The Magazine from Carl Zeiss

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Innovation

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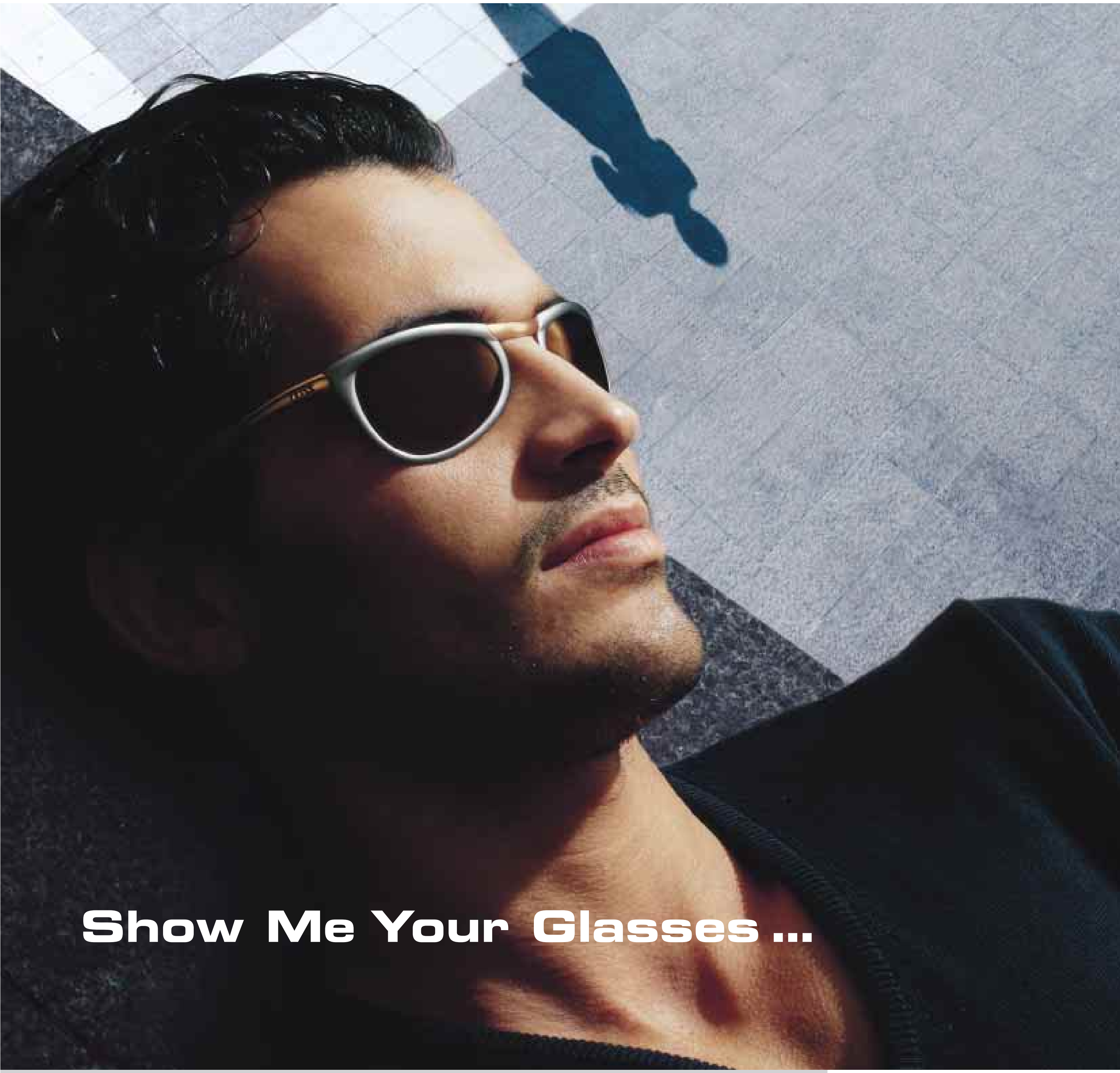

Show Me Your Glasses ...

- Gazing into the Cold Depths of the Universe
- Sun and Truth – As Goethe Didn't Say
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ZEISS

Creating Knowledge, Shaping the Future

Hubert Markl

Sculpture of Minerva made of dark green granite in front of the main entrance of the new headquarters of the Max Planck Society in Munich, created by the Peruvian artist *Fernando de la Jara.*
Photos: Max Planck Society.

Prof. Dr. Hubert Markl is President of the Max Planck Society for the Promotion of Science.

With almost 80 research institutes in the German and European research system, the Max Planck Society, which celebrated its 50th birthday in 1998, enjoys a high degree of recognition and renown. In the performance of its many activities, cooperation with other research institutes and industrial enterprises involved in scientific research is an absolute must. Only if all scientific institutions work hand in hand to achieve progress will it also be possible to be successful on the economic front.

If in its ongoing pursuit of knowledge the world of basic research sometimes appears to be overly defensive of its independence, it is not because it refuses to play its part in helping to achieve the research and development goals of industry, or because it labors under the delusion that the financial resources it receives bear no relation to industry. Researchers want to be useful and are indeed useful by creating the new knowledge that helps mankind to push the frontiers of science forward. They do not accomplish this goal by giving the search for practical applications priority over the quest for knowledge, but by making new discoveries as a result of creative research performed within a framework of freedom and independence. The risk of failure is, of course, always an integral part of this process.

Sowing the Seeds of Future Applications

This does not mean, however, that scientists working in basic research live in a vacuum. In the past few years, industry has had to make considerable savings, also leading to cutbacks in its research activities. Today, however, by developing new techniques and searching for new materials, engineers are advancing into realms which used to be exclusive territory of science. At the same time, many research scientists have long since lost their fear of contact with industry and now see cooperation with the development engineers in industry as an enticing challenge. Year after year, the Max Planck Society concludes 40 to 70 contracts with industrial partners, dealing with projects from which they expect interesting innovation potential. The Max Planck Society wishes to promote the type of basic research that will one day help industry in its own R & D activities.

Another field is the promotion of tomorrow's capabilities by today's research. There are any number of areas in the Max Planck Society where this can be amply demonstrated. A considerable part of our work is focused on materials research. Of the three forms of reality posing a challenge to science – matter, energy and mind – it is matter with which we are most familiar, hence explaining why it would appear to be the best understood and scientifically most thoroughly researched of the three.

Not only the Max Planck Society is convinced that materials research, as the only truly interdisciplinary science and technology, is the most important and technically relevant branch of research in today's natural sciences – apart, of course, from information and communication technology as well as molecular and cell biotechnology. This is not surprising when one considers that other fields that would perhaps immediately spring to mind in this context, e.g. microelectronics, nanotechnology, and hydrogen, solar and fusion energy technology – are all firmly anchored in modern materials research and materials technology, and are dependent to a major extent on the advances being made in materials research if they are to achieve the success they hope for.

The past few decades have also seen dramatic developments in biology and its sister sciences medicine and agricultural biology. Of particular importance in recent times is the extent to which all disciplines in the natural sciences and the field of applied mathematics are rapidly growing together and intensifying their ties to become a single, all-embracing natural science. As we have now discovered the chemical and physical properties of this living matter and learnt how their functional principles can be represented in the form of a mathematical model, it will take only a few more years for us to decode the entire genome of mankind and many dozens of microorganisms, plants and animals – right down to the basic molecular components. This by no means affects only cell-biological processes. It also equally involves the interactions in the behavior between herbivorous animals and the plants they eat, or the flow of substances within entire ecosystems. It is no coincidence that two of the newest Max Planck Institutes in Jena – both in the direct vicinity of the Carl Zeiss plant – are called the "Max Planck Institute of Chemical Ecology" and the "Max Planck Institute of Biogeochemistry".

The fact that knowledge yields power and that power generates even more knowledge was something that Francis Bacon correctly recognized, even if he himself was unable to put this awareness to good use. However, the most important source of power today is not so much influence and financial strength, but the ability to fully unfold one's own intellectual resources.

Contents

Cover photo:
In close cooperation with designers of international renown, not only new eyeglass frames, but also a new collection of sunglasses are being created under the brand "Zeiss. High End Eyewear." The new eyewear combines the values that are the essence of the Zeiss brand – precision, first-class quality and tradition – with emotionality. The result is a distinctive and unmistakable product "language". While *Hannes Wettstein* of the agency 9D Design in Zurich, Switzerland is responsible for the design of the eyeglass frames, the sunglasses were created by the renowned design office "Continuum" in Milan, Italy (see article "Show Me Your Glasses and I'll Tell You Who You Are", pages 24 – 27).

Outside back cover:
The cooperation between Zeiss and SONY is still relatively young, but it is extremely successful. In the past two years, Carl Zeiss has supplied as many as one million lenses for SONY cameras. The latest product is the new Cyber-Shot Zoom DSC F505. It offers a large number of technical highlights and top-class optics: the 7.1 – 35.5 mm **Vario-Sonnar®** f/2.8 lens with a zoom ratio of 1 : 5 considerably determines the dimensions of the camera (see Product Report on page 44).
Photos: SONY.

Publisher's Imprint

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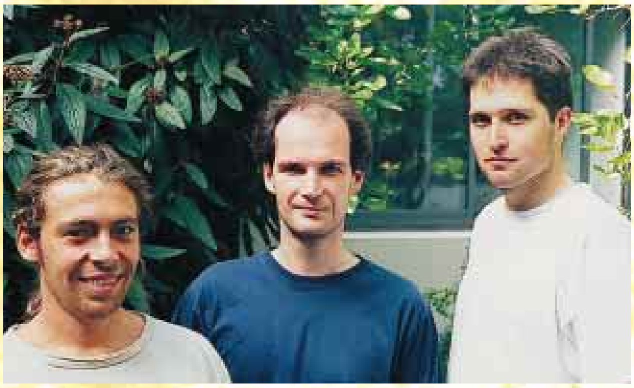
Searching for the Cause of Spinal Muscular Atrophy

Utz Fischer, Stefan Hannus, Oliver Plöttner



Stefan Hannus and Oliver Plöttner (far left and right) are members of the Junior Research Group dealing with spinal muscular atrophy at the Max Planck Institute for Biochemistry, Am Klopferspitz 18a in D-82152 Martinsried, Germany, headed by Dr. Utz Fischer (center).

Never being able to walk or move without assistance: unimaginable for many people, but a bitter reality for patients suffering from spinal muscular atrophy (SMA), a genetically caused disease. In Germany, approx. 100 to 200 people fall ill with SMA every year. In patients with this neuromuscular disease, certain nerve cells in the spinal cord – so-called motoneurons – die, often in the early years of life. Motoneurons are absolutely essential for muscle stimulus. Their loss, as seen in SMA patients, therefore results in a drastic restriction of mobility.

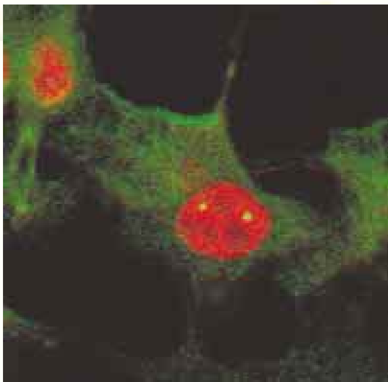


Fig. 1:
Staining of SMN in a connective tissue cell. In this technique, the SMN protein appears in green fluorescence and is localized both in discrete domains in the nucleus (so-called gems) and in the cytoplasm. A typical nucleus protein is stained red. The micrograph was taken with a **LSM 410** confocal laser scanning microscope from Carl Zeiss with a **Plan-Neofluar®**, 100x/1.3 objective.

Depending on the onset and the clinical progression of the disease, SMA is classified into three different types. In the most severe form (Type I, also called *Werdnig-Hoffmann* Disease), a general muscle weakness already occurs in the first three months of life. Children diagnosed with this type will never be able to sit or stand, and, as the muscular power required for the movement of the thorax and diaphragm is no longer adequate for respiration, most will die in the first two years of life. The progression of Type II SMA is less severe, but only patients with the mildest form (Type III, also called *Kugelberg-Welander* Disease) normally survive into adulthood.

Identification of the SMA gene

SMA is an incurable disease. However, surprising insights into the molecular causes of the disease have been possible during the past few years, giving us reason to hope that new therapies can be developed in the future.

Since SMA is a genetic disease, the first step in the molecular analysis of the disease was to find which component of the gene sequence is mutated in SMA patients. In 1995, two likely SMA genes called *Survival of Motor Neurons* (SMN) and *Neuronal Apoptosis Inhibitory Protein* (NAIP) were successfully identified. Both genes are available as duplicates in close proximity to each other on chromosome 5 and display systematic mutations (point mutations and deletions) in SMA patients. Today, it is considered a fact that SMN is the SMA gene; however, it is still unclear whether NAIP also plays a role in the progression of the SMA disease. A systematic genetic examination has shown that one of the two copies of the SMN gene has been lost either partially or completely in more than 90% of all SMA patients. In the remaining cases, mutations in the SMN gene were established which either completely prevent the formation of the SMN protein (expression) or only permit expression of a mutated SMN protein. Interestingly enough, although the SMN protein is formed in SMA patients because of the existence of the second copy of the SMN gene, its quantity is strongly reduced in the body (and particularly in motoneurons). The SMA disease is therefore presumably caused by a

Fig. 2:
Xenopus laevis frog. These organisms allow large quantities of unfertilized oocytes to be obtained. Oocytes are ideal testing systems for many cell-biological and medical examinations.

reduction in SMN expression and not by the complete loss of it ("dosage effect").

SMN: helper protein for the assembly of cellular complexes

The identification of SMN has permitted an analysis of the molecular causes of spinal muscular atrophy. Initial experiments have shown that SMN is formed in every cell of the body and is therefore likely to have a general cellular function. In somatic cells (all body cells except sex cells), SMN displays a spectacular distribution pattern. One part of the protein is distributed homogeneously in the cytoplasm, but another part is concentrated in the cell nucleus, in new domains of unknown function (called gemini of coiled bodies, or "gems") (Fig. 1).

To obtain information about the function of SMN in the body, the oocyte system of the African clawed frog, *Xenopus laevis*, has been used (Fig. 2). With a diameter of approx. 1 to 1.5 mm, the unfertilized ova (oocytes) are unusually large and ideal for micromanipulation experiments (Fig. 3). They are therefore used for various biochemical and cell-biological examinations. SMA researchers were surprised to find that the SMN protein is available in the oocyte in association with a group of macromolecular complexes. These complexes, termed "U snRNPs" (U-rich small nuclear ribonucleoprotein particles), consist of several proteins and a small amount of ribonucleic acid (RNA), and contribute to a considerable extent to a defined step in the development of genetic information (so-called "pre-mRNA splicing") of each cell. To perform this function, the U snRNPs must be assembled first in an orderly process from the individual modules, i.e. the RNA and the proteins. According to recent findings, SMN obviously "helps" some proteins to bind to the RNA and thus to form functional U snRNP particles. Although final experimental proof still remains to be obtained, it is assumed that the SMN deficiency in SMA patients results in defective binding of U snRNPs and that this is at least one of the causes of the disease. However, it remains entirely in the dark for the time being why the mutations in the SMN gene exclusively result in the death of motoneurons of the spinal cord although SMN is evidently required and produced in every cell of the body.

The analysis of the function of the SMN protein is not only of interest for SMA research, but is also relevant to areas more oriented toward basic research. For example, it has always been assumed until now that RNA protein particles such as U snRNPs can form on their own, i. e. without any "outside" assistance from other cellular factors. Quite unexpectedly, SMA research has provided insights into processes in the cell which have remained unexamined so far.

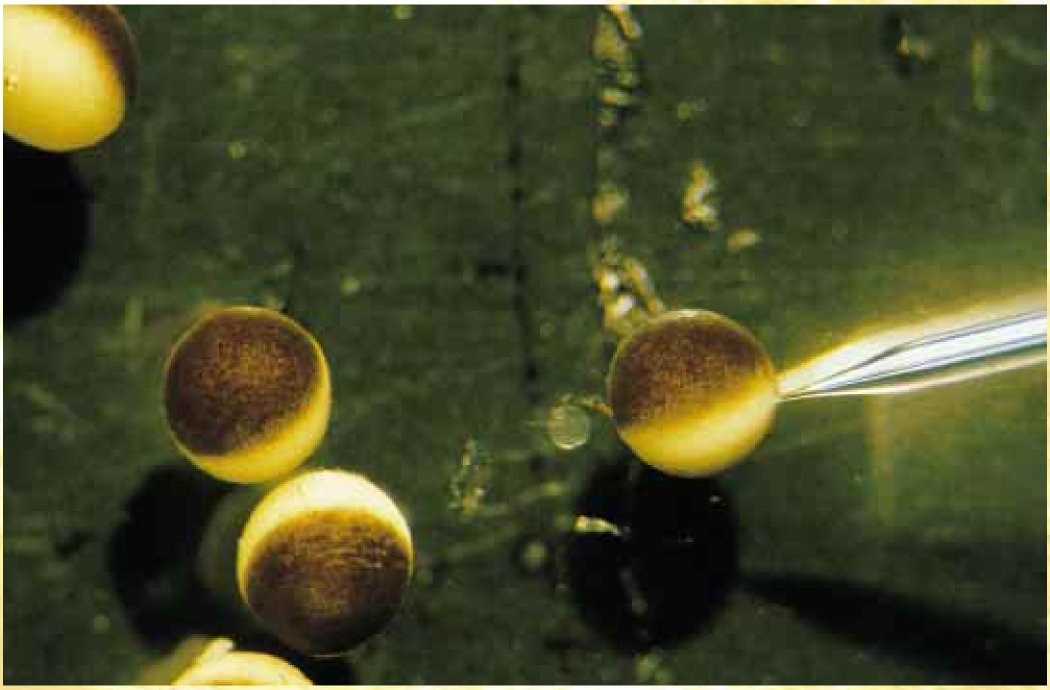


Fig. 3:
Micromanipulation of oocytes of the *Xenopus laevis* frog.

Fig. 4:
Researchers during the micromanipulation of *Xenopus laevis* oocytes, using the **Stemi® SV 6** stereomicroscope from Carl Zeiss.

Independent Junior Research Groups

For 30 years now, the Max Planck Society has been promoting particularly talented young scientists – in addition to the standard promotional measures within the departments of the Institutes – within the framework of fixed-term programs for Independent Research Groups. More than one hundred young scientists chosen through international competition have thus been given the possibility of laying the foundations for a successful professional career as a scientist in their first experience of independent research – and all with a limited, but secure budget. These Junior Groups benefit from the infrastructure and administration of the Max Planck Institutes in which they are integrated, but – in spite of their incorporation in the institute structures and close association with the subject matter dealt with in these institutes – they are in fact independent research organizations.

The manager of a Junior Research Group has the same autonomy for his scientific activities as the scientific staff and directors of the Institute. Normally, one scientist and one or two technical staff members, funds for students taking their doctorate and persons receiving a scholarship, and work material and instruments suitable for the research subject, are at his/her disposal. The Junior Research Groups receive funds for a fixed period of five years.

These groups have been so successful that the Max Planck Society is also considerably promoting similar groups abroad. The first example is two of these groups at the Institute for Cell Biology of the Chinese Academy of Science in Shanghai. Considerations have also been made to form bilateral groups together with scientific organizations from outside Germany, e.g. the CNRS in France or the Weizmann Institute in Israel.

Approaches for the treatment of SMA

Although research into spinal muscular atrophy is only in its initial phase, the findings obtained so far about its molecular causes are quite encouraging. Many laboratories all over the world are now searching for strategies to remove the cellular defect caused by the loss of SMN in the body. This includes the quest for answers to further detailed questions about the function of SMN. However, it will also be of major importance to establish a suitable animal system in which spinal muscular atrophy can be researched through experiments. A decisive step in this direction has recently been made by the gene manipulation of mice, which – like SMA patients – are able to produce only small amounts of SMN protein. The analysis of these mice is currently under way. It is hoped that the specific manipulation of the SMN gene in the mouse will cause a disease which can be compared to that of SMA patients. Such a "mouse model" for SMA could enable the specific development of strategies for the treatment of the human disease.

Fig. 5:
Everyday research in the molecular biological laboratory of the Max Planck Institute of Biochemistry.
Photo: Heddergott.

Plants and Their Secret Weapons

Caroline Liepert

Carl Zeiss Jena GmbH has currently provided accommodation on its premises for two Max Planck Institutes until their own buildings in Jena are completed. Due to the implementation of a strategy focusing certain product lines on the different locations of the Carl Zeiss Group, large facilities at the Jena plant have become vacant. An area of 2,300 m² was used in 1997 to set up laboratories and offices for the Max Planck Institute of Chemical Ecology, including e.g. laboratories for classical chemistry, isotope analysis, analytical metrology and molecular biology. After the completion of an initial study, the Consulting and Engineering business unit of Carl Zeiss performed the overall planning procedure and subsequently monitored the construction work. Only ten months after the signing of the contract, the laboratories were officially handed over to the user.

At the same time as this project, discussions and work were initiated on the second Max Planck Institute on the Zeiss premises: the Institute of Biogeochemistry. State-of-the-art laboratories and offices with a surface totaling 2,600 m² were planned and built for this organization. The institute started its work after only nine months, in June 1998.

Where huge machines used to operate for the electroplating of mechanical components such as microscope stands, state-of-the-art, computer-controlled equipment has now been installed for the separation and identification of natural substances and for the reproduction and research of genetic sequences. These are only a few examples of the instruments used by the Max Planck Institute of Chemical Ecology in Jena for its work. Founded in September 1996 as the second Max Planck Institute in Jena, the organization now has a staff of approx. 130 employees from Germany and abroad working in four scientific departments and in general service teams. The scientists at the institute are exploring the question as to how live organisms communicate with their environment via chemical messengers. What appears to be a pretty straightforward subject at first glance is in fact a highly complex interaction system at different levels – molecular, cellular and organismic – and one which can only be comprehensively investigated in an interdisciplinary approach. It is therefore no surprise that ecologists, biochemists, population geneticists and experts from organic and analytical chemistry work closely together at the institute.

Dr. Caroline Liepert is a research coordinator at the Max Planck Institute of Chemical Ecology, Tatzendpromenade 1a, D-07745 Jena, Germany.

Chemical self-defense of plants

Plants are the focal point of the institute's scientific studies. Their large number of herbivorous enemies has led not only to the growth of thorns and prickles by which many plants keep unwanted visitors at bay, but also to the evolution of effective chemical defense mechanisms. When under attack, plants frequently respond by intensifying their synthesis of specific substances which have an inhibitory or toxic effect on insects. The roots of tobacco plants (*nicotiana*), for example, produce the familiar nicotine, a neurotoxin which may account for as much as 10 % of the leaves' dry

Fig. 1:
Gas chromatography laboratory in the molecular ecology department.

Fig. 2 (in the text):
Caterpillar of the owlet moth on cotton.

Basic Research Under the Roof of Carl Zeiss

Fig. 3:
Caterpillar of the tobacco hawkmoth on tobacco.

Fig. 4 (large photo):
Collection of odorous substances of a corn plant.

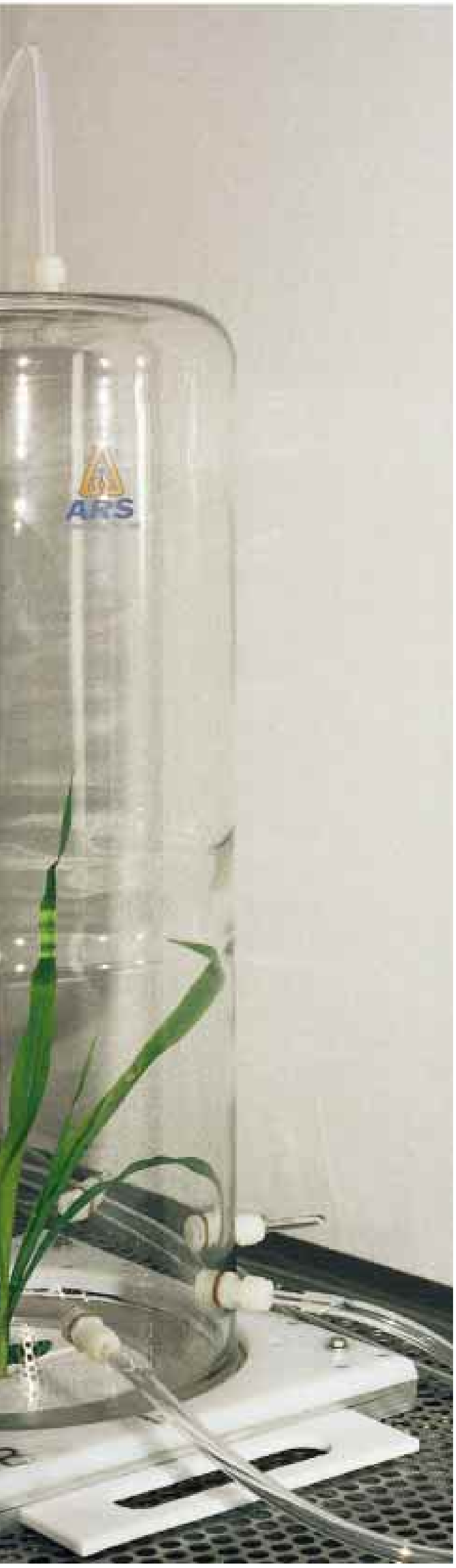
matter. Such a diet is lethal for many insects. It is no accident, therefore, that nicotine is also used as a pesticide. What signals indicate infestation by harmful insects and how are the stimuli transmitted at a molecular level inside the tobacco plant – these are questions which the scientists at the Max Planck Institute are trying to resolve. Beyond this, they are also interested in the ecological consequences of such chemical defense mechanisms. Do tobacco plants produce less seed and, as a result, fewer potential descendants if they have to use more of their metabolic energy for defense than non-infested plants of the same species? These issues are being investigated in laboratory and field experiments.

Figs 5 and 6:
Investigation of nicotine production in tobacco plants.

A further group of secondary substances present in plants which play an important role for defense against herbivores or pathogens and are being studied in depth at the institute comprises glucosinolates or thioglucosides, the parent substance of mustard oils with the pungent taste or odor we are all familiar with from mustard, horseradish or capers. Little is known to date about the biochemistry and genetics of glucosinolate biosynthesis, despite its previously mentioned practical relevance for mankind. Using state-of-the-art biomolecular and genetic methods, the scientists are trying to throw light on the control of the metabolic pathways and to reveal the importance of these substances for the interaction between plants and their herbivorous or pathogenic enemies.

An odorous cry for help

Plants are also able to exchange information via the air – in the form of volatile cues which act as SOS signals – thus protecting themselves against herbivores. The production and emission of odorous substances induced by eating insects also attracts their enemies (insectivores). This means that the plants' odors serve as markers that point the way toward the prey. This phenomenon is also interpreted as the "plant's cry for help". However, these plant odors not only permit insectivores to find their prey more easily, but also induce non-infested plants of the same species in the direct neighborhood to



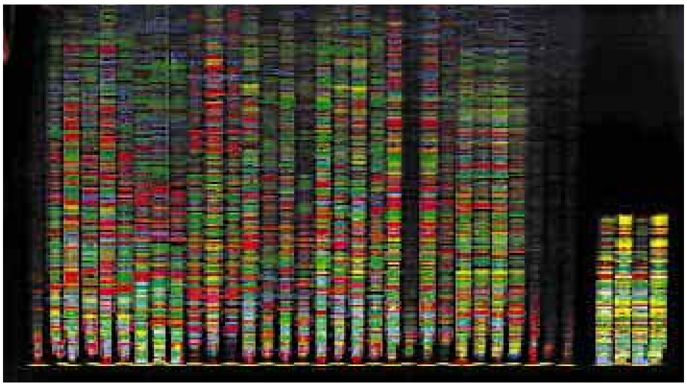


Fig. 7:
DNA analysis using a sequencer.

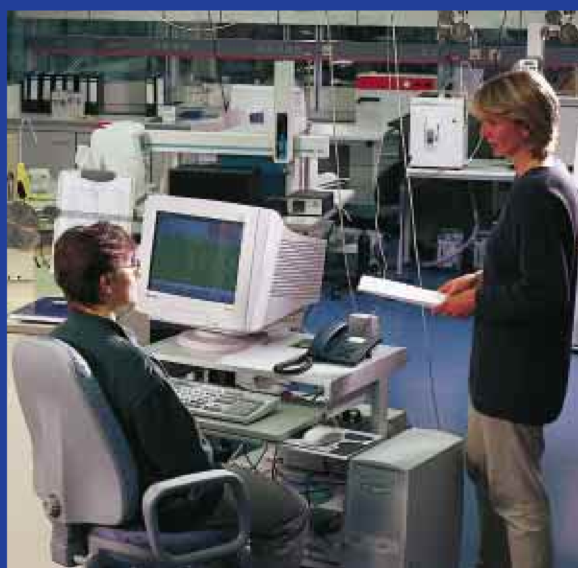
intensify the synthesis of these odorous substances. The importance of this discovery, e.g. for plant protection, is evident. Apart from the content of the volatile cues, the scientists at the Max Planck Institute are primarily interested in the molecular mechanisms of the signal cascade inducing the biosynthesis of odorous substances.

Genes for chemical signals

The infestation of plants by herbivores triggers a complex mechanism in the plant's organism. To understand the basic functional processes of the plant's self defense, it is also essential to identify and characterize the resistance-specific genes involved in the synthesis, storage, identification and metabolism of chemical cue molecules. State-of-the-art biomolecular and genetic methods enable the scientists at the institute to provide information on which areas of the plant's genome are activated or deactivated by infestation. The researchers hope that – irrespective of the considerable potential for applications in agriculture and forestry – the findings will also give them an insight into the processes in which these interrelations of organisms evolved in the past.

Max Planck Institute of Biogeochemistry

Gaschromatography MS laboratory of the Max Planck Institute of Biogeochemistry. The institute studies the behavior of ecosystems and biogeochemical processes in varying climatic conditions. The aim is to understand complex overall systems composed of a large number of interacting subsystems which influence each other. Ultimately this also includes gaining an insight into whether and to what extent nature is still able to compensate for human intervention. For this purpose, systematic experiments must be conducted for the investigation and modeling of functional connections and interactions, followed by the combination of the results with e.g. paleo-data to assess the forecast potential of such models.



Measuring Crop Plant Quality in the Field

Michael Rode, Christian Paul

Michael Rode and Dr. Christian Paul work at the Institute of Crop and Grassland Science of the German Federal Agricultural Research Center (FAL), Bundesallee 50 in D-38116 Braunschweig/ Germany.

The combine harvester which is commonplace in agriculture today was a real technical revolution 50 years ago. This machine made it possible to combine the tedious process of reaping grain in the field with the dusty threshing procedure that usually took place many weeks after the harvest. There are now signs of an advance in agricultural harvesting which could initially result in a similar breakthrough in crop plant cultivation.

For the short period between harvesting and the next sowing, plant breeders need rapid, cost-effective and meaningful analytical techniques to be able to develop crop plants with improved quality. The advances achieved in, for example, the dry matter content of forage grass, the oil content of oilseed rape and the protein content of feed barley depend directly on the intensity of selection from a starting material which consists of thousands of foundation stocks. Instead of conventional "wet chemical" analytical procedures, spectroscopy in the near infrared (NIRS) has proved to be successful for this purpose and can now be transferred from the laboratory to the field as a consequence of newly developed instruments.

Compact, sturdy and fast

On the basis of the equipment devised and the chemometric research carried out by *Norris* in the USA, spectroscopy in the near infrared (NIR) has now made its way into plant breeding. So far, however, the current status of the NIRS instrument technology has limited this analytical procedure to stationary use in the laboratory. The availability of diode arrays for the spectral range of the near infrared now makes it possible to use NIRS directly on agricultural harvest machines. The company Carl Zeiss, the Danish agricultural engineering company Haldrup and the Institute of Crop and Grassland Science of the German Federal Agricultural Research Center have jointly developed a forage harvester for trial plots which allows NIRS measurements on representative samples of the crop during harvesting. The **CORONA NIR** sensor module installed in the harvester is based on the **MMS-NIR** 1.7 diode array spectrometer (Fig. 1) and has been specially designed for the rough conditions of field use.

The particular benefits of the **CORONA NIR** result from the high measuring speed of the **MMS-NIR** 1.7, its high temperature stability, small size and total insensitivity to vibrations and shock. These features clearly distinguish this unit from the NIR measuring instruments used in the laboratory which are unsuitable for mobile use in the rough conditions of field cropping, not only because of their slow measuring speed but also because of their moving, shock-sensitive gratings or filter wheels required for the dispersion of polychromatic light.

Fig. 1:
MMS-NIR 1.7 spectral sensor for the wavelength range from 950 to 1,700 nm.

Background:
Clover-grass mixture
Photo:
AGROCONCEPT,
Bonn/Germany.

Determining the content of water and other constituents

The water content of field crops determines their stability during storage, partially characterizes their nutritional value and is also a crucial factor in fixing their trading price. Water is the constituent which can be most easily determined in the near infrared (Fig. 2). While other constituents of economic importance such as protein, oil and carbohydrates display lower absorptivity in the near infrared (Fig. 3), their contents can nonetheless be determined with high analytical precision by a single, non-destructive measurement of freshly harvested grains and seeds.

Harvesting with spectrometers

In the summer of 1999, the first Haldrup forage harvesters of the new "NIRS harvest line" for such forage plants as grass and clover were purchased by the German plant breeding companies Deutsche Saatveredelung (DSV) and Norddeutsche Pflanzenzucht (NPZ) and tested in the field (Fig. 4). The chemometric calibration of the sensor in field conditions is being continued together with these plant breeding companies. In addition, a combine harvester equipped with a **CORONA NIR** will be available for such grain crops as cereals, oil seeds and grain legumes for the first time in the year 2000.

The integration of NIR diode array spectrometers in agricultural combine harvesters will initially increase the efficacy of plant breeding and testing aimed at creating cultivars with improved properties. In addition, it should not be overlooked that this type of "mobile analysis" can also be transferred to practical agriculture where a wide variety of approaches to so-called "precision farming" are increasingly being tested. Thus, the NIR diode array spectrometers, which are no bigger than a child's hand, could one day make an effective contribution to quality assurance in environmentally compatible plant production.

Fig. 2:
Absorption spectra of grass with different levels of moisture.

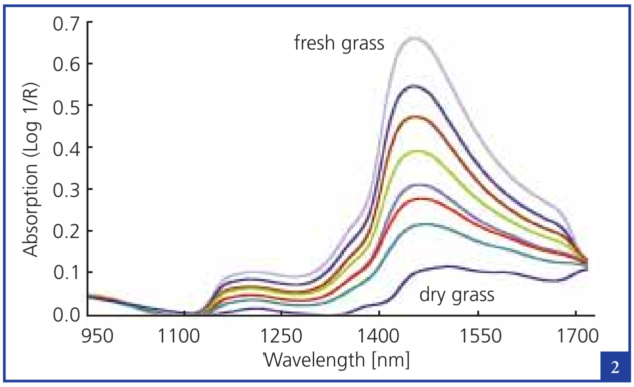


Fig. 3:
Absorption spectra of wheat, linseed and field pea.

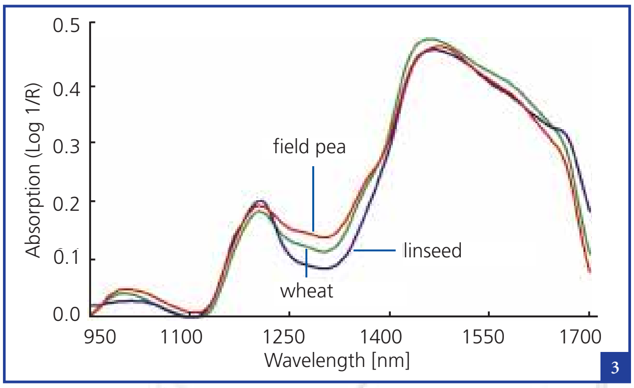
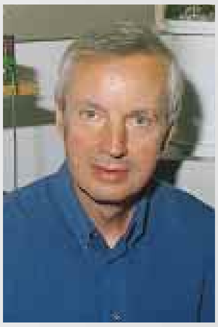


Fig. 4:
Forage harvester from the company Haldrup (Denmark).

Gazing into the Cold Depths of the Universe

Dietrich Lemke



Professor Dietrich Lemke, Max Planck Institute of Astronomy, Königstuhl 17, D-69117 Heidelberg, Germany, is the "Principal Investigator" for the ISOPHOT imaging photopolarimeter.

April 8, 1998 marked the end of observations by the ISO European satellite observatory. The mission, however, is far from over. Since 1999, the data obtained in 12,000 hours of observation ranging from the solar system to extragalactic background radiation has been made accessible to all astronomers for archive observations of the infrared sky.

ISO's mission in space lasted for 29 months, eleven months more than originally planned. Throughout this period, a temperature of as low as minus 271 °C – less than the external temperature in space – was maintained inside the observatory. This permitted the exploration of celestial bodies which are too cold to emit any visible light. One of the four scientific instruments on board ISO was the ISOPHOT imaging photo polarimeter developed by the Max Planck Institute of Astronomy in Heidelberg and manufactured by the companies Dornier, Carl Zeiss and Battelle [1, 2]. With its multitude of high-precision opto-mechanical components, this instrument operated without a hitch in cryovacuum for three years, including the preparatory phase before the launch. The companies involved deserve great praise for this achievement.

Dusty universe

Large parts of the universe remain invisible behind dense, interstellar clouds of dust particles. Infrared waves, however, are able to penetrate this dust virtually unattenuated. Due to its widespread distribution, dust absorbs the short-wave radiation of hot stars and is heated up. Depending on its distance from the star and the size of its particles (small ones are heated to higher temperatures!), the dust reaches temperatures of T ~ 10… 300 K. Further heating of the particles is prevented by the emission of thermal radiation which we observe in the form of infrared radiation. This means that no energy is lost: the luminous intensity of invisible, young stars in dense, circumstellar clouds, for example, emerges in the form of infrared radiation on the much larger surface of the surrounding clouds. The dust transforms the UV radiation of the hot nucleus into the infrared of the packaging. Widely distributed dust seems to be present everywhere in the cosmos (Fig. 1).

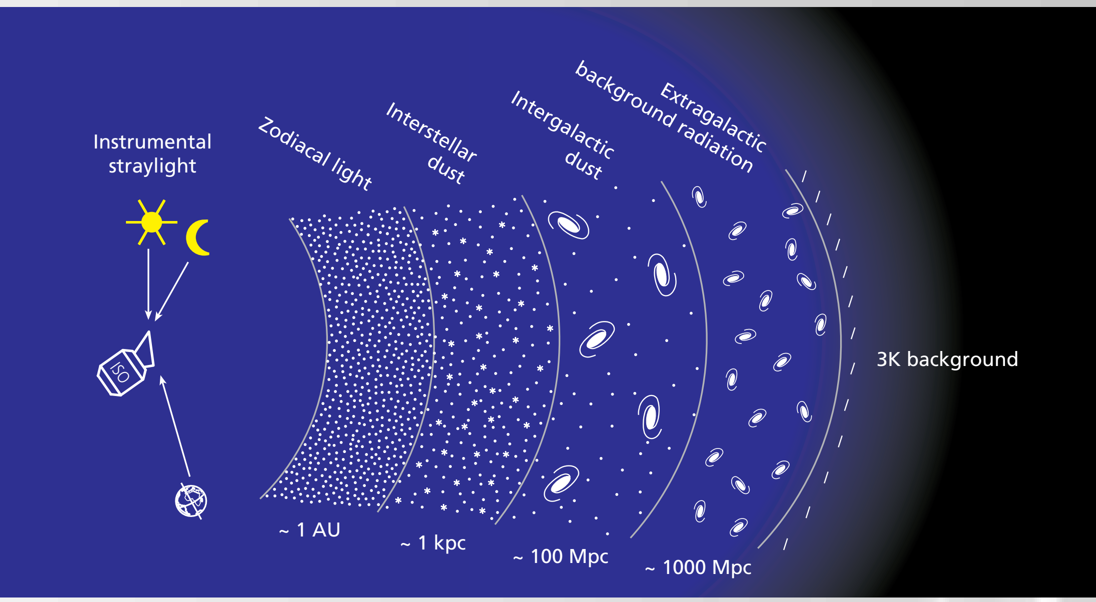
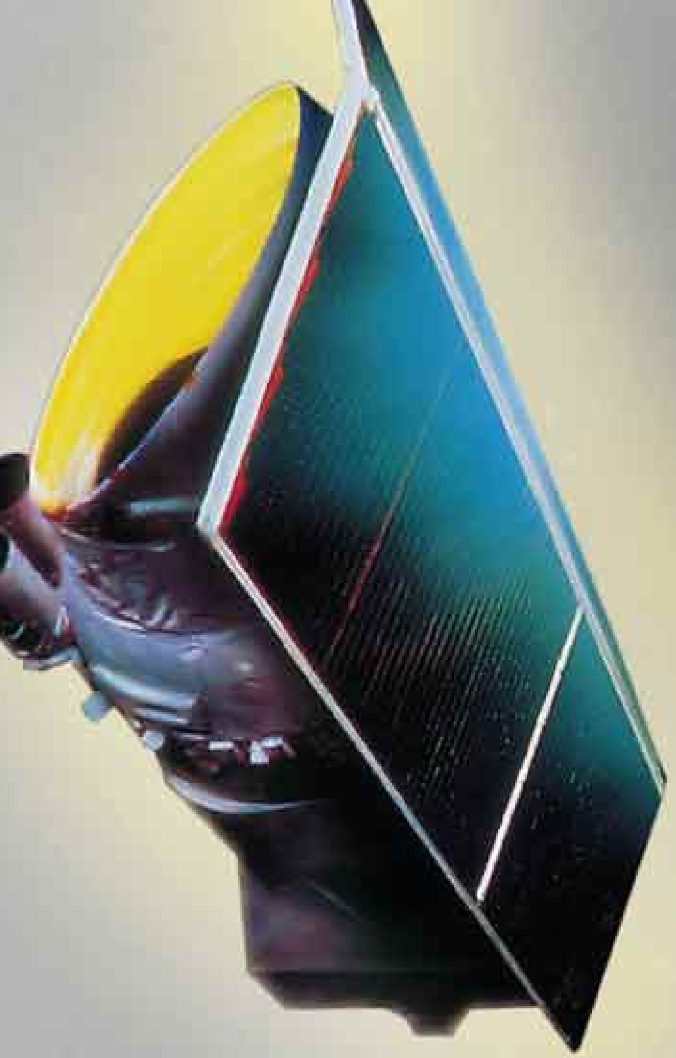


Fig. 1:
To be able to measure extremely faint luminance such as the extragalactic background radiation, all intervening brightness components caused by intergalactic, interstellar and interplanetary dust must be determined separately. Instrumental stray light originating from the sun, moon and earth was established to be negligible in ISO.

Interplanetary and intergalactic dust

Interplanetary dust is concentrated around the sun and in a flat disk around the ecliptic up to a solar distance of 3 AU. The sunlight dispersed by dust is visible as zodiacal light. In the infrared range, the entire sky is brightened up by the dust's thermal radiation in a very wide spectral range from 7 to 70 µm. The high sensitivity of a cold satellite telescope is limited here by the "infrared zodiacal light". Temperature measurements (Fig. 2, [3, 14]) permit improved modeling of the interplanetary dust cloud with respect to its density distribution and the properties of its particles. This is of major importance for gaining an insight into the physical processes of the solar system and addresses issues concerning the life span and supply of the particles (comets, asteroid remnants). All attempts to determine the extragalactic background radiation require the correction of the bright foreground of zodiacal light and, as a result, precise models of the interplanetary dust cloud.

Outside the solar system, the sky is brightened up in patches by the interstellar dust distributed in the form of clouds (cirrus). At even larger distances, extragalactic dust – if it exists at all! – might contribute to the sky signal. To date, it has not been possible to detect any dust between the galaxies in different galaxy clusters. The ISOPHOT camera for the far infrared has now made it possible to extend the wavelength range up to 200 µm. As a result, "color" measurement permitted the excess radiation of intergalactic dust with a temperature of T ~ 30 K present in the



Coma galaxy cluster to be distinguished from galactic interstellar dust with T ~ 17 K (Fig. 3, [4]). It is amazing that dust should exist in the Coma cluster at all although the entire cluster is embedded in plasma gas as hot as T ~ 100 million K. The fact that dust has nevertheless been detected, even if the gas-to-dust ratio was only 10 000 : 1 (the common ratio in galaxies such as Milky Way is 100 : 1), indicates a constant supply of fresh dust. It is expelled from the galaxies of a smaller cluster currently in the process of fusing with the Coma cluster.

A glimpse of the early universe

J. L. Puget (Paris) and his international team used ISOPHOT to look for very distant, young galaxies in celestial regions in our Milky Way displaying an extremely low density of neutral hydrogen and hence a low content of absorbing dust. 24 objects have been found in an area of 1.5 square degrees in the Marano field in the

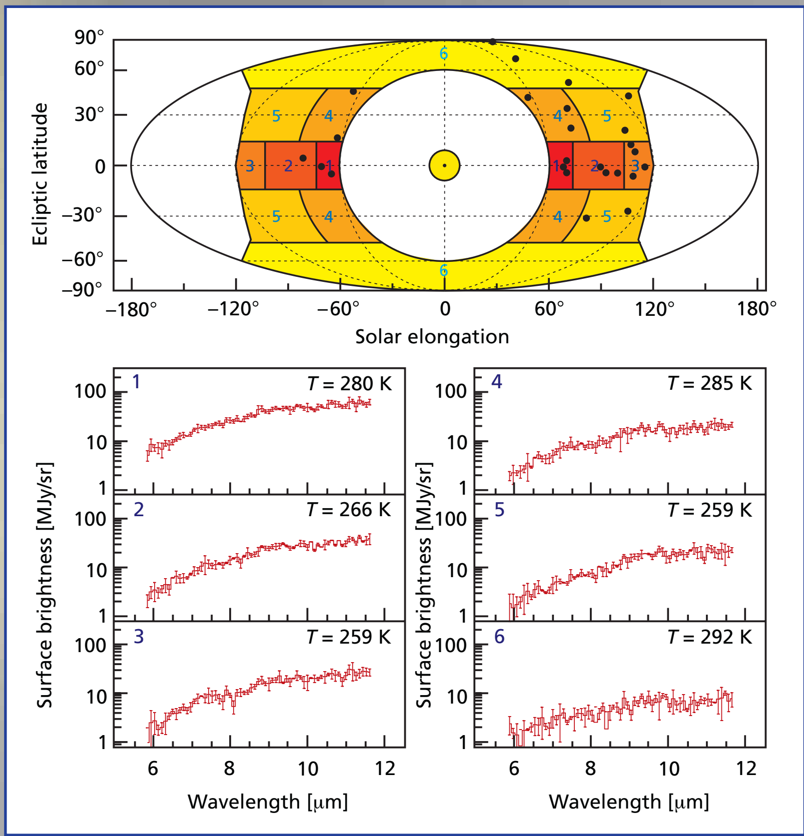


Fig. 2:
The top section of the illustration shows the sky in ecliptic coordinates divided into areas close to the pole and close to the ecliptic, the latter being again divided into regions close to and distant from the sun.
The spectra measured by ISOPHOT-S in the medium infrared indicate the color temperature of the interplanetary dust by comparison with Planck's spectra of the black body. Although the interplanetary dust is hottest above the solar poles, it displays only faint brightness (poorer signal/noise ratio of the measurement!) [14].

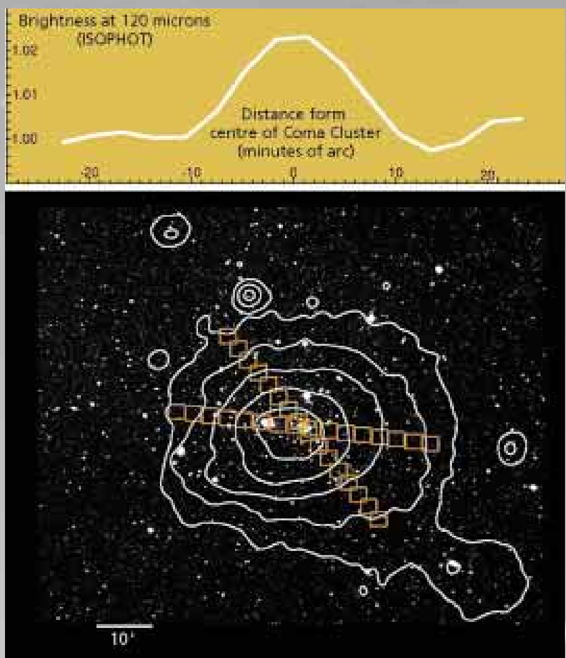


Fig. 3:
The Coma cluster of galaxies is embedded in hot X-ray gas (white ROSAT contour lines). Two intersections with ISOPHOT in the far infrared (orange) show a slight excess of radiation at the cluster's center. It is accounted for as the thermal radiation of intergalactic dust in the cluster [4].

southern sky and have been interpreted as a new class of objects with a pronounced red shift ([5], Fig. 4). The results suggest that dust produced by the first star generation was already abundant in the early universe.

Soot – practically everywhere

The graphite-like polycyclic aromatic hydrocarbons (PAHs) which resemble small soot particles and apparently occur infrequently in the Andromeda galaxy (Fig. 9, [8]) are very common in the cosmos. ISOPHOT helped to detect them in hot ionized gaseous nebulae (HII regions), in warm reflection nebulae and, for the first time, in cold, thin cirrus clouds (Fig. 5). Another first was the scanning of the distant spiral galaxy NGC 891, which we see from the side, from one outer edge to the other to detect the presence of PAHs. Again, the result showed the pervasive presence of soot – from the center to the most distant spiral arms. And everywhere its properties are very similar to those of the PAHs in Milky Way. The PAH lines have even been detected in ultra-luminous infrared galaxies (ULIRGs) whose luminosity exceeds that of the Milky Way ten- to one hundredfold [6]. *R. Genzel* (Garching) and his team observed a large number of ULIRGs using the ISOPHOT-S spectrophotometer, and on the basis of the line widths they concluded what the principal source of energy must be (star formation or Black Hole). Obviously, PAHs are exceptionally stable particles capable of being formed and surviving anywhere in cosmos. The significance of these carbon compounds is demonstrated by recent laboratory results: PAHs in the ice envelopes of simulated cosmic dust particles were subjected to ultraviolet radiation (as emitted by hot stars) and were successfully transformed into biogenic chemical substances [7]. Could such particles – transported to the young earth by meteorites – be the astrophysical origin of life on earth?

Quasars

A few exceptions apart, the infrared gap in the quasars' spectrum was also a gap of knowledge in the model created for these active galaxies [9, 10]. While the visible and radio ranges displayed a synchrotron spectrum, it remained uncertain as to how to bridge the infrared range.

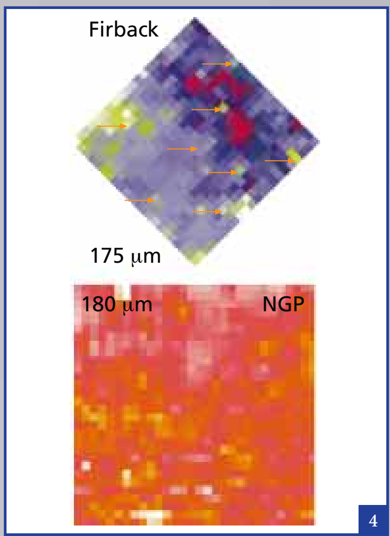


Fig. 4:
The extragalactic background radiation can be studied either by counting the individual sources (top) or using the integrated luminance (bottom). In the FIRBACK program, *Jean Loup Puget's* team detected a large number of sources at 175 µm which, as the brightest single sources, account for approx. one tenth of the expected background radiation from the young universe. *Kalevi Mattila's* team also counted single sources, and distinguishes them from similar-looking cirrus nodes by performing measurements at several different wavelengths. A further aim is to determine the integrated extragalactic background with its characteristic "color" by separating the faint, extended cirrus.

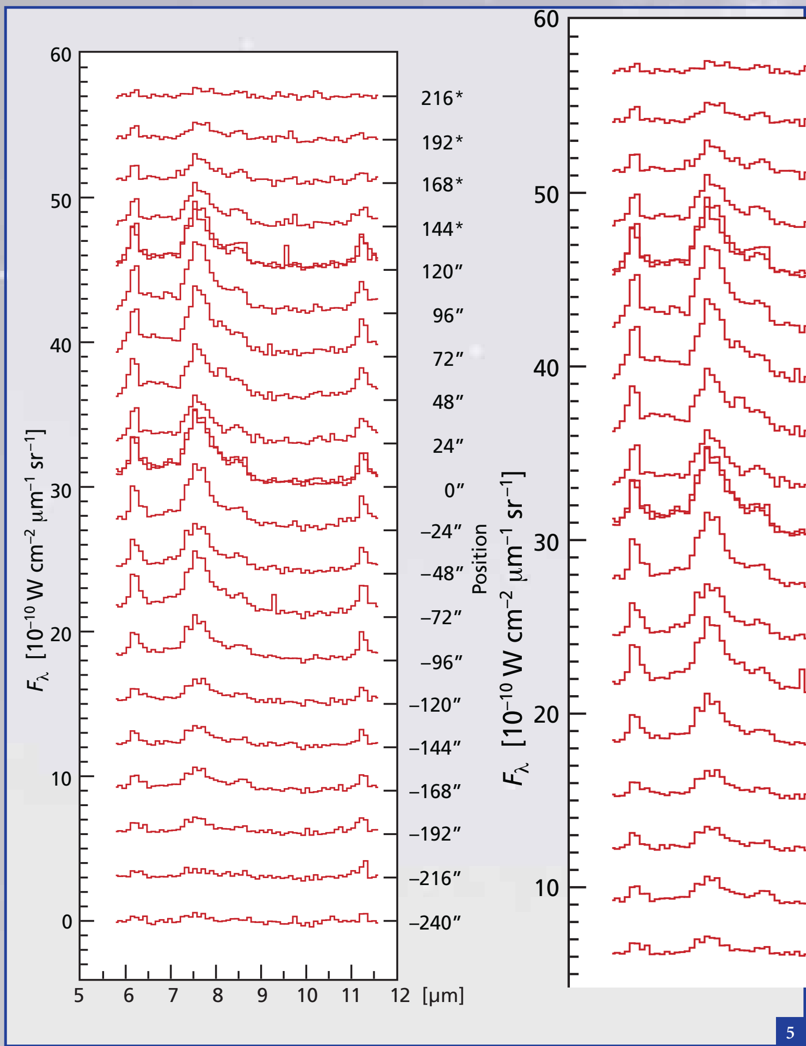


Fig. 5:
Although the intensities and high-energy UV components of stellar radiation differ by several orders of magnitude, the characteristic PAH lines display comparable line thicknesses both in bright reflection nebulae and faint cirrus clouds. The situation is similar in the NGC 891 galaxy, the fist galaxy to be studied from edge to edge [15].

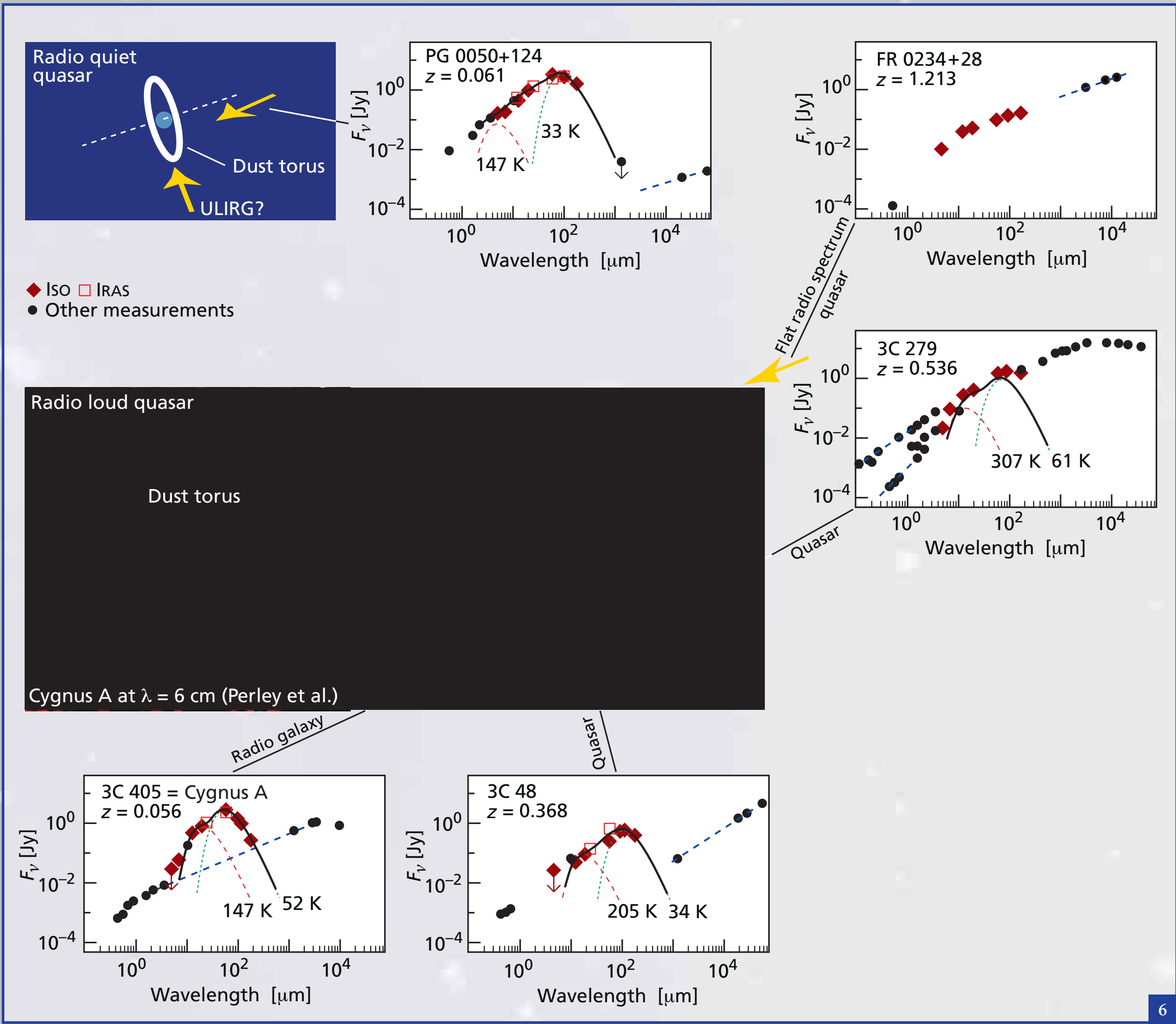


Fig. 6:
The centers of quasars are thought to consist of energy generators formed by black holes surrounded by accretion disks and a dust torus. In the polar jets, highly polarized synchrotron radiation is generated in powerful magnetic fields and can be observed primarily in the radio range (radio loud quasars). Radio quiet quasars have only faint magnetic fields. ISOPHOT observations show intense infrared radiation in many quasars: the "side view" reveals that the synchrotron spectrum (dashed line) is superposed by a dust emission maximum from the torus. In the polar direction, the synchrotron radiation is particularly intense (Doppler-amplified) and outshines a dust emission assumed to lie underneath [9].

ISO furnished the proof that most (presumably even all) quasars are powerful infrared emitters. The maximum in the infrared is caused by the emission of hot and cold dust. In the common model of active galaxies, this dust is heated up in an accumulation of matter (torus) surrounding the accretion disk around the central Black Hole (Fig. 6). A striking similarity exists between the quasar spectrum 3C48 and that of the classical radio galaxy CygA. Are all radio galaxies really quasars?

Water and ice

ISO's spectrometers detected water in many places in the Milky Way. This substantiates the assumption that life could exist in the environment of a large number of stars. The water molecule is of astrophysical importance because its emission contributes to the cooling of the star formation areas, without which the collapse of clouds into protostars would be delayed. The formation rate of water vapor measured by *Harwit* et al. [11] in the vicinity of a very young star in the Orion nebula is impressive: sufficient water to fill all the oceans on earth is produced every thirty minutes! The powerful stellar winds originating from the young star heat up the surrounding interstellar medium to such a degree that all free oxygen combines with the omnipresent hydrogen to form water vapor.

Even frozen water has been detected by ISO in many star formation areas. It envelops the interstellar dust particles which are effectively shielded in dense clouds from the radiation of young stars. In addition, such molecular clouds contain carbon monoxide not only in the abundant gaseous form, but also in the form of solid CO ice. ISOPHOT-S and the short-wave spectrometer SWS also discovered carbon dioxide ice ("dry ice", Fig. 7) which is surprising because gaseous CO_2 is extremely rare. Which processes transformed the CO ice envelopes probably existing at the beginning into CO_2 ice? Laboratory experiments suggest that the ultraviolet radiation of the stars or the cosmic radiation could initiate this transformation via a number of complex chemical processes (formaldehyde?) [12, 13]. The complete process must take place at extremely low temperatures, as the sublimation temperatures of the CO ices lie below –250 °C.

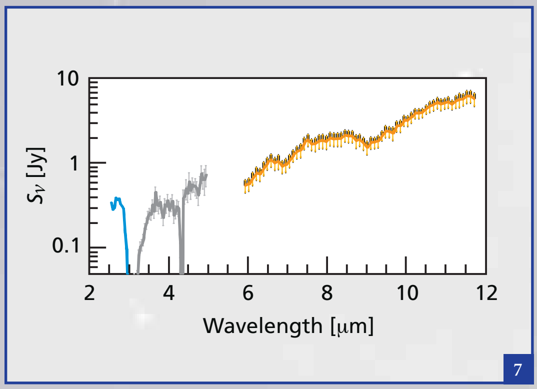


Fig. 7:
Spectrum from the Chameleon dark cloud complex comprising a large number of young stars of low and medium mass, measured by the astronomer team of *Th. Henning* using ISOPHOT-S.
The infrared nebula Cha IRN surrounding one of the objects displays pronounced absorption lines of interstellar H_2O ice (3.1 µm), CO_2 ice (4.27 µm) and, possibly, NH_3 ice (9 µm) [13].

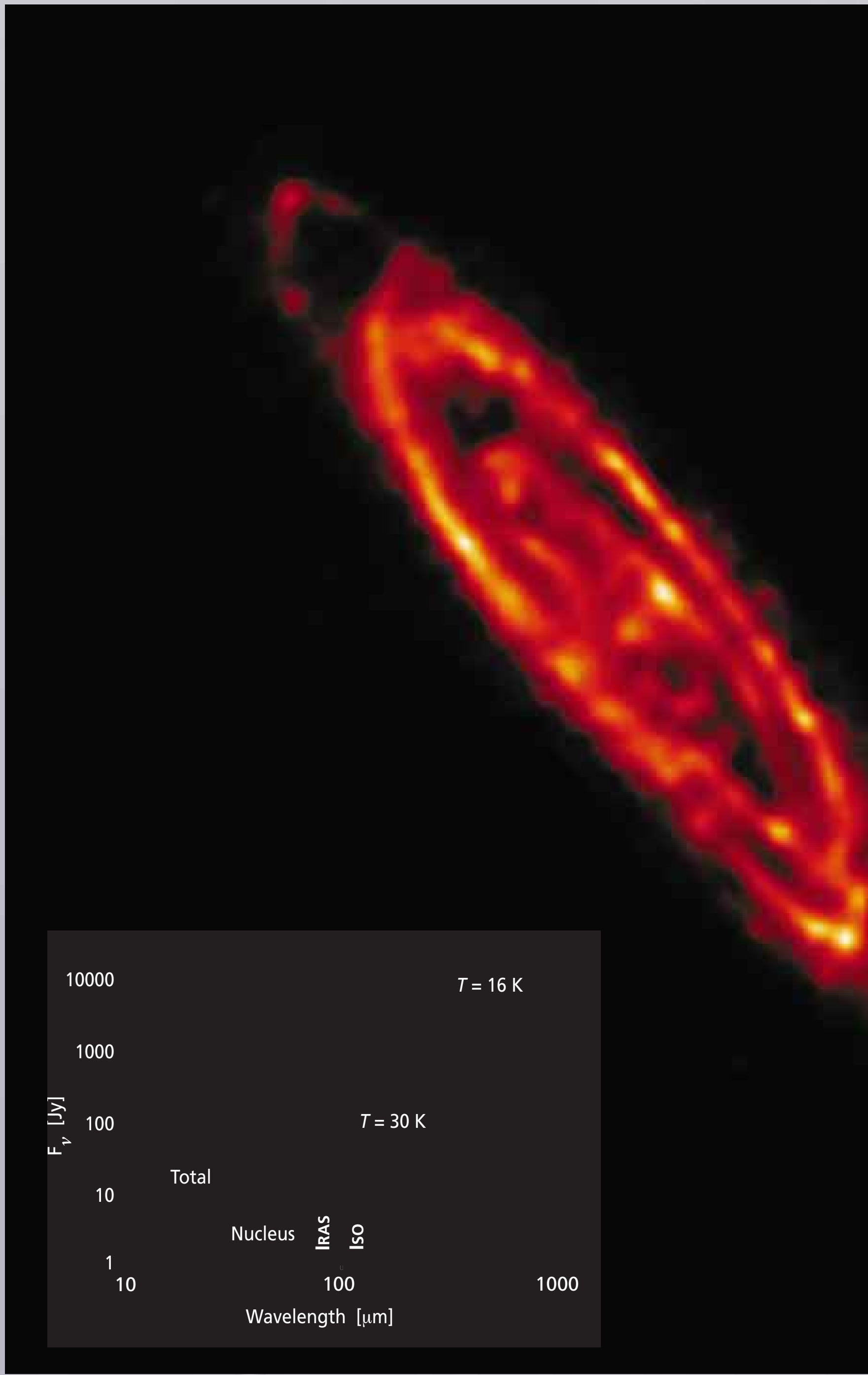


Fig. 8:
The M31 Andromeda galaxy mapped with ISOPHOT at a wavelength of 175 µm. A classical spiral structure is not discernible. The concentric ring with a diameter of 20 kpc (≈ 100 arc min) contains dust with a color temperature of 16 K heated up by increased star formation activity at this location. The core of M31 appears faint due to its relatively high temperature of T ~ 30 K. At the top right, the 175 µm map projected as a top view [8].

Random scans

When slewing from one observation object to the next, the telescope traces an unforeseeable, curved path in the sky to avoid zones which are "out of bounds" for thermal reasons (sun, earth,...). Since the speed along the slew also fluctuates, the slew times count as inevitable losses during a mission. Not so with ISO. During the slew, the ISOPHOT-C200 far infrared camera generated a "strip map" of the sky in the new wavelength region around 175 µm. When lined up, the strip maps with a width of 3 arcsec obtained throughout the mission would cover a length of 150 000°. The strips run in a criss-cross pattern over the entire sky, their highest concentrations being at the sites of popular objects (Magellanic Clouds, calibration sources, . . . Fig. 9). Objects of special interest are those of unusual brightness at 175 µm, i. e. objects containing large quantities of cold dust. This applies to almost half of all galaxies included in the first large scanning catalog! An example is shown in Fig. 10: the high luminosity in the far infrared is thought to be produced here by a temporarily high star formation rate and by the heating of dust due to the interaction of two closely adjacent galaxies. The random scans of ISOPHOT and other ISO instruments have increased the degree of time utilization during the mission to more than 95 %.

Fig. 9:
Picture of the Andromeda galaxy composed of strip maps resulting from the ISOPHOT random scan at 175 µm. The bright star formation ring is clearly recognizable, as can be seen in a comparison with Fig. 8. The picture gives an idea of the degree of sky coverage achieved by the random scan in a much-frequented area (*O. Krause*, MPIA).

"A yield of more than 100 %"

After the last drop of helium had evaporated, the increased noise and the radiation caused by the heating of the telescope abruptly blinded nearly all ISO sensors. The SWS spectrometer, however, continued to supply stellar spectra in the near infrared for a few more weeks. During the weeks after the helium had run out, the ESA performed extensive tests on the satellite's subsystems. ISO was excellently suited for this purpose, as no failures had occurred during the entire mission. This unexpected utilization after the depletion of the helium, the random and parallel scans and the 11-month extension of the mission thanks to the extremely economic use of the helium ". . . have provided a yield of more than 100 % in the ISO mission", said *Dr. Roger Bonnet*, ESA's science director.

Observation continues – in the ISO archive!

The data archive of the ESA ground observatory in Villafranca near Madrid was opened in early 1999. In July, a good year after the end of the mission, the one-year period allowed for the last guarantee observations had elapsed. This means that every astronomer in the world has now unrestricted access to all data via the internet. The archive contains data products such as spectra and maps at different wavelengths generated with the aid of analytical programs ("Pipeline"). Research in the archive is easy: on entry of an object name (M31, . . .) or coordinates (α, δ), a list of the data obtained for the object concerned with different instruments is displayed. Small color pictures provide a fast overview of all maps and spectra available. This permits supplementary information from the infrared range to be added to many research projects performed on the same object in other spectral regions. The archive will certainly also be used for increasing the number of objects in ISO observations to obtain statistically significant quantities. The quasar measurements of all observers, for example, can be combined, or images of the nearest large galaxies can be obtained in the light of their coldest matter. Interested? Then visit the ISO web site http://www.iso.vilspa.esa.es.

Have fun browsing!

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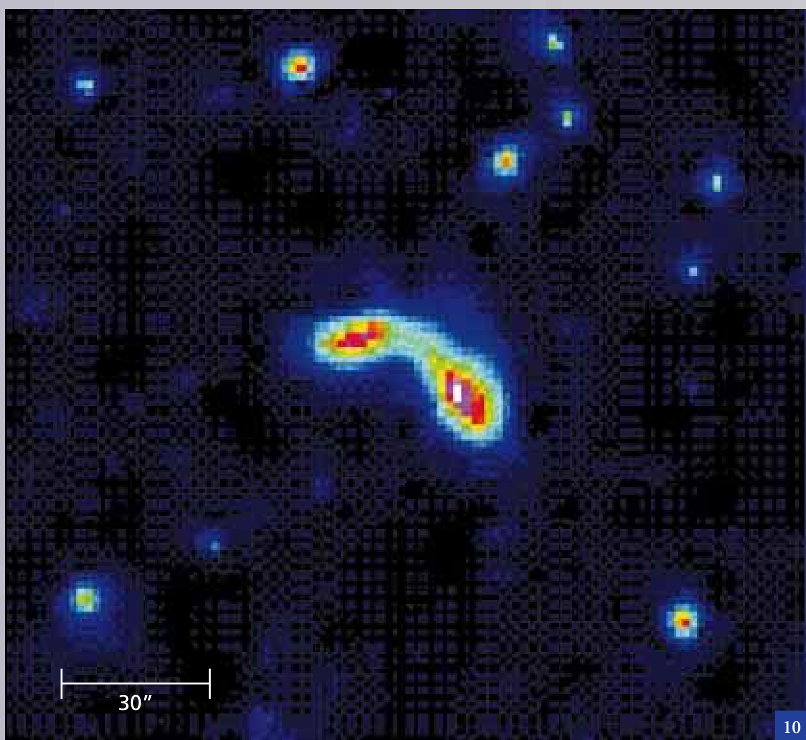

Fig. 10:
Example of a source of unusual brightness at 175 µm discovered in the random scan. The optical image (PSS) shows a pair of fusing (?) galaxies. This interaction presumably triggered an increased star formation rate [16].

Sun and Truth – As Goethe Didn't Say

Lutz Wenke, Friedrich Zöllner, Manfred Tettweiler, Hans-Joachim Teske

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Weimar – Cultural Capital of Europe in 1999. One of the numerous anniversaries celebrated in the cultural capital's eventful year is the 250th birthday of Johann Wolfgang von Goethe. An insight into the life and work of the great poet himself and his contemporaries is given in the Goethe National Museum comprising the poet's home and the Goethe Museum which was reopened in spring 1999 after revamping of the building and its contents. The new permanent exhibition is no longer a conventional presentation of Goethe and his life. Under the symbolic motto "Repeated Reflections", it shows an exposition which is devoted to the period termed "Weimar Classicism" in general and describes the origins and effects of this multi-faceted phenomenon of cultural history.

An impressive technical installation attracts the visitors' attention as soon as they enter the refurbished museum building on a sunny day. The powerful projection of the solar spectrum by a spectral prism apparatus reminds us that *Goethe* devoted long phases of his life to the study of light and the theory of color. In particular, a link is made to his experiments with prisms and his critical analysis of *Newton*. The technical installation was specially developed and manufactured for this purpose at the Institute of Applied Optics of the Friedrich Schiller University in Jena and at Carl Zeiss. The necessary funds were made available by Carl Zeiss, Oberkochen, and SCHOTT GLAS, Mainz.

Showing Light in its True Colors

The "Newtonian poltergeist"

Looking through a prism at a broad strip of white paper against a black background in daylight, *Goethe* observed the so-called edge spectra, the colored seams at the borderlines between white and black. This basic experiment was of such fundamental importance for him that the edge colors can be said to constitute the elementary components of *Goethe's* color theory in much the same way as the spectral colors did in *Newton's*.

Newton's interpretation of the prism experiment describes the "white" light of the sun as being composed of beams of different refracting properties whose lateral spread produces specific color impressions in the eye.

Goethe on the other hand denied the heterogeneity of white light. For him, it was "… the most simple, spectrally unresolved, homogeneous phenomenon we know. It is not composed of different components – least of all of colored kinds of light."

The prism experiment forms the center of *Goethe's* criticism of

Fig. 1:
Goethe National Museum in Weimar.

Newton's approach to which he devoted a major, polemic part of his Theory of Color published in 1810, with the aim of banishing the biased *Newtonian* "poltergeist" for ever. His criticism of *Newton* does not stand up to any sort of examination based on the laws of physics, and it already gave rise to protests in *Goethe's* time.

There's still no getting round the sun

The centerpiece of the new optical installation in Weimar is a heliostat, a computer-controlled mirror on the rooftop of the museum which precisely follows the sun's movement. *Goethe*, who did not have such a facility at his disposal, wrote in his Theory of Colors:

"The objective experiments, on the contrary, necessarily require the sun-light which, even when it is to be had, may not always have the most desirable relation with the apparatus placed opposite to it. Sometimes the sun is too high, sometimes too low, and withal only a short time in the meridian of the best situated room. It changes its direction during the observation, the observer is forced to alter his own position and that of the apparatus,..." (Goethe's Theory of Colors, Didactic Part, § 303, translated by Charles Lock Eastlake, London: Murray 1840).

The heliostat reflects the sunlight via a pathfolding mirror through the oval window of the glass dome into the museum's stairwell (Figs 3 and 4). A specially manufactured achromatic objective lens with a focal length of approx. 2 m and a diameter of 40 cm suspended here images the solar disk onto the slit of a spectral apparatus. Due to the large aperture of this objective lens, approx. 10 percent of the 1 kW light power permanently supplied by our sun per square meter in favorable conditions can actually be utilized.

The spectral apparatus itself comprises the above-mentioned slit, an objective lens imaging this slit onto a projection screen, and two prisms (Fig. 5). The prisms are made of dense flint, a type of glass displaying both a high refractive power and wide dispersion of the individual wavelengths. The spectral apparatus is suspended under the large objective lens at the center of the stairwell's round window (Fig. 4).

The spectrum is presented on a projection screen of 2 m x 0.4 m (Fig. 5) which has been provided with a special coating to permit a brilliant

Figs 2a to 2c:
Interior view of the new Goethe Museum whose exposition on Weimar Classicism presents a panorama of literature, politics and art from the period 1750–1840.
2a: Louise, Queen of Prussia, née Princess of Mecklenburg-Strelitz (1776–1810).
2b: Anatomical specimens from J. W. von Goethe's collection.
2c: Showcase containing the anthology "Über Licht und Farben 2" (On Light and Color 2) 1767–1792.

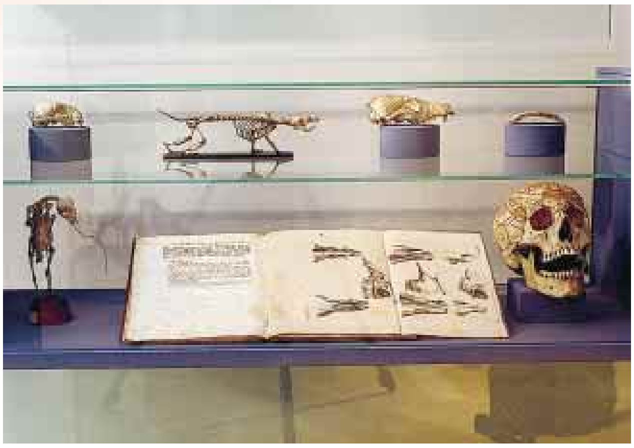


Fig. 3:
Optical beam path for the projection of the solar spectrum.

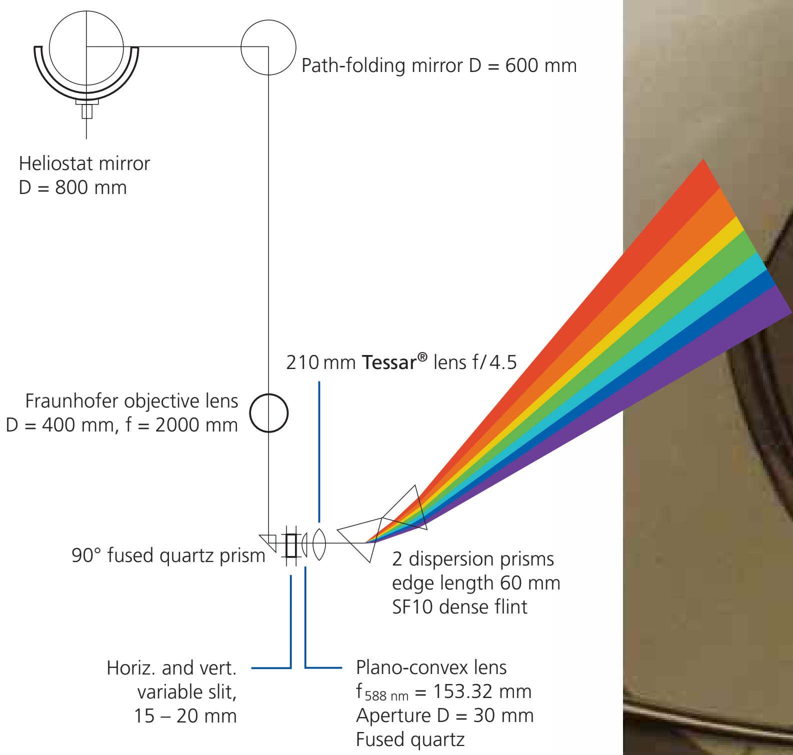


Fig. 4:
Achromatic objective lens and spectral apparatus in the stairwell of the Goethe Museum (upward view).

color phenomenon to be perceived in sunlight "which in general is not very propitious to northern observers". The projection, however, is not an edge spectrum, which would perhaps have been more to *Goethe's* liking. The implementation of this edge spectrum would have necessitated the use of a wide open slit.

Probably the most decisive factor in the planning and installation of the projection system was the fact that, for reasons of cost, the heliostat and pathfolding mirror used are of a type only suitable for the architectural utilization of daylight and sunlight, but not for solar observation. The mirrors are made of float glass with aluminized and varnished back surfaces. Interferometric measurements (Fig. 6) provided PV values of more than 250 µm on a diameter of 800 mm. Special techniques for mounting the mirrors on a steel carrier permitted these surface deformations to be reduced to such an extent that the aberrations of the solar disk on the spectrograph slit reached a tolerable level.

With all prism materials used in practice (and in particular the dense flint glass used here), the visible dispersion spectrum is widely dispersed in the violet and blue range, but compressed in the red range because the dispersion of these materials in the visual range decreases as the wavelength increases (towards red).

Incidentally, the dark lines in the solar spectrum discovered by *Wollaston* and *Fraunhofer* (since 1802) and resulting from the absorption by the sun's and earth's atmosphere cannot be observed. For this, the slit of the spectral apparatus would have to be set to an extremely narrow width which, however, would significantly reduce the illumination intensity and necessitate a real "dark room".

With a slit of moderate width as used in the spectral apparatus installed here, the objective lens projects one virtually monochromatic slit image next to another on the screen, all adding up to a relatively pure spectrum.

Goethe's edge spectra

If the slit of the spectral apparatus is extremely widened or if a broad white strip is observed against black paper through a prism, as described by *Goethe* in the Didactic Part of his Theory of Color, the edge spectrum shown in Fig. 7a will be perceived.

Goethe explains these edge spectra as being the shift of the objects from their real position caused by the effect of the prism. According to *Goethe*, the image is not shifted completely as if it in fact resisted the shift. As a result, a "secondary image" is produced which slightly precedes the actual image.

If the bright rectangle is viewed through a prism, it is shifted to the left by refraction, and the bright secondary image is superposed on the dark paper. *Goethe* propounds that bright on dark produces blue which changes into violet if the effect of the dark increases. On the right edge, the image of the dark surface shifts over the remaining bright "principal image". Dark on bright produces yellow which, according to *Goethe*, accounts for the yellow seam. Where the effect of the dark increases, yellow changes into red.

Goethe called the colors green and purple a "complication" of the colored seams. If an extremely narrow, bright object is placed on a

Fig. 5:
Solar spectrum projected on a specially coated screen.

Background:
J. W. von Goethe in an oil painting by *Ferdinand Jagemann*, 1806.

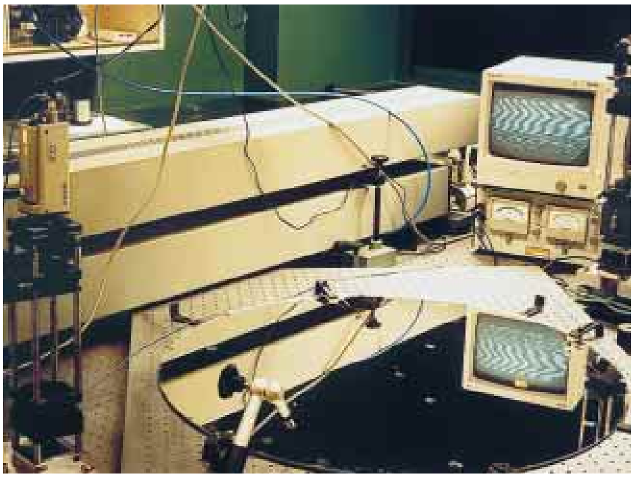
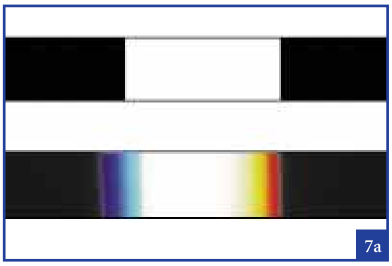
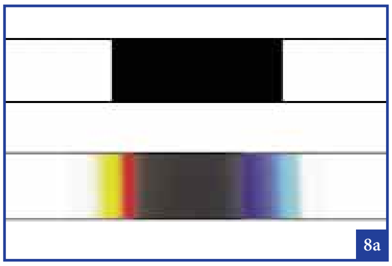
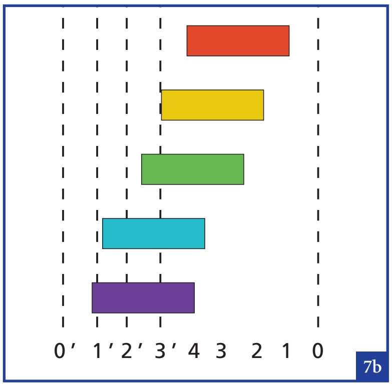


Fig. 6:
Interferometric testing of the mirrors for the projection of the solar spectrum at the Friedrich Schiller University in Jena.







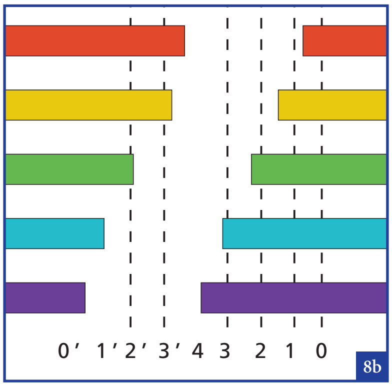


Fig. 7a:
An edge spectrum generated on a wide slit.
7b:
Illustration explaining the edge spectrum.

Fig. 8a:
Goethe's observations of the solar spectrum on the "negative slit".

8b:
Illustration explaining the edge spectrum on the "negative slit".

Photos 1, 4 and 5:
Peter Michaelis
Photo 2 and background on pp. 20/21:
Stiftung Weimarer Klassik, Sigrid Geske.
Photo 6:
FSU Jena.

dark background, the yellow and blue edges on either side are shifted into one another and the mixture of the colors provides green. With a thin, dark object on a bright background, the overlap of the violet and red edges provides purple.

From the physico-optical viewpoint, it is an untenable interpretation that edge spectra should be caused by principal and secondary images and their resistance to displacement. In the case of a wide slit, the edge spectra can be demonstrated to result from the overlap of monochrome slit images, as illustrated in Fig. 7b. For greater clarity, the slit images of the individual colors are shown in a vertical arrangement.

On the right, (starting from 1), the red edge spectrum is very obvious because both red and yellow are fully represented here. On the left in the illustration, the blue edge spectrum is visible (at 1' and 2'). At the position marked with 4, all colors are present and produce white.

Extraordinary observations were made by *Goethe* on the "negative slit" (Fig. 8a): Unlike the experiment described above, a broad black strip is viewed against a white background through the prism. An unusual "reversed spectrum" is observed here, displaying the respective complementary colors of the previously described edge spectrum. The formation of this "reversed spectrum" can be demonstrated in Fig. 8b.

Starting at the top, a dark field should be drawn in the middle between the strips of the same color. The background at 0 and 0' – previously black – is now white because all colors are present here. The previously white center at 4 is now black due to the lack of any color. On the left, the sequence of colors towards the edge is red (3'), reddish yellow (2') and yellow (1'), and on the right violet (3), blue (2) and bluish green (1). *Goethe* lists the following "elements" between white and white, from right to left: blue, bluish red, black, reddish yellow, yellow (Theory of Colors; Didactic Part § 246), corresponding to the positions marked here with 2, 3, 4, 2', 1'.

If the normal slit or the white strip becomes increasingly narrow, the standard prismatic spectrum is gradually obtained, with green instead of white in the middle.

If the "negative slit" or the black strip becomes increasingly narrow, the red and violet spectral ends overlap at position 4 to form purple, the complementary color of green, as can be seen in the illustration. As a result, the following color sequence is obtained with a thin black strip or negative slit: white, yellow, orange, red, purple, violet, blue, bluish green, white.

"My noble physicist opponents", *Goethe* wrote *Zelter* on March 13, 1822, "seem to me like Catholic clerics set on proving wrong a Protestant from the Council of Trent". *Goethe's* opponents always used a method based on the laws of physics to assess and refute his Theory of Colors. This was exactly the method which *Goethe* rejected and for which he substituted an aesthetic approach.

Literature
[1] *Buchwald, E.*: Fünf Kapitel Farbenlehre, Mosbach/Baden 1955.

See You in Africa

Around midday on August 11, 1999, millions of people cast their eyes expectantly toward the heavens. They were waiting with bated breath for a total solar eclipse that was to be visible within a 100 km-wide zone extending from the south of England to India - the one to be seen this century in Germany. However, very few actually managed to see the dramatic corona surrounding the sun as the moon moved in front of it. The hopes of many people were dashed, as the thrilling spectacle was concealed behind a thick cover of cloud.

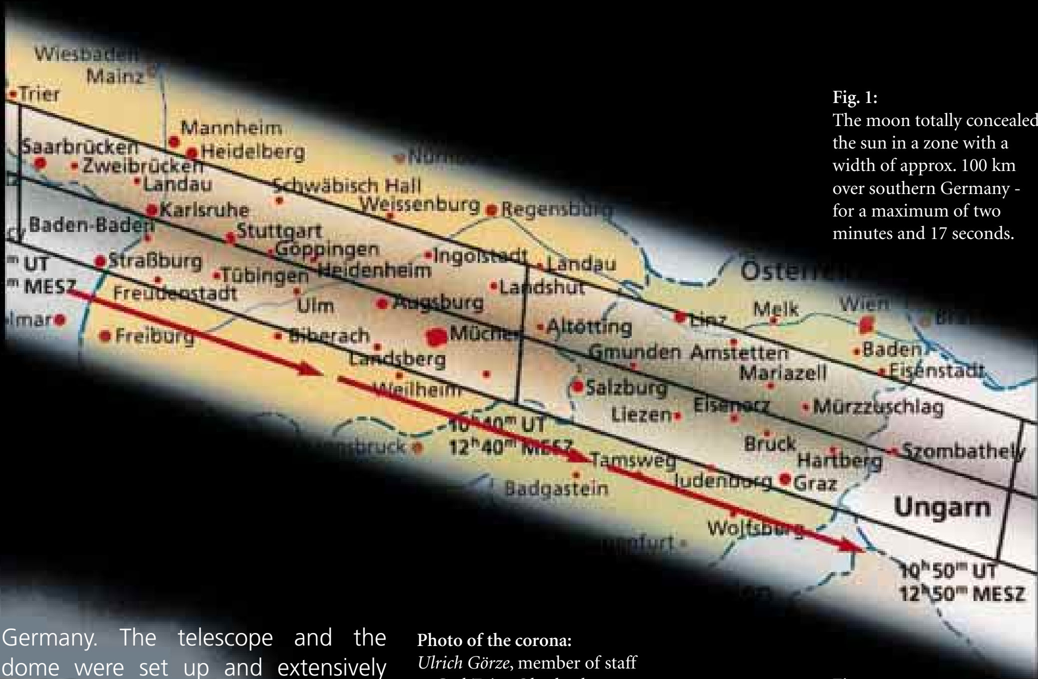


Fig. 1:
The moon totally concealed the sun in a zone with a width of approx. 100 km over southern Germany - for a maximum of two minutes and 17 seconds.

All with an eye to safety

Solar eclipses cannot, of course, be observed with the naked eye: the media in countries across Europe had appealed to the public beforehand to ensure that their eyes were properly protected during the event. Special solar eclipse glasses which reduce harmful solar radiation by a factor of 1 : 100,000 and hence allow safe observation of the sun shield the wearer against both dangerous UV and infrared light and visible glare. A total of 18 million pairs of these glasses were sold on the market, including about 5 million from Carl Zeiss via eyecare professionals or direct distribution channels.

TV pictures with telescope optics by Carl Zeiss

Right on time for the event, the Welzheim Observatory in the Swabian-Franconian Forest in the south of Germany, the observation station of the Carl Zeiss Planetarium in Stuttgart, received a special, new telescope containing central optics from Carl Zeiss. The first task given to this instrument was to support the astrophysical activities during the last solar eclipse of this century in Germany. The telescope and the dome were set up and extensively tested by the firm Baader Planetarium based in Mammendorf near Munich. The heart of the installation, a 150 mm APQ objective lens from Carl Zeiss with a focal length of 1200 mm, provides razor-sharp, detailed and color-corrected images of the sun. Numerous accessories in the specially installed 5 m dome allow photos of such solar activities as sunspots, protuberances or faculae. During the total solar eclipse, the sky over Welzheim was only slightly cloudy, allowing the solar corona to be very impressively observed. Pictures from the telescope were transmitted live by German and European television. The German channel "Südwestfunk" also offered the pictures taken with the solar telescope in Welzheim live on the web.

Africa's turn next time

Despite the inclement weather conditions, the total eclipse was nonetheless an unforgettable event. The next one – at least in these spectacular dimensions – will not take place until June 21, 2001 in Africa. People in Germany have a longer wait ahead of them - until September 3, 2081!

Photo of the corona:
Ulrich Görze, member of staff at Carl Zeiss, Oberkochen.

Fig. 2:
Wearing protective eyewear from Carl Zeiss, the Premier of Bavaria *Edmund Stoiber* (top) and the President of the German Parliament *Wolfgang Thierse* observed the solar eclipse in Oberpfaffenhofen near Munich.
Photo: dpa.

Show Me Your Glasses and I'll Tell You Who You Are

Guenter Möller

Guenter Möller conducted this work with d...c brand & design consultants, Frankfurt, Germany, one year ago. He is currently Managing Director of brandware partners Ltd., London and Frankfurt – a consulting company specializing in strategic product and brand planning.

On the basis of extensive product, design and market analyses, Carl Zeiss has drafted a new positioning strategy for eyeglass frames and has now implemented it in the form of new collections. When devising the new approach to design embodied in the new frames, Carl Zeiss closely examined the preferred styles and esthetic motivations of eyeglass wearers. The following provides a short summary of some of the interesting results obtained.

An evaluation of market observations shows that "type matching", i.e. "What suits my personality as an individual?" – is the key unifying motive behind all purchases of prescription eyewear – to a greater extent than fashion, design, comfort or price. Underlying this key motivating factor is a mindset oriented

"Designers by Zeiss", No. 1: Continuum, Milan

"Designers by Zeiss" – an exciting part of the collection "Zeiss. High End Eyewear." That will be regularly renewed. Internationally acclaimed designers will be providing their own personal interpretation of the subject "The Future" – without ostentation or decoration, but with a lot of surprises. In the first collection, the firm Continuum, Milan, shows its vision of what an eyeglass frame should be. The small, highly specialized teams by no means confine their work to product design, but are also active in such fields as interior design and product planning. The firm's credo: "Design is a function that simplifies the object and highlights the utility of the product". In frame design, this means keeping the materials used to produce the models, e.g. monel, nickel silver or aluminum, as authentic as possible to ensure that their natural structure and composition are prominent. The various components used should never have a predominantly decorative function: with its different material and craftsmanship, for example, the joint should underline its bearing function. For Continuum, design is much more than merely determining the outer shape and appearance of a product: it is the "interface between technology and people".

toward certain ideals or role models and collective esthetic aspirations. Understanding these fundamental connections between basic archetypal styles (including rectangular, oval and circular shapes) and the esthetic orientation of eyeglass wearers was a further step in the development the new Zeiss brand culture which finds expression in the current, initial collection called "Zeiss. High End Eyewear."

Type matching and role models

"Type matching" means firstly that our own personality type, the impact of our own facial features, can be complemented by the styling of our eyeglass frame. The acceptance or rejection of a frame style will thus depend on the degree to which the statement made by the frame style matches our preferred taste or role model.

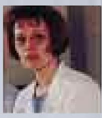
Our ideals are derived from our personal perception of a lifestyle and personal ethos that we consider desirable and that influences the way we think and act. What appeals to us is determined by factors stemming from upbringing and experience, contemporary phenomena and our personal environment.

In analyzing these factors, Zeiss considered the question of whether such ideals and aspirations could be typologized. An attempt was made to identify standard groups of eyeglass wearers who exhibited similar stylistic preferences. And sure enough, on closer examination, certain basic ideals emerged.

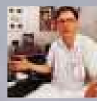
Without any claim to universal applicability or empirical validation, five ideals were identified and visualized in a series of collages. These ideals represent an entirely new framework for comparative esthetics and personal perceptions in the eyewear market. The basis ideas behind this type of market analysis are a further logical development of former target group definitions.

The brains behind the collections: Hannes Wettstein, co-founder and partner of 9D Design, Zurich, Switzerland, winner of many awards, and professor at Karlsruhe Design School, Germany.

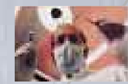
The designer *Hannes Wettstein* uses a metaphor to explain the way he works: "I meet an Egyptian who doesn't speak English or German, and I certainly don't speak any Arabic. So we have to try to use a sort of sign language. In this way, a totally new language can result, one which provides some surprising solutions." This little anecdote shows that for the creator of "Zeiss. High End Eyewear." design is more than form and style. *Wettstein* gets to the very heart of things and their function. And that means entering into an in-depth dialog with both the manufacturer and the potential user. This was also the approach adopted by the well-known Swiss designer when working on the now famous "Metro" low voltage lighting system. The idea was as simple as it was ingenious: inspired by the principle behind cable car systems, *Wettstein* transported light through a cable system. Along the same lines, it was not the intention of the Master of Reverse Thinking (the nickname used by his students) to reinvent eyeglasses for "Zeiss. High End Eyewear." He was much more interested in the functional aspects of the individual components. If his analysis has resulted in the creation of new shapes, then this really is Design by *Hannes Wettstein*.





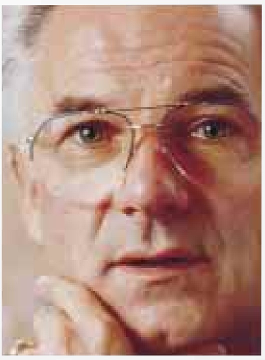





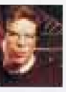
"The Specialist"

Yes, they are still with us, double bridge eyeglass frames. As the long-established answer to the esthetic ideal of older technocrats, engineers, scientists and – depending on their persuasion – politicians (also see "The Diplomat"), the strong geometrical form and compact structure of this frame emphasizes "knowledge". A common attribute of this group, whose function as role models is










likely to remain constant in the foreseeable future, is the desire for structure, precision, control and analysis.

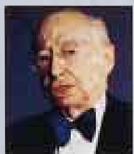
"The Carer"

While the achievers want frames to underline professional competence and vision, the caring among us want their eyewear to express social responsibility, reliability and trustworthiness. This type of person is frequently found in the social or medical professions, where they successfully perform duties involving counseling, supporting, training and protecting. Their frames are typically oval, round or they have rounded corners – archetypal styles that, together with warm materials (acetate, horn) and colors (Havana and earthy tones) are currently enjoying renewed popularity.

"The Achiever"

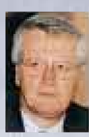
Transparency, lightness and clarity – these are the main stylistic features of the frames preferred by achievers. The word connotes the key qualities of control, domination, leadership and innovation. Most achievers are to be found in the ranks of top management. Achievers want a eyeglass frame that underlines the much needed – but sometimes lacking – professional competence and interpersonal skills of the manager. A species whose function as a role model continues to be high – and not just for up-and-coming managers.









Glasses as a Means of Self-Expression

"The Diva"

We often recognize this type by the highly decorative and glamorous frames they wear and with which they express their charisma, their artistic sensibilities. Divas have no interest in products that are traditional or conventional, but favor extravagantly decorative styles with the aim of setting themselves apart and inspiring admiration.
They usually opt for lavishly decorated frames that many people consider to be showy and ostentatious.





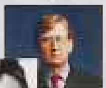

"The Diplomat"

To put the above analysis to the test, we had a look at a group of the population that contains just about all of the ideals and "role models": our politicians or "the Diplomats". The "technocrats" and "individualists" are undoubtedly over-represented here, with true "achievers" or "carers" rather thin on the ground. With its members constantly in the limelight and in the public eye, the effect conveyed by this group is no longer simply a matter of personal taste. PR and image consultants are extremely active in this "market" – even if the opposite would often seem to be the case! However, only in very few cases do they actually manage to create a new role model, but tend to gear their work toward the grouping given above.










"The Individualist"

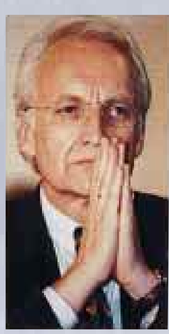
Everybody knows one – the eternal individualist, the self-promoter. With a tendency to stylization and publicity-seeking, these people like their eyeglass frames to proclaim their individuality from afar. With the reductionist and archetypal basic styles they prefer, their faces become a stage with the frame as its leading actor.

This group tends to personalize, to enthuse, to emotionalize. Aspiration and reality merge in the living-out of their individual lifestyles, so that the distinction between their personal and business lives becomes increasingly blurred.

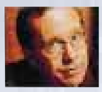
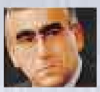










The Colors of Soap

Joachim Rosenfeld

Is it possible to take high-quality photographs of the very delicate colors displayed by the interference phenomenon of a soap film? This was the question I was asked by Prof. Dr. Günter Nimtz and Dr. Werner Klein from the II. Institute of Physics of Cologne University. As I am friends with both gentlemen and they are aware of my enthusiasm for photography I was the next person they thought of. The aim was to create material for a lecture. I rose to this new challenge, and as I became more and more captivated by the beauty of the results I obtained, it was the esthetic aspect that increasingly became the focus of my endeavors.

The device for producing the soap film could not be simpler. A metal tea caddy with a diameter of 8 cm is immersed in soap suds and placed upright. Gravitation then causes the soap film produced to adopt a conical shape, resulting in the formation of horizontal fringes (Fig. 1). By applying pulses of air from a cannula, I managed to bring a bit of life into this stable, but rather dull situation, creating completely new, multi-colored structures which lasted a few seconds. It was when this exciting scenario was in motion that I shot my pictures.

I was surprised at the technical difficulties I encountered when taking the photographs. For instance, the flat soap film cannot be used like a camera-ready copy, as it acts like a mirror. This means that the pictures must be taken at an angle which results in a huge depth-of-field problem at a 1 : 1 reproduction ratio. This requires extreme stopping down of the lens to be able to obtain a picture with edge-to-edge sharpness. The fact that colors only account for approx. 8 % of the incident light in constructive interference explains the large amount of flash energy of 3,000 WS needed.

The camera equipment used consisted of a 553 ELM Hasselblad motor camera with auto-bellows and the excellent 120 mm Zeiss **S-Planar®** f/5.6 macro lens stopped down to 32. The light came from a wafer-area lamp supplied by a Bowens generator. I chose the Fuji Velvia 50 ASA/18 DIN as the slide film due to its high color saturation. With this equipment I took far more than 1000 6 x 6 slides. Using the most attractive of these slides, I created a lap-dissolve show with background music.

I mixed the soap suds myself using sodium oleate and glycerin, adding hydroquinone as an oxidation inhibitor.

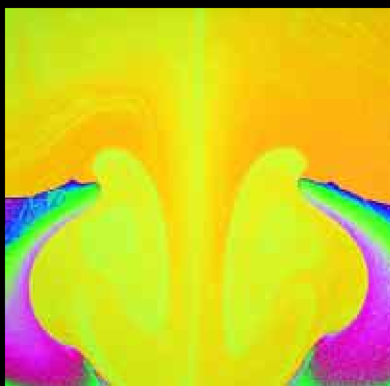
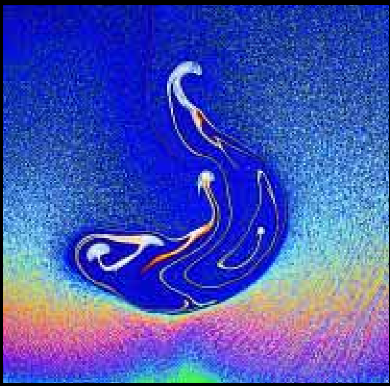
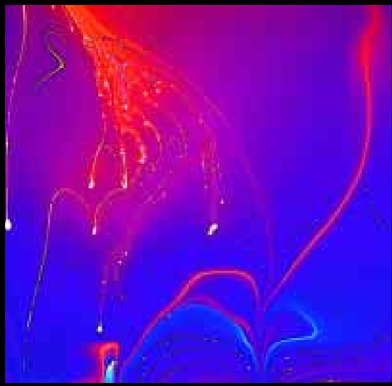


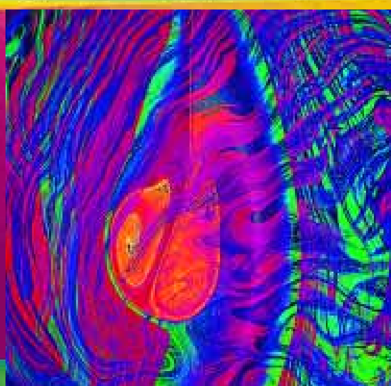
Fig. 1:
Interference on a soap film stood upright (large picture).

Figs. 2 to 8:
Patterns generated by applying whirling action to the soap film.





Dr. Joachim Rosenfeld, Starenweg 42, D-50226 Frechen/Germany, is an ophthalmologist practising in Cologne. His hobbies include photography and classical music. At the early age of 14, he took his first photographs using a Kine Exakta and a 58 mm Zeiss Biotar f/2 lens. Later, he added comprehensive Hasselblad and Contax camera systems with a total of 28 Zeiss lenses to his equipment.



Made in Rio de Janeiro

Eyeglass lenses from Carl Zeiss are certainly no stranger to the South American market. However, to actually buy them, hurdles in the form of long import processes and high import duties had to be crossed in the past.

Fig. 1:
The Mayor of Rio de Janeiro, *Luiz Paulo Conde*, speaking during the ceremony held to mark the opening of the new lens factory.

With the opening of a modern lens factory in Rio de Janeiro in Brazil in September 1999, this is now a thing of the past. On-site production in a market that holds great promise for the future offers considerable benefits not only from the viewpoint of faster processing, but also on the price front. State-of-the-art equipment for the machining and antireflective coating of eyeglass lenses has been installed in the new factory. And a highly qualified workforce will guarantee the fast production of top-quality prescription lenses.

This investment in ultramodern production installations and highly skilled staff strongly underlines the intention of Carl Zeiss to firmly establish its ophthalmic products in Brazil and South America. For eyeglass lenses, Brazil offers a growth potential of around 9 %, far in excess of the world average of 2 %. Via the MERCOSUR economic zone, the other important South American markets are easily accessible from Brazil.

Fig. 2:
Highly skilled workers guarantee the fast production of top-quality prescription lenses.

Fig. 3:
Ultramodern equipment for the machining and antireflective coating of eyeglass lenses was imported for the new factory in Rio.

News from South Africa

Uwe Braehmer

Despite its breathtaking natural beauty, the country at the Cape of Good Hope is no paradise. South Africa is a country of very great contrasts – and an interesting market in which Carl Zeiss does good business despite a difficult economic scenario.

The 100-strong workforce of Carl Zeiss in South Africa, from which the markets in Swaziland, Lesotho, Namibia, Botswana and Zimbabwe are also covered, contribute an annual sales figure approaching DM 20 million to the Carl Zeiss Group. "The name Zeiss enjoys a very high standing here", says *Ernfried Sehnke*, the new President of Carl Zeiss (Pty.) Ltd. in Randburg near Johannesburg. In the past few years of political uncertainty, the excellent reputation of Zeiss products has helped to sustain instrument and system sales

in the areas Medical Systems, Microscopy and Industrial Metrology. The automotive industry in particular is suffering from lower import duties and the reduced buying power in the country. "We are currently using a telemarketing campaign to ask our metrology customers in the car industry and its subcontractors what their concrete requirements actually are. In this way, we aim to enhance service quality – a factor which is now becoming more and more important", explains *Sehnke*.

However, the real cornerstone of business for Carl Zeiss is ophthalmic products which account for around 50 % of overall sales in South Africa. Prescription labs in Johannesburg, Cape Town and Bloemfontein supply the country's eyecare professionals with Zeiss quality. While glass lenses are particularly popular, eyeglass frames and contact lenses from Carl Zeiss have not yet achieved any major degree of success. "Inhibiting factors here include the typical taste and preferences of the South African population and the high price level of Zeiss frames. The more than 150,000 frames that we sell in the country every year are specially designed for this market", explains *Volker Antes*, the manager in charge of ophthalmic products in South Africa.

A further mainstay of business in the South African subsidiary is medical systems and microscopes. In the field of surgical microscopes in particular, Carl Zeiss has a good name in South Africa. "However, the state is providing less and less money for the public health service, with the result that private hospitals are increasingly becoming important clients for us," is how *Sehnke* describes the current trend.

Finally, there is a very special type of merchandise marketed by the Zeiss company in South Africa that enjoyed a real boom in the past thanks to the numerous gold, platinum and diamond mines scattered across the country: precision and analytical balances from the firm Sartorius in Göttingen, Germany.

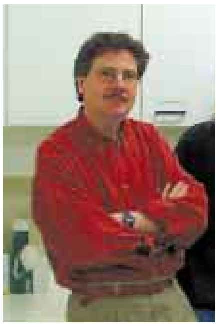
Despite the difficult economic climate, the committed team of the South African sales company has set itself the goal of sustaining sales and expanding new business in some individual segments of the market, in particular by providing customers with even better service.

Figs 1 to 4:
Impressions from South Africa.
1 and 3:
The city of Cape Town with a view of the harbor and the famous Table Mountain in the background.
Photos 1 to 4: dpa.

Fig. 5:
Mr. *Tshabalala*, who works in the shipping area of Carl Zeiss (Pty.) Ltd. in Randburg, was proud to receive his certificate in honor of 25 years of service to the company.

Fig. 6:
President *Ernfried Sehnke* and employee *Alexander Richter* (standing from left to right) with a customer at an **Axiovert® 100 M CARV** microscope.

Award-winning Confocal Micrograph



Dr. Ger J. A. Ramakers won first prize in the Olympus/Current Biology competition with his highly impressive micrograph. He works in the Netherlands Institute for Brain Research, Meibergdreef 33, 1105 AZ Amsterdam ZO, Holland.

In 1998 biomedical researchers worldwide were invited to participate in the Olympus/Current biology Photomicrograph Competition. Among more than 700 entries, first prize was unanimously given to *Dr. Ger Ramakers* from the Neurons and Networks Group at the Netherlands Institute for Brain Research.

The winning photomicrograph was taken with a digital camera on an **LSM 410** inverted confocal laser scanning microscope with **Axiovert® 135M** from Carl Zeiss. It shows a 23-day-old neuron dotted with presynaptic terminals in which regions important for information transfer were stained with immunofluorescent methods in green, red and blue. The fine structure is well resolved by a 40x **Neofluar®** objective with a numerical aperture of 1.3.

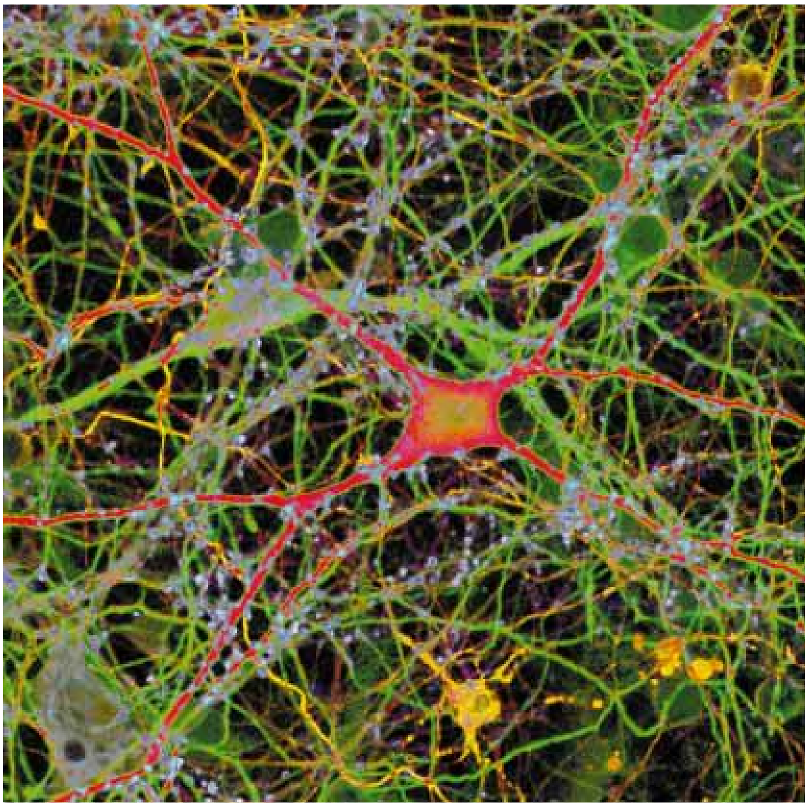
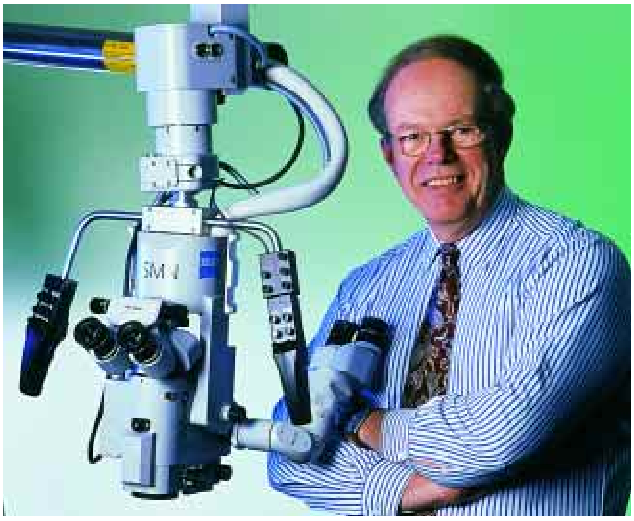


Photo:
An almost mature neuronal network in tissue culture. On the cerebral cortex neurons which were cultivated for 23 days, the inhibitory neurotransmitters were stained with GABA green and the excitatory neurotransmitters with aspartatic acid in red. The blue dots are synapses/synaptic contacts stained with synaptophysin.



New in New York

Equipped with state-of-the-art navigation aids, surgical microscopes from Carl Zeiss point the way to the future of microsurgery. The demand for these leading-edge systems is growing right across the globe.

James J. Kelly, the new President and CEO of the American subsidiary Carl Zeiss Inc. in Thornwood, NY, seen here at an SMN System, is responsible for the US market.

Zeiss Optics No. 1 for Hunters

Fig. 1:
Peter Däpp, Binoculars Division, Carl Zeiss, receiving first prize for the best riflescope for hunting roebucks (Zeiss **Diavari®** VM/V 2.5 – 10 x 50) and the best binocular for hunting roebucks (Zeiss 7 x 45 B T* **DesignSelection**) from *Rüdiger Klotz*, editor-in-chief of "Wild und Hund" magazine.

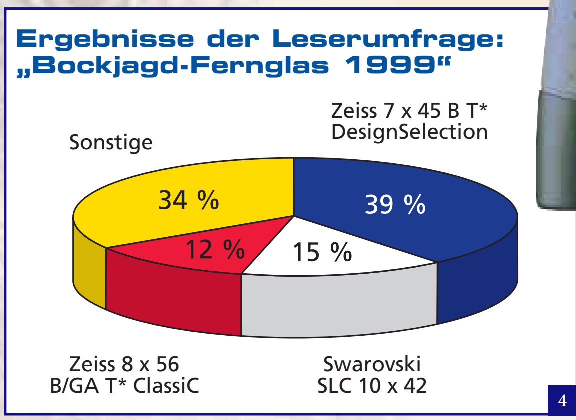
Fig. 2:
7 x 45 B T* **DesignSelection** binocular.

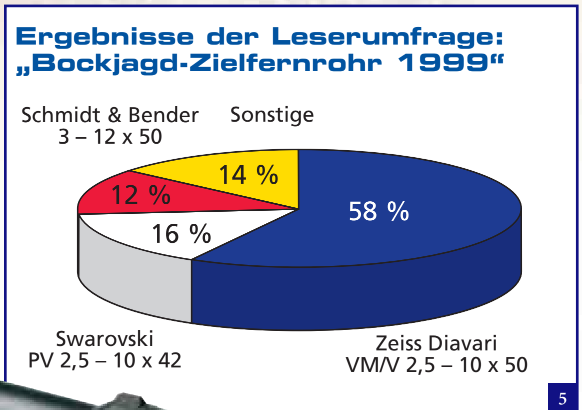
At the International Fair for Hunting and Sports Weapons, Outdoor Wear and Hunting Accessories in Nuremberg, Germany, IWA in short, more than 900 companies from 43 countries displayed the range of hunting optics, hunting weapons and accessories available on the world market.

On the opening day of the fair, "Wild und Hund", the most important national German hunting magazine, awarded prizes to the winners of a broad-based readers' survey in which more than 5000 readers selected what they thought to be the optimum equipment for hunting roebucks. They were asked to name the best hunting weapon, the best spotting scope, the best bullet, the best riflescope and the best pair of binoculars for hunting roebucks.

As in the surveys of previous years, Zeiss hunting optics once again proved to be extremely popular with hunters. From 35 specified riflescopes, the Zeiss **Diavari®** VM/V 2.5 – 10 x 50 from the **Victory** line came first with 58 % of the vote, an outstanding result. The factors crucial to this success were most certainly the superb image quality and the high twilight performance provided by this scope, its large field of view, short design and low weight. In the binoculars assessed, the Zeiss 7 x 45 B T* **DesignSelection** came in first with 39 % of the vote due to its unparalleled image quality. With 12 %, another Zeiss binocular, the 8 x 56 B/GA T* **ClassiC** got third prize – testifying to the undiminished popularity of this traditional binocular.

This recent survey impressively demonstrates Zeiss' leadership in the field of hunting optics in Central Europe.





Figs 4 and 5:
Results of the 1999 "Wild und Hund" readers' survey to discover the optimum binoculars and riflescopes for hunting roebucks.

Fig. 3:
Diavari® VM/V 2.5 – 10 x 50 riflescope.

First the Carl Zeiss Research Award, Then the Nobel Prize

The Egyptian Ahmed Zewail was awarded the Nobel Prize for Chemistry in 1999 for his pioneering work on the observation of ultrafast chemical reactions with femtolaser double pulses.

Photo on right:
Presentation of the Carl Zeiss Research Award to *Prof. Dr. Ahmed Zewail* and *Dr. Yoshihisa Yamamoto* in the Carl Zeiss Planetarium in Stuttgart in 1992.

The Carl Zeiss and Otto Schott Research Awards, each presented once every two years on an alternating basis, were created to motivate and promote primarily young scientists in recognition of outstanding work in the field of optics and glass technology.

Both research awards are administered by the Donors' Association for the Promotion of Science in Germany and are advertised internationally in line with the global sphere of activity of both Carl Zeiss and SCHOTT GLAS. Past winners therefore include not only German physicists and chemists, but also scientists from the USA, Japan and other European countries.

The international importance of the award-winners is amply demonstrated by the example of *Prof. Dr. Ahmed Zewail*, who won the Carl Zeiss Research Award in 1992 for his groundbreaking contributions to the field of femtochemistry. With ultrashort laser double pulses in the femtosecond range (1 millionth of a nanosecond or 10^{-15} of a second!), he succeeded in obtaining direct insights into the dynamics of chemical reactions, providing proof of fundamentally new phenomena in molecular physics.

Seven years later, in the fall of 1999, *Ahmed Zewail* received the most coveted of all scientific awards, the Nobel Prize. His pioneering work on the direct observation of ultrafast reactions in gases, liquids and on surfaces in real time have now provided many new insights into chemistry, giving a dramatic boost to an entire scientific discipline.

Nobel Prize for Medicine

Nobel prizewinner *Günter Blobel* in his lab at the Rockefeller University in New York.
Photo: dpa.

The 1999 Nobel Prize for Medicine was won by *Günter Blobel*, a cell and molecular biologist of German extraction who has been working at the New York Rockefeller University for more than 30 years. He received the award for his pioneering research into proteins. *Blobel* has increased our understanding of how proteins are transported and how they reach their destination. His research has helped scientists to gain more insight into various hereditary diseases which are attributable to deficient protein traffic. With his trail-blazing discoveries, *Blobel* has also played an important role in advancing techniques used in biotechnology and genetic engineering. A better understanding of the processes in the mammalian cell now makes it possible to optimize the performance of biological systems for the benefit of mankind.

At the Howard Hughes Medical Institute of the Rockefeller University in New York, *Günter Blobel* also works with Zeiss microscopes, including the **Axiophot® 1** photomicroscope and the **Axiovert®** microscope.

Günter Blobel numbers among the most fervent supporters of the reconstruction of the Frauenkirche church in Dresden which was destroyed in World War II and will donate part of his prize money to the reconstruction not only of the church, but also of the synagogue in Dresden and of historical buildings in Furbine, Italy.

Otto Schott Research Award

Nowadays, laser technology is an absolute must for sensor systems, materials processing, medicine or telecommunications. Here, glass plays an active role as a laser medium. The two American scientists Professor *Elias Snitzer* (Rutgers University, Piscataway, NJ) and *Dr. John H. Campbell* (Lawrence Livermore National Laboratory, Livermore, CA) received the 1999 Otto Research Award for their exemplary work in the field of laser glass research. The prize, to which the sum of DM 50,000 has been allocated, was presented during an international congress on glass science held in Prague in June 1999.

Elias Snitzer is one of the pioneers in the field of laser glass research. Scientific brilliance, creativity and in particular the ability to identify technologies of key importance for the future have characterized his work for over 40 years. He was the first scientist to prove the suitability of glass for use as an active laser material. His visionary inventions include both neodymium- and erbium-doped laser glass. In another far-reaching discovery that preceded today's communication devices by 30 years, *Snitzer* co-developed the first fiber optic laser amplifier with laser glass.

John H. Campbell was given the award for his leading role in the development, characterization, production and application of optical materials for high-peak-power lasers, and of multicomponent phosphate laser glass in particular. His work has made a major contribution to the building of large high-peak-power laser systems such as the National Ignition Facility (NIF) in the US and the Laser MegaJoule (LMJ) in France.

Fig 1:
Presentation of the 1999 Otto Schott Research Award to *Prof. Elias Snitzer* (2nd from left) and *Dr. John H. Campbell* (2nd from right) by the trustees of the Ernst Abbe Fund (from left to right) *Prof. Gerd Müller*, *Dr. Udo Ungeheur*, *Prof. Donald Uhlmann*.

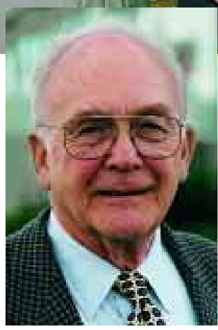


Fig. 2:
Prof. Elias Snitzer.

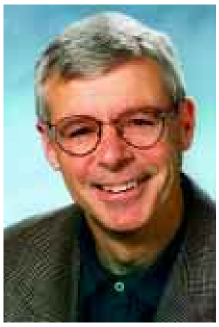


Fig. 3:
Dr. John H. Campbell.

First Place for Zeiss Lens

Carl Zeiss won an award in the survey conducted every year by Color Foto, a German photo magazine, in which readers are asked to select "the best photographic products". In the category "medium-format lenses above DM 1,000", the 120 mm **Apo-Makro-Planar T*** f/4 lens for the new **CONTAX®** 645 came in first with 48 % of the vote for this category. Second place obtained 29.6 % and third place 11.8 % of the vote.

Presentation of the award for the medium-format 120 mm **Apo-Makro-Planar T*** f/4 lens by "Color Foto".

Leonardo da Vinci in Action

Heinz Gundlach

Dr. Heinz Gundlach, a member of the Central Research and Technology Division at Carl Zeiss, is the Manager and Coordinator of the pilot project "Initial and Continuing Training of Biologists and Medical Professionals in Microscopy" and has played a key role in the implementation of the events.

The LEONARDO DA VINCI action program for vocational training in the European Union also promotes cooperation between universities and industry. Carl Zeiss is now represented in this program as the leader of the project "Initial and Continuing Training of Biologists and Medical Professionals in Microscopy".

Innovations in microscopy, the development of new instrument systems and techniques, and the emergence of new fields of application all make it necessary to adapt initial and continuing training in biology and medicine to the state of the art in technology. To ensure that training can keep pace with the extremely rapid developments in science and technology, the appropriate courses must be held in universities and research institutes.

In-depth transnational courses aimed at providing participants with the latest knowledge in modern microscopy therefore constitute a new approach in vocational training which has not been contained in European university education before. Partners from various countries – lecturers in the courses and additional guest tutors from industry and research – are now making European cooperation in the field of vocational training a reality. The resultant high level of the courses allows scientific knowledge, application techniques and experience to be communicated simultaneously to the participants.

In the pilot project "Initial and Continuing Training in Microscopy" which is being supported by the European Union by the provision of funds for personnel and travel expenses as well as for materials, basic courses have already been held on the subjects Image Formation in the Microscope, Illumination and Contrasting Techniques, Conventional and Digital Fluorescence Microscopy, and the Basics of Photomicrography and Digital Image Processing.

Courses, seminars and workshops are also being offered to post docs and scientists on various subjects, e.g. Video Microscopy, Digital Fluorescence Microscopy, Methods and Applications in Cell and Molecular Biology, and Molecular Genetics.

The partner countries are Italy with the University of Pavia (*Prof Dr. I. Freitas, Prof. Dr. C. Pellicciari et al*), Austria with the University of Innsbruck (*Prof. Dr. G. Wick et al*), and the German Cancer Research Center in Heidelberg (*Prof. Dr. M. Trendelenburg, Dr. S. Joos, Dr. J. Kartenbeck, Dr. L. Langbein et al*). Even at this early stage, it is already evident that the initial and ongoing specialist training has improved not only the students' knowledge of microscopy and the associated fields of application, but also the quality of the microscope work performed. The goal is to create training modules in the form of compendiums and electronic media, e.g. CD-ROMs, which can then be passed on to other institutions and other European countries – a further step toward the further networking of Europe.

To date, two basic courses ("Light Microscopy and Photomicrography Techniques") have taken place at the University of Pavia, as well as three symposiums on the subjects "New Frontiers of Optical Microscopy in Cell Biology", "Basics in Fluorescence Microscopy and Fluorochromes" and "Investigating Cell Dynamics and Death by Conventional and Confocal Microscopy". The Cancer Research Center in Heidelberg has been the location for two special courses dealing with the topics "Video Enhanced Microscopy, Digital Imaging and Fluorescence Techniques in Cell Biology" and a symposium entitled "Biomedical Photonics".This year also saw the first hands-on courses and seminars on the "Morphology of the Cytoskeleton", "Methods of Molecular and Cell Biology" and a practical course on human genetics for bio-

Fig. 2:
Training course in immunofluorescence in Innsbruck in 1999.
On the left:
Professor Dr. G. Wick.

Fig. 1:
Basic microscopy course in Pavia in 1999.
On the right:
Prof. Dr. I. Freitas.

programm
LEONARDO DA VINCI

Fig. 3 (below):
Microscopy course in Pavia in 1999. On the left: *Professor Dr. C. Pellicciari.*

logy, medical and dental students in collaboration with the University of Heidelberg.

In Innsbruck a training course has taken place on the subject "Immunofluorescence and Immunohistochemistry" and will be repeated in February 2000 to meet the high level of demand.

For the first time in the LEONARDO program in 1999, Carl Zeiss held an in-depth course in clinical cytology for medical professionals and cytoassistants during the Medica exhibition in Dusseldorf, Germany.

This project will run for three years and ends at the beginning of the year 2001. Further inquiries have since been received from other European countries who wish to conduct similar courses and seminars.

You can find more information in the Internet under:

- europa.eu.int/pol/educ/info_de.htm#leonardo
- www.unipv.it/webbio/anatcomp/leonardo/leonardo.htm
- www.zeiss.de/mikro

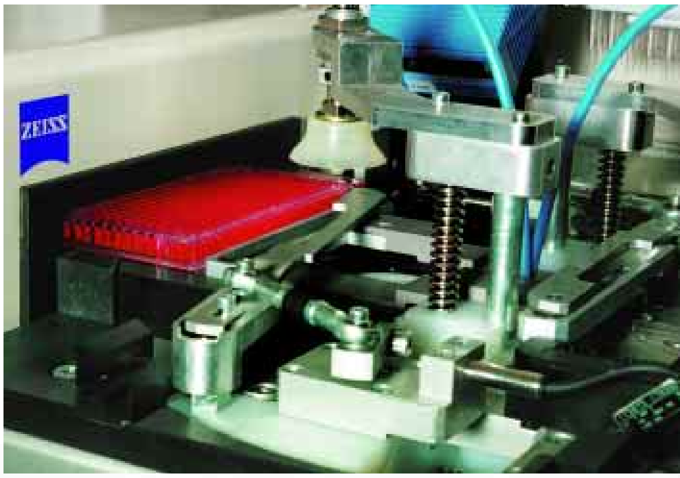
New Standard in Screening Systems

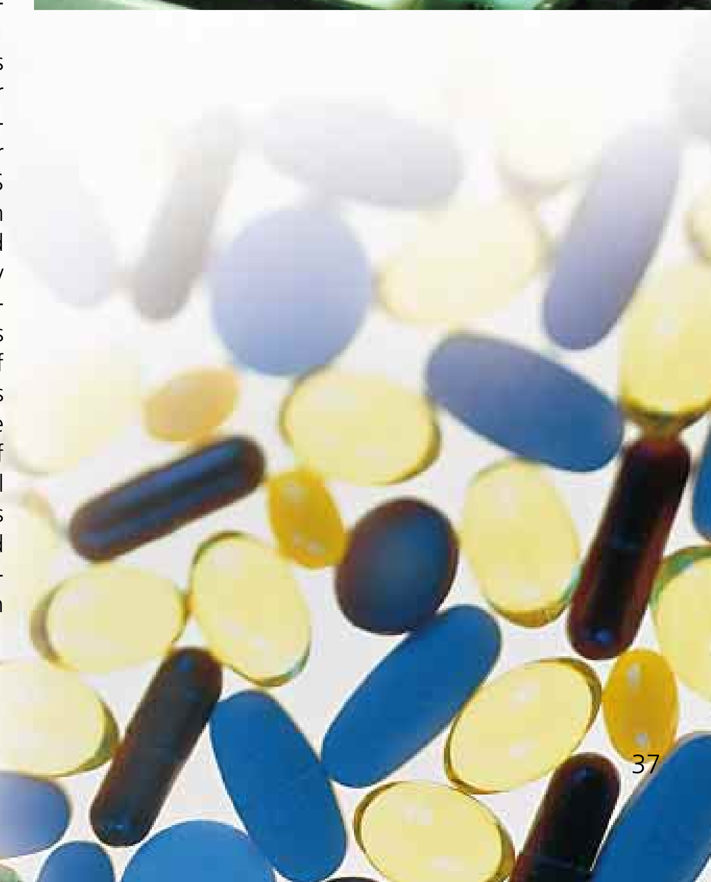
In September 1999, after the successful joint development of a new Ultra High Throughput Screening (UHTS) system started in the fall of 1997, Roche and Carl Zeiss Jena agreed to install the currently most modern UHTS system in all the Roche pharmaceutical research centers throughout the world. The contract covers the installation of six systems. Thanks to their modular and compact design, the systems ideally meet the requirements of the various research centers. Worldwide installation will include the Roche research centers in Switzerland, Germany, England, Japan and the USA. This means that Roche will be the first company to have access to the new UHTS technology from Carl Zeiss.

In the search for new drugs, the protein structures playing a major role in the progress of a disease (drug targets) are systematically examined for their interactions with potential effective substances available from extensive Roche substance libraries. The screening of large substance libraries is aimed at finding suitable drugs quickly and making them available for the subsequent development of pharmaceuticals.

The new UHTS system from Zeiss allows up to 200,000 samples per day to be examined for their efficiency in up to 10 measurements per sample. The centerpiece of the UHTS is a new kind of detection system (Multi-Channel Reader), combined with a newly developed technology and control software for the processing of microplates in which the tests are performed. The miniaturization of test volumes by using microplates with 384 or 1536 wells (sample chambers) results in drastic savings of the biological reagents and chemical substances used. The reader with its 96-channel optics specially designed for this purpose permits the high-precision analysis of 384 samples in 4 steps, or 1536 samples in 16 steps, within only a few seconds. The Zeiss reader performs all the optical detection methods (fluorescence, luminescence and absorption measurements) normally used in biological screening for the detection of interactions between potential effective substances and drug targets, and thus ensures efficient drug research with a high sample throughput.

Photo:
Transport of a 384-well microplate from the turntable of a workstation to the multi-channel reader (left). Carl Zeiss has based this new transport technology on a decentralization strategy to permit high flexibility within single workstations; these are connected in a row through a bi-directional transport belt.





Digital Photogrammetry Focused on the Future

The Carl Zeiss Photogrammetry Division has paved the way for the future by co-founding Z/I Imaging Corp., a joint venture of Carl Zeiss and the US software company Intergraph Corporation. Intergraph is one of the world's leading providers of engineering, mapping/GIS and IT solutions for the process, building, utilities and transportation industries. Carl Zeiss has long-standing experience and an excellent reputation in photogrammetry, especially in the areas of camera and plotting systems. The new company provides photogrammetric image processing software as open solutions both on UNIX systems and on a Windows NT platform. The product range also includes aerial survey cameras for mapping and reconnaissance applications. Another focus in the joint venture's work is R&D to create new products for photogrammetry, mapping and airborne reconnaissance. In addition to providing continued support to the customers of the two former companies, the joint venture aims to address new customer groups in industry, government authorities, the building sector and in data imagery services with its comprehensive product spectrum.

The headquarters for the consolidated global operations of Z/I Imaging Corp. is Huntsville, Alabama/USA. The European business activities of the new joint venture formed by Carl Zeiss and Intergraph are managed from Oberkochen.

Rights of Use for DNA Chips

Carl Zeiss Jena has acquired the exclusive rights of use worldwide for a new generation of DNA chips for cancer diagnosis developed by the German Center of Cancer Research in Heidelberg (DKFZ). Together with scientists from the center, the company intends to develop new diagnostic techniques with which cancer-inducing genetic defects can be detected with a high degree of sensitivity, to the point of market maturity. The chip reader required for this comes from Carl Zeiss. The signing of the license agreement "now allows the development of the new DNA chips for routine use in research and hospitals", said *Dr. Peter Lichter*, manager of the department for the organization of complex genomes at the DKFZ who developed the new technique together with *Prof. Dr. Thomas Cremer* of Heidelberg University.

Strategic Cooperation

The French Metrologic Group based in Meylan near Grenoble, a system specialist in metrology software, and Carl Zeiss Industrial Measuring Technology, Oberkochen, have entered into a strategic partnership. The objective of this cooperation is to provide those customers who want to use manufacturer-independent software packages with uniform, interlocking solutions. Initially, the cooperation will cover Europe and the USA, but will later be extended to the rest of the world.

With the launch of CMM-OS, the new operating program for coordinate measuring machines, Carl Zeiss is meeting the increasing customer demand for open system architectures. The metrology know-how of Carl Zeiss and the accuracy and reliability of the Zeiss coordinate measuring machines are now therefore being made available to all users of manufacturer-independent operating software. The high competence of Metrologic in the conversion of preowned coordinate measuring machines combined with the powerful "Metrolog II" software perfectly supplements the performance portfolio of Carl Zeiss with the many thousand UNIX software packages sold and the newly developed NT-based PC software solutions.

The Metrologic Group is a major manufacturer of measuring software systems and controls for coordinate measuring machines. The company concentrates its market activities on the modernization of coordinate measuring machines.

157 nm Project

The optical lithography used in the fabrication of microchips is constantly advancing toward smaller and smaller feature sizes. Using increasingly complex and better systems, it is possible to generate finer and finer structures. Currently, a working wavelength of 193 nm and feature sizes of as small as 0.15 µm have been achieved. However, the research and the development of the next generations are already in full swing. The next step is lithography at 157 nm. To implement this step rapidly and successfully, several German companies have formed a consortium which is supported by the German Ministry of Education and Research. Responsibility for the coordination of this project rests with Carl Zeiss.

All steps involved in the complex process of chip fabrication must be reconsidered for the new working wavelength of 157 nm. The material for the optical components – as in the working wavelength of 193 nm, this material is CaF_2 – is being developed and produced by the companies Schott ML and Heraeus. The sphere of responsibility of the companies Lambda Physik and L.O.S. GmbH is laser optics and beam delivery systems for the 157-nm F_2 laser. The photoresist development and the mask process are looked after by the company Infineon Technologies AG (formerly Siemens Semiconductor Division). Responsibility for the overall system rests with the company ASM Lithography.

As a leading provider of optical 193-nm technology, Carl Zeiss is optimally poised to also reduce the working wavelength to 157 nm. Several factors will greatly help the company in this process: its in-depth experience gained in CaF_2 technology from material qualification to the processing of lens elements made of this material, the unique anti-reflection coating know-how acquired in highly specific surface coating, the sophisticated measuring and test procedures used in the manufacture of the optical components, and in system integration.

In the years 1999 to 2001, the basic research and development work regarding the material, the mask technology, the laser and the optical technologies are to be performed as part of the 157 nm project. From the year 2001 onward, the concrete tools and processes will then be developed and are scheduled to reach the application stage from 2003. It is hoped that feature sizes of smaller than 0.07 µm (70 nm) can be achieved from 2005.

In addition to the German 157 nm project, similar group initiatives exist in the USA and Japan.

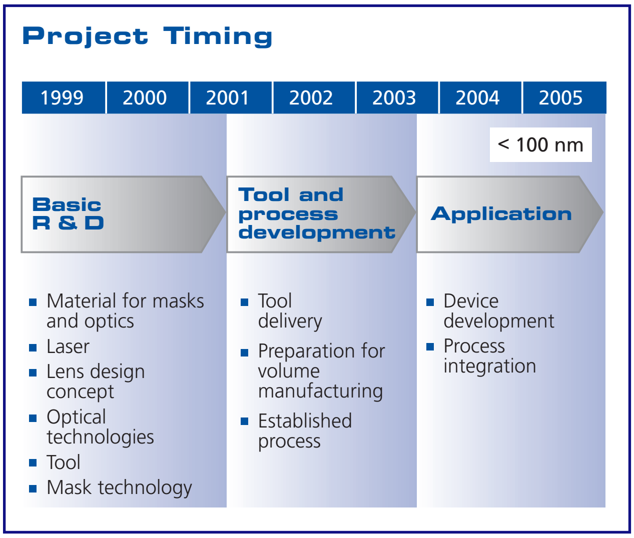


Fig. 1:
Time schedule for the German consortium for 157 nm lithography.

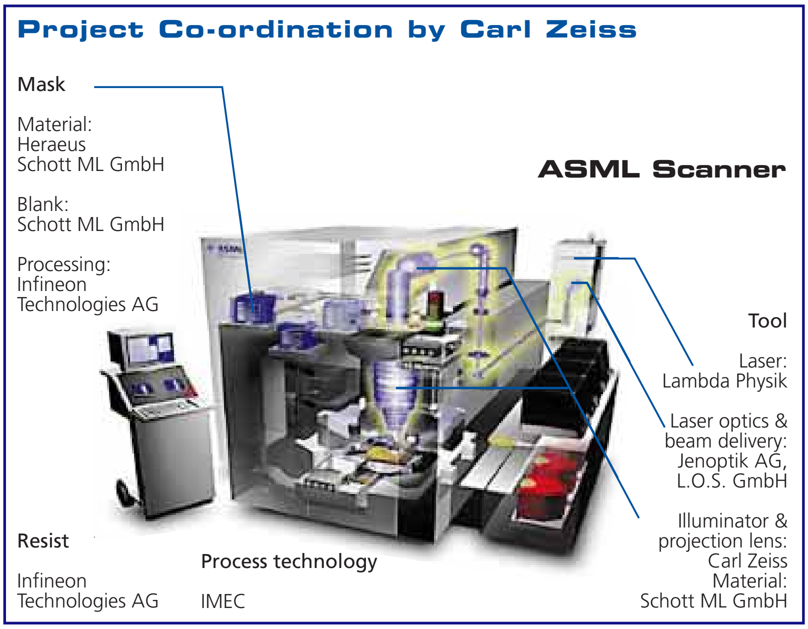


Fig. 2:
The member companies of the German consortium for 157 nm lithography and their responsibilities.

Lenses with a New Dimension of Quality

Photo:
Starlith® 700
semiconductor lens.

A new coating technology for high-performance lenses considerably improves the quality of the exposure systems used in wafer steppers for microchip fabrication. Using a modern software solution as a basis, increased light transmission across the entire lens is achieved. The new coating tools now make it possible to control the coating thickness profile in such a way that it can be adapted to the respective requirements within a specific area or from lens to lens.

This technology developed by Hensoldt AG, Wetzlar, a company of the Carl Zeiss Group, has been adopted in all semiconductor systems supplied by Carl Zeiss. Used as early as 1992 for the exposure systems for the 365 nm, 248 nm and 193 nm wavelengths, this technology is now also used in the **Starlith**® 900, 700 and 400 lithography lenses.

In addition to high-performance lenses, components of interferometers such as **Direct 100** were coated. The new procedure makes it possible to obtain a totally uniform coating across the entire surface of the component, resulting not only in improved light transmission, but also in increased measuring accuracy.

Zeiss with SONY

What on earth was Carl Zeiss doing at the Internationale Funkausstellung (major event for consumer electronics, communications and entertainment) in Berlin in September 1999? The company's cooperation with SONY made it all possible – and the results most certainly turned a lot of heads at the exhibition. Carl Zeiss provided information on its lenses in the SONY digital camcorders and digital still cameras and on the new wide-angle and telephoto converters for these lenses. Also on display was the most recent product of this cooperation, the Cybershot zoom camera which is equipped with a 5x zoom lens.

1

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Figs 1 and 4:
The SONY booth at the Internationale Funkausstellung in Berlin in September 1999 where Carl Zeiss was also represented.

Fig. 2:
DCR-PC100
Digital Camcorder.

Fig. 3:
DSC-F505
Digital Camera.
Photos 2 and 3:
SONY/Wenzel,
Cologne/Germany

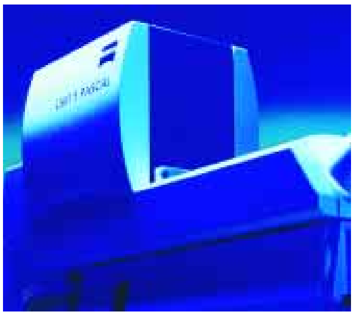
ditioned clean rooms and the utilization of state-of-the-art technologies to provide maximum flexibility, will help Carl Zeiss safeguard its international competitiveness in the field of eyeglasses.

Fig. 2:
Dr. Peter Grassmann, President and CEO of Carl Zeiss, and *Ulrich Pfeiffle*, Mayor of Aalen, at the official opening ceremony.

Figs 3 and 4:
The new facility provides substantially improved production conditions.

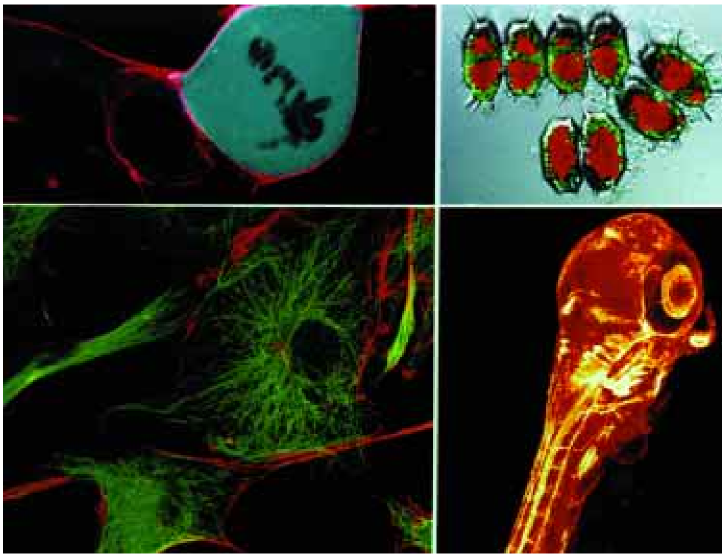
Light Microscopy

The **LSM 5 PASCAL** laser scanning microscope is a high-performance, compact system for individual users and small workgroups involved with biomedical applications, and for material examinations in both routine and research. Due to its confocal technology and scanning procedure, it permits the fast and non-contact fluorescence/reflection recording of three-dimensional microstructures down to the sub-micrometer range. Although the **LSM 5 PASCAL** is available at a surprisingly attractive price, no compromises were made in image quality, flexibility and reliability. Scanning fields of unparalleled size, single images with more than 4 million pixels in up to 4096 gray levels, high flexibility for scanning mode selection, and powerful, user-friendly software are its major benefits. The

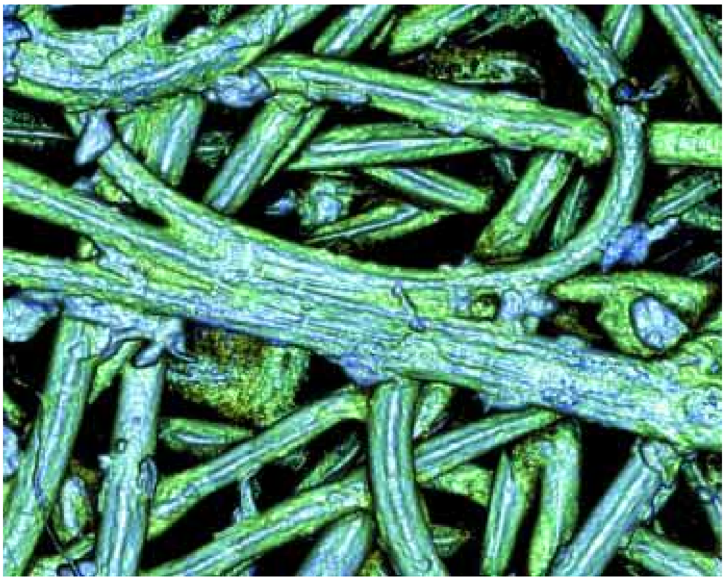


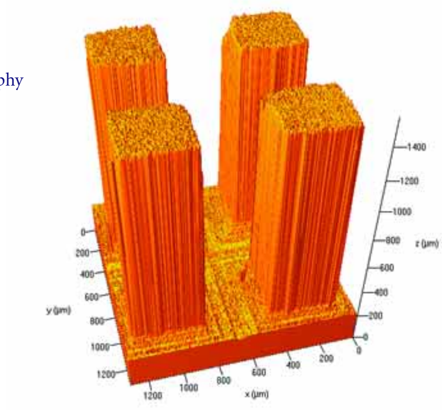
LSM 5 PASCAL laser scanning microscope.

LSM 5 PASCAL user can now fully benefit from the perfect interaction between the fully motorized **Axioplan**® **2** research microscope and the laser scanning microscope. If requirements grow with new applications, the **LSM 5 PASCAL** will keep the pace. For example, a second fluorescence channel and the transmitted-light channel can be retrofitted, up to eight emission filters per channel can be individually changed by the user, and numerous software options, such as enhanced functions for scanning and presentation, are available, to name just a few of the numerous upgrading possibilities. The **LSM 5 PASCAL** will therefore keep in step with your future demands.



Application Examples for LSM 5 PASCAL
Top left: OK cells, mitosis, labeled with eCFP (PSD95) and Alexa546 (Actin).
Top right: Xanthidium cristatum (SAG173.80), 3-channel recording: double fluorescence + DIC.
Bottom left: Endothelial cells, double fluorescence without crosstalk of channels, 2048 x 2048 pixels.
Bottom right: zebra fish embryo, 3-D projection.





Top: 3D illustration of a fiber compound material, taken in fluorescence with "3DforLSM" software, detail: 450 µm x 450 µm x 260 µm.
Right: 3D illustration of the topography of cut PZT ceramic.
(Sample: Fraunhofer Institute for Biomedical Technology, Sulzbach/Germany).

The **Axioplan**® **2 imaging** microscope for fluorescence applications has been optimized for examinations using the FISH (fluorescence in-situ hybridization) and M-FISH techniques in genetics and for multifluorescence applications, e.g. in developmental and cell biology with the wide variety of mutants of GFP. A completely new fluorescence system allows eight different fluorescence images to be recorded manually or automatically controlled by computer. The M-FISH technique, which allows the identification of all 24 human chromosomes through six fluorescence dyes, uses six fluorescence filter sets. The **Axioplan**® **2 imaging** provides numerous new features for digital documentation, particularly for combination with the Zeiss **AxioVision**® software. The high-contrast fluorescence images with optimum resolution which are possible with the

Axioplan® 2 imaging fluorescence microscope.

Axioplan® **2 imaging** make the detection of genetic defects in hereditary diseases quicker and more reliable than with any of the techniques used until now. Outstanding features of the microscope are the improved contrast and the increased detection sensitivity which have been made possible by the so-called "Light Trap" (patent pending) for fluorescence microscopy, and the 8-position filter turret with an unrestricted field of 25 mm which saves time during sample screening. The push-and-click filter changer for high flexibility in the selection of filters permits the installation of a new filter module within seconds without tool or the filter sequence to be matched to the appropriate examination.

The **AxioCam** digital camera permits all users of light microscopes to document their microscopic and macroscopic examinations with high-quality digital images. **AxioCam** provides optimum image quality and ultrahigh resolution both in all biological and medical applications – from pathology, cell research and genetics to neuroscience – and in materials examinations – from metallography and materials analysis to quality assurance, the semiconductor industry and forensic applications. It does not matter which of the standard contrasting techniques in light microscopy (brightfield, darkfield, phase contrast, DIC, etc.) is used. The camera can be easily and conveniently operated via the **AxioVision®** image archiving software, which provides a completely integrated configuration for image acquisition, processing, measurement and archiving in a

AxioCam digital microscope camera.

single program. The ultrahigh image resolution of 3900 x 3090 pixels guarantees loss-free images at full microscope resolution in real color. The resolution can be set in a range from 1300 x 1030 pixels to 3900 x 3090 pixels and matched to the relevant task. The special benefit of the **AxioCam** is that the user requires only a single camera for a variety of applications in microscopy with different resolutions. In addition to convenient camera operation, the **AxioVision®** image documentation system included in the basic configuration permits the processing of the images, the inclusion of text and graphics, and archiving.

The **ConfoCor® 2** is a fluorescence correlation microscope which implements fluorescence correlation spectroscopy in a full-fledged microscope workstation environment. For the first time, it allows biochemists, biophysicists, cell biologists and pharmaceutical researchers to examine the binding behavior of biologically interesting macromolecules, even in living cells. The **ConfoCor® 2** extends the application possibilities of fluorescence correlation spectrometers (FCS). The fluorescence correlation microscope permits the efficient examination of molecular interactions not only in small volumes, but also in living cells for the first time. The benefits of the **ConfoCor® 2** over conventional techniques include a considerably lower sample consumption and higher measuring speeds. The **ConfoCor® 2** permits the new fluorescence cross correlation

ConfoCor® 2 fluorescence correlation microscope.

technique, thus expanding the FCS application spectrum even further. The instrument is fully automated, which means that the user does not have to waste valuable time dealing with the instrument technology.

Surgical Products

The new **OPMI® NCS** on the NC 32 floor stand is setting new standards in its class in terms of price – performance – ergonomics. The new system is based on the "Contraves technology" (suspension system locked in position with magnetic clutches and using counterweights for balancing) introduced by Carl Zeiss in neurosurgery and has been adopted as the worldwide standard for neurosurgical suspension systems. Contraves-type systems provide the surgeon with optimum conditions for moving and positioning the **OPMI®** and with maximum convenience and safety. Further features of this new **OPMI®** system include the Varioskop optics and the high-intensity xenon illumination. The range of time-honored accessories from Carl Zeiss provides many possibilities of adapting the system to different situations in the OR not only in neurosurgery, but also in ENT, mouth and maxillofacial surgery, and in plastic and reconstructive surgery.

The **S8** ceiling mount has been developed for use in ophthalmic surgery, plastic and reconstructive surgery, ENT microsurgery and neurosurgery. This mount provides flexibility, optimum handling and an extremely long arm extension which leaves enough room for the other high-tech units used in a modern microsurgical OR. At the press of a button, magnetic clutches can be released, allowing the **S8** ceiling mount and the **OPMI®** surgical microscope to be moved almost effortlessly. The innovative electronics unit provides many storage possibilities for up to 9 users or applications. User-specific settings of the various microscope functions (lamp brightness, zoom and focusing speed, configuration of the foot control panel) can be activated at the press of a button. The focusing speed and the speed of the lateral movement (X-Y coupling) are dependent on the magnification set, i.e. the speed of these functions is greater with a low magnification providing a larger field of view than with a high magnification and a smaller field of view. Thus, the surgeon never loses sight of the surgical field. With its large, smooth surfaces and internal cable routing, the design of the system also meets the demands made by the OR staff for safe handling and easy asepsis.

OPMI® NCS surgical microscope on a floor stand.

S8 ceiling mount.

Spectral Sensor Systems

The **CORONA** sensor unit offers the possibility of simultaneously capturing and evaluating the visible and near-infrared wavelength range and therefore allows entirely new measuring techniques such as the simultaneous in-line measurement of color and moisture in moving products in the textile and paper industries. The result is enhanced quality, more clarity in production and, consequentially, reduced costs. The sensor units already contain the spectral sensor, the measuring optics, the

CORONA spectral sensor unit.

light source and the necessary interface. Application-specific measuring geometries and accessories also provide solutions to a multitude of measuring tasks. Configurations for color metrics, layer thickness and moisture measurement, the analysis of ingredients in food stuff, and any combinations of these applications are possible. The centerpiece of the **CORONA** measuring head consists of compact and sturdy spectral sensors of the **MMS** family, which guarantee extremely high reproducibility of not only the wavelengths, but also the intensity information. As all kinds of moving parts such as stepping motors or shutters have been dispensed with, high reliability and a permanent and correct state of spectral wavelength are obtained – and all with a scanning time in the millisecond range and with the simultaneous capture of a wavelength range from 350 nm to more than 2000 nm. **CORONA** systems can be used in rough industrial environments and are suitable for portable applications. Depending on the task to be performed, three comprehensive software packages are available.

Camera Lenses

The latest SONY digital camera is equipped with a 5x **Vario Sonnar®** zoom lens from Carl Zeiss. The 7.1-35.5 mm **Vario Sonnar®** f/2.8 lens is a fast, high-performance lens with a zoom ratio of 1:5. The lens fully fills an image field of 4.8 mm x 6.4 mm on the 1/2", 2.1 megapixel detector CCD chip. The focal length of 7.1 mm to 35.5 mm corresponds to a focal length of 38 mm to 190 mm in a high-speed, multi-purpose zoom lens used for 35 mm photography. High-quality optical glass is used for the 10 elements in 7 groups. Together

SONY DSC-F505 Cyber-shot digital still camera with 7.1 – 35.5 mm **VarioSonnar®** f/2.8 lens.

with multicoating, this ensures superb brilliance and color saturation. The superior resolution of details (definition) throughout the entire focal length range is also attributable to the use of two specially computed aspheres. In addition, the optical ray tracing has been precisely matched to the filter and the cover glass of the SONY CCD chip used. Thus, the exacting requirements of a 1/2", CCD image detector with 2.1 megapixels and a Nyquist frequency of 128 line pairs per millimeter are completely met. Even at maximum aperture, the image quality is extremely high across the entire image field.

The high-quality telephoto converter for the digital SONY camcorders (e.g. PC2; PC3; TRV10) with Zeiss optics has been specially matched to the **Vario Sonnar®** zoom lens used in these camcorders. So far, the magnification provided by the telephoto range has often not been large enough to zoom in on an extremely distant object in such a way that it fills the frame. With the 2x telephoto converter, the excellent optical performance of the lens is extended to cover the extreme telephoto range.

Binoculars

The 10 x 30 B MC **Diafun®** binocular is a multi-purpose, high-quality binocular with 10x magnification at a very attractive price. The extremely sturdy binocular housing with its ergonomically successful design accommodates a reliable mechanical system and high-precision optics, securely protected against dust, moisture and temperature extremes. All optical components are provided with a specially matched MC multicoating. This ensures high light transmission and a brilliant, true-color image with high detail recognition even in poor light

Fernglas 10 x 30 B MC **Diafun®**.

conditions. Like all Zeiss binoculars, the new model features special eyepieces which offer eyeglass wearers the full field of view of 96 m at 1,000 m. An internal focusing system allows rapid focusing to a close range of 5 m. These qualities and a light weight of only 450 g make the 10 x 30 B MC **Diafun®** the ideal unit for the hiker and traveler. It is available in a classic black version or in a black/blue version. The delivery package includes a carrying strap with a wide neck pad and a Cordura pouch with a belt loop.

Ophthalmic Products

The progressive lens **Gradal Top®** ***E*** is the result of the optimization of all processes in production – from development right up to the finished lens. As visual requirements are at their most critical in the distance zone of a progressive lens, the product enhancement procedure was focused on this area. While the intermediate zone plays a decisive role in determining the extent to which first-time wearers tolerate a progressive lens, the size of the distance and near zones is of special relevance for practical use by experienced wearers. In

Gradal Top® ***E*** progressive lens.

Gradal Top® ***E***, the ranges of vision have been improved overall, providing the wearer with even more comfortable vision.

Clarity, innovation and avant garde, without exaggerated severity, were the major design parameters specified in the development of the sunglass collection. The quest for new materials or material combinations, the integration of technical precision and a distinctive design are the outstanding features of the collection.

Models 1805 (top) and 1801 (left) of the sunglass collection.

Well Poised for the Future

Carl Zeiss ready and waiting for the euro

The European Union is by far the biggest market for Carl Zeiss. The introduction of a common currency will bring many changes, for which the company has made extensive and detailed preparations.

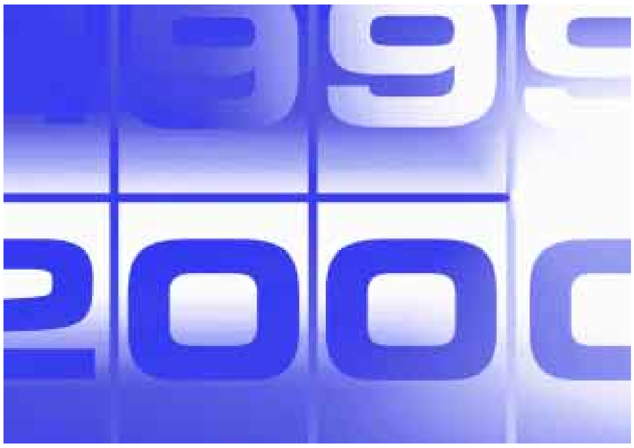
From the viewpoint of data processing, Carl Zeiss has been fully euro-capable since January 1, 1999, i.e. business transactions can be conducted in the euro if the customer so desires. The interest in the euro is particularly high in the Industrial Metrology business group, where international corporations such as DaimlerChrysler or Volkswagen are pressing for a rapid switch to the euro. In Consumer Optics, on the other hand, far fewer clients are demanding a swift switch to the euro, as most of them are retailers who transact their business in cash.

Needless to say, prize quotations and invoices in euros require euro price lists which are now available at Carl Zeiss. At the same time, the financial and accounting departments must be in a position to process documents made out in euros and to make and receive payments in the new currency. The required preparations were completed on schedule in 1998. Indeed, Carl Zeiss was one of the first industrial enterprises in Germany to use euro-capable DB-DIRECT software, a product of the Deutsche Bank for electronic payment transactions.

The euro is still being treated as a foreign currency for the purpose of accounting and data processing. For the time being, the internal unit of account is still the deutsche mark, but the euro will become the corporate currency on October 1, 2000. This is another extremely complex procedure from the IT viewpoint. As in almost all companies in Germany, payroll accounting will be switched to the euro on January 1, 2002, i.e. salaries and wages will be paid in euros when euro bills and coins are actually in everyday use.

Y2K Project: Good planning is half the battle

The turn of the millennium was a major talking point for a long time. The notorious Y2K compliance, i.e. the ability of computers to cope with the changeover to the new date without difficulty, was worrying not only private PC users. Companies whose processes and procedures are now conducted via complex computer networks had to be prepared for all eventualities. At Carl Zeiss, too, anything that could possibly cause disruption in this context was sought and removed, and not only internally but also with customers and suppliers. Firstly, it was important to ensure that the measuring and evaluation systems delivered by Carl Zeiss all guaranteed an absolutely smooth, trouble-free transition to the next millennium. To achieve this goal, our customers were closely incorporated in our numerous activities in this area.



Secondly, the many and diverse processes involved in our contacts with suppliers also had to continue to run smoothly at the turn of the year. To ensure that this was the case, Carl Zeiss wrote to all important suppliers to obtain information on their Year 2000 activities. In the case of particularly critical purchased components, the suppliers were audited by Carl Zeiss in order to guarantee that the required checks and measures had been properly and conscientiously implemented.

Finally, it was also essential that no complications or problems should be experienced in internal processes with regard to Y2K. With this in mind, a special project team at Carl Zeiss registered and assessed more than 4,000 systems with more than 14,000 components throughout the company. 100 teams worked together on projects in the six business groups and central divisions of the company. These figures impressively demonstrate the extremely complex interplay of many factors in the closely networked Zeiss world.

Although all possible sources of disruption had been carefully analyzed and the appropriate measures implemented to remedy them, the company was on special standby during the date change. For a global player like Carl Zeiss, this meant a period of 48 hours for which detailed contingency plans had been devised.

Sales at Carl Zeiss Rise to DM 3.2 billion

Uwe Braehmer

Dr. Uwe Braehmer is Vice President and General Manager in the Central Communication Division of Carl Zeiss.

In the 1998/99 fiscal year, despite the difficulties facing it in the general economic scenario, the Carl Zeiss Group successfully increased its operational business by 6 %. Sales billed before the cutoff date on September 30, 1999 totaled DM 3.2 billion. The operating result was slightly improved. However, due to changes to the law in Germany, high provisions had to be set aside for the employee pension scheme. Structural measures and other provisions also left their mark on the result.

In the 1998/99 fiscal year, growth was achieved by the **Medical Systems** business group with surgical microscopes. Global leadership in the field of traditional surgical microscopes was further expanded. An increasing level of hospital demand for state-of-the-art, computer-controlled navigation systems was evident. New diagnostic and therapy systems for ophthalmology aroused keen interest on the market. Overall, Carl Zeiss recorded sales totaling DM 670 million in business with medical systems, an increase of 11 % over last year.

Fig. 1:
The flexibility of production in the Ophthalmic Instruments Division has been substantially increased through investment in a new manufacturing line. This enabled the division to deliver over 100 additional laser slit lamps at short notice and on schedule to one of the leading manufacturers of medical lasers.

Despite a slowdown in business activity in the automotive sector, a pleasing trend was seen in the **Industrial Metrology** business group. With a 10 % boost in business to DM 475 million, this group also successfully expanded its leadership on the world market. Apart from the automotive industry where Zeiss machines are used for the highly precise measurement of car bodies, chassis and engines, the needs of additional customers in the aircraft and electronics industries were addressed by new products.

After an initial slump in the wake of the global chip crisis, the cornerstone of business at Carl Zeiss was once again **Semiconductor Technology**. Demand for microlithography systems of the modern **Starlith®** generation picked up again, leading to an overall sales volume of DM 480 million in this business group, only 4 % less than last year.

Consumer Optics has now overcome a downturn in business to increase its sales by 8 % to DM 800 million. The demand for high-quality plastic eyeglass lenses was particularly high. Business with eyeglass frames was characterized by intensive preparations for a new collection, and contact lens business by the highly competitive climate in this sector. Binoculars and riflescopes achieved a healthy level of market growth. In the Camera Lens Division, an upswing in business resulted from new products. Cooperation with Sony in this field reached a new highpoint with the delivery of the millionth lens.

Fig. 2:
Modern clean rooms were installed at Hensoldt AG in Wetzlar, a 100 % subsidiary of Carl Zeiss, for the assembly of binoculars and riflescopes. Use was made of experience gained with lenses for illumination systems in the wafer steppers used for chip fabrication. The picture shows lenses being inserted in binoculars – the last phase of assembly before final inspection.

With a 10 % increase in sales to DM 450 million, a marked upturn in business was achieved by the

Microscopy business group. Costly manufacturing and logistic processes for light microscopes and the intensive measures required for the development of microscope systems for biomedical and pharmaceutical research left their mark on the result. In the early summer of 1999, this business group launched an extensive optimization initiative focused primarily on new, innovative platform-based products and the enhancement of all processes.

In the 1998/99 fiscal year, the business group for **Opto-Electronic Systems** concentrated its activities on module and project business as well as optronics (defense and space technology). The main emphasis in Jena was placed on digital projection ("light engines"), an area which achieved healthy growth rates.

An improvement was evident in the Optronics area (ZEO) in Oberkochen despite a difficult procurement market. Overall, sales in this business group rose by 6% to DM 285 million.

After the discontinuation of weak, traditional areas of business in the past few years, Carl Zeiss aims to focus even more sharply on key fields which offer high growth potential for the future. The best opportunities are offered by four major areas: optical systems for biotechnology and medicine, measuring technology for industry, the semiconductor business and all areas of business associated with the eye.

In the next century, global economic development will be centered on the photon, no longer the electron – this is the verdict reached by the American National Research Council on behalf of the US government. With its core competencies in the key technology of optics, Carl Zeiss will be at the forefront of this development right from the outset.

Fig. 3:
Wöhlk Contactlinsen GmbH, a 100 % subsidiary of Carl Zeiss, has moved into a new building near Kiel, a town in the north of Germany. Optimized material flow, a modular infrastructure, optimization of production cycles and the introduction of new technologies are improving the efficiency of the contact lens manufacturer.

Fig. 4:
Concentration of the production of high-quality plastic lenses at the Aalen plant is an integral component of the investment programs with which the Consumer Optics business group aims to enhance its international competitiveness.

Fig. 5:
The highly exact mandrels and measuring technology from Carl Zeiss make a key contribution to the optical quality of the telescope modules for the European X-ray satellite XXM. Over the next ten years, the XMM will discover a million new celestial bodies using three telescopes from Carl Zeiss which will operate in parallel and display an overall optical surface of almost 200 m^2.

With One Million

Into the Year 2000!