tel.	Name	user@astro.rug.nl
4085	Schaap, Drs. W.E.	W.Schaap
4098	Schneider, Mevr. Drs. T.	S.R.Schneider
7753	Serra, Drs. P.	P.Serra
4095	Sikkema, Drs. G.	G.Sikkema
4093	Smith, Dr. M.C.	M.C.Smith
4092	Spaans, Prof. Dr. M.	M.Spaans
4091	Starkenburg, Mevr. E.	E. Starkenburg
4053	Struve, C.	C.Struve
2535	Tempelaar, Dr. M.J.	M.J.Tempelaar
4068	Terlouw, J.P.	J.P.Terlouw
3476	Thomas, Drs. R.M.	R.M.Thomas
4017	Tiesinga, E.	E.Tiesinga
8323	Tolstoy, Prof. Dr. E.	E.Tolstoy
6625	Trager, Dr. S.C.	S.Trager
4011	Valentijn, Prof. Dr. E.A.	E.A.Valentijn
4081	Vegetti, Mevr. S.	S.Vegetti
4077	Verheijen, Dr. M.A.W.	M.A.W.Verheijen
2535	Vermeij, Dr. R.	R.Vermeij
4053	Villalobos, Drs. A.	A. Villalobos
4096	Vogelaar, Drs. M.G.R.	M.G.R.Vogelaar
2535	Vriend, Drs. W.-J.	W.J.Vriend
4076	Vries, Mevr. Drs. G.	G.de.Vries
4086	Weijgaert, Dr. M.A.M. van de	R.van.de.Weygaert
4091	Wiel, M.H.D. van der	M.H.D.van.der.Wiel
4066	Woerden, Prof. Dr. H. van	H.van.Woerden
4098	Wolk, G. van der	G.van.der.Wolk
3487	Yatawatta, Dr. S.	S.Yatawatta
4055	Zaroubi, Dr. S.	S.Zaroubi
4075	Zondervan, Mevr. H.	H.Zondervan
4073	Zwegers-Morris, Mevr. J.I.	J.I.Zwegers-Morris
4071	Zwitser, W.	W.Zwitser

Laboratorium voor Ruimteonderzoek (SRON)

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050–3634035	Adema, Ir. J.	J.Adema
4026	Barkhof, J.	J.Barkhof
8287	Baryshev, A.M.	A.M.Baryshev
4053	Gerlofsma, G.J.	G.J.Gerlofsma
4031	Graauw, Dr. M.W.M. de	Th.de.Graauw
4799	Helmich, Drs. F.P.	F.P.Helmich
8287	Hesper, Dr. R.	R.Hesper
4058	Jellema, Drs. W.	W.Jellema
4035	Mena Mena, Drs. P.	P.Mena.Mena
4043	Roelfsema, Dr. P.R.	P.R.Roelfsema
7753	Shipman, Dr. R.	R.Shipman
4038	Wesselius, Dr. P.R.	P.R. Wesselius
6243	Wild, Prof. Dr. W.	W.Wild

APPENDIX XI : Address

KAPTEYN ASTRONOMICAL INSTITUTE

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Redactie: J.M. van der Hulst, P.C. van der Kruit
Opmaak: M.G. Alberts
Bijlagen: M.G. Alberts en J.I. Zwegers-Morris