

Exploratory Round Table Conferences: In Search of Emerging New Sciences

TEXT GERHARD WEGNER and HANS-WOLFGANG SPIESS



CHINESE ACADEMY OF SCIENCES

MAX-PLANCK-GESellschaft

SHANGHAI INSTITUTE FOR ADVANCED STUDIES

EXPLORATORY ROUND TABLE CONFERENCES

Science, the never-ending frontier, is a major driving force for innovation in society. Unexpected discoveries in a particular area point to novel streams of innovation in other fields; new insights gained by theory shine light onto many so far untouched challenges. New methods and technologies in research trigger innovations in fields that were believed to be disparate for long.

At the same time society expects science to solve important problems in the further development by health care and medicine, pave the road to sustainable technologies and industries that will increase the public wealth and thereby contribute to the well-being of the whole so-

ciety. That is why we speak about a science-and-technology based society.

Organizations like the Chinese Academy of Sciences (CAS) and Max Planck Society (MPG) are endowed to foster this process of ever continuing evolution of science at the highest level of expertise and proficiency. They are supposed to give room to the most brilliant minds to let them participate in the worldwide competition for the best science and most efficient way in which science can produce its fruits.

The very wide scope of modern science and the complexity of the approaches taken by its various disciplines require that organizations like CAS and MPG entertain antenna functions, that is to devel-

op means by which novel ideas and new exceptional challenges are recognized early-on, preferably in their state of emergence. Combined with a rigorous scientific evaluation of these developments the organizations will decide whether these emerging fields need attention beyond the usual. It does not make sense to restrict such attention to the borders of nations but rather search for world-wide activities, since science is by its very nature not bound to individual languages, customs or political settings; important new developments emerge and spread unforeseen but need to be recognized early on by those who carry responsibility for implementing the best science within their organizations.



Following a proposal made by Prof. Gerhard Wegner, the Exploratory Round Table Conferences (ERTC) were established in Shanghai at the Shanghai Institute for Advanced Studies (SIAS) under the auspices of the Shanghai Branch of CAS. A preparatory meeting for the first conference, the ERTC on Synthetic Biology in 2010 heralded its launching. The two ERTC mentors, Prof. Gerhard Wegner and Prof. SHEN Wenqing are seen at the center of front row.

ALLIANCE OF CAS AND MPG IN SEARCH OF STRATEGIES

Based on these lines of thought and in consequence of the privileged partnership between CAS and MPG the presidents of the two organizations decided in 2009 to jointly develop an instrument by which the potential of not yet fully established or newly emerging research areas could be evaluated in a transparent scientific process. The intention was to jointly develop a tool which assists in the setting of priorities in the respective organizations and – wherever possible – to foster mutual interactions between the scientists of the two organizations.

In fact, already several years earlier, Prof. Uli Schwarz of the MPG had – supported by CAS – created the Shanghai Institute for Advanced Studies (SIAS) as a platform to entertain the dialogue among scientists with international background and discuss strategies in research. The untimely death of Prof. Schwarz interrupted this activity. Therefore, it was decided to make use of the existence of SIAS but focus its purpose to the new goals.

Following a proposal made by Prof. Gerhard Wegner the Exploratory Round Table Discussions (ERTC) were established in Shanghai under the auspices of the Shanghai Branch of CAS. An ERTC is held annually since 2010 in the premises of SIAS.

ERTC are meant to offer a platform for scientists of both MPG and CAS to exchange ideas and reflect on the opportunities of newly emerging research areas together with the respective international key players at an early stage of evolving areas. The main objective of the project is to act as a seed towards establishing new topics as part of a priority setting process at the leading edge of science in the supporting organizations CAS and MPG. The reports of the ERTCs in terms of *Action Recommendations* are to be widely distributed among both science policy makers as well as the scientific community at large.

THE SETTING OF ERTCS

The responsibility to realize ERTCs as a working entity was laid in the hands of the two Chairs, Prof. SHEN Wenqing

(CAS Member and Vice President of the National Natural Science Foundation of China, Shanghai Institute of Applied Physics, CAS) and Prof. Gerhard Wegner (former Vice President of MPG and former Director of Max-Planck-Institute for Polymer Research, Mainz). In addition, Prof. ZHU Zhiyuan (Shanghai Institute of Applied Physics, CAS) served as a Co-Chair. In 2014 Prof. Hans-Wolfgang Spiess took over from Prof. Wegner as Chair.

The Chairs suggest the potential theme of each conference based on the input they receive from the scientific community. They create a priority list which is approved jointly by the president of CAS and MPG. Once agreement on the theme is reached, the chairs nominate a steering committee, which is composed of equal numbers of leading scientists of both MPG and CAS. The steering committee has not less than 4 and not more than 8 members. The steering committee which is newly formed for each ERTC deliberates the actual topics to be discussed in the conference and decides on the invitation of the participants. The total number of participants including members of the steering committee is supposed not to exceed 50. In order to facilitate the work of the members of the steering committee they are supported by Fellows; these are – as a rule – younger scientists who assist in collecting background literature and information, taking notes in the actual sessions of the ERTC and assisting in editing the *Action Recommendations*. They are also encouraged to assist in the editing of review papers, which may emerge in consequence of specific ERTCs.

ERTCs differ from usual research conferences in that the participants are **not** meant to give full accounts of their most recent and most important results with all details but rather express their ideas for future research and trends in the field based on very short statements on the state-of-the-art in their fields. This needs a careful selection of the participants by the steering committee combined with proper briefing of all partici-



The two founding fathers of the Shanghai Institute for Advanced Studies (SIAS), CAS, Profs. Uli Schwarz (right) and RAO Yi (left) pose with the SIAS LOGO at the opening celebration in Feb. 2002. Building on this platform for dialogue among scientists with international background and discussions of strategies in research, the Exploratory Round Table Discussions (ERTC) was built later following Prof. Gerhard Wegner's proposal to focus on new goals.

pants. Meetings of the steering committee before each conference and thorough discussion of the specific topics and their representation is, therefore, an integral component to reach the goals. The assistance of the fellows in this process has turned to be of outmost importance.

Each ERTC produces an *Action Recommendation*, which is formulated and edited by all participants jointly based on outlines given by the members of the Steering Committee.

The duration of each ERTC is limited to a total of 3 days of intensive work.

TOPICS AND RESULTS

Four ERTCs have been held since 2010 and a fifth will be held in May of 2014. The following is a short outline of the topics and results:

Synthetic biology (Oct. 2010)

The field covers a broad spectrum from minimal life to artificial photosynthesis; it applies to systems as well as processes that do not exist in nature as such. This serves as a common denominator in this highly interdisciplinary and

evolving field. Frequently synthetic biology is characterized as bringing engineering to biology. A key question of the conference was whether principles of engineering and its methods are apt to describe, handle and modify complex biological systems.

The discussions covered the following sections: Methodology of Synthetic Biology, Chemical Synthetic Biology, Synthetic Cells and Genomes, Synthetic Circuits and Communities. Reducing complexity in a top-down approach starting from single living cells was discussed as well as the bottom-up approach, that is generating systems from scratch and thereby make use of non-natural components with increasing functionality and complexity.

The *Action Recommendations* suggested strongly that increased attention should be given by both CAS and MPG, and in particular co-operation between engineers and life scientists was emphasized. In the mean time a substantial effort named "Max-Syn-Bio" came into operation on the side of MPG, which built its strategy on the outcome of this ERTC.

Quantum information science (Nov. 2011)

Quantum information science (QIS) is one of the most rapidly growing research fields with the potential to shape the technology of the 21st century. It is interdisciplinary in character, bringing together experimentalists and theorists from different scientific areas such as physics, mathematics, chemistry, computer and material sciences. It investigates fundamental issues of quantum physics like non-locality and aims to develop genuine quantum mechanical devices such as quantum computers, quantum networks and quantum simulators. Furthermore, it has impact on other fields of science and technology, for example through the development of devices such as enhanced nano-sensors or atomic clocks.

The actual discussion focused on the topics (1) quantum computation, (2) quantum communication and quantum networks, and (3) quantum simulation. Aspects of materials development and methodology improvement were also deliberated in this context.

The *Action Recommendations* are built on the fact that members of CAS and MPG have been active players in this emerging field and have made pioneering contributions to its rapid progress in the past decade. Building on this momentum, scientists at the two organizations expect to jointly strengthen their activities. There is need to establish umbrella platforms for networking among the local intra-institutional expertise, furthermore to intensify exchanges and links with other internationally leading institutions. In particular, CAS and MPG scientists pledge for stronger collaborations between the Chinese and German communities.

These can be built upon the existing agreement between MPG and CAS. In future, scientists from the two institutions envisage carrying out groundbreaking joint research projects with dedicated funding. One promising frame for such efforts is the recent quantum key distribution test bed in China. Other opportunities for future collaborations are pro-



In 2014 Prof. Hans-Wolfgang Spiess took over from Prof. Wegner as Chair.

vided by the unique range of quantum simulation and network hardware developed at the Max Planck Institutes of Quantum Optics (MPQ) and for the Science of Light (MPL). The participants of the ERTC are convinced that intensified activities and exchange between China and Germany will be crucial in ensuring their leading role in the vibrant and strategic field of quantum information science.

Space-based research (Nov. 2012)

This ERTC received importance as well as international attention because of most recent developments in China. In January of 2011 CAS had approved the implementation of the Strategic Pioneer Program (SPP) on Space Science and it signaled the official kick-off of this program based on scientific space missions with focus on black-hole-properties, physical laws under extreme conditions, the nature of dark matter, life-science in microgravity, solar influence on the earth-space-weather and long-range interferometry and other experiments. CAS had indicated that its Space-Science Program would be open to the whole science community for collaboration. This should include mission-to-mission collaborations, payload piggy backing with for-

eign partners, ground support and data sharing.

These strategies meant that CAS had become a major new player in the worldwide aspirations to explore our solar system, the universe and exploit the opportunities of space-based experimental platforms. Having this in mind, the ERTC concentrated on the following topics: (1) solar system exploration, (2) space-based astronomy, (3) earth observation and (4) microgravity experiments and life science.

The Steering Committee had succeeded to bring together leading scientists that are responsible for strategic planning in their respective organizations for an open and unbiased discussion on middle- and long-term strategic planning of space missions. Among others, the names of Prof. WU Ji (Natl. Space Science Center, CAS), David J. Stevenson (Caltech and NASA), Saku Tsuneta (NADL, Japan), Kiopal Nandra (MPIE, Garching, Germany), Alvaro Gimenez-Canete (European Space Agency, Paris, EU) need to be mentioned.

The discussions as well as the *Action Recommendations* clearly identified the important new opportunities for new explorations and space-based experiments that are now provided by the recent stra-

tegic developments in China under the guidance of CAS. It is foreseen that expertise available at various institutes of MPG in designing and constructing instrumentation for space based missions will be shared with partners of CAS in the context of scientific exploration of the solar system and the universe. Moreover, there is great interest in developing the tools for earth-observation toward unraveling problems in ecology (e.g. animal migration), ecology (water resources and cycles) and climatology. The existing framework of CAS-MPG collaboration offers suitable means for dedicated co-operations.

Electrochemistry revisited: Status and perspectives (Nov. 2013)

Electrochemistry addresses the interplay of chemical and electrical processes and is hence concerned with mutual conversion of electrical and chemical energy and information. In the topography of scientific disciplines, it is a pronouncedly interdisciplinary field, highly relevant for all branches of natural sciences. It is of great unifying potential as it involves the simultaneous presence of electronic and ionic charge carriers and their interactions. Nonetheless, electrochemistry is extraordinarily underestimated these days although the present discussion about energy conversion and storage emphasizes the importance of electrochemistry in terms of batteries, fuel cells and electrolyzers, but may reduce the significance of the field to this admittedly crucial aspect. One needs to mention that it is electrochemistry as well that enables humans to feel, think and act. In other words, electrochemistry is basic to life science as well.

Thus it appeared to be the right time to "revisit electrochemistry" and concentrate on the following issues: (1) solid-state electrochemistry, (2) bioelectrochemistry, (3) photoelectrochemistry and (4) computational electrochemistry. The ERTC gave critical appraisals with emphasis on developing a broad scope rather than looking at a particular electrochemical system such as the ones used in energy storage devices (batteries).

2nd Exploratory Round Table Conference Quantum Information Science
November 2nd ~ 4th, 2011, Shanghai



The ERTC held in November 2011 focused on quantum information science, one of the most rapidly growing research fields with the potential to shape the technology of the 21st century.

The discussion revealed that electrochemistry is intrinsically a cross-sectional discipline, providing basic knowledge in all fields of science. In both CAS and MPG there are no dedicated institutes. In line with its interdisciplinary nature, research is performed throughout the research structure of these organizations. It became clear that further progress of the field involves a strong need for fundamental research, which is widely under-represented at the moment.

The *Action Recommendations* once more indicated that considerable synergies are expected to arise from a better communication between the various sub-fields (examples: defect chemistry for photogalvanic elements, light gated bioelectrochemical structure elements, bioelectrochemical mimetics, computational exploration of mechanistic and materials world). This does not only require identification of model materials

and the advancement of novel methods (in particular in-situ techniques). It is moreover strictly necessary to recognize the underlying basic features, *e.g.* charge carrier chemistry. Furthermore there is a fundamental need for development of novel *in situ/in operando* analysis techniques with strong links to computer modelling and high sensitivity, high specificity and high spatial and time resolution as main drivers for further research.

Synchrotron-based methods obviously form a basis for these techniques, and interdisciplinary collaboration is strongly required for development of such methods.

Cooperation between expert groups of CAS and MPG would be most beneficial to move the field ahead. Therefore, dedicated prolongation of the CAS/MPG program to finance research stays in both directions was strongly recommended on

the basis of jointly developed electrochemical projects. Allocation of funding for 60 man-month of research stays per year was deemed to be appropriate. Similarly, three to five positions in the joint Ph.D. Program of CAS/MPG should be allocated to fundamental research in electrochemistry.

Personalized medicine: From risk factors to disease predisposition (to be held May 2014)

This ERTC will be held in the context of the celebrations of 40 years of cooperation between CAS and MPG in Shanghai, from May 14 to 17, 2014.

The last decades have seen major progress in our knowledge how genetic mutations and polymorphisms affect development of diseases although genetic factors that predispose for common health problems such as diabetes, heart disease, asthma and mental disorders are still only partially understood.

Relatively little attention was paid to the lasting impact of gene-environment interactions on individual health threats. Environmental factors seem to render human patients responsive to disease-causing scenarios that occur only later during live or initiate processes eventually leading to destabilization of regulatory circuits. Only very little is known about propagation of such disease-relevant information, which might be stored in epigenetic memory of cells, in unstable metabolic circuits, in synaptic connections of nerve cells or in morphological changes.

The symposium will discuss emerging concepts how disease-relevant information is propagated in individuals and address strategies how to erase conditions that predispose to chronic or life-threatening disorders. ◀