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VISITORS GUIDE
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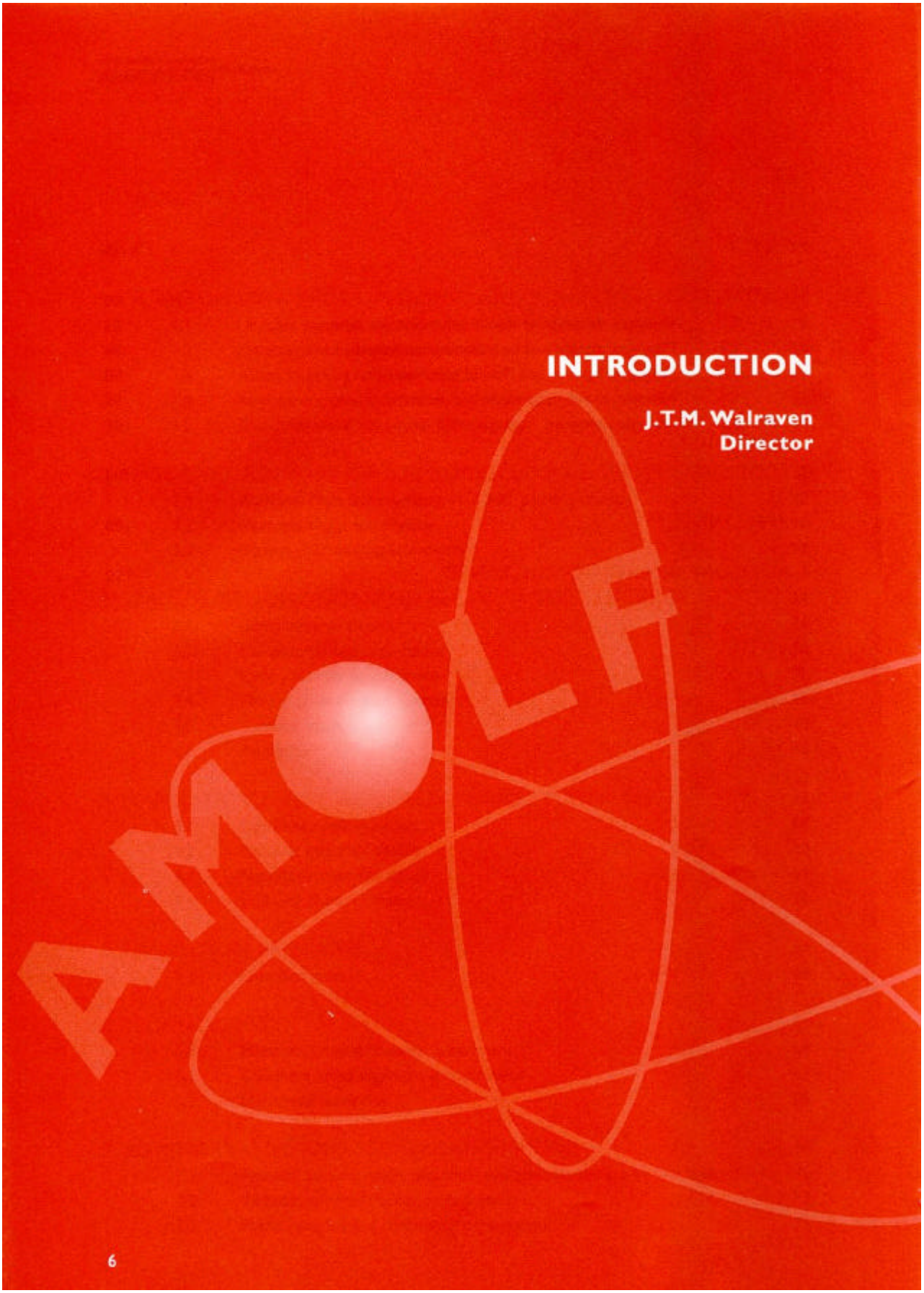
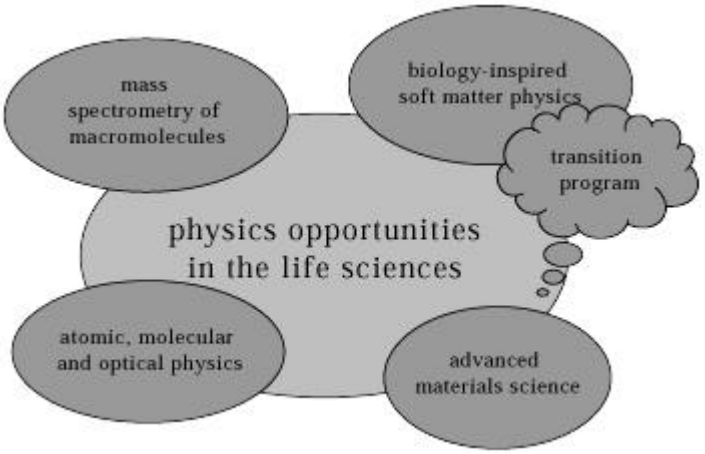


The FOM Institute for Atomic and Molecular Physics (AMOLF) is one of the five national research institutes of the Foundation for Fundamental Research on Matter (FOM). The research

at AMOLF is focused on selected areas of atomic, molecular and optical physics (AMO), and condensed matter physics (CM) with the aim of providing the intellectual underpinning needed to create future advanced technologies. AMOLF stimulates activities of biophysical interest (see figure).



AMOLF is an institute of approximately 100 scientists, 50 technical engineers and 25 supporting staff with an average age of 36 years. An important goal of the institute is the training of scientists and technical engineers for advanced research. This results in a steady flow of researchers and engineers to positions in industry and the academic world. Some 40 graduate students are presently active at AMOLF. They prepare for a Ph.D. degree from one of the 7 universities in the Netherlands where 14 AMOLF staff members hold professorships. The staff also maintains contacts with industrial partners and participates in research programs and program committees, on a national level within FOM and NWO and on an international level within the European Union. Every year, the institute welcomes many visitors from the Netherlands and abroad, and offers positions to undergraduate students and interns.
In this Annual Report an account is given of the scientific progress realized in 2001. The report is addressed, in particular, to those who provide financial support to our research. By offering sufficient detail, we hope that the booklet also proves valuable to others interested in the institute, in particular our scientific visitors.

Present Scientific program
Within the FOM organization the research has been organized in national programs. The AMOLF scientific program centers on four of these FOM programs:

• Quantum dynamics of atomic and molecular systems (QDAMS: 1999-2002)
This program expresses the current strength and immediate research goals of AMOLF in the domain of ultra-fast dynamics of atomic and molecular systems. Very different systems, from isolated atoms to molecules in liquid phases are investigated with light sources ranging from the THz regime up to the XUV. Further, attention is given to the development of related instrumentation.

• Nano-structured opto-electronic materials (NOEM: 1999-2003)
This program accommodates the AMOLF interest in advanced optical materials. It focuses on basic research on new materials and physical phenomena that may become important for future optical applications. Photonic crystals, colloidal materials, and thin film photonic waveguides are investigated. It brings together expertise in hard and soft condensed matter science.

• Structure, function and flow of soft materials (SFFSM: 1999-2006)

This program is aimed at gaining insight in the structural and dynamical properties of various kinds of soft materials (polymers, liquid crystals, colloidal systems and biological materials). The strength of this program is that it emphasizes the unifying aspects rather than the large differences of context and application of these materials.

• Mass spectrometry of biomacromolecular complexes (BIOMSL: 2002-2008)
This program is focused on the development of imaging mass spectrometry of biological and related organic materials as well as on the structural analysis of biomacromolecules. Newly developed mass spectrometric methods are explored and applied in multidisciplinary collaborations with specialists in the life sciences, polymer science and art conservation.

Special Developments in 2001
The year 2001 has brought three new research leaders to the Institute. Dr Sander Woutersen started a group on two-dimensional pump-probe vibration spectroscopy of biomolecules, Dr Sander Tans started a biophysics group initially focusing on protein translocation across bio-membranes and Dr Sander Piersma started a group on imaging mass spectrometry of biomolecular systems. Of our senior staff Dr Huib Bakker was appointed professor of 'Ultrafast spectroscopy of molecules in the condensed phase' at the University of Amsterdam, Dr Ron Heeren as professor of 'Physical aspects of biomolecular mass spectrometry' at Utrecht University and Dr Bela Mulder as professor of 'Theoretical cell physics' at Wageningen University. These are part-time appointments to strengthen our ties with these universities. Two well-known AMOLF faces left the institute, our librarians Saskia Windhouwer and Elin Sputnesset who ran our information services/ library very successfully for many years.

The struggle for laboratory space in our institute took place on several platforms. In the spring the main hall of our institute was reconstructed to accommodate a large NWO investment in imaging mass spectrometry ('mass microscopy') and a FOM investment in scanning electron microscopy. To free valuable laboratory space we constructed in summer and fall temporary office space in a temporary annex to the AMOLF building. This freed valuable laboratory space in the main building that is being prepared, in particular for the groups of Dr Sander Tans and Prof. Marileen Dogterom.

The major event with regard to housing was the announcement of the minister of education that he made a financial reservation to construct an entirely new building for the AMOLF institute. With this decision a long-term goal of vital importance for our organization has entered the stage of dedicated project management.

In 2001 the institute received some 13 million guilders in program funding from the foundation FOM. Together with an additional 4 million guilders of project funding from various sources this yields a total exploitation budget of 17 million guilders. The scientific output of AMOLF in 2001 is written down in 154 publications and 8 Ph.D. theses.

SCIENTIFIC HIGHLIGHTS IN 2001
Prediction of absolute crystal-nucleation rate in hard-sphere colloids
Crystal nucleation is a much-studied phenomenon, yet the rate at which it occurs remains difficult to predict. Small crystal nuclei form spontaneously in supersaturated solutions, but unless their size exceeds a critical value - the so-called critical nucleus - they will re-dissolve rather than grow. This critical nucleus is too small to allow direct observation causing the rate-limiting step difficult to probe experimentally. At AMOLF the nucleation process in a suspension of hard colloidal spheres was studied in computer experiments. Large discrepancies between the computed nucleation rates and those deduced from experiments were obtained: the best

experimental estimates of the crystal nucleation rate seem to be too large by several orders of magnitude. (SFFSM program)

Modified spontaneous emission in three-dimensional photonic crystals
The optical properties of a three-dimensional Si 'woodpile' photonic crystals were determined. The intrinsic luminescence from the poly-Si base material is used as an internal probe of the photonic bandstructure and shows a large gap in the wavelength region 1.4-1.7 micron, characteristic for a bandgap. Spectrally- and angle-resolved optical reflectivity measurements, taken with different input polarizations and sample azimuths, probe the bandstructure from outside. The measured data are in good agreement with calculated spectra, taking into account the presence of a well-defined superstructure in the structure that is related to the woodpile fabrication process. (NOEM program)

Dynamics of water molecules in aqueous solvation shells
The properties of solvation shells around ions and polar molecules are important for understanding the overall dynamics of chemical reactions and the structure of biological complexes in aqueous solution. At AMOLF we developed a method to study the dynamics of water molecules in the solvation shells around Cl-, Br-, and I- anions using femtosecond midinfrared nonlinear spectroscopy. The hydrogen-bond dynamics of the water molecules solvating these ions was found to be slow as compared to pure liquid water, indicating that the aqueous solvation shells of these ions are rigid on the time scale investigated. (QDAMS program)

A dynamical model for plant cell wall architecture formation
In collaboration with Wageningen University a dynamical mathematical model was developed to explain the cell wall architecture in plant cells. The highly regular textures observed in cell walls reflect the spatial organization of the cellulose microfibrils, the most important structural component of cell walls. Many of the layered structures known to occur in real cells can be generated with analytic solutions of this model. These include helicoidal, crossed polylamellate, helical, axial and random textures, which are the basic textures observed in cell walls. (SFFSM program)

Observation of a train of attosecond pulses from high-harmonic generation
In an international co-operation between AMOLF and two French labs (Laboratoire d'Optique Appliquee and Centre d'Etude de Saclay) we have investigated ultraviolet (UV) light pulses emitted when a femtosecond laser is focused in a dilute gas jet. The temporal beating of superposed high harmonics obtained in this process can produce a train of very short intensity spikes, depending on the relative phases of the harmonics. It was found that under proper conditions the light is emitted in bursts of only 220 attoseconds in duration. This makes these pulses by far the shortest ever detected. (QDAMS program)

Microscopic surface patterns of a liquid crystalline polyacrylate film
Forms of self-organization are being actively explored as potentially new approaches for micro fabrication. At AMOLF a liquid crystalline (LC) polymer was investigated that consists of LC molecules (mesogens) laterally grafted onto a classical polymer backbone. This material was shown to form lamellae-like surface ripples on a nanometer length scale when applied to a flat homogeneous glass substrate. This type of self-organization is attributed to the competition between LC order and surface curvature energy. (SFFSM program)

Synthesis of monodisperse rare earth doped colloidal particles
Rare earth doped colloidal particles can serve as optical probes in photonic crystals or as gain medium in polymer waveguides and microcavity lasers. We have developed an acid-based wet-

chemical synthesis route using tetra-ethoxysilane and a rare-earth chloride to form bulk Er, Eu and Tb-doped silica colloids. The particles show high luminescence quantum efficiency, but also large size polydispersity. To reduce the latter, a seeded growth process was developed in which undoped monodisperse colloids were first added to the reaction solution. Transmission electron microscopy reveals the formation of a 5-6 nm thick silica shell doped with the rare earth ions. Luminescence with high quantum efficiency is observed from these particles. (FOM program NOEM)

Phase-fluctuating 3D Bose-Einstein condensates in elongated traps

Bose-Einstein condensed (BEC) gases offer new opportunities to investigate macroscopic quantum behavior in many-body systems. At the BEC transition temperature (Tc), the gas ‘condenses’ into the 'quantum state' of lowest energy (the condensate) which is characterized by an amplitude and a phase. It was commonly assumed that in 3D condensates the phase is the same everywhere. A theoretical study at AMOLF showed that this assumption is not correct for very elongated 3D trapped Bose gases and that even far below Tc the equilibrium state will show phase fluctuating in space and time. The presence of these phase fluctuations allows for extending thermometry of Bose-condensed gases to temperatures well below those established in current experiments. (Transition program)

Displacing Rydberg electrons: the mono-cycle nature of half-cycle pulses

Very weakly bound electrons can survive fields that are strong enough to completely destroy atoms with much less weakly bound electrons. This was demonstrated with THz ‘half-cycle’ pulses in experiments at AMOLF. Such pulses consist of a fast (<1 ps) unipolar pulse, followed by a slow unipolar pulse of opposite polarity. It was found that the interaction of such THz pulses with very high Rydberg states results in a displacement of the electron within the atom, while the ionization is strongly suppressed. In classical terms: the first fast unipolar feature corresponds to a start kick of the Rydberg electron, while the second unipolar feature acts as a stop kick. (QDAMS program)

1. QUANTUM DYNAMICS OF ATOMIC AND MOLECULAR SYSTEMS

Program coordinator: W.J. van der Zande

The central theme of the program on the quantum dynamics of atomic and molecular systems is the investigation and manipulation of dynamical phenomena in atomic and molecular systems under conditions where quantum-mechanical behavior is important.
Emphasis is put on the following aspects:

- The investigation of the dynamics in atoms and molecules at all time scales up to femtoseconds
- Optical manipulation of the internal structure of atomic and molecular systems
- Maintaining state-of-the-art instrumentation
- Development of novel apparatus as spin-off of fundamental research

The quantum character of electronic and nuclear motion manifests itself in physics and chemistry and is therefore of fundamental importance for fields of application such as the manipulation of chemical reactions with light or the modeling of the earth atmosphere. At AMOLF, the research on quantum dynamical phenomena is motivated both from the point of fundamental interest and in view of these applications.
Research momentum is optimized by sharing scientific skills and insights and by pooling of experimental apparatus.

1.1 ULTRAFAST SPECTROSCOPY

H.J. Bakker

This group studies the microscopic structure and dynamics of hydrogen-bonded systems in the condensed phase with ultra-fast, nonlinear spectroscopic techniques.

Hydrogen bonding forms an extremely important, yet poorly understood type of intermolecular interaction, that determines the dynamical and structural properties of many condensed-phase systems. Unfortunately, most condensed-phase systems are strongly inhomogeneous, which implies that the dynamics of the hydrogen-bond interactions cannot be studied with conventional (linear) spectroscopic techniques like infrared absorption or Raman spectroscopy. For these systems, dynamical and microscopic structural information can only be obtained with nonlinear optical techniques. These techniques allow for a separation of the response of a selected sub-ensemble of the molecules from that of the rest of the inhomogeneous ensemble. Examples are saturation pump-probe spectroscopy, spectral-hole burning and photon-echo spectroscopy. These techniques require intense, ultra-short laser pulses of which the central frequency can be tuned to the resonance frequency of molecular vibrations (mid-infrared, 2.5-10 μm) or hydrogen bonds (far-infrared, 50-300 μm). An important part of the research of the group is concerned with the development of new light sources that are active in this frequency region.

In the past, we have studied the microscopic structure and dynamics of pure liquid water (H_2O) and isotopically diluted water (HDO dissolved in D_2O and HDO dissolved in H_2O) using intense femto-second laser pulses with a central wavelength of 3 μm (resonant with the O-H stretch vibration) and 4 μm (resonant with the O-D stretch vibration). For these systems, we studied the time scale on which the hydrogen bonds stretch and contract, i.e. the time on which the water molecules move with respect to each other. For liquid water, we found a characteristic time scale of 400 femtoseconds, for deuterated water of 500 femtoseconds. We also observed that these hydrogen-bond stretching dynamics are strongly coupled to the reorientational motion of the water molecules. This coupling turns out to be responsible for the non-Arrhenius character of the temperature dependence of the reorientation rate. In addition, we studied the vibrational energy relaxation of the O-H stretch vibration of HDO and H_2O. We found that the vibrational lifetime of the O-H stretch vibration is much longer for HDO (approximately 740 femtoseconds at 300 K) than for H_2O (approximately 260 femtoseconds at 300 K). An important difference between HDO and H_2O, that could be responsible for this effect, is that for H_2O the O-H stretch vibration is practically in resonance with the overtone of the H-O-H bending mode, whereas for HDO there is a large energy mismatch between the O-H stretch and the overtone of the H-O-D bending mode. Both for HDO and H_2O the vibrational lifetime shows an anomalous dependence on temperature, i.e. the lifetime becomes approximately 20% longer when the temperature is increased from room temperature to the boiling point.

Recently, we have studied the dynamics of water molecules in solvation shells and of hydroxide ions (OH^-) and protons dissolved in water. Aqueous solvation is a very important, yet practically unexplored subject of research. Aqueous solvation interactions are believed to play a crucial role in chemical reactions and in the determination of the three-dimensional structure of large complicated structures like proteins. A severe complication in studying aqueous solvation dynamics is that it is very difficult to distinguish the response of the solvating water molecules from the bulk water. However, we recently discovered that two-color femtosecond saturation spectroscopy can form a very effective tool in selectively measuring the response of solvating water molecules. We found that the vibrational lifetime of the O-H stretch vibration of HDO molecules in the first solvation shell of the halogenic anions Cl^-, Br^- and I^- is 2.6, 3.3 and 3.6 picoseconds, respectively. These lifetimes are much longer than the vibrational lifetime of bulk HDO molecules, for which we measured a lifetime of 740 femtoseconds. As a result, after a few

picoseconds only the response of the solvating water molecules is observed which enables a detailed, selective study of the dynamics of these molecules. We found that the solvation shell of the anions is surprisingly rigid and well-defined: the rate at which the distance between the anion and the solvating water molecules is modulated is approximately 30 times smaller than the rate at which the hydrogen-bond length between two water molecules in bulk water changes.

Investigators: F. van den Broek, H.-K. Nienhuys, A. Lock, M. Kropman and A.W. Omta
Technical support: H. Schoenmaker, R. Kemper and A. Buyserd
H.J. Bakker is also professor of physical chemistry at the University of Amsterdam.

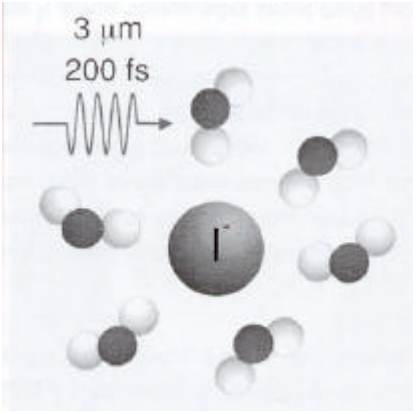


Fig. 1: Schematic pe of a pulsed mid-infrared excitation of a water molecule in the first solvation shell of the I- anion.

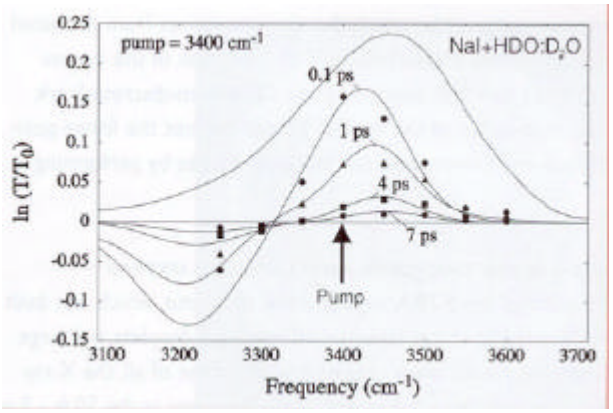


Fig. 2: Spectral hole burning experiment on the O-H stretch vibration of a solution of NaI and HDO dissolved in D_2O. The spectral hole induced by the femtosecond mid-IR pump pulse with a central frequency of 3400 cm-1 (=2.94 μm) is much narrower than the linear absorption spectrum (dashed curve), indicating the strongly inhomogeneous character of the absorption band. With increasing time delay, the hole shifts and broadens, which reflects hydrogen-bond dynamics.

1.2 EXTREME ULTRAVIOLET PHYSICS

M.J.J. Vrakking

This group investigates the fundamental mechanisms of XUV and X-ray generation based on the interaction of ultra-intense femtosecond laser pulses with gaseous (high harmonic generation) and condensed phase (laser plasma formation in clusters and liquids) media. This research offers unique new inroads for studies of molecular reaction dynamics, time-resolved molecular photoionization and photodissociation, and time-resolved X-ray diffraction.

In 2001, we have made progress in the following areas:

Time-resolved molecular alignment

In last year's annual report we reported measurements of dynamic alignment of diatomic molecules in intense laser field dissociative ionization. A narrowing of the measured fragment angular distributions with increasing pulse duration was interpreted in terms of alignment of the molecules in their ground electronic state due to the torque that can be induced by an intense laser. In the spring of 2001 these experiments were extended by carrying out pump-probe experiments, where I2 molecules were first exposed to an intense 1-10 ps pump pulse in order to align them, and then probed using an intense 80 fs laser pulse which initiated a Coulomb explosion of the molecules. The experiments showed convincingly that molecules can be dynamically aligned by the pump laser interaction, and also showed that this interaction can lead to the formation of rotational wavepackets which display alignment at well-defined time-delays following the excitation. Thus, the experiment shows that it is possible to use intense laser excitation to create aligned molecules under field-free conditions, which may have important applications in spectroscopy, high harmonic generation and optical pulse compression.

Photoionization microscopy

Following the construction of a modified velocity map imaging detector involving the use of a magnifying lens halfway between the extraction region and the microchannel plate (MCP) detector, we have performed photoelectron imaging experiments of the threshold photoionization of Xe atoms. In the experiment we have observed oscillatory patterns (see Fig. 1) which can be interpreted as a manifestation of interferences among various classical trajectories by which the electron moves from the atom to the detector. Remarkably, the interference patterns evolve smoothly as a function of the excess energy above the saddlepoint to ionization and - to a first approximation - the quasi-discrete Stark resonances only affect the amplitude of the modulation of the various fringes, but not the fringe position. We have been able to successfully analyze the observed interference structures by performing semiclassical trajectory calculations.

X-ray production in microscopic liquid droplets and large clusters

In the past year we completed the construction of the XTRA experimental apparatus, which was built for experiments on X-ray generation from intense laser excitation of microscopic droplets and large clusters. On both projects the first experimental results were obtained as well. First of all, the X-ray yield from a 10 micron water jet irradiated by intense laser pulses with pulse durations in the 50 fs - 2 ps range was characterized. We observed that the X-ray yield below 1 nm is strongly dependent on the pulse-length, with a ten-fold increase in yield with 500 fs pulses over that obtained with 50 fs or 5 ps pulses. The X-rays are predominantly emitted back towards the propagation direction of the laser. In contrast, when the jet is irradiated with pulses from a ns Nd:YAG laser, the angular distribution is peaked perpendicular to the laser propagation direction. The first experimental results on femtosecond laser irradiation of large clusters have been obtained as well.

Investigators: F. Rosca-Pruna, C. Nicole, H.L. Offerhaus, E. Springate, S. Asseev, Y. Ni, A. Houtepen, F. Lepine, M. Smits and V. Kumarappan
Technical support: R. Kemper, A. Buijserd and H. Schoenmaker

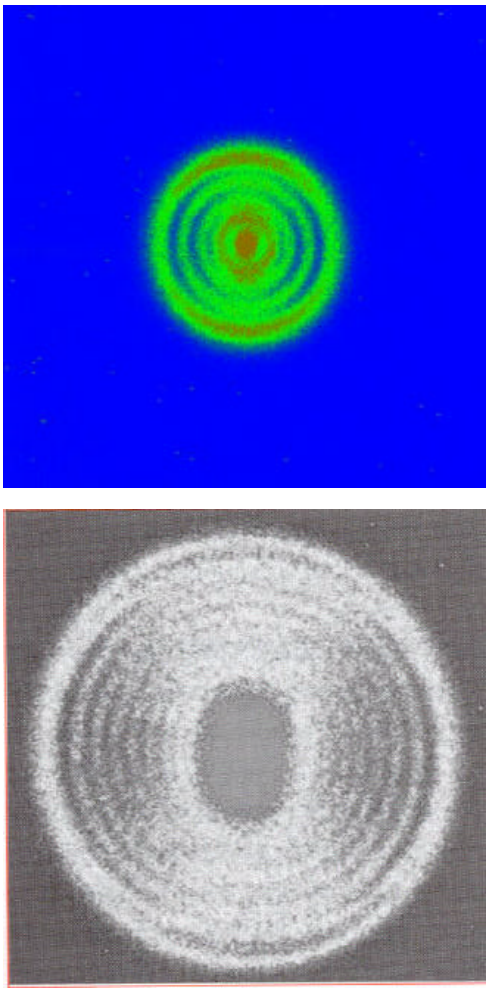


Fig. 1: Experimental photoelectron images recorded in a DC electric field of 320 V/cm, by exciting metastable Xe $6s[3/2]_{J=2}$ 13.8 cm^{-1} (above) and 27.8 cm^{-1} (below) above the saddle-point, with a laser polarized parallel to the plane of the detector and along the vertical axis. The bright central and weaker outer portion of the right image correspond to electrons which ionize directly and indirectly, respectively.

1.3 ATOMS IN STRONG RADIATION FIELDS

H.G. Muller

Present-day lasers can easily generate light intensities large enough to completely overwhelm internal atomic forces. Under such conditions atomic structure is drastically deformed. The ASTRA group studies the behavior of atoms, mostly by analyzing the energy of fragments that originate when the atoms (or larger conglomerates of particles) fall apart.

In 2001 research focused on four topics:

Atomic stabilization

Theoretical considerations predict that at very high light intensities, strongly deformed atoms become quite stable again, in the sense that they do not fall apart rapidly. The aim of this project is to investigate the behavior of such 'Light-induced states' in detail, by creating deformed atomic states in the presence of strong laser radiation by a second, much shorter laser pulse, and probing their persistence with time by a third short (femtosecond) laser pulse. Long-term illness of the principal investigator has obstructed progress of this project.

X-ray production from cluster explosions

This project investigates the laser disintegration of clusters containing thousands of molecules. Clusters this big behave under strong laser irradiation as chunks of condensed matter: fragments of atoms pulled apart by the laser make multiple collisions with other particles in the cluster, creating an avalanche of electrons and highly charged ions. The resulting plasma ball quickly explodes. The collisions strip electrons from the ions much more efficiently than the laser could do it. Highly charged ions formed this way can then pick up electrons from the surrounding gas, and the transferred electrons decay to the ground state under emission of X-rays. The original project, called 'A bucky-ball based X-ray laser' investigated the possibility to use this effect for the purpose of building an X-ray laser. Fullerene molecules proved too small to produce the required high charge states, so that research shifted to (much bigger) Van-der-Waals clusters of carbon-containing molecules (propane, CO_2).

Calculation of multiphoton ionization

Computers have become powerful enough to attack the problem of photoionization by brute-force numerical computation. A computer code to solve the time-dependent Schrödinger equation by newly developed numerical techniques was developed recently at AMOLF. This code was used on the single ionization of argon and helium. The results almost perfectly reproduce the electron spectra from these processes observed experimentally. Unlike in experiments, however, analysis of the calculation is present at any desired level of detail. Movies showing the time-dependent behavior of the wave functions on an atomic scale provide explanations for many hitherto unexplained features in the electron spectra.
A calculation on the excitation to a Rydberg state was made, aimed to resolve a recent controversy about this process.
The computer code was upgraded to handle double-ionization, as part of a project to get a better understanding of atomic correlation in highly perturbed atoms. Double ionization intrinsically is a two-electron problem, requiring calculations in a five-dimensional space. The first results of this were very encouraging
.

Generation of attosecond light pulses

A femtosecond laser pulse focused on a gas jet produces high harmonics of the laser radiation. Many different odd harmonics, all in the XUV region of the spectrum, are emitted simultaneously. The combination of these harmonics leads to a temporal structure in the XUV intensity on the sub-femtosecond (attosecond) time scale. We developed a method to determine

this temporal structure, and tested it at the European laser facility at Palaiseau. This experiment confirmed theoretical predictions that the XUV emission comes as a train of attosecond pulses, with almost no intensity in between those pulses.

Investigators: M. Kalinsky, E. Toma and C. Dinu
H.G. Muller is also professor of physics at the Free University of Amsterdam.

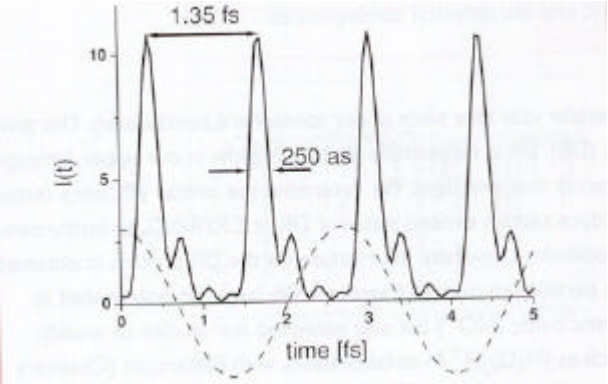


Fig. 1: Temporal intensity profile of a sum of five harmonics (11 to 19) of a Ti:sapphire laser, as reconstructed from measured phases and amplitudes.
The FWHM of each peak is 250 attosecond.
The cosine function represents the infrared probe field for zero delay.

1.4 ATMOSPHERIC PHOTOPHYSICS

W.J. van der Zande

The aim of our research is to provide an accurate description of elementary processes involving photons, electrons, atoms, and molecules. Results are applied in studies into the composition of the earth's atmosphere using also satellite data and atmospheric models. Our studies range from excitation of Rydberg atoms to light scattering from irregular dust particles. In our computational section, radiative transfer codes are developed to determine trace gasses and the strength of air glows.

Reactions of molecules with light and electrons are essential in understanding the composition and dynamics of the earth's atmosphere. The heating of our atmosphere, the ozone hole, the strength of air glows are related to elementary molecular processes. All these processes offer opportunities for fundamental research and generate a continuous demand for experimental innovations.

Light on atoms

Rydberg atoms are excited and exciting species. The electron orbiting time is long and is easily manipulated with electric fields and with electromagnetic radiation. We use ultra-fast half cycle pulses (HCP) to kick electrons in and out of their orbit. In collaboration with Vrakking (see 1.2), the electron ionization process has been studied using imaging techniques. Muller (see 1.3) and Robichaux (Auburn University) contribute theoretically. The analogy between a HCP and the electric field of a colliding electron is studied in experiments in which the effect of a train of electron pulses is compared to the situation of an electromagnetic wave. Using that Rydberg atoms are sensitive to far-infrared radiation, we are also developing an ultrafast thermometer that requires only nanoseconds to determine the temperature of a glowing body.

Light on molecules

In AMOLF, experiments are performed using fast beam-photofragmentation. Recently, we have studied the photo-excitation of triplet molecular hydrogen. Using UV photo-excitation, triplet molecular hydrogen is excited just above the ionization energy. We observe a competition between auto-ionization (---> $H_2^+ + e^-$) and dissociation (---> H(n=2) + H). This observation implies that the inverse process of auto-ionization, which is also known as low energy electron collisions, is also coupled to molecular dissociation. This process has atmospheric and astrophysical consequences.

Electrons on molecular ions

Collisions of thermal electrons and molecular ions take place in our ionosphere continuously. This process is called dissociative recombination (DR). DR is responsible for the air glow in our upper atmosphere through the formation of excited atoms that emit light. We determine the overall efficiency (cross sections) as well as the efficiency to produce certain excited states of DR at CRYRING, an instrument in the Manne Siegbahn Laboratory of Stockholm University. Information on the DR process is obtained by recording how the available energy is partitioned over all fragments. We have not only looked in detail to molecular oxygen (O_2^+) and nitric oxide (NO^+) but also extended our studies to weakly, $(NO)_2^+$, and proton bonded clusters, such as $(H_2O)_2H^+$ in collaborations with Pettersson (Chalmers University) and Larsson (Stockholm University).

Light on dust

Dust is a necessary step in the building of planets and dust pervades our atmosphere affecting both weather and climate through their effect on solar light. In collaboration with astronomers Waters and Hovenier (University of Amsterdam), the complete scattering matrix is determined of

real samples obtained from volcanoes, clay material, and from synthetic analogues of cosmic dust. This data is needed for a correct description of the light transfer through our atmosphere and for an improved interpretation of cosmic observations.

Computational atmospheric photophysics

The Netherlands is responsible for two very advanced satellite spectrometers, GOME (in operation since 1995) and SCIAMACHY (to be launched in 2002). In recent years new numerical techniques have been developed and tested for the analysis of water concentrations in the atmosphere. This provided the first possibility to add water to the detectable trace gasses using GOME. In 2001, we have added detailed comparisons among different databases to the research program. This research is a collaboration with Ubachs (Vrije Universiteit) and Aben (Space Research Organization Netherlands).

Investigators: A. Wetzels, R. Lang, A. Guertler, L. Dinu, A. Petrignani, B. Veihelmann, J. Williams and H. Volten
Technical support: I. Stavenuiter, A. de Snaijer and A. Meijer
W.J. van der Zande is also professor of experimental physics at the University of Nijmegen.

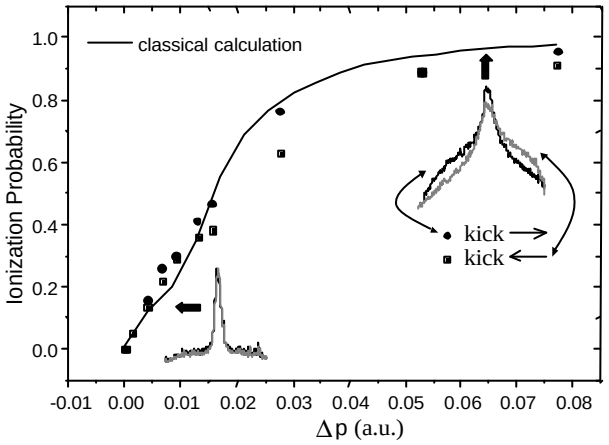


Fig 1: An ultra-short 1 picosecond half-cycle pulse is half an oscillation of the em-field and can give a kick to an electron in its orbit. The ionisation probability has been studied varying the strength of the kick. Xe atoms in high lying Rydberg states are used. The figure shows the momentum transferred by the pulse. The momentum distribution of the electrons is measured using an imaging technique. With very weak kicks, no memory is found of the kick direction. At strong kicks, part of the electrons does not remember the direction of the kick, while part is found kicked in the counter-intuitive direction. The distribution along the kick direction are shown using kicks in both directions.

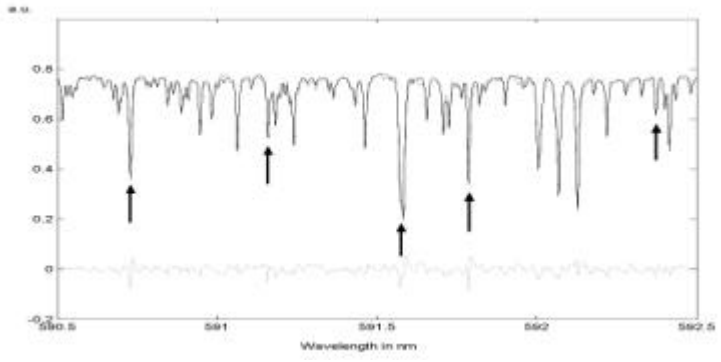


Fig. 2: Atmospheric water vapor absorbs solar light in the visible. The figure shows a spectrum, measured at the ground looking at the sun (gray line, from Rutherford Appleton Lab, UK) also containing solar features (arrows). Model calculations are performed to determine the amount of water in the atmosphere and assess the quality of the laboratory reference input (black line, the dotted line shows differences).

1.5 TWO-DIMENSIONAL VIBRATIONAL SPECTROSCOPY

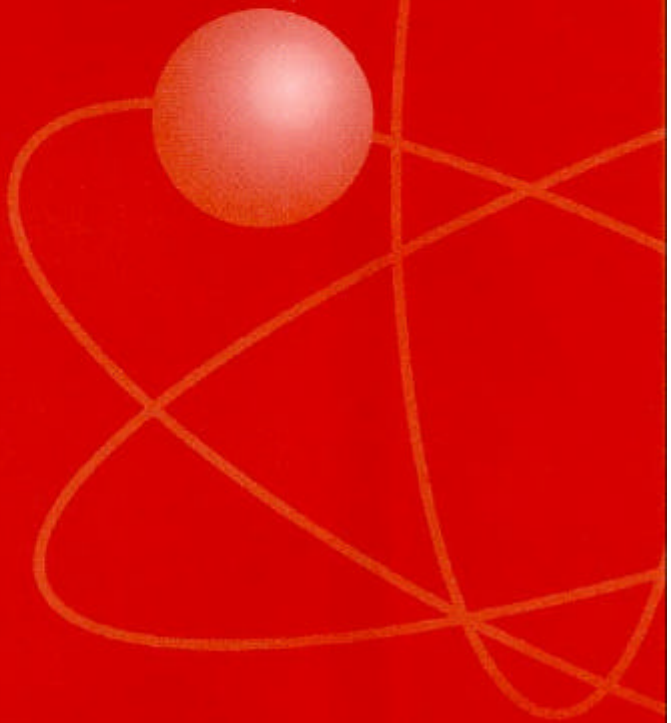
S. Woutersen

The goal of this research project, which has started as of July 2001, is to investigate ultrafast conformational dynamics of biomolecular systems by means of two-dimensional vibrational spectroscopy, a recently developed method in which couplings between vibrations are used to probe molecular structure and dynamics with subpicosecond time resolution. We will focus on nucleic-acid structures and small proteins in solution (the latter in a cooperation with P. Hamm, University of Zürich). The experimental setup, which involves the generation and detection of short (100 fs) and intense pulses in the mid-infrared wavelength region, is currently being constructed.

Technical support: H. Schoenmaker and R. Kemper

2. MASS SPECTROMETRY OF MACROMOLECULAR SYSTEMS

Program coordinator: J.J. Boon



The research objective of this program is the study of ion physical aspects of the mass spectrometry of large polymers and biomolecules, the development of new mass spectrometric methodologies for multidisciplinary biological and environmental studies, and the study of paintings and other art objects using advanced mass spectrometric and imaging spectroscopic methods. A special focus of the ion physical studies is the accurate manipulation and determination of internal energies in model systems and macromolecular ions in various collision-induced dissociation processes. The macromolecule studies concern matrix assisted laser desorption ionization and electrospray studies of lipids, proteins and synthetic polymers using high resolution Fourier transform mass spectrometry for extraction of information on the sequence of monomeric units, the three dimensional structure and non-covalent interactions of the polymers. Collaborative environmental studies are focussed on the mass spectrometric characterization of estuarine and oceanic dissolved organic colloidal matter. A central theme in the multidisciplinary MOLART project on aging processes in paintings is a fundamental study on the present molecular condition of the materials in paintings, which have changed in the course of time as a result of oxidation and cross-linking processes.

New research on mass spectrometric imaging and structural analysis of biomacromolecules will start under the umbrella of the FOM research program Mass spectrometric imaging and structural analysis of biomacromolecular complexes (BIOMSL) in January 2002. An important new instrumental development and major focal point is the construction of an imaging mass spectrometric microscope for studies of molecular distribution of lipids and proteins on cell surfaces. Life science oriented mass spectrometric research and studies of art are the main research topics in the BIOMSL program.

2.1 ANALYTICAL MASS SPECTROMETRY: MOLART PAINTING STUDIES

J.J.Boon

Paintings, an important component of our cultural heritage, undergo undesirable physical and chemical changes that effect their aesthetic quality. The AMOLF MS group is undertaking fundamental studies into the molecular aspects of aging in paintings with a special focus on oxidative changes and processes of cross-linking in the organic fractions of traditional paint.

The MOLART group at AMOLF is involved in the NWO Priority program on Molecular aspects of Aging in Art 'MOLART', an EU environmental dosimetry project 'MIMIC' and a new NWO program on art studies 'De Mayerne'. Quantification of the changes in chemical structure across the varnish, paint layers, grounds and support is an important objective of the fundamental research within MOLART. Our group also participates in MOLARTs' multidisciplinary projects with art historians and restorers such as the studies of the binding media and pigments of the paintings ensemble in the Oranjezaal of the Royal Palace Huis ten Bosch in The Hague. MIMIC is a continuation of the earlier EU funded 'ERA'project which uses egg tempera mock paintings to integrate the chemical effects of environment.

The new De Mayerne Program is named after Dr. De Mayerne, a 17th century doctor who documented paint materials and paintings methods. The program supports five projects which are strongly linked with the research interests of the AMOLF MOLART group. Topics funded are studies on historically accurate reconstructions of paintings with Carlyle (CCI, Canada), coordination chemical studies of lead in traditional oil paint with Haasnoot (UL, Leiden), studies on the media by Van Gogh with Hendriks (Van Gogh Museum), further studies on the Oranjezaal with Van Grevenstein (SRAL) and imaging studies of paint cross sections at AMOLF (MOLMAP).

Protrusions

Aggregation of lead soaps and ionomers is taking place in a number of paintings ranging from the 16th to 20 th century. This phenomenon was first observed in the Rembrandt painting 'The Anatomy lesson of Dr. Nicolaes Tulp' in the collection of the Mauritshuis. Protrusions are disfiguring because they protrude through the paint surface and appear as small white or dark spots with a diameter of about 100 microns. Studies at AMOLF with imaging FTIR and SIMS demonstrate that the original mineral matter consisting of lead containing pigments dissolves leading to the organic rich aggregates, crystallization of minium and remineralization with lead carbonates or leadhydroxychlorides (see Fig. 1).

Smalt containing oil paint

Blue potash glass in oil paint is inherently unstable. Imaging SIMS studies have shown that the loss of potassium leads to a change in color from blue to light pink or brown. This color change is a consequence of the different symmetry of the Cobalt II due to the loss of potassium from the glass. The phenomenon is strongest in oil paint. Chemical drying of oil paint releases small acids which could attack the glass. On the other hand, aged oil paint is a kind of ion exchange medium which readily accepts the potassium. Further comparative studies on paintings and research on model systems are part of the PhD thesis research of Keune.

Indigo in oil paint

Indigo, a blue organic pigment best known from blue jeans, has been used in the past as a coloring substance in oil paint. Indigo has an erratic behavior in oil paints and its stability seems to be dependent on the isolation and preparation methods from plants. The photodecomposition of indigo was investigated in dichloromethane solutions by Petra Novotna using HPLC, mass spectrometry and UV-VIS spectroscopy. Comparison of synthetic and natural indigo

demonstrates no differences in the chemical pathways of the degradation but there are differences in rate of degradation. This difference is now interpreted as due to physical differences in the consistency of the indigo particles which do not dissolve in solvents nor in plant oil.

Varnish mass spectrometry
Comparative studies on neat and aged tri and diterpenoid resins were performed by Dominique Scalerone with DTMS and MALDI-MS. The MALDI studies demonstrate that less polar triterpenoids are replaced by more highly oxygenated aged triterpenoids in both Mastic and Dammar. DTMS detects changes in the size of the polymer fractions of mastic, dammar and sandarac as a function of the light exposure method used to age the samples.

Imaging spectroscopy and MS of samples from modern paintings
Collaborative studies with Dr. Learner of Tate Gallery London are undertaken to determine the nature of the binding medium, the organic pigments and additives in 20th century acrylic paints and samples from modern paintings. LDMS and DTMS are both extremely useful for the qualitative analysis of pigments and media. Imaging SIMS studies of a paint cross section from a painting by P. Caulfield demonstrates that compositional differences exist between the acrylic copolymers used in different paint layers.

Investigators: G. van der Doelen, L. Speleers, J. van den Berg, N. Wyplosz, G. Languri, O. van den Brink, J. van de Weerd, K. Keune, T. Oudemans, W. Muizebelt, P. Novotna, D. Scalerone and B. Marino
Technical support: J. van der Horst, M.C. Duursma, A. Kerkhoff and A. van Loon.
J.J. Boon is also professor of analytical mass spectrometry at the University of Amsterdam.

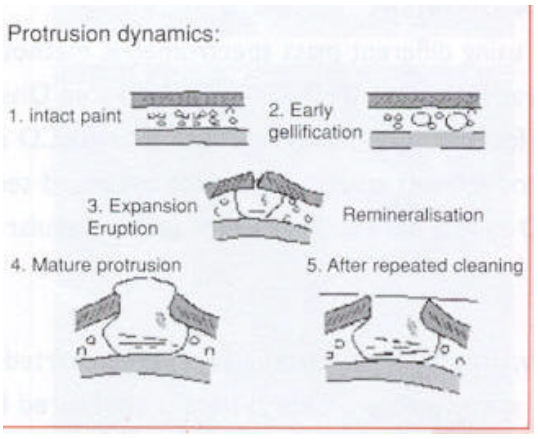


Fig. 1: Protrusions and related crater-like structures are a result of chemical changes in the composition of the underlying ground/intermediate paint layers leading to mechanical expansion and protrusion of the newly formed substances at the surface. Different stages can be observed: early stages with increased transparency; dissolution of lead white and aggregation of organic substances in the paint; expansion of the occluded mass eventually leading to eruption through paint surface; re-mineralisation of mature protrusions with lamellar precipitates of lead containing minerals.
Moisture and accompanying pH excursions towards high basicity are thought to be the main driving forces for the chemical changes. Poor quality of the paint materials may be an underlying cause.

2.2 MACROMOLECULAR ION PHYSICS

R.M.A. Heeren

The aim of this research is to investigate the physical aspects of activation and dissociation of high molecular weight bio-macromolecular complexes to gain insight into the structure and function of a wide scope of polymeric systems ranging from peptides and proteins to industrial synthetic polymers. Special emphasis is placed on the development of methodology for the investigation of the spatial structures formed by macromolecules in complex surfaces.

Internal energy studies and ESI-FTMS of biomolecules

Internal energy studies are focused on the correlation between the internal energy deposition and the consequent conformational changes of protein and/or their complex ions in ESI-FTICR MS. The internal energy of a given ion population is probed with the FTICR-MS using two different methods:
(1) breakdown diagrams at different fixed temperatures, varying the probing kinetic collision energies; (2) temperature scan experiments, keeping the collision energy constant while varying the initial Boltzmann temperature of the ions. These studies make it possible to study effects of both the initial temperature and the on-resonance probing kinetic energy on the effective internal energy deposition efficiency. Theoretical modeling shows good agreement with the experiments.
Protein conformational changes were probed by gas-phase H/D exchange. The preliminary results indicate that ion temperature, ion cooling and thermalisation time do affect the protein conformations. In other words, the change of the internal energy of the protein ions results in changes of protein conformation and can be utilized as means to differentiate the conformations of the protein.

Synthetic polymer studies

The applicability of ESI-FTICRMS as an analytical tool for various classes of synthetic polymers is studied in a collaborative project with AKZO-NOBEL and DSM. A novel MSn approach was developed that allows the study of different types of isomeric structures by a separation based on their difference in appearance energy. The method is called DoDIP: Dissociation of Depleted Ion Populations and uses internal energy differences between different isomers. H/D exchange reactions on trapped polymer ions were used to confirm the presence of different isomers identified with DoDIP.

Electron capture dissociation of Nisin

The fragmentation of Nisin was studied using different mass spectrometric methods. In all cases, Nisin molecules were ionized using Electrospray Ionization (ESI). Collision Activated Dissociation, either in the q-ToF or in the FT-ICR induced the formation of mainly b, y'' and z ions. ECD showed different fragment ions and cleavage sites. The two methods combined provide extended sequence coverage, but most importantly, it was shown that ECD can be used to localize the intramolecular monosulfide bridge.

MS imaging microscopy

In 2001 the ‘NWO-groot project on advanced mass spectrometric imaging started with the delivery of two TRIFT II stigmatic ion imaging mass spectrometers. One system is configured for ToF-SIMS microprobe analysis and is fully operational for the study of the distribution of small molecules and elements at various surfaces (see Fig. 1). It is already routinely employed for the study of embedded paint cross-sections and the study of small oligopeptides using matrix enhanced SIMS. Together with the Dutch Cancer Institute ME-SIMS studies were started on single cell surfaces. The second system will be transformed in the Bio-TRIFT, for mass

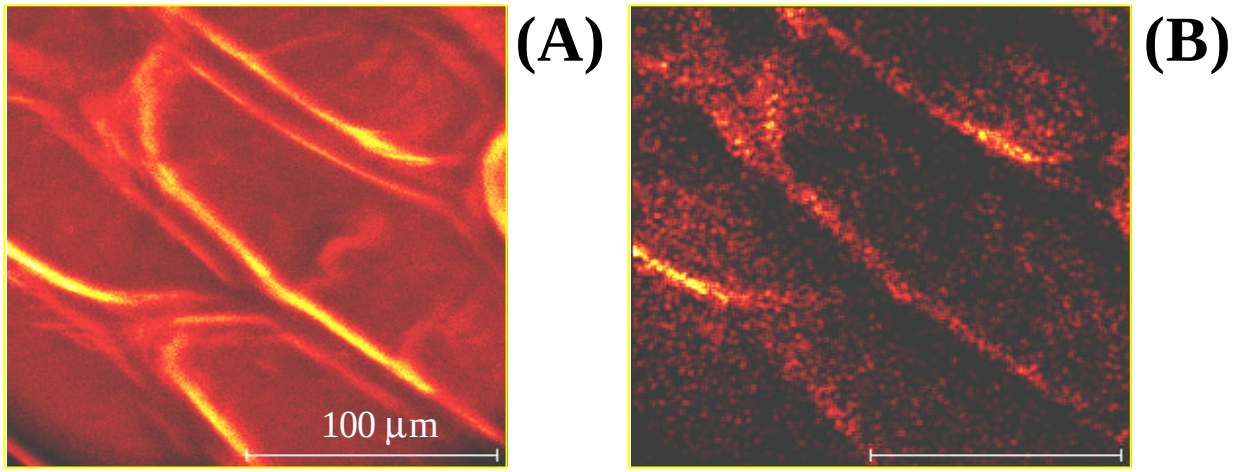
microscopy in the microscope mode. A new laser desorption source was designed and will be implemented in 2002.

Virtual Laboratory development in ICES-KIS

The aim of the Virtual Laboratory (VL) project is to make large scale instrumentation, database and mathematical modeling results available and accessible irrespective of the location of the scientist that requires this infrastructure. In 2001 the infrastructure for advanced internet connections was realized (Giganet) in the mass spectrometric imaging laboratory. A database model set up last year around a generic data-cube was further extended to allows facile comparison between results from different experimental techniques. For this purpose, several chemometric tools were developed to correlate meta-data (generated from principle components extracted from three data sets) resulting from different experiments through a canonical correlation analysis. This meta-data by itself is embedded in a separate database. This innovative VL infrastructure will allow direct scientific collaboration with our partners in the newly approved FOM program Mass spectrometry of macromolecular systems.

Investigators: X. Guo, A. Al-Khalili, N. Wyplosz, S. Koster, S. Luxembourg, A.J. Kleinnijenhuis, G.B. Eijkel and P.G. Kistemaker
Technical support: M.C. Duursma, F.G. Giskes and W. Barsingerhorn
R.M.A. Heeren is also professor of chemistry at Utrecht University.

Fig. 1: An example of microprobe ToF-SIMS imaging on biological tissue with the new imaging instruments: An onion skin was stained with methylene blue, The total ion current clearly depicts the cell structure (A) and a specific cell wall marker was imaged at m/z 465 (B). The images measure 200x200 micrometer.



2.3 BIOMOLECULAR MASS SPECTROMETRY

S. Piersma

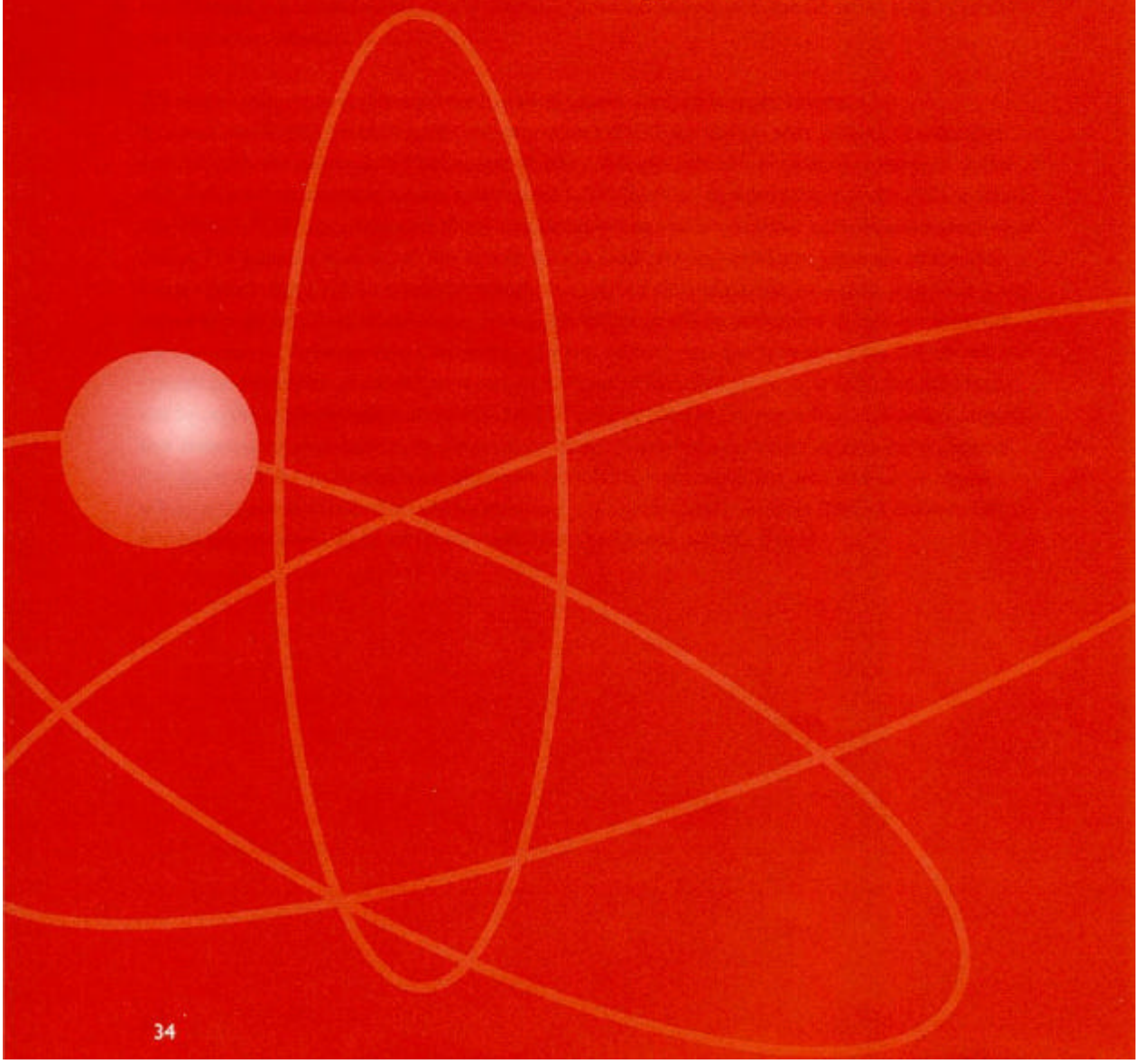
The goal of this research is the development of mass spectrometric instrumentation and biological sample preparation methods for position resolved mass spectrometry of biological tissue slices in order to image the cellular protein and peptide content. This group starts its activities in 2002.

Mapping the distribution of proteins and peptides in biological tissues is an challenging area of biological research. Current methods in proteomics (i.e. the identification of the total protein content of an organism) are bulk identification methods: no position specific information at the cellular level is obtained. Changes in protein expression and distribution are associated with disease states such as cancer and Alzheimers's disease.

We plan to map proteins directly from biological tissues using mass spectrometry.
A cluster ion-TOFMS based imaging mass microscope (MSM) for this purpose is being developed at AMOLF (also see section 2.1). Mass images of 200 x 200 mm with ±1 mm resolution will be acquired, with each pixel representing a mass spectrum of 1-60 kDa. Prior to development of the MSM, a scanning MALDI-TOF microprobe of ±10 mm resolution will be implemented for point-by-point scanning of tissues. The acquired mass signals are specific for the local protein expression, and maps of specific protein distributions can be created. Although an observed mass is specific for a given protein, it is not unique enough for direct identification. Protein identification will be performed on isolated fractions after proteolytic digestion using chromatography and tandem mass spectrometry. Data analysis will be focused on annotation of cellular mass images in terms of identified proteins. In 2002 the main focus will be on the implementation of the MALDI-TOF microprobe (10 mm resolution) and sample preparation techniques: freeze fixation, cryomicrotome slicing, freeze fracture, matrix application, drying and storage, in addition to development of protein identification strategies. The biological tissue samples will be provided and studied in collaboration with the Dutch Cancer Institute (NKI). Collaborations on protein identification will be established with UvA (de Koster) and UU (Heck).

3. STRUCTURE, FUNCTION AND FLOW OF SOFT MATERIALS

Program coordinator: D. Frenkel



Research statement

Soft materials (polymers, liquid-crystals, colloids, food-stuffs, paints, pharmaceuticals and biomaterials) differ in important respects from ‘hard’ materials (metals, semiconductors, dielectrics) as a result of the presence of a large number of degrees of freedom that can be excited at room temperature. These degrees of freedom are associated with structural elements of a size much larger than the atomic scale but sufficiently small for thermal fluctuations to be important. Typical for soft materials is the large diversity in properties even for chemically closely related systems. Here, both the conformational freedom and the mesoscopic size of the building blocks play an important role, the former enabling the variety, the latter allowing the control over their properties. Aside from the large scala of modern functional materials, the endless opportunities for the design of novel materials is manifest in 'living' matter, where energy consuming processes enable the assembly of ever more complex systems.

Within the FOM-wide program Structure, function and flow of soft materials, the research at AMOLF concentrates on the following specific aspects of soft materials:

- Properties associated with length scales where fluctuations dominate
- Phenomena that allow the design of novel materials with specific properties
- Structure formation and transport in bio-molecular systems
- Theoretical and numerical tools to model and predict the properties of soft materials
- Maintaining state-of-the-art instrumentation and the development of novel apparatus

The technical infrastructure provided by AMOLF, and partly funded by this FOM-AMOLF program is essential to carry out this research program, which has some heavy instrumental components:

- X-ray scattering - both in-house on a rotating anode spectrometer and at the European Synchrotron Radiation Facility (ESRF) in Grenoble
- Real-space scanning probes. Both atomic force microscopy, confocal microscopy and optical manipulation (laser tweezers) play a key role
- Workstations and access to main-frame parallel computers

3.1 COMPUTATIONAL PHYSICS

D. Frenkel

The computational physics research at AMOLF focuses on numerical simulation of classical many-body systems with an emphasis on soft condensed matter. Through our numerical work we aim to gain a better understanding of complex, collective phenomena by studying simple model systems that contain the essential physics of the problem. Parallel to such computer 'experiments', we perform numerical simulations of real materials under conditions that are, or could become, accessible to experiment. The main themes of the computational work the study of the structure, dynamics and phase behavior of (bio)macromolecular systems.

During the past year, we made progress in our studies of crystal nucleation and the effect of disorder (point-defects and polydispersity) on the properties of soft crystals. In addition, we devised novel algorithms to study flow in binary mixtures and suspensions of charged colloids.

Crystal nucleation

We have performed a detailed study of crystal nucleation in a suspension of uncharged, hard colloidal spheres. This model system is interesting both from a theoretical and from an experimental point of view. The theoretical importance derives from the fact that the phase behavior and the structural properties of hard spheres are well understood. Hence, this is an ideal system to test existing theories of crystal nucleation. Hard colloidal spheres are also experimentally relevant, as real suspensions of PMMA or silica colloids in appropriate solvents behave like hard-sphere systems. Moreover, the experimental study of crystal nucleation in these systems is an active field of research. In our simulations, we made a number of surprising observations. First of all, we find that the barrier for crystal nucleation is much larger than was thus far assumed on basis of either experiments or theoretical calculations. More importantly, we found that the barrier for crystal nucleation in polydisperse systems depends non-monotonically on supersaturation: at high supersaturations, the nucleation barrier starts to increase again. This finding sheds new light on the microscopic structure of colloidal glasses and may explain why, in experiments, colloidal fluids with a polydispersity exceeding 12%, never crystallize.

Colloidal and Protein crystals

Experimentally, it is very difficult to make good crystals of membrane proteins. This fact seriously hampers the structure determination of such proteins. In order to gain a better understanding of the factors influencing crystallization of such proteins, we performed numerical simulations of the phase diagram of a simple model for membrane proteins. In analogy with the corresponding three-dimensional models, we find that, as the range of attraction decreases, the liquid-gas transition becomes metastable. However, quantitatively, there appear to be large differences between two- and three-dimensional systems. In particular, crystallization in two dimensions proceeds so rapidly that it is virtually impossible to observe the same kind of metastable fluid-fluid demixing that is found in three-dimensional systems.
In a separate study, we computed the equilibrium concentration of interstitials and vacancies in colloidal crystals. We find that, whereas the concentration of interstitials is very low, that of vacancies is quite appreciable (1/4000 near melting). This is of practical importance, as vacancies may have a pronounced effect on the optical properties of colloidal photonic-bandgap materials. Moreover, we find that vacancies in colloidal crystals have a very high mobility.

Algorithms

We developed two novel algorithms to study the flow of complex fluids. The first was a dissipative particle dynamics scheme to simulate the dynamics of non-ideal fluids. On basis of a free-energy density that determines the thermodynamics of the system, we could derive

consistent conservative forces. Using this approach, we could perform coarse-grained simulations of fluid demixing.
A second direction of research was the exploration of a numerical (Lattice-Boltzmann) scheme to simulate electrokinetic effects. We tested this method by calculating the reduced sedimentation velocity for a cubic array of charged spheres in an electrolyte. For this system, we could recover the analytical solution that had been obtained for a weakly charged, isolated sphere in an unbounded electrolyte. However, the numerical scheme makes it possible to go beyond the limit that could be handled with the analytical theory. Comparison of our results with experimental data yielded good agreement in some, but not all, cases. The cause of this discrepancy is not yet clear.

Investigators: M. Alves de Inda, C. Das, S. Auer, S. Pronk, F. Capuani, W.B. Hu, M. Miller, T. Schilling, I. Coluzza and P.R. ten Wolde
D. Frenkel is also professor of chemistry at the Universities of Amsterdam and Utrecht.

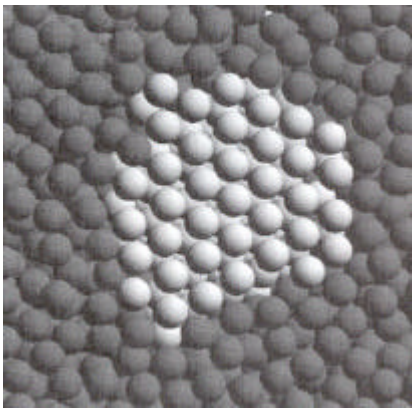


Fig.1: Snapshot of a critical nucleus of a hard-sphere colloidal crystal simulated by kinetic Monte Carlo simulation.

3.2 BIO-ASSEMBLY AND ORGANIZATION

M. Dogterom

The group bio-assembly and organization focuses on the study of physical processes that contribute to the assembly, transport, and spatial organization of macromolecular aggregates in living cells. The aim is to unravel, through quantitative experiments under simplified conditions, the physical mechanisms underlying these processes.

Our research is centered around four projects dealing with the dynamics, force generation, and organization of microtubules and the role of motor proteins and microtubules in organizing membrane structures. Each project is described in some detail below along with progress made in the last year.

Microtubule dynamics under load

Microtubules are rigid biopolymers that self-assemble from tubulin proteins. The assembly of a single microtubule generates pushing forces that are used for transport processes in living cells. We study these forces by letting a microtubule polymerize against a microfabricated glass barrier and analyzing the subsequent buckling of the microtubule. This technique has allowed us to measure force-velocity curves at different tubulin concentrations with forces up to 30 pico-Newton being measured for a single microtubule. In addition we have quantified the effect of load on the catastrophe rate of microtubules. Microtubules occasionally switch from a growing to a shrinking state through a process named dynamic instability. While free growing microtubules do so on a time scale of several minutes (depending on the tubulin concentration), forces that (nearly) stall the growth of the microtubule induce catastrophes after on average 20 seconds. As an alternative technique, we use an optical trap set-up that has produced first results demonstrating the feasibility of the method and promising a much better temporal and spatial resolution on the microtubule growth process.

Positioning of microtubule organizing centers

In many cells, microtubules are nucleated in a radial fashion by microtubule organizing centers forming so-called microtubule asters. In others, such as fission yeast cells, microtubules grow from the surface of the cell nucleus forming a parallel array along the length of the cell. Polymerization forces such as described above are believed to play a role in the positioning of these organizing centers in the confining geometry of the cell. We constructed artificial asters by attaching microtubule nucleation sites to silica beads and showed, using the catastrophe-inducing molecule Stathmin/Op18, that their positioning in microfabricated chambers depends on the presence of sufficient catastrophe events. Using optical tweezers we measured the forces acting on the organizing centers resulting from interactions of dynamic microtubules with the chamber walls, and showed that these forces are limited by buckling of the microtubules.

The plant microtubule cytoskeleton

In plant cells microtubules are nucleated in a more random fashion, and ordered microtubule arrays form just below the cell membrane. In collaboration with the groups of Emons and Gadella from the Universities of Wageningen and Amsterdam we investigate the possible mechanisms by which these ordered arrays form. In addition to studying the spontaneous ordering of microtubules in thin layers through in vitro experiments and computer simulations, we study the possible role of gradients of microtubule attachment sites or molecular motors in creating a concentrated band of microtubules (known in plant cells as the preprophase band). As a first step we used soft-lithography techniques to create patterns of motor proteins on glass surfaces and showed the specific interaction of microtubules with these patterns.

Membrane deformations by molecular motors

Membrane structures in living cells such as the Endoplasmic Reticulum (ER) and the Golgi apparatus show morphologies that differ dramatically from equilibrium lipid bilayer systems. In part, these morphologies are believed to be due to the interaction of lipid bilayers with active components such as molecular motors and dynamic microtubules. To study the morphological changes that arise due to such interactions we have developed an in vitro model system that allows us to link lipid vesicles to a network of microtubules through active motor molecules. Our results show that at sufficiently high motor-coverage of the bilayer, tubular membrane networks are formed resembling the morphology of the ER in living cells (see Fig. 1).

Investigators: M. Cosentino-Lagomarsino, M. de Dood, M. van Duijn, C. Faivre-Moskalenko, M.E. Janson, J. Kerssemakers, G. Koster, C. Rétif and E. Riemslag
Technical support: H. Bar and A. van der Horst
M. Dogterom is also professor of physics at the University of Leiden.

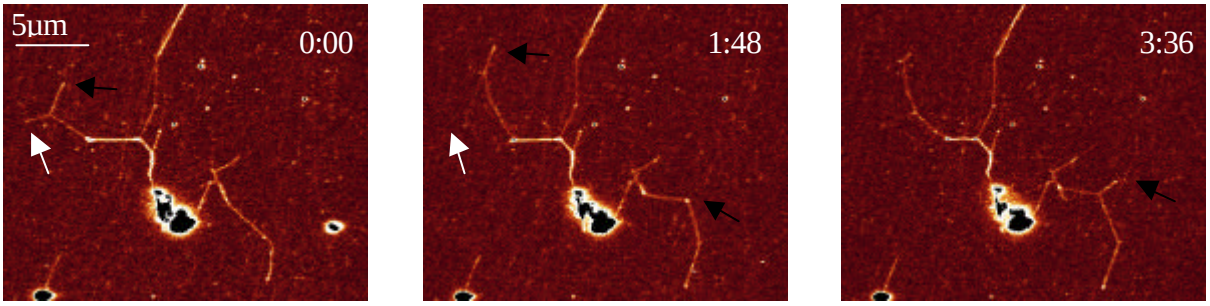


Fig. 1: Formation of a network of membrane tubules by motor proteins. A lipid vesicle covered with fluorescent streptavidin is coated with biotinylated kinesin molecules and allowed to interact with a random network of microtubules deposited on a glass surface. The streptavidin is visualized with confocal scanning microscopy; the microtubules cannot be seen. Membrane tubules appear (black arrows) and disappear (white arrows). Time in minutes and seconds.

3.3 ORDER/DISORDER IN SOFT MATTER

W.H. de Jeu

The objective of the group is to study and control the ordering of soft materials using X-ray methods and optical and atomic force microscopy. Block copolymer films are used to obtain nanostructures and to study polymer crystallization in confined geometries. Small-angle X-ray scattering is applied to investigate shear-induced ordering of (block co-)polymers. Finally smectic membranes are investigated as model systems of low-dimensional ordering.

Microscopic surface patterns in a polymer film

Side-chain liquid crystalline (LC) polymers are an interesting variety of polymer, composed of LC
sidegroups laterally grafted onto a classical polymer backbone. In LC polyacrylate films we observe a remarkable well-defined lateral lamellar structure on the nanometer scale on a homogeneous substrate. These surface ripples stem from a regular height deformation of 0.4-0.5 nm with a periodicity of 9 nm (Fig. 1). They are attributed to a coupling between local LC order and surface curvature. The curvature originates from the simultaneous existence of two different stable types of periodicity. The first one of 3.5 nm corresponds to an interdigitated structure of the side-chain mesogens, the second one of 4.4 nm to an almost bilayer structure. These two structures are observed in bulk samples. We postulate that the surface ripples originate from the competition between the two stable configurations, which at the film surface is accommodated by film curvature.

Diblock co-polymer films

In a diblock copolymer ordering arises due to the difference in chemical properties of the A- and B-blocks ('surfactant'-like behavior). For about equal amounts of A and B this can lead to microphase separation into a lamellar structure. These randomly oriented lamellar microdomains become macroscopic under the influence of surfaces. Within the framework of the EU-network POLYNANO we exploit additional ordering principles within one of the blocks to manipulate and control the generic block copolymer structures in films. An example is the incorporation of a comb-shaped LC block.
If one block is crystallisable, uniform diblock copolymer films provide a precise control of the boundary conditions for crystallization. We crystallized the PEO-blocks of symmetrical PEO-PBh diblock copolymer films isothermally from the ordered melt. An increase in the lamellar thickness of the PEO-blocks is found, which can be accommodated by the rubbery (flexible) walls of the PBh blocks. As the density of PEO increases upon crystallization, this effect is accompanied by a contraction in the lateral direction, leading to the formation of holes and cracks in the films. In contrast to homopolymers, in diblocks equilibrium chain folding can be achieved. Depending on the crystallization temperature changes are observed in the ratio of the folded to the fully extended chain.

Small-angle X-ray scattering

Small-angle X-ray scattering (SAXS) methods can be used to characterize polymer structures and morphologies on the nano- and microscopic scale. We have built in house a SAXS system employing two parabolic graded multiplayer mirrors. This provides an increase of the X-ray flux by an order of magnitude compared to conventional collimation systems, while at the same time the beam divergence is reduced to about 12 mdeg. The SAXS system is supplied with a sample cell combining accurate temperature control with the possibility to apply shear. It can be employed for various types of in-situ measurements such as shear-induced crystallization of polymers and the study of order-disorder transitions in block copolymers.

Smectic membranes in motion

The reduced dimensionality of smectic liquid crystals leads to strong thermal fluctuations of these layers. As a consequence their positional ordering is not truly long-range: the mean-square displacement of the layers diverges with the sample size (Landau-Peierls instability). Due to these properties there is a profound interest in smectic membranes, which have a controlled number of layers. Their dynamics has been studied by X-ray photon correlation spectroscopy using coherent X-rays at beamline ID10A at ESRF (Grenoble). Such measurements reveal two types of fluctuation relaxation phenomena: Oscillatory damping dominates in thin films while thicker ones exhibit an exponential decay. This is in agreement with theory, which predicts a crossover wave vector qc that scales with the membrane thickness L as $q_c \sim L^{-1/2}$. Fluctuations of a particular wavelength can be probed by measuring in off-specular scattering positions. These experiments indicate again a crossover, now from oscillatory damping at long wavelengths to exponential decay for short wavelengths.

Investigators: A. Fera, D. Lambreva, L. Li, R. Opitz, B.I. Ostrovskii (guest), Y. Séréro and I. Sikharulidze

Technical support: E. Prins

W.H. de Jeu is also professor of 'Physical characterization of polymers' at the Eindhoven University of Technology.

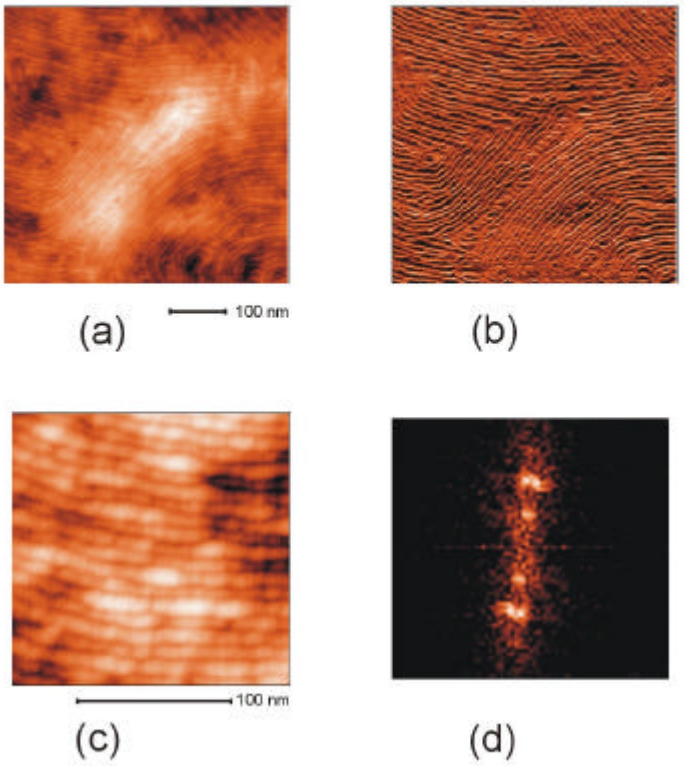


Fig. 1: AFM images of the surface ripples;
(a) height image,
(b) corresponding phase image,
(c) local details,
(d) corresponding Fourier transform.

3.4 THEORY OF BIOMOLECULAR MATTER

B.M. Mulder

The Theory of Complex Fluids group at AMOLF was recently renamed the Theory of Biomolecular Matter group, reflecting the ongoing shift from traditional soft condensed matter topics to a more exclusive focus on biologically relevant systems. The aim of the research is to understand individual and collective behavior of biomacromolecules and their aggregates using the techniques of statistical mechanics and continuum mechanics. Where possible an attempt is made to apply the work to actual components of the living cell.

Liquid crystalline polymers

Our work on the relationship between molecular properties and phase behavior of liquid crystalline polymer materials (LCPs) was successfully concluded. This class of materials is becoming increasingly important for applications in electro-optical devices like displays and non-linear optical elements. We have developed a statistical mechanical formalism that deals with these highly complex systems on a level that still allows the incorporation of enough relevant molecular detail. In its most general form, the technique is capable of describing arbitrarily branched molecular geometries with full compositional heterogeneity. The intermolecular interactions, assumed to be of an entropic nature, are treated at the mean field level within the Onsager approximation, while the intramolecular interactions are treated exactly. We have applied our formalism to the most prevalent class of LCPs, where mesogenic units are suspended from a polymeric backbone through flexible spacers, the so-called side-chain or comb-like LCPs (see Fig. 1).

Force production by growing microtubules

We have continued our studies of the mechanism of force production by growing microtubules. Our focus has been the role of lateral contact interactions between the tubulin dimers that make up protofilaments that combine to form the tubular supramolecular geometry of the microtubule. In the limit where the dynamics is dominated by the lateral interaction energy we obtain an analytically soluble model describing helical growth of the microtubule (see Fig. 2). Interestingly enough, this model provides reasonable fit to the existing experimental data on the force-velocity curves of growing microtubules. The same model can also be also be used to identify the maximal growth velocity of a microtubule for a given load force that can be obtained within the framework of generalized Brownian ratchet models for microtubule growth.

Other topics

Several other topics were also pursued within the group:

- The development of a model for understanding the conformation of DNA based on a semi-realistic base-pair stacking interaction and geometrical constraints imposed by base-pair dimensions and linkage through the sugar-phosphate backbone.
- Modeling of tip growth in plant cells, with an initial focus on the geometrical formulation of the development of axisymmetric surfaces in 3D. This work is in collaboration with Kern, currently at Trinity College, Dublin.
- Within an ongoing collaboration with the Plant Cell Biology department at Wageningen University work was done on the modeling of the development of the plant cell wall (with Emons), quantitative estimates of endo- and exocytosis rates in tip growing cells (with Ketelaar) and the statistics of activation of root hair bending through local application of NOD factor (with Esselink and Lhussier).

Investigators: P. Wessels, C. Tanase and A. Mosakalenko

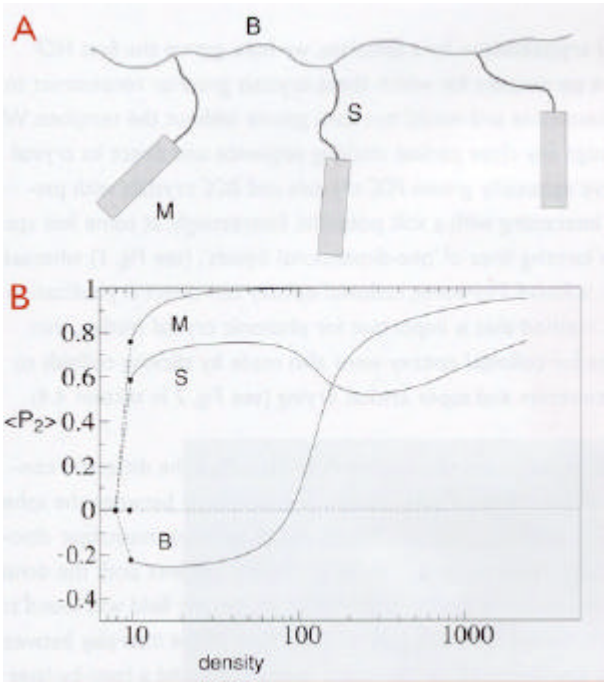


Fig. 1: A) sketch of a typical side-chain liquid crystalline polymer composed of mesogens (M), a backbone (B) and spacers (S). B) nematic order parameter $<P_2>$ of the different components as a function of (scaled) density. Note that the backbone is initially ordered perpendicular to the spacers and mesogens, but co-aligns at higher densities where the excluded volume effects start dominating the elastic effects.

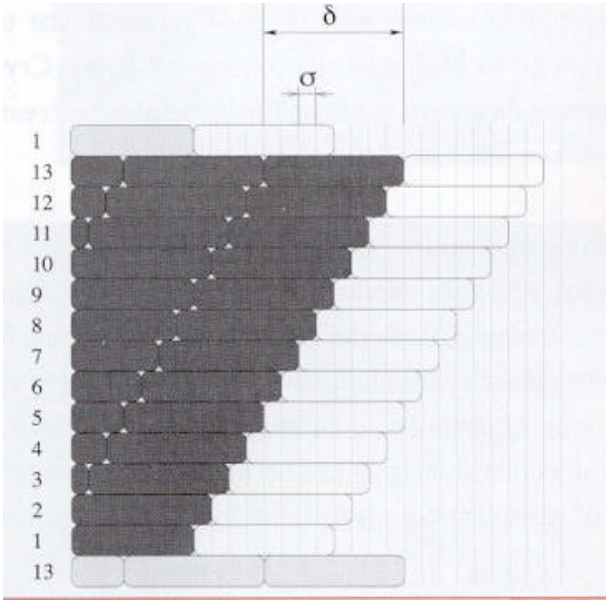


Fig. 2: The geometry of the tip of a growing microtubule. The 13 protofilaments are shown rolled out in a plane for convenience. If the lateral interactions between the tubulin dimmers dominate the dynamics, the microtubule will grow in the indicated ‘staircase’ or helical fashion.

3.5 COLLOIDAL MATTER

A. van Blaaderen

The emphasis of this group is on the quantitative 3D real-space analysis and manipulation of colloidal structures and processes. Motivation comes both from the use of monodisperse colloids as a condensed matter model system, and from their use in applications like photonic crystals and electro-rheological fluids. This group operates in both SFFSM and NOEM programs, jointly with Utrecht University.

Using colloidal epitaxy, directed colloidal crystallization by a template, we have grown the first HCP colloidal crystals and explored the lattice parameters for which these crystals grow or reconstruct to different symmetries. HCP crystals are metastable and would not have grown without the template. We have also shown that it is possible to design any close packed stacking sequence and direct its crystal growth by a template. In addition, we have epitaxially grown FCC crystals and BCC crystals with patterns of lines in dispersions of particles interacting with a soft potential. Interestingly, at some line spacings particles close to the template are forming lines of 'one-dimensional liquids', (see Fig. 1) whereas higher above the template full 3D order is found. Moreover, colloidal epitaxy can direct crystallization with controlled drying as well. With this method that is important for photonic crystal studies, thin colloidal crystals can be grown. Templates for colloidal epitaxy were also made by sticking colloids to an oppositely charged wall with optical tweezers and super critical drying (see Fig. 2 in section 4.4).

If a dispersion of uncharged colloidal spheres is placed in a (uniform) electric field the dielectric constant difference between particles and solvent creates dipolar interaction potentials between the spheres. We have found a new model system in which to study the effects of the induced anisotropic dipolar interactions. With PMMA-shell silica-core dispersed in a mixture of organic solvents both the density and refractive index can be matched. In addition a dipolar response to an electric field was found to be superimposed on a very long-ranged screened Coulomb potential. Because of the interplay between these two long-range and soft potentials a very rich phase diagram is found. We found a layer-by-layer transition of an FCC crystal into a body centered tetragonal (BCT) crystal, when a low frequency (~MHz) electric field is applied to a dispersion of spheres with the field perpendicular to gravity. As a function of field strength first the top layers go to BCT then the subsequent layers. Crystallization in the presence of an electric field that is perpendicular to gravity allows one also to create very large, mm size, single FCC crystals.

In 'proof of principle experiments' we have demonstrated the manipulation of multiple colloidal tracer particles with a high-index core by time-shared optical tweezers in a concentrated dispersion of fluorescent core-shell colloids that were index matched. Both the tracer particles and the fluorescent particles could be imaged simultaneously with reflection and fluorescence confocal microscopy (see Fig. 2). Particles in layers above and below the trapping plane could be imaged as well because the tweezers setup was extended in such a way that the confocal imaging can be performed through an independent lens allowing for even greater flexibility of manipulation, analysis and force measurements.

Investigators AMOLF: J.P. Hoogenboom, K.P. Velikov, A. Yethiraj, D.L.J. Vossen, P. Vergeer, A. Wouterse, E. de Bres and J.H.J. Thijssen
Investigators Utrecht University: M. Dijkstra, A. Imhof, Ch. Graf, A. Moroz, Ch. Christova and C.M. van Kats
Technical support: A. van der Horst, H. Bar and C. J. Wisman (Utrecht)
A. van Blaaderen is also professor of physics at the University of Utrecht in the Debye Institute.

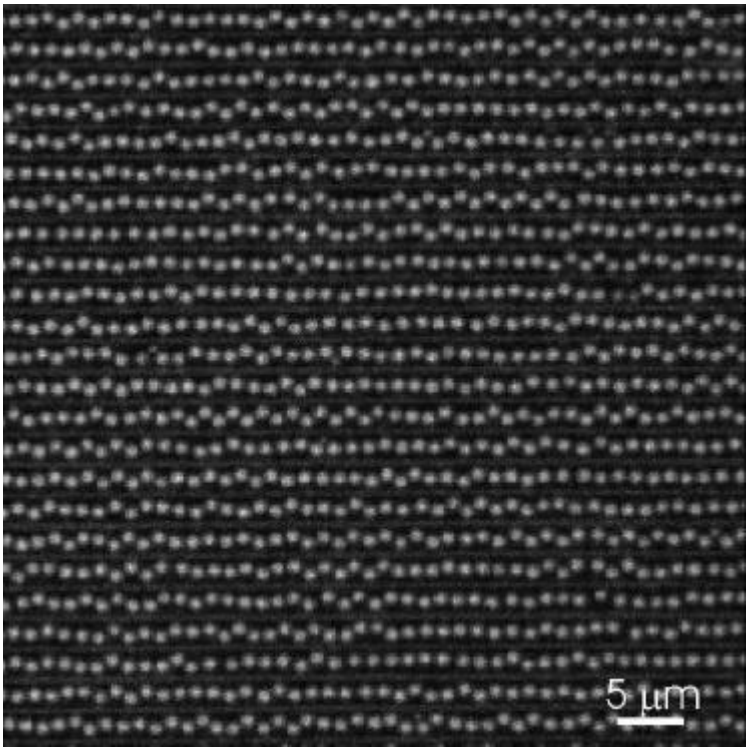


Fig. 1: One-dimensional ordering in the first layer of a suspension of charged PMMA colloids (diameter 1.2 mm) on top of a template of lines. Both template (vaguely) and the colloids in the first layer are visible.

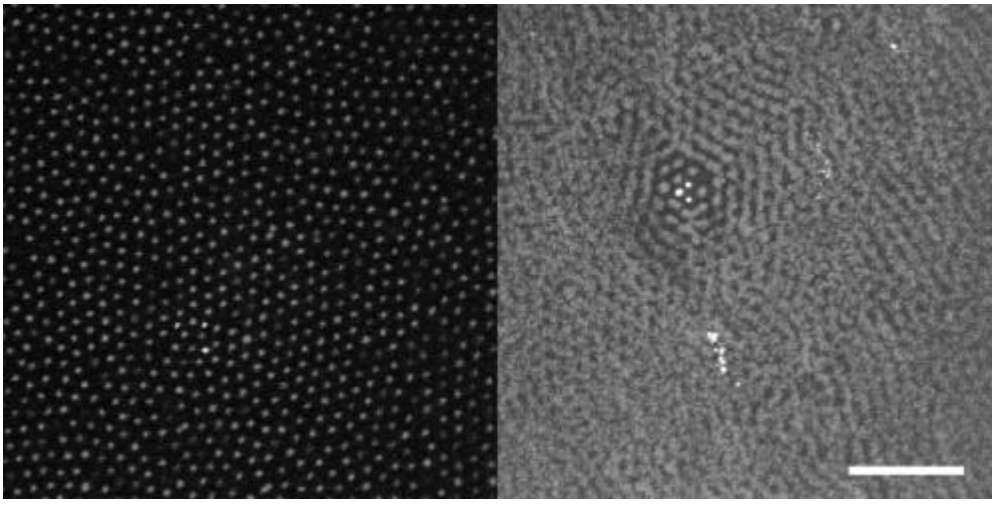


Fig. 2: Combined confocal reflection (white, only tracer particles with ZnS core visible) and fluorescence (gray, only majority particles with fluorescent core visible) microscopy image of dispersion in which three high-index core-shell particles are held with the optical tweezers array. Image on the left is not averaged and the image on the right is averaged over 16 seconds (bar 5 ? m, particle diameter 1.4 ? m).

3.6 BIOPHYSICS

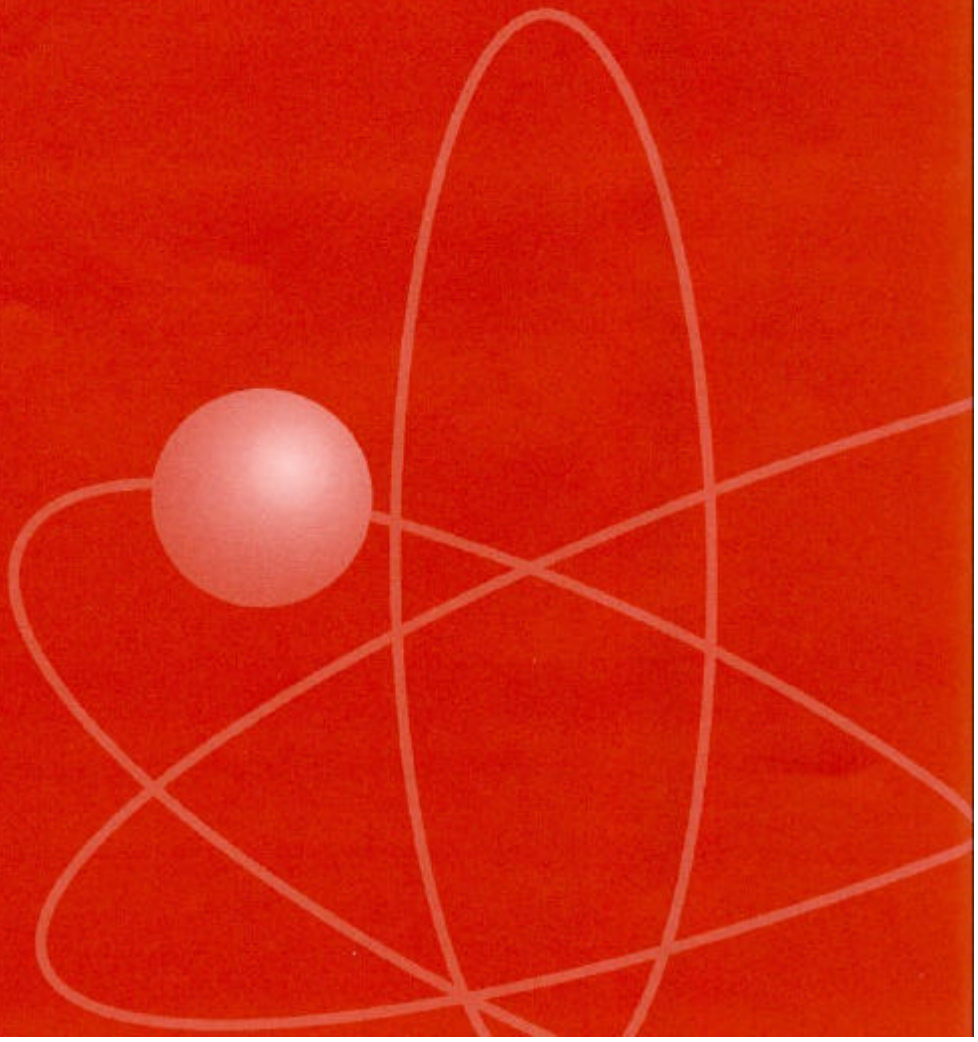
S.J. Tans

Molecular motors residing in cellular membranes possess the ability to actively unfold and transport proteins from one side to the other. This phenomenon exemplifies the intricate tasks proteins can perform, and is essential for the complex organization of cells. In a recently started project, we plan to use optical tweezers to pull on individual proteins while they are being translocated across a membrane. The aim is to uncover the mechanical behavior of this important class of molecular motors in real time. Specifically, we will study the translocation motor termed translocase, which is found in Escherichia coli. The interplay between mechanical and biochemical events has a special focus in this study. We collaborate closely with the group of Driessen of the University of Groningen, who is specialized in the biochemical aspects of this system.

Investigators: R. van Leeuwen and F. Poelwijk
Technical support: H. Bar and A. Kerkhoff

4. NANOSTRUCTURED OPTO-ELECTRONIC MATERIALS

Program coordinator: A. Polman



This program concerns research on materials and physical phenomena in novel photonic materials and structures. It involves thin-film integrated photonic materials made using atomic and molecular scale engineering techniques, as well as colloidal systems. The program's goal is to achieve extreme control of the propagation of optical modes and spontaneous emission in photonic structures.

To achieve this goal, a coherent spectrum of activities is carried out, including studies of two- and three-dimensional photonic crystals, planar integrated optical waveguide materials, and non-linear optical phenomena in metallodielectric thin films. These studies are complemented with theoretical studies on photonic bandstructure and non-linear photonic systems. In addition, a strong emphasis is placed on developing novel nanofabrication techniques. The latter bring together experience in soft condensed matter, biological materials, and photonic materials at AMOLF.

This research program involves fundamental and strategic technological research, with emphasis on new physical phenomena and materials. In many cases, the relation with a possible application is kept in mind and knowledge transfer to industry is actively explored.

4.1 OPTO-ELECTRONIC MATERIALS

A. Polman

This group focuses on the design and fabrication of novel opto-electronic materials using atomic-scale engineering and colloidal manipulation techniques. The aim is to achieve extreme control over the propagation of guided optical modes as well as spontaneous emission in thin-film photonic materials.

Two-dimensional photonic crystals in silicon-on-insulator were fabricated using our optimized anisotropic etching process, developed together with DIMES (Delft). We now have complete control over the technology to fabricate photonic crystals with a bandgap in the near-infrared range. Crystals with different dimensions and orientation were made, and integrated with planar waveguides. We found that low-fluence ion irradiation of single-crystal Si with e.g. Ne or Xe ions leads to the generation of a broad spectrum of point defects that exhibit a broad optical emission spectrum (1.1–1.7 ? m) that be used to probe the photonic bandstructure.

Optical properties and spontaneous emission in three-dimensional photonic crystals were studied in collaboration with the group of S. Lin at Sandia National Laboratories (USA). Spectrally resolved optical reflection measurements were made on three-dimensional Si 'woodpile' lattices (see Fig. 1), as a function of incident angle and for various azimuthal orientations of the crystal. In this way the photonic bandgap around 1.5 ? m could be probed. For both s and p polarization the data are in qualitative agreement with calculations of the reflectivity for these finite-size photonic crystals (2.5 primitive unit cells in the vertical direction). A dip is observed in the transmission spectra and can, according optical field calculations, be fully explained by a well-defined superstructure in the woodpile structure. Defects and irregularities can eventually provide the control of optical modes inside photonic crystals.

Metallodielectric materials are a totally new class of photonic materials that we have started to explore. These experiments were triggered by our work on rare-earth doped optical waveguides, in which we discovered a novel sensitizing effect of Ag. It was found that the spontaneous emission of Er in Ag ion-exchanged silica glass is enhanced more than 100-fold due to this effect. Ion irradiation of Ag-doped glass leads to the formation of Ag nanocrystals, with the size and volume fraction tunable by the ion fluence. These metallodielectric films are highly dispersive, with the complex refractive index varying between 1.6 and 2.8+0.15*i* in the visible range (Fig. 2). We demonstrated that these materials can be used to fabricate waveguide filters and photonic crystals.

We have set up an alliance with Symmorphix Inc. to transfer our knowledge on optical amplifier materials, and carried out a project on erbium-sensitized thulium-doped thin films. There is great interest in Tm because its emission complements that of erbium, thus providing higher bandwidth for optical amplification in the infrared.

Our studies on the fundamentals of ion-solid interactions have lead to a discovery that could trigger a whole new class of photonic materials: when silica colloids doped with a metallic core are irradiated with MeV ions they turn into an oblate shape (see year report 2000). At the same time, however, the metallic core turns into a prolate shape. Anisotropic metals have split plasmon resonance bands that can be used in a variety of (non-linear) optical applications, extending into the important infrared telecommunication wavelength range. Further studies of the ion beam deformation effect were carried out using numerical modeling and in-situ measurements of mechanical stress.

In 2001, we celebrated the 10th anniversary of the opto-electronic materials group. Around 25 group members and alumni gathered for a fruitful workshop and an enjoyable party in Amsterdam. Also, in 2001 significant effort was put in planning for a nanofabrication facility that would be built at AMOLF, in order to provide state-of-the art technology for research in biological materials, soft materials and photonic materials.

Investigators: C. Strohhöfer, M.J.A. de Dood, T. van Dillen, J. Kalkman, H. Isshiki, S. Roorda, J. Penninkhof, and M. Siem
Technical support: J. Derks and J. ter Beek.
A. Polman is also professor of physics at the University of Utrecht.

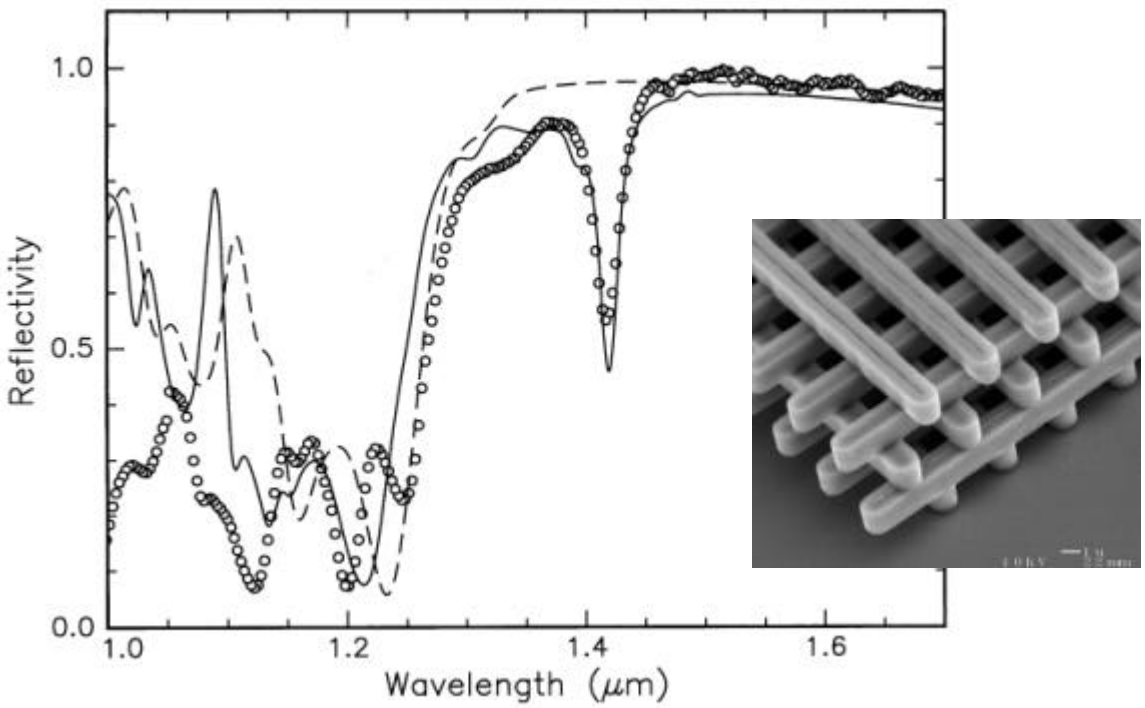


Fig. 1: Optical reflectivity spectrum measured on a three-dimensional Si 'woodpile' photonic crystal (shown in the inset).
The spectrum shows the bandgap ranging from 1.35 ? m-1.7 ? m, and a dip around 1.41 ? m due to a superstructure.
(Work done with Sandia National Labs)

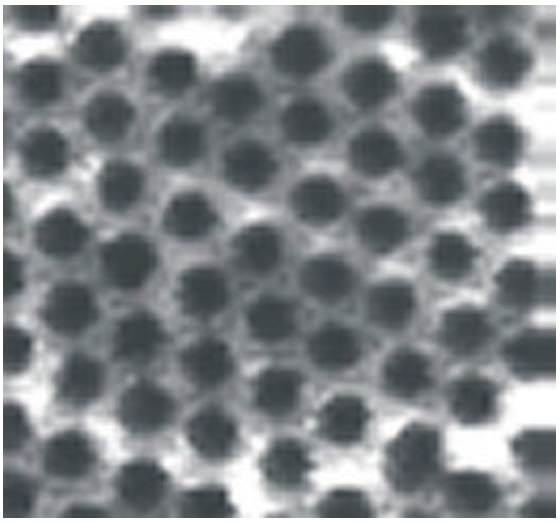


Fig. 2: Metallo-dielectric micropattern made using ion irradiation of silver-dope silica glass through a self-assembled colloidal mask. The contrast in the image reflects the periodic variation in refractive index in the material, due to the periodic formation of silver nanocrystals (2-20 nm diameter).

4.2 PHOTONIC MATERIALS THEORY

A. Tip

A central issue is the study of Maxwell's equations for macroscopic dielectrics, in particular periodic structures such as photonic crystals. Topics under consideration are the band structure and Green's functions for absorptive photonic crystals and the transport of excitation energy between atoms embedded in dielectrics.

Band structure of photonic crystals

Photonic crystals, possessing bandgaps are important devices in view of technological applications. In a complete gap no field modes are present and in partial (or stop) gaps field propagation in particular directions is inhibited. Thus at microwave frequencies, photonic crystals can be used to improve the performance of antennas.

At optical frequencies embedded atoms will not decay if the transition frequency falls into a gap, since there are no field modes available to carry away the energy and this can be useful in devices such as solar cells and solid state lasers. The subject is studied experimentally at AMOLF in the groups of van Blaaderen and Polman.

An interesting aspect of photonic crystals is that, given the dielectric properties of the materials used, the band structure can be predicted numerically, giving useful guidelines for the actual manufacturing of photonic crystals. A few years ago, Alexander Moroz, then a post-doc in the group, started with calculations for three-dimensional systems using an adaptation of the KKR-method of solid state physics. That method is tailor-made for the electromagnetic situation (typically non-overlapping spheres on lattice sites). However, the vector nature of the electromagnetic fields makes the formalism a good deal more complicated than in the solid state case. A large contrast in the electric permeability (permittivity) e between scatterer and background is required to obtain appreciable bandgaps in the optical region with the case of low-e scatterers in a high-e background as the most favorable one. Actually available materials set a severe restriction on what can be achieved along these lines.

The situation improves significantly if Drude-type metallic spheres are used. They behave as lossy dielectrics with the real part of e(w) (w is the angular frequency) ranging through a large interval, including negative values, as w runs through the optical frequency range. Disregarding absorption, a large bandgap is found at frequencies where the absorption is small, thus a posteriori justifying its neglect. The work was continued by van der Lem, who studied 2D configurations (periodic arrays of parallel cylinders).

In the mean time, in a collaboration with Combes (Toulon, France), we investigated the general properties of the band structure in the presence of absorption. It was found that the bands, originally intervals on the real axis, change into areas in the lower complex plane. In addition bandgaps can no longer exist in frequency regions with non-zero absorption. This can be understood by realizing that gaps arise due to the coherent scattering from scatterers at all distances. But, if absorption is present the fields will be attenuated appreciably when arriving at distant scatterers, thus changing the situation. Nevertheless one expects a decrease in atomic decay constants at frequencies where a gap would be present without absorption.

The band structure properties were recently confirmed numerically by Van der Lem, who calculated the 2D-case above. For realistic absorption their real parts do not differ much from the absorptionless situation. At present we are engaged in determining numerically the Green's function for the appropriate Helmholtz equation, atomic decay constants being proportional to its imaginary part.

In September the group was joined by Gralak, a postdoc from France, who is a specialist on woodpile photonic crystals. Here the KKR approach is less suitable and Gralak has set up a different approach for this case. This work has very close links to experimental work in the group of Polman.

Migration of atomic excitation energy through dielectrics

In a number of technological applications it is useful or even necessary to modify the radiative decay properties of atoms, in particular to suppress such a decay. In principle this can be done by embedding the atom in a photonic crystal with a bandgap in the frequency range of interest, although actual realizations are still to be obtained. In practice many embedded atoms will be present and an excited atom can not only de-excite by direct photon emission (if not forbidden by the presence of a bandgap) but it can also transfer its energy to other atoms, for instance by photon re-absorption by another atom or by Förster type processes. Also the actual excitation of an atom of a particular type may be difficult to achieve and can only be done by first optically exciting a neighboring molecule (sensitizer) from which the excitation energy is then transferred by means of a non-electrodynamic process. Moreover, in an actual medium quenchers, such as OH-groups can be present that can pick up the energy and convert it to other modes (vibrations).

In order to disentangle the different occurring processes, it is important to have a theoretical description available. We recently started an investigation of the situation.

An important issue, about which conflicting results can be found in the literature, is the effect of band gaps on Förster processes. We found that this is mainly a matter of definition, involving the gauge that is used for the fields. One particular gauge turned out to be quite natural. It gives a splitting into radiative and non-radiative interactions, where the second are determined by potentials given by the Poisson equation with the static electric permeability estat(c) instead of its vacuum counterpart (which gives rise to Coulomb potentials). With this set-up we conclude that band gaps in the radiative spectrum have nothing to do with Förster processes.

Investigators: J.Q. van der Lem and B. Gralak

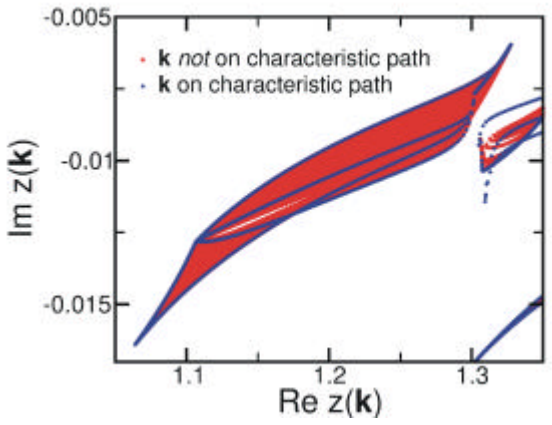


Fig. 1: Detail of the band structure in the complex plane. Note the small hole in the swordfish shaped object.

4.3 NANOFABRICATION LABORATORY

J. Verhoeven

This group conducts fundamental research in layer growth supports other groups in the institute in producing thin films and sub-micron structures, and. The own research projects concern especially the growth from sub-monolayer to several tens of monolayers and the formation of nanostructures.

Scanning probe experiments

The research on the growth of metallic islands on insulator surfaces has been interrupted for a year, as the experimental system required major modifications. The electronics as well as the scanning tunneling microscope itself had to be replaced and as a consequence also new software had to be written. The system will be operational again in January 2002. Chrost successfully demonstrated that it is possible to obtain images with atomic resolution of a silicon surface using a non-contact atomic-force microscope.

Dispersive elements to be applied in the XUV and EUV wavelength region

For our experiments on Cherenkov EUV sources dispersive systems are required. There are three possible candidates: multilayer systems, transmission gratings and reflection gratings. We put a lot of effort in multilayers as well as in transmission gratings. The work on multilayers is part of a collaboration with Philips Research. Transmission gratings will also be applied by the group of Vrakking to separate higher harmonics of short-wavelength lasers.

- **Multilayer systems**

In collaboration with the group of Bijkerk at Rijnhuizen we investigated the growth of W/Si multilayers with a periodicity of 2.5 nm. Especially the possibility to improve the optical properties by treatment of the layers by energetic ions was investigated. Also the applicability as coatings for reflection optical elements to focus Cherenkov radiation is considered.

- **Transmission gratings**

This work is mainly performed at DIMES (van der Drift as supervisor). We managed to make the first transmission grating with a periodicity of 100 nm in a silicon nitride substrate of 30 nm thick (Fig. 1).

Generation of short-wavelength radiation

Most experimental work of this project is carried out at the Technical University Eindhoven. AMOLF is mainly involved in the theoretical part of this project and in the production of dispersive elements to be applied in the experiments. The preliminary experiments on the generation of Cherenkov radiation around the Si L absorption edge were repeated more accurately. The yield turned out to be a factor of 1.5 different than theoretically expected. This can be an indication that the optical constants around the absorption edge require correction. For generation of shorter wavelength Cherenkov radiation (e.g. water window) the energy of the used LINAC was too low (˜ 6 MeV). Therefore quite some effort was put into the modification of a 10 MeV LINAC.

Support activities

The group produces a wide variety of thin films for research groups at AMOLF and other institutes and universities. Scientists from outside often take part in the deposition process or operate the deposition systems themselves to produce layers for their own experiments. Various techniques are available for the production of tailor made thin films: sputter deposition, ion assisted deposition (evaporation), and low energy ion beam modification (< 1000 eV) of thin films.

This year also activities to introduce lateral structures into thin films were started.

Investigators: J. Chrost, H. Hopman, M. Kessels, W. Knulst (TU Eindhoven) and J. Luiten (TU Eindhoven)
Technical support: H. Zeijlemaker and M.P. van den Boer

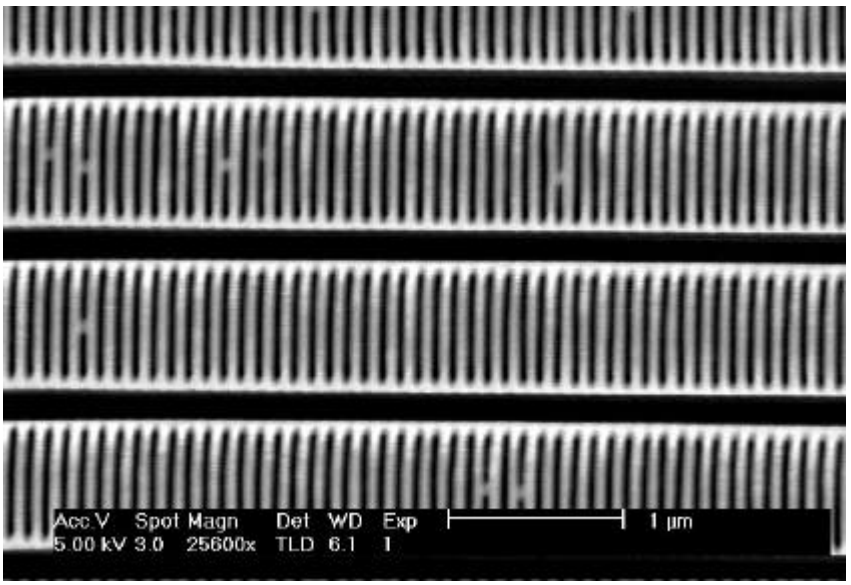


Fig. 1: XUV transmission grating with a periodicity of 100 nm in a silicon nitride substrate of 30 nm thick (scanning electron microscopy image).

4.4 COLLOIDAL PHOTONIC MATTER

A. van Blaaderen

The emphasis of this group is on the quantitative 3D real-space analysis and manipulation of colloidal structures and processes. Motivation comes both from the use of monodisperse colloids as a condensed matter model system, and from their use in applications like photonic crystals and electro-rheological fluids. This group operates in both NOEM and SFFSM programs, jointly with Utrecht University.

In a photonic crystal with a complete bandgap light within a certain frequency range cannot propagate. With these kind of regular 3D structures with feature sizes on the order the wavelength of light it is possible to manipulate both the propagation and the spontaneous emission of light. We have grown thin FCC photonic crystals through a controlled drying procedure of colloidal particles with high-index-ZnS core-shell morphology and of homogeneous silica spheres. After high energy ion irradiation, performed in collaboration with the group of Polman, both the unit cell dimensions and the particle form (spheres versus ellipsoids) could be adjusted. The structures were characterized by electron microscopy and optical transmission measurements.

Together with the group of Polman erbium and other rare earth ions have been incorporated in silica colloidal particles through a wet, acid catalyzed chemical route. The particles were spherical and smooth, but quite polydisperse (>30%). Monodisperse particles Er doped spheres could be obtained by performing seeded growth. After annealing the $^4I_{13/2}$ ---> $^4I_{15/2}$ transition of Er^{3+} at 1.5 micron could be observed with a high quantum efficiency (Fig. 1).

Theory has shown in the last few years that it may be possible to obtain a complete band gap in the visible using metallo-dielectric structures. In order to test these predictions we successfully modified a recent synthesis route for gold particles to that of silver. We obtained particles with radii covering the colloidal range. Although the polydispersity of the particles was too high to obtain close-packed crystals, we did obtain crystals when the filling fraction of the crystals was relatively low. Reflection measurements, done in collaboration with Vos (Amsterdam University) on an amorphous packing of these spheres showed significant (~20%) changes in reflectivity. We have also started the synthesis of metallo-dielectric spheres by growing gold layers around silica and silica on gold spheres. With ion irradiation these spheres could be deformed into core-shell ellipsoids. With electric fields these particles have been crystallized in thin crystals.

We have extended the method of controlled drying to make thin photonic crystals of binary crystals. If a correct size ratio is chosen, close to that for bulk crystallization of binary crystals, AB2, and other binary crystals, can be grown in a layer-by-layer fashion.

A start was made to fabricate 2D and 3D colloidal structures with optical tweezers followed by super critical drying. An example of a 2D colloidal crystals template is shown in Fig. 2.

Investigators AMOLF: J.P. Hoogenboom, K.P. Velikov, A. Yethiraj, D.L.J. Vossen, P. Vergeer, A. Wouterse, E. de Bres and J.H.J. Thijssen
Investigators Utrecht University: M. Dijkstra, A. Imhof, Ch. Graf, A. Moroz, Ch. Christova and C.M. van Kats
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A. van Blaaderen is also professor of physics at the University of Utrecht in the Debye Institute.

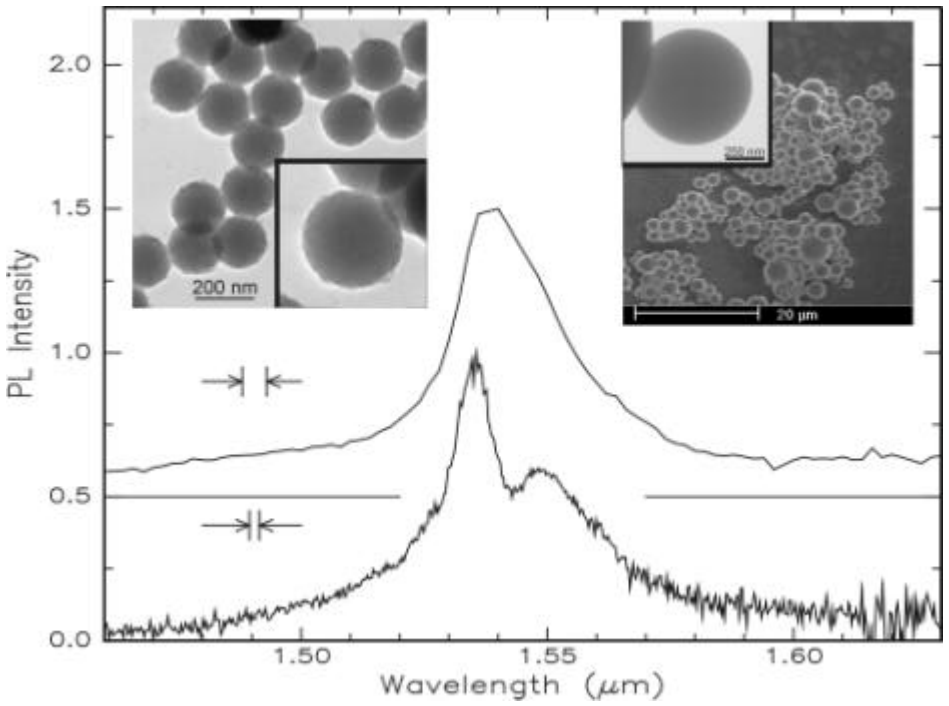


Fig. 1: Normalized Er PL spectra of the polydisperse (inset left) particles and monodisperse particles (inset right) obtained by seeded growth after annealing. The PL of the monodisperse particles is offset for clarity. The arrows indicate the spectral resolution, the PL lifetime of the spheres was ~13 ms.

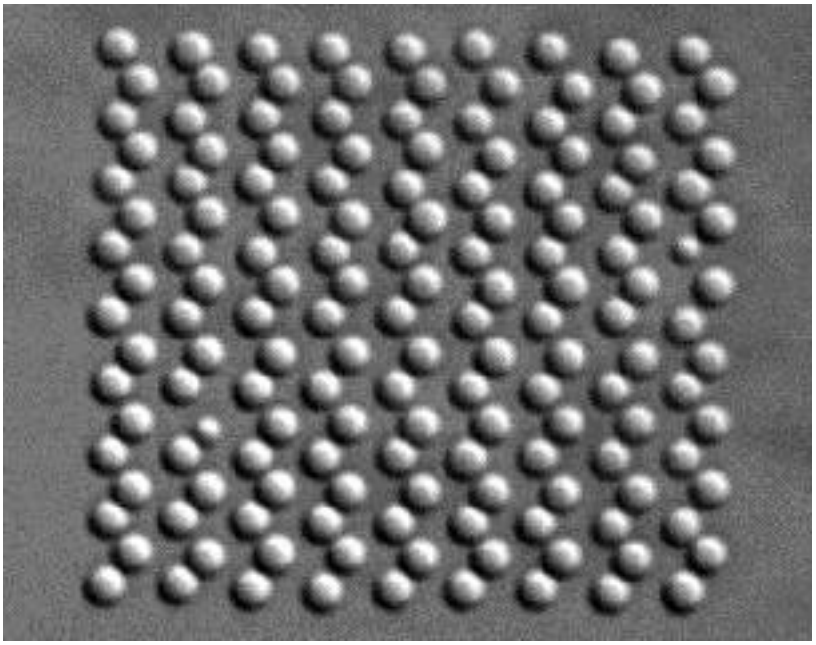


Fig. 2: Template with the symmetry of a (110) HCP layer made by placing the negatively charged 1.4 micron diameter silica speres with optical tweezers on a positively charged wall.

5. TRANSITION PROGRAM

Program coordinator: J.T.M. Walraven

The AMOLF transition program consists of research activities that are not embedded in one of the four main programs of the institute. Presently, the transition program bundles the work on Quantum Gases.

5.1 QUANTUM GASES

J.T.M. Walraven

The research on quantum gases at AMOLF is focused on condensed matter behavior in Bose-Einstein condensed (BEC) trapped gases. The experimental work is done with the ^{87}Rb quantum gas at densities approaching the hydrodynamic regime. The theoretical work is done in tight alliance with the European theory cluster around G.V. Shlyapnikov and is currently focused on phase coherence phenomena and non-conventional quantum degenerate states.

Experiment

In our apparatus we have mostly investigated the experimental conditions under which our Bose-Einstein condensed samples of ^{87}Rb are trapped. We found previously that incomplete rf-evaporation can lead to a substantial heat load and developed an experimental approach to minimize these effects, mostly by optimizing the initial stages of rf-evaporative cooling. To have accurate control over the density of the gas, in particular during the final stages of evaporation, we adapted the coil system of our Ioffe-Pritchard quadrupole trap. Presently, we can independently vary the main trap parameters - the minimum (B0), the radial gradient (B1) and the axial curvature (B2). This allows control over the expansion of the gas without the need of B0-related adjustments of the rf-evaporation frequency. In studying the onset of BEC we found that it is of crucial importance to have precise control over the final stages of rf-evaporative cooling just before the condensate forms. We observed the kinetic bottleneck in condensate formation but for a quantitative analysis it turned out to be crucial to improve the reproducibility of our rf-evaporation scheme. For this purpose we developed a programmable frequency sweep generator based on direct digital synthesis (DDS) by which we can accurately adjust the details of the frequency sweep under control of our main LabView based computer interface. Also the main analysis routines for time-of-flight-absorption imaging were upgraded to allow corrections for saturation effects and spectral background.

Theory

Phase coherence properties form a basis for our understanding of the nature of Bose-condensed states. These properties are of great importance for matter wave interferometry with BECs and for creating CW atom lasers. So far, the studies of trapped condensates were indicating that they are phase coherent. We have found that in very elongated 3D trapped Bose gases, even at temperatures far below the BEC transition temperature, the equilibrium state will be a 3D condensate with fluctuating phase (quasicondensate). The reason is that the axial phase fluctuations acquire 1D character. At sufficiently low temperatures the phase fluctuations are suppressed and the quasicondensate turns to a true condensate. The trapped quasicondensate has the same density profile as the true condensate, but is characterized by drastically different phase coherence properties. We showed that the measurement of phase fluctuations allows for extending thermometry of Bose-condensed gases well below temperatures established in current experiments. Our prediction were confirmed by experiments in Hannover.

The recent experimental creation of dark solitons in trapped condensates opens a unique possibility to study the behavior of these macroscopically excited BEC states. We have derived the diagram of dynamical stability for moving dark solitons in elongated Bose-Einstein condensates and found that for a large soliton velocity even radially Thomas-Fermi (i.e. in total 3D) solitons can be dynamically stable. At finite temperatures the dynamically stable solitons decay due to their interaction with the thermal cloud. We investigated the related dissipative dynamics and showed that it is governed by the absence of topological charge for the soliton and by the extent of non-integrability of this object. The soliton lifetime ranges from milliseconds

in the case of 3D solitons to more than seconds in quasi-1D geometries. We explained the experimental results obtained for 3D solitons.

The recent success in observing quantum degeneracy in ultracold atomic Fermi gases stimulates a search for gaseous Fermi systems with an achievable temperature of superfluid phase transition. The ideas based on Cooper pairing for a short-range Van der Waals interaction between atoms require s-wave scattering and, hence, simultaneous trapping of at least two different fermionic species, with a rather severe constraint on their relative concentration. We have established the feasibility of Cooper pairing in Fermi gases of ultracold dipolar particles. Being electrically polarized, these particles interact via long-range anisotropic (partially attractive) dipole-dipole forces, which provide an energy-independent scattering amplitude for any orbital angular momenta. This opens prospects to achieve the superfluid transition in single-component dipolar Fermi gases, and we calculated the corresponding transition temperature. These prospects are especially interesting in view of the recent success in cooling and trapping of polar molecules.

Investigators: K. Dieckmann, I. Shvarchuck, C. Buggle, M. Kemmann, W. Von Klitzing (experiment), D. Petrov, L. Vichi, G.V. Shlyapnikov (theory), M.A. Baranov, A.E. Muryshev and V.S. Rychkov (guests)
Technical Support: R. Kemper and H. Schoenmaker
G.V. Shlyapnikov is also laboratory head at the RRC Kuchatov Institute in Moscow and professor at the University Paris 6 (Jussieu).
J.T.M. Walraven is also professor of physics at the University of Amsterdam.

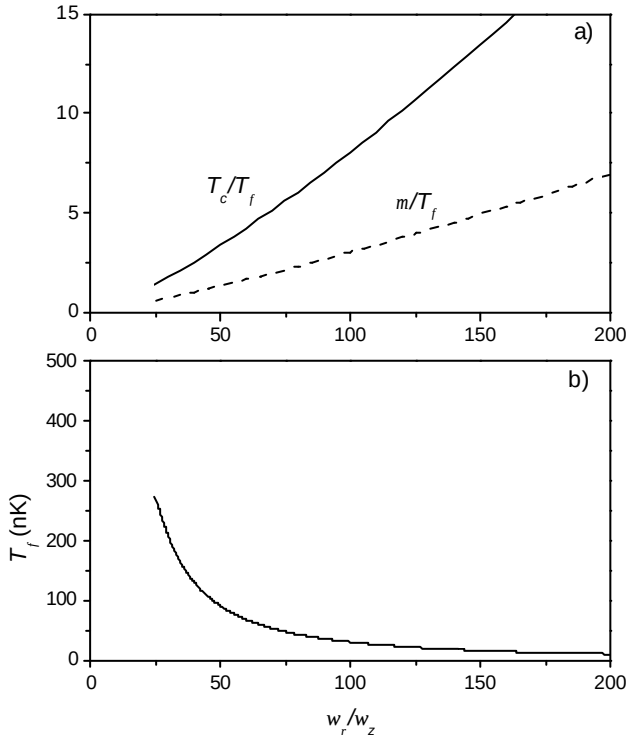
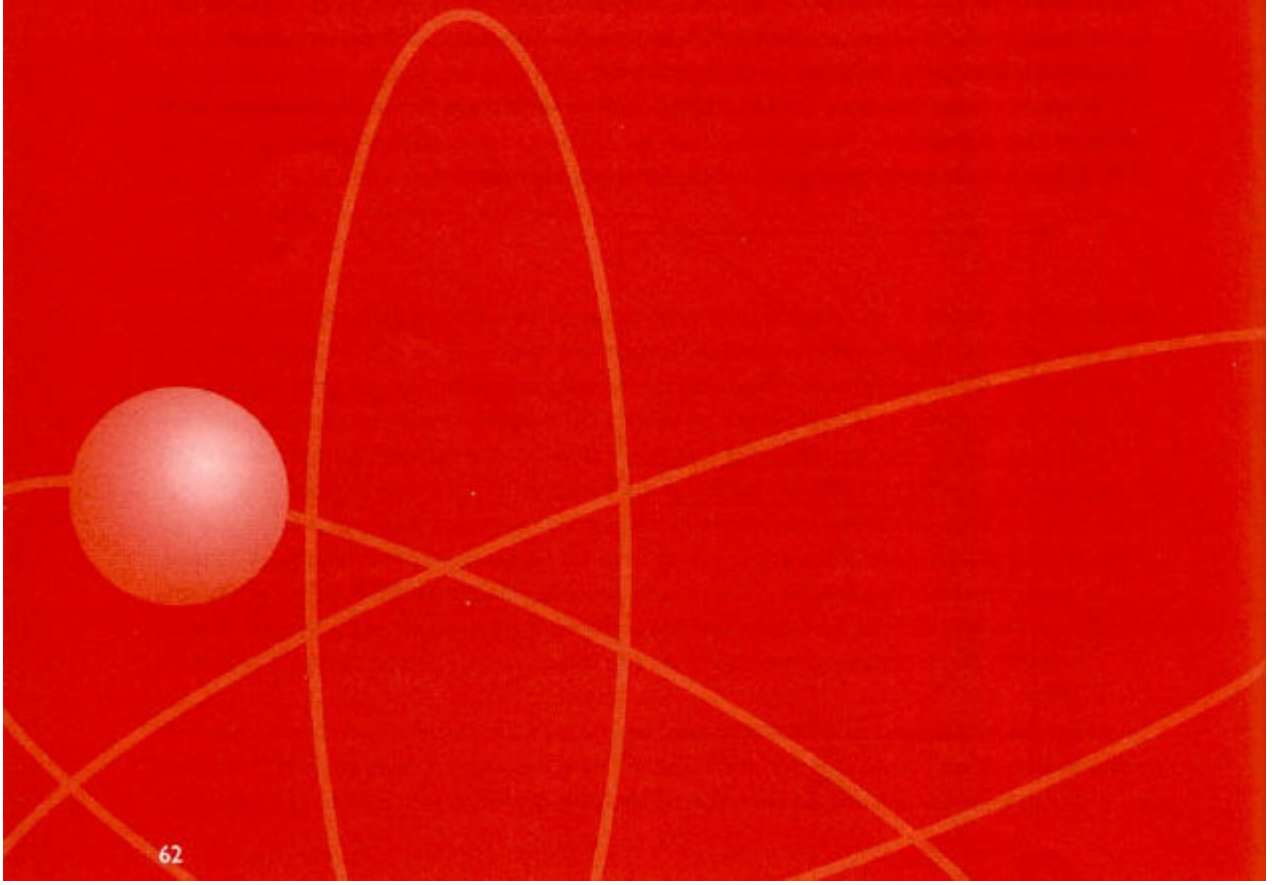


Fig. 1: a) The temperature Tf at which the phase coherence length equals the sample length (compared to both the critical temperature for BEC, Tc, and the chemical potential, m) as a function of the aspect ratio wr/wz of the trap;
b) Tf as a function of wr/wz. Note that for elongated samples the phase fluctuations are observable also far below Tc, where the condensate fraction is close to unity. This offers interesting prospects for thermometry.

6. TECHNOLOGY

P.G. Kistemaker



This division consists of the technological support groups, that help to design, fabricate and maintain the equipment used in the experiments. It also provides the internet and computer support for the institute. It includes an electronics, software and network engineering department, a mechanical engineering department and a mechanical workshop.

6.1 ELECTRONICS, SOFTWARE AND NETWORK ENGINEERING DEPARTMENT

C.B. Okhuijsen

The services of the electronics, software and network engineering laboratory (E&I) are directed towards technical support for the entire institute. In this respect, the results of E&I's efforts are visible in almost all experiments and on every desktop. Representative examples of our work are shown below.

Electronics

The bandwidth of the widely used VME rack system proved to be no longer sufficient for the growing demands of the experiments. We adapted PCI and its deviates (CPCI, Pxi) as our new standard. Our printed circuit board (PCB) design environment was upgraded to a new operating system ORCAD.

Projects completed in 2001

Pulsed high voltage power supply (XUV physics)
Laser dropout compensation (XUV physics)
Ion source modification (Atmospheric photo physics)
AWG/TD fifo hardware (Macromolecular ion physics)
AWG/TD waveform generator (Macromolecular ion physics)
Peltier element using Eurotherm standard (Order/disorder in soft matter)
MicroEnable interface confocal tweezer camera (Biophysics groups)
Direct digital synthesizer (DDS) (Quantum gases)
Fiber coupling for NACRA microscope (Nanofabriacation)
Dials box for NACRA microscope (Nanofabrication)
Pre-amplifier for the CAMERA microscope
Laser timing and synchronisation (Femto physics)
Avalanche diode X-ray detector (Order/disorder in soft matter)
Entrance control system (Safety)
Several HgCdTe amplifiers (Vibrational Dynamics)
MCT IR detector amplifier (Vibrational Dynamics)
Differential opto amplifier (Femto physics)
Differential photodetector (Femto physics)
Drivers and amplifiers for trap oscillation (Quantum gases)
Dust particle measurement (Atmospheric photo physics)
Piezo drivers (XUV physics)
Pulse divider for laser system (XUV physics)
Servo and A/D converter (XUV physics)
Timing distribution amplifier for XUV physics
Fast high-tension amplifier (Atmospheric photo physics)
Switched power supply (XUV physics)
High tension pulse generator (Femto physics)
Triggered high-tension power supply (Atmospheric photo physics)

Software

We introduced a revision control system to guard the number of versions existing for the same software program. A library of useful and often used software components was created and proves to be very useful in standardizing software development. Amongst others it now contains a utility to plot graphs from MFC applications. We plan we extend this library to other operating platforms and programming languages.

Projects completed in 2001
CCD camera mMicroEnable software (XUV physics)
AWG/TD control (Macromolecular ion physics)
XYZ LabView control (Macromolecular ion physics)
IR camera histogram of TIFF files (Macromolecular ion physics)
SGI-320 integration with IDL (Bio-assembly and organization)
RIGAKU X-ray source control (Order/disorder in soft matter)
Universal stepper motor control (Order/disorder in soft matter)
Brown X-ray detector LabVIEW software (Order/disorder in soft matter)
BEC scripting tool with EXCEL functionality (Quantum gases)
Upgrade NACRA control system (Scanning probe laboratory)
Labwide IntraNet database
USB XY-t recorder LabVIEW program
Dust particles software template (Atmospheric photo physics)
LabView software templates (XUV physics)
Data acquisition software HOHAR (XUV physics)
Magnetic key control system

Network and Support
Most of our servers are now backed-up using the services of SARA. This proves to be very advantages in both speed (2 Gbit/sec) and price. Currently about 1.5 Tbyte is stored.
We made a start in increasing the redundancy of the network. Ultimately all critical servers should be doubled. To protect our network against virus and hacked attacks we re-programmed our firewall.

Projects completed in 2001
Update computer cluster (Computational physics)
Group file server (Biomolecular mass spectrometry)
Backup system using SARA

Personnel:
H.P. Alberda, I.A. Attema, H.A. Dekker, N. Dijkhuizen, C.J. van Doornik, D. Driessen, J.N. van Elst, J. ter Horst, M. Konijnenburg, R. Schaafsma, M. Seynen, R. Schoone, D.J.P. Verheijde, A.J.M. Vijftigschild and S.W. Wouda

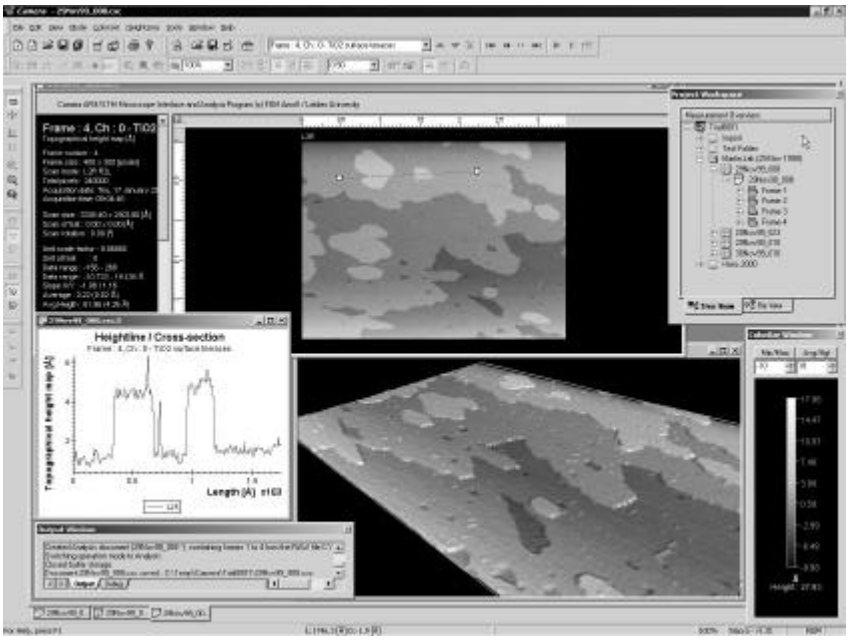


Fig. I: LabView application program to control scanning probe microscope.

6.2 COMPUTER AIDED ENGINEERING DEPARTMENT

I. Cerjak

The CAE-department supplies scientific groups with mechanical designs of scientific equipment, advise on mechanical construction, and solutions and analysis of mechanical problems.

The department has 5 high-end PC workstations to its disposal. One software package, I-DEAS by SDRC, is used for all CAE activities; 3D modeling and assembly, 2D drafting, and finite elements analysis. From 3D models, 2D drawings are automatically generated, on the same models finite element analysis, such as the determination of natural frequencies, heat transfer and physical behaviors, is possible.

Main design-activities 2001

Enhancing TOF mass spectrometer with customized ion- & laser sources, and MCP- & REA-detectors (Macromolecular ion physics).
Design of a 2-meter length quadrupole functioning as an FTI-ion guide (Macromolecular ion physics).
Customization of sample, objective holders and other special components for optical trap microscopy (Bio-assembly/organization and colloidal matter).
Design of miscellaneous equipment for a SAXS bench and design of an X-ray diffraction oven (Order/disorder in soft matter).
Design of an ion source and pulse valve (Atmospheric photo physics).
Design of an electron reflecting detector and a laser trap for a XUV-spectrometer (XUV physics).
The CAE-department also supports the scientists with the realization of conference-posters.

Personnel: J. van Dorsselaer, D. Glastra van Loon and D.J. Spaanderman

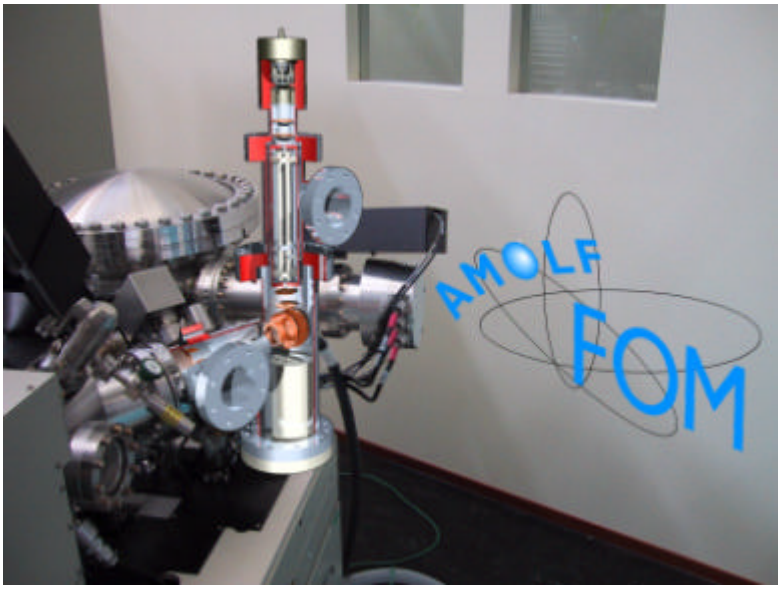


Fig. 1: Virtual reality picture of a TOF mass spectrometer.

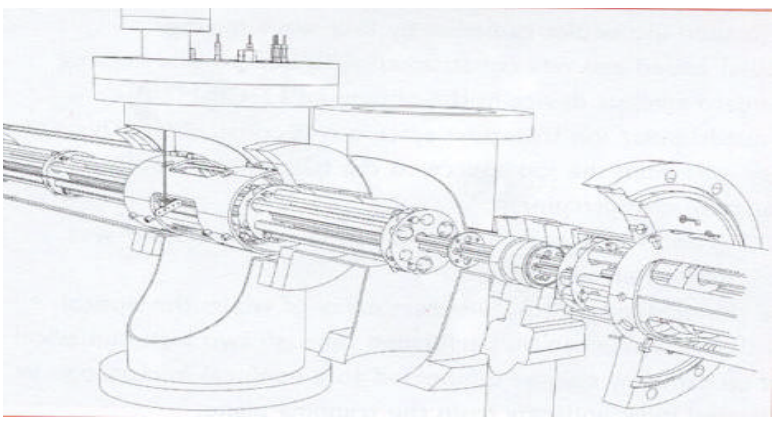


Fig 2: Drawing of FTI ion guide.

6.3 MECHANICAL WORKSHOP

W.H. Brouwer

The workshop makes equipment for laboratory experiments. Tools are available for machining, diamond cutting, vacuum brazing and welding of materials. Three milling machines and a wire electrical discharge machine are computer controlled and are linked to a programmable central workstation. Drawings from the engineering office can be sent to this workstation through a direct link. A new electrical discharge machine has been installed which is a complete 3-D machine. An important function of the workshop is the training of apprentices in precision production.

Examples of equipment manufactured in 2001:

• For the group Order/disorder in soft matter a major effort has been the construction of a movable frame for the stretching of smectic membranes. Incorporation in the existing ovens required some additional modifications. Furthermore several extensions and changes have been made for the apparatus for small angle X-ray scattering (SAXS).
• For the Bose-Einstein-condensation experiment, a high-current coil set for use in a Ioffe-Pritchard quadrupole trap was made.
• For the ion implantation facility, ion source cathodes of a variety of materials were spark-cut. A centrifuge for controlled sample cleaning and drying was made. Several parts required for the installation of the high-resolution SEM were manufactured.
• For the group Atmospheric photo physics, a new prototype fast infrared camera has been constructed. The camera consists of a sensitive gaseous layer of laser excited atoms and is equipped with versatile electron and ion optics. For the translational spectroscopy apparatus, an electron impact ion source has been made which will operate not only in Amsterdam but also at the CRYRING facility in Stockholm. The mechanical workshop has also assisted in starting up a new set-up for light scattering of irregular dust particles, an apparatus that had been developed at the Free University in Amsterdam.
• On the XTRA experiment (X-ray generation by femtosecond laser excitation of liquid droplets and clusters) a reflectron-type electron kinetic energy analyzer has been constructed, which can be used to measure electron kinetic energies as high as 5 keV.
• On the Hohar experiment (generation and application of High Harmonics) an adjustable vacuum cell was constructed for the generation of vacuum-ultraviolet radiation by four-wave mixing.
• For the FTICR-MS experiment a new open ended cell was constructed with heating and cooling capabilities. The cell is currently the standard analysis device in the combined FTICR-MS.
• Also for the FTICR-MS a new RF-only quadrupolar ion transport system was constructed. This will enable the transfer of low kinetic energy ions from the ion source to the ICR cell inside the 7T magnet, improving the overall performance of the instrument.
• For the MS Imaging project in the ‘NWO groot’ framework a new ToF-SIMS sample holder was developed to mount and study biological tissue thin sections.
• Several components were made for the time-shared optical tweezers array of which the optical paths have been doubled in such a way that trapping can be performed through two high numerical aperture lenses simultaneously. This set up can now also be connected to a confocal microscope in such a way that the 3D imaging is performed independently from the trapping plane.
• Several parts of equipment were constructed for the group Vibrational Dynamics. Among these were an optical nitrogen flow box and a newly designed temperature-controlled sample holder. These elements are essential for the performance of high-intensity laser experiments in the mid-infrared part of the spectrum.

• A main revision of NACRA (UHV variable temperature STM) was required. Especially the new, commercially bought, microscope itself needed many modifications. Most important was the development of a new piezo motor.
• Another important activity concerns the formation of spherical glass substrates by melting a sheet of glass in a pre-shaped mold. This development is required for future reflective optical elements for EUV radiation generated by a Cherenkov source.

Personnel: W.J. Barsingerhorn, R. Boddenberg, M.M.J.H. Borsboom, R. Cornelisse, S.M.A. Kraan, J.J. van der Linden, H. Neerings, J-W. Schmidt, H.P. Vader and M.J.A. Witlox

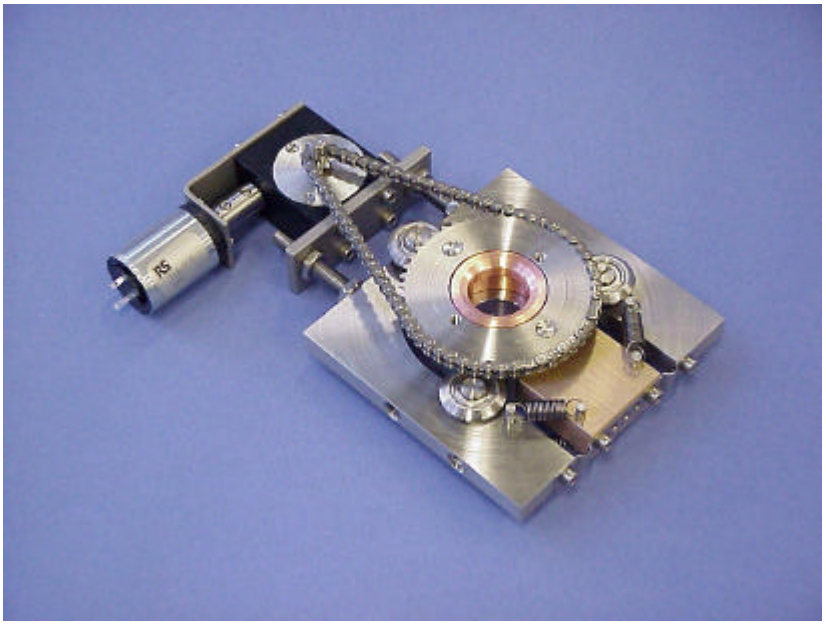
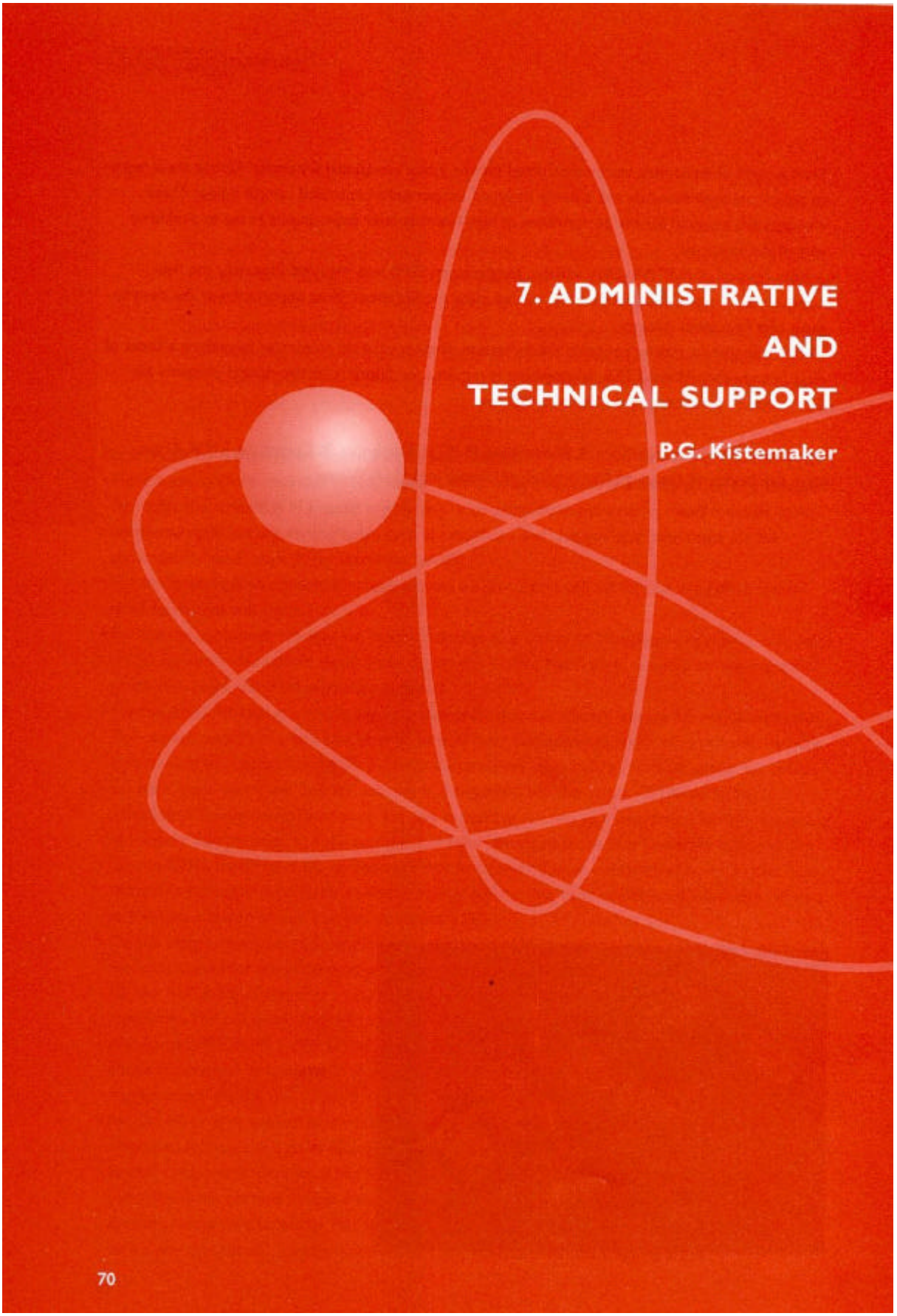


Fig. 1: Rotating sample holder.



7. ADMINISTRATIVE AND TECHNICAL SUPPORT

P.G. Kistemaker

This division combines groups that are responsible for financial administration, personnel management, secretariat and library, as well as public relations and conference organization.

7.1 FINANCIAL ADMINISTRATION, PERSONNEL MANAGEMENT, LIBRARY AND SECRETARIAT

P.G. Kistemaker, J.F. Stiel, W.C. Harmsen, S. Windhouwer, H.J.J.M. Lammers

The financial administration, including ordering of goods, checking invoices, charging the proper budgets and project administration is performed by the purchase department and the financial administration. The bookkeeping is executed on a central computer for the whole FOM organization. Although monthly reports provide accurate information to the budgetholders the access to online-information is only realized in a pilot-project. Quarterly financial reports are introduced as a management information tool for FOM. The Institute is financed by budgets allocated to programs. Therefore costs of technical and general support is billed to the programs. This requires a time-registration of the support departments. Some 40% of the AMOLF budget is financed by special contracts. The percentage of national (NWO) and EU contracts is growing, whereas contracts with Dutch industries have decreased.
Personnel management is continuously changing to more individual arrangements. This reflects the wish to synchronize better the institute and private obligations. Because of the decreased interest of Dutch students for physics and chemistry, many new PhD students come from abroad. Assistance in finding housing and in the adaptation to Dutch regulations asks for a major effort. About 50 employees came in and another 50 left the institute this year. The main part of this flux consists of young scientists and technicians who finished the training on their first job. Supported by European scholarships an increasing number of postdocs from the different European countries stay at AMOLF. Also many PhD students who graduated at AMOLF have obtained an EU-fellowship and have spent a year or two in another European institute.
The Information Service Department includes library services, building and maintenance of the AMOLF website and database building. The librarians are specialized in providing the scientists with appropriate information by means of books, journals, international databases and through contacts with other libraries. Printed versions of journals are minimized and on-line contracts are preferred. These contracts are preferably concluded for all FOM-institutes to share information and costs. The AMOLF website is an important source of information for internal and external users. Therefore much effort is invested in continuously updating and extending of the site.
Management support for the director and program coordinators, as well as the personnel- and the public relations departments are carried out by the secretariat. In addition all regular electronic mail is handled and agendas are managed. Much effort was invested and enjoyment was harvested in lending support to national and international workshops that were organized in cooperation with the public relations department.

Personnel: C.M. van Es, K. Bonsink, G. Joseph, W. van der Kaaij, E.B. Sputnesset, I.R.M. Wijne, D.M.G. Hoogesteijn, A.C. de Geus, Y. Kaluf and M.E. Woltjer

7.2 TECHNICAL SERVICES (FACILITY MANAGEMENT)

H.H. Kersten

Five groups are involved with the care of the facilities.
• The group Technical Services maintains the physical plant. For the major items we have a long term plan (10 years, updated in April '99), financially supported by NWO. Another important task for this group is the preparation and installation of the connections for new experiments. Moreover, Technical Services provide the essential guard duty in the evening and the weekend for the physical plant and the unattended, working, equipment.
• The group Civil Services performs cleaning and maintenance of the rooms and the building. Most of the work is done on a basis of one-year planning. The management of the cafetaria is another activity of this group. A special task for the leader of Civil Services is the allocation of the rooms to the employees of the institute.
• The Purchasing Group orders and receives the goods, and manages the stock. In stock we have about 1800 different items in a wide range from bolts to pencils and lecture bottles to connectors.
• In the Printing shop the large volume copy work is done (also our famous 'IMPULS'). Besides this, information and help is provided for making posters, photographs, overhead sheets and DTP using PhotoShop and Quark XPress.
• At the reception desk the receptionist takes care of connecting phone calls, sorting incoming mail, telefaxes and the presence registration.
• Assistance with finding a living place in Amsterdam for our constantly changing group of foreign guests takes a lot of time and ingenuity. Together with arranging foreign business trips for our staff it is a full time job.
• One of the tasks of the facility manager is taking care for the safety in the institute. The institute has an automatic fire alarm system and an emergency group of about 19 people. They are skilled in first aid, fire extinguishing, evacuation and accident prevention.

Activities

The groups Technical Services and Civil Services have a valuable task in internal moves and renovations in the institute. This year some of the topics were:
• Upgrading the air conditioning system in the laser laboratory. Instead of the normal exhaust grids we use 'air hoses' to bring in the fresh air, resulting in less dust and less uncomfortable cold air.
• Moving an experiment (atmospheric photophysics) and laser from the TUBA-hall to the main hall and building two rooms for a laser and a photon-experiment, both with air conditioning.
• Upgrading the TUBA hall by building a transparent separation wall between this hall and the main hall, a corridor and installing an air conditioning system for the new high resolution mass spectrometers in the group Mass spectrometry of Macromolecular systems.
• Design and building a special room for the SEM in the main hall. Special are the design of this room and the low noise air conditioning system with a good temperature stability.
• Design and construction of a new, temporary building, having 25 offices. This solves the structural shortage of office space. The official opening took place on November 2nd.

We continued making plans to realize a complete new building. It will be situated between the present AMOLF buildings and the new road, called WCW lane. The specifications will be ready in February 2002. The architect will be chosen a few months later. We hope to realize the building in 2004-2005. In November 2001 the government announced the financial support. On and around the Science Center Watergraafsmeer, more participants have plans for new buildings. In May 2002 the municipality will start building the new road, connecting the Molukkenstraat with the Kruislaan, so making this region more accessible. We participate in a

few coordination teams (e.g. energy management, parking management, private domain, access control) to steer these developments and to keep in touch.

Personnel: H. Bar, A. Dijkslag, I.P. Snel, E.R.J. Kruller, S. Jangbahadoor, H. de Jong, W. de Jong, Y.J.M. de Koning, G.H. Kroll, J.L. van der Loo, C.K.J. van der Meer, A-M. Post, M.J.C. Wennekes, G.W. van der Wijk, M. Witlox, H. Sodenkamp, T.W.J. zur Kleinsmiede, M. Roos, E.G. Steunebrink and M.L. Ter Stroot

Fig.1: A temporary office section was added to AMOLF in 2001.

7.3 PUBLIC RELATIONS AND CONFERENCE ORGANIZATION

L. Roos and H.J.J.M. Lammers

This group focuses on all aspects of public relations activities and information to the public. Major tasks for the public relations team are the organization of tours for internal and external groups, the production of brochures, visitors guide, annual report, calendar of events, newsletters and audio-visuals. The team organizes in collaboration with other AMOLF (scientific and support) groups special events, such as farewell receptions, the open house festival, meetings and conferences. There is a fruitful collaboration with communication officers of FOM, NWO, the Dutch Universities, and AMOLF neighboring institutes of the Science and Technology Center (WTCW).

Special attention was paid during the year 2001 to the improvement of the 'physics image' among students and teachers at Dutch high schools. Some 300 teachers of the upper classes of high schools in Amsterdam as well as 300 nation wide were approached with a special invitation to visit AMOLF during a full day. The objective was to decrease the present gap between research and education in physics, chemistry and biology. Although only a few teachers were able to actually visit the lab, the general idea was very positively received and hopefully practical obstacles will be diminished so that more visits can be made in 2002.

Several international and national workshops and meetings were organized during the year, i.e. the 4th Dutch Atmosphere Day (W.J. van der Zande), the Workshop on Photon Physics in Optical Materials (A. Polman), both in Amsterdam, and the 6th European Workshop on Fourier Transform Ion Cyclotron Resonance Mass Spectrometry at the Rolduc Congresscentre in Kerkrade (R.M.A. Heeren).

The year 2001 calendar of events, available on the AMOLF website, contained a variety of activities:

January

02 New Year's gathering
09 Visit of dr. A.P. Meijler (NWO Gebiedsbestuur Exacte Wetenschappen)
30 Symposium and award ceremony of the NWO/SPINOZA prizes 2000 to prof.dr. D. Frenkel, prof.dr. E. van Dishoeck and prof.dr. D. Postma
31 Presentation by D. Frenkel, Spinoza Laureat

February

09 Workshop 4th Dutch Atmosphere Day (Amsterdam)
15 Visit of Prof.dr. E.C. Klasen, general director of NWO, and Prof.dr. C.H.C.M. Buys, member of the policy board of NWO
23 Inaugural Lecture W.J. van der Zande (Nijmegen University)
28 Farewell reception for Dick Glastra van Loon

March

16 Inaugural Lecture of A. van Blaaderen (Utrecht University)
21 Meeting of the Research Policy Board AMOLF
21 'LENTEBORREL' to celebrate Spring (personnel club), première of a video for new AMOLF-employees: 'Eigentijds werk in een laboratorium voor de toekomst'

April

03 Introduction and tour for new employees at AMOLF
09 Visit of a delegation of the FOM Executive board
12 Easter celebration (personnel club)

May

09 Tour for teachers of the Scholengemeenschap Reigersbos, Amsterdam
07 Sports activities and Italian style dinner for employees of the FOM Foundation (personnel club)

June

26 Workshop on Photon Physics in Optical Materials (Amsterdam)
26 Visit of a delegation of the Ministry OC&W

September

05 Introduction and tour for new employees of AMOLF
06 Tour for first year physics and astronomy students of the University of Amsterdam
13 Farewell reception for Saskia Windhouwer and Elin Sputnesset
18 Farewell reception for Jan ter Beek (early retirement)
28 Excursion for all AMOLF personnel to the Dutch Naval Base and the dunes of Schoorl (personnel club)

October

07 Open House Event for the public, children's Fun Lab and Physics alley
16-19 6th European Workshop on Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (Rolduc Congresscentre, Kerkrade)
19 Visit of a delegation of the Ministry of OC&W

November

02 Reception in celebration of the official opening of the building extension (‘OVERLOOP’)
02 Master Course ‘Quantum gassen & vloeistoffen’ (Amsterdam)
07 Meeting of the Research Policy Board AMOLF and Good bye dinner for Peter Wyder
12 Workshop on Nanophotonic interactions (Amsterdam)

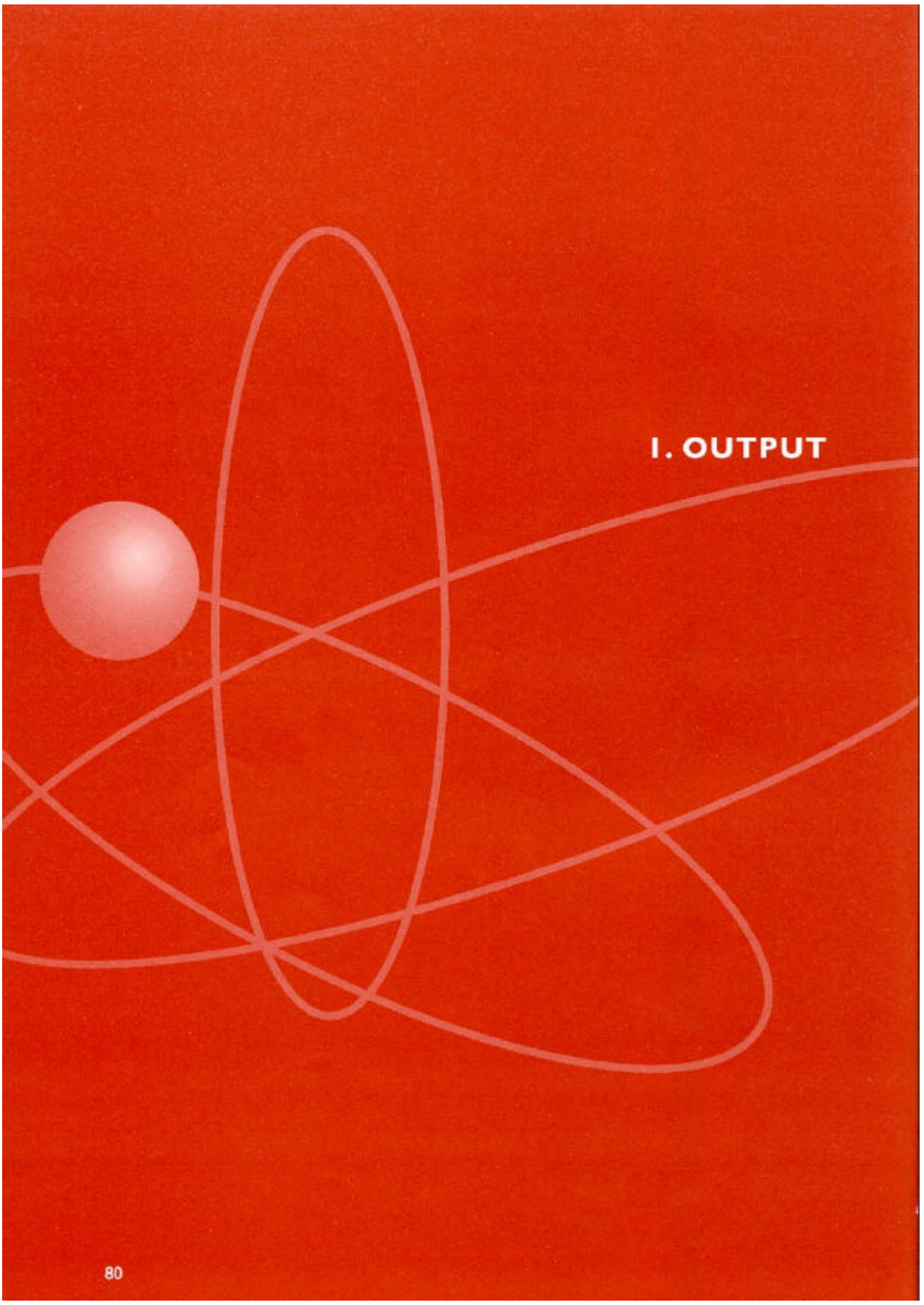
December

05 Visit of St. Nicolas (personnel club)
20 Christmas Colloquium and lunch (personnel club)

The PR activities were supported by members of the technical, household, administrative and secretarial groups, especially by Y. Kaluf, D.M.G. Hoogesteijn, M.E. Woltjer and A.C. de Geus.

photo 1: Postersession at Workshop on Photon physics in optical materials, Artis, Amsterdam

photo 2: A regular victim of St. Nicolaas showing his true sportsmanship.


1. OUTPUT

This chapter features a complete overview per program of the publications, the lectures, conference contributions and theses, as well as overviews of collaboration (national and international), knowledge transfers, and other professional activities.

1.1 QUANTUM DYNAMICS OF ATOMIC AND MOLECULAR SYSTEMS

1.1.1 THESES

PhD theses:

Photofragmentation dynamics of highly excited diatomic molecules
B. Bakker
University of Nijmegen, January 10, 2001

Multichannel decay dynamics of Rydberg atoms and molecules
J.B.M. Warntjes
Vrije Universiteit Amsterdam, May 30, 2001

Making and breaking of Rydberg atoms
C. Wesdorp
Vrije Universiteit Amsterdam, May 31, 2001

Alignment of diatomic molecules induced by intense laser fields
Florentina Rosca-Pruna
Vrije Universiteit, Amsterdam, December 18, 2001

1.1.2 PUBLICATIONS:

M.A.F.H. van den Broek, H.K. Nienhuys and H.J. Bakker: Vibrational dynamics of the C-O stretch vibrational in alcohols. J. Chem. Phys. 114 (2001) 3182-3186.

M.F. Kropman, H.K. Nienhuys, S. Woutersen and H.J. Bakker: Vibrational relaxation and hydrogen-bond dynamics of HDO:H2O. J. Phys. Chem. A 105 (2001) 4622-4626.

A.J. Lock, S. Woutersen and H.J. Bakker: Ultrafast energy equilibration in hydrogen-bonded liquids. J. Phys. Chem. A 105 (2001) 1238-1243.

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Videoclips

M. Kalinski: Quantum localization in circularly polarized electromagnetic field in ultra-strong field limit. Opt. Express 8 (2001) 112-117.

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G. Gabrielse, J. Estrada, J.N. Tan, P. Yesley, N.S. Bowden, P. Oxley, T. Roach, C.H. Storry, M. Wessels, J. Tan, D. Grzonka, W. Oelert, G. Schepers, T. Sefzick, W.H. Breunlich, M. Cargnelli, H. Fuhrmann, R. King, R. Ursin, J. Zmeskal, H. Kalinowsky, C. Wesdorp, J. Walz, K.S.E. Eikema and T.W. Hänsch: First positron cooling of antiprotons. Phys. Lett. B 507 (2001) 1-6.

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W. Ubachs, R. Lang, I. Velchev, W.-Ü.L. Tchang-Brillet, A. Johansson, Z.S. Li, V. Lokhnygin and C.-G. Wahlström: Lifetime measurements on the c'41S+u, n = 0, 1 and 2 states of molecular nitrogen. Chem. Phys. 270 (2001) 215-225.

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A. Le Padellec, N. Djuric, A. Al-Khalili, H. Danared, A.M. Derkatch, A. Neau, D.B. Popovic, S. Rosén, J. Semaniak, R. Thomas, M. af Ugglas, W. Zong and M. Larsson: Resonant ion-pair formation in the recombination of NO+ with electrons: Cross-section determination. Phys. Rev. A 64 (2001) 12702 1-7.

B.L.G. Bakker, D.H. Parker and W.J. van der Zande: Observation of direct dissociative ionization in molecular hydrogen. Phys. Rev. Lett. 86 (2001) 3272-3275.

1.1.3 LECTURES AND PRESENTATIONS

Invited conference lectures:

W.J. van der Zande: The laboratory as atmosphere versus the atmosphere as laboratory, CW-Spectroscopie en Theorie, de Blije Werelt, Lunteren, January 29, 2001

W.J. van der Zande: Trace gas retrieval and laboratory experiments, 4de Nederlandse Atmosfeerdag, AMOLF, Amsterdam, February 9, 2001

H.J. Bakker: Femtosecond mid-infrared spectroscopy of aqueous solvation shells, International Conference on "Molecular Reaction Dynamics in Condensed Matter"
Laguna Beach, CA, USA, February 28–March 2, 2001

H.J. Bakker: FEL(IX)s and infrared spectroscopy of molecular vibrations in soft condensed matter, Free-electron laser workshop FOM-Institute Rijnhuizen, Nieuwegein, March 14-16, 2001

W.J. van der Zande: When an electron meets a molecular ion: dissociative recombination of atmospherically relevant ions, ECAMP VII, Berlin, April 4, 2001

H.J. Bakker: Nonlinear vibrational spectroscopy, Tulip graduate school "Modern developments in Spectroscopy", Noordwijk, May 1–4, 2001

M.J.J. Vrakking: Femtosecond laser-induced alignment of diatomic molecules, NNV Quantum Electronics Day, FOM Institute Rijnhuizen, May 23, 2001

H.J. Bakker: Ultrafast mid-infrared spectroscopy, Summer school for Vibrational Spectroscopy, Berlin, Germany, June 26–30, 2001

H.G. Muller, P. Agostini, Ph. Balcou: Demonstration of attosecond pulse trains from high-harmonic generation, Ultra-Fast Optics 2001, Montebello, Canada, July, 2001

W.J. van der Zande: Dissociative recombination of atmospheric ions, ACS Meeting, Chicago, USA, August 28, 2001

H.J. Bakker: Femtosecond mid-infrared spectroscopy of aqueous solutions, Femtochemistry V, Toledo, Spain, September 1–6, 2001

M. Kropman: Slow rotation of ionic solvation shells, Conference contributions Femtochemistry V, Toledo, Spain, September 1 – 6, 2001

A. Lock: Ultrafast energy equilibration in liquid water, Femtochemistry V, Toledo, Spain, September 1–6, 2001

M.J.J. Vrakking: Time-resolved atomic and molecular physics using the SOLEIL FEL, Workshop Scientific Opportunities with the SOLEIL Free Electron Laser, Paris, France, September 25-26, 2001

M.J.J. Vrakking: Time-resolved atomic and molecular physics using the 4GLS, Workshop on Atomic and Molecular Science using Synchrotron and Laser Radiation, Daresbury, United Kingdom, November 7, 2001

M. Kropman: Dynamics of water molecules in ionic solvation shells, Fallmeeting AQ, Lunteren, November 8-9, 2001

H. Volten: Experimental determination of scattering matrices as functions of the scattering angle, NATO workshop, the optics of cosmic dust, Bratislava, Slowakia, November 16-19, 2001

Conference contributions:

International research school for Cooperation on oceanic, atmospheric and climate change study, Obernai, Germany, March 3-16, 2001

R. Lang, A.N. Maurellis, W.J. van der Zande, I. Aben, J. Landgraf, W. Ubachs: A new retrieval method for remote sensing of atmospheric gases with narrow band absorption spectra (poster)

R. Lang, S. van Dijk, P. Guyon, F. Raes: Physical and chemical characteristics of aerosols: observations and modeling

M. Sneep, R. Lang, H. Nüß, and G. Moortgat: Important photochemical processes in the lower atmosphere

6th International Congress on Optical particle characterisation, Brighton, United Kingdom, April 2-5, 2001

H. Volten: Scattering matrices of red and green clay particles (oral)

COCOMO workshop, Imperial College, London, United Kingdom, April 23, 2001

A. Guertler: Coherent electron scattering (oral)

LPHYS '01, Moscow, Russia, July, 2001

H.G. Muller: Five-dimensional calculations on double ionization of helium

Quantum control of atomic and molecular motions Gordon conference, Mount Holyoke, MS, USA, July 29 -August 3, 2001

F. Rosca-Pruna: Experimental observation of revival structures in femtosecond laser-induced alignment (poster)

ICPEAC 2001, July 18-24, 2001, Santa Fe, NM, USA

A. Guertler, L.D. Noordam, W.J. van der Zande: Coherent electron scattering (poster)

ACS meeting in Chicago, IL, USA, August 29, 2001

A. Petrignani, F. Hellberg, R. Thomas, P. Cosby, M. Larsson, W.J. van der Zande: Dissociative recombination of O2+: branching fractions in the meV energy region (poster)

ETR Network meeting, Prague, Czech-Republik, October 4-7, 2001

Laura Dinu: Autoionisation and photodissociation of H2 Rydberg states (oral)

A. Petrignani: Dissociative recombination on atmospheric gasses (oral)

Workshop on "Recent problems in radiative transfer modelling II" DLR Berlin Adlershof , Germany, October 16, 2001

B. Veihelmann: Water vapor absorption in the weak vibrational rotational overtone band at 585 to 600 nm (oral)

Conference on Matter in ultra intense laser fields, San Feliu de Guixols, Spain, September 2001

E. Springate: X-ray generation from laser-irradiation of a water jet (poster)

1st DOAS workshop, Heidelberg, Germany, September 13-14, 2001

R. Lang: A DOAS parameterization for retrieval of trace gases with highly-structured absorption spectra (oral)

Fom/f Symposium, Amsterdam, September 21, 2001

F. Rosca-Pruna: Experimental observation of revival structures in femtosecond laser-induced alignment (poster)

Meeting sectie AQ van NNV in Lunteren, November 9, 2001
A. Petrignani: Dissociative recombination of atmospheric gasses (oral)
L. Dinu, A. Eppink, F. Rosca-Pruna, H.L, Offerhaus, M. Vrakking, W.J. van der Zande: Application of a double exposure CCD camera with nanosecond time resolution in velocity map imaging (poster)
E. Springate: X-ray generation from laser-irradiation of a water jet (poster)
F. Rosca-Pruna: Experimental observation of revival structures in femtosecond laser-induced alignment (poster)

Meeting of the ATTO European Network, Milan, Italy, November 24, 2001
M.J.J. Vrakking: Detection of attosecond laser pulses using a two-color experiment (oral)

Lectures at universities, institutes and industry:
W.J. van der Zande: When an electron meets an ion: dissociative recombination, Institut für Kernphysik, Frankfurt University, Germany, January 15, 2001

H.G. Muller: Measurement of attosecond pulse trains from high-harmonic generation, Laboratoire Optique Appliquee, Palaiseau, Paris, France, April, 2001

M.J.J. Vrakking: Femtosecond laser-induced alignment of diatomic molecules, University Paul Sabatier, Toulouse, France, June 22, 2001

F. Rosca-Pruna: Spatial alignment of diatomic molecules induced by intense laser fields, University of Nottingham, England, October 1, 2001

H.J. Bakker: Ultrafast motion of water molecules near ions, Ornstein colloquium, Utrecht, October, 2001

F. Rosca-Pruna: Alignment of diatomic molecules induced by intense laser fields, Vrije Universiteit Amsterdam, November 26, 2001

F. Rosca-Pruna: Alignment of diatomic molecules induced by intense laser fields, Institut für Optik und Quantenelektronik, Friedrich Schiller Universitaet, Jena, Germany, November 30, 2001

H.J. Bakker: Nonlinear spectroscopy of water in ionic solutions, Algemeen Natuurkunde colloquium, University of Twente, December 12, 2001

Other lectures:
W.J. van der Zande: Onderzoek in de lucht, inaugural lecture, University of Nijmegen, February 23, 2001

H. Volten: Licht op stofdeeltjes, Volksterrenwacht Amsterdam; Nederlandse Vereninging voor Weer- en Sterrenkunde, October 17, 2001 (oral)

1.1.4 COLLABORATIONS

Academic collaborations:

H.J. Bakker:
Technical University Eindhoven (R.van Santen): Dynamics of hydroxyl ions in water
Technical University Delft (P. Planken): Generation of THz light in air and other centrosymmetric media
University of Aarhus, Danmark (S. Keiding): Far-infrared dielectric response of liquid water
Ecole Polytechnique, Palaiseau, Paris, France (G. Gallot, G. Gale): Hydrogen-bond dynamics of liquid water
Université Pierre et Marie Curie, Paris, France (S. Bratos): Anharmonic interaction of OH stretch vibrations and hydrogen-bond modes in liquid water

M.J.J. Vrakking:
Université de Lyon, France (Ch. Bordas): NWO-Van Gogh Programme
Université Paul Sabatier, Toulouse, France (B. Girard): NWO-Van Gogh Programme

H.G. Muller:
Centre d'Etudes Saclay, France (P. Agostini): Diagnostics of short XUV pulses
European laser facility (LIMANS-III), ENSTA, Palaiseau, Paris, France (P. Balcou): Two-color multiphoto ionization
Harvard University (M. Gavrila): Numerical simulation of photo ionization
Bucharest University (M. Dondera): Numerical simulation of photo ionization

W.J. van der Zande:
Vrije Universiteit, Amsterdam (W. Ubachs): Spectroscopy and dynamics of small molecules and retrieval using satellite data
Space research organization Netherlands (SRON), Utrecht (I. Aben): Retrieval of satellite data
Catholic University Nijmegen (D. Parker): Photodissociation studies of molecular hydrogen/oxygen using velocity map imaging techniques
Amsterdam University (R. Waters, J. Hovenier): Light scattering of non-spherical particles
FOM-Institute Nieuwegein (FELIX, G. Berden): Excitation of Rydberg atoms with fractions of a micropulse
SRI-International, Menlo Park, USA (P. Cosby): Electron-ion recombination

Stockholm University (M. Larsson): Electron-molecular ion recombination
University of Bielefeld (A. Eppink): Advanced imaging methods
Chalmers University (J. Pettersson): Electron-cluster ion recombination
Chemistry Department, Bristol University (R. Dixon): Three body fragmentation of excited water

1.1.5 MISCELLANEOUS

Knowledge transfer:

M.J.J. Vrakking:
We have developed a new method to extract 3D velocity and angular distributions from measured 2D images. Upon request we have thus far made our software available to groups at UC Berkeley, UC Davis and Stonybrook (US), Okazaki (Japan), Canberra (Australia), Lyon and Toulouse (France), Bielefeld and Freiburg (Germany), Aarhus (Denmark), Amsterdam and Nijmegen (The Netherlands).

W.J. van der Zande:
Course "Natuurkunde in de Praktijk": Atmospheric Physics, Catholic University Nijmegen, Freshmen physics

1.2 MASS SPECTROMETRY OF MACROMOLECULAR SYSTEMS

1.2.1 THESES

PhD theses:
Molecular changes in egg tempera paint dosimeters as tools to monitor the museum envrionment
O.F. van den Brink
University of Amsterdam, November 29, 2001

1.2.2 PUBLICATIONS

J.J. Boon, K. Keune, J. van der Weerd, M. Geldof and J.R.J. van Asperen de Boer: Imaging microspectroscopic, secondary ion mass spectrometric and electron microscopic studies on discoloured and partially discoloured smalt in crosssections of 16th century paintings. Chimia 55 (2001) 952-960.

N. Wyplosz, R.M.A. Heeren, G. van Rooij and J. Boon: Analysis of natural organic pigments by laser desorption mass spectrometry (ldms): A preliminary study to spatially resolved mass spectrometry. Dyes in History and Archaelogy 16/17 (2001) 187-198.

E.C. Minor, J.J. Boon, H.R. Harvey and A. Mannino: Estuarine organic matter composition as probed by direct temperature-resolved mass spectrometry and traditional geochemical techniques. Geochim. Cosmochim. Acta 65 (2001) 2819-2834.

S. Koster, C.G. de Koster, R.A.T.M. Van Benthem, M.C. Duursma, J.J. Boon and R.M.A. Heeren: Structural characterization of hyperbranched polyesteramides: MSn and the origin of species. Int. J. Mass Spectrom. Ion Phys. 210/211 (2001) 591-602.

W. Vermerris and J.J. Boon: Tissue-specific patterns of lignification are disturbed in the brown midrib2 mutant of maize (Zea mays L.). J. Agric. Food Chem. 49 (2001) 721-728.

M.F. Santos Bento, H. Pereira, M.A. Cunha, A.M.C. Moutinho, K.J. van den Berg and J.J. Boon: A study of variability of suberin composition in cork from Quercus suber L. using thermally assisted transmethylation GC-MS. J. Anal. Appl. Pyrolysis 57 (2001) 45-55.

J.D.J. van den Berg and J.J. Boon: Unwanted alkylation during direct methylation of fatty (di)acids using tetramethyl ammonium hydroxide reagent in a Curie-point pyrolysis unit. J. Anal. Appl. Pyrolysis 61 (2001) 45-63.

O.F. van den Brink, J.J. Boon, P.B. O'Connor, M.C. Duursma and R.M.A. Heeren: Matrix-assisted laser desorption/ionization Fourier transform mass spectrometric analysis of oxygenated triglycerides and phosphatidylcholines in egg tempera paint dosimeters used for environmental monitoring of museum display conditions. J. Mass Spectrom. 36 (2001) 479-492.

J. MacKay, D.R. Dimmel and J.J. Boon: Pyrolysis mass spectral characterization of wood from cad-deficient pine. J. Wood Chem. Technol. 21 (2001) 19-29.

J.D.J. van den Berg, K.J. van den Berg and J.J. Boon: Determination of the degree of hydrolysis of oil paint samples using a two-step derivatisation method and on-column GC/MS. Prog. Org. Coat. 41 (2001) 143-155.

J.J. Boon, N. Wyplosz, B. Marino, M. Duursma, J. van der Horst and T. Leaner: Mass spectrometric identification of pigments and media in modern paintings. In: Proceedings of the 49th ASMS conference on Mass Spectrometry and Allied Topics, Chicago, Illinois, May 27-31, 2001, (Chicago, 2001). Published on CDROM.

O. van den Brink, M. Duursma, S. Oonk, G.B. Eijkel, J.J. Boon and R.M.A. Heeren: Probing changes in the lipid composition on the surface of laser treated artist paints bij MALDI-MS. In: Proceedings of the 49th ASMS conference on Mass Spectrometry and Allied Topics, Chicago, Illinois, May 27-31, 2001, (Chicago, 2001). Published on CDROM.

S. Koster, C.G. de Koster, B.R. A.T.M., M.C. Duursma, J.J. Boon and R.M.A. Heeren: On the origin of: Structural characterisation of hyperbrached polyesteramides with ESI FTMS. In: Proceedings of the 49th ASMS Conference on Mass Spectrometry and Allied Topics, Chicago, Illonois, May 27-31, 2001, (Chicago, 2001) Published on CDROM.

M.F. Bento, H. Pereira, M.A. Cunha, A.M.C. Moutinho, K.J. van den Berg, J.J. Boon, O. van den Brink and R.M.A. Heeren: Fragmentation of suberin and composition of aliphatic monomers released by methanolysis of cork from Quercus suber L., analysed by GC-MS, SEC and MALDI-MS. Holzforschung 55 (2001) 487-493.

C.-M. Koppelman, T. den Blaauwen, M.C. Duursma, R.M.A. Heeren and N. Nanninga: Escherichia coli minicell membranes are enriched in cardiolipin. J. Bacteriol. 183 (2001) 6144 - 6147.

R.M.A. Heeren, M.C. Duursma, L. Drahos and K. Vékey: ESI-FTICR tandem mass spectrometry in the determination of internal energy relaxation rates of macromolecules. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 355-356.

R.M.A. Heeren, M.C. Duursma, A. de Snaijer, P.G. Kistemaker and J.J. Boon: A novel surface induced dissociation tandem mass spectrometry set-up. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 469-470.

J.D.J. van den Berg, N.D. Vermist and J.J. Boon: MALDI-TOF-MS and ESI-FTMS of oxidised triacylglycerols and oligomers in traditionally prepared linseed oils used for oil paintings. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 822-824.

G.M. Languri, J. van der Horst, W.J. Muizebelt, R.M.A. Heeren and J.J. Boon: Monitoring the effects of traditional 19th century ADDITIVES on the chemical drying of OIL PAINT by mass spectrometry. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 831-832.

N. Wyplosz, M.C. Duursma, J.J. Boon and R.M.A. Heeren: Spatially-resolved TOF-MS analysis of paint materials and easel paintings samples. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 883-884.

O.F. van den Brink, M.C. Duursma, J.J. Boon and R.M.A. Heeren: An ESI-FTMSMS study of the structure of photo-oxidised egg glycerolipids. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 889-890.

S. Koster, M.C. Duursma, J.J. Boon, M.W.F. Nielen, C.G. de Koster and R.M.A. Heeren: Sequencing of synthetic copolyesters by ESI FTMS. In: Adv. Mass Spectrom. 15, edited by E. Gelpi. (Wiley, Chichester, 2001) p. 917-918.

J. van der Weerd, R.M.A. Heeren and J.R.J. van Asperen de Boer: A European 640 x 486 PtSi camera for infrared reflectography. In: La peinture et le laboratoire: procédés, méthodologie, applications, edited by R. van Schoute and H. Verougstraete. (Peeters, Leuven, 2001) (Le dessin sous-jacent et la technologie dans la peinture; colloque 13), p. 231-243.

A.J. Kleinnijenhuis, A.J.R. Heck, R.M.A. Heeren and M.C. Duursma: Localizaton of intramolecular monosulfide bridges in Nisin with bond selective tandem mass spectrometry. In: Proceedings of the 49th ASMS conference on Mass Spectrometry and Allied Topics, Chicago, Illinois, May 27-31, 2001, (Chicago, 2001) Published on CDROM.

R.M.A. Heeren, S. Koster, M. Duursma, X. Guo, N. Nibbering, L. Dharos and K. Vekey: Internal energy control in (activated) ion dissociation experiments. In: Proceedings of the 49th ASMS Conference on Mass Spectrometry and Allied Topics, Chicago, IL, May 27-31, 2001, (Chicago, 2001) Published on CDROM.

1.2.3 LECTURES AND PRESENTATIONS

Invited conference lectures:

R.M.A. Heeren, X. Guo, N.N.M. Nibbering, S. Koster, M. Duursma: Internal energy control in activated ion dissociation experiments, 19th informal meeting on mass spectrometry, Noszvaj, Hungary, April 29-May 4, 2001

R.M.A. Heeren, J. van der Weerd, J.J. Boon: FTIR imaging in biomedicine and culture, 1st International conference on advanced vibrational spectroscopy, Turku, Finland, Augustus19-24, 2001

J.J. Boon: Natural and destructive ageing processes in old master paintings, XVI Congreso Nationale di chimica analytica, chimic analytica e scienze di mare Portonovo, Ancona, Italy, September 24-28, 2001

R.M.A. Heeren: Controlled laser cleaning of paintings: fundamentals and applications, Symposium "Het gebruik van lasers bij schilderijrestauratie", Rijksmuseum Twente, Enschede, November 22, 2001

Conference contributions:

Sanibel Conference on informatics and mass spectrometry, Sanibel, Florida, USA, January 19-22, 2001

G.B. Eijkel, H. Afsarmanesh, D. Groep, A. Frenkel, R.M.A. Heeren: Mass Spectrometry in the Amsterdam Virtual Laboratory: Development of a high-performance platform for meta-data analysis (poster)

O.F. van den Brink, G.B. Eijkel, J.J. Boon: Discriminant analysis and mass spectrometry of paint-based dosimeters for environmental monitoring
of museums (poster)

Discussion group for polymer separation methods, TNO-Voeding, Zeist, March 8, 2001

S. Koster: Structural analysis of linear and hyperbranched polymers with ESI FTMS (poster)

ICOMCC Interim meeting, modern materials workshop, Cologne, Germany, 12-14 March 2001
J.J. Boon, T.S. Learner, N.Wyplosz, R.M.A. Heeren: Mass spectrometric identification of pigments and media in modern paints (oral)

IR-FEL workshop, Nieuwegein, March 15, 2001
R.M.A. Heeren: IR-pump probe experiments on trapped macromolecualr ions

49 th ASMS conference on Mass spectrometry and allied topics, Chicago, IL, USA, May 27-31, 2001
A.J. Kleinnijenhuis, A.J.R. Heck, R.M.A. Heeren, M.C. Duursma: Localization of intramolecular monosulfide bridges in Nisin with bond selective tandem mass spectrometry (poster)
S. Koster, C.G. de Koster, R.A.T.M. van Benthem,
M.C. Duursma, J.J.Boon, R.M.A. Heeren: On the origin of species: structural characterisation of hyperbranched polyesteramides with ESI FTMS (poster)
R.M.A. Heeren, S. Koster, M. Duursma, X. Guo, N. Nibbering, L. Drahos and K. Vekey: Internal energy control in (activated) ion dissociation experiments(oral)
O.F. van den Brink, M. Duursma, S. Oonk, G.B. Eijkel, J.J. Boon, R.M.A. Heeren: Probing changes in the lipid composition on the surface of laser treated artist paints by MALDI-MS (poster)
J.J. Boon, N. Wyplosz, B. Marino, M. Duursma, J. van der Horst, T. Learner: Mass spectrometric identification of pigments and media in modern paintings (oral)

1 st International conference on advanced vibrational spectroscopy, Turku, Finland, August 19-24, 2001
J. van der Weerd, M. Geldof, R.M.A. Heeren, J.J. Boon: Ongoing changes in old master's paint studied by imaging FTIR (poster)

First European Coatings Conference, Symposium on film formation, Zürich, Switzerland, September 6, 2001
W.J. Muizebelt: Crosslink mechanisms of alkyd resins studied using model compounds (oral)

ICT-KennisCongres 2001, Nederlands Congres Centrum, Den Haag, September 6-7, 2001
G.B. Eijkel, R.M.A. Heeren: Development of a high-performance platform for meta-data analysis (poster)

Deterioration of artists' paints: effects and analysis, British museum, London, United Kingdom, September 10-11, 2001
J.J. Boon, K. Keune, J. van der Weerd, P. Noble: Chemical changes in old master paintings:dissolution, metal soap formation, and remineralisation processes in lead pigmented paint layers of 17 th C paintings (oral)
G. Languri, J. van den Berg, J.J.Boon: Effects of additions of mastic, Copiava balsam, asphalt or earth pigments on the chemical drying of oil paint (oral)
R. Boitelle, K.J. van den Berg, M. Geldof, G. Languri: Descending into the details of Th.Rousseau's "La descente des vaches" (Museum Mesdag, The Hague) – Technical Research of a darkening painting (oral)

FOM/f Symposium, Amsterdam, September 21, 2001
B. Marino, J.J. Boon, J. van der Horst, T. Learner: DT - Mass spectrometric study of 20 th century paints (poster)

KNCV Macromoleculaire Sectie, Wageningen, October 3, 2001
W.J. Muizebelt, J. van der Weerd, M. Duursma, J. Boon: Oxidation and crosslinking of unsaturated fatty acids in alkyd resins and linseed oil (oral)

European DR Network meeting, Prague, Czech-Republik, October 4-7, 2001
A. Al-Khalili: Dissociative recombination of biomolecues

6 th European workshop on Fourier transform ion cyclotron resonance mass spectrometry, Kerkrade, October 16-19, 2001
X. Guo: Manipulating internal energy and protein conformation in ESI FT-ICR MS (oral)
S. Koster: Isomer separation of hyperbranched polyesteramides using H/D exchange and MSn (oral)
O. van de Brink: ESI-FTMS(MS) of oxidized egg glycerolipids (oral)
L. Drahos: Time resolved modelling of internal energy changes in FT-ICR using massKinetics (oral)
A. Al-Khalili: A new thermostat open ended capacitively coupled ICR cell design (poster)
A.J. Kleinnijenhuis: Localisation of intramolecular lanthionine bridges in Nisin using electron capture dissociation (poster)

Symposium on Technical art history, RKD, The Hague, October 29-30, 2001
L. Speleers: "Het valdt in t groodt ongelijck moeyelycker als gegist hadde…": making the large-scale paintings for the Oranjezaal

20 th Annual Meeting of Dyes in history and archaeology, Instituut Collectie Nederland (ICN), Amsterdam, November 1-2, 2001
B. Marino, J. van der Horst, M. Duursma, N. Wyplosz,
J. J. Boon, T. Learner: Mass spectrometric studies of 20th C organic pigments and their paints (poster)

Fall meeting of the Nederlandse Vereniging voor Massaspectrometrie, Weesp, November 7, 2001
G.B. Eijkel: VLAM-G;Virtual Laboratory Amsterdam on GRID

Infrarood en Raman Discussiegroep, RIVM, Bilthoven, November 15, 2001
J. van der Weerd: Extreem verouderde verf

Lectures at universities, institutes and industry:
J.J. Boon: Mass spectrometry and imaging studies of modern artist's materials and cross-sections, Institute Collectie Nederland (ICN), October 10, 2001

J.J. Boon: Scientific examination of paintings, Allied Circle, Doelen Hotel Amsterdam, October 31, 2001

R.M.A. Heeren: Macromolecular structural studies with mass spectrometry, Natuurkundig colloquium, Vrije Universiteit, Amsterdam, 18 January 2001

R.M.A. Heeren: Modern possibilities of mass spectrometry, Philips Natuurkundig Laboratorium, Eindhoven, April 11, 2001

R.M.A. Heeren: Internal energy control and macromolecular structure, Utrecht University, Biomolecular MS department, Utrecht, June 20, 2001

R.M.A. Heeren: VL in material science: Chemical imaging a typical VL application, IBM-surfnet meeting, University of Amsterdam, Amsterdam, September 19, 2001

R.M.A. Heeren: Biomolecules on surfaces: the chemical imaging approach, Van Marum lezing Leiden University, Leiden, December 11, 2001

S. Koster: Characterisation of synthetic polymers with ESI FTMS, Thermo Hybaid, Ulm, Germany, May 2, 2001

S. Koster: Isomer separation with pseudo MSn and H/D exchange, Institute of microtechnology, University of Neuchâtel, Neuchâtel, Switzerland, August 22, 2001

S. Koster: Isomer separation with pseudo MSn and H/D exchange, Department of Chemistry, Louisiana State University, Baton Rouge, USA, August 27, 2001

S. Koster: Isomer separation with pseudo MSn and H/D exchange, Oak Ridge National Laboratories, Oak Ridge, USA, August 29, 2001

B. Marino: Imaging and Structural Analysis of Cross Sections of Paint Concorso a n°147 Borse di Studio per Corsi di Perfezionamento all'Estero, Università degli Studi di Roma "La Sapienza", Roma, Italy, September 22, 2001

J. van der Weerd: Ernstig zieke schilderijen, Dwarsverband commissie, Rijksmuseum Amsterdam, January 26, 2001

J. van der Weerd, S. Luxembourg: Imaging techniques in the analysis of paint, Study day for ICN students, AMOLF, Amsterdam, May 29, 2001

1.2.4 COLLABORATIONS

Academic collaborations:
University Utrecht (A.J.R. Heck): Dissociative recombination of multiply charged proteins

Nederlands Kanker Instituut (K. Jalink): Investigation of lipid composition on cell surfaces and investigation of lipid molecular structure

Hungarian Academy of Sciences (K. Vekey, L. Drahos): Internal energy studies of macromolecules

Boston University (P.B.O'Connor): FTMS software development

University of Georgia, USA (T. Mize): Internal energy in the structural analysis of nylon

Industrial collaborations:
Akzo/DSM (P. van Woerkom, C.G. de Koster): FT-ICRMS studies of synthetic polymers

Organon (H. Veenstra): Drug distribution analysis in pharmaceutical systems

Physical electronics Inc. (W. Betz, D. Wayne): Mass spectrometric imaging instrument development

Bio-Rad (J. Wilson): Detector and data processing
algorithm development

1.2.5 MISCELLANEOUS:

Knowledge transfer:
R.M.A. Heeren:
EU-CRAFT meeting lectures
Biomolecular MS course, Utrecht University, Utrecht, April 2-6, 2001
Biomolecular MS course, Utrecht University, Utrecht, September 24-28, 2001

1.3 STRUCTURE, FUNCTION AND FLOW OF SOFT MATERIALS

1.3.1 THESES

PhD theses:
Ordering and fluctuations in smectic membranes
A. Fera
Eindhoven University of Technology, December 12, 2001

Undergraduate theses:
Patterning and drying 2-D colloidal structures using optical tweezers
K. Overgaag
Technische Hogeschool Reiswijk, June, 2001

How do smectic liquid crystals with different molecular length mix?
H. Keymeulen
University of Gent, Belgium, June 14, 2001

Real-space analysis of a colloidal crystal and crystallization in a gravitational field
P. Vergeer
Utrecht University, August, 2001

1.3.2 PUBLICATIONS

M.G. Noro and D. Frenkel: Phase behavior of a simple model for membrane proteins. J. Chem. Phys. 114 (2001) 2477-2483.

I. Pagonabarraga and D. Frenkel: Dissipative particle dynamics for interacting systems. J. Chem. Phys. 115 (2001) 5015-5026.

S. Pronk and D. Frenkel: Point defects in hard-sphere crystals. J. Phys. Chem. B 105 (2001) 6722-6727.

S. Auer and D. Frenkel: Prediction of absolute crystal-nucleation rate in hard-sphere colloids. Nature 409 (2001) 1020-1023.

S. Auer and D. Frenkel: Suppression of crystal nucleation in polydisperse colloids due to increase of the surface free energy. Nature 413 (2001) 711-713.

M.A. Inda and R.H. Bisseling: A simple and efficient parallel FFT algorithm using the BSP model. Parallel Comput. 27 (2001) 1847-1878.

C.P. Lowe, M.H.J. Hagen and D. Frenkel: Response to "Rotational velocity autocorrelation function of interacting Brownian particles". Physica A 289 (2001) 419-421.

J. Horbach and D. Frenkel: Lattice-Boltzmann method for the simulation of transport phenomena in charged colloids. Phys. Rev. E 64 (2001) 61507 1-8.

D. Sentenac, B.I. Ostrovskii and W.H. de Jeu: Microscopic surface patterns of a liquid crystalline polyacrylate film. Adv. Mater. 13 (2001) 1079-1081.

B.I. Ostrovskii and W.H. de Jeu: Structure and thermal fluctuations in the thin films of smectic liquid crystals.

Crystallogr. Rep. 46 (2001) 680-686.
Translated from Russian: Kristallografiya vol.46, no.4; July-Aug. 2001; p.749-55

R.P. Nieuwhof, P. Kimkes, A.T.M. Marcelis, E.J.R. Sudhölter,
R. Opitz and W.H. de Jeu: Langmuir and Langmuir-Blodgett films of side-chain liquid-crystalline poly(maleic acid-alt-1-alkene)s. Langmuir 17 (2001) 78-85.

W.H. de Jeu: Zelforganisatie in een polymeerfilm. Ned. Tijdschr. Natuurkd. 67 (2001) 372-374.

Structure and frustration in liquid crystalline polyacrylates I. Bulk behaviour, B.I. Ostrovskii, S.N. Sulyanov, N.I. Boiko, V.P. Shibaev and W.H. de Jeu, Eur. Phys. J. E 6, 277-285 (2001).

Structure and frustration in liquid crystalline polyacrylates II. Thin-film properties, B.I. Ostrovskii, D. Sentenac,
I.I. Samoilenko and W.H. de Jeu, Eur. Phys. J. E 6, 287-294 (2001).

A. Fera, I.P. Dolbnya, R. Optiz, B.I. Ostrovskii and W.H. de Jeu: Crystalline smectic-B films as fluctuating systems : Static and dynamic x-ray scattering. Phys. Rev. E 63 (2001) 020601 1-4.

A. Fera, R. Opitz, W.H. de Jeu, B.I. Ostrovskii, D. Schlauf and C. Bahr: Structure of freely suspended chiral smectic films as determined by x-ray reflectivity and optical ellipsometry. Phys. Rev. E 64 (2001) 21702 1-8.

B. Groh and B. Mulder: A closer look at crystallization of parallel hard cubes. J. Chem. Phys. 114 (2001) 3653-3658.

B. Groh and M. Schmidt: Density-functional theory for structure and freezing of star polymer solutions. J. Chem. Phys. 114 (2001) 5450-5456.

B.M. Mulder and A.M.C. Emons: A dynamical model for plant cell wall architecture formation. J. Math. Biol. 42 (2001) 261-289.

A.M.C. Emons and B.M. Mulder: Microfibrils build architecture: A geometrical model. In: Molecular Breeding of Woody Plants, edited by N. Morohoshi and A. Komamine. (Elsevier, Amsterdam, 2001) (Progress in Biotechnology, 18) p. 111-119.

E.H.A. de Hoog, W.K. Kegel, A. van Blaaderen and
H.N.W. Lekkerkerker: Direct observation of crystallization and aggregation in a phase-separating colloid-polymer suspension. Phys. Rev. E 64 (2001) 021407 1-9.

1.3.3 LECTURES AND PRESENTATIONS

Invited conference lectures:
D. Frenkel: Predicting the nucleation rate of hard-sphere colloids: success or failure? Statistical Mechanics 2001, Berkeley, CA, USA, January 5-6, 2001

D. Frenkel: Simulating crystal nucleation rates, MRS Spring Meeting, San Francisco, CA, USA, April 16-20, 2001

D. Frenkel: Do we understand homogeneous nucleation? Principles of soft matter, 21st CNLS Annual Conference, Santa Fe, NM, USA, May 21-25, 2001

D. Frenkel: Numerical simulation of rare events, IFIP WG 2.5 Workshop, CWI, Amsterdam, May 28-29, 2001

D. Frenkel: Watching the birth of a crystal - computer simulation of crystal nucleation, Plenary talk, INFM annual meeting, Rome, Italy, June 20, 2001

M. Dogterom: Forces and dynamics of single microtubules in contact with a barrier, 1st International MTBio Workshop on Function and Regulation of Cellular Systems: Experiments and Models, Dresden, Germany, June 25-30, 2001

D. Frenkel: Simulating crystal nucleation: nuclei, barriers and rates, CCP5/SIMU workshop on Nucleation and Growth, King's College, London, United Kingdom, July 2-3, 2001

W.H. de Jeu: Coherent diffraction from smectic membranes, Gordon x-ray conference, New London, USA, July 22, 2001

J.P. Hoogenboom: Colloidal epitaxy: real-space analysis of (non-)equilibrium colloidal crystallization, ICCG-13 International Conference on Crystal Growth 13, Kyoto, Japan, August 4, 2001

M. Dogterom: Thermal ratchets? Force generation by self-assembly of cytoskeletal polymers, assembly and self-assembly at the interface of biology, chemistry and physics, Il Ciocco, Italy, August 20-25, 2001

M. Dogterom: Force generation by polymerization of cytoskeletal filaments, 16th European Cytoskeleton Forum, Maastricht, August 22-26, 2001

D. Frenkel: Soft matter, series of lectures at the International Summer School on Fundamental Problems in Statistical Physics X, Haus Altenberg, Germany, August 20-September 2, 2001

D. Frenkel: Simulating crystal nucleation rates, Plenary Talk, Conference on Computational Physics 2001, Aachen, Germany, September 5-8, 2001

D. Frenkel: Simulation of crystal nucleation and the microscopic structure of colloidal glasses, Plenary talk, ICAPP2001, Yonezawa, Japan, October 30-November 2, 2001

M. Dogterom: Assembly and forces of cytoskeletal polymers, NWO Special Year on Mathematical Biology: from Chemistry to Life, Eindhoven, November 30, 2001

Conference contributions:
NWO-CW - Liquids and Interfaces 2001, Lunteren, January 19-20, 2001
D.L.J. Vossen, J.P. Hoogenboom, A. van der Horst,
A. van Blaaderen: Optical tweezers in concentrated colloidal dispersions (oral)
J.P. Hoogenboom, D.L.J. Vossen, A.K. van Langen-Suurling,

H. Romijn, A. van Blaaderen: Colloidal Epitaxy: Directing colloidal crystallization by using patterned surfaces (poster)

COST WG3 workshop, Paris, France, January 26, 2001
W.H. de Jeu: Nanostructures and cystallization in block copolymer films (oral)

FOM Meeting on Statistical Physics, Lunteren, February1-2, 2001
M. Alves de Inda, D. Frenkel: Combining the multiple histogram method and the Rosenbluth sampling to study the conformational behavior of polymers (poster)
S. Pronk, D. Frenkel: Interstitials and vacancies in hard sphere crystals (poster)
J. Horbach, D. Frenkel: Lattice-Boltzmann simulations of charged colloids (poster)
F. Capuani, D. Frenkel: How do velocity fluctuations decay in porous media? (poster)
M. Janson: In vitro measurements of forces generated by single polymerizing microtubules (poster)
G. Koster: Spatial organization of lipid bilayers by microtubules and motor proteins (poster)
C. Faivre-Moskalenko: Dynamics and organization of microtubule asters in micro-fabricated cells (poster)
M. Cosentino-Lagomarsino: Biological rods: microtubules as a model system for the isotropic to nematic transition of polydisperse rods in a slit pore (poster)
R. Opitz: Crystallization in thin diblock copolymer films (oral)
I. Sikharulidze: Smectic membranes in motion: a study by x-ray photon correlation spectroscopy (poster)
W.H. de Jeu: Temperature dependence of the lamellar period in diblock copolymers (poster)
C. Tanase, B.M. Mulder, M. Dogterom: The generalized Brownian ratchet model for microtubule force production (poster)
B. Groh, B.M. Mulder: The crystallization of parallel hard cubes (poster)
D.L.J. Vossen, J.P. Hoogenboom, A. van der Horst, K.P. Velikov, A. van Blaaderen: Optical tweezers in concentrated colloidal dispersions (poster)
P. Vergeer, D. Derks, J.P. Hoogenboom, and A. van Blaaderen: Gravity-induced crystallization of colloids: A real-space analysis (poster)
J.P. Hoogenboom, D.L.J.Vossen, A.K. van Langen-Suurling, H. Romijn, A. van Blaaderen: Directed assembly and real-space analysis of (non-)equilibrium colloidal structures (oral)

Polymeerdagen Nederland, Lunteren, February 12-13, 2001
W.H. de Jeu: Crystallization in thin films of diblock copolymers with one crystallizable block (oral)
W.H. de Jeu: Organization in thin block copolymer films (poster)
D.M. Lambreva: Temperature dependence of the lamellar period in diblock copolymers (poster)

11 th ESRF Users' meeting 2001, Grenoble, France, February 19, 2001
I.P. Dolbnya: Smectic membranes in motion: a study by x-ray photon correlation spectroscopy (poster)

Dutch Astrophysics Day, Leiden, March 1, 2001
D. Frenkel: The astrophysics of milk - from colloids to the cosmos (oral)

PAC Symposium, Leiden, March 2, 2001
P. Vergeer, D. Derks, J.P. Hoogenboom, A. van Blaaderen: Gravity-induced crystallization of colloids: a real-space analysis (poster)

American Physical Society March Meeting, Seattle, U.S.A, March 12-16, 2001
A. Yethiraj, A. van Blaaderen: Confocal microscopy study of electric-field induced structures and phases in model colloidal electrorheological fluids (oral)

6 th European conference on Liquid Crystals, Halle, Germany, March 25-30, 2001
A. Fera: Crystalline smectic B films as fluctuating systems: static and dynamic x-ray scattering (oral)
P. Wessels and B.M. Mulder: Molecular theory for nematic order in side-chain liquid-crystalline polymers (poster)

Chemical Society National Meeting, San Diego, CA, USA, April 1-5, 2001
A. van Blaaderen, A. Moroz, K.P. Velikov: Monodisperse core-shell colloidal spheres of zinc sulfide and silica for photonic applications (poster)

NeVAC Students Day 2001, Eindhoven, April 6, 2001
K. Overgaag, J.P. Hoogenboom, D.L.J. Vossen, A. van Blaaderen: Patterning 2D colloidal structures using optical tweezers (poster)

Cost Action E20 Workshop "Interaction between cell wall components", Uppsala, Sweden, April 26-28, 2001
B.M. Mulder: What does the geometrical model for microfibril deposition have to say about interactions between cell wall components? (I) The mathematical theory (oral)

Materials Research 2001, Veldhoven, May 8-9, 2001
M. A. Inda and D. Frenkel: Studying the deformation behavior of polymers by combining the multiple histogram method and the Rosenbluth sampling (poster)
L. Li: Tracing the crystallization process of block copolymer with in-house SAXS (poster)
R. Opitz: Observing the crystallization of diblock copolymers in thin films (poster)

Workshop Scientific Computing and the Computational Sciences, CWI, Amsterdam, May 28, 2001
D. Frenkel: Numerical simulation of rare events (oral)

First International MTBio Workshop on function and regulation of cellular systems, Dresden, Germany June 24-30, 2001
B.M. Mulder, A.M.C. Emons: A model for plant cell wall construction (poster)
B.M. Mulder, N. Kern, A.M.C. Emons: Steps towards a model for tip growth in plant cells (poster)

Summerschool Physics of bio-molecules and cells, Les Houches, France, July 2-27, 2001
G. Koster: Spatial organization of lipid bilayers by microtubules and motor proteins (poster)

Eigh th International Conference on electrorheological fluids and magnetorheological suspensions, Nice, France, July 9-13, 2001
A. van Blaaderen, A. Yethiraj: Confocal microscopy study of electric-field-induced phases in model hard-sphere colloidal electro-rheological fluids (oral)
A. Yethiraj, A. van Blaaderen: Confocal microscopy study of electric-field-induced phases in a novel colloidal model
system (oral)
A. Wouterse, A. Yethiraj, A. van Blaaderen: Electric-field-induced layer-by-layer phase transition in a model colloidal electrorheological fluid (poster)

Assembly and self-assembly at the interface of biology, chemistry and physics, Il Ciocco, Italy, August 20-25, 2001
C. Faivre-Moskalenko: Dynamics and organization of microtubule asters in micro-fabricated cells (poster)

International summer school fundamental problems in statistical physics X, Altenberg, Germany, August 20 - September 2, 2001
M. Cosentino-Lagomarsino: Organization and propulsion of biofilaments (poster)

Time-resolved investigations of structural changes in soft and solid matter with neutrons and x-rays ESF workshop, Sommerfeld, Germany, September 5-7, 2001
I. Sikharulidze: Dynamic x-ray scattering from smectic membranes (oral)

SIMU Conference Konstanz, Germany, September 10-13, 2001
W. Hu, D. Frenkel, V. Mathot: Lattice model for disorder-order phase transitions of homopolymer (poster)

5 th Autumn School 'X-ray scattering from surfaces and thin layers', Smolenitze, Slovakia, September 12-15, 2001
D.M. Lambreva: Temperature dependence of the lamellar period in diblock copolymers (poster)

General Physics Seminar, Amsterdam University, September 20, 2001
D. Frenkel: The breakdown of the classical theory of nucleation (oral)

FOM/f Symposium, Amsterdam, September 21, 2001
C. Graf, A. van Blaaderen: Metallic particles with a dielectric core and/or shell for non-linear photonic applications (poster)

WE-Heraeus Seminar, Freiburg, Germany, October 10-13, 2001
W. Hu, D. Frenkel, V. Mathot: Reversible premelting of a single-chain crystallite (poster)
L. Li: The early stage of crystallization of nylon 12 (poster)
W.H. de Jeu: Crystallization in uniform diblock copolymer films with one cyrstallizable block (poster)

Meeting SoftLink Users Committee, Utrecht, October 11, 2001
D.M. Lambreva: Crystallization of polymers in external fields (poster)

Fall Meeting Physical Chemistry, Schiermonnikoog, November 5, 2001
P. Wessels: Competing components: orientational ordering in side chain liquid crystalline polymers (oral)

NWO topical meeting on Mathematical Biology, Eindhoven, November 30, 2001
D. Frenkel: Protein crystallization (oral)

41 st Annual Meeting of the American Society for Cell Biology, Washington, USA, December 8-12, 2001
M. Janson, M. de Dood, M. Dogterom: Catastrophe frequency is increased for microtubules under force (poster)

General Physics Seminar, Eindhoven University, December 13, 2001
D. Frenkel: Crystal nucleation: black art or science? (oral)

FOM Condensed Matter 2001, Veldhoven, December 18-19, 2001
D. Frenkel: Do we understand crystal nucleation? (oral)
C. Faivre-Moskalenko, A. van der Horst, M. Dogterom: Dynamics and forces of microtubule asters in microfabricated cells (poster)

Lectures at universities, institutes and industry:
M. Dogterom: Force generation by self-assembling biopolymers, Saarbruecken University, Physics Department, Germany, January 9, 2001

W.H. de Jeu: Ordering and crystallization in diblock copolymer films, Makromolekulares Institut, Universität Freiburg, Germany, January 19, 2001

M. Dogterom: Studying microtubule force generation with laser tweezers, Leiden University, Physics Department, January 26, 2001

C. Faivre-Moskalenko: Dynamique et organisation d'asters de microtubules en géométrie confinée, Centre de Recherche Paul Pascal, Bordeaux, France, January 30, 2001

A. van Blaaderen: Manipulating colloidal crystallization: fundamental condensed matter physics and photonic applications, NASA Glenn National Research Center for Microgravity Research, Cleveland, OH, USA, February 29, 2001

C. Faivre-Moskalenko: Dynamics and organization of microtubule asters in micro-fabricated cells, Wageningen University, March 2, 2001

B.M. Mulder: Steps towards a model of tip growth, Laboratory for Plant Cell Biology, Wageningen University, March 16, 2001

M. Dogterom: Force generation by self-assembling protein polymers, Philips Research, Eindhoven, April 11, 2001

D. Frenkel: Nucleation beyond Ostwald, Rockefeller University, New York, NY, USA, April 13, 2001

M. Dogterom: Single microtubule force generation, Institut Curie, Paris, France, April 18, 2001

B.M. Mulder, A.M.C. Emons: A model for cell wall deposition, Plant Research International, Wageningen, April 29, 2001

M. Cosentino-Lagomarsino: "Rowers" coupled hydrodynamically. Symmetry breaking, macroscopic flows, and metachronal waves (collective motions) by stochastic noise, Department of Theoretical Physics, University of Milan I, Italy, May 14, 2001

F. Capuani: Flow in porous media - the decay of velocity fluctuations, University of Mainz "Johannes Gutenberg", Germany, May 31, 2001

W.H. de Jeu: Smectic membranes in motion: surface diffraction and dynamic x-ray scattering, Universität Kiel, Germany, June 19, 2001

W.H. de Jeu: Surface diffraction and dynamic x-ray scattering in smectic membranes, Physics department, University of Minnesota, Minneapolis, USA, July 17, 2001

W.H. de Jeu: Surface diffraction and dynamic x-ray scattering in smectic membranes, Physics department, Iowa State University, Ames, USA, July 18, 2001

W.H. de Jeu: Surface diffraction and dynamic x-ray scattering in smectic membranes, Advanced photon source, Argonne National Laboratory, Argonne, USA, July 20, 2001

D. Frenkel: Challenges for numerical simulations in physics,
Seminar "Vereniging voor Technische Physica", Delft, October 3, 2001

D. Frenkel: How to bluff your way into Entropy, Seminar "Studium Generale", Delft University, October 8, 2001

M. v. Duijn: Developing a model for the formation of membrane tubules, Insititut Curie, Paris, France, October 15, 2001

W.H. de Jeu: Investigation of thin films, x-ray coherent spectroscopy applications, DESY, Hamburg, Germany, October 17, 2001

M. Dogterom: Self-assembling biopolymers: dynamics and force generation, FOM Institute for Plasma Physics, Rijnhuizen, October 18, 2001

M. Dogterom: Force generation by the assembly of cytoskeletal filaments, BioScience Initiative Colloquium, Leiden University, October 25, 2001

F. Capuani: Hydrodynamic Dispersion Coefficients in Porous Media, University of Rome "La Sapienza", Italy, October 26, 2001

D. Frenkel: The effect of disorder on the formation of crystals and liquid crystals, Department of Physics, University of Tsukuba, Tsukuba, Japan, October 29, 2001

A. Wouterse, A. Yethiraj, A. van Blaaderen: Field-induced solid-solid phase transition in colloidal electro-rheological fluids, University of Amsterdam, October 29, 2001

M. Dogterom: Dynamics of single microtubules under load and asters in confined geometries, EMBL Heidelberg, Germany, November 22, 2001

N. Combe: Cinétique de relaxation vers la forme d'équilibre de nanocristaux, Laboratoire des Sciences et Matériaux pour l'Electronique et d'Automatique, Université Blaise Pascal, Clermont Ferrand, France, November 23, 2001

N. Combe: Cinétique de relaxation vers la forme d'équilibre de nanocristaux, Laboratoire Matériaux et Microélectronique de Provence, Université d'Aix-Marseille, Marseille, France, November 26, 2001

W.H. de Jeu: Smectic membranes in motion: surface diffraction and dynamic x-ray scattering. Institut Max von Laue - Paul Langevin, Grenoble, France, December 6, 2001

M. Janson: Microtubule dynamic instability under load, University of North Carolina Department of Biology, at Chapel Hill, NC, USA, December 14, 2001

M. Janson: Microtubule dynamic instability under load, Columbia University, New York, NY, USA, Department of microbiology, December 18, 2001

M. Janson: Microtubule dynamic instability under load, Whitehead Institute for Biomedical Research, MIT, Cambridge, MS, USA, December 21, 2001

Other Lectures:
D. Frenkel: Order from disorder: the silent force of entropy, Spinoza Lecture, Den Haag, January 30, 2001

M. Dogterom: Biomoleculaire machines, Natuurkundig Gezelschap, Utrecht, May 8, 2001

A. van Blaaderen: Harde bollen, zachte materie, slimme materialen, Inaugural lecture, Utrecht University, March 16, 2001

1.3.4 COLLABORATIONS

Academic collaborations:
D. Frenkel:
Utrecht University (H.N.W. Lekkerkerker): Protein crystallization and gelation
University of Amsterdam (B. Smit): Bilateral contacts
Technical University Delft (C. Lowe): Colloidal dynamics
Amsterdam Center for Computational Science, ACCS
(D. Frenkel is scientific coordinator)
University of Groningen (A. Brisson): Crystallization of membrane proteins
James Franck Institute, University of Chicago, USA: Modeling homogeneous nucleation.
Co-chairman, ESF, PESC network on computer simulations (SIMU)

M. Dogterom:
Wageningen University (A.M.E. Emons, J. Vos): Preprophase band formation in plant cells
University of Amsterdam (P. Dhonukshe, D. Gadella): Preprophase band formation in plant cells
University of Amsterdam (T. den Blaauwen): Cell division in E. coli
Utrecht University (M. Dijkstra): Polydisperse rods in slit pores
EMBL, Heidelberg (F. Nédélec, T. Surrey): In vitro microtubule organization
Institut Curie, Paris, France (A. Roux, P. Bassereau, J. Prost): Membrane tubule formation

W.H. de Jeu:
Technical University Eindhoven (Lemstra, Rastogi): Polymer crystallization
Technical University Eindhoven (Sybesma, Van de Schoot): Dynamics of H-bonded polymers
Technical University Eindhoven (Brokken, Vellinga): Adhesion of polymers
Wageningen University (Sudhölter): Liquid crystalline polymer films
TNO Eindhoven (H. Fisher): Block copolymers Enschede
(J. Vancso): POLYNANO, Ordered polymeric nanostructures: formation, characterisation, applications (EU Network)
Mulhouse, France (G. Reiter, J.U. Sommer): POLYNANO, Ordered polymeric nanostructures: formation, characterisation, applications (EU Network)
Ulm, Germany (M. Möller): Ordered polymeric nanostructures: formation, characterisation, applications
Neuchâtel, Switzerland (H. Heinzelmann): Ordered polymeric nanostructures: formation, characterisation, applications (EU Network)

Athens, Greece (N. Hadjichristidis): Ordered polymeric nanostructures: formation, characterisation, Applications (EU Network)
Freiburg, Germany (T. Thurn-Albrecht): Ordered polymeric nanostructures: formation, characterisation, applications (EU Network)
ESRF, Grenoble, France (Gruebel, Madsen): X-ray correlation spectroscopy (long-term beamtime)
ILL, Grenoble, France (Farago): Neutron spin echo measurements of smectic films
Freiburg University, Germany (Finkelmann): Smectic elastomers
Crystallographic Institute, Moscow, Russia (Dr. Ostrovskii): Liquid crystalline (polymer) films
HASYLAB, Hamburg, Germany (Seeck): X-ray scattering of block copolymer films
University of Minnesota, Minneapolis, USA (Cheng Cher Huang): Free-standing smectic films
St. Petersburg University, Petrodvoretz, Russia (Val'kov): Theory of smectic membranes

B.M. Mulder:
Wageningen Universiteit (A. M. C. Emons, F. Lhussier,
J. Esseling, T. Ketelaar): Physics and modelling of plant cells
Trinity College Dublin, Ireland (N. Kern): Models of tip growth in plants
National Technical University, Athens, Greece
(C. Paraskevaidis and C. Papatriantafillou): Inhomogeneous spin models
A. van Blaaderen:
Debye Institute, Van 't Hoff Lab, Utrecht University (H.N.W. Lekkerkerker): Depletion interactions
Debye Institute, Van 't Hoff Lab, Utrecht University
(W.K. Kegel, N. Simeonova): Colloidal glasses and crystallization, synthesis of silica-pmma core-shell particles
Debye Institute, Condensed Matter section, Utrecht University (J.I. Dijkhuis, H. C. Gerritsen): Gold-silica core-shell structures
DIMES, Delft (A.K. van Langen-Suurling, J. Romijn): Templates for colloidal epitaxy
University of Princeton, USA (P.M. Chaikin, W.B. Russel): Colloids under microgravity
Brandeis University, Boston, USA (S. Fraden,
U. Dassanayake): Electro-rheological fluids

Industrial collaborations:
D. Frenkel:
Scientific Advisory Board, Inductive Devices, Pasadena, CA, USA (L. Bogarad)

W.H. de Jeu:
Crystallisation of polymers (Softlink-project), cooperation with DSM-Research (M. van Gurp and W. Gabielse)

A. van Blaaderen:
Bell Labs, Lucent Technologies, Murray Hill, USA
(P. Wiltzius): Colloidal epitaxy
Philips Research, Eindhoven, several contacts and subjects

1.3.5 MISCELLANEOUS

Knowledge transfer:

D. Frenkel:
International master course molecular simulation, University of Amsterdam
Simulations of rare events, lectures at winterschool for theoretical physical chemistry, Han, Belgium, February 8, 2001
Nucleation - beyond Ostwald, MSC conferentie Vlieland 2001, April 23, 2001
Monte Carlo Simulations, RPK Polymer physics course, Utrecht, May 11, 2001

M. Dogterom:
University of Amsterdam, Department of Biology: lecture course on molecular cytology
Les Houches, France: lecture in summer school on Physics of biomolecules and cells
Leiden University, Department of Physics: Capita selecta biophysics lecture series
Wageningen University: lecture in course on Cytochemistry
Joint work discussions (6 national institutions) on physics of living systems, bi-monthly, Amsterdam

B.M. Mulder:
Modelling Plant Cell Wall Formation (undergraduate lecture), Laboratory for Plant cell biology, Wageningen University, June 15, 2001
The Pleasures (and Pitfalls) of counting (lecture), Laboratory for Plant Cell Biology, Wageningen University, October 19, 2001
Fitting Fibrils: A geometrical approach to plant cell wall texture development (guest lecture), Laboratory for Genetics, Wageningen University, October 26, 2001

A. van Blaaderen:
Manipulation of colloidal crystallization, guest lectures in the series: Interdisciplinary Lectures - Colloids - synthesis, physics and application, University of Ulm, Ulm, Germany, February 6, 2001

External users:

W.H. de Jeu:
Technische Universiteit Delft (Van der Drift): X-ray reflectivity set-up
Wageningen University (group Sudhölter): ibid

Patents:

Method and device for imaging the dynamic behaviour of microstructures under the influence of deformation
M. Paques, A. Imhof, A. van Blaaderen, Y. Nicolas, European Patent 01204378.2 – 1236, filed November 15, 2001

1.4 NANOSTRUCTURED OPTO-ELECTRONIC MATERIALS

1.4.1 THESES

PhD theses:
Optical properties of ion beam modified waveguide materials doped with erbium and silver
C. Strohhöfer
Utrecht University, December 2001

Undergraduate theses:
Synthesis and optical properties of rare earth doped colloids
B. Berkhout
University of Amsterdam, March 2001

Patterning and drying 2-D colloidal structures using optical tweezers
K. Overgaag
Technische Hogeschool Rijswijk, June, 2001

Real-space analysis of a colloidal crystal and crystallization in a gravitational field
P. Vergeer
Utrecht University, August, 2001

1.4.2 PUBLICATIONS

L.H. Slooff, A. Polman, F. Cacialli, R.H. Friend, G.A. Hebbink, F.C.J.M. van Veggel and D.N. Reinhoudt: Near-infrared electroluminescence of polymer light-emitting diodes doped with a lissamine-sensitized Nd^{3+} complex. Appl. Phys. Lett. 78 (2001) 2122-2124.

T. van Dillen, A. van Blaaderen, W. Fukarek and A. Polman: Energy-dependent anisotropic deformation of colloidal silica particles under MeV Au irradiation. Appl. Phys. Lett. 78 (2001) 910-912.

M.J.A. de Dood, L.H. Slooff, A. Moroz, A. van Blaaderen and A. Polman: Modified spontaneous emission in erbium-doped SiO_2 spherical colloids. Appl. Phys. Lett. 79 (2001) 3585-3587.

J. van der Elsken, W. Bras and J. Michielsen: Small-angle X-ray scattering by PVP-water mixtures. J. Appl. Cryst. 34 (2001) 62-64.

C. Strohhöfer and A. Polman: Relationship between gain and Yb^{3+} concentration in Er^{3+}-Yb^{3+} doped waveguide amplifiers. J. Appl. Phys. 90 (2001) 4314-4320.

L.H. Slooff, P.G. Kik, A. Tip and A. Polman: Pumping planar waveguide amplifiers using a coupled waveguide system. J. Lightwave Tech. 19 (2001) 1740-1744.

L.H. Slooff, A. Polman, S.I. Klink, L. Grave, F.C.J.M. van Veggel and J.W. Hofstraat: Concentration effects in the photodegradation of lissamine-functionalized neodymium complexes in polymer waveguides. J. Opt. Soc. Am. B 18 (2001) 1690-1694.

P.G. Kik and A. Polman: Exciton-erbium energy transfer in Si nanocrystal-doped SiO_2. Mater. Sci. Eng. B 81 (2001) 3-8.

A. Polman and P. Wiltzius: Materials science aspects of photonic crystals. MRS Bull. 26 (2001) 608-613.

L. Slooff: Plastic lichtversterkers. Ned. Tijdschr. Natuurkd. 67 (2001) 116-119.

T. van Dillen, E. Snoeks, W. Fukarek, C.M. van Kats, K.P. Velikov, A. van Blaaderen and A. Polman: Anisotropic deformation of colloidal particles under MeV ion irradiation. Nucl. Instrum. Methods Phys. Res. B 175-177 (2001) 350-356.

E. Snoeks, A. van Blaaderen, T. van Dillen, C.M. van Kats, K. Velikov, M.L. Brongersma and A. Polman: Colloidal assemblies modified by ion irradiation. Nucl. Instrum. Methods Phys. Res. B 178 (2001) 62-68.

C. Strohhöfer and A. Polman: Enhancement of Er^{3+4} $I_{13/2}$ population in Y_2O_3 by energy transfer to Ce^{3+}. Opt. Mater. 17 (2001) 445-451.

A. Polman: Erbium as a probe of everything? Physica B 300 (2001) 78-90. Contribution to special Centennial issue of Physica B

A. Polman: Miniature erbium doped planar optical amplifiers. In: ECOC'01 - Amsterdam: 27th European Conference on Optical Communication, September 30-October 4, 2001, RAI Congress Centre, Amsterdam, The Netherlands, (2001) p. 632-633.

M.J.A. de Dood, L.H. Slooff, T.M. Hensen, D.L.J. Vossen, A. Moroz, T. Zijlstra, E.W.J.M. van der Drift, A. van Blaaderen and A. Polman: 1, 2 and 3 dimensional photonic materials made using ion beams: Fabrication and optical density-of-states. In: Photonic Crystals and Light Localization in the 21st Century: Proc. of the NATO Advances Study on Photonic Crystals and Light Localization, Crete, Greece June 18-30, 2000, edited by C.M. Soukoulis. (Kluwer, Dordrecht, 2001) (Nato Science Series C: Mathematical and Physical Sciences, 563) p. 555-566.

W.L. Vos and A. Polman, Optical probes inside photonic crystals, MRS Bulletin 26 No. 8, 642(2001)

A. Polman, Erbium-doped planar optical amplifiers, Proceedings 10th European conference on integrated optics (ECIO), Paderborn, Germany, April 4-6, 2001, p. 75

M.J.A. de Dood, L.H. Slooff, A. Moroz, A. van Blaaderen and A. Polman: Local optical density of states in SiO2 spherical microcavities: theory and experiment. Phys. Rev. A. 64, (2001) 33807.

A. Tip, L. Knöll, S. Scheel and D.G. Welsch: Equivalence of the Langevin and auxiliary-field quantization methods for absorbing dielectrics. Phys. Rev. A 63 (2001) 43806 1-7.

A. Moroz, A. Tip and J.M. Combes: Absorption in periodic layered structures. Synth. Met. 116 (2001) 481 - 484.
A. Moroz: Exponentially convergent lattice sums, Opt. Lett. 26 (2001) 1119.

W. Knulst, O.J. Luiten, M.J. van der Wiel and J. Verhoeven: Observation of narrow-band Si L-edge Cerenkov radiation generated by 5 MeV electrons. Appl. Phys. Lett. 79 (2001) 2999-3001.

H.J. Hopman, H. Zeijlemaker and J. Verhoeven: Secondary electron emission data of cesiated oxygen free high conductivity copper, II. Appl. Surf. Sci. 171 (2001) 197-206.

M.J.J. Jak, C. Konstapel, A. van Kreuningen, J. Chrost, J. Verhoeven and J.W.M. Frenken: The influence of substrate defects on the growth rate of palladium nanoparticles on a TiO2(110) surface. Surf. Sci. 474 (2001) 28-36.

M.J.J. Jak, C. Konstapel, A.v. van Kreuningen, J. Verhoeven, R. van Gastel and J.W.M. Frenken: Automated detection of particles, clusters and islands in scanning probe microscopy images. Surf. Sci. 494 (2001) 43-52.

A. van Blaaderen: Met ionen colloiden bombarderen. Chemisch Weekblad 19 (2001) 12-13.

K.P. Velikov and A. van Blaaderen: Synthesis and characterization of monodisperse core-shell colloidal spheres of zinc sulfide and silica. Langmuir 17 (2001) 4779-4786.

M.J.A. de Dood, L.H. Slooff, A. Polman, A. Moroz and A. van Blaaderen: Local optical density of states in SiO_2 spherical microcavities: Theory and experiment. Phys. Rev. A 64 (2001) 33807 1-7.

A. van Blaaderen, K.P. Velikov, J.P. Hoogenboom, D.L.J. Vossen, A. Yethiraj, R. Dullens, T. van Dillen and A. Polman: Manipulating colloidal crystallization for photonic applications: From self-organization to do-it-yourself organization. In: Photonic Crystals and Light Localization in the 21st Century : Proc. of the NATO Advances Study on Photonic Crystals and Light Localization, Crete, Greece June 18-30, 2000, edited by C.M. Soukoulis. (Kluwer, Drodrecht, 2001) (Nato Science Series C: Mathematical and Physical Sciences, 563) p. 239-251.

A. Moroz: Toward complete photonic band gap structures below infrared wavelengths. In: Photonic Crystals and Light Localization in the 21st Century: Proc. of the NATO Advances Study on Photonic Crystals and Light Localization, Crete, Greece June 18-30, 2000, edited by C.M. Soukoulis. (Kluwer, Dordrecht, 2001) (Nato Science Series C: Mathematical and Physical Sciences, 563) p. 373.

1.4.3 LECTURES AND PRESENTATIONS

Invited conference lectures:

A. Polman: Rare-earth doped microphotonic materials, Conference on Solid State Chemistry and Materials, Lunteren, January 22-23, 2001

A. van Blaaderen: Manipulation of colloidal crystallization for photonic applications, Particles 2001, Orlando, FL, USA, February 24-27, 2001

A. van Blaaderen: Manipulation of colloidal crystallization for photonic applications, American Chemical Society National Meeting, San Diego, CA, USA, April 1-5, 2001

A. van Blaaderen: Manipulating colloidal crystallization, Gordon conference on materials processes far from equilibrium, Meriden, NH, USA, July 1-6, 2001

A. Polman: Radiation-induced plastic flow of silica glass, Gordon conference on materials processes far from equilibrium, Meriden, NH, USA, July 1-6, 2001

J.P. Hoogenboom: Colloidal epitaxy: real-space analysis of (non-)equilibrium colloidal crystallization, ICCG-13 International Conference on Crystal Growth 13, Kyoto, Japan, August 4, 2001

A. Polman: Exciting lanthanide implanted photonic materials, 11th International conference on radiation effects in insulators, Lisbon, Portugal, September 3-7, 2001

A. Polman: Optical probes inside photonic crystals, MRS Fall Meeting Boston, MA, November 24-30, 2001

A. Polman: Metallodielectric photonic materials, MRS Fall Meeting, Boston, November 26-30, 2001

Conference contributions:

NWO-CW - Liquids and Interfaces 2001, Lunteren, January 19-20, 2001
C. Graf, A. van Blaaderen: Metallic particles with a dielectric core and/or shell for non-linear photonic applications (poster)

Chemical Society National Meeting, San Diego, CA, USA, April 1-5, 2001
A. van Blaaderen, A. Moroz, K.P. Velikov: Monodisperse core-shell colloidal spheres of zinc sulfide and silica for photonic applications (poster)

10th European conference on integrated optics, Paderborn, Germany, April 4-6, 2001
A. Polman: Miniature erbium doped planar amplifiers (oral)

NeVAC Students Day 2001, Eindhoven, April 6, 2001
K. Overgaag, J.P. Hoogenboom, D.L.J. Vossen, A. van Blaaderen: Patterning 2D colloidal structures using optical tweezers (poster)

Materials Research 2001, Veldhoven, May 8-9, 2001
A. Polman: Colloidal ellipsoids with continuously variable shape (oral)

24th ESTEC Antenna Workshop on Innovative Periodic Antennas: Photonic Bandgap, Fractal and Frequency Selective Structures, Noordwijk, May 30-June 1, 2001
A. Tip: How absorption affects photonic crystals (oral)
J.Q. van der Lem: Band structures of absorptive 2D photonic crystals (oral)

Euresco Workshop on photonic crystals, St. Andrews, United Kingdom, June 11-14, 2001
M.J.A. de Dood: Nanostructured light emitters in 3-D photonic crystals (poster)

20th Electronic materials symposium, Tokyo, Japan, June 20, 2001
H. Isshiki: 1.5 mm room temperature emission from Er-O complexes formed in silicon photonic crystals

Photon physics in optical materials, Amsterdam, June 26, 2001
D.L.J. Vossen, J.P. Hoogenboom, K. Overgaag, A. van Blaaderen: Direct patterning of surfaces with colloidal particles using optical tweezers (poster)
C. Graf, A. van Blaaderen: Metallo-dielectric colloidal particles for photonic applications (oral)
M.J.A. de Dood: Local optical density of states in a spherical microcavity: Theory and experiment (oral)
A. Polman: Förster energy transfer and the local optical density-of-states (poster)

P.G. Kik: Optical gain perspective of silicon nanocrystals (poster)
C. Strohhöfer: Energy transfer in novel rare earth doped photonic materials (poster)
F.C.J.M. van Veggel: Polymer based amplifiers and light-emitting diodes via sensitized near-infrared luminescence of lanthanide complexes (oral)
B. Berkhout: Synthesis and optical properties of rare earth doped colloids (poster)

Gordon conference on materials processes far from equilibrium, Meriden, NH, USA, July 1-6, 2001
T. van Dillen: Ion irradiation-induced plastic deformation of colloidal particles (poster)

MAX-Laboratory at the Lund University, Lund, Sweden, July 17-20, 2001
W. Knulst: Generation and Uses of VUV and Soft X-Ray Coherent Radiation Pulses(oral)

11th International conference on radiation effects in insulators, Lisbon, Portugal, September 3-7, 2001
A. Polman: Ion irradiation-induced plastic deformation of colloidal particles (poster)

FOM/f Symposium, Amsterdam, September 21, 2001
C. Graf, A. van Blaaderen: Metallic particles with a dielectric core and/or shell for non-linear photonic applications (poster)

European Conference on optical communication, Amsterdam, October 1-4, 2001
A. Polman: Miniature erbium doped planar optical amplifiers (oral)

IUVSTA 15th International Vacuum Congres, San Fransisco, CA, USA, October 28–November 2, 2001
E. Louis, I.J. Wever, A.E. Yakshin, F. Bijkerk, J. Verhoeven,
E. Ziegler: Micro-crystallites in Mo/Si multilayer EUV coatings (poster)

MRS Fall meeting, Boston, MA, USA, November 24-30, 2001 K.P. Velikov, G.E. Zegers, W.L. Vos, A. Moroz, A. van Blaaderen: Metallo-dielectric photonic crystals and glasses of silver colloidal particles (oral)
K.P. Velikov, T. van Dillen, A. Polman, A. van Blaaderen: Anisotropic deformation of photonic crystals of spherical inorganic colloidal particles (oral)
K.P. Velikov, Ch. G. Christova, R. Dullens, A. van Blaaderen: Non-equilibrium layer-by-layer growth of binary colloidal crystals (poster)
K.P. Velikov, A. Moroz, A. van Blaaderen: Photonic crystals of core-shell colloidal particles (poster)
D.L.J. Vossen , J.P. Hoogenboom, K. Overgaag, A. van Blaaderen: Direct patterning of surfaces with colloidal particles using optical tweezers (oral)
C. Graf, A. van Blaaderen: Metallo-dielectric colloidal particles for photonic applications
K. Velikov: Anisotropic deformation of photonic crystals of spherical inorganic colloidal particles (oral)
A. Polman: Optical gain perspective of Si nanocrystals (oral)

Réunion GdR "Microcavités et Cristaux Photoniques", Montpellier, France, December 6-7, 2001
B. Gralak, S. Enoch, G. Tayeb: Sélectivite angulaire et taux d'émission d'une source: peut-on les réconcilier? (oral)

QMath8 conference, Taxco, Mexico, December 10-14, 2001
A. Tip: Maxwell with a touch of Schrödinger (oral)

FOM Condensed Matter 2001, Veldhoven, December 18-19, 2001
K.P. Velikov, C.G. Christova, R.P.A. Dullens, T. van Dillen,
A. Polman, A. van Blaaderen: Photonic Crystals by Controlled Drying of Colloidal Dispersions (oral)
J.P. Hoogenboom, A. Yethiraj, A.K. van Langen-Suurling,
H. Romijn, A. van Blaaderen: Epitaxial and homogeneous crystallization of charged colloids in milli-gravity (poster)
D.L.J. Vossen , J.P. Hoogenboom, K. Overgaag,
A. van Blaaderen: Direct patterning of surfaces with colloidal particles using optical tweezers (poster)
J.Q. van der Lem: Bandstructures of absorptive 2D photonic crystals (poster)
M.J.A. de Dood: Modified spontaneous emission in silicon photonic woodpile structures (oral)
C. Strohhöfer: Silver nanocrystals in glass: highly dispersive micropatterns (oral)
J. Kalkman, C. Strohhöfer, B. Gralak, M.J.A. de Dood and
A. Polman: Controlling the spontaneous emission of optical probes on photonic structures (poster)
T. van Dillen, M. Siem, S. Roorda, A. van Blaaderen and
A. Polman: Ion irradiation-induced deformation of optical materials (poster)

Lectures at universities, institutes and industry:
A. Polman: Silicon microphotonics, ST Microelectronics, Catania, Italy, January 30, 2001

A. Polman: Local optical density of states in 1, 2, and 3D photonic materials
University of Exeter, United Kingdom, February 20, 2001

A. van Blaaderen: Manipulating colloidal crystallization:
fundamental condensed matter physics and photonic
applications, NASA Glenn National Research Center for Microgravity Research, Cleveland, OH, USA, February 29, 2001

C. Strohhöfer: Transfer d'énergie dans des matériaux guides d'onde dopés erbium, Laboratoire d'Electromagnétisme, Microondes et Optoélectronique (LEMO), Grenoble, March 6, 2001

A. van Blaaderen: Manipulation of colloidal crystallizaton for photonic applications, Colloquium, University of Eindhoven, May 10, 2001

Other lectures:
A. van Blaaderen: Harde bollen, zachte materie, slimme materialen, Inaugural lecture, Utrecht University, March 16, 2001

1.4.4 COLLABORATIONS

Academic collaborations:
A. Polman:
Technical University Delft (J.W.M. van Uffelen,
E. van der Drift): lithography, waveguide processing
Twente University (F.C.J.M. van Veggel): organic synthesis

Debye Institute (A. van Blaaderen, C. van Kats): colloid
synthesis, SEM
Research Center Rossendorf, Germany (W. Möller): ion irradiation of colloidal particles
California Institute of Technology (H.A. Atwater): nanophotonic materials

A. van Blaaderen:
Debye Institute, Van 't Hoff Lab., Utrecht University (H.N.W. Lekkerkerker): depletion interactions
Debye Institute, Van 't Hoff Lab., Utrecht University
(W.K. Kegel, N. Simeonova): colloidal glasses and crystallization, synthesis of silica-pmma core-shell particles
Debye Institute, Condensed Matter section, Utrecht University (J.I. Dijkhuis, H. C. Gerritsen): gold-silica core-shell structures
DIMES, Delft (A.K. van Langen-Suurling, J. Romijn): templates for colloidal epitaxy
University of Princeton, USA (P.M. Chaikin, W.B. Russel): colloids under microgravity
Brandeis University, Boston, USA (S. Fraden, U. Dassanayake): electro-rheological fluids

A. Tip:
J. M. Combes (Toulon): Mathematical aspects of absorptive photonic crystals, such as a perturbation theory for small absorption
Quantum Optics group, Jena, Germany (L. Knoell and D.G. Welsch)
Imperial College, London, United Kingdom (Stefan Scheel)

J. Verhoeven:
University of Leiden (A.W. Kleyn and J. Frenken): Metal islands on insulating surfaces
Debye Institute, Utrecht (O.L.J. Gijzeman): Metal islands on insulating surfaces
Technical University, Eindhoven (M.J. van der Wiel and J. Luiten): STW project Cherenkov and Transition radiation
FOM Institute Rijnhuizen, Nieuwegein (F. Bijkerk): LZM project multilayers
Dimes, Delft (E. van der Drift): Transmission gratings

Polytechnic University, Kharkov, Ukraine (Y. Pershin): INTAS project Multilayers
Physics Institute, Yerevan, Armenia (Zhyrair Gevorkian): Cherenkov and transition radiation
ESRF Grenoble (Eric Ziegler): Multilayers
Philips Research, Eindhoven (B. Buijsse): LZM multilayers "water window"
Philips Research, Eindhoven (J. Jonkers): STW project Cherenkov and transition radiation
Philips Analytical, Almelo (B. Vrebos): Multilayers

Industrial collaborations:
A. van Blaaderen:
Bell Labs, Lucent Technologies, Murray Hill, USA (P. Wiltzius): colloidal epitaxy
Philips Research, Eindhoven, several contacts and subjects

A. Polman:
ST Microelectronics/CNR-IMETEM, Catania, Italy (S. Coffa): Si waveguides, optical interconnects

J. Verhoeven:
Philips Research, Eindhoven (B. Buijsse): LZM multilayers "water window"
Philips Research, Eindhoven (J. Jonkers): STW project Cherenkov and transition radiation
Philips Analytical, Almelo (B. Vrebos): Multilayers

1.4.5 MISCELLANEOUS

Knowledge transfer:
A. van Blaaderen:
Manipulation of Colloidal Crystallization, guest lectures in the series: Interdisciplinary Lectures - Colloids - Synthesis, Physics & Application, University of Ulm, Ulm, Germany, February 6, 2001

A. Polman:
How to start a career in physics
Scuola Superiore di Catania, Catania, Italy, January 30, 2001

Highlights in physics - Fotonische materialen
University of Amsterdam, April 19, 2001

Wetenschap in de muziek: optische akkoorden en concert voor cello en two percussive instruments, bijdrage aan VPRO radioprogramma, July 10, 2001

Materials science aspects of photonic crystals
Editors: A. Polman and P. Wiltzius, MRS Bulletin 26, No. 8 (2001)

The program programmed – abstract handling, program planning and manuscript handling for a scientific conference
A. Polman, FOM-Institute for Atomic and Molecular Physics, June 2001, ISBN 90-801704-5-3

External users of equipment at AMOLF:
A. Polman:
The RBS facility is part of the FOM program IGM, and was visited by external users from different Dutch institutes.

Patents:
Method and device for imaging the dynamic behaviour of microstructures under the influence of deformation
M. Paques, A. Imhof, A. van Blaaderen, Y. Nicolas, European Patent 01204378.2 – 1236, filed November 15, 2001

Optical devices
C. Strohhöfer, A. Polman, filed November 23, 2001

Silver-sensitized erbium-doped planar waveguide amplifier
C. Strohhöfer, A. Polman, provisional application, filed November 23, 2001

1.5 TRANSITION PROGRAM

1.5.1 THESES

PhD theses:
Bose-Einstein condensation with high atom number in a deep magnetic trap
K. Dieckmann
Universiteit van Amsterdam, March 2, 2001

1.5.2 PUBLICATIONS

G.V. Shlyapnikov: Quantum degeneracy and Bose-Einstein condensation in low-dimensional trapped gases = Dégénérescence quantique et condensation de Bose-Einstein dans des gaz piégés de basse dimensionalité. C.R. Acad. Sci. IV, Phys. 2 (2001) 407-417.

B.J. Verhaar and J.T.M. Walraven: Nobelprijs natuurkunde 2001. Ned. Tijdschr. Natuurkd. 67 (2001) 336-337.

P.O. Fedichev and G.V. Shlyapnikov: Critical velocity in cylindrical Bose-Einstein condensates. Phys. Rev. A 63 (2001) 45601 1-3.

D.S. Petrov and G.V. Shlyapnikov: Interatomic collisions in a tightly confined Bose gas. Phys. Rev. A 64 (2001) 12706 1-14.

D.S. Petrov, G.V. Shlyapnikov and J.T.M. Walraven: Phase-fluctuating 3D Bose-Einstein condensates in elongated traps. Phys. Rev. Lett. 87 (2001) 50404 1-4.

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1.5.3 LECTURES AND PRESENTATIONS

Invited conference lectures:
G.V. Shlyapnikov: Trapped Bose-condensed gases; dynamics, vortices, and low dimensions, International workshop "Theory of quantum gases and quantum decoherence", Salerno, Italy, June 3-5, 2001

D.S. Petrov: Interparticle interaction in quasi-2D gases and prospects for the BCS transition, International workshop "Theory of quantum gases and quantum decoherence", Salerno, Italy, June 3-5, 2001

G.V. Shlyapnikov: Interatomic collisions in tightly confined gases, International conference on laser spectroscopy, Snowbird, UT, USA, June 10-15, 2001

G.V. Shlyapnikov: Phase-fluctuating Bose-Einstein condensates, Aspen meeting "Fundamental issues in quantum gases", Aspen, USA, June 16-July 8, 2001

D.S. Petrov: Quantum degenerate regimes in low-dimensional trapped gases, International conference on Laser physics, Moscow, Russia, July 3-7, 2001

G.V. Shlyapnikov: Dynamics of vortices and solitons in trapped condensates, Workshop on quantum gases, Konstanz, Germany, July 18-21, 2001

G.V. Shlyapnikov: Quantum degeneracy in low-dimensional gases, International conference "Quantum fluids and solids", Konstanz, Germany, July 23-27, 2001

G.V. Shlyapnikov: Dissipative dynamics of dark solitons in trapped Bose-Einstein condensates, International symposium "Quantum Challenges", Essen, Germany, September 6-8, 2001

G.V. Shlyapnikov, Regimes of quantum degeneracy in low-dimensional trapped Bose gases, European Research Conference on ultracold gases BEC-2001, Sant-Feliu, Spain, September 16-20, 2001

G.V. Shlyapnikov: Quasicondensates in ultracold trapped Bose gases, International symposium "Beyond BEC", Boston, USA, November 2-3, 2001

Conference contributions:
International workshop "Theory of quantum gases and quantum decoherence", Salerno, Italy, June 3-5, 2001
L. Vichi: Hydrodynamic damping of excitations in Bose-condensed gases (poster)

International conference on Laser Spectroscopy, Snowbird, UT, USA, June 10-15, 2001
D.S. Petrov: Superfluid transition in quasi-2D Fermi gases (poster)

International conference "Quantum Optics V", Zakopane, Poland, June 20-27, 2001
L. Vichi: Damping of excitations in Bose-condensed gases with hydrodynamic thermal clouds (poster)
D.S. Petrov: BCS transition in 2D Fermi gases, (poster)

International conference "Quantum fluids and solids", Konstanz, Germany, July 23-27, 2001
L. Vichi: Damping of phonons in Bose-condensed gases (poster)

European Research Conference on ultracold gases BEC-2001, Sant-Feliu, Spain, September 16-20, 2001
D.S. Petrov: Towards BCS transition in quasi-2D Fermi gases (poster)

Lunteren meeting, November 8-9, 2001
D.S. Petrov: Phase-fluctuating 3D condensates in elongated traps (oral)

Lectures at universities, institutes and industry:
G.V. Shlyapnikov: BEC in low-dimensional gases, University of Glasgow, United Kingdom, January 20, 2001

D.S. Petrov: Tunable interactions in quasi-2D gases, Max Planck Institute for Nuclear Physics, Heidelberg, Germany, February 7, 2001

G.V. Shlyapnikov: Lecture course on Bose-Einstein condensation, University of Konstanz, Germany, July 30-August 11, 2001

G.V. Shlyapnikov: Phase fluctuations in trapped Bose-Einstein condensed gases, FOM Meeting on Cold Atoms, Utrecht, November 23, 2001

J.T.M. Walraven: Oort clouds, cold clouds, FOM Meeting Cold Atoms, Utrecht, November 23, 2001

J.T.M. Walraven: Properties of Bose-Einstein condensates, Netherlands Institute for Nuclear and High-Energy Physics (NIKHEF), Amsterdam, November 30, 2001

Other lectures:
J.T.M. Walraven: Bose-Einstein Condensatie, Natuurkundig Genootschap Wessel Knoops, Arnhem, October 9, 2001

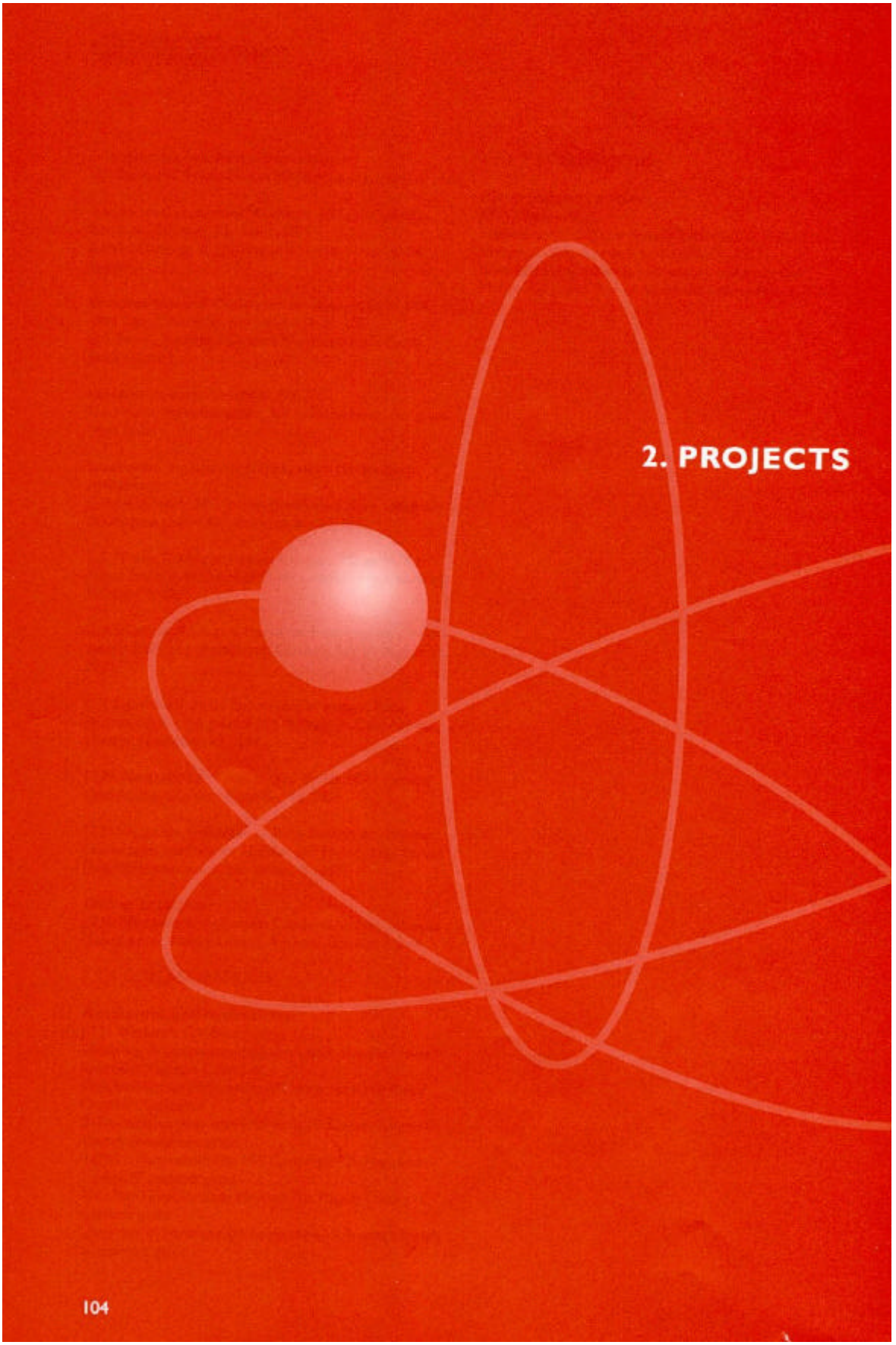
1.5.4 COLLABORATIONS

Academic collaborations:
J.T.M. Walraven/G.V. Shlyapnikov:
University of Amsterdam (H.B. van Linden van den Heuvell): Biweekly Quantum Collective
Vrije Universiteit Amsterdam (W. Hogervorst): Biweekly Quantum Collective
INTAS collaboration with ENS Paris (C. Cohen-Tannoudji): Theory of quantum gases
INTAS collaboration with MPI Garching (T.W. Haensch): Theory of quantum gases
RRC Kurchatov Institute Moscow (Yu. Kagan): Theory of quantum gases
University of Hannover (M. Lewenstein, W. Ertmer): Theory of quantum gases

1.5.5 MISCELLANEOUS

Knowledge transfer:
J.T.M. Walraven:
Lecture series on Experimental Techniques in Physics, University of Amsterdam, January-March, 2001

Bose-Einstein Condensatie, University of Amsterdam Master Course in Physics, Amsterdam, November 2, 2001



2. PROJECTS

In the year 2001 the FOM-Institute for Atomic and molecular physics received a budget of 6.2 Me from the Foundation FOM for the execution of 5 research programs. This budget is used to cover the salary costs of the permanent staff (physicists, technical and other support) and the running costs of the institute. An additional budget of 2.7 Me was acquired by grants for research proposals and 3.8 Me for investments. These special projects allow for investments in new equipment and to hire PhD-students and post-docs on a temporary basis. All running projects are listed below together with the organization that provided the financial support for 2001.

QUANTUM DYNAMICS OF ATOMIC AND MOLECULAR SYSTEMS

Molecular vibrations studied and controlled with fs IR pulses	FOM grant
Spatio-temporal correlation of the zero-point EM field	FOM grant
A buckyball-based femtosecond x-ray laser	FOM grant
Light-induced atomic states	FOM grant
Few-cycle ionization: a matter of field or frequency	FOM grant
Recombination in ultra-cold plasmas: a route to trapped anti-hydrogen	FOM grant
Towards attosecond laser pulses	FOM grant
Zero-point E-M field fluctuations in dielectric media	FOM subdivision grant
Quantum nature of proton transfer in liquid water	FOM subdivision grant
Quantification of oxygen green and red air-glows	FOM subdivision grant
Photo-dissociation of molecular oxygen	FOM subdivision grant
Laser-generated XUV radiation in clusters and droplets	FOM program TFF
X-ray generation through laser irradiation	European scientific program
Time and energy resolved photodissociation dynamics	European scientific program
Coherence and control in atomic systems processing	European scientific program
Direct visualization of chemical dynamics	European scientific program
Electron transfer reactions	European scientific program
Emission and dissociation of molecular nitrogen	SRON
An accu operational water column for GOME	NWO/ALW
Aerosol light scattering	NWO/UvA
Acid base reactions via controlled solvent motion	NWO/CW
Proton transfer in liquids	NWO grant
Ultrafast camera	STW
Laser system for 2-D vibrational spectroscopy	FOM investment
Femtosecond oscillator	FOM investment

MASS SPECTROMETRY OF MACROMOLECULAR SYSTEMS

Energy conversion in macromolecules	FOM grant
Electron capture in multiply charged proteins	FOM subdivision grant
Molart, molecular origin of art-conservation	NWO project
MIMIC European scientific program Student grant	NUFFIC
Polymer analysis	DSM/AKZO
Virtual laboratory	UvA/ICES-KIS
RF ionguide system	FOM investment
Imaging mass spectrometer	NWO investment

STRUCTURE, FUNCTION AND FLOW OF SOFT MATERIALS

Colloidal epitaxy: a novel way to manipulate crystallization	FOM grant
Colloidal crystals with a 3D photonic bandgap: experiment	FOM grant
Direct measurement of colloidal potential of mean force	FOM grant

Biopolymers at work: force production by assembling microtubules	FOM grant
Self-organization of microtubule asters in confined geometries	FOM grant
DNA as a microphase	FOM grant
Pulling on proteins during translocation	FOM grant
Crystallization of polymers on substrates and in thin films	FOM priority grant
Novel simulation techniques to predict crystallization rates	FOM priority grant
Order/disorder at interfaces of soft condensed matter	FOM subdivision grant
Simulation of complex phenomena in simple systems	FOM subdivision grant
Computer simulation of suspensions and porous media	FOM subdivision grant
Simulating self-assembled cubatics	FOM subdivision grant
Modeling assisted folding of bio-macromolecules	SOFTLINK program
Structuring soft matter, the spatial and temporal evolution	SOFTLINK program
Numerical study of crystallization of bio-molecules	European scientific program
Nucleus: nucleation of the solid	European scientific program
Ordered polymeric nanostructures	European scientific program
SPINOZA research grant	NWO grant
Thin molecular films, co-operation with Russian federation	NWO grant
Globular proteins	NWO grant
Plant microtubule dynamics	NWO/ALW grant
Cytoskeletal structures	NWO/ALW grant
Simulation of co-polymers	DSM
Optical manipulation system, part II	FOM investment

NANOSTRUCTURED OPTO-ELECTRICAL MATERIALS

Colloidal crystals with a 3D photonic bandgap: theory	FOM grant
Colloidal crystals with a 3D photonic bandgap: experiment	FOM grant
Colloidal ellipsoids with variable shape	FOM grant
Silicon based microphotonics	FOM subdivision grant
Silicon compatible opto-electronics	European scientific program
Facility for Rutherford backscattering analysis	FOM facility grant
Multilayers systems as optical coatings	STW grant
Cherenkov radiation	STW grant

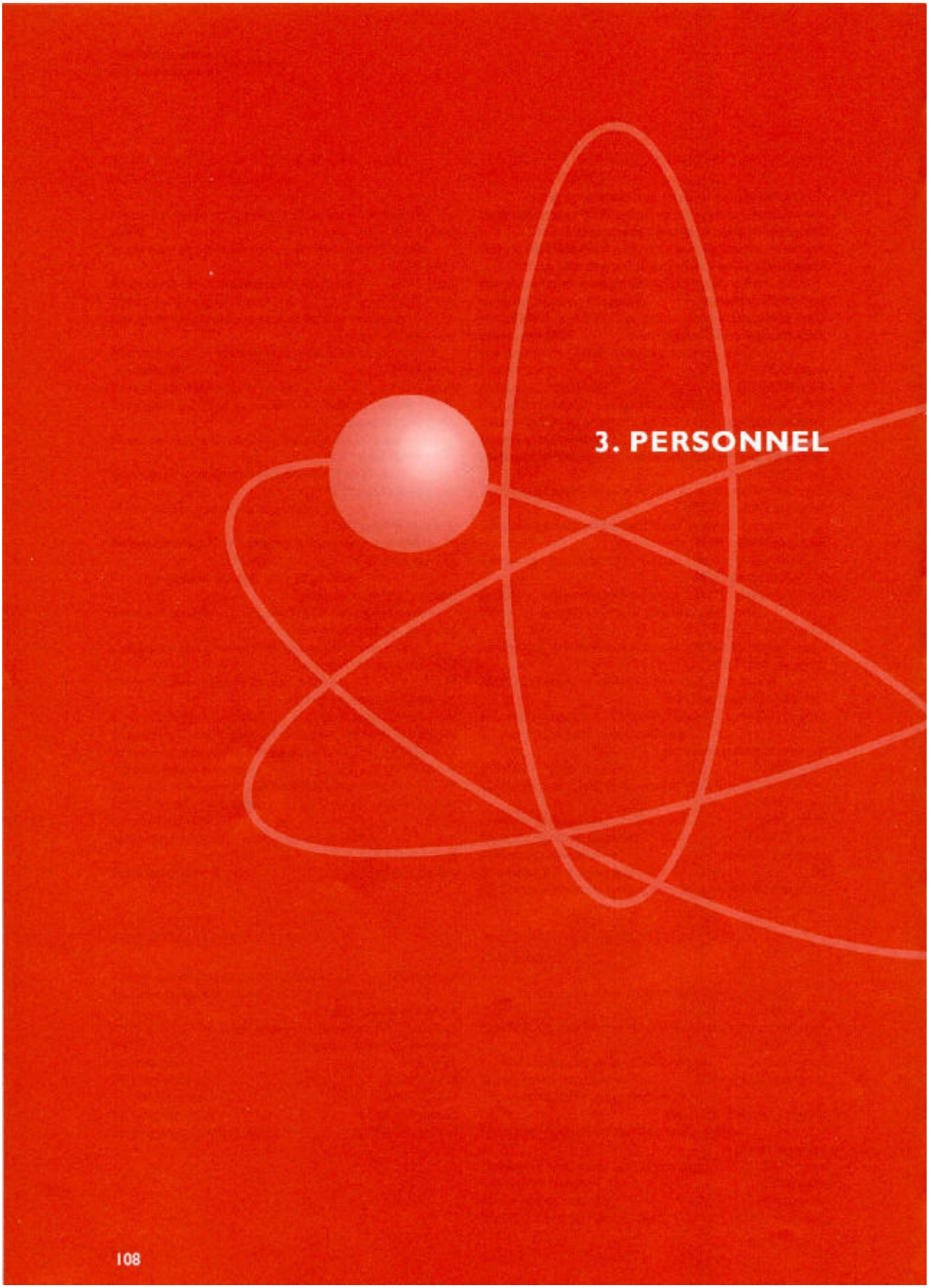
Planar optical amplifier Symmorphix Scanning electron microscope FOM investment

TRANSITION PROGRAMS

Condensed matter behavior in dilute atomic gases	FOM subdivision grant
The onset of phase coherence phenomena in BEC	FOM subdivision grant
Kinetics and phase coherence in trapped cold gases	European scientific program
Surface photochemistry	European scientific program
Ultra cold gases	NWO grant
Instrumentation BEC experiment	FOM investment

TECHNOLOGY

E-beam welding HVEE Company Thin layer services European Space Agency
Computer and network facilities FOM investment



3. PERSONNEL

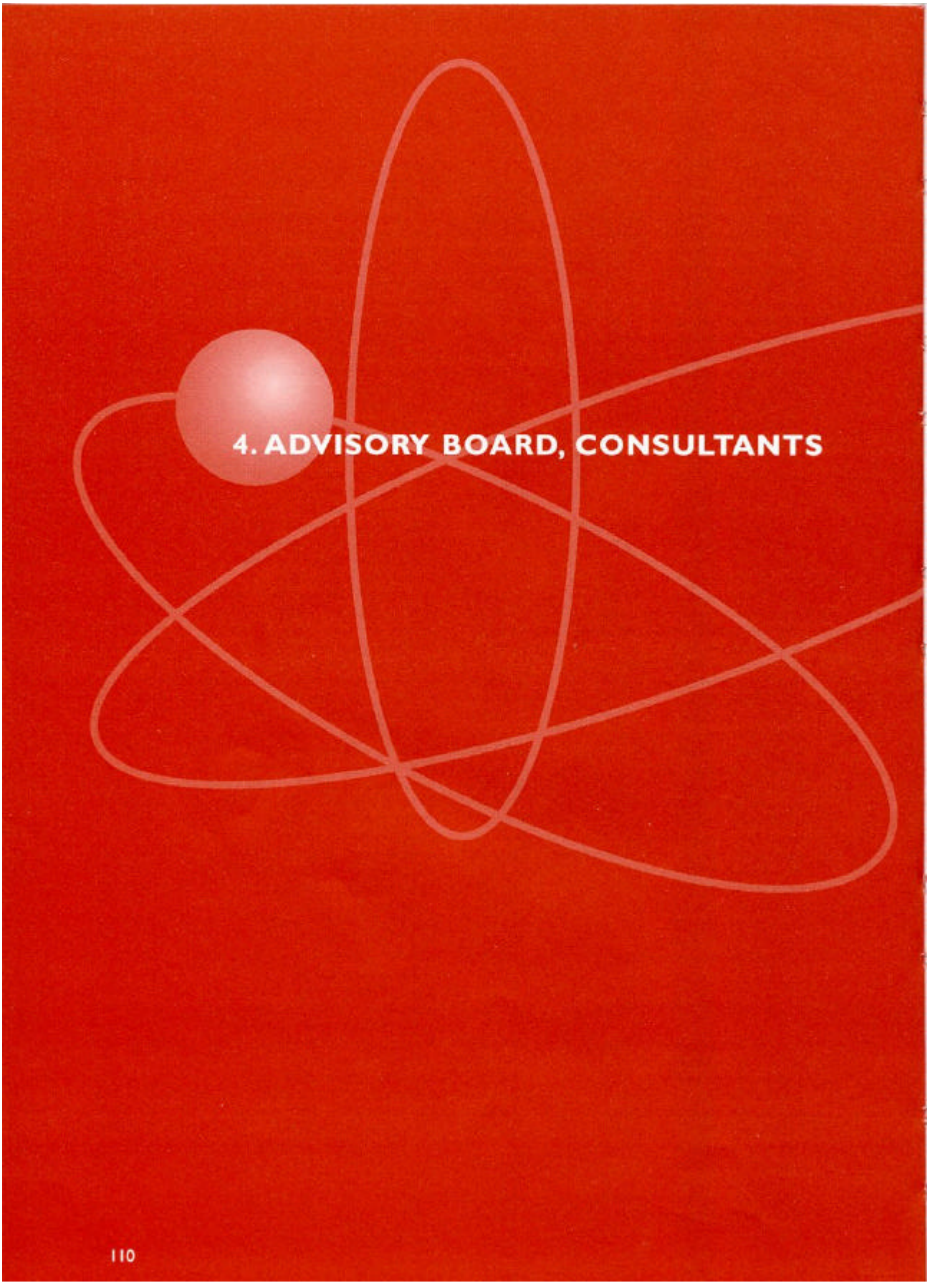
NEW COLLEAGUES IN 2001

Ivan Coluzza (PhD student) 01-01-2001
Margriet Eikema Hommes (guest) 01-01-2001
Anne Kleinnijenhuis (PhD student) 17-01-2001
Joan Penninkhof (trainee WO) 22-01-2001
Hester Volten (postdoc) 01-02-2001
Christian Buggle (PhD student) 16-02-2001
Jeroen Kalkman (PhD student) 19-02-2001
Marlies Woltjer (secretary) 1-02-2001
Stefan Luxembourg (PhD student) 01-03-2001
Dirk-Jan Spaanderman (designer) 01-03-2001
Jason Williams (postdoc) 01-03-2001
Wenbing Hu (postdoc) 01-04-2001
Beatrice Marino (PhD student) 01-04-2001
Mathilde de Dood (trainee WO) 10-04-2001
Serguei Asseev (postdoc) 1-05-2001
Annemie Emons (consultant) 01-05-2001
Jacob Kerssemakers (postdoc) 01-05-2001
Ben Veihelmann (PhD student) 01-05-2001
Max Siem (trainee WO) 16-05-2001
Rutger Schoone (computer technician) 21-05-2001
Anne Willem Omta (trainee WO) 01-06-2001
Martijn van Duijn (postdoc) 18-06-2001
Mark Miller (postdoc) 25-06-2001
Sander Woutersen (project leader) 01-07-2001
Sjoerd Roorda (guest from Canada) 01-08-2001
Jan-Willem Schmidt (mechanical technician) 13-08-2001
Nicolas Combe (postdoc) 01-09-2001
Frank Hoogland (trainee HBO) 01-09-2001
Mark Kemmann (PhD student) 01-09-2001
Tanja Schilling (postdoc) 01-09-2001
Tobias Tiecke (trainee WO) 01-09-2001
Pieter Rein ten Wolde (postdoc) 01-09-2001
Arnold Bussink (trainee WO) 10-09-2001
Erik de Bres (trainee WO) 01-10-2001
Boris Gralak (postdoc) 01-10-2001
Ruud van Leeuwen (PhD student) 01-10-2001
Eva Riemslag (trainee WO) 01-10-2001
Sander Tans (project leader) 01-10-2001
Annelies van Loon (jr. technical researcher) 16-11-2001
Frank Poelwijk (PhD student) 16-11-2001
Job Thijssen (trainee WO) 19-11-2001
Krista de Geus (secretary) 22-11-2001
Grace Joseph (librarian) 01-12-2001
Yongfeng Ni (PhD student) 08-12-2001
Robby Lieuw (technical services) 10-12-2001

COLLEAGUES WHO LEFT IN 2001

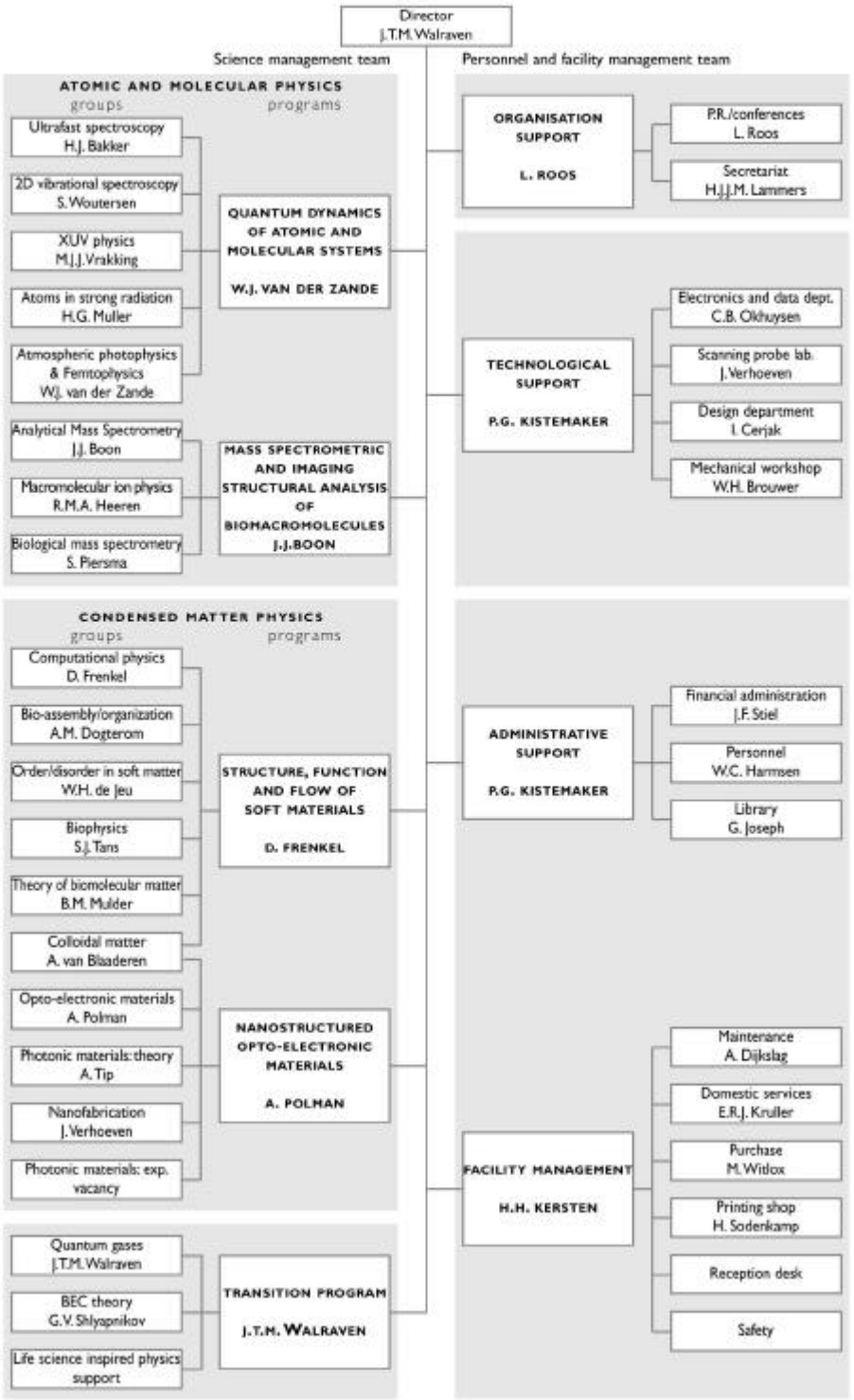
Christian Bordas (guest from France) 28-01-2001
Jeroen Vink (trainee HBO) 29-01-2001
Jörgen Smit (trainee MBO) 01-02-2001
Jorrit van den Berg (researcher) 15-02-2001
Matt Kalinski (guest from Poland) 16-02-2001
Frank Lepine (guest from France) 16-02-2001
Dick Glastra van Loon (head design department) 01-03-2001
Martin Jak (researcher) 01-03-2001
Sanny Kraan (mechanical technician) 01-03-2001
Basjan Berkhout (trainee WO) 16-03-2001
Jürgen Chrost (researcher/post doc) 01-04-2001
Kai Dieckmann (PhD student) 01-04-2001
Jurgen Horbach (guest from Germany) 01-04-2001
Stijn Oonk (jr. technical researcher) 01-04-2001
Henk Timmer (technical services) 01-04-2001
Misha Baranov (guest from Russia) 21-04-2001
Fatma Öner (trainee MBO) 21-04-2001
Dennis Driessen (computer engineer) 01-05-2001
Hideo Isshiki (guest from Japan) 01-05-2001
Valentin Rychkov (guest from Russia) 01-05-2001
Tina Weeding (researcher) 01-05-2001
Marc Smits (guest) 10-05-2001
Pieter de Koning (trainee HBO) 01-06-2001
Karin Overgaag (trainee HBO) 01-06-2001
Andrey Muryshev (guest from Russia) 19-06-2001
Jan ter Beek (technician) 01-07-2001
Richard Cornelisse (trainee MBO) 01-07-2001
Heilke Keymeulen (trainee WO) 01-07-2001
Olga Muñoz (guest from Spain) 01-07-2001
Celine Nicole (postdoc) 01-07-2001
Ricarda Opitz (postdoc) 01-07-2001
Boris Ostrovski (guest from Russia) 01-07-2001
Bernd Riedmüller (PhD student) 01-07-2001
Bogdan Serbanoiu (guest from Romania) 01-07-2001
Tobias Tiecke (trainee WO) 01-07-2001
Graziëlla van Velzen (electronical technician) 01-07-2001
Louis Spruit (trainee MBO) 07-07-2001
Maarten van Wieren (trainee WO) 15-07-2001
Arjan Houtepen (trainee WO) 16-07-2001
Eva Riemslag (trainee WO) 21-07-2001
Manja Ackema - Welbergen (catering services) 01-08-2001
Arnold Bussink (trainee WO) 01-08-2001
Donna Mehos (editor/secretary) 01-08-2001
Herman Offerhaus (postdoc) 01-08-2001
Marcel Warntjes (researcher) 01-08-2001
Dorit Nötzel (guest from Germany) 03-08-2001
Ingmar Swart (guest) 11-08-2001
Erik de Bres (trainee WO) 18-08-2001
Oscar van den Brink (researcher) 01-09-2001
Cendrine Faivre (postdoc) 01-09-2001

Jurgen Horbach (guest from Germany)	01-09-2001
Vinod Kumarappan (guest from India)	01-09-2001
Andrei Moskalenko (postdoc)	01-09-2001
Elin Sputnesset (librarian)	01-09-2001
Kees Wesdorp (PhD student)	01-09-2001
Ionel Ciobicã (PhD student)	01-10-2001
Petra Novotná (guest from Tzech Republic)	01-10-2001
Nick Wyplosz (researcher)	01-10-2001
Alexei Val'kov (guest from Russia)	07-10-2001
Dominique Scalarone (guest from Italy)	20-10-2001
Andrey Muryshev (guest from Russia)	27-10-2001
Norbert Kern (postdoc)	01-11-2001
Lorenzo Vichi (postdoc)	01-11-2001
Chris Rétif (trainee HBO)	15-12-2001
Sander Koster (PhD student)	31-12-2001
Christof Strohhöfer (PhD student)	31-12-2001
Job Thijssen (trainee WO)	31-12-2001
Alan Wouterse (trainee HBO)	31-12-2001



4. ADVISORY BOARD, CONSULTANTS

ORGANIZATION SCHEME AMOLF 01-01-200



Colophon

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