Astronomical Institute
Anton Pannekoek

Annual Report 2004

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A. Raassen, R. A. M. J. Wijers, R. Wijnands (from
January 1st) and P. Ehrenfreund (till September).
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1. Report of the Director

1.1 Introduction and Highlights

The institute continued on the course set out in previous years in its research plan 2000 – 2005 "Frontiers in Astronomy and Cosmic Physics", in the framework of the national research school NOVA for which the University of Amsterdam carried the responsibility as "penvoerder" for the period 1-9-1997 till 1-9-2002. On 1-9-2002 the "penvoorderschap" rotated for the next five years to the Rijks Universiteit Groningen. In 1999 NOVA started its ten-year "Dieptestrategie" research programme "Astrophysics: Unravelling the History of the Universe" as a national "top-researchschool". Our institute plays a major role in two of NOVA’s three research themes: "Late Stages of Stellar Evolution: Physics of Neutron Stars and Black Holes" and "Birth and Death of Stars: The Lifecycle of Gas and Dust", as outlined in the Institute's research plan 2000 – 2005.

Notable Events and Developments

- Prof. Michiel van der Klis was awarded the Spinoza Prize 2004, the highest award for achievement in science in the Netherlands, in a ceremony in The Hague on November 3, by the Minister of Science. He was awarded the Spinoza Prize for his pioneering work in the study of the time variability of X-ray binaries, and especially for discovering quasi-periodic oscillations in their X-ray flux and developing these as a tool for classifying common behavior among different systems and for probing the relativistic gravitational fields near their centers. For this work, he was previously awarded the Rossi Prize of the AAS and the Zel'dovich Award of the Russian Academy of Sciences, among others. The field of X-ray timing studies of compact objects remains a very lively one, and the support provided by the prize money will help keep the Amsterdam group at the forefront of new developments in this fundamental area.

- The one-day Symposium for celebrating this award on November 11.
- The appointment of Prof. R. Wijers as member of the Netherlands Space Research Organization (SRON).
- The appointment of Dr. L. Waters as member of the board of the Netherlands Foundation for Research in Astronomy (ASTRON) in Dwingeloo.
- The awarding of a five year Royal Academy (KNAW) fellowship to Dr. S. Portegies Zwart, in December.
- The workshop "Black holes on all scales", 13 – 15 July 2004, organized by R.
Fender, M., van der Klis and T. Maccorone.
- The MODEST 4b workshop, organized by S. Portegies Zwart, 7 - 8 June 2004.
- The Babylonian Astronomy Workshop, organized by T. de Jong, 26 - 28 May.
- The organization by the Institute of the "Viva Fysica" day for teachers and students of high schools, on 23 January, which was attended by several hundred participants from all over the country.

Research Highlights
- The discovery of an ultrarelativistic jet in the neutron star binary Circinus X-1 (Fender).
- The formation of intermediate mass black holes in young clusters was investigated, and an explanation found why one of two massive young clusters in M 82, MGG-11, contains a candidate for such an object, while the other (MGG-9) does not (Portegies Zwart et al.).
- The excellent performance of the mid-infrared long baseline interferometric instrument MIDI on ESO's Very Large Telescope (VLT) in Chile (Netherlands PI L. Waters). This instrument is now the first common-user interferometric instrument on the VLT, producing milli-arcsecond resolution, and has brought interferometry as a standard observing technique to the European astronomical community.
- The study of the building blocks of planets within the "terrestrial" region of protoplanetary disks, by using the MIDI interferometric instrument on ESO's VLT. For the first time, the composition of dust in the terrestrial regions of proto-planetary disks could be measured. The dust in these regions turns out to be chrysotile silicates, a unique new result which suggests that terrestrial-like planets can form in such inner disk regions (van Boekel, M. in, Waters, Dominik, de Koter).
- Resolution of the central dusty torus in the active galaxy nucleus of NGC 1068 Jaffe et al. (co-author Waters) on the basis of MIDI observations presenting the first optical/infrared fringes ever detected in an extragalactic object.
- Precision radio timing enabled the discovery of the first gamma-ray pulse in a millisecond pulsar, J0218+4232 (Stappers, H. ermsen, K. uiper [SRON]).
- The discovery of the highest-ever column density DLA in the host of GRB030323, without any associated dust and low metallicity (1% of solar) (Vreeswijk, Wijers, et al.).
- The black hole in GX 339-4 must be a rapidly rotating Kerr black hole (a=0.8-0.9) rather than a Schwarzschild one (Van der Klis, Wijnands, with Miller [CfA] and co-workers).
- Recognition of the existence of two classes of neutron stars in binary pulsars, with different masses and space velocities, one class originating from 8-12 M_S stars, the other from more massive stars (Van den Heuvel).
- The first detection of H2D+ (ionized hydrogen-deuterium molecules) in circumstellar disks by Ceccarelli et al. (co-author C. Dominik).
- The MODEST consortium, of which Portegies Zwart is a member, has acquired an externally funded new machine, call MODESTA, which has become operational in October 2004. It is a parallel computer in which each node has a GRAPE, which achieves 1.01 TeraFLOPs sustained speed. The computer will be used to compute the dynamics of evolving stellar clusters.
1.2 General Information

Mission and Research Themes

The ultimate goal of astronomical research is to understand the Universe and the objects within it in terms of the laws of physics. The structure of the Universe and its development over the course of time, the nature, formation, and evolution of planets, stars, galaxies, clusters and super clusters of galaxies, and the properties of the medium in which these are embedded, are all important objects for study. Cosmological questions concerning the nature and evolution of the Universe relate directly to such questions as the geometry of space-time, the nature of dark matter which constitutes over 90% of the gravitating mass in the Universe but leaves no trace in the form of electromagnetic radiation, the formation of the elements, of planetary systems, and ultimately, the origin of the Earth and of life. Furthermore, the Universe provides a unique laboratory for investigating and testing the laws of chemistry and physics under conditions far more extreme than can be reached in laboratories on Earth: astrophysicists study phenomena involving enormous scales of length and mass (the Universe as a whole), huge densities (e.g., neutron stars, black holes), extreme vacua (interstellar and intergalactic media), immense energies (explosive phenomena such as supernovae and quasars), and intense fluxes of particles and radiation (neutrinos, gamma-ray bursts).

Since 1992, all graduate astronomy education in the Netherlands has been concentrated in NOVA, the Netherlands Graduate School for Astronomy. NOVA is a federation of the astronomy institutes at the universities of Amsterdam (UvA), Groningen (RuG), Leiden (RuL), and Utrecht (UU), and also includes the new astronomy group at the Katholieke Universiteit Nijmegen (KUN). The University of Amsterdam carried the responsibility (penvoerderschap) for NOVA for a five-year period from 1997 through 2002 (the penvoerderschap rotates among the four large participating institutes every 5 years). In 2003 the "penvoerderschap" went to the University of Groningen.

The mission of the four university institutes that together constitute NOVA is two-fold:

- to train students and young astronomers at the highest international level;
- to carry out frontline astronomical research in the Netherlands.

In 1998 NOVA was selected by the Minister of Science as one of the six "Top Research Schools" in the country, granting it substantial extra funding for a period of ten years, starting 1-1-1999.

NOVA has three main research themes:
1. Formation and Evolution of galaxies: from high redshift to the present
2. Birth and Death of Stars: the life cycle of matter in the Universe

Research at the University of Amsterdam largely concentrates on the last-mentioned two themes, which we, according to the energies of the electromagnetic radiations emitted by the objects, indicate as "Low Energy Astrophysics" and "High Energy Astrophysics", respectively. These names will be used throughout this report. Through the studies of Gamma Ray Burst sources, the research of the institute now also branches out into the first-mentioned theme. The table on page 8 gives an overview of the present research fields in the Institute, as summarized in the Institute’s research plan for the period 2000 – 2005: "Frontiers in Astronomy and Cosmic Physics".

The Astronomical Institute Anton Pannekoek also considers as an important part of its mission: the dissemination of the results of astronomical research to the general public and to schools. NOVA’s national Office of Public Outreach is located at the institute, and Prof. T. de Jong is member of the Board of the Amsterdam Zoological Garden "Artis", responsible for the Artis-Planetarium – an important educational facility for astronomy. The foundation of this Planetarium in 1982 was the initiative of two UvA professors: E.P.J. van den Heuvel and J.W. Hovenier (at that time professor at the Vrije Universiteit).

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Management Team
### Table 1: Areas and subjects of planned research

<table>
<thead>
<tr>
<th>High-energy and relativistic astrophysics: Final stages of stellar evolution: physics of neutron stars and black holes</th>
<th>Low-energy astrophysics: Birth and death of stars: the life cycle of matter in the universe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area</strong></td>
<td><strong>Subject</strong></td>
</tr>
<tr>
<td>Physics of neutron stars and black holes</td>
<td>Measurement of fundamental parameters of neutron stars (mass, radius, rotation period, magnetic field) and black holes (mass, angular momentum).</td>
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<tr>
<td></td>
<td>Observed behavior of matter in ultra strong gravitational fields; tests of general relativity: frame dragging, last stable orbit.</td>
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<tr>
<td></td>
<td>Studies of relativistic outflows.</td>
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<tr>
<td></td>
<td>Study of (binary) radio pulsars; tests of general relativity.</td>
</tr>
<tr>
<td></td>
<td>Theoretical studies of the formation and evolution of neutron stars (NS) and black holes (BH) in binary systems; formation rate of double neutron stars and black holes.</td>
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<td></td>
<td>Evolution of stellar populations (clusters) with a realistic binary fraction; dynamical formation of NS and BH binaries.</td>
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<tr>
<td>Gamma-Ray Burst Sources</td>
<td>Optical identifications, light curves, redshift distributions, cosmological evolution.</td>
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<tr>
<td></td>
<td>Study of population of parent galaxies as function of redshift.</td>
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<td></td>
<td>Theoretical modeling of bursts; relativistic acceleration mechanisms.</td>
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<td></td>
<td>Search for proto-planets and planets around other stars, using VLTI, ALMA, FIRST.</td>
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<td></td>
<td>Study of formation and evolution of massive stars in Local Group and &quot;Starburst Galaxies&quot;; relation to chemical evolution and dust formation in galaxies in the early Universe.</td>
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<tr>
<td></td>
<td>Theoretical modeling of spectra of circumstellar gas and dust.</td>
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<tr>
<td>Solar System Studies, Lab. Astrophysics</td>
<td>Spectroscopy and photometric studies of planets, comets and asteroids, in order to compare with observed properties of (proto-) planetary systems around other stars, laboratory experiments in light scattering and polarization.</td>
</tr>
<tr>
<td>Late Stages of Stellar Evolution, Mass Loss</td>
<td>Studies of dense circumstellar matter around highly evolved stars; AGB and post-AGB stars; formation of dust in envelopes of these stars.</td>
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<td></td>
<td>Studies of winds of massive stars and mass loss from luminous blue variables (LBVs).</td>
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2. Research Activities

The Institute's research can be broadly divided into relativistic astrophysics of compact objects ('high-energy astrophysics') on the one hand, and star- and planet formation ('low-energy astrophysics') on the other. However, there is a large amount of overlap between the two in the area of studying the nature and evolution of massive stars, so the separation is not very sharp. Overall, the Institute's research touches on most aspects of the life cycle of stars, from their birth out of clouds of dust and gas, to their final explosions when they return much of their gas back to those clouds. We report here on the main research results of the institute that appeared in print in 2004, starting with star and planet formation, followed by the astrophysics of stars and star clusters, to the final fate of stars and physics of compact objects.

2.1 High Energy Astrophysics: Relativistic Astrophysics and Compact Objects

When stars more massive than about 10 times the Sun die, they leave a very compact remnant behind, either a black hole or a neutron star, near which gravity is so strong that one must describe its effects by Einstein's theory of general relativity. The process of material falling into these pits of strong gravity is called accretion. Matter arrives near the compact remnant with nearly the speed of light and gets heated enough to emit X-rays. Some material is flung out again from near the center in narrow beams of material ('jets'). By studying the light emitted from the accreting material and the jets (predominantly X-rays and radio waves), we can study the behavior of material in strong gravity and test Einstein's theory.

In recent years it is becoming clear that many features of this process are very similar between black holes in binary stars, which are typically ten times the mass of the Sun, and black holes in the centers of galaxies, which can be up to a billion times the mass of the Sun. Even when comparing neutron stars and black holes, the accretion process and the jets show many similarities.

Neutron stars can be visible by other means than accretion: when they spin they emit relativistic particles at the expense of their spin energy. These particles emit beams of radio waves as they leave along the strong magnetic field of the neutron star so that two beams of radiation are emitted, like beams of a lighthouse. Sometimes the radiation also includes X and gamma rays. When these beams zip by the earth, we see flashes of light once or twice per revolution of
the neutron star, which has given them the name 'pulsars'. More recently, another type of neutron star has been found with an even stronger magnetic field; because this field is the source of energy for their emission, we call them 'magnetars'.

2.1.1 Probing relativistic potentials with X rays

Black hole candidates

Yu (Illinois), Van der Klis and Fender performed a comparative study of black hole and neutron star X-ray outbursts. In these outbursts, which last for weeks to months, a flare of soft X rays comes days to weeks after the initial flare in hard X rays. Surprisingly, it turned out to be possible to predict the flux of the soft X-ray flare from that of the preceding hard X-ray flare. They conclude from this that X-ray outbursts are determined by processes that take place in the outer parts of the accretion disk, even though the outbursts themselves occur in the inner parts of the disk.

In a number of articles Miller (CfA), Wijnands, Van der Klis and co-workers reported on observations with the Chandra, XMM-Newton and Rossi XTE X-ray satellites of the black hole candidate GX 339-4 during its large 2002/2003 outburst. An extremely skewed, relativistic Fe K emission line and ionised disk reflection spectrum were revealed in these observations. Self-consistent models for the Fe K emission-line profile and disk reflection spectrum rule out an inner disk radius compatible with a Schwarzschild black hole at high confidence. The best-fit inner disk radius of 2-3 gravitational radii suggests that GX 339-4 harbours a black hole with Kerr rotation parameter 0.8-0.9 (the theoretical maximum is 1). The extreme red wing of the line requires a centrally concentrated source of hard X rays that can strongly illuminate the inner disk. Hard X-ray emission from the base of a jet, enhanced by gravitational light-bending effects, could create the concentrated hard X-ray emission. Further work on this large outburst of GX 339-4 using the Rossi XTE in collaboration with Belloni (Milan) is in preparation.

Gogus (NASA), Van der Klis and co-workers reported on two outbursts of the X-ray binary XTE J1908-094 and from the outburst characteristics concluded that the source is a black hole candidate.

2.1.2 AGN

As noted earlier, there are considerable overlaps in the basic physics of central black holes of galaxies and stellar-mass black holes as we study in our own Milky Way. Due to the large difference in mass, which results in a large difference in the size of the systems and in the time scales on which events take place (everything is $10^7 - 10^8$ times slower in an AGN), what we learn from these two types of object is quite complementary.

K-shell absorption lines of O V have been studied in the outflow of Mrk 279. These are not from the usual K-shell absorption by excitation from the O V ground state $1s^22s^2$, but by excitation from an excited metastable level in the $1s^22s2p$ configuration. The population of this metastable level is density sensitive. One of the problems in modelling the outflow is the distance of the wind to the central source. If the density is known the distance can be determined. Therefore the identification of density sensitive features in the spectra of the outflow wind is a tool to determine density and distance from the outflowing wind to the central source. The wavelengths and oscillator strengths of the (density sensitive) absorption lines from the metastable levels were calculated by means of the Cowan code. The basis of these calculations a number of absorption features of O V could be identified. Absorption lines of O V from the ground state were clearly identified. However, the identification of lines from the metastable level is somewhat uncertain. If present the density is of the order of $10^{11}$ cm$^{-3}$, resulting in a distance to the central source of the order of light months.

Low ionisation nuclear emission line region (LINER) galaxies are characterized by optical emission line ratios, which indicate a low level of ionisation. The origin of these emission lines is still the subject of debate: the lines are attributed either to shock heating or to photo-ionisation by a central AGN. The relationship between LINER galaxies, normal galaxies and quasars is still unknown and many LINERs are known to have active galactic nuclei. Starling and collaborators at Mullard Space Science Laboratory, have analysed a recent XMM-Newton observation of the LINER galaxy NGC 7213 with both broad-band and high resolution X-ray spectra and UV photometry. The nuclear radiation at X-ray wavelengths in NGC 7213 is substantially more Seyfert-like than the AGN component in the nearby LINER galaxy M 81, meaning NGC 7213 has the properties of a galaxy somewhere in between a typical Seyfert and a LINER galaxy.
It is likely that there is a continuous distribution of galaxy nuclei between the LINERs and ‘normal’ Seyfert nuclei, over which the X-ray spectral features characteristic of Seyferts such as the neutral Fe K-alpha line, become successively more prominent, while the features characteristic of LINERs such as soft X-ray emission lines diminish in significance. The accretion rate onto the black hole with respect to the Eddington rate is likely to be the overriding factor, with LINER galaxies accreting at much lower rates than Seyfert galaxies, probably due to a lack of material available for accretion in the central regions. In this case LINERs are simply fuel-starved AGN, and could represent the weak, but not yet silent remnants that have evolved from a previous generation of Seyferts and QSOs.

BL Lac objects are associated with the nuclei of active galaxies (AGN). What differentiates them from other AGN is the weakness of their optical emission lines, the compactness of their radio emission, and the high degree of variability they often exhibit. From these and other properties, it has been suggested that in BL Lacs we see emission coming from a jet directed nearly along the line of sight. 1803+784 is a BL Lac with rather remarkable properties. In addition to its compact nuclear emission, it has a very faint secondary component extending for over 300 kpc. Although the inner and outer components of radio sources are usually collinear, in 1803+784 this would imply a source with a deprojected size of many Mpc. The alternatives are that we are either not looking along the jet’s axis, or that the inner and outer component axes do not line up. With Britzen and colleagues at the MPI in Bonn, Strom completed a study of the large- and small-scale structures in this unusual source. The fine structure has been mapped with VLBI arrays like the European VLBI Network (EVN), while the Westerbork Telescope (WSRT) was used to map the most extended emission. From this data, it is possible to trace the direction of the inner jet as it bends through a projected angle of nearly 90 degrees, to finally point along the outer component, suggesting that the nucleus continues to energize the outer structure.

2.1.3 Neutron stars

New and exiting results are continuously being published about the growing group of accreting millisecond X-ray pulsars, of which the first one was discovered nearly 8 years ago by Wijnands & van der Klis. These systems are important for our understanding of binary evolution, especially the link between accreting neutron stars and the millisecond radio pulsars. Wijnands completed several review articles, including for the book "Pulsars New Research" (Nova Science Publishers), in which he summarized all our observational knowledge of these systems. Van Straaten defended his thesis in April, demonstrating that the aperiodic variability of millisecond pulsars and that of ordinary accreting low-magnetic neutron stars is closely related but shows intriguing differences.

Dr. Rudy Wijnands joined the institute as a ‘Univiersitair Docent’. He and his group focus on the X-ray characteristics of accreting neutron stars and black holes in X-ray transients (systems which accrete only sporadically at very high accretion levels). In their "quiescent states", during which no or hardly any accretion occurs, these objects can still be detected in X rays but at very low levels. The origin of this quiescent X-ray emission is not yet clear; it could be due to residual accretion down to the surface of the neutron star or the magnetospheric boundary, or to the cooling of the accretion heated neutron star. Wijnands and his collaborators studied the enigmatic neutron star X-ray transient M X B 1659-29 during its quiescent state. This system is one of the rare neutron-star X-ray transients that accrete matter at a very high level for several years to several decades (instead of weeks to months which is more usual) before turning off again. In such systems, the long period of active accretion will have heated up the neutron-star crust to very high temperatures and the crust should be considerably out of thermal equilibrium with the core. Wijnands and co-workers observed M X B 1659-29 on several occasions with the Chandra X-ray Telescope after the 2.5 years accretion episode of the source. They unexpectedly found that the crust of the neutron star in this system cooled down rapidly in only 1.5 years (see figure 1). These results strongly indicate that the neutron-star crust has a high heat conductivity, e.g. due to consisting of crystalline iron with very few impurities caused by other elements. Furthermore, their results also indicate that the neutron star core is much colder than expected from the standard core cooling models, requiring extra cooling processes to be present in the core.
Figure 1: The cooling of MXB 1659--29 after the end of its active stage. The bolometric flux (left) and the effective temperature (right) decrease more rapidly than had been expected, indicating unusual properties of both core and crust of the neutron star.

Di Salvo, Mendez, Van der Klis and co-workers discovered a broad iron K line in the neutron star 4U 1705-44. This is of particular interest as this can provide a link with similar Fe lines seen from the strong field gravity region around black holes, and because 4U 1705-44 is a known producer of kHz quasi-periodic signals, which are also thought to arise in the strong field region.

Reig (Valencia), Van Straaten and Van der Klis analysed five X-ray outbursts of the neutron star Aquila X-1. Among the many results of this extensive study the discovery of a 6-10 Hz quasi-periodic oscillation previously unknown in this source stands out. Such oscillations were previously attributed to instability in the accretion flow that occurs when the radiation force is as strong as the neutron star’s gravity. However, in Aquila X-1 this oscillation is detected at much lower radiation levels, which puts this model in doubt.

Kuulkers (ESA), Van Straaten, Altamirano, Van der Klis and co-workers studied the properties of a so-called ‘superburst’ in the source 4U 1636-53. The burst (due to thermonuclear burning of carbon in the neutron star’s lower atmosphere) provides the strongest constraints so far on the effect of such an explosion on the more ordinary hydrogen/helium burning bursts. These bursts were suppressed by the superburst and were first seen again 23 days after its occurrence, providing further insight in the sensitivity of the burst phenomenon to the physical circumstances in the bursting layer of the neutron star’s atmosphere.

O’Brien (UK), Van der Klis and co-workers performed simultaneous X-ray and optical spectroscopic observations of the neutron star system Cygnus X-2 using the Rossi X-ray Timing Explorer satellite and the 10 meter Keck II telescope. This project involved the analysis of 220000 optical spectra of the source, each integrated over 72 msec. A linear increase was observed in optical flux with mass accretion rate as inferred from X-ray hardness measurements, whereas the X-ray flux shows a more complex relation to the accretion rate.

Homan (MIT), Wijnands, Fender, Di Salvo, Van der Klis and co-workers studied the correlation between X-ray and radio flux of the neutron star GX 13+1. A delay of 40 minutes was found between X-ray and radio variations, similar to what was previously seen in black holes, strongly suggesting a similar production mechanism of the radio flux, namely, in a jet.

Nelemans (IoA Cambridge, UK), Van der Klis and co-workers performed optical spectroscopy of a number of ultra-compact neutron star X-ray binaries, with very short orbital periods. No evidence was found for hydrogen or helium emission lines, as are seen in classical X-ray binaries, but carbon and oxygen lines were seen. This provides evidence for the donor stars in these systems being carbon-oxygen white dwarfs.

Di Salvo and co-workers studied the 13.6 sec X-ray pulsar EXO 0531-6609.2 using two BeppoSA X observations. They found a spin-up: the pulse period became shorter at an average rate of one part in ten billion per cycle. By comparing this with previously reported period measurements they concluded that the star shows alternating spin-up and spin-down behaviour that correlates well with the X-ray luminosity.

Using the Chandra X-ray Telescope, Jonker (CfA), Wijnands & Van der Klis studied another neutron-star X-ray transient, SAX J1810.8-2609, in its quiescent state. They found that the source was very weak in quiescence with a X-ray luminosity of only $\sim 10^{32}$ erg s$^{-1}$ which is at the low end of the luminosity range seen for other quiescent neutron-star X-ray transients. This detection supports the suggestion that there exists a group of faint quiescent neutron star systems with lower luminosities and different spectral characteristics compared to the brighter systems.

2.1.4 Pulsars and magnetars

The pulsar group has continued to pursue a better understanding of the pulsar emission mechanism through the use of high quality observations using the
Westerbork Synthesis Radio Telescope and the pulsar machine PuMa and also the development of new analysis techniques.

Weltvrede, Stappers and Edwards have been working on a large survey of almost 200 radio pulsars with the aim to find out what the subpulse modulation properties of these pulsars are. The individual, stable and highly repeatable average pulse profiles of radio pulsars are often the sum of many subpulses. These subpulses are believed to be directly related to the active emission regions and so an improved understanding is important for better constraining the emission models. In a number of bright pulsars these subpulses were known to change in a systematic way, such that they are seen to drift across the window defined by the average pulse profile. This drifting phenomenon is not understood but is thought to be related to the local magnetic and electric field conditions. Until now only a small number of pulsars had been shown to exhibit this phenomenon.

Using a 2D-fluctuation spectrum analysis developed by Edwards and Stappers on our new sample of data we have tripled the sample of drifters. Moreover our source list is unbiased on pulsar type, which allows us for the first time ever to measure statistics of the relationship between subpulse modulation properties and other properties of the pulsar such as its magnetic field strength or age. As well as measuring the statistics we have found a number of pulsars with interesting subpulse properties which deserve follow up research. For example, we have found six new bi-drifting pulsars. These are pulsars with different subpulse drift directions in different pulse profile components, which triples the total number of these sources known. This kind of behaviour is unexpected in most models for drifting subpulses and thus we are planning further observations and more sophisticated analysis of these sources with which to better constrain these models or potentially develop new models.

Polarization observations provide another excellent tool for probing the emission properties of radio pulsars. The dependence of linear polarization position angle on pulsar rotational phase, can, for some pulsars, be explained as arising in the vicinity of the magnetic pole, polarized linearly at the position angle of the sky projection of the magnetic field lines. For other pulsars this is not the case, and for some of these the distribution of position angles (PAs) in individual pulses has been shown to be bimodal about two values separated by 90 degrees, so called orthogonal polarization modes (OPMs). Some pulsars even show jumps of 90 degrees in their PAs indicating a change in dominance between the two OPMs. The origins of these modes, the deviations from orthogonality observed in some pulsars and the origin of circular polarization are not yet well understood, but are the subject of detailed study.

Edwards and Stappers have made a detailed study of the polarization of single pulses from PSR B0329+54 using the W SRT and PuMa and employing new techniques to place greater constraints on the nature and origin of ellipticity and non-orthogonality of pulsar polarization. They find that the distribution of polarization orientations in the central component of the pulse profile diverges strongly from the standard pictured of OPMs. They argue that the observed properties can be understood in terms of birefringent alterations in the relative phase of two elliptically polarized propagation modes in the pulsar magnetosphere (i.e. generalized Faraday rotation). The ellipticity of the modes implies a significant charge density in the plasma, and the presence of both senses of circular polarization, yet only one mode shows the effect, indicates that refracted ordinary-mode rays are important in pulsar emission. Over the rest of the pulse profile the emission is observed to be broadly consistent with the OPM model.

In collaboration with Hermsen and Kuiper (SRON), Stappers also pursued the nature of the emission process at higher energies. Typically long integrations are needed to detect radio pulsars at X-ray and gamma-ray wavelengths, if they can be detected at all. The long (sometimes many days) observations are often also made up of observations separated by days or weeks. Therefore, in order to coherently fold the data at the correct pulsar period, a very accurate model of how the pulsar period has evolved over this period of time is required.

The millisecond pulsar J0218+4232 is one of only a handful of radio pulsars to be detected at high photon energies and is also a part of the high precision pulsar timing program being led by Stappers at the W SRT. The precise ephemeris for the pulsar, which this program has determined, has allowed us to fold both X-ray and gamma-ray data to form more accurate pulse profiles. This has allowed us to show in X-ray data from the Chandra X-ray Observatory that the unpulsed component seen in the X rays is not spatially extended. We were also able to confirm the presence of a high-energy gamma-ray pulse, the first such detection for a millisecond pulsar. It was also possible to use the precise ephemeris to carry out absolute time alignment between radio, X-ray and gamma-ray profiles, which shows that the two non-thermal pulses in the X-ray profile are found to be aligned with two of the three pulses visible at radio frequencies and more importantly with the two gamma-ray pulses seen in the MeV pulse profile.

In collaboration with Kuiper (SRON), Hermsen and Mendez reported the
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Isolated neutron stars are supposed to be steady X-ray sources; for that reason, one of them, RX J0720-3125, was regularly observed with XMM-Newton as a calibration source. Surprisingly, comparison of the observations made with the Reflection Grating Spectrometer on board XMM-Newton show that the X-ray spectrum of RX J0720-3125 changes on time scales of months to years. The changes are such that the emission in the hard part of the spectrum (below ~20 Angstroms) increases, whereas the emission at longer wavelengths decreases. These changes are inconsistentboth with an increase/decrease of the temperature at the surface of the neutron star (in that case the emission should increase/decrease simultaneously at every wavelength) or a change of the (local) absorbing material along the line of sight (this cannot account for the flux increase at short wavelengths). Comparisons with other sources show that the spectral changes are not due to long-term changes of the instrument calibration. Furthermore, the change is accompanied by an energy-dependent change in the pulse profile, which also rules out that possibility. Observations with the Low-Energy Transmission Grating Spectrometer on board Chandra confirm these results. The most likely explanation for this behaviour is precession of the neutron star in RX J0720-3125. In the past, precession of the neutron star has been proposed as the mechanism responsible for the long-term variations in both the pulse profile and the rate of slow-down of the radio pulsar PSR B1828-11. If this interpretation is correct, it implies that the neutron star in RX J0720-3125 is not spherical, and the required amplitude of the deformation would exclude the popular model for glitches as due to vortex pinning (the tying of rotation vortices of the super fluid interior to atomic nuclei in the solid crust).

2.1.5 Jets

In the field of jets in X-ray binaries and their relation to those in Active Galactic Nuclei, further significant progress was made in both observational and inter-pretation. Fender and collaborators published an article in Nature reporting the discovery of the first ultra-relativistic jet from a neutron star X-ray binary, CX J0142-48, which is the fastest-moving bulk flow ever observed within our galaxy. Fender and Belloni further completed a paper for Annual Reviews of Astronomy & Astrophysics, on the disc-jet coupling in accreting black holes systems. This in turn led to another paper, together with Gallo, putting forward a ‘unified’ model for the disc-jet coupling in black hole X-ray binaries. Fender was involved in several other papers on this topic, and also wrote a review chapter on jet from galactic binaries for the forthcoming book setting out the science case for the Square Kilometre Array. Also, the group organized an international meeting at the Institute in July, entitled ‘From X-ray Binaries to Quasars: Black Holes Accretion on All Mass Scales’. It was devoted to the theme of unifying the physics of many types of accreting high-energy source. About 50 people attended and made the meeting very lively and successful.

Gallo, Fender and co-workers also discovered a large-scale, relativistic jet from Galactic stellar black hole G339-4. In 2002 May, the source displayed a dramatic outburst in X-ray luminosity, contemporaneously exhibiting a very bright radio flare. We monitored this outburst with the Australia Telescope Compact Array over different epochs, and imaged a collimated structure extending to about 12 arcsec, with apparent velocity greater than 0.9 times the speed of light. These observations confirm that transient large-scale jets are likely to be common events triggered by X-ray state transitions in black hole X-ray binaries. In order to study the possible jet emission, and in general the disc-jet connection in low-magnetic field neutron star X-ray binaries during their soft X-ray state, and compare their behaviour with black hole XRBs, Migliari studied simultaneous radio/X-ray observations of the systems 4U 1820-30 and Ser X-1. Migliari, Fender, and collaborators made use of Very Large Array (VLA) radio observations, Rossi X-ray Timing Explorer (RXTE) X-ray observations, and also of Cerro Tololo Inter-American Observatory optical observations to identify, comparing the optical and the radio counterpart positions of the binary they have found, the actual optical counterpart of Ser X-1.

2.1.6 Gamma-ray sources

Hermesen continued his search for counterparts of the unidentified high-energy (above 100 MeV) gamma-ray sources detected between 1991 and 2000 by EGRET aboard NASA’s Compton Gamma-Ray Observatory. Candidate-counterparts are Galactic objects like rotation-powered neutron stars, including
millisecond pulsars, micro-quasars, different types of transient X-ray binaries, but also AGN, the latter when their powerful relativistic outflows (jets) are directed towards us (blazars). The very luminous high-energy gamma-ray sources have positional uncertainties of about 0.5 to 1.0 degree, and appear to be very weak X-ray sources, making identification difficult. H. Hermsen and co-workers investigated at intermediate energies the MeV properties of 173 unidentified EGRET sources by analysing the simultaneously collected COMPTEL MeV data for each individual source. For 22 EGRET sources additional constraining information was obtained. These sources have spectra with turnovers/breaks between 1 MeV and 100 MeV, reaching their maximum luminosities in this energy window. A 100 MeV they have rather soft spectra (average photon index 2.7), seem to cluster in the inner Galaxy, and about 50% of them appear to be variable. Together with D. H. Hartog, K. Uiper (SRON), and Van der Klis, Hermsen searched with the imager IBIS aboard ESA’s INTEGRAL for counterparts in the hard X-ray window. So far no identification with a galactic object could be claimed, but detection of several new hard X-ray sources has been reported in Astronomers Telegrams, e.g. IGR J00234+6141, a new X-ray binary, IGR J00370+6122, a new high-mass X-ray binary, and the detection of hard X-rays from the Anomalous X-ray Pulsar/magnetar 4U 0142+614. These “serendipitous” detections of new sources as well as known sources in the large field-of-view of INTEGRAL are being followed up.

Patel (NASA), Van der Klis and co-workers also with INTEGRAL found an enigmatic new transient source called IGR J16358-4726. This object has a very strong periodic flux modulation with a period of about 6000 seconds and peak-to-peak pulse fraction of 70%. The nature of this object is under investigation.

As part of a large collaboration, Van der Klis participated in several target of opportunity observations with the INTEGRAL gamma-ray satellite of the soft gamma-ray repeater 5GR 1806-20. This object is thought to be a magnetar: a neutron star with an ultra-strong magnetic field occasionally producing large numbers of soft gamma-ray bursts through electromagnetic processes. More than 100 bursts were detected.

### 2.1.7 Gamma-ray bursts

The study of these cosmic explosions has vastly expanded since the discovery in 1997 of long-wavelength afterglows in GRBs. The Amsterdam group and our colleagues at SRON/Utrecht played a key role in this breakthrough via their involvement in the Italian-Dutch BeppoSAX satellite as well as via the discovery of the first optical afterglow. After a difficult period following the death of Van Paradijs, the gamma-ray burst group is expanding again. Support from NWO through a vici grant to Wijers has greatly helped this, in anticipation of the launch of the Swift satellite, which eventually occurred in November 2004; Swift appears to be functioning very well. The group’s new members are PhD students Curran and Spreeuw, and postdoctoral fellows Pe’er and Yoon (the latter funded by an NWO Veni grant). The Amsterdam group continues to play a leading role in GRACE, an international collaboration for observing GRB afterglows at ESO, and is PI of the EU-funded Research Training Network on GRBs, which had a successful midterm evaluation with its EU grant officer during a meeting in Rome in October.

The study of gamma-ray bursts continues to generate considerable excitement. Progress is being made both in revealing what the sources and mechanisms are of these most energetic events, and in using their bright presence in the early, distant Universe to study the history of star formation as soon as half a billion years after the Big Bang.

### 2.1.8 Gamma-ray burst sources and mechanisms

It has been established that gamma-ray bursts of the long-soft variety, which have a duration of more than 2 s and constitute about 75% of the observed BATSE population and which are the only ones for which afterglows have been observed, are associated with massive stars. In a few cases, it has been shown that they are specifically associated with a very energetic type Ic supernova, sometimes called ‘hyper nova’ or ‘collapsar’. Kouveliotou (NASA MSFC), Wijers, and collaborators (2004) did a comparative study of the late-time X-ray behaviour of peculiar supernovae and some gamma-ray bursts with a known or suspected supernova association. They found that the initial fluxes and rates of decay vary greatly between objects, but that they all seem to converge towards a luminosity of about 10^{41} erg/s after 1000 days. It is an important unsolved problem whether the ones that start low are intrinsically weak, or whether the X-ray emission is beamed at early times and the difference between weak and strong depends on our viewing angle.

A type of gamma-ray burst that was identified first by BeppoSAX are the so-called X-ray flashes (XRFs), which resemble long-soft bursts in many ways, but have a relatively much softer spectrum. Their afterglow properties have only been tested very few times. The work of Fynbo (Copenhagen), Wijers, and
collaborators on XRF 030723 is particularly interesting: despite deep spectroscopy, no optical lines were found that allowed a redshift measurement. However, the light curve is very peculiar, and shows a re-rise and fall superposed on a more usual behaviour 1-2 weeks after the burst. This could be a supernova component, but then it is a different type of supernova than the energetic Ic's seen in previous cases.

Studies of the light curve and polarization of the afterglow of GRB 020813 by Lazzati (Cambridge), Gorosabel (Granada), Wijers, Rol, and co-workers demonstrated that the magnetic field structure in the outflow of a gamma-ray burst can be constrained with polarization measurements, but that firm constraints require a significant number of measurements before and after the jet break. The study found some indication that the polarization of afterglows with smooth light curves may be somewhat lower than of irregular afterglows. The extensive afterglow program of GRACE also produced studies of the afterglows of GRB 030226 and GRB 030528.

2.1.9 Gamma-ray bursts as probes of the universe

The power of gamma-ray bursts to probe the conditions of star formation at high redshift and the nature of galaxies in which they occur has been demonstrated again clearly with a number of studies. The host galaxies of gamma-ray bursts are under luminous on average relative to other samples of galaxies at the same redshift. At present, the cause for this is not known. It may be that star formation is dominated by faint small galaxies, which are underrepresented in magnitude-limited optical surveys. A gamma-ray burst can be detected even when the host is not visible, however, and absorption lines in its spectrum provide information about the host, so such a sample has no bias on galaxy luminosity. A study by Tanvir (Hertfordshire), Wijers, and co-workers of SCUBA data on gamma-ray burst hosts revealed that the fraction of such hosts that is over luminous in the sub-mm band is rather less than one would expect based on the hypothesis that the gamma-ray burst rate traces the star formation rate.

The strongest ever damped Lyman alpha system was found in the spectrum of the afterglow of GRB 030323 by Vreeswijk (ESO), Wijers, and collaborators, at redshift 3.37. It has a hydrogen column of almost $10^{22}$ cm$^{-2}$ in atomic hydrogen, and no detectable molecular hydrogen, implying a molecular fraction of less than $10^{-5}$. There is no indication of any extinction due to dust in the spectrum, whereas such a H column in our galaxy brings 10 magnitudes of visual extinction. They conclude that the host is very dusty and metal poor.

These studies taken together suggest that the relation between star formation and occurrence of gamma-ray bursts: the latter may occur relatively more often in metal poor and/or small hosts.

Figure 2: The optical spectrum of the afterglow of GRB 030323. Due to the redshift of $z=3.37$, the yellow-red light we see is really ultraviolet. The deep line near 4500 Ångstrom is therefore really the Hydrogen Lyman alpha line, indicating a very large cloud of gas in front of this burst. The dust normally associated with that gas would totally obscure all the light, so we conclude that the gas in the galaxy where GRB030323 took place has extremely little dust in it.

A study by Jacobsson (Copenhagen), Wijers, and co-workers of the absorption lines in GRB 030429 at $z=2.66$ found that the spectrum was rich enough that it provided information about material on all size scales around the burst: the stellar wind, the host ISM, and even the intergalactic medium had left signatures in the spectra.

2.2 Astrophysics of Stars and Star Clusters

Stars are usually born in groups, called clusters, of size varying from a few tens of stars to hundreds of thousands. Studying stars in their cluster environment is often helpful because important properties such as their ages and distances are more easily determined for a whole cluster than for an individual star. Both for understanding the birth of stars, and for understanding their eventual fates, the study of stellar evolution is fundamental.

The evolution of massive stars is a key research topic at the institute. These stars end their lives in a supernova explosion, and are likely candidates for the progenitors of gamma ray bursts. After such cosmic fireworks, the cinders that are
left are either neutron stars or black holes. Mass loss plays a pivotal role in the lives of massive stars, and essentially controls the nature of the compact remnant. Therefore, the mechanism of mass-loss is studied intensively at the Anton Pannekoek institute.

The life of stars can be complicated by their cluster environment, because some clusters are dense enough that stars can collide in them, leading to novel pathways for making various objects (such as X-ray binaries) and to certain objects that may not form in any other way (such as possibly ultra massive stars).

There is already a long tradition of research at the institute of investigating globular clusters, which are very old (many billions of years) in order to explain the unusually large numbers of X-ray binaries and pulsars in them. More recently, research has focused also on young clusters. One goal here is to study a population of more or less coeval stars and try to reconstruct the natal properties of the binaries among them. Another is to investigate the interplay between stellar and dynamical evolution in cluster environments in which the characteristic timescales of these processes are comparable (a few million years).

2.2.1 The formation and early evolution of massive stars

Though massive stars are rare, they are important contributors to the energy, momentum, ionising radiation, and nuclear processed material in the ISM of their host galaxies. They end their lives in a supernova explosion, and are likely candidates for the progenitors of gamma ray bursts. Surprisingly little is known about the formation, life, and death of massive stars. To put it bluntly: we do not know how massive stars form. An important reason for this gap in our knowledge is that these star form deeply embedded in their natal gas and dust clouds, therefore (almost) their entire formation process is obscured from view. Once formed, these stars show strong outflows through which they integrated over their entire lifetime - may loose up to 80 or 90 percent of their initial mass. These stellar winds are poorly understood. In view of the impact of these winds on the properties and evolution of the galaxies in which these massive stars reside, it is a fundamental goal in stellar astrophysics to understand the wind driving mechanism(s) and to predict the mass-loss properties for all types of massive stars throughout cosmological time. Massive stars evolve through different phases (called types), starting out as O stars. At some point they evolve into luminous blue variables. Finally, they end their life in a supernova explosion somewhere during their red Supergiant or Wolf-Rayet phase.

Lenorzer, Bik, de Koter, Waters, Kaper, and others continued their study of the photometric and spectroscopic properties of the youngest massive stars, deeply embedded in their natal cloud. These star-forming regions are totally obscured in visible light; observations are required at near-infrared wavelengths, where the extinction due to the surrounding gas and dust is strongly reduced, in order to study the formation process of massive stars. With the discovery of IRS 2b, the O star ionising the Flame Nebula (N GC 2004), the nature of the bright infrared source IRS 2 remains unclear. IRS 2 is associated with the ultra-compact radio source G 206.543-16.347 and a historical example of a massive young stellar object (YSO). However, Lenorzer et al. (2004) demonstrate that much of the mid-infrared emission towards IRS 2, as well as the far infrared emission peaking at 100 micron, do not originate in the direct surroundings of IRS 2, but instead from an extended molecular cloud. Using simple gaseous and/or dust models of prescribed geometry, they find strong indications that the infrared flux originating in the circumstellar material of IRS 2 is dominated by emission from a dense gaseous disk with a radius of about 0.6 AU. At radio wavelengths the flux density distribution is best described by a stellar wind recombining at a radius of about 100 AU. Although NGC 2004 IR S 2 shares many similarities with BN-like objects, no evidence is found for the presence of a dust shell surrounding this object.

Schröder, Kaper and others compare the absolute visual magnitude of the majority of bright O stars in the sky as predicted from their spectral type with the absolute magnitude calculated from their apparent magnitude and the Hipparcos parallax. They find that many stars appear to be much fainter than expected, up to five magnitudes. No evidence is found for a correlation between magnitude differences and the stellar rotational velocity as suggested for OB stars by Lamers et al. (1997, A & A, 325, L25), whose small sample of stars is partly included in ours. Instead, by means of a simulation they show how these differences arise naturally from the large distances at which O stars are located, and the level of precision of the parallax measurements achieved by Hipparcos. Straightforwardly deriving a distance from the Hipparcos parallax yields reliable results for one or two O stars only.

The relatively bright T Tauri Star SU Aurigae was observed in 1996 with the international MuSiCos team, existing of a global multisided network of 2m class telescopes with high resolution spectrographs, over a period of 10 days, and participation of Amsterdam observers (H enrichs, Kaper). The analysis turned out to be equally successful as very complicated because of the different instrumentation techniques, and uncovered a 2.7 days rotation period, whereas syste-
Magnetic line profile changes lead to Doppler imaging of the surface. Some magnetic measurements were also collected and a marginal value could be set.

Since the thesis of de Jong in 2000, de Jong, Kaper and Henrichs worked with John Brown (Glasgow) on the inverse problem of converting real data to a physical model, applied to rotationally modulated stellar wind structures, in order to extract the relevant physical parameters. It was demonstrated to work under certain conditions when applied to massive stars, which show abundantly absorption features in their winds.

Mokiem, de Koter and co-workers presented state-of-the-art predictions of the effect of metal content on the ionising continua of hydrogen, helium, and other prominent nebular species of O main sequence stars. It is found that the total number of Lyman photons emitted by O dwarf atmospheres is almost independent of line blanketing effects and metallicity for a given effective temperature. However, it is shown that the spectral energy distribution at wavelengths of 450 Å or shorter is highly dependent on metallicity. This is reflected in the behaviour of nebular fine-structure line ratios such as [N II]/[N I] 15.5/12.8 micron and [O I]/[O II] 9.0/7.0 micron. This dependence complicates the use of these nebular ratios as diagnostic tools for the effective temperature determination of the ionizing stars in H II regions and for age dating of starburst regions in galaxies.

State-of-the-art line blanketed unified stellar photosphere & wind models for O-type stars were computed by Lenorzer, Mokiem, de Koter, and Puls, in order to evaluated the potential of near-infrared spectral lines for characterization of stellar and stellar wind properties. The model grid includes dwarfs, giants, and super giants. The behaviour of the strongest lines of hydrogen and helium in spectral windows that can be observed using ground-based instrumentation was investigated and compared with observations. Our main findings are that (i) He I/He II lines in the J, H, and K bands can be used for spectral type determination; (ii) wind clumping is distance dependent, and (iii) that the Br line is an excellent mass-loss indicator.

Smith, in collaboration with de Koter investigated the distribution of luminous blue variable stars (LBVs) in the Hertzsprung-Russell diagram. There appears to be a deficiency of these massive post-main sequence stars at luminosities between 400,000 and 630,000 solar luminosities. The upper boundary, interestingly, is also where the temperature-dependent S Doradus instability strip intersects the bistability jump at 21,000 degrees. Because of increased opacity, winds of early-type super giants are slower and denser on the cool side of the bistability jump, and we postulate that this may trigger optically thick winds that inhibit quiescent LBVs from residing there. We conduct numerical simulations of radiation-driven winds and show that for relatively low stellar masses the crossing of the bistability jump may result in an apparent shift of the star in the H-R diagram, that brings the object in the region where yellow hyper giants are observed. These yellow hyper giants show a preferred luminosity range that is complementary to the LBVs (i.e. they all have luminosities between 400,000 and 630,000 times the solar value). This suggests a direct link between LBVs and yellow hyper giants.

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Figure 3: Upper Hertzsprung-Russell diagram for Luminous Blue Variable (LBV) stars and related stars, including LBV candidates with circumstellar shells and cool hyper giants. Shaded areas represent the places where LBVs are most commonly found: either on the diagonal S Doradus instability strip or in the nearly constant temperature outburst phase. Note that the yellow hyper giants show a preferred luminosity range that is complementary to the LBVs, suggesting a direct link between LBVs and yellow hyper giants. Numerical simulations of radiation-driven LBV winds show that, if the stellar mass is as low as ~10 solar masses, in this particular luminosity range outflows may develop that are so intense that they essentially produce an opaque cocoon (or pseudo photosphere) around the star that makes the star appear to have a temperature that is roughly 5,000 K.

Massive stars up to spectral type B1 show strong X-ray radiation. The X-ray spectra obtained from these sources show a broad temperature range that is
described by several temperature components. Temperatures in the range from .5 to 5-M K can be understood from instabilities in the wind and clumps formed in the wind. The higher temperatures, however, only appear in binary systems. They are the result of the colliding wind between the two stars. Over the last year we have investigated the X-ray spectrum of the β-C ephelid like variable star β-Cen. This star shows an optical and UV variability on a period of 0.157–day. No relation between the variability of this star in the optical spectrum and the emissivity in the X-ray range could be established. The surface temperature of β-Cen is 21100–K. This positions this star right on the bi-stability point where Fe-IV or Fe-III dominates the spectrum and therefore strongly affects the wind properties. The determined temperatures range from .9 to 7-M K. The higher temperature component can be explained only when β-Cen is at the higher (hotter) side of the bi-stability point or when the high temperature component is caused by a wind-wind collisions with a companying star.

2.2.2 Evolution of binary stars

The Wolf-Rayet object WR 20a was discovered as an emission-line star in a Schmidt survey at the Bossche Observatory in Lembang (West Java, Indonesia). While it took until 1991 to recognize its WR characteristics, only recently its massive binary characteristics were recognized, by Rauw et al. including van der Hucht from Amsterdam. The object turned out to consist of two WN6ha objects of almost similar mass, 83 and 82 solar masses, orbiting each other with a period of 3.686 days. This makes WR 20a the heaviest binary ever weighed. At a distance of 7.9 kpc, the objects belongs to the open cluster Westerlund 2 in Carina, but its location, 1.1pc from the cluster core, suggests that the WR 20a was ejected from the core by dynamical interaction. Finally, the position of the binary components in the H-R diagram suggests that they are core-hydrogen burning stars in a pre-LBV phase.

Dewi and Van den H euvel examined the formation of the double radio pulsar system PSR J0737-3039, which has an orbital period of only 2.4 hours and an orbital eccentricity of 0.09. They found that the system must have originated from a helium star plus neutron star binary, in which the helium star had a relatively low mass (< 3.5 solar masses), and they were able to put constraints on the velocity kick that the second-born neutron star received at its birth.

Van den H euvel analysed the properties of the 7 double neutron star systems that are presently known in the disk of our Galaxy. He found that in 5 out of these 7 systems the mass of the second-born neutron star is very low, between 1.18 and 1.30 Solar masses. Just all these 5 systems have a low orbital eccentricity, between 0.09 and 0.25, indicating that the second-born neutron star cannot have received a large kick velocity (a few hundred km/s) at its birth, as was so far assumed to always be the case. This finding is similar to the discovery by Pfahl et al. in 2002 that there is a population of B-emission X-ray binaries which have very small orbital eccentricities, indicating that their neutron stars also received at most a very small kick velocity (< 50 km/s) at their births. Based on the finding that the "low-kick velocity" neutron stars always have a small mass (on average 1.24 solar masses) van den H euvel suggested that these neutron stars were formed by the electron-capture collapse of the degenerate Oxygen-N neon-M magnesium cores of stars with initial main-sequence masses in the range 8 to 12 solar masses. At the time of collapse the cores of these stars have a mass of 1.44 solar masses and after losing the gravitational binding energy of a neutron star (~ 0.20 solar masses) these will produce neutron stars with a mass of ~ 1.24 solar masses. On the other hand, stars with initial main-sequence masses above 12 solar masses will evolve to produce a collapsing iron core. It is suggested that these collapses produce the neutron stars with high birth kick velocities, of order at least a few hundred km/s.

Together with Bitzakraki (University of Athens, Greece) and Tout (Cambridge University UK), Van den H euvel completed a study of evolutionary models for the formation of the Luminous Supersoft X-ray Sources, which are white dwarfs in binaries with surface nuclear burning.

Sipior, Portegies Zwart, and co-workers investigated the possibility that mass transfer early in the evolution of a massive binary can effect a reversal of the end states of the two components, resulting in a neutron star that forms before a black hole. In this sense, such systems would comprise the high-mass analogues of white dwarf-neutron star systems such as PSR B2303+46. One consequence of this reversal is that a second episode of mass transfer from the black hole progenitor star can recycle the nascent neutron star, extending the life of the pulsar. A n estimate of the formation rate through this channel is first performed via a simple analytical approach, and then refined using the results of the SeBa binary evolution package. The central role of kicks in determining the survival rate of these binaries is clearly demonstrated. The final result is expressed in terms of the number of field pulsars one can expect for every single neutron star-black hole (ns, bh) binary. We also calculate this figure for black hole-neutron star (bh, ns) systems formed through the usual channel. Assuming kicks drawn from the distribution of Cordes & Chernoff, we find an
expectation value of one (ns, bh) binary per $4 \times 10^4$ pulsars, and one (bh, ns)
system for every 1500 pulsars. This helps to explain why neither system has
been seen to date, though it suggests that detection of a (bh, ns) binary is
imminent.

2.2.3 Dynamics of star clusters and stellar encounters

The study of evolving star clusters as a collection of point masses requires
dedicated computer hardware if the number of stars becomes as large as in real
clusters. To this end, the GRAvity PipE (GRAPE) developed at Tokyo
University. These dedicated machines are built, supported, and used within the
context of the MODEST collaboration. In Amsterdam, the effort is led by
Portegies Zwart, who holds a joint appointment between API and IVl
(Computer Science). In addition to the N-body dynamics, a realistic calculation
must account for stellar evolution, which is done on a fast workstation. Quite
generally, therefore, such calculations require hybrid computing, meaning that a
mix of algorithms run simultaneously to do the calculation, often on a number of
different platforms of which the actions have to be coordinated. The
Amsterdam group organized the Modest-4b workshop in June 2004, where the
collaboration met to discuss progress and to work together. A major milestone
was achieved in October, when the NWO-funded MODEST platform of
dedicated parallel computers with GRAPE boards became available for
production, with 1.01 TFLOPs sustained speed.

A luminous X-ray source is associated with a cluster (MGG-11) of young stars
∼ 200, pc from the centre of the starburst galaxy M 82. The properties of the
X-ray source are best explained by a black hole with a mass of at least 350 $M_\odot$
which is intermediate between stellar-mass and super massive black holes.
A nearby but somewhat more massive star cluster (MGG-9) shows no evidence
of such an intermediate mass black hole, raising the issue of just what physical
characteristics of the clusters can account for this difference. Here we report
numerical simulations of the evolution and the motions of stars within the
clusters, where stars are allowed to merger with each other. We find that for
MGG-11 dynamical friction leads to the massive stars sinking rapidly to the
centre of the cluster to participate in a runaway collision, thereby producing a
star of 800 -- 3000 $M_\odot$, which ultimately collapses to a black hole of intermediate
mass. No such runaway occurs in the cluster MGG-9 because the larger cluster
radius leads to a mass-segregation timescale a factor of five longer than for
MGG-11.

Figure 4: Chandra X-ray image (in R.A. and Dec.) of the relevant part of the starburst
galaxy M 82 with the observed star clusters indicated. The colour image is from the 28
October 1999 X-ray observation by Matsumoto et al, (2001), with about arcsecond
positional accuracy. The brightest X-ray source (M 82 X-1) is near the centre of the image.
The star clusters are indicated by circles. The positions of the two star clusters MGG-9
and MGG-11 are indicated with squares. The magnified infrared images of these star
clusters from the McCrady et al observations are presented in the upper right (MGG-11)
and lower left (MGG-9) corners.

Gualandris, Portegies Zwart, and co-workers studied the dynamical interaction
in which the two single runaway stars, AE Aur and ι Col, and the binary ι Ori
acquired their unusually high space velocity. The two single runaways move in
almost opposite directions with a velocity greater than 100 km/s away from the
Trapezium cluster. The star ι Orionis is an eccentric (e = 0.8) binary moving
with a velocity of about 10 km/s at almost right angles with respect to the two
single stars. The kinematic properties of the system suggest that a strong
dynamical encounter occurred in the Trapezium cluster about 2.5 Myr ago.
Curiously enough, the two binary components have similar spectral type but
very different masses, indicating that their ages must be quite different. This
observation leads to the hypothesis that an exchange interaction occurred in
which an older star was swapped into the original i Orionis binary. We test this hypothesis by a combination of N-body simulations, binary evolution calculations and stellar evolution calculations to constrain the age discrepancy of the two binary components. We find that an encounter between two low eccentricity (0.4 <= e <= 0.6) binaries with comparable binding energy, provides a plausible solution to this problem.

Bassa (UU), Van der Klis and co-workers performed observations of the Galactic globular cluster M 4 down to a limiting luminosity of 1029 erg/sec, which was the deepest X-ray observation of a globular cluster. 12 X-ray sources were detected inside the core and 19 more further out the cluster. Comparison of M 4 with the globular clusters 47 Tuc and NGC 6397 suggested a scaling of the number of active binaries in these clusters with the cluster (core) mass.

2.3 Low Energy Astrophysics: The life cycle of stars and planets

Throughout cosmological time stars form out of interstellar gas and dust clouds. During their lives, they give back the major part of their stellar material to the interstellar medium by means of stellar outflows and supernova explosions. Part of the material that is returned has been processed by thermonuclear reactions, thus assuring a slow but continuous enrichment of our Universe with elements more massive than Lithium. This is vitally important, as these "heavy elements'' may condense in solid state form. Typically, in the medium between the stars about one percent of the total mass is in solid particles, called "dust''. During the formation of stars these dust grains may grow and aggregate to form planets, which are thought to be one of the essential ecological requirements for life.

One of the key research areas at the Anton Pannekoek institute is the study of this great cycle of gas and dust. We do so by focusing on those phases in the lives of stars in which their interaction with the interstellar medium is strong. Special emphasis is placed on the properties and life cycle of dust particles. The size, shape, structure and composition of dust particles are also investigated experimentally in our light scattering laboratory. Involvement in the planning for, construction, and/or science verification and exploitation of new instrumentation constituted the Mid-Infrared Interferometric Instrument MIDI, commissioned in the spring of 2003 at the Very Large Telescope (VLT) in Paranal, Chile, and the Characterization of Exoplanets using Optical and Infrared Polarimetry and Spectroscopy instrument CH EOPS. CH EOPS has been proposed for use on the VLT.

Reported below are the main activities and results obtained in 2004 by the members of the low energy astrophysics group: Roy van Boekel, Rien Dijkstra, Carsten Dominik, Sacha Hony, Huib H enrichs, Joop Hovenier, Teije de Jong, Ale de Koter, Joke Meijer, Michiel Min, Rohied Mokiem, Roald Schnerr, Daphne Stam, Hester Volten, and Rens Waters.

2.3.1 First scientific results of the Mid-infrared Interferometric Instrument for the VLTI, MIDI.

Being the first mid-infrared long baseline interferometric instrument for large apertures to become available, MIDI has broken ground in high angular resolution studies of warm dust surrounding stars and galactic nuclei. In a time where VLTI is under discussion, MIDI has proven that the VLTI concept is powerful and is delivering top level science already now, at the early stages of its operation. The impact of MIDI is also on a different level: being a common user instrument, MIDI brings optical interferometry into the realm of standard observing techniques and moves it away from experts only, set-ups that have characterized most optical interferometers so far.

Jaffe et al. including Waters from Amsterdam (2004 N ature 429, 47) presented the first optical/infrared fringes ever detected in an extragalactic object, the Active Galactic Nucleus (AGN) NGC 1068. One of the main astrophysical questions relating to the nature of the cores of AGN is the structure and origin of the circum-nuclear torus. This torus is a key ingredient in the unification of different types of AGN, whose spectral differences can be explained in terms of different orientations on the sky of a massive black hole surrounded by an accretion disk and a dusty torus. Several models have been proposed in the literature for the geometry of the torus, the main difference between these models being the spatial extent of the mid-IR emission the torus produces. The MIDI observations favour a compact torus with a fairly large scale-height, which may not be easily explained in terms of a disk in hydrostatic equilibrium.

The spectrally dispersed fringe detection mode of MIDI has also allowed a reconstruction of the mid-IR spectrum of the inner dust regions of the core of NGC 1068. The 10 micron spectral region is dominated by the amorphous silicate absorption spectrum, due to the Si-O stretch resonance in SiO4 tetraeders. While the absorption feature seen in single telescope data has a shape very similar to that seen in the diffuse interstellar medium of our own galaxy, the hot dust near the core of NGC 1068 has a feature, which is shifted to longer wavelengths. A plausible explanation for this is a difference in chemical
composition of the hot silicates. Al-rich materials survive at high temperatures, and such grains have a feature which is shifted redwards compared to that of standard Mg/Fe rich silicates. Interestingly there is no evidence for emission from Polycyclic Aromatic Hydrocarbons (PAHs). Apparently these (rather stable) large C-rich molecules, that are ubiquitous in interstellar space, do not survive close to the black hole.

Van Boekel, Min, Waters, Dominik, de Koter and co-workers (2004 Nature 432, 479) analyzed MIDI interferometric spectra of the dust in the inner regions of proto-planetary disks surrounding three intermediate mass pre-main-sequence stars known as Herbig Ae/Be stars. The stars are at typical distances of 100 to 200 pc, which gives a spatial resolution of about 1-2 AU using a baseline length of 100 meters and a wavelength of 10 microns. For the first time, the composition of dust in the terrestrial regions of proto-planetary disks could be measured (see Figure 5). The dust in these inner disk regions turns out to be highly crystalline, much more so than in the outer disk regions. The presence of crystalline silicates was already known from single telescope observations of the integrated light of the disk. However, location and origin of these crystals remain a matter of debate. The MIDI data show that the crystals most likely form in the inner disk regions by thermal annealing of amorphous grains that enter the disk from interstellar space, and by chemical equilibrium reactions with the gas. The MIDI data also show evidence for a gradient in the chemical composition of the crystals, with more forsterite in the innermost regions, and more enstatite further out. This gradient in chemical composition was predicted by disk models.

Figure 5: Infrared spectra of the inner (1-2 AU) and outer (2-20 AU) disk regions of three Herbig Ae stars. The regions that dominate the inner and outer disk spectra are indicated in the schematic representation of a proto-planetary disk at the top of the figure (not to scale). The flux levels are scaled such that the sum of the inner and outer disk spectrum is normalized to unity, allowing the relative contributions of these two disk regions to be easily estimated. The uncertainties in the spectra are indicated by the error bars in the lower left corner of each graph. The differences in shape between the inner and outer disk spectra are clearly visible in all three sources, indicating a difference in dust mineralogy. The broadening of the feature as seen in the inner disk spectra indicates grain growth, while the resonance at 11.3 micron indicates the presence of highly crystalline (40 to 95 percent) silicates. The implication of this result is that the building blocks of planets within the equivalent of the terrestrial planet formation region in our solar system are indeed present around newly formed stars, and that these building blocks are crystals.

The fact that silicates crystallize before any terrestrial planets are formed is consistent with the composition of asteroids in the solar system.

The MIDI data also allow for the first time to investigate the relationship between the disk geometry and the shape of the infrared spectrum of proto-planetary disks. Previous studies had suggested that disks with a steep infrared spectrum should be smaller than those with a 'redder' spectral shape. Preliminary analysis of a small number of sources indeed suggests that this is the case. It provides an observational basis for the concept of flaring versus self-shadowed disks. (Leinert, in collaboration with van Boekel, Waters, Dominik and others).
2.3.2 The characterization of exoplanets by opto-infrared polarimetry and spectroscopy

The CHEOPS phase A study, partly funded by ESO and with a Dutch contribution from NOVA, has seen its completion in 2004. CHEOPS stands for CH aracterizing Exoplanets by O pt o-infrared Polari metry and Spectroscopy. It is a possible second generation VLT instrument. The Dutch contribution to the project focuses on polarimetry of exo-planetary atmospheres, and on the adaptive optics system of the instrument. The consortium has held several meetings in 2004, the most recent one at Ringberg Castle, Germany, in September 2004. The Phase A study report was offered to ESO early November, and a review board meeting was held at ESO Garching on December 16. A decision about the project is expected by mid-2005.

Numerical simulations of starlight that is reflected by extrasolar planets have been performed for both gas giants and terrestrial type planets, i.e. Venus, Earth, and Mars-like. Our simulations clearly show that polarimetry can be used both for the detection and the characterization of extrasolar planets. Polarimetry is valuable for detection because the direct, unscattered starlight is generally unpolarised, while starlight that has been reflected by a planet will generally be polarized. Polarimetry is valuable for planet characterization because the degree of polarization of starlight that has been reflected by a planet depends strongly on the composition and structure of the planetary atmosphere. The results of the simulations for the gas giants have been used in a study for CHEOPS, a planet-finding instrument that has been proposed for the VLT. This instrument has a dedicated polarimeter to search for extrasolar planets and to characterize them. The results of the terrestrial type planets are useful in studies for instruments like the space-based NASA’s TPF (Terrestrial Planet Finder) or ESA’s Darwin mission. (Stam)

2.3.3 The structure and evolution of proto-planetary disks and the onset of planet formation around young stellar objects.

Several studies focused on the composition of dust in proto-planetary disks, using infrared spectroscopy. The remarkable ISO spectrum of HD 100453 shows very little structure in the 10-30 micron wavelength range, and at the same time a rather prominent 33.5 micron forsterite band is apparent. This can be understood if the silicate dust grains in the disk of HD 100453 have grown to sizes of several microns. At such grain size, bands at short wavelengths weaken considerably while the longer wavelength bands remain strong.

(Vandenbussche, D ominik, M in, van Boekel, Waters, M eeuws, de K oter)

Van Boekel, Waters, D ominik, de K oter and others studied the spatial distribution of silicates and carbonaceous dust in the H erbig A e stars H D 100546 and H D 97048. In H D 100546 the silicates are predominantly originating from the inner several tens of A U, while the 11.3 micron PAH emission comes from a more extended region. In H D 97048 no silicates are detected, but the source is extended both in the continuum and in the PAH bands. This shows that small, super-heated carbonaceous particles are present in the outer disk regions of H D 97048. When combined with the lack of silicate emission bands, the data suggest that grains are large in the inner disk region, but that substantial grain aggregation has not yet occurred in the outer few 100 A U of the disk.

Acke, van Boekel, Waters and co-workers showed that the slope of the millimeter dust spectrum in proto-planetary disks correlates with the shape of the mid-infrared spectrum. Flat millimeter slopes typically occur in disks with steep mid-infrared spectra. These observations are interpreted in terms of an evolution from flaring to self-shadowed disk geometry, during which the cold mid-plane grains, responsible for the millimeter continuum, grow to sizes of millimeters or centimeters.

The structure of protoplanetary disks is in the later evolutionary phases determined by the irradiation from the star. Dust grains in the upper disk atmosphere absorb stellar radiation and redirect part of the absorbed energy down into the disk where it determines the disk temperature and therefore its vertical structure. Since dust grains are responsible for the reprocessing of stellar radiation, the amount and distribution of dust grains is important for understanding the disk structure.

Dullemond and D ominik (2004a) have analysed the dependence of disk structure on the dust mass, and on the radial distribution of dust grains. An important effect is that if the outer disk dust opacity decreases below a threshold value, the outer disk will cease to flare, i.e. it will no longer expose an optically thick surface to the stellar light. These disks are called self-shadowed, and show spectral energy distributions consistent with the so-called group II sources among H erbig A eBe stars. The same authors have also analysed the effects of grain settling on disk structure and SED. The gravitational field of the star causes grains to settle toward the midplane, unless this settling motion is counteracted by turbulent mixing in the disk. The study shows that significant mixing in disks is required to explain the observed SEDs. It also shows that
settling can cause the outer disk to switch from flaring to self-shadowed, once the settling dust receded below the shadow caused by the optically thick inner disk. This effect is dramatically illustrated in figure 6.

Figure 6: The effect of dust settling on the scattering intensity of a protoplanetary disk. Optical stellar light is reflected of an evolving dust disk. Over time, the dust grains settle towards the disk midplane. When this happens the outer disk regions are no longer directly illuminated by the central star as this light is blocked by the optically thick inner parts of the proto-planetary disk. At one million years of disk evolution, this self-shadowing effect caused the disk to suddenly appear much smaller. From Dullemond and Dominik 2004b.

The mid-plane gas in circumstellar disks is very difficult to observe, because hardly any tracers exist for this gas. The most abundant molecule in cold gas is H₂, but it cannot be observed because it has no dipole-moment and therefore no rotational transitions that could be detected at submm wavelength. The main tracer for molecular gas has therefore traditionally been CO. However, at temperatures below 20K and high densities, this molecule freezes out onto dust grains. The only important molecules remaining in the gas are H₂ and H₃⁺, both undetectable because of their symmetric structure. However, observations of cold molecular cloud cores have recently shown that the deuterated isotopes of various molecules including H₃⁺ can be enhanced in abundance by factors up to 10¹⁴. A search for H₂D⁺ in the DM Tau and TW Hya disks by Ceccarelli, Dominik et al. (2004) has been successful in detecting this molecule, providing the first tracer for the cold midplane gas in such disks.

2.3.4 Dust in outflows of evolved low-mass stars

A symptomatic giant branch (AGB) stars are the evolved states of low and intermediate stars. These stars are very luminous (10⁴ L☉) and very large (1000 R☉), and they lose mass at very high rates (10⁻⁴ M☉/yr). In the wind that is carrying the mass loss, first oxides and silicate particles form. Much farther away from the star, when the temperatures have dropped to below 100 K, water molecules may freeze out onto the surfaces of silicate dust particles.

Justtanont, in collaboration with de Jong, Waters and others analysed the ISO spectrum of W Hya, a low mass loss rate oxygen-rich A Asymptotic Giant Branch star. The dust composition was found to be dominated by silicates, aluminium oxides and magnesium-iron oxides. The ISO Fabry-Perot spectrum of CO² near 15 microns allowed for the first time an analysis of the individual rotational lines in the CO² fundamental bending mode resonance. The CO² gas was found to be at about 450 K (excitation temperature) located in an extended region, and an inner region with much hotter (~1000 K) gas must also be present.

Dijkstra, Dominik, de Koter et al. have analysed the conditions under which water ice growth will be efficient. The most important parameter for the formation of ice is the drift velocity of the silicate dust grains through the gas. This drift is due to radiation pressure on grains. Depending on the mass loss rate of the star, these drift velocities can be tens of km/s (in low mass loss stars) or below 1 km/s (in high mass loss stars). The high drift velocities turn out to be prohibitive for ice formation, because the collisions between gas and dust are so energetic that any ice molecules attached to the grains surface will be sputtered off immediately. At low collision energies, ice formation is efficient and can convert most of the water vapour into solid ice.

VLBA studies of the SiO maser transitions at 42.8 and 43.1 GHz in several vari able stars revealed the location of the SiO emitting region. The target stars were also observed using near-IR interferometric techniques to establish the location of the hot molecular layers and the dust condensation location with respect to the SiO maser locations. The emerging picture is that of SiO maser regions located inwards of the dust inner radius, and close to the location of the hot molecular layers. However, in some cases the SiO maser region is sub-
2.3.5 Experimental and theoretical studies of light scattering on dust

In the light scattering laboratory in Amsterdam the scattering properties of particles taken from seven volcanic ashes were measured. These scattering properties, including polarization, were measured as functions of the scattering angle at a wavelength of 632.8 nm. The samples were provided by NASA and were collected at different distances from the volcanoes. They contain small irregularly shaped particles that may remain in the atmosphere up to days, e.g. influencing the climate on Earth. Munoz, Volten, Waters, Hovenier, and co-workers found that the seven samples show a quite similar scattering behavior. Therefore an average could be constructed that can be used for interpretation of remote-sensing data after a volcanic eruption. So far, often calculations for homogeneous spherical particles were used for this purpose. However, this may lead to serious errors in the interpretation of remote-sensing data.

In simulations of polarimetric satellite observations of sunlight reflected by a turbid atmosphere over the ocean, Veihelmann, Volten, and Van der Zande determined the sensitivity of these observations with respect to the optical thickness and the single-scattering albedo of irregular mineral particles. For the simulations, measured scattering properties of irregularly-shaped mineral particles were used, obtained with the light scattering facility in Amsterdam. The simulated results indicated that both the optical thickness and the single-scattering albedo can be retrieved from simultaneous polarization and intensity measurements. It was also found that numerical approximations of the scattering properties using spheres or spheroids with a distribution of moderate axis ratios can lead to large errors of the simulated light intensities. A spheroidal approximation including extreme axis ratios was found to be the most appropriate one for simulations of light scattering by irregular mineral aerosol particles, if measured scattering matrices are not available.

Measurements of the phase-angle dependence of the intensity and degree of linear polarization for incident unpolarized light of (i) particles in air and (ii) the same particles on a surface, were obtained at two wavelengths, 0.63 and 0.44 micrometer. The surface measurements were carried out in Kharkov and the scattering measurements of particles in air in Amsterdam, by Volten. Investigations of the (negative) polarization of particulate surfaces at small phase angles are important in research of atmosphereless celestial bodies. We have studied a suite of samples of natural mineral particles that are characterized by a variety of shapes and colors. We found evidence that the negative polarization of the surfaces may sometimes be a remnant of the negative polarization of the single scattering by particles constituting the surfaces. This provides important insights into the origin of the phenomenon of "negative polarization" observed for e.g. asteroids and planetary regoliths. (Shkuratov et al.)

Figure 7: Curves of the degree of linear polarization for unpolarized light as a function of the phase angle (in degrees) for olivine particles (effective radius 1.3 micrometer) in red (xxx) and blue light (++++) obtained with the Amsterdam Light Scattering Facility. Large symbols correspond to single scattering measurements. Small symbols present particulate surface data. The inserted plot placed in the bottom right corner is a magnified portion of polarimetric data for the particulate surface. A nother inset is a microscopic image (1mm x 1mm) of the particulate surface.

* Initiative to develop a polarization nephelometer for use on future planetary descent probes.

Banfield, et al. including Stam and Volten from Amsterdam have proposed to develop a polarization nephelometer for use on future planetary descent probes. It will measure both the scattered intensity and polarization phase functions of the particles it encounters descending through an atmosphere. These measurements will be taken at two wavelengths, one near 500nm and another near 1 micrometer. Adding polarization measurements to the intensity phase functions...
will greatly increase our ability to constrain the size distribution, shape and composition of the sampled particles. There remain important questions about these parameters of the atmospheric particles on Venus, the giant planets and Titan. Probe missions to Venus and Jupiter have been identified as a priority by NASA, and our proposed instrument would be an excellent candidate for flight. We also hope that future probe missions to Saturn, Uranus, Neptune or Titan will employ our instrument. We have proposed to design and build a flexible breadboard nephelometer to test the components and design of our approach. With the knowledge gained in this flexible design, we would then design and build a breadboard polarization nephelometer more suited to integration on a planetary descent probe. Considerations will also be given to mass, volume, power and cost.

In the book "Transfer of polarized light in planetary atmospheres", Hovenier, van der Mee, and Domke expound the principle elements of the theory of polarized light transfer in planetary atmospheres. Basic concepts and practical methods are emphasized, both for single and multiple scattering of electromagnetic radiation by molecules and particles in the atmospheres of planets in the Solar System, including the Earth, and beyond. A large part of the book is also useful for studies of light scattering by particles in comets, the interplanetary and interstellar medium, circumstellar disks, reflection nebulae, water bodies like oceans and suspensions of particles in a gas or liquid in the laboratory. Throughout the book symmetry principles, such as the reciprocity principle and the mirror symmetry principle, are employed. In this way the theory is made more transparent and easier to understand than in most papers on the subject. In addition, significant computational reductions, resulting from symmetry principles, are presented. Each chapter concludes with a number of problems with answers or hints for solution. The book is suitable as a textbook for advanced undergraduates and graduate students. It will also be of interest to science professionals in one of the many disciplines in which electromagnetic scattering plays an important role, like astrophysics, atmospheric optics, remote sensing, marine optics, biophysics and biomedicine.

Mishchenko, in collaboration with Hovenier and Mackowski present a detailed analysis of the concept of single scattering by a small volume element filled with sparsely and randomly positioned particles. This concept plays a fundamental role in the theory of radiative transfer in scattering media such as planetary atmospheres, reflection nebulae and circumstellar disks. The far-field single scattering approximation is compared with the so-called first order scattering approximation. For illustration numerical computations with the T-matrix method are performed for randomly oriented two-sphere clusters. It is demonstrated that the two approximations give essentially the same result.

M in, Dominik, and Waters have studied the emission spectra of very large dust grains. Resonances at certain wavelengths in the bulk refractive index of the dust material lead to corresponding emission enhancements in the spectra when the dust grains are very small, which allows to identify the dust materials. It is generally assumed that the emission spectrum of a very large grain is a smooth function of wavelength and shows no diagnostic for the mineralogy. M in et al. have shown that for arbitrarily large particles, detectable spectral structure is still visible. An application to the dust around Vega is also presented. The spectral structure predicted should be observable with the infrared spectrometer onboard the Spitzer space telescope and can be used to determine the mineralogy of the dust around Vega.

### 2.3.6 The atmospheres of solar and extrasolar planets

Roos-Serote, Stam, and Fender participated in radio observations of Mars, taking profit of the close approach of Mars during the summer 2003 opposition, trying to detect radiosignals due to electric discharges in large dust storms. We have combined observations by the Westerbork Synthesis Radio Telescope (WSRT) and the meridian radio telescope in Nançay, France. Unfortunately, no large dust storms appeared to be present during our radio observations. However, the radio observations do provide a unique map of the background of Mars' radio-emissions. Mars' radio spectrum at centimetre wavelengths is produced by thermal radiation from the surface and sub-surface. Our observational data do show a significant longitudinal variation (in neither the WSRT nor the Nançay observations the disk is resolved), which can possibly be linked with temperature and hence compositional variations in Mars' subsurface.

### 2.4 History of Astronomy

Early radio astronomical research in the Netherlands involving the prediction of the 21 cm HI line by Van de Hulst and its detection in Kootwijk by Muller and Oort have been well documented. Less well known are the parallel developments at Kootwijk and Nederhorst den Berg, especially in solar radio astronomy and ionospheric research. A number of sources have been consulted to build up a picture of this side of the research effort. Much of the observing was done using Wurzburg 7.5 m parabolic reflectors, of which there were probably six in use at the two PTT stations (including the one loaned to SRZM for the
HI work). The important role played by Ir A.H. de Voogt (Head of the Central Department for Radio of the PTT) has emerged from this research, who was responsible for "rescuing" the abandoned Wurzburgs, but who also took many initiatives in the early days. The results of this research were presented at an international conference in June.

As an extension to this work, some time was spent working with Huug van Woerden on cataloguing radio telescopes and instruments in the Netherlands, which, for historical reasons, deserve to be preserved. The result of this was a report to an international work group on historical radio telescopes.

A paper discussing ancient Oriental observations of transient phenomena was nearly completed. In it, an attempt is made to understand descriptions, which have, in the past, been interpreted as indicating brightness. The conclusion is that most of the descriptions probably have nothing to do with an object's brightness, although an exception may be in the period of the Song Dynasty.
3. Maatschappelijke activiteiten

3.1 Onderwijs (this section is in Dutch language)

3.1.1 Inleiding

Met ingang van het studiejaar 2003-2004 is de doctoraal opleiding Sterrenkunde gesplitst in een bacheloropleiding ‘Natuur- en Sterrenkunde’ gedurende de eerste drie jaar van de studie en een masteropleiding ‘Astronomy and Astrophysics’ voor de daarop volgende twee jaar van de opleiding. In het begin van het eerste jaar wordt een college Inleiding exacte wetenschappen gegeven door vier docenten uit de faculteit FNWI (waaronder een sterrenkundige: R. Wijers) dat beoogt de beginnende studenten enthousiast te maken voor een studie in een van de beta-richtingen.


Het grootste deel van de onderwijsinspanningen van het instituut is in feite gelegen in het verzorgen van de verplichte - en keuzevakken sterrenkunde voor de bacheloropleiding. Ook de projecten aan het eind van het tweede-, en derde jaar (bachelor scriptie: 12 EC) worden gedeeltelijk door sterrenkunde verzorgd en vergen een aanzienlijke onderwijsinspanning.

De masteropleiding kent zoals gebruikelijk drie varianten, te weten de onderzoeksopleiding (O-variant), de communicatieve/educatieve CE-variant en de maatschappelijke M-variant. Bij de twee laatste varianten wordt een belangrijk deel (60 EC) buiten de sterrenkunde ingevuld. De O-variant bestaat voornamelijk uit sterrenkundevakken waarbij reeds in het tweede semester van het eerste jaar met het onderzoeksproject wordt gestart dat in totaal 60 EC, dus de helft van de studie, beslaat. Er worden vier sterrenkundige basiscolleges...
gegeven waarin de stof, zoals behandeld in de bachelorfase, verder wordt uitgediept. Voor de O-variant zijn deze basiscolleges verplicht (voor de twee andere varianten slechts twee) terwijl daarnaast nog vier specialisatievakken worden verzorgd waaruit studenten een keuze kunnen maken. Naast de opleiding voor het masterdiploma is de primaire onderwijsactiviteit van het instituut de opleiding tot zelfstandig onderzoeker welke plaats vindt in het kader van de Toponderzoeksschool NOVA. In dit kader worden elk jaar landelijke aio-colleges verzorgd, mede door docenten van het API. Het Sterrenkundig Instituut en het Centrum voor Hoge Energie Astronomie zijn in feite in hoge mate een "graduate school", met thans een twintigtal promovendi. In het jaar 2004 behaalden acht promovendi de doctorsgraad (§3.1.3).

3.1.2. Sterrenkundecolleges voor de bacheloropleiding natuur- en sterrenkunde

1e jaar: Structuur en patroonvorming in de natuur (1/4 deel), Sterrenkunde I inclusief (waarneem)practicum en Zonnestelsel. 2e jaar: Ster- en Atoomfysica, M elkwegstelsels, Project sterrenkunde. 3e jaar: Waarneempracticum, A strophysica van compacte sterren, Inleiding kosmologie en Bachelorproject sterrenkunde III.


Postdoctoraal onderwijs:

In het kader van de landelijke onderzoeksschool NOVA wordt er wisselend een college gegeven:
- Massaverlies van sterren, Late evolutiestadia van sterrenstelsels
- Infrarood astronomie
- Geavanceerde dynamica van sterrenstelsels
- Technieken van ruimte onderzoek en sterrenkunde
- Waarvan een gedeelte door docenten van het API.

3.1.3 Doctoraal examens en promoties in 2004

Doctoraal Examens ("Masters degrees" awarded)

In 2004 deden 5 studenten met goed gevolg het doctoraal examen:

- B. van Dalen 23 februari 2004
- S.P. Tigelaar 29 maart 2004
- E. ten K ulve 29 maart 2004
- T. J. Reerink 24 mei 2004
- D. J.P. Lommen 20 december 2004

Studentenaantal in afstudeerprojecten Sterrenkunde 2004: 14

Promoties (Ph.D., degrees awarded)

- A. Lenorzer 14 jan. Near-infrared spectroscopic analysis of hot massive stars
- E. Rol 29 jan. The Physics of Gamma-ray Burst Afterglows
- J. Braithwaite 8 april Stable and unstable magnetic fields in stars
- S. van Straaten 22 april Timing Similarities among N eutron Stars
- A. Bik 27 sept. The stellar content of high-mass star-forming regions
- M. Klein Wolt 30 sept. Black H ole X-ray Binaries
- R. van Boekel 21 okt. High Spatial Resolution Infrared Studies of Protoplanetary Disks
- C. Dijkstra 23 nov. Silicates and Water I ce Around Evolved Stars

3.1.4 Onderwijs en voorlichtingsactiviteiten van de staf in 2003

(Colleges aangeduid met I: propedeuse, de andere colleges en practica: doctoraalfase)

Rooster 2003-2004

2e & 3e trimester 5 januari t/m 25 juni 2004

- E. van den H uvel Sterrenkunde 2 4 uur/week
- M. van der K lis (c.s.) Sterrenkunde practicum I 6 uur/week
- G. Hammerschlag (c.s.) Sterrenkunde IB (Werkcollege) 4 uur/week
- T. Raassen Keuzevoorlichting/Stud.sem. 1 uur/week
- H. Henrichs Zonnestelsel 4 uur/week
- R. Waters/C. Dominik Formation of Stars and Planets 3 uur/week
- L. v.d. Horn Hydrodynamics 3 uur/week
- L. v.d. Horn Electrodyn.& relativiteitstheorie 4 uur/week
T. Raassen  Highlights I  2 uur/week  Waarnemenpraktijk 1e jaars
R. Strom/B. Stappers  Radioastronomy  3 uur/week  Nick Cox
L. Kaper  Sterrenkunde colloquium  1 uur/week  Waarnemenpraktijk, 3e jaars
E.v.d.Heuvel/R. Fender  Inleiding Kosmologie  4 uur/week  Michiel M in, Roald Schnerr
R. Wijnands  A strophysica Compacte Sterren  4 uur/week
G. J. Savonije

Rooster 2004-2005
1e trimester 6 september 2004 t/m 30 januari 2005

T. de Jong/Kaper  Melkwegstelsels  5 uur/week  A psidsbeweging in de dubbelster 96 Her culis (L. Rasmijn en M. H oogeveen)
L. Kaper  Sterrenkunde colloquium  1 uur/week  H uib H enrichs, Roald Schnerr
L. Kaper  Ster- & atoomfysica  4 uur/week
M. van der Klis (c.s.)  Sterrenkunde I A, B, C (WC)  4 uur/week
M. van der Klis  Sterrenkunde I (HC)  2 uur/week
T. Raassen  Keuzevoorlichting/stud.seminar  1,5 uur/week
R. Wijers (c.s.)  Waarneempracticum P1 & 2  6 uur/week
R. Wijers  Structuur & patroonvorming  2 uur/week
L. v.d. Horn  Electrodynamic & relativiteitstheorie  4 uur/week
R. Waters  Interstellar/Circ.Stellar Matter  3 uur/week
A. de Koter  Stellar atmosph & radiation transf.  3 uur/week

Inzet promotendi bij werkcolleges en practica
Werkcollege Sterrenkunde I (sept. – dec.)
A. van der H orst, K. Wiersema, P. Weltevrede
1e jaars college Symmetrie patronen in de natuur
Roald Schnerr
Werkcollege Sterrenkunde IIa (feb. – april)
J. Meijer
Werkcollege Ster & A toomfysica (jan. – juni)
Th. K ouwenhoven, D. A tamirano
Werkcollege ‘Het Zonnestelsel’ (sept. – dec.)
Th. K ouwenhoven
Practicum Sterrenkunde III
K. W iersema
Werkcollege ‘Stellar atmospheres and radiative transfer’ (sept. – dec.)
Rohied M okiem
Werkcollege ICM (oct. – dec.)
J. Meijer
Werkcollege Melkwegstelsels (oct. – dec.)
Peter Curran

Projecten Sterrenkunde voor 2e jaars studenten
Ellipsoidale variaties in de lichtcurve van zware massa röntgen-dubbelsterren
(H. Veerman, J. van Breemen, Th. De Boer)
L. Kaper
A psidsbeweging in de dubbelster 96 Her culis (L. Rasmijn en M. H oogeveen)
H uib H enrichs, Roald Schnerr

Begeleiding Kandidaatsprojecten
Simulating gamma-ray burst spectra using C (D. Meerburg & A. Teenstra)
R. Wijers
A. van der H orst
GRB Jet Polarisation (G. K ardoulos)
R. Wijers
A. van der H orst

Begeleiding afstudieprojecten (4e jaars studenten)
Hydrodynamic instabilities and neutrino diffusion in the gravitational collapse of stars (E. Glebbeek)
L. van den H orn
The origin of discrete components in xi Persei & An analysis of ultraviolet resonance lines in early-type stars (E. ten Kulve)
H uib H enrichs

Promotors en co-promotors en overige commissieleden
A. Bik: L. Waters (promotor), L. K aper (co-promotor), A. de Koter, R. Wijers, P. Ehrenfreund
R. van Boekel: L. Waters (promotor), A. de Koter
J. Braithwaite, H. Spruit (promotor), E. van den H euvel, H. H enrichs, L. Waters, R. Wijers, M. van der Klis
C. Dijkstra, L. Waters (promotor), C. Dominik (co-promotor), A. de Koter
M. Klein W olf, M. van der Klis (promotor), E. van den H euvel, R. Wijers
A. Lenorzer, L. Waters (promotor), A. de Koter (co-promotor), R. Wijers, H. H enrichs, L. K aper
E. Rol: E. van den H euvel (promotor), R. Wijers (promotor),
L. K aper (co-promotor), A. de Koter (co-promotor)
La Palma waarneemproject
Het masterprogramma "Astronomy & Astrophysics" van het sterrenkundig instituut kent sinds 2003 een waarneemproject op het Roque de Los Muchachos Observatory te La Palma, Spanje, waar de Isaac Newton Group of Telescopes (INT) is gesitueerd. De INT wordt mede gefinancierd door de Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO).

Het idee achter het "La Palma waarneemproject" is om studenten uit de eerste hand alle aspecten van het definiëren en uitvoeren van een waarneemprogramma te leren, inclusief het werk op de telescooplocatie. Studenten worden daartoe gevraagd om een waarneemprogramma te definiëren voor de 1.2 meter Mercator telescoop, die door België (Leuven) geëxploiteerd wordt in een samenwerkingsproject met het Observatoire de Genève. De studenten schrijven een waarneemvoorstel waarin ze de algemene wetenschappelijke achtergrond uiteenzetten, het directe doel van de waarnemingen beschrijven, de uitvoerbaarheid, alsook de analyse en interpretatiestrategie uitwerken.

Ze reizen naar de Canarische Eilanden in een groep van ongeveer 8 à 10 studenten en twee begeleiders om de waarnemingen uit te voeren. Gedurende een week nemen ze - als de weersomstandigheden het toestaan - elk hun bronnen waar, daarbij geassisteerd door de andere studenten. Bij terughoming analyseren ze de data en schrijven een verslag. Het soort projecten die de studenten kiezen variëert van objecten in het zonnestelsel tot massive Röntgen dubbelsterren, stervorming en interstellaire materie.
3.2 Public Outreach Activities, Awards, Prizes etc

3.2.1 Scientists in press articles

Arjan Bik
Sterren in de kraamkamer, Folia, 24 sept.

Rob Fender
Neutronenster stoot jets uit, Folia, 23 jan.

Ed van den Heuvel
De eerste stap van de astronoom Ed van den Heuvel. "Je kunt je voorstellen dat ik nogal verbouwereerd was," A kademienieuws, april

Michiel van der Klis
Zwarte gaten goed voor Spinozapremie, N oord H ollands D agblad, 8 juni
O p zoek naar de oorsprong Volkskrant, 12 juni
W O - Spinozapremie voor M ichiel van der K lis, N ed. T ijdsschrift voor N atuurkunde, juli 2004
I k heb de heilige graal gevonden, Folia, 29 okt.
Spinozapremie voor Schager wetenschapper, N oord H oll. D agblad 4 nov.

Simon Portegies Zwart
Stellar Breakups, Sky & Telescope, 4 februari
Black holes in the middle A stronomy, maart
R esearchers R esolve Intermediate M ass B lack H oles M ystery C handra press room, 10 april
O p hol geslagen sterren mogelijk oorzaak middelgrote zwarte gaten, N ew S cientist, 14 april
R unaway stars may solve black hole riddle, A ddict 3D , 15 april
A msterdammers vinden zwart gat, Volkskrant, 18 april
Intermediate mass black hole mystery resolved, Spaceflight now, 19 april
Black hole construaction zone Sky & Telescope, 20 april
G rupo propoe receta para buracos negros jornal de C iencia, 22 april
K ettingbotsing leidt tot zwart gat, Folia, 23 april
M iddelszwarte zwarte gaten, N RC , 24 april
C oliding Stars M ay F rom Intermediate Black H oles, S cientific A merican, 28 april
V ermiste zwarte gaten terechtr, N eews P latform, aprill
H ow to build a midsize black hole Sky & Telescope, aug.
M elkweg heeft tweede zwart gat, Volkskrant 13 nov.
3.2.2 Popular lectures

Huib Henrichs
H et Zonnestelsel in perspectief dl. 1, Centrale Commissie voor het
Interkerkelijk Vormingswerk, Bussum, 17 november
H et Zonnestelsel in perspectief dl. 2, Centrale Commissie voor het
Interkerkelijk Vormingswerk, Bussum, 24 november

Ed van den Heuvel
Netherlands Astronomy and LOFAR A stron D wingeloo, ceremoniële vergade-
ing voor het tekenen van het LOFAR contract door M inister M. van der
Heven, 23 februari
Astronómica door de eeuwen heen,D rents Museum Assen, LOFAR viering voor
regeringsvertegenwoordigers en burgemeesters in de N oordelijke provincies, 23
februari
Gamma Flitsen: de krachtigste explosies in het heer A msterdamse
A cademische Club, 1 april
N ederland en de Sterren, Symposium t.g.v. de uitreiking van de Christiaan
H uygens Prijs, Voorschoten, 28 oktober

Alexander van der Horst
Supernovae en Gammaflitsers, Lion’s Club, Muiden, 13 april
GRBs en A Pi – Flitsend onderzoek in A msterdam,E erste jaars studenten, 29
november
Robotische Telescopen, U v A B èta Festival in N E M O, 6 december

Lex Kaper
Nutronensterren, zwarte gaten en gamma-ray bursts, N V W S D ordrecht, 6
februari
C urrus sterevolutie,K N V W S A mersfoort, maart
Nutronensterren, zwarte gaten en gamma-ray bursts, N V W S H eeren, 24 april

Michiel van der Klis
Spinozaprijs Ceremonie D en H aag, 3 november

Alex de Koter
G(e)varen) in de ruimte, IM C Weekendschool, A msterdam, 14 maart

Thijs Kouwenhoven
Leven in het H eelal, Rotary Club H aarlemmermeer-Schiphol, 29 maart
Leven in het H eelal, Rotary Club H aarlemmermeer, 1 april
Leven in het H eelal, Rotary Club A msterdam-Sloterdijk, 21 april
C assini-H uygens: D e reis naar Saturnus en Titan, Wetenschapsdag, A msterdam,
23 oktober

Dave Lommen
Study of X-ray Binaries, Sterrenwacht L eiden, 14 mei

Mariano Méndez
The X-ray Universe, Univ. of D urban, 1 juli
A fatal attraction: E en zeer korte introductie tot Zwarte Gaten in het healal,
O pen D ag S RO N, U trecht, 24 oktober

Simon Portegies Zwart
A msterdammers maken zwart gat, N VS, M idden L imburg, 18 april

Ton Raassen
Ruim, Ruimte, Ruimst, Bussum, 10 nov.

Daphne Stam
Planetten bij andere sterren, A lkmaarse Weer- en Sterrenkundige Vereniging
E tius, 30 januari
O p zoek naar andere planeten, Sterrenkundige ver. P hilippus L ansb ergen,
M iddelburg, 19 november

Richard Strom
Black Holes, K N V W S, Enschede, 13 januari
China: cultuur en wetenschap van een zeer oude beschaving, K N V W S Z wolle,
15 april / P utten, 25 oktober
Pulsars: supersnelle tollen van 3000 biljoen biljoen ton neutronen,
A ssen, 29 oktober / H ilversum, 19 november
Wat was de ster van Bethlehem?, M iddenved, 22 december
Leo van den Horn & Patrick Weltevrede
De neus van Einstein en gedachten over het ‘niets’. Sterrenwacht Vesta, Oostzaan, 24 oktober

Rens Waters
Stardust, KNVWS Lezing, 25 sept.
Het Heelal: een hersenkraker, Open Dag Amsterdam, 23 okt.
Kun je leven op Mars, NEMO kinderlezing, 19 dec.

Klaas Wiersema
Dimensions in astronomy, CSG Jan Arentsz, Alkmaar, 18 maart

3.2.3 Popular publications

Huib Henrichs
Sterren en hun levensloop, Jaarboek Studentenvereniging Pyrus, Universiteit Wageningen, 2004

3.2.4 Interviews and appearances on radio/tv

Lex Kaper
Teleac Radio HoeZo?, n.a.v. toekenning NWO gelden X-shooter, 2 september

Michiel van der Klis
Business radio, 8 juni
Teleac Radio, 22 juni
Salto radio, 4 november

Simon Portegies Zwart
Astronomia: Czarna dziura w budowie, Polskie Radio, 14 april
Middengaten, N oorderlucht VPRO, 14 april
New support for black hole theory BBC News, 15 april
Missende zwarte gaten in het heelal, N oorderlucht, VPRO Radio, 20 april
HoeZo!, Teleac Radio, 2 juli
N oorderlucht VPRO Radio, 18 & 19 november

Daphne Stam
Kunnen we leven op Mars?, Radio N oord-Holland, 16 december
4. Management

4.1 Finance

<table>
<thead>
<tr>
<th>Direct funding (k€)</th>
<th>External funding (k€)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>FNWI lump sum</td>
<td>939</td>
<td>NWO</td>
</tr>
<tr>
<td>NOVA</td>
<td>1.080</td>
<td>EU</td>
</tr>
<tr>
<td>CvB UvA</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>KN AW</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>NOVA reserve</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Other income</td>
<td>118</td>
<td></td>
</tr>
<tr>
<td><strong>Total income</strong></td>
<td><strong>2.457</strong></td>
<td><strong>Total income</strong></td>
</tr>
<tr>
<td>Personnel</td>
<td>1.869</td>
<td>Personnel</td>
</tr>
<tr>
<td>Other costs</td>
<td>576</td>
<td>Other costs</td>
</tr>
<tr>
<td><strong>Total costs</strong></td>
<td><strong>2.445</strong></td>
<td><strong>Total costs</strong></td>
</tr>
<tr>
<td><strong>NET RESULT</strong></td>
<td><strong>12</strong></td>
<td><strong>NET RESULT</strong></td>
</tr>
</tbody>
</table>

The table gives the real income and expenditure of the Astronomical Institute in 2004. It shows clearly that the institute has a relatively small income of ‘hard money’: the FNWI lump sum of k 939. The other direct funding by NOVA etc. is soft money that is acquired for a limited period. Together with the external funding the total income of API is more than 3 times the lump sum budget. Over the years the direct lump sum financing is becoming based on teaching input and on the number of completed PhD theses. Since almost all API PhD’s are funded externally and already extra cutbacks in the direct budget are foreseen for the coming years, the income generated by soft money remains of extreme importance for the institute.

4.2 Human Resources

People working at the institute and the vacant positions on 31 December 2004, are listed below.

Professor P. Ehrenfreund and Dr. S. Ingemann Jorgensen left the institute on 31 August.

theme 1 = High Energy Astrophysics;
theme 2 = Low Energy Astrophysics
Permanent scientific staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Theme</th>
<th>FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.P.J. van den H (HL)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>M. v.d. K (HL)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>T. de Jong (HL)</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>L.B.F.M. Waters (HL)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>R.A.M. J. Wijers (HL)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>G.J. Savonije (UHD)</td>
<td>1+2</td>
<td>1.0</td>
</tr>
<tr>
<td>H.F. H. Heinrichs (UHD)</td>
<td>1+2</td>
<td>0.8</td>
</tr>
<tr>
<td>L.J. van den Horn (UHD)</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>A. de Koter (UHD)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>G.C.M. J. Hammerschlag-H.ensberge (UHD)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>A.J.J. Raassen (UDD)</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>L. Kaper (UDD)</td>
<td>1+2</td>
<td>1.0</td>
</tr>
<tr>
<td>R.A.D. Wijnands (UDD)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>vacancy (UDD)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Th. Nieuwenhuizen (UHD ITFA)</td>
<td>-</td>
<td>(0.2)^3</td>
</tr>
</tbody>
</table>

Total (of which 2 overlap): 11.2

Externally funded (semi) permanent staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Theme</th>
<th>FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. Icke (UL, CHEAF bijz. HL)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>R. Strom (ASTRON; H.L)</td>
<td>1+2</td>
<td>0.2</td>
</tr>
<tr>
<td>J. Hovenier (em. VU, em. UVA)</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>H.C. Spruit (AVI CHEAF bijz.HL)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>K.A. van der Hucht (SRON, UHD)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>R.P. Fender (Uiv. of Southampton, UHD)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>R.M. Mendez (SRON, UHD)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>B.W. Stappers (ASTRON, UDD)</td>
<td>1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Temporary staff: Postdocs and Fellows

<table>
<thead>
<tr>
<th>Name</th>
<th>Theme</th>
<th>FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. L.K.C. Decin (Universiteit Leuven)</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Dr. C. Dominik (CvB-UOEF)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. T.J. Maccarone (UOVA)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. J.C.A. Miller-Jones (NWO)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. A. Pe’er (NWO)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. S.F. Portegies Zwart (KNAW) (+0.5 at lvi)</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Dr. M.S. Sipior (NWO) (+0.5 at lvi)</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Dr. D.M. Stam (NWO VEN)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. R.L.C. Starling (EC-RTN)</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. H. Volten (NASA)</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>Dr. S.-C. Yoon (NWO-VEN)</td>
<td>1</td>
<td>1.0</td>
</tr>
</tbody>
</table>


Ph.D. Students

During 2004, 8 PhD students obtained their PhD’s, two of which had already left before 2004; the remaining six left in 2004. By the end of 2004, 21 PhD students are working at the Institute, of which 1 is directly University funded and 20 are externally funded. Six new students started a PhD in 2004. Names can be found in Appendix II.

Supporting Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.s. L. Stolte (1.0)</td>
<td>Business manager</td>
</tr>
<tr>
<td>M.s. M.C. van Beurden (0.8)</td>
<td>Secretary (0.4 UVA + 0.4 ASTRON)</td>
</tr>
<tr>
<td>M.s.drs. F.E. Kroon (0.4)</td>
<td>Secretary</td>
</tr>
<tr>
<td>M.s.drs. A. Lenssen (0.55)</td>
<td>Secretary</td>
</tr>
<tr>
<td>Dr. M.H.M. Hemskerk (1.0)</td>
<td>Software engineer</td>
</tr>
<tr>
<td>Dr. J. Visser (0.5)</td>
<td>Communication adviser (NOVA)</td>
</tr>
<tr>
<td>M.s. E.S. van IJzeren (0.3)</td>
<td>Librarian (FNWI-library staff)</td>
</tr>
</tbody>
</table>

Ms. G.P. Aling worked as a secretary during the maternity leave of A. Lenssen from April till December (funded by UVA-ECM). A.A.J. Jaspers left at 30 September. He worked as communication manager at the NOVA Information Center since the start of the C Center in 2000.

1 Funded by NOVA-overlap position till mid-2005
2 + 0.125 SRON funded, for a period of 10yrs from 1-1-’99
3 Our budget has been decreased in 2002 to pay for this position although it is not part of our official formation (due to Wins-reorganization)
Summary
In the table below all staff working in the institute on 31 December 2004 is summarized in terms of function, fte and funding:

<table>
<thead>
<tr>
<th>Function</th>
<th>Direct funding F N W I</th>
<th>Direct funding N O V A, C v B, K N A W</th>
<th>External funding N W O, A S T R O N, S R O N, E C, etc</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full professor</td>
<td>3.2</td>
<td>1.0</td>
<td>1.1</td>
<td>5.3</td>
</tr>
<tr>
<td>Associate professor</td>
<td>3.3</td>
<td></td>
<td></td>
<td>3.9</td>
</tr>
<tr>
<td>Assistant professor</td>
<td>2.6</td>
<td>1.0</td>
<td>0.3</td>
<td>3.9</td>
</tr>
<tr>
<td>K N A W fellow</td>
<td></td>
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<td></td>
<td>0.5</td>
</tr>
<tr>
<td>Postdoc</td>
<td></td>
<td>2.0</td>
<td>6.7</td>
<td>8.7</td>
</tr>
<tr>
<td>Ph. D. students</td>
<td>1.0</td>
<td>9.0</td>
<td>11.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Supporting staff</td>
<td>3.4</td>
<td>0.8</td>
<td>0.4</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13.5</strong></td>
<td><strong>14.3</strong></td>
<td><strong>20.1</strong></td>
<td><strong>47.9</strong></td>
</tr>
</tbody>
</table>
Appendix I: Institute Staff on 31-12-2004

Gewoon Hoogleraren
Prof. Dr. E. P. J. van den Heuvel, Prof. Dr. T. de Jong (0.2 fte), Prof. Dr. M. B. M. van der Klis, Prof. Dr. L. B. F. M. Waters (N O V A) (tevens deeltijd hoogleraar K. U. Leuven), Prof. Dr. R. A. M. J. Wijers

Bijzonder Hoogleraren en onbezoldigde hoogleraren
Prof. Dr. W. Hermsen (0.2 fte, S R O N), Prof. Dr. V. Icke (0.2 fte C H E A F bijz. h. i., Stichting Beta-Plus, U L), Prof. Dr. R. Strom (0.2 fte, affiliated prof.; N W O Foundation A S T R O N, D wingeloo), Prof. Dr. H. Spruit (0.2 fte, M P I A, Garching; bijz. h. i. A U V)

Emeriti
Prof. Dr. J. W. Hovenier, Prof. Dr. P. S. The

Universitaire hoofddocenten
Dr. R. P. Fender (0.2 fte, Southampton U K), Dr. H. F. H enriches (0.8 fte) (tevens 0.2 fte hoogleraar V U), Dr. L. J. van den Horn (0.5 fte), Dr. K. A. van der Hucht (0.2 fte, S R O N), Dr. A. de Koter, Dr. R. M. M endez (0.2 fte, S R O N), Dr. G. J. Savonije

Universitaire Docenten
M w. Dr. G. H ammerslag-H ensberge (0.2 fte), Dr. L. K apers, Dr. T. R aassen (0.5 fte) (0.125 fte S R O N), Dr. B. W. Stappers (0.2 fte, A S T R O N), Dr. R. A. D. W ijnands (N O V A)

K N A W - Fellow
Dr. S. F. P ortegies Z wartz (0.5 fte A stron. I nst.; 0.5 fte I nformatics I nst.)

Postdocs (met financieringsbron)
Dr. C. D ominik (U V A), Dr. T. J. M accarone (N O V A), Dr. J. M. M iller-J ones (N W O - V I D I), Dr. A. Pe’er (N W O - V I C I), Dr. M. S. Sipior (N W O) (0.5 fte A P I, 0.5 fte), M w. Dr. D. M. S t a m (N W O - V E N I), M w. D r s. R. L. C. S tarling (E C / R T N), M w. Dr. H. V olt en (N A S A), Dr. S. C. Y oon (N W O - V E N I) M w. dr. L. K. E. D ec in (gedetacheerd U niv. L euven)

Ph. D. students (met financieringsbron)
D r s. D. A ltamirano (N O V A), D r s. N. L. J. C o x (N O V A), D r s. P. A. C urran (N W O - V I C I), D r s. E. G aburov (N W O), M w. D r s. E. G allo (N O V A), M w.
Appendix II: Promovendi en promoties 2004

<table>
<thead>
<tr>
<th>AIO ‘s/OIO ‘s</th>
<th>promotor/co-promotor</th>
<th>einde contract</th>
<th>promotie</th>
<th>gs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evert Rol</td>
<td>van den Heuvel/Kaper</td>
<td>01-01-04</td>
<td>29-01-0</td>
<td>NWO</td>
</tr>
<tr>
<td>Annique Lenorzer</td>
<td>Waters/de Koter/Kaper</td>
<td>01-01-04</td>
<td>14-01-0</td>
<td>COF</td>
</tr>
<tr>
<td>J. Braithwaite</td>
<td>Spruit</td>
<td>08-04-04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steve van Straaten</td>
<td>van der Klis</td>
<td>01-03-04</td>
<td>22-04-04</td>
<td>NWO</td>
</tr>
<tr>
<td>Marc Klen Wolt</td>
<td>van der Klis</td>
<td>01-07-04</td>
<td>30-09-04</td>
<td>API</td>
</tr>
<tr>
<td>Roy van Boekel</td>
<td>Waters/Pel</td>
<td>15-08-04</td>
<td>21-10-04</td>
<td>NVOA</td>
</tr>
<tr>
<td>Arjan Bik</td>
<td>Waters/Kaper</td>
<td>01-08-04</td>
<td>27-09-04</td>
<td>NVOA</td>
</tr>
<tr>
<td>Rien Dijkstra</td>
<td>Waters</td>
<td>01-10-04</td>
<td>23-11-04</td>
<td>NVOA</td>
</tr>
<tr>
<td>Arjen van de Meer</td>
<td>van den Heuvel</td>
<td>01-06-05</td>
<td></td>
<td>NVOA</td>
</tr>
<tr>
<td>Michiel Min</td>
<td>Waters/de Koter</td>
<td>01-04-05</td>
<td>12-05-05</td>
<td>COF</td>
</tr>
<tr>
<td>Rohied Mokiem</td>
<td>vd H heuvel/de Koter</td>
<td>01-12-05</td>
<td></td>
<td>NWO</td>
</tr>
<tr>
<td>Elena Gallo</td>
<td>van der Klis/Fender</td>
<td>16-09-05</td>
<td></td>
<td>NVOA</td>
</tr>
<tr>
<td>Simone Migliari</td>
<td>van der Klis/Fender</td>
<td>16-09-05</td>
<td></td>
<td>NWO</td>
</tr>
<tr>
<td>Nick Cox</td>
<td>Ehrenfreund/Kaper</td>
<td>01-05-06</td>
<td></td>
<td>NVOA</td>
</tr>
<tr>
<td>Thijs Kouwenhoven</td>
<td>Kaper</td>
<td>01-09-06</td>
<td></td>
<td>NWO</td>
</tr>
<tr>
<td>Allesia Gualandris</td>
<td>vdH heuvel/Sloot/</td>
<td>01-09-06</td>
<td></td>
<td>NWO</td>
</tr>
<tr>
<td>(0.5 API + 0.5 IvI</td>
<td>Portegies Zwart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peter den H artog</td>
<td>van der Klis/H ermsen</td>
<td>01-11-06</td>
<td>SRO N</td>
<td></td>
</tr>
<tr>
<td>Patrick Weltevrede</td>
<td>vd Klis/Stappers</td>
<td>01-12-06</td>
<td></td>
<td>NVOA</td>
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<tr>
<td>Roald Schnerr</td>
<td>H enrichs</td>
<td>01-12-06</td>
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<td>NVOA</td>
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<tr>
<td>Joke Meijer</td>
<td>Waters/de Koter</td>
<td>01-01-07</td>
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<td>NVOA</td>
</tr>
<tr>
<td>Alexander v.d. Horst</td>
<td>Wijers</td>
<td>01-09-07</td>
<td></td>
<td>API</td>
</tr>
<tr>
<td>Klaas Wiersema</td>
<td>Wijers</td>
<td>01-10-07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diego Aitamirano</td>
<td>Van der Klis</td>
<td>17-11-07</td>
<td></td>
<td>NVOA</td>
</tr>
<tr>
<td>Evgenii G aburov</td>
<td>Portegies Zwart</td>
<td>01-08-08</td>
<td></td>
<td>NWO</td>
</tr>
<tr>
<td>Dominik Paszun</td>
<td>Waters/Dominik</td>
<td>15-08-08</td>
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<td>NWO</td>
</tr>
<tr>
<td>Peter A. Curran</td>
<td>Wijers</td>
<td>01-10-08</td>
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<td>NWO-VICI</td>
</tr>
<tr>
<td>Hanno Spreeuw</td>
<td>Wijers</td>
<td>01-11-08</td>
<td></td>
<td>NWO-VICI</td>
</tr>
<tr>
<td>Gemma Janssen</td>
<td>vd Klis/Stappers</td>
<td>15-11-08</td>
<td></td>
<td>NWO</td>
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<tr>
<td>Valeriu Tudose</td>
<td>vd Klis/Fender</td>
<td>01-12-08</td>
<td></td>
<td>NWO-VIDI</td>
</tr>
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</table>
### Appendix III: Memberships

#### Committee memberships of the University of Amsterdam

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Dominik</td>
<td>Coordinator Wetenschapsdag October 23</td>
</tr>
<tr>
<td></td>
<td>Member Promotiebegeleidingscommissie Astronomical Institute</td>
</tr>
<tr>
<td>R.P. Fender (till O october)</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>M. H. eenskerk</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>H. H. Henrichs</td>
<td>Member Commissie World Year of Physics 2005</td>
</tr>
<tr>
<td></td>
<td>Member Bibliotheekcommissie Faculty FNWI for the Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Huisvestingscommissie Faculty NWI</td>
</tr>
<tr>
<td></td>
<td>Member Studenten-klachtencommissie for Astronomy students FNWI</td>
</tr>
<tr>
<td></td>
<td>Member Beheergroep Sterrenkoepel, Telescopen en instrumentatie</td>
</tr>
<tr>
<td></td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>E.P.J. van den Heuvel</td>
<td>Chairman Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Universitaire Onderzoek Commissie (till summer 2004)</td>
</tr>
<tr>
<td></td>
<td>Member of the group of Institute Directors (meets once a month)</td>
</tr>
<tr>
<td></td>
<td>Member of the Adviescommissie voor Bijzonder Leerstoelen van de</td>
</tr>
<tr>
<td></td>
<td>Amsterdamse Universiteits Vereniging</td>
</tr>
<tr>
<td>L. van den Horn</td>
<td>Member European Mobility Scheme for Physics Students</td>
</tr>
<tr>
<td></td>
<td>Member Examencommissie Faculty NWI</td>
</tr>
<tr>
<td>L. Kaper</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Delegation Board UvA visiting South America</td>
</tr>
<tr>
<td></td>
<td>Chairman Colloquiumcommissie</td>
</tr>
<tr>
<td>M. van der Klis</td>
<td>Member UD benoemingscommissie</td>
</tr>
<tr>
<td>A. de Koter</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>R.P. Fender (till O october)</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>A. Raassen</td>
<td>Member Ondernemingsraad (OR) of the Faculty NWI</td>
</tr>
<tr>
<td></td>
<td>Chairman Commissie Financiën OR-Faculty NWI</td>
</tr>
<tr>
<td>A. de Koter</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td>G.J. Savonije</td>
<td>Coordinator Onderwijs Sterrenkunde UvA</td>
</tr>
<tr>
<td></td>
<td>Coordinator Masteropleiding Astronomical &amp; Astrophysics</td>
</tr>
<tr>
<td>E.P.J. van den Heuvel</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Landelijke Onderwijs/Nova Onderwijs Commissie</td>
</tr>
<tr>
<td>L. Stolte</td>
<td>Secretary Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Bedrijfsvoeringsoverleg FNWI</td>
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<td></td>
<td>Member Colegaal O verleg Bedrijfsvoerders FNWI</td>
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<tr>
<td></td>
<td>Treasurer Central Organization O pen Dag WTCW</td>
</tr>
<tr>
<td>L. B.M.F. Waters</td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Senate of University of Amsterdam</td>
</tr>
<tr>
<td>K. Wiersema</td>
<td>Member Landelijke en Nova Onderwijs Commissies (LOC NO C)</td>
</tr>
<tr>
<td>R. Wijers</td>
<td>Member Opleidingcommissie N atuur- en Sterrenkunde</td>
</tr>
<tr>
<td></td>
<td>Member Management Team Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Co-organizer College Interdisciplinaire N atuurwetenschappen (IN W)</td>
</tr>
<tr>
<td></td>
<td>Chairman Promotiebegeleidingscommissie Astronomical Institute</td>
</tr>
<tr>
<td></td>
<td>Member Opleidingcommissie Physics and Astronomy</td>
</tr>
<tr>
<td></td>
<td>Coordinator Master Progam Astronomy and Astrophysics</td>
</tr>
<tr>
<td></td>
<td>Member Curriculum Committee Physics and Astronomy</td>
</tr>
</tbody>
</table>
R. Wijnands
Member Management Team Astronomical Institute
Member Colloquiumcommissie

Science Policy Functions

P. Ehrenfreund
Vice-president, European Exo/Astrobiology Network
Member, European Space Science Committee, Committee on the Origins and Evolution of Life COEL
Member, IM EWG, International Mars Exploration Working Group
Member, LWSG, Life Science Working Group
Member, LPSAC, Life and Physical Science Advisory Committee
Member, Scientific Advisory Board SRON
Member of COSPAR, EGS and ISSOL
Teamleader ISSI International Space Science Institute
Teamleader Topical Team ESA "Physico-Chemistry of Ices in Space"
Discipline Editor 'Planetary and Space Science'
Discipline Editor 'International Journal of Astrobiology'
Discipline Editor 'Astrobiology'
Co-Investigator NAI Node NASA Goddard
Co-Investigator NAI Node Univ. of Hawaii

R. Fender
Member of LOFAR Nederland Stuurgroep (NL-SG)
Member of ASTRON Telescopes Time Allocation Committee
Member ESO Telescope Time Allocation Committee

G. Hammerschlag-Hensberge
Treasurer Nederlandse Astronomen Club (NAC)

H. Henrichs
Member NUVA (Network voor UV Astronomy)
Member WIC (World Space Observatory Implementation Committee)
Member IAU Working group on Active B stars

W. Hermsen
Vice-president, Committee on Space Research (COSPAR) of the International Council of Scientific Unions (ICSU) and Chairman of the Publications Committee

Chair, COSPAR Sub-commission E1 on Galactic and Extragalactic Astrophysics
Vice-president, COSPAR Scientific Commission E on Research in Astrophysics form Space
Secretary, IAA Academy Commission I on Space Physical Sciences
Vice-president INTEGRAL Science Working Team (ESA mission scientist)
Member, NASA GLAST (Gamma-ray Large Area Telescope) Users Committee
Member, Advisory Board NOVA PUMA at Westerbork Synthesis Radio Telescope
Member SO C The INTEGRAL Universe Workshop, Munich, Feb. 16-20
Member SO C 4th COSPAR-IAU U Capacity-Building Workshop "Data processing from the Chandra and XMM-Newton Space Missions", Durbur, June 28 - July 9
Member SO C Symposium on "High-Energy Gamma-Ray Astronomy", Heidelberg, July 26 - 29
Member SO C COSPAR Colloquium on Spectra and Timing of Compact X-ray Binaries, Mumbai, Jan. 17 - 21 2005-02-09
Co-organizer INTEGRAL Science Workshop, Noordwijk, Jan. 18 - 21

E.P.J. van den Heuvel
Member Science Advisory Board Physics and Astrophysics, FWO Vlaanderen
Chairman Netherlands Foundation for Research in Astronomy (N FRA/ASTRON/NWO)
Member (vice Chair), Board of the Netherlands Research School for Astronomy NOVA
Chair of Board of EU Research and Training Network "Gamma-Ray Bursts, an Enigma and Tool", 2002 - 2006
Member, Associations of Board-Chairs of NWO Institutes
Chairman Leids Kerkhoven Bosscha Fonds, Leiden
Member, Board of "Jan Hendrik Oort Fonds", Leiden
Member, Board of "Leids Sterrewacht Fonds", Leiden
Chair, INTEGRAL - satellite Time Allocation Committee, ESA-ESTEC (2001 - )
Chair of Board of "Museum Sterrenwacht Sonnenborgh", Utrecht
Chair of Association of Laureates of NWO’s Spinoza Prize
Member, "Raad voor Natuur- en Sterrenkunde", KN AW
Member of the Steering Committee of the OECD Global Science Forum on "Future Large Facilities for Astronomy and Astrophysics", München/Washington D.C.
Member, Ethics Committee of the Royal Netherlands Academy of Sciences (KNAW)
Secretary, Section for Physics & Astronomy, Royal Netherlands Academy of Sciences (KNAW)
Member, Netherlands Committee for Astronomy
Co-editor "New Astronomy", Elsevier Amsterdam
Member, Editorial Board "Astrophysics and Space Science", Kluwer Academic Publishers, Dordrecht
Member, Board of "Astronomy Fonds voor de Astrophysica"
Member, Board of "Jan van Paradijs Fonds"

J. Hovenier
Member Science Advisory Committee of Journal of Quantitative Spectroscopy and Radiative Transfer

Karel van der Hucht
Co-director of the Leids Kerkhoven-Bosscha Fonds
Co-director of the Leids Sterrewacht Fonds
Representative IAU, UN-Commission of Scientific and Technical Sub-Committee
Member, WSO/UV Implementation Committee (WIC) and National WSO Working group
Secretary, Steering Committee Indonesian-Netherlands Astrophysics (INA)
Secretary, Dutch-Belgian Working Group on Stars with Extended Atmospheres (SU.A)
Member SOC 7th Pacific Rim Conference on Stellar Astrophysics, Seoul, Korea, Nov. 1 - 5

T. de Jong
IAU Commission 33, Interstellar Matter
IAU Commission 34, Galaxies
IAU History of Astronomy Division (Commission 41)
Member Scientific Committee NLR/NIVR
Member Board Artis Natura Magistra
Member Commission of CHAMAS of IUHPSThis is the end of the text.
R.G. Strom
Secretary of the European VLBI Network Program Committee, TAC
Member, Board, Stichting voor Eurasiatische Hemelkunde
Co-chair, Scientific Organizing Committee and proceedings co-editor, 5th IC O A (O ct. 2004)
Chairman XMM -Newton panel, A O -3 proposal review
Member, Scientific Organizing Committee, "The New Astronomy: Opening the Electromagnetic Window and Expanding our View of Earth" (June 2004)
Member, K A RST Support Group, N ational A stronomical O bservatories – C hinese A cademy of Sciences
Member of Working Committee, International Conference on O riental Astronomy (IC O A)
Member of Commissions 28 (Galaxies), 34 (Interstellar Matter), 40 (Radio Astronomy) and 41 (History of Astronomy) of the IAU
IAU representative to the International Geosphere-Biosphere Programme

L. B. F. M. Waters
Member N ational School for Research in Astronomy (NO VA)
Member ESO -ESA G ENIE Science Team
Member ESO VLT I Steering committee
Member ESO VLT I Science D emonstration Team
Chairman, Dutch Science Team for VISIR
Co-principal investigator for M id-infrared Instrument for VLT I M ID I
Co-chair, N O VA VLT I team
Member N W O C ommittee "A dvices C ommission A stronomy"
Member, advisory board Lorentz Center
Member, science team for H I F I, the heterodyne receiver for FIRST
Member, Dutch Science team M IR I instrument for JWST
Member N EVEC management team
Member science advisory board M PIA H eidelberg
Co-I CHEOPS Phase-A Study
Member "N ationaal Platform Planeetonderzoek"

R. A. M. J. Wijers
Coordinator G RACE
Coordinator EU RTN "Gamma-Ray Bursts: An enigma and a tool"
Co-editor N ew A stronomy Reviews
Member Board Stichting Ams terdams Fonds voor de A strofysica
Member ESO VLT I Rapid Response M ode Science W orking Group

Chair section A stronomy of Dutch Physical Society
Member N W O jury for N W O O pen Competition and N W O M edium-L arge
Member, A STRON contactraad
Member SRO N council
Co-chair L O F AR A stronomy Research Committee
Member advisory board Lorentz Center
Member Committee for A stronuclear Physics in the N etherslands
Member LOC Viva Fysica
Chairman C ommittee 46 of IAU
Member SO C Padova G RB meeting (April)
Member SO C 4th C onference on GRB’s in the A fterglow Era (O ct.)
Editor N ew A stronomy Reviews

M emberships of Learned Societies

P. Ehrenfreund
Member International A stronomical U nion (I A U)
Member A merican A stronomical Society (A AS)

W. H ermsen
Member International A cademy of A stronautics (I A A)
Member E uropean A cademy of Sciences (EAS)

H. H enrichs
Member International A stronomical U nion (I A U)
Member A merican A stronomical Society (A AS)
Member N ederlandse A stronomen C lub (NAC)

E. P. J. van den H euvel
Member K oninklijke N ederlandse A kademi e van W etenschappen, A msterdam (K N A W)
Member H olllandse M aatschappij van W etenschappen, H aarlem
Member A cademia E uropa, London
Honorary Fellow I ndian A cademy of Sciences
Member N ew Y ork A cademy of Sciences
Member N ederlandse A stronomen C lub (NAC)
Member N ederlands Physical Society NNV
Member International A stronomical U nion (I A U)
Member E uropean A stronomical Society (EAS)
Member R oyal A stronomical Society (RAS)
Appendix IV: Visiting Scientists

January
- Drs. R. Brasser, Univ. of Helsinki, (5)
- Dr. J. van Loon, K eele University, U SA (13-14)
- Dr. J. Puls, Institut für Astronomie und Astrophysik, München (13-15)
- Dr. D. Schaerer, Observatoire de Genève, Switzerland (14)
- Drs. C. H opman, Weizmann Inst. Rehovot (Israel) (23)
- Dr. B. E lmegreen, IBM T. J. Watson Research Center, U SA (25 – 27)
- Dr. E. Rol, Univ. of Leicester, U K (28 – Febr. 2; May 14 & 24; August 8)

February
- Dr. J. Malzac, CNR S, Toulouse, France (5+6)
- Dr. A. Pe’er, Weizmann Institute, Israel (9+10)
- Drs. Evghenii Gaburov, Univ. Leicester, UK (11+12)
- Dr. Peter Jonker, Harvard-Smithsonian Center for Astrophysics, Cambridge, U SA (7-20)
- Prof. P. Ghosh, Tata Inst. of Fundamental Res., Mumbai, India (21-28)
- Dr. C. Brockopp, MSSL, Dorking, U K (22-27)
- Dr. B. Elmegreen, IBM T. J. Watson Research Center, U SA (26)

March
- Dr. O. Chesneau, MPI für Astronomie, Heidelberg, Germany (2-5)
- Drs. T. Verhoelst, Observatoire de Paris, France (5)
- Dr. S. McMillan, Drexel Univ., USA (22 – 25)
- Prof. Dr. A. King, Univ. of Leicester (22-26; April 21-23, July 13 – 15)
- Dr. T. Belloni, Osservatorio Astronomico di Brera, Merate, Italy (29-April 2)

April
- Prof. L. D e Pater, U CL A Berkely, U SA (7)
- Prof. L. Yungelson, Astron. Inst. Russian A. c. of Sciences (12- July 7)
- Prof. N arlikar, Inter Univ. C enter for A stronomy and A strophysics, Pune, India, and Collège de France, Paris (24-May 01)
- Dr. O. Muñoz, Inst. de Astrofisica, Granada, Spain (26-May 14)
- Dr. P. Vreeswijk, ESO, Santiago, Chile (26)
- Dr. F. Kemper, Dept. of Physics & A stron. U CL A, LA, U SA, (26-29)

May
- Prof. Dr. J. Rankin, Univ. of Vermont, U SA (5-12)
- Dr. A. Moin (19)

June
- Prof. Dr. D. C. H eggie, U niv. of Edinburg, U K (5 – 9)
- Dr. A. C elotti, SI SSA, T rieste, Italy (29 – July 3)
- Dr. R. Jonker, Institute of Astronomy, Cambridge, U K (28 – July 17)
- Dr. J. Collins, Bloomberg U niversity, Pennsylvania, U SA (3)

July
- Dr. R. Iping, NASA's GS FC, U SA (1-27)
- Prof. Dr. D. C. H eggie, U niv. of Edinburg, U K (27)
- Drs. J. M. Jones, Dept. of A stronomy, O xford University, U K (12-20)
- Dr. S. Markoff, M IT Cambridge, U SA (12-21)
- Prof. Dr. J. Bjorkman, U niv. of Toledo, Spain (15-16)
- Dr. I. A. Dacosta, N ASA/G S FC, U SA (15-16, 19-23)
- Dr. B. Brandl, L eiden University (22)

August
- Drs. H. Spreeuw (24)
- M. Linares, U niv. of Barcelona, Spain (24)
- Drs. V. Tudose, U niv. of Bucharest, Romania (25)
- Drs. Berciano A lba, K apteyns Inst., Groningen, (25)
- M. Ibana, U niv. of Tokyo, Japan (27 – 29)
- Dr. F. Selsis, C entre de A strobiologia, M adrid, Spain (27-Sept 1)
- Dr. H. Lamer, Space Research Institute, Graz, A ustria (31-Sept 2)

September
- Prof. Dr. M. Hanson, U niv. of Cincinnaty, USA (26-29)
- Prof. Dr. Th. Henning, MPIA, H eidelberg, Germany (27)
- Prof. Dr. A. Tielens, Univ. Groningen (27)
- Prof. Dr. H. Lamer, Univ. Utrecht (27)
- Drs. E. Treister, Yale University, U SA (23-26)
- Dr. J. Bouwman, C EA Serv. d'Astrophysique, Saclay, France (27 – Oct 1)
- Dr. P. Jonker, Harvard-Smithsonian Center for Astroph., Cambridge, U SA (28 – 0 Oct 6)
Appendix V: Colloquia

January
(9) Bart van Dalen, Univ. of Amsterdam, Graduation Colloquium
Modelling the CO bandhead emission in 51 Oph
(13) Jacco van Loon, Keele University
Mass loss from red giants in globular clusters
(22) Ciovis H Opman, Weizmann Inst. Rehovot (Israel)
Massive black holes and stars

February
(6) Julien Malzac, IoA Cambridge
Optical/X-ray correlations in the X-ray binary XTE J 1118+480
(19) Sander Tigelaar, Univ. of Amsterdam, Graduation colloquium
Cygnus X-1 from radio to gamma-rays
(20) Tiziana di Salvo, Univ. of Palermo, Italy
Millisecond Pulsars hidden in Low Mass X-ray Binaries
(26) Bruce Elmegreen, IBM T.J. Watson Research Center, USA
ISM Turbulence: Processes and Problems

March
(12) Indranil Chattopadhyay, KU Leuven
Interaction of Jets with radiations from TCAF discs
(17) Evan ten Kulve, Univ. of Amsterdam, Graduation colloquium
Variable stellar winds and magnetic fields in early-type stars
(19) Carsten Dominik, Univ. of Amsterdam
Tracing evolutionary processes in circumstellar disks
(26) Anthony Brown, Leiden Observatory
Gaia: current status and activities

April
(2) Teije de Jong, Univ. of Amsterdam
Dating the observations on the Venus tablet of Ammisaduqa
(7) Imke de Pater, UCLA Berkeley, NOVA Colloquium
Titan: a pre-Cassini view
(23) Neal Evans, Univ. of Texas, NOVA Colloquium
The Formation of Low Mass Stars: Overview and Recent Results from the Spitzer Space Telescope
(27) Thomas Reerink, Univ. van Amsterdam, Graduation colloquium
Detailed study of the persistently bright atoll sources
May
(7) Peter Barthel, Kapteyn Instituut Groningen
To be or not to be active

June
(4) Donald Goldsmith, NOVA Colloquium
Popularization of astronomy in the US
(11) Karel van der Hucht, SRON Utrecht
Wolf-Rayet WO stars as supernova and gamma-ray-burst progenitors
(18) Joeri van Leeuwen, Utrecht U niv.
Drifting subpulses and the pulsar emission mechanism
(25) Reynier Peletier, Kapteyn Instituut Groningen
The formation of Galactic Bulges

July
(2) Charlotte Lemmens, Stichting Astronomium, Dwingeloo
Permanente publiekssattractie natuurwetenschappen
(29) Luciano Burderi, Osserv. Astron. di Monteporzio and Univ. of Cagliari
Accretion and magneto-dipole emission in fast-rotating neutron stars: new spin-equilibrium lines

September
(9) Jerome Petri, Utrecht University
Adiabatic oscillations in accretion disks and Q POs
(17) Sung-Chul Yoon, Utrecht University
Progenitor evolution of Type Ia supernovae: effects of rotation
(24) Ezequiel Treister, Yale U niv./U niv. de Chile
Hidden Black Hole Activity in the Early Universe
(29) Rob Fender, UVA/Southampton
Astrrophysics of jets

October
(1) Kostas Tziotziou, Utrecht University
Dynamics of the chromospheric fine structure and its role in the mass balance and heating of the solar corona
(8) Eva Grebel, Basel University, NOVA colloquium
The Violent Local Group: A History of Accretion and Survival

November
(5) Marijn Franx, Leiden Observatory
A new population of high redshift galaxies
(22) Wing-Fai Thi, U niv. of Amsterdam
The molecular content of circumstellar disks around young stars

December
(3) Mike Garrett, JIVE
21st Century Very Long Baseline Interferometry
(10) Dave Lommen, U niv. of Amsterdam, Graduation colloquium
The masses in the Cyg X-3 system
(13) Rien Dijkstra, U niversiteit van Amsterdam
Silicates and Water Ice Around Evolved Stars
(17) Dick Swaab, Nederlands Instituut voor hersenonderzoek, Christmas colloquium
Wij zijn ons brein
Appendix VI: Scientific Meetings

A. Participation in Scientific Meetings

Conf. of the American Astronomical Society Atlanta, U.S.A., Jan. 4 – 8
Simon Portegies Zwart

MODEST 4b-meeting, Geneva, Swiss, Jan. 12 – 14
Alessia Gualandris

Ed van den Heuvel, Ben Stappers

RAS meeting: "Time domain astrophysics", London, U.K., Feb. 2nd
Diego Altamirano, Rhaana Starling

Klaas Wiersema

Workshop Planeetonderzoek, Space Expo, Noordwijk, Feb. 13
Daphne Stam, Hester Volten

The 5th Integral Workshop "The Integral Universe", München, Germany, Feb. 16 – 20
Wim Hermens, Ed van den H euvel, Dave Lommen

Workshop on Molecules, Zwolle, Feb. 18 – 19
Richard Strom

Ceremonial Meeting for the signing of the LOFAR Contract by Minister M.
van der Hoeven, ASTRON, Dwingeloo, Feb. 23
Ed van den H euvel

ESA/ESTEC Pasteur Payload/Exomars Working Group, N oordwijk, M arch 8 – 13
Pascale Ehrenfreund

Astronomical Polarimetry: Current Status and Future Directions, Waikoloa Beach, H awaii, M arch 15 – 19
Daphne Stam (poster)

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MODEST 4a: "School on Numerical N-body dynamics", Strasbourg, France, M arch 19 – 22
Alessia Gualandris, Thijs Kouwenhoven, Michael Sipior

National Astronomy Meeting, Milton Keynes, U.K., M arch 29 – April 2
Ben Stappers

Dutch Astrophysics Days, N ijmegen, A pril 1 – 2
Alessia Gualandris, Alexander van der Horst, Simon Portegies Zwart, Michael Sipior

Ed van den H euvel

Workshop Interstellar Scintillation of Extragalactic Radio Sources, D wingeloo, A pril 5 – 7
Alexander van der Horst

Modeling the structure, chemistry and appearance of protoplanetary disks,
Ringberg Castle, Germany, A pril 12 – 17
Carsten Dominik, Joke Meijer

Attendance of launch ceremonies and launch of Dutch astronaut A. Kuipers to the International Space Station, A pril 19, Baikanur, Kazakhstan, A pril 17 – 20,
Ed van den H euvel

RTN Meeting, Padova O bservatory, Italy, A pril 19 – 21
Alexander van der Horst, Rhaana Starling, Klaas Wiersema

Astro Particle Physics Symposium, N I K H E F Amsterdam, A pril 26
Alexander van der Horst, Rhaana Starling, Klaas Wiersema

European Geophysical Union, Nice, France, A pril 26 – 30
Pascale Ehrenfreund

Thijs Kouwenhoven ('invited judge')
The Fate of the Most Massive Stars Symposium, Wyoming, USA, May 23 – 29
Alex de Koter, Rohied Mokiem

NAC-meeting, Vlieland, May 26 – 28
Diego Altamirano, Nick Cox (poster), Rien Dijkstra (poster), Alessia Gualandris, Godelieve H ammerschlag-H ensberge (penningmeester), Alexander van der H orst (poster), Lex K aper, Thijs K ouwenhoven, Dave Lommen, Arjen van der M eer, Michiel M in, Simon Portegies Zwart, Roald Schnerr, Michael Sipior, Rhaana Starling (poster), Patrick Weltevrede, (poster), Klaas Wiersema

2nd Workshop on the nature of the High-energy Unidentified Sources: The Multiwavelengths Approach to Unidentified Gamma-Ray Sources, Hong Kong, June 1 – 4
Wim H ermsen

Modest 4b: "Performing direct N-body calculations using parallel computing and special purpose hardware", Amsterdam, June 7 – 8
Alessia Gualandris, Thijs K ouwenhoven, Michael Sipior

IAU Colloquium 196 "Transits of Venus", Preston, UK, June 7 – 11
Richard Strom

The Electromagnetic Spectrum of Neutron Stars, Marmaris, Turkey, June 7 – 18
Diego Altamirano, Ed van den H euvel, Michiel van der K lijs (invited speaker), Dave Lommen, Simone M igliari

Interstellar & Circumstellar Matter VII, Amsterdam, June 14
Nick Cox

"The New Astronomy: Opening the Electromagnetic Window and Expanding our View of Planet Earth", Seattle, USA, June 16 – 18
Richard Strom

Gravitational Wave astronomy, Penn State University, USA, June 18 – 21
Simon Portegies Zwart

Drifting Subpulsus, Nijmegen Pulsar Meeting, June 28 – 29
Ben Stappers

Advanced School for Multiwavelength Astrophysics, Durban, South Africa,
Carsten Dominik, Daphne Stam, Rens Waters

Alpbach Summerschool: Birth, Life and Death of Stars, Alpbach Austria, July 27 – August 5
Nick Cox

Hot Star Meeting, Tennessee, U.S.A., July
Roald Schnerr

Conference M O D E S T 5b, Hamilton, U.S.A., August 11 – 14
Simon Portegies Zwart, Michael Sipior

8th Int. Colloquium on Atomic Spectra and Oscillator Strengths for Astrophysical and Laboratory Plasmas ASOS 8, Madison, Wisconsin, U.S.A., Aug. 9 – 13
Ton Raassen

Massive Stars in Interacting Binaries, Sacacomie (Montreal), Canada, August 16 – 20
Ed van den Heuvel, Arjan van der Hucht, Lex Kaper, Arjen van der Meer
Simon Portegies Zwart

Young European Radio Astronomer Conference, Cork, Ireland, Aug. 30 – Sept. 3
Elena Gallo

Blue Gene/L workshop, Juelich, Germany, Sept. 7 – 8
Simon Portegies Zwart

CHEOPS consortium meeting, Ringberg, Germany, Sept 12-15
Carsten Dominik
Rens Waters

Huib Hulst, Alex de Koter

Joint meeting of the Czech Astronomical Society and the Astronomische Gesellschaft, Prague, Czech Republic, Sept. 20 – 25
Thijs Kouwenhoven (poster)

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Workshop "U V-road to Astronomy", Madrid, Spain, Sept. 21 – 25
Huib Hulst

2nd Symposium on Particle Astrophysics in the Netherlands, Nijmegen, Sept. 24
Ed van den Heuvel, Alexander van der Horst

Light, Dust and Chemical Evolution, Gerace, Italy, Sept. 26 – 30
Michiel Min

CHEOPS science group meeting, Heidelberg, Oct. 4 – 7
Carsten Dominik

5th intern. Conf. on Oriental Astronomy, Chiang Mai, Thailand, Oct. 4 – 8
Richard Strom

NOVA Fall School, Dwingeloo, Oct. 4 – 8
Diego Altamirano
Alessia Gualandris

7th European VLBI Network Symposium, Toledo, Spain, Oct. 12 – 15
Richard Strom

Gamma-ray bursts in the afterglow era: 4th workshop, Rome, Oct. 18 – 23
Ed van den Heuvel, Alexander van der Horst (poster), Rhaana Starling (poster), Klaas Wiersema

FLAMES hot star survey consortium Workshop, Munich, Germany, Oct. 26-27
Alex de Koter, Rohied Mokiem

The dusty and Molecular Universe: A prelude to HERSCHEL and ALMA, Paris, Oct. 26-29
Carsten Dominik

Symposium for Awarding of the Christiaan Huygens Prize, Voorschoten, Oct. 28
Ed van den Heuvel (member Jury)

Spinoza symposium on Neutron Stars, Black Holes & Accretion, in honor of M. van der Klis, Amsterdam, Nov. 11
Ed van den Heuvel, Michiel van der Klis, Mariano Méndez, Simon Portegies Zwart, Rudy Wijnands
I20 Symposium on "Big History", Amsterdam, Nov. 26
Ed van den Heuvel

Symposium for the EU Descartes Prize, Prague, Czech, Dec. 1-3
Ed van den Heuvel (member Jury)

Workshop MODEST 5a, Edinburgh, UK, Dec. 15 - 17
Michael Sipior

Theory meets observation, workshop on Planet Formation, Ringberg Castle, Germany, Dec. 19 – 22
Dominik Paszun

Zeldovich 90 Meeting, Moscow, Russia, Dec. 20 – 24
Ed van den Heuvel, Michiel van der Klis (invited speaker), Rudy Wijnands

B. Scientific talks at Astronomical Institutes and Conferences

Carsten Dominik
Probing evolutionary processes in disks, Grenoble, March 11
Dust coagulation and "Conference Summary", Ringberg, April 12-17
Composition of Debris disks, San Diego, July 26-31
Staub in protoplanetaren Scheiben, Heidelberg, Oct. 25
Prospects for protoplanetary disks with Herschel, Paris, Oct. 27

Pascale Ehrenfreund
A biolog: the Search for life in the Universe, Jena, Feb. 2
A biolog: the Search for life in the Universe, Berlin, Feb. 3
A biolog: Vienna, April 19
The Mars Organic De te r, M OD, N ice, April 27
A P M ALDI for the detection of biological molecules in ice, April 28
A voyage from dark clouds to the early Earth, Carnegie Inst., May 13
A biolog: Braunschweig, June 8
Exogenous and endogenous sources for the origin of life, Edinburgh, July 2
Exogenous and endogenous contributions to the origin of life, Reykjavik, July 13
E A N A, A biolog in Europe, NASA Ames, March 28

Elena Gallo
Black hole X-ray Binary jets, Sydney, Feb. 10
Black hole X-ray Binary jets, Epping, Feb. 13
Black hole X-ray Binary jets, Melbourne, Feb. 12
Black Hole X-ray Binary Jets: the radio zoo, Cefalu, July 5
The power content of black hole X-ray binary jets, Cork, Sept. 1st
Accretion modes and jets, production in black hole X-ray binaries, Cambridge, USA, Dec. 1; MIT Cambridge, USA, Dec. 3; Santa Barbara USA, Dec. 10; Stanford USA, Dec. 7.

Alessia Gualandris
Performance analysis of parallel algorithms for the astrophysical N-body problem, Amsterdam, June 8
N-body simulations of star clusters, Wingeloo, Oct. 5

Huib Henrichs
Observerd magnetism in massive stars, Johnson City, USA, July 8
Magnetic fields in massive stars, Madison, USA, Sept. 16
The role of magnetic fields in massive stars, Madison, Sept. 18
Magnetic fields in massive stars, Groningen, Dec. 7

Wim Hermsen
The Vela pulsar and its pulsar wind nebula: High-energy characteristics with first results from IBIS/INTEGRAL, München, Feb. 19
Hard X-ray emission from AXP 1E 1841-045 and 1RXS J 170849.0-40091: A new class of high-energy gamma-ray sources, Hong Kong, June 1
Discovery of hard non-thermal X-ray emission from Anomalous X-ray Pulsars, Paris, July 22

Ed van den Heuvel
Formation of double neutron stars, Aspen, Jan. 14
X-ray Binaries and their descendants: Binary Radio Pulsars; Evidence for three classes of neutron stars, München, Feb. 18
Future Facilities for High Energy Astrophysics, Washington DC, Apr. 5
Formation and evolution of neutron stars and black holes in binary systems, Marmaris, June 10
Summary and Conclusions, Marmaris, June 18
Gamma-Ray Bursts and Massive Binaries, Sacacomie, August 18
Conference Summary, Sacacomie, August 20
Welcome and Introduction, Amsterdam, Nov. 11
Comments on How Big History Works, Amsterdam, Nov. 26
Formation of double neutron stars: evidence for three classes of neutron stars?, Moscow, Dec. 23

Karel van der Hucht
XMM -N ewton studies of the Wolf-Rayet colliding wind binaries WR 25 (WN 6h+O 4f) and WR 11 (WC 8+O 7.5I-I-V), Sacacomie, August

Lex Kaper
Massive stars and their compact remnants in high-mass X-ray binaries, Sacacomie, Aug. 19

Michiel van der Klis
X-ray binaries, Inst. Theoretische Fysica, Amsterdam, Feb. 26
Millisecond accreting pulsars, KNAW, Amsterdam, Feb. 29
Timing X-ray stars, Marmaris, Turkey, June 18
Timing X-ray stars, Cefalu, Italy, July 5
N eutron Star vs. black hole variability, Amsterdam, July 13
Common timing features in neutron stars and black holes, Moscow, Russia, Dec. 21

Alex de Koter
The stellar winds of the most massive stars, Porto, Portugal, Feb. 11
VIN C1 measurement of the size and shape of the stellar wind of eta Carinae, Wyoming, May 24
The total mass, mineralogy, and spatial distribution of the dust around eta Carinae, Wyoming, May 26
The life and death of the most massive stars in galaxies, UvA, A'dam, Sept. 7
Direct measurement of the size and shape of the present-day stellar wind of eta Carinae, M adison, Sept. 17
Galaxies and Strategy in the O star program of FLAMES, Munich, Oct. 26
The death-struggle of eta Carinae, the most massive star in the Galaxy, UvA, Amsterdam, Nov. 19

Thijs Kouwenhoven
The Binary Population in Sco OB2, Vlieland, May 27

Tom Maccarone
Progress towards a unified picture of the disk-jet connection, Gainesville, USA, March 24

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X-ray Binaries in Elliptical Galaxies and the Globular cluster connection, Southampton, UK, Nov. 26

Arjen van der Meer
On the mass distribution of neutron stars in HMXBs, Montreal, Canada, Aug. 19

Joke Meijer
Understanding the SEDs of Herbig Ae/Be stars, Ringberg Castle, April 16

Mariano Méndez
Neutron stars burst spectra with Perseus, ESTEC, N oordwijk, March 26
Galactic X-ray sources, Data processing from the Chandra and XMM -N ewton space missions, D urban, July
High-energy astrophysics, France, July
Unexpected variability in the X-ray emission of the isolated neutron star RX J0720.4-3125, Paris, July 23
Science case for a calorimeter on SRO, Ntrecht, O ct. 26
N eutron Stars: Equation of state, Amsterdam, Nov. 11
Selected results from C handra and XMM -N ewton, SRO, N, Nov. 16
Magnetic Fields in isolated neutron stars and neutron stars in binary systems, Angra dos Reis, Brazil, Dec. 1

Simone Migliari
Radio and X-ray jets in SS 433, Sydney, January
What can we learn from N S X-ray binary jets, Amsterdam, 15 July
Disk-jet coupling in X-ray binaries: neutron stars vs. black holes, M IT Cambridge & U CSD San Diego, USA, 10, 12, 17, 19 N ovember

Michiel Min
Dust processing in protoplanetary disks, Vlieland, May 26
Modeling optical properties of dust grains using a distribution of hollow spheres, Gerace, Italy, Sept. 30

Rohied Mokiem
Automatic fitting of O-star spectra with FASTWIN D Flames Workshop, M unich, O ct. 26

Ton Raassen
X-Ray Spectra of Cool and Hot Stars obtained with Chandra and XMM -N ewton, Madison, Wisconsin, USA, Aug. 9-13
Gertjan Savonije
Tidal resonance locking in eccentric binary systems. BA G workshop op Koninklijke Sterrenwacht Brussel (Ukkel), Belgium, Oct. 15

Michael Sipior
Shredding star clusters: an overview, SCS Informatics Colloquium, Amsterdam, April 16

Daphne Stam
Flux and Polarization Spectra of Extrasolar Planets, Space Expo, Feb. 13
Towards the Detection of Extrasolar Planets, SRON, May 11
A Polarized View on Terrestrial Extrasolar Planets, San Diego, July 28

Ben Stappers
An X-ray nebula associated with the black widow pulsar B1957+20, Aspen, Jan. 15
An X-ray nebula associated with the black widow pulsar B1957+20, Milton Keynes, April 1st

Rhaana Starling
WHT spectroscopy of GRB 021004, RTN meeting Padova Obs, April 20
From AGN to GRBs - training through research, Rome, Oct. 18

Richard Strom
Shades of the Goddess: Venus in transit, Conference summary Preston, June 11
Radio A stronomy in Holland before 1960: Just a bit more than H.I, Seattle, June 16
History of radio astronomy in Holland, 1940 - 1960. (With some comments about the history of radio astronomy in China), Urumqi China, Sept. 16
Radio astronomy in Holland before 1960, NAO, Beijing, China, Sept. 23
What is the primary beam response of an interferometer with unequal elements?, Toledo, Oct. 25

Hester Volten
Experimental light scattering by small planetary particles, N oordwijk, Feb. 23

Rens Waters
First results from MIDI, Luik, Belgium, Feb. 20
Mineralogy of proto-planetary disks, San Diego, July 28

Rudy Wijnands
Ten years of discovery with Michiel Amsterdam, Nov. 11

Lev Yungelson
Population synthesis for low and intermediate mass binaries, Cefalu, July

C. Working Visits
Pascale Ehrenfreund
Jet Propulsion Laboratory, Pasadena, U SA, Feb. 9 - 13
Atacama Desert, Yungai Geochemistry Station, Chile, Feb. 14 - March 2
Dutch Ruimtevaart Stakeholder meetings, March 23, April 8, June 15
NASA Astrobiology Conference, Ames, USA, May 16 - 17
University of Braunschweig, Germany, June 8 - 9
University of Vienna, Austria, July 1 - 7
Elena G ailo
University of Sydney, Australia, Feb. 8 - 14

Alessia Gualandris
University of Cagliari, Italy, collaboration with Monica Colpi and Andrea Possenti on the study of the dynamics of XTE J1118+480, June 13 - 20

Lex Kaper
X-shooter meetings:
ASTRON, Dwingeloo, Jan. 8; Aug. 30; Sept. 1; Oct. 13; Nov. 10
ESO, Garching, Germany, Jan. 19 - 21; Dec. 14 - 15
Copenhagen, Denmark, June 8 - 9
University of Vienna, Austria, July 1 - 7
Trieste, Italy, Sept. 20 - 21

Other meetings:
ESO User Committee, April 20
ESO Contact Committee, June 4, Dec. 6
Visit ESO Paranal with College van Bestuur UvA, Oct. 14 - 20
NOVA Instrument Steering Committee, Amsterdam, Oct. 4

Astronomical Institute Anton Pannekoek
Michiel van der Klis
ESA Astronomy Working Group, Paris, Jan. 15 - 16
ESA Cosmic Vision Workshop, Paris, Sept. 15 - 16
ESTEC, Noordwijk, Sept. 27 - 28
Integral Time Allocation Committee, ESTEC, Noordwijk, Dec. 6 - 8

Jodrell Bank Observatory, UK, Dec. 21 - 23

James Miller-Jones
CHEOPS Workshop, Amsterdam, April 5 - 6
Venus PFS meeting, Frascati, Italy, May 18 - 20
Darwin meeting, Amsterdam, August 31 - Sept. 1 - 2
CHEOPS Workshop, Ringberg Castle, München, Germany, Sept. 12 - 15
Venus Virtis meeting, Bilbao, Spain, Dec. 1 - 2

Daphne Stam
CHEOPS Workshop, Amsterdam, April 5 - 6
Venus PFS meeting, Frascati, Italy, May 18 - 20
Darwin meeting, Amsterdam, August 31 - Sept. 1 - 2
CHEOPS Workshop, Ringberg Castle, München, Germany, Sept. 12 - 15
Venus Virtis meeting, Bilbao, Spain, Dec. 1 - 2

Rens Waters
GENIE science team meeting, ESTEC, Noordwijk, Jan. 12 & Dec. 1 - 2
MIDI meeting, MPIA Heidelberg, Jan. 15 - 16 & Nov. 29 - 30
VISIR science meeting, CEA, Paris, July 13
Science meeting, MPIA Heidelberg, Nov. 15 - 16
CHEOPS review at ESO Garching, Dec. 16

Rudy Wijnands
School of Physics and Astronomy, Univ. of St. Andrews, UK, Jan. 27 - 30

Appendix VII: Observing Sessions

Dr. N. Cox
TBL/Musicos, Pic du Midi (France), May 31 - June 12

Dr. E. Gallo
Australia Telescope Compact Array, Narrabri, Australia, Feb. 3 - 7

Dr. H. Henrichs
Observatoire St. Veran, France, August 2 - 4
TNG, La Palma, Spain, Oct. 26 - Nov. 1
TBL, Pic du Midi, France, Nov. 3 - 9

Dr. S. Migliari
Australia Telescope National Facility, Narrabri, Australia, Jan. 6
Mount Siding Spring O b s., Coonanbarabran, Australia, Jan. 12 - 13

Rohied Mokiem
TBL, Pic du Midi, France, June 8 - 19

Dr. R. Schnerr
TNG, La Palma (Canarian Islands), October 25 - November 1
TBL, Pic du Midi (France), November 3 - 17

Dr. R. Strom
Xinglong Observatory, China, August 17 - 23, September 7 - 9
Appendix VIII: Scientific Publications

8.1 Dissertations


8.2 Publications in international refereed journals


8.3 Publications in conference proceedings

Entry and Descent Trajectory Analysis and Science (pp. 287-294) N oordwijk, N etherlands: ESA.


Maccarone, T.J., Kundu, A., Zepf, S.E., & Puzia, T.H. (2004). X-ray Binaries in Early Type Galaxies and the Globular Cluster Connection. In G. Tovmassian & E. Sion (Eds.), Compact Binaries in the Galaxy and Beyond (pp. 73-74). IAU.


Maccarone, T.J., Kundu, A., Zepf, S.E., & Puzia, T.H. (2004). X-ray Binaries in Early Type Galaxies and the Globular Cluster Connection. In G. Tovmassian & E. Sion (Eds.), Compact Binaries in the Galaxy and Beyond (pp. 73-74). IAU.

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Maccarone, T.J., Kundu, A., Zepf, S.E., & Puzia, T.H. (2004). X-ray Binaries in Early Type Galaxies and the Globular Cluster Connection. In G. Tovmassian & E. Sion (Eds.), Compact Binaries in the Galaxy and Beyond (pp. 73-74). IAU.

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8.4 Publications in non-refereed journals


### 8.6 Books and Reports


## Appendix IX: Contact Information

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