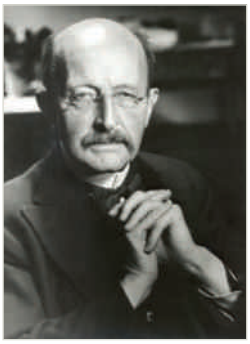
# THE MAX PLANCK APPROACH

## THE ROLE OF THE MAX PLANCK SOCIETY WITHIN THE GERMAN SCIENCE SYSTEM



Support for the German science system comes from both the state and private sectors. Private enterprise accounts for two-thirds of expenditure on research and development in Germany; the remaining third is mainly provided by the state universities, which not only offer an academic curriculum but also carry out a wide range of research activities. In addition, several other research organizations provide specific contributions to the science system. In terms of the overall structure of German science and research, based on its science-led procedures, the Max Planck Society stands for the opening up of new fields in basic research, building strongly on the individual creativity of its scientists.

» Knowledge must precede application

This stipulation, formulated by Max Planck, continues to determine the role and self-perception of the Max Planck Society. Because the Society carries out basic research in the natural sciences and the humanities as an autonomous scientific institution, it must compete at international levels for the brightest minds and the best ideas.

Whoever wishes to acquire knowledge must explore new paths. Genuine innovation is usually achieved in small, flexible groups that foster close bonds and daring approaches. These groups must also have a long-term perspective to allow the constant exploration of new methods and options until a breakthrough is made.

Interdisciplinary cooperation is an important prerequisite for the identification of these new paths. By allowing specialists, who produce outstanding work in their own fields, to cooperate in a spirit of understanding and openness towards other disciplines without having to compete for resources, it is possible to generate new, dynamic scientific ideas with enormous potential. This is the kind of interdisciplinary cooperation that takes place in the Max Planck institutes.

A science system requires wide coverage as well as excellence. A country like Germany, which depends heavily on technological innovation and endeavours to gear its social system towards the well-being of its citizens by adopting modern approaches, requires a broad base of specialists with a scientific background. However, to genuinely take the lead in international competition for knowledge and innovation, Germany also requires a sufficient number of outstanding researchers from the select group of global pioneers in the different fields of scientific knowledge.

### THE HARNACK PRINCIPLE

The fundamental principle of the Max Planck Society is to allow outstandingly creative scientists, who think in interdisciplinary terms, scope for independent scientific development. The Harnack principle takes its name from the first President of the Kaiser Wilhelm Society, which was the Max Planck Society's predecessor organization. It represents a traditional policy of appointing the brightest minds as Scientific Members of the Max Planck Society, and building whole departments around these exceptional individuals when they become departmental directors. Yet the Harnack principle is concerned with more than just the central role of these researchers. It can also be seen as a complex of guiding principles for the overall organization of research, with the aim of making new scientific perspectives effective in the long term.

The necessary freedom to achieve this aim is afforded by the Society's exceptional organizational structure. The Scientific Member alone decides on his or her research objectives and methods. Such conditions, combined with rigorous selection of candidates for appointment, have made the Max Planck Society one of the most attractive destinations in Germany for leading international scientists.

Once appointed, the heads of department or Max Planck Research Groups do not follow a curriculum or research programme determined by the organization or by market requirements. Instead, they rely on their own intuition, which allows them as researchers to transform and advance the cause of science. The critical factor in the distribution of resources within the Max Planck Society is not an institute's overall performance — such as the provision of particular courses or mastery of organizational tasks — but the intellectual achievements of individuals and their teams, for example by making new discoveries or advancing knowledge to change the course of science. The Max Planck Society and its scientists see themselves as pioneers. This requires establishment of a 'community of

above | Sculpture of the head of Minerva, the goddess of wisdom, outside the headquarters of the Max Planck Society.

left | Max Planck (1858-1947), founder of quantum theory, and former President of the Kaiser Wilhelm Society.

trust', the basic units of which are the institutes.

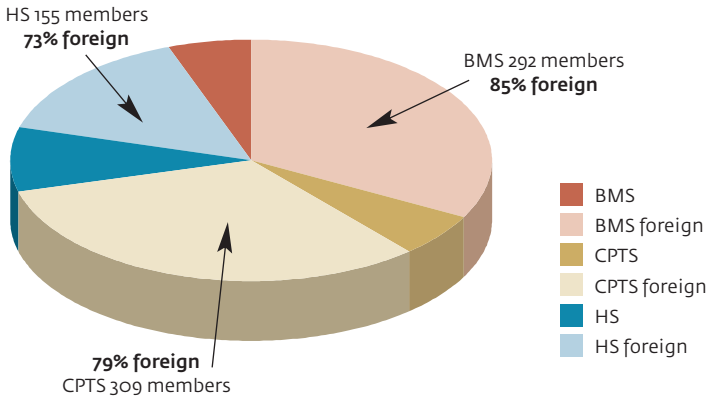
Genuine innovation can also be achieved through the adoption of a long-term approach to work. At the Max Planck Society, success is rarely measured over short periods of time. The adoption of such a far-sighted approach is the only way to meet the challenge of exploring the unknown, which is always essential if important breakthroughs are to be made. Crucial scientific landmarks are often achieved by embarking on unknown paths.

## High trust: a leap of faith

Appointments, made in accordance with the Harnack principle, involve the provision of funding based on a profound leap of faith. Therefore, the Max Planck Society's finance model for Scientific Members is often referred to as being based on a high-trust principle. This contrasts with the low-trust principle, whereby funding is allocated purely on a project or programme basis, which has increasingly been used in the German science system over the past few years. At a Max Planck institute, when a scientist is appointed as director, he or she is provided with resources until his or her retirement as a Scientific Member. Depending on the age at which such an appointment is made, this allows for between 20 and 30 years of independent research — an appropriate period of time for the development of the new scientific ideas required to achieve breakthroughs.

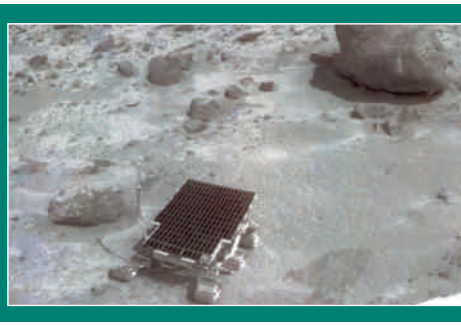
Comprehensive quality assurance is an essential element of the high-trust principle practised by the Max Planck Society. This is why the Society established an effective system of Scientific Advisory Boards (Fig. 1). Every two years, a researcher's work is subject to critical assessment from internationally outstanding and independent colleagues within the relevant specialist discipline. The members of these Scientific Advisory Boards are both assessors and advisors to the researcher being evaluated. The deliberations of the Scientific Advisory Boards also influence the distribution of funds by the Max Planck Society: if the evaluation establishes that a department or institute has a particularly outstanding or notably weak research performance, this will have an impact on the research resources provided to the Scientific Members concerned and their personal earnings. Every six years, there is an extended evaluation of thematically-related institutes, which are grouped into a Max Planck Society research field. Comparative evaluation within the field is important, as is comparison with international developments in the field and the benchmarking of the evaluation procedure.

**Fig. 1** | Numbers of Scientific Advisory Board members and proportion of foreign members.




There are around 756 highly qualified Max Planck Institute Scientific Advisory Board members in total: between 5 and 15 per Max Planck Institute, depending on size and subject.
BMS, Biology and Medicine Section; CPTS, Chemistry, Physics and Technology Section; HS, Humanities Section.

"The Harnack principle represents the traditional policy of appointing the brightest minds as Scientific Members of the Max Planck Society. It also stands for a complex of guiding principles for the overall organization of research, with the aim of making new scientific perspectives effective in the long term."



**Box 1** | Examples of Max Planck Society research partnerships

- **EnerChem**: This project involves the Max Planck Institute of Colloids and Interfaces, the Max Planck Institute for Solid State Research, the Max Planck Institute for Polymer Research, the Max Planck Institute of Coal Research and the Fritz Haber Institute of the Max Planck Society. It focuses on the central issues concerning global energy supply in the twenty-first century. By adopting a knowledge-based approach, it aims to develop new carbons as catalysts and electrodes for various storage applications for chemical and electrical energy.
- **MaxNetAging**: This research network, involving more than 12 Max Planck institutes and various leading national and international partners, examines the causes, patterns, processes and consequences of ageing.
- **Earth System Research Partnership**: This partnership involves the Max Planck Institute for Chemistry, the Max Planck Institute for Meteorology and the Max Planck Institute for Biogeochemistry. It is engaged in the comprehensive analysis of the processes that contribute to climate change, including global warming.

## INTERNAL STRUCTURES AND PROCESSES: FORM FOLLOWS FUNCTION

An important factor in the success of the Max Planck Society is the commitment of Scientific Members to think beyond their own departments in the interest of the Society as a whole. This commitment is exemplified by the regular meetings of the three Sections (Biology and Medicine; Chemistry, Physics and Technology; and the Humanities). The Sections include all Scientific Members and representatives of the other scientific staff members for each of the scientific fields. At these meetings, the Sections discuss the future scientific development of the Max Planck Society and establish the basis for key decisions.

A natural starting point for the reorientation of institutes arises when Scientific Members retire. At such times, suitable new topics are integrated into the portfolio of the institutes through the careful development of existing topics, and ways of launching new areas are established. The approach adopted varies depending on the situation.

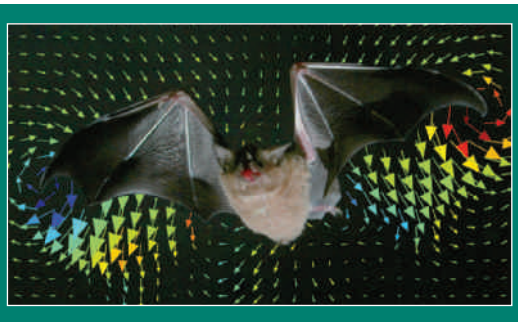
If only one director leaves, an institute is requested to identify an outstanding researcher who best matches the institute's overall profile and who can offer the greatest potential for innovation. As part of this process, the institute consults with the Perspectives Commission of the relevant Section. An appointment committee, comprising high-ranking internal and external individuals established by the Section, examines the proposal and independently looks for suitable candidates. Following evaluation by a large number of renowned international experts, the final scientific assessment is carried out by the Section members. A core element of the Max Planck Society's culture is to expand the organization's common scientific basis by recruiting highly creative minds, and to improve the society's overall performance continuously through the appointment of outstanding colleagues.

If several Scientific Members leave an institute, or if it is deemed appropriate by the President or the Sections for other reasons, consultation on the subsequent procedure takes place at a higher level. A Core Committee or Presidential Committee consults on development options, suitable fields and possible candidates. An extensive range of instruments, such as search symposia and the drawing up of competing strategic proposals is available for this task. The Max Planck Society also attaches great importance to external expertise in these processes.

Although research fields are sometimes first identified during the appointment procedure, this does not conflict with the concept of appointments based on the Harnack principle; the main focus always remains the person to be appointed. If the best possible person cannot be attracted in a particular field, a new research topic is selected. Excellence is not compromised. The Max Planck Society sometimes identifies outstanding researchers before establishing the Max Planck institute that would provide the most beneficial working opportunities for them.

When a suitable candidate is identified, the decision to appoint him or her is made by the Senate of the Max Planck Society. This body is made up of outstanding figures from the fields of science, industry and politics, and further social groups. As with other important decisions, such as the founding of new institutes, the Max Planck Society also avails itself of independent assessments by external experts in this instance.

The President formulates the basic aspects of the Society's science policy and is supported by the Perspectives Council, which represents a permanent


above, left to right

Pathfinder mission 1997: Exploring Mars with cutting-edge technology provided by a Max Planck institute.

Bat aerodynamics: Modelling the movements and forces exerted by a bat in flight.

Literature research: The entire holdings of this Max Planck research library are organized according to the principles of an open-access system.

Presidential Committee, and the Senate Committee for Research Planning (a sub-committee of the Senate).

To shape the future development of the Max Planck Society, the President can also implement structural measures and promote activities using the Strategic Innovation Fund. This is the case, for example, with setting up new cross-institutional research initiatives, appointing Max Planck Fellows, establishing international Max Planck Centers, and financing cooperation projects between Max Planck institutes and Fraunhofer institutes. Innovative individual projects, additional so-called free floating Max Planck Research Groups, Partner Groups abroad and the Minerva women's programme also receive support from this Fund.

## BASIC RESEARCH FOR SOCIETY

Basic research is the most important way of finding genuinely innovative solutions to significant problems, which in various fields increasingly requires the pooling of expertise. Max Planck institutes form partnerships with each other and with external partners (Box 1). These partnerships also involve co-operation with industry and provide comprehensive consultation services to politicians on issues of major national significance.

### Unity of research and education

Research and the education of junior scientists go hand-in-hand at the Max Planck Society. Scientists from the institutes lecture at universities and supervise junior scientists in the final stage of their academic education: the doctoral thesis. If directors are not members of staff at a university, they work closely with them. For instance, in 2008, scientists from the Max Planck institutes provided more than 4,000 semester hours of lectures and supervised more than 4,500 doctoral students.

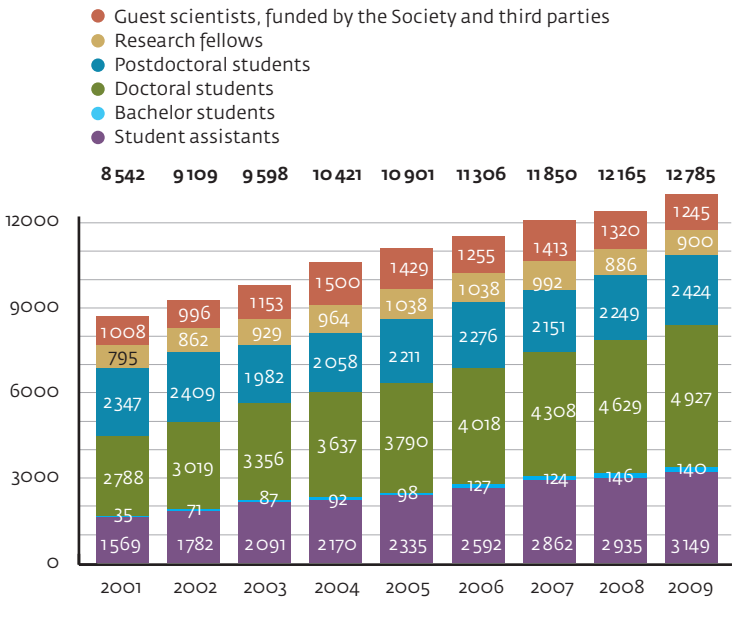
### Support of junior scientists

The Max Planck Society has consistently increased the number of junior research scientists working within the organization in recent years (Fig. 2). On the completion of their qualifications at a Max Planck institute, many of these scientists are available to German society as highly qualified specialists. Of a total of 69 former heads of independent Max Planck Research Groups, 56 now hold associate or full professorships (81%). Among the 255 former senior research scientists who have left the Max Planck Society since 2000, 107 now hold an associate or full professorship (42%).

There has been a significant rise in the number of doctoral students over the past ten years. Whereas the number of doctoral students from Germany increased by one-quarter, the number of foreign doctoral students almost quadrupled. The Max Planck Society thereby not only attracts excellent young scientists to its own institutes, but, within the framework of the International Max Planck Research Schools (IMPRS), the Max Planck institutes also cooperate on doctoral education with many German universities, at which one-third of the participants work. The IMPRS, in particular, attract talented junior scientists from all over the world. More than one-half of their participants are of foreign nationality.

**Fig. 2 | Numbers of junior researchers and guest scientists.**

The numbers of student assistants, holders of a bachelor's degree at an International Max Planck Research School, doctoral students, postdoctoral students, research fellows and guest scientists since 2001 are shown.




Pathfinder: JPL/NASA; Bat: L.C. Johansson/M. Wolf/A. Hedenström; Library: Kunsthistorisches Institut in Florence – MPI

"As a renowned basic research institution, the Max Planck Society enhances the German science system through its capacity for innovation, outstanding performance and high profile. Granting scope for independent scientific development, it is one of the most attractive destinations in Germany for leading international scientists."

**Box 2** | **Examples of successful technology transfer**

• For more than 40 years, the low-pressure synthesis of polyethylene has been enabled by an organometallic catalyst from the Max Planck Institute of Coal Research in Mülheim/Ruhr. More than 30 million tonnes of polyethylene are produced each year, making it one of the most important industrial plastics.

• Magnetic resonance imaging scanners used in clinical examinations throughout the world use the FLASH process developed by the Max Planck Institute for Biophysical Chemistry in Göttingen more than 20 years ago. This is the only way in which scans can be carried out on a timescale that can be tolerated by patients.

• The cancer drug SUTENT (sunitinib malate), which was developed more than ten years ago at the Max Planck Institute of Biochemistry, introduced a new active principle to the modern treatment of tumours. A medicine based on this technology was licensed in 2006 and could break through the US$1 billion sales barrier for blockbuster drugs in 2010.

• The first successful use of small double-stranded RNA molecules in mammals (so-called RNA interference) in 2001 at the Max Planck Institute for Biophysical Chemistry in Göttingen paved the way for a completely new approach to the treatment of many diseases. Great medical hopes and economic expectations worldwide are pinned on this technology.

### Networking

The close networking between universities and the Max Planck institutes generates significant benefits in all locations. This is clearly evidenced, for example, by the Excellence Initiative of the German federal government and the governments of the federal states: applications for this initiative that were jointly submitted by a university and a Max Planck institute had a success rate that was approximately twice as high as that for applications that did not involve the Max Planck Society.

Basic research and application can no longer be separated. Therefore, scientists from the Fraunhofer-Gesellschaft and the Max Planck Society cooperate closely on various research topics. Knowledge recently acquired from basic research is developed into ready-for-market technology, which raises new scientific questions in turn, and provides innovative equipment and methods for basic research. Examples include:

- NanoSTRESS project, for the development of measurement procedures and simulation techniques for thin films, nanostructures and innovative devices,
- KORONA, for the development of a coherent X-ray source for the generation and analysis of nanostructures, and
- BIOSOL, for the molecular analysis and sustainable exploitation of the genetic diversity of *Solanum tuberosum* (potato).

### Technology transfer

The Max Planck Society along with its subsidiary Max Planck Innovation has been operating one of the most successful technology-transfer centres in Europe for decades. For the past few years, this centre has generated around 15 million in transfer revenues each year — a mere fraction of the economic and societal added-value created by the research results of the Max Planck Society (Box 2).

### International outlook

The quest for scientific insight is a globally-oriented process, and knowledge is a transnational continuum. A large proportion of the scientists at the Max Planck institutes come from abroad: 30% of directors and 50% of doctoral students are of foreign nationality, 2,500 cooperation projects exist between the Max Planck institutes and foreign organizations, and 6,000 guest scientists at the Max Planck institutes are from a foreign country.

The shift in the global balance of power has also had an impact on science. Today, more than 90% of global knowledge comes from outside of Germany. German research must, therefore, engage intensively in the science 'hot spots' abroad and prove its capacity for performance there.

In view of this situation, the Max Planck Society also maintains a significant presence abroad through its research and cooperation projects, for example, through Partner Groups headed by young scientists previously employed at Max Planck

institutes, Max Planck Research Groups and participation in major international projects (Box 3). In Europe, there are Max Planck institutes that are based traditionally abroad: two in Italy and one in the Netherlands. The new Max Planck institute in Florida, and the recently-established Partner Institutes in Shanghai and Buenos Aires, which are operated as cooperation projects with local scientific organizations, should also be mentioned in this context. The Society's international presence is being further enhanced through the establishment of international Max Planck Centers — scientific platforms with a lifespan limited to a maximum of ten years, in which the Max Planck institutes involved and their international partners pool their expertise. A Center of this kind was recently established in India. However, the Max Planck Society's international outlook is not an end in itself. Additional scientific benefits are seen as prerequisites and benchmarks in all international activities.


above | With 77 Max Planck institutes in Germany and 4 abroad, the Max Planck Society counts on flexible medium-sized research entities united in international partnership.

## SPREAD OUT BUT WITH A GLOBAL PROFILE

Through the geographical distribution of its institutes, the Max Planck Society makes a significant contribution to the establishment of equal living conditions in the different regions of Germany. It can always avail itself of favourable location factors, and outstanding scientists are attracted to these locations thanks to the reputation and organizational principles of its institutes. The research topics of the Max Planck institutes are often taken up and complemented by local universities. A radical split between research-intensive and research-deprived regions, which has led, in part, to significant economic imbalances in the United States, has been avoided in Germany up to now. The Max Planck Society has made a major contribution in this respect.

Despite the fact that its institutes are distributed across various locations (see map), the Max Planck Society is still perceived internationally as a single entity. As a renowned basic research institution, it enhances the German science system through its capacity for innovation, outstanding performance and high profile.

**Box 3** | Examples of international cooperation projects

- **Common LAnguage Resources and technology INitiative (CLARIN):** Max Planck Institute for Psycholinguistics and 33 partners in 32 countries. This is a cooperation project that combines linguistics technologies for research in the human sciences.
- **Extreme Light Intensity short pulse laser (ELI):** Max Planck Institute of Quantum Optics and 36 institutions in 13 countries. The aim is to develop a new kind of laser, the intensity of which outperforms current lasers by a factor of one million.
- **INtegrated STRUCTural biology infrastructure (INSTRUCT):** Max Planck Institute of Biochemistry and 11 partners in 5 European countries. The aim is to combine structural biological information to form a dynamic picture of cellular processes.
- **Atacama Large Millimeter/submillimeter Array (ALMA):** Max Planck Institute for Radio Astronomy and partners from Europe, Eastern Asia and North America in cooperation with the Republic of Chile. The instrument under development comprises 66 antennae for radio-astronomical investigations into the origins of the Universe.